Ecological Economics and Social-Ecological Movements

Sciencie, policy and challenges to global processes in a troubled world

David Barkin
Graciela Carrillo
Coordinadores

Casa abierta al tiempo

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Ecological Economics and Social-Ecological Movements. Science, policy and challenges to global processes in a troubled world

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David Barkin Rappaport
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UNIVERSIDAD AUTÓNOMA METROPOLITANA
UNIDAD XOCHIMILCO División de Ciencias Sociales y Humanidades

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Introducción

La economía ecológica y los movimientos sociales. Ciencia, política y cambio en los procesos globales en un mundo turbulento

David Barkin Rappaport
Graciela Carrillo González

Desde que la Sociedad Internacional de Economía Ecológica (ISEE, por sus siglas en inglés) fue fundada, hace más de un cuarto de siglo, la comunidad internacional ha generado una cantidad sustancial de leyes y acuerdos que reconocen nuestra responsabilidad colectiva frente a la grave amenaza para la conservación del ambiente, la preservación de los recursos naturales, la estabilidad social y la identidad cultural de los pueblos. Nuestra Sociedad está comprometida con la identificación y comprensión de los obstáculos subyacentes a la implementación de políticas efectivas que aborden las limitaciones de instituciones existentes, así como con la búsqueda de nuevos enfoques que permitan superar la creciente crisis socio-ambiental.

La falta de flexibilidad de las instituciones existentes en la mayoría de los países, así como la captura por intereses arraigados de muchas organizaciones internacionales, que promueven nociones no críticas de modernización ecológica como "el desarrollo sustentable" o "la economía circular", siguen generando obstáculos complejos para aquellos que se encuentran en busca de soluciones a problemas claramente identificados; como consecuencia, el conflicto social y político se está intensificando en todo el mundo. Al mismo tiempo, descubrimos que pueblos alrededor del mundo están adoptando maneras alternativas para organizarse, forjando nuevos modelos de "buen vivir", a menudo escogiendo vivir al margen de sus sociedades en lugar de abrirse a la explotación ambiental y económica, y al colonialismo interno y externo. Los economistas ecológicos descubren que estos pueblos tienen mucho que enseñarnos sobre posibles rutas alternativas para abordar los desafíos. En la terminología de Karl Polanyi, estos pueblos se niegan a ser incorporados al "sistema general de mercado". México es uno de los países donde dichos experimentos sociales son influyentes y extendidos.

El modelo capitalista con una gran capacidad de recomposición ante diversas crisis y amenazas de crisis a lo largo de su historia, se consolidó con el esquema de la globalización y bajo esta perspectiva se potencializaron las posibilidades de expansión para los agentes económicos, principalmente del primer mundo, generando en el proceso profundos impactos ambientales que se concentraron en los países emergentes y del tercer mundo. Esta es la dinámica que dio origen a la Escuela Estructuralista Latinoamericana a mediados del siglo XX con sus diversas teorías de la dependencia (e.g.Cardoso y Faletto, 1978) .

En las últimas décadas del siglo XX se hizo evidente que el modelo capitalista no solo generó una crisis económica que se manifestaba en la gran inequidad y concentración de la riqueza, sino que también modificó nocivamente el stock de los recursos naturales y el clima del planeta. Esta situación fue severamente cuestionada por diversos sectores sociales, a partir de los años setenta, cuando la cantidad de estudios, desde distintas disciplinas, proliferaron en universidades, centros de investigación y foros nacionales e internacionales. El tema se incorporó por primera vez y con gran relevancia dentro de la agenda internacional, en el año 1972 con la convocatoria de la Conferencia de Naciones Unidas sobre el Medio Ambiente Humano en Estocolmo, Suecia. Esta preocupación se elevó a nivel de alarma entre amplios grupos sociales quienes impulsaron un debate internacional en el mismo año con la publicación de reporte del Club de Roma, *Los Límites del Crecimiento* (Meadows, *et al.,* 1972).

Durante los siguientes años la inquietud sobre los problemas ambientales se hizo manifiesta en todos los ámbitos, tanto a nivel local como nacional y planetario, dando lugar a la construcción de esquemas teóricos que provenían tanto de las ciencias naturales como de las ciencias sociales. De este modo, el estudio del medio ambiente se conformó como un tema de carácter transdisciplinario que difícilmente se puede abordar desde un solo campo del conocimiento.

Entre los economistas, se definieron dos marcos de análisis e interpretación de los temas ambientales. Uno de ellos, a partir de las aportaciones de la teoría neoclásica, la denominada economía ambiental se fundó en ésta primera época. La otra escuela se institucionalizó a finales de los años ochenta con la creación de la Sociedad Internacional de Economía Ecológica (ISEE). Esta corriente cuenta como una de sus bases teóricas fundacionales el trabajo de Nicolás Georgescu-Rögen que se formalizó en 1971, con la publicación de su libro, La Ley de la Entropía y El Proceso Económico. Desde sus principios este campo se caracteriza por un cuerpo teórico ecléctico que sumó elementos de la economía ortodoxa con aportaciones de las ciencias naturales y posteriormente de la ecología política.

Desde la economía ambiental aparecen tempranamente, entre los años veinte y treinta, trabajos con intereses muy específicos en cuanto a los efectos de la contaminación y el manejo adecuado de los recursos naturales (Pigou 1920,1932 y Hotelling, 1931). Posteriormente, R. Coase (1960) reconsidera el problema ambiental y desarrolla una construcción conceptual que percibe al sistema natural como parte del sistema económico por tanto, propone darle un tratamiento de carácter crematístico a los aspectos relacionado con el uso de los recursos naturales utilizando los instrumentos de la economía neoclásica.

A partir de los años setenta otros economistas ofrecen planteamientos más consistentes, exigiendo a sus colegas enfrentar la profunda contradicción entre la dinámica de la sociedad capitalista y las posibilidades para conservar el planeta. Estas discusiones dan lugar al surgimiento de nuevas disciplinas, impulsado por los trabajos de K. Boulding (1966), N. Georgescu-Roegen (1971), P. Erlich (1971), H. Odum (1971), W. Kapp (1963) y posteriormente R. Costanza (1989) y H. Daly, (1992), entre otros, desde una variedad de perspectivas. En América Latina, O. Sunkel y N. Glligo (1980) reunieron algunos de los pensadores más perpicaces en la región para su propia reflexión crítica. Proponen una serie de elementos que contribuyen a la construcción de la economía ecológica. Este nuevo campo de trabajo se sustenta en la necesidad de reconocer la estrecha relación que existe entre los ecosistemas naturales, el sistema económico y las instituciones sociales y políticas, pero no bajo una relación de subordinación de los primeros frente a los últimos, sino orientados hacia la idea de la co-evolución que se rige por la equidad.

Los primeros pasos de la economía ecológica fueron buscar una reconciliación entre economía y sistemas naturales, con la integración de los planteamientos teóricos de la biología y la economía, lo cual implicaba la cooperación de los científicos de ambas áreas y una postura abierta para aprender sobre la teoría y el contenido de la otra disciplina. Actualmente se discute como algo casi convencional entre la comunidad científica de distintos campos, donde no necesariamente se llega a reconocer como economía ecológica pero se incorpora cada vez más la consideración de los principios que van en la misma tónica, incluyendo la idea de la complejidad del sistema natural y de las interacciones que se establecen por parte del sistema económico con dicho sistema natural, a partir de la actividad propia de los distintos sectores económicos (Holland, 2004)

Científicos y estudiosos del tema han declarado que los cambios que experimenta el medio ambiente en la actualidad, tanto por su rapidez como por su carácter, no tienen precedentes y del mismo modo dan cuenta de los importantes cambios de actitud dentro de la sociedad. Ambas situaciones justifican el surgimiento de disciplinas y enfoques que integran un mayor número de elementos explicativos y proponen diversas alternativas, sobre la base del aprendizaje, que estén en función de estas nuevas necesidades.

Estas nuevas necesidades de la sociedad van más allá de la información y un mayor entendimiento de la dinámica que siguen los ecosistemas naturales y en general los sistemas complejos (Holland, 2004). En este sentido, Daly afirmó que "los biólogos han aceptado ahora el hecho de que nosotros –los economistas- no podemos salvar el medio ambiente de manera aislada desde los problemas de la economía y la sociedad, por ello es básica la economía ecológica" (Daly,1992).

La economía ecológica marcó enfáticamente en un primer momento la relación entre sistema natural y sistema económico como un sistema conexo e interdependientes. Contabiliza los ciclos de la materia y los flujos de la energía, analiza las discrepancias entre tiempo económico y tiempo biogeoquímico e infieren que en el ciclo económico se aborda desde las materias primas hasta la reincorporación de los residuos (Martínez Alier,1996).

Sin embargo, en un segundo momento, ya entrado el siglo XXI, el enfoque eco-integrador de los economistas ecológicos ha incorporado a su análisis el metabolismo social, como una línea de abordaje que conecta los flujos materiales y energéticos entre la sociedad y la naturaleza. Para Victor Toledo el metabolismo social es un acto de apropiación de la naturaleza por el cual "los seres humanos hacen transitar un fragmento de la materia y/o energía desde el espacio natural hasta el espacio social" (Toledo, 2003:139), esto refiere a las actividades productivas y de extracción que se realizan por parte de los seres humanos. Señala además que este tipo de relación está determinada por el nivel de desarrollo socio-económico, es decir incorpora un componente histórico que se ha complejizado en el actual escenario del capitalismo global debido al aumento acelerado de la extracción y uso de los recursos naturales, y cuyas repercusiones sobre las sociedades impactadas dan lugar a manifestaciones y movimientos sociales vinculados a la defensa de sus recursos y sus territorios, y a la búsqueda de esquemas alternativos de gobernanza y relación con la naturaleza. De este modo la economía ecológica incorpora a su campo de estudio el análisis de los movimientos socioambientales (Barkin *et al.*, 2012).

Esta publicación parte de reconocer el deterioro y la perturbación global que ha derivado del abuso en la utilización de los recursos naturales y de los impactos sobre el ambiente, causados por el excesivo y complejo consumo de las sociedades modernas que ha dejado al margen a innumerables comunidades rurales. Reune algunos de los trabajos presentados durante el XV Congreso Internacional de la ISEE, que se llevó a cabo en la ciudad colonial de Puebla, México. Se centra particularmente en las respuestas de diversos grupos de actores que han reaccionado con propuestas teóricas y productivas, así como con manifestaciones sociales y de confrontación en defensa de territorios que se ven impactados a nivel local con repercusiones a nivel global. El libro se organiza en seis apartados que abordan los temas generales que se discuten y se consideran centrales en el debate entre el modelo económico vigente y las repercusiones ambientales y sociales del mismo.

a) El paradigma de la economía ecológica

Desde la perspectiva académica los primeros trabajos que llamaron la atención sobre los efectos nocivos sobre el medio ambiente hicieron eco en los años sesenta, como una derivación de las actividades productivas del modelo económico vigente. Esa línea el debate teórico ofrece un serio cuestionamiento de la necesidad de un cambio de paradigma que transite hacia un modelo más conectado con el medio natural. En este apartado se incluyen tres trabajos que abordan los principios de la economía ecológica, explicando con cierto detalle el modelo de metabolismo social; planteando la centralidad del concepto de "cuidado" para la sociedad y su patrimonio natural en el contexto de una reducción de la población; y una propuesta de análisis que integra la termodinámica a los fenómenos sociales y productivos para un instrumento que contribuya a la formulación de una política ecológica hacía el futuro.

b) La transición energética

El modelo actual basado en el uso de combustibles fósiles, refleja de manera muy clara su irracionalidad. Así, entre las prioridades de la política pública a nivel internacional esta la necesidad de una transición hacia otro tipo de energías renovables y "limpias" que ofrezcan una alternativa a las necesidades de la sociedad moderna. Ahora, hay severos cuestionamientos que apuntan a la idea de que se han exacerbado los niveles de consumo energético exosomático en las sociedades modernas y aún transitando hacia un nuevo tipo de energías no será suficiente si no se impulsa un proceso de reducción de consumos en el marco de una lógica de descrecimiento.

c) Los servicios ecosistémicos

Una de las posiciones centrales en el debate ambientalista es la necesidad de poner en el centro de las decisiones la conservación de los ecosistemas bajo un esquema social participativo que incorpore a la lógica comunitaria y de la sociedad en general, la idea de asumir a la especie humana como un parte integral del sistema natural. En este apartado se incorporan cuatro artículos con una orientación básicamente conservacionista y una fuerte crítica al enfoque antropocéntrico y economicista en el tratamiento de los ecosistemas.

Dos de los capítulos refieren a México y confirman la dificultad de inducir a las poblaciones locales a emprender acciones conservacionistas sin tomar en cuenta sus múltiples y complejas preocupaciones para fortalecer sus comunidades. El artículo sobre un humedal en la India enfatiza la necesidad de considerar las necesidades básicas de la población en cualquier programa de protección. El análisis de las especies en peligro de extinción es contundente: concluye con la necesidad de emprender una senda de decrecimiento para seguir dentro de los actuales límites planetarios que enfrentamos.

d) Economía y sustentabilidad

La sustentabilidad se asocia directamente al desarrollo (en sus esferas economica, social y ambiental), planteando el interrogante de si es posible compatibilizar el cuidado del medio ambiente con la equidad social en la economía como la conocemos hoy. Se plantea esta "sotenibilidad económica" como una meta aspiracional que es tema de amplio debate. No sorprende, entonces, que esta sección es la más grande, con ocho capítulos en los que participan 18 autores. Es aquí donde se nota las profundas diferencias entre los participantes y una abundante evidencia de que las políticas actuales no están contribuyendo a atenuar las contradicciones.

Las investigaciones presentadas en esta parte reflejan la enorme dificultad de operacionalizar programas efectivos para lograr bienestar social y económico. Hay numerosas comunidades y propuestas para reorientar la producción en direcciones menos destructivas, pero en muchas instancias los actores preponderantes en la sociedad reorientan los esfuerzos en provecho propio. El pago por servicios ambientales experimentado en México solo evadió algunos de las presiones del mercado; una comunidad indígena en México está avanzando en proteger sus bosques, adoptando formas de organización social y política que refleja una relación diferente con su entorno, basado en un sistema de creencias tradcional. Asimismo, el programa educativo respecto al daño ocasionado por el mercurio en Bogotá logró influir en la agenda pública. En contraste, la evolución de la deuda pública en Argentina contribuyó a ensanchar la deuda ecológica a través del connotado proceso de intercambio desigual; el optimismo implicito en buscar otra forma de conceptualizar el crecimiento económico en Estados Unidos es el propósito del análisis que muestra que los deficit fiscal y ecológico en el país están creciendo.

Los tres reportes provenientes de Asia ofrecen visiones variadas. El desarrollo en la cuenca del Mekong ha convertido la arena en mercancía para la construcción que amenza el equilibro ecológico en la zona; en la India, un programa que genera energías renovables podría impulsar la creación de empleo, pero no está claro si vendría acompañado con buenas condiciones de trabajo; un estudio en Japón muestra el valor de un nuevo instrumento que identifica estrategias integrales (enfoque de sistema) para defender los ambientes costeros frágiles.

e) Conflictos sociales y ambientales

En el proceso de construcción hacia un nuevo paradigma que incorpore como prioridad el medio ambiente, la participación social ocupa un papel relevante que recoge las distintas perspectivas e iniciativas. Este activismo surge en respuesta a afectaciones directas y a la necesidad de construir esquemas alternativos de gobernanza para la incorporación de nuevas opciones en la vida comunitaria, que fortalezcan el tejido social y esten en armonia con la naturaleza. En esta sección se presentan seis analisis, tres con base en experiencias concretas y otras que son planteamientos analíticos que revelan como se está pensando en torno a las divergencias entre los intereses de distinto grupos.

El recuento de la situación en Brasil descansa sobre un proyecto ambicioso que ofrece documentar las luchas para la justicia ambiental a escala mundial; este trabajo sistematiza parte de la información para el país más grande de América Latina. Uno de los capítulos mexicanos documentó un ejemplo de muchos, donde las comunidades están protegiendo sus bosques como parte de una estrategia para asegurar su bienestar; México es señalado como el país en el mundo donde los bosques comunitarios están mejor protegidos por las organizaciones comunitarias. El otro caso mexicano documenta la importancia de los servicios ambientales para la comunidad pero identifica la fragilidad de su situación actual; el estudio aborda posibles estrategias para mejorar su situación.

Los demás capítulos adoptan enfoques más analíticos. Uno se concentra en el problema de la etica ambientalista, mencionando los sistemas de valores indígenas como base para su reformulación. El siguiente nos lleva a entender algo del origen del “Buen Vivir” en la nueva constitución de Bolivia; ofrece una introducción para muchos economistas ecológicos que todavía no están familiarizado con este concepto. La tercera contribución contrasta la tradición de la economía ortodoxa con la necesidad de introducir “el hombre” y su relación con el planeta en el centro del análisis, como es el caso en el pensamiento indígena.

f) Agroecología y sistemas alimentarios sustentables

La propuesta de economía ecológica se ha avocado a la construcción de conceptos y de herramientas concretas para avanzar hacia un modelo alternativo de sociedad en sus distintos sectores. En el caso del sector agrícola ha sido muy evidente el impacto negativo que deriva del modelo agroindustrial, basado en el uso de agroquímicos y prácticas destructivas del suelo y de los acuíferos, lo cual ha repercutido no solo en un deterioro de los terrenos y recursos naturales sino también en severos daños a la salud animal y humana. En este escenario la transición de los sistemas agroalimentarios hacia prácticas agroecológicas se propone como una alternativa de resarcimiento y como una respuesta al nocivo impacto de la agricultura industrializada en el actual enfoque global. Esta última sección incluye cuatro artículos sobre sistemas productivos agrícolas que incorporan a la economía ecológica en sus prácticas ya sea para un consumo local o bien para participar en el mercado con una oferta diferente más en armonia con la naturaleza y el bienestar humano.

El primero, firmemente arraigado en la estructura de la agricultura mexicana examina el potencial para que el país vuelva a ser autosuficiente en alimentos básicos. La segunda aportación está basada en una larga experiencia en promover la producción orgánica de frutas y hortalizas y su integración en redes para la comercialización directa a los consumidores; este caso es un excelente ejemplo de como los investigadores pueden incidir directamente en el bienestar de sus colaboradores a través de programas de extensionismo y organización. El tercer analísis examina la experiencia desde Argentina, donde la situación no es tan alentadora. A pesar de los conocimientos y los recursos, el modelo agroindustrial y estractivista no ha podido ser remplazado por la alternativa que el autor ha promovido durante muchos años. El último capítulo muestra la relación entre la agroecología y la versión latinoamericana de la economía ecológica: la radical. Ofrece una explicación clara que pone en evidencia algunas de las bases para las profundas diferencias entre las distintas “escuelas” en este campo de trabajo.

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Introduction

Ecological Economics and Social Movements. Science, Politics and Changes in Global Processes in a Turbulent World

David Barkin Rappaport
Graciela Carrillo González

Since the International Society for Ecological Economics (ISEE) was founded, more than a quarter of a century ago, the international community has created a considerable quantity of laws and agreements that recognize our collective responsibility to face the grave threats to environmental conservation, to the preservation of natural resources, to social stability and to the cultural identity of peoples around the world. Our Society is committed to identifying and understanding the underlying obstacles to implementing effective policies that address existing institutional limitations, as well as to searching for new approaches to confront the increasing socio-environmental crisis.

The lack of flexibility of the existing institutions in most countries, as well as the capture by international organizations with vested interests, (that promote uncritical notions of ecological modernization, such as "sustainable development" and "circular economy"), continue to generate obstacles for people searching for solutions. Therefore, social and political conflicts are intensifying. At the same time, we learn that peoples around the world are adopting new alternatives to organize, forging their own models of *"buen vivir"*, often choosing to live at the margins of their societies in place of opening up to environmental and economic exploitation, and to internal and external colonialism. Ecological economists have discovered that these peoples have a lot to teach us about the possible alternative routes to address the challenges. In Karl Polanyi´s (1944) terminology, these peoples refuse to be incorporated into the "general market system". Mexico is one of those countries where such social experiments are influential and extended (Barkin and Sánchez, 2019).

The capitalist model continues to demonstrate a great ability to restructure itself in the face of threats of crisis throughout its history. It was consolidated through the globalization process, and strengthened the ability of economic agents to expand from the first world, intensifying social problems and provoking great environmental damage in the emerging countries and the third world. This dynamic gave rise to the Latin American Structuralist School during the middle part of the 20*th* century, with its diverse dependency theories (e.g. Cardoso and Faletto, 1979).

In the last decades of the 20*th* century, it became evident that the capitalist model not only generates economic crises, creating great inequality and concentration of wealth, but also consumes an important share of the earth´s natural resources and dramatically changes the climate. This situation was strongly questioned by diverse social sectors starting in the 1970s, as critical studies from different disciplines proliferated. The problem became significant in the international agenda in 1972, with the convening of the United Nations Conference on the Human Environment, held in Stockholm, Sweden. At the same time, this concern spread rapidly among many social groups with the publication of the Club of Rome´s *The Limits to Growt*h (Meadows *et al.*, 1972).

During the following years, the threat of environmental problems became evident in all spheres, from the local to national and planetary levels, giving rise to the construction of theoretical schemes that came from the natural as well as the social sciences. In this way, the study of the environment acquired a transdisciplinary character.

Among economists, two frames of analysis and interpretation of environmental topics were defined. One was firmly rooted in the neo-classical tradition, the so-called *Environmental Economics* School, founded in the first era. The other school became institutionalized at the end of the 1980´s, with the creation of the ISEE. This current holds as one of its theoretical foundations the work of Nicolas Georgescu-Roegen, who formalized it with the publication of *The Entropy Law and the Economic Process* in 1971. From the start, it has been characterized by an eclectic theoretical literature that combined several elements of orthodox economics with contributions from the natural sciences and later from Political Ecology.

Very early in the past century, between the 1920´s and 1930´s articles appeared examining the effects of pollution and the appropriate management of natural resources (Pigou 1920 and Hotelling, 1931). Later on, Coase (1960) reconsidered the environmental problem and developed a conceptual model that perceives the natural system as part of the economic system and as such, he proposed giving the study of the aspects related to the use of natural resources a chrematistic character, utilizing instruments from Neo-classical Economics.

From the seventies on, other economists offer more consistent propositions, demanding their colleagues to face the profound contradiction between the dynamics of capitalist society and the possibilities for conserving the planet. These discussions gave way to the rise of new disciplines, incorporating the works of Boulding (1966), Georgescu-Roegen (1971), Ehrlich (1971), Odum (1971), Kapp (1963) and later Costanza (1991) and H. Daly (1992), among other, from a variety of perspectives. In Latin America, Sunkel and Gligo (1980) brought together some of the most insightful thinkers in the region stimulating their own critical reflection. This literature offered a series of elements that contributed to the construction of Ecological Economics. This new field of work is sustained by the need to recognize the close relationship that exists between the natural ecosystems, the economic system and the social and political institutions, but without subordinating the planet to the economy, but guided by the idea of co-evolution and social equity.

The first steps of Ecological Economics were to search for a way to reconcile the economy and the natural systems, through the integration of the theoretical approaches of biology and economics, which implied the cooperation of scientists from both areas and a willingness to learn about the content and theory of another discipline. Today, this idea is considered almost as something conventional within the scientific community, although it is not necessarily recognized as Ecological Economics; but the consideration of its principles are increasingly common, including the idea of the complexity of the natural system and the interactions that are established by the economic system on the natural system, based on the activity of each economic sector (Holland, 2004).

Scientists and others who study the subject have declared that today's environmental changes are unprecedented, due to their speed as well as their character, while these changes also reflect important changes in social attitudes. Both dimensions justify the rise of disciplines and approaches that integrate a greater number of explanatory elements and propose diverse alternatives that respond to these new needs.

These new needs of society go far beyond a search for information and a greater understanding of natural ecosystems dynamics and in general, complex systems (Holland, 2004). In this sense, Daly claimed that "biologists have now accepted the fact that we- the economists- cannot save the environment in an isolated way, parting from economic and social problems, that is why Ecological Economics is basic" (Daly, 1992).

In its first stage, Ecological Economics was emphatic in insisting on the relationship between the natural and the economic systems as a single, connected and interdependent system. It counted the cycles of matter and the energy flows, analyzed the discrepancy between economic time and biogeochemical time, and stressed the obvious fact that economic cycles should consider not only obtaining raw materials but also the reincorporation of residues (Martínez Alier, 1996).

Nevertheless, later on, at the dawn of the 21st century, the eco-integrating approach of ecological economists incorporated the idea of social metabolism to its analysis, an approach that connects the material and energy flows between society and nature. For Victor Toledo, the social metabolism is an act of appropriation of nature through which "human beings make a fragment of matter/energy transit from the natural space to the social space (Toledo, 2003:139)". It refers to the productive and extractive activities that are performed by human beings that depend on the level of socio-economic development, incorporating a historical component that has become more complex in the actual global capitalist scenario, due to the accelerated rate of extraction and use of natural resources, whose effects on the affected societies are provoking social movements linked to the defense of community resources and territories, and to the search for alternative governance schemes and systems for relating to nature. Ecological Economics has become increasingly complex, incorporating the analysis of socio-environmental movements (Barkin *et al.*, 2012).

This collection of essays starts from the recognition of the global damage and disruption resulting from the abuse of the use of natural resources, and of the impacts on the environment caused by the excessive and complex consumption of modern societies, which has marginalized innumerable of communities. It brings together some of the works presented at the XV

International Congress of the ISEE, which took place in the colonial city of Puebla, in Mexico. It lends particular attention to the responses of diverse groups of actors that have reacted with theoretical and productive proposals, as well as with social movements and confrontations for the defense of territories that are being impacted at the local level with global repercussions. The book is organized in six parts that address the general themes that were discussed and are considered central in the debate between the reigning economic system and its environmental and social effects.

a) The Ecological Economics Paradigm

From an academic perspective, the first works that echoed during the 70´s called attention to the detrimental effects of the economy on the environment, as a consequence of the economic activities of the existing economic model. That line of theoretical debate offers a serious defense of the need for a paradigm shift moving towards a model that is more connected and sensitive to nature. This section includes three articles that address the principles of Ecological Economics: 1) explaining with some detail the social metabolism model; 2) suggesting the centrality of the concept of "caring" for society and its natural heritage in the context of population decrease; and 3) an analytical proposal that integrates thermodynamics with social and productive phenomena, so as to create an instrument that can contribute to the formulation of ecological policy towards the future.

b) Energy transition

The current model based on the use of fossil fuels clearly reflects its irrationality. At the international level, public policy priorities point to the need for a transition to other types of renewable and "clean" energies, which offer an alternative for the necessities posed by a modern society. Now, there are several critiques that point to the idea that the present levels of exosomatic energy consumption have risen and that even transitioning to new types of energies will not be enough, if we don´t contemplate a process of consumption reduction in the frame of a logic of de-growth.

c) Ecosystem services

One of the central positions in the environmental debate is the need to put the conservation of ecosystems at the center of decisions. This requires a scheme of social participation incorporating a logic of community and of society's well-being, considering the human species to be an integral part of the natural system. This section presents four articles with an orientation that is mainly conservationist and a strong critique of the anthropocentric and economic approach to the treatment ecosystem management.

Two of these chapters refer to Mexico and confirm the difficulty in inducing local populations to engage in conservation actions without taking into account their multiple and complex concerns to strengthen their communities. The article about a wetland in India emphasizes the need to consider the basic needs of the population in any protection program.

The analysis about species at risk of extinction is compelling: it concludes that there is a need to embark on a de-growth path if we are to live within the present planetary limits.

d) Economy and sustainability

Sustainability is directly associated to development (in its economic, social and environmental spheres), posing the question of whether it is possible to reconcile caring for the environment with social equity in the economy as we know it today. This "economic sustainability" is proposed as an aspirational goal, a topic for ample debate. It is no surprise then that this section is the largest, with eight chapters written by 18 authors. It is here where we note the profound differences among participants and abundant evidence that present policies are not contributing to the mitigation of these contradictions.

The research presented in this part reflects the enormous difficulty in operationalizing effective programs to promote social and economic well-being. There are many communities and proposals to re-orient production in less destructive directions, but in many instances the dominant actors in society redirect these efforts for their own benefit. The "payment for environmental services" scheme implemented in Mexico only avoided some market pressures; the study of an indigenous community in Mexico shows how it is advancing in protecting its forests, adopting ways to organize politically and socially that reflect a different relationship with their surroundings, based on a traditional system of beliefs. Similarly, the education program focusing on the harm caused by mercury in Bogotá was able to influence the public agenda. In contrast, the evolution of public debt in Argentina contributed to the swelling of the ecological debt through a process of unequal exchange; the implicit optimism in searching for another way to conceptualize economic growth in the United States is the focus of the analysis, which shows that the fiscal and ecological deficits in this country are growing *pari passu.*

The three reports coming from Asia offer varying visions. The development of the Mekong Basin has turned sand into a commodity for the construction sector, threatening ecological equilibrium in the zone; in India, a renewable energy program could propel the creation of employment, but it is not clear if this would be accompanied by good working conditions; a study in Japan shows the value of a new instrument that identifies integral strategies (systems approach) to defend fragile coastal environments.

e) Environmental and social conflicts

In the process of constructing a new paradigm that incorporates the environment as a priority, social participation occupies an important role that allows for a diversity of perspectives and initiatives. This activism arises in response to direct impact of and need to construct alternative governance schemes for the incorporation of new options for community life, which may strengthen social fabric, in harmony with nature. The six chapters present a variety of cases. Three are based on concrete experiences while the others are analytical approaches that reveal how the divergence between the interests among distinct groups is being considered by analysts.

The Brazilian account documents the struggles for environmental justice at a global scale; this work systematizes part of the information for the largest country in Latin America. The first Mexican chapter presents an example among many, where communities are protecting their forests as part of a strategy to ensure and improve their well-being; Mexico is the country in the world where forests are best protected by local community organizations. The other Mexican case documents the importance of environmental services for the community, but identifies the fragility of the program at present; the study addresses possible strategies to improve the situation.

The other chapters adopt more analytical approaches. One concentrates on environmental ethics, examining indigenous value systems as a basis for their reformulation. The following chapter provides an understanding of the origins of "Buen Vivir" in the new Bolivian constitution; it offers an introduction for many ecological economists who are not yet familiar with this concept. The third contribution contrasts the tradition of orthodox economics with the need to introduce "man" in a relationship with the planet as the center of the analysis, common in many indigenous cosmovisions.

f) Agroecology and sustainable food systems

Ecological Economics has concentrated on the construction of concepts and concrete tools to advance towards an alternative social model in its different sectors. In the case of the agricultural sector, it is very evident that the agroindustrial model has very negative impacts, derived from the use of agrochemicals and practices that destroy soils and aquifers, causing not only the deterioration of the land and natural resources, but also severe damage to animal and human health. In this scenario the transition from agrofood systems to agroecological practices is proposed as an alternative for restoration and as a response to the harmful impact of industrialized agriculture. In this last section, four articles about agricultural systems incorporate Ecological Economics in their analysis, be it for local consumption or to participate in the market, offering something different, something that is in closer harmony with nature and human well-being.

The first, based on the Mexican agricultural structure, examines the potential for Mexico to regain its self-sufficiency in basic foods. The second contribution is based on a large-scale experience to promote the organic production of fruits and produce and their integration in direct-consumer commercialization networks; this case is an excellent example of how researchers can impact directly on the well-being of their collaborators, through extension and organizational programs. The third analysis examines the experience from Argentina, where the situation is not so encouraging. Regardless of knowledge and resources, the agroindustrial and extractivist model has not been replaced by the alternative that the author has promoted during many years. The last chapter shows the relationship between agroecology and the Latin American version of radical Ecological Economics. It offers a clear explanation illustrates the origins of the profound differences among the different "schools" in this field.

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RESÚMENES

I. ECOLOGICAL ECONOMICS AS A PARADIGM

Social metabolism: a construct for teaching and research in ecological economics

David Barkin Rappaport

Resumen

Ecological economics offers a way to approach the relationship between societies and the natural world. The concept of social metabolism (SM) offers an approach to systematizing this relationship by examining the biophysical basis for social processes.

In its most didactic form, SM breaks down these processes into five discrete stages in the social and productive process between the use of resources and the disposition of wastes: appropriation, transformation, circulation, consumption, and excretion. This analytical approach elegantly incorporates many of the issues examined by ecological economists, especially the particularly important contributions of Nicolas Georgescu-Rögen in his seminal work on the Entropy Law (1971) which describes the material limits to human activity, although it does not determine our history.

In this paper, I will trace some of the ways in which SM has been used productively to describe productive developments and to offer insights into the differences between those processes that are destructive and those that contribute to an optimal satisfaction of social needs while taking into account the natural boundaries within which they operate. The presentation identifies the institutional and cosmological elements that influence these differences.

Notion of capital bases: What lessons are learned about ecological economics from Japan's experience as a population declining society?

Hidefumi kurasaka

Resumen

The population of Japan entered a declining process in 2008. This makes it difficult to make GDP as suitable economic indicator. In addition, labor shortages in industrial sectors such as agriculture, forestry and fisheries, nursing care, construction, transportation have become serious. I will show that the experience of population reduction in Japan helps to build an economic theory of degrowth.

In this paper, I define the term capital base as an existence with a mechanism that brings usefulness, and that is not lost by giving usefulness. This is a concept equivalent to "fund

- service resources" in ecological economics. The capital base is not lost by use, but it is an irreversibly lost entity by exceeding the threshold. "Care" of the capital base can extend the period during which the capital base can be used, and can increase the amount of service provided per unit time. "Care" does not create something new. It is necessary to recognize "care" as a different concept from "production" which creates something new service.

Regarding the extent to which the capital base should be "cared for", meaningful answers cannot be obtained from price adjustment in the market. These levels need to be socially decided through collective decision-making processes based on off-market principles. The labor demand for care will be decided according to the existence of the capital base that will be maintained and managed in the future. This labor demand is not always satisfied by labor supply from the labor market. If it is not satisfied, it must raise labor demand or reduce the amount of capital base to maintain. We should intervene in the market to realize the "full care" state. This "full care" must become a new economic indicator aligned with GDP.

A policy compass for ecological economics

Michèle Friend

Resumen

A policy compass makes a mathematical aggregation of several statistics. The result is one arrow on a trisected circle representing three general qualities: harmony, suppression and passion. The construction combines quantities, qualities and cultural or emotional reaction to statistical data. A compass can be constructed for any institution. Policy can then be based on the position and length of the arrow, and the process of constructing the arrow.

The adaptation for ecological economics concerns two points: one is that we make three separate compasses: one for the eco-sphere, one for the socio-sphere and one for the economic sphere. The compass for the eco-sphere is the largest, so has the most influence on the final arrow reading. The size of the socio-sphere compass is between the eco-sphere and the economic sphere. This reflects the idea central to ecological economics that the economy depends on society, and society depends on the natural environment. The other point is that the construction of the compass for the eco-sphere is done in terms of thermodynamic parameters and eco-system health indicators. The indicators sometimes are, and sometimes use, the algorithms of the SAGE-P system of accounts.

II. ENERGY TRANSITIONS

Testing the dynamic relationship among CO_2 emissions, economic growth, energy consumption and tourism development. Evidence for Uruguay

Juan Gabriel Brida
Bibiana Lanzilotta
Fiorella Pizzolón

Resumen

Some authors argue that the tourism sector has the problem that is "addicted" to growth and this fact is incompatible with sustainable goals. The literature in this area shows evidence that the environmental Kuznets curve (EKC) hypothesis induced by tourism is verified, with some differences between developed and developing economies.

In previous empirical research on country-studies, linear cointegration techniques and Granger causality test are usually applied in order to test the EKC hypothesis. The present study explores the linkages between CO_2 emissions, economic growth, energy consumption and tourism development for Uruguay without imposing -a priori- any parametric model, in order to investigate the presence of nonlinearity in the relation, as is postulated by the EKC hypothesis. The paper empirically examines the dynamic long run relationship among these variables, using data for the period 1960-2014.

Within this framework, we test the existence of nonlinear cointegration relationship and the causality applying nonparametric tests. Our findings show that this methodology provides a more suitable way to represent linkages between the variables under study for the case of Uruguay. Nevertheless, the evidence with respect to the causality between tourism growth and CO_2 emissions is weak. Policy implications, limitations of the study and future research are proposed and discussed.

La dimensión energética en el metabolismo urbano: la premura por los indicadores regionales y urbanos en México

Jorge Hurtado López
Jorge Antonio Mejía Rodríguez

Resumen

El propósito del trabajo reside en explorar la dimensión energética en el paradigma del metabolismo urbano. Si partimos de la premisa general de que todo ser vivo funciona gracias al movimiento (energía) de su sistema metabólico, entonces, por analogía, el flujo energético que recibe una región y/o ciudad, le permite en la práctica, el funcionamiento de sus componentes económicos y sociales que la integran. Por ende, al igual que un ser vivo, el desarrollo regional y urbano requieren de un suministro energético continuo que le permita movilizar la entrada

y salida de fluidos y materiales, para su pleno sostenimiento. De lo contrario, la posibilidad real de una ruptura social del proceso metabólico está presente. En tal sentido, el objetivo del trabajo reside en realizar un primer acercamiento al objeto de estudio, acorde al siguiente planteamiento: ¿Existe la posibilidad de rupturas metabólicas (sociales) a falta del suministro energético? Asimismo, ¿Se cuenta con indicadores energéticos a escala regional y urbana en México? ¿Cuáles y qué tipo de indicadores debieran generarse en el corto, mediano y largo plazos? El método a seguir consistió en efectuar una revisión cuantitativa y cualitativa de los indicadores energéticos disponibles. Los resultados del trabajo permitirán contar con elementos para sugerir propuestas orientadas a destacar la necesidad impostergable de contar con indicadores energéticos a esa escala territorial, para medir la magnitud del deterioro ecológico y social implícito en dichos procesos productivos.

Análisis del sistema de extracción de petróleo a partir del uso de la Tasa de Retorno Energética (TRE) para el caso del Ecuador

Rony Parra

Resumen

Analizar el sistema de extracción de petróleo del Ecuador a partir del cálculo del consumo de energía por unidad de producción en los diferentes bloques petroleros en operación, para lo cual se utilizará como un indicador la Tasa de Retorno Energético TRE, cuya ecuación está dada por: TRE = Cantidad de energía subministrada/ La cantidad de energía utilizada en el proceso de suministro.

El estudio se basa en el entendimiento del metabolismo energético en los procesos, para lo cual se construyó una gramática del sistema que fuera común para todos los bloques, identificando las entradas, procesos de transformación y salidas de energía. Luego se caracterizó el tipo de tecnología y el combustible utilizado en la generación térmica de electricidad, para finalmente compararlo con la producción petrolera entregada por cada bloque al Estado ecuatoriano en un punto de fiscalización

Se observa que el gasto energético en los procesos de extracción petrolera es considerable, teniendo en cuenta que en el 2016 se consumieron 1,481 millones de barriles de crudo, 4,488 millones de barriles de diésel y 2,943 millones de pies cúbicos de gas, para extraer 176 millones de barriles de petróleo. La tasa de retorno energético calculada es de 28,5:1, lo que implica que en los bloques ecuatorianos por cada unidad energética invertida se obtiene 28,5 unidades energéticas entregadas al consumo de los procesos económicos

La transición energética en México. En el marco de la reforma energética

Diana Patricia Rivera Delgado
Graciela Carrillo González

Resumen

Los graves problemas que se enfrentan de contaminación ambiental, dependencia de los combustibles fósiles y eficiencia energética han orillado a la búsqueda de alternativas que desde la política pública de varios países, ya apunta hacia una transición energética. Para moverse hacia un nuevo patrón energético es necesario modificar el modelo productivo y en ello las institucionales juegan un papel fundamental normando el quehacer público y privado, direccionándolo hacia este nuevo arquetipo social/económico. El antecedente para la transición en México se dio con el Programa Sectorial de Energía 2007-2012, que recoge el compromiso del país para impulsar acciones que contribuyeran a la mitigación del cambio climático, después de varios intentos ante el Congreso de la Unión, en el año 2013 se aprueba la llamada Reforma Energética (RE). Este trabajo aplica la metodología de minería de texto para analizar los documentos generados en la RE que promueven la transición a energías limpias, sustentables y eficientes.

Los resultados de la minería de textos arrojan una serie de conceptos que reiteradamente se incluyen en las leyes primarias y secundarias vinculadas a la RE y dan indicios de una serie de elementos que derivan de una reforma que se impulsó en el marco de un gobierno orientado a promover la participación privada nacional e internacional en los procesos de modernización y explotación de los recursos naturales para la generación de energía. Finalmente se presentan una serie de reflexiones derivadas de los planteamientos de la teoría de transiciones energéticas y su relación con el contexto actual que se vislumbra para este sector en el actual gobierno.

Are climate change policies counterproductive? A critical approach to the Green Paradox

Jordi Roca Jusmet

Resumen

Hans-Werner Sinn (2008; 2010) utiliza el concepto “paradoja verde” para indicar que la mayoría de políticas para reducir las emisiones futuras de carbono están condenadas al fracaso: los propietarios de combustibles fósiles reaccionarán avanzando y no atrasando la extracción para evitar su pérdida de valor futuro. El objetivo de la ponencia es discutir la importancia que puede tener este fenómeno.

Analizo críticamente la base teórica que conduce a la conclusión de Sinn. Su punto de partida es la versión más simple del modelo de Hotelling sobre precios de los recursos no renovables (1931). La conclusión no es pertinente cuando los costes de extracción de diferentes explotaciones son –como en la realidad- diferentes. Además de esta crítica “interna”, cuestiono aspectos claves del modelo: 1) su concepto de equilibrio no considera adecuadamente la

incertidumbre sobre el futuro; 2) no tiene en cuenta que la extracción de recursos requiere inversiones que impiden aumentar la oferta inmediatamente y comportan costes hundidos o irreversibles.

El pesimismo extremo de Sinn es injustificado. Es cierto que: 1) la única garantía de disminuir las emisiones de carbono sería aplicar de forma efectiva un límite global a las emisiones (o de las cantidades extraíbles de combustibles fósiles); 2) la "paradoja verde" es una posibilidad teórica. Sin embargo, las políticas orientadas a cambiar los estilos de vida y hacia la transición energética en general no serán inútiles y mucho menos contraproducentes sobre todo cuando son radicales y no se aplazan a un futuro lejano.

III. ECOSYSTEM SERVICES

El capital y la producción de sujetos conservacionistas. El caso de San Juan Raya y la Reserva de la Biosfera Tehuacán-Cuicatlán

César Durán Zepeda

Resumen

A partir de la creación de la Reserva de la Biosfera Tehuacán-Cuicatlán, en 1998, las actividades económicas de la población de San Juan Raya, Zapotitlán Salinas, Puebla, se modificaron y encaminaron hacia la organización de actividades ecoturísticas. Este cambio respondió a la implementación de políticas ambientales neoliberales, cuya justificación es la conservación de la naturaleza, aunque generaron conflictos sociales en la localidad. El objetivo de esta ponencia es dar a conocer algunos de estos conflictos derivados de las disputas por la apropiación de los recursos naturales y financieros disponibles en y para la Reserva de la Biosfera Tehuacán-Cuicatlán. Para esto, se partió de la premisa de que la conservación de la naturaleza forma parte del ciclo histórico de transformación y expansión del capital en la que ha encontrado un nuevo horizonte para la acumulación. Se aplicaron un conjunto de técnicas cualitativas como la observación participante, la observación directa, entrevistas, estancias de campo y una exhaustiva revisión bibliográfica que, articuladas con un análisis teórico de corte marxista, dieron como resultado una etnografía sobre la conservación. Algunas de las conclusiones apuntan que los conflictos sociales en San Juan Raya no se resuelven, ni se contienen debido a su carácter estructural e histórico; también a que las áreas "naturales" protegidas se convirtieron en depositarias de un capital financiero "exclusivo para la conservación" que ha transformado a las poblaciones en "sujetos conservacionistas".

Economic valuation of Vembanad Wetland ecosystem, India

Durga Ar

Resumen

Valuation of ecosystem services of wetland with its potential to influence environmental decision play a substantial role in maintaining the ecological balance and ensuring the sustainable livelihood of the human community. However, due to unsustainable development practices followed these wetlands are under pressure and an understanding of total economic value of these fragile resource is highly essential for an economically justifiable decision making. The present paper analyses the economic value of Vembanad wetland in India by focusing on the provisioning services and determinants of willingness to pay of the stakeholders for the improved conservation.

The estimation of the economic value of the wetland system with special reference to provisioning services (coir retting, human consumption and irrigation for paddy) was determined by employing a production function approach. viz. Quadratic and linear production function approach. To determine willingness to pay of the stakeholders for the improved conservation, contingent valuation method - iterative bidding game for domestic households and coir processing industries) and travel cost method (for tourists) was employed.

The study reveals that conservation measures have to be scaled up so that good water is available for consumption and other activities in the household and for the coir retting. The monetary value attached to the wetland ecosystem signifies the economic importance as well as the conservation efforts like setting up of waste water treatment plants in the area. Furthermore institutional arrangements like activities of tourism promotion council should be enhanced so that people continue visiting the site at the expense of their travel cost.

Economics in the anthropocene: species extinction or steady state economics

Joeri Sol

Resumen

At the dawn of the Anthropocene, continued economic growth carries the risk of irreversibly damaging the global carrying capacity. Using the International Union for the Conservation of Nature Red List of Threatened Species (2016), I calculate expected extinction rates during the coming century for 557 regions. I illustrate that these rates exceed the planetary boundary formulated by Rockström et al. (2009) virtually everywhere and increase with population density and GDP per capita. By doing so, this paper contributes to an ongoing debate whether absolute or relative scarcity is more relevant to economic thought. My findings suggest that the conservation of nature requires degrowth and the transition to a global steady state economy.

> *"I cannot, therefore, regard the stationary state of capital and wealth with the unaffected aversion so generally manifested towards it by political economists of the old school. I am inclined to believe that it would be, on the whole, a very considerable improvement on our present condition." John S. Mill (1848, Book 4, Chapter 6)*

¿Es posible restaurar y conservar humedales mientras se promueve el desarrollo comunitario?: Un reto transdisciplinario en la Subcuenca Nuxco, México

Sandy Astrid Medina Valdivia
Carmen Maganda Ramírez

Resumen

Esta ponencia argumenta la necesidad de dedicar más esfuerzos trans e interdisciplinarios para identificar y reconocer las perspectivas de los actores sociales -beneficiarios locales directos- respecto al manejo de los ecosistemas que les rodean. Múltiples programas de conservación de la naturaleza se implementan bajo enfoques de escaza consideración de los aspectos sociales, sin embargo, el involucramiento de los actores locales permite entender la relación que guardan las comunidades con los sistemas naturales y la selección de modelo adecuado de conservación. En ese sentido, el objetivo de este estudio es abordar el tema de conservación de la naturaleza desde la óptica transdisciplinar combinando un enfoque comunitario de manejo de los recursos naturales, con el análisis de las percepciones sobre servicios ecosistémicos y la participación de los actores comunitarios en la restauración ecológica de manglares en la subcuenca Nuxco.

IV. ECONOMICS AND SUSTAINABILITY

Del proyecto de aula a la política pública: educación y servicio en relación con la contaminación por mercurio en Bogotá, Colombia

Cristian Julián Díaz Álvarez

Resumen

Esta experiencia académica y profesional muestra que el desarrollo de proyectos de aula en el tema de los conflictos ambientales urbanos, puede dinamizar investigaciones formales y extensión solidaria con incidencia en la gestión ambiental y la política pública. Desde la metodología de aprendizaje y servicio en la docencia, se articularon durante cinco años la investigación básica y aplicada, y la extensión solidaria, propiamente en lo relacionado con la contaminación por mercurio en Bogotá, Colombia. El proceso inició con la formulación y desarrollo de proyectos de aula en asignaturas seleccionadas; posteriormente se materializaron investigaciones financiadas y consultorías gratuitas cuyos resultados se sistematizaron y comunicaron en medios académicos y de comunicación masiva. A lo largo del proceso se evidenció la presencia de mercurio en la ciudad y la existencia de un ciclo urbano que está afectando la calidad ambiental y la salud pública. Así mismo, se logró el empoderamiento de individuos y comunidades quienes están exigiendo a los poderes Ejecutivo, Legislativo y Judicial acciones claras de prevención, mitigación, control y remediación de la contaminación; así como la atención de casos de toxicológicos. Finalmente, se logró definir una agenda política con relación al tema del mercurio en Bogotá y el país, en el marco del Convenio de Minamata.

El intercambio ecológicamente desigual como nexo entre deuda externa y deuda ecológica

Guillermo Peinado

Resumen
A través del concepto de Intercambio ecológicamente desigual se busca visibilizar los flujos de materiales y energía escasamente remunerados hacia el resto del mundo desde Argentina y se pretenden visibilizar las conexiones que transforman a los países deudores financieros en acreedores de una creciente Deuda ecológica.

En función de ello el presente trabajo busca determinar la existencia (o no) de situaciones de Intercambio ecológicamente desigual en Argentina a partir del indicador biofísicos de la huella ecológica para el período 1961-2013, y de las Cuentas Nacionales publicadas por el Banco Mundial en el mismo período. Posteriormente se estima la deuda ecológica como el equivalente (monetario y biofísicos) del déficit ecológico, siendo éste último la diferencia entre la huella ecológica y la capacidad de carga de cada país y se compara su evolución con el endeudamiento monetario externo publicado por el Banco Mundial (1970-2017).

En simultáneo con el creciente endeudamiento monetario externo (1970-2017), este indicador multicriterio refleja la existencia de un profundo intercambio ecológicamente desigual y crecientes procesos de pérdida ecológica en Argentina (1961-2013). De esta manera se evidencia que la deuda monetaria externa y la deuda ecológica están estrechamente relacionadas.

De esta manera, la sustentabilidad económica entra en tensión con la sustentabilidad ambiental, y comercio internacional se convierte en un vector de provisión de sustentabilidad ecológica a los países centrales a través de un Intercambio ecológicamente desigual forzado por la posición de deudor monetario, que sin embargo debería estar transformando a países como Argentina en acreedores de una creciente Deuda Ecológica.

Responding to economic and ecological deficits

Jonathan Harris

Resumen
Macroeconomic theory has been shaken up in the wake of the financial crisis, with neoclassical approaches proving inadequate to analyze or respond to the need for policy action. I have proposed a "green Keynesian" approach, combining the radical Keynesian analysis of the need for activist policy with ecological priorities such as drastic carbon emissions reduction.

In the years since the financial crisis, both economic and ecological deficits have increased. This poses a challenge for "green Keynesian" policy. It is therefore necessary to have effective analyses to measure and respond to ecological deficits, and policy measures to deal with

economic deficits. This paper proposes a new approach to measuring ecological deficits, and a new perspective on economic deficits and debt. The analysis involves reconceptualizing economic growth and degrowth, and provides an alternative to current U.S. policies under the Trump administration, which are contributing to widening both deficits.

Property rights and the economy of sand in the Mekong delta an inquiry into law in the Anthropocene

Oliver Braunschweig

Resumen

Human society has become a major force of planetary change. This paper advocates an ecologically informed notion of property rights, in which human societies are considered a niche building species.

Human niche-building in the Mekong Delta has long been a force structuring the interplay of sand and water. Traditional agriculture is thus political and yet still embedded in the ecological processes of the region. But green-revolution agriculture intensified the de-coupling from these natural cycles, and sand has become an essential commodity in the construction sector. Property rights arguably structure these systems. To elucidate their role, international, national, and local aspects of political and property rights are considered and contrasted with traditional (ethno-ecological) notions. This paper draws on existing historical, ethnographic, sociological, political, and ecological work.

A policy proposal for green jobs in India: A quantitative analysis on inclusivity of green jobs

Rohit Azad
Shouvik Chakraborty

Resumen

The green energy has shown great potential to generate wealth and jobs. Our estimates show that for every million US dollars invested in the Indian economy annually, the total number of jobs generated through our green energy program will be 197 jobs compared to only 82 jobs in the fossil fuel program. To the best of our knowledge, for the first time in the literature, this study analysed the composition of employment to reflect on the type and quality of jobs created through investments in the green energy program in India. The renewable energy sector and the energy efficiency sector generates 216 and 161 jobs respectively per million USD of investment. The bioenergy sector is the most labour-intensive sector. Within the energy efficiency program, weatherization and building retrofits seem to be the most labour-intensive sectors. Regarding the composition of employment, the green energy program is

more progressive than its fossil fuel counterpart, whether we look at it through the lens of gender, region, caste or skill. This study argues that in the long-run, building a green energy economy in India, as opposed to expanding its existing fossil-fuel dominated energy system, will generate both significant opportunities and challenges in terms of the employment effects. The opportunities exist since there will be an overall net gain of employment in the economy with the expansion of the green energy program. The challenges, then, will be to encourage and support these workplaces to become increasingly organised and formalised such that this expanding workforce benefits from better quality jobs, higher and stable earnings, and other employment benefits like health insurance, pension and enhanced social security. This paper presents a green energy policy proposal, which not only has a higher employment potential but also delivers higher growth to the economy because of the increased fiscal expenditure that this program entails.

Study of the contribution of sustainability indicators to the development of sustainable coastal zones - a systems approach. Western Japan

Uehara Takuro
Takeshi Hidaka

Resumen

Sustainability indicators are an important management tool used to realize and sustain the desired state of coastal zones. They simplify, quantify, analyze, and communicate the complexity of coastal zones. However, because of such simplification, indicator selection needs to consider two primary issues, namely, the causal relationships between indicators and other components of the coastal zones as a complex social-ecological system, and the contribution of the selected indicators to management goals (e.g., sustainable coastal zones). Since the root cause of these issues is the “systemness” of coastal zones, which is difficult to capture with indicators, this study applied Causal Loop Diagrams (CLD) as a type of systems approach as a solution; As a case study, the sustainability indicators set in the action plan for Omura Bay, Western Japan, were translated into a CLD. The plan was aimed at realizing and sustaining “Satoumi,” a Japanese concept of desirable socio-ecological production landscapes. This study showed that the CLD 1) helped indicator selection by assessing current indicators and identifying those missing with regards to their contributions to Satoumi, and 2) identified research priorities to verify hypothetical relationships that lack hard data.

Control y gestión sustentable del territorio michoacano. Pueblo de San Francisco Pichátaro, Michoacán, México

Wuendy Asuet Armenta Barrera

Resumen

El objetivo de la investigación es indagar, analizar, estructurar y clasificar las estrategias sociales, económicas, políticas, legales y culturales que el pueblo de San Francisco Pichátaro ha realizado en los últimos años para defender, mantener y fortalecer su territorio de la deforestación, así como la reconstrucción de su organización social y la revitalización de su cultivo y cosecha de agua. La metodología que se utilizará es la revisión del estado del arte de la literatura publicada a nivel nacional e internacional, de las investigaciones realizadas en temas relacionados, así como la investigación de campo en el territorio de San Francisco Pichátaro, a través de la observación y la recolección de datos cualitativos de los procesos sociales, políticos, culturales, económicos y ecológicos de estos grupos. La demanda de recursos naturales por el Capital tensa a nivel ecosistémico y social a las regiones boscosas como el territorio de San Francisco Pichátaro. Está localidad, situada en el municipio de Tingambato en el estado mexicano de Michoacán de Ocampo, es una zona boscosa donde aún se pueden encontrar pinos, encinos y madroños, entre otras especies de árboles y plantas. Es un pueblo purépecha que a través de su cosmovisión y autogobierno están proponiendo estrategias de apropiación, uso y desecho de la naturaleza tomando en consideración los procesos bióticos, al mismo tiempo que persiguen generar bienestar ecológico, económico y social para la totalidad de la población (o la mayoría) que habita el territorio a través del trabajo colectivo que se organiza en las asambleas comunitarias.

V. SOCIAL AND ENVIRONMENTAL CONFLICTS

Can local environmental justice organizations change national policies in Latin America? Selected Brazilian conflicts

Joseph S. Weiss

Resumen

In this paper the author begins to answer this broad question. To what extent do local movements develop into national struggles, organizing alliances and networks to pressure for and achieve national policy change or better enforcement? Of a total of 103 local conflicts reported by EJ Atlas (2018), the author selected 47 land and natural resource conflicts led by six types of Brazilian movements. These efforts of environmental justice activism towards sustainability are conceived as achieving five levels of conflict outcomes or scenarios, the dependent variable: Of these, 1) 28 were completely unsuccessful, 2) 10, partially or temporarily successful, 3) 8 managed to stop or change the project by collective action and/or litigation, 4)

one changed national policies and 5) none moved toward ecologically sustainable societies, an idealistic long-term view that socio-ecological struggles propose to achieve. With the fact sheets from Ejolt questionnaires responses, published news reports and the author's knowledge, independent variables were built for the conflicts' mobilization structures: 1) ties with the movement's own national organizations, if any, 2) national and international networking; and for their political opportunity structures: 3) each movement's legal framework (constitutional, legislative and/or policy), 4) adversary strength and 5) government opposition or support. Regression analysis for the conflict sample indicated that a movement's legal framework and network building and support contributed to favorable outcomes while the strength of a movement's own national organization and adversary strength did not affect conflict results. A similar analysis is underway on Colombian social and environmental mining conflicts. To further these results, we propose that the EJ Atlas add these factors to its research agenda, along with national movements representing local groups, networks, policy demands and achievements.

Community logic as a basis for socio-economic and environmental resilience: Santa Cruz Tepetotutla, Oaxaca, Mexico

Mara Rosas Baños

Resumen

The indigenous community of Santa Cruz Tepetotutla in Mexico provides an excellent example of the resilience that goes far beyond the basic knowledge of how to identify changes in the climate or of the mechanisms needed to protect against the impact of such changes. The aspiration of sustainable development in terms of the integration of social, ecological and economic systems is expressed in the construction of an ecological and socioeconomic community model, which has the characteristic of having been built thanks to the resilience. In possession of over 12,000 hectares of evergreen forest, with more than 26 species in danger of extinction, the community faces a constant struggle between adaptation and resistance in order to survive conditions of extreme adversity. Community logic understands the value of conservation for the community, including for future generations and also for people outside the community.

Servicios ambientales y percepción social: Delta del río Usumacinta, sureste de México

Vera Camacho-Valdez
Andrea Saenz-Arroyo

Resumen

En México muchos cuerpos de agua enfrentan graves amenazas por la actividad humana, los ríos conforman una parte central de los ecosistemas que existen dentro de las cuencas. La cuenca del río Usumacinta es reconocida por la alta diversidad biológica y cultural que posee, sin embargo, los asentamientos urbanos y los proyectos económicos que rodean la zona han generado una fuerte presión sobre los ecosistemas debilitando su funcionamiento, lo que ha propiciado con el tiempo modificaciones importantes al entorno. El escenario que se vive actualmente en esta cuenca hace necesario establecer modelos de gestión donde se considere la finitud de los recursos y los límites de la diversidad de las especies. El objetivo de esta investigación fue por un lado describir de forma cualitativa y participativa los servicios ambientales que constituyen la parte baja de la cuenca; y por el otro, analizar espacialmente los ecosistemas y aplicar el método de transferencia de valores, para estimar los valores de referencias de los servicios ambientales que de ellos se derivan. Los resultados indican que las poblaciones rurales que habitan en esta zona dependen fuertemente de los servicios ambientales de aprovisionamiento para su subsistencia, se encontró que las inundaciones representan una de las mayores amenazas para la gente e incluso para la biota. Finalmente se calculço que los humedales de la zona aportan un valor económico de más de 13,000 millones de dólares al año.

Containing the world's environmental problems: an interdisciplinary approach applied to Malaysia

Choy Yee Keong

Resumen

To explore why international and national environmental treaties, laws and regulations have been unable to make significant progress in arresting rapid global environmental changes, and to suggest ways of mitigating the problematic situation.

The paper uses an interdisciplinary approach in analyzing the root causes of global environmental change beyond the environmental dimensions with a view to finding practical solutions to manage them. This involves a combination of a theoretical analysis of human, environmental value, and ethical orientations, quantitative and empirical assessments of the connection between international/national environmental protection initiatives and global environmental changes, and field research using face-to-face interviews with over 400 indigenous people in the Borneo rainforests in Malaysia exploring their relationship with nature, and the ethical and environmental implications.

The analysis challenges the paradox of global/national environmental protection measures and highlights the relevance and significance of the contribution of environmental ethics in healing our environmentally troubled world. It generates a holistic understanding of the

human-nature relationship and provides logical and ethical ways of guiding us to intrinsically understand the natural world around us and our place in it, hence shaping our environmental attitude and commitment. The integrated analysis also elucidates a theoretically supported-indigenous environmental value system to serve as ethical foundation for the articulation of practical strategies and solutions to real-life environmental problems which cannot be effectively managed using international/national environmental regulatory controlling measures alone.

The Living Well Development Paradigm in the 2020-2025 Agenda of The Plurinational State of Bolivia

Eduardo Lopez Rosse

Resumen

Our continent was invaded 526 years ago by European colonizers who changed our traditional livelihoods, conquered our local governments and almost annihilated us and through slavery made us exploit our natural resources to benefit European kings. Times of change brought hope for the exploited people of Bolivia in 2005; the MAS-IPSP, a socialist party led by Evo Morales Ayma, the first Indian president of Bolivia, won the national election. During the last twelve years, inclusive public policies were developed benefiting all people in the new Plurinational State of Bolivia and one of the most interesting public policies is the rescue of traditional values of the Inca times such as the Sumaj Kausay (Living Well, in English) which is the principal political and social instrument in the MAS-IPSP party that drives all the public policies since 2006. The Living Well has many people in favor and few against. There are excellent experiences in Ecuador and it was conceived as an alternate approach to capitalism, people-centered with a harmonious relationship to The Mother Earth. To continue in the next six years after the 2019 Presidential election, the MAS-IPSP developed the Agenda Patriotica 2020-2025, a document based on thirteen pillars for the development of the Plurinational State of Bolivia. These pillars deal with the development of six capitals: social, physical, natural, cultural, economic, and human. It also has sixty six dimensions which must be implemented for the proposed development objectives. This paper describes the causes that led to the adoption of “Living Well” in The Plurinational State of Bolivia’s public policies, the Agenda Patriotica 2020-2025 as a national guide for participatory development, and the description of the opportunities and limitations of the Agenda.

La insostenibilidad de las teorías económicas convencionales frente a la triple crisis; ecológica, económica y social. Una aproximación a la cosmovisión indígena en México como respuesta

Ismael Sánchez Brito

Resumen
Las corrientes del pensamiento económico moderno distan mucho de darle un papel preponderante a la naturaleza, si bien es cierto que los teóricos de la economía clásica como Adam Smith, Malthus, David Ricardo le daban un valor prioritario a la tierra, como un recurso que agregaba valor, otros autores como Marx y los neoclásicos lo dejan de lado totalmente para centrar sus análisis en una visión totalmente antropocéntrica. Lo cierto es que en ninguno de estos autores se observa la importancia de la naturaleza como fuente de vida. En ese contexto y bajo estos marcos de análisis difícilmente se puede hallar explicación a la compleja problemática ambiental, social y económica que se enfrenta actualmente. Por lo que es necesario realizar una reflexión acerca de la base teórica de la economía moderna, los clásicos, neoclásicos y marxista, y su relación con la naturaleza y preguntarse si el marco teórico es el adecuado para afrontar estos problemas o revisar otras fuentes del pensamiento no necesariamente económicas basada en otras visiones, dónde las relaciones ser humano-naturaleza se reproducen de manera cotidiana y forman parte de la esencia misma de las personas, esta visión proviene del pensamiento y filosofía de los grupos indígenas. El objetivo de este trabajo es hacer un cuestionamiento al pensamiento económico a ortodoxo y abrir espacios a la reflexión y reconsideración de la cosmovisión de los pueblos indígenas de México para entender y atender los complejos problemas ambientales que enfrentamos hoy en día.

VI. AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

Agricultura Ecológica y Soberanía Alimentaria en México: El potencial para producir maíz y frijol bajo sistemas de producción ecológica

Darío Alejandro Escobar Moreno

Resumen
Se presentan resultados de una investigación que apoyan la propuesta de que México desarrolle sus capacidades para la producción de alimentos básicos a partir del impulso a la agricultura ecológica, para la consecución de la Soberanía alimentaria. Se discuten de manera crítica los conceptos de Soberanía y Seguridad Alimentaria, así como los de Agricultura convencional y Agricultura ecológica. Se estima la capacidad de producción de maíz y frijol con base en resultados de investigación de campo realizado por grupos de investigadores de la Universidad Autónoma Chapingo en los estados de Oaxaca y Zacatecas, durante los últimos. Se proponen algunos lineamientos de cómo apoyar a la agricultura ecológica, con el

objetivo de lograr la soberanía alimentaria, desde las políticas públicas.

Los resultados muestran que México posee capacidad para producir suficiente maíz y frijol en sus regiones campesinas, a partir de sistemas de producción de agricultura ecológica. El impulso de los sistemas de producción ecológica de alimentos conllevaría a una mejora sustantiva en la preservación de los recursos productivos en el campo, beneficiaría a las poblaciones campesinas y contribuiría a tener una alimentación más sana y nutritiva para la mayoría de la población.

La certificación orgánica participativa en el tianguis orgánico Chapingo, México: avances y retos desde la mirada de la agroecología

Laura Gómez Tovar
Rosa Cecilia Rodríguez Silva
Manuel Gómez Cruz

Resumen

Una de las más importantes repercusiones de los problemas ambientales se ha puesto de manifiesto en afectaciones graves a la salud de las personas, esta situación abrió todo un debate desde hace cerca de tres décadas sobre el tipo de alimentos que consumimos y la necesidad de evitar el uso de agroquímicos para su producción. Esta iniciativa ha incrementado la oferta de productos sano, naturales, verdes u orgánicos y ello ha llevado también a la necesidad de hacer certificaciones que permitan constatar y dar seguridad al consumidor de las características de los productos que compra y consume.

En el año 2003 se conformó el Tianguis Orgánico Chapingo, con el objetivo de abrir espacios de venta para los productores y ofrecer alimentos sanos a los consumidores que habitan en los alrededores de la Universidad Chapingo. Dos años más tarde se inicia con la tarea de certificar los productos orgánicos ahí ofrecidos y ello deriva en la primera experiencia en México de lo que hoy se conoce como certificación participativa.

El objetivo de esta investigación fue, a partir de 5 estudios de caso de productores del Tianguis Orgánico Chapingo, detectar las principales fortalezas que se han creado dentro de la organización, así como las limitantes y retos que se enfrentan actualmente en este modelo de certificación orgánica participativa. Se encontró como principales fortalezas el intercambio de conocimientos valiosos entre los productores y el comité de certificación; y la disciplina en la revisión estricta para ofrecer productos que cumplan con los requisitos. Entre las limitaciones se observó la falta de tiempo para hacer visitas de campo; falta de conocimiento de los productores sobre algunos estándares importantes y la dificultad para mantener los registros de producción y ventas. Se corrobora que la certificación participativa aporta a la agroecología mediante la conexión de dos enlaces valiosos para su crecimiento: los consumidores y los productores, al favorecer sistemas de producción sanos, locales, biodiversos, participativos y de economía solidaria.

Análisis de los modelos agrícolas y los sistemas agroalimentarios en América Latina y en La Argentina: una mirada propositiva frente al actual enfoque global

Walter Pengue

Resumen

Realizar un análisis crítico y propositivo sobre las actuales propuestas de catalogación del sistema agroalimentario mundial y promover un modelo ecológico, agronómico y alimentario (eco-agro-alimentario) sostenible para la América Latina y el análisis del caso de Argentina. Se aplicaron los marcos internacionales recientes con el fin de contrastar los actuales modelos agrícolas revisados y propuestos y la realidad latinoamericana. Se identifican las lagunas de información y, en especial, aquellas situaciones donde es más que destacable la propuesta alternativa de la soberanía alimentaria y las formas de acceder a la producción y a los alimentos en América Latina.

Luego se contrastan los últimos avances globales con la situación de los Organismos regionales que trabajan con el tema como CEPAL y cómo existen o no posiciones encontradas respecto a estas definiciones.

Finalmente se aplicó el framework al caso argentino y otros países de la región y se presenta el análisis matricial de resultados, identificando los escenarios e impactos de uno u otro modelo propuesto en la región y el país.

Es notable que a pesar de adherirse a las Metas del Desarrollo Sostenible 2015-2030, y los importantes aportes de información dados en el marco del TEEB y el IPBES a los gobiernos, la Argentina y la gran mayoría de los países de la región están siguiendo el andarivel dado por la promoción de las exportaciones de commodities, la no inclusión de externalidades y la no identificación de invisibles ni intangibles.

Estas externalidades están presentadas y valoradas, como así también el conjunto de invisibles e intangibles integrados (huellas, mochilas y flujo virtual) y los costos en salud invisibles que comienzan a identificarse en el sistema. Se presentan aquí y se analizan los costos socioambientales en el país y también una extrapolación en la región, de los impactos producidos en especial por el modelo agrícola industrial basado en transgénicos, agroquímicos e intensificación energética, que ya también comienzan a ser mencionados en los documentos de base utilizados para el análisis expuesto.

Se presentan las métricas dadas por las externalidades, intangibles e invisibles, identificadas por cada modelo agrícola y el sistema alimentario, en los planos regional, nacional y local.

Ecological economics and agroecology: A touch of radicalism applied to Brazil

Lúcio André Fernandes
Décio Cotrim

The debate about theoretical perspectives to sustainability has opened up many diverse possibilities. This paper aims to introduce the 'Agroecology' approach, developed in Brazil, and its relation to the Ecological Economics (EcoEco) as theoretical contributions to this theme. The methodology used in this paper is a theoretical review aiming at the comparison of the two perspectives. These two approaches have been defined as sciences of sustainability, the first in the field of agriculture and the second in the realm of economics.

Agroeocology can be understood from a threefold perspective: as a scientific approach to sustainable agriculture, as a social movement, and as a practice. This conceptualization allows us to understand Agroecology as an application of ecological principles in the design and management of agroecosystems, as well as a methodology that comprises bottom up, participatory and systemic approaches, from a co-evolutionary perspective. Ecological Economics (EcoEco) has theoretical proximity with these agroecological ideas since it uses the strong sustainability definition. Nevertheless, the strong sustainability definition is approached differently by different branches of EcoEco. The closest to Agroecology seems to be the radical EcoEco which includes not only a critical theoretical perspective, but also an important political dimension, getting closer to the political ecology movement. In order to achieve a conclusion we claim Agroecology is necessarily the sustainable agriculture of the impoverished, an element that gives it political power as a social movement, a perspective that is also very strong in the radical EcoEco.

I. ECOLOGICAL ECONOMICS AS A PARADIGM

Social metabolism: a construct for teaching and research in ecological economics

David Barkin Rappaport*

Introduction

Ecological Economics (EE) is developing along a number of diverging paths during its short history. Although there is a vague general agreement that it is innovative in its insistence that the economy should not be at the center of the social-ecological system in which we live, there is no consensus on what that means for analysis or policy-making (Barkin *et al.*, 2012, Spash, 2013). Clarifying the various strands of EE is not simply an academic exercise; rather, it is a central part of an ethical and political debate of the role of science and its commitment with "society" and the maintenance of appropriate levels of ecological resilience. It is a field deeply concerned with the confronting the roots of the environmental problems that are generating today's complex crises.

This approach is qualitatively different from dominant versions of EE based (directly or indirectly) on a conservationist vision of society, be it economistic or ecological. Its point of departure is the methodology of the **social metabolism** (SM), enriched by other theoretical perspectives that were central to the emergence of EE as a field (such as those of Georgescu-Roegen, 1971, for example) as well as the plethora of rural praxis (often coming from the cultures of indigenous peoples). This complex and multidimensional heritage is the basis for our formulation of a "bottom up" version of radical EE.

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Our work seeks to identify and understand the roots of the present socio-ecological and economic crises. In this regard, it critically distances itself from two influential lines of analysis. There is the dominant argument based on orthodox (neoclassical) economic theory that insists on the possibility or necessity of promoting economic growth to generate the resources needed to confront the crises; it proposes fixing appropriate prices on commodities (natural resources) and environmental services to allow the market to attend to the problems of reducing over-exploitation and degradation while controlling emissions (e.g., Barbier and Markandaya, 2013). At the other extreme of the spectrum, less influential but still quite important, are those that accept the idea that continuing growth is the root of the problem of planetary balance; they recognize that the prevailing social, economic and cultural system must subordinate itself to the postulates of Deep Ecology (Naess, 2008) or Conservation Biology (Chicchón, 2000). Both perspectives within EE (anthropocentric and ecocentric) share a common feature: they do not consider the impact of dominant economic structures or the significance of the cultural diversity that characterize today's world. As a consequence, they cannot understand the influence of the prevailing "social contract" in generating today's crises and limiting the possibilities for change.

In contrast, we are shaping a variety of EE rooted in the theoretical-methodological proposals from heterodox economics and ecology as well as from the social praxis that explicitly incorporate the need for reshaping the SM. The radical analysis demonstrates that the price system and the market themselves are part of the problem, requiring new social contracts (with a different power structure) recognizing the significance of cultural diversity and the limits of ecological resilience to assure the maintenance of ecosystem functions that permit human development. This approach is useful to understand and accompany those peoples explicitly engaged in strengthening institutions capable of resisting the efforts to assimilate them into the expanding international division of labor and capital in the national and global capitalist system. This ethical-political analysis is attracting scholars who are discovering that in the Global South there are millions of peoples organized into traditional and intentional communities seeking to associate with others and oftentimes receptive to the collaborative efforts of scholars developing this line of EE.

The Five Stages of the Social Metabolism

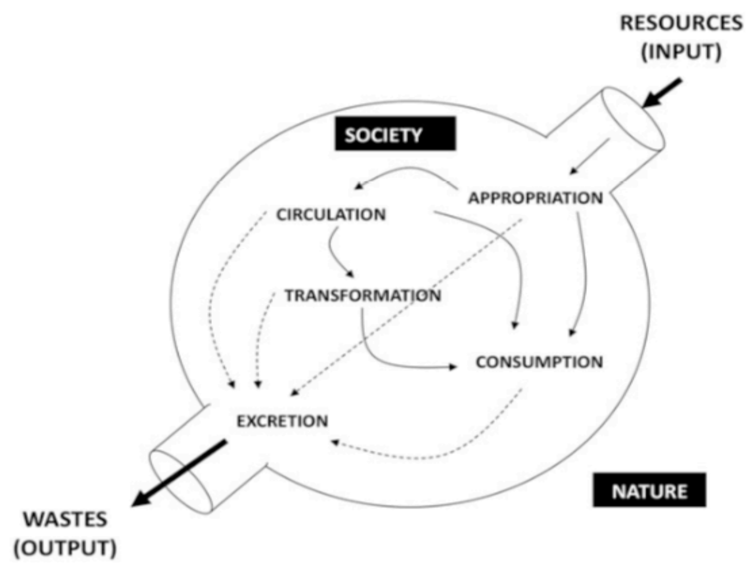
This history is transforming our understanding the relationship between our societies and the planet. Georgescu-Roegen, often considered the father of modern EE, was quite adamant in insisting on the centrality of natural forces in setting limits on the possibilities of use of energy and other resources in production and consumption. His treatise on *"The Entropy Law and the Economic Process"* (1971) obliged open-minded scientists to rethink the fundamental tenets of economic "science", moving us to develop new ways of integrating the whole cycle of resource use, production, and disposal into a single model of human activity. This led us to rescue the initial insights of XIX century thinkers (von Liebig, Marx) who coined the concept of the **social metabolism** (SM) to address the biophysical processes inherent in the interaction between socio-economic and natural systems.

We (re)learned that our activity does not begin in the household or factor markets nor does it end in consumption, as in the closed circular models of standard textbooks. We cannot undertake virtually any activity without first appropriating resources and energy from nature;

and yet this simple truth escapes mainstream analysis. Once appropriated, the economic machine enters into action, transforming the goods and services that traditional frameworks describe so well, although often abstracted from reality! These goods and services then have to be distributed for investment and consumption, another set of activities for which conventional approaches have been well honed, albeit in somewhat complicated and often unrealistic fashion. Finally, and inevitably, the process must end by disposing of the effluents, the unrecoverable detritus that takes the form of solid waste, biological leftovers, and degraded energy (entropy).[1]

This (overly) simplified description of the concept of the SM is often portrayed as a schematic diagram, somewhat like the following:

FIGURE 1. METABOLIC PROCESSES: RELATION BETWEEN SOCIETY AND NATURE



Taken from: González de Molina and Toledo (2014).

This revised model of the social system has important implications for our research. It facilitates an understanding of the complexity of the social systems shaping the SM. For example, even in the first stage of the process, we are confronted by a profound chasm between the visions of peoples who are historical occupants of territories that sustain a traditional lifestyle, attempting to protect their natural heritage, and the modern enterprises that identify valuable resources needed to expand the productive systems that will provide them with greater profits and success in the global market. The historical process of social domination has generally involved the expropriation of the original claimants, frequently accompanied by the dismemberment of their societies and even the existence of their cultures. Recent developments in the international community, however, are contributing to erecting a bulwark against this unequal struggle, obliging nation-states to protect the rights of these peoples, by requiring "prior and informed consent" for any incursions as well as creating new institutions to accompany them in their efforts to strengthen their own societies or shape new

1 The modern history of the use of this concept is examined in a scholarly fashion by Infante *et al.*, 2017.

ones.[2] As will become evident, this movement towards privatization contrasts strongly with the socialization of the effects of disposal (excretion) in the fifth stage of the SM, reproducing a familiar tendency in the capitalist economy to appropriate benefits for capital and socialize costs to the most vulnerable groups.

In the second stage of the SM we discover even more contentious disputes about the nature of the economic system. The resources that were extracted must be transformed by productive groups, be they small family units, local collectives or large enterprises. In this process, questions arise as to what should be produced, the technologies to be used, and the uses to which the products serve. Here very important questions arise about the nature of the labor process (embracing issues of the well-being of the workers, their ability to support their families, and their relationships with each other and the organizers of the system), the advisability of using processes that might harm the environment or produce goods that are dangerous to use or consume (e.g., creating genetically modified plants and animals or products dangerous for society), and, the matter of the advisability of creating certain productive systems in the first place (i.e., the matter of producing armaments or consumer products that are inimical to the health of the consumer). In this phase of economic organization, questions arise as to how decisions about technologies might be evaluated; perhaps two of the most pressing at the present time, is how to evaluate the "trade-off" between fossil fuels and renewable energies and how to design appropriate transport systems.

A third phase of the SM, distribution, is still more difficult to consider within the framework of the present organization of the global capitalist economy.[3] We are witnessing momentous changes in the volumes of products exchanged, the ways in which they are distributed, and the impacts of these movements on the shape of society and the institutions that it has created. Here again, there are important disputes about the advisability of the large-scale, long-distance, (cross) transport of products when compared to more localized systems of markets and exchange; the debate is not merely theoretical, because the implications are proving quite important for the welfare of different social groups and for the prevalence of different technologies. Quite specifically, the survival or resurgence of local and regional markets offers a direct challenge to the control by the large enterprises that dominate global trade and limit the variety of products and the technological systems that can thrive in the present economy. Thus, in response to these differing visions of the system, some practitioners in EE are contributing to our understanding of the advantages of agroecology (Rosset and Altieri, 2018) and small-scale industrial production to attend to local markets by organizations in which working conditions and technologies are well-suited to local social structures and environments (Barkin and Lemus, 2106), these colleagues have been at the forefront of efforts to protect and enrich the biocultural legacy of peoples who are promoting a symbiotic interaction between their societies and the environment (Maffi, 2001; Borrini-Feyerabend *et al.*, 2007; van der Ploeg, 2008; Scoones, 2016).[4]

2 Some of the work in EE that analyzes these conflicts is being assembled by the international collaborative effort to describe conflicts involving issues of environmental justice (http://www.ejolt.org).

3 There is a very important matter in this chapter of distribution that we are omitting for lack of space: the question of inter-personal inequality that is certainly at an all-time high at this moment in modern history. There is no longer any doubt that the yawning chasm in control of wealth and the resulting abysmal deterioration in the quality of life of a very large segment of the world´s population is a direct consequence of the present organization of property rights and the productive system. Branko Milanovic (2015) is one of the more scholarly economists to look at this problem in historical perspective.

4 It would be hard to overemphasize the significance of this biocultural legacy. There is a burgeoning literature describing the

Consumption itself is, of course, a particularly problematic area of analysis. Here analysts are faced most dramatically with the question of the challenge of limiting individual freedoms in a world of limited possibilities. The basic model of orthodox economic analysis is anchored in the paradigm of methodological individualism in which each actor makes 'rational' decisions that lead to optimal solutions if they all have sufficient information. The result of this process has been a consumption led process of personal "insatisfaction" that is generating a cumulative and seemingly endless process of environmental degradation and resource depletion. In response to this dynamic, a new current of political and social analysis is developing in groups associated with EE, proposing a model of "degrowth" as a necessary alternative to the present structure of economic organization (D'Alisa *et al.*, 2014). In a separate, but closely related political movement emerging from the Global South, a large variety of alternative proposals that can be broadly grouped under the theme of "buen vivir" or "good living" offer actually existing models of social organization, material production, and environmental management to confront the challenges posed by the global disorder (Escobar *et al.*, 2019).

The last phase of the SM is excretion, or disposal. This is, in fact, one of the greatest sources of problems and dispute in the current political arena directly involving EE. This matter is dramatically disputed in the international arena because it raises the question of what are the underlying causes of the meteorological phenomena that are currently summarized as "climate change" and who should assume the costs of their control. It is clear that these events are provoking important modifications in weather patterns that threaten the livelihoods of millions and the very existence of numerous peoples and countries. This is a crucial matter for EE, generating a burgeoning literature that frames the debates on the most appropriate policies to reverse the deteriorating global situation. Of course, disposal encompasses much more than the greenhouse gases that are an object of contention in the political arena; the whole problem of "externalities" raises the central issue of environmental justice that differentiates orthodox frameworks from radical analyses of EE.

Contributions of other theorists

Of course, there are profound differences in the way in which different rural and urban societies operate within this framework and a great deal of empirical work is being conducted to critically examine their impacts. This research is proving particularly productive in identifying the ways in which each productive system contributes to local, regional and global problems of environmental deterioration and the possibilities for modification.[5]

What does this approach mean for teaching and research? Perhaps the most important lesson to be gleaned from this work is the double embeddedness of the economy. Karl Polanyi´s (1944) important observation and reminder that the economy is profoundly rooted in society was a direct attack against the rise of marginalist economics revolution of the late XIX century, a process that was directly tied to the rise of the British industrial class and their systematic unraveling of the social institutions that had protected the peasantry and workers for so long.

efforts of indigenous peoples around the world to learn more about this heritage and apply it to their current circumstances (e,g., Boege, 2008). The "Red Temática sobre el Patrimonio Biocultural" organized in Mexico incorporates scholars and communities in a concerted effort to describe, protect, and enrich this legacy with publications and research programs. (https://www.crim.unam.mx/patrimoniobiocultural/node/9)

5 A careful examination of some of these contributions can be found in Gonzalez de Molina y Toledo, 2011 and 2014.

The second process is that of the relationship of societies to the ecosystems on which we all depend; this has become increasingly evident in the recent period as we become aware of the extraordinary heavy 'footprint' that the current organization of society is generating. Polanyi insisted on the significance of the "double movement" provoked by the seemingly unfettered advance of the capitalist system and its state; today a flourishing literature in EE is documenting not only the resistance to these advances, but also the deliberate strategies of communities throughout the world to construct their own alternatives (Escobar, 2017; Martínez-Alier *et al.*, 2014; Petras y Veltmeyer, 2018; Temper *et al.,* 2015, 2018).

This embeddedness is not something to be taken lightly or dismissed simply as a "fact of life." Most economic analysis still is framed as if the institutions and variables of material production and exchange operate in a vacuum, distant from the social institutions, values and ethical norms in which they are shaped and operate. Thus, the notion of equilibrium itself presupposes a social contract in which all the participants are in agreement about the structure of society and the relations among social groups; it is clear that this is not the case in today's world in which growing inequalities among individuals and the exercise of power by corporate behemoths is generating intense manifestations of discontent. Some economists argue that these problems can be confronted with minor reforms of the political system, while a growing consensus relates these problems to the same problems that evolved to generate the distortions in the structure of production and consumption creating the global environmental crisis.

EE is in the midst of this debate. Incorporating this double embeddedness requires an important departure from orthodox analysis. Some of the most pressing points of contention among those who want to move forward are unresolved: can the market be shaped ('tamed') as a force for reducing social conflict and environmental damage? The EE literature is wrought with soul-searching about how the market works: what are the real mechanisms for price formation? How do the various actors influence market dynamics? Can the market adequately reflect the interests of the majority of people, i.e. workers and consumers? Increasingly, we have come to the realization that the answer to all of these queries is negative. Today's global market is controlled by the same forces that determine the shape of world financial markets and these same interests percolate down to the interstices of national, regional, and local markets, only modified by the operation of local interests that attempt to dominate within their spheres of influence. The serious efforts by economists to estimate "shadow prices" further highlight our inability to depend on the market mechanism to serve social and environmental purposes.[6]

In this context, the model of the SM offers a heuristic instrument to facilitate our understanding of the complex interrelationships between natural processes and social institutions. By obliging us to systematize the flows between different stages in the process of natural and social reproduction, we must delve into the origins of the resources (material and energy), the processes of transformation, and the uses of the goods that we produce as well as the "leftovers" that inevitably accumulate.

This system does not operate in a vacuum. Examining these resource flows does not explain how the organization of the system underpinning the SM was shaped or how it is structured, nor does it identify the forces that are at work to shape the system. Much of the

6 The proliferation of market-based programs to incorporate social and political objectives into the market, such as payments for environmental services, generally reinforces the discriminatory effects of the price system, which seriously undervalues peasant and indigenous peoples' work and managerial capacities.

work of EE involves descriptions of each of the five stages of the operation of the SM. This work involves careful research about how decisions are made as to where the resources are to be sourced, who should control these resources, what is to be produced, who controls the process, where and for whom the products are destined, and how the remainders from the system are disposed.

Ecological Economics from Below: People developing a progressive social metabolism

Research from myriad communities throughout the Global South confirms that an approach that incorporates the SM offers EE a better understanding of the possibilities of constructing other worlds in the midst of the ongoing struggles by large capital to continue "business as usual" (Barkin, 2017). Today, we are learning that there are many different ways in which these peoples are organizing themselves to strengthen their institutions and diversify their productive systems while trying to assure the health of their ecosystems. These experiences expand the boundaries of the SM model, facilitating an understanding of how peoples' struggles are ensuring that their social and productive activities are effectively contributing to environmental equilibria and social justice.

This is particularly evident in the indigenous and peasant communities in Latin America. The Andean heritage, summarized in the "buen vivir" that was codified in the constitutions of Bolivia and Ecuador sparked a global interest in understanding the significance of alternative cosmovisions for organizing society and redefining relations between societies and the planet. In other parts of the region, similar definitions of peoples' heritages and beliefs are guiding the way for them to perfect their systems of governance while diversifying their productive systems and broadening their knowledge and honing their skills to assure an increasing quality of life; these include numerous doctrines that are the focus of further discussion and elaboration in their respective regions, such as *Ubuntu* (East Africa), *Swaraj* (India), *AbyaYala* (Panama), *Mandar Obedeciendo* (Chiapas, Mexico) and *Comunalidad* (Oaxaca, Mexico), to mention just a few of the better known. Throughout the region, peoples are sharing these understandings, convening meetings to exchange information about their approaches and inviting others to join them in the efforts to build alliances and support each other.

In this process the communities are embarking on a variety of approaches to operationalize these cosmologies. We find that they share a variety of common traits that we characterize as "*convivial austerity*", following an early formulation by Ivan Illich. His formulation of an alternative approach to living in a more just world in *Tools for Conviviality* (1973) suggested an autonomous and creative interaction of individuals within society and with their environments to assure their quality of life and the health of their ecosystems; this social process was only constrained by the possibilities of their surroundings and the ability to create alliances to work with other communities, both near and far. He continued, explaining that the resulting "austerity" would be based on friendship and mutual support, not limiting the societies to a drab existence but rather inducing them to deepen their ability to live "joyfully."

We are advancing in this formulation, suggesting that the participating communities are, in fact, becoming the vanguard of a new revolutionary movement, transforming their possibilities for forging alternative worlds by side-stepping the need to confront directly the "powers that be" in the larger societies of which they are a part. By asserting control over their territories and organizing themselves to produce the goods they need for their own reproduction and interaction with the other groups with whom they are building alliances, they are indeed creating the building blocks for the post-capitalist societies capable of confronting the impending social, political and environmental crises (Barkin and Sánchez, 2019).

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Notion of capital bases: What lessons are learned about ecological economics from Japan's experience as a population declining society?

Hidefumi Kurasaka*

1. Japan a country of 'degrowth'

1.1. The situation of 'degrowth' in Japan

The population of Japan turned to a decreasing trend at the peak of 2008. Figure 1 shows the long-term trend of Japan's population based on the population projection by the National Institute of Population and Social Security Research. According to the estimated future population of Japan up to 2065, published in April 2017, the total special fertility rate is forecasted to recover to 1.44 in 2065 (the previous estimate being 1.35 in 2060), and this will somewhat put the brakes on the population decline. However, we can see that the overall trend will not change substantially.

The decline in 1945 is the impact of World War II. At that time, 2.3 million people were lost in one year, but the population recovered the following years. It is predicted that the population will be below 60 million in 2100, falling back to the level of the Taisho era, and the population decline expected in the future will be at the average rate of 800,000 annually until 2060. With this population decline, the population aging will progress. Because of this, the working age population will decrease faster than the population will decrease. From the viewpoint of sustainability of the economic society, it can be said that Japan has come to a significant turning point.

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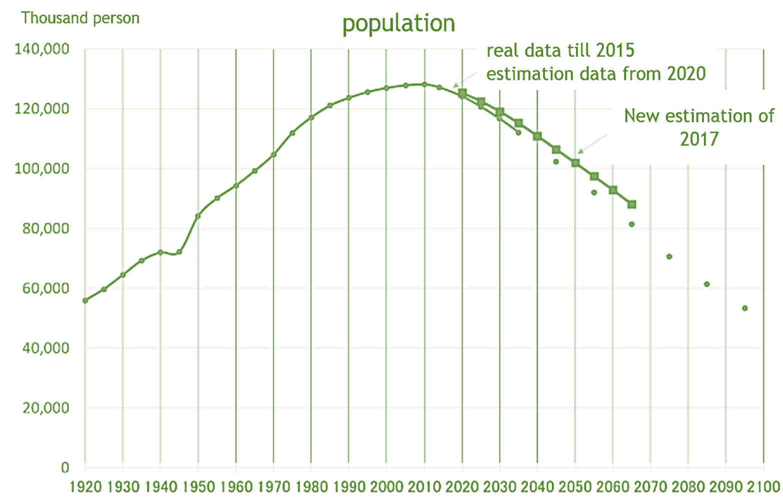
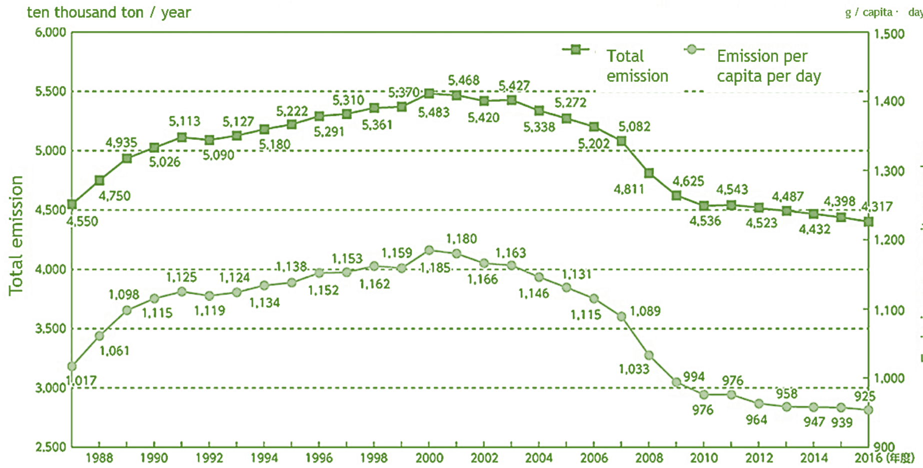
FIGURE 1. A LONG-TERM TREND OF THE JAPANESE POPULATION



Source: created by the author from the Ministry of Internal Affairs "Japanese statistics 2016". Taisho 9 years - Heisei era 2005, 22 years population by census (population survey in 1964) (including unknown age in total population). Estimated population on October 1, based on the census population for Heisei 18-21, 23-26. Showa 20 ~ 45 excluding Okinawa Prefecture (Total number of total population since 1959, population by gender and age 3 classification includes Okinawa prefecture, but the population by age 3 in 1945 is Okinawa prefecture except). For the future population, the median estimate of October 1 each year by the National Institute of Social Security and Population Research, based on the fact that the basic cumulative result such as the census population etc. of 2010 and the confirmed number of demographics statistics of the same year was announced value. (Mid-death median) estimate (line from 2020 to 2065) of Japan's estimated future population (estimated in 2007).

As the population declines, waste emissions and energy consumption are also declining. Figure 2 shows the transition of general waste emissions in Japan. Before the population declined, policies toward waste reduction were effective in Japan, and total waste emissions and per capita emissions also declined.

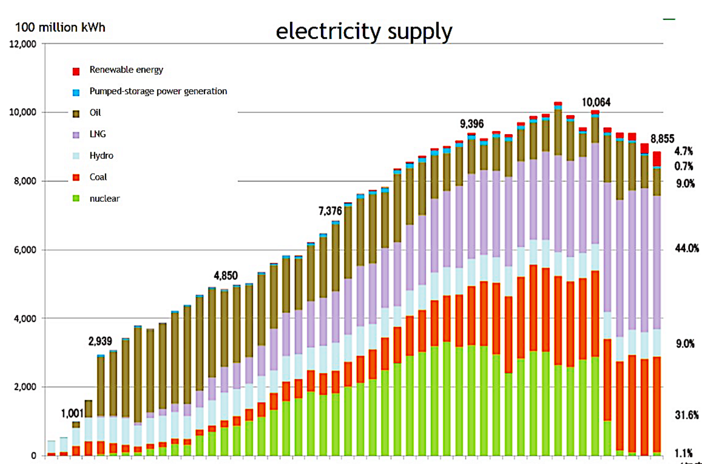
FIGURE 2. TOTAL EMISSION OF GENERAL WASTE AND WASTE EMISSION PER CAPITA PER DAY IN JAPAN



Source: Ministry of the environment, Japan.

Also, Figure 3 shows the transition of the amount of power supply. Due to the accident at the nuclear power plant during the 2011 Great Earthquake, nuclear power generation is almost not in operation. That amount is covered by a thermal power plant that consumes fossil fuels. From this figure, we can see that the supply of electricity is in a declining phase regardless of the accident in 2011.

FIGURE 3. THE TREND OF ELECTRICITY SUPPLY IN JAPAN



Source: resource and energy agency, Japan

Figure 4 shows the growth rate of GNP in Japan is also declining. Due to the decline in the working-age population, production capacity will decrease. Also, due to the population decline, domestic demand may decline, and the economy may recede.

FIGURE 4. THE TREND OF GDP IN JAPAN

Source: Gross domestic product (expenditure side, real: linkage method: Chain price of 2011 calendar year) from Annual estimate of the national economy, Japan.

1.2. Unintentional 'degrowth' in Japan

It should be noted that the Japanese government did not want to be a "degrowth" country. There has been a claim that economic growth can be made even under a declining population. For example, a group of the Ministry of Economy, Trade and Industry stated, "(the constraining factor that is the population decline) can be overcome by enhancing abilities of individuals, increasing productivity, and shifting the industrial structures toward a more productive field in Asia," and claimed that it was possible to achieve a 2.2% growth in real growth rate on the annual average by 2015 (Kitabata, Oshita, Saito 2016).

This goal has been adopted as it is in "Economic Growth Strategy Outline" formulated by the Fiscal and Economic Integrated Reform Council in 2006. However, since the Economic Growth Strategy Outline, the real growth rate of Japan's GDP is in a situation where the long-term declining trend has not stopped, as shown in Figure 4. Even in the face of such a reality, there is something persistent about the growing faith that prevails among economists. Hiroshi Yoshikawa states as follows. "Even in a mature, developed nation, economic growth that fits each economy, as if it is more comfortable for each person to walk at the pace that suits him rather than staying still for a single point for a long time, it is much more natural than zero growth. Under zero growth, employment of the current working generation, especially young people, has no choice but deteriorate. From that viewpoint also, economic growth is necessary. That is my opinion." Then, he insists that product innovation is "source of economic growth in developed countries (Yoshikawa 2016)."

If the productivity per capita multiplied by the working age population is GDP, and if the productive age population decreases unless productivity per capita is raised at a rate that exceeds that of decrease, we cannot expect a GDP growth as compared to the previous fiscal year. This is the same with the demand aspect, and economic growth cannot be expected without acquiring foreign demand to the extent that it can supplement the decrease in domestic demand due to the declining population. Even if he states that economic growth is possible, without verifying its feasibility, it is probably not convincing. The group of the Ministry of Economy, Trade and Industry, mentioned above, named its strategy the "new strategy," and in those words are written, "We would like to show that growth is possible even in the society where the population is going to decrease from now. This is the new growth." Their extremely emotional obsession with growth is humorous and at the same time harmful.

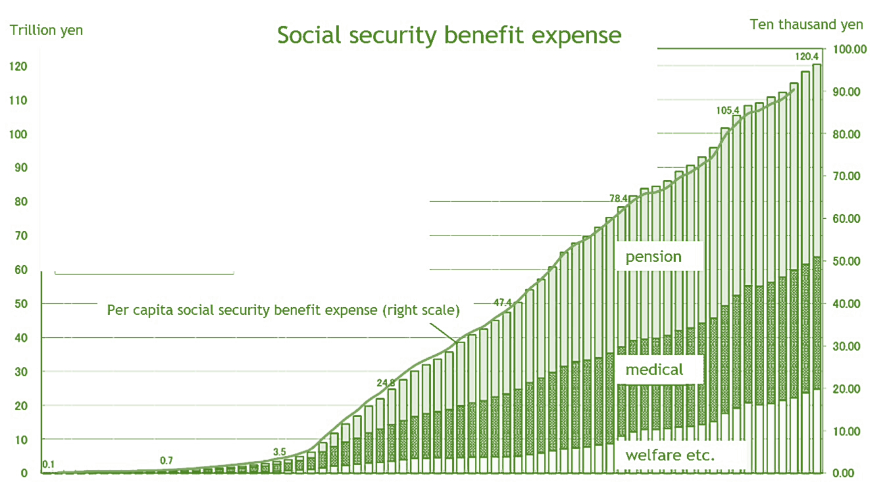
2. Lessons from Japanese "degrowth" experiences

2.1. "Degrowth" is not a sufficient condition of a sustainable society

Here's a question. Has Japan as a degrowth society become a sustainable society? The answer is no. In population declining society, various sustainability issues are emerging. Degrowth does not guarantee the sustainability of society.

First of all, in Japan, aging is proceeding as well. For this reason, social security expenditures such as medical care and nursing care are rapidly increasing (Figure 5). This can be regarded as deterioration in the human capital base.

FIGURE 5. SOCIAL SECURITY EXPENDITURES IN JAPAN



Source: National Institute of Social Security and Population Research.

Decreasing population means it is a decrease in the labor force to care for physical capital such as artificial capital base and natural capital base. Concerning the artificial capital base, various buildings and construction made during the rapid growth period will have their renewal timings concurrently. For example, at the Ministry of Land, Infrastructure, Transport and Tourism, renewal, maintenance, and management expenses in the infrastructure improvement will increase sharply, reaching 15 trillion yen around 2030 which is almost twice as much from now, and it is expected to maintain the same level after that.

If the population declines, will nature be enriched? This answer is also no. Regarding the natural capital base, it means that the once human-made nature such as artificial forests and agricultural land will be abandoned. For example, according to the agriculture and forestry census in Japan, the number of forestry workers has declined rapidly from 146,000 in 1980 to 51,000 in 2010. Besides, the number of workers engaged in agriculture as a work decreased from 5,428,000 in 1985 to 1,754,000 in 2015. The average age of agricultural workers is 67 years old in 2015, and it is expected that the number of agricultural workers will further decrease in the future. The abandonment of nature leads to deterioration of the quality of nature. In the national biodiversity strategy of Japan, the impact of reducing and withdrawing human action against nature is regarded as a crisis of biodiversity. Managing the breeding of wildlife, such as wild boar and deer, mainly on abandoned artificial forests is an issue.

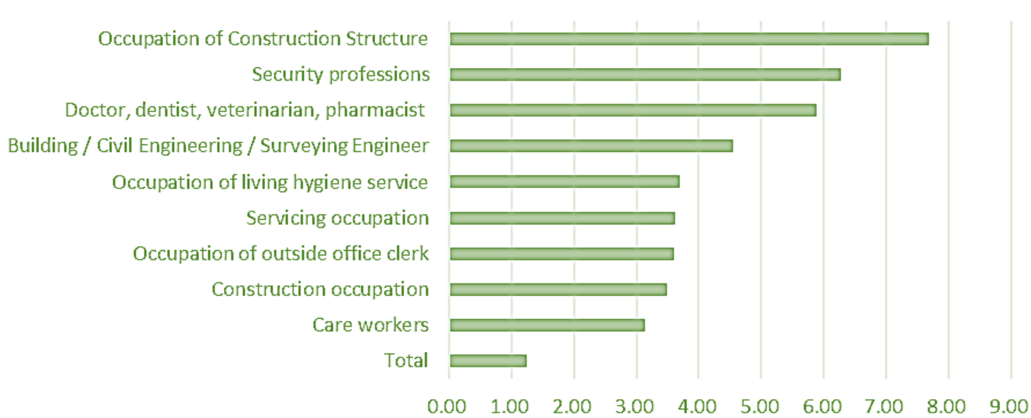
Furthermore, as the population declines, the network of cooperation among people is compromised as symbolized by words such as lonely death, shopping refugees, and disconnected society. It is a deterioration of the social capital. For example, the single household the ratio was 18.2% in 1986, but it is predicted that in 2030 it will double to 37.4% by the National Institute of Social Security and Population Research, Japan. In this way, in the population declining society, the sustainability of society is threatened by the deterioration of the four capital bases of the human capital base, the artificial capital base, the natural capital base, and the social capital base. Thus degrowth would not guarantee the social sustainability.

2.2. Shortage of 'cark work' becomes a problem rather than work sharing

In various degrowth literature (Jackson, 2009; NEF, 2009; Kallis *et al.*, 2012), there is a recognition that less growth means fewer jobs. Latouche and Harpages insist that "let's reduce the amount of work to live better" (Latouche and Harpages, 2010). However, Japanese lesson tells that since a 'degrowth' society faces a shortage of labor force, the necessity of work sharing is low.

In Japan, especially in the industry related to the care of the four capital bases, including, doctor, care service worker, construction worker, and various service occupations, the shortage of labor is becoming severe (Figure 6).

FIGURE 6. JOB OPENINGS MULTIPLIER IN JAPAN BY OCCUPATION WITH HIGHER RATES



Source: Ministry of Health, Labour and Welfare, Japan.

We would say these occupations, which engage in, maintain and care the four capital bases as 'care work.' Care work for the human capital base includes job categories such as childcare, education, medical care, and nursing care. For the artificial capital base, job categories such as architecture/construction, repair, and recycling are applicable. The sharing service that has been drawing attention can be categorized as a kind of care work from the point of utilizing the existing artificial capital base. Typical care work industries for the natural capital base are agriculture, forestry, and fisheries. The renewable energy industry can also be said a care work sector for the natural capital base. As a care work related to the social capital base, NPO and the like concerning town development including civil servants and shopping districts may be applicable.

'Care work' has a characteristic that it requires a certain technique and mass production cannot be performed because it must properly perform maintenance according to the object. For this reason, it is a business with a generally low margin. Under the declining population, shortage of human resources will become obvious earlier in industries corresponding to 'care work.'

2.3. Universality of Japanese experience

Japan is not the only country facing a declining population. There are several countries where the population is decreasing, including Bulgaria, Georgia, Greece, Hungary, Italy, Latvia, Poland, Portugal, Romania, Spain, and Ukraine. Thus, Southern Europe and Eastern Europe have already entered a declining population. According to the United Nations' population forecast, in Asia and Latin America, the population will decrease with peaks around 2060. On the other hand, in Africa, North America and Oceania, it is predicted that population growth will continue until 2100. Speaking roughly, we would say that in nearly half of the world, in the near future, as in Japan, the population will fall. Thus the sustainability issues in population decreasing society would be a worldwide issue shortly.

3. Reconstructing ecological economics based on lessons learned in Japan

3.1. 'Degrowth' and ecological economics

In ecological economics, it seems that interest has been biased toward 'degrowth'. Weiss and Cattaneo (2017) reports that "the first articles referring to 'degrowth' in their title appeared in the English academic literature around the year 2006. By 31 December 2015, 91 articles had been published." They counted 18 out of the 91 articles (19.8%) were published by Ecological Economics.

One of the central issues in Ecological Economics has been 'sustainable scale.' Daly (1992) defined that scale as "the physical volume of the throughput, the flow of matter-energy from the environment as low-entropy raw materials, and back to the environment as high-entropy wastes." And, he wrote, "economic theory needs to catch up with policy in recognizing that scale issues cannot be reduced to either allocation or distribution."

The target of 'Degrowth' is the physical volume of the throughput. The Japanese experiences tell us that the control of the volume of the throughput is not enough to assure the social sustainability. We need put another aspect into the theoretical system of ecological economics, namely the sustainability of capital bases.

3.2. 'capital bases' and 'throughput resources'

Then, we would like to define what capital base is. The capital base is defined as an existence with a mechanism that brings usability in which it will not be lost by providing usability. The word 'capital' includes the meaning of a financial asset whose purpose is to be increased. Words such as capital, fund, and stock are often interpreted as words that are related to the management of financial assets. Therefore, we decided to use the term 'capital base' instead of 'capital' only.

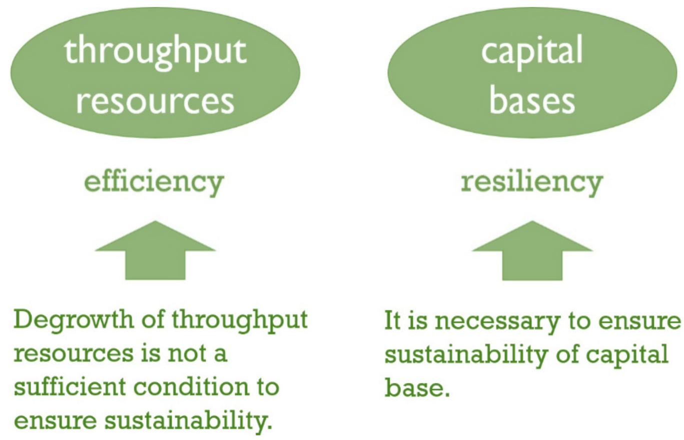
The 'capital base' is a similar concept of the fund-service resources in ecological economics. Georgescu-Roegen (1971) pointed out that 'fund' and 'stock' are different. He uses a hotel room or a light bulb as an example of a fund and a piece of candy as an example of stock. Daly and Farley (2004) made a distinction between 'fund-service resources' and 'stock-flow resources'. The former is a resource which "suffers wear and tear from production but does not become a part of (does not embodied in) the things produced". The latter is a resource which "is materially transformed into what it produces".

On the other hand, we also want to define the concept of 'throughput resources' as a concept equivalent to the stock-flow resources. Throughput resources are defined as a resource that deforms physically when providing usability and do not remain. The use of throughput resources leads to an increase in environmental burden, which refers to the impact added to the physical environment by human activities and needs to be assimilated using ecosystem services. If the environmental burden occurs, the volume of ecosystem services will decrease.

Exhaustible resources are those in which the mechanism of the natural capital base that produces the resource is lost. Mineral resources and fossil fuels are typical examples. On the other hand, renewable resources are those that have not lost the capital base function that produced the resource. For example, sunlight, wind, waves, geothermal, tides, and biological resources (biomass) are typical. It runs out if it exceeds the update speed. Water is renewable if it can be updated by water circulation systems (natural capital base) like rainwater, surface water, and seawater. If it is separated from the water circulation system like the desert groundwater or glacier, it is an exhaustible resource. Crops are renewable throughput resources, and agricultural land is a capital base that produces crops which combine the natural capital base and artificial capital base. A captured fish is a renewable throughput resource, and the system that reproduces fish is the capital base for fish. Even when fully cultivated, the species of fish itself is a natural capital base.

The notion of 'degrowth' is concerning with the physical volume of the throughput resources. The keyword for the throughput resources management is efficiency. However, 'degrowth' of throughput resources is not a sufficient condition to ensure social sustainability. Ensuring sustainability or resiliency of capital bases is necessary (Figure 8).

FIGURE 8. 'CAPITAL BASES' AND 'THROUGHPUT RESOURCES'



Source: author.

3.3. Principles of throughput resources management

Before step into the explanation of capital base management, we will briefly explain how to manage throughput resources. We need to make policies to improve the efficiency of throughput resources. The overall ecological economic efficiency of Daly (1996) is a rare attempt in ecological economists to indicate the way to improve the throughput efficiency (Figure 9). In Figure 9, MMK stands for man-made capital and NK for natural capital. As Jollands (2006) commented, "ecological economists have done little work to apply his concept or develop his ideas further." The most significant deficit in Daly's efficiency is that stock indicators such as MMK stock and NK stock are placed in the identity. That is, this identity is mixed with stock indicators and flow indicators. Furthermore, the amount of NK stock would be given by nature and would be out of human control.

FIGURE 9. DALY'S OVERALL ECOLOGICAL ECONOMIC EFFICIENCY

$$\frac{\text{MMK services gained}}{\text{NK services sactificed}} \equiv \underbrace{\frac{\text{MMK services gained}}{\text{MMK stock}}}_{\boxed{\text{service efficiency}}} \times \underbrace{\frac{\text{MMK stock}}{\text{throughput}}}_{\boxed{\text{maintenance efficiency}}} \times \underbrace{\frac{\text{throughput}}{\text{NK stock}}}_{\boxed{\text{growth/harvest efficiency}}} \times \underbrace{\frac{\text{NK stock}}{\text{NK services sacrificed}}}_{\boxed{\text{ecosystem service efficiency}}}$$

Source: Daly (1996: 84).

Figure 10 shows the modified version of the identity of throughput efficiency. First of all, throughput resources would serve to increase in various services by the production of various capital bases and creation of new throughput resources. Also, we omit stock indicators and use flow indicators only such as amounts of throughput resources and environmental load.

FIGURE 10. ECOLOGICAL EFFICIENCY OF THROUGHPUT MANAGEMENT

$$\frac{\text{amount of increase in services}}{\text{amount of decrease in ecosystem services}} \equiv \underbrace{\frac{\text{amount of increase in services}}{\text{amount of throughput resources}}}_{\boxed{\text{service efficiency}}} \times \underbrace{\frac{\text{amount of throughput resources}}{\text{amount of environmental load}}}_{\boxed{\text{impact efficiency}}} \times \underbrace{\frac{\text{amount of environmental load}}{\text{amount of decrease in ecosystem services}}}_{\boxed{\text{assimilation efficiency}}}$$

Source: author.

The first ratio is named 'service efficiency' of throughput resources. The second ratio 'impact efficiency' measures the degree of environmental load per unit of throughput resources. Coal energy is not an impact efficient option compared to solar energy. The third ratio 'assimilation efficiency' reflects the degree of decrease in ecosystem services per unit of environmental load. If we emit environmental load in a fragile ecosystem, the amount of decrease in ecosystem services would be more substantial.

To improve the throughput efficiency, we need to give an appropriate price for the usage of throughput resource. This would lead a degrowth society.

3.4. Principles of capital base management

Principles of capital base management would be different from the ones of throughput resources management. There are several keywords in capital base management. One is 'thresholds.' There are thresholds in the capital base where the mechanism that brings usability cannot be sustained. For example, the human capital base has various conditions for sustaining human life and health. The artificial capital base has various conditions concerning maintenance, repair, and renewal of artifacts. The natural capital base has various conditions for securing the usability of agricultural land, forest land, and the like. Regarding social capital base, although it is not as bright as the other three capital bases, a threshold of human occupancy conditions (number and density) for sustaining people's cooperative relationship is assumed.

Another keyword is 'care.' Although capital base does not disappear as it is used, it is possible that it could be irreversibly lost its mechanism if it exceeds the threshold. If it is cared, the capital base can be used for longer periods of time. Furthermore, care can also increase the amount of service that the capital base is able to provide per unit of time. Care does not create anything new. It is necessary to recognize that the concept of 'care' is different from the concept of 'production,' which is the creation of new services.

The level of threshold is sometimes unclear, especially for natural capital bases. So we need to monitor the status and to prepare for the unexpected situation. Levin (2000) presents eight commandments of environmental management: (1) reduce uncertainty, (2) prepare for unexpected circumstances, (3) maintain inhomogeneity, (4) keep modular structure, (5) secure redundancy, (6) strengthen feedback, (7) build relationship of trust, and (8) provide things you want to other people as well.

We propose following five principles of capital base management. Firstly, *threshold identification;* we have to estimate the threshold beyond which the system can no longer be sustained longer. Second, status monitoring; it is necessary to install a monitoring system for checking whether the system is approaching the threshold. The third one is *impact management*; we must implement compensatory measures for environmental load that occur even after making efforts to minimize environmental load. Fourthly, *disturbance handling*; we have to take measures to secure a sufficient amount of resilience even if part of the system is damaged due to an external disturbance. Lastly, *adequate care*; we must take care in a suitable manner corresponding to the physical state of the capital.

It should be noted that there are principles that will not come out from the idea of pursuing efficiency in the market. For example, pursuing only profit maximization invites the planting of similar crops and leads to the creation of vulnerable ecosystems.

4. Capital base management and "Degrowth"

In a society with a declining population, it is necessary to re-define the economic indicators. Boulding (1966) pointed out 50 years ago about the necessity of converting from flow indicator to stock indicator. He said the economy where environmental constraints are actualized (the spaceman economy) is different from the economy without environmental constraints (the cowboy economy) and stated as the following. "In the spaceman economy, throughput is by no means a desideratum, and is indeed to be regarded as something to be minimized rather than maximized. The essential measure of the success of the economy is not production and consumption at all, but the nature, extent, quality, and complexity of the total capital stock, including in this the state of the human bodies and minds included in the system. In the spaceman economy, what we are primarily concerned with is stock maintenance, and any technological change which results in the maintenance of a given total stock with a lessened throughput (that is, less production and consumption) is clearly a gain."

The discussion of Boulding indicates that it is not appropriate to set the expanding of flow of physical production and consumption as an indicator for good economy. If you focus on the environmental burden accompanying the use of resource energy, and it is necessary to switch to an indicator of keeping the state of the capital stock, which human life is based on, healthy. However, despite the global environmental constraint of global warming becoming apparent, we are still not fully aware of the environmental constraints associated with the use of resource energy, so flow-based economic indicators as symbolized by the growth rate of GDP compared to the previous year are emphasized in the economic management of countries around the world.

However, due to the declining population and the aging of society that Japan faces, the expansion of flow has become difficult due to the shrinking of population base supporting the economy. At the same time, it has become impossible to cover the necessary care work for the capital base in the region. Through these two factors, inevitably, we had no choice but to switch the economic indicators from flow-based to stocked-base and think about the sustainability of the capital base stock.

One possible indicators focusing on the capital base are the indicators for measuring how much the needs of care for the capital base is satisfied; such as the proportion of care recipients/ patients who are appropriately receiving nursing care/medical service, the proportion of buildings/infrastructure that are appropriately maintained and renewed, and the proportion of cultivated land/artificial forests that are appropriately maintained and managed.

Concerning these indicators, we can set targets in a positive direction even in a society in which the population is decreasing. It will aim for a richness towards increasing the amount of healthy stock per capita.

The policy of capital base management in a population declining society may function to reduce the size of society. In Japan, a compact city is one of the keywords in urban planning. We need to build a consensus regarding the amount of a capital base that should be maintained. Although it is difficult to reduce the number of people through policy, the amount of the artificial capital base can be reduced by choosing to destroy it, and the amount of the natural capital base can be reduced by switching over to natural renewal. If you have an excessive capital base, you will not be able to maintain it. In this way, capital base management could lead to a reduction in the size of society.

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A policy compass for ecological economics

Michèle Friend*

Introduction

A policy compass indicates the direction in which an institution is going in terms of three general qualities. The three qualities are: suppression, harmony and excitement.

Any formal institution can develop a policy compass to examine the discrepancy between what the institution would like to do (suggested in its mandate) and the actual performance and situation it finds itself in. The latter is determined through an aggregation of a table of statistical data and facts. The aggregation is made robust and stable, and therefore relatively objective, using meta-requirements of convergence.

Here, I present a version of the compass adapted to embed the central ideas of ecological economics: that society is dependent on the environment, that economic activity is dependent on society; that we live in a world subject to the first two laws of thermodynamics; that the planet we live on is limited in space and resources; that some of our practices have harmful and irreversible consequences on the natural environment; that there are values other than value in exchange, such as intrinsic value and use value.

In this paper, I display the policy compass in general. This is followed by the adaptation for ecological economics. The policy compass is original, and so is the adaptation. The compass is inspired by the work of Anthony Friend, Rob Hoffman, Satish Kumar, Georgescu-Roegen, Stanislav Schmelev, Peter Söderbaum and Arild Vatn. In the conclusion, I discuss the accompanying conception of sustainability.

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Sometimes policy decisions are made only on the basis of a monetary calculation – for maximising profit. This is appropriate when maximising profit in the short term is the highest or only consideration. At best, this is suitable for profit-only businesses, or for institutions in financial crisis, although even this is disputable (Varoufakis 2017). It is inappropriate on other occasions and for other institutions, when we have a mandate that is partly normative and qualitative.

While I hesitate to offer a diagnosis, I suspect that we make policy decisions in this way because we have one numerical figure: a money amount. This is thought to be simple, objective and we believe we understand it. Moreover, we think that if our institution has surplus money, then we cut ourselves the slack to execute the real mandate better. In other words, all too often, we *defer* trying to realise the mandate *directly* under two sorts of pressure, one is that it is too complicated to explain or understand the implications of non-monetary policy, the other is that at a later date, when we have the cash, we can think at greater leisure how to better realise the policy and what that means. So, even when the mandate is clearly not monetary, policy decisions are made in monetary terms.

This is no accident. In the modern world, our acceptance of finance-based decisions is systemic. In the modern world, we are taught from a very young age to behave as *homo-economicus*, and that institutions are 'better off' if we make similar sorts of decision for them. Universities increasingly teach only neoclassical economic theory (Söderbaum, 2017, 26). We believe that we understand credit and debit, and we do to some extent, but as a 'value' it is highly abstract and only reflects value in exchange. It follows that in many instances making policy decisions based the idea of maximising profit is inadequate.

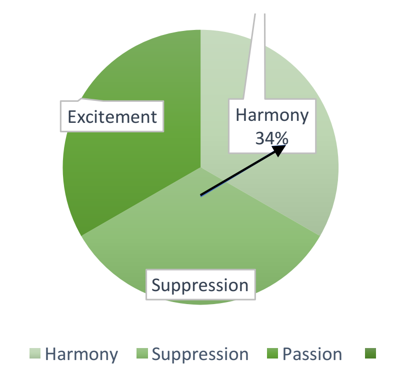
As a policy maker, we could be more sophisticated. We could use some of the many lovely tools for making policy decisions: have recourse to multi-criteria decision aides as found in Shmelev (2012). Fitoussi, Sen and Stiglitz, propose a 'dash-board' of such decision aides (Fitoussi *et. al.,* 2010). But, unless one is trained to read these representations of data, or to read a table of data, it is very difficult to use them to make a policy decision. It is even harder to justify that decision to people who lack the training. Of course, one could defer to the authority of an expert trained in using such aides, but then we replace democracy with technocracy. (Söderbaum 2017, 35).

In this paper, I propose a *new* tool for policy analysis, justification, development and change. I call it a 'policy compass'. It can be used for policies in any institution. Here, I adapt the policy compass to reflect the very important ideas in ecological economics: that the economy is a subset of society, and society is a subset of the natural environment. Here, 'subset' is an existential dependence relation. I include in ecological economic thinking the ideas that: we live in a world subject to at least the first two laws of thermodynamics, the planet we live on is limited in space and resources, some of our practices have harmful and irreversible consequences on the natural environment (Rapport and Maffi 2010) and there are values other than value in exchange, such as intrinsic value and use value.

Visually, the policy compass is something very simple and intuitive. See figure 1. This makes it easy to use for development and justification of policy. To construct a compass, we weigh and assess individual statistics and facts, entering the data on a table. We then represent each statistic on the compass and mathematically aggregate them to make one arrow. The compass has three sectors: suppression, harmony and excitement. The constructed arrow indicates the *direction* in which the institution is heading. The final arrow is in one of sectors, reflecting the fact that the statistics, when aggregated, show that *overall*, the institution displays this quality more than the others. The angle of the arrow *within* the quality indicates the degree to which it approaches, or tends away from, the other qualities. The length indicates the strength with which it sits in that quality. A shorter arrow would indicate more balance between the three qualities.

Behind the simple final representation lies a culturally sensitive, statistically robust and holistic construction.

FIGURE 1. A POLICY COMPASS



Following Kumar (2007), the general qualities are inspired by the three gunas of Hindu, Jain and Buddhist philosophy: *tamas*, *raja*, and *sattva*.[1] I translate these as: suppression, excitement and harmony, respectively. These are general, in the sense that other qualities fall under them.

Policy decisions are then made on the basis of the 'final arrow', as depicted in figure 1. With the arrow, we can then make, analyse, critique and adjust decisions about the general qualitative direction of the institution, based on the angle and length of the arrow. As an institution, we might want to lengthen or shorten the arrow or we might want to change its sector or angle within a sector. How we create a new policy, how we adapt or change a policy, how we analyse or criticise a policy, how we justify a policy will then depend on the table of statistical data.

We can be superficial in our policy decisions. We can create, adapt, analyse, criticise or justify a policy in a very *superficial* manner by addressing or gerrymandering the *representation* of the statistics that swings, lengthen or shorten the final arrow. Or, we can create, adapt, analyse, criticise or justify a policy in a *superficial* manner by addressing *particular statistics* that help or hinder the direction or length of the arrow. Or, *more deeply*, we can look at the *underlying causes* of the dominant statistics. The soundness and longevity of a policy will depend on the depth of analysis.

The following sections give the structure of the paper: (1) getting an overall sense of the trisected compass and how the statistics fit. (2) The method: choosing particular statistics,

1 The idea of contrasting these qualities is present in several deep religious traditions. I am not engaging the traditions as such. In particular, I distance myself from particular religious conceptions of when and how to apply them and how they interact with each other. I simply follow Kumar and make use of three qualities that can be applied to any institution. The meta-analysis of what to do when a particular quality is present and dominating will depend on the institution and it's cultural setting.

assembling them in a table. (3) The adaptation of the method to reflect the conceptions and normative concerns of ecological economics. (4) The policy compass and what it helps us to understand about our conception of sustainability. (5) Philosophical reflections and conclusion.

1. Explanation of the General Qualities

We start with three very general qualities.[2] They are inspired by[3] the three *gunas* of ancient Hindu, Jain and Buddhist literature. The *gunas* are: *sattva*, *raja* and *tamas*. Each of these general qualities, has sub-qualities. Examples of sub-qualities of harmonious are: pure, good, constructive, respectful, pleasant, soft, easy, light, natural and seamless. Examples of sub-qualities of excitement are: active, plush, lively, confused, regal, passionate, sensational, perfumed, exotic, brassy, colourful, showy and spectacular. Examples of sub-qualities of suppression are: darkness, destructive, harmful, painful, chaotic, stinky, abrasive, constricting, despotic, putrid, diseased, depressing, morbid, violent, invasive and violent.

The importance of the three general qualities is that on considered reflection, every object or institution will have one that predominates. Time has the three qualities. "Living in the here and now, acting spontaneously and unselfconsciously, responding to a situation as it is and seeing the present moment is sattvic." (Kumar, 27). "Dwelling on the future is rajasic [especially when] … we become involved in exciting projects." (Kumar 28). "Living in the past is tamasic: Why did you do that? Why didn't I do that? You shouldn't have done that! We complain and moan." (Kumar 29). Food has the three qualities: sweet and light food is sattvic, spicy food is rajasic and heavy and stale food is tamasic. (Kumar, 30). Buildings have these qualities. Houses are sattvic, palaces are rajasic, prisons are tamasic. (Kumar, 34).

Try the following exercise: compare a primary school, a prison and a world-class sports team. The primary school falls under: 'harmony'. This is because it is normal for children to receive a primary school education. This helps to unite the society, giving the students social skills and literacy in numbers and letters so that they can communicate more widely. The prison falls under: 'suppressive' since prisoners are restricted in their movements, have little control over their daily routine, are punished for disobeying rules and are constantly watched. A more enlightened prison aiming at re-integration in society will still be suppressive, but, provided that the techniques used are kind and constructive, its arrow will tend more towards harmony than that of a retributive prison. The world-class sports team falls under: 'excitement'. They show outstanding physical ability, are matched only by the best in the world, bring pride and excitement to those who follow their results and they might enjoy a high degree of publicity.

Within an institution, we also see the three qualities. For example, in the primary school, rules and punishments are tamasic, performances to parents, such as end of year plays are rajasic and general health and normal accomplishments of students are sattvic.

Outward appearances and first associations might be deceptive. A person might be very wealthy and live in a rich dwelling, so we would suppose that person to be *rajasic* or exciting, but spiritually, he, or she, might be serene and modest and so *sattvic* or harmonious. In contrast, a person might appear modest and unassuming, so appear *sattvic* or harmonious, but on a

2 We might think of these are meta-qualities.

3 The use of the guna terms is only meant as a conceptual inspiration. It is not meant as a spiritual exercise in Hindu philosophy. The choice of the concepts of the three gunas will be discussed in the conclusion.

spiritual level be full of rage and greed, and so is more *tamasic*, or suppressive. The analysis for the entering data on the table is better if we are sensitive beyond mere appearance.

Not only might outer appearances be deceptive, but institutions and people change in their general qualities. For example, a school might change over time. It might start as harmonious in its first years, then it might move into the general quality of passionate as it gains a strong reputation and gains a reputation for academic success. In an attempt to protect the high reputation, the school might become suppressive: with more rules, high standards (so failing more students) and an increase in ruthless measures taken to remove students who disrupt the flow of teaching, and mar the reputation. So, general qualities of an institution can change over time. We can track such changes by looking at the statistics that separately indicate the general qualities at different times.

The statistics are entered on a table. Each statistic is represented as an 'indicator arrow'. They are mathematically aggregated, to make a final arrow that represents the whole table of data.

With the final arrow, we can take different attitudes towards what the arrow indicates, and we can be more or less subtle in our policy changes. In general, and in Ancient Indian philosophical thinking, *sattva*, or harmony is the path of wisdom. So we seek to re-balance a person or an institution by guiding them more towards harmony. In Western and Modern thinking, where we seek indications of 'progress', we tend to be attracted to excitement in an institution. In Ancient Indian philosophy, we are warned against the danger that excitement falls towards suppression. For example, as school policy makers for our passionate school, we are under the threat of the arrow moving too much towards suppression. We then can make a choice about what attitude to take: to align policy with Ancient Indian Philosophy, or with more Modern thinking. This is a philosophical choice that we make, and we should do so consciously, that is conscious of our having made a philosophical choice.

We might be very superficial by changing the way we enter data in the table. We might be (merely) superficial, by addressing particular statistics, or we might be deeper in our analysis by looking at underlying causes of favoured or disfavoured indicators. How superficial we want to be in our analysis depends on how deep we want our justification to be for policy changes or decisions, and on the longevity we wish for those decisions.

Claim 1: The deeper the analysis, ceteris paribus, the greater the longevity of the policy.

So, we can make, analyse, justify, criticise, modify policy based on the final arrow and our ambitions for the institution. This is the purpose of the policy compass. How do we make the table?

2. The Indicator Arrows: Choosing Statistical Data

The final arrow is the result of aggregating statistical data represented by indicator arrows that represent statistics. To make a table, we choose data that is available, accurate (recent, representative and sufficient) and which we can safely assume will be available in the future (if we are interested in comparing policy of one institution over time) or is available for comparative institutions (if we want to compare institutions to each other). Thus,

Step 1: our first task is to find some data on the institution.

Step 2: verify that the quality of the data is reasonably high.

Such tasks are not meant to be very controversial, at least in the 'Western'/ 'Northern' world, but might be much more challenging to carry out in some communities or for some institutions. A more stable and formal institution, such as a government, a well-established industry or a university will all have relatively high quality data available for analysis. We now start the special work for the compass.

Step 3: for any institution, and for the data available, categorise the data in terms of the general qualities.

This third step is not all that mysterious, but there are some complications to be seen soon. Starting with the banality of the step: when someone informs us of a statistic, he, or she, does so to indicate a general quality to which we are supposed to react emotionally. The person might elicit the general sensation: that by-and-large everything is running smoothly (harmony), or that we should be on our guard, feel angry, frustrated or want to take political action (suppression) or that we should feel excited, proud/ jealous or passionate. A borderline feeling such as 'alarm' might be thought of as part of suppression and tend more-or-less towards passion. To construct the compass, we want consider statistics that each *positively* indicate *one* of the three general qualities. By 'positively' I mean that the statistic indicates the *presence* of the general quality, not its absence. This is a bit confusing with suppression, since it is often thought to be a 'negative quality'.

To dispel the confusion, distinguish between the numerical conception of 'positive' and the emotional or normative conception of 'positive'. We choose statistics that *numerically* positively represent suppression. If they very strongly represent suppression then they will have greater length. For example, negative (in our feeling) national statistics that will positively (in the numerical sense) show suppression is the number of: suicides, fatal accidents, crime rates, natural disasters or percentage of prisoners. If these are small, negligible or not alarming, then we still place the indicator in suppression, but we shorten the length of the arrow that represents the statistic on our compass.

This reflection on the qualitative and emotional reaction to the data draws a *normative* and *culturally sensitive* aspect to the analysis. This is deliberate, and is considered to be a strength of the compass: that we can now be quite explicit as to where and in what sense our policy has a normative element, and that different cultures might react in different ways to the 'same' statistic, and might change their reaction over time. For example, what used to be alarming rates of death by motor car accident has changed over time.

If there is too much disagreement about which general quality a statistic belongs to, then drop that statistic and look for another, or split it into two statistics with details that make it clear which general quality it exemplifies. For example, we might have to be explicit about the perspective from which a statistic is viewed: from this perspective the indicator indicates this, but from that perspective it indicates something else. We now have two indicators. The sub-culture sensitivity is then made explicit in the table by adding qualifying remarks to the name for the statistic.

Summarising: the third task is delicate but also adds normativity and depth. Continuing with the method, we want to represent each statistic as an indicator arrow on the circle. The first task is sufficient for us to draw arrows at all. The second task ensures reliability. The third task situates each indicator arrow in one of the sectors. We draw a table with one column for general quality, a second column for the name and any qualifiers. See table 1. What of angle and length?

TABLE 1. AN EXAMPLE OF A TABLE FOR PLOTTING INDICATOR ARROWS

General Quality	Name of Indicator and Notes	angle	length
Harmony	Stability in wages	100	.5
Harmony	General good health of employees	30	.8
Harmony	Natural zone in space	110	.2
Passion	Money earning charity drive	140	.2
Passion	Publicity for art show	240	.2
Passion	Tree planting	150	.1
Suppression	Money ill spent on equipment	320	.6
Suppression	People fired from company	270	.6
Suppression	Use of energy in building	280	.3

We now have to be even more sensitive to culture and pay close attention to the nuance surrounding the qualitative measure of the indicator arrow. Some statistics will fall in the middle of the third, and some will tend towards one of the other thirds, in limit cases an indicator arrow might sit right on the border between two qualities. In such a case, I recommend that we choose another statistic, for reasons concerning the aggregation technique. To determine the degree of the statistic, we design a protocol.

Step 4: For the indicator arrows, choose or make up a protocol to determine the precise degree, or angle.

One easy protocol is to use visual feedback. We display an indicator arrow on the circle and see how decision makers feel it represents its share in the major and lesser quality, we move it around, discuss the changes until we reach consensus.

An alternative protocol is to vote. Say, a large group decides on an indicator arrow for the suppressive third. We then vote on whether the arrow should then swing towards harmony or passion. If 20% would swing the arrow towards harmony, and 80% would swing it towards excitement, then since there are 120 degrees allotted to suppression sector, the arrow will be 960 towards passion.

We might want to do something more sophisticated than 'yes or no' voting, and have weighted votes, so people who feel strongly, medium or lightly about their choice. We might also want some voter's votes to count more than others and so on. These choices about protocol are *worth* discussing and considering carefully, since they indirectly answer to claim

1. Eliciting these discussions and being explicit about the decisions made is a deliberate part of the exercise of constructing the table for the compass. These questions are philosophical and important. But they also answer to robustness considerations which we shall see next.

When making policies, based on statistical findings, it is highly relevant and important to have these discussions about what it is that a statistic indicates in general, and not be afraid to change the name of the indicator to reflect further subtleties. Such discussion might be long and frustrating for some people, but they will save time in the long run, due to the stability of the policy. The stability is promoted by robustness. This is increased by (i) understanding how others react to statistics, (ii) by the transparency of the procedure, (iii) by increasing the number of people consulted and (iv) by increasing the variety of types of people consulted.

What of length? This is just as important as degree, but in some ways it is less problematic. Length of arrow is a numerical measure that is used for comparison of that statistic with others of the same sort. Length will be nothing more mysterious than a function of scale, what we think are reasonable parameters and where other comparable statistics lie. To dispel the mystery, think of our usual representation of comparative statistics. We start by stating a fact. For example: the average longevity of the population is seventy years. This bald statement will elicit no emotional reaction without some context which might be known already or which might need to be articulated. Say that this is the statistic today, and that it was higher twenty years ago, when it was seventy-six. To represent the relationship between the two statistics we draw a graph with a bottom line labelled with a progression from left to right to indicate time, and another vertical line at the left labelled bottom to top to indicate measures of longevity. We usually will miss out the possibility that longevity is equal to 0 – 50 years. The maximum would be, say, 100 years. The dates will not start with the beginning of mankind, but might track longevity over the last 50 years. We then plot the two measures on the graph. We decide on the scale and parameters of representation almost without thinking, and deciding on the length of the arrow for the compass is the same.

However, there is a subtlety we should address immediately. We should not confuse the (a) exercise of fitting the representation aesthetically on a graph, with (b) gerrymandering the representation it in such a way as to increase/ decrease an emotional reaction. Whether the representation elicits alarm or not will depend on choice of scale.

In the case of our indicator arrow on the circle, its length is then determined as a function of scale relative to the radius of the circle, so the maximum length is the full radius and the minimum is zero. For each indicator arrow, we fix the parameters according to what is reasonably imaginable. The statistic is then very high if the number reaches the edge of the circle but is low if it is close to the centre.

(b) We might want to work backwards and 'down-play' the emotion elicited. We then change the scale. This is not recommended for reasons of robustness, or objectivity which in turn depends on honesty in representation.

Now note: say longevity of a population belongs in harmony. A high longevity is more harmonious, say, than a low longevity, subject to considerations about what it is that is influencing the statistic be it for suppressive reasons (no laws allowing people to terminate their lives, so the quality of life is very low at the end of life) or for passionate reasons (the quality of health is very good even at the end of life). To re-enforce the quality of harmony, the arrow will be longer. A longer average longevity brings the arrow closer to the edge of the circle.

Step 5: For every indicator arrow, determine the length of the arrow following some protocol.

None of the above tasks is impossible, although for some analysts or policy makers it might be worth making the protocol explicit, again adding depth to the exercise. Developing the indicator arrows and accompanying protocols is the hardest, most time consuming and most qualitative and normative part of the exercise. However, for making future compasses, once the norm is in place, the discussions about protocol might not have to be revisited each time for each statistic. So, the time invested in deciding on protocol in the first place is well worth the effort in the future.

Step 6: Enter the statistics on a table with four columns: the general quality, the name and any qualifiers, the angle and the length.

Having chosen and developed the indicator arrows, we enter these in a table. Each arrow has a general quality, a name, an angle and a length. See table 1. We use an aggregation technique to end up with a final arrow that represents the table of data in terms of the three general qualities. See figure 1.

To read the final arrow we would see that the institution in question is in the harmony sector. The arrow is fairly long, so the institution is strongly in this sector. We might be quite satisfied with this result, depending on our culture, the mandate of the institution and its context. If we want to change the final arrow, then we look back to the table.

We can now make new policies based on the final arrow, change existing policies, criticise policies and justify policies. We make the new policies, changes, criticisms and justifications based upon recovering the story we told in developing the indicator arrows. As was remarked in the previous section we can perform these exercises in a superficial manner or in a deeper manner. If our arrow is robust, then the margin between superficial and deep treatment diminishes.

3. Adapting the Compass to Align it with Ecological Economic Thinking

We now consider our institution from the perspective of ecological economics. This has three separate elements, the first conceptual, the second conceptual-normative and the third is ethically-normative.

The conceptual element is that we think that economic activity, the econo-sphere is dependent upon, society. The socio-sphere and society is dependent upon, the physical and biological environment: the eco-sphere. We also consider that we live in a world subject to at least the first two laws of thermodynamics; that the planet we live on is limited in space and resources; that some of our practices have harmful and irreversible consequences on the natural environment; that there are values other than value in exchange, such as intrinsic value and use value.

The conceptual-normative element is that as ecological economists, we want the world to be a certain way. We then critique institutions on the basis of the extent to which they align with that vision. What is the vision? The we should make policies that *bring us closer* *towards* living within the natural flows: of heat from the sun, and heat dissipated from the earth, the flows of water, the flows of air. We wean ourselves from using up our fund of low entropy. The rate at which we wean ourselves and approach sustainability within the natural flows is culturally sensitive. We, decide for example on a *culturally acceptable* rate of entropy production, of pollution, of disruption of flows and of biodiversity loss. We actively engage in trying to slow these rates. We recognise three sorts of value: value in exchange, use value and intrinsic value.

The ethically-normative element is one step of generality up. We consciously endorse the above conceptual-normative element as a matter of moral principle.

To conform to the three elements, we make a more elaborate construction.

Step 7: Make tables and policy compasses for each sphere separately: one representing the relationship of the institution with the eco-sphere, one for the relationship of the institution to the socio-sphere and one representing the relationship of the institution to the econo-sphere. We now have nine sectors, three in each of three spheres. See figure 2.

FIGURE 2. THREE TABLES, ONE FOR EACH SPHERE

Table for *econo*-sphere

General quality	Name and qualifications	Angle	Length	Corrected length
Har	Steady wages	20	.5	.15
Har	Regular turnover of merchandise	60	.9	.3
Har	books are balanced	60	.4	.12
Supp	debt	160	.6	.2
Supp	Cutting back	180	.9	.3
Supp	bankruptcy	160	.0	.0
Pass	sudden profits	250	.5	.15
Pass	Earning spikes	300	.6	.2
Pass	Re-structuring human resources	350	.6	.2

Table for *socio*-sphere

General quality	Name and qualifications	Angle	Length	Corrected length
Har	general happiness	30	.6	.2
Har	Regular work	40	.9	.3
Har	Regular use by members	20	.9	.3
Supp	People suffering from depression	130	.2	.06
Supp	Days of sick-leave by employees	200	.8	.27
Supp	Graffiti (incidences of)	220	.3	.1
Pass	Festive days	300	.6	.2
Pass	Days of exhibition	300	.9	.3
Pass	Reports in media	320	.9	.3

Table for *eco*-sphere

General quality	Name and qualifications	Angle	Length	Corrected length
Har	Biodiversity of ecosystem	30	.2	.06
Har	Stable mammal population	90	.6	.2
Har	Predictability of rain	100	..2	.06
Supp	Mercury pollution in water	200	.9	.3
Supp	Unabsorbed carbon monoxide and dioxide	190	.6	.2
Supp	Fossil fuels burned	220	.9	.3
Pass	Acreage of crops	300	.6	.2
Pass	Acreage of cattle	250	.9	.3
Pass	Acreage of private gardens	330	.2	.06

Start with the economy table. Economic value, is value in exchange. The time-frame is short, since exchange value changes quickly. The length of arrows indicates the extent of the value. Economic institutional *harmony* is indicated by steady wages, regular turn-over, the books balancing and so on. Large profits, surprise booms or spikes, changes in the economic structure indicate economic institutional passion. Economic *suppression* is indicated by debt, having to 'down-size', bankruptcy.

Social value of an object, or institution is value in use. The time-frame is longer than for the econo-sphere. Social institutional *harmony* is indicated by general contentment, regularity of work and use of the institution, lack of conflict with the society in which the institution is couched. Social institutional *passion* is indicated by festivals, exhibitions, provocative art work, sensational successes covered in the press. *Suppression* is marked by depression, disease, and violence.

Environmental value is intrinsic or existential value. The time frame is long. Environmental institutional *harmony* is indicated by the state of nature without humans. There are flows and cycles and these blend and combine to show a steady state of the environment and individual ecologies in the long term. Environmental *passion* is had when humans intervene. We control nature, we 'enhance' it and shape it. So indicators would include quantities and qualities of manicured gardens, indoor plants, selectively bred animals and farmland.

We have to always be careful with the passion quality because it can easily tip an institution into *suppression*. Environmental institutional suppression concerns: pollution of water, soil and air, covering soil by buildings or cement, waste, and especially entropic measures such as use of non-renewable resources.

For the purposes of ecological economics, we make the following general recommendations for the indicators in all the tables. Consider that we live in a world subject to at least the first two laws of thermodynamics, so some indicators have got to reflect the entropy production of the institution; that the planet we live on is limited in space and resources, so when we use up the natural space, there is a debt to pay. The general idea is to follow Georgescu-Roegen (1971) and think in terms of the fund-flow model of the natural environment. We have a fund of low entropy that we can use up quickly or more slowly. This includes non-renewable (or too slowly renewed) resources: coal, oil, gas. We want to use these up as slowly as possible – *aiming towards* the rate of replacement, although we know that it might be impossible on balance against social unrest, to *achieve* the use of slowly replaced resources *at or below* the rate of replacement. Following Georgescu-Roegen again, we note that there is a flow of heat from the sun and dissipation of heat from the Earth. Within this flow (over which we have slow control through the emission of greenhouse gasses) we respect the rate at which natural resources such as: food, fibre, wood, replenish themselves naturally.

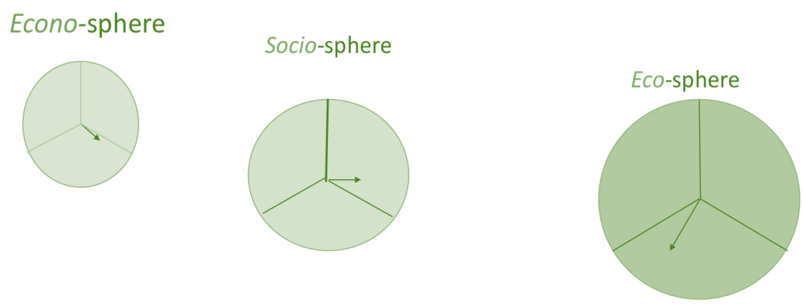
Another important sort of indicator comes from the thought that some of our practices have harmful and irreversible consequences on the natural environment. Here we use the metaphor of health of an organism and with some changes in the metaphor, apply it to whole eco-systems. Rapport (2012) has developed a number of these indicators. Most of them concern natural ecosystems that are stressed by human activity in the form of pollution. So the third, related, general idea is to think in terms of pollution, waste and clean-up. Once pollution has been released into the environment it starts to damage the natural eco-systems. There are limits over which the natural systems cannot cope and they become 'unhealthy' or 'collapse'. What replaces them is a less *healthy* natural eco-system. (Rapport and Maffi 2010). Some pollutants are dispersed quickly and others slowly, the effect of mixed pollution is rarely known. We aim to respect the rates of dispersal and monitor the health of eco-systems to warn us of natural limits. Thus, the statistics falling under these three general ideas are what to use to find the relevant statistics for the eco-sphere.

Being explicit about the normative aspect of ecological economics, we would like our institution arrows to be in the sector of harmony. So as a policy analyst or consultant using the ecological economics compass we advise that policy brings the arrow of the institution into the harmony sector. If it is already there, then carry on as before and address concerns in the socio-sphere or the economy-sphere!

Step 8: Construct three compasses: one per table.

The conceptual-normative element of ecological economics is represented by the subset relationship of the three circles. We think that the environment has to be given priority over society, and the latter has priority over economic considerations. This will now be represented by the relative sizes of the *circles*, representing the three tables. See figure 4.[4]

FIGURE 4. THREE SPHERES



Step 9: Place the spheres concentrically in the following proportions: the radius of the eco-sphere is the longest; the radius of the econo-sphere is half the length of the eco-sphere, and the length of the radius of the socio-sphere is exactly half way between the two, add the three arrows by vector addition. This is the final arrow for the ecological economics compass.

The final compass will look again like the one in figure 1. The relative length of the radii of the three circles reflects how much more important we think, for example, that the eco-sphere is with respect to the socio-sphere.

This compass is constructed using the thinking behind ecological economics. If the environment is doing well, then we need not take care of it, and we can concentrate on society or the economy or both. Because the eco-sphere arrows are more influential over the position and length of the final arrow, it is the statistics concerning the environment that we will heed the most in making our policy decisions – unless the eco-sphere is doing well.

Returning to the three *gunas* or the three general qualities, for the purposes of getting along with the environment, we would like our final institutional arrows to be in the quality of sattva. Even an institution that is normally suppressive, such as a prison might have its final arrow in sattva – if healthy gardens are created and maintained, waste is well-managed and so on!

4. Sustainability and the Policy Compass

It is politically in *vogue* to claim that an institution is "sustainable". Such a claim is almost empty when we consider the number of different definitions we might have for the word 'sustainability'. An industry might be deemed 'unsustainable' just because it is not financially solvent; or, we might be concerned with sustaining a certain standard of living; or we might

4 We do not label the three qualities, but they are still there.

be concerned with the stability of an ecological system. The word 'sustainability' was used to refer to the natural environment, but has been appropriated by business and government because of the new, fashionable and strongly positive connotation. Since it is a vague but positive term, its meaning is seldom made explicit by business or government.

Ecological economists use the word in the older sense. This is to reflect the scientifically established reality of how it is that the environment is doing, and to acknowledge our dependence on that environment. We have to ensure that the eco-sphere is sustained and not collapsing. It is only if this is sustained, that we can think of sustaining society (within the bounds and context of the natural environment). This is important for government, other public institutions, many non-profit organisations and many NGOs (non-governmental organisations); but, at least for the ecological economist, government ought to take very seriously the natural environment in which, and from which, the society lives. Lastly, economic activity should not be 'sustained' at the 'cost' of society (stimulating social break-down). Thus, the ethical element is what plays into the notion of sustainability for the ecological economist. Similarly, a business institution which claims sustainability in the ecological economist's sense would take seriously both the social aspects internal to the institution, the external aspects: the society in which it is couched and the natural environment. Thus, I put forward the claim that

Claim 2: for the ecological economist, an institution is sustainable iff the ecologial-economics policy compass's final arrow is in the third of harmony.

'Sustainability' is here taken to set an ethical and normative standard; reflecting what it is we want to sustain and what we are willing to sacrifice. Under ethical-normativity, we want for the natural environment to remain relatively stable. In very basic terms we need to ensure that water, the air and the soil are natural and harmonious. It is only then that the bio-sphere can continue in a healthy manner.

We all know that increasing entropy damages the environment, and therefore, entropy production is one of the obvious choices for representing the suppressive with respect to the environment. Another environmentally suppression indicator is pollution. Insofar as we are willing to sacrifice the environment to our social or economic ambitions, we think less and less in alignment with ecological economists. Let us be quite clear. There is the scientific aspect of ecological economics and the more ethical aspect. It is this distinction that has been drawn out in the exercise of constructing our ecological-economic policy compass.

Philosophical Remarks and Conclusion

As noted in the introduction, we can construct several aggregated arrows, representing change in an institution over time, or for comparing institutions to each other. The construction is sensitive work due to our making qualitative decisions, as per section two. But it is not impossible.

Remark 1: Our analysis can be shallow or deep.

We can gerrymander an 'outlier' statistic in our table, where an 'outlier' statistic is one that influences the length and direction of the aggregated arrow disproportionately. We can simply erase it and replace it with a 'better behaved' statistic, or we can change direction and length. Of course, with such gerrymandering, relative 'objectivity' is then sacrificed, since rather than deciding on the direction and length *independently* of the other indicator arrows, we do so with respect to the other indicator arrows and in particular *with respect* to the final arrow and its representation on the ecological economic compass. This is trickery, but might be enough to justify a policy in the short term or to a gullible audience. The robustness checks counter the gerrymandering, so it is with a less robust compass that gerrymandering is easier. Because we have consulted a variety of people, with different expertise, we should get all the outlier arrows.

A deeper analysis can be made by working out how to change the reality behind the length and direction of the various arrows. This can be done through changes in policy that address particular statistics. For example, if an alarming number of people are dying of lung cancer, and this is statistically linked to smoking heavily, then we design policies to encourage general lung health, and decrease smoking.

An even deeper analysis involves looking at the statistics more thoroughly: re-examining the context and culture that give weight to the decisions concerning degree and length. We can also look for the underlying causes of the statistics or by looking at the whole, hence the holistic aspect of the analysis. Returning to the smoking example, we might notice that smoking is considered to be 'cool' in some sub-cultures, so we can try to counter that image in the broader media. We might also notice that it is associated with rebellion or disquiet. In this case, we might want to look for means of making people feel more at ease and in tune with society.

Remark 2: There are checks for robustness of the sector arrows.

By 'robustness' we mean that the sector arrows are quite stable – adding more indicators does not alter the angle or length of the sector arrow very significantly – there are no *undiscovered* 'outlier arrows' – ones that significantly change the direction or length of the sector arrow, and therefore the final arrow.

It is not always possible to ensure robustness. If we lack robustness, then we make policy decisions that address the lack of data, the poor quality of the data or lack of consultation. In this way we understand the *limitations* of the compass exercise.

Remark 3: Even when we do not have a robust compass, and enough data, we still learn valuable lessons from the exercise of constructing the compass.[5]

It is not always straightforward or possible to construct a compass that passes the robustness checks. In these cases, we develop policy recommendations to get better statistics! We can choose them, and name them very carefully in advance. It is with the material we have, and under constraints, that we do the best we can. We then have an explanation as to why we made a particular policy decision, and a *partial* justification for the policies, but the explanation *includes* discussing the quantity and quality of the statistics, so it is a more abstract and technical explanation and justification than we ideally want.

More important, we make our policy recommendations with a degree of hesitancy. By trying to make a policy compass we have a good sense of why we are hesitating, and we can share this information with those concerned. They can then be vigilant about the success of the policy and understand the importance of having a good suite of reliable statistics. Moreover, we have a pretty good idea of how to change the policy if we later learn new statistics that

5 Nicole McLernon drew my attention to this, and together we explored the merits of using a non-robust compass.

influence the position or length of the non-robust arrow. So we can anticipate. After all, when we make policy decisions, we know in advance that we do so with imperfect information, that the context changes, that values change, but we make the decisions despite this. With the use of a policy compass, even a non-robust one, we do *better* than just take a guess, trusting our instinct, or making the decision on the basis of a monetary calculation to maximise profit.

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II. ENERGY TRANSITIONS

Testing the dynamic relationship among CO_2 emissions, economic growth, energy consumption and tourism development. Evidence for Uruguay

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Introduction

Carbon dioxide (CO2) emissions are directly linked with the use of energy and have an essential role in the current debate on sustainable tourism development and environmental protection. Some authors argue that the tourism sector has the problem that is "addicted" to growth and this fact is incompatible with sustainable goals. The literature in this area shows evidence that the environmental Kuznets curve (EKC) hypothesis induced by tourism is verified, with some differences between developed and developing economies.

In previous empirical research on country-studies, linear cointegration techniques and Granger causality test are usually applied in order to test the EKC hypothesis. The present study explores the linkages between CO2 emissions, economic growth, energy consumption and tourism development for Uruguay without imposing -a priori- any parametric model, in order to investigate the presence of nonlinearity in the relation, as is postulated by the EKC hypothesis. The paper empirically examines the dynamic long run relationship among these variables, using data for the period 1960-2014.

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Within this framework, we test the existence of nonlinear cointegration relationship and the causality applying nonparametric tests. Our findings show that this methodology provides a more suitable way to represent linkages between the variables under study for the case of Uruguay. Nevertheless, the evidence with respect to the causality between tourism growth and CO_2 emissions is weak. Policy implications, limitations of the study and future research are proposed and discussed.

1. Energy and economic growth

Many studies explore the relationship among energy consumption, environmental pollution (usually proxied by carbon dioxide (CO_2) emissions), and economic growth. However, less attention has been paid to this relationship with respect to the tourism sector, a particular sector of the economy that deserves attention.

Tourism is a large and dynamic economic sector. Its total contribution accounts for 10.4% of global gross domestic product (GDP), 9.9% of total employment, and 4.5% of total investment, in 2017. In the recent years, it has registered a steady growth rate of 4% annually. (World Travel and Tourism Council, 2018). Several studies have confirmed tourism development as an engine of economic growth in some countries. Brida et al. (2014) conduct an exhaustive review of approximately 100 peer-reviewed published papers on the tourism-led growth hypothesis (TLGH) and find that with a few exceptions, the empirical findings suggest that overall international tourism drives economic growth. More recently, Risso (2018) finds supporting evidence in support of the tourism-led growth hypothesis at a worldwide level.

However, with growth arise sustainability challenges. Like any other industry, tourism can induce pressure on the environment. The development of this sector also contributes to the development of other segments, leading to a higher demand of energy (Becken et al., 2001, 2003; Gössling, 2002), which can be a source of environmental degradation (Xuchao *et al.*, 2010). Therefore, an exploration of the relationship among CO_2 emissions, economic growth, energy consumption and tourism development is of great interest to both policy makers and practitioners in tourism and would be a contribution to tourism literature.

The empirical link between environmental pollution (proxied by CO_2 emissions) and energy consumption has been extensively investigated and validated in the energy economics literature (Alam *et al.*, 2011; Ang, 2008; Soytas *et al.*, 2007; Xing-Ping and Xiao-Mei, 2009); even though, the direction of causality between them still remains unclear. The literature focusing on the impact of tourism on CO_2 emissions has been growing in the last decade (Neto, 2003; Holden, 2009; Lin, 2010; Perch-Nielsen *et al.*, 2010; Dubois *et al.*, 2011; Gössling, 2013; Saenz-de-Miera and Rosselló, 2014; Solarin, 2014; Tsai *et al.*, (2014)). Regarding country panel analysis, Lee and Brahmasrene (2013) find that a long-run equilibrium relationship exists among tourism, CO_2 emissions, economic growth and foreign direct investment (FDI) in European Union countries. Furthermore, they find that tourism, CO_2 emissions and FDI have high significant positive effect on economic growth. Economic growth, in turn, shows a high significant positive impact on CO_2 emissions while tourism and FDI incur a high significant negative impact on CO_2 emissions. Gössling (2013) finds that while emissions from tourism are significant in all 22 countries studied[1], they may, in some countries, exceed 'official' emissions as calculated on

1 New Zealand, Norway, Sweden, Germany, Australia, Switzerland, Maldives, The Netherlands, Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Jamaica, St. Kitts and Nevis, St. Lucia, St. Vincent

the basis of guidelines for national emission inventories under the Kyoto Protocol. Regarding individual country analysis, Katircioglu (2014b) finds that tourism development in Turkey has resulted not only in considerable increases in energy use but also considerable increases in climate change. Katircioglu et al. (2014) find that tourism development is a catalyst for increases in energy consumption and carbon emissions in the case of Cyprus.

Other studies have tested the validity of the Environmental Kuznets Curve (EKC) hypothesis, which investigates the relationship between environmental pollution and real income growth (Grossman and Krueger, 1991; Shafik and Bandypadhyay, 1992; Coondoo and Dinda, 2002; Dinda, 2004; Stern, 2004; Luzzati and Orsini, 2009). Empirical evidence on the EKC hypothesis is anything but convergent. While some studies find a linear relationship between environmental degradation and economic growth (Shafik and Bandyopadhyay, 1992, Akbostanci *et al*., 2009), others have provided evidence in support of an inverted U-shaped relationship in line with the EKC prediction (Lindmark, 2002) though discrepancies have emerged in terms of the exact 'turning point'. The benchmark study in this literature remains that by List and Gallet (1999) who showed that over the period 1929-1994, in the US, an inverted-U shaped EKC characterized the relationship between per capita emissions and per capita income at state level. Other studies still, have found an 'N-shaped relationship' (for example, Friedl and Getzner, 2003) which suggests that any decline of environmental degradation is only limited to the short term (He and Richard, 2010). Moreover, many studies have integrated the investigation of the relationship between energy consumption and output growth within the EKC framework (for example, Ozturk and Acaravci, 2010). Indeed, the evidence of the impact of energy use and economic growth on CO_2 emissions is so overwhelming, that both of these variables are now routinely integrated into the analysis.

To sum up, the increasing importance of the tourism sector and its potential threat to the environment, made researchers focus on the relationship between tourism growth and environment sustainability. This is a key question for policymakers, who face a dilemma of stimulating economic development via tourism-led growth while protecting the environment, and A crucial concept on the subject, as mentioned above, is the EKC hypothesis. But, as stated before, there are not many studies that explore the EKC hypothesis induced by tourism. Katircioglu (2014a) and De Vita *et al.,* (2015) for individual countries, and Dogan *et al.,* (2015) and Ozturk *et al.,* (2015) for a panel of countries, are the first ones to examine the relationship between tourism development and environmental degradation -measure as CO_2 emissions in the first three studies and the ecological footprint in the last one[2] - within an EKC framework. Katircioglu (2014a) finds that that tourism development and carbon emissions are in long-term equilibrium relationship, tourist arrivals have a negatively significant effects on carbon dioxide emission levels both in the long-term and the short-term, and verifies the tourism-induced EKC hypothesis in the case of Singapore.De Vita *et al.,* (2015) find that international tourist arrivals into Turkey alongside income, squared income and energy consumption, cointegrate with CO2 emissions. They find that tourist arrivals, growth, and energy consumption exert a positive and significant impact on CO2 emissions in the long-run. The results of this study provide empirical support to EKC hypothesis showing that at exponential levels of growth,

and the Grenadines, Suriname, and Turks and Caicos.

2 Ozturk *et al.* (2015) point that most of the existing literature employed environmental indicators such as CO2 emissions, sulfur dioxide (SO2), dark matter (fine smoke), and suspended particle matter (SPM) as the endogenous variables. Nevertheless, these indicators only represent a small portion of the environmental degradation caused by tourism.

CO_2 emissions decline. Dogan *et al.,* (2015) analyze the long-run dynamic relationship of CO_2 emissions, real GDP, energy consumption, trade and tourism under an EKC model for the OECD countries, and find that the EKC hypothesis cannot be supported. Finally, Ozturk et al. (2015) analyse a panel of 144 countries and find that the number of them that have a negative relationship between the ecological footprint and its determinants (GDP growth from tourism, energy consumption, trade openness, and urbanization) is more existent in the upper middle- and high-income countries. Moreover, they notice that the EKC hypothesis is more present in the upper middle- and high-income countries than the other income countries. More recently, Paramati et al. (2017) analyze 26 developed economies and 18 developing economies, and find that the impact of tourism on CO_2 emissions is reducing much faster in developed economies than in developing economies, providing evidence of the environmental Kuznets curve (EKC) hypothesis on the link between tourism growth and CO_2 emissions.

In Uruguay, the tourism sector's total contribution accounts for 10.6% of the GDP, 10.2% of total employment, and 7.7% of total investment, in 2017. In the recent years, it has registered a volatile behavior, but since 2015 it has verified positive growth rates. (World Travel and Tourism Council, 2018). Brida *et al.,* (2013a) and Brida *et al.,* (2013b) confirms that the tourism-led growth hypothesis is valid for Uruguay; tourism is the locomotive sector of the economy. Additionally, pollution levels (both measured by CO_2 emissions and the ecological footprint) have been increasing and have become a concern for environmental authorities. Emissions almost duplicated from the 1960s to the last 10 years for which data are available (by 2014), from 2.13 metric tons per capita to 4.28 metric tons per capita. Although the evolution in recent years has not been constantly increasing, the last five years have seen an increase of more than 10%. Despite de fact that the environmental authorities has set the goal of maintaining net-emissions at a constant level from INGEI 2008 onwards the emissions exceed the CO_2 captured nationally due to the increase in emissions Energy sector and to the reduction of removals of forest plantations (MVOTMA-SNRCC, 2017).

The rest of the article is structured as follows. First, we define the methodological framework of the present study; then we introduce the data used; the following section presents the empirical results, and the final section contains the preliminary conclusions.

2. Methodological framework

In order to test and estimate the relationship between CO_2 emissions, economic growth, energy consumption and tourism development for Uruguay, we follow the procedure suggested by Breitung (2001), Holmes and Hutton (1990), and Ye Lim et al. (2011). This procedure has the following steps: (i) testing nonparametric unit root, (ii) testing the existence of cointegration by using nonparametric tests, (iii) testing linearity, and (iv) performing the rank-causality test. A quick reference of these tests is presented in what follows.

2.1. Nonparametric Unit Root Test

Breitung (2002) proposes a statistic test that does not require the specification of the short run dynamic; such approach is called "model free" or "nonparametric" because the asymptotic properties of the test do not depend on the short run dynamics or the nuisance parameters. As a result, the test proposed by Breitung is robust against a possible misspecification. Following Davison (2002), Breitung take a definition of integration that is not restricted to a specific time series model:

A time series y_tis integrated of order one (I(1)) if, as $T \to \infty$,

(1) $$\square^{-1/2} \square_{[\square\square]} \underset{T\to\infty}{\Longrightarrow} \sigma W(a)$$

where the symbol $\underset{T\to\infty}{\Longrightarrow}$ means weak convergence with respect to the associated probability measure, σ>0 is a constant, [.] represents the integer part, and W(a) is a Brownian motion defined on C[0,1]. Breitung (2002) proposes the variance ratio statistic to test the null hypothesis that yt is I(1) against the alternative hypothesis yt is I(0). Critical values are available in Breitung (2002).

The Qt is the variance ratio of the partial sums and the original series, and variance ratio statistic is defined as:

(2) $$\widehat{Q_T} = \frac{T^{-1}\sum_{t=1}^{T}\hat{U}_t^2}{\sum_{t=1}^{T}\hat{u}_t^2}$$

where $\hat{U}t=\hat{u}_1+\ldots+\hat{u}t$ and $\hat{u}t=yt-\hat{\delta}'zt$ are the ordinary least square (OLS) residuals from the regression of the data yt on (i) $zt=0$, let $\hat{u}=yt$, with no deterministic term, (ii)$zt=1$, with an intercept, or (iii) $zt=(1,t)'$, with an intercept and linear trend, respectively. The variance ratio statistic is a left tailed test, where the hypothesis of a unit root process is rejected if the test statistic value is smaller than the critical value.

2.2 Rank test for cointegration

Breitung (2001) introduces a nonparametric test procedure to test the hypothesis of a cointegration relationship and to identify whether this link is nonlinear. Breitung procedure proposed a rank transformation for the series involved and checks whether the ranked series move together over time towards a linear or nonlinear long-term cointegrating equilibrium. The procedure starts checking the cointegration by using the rank test. If cointegration is accepted, the technique follows with examining linearity in the cointegration relationship, by using a scoring test.

Let $f(xt)\sim I(1)$ and $g(yt)\sim I(1)$ nonlinear increasing functions of xt and yt, and $\hat{u}t\sim I(0)$. Let suppose that a nonlinear cointegration relationship between xt and yt is given by

(3) $$\mu_t = g(y_t) - f(x_t)$$

The rank statistic is constructed by replacing f(xt) and g(yt) by the ranked series

(4) $$R_T[f(x_t)] = R_T(x_t)$$

and

(5) $$R_T[g(y_t)] = R_T(y_t)$$

Given that the sequence of ranks is invariant under monotonic transformations of the variables, if xt or yt are random walk process then $Rt\,[f(xt)]$ and $Rt\,[g(yt)]$ behaves like the ranked random walks as $Rt(xt)$ and $Rt(yt)$.

The rank test procedure is based on two "distance measures" between the sequences of R*t*(x*t*) and R*t*(y*t*). The cointegration test is based on the difference between the sequences on the ranks can be detected by the bivariate statistics K*t**: and ξ*t**:,

(6) $$K_T^* = T^{-1} \max_t |d_t| / \hat{\sigma}_{\Delta d}$$

(7) $$\xi_T^* = T^{-3} \sum_{t=1}^{T} d_t^2 / \hat{\sigma}_{\Delta d}^2,$$

where

(8) $$d_t = R_T(y_t) - R_T(x_t),$$

for R*t*(y*t*)= Rank [of y*t* among$y_1,\dots,y_t$] and R*t* (x*t*) = Rank [of x*t* among $x_1,\dots,x_t$]. The max*t* |d*t*| is the maximum value of |d*t* | over t=1,2, …, T and

(9) $$\hat{\sigma}_{\Delta d}^2 = T^{-2} \sum_{t=2}^{T} (d_t - d_{t-1})^2$$

adjusts for possible correlation between the series of interest.

2.3 Rank test for (neglected) nonlinearity

If cointegration is not neglected in the first step, then we test the linearity of the cointegration relationship. For a convenient representation of the alternative and null hypothesis Breitung (2002) follows Granger (1995) and represents the nonlinear relationship as:

(10) $$y_t = \gamma_0 + \gamma_1 x_t + f^*(x_t) + u_t,$$

where $\gamma_0+\gamma_1$ x*t* is the linear part of the relationship. Only when *f** (x*t*)=0 there is a linear relationship between the variables. In this test the multiple of the rank transformation is used instead of using *f** (x*t*).

Under the assumption that xt is exogenous and ut is a white noise with u*t*~*N*(0,σ^2) a score test is obtained as the T*R^2 statistic of the MCO:

(11) $$\tilde{u}_t = c_0 + c_1 x_t + c_2 R_t(x_t) + e_t.$$

Breitung (2001) generalizes the score test for the ECM representation and applies it to contrast the null hypothesis of linear cointegration against the alternative hypothesis of nonlinear cointegration. To compute the score statistic, the following two multiple regressions are run, consecutively:

(12) $$y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} y_{t-i} + \alpha_2 x_t + \sum_{i=-p}^{p} \alpha_{3i} \Delta x_{t-i} + u_t$$

(13) $$\tilde{u}_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} y_{t-i} + \beta_2 x_t + \sum_{i=-p}^{p} \beta_{3i} \Delta x_{t-i} + +\theta_1 R_T(x_t) + +\tilde{v}_t,$$

where $\beta_0 + \sum_{i=1}^{p} \beta_{1i} y_{t-i} + \beta_2 x_t + \sum_{i=-p}^{p} \beta_{3i} \Delta x_{t-i}$ is the linear part of the relationship and it involves the ranked series R*T* (x*jt*).

Under the null hypothesis, it is assumed that the coefficients for the ranked series are equal

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ically as a χ^2 distribution, where T is the number of observations and R^2 is the coefficient of determination of the second equation. The null hypothesis may be rejected in favour of nonlinear relationship if the score statistic value exceeds the χ^2 critical values with one degree of freedom (when two variables are involved).

2.4 Causality Rank Test

Conventional Granger causality test uses Vector Autoregression (VAR) or Vector Error Correction Model (VECM). However, results from the conventional parametric tests are limited by the augmenting hypothesis of the specific functional forms of the variables and the assumptions of homoscedasticity and normality of the error terms. As pointed by Ye Lim et al. (2011), violation of these conditions can cause spurious causality conclusions. For these casas, Holmes and Hutton (1990) proposed a multiple rank F-test, more robust than the standard Granger causality test. In case that the conditions of Granger estimations are satisfied, the multiple rank F-test results are alike the Granger results.

Holmes and Hutton (1990) analysed the small sample properties of the multiple rank F-test, showing that with non-normal error distributions the test has significant power advantages both in small and in large sample. This is valid for both weak and strong relationships between the variables.

The Holmes and Hutton (1990) multiple rank F-test is based on rank ordering of each variable. In this test, the causal relationship between y_t and x_t involves a test of a subset of q coefficients in the Autoregressive Distributed Lag (ARDL) model. The multiple rank F-test in ARDL (p,q) model can be written as:

$$R(y_t) = a_0 + \sum_{i=1}^{p} a_{1i} R(y_{t-i}) + \sum_{i=1}^{q} a_{2i} R(x_{t-i}) + e_t \quad (14)$$

$$R(x_t) = b_0 + \sum_{i=1}^{p} b_{1i} R(x_{t-i}) + \sum_{i=1}^{q} b_{2i} R(y_{t-i}) + \varepsilon_t, \quad (15)$$

where R(·) represents a rank order transformation and, each lagged values of the series in each model are treated as separate variables when calculating their ranks, for example, $R(Yt)$ and $R(Yt_{-1})$. The residuals, et and εt are assumed to be serially uncorrelated, and p and q may differ in each equation. When choosing p and q, two things have to be considered: the significance of the estimated coefficients and the serial correlation of resulting residuals.

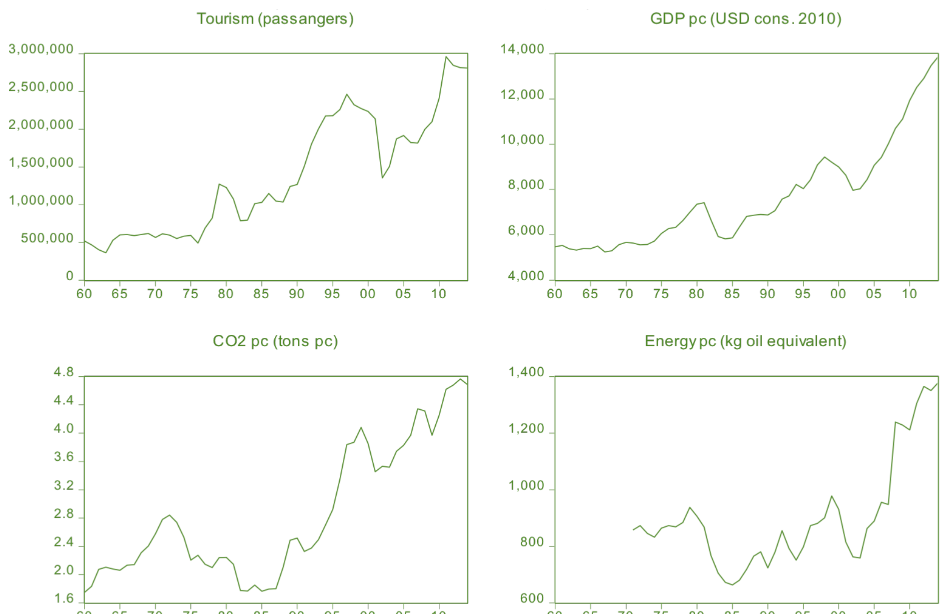
From (14) rejection of the null hypothesis ($a_2 i$=0) implies causality from X to Y; whereas in (15), rejection of the null hypothesis ($a_2 i$=0) implies the reverse causality from Y to X. The null hypothesis is rejected if the F-test statistic is significant with respective q´s value and N-K (K=p+q+1) degrees of freedom.

3. Data

Tourism demand is represented by the number of passengers arrived (*T*). To measure economic growth, per capita gross domestic product (*GDPpc*) is considered, in order to account for emissions, we take the indicator of CO_2 emissions (metric tons per capita, CO_2pc) and we represent energy consumption by the per capita consumption of kilograms of oil equivalent (*Epc*). For the empirical work, variables are considered in their logarithmic transformation (*t*=log(T); gdp=log(GDP*pc*); co2=log(CO2*pc*);ene=log(*Epc*)).

All the variables have the same source: World Bank database. The sample under analysis is 1960 to 2014, except for energy consumption, that is only available since 1971. Figure 1 shows the evolution of the four variables.

FIGURE 1. TOURISM, GDP PC, CO2 EMISSIONS AND ENERGY CONSUMPTION IN URUGUAY. 1960-2014



Source: World Bank.

Unit root tests results, reported in Table 1, show that all the variables are non-stationary I(1) in the sample analyzed.

TABLE 1. NONPARAMETRIC UNIT ROOT TEST RESULTS (VARIABLES IN LOGS)

	Variables	No deterministic	Mean Adjusted	Trend Adjusted
Level	Tourism	0.33039	0.09085	0.00520
	GDPpc	0.33354	0.08739	0.01008
	CO2pc	0.24369	0.07133	0.01540
	Energy	0.33829	0.04556	0.01686
First difference	Tourism	0.01498**	0.00082***	0.00082***
	GDPpc	0.026042*	0.00741**	0.00123***
	CO2pc	0.01980**	0.00268**	0.00214**
	Energy	0.00410***	0.00742**	0.00109***

Notes: The hypothesis of a unit root process is rejected if the test statistic falls below the respective critical values. *, ** and *** denote significance at 10%, 5%. Source: authors calculations.

4. Results

As we explain above, in order to explore the long-run linkages between CO_2 emissions, economic growth, energy consumption and tourism cointegration and causality are tested by running out free-model tests.

We consider three alternative sets of variables. The first one consisting of the four variables mentioned. Each one of the remaining sets consist of only three variables: CO_2 emissions, energy consumption and tourism (the second one), and CO_2 emissions, economic growth, and tourism the third one.

Results of nonparametric cointegration test for each alternative are presented in Table 2.

TABLE 2. RESULTS OF NONPARAMETRIC COINTEGRATION TEST

	Test Statistics	
	$\Xi T^*[2]$	$T \cdot R^2$
[t, co_2, ene, gdp]	0.0010***	9.1150**
Significance Level	**Critical values**	
10%	0.0160	6.2500
5%	0.0137	7.8100
1%	0.0100	11.3400
[t, co_2, ene]	0.0008***	16.9860***
[t, co_2, gdp]	0.0014**	7.4910**

Significance Level	Critical values	
10%	0.0197	4.6052
5%	0.0165	5.9915
1%	0.0119	9.2104

Notes: The hypothesis of no cointegration is rejected if the rank statistic, ΞT^* [2], is below the respective critical value and the hypothesis of linearity is rejected if the score statistic, $T{\cdot}R^2$, exceeds the χ^2 critical values. *, ** and *** denote significance at 10%, 5%, according with the grades of freedom of each estimation.

TABLE 3. RESULTS OF NONPARAMETRIC CAUSALITY TEST BETWEEN

H-H causality test	Uruguay		
	df	Pr.	NC
d(t)-->d(co₂)	(4, 22)	0.30	A
t-->co₂	(4, 23)	0.001	R (1%)

Notes: F-statistic, df (degree freedom), NC: H0: noncausality.

The results of these tests confirm the causality from tourism (represented with arrivals of passengers) to CO_2 emissions when the test is performed in levels (i.e. for the long run). The sign of the effect is positive in the regression of the ranked variables (see Annex).

However, the evidence does not allow accepting causality from tourism to emissions in the short-run, that is when the H-H causality test is run in first differences.

In summary, the empirical results show that tourism development, CO_2 emissions, energy consumption and per capita GDP are in long-term equilibrium relationship between 1960-2014) for Uruguay. This relationship, as is postulated by the EKC hypothesis, is non-linear. Additionally, results of non-parametric causality test show that in the long-run, there is a causal relationship from tourism to CO_2 emissions, so tourism-induced EKC hypothesis may be verified for Uruguay.

Concluding remarks

Differing from other case studies, this paper explores the linkages between CO_2 emissions, economic growth, energy consumption and tourism development without imposing -a priori- any parametric model. In order to investigate the presence of nonlinearity in the relation, as is postulated by the EKC hypothesis, we applied the methodology proposed by Breitung (2001), Holmes and Hutton (1990), and Ye Lim *et al.*, (2011), to the period 1960-2014 in Uruguay.

Empirical results for Uruguay show that tourism development, CO2 emissions, energy consumption and per capita GDP have non-linear long-term equilibrium relationship, as is postulated for the EKC hypothesis.

With regard to the causality analysis, results of non-parametric test show that in the long-run, there is a causal relationship from tourism to CO_2 emissions. Nevertheless, the evidence with respect to the causality between tourism growth and CO_2 emissions is not verified in the short-run.

To similar findings arrived Ozturk *et al.*, (2015) using a different indicator of contamination, ecological footprint, and different estimation techniques (panel techniques). Nevertheless, as long as we know, this is the first work that empirical test this relation without imposing a-priori any model, within the framework of a case study analysis.

The evidence reached in this paper suggests that tourism policies has to pay attention in the development of more effective environmental friendly tourism programs.

Further research may extend this methodology to study other Latin-American countries. Additionally, considering other variables to represent contamination, e.g. ecological footprint, may give robustness to the empirical findings about the effect of tourism development to the environment.

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Annex. Causality test (Holmes and Hutton)

Regression in levels

Dependent Variable: YRANK				
Method: Stepwise Regression				
Sample (adjusted): 1973 2014				
Included observations: 42 after adjustments				
Number of always included regressors: 1				
Number of search regressors: 16				
Selection method: Uni-directional				
Stopping criterion: t-stat = 1.6				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
C	-2.006686	1.974842	-1.016125	0.3170
YRANK_1	0.807544	0.099289	8.133246	0.0000
WRANK_1	0.248516	0.178274	1.394011	0.1726
WRANK_4	-0.539879	0.277002	-1.949010	0.0598
YRANK_4	0.190414	0.105445	1.805809	0.0801
XRANK_3	-0.414428	0.181975	-2.277386	0.0294
ZRANK_2	-0.342754	0.094477	-3.627921	0.0010
XRANK_2	0.393924	0.183517	2.146525	0.0393
WRANK_3	0.590995	0.352657	1.675836	0.1032
R-squared	0.944538	Mean dependent var		31.14286
Adjusted R-squared	0.931093	S.D. dependent var		16.13143
S.E. of regression	4.234532	Akaike info criterion		5.911832
Sum squared resid	591.7315	Schwarz criterion		6.284190
Log likelihood	-115.1485	Hannan-Quinn criter.		6.048316
F-statistic	70.25031	Durbin-Watson stat		2.034893
Prob(F-statistic)	0.000000			
Selection Summary				
Removed YRANK_3				
Removed XRANK_1				
Removed ZRANK_3				
Removed XRANK_4				
Removed ZRANK_1				
Removed YRANK_2				
Removed WRANK_2				
Removed ZRANK_4				

Note: final equation sample is larger than stepwise sample (rejected regressors contain missing values).

*Note: p-values and subsequent tests do not account for stepwise selection.

(y=co2; x=passengers; z= energy pc; w=gdppc).

Regression in first differences

Dependent Variable: DYRANK				
Method: Stepwise Regression				
Sample (adjusted): 1965 2014				
Included observations: 50 after adjustments				
Number of always included regressors: 1				
Number of search regressors: 16				
Selection method: Uni-directional				
Stopping criterion: t-stat = 1.6				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	25.98089	5.336542	4.868488	0.0000
DWRANK_4	-0.310329	0.144300	-2.150581	0.0367
DYRANK_1	0.344648	0.135480	2.543897	0.0143
R-squared	0.179113	Mean dependent var		27.18000
Adjusted R-squared	0.144182	S.D. dependent var		15.86125
S.E. of regression	14.67331	Akaike info criterion		8.268062
Sum squared resid	10119.38	Schwarz criterion		8.382784
Log likelihood	-203.7016	Hannan-Quinn criter.		8.311749
F-statistic	5.127573	Durbin-Watson stat		1.990116
Prob(F-statistic)	0.009675			
Selection Summary				
Removed DZRANK_3				
Removed DZRANK_1				
Removed DWRANK_1				
Removed DXRANK_1				
Removed DWRANK_2				
Removed DXRANK_4				
Removed DYRANK_2				
Removed DYRANK_3				
Removed DXRANK_3				
Removed DZRANK_4				
Removed DYRANK_4				
Removed DZRANK_2				
Removed DXRANK_2				
Removed DWRANK_3				

Note: final equation sample is larger than stepwise sample (rejected regressors contain missing values)

*Note: p-values and subsequent tests do not account for stepwise selection.

La dimensión energética en el metabolismo urbano: la premura por los indicadores regionales y urbanos en México

Jorge Antonio Mejía Rodríguez*
Jorge Hurtado López**

Introducción

El objetivo del trabajo reside en explorar la existencia de indicadores energéticos a nivel regional y urbano en México; ya que, al parecer, los disponibles hasta la fecha sólo se refieren a la distribución y venta de energía eléctrica a nivel estatal y municipal. Sin embargo, cuando tratamos de obtener información sobre otro tipo de indicadores, por ejemplo, aquellos relacionados con los petrolíferos, aún no se generan a esa escala geográfica en nuestro país. De lo contrario, si contáramos con ellos, esto nos permitiría conocer los datos de volúmenes de oferta y demanda por ciudad. Lo cual, nos permitiría investigar entre otras cosas, la dimensión energética del paradigma del metabolismo urbano. Es decir, conocer los flujos energéticos de entrada y salida en una ciudad.

En tal sentido, se parte del siguiente planteamiento del problema: ¿Se cuenta con indicadores energéticos a escala regional y urbana en México? ¿Cuáles y qué tipo de indicadores debieran generarse en el corto, mediano y largo plazos? ¿Es posible construir un índice del volumen de gas natural suministrado a nivel estatal? El método a seguir consistió en efectuar una revisión bibliográfica sobre el paradigma del metabolismo urbano, así como una exhaustiva revisión cuantitativa y cualitativa de los indicadores energéticos regionales disponibles.

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Los resultados preliminares del trabajo permiten adelantar que si es posible generar indicadores de oferta y demanda de petrolíferos a escala regional, como es el caso del Índice del Volumen Físico del Gas Natural para Jalisco (IVFGNJ) en el periodo referido, construido a partir de una solicitud de datos al organismo regulador oficial. Lo cual, nos brinda elementos para sugerir propuestas orientadas a destacar la necesidad impostergable de contar con indicadores energéticos a esa escala territorial, a efecto de medir la magnitud del deterioro ecológico y social implícito en dichos procesos productivos.

1. Preámbulo

La globalización capitalista imperante nos ha orillado a la disyuntiva ecológica actual de cambiar la forma en que se han venido haciendo las cosas en términos globales y locales, ello supone la modificación del paradigma de la explotación irracional de los recursos, para transitar hacia otro que valore el uso sustentable de los mismos. Lo cual, implica cambiar paulatinamente el modelo energético imperante basado en combustibles fósiles por opciones energéticas más amigables con el medio ambiente. Por tanto, tal situación actual nos lleva a la imperiosa necesidad de crear un nuevo modelo de desarrollo económico y otro proyecto de sociedad concebido para ser duradero y sostenible, capaz de responder a las necesidades del presente, sin comprometer las generaciones futuras.

Por ende, sin duda "la energía es el verdadero talón de Aquiles de la Sociedad Industrial, del modelo productivista (tanto da que sea capitalista como socialista): está llamado a ser el primer recurso en agotarse. Paradójicamente el factor que ha permitido su expansión y consolidación puede conducirle a su final. Por eso la cuestión de la energía como insumo esencial, es una de las cuestiones centrales en la reflexión sobre la sostenibilidad del actual modelo productivo. La búsqueda del hombre por nuevas opciones de fuentes energéticas nunca fue tan intensa, por diversos factores (financieros, estratégicos, ambientales, etc.) las hidroeléctricas y las plantas nucleares han dejado de ser señaladas como la solución para responder al aumento creciente de la demanda de energía" (Castillo Merighi, C.; *et al*,. 2009: 40).

Por su parte, desde la perspectiva que engloba el actual modelo productivo imperante y sus implicaciones urbanas, el enfoque hacia la sustentabilidad es prácticamente el mismo. "La conciencia de la crisis ecológica presiona en la constitución de un nuevo paradigma científico, frente al de la modernidad y el industrialismo que han instaurado el reino del crecimiento y el desarrollo como objetivos irrenunciables. El escenario de la degradación ecológica, y en particular el de la crisis energética, ha impulsado la emergencia de la reflexión sobre los límites del planeta, y del modelo productivista. Es difícil pensar cómo puede producirse la transición desde un modelo que hace del crecimiento el núcleo central de su actuación, a otro basado en el reconocimiento y la auto-imposición de límites" (Gaja i Díaz, F. 2005: 37-38).

En tal sentido, y dadas las limitadas opciones energéticas disponibles en el modelo de los combustibles fósiles imperante, es preciso destacar que el gas natural, no obstante que es un hidrocarburo, se está erigiendo como uno de los energéticos más demandados para el presente siglo 21, en la transición del agotamiento paulatino del petróleo hacia opciones energéticas alternativas. Sin embargo, con toda la aparente contrariedad que ello supone, el gas natural está definido como el energético predilecto al generar menos gases de efecto invernadero "Geis" que el resto de los hidrocarburos. Es visto como el hidrocarburo de "energías limpias".

Considerando lo anterior, y dadas las enormes reservas mundiales de combustibles fósiles existentes en el planeta (petróleo, gas natural, carbón, entre otras), mismas que se estima su agotamiento durante el presente siglo XXl; aparte de que son el alma y sustento de la operación cotidiana de las corporaciones del orbe, y, por tanto, del poder hegemónico capitalista que detentan.

Por ello, "En la actualidad, la extensión energética convencional hacia los países en vías de desarrollo ha de pasar por los combustibles fósiles; en los países desarrollados debiéramos moderar el consumo, pero los países menos favorecidos han de incrementar sus demandas energéticas. Esto visto desde el observador que tiene su vida más o menos resuelta, no es bueno, ni para la evolución del cambio climático, ni para la tranquilidad en los mercados de los hidrocarburos" (Menéndez P. E.; Feijó L. A. 2005: 196).

Con base en lo anterior, y considerando que en nuestro país se ha estado ampliando la infraestructura para expandir el suministro de éste energético en el país, a partir de la reforma energética del año 2013, el propósito del trabajo reside en explorar la existencia de indicadores energéticos a nivel regional y urbano en México; ya que, al parecer, los disponibles hasta la fecha sólo se refieren a la distribución y venta de energía eléctrica a nivel estatal y municipal. Sin embargo, cuando tratamos de obtener información sobre otro tipo de indicadores, por ejemplo, aquellos relacionados con los petrolíferos, aún no se generan a esa escala geográfica en México. De lo contrario, si contáramos con ellos, esto nos permitiría conocer los datos de volúmenes de oferta y demanda por ciudad. Lo cual, nos permitiría investigar entre otras cosas, la dimensión energética del paradigma del metabolismo urbano. Es decir, conocer los flujos energéticos de entrada y salida en una ciudad. Así como, investigar más respecto a la emisión de contaminantes en nuestras ciudades.

En tal sentido, se parte del siguiente planteamiento del problema: ¿Se cuenta con indicadores energéticos sobre hidrocarburos a escala regional y urbana en México?, ¿Cuáles son los volúmenes de suministro de gas natural a nivel nacional y en la región Guadalajara en los años más recientes?, ¿Es posible construir un índice del volumen de gas natural a nivel regional? ¿Este índice no puede permitir evidenciar la falta de suministro de dicho energético en un lapso específico?

El método a seguir consistió en efectuar una revisión cuantitativa y cualitativa de los indicadores energéticos disponibles. Cabe mencionar que, ante la carencia de información disponible sobre hidrocarburos a nivel regional, se optó por realizar una solicitud de información vía transparencia al organismo rector en la materia hasta ese momento, es decir, la Comisión Reguladora de Energía (CRE), instancia que tardó aproximadamente año y medio en entregar la información solicitada, por la dificultad de procesar los volúmenes diarios de suministro, de un conjunto de entre 300 puntos del sistema nacional de gasoductos y seleccionar sólo aquellos dirigidos a la región de interés.

Los resultados preliminares del trabajo permiten adelantar que si es posible generar indicadores de oferta y demanda de petrolíferos a escala regional, como es el caso del Índice del Volumen Físico del Gas Natural para Guadalajara (IVFGNG) en el periodo referido, construido a partir de una solicitud de datos al organismo regulador oficial. Lo cual, nos brinda elementos para sugerir propuestas orientadas a destacar la necesidad impostergable de contar con indicadores energéticos a esa escala territorial, a efecto de medir la magnitud del deterioro ecológico y social implícito en dichos procesos productivos.

No obstante, el panorama no es nada alentador, dado que la construcción de este tipo de indicadores supone un enorme esfuerzo de captación y clasificación institucional de innumerables fuentes de suministro local y regional en nuestro país, ya que necesariamente deben acotarse y ajustarse los procedimientos, sobre todo ahora que las empresas productivas del Estado, tanto PEMEX, como CFE, deben compartir sus redes de suministro y distribución con empresas privadas nacionales y locales.

2. El Paradigma del metabolismo urbano

De acuerdo con MacKillop, F. (2014), una forma magistral de definir el metabolismo urbano es considerándolo como lo define Kennedy “La suma total de los procesos técnicos y socioeconómicos que se producen en las ciudades, lo que resulta en el crecimiento, la producción de energía, y la eliminación de residuos” (Kennedy *et al.*, 2007: 44).

Los orígenes del concepto se remontan a Carlos Marx, quien analiza primero el metabolismo urbano en 1883, y utiliza el concepto para describir los intercambios de materia y energía entre la naturaleza y la sociedad en su crítica de la industrialización.

Más tarde, Wolman (1965) relanzó el concepto metabolismo urbano en respuesta al deterioro de las cualidades del aire y del agua en las ciudades estadounidenses. Como se sabe, el concepto surgió del deseo de cuantificar, con el fin de cambiar/mejorar.

No obstante, el concepto de metabolismo urbano tiene un aspecto crítico, ¿Por qué necesitamos abordarlo? La mayoría de la población del planeta vive en ciudades y por ende, el metabolismo de estas ciudades se está acelerando, lo que conlleva a un mayor impacto en el medio ambiente, la calidad de vida y la salud de la población, etc. Esto nos lleva a generar un metabolismo alto, el cual, se debe a que nuestros edificios y ciudades son intensivos en el uso de recursos ineficientes en su operación.

En tal sentido, la comprensión y el metabolismo de regulación están a un paso por primera vez, en avanzar hacia la sostenibilidad. En algunos aspectos, la ciudad es como una planta natural extendiendo más y más sus raíces, hasta que sus necesidades de recursos están satisfechas. Un aspecto de este crecimiento es que las ciudades requieren un mayor gasto de energía para el transporte, puesto que los materiales viajan a distancias cada vez mayores.

Por ende, de acuerdo con el (Informe Bruntland de la ONU, 1987 Nuestro Futuro Común), el desarrollo económico de hoy no debe impedir el desarrollo de mañana. Así, en términos del metabolismo urbano: La ciudad cada vez utiliza más recursos y produce más residuos que los que el ambiente puede proporcionar y absorber. Por tanto, dicho concepto, nos hace más conscientes de nuestra huella ecológica.

MacKillop, F. (2014) resume los beneficios y consideraciones del concepto de metabolismo urbano:

- Los modelos matemáticos son posibles de construirse
- La comparación entre ciudades es posible
- Podemos conocer los efectos del uso de los recursos

- El concepto y las herramientas del metabolismo hacen posible hacer investigación en los edificios, las ciudades y el medio ambiente, desde un entorno científico y objetivo
- Esto puede constituir la base para realizar estudios científicos e implementar políticas racionales
- Las ciudades necesitan insumos y/o recursos materiales para crecer, estos recursos son, por ejemplo, agua, energía, construcción, etc.
- Las transformaciones se producen dentro de la ciudad y más allá de ella, debido a los procesos productivos inmersos en su espacio regional
- Muchas ciudades cada vez exportan más y llegan más lejos, generando impactos regionales y globales
- El agua representa de entrada, el insumo o recurso mayor utilizado
- La mayor parte de este flujo de agua se descarga como agua residual y el resto se pierde por fugas y actividades como el riego de jardines.
- Las ciudades necesitan suministros de energía y también producen energía a través del calor, éste es un mecanismo circular con efectos de retroalimentación: la energía más utilizada produce más calor y éste, más necesidad de energía para enfriar etc.
- La energía se importa cada vez de más y más lejos, con el aumento de los impactos globales que eso supone
- Las ciudades utilizan los recursos que adquieren en formas muy específicas, las cuales, están vinculadas a la geografía local, la historia, la cultura y las estructuras de poder político
- Los recursos se transforman en la ciudad, generando residuos diversos
- El entorno de los edificios construidos, calles etc.; es el resultado de estas transformaciones
- El entorno construido también da forma a transformaciones futuras
- La gestión de los recursos también influye en la evolución de las dinámicas socio-políticas en la ciudad
- Las ciudades son espacios proclives a las desigualdades en el uso/acceso de los recursos. Los recursos requeridos por las ciudades no fluyen de manera uniforme a todos los ciudadanos, su flujo refleja las desigualdades existentes, las refuerza, y crea otras nuevas
- Las redes construidas para transportar recursos reflejan también estas relaciones de poder y la discriminación
- Predominan dinámicas de segregación/fragmentación que están presentes en la esfera laboral
- La desigualdad también está presente en el acceso a los servicios como agua y electricidad, alcantarillado y al transporte
- Así, mismo, se forman redes para eludir ciertas partes de las ciudades (los más pobres, los menos poderosos) a favor de los demás (el más rico, los más poderosos)

Algunos de los principales estudios sobre metabolismo urbano y sus resultados son:

- Bruselas: los ecologistas Duvigneaud y Denaeyer-De Smet (1977), incluyeron la cuantificación de la biomasa urbana e incluso las descargas orgánicas de los gatos y los perros.

- Hong Kong: Newcombe y sus colegas (1978) fueron capaces de determinar las entradas y salidas de materiales de construcción y productos terminados. Una actualización del estudio de Hong Kong fue realizada por Warren-Rodas y Koenig (2001), el cual, mostró que el consumo de alimentos per cápita, agua y materiales había aumentado en un 20%, 40% y 149%, respectivamente, desde 1971 hasta 1997.

- Sydney, (1999) Newman Introdujo la noción de calidad de vida y bienestar en el análisis del metabolismo.

En resumen, MacKillop, F. (2014), sostiene que el metabolismo de las ciudades y los edificios es esencialmente lineal, y por lo tanto, ineficiente y con externalidades negativas. Por tanto, tenemos que encontrar la forma de generar ciclos de cierre, para que todos estos ciclos sean en entornos locales lo más posible. Así, mismo, las herramientas de planificación y la ciencia del clima urbano pueden ayudarnos a diseñar mejores edificios y ciudades, pero también tenemos que entender cómo la gente usa los edificios y las ciudades.

¿Reusar o expulsar? Lineal vs circular

La idea central del metabolismo reside en que las ciudades modernas y edificios tienen metabolismos lineales: es decir, generan recursos y producen residuos y emisiones. Por lo que, el costo de su existencia se extiende sobre el resto de las ciudades o áreas circundantes, incluso del mundo. Por lo que se requieren ciclos de cierre que pueden ayudar a mejorar estos espacios.

¿Cómo cambiar el metabolismo del entorno construido?

Sobre todo, a través de construir edificios más eficientes, mejor diseñados; ciudades más densas, más compactas que ofrecen una mezcla de usos; así como la reducción de necesidades de transporte y energía. Por lo que, se requiere un cambio general en las mentalidades y estilos de vida, y una redefinición de la ciudad en torno a nuevos principios.

Por otra parte, y desde una perspectiva latinoamericana, González Dania. Nos resume dicho modelo teórico, al destacar que las ciudades forman parte del medio ambiente construido y creado por el hombre, y como tal, interactúan con el medio ambiente natural. Por tanto, y según el modelo de desarrollo lineal y "productivista" imperante hasta hoy, el metabolismo lineal de las ciudades las convierte en consumidoras de recursos provenientes del medio natural, a la vez que depositan en éste, los desechos que en ellas se producen. Esta situación conduce al agotamiento de recursos y la contaminación ambiental que caracterizan la crisis del mundo actual, cuando las necesidades del ecosistema urbano (que se alimenta de otros) sobrepasan las posibilidades de su territorio de influencia para reproducir los recursos y reciclar los desechos (lo que comúnmente se conoce como capacidad de carga).

Por lo tanto, para que una ciudad sea más sustentable es necesario, transformar el metabolismo lineal en metabolismo circular, donde la mayoría de lo que salga pueda ser reutilizado en el sistema de producción y, con ello, afectar un entorno mucho menor. Así, en la medida en que se encuentren y apliquen soluciones de sistemas circulares para el agua, la basura, la energía y los alimentos, nos acercaremos, cada vez más, a un desarrollo sustentable de las ciudades, con un mejor uso de los abundantes recursos humanos, los preciosos recursos naturales y los escasos recursos financieros.

Otro aspecto importante es la escala y dimensiones del asentamiento urbano, ya que influye en la posibilidad de un mayor o menor acercamiento a una solución sustentable. Si se descomponen problemas grandes en varios pequeños, que resulten más "manejables", será más fácil enfrentar su solución. Por tanto, las ciudades sustentables pudieran estar estructuradas en sistemas de partes con el mayor grado posible de autonomía.

FIGURA 1. ESQUEMA DEL CICLO DE ENTRADA Y SALIDA EN LAS CIUDADES

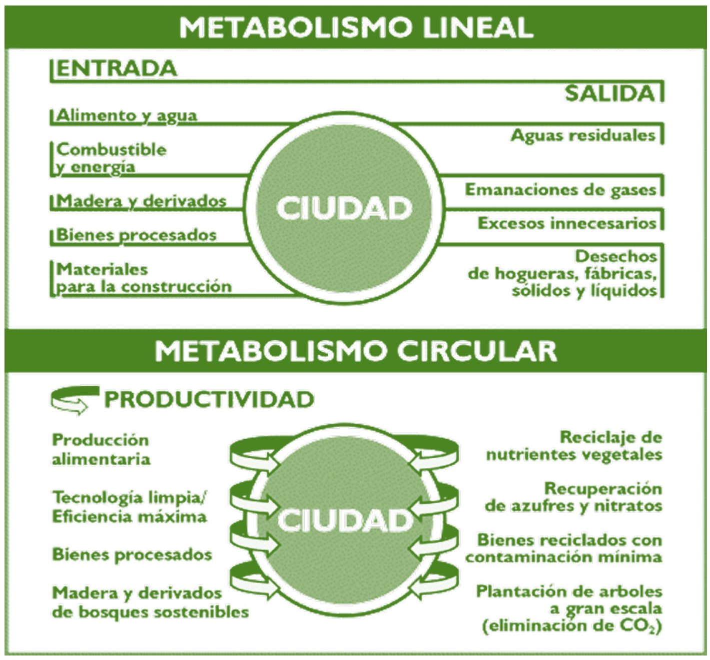
Fuente: Tomado de González D. 2013.

Un aspecto de la planeación urbana que guarda una relación directa con el desarrollo sustentable es el aprovechamiento del suelo como recurso prácticamente no renovable, pues una vez que se construye sobre él, tardará mucho en ser usado nuevamente, en dependencia de la vida útil de la edificación. Como es conocido, lo más común es que los países que han tenido históricamente una posición destacada en la preocupación por la preservación del medio ambiente, de manera general, se proponen hoy como principio indiscutible para la sustentabilidad urbana, el incremento de la densidad de uso del suelo, aprovechando sobre todo las áreas urbanas ya existentes. El acceso al suelo es hoy un factor decisivo para resolver el problema de la vivienda en los sectores poblacionales de más bajos ingresos en los países en desarrollo. Sin embargo, las tipologías arquitectónicas y urbanas que se corresponden con los sistemas de gestión y las soluciones constructivas empleadas en esos casos, generan en las ciudades del tercer mundo, desarrollos urbanos marginales y periféricos de muy bajas densidades.

Como sabemos, las áreas verdes urbanas desempeñan múltiples funciones de saneamiento ambiental: producción de oxígeno, filtro para la contaminación, barrera contra ruidos, etc. También en climas cálidos como el nuestro, el efecto de la "sombra viva" es insuperable y contribuye notablemente a la reducción de la temperatura en espacios exteriores, contrarrestando el efecto de la "isla de calor urbana".

Otro aspecto relevante en la planeación de las ciudades que también desempeña un papel decisivo, es la reducción de las necesidades de transportación, tanto de personas como de productos. Por lo que, el crecimiento excesivo de las ciudades, la zonificación de sus funciones, la aparición de "ciudades satélites" o "ciudades dormitorio" han ocasionado consecuencias negativas, como la expansión de las autopistas y líneas de ferrocarril, que constituyen, además, barreras en el paisaje urbano. Otro aspecto importante en la sustentabilidad de las ciudades es, por tanto, garantizar un buen sistema de transporte público, sano, seguro y eficiente, que resulte competitivo con el automóvil como medio de transporte individual. No obstante, las tendencias en este sentido en los países desarrollados se dirigen en la actualidad a incrementar la capacidad de carga de los medios de transporte disponibles, particularmente los de pasajeros; buscar otras fuentes de energía para sustituir los combustibles fósiles, tal es el caso del etanol en los autobuses y autos eléctricos. Así como también combinar estos medios de transporte con el uso extendido de bicicletas en áreas centrales. Otro aspecto a considerar es la seguridad del tráfico urbano, la reducción de velocidades y construir calles, carreteras, vehículos y equipamientos más seguros.

FIGURA 2. COMPARATIVO ENTRE EL METABOLISMO LINEAL Y CIRCULAR



Fuente: Tomado de González D. 2013.

La necesidad de incorporar el diseño bioclimático a escala urbana y arquitectónica constituye otra vía para mejorar las condiciones ambientales y reducir el consumo de energía convencional en los espacios habitables, todo lo cual contribuye al logro del desarrollo sustentable.

Así mismo, otro importante recurso que se consume en las ciudades es el agua. Las fuentes de agua, su calidad y saneamiento, las formas de abasto y bombeo (aprovechamiento de la gravedad o energías renovables) influyen considerablemente en la calidad de la vida y el consumo de recursos. Por otra parte, el agua es un preciado recurso que puede ser reciclado o reusado, tanto a escala de los edificios o de conjuntos, como a escala de ciudad. El aprovechamiento del agua pluvial es también una forma de ahorrarla, sobre todo en lugares donde la lluvia es abundante y la disponibilidad de agua potable es insuficiente. De ahí que la evacuación y tratamiento de los residuales urbanos es otro factor de vital importancia en el desarrollo urbano sustentable.

El reciclaje de todos los desechos posibles minimiza la cantidad de residuos que se incorporan al medio ambiente y con ello su contaminación, así como la cantidad de recursos y materias primas necesarias. Para ello, es imprescindible la recolección separada de los desechos sólidos y líquidos, orgánicos e inorgánicos, de forma clasificada. Los residuos sólidos orgánicos pueden ser tratados para producir composta (un abono orgánico de excelente calidad), o en bio-digestores para obtener biogás (gas combustible) y abono. Los residuos inorgánicos (vidrio, papel, cartón, metales) pueden ser reciclados como materia prima en la producción de nuevos productos.

Así mismo la participación social en los procesos de gestión urbana es una condición esencial del desarrollo sustentable. Cualquier proceso sustentable ha de desarrollarse de abajo a arriba y de adentro hacia afuera, debe ser específico y descentralizado. Por último, las tecnologías y los materiales de construcción empleados en la ejecución de los edificios que conforman la ciudad, también influyen de forma considerable en su sustentabilidad (González D. 2013: 18-20).

3. Construcción e interpretación del Índice del Volumen Físico del Gas Natural de la región Guadalajara 2000-2013

Con el objeto de comprobar fehacientemente la existencia de la falla en el suministro de gas natural en la región Guadalajara, durante los años recientes, se realizó una solicitud de información sobre los volúmenes del energético a la Comisión Reguladora de Energía (CRE), organismo autónomo, pero con adscripción a la Secretaría de Energía, instancia rectora del sector energético en el país.

Gracias a la política vigente de transparencia y acceso a la información, a través del órgano interno de control (contraloría interna de dicha dependencia), se obtuvieron los datos de la serie 2000-2013, los datos sobre dichos flujos y el cálculo realizado de las variaciones porcentuales anuales se muestra a continuación. Cabe aclarar que ésta es la primera vez que se elabora el índice, para efectos de comprobar con un método matemático, la existencia de los flujos del energético en el periodo referido y comprobar su desabasto en la región Guadalajara.

Así, mismo, es preciso explicar que la fórmula para obtener el índice del Volumen Físico del Gas Natural de la entidad, se resume restando el volumen físico del suministro del gas natural del último año, menos el valor del año previo, y el resultado se divide entre el valor suministrado el primer año del periodo estudiado. Cabe señalar que éste, indicador que se genera por primera vez para el periodo referido, por medio del cual, se comprueba que durante el año 2012, ocurrió una falla en la seguridad energética de ese hidrocarburo en la región, al demostrarse una baja del 33.7% .

Cabe aclarar, que la otra baja pronunciada que se muestra en el periodo; es decir, la del año 2004, el órgano oficial (CRE), aclara que se refiere a que los datos están incompletos, es decir, se precisa que el registro del volumen de gas para ese año, sólo se refiere al del primer semestre. Por lo que, se evidencia que durante el año 2012, ocurrió un desabasto del energético, ocasionado por la saturación de la demanda en la región centro occidente. Por lo que, el único gasoducto proveniente de Salamanca, Guanajuato; fue insuficiente para abastecer la demanda de la ZMG.

Como puede observarse, la importancia en la generación de indicadores como el anterior, representa un ejemplo de que la persistencia de indagar y acudir a las fuentes oficiales, cuando se presume la existencia de los datos; es sumamente relevante, dado que el esfuerzo por demostrar la evidencia cuantitativa con datos oficiales, más que la versión empírica (prensa) del fenómeno de la vulnerabilidad de la seguridad energética a nivel regional y urbano, si es posible, siempre y cuando se haga la búsqueda y el procesamiento de la información correspondiente, mediante la solicitud de los datos vía transparencia, de forma directa, o a través de la instancia federal y/o estatal respectiva. Por lo que, con esto ha sido posible validar el hecho descrito por los medios de información y las versiones de afectación descritas por los empresarios de las zonas industriales de El Salto y la de Guadalajara específicamente. Enseguida se muestran los cuadros y gráficas alusivos al objeto de estudio.

CUADRO 1. VOLÚMENES DE GAS NATURAL SUMINISTRADOS A LA REGIÓN GUADALAJARA POR EL SNG, 2000-2013

AÑO	Punto de extracción Guadalajara	IVFGN	Variación %	NACIONAL	IVFGN	Variación %
2000	22,194,208	100	NA	1,104,237,503	100	NA
2001	17,227,773	77.6	-22.4	1,122,235,185	101.6	1.6
2002	21,567,645	97.2	25.2	1,314,307,405	119.0	17.1
2003	19,609,612	88.4	-9.1	1,433,138,186	129.8	9.0
2004[/2]	8,837,166	39.8	-54.9	869,503,410	78.7	-39.3
2005	17,666,076	79.6	99.9	1,451,722,236	131.5	67.0
2006	18,262,352	82.3	3.4	1,711,797,614	155.0	17.9
2007	17,681,929	79.7	-3.2	1,598,734,502	144.8	-6.6
2008	18,543,489	83.6	4.9	1,694,237,056	153.4	6.0
2009	18,738,676	84.4	1.1	1,676,639,823	151.8	-1.0
2010	20,315,405	91.5	8.4	1,722,593,964	156.0	2.7
2011	21,219,630	95.6	4.5	1,858,663,823	168.3	7.9
2012	14,061,266	63.4	-33.7	1,715,372,889	155.3	-7.7
2013	20,666,545	93.1	47.0	1,718,143,645	155.6	0.2

Fuente: CRE/[1] Información entregada semestralmente por PGPB: cantidades de gas por punto de inyección y estracción.

CUADRO 2. ELEMENTOS DE LA FÓRMULA DEL IVFGNG

Indicador Propuesto:

Indicador del Volumen Físico del Gas Natural de la Región Guadalajara

Índice del Volumen Físico del Gas Natural: Relaciona el suministro obtenido en el periodo de estudio, respecto a la del periodo base. El método para obtenerlo es dividir los valores del año de estudio entre los valores del año base y multiplicar el resultado por 100.

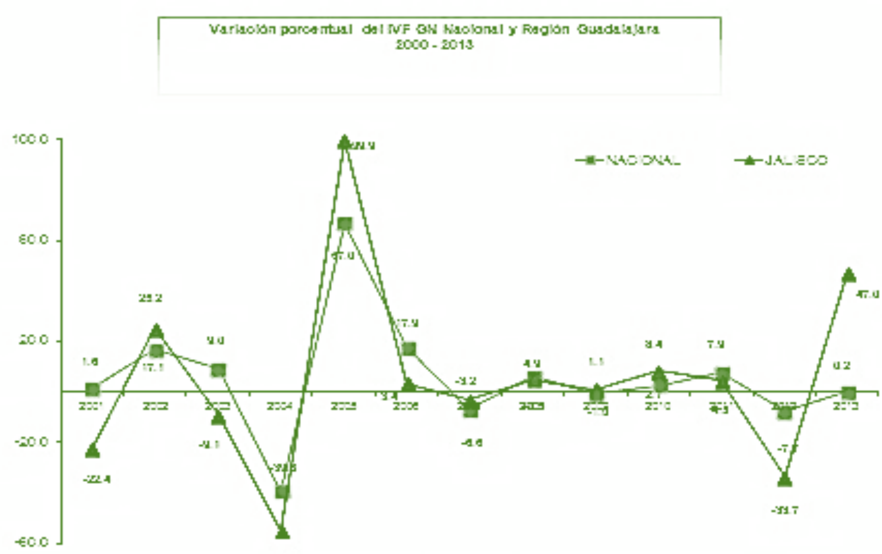
GRÁFICA 1. VOLÚMENES DE GN NACIONAL Y REGIÓN GUADALAJARA, 2000-2013

Fuente: CRE/¹ Información entregada semestralmente por PGPB: cantidades de gas por punto de inyección y estracción.

GRÁFICA 2. IVFGN NACIONAL Y REGIÓN GUADALAJARA, 2000-2013

Fuente: CRE/¹ Información entregada semestralmente por PGPB: cantidades de gas por punto de inyección y estracción.

GRÁFICA 3. VARIACIÓN PORCENTUAL DEL IVFGN NACIONAL Y REGIÓN GUADALAJARA 2000-2013



Fuente: CRE/¹ Información entregada semestralmente por PGPB: cantidades de gas por punto de inyección y estracción.

4. Conclusiones

El objetivo del trabajo se basó en explorar la existencia de indicadores energéticos a nivel regional y urbano en México. El resultado nos permite saber que los disponibles hasta la fecha sólo se refieren a la distribución y venta de energía eléctrica a nivel estatal y municipal. Por lo que no existen datos y, mucho menos, indicadores sobre el suministro de combustibles fósiles a nivel regional en nuestro país. Por lo que, es lamentable que la información sobre otro tipo de indicadores (petrolíferos), aún no se generan a esa escala geográfica en México. Por ende, si contáramos con ellos, esto nos permitiría conocer los datos de volúmenes de oferta y demanda por ciudad. Lo cual, nos permitiría investigar entre otras cosas, la dimensión energética del paradigma del metabolismo urbano. Es decir, conocer los flujos energéticos de entrada y salida por ciudades.

En tal sentido, las respuestas a los planteamientos expresados inicialmente, son que hasta agosto del 2018 no se cuenta con indicadores energéticos a escala regional y urbana en México, más allá de los eléctricos; por lo que es importante avanzar en la generación de indicadores energéticos del suministro de petrolíferos lo antes posible. Así mismo, la investigación permitió demostrar que si es posible construir un índice del volumen de gas natural suministrado a nivel estatal con la información disponible, si se desagrega a esa escala territorial.

Respecto al paradigma del metabolismo urbano, podemos definirlo como "La suma total de los procesos técnicos y socioeconómicos que se producen en las ciudades, lo que resulta en el crecimiento, la producción de energía, y la eliminación de residuos" (Kennedy *et al.,* 2007: 44). Más tarde, Wolman (1965) relanzó el concepto en respuesta al deterioro de las cualidades del aire y del agua en las ciudades estadounidenses. Como se sabe, el concepto entonces, surgió del deseo de cuantificar, con el fin de cambiar/mejorar el estado de cosas en las ciudades norteamericanas.

Por otra parte, los resultados preliminares del trabajo permiten adelantar que si es posible generar indicadores de oferta y demanda de petrolíferos a escala regional, como es el caso del Índice del Volumen Físico del Gas Natural para Jalisco (IVFGNJ) y/o Región Guadalajara, en el periodo referido; el cual, fue construido a partir de la solicitud de datos al organismo regulador oficial. Por lo que, el resultado obtenido del presente trabajo brinda elementos para sugerir propuestas orientadas a destacar la necesidad impostergable de contar con indicadores energéticos a esa escala territorial, a efecto de medir la magnitud del deterioro ecológico y social implícito en los procesos productivos implícitos en los metabolismos urbanos en México.

Finalmente, la generación del Índice del Volumen Físico del Gas Natural de la Región Guadalajara (IVFGNG), es un ejemplo de que, al obtener y procesar los datos oficiales, se comprueba con evidencia cuantitativa, más que la empírica (prensa), que el fenómeno de la vulnerabilidad del suministro energético (gas natural) a nivel regional y urbano, si ocurrió; tal y como fue descrito por los medios de comunicación y las empresas manufactureras directamente afectadas, de las zonas industriales de los municipios de El Salto y de Guadalajara, en cuanto a lo que se denominaron como las "alertas críticas", anunciadas durante los años de 2012 y 2013, respecto a la falta de suministro de gas natural en dicha región. Así, la conclusión general del trabajo es que con el indicador generado, se permite comprobar la necesidad impostergable de contar con indicadores de los combustibles fósiles, para realizar cuanto antes, estudios de flujos energéticos, acorde al concepto del metabolismo urbano.

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SUMINISTRO DE GAS POR DUCTOS AL CONSUMIDOR FINAL (222210) (VALORES ABSOLUTOS)

Entidad y municipio	Unidades Económicas			Personal ocupado total			Total de remuneraciones			Producción bruta total			Formación bruta de capital fijo			Valor total de los activos fijos		
	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014
Total Nacional	14	7	15	6 056	868	1 438	288 731	47 007	0	2 342 745	2 674 450	3 384 364	1 591 422	505 781	1 491 087	9 751 036	6 030 564	21 245 525
Total Baja California				96			0			47 791			6 521			180 753		
002 Mexicali	*			96			0			47 791			6 521			180 753		
Total Coahuila de Zaragoza			*	53		75	7 061			51 411		49 675	13 384		52 648	69 807		1 160 578
05 Piedras Negras	*			53			7 061			51 411			133 384			69 807		
Total Chihuahua		*		627	132	0	56 277	0		268 169	152 447		51 631	50 392		466 752	472 046	
019 Chihuahua		*			132			0			152 447			50 392			472 046	
037 Juárez	*			627			56 277			268 169			51 631			466 752		
Total Distrito Federal	*	*	8	1 619	588	693	55 535	0		600 699	2 176 743	2 132 823	431 577	338 467	673 282	2 173 050	4 779 474	8 108 572
016 Miguel Hidalgo	*	*		1 619	588		55 535	0		600 699	2 176 743		431 577	338 467		2 173 050	4 779 474	
Guanajuato						130						237 290			297 523			2 252 120
Total Jalisco			*	62		52	0			15 492		254 487	102 020		63 933	226 408		785 098
039 Guadalajara	*			62			0			15 492			102 020			226 408		
Total México	*	*	*		17	36		4 046			49 061	111 980		46 760	54 408		161 297	496 548
057 Naucalpan de Juárez	*	*			17			4 046			49 061			46 760			161 297	
Total Nuevo León	*	*	*	3301	102	341	167 949	39 385		1 172 152	247 656	236 548	705 766	68 833	287 627	5 521 288	418 190	6 591 000
039 Monterrey	*	*		3186	102		135 631	39 385		1 002 598	247 656		700 778	68 833		4 595 872	418 190	
046 San Nicolás de los Garza	*			115			32 318			169 554			4 988			925 416		
Puebla	*			75			0			33 218			100 612		40 973	149 366		
114 Puebla	*			75			0			33 218			100 612			149 366		
Querétaro de Arteaga	*			82		94	0			61 565		353 430	80 864			351 774		1 335 997
014 Querétaro	*			82			0			61 565			80 864			351 774		
Total Sonora	*			55	29		1 909	3 576		36 761	48 543		- 95	1 329		230 532	199 557	
019 Cananea	*	*		25	29		1 909	3 576		10 500	11 648		- 95	- 80		32 145	33 877	
030 Hermosillo	*	*		30	0		0	0		26 261	36 895		0	1 409		198 387	165 680	
Total Tamaulipas	*		*	86		17	0			55 487		8 131	99 142		20 693	381 306		515 612
022 Matamoros	*			45			0			24 112			91 150			183 165		
038 Tampico	*			41			0			31 375			7 992			198 141		

SUMINISTRO DE GAS POR DUCTOS AL CONSUMIDOR FINAL (222210) (PORCENTAJES)

Municipio	Personal ocupado total			Total de remuneraciones (Miles de pesos)			Producción bruta total (Miles de pesos)			Formación bruta de capital fijo (Miles de pesos)			Valor total de los activos fijos (Miles de pesos)		
	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014	2004	2009	2014
Nacional	100.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	101.0	100.0	100.0	100.0
Baja California	1.6	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.4	0.0	0.0	1.9	0.0	0.0
Coahuila de Zaragoza	0.9	0.0	5.2	2.4	0.0	0.0	2.2	0.0	1.5	0.8	0.0	3.5	0.7	0.0	5.5
Chihuahua	10.4	15.2	0.0	19.5	0.0	0.0	11.4	5.7	0.0	3.2	10.0	0.0	4.8	7.8	0.0
Distrito Federal	26.7	67.7	48.2	19.2	0.0	0.0	25.6	81.4	63.0	27.1	66.9	45.2	22.3	79.3	38.2
Guanajuato	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	20.0	0.0	0.0	10.6
Jalisco	1.0	0.0	3.6	0.0	0.0	0.0	0.7	0.0	7.5	6.4	0.0	4.3	2.3	0.0	3.7
Guanajuato	0.0	0.0	9.0	0.0	0.0	0.0	0.0	0.0	7.0	0.0	0.0	20.0	0.0	0.0	10.6
México	0.0	2.0	2.5	0.0	8.6	0.0	0.0	1.8	3.3	0.0	9.2	3.6	0.0	2.7	2.3
Nuevo León	54.5	11.8	23.7	58.2	83.8	0.0	50.0	9.3	7.0	44.3	13.6	19.3	56.6	6.9	31.0
Puebla	1.2	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	6.3	0.0	2.7	1.5	0.0	0.0
Querétaro de Arteaga	1.4	0.0	6.5	0.0	0.0	0.0	2.6	0.0	10.4	5.1	0.0	0.0	3.6	0.0	6.3
Sonora	0.9	3.3	0.0	0.7	7.6	0.0	1.6	1.8	0.0	0.0	0.3	0.0	2.4	3.3	0.0
Tamaulipas	1.4	0.0	1.2	0.0	0.0	0.0	2.4	0.0	0.2	6.2	0.0	1.4	3.9	0.0	2.4

Fuente: INEGI. Censos Económicos 2004, 2009 y 2014 Resultados definitivos.

Nota: confidencialidad de los datos proporcionados con fines estadísticos la columna unidades económicas se encuentra inhibida en varios renglones, mostrando un asterisco (*). Esto se debe a que la ley del sistema nacional de informacion estadística y geográfica, en vigor, en sus artículos 37, 38, 42 y 47 establece la confidencialidad de la información. El artículo 37 señala que: ''los datos que proporcionen para fines estadísticos los informantes del sistema a las unidades en términos de la presente ley, serán estrictamente confidenciales y bajo ninguna circunstancia podrán utilizarse para otro fin que no sea el estadístico..''; mientras que el artículo 38 cita textualmente: ''los datos e informes que los informantes del sistema proporcionen para fines estadísticos y que provengan de registros administrativos, serán manejados observando los principios de confidencialidad y reserva, por lo que no podrán divulgarse en ningún caso en forma nominativa o individualizada, ni harán prueba ante autoridad judical o administrativa, incluyendo la fiscal, en juicio o fuera de él..''. el artículo 42 hace referencia a la posibilidad de denunciar la violación a los ya mencionados principios de confidencialidad y reserva; mientras que el artículo 47 dicta que: '' la información no queda sujeta a la ley federal de transparencia y acceso a la información pública gubernamental''.

FLUJO DE GAS NATURAL POR REGIONES EN MÉXICO 2010-2015 (GIGAJOULES POR AÑO)

Zonas tarifarias	Flujo (Gigajoules por año)						Porcentajes					
	2010	2011	2012	2013	2014	2015	2010	2011	2012	2013	2014	2015*
Golfo-Centro	193,086,157	206,252,934	228,241,189	223,853,143	212,840,498	125,220,861	11.0	11.9	13.6	12.8	12.1	13.7
Golfo-Golfo	810,515,809	700,539,084	664,173,648	641,060,367	632,026,307	363,979,308	46.1	40.4	39.7	36.6	35.9	39.7
Golfo-Norte	68,508,294	88,634,768	78,833,214	90,778,543	93,340,428	46,515,605	3.9	5.1	4.7	5.2	5.3	5.1
Golfo-Occidente	140,904,120	131,298,146	127,901,469	113,624,744	117,218,034	63,966,993	8.0	7.6	7.6	6.5	6.7	7.0
Norte-Norte	38,322,912	43,104,331	43,660,907	46,754,858	45,966,430	24,191,286	2.2	2.5	2.6	2.7	2.6	2.6
Sur-Centro	48,887,083	75,764,446	50,648,382	86,530,515	85,922,573	38,072,968	2.8	4.4	3.0	4.9	4.9	4.2
Sur-Golfo	25,660,239	3,245,977	19,241,731	51,937,973	52,766,075	14,635,604	1.5	0.2	1.1	3.0	3.0	1.6
Sur-Occidente	50,705,590	83,894,076	92,253,246	78,895,971	105,814,933	35,741,996	2.9	4.8	5.5	4.5	6.0	3.9
Sur-Sur	382,463,273	402,051,982	369,013,029	417,273,683	414,574,540	196,686,592	21.7	23.2	22.0	23.8	23.5	21.5
Occidente-Occidente	0	0	0	0	0	7,465,487	0.0	0.0	0.0	0.0	0.0	0.8
Flujo total en el Sistema Nacional de Gasoductos	1,759,053,477	1,734,785,744	1,673,966,815	1,750,709,797	1,760,469,818	916,476,700	100.0	100.0	100.0	100.0	100.0	100.0

Fuente: PGPB. Flujos transportados por trayecto entre zonas tarifarias del SNG, 2010 - 2015
Datos disponibles solo del primer semestre.

Análisis del sistema de extracción de petróleo a partir del uso de la Tasa de Retorno Energética (TRE) para el caso del Ecuador

Rony Parra*

Introducción

El sistema energético global depende en gran medida de la producción de combustibles fósiles y aunque existen esfuerzos para reducir las emisiones de gases de efecto invernadero (GEI) y cambio hacia un modelo de energía renovable, el petróleo sigue formando parte esencial de la cadena energética global. De acuerdo a la Agencia internacional de Energía, en el 2015 se consumió 3820 Mtoe de un consumo total de energía final de 9383 Mtoe (International Energy Agency, 2017).

El sector del petróleo, además de suministrar combustibles para la actividad económica, también es una industria intensiva en energía, factor que interviene en el encarecimiento de los costos ambientales. El sistema de energía se encuentra en transición del petróleo producido convencionalmente a una variedad de sustitutos, con riesgos económicos, estratégicos y ambientales (Farrell & Brandt, 2006).

El agotamiento eminente de reservas de crudo convencional y los avances en técnicas de perforación, imágenes sísmicas y nuevas formas de extracción, pronostican una tendencia global hacia la extracción de petróleos pesados, no convencionales y pizarras bituminosas que requiere mayores inversiones tecnológicas y energéticas (World Energy Council, 2016).

Este trabajo analiza el sistema de extracción de petróleo del Ecuador bajo variables biofísicas de insumo–producto y de abajo hacia arriba, a partir del rendimiento energético, determinada como la energía de salida por unidad de energía consumida (diferenciando el consumo de energía térmica y mecánica), integrando tipologías de bloques a partir de la calidad de petróleo.

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Para el caso de estudio, al 2016 se determinó que el sector de extracción de petróleo del Ecuador requirió 63.03 PJ de energía para producir 1487.3 PJ, es decir una Tasa de Retorno Energético TRE o EROI por sus siglas en inglés (Energy Returned on Investment) de 24:1, sin embargo, se evidencia que el EROI difiere significativamente cuando analizamos bloques de acuerdo a la calidad del petróleo. Para los bloques de crudo medio (10≤API≤21) la relación se situó en 36:1, mientras que para los bloques de petróleo pesado (22≤API≤30) la relación bajó a 18:1.

1. Antecedentes

La extracción de petróleo es uno de los procesos industriales que demanda altas cantidades energéticas para su operatividad, si bien, la explotación de los primeros campos en el mundo resultaba fácilmente aprovechables por las características propias del recurso y de sus yacimientos, con el paso del tiempo el grado de dificultad para extraer el mismo volumen de petróleo se incrementó. Esto implica, entre otras cosas, un aumento en la intensidad energética en los subprocesos. El índice de retorno de la energía permite conocer la calidad del recurso: un recurso de alta calidad requerirá menos energía para ser extraído y aprovechado que uno de baja calidad (Brandt, 2011). Esta relación también da una idea de la eficiencia con la que la industria gestiona los recursos.

Revisando la literatura, se observa poca atención a los efectos específicos que causa la disminución de las reservas convencionales de petróleo y a la posibilidad de sustitutos con mayores costos ambientales. Hall, Cleveland, Brandt y Tripathi abordan esta problemática desde la Tasa de Retorno Energético EROI y sus trabajos los realizan principalmente en los campos de petróleo y gas de EEUU, utilizan para ello información estadística agregada de *arriba hacia abajo* y a un ámbito nacional, mostrando reducciones significanticas del EROI al comparar campos desde 1919 hasta el 2014 (Hall, 1981; Cleveland, 2005; Brandt *et al.*, 2011; Tripathi y Brandt,2017).

Tomando como ejemplo el estudio Guilford y Hall, los campos estadounidenses en 1970 consumían energía equivalente a un barril de petróleo para extraer 30 barriles a superficie y en el 2005 la tasa de extracción se situó por debajo de 10 barriles. Una realidad similar se observó en el campo Daqing en China, la tasa de rendimiento de energía cayó de 10:1 en el 2001 a 6:1 en el 2012 (Guilford y Hall, 2011). Para los campos rusos se realizaron trabajos similares mostrando caídas en el retorno energético del 17% entre campos evaluados desde 2005 al 2012 (Nogovitsyn and Sokolov,2014), en Canadá esta relación cayó el 13% para campos evaluados desde 1990 a 2008 (Poisson and Hall,2013).

Court y Fizaine por su parte muestran estudios sobre EROI a una escala global para combustibles fósiles, muestran una metodología a partir de las inversiones monetarias realizadas y aproximando los costos realizados en energía en los sectores del carbón, petróleo y gas, para lo cual parte de información estadística financiera agregada: cantidad y precios de la energía, producto interno bruto global y la estimación del rendimiento monetario de la inversión en los sectores de energía fósil (Court & Fizaine, 2017). Esto eminentemente acarreará un margen de error si lo comparamos con estudio de *abajo hacia arriba*.

También se realizaron estudios del EROI para tecnologías y combustibles específicos, trabajos comparativos en el área de la aviación con combustibles alternativos a los fósiles como una opción para mitigar el cambio climático (Trivedi *et al.*, 2015), análisis del potencial eólico a escala global, considerando en su análisis el cálculo de la tasa de retorno energético como una limitante física del modelo (Dupont, Koppelaar, & Jeanmart, 2018) o el uso del EROI para comparar tecnologías para la producción de electricidad a partir de la disponibilidad de biomasas y un ciclo combinado de producción de electricidad con fuentes eólicas y gas natural (Parkhurst, Saffron, & Miller, 2016).

Brad presenta un aporte a la metodología de *abajo hacia arriba*, partiendo del ciclo de vida LCA y luego calculando el EROI para los campos petroleros en California. Su estudio lo realiza en tres etapas extracción, refinación y consumo de combustibles; sin embargo, en su modelo no contempla que algunos de los productos finales de la extracción de petróleo y gas, de hecho, irán a otros sectores de extracción de energía, ya sea directa o indirectamente y no a los consumidores finales no energéticos (Brandt, 2011).

La definición de límites del sistema es esencial para el entendimiento de la problemática energética, es decir, determinar dónde comienza y termina un sistema no debe considerarse menor, ya que puede producirse resultados diferentes para el mismo proceso (Parra, Di Felice, Giampietro, & Ramos-Martin, 2018).

Centrando la discusión para el caso de estudio, en el sector de extracción de petróleo del Ecuador se tiene trabajos principalmente enfocados al estado actual de la política de extracción de petróleo en relación con el desarrollo sostenible (Fontaine, 2003), indicadores económicos (Martínez,Javier; Parra,Rony; Reis, 2016) y evaluación de impactos sociales y ambientales de la extracción de petróleo en las poblaciones locales ((Vallejo, Burbano, Falconí, & Larrea, 2015) y (Rodríguez, 1998)).

Respecto al análisis con variables biofísicas, se presenta un único trabajo sobre el metabolismo en el sector petrolero del Ecuador que formaliza una metodología para describir la extracción de petróleo basada en la distinción entre elementos funcionales y estructurales, utilizando el Análisis Integrado de Escala Múltiple del Metabolismo de la Sociedad y del Ecosistema MuSIASEM por sus siglas en inglés (Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism). En dónde se describe que, la extracción de petróleo en Ecuador consume por metro cúbico de petróleo más de 100 kWh de electricidad y 1.5 GJ de combustibles, que requieren 3 kW de capacidad de potencia instalada y 2 horas de actividad humana (Parra *et al.*, 2018). Estos principios serán usados y descritos en el apartado metodológico de este trabajo.

2. Metodología

Es importante hacer una descripción teórica de lo que es la Tasa de Retorno energético TRE o Energy Returned on Investment EROI (por su significado en inglés). EROI muestra el gasto o la inversión de energía en un proceso determinado y está definida por la cantidad de energía entregada en un proceso específico sobre la cantidad de energía utilizada en el mismo proceso. Es una medida de la accesibilidad de un recurso, lo que significa que cuanto mayor sea el EROI, mayor será la cantidad de energía neta entregada a la sociedad para apoyar el crecimiento económico (Hall *et al.*, 2014).

En los procesos de extracción petrolera permitirá identificar cuánta energía se devuelve a la sociedad en forma de petróleo en comparación con lo que se invirtió en la industria para conseguirlo y cómo esta relación se comporta en el tiempo. Si el resultado es cada vez mayor mientras transcurre el tiempo, entonces se tendría la evidencia de que las nuevas tecnologías están actualmente superando el agotamiento del recurso (Gagnon, 2009).

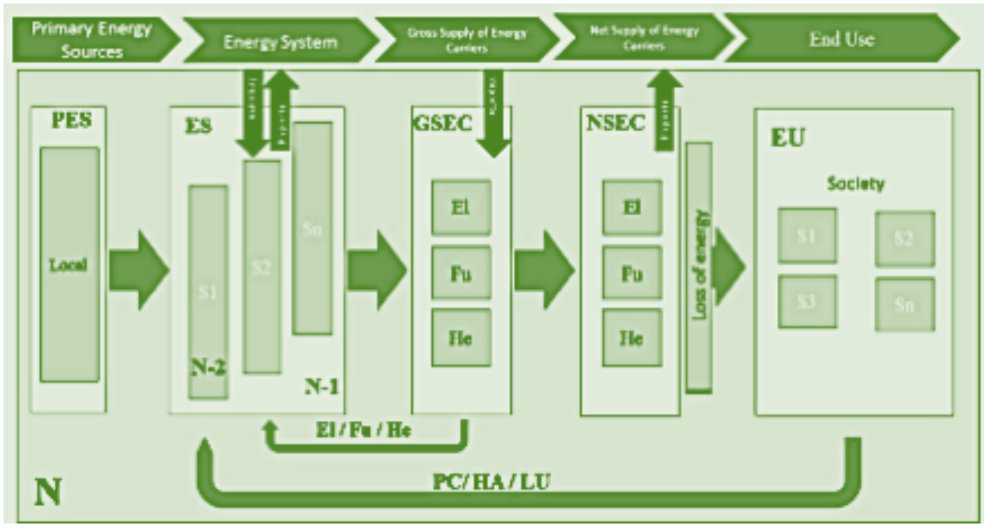
Si el EROI es menor a 1, el proceso estaría gastando más energía de la que se recupera, lo que supondría bajo consideraciones biofísicas, no continuar con esa actividad. Si la tasa es mayor que 1 indica que la energía total es mayor que la energía invertida dejando un saldo neto positivo. Una consideración importante para la aplicación del indicador es que el numerador y denominador tienen que tener las mismas unidades, por lo que la proporción obtenida es adimensional (100:1 implica que un determinado proceso produce 100 unidades energéticas en una inversión de 1 unidad energética).

Una de las principales dificultades de usar el EROI como indicador de escases energético es la fijación de los límites del proceso, hay autores que usan diferentes relaciones entre energía entregada y gastada en el proceso, difiere de la escala y del propósito. Por un lado, se compara la energía producida sobre la energía interna producida y gastada, pero también existe otra métrica que incorpora la energía externa consumida (Brandt, 2011).

Spitzley y Keolian encontraron más de 10 relaciones de retorno de energía que se han utilizado en trabajos anteriores. Estas relaciones difieren en los límites del sistema, en el propósito del investigador y en la inclusión o exclusión de varios tipos de energía (Spitzley, D. y Keoleian, G,2004). En varios casos los autores no especifican que relación de retorno de energía utiliza eso dificulta compararlos con otros estudios de caso.

Para nuestro ensayo identificaremos la escala de trabajo y fijaremos los límites del sistema a partir de los principios de MuSIASEM, entendiendo que la dinámica de los flujos de energía en la extracción de petróleo es parte funcional del sector de energía. MuSIASEM es un esquema contable desarrollado por Giampietro y Mayumi (Giampietro, 2003; Giampietro *et al.,* 2013, 2011, 2009; Giampietro y Mayumi, 2000; Pastore *et al.*, 2000). El enfoque proporciona una aplicación del esquema de fondos de flujo de Georgescu-Roegen (Georgescu-Roegen, 1971), que vincula las variables socioeconómicas y biofísicas de manera integrada.

GRÁFICA 1. GRAMÁTICA DE LA ENERGÍA

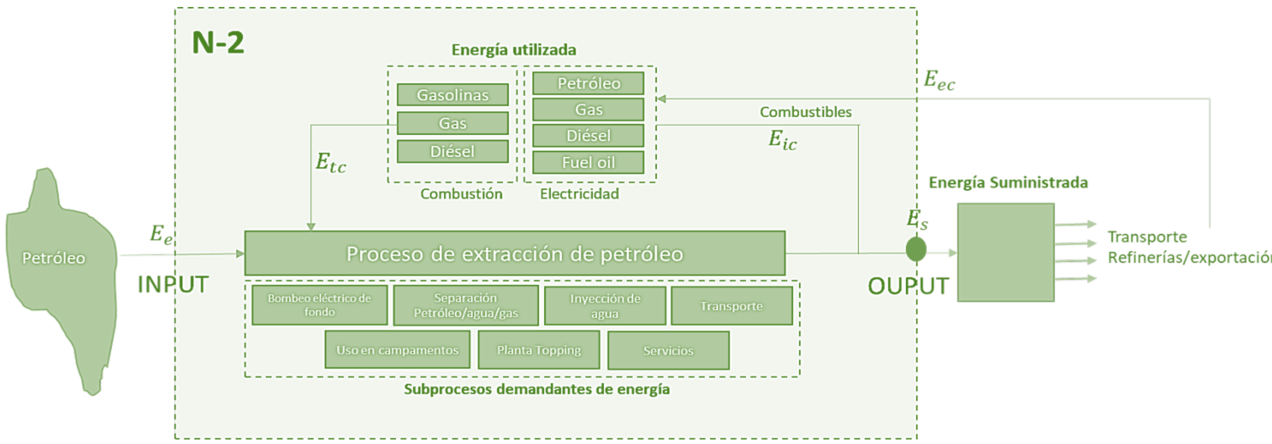


PES: Primary Energy Sourse; EC: Energy carrier; ES: Energy System; El: Electricity; Fu: Fuels; He: Heat; PC: Power Capacity; LU: Land Use; HA: Human Activity.
Fuente: (Parra *et al.*, 2018).

La gramática energética de MuSIASEM ha sido descrita y aplicada en detalle - ver, por ejemplo, (Velasco-Fernández et al., 2015) y (Giampietro et al.,2014). Sus dos conceptos principales, esenciales para comprender el análisis propuesto, son la distinción entre fuentes de energía primaria (PES) y portadores de energía (EC), y la desagregación entre energía mecánica (electricidad) y energía térmica (calor y combustibles). Otro pilar es la distinción entre fondos y flujos. Los fondos son elementos cuya identidad permanece intacta sobre la escala de análisis espacial y temporal elegida, mientras que los flujos son elementos que ingresan al sistema sin existir o salen de él sin ingresar. Los fondos deben mantenerse para poder metabolizar los flujos. muchas formas de contabilidad de materiales y energía solo consideran los flujos y no consideran la importancia clave de caracterizar los fondos necesarios para reproducir y/o utilizar dichos flujos. El uso del suelo, la actividad humana y la capacidad energética (tecnología) son ejemplos de fondos, mientras que la electricidad producida y consumida, el agua consumida y los combustibles consumidos y producidos, así como el petróleo extraído, son ejemplos de flujos.

En la gráfica 1, se diferencia el nivel N-2 que corresponde al sector de la extracción de petróleo, dentro del sistema energético global, con lo cual visualmente se puede entender la dimensión en la que trabajaremos, además se identifica las variables de insumo / producto biofísicos y energéticos. Ahora bien, para fijar los límites del sistema a continuación estructuramos un esquema de gramática para el sistema de extracción.

GRÁFICA 2. SISTEMA DE EXTRACCIÓN DE PETRÓLEO



Fuente: elaboración propia.

El estudio se reduce únicamente a los flujos energéticos, dejando de lado la contabilidad de los fondos y otros flujos que entran (ejemplo: agua) y salen del sistema (ejemplo: residuos). El esquema distingue la línea de secuencia del proceso, desde la entrada de petróleo a boca de pozo, actividades de transformación y la salida de petróleo del sistema. El petróleo de salida es transportado y refinado para luego regresar al sistema como combustibles.

Determinación de la ecuación para el cálculo del EROI

E_e:*Energía del petróleo extraido a boca de pozo*

E_s:*Energía del petróleo entregado por el sistema*

E_{ec}=E_ec1+E_(ec2): *Energía externa que se consume en el sistema*

E_{ic}=E_ic1+ E_ic2: *Energía interna producida y consumida por el sistema*

E_{tc}=*Energía total consumida en el sistema*

E_{ec}1:*Energía externa consumida de conbustibles*

E_{ec1}:*Energía externa consumida de electricidad*

E_{ic1}:*Energía interna producida y consumida de combustibles*

E_{ic1}:*Energía interna producida y consumida de electricidad*

$$EROI= \frac{E_s}{E_{tc}}$$

$$EROI= \frac{E_s}{E_{ic}+E_{ec}}$$

$$EROI= \frac{E_s}{E_{ec1}+E_{ec2}+E_{ic1}+E_{ic2}}$$

En el sistema para el caso de estudio no existe alimentación de energía eléctrica externa de fuentes renovables. La oferta térmica de electricidad se produce a partir de los combustibles propios del sistema o combustibles exportados. Esto ayuda al análisis ya que la contabilidad de energía consumida se la puede agregar a la categoría de combustibles, caso contrario el consumo de energía estaría dado como un vector diferenciando los combustibles y la electricidad.

$$EROI = \frac{E_S}{E_{ec1} + E_{ic1}}$$

En Eec1 no se contabiliza el gasto de energía que se invirtió en producirla y llevarla al sistema N-2 (transporte y refinación). Esta consideración se la debe realizar cuando se contabilicen los datos agregado en el nivel N.

Para entender cómo cambia el EROI entre petróleos livianos y pesados, los bloques petroleros son agrupados en tipologías por su calidad de petróleo extraído, para ello utilizamos la clasificación de densidad API. Mientras mayor sea el API el EROI será mayor y por el contrario el EROI disminuirá, puesto que el proceso será más intensivo en energía para extraer petróleos más pesados.

TABLA 1. CALIFICACIÓN DEL PETRÓLEO POR SU DENSIDAD API

API gravity (º)	Classification
> 31º	Light oil
22-31º	Medium oil
10-22º	Heavy oil
< 10º	Extra heavy oil

Fuente: American Petroleum Institute.

Dentro de la metodología se contempló lo siguiente:

•Se consideraron los 33 bloques petroleros que se encontraron en operación en el 2016, por empresas públicas y privadas.

•Se caracterizó el sistema de generación eléctrica (térmica) a partir de la capacidad instalada por tipo de combustible utilizado en cada bloque (petróleo, diésel y gas).

•Se identificó la importación de combustibles al sistema, diferenciándolos por tipo de combustible (diésel, fuel oil y gasolina).

•Se contempló la producción petrolera fiscalizada (producción petrolera entregada al Estado en un punto de fiscalización) que es la resultante de la resta de la producción a boca de pozo (producción petrolera cuantificada a la salida de cada pozo) menos el petróleo utilizado en el autoconsumo en cada bloque.

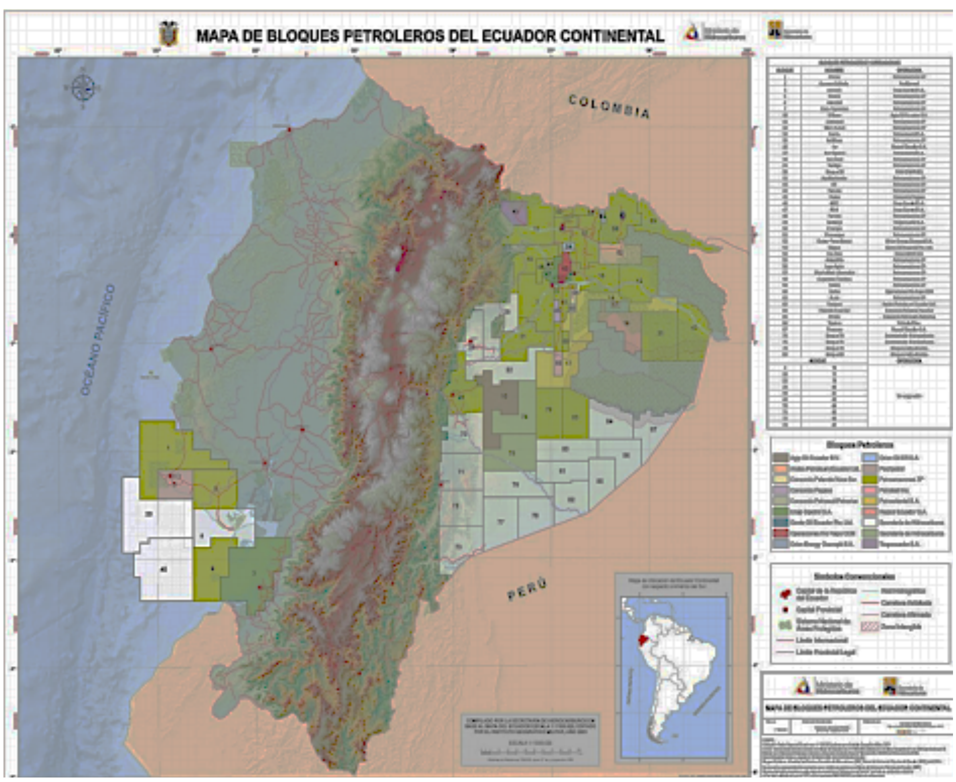
•Se calculó la tasa de retorno energético EROI por bloque y agregada.

3. Descripción del sistema petrolero del Ecuador

América Latina es un exportador neto de petróleo y gas, y las políticas públicas impulsan un aumento de la capacidad de extracción y refinación en los próximos años, aunque las regulaciones varían según los países (Hollanda et al., 2016). En Ecuador, a medida que las reservas de petróleo convencional se agotan con el tiempo, las cifras estadísticas gubernamentales sobre reservas sugieren que se está produciendo gradualmente un cambio de petróleo liviano y mediano a pesado (ARCH, 2016). La extracción de petróleo en Ecuador fue menor (28 Mtep en 2015) en comparación con otros países latinoamericanos como México (131 Mtep en 2015) o Brasil (133 Mtep en 2015) (Agencia Internacional de Energía, 2017). La extracción nacional del Ecuador creció de manera constante en los últimos años, casi duplicándose entre 2000 y 2014 (Hollanda et al., 2016). La cantidad de petróleo extraído está más allá de la capacidad de refinación del país, lo que significa que el país es un exportador neto de petróleo crudo y un importador neto de productos combustibles. Entre las políticas energéticas de mayor importancia se encuentran la construcción de hidroeléctricas y la posición de construir una nueva refinería que reduzca la brecha entre producción e importación de derivados (Ministerio de Energía y Recursos Naturales no Renovables, 2018).

En este contexto, es importante comprender el funcionamiento del metabolismo actual de la extracción de petróleo, toda vez que un cambio en la intensidad energética por la migración hacia la explotación de petróleo pesado, impactará en la planificación energética del país.

GRÁFICA 3. BLOQUES PETROLEROS DEL ECUADOR



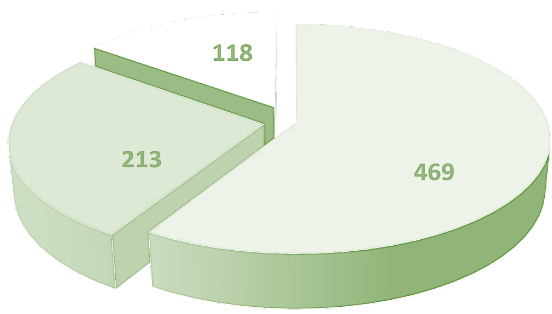
Fuente: ARCH, 2016.

En el 2016 se identificaron 33 bloques petroleros en operación, sin tomar en cuenta el Campo Amistad que produce gas natural, 16 bloques fueron operados por empresas privadas y 17 administrados por la Empresa Pública Petroamazonas EP. La producción de petróleo nacional estuvo en el orden de 31.9 millones de m3 de los cuales el 79% de producción fue de la empresa pública y el 21% perteneció al sector privado (ARCH, 2016).

El sistema de generación de electricidad no mantiene una infraestructura homogénea entre bloques, es decir que cada operador diseña su capacidad instalada de acuerdo a su necesidad y a la disponibilidad del tipo de combustible. Unos cuentan con sistemas desconcentrados por cada centro de consumo (empresas privadas) y otros se manejan de forma centralizada y luego se distribuye a cada centro de consumo (empresa pública), por lo que resulta complejo separar los consumos por cada bloque. Tienen sistemas de backup para atender demandas de energía no consideradas y/o para entrar en operación cuando existen paradas programadas por mantenimiento de equipos.

El sistema está configurado en su totalidad por la generación térmica de electricidad, utilizando sistemas a crudo, diésel, gas y/o híbridos gas / petróleo y diésel / petróleo.

GRAFICA N°4. CAPACIDAD INSTALADA DE GENERACIÓN (33 BLOQUES) EN MW



Fuente: elaboración propia con base en EP Petroamazonas, 2016.

El total de capacidad instalada para generación eléctrica fue de 1.012 MW, contemplando el tipo de tecnología por uso de combustible, el 46% de la infraestructura está instalada para funcionar con diésel, el 21% funciona a crudo, el 18% usa gas y el resto está configurado para funcionar con sistemas híbridos. En la actualidad existen campos que han migrado de diésel a gas por una política de Estado.

La infraestructura instalada varía dependiendo del tipo de combustible que ocupan sus sistemas, principalmente los consumos de electricidad en los bloques petroleros responden al uso de petróleo aprovechado directamente en cada bloque antes de la entrega del punto de fiscalización, diésel producido en las plantas refinadoras pequeñas en bloques con autonomía o a partir del diésel importado y el gas asociado a la extracción que es aprovechado luego de un proceso de tratamiento, en el 2016 se consumieron 3390 GWh en todo el sistema de extracción.

4. Energía del petróleo entregado por el sistema *Es*

El petróleo entregado al sistema se lo consiguió directamente de los reportes anuales de producción fiscalizada que cada empresa realiza al Estado. La producción total presentada en unidades de energía fue de 1487,3 PJ, el 71 % proviene de la extracción de petróleo medio con 1067 PJ, el 28% corresponde a petróleo pesado con 410 PJ, y el 1% es petróleo liviano con

9,8 PJ. Aunque la producción de petróleo liviano no es significativa dentro de la producción nacional, lo es para fines de cálculo de su intensidad de energía.

TABLA 2. PRODUCCIÓN DE PETRÓLEO 2016

		BLOQUE	Producción (1000 m3)	Producción (MJ)	%	°API	Tipo de petróleo
1	2	GUSTAVO GALINDO	66.740	3.110.729.332	0	36,28	liviano
2	1	PACOA	2.484	115.800.855	0	33,00	liviano
3	49	BERMEJO	141.865	6.612.241.567	0	31,20	liviano
4	64	PALANDA YUCA SUR	138.039	6.433.919.281	0	23,62	medio
5	53	SINGUE	4.214.050	196.414.921.503	13	27,41	medio
6	60	SACHA	114.601	5.341.512.121	0	25,80	medio
7	44	PUCUNA	223.510	10.417.678.729	1	31,00	medio
8	56	LAGO AGRIO	288.474	13.445.649.550	1	28,60	medio
9	57	SHUSHUFINDI LIBERTADOR	3.935.667	183.439.626.046	12	27,37	medio
10	58	CUYABENO-TIPISHCA	265.230	12.362.261.942	1	25,64	medio
11	46	MDC SIPEC	6.779.449	315.987.004.660	21	23,49	medio
12	47	PBHI	1.531.831	71.397.916.027	5	25,92	medio
13	52	OCANO - PEÑA BLANCA	123.374	5.750.405.489	0	23,00	pesado
14	12	EDEN YUTURI	470.052	21.908.909.786	1	22,63	pesado
15	18	PALO AZUL	657.708	30.655.486.612	2	22,55	pesado
16	61	AUCA	1.870.854	87.199.630.583	6	22,42	pesado
17	7	COCA PAYAMINO	2.289.383	106.707.103.491	7	22,38	pesado
18	10	VILLANO	240.980	11.231.961.714	1	18,64	pesado
19	62	TARAPOA	36.403	1.696.726.363	0	20,98	pesado
20	45	PUMA	38.356	1.787.757.390	0	16,08	pesado
21	65	PINDO	486.301	22.666.285.713	2	19,95	pesado
22	54	ENO - RON	229.351	10.689.945.561	1	12,52	pesado
23	15	INDILLANA	971.648	45.288.066.614	3	20,10	pesado
24	21	YURALPA	1.679.924	78.300.470.746	5	17,20	pesado
25	31	Bloque 31	12.959	604.009.562	0	18,00	pesado
26	43	ITT	138.056	6.434.722.634	0	14,10	pesado
27	55	ARMADILLO	210.524	9.812.439.905	1	12,70	pesado
28	59	VINITA	337.366	15.724.485.037	1	15,30	pesado
29	66	TIGUINO	2.013.180	93.833.386.844	6	19,59	pesado
30	14	NANTU	329.158	15.341.909.217	1	19,44	pesado
31	17	HORMIGUERO	619.617	28.880.059.410	2	18,87	pesado
32	16	IRO	1.242.897	57.930.851.601	4	14,58	pesado
33	67	TIVACUNO	210.528	9.812.602.265	1	18,70	pesado
Total			31.910.559	1.487.336.478.151			

Fuente: elaboración propia con base en ARCH,2016.

5. Energía total consumida en el Sistema $Etc=Eec_1+Eic_1$

La información sobre consumos de energía a la escala que se requiere no se encuentran disponibles n las fuentes oficiales, sin embargo, los datos fueron recogidos de fuentes primaria en varios bloques, entrevistas y complementado con datos estadísticos de empresas y entidades gubernamentales. La generación de electricidad es totalmente térmica a partir de la disponibilidad de los combustibles y de la tecnología instalada. Existen bloques que producen su propio combustible (plantas topping) y otros los importan para la generación de electricidad.

Los principales subprocesos demandantes de electricidad se resumen en el sistema de bombas eléctricas en pozos y en el transporte, proceso de separación de sedimentos, agua y gas, inyección de agua de formación al subsuelo y el suministro de energía a las instalaciones y campamentos. Por su parte el consumo de combustibles para combustión interna en la operación de maquinaria pesada y transporte entre campamentos provienen en su totalidad de la importación al sistema.

TABLA N°3. CONSUMOS INTERNOS Y EXTREMOS DE ENERGÍA

BLOQUE	NOMBRE BLOQUE	Producción MJ	Combustible para Generación	FUELOIL MJ	Diesel2 MJ	Gas Natural MJ	Crudo MJ	Combustible para combustión interna	Diesel MJ	Gasolina MJ	Gas Natural MJ
2	GUSTAVO GALINDO	3.110.729.332	93.918.517	-	8.091.889	85.826.628	-	790.957.224	13.008.959	1.236.698	776.711.567
1	PACOA	115.800.855	5.710.310	-	5.710.310	-	-	9.620.485.981	9.426.996.357	193.489.624	-
49	BERMEJO	6.612.241.567	237.251.086	-	-	237.251.086	-	13.727.914	9.837.742	3.890.172	-
52	OCANO - PEÑA BLANCA	6.433.919.281	212.187.021	3.655.156	208.531.865	-	-	-	-	-	-
60	SACHA	196.414.921.503	952.090.518	185.187.585	620.138.824	24.623.672	122.140.437	2.556.458.595	2.554.460.803	1.997.792	-
44	PUCUNA	5.341.512.121	-	-	-	-	-	-	-	-	-
56	LAGO AGRIO	10.417.678.729	884.329.981	-	388.508.754	-	495.821.227	-	-	-	-
47	PBHI	13.445.649.550	43.727.629	-	43.126.028	601.600	-	(35.955.007)	(35.955.007)	-	-
61	AUCA	183.439.626.046	1.725.495.556	-	1.418.292.729	-	307.202.827	1.900.352.962	1.900.352.962	-	-
53	SINGUE	12.362.261.942	958.265.125	-	-	-	-	102.785.560	102.785.560	-	-
57	SHUSHUFINDI LIBERTADOR	315.987.004.660	5.121.644.208	-	2.324.473.816	2.027.575.722	769.594.670	1.456.985.232	1.456.985.232	-	-
58	CUYABENO-TIPISHCA	71.397.916.027	1.165.303.868	-	754.263.223	241.145.409	169.895.237	1.506.998.332	1.506.998.332	-	-
64	PALANDA YUCA SUR	5.750.405.489	380.258.632	-	-	-	-	192.233.821	191.542.500	691.321	-
46	MDC SIPEC	21.908.909.786	297.475.215	-	10.454	297.464.761	-	128.512.820	125.752.053	2.760.767	-
18	PALO AZUL	30.655.486.612	2.256.579.348	-	15.392.810	1.123.212.343	1.117.974.195	-	-	-	-
7	COCA PAYAMINO	87.199.630.583	1.214.226.448	-	913.391.370	-	300.835.078	1.300.508.632	1.300.508.632	-	-
12	EDEN YUTURI	106.707.103.491	5.165.474.712	-	142.050.090	773.680.572	4.249.744.049	-	-	-	-
54	ENO - RON	11.231.961.714	514.179.642	5.145.010	509.034.632	-	-	-	-	-	-
59	VINITA	1.696.726.363	38.672.934	-	38.672.934	-	-	-	-	-	-
45	PUMA	1.787.757.390	-	-	-	-	-	38.509.610	38.446.866	62.745	-
43	ITT	22.666.285.713	-	-	-	-	-	-	-	-	-
65	PINDO	10.689.945.561	625.032.523	-	-	-	-	149.818.866	149.570.397	248.469	-
31	Bloque 31	45.288.066.614	77.565.718	-	77.565.718	-	-	-	-	-	-
15	INDILLANA	78.300.470.746	3.571.617.092	-	754.217.164	1.942.750.924	874.649.004	-	-	-	-
55	ARMADILLO	604.009.562	-	-	-	-	-	-	-	-	-
66	TIGUINO	6.434.722.634	-	-	-	-	-	157.996.510	156.123.580	1.872.930	-
14	NANTU	9.812.439.905	351.600.107	-	195.704.519	155.895.587	-	171.223.680	169.968.786	1.254.894	-
17	HORMIGUERO	15.724.485.037	732.696.012	-	625.248.802	107.447.210	-	11.585.304	5.310.833	6.274.471	-
62	TARAPOA	93.833.386.844	4.357.906.346	-	572.071.010	1.710.459.881	2.075.375.455	12.046.984	-	12.046.984	-
21	YURALPA	15.341.909.217	570.306.216	-	1.767.045	-	568.539.171	-	-	-	-
10	VILLANO	28.880.059.410	2.381.950.782	-	8.046.973	-	2.373.903.809	12.012.197	8.247.515	3.764.683	-
16	IRO	57.930.851.601	8.995.944.948	-	3.330.895.971	2.029.940.105	3.635.108.871	48.718.135	31.149.617	17.568.519	-
67	TIVACUNO	9.812.602.265	-	-	-	-	-	415.679	415.679	-	-
		1.487.336.478.151	42.931.410.495	193.987.751	12.955.206.932	10.757.875.500	17.060.784.031	20.136.379.032	19.112.507.398	247.160.068	776.711.567

Fuente: elaboración propia con base en ARCH, MICSE, ARCONEL, PETROAMAZONAS EP, 2016.

El consumo total de energía fue de 63,03 PJ, el 68% con 42,9 PJ corresponde a los combustibles (producidos e importados) para generación de *electricidad* y el 32% con 20,13 PJ pertenece a los combustibles para la combustión interna en motores.

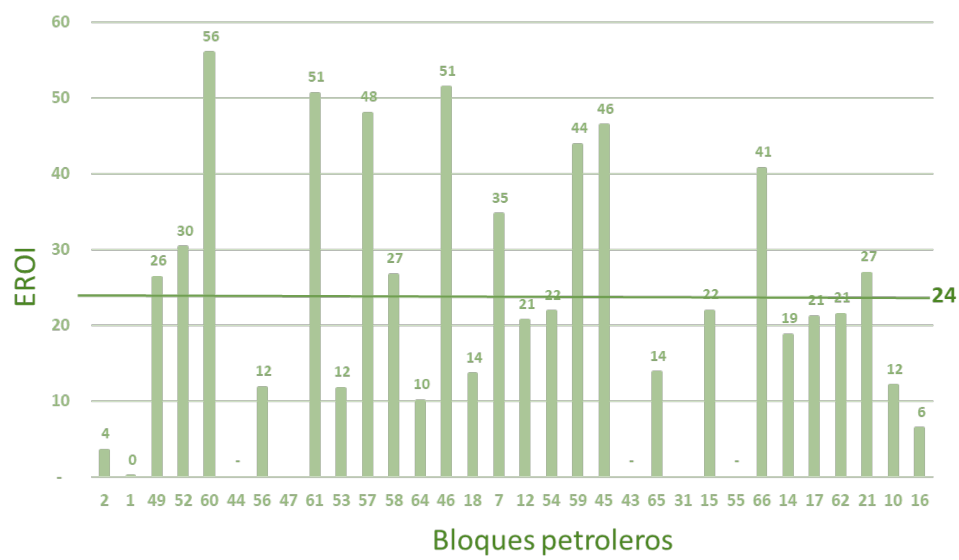
En bloques de petróleo pesado el consumo representó el 36% con 22,8 PJ, de petróleo medio el 47 % con 29,4 PJ y de petróleo liviano el 17% con10,7 PJ. Un caso particular se observa en los bloques de crudo liviano, pese a que su producción representa menos del 1 %, consume un 17% del total nacional.

6. Cálculo EROI

La tasa de retorno energético en el sistema de extracción de petróleo fue de de 24:1, considerando una canasta de producción de petróleo pesado (28%), medio (71 %) y liviano (1%). Esto quiere decir que por cada barril invertido se producen 24. Ahora bien, comparando el retorno energético para los diferentes tipos de petróleo de la canasta ecuatoriana, se observa que el grupo de bloques de petróleo medio guardan una relación de 36:1 y el grupo de bloques con petróleo pesado la relación baja a 18:1. Esto es entendible desde el punto de visto técnico, pues a mayor grado API los subprocesos en la extracción se vuelven más intensivos en energía

(Mayor BSW y mayor capacidad para reinyección de agua, sistema especiales de bombas para manejar petróleo pesado, procesos térmicos para el transporte, entre otros).

GRÁFICA N°5. TASA DE RETORNO ENERGÉTICO EROI



Fuente: elaboración propia.

Conclusiones

La aplicación del MuSIASEM para identificar la escala y fijar los límites al ensayo, nos permitió ubicar el proceso de extracción de petróleo en un todo funcional del sistema de energía. Los resultados servirán de base para continuar trabajando en la identificación de los retornos de energía en otros procesos y sistemas dentro de la gramática de energía establecida. La bondad de trabajar con información primaria fue de mucha utilidad para conseguir el nivel de detalle en cada bloque petrolero y generar un esquema de entradas y salidas de energía que puede replicarse a otros campos en otras zonas geográficas.

Los resultados nacionales agregados muestran una relación de energía producida sobre la energía invertida de 24:1. Existen bloques con mayor rendimiento cuya relación supera 50:1 y otros muestran su sentido de escasez, situarse cercanos a 1:1, en cuyo caso estarían en el límite biofísico para recuperar un recurso energético, es decir que la cantidad de energía que se invierte es igual a la energía que produce el sistema.

Al comparar el EROI de los bloques de petróleo medio y pesado, se observó que la canasta de petróleos medios muestra un mejor rendimiento con un EROI de 36:1, mientras que para los petróleos pesados el EROI cayó significativamente a 18:1.

Para el caso de la canasta de petróleo liviano, el EROI es el más bajo llegando a 2:1, este resultado es contradictorio a la hipótesis planteada. La respuesta está en que los bloques de petróleo liviano son los más antiguos del país y superan los 70 años de explotación por lo que se encuentran en la etapa final de producción. Este es un buen ejemplo de escasez del recurso, producen menos del 1% del petróleo nacional y consumen el 17% del consumo nacional.

El EROI, variará no solo por la calidad del petróleo y la antigüedad de los reservorios, sino por otros factores adicionales como: tecnología de perforación y extracción, cantidad de agua de formación, eficiencia en la operación, ubicación geográfica de los campos, entre otros, por lo que es necesario integrar en el análisis otras variables y a diferentes escalas para el entendimiento de uno de los procesos más intensivos de energía.

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La transición energética en México. En el marco de la reforma energética

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Introducción

El tema de la transición energética es ampliamente debatido en los ámbitos nacionales e internacional como un proceso ineludible frente a los elevados consumos de energía, la crisis de los combustibles fósiles y los severos impactos sobre el ambiente que derivan de un paradigma productivo basado en el uso de este tipo de combustibles. El transitar hacia un paradigma diferente, en este caso energético, es un proceso de muy largo plazo que requiere de una serie de innovaciones, transformaciones tecnológicas, de infraestructura y de capacidades en el ámbito productivo; cambios sociales relacionados con la educación, los hábitos y los patrones de consumo; y cambios institucionales que normen el quehacer público y privado, bajo esa lógica también se consideran nuevas formas de interrelación entre los diversos sectores.

En este trabajo, se parte de un reconocimiento de que el contexto internacional ha empezado a establecer condiciones para la transición energética y ello ha ido permeando a los diferentes países. En ese tenor se revisa el caso de México, analizando como un inicio al proceso de transición la legislación derivada de la Reforma Energética con el fin de identificar posibles líneas de política pública que pudieran motivar a la reconfiguración de una matriz energética más orientada a las energías alternativas.

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La metodología utilizada es la de minería de textos, cuyos resultados arrojan una serie de conceptos que reiteradamente se incluyen en la leyes primarias y secundarias vinculadas a la Reforma Energética y posteriormente se presentan una serie de reflexiones derivadas de los planteamientos de la teoría de transiciones energéticas y su relación con el contexto actual que se vislumbra para este sector en el actual gobierno.

1. Las Transiciones Sustentables

El término transición se utiliza ampliamente en varias disciplinas científicas como la demografía, la ecología y la psicología, hace referencia a un cambio no lineal de un equilibrio dinámico a otro[1]. Las raíces teóricas de los estudios de transición se basan en los trabajos realizados por académicos de diversas áreas, sobre todo en el campo de estudios de la ciencia, la tecnología y la innovación y también en los estudios de sistemas complejos y sistemas socio-ecológicos (Grin, 2016). Durante la década de 1990, el concepto de transiciones surgió en diferentes ámbitos de la comunidad científica como un planteamiento novedoso para abordar la sustentabilidad y el cambio social a gran escala (Kemp, 1994a). El enfoque de transiciones sustentables de acuerdo con Kemp (1994), se entiende desde diversas perspectivas que tienen como objetivo mejorar la comprensión de los regímenes sociales que hoy en día son insostenibles y proponen las posibles vías de transición, con estratégias de gestión para llevar a cabo el cambio.

Las transiciones se traducen en profundas transformaciones sociales que implican cambios tanto en las prácticas e interacciones entre individuos, como en las estructuras institucionales, de infraestructura y discursivas en las que se insertan (Grin, 2016). La lógica de los estudios de transición se basan en el diagnóstico de problemas sociales persistentes, y de problemas manifiestos en el entorno natural como el agotamiento de recursos naturales, el cambio climático que impactan en lo social y económico y para lo cual se busca una solución. Una transición implica cambios de largo alcance en diferentes dimensiones como: tecnológicas, materiales, organizacionales, insitucionales, políticas, económicas y socio culturales, e involucran a una amplia gama de actores que participan en varias dimensiones al mismo tiempo. Las estructuras tecnológicas e institucionales cambian fundamentalmente y también lo hacen las percepciones y preferencias de los consumidores a un determinado producto y/o servicio; se debe de considerar que las transiciones implican cambios en largos periodos de tiempo (Markard *et. al.,* 2012).

En este contexto, las transiciones refieren a cambios sociales de amplias dimensiones y que son considerados necesarios para resolver grandes desafíos con modificaciones disruptivas a gran escala en los sistemas sociales (Loorbach *et al.,* 2017). Dichas variaciones desafían las estrucutras establecidas, enfrentándose a los retos que impone la búsqueda de la sustentabilidad, y presentan oportunidades para alteraciones radicales en el sistema. Las transiciones son complejas debido a la multitud de interacciones pertinentes entre los agentes participantes del sistema, como: las empresas y sus proveedores, las autoridades públicas a

1 En demografía se define una transición demográfica al cambio que experimentan las poblaciones en tasas de natalidad y mortalidad, es un proceso que sigue cinco etapas dónde se pasa de una alta tasa de natalidad a una tasa de mortalidad baja con lento crecimiento en la población. Por otro lado, en ecología los ecosistemas de transición se refieren a aquellos ambientes que pasan por una serie de cambios en el clima, son las zonas de la naturaleza donde confluyen dos ecosistemas distintos. La psicología la define como importantes cambios cualitativos internos de las personas y dichas alteraciones tienen un efecto directo en las relaciones personales y los roles que esos individios juegan en la sociedad.

nivel local, nacional y transnacional, los usuarios, los institutos de conocimiento y los grupos sociales (Elzen, *et al.,* 2002).

Una transición sustentable requiere de: innovaciones, inversiones, aprendizaje y desarrollo tecnológico para respaldar los procesos de transformación en diferentes campos; incluidas las nuevas tecnologías, productos e infraestructuras. Así como también, nuevas reglas, normas e interacciones sociales. Si bien las transiciones implican cambios estructurales, algunos elementos del sistema no cambian, lo que varía son los supuestos, las prácticas y las normas (Loorbach *et. al.,* 2017). En la transición energética se apuesta por una transformación de los usos y las fuentes de energía que promuevan alternativas al desarrollo actual, busca promover el cambio a diferentes niveles. La transición energética es más que un cambio tecnológico, pues involucra ajustes en las instituciones, disputas de poder entre los intereses del sector y los nuevos participantes, así como también, un cambio sociocultural en las instituciones existentes (Loorbach *et al.,* 2017). En éstas nuevas dinámicas se producirán innovaciones a nivel individual o a nivel de productos, procesos y proyectos.

Algunos autores como Kempt centran su análsis en el papel fundamental de la tecnología para sustentar la transición, en estos planteamientos el concepto de transición enfatiza en el papel que puede desempeñar la tecnología para lograr los objetivos ambientales que se han propuesto las sociedades. En la literatura se ha definido que el cumplimiento de éstas metas dependerá; del apoyo público y privado a las tecnologías beneficiosas para el medio ambiente, del crecimiento economico y poblacional, así como tambien de los compromisos que adquiera el sector productivo con la reducción de emisiones y el uso eficiente de los recursos (Kemp, 1994b).

En los países desarrollados, las instituciones suelen considerarse maduras, centrando su análisis en la modificación institucional continua e incremental (Crouch y Keune, 2005; Vogel, 2005). En cambio, en los países en desarrollo o emergentes se presta más atención a la creación de instituciones, la desorganización institucional y las interacciones de las instituciones formales e informales (Estrin y Prevezer, 2011; Grzymala-Busse, 2010; Slater, 2010). El cambio institucional en el contexto de países emergentes se suele considerar como un paradigma de cambio discontinuo que se produce como consecuencia de choques exógenos a entornos institucionales inestables (Slater, 2010; Weyland, 2008)(Karaulova, *et. al.,* 2017). El análisis del marco normativo busca conocer cómo las instituciones creadas a partir de cambios disruptivos, como podría llegar a ser una Reforma Energética están delineando las instituciones y los agentes participantes del sistema económico a fin de promover el incremento en la participación de las fuentes de energía renovables en la matriz energética. Los agentes participantes en la transición energética forman parte del emprendimiento institucional y juegan un papel preponderante pues de acuerdo con Kukk et al., (2016) dichos actores realizan tres actividades con el fin de modificar las instituciones: creación, destrucción y cambio institucional.

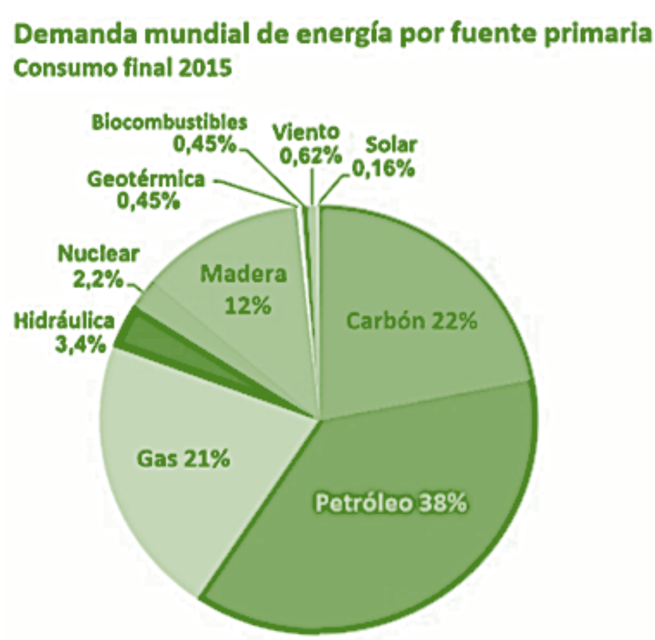
2. El Contexto en el Sector de la Energía

El crecimiento de las economías en el mundo ha ido acompañado de un aumento en el consumo de energía, en particular durante la segunda mitad del siglo XX y lo que va del XXI se observó un rápido incremento del mismo para sostener la actividad productiva y un estilo de vida moderno para la sociedad. Aún cuando existen diversas fuentes de energía identificadas desde hace siglos, la más importante para la sociedad actual ha sido el uso de los combustibles fósiles, de los cuales el petróleo ha ofrecido las mayores posibilidades para la innovación y el desarrollo tecnológico, pero al mismo tiempo también ha generado el mayor impacto ambiental tanto de manera directa como indirecta.

El aumento de la población, la mayor demanda por energía eléctrica, el surgimiento del mercado de autos y aviones y el desarrollo de muchos otros sectores industriales, colocó al petróleo como el combustible más importante del último siglo, lo cual condujó a una cada vez mayor extracción del mismo y a un abatimiento en costos que mantuvo por décadas el precio del barril a 5 dólares, al no atribuirle un precio al recurso natural como tal. Esta dinámica duró hasta los años setenta en que se presenta la crisis del petróleo y con ello un fuerte aumento en el precio del combustible. A partir de ese momento el carbón y la energía eléctrica se destinaron para la generación de electricidad y el petróleo se mantuvo para abastecer prioritariamente a la industria.

En cuanto a las llamadas energías renovables, su desarrollo ha sido diverso en los distintos países, algunos de ellos han aprovechado como fuente principal la energía hidraúlica, en otros casos la eólica, la geotérmica o la solar. Sin embargo, y a pesar de que en las últimas décadas la generación y aprovechamiento de este tipo de energías va en aumento, la matriz energética mundial no muestra un equilibrio entre las distintas fuentes y el aumento en el consumo de los combustibles fósiles (petróleo, gas y carbón) sigue siendo mucho mayor al aportar más del 80% del consumo de energía primaria en el mundo. (Ver Gráfico 1)

GRÁFICO 1. DEMANDA MUNDIAL DE ENERGÍA 2015 (%)

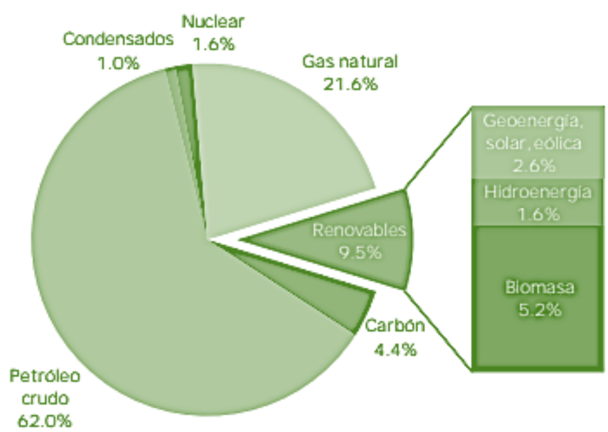


Fuente: tomado de Ocampo, E. (2017).

El 80% de las grandes reservas probadas de petróleo (1.7 billones de barriles), se encuentran en solo 8 países, la mayoría en la zona oriente del mundo, con excepción de Canadá y Venezuela, en el caso de las reservas de gas (186 billones de metros cúbicos) también se ubican en la misma zona, en tanto que los principales consumidores están en la parte occidental. El carbón también sigue siendo una fuente importante de energía y se estiman reservas probadas de cerca de 900 mil millones de toneladas. Este tipo de combustibles enfrentan importantes desafíos vinculados al comportamiento de los precios internacionales y a una tendencia al agotamiento de las reservas, dados los elevados patrones de consumo en el mundo. (Ocampo, E., 2017)

En el caso de México, la posición ventajosa que tuvo a partir de los años setenta, con el descubrimiento de importantes yacimientos petroleros, lo impulsó a centrar su oferta energética en el petróleo y ello se refleja en una matriz energética con una tendencia similar a la matriz mundial, donde se observa que la participación de las energías alternativas es mínima, en tanto el petróleo,el gas y el carbón concentran el 88% de la produccióny el consumo. (Ver gráfico 2)

GRÁFICO 2. DEMANDA DE ENERGÍA EN MÉXICO 2017 (%)



Fuente: Sistema de Información Energética, Sener.
[1]Incluye grandes hidroeléctricas
Nota: Todos los porcentajes son respecto al total de la producción de energía primaria.
El biogás representó 0.04%.
La suma de los parciales puede no coincidir con el total debido al redondeo de cifras.

Fuente: Secretaría de Energía, 2017.

Este escenario que describe el uso predominante de los combustibles fósiles en toda actividad económica y social, se enfrenta a una fuerte disyuntiva que es el agotamiento de las reservas de petróleo convencional en el mundo, lo cual ya se discutía desde la década de los años cincuenta con el trabajo de Marion King Hubbert, "*Nuclear energy and fossil fuels*", en el cual sostuvo que la producción de petróleo de los Estados Unidos tendría su cénit en la década de los años setenta, y continuaría hacia un rápido declive, predicción muy criticada en su momento que se corrobora catorce años después, cuando la producción anual del combustible fósil empezó a disminuir y continuó bajando hasta que las importaciones de petróleo crudo superaron la producción local estadounidense en 1993.

Para México la situación ha sido similar, pues aunque los descubrimientos de yacimientos petroleros han continuado, aún en años recientes, al parecer las reservas probadas son menores, los costos por exploración y extracción tienden a incrementarse y el precio del petróleo ha bajado a nivel internacional, todo ello con un impacto económico importante al que se suma el ya ampliamente estudiado impacto ambiental. La respuesta de países como Estados Unidos y Canadá que han desarrollado prácticas de extracción como el fracking y las arenas vituminosas, con altos costos económicos, ambientales y sociales, ha reconfigurado en alguna medida el escenario geopolítico internacional. Sin embargo y a pesar de la apuesta que se hace a esas alternativas energéticas que impulsan la extracción de petróleo no convencional, es absolutamente necesario incursionar en una transición energética que incorpore otras fuentes de energía, que si bien es cierto no son totalmente limpias, si permitirían una modificación de la matriz energética menos dependiente de los combustibles fósiles y con un menor impacto ambiental que contribuya a mitigar los efectos del cambio climático.

La urgente necesidad de un proceso de transición energética es universalmente aceptado y se ha avanzado ya en muchos países, en particular China, Estados Unidos, Alemania, España y los países nórdicos han hecho grandes inversiones en innovaciones tecnológicas dirigidas a la eficiencia energética y al aprovechamiento de fuentes alternativas como el sol, el aire, la geotermia, la biomasa, etc., se espera con ello alcanzar en el largo plazo la seguridad energética y una mayor proximidad hacia la sustentabilidad. Sin embargo, a pesar del gran potencial técnico de las energías renovables en muchos países desarrollados y emergentes, el progreso en la adopción de las innovaciones para la generación de energía y el avance hacia una matriz energética diversificada sigue siendo lento.

De acuerdo con Loorbach *et al.,* (2017), la sociedad lleva más de 40 años argumentando que la era de los combustibles fósiles está llegando a su fin y es necesario un cambio a sistemas energéticos sustentables. Sólo en el último decenio se ha avanzado realmente en la difusión de las energías renovables. Ésta tendencia coincide con la crisis energética que enfrenta el mundo, en dónde los abastecimientos petrolíferos son insuficientes y los nuevos descubrimientos de pozos petroleros son esporádicos y de menor tamaño. Los yacimientos que quedan por desarrollar son de alta complejidad y de baja productividad y requieren de altos niveles de inversión para su desarrollo, además de presentar riesgos geológicos y comerciales (Ocampo, 2015).

México enfrenta un período complicado de transición política y económica que está llevando de una estrategia (Reforma Energética) basada en la inversión privada de capitales internacionales para el impulso a la exploración, explotación y transformación de petróleo, así como de instalación y aprovechamiento de energías alternativas, hacia un modelo de aprovechamiento de los recursos energéticos mixto basado en la participación mayoritaria del sector público con acompañamiento regulado de la inversión pública. Con el nuevo gobierno se ha señalado que:

> *"El presidente de México, Andrés Manuel López Obrador, ratificó la determinación de su gobierno de no continuar, por el momento, con el esquema de rondas de extracción de petróleo en aguas profundas, hasta en tanto las empresas que obtuvieron contratos con la Reforma Energética ofrezcan resultados en materia de inversión, pues aseguró que, después de cuatro años,* ***ni un solo barril se ha extraído producto de tales contratos****".* González, N. Excelsior (6/12/2018).

Asimismo se argumenta que la inversión privada ha sido mínima. Esto se contrapone a declaraciones de la Comisión Nacional de Hidrocarburos que en las mismas fechas señaló que empresas a las que se les adjudicó proyecto en las rondas 1.3 y 2.3 estaban produciendo alrededor de 12 mil barriles diarios.

En esas condiciones el impulso hacia un nuevo modelo que promueva la descarbonización del consumo energético, resulta un tanto difícil en el plazo inmediato ya que será necesario la construcción de una institucionalidad que defina la estrategia y el grado de participación de los distintos actores para la construcción de una vía que conduzca hacia la diversificación de la matriz energética del país.

Dicha transición requiere que la participación de los actores del sistema económico esté orientada al consumo y suministro de energías renovables y a la eficiencia energética. Así como también un marco normativo capaz de promover los cambios necesarios y regular las participaciones a fin de lograr la descarbonización. Se deberán redireccionar los recursos financieros que hoy en día subsidian, directa e indirectamente, a los combustibles fósiles en alternativas ecológicamente integrales, y evaluar las inversiones en infraestructura de petróleo y gas en el contexto de cambio climático y del mercado energético, con una tendencia a reducir los gastos en la exploración de hidrocarburo (Currás, Tabaré A. y Lorenzo, 2017). Aunado a esto, la supervivencia a largo plazo del sistema económico dependerá de su capacidad para crear y mantener procesos económicos sostenibles, que no impliquen la creación de valor a corto plazo a expensas de la riqueza a largo plazo (Carrillo-Hermosilla *et. al.,* 2010).

En este sentido, las mejoras ambientales pueden ir de la mano con innovaciones incrementales, sin embargo para realizar transiciones es necesario un cambio sistémico. Dichas transformaciones implican nuevas tecnologías, mercados, formas de consumo, regulaciones, infraestructuras y reconfiguraciones culturales. Se debe asumir este proceso como un gran desafío de corte sistémico que implica una serie de cambios estructurales en los regímenes sociales.

3. La Reforma Energética en México

La transición energética hacia energías renovables requiere el desarrollo de un marco normativo e institucional que contribuya a incrementar la participación de las energías renovables en la matriz energética, este fue el argumento de partida para que el Estado Mexicano iniciara un proceso de modificaciones a la ley para dar certidumbre a la iniciativa privada e incentivar las inversiones en el sector energético. El antecedente para esta iniciativa de transición se dio con el Programa Sectorial de Energía 2007-2012, el cual recoge el compromiso de México de impulsar acciones en el país para contribuir a la mitigación del cambio climático, después de varios intentos ante el Congreso de la Unión, en el año 2013 se aprueba la llamada Reforma Energética.

En este contexto de la Reforma Energética (RE), la Secretaría de Energía (SENER) propuso la modificación y creación de leyes, así como de una serie de instrumentos enfocados al aprovechamiento de las energías renovables con el objetivo de modernizar la composición de la matriz energética mexicana. Cabe señalar, que aún cuando se abre el espacio en la legislación y a partir una serie de licitaciones programadas para la entrada de inversiones en energías alternativas para la generación de electricidad, el mayor peso de la Reforma Energética estuvo en las licitaciones dirigidas a la explotación de petróleo.

Los instrumentos de política pública creados para potencializar el uso de energías renovables fueron un conjunto de acciones, estrategias, programas, lineamientos y normas, enmarcados en una serie de políticas de fomento a las energías renovables para fortalecer un sector energético basado en tecnologías limpias, energéticamente eficientes y que promueve la productividad, el desarrollo sustentable y la equidad social en el México (SENER, 2016), en el cuadro 1 se muestran los instrumentos de política para el fomento de las energías renovables.

CUADRO 1. POLÍTICAS DE FOMENTO DE LAS ENERGÍAS RENOVABLES

Instrumentos	Políticas de fomento de energías renovables
Planes	Plan Nacional de Desarrollo
Estrategias	Estrategia Nacional de Cambio Climático
	Estrategia de Transición para Promover el Uso de Tecnologías y Combustibles más Limpios
Programas	Programa Sectorial de Energía
	Programa Nacional para el Aprovechamiento Sustentable de la Energía (2014-2018)
	Programa Especial de la Transición Energética
	Programa Especial para el Aprovechamiento de Energías Renovables 2014-2018
	Programa de Desarrollo del Sistema Eléctrico Nacional
Lineamientos y Normas	Lineamientos que establecen los criterios para el otorgamiento de CELs y los requisitos para su adquisición
	Establecimiento de criterios normativos de Energías Limpias, Eficiencia Energética, Cogeneración Eficiente, Sistemas de generación limpia distribuida, Emisiones de gases y compuestos de efecto invernadero
	Bases del mercado Eléctrico
	Acuerdos voluntarios para reducir la intensidad energética en sectores productivos con consumos significativos

Fuente: SENER (2016).

La Ley de Transición Energética (LTE): tiene como objetivos principales: i) reducir la dependencia a los combustibles fósiles para la generación de energía eléctrica; ii) el aprovechamiento sustentable de la energía en todos los procesos y actividades para su explotación; y iii) Promover un conjunto de actividades, tales como investigación y desarrollo, diseño, fabricación y producción de tecnologías que promuevan el uso de energías renovables (SEGOB, 2015). Esta LTE ha generado un marco legal que regula la participación de las energías renovables, el cual se sintetiza en el cuadro 2.

CUADRO 2. MARCO LEGAL DE PARTICIPACIÓN DE ENERGÍAS RENOVABLES EN MÉXICO

Constitución Política de los Estados Unidos Mexicanos	Leyes	Reglamentos
Artículo 4 Articulo 25 Artículo 27 Artículo 28	Ley de Planeación Ley de Órganos Reguladores coordinados en materia Energética Ley General de Cambio Climáticos Ley de la Industria Eléctrica Ley de la Comisión Federal de Electricidad Ley de Transición Energética Ley de Energía Geotérmica Ley de Promoción y Desarrollo de los Bioenergéticos	Reglamento de la Ley de la Industria Eléctrica Reglamento de la Ley de la Comisión Federal de Electricidad Reglamento de la Ley de Transición Energética Reglamento de la Ley de Energía Geotérmica Reglamento de la Ley de Promoción y Desarrollo de los Bioenergéticos

Fuente: SENER (2016).

Programa Especial para el uso de Energías Renovables: tiene objetivos y metas específicos para el uso de energía renovable, como la inclusión de éstas en la generación de electricidad. Define estrategias y acciones necesarias para cumplir con ellos y también para la promoción de las energías renovables en la generación de electricidad en comunidades rurales (IRENA, 2015).

Fondo de Sustentabilidad Energética de la Secretaría de Energía, este busca fortalecer al sector energético nacional a través de cuatro líneas de acción: eficiencia energética; fuentes renovables; uso de tecnologías limpias; y diversificación de fuentes primarias de energía (SENER, 2014).

Estrategia Nacional de Transición Energética y Aprovechamiento Sustentable de la Energía (ENTEASE), es el mecanismo mediante el cual el Estado Mexicano impulsa las políticas, programas, acciones y proyectos encaminados a conseguir una mayor utilización y aprovechamiento de las fuentes de energía renovables y las tecnologías limpias; promover la eficiencia y sustentabilidad energética; así como la reducción de la dependencia de México de los hidrocarburos como fuente primaria de energía. Así está estipulado en el Artículo 22 de la Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética (LAERFTE) (SENER, 2015).

Fondo para la Transición Energética y el Aprovechamiento Sustentable de la Energía (FOTEASE): es un instrumento de política pública de la Secretaría de Energía que tiene como objetivo el incremento de acciones que incentiven el cumplimiento de la ENTEASE, promoviendo la utilización, el desarrollo y la inversión de las energías renovables y la eficiencia energética (SENER, 2018). Centros Mexicanos de Innovación en Energía (CeMIE’s), son un instrumento que busca impulsar las energías renovables y limpias a través del fortalecimiento y vinculación de las capacidades científicas y tecnológicas del país. Los CeMIE´s están integrados por instituciones de educación superior, centros de investigación públicos y privados y empresas privadas y públicas integrantes de la industria eléctrica (INEEL, 2015).

La Ley de Transición Energética, puntualiza que para el año 2024 al menos el 35% de las energías totales que se consuman, provendrán de fuentes renovables y limpias; como las geotérmicas, eólicas, solares, hidráulicas y se aprovecharán las superficies disponibles en el territorio nacional. Sin embargo, para llevar a cabo la transición energética se requiere un conjunto de instrumentos de política nacional en materia de obligaciones de energías renovables y aprovechamiento sustentable de la energía, a mediano y largo plazo.

Para lograr dichos objetivos, el marco normativo del sector energético se ha modificado y ha generado una gran cantidad de información a través de los instrumentos acuñados a partir de la reforma energética. Los datos de textos (artículos, leyes, reglamentos, planes, estrategias, programas y los lineamientos y normas) son una fuente de información que puede ser analizada mediante métodos de minería de texto (MT).

Para este trabajo se utilizó dicha metodología para analizar los documentos generados en la Reforma Energética que promueven la transición a energías limpias, sustentables y eficientes. Basado en los componentes que propone el enfoque de Transiciones Sustentables, se analizaron los términos que representan componentes de las transiciones (propuestos teóricamente). Se utilizó la minería de texto como un enfoque cualitativo y cuantitativo mixto para complementar la presentación cuantitativa del contenido de los documentos.

4. Metodología

El diseño metodológico utilizado fue el análisis de MT, el insumo de información se obtuvo a partir de un conjunto de herramientas de búsqueda de los instrumentos de política pública que se han creado en el último sexenio y cuyo objetivo es incentivar la transición energética, el uso de energías renovables y la eficiencia energética.

La MT sirve para identificar patrones de una colección de textos, mediante el uso de computadoras y métodos de procesamiento de lenguaje natural, es posible manejar grandes cantidades de datos de texto sin estructurar (Blake, 2011). Dicha metodología comprende generalmente seis pasos:

i) selección

ii) procesamiento

iii) transformación

iv) minería de datos

v) interpretación

vi) evaluación.

La MT, también conocida como Análisis Inteligente de Textos, Extracción de Datos de Texto o Descubrimiento de Conocimientos en Texto (KDT), se refiere generalmente al proceso de extraer información y conocimientos interesantes y no triviales del texto no estructurado (Gupta & Lehal, 2009). La aplicación de un enfoque asistido por computadora, basado en el recuento de la ocurrencia y co-ocurrencia de términos, permite la repetición y facilita la comparación (Gupta & Lehal, 2009), en cuanto a la composición de las estrategias de transición energéticas propuestas institucionalmente.

La MT es el proceso de identificar patrones nuevos, interesantes y comprensibles a partir de una colección de textos (Blake, 2011). La MT puede ser aplicada en diversos sectores, como: telecomunicaciones, tecnologías de la información, energía, política (análisis) y farmacéutico, por mencionar algunos. Siguiendo a Frawley, Piatetsky-Shapiro & Matheus (1992), este análisis permitió el descubrimiento de patrones no triviales o temas -previamente desconocidos- que surgen al emplear herramientas para mostrar la frecuencia de términos y su nivel de asociación. Estas herramientas fueron implementadas en el análisis de todos los documentos, exceptuando: índices, gráficas, pie de páginas y referencias. Las herramientas de minería de texto utilizadas fueron: nube de palabras, coeficiente de asociación, n-gram y términos co-ocurrentes. Siguiendo a Kumar & Paul, 2003; Silge y Robinson (2016), a continuación se menciona brevemente su propósito y cómo el *output* de una constituyó el *input* de la otra.

La primera herramienta, *word cloud* o nube de palabras, tiene como finalidad detectar palabras clave y presentar el resultado de forma visual. La importancia de una determinada palabra, está relacionada con su aparición en un texto (o conjunto de documentos). En consecuencia, una palabra es clave en un texto (o conjunto de documentos) mientras más frecuente sea en él, describiendo una relación positiva entre importancia y frecuencia:

$$I = f(A)$$

Donde I es la importancia que tiene una determinada palabra, y, A la suma total de las veces que aparece una determinada palabra en un texto (o conjunto de documentos). A saber:

$$I = f(A) = \sum_{i=1}^{n} x_i = x_{1t} + x_{2t} + x_{3t} + \cdots + x_{nt},$$

Entendiéndose que la suma de la aparición de una determinada palabra (x) determina la importancia en el texto (i = 1; o conjunto de documentos i = n), para un período t.

La identificación de palabras claves (*output* de la *word cloud* o nube de palabras) constituye el *input* para determinar su asociación con otras palabras, denominado como coeficiente de asociación. Este coeficiente se obtiene empleando el método euclidiano para determinar la distancia entre dos puntos:

$$r = d_{euc}(x, y) = \sqrt{\sum_{i=1}^{n} (x_i - y_i)_t^2},$$

Donde x es la palabra clave, y, y la palabra con la que se encuentra asociada. El coeficiente de asociación, r, es un número que se encuentra entre 0 y 1. Un r más cercano a uno refleja una alta asociación entre x y y, mientras que uno cercano a 0 una disociación.

El n-gram es una herramienta que incorpora los dos resultados antes obtenidos para proporcionar conjuntos de un número n de palabras, elegidas de acuerdo con los fines del investigador. La conformación de estos conjuntos de palabras reúnen dos condiciones: i) altos coeficientes de asociación (es decir que las palabras se encuentren cercanas una de otra); y, ii) altas frecuencias (esto es que la combinación a través de su cercanía presenta importancia en el conjunto de documentos).

La especificidad que proporciona el n-gram incrementa a medida que n aumenta. Por ejemplo, un conjunto formado por cuatro palabras suministra mayor detalle para la explicación de un determinado tema que un conjunto formado por dos palabras. Del mismo modo, otro aspecto a considerar es que el aumento de la n reduce, en número, los conjuntos de palabras ya que habrá cada vez menos conjuntos que cumplan con las dos condiciones señaladas anteriormente. Por lo que, la determinación de una *n* óptima no existe, y únicamente es definida a criterio del investigador.

Las reglas de co-ocurrencia permiten detectar y agrupar conceptos que están estrechamente relacionados dentro del conjunto de documentos. La idea radica en que cuando en los registros a menudo se encuentran conceptos que aparecen juntos, esa co-ocurrencia refleja una relación subyacente que probablemente sea valiosa para las definiciones de categorías. Esta técnica crea reglas de co-ocurrencia que pueden utilizarse para crear una categoría nueva, para ampliar una categoría o como entrada a otra técnica de categoría. Se considera que la co-ocurrencia de dos conceptos es muy alta si estos aparecen con frecuencia juntos en un conjunto de registros y lo hacen raramente separados en el resto de los registros (Figueiredo *et al.,* 2011).

El software de código abierto R fue elegido en la investigación como lenguaje de programación de alto nivel debido a que proporciona interfaces a otras soluciones de software y ofrece un conjunto creciente de paquetes de extensión para varias metodologías incluyendo la minería de texto. R se combinó con las siguientes soluciones de software para convertir documentos PDF en texto plano: PDF a TXT (*ilovepdf.com*). El proceso de búsqueda del conjunto de artículos analizados comenzó con la exploración de los documentos oficiales principales que trataban de Reforma Energética y Transición Energética, dichos: artículos, leyes, reglamentos, planes, estrategias, programas, lineamientos y normas fueron descargados de las páginas de gobierno oficiales, en formatos PDF. Una vez que se obtuvieron en dicho formato se transformaron en texto plano

La siguiente sección presenta los resultados obtenidos de la minería de texto y aplicación de las herramientas mencionadas mediante un algoritmo desarrollado en el lenguaje y ambiente para cómputo estadístico y gráfico R. Igualmente, se presenta un breve panorama de geo-localización de la producción de conocimiento sobre innovación social realizada por país.

5. Análisis de Resultados

La Transición Energética se ha abordado en esta investigación desde el enfoque de instituciones, especialmente desde la percepción que brinda el marco normativo que ha guiado este cambio en el contexto energético mexicano.

GRÁFICO 3. NUBE DE PALABRAS DE DOCUMENTOS OFICIALES
DE LA REFORMA ENERGÉTICA EN MÉXICO

Fuente: elaboración propia.

En el Cuadro 3, se sitematizan los resultados que arroja la nube de palabras, se puede observar que lostérminos clave de los documentos analizados coinciden con el propósito de crear un escenario en el que se dé impulso al aprovechamiento de la energía de manera sustentable.

Se observa la necesidad de crear una modificación institucional al integrar al marco normativo el tema de las energías limpias y dando un enfoque sustentable a la gestión y aprovechamiento energético. Esto cumple con los propósitos del emprendimiento institucional pues se están destruyendo y creando nuevas instituciones que sienta las bases para una transición energética en el país a largo plazo.

Los hechos estilizados obtenidos fueron complementados con la aplicación del n-gram y del coeficiente de asociación que se presenta a continuación.

CUADRO 3. TEMAS DE LA TRANSICIÓN ENERGÉTICA

Tema	Términos con mayor asociación	Coeficiente de asociación
Transición	Descentralizada	0.97
	Eficiencia	0.87
Sustentable	Aprovechamiento	0.97
	Gobernanza	0.96
Eficiencia	Mitigación	0.86
	Sustentable	0.87
Energéticos	Ahorros	0.72
	Certificación	0.72
Mercado	Eléctrico	0.99
	Interconexión	0.99
Industria	Redes	0.98
	Distribución	0.96
Limpias	Inteligentes	0.89
	Equipos	0.98

Fuente: elaboración propia.

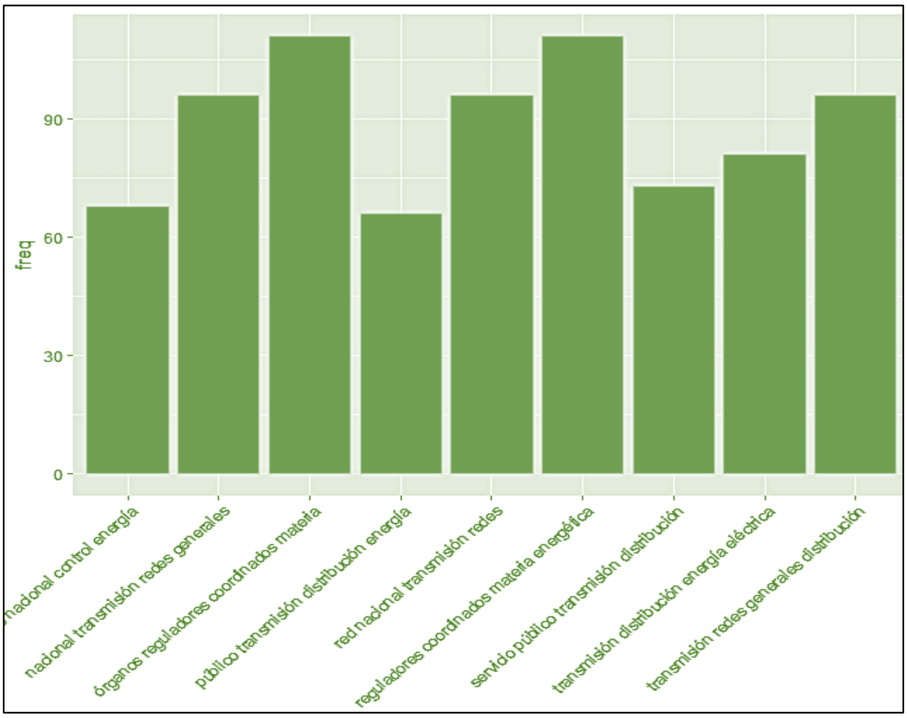
La pregunta que surge tras la lectura del Cuadro 3 es: ¿qué temas integran el marco normativo de la transición energética mexicana?

Pues bien, el Cuadro 3 presenta no sólo los grandes temas abordados en los documentos oficiales, sino también el coeficiente de asociación que ayudó a identificar sus términos con mayor asociación. Cabe señalar que los temas para cada período fueron obtenidos del análisis de palabras que se muestra en la Figura 3. Asimismo se tomaron como coeficientes medios los valores entre 0.70 y 0.79 y altos entre 0.87 y 0.99, cuidando que la explicación sea lo más simple al elegir ciertas palabras entre la extensa variedad de resultados que se extrajo a través de la minería de texto.

Los temas abordados de transiciones sustentable hacen referencia a que es un proceso descentralizado donde la eficiencia y el aprovechamiento son factores fundamentales para lograr el proceso de gobernanza que estimule este cambio en el paradigma energético nacional. Cuando se hace referencia a la eficiencia energética, los términos asociados hacen hincapié en la mitigación (con referencia al cambio climático) en los ahorros y en la certificación, como se puede observar en el cuadro 3, los coeficientes de asociación de los términos son medios y altos, lo que significa que a nivel normativo éstos temas cobran relevancia cuando se trata de generar escenarios que regulen la transición energética.

En cuanto a los temas relacionados con mercado e industria, es evidente que en los documentos se habla sobre el mercado eléctrico, la interconexión y sobre todo se hace referencia a la distribución de la energía una vez que participen actores privados en la generación energética, esto es significativo pues uno de los objetivos de la reforma energética es la participación a través de una mayor inversión en el sector energético mexicano, con el objetivo de desarrollar el país y modernizar el sector. Los temas principales también se pueden observar gráficamente en el *tetra-gram* de la Gráfico 4.

GRÁFICO 4. TETRA-GRAM DE DOCUMENTOS OFICIALES ANALIZADOS

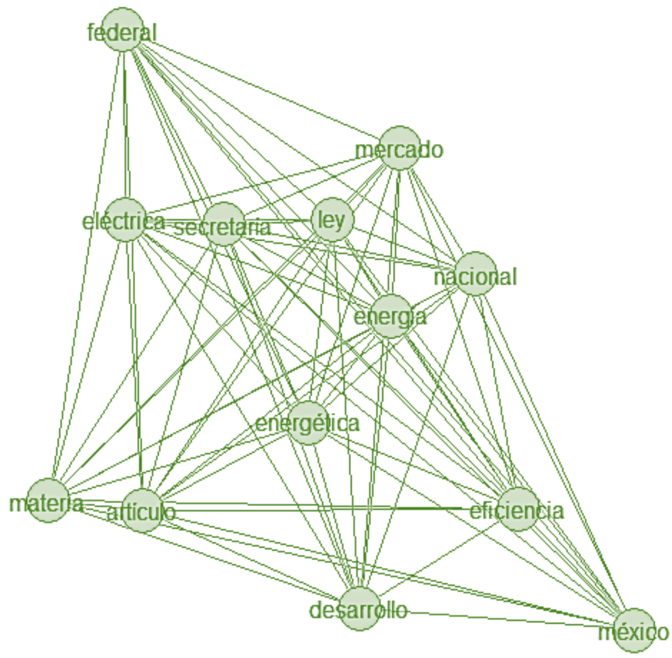


Fuente: elaboración propia.

Como se mencionó en el apartado metodológico los términos co-ocurrentes de un conjunto de documentos sirven para conocer aquellos conceptos que están estrechamente relacionados dentro de los documentos analizados.

En el caso específico del marco normativo propuesto por la Reforma Energética para la Transición Energética en México se puede observar que derivan varias categorías para el análisis, tales como desarrollo-eficiencia.-energía, puesto que estos términos aparecen con frecuencia juntos en los registros, también aparece de manera frecuente mercado eléctrico y mercado energético. Los términos co ocurrentes nos sirven para categorizar la normatividad de la TE, como se observa en el gráfico 5.

GRÁFICO 5. TÉRMINOS CO-OCURRENTES



Fuente: elaboración propia.

El uso de esta metodología nos ha permitido un acercamiento al discurso de la Reforma Energética a partir de una revisión de los documentos que son la base de la propuesta, sin embargo, también presenta limitaciones en el sentido de que si se analiza el resultado fuera del contexto nacional e internacional, la orientación o explicaciones que deriven del análisis de los resultados podrían estar sesgadas o ser insuficientes. En ese sentido, se incorpora una reflexión analítica que suma a los resultados de la MT, los elementos del contexto energético y los conceptos base de una transición.

El proceso de transición en México, debe pasar necesariamente por transformaciones sociales y cambios en las estructuras institucionales, que incentiven las innovaciones, las inversiones, el aprendizaje y el desarrollo tecnológico para respaldar los procesos de transformación, así como también, nuevas reglas, normas e interacciones sociales. La Reforma Energética sentó bases a partir de una serie de modificaciones a la norma para promover y facilitar la participación de la inversión privada en los procesos de explotación y transformación de energía convencional y alternativa. Dando lugar al surgimiento de organismos reguladores, de nuevos actores en la producción y de la apertura de procesos de licitación para facilitar la incorporación de la inversión privada al sector.

Los resultados del análisis con MT de la legislación nueva y modificada que derivó de dicha reforma, arrojó como conceptos centrales, el mercado eléctrico, la gobernanza, la sustentabilidad, la eficiencia, la interconexión, las redes y la distribución, todo ello ligado a una visión moderna en el tratamiento del sector energético. Sobre esta tendencia se avanzó cerca de cinco años, lo que llevó a varias concesiones a empresas nacionales e internacionales para la explotación y producción de petróleo y energías alternativas. Asimismo la norma institucionalizó la participación de empresas internacionales que ya tenían inversiones en energías como la eólica, principalmente, y en menor medida en la energía solar, desde finales de los años noventa.

Con el cambio de gobierno, los ajustes a la norma han quedado plasmados en la legislación, sin embargo los procesos de licitación se han suspendido y se está en un etapa de redefinición para determinar el papel que jugarán los distintos actores en la producción de energía y en el desarrollo de las tecnologías que facilitarían el proceso de transición. Un proceso que como marca la teoría es de largo plazo y está en función de la disponibilidad de tecnología y de un marco institucional que defina en un sentido u otro qué sectores encabezarán dicha transición.

Conclusiones

El contexto internacional para el sector de la energía conduce inevitablemente hacia una transformación, la reducción en las reservas probadas de petróleo y los fuertes impactos ambientales que ya han sido corroborados por su utilización intensiva apuntan hacia un nuevo paradigma que adopte como base el uso de otro tipo de energías, hoy llamadas alternativas, y que se modifique de manera sustantiva la matriz energética. Sin embargo, existe un fuerte debate en cuanto a las crecientes tasas de consumo de energía en la sociedad moderna, que hacen francamente difícil la posibilidad de sustituir significativamente al petróleo y el gas por energía eólica, solar o cualquier otra "energía limpia".

En el caso de México, las estimaciones muestran que los parques eólicos y el surgimiento de empresas que ofrecen tecnologías para aprovechar la energía solar son totalmente insuficientes para cubrir, tan solo la demanda nacional de electricidad, y mucho menos en el caso de la energía geotérmica cuyos usos hasta ahora son directos y muy limitados en el país.

Este contexto es determinante para explicar si se percibe una tendencia hacia la transición energética, si bien es cierto que las estructuras gubernamentales e institucionales se han desplazado en algún sentido para facilitar el proceso, también queda claro que este sería muy lento no solo por la dinámica misma que implica una transición, sino también por la situación particular que está atravesando el país.

La MT nos da indicios de una serie de elementos a incorporar que derivan de una Reforma Energética que se impulsó en el marco de un gobierno orientado a promover la participación privada nacional e internacional en los procesos de modernización y explotación de los recursos naturales para la generación de energía, en este marco también se privilegió a los megaproyectos cuyo impacto ambiental y social es muy cuestionable, en el gobierno actual esta orientación ha cambiado y el lenguaje, los conceptos clave y la misma dirección a seguir están en una indefinición, a pesar de las presiones del contexto internacional y de la necesidad inminente de transitar hacia el consumo de un tipo de energía que sustituya al combustible fósil.

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Are climate change policies counterproductive? A critical approach to the Green Paradox

Jordi Roca Jusmet*

1. Introduction: fossil fuel supply and climate change policies

The problem of climate change is mainly due to CO_2 emissions from fossil fuel combustion. Future emissions of greenhouse gases will depend on many factors – such as deforestation or reforestation, waste management, the use of fertilisers in agriculture or diets – but the use of fossil fuels is definitely the key one at least for the next decades.

The total amount of carbon that can be emitted being compatible with a target of limiting the temperature increase is usually known as "carbon budget" (UNEP, 2017). For example, we can speak about the carbon budget for a maximum variation of 2ºC for the 21st century in comparison with preindustrial temperature, the main reference objective of the 2015 climate change Paris Agreement. Its exact value is impossible to determine because of the uncertainties of climate models and other factors.[1] However, there is scientific consensus that the 2ºC objective –not to speak about the 1.5ºC objective-[2] implies that most fossil fuel reserves should remain underground (McGlade and Ekins, 2015). Accessible fossil fuel resources are very limited and they are being exploited at an accelerated rate that will lead to their depletion in the not too distant future (especially in the case of oil, as evidenced by the debate on the peak oil: Kerschner and Capellán Pérez, 2017) but they are not at all scarce enough to avoid the risks of experiencing catastrophic climate change. In this regard, as in others, Boulding was a visionary highlighting more than 50 years ago: "Oddly enough, it seems to be in pollution

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1 If we refer strictly to CO2 fossil fuel emissions, the amount of carbon emitted compatible with a certain temperature level also depends on what happens with other gases and natural carbon sinks. The optimists also consider new technologies for carbon capture and storage, but the precautionary principle needs to be very sceptic about these possibilities.

2 A recent IPCC (2018) report urges efforts to limit temperature rise to 1.5ºC above pre-industrial levels.

rather than in exhaustion that the problem is first becoming (...) And the atmosphere may become man's major problem in another generation" (Boulding, 1966, p.12).

Given the relationship between fossil fuel burning and climate change, it is unavoidable to conclude that the only guarantee of a successful policy against this problem would be a restriction on the global supply of fossil fuels. A way to achieve this rationing would be to establish a global carbon emissions target and to distribute it through compulsory maximum national quotas of carbon emissions which – to make policy less rigid – could be marketable. Perhaps in the future there might be an agreement to limit global emissions at a sufficient level but this is not at all the situation today with the Paris Agreement based on purely voluntary and insufficient national contributions (UNEP, 2017).

Moreover, there are more and more social mobilisations in many places in the world aimed at blocking the extraction of fossil fuels, or the construction of infrastructures for their transport (such as oil or gas pipelines) that sometimes lead to making some projects inviable (Klein, 2014; EJOL, 2015). These mobilisations will probably increase and paralyse some projects and could even lead to formal banning of certain techniques (such as fracking) at national or regional level or the exploitation of certain sensible areas. This can be very important to preserve fragile natural areas and the life and health of communities affected by some projects and also could be key -much more than it is usually thought as we will see later- for reducing the future supply of fossil fuels. However, it is difficult that these type of mobilisations could be enough to reduce global carbon emissions in the necessary magnitude.

In the absence of global limits on carbon emissions, many actions and policies have been raised at regional, national, and local levels such as regulatory energy standards, incentives for renewable energies and investments in energy efficiency, carbon taxes or carbon cap and trade systems. It is expected that these policies will reduce fossil fuels use.[3]

Obviously all these policies have several difficulties. First of all, climate change is a global problem and for this reason, political decisions are possible, but in the absence of global compulsory requirements, they must overcome the free-rider problem. There are also other obstacles. For instance, an increase in energy efficiency will tend to provoke a rebound effect that will partially compensate –or even in some extreme cases, it could more than compensate- the decrease in energy demand (Sorrell, 2007). Another significant problem is the potential carbon leakage: if one region, nation or town decides to introduce a carbon tax (or any policy that increases costs for domestic enterprises), part of domestic production could be replaced by imports increasing emissions elsewhere and consequently global emissions would decrease less than expected (or in the worst case they would increase). All these difficulties are very real and it is necessary to take them into account in order to apply effective policies.[4]

Last years, the German economist Hans-Werner Sinn (2008, 2012) has raised a very different type of concern. Climate change policies could be counterproductive, increasing and not decreasing emissions due to the reaction of fossil fuel owners faced with these policies. He uses the term "green paradox" to refer to this counterproductive effect.[5]

3 In this article I do not refer to the greenhouse gases emissions other than carbon emissions from the use of fossil fuels.

4 For example, carbon leakage could be combated by introducing carbon border taxes to "level the playing field" between different countries. See Rocchi et al. (2018).

5 Sinn introduced the term green paradox. The name was new, but the idea of the possible perverse effects of climate policies due to the supply reaction was not new: see Sinclair (1992).

After this introductory section, I explain the green paradox concept and the conclusions about climate change policies that Sinn derives from this concept. According to this author (almost all) climate policies could be not only ineffective but even counterproductive (section 2). In section 3 I present the theoretical explanation of the green paradox using a very simple exhaustion resource Hotelling model (section 3). The following sections use three different arguments to explain that the pessimistic conclusions of the simple model can hardly be extended to the real world. The first one is that the conclusions about the effects of climate change policies obtained in a very simple Hotelling model with homogeneous resources cannot be extended for more realistic assumptions (section 4). The second argument is that the concept itself of equilibrium price in this type of model is very problematic taking into account the uncertainty of the future, a limitation that usually is completely forgotten or at least much undervalued (section 5). The third argument is that fossil fuel extraction industries have some characteristics that prevent quick -and much less immediate- adjustments and without costs as those foreseen in the usual Hotelling models (section 6). In section 7, I consider these very different critiques to argue that green paradox is a theoretical possibility to take into account but that in most cases it is very unlikely that climate change policies backfire due to green paradox. Finally, section 8 concludes.

It is worth emphasising that this article does not question the green paradox concept or even its potential existence as it considers that there is a case for the green paradox. What is questioned is the great practical relevance that the green paradox according to Sinn would have. Since the initial contributions of this author, there has been extensive literature on the subject that in many cases has been aimed precisely at qualifying or criticising the conclusions of Sinn. However, his seminal contributions continue to have strong influence.

2. The green paradox according to Sinn

Hans-Werner Sinn popularised the term green paradox in articles published in several newspapers and magazines in various countries, in his 2008 book *Das Grüne Paradoxon*, which generated much political debate in Germany, and in its English version *The Green Paradox* published in 2012. The term also provoked much academic debate, an example of which is the 2015 special issue of the *Review of Environmental Economics and Policy* (Jensen *et al.*, 2015).

The reasonable point of departure of Sinn (2008, 2012) is that it is naive to think that the effects of demand[6] and tax policies will not depend on how the fossil fuel owners react. Supply matters. This is indisputable, as can be seen in a very extreme example. Let me assume that fossil fuel supply was totally inelastic, that is to say, owners continue to sell exactly the same quantities after the announcement or implementation of climate change policies. In this case, the unique effect of these policies would be the fall in fossil fuels prices but not in the quantities sold or, in the case of taxes, the effect would be purely redistributive: resource owners would earn less money at the expense of tax revenues without varying amounts sold.

But Sinn's argument goes far beyond pointing out the clear –but many times forgotten- importance of supply. Sinn argues that the effect of demand and tax policies will likely accelerate climate change if policies become stronger over time, as it is often proposed, and seems reasonable for the practical viability of a global transition to a decarbonised energy

6 I use the term demand policies in this article in a very broad sense even including social movements that promote less carbon intensive lifestyles.

model. In his own words: "Policies aimed at limiting or reducing the possibility of generating resource-derived revenues in the future will induce resource owners to bring their sales forward to the present. This, in turn, will depress current market prices and increase resource demand, thus accelerating global warming" (Sinn, 2015, p.240). The idea is the following. Fossil-fuel owners will prefer to sell their valuable resources when policies against climate change are still relatively timid for fear that in the future, when policies are stronger, their rents will be lower, or will completely disappear. By using his own comparison, from the point of view of resource owners, the prospect of an increasingly ambitious climate change policy can be seen as the perspective of a future "expropriation" of their resources; and given this perspective it would be better to sell the resource as soon as possible and thus the amount sold, and in consequence the carbon emissions, would increase.

The Green Paradox book distils first of all a critique of German "green" policies that according to the author would imply enormous costs for the country but whose only results would be to increase emissions of countries that do not make the same commitments (carbon leakage)[7] and at the global level would not lead to less emissions but more emissions to the extent that there is an expectation that the measures will harden and generalise in the future as is precisely their intention. "Green" policy would be well-intentioned, but not effective: "The road to hell, after all, is paved with good intentions" (Sinn, 2010, p.232). The conclusion on climate change policies is very pessimistic and not only for regional or national policies but also for policies such as global carbon taxes defended by many economists (Baranzini *et al.*, 2017; Boyce, 2018). Almost the only exception would be an effective global emissions rationing policy[8] and even in this case if the period between the announcement of this policy and its effective implementation were too long, the problem of the green paradox would appear.

3. The green paradox in a very simple Hotelling model

The contributions of Sinn (2008, 2012) and the most part of the green paradox literature is based on the model of Harold Hotelling (1931) that still today remains the indisputable reference of neoclassical economic theory on the price of non-renewable resources. Although the model is well known, it is worth remembering its basic points. For that, I will use a very simple version of the model, which is sufficient to understand the green paradox concept.

A situation of perfect competition is assumed, in the sense that the resource owners have no market power, that is, they think that their individual decisions do not affect the price at all. All the resource stock is homogenous and the unit extraction cost is constant. The scarcity *of the resource gives rise to a resource rent* (or royalty), a positive difference between the selling

7 Sinn (2012) does not use carbon leakage in the most usual sense of substitution of domestic productions by imports not affected by the domestic policy (as myself in section 1). His explanation is linked to the global character of fossil fuel markets. He argues that when demand for fossil fuels declines in a country, global demand will decline and prices will fall and this will offset the decrease in sales and emissions in the country in favour of emissions in other countries. A partial carbon leakage in this sense is a real possibility especially in the short term, but carbon leakage is not the object of this article and I will limit myself to the green paradox concept in Sinn´s definition. However, some authors analyse carbon leakage and green paradox in the same conceptual framework: "We define leakage as the shift in emissions from the future to the present (temporal leakage) or from conforming to non-conforming countries (spatial leakage)" (Michielsen, 2011, p.3).

8 The emissions trade systems in only a country or region would be affected -according to Sinn (2012)- by the same problems as most policies because they do not stablish a global limit for carbon emissions.

price and the extraction cost. Moreover, it is assumed that the quantity demanded is null if the price is higher than a price that is normally known as the choke price.

Hotelling analyses the path or trajectory of prices and extractions of "equilibrium"[9] that it is compatible with a maximising behaviour of the owners, that`s to say, with the objective of maximising the present value of their resource rents. The path will depend on the interest rate i, the total resource stock and the present and future demand functions and extraction costs. The two conditions are:

1) The resource rent r (net price of extraction cost) must increase at a rate equal to the interest rate i: $r_t = r_o (1+i)^t$ or, in continuous terms, $r_t = r_o e^{it}$

In other words, the discounted rent should be constant along the time. This is the famous *Hotelling rule*. The reason for this condition is that if the price grew at a higher rate, there would be opportunities to increase the present value of the rent by postponing sales; and in case the price grew at a slower pace, it would be profitable to advance sales.

2) The resource stock should be completely exhausted just at the time the price reaches the choke price. If the resource is exhausted before the price is so high that the demand is null, as if there is a part of the stock that remains as unsold resource, some owners could increase their rents delaying or advancing some sales.

Using this type of model, we can see how climate change policies will affect the equilibrium fossil fuel price path. Let me look at the case of global carbon taxes in which Sinn focuses especially using it as a benchmark for most climate change policies. We can compare a situation without carbon taxes with a situation in which a global carbon tax is introduced. In this new situation, it is the net price not only of the extraction cost but also of the tax which should follow the Hotelling rule. The mathematical conclusion is that if the carbon tax grew over time at a rate higher than the rate of interest, the tax will lead to advance and not delay the extraction of fossil fuels. Therefore, the current final prices (including the tax!) should fall to reach a new equilibrium compatible with the maximisation of present value of resource rents: lower prices will imply more fossil fuel use and more emissions. This is the green paradox.

It is important to emphasise that the conclusion refers in fact not to any introduction of carbon taxes but only to the introduction of taxes that significantly increase over time. For instance, a constant carbon tax would reduce current extraction in favour of future extraction. In any case, if the model implications were applicable to the real world, it would be very bad news for many carbon tax (and other climate change policy) proposals. It is very difficult that people accept high taxes (and in general strong climate change policies) immediately and a way of reducing resistance to carbon taxes is phasing them over time (Carattini, Carvalho and Fankhauser, 2018).

4. Beyond the simplest Hotelling models

Several authors have emphasised that carbon taxes –and other climate change policies- will have, using the Edenfhoer and Kalkuhl (2011) terms, not only a *timing effect*, affecting intertemporal reallocation of resource extraction but also a *volume effect*, lowering cumulative future extraction.

9 Later, I will deal critically with the implicit concept of equilibrium in Hotelling (1931) which characterises the economic theory on non-renewable resources inspired by his article.

The possibility of a volume effect could raise even in a simple Hotelling model with a homogeneous resource as it is assumed in the previous section. Even in this case, an exclusive focus on the timing effect is only justified if we assume that the scarcity resource rent is always positive. However, if the carbon tax was sufficiently high, the resource rent would disappear and the final price would increase and be determined by the sum of the extractive cost and the tax.[10] (Hoel, 2012; Edenfhoer and Kalkuhl, 2011).

However, the main objection to forgetting the volume effect is that coal, oil or gas resources are not homogenous at all. The extraction costs are very different in different sites. Using a Hotelling model with heterogeneous resources, Hoel (2012) concludes that "some resources that would have been extracted if there were no carbon tax will thus be left unextracted with a positive carbon tax. Total emissions therefore decline as a response to a carbon tax, no matter what time profile the carbon tax has." (Hoel, 2012: 8). The effect of carbon taxes could be extended to other climate change policies (see also van der Ploeg, 2013).

Sinn focused only on temporal reallocation of resource extraction and doubted about the practical relevance of the previous considerations, basically arguing that we do not know the technologies and preferences in a very distant and uncertain future and in consequence we cannot assume that some resources will never be exploited (Sinn, 2015: 243; see also Sinn, 2012, pp.203-207). Of course, nobody knows what could happen in the next centuries or even millenniums, but the relevant thing, in political terms, is how climate policies can influence the amount of fossil fuels that now and in the coming decades –we could say in this century, adopting the usual temporal perspective of the carbon budget concept- will be extracted.

As several authors have emphasised, we should distinguish between green paradox in a weak sense and green paradox in a strong sense (Gerlgh, 2010; Baranzini and Carattini, 2014; Jensen *et al.*, 2015). A policy against climate change could cause the paradox in a weak sense by advancing emissions in some period but its global effect on climate change could be judged beneficial if emissions are later sufficiently reduced.[11] In this case, green paradox did not backfire the benefits of the policy even though it would reduce these benefits and it would be very relevant to analyse how to avoid –or at least reduce- green paradox.

5. Hotelling models: a problematic idea of equilibrium

The 1931 Hotelling article was a very important contribution because it emphasised that owners of exhaustible resources should look not only at the present, but also towards the future, if they want to maximise their rents. But, as we have seen, he went far beyond this important idea. He used his model as a theoretical tool for explaining the effective price path of non-renewable resources (in conditions of perfect competition). Thus, his theory has been interpreted as a theory about the market equilibrium prices. This is certainly the case of Sinn,

10 Obviously, the final price should also cover other costs such as transport cost that have not been considered in this article for the simplicity of the argument.

11 Gerlagh (2010) defines green paradox in a strong sense when a policy not only provokes more current emissions but also "increases cumulative damages associated with emissions as well, evaluated at the net present value" (p. 3). I use the term more loosely without a precise definition because I consider this definition very problematic. Climate change affects different generations and discounting the future in social evaluation (as in calculations of social cost-benefit analysis) can be considered discriminatory against future generations. See Azar and Sterner (1996), Martínez Alier and Roca Jusmet (2013) and Llavador, Roemer and Silvestre (2015).

who focuses on how different policies affect the "market equilibrium (in the sense of the Hotelling rule) in which the resource owners are indifferent between selling now and selling later" (Sinn, 2012: 193).

However, the Hotelling price path can hardly be considered an equilibrium path in the usual sense of the term "equilibrium", that is to say, in the sense that there are some forces that press to move the price towards the equilibrium price when the current price differs from this one. One thing is that there is a single price path that ex post is compatible with maximising the (present value of the) rents by all the owners, and another very different thing is that there are some mechanisms that determine that effective market price will tend to this path when the future is uncertain. This is the key theoretical weakness of the Hotelling model that has almost always been forgotten or at least much undervalued.[12]

The fact is that nobody knows whether the price is or is not the "right" one in the sense that it does not allow to obtain more rents by delaying or advancing the sales of the resource. The reason is very simple: nobody has, nor can anyone have, the relevant information, including how demand and extraction technologies will evolve in the future. The usual explicit or implicit idea to try to answer this criticism is replacing the lack of information about the future with the expectations about the future. But this does not solve the problem. Any reasonable idea of equilibrium in a competitive market should be based on plausible responses by individual price-takers to signals provided by the market itself and not in complex mathematical calculations using uncertain variables.

Actually, owners make decisions in a context in which their expectations about the future are diverse and generally poorly defined. This is not to say that ideas about the future and positive or negative news for owners do not influence their decisions There is no doubt that new important data (or new dominant expectations) on –for instance- renewable energy technological development, discovery of new reserves or climate change agreements can influence the owners´ decisions and the prices, but it is not clear at all in which magnitude or even in which direction.[13] I think it is a misguided view of the market dynamics to try to explain these changes as a movement from an initial equilibrium path in which everyone is maximising their rents to another defined equilibrium path that permits to maximise rents according to the new data (or expectations). However, this is –as we have seen- the approach used by Sinn in explaining the effect of climate change policies in fossil fuel supply and in consequence in carbon emissions.

6. The delay between the decision to exploit fossil fuel reserves and their effective exploitation and the importance of sunk costs

Usual Hotelling models and Sinn's explanation of the green paradox have another serious limitation. In the words of Cairns (2014): "The key assumption, usually glossed over, is that output can be re-arranged as desired. It implies that the output decision is made period-by-

12 Only a few authors such as E.J. Mishan (1981, chap. 62-65) highlighted the problem: "There are not forces arising simply from the operation of competitive mining firms, which act to bring the path of market prices over time into line with the Hotelling-efficient price path" (Mishan, 1981, p.492) (see also Roca, 1991).

13 For instance, if one thinks that it is better to extract as soon as possible taking into account expected future aggressive climate change policies, one also could think that the other producers could react in the same way and prices could dramatically fall precisely when the extractions begin to take place.

period, with no restriction other than exhaustibility. The sole physical limit to the level of output is held to be the level of remaining reserves" (p, 81). Thus, current price and expected future prices (nets of taxes and extraction costs) would be the only variables that would determine if the current extraction would increase or decrease.

However, this is totally away from reality as "technological models" have emphasised.[14] The basic characteristics of fossil fuel extraction sectors could be summarised as follows. In each period, there are some resources in exploitation and their potential output or extraction capacity is limited by previous investments that involved important sunk or irreversible costs. In consequence, very short-term supply can be considered totally inelastic above capacity. Extraction marginal costs are usually far below the fossil fuel price and price-taker producers tend to extract the maximum possible resource except if the prices fall so much that they decide to close the exploitation.[15] Thus, for a wide range of prices, the quantity supplied in a competitive context will be basically constant and insensitive to the price and expected future prices; the relevant options –"corner" solutions- are to produce at the maximum extraction capacity or do not produce at all.[16]

If we go beyond the very short term, the evolution of the extraction capacity over time will depend on two factors. On one hand, the extraction capacity tends to decrease over time because extraction declines as exploited resources are running out. On the other hand, the development of new reserves adds new extraction capacity but this development requires investment decisions that will result in additional extractions only some years later. [17]

Even if we accepted –following Sinn- that many climate change policies would incentive owners to increase current fossil fuel extraction, the limitations to act in this sense are considerable. Quoting again Cairns: "In a technological model, the extent to which the industry can act upon the incentive is limited. Contrary to a Hotelling model, it is not possible to increase production from reserves that are currently in production: the capacities are fixed by previous investment. Moreover, for development investments that are currently in progress (…), the incentive cannot move production toward the present because it is already being implemented in the present. For the great bulk of production in the near term, then, the tendency of the tax is not to increase but, if anything, to decrease production. Responding to the increase requires irreversible investment at new reserves" (Cairns, 2014: 84).

14 This type of models has mainly analysed the petroleum industry (see for instance Adelman, 1990; Thompson, 2001 and Cairns, 2014), but the main aspects can be extended to other fossil fuel resources.

15 Of course, global fossil fuel markets are not perfectly competitive especially in the case of oil where prices in some periods have been strongly affected by strategic supply decisions from Saudi Arabia or OPEC as a cartel. However, the assumption in this and in previous sections has been a competitive price taker behaviour for two reasons. First, because Sinn's analysis is based on this assumption. Secondly, because in most situations the assumption that most individual sellers do not act to influence global fossil fuel prices is not far from reality.

16 This explains that when demand falls abruptly, as happened with the financial crisis of 2008, the quantity supplied in the short term is not normally very affected and prices fall dramatically.

17 In section 1 I referred to actions to block certain fossil fuels projects. There, I indicated that it was difficult for these actions to be sufficient to reduce radically global emissions at least in the near future. However, it can now be highlighted that since developing resources to be exploited implies a lot of investment and time, blocking some projects will reduce emissions at least to the extent that it will be impossible to quickly replace the avoided extraction with the exploitation of other resources that replace it (and/or constructing alternative infrastructures for transporting fossil fuels). Moreover, as we will see later, the actions could have a great indirect effect creating more risk for future investments.

Thus, a green paradox, in case it occurred, would not affect the amount of resources supplied in the market until years after knowing the news on climate change policies that would justify the decisions of the owners to sell as soon as possible.[18] Moreover, and even more important, the decision for the owners is not if it is better to sell now taking into account the current costs and prices but it is whether or not to invest now in developing new reserves for selling them years (and probably decades) later without any guaranty of covering important sunk, irreversible costs. The timing and level of investment will determine extraction capacity for the following decades. If some owners have the expectation that policies –for instance carbon taxes- will be significantly stronger in the future than nowadays there could be a green paradox in the sense that climate change policies result in advancing or increasing investments in fossil fuel extraction sectors. This is possible, but the question is whether this is or it is not a probable outcome.

The first condition for investing in new extraction capacity is to expect to have a positive present value during the long period between the start of investment and the projected lifetime of the reserve.[19] In general, we can think that climate change policies –even when its initial impact is limited- will increase the risk of economic losses that could be very important taking into account that fossil fuel extraction is a very capital-intensity activity and a great part of costs are sunk costs. In this sense climate change policies would most likely have a "disinvestment" effect[20] reducing future potential supply and carbon emissions. This "disinvestment" in fossil fuel extraction sectors could be provoked not only by climate change policies in the traditional sense but also by grass-roots social and political movements oriented to block or ban fossil fuels activities because they certainly increase the risk of failed investments. Thus the importance of these movements goes much beyond their direct effects of paralysing certain projects, generating a greater "political risk" of the investments.

7. Is the green paradox so relevant for climate change policy?

One assumption of a part of green paradox analysis is that the global supply of fossil fuels is very elastic in the short term, while the long term supply is completely inelastic. Resource owners could freely change the temporal profile of extraction of total stock, and this temporal profile would be the only important factor for climate change. Thus, perhaps we could talk about the paradox of (some) green paradox analysis because –as we have seen in the previous sections- the short term supply is rather inelastic while the effective long term supply is elastic because the total amount of resources that will be exploited sometime (or, if one prefers, during

18 In fact, this is only completely true in a situation where all the producers are operating at the maximum extraction capacity. When there are strategic behaviours of a cartel or a "dominant" company – or country- that deliberately maintains significant exceeding productive capacity, supply could be increased even in a very short term. It could be that the cartel –country or company- responded to climate change policies by increasing the amount supplied. However, it does not seem likely at all that a deliberate restriction of the supply to keep prices will be relaxed or abandoned precisely in the context of policies that reduce owners´ rents.

19 Let me call 0 the present moment and let me assume that the delay between the moment in which an investment decision is implemented and the moment in which fossil fuel extraction begins is equal to x years, and that the projected life of the exploitation is y years. The prices and taxes that are relevant for the present value of investing now are prices and taxes during periods [x, x+y] and [x+t, x+y+t] respectively.

20 Another activity that can be affected by "disinvestment" is the exploration on new reserves and this will have consequences for the potential supply in the long term.

a certain long period such as the 21st century) depends on economic, social and political factors. Cumulative extraction is obviously limited by geology, but the relevant total supply will depend on these factors.

Thus, Sinn is right in arguing that a successful climate change policy requires to reduce the amount of fossil fuels sold in the global market, but he does not focus on the key question: how different policies could affect how much fossil fuels will remain underground? Of course, the timing of extraction is important for climate change and for the possibilities of human adaptation to it, but when we are referring to the climate change during the present century we probably can assume that: "Research of climate scientists suggests that leaving more fossil fuel unexploited is more important than how fast a given amount of carbon reserves is extracted and released into the atmosphere" (van der Ploeg, 2013: 8).

Another surprising feature of Sinn's analysis is that the positive or negative effect of climate change policies did not depend at all on the intensity of these policies but only on the temporal evolution of the implementation of these policies. Thus, as we have seen, a global carbon tax would provoke the green paradox when the tax (or more exactly the expected future tax) increases at a rate higher than the rate of interest independently on the level of taxation; on the contrary, a constant carbon tax (or better a decreasing tax!) would always reduce current extraction.

But as Hoel (2012) clearly argues "if a sufficiently high carbon tax is introduced, emissions will for sure decline" (p.22). Following the example of this author, we can assume that on average a ton of coal generates about 2 tons of CO_2. With a global carbon tax of $50/tn$CO_2$ the price of coal should be considerably higher than the current one to be able to cover extraction costs.[21] Extraction costs and taxes set a minimum threshold below which fossil fuel prices cannot go down.[22] This is an easy but very important conclusion.

Many authors propose carbon taxes exceeding $100/tn$CO_2$ (Baranzini *et al*. 2017; Howarth et al., 2014; van den Bergh and Botzen, 2014)). If we were able to implement these proposals at a global level, coal prices would more than double over current ones. In the case of oil, emissions per barrel are approximately 0.43 tons of CO_2 so a tax of $100/tn$CO_2$ would correspond to about $43 per barrel (Hoel, 2012). The impact would be much smaller than in the case of coal, but also very significant. In the last decade world prices have sometimes been below this value so there is no doubt that a tax of this magnitude would have increased the final prices of oil products and, in consequence, the quantity demanded and emissions. One characteristic of the oil industry is that at the same time there are exploitations with very different unity costs.[23] Thus, even with relatively high prices, the exploitation of some deposits of unconventional oil –such as tar sands or shale oil- could become ruinous with so high carbon tax.

But now we should return to the general debate on the importance of green paradox.

21 According to the World Bank the 2018 average price of coal from Australia was $107,6 per ton and the price of coal from South Africa was $89.9 per ton http://pubdocs.worldbank.org/en/550191549309123169/CMO-Pink-Sheet-February-2019.pdf.

22 To simplify the argument, I am assuming that the tax is applied on the extraction or first sale of fossil fuel. Moreover, in the short term it could be that the net prices of taxes do not covering all the extraction costs but at least they should cover the marginal costs of extraction.

23 By the way, we can observe that this fact enters in contradiction with the conclusions of competitive Hotelling models according to which less expensive deposits are always exploited first.

As we have seen the only possible effect of climate changes policies in the very short term could be –and certainly would be if policies are sufficiently strong, as the previous example demonstrates- to reduce extraction and emissions. The simple reason is that extraction capacity can hardly increase in the short term or can only increase due to investment decisions taking it years before.[24]

It seems clear that the context most favourable to a green paradox would be to announce a strong policy -in a credible way- for a distant future, while not acting or acting in an extremely weak way during several decades.[25] Thus, there is a case for the green paradox. Perhaps the current situation in which international agreements are so insufficient, but most discourses speak on a decarbonised economy for the second part of this century, could be associated with this situation; but I would make the qualification that not acting now -or acting in a very weak way- does not favour expectations on an effective transition to a decarbonized economy some decades later.

In practice there could be a trade-off between the intensity of policies and the capacity of introducing them quickly. The implementation of very strong global policies can hardly be done immediately. Moreover effective climate change policies will normally generate expectations on stronger policies in the future. Only with strong policies can we expect an important disinvestment effect in fossil fuel extraction industry that is an unavoidable condition for an energy transition to a decarbonised economy. The green paradox concept is useful for advising on the dangers of delaying the policies a lot but renouncing to strong climate change policies because the fear of the green paradox would be renouncing to disinvestment in fossil fuel extraction industries and, in consequence, to an effective climate change policy.

Here it is also important to introduce a distinction between different fossil fuels. In Sinn´s model all fossil fuels are considered as an aggregate as if a unique market existed. However, as Michelson (2011) pointed out, the characteristics of, on the one hand, conventional oil and natural gas and, on the other hand, coal and unconventional oil are very different. Conventional oil and natural gas are far more scarce and the weight of scarcity rents in the final price are much more important than in the case of unconventional oil and gas and coal, which are much more abundant, but also much more expensive to extract and dirtier.[26]

Thus, we can expect that the green paradox is much more probable in the case of conventional oil and natural gas than in the case of the most problematic fossil fuels in terms of carbon emissions in which prices are much more determined by extractive costs and carbon taxes. That is good news because a green paradox for some fossil fuels could occur at the same time as a reduction in the use of their most problematic (imperfect) substitutes so that total carbon emissions do not increase even temporally.

24 Unless there are owners who are restricting supply in order to maintain prices. See note 19.

25 And one even could doubt about the relevance of the term "paradox" in this case because the increase in emissions would not be a consequence of climate change policies but the consequence of a very long period without policies, or very weak ones.

26 The carbon emissions by unit of energy of coal are much higher than the emissions from other fossil fuels. In the case of unconventional oil, the EROI (energy returned on energy invested) is very low in comparison with conventional oil and in consequence the emissions by unit of net energy are higher. This article only analyses climate change but it can be pointed out that other environmental impacts are also much more important for coal and unconventional oil and gas than for conventional oil and gas.

Let me finish this section with an illustrative example. Imagine that a global carbon tax of \$20/tnCO_2 was now implemented and there was a credible agreement of increasing it a 10% yearly for the next decades (the value in 20 years would be about \$135\$). According to Sinn this tax policy would be counterproductive (assuming an interest rate lower than 10%) due to the reaction of owners advancing extraction. I think the previous analysis highlights that the conclusion is not only contrary to common sense but really is in all probability completely wrong. Obviously, for climate change it would be better to introduce a tax of 135/tnCO_2 immediately, but if this were politically unfeasible I do not believe at all that it justified giving up a tax that grew progressively from \$20 to \$135.In more general terms, the green paradox does not justify at all to renounce climate change policies or weaken them at all but it certainly also gives an additional argument to reduce the temporal delay between the political debate and the announcement of policies and their effective implementation as much as possible.

8. Conclusions

Hans-Werner Sinn raised correctly the importance of fossil fuel supply reactions in front of climate change policies and he introduced the concept green paradox to indicate that these reactions could provoke an increasing of carbon emissions. This is certainly a possibility and it is a merit of this author to stimulate the debate about it.

Sinn gave enormous importance to the green paradox as a great obstacle to implement effective climate policies. Since his seminal contributions, the debate has been very rich and many authors have expressed sceptical positions about the practical importance of the green paradox. However, many references to the concept still have a very pessimistic bias.

There are many reasons to be very alarmed about climate change. The problem is very serious and there are many obstacles to apply effective global policies against it. However, the arguments of this article point to conclude that in the real world the possibility that climate change policies provoke a green paradox advancing and not delaying the global extraction of a fossil fuel is low. Moreover, it is important to emphasize two more aspects that made more unprovable the backfire of climate change policy due to the green paradox. The first one is that, even in the case of a certain temporal green paradox in the global extraction of a fossil fuel, its negative effects on climate change could be more than compensated by a posterior reduction in its extraction. The second one is that a green paradox for some fossil fuels (such as conventional oil and natural gas) could coexist with a decrease in the extraction of other fossil fuels (such as coal and unconventional oil and natural gas) resulting in a permanent decreasing of carbon emissions.

In any case, the green paradox concept gives an additional argument for trying to reach an effective and ambitious global rationing of fossil fuel extraction and/or carbon emissions. I agree with Sinn that this difficult political objective would be the best policy. However, while this is not possible, it is necessary to act as quickly and strongly as possible using different tools including demand and carbon pricing policies, changes in individual lifestyles and social movements to block fossil fuel projects.

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III. ECOSYSTEM SERVICES

El capital y la producción de sujetos conservacionistas. El caso de San Juan Raya y la Reserva de la Biosfera Tehuacán-Cuicatlán

César Durán Zepeda*

Introducción

A partir de la creación de la Reserva de la Biosfera Tehuacán-Cuicatlán, en 1998, las actividades económicas de la población de San Juan Raya, Zapotitlán Salinas, Puebla, se modificaron y encaminaron hacia la organización de actividades ecoturísticas. Este cambio respondió a la implementación de políticas ambientales neoliberales, cuya justificación es la conservación de la naturaleza, aunque generaron conflictos sociales en la localidad. El objetivo de esta ponencia es dar a conocer algunos de estos conflictos derivados de las disputas por la apropiación de los recursos naturales y financieros disponibles en y para la Reserva de la Biosfera Tehuacán-Cuicatlán. Para esto, se partió de la premisa de que la conservación de la naturaleza forma parte del ciclo histórico de transformación y expansión del capital en la que ha encontrado un nuevo horizonte para la acumulación.

Se aplicaron un conjunto de técnicas cualitativas como la observación participante, la observación directa, entrevistas, estancias de campo y una exhaustiva revisión bibliográfica que, articuladas con un análisis teórico de corte marxista, dieron como resultado una etnografía sobre la conservación.

Algunas de las conclusiones apuntan que los conflictos sociales en San Juan Raya no se resuelven, ni se contienen debido a su carácter estructural e histórico; también a que las áreas "naturales" protegidas se convirtieron en depositarias de un capital financiero "exclusivo para la conservación" que ha transformado a las poblaciones en "sujetos conservacionistas".

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1. Antecedentes

En nuestros días, la conservación se considera una actividad inherentemente benigna para la naturaleza y la sociedad. Sin embargo, forma parte del ciclo histórico de transformación del capitalismo (Cortés *et al.,* 2014) que, por un lado, es el responsable del deterioro de la naturaleza y, por otro, ha visto en la conservación un nuevo horizonte para explotar bienes naturales y acumular capital. El origen de la conservación en la época moderna data de 1872 y se localiza en Estados Unidos de Norteamérica con el primer parque nacional del mundo: Yellowstone (Santamarina, 2009)[1]. Desde la creación de aquel parque hasta la innovación de la figura de las Reservas de la Biosfera (a principios de la década de 1970), la conservación se caracterizó por la expropiación de tierras, el cambio de uso de suelo y el desplazamiento de las poblaciones locales. Con el modelo de las Reservas de la Biosfera, el conservacionismo buscó revertir estas lógicas de expulsión, al poner interés en el desarrollo económico de las poblaciones locales (generalmente, campesinas, indígenas y pobres) e integrarlas a las labores de conservación.

Ahora bien, es importante señalar, no sólo el origen, sino también las causas que motivaron delimitar territorios para controlar el acceso y uso de los bienes naturales. En el siglo XIX la "conquista del Oeste" norteamericano, motivó a las elites de clase a reservarse un territorio libre de la actividad mercantil y destinarlo a la investigación científica y a la contemplación de la naturaleza; asimismo, en Europa, el crecimiento industrial y urbano provocaron la deforestación y la aristocracia delimitó territorios para la contemplación lúdica (Santamarina *et al*., 2014). De igual manera, a mediados del siglo XX, el crecimiento sostenido de los países industrializados afectó la calidad del ambiente y la disponibilidad de los recursos naturales (Laurín, 2015). En respuesta a ello, en 1972 se llevó a cabo la Conferencia de Naciones Unidas sobre el Medio Ambiente Humano en Estocolmo, Suecia, con la que la crisis ambiental adquirió un carácter internacional y político. Aquella politización de la naturaleza (Latour, 2004), adquirió relevancia económica, en 1987, con la aparición del modelo de desarrollo sustentable y, a partir de 1992 (en la Cumbre de la Tierra en Río de Janeiro, Brasil), éste se convirtió en el modelo hegemónico acerca de la manera de cómo debe llevarse a cabo la conservación.

Alrededor del mundo, se invierten millones de dólares en áreas "naturales" protegidas, a través de proyectos de investigación científica, sociales y económicos que buscan preservar y, al mismo tiempo, explotar la naturaleza de manera "sustentable". En este sentido, las Reservas de la Biosfera son consideradas como la mejor opción para implementar dichos proyectos. En México, así como en muchos países, las políticas neoliberales condicionaron las políticas de conservación, las cuales adquirieron un matiz de mercado, a partir de la década de 1990. De este modo, la creación de áreas protegidas ha venido aparejada con la implementación de proyectos sustentables que promueven la creación de productos y servicios ambientales, ecológicos o "amigables con la naturaleza". No obstante, las autoridades gubernamentales, empresariales y de la sociedad civil, tienden a minimizar las implicaciones económicas, políticas y culturales que los proyectos sustentables tienen sobre la vida de las poblaciones que habitan las áreas protegidas. Aún más, omiten o tergiversan los problemas y conflictos sociales que se generan alrededor. La omisión o tergiversación de estos conflictos, puede derivar en consecuencias perniciosas para los bienes naturales, económicos y socioculturales de un país. De ahí la importancia de abordarlos.

1 Si bien, Yellowstone es ampliamente reconocido como el "origen" de la creación de áreas naturales protegidas, cabe señalar al Bosque de Fontainebleau, Francia como la primera reserva natural del mundo decretada en 1848.

En la presente ponencia[2] se concibe a la conservación de la naturaleza como una forma de "acumulación por desposesión" (Harvey, 2005). Para Harvey (2005), las nuevas formas de despojo en el capitalismo neoliberal o buitre, remiten a la inversión del capital financiero en espacios anteriormente desvalorizados. Esta inversión y flujo del capital posibilitan la emergencia de nuevos mercados (ecoturismo) o la reproducción de los ya existentes (infraestructuras carreteras, telecomunicaciones, etc.) que, a su vez, transforman directa o indirectamente la vida de las personas. Para el caso de las Reservas de la Biosfera, la revaloración (simbólica y económica) de territorios, bienes, servicios, paisajes, etc. despierta el interés de las clases capitalistas para invertir en la conservación y movilizar su capital. Así, estos espacios protegidos se convierten en depositarios de un capital exclusivo para la conservación (tanto privado como público) que, a través de las políticas ambientales neoliberales, los Estados distribuyen a las poblaciones locales en forma de capacitaciones, talleres o incentivos para realizar labores conservacionistas.

Con base en lo anterior, la presente ponencia toma como caso de estudio a la Reserva de la Biosfera Tehuacán-Cuicatlán (en adelante, la RBTC) y a la localidad de San Juan Raya. El objetivo es dar a conocer algunos de los problemas o conflictos sociales suscitados en la localidad a partir de la creación de la RBTC.

2. Metodología

Se realizó trabajo de campo en la localidad de San Juan Raya durante los meses de junio, julio, agosto y septiembre del año 2016[3]. De acuerdo con el tema de estudio y debido a su carácter predominantemente cualitativo, se privilegiaron la observación participante y la entrevista como las técnicas adecuadas para recabar información.

Revisión documental y bibliográfica. Se revisaron documentos sobre acuerdos y convenios internacionales acerca de la protección del ambiente y la conservación de la biodiversidad, lo cual permitió contrastar la retórica ambientalista de los programas y acciones de la política ambiental mexicana, con las formas que adquieren en la vida cotidiana de las poblaciones. Asimismo, se revisaron casos de estudio en torno a los conflictos en Reservas de la Biosfera en México; esto permitió identificar convergencias estructurales y divergencias particulares entre todos los casos, incluida mi investigación.

Observación participante. La participación en la vida diaria de las personas permitió aprehender detalles que, de otra forma, pasan desapercibidos o son ignorados por las autoridades ambientales: los problemas cotidianos de la población, el silencio sobre los conflictos sociales, así como las consecuencias de los programas y acciones ambientales en la vida de las personas. Se asistió a algunas asambleas comunales (cuando las autoridades comunitarias me lo permitieron); juntas de comités; labores agrícolas; recorridos turísticos, etc., lo cual permitió generar *rapport*[4] (en particular con muchos de los informantes principales) y recabar *testimonios*,

2 Resultado de mi tesis de maestría titulada: «Esa Reserva nomás nos vino a Chingar». Territorialización eco-neoliberal y conflicto social: San Juan Raya y la Reserva de la Biosfera Tehuacán-Cuicatlán.

3 Los casos analizados fueron sobre las siguientes Reservas de la Biosfera: Ría Lagartos, Yucatán (Doyon, 2008); Sian ka'an, Quintana Roo (Brenner, 2010); Tuxtlas, Veracruz (Von Bertrab, 2010); Mariposa Monarca, Michoacán (Brenner y San German, 2012); Ría Celestún, Yucatán (Córdoba, 2012; González, 2015); Alto Golfo de California y el Delta del Río Colorado, Sonora y Baja California (Morales, 2015); Montes Azules, Chiapas (Megchún, 2016) y Tehuacán-Cuicatlán (Lee, 2014).

4 En la jerga antropológica, el término se utiliza para describir el desarrollo de buenas relaciones de confianza y excelente

relatos y opiniones sobre la experiencia de vivir en la RBTC. Esta estrategia fue de vital importancia para *comprender* la vida local, vinculada con las dinámicas regionales, nacionales e, internacionales; sobre todo, ayudó a identificar los problemas y conflictos sociales de los pobladores, explicar su silencio sobre los mismos y las formas como experimentan en "carne propia" el hecho de vivir dentro de la RBTC, es decir, las consecuencias de los programas y acciones de las políticas ambientales (de conservación) internacionales y nacionales, así como de la fuerza del capital financiero "verde" que condiciona las actividades económicas, políticas y culturales de las poblaciones.

Entrevistas (estructuradas, semiestructuradas y abiertas[5]). Se entrevistó a 50 pobladores de San Juan Raya; a funcionarios, ex funcionarios y habitantes de la cabecera del municipio de Zapotitlán Salinas y de la localidad de Santa Ana Teloxtoc; asimismo, a autoridades de la Dirección de la RBTC y a un biólogo, un paleontólogo y dos turistólogos relacionados directa o indirectamente con la RBTC.

El trabajo puntual en *el diario de campo antropológico* se perfiló como la principal herramienta para el registro, análisis y reflexión de la información recabada en la localidad. En la obra colectiva, *Fieldnotes*. *The Makings Anthropology* (Sanjek, 1990), los autores muestran las diversas formas de elaborar y utilizar las notas de campo. De acuerdo con los autores, considero que las notas que se realizan durante el trabajo de campo, así como el posterior tratamiento de las mismas forman parte importante de la materia prima para la confección de los datos *etnográficos*. Así, por ejemplo, Jean E. Jackson explora las emociones implícitas en las personas (y en los etnógrafos) en el momento de las entrevistas y conversaciones; Roger Sanjek destaca los diferentes usos y sentidos que las notas adquieren (para un mismo o diferentes antropólogos) en tiempos y lugares diferentes; y, Simon Ottenberg expone la importancia de dos tipos de notas de campo: notas manuscritas y notas mentales. Las primeras, son aquellas que logran escribirse en un cuaderno de notas, en el diario de campo o en un procesador de textos. Las segundas, remiten a las experiencias o recuerdos del etnógrafo que no quedaron registrados de forma escrita, pero que contienen un importante cúmulo de información que da sentido a las experiencias etnográficas.

Todas estas formas de elaborar y analizar notas de campo fueron útiles durante el trabajo y para el posterior análisis de la información. No obstante, la práctica y elaboración de notas mentales fueron primordiales para aprehender aquella información que, por diferentes circunstancias, no podía registrarse en el cuaderno de notas, en el diario de campo o en una grabadora (en el momento de las entrevistas o los recorridos de campo), toda vez que las personas no autorizaban grabar la entrevista o que, de manera tácita, proporcionaban datos que las comprometía. Sin embargo, dichos datos orientaron y dieron luz a la investigación. El carácter "comprometedor" de ciertos testimonios y actividades de las personas que conocí en el trabajo de campo revelan los procesos del capitalismo avasallador que ha configurado las condiciones (precarias) de reproducción social de la población de San Juan Raya. Es importante destacar que cada una de las actividades económicas de la población, así como sus ideas,

comunicación con las personas de las localidades o grupos de análisis.

5 Cabe destacar la prevalencia de estas últimas, toda vez que las entrevistas estructuradas arrojaban información acartonada que negaba la existencia de conflictos; negación que contradecía las innumerables quejas en contra de la RBTC, vertidas en los relatos y testimonios de los entrevistados (sobre todo, habitantes locales).

opiniones, anhelos, etc. de las personas, no derivan ciento por ciento de una responsabilidad individual, sino colectiva, institucional e ideológica[6].

3. Conflictos sociales por la apropiación de los recursos naturales y financieros en San Juan Raya

La RBTC, una de las 686 Reservas de la Biosfera registradas en la Red Mundial de Reservas de Biosfera, es un territorio semidesértico, ubicado entre los estados de Puebla y Oaxaca, México. A partir del decreto de dicho territorio como área "natural" protegida, el cambio de uso de suelo pasó del carácter productivo al de conservación. San Juan Raya, una de las 276 localidades de la RBTC, distribuidas en los 51 municipios entre Puebla y Oaxaca, es una junta auxiliar del municipio de Zapotitlán Salinas, ubicada al sureste del estado de Puebla. Con una población de 200 habitantes (aproximadamente), los bienes comunales de la localidad, así como del municipio, pasaron a formar parte del territorio de la RBTC. De esta manera, las actividades agropecuarias se modificaron y se encaminaron hacia la organización de actividades ecoturísticas.

Antes de la RBTC, las actividades económicas de la población de San Juan Raya consistían en el corte y procesamiento de izote; la cría y pastoreo de ganado caprino; la recolección y comercialización de leña, y la agricultura de temporal y de subsistencia. Después de la RBTC, las nuevas condiciones de uso y acceso a los recursos naturales obligaron a la población a organizarse en torno a actividades relacionadas con el turismo, incentivadas por los organismos gubernamentales, empresariales y de la sociedad civil. Este cambio respondió a la implementación de políticas ambientales neoliberales que promovieron el desarrollo de actividades relacionadas con los "mercados de la conservación" en la RBTC: Pago por Servicios Ambientales (PSA), artesanías de palma y barro, producción de pitahaya y turismo.

Es ampliamente reconocido que la actividad turística en áreas protegidas beneficia a unos y excluye a otros (Córdoba y Ordoñez *et al*., 2004; Brenner y San German, 2012; Córdoba, 2012; Early, 2010; Megchún, 2016, entre otros). No obstante, todos están en una constante lucha por hacerse, o mantenerse, de los beneficios derivados del turismo y la conservación. Cada individuo, familia y "comunidad" busca su propio beneficio. De acuerdo con Roseberry (2007), debido a que en el interior tanto de las clases dominantes como de las clases dominadas existen fracciones de clase con intereses diferenciados, las diversas alianzas entre las clases y fracciones de clase dan lugar a múltiples sitios de dominación que forman campos de fuerza multidimensionales. Estos intrincados campos pueden aprehenderse por medio de la noción de "comunidad" de Roseberry (2014) quien la define como una asociación política en contextos de poder desigual, en momentos y lugares determinados, cuyas relaciones que la componen pueden o no establecerse en diferentes niveles (local, regional, nacional e internacional) y siempre en constante cambio. El carácter procesual de estas nociones permite dilucidar y entender lo que sucede, y no de manera exclusiva, en San Juan Raya con relación a la RBTC.

Una de las situaciones más comunes en las Reservas de la Biosfera es la confusión que se genera en torno a las nuevas condiciones de uso de los recursos, es decir, qué sí y qué no está permitido hacer. Precisamente, una vez que se decretó la RBTC, además de que a los sanjuanenses no les «cuadraba» que unas personas ajenas al territorio les prohibieran sus

6 Es importante señalar que los nombres de las personas que aparecieron en el documento fueron cambiados con el propósito de salvaguardar su identidad y no poner en riesgo su integridad física o moral.

fuentes de trabajo —como me dijo Eleuterio[7]—, no entendían si podían o no abrir más terrenos para cultivo, cortar o no izote[8] y recolectar o no leña. Ocurrió y todavía ocurre que entre los mismos sanjuanenses vigilan su comportamiento. Por ejemplo, Bruno[9] me relató que: «nomás llegó la Reserva y todo mundo andaba al pendiente de todos. No podías ir a cazar un conejo porque no faltaba alguien que te delatara… uno de esos es el Pancho[10], ese wey es un puto acusón… ese, nomás veía que llegaban los de la Reserva, les iba a contar el chisme». Por su parte, las autoridades comunales de Zapotitlán aplicaban multas a los pobladores que fueran sorprendidos realizando alguna actividad prohibida (a pesar de la confusión que había en torno a qué exactamente estaba prohibido). Esta situación propició beneficios personales y grupales a unos y perjudicó a otros. En consecuencia, se desataron rencillas entre los mismos pobladores. Una comerciante de Zapotitlán me dijo: «o sea, se contradicen los de la Reserva, porque por un lado nos dicen que no debemos de cortar plantas, ni abrir terrenos, que esto y que lo otro, pero por otro lado dejan que otros exploten el cerro ¡Sí, ponen dinamita para que se abra el cerro! ¡Uh! Si vieras el polvaderón que sale cuando lo hacen estallar. A ver, ¿cómo está eso? Cómo a unos les prohíben y a otros los dejan hacer lo que quieran. No, pos no entendemos ¿verdad, tú? —se dirigía a su hijo, quien asentaba con la cabeza—»11. De igual manera, un habitante de Santa Ana Teloxtoc fue detenido por las autoridades ambientales y lo amenazaron con multarlo con miles de pesos. Él no se explica por qué a unos sí los dejan extraer rocas y a otros no. «Pero luego nomás es cuestión de suerte —me decía el entrevistado— porque no siempre andan vigilando, pero si te cachan, pues se te dejan caer. Esa vez que me detuvieron les dije que lo de la extracción de la piedra era mi única fuente de trabajo, pero que había otros que sacaban ¡cantidades! Por qué a esos no les decían nada?»12. Con o sin el permiso de las autoridades correspondientes para la explotación de los recursos naturales en la RBTC13, estas situaciones confunden a la mayoría de los habitantes que, por otro lado, señalan a las autoridades municipales de estar coludidas con las empresas que explotan las minas14, a pesar de ser un área protegida.

Dichas confusiones se reforzaron con la bien conocida tardanza en la elaboración del Plan de Manejo de la RBTC, el cual fue publicado hasta el año 2013 (SEMARNAT, 2013), es decir, quince años después (¡!) de la declaración oficial en 1998. Históricamente, las áreas protegidas han sido declaradas “al vapor” bajo el argumento de que ante el embate de la pérdida acelerada de especies “más áreas protegidas son mejor que menos” (Gómez-Pompa y Dirzo, 1995). Una de las justificaciones en la demora para elaborar los Planes de Manejo es la falta de recursos. En la RBTC, fue hasta 2006-2007 que se realizaron los diagnósticos, talleres y estudios del territorio que abarcó la RBTC con el objetivo de elaborar el Plan de Manejo. El biólogo Olvera[11], quien participó en tales actividades, refirió:

7 Sanjuanense de 50 años de edad y ha participado activamente en la organización de actividades turísticas.

8 «Por un lado nos decían: ya no deben cortar izote, pues ahora está prohibido. Pero, por otro lado, nos decían: pueden cortarlo, pero con un permiso para hacerlo de manera sustentable. No, pos no entendíamos» (Eleuterio, agosto de 2016).

9 Sanjuanense de 54 años de edad, dedicado mayormente las actividades agrícolas.

10 Pancho es uno de los principales personajes de San Juan Raya. Al igual que Eleuterio, ha participado en diferentes comités que han dado cierto rumbo a las actividades comunales. Pancho es considerado por sus vecinos sanjuanenses como una persona conflictiva: «a ese nomas le gusta chingar».

11 Olvera es un hombre que ronda los cincuenta años de edad, biólogo y “avecindado” en San Juan Raya, pues se casó con una sanjuanense.

> *En el plan de manejo nomás sentamos las bases para que pudiera estructurarse. Yo no participé [en la elaboración del Plan]. No sé si lo terminó de hacer la UAM-Xochimilco, no sé. Lo tengo aquí, nos los mandó Ernesto [el actual Director de la RBTC]. No lo he revisado realmente. El rollo es que este tipo de documentos… [es decir] lo que se vuelve un tipo de reglamentación, si no lo hiciste dentro del ámbito de convivir con la gente y conocer las propias necesidades de cada comunidad, se convierte en un plan muy general, un plan muy general que solamente está cubriendo un requisito para que se termine el proceso de [creación de] un área natural protegida*[12].

Al respecto, Ignacio[13] (hijo de Pancho) me dijo: «se supone que la Reserva debe de respetar los usos y costumbres de las comunidades, pues hasta en el mismo decreto hay un punto que habla de esto, pero no lo hace, no nos toma en cuenta»[14]. De la misma manera, Mateo[15] refirió: «supuestamente la Reserva debe tomarnos en cuenta, pero ¿a poco nos tomaron en cuenta cuando se reunieron en sus oficinas… a poco nos preguntaron si estábamos o no de acuerdo con entrar a la Reserva?». Por su parte Eleuterio dijo: «no ha habido problemas con la Reserva. Bueno, al principio sí. A la gente como que no le gustaba, la gente decía: 'bueno, pero quiénes son ellos que nos vienen a impedir y determinar ciertas cosas a nosotros como gente de aquí del pueblo, que es nuestro territorio. Pero ya en el último de los casos como que ya se ha llegado a un acuerdo y ya estamos sabedores de qué se puede y qué no se puede hacer'»[16].

Otra de las situaciones problemáticas que ocurrieron en San Juan Raya remite a las expectativas creadas por los funcionarios de la Dirección de la RBTC. Ignacio me decía: «cuando vinieron los de la Reserva, nos hablaron rebonito sobre las plantas y el turismo, pero ¡puro cuento! Nos dijeron que según íbamos a tener muchos beneficios con la RBTC. Que a cambio de las prohibiciones nos iban a apoyar con el turismo, pero lo que nos han dado nomás es para "taparle el ojo al macho" o sea paliativos… nomás nos engañan»[17]. Estos "paliativos" refieren al Programa de Empleo Temporal (PET) que la Dirección de la RBTC ha dado a los pobladores como parte de los apoyos gubernamentales. Con el PET los pobladores han recibido pagos por realizar obras de mantenimiento en la localidad. Sin embargo, muchos pobladores afirman que estos "trabajos" «nomás son de un rato, una vez que se terminan hay que buscar de dónde sacar pa' la papa». Además, los PET, así como los programas de reforestación son objeto de pleitos entre los pobladores.

El caso de la faena organizada el sábado 17 de septiembre de 2016 para plantar árboles de mezquite, guaje y fresno como parte del programa ProÁrbol[18] de la Comisión Nacional Forestal (CONAFOR) puede ilustrar los intereses que están en juego. Durante la mañana de

12 Entrevista a Olvera, junio de 2016.

13 Ignacio, ronda los 40 años de edad. Fue otro de los "pioneros" del turismo en la localidad. De profesión veterinario, es uno de los pocos sanjuanenses que realizó estudios universitarios.

14 Entrevista a Ignacio, marzo de 2013. Ignacio hizo referencia al artículo décimo cuarto del Decreto de la RBTC: "En la ejecución de las acciones de conservación y preservación del área se respetarán los usos, tradiciones y costumbres de los grupos indígenas que la habitan y, en su caso se concertarán con ellos las acciones para alcanzar los fines del presente Decreto" (DOF, 18 de septiembre de 1998).

15 Mateo es uno de los principales líderes de opinión de San Juan Raya, pionero en la organización de actividades turísticas y ha encabezado muchos de los comités locales.

16 Entrevista a Eleuterio, julio de 2016.

17 Entrevista a Ignacio, marzo 2013.

18 ProÁrbol es un programa de reforestación que tiene sus orígenes a mediados de los años noventa del siglo XX en México. Con base en el paradigma el desarrollo sustentable, el programa busca aminorar la deforestación e incentivar la economía de las poblaciones locales.

aquel sábado "toda" la población se reunió en las canchas de basquetbol y el representante de los bienes comunales de San Juan Raya pasó lista, para después cargar en las camionetas disponibles los árboles que se iban a plantar. Cargados con palas, picos, escobas, refrescos y comida subimos a las camionetas rumbo a los terrenos de las familias que les tocó, en esa ocasión, recibir la reforestación en sus terrenos. Horas antes, Eleuterio tocó a mi puerta y, aún adormilado, abrí y escuché su solicitud de acudir a la faena en lugar de él. Desde luego, acepté. No obstante, no pasé lista cuando mencionaron el nombre de Eleuterio. Aún así, realicé todo lo que me dijeron y, al final de la jornada, volvieron a pasar lista. Pero justo en ese momento, los pobladores entablaron una discusión acalorada en torno a un problema: aceptar o no pagarle a los hijos(as) —menores de edad— que fueron a la faena en representación de sus padres. Los dimes y diretes prolongaron la discusión hasta muy entrada la noche. Incluso, unos turistas que andaban por ahí husmearon curiosos el debate. Ante dicha situación, preferí esperar antes de pasar lista a nombre de Eleuterio. Afortunadamente, el hijo mayor de Eleuterio expuso la situación de su padre (y la mía). Sin embargo, esto sólo provocó los reclamos[19] de varios comuneros sin llegar a una solución concreta. Al final, la multitud se dispersó quedando sólo algunas personas que continuaron discutiendo sobre los partidos políticos, el turismo y «los problemas de siempre de acá de la comunidad» —como dijo Pancho. Los días siguientes tanto Eleuterio como yo nos mirábamos apenados. La razón, le hice perder 300 pesos, cantidad que recibió cada uno de los pobladores que se anotaron previamente —que pasaron lista y acudieron a la faena— para ser beneficiarios del programa de reforestación de la CONAFOR. A pesar del mal entendido[20], días después coincidí con Eleuterio afuera de su casa. Sin más palabras me dijo: «Aquí no pasó nada, ¡qué siga la fiesta!».

Esta es otra muestra de los problemas que se generan por la apropiación de los recursos, en este caso, los árboles plantados, los 300 pesos y el trabajo realizado por los pobladores. Y, si bien a todos les tocó un beneficio, las discordias de antaño y las que se generan en cada nueva situación tienen repercusiones en los subsecuentes apoyos gubernamentales. O en palabras de la Comunera (aquella persona que me habló abiertamente de los problemas y conflictos sociales en San Juan Raya): «cada quien ve por sus intereses». Al respecto, Julia[21] me dijo: «mira, aquí cada quien beneficia a los suyos. Por ejemplo, si llega un programa del gobierno, y si mengano, zutano o perengano es el que le toca estar en el comité para coordinar el programa, pos anota a sus hijos, a sus sobrinos, que a la hermana o al hermano y así… pero no anota a los que le caen mal o con los que tiene problemas, así se desquita. Por ejemplo, a mí apenas me tocó estar en un comité, y pos me tocó revisar quién sí y quién no entraba, y cuando vi que [cierta persona] se había anotado, dije: '¡No, ahora me lo chingo! Porque a ese [cuando le toca alguna comisión] nomás beneficia a sus parientes que ni siquiera viven aquí' (risas)»[22].

19 Entre el bullicio de la gente alcancé a escuchar a Pancho: «No, no se debe aceptar que otros vayan en el lugar de los que se anotaron». No obstante, Chucho le replicó a Pancho: «entonces hay que respetar los acuerdos porque la vez pasada se dijo que sí se permitiría y ahora dicen que no, ¿quién los entiende?».

20 Aquella mañana en que Eleuterio me despertó le pregunté si no habría problema que yo fuera en su lugar, a lo que me respondió: «¡No, no hay bronca! Tú ve y ya, es que yo tengo que hacer otras cosas y no me va a dar tiempo, ahí luego me pongo con algo».

21 Julia es una sanjuanenses que ha participado activamente en la organización de actividades turísticas.

22 Entrevista a Julia, abril de 2013.

Con base en lo dicho, es pertinente aseverar que la población de San Juan Raya no es uniforme sino fragmentaria. La idea de San Juan Raya como una comunidad armónica encubre las relaciones conflictivas al interior de la población; incluso, al interior de una misma unidad doméstica existen "rencillas familiares" que, en un momento determinado, influyen en el rumbo que pueden tomar las relaciones familiares y comunales. De este modo, los y las sanjuanenses experimentan un vaivén en la vida comunal que los puede poner dentro o fuera de los recursos del Estado o la sociedad civil. Tal fue el caso de Emma[23]. Esta comunera tenía una tienda cerca del museo[24] y era muy participativa en las actividades comunales: asistía a las asambleas, opinaba, proponía, etc. Pero cuando la asamblea decidió cambiar la recepción de turistas a la palapa de las artesanas, Emma resultó "afectada". Antes de esta decisión comunal la recepción de los turistas se realizaba en el museo, por lo que todos los turistas tenían que entrar a la tienda de Emma. Después de la decisión, Emma tuvo que cerrar su local y trasladar su tienda a la casa de sus padres. A raíz de ésto dejó de asistir a las asambleas comunales y guarda cierto "rencor" a aquellas personas que hicieron la petición a la asamblea de «bajar la recepción a las palapas». Y a la inversa, aquellas personas que hicieron la petición le tenían "rencor" a Emma. Cabe mencionar que estas comuneras "siempre" han tenido problemas entre sí. A propósito del traslado de la recepción, Olvera me dijo: «El acierto más grande de la comunidad fue que trajeran la recepción de turistas directamente al lugar donde están las artesanas: los turistas llegan, entran y mientras esperan su turno, están observando y compran el trabajo de las artesanas. Así todo mundo obtiene un beneficio. Pero antes no era así. Antes, los beneficios se concentraban solamente en unas cuantas personas que tenían sus puestos de artesanías y tiendas en la entrada del museo. Pero ahora no: si quieres un beneficio, pues trae tu puesto de artesanías y vende»[25].

Las rencillas cotidianas están permeadas por las relaciones que los sanjuanenses han establecido con otros sujetos de otras localidades o grupos de la sociedad civil. Quizás el grupo de mayor prestigio en San Juan Raya sea el de los biólogos. Los sanjuanenses tienen una "buena imagen" de ellos. De hecho, Rogelio —el propietario de las únicas cabañas en la localidad— cursó algunos semestres de la carrera de biología en la BUAP, pero no concluyó. Muchos jóvenes (hombres y mujeres) en edad escolar aspiran a estudiar biología, paleontología, veterinaria y zootecnia Esta aspiración nace de la fuerte presencia en la localidad de profesionales de dichas carreras; por ejemplo, el biólogo Olvera está casado con una comunera de San Juan Raya; el biólogo Jaime Ceballos, dicen muchos comuneros: «nos echó mucho la mano» y el paleontólogo Eduardo Spotila es compadre de Rosalía. Por otro lado, así como los biólogos gozan de reconocimiento social, también son señalados como oportunistas o «aprovechados». En alguna ocasión, Julia se refirió a la UNAM de la siguiente manera: «a San Juan Raya vienen muchos investigadores de la UÑAM (sic) —mientras aseveraba esto, sonreía y con su mano derecha, a la altura de su abdomen, simulaba rascar "algo" en el aire— ¿sí me entiendes no? O sea que así como nos han echado la mano, también ellos buscan su propio beneficio»[26]. Lee

23 Emma tenía 40 años de edad en el 2016. Al igual que algunos de sus hermanos, trabajó en Estados Unidos. Al retornar a San Juan Raya, se insertó inmediatamente a las actividades turísticas y manifestaba interés en ellas.

24 El Museo Paleontológico San Juan Raya se construyó cerca de los terrenos de sus padres. Emma, al ver que el turismo iba en aumento, le propuso a su madre construir un local y abrir una tienda. Para lograrlo, echó mano de los ahorros que juntó como migrante en Estados Unidos. Por su parte, su madre puso el terreno. Efectivamente, la tienda le «resultó» y se convirtió en su «única fuente de trabajo» -como solía decirme-.

25 Entrevista a Olvera, junio de 2016.

26 Entrevista a julia, junio de 2012.

(2014), por ejemplo, refiere que en 1999 investigadores de la UNAM intentaron extraer algunos ejemplares de flora para un banco de germoplasma. Sin embargo, un grupo de zapotitecos lo impidió. Este grupo instaló un letrero con la leyenda "Tierra y Libertad" afuera del jardín botánico. En entrevista con uno de aquellos zapotitecos, me refirió que «se tomó el jardín porque esos pendejos [se refería a ciertos biólogos] nomás venían a hacer desmadre, se ponían a tomar, a coger… eran unos pinches biólogos los que ya se creían y, todavía, se creen los dueños del jardín botánico…»[27]. Cabe resaltar que este zapotiteco[28] fue uno de tantos que estuvo de acuerdo en aceptar el Programa de Certificación de Derechos Ejidales y Titulación de Solares (PROCEDE): por un lado, luchó por la tierra del "pueblo" y, por otro, vio con buenos ojos la posibilidad de vender esa misma tierra.

Uno de los acontecimientos más «sonados» sobre los investigadores en San Juan Raya remite a la ocasión en que Pancho llevó al paleontólogo Eduardo Spotila —por la noche y sin permiso del comité de los bienes comunales— a recorrer ciertas zonas del monte. Según el testimonio de Plutarco Márquez (entonces representante y presidente del comité de los bienes comunales en San Juan Raya): «en aquella ocasión yo era la autoridad de los bienes comunales. Al recibir el reporte de que "alguien" andaba *conejeando* [cazando conejos] acudí al lugar y me encontré al Pancho quien no reportó su recorrido. No había problema que hiciera el recorrido, sino que no se reportó a las autoridades»[29]. Pancho fue citado a asamblea, le llamaron la atención y tuvo que pagar su recorrido (no autorizado) al comité del museo (el cual administra los recorridos turísticos o no turísticos). Cabe resaltar que tanto el paleontólogo como Pancho conocían las reglas internas en cuanto a la realización de recorridos (a turistas o investigadores) y ambos las ignoraron deliberadamente. Por su parte, el mismo Olvera aseguró que «fue muy difícil que estos profesores, que ya tienen años viniendo aquí se acataran a una reglamentación que la misma comunidad estructuró: que tienen que llevar sus guías [de la localidad] pagados por ellos mismos a los lugares a donde ellos quieren hacer recorrido»[30]. Es preciso mencionar que la cuota de los recorridos se divide en dos: una parte se le da al guía en turno que lo realizará y la otra ingresa al museo, es decir, a un fondo comunal.

4. Rechazo de la cuota del derecho de admisión a una área natural protegida

El primero de noviembre de 2011 almorzaba en casa de Emma. De pronto, Emma entró a la cocina y, exaltada, me contó de un acontecimiento que acababa de ocurrir:

> *Los de la Reserva ya quieren cobrar derecho de admisión a la RBTC…vinieron dos chavas de la Reserva y empezaron a cobrarles a los turistas una cuota disque para poder estar dentro de la Reserva. Yo estaba en la tienda y escuché que una de las de la Reserva le quería cobrar a un turista. El turista les preguntó: 'cómo que me quieren cobrar, si hasta el momento he recorrido toda la Reserva y en ningún lugar me habían cobrado'. Entonces, agarré y le dije a las de la Reserva que cómo era posible que llegaran así nomás, de momento y les quieran cobrar a los turistas. Y si es así, pues primero que le expliquen al turista qué es un área natural protegida, qué es una Reserva y todo eso ¿no? No que nomás llegan de repente y no explican ni nada… No, así, pues no se vale[31]. Pero ya dieron aviso al comité del museo.*

27 Entrevista a uno de los líderes de la cabecera municipal de Zapotitlán Salinas, septiembre de 2016.

28 Gentilicio para referirse a los habitantes de Zapotitlán Salinas.

29 Entrevista a Plutarco Márquez, junio de 2016.

30 Entrevista a Olvera, junio de 2016.

31 En el momento del cobro inesperado Emma estaba despachando en su tienda. Cada semana se alternaba con otra sanjua-

Por la tarde, "los de la Reserva", acompañados del director de la misma, se reunieron con el comité del museo para aclarar el asunto. Entre dimes y diretes, silencios e intervenciones[32], el director de la RBTC explicó a los sanjuanenses la función de la cuota de admisión a un área natural protegida. En pocas palabras, un impuesto federal. Sin embargo, los sanjuanenses le recordaron al director el acta de asamblea donde quedó asentado que tal cobro no se realizaría hasta que el turismo les asegurara un ingreso constante (a toda la población). No obstante, un funcionario de la Dirección de la RBTC, arremetió: «lo tienen que hacer, ya están certificados».

El presidente en turno del museo (Ignacio) aprovechó la presencia del director y señaló a los zapotitecos por los malos y perjudiciales recorridos que estaban organizando: senderos no aprobados y paquetes turísticos que incluían a San Juan Raya (sin la autorización de los sanjuanenses). También manifestó su malestar por el saqueo de fósiles: «hasta los jipis los andan vendiendo. Dicen que los han visto en el centro de Puebla y de Oaxaca». El director les aconsejó que denunciaran el robo de fósiles en el INAH (Instituto de Nacional de Antropología e Historia). Cabe agregar que una de las prácticas cotidianas en la zona es la extracción de fósiles por parte de los turistas y su venta por algunas pobladores de la RBTC —en cierta ocasión una persona ofreció fósiles a unos turistas que, nerviosos e interesados, rechazaron la oferta. Paradójicamente, estudiantes, maestros e investigadores… en fin, también "turistas" logran extraer alguna pieza fósil o algún recurso disponible en San Juan Raya—. En un intento para calmar el ambiente de la reunión, el director de la RBTC motivó a los pobladores expresándoles la importancia que tiene "San Juan Raya" como lugar turístico. «Ustedes ya están bien posicionados, mucha gente de otros lugares del mundo los quiere conocer»[33]. Al final de la reunión, los pobladores le indicaron al director que realizarían una asamblea a la mañana siguiente para que fuera la gente la que decidiera aceptar o no la cuota. La resolución de la asamblea fue en contra. Olvera me explicaba el mecanismo burocrático de la cuota y su opinión sobre ésta:

> *Por entrar a un área natural protegida se paga un impuesto, y ese impuesto entra a la tesorería de la federación y después de 500 años, entre comillas, regresa a la comunidad […] Pero no tuvo éxito en la Reserva. En la Reserva no tiene éxito porque tanto el proyecto de San Juan Raya, Zapotitlán, Tecomavaca, son proyectos que han nacido dentro de la comunidad, son proyectos donde la gente dice: 'son de nosotros'. Y se quiso empezar a hacer así en San Juan Raya [cobrar del derecho de admisión]. Pero da la casualidad que este proyecto es un proyecto que le ha costado a la comunidad. Bien sencillo de entenderlo. La inconformidad de la gente es que dice 'tú, la Dirección de la Reserva, por qué cobras'… Después de que entró mi esposa en el rollo del comité y todo eso del turismo, la Reserva empezó a jalar recurso hacia acá, pero el proyecto como tal nació como proyecto comunitario, a pesar de que la Reserva ha jalado recursos es, sigue siendo, un proyecto comunitario. Aunque lo pueda financiar una fundación cualquiera, la gente sabe que este es su proyecto. Y si vienen los funcionarios o viene gente a querer cobrarles a los turistas por el simple hecho de estar dentro de una Reserva, la gente se va a indignar porque '¡oye, yo lo estoy cuidando, es mi proyecto, yo lo estoy haciendo, yo lo estoy viviendo, yo lo estoy desarrollando con todas mis capacidades, con mis problemas y mis aciertos, pero esto es mi*

nense para trabajar como recepcionistas en el museo. Por lo tanto, era evidente que Emma conocía a la perfección los procedimientos para atender a los turistas.

32 Los funcionarios acusados casi no intervinieron en la discusión. El diálogo se entabló entre el director y los sanjuanenses que asistieron a la reunión.

33 Pantoja, un turistólogo que conocí en San Juan Raya (dio capacitaciones en ésta y otras localidades de la RBTC como parte de un proyecto de desarrollo sustentable para la misma), me explicaba que este tipo de áreas protegidas entran a diferentes redes de turismo internacional. Aseguraba que «siempre hay gente que quiere conocer estos sitios y la SEMARNAT ubica y facilita el nicho de mercado» (Entrevista a Pantoja, junio de 2011.

proyecto, yo no acepto que tu vengas y les cobres por persona el derecho de estar dentro un área natural protegida…![34].

Después de lo ocurrido muchos pobladores no se preguntaban por qué "los de la Reserva" querían cobrar el derecho de admisión a un área natural protegida, sino por qué querían hacerlo en la entrada del camino hacia San Juan Raya. Estos mismos pobladores señalaban que si querían cobrarlo que lo hicieran desde Tehuacán o, en todo caso, desde Zapotitlán Salinas (sobre la carretera de la cabecera municipal), ya que, a final de cuentas —afirmaban—, esas localidades también son parte de la RBTC. «Ya nomás faltaba que quisieran que nosotros cobráramos por ellos», expresó una sanjuanense. Olvera, un tanto molesto, y de acuerdo a su larga experiencia de trabajo, refiere que el rechazo de la cuota se debió tanto al carácter "comunitario" de los proyectos de las poblaciones y «la otra [razón], bien sencilla de entender, es la actitud del funcionario. El funcionario de las dependencias federales son funcionarios que llegan y siempre manifiestan prepotencia y, pues no tiene por qué ser así»[35].

Conclusiones

Los proyectos sustentables, aplicados en la localidad de San Juan Raya, basados en la innovación de bienes y servicios "amigables con el medio ambiente", así como en la competitividad, exacerbaron los conflictos sociales existentes al interior de la población. Asimismo, los recursos financieros disponibles generaron disputas por su apropiación. En consecuencia, los sanjuanenses (y los diversos grupos relacionados con la RBTC) se han visto envueltos en conflictos de intereses, corrupción, desvío de recursos, incumplimiento de las normas y leyes ambientales, clientelismo político, entre otras problemáticas, que han generado un ambiente de silencio[36] y conflictividad social en la localidad.

El capital que circula en torno a la RBTC, no sólo sujeta a los sanjuanenses, también a cada uno de los sujetos de la cadena burocrática: funcionarios de la Dirección de la RBTC, de la Comisión Nacional de Áreas Naturales Protegidas (CONANP), de la Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT) y de las OSC, pues tal como los mismos funcionarios suelen afirmar: "somos gestores y promotores de la conservación", esto es, empleados o subempleados de una burocracia nacional e internacional, que convergen en las convocatorias para concursar por un donativo otorgado por las grandes instituciones y corporaciones multilaterales y, así, recibir un pago eventual (o dado el caso, un salario) por su trabajo en *pro* de la conservación.

Sin embargo, cabe preguntarse: ¿Quién(es) realiza(n) las labores de conservación en la RBTC? En general, todos los sujetos involucrados con la RBTC, sea el agricultor de San Juan Raya (que en determinados momentos se ocupa de guía de turista, gendarme ambiental o ayudante de albañil), sea el Director de la RBTC o el paleontólogo de la UNAM. Pero son los sanjuanenses quienes, de manera concreta, realizan los trabajos de conservación; quienes dejaron de cortar izote, abrir terrenos para cultivo, criar ganado caprino de manera extensiva y comercializar leña; quienes, después del decreto de la RBTC, acataron los mandatos de la "conservación neoliberal" (Igoe y Brockington, 2007): aprender a comercializarse a sí mismos

34 Entrevista a Olvera, junio de 2016.

35 Entrevista a Olvera, junio de 2016.

36 Sin duda, este ambiente de silencio se da en otros casos de estudio.

como "campesinos" o "indígenas" conscientes del cuidado de la naturaleza y a quienes, cuya fuerza de trabajo, se explota para mantener en excelentes condiciones la calidad de la naturaleza. Así, los sanjuanenses han sido capacitados (y ellos mismos se han capacitado) para "trabajar" como servidores turísticos de un turismo regional, nacional e internacional que de manera creciente arriba a la RBTC.

Los beneficios ecológicos y económicos de las labores de conservación, realizadas por los sanjuanenses, son disputados por los diferentes actores vinculados con la RBTC. Como suelen afirmar la población de San Juan Raya: «los de la Dirección de la Reserva se paran el cuello ante la sociedad, por un trabajo de conservación que ellos no hacen, sino que lo realizamos nosotros». Los reclamos que expresan los sanjuanenses (de manera verbal) por el reconocimiento de sus labores de conservación, apelan, precisamente, a la retórica ambientalista o de sustentabilidad que los organismos gubernamentales promueven, pero que contrastan con la realidad de su aplicación. Sobre todo cuando los funcionarios ambientales se ven involucrados en acciones deshonestas que afectan a la naturaleza o cuando se muestran incapaces de comunicar, con claridad, lo que está o no prohibido realizar en el territorio protegido. Por lo tanto, las labores de conservación son, en sí mismas, objeto de disputas.

Es importante apuntar que uno de los principales objetivos fundacionales de las Reservas de la Biosfera fue terminar con la lógica de expulsión practicada por los parques nacionales. En la actualidad, las Reservas de la Biosfera, no sólo han integrado a las poblaciones locales en los trabajos de conservación, también, por esta misma vía, explotan su fuerza de trabajo que contribuye a mantener a la naturaleza en excelente estado de conservación y, así, ser dable para entrar a los cauces del capital financiero, a través de los mercados *ecofriendly*. En suma, la revalorización del territorio y de los bienes naturales de la RBTC, así como de la fuerza de trabajo de los sanjuanenses responden a la emergencia de la conservación como un nuevo "espacio de acumulación de capital" (Harvey, 2007). Sin embargo, los aparentes beneficios derivados de la conservación en San Juan Raya, quedan soterrados por las condiciones de precariedad en la que viven los sanjuanenses y, las disputas por la apropiación de los recursos, fragmentan a la población. La coerción de las políticas ambientales neoliberales, se expresa tanto en estas disputas como en el desarrollo de productos y servicios destinados al consumo turístico. En este contexto, los sanjuanenses solían afirmar: «tuvimos que obedecer, si no, pues ¡tambo!».

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Economic valuation of Vembanad Wetland ecosystem, India

Durga Ar*

Introduction

Wetlands are one of the most productive and life supporting ecosystems in the world and together with agricultural and forest ecosystems provide diverse tangible and intangible benefits on a sustainable basis. Despite their importance in maintaining the ecological balance and ensuring the sustainable livelihood of the human community, globally, wetlands are under heavy pressure due to unsustainable development practices followed. The main reason for excessive depletion and conversion of wetland resources is the failure to properly account their values, particularly, the non-use and functional values (Barbier *et.al.*, 1997; Turner, *et.al.*, 2003). So, valuing it (in economic terms) and comparing it with the cost of preventing the damage (World Bank, 1992) would provide a basic benchmark information about the significant economic benefits of wetlands, and assist in the restoration and investment decisions(Sumana, 2004).

Kerala is known for its rich coastal wetlands and backwaters. Vembanad Wetland Ecosystem (VWS) one of the wetland of Kerala is a part of largest Ramsar site in India. The unique ecology of this wetland ecosystem supports multiplicity of enterprises based on inland fisheries, paddy, coconut, and other allied enterprises (Planning Commission, 2008; Kerala State of Environment and Related Issues, ENVIS, 2018).

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As this wetland is dominated with the rice cultivating zones, the tendency of farmers to use high yielding varieties of seeds, fertilizers and pesticides affect it adversely. The proportion of fertilizer and pesticide residuals in the drinking water sources of the adjacent residential areas is increasing at an alarming rate. Furthermore, extraction of coir fibre and small-scale production of many coir-based products provides employment to almost 70 per cent of the womenfolk in the area (MSSRF, 2007). Incidentally, this coir fibre production involving coconut husk retting in the shallow waters of the VWS and its waterways is a major contributor of water pollution.

Backwater tourism, tourist resorts and houseboat cruise is an economic activity, marketing the scenic and natural charm of Vembanad. They are increasingly contributing to the water pollution through fuel spillage and discharge of human waste directly into the water body. Besides, lack of drinking water is a serious problem and more than 80 per cent of the people are reported to be relying on the contaminated canal water for their daily needs such as for cleaning utensils, washing cloth and taking bath (MSSRF,2007). Due to these enormous anthropogenic activities (network of roads, reclamation of wetlands and construction activities and vulnerability of the area to regular flooding), a serious man-made crisis has been created on ecology, livelihoods and agricultural activities contributing to a spiralling agrarian distress in the region(Sreejith, 2013; Rao and Balasubramanian, 2017, 2018). This ignorance or misunderstanding of the value of goods and services provided by the wetland has resulted in its conversion to intensive agricultural, industrial or residential purposes (Jeena, 2010). Hence, there is an urgent need to understand the economic benefits and assign quantitative values to the goods and services provided by them to the beneficiaries as well as the policy makers. In this regard, the paper tries to quantify the value of the goods and services provided and assess the relative efficiency of many alternative uses of wetland and to choose the option which yields maximum net benefits to the society.

With the above background, the present paper makes an effort to examine the economic value of Vembanad wetland by focussing on the provisioning services. The specific objectives of the paper are,

a) To estimate the economic value of the wetland system with special reference to provisioning services

b) To find out the determinants of Willingness To Pay of the stakeholders for the

improved conservation;

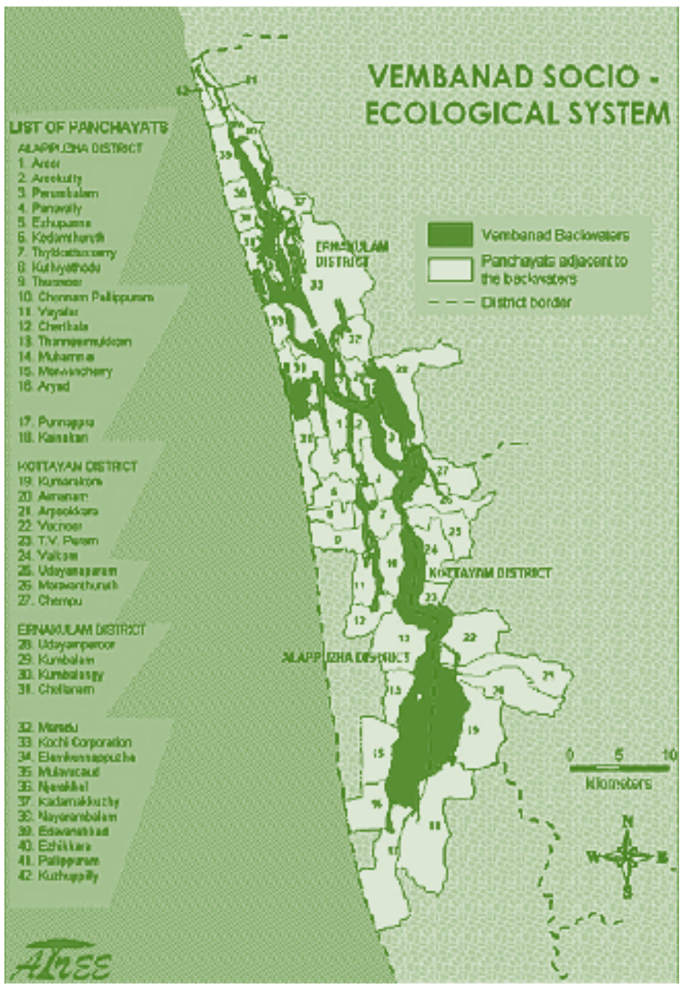
c) To suggest suitable policy measures for the conservation

1. Data and Methodology

1.1 Study Area

Vembanad wetland Ecosystem was purposively selected because the environmental conditions of the lake is in a steady decline due to severe anthropogenic pressures which pose grave threats to the ecosystem (Priyadarsanan et al, 2008). Vembanad - Kol - Wetland – System, one of the three Ramsar sites in Kerala (November 2002), is the largest estuarine system of the western coastal wetland systems and is spread over the districts of Alappuzha, Kottayam, Ernakulam and Thrissur, Kerala. The VKW is a complex aquatic system of 96 km with long coastal backwaters, lagoons, marshes, mangroves and reclaimed lands, with intricate networks of natural channels and man-made canals extending from Kuttanad in the south to the Kol lands of Thrissur in the north. The total area of the wetland system is 1521.5 sq. km.,- approximately 4 per cent of the State's geographic area. The wetland is mostly waterlogged with depths ranging from 0.6 m to – 2.2m and is typically divided into two distinct segments - the freshwater dominant southern zone and the saltwater dominant northern zone.

FIGURE 1. MAP SHOWING VEMBANAD WETLAND ECOSYTEM



Source: Priyadarsanan D.R. *et al,* (2008).

1.2 Data

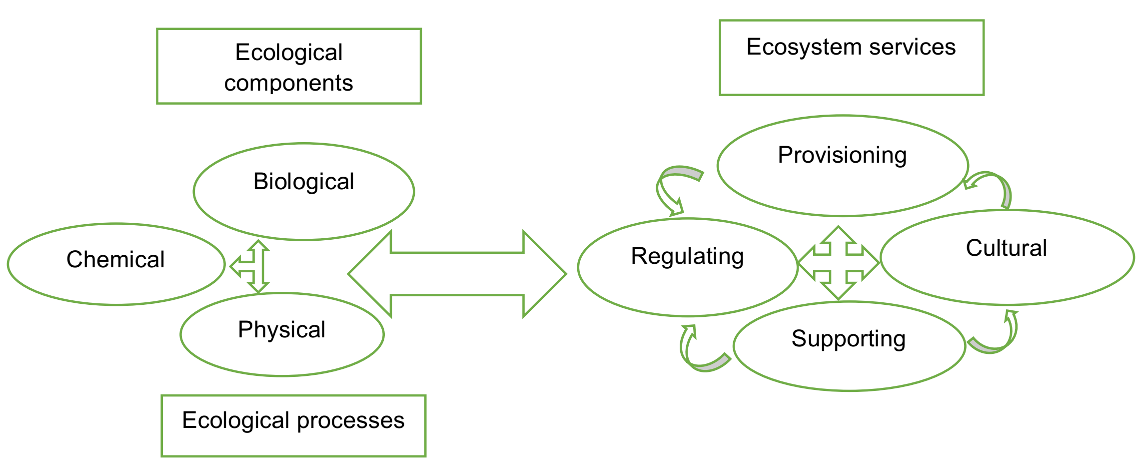
Alappuzha district of Kerala was purposively selected for the study because the area has become a causal factor to the ecological decay characterized by pollution of water body due to many factors and declining ecosystem services and goods like fishery loss. From the selected district, two blocks, Chertala and Alappuzha were purposively selected. Then from each blocks, villages adjacent to the lake were purposively selected for the study. The study was initiated by holding informal discussions with local residents, officials of agriculture/fisheries department, members of local self governments and elderly people in the locality and also by direct observations. Through this process, four groups of stakeholders who depended on the ecosystem were identified. They were categorized as paddy farmers, coconut farmers, tourists and domestic consumers. A random sample of 30 each was identified for each stakeholder group. The study, thus, was based on primary data from 120 respondents (30 x 4). In order to fulfill the objectives of the study, necessary primary data were obtained from the sample respondents by the personal interview method, using a pre-tested and structured schedule. The method of personal interview was adopted to ensure that the data obtained from the respondents were relevant, comprehensive and reasonably correct and precise. The data were collected from these four types of stakeholders using separate questionnaire. Questions were focused on the ecosystem services used, people's dependency on them and their willingness to pay for conservation. Agricultural officers, NGOs, research institutes, and Paadasekhara committee members, and other organizations were consulted for listing of ecosystem services of the wetland during the period of study.

1.3 Methodology

Theoretical framework

Wetlands are composed of a number of physical, biological and chemical components such as soil, water, plant and animal species, and nutrients. Interactions among and within these components allow the wetland to perform certain functions. The various environmental benefits of wetlands are measured in terms of their contribution to provide goods and services of value to humanity. Inorder to value wetland uses and take these into account when making policies that affect wetlands, then a framework for distinguishing and grouping the values is required. Hence, the concept of total economic value (TEV) provides a framework (Table 1) that would convert wetland characteristics (ecological processes and components) into its services which can then be quantified in appropriate units (biophysical or otherwise) to determine their value (importance) to the human society (Fig.2.).

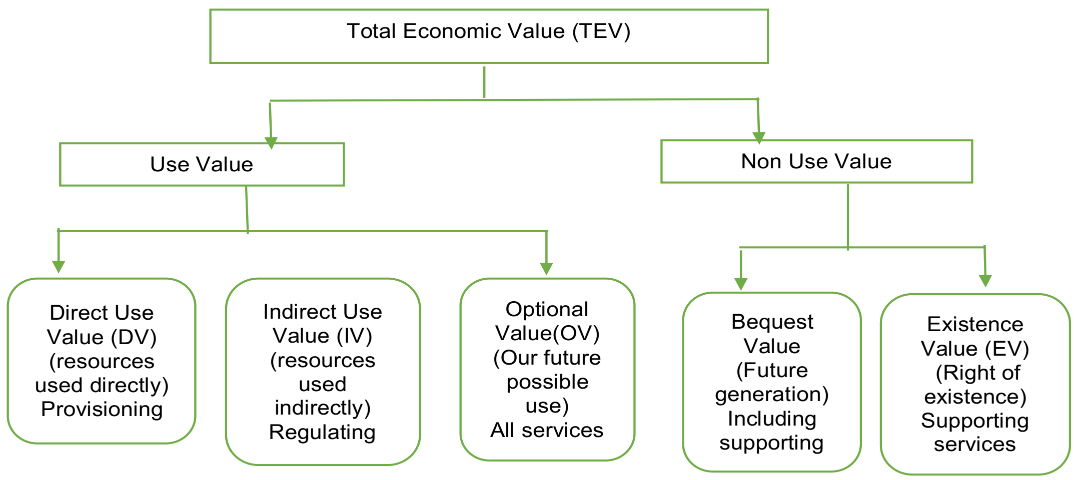
FIGURE. 2. RELATIONSHIPS AMONG ECOLOGICAL COMPONENTS AND PROCESSES THAT COMPRISE A WETLAND AND THE ECOSYSTEM SERVICES THEY DELIVER



Source: Adapted from Edward et al (1997) and de Groot (2006).

The economic value of wetland eco-systems can be divided into four categories based on the benefits/functions/services provided by the ecosystem: direct (DV), indirect (IV), option (OV) and existence (EV) values, where the Total Economic Value (TEV) = DV + IV+ OV + EV

FIGURE 3. TOTAL ECONOMIC VALUE FRAMEWORK



Source: Adapted from Nile Basin Capacity Building Network (2016).

Direct use values are derived from ecosystem services that are used directly by human beings. They include the value of consumptive uses such as harvesting of food products, timber for fuel or construction, medicinal products, and hunting of animals for consumption as well as the value of non-consumptive uses such as the enjoyment of recreational and cultural amenities like wildlife and bird watching, water sporting, and spiritual and social services that do not require harvesting of products. They are typically enjoyed by people located in the ecosystem itself.

Indirect use values are derived from ecosystem services that provide benefits outside the ecosystem viz. natural water filtration, which often benefits people far downstream; the storm protection function of coastal mangrove forests, which benefits coastal properties and infrastructure; and carbon sequestration, which benefits the entire global community by reducing climate change.

Option values are derived from preserving the option to use in the future services that may not be used at present, either by oneself (option value) or by others or heirs (bequest value). Provisioning, regulating, and cultural services form a part of option value to the extent that they are not used now but may be used in the future. Non-use values refer to the value people may place on knowing that a resource exists even if they never use that resource directly. It is usually known as existence value (or, sometimes, passive use value). Some of the ecosystem services provided by wetland are presented in the table 1.

TABLE 1. EXAMPLES OF ECOSYSTEM SERVICES PROVIDED BY WETLAND

Provisioning	Regulating	Cultural and Amenity	Supporting
Food: production of fish, algae and invertebrates	Air quality regulation: e.g., capturing dust particles	Cultural heritage and identity: sense of place and belonging	Biodiversity & nursery: Habitats for resident or transient species
Fresh water: storage and retention of water; provision of water for irrigation and for drinking	Climate regulation: regulation of greenhouse gases, temperature, precipitation, and other climatic processes	Spiritual & artistic inspiration: nature as a source of inspiration for art and religion	Soil formation: sediment retention, accumulation of organic matter
Fiber & fuel & other raw materials: production of timber, fuel wood, peat, fodder, aggregates	Hydrological regimes: groundwater recharge/ discharge; storage of water for agriculture or industry	Recreational: opportunities for tourism and recreational activities	Nutrient cycling: storage, recycling, processing and acquisition of nutrients
Biochemical products and medicinal resources	Pollution control & detoxification: retention, recovery and removal of excess nutrients/ pollutants	Aesthetic: appreciation of natural scenery (other than through deliberate recreational activities)	
Genetic materials: genes for resistance to plant pathogens	Erosion protection: retention of soils	Educational: opportunities for formal, informal education/training	
Ornamental species: e.g., aquarium fish and plants	Natural hazard mitigation: flood control, storm & coastal protection		
	Biological Regulation: e.g., control of pest species and pollination		

Source: Adapted from Nile Basin Capacity Building Network (2016).

Based on this theoretical framework various ecosystem services were classified and categorised from the study area and the indicators were identified to estimate the TEV of the Vembanad wetland ecosystem with special reference to the provisioning services.

2. Analytical framework

2.1 Estimation of the economic value of the wetland system with special reference to provisioning services

2.1.1 Economic value of lake water used for coir retting

Following Karthikeyan et. al. (2009) the economic value of water used for the coir retting was determined by employing production function approach. The marginal value of water of each ha. cm. is the marginal physical product times the output price. A quadratic production function was estimated with retted coir (kgs/ha.) as dependent variable and volume of water used in ha.cm (WATER) as independent variable. The volume of water used was estimated by measuring the volume of the rectangular pit used for retting the coir. The estimated production function is as follows

$$\text{COIR} = \alpha + \beta_1 \text{ WATER} + \beta_2 \text{ WATER}^2$$

Where:

COIR: Quantity of coir after retting (kg)

WATER: Volume of water used for retting in ha cm

2.1.2 Economic value of lake water used for human uses

Pricing irrigation water would provide the actual value and highlight the total economic value of the resource. Devi(2008) has estimated the value of irrigation water based on water productivity for non irrigation purpose both for human uses and non human use through several production functions. Following Indira Devi (2008) the economic value of lake water for human use was determined by employing a linear production function approach. The linear production function was estimated with volume of water used in ha.cm (WATER) as dependent variable and family size, distance of user point from lake and cost of using alternate methods or cost of using pipe water as independent variable. The estimated production function is as follows

$$\text{WATER} = \alpha + \beta_1 \text{ FSIZE} + \beta_2 \text{ DIST} + \beta_3 \text{ ALTC}$$

Where:

WATER: Quantity of water use (m^3/year)

FSIZE: Family size (numbers)

DIST: Distance of user point from lake (m)

ALTC: Cost of using alternate methods – cost of using pipe water (Rs)

On estimation of Demand function, the value is estimated by multiplying unit cost with mean consumption

2.1.3. Economic value of lake water used for irrigation (paddy)

Following Devi(2008) and Karthikeyan *et. al.* (2009) the economic value of lake water used for irrigation was also determined by employing production function approach. Here a quadratic production function was estimated with yield (kgs/ha.) as dependent variable and volume of irrigation water used in ha.cm (WATER) as independent variable. The estimated production function is as follows:

$$YIELD = \alpha + \beta_1 WATER + \beta_2 WATER^2$$

Where:

YIELD: Yield of paddy (kg/ha)

WATER: Volume of water used for irrigation in ha cm

2.2 To determine Willingness To Pay of the stakeholders for the improved conservation: Contingent Valuation Method

2.2.1 Domestic Households

Following Loomis *et. al.,* (2000), iterative bidding game was used to know the willingness to pay of the stakeholders. Respondents were asked whether he or she would pay Rs. X for the situation described. This amount varied iteratively until a maximum willingness to pay is reached.

Wording of WTP question

The specific wording of WTP stated to respondents were as follows:

"The conservation easements along the wetland for conservation, costs a great deal of money. To fund these actions a water treatment plant has been proposed by the government for good quality water. All citizens would be asked to pay an increased water bill with the assurance that fund will be used for the same. Half of the funding would be taken by the government and the other half from the people based on the population. The charges ranging from Rs. 100 to Rs. 300 were proposed until a maximum willingness to pay is reached".

The model was statistically estimated using the linear production function and the respondents were asked how much they are willingness to pay for getting good quality water for consumption until a maximum value is reached. The model used for the present study was in the following form:

$$WTP = \alpha + \beta_1 INCOME + \beta_2 FSIZ + \beta_3 DIST + \beta_4 WATER + \beta_5 EDN$$

Where:

WTP : Willingness to pay in Rs.

INCOME: Family income (Rs/yr)

FSIZ : Family size

DIST : Distance of user point from house (m)

WATER : Quantity of water used (litre)

EDN : Education (1=Primary, 2=Middle, 3=Secondary, 4=Higher secondary, 5=Graduate, 6= Post Graduate, 7= others)

2.2.2. Coir Processing Industries

Following Devi(2008), a linear production was employed for analyzing the economic value of lake water used for non human uses here, coir retiing So, iterative bidding game was used to know whether he or she would pay Rs. X for the situation described. The amount was varied iteratively until a maximum willingness to pay was reached so that coconut farmers can pay.

Wording of WTP question

> *"There is a dire need to reduce the pollution load in the lake due to coconut husk retting so minimization of the water pollution by following the chemical treatment method has been proposed. The charges ranging from Rs. 150 to Rs. 350 were planned depending on their expense on coir retting until a maximum willingness to pay is reached".*

The statistical model used for the study was:

$$WTP = \alpha + \beta_1 \text{ INCOME} + \beta_2 \text{ DIST} + \beta_3 \text{ WATER} + \beta_4 \text{ EDN}$$

Where:

WTP: willingness to pay in Rs.

INCOME: Family income (Rs/yr)

FSDIST: Distance of user point from house (m)

WATER: Quantity of water used (litre)

EDN: Education (1=Primary, 2=Middle, 3=Secondary, 4=Higher secondary, 5=Graduate, 6= Post Graduate, 7= others)

2.2.3 Tourists

Following Bateman (1993), Sukanya (2013) and Rao and Balasubramnian (2017), Travel Cost method (TCM) was used to evaluate the recreational use value for the lake by relating demand for that lake (measured as site visits) to its price (measured as the cost of visiting the site). The demand function estimated by the TCM is an uncompensated ordinary demand curve incorporating income effects and the welfare measure obtained from it will be that of Marshallian consumer surplus. The travel cost method for valuing an environmental good was developed under the assumption that there is a weak complementary relationship between the demand for the environmental good and the private good travel. It was assumed that the individuals utility depends on the total time spent at the site, the quality of the site and the quantity of private good other than travel consumed (Rao and Balasubramanian, 2017). The time spent on the site by the individual can be represented by the number of visits.

The fundamental insight that drives this model is that if a consumer wants to use the recreational services of a site he has to visit it. The travel cost to reach the site is considered as the implicit or the surrogate price of the visit, and changes in the travel cost will cause a variation in the quantity of visits. The Individual Travel Cost Method (ITCM) was used in the present study and a 'trip-generation function' (*tgf*) was formulated with number of visits made by the individual per year as dependent variable and socio-economic variables and travel cost as independent variable. The model employed here is as follows:

$V = \alpha + \beta 1TCOST + \beta_2 \, INCOME + \beta_3 \, FSIZE + \beta_4 \, MAST + \beta_5 \, EDN$

Where:

V: Number of visits made by individual per year

TCOST: Individual total cost of visiting the site (Rs./yr)

INCOME: Income of the individual household (Rs./yr)

FSIZE: Family size

MAST: Marital Status (1=married, 0=unmarried)

EDN: Education (1=Primary, 2=Middle, 3=Secondary, 4=Higher secondary, 5=Graduate, 6= Post Graduate, 7=others)

3. Results and Discussion

3.1. General Characteristic of the households

An understanding of the household characteristics is important to stakeholder perseverance on wetland management. Table2. provides basic features of the sample respondents.

TABLE 2. GENERAL CHARACTERISTIC OF THE HOUSEHOLDS

Particulars	Respondents
Average size of the family	4.64
Number of workers per family	2.24
Average age of head of the family (years)	51.90
Average educational status	3.61
Average farming experience (years)	27.4
Average farm size (hectares)	2.60
Non-farm income(Rs lakhs/year/household)	0.45
Off-farm income (Rs lakhs/year/household)	0.32
Gross Cropped Area	2.12

Source: Primary household survey.

The size of the family and its composition decides the contribution of family labour and use of hired labour employed for various cultivation practices. The results given in the table indicated that average size of the family was nearly five. Among the sample respondents, number of workers per family was two which indicated that some of the farm households' depended on hired labourers for various operations. Age of farmers matters a lot in any analysis pertaining to the agricultural sector. It was observed that the overwhelming majority of the respondents were above the age of 50. Examining the educational level of the farmers would be useful to understand how they have perceived the wetland and do they gain any benefit from its services. Majority of the respondents had attained either primary or secondary level of education with an average primary schooling among the respondents. It is believed that experience in farming in general improves the efficiency of the farmers. The average farming experience among respondents was found to be twenty seven. The contribution from the non farm income was Rs. 0.45 lakhs/year/household and that of off farm income was 0.32 lakhs/year/household.

3.2. Ecosystem services of Vembanad Wetland Ecosystem

Vembanad Wetland Ecosystem (VWS) provides an array of services which can be categorised into provisioning, supporting, regulating and cultural services (Bhatta et al, 2016). The present study has identified the following ecosystem services provided by VWS in the study area (Table 3).

TABLE 3. ECOSYSTEM SERVICES IDENTIFIED IN THE STUDY AREA

Ecosytem services	Nature of service	Biophysical/socioeconomic indicator
Provisioning	Food and raw materials: Paddy, fish, coconut, ducks, lotus, edible plants Water for agricultural production, coir retting drinking, washing etc.	Value of output. Area irrigated, duration of water supply, quantity and value of water used in agriculture and for coir retting
Regulating	Nutrient cycling, flood control, siltation control, water regulation and recharge	Removal of nutrients by wetlands (in tonnes or per cent) Water quality in aquatic ecosystems (sediment, turbidity, phosphorous, nutrients etc.)
Supporting	Biodiversity conservation	Number of flora and fauna supported by the ecosystem
Cultural and aesthetic	Tourism, water sports	No. of visitors to the site/year Amount from tourism

Source: Primary household survey.

Vembanad wetland is the largest humid tropical wetland ecosystem of the southwest coast of India. It is a complex system of backwaters, marshes, lagoons, mangrove forests, reclaimed land and an intricate network of natural and manmade canals. Based on the rich biodiversity and socio economic importance, Vembanad lake was declared as Ramsar site, a wetland of national importance in November 2002. A large population living in the drainage basin is directly or indirectly dependant upon this wetland for their livelihood. Major livelihood activities dependant on the lake area are agriculture, fishing, tourism, inland navigation, coir retting, lime shell collection, shrimp/crab farming, sand mining and fodder collection for livestock (Bassi *et al*, 2014). So the major provisioning services identified during the survey are food and raw materials viz. paddy, fish, coconut, ducks, lotus, edible plants and water for agricultural production, coir retting and for other purposes like drinking, washing etc. Different stakeholders were identified and TEV was calculated to understand the economic value associated with the provisioning services of the wetland. The provisioning services thus identified was classified under three headings such as for coir retting, domestic purpose and for irrigation.

3.3. Economic value of lake water with special reference to provisioning services

3.3.1 Economic value of lake water used for coir retting

Coir is the major industry in VWS where most of the retting of the coconut husk to extract fibre is done by immersing coconut husks either by constructing a small area for retting or in the backwater itself (Priyadarsanaan et al, 2008; Ajit, 2008; Coir board, 2018). It was found that majority of the stakeholders in the study area constructed a small land where lake water is let in to ret the coir husk. These stakeholders were asked the area of the land set aside for coir retting. Thus the volume of water used for retting was obtained.

The estimated equation was obtained as:

Y = 4145.83 + 1.39 WATER *– 0.00005 WATER^2

(2.464) (2.752) (-0.634)

Adjusted R^2 = 0.88

*Note: Figures in parentheses indicate estimated t ratio. *: significant at 10 per cent level.*

The price of output (retted coir) is INR 26.58/kg. The quantity of water use is 6572.96 ha cm. The value of the marginal product of water (VMP) is evaluated at mean values of water use.

Marginal Value Product = Marginal Physical Product * Price of one unit of retted coir (INR/kg). The estimated values of quadratic production function were used to derive the marginal value product of water for coir retting.

MPP = 1.39 – (2* 0.00005) WATER

VMP = MPP *Py

VMP = [1.39 – (2* 0.00005) WATER] *26.58

VMP = INR 19.483

It is evident that the marginal productivity of water was worked out to INR19.483. It is lucid from the analysis that the coconut farmers have to pay an amount of INR 19.483 for retting of coir.

3.3.2. Economic value of lake water used for paddy farmers

The Vemband lake also supports a highly productive agricultural system-Kuttanad, a reclaimed portion of the lake- below sea level farming system (Indiawater portal, 2018) and recognized by FAO as Globally Important Agricultural Heritage System(GIAHS) (FAO, 2018). Paddy being the main crop, constant dewatering in the field is necessitated during the cropping due to the peculiar topography (Kuttanadu Vikasana Samithy, 2018). Water management is done with the process of letting in the lake water and draining out which is continuous throughout the cropping season for washing out the salts and regulating soil pH to the optimum for better crop growth (MSSRF, 2018). Irrigation is done usually at weekly intervals by opening the sluices in the outer bunds. So the amount of water that is let into each polder was calculated by multiplying the polder area with the height of water in the field. Hence the volume of water used for irrigation could be obtained.

The estimated equation was obtained as:

Y = 5378.18 + 13.09 WATER * - 0.04 WATER2

(15.79) (1.82) (-1.41)

Adjusted R^2 = 0.07

*Note: Figures in parentheses indicate estimated t ratio. *: significant at 10 per cent level.*

The price of output (paddy) is INR 19/kg. The quantity of water use is 74.29 ha cm. The value of the marginal product of water (VMP) is evaluated at mean values of water use.

Marginal Value Product = Marginal Physical Product * Price of one unit of paddy (INR/kg)

MPP = 13.09 - (2* 0.04) WATER

VMP = MPP *Py

VMP = [13.09 - (2* 0.04) WATER] * 19

VMP = [13.09 – 5.94] * 19

VMP = Rs 134.07

The estimated values of quadratic production function were used to derive the marginal value product of water across seasons. It is evident that the marginal productivity of water worked out to INR 134.07.

3.3.3 Economic value of lake water used for human uses

Large number of population depends directly or indirectly on this wetland for their livelihood activities like domestic consumption and for health, sanitation and clean drinking water. It was noticed from the study area that people depend solely on this wetland for their daily needs like washing, cleaning, drinking etc. (MSSRF, 2007). The respondents were asked the amount of water used for these activities and computed accordingly since they used pots of different sizes to take water from the lake.

The estimated equation was obtained as:

Y = 48.051 + 2.673 FSIZE** + 2.238 DIST*** + 0.069 ALTC*

(27.15) (2.38) (1.72) (2.76)

Adjusted R^2 = 0.88

*Note: Figures in parentheses indicate estimated t ratio. *: significant at 10 per cent level, **: significant at 5per cent level, ***: significant at 1per cent level.*

The quantity of water use is 155.17 ha cm. The value is estimated by multiplying unit cost with mean consumption.

MVP = 155* 4 MVP = INR 6510

It could be seen that the MVP of lake water used for various human uses was very high that clearly denotes the dependency of the people on wetland ecosystem. MVP also signifies the importance of Vembanad wetland on livelihood of the people in the area.

TABLE 4. TOTAL ECONOMIC VALUE OF LAKE WATER

Sl.No.	Particulars	TEV of lake water (Rs.)
1	Coir Processing Industries	2.90
2	Paddy farmers	134.07
3	Domestic Households	6510
	Total	6647.97

Source: Primary household survey.

It could be interpreted that the economic value of the wetland is very high amounting to approximately Rs. 6648 which clearly indicate the significance of the wetland and the dependence of various stakeholders for their livelihood. The beauty and bounty of this ecosystem should be preserved by creating an economic stake in its conservation through various policy interventions.

3.4. Willingness to pay for the improved conservation by different stakeholders

The Willingness To Pay is the amount of money that a consumer is willing to make in order to consume a particular unit of a commodity. In the present study, it is used to identify the amount of money that the urban stakeholders are willing to pay to conserve wetland and thereby to estimate TEV. It was observed from the study that almost all of the households are interested in the improved conservation of the wetland. Majority of the livelihood strategies were directly linked to the ecosystem services provided by the Vembanad wetlands.

Loomis *et al.,* (2000), Sumana(2004) and Binilkumar (2009) estimated farmers' Willingness To Pay for wetland conservation using contingent valuation method. These studies have tried to find out the determinants of the WTP of the farmers with an Ordinary Least Square (OLS) regression analysis of WTP with the socio-economic variables and reported causal relationship between socioeconomic characteristics of the stakeholders and WTP. In line with the above literature, the causal relationship between the socio-economic variables and WTP. WTP was examined with an OLS regression model.

1) Domestic households

It was observed that income, family size and amount of water usage were observed to have positive significant influence on WTP.

TABLE 5. ESTIMATION OF WILLING TO PAY FOR IMPROVED CONSERVATION

Variables	Coefficient
Constant	296.62 (4.18)
INCOME	0.0006*** (8.11)
FSIZE	2.39** (2.48)
DIST	0.065 (0.02)
WATER	1.36*** (3.37)
EDN	5.23 (1.19)

Source: Primary household survey.

Note: Figures in parentheses indicate estimated t ratio. *: significant at 10 per cent level, **: significant at 5per cent level, ***: significant at 1per cent level.

It could be observed that households with higher income are ready to pay for good quality water. Households with larger family size require more amount of water so they are ready to pay for the management of lake water.

2) Coir processing industries

The variables family income, distance from the lake and quantity of water used were found to have positive and significant influence on the improved conservation of the lake. As the family income increases the coconut famers are interested to pay for the chemical treatment method.

TABLE 6. ESTIMATION OF WILLINGNESS TO PAY FOR IMPROVED

Variables	Coefficient
Constant	296.62 (4.18)
INCOME Oiuytr1f	2.247** QcA
DIST	0.938** (1.71)
WATER	2.69*** (3.37)
EDN	5.23 (1.19)

Source: Primary household survey.

Note: Figures in parentheses indicate estimated t ratio. *: significant at 10 per cent level, **: significant at 5per cent level, ***: significant at 1per cent level.

It is evident that distance and quantity of water use have a significant influence on conservation. It is implicit that coconut farmers who are nearer to the lake find it easy to ret the coir due to the availability of water. So the value they attach to the lake is higher.

3) Tourists

Vembanad wetlands and the backwaters are the major tourist destination from people across the world. Maximum tourist inflow is during December to March ever year. Almost 80 per cent of the tourist are domestic while United Kingdom, Germany and France are the major countries from which foreign tourists arrive. The amount of tourist visit is also higher during the August month during which the famous Nehru Trophy Boat race is held at the Punnamada lake of Alleppey. (Rao and Balasubramanian. 2017). Besides, the major attraction of Vembanad is boating in backwaters and the experience of houseboat stays. The foreign tourists in particular are also interested in farm stays in villages.

The tourists or the general public are those stakeholders who reside away from the wetlands and visit the place for the different services. They have no direct dependence on the wetland ecosystem. The occupational activities of this stakeholder group are diverse and it may or may not be dependent on the wetlands. This group represents the society in general and incudes various Government and private employees along with the students, scientists, businessmen etc.

Recreation benefits of Vemband wetlands were estimated using the Travel cost model. The trip generating function was expressed using number of visits per year as dependent variable. The independent variables were socio-economic variables and travel cost to the site. The signs of the coefficients were in consistence with the economic theory. The independent variables that significantly affect the trip generating function are travel cost, family size and income.

TABLE 7. ESTIMATION OF WILLINGNESS TO PAY FOR IMPROVED CONSERVATION BY TOURISTS

Variables	Coefficient
Constant	-0.205 (-0.204)
TCOST	0.032*** (1.85)
INCOME	0.00005*** (1.85)
FSIZE	482.65* (2.57)
MAST	0.02 (0.13)
EDN	0.06 (0.13)

Source: Primary household survey.

Note: Figures in parentheses indicate estimated t ratio.*: significant at 10 per cent level,**:significant. at 5per cent level, ***: significant at 1per cent level.

It is observed that income of tourist exerted significant positive influence on the visiting rate to the lake. It could be inferred that tourists with high income visit the site because of the backwaters and the peculiar house boating tourism in the area. Further, tourists in a group or as a family visit the site for the recreational purpose. The result are in congruence with study of Vijayan and Job (2015), Rao and Balasubramanian (2017) and Binilkumar and Ramanathan (2009). The results also highlight the importance of international and national tourist visiting the area as the travel cost that they incur is more. Hence irrespective of the high travel cost tourist visit the lake and enjoy the beauty.

4. Summary and Conclusion

The study revealed that the total economic value of lake is Rs. 6647.97. This shows that conservation measures have to be taken up so that good water is available for consumption and other activities in the household and for the coir retting. Willingness to pay by different stakeholders for the improved conservation of the lake indicates that they are ready to pay at any cost. Distance from the lake is another factor, as evidenced by the positive value of the coefficient in the case of two stakeholder groups. Income and family size exerted significant positive influence on WTP by coconut farmers and tourists. Contingent valuation studies shows that mean WTP is sufficient to pay for the conservation measures on wetland. The monetary value attached to the wetland ecosystem signifies the economic importance and conservation efforts like waste, water treatment plants to be taken up. Travel cost method indicates that people are willing to visit the site at the expense of their travel cost; hence activities of Institutional mechanism like tourism promotion council should be enhanced.

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Economics in the anthropocene: species extinction or steady state economics*

Joeri Sol**

At the dawn of the Anthropocene, continued economic growth carries the risk of irreversibly damaging the global carrying capacity. Using the International Union for the Conservation of Nature Red List of Threatened Species (2016), I calculate expected extinction rates during the coming century for 557 regions. I illustrate that these rates exceed the planetary boundary formulated by Rockström et al. (2009) virtually everywhere and increase with population density and GDP per capita. By doing so, this paper contributes to an ongoing debate whether absolute or relative scarcity is more relevant to economic thought. My findings suggest that the conservation of nature requires degrowth and the transition to a global steady state economy.

> *"I cannot, therefore, regard the stationary state of capital and wealth with the unaffected aversion so generally manifested towards it by political economists of the old school. I am inclined to believe that it would be, on the whole, a very considerable improvement on our present condition."*
>
> *John S. Mill (1848, Book 4, Chapter 6.*

* This chapter is an earlier version of Sol (2019).

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Introduction

The Anthropocene refers to the geological epoch during which mankind has obtained an influence over global natural processes (Crutzen, 2002). Although the Anthropocene has yet to be formalized by the International Union of Geological Sciences, Waters *et al.,* (2016) argue that humanity's stratigraphic signature is already sufficiently distinct to recognize this geological epoch by reviewing evidence on the growth of new materials (e.g. concrete and plastics) and the transformation of land and ocean surface by mineral extraction and trawler fishing. Wackernagel *et al.,* (2002) estimated that consumption rose from using 70% of Earth's regenerative capacity in 1961 to 120% in 1999, and according to WWF (2016), it currently takes 1.6 Earths to provide for the renewable resources that we lay claim on.

Inspired by the (pending) arrival of the Anthropocene, Rockström et al. (2009) formulate planetary boundaries for economic activity and assign parameter values to eight such ecological limits. Currently, we surpass three safe thresholds: climate change, biodiversity loss, and our influence over the nitrogen cycle. According to Steffen *et al.,* (2015), who propose to add a zone of uncertainty, the latter two boundaries are transgressed beyond doubt. Naturally, the idea that economic growth can only be a transitory stage is not new to economics (Malthus, 1798; Mill, 1848; Boulding, 1966; Georgescu-Roegen, 1971; Meadows *et al.,* 1972). Daly (1974) already reasoned for the desirability and necessity of steady state economics based on common sense and the second law of thermodynamics. The accumulated evidence that continued economic growth could seriously harm global carrying capacity makes a paradigm shift to steady state economics urgent as well.[1]

This paper concentrates on biodiversity loss. Reductions in biodiversity impair global carrying capacity through reduced ecosystem efficiency and resilience, increased risks of infectious diseases, and for many, lower immaterial value.[2] Background extinction due to natural selection is thought to lie between 0.1 and 1 extinctions per million species years (E/MSY), and more likely to be close to 0.1 (Pimm *et al.,* 2014). Rockström *et al.,* (2009) set the planetary boundary for biodiversity loss at 10 E/MSY and Steffen *et al.,* (2015) add a zone of uncertainty up to 100 E/MSY. The current extinction rate is estimated to lie between 100 and 1000 E/MSY (Pimm *et al.,* 1995; Pimm et al., 2014). Using International Union for the Conservation of Nature (IUCN) Red List of Threatened Species data (2016), and conservative assumptions spelled out in Section 2, I calculate a global expected extinction rate of 759 E/MSY for the coming century.

1 This paper follows Daly (2013)'s recommendation to distinguish between economic growth and economic development. A steady state economy does not allow for quantitative growth of physical wealth, but does leave room for development, i.e., qualitative improvements in the amount of service obtained from this wealth. Steady state economics should not be confused with the steady state growth paths studied by Solow (1956), unless economic growth in Solow (1956) is interpreted exclusively in terms of development.

2 See, for example, Cardinale et al. (2012, p. 60-61) on ecosystem efficiency: "… as a general rule, reductions in the number of genes, species and functional groups of organisms reduce the efficiency by which whole communities capture biologically essential resources (nutrients, water, light, prey), and convert those resources into biomass." Rockström et al. (2009, p. 474) on ecosystem stability: "Ecosystems that depend on a few or single species for critical functions are vulnerable to disturbances, such as disease, and at a greater risk of tipping into undesired states." And, Keesing et al. (2010, p. 647) on infectious disease: "… in recent years, a consistent picture has emerged—biodiversity loss tends to increase pathogen transmission and disease incidence." Immaterial value is also referred to as intrinsic value or existence value. Finally, see Chapin et al. (2000) and Costanza et al. (1997) for examples of the importance of biodiversity for ecosystem services and the valuation of these services, respectively.

This paper contributes by exploring regional variation in expected biodiversity loss across 557 regions, covering about 99% of the global surface. Although I find large variation in regional expected extinction rates, my findings suggest biodiversity loss is a concern nearly everywhere: only 17 regions stay below the proposed planetary boundary for biodiversity loss and 192 regions have expected extinction rates that can be considered within the zone of uncertainty. The lowest expected extinction rates are found in sparsely populated regions in the Northern hemisphere, while the highest rates are in tropical regions and on islands.

Subsequently, I regress expected extinction rates on both human population density and GDP per capita while controlling for the land surface of the region, for the regions being islands, landlocked, or mega cities, for 11 (sub)continental dummies, and for 3 weather type dummies (that is, deserts, semi-arid and tropical regions). Both population density and GDP per capita show a significant positive association with expected species extinction. Although these partial correlations do not allow for causal inference of an effect of human activity on species extinction, my findings are consistent with the interpretation that economic growth beyond planetary boundaries damages global carrying capacity and that absolute scarcity rather than relative scarcity should be the starting point for economic thought on the conservation of nature.[3]

This chapter proceeds as follows: Section 1 describes the data, Section 2 contains the analysis, Section 3 presents a discussion of the results and Section 4 concludes.

1. Data

The IUCN Red List of Threatened Species contains assessments of extinction threat levels for both plant and animal species based on population size, habitat range, and estimated extinction risk. This paper uses the 2016-2 version that contains 82,954 assessments, categorized as either least concern (39,053), data deficient (13,489), vulnerable (11,219), endangered (7,602), near threatened (5,323), critically endangered (5,107), extinct (855), lower risk/conservation dependent (238), or extinct in the wild (68). Most of the assessments are carried out by the IUCN Species Survival Commission, and all assessment are reviewed by a member from the Red List Authority on the relevant taxonomic group. Close to 70 percent of species has been (re)assessed after 2010.

To construct my dependent variable, *Extinction rate*, I assume that the elevated extinction risk criterion – which is one out of five sufficiency criteria for the assessment categories vulnerable, endangered and critically endangered – is a valid estimate for the extinction risk of each assessment within the category.[4] For critically endangered species, the extinction risk criterion specifies a probability of extinction of at least 50% during the coming 10 years, and for endangered and vulnerable species 20% and 10% within 20 and 100 years, respectively (IUCN, 2012). I use these probabilities to calculate the number of expect extinctions during

3 See Baumgärtner et al (2006) for a review of both scarcity concepts in relation to biodiversity loss.

4 On the hand, one can argue that this assumption leads underestimation of the extinction rate, as it is a sufficiency criterion. On the other hand, it is only one out of five sufficiency criteria, allowing for overestimation of the extinction rate. Other sufficiency conditions specify population size, changes to population size and habitat ranges; for example, a "population size estimated to number fewer than 50 mature individuals" gives the assessment critically endangered (IUCN 2012, p.9). See IUCN (2012) for the complete description of the sufficiency criteria. Section 4 also addresses the practice of turning assessment categories into extinction probabilities and some robustness checks.

the coming century and add the expected background extinctions by multiplying the number of non-extinct non-data deficient species with the upper bound estimate for background extinction from Rockström et al. (2009) of 1 E/MSY.[5] Finally, I express this estimate for expected extinctions relative to the background extinctions. Under these assumptions, *Extinction rate* ranges from 1 (i.e., no species has an elevated extinction risk) to 5001 (i.e., all species are critically endangered). Globally, the expected extinction rate is 759 times the background extinction rate, or slightly over 15% of its theoretical maximum.[6] The proposed planetary boundary is 10 times background extinction, and the zone of uncertainty ends at 100 times the background rate.

To calculate the regional estimates, I only consider the assessments of species that were labelled as once native to the region. Although I refer to regional estimates, I base my estimates on global extinction risk; for example, the Giant Panda which is assessed as vulnerable and regionally extinct in Hunan, contributes to the extinction rate of Hunan, because it is labelled as once native to the region.[7] Figure 1 presents the geographical distribution of *Extinction rate* for 538 terrestrial regions and 19 oceanic regions, covering about 99% of global surface.

Figure 1 depicts regions that stay below the planetary boundary for biodiversity loss in a dark green color (17 regions, representing 2.6 percent of assessed land surface) and those that stay within in the zone of uncertainty in light green and yellow (192 regions, making up 46.2 percent of assessed land surface).[8] Due to the positive skew in the regional estimates, illustrated in Figure 2, I chose different bin sizes for the colors used in Figure 1; apart from the consideration that the extinction rates should be comparable within color category and the intention to illustrate the variation in extinction rates, the other cut-off levels are arbitrary. In the regression analysis, I use *Ln Extinction rate* as my dependent variable due to the earlier mentioned skew.

5 I further assume that (critically) endangered species that managed to survive (ten) twenty years will continue to do so for the remainder of the century. Assuming that (critically) endangered species that survive (ten) twenty years face an unchanged extinction risk, would more than double the global extinction rate estimate. This alternative assumption also implies that less than one in thousand critically endangered species can be expected to survive the century.

6 This estimate of 759 consists of the expected extinctions due to heightened extinction risk (5,195.8=0.5*5,107+0.2*7,602+0.1*11,219) plus background extinctions (6.852 = 1*(82,954 – 855 – 86 – 13,489)* 100/1,000,000) relative to the background extinctions. Using the lower bound for background extinction gives an expected rate of 7,584 times the background rate and planetary boundary of 100 times the background rate. In the remainder of the paper, I discuss the estimates relative to the upper bound.

7 Cardillo et al. (2005) find little relation between human population density and the extinction risk of large mammal species and suggest that the most vulnerable species have already disappeared from populous regions; calculating extinction rates over species that were once native to the region preempts this.

8 In case I was unable to determine whether an area was assessed, or uncertain about the area to which an IUCN location label referred, I left the area blank. Note that, all oceanic regions exceed the planetary boundary for biodiversity loss beyond doubt. These 19 FAO marine regions are not included in the analysis and left undiscussed except for footnote 11 and Appendix B.

FIGURE 1. GEOGRAPHICAL DISTRIBUTION OF EXTINCTION RATE

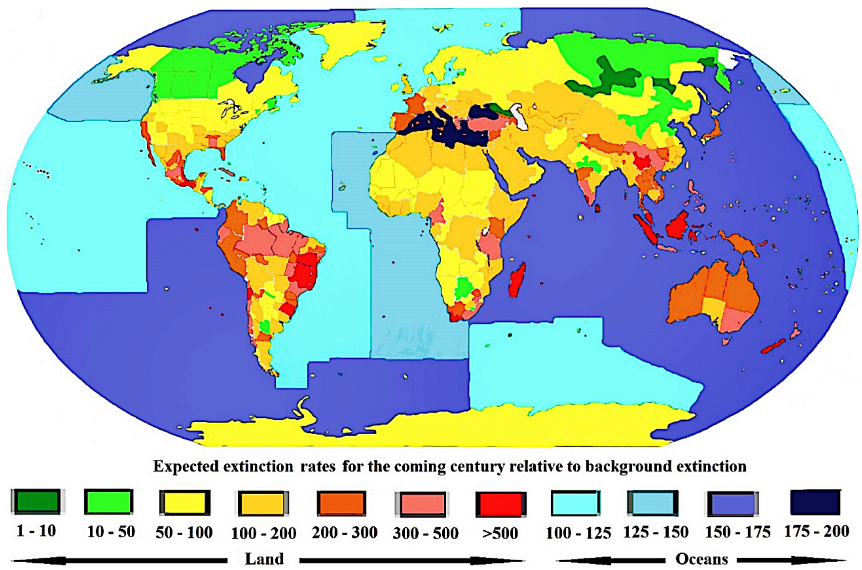

FIGURE 2: DISTRIBUTION OF EXTINCTION RATE BY REGION TYPE

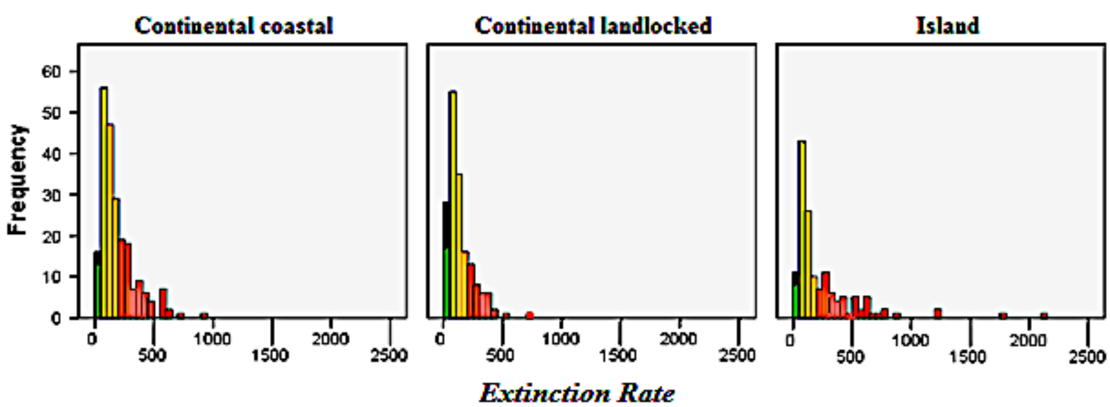

Table 1 presents the number of observations, mean, and standard deviation for Extinction rate along with *Population density*, *GDP per capita*, *Land surface*, *Species assessed*, D*ata deficient species*, and their correlations. For population density, GDP per capita and land surface, I used 2015 estimates from the World Bank for most countries, complemented with regional estimates from various sources.[9] These variables exhibit a large positive skew as well, hence I use their logged values in the regression analysis. The number of observations drops to 508, due to the

9 The additional sources include data from the United Nations, the CIA World Factbook, Eurostat and various national statistics agencies; that is, for Argentina (23 regions), Australia (8 regions), Brazil (27 regions), Canada (13 regions), Chile (12 regions), China (31 regions), India (31 regions), Indonesia (7 regions), Japan (5 regions), Mexico (32 regions), Russia (21 regions), South Africa (9 regions), and the United States (50 regions). In the regression analysis, I cluster standard errors on the (sub-) continental and national level to address possible differences in measurement between these agencies. Appendix A provides more detail on the omitted regions and additional sources.

omission of uninhabited regions and regions for which I did not find information on GDP per capita.

TABLE 1: DESCRIPTIVE STATISTICS AND CORRELATIONS

	N	Mean	SD	(2)	(3)	(4)	(5)	(6)
(1) Extinction rate	508	191.7	200.8	-.02	-.10**	-.09**	.01	.14***
(2) Population density	508	270.4	1178.3		.20***	-.10**	-.04	-.02
(3) GDP per capita	508	20.7	19.5			.03	-.11**	-.13***
(4) Land surface	508	256.4	466.4				.20***	.19***
(5) Species assessed	508	876.2	969.9					.90***
(6) Data deficient species	508	60.1	86.9					

***, **, * indicate correlations significantly different from zero at the 1%, 5%, and 10%.
(1) in expected extinctions per background extinctions, (2) in inhabitant per square kilometer, (3) in 1,000 2011 PPP international dollars, (4) in 1,000 square kilometers, (5) and (6) in number of species.

The difference between the regional mean (192) and global extinction rate (759) may be surprising at first, however this difference is expected when (critically) endangered species have smaller habitats; in other words, species without an elevated extinction risk occur in several regional estimates, but only once in the global estimate. For this reason, all regressions control for land surface. Inspection of Figure 1 and 2 reveals that part of the variation may be attributed to regions being coastal, landlocked or islands, where landlocked regions have lower extinction rates and islands have higher rates. Similarly, Figure 1 shows notable (sub) continental variation, possibly related to the type of ecosystems. In the regression analysis, I add 17 dummies to control for the regions' type, location and weather.[10]

10 In the regression analysis I introduce 11 (sub)continental dummy variables for *Caribbean* (28 regions), *East Asia* (42 regions), *Europe* (45 regions), *Mesoamerica* (39 regions), *North Africa* (7 regions), *North America* (64 regions), *North Asia* (26 regions), *Oceania* (38 regions), *South and Southeast Asia* (55 regions), *Sub Saharan Africa* (61 regions), *West and Central Asia* (27 regions), where the 76 regions in South America serve as the base category. I followed IUCN's division of (sub)continental areas, except for the Canary Islands and Madeira (relabeled as North African regions instead of European) and Hawaii (relabeled to belong to Oceania instead of North America). I add two dummy variables landlocked (172 regions) and island (117 regions), where the 219 coastal regions serve as the base category. I add a dummy for city states (11 regions); the results are robust to the exclusion of these regions (and even slightly more pronounced). Finally, I created three dummies based on average annual precipitation in region's capital: that is, deserts (35 regions, < 250 mm), semi-arid (65 regions, 250 mm to 500 mm) and tropical (30 regions, > 2500mm). The weather information was obtained through Wikipedia pages that link to several meteorological websites, and due to possible lower reliability, added separately in the regression analysis. The results in Table 2 are robust to the exclusion of these weather dummies, although *Ln GDP per cap* is only significant at the 10% level after the clustering of standard errors in (3).

2. Analysis

I regress the logged values of *Extinction rate* on the logged values *of Population density* and *GDP per capita* using Ordinary Least Squares, giving the following regression equation:

$$Ln\ Extinction\ rate_i = \beta_0 + \beta_1 Ln\ Population\ density_i + \beta_2 Ln\ GDP\ per\ capita_i + \sum_{j=3}^{19} \beta_j\ Control_{ji} + \varepsilon_i, \quad (1)$$

Where i refers to the region and j to the earlier discussed controls. Under the null hypothesis, supposing that absolute scarcity is irrelevant, one may expect $\beta_1 \leq 0$ and β_2//≤ 0; that is, regional population density and GDP per capita are either unrelated to extinction rates or negatively related (e.g. when more prosperous regions have more means for conservation or outsource their polluting activities).[11] The alternative hypothesis, $\beta1 > 0$ and $\beta2 > 0$, is consistent with absolute scarcity being relevant; more densely populated regions and regions with more economic activity are associated with higher extinction rates. Table 2 presents the estimates of equation (1) using the region type controls in column (1) and with weather type controls added in column (2). In column (3), I cluster standard errors on the (sub)continental and national level, as detailed in footnote 9.

Table 2 shows that both population density and GDP per capita are positively associated with extinction rates, and statistically significant at the 1 percent level (also jointly, as illustrated by the F-statistics). Column (1) of Table 2 shows that a doubling of population density and a doubling of GDP per capita are associated with an increase in the extinction rate of a little over 13 percent and close to 15 percent, respectively. Controlling for the weather type of the region in column (2) hardly changes the estimated coefficient of population density and increases the estimate for GDP per capita to 17 percent per doubling. Clustering the standard errors on 24 (sub)continental and national clusters in column (3) reduces the significance for GDP per capita slightly (*p-value* = 0.031). To put these estimates in perspective, a 15 percent higher extinction rate would give 785 additional expected extinctions during the coming century, almost equal to the number of recorded extinctions during the past millennium.[12]

Although partial correlations do not allow for causal inference of an effect of human activity on species extinction, it is difficult to think of other explanations.[13] One such alternative explanation could be that the assessment process rather than absolute scarcity explains the earlier shown relations. If endangered species are more difficult to assess for researchers in more sparsely populated regions or researchers in richer regions have more means to make such assessments, extinction rates may vary with assessment effort.While there does seem to

11 The (sub)continental controls partially address this issue; that is, the coefficients for population density and GDP per capita are estimated on within (sub)continental variation of extinction rates, so possible differences due to international trade between the global North and South would be captured by these (sub)continental controls. Appendix B presents a scatterplot of *Ln Extinction rate* and *Ln Population density* for (sub)continental and FAO marine regions suggesting that a positive relation may also present at the (sub)continental and oceanic level, but not for Ln GDP per capita. Note that, even though I specified one-tailed hypotheses, the p-values throughout the paper refer to two-tailed tests.

12 The global extinction rate would be raised from 759 to 873, or 114 times the background extinction of 6.9 species, and some of the 855 extinctions date back from the 11th century (e.g., the Madagascan Dwarf Hippopotamus). If anything, I expect my estimates to suffer from a downward attenuation bias due to regional spillovers.

13 Dirzo et al. (2014) uses an earlier version of the IUCN Red List to illustrate that the body mass of extinct fauna is larger than that of threatened fauna, which in turn is much larger than non-threatened fauna; a pattern consistent with a human influence.

be some merit to this alternative explanation, controlling for the number of species assessed and the number of data deficient species does not change the results qualitatively.[14]

TABLE 2: OLS REGRESSIONS OF LN EXTINCTION RATE ON LN

	(1)	(2)	(3)	(4)
Ln Population density	.132*** (.027) [.218]	.134*** (.028) [.223]	.134*** (.039)	.114*** (.029) [.189]
Ln GDP per capita	.148*** (.049) [.140]	.172*** (.050) [.163]	.172** (.075)	.171*** (.049) [.162]
Ln Species assessed				-.213*** (.074) [-.229]
Ln Data deficient species				.295*** (.067) [.356]
Region type controls included	YES	YES	YES	YES
Weather controls included	NO	YES	YES	YES
Standard errors clustered (n=24)	NO	NO	YES	NO
N	508	508	508	508
R^2	.532	.537	.537	.556
F-statistica[a]	15.00***	15.70***	15.70***	13.41***

***, **, * indicate coefficients significantly different from zero at the 1%, 5%, and 10%, standard errors are shown in parentheses and standardized coefficients in brackets.

a. Comparison to a model that contains only the control variables, reported in Appendix C.

3. Discussion

Although the practice of turning assessment categories into extinction probabilities is not undebated (e.g. rankings that combine assessment categories are sensitive to the chosen weights), Mooers et al. (2009, p. 3700) describe that: "The Red List is *currently the only basis we know of for consistent, broadly-available estimates of extinction risk, and indeed was originally formulated to be consistent with (at least) notional probabilities of extinction*."[15] Likewise, the partial

14 Appendix C show that some of the control variables change more dramatically upon the inclusion of the number of species assessed and the number of data deficient species; e.g., the landlocked dummy is no longer significantly related to extinction rates, while the South and Southeast Asia dummy turns significant. The clustering of standard errors in (4) gives p-values of .025 and .043 for *Ln Population density* and *Ln GDP per capita*, respectively, while *Ln Species assessed and Ln Data deficient* are not robust to clustering with p-values of .384 and .092.

15 On top, *Extinction* rate is sensitive to the chosen timespan. For example, calculating the extinction rate for the coming two decades based on critically endangered species and endangered species only (while leaving other assumptions spelled out in Section 2 unchanged), raises the theoretical maximum *Extinction rate* to 25,001. Appendix D illustrates that *Extinction rate* can mask rather different underlying distributions of assessment categories, especially for small samples, using only species that are endemic to Mexican states. Using an alternative method, based on simulations of species abundance and habitat size relations, Pimm and Raven (2000) estimate extinction rates ranging between 3,000 E/MSY to almost 50,000 E/MSY for the

correlations that I present are meant to demonstrate limits to growth rather than present precise point estimates of how population density and GDP per capita contribute to species extinction. That said, the results are robust to using the assessment categories as dependent variables: replacing Extinction rate in column (4) of Table 2 with the percentage of critically endangered species, the percentage of critically endangered and endangered species, or the percentage of (critically) endangered and vulnerable species gives standardized coefficients of roughly the same size.[16] Moreover, *Extinction rate* is related closely to the Red List Index used in Hoffman et al. (2010) and Rodriguez *et al.,* (2014), with the advantage of facilitating interpretation in terms of the planetary boundary concept.[17]

While I do consider the regional variation in *Extinction rate* that I illustrate in this paper informative, I caution the reader to base conservation priorities solely on these rates. In terms of the library metaphor in Weitzman (1998)'s Noah's Ark problem, the expected extinction rates could be considered the state of a library, but not the number of books in the library (i.e., species richness) nor their distinctiveness (i.e., species' isolation on a phylogenetic tree).[18]For maps of species richness and genetic diversity, see Grenyer *et al.,* (2006) and Miraldo *et al.,* (2014), respectively, and Rodriguez *et al.,* (2014) presents maps for changes in the Red List Index and dominant threats to endangered species.[19]

So far, this paper has ignored the information on the type of threats provided with the IUCN assessments. Some of the main threats (biological resource use, agri- and aquaculture, and residential and commercial development) could be remedied against by protecting sufficiently large habitats. Unfortunately, most nations still fail to meet the 2020 Aichi Biodiversity Targets for legally protected areas, set at 17 and 10 percent of land surface and territorial waters, respectively (CBD, 2010).[20] Moreover, protected areas are biased towards locations where they prevent little land conversion (Joppa and Pfaff, 2009) and are often undervalued (Watson *et al.,* 2014). However, it is unlikely that economic growth will help to close the gaps in conservation budgets; that is, I find little evidence in favor of an Environmental Kuznets Curve for expected extinction rates.[21] More emphatically, the estimated shortfall of the global conservation budget

coming century.

16 For *Population density*, the standardized coefficients (and p-values) are .158 (.014), .267 (<.001), and .213 (<.001), respectively, while for *GDP per capita* I find .209 (.001), .222 (<.001), and .127 (.021). Using Tobit regressions instead of OLS, raises the estimated coefficients a little and reduces the p-values; the results are available upon request.

17 The Red List Index (RLI), as defined in Butchart et al. (2007), ranges from zero to one, where zero refers to all species being extinct and one to all species being categorized as least concern. My Extinction rate measure can be translated into the RLI without the extinct categories: If, instead, we define RLIx only over extant species and refer to zero as all species being critically endangered, then RLIx = (5001 – *Extinction rate*) / 5000.

18 Weitzman (1998) models a policymaker (Noah) that maximizes biodiversity subject to a limited conservation budget (the Ark). Recent extensions to this seminal model illustrate that introducing species interactions (Courtois et al., 2014) or allowing for uncertainty about future states of the world (Perry and Shankar, 2017) changes the distribution of the conservation budget; e.g. towards prey instead of predators or towards keystone species, respectively. In a different approach, Conrad (2018) applies real option theory to determine at what population size policymakers should initiate conservation measures.

19 To be more precise, Grenyer et al. (2006) maps the species richness of vertebrates, see Joppa et al. (2013) for endemic plants. Hoffman et al. (2010) find that on average 52 species per year move one Red List category closer to extinction and estimate that this trend would have been at least 20 percent worse without conservation efforts.

20 Data from the World Bank shows that 95 out of 213 countries met the target for protection on land in 2017, and 43 out of 176 countries did so for marine areas.

21 While adding Ln GDP per capita squared does give a negative coefficient (p-value .078), the predicted turning point is at

seems rather modest: McCarthy *et al.*, (2012: 4) find that: "*the total required is less than 20% of annual global consumer spending on soft drinks*."

4. Conclusion

The analysis of IUCN Red List assessments presented in this paper reveals that expected biodiversity loss is surpassing safe thresholds virtually everywhere and that species extinction is increasing with population density and GDP per capita. This association between the rate of species extinction and human activity is unlikely to be the result of the assessment process, suggesting that the conservation of nature would benefit from degrowth or the transition to a steady state economy.

Serious action to preserve biodiversity, considered a moral obligation by many, requires institutional changes that go beyond the establishment of protected areas: for example, climate change is closely related to species extinction (Pounds *et al.,* 2006; Frieler *et al.,* 2013), putting constraints on the collective consumption of fossil fuels (McGlade and Ekins, 2015). Victor (2008) explores policy mixes that enable the transition to a steady state economy and presents simulations of such a transition for Canada, showing that it allows for lower greenhouse gas emissions, less poverty, more leisure and fiscal balance. In short, economic policy in the Anthropocene should aim to improve carrying capacity rather than zealously chase economic growth.

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the 95th percentile of highest income and I find no evidence for the downward-sloping part of the EKC: adding *Ln GDP per capita interacted* with dummies for the top quartile, decile or top 5 percent of GDP per capita gives insignificant results. Moreover, Mills and Waite (2009) show that initial evidence of an EKC for deforestation can be spurious when addressing issues of heteroskedasticity and autocorrelation.

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Appendix A

Extended data description: omitted regions

The 30 regions that are excluded from the analysis are: 1. Amsterdam and Saint-Paul Islands (59.8), 2. Antarctica (85.2), 3. Antipodean Islands (72.4), 4. Ascension Island (168.3), 5. Bouvet Island (96.2), 6. Clipperton Island (89.0), 7. Cocos Island (188.5), 8. Cocos Keeling Islands (61.2), 9. Crozet Islands (1), 10. Guadalupe Island (445.6), 11. Heard Island and McDonald Islands (237.1), 12. Johnston Atoll (36.9), 13. Kazan-retto (455.6), 14. Kerguelen Islands (38.0), 15. Kermadec Islands (117.3) 16. Macquarie Island (236.3), 17. Marcus Island (106.3), 18. Marion and Prince-Edward Islands (29.6), 19. Norfolk Island (114.6), 20. North Solomon Islands (256.6), 21. Paracel Islands (21.4), 22. Revillagigedo Islands (334.3), 23. Saba (134.8), 24. Saint Helena (665.2), 25. Savage Islands (32.1), 26. Sint Eustatius (137.2), 27. South Georgia and the South Sandwich Islands (98.2), 28. Tristan da Cunha (266.3), 29. Wake Islands (37.4), 30. Western Sahara (82.3), with *Extinction* rate in parentheses. These regions represent nearly 10% of the assessed land surface, mostly due to the Antarctica, and have a slightly lower average *Extinction* rate (mean 156.8).

Extended data description: additional sources and robustness checks

I used the World Bank (data.worldbank.org) 2015 data on population density for the 191 regions listed below, and for 168 of these regions (unless indicated otherwise in parentheses), I also used the 2015 data on GDP per capita: Afghanistan, Albania, Algeria, American Samoa (CIA 2016 GDP), Andorra (UN 2017 GDP per capita), Angola, Antigua and Barbuda, Armenia, Aruba (World Bank 2011 GDP), Austria, Azerbaijan, The Bahamas, Bahrain, Bangladesh, Barbados, Belarus, Belgium, Belize, Benin, Bermuda (World Bank 2013 GDP), Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, British Virgin Islands (UN 2017 GDP), Brunei Darussalam, Bulgaria, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Cayman Islands (World Bank 2011 GDP), Central African Republic, Chad, Colombia, Comoros, Dem. Rep. Congo, Rep. Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba (UN 2017 GDP), Curacao (UN 2017 GDP), Czech Republic, Denmark, Djibouti(World Bank 2011 GDP), Dominica, Dominican Republic, Ecuador, Arab Rep. Egypt, El Salvador, Equatorial Guinea, Eritrea (World Bank 2011 GDP), Estonia, Ethiopia, Faroe Islands (CIA 2014 GDP), Fiji, Finland, France, Gabon, The Gambia, Georgia, Germany, Ghana, Greece, Greenland (UN 2017 GDP), Grenada, Guam (CIA 2015 GDP), Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, Islamic Rep. Iran, Iraq, Ireland, Israel, Italy, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Dem. People's Rep. Korea (UN 2017 GDP), Rep. Korea, Kuwait, Kyrgyz Republic, Lao PDR, Latvia, Lebanon, Lesotho, Liberia, Libya, Lithuania, Luxembourg, Macao, Macedonia FYR, Madagascar, Malawi, Maldives, Mali, Malta, Marshall Islands, Mauritania, Mauritius, Micronesia Fed. States., Moldova, Mongolia, Montenegro, Morocco, Mozambique, Myanmar, Namibia, Nauru, Nepal, Netherlands, New Caledonia (UN 2017 GDP), Nicaragua, Niger, Nigeria, Northern Mariana Islands (CIA 2016 GDP), Norway, Oman, Pakistan, Palau, Panama, Papua New Guinea, Paraguay, Peninsular Malaysia, Peru, Philippines, Poland, Portugal, Puerto Rico, Qatar, Romania, Rwanda, Samoa, Saudi Arabia, Senegal, Serbia, Seychelles, Sierra Leone, Singapore, Sint Maarten (World Bank 2011 GDP), Slovak Republic, Slovenia, Solomon Islands, Somalia (UN 2017 GDP), Spain, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Martin (CIA 2005 GDP), St. Vincent and the Grenadines, Sudan, Suriname, Sweden, Switzerland, Syrian Arab Republic (UN 2017 GDP), Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Tonga, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Turks and Caicos (UN 2017 GDP), Tuvalu, Uganda, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Vanuatu, Venezuela RB (World Bank 2014 GDP), Vietnam, U.S. Virgin Islands (CIA 2016 GDP), West Bank and Gaza, Yemen Rep., Zambia, and Zimbabwe.

I used the UN (data.un.org) 2017 data on population density for 13 regions listed below and on GDP per capita for 5 of these regions, for another 5 of these regions I used the CIA World Factbook GDP per capita data (with the year of the estimate in parentheses), and of the remaining 3 I used Eurostat 2016 GDP per capita data (indicated with an *): Anguilla, Cook Islands, Falkland Islands (2015), French Guiana*, Guadeloupe*, Martinique, Montserrat, Niue (2003), Saint Pierre and Miquelon (2006), South Sudan, Swaziland, Tokelau (1993), and Wallis and Futuna (2004). I used population density and GDP per capita from Eurostat 2016 for an additional 9 regions, being: Åland, Azores, Baleares, Canary Islands, Corsica, Crete, Madeira, Sardinia and Sicilia.

The regional estimates for the counties listed in footnote 9 (and below) were obtained from ranked lists on Wikipedia pages that linked to the respective national statistics bureaus: For Argentinian (23 regions), population and GDP data are for 2013 and 2008 come from the Instituto Nacional de Estadística y Censos de la República; for Australia (8 regions), population density and GDP data for 2017 and 2016 come from the Australian Bureau of Statistics; for Brazil (27 regions), population and GDP data for 2014 and 2015 come from the Brazilian Institute of Geography and Statistics; for Canada (13 regions), population and GDP for 2016 come from Statistics Canada; for Chile (12 regions), population and GDP data for 2015 and 2014 come from the National Statistics Office's and the Central Bank of Chile, respectively; for China (31 regions), population and GDP data for 2016 and 2015 come from the National Bureau of Statistics of China; for India (31 regions), population and GDP data for 2011 and 2016 come from the Ministry of Statistics and Program Implementation; for Indonesia (7 regions), population and GDP data for 2017 come from Badan Pusat Statistik; for Japan (5 regions), population and GDP data for 2007 come from the Statistics Bureau of Japan; for Mexico (32 regions), population and GDP data for 2015 come from the Instituto Nacional de Estadística y Geografía; for Russia (21 regions), population and GDP data for 2018 and 2009 come from the Federal State Statistics Service and UNDP National Human Development Report for the Russian Federation, respectively; for South Africa (9 regions), population and GDP data for 2011 and 2010 come from Statistics South Africa; for United States (50 regions), population and GDP data for 2015 come from the Bureau of Economic Analysis.

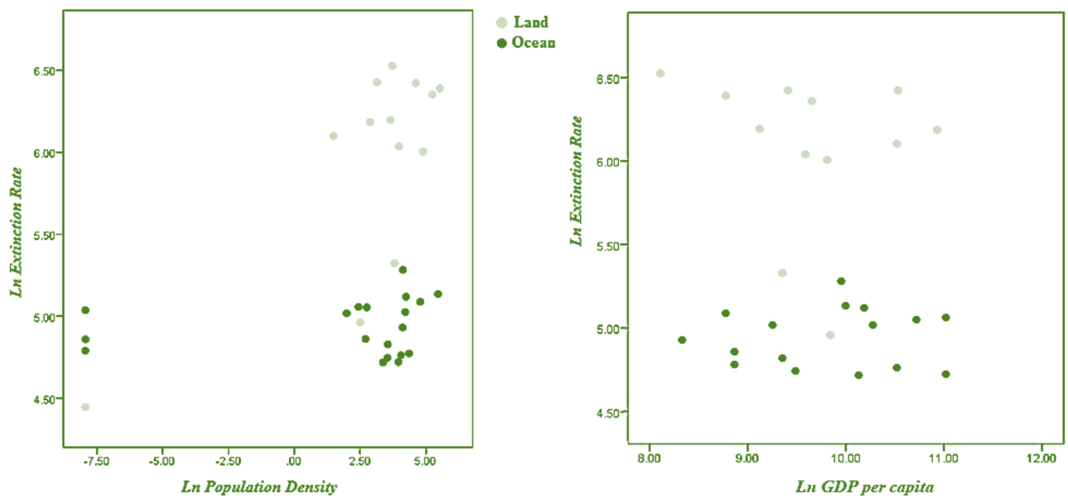
Finally, for 24 regions, I either use estimates provided on the Wikipedia about the region referring to a local census, or in case I was unable to find an estimate, I used the national average. The details are available upon request, and none of the results are not sensitive to the inclusion these regions.

I also ran the regressions displayed in column (1), (2) and (4) of Table 2 using only the 213 observations with World Bank, UN, CIA World Factbook and Eurostat data, complemented with the 13 countries listed in footnote 9 instead of their regional estimated (and New Zealand, as there were 3 regions from New Zealand in the 26 unlisted regions above). For this smaller, the population density results sample are similar across the three specifications and the coefficient for GDP per capita are about half the size and only borderline significant (with p-values of .221, .072, and .113).

I could only find 2015 estimates for about half of the regions. As a robustness check, I corrected national estimates from another year by the World Bank's World average population and GDP growth rates, and similarly, corrected regional estimates from another year by their national average population and GDP growth rates according to the World Bank data. The results are robust to using these corrected population density and GDP per capita variables.

Appendix B

SCATTERPLOTS OF *LN EXTINCTION RATE WITH LN POPULATION DENSITY AND LN GDP PER CAPITA* FOR (SUB)CONTINENTAL AND FAO MARINE REGIONS



To calculate the population density for the 19 FAO Marine regions, I divided the sum of the population of all islands within and all coastal regions adjacent to the FAO region by the sum of the land surface for these regions; likewise, for the GDP per capita I divided the sum of the GDP by the sum of the population for the same regions. For the 13 (sub)continental regions, the 12 described in footnote 10 plus Antarctica, I included all landlocked regions in these sums as well. Note that, Antarctica and the 3 Antarctic oceans regions are not included in the scatterplot for GDP per capita. An OLS regression of *Ln Extinction rate on Ln Population density, Ln Land surface*, and a 'land dummy' for the (sub)continental observations, yields a standardized coefficient for population density of 0.267 (p-value=.020). However, this result is sensitive to the inclusion of Antarctica and the 3 Antarctic oceans regions. Without these observations, the coefficient is almost half and no longer significant (.140, p-value = .157). The relationship between the extinction rate and GDP per capita is not significant (and negative) at this (sub)continental level.

Appendix C

OLS REGRESSION LN EXTINCTION RATE ON CONTROLS

Dependent variable		*Ln Extinction rate*	
Independent variables	**(1)**	**(2)**	**(4)[a]**
Ln Land surface	.079*** (.021)	.082*** (.021)	.104*** (.025)
Island	.536*** (.138)	.544*** (.140)	.514*** (.139)
Landlocked	-.334*** (.085)	-.336*** (.086)	-.060 (.094)
Caribbean	-.923*** (.213)	-.947*** (.214)	-1.272*** (.239)
East Asia	-.516*** (.164)	-.541*** (.165)	-1.049*** (.178)
Europe	-.779*** (.156)	-.814*** (.157)	-1.236*** (.182)
Mesoamerica	.113 (.162)	.098 (.163)	.085 (.160)
North Africa	-.252 (.325)	-.195 (.327)	-.622* (.325)
North America	-.945*** (.139)	-.967*** (.140)	-1.039*** (.186)
North Asia	-3.439*** (.186)	-3.442*** (.187)	-3.488*** (.179)
Oceania	-.197 (.185)	-.228 (.186)	-.371* (.192)
South and Southeast Asia	-.211 (.148)	-.245 (.152)	-.664*** (.164)
Sub-Saharan Africa	-.377*** (.141)	-.387*** (.141)	-.415** (.160)
West and Central Asia	-.346* (.183)	-.242 (.194)	-.583*** (.209)
City	.076 (.273)	.072 (.274)	-.255 (.269)
Desert		-.305* (.157)	-.252 (.155)
Semi-arid		-.055 (.118)	.107 (.117)
Tropical		-.031 (.168)	.104 (.164)
N	508	508	508
R^2	.503	.507	-

***, **, * indicate coefficients significantly different from zero at the 1%, 5%, and 10%, standard errors are shown in parentheses and standardized coefficients in brackets.
a. Reports the estimated coefficients for the control variables of column (4) in Table 2.

Appendix D

FIGURE D1. GEOGRAPHICAL DISTRIBUTION OF EXTINCTION RATE FOR MEXICO USING ONLY SPECIES THAT ARE ENDEMIC TO THE STATE. FIGURE D1 USES THE SAME DATA VISUALIZATION METHOD AS FIGURE 1, ONLY A DIFFERENT SCALE

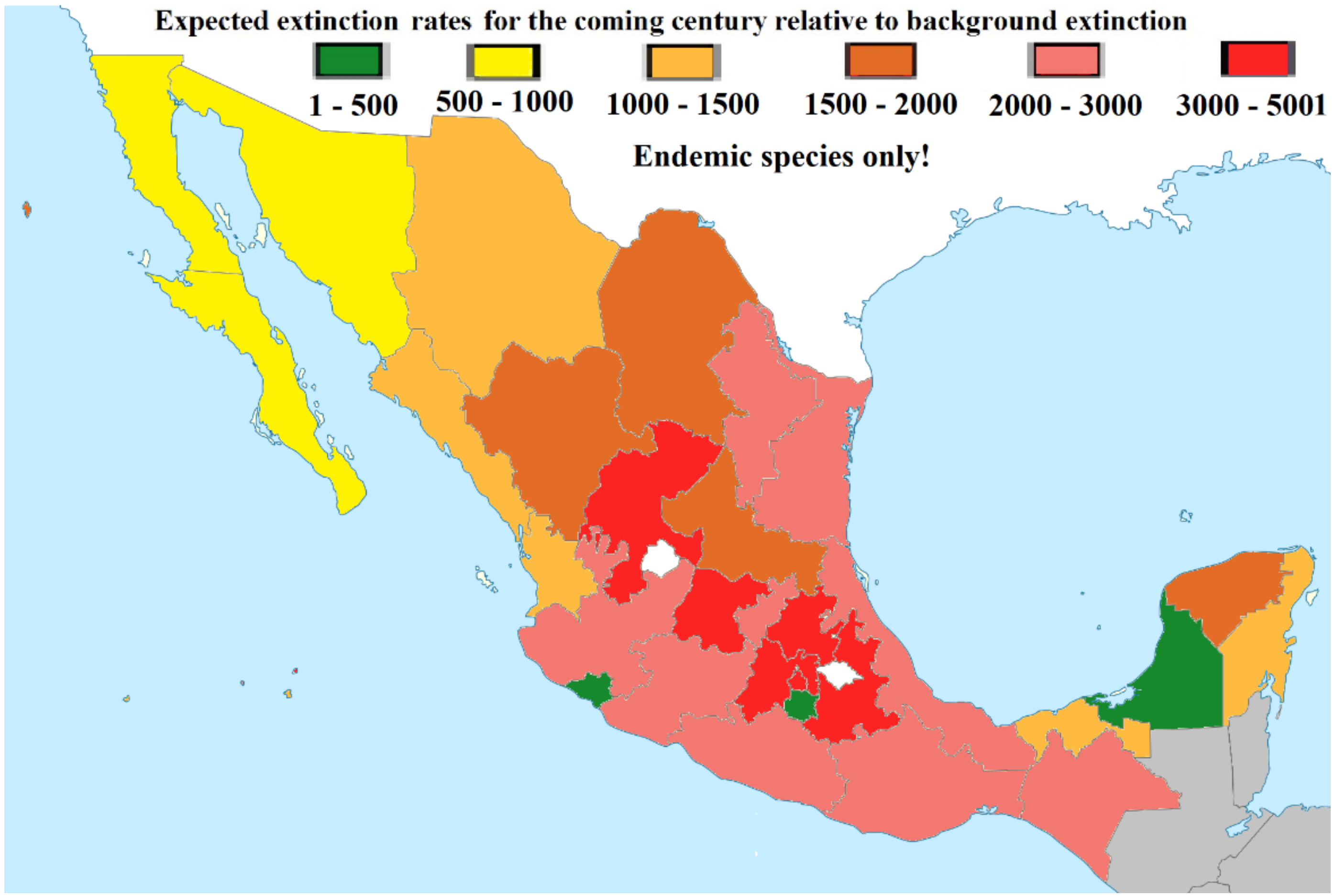
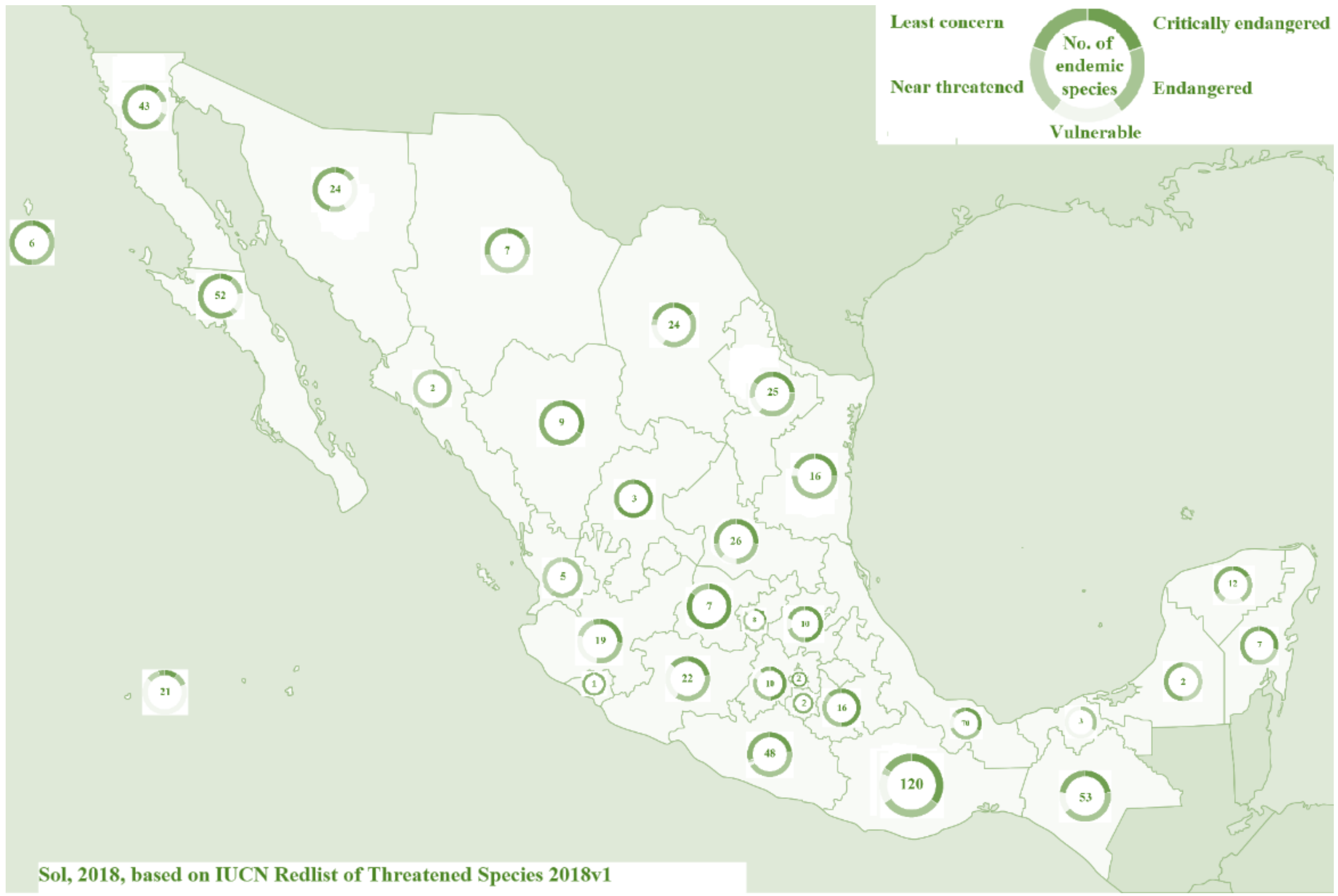


FIGURE D2: GEOGRAPHICAL DISTRIBUTION OF EXTINCTION RATE FOR MEXICO USING ONLY SPECIES THAT ARE ENDEMIC TO THE STATE



Source: figure D2 illustrates that different combinations of assessment categories can give almost the same *Extinction rate* (e.g. compare Coahuila and Durango). Note that, both figures use a same, next wave of IUCN Red List 2018 data.

¿Es posible restaurar y conservar humedales mientras se promueve el desarrollo comunitario?: Un reto transdisciplinario en la Subcuenca Nuxco, México

Sandy Astrid Medina Valdivia*
Carmen Maganda Ramírez**

Introducción

Este capítulo argumenta la necesidad de dedicar más esfuerzos trans e interdisciplinarios para identificar y reconocer las perspectivas de los actores sociales -beneficiarios locales directos- respecto al manejo de los ecosistemas que les rodean. Múltiples programas de conservación de la naturaleza se implementan bajo enfoques de escaza consideración de los aspectos sociales, sin embargo, el involucramiento de los actores locales permite entender la relación que guardan las comunidades con los sistemas naturales y la selección de modelo adecuado de conservación. En ese sentido, el objetivo de este estudio es abordar el tema de conservación de la naturaleza desde la óptica transdisciplinar combinando un enfoque comunitario de manejo de los recursos naturales, con el análisis de las percepciones sobre servicios ecosistémicos y la participación de los actores comunitarios en la restauración ecológica de manglares en la subcuenca Nuxco.

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1. Antecedentes

La crisis ambiental alcanzó a México en un momento en el que los estudios disciplinarios, como en ecología, son por si solos insuficientes para dar respuesta a los problemas derivados de esta crisis, que se expanden por todos los rincones del país. Afortunadamente, en el llamado a la integración y fortalecimiento de grupos formados por investigadores de diversas disciplinas, así como la colaboración de actores no académicos, y en el desarrollo de estudios aplicados a la conservación parecen vislumbrarse los medios para mejorar este escenario (List *et al.*, 2017; Balvanera *et al.,* 2017).

En este contexto, la ecología de la restauración juega un papel importante para restaurar los ecosistemas degradados de México. Sin embargo, con aproximadamente el 90% del territorio nacional en manos de la propiedad privada y ejidal, esta disciplina adquiere una dimensión social importante que precisa recuperar no solo la estructura y función de los sistemas ecológicos, sino también el bienestar de los grupos sociales involucrados (López-Barrera *et al.*, 2017).

En ese sentido, uno de los ecosistemas más amenazados en nuestro país y que ha recibido poca atención para su restauración, son los manglares (Ceccon *et al.,* 2015). A pesar de los múltiples beneficios que brindan, los manglares han sufrido alteraciones en su estructura y funcionamiento a consecuencia de diversos factores, entre los destacan, la explotación y uso intensivo de los recursos naturales para satisfacer las necesidades de la creciente población (Marín et al., 2016), la expansión de los cultivos agrícolas y la ganadería, así como, el cambio de uso de suelo derivado de actividades antropogénicas (Valderrama *et al.*, 2017).

En el estado de Guerrero, datos recientes señalan que durante el período de 2010 al 2015 la frontera agrícola-pecuaria asociada a los manglares aumentó 6,453 hectáreas, además de presentarse pérdidas netas del 17.8% de áreas de manglar durante el mismo período (Valderrama *et al.*, 2017). Algunos de los factores causales han sido el uso directo estos como pastizales para el ganado y la deforestación para actividades agrícolas y turísticas que demandan el cambio de uso de suelo. Sin embargo, es importante considerar que las comunidades aledañas a estos ecosistemas suelen basar un gran porcentaje de sus ingresos al uso y explotación de los servicios ecosistémicos que estos les brindan, por lo que cualquier estrategia que se implemente debería unificar el desarrollo económico y social con la conservación del capital natural de la región.

En particular, consideramos que la participación comunitaria es clave para el éxito en la restauración ecológica, tal como lo demuestran Zaldívar-Jiménez *et al.,* (2017), quienes lograron restaurar sitios con manglar severamente degradado en Laguna de Términos en Campeche. Ellos señalan que las comunidades donde se llevó a cabo el proyecto de restauración consolidaron sus capacidades organizativas y su conciencia ambiental. Además, resaltan que el compromiso de los actores locales con el proyecto de restauración y la participación efectiva de la comunidad fueron aspectos claves para lograr los impactos sostenibles.

Por lo que se refiere al estudio de percepciones, podemos identificar dos estudios pioneros en México, uno el de Arizpe *et al.,* (1993) en la selva lacandona en Chiapas, donde analizan la deforestación de la selva desde la perspectiva cultural y señalan que los asuntos sociales y ambientales son inseparables y por lo tanto debemos tener el objetivo común de discutir cómo lograr que todos podamos vivir de manera digna. El otro, realizado por Lazos y Paré (2000) sobre comunidades nahuas del sur de Veracruz, donde las autoras afirman que la manera en cómo los habitantes perciben sus recursos naturales influye en la transformación de estos. En ambos trabajos, la percepción es un elemento que transforma el medio, a través del comportamiento de las personas y por ello consideran importante contemplar en la planeación de la solución de la crisis ambiental el conocimiento o interpretación de las percepciones de las partes interesadas para comprender y poder influir en la toma de decisiones.

Actualmente, la investigación científica en México desarrolla el estudio de las percepciones ambientales en diferentes escenarios; se analiza la percepción sobre los sistemas naturales y los servicios ambientales que producen (Marín-Muñiz *et al.*, 2016), la vulnerabilidad climática (López-García y Manzano, 2016) o el estado de algún elemento físico o biológico en particular, como la calidad del agua de los ríos y arroyos (Benez *et al.*, 2010). Además, es común que se realicen en ecosistemas que poseen decretos de protección ambiental (Bertoni y López, 2010; López-Medellín *et al.*, 2017). Sin embargo, creemos que es importante que este tipo de estudios se realicen también en las zonas donde no existen decretos de protección ambiental, como es nuestro caso de estudio, para formar lazos entre las localidades respecto a las decisiones sobre sus recursos naturales.

Conocer las percepciones sobre los sistemas naturales contribuyen en la búsqueda de solución a los problemas relacionados con la conservación de la biodiversidad, porque incluyen el papel de la dimensión humana en estos conflictos y los cambios que producen sus acciones sobre el funcionamiento de los procesos naturales del ambiente (Castillo *et al.*, 2009). Tomando en cuenta que nuestro estudio es sobre la percepción de servicios ecosistémicos pero que también propone un proyecto de restauración, las percepciones serán una herramienta útil para buscar el consenso previo a la implementación de acciones de restauración de los humedales, así como para desarrollar estrategias y generar políticas locales a favor de la conservación y manejo de los ecosistemas tal y como lo señalan los estudios realizados por Meli *et al.*, (2017) y Peralta-Rivero *et al.*, (2016).

Basado en lo anterior y para efectos de este estudio consideremos a las percepciones como "las interpretaciones y valoraciones de la naturaleza basadas en la experiencia y la continua interacción del ser humano con el entorno biofísico y social".

Por otra parte, la vinculación de los factores ecológicos con los sociales sigue siendo un reto en la investigación contemporánea. En esta propuesta metodológica utilizamos el enfoque socioecosistémico que resulta fundamental en los temas de conservación y en el desarrollo sostenible, ya que permite comprender las interacciones de la sociedad con los sistemas naturales, como la relación del mantenimiento de la integridad de los ecosistemas con el bienestar humano y contribuye a lograr la sostenibilidad para ambos (Fischer *et al.*, 2015; Maass, 2017).

En primer lugar, el estudio de las percepciones sobre los servicios ecosistémicos proporcionará información sobre la historia ambiental del lugar y la valoración e importancia de los humedales costeros para las comunidades locales (Marín-Muñiz *et al.*, 2016). Asimismo, permitirá conocer las necesidades de los usuarios y los beneficios que estos perciben de los ecosistemas de manglar (Stone *et al.*, 2008). Seleccionamos el marco de los servicios ecosistémicos ya que por un lado están directamente relacionados con los atributos de la biodiversidad (Harrison *et al.*, 2014) y por otro con la salud y el bienestar humano (Balvanera y Cotler, 2009).

En segundo lugar, presentamos una propuesta de restauración que incluye la participación de la comunidad en las diferentes etapas del proyecto, esto permitirá involucrar a los actores sociales interesados en el manejo de los recursos de su territorio, así como la identificación de sus capacidades gestoras, proporcionando la dimensión social del proyecto de restauración ecológica y su continuidad en el largo plazo.

2. Metodología

El objetivo de esta propuesta metodológica es abordar el tema de conservación de la naturaleza desde la óptica transdisciplinar y el enfoque del manejo comunitario de los recursos naturales combinando el análisis de las percepciones sobre servicios ecosistémicos con la participación de los actores comunitarios en la restauración ecológica de manglares en la subcuenca Nuxco.

Los objetivos planteados forman parte de la tesis doctoral que sustenta este trabajo, nos hemos propuesto evaluar particularmente la integridad ecológica de los humedales costeros de la subcuenca mediante parámetros ecológicos y la diversidad funcional de la avifauna, al mismo tiempo que analizaremos las percepciones locales para -idealmente- generar una propuesta de planeación comunitaria para el uso y conservación. Dicha propuesta final, incluye el proyecto de restauración ecológica de manglares que se menciona en este extenso.

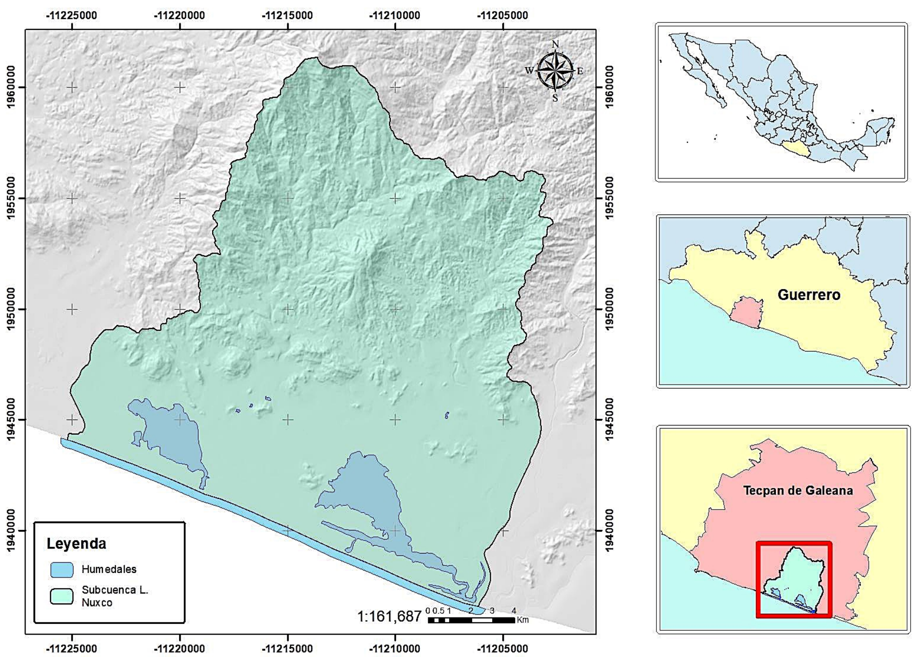
2.1 Descripción del área de estudio

La investigación se realizará en la subcuenca Laguna Nuxco, ubicada en la zona costera del municipio de Tecpan de Galeana en el estado de Guerrero (Fig. 1). El clima de la región es cálido subhúmedo (Aw”0(w)i) con régimen de lluvias en verano. Posee un gradiente de temperatura que va de 14 a 28 °C y un gradiente de precipitación de 800 a 2500 mm (INEGI, 2010).

La subcuenca comprende una superficie de 291.33 km2 y dentro de esta se encuentran dos cuerpos de agua: Laguna de Nuxco y Estero El Plan, ambos poseen características diferentes; la primera posee principalmente vegetación de manglar, con especies como mangle rojo (*Rizhophora mangle*) mangle blanco (*Laguncularia racemosa*) y mangle negro (*Avicennia germinans*) el segundo incluye un humedal herbáceo dominado por tular (Typha dominguensis); parches de selva inundable con especies como *Annona glabra* y *Sabal mexicana*; y parches de mangle rojo y mangle botoncillo (*Conocarpus erectus*). Es importante mencionar que el área propuesta para restauración se encuentra en el Estero El Plan.

A su vez, estos humedales costeros convergen con el desarrollo de las actividades agropecuarias de la región, ya que el municipio se caracteriza por ser líder estatal en producción de copra y plátano, y líder nacional en producción de mango. Como resultado, el área de estudio presenta zonas con alto nivel de deterioro, las cuales han sido transformadas en pastizales para el desarrollo de la ganadería y áreas de agricultura de temporal permanente. Aunque existen diferentes asentamientos humanos dentro de la subcuenca, las localidades con mayor número de habitantes son Nuxco y Tenexpa, con aproximadamente dos mil habitantes cada una (INEGI, 2010).

FIGURA 1. LOCALIZACIÓN DEL ÁREA DE ESTUDIO



Fuente: elaboración propia a partir de datos de INEGI.

2.2 Consideraciones éticas

Adoptamos las condiciones éticas establecidas en el Protocolo de Nagoya sobre el Acceso y Participación en los Beneficios, un tratado internacional que deriva del Convenio sobre la Diversidad Biológica (CDB) en el que se promueve la obtención del Consentimiento Previo Libre e Informado (CPLI) de los proveedores y/o comunidades locales, antes de acceder a los recursos genéticos y naturales con fines de uso o investigación.

Este contexto ético es importante porque provee seguridad jurídica; transparencia en la información que genera la investigación; así como el compromiso por parte de los usuarios de la participación equitativa en los beneficios para compensar a las comunidades locales por utilizar su conocimiento tradicional y sus recursos biológicos.

2.3 Enfoque mixto

Utilizamos una aproximación metodológica mixta que incluye diferentes instrumentos para la recolección y análisis de datos ecológicos y sociales, así como la vinculación de ambos bajo el enfoque socioecosistémico. Los métodos, técnicas y análisis de la parte ecológica y social los realizaremos de manera simultánea.

3. Desarrollo

A continuación, presentamos la propuesta metodológica para abordar de manera integral el socioecosistema que conforma la subcuenca.

3.1 Percepciones locales sobre servicios ecosistémicos de los humedales costeros

Esta parte inicial está dividida en tres etapas: a) trabajo piloto, b) colecta de información con actores clave, y c) taller participativo.

1. Trabajo piloto

En esta primera etapa se realizaremos visitas periódicas a las localidades de la subcuenca para identificar a sujetos potenciales en el manejo de los humedales utilizando un muestreo no probabilístico llamado "bola de nieve", esto mediante la conversación con los pobladores locales y la aplicación de entrevistas semiestructuradas; este muestreo terminará cuando los nombres se repitan y ya no aparezcan nuevos actores. Con esta información, elaboraremos una lista con los nombres de los actores que sean mencionados y la frecuencia con la que aparecen.

No solo se generará el listado de actores clave, sino que se utilizarán los resultados de las entrevistas para: a) Definir el diseño de los instrumentos que se aplicarán en la próxima etapa; b) Precisar si estos se aplicarán solo a los actores clave o si será necesario aplicarlo a otros sujetos; c) Terminar de definir los ejes temáticos que se utilizarán.

2. Colecta de datos con informantes clave

Para esta segunda etapa elaboraremos y aplicaremos una herramienta del tipo encuesta y/o entrevista que permitirá ahondar en la percepción sobre los servicios ecosistémicos de los humedales costeros; ambos instrumentos serán considerados en función de su utilidad y aplicabilidad. Hernández-Sampieri (2014) los define como: 1) entrevista semiestructurada: se utiliza una guía de preguntas y permite adicionar las que sean necesarias para mayor precisión en la opinión y para obtener más información; 2) cuestionario o encuesta: este instrumento puede ser útil y eficaz para obtener información en un período relativamente corto de tiempo, se obtienen respuestas fijas (las cuales pueden ser potencialmente evaluadas en la escala de Likert) pero también da pie a respuestas con mayor profundidad para preguntas específicas.

Las herramientas seleccionadas tendrán los ejes temáticos siguientes: usos de cada humedal (ganadería, agricultura, turístico), tipo de manejo que tiene (conservación, restauración), valores que le asignan los locales al humedal (económico, espiritual, estético, cultural, etc.). El muestreo para aplicar las herramientas será del tipo dirigido o intencional (Martínez-Salgado, 2012) dado que la muestra será seleccionada a partir de los pobladores locales que hagan uso y/o manejo de los humedales y que brindarán información más detallada sobre el tema de interés en esta investigación.

3. Taller participativo

En esta tercera etapa desarrollaremos un taller participativo donde se aplicarán las siguientes técnicas:

c.1) Listado libre, el cual consiste en crear y organizar los elementos de una lista e identificar los más importantes, esto es útil para conocer las nociones más relevantes que tiene la comunidad de los humedales costeros. Esta técnica tendrá un análisis cuantitativo al utilizar el rango promedio y la frecuencia de ocurrencia de las palabras mencionadas, además que puede ser representado al final en una "nube de palabras".

c.2) Línea de tiempo, dónde se marcarán los eventos más relevantes de la historia de la comunidad en el contexto de los humedales, como ejemplo puede ser la modificación del terreno por huracanes, inundaciones, etc. (esto aplica en la comunidad porque se puede observar la percepción de los humedales como protección en eventos de esta escala).

c.3) Mapeo participativo, donde se explorarán las imágenes espaciales que las personas tienen sobre el territorio que habitan, y en particular para conocer como perciben los humedales y sus límites con otros ecosistemas, cuál es el límite de inundación de los terrenos, que actividades realizan dentro de ellos, etc. El número de participantes en el taller y la comunidad donde se realizará se definirán a partir de los resultados de las primeras etapas.

4. Análisis de datos

Para analizar los datos cualitativos utilizaremos los softwares Excel y Atlas.ti®, ya que permiten codificar plantillas de datos y facilitar la interpretación y el descubrimiento de patrones en las respuestas de los entrevistados. Por otra parte, los resultados obtenidos serán contrastados por comunidad y por grupo de actores.

4.1 Validación

Para la validación de los datos, realizaremos la triangulación de la información, mediante la comparación de los resultados obtenidos con diferentes instrumentos de colecta (entrevista y/o encuesta, taller participativo).

Por otro lado, para la validación de los resultados finales se realizaremos una la presentación de los resultados a los pobladores de la comunidad donde se realizará la investigación, para verificar que las conclusiones y propuestas se ajustan a la realidad y necesidades de la población. También, planeamos presentar resultados en contextos internacionales, para generar un análisis comparativo y obtener puntos de vista complementarios a los datos que habremos interpretado.

En la tabla 1 presentamos la propuesta metodológica acotada que incluye las diferentes etapas del estudio de percepciones y el proyecto de restauración.

5. Diseño del procedimiento de la participación social en la restauración ecológica de manglares

Elaboramos un proyecto de largo plazo cuya meta principal es la conservación y restauración de los manglares de la subcuenca mediante el fortalecimiento y capacitación de la comunidad en el uso sostenible de sus recursos naturales. Para cumplir con dicha meta, hemos propuesto dos objetivos a corto plazo, el primero es involucrar a los actores, en la planeación y organización de las actividades para la restauración ecológica de los manglares. El segundo objetivo es realizar el diagnóstico ambiental los manglares de la subcuenca y determinar las áreas con potencial para la restauración ecológica.

Utilizaremos la información de la primera parte de la investigación para la propuesta de restauración ecológica participativa, que, si bien ya hemos diseñado, aún no puede ser ejecutada, debido a que hace falta conocer cuáles son los intereses de los habitantes de las localidades respecto al tema de restauración de manglares y su interés en participar en dicho proyecto.

1.Participación comunitaria en la planeación y organización de las actividades para la restauración ecológica de los manglares

Para lograr la participación comunitaria, primero solicitaremos la presentación del proyecto frente a la Asamblea General, en donde se explicarán los beneficios del proyecto para su bienestar, así como los futuros beneficios económicos en caso de obtener financiamiento para el proyecto. Será de gran importancia identificar a los líderes de opinión para que apoyen en la comunicación con el resto de las localidades.

Una de las actividades que contemplamos para este proyecto es la construcción de un vivero comunitario para producir plantas de mangle. La producción de dicho vivero comenzará con la identificación de áreas semilleras, así como el transporte, selección y siembra de propágulos en los sitios definidos para tal fin. Los propágulos recolectados podrán mantenerse en el vivero hasta tener las condiciones idóneas para su traslado y siembra. La plantación se realizará en los sitios destinados, en los que se realizará el monitoreo posterior.

Es importante mencionar que, se pretende trasmitir los conocimientos de especialistas en restauración a los miembros voluntarios para que aprendan a desarrollar cada una de las actividades del proceso.

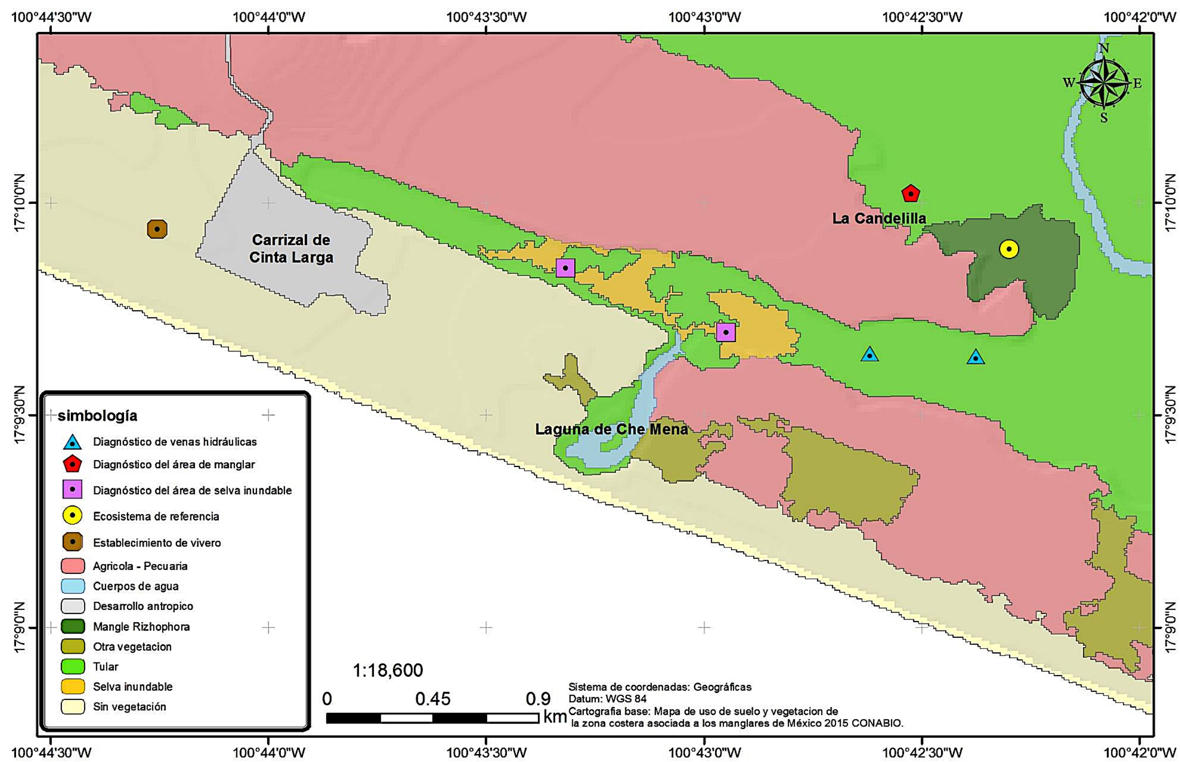
2. Diagnóstico ambiental de los manglares

Como se mencionó anteriormente, el sitio propuesto para restauración se encuentra dentro del Estero El Plan (Fig. 2). En visitas previas identificamos los principales agentes de tensión sobre este sitio, que son el cambio de uso de suelo y la modificación del hidroperiodo debido a la apertura artificial de la barra de arena que conecta el estero con el mar. El sitio que se ha contemplado para utilizar como ecosistema de referencia es un área de 17 hectáreas de *Rizhophora mangle*. En dicho espacio se obtendrán datos derivados de análisis fisicoquímicos, así como de estructura y composición del manglar para construir la línea base que servirá para comparar los sitios de restauración y registrar el progreso de estos mismos en relación con los parámetros determinados en el ecosistema de referencia.

Para reforzar lo anterior, realizaremos un análisis retrospectivo del área propuesta para restauración, mediante la búsqueda de ortofotos en INEGI para verificar la superficie que estaba ocupada por manglar, complementariamente se realizará la reconstrucción histórica de los sitios con manglar y de la transición que tuvieron de zona forestal a zona agrícola o ganadera, esto mediante el testimonio de los actores locales que cuenten con terrenos aledaños al manglar o que conozcan el área, asimismo se llevará a cabo la actualización de los mapas de uso de suelo de la subcuenca (Fig. 3).

También, realizaremos la descripción de las características de los sitios a restaurar que son: uso de suelo actual, condiciones hidrológicas, presencia de auto regeneración, perturbaciones actuales y anteriores (presencia de incendios, modificación o interrupción de los canales, presencia de especies invasivas, modificación del microrelieve, etc.) y condiciones fisicoquímicas para determinar sin son áreas con potencial para la restauración ecológica. En este punto, la participación de la comunidad es importante para conocer las principales causas de los impactos y como pueden conflictuar la conservación de los manglares con el desarrollo económico.

FIGURA 2. MAPA DE LOS SITIOS DONDE SE REALIZARÁN LAS ACTIVIDADES DEL PROYECTO DE RESTAURACIÓN

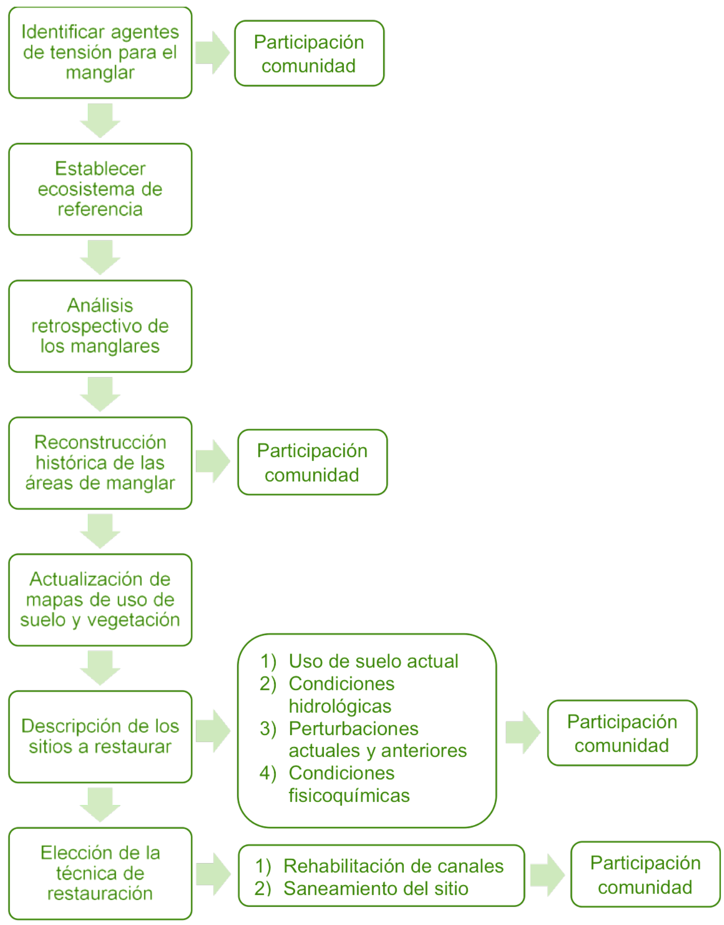


Fuente: elaboración propia a partir de datos de CONABIO.

Posteriormente elegiremos la técnica de restauración más conveniente, que puede ser pasiva (reducción de perturbaciones mediante la rehabilitación de canales y saneamiento del manglar) o activa (reforestación mediante la siembra directa propágulos colectados en el ecosistema de referencia o la siembra de plántulas producidas en vivero).

Además, esta propuesta incluye un programa de monitoreo en las etapas de producción, donde se verificará la calidad y cantidad de propágulos colectados, porcentaje de germinación de las semillas sembradas, crecimiento de las plántulas, así como la calidad de las plantas (tamaño y presencia de plagas).

FIGURA 3. DISEÑO METODOLÓGICO DEL DIAGNÓSTICO Y LA RESTAURACIÓN DE LOS MANGLARES PARA EL PROYECTO DE RESTAURACIÓN PARTICIPATIVA EN LA SUBCUENCA NUXCO



5.3 Indicadores de éxito

Por lo que se refiere al seguimiento de las actividades del proyecto de restauración, desarrollamos indicadores de éxito ecológico, así como indicadores de la parte social. Lo anterior es de suma importancia teniendo en cuenta que todas las acciones emprendidas en torno a la restauración comunitaria deberán tener un seguimiento para conocer los impactos que el proyecto de restauración ocasionará en los habitantes de las localidades y en el ecosistema que se pretende recuperar.

Estos indicadores a su vez constituyen el monitoreo del éxito de la restauración, lo que permitirá saber cuáles son las zonas donde podría invertirse más esfuerzo para mejorar y analizar las causas en caso de no tener éxito.

En el aspecto ecológico, los indicadores están planteados primero para la etapa de plantación: el porcentaje de sobrevivencia de los propágulos; segundo, para la etapa de monitoreo que incluye las características de las plantas sembradas (altura, diámetro y porcentaje de cobertura) y la presencia de especies de fauna que puedan estar interactuando con el sitio intervenido (recuperación de las interacciones dentro del ecosistema). También se considerarán los datos fisicoquímicos del sitio restaurado con relación al ecosistema de referencia. Los indicadores de éxito en la parte social serán la adquisición de capacidades gestoras y técnicas de los actores comunitarios involucrados en el proyecto, así como mejor organización y participación en actividades comunitarias. Un aspecto importante que considerar es la equidad de género en la toma de decisiones equitativas entre hombres y mujeres.

Por otro lado, esperamos diferentes resultados para el proyecto, los cuales funcionarán como indicadores de éxito secundarios. Los resultados a corto plazo son: obtener información acerca del manejo, uso tradicional y aprovechamiento de los manglares, por parte de los habitantes de la localidad, establecer áreas piloto destinadas voluntariamente e identificar alternativas productivas sostenibles.

También, hemos considerado resultados en el largo plazo, estos son: incremento en el conocimiento de la comunidad local acerca de los recursos y beneficios derivados del ecosistema de manglar y los ecosistemas asociados, minimizar actividades que tengan efectos adversos sobre el ecosistema de manglar, la autogestión de la comunidad para apoyos financieros con base en los recursos de la subcuenca, y finalmente, la diversificación de actividades productivas sustentadas en la conservación del funcionamiento de los ecosistemas y en la restauración de los manglares con base en grupos comunitarios organizados.

TABLA 1. DESARROLLO DE LA PROPUESTA METODOLÓGICA PARA EL ESTUDIO DE PERCEPCIONES QUE SE REALIZARÁ DE MANERA SIMULTÁNEA CON LAS ACTIVIDADES SOCIALES QUE INCLUYE EL PROYECTO DE RESTAURACIÓN

Objetivo	**Objetivo**	
Identificar a los actores sociales interesados o involucrados en el uso y manejo de los humedales costeros de la subcuenca de Nuxco	Involucrar a los actores, en la planeación y organización de las actividades para la restauración ecológica de los manglares	Realizar el diagnóstico ambiental de los manglares
Metodología	**Metodología**	
1ª etapa: Trabajo piloto	Presentación del proyecto en la Asamblea General	Identificar agentes de tensión de los manglares
Muestreo “Bola de nieve”		
Entrevistas semiestructuradas		
Listado de actores clave	Identificar líderes de opinión para facilitar la comunicación respecto a las actividades del proyecto	Establecer ecosistema de referencia
Diseño de los instrumentos para la fase siguiente. Definir instrumentos sig. etapa, precisar aplicación (actores clave u otros) y terminar de definir los ejes temáticos		
2ª etapa: Colecta de datos con informantes clave		Realizar análisis fisicoquímicos
Muestreo dirigido o intencional		
Objetivo	**Objetivo**	
Conocer y analizar las percepciones de los actores locales sobre los servicios ecosistémicos de los humedales costeros de la subcuenca Nuxco	Involucrar a los actores, en la planeación y organización de las actividades para la restauración ecológica de los manglares	Determinar las áreas con potencial para la restauración ecológica

<table>
<tr><th>Metodología</th><th colspan="2">Metodología</th></tr>
<tr><td>Aplicación de entrevistas semiestructuradas a actores clave</td><td rowspan="2">Guías de campo y colaboradores para la evaluación del manglar</td><td rowspan="2">Evaluación de la estructura y composición del manglar</td></tr>
<tr><td>Aplicación de encuesta a los actores clave. La escala de Likert es potencial para esta encuesta</td></tr>
<tr><th>3ª etapa: Taller participativo</th><th colspan="2">Planeación de las actividades</th></tr>
<tr><td rowspan="2">Listado libre: crear y organizar los elementos de una lista e identificar los más importantes</td><td rowspan="4">Reconstrucción histórica de las áreas de manglar con el testimonio de los ejidatarios</td><td>Análisis retrospectivo de los manglares: Búsqueda de ortofotos en INEGI</td></tr>
<tr><td>Actualización de mapas de uso de suelo y vegetación</td></tr>
<tr><td>Línea de tiempo: marcar los eventos más relevantes de la historia de la comunidad en el contexto de los humedales.</td><td>Descripción de los sitios a restaurar</td></tr>
<tr><td>Mapeo participativo: explorar las imágenes espaciales que las personas tienen sobre el territorio, en particular los humedales y sus límites con otros ecosistemas.</td><td>Elección de la técnica de restauración</td></tr>
<tr><td rowspan="2">Análisis de la información obtenida en el taller</td><th colspan="2">Realizar la restauración</th></tr>
<tr><td>Voluntarios para aprender técnicas de restauración</td><td>Rehabilitación de canales y Saneamiento del sitio</td></tr>
<tr><th>Análisis de datos</th><td rowspan="8">Establecer acuerdos de respeto y voluntariado para asegurar la restauración a largo plazo</td><td rowspan="8">Monitoreo del sitio de restauración</td></tr>
<tr><td>Datos cualitativos</td></tr>
<tr><td>Excel y Atlas.ti® Codificar plantillas de datos y facilitar la interpretación y descubrimiento de patrones en respuestas de los entrevistados</td></tr>
<tr><td>Contraste por comunidad y grupo de actores</td></tr>
<tr><th>Validación</th></tr>
<tr><td>Triangulación de la información: comparar resultados con diferentes instrumentos de colecta.</td></tr>
<tr><td>Presentar resultados a pobladores ¿se ajustan a la realidad?</td></tr>
<tr><td>Presentar resultados a investigadores (contexto internacional).</td></tr>
<tr><td>Generar un análisis comparativo y obtener puntos de vista complementarios a los datos que el investigador ha interpretado.</td><td>Aplicación de indicadores sociales</td><td>Aplicación indicadores ecológicos</td></tr>
</table>

Fuente: elaboración propia.

Conclusiones

Hasta el momento, sabemos que las principales amenazas para los ecosistemas de manglar en el área de estudio son el cambio de uso de suelo y la modificación del hidroperiodo en el manglar. Sin embargo, consideramos que nuestro papel como investigadoras es el reconocer que existen causas de carácter económico y cultural detrás de estas acciones.

Es importante mencionar que el éxito del proyecto de restauración a largo plazo depende en gran medida de las consideraciones éticas que proponemos en la parte metodológica. Estas constituyen el acercamiento con los habitantes de las localidades de la subcuenca Nuxco y fomentan una relación de respeto y correspondencia por parte del investigador hacia los actores locales, al mismo tiempo que se impulsa el sentido de pertenencia del proyecto de restauración y conservación.

Aunado a lo anterior, consideramos que la vinculación entre diferentes sectores de la sociedad reforzará el éxito del proyecto de restauración y permitirá contextualizar los resultados que se obtenidos. Por esto, se tomarán en cuenta las diferentes instancias político-administrativas que convergen en el territorio de la subcuenca, representadas por el comisariado municipal presente en cada uno las localidades, así como los miembros de la Asamblea General de los ejidos de Nuxco y de Tenexpa. Creemos que es sustancial para el desarrollo de este estudio respetar los acuerdos o reglamentos internos preestablecidos por estas instancias, ya que permitirá el desarrollo idóneo de las actividades establecidas en las diferentes etapas de la presente propuesta metodológica, y facilitará el proceso de la restauración en el aspecto social, tanto para la fase exploratoria como para la fase de monitoreo a largo plazo.

Otro aspecto fundamental que refuerza la transdisciplinariedad de este estudio es que se identificarán grupos sociales como Organizaciones No Gubernamentales interesadas en el aprovechamiento sostenible o conservación de los recursos naturales que deseen participar en el proyecto. Aunado a ello, se pretende vincular a Universidad Autónoma de Guerrero para que los estudiantes participen en los procesos e impulsar la investigación del uso y manejo de recursos naturales, así como de la conservación de ecosistemas naturales.

Con respecto al conocimiento de las percepciones de los habitantes de la subcuenca Nuxco sobre los servicios ecosistémicos que les brindan los humedales costeros, nos permitirá saber si los impactos negativos actuales se deben a los valores y actitudes que los habitantes locales otorgan o si existen causas subyacentes que no involucran las percepciones de las comunidades, como las políticas públicas que se aplican en la región, la pobreza de las familias que habitan la subcuenca, entre otras.

La propuesta metodológica que presentamos cumplirá con el objetivo de involucrar a los actores (hasta ahora dispersos) en la planeación y organización de las actividades para la restauración ecológica de los manglares., consideramos que es una metodología valiosa para fines de conservación y de desarrollo comunitario, ya que nos permitirá realizar el diagnóstico de los manglares de la subcuenca combinando los aspectos ecológicos con la perspectiva de la comunidad, lo que a su vez facilitará establecer las áreas con potencial para la restauración y asegurar que las actividades de la restauración no se verán obstruidas por una insuficiente consideración de los usuarios de los manglares. No obstante, tenemos en cuenta que realizar el estudio de percepción de manera simultánea con la planeación del proyecto de restauración debe ser de manera cautelosa, para no inferir en los resultados que pudieran obtenerse en las diversas etapas y construir la realidad de la subcuenca de la forma más objetiva posible.

Finalmente, toda la información nos será útil para construir de manera integrada, de acuerdo con los intereses de los actores locales, los planes de conservación de los humedales costeros de la subcuenca en el marco de las políticas nacionales e internacionales.

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IV. ECONOMICS AND SUSTAINABILITY

Del proyecto de aula a la política pública: educación y servicio en relación con la contaminación por mercurio en Bogotá, Colombia

Cristian Julián Díaz Álvarez*

Introducción

La tercera función misional de la universidad exige una verdadera intervención positiva en el medio, fundamentada en valores éticos y recias convicciones para poder responder efectivamente ante el sufrimiento, la desigualdad, la inequidad y lo fútil (Velasco, 2012), y no tanto desde el interés crematístico de generar una fuente complementaria de ingresos a las matrículas. Propiamente, un programa de formación en pregrado en el área ambiental, entre muchas otras cosas, debería mantener una posición crítica ante la evidente inestabilidad natural y social, exacerbada por el reinante modelo de crecimiento económico, así como una recia convicción para intervenir positivamente en el medio, ya sea desde la prevención, el control, la mitigación y/o compensación de la contaminación, o desde el trabajo comunitario o el actuar político.

Atendiendo este llamado, una unidad académica de Ingeniería Ambiental, perteneciente a una universidad privada en Colombia[1], deseaba desarrollar extensión solidaria bajo un esquema de aprendizaje y servicio (Mendía, 2012), a través de proyectos que permitieran el mejoramiento de la calidad de vida de las personas y/o comunidades en la ciudad de Bogotá y su conurbano. Para lo cual, durante el último quinquenio se formularon proyectos de aula que pudieran catapultar proyectos formales de investigación y extensión con potencial de incidencia en el medio.

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1 Programa de pregrado de Ingeniería Ambiental de la Universidad Central.

En este orden de ideas, se logró articular correctamente la docencia, la investigación básica y aplicada, y la extensión en un área poco habitual en la ingeniería: los conflictos ambientales; siendo el principal teatro de operación las zonas urbanas, periurbanas y rurales afectadas por la actividad minera y la industria, entre otros.

El valioso y relevante trabajo académico que se presenta en este escrito es el descubrimiento de un problema ambiental urbano desconocido por la autoridad ambiental del Distrito Capital de Bogotá: la presencia de mercurio en la ciudad y la existencia de un ciclo urbano que está afectando la calidad de vida de la población. Proyecto que ha permitido un empoderamiento de sujetos políticos que, con mucho esfuerzo ante varios avatares, han consolidado núcleos de energía (Lamoneda, 2014) que están cambiando la realidad y resarciendo derechos en materia laboral y ambiental.

Así mismo, esta intervención dinamizó el ejercicio docente en ciertos espacios formativos[2] del programa de pregrado, al permitir la adecuada validación de las hipótesis de verdad inicial sobre la cual se soportan los distintos dispositivos pedagógicos[3] del sílabo y el Plan de Desarrollo de las Asignaturas - PDA, atendiendo el modelo pedagógico de aprendizaje basado en problemas y proyectos de aula (Giussani, 2011; Universidad Central, 2013).

1. El proyecto de aula propuesto: El mercurio en los ambientes urbanos

El mercurio y sus compuestos tienden a ser potencialmente tóxicos para los organismos debido a su potencial de bioacumulación a través de la cadena trófica, y a su capacidad de atacar las neuronas del cerebro e inhibir los grupos sulfhidrilo (SH) de varias enzimas esenciales. En síntesis, causa lesión celular en cualquier tejido donde se acumule en una concentración suficiente (Díaz *et al.*, 2018, OMS, 2017; PNUD, 2016).

Su presencia en los ambientes urbanos es posible debido a su liberación intencional, no intencional y accidental durante su uso en sistemas productivos, por ser constituyente de productos de consumo masivo (lámparas fluorescentes, baterías, cosméticos, recubrimientos, entre otros) y hospitalarios, y por ser utilizado en el sector agrícola en forma de plaguicidas y pesticidas organomercuriales. Metal pesado que se convierte en un indicador alarmante del actual modelo metabólico lineal de un sistema constituido por ocho millones de personas, dos y medio unidades habitacionales y, alrededor de cuatros cientos mil unidades productivas (Díaz y Bustos, 2018; SDP, 2016).

En mérito de esta realidad, el profesor líder del espacio formativo *Gestión Integral de la Calidad del Aire*, con el apoyo de tres colegas de la unidad académica, definieron en el PDA del año 2011 el desarrollo de un proyecto de aula para dimensionar la presencia de mercurio en el aire de Bogotá, cuyos resultados parciales motivaron a estudiantes para desarrollar sus trabajos de grado en relación con esta problemática, bajo la modalidad de trabajo escrito de investigación.

2 Las asignaturas son: a) Gestión integral de la calidad del aire, b) Sistemas de información geográfica, c) Control de operaciones y procesos y, d) Ambiente y empresa, éste último, un curso de modalidad de grado.

3 Los dispositivos que aplican en el curso de Gestión Integral de la Calidad del Aire son: a) el trabajo de campo, b) los estudios de caso y, c) la clase.

Las evidencias preliminares sobre la potencial existencia de mercurio en la capital colombiana[4] exigieron mantener la temática durante seis periodos académicos en sendos grupos del curso, mediante la discusión y la lectura crítica de reportajes, notas en medios de comunicación, documentos, informes, normas y políticas públicas asociadas con las distintas matrices ambientales y las fuentes. Trabajo académico que contó con el apoyo de profesores de otras asignaturas, especialmente del área de geomática y del componente básico en ingeniería (balances de materia y energía).

La demostración definitiva de la presencia de este metal pesado y la existencia de un ciclo urbano del mismo en la capital colombiana, no sólo dinamizó aún más el proceso de enseñanza y de aprendizaje[5] e investir de mayor credibilidad al profesor en la exposición de contenidos y la argumentación, sino que logró un *spin off* para la formulación y desarrollo de proyectos de investigación formativa, formal y propiamente dicha; así como proyectos de extensión solidaria y remunerada con comunidades de base y empresas del sector real (Figura 1).

FIGURA 1. PROCESO REALIZADO A CABO PARA LLEVARPROYECTOS DE AULA HASTA PROYECTOS FORMALES DE INVESTIGACIÓN Y EXTENSIÓN

Nota: I es instrumento de gestión interna o externa y E corresponde a la Entidad dónde se lleva a cabo el trámite.
Fuente: elaboración propia.

Posteriormente, los resultados de investigación y de extensión fueron sistematizados como producción académica indizable (ponencias, artículos de divulgación e investigación y libros) y prudentemente ajustados para su socialización ante la comunidad, medios de comunicación y gestores de política pública (Figura 2). Estas acciones permitieron no sólo mejorar los indicadores cienciométricos de la unidad y del grupo de investigación correspondiente, sino que permitieron la motivación de comunidades de base -expuestas a altas concentraciones de mercurio- para adelantar posteriores trabajos y proyectos de extensión con el fin de dar a conocer su situación y exigir el cumplimiento de sus derechos, especialmente los consagrados en la Artículos 78, 79 y 80 de la Constitución Política de Colombia. De igual

4 Advertidas por el autor principal desde el año 2007 a la comunidad científica nacional en las cuatro versiones del Congreso Colombiano de Calidad del Aire y Salud Pública – CASAP.

5 Al exigir la actualización del Plan de Desarrollo de la Asignatura – PDA al permitir el análisis y estudio de un nuevo caso.

forma, se logró despertar el interés de entidades públicas –de orden nacional y distrital- con funciones relacionadas con la protección del medio ambiente y la salud, en lo concerniente a la identificación del problema y la proposición y puesta en marcha de soluciones viables.

FIGURA 2. PRODUCTOS ALCANZADOS LUEGO DEL PLANTEAMIENTO DEL PROYECTO DE AULA

Fuente: elaboración propia con información de Universidad Central (2017).

La socialización del saber científico a un público no especializado, a través de los medios de comunicación, visibilizó el problema y a los afectados, incluyéndolos en la agenda ambiental y política del Distrito Capital y la Nación. Así mismo, la Institución –reflejada en el Departamento de Ingeniería Ambiental- se benefició al convertirse en referente en este importante y sensible asunto en Bogotá y su región de influencia. De igual manera, se logró un sano disentimiento con las Secretarías Distritales de Ambiente y de Salud de Bogotá sobre la existencia del problema y el nivel de riesgo inherente; así mismo, con el Ministerio de Salud y Protección Social y la Procuraduría General de la República, el cual todavía se mantiene vigente.

El climax del trabajo se ha alcanzado con el llamado del poder judicial a los profesores participantes en el proyecto para fungir como expertos ambientales en investigaciones penales por casos de contaminación por mercurio y otros metales pesados (Juzgados y Fiscalía General de Nación); y al incidir políticamente en el poder legislativo (Cámara de Representantes), participando de mesas técnicas y audiencias públicas en cuanto a la presencia, contaminación y efectos para la salud por los metales pesados se refiere. Participación que coadyuvó a la ratificación, por parte de Colombia, del Convenio de Minamata, el cual se encuentra a la espera de la sanción presidencial y de revisión por parte de la Corte Constitucional.

2. Escenarios Complejos y Respuestas No Lineales

En virtud de la dinámica y alcance obtenido en el otrora proyecto de aula sobre mercurio, los posteriores trabajos académicos se operaron dentro de una realidad compleja que se suscitó a partir de las relaciones entre los distintos subsistemas en donde hubo intervención y en donde se presentaron efectos colaterales (individuo, comunidad, entidades públicas, empresa privada, medios de comunicación y poderes legislativo, ejecutivo y judicial); así mismo, por las tensiones con distintos y heterogéneos actores, cuyas posiciones y manifestaciones evidentes o imperceptibles dependen de procesos interdefinibles y múltiples de difícil identificación o previsión, los cuales resultan de la confluencia de diversos factores no aislados y fuerzas impulsoras que a veces sobrepasan el quehacer académico (García, 2006). Entre estas manifestaciones se encuentran el interés financiero y el lucro, la necesidad de ahorro y reducción del gasto, la salvaguarda de la salud y la vida, la protección de los sistemas naturales, la búsqueda de la verdad y de la justicia ambiental, las ansias de poder, y el interés político, entre otros.

La complejidad del asunto también se verificó cuando las repuestas del sistema –reflejado en los diferentes actores, sus relaciones y las condiciones de contorno- dejaron de ser predecibles; toda vez que se esperaba una buena réplica por parte de las autoridades ambientales y de salud del distrito y del conurbano, la cual fue totalmente opuesta al vilipendiarse el trabajo realizado; así mismo, el volumen de requerimientos jurídicos por parte de terceros y la presión de algunos medios de comunicación por mostrar una realidad parcial con un fin amarillista.

Lo más sorprendente del caso fue el cambio de actitud institucional hacia el proyecto; pasando de un frenesí por la visibilidad en medios de comunicación, a un distanciamiento por los advertidos efectos colaterales del proyecto, a saber: i) las recurrentes citaciones por parte de la Fiscalía General de la Nación, a través de su Cuerpo Técnico de Investigación – CTI; ii) La referencia técnica para varios procesos legales en juzgados del Distrito Capital; iii) La presión de los actores denunciados públicamente y; iv) La envidia de cuadros directivos por la pérdida de visibilidad de otros proyectos en curso y de sus unidades académicas. Al final, el equipo de trabajo se diluyó y el líder del proyecto fue despedido sin justa causa por las directivas de la institución.

A la complejidad de este asunto se le suma la heterogeneidad y relatividad de los puntos de vista de los distintos observadores del problema identificado, quienes, influenciados por el contexto, la historia y el espíritu, actuaron a partir de los modelos mentales adquiridos por la educación previa, la exposición a bibliografía, a las experiencias vividas, al medio cultural, a los paradigmas previos y, a las creencias religiosas y sus propios intereses (Ciurana, 2007; Díaz, 2013). Esto se valida a partir de las distintas posiciones planteadas por los diversos actores, quienes todavía conciben aisladamente el asunto, ya que para algunos el problema es netamente técnico, para la comunidad el escenario es un ejemplo de conflicto ambiental, para los académicos es un excelente estudio de caso de justicia ambiental, para los actores políticos es una oportunidad para catapultarse en las esferas del poder, para los entes de control es un asunto de Gobierno, o como un tema jurídico para el poder judicial. Pero ninguno de los actores lo considera como un problema complejo.

FIGURA 3. LA HETEROGENEIDAD DE LOS DISTINTOS ACTORES EN EL PROBLEMA COMPLEJO ABORDADO

Fuente: elaboración propia con imágenes institucionales de la Procuraduría General de la Nación, la Fiscalía General de la Nación, el Ministerio de Salud y Protección Social, la Cámara de Representantes, la Secretaría de Ambiente del Distrito Capital y el Sindicato de Trabajadores de la Industria del Vidrio.

Es por esto que, a lo largo de la experiencia académica del equipo de trabajo, se presentaron tanto el estado de irresolución, duda y confusión cuando se intentó dimensionar y comprender el tejido de eventos, acciones, interacciones, retroacciones, determinaciones y azares que constituyen el mundo fenoménico del problema del mercurio en Bogotá – Región, como la difícil estandarización del pensamiento, así como su sistematización, comunicación y réplica a través de medios formales como ponencias, artículos, libros y medios de comunicación; algo que Edgar Morin y colaboradores (2006) ya habían advertido en su libro *Educar en la Era Planetaria*.

3. Dificultades a tener en cuenta en futuros proyectos

Para el desarrollo de proyectos de esta naturaleza, con varios efectos colaterales, el compromiso social y la práctica pedagógica en el ámbito universitario tiene que atender y resolver varios inconvenientes, entre los cuales se pueden enunciar:

• Los valores éticos institucionales no necesariamente son compartidos por el personal académico, administrativo y/o estudiantes; de tal forma que la prioridad de responder ante el sufrimiento de los otros queda relegada ante objetivos cienciométricos y de ranking, asignación presupuestal, procesos y procedimientos burocratizados e intereses personales.

• La credibilidad de la Academia ha perdido su valor social, de tal forma que los resultados, información y datos rigurosamente obtenidos pueden ser vilipendiados en cualquier momento a través de sistemas masivos de comunicación, redes sociales o comunicados de prensa, lo que obliga a tener oficinas de prensa y jurídicas para contrarrestar los ataques y blindar legalmente los productos académicos y los investigadores.

• La dificultad para formalizar los proyectos de extensión solidaria dentro de la estructura académico administrativa de la institución, ya sea por la exigencia de réditos financieros, los egos de algunos miembros de la comunidad universitaria o la resistencia de las comunidades de base y beneficiarías para poner por escrito y normalizar los compromisos, objetivos, alcances, recursos y responsabilidades del proyecto.

• La enajenación de los estudiantes ante la realidad nacional, reduciendo así su capacidad de pensamiento crítico y de argumentación; y por ende, su falta de interés por mejorar la realidad existente.

Finalmente, un asunto a tener en cuenta en las intervenciones de este tipo es contar con un verdadero, sincero e irrestricto apoyo institucional al proyecto y a los profesores involucrados; principalmente ante las secuelas producto de la denuncia de los conflictos ambientales, del empoderamiento de comunidades de base, de las propuestas para el cumplimiento y/o sobrepaso de la normativa ambiental vigente y, la visibilidad ante entes de comando y control fiscal, ambiental y judicial.

Conclusiones

La experiencia académica expuesta logró fomentar el interés de la comunidad sobre los problemas que los aquejan, y la comprensión de los conceptos y métodos de la ciencia, la técnica y la tecnología, propiamente en lo relacionado con la contaminación por mercurio en ambientes urbanos; De igual manera, y por encima de todo, le permitió a distintos actores contar con herramientas para iniciar procesos mucho más formales para tratar resarcir sus derechos y alcanzar la solución óptima anhelada, luego de años de olvido por parte de los distintos organismos estatales y distritales de control.

Es importante resaltar que la función social de la Universidad conlleva, en casos como el expuesto, a tener que afrontar debates que trascienden la frontera académica, teniendo un impacto más directo en la sociedad. Sin embargo, más allá de los proyectos, los resultados obtenidos, los indicadores cienciométricos y la noticia, hay implicaciones jurídicas que es menester prever, como las potenciales respuestas que se generen desde los distintos actores que se consideren afectados por la intervención realizada.

La experiencia evidencia que el conocimiento y su proceso de generación, publicación y transferencia no es neutral, ya que –al desarrollarse en un contexto específico- atiende intereses propios o colectivos; que para este caso, corresponden al mejoramiento de la calidad de vida de las personas, la alerta y suministro de información a la comunidad y autoridades ambientales, la incidencia en la política pública, y por default, el reconocimiento de los investigadores y el engrandecimiento de la imagen institucional.

La extensión solidaria de alto riesgo debe realizarse, con las respectivas precauciones, por parte de las universidades y centros de investigación, ya que existen muchas comunidades necesitadas que no cuentan con los recursos necesarios para desarrollar proyectos o contratar firmas de consultoría. Este riesgo debe ser asumido como parte de la función social de la Universidad.

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El intercambio ecológicamente desigual como nexo entre deuda externa y deuda ecológica

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Introducción

El presente trabajo tiene como objetivo relacionar los conceptos de deuda externa y deuda ecológica. Para ello, en primer lugar enfatizaremos sobre el efecto de la toma de deuda monetaria a través de diversos mecanismos y actores financieros bajo el modelo de valorización financiera (1976-2001). En particular, nos centraremos en el proceso de endeudamiento externo en Argentina en ese periodo y las consecuencias que tiene en el sector externo.

En este sentido, en un segundo lugar analizaremos la matriz exportadora de Argentina ya que es el sector donde se generan las divisas necesarias para el pago de dicha deuda y de sus intereses. Bajo este marco, vincularemos la matriz con las tensiones socioambientales que ocurren en el país. De esta manera, introduciremos la categoría de intercambio ecológicamente desigual, entendiendo a este como los flujos de materiales y energía escasamente remunerados hacia el resto del mundo (Peinado, 2015).

El intercambio ecológicamente desigual si bien puede estar permitiendo evitar el recrudecimiento de la restricción externa[1] (vía acumulación de divisas) y garantizando el pago de intereses de la deuda, implica procesos de reducción del capital natural (Peinado, 2015).

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1 El fenómeno de la restricción externa refiere a la imposibilidad de lograr un crecimiento sostenido en una economía por la dificultad para obtener divisas.

A través de los indicadores biofísicos, como la huella ecológica (*Global Footprint Network*) y la biocapacidad disponible podemos visualizar esta problemática.

Este desarrollo teórico permite evidenciar las tensiones entre la sustentabilidad económica y la sustentabilidad ambiental, así como la provisión de sustentabilidad ecológica a los países centrales (Peinado, 2019). En ese sentido, se pretende visibilizar las conexiones que transforman a los países deudores financieros en acreedores de una creciente deuda ecológica.

Si bien el concepto de deuda ecológica abarca distintos factores, nos centraremos en la deuda contraída por los países centrales a través de la desposesión de los recursos naturales por su venta subvaluada, es decir, en el intercambio ecológicamente desigual. Sin embargo, el concepto de deuda ecológica incluye también la importación de residuos tóxicos, la biopiratería y la deuda de carbono (Aguilar González, 2013; Villalba, 2008; Colectivo de Difusión de la Deuda Ecológica (CDE), 2003).

La deuda ecológica, bajo este análisis teórico, es una herramienta interdisciplinar para denunciar la insostenibilidad ecológica y social de nuestra región y cuestionar los mecanismos de dominación de los países centrales invisibilizados por la legitimidad de la deuda externa.

Objetivos

El objetivo principal del trabajo es poder vincular los conceptos de deuda externa y deuda ecológica. Si bien estas categorías conceptuales no se relacionan directamente, podemos encontrar sus vínculos a través de variables económicas y biofísicas. En este sentido, los objetivos específicos apuntan a:

- Relacionar el proceso de endeudamiento externo y el pago del mismo a través del aumento de la presión sobre la matriz exportadora.
- Analizar la estructura exportadora de Argentina y su vínculo con el comercio internacional para visualizar si existe un intercambio ecológicamente desigual (factor componente de la deuda ecológica).
- Verificar si este intercambio ecológicamente desigual derivó en una pérdida ecológica, es decir, en un achicamiento de la capacidad de carga de cada país por el aumento de la huella ecológica.

Metodología y fuentes

Para el análisis de las variables citadas utilizaremos tanto indicadores monetarios como biofísicos. Los primeros serán elaborados con datos del Ministerio de Economía y el Instituto Nacional de Estadísticas y Censos (INDEC). Se trata de datos relacionados con la composición de la deuda externa y la estructura de la matriz exportadora argentina.

En lo que respecta a los indicadores biofísicos trabajaremos con la Huella Ecológica, que se define como "el área de tierra y agua biológicamente productiva que se necesita para producir los recursos que consume un individuo, población o actividad y para absorber los residuos que ello genera, considerando la tecnología y gestión de recursos imperante" (World Wildlife Fund, 2012: 135).

Para su dimensionamiento se la compara con otro indicador biofísico como es la biocapacidad disponible. Esta es entendida como la capacidad de los ecosistemas para producir materiales biológicos útiles y absorber los materiales de desecho generados por los seres humanos, utilizando los actuales esquemas de gestión y tecnologías de extracción. Tanto la Huella Ecológica como la biocapacidad se expresan en hectáreas globales (hectáreas biológicamente productivas de tierra de productividad media, GHA).

La diferencia entre ambos indicadores permite conocer el nivel de deuda o de reserva ecológica existente. En este trabajo se utilizan los datos proporcionados por la Global Footprint Network en www.ecologicalfootprint.org.

1. Resultados y discusión

1.1. El Endeudamiento Externo: pilar del modelo de valorización financiera

En el contexto económico de la última dictadura militar (1976-1983) se implementó un cambio del patrón de acumulación de capital, dejando atrás la segunda etapa de la industrialización por sustitución de importaciones e instaurando un proceso de acumulación basado en la valorización financiera que se mantuvo hasta la crisis del 2001. En este marco, y en el contexto del auge de los flujos financieros a nivel mundial, tuvo lugar un drástico viraje tanto en las características de los deudores y los acreedores externos como en la dimensión y el papel que cumplía el endeudamiento externo en la economía argentina.

En ese periodo, la deuda externa cumplió un papel central. El mecanismo implementado, conocido como "bicicleta financiera", consistió en una toma de deuda externa por fracciones del capital dominante, que luego colocaban en activos financieros en el mercado interno para aprovechar el diferencial entre la tasa de interés local e internacional. Dicho diferencial le permitía al capital obtener una ganancia financiera que, posteriormente, era remitida al exterior en un proceso de fuga de capitales. De esta manera, a diferencia de lo que ocurría durante la segunda etapa de la industrialización sustitutiva[2], la fuga de capitales al exterior estuvo intrínsecamente vinculada al endeudamiento externo.

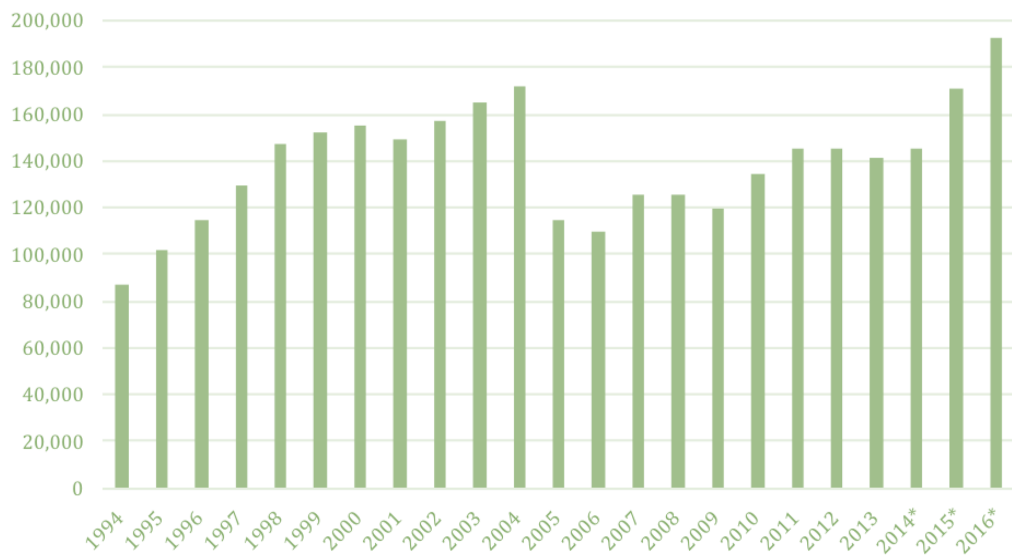
El modelo de valorización financiera fue posible por tres procesos fundamentales propiciados por el Estado. En primer lugar, aseguró una tasa de interés interna mayor a la internacional a través de su propio endeudamiento. Por otra parte, el mismo sector público propició las divisas necesarias que posibilitaron la fuga de capitales. Por último, se llevó a cabo un proceso de estatización de deuda externa privada, lo que permitió al capital iniciar nuevas etapas de endeudamiento (Manzanelli, Barrera, Wainer, y Bona, 2015).

Este patrón de acumulación derivó en dos restricciones de diferente tipo. En primer lugar, la salida de divisas al exterior en concepto de pago de intereses a los acreedores externos,[3] que durante la etapa 1975-2001 se expandió al 16% anual y acumuló al final del período 117 mil millones de dólares. En segundo lugar, la fuga de capitales locales al exterior, cuyo monto acumulado al final del período llegó a 138 mil millones de dólares (Manzanelli, Barrera, Wainer, y Bona, 2015).

2 Para los procesos de fuga de capitales y restricción externa en los procesos de sustitución de importaciones ver Braun y Joy (1981) y Diamand (1973).

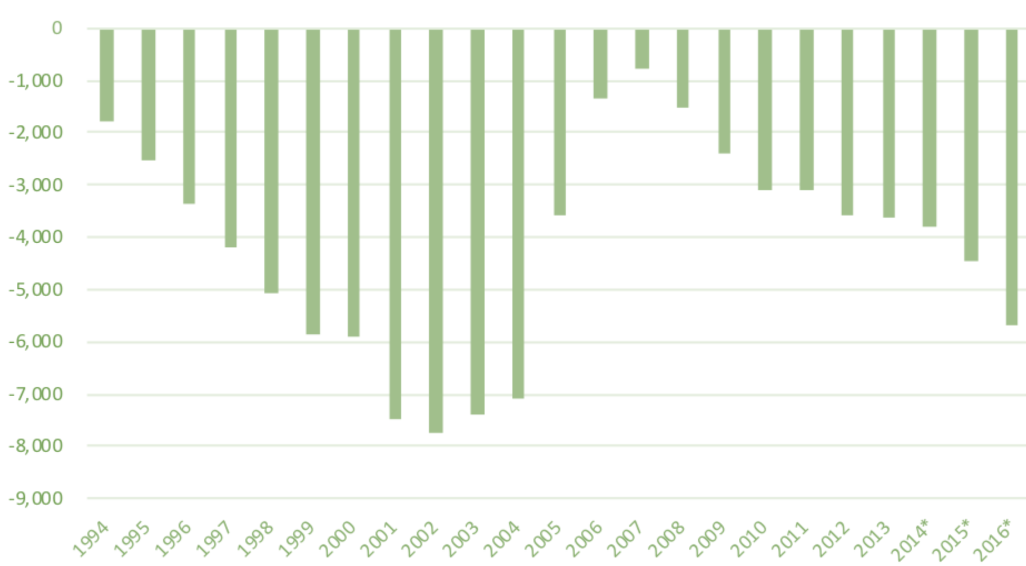
3 Los organismos internacionales de crédito, los bancos transnacionales y los tenedores de bonos o títulos emitidos tanto por el sector público como por el sector privado.

GRÁFICO 1. EVOLUCIÓN DE DEUDA EXTERNA.
MILLONES DE DÓLARES. ARGENTINA. 1994-2016



Fuente: elaboración propia en base a datos del Ministerio de Economía, Argentina.

GRÁFICO 2: EVOLUCIÓN DE LOS INTERESES DE LA DEUDA.
MILLONES DE DÓLARES. ARGENTINA. 1994-2016



Fuente: elaboración propia en base a datos del Ministerio de Economía, Argentina.

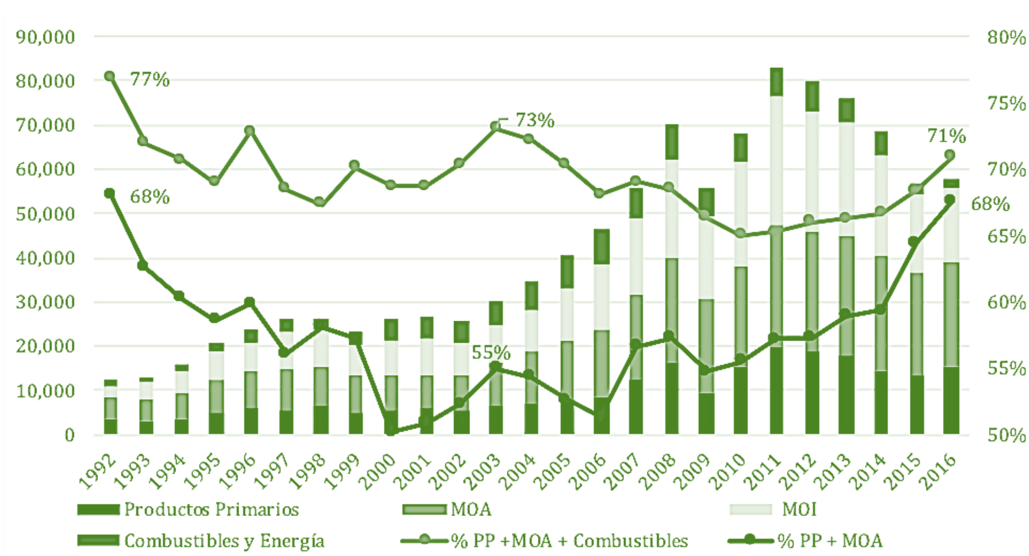
Como se puede observar en los gráficos 1 y 2, el proceso de deuda externa creció un 70,52% entre 1994 y 2000 y sus respectivos intereses crecieron más de tres veces en el mismo periodo. Este proceso agudizó la restricción externa generando una presión sobre las cuentas externas debido a la necesidad de divisas para el pago de los intereses de la deuda, no sólo en el periodo citado sino luego de la crisis del 2002. Por el contrario, si tomamos el periodo de la posconvertibilidad (2003-2014) observamos que la deuda disminuyó en un 12% y la carga de los intereses sobre las cuentas externas se redujo a la mitad. Este proceso de desendeudamiento tuvo su correlato con la profundización de la reprimarización de las exportaciones.

1.2. La posconvertibilidad (2003-2015). Reprimarización económica e intercambio ecológicamente desigual

El modelo de valorización financiera derivó en una de las más profundas crisis de la historia argentina (1998-2002). Luego de la salida del régimen de la convertibilidad[4], la economía argentina exhibió un desempeño destacado que se reflejó en buena parte de sus indicadores. En materia externa hubo un superávit holgado que hizo posible una importante acumulación de reservas internacionales hasta 2010. Este ingreso de divisas por el canal comercial permitió que se diese un proceso de desendeudamiento, sin generar mayores tensiones en el sector externo hasta la finalización de la primera década del nuevo siglo. En este marco, en el año 2006 se canceló de forma anticipada la totalidad de la deuda remanente con el Fondo Monetario Internacional (Schorr y Wainer, 2014).

Luego de la crisis y a partir del año 2003 se alteraron muchos de los basamentos fundamentales sobre los que se sostuvo el modelo previo aunque se observaron continuidades en la estructura económica. Por un lado, se mejoraron visiblemente ciertos indicadores macroeconómicos como el nivel de empleo, de producto, producción industrial y la distribución del ingreso. Sin embargo, se consolido un patrón productivo concentrado y extranjerizado (Gaggero, Schorr, y Wainer, 2014) y una inserción con el mercado mundial basada en la exportación de commodities y productos asociados a estos propias del modelo anterior.

GRÁFICO 3: ESTRUCTURA EXPORTADORA.
MILLONES DE DÓLARES. ARGENTINA. 1992-2016



Fuente: elaboración propia en base a datos del INDEC y Ministerio de Economía, Argentina.

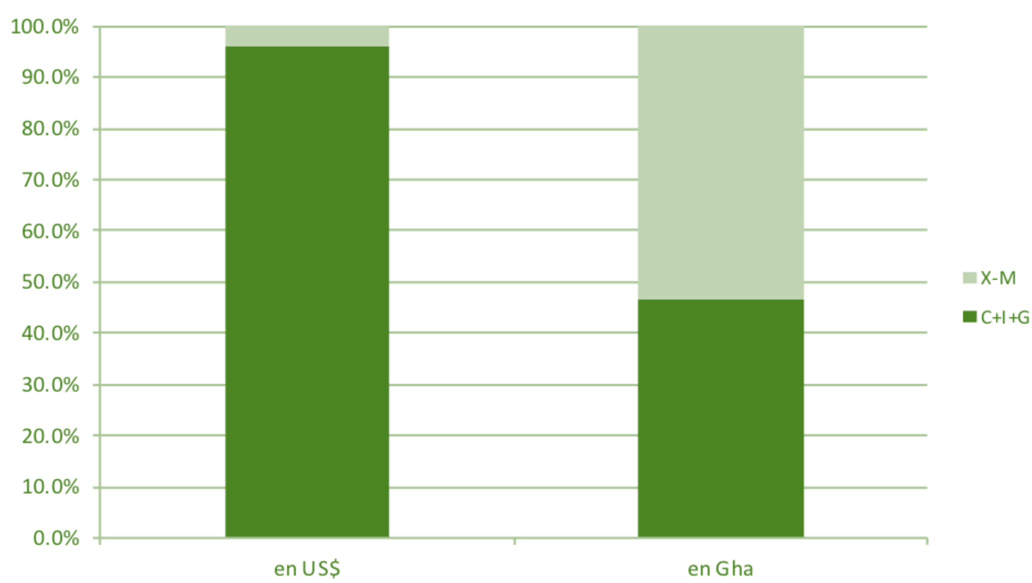
4 Régimen implementado en 1991 siguiendo los lineamientos del modelo de valorización financiera y las pautas establecidas por organismos internacionales.

En el gráfico 3 se puede observar la concentración de los de los productos primarios y sus derivados (manufacturas de origen agropecuarios, MOA) en la estructura exportadora. Esta tendencia se profundizo en la posconvertibilidad donde pasaron de representar el 55% en el año 2003 al 64% en el 2015. Esta forma de insertarse en el mundo a partir de la acentuación de la matriz exportadora-primaria con eje en la extracción y exportación de recursos naturales (y manufacturas derivadas), hace que la explotación de la naturaleza asuma un lugar central en el patrón de acumulación y reproducción del capital (Belloni & Peinado, 2013).

Dicha relación en el comercio internacional da lugar a lo que denominaremos intercambio ecológicamente desigual. A través de esta teoría, se plantea el hecho de que un patrón de comercio internacional financieramente equilibrado (exportaciones e importaciones por el mismo monto monetario), puede también ser ecológicamente desigual por medio de un desbalance del contenido de recursos naturales (en términos de materiales y energía) de las exportaciones netas (Muradian & Martínez-Alier, 2001). Para poner a prueba la existencia de este mecanismo desigual se han utilizado indicadores biofísicos construidos en el marco del análisis de flujos de materiales del campo de la Economía Ecológica. Bajo este marco teórico se trabaja con la Huella Ecológica y la biocapacidad neta disponible con el objetivo de visibilizar los impactos de las actividades económicas, y en especial del actual patrón de inserción externo, en el capital natural de la economía nacional[5].

Si se compara la participación del sector externo frente al consumo doméstico en el producto en dólares y hectáreas globales, se puede apreciar que el peso del sector externo se torna superior frente al consumo doméstico.

GRÁFICO 4. PRINCIPALES AGREGADOS DE LAS CUENTAS NACIONALES. DÓLARES CORRIENTES Y GHA PER CÁPITA. ARGENTINA. 2008



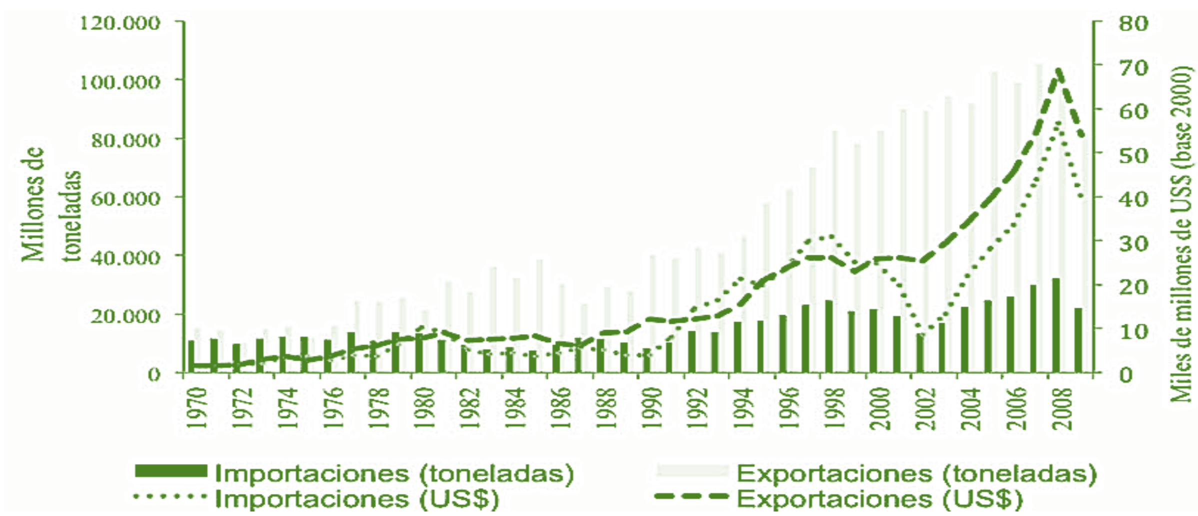
Fuente: elaboración propia en base a datos de CEPAL–CEPALSTAT y Global Footprint Network en World Wildlife Fund (2012).

5 Para un estudio de la región con otros indicadores biofísicos como la huella hídrica o la balanza física ver Ganem, Peinado, Piccolo y Valerio (2015).

De esta manera, a través de la Huella ecológica, se observa que el saldo comercial favorable de Argentina es factible en el marco del alza del precio de los *commodities* a través de una elevada utilización de sus recursos naturales. En este sentido, el balance comercial en dólares además de tener un peso cada vez más importante de las importaciones de bienes de capital e insumos (Belloni & Peinado, 2013), tiene una dinámica altamente deficitaria en términos de recursos naturales por el carácter intensivo de las exportaciones argentinas.

Por su parte el trabajo de Walter, Brun, Pérez Manrique, González Martínez y Martínez Alier (2013) a través de la Balanza comercial física también visibiliza la situación de Intercambio ecológicamente desigual que enfrenta Argentina.

GRÁFICO 5. BALANCE COMERCIAL FÍSICO Y MONETARIO.
MILLONES DE TONELADAS Y MILLONES DE US$ DEL 2000. ARGENTINA. 1970-2009

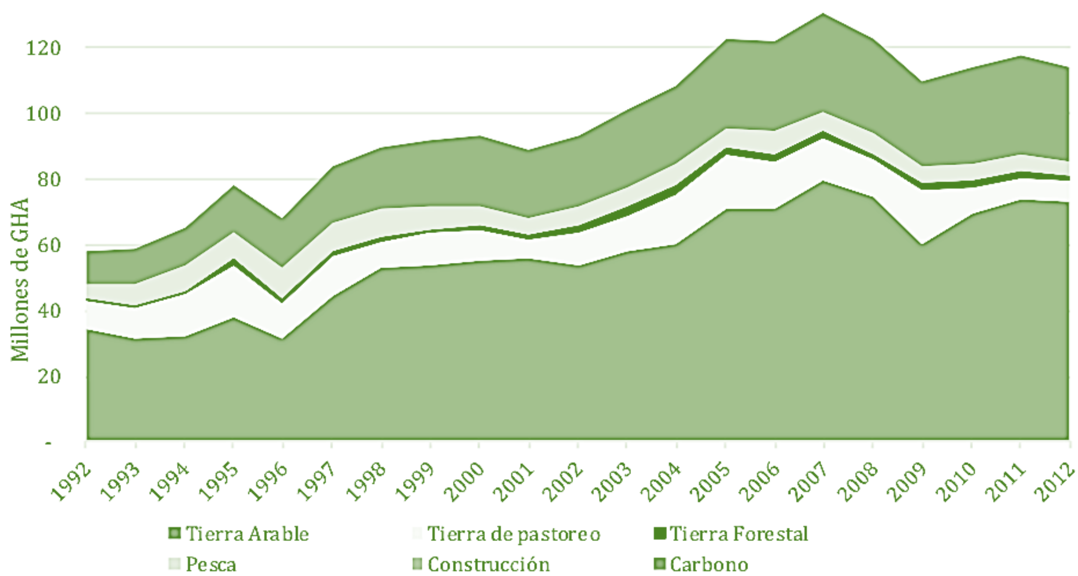


Fuente: Walter, Brun, Pérez Manrique, González Martínez y Martínez Alier (2013: 95).

En el gráfico 5 se aprecia cómo la tendencia creciente de las exportaciones en términos monetarios se encuentra asociada a una creciente exportación de materiales y energía en términos físicos, mientras que el crecimiento en términos monetarios de las importaciones no se encuentra tan asociado a incremento en los volúmenes de materiales y energía importados. El Intercambio ecológicamente desigual queda claramente expresado en años como 2000 en los que mientras el saldo comercial en términos monetarios fue cercano a cero (es decir una balanza comercial monetaria relativamente equilibrada), el saldo comercial físico fue altamente deficitario para Argentina. A partir de allí comienzan a mejorar los términos del intercambio para países periféricos como Argentina, pero aun siendo desfavorables. "Esta figura ilustra así la trampa en la que Argentina se encuentra, en la que, para aumentar sus ingresos necesita exportar crecientes cantidades de materiales. Pero, ¿a qué costo socio-ambiental?" (Walter, Brun, Pérez-Manrique, González Martínez, & Martínez Alier, 2013: 96)

Así, la inserción de Argentina en la economía mundial esconde un balance deficitario en términos de materiales y energía que implica una reducción inmediata del capital natural determinada por los recursos no renovables (minerales e hidrocarburos), y que presiona directamente sobre la biocapacidad existente al implicar desgaste y erosión de las aptitudes naturales de recursos renovables.

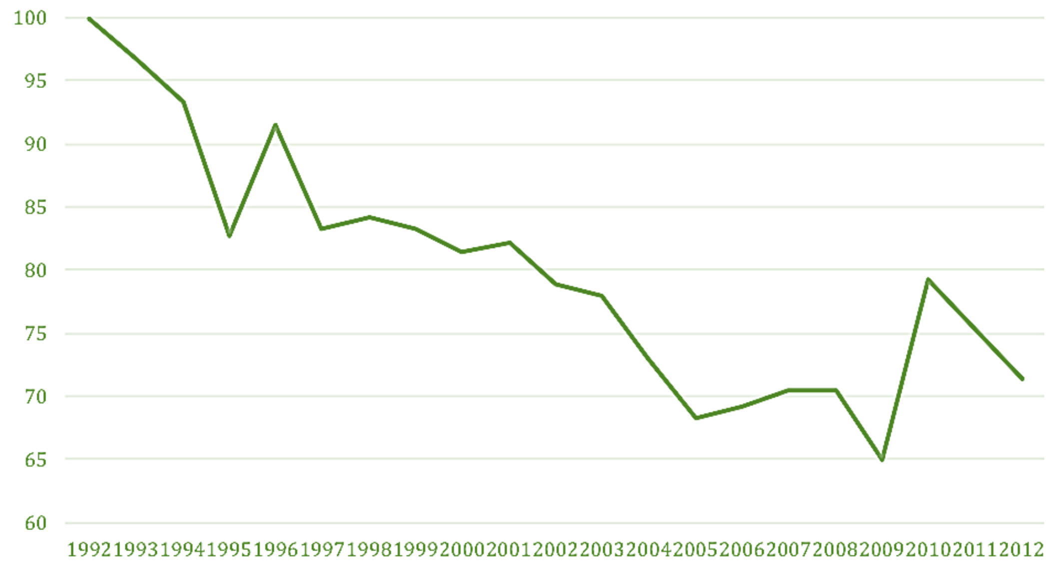
GRÁFICO 6. COMPOSICIÓN DE LAS EXPORTACIONES SEGÚN LA HUELLA ECOLÓGICA. ARGENTINA. 1992-2012



Fuente: elaboración propia en base a datos de www.ecologicalfootprint.org

Observando el gráfico 6 podemos ver que la huella ecológica de las exportaciones se incrementó un 96% en el periodo 1992-2012, cambiando su disposición. En este sentido, se destaca la categoría tierra arable que presentó una expansión del 113% poniendo de manifiesto la preponderancia de los productos primarios (en especial, la soja) en las exportaciones. Si comparamos este aumento de la huella ecológica con la biocapacidad en términos per cápita, tomando como año base 1992, podemos concluir que hubo un incremento del déficit ecológico cercano al 30%. Esto es producto tanto de una caída en la biocapacidad como del aumento de la huella ecológica de ltas exportaciones producto de una utilización intensiva de recursos.

Gráfico 7. Diferencia entre biocapacidad y huella ecológica de las exportaciones (per cápita). Base 100=1992. Argentina. 1992-2012



Fuente: elaboración propia en base de datos base a datos de www.ecologicalfootprint.org

Conclusiones

En este trabajo visibilizamos a través de los indicadores monetarios y biofísicos como los procesos de endeudamiento en Argentina se tradujeron en un incremento del intercambio ecológicamente desigual y el aumento del déficit ecológico, es decir, la reducción del capital natural. Esto profundiza la dependencia hacia los países centrales debido, por un lado a un proceso de endeudamiento previo y, por otro lado, a la consolidación de una matriz exportadora centrada en productos primarios que se utiliza para pagar dicho endeudamiento y sus intereses.

Así se vislumbra como la deuda externa y la deuda ecológica están vinculadas (Aguilar González, 2013). La obligación de pagar la deuda externa y sus intereses obliga a conseguir un excedente monetario que como podemos observar, en gran parte, proviene del proceso de reprimarización económica y de un intercambio ecológicamente desigual. Esto profundiza un patrón de dependencia entre países acreedores de deuda externa (países centrales) y países acreedores de deuda ecológica (países periféricos) ya que solo la primera es reconocida.

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Responding to economic and ecological deficits

Jonathan Harris*

Introduction

Macroeconomic theory was shaken up in the wake of the 2008 financial crisis, with neoclassical approaches proving inadequate to analyze or respond to the need for policy action. Despite efforts to return to more conventional macro perspectives, a continuing re-evaluation of economic theory has important implications both for traditional economic concerns such as employment and inflation, and for ecological issues and the climate crisis. One important aspect of this reorientation of theory is the analysis of economic and ecological deficits.

To some degree, the aftermath of the fiscal crisis led to a rebirth of Keynesian theory and policy. In the simplest terms, a classical or neoclassical view is best suited to a stable and growing economy, so that an economy that suffers from severe instability, and as a result plunges into major recession, necessitates a rethinking of classical principles, exactly the process that led Keynes to propose his alternative view in the 1930's. A somewhat similar rethinking was initiated by the financial crisis, but has been left incomplete, especially in terms of its ecological implications.

In the urgent situation of 2008/2009, when the economy of the United States and in many respects the entire world economy hovered on the brink of a new Great Depression, policymakers in the U.S. turned to Keynesian solutions: government action to rescue the banking system and to stimulate the economy through expansionary fiscal and monetary policy on a massive scale, significantly increasing fiscal deficits in the process. European policy makers were slower to adopt such measures, but there is considerable evidence that large-scale stimulus in the United States and in China saved the world economy from a 1930's-type fate.

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At roughly the same time as the economic crisis unfolded, awareness was growing of the urgency of environmental problems, especially climate change. One of the features of the economic stimulus program adopted under the Obama administration in 2009 was a significant "green" component, including such measures as investment in energy efficiency, renewable energy, and other green spending. Green stimulus government spending in China was even higher, at over $200 billion (Tienhaara, 2018).[1] Thus the response to the economic crisis also involved at least a partial response to environmental crises as well.

The practical evidence of the success of Keynesian policies, including "green" investment, has not lead to a major change in either macroeconomic theory or practice. The European Central Bank eventually followed the lead of the U.S. Federal Reserve, adopting monetary expansion and "quantitative easing", expanding the monetary base and implicitly accepting that classically-oriented policies of austerity were a mistake, but there was no rush in the economics profession either in the U.S. or Europe to revise standard economic theory. Once economies had recovered significantly enough to reduce the immediate crisis and risk of collapse, it seemed that standard approaches were once again good enough to analyze economic developments, with perhaps a grudging nod to the temporary need for fiscal and monetary stimulus. Potentially larger-scale green Keynesian polices, such as extensive investment in the solar power, especially in high-potential areas such as southern Europe or the U.S. South and Southwest, have not been pursued.

Some critics have argued that "green" Keynesianism presents an apparent paradox: if green Keynesian policies are effective at promoting growth they will likely be harmful to the environment, yet if they are environmentally effective they will not encourage much growth (Blackwater, 2012). But the key to resolving this paradox is to think about how economic activity can be specifically directed with Keynesian policies.

Instead of thinking of consumption (C), investment (I), and government spending (G) in the aggregate, we can divide each of these terms into a component that is resource- and energy-intensive and another that is more environmentally benign. Thus, it is possible to achieve a growing economy (measured in terms of employment and well-being) while reducing throughput—the flow of inputs into the economy and outputs of wastes and pollution into the environment. As I have suggested elsewhere:

> *We can distinguish between those macroeconomic aggregates that should be strictly limited – resource-intensive consumption and investment, and energy-intensive infrastructure – and those that can expand over time without negative environmental consequences. The latter would include large areas of health, education, cultural activity, and resource- and energy-conserving investment. . . there is plenty of scope for growth in economic activity concentrated in these categories, without growth in resource throughput, and with a significant decline in the most damaging throughput, that of carbon-intensive fuels (Harris, 2013: 72).*

There is an extensive debate on the possibility of achieving "absolute decoupling" – reducing overall resource inputs, specifically carbon-based fuels, while "growing" the economy. Advocates of "degrowth" argue that absolute decoupling is unlikely to be possible, meaning that consumption must be reduced if carbon reduction targets are to be achieved (Victor, 2008; Jackson, 2009; Martínez-Alier, Joan *et al.*, 2010; Kallis *et al.*, 2012; Kallis, 2018). But regardless of whether we anticipate only "relative decoupling" – reducing the carbon

1 http://www.wri.org/resources/charts-graphs/green-stimulus-spending-country.

intensity of the economy – or absolute decoupling, some form of green Keynesian policies will be essential to redirect economic activity away from a carbon-intensive path (Pollin, 2015, 2018).

The use of Keynesian policies, whether conventional or "green", raises the issue of deficits. Keynesian policy, of course, often involves fiscal deficits. A well-established conservative critique of Keynesianism claims that it attempts to achieve short-term stimulus at the expense of increased deficits and debt, which will ultimately damage the economy, most likely through inflation but also possibly through an eventual sovereign debt crisis. Numerous predictions of ruinous inflation by conservative critics of the Obama stimulus failed to materialize, but the issue of deficits and long-term debt remains an important issue.

Another kind of deficit is also relevant to green Keynesian analysis and policy. Ecological deficits, not a traditional concern of mainstream economics, have been introduced as an important topic by measures such as the Genuine Progress Index (Talberth *et al.*, 2007; Talberth and Weisdorf, 2017) and ecological footprint analysis (Wackernagel and Rees, 1996). These ecological economics perspectives emphasize that economic growth is typically accompanied by increased resource and environmental demands, often in excess of regional or planetary capacity. Just as a traditional deficit arises from government spending in excess of its revenues, an ecological deficit is created when an economy withdraws resources in excess of the ecosystem's capacity to renew them, or overloads the ecosystem with waste outputs in excess of its ability to absorb them. There are various ways of measuring such ecological deficits, discussed further below. A prime goal of green Keynesianism must be to reduce or eliminate ecological deficits.

In the years since the financial crisis, both economic and ecological deficits have increased. This poses a challenge for "green Keynesian" policy. It is therefore necessary to have effective analyses to measure and respond to ecological deficits, and policy measures to deal with economic deficits.

This paper proposes a new approach to measuring ecological deficits, and a new perspective on economic deficits and debt. The analysis involves reconceptualizing economic growth and degrowth and provides an alternative to current U.S. policies under the Trump administration, which are contributing to widening both deficits.

1. Measuring ecological deficits

The best-known measure of ecological deficits is the ecological footprint concept. This measures the use of ecological assets "including plant-based food and fiber products, livestock and fish products, timber and other forest products, and space for urban infrastructure," including for waste absorption, and compares it to biocapacity measured in standardized hectares of global average productivity.[2] When asset use as measured by the ecological footprint exceeds available biocapacity, there is an ecological deficit, for a country, region, or the world as a whole. The global ecological deficit is estimated at 70% of global biocapacity, or as the Footprint Network more dramatically puts it, "humanity uses the equivalent of 1.7 Earths to provide the resources we use and absorb our waste."

2 See https://www.footprintnetwork.org/our-work/ecological-footprint/

A basic principle for ecological macroeconomics should be that resource use should not exceed biocapacity, and the ecological footprint analysis broadly indicates that this principle is being violated for the world as a whole, as well as for major countries and regions including as the United States, the European Union, and China. A more disaggregated view of the ecological footprint, however, reveals some serious shortcomings of the measure.

The footprint analysis divides land (and water) types into five major categories: built-up land, cropland, fishing grounds, forested land, and grazing land, with an additional category for carbon emissions, based on a theoretical estimate of how much land would be required to absorb carbon emissions. The methodology used calculates "global hectares" based on world average biological productivity for each type of land use for a given year.

One result of this methodology is that the biocapacity and footprint for the category of cropland are identically equal, indicating neither surplus nor deficit. (The identity is left unchanged by either expansion of cropland area or change in cropland productivity. For example, a 10% increase in global average cropland productivity would increase both cropland biocapacity and footprint by 10%, cancelling out exactly.) The same notional equivalence is applied to built-up area: its "productivity" is considered to be exactly what is needed for the functions of urban or suburban use. For fishing grounds, forest products, and grazing land the total global biocapacity in each case exceeds the footprint of human use (see Table 1).

TABLE 1. GLOBAL ECOLOGICAL FOOTPRINT AND BIOCAPACITY[3]

2014 trillion global hectares	Carbon	Built-up land	Cropland	Fishing grounds	Forests	Grazing lands	Total without carbon	Total with carbon
Biocapacity	0	0.5	4.0	1.1	5.2	1.5	12.2	12.2
Footprint	12.4	0.5	4.0	0.7	2.0	1.1	8.2	20.6
Surplus/deficit	-12.4	0	0	0.4	3.2	0.4	4.0	-8.4

Source: authors´ calculation.

This breakdown of land use means that if we sum up total global biocapacity and total global footprint *excluding* carbon emissions, the result is a global surplus: global biocapacity for 2014 was approximately 12.2 trillion standard hectares, while footprint requirements were approximately 8.2 trillion hectares, resulting in a net global surplus of 4 trillion hectares. But when the carbon category is included, this surplus turns into a deficit of 8.2 trillion hectares (Table 1). Thus the global ecological deficit, as estimated by footprint analysis, is entirely due to excessive carbon emissions. The forest, fishing, and grazing land categories each show a surplus, while cropland and built-up land show an exact balance as a necessary result of the methodology employed.

For purposes of ecological macroeconomics, this approach has serious problems. Taken at face value, it indicates no significant ecological problems with cropland, forest land, grazing land, and fisheries, since each category shows either a surplus of biocapacity over human use or, in the case of cropland, an exact equivalence. Conceivably deficits in these categories could arise at some point in the future if demand for forest products, fishery products, or grazing

3 http://data.footprintnetwork.org/#/countryTrends?cn=5001&type=BCtot,EFCtot

land grew significantly; but for cropland there will never be a deficit. Even if, for example, soil depletion cut agricultural productivity in half, this would simply reduce both output and biocapacity by the same amount, still giving an exact equivalence between the two.

The forest measurement is also problematic, since it compares total forest area to annual demand for forest products, converted into area terms via the global hectares methodology. This means that Brazil, for example has a large surplus of forest biocapacity, which in turn drives a large surplus in its ecological footprint as a whole. But this does not mean that there is no significant deforestation occurring in Brazil. It only indicates that demand for forest products in a single year is not sufficient to deforest the entire Brazilian Amazon, thereby confusing stocks (of standing forest biomass) and flows (of forest biomass annual harvest). Clearly, this is not the measure we should seek to indicate ecological deficits in forest management.

Even the carbon measure, which is what drives the "1.7 Earths" overall planetary deficit, has a significant problem. Suppose that it was possible, at some point in the future, to reduce global carbon emissions by 67%. If the other land use and biocapacity categories remained at about the same level, the deficit due to the remaining carbon emissions would be exactly offset by the surplus in forests, fishing, and grazing lands. This would eliminate overshoot in the global footprint, making it appear that resource use on the planet as a whole was sustainable (i.e. we would need only one Earth to supply human needs). But this result would conceal both the continuing increase in carbon accumulation and all other problems associated with deforestation, cropland and grazing land degradation, water overdraft, etc.

The ecological footprint analysis has played a useful role in drawing public attention to the concept of planetary overshoot, but in order to have a reliable indication of actual ecological deficits, we need more disaggregated measures, using different principles and methodology.

Rather than using total biocapacity as a standard, the operative principle for an ecological deficit measure should be that withdrawal or demand for resources or waste absorption should not exceed regenerative capacity in any given period, consistent with ecological economics principles articulated by Herman Daly (Daly, 1996). Since there is no single unitary measure for depletion or degradation of different kinds of resources, it will be necessary to measure different kinds of deficit for different resources, with a goal of reducing all of these to zero or replacing them with surpluses. A basic list of important areas of ecological deficit should include:

1. Carbon. Human generated carbon emissions in excess of natural absorption capacity constitute an ecological deficit that needs to be reduced to zero (or to a surplus, meaning net carbon absorption). This is the most obvious and urgent ecological deficit, and must serve as a fundamental guide to macroeconomic policy.

2. Forests and Wetlands. No net loss of forests and wetlands is a minimal goal. But in order to make progress towards the carbon goal, it will almost certainly be necessary to expand forest and wetland area, requiring protecting existing forests and wetlands as well as reforestation or forest and wetland expansion. Different types of forest need to be accounted for separately, since replacing tropical forest with second-growth or plantation forest, or with additional forests in temperate zones, represents a net ecological loss.

3. Soils. Degradation of soils can be measured by loss of nutrients and carbon. This is a more appropriate measure than agricultural productivity, since increases in short-term yields can mask long-term degradation. Increasing soil carbon is also likely to be essential to the atmospheric carbon emissions reduction goal, so this also is an area where eliminating deficits is not sufficient; we need to move to surplus, in the sense of building up soil carbon and other nutrients.

4. Fisheries. Numerous global fisheries are in decline; to meet ecological criteria fisheries need to have stable fish biomass and ecological balance. Note that in theory some reduction in total fish biomass below maximum natural levels is acceptable, provided that the reduced level is stable and provides for sustainable yield over time. But most fisheries are already at or below sustainable yield levels.

5. Grazing Lands. As with soils, the quality of grazing lands needs to be maintained or improved over time. Excessive grazing and degradation of grazing lands constitutes an ecological deficit.

6. Water. Depletion or degradation of groundwater is an ecological deficit, as is sustained water pollution. Water withdrawals need to be at sustainable levels, taking into account reduced rainfall or snowpack resulting from climate change.

7. Biodiversity. Species loss is a clear ecological deficit. It is not possible under current circumstances to reduce species loss to zero, but that goal needs to be approached as much as possible. This objective, of course, is interrelated with deficit reduction goals for forests, wetlands, fisheries, and land use in general. Built-up land will inevitably increase over time, but specific locations need to be restricted to protect biodiversity; the same is true for expansion of agricultural land and grazing lands. Agricultural and grazing techniques are also highly relevant to biodiversity, with agroecological techniques being essential.

This listing is certainly not exhaustive, but the use of these deficit measurements to guide macroeconomic and industry-level policy would be a huge improvement over current practices, and has significant implications for economic theory, including the analysis of more traditionally measured deficits and debt.

2. Assessing economic deficits

Concern over economic deficits has traditionally been the province of conservatives, who criticize Keynesian willingness to engage in government spending, but recent developments in the U.S. have turned the usual logic on its head. The large individual and corporate tax cuts passed by the Trump administration and the Republican Congress in December 2017 brought warnings from more Keynesian-oriented economists that stimulus was being applied at the wrong stage of the economic cycle, and the Congressional Budget Office projected that, after falling during the later years of the Obama administration, the deficit was once again set to soar over $1 trillion by 2019 (CBO, 2018).

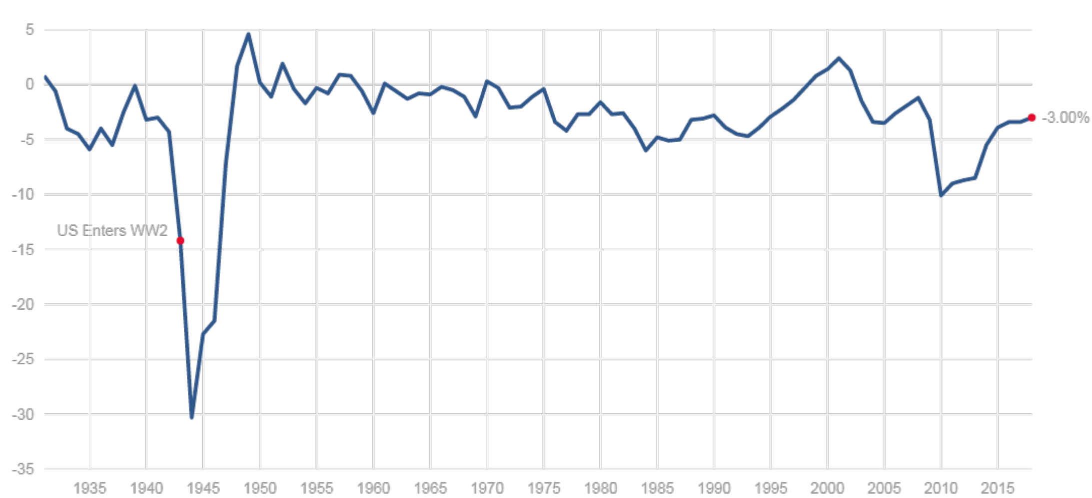
How can we evaluate this situation? One rule of thumb that has often been used by Keynesian analysts to evaluate deficits and debt is that deficits, measured as a percent of GDP, should on average be no higher than the rate of economic growth. While giving some flexibility for stimulatory spending or tax cuts, this rule would keep the debt/GDP ratio approximately constant. After running large deficits during the economic crisis and recovery period of 2009-2014, leading to a significant increase in the debt/GDP ratio, the Obama administration appeared to be more or less back in accordance with the rule by 2015, with deficits of $500-600 billion, or about 3% of GDP, in fiscal years 2015 and 2016 (Figure 1). But the Trump administration has moved rapidly back to larger deficits, with the deficit currently on track for over $1 trillion or about 5% of GDP, by 2019 (Figure 2).

What are the problems with increasing deficits and a rising debt/GDP ratio? One important issue is that high deficits and debt constrain infrastructure investment. This is especially the case with the Trump tax cuts, which benefit primarily upper-income taxpayers and large corporations (Figure 3). While increasing inequality, they also create a situation where social spending and infrastructure investment can only be achieved at the cost of even higher deficits.

If we adopt goals of stabilizing the debt/GDP ratio, expanding infrastructure investment including green investment, and promoting greater income and wealth equity, it will be essential to repeal most or all of the 2017 tax cuts. Some reductions in personal taxes that benefit primarily lower and middle-income taxpayers would be consistent with the goal of reducing inequality, but overall there is a clear need to raise significantly more revenue to address social and environmental goals.

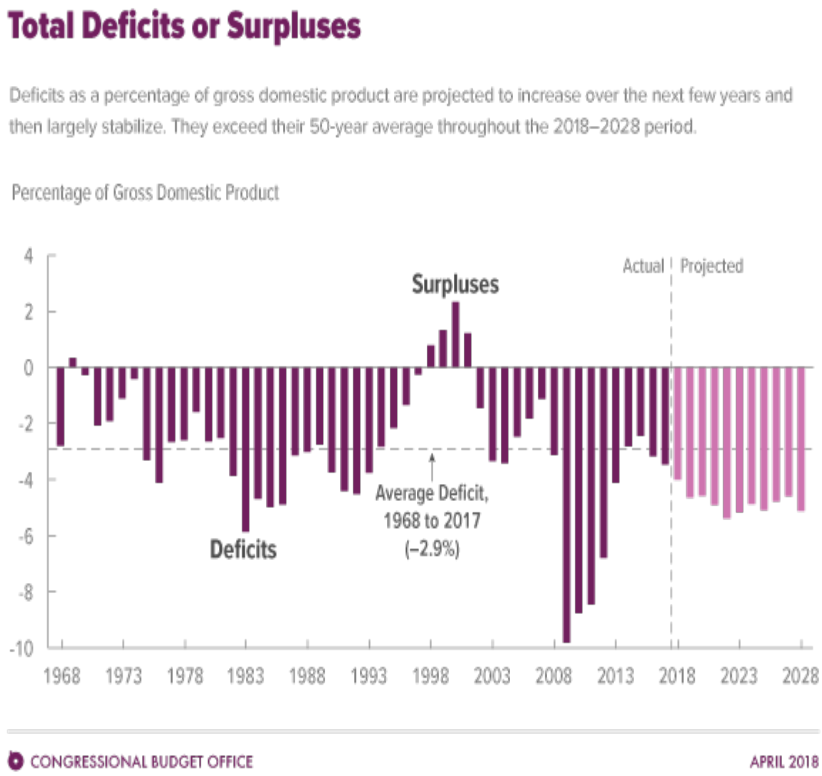
The goal of stabilizing the debt/GDP ratio would become easier with more rapid economic growth (unconvincingly promised by the Trump administration). But on the other hand a move towards a slower-growing economy would make the deficit reduction goals tougher, and the no-growth economy environed by Daly, Victor, Jackson, and others would require a balanced budget as an eventual requirement for a steady state economy (Daly, 1996; Victor, 2008; Jackson, 2009). This indicates a likely conflict between the goals of reducing economic and ecological deficits. We therefore need to explore the specific economic implications of reducing ecological deficits.

FIGURE 1: U.S. FEDERAL DEFICIT AS A PERCENT OF GDP



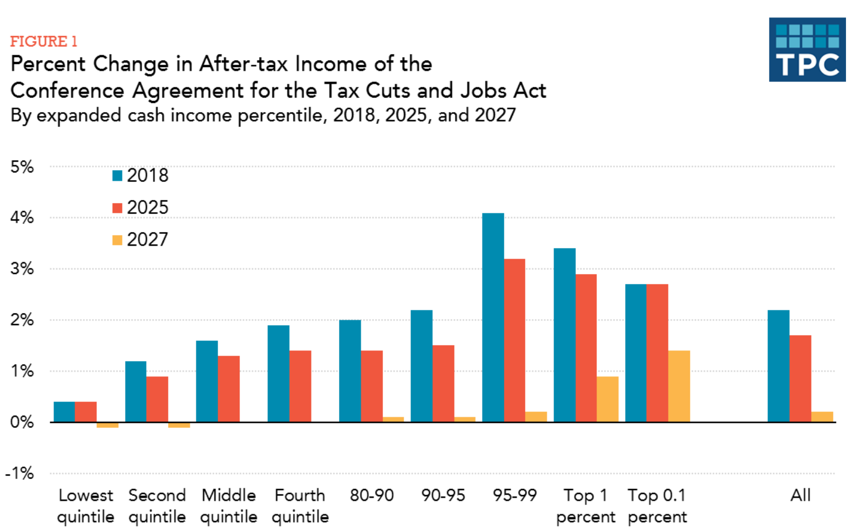
Source: White House Office of Management and Budget, Summary of Receipts, Outlays, and Surpluses or Deficits (-) as Percentages of GDP, 2016.

FIGURE 2. PROJECTED FEDERAL BUDGET DEFICITS THROUGH 2028



Source: Congressional Budget Office, 2018. CBO's Projections of Deficits and Debt for the 2018–2028 Period.

FIGURE 3. DISTRIBUTIONAL IMPACT OF THE 2017 INDIVIDUAL TAX CUTS



Source: Tax Policy Center, Distributional Analysis of the Tax Cuts and Jobs Act, 2017.

3. Policies to reduce ecological deficits

What will it take to reduce or eliminate ecological deficits? The task is huge, but it does not necessarily involve high economic costs in all cases. Most ecological deficits arise from the exploitation of "free" or low-priced natural resources. Putting a proper price on these resources can be consistent with both good economic theory and sound ecological principles, and generally implies a shift in economic techniques and activities rather than an absolute cost. In some cases, greater efficiency in resource use can save money as well as reduce ecosystem impact. In terms of the specific ecosystem deficits identified above, some policy options include:

Carbon: as noted above, an elimination of the atmospheric carbon deficit implies reducing net carbon emissions to zero, or possibly below zero to reduce atmospheric accumulations. At a minimum, this requires a complete transition away from carbon-based energy to energy efficiency and renewable energy. But it also almost certainly involves significant additional carbon absorption by forests, soils, and wetlands. Some aspects of this massive project will have major economic costs, specifically the infrastructure investment needed to create a new energy and transportation economy. Some of these costs will be borne by private companies, responding to economic incentives such as carbon taxes or cap-and-trade programs. But some will require government investment, which could in theory be offset at least in part by carbon tax revenues. Since carbon taxes are regressive, a portion of the revenue stream associated with them needs to be channeled into individual per capita rebates (which have the effect of changing the net tax impact from regressive to progressive or at least proportional), or into social investment that primarily befits lower-income individuals and families, such as health care and education. To the extent that necessary infrastructure investment is not covered by remaining carbon tax revenues, it will need to be funded out of general government budgets.

Forests and Wetlands: Protecting existing forests and wetlands and expanding forested area through reforestation is more a matter of implementing good policies than of major government expenditures. There may even be net positive government revenues from moving away from policies that currently subsidize exploitation of public lands through low access fees.

Soils: Agroecological practices that build up soil carbon and nutrients also do not necessarily involve large government expenditures. To the extent that costs are involved, for example through subsidies for organic and agroecological farming practices, these may be covered through redirecting existing, mostly ecologically damaging, subsidies currently favoring industrial agriculture. Another potential funding stream is certified carbon credits for carbon-storing farming and forestry practices, which can be sold to industries subject to cap-and-trade schemes. The latter raises institutional issues, specifically the need to avoid rewarding middlemen and land speculators at the expense of smallholders, but these issues are not unresolvable.

Water: In almost all areas of the world, water management and groundwater overdraft and pollution is a major issue, and in some areas it is a critical limiting factor on economic development. Climate change is likely to make these issues more pressing. But as with forests and soils, the necessary policies involve reform of current management strategies in order to conserve water, promote efficient and equitable water use, and prevent pollution. Significant expenditure is involved for water infrastructure, and since water privatization has a clear record of serious problems with inequity and corporate water overdraft, this area is an important aspect of infrastructure investment. Water pricing, if appropriately managed for equity using increasing block rates, can provide some necessary revenue.

Fisheries, Grazing Lands, Biodiversity: All of these require sustainable management techniques and protection of ecosystems. Large expenditure is likely not necessary, and as with agriculture and forests, the redirection of current perverse subsides and the imposition of appropriate license fees, replacing e.g. giveaways of public land for grazing, can generate some additional revenue. Effective species and ecosystem protection requires limits on economic activity, which carry an implicit cost in terms of reduced production and possibly associated tax revenues, but direct government expenditures, for example for land acquisition, are probably not large.

In summary, the elimination of ecological deficits requires massive reform of current policies and significant modification of economic production techniques, but not necessarily large public expenditure, except for necessary infrastructure investment.

4. Policies to control economic deficits and debt

As has been noted, the politics of deficit management has undergone a shift in recent years. Deficit alarmism has historically been used by conservatives primarily to call for cutbacks in social spending and "entitlements" (a loaded term intended to convey that fundamental social security and medical care are a kind of freeloading). Genuine concern about the need to control deficits would take a different form. As noted above, a reasonable initial goal would be a deficit of no more than about 3% of GDP, gradually reduced over time. This might be achieved by various measures on both the spending and revenue sides of the budget:

Spending: Major cuts in essential social programs such as social security, Medicare, and Medicaid in the U.S. and comparable programs in other countries, should be ruled out. If anything, spending in these areas is likely to increase to meet social needs. Cost controls in the medical area, however, can make a big difference in the rate of increase without necessarily impacting the quality of health care, by shifting emphasis to preventative programs and moving towards single-payer insurance. Greater efficiency in other areas such as military spending can also reduce overall expenditure (without getting into debates over appropriate levels of military preparedness and deployment). The distribution of Federal expenditures means that other than improved efficiency in these areas there is little opportunity for cutbacks in spending without doing damage to essential government functions. One area that could potentially be reduced is agricultural subsidies, but this represents a small portion of the overall budget, and as noted above there may be a need to shift these subsidies rather than eliminating them, to encourage more agro-ecologically sound farming practices or land conservation.

Revenue: Clearly, given limited opportunities for expenditure reduction, reducing deficits must depend on increased revenues. In the U.S., this implies at a minimum reversing most of the 2017 tax cuts, especially those for upper-income individuals, and closing loopholes such as the infamous carried interest provision. There is room for continuing debate about appropriate corporate tax rates, but it is notable that earlier discussions of lowering corporate tax rates proposed lower rates as a tradeoff for closing loopholes; in fact, the 2017 tax package did little or nothing to close major loopholes. Another opportunity for increased revenue is a carbon tax with rebate. A carbon tax can be made progressive or at least proportional without rebating all revenue, meaning that some net revenues received from upper-income (and high-energy consuming) taxpayers could be available for deficit reduction. Another option is a financial transaction or "Tobin" tax, set at a very low rate but with significant revenue potential due to the high volume of financial transactions.

The main reason for the currently increasing Federal deficits in the U.S. is the 2017 tax cut package, not rising "entitlement" spending (Baily *et al.*, 2018). Therefore the reversal of these tax cuts is critical to economic deficit reduction, as well as to enabling the increased infrastructure spending that will be necessary to repair crumbling bridges, water systems, etc., to promote a renewable energy transition, and to reduce ecological deficits. Other sources of revenue consistent with a goal or reducing inequality will also be required for effective deficit reduction.

5. Growth, degrowth, and deficits

It is easier to manage deficits in a growing economy. But this itself is not a case for promoting economic growth. Advocates of "degrowth" suggest that technological progress and shifts to less carbon-intensive energy sources will not be sufficient to meet necessary carbon reduction goals. Therefore, they argue, reduction in overall consumption is necessary (Hickel, 2018). Peter Victor and Tim Jackson have made a case for "Managing without Growth" and "Prosperity without Growth" (Victor, 2008; Jackson, 2009).

But the picture is somewhat more complex than simply a need for "degrowth". For example, if we examine the actual requirements for reducing carbon emissions, ultimately to zero, we find very significant potential for reductions through energy efficiency and a shift to renewable sources. I have proposed elsewhere a "middle way" including aspects of technological modification and aspects of growth reduction (Harris, 2009).

We might call this approach the 2% solution, based on the following principles:

(i) reduce overall energy use by 1% of current energy consumption per year;

(ii) increase the share of renewables by 1% of current energy consumption per year.

Neither of these sounds like an impossible goal for currently developed economies. U.S. primary energy consumption has been approximately stable for the last 20 years, and has actually declined over the last 10 years, despite increasing population, while renewable energy production has increased its share by about 5% of total energy production over the last ten years.[4] As a result, U.S. CO_2 emissions have fallen by 14% over the period 2007-2016 (Figure 4).

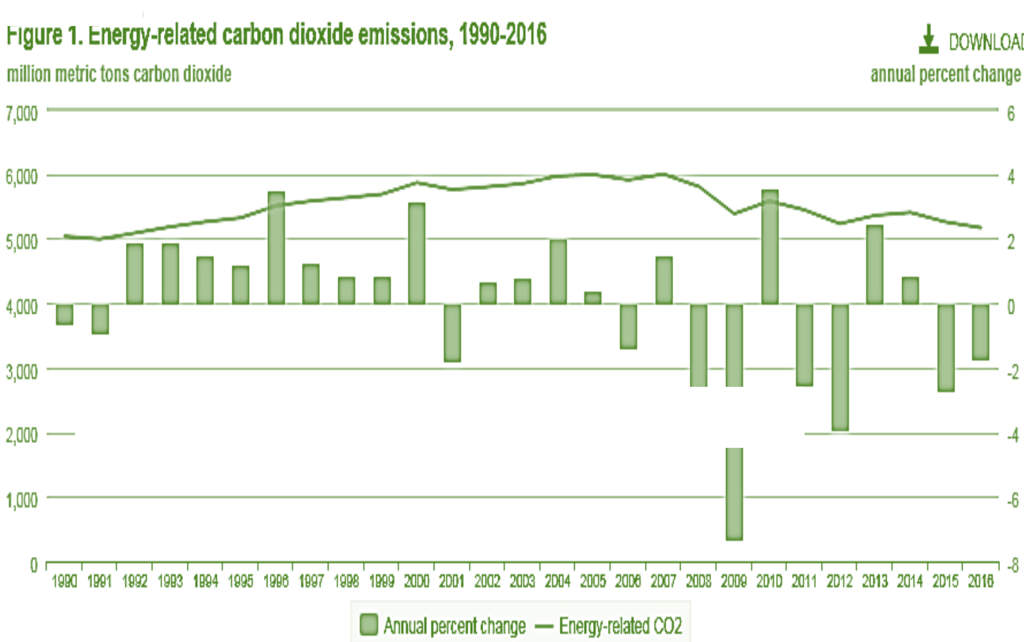
Thus, a modest increase in these current rates would lead to a net reduction in fossil fuel use of about 2% of total current energy use per year, resulting in a reduction of 50% in about 20 years (since current fossil fuel use is about 80% of total U.S. energy use), and a reduction to zero in about 40 years. This is achieved both by "lowering the ceiling" – reducing total energy use – and "raising the floor" – increasing the percentage of renewables – thereby squeezing the fossil fuel consumption between these two. Of course, the difficulty of achieving these targets would increase as we approached 100% reduction – but at least the first half of this trajectory seems relatively easily within reach (Figure 5).

4 https://www.statista.com/statistics/265571/primary-energy-consumption-in-the-united-states/; https://www.eia.gov/totalenergy/data/monthly/pdf/sec2_3.pdf; https://www.eia.gov/totalenergy/data/monthly/pdf/sec1_5.pdf

A concern with increased energy efficiency is the "rebound effect" – if it becomes more efficient, and therefore cheaper, to operate a car or air-conditioner per mile or per degree, people will tend to increase their consumption in response. This effect would tend to reduce, and possibly even completely counteract, the impact of technological progress in cutting total energy use (Sorrell, 2008; van den Bergh, 2011; Wallenborn, 2018). But this problem can easily be dealt with, at least in theory, by increasing the price of energy to compensate for the efficiency improvement, so that the net cost per mile or per degree remains the same. This strengthens the case for a carbon tax or cap-and-trade system. The barriers to implementing this are political, not economic.

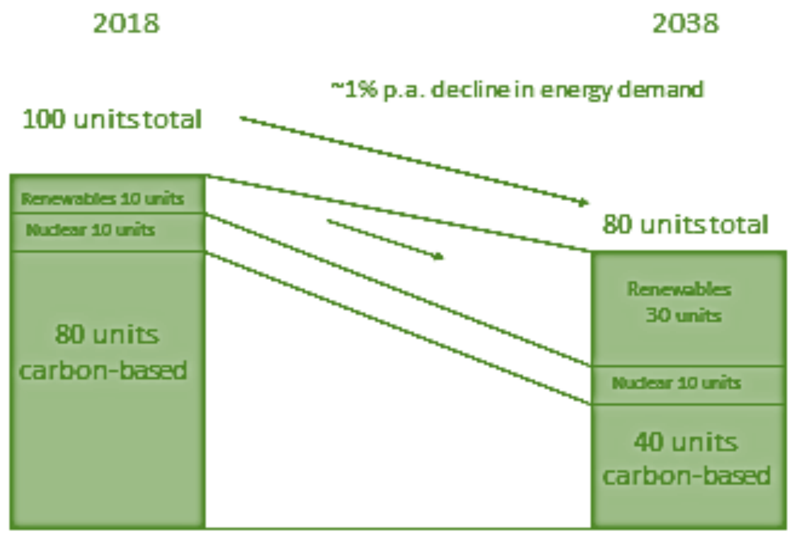
For developing economies, overall energy use is likely to increase. But for these economies, the potential for reducing the rate of increase through increased efficiency is very great since many developing economies currently have highly inefficient energy use. The potential for renewables in these economies is also great, with Bloomberg New Energy Finance predicting that wind and solar will account for 64 percent of new generating capacity to be installed over the next 25 years (Bloomberg, 2016).

FIGURE 4: U.S. ENERGY-RELATED CARBON DIOXIDE EMISSIONS



Source: U.S. Energy Information Administration, Monthly Energy Review, August 2017.

FIGURE 5: CARBON REDUCTION SCENARIO WITH EFFICIENCY AND RENEWABLES



Based on modest investment in services, efficiency, renewables, with no loss in employment (probably a gain). Nuclear clould also be replaced with renewables.

A similar logic may apply to other ecological deficits. It is true that these deficits are driven by increasing population and growth in resource use, putting pressure on forests, water, soils, fisheries, and other ecosystems. But there is considerable opportunity to reduce the deficits by efficient resource use and regenerative management.

A comprehensive study of global resource use found that best practices for efficient resource use could reduce projected 2050 resource use levels by about 50% (Dittrich *et al.*, 2012). As with carbon emissions, further reductions are more difficult, and growing population and consumption mean that resource use levels trend upward even with high efficiency. To achieve stable or declining levels of resource consumption requires both low population growth and some consumption reduction in high and medium consumption countries.

There is clearly a need for major changes both in production techniques and in the composition of consumption, with overall reduction of consumption in resource-intensive areas (e.g. meat-eating, air travel) but also the possibility for expansion of human services such as health care and education. While eliminating ecological deficits will ultimately require both population stabilization and reduction in some kinds of consumption, very significant progress can be made without requiring drastic degrowth. The infrastructure investment required for a transition to renewable energy and ecologically sustainable production can in fact be viewed as a new kind of economic growth, with huge employment-creating opportunities (Global Commission on the Economy and Climate, 2018).

6. Towards consistent and effective policies, and a new macroeconomics

Macroeconomics for the twenty-first century requires a reorientation away from standard growth-oriented models, but does not necessarily require an overall commitment to degrowth.

As Robert Pollin has argued, a "Green New Deal" could dramatically reduce carbon emissions while increasing employment, without requiring drastic reduction in consumption (Pollin, 2015, 2018). Revised macroeconomic goals should include:

(i) Rapid reduction of carbon emissions through investment in energy efficiency and renewables, and through increased carbon storage in forest and soils.

(ii) Adaptation to ecological limits to growth, including carbon limits but also sustainable use limits related to water, land, forests, fisheries, and other ecosystems.

(iii) Limiting both economic and ecological deficits, with the ultimate goal of reduction to zero.

(iv) Revenue generation through increased taxes on upper incomes and corporations, carbon tax with partial rebate, and financial transactions tax.

(v) Using "green" Keynesian policies for infrastructure investment and development of renewable energy technologies (Kemp-Benedict, 2018).

Economies based on these principles will look different, with more emphasis on human services and less on resource-intensive goods production, significantly lower overall energy use and a vastly expanded renewable energy infrastructure. But there is no reason that a combination of existing policy tools and newer ecologically-oriented policies cannot promote prosperity as well as stabilization of both economic and ecological systems. There is an increasing theoretical literature on the overlap of ecological, Keynesian, and post-Keynesian economics and the development of ecological macroeconomic models (Kronenberg, 2010; Fontana and Sawyer, 2016; Taylor, Rezai, and Foley, 2016; Hardt and O'Neill, 2017). Macroeconomic theory developed along these lines can provide better guidance than conventional approaches to understanding and responding to problems of economic and ecological deficits.

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Property rights and the economy of sand in the Mekong delta an inquiry into law in the Anthropocene

Oliver Braunschweig*

Introduction

This article brings together legal, anthropological, economic, and ecological systems analysis to advocate a re-definition of property relations and to include non-human entities as holder of rights, and to join legal and ecological landscaping-approaches in analysis. It develops these ideas through the topic of sand in the Vietnamese Mekong Delta, as sand mining has seen increasing international coverage due to the economic gain and social, environmental, and economic costs in sand mining (AFP 2016; Forsyth and Hruby 2017; Schader 2017; Wallace 2017).

Law and Property Rights

Law is a force of order. As Gordon (1984:109) writes to drive home the notion of guidance which many people perceive as the inherent importance of lawfulness: "«Either this world,» legal actions are always implicitly asserting, «some slightly amended version of this world, or the Deluge.»" But what order is and for whom, indeed even what a society is and what should be "legal", is an old and important debate.

Evolutionary Functionalism

According to Gordon (1984) evolutionary functionalism characterizes mainstream legal thought. Generally, it is a teleological theory, in which society will develop along its natural—and therefore inherent, proper, and good—development path if it is properly shepherded by law.Law shapes society and gives it its inherent, proper form[1]. What constitutes "natural" and

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1 The imagery used is on purpose reminiscent of Aristotelian thought and of Greek sculpting: The perfect sculpture (society) is in the stone. The chisel and hammer are the tools (law) of the sculptor (the judicial body) which brings out the perfection which is supposed to be inherent in the stone. This line of thought also seemed to be in line with "natural law", as based on

"good" has undergone changes from the great liberalization utopia of Scottish Enlightenment to the increasingly narrow economistic definitions of "modernization" and "political and economic development" with "efficiency" as the main benchmark, arguing that "developed" means "efficient" and vice versa).

Gordon splits evolutionary functionalism into two camps, the formalist and the realist. In the formalist variation, the legal system draws on internal traditions of legal thought to translate society's goals into a coherent legal system. The realist school focuses on law as the outcome of the judicial process, when officials interact with disputes. Legal practitioners should be immune to short-term political or economic interests, so that their self-conscious re-evaluation of social needs leads to a judicious development of law. For both schools, social and political crises are deviations from society's natural development, but while the formalist school perceived the 1930s in the US as the high point of clarity—capitalism and state clearly separated with rights clearly defined to help the development of each of these two aspects separately—while the realist school perceived the 19030s as the low point—because the legal system had lost touch with societal realities. Though Gordon clearly favors the realist school, he critiques both for thinking of law only as a *policy instrument*.

Kennedy (2011) critiques recent legal theory's focus on "Law & Economics" (L&Ec) which calls for clear and strong property rights as the main idea for good development. It draws largely on the Coasean theorem which postulates that under such legal circumstances individualist utility-maximizing behavior also maximizes society's utility. From this perspective, society first and foremost needs enforceable, transparent, and legally consistent laws, the actual distribution of rights is secondary for utility-maximization. Kennedy criticizes that this approach has not yielded more than rule-of-thumb ideas about how rules should look like, and calls out the harmful effects which come out of the approach's disregard for the *specificity of situations*.

1. Critiques and Elaborations

Drawing on several legal articles three main aspects determining the effects of law have been distilled, (1) existing power relations, (2) historical development and the creation of identities and meaning, and (3) crises and conflict. These are complementary and sometimes conflictual.

1.1 On Existing Power Relations: Interests and Domination

According to Gordon (1984) Western legal tradition at the beginning of the 20th century saw all legislation taking specific interest groups into account as bad legislation. Yet scholars like Lawrence Friedman, Gabriel Kolko, and others increasingly argued that all law was the product of interest group pressures, drawing on the experience that all legal decisions follow a struggle of differing interests with potentially huge power differentials.

One such power differential is discursive. Long (2012) draws on Hohfeld by arguing that "property" solely understood as consisting of *rights over a thing* are a discursive bulwark against community interests: A *right* creates a correlative *duty* on the side of a clearly specified other to respect this right. Yet sometimes "rights" are invoked when they are in fact "privileges",

the description of Burdon (2012).

a situation when there is freedom to do something because no duty *not to* exists. In tort law, certain damages are not legally injury ("damnum absque injuria"), the damaged has no "right" to not be damaged. To express all of these relations, Long proposes the discursive use of legal "interests" to enable a conversation *about* what ought to be the legal social relations, since property rights are *social relations through things.* While he acknowledges that safeguarding against the Leviathan is important, he also argues that it may be incomplete and one-sided. An example of his: a landowner pollutes, and a neighbor tries to prevent the pollution in court, but she loses the case.

This ruling *does not* create a *right* for the polluter to pollute, but it creates a situation of *privilege* of the polluter *in their relation to the neighbor who went to court through their property*. Though if the neighbor wins in court, she will have gained the *right to be free from her neighbor's pollution*—a ruling which created the correlative *duty* for the polluter *not to pollute*. Long argues that speaking in terms of property "interests" can help understand what really is at stake in each situation and thus help break through some property rights stalemates.

Law is not just a text, but extends to the enforcement mechanism, as it in itself constitutes a distribution of legal rights and privileges. Kennedy (1991:334) writes that in the case of laws against rape "protective rules are dramatically limited in their impact by the decision to make available only a given quantum of resources for enforcement…" so that "…rape and marital battery will be sufficiently common experiences…" to shape the relations between the genders. Individual cases aggregate to societal patterns, thus shaping webs of experiences and legal interests between people. But organized social structures may themselves also impose a whole set of laws: "Histories of legal oppressions—of slavery, Indian Removal laws, Black Codes, labor injunctions—are indispensable reminders that there's often nothing subtle about the way the powerful deploy the legal system to keep themselves organized and their victims disorganized and scared" Gordon (1984:75). Kennedy (1991:342ff) elaborates that oppressive laws may use universal-sounding language but be highly precise in their effects on specific populations, and may have deep distributional effects, again impacting the overall structure (e.g. US voting rights cases). The *structuring force* of law in society is all the more powerful because of the multiple ways in which laws or their absence shape lives: Continuing the earlier case, a *plethora* of laws impact humans of different genders in specific ways, distribute power and experiences, and structure the options available[2]. This argument asks us to consider the aggregate 'social landscapes' of laws and structures.

1.2 On Development Through History: the Creation of Meaningful Worlds

Legal social landscapes impact the development of a society. A person's upbringing and self- or other-ascribed identities shape tastes, preferences, and what is likely to be known and experienced by them. These are *direct* relations and relations *through things* (property). Kennedy (1991) elucidates these powers and the pervasiveness of normative ideas in society by drawing on Foucault. Norms play an important role in legitimizing certain actions, and institutions create transpersonal acceptance through coercion and disciplinary in networks of people—not just through raw transactional power in the Weberian sense. "Legal necessity" is

2 e.g. "the legalization of contraception and abortion, limited protection against domestic abuse, no-fault divorce, a presumption of custody in the mother, some enforcement of child support rules, and alimony without finding a fault in the husband […, or] alternatives to wife-homemaker status..." (Kennedy 1991:345)

a discursive power and draws on knowledges which form "the mystified background rules for cooperative/competitive struggle" Kennedy (1991: 362).

Purdy gives an example which shows that such ideas may fundamentally be self-referential and self-reinforcing: Market society *created* the idea of a fundamentally "free" human being because it structured society in a way that the potential participants in an exchange actually came to see themselves as equal enough to accept the other as having a right to give or not to give; and that money became an accepted way of speaking to the other's self-interest. "The organizing principle of this idea was a property rule: energy, time, and talent—in a word, labor—were defined as inherently the property of the person in whose body they resided. They were alienable, but only, as it were, at retail, not at wholesale." (Purdy 2006: 740)

This also shows that property always has a *public and a private* face—be it the question of who owns a body and a body's faculties (as laborers or as a body with a certain sex or gender) or who may do what with a piece of land. The systems which enact and elaborate these rules are themselves to a varying degree social norms and interests of different people or strata, judicial systems, and political power structures. Structuring legal patterns may impact specific identities, majorities and minorities, in different ways. Each may exhibit different structuring patterns inside themselves, and we should remember that "the practices and folk concepts of many groups in contemporary Western societies [and all others] diverge from the assumptions of their theoreticians in the academy, in government, and in law." (Hann 2009:2) The dichotomous use of "public" *versus* "private law" may hide more than it reveals, as societal conflicts on what constitutes (good) "law" also change what is "private" or "public" (see Hann 2009; Long 2012).

In all of these ways, legal systems can be hegemonic with (property) law structuring a diverse society through legitimating language and meaning-creating practices, keeping the subjects *steady enough* to inhibit (successful) rebellion.

1.3 Conflict and Crises

Gordon criticizes both the realist and the formalist approaches for not including indeterminacy *enough* in the theory, a demand to expand on Critical Legal Histories' process-orientation: Law tends to reflect hegemonic interests but societal structures are not static. Interests and interpretations of justice change, giving rise to formerly inexistent conflicts. In these moments the fundamental *indeterminacy* and contextually informed meaning of laws becomes truly palpable. Kennedy (1991) notes that actors put much force into the settlement of seemingly "small" issues on a daily basis. They know that the *aggregate of small issues*—the landscape of law—truly affects social power distribution. But crises bring forth all of what is at stake; they show the system's malleability.

Ecological crises are often felt as social or economic crises, and yet ecological concerns are often seen as distinct from questions of property rights. Long disagrees with this, and he focuses on property "interests" and Hohfeld's differentiation of "rights/duties" and "privileges" due to its "…rhetorical effect as we engage in community discussions about how we should or should not regulate land." (Long 2012:335) A discussion of interests allows for better-informed decision-making by discussing the forces coalescing on a specific topic, while a mere focus on rights paints non-individual interests as inherently oppressive. While "efficiency", both legally and economically, concerns itself with the micro-level—because aggregation is treated as simple—interests become palpable at many different scales of analysis, also as spatially or temporally occurring phenomena, where ecological concerns and crises often figure. Through a focus on interests a community can weigh the different legitimate interests. This often places heavy weight on scientific inquiry, since causal relations are important to understand how divergent interests are connected.

It serves to remark that ecological crises are truly global by now, so that even the Stratigraphy Commission of the Geological Society (which formally designates geological eras) is considering whether Earth has left the Holocene and entered the 'age of humanity', the Anthropocene, in which "people have become a force, arguably the force, in the development of the planet. From atmospheric chemistry and global weather patterns to biodiversity, the world we inhabit is increasingly the world we are creating." (Purdy 2015b:1620f)

Locally and globally, ecological and legal systems demand analysis, and since ecological crises are aggregate crises—often only palpable at the landscape- or phenomenon-level—the way in which these systems are analyzed becomes a central legal concern. Burdon (2012), for example, suggests to conceive of humans as fundamentally and legally *embedded* in webs of interaction and dependence with the rest of what he terms "Earth Community"—all the living and non-living entities on earth. Sand and—more generally—*land* is such non-living entity. In order to discuss how sand may come to matter legally, we will now delve into the case of this thesis.

2. The Vietnamese Mekong Delta Embedded

In an attempt to answer the legal call to consider different analysis-scales, we will follow the ecological system analysis of Allen et al. (1984). Their approach describes *emergent behavior*[3] and lays out a systematic approach to deal with them: Data collection of a specific grain and extent makes visible what they call a "surface". By changing grain and/or extent, one may move into or out of such surfaces. From these parts one may, finally, *infer* the whole. Yet "jumps" in logic always exist, because certain surfaces evade clear connection—the system exhibits emergent behavior[4].

In our case, we will describe the economic uses of sand and the problems associated with over-exploitation. Then, in an attempt to describe today's world and possibilities, we will turn to the ecological system and social history of the Mekong Delta, local epistemologies, and current economic and socio-political power structures. Finally, possible intervening strategies and thoughts on legal theory will be presented.

2.1 Economic Development and Sand

Sand and gravel ("aggregates") are the most mined materials (68-85%), and after water they are the most widely used resource in the world, especially in construction. Concrete consists of

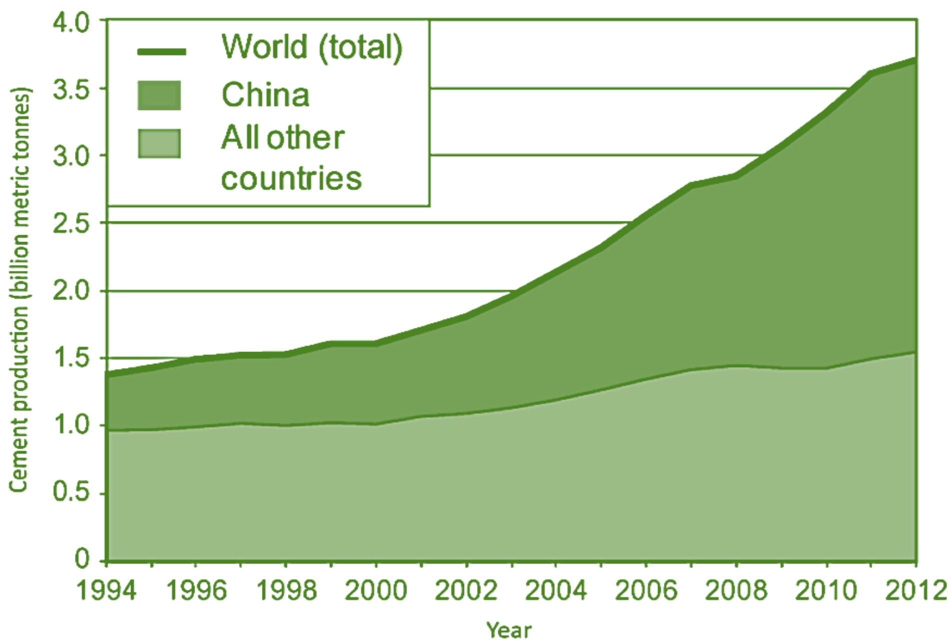
3 This is an important discussion also in Economics, where mainstream theoreticians often argue that emergent patterns are either negligible or actually inexistent. For a critical engagement, see e.g. Kirman (1992).

4 Emergence does not necessarily mean that there is no way at all to connect different surfaces. It does mean that there may not be a way for human science to do so (yet—or ever).

one part cement, 7 part aggregates, and water. Yet aggregates also find use in land reclamation and drainage systems, as construction foundations, and for the production of glass, electronics, and aeronautics. Sand and gravel are at the heart of current economic system(s).

Construction also boomed in South-Eastern Asia during the massive capitalist-inspired economic growth of the past decades, contributing significantly to tripling worldwide cement use (a proxy for construction and for aggregates use) 1994 and 2012 (see Illustration Illustration). In 2012 China used 58% of the world's cement production, while Singapore has been the biggest *importer* of sand over the past 20 years (mostly for land reclamations). These sharp increases in the use of aggregates for exclusively human ends have made "humankind the largest of the planet's transforming agent with respect to aggregates" (Peduzzi 2014:2)—humanity uses twice the yearly amount of aggregates carried by all the rivers in the world.

ILLUSTRATION 1. WORLDWIDE CEMENT PRODUCTION,
A PROXY FOR WORLDWIDE AGGREGATE USE



Source: Peduzzi (2014).

The resulting decline in fluvial and alluvial aggregate repositories through sand dredging has even led extractors to start mining the sea floor despite higher costs. (Partly becase it requires heavy washing to inhibit salt-related corrosion of metal structures in concrete.) While economic growth has alleviated poverty, aggregate use has increasingly led to adverse socio-economic and ecological effects, as many species crucially depend on it in rivers, as sediments, on sea floors. (Peduzzi 2014) Dams, restricting both the flow of water and of sediments, have so far largely been built in the upper Mekong, mostly in China (Arias 2013:34–37), and between 1990 and 2004 total yearly sediment load has decreased from 160 to 75 million tonnes. (Goichot 2016) (See Table Table for the main ecological consequences of missing sand).

TABLE 1. THE MAIN CONSEQUENCES OF AGGREGATES EXTRACTION

Impacts on	Description
Biodiversity	Impacts on related ecosystems (for example fisheries)
Land losses	Both inland and coastal through erosion
Hydrological function	Change in water flows, flood regulation and marine currents
Water supply	Through lowering of the water table and pollution
Infrastructures	Damage to bridges, river embankments and coastal infrastructures
Climate	Directly through transport emissions, indirectly through cement production
Landscape	Coastal erosion, changes in deltaic structures, quarries, pollution of rivers
Extreme events	Decline of protection against extreme events (flood, drought, storm surge)

Source: Peduzzi 2014: 2.

The Mekong River, and the Tonle Sap Lake[5] which it feeds, are one of the biggest inland fisheries worldwide, but mining and erosion destroy habitats and disturb the fish populations. Between 1998 and 2008 crops have increasingly been ruined because water level drops in the delta have led to deeper saltwater intrusions. Though formerly growing, the delta is now receding by around 12 meters a year. (Forsyth and Hruby 2017; Goichot 2016; Mulhollem 2013) In other words, the actions of many individuals, of states and of firms lead to large aggregate changes in the ecosystem and the landscape. It is in these social and ecological systems that we will try to identify systemic factors to bridge the gap between knowledge and practice (see Nassauer and Opdam 2008).

It serves to describe social history as embedded in ecosystems to conceptualize humans' responsibility towards a healthy ecosystem (see Williams 1980) and to minimize the possibility of inadvertently deepening the metabolic rift which undergirds the current problematic configuration of humans in the ecosystem (Schneider and McMichael 2010). In this spirit we are reducing grain and increasing extent from sand-mining processes (phenomenon) towards the larger system (spatial analysis).

2.2 The Mekong Delta Ecosystem and Human Life

The Mekong River Delta spans an area of 39'000 km² (Renaud and Kuenzer 2012:3), and can be seen as a large sponge between land, sweet water, and salt water (see illustration Illustration). During the monsoon season heavy rains, water flows, and simultaneous high tides cause land inundations for months. During the dry season, salt water intrudes into up to a third of the delta (see illustration Illustration). These seasonal floods have deeply affect species'

5 The Tonle Sap Lake in Cambodia is a major part in the world's largest freshwater flow reversal system: Its main tributary fills it during the wet season and again discharges it during the dry season. The lake undergoes large size fluctuations and naturally reduces flood intensities in the delta. (Arias 2013).

reproduction (such as fish, upon which both peasant and capitalist economies depend). They reduce salinity and lead to "an explosive annual reproductive out-burst" through nutrient release from inundated soils (Pantulu 1986, in McElwee and Horowitz 1999: 40).

This release also causes high levels of acidity through decomposition (in dryer areas the pH level may fall to less than 3). Seasonally inundated areas are often grasslands. The floods are also the crucial importer of nutrients into the delta. (Sterling, Hurley, and Le 2006: 265–70) And still, the ecological system of the delta is still not very well understood, with research on social as well as ecological aspects lacking—partly due to disrup¬tions and destruction during colonia¬lism, war, and times of mismanagement. Nontheless, because capitalist resource use favors plannability and control over nature, this seasonal flood cycle with nutrients, salinity, and acidity has been increasingly disturbed.

An illustration for the tress on the ecological system is the fate of mangroves: They stabilize the shoreline, minimize wave damage, reduce (damaging) sediment load onto reefs, provide habitats for fish, birds, crabs, and snails. They form transition zones from saltier waters to freshwater swamps. But after the heavy destruction during the American (Vietnam) War, increased human exploitation have put them under pressure: they are being logged for firewood and removed to make room for agri- and aquaculture (e.g. shrimp production) (Sterling et al. 2006: 92f).

2.3 Human Niche-Building and Traditional Epistemologies

Human interference in this system is old, though, and on the way to tunneling back from the ecological to the social, it may serve us well to take a look at traditional epistemologies, which have long played a role and arguably continue still do so today, also in the structuring of property rights (for inspiration for the approach, see Gray 1988; Ingold 1992).

The 'local' traditional epistemologies are difficult to ascertain, since the Mekong Delta has many ethnic minorities, and research on everyday interactions and thinking is hard to come by (see e.g. Gorman 2013). Even what is 'local' is not so clear: the ethnic (now-majority) Vietnamese called Kinh, only established their majority between the 17*th* and 18*th* century. Coming from the North and settling in the Delta, they displaced the ethnic Khmer from large areas. This land takeover was internally legitimized through the work that was put into making the largely uncultivated lands arable: "In Vietnamese historiography, the conquest of the delta has been viewed as the 'breaking' of 'fresh ground' (khan hoang), implying that the 'land was unused and therefore available', and 'that hard work was needed to make the land viable before ownership could be conferred'. (Ang forthcoming)" (Gorman 2013: 505)[6] This historical background of the disciplinary power behind transpersonal acceptance (see Kennedy 1991) plays a role still today in property relations and political structure in the delta.

Human niche-building in this environment—political and socio-ecological hegemony—has long been about water management (Biggs 2011), as also the founding myths attest to: in the Northern Red River Delta (a similarly large delta, though more mountainous) it is a battle between two sons of a sea-dragon god and a fairy. These sons, one representing the

6 Interestingly, this reasoning seems to mirror, at least on such a basic level, the reasoning employed by many Western colonialists, for example in the US (see e.g. Purdy 2015a on the question of "who may use land which was not used or not used enough"; but also Hume's descriptions of where initial ownership came from: work).

mountains, the other the onslaught of the sea, fought over a loved one. And it is "the annual floods that can devastate the north's low-lying delta [which] are said to stem from this epic battle. The legend reflects the constant struggle to control water in the Red River Delta, which most certainly contributed to the development of centralized communities, since coordination is necessary for effective water management. (Sterling *et al.,* 2006: 27f)

Such stories, belonging to traditional peasant societies, are part and parcel of a legitimizing embedded law-system which also served to preserve human habitation in the area for generations. It legitimized of public power and the establishment of norms regarding individual behaviors. A similar struggle in the South also permeated into traditional agriculture. The (traditional) low dykes are an example of niche-building practices: by retaining water and nutrients from the high floods, these dykes allow growing into the dry season (i.e. a second crop per year). And by keeping the lower early floods out, they allow harvesting this second crop (without it getting destroyed by the waters). Normally only after the second crop has been brought it, do the higher floods reach the cropland, again bringing in water and nutrients into the agricultural system. This carefully balanced system enables more dense human population without destroying the underpinning ecological mechanisms. (Apel *et al.,* 2012) Thinking in terms of the Foucaultian creation of meaningful worlds the imagery of the Mekong River itself in local traditional discourses could be fundamentally important, though (to my surprise), I have not been able to find useful material, not even on the ubiquitous symbol of dragons.[7] Dragons have long been an important symbol in Vietnam (stemming from early Han Chinese influence), as good and bad omens of power, as symbols of hierarchy, natural forces and order. But not even for the Mekong River's local name—*River of Nine Dragons, Song Cuu Long*—did I find descriptions (other than it splitting into nine mouths). Local epistemological descriptions for the Mekong do exist, but not for the *Delta* (see Elvin 1998; Hongsuwan 2011; Tho 2015; Tueller 2013). To illustrate the point, here follows a description of how a people north of the delta connect the local ecological with the social (also property) realm:

For the M'nong, water protection goes beyond water provisioning. It includes the protection of several food resources and expresses an appreciation for the complex web of interdependence of humans and the ecological system they depend on. The following poem clearly shows this:

"Forests are common (property)
Land is common
(Fishing) streams belong to village
Fish in streams people can catch
But catching young-frogs has to leave parent-frogs
Catching young-fish has to leave parent-fish
Cutting down bamboos without touch to young ones
Heating bee hives without harm to bee queen
Poisonous fishing make streams poor,...
Want to eat frogs, shooting them with arrows
Want to eat fish, catching them with baskets
No fishing with poison leaves
That can kill all small crabs and shrimps.
The village will hold a court
Who poisoning fish, will be accountable and guilty" (Dung, Le Nguyen, and Tinh 2006: 16)

7 Many articles mention "dragons", but none dare explain the deeper embedded cultural knowledges connected to them, not even Lien and Sharock in their "Descending Dragon, Rising Tiger: A History of Vietnam" (2014).

To further illustrate the point of local, embedded epistemologies crossing from political, to property, to social, and into ecological realms all at once, here an excerpt about a different minority, the Cham, also living to the North of the delta:

> *"As traditional wet-rice cultivators, Cham people in Ninh Thuan province hold a system of significant beliefs and rituals related to water, such as rain worship, dam and canal opening and waterhead blocking. The Cham's customary law contains detailed regulations on procedures on land reclamation, watershed protection, reservoir maintenance, including rights and obligations of community members towards water protection and management. For instance, it specifies that every member of the community is responsible for protecting water sources, participating in canal dredging, contributing to worship costs; preventing theft of water and exploitation of watersheds (Hung 2006)." (Dung et al. 2006: 17)*

Similar notions probably still play a role today in the delta, and arguably more so for rural and minority populations, but research for them, and for (peri-) urban and majority populations lacks.

As we move from the ecological and and epistemology towards majority history and into politics and economics—a reduction in grain and an increase in extent—we should remember how (legal) social landscapes inform identities, influence bargaining power, and structures the possibility-realm of individuals and groups—also in self-referential manners (see earlier). The account below explicates what Kennedy (2011) means by noting that—contrary to the Coasean theorem—all 'initial' allotments are *also distributional*, and that distribution influences development ('dynamic efficiency').

2.4 Modern Political History of the Mekong Delta[8]

The main issues regarding today's social structures can probably be understood by starting with the Nguyen dynasty in the 19*th* c., considered a Vassal of the Chinese Emperor's, under which the Northern and Southern parts of today's Vietnam have been unified in one country—including over 54 ethnic minorities, many trans-boundary (in the South the power was based on the above-described land takeover). It is then that the delta became the rice basket of Vietnam. As a place of refuge for aristocrats fleeing the French Revolution, European technologies together with Christianity also arrived around that time. But local power legitimation was at odds with Christian theology's problems with the god-like images of the emperors (with dragon-symbols).

The ensuing suppression of Christianity (especially due to the normative and potentially political opposition to the existing hegemony) would later be used by capitalist Frenchmen to argue for the imposition of freedom of religion and of free trade, backed by French army dispatches (though Paris was not always in the knowing), thus expressing the imposition of rules by yet another, newly arrived elite. By the mid-19th century France had occupied the South and installed a Protectorate in the North. Vietnamese Resistance movements remained largely ineffective, while local Vietnamese elites—taking advantage of the French Colonialists' limited understanding of local property law—often claimed others' lands as theirs, relying on the owners' illiteracy to win the disputes. The peasants, robbed of their land, would move further out and clear/appropriate new lands for themselves.

8 Unless otherwise noted, the historical account is based on Lien and Sharock (2014).

Between the 1880s and 1930s this process led to a quadrupling of agricultural lands. By the 1940s no more free land was available in large quantities. The French had further symbols of power: they increased dyke, waterway, and canal constructions. While French nationals and the Vietnamese upper classes were enriched, the lower classes saw themselves ever more exploited. By the 1930s about 75% of the population were landless tenant farmers who worked on land owned by about 2% of the population. The remainder were landless laborers and a small group of independent peasant farmers. But this regime lacked traditional paternalistic systems restricting exploitation, so that resistance from below was constant and sometimes even violent. The peasant argument was that labor constituted ownership—a communitarian logic contradictory to the French colonial system of formalized legal titles. (Gorman 2013:505ff) This may be understood as the normative legal system of large parts of the population being overtly at odds with the 'legal' system, expressing the elite's and French interests. Anti-French nationalist and socialist agitation reached highs when many Vietnamese were drafted into the French Army during World War 1, and when during the Second World War up to two million Vietnamese died of starvation due to French appeasement politics: they had sent much-needed food and other materials to Japan.

Ultimately, the Viet Minh took power and the Nguyen king abdicated in 1945. But neither the French nor the British or the USA accepted the nationalist movement, and a war broke out along international fault lines. (The countryside under China- and USSR-backed Communists Vietnamese rule, the bigger cities under French-backed Vietnamese ex-Emperor Bao Dai's rule. This rural/urban divide is relevant still today.) Increasing US-involvement under the Truman doctrine eventually led to a total of over 2.5 million US soldiers who served in Vietnam with US army casualties around 60'000, Southern Vietnamese army casualties around 200'000, and about 1 million military casualties in the North, next to over 2 million Vietnamese civilian deaths between 1954-75. During these years, many villages, cities, and much of the infrastructure for water management and industry, were utterly destroyed. Sterling *et al.*, (2006:273–75) also point out the devastating effects of napalm and defoliants on mangroves and the ecological system.

Because their power in the rural areas of the South, the Communists advocated and even implemented the first land redistributions. To combat Communist sympathies, the capitalist South Vietnamese Government adopted the same in the 1960s. It gave laborers the legal title of the land they had worked on, thus making a part-step towards traditional property ideas. But the land plots were not equal, thus retaining traits of unequal distributions. While it reduced the power of the rural elites, this policy created a larger population of landed laborers open to the ideas of political and market liberalism, and to Green Revolution practices, while others still lacked enough land to make ends meet. These new "middle" and "upper" peasants replaced the former landlords yet entrenched capitalist practices. (Gorman 2013:507f)

After the signing of a peace treaty in 1973—and the Communist North overpowering the remnants of the Southern army—many Southern officials were sent to "re-education camps" from which many never returned, or only with severely damaged health, and several hundred thousands fled over the sea (known as "boat people").

3. Capitalist and Socialist Modes – The Political Side of (all) Property

The Northern and Central Vietnamese communist structures were based on a different historical development as a Protectorate and not similarly colonized. Thus the inclusion of the capitalist Southern Vietnam into the Communist structures proved difficult: the two attempts to equalize land holdings were met by increasing opposition by the middle and upper peasants, though 25% of the population in the Mekong Delta was basically landless. The newly created middle and upper peasants claimed land rights based on their past labor: the traditional justification served to underpin an unequal and new distribution. Sometimes upper peasants destroyed property rather than hand it over (killing oxens, destroying machinery, rice fields, or fruit trees). And even some poor farmers *declined* to receive the land based, on the same arguments of past labor. In this crisis a notion of 'moral economy'—commonly shared notions of how a just economy should work—came to the fore which were rooted in a culture which was, at least in part, shared across class. (Gorman 2013: 509f)

The crisis continued with Southern Capitalist systems collapsing and Communist resettlement and forced-labor programs leading to countless deaths. A war with Cambodia's Pol Pot Regime followed in 1978/9. With hundreds of thousands fleeing in 1979 alone, the Vietnamese Central Committee acknowledged that its economic plans and collectivizations had brought about ruin far beyond the American (Vietnam) War's destruction. By 1985 Vietnam was the 15th poorest country in the world. Remnants of the Capitalist system in the South had largely turned into corrupt networks. In 1986—coinciding with *Glasnost*—the Vietnamese government started *Doi Moi* ("Renovation") to combat 'chronic hunger' and increase growth.

Changes in the international language legitimated policy changes, the Soviet Union would fall soon after, and all the while Southern cadres with their more capitalist-friendly networks rose to power in the Party and became richer. In 1988 "Resolution 10" allowed limited private production, abolished agricultural collectives, and gave farmer tenants long-term land-use rights for 10-20 years. The extent and modalities of the implementation were relegated to provincial and local officials, though. Gorman (2013:510f) argues that the upper peasants successfully used this openness and the economic crisis to push for implementation along their ideas of rightful ownership, arguing that they had been the ones to work the land initially and that they were more agriculturally productive. That the latter was also due to their higher capital use, was conveniently not mentioned. Upper and middle peasants marched on government buildings and filed over 200,000 petitions for land restitution to the pre-Communist distribution (with some people forcefully occupying their former lands). The existing opposition among the poor was shut out, while other poor who had to vacate lands even accepted the moral-economic ideas expressed by the coalition. This (and the resulting local cadres' enrichment) were arguably based on a 'moral economy', a hegemonic notion of just distribution shared also by the poor.

The local and provincial government's espousing of a language of commodification and efficiency was probably partly due to the internal weakness of the CPV. This ultimately led to an almost complete reversal of the Communist redistribution, back to the situation under the capitalist regime two decades earlier. Additionally, private ownership was strengthened and more trade in land and other inputs allowed. Collectives were broken up and shared means of production auctioned to the highest bidder. All of this led to a "rapid re-emergence of a stratum of capitalist farmers, setting the scene for a new wave of accumulation within the agricultural sector" (Gorman 2013:516). Landlessness rose to 16% by the early 1990s, a whole stratum of poor emerged again, income inequality and food insecurity rose again. By 2005 about 25% of the rural population was landless and largely dependent on seasonal agricultural work, often on commercial farms. Yet the Mekong Delta also became the main regional exporter of rice.

3.1 Property Structure and Land Use

These outcomes become even more pertinent when compared to the development in the Red River Delta in the North. There, the poorer segments of peasantry successfully opposed the introduction of market-based bidding mechanisms to allocate land use rights—even for the least fertile grounds—arguing that they would aid the rich and "violate the principles of social justice". (Ngo Vinh Long 1993:198 in Gorman 2013:518) There was no bifurcation into rich and poor as in the Mekong Delta, and almost no household had to exclusively rely on labor rendered in service to others for their income, but agricultural productivity also remained lower.

Capitalist productivity in the South is not just due to machinery, though. The introduction of Green Revolution practices replaced the traditional two-crop system with more industrialized agriculture relying on *higher dykes*. These higher dykes keep even the highest floods out and thus allow three rice harvests per year. This exemplifies the use of sand for infrastructure construction (concrete and other) and concomitantly the diversion of waters (with sediments and sand) away from the fields. The higher dykes, though, also allow for security from the increasing salt water intrusions, and are part of the strategies to combat the effects not just of the decreased sedimentation and land degradation, but also of the expected rise in water levels through climate change. (Anthony *et al.*, 2015; Apel *et al.*, 2012) Yet petrochemical fertilizers became necessary to make up for the loss in nutrient import. These "externalities" should thus be understood as deeply connected to the historical struggles over property rights and the legally undergirded patterns of accumulation.

Overall between 1990 and 2010 per capita income in Vietnam almost quintupled. And still, many of the problems of its history persist (such as lacking education dating back to French suppression, high unemployment, corruption, bureaucratic administration as well as political illiberalism).

While some commentators argue that this boom in agricultural production and exports was due to the 'freeing of the market forces', Gorman argues that it was due to increased exploitation. From the perspective espoused in this article, the crisis led to fundamental changes in actors' bundles of rights and legal landscapes, ultimately allowing for narrowly defined productivity and international competitiveness increases through cost reductions in production via the use of low-wage earners' desperation *and* increased ecological exploitation through Green Revolution practices.

3.2 Current Social Power Structures and Property Right Laws

The divergent developments inside of Vietnam show the importance of perceiving law as malleable due to divergent interests and identities, the occurrence of crises, and the (sometimes) changing hegemonic and moral discourses—or the different effects of the same discourses in a changed society. With this in mind, we will increase the grain and decrease the extent of our inquiry to focus on current power structures and property notions.

The Viet Minh had established clear top-down command lines during American/ Vietnam war. Today still the one-party government has a limited connection to the local, and is highly centralized. The Communist Party of Vietnam (CPV) is not easy to distinguish from the officially separate legislative, executive, and judicial powers. Delineations between 'private' and 'public' are difficult to assess, with uncertainty even being "a principle of rule" (Gainsborough 2010, in Kleinen 2015: 22).

With the 1954 land reform, all old property rights were abolished and three tiers of land property established: The whole people is the "owner" of all land, while the government represents 'the people' and exterts "rights of control" and allocates "rights of use" to individuals, household, or organizations. Private "ownership" of land does not exist legally, only long-term usufruct (or tenure) rights for 20-50 years with limits on what the owners may do with the land. (Kleinen 2015:60f) The Ministry of Natural Resources and Environment decrees on these use rights for land, water, and mineral resources, though their administration takes place at all levels from the national to townships. Though nationally legal, markets for the sale of land-use rights do not exist everywhere. (USAID 2013)

The State can retract land rights (e.g. for such goals as infrastructure or economic development) and should compensate based on market prices. But the system does not work well. 70% of all formal complaints against the government are about land, and of those 70% are about compensation. One of the issues at play may be a question of valuation, since in traditional agricultural communities land is not valued in money but in its ability to feed the people living on it and the generational transmission of a stewardship relation to the land. Market-prices cannot reflect this. (see Martinez-Alier 2008) While women and men are legally equal, married women tend to (illegally) not be mentioned on land-use certificates. This reduces their access to land and their financial security. (USAID 2013)

3.3 Group Powers and Rights: Social Landscaping

As Hirsch and Scurrah (2015) point out, 'land grabbing' in the region is based on the notion that much land which states define as 'theirs' and as 'wasteland' or 'un(der)utilized' is in fact part of what local smallholders or communities practicing rotational agriculture depend on, often without property/land-use titles. Reminiscent of French colonialist practices in South Vietnam, USAID (2013:1) points out that although now legal, such traditional communal "tenure"[9] has not been recognized in practice. Most often, it is minorities' traditional lands which are given to other groups and extractive industries.

Law is also its implementation. Kleinen (2015) argues that in Vietnam, like in China and the former Soviet Union, one ethnicity governs and excludes other (sometimes transboundary) ethnicities. The latter often resist their incorporation into the State—also by mimicking the use of politically opportune language to further their own goals—and retain "finely tuned indigenous knowledge […] of food systems" (ibid:40) which also express property rights regimes. The majority Vietnamese Kinh comprise about 86% of the total population and are much better off than the 50+ minority ethnicities, which are furthermore seen as a threat to

9 "Tenure" since the government would not call it ownership, see above.

political stability. They are paid up to a quarter less than Kinh for the same work, illiteracy is higher, poverty much likelier (with more than 20% of the poor coming from these 14%), and State media in Vietnam is rife with stereotypes about them. (PHO 2015) The government's focus is on retaining power by catering especially to the Kinh and their poor, while suppressing dissent and extracting rent through economic growth (ibid:25-31). Hirsch and Scurrah (2015: 4) describe governance as a "superimposition of neoliberal development strategy on socialist-authoritarian political arrangements" with "…a strong modernist ideological backup for […] land deals, based on assumptions of the superiority of large scale, industrial-type production based on regularised wage labour arrangements taking advantage of presumed economies of scale." This description of the CPV sounds astonishingly similar to what had happened in the Mekong Delta.

This hegemony is undergirded by specific channels of communication and power: The central government makes law. Helped by and beholden to local organizations and the population, local party chapters should implement the law. Next to the local chapters, Communist Mass Organizations also channel local concerns to the party leaders and the State, thus shaping legislation and government decisions, though officially they serve as alternative ways to enforce legislation. De facto, power inside the Party is not simply authoritarian but dialogical.

This has become more evident as other such channels have increasingly sprung up. No legal basis for NGO's exists, and groups or journalists critical to the CPV (e.g. demanding democratization) are repressed, yet certain topical organizations which are seen as loyal to the State—often led by family members of former revolutionaries—are tolerated, it seems especially when they fit into the State's development goals of decreasing poverty and increasing growth. They focus on "non-political" matters like agriculture, fishery, construction, sanitation, or health care, like the national Vietnam Gardening Association which is "based upon a traditional approach to family food production […] combining an orchard […], a fishpond […] and animal shed […] for pigs" (Kleinen 2015: 35f).

3.4 Individual (Economic) Land-Use Rights

Since the beginning of Doi Moi local capitalist and international investment have become possible. In the narrowly defined 'economic' field, as long as the State's interests are not contradicted. The State's foci lie in infrastructure projects, joint ventures with international investors, and (re-)allocations of land-use rights[10]. Land transactions hinge on several aspects: Legally, private or public actors gain the rights to develop an area as specified in the government's construction master plan. The (then) former land holders have a right to compensation at market value, which is theoretically assessed by the government. A site clearance committee with strong local political associations mediates in the dialogue between developer and former land holders on clearance and compensation. As theoretically mentioned earlier, these "money for land" and "land for land" compensation schemes are often seen as inadequate, too slow in being administered, and lacking solutions for lost crops due to land attribution delays). (Garschagen, Renaud, and Birkmann 2011: 155f)

10 Sand falls into all three spheres, as it is the main input into concrete, it is exported, and it is an essential part of what makes up land in the Mekong Delta.

But owing to its shaky power and the need for a somewhat dialogical approach, the CPV's policies have not just been successfully challenged in the South (see above), but all over the country. Kleinen (2015:90ff) describes cases of successful citizen mobilization in the Red River Delta regarding urbanization in the peri-urban areas. Where peasant lifestyles increasingly meet the potentials and threatening changes of urban life, land reallocations for infrastructure and private industry have met persistent local resistance, demanding more favorable outcomes for the local communities. He argues that successful mobilizations seem to be ad-hoc, loose organizations, not seeking official recognition, "with a handful of individuals stepping up to a problem and providing consistent, responsible leadership" (ibid:92), supported by personal networks into State and Party—both through official Mass Organizations and unofficial topical organizations. With backing from local party cadres, the mobilization eschewing 'political', anti-Statist, or e.g. anti-Chinese rhetoric, these citizens achieved land allocation renegotiations and higher compensation for lost land. The contestations of land use rights mirror the relatively unstable hegemony of the central government, hoping for rents from reallocations and fearing loss of already limited local power.

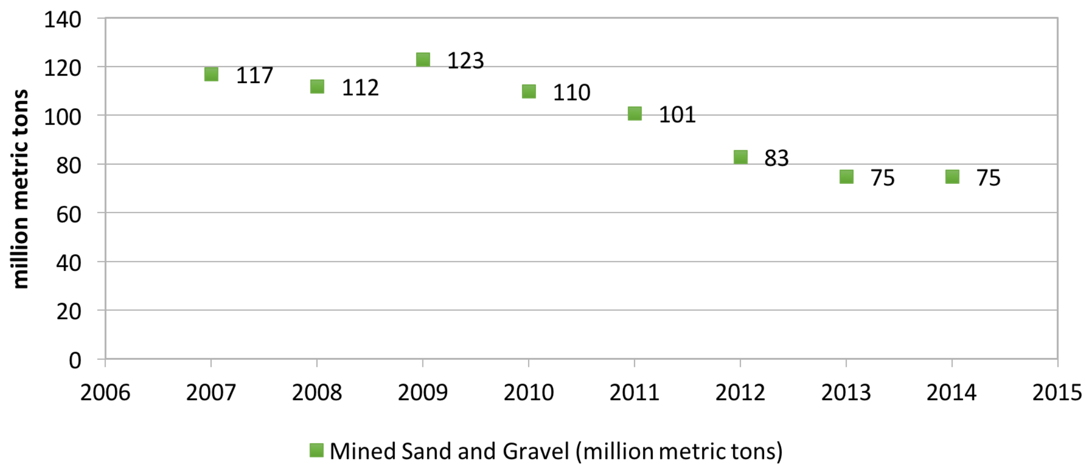
3.5 Mineral Mining

Legally, sand extraction falls specifically under mining. It is one of over 60 types of minerals mined in Vietnam, all of which have have socio-economic and ecological effects. A first law on minerals was introduced in 1996 and replaced in 2010. Under it, the Ministry of Natural Resource and the Environment defines a master plan and administers the mineral development strategies—through geological surveys, management of mineral exploitation and mining—to strengthen "efficient and effective mining practices and sustainable develoment" (USAID 2013:23). The Prime Minister approves the overall strategy. The mining and quarrying industry must prepare environmental and social impact assessments. For future clean-ups, the State can collect fees, though the revenues often pay for existing pollution. (ibid)

Like land, minerals are the whole people's property and are administered by the State. Local joint ventures are necessary for foreign investment in mining. For small-scale operations and "for common construction materials" the aforementioned Ministry and provincial authorities handle the licensing. (ibid) A two-year license for fluvial aggregates mining costs $49, for other minerals a license costs up to $4,890. (Fong-Sam 2013: 28.2)

In 2014 the government increased export taxes for aggregates from 6% to 7%. But I have been unable to find information on Vietnam's aggregates export, or on the actual volume used in construction. The US Geological Survey Minerals Yearbook, though, mentions the continuing construction and cement-production boom (Fong-Sam 2017:27.4). Absent further corroborations, this makes questionable the marked reductions in aggregates mining from a high of 123 to 75 million tons between 2009 and 2014 (see illustration Illustration). Aggregates export would have needed to fall drastically for the mining not to slow down the construction boom. Overall, there are hints that sand over-exploitation in Vietnam is being tackled, though the actual decision-making process, the envisioned goals, and the political and scientific reasoning behind it have not been described in detail in any of the draw-upon publications.

ILLUSTRATION 2. SAND AND GRAVEL MINING IN VIETNAM, ROUNDED MILLION TONS P.A.



Source: Fong-Sam 2013, 2017.

3.6 International Relations

Towards a fuller assessment of the socio-ecological system and aggregates mining in it, we will move towards coarser grain and much wider extent. The Mekong River basin spans over China, Myanmar, Thailand, Laos, Cambodia, and Vietnam. The Mekong River Agreement (which China and Laos have not signed) established the Mekong River Commission in 1957, which though found itself largely in a political stalemate until the early 1990s. (McElwee and Horowitz 1999:11ff) Its foundation was based on an extractive developmental logic creating transnational acceptance for the national governments' focus on economistic[11] approaches to value at the expense of local, traditional communities. This shines through in this paragraph from the founding document: "the Mekong basin commons are regarded as a hitherto unexploited resource to be harnessed for economic development" (Ahmed and Hirsch 2000:3). It marks the establishment of a common hegemonic approach, structuring inter- and intra-national relations in line with extractive and big infrastructure projects to disregard local legal and moral economies: Since the 1990s dam construction has strongly increased, while calls for more inclusionary and environmentally sound project development have gone largely unheeded. The World Bank's regulations know compensation only for the displaced from the reservoir area, though it has not distanced itself from forced removal practices. The World Bank and major construction companies' actions and words paint as a mere privilege these communities' age-old reliance on the ecological system's functioning (see above) and deep connections to their soil. (Goodland 2010; McElwee and Horowitz 1999:12) Sand dredging only adds to these negative effects on peasant lifestyles, fisheries, and others, by reducing the sediment load further. Dredging harms aquatic life and the deep underwater pits are slowly filled by newly arriving sediment, thus missing downstream and causing erosion. Also land owners' and fishers' reliance on the ecological system is a mere *privilege* which sand dredgers may disregard.

11 More on economism e.g. Martinez-Alier (2008), Robertson (2006).

> *"Large-scale bedload extractions in the Lower Mekong started in the 1990s and served as fill for land reclamation operations especially in the area of Phnom Penh (Pierdet, 2008), and the practise had attained alarming proportions by the year 2009 (Global Witness, 2010), encouraged by strong and rising demands from the civil industry, and by sand exports from Cambodia to Singapore." (Anthony et al. 2015: 184)*

Regionally aligned governmental and investors' economic interests in a poor but economically growing country and region are thus contrasted with the destruction of economically important environmental services, the two being intimately connected. A seemingly natural chaotic system of floods and saline intrusion is being replaced with a "well-ordered" system, having already led to population displacements. Shoreline are eroding and fisheries (and other) have been harmed through ill-understood changes to the natural environment. (Anthony *et al.*, 2015:1, 177, 186) A better understanding of how these factors coalesce into phenomena (e.g. Jackson 2008) is crucial in order to overcome the harmful influences of the social system onto its embedding ecological system (e.g. Schneider and McMichael 2010). The scientific discrepancy is consistent, as interventions often take place at very local levels in the Mekong Delta while research mostly takes place at landscape-phenomenon-levels (Fabres 2011:12–14).

4. Design: Thoughts Towards an Intervening Strategy

In the following part the focus shifts from describing structures to inferring what *design solutions may be possible* (see e.g. Demos 2016). I will argue that the focal point of the intervening strategy should be the *peri-urban areas*. In the early years in power, the CPV largely neglected the *urban* areas, and has increasingly focused on them in recent years. But the area and population *between* the urban and the rural—literally at the forefront of rapid urbanization and ecological degradation—still has not entered into the government's policy focus. (Garschagen et al. 2011) So while Ho Chi Minh City and the wider Mekong River Delta are "the main business center, rice and fisheries producer, and revenue earner in Vietnam" (Fabres 2011:8), land price increases and expropriations, increasing environmental and health stress, as well as difficulties in political organizing lead to losses in resilience especially for the peri-urban. National and international agencies have urged a development re-examination towards focusing on the quality of growth (ibid). I am positing the peri-urban population as *umbrella and indicator* **actor** for such changes (see Berthet, Bretagnolle, and Segrestin 2012). Sand may be made into a symbol of the nexus of most of the issues outlined above as it is a biophysical in-between-resource with solid and fluid characteristics; it comes in the same manner as nutrients do, with the floods, and builds the land just as the nutrients replenish the soil for agriculture; sand stands for the need of migratory fish to have open rivers, and it is a literal symbol of current management techniques and infrastructure approaches by ossifying processes—sand turns into concrete, ebbs and flows are increasingly tamed into uniform streams. A lack of sand has effects on both land-holding and water-resource possibilities—it has impacts on holders of land-use and water-use rights, in a similar way as the M'nong poem suggests.

It is such an imagery based on the 'scientifically local' which could be brought into connection with historically local epistemologies (e.g. Altieri 2004; Stuiver, Leeuwis, and van der Ploeg 2004) to build a loose coalition of organizations and individuals, much in the manner of the successful citizen mobilizations outlined above. The following story by Kleinen

(2007:258) additionally suggests that there exist local, traditional epistemologies which could span the outlined divide between personal gains and system health: With privatizations and fish population destructions increasingly pressing local fishermen into using the common property sand for personal gain, one of them expressed his unease by remarking: "I am stealing from the Gods!"[12]

The intervention would bring urban, peri-urban, and rural citizens to joint workshops. In these the different fields of contention, of opportunity and regress (especially in how sand seems to combine many of these issues), would be analyzed in a participatory and dialogical manner, with an open ear to the different epistemologies relating to the many ethnic, religious, gender, and other differences—and bring in normative notions relating to the environment, justice, property, income and distributional issues. The point is to create on open-minded approach modeled after the successful cases of 'non-political' citizen mobilizations, building on local understandings of preservation as a public interest, and inspired by how changing language could inspire other approaches (like exchanging property "rights" for property "interests", Long 2012). The goal is expressly not to create a political movement or critical masses but to create room for the exploration of local epistemologies, for peasant-led education on ecological and economic issues. Such workshops should include local political cadres and representatives of the Communist Mass Organizations to ensure political survival and allow for tapping into the dialogical government system within politically accepted bounds.

The CPV's growing interest in the quality of economic growth further raises the chances of this approach. The current development model creates with one hand and destroys with the other. The local epistemologies, insofar as they have survived, could bring together the ecological knowledge and popular support for a change in the metrics of good development and increase wellbeing within the ecological system (e.g. Corbera 2015; Gliessman 2008; Gómez-Baggethun et al. 2010; Kosoy and Corbera 2010).

This approach is not yet ready to be implemented. More sustainable forms of agri- and aquaculture in the Delta demand more detailed exploration, also in how they interact with local majority and minority epistemologies. The embeddedness of the Vietnamese economy in the regional and global economy has only been shortly described.

5. Law in the Anthropocene

In the past few paragraphs, notions like "preservation", "sustainable agriculture", or "economic wellbeing" were mentioned as if there were no contradictions between these. Of course there are contradictions which are being exacerbated by "using nature"—a use which is deeply reflected in the historical and today's conflicting notions of property rights and privileges. The description is inspired by what Gordon (1984) has pointed out: one may need to draw upon many different and even contradictory story-lines to give a fuller story. Such an understanding is equally found in Hann's (2000, 2009) anthropological inquiries, arguing that property relations are deeply social and that 'shock therapy' to post-socialist countries are as simplistic and destructive as collectivizations 'overnight'. A focus on the neoliberal approaches to this social thicket not only neglects the public side of all property but is expressive of a

12 I have as of yet still not been able to truly find out in what ways sand is used for personal gain, since Kleinen does not further elaborate, and other sources also only hint at this without truly explaining it. Also the notion of "Gods" does not receive further elaboration.

developmental state of mind which seems to believe that through the imposition of a a clear structure in law comes about a clarity of social (property) relations which then shape society in peaceful ways and lead it to prosperity. Even a one-party State like Vietnam, though, has a part dialogical approach and is not *just* authoritarian, at least when regime can (or has to) bolster its power through such actions. And even ecological questions seem to be taken up by this government, though *the extent* thereof is unclear and still lacking.

While absolute poverty has indeed luckily been reduced in Vietnam since Doi Moi, political freedom has not budged much and ecological destruction and minority neglect and oppression de facto continue.

But Law in the Anthropocene cannot continue to look at these as separate The simple solution of 'privatize and let markets prevail' is not what Western governments do in agriculture or anywhere (see Hann 2009), where state regulations and subsidies heavily qualify the property rights of the Western farmers, and indeed, markets are fundamentally bundles of rights and privileges, they do not 'just exist'—yet post-socialist countries are still advised to do exactly as Western countries do not themselves do: pretend that 'the market' will arise out of state-imposed property-rights definitions even where at odd with local understandings. The capitalist system in the Mekong Delta region—remnants of centuries, colonization, civil war, and layers of mis-management—can serve as a model to show the different outcomes in terms of growth, distribution, and ecological outcomes through ill-advised, power-hungry, or one-sided policy changes (even in places where privatization policies are demanded by large parts of the population).

But the relation to land points to the deeper-lying problem, the one of ecology. As we debate whether entered the Anthropocene, the era of humanity as the biggest shaper of geological processes, we must rethink the notions of "nature" and "humanity". The legal link between these is "property", which is not just a social category *connecting people through things* but rather sets of relations which deeply connect us (1) as human beings between one another and (2) as a species to the living and non-living entities of this planet. We should consider seriously what authors like Burdon (2012) write, using concepts like stewardship (a *duty*, thus conferring legal rights onto the other side), or moral and legal responsibilities towards all of Earth Community (which includes humans and our ability to live decent lives). Human laws should circumscribe humanity's niche-building to live with, off, and supportive of other species and non-living processes. Burdon places this "human law" hierarchically below a "Great Law": A law which gives rights, duties, and privileges to all of Earth's living and non-living communities. "Human law", then, would give *aggregate* limits and freedoms to the human species.

Purdy (2015a, 2015b) focuses more on the Foucaultian aspects of how structures may enable humans to *experience* how enmeshed human life is with our ecological community, and on the need for a renewed *political movement* demanding the inclusion of more diverse voices to overcome the current impasse in environmental lawmaking. The continual (re-) creation of identities and etymologies within the ecological community is a necessity to bring care-taking deeper into ecological law. Such a reshuffling of rights, duties, and privileges is a normative project which should and cannot be achieved through markets or technocratic rule, even in autocratic yet dialogical countries like Vietnam. There like elsewhere structures and interests do not allow for a simple top-down application of such ecologically-inspired ideas.

Policy should learn from a design-approach which includes social, political, moral, structural, minority-cosmological, and aggregate landscape-approaches, not just sovereign power.

When the environmental movement espouses explicit non-ownership interests in nature, this should in fact be put into property terms, but with enforceable rights being given to these non-human entities—and humans and their society having the correlative *duties*. If we take serously the ecologico-legal phenomenon- and landscaping-view, we have to rethink 'injury' and causality: how far downstream of a source of potential injury do the effects still count as saliently originating in the source? Currently, climate change in the US is treated as too complex and interdependent for the legal system to assign actors any kind of responsibility. This is what 'externalities' are: effects deemed diffuse enough so that the direct causal relations are too difficult to establish, so that the origin cannot be held accountable (Purdy 2015b:1626ff), or the willful legal definition that a certain effect falls under "damnum absque injuria", which is when an activity is a privilege to harm others (i.e. the absence of the damaged one's *right* to not be harmed). This is how most non-human entities are treated currently, as entities for whom harm does not legally constitute injury in our laws.

The Coasean theorem argues that clear and strong property rights allow solving externalities. But when privileges enter the picture—as they always do and must—and when causal relations are only understood or retraceable at the aggregate—as they often are in the case of externalities—then the Coasean theorem does not hold. Though if non-human entities were given enforceable legal rights, a part of the theorem might be redeemed for ecologically more sensible solutions. It still couldn't account for privileges, though, making it only helpful as a thought exercise, not as a policy proposal. To get to real policy proposals, also on the topic of sand—a material very strongly used in human niche-building—research on the real social, economic, historical, cosmological, and ecological aspects and legal underbelly of a topic is necessary, especially in a colonially and war-damaged area like the Mekong Delta.

A note on rethinking "nature": Why not talk about nature as a laborer and caregiver, towards which we owe a duty and stewardship, like the M'nong people do, and as was expressed in many pre-industrial traditions of Western thought as well, e.g. by Adam Smith (1994, Chapter V: On the Different Employments of Capital): "In agriculture, too, Nature labours along with man; and though her labour costs no expense, its produce has its value, as well as that of the most expensive workmen.". Nature does the work of reproduction and of caregiving, instead of accumulation. But it is all too often only "a gendered afterthought to the real dynamos of the economy, when in reality no shared life could do without it." (Purdy 2015a, chapter 7)

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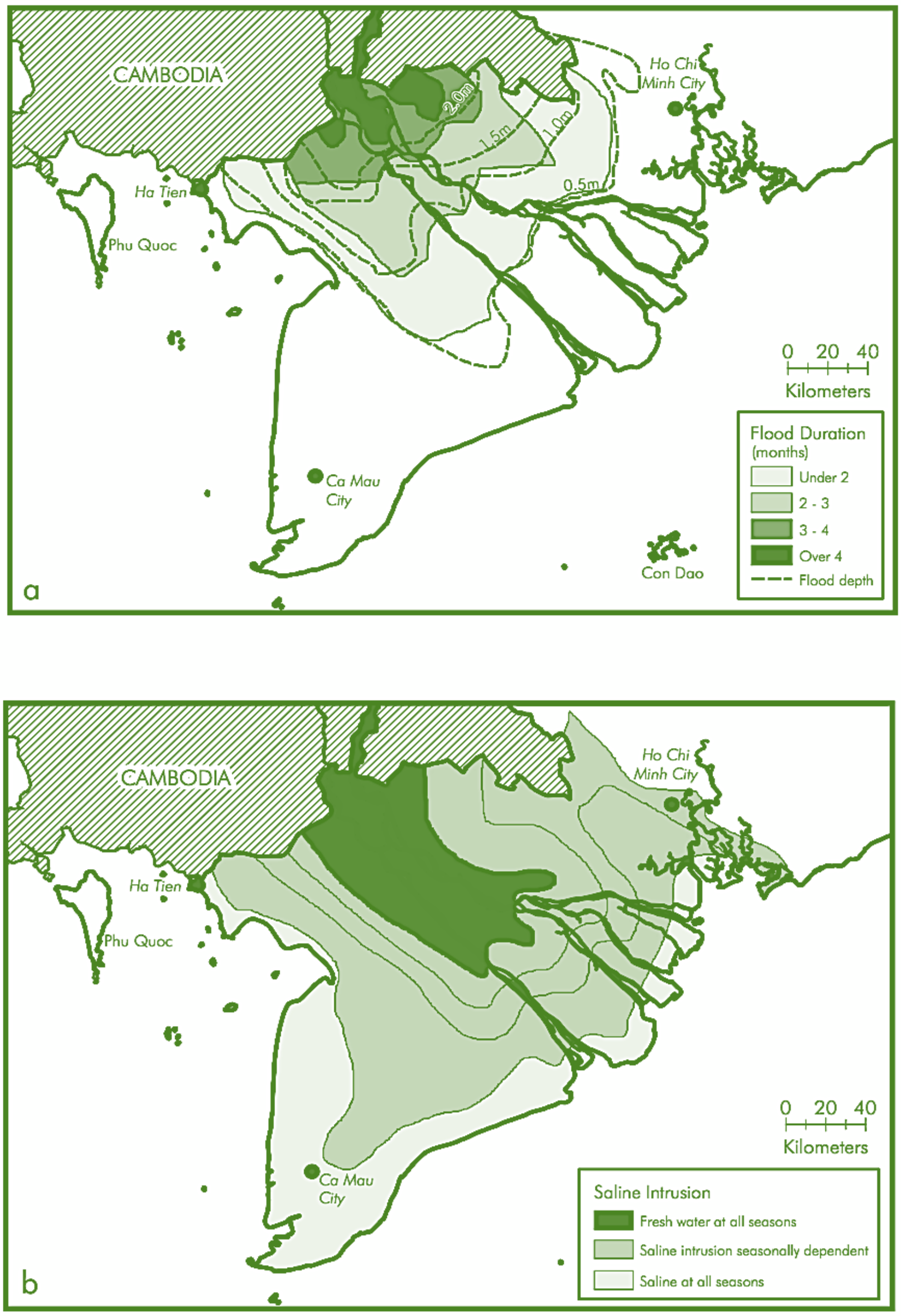
Appendix

FIGURE 53. DURATION OF FLOODING
(A) AND SALINITY INTRUSION
(B) ACROSS THE MEKONG DELTA



Source: After Akira 2003.

A policy proposal for green jobs in india: A quantitative analysis on inclusivity of green jobs*

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Introduction

This paper presents a green energy policy proposal, which not only has a higher employment potential but also delivers higher growth to the economy because of the increased fiscal expenditure that this program entails. Our estimates show that for every million US dollars invested in the Indian economy annually, the total number of jobs generated through our green energy program will be 197 jobs compared to only 82 jobs in the fossil fuel program. To the best of our knowledge, for the first time in the literature, this study analysed the composition of employment to reflect on the type and quality of jobs created through investments in the green energy program in India.

The renewable energy sector and the energy efficiency sector generates 216 and 161 jobs respectively per million USD of investment. The bioenergy sector is the most labour-intensive sector. Within the energy efficiency program, weatherization and building retrofits seem to be the most labour-intensive sectors. Regarding the composition of employment, the green energy program is more progressive than its fossil fuel counterpart, whether we look at it through the lens of gender, region, caste or skill.

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This study argues that in the long-run, building a green energy economy in India, as opposed to expanding its existing fossil-fuel dominated energy system, will generate both significant opportunities and challenges in terms of the employment effects. The opportunities exist since there will be an overall net gain of employment in the economy with the expansion of the green energy program. The challenges, then, will be to encourage and support these workplaces to become increasingly organised and formalised such that this expanding workforce benefits from better quality jobs, higher and stable earnings, and other employment benefits like health insurance, pension and enhanced social security.

1. Background

The policymakers, particularly on the Right side of the aisle, have traditionally stigmatized any form of environmental regulations, as being a detrimental practice, which raises the cost of production, disproportionately affects the small businesses, and imposes expenses on the economy that tend to stifle economic growth and cut levels of employment (Murphy, Michaels and Knappenberger, 2015). So, what this argument does is to essentially juxtapose environmental regulations against the growth and job opportunities in any economy. In the specific context of developing countries, this raises serious concerns about any environmental regulations as these economies are already reeling under problems of severe unemployment and poverty. Therefore, any discussion on clean energy in the context of a developing economy is usually taken with a grain of salt since it somehow tends to generate a feeling among the politicians as well as the policymakers that it will inflict hardships on the economy.

However, with the ongoing research in the field of employment generation through investments in a clean energy programme, opinions are much more favourable to the positive synergies between environmental regulation policies and the increased levels of growth and employment. Recent studies show that investments in renewable energy and energy efficiency not only doesn't slow down the growth process of the economy but also generates net positive jobs in the economy (Wei, Patadia and Kammen, 2010; Pollin *et al.*, 2015; Pollin, 2015). This is so because the clean energy sector has a higher employment elasticity than the fossil fuel sector per unit of money invested. It is to be noted that there are considerable variations between technologies, with wind power appearing to be relatively less labour-intensive, while solar and energy efficiency investments appear more labour-intensive.

Pollin and Chakraborty (2015), focusing on India, have found substantial evidence for the increased employment impacts of clean energy investment. They have shown employing an input-output methodology that job creation in the clean energy sector is almost twice when compared to the fossil fuel industry.

Moreover, it is important to recognise that the majority of jobs created through investments in the renewable energy and energy efficiency programs will be in the same areas of employment in which people are already working. It signifies that with investments in the clean energy programme there will be no dramatic change in the overall employment structure of the economy. For example, constructing a solar panel will create jobs in the electrical and electronics industry, metal and plastic industry, and truck drivers, among others. Similarly, expanding the public transportation system will employ civil engineers, construction workers, and dispatchers. Hence, for a national clean energy programme to generate these types of job opportunities, it will not be necessary for the government to introduce a distinct new set of vocational training programs that differ significantly from the existing skill development practices in these economies. This does not imply that there will be no skill updating required for these new jobs. A 2011 global survey study commissioned by the ILO, which analysed skill requirements tied to specific green economy occupations in 21 countries, including India, argued that most clean energy and other green economy occupations will require updating skills as opposed to training workers for entirely new professions (Strietska-Ilina *et al.,* 2011).

Another significant aspect of clean energy investments is the inclusiveness of the programme, especially regarding the quality of jobs generated by the programme. It is not only important to analyse the total number of jobs generated in the economy through investments in clean energy, but also the nature of distribution of those jobs around issues of gender, region, skills, etc. In the Indian case, another area of interest will be the division of work based on the caste profile.

To the best of our knowledge, no such macro-study highlighting the composition of employment in the clean energy sector is available for the Indian economy. Pollin *et al.,* (2015) studied the quality of jobs created through investments in the clean energy sector for the economies of Brazil, Germany, Indonesia, South Africa and South Korea. The results obtained by the authors varied substantially by country. The study found a high proportion of employment in informal sectors in Brazil, Indonesia, and South Africa. In all the five countries studied, male jobs profoundly dominated the clean energy sector. It is primarily because of the significant role played by both the manufacturing and the construction of the overall clean energy investments. Notwithstanding these biases, the employment compositions are still significantly less skewed when compared to those in the fossil fuel industry. Given this backdrop, it becomes pertinent to discuss the details of our proposed policy framework.

The paper is divided into six sections. The second section discusses issues of fiscal policy and its effects on growth, employment, labour productivity in a theoretical context. The third section presents the salient features of our proposal. The fourth and the fifth sections present the methodology and results respectively. The last section concludes the paper.

2. Issues of Growth, Productivity and Wages

While our proposal is a combination of public and private contribution to greening the economy, we need to briefly discuss the rationale for fiscal expenditure since it is usually subject to severe criticism particularly in the mainstream literature, both for short and long run. Even in the green growth literature these issues have been raised and has been argued that such fiscal expenditure should be planned in a countercyclical way to avoid overheating in the economy during high demand phases of a business cycle (Blyth *et al.*, 2014). Moreover, a decline in labour productivity (higher employment elasticities) as a result of green technologies has also been considered as hampering the growth prospects in the long run. In what follows, we counter both these arguments.

2.1. Is Fiscal Expansion Contractionary in the end?

In the mainstream literature, in the short term, fiscal expenditure is assumed to increase interest rates, thereby, crowding out private investment; increase inflation, especially if the economy is working along its full capacity/employment frontier; have no effect on the output since rational agents cut down on their consumption expenditure in anticipation of an increase in taxes in the next period (Ricardian equivalence). In the long term, it is argued that growth rate is either exogenously given by the rate of growth of labour force and its productivity or endogenously determined labour productivity. In either case, demand management policies cannot affect the long run growth since they cannot change the natural rate of growth. In fact by disturbing the incentive system, it harms the efficiency of the economy.

On the issue of crowding out, the route of increased interest rate is flawed because central bank sets the interest rate, which unless changed through policy remains where it was announced before the fiscal expansion took place. As for the issue of inflation, the usual assumption is a fiscal expansion entails ‘too much money chasing too few goods’. This argument is erroneous too as the pool of goods itself expands as a result of the multiplier that this expansion sets in motion. In situations, such as full employment or full capacity, where the pool can’t be increased, the argument will hold true for any form of expenditure, private investment or consumption alike. So, there’s nothing exceptional about fiscal expenditure in that case.

As for the long run, a fundamental problem with growth theories of this variety (supply-side) is that they *assume* that supply creates demand in the long run. In these models, investment is equal to the full employment savings by *assumption*. There is no role for expectations, which makes them inapplicable for an economy which is premised on expectations about the markets. As soon as an independent investment function is introduced, which is indeed an inalienable part of a capitalist system, the causality moves in the opposite direction (Sen, 1970). The alternative theories of growth originating from the Kalecki-Keynesian tradition show that capacity utilisation, and hence, the growth rate, is endogenous to the system, which is determined by the level of exogenous sources of demand, such as public investment, the ‘animal spirits’, the multiplier and the technologically given output-capital ratio. Let’s look at this issue more closely since it has direct implications for the employment generating capacity of this endogenously determined rate of growth.

2.2 Growth and Employment Prospects of the Green Policy

Unlike the mainstream literature, where the natural rate of growth determines the potential (and actual) rate of growth, in the heterodox literature, the causality runs in the opposite direction. It is the endogenously demand-determined rate of growth, as described above, which determines the natural rate of growth, either through changes in the rate of growth of labour force through immigration n or through changes in the rate of growth of labour productivity m through the Kaldor-Verdoorn law. The first route is a little far fetched in the context of developing economies since they have large internal labour reserves, so, we focus on the second to discuss the employment generating capacities of the green growth programme we profess below.

Since green growth expenditure, which is part public and part private, is a capital expenditure, it also creates capacity simultaneously. So, unlike the usual government consumption expenditure *Gc*, this would show up on the investment side. I_g, accordingly represents government financed capital expenditure whereas private investment is given by *Ip* and their sum is the total investment I in the economy. Given that this policy may have implications for trade balance of the economy owing to the import intensity of greener technologies, we discuss an open economy version with fixed exchange rates (for simplicity). Exports X are determined in that case exogenously by external demand. Imports M are a constant proportion μ of the total domestic output. We will discuss the changes in import intensity as a comparative static exercise. c is the Keynesian average propensity to consume, t is the tax rate, which is indirect in nature i.e. we abstract away from direct taxes for simplicity of representation.

$$\begin{aligned} O &= cO + I + \bar{G}_c - t.O + \bar{X} - \mu O \\ &= \tfrac{I_p + I_g + \bar{G}_c + \bar{X}}{s+t+\mu}; \qquad I \equiv I_p + I_g \\ &= \tau(I_p + I_g + \bar{G}_c + \bar{X}); \qquad \tau = \tfrac{1}{s+t+\mu} > 1 \end{aligned}$$

It can be seen from equation 1, an increase in green growth investment, ceteris paribus, increases the output of the economy in the short run provided the latter does not reach its full capacity level ahead of the multiplier (τ) process playing itself out. An increase in import intensity partially nullifies this effect since it dampens the multiplier because a part of the demand 'leaks out' of the economy.

The private sector incurs a part of this green expenditure, so, it shows up in their investment function. Moreover, private investment also rises as a result of this increase in demand for the output. So, the long run effect can be captured by making private investment a positive function of output and an autonomous factor given by γ_0, which increases as a result of increased green expenditure by the private corporate sector.

(2) $$I_p = \gamma_0 + \gamma_u \cdot O; \qquad \gamma_0, \gamma_u > 0$$

The second part of this function represents the crowding in effect of the increased government expenditure[1]. Substituting for output from equation 1, we can get a long run equilibrium in the following form.

(3) $$\begin{aligned} (1 - \tau\gamma_u)I_p &= \gamma_0 + \tau\gamma_u(I_g + \bar{A}); \quad \bar{A} = \bar{G}_c + \bar{X} \\ I^* &= \tfrac{\gamma_0 + I_g + \tau\gamma_u \bar{A}}{1 - \tau\gamma_u} \end{aligned}$$

As is assumed in the Kaleckian models of this variety, the Keynesian stability condition holds, i.e. the savings function is more responsive than the investment function with respect to output. So, the denominator of the equilibrium investment level is positive. Dividing equation 3 by the capital stock gives us the endogenously determined rate of growth of the economy. Any increase in the fiscal expenditure *Ig* as well as corporate expenditure γ_0, the combination of which is 1.5% of GDP as discussed below in our case, on green growth increases not just the output in the short run, it unleashes a higher growth trajectory in the long run as well. This is the exact opposite of what the mainstream green growth theory predicts [Blyth *et al.*, 2014].

However, how does employment figure in all of this? As discussed above, it is the so-called natural rate of growth which is endogenised with the actual rate of growth driving the latter. Using a Kaldor-Verdoorn (KV) kind of a growth of labour productivity, which is the

1 It can be noticed that the crowding out effect is missing here. The reason for that has been discussed above. Had there been a crowding out channel, it can be incorporated by introducing an interest rate term.

function of the growth rate itself, we can say that the rate of growth of employment (hence of unemployment) would be given by the difference between the actual rate of growth and the KV growth of labour productivity.

$$\begin{aligned} n &= g - m(g) \\ \frac{dn}{dg} &= 1 - m' \end{aligned} \tag{4}$$

Whether the rate of growth of employment will rise as a result of higher growth will depend on whether labour productivity rises slower than the rate of growth. What we show below is that being more labour intensive, green growth expenditure generates higher employment growth in the economy. Regarding equation 4, m' of green technologies is lower than that of the fossil fuel based technologies.

Since this comes across as low labour productivity path, a word of caution is required. A lower labour productivity growth does not mean a lower growth path because, as discussed above, it is not the productivity which determines the rate of growth but the other way around. Since the rate of growth is determined endogenously (through demand) as depicted in equation 3, the role of labour productivity is only in determining the rate of growth of employment.

As for the carbon emissions resulting from this process, let's start with the proposition that there are two forms of energy programs available: fossil fuel-based E_f (with proportion α) and green energy E_g, with carbon emissions per unit given by c and zero respectively. Let's say the technologically given output-energy ratio is ε, then carbon emission C per unit of output in an economy can be calculated as follows,

$$\begin{aligned} O^* &= \varepsilon \cdot (E_f + E_g) \\ \frac{C}{O^*} &= \frac{cE_f}{O^*} = \frac{c\alpha}{\varepsilon} \end{aligned} \tag{5}$$

There are three ways in which the carbon intensity of an economy can be brought down: (a) moving towards fossil fuels with lower carbon emitting properties (a fall in c); (b) increasing the efficiency of energy usage, which is quite low for the India (a rise in ε); (c) increased investment in greener forms of energy so that the dependence on fossil fuels declines (fall in α). We look at these three possibilities below followed by a discussion on employment generating capacity of this programme.

3 Policy Proposal

3.1 Fiscal Proposal and Controlling Emissions

A detailed proposal on decreasing the dependence on fossil fuels (decreasing α), or within the fossil fuels moving towards low emission sources (decreasing c) and increasing the efficiency of energy usage (increasing ε) for India has been presented in Pollin and Chakraborty (2015). We present here some of the salient features of that proposal:

1. Raise the economy's level of energy efficiency through the operations of buildings, industry and public transportation systems.

2. Among fossil fuel energy sources, increase the proportion of natural gas consumption relative to coal, since carbon emissions from burning natural gas are about one-half those from coal.

3. Invest in the development and commercialisation of some combination of the following technologies:

(a) Clean renewables, including solar, wind, hydro, geothermal and low-emissions bioenergy;

(b) Nuclear power;

(c) Carbon Capture and Sequestration (CCS) processes in generating coal, oil, and natural gas-powered energy.

Of these three, the primary focus should be on 1, and 3 (a) above as Pollin *et al.*, (2015) and Pollin (2015) have argued. Declining costs of production of clean renewables and, hence, favourable prices are one of the principal reasons for why the transition from non-renewable to these is not altogether unrealistic even in the short run. In fact, the reliance on solar energy in the rural areas in India is on a rise ever since the solar panels have become relatively inexpensive. Pollin and Chakraborty (2015) have estimated that the costs of generating electricity through clean renewables in India will be 25% lower than those in the US, which is approximately $200 billion per Q-BTU of capacity. Based on this, they have calculated the level of investment necessary to ensure a significant shift in the energy mix of India.

For raising energy efficiency, on the other hand, Pollin and Chakraborty (2015) have assumed a conservative average figure for India of $11 billion per Q-BTU of savings. They have further argued that the "rebound effects", i.e. increase in usage of energy on account of a fall in its cost, will cancel out across different usages and in activities where it does not, carbon tax/cap can be used.

Based on these estimates to fundamentally change the energy mix as well as increasing efficiency of existing sources of energy usage in India, Pollin and Chakraborty (2015) show that an additional 1.5% of the GDP (to the existing 0.5% being spent currently on green energy) is required assuming the Indian economy grows at an average of 6% *per annum* over the next two decades. This includes developing the infrastructure required to make these sources of energy accessible to those it does not reach at the present moment. For this paper, we borrow this figure for estimations made below.

3.2 Infrastructure Development for the Program

So far we have not discussed the actual implementation of this policy except in terms of how to finance it.

Since we are considering a combination of renewable and non-renewable source-based energy generation, we discuss the infrastructure requirements for each of them. As far as renewables are concerned, following are the sources: solar, small hydro, wind, biomass, geothermal and tidal energy. Gradually the role of the non-renewables would decline, but until such time that renewables are self-sufficient, the role of non-renewables will be significant. Let us first discuss the case of renewables and the untapped potential for India followed by a discussion on expanding the current power infrastructure.

Sukhatme (2012), among others, has estimated the renewable energy potential untapped in India so far for each of these sources. For solar power, Sukhatme (2012) estimates that if 10% of the barren land is used, it can potentially generate 5.4 quads of electricity per year. In this context, he also discusses the role of the decentralised usage of rooftop photovoltaic (PV) sources, which while contributing marginally to the national electricity generation can significantly contribute to the domestic usage of electricity for a majority of the population. For hydroelectric power generation, if 60% of the potential is utilised, about 1.1 quads can be produced per year spread across large and small plants. In the case of wind energy, he estimates that if a reasonable 40% of the total potential wind energy is tapped, then 4.8 quads can be produced per year. The other sources do not contribute a significant amount to total energy generation. Based on these estimates, he shows that the median potential energy generation through renewable resources under reasonable assumptions is 11.7 quads per year.

The smart grids can be so designed that the electricity generated through non-renewables kicks in only after the renewables are exhausted during a day. This might vary from day to day depending on weather conditions, for eg. lack of wind, an overcast day but since we are taking into account the backup being provided by non-renewables (at least up to that stage when technology and infrastructure is developed enough to meet the entire demand through renewables alone), delivery of electricity round the clock should not be a problem.

As a result of this policy, the carbon footprint of the Indian economy will be decreased by half in per capita terms from what the IEA predicts over the next two decades. Pollin and Chakraborty (2015) show that the per capita emissions will fall to 1.5 metric tonnes as opposed to 3.1 metric tonnes that the IEA predicts under the current policy scenario (0.6% of GDP continues to be spent).

TABLE 1. COST ASSUMPTIONS AND IMPACT OF THE CLEA RENEWABLE ENERGY PROGRAM

Cost Assumptions of our Model		
8. 20-year investment period. 9. 3-year delay in Implementing program. 10. 17-year spending cycle		
	Clean Renewable Energy	Energy Efficiency
(1) Cost Assumptions	$200 billion per Q-BTU of capacity	$11 billion per Q-BTU of energy savings
(2) Annual Spending Levels	$40 billion per year (=1% of midrange GDP)	$20 billion per year (=0.5% of midrange GDP)
(3) Total Spending	$680 billion	$340 billion
(4) Total Capacity Expansion or Energy Savings	3.4 Q-BTUs of new capacity	$30.9 Q-BTUs of energy savings
Impact of Our Clean Energy Program Compared to IEA		
	IEA's 2035 Current Policies Scenario	20-year Clean Energy Investment Scenario
(5) Total energy consumption	67.7Q-BTUs	36.8Q-BTUs
(6) Total clean renewable energy supply	1.7 Q-BTUs	5.1Q-BTUs
(7) Total nuclear power supply	1.7 Q-BTUs	0 Q-BTUs
(8) Total fossil fuels + high emissions renewable	64.6 Q-BTUs	31.7 Q-BTUs
Total CO2 emissions (metric ton)	4.7 billion	2.2 billion (based on 70 million metric ton average)
Total CO2 emissions per capita (metric tons)	3.1 ton	1.5 ton (based on 1.5 billion population)

Source: table cited from Pollin and Chakraborty (2015).

3.3 Employment: Green Job-creating Growth

The additional spending of 1.5% of the GDP on clean energy programme, over and above the current 0.6% of the GDP, will create additional jobs in the Indian economy. In fact, it generates positive *net* employment in the clean energy sector, even after we take into full account the job losses that will result due to the contraction in India's demand for fossil fuel energy. On this aspect of our policy, readers can refer to an earlier study (Pollin and Chakraborty, 2015), where it is shown that the green growth policy does not stall the employment rate. Instead, it has high employment multipliers on account of higher labour intensities of the green energy processes in comparison to the fossil fuel industry.

The Indian economy is already suffering from high levels of unemployment. Any respite in this area will benefit the poorer sections of the society, which on its own makes green growth inclusive. The previous estimates of Pollin and Chakraborty (2015) show that the total amount of direct plus indirect jobs generated through the clean energy investment project at 1.5% of India's GDP would be around 12 million jobs. It is about 2.5% of the overall Indian labour force of 488 million people as of 2013. Overall, the study finds that the *net* gain in employment through shifting funds out of the fossil fuel industries and into the clean energy at the level of 1.5% of India's GDP would be around 6.3 million jobs, which is approximately 1.3% of the country's 2013 workforce. It is important to state here that although the impact of clean energy investments would be strongly positive in terms of employment, its overall scope would be modest compared to the aggregate employment level in India.

Another important issue concerning the quality of jobs created through investments in the clean energy programme in India has been addressed in this study. In this paper, we build on Pollin and Chakraborty (2015) by estimating the gender, region, caste, skill and sectoral composition (formal *vs* informal) of the employment generated within the green energy sector. This is particularly important in the Indian case as the recent growth experience has shown that it not only failed to create enough jobs but also the jobs that have been created are skewed in terms of gender and region (Rawal and Saha, 2015). Rawal and Saha (2015) show a sharp decline in female workforce participation rate from 41% in 1999-2000 to 32% in 2011-12, with the decline being sharper in the rural areas (48% in 1999-2000 to 37% in 2011-12). The authors attribute this fall primarily to the massive contraction of employment opportunities in agriculture. Since a significant chunk of the expenses for the clean, renewable energy programme is spent for rural electrification and also for the development of the rural agricultural sector to produce clean bio-energy, it will help in addressing to some extent the problems related to the recent job trajectory in India.

4 Methodology and Data

4.1 Methodology

The methodology used in the paper is similar to the existing literature. We employ the Input-Output technique to estimate the job numbers generated through investments in the clean energy program. It is static in nature i.e. it does not take into account the changes in employment elasticities that might result from technological innovations in the future. The best case scenario is projecting employment generating capacities of different sectors based on their current elasticities. In that sense, these could overstate the case since technological innovations are more likely to increase labour productivities within a given sector. However, it is safe to assume that the *relative* elasticities across the sectors are more likely to stay similar to what they are at the moment. Since it is difficult to estimate what the labour productivities in the future are going to be like, we take the current structure of production as given and extrapolate it in the future (discussed in details in the penultimate section).

One of the limitations of this methodology, which is a limitation for any work based on the I-O methodology, is that it does not take into account the changes in the production structure such a capital expenditure will entail in the future and to that effect is a static analysis in nature. The alternative to that is comparative general equilibrium modelling, which requires demand and supply elasticities to be taken into account to present a dynamic picture but it has its limitations along with the issue of the unreliability of these elasticities.[2] At the end of the day, it is always better to tell a story in as simple a term as possible because it is not about the exact numbers as they will pan out but more about the relative trends in different scenarios.

2 For a detailed discussion on the advantages and disadvantages of this methodology, see (Pollin et al., 2015: p.123-144).

4.1.1 Employment Multipliers

A detailed methodology of calculating the employment multipliers as a result of the clean energy policy has been discussed in Pollin *et al.*, (2015) and Pollin and Chakraborty (2015). Our estimates on employment generation draw directly from the Input-Output (I/O) tables and the employment and unemployment surveys of National Sample Surey (NSS) for India.

We take into account the direct and indirect content of one commodity in a unit of another commodity through the I/O table. The elements a*ij* of the Leontief inverse matrix gives us the total input of commodity *j* embodied in output of commodity *i*. We match the NSS sectors with that of the I/O sectors to get the employment-output ratios (measured in employment per million dollar value of the gross output of an industry) for each of the I/O sectors.[3] Multiplying the Leontief inverse matrix with the employment-output ratios calculated thus gives us the employment matrix (*EM*), the diagonal elements of which tell us the direct employment generated by the sector and the sum of the rest of the column elements gives us the indirect employment generated for the sector in that column.

Combining the two components of employment, which is the total sum of the columns, generates the total employment multiplier for each of the sectors per million USD spent in these sectors. The next step is to find out the employment multiplier generated as a result of the different forms of energy-related investments.

Concerning equation 5, we divide the energy policy into two categories: improving energy efficiency (ε) and expenditure in renewable energy Eg. As opposed to that, the employment generated in the fossil fuels F industry is taken as a benchmark against which the green energy programme is being measured. Within this division, the first is sub-divided into weatherisation, industrial energy efficiency, smart grids & grid upgrade and public transportation; the second is divided into bioenergy, solar, wind, geothermal and small hydro. The fossil fuel is divided into coal and oil/gas production.[4]

Based on the employment matrix and the expenditure on each of these sub-divisional categories of energy programme, we can find the number of jobs that can be generated per million USD spent on these programmes. With the different weights for these subdivisions, we calculate the weighted-average of employment generated per million USD spent under the two categories of the energy programme. Finally, the relative weight of the two parts of the energy programme gives us the total employment generated through this green energy programme. These numbers are then compared with the fossil fuel employment generating capacity for the same amount of money spent.

The composition of employment based on region, gender, caste, education, sector has been calculated based on the NSS which provides this information at the level of individual industries.

4.2 Data sources

We use the latest NSS 68*th* round unit level data (survey done in 2011-12), and the corresponding

3 Table A1 in the Appendix provides all the industry-wise details of the matching principle employed.

4 Table A2 in the Appendix provides the detailed weights of each industry used to build each of these individual energy sectors and the weights to generate the programs.

source for the Input-Output table is OECD database. NSS schedule 10 has been used to calculate the employment intensity of different sectors.

5 Results

5.1 International employment estimates

Before presenting our results, let us take a look at green job estimates at the global level. International experience shows that the countries which have already invested in clean energy programme, have immensely benefited in terms of employment. Over a period of more than a decade spanning 2004 to 2016, the estimated gross global renewable energy jobs increased almost eight times from 1.3 million to more than 9.8 million (IRENA, 2017). Globally, the clean energy sector is turning out to be one of the most labour intensive sectors, with favourable policy frameworks in several economies further helping in the generation of these jobs. Solar PV, for instance, creates more than twice the number of jobs per unit of electricity generation compared with coal or natural gas (Blyth, 2014).

According to a recent report published by the EDF Climate Corps, the clean energy jobs in the United States is around 3.0 million in 2016, with the energy efficiency sector employing 70% of it (Environmental Defense Funds Climate Corps & Meister Consultants Group, 2017). It also suggests that solar and wind industries are each creating jobs at a rate 12 times faster than that of the rest of the U.S. economy. Rising automation in extraction, overcapacity, industry consolidation, regional shifts, and the substitution of coal by natural gas in the power sector are resulting in job losses in the fossil-fuel sector in some countries. Renewable energy is already contributing to job creation in many of these markets. In the specific case of the United States, solar generating capacity represents only slightly more than 1% of the total power capacity (coal at 26%). However, solar workers are already twice as numerous as those in the highly automated coal industry (Department of Energy, 2017).

Even in a developing economy like China, the renewable energy sector employed 3.5 million people compared to 2.8 million working in the country's fossil fuel industry in 2016 (International Renewable Energy National Agency, 2017). The key job markets in the hydropower sector are China, India, Brazil, the Russian Federation and Vietnam, which together account for 62% of the total. India's labour-intensive hydropower sector accounted for 16% of the jobs, followed by Brazil, the Russian Federation and Vietnam.

It might also help to locate our proposal and its implications in the context of other estimates about employment generating capacity of green energy in India (International Renewable Energy National Agency, 2017). Up-to-date information for India is limited, making the extent and recent trends of renewable energy employment hard to determine. The closest estimate has been compiled from different sources by International Renewable Energy National Agency (2017), which shows that, in the large hydropower generation, which has the most reliable data available, employment has more than doubled from 100,000 to 240,000 between 2014 and 2016. For the rest of the renewable energy sources, employment generation has varied between 391,000 to 385,000 during the same period with the marginal decline arising in the solar heating/cooling category.

In India, utility-scale and rooftop solar installations reached 4.9 GW in 2016, and domestic project developers won more than 90% of tendered PV capacity - benefiting domestic employment.[5] For 2017, PV installations employment should continue to expand dramatically, given that an expected 8.8 GW of capacity will be added, almost double the pace of 2016 (Bridge to India, 2017). While domestic installers fared well, manufacturers continued to struggle because the cost of Indian-made modules is 10% higher than their Chinese counterparts, thereby, increase the import intensity on this count (rise of μ). The government has tried to find ways of addressing this rising import intensity through capital subsidies, interest-free loans and tax breaks, so-called Viability Gap Funding allocated through a bidding process, and a waiver of VAT and countervailing duties on domestically-produced components.[6] In the area of utility- and park-scale PV projects, the Council on Energy Environment and Water (CEEW) and the National Research Development Corporation (NRDC) project that it could create 58,000 direct jobs through 2022 (IRENA, 2017).

5.2 Our results

The basic structure of the results for employment follows an earlier study (Pollin and Chakraborty, 2015), so the readers are referred to that for details and comparison. The findings here are comparable to the earlier study. Additionally, in this study, given the emphasis on the public transport sector, we have estimated, for the first time in case of India, the employment figures resulting from investments in the public transport system. Given the rising levels of pollution, which many in the popular press have justly called a medical emergency, it is critical for the economy to invest in a green public transport system.[7]

The results presented here are at a more disaggregated level, and the results may differ from Pollin and Chakraborty (2015) since we have used the latest NSS 68th round unit level data and the corresponding source for the Input-Output table is OECD database.[8] The total employment generated through the green energy programme is almost 2.5 times the jobs created through the same amount of investment in a fossil fuel programme. For a million US dollar investment, 197 jobs will be created in the green energy programme compared to 82 jobs in the fossil fuel industry in India (Table 2).

5 These statistics have been cited from http://www.bridgetoindia.com/2016-great-year-indian-solar-industry-best-yet-come/ (accessed on February 22, 2018).

6 This discussion has benefited from International Renewable Energy National Agency (2017) and Mercom Capital Group (2017) (https://mercomindia.com/mercom-exclusive-can-domestic-manufacturers-capture-larger-piece-growing-indian-solar-market/ (accessed on February 22, 2018))

7 The importance of an expanded public transport system, especially the Indian railways, and its associated benefits has been discussed in great details in a report published by the Planning Commission (Government of India, 2014).

8 The other reason for the aggregate figures to differ is due to the inclusion of public transport system in the calculations.

TABLE 2. EMPLOYMENT GENERATION FROM INVESTMENTS IN GREEN ENERGY VIS-Á-VIS FOSSIL FUEL PROGRAM

	Direct	Indirect	Total
Green Energy	115.2	82.2	197.4
Energy Efficiency (33%)	76.9	83.8	160.7
Renewable Energy (67%)	134.0	81.4	215.5
Fossil Fuel Program	29.8	52.6	82.4

Source: authors calculations (see text for details).
Note: jobs per $1 million; figures are for 2011-12.

These employment figures for renewable energy vis-à-vis the fossil fuel industry should not be startling as they are in tandem with the international estimates discussed earlier.

We also report the distribution of these green jobs across different components of the clean energy programme in Table 3. As observed in Table 3, the renewable energy sector and the energy efficiency sector generates 216 and 161 jobs respectively per million dollars of investment. These results are again quite similar to our earlier findings (Pollin and Chakraborty, 2015). The bioenergy sector is the most labour intensive sector. We find that almost 429 jobs can be generated per million dollars of investment in this sector. In other renewable energy sectors – hydro, wind, solar and geothermal - the total employment creation ranges from 142 to 177 jobs per million dollars of investment. Within the energy efficiency programme, weatherization and building retrofits seem to be the most labour intensive sector generating around 218 jobs per million dollars, followed by the public transport sector which creates roughly around 150 jobs per million dollars of investment. The latter again brings forth the importance of the public transport sector in the Indian economy.

TABLE 3. EMPLOYMENT CREATION THROUGH SPENDING IN ALTERNATIVE ENERGY SECTORS

	Direct	Indirect	Total
Renewable Energy			
Bioenergy	375.9	53.4	429.3
Solar	67.2	85.4	152.6
Wind	56.6	85.7	142.2
Geothermal	91.1	86.0	177.1
Small Hydro	79.3	96.7	176.0
Weighted Average for Renewables	134.0	81.4	215.5
Energy Efficiency			
Weatherization	135.5	82.9	218.4
Industrial EE	56.9	92.7	149.6
Smart Grids	46.7	79.2	125.9
Public Transportation	71.8	78.4	150.2
Weighted Average for Energy Efficiency	77.7	83.3	161.0
Fossil Fuels			
Coal	35.0	56.6	91.6
Oil and Natural Gas	24.5	48.6	73.2
Weighted Average for Fossil Fuels	29.8	52.6	82.4

Source: authors calculations (see text for details).

Note: jobs per $1 million; figures are for 2011-12.

As mentioned earlier, we have, for the first time, looked into the composition of employment to reflect on the type and quality of jobs created through investments in the green energy programme in India. To study this aspect, we looked into the gender-wise composition of jobs created in the green energy programme as compared to those in the fossil fuel industry. The job distribution in the green energy programme is more favourable towards females compared to those in the fossil fuel industries. We find that the ratio of male to female jobs in the green energy programme is 4:1 as against 7:1 in the fossil fuel industry indicating that green energy programme is more equitable regarding the gender distribution of jobs. As evident from Table 4, for every million dollars of investments, 37 jobs are created for females in the green energy programme compared to 11 jobs in the fossil fuel industry. This is in line with Baruah (2014) who argues that there is ‘tremendous potential’ to generate employment and other livelihood opportunities for women at all levels of the clean energy chain. Although male jobs dominate 81.1% of total employment in the green energy program, in the fossil fuel sector these jobs constitute 86.9% of the total employment. This, in general, reflects the male dominance of employment in the energy sector. The investments in a clean energy economy should be seen as an occasion to provide a whole range of new opportunities for women. Employment opportunities for women is overall worse than in the various clean energy sectors.

TABLE 4. GENDER-WISE DISTRIBUTION OF JOBS

	Direct	Indirect	Total
Green Energy			
Male	89.0	71.1	160.1 (81.1%)
Female	26.2	11.1	37.3 (18.9%)
Fossil Fuels			
Male	25.2	46.4	71.6 (86.9%)
Female	4.6	6.3	10.8 (13.1%)

Source: authors' calculation.

Note: the bracketed figures show the share of jobs.

TABLE 5. REGION-WISE DISTRIBUTION OF JOBS

	Direct	Indirect	Total
Green Energy			
Rural	86.0	36.9	122.9 (62.3%)
Urban	29.1	45.3	74.5 (37.7%)
Fossil Fuels			
Rural	17.3	23.1	40.4 (49.0%)
Urban	12.5	29.5	42.0 (51.0%)

Source: authors' calculation.

Note: the bracketed figures show the share of jobs.

We further decomposed the job numbers to find out the region wise distribution of employment generated through investments in the green energy programme vis-à-vis those of the fossil fuel industry. We observe that the allocation of jobs is more favourable for the rural sector in the green energy programme when compared to those of the fossil fuel industry. From Table 5, we observe that in the green energy programme, for every one job generated in the urban sector, almost two equivalent jobs are generated in the rural sector. In the case of the fossil fuel industry, that ratio is nearly 1:1. Similarly, the rural share of employment in the green energy program is 62.3%, whereas the urban share is less than even 40.0%. It shows that with investments in the clean energy program, more employment opportunities will be generated in the rural areas, which to a certain extent might solve the acute unemployment problem in these areas. However, in both the scenarios, more indirect jobs are created in the urban sector.

We extend this analysis to see how the green energy programme affects different caste groups (Table 6). For the same amount of expenditure, the green energy programme generates 1.5 and 1.3 times higher jobs than fossil fuels for the STs and SCs respectively. In percentage terms, the share of the SCs and STs, who represent the most deprived sections of the Indian society, in the clean energy program is 31.6%, whereas the share of the same group in the fossil fuel sector is 23.8%. Hence, the upper castes of the Indian population has a much lower representation of 28.9% in the green energy program compared to 34.6% in the fossil fuel sector. The reason for this is that the green jobs created in rural areas have a higher proportion of the workers coming from these oppressed sections.

TABLE 6. CASTE-WISE DISTRIBUTION OF JOBS

	Direct	Indirect	Total
Green Energy			
ST	12.5	4.6	17.1 (8.7%)
SC	27.4	17.7	45.1 (22.9%)
OBC	47.6	30.5	78.1 (39.6%)
G	27.6	29.5	57.0 (28.9%)
Fossil Fuels			
ST	2.8	2.1	4.8 (5.8%)
SC	7.4	7.5	14.8 (18.0%)
OBC	12.1	22.2	34.3 (41.6%)
G	7.5	21.0	28.5 (34.6%)

Source: authors' calculation.

Note: the bracketed figures show the share of jobs.

Notations: ST= Scheduled Tribes; SC= Scheduled Castes; OBC= Other Backward Castes; G= General (Upper Castes).

It is usually assumed that there might be a skill gap between the demand and supply of labour in developing countries, which might be particularly acute in newer areas of technologies, say the green sector, since the skill requirements are yet unknown. Fortunately, the skill requirement based on the current state of green technology and its impact on jobs created in the process is not a black box because most of these sectors are already in operation. We find that the skill set required in green energy are tilted towards unskilled labour (table 7). For every high skilled job created in the green energy sector, more than six unskilled jobs will be created whereas, in the fossil fuel, it creates less than four jobs. Our findings are similar to a primary survey based study done by Jairaj et al. (2017), where the authors find that 'many clean energy jobs in fields such as construction, installation, sales, and operations and maintenance will go to unskilled and semi-skilled workers—those who lack the formal training or educational background needed to secure well-paid, full-time employment.' Not surprisingly, the educational attainment levels in the clean energy sectors are relatively low, though basically not less so than in the fossil fuel sectors. In table 7, the composition of employment based on education levels shows that 36.1% jobs in the fossil fuel sector are for graduate and higher degree holders, while in the clean energy sector that proportion is only 14.0%. A distribution tilted in favour of unskilled labour in the green energy sector makes it a more inclusive growth strategy.

TABLE 7. EDUCATION-WISE DISTRIBUTION OF JOBS

	Direct	Indirect	Total
Green Energy			
No Education or Below Primary	50.9	20.5	71.4 (36.2%)
School Education (including diplomas)	55.2	43.2	98.5 (49.9%)
Graduates and above	9.3	18.3	27.6
			(14.0%)
Fossil Fuel			
No Education to Below Primary	37.9	14.5	52.4 (21.8%)
School Education (including diplomas)	0.5	0.2	0.7 (42.1%)
Graduates and above	12.5	5.7	18.3 (36.1%)

Source: authors' calculation.

Note: the bracketed figures show the share of jobs.

However, the distribution of jobs across unorganized and organized sectors of the economy is skewed in favour of the former for the clean energy vis-á-vis the fossil fuel sector. From investments in the clean energy program, for every one job in the unorganized sector, only one job is created in the organized sector, whereas in the fossil fuel sector for every one job in the unorganized sector, almost six jobs are created in the organized sector. International experiences from Bangladesh show that if policies can be properly framed in the green energy program, it significantly improves the livelihoods of the poor, especially the youth and women in the unorganized sector (Islam *et al.*, 2011). The Indian experience shows that the jobs generated in the clean energy sector provide reliable income, healthcare benefits, employee safety policies, and training/capacity building opportunities. However, the loophole is that there is a major tendency of the employers to hire workers as contractors so that the latter is not subjected to the same labour standards as provided by the Industrial Disputes Act of 1947 (Jairaj *et al.*, 2017) . This policy loophole needs to be immediately closed. It poses a major challenge to this program and to the system as a whole. The challenge will be precisely to encourage these workplaces to become increasingly organized. A similar recommendation is also given by Jairaj *et al.,* (2017) where the authors argue that policies and programs should be designed in ways that embed and foster community- and village-level project ownership, and also end the process of hiring workers as contractors.

TABLE 8. SECTOR-WISE (INFORMAL/FORMAL) SHARE IN JOBS

	Direct	Indirect	Total
Green Energy			
Unorganized	74.5	31.9	106.5 (53.9%)
Organized	40.9	50.1	91.0 (46.1%)
Fossil Fuel			
Unorganized	5.0	7.2	12.2 (14.8%)
Organized	24.7	45.4	70.2 (85.2%)

Source: authors' calculation.

Note: the bracketed figures show the share of jobs.

6. Total Employment Creation from the Clean Energy Program

In this section, we report the overall job numbers generated through this Indian clean energy investment programme at the level of 1.5% of GDP. However, to report these numbers we need to make two significant assumptions. Firstly, we assume that the 'domestic content' is stable as the renewable energy and energy efficiency investments expand significantly, i.e. there is no change in the proportion of the imported inputs to meet the expanding demands of renewable energy and energy efficiency sectors.[9] Secondly, we assume that only 70% of the total investment for clean energy will be spent on creating capacity and producing, refining, transporting and marketing energy. The rest 30% will be allocated to cover the financing costs

9 The reason why we make this assumption is that earlier studies done by Pollin and Chakraborty (2015) and Pollin et al. (2015) on India and other countries showed that declines in domestic contents don't cause a significant change in the employment figures.

of these projects. Employing these assumptions in Table 9, we estimate that the total amount of jobs created through the clean energy investment project would be about 8.3 million in Year 1. This is approximately about 1.6% of the total labour force of the Indian economy, which is around 503.8 millions as of 2015.[10] The net gains in employment over the fossil fuel industry is around 4.8 million jobs in Year 1. The net gains in employment from investments in the clean energy program vis-á-vis the fossil fuel program will be around 1.0% of India's total labour force in 2015, which is strongly positive. However, the overall scope of making a significant impact on the Indian labour market would be relatively modest.

TABLE 9: OVERALL EMPLOYMENT IMPACT OF CLEAN ENERGY PROGRAM ASSUMPTIONS OF OUR PROGRAM

• Domestic content' remains stable • 70% of investment for capacity creation/production/distribution • Indian labor force in 2015 = 503.8 million			
	Clean Energy	**Fossil Fuel**	**Net Employment**
Total Employment	8.3 million	3.5 million	4.8 million
Share of Total Labor Force	1.6%	0.7%	1.0%

Source: authors' calculation

Note: the employment figures are for Year 1 of the 20-year program.

Conclusion

In this paper, we have presented a green energy policy proposal, which not only has a higher employment potential but also delivers higher growth to the economy on account of the increased fiscal expenditure that this programme entails. Regarding the composition of employment, the green energy programme is more progressive than its fossil fuel counterpart, whether we look at it through the lens of gender, region, caste or skill. Our focus has been primarily on direct and indirect jobs calculated from the current I-O structure of the Indian economy. So, while we have not managed to calculate jobs generated through the multiplier effect, what the literature refers to as 'induced' jobs, we can say with some degree of certainty that the induced jobs will be even higher in the green energy programme since the green jobs created are skewed towards the poorer sections of the population who have a higher propensity to consume, thereby, have a higher demand multiplier.

In the long-run, building a clean energy economy in India, as opposed to expanding its existing fossil-fuel dominated energy system, will generate both major opportunities and challenges for the economy in terms of the employment effects. The opportunities exist since there will be an overall net gain of employment in the Indian economy with the expansion of our clean energy program. The challenges, then, will be to encourage and support these workplaces to become increasingly organized and formalized such that this expanding workforce benefits from better quality jobs, higher and stable earnings, and other employment benefits like health insurance, pension and enhanced social security. Otherwise, a significant objective of this program, which is a better livelihood for the Indian workforce, gets defeated.

10 The data has been cited from World Development Indicators, World Bank.

An organized workforce will, in turn, allow for higher productivity, higher earnings and, thereby, a more rapidly growing clean energy sector for the Indian economy.

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Appendix

TABLE A1. CODE MATCHING FROM INPUT-OUTPUT TABLES TO NSS CATEGORIES: EMPLOYMENT SCENARIO

Industrial Categories	IO Codes*	NIC-2008(Sec & Div) **
Agriculture & Allied Activities	C01T05	Sec A
Mining & Quarrying	C10T14	Sec B
Food Products & Related Items	C15T16	Div 10+ Div 11+ Div 12
Textiles, Leather & Related Items	C17T19	Div 13+ Div 14+ Div 15
Wood & Related Items	C20	Div 16
Pulp, paper, & Related Items	C21T22	Div 17 + Div 18
Coke, & Related Items	C23	Div 19
Chemicals & Related Items	C24	Div 20 + Div 21
Rubber & Plastic Products	C25	Div 22
Non-metallic Mineral Products	C26	Div 23
Basic Metals	C27	Div 24
Fabricated Metal Products	C28	Div 25
Machinery & Equipment, nec	C29	Div 28
Computer & Related Items	C30T33X	Div 26
Electrical Machinery & Apparatus, nec	C31	Div 27
Motor Vehicles & Related Items	C34	Div 29
Other Transport Equipments	C35	Div 30
Manufacturing nec; recycling	C36T37	Div 31+ Div 32+ Div 33
Electricity, Gas & Water Supply	C40T41	Sec D + Sec E
Construction	C45	Sec F
Wholesale & Retail Trade; Repairs	C50T52	Sec G
Hotels & Restaurants	C55	Sec I
Transport & Storage	C60T63	Sec H
Postage & Telecommunication	C64	Sec J -Div 62
Financial intermediation	C65T67	Sec K
Real Estate Activities	C70	Sec L
Renting of Machinery & Equipment	C71	Div 77
Computer & Related Activities	C72	Div 62
R&D & Other Business Activities	C73T74	Sec M + Sec N - Div 77
Public Admin; Defense & CSS	C75	Sec O
Education	C80	Sec P
Health & Social Work	C85	Sec Q
Other Community, Social & Personal Services	C90T93	Sec R+S+T+U

Source: compiled by authors from IO, NSS

Notes: *codes are taken from OECD Input-Output Tables (IOT), 2015; **NIC Codes are in the Schedule 10 of NSS 68th round; Sec stands for Section and Div stands for Division; nec stands for not elsewhere classified.

TABLE A2. WEIGHTING ASSUMPTIONS FOR SPECIFYING CLEAN ENERGY SECTORS WITHIN INDIA'S INPUT-OUTPUT MODEL

Category	I-O Industry	Weights
Bioenergy	Agriculture, Hunting, Forestry & Fishing	50.0%
	Coke, Refined Petroleum Products & Nuclear Fuel	12.5%
	Construction	25.0%
	R&D & Other Business Activities	12.5%
Solar	Basic Metals	8.75%
	Fabricated Metals	8.75%
	Computer, Electronic & Optical Equipment	17.5%
	Electrical Machinery & Apparatus, nec	17.5%
	Construction	30.0%
	R&D & Other Business Activities	17.5%
Wind	Rubber & Plastic Products	12.0%
	Basic Metals	6.00%
	Fabricated Metals	6.00%
	Computer, Electronic & Optical Equipment	21.5%
	Electrical Machinery & Apparatus, nec	21.5%
	Construction	26.0%
	R&D & Other Business Activities	7.0%
Geothermal	Mining & Quarrying	15.0%
	Computer, Electronic & Optical Equipment	5.0%
	Electrical Machinery & Apparatus, nec	5.0%
	Construction	45.0%
	R&D & Other Business Activities	30.0%
Small Hydro	Other Non-metallic Mineral Products	18.2%
	Computer, Electronic & Optical Equipment	10.5%
	Electrical Machinery & Apparatus, nec	10.5%
	Construction	18.2%
	R&D & Other Business Activities	42.6%

Source: compiled by authors from IO, NSS.

TABLE A3: WEIGHTING ASSUMPTIONS FOR SPECIFYING CLEAN ENERGY SECTORS WITHIN INDIA'S INPUT-OUTPUT MODEL (CONTD.)

Category	I-O Industry	Weights
Weatherization	Construction	100.0%
Industrial EE	Computer, Electronic & Optical Equipment	25.0%
	Electrical Machinery & Apparatus, nec	25.0%
	Construction	20.0%
	R&D & Other Business Activities	30.0%
Smart Grids	Computer, Electronic & Optical Equipment	37.5%
	Electrical Machinery & Apparatus, nec	37.5%
	Construction	25.0%
Public Transportation	Other Transport Equipment	30.0%
	Construction	20.0%
	Transport & Storage	50.0%
Coal	Mining & Quarrying	50.0%
	Chemical & Chemical Products	50.0%
Oil & Gas	Mining & Quarrying	50.0%
	Coke, Refined Petroleum Products & Nuclear Fuel	50.0%
Renewable Energy	Bioenergy	20.0%
	Solar Energy	20.0%
	Wind Energy	20.0%
	Geothermal	20.0%
	Small Hydro	20.0%
Energy Efficiency	Weatherization	25.0%
	Industrial Energy Efficiency	25.0%
	Smart Grids & Upgrades	25.0%
	Public Transportation	25.0%
Fossil Fuel	Coal	50.0%
	Oil and Gas	50.0%

Source: compiled by authors from IO, NSS.

Study of the contribution of sustainability indicators to the development of sustainable coastal zones - a systems approach. Western Japan [1]

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Introduction

Coastal zones are Social-Ecological Systems (SESs) where humans are a part of nature (Berkes and Folke, 1998). SESs including coastal zones are complex due to the dynamic interactions and feedback between components, processes, and systems that make up these SESs (Costanza and Ruth, 1998; Limburg *et al.*, 2002). They can also be considered as complex adaptive systems that exhibit nonlinear feedbacks, strategic interactions, individual and spatial heterogeneity, and varying time scales (Atkins *et al.*, 2011; Levin *et al.*, 2013). Therefore, understanding and assessing this complexity is imperative to successful coastal zone management.

Since coastal zones include the sea and the surrounding land areas, the management of these zones require covering both areas in an integrated system to capture their dynamic interactions. Integrated Coastal Zone Management (ICZM) has been adopted as an effective measure to manage coastal zones sustainably (Pickaver, Gilbert and Breton, 2004; Maccarrone *et al.*, 2014; Karnauskaitė *et al.*, 2018).

To aid SES management including ICZM, there has been a growing literature in ecosystem services and sustainability science. However, their practical impacts on the ICZM are limited (Abson *et al.*, 2017; Saarikoski *et al.*, 2017). As a result, mainstreaming, or linking science to policy, requires immediate attention (Cowling *et al.*, 2008; Olander and Maltby, 2014; Luederitz *et al.*, 2017; Potschin-Young *et al.*, 2017).This study aims at bridging the gap between science and policy by focusing on the current ICZM practices rather than designing a desirable ICZM from

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the beginning. The policy arena in which ICZM is designed and implemented is contextually objective and to contribute to the policy, studies should be relevant to the current context.

Among various approaches to ICZM, this study focuses on indicators because they have been recognized to be one of the primary inputs to ICZM and are in increasing demand (Maccarrone *et al.*, 2014). Indicators can simplify, quantify, analyze and communicate complex SESs (Singh *et al.*, 2012). In addition, they also help in assessing the progress of management programs (Karnauskaitė *et al.*, 2018) by providing a simple interface to integrate the complex SESs into a set of comparable quantities (Singh *et al.*, 2012). This is an indispensable source of information as it provides an analysis of the overall performance of various departments (e.g., fishery department, environmental conservation department, etc.), which typically conduct management programs independently.

While such a simplification is inevitable for managing complex SESs, there are at least two primary challenges indicators face, that sustainability indicators should reflect the causal relationships of SESs (Perdicoúlis and Glasson, 2011; Maccarrone *et al.*, 2014; Costanza *et al.*, 2016) and that they should have their intended impact with regards to sustainability, which might not always occur (Singh *et al.*, 2012; Maccarrone *et al.*, 2014; Costanza *et al.*, 2016). Due to simplification of the complex interface, the relationship between indicators and the nature of their impact in SESs is often neglected, and the contribution of indicators to the system objectives (i.e., sustainability) is overlooked. Since in reality, the indicators form causal relationships in SESs, (e.g. an improvement of one indicator (e.g., fish catch) could result in the deterioration of another (e.g., marine ecosystems)), trade-offs and synergies between indicators should be considered. These relationships are not necessarily direct but may include some components of SESs. Therefore, SES indicator selection demands a careful investigation of their causal relationships. Similarly, since sustainability activities often involve various entities (e.g. multiple departments at the municipality) acting independently (Singh *et al.*, 2012), supervising all activities aimed at improving the indicators is a challenge. For example, each department in charge of some of the indicators could try to optimize locally without realizing its impact on the whole, which does not necessarily lead to optimization at a system level (Stroh, 2015). Therefore, assuming that individual actions will naturally lead to system-level sustainability is even dangerous (Anderies *et al.*, 2013).

The "systemness" (Lendaris, 1986) of SESs is the root cause of these challenges. A system is "more than the sum of its parts" (Meadows, 2008); a change in one component of a system could influence the entire system, including its own component, via feedback process. Also, a system is organized to achieve some objectives (e.g., the sustainability of the system) (Meadows, 2008). Assuming the systemness as the key to successful indicators, this study hypothesizes that a systems approach improves sustainability indicators. In other words, using a systems approach, we can improve indicator selections in spite of the two challenges involved. The purpose of this study is to describe and assess existing sustainable indicators in order to improve their performance regarding sustainability developments by using a systems approach in the form of Causal Loop Diagrams (CLD). Omura Bay, an enclosed sea located in Western Japan with an action plan for ICZM is chosen as a case study. There have been various attempts at using a systems approach for indicator selection. For example, the PSR (pressure–state–response) framework and the DPSIR (Drivers-Pressures-State Change-Impact-Response) framework have been developed as a system-based approach (Atkins *et al.*, 2011). However, they do not reflect the systemness well as we discuss later (Perdicoúlis and Glasson, 2011).

The rest of the paper is organized as follows. In Section 2, the basics and advantages of CLD, the primary method applied in this study, are explained after a short description of the case study. Section 3 demonstrates and discusses a CLD for Omura Bay. In Section 4, the conclusions of the study are summarized. Finally, Section 5 gives an overview of the scope of future research related to this study.

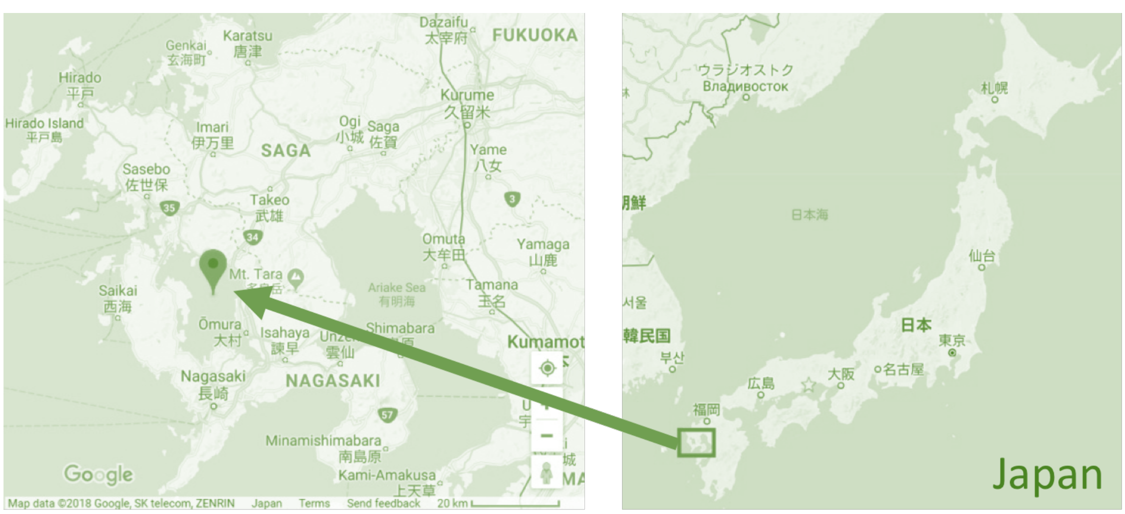
2. Materials & Methods

This section first describes a site in which CLD was applied to indicators as a case study. Then, it explains the basics and discusses the advantages of CLD.

2.1. Case Study: Omura Bay

Omura Bay is an enclosed coastal sea located in Nagasaki Prefecture, Western Japan (Figure 1). The sea covers an area of 320 km² and is approximately 14.8 m deep with a coastline of length 360 km (Ocean Policy Research Institute and Nagasaki Prefecture, 2011). Because there are few shallow bottoms, nutrients from the land areas directly sink to the deep bottoms (Ocean Policy Research Institute and Nagasaki Prefecture, 2011).

FIGURE 1. LOCATION OF THE SITE SELECTED FOR THE CASE STUDY - OMURA BAY



About 280,000 people live along the coast, accounting for 20 % of the total population of Nagasaki Prefecture (Nagasaki Prefecture, 2014). The bay is not accessible to the residents for recreational purposes like swimming, owing to its depth at most points. It is an ecologically important site, as it contains several endangered species, including finless porpoises (*Neophocaena phocaenoides*) and Horseshoe crabs (*Tachypleus tridentatus*) (Nagasaki Prefecture, 2017). Additionally, the bay is important for the fishery industry, since several species of fish are found here (including squillas (*Oratosquilla oratoria*), sea cucumbers (Holothuroidea), and turban shells (*Turbo sazae*) (Omura City, 2016)) and it also acts as a fish nursery both inside and outside the bay (Nagasaki Prefecture, 2014). However, it has faced several challenges including a decline in fish catch, the deterioration of sea bottoms reportedly due to eutrophication, red tide, and dysoxic water mass (Nagasaki Prefecture, 2014).

In response to the deterioration of the bay, Nagasaki Prefecture has implemented action plans for conserving and revitalizing Omura Bay since 2003 (Phase 1). The current plan is the third phase adopted in 2014 (Nagasaki Prefecture, 2014). The plan was formulated by a panel of experts from private sectors, fishery, Non-Profit Organizations (NPOs) and universities. Its objective is to realize Satoumi, a Japanese concept describing a desired state of socio-ecological production landscape (Duraiappah *et al.*, 2012; Gu and Subramanian, 2014), in which high productivity and rich biodiversity is maintained through human intervention (Yanagi, 2012). The action plan adopted an image (Figure 2), called the "sea of treasure", provided by the Japanese Ministry of the Environment as the desired state where economic activities thrive and people recreate and communicate (Nagasaki Prefecture, 2014).

FIGURE 2. AN IMAGE DEPICTING SATOUMI

Source: Japanese Ministry of the Environment.

To realize and sustain the desired state, the plan stipulates four major items followed by ten intermediate and seventeen minor items as shown in Table 1. To operationalize the plan, it sets indicators corresponding to each minor item, that is, there are seventeen indicators. Each of these indicators were assigned to a relevant department at Nagasaki Prefecture, where each department is in charge of achieving the target level of its assigned indicator and is expected to work with relevant stakeholders such as municipalities and NPOs.

TABLE 1. PHASE 3 ACTION PLAN: ORGANIZATION OF MEASURES

Major Item	Intermediate Item	Minor Item	Indicator
Creating unified Satoumi from mountain to sea	Curbing inflow of domestic wastewater	Approaches for promoting wastewater treatment	Population penetration rate of Omura Watershed basin contamination treatment
		Approaches for advanced sewage treatment	Formulation of a comprehensive sewerage improvement plan by basin area
		Regulation of wastewater from factories, workplaces, etc.	Standard wastewater conformity rate for the Omura Bay basin
	Curbing inflow loads from surface sources	Promotion of environment conservation-type agriculture	Land area for addressing organic/special cultivation
		Ongoing demonstration of the public functions of forestry	Maintained forestry area
		Promotion of resource recycling and livestock farming practices	Number of cases of administrative guidance in the Omura Bay basin area based on the livestock waste management law
	Measures to prevent oxygen deficient water, deterioration of bottom sediment, etc.	Measures to prevent oxygen deficient water, deterioration of bottom sediment, etc.	Research into practical applications of aeration technologies to ameliorate poor water oxygenation
Creating Satoumi through conservation of biodiversity	Ecosystem surveys	Implementation of monitoring surveys of living organisms	Number of surveys of wild animals and plants implemented by experts
	Protection of rare fauna and flora, etc.	Protection of rare fauna and flora, etc.	Designation of preservation areas for rare animal and plant species
	Maintenance of habitats for living organisms	Creation of shallow bottom	Creation of shallow bottom using recycled sand and other materials
		Improvement of environments where living organisms can thrive	Number of sites with active work for conservation of flora and fauna (conservation of biodiversity) (cumulative)

Creating a thriving Satoumi	Promotion of the fishing industry	Maintenance and recovery of marine resources by resource management and seedling release	Sea surface fishery output
		Creation of fishing grounds for maintenance and recovery of marine resources	Number of environmental conservation activities
	Expansion 'Omura Bay' brand product consumption	Expansion of 'Omura Bay' brand product consumption	Number of times "food business meetings" are held
Creating Satoumi through all of our joint efforts	Environmental considerations	Approaches for building a low-carbon, recycling-oriented society	Number of Nagasaki Environment Prefectural Congress Conferences held
		Promotion of environmental education	Number of times environmental advisers are dispatched
	Approach for regional collaboration	Approach for regional collaboration through the Omura Bay Environmental Network	Number of activities presentation meetings, etc., held

Source: Japanese Ministry of the Environment.

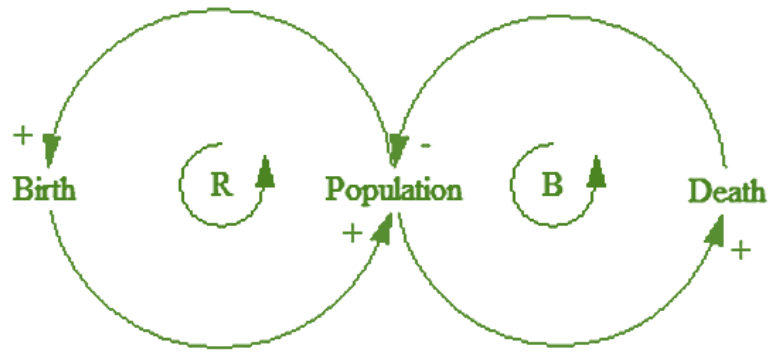
2.2 Causal Loop Diagrams

Causal Loop Diagrams (CLD), drawn from a systems approach (Bastianoni *et al.*, 2018), was adopted to describe and assess the indicators set in Phase 3 of the Action Plan. A systems approach is effective particularly when a target is complex, and its complexity is attributed to systemness (Lendaris, 1986), that is, the feedback structure of elements, processes, and sub-systems in the system (Sterman, 2000). Because it is a holistic approach, it helps to avoid neglecting important components and optimize the selection of details to draw a complete picture of the reality (Bastianoni *et al.*, 2018).

2.2.1 Basics of CLD

Causal Loop Diagrams (CLD) draw a system's feedback structure using elements of the system and arrows connecting them. The direction of the arrow indicates the cause and effect relationship. "+" indicates cause and effect change in the same direction. "−" indicates cause and effect change in the opposite direction. Figure 3 illustrates an example of a CLD of population dynamics in which it is observed that an increase in population increases birth but results in a decrease in death. When cause and effect relationships are closed, it constitutes a feedback structure. For example, an increase in population will increase birth, which in turn increases population. When feedback reinforces the elements of the system, it is called a reinforcing or positive feedback loop (depicted by R with a circular arrow), while when feedback has a reducing effect on the elements is called a balancing or negative feedback loop (depicted by a B with a circular arrow). A system, in general, comprises combinations of reinforcing and balancing feedback loops.

FIGURE 3. A CLD OF POPULATION DYNAMICS



Studies have been conducted using CLD for coastal zone management. For example, Tan et al. (2018) adopted a CLD to select the driving-force, state, and response indicator set for an ICZM at Kaohsiung, a city port in Taiwan. They conducted the Delphi method by involving stakeholders to develop the CLD and select indicators (Tan et al., 2018). They further developed a system dynamics-based decision support system for Kaohsiung. Similarly, Lopes and Videira (2017) developed CLD with their stakeholders for a natural park in Portugal, using participatory systems mapping, and proposed a set of indicators (Lopes and Videira, 2017). However, most studies develop CLD to capture what stakeholders wish or demand, rather than describing current ICZM practices (or supply side).

2.2.2 Strengths of CLD

There are two primary strengths regarding the use of CLD for sustainability indicators. First, CLD can describe interactions between indicators along with their relationships with other components of the SESs. Second, it can also describe how each indicator contributes to system objectives (e.g., sustainability). With these descriptions, we can assess the appropriateness of the current indicators and identify missing indicators concerning their contributions to the system objectives.

In addition to these two primary strengths, CLD have two further benefits. Since they encourage the use of soft data (e.g., narratives, news articles, etc.) (Sterman, 2000), we can incorporate "hypothetical" relationships, in the sense that their relationships are not verified with hard data (i.e., numerical data which enable to build mathematical formulae to explain the relationships), allowing us to identify data and research topics we should priotize. In addition, because of the complexity of SESs, it may be impossible to obtain a complete set of mathematical formulae which explains the relationships between elements and the corresponding hard data (Akmalah and Grigg, 2011), so that we often rely on some soft data, rather than waiting for the availability of numerical data or ignoring it. Another advantage of CLD is that while they are a qualitative description of a system, they can be a base for system dynamics, that is, a quantitative description of a system (Sterman, 2000). Tan *et al.* (2018) developed a system dynamics model based on the CLD. However, given the dynamic complexity of SESs, making indicators dynamic is critical (Karnauskaitė *et al.*, 2018).

2.2.3 Procedure of drawing a CLD

A CLD was drawn to reflect the aim of the action plan and its implementation, as designed by Nagasaki Prefecture for the conservation and revitalization the Omura Bay (Nagasaki Prefecture, 2014), as accurately as possible.

To verify the CLD drawn based on the action plan, several interviews with government officials at Nagasaki Prefecture were conducted in August 2018. The purpose of the interviews was not to enrich the CLD by reflecting their opinions but to confirm if the CLD reflects what the action plan states. With the results from these interviews, amendments to the CLD were implemented to reflect the action plan more accurately.

3. Results & Discussion

Figure 4 shows the CLD developed based on the action plan. It describes how the sustainability indicators relate to each other in the SES of Omura Bay and their contributions to the management goals (i.e., Satoumi, the desired state set in the action plan).

3.1 Assessing the current indicators and identifying the missing indicators

The CLD helped assess indicators and identify missing indicators according to the management goals. It showed that the current indicators require further improvement to attain the specified standards of the action plan. First, the plan was particularly focused on water quality with eight out of seventeen indicators targeted at its improvement. Although this is critical for a water body in general, better water quality cannot be measured by a single entity (for example, Chemical Oxygen Demand (COD) is not the sole means to enrich the sea) In addition, better water quality is not necessarily a good thing for a rich ecosystem. For example, the relationship between the transparency of water and fish catch is nonlinear, as completely clean (or transparent) water could have negative impacts on fish population because of the shortage of nutrients (Yanagi, 2017). Second, although the management goals stipulated that the plan encourage various economic activities, the CLD shows that indicators were targeted solely at fishery ("I12 Sea surface fishery output" and "Consumption of products made in Omura Bay") during the implementation. Therefore, other indicators which encourage a variety of economic activities should be considered. Third, in consistency with the management goals, the CLD shows that the plan could contribute to enhancing biodiversity by "I8 Number of surveys of wild animals and plants implemented by experts", "I9 Designation of preservation areas for rare animals and plant species", "I10 Creation of shallow bottom using recycled sand and other materials", and "I11 Number of sites with active work for conservation of flora and fauna (conservation of biodiversity) (cumulative)" [Figure 4]. Fourth, "I15 Number of Nagasaki Environment Prefectural Congress Conferences held" and "I16 Number of times environmental advisors were dispatched" is considered to contribute to "Recognition as shared property" [Figure 4] but it is not clear how the recognition contributes to the management goals. Lastly, there was no indicator explicitly mentioned, which improved Omura Bay as a place where people recreate and communicate, although the recognition of the region as shared property could be pertinent to this goal by spreading awareness. Without a specific indicator, there is no obligation or incentive to make an effort. Another interesting observation was that, in an interview for verifying the CLD, one interviewee asserted "I10 Creation of shallow bottom using recycled sand and other materials" [Figure 4] promoted the recreation and communication among the residents, rather than improving water quality.

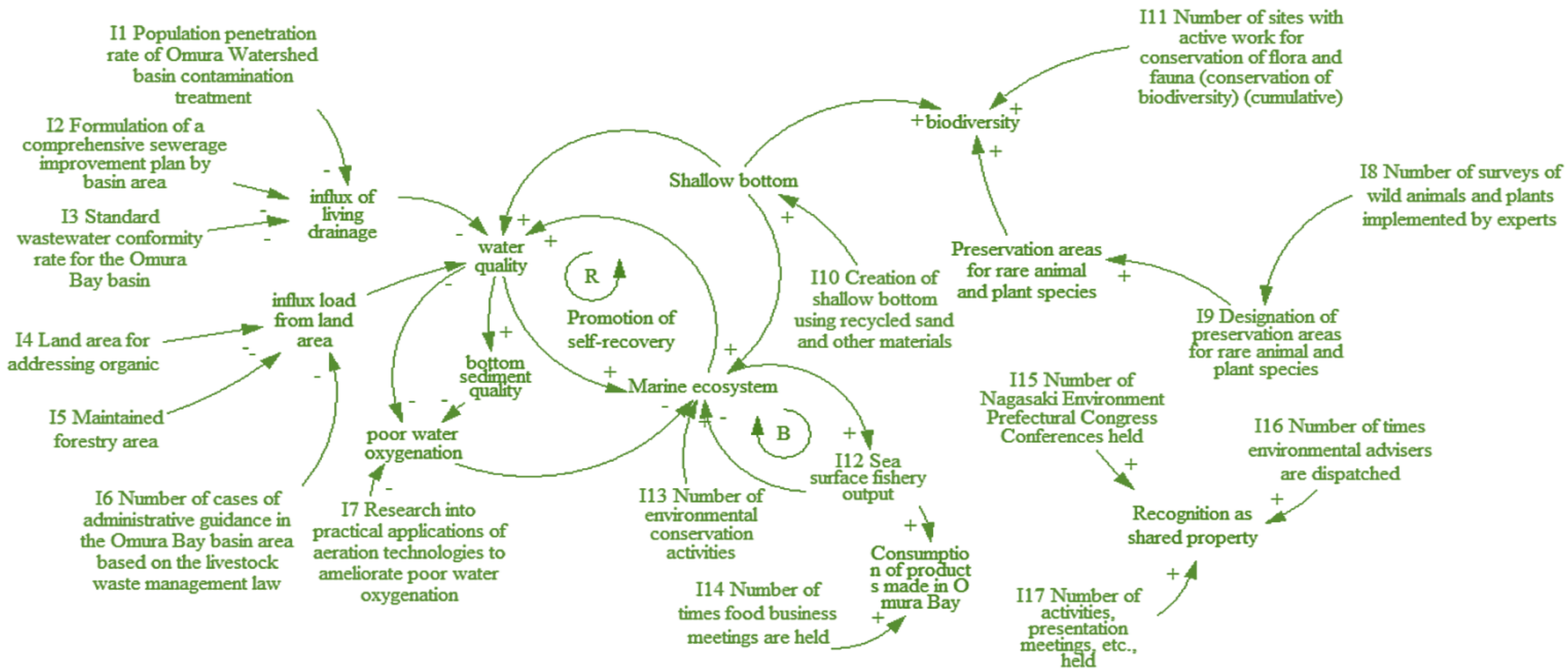
Nagasaki Prefecture developed a shallow bottom and beach by depositing large quantities of sand, made of finely crushed glass, in Omura Bay. The original aim was to improve water quality by creating an environment suitable for Japanese littlenecks (*Ruditapes philippinarum*) which feed on Phytoplankton. However, because sand crystals are made of colorful recycled and finely crushed glass, it adds to the scenic beauty of the place, making it a popular tourist destination (The Yomiuri Shimbun, 2018). This relationship was not included in the CLD as it was not a part of the original action plan and was an unexpected benefit of the ICZM (The Yomiuri Shimbun, 2018).

3.2 Hypothetical relationships and research priorities

The causal relationships in Figure 4 are mostly hypothetical as hard data were not available for verification. For example, it should be reasonable to assume that "I2 Formulation of a comprehensive sewerage improvement plan by basin area" contributes to "influx of living drainage" and thus, "water quality" [Figure 4], but the mathematical form of these relationships is not known. Another example of a hypothetical relationship, which is also the key relationship to the ICZM, is the balance described with reinforcing loop ("Promotion of self-recovery") and balancing loop ("Trade-off") in the CLD. The dynamic state of the "Marine ecosystem" depends on the relative strength of these feedbacks (for e.g., if the balancing loop dominates (i.e., overfishing), the "Marine ecosystem" deteriorates) [Figure 4]. Therefore, it is important to gather more information about the causal relationship regarding the reinforcing and balancing loops.

While the CLD help identify research priorities, it is also important to know that it may be unrealistic to expect the availability of hard data, usually in the form of observations, within a reasonable time period. The complex nature of SESs (Costanza et al., 1993; Limburg *et al.*, 2002) makes it critical to keep adopting hypothetical relationships based on soft data and updating the CLD as new information becomes available. The ICZM and indicator selection should therefore be adaptive (Folke *et al.*, 2002).

FIGURE 4. A CLD DEVELOPED BASED ON THE ACTION PLAN.
VARIABLES FROM 1 TO 17 WERE ADOPTED FROM PHASE 3 ACTION PLAN



Conclusions

Sustainability indicators have previously been used as a promising tool for ICZM (Maccarrone *et al.,* 2014). However, the systemness of coastal zones raises two challenges regarding the selection of sustainability indicators; the reflection of causal relationships between indicators and other critical components of coastal zones, and the contribution of sustainability indicators to sustainability. This study proposed the use of Causal Loop Diagrams (CLD) to deal with these challenges.

Using Omura Bay, an enclosed sea in Western Japan, as a case study, our study translated the indicators set in the action plan into a CLD to describe and assess these indicators with regards to their contribution to the system objective, i.e., Satoumi.

The CLD described interactions between indicators along with their relationships with other components of SES of Omura Bay. It also elucidated how each indicator contributes to the realization and sustainability of Satoumi. The CLD shows that indicators put particular emphasis on water quality improvement and fishery, which, although important, are not sufficient to realize and sustain Satoumi. Indicators for other economic activities and the promotion of recreation and communication are lacking, while those regarding the recognition of the sea as a shared property do not indicate any clear contribution to Satoumi. In addition to assessing the indicators, the CLD helped identify research priorities because it includes hypothetical relationships among indicators and other components of Omura Bay.

Important hypothetical relationships such as the reinforcing and balancing feedback loops in Figure 4 require hard data for verification. It helps policy makers and scientists invest their limited resources in topics with priority. However, at the same time, availability of hard data within a reasonable time frame is impractical because of the complexity of SESs (Limburg *et al.,* 2002). Therefore, adaptive management in which ICZM adjusts to new scientific information is recommended.

Scope of Future Work

There are at least two future research directions to make a better contribution to ICZM. First, to better inform ICZM, it is critical to reflect the demand side of the ecosystem services, or what people desire. This study described and assessed the current ICZM practices based on the indicators set in the action plan, or supply side of ecosystem services provided by Omura Bay. Although the action plan reflects the stakeholders' opinions in its target to some degree, it does not sufficiently reflect what people desire because it included a small committee with limited stakeholders and took an overall top-down approach. Therefore, it would be insightful if another CLD is drawn from what people desire by using a participatory process (e.g., Lopes and Videira (2017)) and is compared with the supply side CLD (i.e., the CLD in this study) to improve ICZM by elucidating the difference between demand and supply side.

Second, since CLD can be a base for the system dynamics modeling, a quantitative approach (Sterman, 2000; Uehara, Nagase and Wakeland, 2015; Cordier et al., 2017; Tan *et al.,* 2018; Uehara, Cordier and Hamaide, 2018), they can be used to quantify the relationships between indicators and other components of SESs as a representation of the system dynamics (Karnauskaitė *et al.,* 2018).

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Control y gestión sustentable del territorio michoacano. Pueblo de San Francisco Pichátaro, Michoacán, México

Wuendy Asuet Armenta Barrera*

"En la medida en que el recuerdo de las acciones colectivas
se enlaza con los caprichos de la topografía…
el espacio se convierte en territorio"

Paul Claval

Introducción

El territorio es un espacio biofísico determinado, donde se desenvuelve un grupo social durante un tiempo indeterminado, que entrelaza relaciones sociales, políticas, culturales, económicas, que tienen signo y significado basado en su cosmogonía (Lefebvre, 1969). Las comunidades indígenas, generalmente, entienden la vida de forma comunitaria. Para ellos todo está unido e integrado, existe una interdependencia entre todo y todos (Huanacuni, 2010). Los relatos de los abuelos han transmitido los saberes y el conocimiento del territorio de manera oral de generación en generación, a través de cuentos, historias y mitos. Dicho conocimiento es esencial para controlarlo y gestionarlo de manera colectiva, con la finalidad de la permanencia del grupo social. Para ello, es necesario instituir proyectos de vida comunal, como base para generar ordenamientos territoriales jurídicos, que coadyuven a la protección y conservación de los territorios.

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La comunidad indígena de San Francisco Pichátaro, es una localidad situada en el municipio de Tingambato, en el Estado mexicano de Michoacán de Ocampo. Su organización social es una simbiosis que fluye de lo individual-familiar a la organización barrial, a la comunidad, a la estructura regional purépecha y de manera inversa (Dietz, 1999). Es, también, una comunidad agraria que ha luchado, en los últimos años, por defender su derecho a su libre determinación, a nombrar sus autoridades y a revitalizar sus formas organizativas, para proveerse mejores calidades de vida, a la par que mantienen y fortalecen su territorio, es especial el cuidado de sus recursos forestales.

El presente documento es el resultado de una investigación documental y de trabajo de campo en la comunidad indígena de San Francisco Pichátaro. La investigación forma parte del proyecto de estancia posdoctoral inscrito en el Instituto de Investigaciones en Ecosistemas y Sustentabilidad (IIES) de la Universidad Nacional Autónoma de México (UNAM), campus Morelia. La finalidad de este trabajo es la de aportar al debate público sobre la autodeterminación de los pueblos, a través del control y de la gestión sustentable de sus territorios.

El ensayo se integra de tres apartados. En el primero pretende explicar qué se entiende por territorio como proyecto de vida. Se busca desentrañar las acciones colectivas que fundan un territorio, su transmisión, mantenimiento y fortalecimiento, en el marco de las cosmogonías de sus pobladores. El objetivo principal del apartado es hacer hincapié en que el territorio es un dador de vida que crea identidad social.

El segundo apartado expone el entramado social que rige la organización de las poblaciones indígenas. Las comunidades indígenas han basado su fortaleza para mantenerse, a pesar de las políticas de homogenización nacionales e internacionales, en su organización social colectiva. Es a través del trabajo colectivo, las faenas, las manos vuelta, las mingas, etc., que se entrelazan relaciones sociales de complementariedad, reciprocidad e intercambio, no sólo con sus congéneres, sino con la naturaleza misma. Para ello se organizan en asambleas y proponen autoridades itinerantes, que contribuyan al logro de las metas colectivas.

Finalmente, el tercer apartado muestra el caso de estudio, donde se plasman las transformaciones y retos que la comunidad de San Francisco Pichátaro afronta para reivindicar su ser indígena y mantener su territorio, que le permita generarse mejores calidades de vida.

1. El territorio como proyecto de vida

El territorio es la piedra angular sobre la que se fundan las cosmovisiones indígenas (Villoro, 1999). En la cosmovisión de cada pueblo existe un momento fundacional, donde surge el nombre del lugar, generalmente, de las características físicas del espacio o de sucesos importantes para la constitución del asentamiento. Desde la antigüedad, los conocimientos, la sabiduría, el aprendizaje, en general la forma de entender el mundo se ha transmitido a través de cuentos, mitos e historias de manera oral.[1] Se ha enseñado a la comunidad cuál es la estructura del universo, sus energías, sus dioses, los ciclos de la Tierra y el lugar que la humanidad ocupa en ella.

1 La formalización del conocimiento a través del lenguaje escrito es reciente y la expansión de dicho conocimiento a la mayoría de la humanidad aún más. Inclusive en nuestros días, existen millones de personas en el mundo que no tienen acceso a la educación escolar o universitaria. En el caso de las culturas indígenas de México se están realizando importantes esfuerzos por parte de sus colectivos para plasmar en el arte y por escrito, en su idioma nativo, su cosmogonía con la colaboración de las Universidades.

A través de la lengua se va transmitiendo de generación en generación los mitos de la creación del grupo social, fomentando el arraigo y amor de los descendientes por la tierra de "los abuelos[2]" (ascendientes). De acuerdo con Huanacuni (2010) para los pueblos indígenas originarios del Abya Yala[3]… "la vida se concibe de forma comunitaria, no solo como relación social sino como profunda relación de vida" (Ídem:20). Esta visión implica que todo está unido e integrado y que existe una interdependencia entre todo y todos. El territorio envuelve, por tanto, relaciones sociales, políticas, culturales, económicas, que tienen signo y significado para una población por periodos indeterminados, en un espacio determinado, bajo una cosmogonía determinada (Lefebvre, 1969).

El territorio como espacio biofísico proporciona los elementos materiales necesarios para la producción e intercambio de bienes imprescindibles para la sobrevivencia[4] (Artigas, 2012). Es común escuchar de "los abuelos" que la fundación del pueblo se inició cerca de un río o de un ojo de agua (Ávila, 1996). El abastecimiento de agua ha sido vital para el desarrollo de la vida humana, y en particular para la producción de alimentos. La escasez de agua por deterioro del ecosistema, por privatización o por trasiego a otra comunidad ha sido uno de los principales determinantes que ha generado movimientos sociales en defensa de los territorios[5], tanto a nivel nacional como mundial.

En nuestro país, la tenencia de la tierra ha ido de la corriente ideológica de propiedad colectiva a propiedad individual y viceversa. Actualmente, se reconocen en la Constitución política de la federación cuatro tipos de tenencia del suelo: propiedad estatal (federación, estados y municipios), propiedad individual, propiedad ejidal y propiedad comunal. Muchas de las comunidades indígenas de nuestro país se encuentran asentadas en espacios de propiedad ejidal o comunal; a pesar de la corriente ideológica del libre mercado que pugna por la mínima propiedad estatal y por la exclusividad de la propiedad privada.

El conocimiento de los territorios es esencial para ejercer control y gestionar de manera sustentable los espacios. Debido a migraciones, políticas públicas o desinterés de los habitantes por el devenir social y económico de sobrevivencia, se había desdeñado el conocimiento oral de sus habitantes por su territorio. No obstante, en los últimos años, debido a concesiones estatales de los espacios a empresas privadas externas a la comunidad, se ha pugnado por retomar el conocimiento de los espacios y generar ordenamientos territoriales jurídicos que coadyuven a la defensa de sus territorios[6].

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2 En las comunidades indígenas de México es muy común escuchar hablar de "los abuelos" y se refiere a los habitantes que ocuparon el espacio previamente y con los cuales tienen relación parental indeterminada, por lo menos, por más de 5 generaciones.

3 Abya Yala es el nombre con que se conoce al continente que hoy se nombra América, que literalmente significaría tierra en plena madurez o tierra de sangre vital. Dicho nombre le fue dado por el pueblo Kuna en Panamá y en Colombia; y la nación Guna Yala del actual Panamá, antes del arribó de Cristóbal Colón.

4 La canasta básica de bienes y servicios que el grupo social debe cubrir está íntimamente relacionada a su identidad cultural, existiendo bienes no solo materiales sino espirituales y culturales.

5 Un ejemplo es el movimiento por la defensa del bosque y la seguridad de los habitantes de San Francisco Cherán en el Estado de Michoacán (Aragón, 2018; García, 2016; Romero, 2015), entre muchos otros.

6 El primer ordenamiento territorial generado por la comunidad en coordinación con la universidad, con académicos y con las autoridades municipales y estatales fue el Ordenamiento Territorial de Cuetzalan del Progreso en el Estado de Puebla publicado el 3 de diciembre de 2010 en el Diario Oficial del Estado.

Pero más allá de un ordenamiento territorial que cumpla con los requisitos de ordenamiento municipal, es necesario que la población realice de manera interna "proyectos de vida comunal" que generen conocimiento propio de los espacios. Muchos colectivos y movimientos sociales, generados de manera interna o externos a la comunidad, conformados por miembros de esta, estudiantes universitarios, profesionales e investigadores, están trabajando codo a codo en los espacios, para apoyarlos a generar las dinámicas necesarias que contribuyan a documentar estos conocimientos. Estos saberes son indispensables para conocer y proteger el patrimonio biocultural de los pueblos indígenas (Toledo *et al.,* 2014). A la par que les permiten diversificar sus actividades productivas conservando y defendiendo sus territorios.

Los proyectos de vida comunal han surgido por la necesidad imperante de conocer y reconocer sus territorios. "Los dolores[7]" que el deterioro ambiental ha dejado en sus ecosistemas, que permean en su vida cotidiana, ha sido la fuente principal para trabajar en este tipo actividades, más allá de sólo un mapeo de recursos en el espacio. La diferencia ente mapear recursos y construir proyectos de vida en un territorio se sustenta en las racionalidades implícitas. Los proyectos de vida comunal implican reconocer derechos a la naturaleza y no considerar el espacio exclusivamente como un bastión de recursos naturales.

Ante la expansión de políticas públicas, durante los últimos cuarenta años, que pugnan por la comercialización masiva de los recursos naturales y que han dejado fuertes impactos ambientales (Garibay *et al.*, 2011; Rosete *et al.,* 1997), las comunidades indígenas trabajan por conservar sus territorios. Estas comunidades intentan adaptar sus espacios a los cambios climáticos globales, retomando y revalorizando sus conocimientos ancestrales en el afán de proteger a la naturaleza y protegerse (Muñoz, 2015; Participación de la Comisión Sexta del EZLN, 2015; Toledo *et al.,* 2014). El patrimonio biocultural de los territorios indígenas no podría entenderse sin el complejo entramado de sus cosmovisiones y de las relaciones sociales de sus habitantes (Boege, 2008; Martínez-Luna, 2003).

El rescate de la lengua nativa ha generado una catarsis en las comunidades, que les ha permitido revalorizar su ser indígena y reconstruir sus territorios. En la construcción de una nación mexicana se instó a la homogenización poblacional del ciudadano, que, si bien es necesaria para garantizar los derechos humanos, se basó en despreciar las raíces indígenas (Bonfil, 1990). Al menoscabarse las lenguas nativas se desechaban también los saberes, las formas de hacer y permanecer de estos grupos milenarios (Boege, 2008; Toledo *et al.,* 2008). No obstante, muchos de los grupos indígenas están trabajando explícitamente por reconstruir y fomentar el uso de la lengua nativa.

Al nombrar los espacios biofísicos en la lengua nativa han redescubierto los saberes de los abuelos. Al construir los proyectos de vida comunal en estas lenguas se forja la identidad comunitaria que propicia reconocer los dolores y vislumbrar los sueños y esperanzas. Es decir, las toponimias, que generalmente son nombres con características físicas de los espacios, pueden ayudar a reflejar y concientizar los daños ambientales que los territorios están padeciendo, al comparar el significado versus las condiciones actuales. A la par que se involucra a las nuevas generaciones en el arraigo y cuidado de los territorios.

7 En las cosmovisiones indígenas la población asemeja el espacio biofísico a un cuerpo humano que tiene sueños y esperanzas, pero que también sufre y tiene dolores. La naturaleza es para las cosmovisiones indígenas un espacio al que se pertenece y se tiene el deber de cuidar.

Cabe señalar que, la conexión con la tierra permite mayor independencia económica. La producción de alimentos bajo producción tradicional podría generar capacidad de enfrentar a las fuerzas de la economía (Barkin *et al.*, 2012; Barrera-Bassols *et al.*, 2009). Sin embargo, la política económica imperante en nuestro país sobre alimentos debilita estas capacidades. Muchos de los pobladores ante la baja posibilidad de hacer frente a sus necesidades cotidianas y ante el creciente endeudamiento privado para la adquisición de bienes se ven obligados a cambiar su actividad productiva hacia otros sectores o migrar de sus territorios.

Cuando el grupo social que permanece en el territorio puede controlar a nivel colectivo los insumos que proporciona la naturaleza, puede garantizarse una mejor calidad de vida para sus pobladores y realizar intercambios metabólicos más armoniosos con la naturaleza que le pueden abonar a la permanencia en esos ecosistemas (Barkin, 1999). Este argumento se sustenta en que al controlar los medios de vida la colectividad, pueden lograr una mejor asignación de recursos porque los motivos que conllevan a dicha asignación estarán en proporción a las necesidades de cada individuo o familia y del grupo social en general, bajo normas de trabajo colectivo y limites naturales de los ecosistemas. El control colectivo del territorio es fundamental para la permanencia de estos pueblos.

La asignación de recursos no está exenta de conflictos internos. Los intereses individuales o familiares se pueden contraponer a los intereses colectivos (Martínez-Luna, 2003). Sin embargo, a través de las asambleas los miembros de estas colectividades ponen en tela de juicio las argumentaciones tanto de intereses individuales o familiares como colectivos, siempre anteponiendo el fin último de la colectividad: permanecer. El conocimiento y control del territorio da pie para consolidar las estrategias de permanencia de los grupos sociales. El control del territorio se convierte en el baluarte para hacer posibles los sueños y las esperanzas de los propios pobladores (Manzo, 2011).

Donde los territorios tienen propiedad comunal o ejidal, existe posesión de uso individual o familiar y de uso colectivo (Martínez-Luna, 2003). Inclusive, en territorios donde la propiedad jurídica es privada, pero que viven en un tipo de organización social donde la preminencia la tiene la comunidad y la naturaleza, se suelen asignar espacios para la colectividad. Es común, aún en las comunidades indígenas con propiedad privada, que por usos y costumbres exista derechos de paso para la comunidad, se permita la recolección de leña o allegarse de bienes del monte (plantas o animales silvestres) en los espacios al aire libre.

Las fiestas patronales de los pueblos indígenas son prueba de la cohesión social y la retroalimentación de la identidad. Las fiestas se celebran con base en los ciclos agrícolas establecidos por la temporada de lluvias, más allá que el nombre de la fiesta refiera a una celebración religiosa católica (Ávila, 1996). La realización de éstas pone de manifiesto un fuerte entramado de organización social. Para llevarlas a cabo se requiere tanto la movilización de capacidades y recursos de los pobladores que habitan en el territorio como de aquellos que migraron y han decidido seguir perteneciendo a la comunidad (Martínez-Luna, 2003).

El territorio es para la población indígena más que un facilitador de medios de vida; es también forjador de identidad: quiénes fueron, quiénes son y quiénes serán (Martínez-Luna, 2003; Dietz, 1999; Álvarez, 1988). Esta identidad cultural se fragua en el día a día dentro del espacio, mediante complejos lazos sociales que se hilan en el entramado social. La identidad cultural es un sentimiento de arraigo al territorio (Manzo, 2011). Las cosmovisiones nacen, se fortalecen y se regeneran dentro de un territorio.

2. La organización social que forja territorios

En el entramado social de las poblaciones indígenas, de manera general, podemos visualizar tipos de organizaciones donde la autoridad máxima es el colectivo, la asamblea comunitaria o ejidal. A través de las asambleas comunitarias se designan a autoridades éticas e itinerantes, que se vinculan con el colectivo para organizar el trabajo, para el logro de los objetivos planteados en estas asambleas (Manzo, 2011). Estas sociedades se regulan bajo el ideal del libre albedrío de sus miembros, pero siempre bajo los límites que ellos mismos se han impuesto en las asambleas comunitarias, en pro de los intereses tanto individuales o familiares, como de los intereses colectivos.

Existe posesión individual de los espacios, tanto de los espacios privados como de los espacios productivos. Se es poseedor de un espacio privado en la zona habitable de la comunidad o del ejido. Los espacios productivos como las parcelas y los montes suelen designarse como espacios privados o colectivos dependiendo de la historia de la comunidad y de los convenios internos a los que se haya llegado en el transcurrir de los años. Generalmente, las fuentes de agua en los montes, las plantas y animales silvestres son espacios donde toda la comunidad puede abastecerse y esta obligada a su cuidado (Espín, 1986).

Los espacios considerados como privados pueden cambiar de poseedor de acuerdo con los convenios que entre particulares se realicen (Dietz, 1999). Es necesario avisar a las autoridades comunales o ejidales para garantizar que el nuevo poseedor sea miembro de la comunidad y no dejar los espacios a fuereños[8]. Lo anterior es imprescindible para garantizar la permanencia como propiedad comunal o ejidal de los espacios tantos habitacionales como productivos. La división y posesión de los espacios privados en manos de fuereños, podría generar una fragmentación irreversible de la propiedad comunal o ejidal, al ampararse en las leyes federales existentes y la facilidad de la política pública de certeza jurídica de la tenencia de la tierra del estado mexicano, que busca transformar la propiedad colectiva en propiedad privada.

La participación en asambleas, como autoridad o en el trabajo colectivo es una obligación de todo miembro de la comunidad, es un símbolo de pertenencia (Martínez-Luna, 2003). Para pertenecer a una comunidad indígena, no basta con habitar en el sitio. La pertenencia se obtiene primeramente por parentesco consanguíneo o por afinidad con un comunero o ejidatario (familia) (Dietz, 1999). Adicionalmente, conforme transcurre la vida de los pobladores cada miembro va participando en las actividades que se asignan de acuerdo con edades y géneros para realizar los trabajos colectivos[9] y los cargos: civiles, políticos o religiosos. Los cargos o roles como autoridad se van asignando conforme a la identidad cultural de cada grupo social, pueden ser en forma de escalonada o rotatorios.

No obstante, cada rol es vital para el buen funcionamiento de la comunidad, no existen cargos desdeñables o de menor importancia. Cada cargo, si existe, es porque a la colectividad le pareció imprescindible. Los cargos como autoridad son honoríficos, generalmente sin

8 Un fuereño es aquella persona física que no es reconocida por parte de la comunidad indígena como miembro.

9 Al trabajo colectivo se le suele dar el nombre de tequio o faena. Los miembros de la comunidad se obligan a realizar, de manera gustosa en días de descanso oficiales, labores donde la fuerza de un individuo o familia no es suficiente y la realización de dichas labores son de beneficio para la comunidad. Suele haber un trabajo denominado mano vuelta que significa que alguien realiza trabajo para un miembro de la comunidad que lo necesita y en el futuro la comunidad se obliga a regresar otro trabajo no especifico, dependiendo de la necesidad del primero y de las posibilidades de la comunidad.

retribución monetaria[10], por periodos de uno a tres años, en donde la comunidad está siempre vigilante del buen desempeño de sus autoridades coadyuvando con trabajo individual o familiar y/o colectivo para el logro de los intereses comunitarios. Si una autoridad no cumple como lo esperaba la colectividad puede ser removido del cargo en cuestión de días o meses. A la inversa, si el colectivo está conforme con el trabajo desempeñado por la autoridad podría ser ratificado en su puesto por otro periodo o periodos.

Es muy común que legalmente los comuneros o ejidatarios, inscritos ante las autoridades agrarias mexicanas, como propietarios de los espacios, sean hombres. También es común que, en el registro oficial el número de miembros de una comunidad o ejido es inferior a los habitantes que las autoridades comunales reconocen como miembros. Estas prácticas se fundamentan primeramente en la costumbre que sólo los hijos varones tenían derecho a las tierras, porque eran ellos quienes proveían a la familia, suponiendo que las hijas al casarse estaban protegidas por los esposos (Dietz, 1999; Espín, 1986). Aunado al engorroso y oneroso trámite burocrático, ante las autoridades agrarias para modificar los estatutos, cada vez que un habitante modificará sus derechos como miembro.

En la práctica, son las autoridades comunales o ejidales quienes proporcionan a los habitantes "una constancia de residente" como miembros de la comunidad-ejido o como avecindados, de acuerdo con las normas que para ello se hayan votado en las asambleas generales. La participación de las mujeres, en las asambleas generales y como autoridad, se ha incrementado de acuerdo con las propias transformaciones de cada comunidad o ejido, frente al reconocimiento que la propia nación y el mundo ha hecho de los derechos de las mujeres. En el pasado, hombres y mujeres tenían responsabilidades y cargos estrictamente vinculados con su género. Las transformaciones globales de los roles de genero han permeado en las comunidades, las mujeres y niñas, participan en la comunidad y han trasmutado las relaciones internas de la propia comunidad.

Las problemáticas en asambleas, generalmente, consisten en hacer coincidir intereses individuales o familiares con intereses colectivos (Martínez-Luna, 2003). La toma de decisiones no es por mayoría calificada o por personajes ilustres, sino por el convencimiento unánime de los miembros de la comunidad. La discusión de los problemas que aquejen a la comunidad puede durar horas, días o semanas; sin embargo, una vez tomadas las decisiones la comunidad entera avalará los resultados positivos o negativos resultantes (Participación de la Comisión Sexta del EZLN, 2015).

En las asambleas se discuten temas relevantes para la comunidad aun cuando puedan surgir de pequeños sectores del colectivo. Estas comunidades se precian de discernir entre problemáticas individuales o familiares que sólo incumban a los involucrados, respetando los ámbitos privados, y las problemáticas individuales o familiares que afectan o pueden afectar la vida comunitaria. Las problemáticas planteadas en asambleas pueden variar en un sinfín de temas: sociales, culturales, religiosas, políticas, económicas, de salud, de educación, de equidad de género, de turismo, de festividades, ambientales, entre otros. Suelen integrarse

10 Existen cargos en las comunidades que se han revalidado ante instancias municipales, estatales y federales como trabajos de las dependencias de gobierno, por los cuales si se les retribuye de manera pecuniaria a dichas autoridades comunales o ejidales. Al modificarse los cargos honoríficos por cargos con retribución económica ha generado algunos problemas internos entre quienes deben dejar de lado sus quehaceres individuales sólo por cumplir con la comunidad y los que obtienen un beneficio monetario.

comités de ejecución y vigilancia que verifiquen las acciones de las autoridades sobre temas muy específicos y transcendentales para el buen funcionamiento de la comunidad.

Esta capacidad social de toma de decisiones sobre sus problemáticas da pie a que independientemente de las estructuras formales de la vida municipal, estatal, regional o nacional, en la que también se encuentran inmersos, puedan autodeterminarse[11] dentro de sus territorios (Porto-Goncalves, 2009). Sin menoscabar el cumplimiento que deben observar del marco jurídico que se les impone desde las estructuras formales. El control y manejo del territorio de manera colectiva, así como el proveerse de un autogobierno forjan el camino hacia la autonomía, que pretende instituir mejores condiciones de vida para los miembros de la comunidad, dentro de un medio ambiente ecológicamente sano (Toledo *et al.,* 2008).

La organización social de estos grupos indígenas genera capacidades para el logro de sus intereses tanto individuales o familiares como colectivos (Barkin *et al.,* 2012). Dentro de sus organizaciones como comunidad se genera e intercambia conocimiento y experiencias de diversos ámbitos de la vida, desde la forma de cultivar la tierra, conocimiento de campesino a campesino, formas de comercialización de los productos, acceder a mejores viviendas, mejoras de servicios de salud, mejoras de servicios educativos, mejoras de servicios públicos, entre otros muchos saberes (Toledo *et al.,* 2014). Algunas veces las construcciones de las posibles soluciones vienen de recursos gubernamentales, de instituciones académicas o de organismos no gubernamentales nacionales o internacionales.

Las transformaciones sociales internas de los espacios permiten que se regeneren o se fragmenten los territorios. Los momentos de unidad o disgregación de la comunidad en el devenir de la vida son normales. Pero, la estabilidad del territorio dependerá invariablemente de las estrategias asumidas e implementadas por todos los miembros en pro de la permanencia como grupo. Así como de la forma en la que se toman y asumen las decisiones.

Para generar ordenamientos territoriales municipales emergidos de la comunidad es indispensable una organización social fuerte. La base de la organización social es la participación de los miembros y la forma en la que se comunica, se socializa y se concientiza la información acerca de los problemas y las posibles soluciones de la comunidad. Por ello, una organización social fuerte es aquella donde las decisiones se toman, se asumen y se ejecutan en colectivo. Los territorios son espacios vivos que se reconstruyen en la cotidianidad de la vida.

La vida comunal se edifica en el devenir de los días. Pero que a veces suelen tener sobresaltos provocados de manera externa. Es necesario, por ello, construir proyectos de vida comunal, más allá de sólo ordenamiento territoriales jurídicos, donde se conozca y reconozcan las fortalezas y virtudes no sólo de los espacios biofísicos sino de la organización social. Cada comunidad, dependiendo de sus tiempos y necesidades, genera los espacios necesarios para la realización de estos proyectos. No obstante, la organización social interna de la comunidad no es, ni debe ser, un ente aislado de las organizaciones sociales de otras comunidades circunvecinas, regionales, nacionales o mundiales. La fuerza de las organizaciones sociales en los territorios se fortalece también mediante los lazos que se tenga con otras comunidades (Romero, 2015; Toledo *et al.,* 2014; Barkin *et al.,* 2012; Dietz, 1999).

11 En México, el derecho a la autodeterminación de los pueblos indígenas, que implica el deber de los Estados de consultar las medidas legislativas y administrativas susceptibles de afectar directamente a los pueblos originarios, se encuentra reconocido en la ratificación que hizo la nación del Convenio 169 sobre pueblos indígenas y tribales de la Organización Internacional del Trabajo OIT el 5 de septiembre de 1990 y en el artículo primero y segundo de la Constitución Política de los Estados Unidos Mexicanos vigentes.

3. El territorio pichatareño

San Francisco Pichátaro es oficialmente una Tenencia[12] del municipio de Tingambato en el estado mexicano de Michoacán de Ocampo. Es también una comunidad agraria reconocida por las leyes e instituciones respectivas, a partir del 27 de abril de 1936 de acuerdos con los títulos primordiales que datan del 6 de agosto de 1623. El pueblo de Pichátaro surgió por la negociación de siete señoríos purépechas que habitaban la zona y los españoles que arribaron al área, tras la conquista de México-Tenochtitlán y la expansión colonial para el Reino de España. La organización social y el territorio actual, divididos en siete barrios, se remonta a la fundación del pueblo.

Se encuentra a 2380 metros de altitud, es una región boscosa de pinos, encinos y madroños, entre otras especies de árboles y plantas (Garibay *et al.*, 2011, Rosete *et al.*, 1997). De acuerdo con el censo del INEGI de 2010, el 42.31% de la población se consideraba indígena de la etnia purépecha. Hasta el 2014, sus autoridades consistían en un Jefe de Tenencia, un Representante de Bienes Comunales y siete Encabezados de Barrio que se elegían cada año o cada tres, dependiendo de las actividades que realizaban. No obstante, la asamblea comunal ha sido la máxima autoridad del pueblo, aunada a las asambleas barriales (Dietz, 1999).

Los barrios que integran el pueblo de Pichátaro son: San Francisco, San Miguel, Santos Reyes, Santo Tomás I, Santo Tomás II, San Bartolo I y San Bartolo II. La organización por barrios no sólo es una organización geográfica del espacio habitado, sino una construcción ideológica, política, cultural, social, religiosa y productiva de toda la comunidad agraria (Dietz, 1999). A partir de 2015 surgió un movimiento de transformación de la vida interna de Pichátaro. Esta transformación se desencadenó por la disputa de los recursos públicos federales del ramo 33[13] que por motivos poblacionales le correspondían y que las autoridades de la cabecera municipal de Tingambato no les proporcionaron durante 2014.

A través de las asambleas barriales y la asamblea general comunal, los habitantes del pueblo de San Francisco Pichátaro decidieron pelear los recursos federales a través de instancias judiciales. Buscaron el apoyo del grupo de abogados, Colectivo Emancipaciones, que asesoró al municipio de San Francisco Cherán, para que los apoyará a obligar a las autoridades de la cabecera municipal de Tingambato y/o a la federación a proporcionarles lo recursos que del ramo 33 les correspondían. La primera estrategia legal y política fue reasumirse como etnia cien por ciento purépecha. A pesar de que San Francisco Pichátaro no es no cabecera municipal como lo es San Francisco Cherán, sino una Tenencia (submunicipalidad), han estado luchando porque las autoridades mexicanas federales, estatales y municipales, le reconozcan el derecho a decidir sobre su territorio.

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12 La división política y administrativa del municipio, de acuerdo con la Constitución del Estado Libre y Soberano de Michoacán, se divide en: cabecera municipal y tenencias. Cuyas autoridades son: un presidente municipal, un síndico, cuatro regidores de mayoría relativa y tres regidores de representación proporcional, así como jefes de tenencia y encargados del orden que reportan directamente al presidente municipal. Estas autoridades son elegidas a través del sistema político de partidos cuyas elecciones se realizan de acuerdo con las leyes electorales del Estado.

13 Las aportaciones federales para entidades federativas y municipios, o Ramo 33, es el mecanismo presupuestario diseñado para transferir a los estados y municipios recursos que les permitan fortalecer su capacidad de respuesta y atender demandas de gobierno en los rubros de: educación, salud, infraestructura básica, fortalecimiento financiero y seguridad pública, programas alimenticios y de asistencia social e infraestructura educativa. Con tales recursos, la federación apoya a los gobiernos locales para que atiendan las necesidades de su población; buscando, además, fortalecer los presupuestos de las entidades federativas y las regiones que conforman.

Mediante su cosmovisión, su organización social y su trabajo colectivo (faenas), están transformando su propia existencia. Está organización social les ha permitido que el 4 de julio de 2016, la Sala Superior del Tribunal Electoral del Poder Judicial de la Federación (TEPJF) les reconociera el derecho a la libre determinación, a nombrar autoridades y a revitalizar las formas organizativas propias de la comunidad, así como el derecho al libre desarrollo económico (Aragón, 2018). Bajo este nuevo panorama las autoridades de la comunidad se reorganizaron. Surgieron de los siete encabezados de barrio pre-existentes, que presiden las asambleas barriales, siete concejales miembros del Concejo Comunal.

El Concejo Comunal, es el órgano ejecutivo que remplaza las actividades que anteriormente realizaba el Jefe de Tenencia y que a la par con el representante de bienes comunales son las autoridades de esta Tenencia. Cabe señalar que, a pesar del reconocimiento de su derecho a la libre autodeterminación como pueblo indígena, las autoridades comunales de Pichátaro, han estado en constante enfrentamiento con autoridades municipales, estatales y federales que no les pueden reconocer de manera automática su envestidura. Debido a que no existe un marco jurídico federal o estatal que de manera explícita les otorgue esta potestad de autoridad. Por lo anterior, han estado luchando de manera judicial, permanentemente, para que se les reconozco su envestidura como autoridad.

Las actividades productivas que los pobladores de esta comunidad indígena realizan son diversas. La población masculina, mayoritariamente, labora como artesano de muebles rústicos de pino, alternando con actividades agrícolas, milpa[14] y avena forrajera, para autoconsumo o pequeña comercialización, así como actividades silvícolas, ganadería a pequeña escala, comercio y servicios. Las mujeres se dedican a actividades domésticas, comercio, como artesanas que bordan prendas bajo la técnica de punto de cruz[15], en actividades de servicios, y en el cuidado de los ekuaros[16].

La praxis de la cultura purépecha se circunscribe dentro de un sistema de segmentos espaciales funcionalmente entrelazados: "… la unidad doméstica como núcleo de articulación del principio de parentesco…, el barrio como centro articulatorio del principio de residencia…, la comunidad como institución aglutinadora de ambos principios… y la región como el espacio de confluencia entre la cultura íntima intracomunal y la cultura de las relaciones sociales externacomunal (Dietz,1999: 117)".

Por tanto, el núcleo de la praxis cultural purépecha está conformado por la unidad doméstica. El individuo pertenece a una determinada comunidad, tiene un estatus social, donde se le reconoce como comunero debido a que es miembro de una familia y reside en un barrio. Donde el jefe de familia goza de una membresía otorgada por su participación en los

14 Pichátaro se ha autodeclarado territorio libre de maíz transgénico y se cuenta con una gran variedad de maíces nativos de la región (Barrera-Bassols et al., 2009).

15 Las prendas pueden ser: ropa femenina como blusas o faldones, caminos de mesa para los alteres de la Iglesia, prendas de uso doméstico como servilletas, manteles, sabanas, cojines, etc.

16 El ekuaro es un sistema etnoagroforestal tradicional y complejo propio de los purépechas. La palabra ekuarhu significa patio, lo que esta fuera de la casa o el lugar donde se ve ampliamente. Es una prolongación de la habitación purépecha, donde se encuentra la crianza de ganado mayor y menor. También se cultivan diferente tipo de vegetación, árboles, arbustos, herbáceas, cuya arquitectura semeja a los bosques, no mayor a media hectárea, relacionada con la vida cotidiana, utilizados para fines alimenticios, medicinales, aromáticos y religiosos. En este espacio no se utilizan fertilizantes químicos ni pesticidas y la tierra es trabajada y cultivada preponderantemente con la azada. El manejo del espacio se realiza principalmente por mujeres y niños (Barrera-Bassols, 2003).

asuntos barriales y comunales. Su familia es parte integrante del barrio y de la comunidad porque el cabeza de la unidad doméstica cumple con sus obligaciones para con el barrio y la comunidad.

A través de este entramado que va de lo individual-familiar a lo regional es como los pobladores de Pichátaro trabajan, en el día a día, para controlar y gestionar su territorio. La diversificación productiva de la familia extensa les asegura la sobrevivencia. La pertenencia a la organización barrial, por residencia, les permite gozar de los espacios habitacionales y productivos, tanto en el asentamiento humano, como en las parcelas agrícolas y en el bosque. La organización comunal convoca a la tutela de su ser indígena, a la protección de sus zonas boscosas y en general a proteger sus derechos comunales hacia dentro como hacia afuera de la comunidad. A la par, la comunidad se desenvuelve en un andamiaje regional.

Los conflictos internos y externos en la comunidad se derivan por el acceso y uso de las parcelas agrícolas[17] y el bosque. Existen momentos en los cuales se tensan los intereses personales versus los intereses colectivos tanto dentro de la comunidad como con sus vecinos regionales o con actores externos a la región. Los recursos maderables del bosque, principalmente, son la manzana de la discordia económica. No obstante, los pichatareños luchan para restaurar, conservar y proteger sus zonas boscosas.

A través de las faenas colectivas, barriales o comunales, realizan trabajos para prevenir incendios forestales, mantener los ojos de agua, que surten al asentamiento humano y a los abrevaderos para los animales de trabajo y ganado, reforestan las zonas boscosas y protegen los bosques de los talamontes, internos en la comunidad, vecinos regionales o ajenos a la región. Para ello buscan en los programas estatales o federales recursos monetarios, materiales o humanos que pueda facilitar los insumos que ellos no poseen. Así como apoyo en universidades, comunidad académica, organizaciones indígenas, campesinas, ejidales y comunales, regionales, nacionales o internacionales, que les ayuden a proteger sus bosques. Los pichatareños luchan por controlar, gestionar y defender su territorio, a la par que buscan la reivindicación de su ser indígena.

Conclusiones

Los territorios son el resultado del arduo trabajo cotidiano de sus pobladores por reconstruir y mantener su hábitat. El conocimiento del espacio y los saberes que implica son esenciales para controlar y gestionar los ecosistemas. Su transmisión exitosa, hacia las nuevas generaciones, pugnará por el arraigo de sus futuros pobladores por el territorio. Una herramienta clave para conocer los espacios, la forma en que esta organizada la comunidad, es realizar y actualizar proyectos de vida comunal.

Los proyectos de vida comunal contienen la información más íntima de la comunidad. Estos proyectos pueden ser la base de ordenamientos territoriales jurídicos, que coadyuven a

17 En años recientes, algunos comuneros han rentado sus parcelas agrícolas para el cultivo de papa de temporal, bajo técnicas que priorizan el uso de agroquímicos y pesticidas. Como no rotan los cultivos exponen los suelos a su sobreexplotación, a la propagación de plagas, que le son inherentes al cultivo, y a la erosión, por aire y/o por lluvia. A la par que el uso de pesticida contamina los mantos acuíferos. Al cultivo de papa se ha sumado las huertas de aguacate que se expanden en la región purépecha. Adicional a los efectos ya comentados para el cultivo de la papa, se puede agregar que las huertas requieren riego durante todo el año, en una zona con problemas hídricos inherentes a su orografía (Ávila, 1999). Dentro de las huertas, en Pichátaro, se han construido ollas de agua, de entre 5 y 20m3 aproximadamente, que obstruyen la filtración de la lluvia.

la defensa de los espacios y del territorio, frente a disputas internas o frente a actores externos al grupo social. Tanto los proyectos de vida comunal (conocimiento), como los ordenamientos territoriales (instrumento de defensa jurídica) y una organización social fuerte, contribuyen para ejercer un control y una gestión sustentable de los territorios, que les puedan proveer buenas calidades de vida. El escrutinio que se realiza de los proyectos de vida comunal en las asambleas comunitarias, respetando los asuntos privados de los colectivos, son la fuerza de acción que permite la permanencia de los grupos sociales en los territorios.

La comunidad indígena de San Francisco Pichátaro se constituyó durante la época colonial y ha permanecido en su territorio, a pesar de las diferentes transformaciones de la nación mexicana. El arraigo a su cultura, a su ser indígena, les ha permitido generar lazos de ayuda mutua con sus congéneres, dentro del barrio, de la comunidad y de la región. Frente al reconocimiento mundial de las civilizaciones originarias y sus derechos sociales, la comunidad de Pichátaro, ha sido reconocida por las autoridades mexicanas, como un sujeto jurídico colectivo. Este reconocimiento implica que la comunidad tiene su propia personalidad jurídica con derecho a la propiedad del territorio, a la libre determinación, a nombrar a sus propias autoridades y a revitalizar las formas organizativas que les provean mejores calidades de vida. Ante los cambios regionales, nacionales e internacionales que permean en la comunidad, el principal reto, sigue siendo la permanencia, pero arraigados a su territorio y a su forma de organización social podrán lograrlo.

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V. SOCIAL AND ENVIRONMENTAL CONFLICTS

Can local environmental justice organizations change national policies in Latin America? Selected Brazilian conflicts

Joseph S. Weiss*

Introduction

Drawing on radical ideas of ecological economics, political ecology and sociological analysis of social movements, the author begins to answer this broad question. To what extent do local movements develop into national struggles, organizing alliances and networks to pressure for and achieve national policy change or better enforcement? Of a total of 103 local conflicts reported by EJ Atlas (2018), the author selected 47 land and natural resource conflicts led by six types of Brazilian movements. These efforts of environmental justice activism towards sustainability are conceived as achieving five levels of conflict outcomes or scenarios, the dependent variable: Of these, 1) 28 were completely unsuccessful, 2) 10, partially or temporarily successful, 3) 8 managed to stop or change the project by collective action and/or litigation, 4) one changed national policies and 5) none moved toward ecologically sustainable societies, an idealistic long-term view that socio-ecological struggles propose to achieve. With the fact sheets from Ejolt questionnaires responses, published news reports and the author's knowledge, independent variables were built for the conflicts' mobilization structures: 1) ties with the movement's own national organizations, if any, 2) national and international networking; and for their political opportunity structures: 3) each movement's legal framework (constitutional, legislative and/or policy), 4) adversary strength and 5) government opposition or support. Regression analysis for the conflict sample indicated that a movement's legal framework and network building and support contributed to favorable outcomes while the strength of a movement's own national organization and adversary strength did not affect conflict results. A similar analysis is underway on Colombian social and environmental mining conflicts. To further these results, we propose that the EJ Atlas add these factors to its research agenda, along with national movements representing local groups, networks, policy demands and achievements.

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1. Background

Since the 1990s, many Latin American countries have been going through a strong reprimarization process, which changed their social metabolism as well as intensified, environmental pressures and conflicts. Perez-Rincon et al (2017) suggest that such conflicts are explained by the structural shifts of the economies and the concomitant changes in their metabolic profiles. The primary sector of four Andean countries (Colombia, Ecuador, Peru and Bolivia) increased its importance. The domestic extraction of materials jumped from 336 to 1145 MT between 1970 and 2012, driven by the fossil fuel and mining sectors, reflecting in the environmental conflicts. Such conflicts produce social mobilizations, which if successful, might help move society towards sustainability and environmental equity.

During the same period, consistent with the Washington Consensus, transnational corporations pressed for deregulation, while international donors' development theory and practice turned to local solutions with subnational and civil society clients, isolated from national policies, leaving inequality and power relations aside, leading to mostly local results.[1] Despite this neoliberal detraction from the State, most were forced to admit its role in defining and enforcing rules and its profound influence on the strength and impact of civil society organizations (Bursztyn 1993).

The key basis of this paper is to follow Joan Martinez-Alier and the Ejolt-EJ team's lead in world-wide environmental justice activism and their efforts in collecting data on more than 2477 socio-ecological conflicts (by May 2018), thus backing local struggles against environmental and social injustices (Martinez-Alier 2002; Anguelovski & Martinez-Alier 2014; ejolt.org 2016, ejatlas.org 2017).

This interdisciplinary article draws on radical ideas of sociological analysis of environmental justice, political ecology, socio-ecological movements, ecological economics and public policy analysis to seek answers to the title question: Despite pressures towards deregulation, can local environmental justice organizations, through conflicts over the use of land and natural resources, not only succeed in their local demands, but also change related national policies? Can local land and natural resource conflicts develop into national struggles, networks and alliances to dialogue with governments and demand policy change? If so, how can this be achieved and under what circumstances? In light of the above questions, we briefly review the concepts of environmental justice, political ecology and socio-ecological movements and their relevance to some of these movements in Brazil.

1.1 Environmental Justice

The environmental justice framework incorporates the principle of the right of all individuals to healthy environments and sustainable livelihoods, protected from environmental degradation. This movement-developed concept focuses on the equitable distribution of environmental risks, costs and benefits, independent of ethnicity, income, social position or power. It requires democratic decision-making processes, based on empowered, well-organized and informed fragile groups to equitably access natural resources without disproportionately bearing environmental impacts.

1 This assertion may also be valid for European foreign assistance policy on social problems.

In Latin America, similar movements link environmental and social movements on a common agenda bringing together common struggles for human and environmental rights in a global quest for well-being and a sustainable future for the excluded (Santilli 2004; Hochstetler and Keck 2007). Weiss and Nascimento (2013) reviewed civil society's pressures to approve and implement Brazilian policies which protect its peoples and its natural resources from these injustices.

1.2 Political Ecology

Bryant and Bailey (1997) considered political ecology and ecological economics as sharing a radical and ecocentric perspective. In brief, political ecology draws on theories of social and political change to understand the systemic causes of inequality and environmental degradation, looking at the drivers of environmental conflict resulting in unjust burdens on communities and nations. It supports action research with global environmental and climate justice movements. They also indicate the field's variety of approaches, also visible in a recent collection (Peet, Robbins and Watts 2011). Concentrating on different actor interests, characteristics and actions and the central importance of politics is helpful to understand actors influence upon processes. "Third World political ecology goes beyond the study and analysis of socio-environmental processes and conflicts or the sociology of resistance movements. It is historically, theoretically and politically committed to a sustainable future and other possible worlds (Leff, 2017, p. 237; Scheidel *et al.*, 2018)."

1.3 Socio-ecological movements

Following Ostrom's (1990) dictum that supportive national policy is one of the few recurring ingredients necessary for the success of local, community–based initiatives, we feel it necessary to look at the ties of local processes to national policies. This can be considered as within lines of enquiry from social movement theory that seek to explain why and how social mobilization occurs, how marginalized groups can access alternative sources of power, mobilize resources and create networks based on shared identities moving towards social transformation (Temper *et al.*, 2018; Temper *et al.*, 2015: 261; Porta and Diani, 2006; Rucht, 1991; Tarrow 1998). They find that conditions which make network groups effective in influencing policy are often due to their ability to achieve leverage, through network strength and density, issue-resonance (possibly measureable by tweet or browser numbers) and target vulnerability. Poletta (2014) described three "essential ingredients" of movement leverage that contribute to mobilization: political opportunities, mobilizing structures, and resonant frames or effective messaging. This is consistent with the social movement constructs of political opportunity structure, framing and mobilization structure.

Keck and Sikkink (1998: 26) show that environmental justice movements can be examined productively at local scales and as they organize into transnational coalitions, across space and places. Their line of research on transnational networks linkages with local issues includes NGOs and other support groups (religious, labor), local movements, foundations and other donors, multilateral organizations and governments. They look at issue and actor characteristics; how networks affect political outcomes; and conditions which make networks effective. Skimming over national networks and their influence on policies, they do not emphasize their relevance to national policy issues, despite noting that national groups go international to seek stronger support. Nor do they include state and national movement organizations, representing EJOs (environmental justice organizations), important to build alliances with other organizations into advocacy networks.

Our analysis seeks to discover which factors contribute to local movements developing into national level protests and civil disobedience actions. Do they get together with other local organizations on similar agendas to form national organizations? Do they build networks with movements on other agendas that agree on key issues? Are local issues of sufficient national importance or issue-resonant for national government to deal with them directly? Do they achieve policy changes and what are the repercussions?

2 Methods

After presenting the Ejatlas questionnaire, the typology of 5 movement outcomes or scenarios, their contributing factors, the subset of conflicts documented in the ejatlas.org, organized into six land and water-based movements in Brazil, the use of the Ejatlas data and complementary sources is described and a regression analysis is presented. To identify factors which contribute to outcomes, conflicts are studied in which local EJOs with potentially impacted peoples seek to defend their livelihoods and cultures while protecting natural resources.

2.1 The questionnaire

The Ejatlas questionnaire (see Appendix 1) has generated a wealth of data (Ejolt.org, 2016). However, It does not ask about local EJO efforts to pressure their government to change policy or even to enforce existing policy which protect traditional and impacted peoples.[2] Although not prepared for this purpose, we organize the data on the Ejatlas fact sheets for the 47 conflicts, prepared from the EJO questionnaires. While the questionnaire does not get to this topic, some fact sheets mention national movement organizations, allies and adversaries. While this material provides detailed descriptions and analyses of the conflicts, few refer to efforts to change national policies.

To complement this information, we seek other sources on the legal framework (constitutional, legislative and policy background), ties with the movements own national organizations, national and international networking, adversary strength and the influence of governments, whether positive or negative, upon each conflict.

Sustainable outcomes and contributing factors

We identify five scenarios, two unsuccessful:

(1) completely unsuccessful conflicts and;

(2) those which are partially or temporarily successful; and three of which contribute towards achieving a just and sustainable future;

2 Including the application of international agreements to which Brazil is signatory.

(3) Contestation through non-violent/violent actions[3] to stop or change projects, up through litigation, but undertake few actions to enforce or change national policies (Temper *et al.*, 2015);

(4) In addition, pragmatically pressing politicians and policy-makers and sensitizing public opinion to implement public policies which enforce or change national policies or legislation (Brazilian Society for Ecological Economics *et al.*, 2017) or

(5) Idealistically seeking "socioenvironmental struggles leading to ecologically [and economically] sustainable societies (Leff 2017: 234)."

It seems as if the third scenario does not go far enough while the fifth takes a long-term view which may neither lead to short-term suggestions nor a long-term impact on society.

2.2 The identified movements and selected conflicts

Of the 103 Brazilian socio-ecological conflicts registered in the Ejatlas by May 2018, 47 local environmental justice land-based conflicts were selected in two Ejatlas categories (biomass and land conflicts and water management) led by six land-based movements (see box 1).[4] In Brazil, all six movements have organized at state and national levels, where they have become the natural representatives of civil society, backed by networks, to dialogue with governments and demand policy change outcomes. However, some projects began before these organizations were created.

BOX 1. SIX BRAZILIAN LAND-BASED MOVEMENT CATEGORIES

1. Landless Farm Workers - MST organized in 1985, settled 350,000 families, mostly in the Amazon. 1,722 murdered. 1988 constitutional terms are less favorable than prior law. Seeking to occupy unproductive land, they face strong adversaries.
2. Indigenous Peoples -.Constitution recognizes land and cultural rights. In 1989, the Indigenous Organizations of the Brazilian Amazon Coordination (COIAB) had 160 peoples on 118 M ha. In 2002, the Brazilian Indigenous Peoples Articulation (APIB) increased its membership to 254 peoples. They cover 23% of the Amazon.
3. Quilombola Peoples - The Constitution provides for land and cultural rights. The Quilombola National Coalition Articulation of Rural Black Communities (CONAQ) was created in 1996. According to conaq.org.br, of a total of about 5,000 communities, 2847 have been state certified, 1533 federal processes have begun and 154 have received collective land titles.
4. Extractivists: Extractivist peoples national council (CNS). It protected the forest through non-violent action and built a broad international network. Ranchers killed Chico Mendes. Extractive reserves were created by decree. As of 2018, there are 191 extractive reserves on land with a total of approximately 40,000 families on almost 300,000 square km.
5. *Dam Affected Peoples* - Dam-expelled movement (MAB). Protest for non-compliance of compensation commitments.
6. Other Settlers - Confederation of family farm workers - CONTRAF, a member of Central Unico dos Trabalhadores (CUT).
Sources: Apib, 2018; Brazil, 2018; Coiab, 2018; Conaq, 2018; Contrafbrasil, 2018; Costa, 2006, CPT, 2017.

Note: (facing large ranchers and farmers, often pressuring to sell, land grabbers, militias)

3 These include campaigning, petitions, meetings, demonstrations, boycotts, strikes, threats, civil disobedience, collective violence, and other forms of action (Tilly 1993, Temper et al, 2015; 262).

4 The National Farm Workers Confederation (CONTAG), established in the 1960s, is not currently leading conflicts. See Picoletto, 2018, for discussion on competing movements.

2.3 Leverage variables

We attribute the values of five movement leverage variables which contribute to the outcome, by interpreting the fact sheets, conflict by conflict, integrated with other sources, knowledge and understanding of the situations. Of the five: Two are mobilization structure variables: 1) O - the strength of the movement's own national organization, applied at the time of the conflict, 2) N - the reach of the conflict to a national and international network support. Other possible variables not available at this time might include political institutions and organizations, key movement leaders' staff experience, etc. Three are political opportunity structure variables: 3) A - adversary strength and 4) G - government opposition or support for the conflict and 5) L - legal support based on existing constitutions, laws and practices. No information is available for framing. By using 0-1 variables, we also analyze the extent to which other conflict criteria affect the outcome, including the Ejatlas conflict and the key movement categories involved. See variable definitions in Appendix 2.

3. Conference Proceedings

A data base was generated with the values assigned to five leverage variables on 47 conflicts, as well as two category variables (zero-one), six socio-ecological movement categories leading the conflicts, and the two conflict categories (land and water). A correlation matrix and then multiple regression analysis were used to estimate the coefficients, standard errors and t-tests for these variables.

Of the two mobilization variables, we expected that the strength of a movement's national organization would improve chances for success. However, in the conflct sample, this seems not essential to building national and international networks.

The analysis also suggests that among the three political opportunity structure variables, the legal framework (L) improved chances of success. Of the six Brazilian movements backing local environmental justice land-based conflicts with national organizations, four had good legal support, two of which often benefitted from rights approved in the 1988 constitution (indigenous and quilombola peoples) and one through a presidential decree shortly thereafter (extractive reserves), held up by the Supreme Court. This led to limited policy change towards their objectives of social well-being and more natural resource protection. Despite no change in legislation, the landless farm workers selectively invaded latifundia, forcing the government to buy the land[5] and slowly increased the number of settler beneficiaries. The dam-affected peoples have not achieved policy change, possibly because they seek private sector compliance, which has been even less responsive. Despite Terra Legal, an Amazon land registry designed to provide titles to family farmers, they have had limited results. Instead, other people have often managed to validate their land claims. However, the strength of conflict adversaries (A) and government opposition or support for the movement (G) were not relevant for the conflict sample studied.

5 Often after the owners had already sought out the government to offer their land.

4 Results: Analysis of Brazilian land and water conflicts

To begin analysis of the Brazilian database, a correlation matrix was obtained among the leverage variables and outcome variable. After reviewing the correlation matrix, alternative regression models were considered. The general function analyzed was:

Outcome = f (mobilization structure, political opportunity structure, categories)

or

Outcome = f (support from own national organization, network support, level of supporting legislation, adversary strength (-), federal government support, Ejatlas category, movement type)

The preliminary conclusions based on these models of effects upon the outcomes for our EJatlas conflict sample are:

Among the leverage variables, outcome was significantly affected by:

N: The support of a national or international network;

L: level of supporting legislation;

G: federal government backing, all contributed to a favorable outcome towards sustainability.

The other variables were not shown to be significant in this sample, as measured:

O: the support of the movement's own national organization and

A: the strength of the adversaries, often reflecting the focus that they had on the specific conflict.

Of the zero-one variables included to determine whether one movement was more effective than another, the only significant difference found among the movements was that the landless workers' movement (MST) had greater effect on outcome than the others. Therefore, we designed a variable called non-MST (MN1) which was also significant but negative. There was no significant difference between the two categories included, water and land.

The estimated regression function is as follows. Below it are lines for the standard error and T-test.

Y= 1,44	-0,73MN1	0,29 N	0,18L	0,26G	r2 = 0,38
0.28	0.24	0.20	0.08	0.15	Standard error
5.21	-3.01	1.43	2.30	1.79	T-test

Governments may oppose, support or not take a position on local resistance to projects. These results suggest that government influence (G) upon conflicts may be significant, both when supported by existing legislation (L, constitutional or not, prior to the conflict) and when government intervenes during the conflict towards a more sustainable outcome. Network support (N) may not only help the affected movements and their members directly but also by information and pressure placed upon governments. In order to better illustrate the study's results, we present comments on specific conflicts in Appendix 3.

5 General Considerations

These leverage elements may lead to stopped projects, social and economic structural change, as well as changes in public policies and/or legislation conducive to environmental justice.

After a review of a sample of 47 Brazilian conflicts and their policy impacts, we identify circumstances and actions which may have helped or hindered achieving their movements' policy objectives. In conclusion, building and keeping strong alliances under integrated frames and strong mobilization enhance chances of success. Misaligned power between economic forces and governance capacity (Ruggie, 2007) can increase prospects for failure. Government will and international organizations may oppose and/or favor these struggles' demands. Actions designed to achieve policy change by overcoming challenges may include non-violent/violent actions, information to influence public opinion, legal disputes and pressures on politicians and policy-makers.

6 Continuing studies

Due to time constraints, Professor Mario Alejandro Perez Rincon of Universidad del Valle, Colombia was unable to complete similar research on Colombian socio-environmental mining conflicts.

As a result of this research, a possibly more efficient approach was found:

select those conflicts which were reasonably effective in achieving success such as the El Salvador's ban on mining projects and the Colombian court prohibition of mining on the high open fields (páramos);

analyze what leverage factors contributed to their success;

seek to generalize based on large samples of Ejolt-registered conflicts and further information.

Personal interpretation of the Ejatlas fact sheets based on political knowledge is not sufficient to further analyze this issue. Therefore, one study result is to suggest that the environmental justice movement add to its research agenda the existing constitutional and policy framework, national and state representation of local groups, their influence on policy issues and demands, work to build issue-based networks, policy decision structures, interactions with policy makers, policy outcomes - changes achieved or resisted, etc.

This would suggest that the questionnaire could include actions such as organizing national entities representing similar local struggles throughout the country, aligning frames with other national organizations to build and strengthen alliances, enabling avenues of communication with the broader society, working to pass legislation, contesting constitutional issues in courts, etc.

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Appendix 1

Ejolt Survey Form

Appendix 2

VARIABLE DEFINITIONS

Variable	Symbol	Value	Classification
Ejatlas category	C	1	Water mgmt. Dam
		2	Land and Biomass conflict
Movement category*	M		
		1	Landless farm workers & resulting settlers
		2	Indigenous
		3	Quilombola
		4	Extractivist and riverdweller
		5	Affected by dams
		6	Other settlers
		7	Family farmers (often without land title)
Leverage variables - mobilization structure			
Support of the movement's	O		
national organization		0	None or inactive
		1	Weak
		2	Strong
Network support including	N		
national/int'l organization		0	None or inactive
		1	Weak
		2	Strong
Leverage variables - political opportunity structure			
Legal support	L	0	None
		1	Corporate compensation/ private sector decisions
		2	Government compensation
		3	Legislative support
		4	Constitutional support
Adversary strength	A		
		1	Low
		2	High
Government support	G		

		0	Against
		1	Low
		2	High
Dependent variable - outcome	Y		
		1	Unsuccessful
		2	Won temporarily or partially
		3	Local conflict won
		4	National policy change achieved
		5	Societal or private sector change

*See Box 1 ** including green desert women

Appendix 3

Selected Brazilian Conflicts

The author selected the following conflicts listed on Ejatlas. Most of them became iconic, having received considerable news coverage.

Chico Mendes led a group of Acrean rubbertappers, with whom I've often been in contact over the years, to carry out a true agrarian reform, escaping debt bondage. They stopped ranchers and loggers efforts to cut the forest through 40 non-violent actions (empates). They came up with a new concept, the extractive reserve. Like Brazil's indigenous lands, they were offered land grants for sustainable use with government retaining the property. The network brought Chico Mendes to Washington, DC. His assassination led to international support and a new law for extractive reserves applied all over Brazil. See Hochstetler & Keck, 2007. Grades: N- network 2 strong; L - Legal 1 only corporate interpretation of laws; - and G - government support – 0; O own national organization (people affected by dams) 1 - weak; A - adversary strength - 1; Y outcome - 2.

Empate on the road to Boca do Acre, September 1979, José Maria Barbosa, CPT collection www.flickr.com/photos/jorgeviana/6144468255

In December 2017, I visited a sustainable community forest management project in Porto de Moz, Pará, a municipality at the lower Xingu River as it flows into the lower Amazon. It had a high rate of illegal deforestation. To reduce it, the federal government decided to make 80% of its area into an extractive reserve called "Green Forever" which won a prize for applying the concept of sustainably managed forest in six communities. After a number of years, they organized associations and are cutting and selling a few trees each year. Their area should maintain prior forest conditions over the next 30 or so years. Grades: N- network strong 2; L - Legal, extractive reserve legislation 3; G- government support – 2; O - own national organization (extractive peoples) 1 - locally weak; A - adversary strength - 1; Y outcome - 1.

At the same time, I passed through Altamira, Pará. There, Belo Monte is one of the world's largest hydroelectric plants. To license the project the owner went through 2 key steps: 1. After a very broad international network fought strongly against the project, it was adjusted to include expenses of an additional billion dollars for mitigation projects which were never completed; and 2. To issue the license, Brazil's president had to fire the president of the environmental licensing agency who had refused to sign based on negative technical reports. Grades: N- network 2 strong; L - Legal support 1; G - government support – 0; O - own national organization (dam-affected people) 1 - weak; A - adversary strength - 2; Y outcome 0.

Photo Protest Belo Monte.

Sister Dorothy was murdered in Anapu, Pará after promoting reforestation by families on a sustainable settlement whose land is sought by land grabbers. During the past year, they attacked the local land regulation agency and began burning the forest, seeking to sell illegal lots, supposedly upon orders from Dorothy's murderer, found guilty and now in jail. Federal prosecutors order the referred agency to act. Grades: N- network 1 weak; L - Legal support 0; G - government support –1; O - own national organization 0 - none; A - adversary strength - strong 2; Y outcome 0.5.

Invasores abrem caminho da floresta na Reserva Legal do Virola-Jatobá - Foto: Roberto Porro, pesquisador da Embrapa Amazônia Oriental 23/4/18

Agroindustry drive Guarani-Kaiowá from ancestral land, Dourados, MS. This indigenous group has been driven off 90% of their land by soybean farmers and their agents. Many have been murdered. They have one of the highest rates of young suicides in the country, out of despair. There have been gains and losses in the courts.

Grades: N- network 1 weak; L - Legal support 1; - and G - government support –1; O - own national organization 1 - weak; A- adversary strength - strong 2; Y outcome 0.

Fibria and Eldorado Brasil, Mato Grosso do Sul. These major forest product companies bought a pulp mill, eucalyptus plantations and other land funded by Brazil's development bank. Small-scale farmers and mothers are opposed to the "green desert" development model and concerned about aerial application of pesticides and increased land property concentration, strong negative impacts on biodiversity depletion and pollution of water sources and soils as well as bad working conditions. Grades: N- network 1 weak; L - Legal support 0; - and G - government support 0; O - own national organization 1 - weak; A- adversary strength - strong 2; Y outcome 0.

Lumber, in Labrea, Amazonas, is cut illegally at the highest rate of deforestation in the state. The land is disputed by lumber companies, large soybean producers and ranchers. The extractivists sought to establish two extractive reserves in the municipality with Federal Government support. Community struggles to create and defend the Middle Purus and Ituxi

Rivers Extractive Reserves began in 2001. They were approved in 2008, benefitting about 3,500 extractivists. The rights to use (equivalent to land titles) were issued in 2014 for the Médio Purus Resex and for the Ituxi in October 2017. Grades: N- network 1 weak; L - Legal support 3; and G - government support – 1; O - own national organization 1 - weak; A- adversary strength - strong 2; Y outcome 1.

Raposa Serra do Sol, Roraima. This indigenous land obtained recognition in 2005 after a 30-year struggle threatened by ranchers, large rice farmers and miners. It is mostly on deforested land, with over 40 thousand indigenous residents. The final decision was made by Brazil's Supreme Court. Grades: N- network 2 strong; L - Legal support, constitutional 4; G - government support – 2; O - own national organization 1 - weak; A- adversary strength - strong 2; Y outcome 1.

São Luiz doTapajós hydroelectric dam. The government had planned to begin its first plants on the Tapajós River. The Ejatlas headline of this dam is "Strong opposition, legal flaws and demarcation of land by indigenous communities led to the cancellation of the first of the dam projects on the Tapajós river. Big victory for environmental justice now challenges the future of other projects.” Grades: N- network 2 strong; L - Legal support, constitutional 4;- G; - government support – 0; O - own national organization - 2; A- adversary strength - strong 2; Y outcome 1.

Community logic as a basis for socio-economic and environmental resilience: Santa Cruz Tepetotutla, Oaxaca, Mexico

Mara Rosas Baños*

Introduction

Historically indigenous communities have been greatly harmed by the policies of Western development; a development that has been responsible for accelerating climate change and, in general, for the ecological crisis. In response their capacity for resilience and adaptation has developed up to the point of endangering the possibility of the continuity of community life. This characteristic has been studied using the concept of resilience. This term refers to the way in which ecosystems or subjects are able to overcome adversity. Holling (1973) used this term for the first time to analyse the stability of ecological systems using a transdisciplinary approach in which resilience determines the persistence of relationships within a system and is a measure of the ability of this system to absorb changes in the state of the variables. In general terms resilience is a property of a system and either persistence or the probability of extinction is the result.

This approach has been used to analyse community resilience from the perspective of complex systems and thus to understand their capacity to respond to changes. From this perspective the notion of resilience presents an evolutionary character which is emerging and adapting (Sánchez, 2014). According to Kirmayer (*et al.*, 2011), indigenous resilience has to be rethought to include adverse cultural, geographic, social and historical aspects that indigenous communities have faced. The resilience of indigenous communities is connected with their historical roots in the land, their community and their interaction with the environment, but specifically with culture and identity. Reilience as an opportunity for transformation has to do with the possibility not only of overcoming risks, but with the ability to learn and guide efforts to transform activities in a creative way (Uriarte, 2013).

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The concept of resilience has been useful in understanding the adaptation-resistance mechanisms of rural communities, especially facing the threats of climate change. According to international organizations, climate change has negative effects mainly on rural communities in Latin America due to the geographical vulnerability of the region, the social vulnerability of specific populations, the low government responses of institutions at different levels to medium and long term problems (ECLAC, 2014) which threaten food security and destroy basic infrastructure (Tyler *et al,.* 2013). However, the resilience of indigenous communities can be observed in various aspects of their life. Several studies have focused on the usefulness of traditional knowledge to determine mechanisms of adaptation to climatic variability and its varied impacts (Hiwasaki, 2014, DeAngelis, 2013, Kirmayer *et al.,* 2011). In this paper, the research focuses on the capacity of the community of Santa Cruz Tepetotutla to create strategies to address the various adversities that have historically affected aspects of productivity and the resulting adaptation of mechanisms to mitigate climate change. This article uses a theoretical approach constructed by the author, using anthropology and sociology, which constitutes an approach to community logic; logic in which social, ecological and economic systems have been historically intricate. This approach in turn serves as a foundation for the approach of resilience proposed by Berkes (2007; 2012). Using the perspective of adaptive resilience, the author combines both approaches to understand how, through facing adverse historical conditions, the indigenous community of Santa Cruz Tepetotutla has been transformed and has adapted yet, at the same time, has resisted the danger of disappearance as a Chinantec community. Instead it has become an economic conservation community, based in participation in consciousness-raising of the environment, and contributing to the rescue of the knowledge of the importance of forests, in combination with productive and conservation strategies that drive public institutions.

Mexico is one of the most biodiverse countries in the world. Most of this biological wealth is found in forests and jungles, 70% of which are in the hands of communities and ejidos (CONAFOR, 2015) under governance as social property. This is the case of an area known as the Chinantla, located in the Sierra Norte of the State of Oaxaca. This area has one of the most important high perennial forests in Mexico, which shelters 26 endangered species; 5 of flora, 13 of birds and 8 of mammals, among them the puma and the jaguar. It is considered as one of the regions with the greatest diversity of ecosystems in the whole country, besides having hydrological importance (WWF, 2014). The indigenous community of Santa Cruz Tepetotutla is found in Chinantla. In 2004, along with five other indigenous communities, it created the Committee of Natural Resources of Chinantla Alta (CORENCHI), which covers an extension of 26 thousand hectares of Areas of Voluntary Conservation of Biodiversity. It is necessary to emphasize that in 2000 the federal government, through the National Forest Commission, created the National Commission of Natural Protected Areas as a conservation mechanism and as a strategy against Climate Change, launching a call for the Resilience of Mexico from 2015-2020. However, since the creation of this commission, there have been important local initiatives of voluntary conservation by forest owners, specifically by indigenous communities.

Analysis emphasizes that there is an intricate relationship between the resilience that the community has developed in its effort not to disappear, and the way in which it has reached a deeper understanding of the importance of the conservation of its forests and the sustainable management of its natural heritage. This, in turn, is fully related to the cultural and historical aspects referred to by Kirmayer (2011). Here resilience is analysed as a result of community logic. This approach was built theoretically from anthropological and sociological studies, and permits us to understand how, despite the marginalized conditions in which peasant communities live, on facing the fall in coffee prices and losing its source of monetary income, one of the first actions the community under investigation took was to decide to compromise its natural heritage in the constitution of a natural area of voluntary conservation. This is an action that under the economic rationality of homo economicus cannot be explained, as the income received by the community for Hydrological Environmental Services is minimal and, according to Nieratka, *et al.,* (2015) do not provide sufficient resources to overcome poverty levels in the community. The community in gambling on conservation is aware that the benefits for themselves will only be seen in the medium or long term.

1. Community logic and indigenous climate resilience

One of the theoretical approaches to peasant logic is that presented by moral economy, known as subsistence ethics (Scott, 1976). It is seen to be in the interest of community members that community resources are used to guarantee the minimum subsistence of all the community via the redistribution of material and monetary resources through gifts, parties and traditional activities. However, the contact between rural and urban communities generates the loss of subsistence ethics and, therefore, the change of peasant logic (Ramírez de Haro, 1997). According to this approach, the resilience that members of the community have is determined by community logic that would be expressed from this focus on subsistence ethics; the peasant community as a whole can be understood as a socioecological, interdependent and non-linear system with feedbacks at different levels, in accordance with the adaptive complex systems approach (Castillo and Velázquez, 2015).

Moral economics integrates the study of social norms and economic patterns in traditional societies under assault by global forces of change which threaten its extinction. The "moral economists" base their studies on subsistence agriculture to give a better explanation of peasant norms, customs and beliefs. They also seek historical explanations of passive behaviour, resistance or peasant rebellions, in the variable strategies by which peasants seek to maintain the security of their subsistence level and defend their way of life from external and impersonal threats (Brooke, 1988). Scott (1976) points out that if we understand the indignation and the rage that prevents them from risking everything, we could understand what he calls their moral economy: their notion of economic justice and their definition of labour and exploitation, which provide a more complete understanding of the normative roots of peasant politics. It is here that Berkes' (2007) approach to resilience in societies facing uncertainty and vulnerability is highly applicable. Peasant communities often face changes arising from national policy or the context of international trade. This author analyses resilience examining the capacity of a system to absorb recurrent disturbances and to enable the survival of essential structures. Resilience is capable of dealing with the integrated economic and ecological social system. In placing emphasis on the ability of a system to deal with risk, resilience permits the analysis of diverse responses, including strategies which range from the absorption of a disturbance, through the adaptation to the said disturbance or the reorganization around it. It also involves responses in terms of policy options to deal with uncertainty and change.

On the grounds that rationality implies the establishment of necessary relations in all spheres of human life, particularly in the case of the logic of reproduction of the community system, we return to the analysis of the concrete in the construction of knowledge in rural communities Levy-Strauss (2003). The evolution of the communities has led them to establish a combination of concrete and abstract thinking which is different from the dominant system, but is also different from what was previously posited as precapitalist logic. In community logic, concrete thinking is determinant in fundamental relationships, for instance social, political, economic, ecological, etc... This structure is constructed on the basis of this determination. "The logical structures of the concrete, constructed by man in his ecosocial environment, incorporate elements of everyday life "(Bravo, 2000). As of old, anthropology has studied the socio-ecological system as a whole, nevertheless, science has insisted on the arbitrary separation between natural and social sciences. Socio-ecological systems refer to a holistic point of view of the components and interrelationships between these components of the system. According to Berkes (2000), the link between social and ecological systems is consistent with the classic literature of human ecology. However, to these two systems it is essential to integrate a third: the economic.

Ancient indigenous communities constructed their thinking, language and science based on the real or the concrete, by using laws of association between opposites; opposition-correlation, exclusion-inclusion and incompatibility-compatibility, that is, logic-antagonistic (Bravo, 2000). Philosophers, anthropologists, geographers, political ecologists and political economists have all shown that many rural communities "construct" nature in ways that are strikingly different from dominant modern forms (Escobar, 2000: 118). They classify, and therefore use, natural environments in very particular ways. The concept of the concrete was the source of the construction of science and its social structure (Lévi-Strauss, 2003). At present, indigenous and peasant communities are characterized by a series of attitudes regarding nature, production and social organization that have their roots in a particular concrete-abstract configuration.

The social structure that is built on this particular combination of the concrete-abstract enables relationships of trust, reciprocity and cooperation. Relationships that are materialized in institutions of community cooperation. In its social construction nature plays an essential role, along with cultural aspects, in determining the characteristics of the type of productive structures that will be reproduced. The components of social and ecological systems that feedback and allow co-evolution are here present. From the evolutionary perspective, organisms adapt and co-evolve with their environment, giving life to a series of institutions regarding the governance of common property which are characteristic of this type of self-organized societies (Berkes 2000, 2004). The management of natural heritage by some rural communities has demonstrated a particular logic based on the conditions of subsistence which has evolved without departing from its concrete-abstract configuration and therefore allows the identification of conservation activities linked to productive management in some rural communities, especially in indigenous communities (Rosas and Barkin, 2006; Rosas , 2011).

The complex combination of abstract-concrete thinking is also present in the capitalist social structure; however, it works in a different way. With the development of the dominant mode of production, concrete thought is lessened in fundamental social relations. Capitalist productive relations are indifferent in a very broad sense: the labour force that enters the productive process is indifferent to the object it transforms. There is a lack of aspects of reciprocity, solidarity, etc., and the concrete has shifted to the mercantile sphere where this abstract -concrete relationship can be observed in areas such as marketing and in the commercialisation of products and services. "It is a question of an economic world settled comfortably on a philosophical structure of the type supported by Jean Braudillard, where all reality has become simulation and human acts are reduced to manipulation of abstractions" (Altamira, 2006: 21).

Community logic of the concrete - abstract "fixes the image to the act of conscience that accompanies it" (Lévi-Strauss, 2003: 41). The ability to closely identify with all the facts that involve aspects of every kind in the communities makes possible the rules which are required to limit the use of natural resources. The theory of collective action considers the first stage of collective organization to be the definition of the limits for the use of the natural resources of communal property. This is because the rules of use restrict the time, place, technology and the quantity of units of the resource. These are related to the local conditions, the rules that regulate the labour supply and the materials required to maintain the resource and the organization. It considers as complementary actions the appropriation, provision, supervision, enforcement of rules, conflict resolution and management activities organized in multiple complementary strata (Ostrom, 2000). Even though this schematization of effects is correct, each element is immersed in a social agreement that is made possible by community logic and which materializes in a form of decision-making in a group to reach consensus and strengthen social cohesion. Changes in individual and collective consciousness are generated by the crisis of the system or its structures, cognitive fields, or reflections on the experiences of the participants that, outside the stereotyped, distorted theories, allow them to see what is different. "to see what is new, distinctive and creative in the emerging ideologies and the different expressions and conceptions of those who manifest them "(González Casanova, 2006: 31).

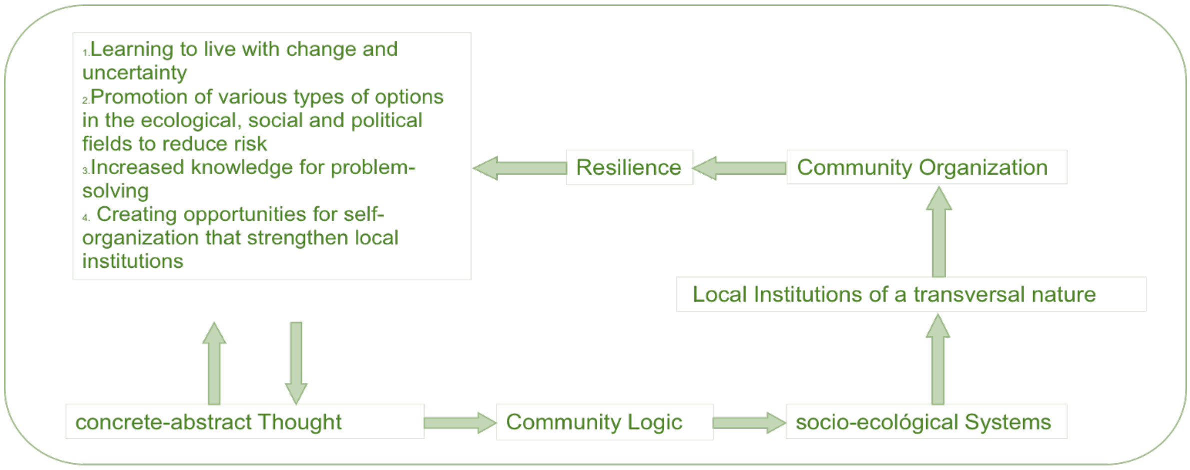
2. Methodology

Theoretical research began in 2009 and was investigated through the study of several cases (Rosas, 2011a; Rosas, 2011b; Rosas, *et al.,* 2013a, Rosas *et al.,* 2013b; Rosas and Antonio, 2015). For qualitative research, interviews were conducted during May 2017 with key stakeholders and participant observation. The following factors identified by Berkes (2007) were used as a basis to analyse the capacity to build resilience:

1. Learning to live with change and uncertainty
2. Promotion of diverse types of options to reduce risk in ecological, social and political areas
3. Increased knowledge for problem-solving
4. Creating opportunities for self-organization which strengthen local institutions.

A documentary inquiry was made regarding the study community to supplement the responses of the participants. The following diagram was constructed from the theoretical framework to analyse the interaction between logic and community resilience.

FIGURE 1. COMMUNITY LOGIC AS THE BASIS OF RESILIENCE



Source: own elaboration.

Community logic in Figure one is analysed as the foundation of the capacity of resilience of the community. It is constructed from the form of abstract-concrete thought and allows the analysis of the integration of the socioeconomic and ecological systems and the type of local institutions which govern the community.

3. Resilience from the community logic of Santa Cruz Tepetotutla, Oaxaca

Santa Cruz Tepetotutla is an indigenous locality of the municipality of San Felipe Usila, located in the North Sierra of the State of Oaxaca, Mexico. San Felipe Usila, is located in the Papaloapan region in the north of the state at coordinates 96º31 'west longitude and 17º53' north latitude, at a height of 100 meters above sea level.

The municipality has an area of 439.04 km^2, which represents 0.47% of the State of Oaxaca[1]. Santa Cruz Tepetotutla is one of the 32 localities of the municipality. It has a total area of 12,372 hectares and has a strategic geographical position, being located in the subbasin of the rivers Usila and National Valley of the basin of the Papaloapan River.

1 http://www.inafed.gob.mx/work/enciclopedia/EMM20oaxaca/municipios/20136a.html

FIGURE 2. GEOGRAPHICAL LOCATION OF SANTA MARIA TEPETOTUTLA, MÉXICO

The population has declined in the last three decades, from 705 in 1990 to 429 in 2010 with 216 women and 213 men (CONAPO, 2011). The number of inhabited dwellings is reported at 113. This population is in conditions of high marginalization, however, some of the indicators of marginalization show a slight improvement in 2010 compared to 2005. For example, the number of illiterate people over 15 years of age went from 32.48 to 26.45 per cent, and regarding access to water, land, among others (Table 1).

TABLE 1. INDICATORS OF MARGINALIZATION

Santa Cruz Tepetotutla	2005	2010
Total population	468	429
% Population aged 15 years and over illiterate	32.48	26.45
% Population aged 15 years or more without complete primary	58.24	51.62
% Private households inhabited without toilet	0.9	2.65
% Private dwellings inhabited without electricity	5.41	0.00
% Private households inhabited without piped water	11.93	2.68
% Occupants per room in private dwellings	50.46	1.29
% Private dwelling with ground floor	83.49	51.79
% Private homes inhabited without a refrigerator	80.18	55.75
Index of marginalization	0.29042	0.02253
Degree of marginalization	high	high
Lugar que ocupa en el contexto nacional		43,541

Source: estimaciones of CONAPO , Índices de marginación 2005; y CONAPO (2011).

Santa Cruz Tepetotutla is a community of the Chinantec ethnic group. They call themselves "tsa ju jmí" which means people of ancient word. From the colonial period until now, the municipalities of the area known as Chinantla have been far removed from the type of economic development found in the state capital (De Teresa, 1999). Chinantecos have been exposed to events that have risked their ethnic continuity. Historically they have suffered from epidemics, natural disasters, cruel *cacicazgos* (De Teresa, 1999), and the relocation of more than 26 thousand Chinantecos for the construction of the Cerro de Oro dam (Rojo, 2014). The Chinantecos date back approximately 3500 years and their language is one of the oldest. Between 1455 and 1456, Moctezuma established their territory in the Chinantla. Their warriors controlled the indigenous towns of the region; Mazatecos, Chinantecos, Cuicatecos and Popolucas, but the Chinantecos rebelled several times against control by the Mexicas. Nevertheless, the suppressed peoples could maintain their customs, their leaders and could worship their gods. Cortés applied for this area as *encomienda* because of the vast natural resources it had including gold (Barabas and Bartolome, 1999).

The history of Santa Cruz Tepetotutla shows the way in which the community has adapted to adverse conditions in both productive and social aspects, being an autarchic community, until the late sixties of the last century. Due to the lack of communication channels, their food depended only on their environment. Historically they have produced maize and beans. The sowing has diversified very slowly. The community always made use of the means of subsistence provided by nature. A common practice in the community was huntin.

In 1920, an epidemic seriously affected the community, because they did not have medical services to cope with it. This forced them to move from a higher location to a lower one as the only way they had to stop the deaths. Their fight against *caciquismo* was one of the events that most remember when comparing the new times with the old times. The gravity of these earlier events contributed to the fact that changes were more rapid after the 1980s; the decade in which neoliberalism began in Mexico. It is interesting that within the time line developed by the community, the fall in coffee prices is not highlighted, despite the fact that during the investigation tours and the interviews with the key players, it was referred to as a particularly difficult event for the community. Cultivation of coffee began to be practiced in 1950, however, it was not until the 1970s that it became the principal productive activity that generated the main source of income and changed living conditions. In the 1980s the community began to build houses with materials such as cement obtained with the income derived from the sale of coffee. The arrival of the Mexican Coffee Institute (INMECAFE) in the community in the 1980s enabled coffee production to increase, specifically due to technical advice and the guarantee of securing the sale (Molina, 2011). In this decade the General Coordination of the National Plan for Depressed Areas also came to the community and installed the first CONASUPO store in 1981. The community of Santa Cruz Tepetotutla has linked the appearance of this store with access to junk food and the emergence of some diseases that are reported in Table two.

TABLE 2: LIVING WITH CHANGES AND UNCERTAINTY FROM THE 80S. THE EMPHASIS ON ECOLOGICAL OPTIONS DERIVED FROM GREATER KNOWLEDGE OF EXTERNAL CONDITIONS

Year	1983-1987	1990-1999	2000-2005	2006-2010	2010-2013
Aspects of community organization	The first internal regulation of communal resources is established		In 2000 the community cooperates for the expenses or commissions of the elementary school and high school parents committee. In 2002, the community statutes were formulated. The first regional committee of CORENCHI	The community receives an honorable mention of the merit of conservation by the Secretary of Environment and Natural Resources	
Aspects of adaptation in social terms: food, health and migration	Disappearance trout, bobo fish and shrimp from the river due to the construction of the Cerro de Oro dam	In 1990 the population is reduced from 1000 to 400 inhabitants approximately by migration to Oaxaca and the USA. In 1994 the first cases of hepatitis occurred. In 1996 the first health clinic was installed. In 1998 the first cases of diabetes, gastritis and tumors			
Aspects of productive adaptation and commercialization	The first mill of nixtamal with motor arrives replacing the metate and the manual mill	In 1994 the PROCAMPO program begins. In 1997, coffee producers organized to market coffee. There is a forest fire where the Model Station is now (Its ecotourism center)	The Social Security Fund is obtained for payment for water services by the National Forest Commission	A trout pond is built. Backyard vegetables are grown and broilers are reared	The Community Forestry Center is inaugurated. Community technicians are appointed for environmental monitoring

Aspects of adaptation to the ecological environment	By decision of assembly the decision is made to tie up the dogs	In 1998 the first forest management study was carried out by Francisco Chapela of the Autonomous University of Chapingo	In 2001, a request was made to establish a community conservation area. In 2002, it began its relationship with the Civil Geoconservation Association. Awareness-raising works for the population are beginning for conservation community.	A tornado is presented that destroys infrastructure and leaves the town incommunicado for two months	
Infrastructure		In 1990 the first electric power poles were installed and in 1991 the community had electricity for the first time. In 1999 the telesecundaria school was created by management of the director of the primary school.	The first pickup truck in town. The first radio to communicate with the municipality. The first machine to open roads arrives. In 2004 the road was opened. Radios are obtained for communication with the communities of CORENCHI.	Community House, Cultural Center is built. The court of the locality is established. A bus is bought. Inaugurate primary school computer center	The roof of the local court is rebuilt. The internet is installed in the health center and in primary school. Main street is paved

Source: compiled based on interviews and documents with the community (time line in the ecotourism center).

According to an interview with the President of the Organization Light Chinanteca of Coffee Producers, they started to plant coffee in 1950 but there were few producers in the community. They began to cultivate Creole coffee. According to the members of the community, it is a resistant plant with a good lifespan. Over time, more and more families began to dedicate themselves to the cultivation of coffee. At first, the cultivation served only as a means to exchange for basic products like bread, sugar, etc., but little by little, the community began to see that the cultivation of coffee gave sustenance to the community and that it was what they should dedicate themselves to. As production increased, several farmers used more and more land for planting coffee, but they did not have roads to carry basic necessities to the community or to sell coffee. By 1970 Santa Cruz was already producing a lot of coffee.

> *"We got to produce up to 120 tons. We harvested enough coffee and that gave us the sustenance to survive in the community. Little by little, INMECAFE arrived. We were told that the Creole plant did not yield much coffee, although the grains of the Creole plant are bigger. When INMECAFE came, they introduced other varieties; the caturra, the new world, the garnica. These did produce a lot, but only for three or four years. Afterwards, when they no longer yielded a crop we substituted the native plant for all these varieties but that plant began to deteriorate rapidly and after three or four years no longer bore fruit. To market our product we had to organize ourselves. We had urgent needs to build. In 1968, a runway was built. In 1969, another, longer runway was built. We made a warehouse where the coffee*

was gathered, and they took it by airplanes to Tuxtepec. That was the way we worked the coffee. Now we want to rescue the coffee production "(Interview, May 18, 2017).

They formed a cooperative in 1982, but, due to a problem with the coordinator of coffee producers of Oaxaca, the name was changed to Luz Chinanteca. In the 1970s, there were considerable areas for cultivation available, but, with the fall in coffee prices, many producers became discouraged, destroying their plants and planting other types of crop and they were losing productivity. Everyone registered only 3 or 4 hectares of plantations. They know because the coffee Census took data at this time. The fall in international coffee prices was mainly due to an International Coffee Organization resolution in 1989 which led to the elimination of the system that kept the INMECAFE quotas, leaving it open to market forces which resulted in the volatility of international prices. In addition, the significant growth of Vietnam's coffee production contributed to a crisis, with Vietnam occupying the first place in the world production of robust coffee. The new rules of the market led to an international restructuring of coffee producers leaving in a good position only those who succeeded in introducing their production in niche markets, such as specialty coffee or fair trade (CEDRSSA, 2014).

The fall in prices of coffee was a major shock to the community. Its only source of income had been reduced to coffee cultivation, since the planting of maize has always been at subsistence level. This is one of the main causes that led to a significant migration, as shown in table two. This situation forced the community to seek alternatives and to develop a series of actions that could be complemented mainly with conservation activities that they had been developing for some time, as will be seen later. Currently, through the National Commission for the Development of Indigenous Peoples (CDI), a portion of the coffee producers have agreed to receive support in the form of 500 young plants that will be sown in the months of June and July of the current year. They are organized in a cooperative consisting of one hundred partners who want to rescue the cultivation of coffee. In October of 2015 the Secretariat of Agriculture, Livestock, Rural Development and Fishing (SAGARPA) provided the cooperative with 550 plants.

Only in recent years did they learn that there is a difference between organic and inorganic coffee. Since the beginning, they have practically produced coffee organically. Even though INMECAFE provided them with fertilizers, they did not apply them because they considered that they were not necessary. According to the interviews, they have always had a vast variety of vegetation that allows them to control pests. What they currently do is have living barriers. Today all the producers have their certificate as organic producers. Last year there was only one ton of production. Up until May 2017, when the investigation was undertaken, they had already produced three and a half tons. They are currently affiliated to the Organic Coffee Growers Network of Oaxaca. The Network collects and exports coffee. The price they currently receive for their coffee varies according to the stock exchange. The kilo of parchment coffee is paid at 40 or 45 pesos, however, they recently negotiated with the network that they would pay 50 pesos per kilo. The network has technicians who advise them and make visits to the communities to supervise the plots and ensure that it is organic coffee. The most resistant plants are Creole. The coffee produced in the community is high altitude coffee.

4. The creation of the Natural Area of Voluntary Conservation and Payment for Environmental Services

Protected Natural Areas (ANP), which have been the main conservation instrument in Mexico, are created by presidential decree. Forest cover in Mexico covers an area of 71 million hectares. However, in 2006 only 15 million hectares were under ANP (Anta, 2007). Up until 2016 there only 176 areas (ANPs) were registered, covering 12.93% of the national territory. These include the Voluntary Conservation Areas (ACVs) which, as of 2008, were included in the ANP registry. The National Commission of Protected Natural Areas (CONANP) is in charge of its administration. This Commission was formed in 2000 as a decentralized body of the Ministry of Environment and Natural Resources (SEMARNAT) (CONANP, 2014).

The difficulty encountered in extending PNAs is that approximately 70% of the forests in Mexico belong to peasant and indigenous communities (CONAFOR, 2015). Voluntary biodiversity conservation initiatives have, however, emerged thanks to the modification of the General Law of Ecological Equilibrium in1996, which now permits indigenous peoples, public and private social organizations to promote Natural Protected Areas (ANPs) in their properties for the protection and conservation of biodiversity. Up to 2007 there were 90 Voluntary Conservation Areas in Oaxaca covering 265 thousand hectares. It is the State with the highest number of ACV (Anta, 2007). It is also one of the most ethnically and biologically diverse states. At the national level, there are 381 certified areas covering 409,443 hectares in which 11 ethnic groups participate.

In 2004, the community of Santa Cruz Tepetotutla, along with 5 other communities of the region, created the Committee of Natural Resources of Chinantla Alta (CORENCHI). In total, the six communities cover a territory of 34,692.39 hectares of which 77% is certified as ACV (Nieratka, *et al.*, 2015). Santa Cruz Tepetotutla has an ACV that coverss 78% of its territory. Since the 1990s, the community began to investigate what could be done to advance conservation. As shown in Table 3, their concern for forest care was evident from 1970 due to their gradual inclusion in their community statutes. In 1990, through contact via radio and with researchers who passed through the community, they realized that their forests could form a voluntary conservation area together with others of the region. According to an interview with one of the founders of the Conservation Area project:

> *"We have been making use sustainable resources for a long time. We obtain edible plants, medicines, fungi, wild fruits. We are directing people to make the most of the forest in a responsible way, but not from a non-participatory forest, but an active one. It has a price. We started this project for community security. We began to investigate what could be done to encourage or support our communities. Through the community process, we discovered that there were many programs which we could access via the activities we were already doing. In 1980, researchers and biologists visited us. They commented on the beauty of the place, and we reconsidered and said if it is beautiful, we should work to become consciously aware of it. What we aspire to is to be able to give employment to our young people. We say no to migration and, if someone has to go, it should not be because they have no other options here "(Interview, May 17, 2017).*

In this context, Santa Cruz Tepetotutla invited the communities of San Antonio del Barrio, San Pedro Tlatepusco, San Antonio Analco and Nopalera del Rosario to form a conservation community. When it was founded CORENCHI had a surface area of continuous vegetation of 26,770 ha in a good state of conservation. The agreement signed between these communities was that as trees, plants, mountain animals, water, and oxygen do not have territorial limits, to commit to their conservation and sustainable use. CORENCHI is a Civil Association represented by four delegates and one agrarian authority appointed by each agrarian authority of the communities that form it. Each of them are chosen by their respective Community Assemblies which in turn have the same organization as the community committees, which are composed of a president, a secretary and a treasurer (Mondragón, s / f). The positions last two years. It is important to mention that Santa Cruz Tepetotutla is a community of uses and customs in which activities assigned to citizens through the Assembly are generally unpaid.

The location of Santa Cruz Tepetotutla and the communities that make up CORENCHI is strategic, located in the foothills of the Sierra Norte de Oaxaca, the Sierra has temperate forests, humid jungles and mesophilic mountain forest. Two ethnic groups inhabit this area: the Zapotecos and the Chinantecos. Highlights are the high perennifolia forest, the mesophyll forest and the pine and oak forest. Chinantla has the largest area of mesophilic mountain forest in Mexico. Chinantla is also located in an area of great hydrological relevance, since it is one of the areas with the highest average annual rainfall and the watersheds of the Papaloapan basin (WWF, 2014).

5. Payment for Hydrological Environmental Services in 2004

The Payment for Environmental Hydrological Services (PSAH) was granted to CORENCHI in 2004 by the National Forestry Commission for an area that covered 16,054 hectares, to the amount of US$ 2,199,070, which was divided into ten annual payments. The population of the communities in 2004 was 2039 inhabitants so the division was the amount of US $ 0.21 per day for each person (Mondargon, s / f). Between 2005 and 2010, Santa Cruz Tepetotutla received US $ 579,540.23 for an area of 2,941.5 hectares. This community implemented a reinforcement of the community rules to sanction and to avoid corruption. The relevant decisions of the community are taken through the General Assembly of Comuneros, the highest community institution. Each of the five communities that received PSAH have the ability to individually decide the use of such income. From the research of Nieratka et al. (2015), regarding the relationship between PSAH social capital and poverty reduction, figure two shows the distribution of income. It is noteworthy that 72.5% is intended for the direct payment of members of the community. This distribution is necessary because the whole community participates in the conservation activities. All community members are considered providers of environmental services. There is a small percentage of 2.5% that is designated for scholarships. According to the interviews conducted, the majority of the population aspires that their children study at higher and university level. Sadly, the amount is not sufficient to meet the needs of the young people of the community.

The local instruments for conservation are primarily the community statutes, i.e. the rules governing the behaviour of members of the community. In second place is the territorial order. The water provided is intended for domestic, hydroelectric and industrial use, including paper, sugar, alcohol and beer. It benefits about 265,000 people, industry and a hydroelectric plant. However, the financing was only from the National Forestry Commission, which in reality implies that there is no market for such an environmental service. According to the regional study carried out by FAO (2014) the mechanism is based on the community conception of the environmental value of the forest, however, payment for environmental services is an economic instrument designed to be used in a market, in which the beneficiaries of environmental services pay the suppliers. In this case, the State has absorbed all the financing. It should be noted that the results in terms of improving socioeconomic conditions for communities through the use of this type of instrument are not favourable, despite the fact that the distribution of income is done in an equitable way. Nieratka *et al.*, (2015) show that through the PSAH the improvement of Santa Cruz Tepetotutla in terms of alleviating poverty is very little.

6. Ecotourism

The ecotourism committee considers that ecotourism is an economic activity that is compatible with conservation. The project started in 2006 with the aim of survival. The community considers that conservation is more important than the amount of money they could get by allowing activities that would destroy their forest. The initiative of the project is from the community, even though external participants have contributed to the financing. Ecotourism implies raising the awareness of people and recognizing that a lot of patience is needed to achieve the level of awareness that is required in these times. The community anticipates that the influx of tourists to its ecotourism centre named Model Station, will increase because little by little people will start to become aware of the relevance of such projects.

> *"We are peasants but we have a practical training in life. I have entered into the identification of scientific names of plants. The community was initially afraid of not being able to handle the project, but we took risks. We found programs to finance this project. On the tours, we can drink the water of our springs because we have a local order. We have a responsibility to the forests. When we talk about these forests, the people who do not know them think that the forest needs the hand of the peasant, or that the peasants are the worst predators. There is the contradiction. But we live in the forest. The community process and the process of life depend on our forests. We know that from our grandparents and we have to look after them for our grandchildren. "(Interview on May 19, 2017).*

One of the main concerns of the community is to offer economic alternatives for young people and thus reduce migration. In 2015, the community held a Biodiversity Fair to promote conservation and ecotourism, with the motto "Local actions with global benefit". In that year, there were only 28 visitors during the Fair. The Community House was built in order to have a space for workshops and for work with the families of the community; however, it is also used to host visitors when the Ecotourism Centre is not enough, as it has a capacity of between 35 to 40 people. It has never exceeded this capacity. Tourists have been national students, foreigners and researchers. Women and young people have been incorporated into the ecotourism project because the community is small and because it believes that their customs can be modified for the benefit of the community. All the activities that are practiced in the Ecotourism Centre can be considered as having no significant impact. The guides have been training informally. They have gained their knowledge principally through their interaction with the researchers who visit the community. The design of the ecotourism activities prevents tourists from putting at risk species of flora and fauna. They practice mainly a type of ecotourism directed at people with knowledge of biology and have acquired equipment, like camera traps to monitor the species which are mainly in danger of extinction.

7. Other productive projects

The planting of corn continues to be one of the main economic activities of the community. The slash and burn technique is used, although this technique has been questioned. The community is very careful with the controlled fires. It is for this reason that there are rules in the community statutes. Corn planting is one of its main means of survival, however, due to the fall in international coffee prices, the community realized that it could not depend on a single activity, which is why it has diversified its economic activities and ways to obtain basic food, such as backyard gardens. The backyard garden is a practice of grandparents which being recovered because it is intended to achieve food self-sufficiency. In a garden, there may be lettuce, sweet potatoes, tomato, banana, tepejilote, oregano, cilantro, etc. There is a practice of sharing with families that did not do produce much. The backyard gardens provide food and medicinal plants and have also been able to feed visitors to the Ecotourism Centre. There is a cooperative of producers of honey, which brings together four communities. In Santa Cruz Tepetotutla there are eleven families that are dedicated to apiculture. Previously honey was extracted the rustic way, but, with the arrival of the African bee, people stopped beekeeping.

After the fall in coffee prices, people returned to beekeeping to find a way to survive, but only in a limited way. In 2013, the four communities began to work together because they sought funding to resume the production of honey. In the first year they obtained 200 litres, the following year the amount increased to 700 litres and they are currently expecting to acquire 2 tons of honey. Honey is sold locally and also in the city of Oaxaca. They have not been able to make bigger commitments. Although the cooperative is open to integrate all the members of the communities, there are people who fear the bees and who will not participate. Despite being produced organically, it is still not certified as organic: the certification costs more money than the community currently has available. At the moment they are not pursuing this as they first want to be able to produce larger amounts. Locally a litre of honey is sold in the market for one hundred pesos. The training they have received from the National Commission for the Knowledge and Use of Biodiversity (CONABIO) has been very important for the management of apiaries and the increase in honey collection. The project they have with CONABIO includes marketing support.

Other complementary activities include the production of liana handicrafts; baskets, ornaments and souvenirs for visitors, most of whom are men. A family of the community had the initiative to begin breeding trout. They now have three ponds. In addition, there is a project to rescue the waist loom.

Conclusions

Community logic is expressed in the form of organization, the way in which decisions are made, their conception of what the forests mean to them. It is an expression of the structure of their thinking, which leads them to recognize the forest as something concrete in their lives that gives them sustenance but with meaning that goes beyond the mere existence of each plant, each tree, and each animal. As shown in the historical events of the community, the way of life has been based on non-predatory activities that have allowed them to have the forests in a good state of conservation today (Mondragon report (s/date) for FAO). At all times the search for a balance between the means of subsistence and the conservation of its forests, the survival of the community and the forest are from integrated community logic.

Community logic is also present in the construction of its institutions, specifically the General Assembly of Comuneros which is the expression of a form of government and decision-making governed by principles that respond to collective needs. This is where the community agrees the rules that will govern their life and the productive activities that they develop. It is there where decisions are made about the community heritage. It is where they analyse how to distribute the income obtained by the PSAH. It is where certain activities that could have a negative impact on the forest are reported, for example burning for sowing. It was where the entire community was informed about the alternatives that could be adopted for the conservation of their forests and how these alternatives would lead to the adoption of other economic activities for the community.

Resilience is presented throughout the narrative of historical events. The first aspect that Berkes considers for the analysis of this concept is the ability to learn to live with changes and uncertainty. As tables one and two demonstrate, resilience has been a constant in this community; from life under the cacicazgos, the confrontation with the epidemic and various diseases, to the loss of the only source of income. Their strategies had to go beyond the search for a cure, because they did not have any medical service. Their options were found in prevention. When they relate how their statutes have been modified, they demonstrate an evolution in the way in which they understand the circumstances that threaten them and how to deal with them. In the case of the productive aspects the community has always been exposed to uncertainty, derived from the fact that their activities were based on temporary agriculture with maize as their main subsistence product.

With regard to the second aspect of resilience (Figure 1), which refers to the promotion of various types of ecological, social and political options for reducing risk, the community organization has allowed the implementation of new rules in community statutes. It has allowed a clarity regarding the relevance of their forests not only for themselves but also for the rest of society, and conservation as a life option was placed in the community as the foundation of their socio-economic system. It is here that one can analyse the intricacies of social, economic and ecological systems. Community history and decision-making are clear examples of the constant search for options to reduce the risks of living from an environment that offers basic living conditions.

The third aspect of resilience is the increase in knowledge for problem-solving (Figure 1). This point is interesting, as the linking of the community with researchers and external institutions has enabled them to identify aspects of their own community and their productive techniques that can be improved. In this respect the community is very open and have learned to manage government support, and are very receptive to what they can learn from tourists and they are also aware of what they can teach them. During the communication in the tours that occur in ecotourism, the guides work conscientiously to increase the ecological awareness of the visitor. They even mention that those who have visited the community the most have been researchers and university students and they have been able to establish a very interesting relationship of knowledge exchange.

The last aspect of resilience analysis is the creation of opportunities for self-organization that strengthen local institutions. From the experience of the community of Santa Cruz Tepetotutla, this aspect of resilience appears to be the most appropriate from which to initiate the analysis. Although the aspects of resilience seem to be consecutive, nevertheless, a deeper analysis of each one leads us to identify the presence of every aspect within the others. The strengthening of opportunities for self-organization is an aspect that has been strengthened in the community. The community has historically organized and provided social cohesion that, ultimately, has allowed them to survive in the way. Subsistence ethics as identified by Scott (1973) is the capacity for self-organization to use the resources that allow peasant communities to survive. Their living conditions are linked to opportunities that the community as a whole can adopt.

Theoretical analysis seeks an integration of knowledge of the areas of social sciences with aspects that have to do with the adaptation to the ecological environment. The formulation of community logic from the aspects that Lévi-Strauss identifies as abstract and concrete thinking in indigenous communities, allows a deeper exploration of the reasons that lead to resilience, and to an understanding of how it is more feasible that these communities, having clearly identified the intricacies of their social, economic and ecological systems, can carry out actions for their survival that guarantee ecological conservation.

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Servicios ambientales y percepción social: Delta del río Usumacinta, sureste de México

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Introducción

La cuenca del río Usumacinta es considerada uno de los territorios con la más alta diversidad biológica y cultural. A pesar de que actualmente hay un reconocimiento de la importancia ecológica y cultural de esta cuenca, los ecosistemas que la constituyen están bajo una fuerte presión antropogénica. Lo anterior ha dado como resultado la destrucción o modificación sustancial de los ecosistemas, lo cual, debilita el funcionamiento y por consecuencia amenaza la capacidad de los ecosistemas para suministrar servicios ambientales a las poblaciones de la región.

En parte, como respuesta a esta situación, es necesario que la biodiversidad y sus servicios ambientales asociados no sean tratados como bienes inagotables, y su verdadero valor para la sociedad sean tomados en cuenta de una manera adecuada. En este sentido, el objetivo de esta investigación fue por un lado describir de forma cualitativa y participativa los servicios ambientales que constituyen la parte baja de la cuenca; y por el otro, analizar espacialmente los ecosistemas y conjuntamente con la aplicación del método de transferencia de valores, estimar valores de referencias de los servicios ambientales que de ellos se derivan. Los resultados indican que las poblaciones rurales que habitan en esta zona dependen fuertemente de los servicios ambientales de aprovisionamiento para su subsistencia y que las inundaciones destacan como una de las amenazas más importantes. Se determinó además que los humedales de la zona aportan un valor económico que asciende a más de 13,000 millones de dólares anuales.

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El concepto de servicio ambiental empieza a gestarse en las décadas de 1960 y 1970, a raíz de la denuncia de los efectos negativos de la contaminación, la deforestación de bosques, tropicales particularmente, la reducción de la capa de ozono, el colapso de algunas de las más importantes pesquerías de especies pelágicas y el cambio en el clima (Carson 1962; Saville y Bayley 1980; Farman *et al.,* 1985). Este concepto surge como esquema para estructurar y sintetizar conocimiento biofísico en términos de bienestar humano. En la última década, desde la publicación de la *Evaluación de los Ecosistemas del Milenio* (MEA, 2005), el número de publicaciones con respecto al estudio de los servicios ambientales ha aumentado de manera significativa convirtiéndose en un área importante de investigación (Fisher *et al.,* 2009). Tener conocimiento de los ecosistemas desde la perspectiva de los seres humanos como beneficiarios tiene un enorme potencial para la protección de los ecosistemas y los servicios que proporcionan (Bass 2006).

Debido a que las cuencas conectan e integran ecosistemas tanto terrestres como de agua dulce y costeros, ellas proporcionan una variedad de valiosos servicios ambientales, entre los que destacan, purificación de agua dulce, la provisión de hábitat para la pesca y la diversidad biológica, el secuestro de carbono que ayuda a mitigar el cambio climático, y el apoyo para la recreación y el turismo, entre otros (Postel y Barton 2005). En gran parte del mundo, la conversión y modificación de los ecosistemas que constituyen las cuencas hidrográficas ha ido en aumento. Un análisis global de 106 cuencas primarias encontró que en casi un tercio de ellas, más de la mitad de la superficie de tierra se ha convertido en zonas agrícolas o de uso urbano-industrial (Revenga *et al.,* 1998). Lo anterior ha provocado una reducción en los beneficios netos que la sociedad obtiene de las cuencas, además de consecuencias ambientales a nivel local, regional y global.

En parte, como respuesta a esta situación, es necesario que la biodiversidad y sus servicios ambientales asociados no sean tratados como bienes inagotables, y su verdadero valor para la sociedad así como los costos de su pérdida o degradación, sean tomados en cuenta de una manera adecuada (Costanza *et al.,* 1997; Blignaut y Moolman 2006; Carpenter *et al.,* 2006; TEEB in Policy 2011).

La importancia que tienen los ecosistemas con respecto a la sociedad humana puede verse desde muchas dimensiones: ecológicas, socioculturales y económicas. Sin embargo, expresar el valor de los servicios ambientales en unidades monetarias es una herramienta importante para dar a conocer y transmitir la importancia de los ecosistemas y la biodiversidad a los tomadores de decisiones. La información con respecto a los valores monetarios permite un uso más eficiente de los recursos a través de la identificación de áreas en donde la protección o restauración es económicamente más viable (Crossman y Bryan 2009; Crossman *et al.,* 2011).

De manera complementaria al análisis económico, en los últimos años se ha introducido el análisis espacial como herramienta para representar el valor económico de los servicios ambientales. Información basada en mapas ha sido utilizada para analizar la distribución espacial de múltiples servicios ambientales a escalas locales (Naidoo y Adamowicz 2006; Nelson *et al.,* 2008; Lautenbach *et al.,* 2011; Lavorel y Grigulis 2012), regionales (Chan *et al.,* 2006; Metzger *et al.,* 2006) y globales (Naidoo *et al.,* 2008; Luck *et al.,* 2009). De hecho la naturaleza variable en el espacio de la generación de los servicios ambientales y los flujos de valor hace que la representación en mapas para efectos de planificación esté siendo más importante y se considere una de las principales herramientas para la toma de decisiones en cuanto a la planeación ambiental.

En México, la cuenca del río Usumacinta es considerada uno de los territorios con la más alta diversidad biológica y cultural (Toledo 2003). Las funciones ecológicas que se llevan a cabo en esta cuenca, se mantienen a través de una diversidad de ecosistemas, entre los que destacan, ríos, sistemas lagunares, extensos bosques de manglar, masas forestales selváticas y boscosas, y recursos marinos de la plataforma continental. Estos ecosistemas son igualmente relevantes a nivel social, ya que, proporcionan servicios ambientales a las comunidades de esta región, muchos de los cuales son fundamentales para el bienestar de las poblaciones que habitan la cuenca.

A pesar de que actualmente hay un reconocimiento de la importancia ecológica y cultural de la cuenca del río Usumacinta, los ecosistemas que la constituyen están bajo una fuerte presión antropogénica, resultado de las actividades humanas que conllevan cambios en el uso del suelo, como la conversión de humedales a tierras de cultivo, ganadería y zonas urbanas; la deforestación de los bosques; y la utilización de los recursos del subsuelo como los yacimientos de petróleo. Lo anterior ha dado como resultado la destrucción o modificación sustancial de los ecosistemas y una pérdida de biodiversidad, la cual, debilita el funcionamiento y por consecuencia amenaza la capacidad de los ecosistemas para suministrar servicios ambientales a las poblaciones de la región.

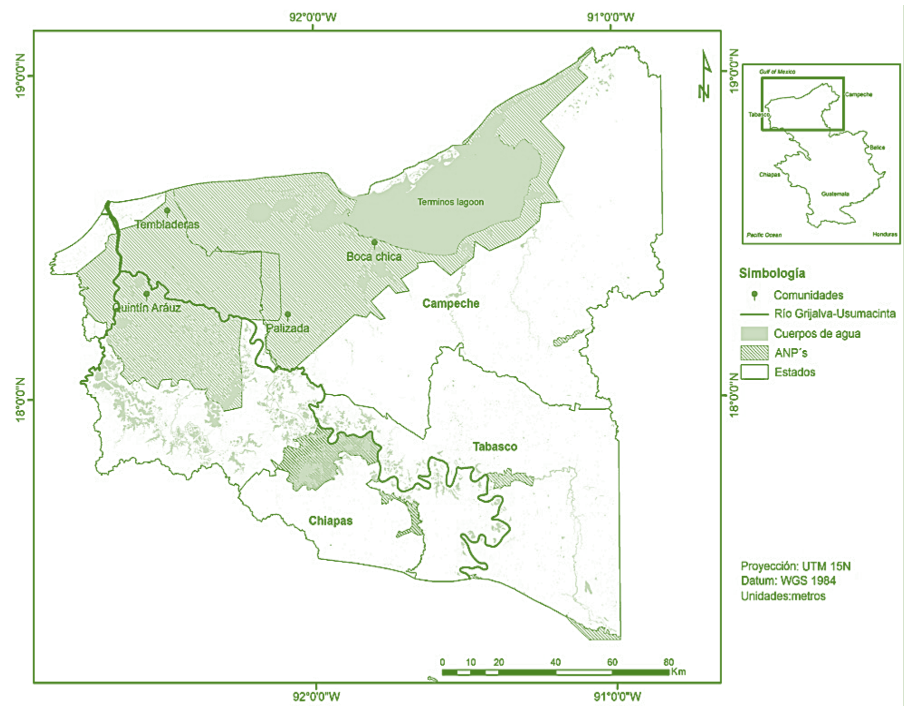
Como una primera aproximación en la evaluación de los servicios ambientales proporcionados por esta gran cuenca, el objetivo de este trabajo fue por un lado describir de forma cualitativa y participativa los servicios ambientales que constituyen la parte baja de la cuenca; y por el otro, tomando ventaja del uso de la percepción remota y los sistemas de información geográfica (SIG), analizar espacialmente los ecosistemas y conjuntamente con la aplicación del método de transferencia de valores, estimar valores de referencias de los servicios ambientales que de ellos se derivan.

1. Área de estudio

El área de estudio tiene una superficie de aproximadamente 2,500,000 ha y está localizada entre los estados de Campeche, Tabasco y Chiapas, en el sureste de México. El Delta es parte de la cuenca del Usumacinta que comprende un río principal, el Usumacinta, un tributario, el río Grijalva y la Laguna de Términos (Figura 1). En los últimos 50 años, se han construido cuatro grandes presas a lo largo del río Grijalva que han causado un impacto significativo en el paisaje circundante, la fragmentación de la cuenca y cambios en la regulación del flujo de agua natural (Wilkerson 1986; Muñoz-Salina y Castillo 2015). Los principales factores físicos que afectan los humedales del Delta del Usumacinta son: a) precipitación, b) pulsos de inundación, y c) la planicie costera de Tabasco y Campeche. Los pulsos de agua dulce con altos sedimentos suspendidos, nutrientes inorgánicos y materiales orgánicos generan extensos humedales como la Laguna de Términos y los Pantanos de Centla (el humedal costero más grande de las tierras bajas de Mesoamérica) (Yañez-Arancibia *et al.,* 2009).

Hay 14 municipios en la región, pero a excepción del de Carmen y Centro, todas estas zonas tienen un alto grado de marginación. Ciudad del Carmen es la ciudad más importante, con una población de 221,000 habitantes e infraestructura para apoyar la industria petrolera y otras actividades económicas (turismo, pesca, refugio) (INEGI 2010). El área de estudio se caracteriza principalmente por un clima cálido y húmedo y tiene una precipitación de entre 1,200 y 2,500 mm durante el verano con una temperatura promedio anual de 26-27 °C (INEGI 2008).

FIGURA 1. ÁREA DE ESTUDIO. DELTA DEL RÍO USUMACINTA, SUR DE MÉXICO Y UBICACIÓN DE LAS COMUNIDADES ENTREVISTADAS



2. Métodos

2.1 Clasificación de los humedales

Los datos utilizados para identificar la distribución de los tipos de humedales y usos de suelo presentes en el Delta, se obtuvieron a través de imágenes de satélite del sensor Landsat 8 OLI adquiridas en mayo del 2013. Estas imágenes disponen de lecturas de once canales o bandas, situadas en distintas zonas del espectro electromagnético y tienen una resolución de 30 metros. Los programas Idrisi Selva y ArcGis 10 se utilizaron para la clasificación de las imágenes, el desarrollo del SIG y para producir el mapa de los tipos de cobertura.

La clasificación estuvo basada en el método propuesto por Paniagua et al. (2011), en el cual, se presenta una metodología de clasificación hibrida de coberturas, es decir, se integra una clasificación digital de imágenes de satélite con fotointerpretación. Previo a la clasificación se llevó a cabo la corrección atmosférica de las imágenes, utilizando el módulo AtmosC del programa Idrisi Selva. Una vez corregidas las imágenes, se seleccionaron campos de entrenamiento mediante segmentación de imágenes. En la cual, no solo se toma el valor espectral del pixel individual, sino que se compara valores de pixeles vecinos, para definir estructuras de forma, tono, etc. El proceso de segmentación divide la imagen en polígonos homogéneos tanto espectral como espacialmente. A partir de ahí se seleccionaron los campos de entrenamiento para cada tipo de cobertura y se etiquetaron con el nombre de cada clase.

La clasificación digital se realizó utilizando el método supervisado, el cual utilizó los campos de entrenamiento previamente digitalizados con el fin de extraer una firma espectral de cada una de las clases seleccionadas (Campbell 1996). Estas firmas nos sirvieron de patrón para que a través de un algoritmo de clasificación se clasificara el resto de los pixeles de la imagen. El algoritmo de clasificación utilizado fue el de Máxima Verosimilitud disponible en el programa Idrisi Selva, el cual separa las clases con base en una función de densidad de probabilidad, asociada a la firma correspondiente a un campo de entrenamiento en particular. Los pixeles se asignan a la clase donde la probabilidad de pertenencia es mayor, dada la información específica de las firmas consideradas. Este método no solo considera los valores promedio, sino también la variabilidad de los valores de brillantez en cada clase (Campbell 1996).

La validación se evaluó a través de matrices de error, las cuales, permiten valorar la exactitud individual de cada clase y la exactitud total de la clasificación. La matriz se construyó para todos los pixeles del mapa temático por la tabulación cruzada (crosstab) de éste con datos de referencia o prueba. Las coincidencias entre los dos conjuntos de datos (diagonal principal) se utilizaron para estimar la exactitud total (%). El índice de Kappa (K') se utilizó como medida de correspondencia entre la clasificación y los datos de referencia a nivel del paisaje (Congalton y Green 1999).

2.2 Servicios ambientales y meta-análisis desde la literatura de valoración

Aunque existen diferentes enfoques para la clasificación de los servicios ambientales (Camacho-Valdez y Ruiz-Luna 2012), en esta investigación se siguió el marco ampliamente aceptado propuesto por la Evaluación de Ecosistemas del Milenio (MEA 2005). Esta evaluación clasifica los servicios ambientales en servicios de aprovisionamiento, regulación, soporte y servicios culturales.

Los servicios ambientales derivados de cada tipo de humedal se identificaron sobre la base de referencias de estudios empíricos, principalmente a partir de las bases de datos proporcionadas por Ghermandi *et al.*, (2010) y Van der Ploeg *et al.*, (2010). Este conjunto de datos se utilizó también como punto de partida para llevar a cabo el meta-análisis y con esto validar y aplicar el método de transferencia de valores. Para seleccionar los estudios de las bases de datos originales e ir generando nuestra base de datos para los humedales presentes en el Delta del Usumacinta se desarrollaron distintos criterios. El primero de estos criterios fue seleccionar únicamente los humedales que estuvieran presentes en nuestro caso de estudio. El segundo, la literatura incluida en el análisis consistió en publicaciones, libros y reportes. Adicionalmente, se incluyeron en la base de datos únicamente estudios primarios; estudios en donde se utilizara el método de transferencia de valores no fueron considerados.

Se generó una base de datos en donde se incluyó el servicio ambiental y tipo de ecosistema valorado, método de valoración, año de estudio, ubicación geográfica y la estimación del valor por hectárea, entre otros atributos. Para permitir comparaciones entre los valores de los humedales que han sido calculados en diferentes años y expresados en diferentes monedas y medidas los datos se estandarizaron a una medida y moneda común (2007$/ha/año).

2.3 Valoración de los servicios ambientales

Se aplicó el método de transferencia de valores con el objetivo de predecir los valores de los servicios ambientales asociados a cada tipo de humedales previamente definidos en la tipología. La transferencia de valores implica simplemente transferir el valor (es) estimado (s) en uno o más estudios primarios (bases de datos) al sitio de interés. Como se recomienda en la literatura, todos los resultados presentados representan la media estadística derivada de las estimaciones individuales del valor de los servicios ambientales de la base de datos generada, expresados en dólares por hectárea por año (Eade y Moran 1996; Costanza et al. 1997; Wilson et al. 2004). La utilidad de este método es que puede aplicarse en una escala que es inviable para un estudio primario en términos de valorar un gran número de sitios en diferentes regiones, como es el caso del Delta del Usumacinta.

2.3.1 Valor económico total

Una vez que el mapa temático de los humedales se diseñó, a cada tipo de humedal se le asignó un valor derivado del método de transferencia de valores, permitiendo que los valores de los servicios ambientales fueran representados por tipo de servicio y ecosistema.

El valor total de los servicios ambientales representados para cada tipo de cobertura se obtuvo multiplicando el valor estimado del área (ha) de cada clase de humedal por el coeficiente de valor ($/ha/año) para cada servicio ambiental asociado a cada entidad con la siguiente formula:

$$\mathbf{V}\ (\mathbf{ES_i}\ ) = \sum_{k=1}^{n} \mathbf{A}\ (\mathbf{LU_i}) \times \mathbf{V}\ (\mathbf{ES}_{k\mathbf{i}})$$

Donde:

$\mathbf{A}\ (\mathbf{LU_i})$ = área del tipo de cobertura (i)

$\mathbf{V}\ (\mathbf{ES}_{k\mathbf{i}})$ = valor anual por unidad de área para tipos de servicios ambientales (k) generado por tipo de cobertura o entidad (i)

2.4 Percepción social de los servicios ambientales

Con el fin de complementar los valores de los servicios ambientales estimados a través del método de transferencia de valor, se implementó un enfoque participativo cualitativo en la investigación. El objetivo de esta implementación fue comparar los resultados obtenidos con ambos métodos, buscando similitudes y diferencias. Para lograr esto, recopilamos datos relevantes sobre los servicios ambientales, los ingresos, las amenazas y los medios de vida locales en 4 comunidades distribuidas a lo largo de los humedales presentes en el Delta del Usumacinta (Figura 1). Las principales herramientas de recopilación de datos comprendían un formato de entrevistas semiestructuradas.

Diez entrevistas semiestructuradas en cada una de las cuatro comunidades seleccionadas se llevaron a cabo entre octubre de 2014 y marzo de 2015. Se diseñaron siguiendo trayectorias temáticas que se cubrieron durante el curso de la entrevista, en lugar de una secuencia de comandos de preguntas estandarizadas. De esta forma, las entrevistas semiestructuradas nos permitieron una comunicación enfocada, conversacional y bidireccional (Meli *et al.*, 2015). La selección de las comunidades se basó en los siguientes criterios: 1) ubicación, 2) tamaño de la población, 3) tipo de asentamiento, 4) antigüedad, 5) nivel de transformación del medio ambiente, 6) actividades económicas, 7) etnia, 8) nivel de marginación (nivel de educación) y 9) seguridad de los investigadores. En la aplicación de las entrevistas, tuvimos cuidado de tener una buena representación de las edades, el género, los niveles educativos y los sectores sociales. Las 40 entrevistas fueron grabadas digitalmente y transcritas.

2.5 Análisis espacial

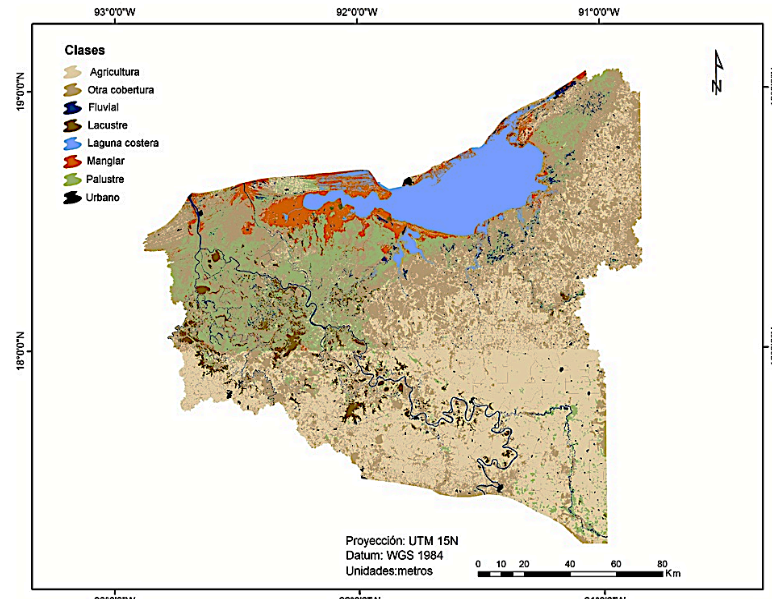
Las estimaciones de valor se representaron espacialmente en el Delta del Usumacinta mostrando el flujo anual de los servicios ambientales proporcionados por cada tipo de humedal. Los análisis y los mapas se generaron con el programa ArcGis 10, utilizando los mapas temáticos previamente diseñados.

3. Resultados

3.1 Clasificación de los ecosistemas

El proceso de clasificación para las escenas Landsat se llevó a cabo en un polígono con un área de aproximadamente 2,590,699 ha. Dicho proceso dio lugar a ocho clases informacionales que corresponden a: áreas urbanas, agricultura, cinco clases de humedales (lagunas costera, manglar, fluvial, palustre y lacustre) y otras coberturas (Figura 2). La estructura espacial de los tipos de coberturas y usos de suelo fue aceptada después de un proceso de validación basado en puntos de referencia, alcanzando una exactitud global de 86 % y un índice de *K'* de 0.85, lo cual, demuestra estadísticamente que la clasificación obtenida es mejor que una producida al azar.

FIGURA 2. CLASIFICACIÓN DE LOS USOS DE SUELO Y HUMEDALES EN EL DELTA DEL USUMACINTA A TRAVÉS DE IMÁGENES LANDSAT TM DEL 2013



De los humedales, los palustres fueron los mejor representados, cubriendo el 12% de la superficie total del área de estudio, mientras que en usos de suelo, fue la agricultura con 1,018,186 ha (39%). Después de los sistemas palustres, las lagunas costeras fueron los humedales más importantes en términos de cobertura (228,201 ha), representando el 9% de la superficie total. Los manglares, sistemas lacustres y sistemas fluviales presentaron menores superficies (Tabla 1).

TABLA 1. CLASES DE HUMEDALES Y USOS DE SUELO EN EL DELTA DELUSUMACINTA (IMÁGENES LANDSAT Y DIGITALIZACIÓN DE DATOS AUXILIARES)

ID	Clase	Descripción	Área	
			ha	%
1	Lagunas costeras	Humedales estuarinos submareales	228,201	9
2	Manglar	Humedales estuarinos intermareales conformados por la asociación de especies de mangle	108,600	4
3	Fluvial	Humedales continentales fluviales permanentes y estacionales: ríos y canales	54,178	2
4	Palustre	Humedales continentales palustres: pantano, tular, popal, llanura inundada	320,285	12
5	Lacustre	Humedales continentales lacustres permanentes y estacionales: lago, charca, cuerpo de agua	62,442	2
6	Agrícultura	Coberturas inducidas: agrícola, pecuario y pastizal	1,018,186	39
7	Urbano	Áreas urbanas: poblados, ciudades, etc.	9,471	1
8	Otras coberturas	Vegetación natural: bosque tropical, vegetación secundaria, caminos, suelos desnudos, etc.	789,336	30

3.2 Meta-análisis de la literatura de valoración

De las bases de datos originales, se obtuvieron 213 observaciones independientes de 103 estudios relacionados con la valoración económica de los servicios ambientales en humedales. La mayoría de los reportes de valoración global en humedales provienen de localidades de Asia (71), Norteamérica (48), Europa (42) y África (31), aunque los 5 continentes están representados, incluidos también reportes de Sudamérica (15) y Australia (6).

La mayoría de los ecosistemas en el conjunto de datos se relaciona con estudios en manglares (91), sistemas fluviales (69); mientras que en menor proporción en sistemas palustres (39), lacustres (29) y lagunas costeras (15). Al menos un valor de servicio ambiental se encontró para cada uno de los tipos de humedales, divididos estos siguiendo la clasificación de ecosistemas del mileno (MEA 2005) con cuatro categorías: aprovisionamiento, regulación, soporte y culturales (Tabla 3). De estos, los más estudiados en la literatura son los servicios de aprovisionamiento (135), como el soporte de pesquerías y cosecha de materiales naturales. En los servicios de regulación destaca el de protección contra inundaciones y tormentas (30) y en los de soporte y culturales, biodiversidad y actividades recreacionales (20).

TABLA 3. SERVICIOS AMBIENTALES Y NÚMERO DE OBSERVACIONES POR CADA TIPO DE COBERTURA

	Laguna costera	Manglar	Fluvial	Palustre	Lacustre	Total SE
Servicios de aprovisionamiento	7	72	29	19	8	135
Soporte de pesquería	3	30	11	9	4	57
Abastecimiento de agua	1	1	8	6	2	18
Cosecha de materiales naturales	3	23	9	2	2	39
Combustible		18	1	1		20
Recurso ornamental				1		1
Servicios de regulación	3	10	22	11	1	47
Control del clima		1				1
Protección contra inundaciones y tormentas	3	9	14	3	1	30
Mejoramiento de la calidad del agua			8	8		16
Servicios de soporte	0	5	10	4	2	21
Patrimonio genético				1		1
Biodiversidad		5	10	3	2	20
Servicios culturales	5	4	8	5	18	40
Paisaje y vista escénica	1		1		7	9
Actividades recreacionales	1	3	5	4	7	20
Pesca y caza recreacional	3	1	2	1	4	11
Total	15	91	69	39	29	243

3.3. Valoración de los servicios ambientales en el Delta del Usumacinta

Después de realizar el análisis de los datos, se aplicó el método de transferencia de valores para predecir los valores de los servicios ambientales asociados a cada tipo de humedal en la zona de estudio (Tabla 4). Los resultados muestran que el sistema fluvial es la cobertura con el valor promedio anual más alto con $56,122 dólares por hectárea por año. Este valor se debe a la contribución del servicio ambiental de protección contra inundaciones y tormentas. El manglar, el sistema palustre y lacustre también contribuyen significativamente al análisis de valoración con un promedio de $12,470, $24,035 y $8,533 dólares por hectárea por año, respectivamente. Las lagunas costeras son los humedales con el menor valor promedio con $4,755 dólares por hectárea por año.

Los valores totales de los servicios ambientales revelan una considerable variabilidad (Tabla 4). Protección contra inundaciones y tormentas es el servicio ambiental con el valor más alto ($ 42,436 dólares por hectárea por año), seguido del de actividades recreacionales y biodiversidad ($15,880 y $14,156 dólares por hectárea por año, respectivamente). En general, los servicios de regulación y los culturales son los más valorados en la base de datos adaptada.

TABLA 4. VALOR ANUAL (2007$/HA/AÑO) DE LOS SERVICIOS AMBIENTALES POR CADA TIPO DE COBERTURA

	Manglar	Laguna costera	Fluvial	Palustre	Lacustre	Valor/ SE
Servicios de aprovisionamiento	3,972	790	7,464	5,346	899	18,471
Soporte de pesquería	2,826	326	5,187	637	868	9,844
Abastecimiento de agua	683	3	1,382	1,217	24	3,309
Cosecha de materiales naturales	250	461	715	3,353	8	4,787
Combustible	212		180	26		418
Recurso ornamental				114		114
Servicios de regulación	2,225	130	39,669	6,247	23	48,294
Control del clima	7					7
Protección contra inundaciones y tormentas	2,218	130	37,694	2,371	23	42,436
Mejoramiento de la calidad del agua			1,975	3,876		5,851
Servicios de soporte	5,773	0	3,837	208	4,369	14,187
Patrimonio genético				31		31
Biodiversidad	5,773		3,837	177	4,369	14,156
Servicios culturales	501	3,835	5,152	12,235	3,241	24,964
Paisaje y vista escénica		460	3,291		1,295	5,046
Actividades recreacionales	472	151	1,202	12,198	1,857	15,880
Pesca y caza recreacional	28	3,224	658	37	89	4,036
Valor anual	12,470	4,755	56,122	24,035	8,533	105,916

El flujo anual del valor de los servicios ambientales por cada tipo de humedal, derivado de cada valor del servicio ambiental por el área del tipo de cobertura correspondiente (Tabla 5), nos da un total de más de $13,000 millones de dólares por año. De todas las coberturas incluidas en el análisis, el sistema palustre es el que aporta el mayor flujo anual ($7,698 millones de dólares por año), debido a su alta representación en términos de cobertura con respecto al área total de la zona de estudio (13%) y a su valor significativamente alto ($24,035 dólares por hectárea por año). Los sistemas estuarinos (lagunas costeras y manglar) junto con el fluvial tienen una aportación importante al valor económico total con alrededor de $2,300 millones de dólares por año, mientras que el sistema lacustre, es la clase que menor aportación tiene al valor total ($532 millones de dólares por año).

TABLA 5. FLUJO ANUAL (2007$/HA/AÑO) DE LOS SERVICIOS AMBIENTALES POR CADA TIPO DE COBERTURA

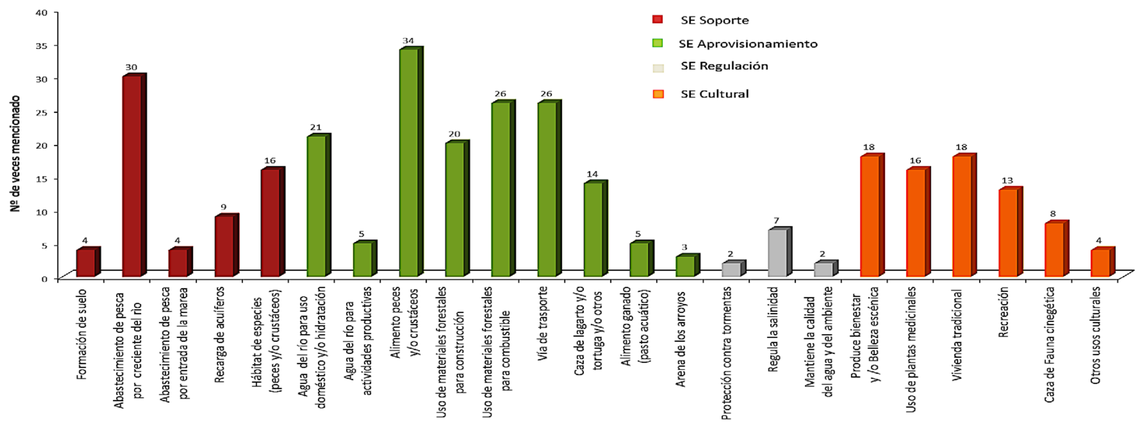
Clase	Valor anual de los SE (2007$/ha/año)	Área (ha)	Flujo anual (2007$/año)
Laguna costera	4,755	228,201	1,085,097,847
Manglar	12,470	108,600	1,354,245,492
Fluvial	56,122	54,178	3,040,568,175
Palustre	24,035	320,285	7,698,055,263
Lacustre	8,533	62,442	532,818,439
Total		773,707	13,710,785,216

3.4 Importancia de los servicios ambientales para los modos de vida comunitarios

El análisis de las entrevistas semiestructuradas nos permitió identificar la dependencia de la población local respecto a los humedales a través de la provisión de servicios ambientales. Todos los encuestados eran adultos (> 18 años) cuya edad y antigüedad promedio en la comunidad fueron 52 (rango entre 28 y 82 años) y 32 años, respectivamente; El 57.5% eran hombres y el 42.5% mujeres.

La figura 3 muestra la frecuencia de aparición de los servicios ambientales a nivel de toda la zona de estudio (4 comunidades, 40 entrevistas). En esta figura observamos que 15 servicios ambientales son importantes para las personas locales. Entre estos servicios ambientales, el mayor número de servicios mencionados en las entrevistas son los correspondientes a aprovisionamiento (39%), seguidos de los culturales (26%) y finalmente los servicios de regulación (13%). La evaluación de los servicios de aprovisionamiento muestra que los humedales actuales proporcionan diversos servicios ambientales para la población local, destacando los de alimento (85%), el apoyo a la pesca comercial (80%) y la leña (65%). Otros servicios frecuentemente identificados fueron el suministro de agua (52.5%), recolección de materiales naturales (50%), servicios y estética (45%), recursos medicinales (40%) y actividades recreativas (32.5%). El control de inundaciones y el amortiguamiento de tormentas fue el servicio menos identificado por los encuestados (5%).

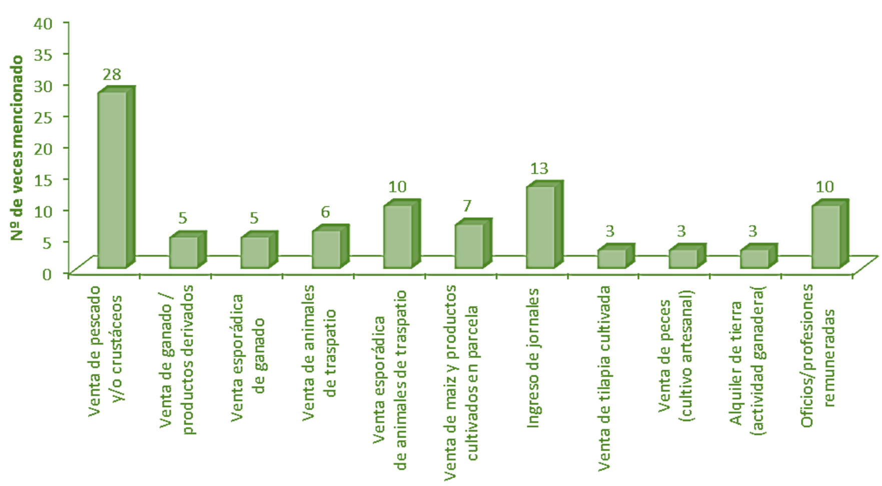
FIGURA 3. FRECUENCIA DE APARICIÓN DE LOS SERVICIOS AMBIENTALES EN LA ZONA DE ESTUDIO



Fuente: 40 entrevistas en 4 comunidades.

La mayoría de los encuestados combina dos o tres actividades para obtener ingresos, siendo la pesca y el trabajo temporal (por ejemplo, pago temporal para la pesca, el ganado o la albañilería) las principales actividades económicas identificadas en las cuatro comunidades incluidas en el análisis (Figura 4).

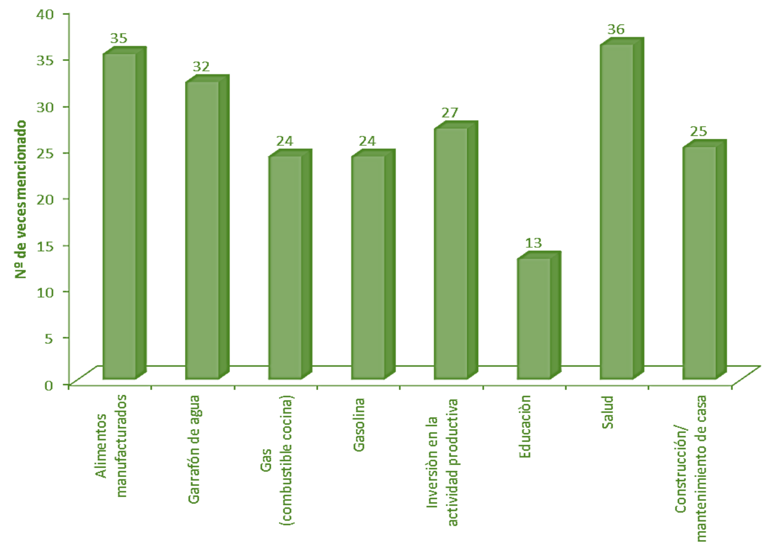
FIGURA 4. FRECUENCIA DE APARICIÓN DEL CAPITAL ECONÓMICO EN LA ZONA DE ESTUDIO



Fuente: 40 entrevistas en 4 comunidades.

En la figura 5, observamos que la mayor parte del ingreso se gasta en salud privada (92%), seguido de la compra de alimentos manufacturados (89%), garrafón de agua (82%), inversión en la actividad productiva (69%), construcción o mantenimiento de la vivienda (64%), gas y gasolina (61%) y educación (34%). Los bienes externos que se mencionan ser adquiridos con mayor frecuencia y que suplen a los servicios ambientales son: compra de alimentos manufacturados (89%), garrafón de agua (82%) y gas (combustible para cocinar) (61%).

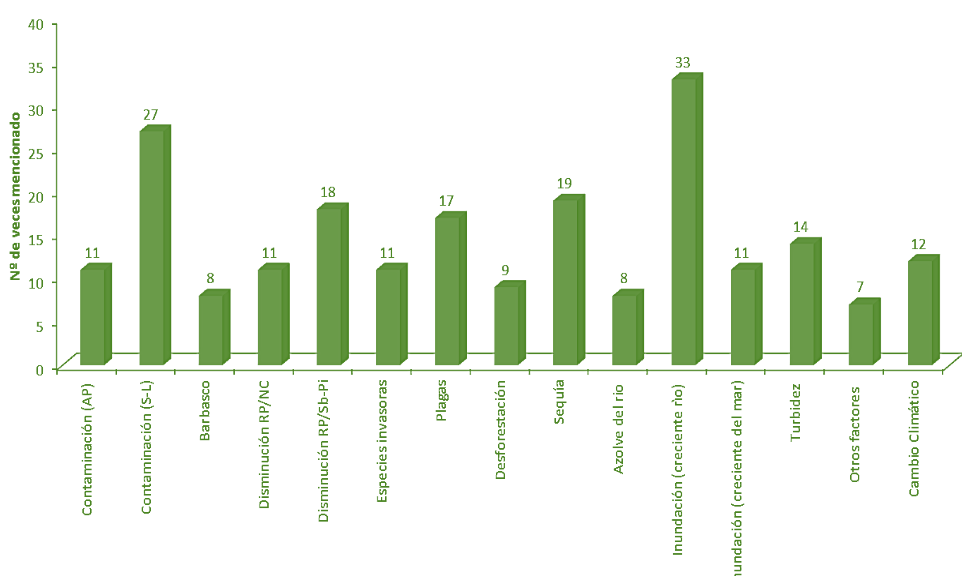
FIGURA 5. FRECUENCIA DE APARICIÓN DE BIENES EXTERNOS Y GASTOS DE INGRESOS EN LA ZONA DE ESTUDIO



Fuente: 40 entrevistas en 4 ciudades.

En la figura 6 se muestra la frecuencia de aparición de las amenazas a nivel de todas las comunidades. En general se aprecia que las amenazas con mayor frecuencia de aparición, fueron, según su orden de importancia: inundación (por creciente del río) (85%) y contaminación del agua por residuos sólidos-líquidos (69%). Otras amenazas recurrentes son: la sequía (disminución del caudal del río) (49%), disminución de la captura de recursos pesqueros por sobrepesca y pesca ilegal (46%) y la existencia de plagas (44%).

FIGURA 6. FRECUENCIA DE APARICIÓN DE LAS AMENAZAS A LAS ACTIVIDADES PRODUCTIVAS Y VIDA EN LA COMUNIDAD EN LA ZONA DE ESTUDIO

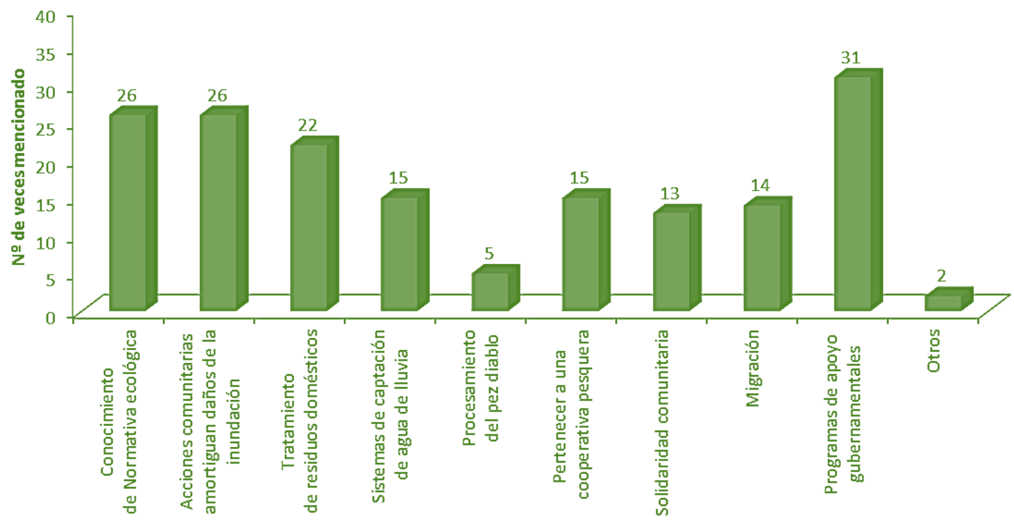


Fuente: 40 entrevistas en 4 ciudades

Contaminación (AP): Actividades petroleras como fuente de contaminación. Contaminación (S-L): Contaminación por residuos sólidos-líquidos. Disminución RP/NC: Disminución en la captura de recursos pesqueros (no mencionan causa específica). Disminución RP/Sb-Pi: Disminución en la captura de recursos pesqueros por sobrepesca o pesca ilegal.

Las medidas para paliar amenazas con mayor frecuencia de aparición, fueron, según su orden de importancia (Figura 7): programas de apoyo gubernamentales (que incluyen talleres de capacitación) (77.5%), seguidas del conocimiento de la normativa ecológica (65%), acciones comunitarias que amortiguan daños derivados de la inundación (65%) y tratamiento de residuos domésticos (55%).

FIGURA 7. FRECUENCIA DE APARICIÓN DE LAS MEDIDAS PARA PALIAR LAS AMENAZAS EN LA ZONA DE ESTUDIO



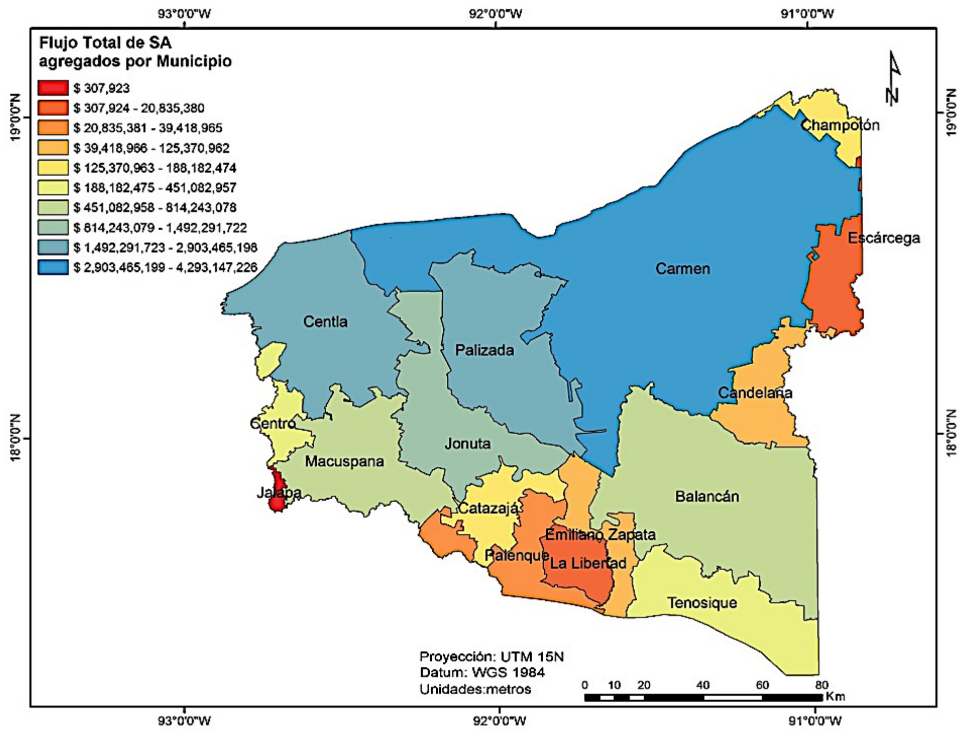
Fuente: 40 entrevistas en 4 ciudades

3.5 Análisis espacial del flujo de valor de los servicios ambientales

Una vez obtenido el flujo anual del valor de los servicios ambientales por cada tipo de cobertura, se diseñó un mapa ilustrando la distribución espacial de dichos flujos en el Delta del Usumacinta. Para fines de representación estos flujos fueron agregados cada municipio (Figura 3).

De manera general, este mapa muestra cierto grado de heterogeneidad en la distribución espacial de los valores, en donde los valores más altos se concentran en la zona más costera del área de estudio, principalmente en la zona de pantanos (sistemas palustres) y zonas lagunares (Laguna de Términos); las agregaciones con menor valor se ubican en la zona más interior, en donde ha habido un cambio de uso de suelo de los ecosistemas naturales a agricultura como una de las principales actividades en esta región. La parte más representativa a nivel espacial es la zona de pantanos o humedales palustres, los cuales además de ser importantes en términos superficies también los son en términos de suministro de servicios ambientales y de valor económico.

FIGURE 3. FLUJO TOTAL DE LOS SERVICIOS AMBIENTALES (2007$/AÑO) AGREGADOS PARA CADA MUNICIPIO EN EL ÁREA DE ESTUDIO



4 Discusión

4.1 Servicios ambientales y modos de vida

Tras este análisis general se concluye que las poblaciones rurales que habitan en esta zona dependen fuertemente de los servicios ambientales para su subsistencia, sobretodo de los de aprovisionamiento, resaltando el que proporciona la pesca y que se traduce en ingresos y alimento en todas las comunidades consultadas. Los ecosistemas del Delta del Usumacinta distan de encontrarse en un estado óptimo, entre las principales amenazas definidas, destacan las relacionadas con la alteración de la dinámica hidrológica del río (inundación por creciente o entrada de agua marina, sequía, azolve) y la contaminación. Por lo que cualquier intervención en la dinámica hidrológica que no considerara esta dependencia de las comunidades de los servicios ambientales y la falta de medidas actuales para paliar amenazas haría más vulnerable su frágil economía de subsistencia y por lo tanto sus modos de vida actuales.

Cualquier proyecto que se pretenda ejecutar cuenca arriba debe considerar que se sumará a los múltiples factores de estrés que hoy ya afectan a las comunidades del Delta. Las políticas de planeación de la cuenca, deben considerar las múltiples comunidades que aun dependen del flujo de los servicios ambientales del río y cuya economía se ha mermado en los últimos 40 años. De continuar el modelo de desarrollo sin considerar los efectos en las sociedades que habitan el Delta del Usumacinta, la alta e importante biodiversidad de la zona tenderá a reducirse y con esto desaparecerán los poblados de esta región, transformándose en cinturones periféricos del desarrollo urbano.

4.2 Valoración económica y análisis espacial

Gracias al rápido desarrollo de la tecnología relacionada con la percepción remota y los SIG, la disponibilidad de datos espaciales se ha incrementado significativamente durante la última década (Hou *et al.,* 2013). Si bien, hay debates respecto a la exactitud de los mapas de cobertura y uso de suelo derivados de la clasificación de imágenes satélite (Álvarez-Martínez *et al.,* 2010). En muchos casos, estas herramientas espaciales pueden ser la única forma económicamente viable para reunir información regular sobre las coberturas y usos de suelo (Verstraete *et al.,* 1996; Seidl y Moraes 2000). De hecho, la generación de mapas con una alta resolución es costosa, e incluso los mapas con mayor detalle suelen tener discrepancias a nivel local (Maes *et al.,* 2011). En este contexto, la presente investigación tomó ventaja del uso de imágenes de satélite Landsat y SIG para analizar la distribución de los humedales y usos de suelo en el Delta del Usumacinta y posteriormente con la información espacial generada, evaluar el flujo de los servicios ambientales en esta región.

El mapa de coberturas generado fue aceptado después de un proceso de validación, alcanzando una exactitud de 86% y un estimador del coeficiente de Kappa de 0.85, indicándonos una fuerte coincidencia entre los datos de referencia y el mapa temático generado. En donde, el tipo de humedal más representativo, en términos de superficie, fueron los palustres con una extensión de más de 590,000 ha, representando el 60% del total de los humedales presentes. Este dato coincide con lo encontrado en otros estudios realizados en la región (Barba-Macías *et al.,* 2014), quienes reportan que el humedal palustre o de pantano es el tipo de humedal más ampliamente distribuido en el territorio estudiado, ocupando una superficie de 508,471 ha. La presencia de este tipo de humedal se debe principalmente a las características geológicas e hidrológicas presentes en esta región, las cuales, originan áreas de acumulación aluvial de sedimentos terrígenos, favoreciendo la formación de áreas susceptibles de inundación (Cámara-Córdova 2000).

Conclusiones

Basándonos en las estimaciones de los servicios ambientales obtenidas a través del esquema de transferencia de valor directa y siendo validado este proceso con la aplicación de un meta-análisis, se determinó que el valor económico total en el Delta del Usumacinta asciende a más de 13,000 millones de dólares anuales, destacando la zona más costera con la concentración de valores más alto, en donde los humedales (fluviales y palustres) son algunos de los ecosistemas con mayor presencia. Este resultado tiene que ser tratado como una estimación conservadora debido que en la literatura revisada para llevar a cabo la transferencia de valores hay servicios ambientales de cierto tipo de coberturas que han sido más estudiados que otros. Por ejemplo, se encontró que los manglares y los ambientes fluviales son los ecosistemas que con mayor frecuencia se evalúan, a diferencia de las lagunas costeras y los sistemas lacustres, ecosistemas con menor representación en la literatura de valoración global. Esta falta de datos no es exclusiva de esta investigación, varios autores han reportado dificultades en la integración de datos de valoración a partir de fuentes heterogéneas (Pendleton *et al.,* 2007; Troy y Wilson 2006; Camacho-Valdez *et al.,* 2013), destacando que si bien la literatura de valoración ha aumentado en los últimos años, ésta continúa sesgada a cierto tipo de servicios ambientales y de ecosistemas. Lo anterior resalta la necesidad de realizar nuevas investigaciones enfocadas a ciertos servicios ambientales (e.g. recursos ornamentales, control del clima y recursos genéticos) y ecosistemas (e.g. lagunas costeras y bosques templados) que están actualmente poco estudiados en términos de valoración económica (De Groot *et al.*, 2012). De hecho una de las desventajas del método de transferencia de valores es que, está inevitablemente limitado a la disponibilidad de los estudios primarios llevados a cabo en ecosistemas y servicios ambientales muy específicos (Ghermandi *et al.*, 2011).

A pesar de estas limitaciones, los valores estimados en este trabajo ilustran qué equivalencia monetaria pueden tener los ecosistemas del Delta del Usumacinta en relación a los servicios que prestan; y representan además las estimaciones iniciales del costo que supondría para la sociedad en el caso de que estos ecosistemas se perdieran o se vieran modificados. Sin embargo, es necesario aclarar, como lo hacen de Groot *et al.*, (2012) y Costanza *et al.*, (2014), que expresar el valor en términos monetarios no sugiere que los valores necesariamente se deban utilizar como base para el establecimiento de precios y no significa que ellos puedan ser tratados como bienes privados que puedan ser comercializados en los mercados. La mayoría de los servicios estudiados aquí son bienes públicos que no pueden o no deberían ser privatizados. Necesariamente la valoración económica tendría que actuar como una poderosa forma de retroalimentación y como una herramienta para la reflexión, la cual, nos ayude a repensar nuestra relación con el entorno natural, alertándonos sobre las consecuencias de nuestras decisiones (TEEB-Foundation 2010). Por otra parte, las estimaciones de valor de una amplia gama de servicios ambientales es un paso esencial para mejorar los incentivos y generar las inversiones necesarias para su conservación y uso sostenible, como por ejemplo los sistemas de pago por servicios ambientales (Farley y Costanza 2010).

Cada alternativa que se elija con respecto a un ecosistema en el Delta del Usumacinta, ya sea conservarlo en su estado natural o convirtiéndolo a otro uso, va a tener implicaciones en términos de valores ganados o perdidos. La decisión en cuanto a qué uso darle a determinado ecosistema, sólo debe hacerse si las pérdidas y ganancias se analizan y evalúan correctamente; de ahí la importancia académica de este tipo de estudios, los cuales pueden servir de base en la planeación de políticas medio-ambientales en México.

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Containing the world's environmental problems: an interdisciplinary approach applied to Malaysia

Choy Yee Keong*

Introduction

The United Nations convened its first and paradigm-breaking global environmental conference, the Stockholm Conference in 1972 to launch "a new liberation movement to free men from the threat of their own thralldom to environmental perils of their own making" (United Nations 1972:45). Since then, a multitude of international environmental conferences have been held and hundreds of multilateral environmental documents adopted, generating the momentum needed to promote sustainable use and management of natural resources and environmental protection globally.

Despite this, nonetheless, our Earth system is still under considerable stress and its ecological integrity is at stake. The situation is particularly worrisome in the Asian developing countries whose environmental protection efforts often clash with the fervent pursuit of socio-economic growth, leading to inadequate, ineffective or biased environmental policy enforcement. Today, overexploitation of natural resources, deforestation, habitat destruction and pollution are some of the most significant threats to the global terrestrial biodiversity. The looming global biodiversity crisis demands immediate attention and mitigating measures must be taken before a full-blown ecological disaster occurs.

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Against this backdrop, the present article aims to explore why international and national environmental efforts have been unable to make significant progress in arresting rapid global environmental decline and biodiversity loss, and to suggest ways of mitigating the problematic situation. Using interdisciplinary approach including content analysis and empirical assessments, it further examines the state of the global environment in general, and biodiversity decline in particular with special reference to the biologically diverse regions in Asia.

This allows us to observe clearly how the sustainable use of our natural environment as promoted by the United Nations has turned into an "opulent" model of resource extraction, with profoundly damaging environmental effects. It also enables us to appreciate fully the underlying causes of global environmental change and the paradox of global/national environmental protection measures.

Considering the above disturbing situations, the article delves further to evaluate theoretically and empirically the role of environmental ethics in influencing individual behaviour and government policy in promoting environmental sustainability. The empirical study is premised on evidence gathered from field research on indigenous environmental worldviews conducted in the Borneo state of Sarawak in Malaysia between 2008 and 2011. It is concluded that human heedless and unrestrained exploitation of our Earth system can possibly be avoided only by altering our actions founded on holistic environmental beliefs, ecological attitudes and values.

1. The United Nations environmental protection initiatives

The Stockholm Conference in 1972 was the first world conference on the environment convened out of a deep concern over the persistent trends of global environmental degradation confronting humanity. It aimed to heighten global environmental awareness and to call on the international community to intensify environmental protection efforts. The Conference adopted the Stockholm Declaration which aimed to guide the international community on the protection of our Earth system. It also unveiled the Stockholm Action Plan on the Human Environment which includes 109 concrete and specific recommendations for international and national actions to arrest global environmental decline (Sohn 1973). The Conference also laid the foundation for the creation and adoption of a series of important environmental documents at and after the conference. These include the 1972 World Heritage Convention and, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES Secretariat 2010).

As listed in Table 1 below, the United Nations has, for the past few decades since Stockholm, made continuous unrelenting efforts to strengthen global commitment to environmental protection. Hundreds of multilateral environmental treaties, agreements, declarations, and action plans were signed, adopted or endorsed by the member states of the United Nations to reinforce international cooperation on environmental issues

TABLE 1. MAJOR GLOBAL ENVIRONMENTAL CONFERENCES RELATED TO ENVIRONMENTAL AND BIODIVERSITY PROTECTION

Year	Global environmental conferences	Outcomes
1980	International Union for Conservation of Nature (IUCN) (currently the World Conservation Union) in collaboration with the United Nations Environment Programme (UNEP), and the World Wide Fund for Nature (WWF)	Published the World Conservation Strategy to promote sustainable resource use within the carrying capacities of the ecosystems (ecological sustainability). Particularly, its main objectives are (a) to maintain essential ecological processes and life support systems, (b) to preserve genetic diversity, and (c) to ensure the sustainable utilization of species and ecosystems.
1982	United Nations 48th plenary meeting	World Chartered for Nature was adopted to protect the ecological integrity, diversity and genetic viability of ecosystems. It also acknowledged the importance of protecting the intrinsic value of natural resources and called for our understanding of human dependence on nature for long-term socio-economic sustenance.
1991	International Union for Conservation of Nature (IUCN) (currently the World Conservation Union), the United Nations Environment Programme (UNEP), and the World Wide Fund for Nature (WWF)	Published Caring for the Earth with the aims of securing a widespread and deeply held commitment to the ethic for sustainable living and to integrate conservation and development.
1992	UN Conference on Environment and Development (the Earth Summit/Rio Summit) held in Rio de Janeiro, Brazil	Documents adopted: (i) The Rio Declaration on Environment and Development (ii) Agenda 21; (iii) Statement of Forest Principles; (iv) The United Nations Framework Convention on Climate Change (UNFCCC), and (v) Convention on Biological Diversity (CBD)
1997	Rio+5 Summit (Earth Summit II) held in New York	Special session to review and appraise the implementation of Agenda 21and to deepen the commitments made at Rio (1992)
2000	Millennium Summit held in New York	Adopted the Millennium Declaration which contained eight Millennium Development Goals (MDGs) one of whihc is to ensure environmental sustainability (Goal 7). The Declaration also stated that efforts must be taken to counter the threat of the planet being irredeemably spoiled by human activities. It also called for a new ethic of conservation and stewardship to protect the environment. The Summit committed member nations to achieve these goals by 2015
2002	World Summit on Sustainable Development held in Johannesburg	Adopted the Johannesburg Declaration on Sustainable Development and the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation).The meeting primarily involved in reviews of progress of the aims set out in Agenda 21 and to agree a new global deal on sustainable development.
2012	The United Nations Conference on Sustainable Development (the Earth Summit or the Rio+20 Summit) held in Rio de Janeiro, Brazil	The conference reaffirmed global commitment to achieve internationally agreed development goals, including the Millennium Development Goals by 2015. It has also developed a set of Sustainable Development Goals (SDGs) by expanding the MDGs to serve as the post 2015 development agenda. The conference adopted The Future We Want" – the declaration on sustainable development and a green economy adopted at the conference.
2013	Global Millennium Development Goals (MDGs) Conference	Aimed at maintaining the momentum for accelerating progress to 2015 – the target date of the global millennium development goals, while taking stock of lessons learned, and practical knowledge and evidence accumulated from efforts to achieve the MDGs through a series of working papers.

Source: compiled by the author from various sources.

Worth emphasized is the Earth Summit held in 1992. The Summit aimed "to help Governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet (United Nations 1997). Some of the important documents adopted at the Conference for this purpose are as follows:

(iii) The Rio Declaration and Development-a programme of action spelling out 27 guiding principles for the management of natural resources and the environment.

(iv) Agenda 21-a 40-chapter and 800-page agreement laying down 115 specific programmes to help achieve sustainable development.

(v) Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests-a brief document containing 15 principles to guide the management, conservation and sustainable development of all types of forests.

(vi) Convention on Biological Diversity (CBD)-a legally binding multilateral agreement aims to protect the diversity of species and habitats in the world.

Worth noting is the adoption of the legally binding agreement, the CBD. It significantly reinforced the United Nations' framework for environmental decision-making which hinges fundamentally on Agenda 21 and the Rio Declaration. This, together with a wide range of environmental and development principles expounded in various international documents as shown in Table 1 represent milestones in the development of environmental governance across countries in the world to translate sustainable development visions into reality. Indeed, as demonstrated in the next section based on various case studies in the biologically rich Asian countries, the United Nations environmental protection initiatives especially the CBD and Agenda 21 provided the foundation and impetus for shaping global environment and sustainable development.

2. The United Nations environmental protection initiatives and global environmental sustainability: an Asian perspective

2.1 China

In response to the United Nations' call on the international community to promote environmental conservation and sustainable development, virtually all countries across the globe have undertaken efforts to streamline their development path for a wiser use of nature that is critical to the wellbeing and livelihood of the present as well as the future generations.

In the wake of the Earth Summit held in 1992, China, for instance, ratified the CBD. This was followed by the formulation and adoption of the National Biodiversity Action Plan in 1994 aimed at halting the loss of biodiversity by 2020. In the same year, it also adopted its local Agenda 21 which sought to reinforce its commitment to environmental preservation and sustainable resource use while pursuing socio-economic development (Choy 2016). At the same time, it enacted and revised various environmental laws, some of which are indicated below, in order to strengthen its environmental protection efforts (Choy 2018a):

(vi) Environmental Protection Law (1979, amended 1989)

(vii) Wildlife Protection Law (1986, amended in 2000 and 2004),

(viii) Fisheries Law (1986, amended in 2000 and 2004),

(ix) Water Pollution Prevention Law (1984, revised in 1996)

(x) Protection of Terrestrial Wildlife Law (1992), and

(xi) Regulation of Aquatic Wild Animals (1993)

2.2 Brazil

Since becoming a signatory to CBD in 1992, Brazil has exerted much effort to promote environmental conservation and sustainable resource use. When it ratified the CBD in 1994, it instituted the National Programme of Biological Diversity (PRONABIO) to reinforce its commitments to protect its mega-diverse biodiversity based on habitat conservation, and to promote sustainable use of biological resources (Ministry of Environment, Brazil 2004; 2016). In 2002, the government established its National Biodiversity Policy-PNB along with its National Biodiversity Action Plan-PAN (BIO) to streamline environmental conservation efforts. Subsequently, Brazil increased its protected area by five percent between 2003 and 2009. This increased the total protected area to 27.8 percent of the national terrestrial and marine areas in 2009 (CBD Secretariat 2011). The government has also enacted various legislations including Law No. 6,938 (1981), Law No. 7.347 (1985) and the Federal Constitution of the Republic of 1988 to guide biodiversity conservation and sustainable resource use (Ministry of Environment, Brazil 1998).

The Brazilian government has also launched the Amazon Region Protected Areas Program (Arpa) during the Rio +10 Summit held in 2002. The Program aimed to ensure the creation, implementation and consolidation of protected areas covering at least 50 million hectares (ha) in the Amazon (Ministry of Environment, Brazil 2005). It has also launched the Ecological Corridors Project in the Amazon and the Atlantic Forest to enhance environmental protection (Ministry of Environment, Brazil 1998).

2.3 Democratic Republic of Congo (DRC)

In the African region, the Democratic Republic of Congo (DRC), for instance, adopted the Forest Code in 2002 which contained a set of new forest policies developed in the 1990s to govern forestry management. Since its ratification of the CBD in 1994, the DRC has developed the National Biodiversity Strategies and Action Plans to promote biodiversity conservation and sustainable use of biological resources in compliance with the CBD. It has also ratified the CITES in 1976 to ensure that international trade in specimens of wild animals and plants does not threaten their survival (Mpoyi *et al.*, 2013). As a show of commitment to contribute to promoting global environmental sustainability, it has also undertaken to ratify the World Natural and Cultural Heritage Convention to ensure the conservation and preservation of cultural properties including nature reserves. Some of the natural properties inscribed under its world heritage list include Garamba National Park (1980), Kahuzi-Biega National Park (1980), Okapi Wildlife Reserve (1996), Salonga National Park (1984) and Virunga National Park (1979) (Seyler *et al.*, 2010). Also, the DRC's constitution stipulates that all properly concluded treaties and international agreements take precedence over national laws (Seyler et al. 2010).

2.4 Southeast Asia

Leaders in Southeast Asia have also ratified various international agreements including the CBD as a sign of commitment to strengthen their environmental policies and to ensure conservation and sustainable management of their environment. A proliferation of conventions, declarations and programmes dealing with environmental protection, biodiversity conservation and sustainable resource use practices across the region has resulted. Malaysia, Indonesia, Thailand, the Philippines and Vietnam, for example, have strengthened their environmental controlling framework based on the establishment of ministerial environmental departments (Choy 2015, 2016). Each nation has also created its local Agenda 21 in order to execute full integration of the sustainability principles and environmental concerns of Agenda 21 in development policies. Environmental protection is also being reinforced based on the enactment of a wide range of environmental laws (Choy 2016). Each country has also ratified the CITES in an attempt to enhance biodiversity protection.

The above examples demonstrate that, for the past few decades, from the watershed Stockholm Conference to the world's grandiose Earth Summit and the Global Millennium Goals Conference, the United Nations has raised an unprecedented show of collective global awareness and concern for environmental issues. The United Nations conferences also provided valuable inputs for decision-making and inspired the creation of a wide range of policies that guide the international community in environmental management and sustainable resource use.

3. The United Nations environmental paradox: an empirical assessment

3.1 The global state of environment in general

Yet, despite these environmental initiatives, the overall global environment has in fact worsened and new environmental threats and challenges continue to emerge. For more than 45 years since Stockholm, the promise of a sustainable planet has largely evaporated. In general, various international biodiversity assessment reports, both old and recent, provide incontrovertible evidence that massive biodiversity loss remains one of the most serious problems that threatens the very existence of our Planet. It also noteworthy that humanity is now using nature's services 50 percent faster than the Earth can replenish and this trend is growing persistently (WWF 2010).

Humans' increasing demand on nature services as a result of uncontrolled socio-economic activities has directly affected at least 83 percent of the planet's viable land surface (Sanderson *et al.*, 2002). For example, between 2000 and 2012, the world lost 2.3 million square kilometers (230 million ha) of forests despite having various international and domestic forest policies, laws and regulations to guide sustainable forest management. The countries with the highest tree cover loss are Russia, Brazil, Canada, United States, and Indonesia (Hansen et al. 2013, World Resource Institute 2014). In addition, the 10 most at-risk forested hotspots in Indo-Burma, New Caledonia, Sundaland, the Philippines, the Atlantic Forest, the mountains of Southwest China, the California Floristic Province, the coastal forests of Eastern Africa, Madagascar and the Indian Ocean Islands, and Eastern Afromontane have depleted 90 percent of their original habitat, causing irreversible destruction to many of their endemic fauna and flora (Conservational International 2011).

Extensive environmental degradation followed by widespread habitat destruction has resulted in massive biodiversity loss. For example, roughly 10 to 30 percent of the mammal, bird and amphibian species are being threatened with the risk of extinction due to human uncontrolled activities (Millennium Ecosystem Assessment 2005, Hilton-Taylor *et al.*, 2009). Also, for the past few decades between 1970 and 2010, animal populations have declined by 52 percent due to habitat loss and degradation, driven again, by unsustainable human practices (WWF 2014).

In the 1970s and 1980s, an estimated 60 million tons of bottom-living (or benthic) life perished from hypoxia in the Black Sea beach resorts in Romania and Ukraine due to the expansion of ocean dead zones (Mee 2006). Ocean dead zones are coastal areas where oxygen levels have dropped too low to support most marine life. Ocean dead zones are caused by the accumulation of nutrient-enriched (nitrogen and phosphorous) water from agricultural runoff discharged directly into the ocean, giving rise to nutrient-driven oxygen decline. In the Gulf of Mexico, dead fish float on the coast due to the formation of a dead zone in the gulf each year. The Gulf of Mexico dead zone is the second largest human-caused dead zone in the world (NOAA 2015). The number of dead zones on Earth has doubled every decade since the

1960s. Worldwide, there are now about 550 dead zones covering 250,000 square kilometres in both freshwater bodies, including rivers, ponds and lakes, and salt water bodies, the oceans (Zimdahl 2015, NOAA 2015, Hand 2016, Breitburg *et al.*, 2018).

3.2 The state of environment in Asian developing regions

On the national front, despite putting in place various comprehensive and encompassing environmental protection measures and programmes in the biologically rich Asian developing countries as discussed above, they generally failed to halt further environmental decline.

3.2.1 China

In China, for example, despite enacting various environmental laws to regulate and control environmental quality, about half of the 20,000 petrochemical plants located by the bank of the Yangtze River released large amounts of industrial wastes including toxic wastes, heavy metals, chemical effluents, agricultural runoff and organic matters, into the river. The amount of discharge increased at an alarming rate from 15 billion tons in the 1980s to 33.9 billion tons in 2010, causing unprecedented destructive impact on the Yangtze aquatic ecosystem (Choy 2016). Also, it is estimated that 5,850 tons of organic pollutants are released into Chinese waters everyday compared to 2,750 tons in the United States, 1,700 tons in Japan, 1,150 tons in Germany, 1,600 tons in India, and 300 tons in South Africa (Refkin & Cray 2013). Water pollution is so acute that up to 70 percent of China's rivers and lakes are seriously polluted (Morton 2006; WWF 2012). It is worth noting that of the world's 20 most polluted rivers, 16 are in China (McBeath & Leng 2006).

Unmitigated river pollution and extensive habitat degradation coupled with illegal and unsustainable bycatch by fishermen have resulted in the extinction of the world's most critically endangered and rare cetacean, the Yangtze River dolphin or the Baiji, which is categorized as the First Category of National Key Protected Wildlife Species in China (Choy 2016). In addition, other state protected species which are facing the risk of extinction as a result of extensive habitat destruction in the Three Gorges region include the Yangtze finless porpoise, the Chinese alligator, the Chinese giant Salamander, the Siberian Crane, and the giant Panda (WWF 2004, Choy 2016).

Ilegal wildlife trade in China has also contributed to endangering the continued survival of many of its rare and endangered species. China is a top consumer country of illegal wildlife products and one of the world's hotspots for illegal trade in wildlife and wildlife parts (Felbab-Brown 2011). Furthermore, compared to the average global rate of biological loss of 10 percent, the rate of biodiversity loss in China is about 15 to 20 percent. The China Red List indicates that 40 percent of mammals, seven percent of birds, 28 percent of reptiles, 40 percent of amphibians and three percent of fish are vulnerable to ecological destruction (McBeath et al. 2014).

3.2.2 Brazil

In Brazil, despite putting in place comprehensive environmental conservation policies as discussed above, extensive habitat fragmentation or destruction caused by widespread agricultural land conversion and cattle ranching, and rapid urbanization has halved the population of Brazilian bare-faced tamarins in 18 years. Demonstrably, the Atlantic forest ecosystem which is one of the most diverse and unique in the world is increasingly subject to ecological destruction due to severe and unsustainable human-induced physical transformation. While more than 20 percent of the Amazon forest has gone, 93 percent of the Atlantic Forest has disappeared (Galindo-Leal & Câmara 2003; Tabarelli *et al.,* 2005). The remaining forest cover exists mostly in isolated remnants scattered throughout a landscape dominated by agricultural uses. A vast majority of the animals and plants are threatened with the risk of extinction due to logging, poaching of flora and fauna, illegal settlement and commercial agricultural development (Galindo-Leal & Câmara).

Of Brazil's 69 severely endangered mammals, 38 are from the Atlantic Rainforest and of 160 endangered birds and 20 endangered reptiles, 18 and 13 species of these respectively are also from the region (IRC 2016). The jaguars, lowland tapirs, woolly spider-monkeys and giant anteaters, among the most ancient and threatened tropical mammal species on the planet, are now almost absent in the Brazilian northeastern forests while the white-lipped peccary has been completely wiped out from the region (Angelo 2012). The extremely biodiversity rich Atlantic forests of Brazil which have been severely degraded is considered one of the most threatened global hotspots calling for urgent protection (Conservation International 2010).

3.3.3 Democratic Republic of Congo (DRC)

In DRC, despite its political commitment to strengthen environmental protection as discussed above, its biodiversity conservation efforts seem to have been overshadowed by humans' exploitative behaviour and heedless actions. For instance, extensive deforestation and habitat destruction, illegal logging activities, overhunting, illegal bushmeat and exotic wildlife trade are increasingly threatening the continued existence of many of the flora and fauna species at an alarming rate (Seyler *et al.,* 2010; UNESCO 2010). Despite the fact that around 18 million ha or eight percent of the national territory have been designated as parks and protected or conservation areas, most of these exist on paper only (Seyler *et al.,* 2010). For example, many forest concessions are in the biodiversity rich intact forests such as areas inside the Maringa-Lapori-Wamba landscape, which is a critical habitat for some of the last viable population of bonobos (Greenpeace 2007). Although there are 72 threatened and endangered species, especially of mammals, that are completely protected by law in DRC, their protection in reality is very weak (Seyler *et al.*, 2010).

Unsustainable activities in the country's World Heritage sites such as poaching of rhino, elephant and buffalo by local hunters and highly armed and well organized horsemen from Sudan in the Garamba National Park, poaching of elephant and commercial hunting for the bushmeat trade in Okapi Wildlife Reserve and Salonga National Park and poaching of large mammals, particularly hippo, in the central and northern parts of the Virunga National Park have all coalesced, threatening the continued survival of the diverse flora and fauna that used to flourish in the region (UNESCO 2010). The northern white rhino, which depended on the protection of its habitat in the Garamba National Park for survival has apparently become extinct in the wild due to widespread poaching and illegal trade in rhino horn.

3.2.3 Southeast Asia

In Southeast Asia, despite putting in place far-reaching environmental laws and policies, and increasing environmental protection efforts, they do not seem to have been able to protect the regional biological environment from ecological impoverishment.

In Indonesia, for example, massive scale of deforestation and commercial oil palm plantation development in the past few decades has led to extensive natural habitat destruction. It is reported that from 2000 to 2009, dry primary forest shrank from 42.25 million to 32.18 million ha (Ministry of Environment and Forestry of Indonesia 2014). This threatens the continued survival of a wide range of rare and endangered animal species such as the Sumatran tiger, the Sumatran elephant, the Javan rhinoceros and the orangutan (Uryu *et al.*, 2008, Choy 2015, 2016, 2018a)

Demonstrably, in Riau, Sumatra, the critically endangered Sumatran elephants which thrived well in the once thick lowland forest in Tesso Nilo National Park, have declined by up to 84 percent from an average of 1,342 in 1984, to approximately 210 in 2007, this being largely attributed to poaching, and extensive habitat fragmentation caused by commercial agricultural expansion and uncontrolled logging activities (Uryu *et al.*, 2008, Nicholas 2018). Also, between 1999 and 2015, it is estimated that about 148,500 orangutan have been lost from the forests due to habitat destruction coupled with reckless hunting, poaching and killing (Voigt *et al.*, 2018). Reckless human behaviours and actions have also led to the extinction of the Balinese, Caspian and Javan tigers (TRAFFIC 2008; Jackson & Nowell 2008). Currently, Indonesia is considered as one of the top ten countries in the world with the greatest number of threatened species, and is a global hotspot of great conservation concern (Hickey et al. 2004; Yeager 2008; ACB 2010).

In Malaysia, massive habitat loss as a result of uncontrolled logging activities, mega-dam construction, and commercial oil palm plantation expansions are posing a significant threat to the continued existence of a wide range of endangered animal species such as the tiger, the pygmy elephant, the orangutan, and the clouded leopard (Choy 2015, 2016, 2018a). Also, human unsustainable practices have led to the extinction of the Indian grey mongoose, the Javan and Sumatran rhinoceros, the Banteng, and the leatherback turtle (Gates 2013, Zorthian 2015, Choy 2015, 2016, 2018a). Overall, about 14 percent of the mammals in Malaysia have been identified as endangered under the IUCN Red List while 47 out of the 218 species of amphibians are threatened with extinction (Hilton-Taylor *et al.*, 2009). Globally, Malaysia is classified as a critical area for biodiversity conservation.

The alarming rate of deforestation in the Philippines which has left the country with only six million ha of the forest from 17 million ha in 1935 has had destructive ecological impact. Currently, the Philippines has the lowest forest cover in Southeast Asia (Rebugio et al., 2007, Choy 2015, 2016, 2018a). This has negatively affected the continued survival of a vast range of endemic species including the Philippines eagle, the Philippines tarsier, and the Philippines spotted deer (Conservation International 2011, Maala 2001, Choy 2015, 2016, 2018a). Many species such as the Cebu warty pig and Panay flying fox which could not survive outside of their natural habitat have become extinct (Alave 2011).

It is said that only four percent of the country's forest habitat is suitable for a large number of endemic species, including 6,000 plant species and 1,196 known species of amphibians, birds, mammals and reptiles (Isaacson 2011; Alave 2011). Massive loss of natural habitat has resulted in the Philippines having more endemic species that are severely threatened than any other country in the world (Oliver 2006, ACB 2010). It is reported that the rate of species extinction is 1,000 times the natural rate (Isaacson 2011). In fact, the Philippines is one of the few nations in the world that is, in its entirety, both a hotspot and a mega-diversity region as well as one of the top priority sites for global conservation (ACB 2010; Conservation International 2011). The country is often named as "the hottest of the hot spots" (Alave 2011).

In Thailand, despite the compliance of the CBD, however, habitat loss caused by widespread deforestation has adversely affected the continued existence of roughly 45 species of birds, 23 species of reptiles and 72 species of fish (ESCAP 2011). Also, some of the species protected under the country's Wildlife Protection and Preservation Act have become extinct due to human unsustainable practices. These include Schomburgk's deer, giant ibis, large grass-warbler, silver shark, Eld's brown-antlered deer, kouprey, white-shoulder ibis, milky stork and, the Javan and Sumatran rhinoceros (OEPP, Thailand 2000).

In addition, the conversion of forests to rubber and oil palm plantations has resulted in a 60 percent decline in bird species richness (Aratrakorn et al. 2006). The trafficking of wild animals and wild plants, and Illegal logging activities in various protected areas such as the Phu Wiang National Park, Phu Phan National Park, Phu Sithan Wildlife Sanctuaries, Thap Lan National Park and Ta Phraya National Park continue to exert immense pressure on the ecological integrity of the country's biodiversity (ONREPP, Thailand 2014).

In Vietnam, despite the increasing number of protected areas established in line with CBD to protect its biodiversity, however, the number of threatened species has increased. According to the Vietnam Red Book 2007, the total number of endangered wildlife species had increased by 161 species to 882 compared to the previous Red Book published in 1992-1996. Between 1990 and 2005, for example, the country lost 78 percent of its rich and closed-canopy forest (Mongabay 2009).

This massive destruction in the closed-canopy forest is pushing roughly 700 and 300 plant and animal species respectively, including the banting, the Javan rhinoceros, the tiger, the Asian elephant, and the saola, to the brink of extinction. Indeed, nine rare animal and plant species including the Java and Sumatran rhinoceros, the sika deer, Eld's deer, and the kouprey, and two Lady's slipper orchid (Paphiopedilum) species have become extinct in the wild (Ministry of Natural Resources and Environment, Vietnam 2008, Drollette 2013b, Main 2013). The main drivers behind this biodiversity loss are habitat destruction caused by unrestrained logging activities, coffee plantation development, dam infrastructure development, poaching and illegal wildlife trade (Drollette 2013a).

4. Global environmental decline and biodiversity degradation: the anthropocentric view of environmental sustainability

The above discussion paradoxically demonstrates that despite putting in place well-established environmental policies and legislative frameworks to protect our Earth system, the global environment together with its biodiversity is still increasingly under serious threat. This has raised important questions about the environmental assumptions fundamentally made in the global economic system. That said, under the contemporary dynamic capitalist society, the emphasis is on the quest for socioeconomic progress with the natural systems subsumed to capitalist exploitation for the promotion of economic prosperity and social wellbeing. For this very reason, the natural environment is largely treated as a horn of plenty which offers us everything gratis for the enhancement of socioeconomic wellbeing.

Put differently, the global discourse of environmentalism has been consistently skewed towards the anthropocentric consideration of human interests since Stockholm. More particularly, the global and national environmental conservation efforts as elucidated above are anthropocentrically motivated in that socioeconomic growth takes precedence over environmental sustainability when material progress clashes with environmental interest. Thus, despite the adoption of a plethora of environmental conservation laws and policies to promote environmental sustainability, it has not been possible to reverse the extensive scale of environmental degradation and biodiversity decline. The upshot is that to a large extent, sustainable development as endorsed by the global community means sustaining socioeconomic growth ad infinitum rather than sustaining the environment for the benefits of future generations-an anthropocentric view of environmental sustainability. Under this view, the main focus is primarily on human beings and short-term economic interest. That is to say, the economy dominates the environment.

In extension, anthropocentrism is commonly understood as a theory of value which maintains that only humans have intrinsic moral value (Thompson 2017). In other words, anthropocentrism "gives either exclusive or primary consideration to human interests above the good of other species" (Taylor 1983: 240). Individuals with anthropocentric viewpoints tend to value nature instrumentally as a resource to be exploited for human benefit, that is, for its instrumental value. Instrumental value is defined as the value of an object not as an end in itself but as a means of acquiring something else, that is, a means to another's ends (Choy 2014) This may be contrasted to intrinsic value which refers to the value something has in itself, for its own sake, or for its own existence regardless of its value to humanity (Choy 2014).

Furthermore, anthropocentrism holds that our Earth system, which is central to human welfare, exists instrumentally for the sake of the human race and is also to be instrumentally managed by human beings (Lamb 1999). Hence, only humans are considered the morally considerable class of beings, and the ecological concern for the natural environment stems from the consideration of whether human socioeconomic wellbeing will be adversely impacted by its degradation. Thus, humans are usually regarded as separate from and above nature. They further consider themselves as having no direct moral duties to protect its ecological integrity. This self-centered attitude which is predominantly based on self-interests and economic benefits may be considered as a strong form of anthropocentrism (Thompson 2017). In comparison, a weak form of anthropocentrism is based loosely on human-centred value system. Individuals with weak anthropocentric inclination tend to exhibit a rational appreciation of the intrinsic value of nature which may be based on religious beliefs (religious value) or aesthetic satisfaction (aesthetic value), among others, and are concerned for their protection.

It is thus increasingly clear that since Stockholm, although environmental sustainability has been considered by the international community as the prerequisite for sustainable development, it alone is not sufficient to trigger environmentally responsible behaviours and actions because individuals who express concern may not indulge in environmentally responsible or protective behaviours (Maloney & Ward 1973; Scott & Willits 1994). This is particularly true for individuals with strong anthropocentric concern for the environment whose interests are narrowly and instrumentally aimed at preserving the socioeconomic welfare of humanity.

5. Global environmental sustainability: the return of Aldo Leopold's land ethic

It must thus be admitted that moving to an environmentally sustainable world cannot be achieved merely through the ratification of environmental treaties or the enactment of environmental legislations. It also cannot be attained through the demonstration of environmental concern or political commitment to environmental sustainability alone. These environmental concerns and initiatives, no matter how sweeping and unambiguous, are only hortatory gestures unless they are implemented in reality and effectively. To translate environmental commitments into real actions, it is necessary for individuals or policy makers to move away from the anthropocentric view of environmental sustainability to embracing an ecocentric view of nature.

Ecocentrism finds intrinsic value in all of nature. It takes a much wider view of the world than does anthropocentrism. Ecocentrism engenders the "moral dimension of the relationship between human beings and non-human nature - animals and plants, local populations, natural resources and ecosystems, landscapes, as well as biosphere and the cosmos" (Gordon 2017). In other words, it is an Earth-respecting belief system.

Ecocentrism may be contrasted to biocentrism. Biocentrism which also sees intrinsic value in non-human living things is a narrowly focused environmental philosophy in that it emphasizes the values and rights of individual non-human living things. It is a kind of individualism and its individualistic characteristic is unlikely to contribute to promoting global environmental sustainability because moral concerns only extend to individual beings rather than to the natural environment as a whole.

Thus, ecocentrism has much to offer as a practical ethical theory to guide the development of morally justifiable and more effective environmental policies to address our pressing global environmental problems. In this regard, we may take the vantage point of Aldo Leopold, an internationally influential environmental ethicist. Leopold's environmental philosophy holistically stretches the extension of moral considerability not only to animals, but also to land. Leopold's definition of land is an all-embracing term which comprises the sum total of biotic, abiotic, cultural and philosophical elements that may collectively be called the "environment". Biotic elements may include plants and animals while abiotic elements refer to the physical features and surrounding natural conditions. The cultural component covers economic, social and political factors in association with natural resource use or environmental exploitation while philosophical factors concern our ethical interaction with nature. Thus, Leopold land ethic is an all-encompassing form of ecocentrism.

Leopold's holistic concern for the environment stems from his foresight of the environmentally destructive impacts of anthropocentrism which gives rise to human abusive instrumental use of nature. As he pointed out succinctly, "we abuse land because we regard it as a commodity belonging to us" (Leopold 1949: xviii). However, Leopold contends that, "When we see land as a community to which we belong, we may begin to use it with love and respect" (Leopold 1949: vviii). For Leopold, the ethical principle for the extension of moral considerability to land should be based on human prudent use of nature. Such prudent use may be expressed in terms of an "extension of the social conscience from people to land" (Leopold 1949: .223). Social conscience is associated with the expression of "love, respect, admiration and a high regard for its value" (Leopold 1949: 223). By value, Leopold means intrinsic value, that is, value in the "philosophical sense" (Leopold 1949: 223). The extension of moral consideration to the natural system in this manner serves to connect humans with the natural system ethically. This gives rise to what Leopold calls a land ethic which he defines as "the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of land" (Leopold 1949: 258).

In short, "a land ethic changes the role of Homo sapiens from conqueror of the land-community to plain members and citizens of it. It implies respect for his fellow-members, and also respect for the community as such" (Leopold 1949: 240). Implicitly, humans are not above or separate from nature as in anthropocentrism but merely constitute a part of it. This suggests that there is an intimate connection between the well-being of humanity and the ecological integrity of our Earth system. It further implies that humans need to shift away from anthropocentrism to embracing our Earth system as worthy of moral consideration. Thus, Leopold urges us to "quit thinking about decent land-use as solely an economic problem" (Leopold 1949: 262). He professes that it is necessary to examine whether man's instrumental use of nature is "ethically and esthetically right" and "economically expedient" (Leopold 1949: 262).

For Leopold, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1949: 262). This "right" principle requires us to undertake "obligations over and above self-interest" to preserve the integrity and continuous existence of the biotic community (Leopold 1949: 209). Obligation, in Leopold's tradition means "a limitation on freedom of action in the struggle for existence" (Leopold 1949: 202). This refers to prudent use of our natural system. It further means that we should accord a moral or ethical standing to the natural environment, one of the most important philosophical attitudes towards promoting global environmental sustainability.

However, it must be noted that Leopold's land ethic does not necessarily call upon us to completely withhold any form of ecological disturbances of nature. Rather, it requires us to shoulder certain moral obligations to protect the environment when harnessing its economic use through "positive exercise of skill and insight" to keep "the resource in working order, as well as preventing overuse" (Leopold 1999: 164).

Leopold land ethic differs from biocentrism in that in ethical holism, right and wrong are a function of the ecological integrity of the biotic community rather than of its individual constitutive members. It also completely rejects the anthropocentric view of nature. Thus, it provides the ethical entry point for a systematic and gradual shift in our anthropocentric conception of nature towards embracing the ecocentric philosophy of environmentalism to protect the ecological health of our Earth System when optimizing its economic use. As empirically demonstrates in the following section, the ecocentric environmental philosophy has a distinct and integral role to play in promoting global environmental sustainability.

6. Indigenous environmental worldviews and environmental sustainability: an empirical assessment

6.1 Interview and field observations: targeted areas of study

This section seeks to evaluate the environmental worldviews of the indigenous communities that have brought to bear on the practical importance of Leopold-ecocentrism underpinning environmental sustainability in a real world system. This is achieved based on empirical evidence gathered from field study in the Borneo state of Sarawak in Malaysia through face-to-face interviews and field observations in various parts of the forest interior (Table 2).

TABLE 2. TARGETED AREAS OF STUDY

Year	Name of longhouse	Tribe
2008	Tanah Mawang	Iban
	Long Bala	Kenyah
	Long Apok	Penan
	Rumah Anthony Lerang	Kenyah
	Rumah Bagong	Iban
	Long Biah	Kenyah
	Rumah Jalong	Kenyah
	Nanga Entawai	Iban
	Rumah Kulleh	Iban
	Rumah Amit	Iban
	Rumah Mulie	Iban
	Uma Sambop	Kenyah
	Rumah Kiri	Iban
2009	Long Wat	Penan
	Long Jek	Penan
	Long Koyan	Kenyah
	Long Lawen	Kenyah
	Rumah Sekapan Pitt	Kenyah
	Long Dungun	Kenyah
	Sekapang Panjang	Kenyah
	Rumah Aging Long	Penan
	Kampong Sg. Entulang	Iban
	Kampong Sg. Buri	Iban
	Long Laput	Kayan
	Long Tutoh	Kenyah
	Long Ikang	Kenyah
	Long Banyok	Kenyah
	Long Puak	Kenyah
	Long Miri	Kenyah
	Long Na'ah	Kayan
	Long Pillah	Kayan
	Long Kesih	Kayan
2010	Arur Dalan	Kelabit
	Bario Asal	Kelabit
	Ulung Palang	Kelabit
	Batu Bungan	Penan
	Rumah Busang	Iban
	Rumah Genatan	Iban
	Rumah Ranggong, Sungai Sah	Iban
	Rumah Umpur	Iban
	Rumah Ampau	Iban
	Rumah Tinggang	Iban
	Rumah Usek	Iban
2011	Long Terawan	Berawan
	Long Imang	Penan
	Batu Bungan	Penan

Interviews with the indigenous people, including village headmen and old and young men and women, were carried out in the period between 2008 and 2011. The main aim of the field research was to explore the local people's environmental worldviews. On average, 10–15 people from each household were interviewed, depending on whether the prospective interviewees were in their longhouses or the surrounding vicinity and also, on their willingness to be interviewed. Unless otherwise indicated, the names of the interviewees are withheld in order to protect their privacy, as agreed.

A total of 495 local people from various tribal groups and in different geographic locations were interviewed. The following are some of the areas of interest for the interview questions:

(i) the moral concern for environmental protection for the benefit of future generations

(ii) environmental preference: willingness to accept compensation for the loss of land and forests

(iii) human relationship with nature including the local people's emotional attachment to their natural surroundings.

6.2 Selected samples of interview

The following are some of the selected excerpts from the interviews.

To begin with, when asked about his views on his community's environmental perceptions at an interview with the seventh generation longhouse chief from the Kenyah tribal group in Long Bala in 2008, he replied: "The land and forests here are very important to us. We will not sell them regardless of the amount of money anyone including the state government is willing to pay us. We feel happy living together with nature, and we owe a traditional duty to our ancestors and future generations to protect them from degradation…"

The rest of the respondents including Roslin (41 years), Mering (41 years), and Usen (48 years) also concurred with their Chief and all stressed that they felt very happy to be with the environment.

In a separate interview conducted with the Kenyah community in Uma Sambop in 2008; the longhouse's chief who showed an extraordinarily strong attachment to the natural environment, had the following to say: "An indigenous individual who has lost his ancestral land is just like a ship without a captain…"

At another interview conducted with the Penan tribal group in Long Apok in 2008, the longhouse chief, Junie Lating, said: "…surely, we love and show due respect to our ancestral land and forests. We will not sell them irrespective of the amount of money an interested party is willing to pay…. I feel very happy to live side by side with our natural surrounding…" (May 2008).

Other respondents including Jaya Udau (30 years), Jackson Lavang (39 years), Joy Bunyi (30+ years), and Alo Jackson (20+ years) also revealed a strong belief that nature and humans are interconnected and the relationship has inherent values that cannot be compensated with monetary or material benefits.

In another interview conducted in 2009 with the Kenyah tribal group in Long Lawen, the longhouse chief, Gara Jalong explained: "Lands and forests are our Datuk Nenek Moyang Temuda (ancestral domain). They are our cultural identity and we are bound by our adat (custom) to protect them from degradation so that they could be passed down to our future generations in good state…"

We conducted further interviews with other local inhabitants in the same community including Juk Nyok Along, Loong Lian, Siting Selong, Suti Lawa, Nyanting Anyie, Julit and Sam. All reported that they feel psychologically comfortable, spiritually satisfied, and economically stable living in the forests. They also conceded that they were bound by their adat to use the land in a sustainable way in order protect the interests of their future generations.

In a separate interview conducted with the Penan community in Rumah Aging in 2009, the chief of the longhouse contended that:

> *"We show a lot of respect and love to our surrounding areas including the trees planted by our Datuk Nenek Moyang (ancestors)…Sometimes we feel a sense of emptiness in our heart when we see some of the forests surrounding our areas have been felled by the private developers for plantation development… we also feel sad when some of the wild birds which used to rest or fly around in our areas disappeared because of this…"*

Interviews conducted with the Penan community in 2011 in Batu Bungan longhouse also revealed the same environmental sentiments, belief and value system. For example, as Mamat Beti (34 years) disclosed, "I will not sell off my land irrespective of the amount an outsider is willing to pay because by tradition, I have a responsibility to preserve it for the sake of my children and grandchildren. In addition, land and forests form a part of our cultural identity and we cannot live without them…"

For the rest of the respondents interviewed, it may be simply summarized as follows:

(i) All unanimously attest that by tradition, they have a responsibility to use their land resources sustainably and to protect them from alienation or degradation for the benefit of their future generations.

(ii) All show due respect and passion toward their surrounding areas, including the trees planted by their ancestors.

(iii) All refuse to recognize any tradeoff between their ancestral land and forests and monetary benefits.

The above revelations uncovered some of the salient features of the ethical and moral orientations of the local communities toward the natural environment. The field studies also indicated that the local communities are steadfast in upholding the moral codes of the ecocentric-environmental behaviors when interacting with nature. This has enabled them to protect and preserve their natural environment for the past few centuries. A good demonstrable example is found in Long Lawen which is located in one of the most remote parts of Sarawak (Figure 1). The Long Lawen's case study is further compared to the anthropocentrically premised commercial land use patterns of the economic agents (Figure 2). This allows us to appreciate fully the environmental distinctions between these two contrasting environmental views. This is followed by an examination of the underlying forces governing the indigenous environmental worldviews in the next sub-section.

FIGURE 1. FIELD OBSERVATION IN LONG LAWEN: POSITIVE RELATIONSHIP BETWEEN ECOCENTRISM AND ENVIRONMENTAL SUSTAINABILITY

Source: pictures taken by the author in 2009.

The local community (Kenyah tribal group) in Long Lawen owns roughly 21,700 ha of land which typically consists of a matrix of old secondary (9,800 ha) and primary (11,900 ha) forests. Each household, depending on the size of its family, instrumentally uses about 10 to 20 acres of the secondary forests for shifting cultivation. The same piece of land is used over and over again after it is allowed to replenish. This helps them to avoid extensive forest destruction. The primary forests known as the community forests constitute parts of the intrinsically and morally defined ancestral domain of the local community. They are completely protected and preserved for the benefits of present and future generations. This is further clarified conceptually in sub-section c below.

FIGURE 2: FIELD OBSERVATION: THE NEXUS OF ANTHROPOCENTRISM AND ENVIRONMENTAL DESTRUCTION

Source: pictures taken by the author during a field trip to Arur Dalan, Bario Asal and Ulung Palang in Bario Highland in 2010.

As distinct from the indigenous people, to the economic agents, forests are anthropocentrically viewed as a means to enhance economic gains. In the above diagram, forests are first logged for timber production after which the logged-over areas are irreversibly converted into oil palm plantations, causing extensive habitat destruction. The primary concern for this anthropocentric land use practice is profit maximization while the moral concern for its conservation is absent.

7. Empirical findings and the indigenous environmental worldviews

Despite the diversity among indigenous groups, tribal languages, and geographic locations, all respondents interviewed consistently recognize the cultural importance of the forest landscapes that were once the dwellings of their remote ancestors. Generally, all the tribal groups share common cultural beliefs, ethical interests and moral responsibilities over their land and forests. Accordingly, to the indigenous people, the surrounding forested environment has meanings and significance to their traditional ways of life, cultural identity, spirituality, genealogical and intergenerational relations, and repositories of memory (Choy 2018b).

Hence, the natural environment is intrinsically preferred because apart from its instrumental value, it is also intrinsically imbued with an array of distinctive non-economic attributes such as psychological value, sense-of-place value, spiritual value, cultural value, and moral value, among others. This explains why the indigenous people interviewed displayed a high degree of inclusion of nature within their cognitive self. For individuals with a high degree of environmental inclusion, self and nature are interconnected (Schultz *et al.,* 2005). Thus, the indigenous people are intrinsically skewed and ethically oriented to affirm a moral sense of custodial responsibility to protect the "integrity, stability, and beauty" of the forest landscapes based on a culturally viable and mutually beneficial relationship with nature when optimizing its economic use. This ecocentric view of nature and the ecological conscience for environmental protection are deeply embedded in the indigenous culture more than 500 years ago. This has enabled them to protect their natural environment for the past few centuries as illustrated in Figure 1 above.

As noted above, the indigenous communities also consider their land resources as having instrumental value- an environmentally exploitative value judgment. However, due to their strong environmental inclusiveness, the extent of moral considerability or degree of land ethic to be accorded to land resources will be extraordinarily far-reaching. This in turn, serves as an effective means to avoid abusive instrumental use of nature. The shifting cultivation as traditionally practiced by the local community which involves small-scale land clearing as contrasted to the environmentally destructive land use practices of the economic agents is a case in point (Figure 1 & 2 above).

The above findings reveal that the indigenous environmental worldviews found a correspondence with the focus of Leopold's land ethic. They also shed immense insights into the question of how we should redefine our instrumental relationships with nature in a highly human-centred world and how changing environmental value judgments premised on ecocentrism may help us to realign our sense of duty and obligation towards our Earth system. In other words, mapping the way forward towards global environmental sustainability necessarily calls for the needs to streamline our ethical attunement to nature based on ecocentrism when optimizing its economic use.

Conclusions

The present research contributes to both theoretical and empirical evidence of the importance of environmental ethics in addressing global environmental problems confronting us today. Despite that the past United Nations' environmental protection initiatives have resulted in the rapid growth of environmental awareness, laws and regulations to address the devastating consequences of man's unsustainable environmental practices, our Earth system is still heading towards a precarious state of development.

The discussion and critical assessment of the effectiveness of the global environmental initiatives and domestic legal environmental instruments provide compelling evidence that global environmental and ecological issues are increasingly reaching crisis levels. This reflects the structural inability of the United Nations to promote global environmental sustainability. It seems that the legal regimes established in response to the United Nations' call for greater commitments and efforts for environmental protection has mostly been reactive to emerging environmental problems instead of displaying serious or genuine concern to tackle them.

A spectre is thus haunting the United Nations: the spectre of ineffective implementation and lack of positive behavioural changes amidst progressive development of multilateral cooperation and institution building across the globe since Stockholm. Obviously, global environmental problems involve economic, political and social issues. However, what is less obvious is that they also entail ethical questions for the human race. To be sure, the adoption or endorsement of international environmental treaties and global environmental pledges or commitment per se alone will not endure without strong and genuine commitment to protect our Earth system.

In short, getting world leaders or the global community to transform their commitment into real action cannot happen in a vacuum. Rather, it must necessarily be motivated from something which is distinctly capable of exerting a certain form of coercive influence on their mental representation of nature based on shared moral sentiments and ethical responsibilities. Here, Aldo Leopold's land ethic as empirically verified based on the field studies with the indigenous people in Sarawak, can offer one of the major keys to guide the global community towards a more environmentally benign mode of development. Implicitly, without emphasizing human moral causes of environmentally destructive practices and the ethical imperatives for environmental protection, the international documents signed or endorsed at each United Nations conference or national environmental law enacted in each member state will not produce real or lasting effect.

In a nutshell, environmental problems cannot be effectively circumvented without first breaking the ethical impasse of environmentalism. The ethical reasoning for environmentalism is particularly important in serving as a more effective motivation for environmental obligatory actions. Hence, the need for an ethical framework and moral justification to command, regulate and constrain human environmental attitudes, behaviours and actions within the planetary boundary limit of growth or material progress, is a categorical imperative.

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The living Well Development Paradigm in the 2020-2025 Agenda of The Plurinational State of Bolivia

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Introduction

More than 500 years ago, our Abya Yala was invaded by Spaniards and Portuguese looking for natural resources such as gold, precious rocks, silver and condiments. During these ravenous endeavors, the new conquerors wiped off indigenous populations and imposed new colonial policies in order to over-exploit mineral resources such as silver and gold. These colonial policies can be divided into three groups:

1. *Division of the conquered territories:* european conquerors divided the territories into two areas: Alto Peru and Bajo Peru creating the first colonial settlements from the Peruvian Coasts of Lima to the Southern territory of Argentina. Europeans in the Alto Peru conquered the Charcas population lead by Hernando Pizarro who established the first Spanish town of Chuquisaca (La Plata, now Sucre). From 1538 to 1539, Chuquisaca became the managerial center of The Alto Peru providing the first urban settlement and starting for the silver route with the mining camps. In 1545, the silver mine of The Cerro Rico was discovered and the City of Potosi was settled to mine this mineral. Conquerors altered the invaded territories by destroying the social capital and slave the indigenous population. Also, the king of Spain gave encomiendas[1] to confident conquerors such as The Pizarros. The first encomiendas grouped the indigenous populations into small units (ayllus, parcialidades, lineajes confederados) that were managed by Spaniards who exploited them by forced labor, taxes and tributes for the Spanish Crown and themselves.

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1 indigenous natural capital, population in a determined territory who were obligated to pay taxes to the one in charge.

2. *Abolition of traditional costumes and social organizations:* once, Spain conquered these territories and divided them into encomiendas, new policies abolished the traditional costumes of the indigenous populations such as the Mita[2] in order to satisfy the ravenous desires for silver and resources. The social organizations were destroyed by force as well as by disease. Conquerors brought new diseases such as measles to these new territories affecting indigenous populations.

3. *Slavery of the colonized population's workforce for exploiting natural resources:* conquerors and the Catholic Church declared inferior beings with no souls to local indigenous people who were forced to adopt an alien religion that punished their cultural and social costumes and forbid to adore their gods such as the Pachamama. Furthermore, conquerors at the enmiendas selected young labor force to be sent to rich mines in Potosi where they were exploited by force until they die. The introduction of foreign agricultural species such as grapes from Spain brought new means for producing wine in order to satisfy the demand for them in the masses (Larson, 2017).

These colonizing policies shaped by the slavery, forced labor and orchestrated killing of the natural born dwellers of these territories altered social, natural, physical, cultural capitals of the indigenous population. The most threatening experience conquered experienced besides forced slavery was the dissolution of the cultural and social capitals such as the Living Well (*Suma Qamana* in Aymara, *Sumaj Kawsay* in Quechua, *Ñande Reko* in Guarani).

The Living Well before the colonization meant to live in harmony with nature and people. Now, politicians, activists and people proposed the rescue of the original Living Well at the International community but with some changes for our modern times and contrasting it with other development approaches such as the Green Economy.

2. The Green Economy

The Green Economy is a capitalist approach that emphasizes economic growth, pricing mechanisms, and technology in order to reduce environmental problems (UNEP 2011). Green Economy was debated at the 2012 United Nations Conference on Sustainable Development (Rio+20). Critiques of Green Economy came from indigenous movements that observed that Green Economy favors corporations. One of the most discussed tools of the Green Economy is the Environmental Payment Services (EPS) that values biodiversity and the ecosystem services. The EPS are part of the biodiversity conservation paradigm, ecosystem services, deforestation reduction and strengthening of the food production systems. The REDD+ (Reducción de Emisiones por Deforestación y Degradación Forestal) is an international engagement to reduce carbon emissions in which developing countries are paid by rich countries in order to forest and reduce these emissions creating a marker-based approach for carbon. The PNUMA considers that a green economy must enhance the human wellbeing and social equity as well as reducing the environmental risks (PNUMA, 2011).

PNUMA exposes that during the last two decades a huge quantity of financial capital was given by donors and governments to support fossil fuels, real estate and not sustainable agriculture and clean energy. The Green Economy must be understood as natural capital that has a value due that the capitalism has built to much physical capital and caused a progressive

2 Labor force for common wellbeing

degradation of the natural capital and this current trend has affected the human wellbeing and risking it for future generations. The PNUMA states that in order to reach the sustainable development is fundamental to pay and invest in these sectors: agriculture, buildings, energy, fisheries, forest management, industry, tourism, transportation, garbage management and water. The governments that adopted the green economy approach for their development should measure and assess the quantification of nature using mechanisms such as the environmental services to report periodically to donors and agencies of their engaged goals. This approach is contrasted with the Living Well Approach because considers that the Green Economy is a market-driven approach.

The tool of the green economy is the Environmental Payment Services (EPS) which was molded by the capitalism for greening the economy which values biodiversity and the EPS. This approach was adopted for biodiversity conservation, ecosystem services, deforestation reduction and the enhancement of production systems. This approach can be used for westernized modern nations. According to Wunder (2008), the EPS are part of a new and direct conservation paradigm that creates communicating bridges with land owners and EPS users who create a market where natural capital is sold and bought (market-based approach) and public natural capital can be transformed in private natural capital and vice versa.

The REDD+ proposal understands an EPS at global level and Countries involved into it that need to reduce carbon emissions make transactions with other developed countries that have forests. This tool help developing countries to sell carbon that is retained in their forests and developed countries can buy this carbon in order to reduce carbon emissions through a market-based approach for carbon.

3. The Living Well

The Living Well differs from other understandings of wellbeing in its critique of individual profit, paternalism, capitalism, ravenous appetite for the valuation of natural resources for extractive activities. From an academic point of view, the Living Well can be understood as a Polanyian Contra-movement to capitalism that contrasts the mantras of neoliberal privatization of natural resources (e.g., petrol). From a sociologist and philosophical point of views, there are two paradigms.

The first, the Occidental Paradigm recognizes the extreme individual paradigm for individual wellbeing and the extreme collective paradigm that leads to the Human Wellbeing. The second, the native peoples with the communitarian paradigm of the Living Well. Many nations have their own definition of Living Well. For The Mapuche Nation is called ***Kyme Mogen*** which is conceived as a perpetual man-nature relationship, harmony and balance with Mother Earth, No violence, and to live with affection and empathy. For the Aymaras is called ***Sumaj Qamaña*** (Sumaj: excellent, magnificent, beautiful and Qamaña: Living, to being). So, Sumaj Qamana means: to live in balance and harmony, to know how to live, living well, to live with plenitude. For The Argentinean Kollas shares the principles of harmony and community, living with nature not against it in which the human is land that walks. For the Native Colombian Communities grouped in the Coordinadora de Organizaciones Indígenas de la Cuenca Amazónica (COICA) are referred to Living Well as returning to the ***Maloka*** which means to return to be ourselves, to feel pleasure in the dance that links your body with the spirit, to protect our knowledge, technologies and sacred lands, to be communitarian and not individual, to live in the circular time of the great return, where the future is always in the back. For the Mayans, there are two words to describe the Living Well such as ***Ronojeri K'o uchak upatan***: all has a function and a reason to be, Ronojeri jastaq Ki chapon Kib', all the elements of the universe are linked. So Living Well means: to recognize Earth is the mother that protects us, and all the environment and the ecosystems communicate with us and our ancestors, that the human is an element of the universe, the cosmovisions are means to communicate with the nature. For the Guarani Nation, ***Teko Kavi*** means Good Life and implies to respect life and can be understood by this quotation "You are well when you are well with nature, with the spirits, elders, and children and with everything that surrounds you, that is Living Well". For the Araona Nation, Living Well is living in harmony and love, free, calmly and happy and Finally, for the Qhechua, The Living Well is the ***Sumaj Kausay*** which is the collective subject, the labor is communitarian and a respectful management of natural resources, abstention of the surpluses and harmonization with the nature.

Few nations took the first steps to change their constitutional statements which included the Living Well Approaches such as Ecuador and The Plurinational State of Bolivia. In Ecuador, indigenous movements promoted new alternatives in the political and economic realities of Post-Neoliberal governmental. Living Well represents a new development paradigm that initiates a series of socioeconomic transformations, popular capitalism and socialism (Ramirez, 2011). In the Ecuadorian Constitution, Living Well implies more than improving the population's quality of life and an economic system that promotes equality through social and territorial redistribution of the benefits of development, guarantees national sovereignty, and promotes cultural diversity (Art. 276, 2008 Constitution). One of the most outstanding measures in the Constitution is the recognition of the two major indigenous languages (Qhechua and Shuar) to facilitate intercultural engagement between indigenous peoples and the state (Quintero Lopez, 2009).

The Plurinational State of Bolivia has stated since its re-foundation in 2006 and with the MAS political party participation that the actual capitalistic model has created shocking effects for humankind and environment such as: 1) the division of rich and poor countries,2) social and economic inequity, 3) environmental crisis (pollution, climatic change, deforestation), 4) food crisis, 5) financial crisis, 6) monopoly of the food chains. Those are the causes why The Plurinational State of Bolivia has emphatically criticized the Green Economy Approach. It was during the Rio+20 Summit that was recognized that there are other alternative approaches rather than The Green Economy for sustainable development and in the written document at the International Summit states that the Green Economy is not an approach, it is only a tool to pursue the sustainable development instead. Specifically, in the Paragraph 56 of the Rio+20 ¨The Future We Want¨ document recognizes that there are not only a unique model for sustainable development if not many approaches, visions, models and tools available in every country according to the international and national objectives for development (UN, 2012). During the preparation of this document in Rio de Janeiro, The Plurinational State of Bolivia has succeeded to incorporate other paragraphs that deal with Mother Earth:

Paragraph 39. We recognize the Planet Earth and its ecosystems that are our home and that the Mother Earth is a common expression in many countries. We are convinced in order to create a fairer balance between the environmental, social and economic needs for present and future generations, it is necessary to promote the harmony with nature. Paragraph 40. We ask to be incorporated more holistic and integrated approaches for sustainable development that drive men to live in harmony with nature and help to adopt of measures to re-establish the health and the integrity of The Earth ecosystem. Finally, The Plurinational State of Bolivia stated that our country does not recognize the Green Economy as a tool for the achievement of the sustainable development and poverty eradication. As a matter of fact, Green Economy is understood as the economization of the nature functions and cycles, the Environmental Payment Services, the evasion of the environmental agreements by developed countries. Another achievement of our country is the elimination of the Green Economy in the document of the COP 11 of the CBD (Hyderabad, India, 2012) in which has been that the biodiversity and development relationships take into account other approaches such as the Living Well in harmony and balance with Mother Earth as well as the mechanisms for conservation of the environmental functions were not market-based. In the CDS Rio+20 ¨The Future We Want¨ countries decided to take multilateral actions in order to define the Sustainable Development Goals (SDG). The Plurinational State of Bolivia has woken up aggressively to change the westernized idealistic approach of The Green Economy with the Living Well in harmony and balance to Mother Earth. Bolivia in the only one country that has stepped aside of The Green Economy Approach and it is promoting in the United Nations the development paradigm of the Living Well in harmony and balance with The Mother Earth and assuming the lead worldwide.

The Plurinational State of Bolivia disagrees with the Environmental Payment Services (EPS) and has stated it in the International Summits and Conferences because these are market-based approaches for the natural capital. Also, Bolivia has stated the erase of the EPS and has inquired the market-based approaches creating the consideration at the general council that there are two approaches that must be recognized such as the market-based approaches (Green Economy) and the Non market-based approaches (The Living Well). Furthermore, Bolivia has eliminated the acronym REDD+ of many international documents because is not a recognized acronym for the United Nations. For the Group 77 and China (G-77+China) in which Bolivia is included and has represented all developing countries with voice participation in the Sustainable Development Conference. A proposal from the G-77+China Summit established a full respect of the sovereignty of the countries in order to define their policies and plans as they consider Green Economy. Furthermore, the Agenda 21 was acknowledged as the pillar of the sustainable development and erased the green adjective of the words related to development such as: green jobs, green agriculture (G-77+China, 2012). The most important achievement from the G-77+China Summit was the recognition of the multiple and diverse approaches and models of development worldwide and with an alternative green economy approach which is neither monopolist nor privatizing.

4. World People´s International Conference on Climatic Change and the Rights of the Mother Earth

The Plurinational State of Bolivia has invited to governmental and social organizations representatives to attend the International Conference of the People´s on Climatic Change and the Rights of the Mother Earth held in Tiquipaya, Cochabamba in April 2010. In this event attended only 30,000 thousand people from around The World. The principal conclusions of this magnificent event were adopted by the government of Bolivia as an agenda for its response to climatic change. The principal conclusions for the building of the Bolivian position are the following:

a) We propose that People's World must rescue, revalue and enhance the knowledge and ancestral practices of the natives. In order to fight the climatic change we must recognize the Mother Earth as a living being that we interact with it.

b) We must create a new system based on the respect to Mother Earth Rights and Human Rights

c) To engage in a 300 ppm (parts per million) of emissions of greenhouse gases in the atmosphere in order to limit the average global temperature at the maximum level of 1 C.

d) The developed countries, principal promoters of the climatic change, assume their historical responsibility in all dimensions envisioning a fair solution, effective and scientific to climatic change.

e) We demand the right to have and access to water for all the People and we also support the Bolivian proposal to recognize water as a primordial human right

f) The UN Declaration on Indigenous Peoples Rights must be recognized, implemented and integrated in the climatic change negotiations

g) We condemn the market-based mechanisms such as the REDD (Reducción de Emisiones por la Deforestación y Degradación de Bosques) and their versions + and ++, that are ripping away the People's sovereignty and their right to choose freely and be informed that it is against the people's rights, costumes and traditions and the Mother Earth rights.

h) We demand People to propose and promote a deep reform of the United Nations Organization (UNO) in order that all member states fulfill the decisions of The International Committee of Environmental and Climatic Justice.

The Plurinational State of Bolivia has maintained its International position on the conclusions of the Peoples World Conference on Climatic Change and The Rights of Mother Earth due to the fact that The COP 16 Summit held in Cancun, Mexico in December 2010 did not incorporate the Tiquipaya´s Conference Conclusions and Bolivia refused the agreements of the COP 16 Summit.

5. The Plurinational State of Bolivia against the anthropocentric, capitalist and monocentric thinking

The principal objective of the Bolivian position in the international arena is to defeat the anthropocentric, capitalist and mono-centric thinking through the recognition of different approaches and visions such as the Living Well in harmony and balance with Mother Earth. This approach is cosmo-centric because men and nature complete each other and it is based on the Economy of the Mother Earth that has an anti-capitalist character and it is polycentric recognizing the diversity, social, cultural and political plurality in the world. These three characters are:

1) The transition of the anthropocentric thinking in which nucleus is the human being, with the right to exploit the Mother Earth to a cosmo-centric thinking in which the human

and nature are equal. It is very important to recognize the Mother Earth Rights and to stop the climatic change impacts and loss of diversity.

2) The transition of the westernized capitalistic and colonial thinking, which philosophical comprehension and world vision which is done by the Green Economy and it is contrasted with the Economy of the Mother Earth which is not market-based but the income generating mechanism from the nature are articulated with the re-distribution and the respect of the Mother Earth and the construction of a non-capitalistic society

3) The first step for the Living Well construction is the eradication of extreme poverty but respecting the Mother Earth Rights. For a better understanding, the capitalistic model in the environmental economics is ¨The economics of ecosystem and diversity¨(TEEB) and its tool is the Environmental Payment Services (EPS), The TEEB reinforces the expansion of the markets and the capitalism towards the nature. For the Bolivians, the developmental model is the Living Well in harmony and balance with Mother Earth and its principal tool is the ¨Management of the Living Systems of the Mother Earth¨(GSV). For the capitalism the solution for the environmental problems is the building of the market-based approaches. On contrast, The Living Well Model, the solution to the most overwhelming problems such as climatic change, loss of biodiversity and the access to genetic resources is the building of non-market-based mechanisms and the consolidation of the Mother Earth Economics fundamentals. The Bolivian agenda is integral and can be resumed in the following: ¨Integral and sustainable management of the living systems of the Mother Earth with a global mitigation and adaptation approaches to climatic change. Also, the Bolivian position considers as the first step the extreme poverty eradication, in the Mother Earth Rights. To succeed on that, it is necessary to recognize the universal human rights such as the access to water and basic sanitation access.

5.1 Living Well in harmony and balance with Mother Earth

The capitalism is based on the idea to succeed all people's wellbeing. This model puts first the economic progress, in which nature is an inert object that can be exploited by an infinite resources source and an inert object (natural capital) which is done by the highest living form in The Earth and its tool is the Green Economy.

The Green Economy is excluding in comparison to the Mother Earth Economy which is inclusive. The Living Well is a concept that is integrated to the Political Constitution Statement of the Plurinational State of Bolivia. The Constitution states that Bolivia will be a ¨State based on the respect, equity between all with principles of sovereignty, dignity, solidarity, harmony and equity in the distribution and re-distribution of the social product following the Living Well ideals. The Article 8 Paragraph I of the constitution establishes that ¨the state assumes and promotes the plural-societal moral and ethical principles of ***Ama Qhella, Ama Sua, Ama Llulla*** (Do not be Lazy, Do not steal, Do not lie), ***Sumaj Qamaña*** (Living Well). The Living Well is central in the Development National Plan of Bolivia (2006-2011) called: ¨Proud, Productive, Free and Democratic Bolivia for Living Well (The Supreme Decree 29272 September 2007). The Plurinational State of Bolivia has chosen the Living Well model as its own civilization horizon and the balance with mother Earth in order to build a more equal society, fair and solidarity. So, in the First World Forum of Environmental Ministries held in Nairobi, March 2013) was established that there are two paradigms: The Green Economy and The Living Well in harmony and balance with Mother Earth. From the Bolivian point of view, The Living Well has three dimensions that can not be understood separately. These dimensions are:

• *Dimension of values:* To know how to grow, to eat, to dance, to work, to communicate, to dream, to listen, to think

• *Dimension of balance between human being in harmony with Mother Earth*: that means Living Well with oneself, the community and in harmony and balance with Mother Earth. That is the vision of the National Development Plan ¨Proud, Free, Productive and Democratic Bolivia for Living Well (Supreme Decree 29272 September 2007)

• *Political and civilization Dimension*: In which the Living Well is the alternative model to capitalism and it is expressed in a Plurinational State, decolonization and sovereignty and free.

It is impossible to think the Living Well out of these dimensions. The Living Well states a moral revolution, is a construction process of balances between people and natural capital. The articulation of these dimensions is placed in the Law 300 Mother Earth Framework and the integral development for Living Well (Bolivia, 2012). In Contrast, The Western Model was linked to Sustainable Development with the economic, social and environmental dimensions which were expressed with the Millennium Development Goals. Bolivia has demanded with the support of the G-77+China that ¨The future we want¨ document of Rio+20 that was incorporated in the Paragraph 56[3].

5.2 The Economics of Mother Earth

The economics of Mother Earth has the mission of connecting men and nature through the following issues: i) the recognition of the Mother Earth Rights and of the peoples, with the national laws for the not marketization of environmental functions and the sustainable management of the living ecosystems; ii) the enhancement of the ethical and communitarian values for Living Well in harmony and balance with Mother Earth; iii) the enhancement of the collective action of the people to achieve the Living Well. The legal supporting environment is composed by Law 300 Mother Earth Framework and the Integral Development Plan for Living Well according to the following:

a) Mother Earth Rights as a collective subject of public awareness

b) Fundamental, civic, political, social, economic and cultural rights of the peoples

c) Collective and individual rights of the peoples and nations

d) Urban and rural population rights to live in a fair, equal and solidarity society with no material, social, spiritual poverty

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3 "We affirm that every country has different approaches, visions, models and tools, in function of the circumstances and national priorities to achieve the sustainable development in its three dimensions which is our general objective. We consider that the Green Economy in the context of the sustainable development and the eradication of poverty and it is the most important tool available to achieve sustainable development which is an alternative for policies formulation, but they do not consist in a series of rigid norms. We state that The Green Economy must contribute to the poverty eradication and the green sustainable development, increasing social inclusion, enhancement of the human wellbeing and the creation of employment opportunities and fair labor for all, keeping at the same time a healthy functioning of the Earth's ecosystems" (UN, 2012).

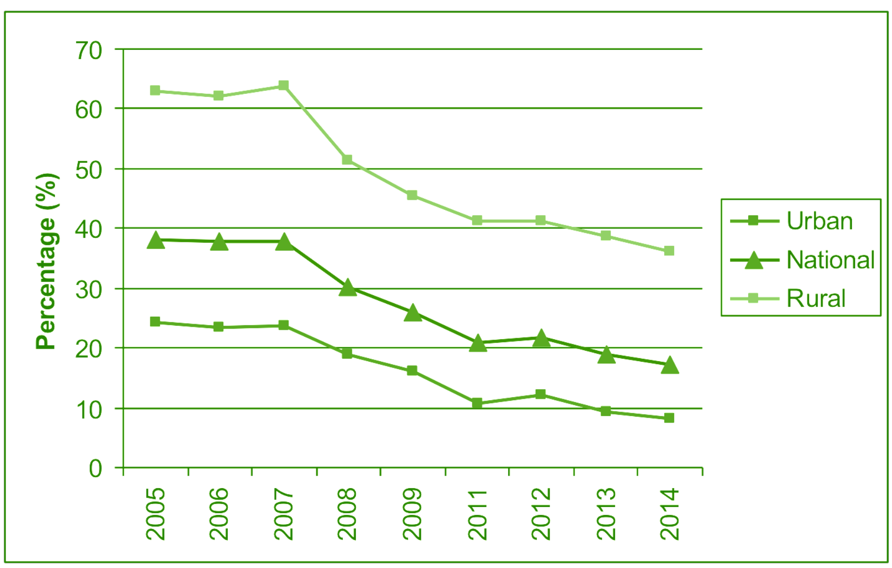
6. The 2020-2025 Patriotic Agenda

In 2025 Bolivia will have accomplished 200 years since its foundation, the President of The Plurinational State of Bolivia, Evo Morales Ayma has planned 13 pillars for the constitution of a Proud and Free Bolivia, with the objective of leverage an state and a society more inclusive, participative, democratic, with no discrimination, racism, hate and division. This agenda has 13 pillars each one with its 66 dimensions.

6.1 Pillar 1. Extreme poverty eradication

The public policies of The Plurinational State are oriented to eradicate extreme poverty, all sorts of exclusion, social, cultural and economic exclusion. Since 2008, the reduction of extreme poverty has decreased from 38.2% in 2005 to 17.3% in 2014. In the urban scenario the extreme poverty reduced from 24.3 to 8.3%. In the rural scenario, the reduction was from 62.9% to 36.1% (Graph 1).

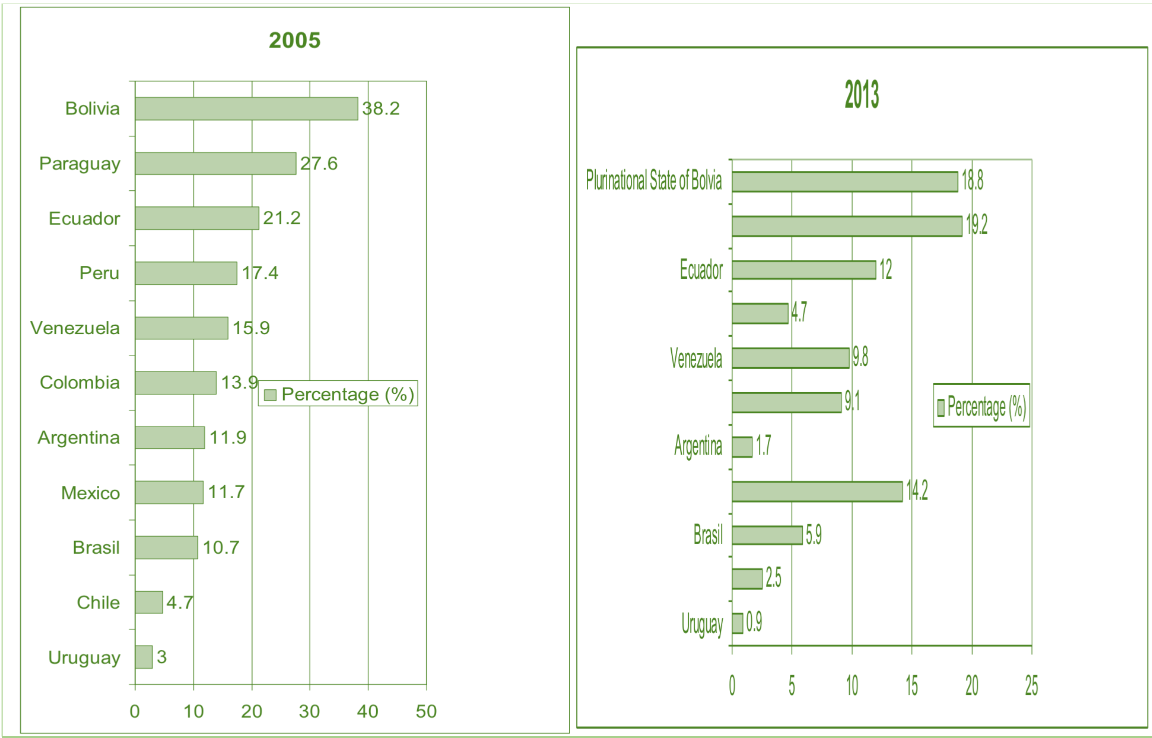
GRAPH 1. EXTREME POVERTY
(PERCENTAGE)



Source: Social, Political and Economic Analysis Unit (UDAPE) with data on home surveys of the National Statistics Institute (INE).

Since 2011, Bolivia is not the poorest country of LAC, but there is still more work to do for the next years (Graph 2).

GRAPH 2. LATIN AMERICA: EXTREME POVERTY
(PERCENTAGE)



Source: CEPAL, 2014

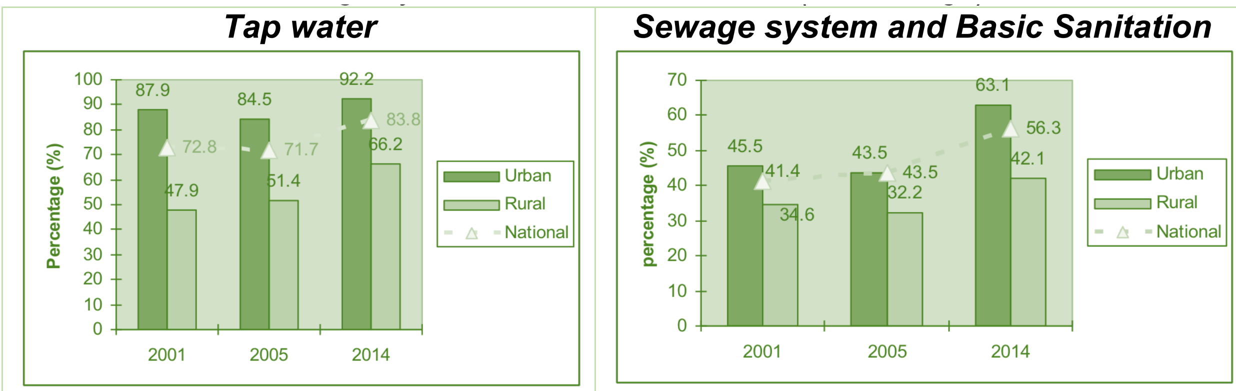
Extreme poverty is an insult for a country that is rich in natural resources and that promotes the communal socialism. In our context, poverty has three dimensions: social, physical and spiritual. The definition of poverty manifests the lack of access to basic services and fair living conditions. Social poverty is understood in the individualistic predominance over communal values and the spiritual poverty manifests in the promotion of consumerism, individualism, discrimination and racism. In Bolivia the extreme poverty has indigenous face of women and children. Rich cultural communities still live in physical poverty due to the impacts of the colonization processes, land expropriation and the ripping off their natural resources. The Plurinational State of Bolivia has reduced extreme poverty from 38.2% (2005) to 18.8% (2013) a 19.4% reduction in eight years which is remarkable.

6.2 Pillar 2. Socialization and universalization of the basic services with sovereignty for Living Well

The New Political Constitution of The Plurinational State of Bolivia (2009) has determined that all basic services are human rights which cannot be considered as business and neither privatized for lucrative purposes.

Basically, these services are water and sanitation, health, education and sports. Other recognized services are the access to information, internet and telephone, electric power. In order to guarantee the access to these services it is necessary to invest and state control.

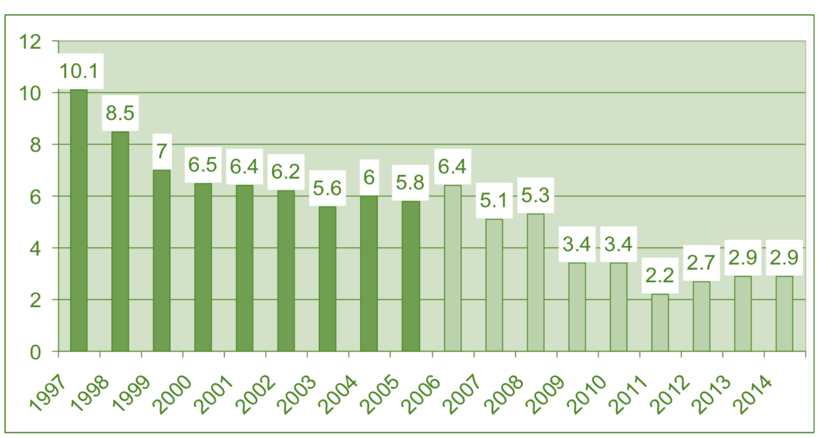
GRAPH 3. POPULATION WITH ACCESS TO TAP WATER, SEWAGE SYSTEM AND BASIC SANITATION (PERCENTAGE)



Source: Ministry of Environment and Water and Vice-Ministry of Sewage and Basic Sanitation 2016.

According to the released statistics the access to tap water in the urban scenario has increased only 7.7% from 2005 to 2014. On the other hand, in the rural scenario, a 18.3% increment is recorded from 2001 to 2014 respectively (Graph 3). At national level there was a 12.1% increment of the population that has access to tap water. The access to sewage and basic sanitation services in the urban scenario has increased 19.6% from 2005 to 2014. In the rural scenario, there was a 9.9% increment in the same period of time. At national level, there was a 24.1% increment in the population that has access to these services.

GRAPH 4. THE GINI'S COEFFICIENT



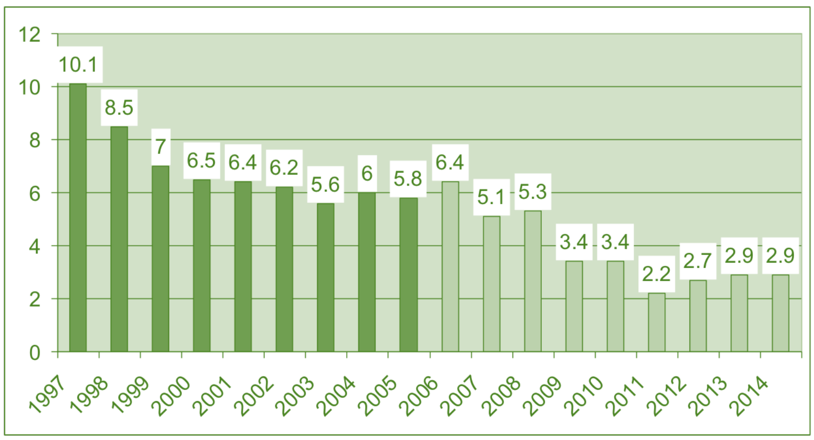
Source: CEPAL, 2014.

The Gini's Coefficient has experienced a progressive reduction from 0.6 (2005) to 0.46 (2010). Then a stagnant increase was reported from 0.46 (2010) to 0.49 (2013).

6.3 Pillar 3. Health, education and sport for the formation of an integral human being

Health, Education, Leisure and Sports are important dimensions for life. It is compulsory that the State provides and guarantees public and free education, health and free services that provide happiness and well-being to people. During the neoliberal period (1997-2005) the school abandonment rate was high until the beginning of the socialist period (2006-today) (Graph 5).

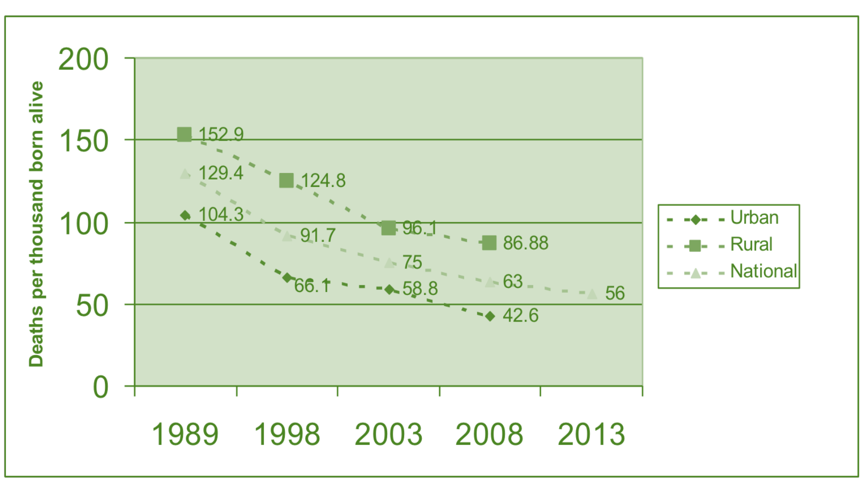
GRAPH 5. SCHOOL ABANDONMENT RATE (1997-2014)



Source: Ministry of Education, 2015.

At national level the reduction of the Children's Death Mortality Rate was recorded from 129.4 (1989) to 56 (2013). In the urban scenario a 12.4 reduction rate is reported (2005-2008) in the beginning years of the socialist period. On the other hand, in the rural scenario a 9.22 reduction is registered (Graph 6).

GRAPH 6. CHILDREN'S DEATH MORTALITY RATE



Source: UDAPE 2014

6.4 Pillar 4. Scientific and Technological Sovereignty with owned identity

In order to manage and process basic productive inputs, we need access to scientific knowledge and technological devices to promote our plural economy, extreme poverty eradication and the universalization of the basic services. Our country cannot be only a producer of natural resources. As a matter of fact, we must transform them and add value.

6.5 Pillar 5. Communal Financial sovereignty with no slavery to financial capitalism

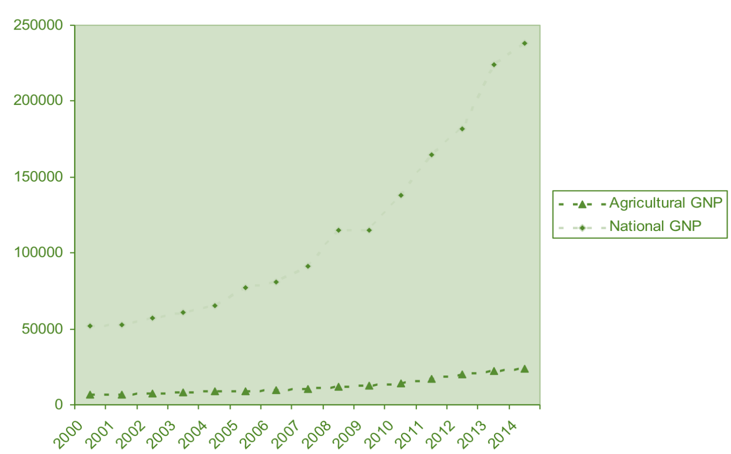
Bolivia is free and cannot stand the influence of foreign financial capitalism that promotes canned proceeds for neoliberal policies such as privatizations that lucre for themselves and not for the people. Bolivia is a proud country and never again will beg to multinationals risking its natural resources for exploitation. We must be isolated from the World Bank and the International Monetary Fund that conditioned us in the neoliberal past risking our future.

6.6 Pillar 6. Productive sovereignty with diversification and integral development with no dictatorship of the capitalist market

The Bolivian economy is highly dependent of the mineral and natural gas exploitation which is an inheritance of the Colonial and Republican times. We must build a plural economy which is diversified and rescues our potential and capabilities respecting the Mother Earth Rights. The Plurinational State of Bolivia promotes and enhances the agriculture and husbandry in all levels, forest conservation, eco-tourism, transport and communications.

The Graph shows that the agricultural GNP has been increasing since 2005 till 2014. During this period this GNP has doubled and in 2011 it started skyrocketing due to the Agricultural Revolution (Law No 144). In spite of this trend, the agricultural GNP is a supplementary GNP. On the other hand, the National GNP has started climbing since 2005 due to the Nationalization of the Natural Gas and Petrol reserves (Graph 7).

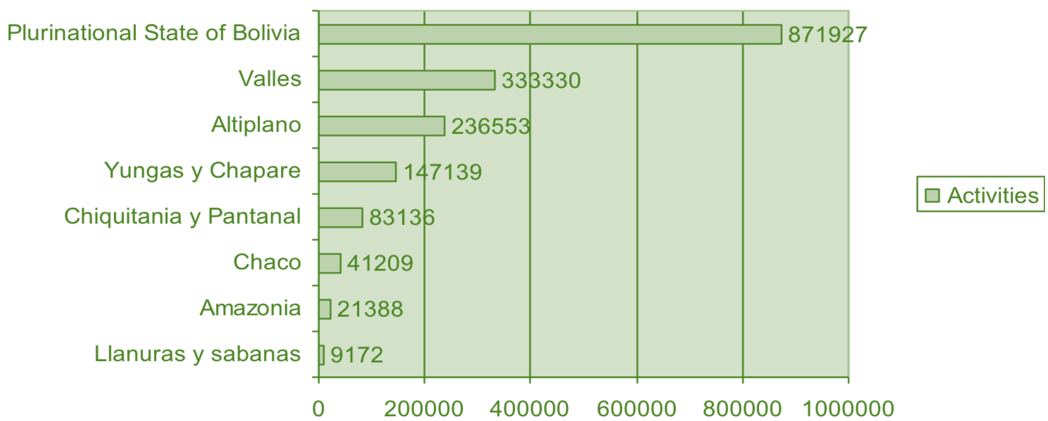
GRAPH 7. AGRICULTURAL GNP AND NATIONAL GNP



Source: INE 2015.

Until 2014, The Plurinational State of Bolivia had 871927 farming units. Those units can be grouped into 7 productive regions: Valleys (38.22%), Highlands (27.12%), Yungas and Chapare (16.87%), Chiquitania and Pantanal (9.53%), Chaco (4.72%), Amazonia (2.45%) and Llanuras and Sabanas (1.05%) (Graph 8).

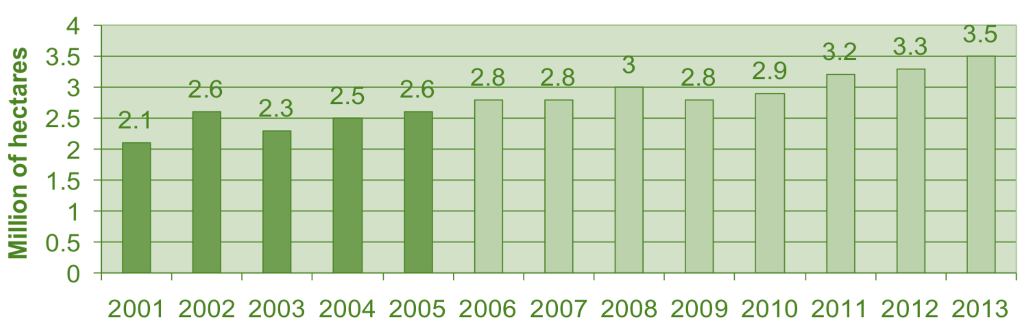
GRAPH 8. NUMBER OF FARMING ACTIVITIES



Source: INE 2014

The principal crops are oil seed crops (soybean, sunflower), maize and vegetables. There has been an increment from 2.8 (2006) to 3.5 million of hectares (2013) (Graph 9).

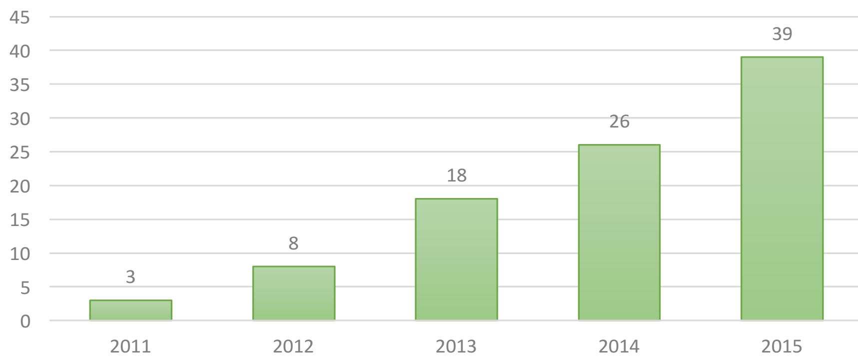
GRAPH 9. PRINCIPAL CROPS CULTIVATED AREA (WINTER AND SUMMER CAMPAIGNS)



Source: INE 2014. Ministry of Rural Development and Lands, National Council of Organic Production (CNAPE 2016)

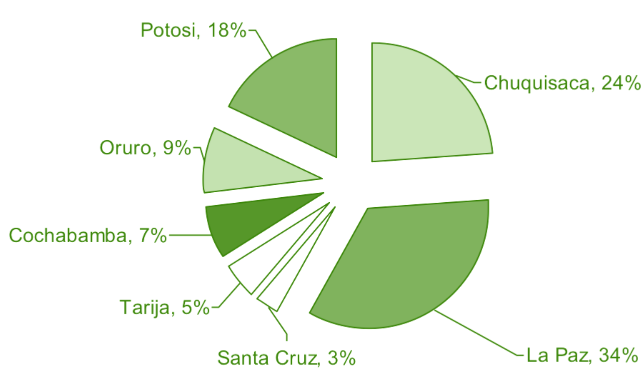
Since the publication of the regulations of the Law No 3525/2005 Promotion of the Organic Production and Non Timber Forestal Products Collection in 2011, a legal and productive arena was exploited. The Municipalities of the Valleys and Highlands had adopted the regulations for the promotion of organic production and prepared their local public policies. Since 2011 to 2015 there was a progressive increment of the number of local organic production committee known as Participatory Guarantee Systems (PGS) committees which were accredited by the SENASAG[4], UC-CNAPE[5] and AOPEB[6] (Graph 10).

GRAPH 10. NUMBER OF ORGANIC PRODUCTION COMMITTEES IN THE PLURINATIONAL STATE OF BOLIVIA



The Department of La Paz has the major affiliates to organic activities (34%), Chuquisaca (24%), Potosi (18%). Oruro (9%), Cochabamba (7%), Tarija (5%) and Santa Cruz (3%) (Graph 11).

GRAPH 11. PARTICIPATORY GUARANTEE SYSTEM BY DEPARTMENT



Source: CNAPE 2013

6.7 Pillar 7. Sovereignty on our natural resources with nationalization, industrialization and commercialization in harmony and balance with Mother Earth

In Bolivia we have built with dignity, pride and sovereignty our economical independence through the people and the nationalization process of our natural resources disenchanting the

4 SENASAG (National Secretary of Agricultural and Livestock Safety).

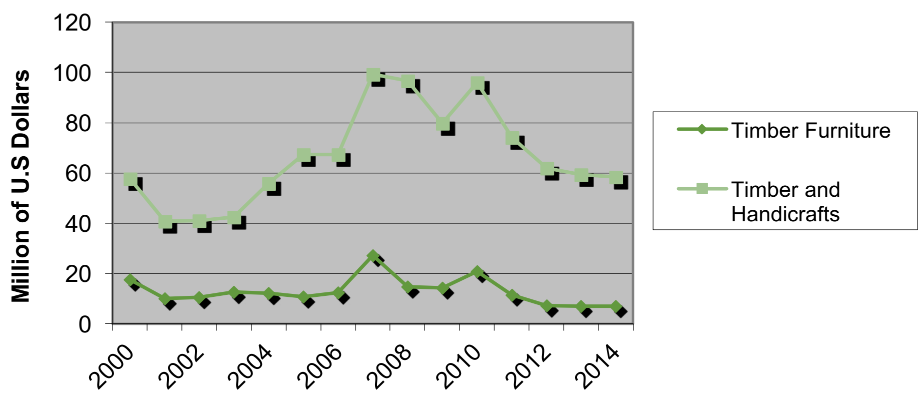
5 UC-CNAPE (Coordination Unit- Organic Production National Committee).

6 AOPEB (The Bolivian Organic Producers Association)

privatization processes. Neoliberal times will not come back again. We have broken the slavery and humiliation chains with the nationalization of natural resources. The industrialization and transformation of our strategic resources are the basis for advancing in the eradication of extreme poverty.

During the Republican Period (1825-2005) the capitalism had rip off The Mother Earth as an object that drove to "The Curse of the Natural Resources" that drove Chile to invade the Bolivian Coasts in order to obtain the phosphates for industrial and imperialist purposes overseas in 1879. Also, the search for petrol drove Bolivia and Paraguay to The Chaco War in 1935. During this war, 150 thousand souls were lost and part of the National territory.

GRAPH 12. EXPORTATION OF TIMBER PRODUCTS (2000-2014)



Source: INE 2015

The production of timber shows an oscillating behavior with peaks in 2007 and 2010 due to the lack of a certification scheme that protects and preserves this natural resource. It is notorious that timber is an expensive and luxurious resource and the production of furniture starts declining since 2011 (Graph 12).

6.8 Pillar 8. Food sovereignty through the construction of the know how to Eat Well

Bolivia had stepped forward in the food decolonization through the ¨The Know How to Living Well¨. The foods are not merchandise anymore but a precious gift of Mother Earth and they are in the heart of the Living Well. In Bolivia, when ¨Know How to feed for Living Well¨ is spoken, we refer to have food sovereignty as a human right for access to healthy and safety food. This means to enhance our local productive practices and guarantee all productive tasks to be forwarded to satisfy the nutritious needs of the Bolivians. At the beginning of 2016, the National Law No 775 Eating Healthy Food was promulgated that states that we must encourage the consumption of native foods and plates in order to combat malnutrition and the conversion of our food habits to eat healthier.

6.9 Pillar 9. Environmental sovereignty with integral development respecting The Mother Earth Rights

While Westernized capitalist societies are forwarding to the Green Economy benefiting multinationals, Bolivia will have achieved by 2025 an International Alternative Process based on the respect and recognition of the Mother Earth Rights. By 2025, Bolivia will have consolidated and agricultural-forestal agenda for producing foods and forest conservation.

6.10 Pillar 10. Nations integration with sovereignty

We must build and enhance our integration agreements with other local governments in a peaceful and collaborative framework. Against the Mother Earth ripping off by Westernized societies, we must build a South-South Diplomacy to be strengthened. It is a crucial moment in which south countries and some of the North must support and strengthen each other in the technological, financial and cultural arenas.

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A very interesting proposal for the World was the ¨Universal Citizenship¨ that states that all people have the right to live, travel and work overseas with no restrains if they comply with the International and National laws.

6.11 Pillar 11. Sovereignty and transparency of the public management under the principles of Ama Sua, Ama Llulla and Ama Quella

The objective is to create a strong, efficient and democratic state in order to respond to the people's needs under the transparency, ethics and moral values using the principles of not stealing, not lying and not to be lazy. For this purpose, the State needs engaged service providers in the legal system, policemen engaged in the city security and the army engaged in the protection of the constitution.

6.12 Pillar 12. Enjoy of the Happiness of our feasts, music, rivers, forests, mountains, clean air, and dreams

Bolivia, as a Plurinational State, promotes the solidarity, complementarily and respect to our cultures, environment and the Mother Earth. There is a balanced participation of the touristic, environmental, cultural institutions. The folklore in Bolivia is richer than other scenarios. Every Department has more than one religious feast such as Urkupina in Cochabamba, Socavon in Oruro, El Carmen in La Paz and Cotoca in Santa Cruz. Also the Carnivals that extends from February to march in all the territory and the well known is the Carnival of Oruro. Music is a delight for Bolivians and foreigners as well. Folklorists create new songs every year that are a hit in the Country. The well known groups are The Kjarkas, Kori Huairas.

Amaru and Baleno. Also Modern music is composed and played and the well known groups are Octavia, Sacrilegio and Maraketa Blindada (Rock Music) and Kirquina, Veneno and Luna Diabla (Alternative Pop).

Furthermore, the Nature is everywhere and it is the most beautiful resource in the Country. The Uyuni Salt Dessert is a very well known place and the scenario of the latest Dakar International Rally and the latest Star Wars Cult movies.

6.13 Pillar 13. Sovereign re-encounter with our joy, happiness, future and our sea

For 2025, Bolivia will return to the sea peacefully, not using the force but reason and solidarity. During the Republican Period (1825-2005), it is known that Bolivia was born with a direct access to the Pacific Ocean and with harbors. Chilean oligarchy allied with imperial interests planned an invasion and appropriate of our natural resources since 1879. In the Socialist period (2006-today), a foreign policy was designed in order to prepare an Agenda with Michelle Bachelet (president of Chile) treating the difficult and bureaucratic exportation of Bolivian products through Chilean Customs and Harbors and the access to the ocean with sovereignty by Bolivians and the Silalas River issues. The next October 1*st* 2018, The International Court of the Hague will dictate a verdict for the initial Bolivian sue against Chile.

The Plurinational State of Bolivia has always looked for a peaceful dialogue with Chilean representatives according to previous historical agreements and treaties. Our representatives worked fruitless during five years. In 2011 Chile's government closed negotiations with The Plurinational State of Bolivia's government and all the advances made were abandoned. For this reason, in 2013, Bolivia sued Chile to The Hague International Justice Court in order to start over the Pacific Ocean access. The court has determined so far: 1) Bolivia was born with a clear access to the Pacific Ocean, 2) Chile offered many negotiating choices but none were accomplished, 3) the 1904 Treaty did not solve the access to the Pacific Ocean for Bolivia and our claim is considered a turning point in the overseas policies. Another, international claim is the Silala River which water is used by Chile, but the waters are born in the Bolivian territory. The Annex 1 shows a summary of the pillars, goals and potential indicators.

Concluding Remarks

The Agenda Patriotica 2020-2025 is the guideline for the development in the social, economic, environmental, social arenas for the next six years in The Plurinational State of Bolivia. It is also an alternative to the 2030 United Nations Agenda for Sustainable Development. It has thirteen pillars and sixty six dimensions.

A remarking issue of the Agenda, is that is a flexible instrument which can be used as a start line to develop other agendas for public enterprises, public institutions due to the selection of the suitable indicators for development and enhancement of public policies.

The accomplishment of the thirteen pillars will ensure that our plurinational society will assure The Living Well objectives and the measurement of the indicators will help to orient the public policies at national, regional and municipal levels.

All municipalities must adequate their public policies to the 2020-2025 Patriotic Agenda and the national Law 777 for the Elaboration of Strategic Development Plans, but some municipal governments that belong to the opposite parties such as the Gobierno Autónomo Municipal of Cochabamba (GAMC) that unmarked itself from this National Agenda due to its autonomic character and adopted the United Nations Sustainable Development Agenda 2030 instead. In spite this auto-marginalization of the GAMC from the 2020-2025 Patriotic Agenda, this opposite municipal government lead by the Democrats is facing the most notorious and rampageous corruption cases in the whole municipal history of the City of Cochabamba.

It should be a compulsory act that all the departmental and municipal governments to line up with the 2020-2025 Patriotic Agenda and help to enhance it better with the participation of all actors in order to develop indicators for measurement and surveying.

It is recommended that indicators must be proposed by a participatory way that must be suitable for assessment and measurement periodically. As a matter of fact, the Agenda Patriotica is a general guideline for common development, but it can be enhanced for local purposes such as a municipal government.

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La insostenibilidad de las teorías económicas convencionales frente a la triple crisis; ecológica, económica y social. Una aproximación a la cosmovisión indígena en México como respuesta

Ismael Sánchez Brito*

Introducción

En la actualidad con los problemas ambientales, sociales y económicos, de ámbito local, regional, nacional y global, es necesario realizar una reflexión acerca de la base teórica de la economía moderna, los clásicos, neoclásicos y marxista, y su relación con la naturaleza y preguntarse si el marco teórico es el adecuado para afrontar estos problemas o revisar otras fuentes del pensamiento no necesariamente económico basado en otra visión, dónde las relaciones ser humano-naturaleza se reproducen de manera cotidiana. Si bien los "padres" de la economía moderna --Smith, Ricardo, Marx y la teoría económica neoclásica con el surgimiento de la escuela marginalista-- explican cómo se produce la riqueza, su acumulación, distribución y optimización de factores, en ninguno de estos marcos teóricos se observa la importancia de la naturaleza como fuente de vida, además de considerar al "hombre" como el sujeto o centro de estudio (antroponcentrismo), mientras que en la cotidianidad se reproduce otras formas de relación con la naturaleza y sociedad, dónde el origen proviene del pensamiento y filosofía indígena.

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La actual crisis ecológica, económica y social hace necesario replantear la visión de cómo plantear los problemas y bajo que enfoque teórico resolverlos. Estás crisis están basadas bajo un modelo de producción específico el capitalista que se encuentra sustentado y justificado en teorías económicas convencionales. Algunos datos de la crisis global las crisis financieras y económicas permanentes en la economía mundial de la década de los noventa del siglo pasado y la crisis reciente en Estados Unidos de América en el 2008. La persistencia del desempleo, el cual se mantiene en niveles altos en Estados Unidos de América (EUA) la desocupación llego al 10% en octubre de 2010 y en el año 2015 por arriba del 6% y en Europa la tasa de desempleo ha seguido a una tendencia al alza ubicándose por arriba del 10%. De acuerdo con Pogge (2009), en 1820 la relación del ingreso del 20% más rico respecto al 20% más pobre del mundo era de 3 a 1; en 1913 llegó a 11 a 1 y a finales del siglo pasado (1997) era de 74 a 1 (Damián, 2015).

En las últimas tres décadas, el sector financiero ha registrado una expansión sin precedentes. En términos de acervos, entre 1980 y 2014 los activos a nivel mundial (sin tener en cuenta los derivados) se expandieron de 12 billones a 294 billones de dólares (1.1. y 3.7 veces el PIB mundial respectivamente). Por su parte, en el mismo período, el valor de los contratos de derivados pasó de 1 billón a 692 billones de dólares, lo que representa cerca del 70% de los acervos globales de activos financieros. Por su parte, los derivados, cuyo valor era cercano al [1]PIB en 1980, pasaron a representar más de diez veces el valor del PIB mundial a partir de la segunda mitad de la década de 2000 (CEPAL, 2016).

De acuerdo a la Organización de las Naciones Unidas (ONU) se refiere a avances respecto a los Objetivos de Desarrollo del Milenio (ODM) en el caso de la pobreza extrema y el hambre casi la mitad de la población de las regiones en desarrollo vivía con menos de 1.25 dólares al día en 1990, este porcentaje ha descendido a 14% en 2015. También menciona el informe que a nivel mundial la cantidad de personas que viven en pobreza extrema se ha reducido en más de la mitad, cayendo de 1,900 millones en 1990 a 836 millones en 2015 (ONU, 2015).

La desigualdad se ha incrementado en prácticamente en todas las regiones del mundo en décadas recientes, aunque en distintas velocidades. La desigualdad de ingresos varía significativamente entre regiones. En 2016, la participación en el Ingreso Nacional de apenas el 10% de individuos con mayores ingresos era 37% en Europa, 41% en China, 46% en Rusia, 47% en Estados Unidos-Canadá y aproximadamente 55% en África Subsahariana, Brasil e India. En Medio Oriente, la región más desigual del mundo se apropiaba del 61% del Ingreso Nacional (Alvaredo *et al.*, 2018).

Así mismo la crisis ecológica respecto al cambio climático en el informe del Grupo Intergubernamental de Expertos sobre Cambio Climático (IPCC) menciona que es clara y las emisiones antropogénicas recientes de gases de efecto invernadero son las más altas de la historia. Los cambios climáticos recientes han tenido impactos generalizados en los sistemas humanos y naturales (IPCC, 2015). Es probable que el periodo 1983-2012 haya sido el periodo de 30 años más cálido de los últimos 1,400 años en el hemisferio norte, donde pudieron hacer esta evaluación (IPCC, 2015). Los datos de temperatura de la superficie terrestre y oceánica, combinados y promediados globalmente, calculados a partir de una tendencia lineal. Muestran un calentamiento de 0.85 °C, durante el periodo 1880-2012 (IPCC, 2015).

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Algunos datos de los cambios de la estructura y funcionamiento de los ecosistemas en el informe de la Evaluación de los Ecosistemas del Milenio (2005) mencionan que se ha convertido más superficie en tierra laborable desde 1945 que en los siglos XVIII y XIX juntos. Aproximadamente el 20% de los arrecifes de coral del mundo se perdieron y 20% más se degradaron en las últimas décadas del siglo XX y alrededor del 35% de las zonas de manglares se perdió durante ese mismo tiempo. La cantidad de agua embalsada en presas se ha cuadriplicado desde 1960, y la cantidad de agua contenida en embalses es de tres a seis veces mayor que la de los ríos naturales. La toma de agua desde los ríos y lagos se ha duplicado desde 1960 y la mayor parte del agua utilizada (el 70% mundial) se destina a la agricultura. El número de especies sobre el planeta está disminuyendo. En los últimos siglos, los seres humanos han hecho aumentar la tasa de extinción de especies hasta 1,000 veces por encima de las tasas típicas de la historia del planeta. Entre el 10 y 30% de las especies de mamíferos, aves y anfibios están actualmente amenazadas de extinción (EEM, 2005).

Está crisis global es el efecto del modo de producción vigente y de relaciones sociales de producción bajo el enfoque de acumulación de capital y de la apropiación de la renta que provee los recursos naturales. Actualmente se sigue promoviendo las mismas teorías sin detenernos a reflexionar, si está forma de pensamiento permita resolver los problemas actuales o acentuarlos. En el presente trabajo tiene como objetivo plantear de una manera breve y general la cosmovisión indígena como una respuesta a esta crisis.

1. Revisión de la teoría de la renta

La teoría de la renta es uno de los conceptos que se debe de revisar para entender la visión de la economía clásica incluyendo el marxismo para comprender el uso de los recursos naturales.

La Teoría de la Renta, es el primer concepto que se considera para la valoración de los recursos naturales principalmente la tierra. El tema de la renta de la tierra ha sido controvertido desde sus inicios. Fue abordado por Smith (1776), totalmente reformulado por Ricardo (1817) y profundizado por Marx (1867) (Farina, 2006).

La Teoría de la Renta tiene implicaciones importantes respecto al uso de los recursos naturales renovables y no renovables, mucho antes de mencionar los economistas neoclásicos.

El debate teórico en torno a la renta, salvo algunas excepciones, fue prácticamente abandonado por la economía política. Este abandono está fuertemente vinculado al abandono de la teoría del valor trabajo y al predominio de

las teorías subjetivas del valor. La importancia del tema radica en que, si no se tiene en cuenta la teoría de la renta, se está igualando a los medios de producción producidos con los no producidos. Este error conlleva a considerar a la tierra como si fuera capital y a ignorar en que las distintas rentas forman o no parte de la conformación de los precios (Farina, 2006).

Las aportaciones principales son los conceptos de renta absoluta, renta diferencial y conceptos como el de rendimientos decrecientes, la diferencia tecnológica y derechos de propiedad de los recursos.

Uno de los grandes méritos de A. Smith consiste en haber expuesto cómo la renta del suelo del capital invertido en la producción de otros productos agrícolas, por ejemplo, de lino, de plantas colorantes, en la ganadería como una rama independiente, etc., se halla determinada por la renta del suelo que arroja el capital invertido en la producción del medio alimenticio fundamental (Marx, 1946).

Ricardo (1817) define la renta aquella parte del producto de la tierra que se paga al terrateniente por el uso de las energías indestructibles del suelo. Se confunde a menudo con el interés y la utilidad del capital y en lenguaje popular, dicho término se aplica a cualquier suma anualmente pagada por el agricultor a su terrateniente (Ricardo, 1994).

Adam Smith habla de la renta, en el sentido estricto al cual deseó limitar dicho término, pero con más frecuencia lo menciona en el sentido popular en que por lo se emplea. Nos dice que la demanda de madera, y su elevado precio consiguiente en las naciones meridionales de Europa, hizo que se pagara una renta por los bosques de Noruega, que antes no arrojaban renta alguna. Sin embargo ¿no es evidente que la persona que pagó lo que él llama renta, la pagó en consideración del bien valioso que entonces existía en la tierra, y que en realidad recupera lo pagado con una utilidad, mediante la venta de la madera? En verdad sí, después de haber removido la madera, fuera pagada al terrateniente alguna compensación por el uso de la tierra, con el propósito de cultivar árboles o cualquier otra cosecha, con miras a una demanda futura, dicha compensación podría llamarse con justicia renta, porque se pagaría por la energía productiva de la tierra; pero en el casi citado por Smith, la compensación fue pagada por la libertad de extraer y vender la madera y no por la libertad de cultivar los árboles que la producen (Ricardo,1994).

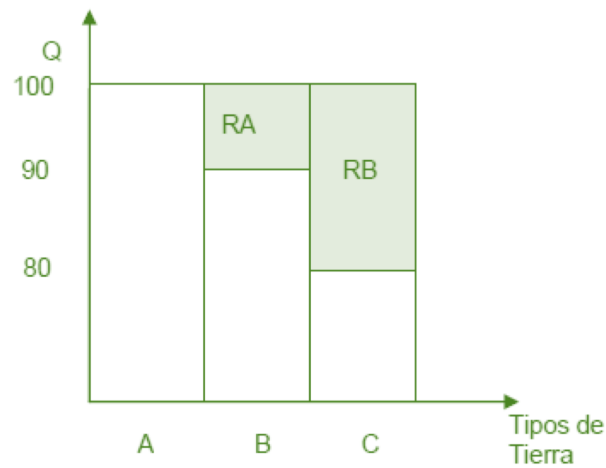
En la primera colonización de un país, en el cual existe abundancia de tierra rica y fértil, requiriéndose cultivar tan sólo una proporción muy reducida para el sostenimiento de la población existente, porción ésta que puede cultivarse con el capital a la disposición de la población, no habrá renta, ya que nadie pagaría por el uso de la tierra, cuando todavía no es de propiedad privada una gran extensión de ésta y donde quedan grandes extensiones a disposición de quienes deseen cultivarlas (Ricardo, 1994).

Según los principios ordinarios de la oferta y la demanda, ninguna renta se pagaría por dicha tierra y ello obedece a la misma razón ya mencionada de que tampoco hay que dar nada por usar el aire y el agua, o por cualquier otro don que la naturaleza nos brinde en cantidad ilimitada. Con una cierta cantidad de materiales, y con la ayuda de la presión atmosférica, de la elasticidad del vapor, los motores pueden desempeñar trabajo y abreviar el esfuerzo humano en una gran proporción; pero ningún cargo se hace por el uso de esas ayudas naturales, debido a que son inagotables y se hallan a disposición del hombre (Ricardo, 1994).

Si toda la tierra tuviera las misma propiedades, si su cantidad fuera ilimitada y su calidad uniforme, su uso no ocasionaría ningún cargo, a menos que brindara ventajas peculiares de la situación. Por tanto únicamente por que la tierra no es ilimitada en cantidad ni uniforme en calidad y porque el incremento de la población, la tierra de calidad inferior o menos ventajosamente situada tiene que ponerse en cultivo, se paga renta por su uso. Con el progreso de la sociedad, cuando se inicia el cultivo de la tierra de segundo grado de fertilidad, principio inmediatamente la renta en la tierra de la primera calidad y la magnitud de dicha renta dependerá de la diferencia en la calidad de estas dos porciones de tierra.

Cuando se inicia el cultivo de tierras de tercera calidad, la renta comienza inmediatamente en la de la segunda y está regulada, como antes por las diferencias en sus energías productivas. Al mismo tiempo la renta de la primera calidad aumentará, ya que esta siempre debe ser superior a la segunda, por razón de la diferencia existente entre el producto que rinde, con una cierta cantidad de capital y trabajo. Con cada nueva etapa en el progreso de la población, que obliga al país a recurrir a tierras de peor calidad para permitirle abastecerla con alimentos, la renta aumentará en la totalidad de la tierras más fértiles (Ricardo, 1994).

FIGURA 1. TIPOS DE FERTILIDAD DE LA TIERRA



Fuente: elaboración propia con datos de Ricardo, 1994.

En la figura 2, se observa que existen tres tipos de tierra con diferente tipo de fertilidad, el tipo A produce 100 unidades, el B 90 unidades y el C 80. La renta diferencial para la tierra B es de 10 unidades (RA) lo que cobrará el terrateniente, mientras que el C la renta será de 20 unidades (RB), tomando como referencia la tierra más fértil. También se pude observar en la gráfica el concepto de rendimientos decrecientes, es decir suponiendo que los factores de capital y trabajo son constantes en las tres tierras, la producción seguirá siendo positiva pero decreciente esto debido al factor natural de la tierra.

La premisa que se parte, dentro del régimen capitalista de producción es, por tanto esta: los verdaderos agricultores son obreros asalariados, empleados por un capitalista, el arrendatario, el cual no ve en la agricultura más que un campo especial de explotación del capital, de inversión de su capital en una rama especial de la producción. Este arrendatario capitalista paga al terrateniente, al propietario de la tierra explotada por él, en determinados plazos a cambio de la autorización que aquél le otorgue invertir su capital en este campo especial de producción. Esta suma de dinero recibe el nombre de renta del suelo ya se abone por una tierra, un solar, una mina, una pesquería, un bosque, etc. Se paga por todo el tiempo durante el cual el suelo haya sido cedido, arrendado contractualmente al capitalista por el terrateniente (Marx, 1946).

Por consiguiente, la renta del suelo es la forma en que se valoriza la propiedad territorial. Además, nos hallamos aquí en presencia de las tres clases que forman el marco de la sociedad moderna, juntas las tres y enfrentándose entre sí, a saber: obreros asalariados, capitalistas industriales y terratenientes (Marx, 1946).

Bajo el concepto de la renta diferencial Ricardo menciona siempre que disminuye la desigualdad en el producto obtenido con porciones sucesivas de capital empleadas en las mismas tierras o en tierras nuevas, la renta tiende a disminuir y cuando dicha desigualdad aumenta ocurre el efecto contrario y la renta tiende a aumentar (Ricardo, 1994).

Marx menciona que entre las causas de que la renta aumenta no se cuentan solamente las generales (la fertilidad y la situación de la tierra), sino además: 1) el reparto de los impuestos y contribuciones, según que se distribuyan por igual o no, 2) Las desigualdades que provienen del distinto grado de desarrollo de la agricultura en las diferentes partes del país y 3) La desigualdad de distribución de capital entre los arrendatarios de la tierra (Marx, 1946).

En lo tocante a la renta diferencial el valor comercial es siempre superior al precio total de producción de la masa de productos (Marx, 1946). Un concepto que aporta Carlos Marx es el de la renta absoluta. La renta absoluta se define a partir del tributo que cobra el propietario de la tierra, partiendo del derecho de propiedad privada sobre la renta. El monopolio de la propiedad privada sobre la tierra constituye la causa originaria de la renta absoluta, que se paga por cualquier terreno independientemente de su fertilidad y del lugar en que se encuentra. La renta absoluta es el remanente del valor del producto agrícola sobre el precio social de producción. Como un ejemplo es el precio de venta de granos en 140 unidades monetarias y el costo de producción es de 120, la diferencia de 20 unidades es la renta absoluta, que va parar a manos del propietario de la tierra (Nikitin, 1980).

2. Economía neoclásica

Los iniciadores de la escuela marginalista o neoclásica fueron Carl Menger (1867), Leon Walras (1860), William Stanley Jevons (1870), Alfred Marshall (1890) a principios del siglo XX con una fuerte influencia de Jeremy Bentham (1789). Menger afirmaba que el método económico debía sustentarse en una base individualista, posición que sería confirmada por Walras, fundamentalmente con el desarrollo del concepto del valor de cambio, basado en la utilidad individual y la relativa escasez de la cantidad de los bienes que satisfacen ciertas necesidades.

Es justamente el carácter de escasez y la capacidad de satisfacer necesidades el que, según Menger, confiere a las cosas su carácter económico. Las cosas ilimitadas no poseen valor alguno (Bifani, 1980).

El pensamiento neoclásico se caracteriza por el esfuerzo de sistematización y perfeccionamiento instrumental analítico desde un punto de vista ideológico, conceptual y metodológico, que tendría profundas y múltiples implicaciones para la ciencia económica e indirectamente en la consideración de los aspectos sociales y ambientales del desarrollo (Bifani, 1980).

El rasgo principal es que la ciencia económica se hace más formal y abstracta, reflejando una falta de interés por el carácter social de la actividad económica: la producción y el consumo. Lo sociedad pasa a ser concebida como una aglomeración de individuos, ignorándose los aspectos históricos del sistema social, que condicionan y determinan una situación en un momento dado (Bifani,1980).

Los pensadores anteriores como Adam Smith (1776), David Ricardo (1817) y Carlos Marx (1867), asentaban el análisis económico en una cierta visión de la sociedad, de sus estructuras y de su venir histórico. Los neoclásicos van a concentrar su atención en la conducta individual, orientada a maximizar sus utilidades y placer bajo ciertos supuestos de racionalidad (Bifani, 1980).

León Walras describió el equilibrio general de la competencia perfecta para explicar cómo los precios se pueden determinar por las interacciones de los mercados para diversas mercancías. Los supuestos de competencia perfecta se basa en los siguientes supuestos: a) gran cantidad de vendedores y de compradores, b) homogeneidad de productos, c) libre entrada y salida de empresas del mercado, d) maximización de los beneficios, e) ausencia de control estatal, f) movilidad perfecta de los factores de producción, g) conocimiento perfecto del mercado y h) ausencia de externalidades tecnológicas y ambientales (Koutsoyanis, 2002).

Para la teoría neoclásica la maximización del bienestar supone la posibilidad del individuo de jerarquizar sus posibles objetivos en un orden de preferencias que, en último término, define una función de bienestar individual, cuya suma permite obtener la función de bienestar total de la sociedad o función social de bienestar (Bifani, 1980). El planteamiento neoclásico establece que la acción racional de las diferentes unidades del sistema económico, orientadas al logro de su bienestar individual, lleva al sistema a una situación de óptimo de equilibrio definida en términos paretianos (Bifani, 1980).

El óptimo de Pareto se logra en el mercado cuando después de un cambio, el resultado de la suma algebraica entre ganadores y perdedores revela que los ganadores compensan con creces a los perdedores. Pareto (1870) definía como una posición óptima aquella en la cual no se puede mejorar la situación de dos partes al mismo tiempo. La teoría del óptimo de Pareto, es el desarrollo de la teoría del equilibrio general de Leon Walras (Bifani, 1980).

De acuerdo con la teoría neoclásica, sólo bajo condiciones de competencia perfecta, la asignación de los factores de producción -trabajo, capital, recursos naturales- entre sus usos alternativos, como resultado de los mecanismos de mercado, libres de interferencias, permitiría alcanzar el máximo bienestar social sin discrepancias entre intereses privados y sociales, dada una determinada distribución del ingreso. Se sabe, también, que tales condiciones son imposibles de lograr en el mundo real, salvo algunas aproximaciones en el caso de ciertos mercados muy particulares; en consecuencia, en el mundo real, deben esperarse discrepancias de grado variable entre intereses sociales y privados, independientemente de cuan perfectos sean los mercados, mayores cuanto más imperfectos lo sean (CEPAL, 1991).

3. Cosmovisión indígena

De acuerdo al Censo de Población y Vivienda 2010, el Instituto Nacional de Estadística y Geografía (INEGI) estima una población de 15.7 millones de indígenas en México. Existen 11.1 millones que viven en un hogar indígena. De los 15.7 millones, 6.6 millones son hablantes de lengua indígena y 9.1 millones no hablan lengua indígena y 440 mil de los hablantes no se consideran indígenas (CDI, 2014). Un rasgo fundamental de la población indígena es su diversidad y pluralidad. Los indígenas mexicanos no son un cuerpo homogéneo. Por eso, si bien, en México existen 68 pueblos indígenas que se corresponden con las 68 lenguas que se hablan en todo el país (CDI, 2014).

Lo anterior es sola una referencia de la población actual indígena, lo que se debe resaltar son las acciones y decisiones económicas cotidianas de las familias y que el pensamiento indígena se encuentran subsumidas en el proceso. Lo anterior ha trascendido a pesar de diversos procesos históricos que ha tenido el país, trescientos años de colonización, la revolución de la independencia, invasiones extranjeras, la revolución mexicana, el México postrevolucionario con aplicación de diferentes modelos económicos pasando desde el modelo de sustitución de importaciones hasta el modelo de apertura comercial y financiera vigente hasta la actualidad.

Sin embargo hay que mencionar que en la actualidad los indígenas siguen realizando sus actividades a partir de su visión del mundo y con ello preservar y conservar los recursos naturales además de generar riqueza. Por ejemplo; en más de 80 de las 176 áreas naturales protegidas (ANP) de competencia federal, la presencia de 267 mil indígenas destaca que han preservado en buen estado los diversos ecosistemas y su biodiversidad (CDI, 2014). Así mismo en el manejo del agua se refiere la cosmovisión como al conocimiento y saberes tradicionales puestos en acción mediante la organización social para el manejo del agua; las prácticas locales para la protección, cuidado y abastecimiento de agua y el manejo de los recursos naturales, en oposición a la sobreexplotación y el mercantilismo de los recursos hídricos y de la naturaleza en general vistas diariamente en nuestro mundo actual (SEMARNAT, 2016).

En la alimentación en el caso de la tortilla tiene más de dos mil años, como principal fuente de energía, nutrición e identidad cultural. Los mexicanos hemos sido nutridos y criados a base de tortillas, en los cuales se concentran los conocimientos y tradiciones de múltiples generaciones de agricultores, consumidores madres de familia y comerciantes (Mier, 2018), existen en el país más de dos millones de campesinos cultivando maíz, así como alrededor de 80 mil tortillerías (Mier, 2018). La cultura del maíz en nuestro país se ha venido forjando a lo largo de más de ocho mil años. Por decenas de generaciones, los saberes y tradiciones relacionadas a la siembra y consumo de maíz han sido transmitida de generación en generación hasta nuestro días (Mier, 2018). Así mismo celebraciones religiosas con sincretismo por ejemplo el día de la Candelaria, con el tradicional consumo de tamales y atole, generó una derrama económica de 26 millones 400 mil pesos datos de la Cámara Nacional de Comercio, Servicios y Turismo en Pequeño (Canacope) de la Ciudad de México (Saldaña, 2018).

Lo anterior hace preguntar ¿Cuál es el pensamiento filosófico basado para reproducir el cuidado del ambiente y los recursos naturales? ¿Por qué seguimos reproduciendo ese patrón a pesar del bombardeo ideológico de las teorías económicas convencionales? ¿Por qué este pensamiento filosófico a su vez genera riqueza que sustenta y reproduce la vida y no el capital? Desafortunadamente no se tienen fuentes escritas para seguir el origen del pensamiento filosófico sin embargo se ha transferido el conocimiento vía oral por generaciones.

Portilla describe que Sahagún dio principio a sus investigaciones a partir de 1547. Había trascurrido entonces sólo 26 años desde la toma de Tenochtitlan. Era, pues fácil encontrar, no sólo en la capital azteca, sino en Texcoco, Tepepulco, Tlatelolco, etc., no pocos hombres maduros de 50 a 70 años, que habían vivido en sus pueblos y ciudades, desde unos 24 hasta casi 50 años antes de la venida a los españoles (Portilla, 2006), también se menciona que a falta de una escritura por medio del aprendizaje de memoria, que servía para entender las ilustraciones de los códices. En este sentido, no puede caber duda alguna, que entre las doctrinas que se enseñaban a lo más selecto de la juventud náhuatl debió hallarse incluido lo más elevado de su pensamiento, encerrado muchas veces en los cantares y discursos aprendidos de memoria (Portilla, 2006).

Así mismo el pensamiento cosmológico náhuatl encontraremos, más aún que en sus ideas acerca del hombre, innumerables mitos. Pero hallaremos también en él profundos atisbos de validez universal. De igual manera que Heráclito con sus mitos del fuego inextinguible y de la guerra "padre de todas las cosas", o que Aristóteles con su afirmación del motor inmóvil que atrae, despertando el amor en todo lo que existe, así también los *tlamatinime*, tratando de comprender el origen temporal del mundo y su posición cardinal en el espacio, forjaron toda una serie de concepciones de rico simbolismo que cada vez iban depurando y racionalizando más (Portilla, 2006).

El pensamiento cosmológico náhuatl había llegado a distinguir claramente entre lo que era explicación *verdadera* –sobre bases firmes- y lo que no rebasaba aún el estadio de la mera credulidad mágico-religiosa. En otras palabras, valiéndonos de nuevo anacrónicamente de un término occidental, el más aproximado para expresar la distinción percibida por los sabios nahuas, diremos que sabían separar lo verdadero –lo científico- del que no era tal (Portilla, 2006).

A partir del nacimiento de cuatro dioses hermanos, hijos de la dualidad suprema Tonacatecuhtli, se juntaron para ver cómo se harían las cosas, designando a Quetzalcóatl y a Huitzilopochtli para que crearan el fuego después hicieron medio sol y crearon a la pareja primigenia: Oxomoco y Cipactónatl, a quienes mandaron que labrasen la tierra, en el caso primero, y a ella que tejiese y curase a la gente y le dieron granos de maíz para hacer hechicerías. De ellos nacieron los macehuales. Los actos de creación se suceden una a otro y es así como vemos el orden siguiente: primero se hicieron 365 días divididos en 18 meses de 20 días cada uno, más los cinco días aciagos o nemontemi, con lo que se establece el calendario solar. A continuación crearon los niveles del universo, por lo que hicieron a los dioses Mictlantecuhtli y Mictlancíhuatl, "marido y mujer", dualidad que ocupó el Mictlan o noveno escaño del inframundo. Luego crearon los trece niveles celestes y en medio establecieron el agua donde crearon al Cipactli o especie de cocodrilo que formó la tierra. De esta manera quedó estructurado el orden universal con la tierra, donde habita el hombre, y los niveles celestes y el inframundo. Los cuatro rumbos del universo fueron ocupados por Tezcatlipoca en diferentes variantes en tanto que el centro, desde los niveles celestes hasta el inframundo, estaba ocupado por la dualidad por excelencia con sus diferentes nombres: Ometéotl y Omecíhuatl, o, por otro nombre Tonacatecuhtli y Tonacacíhuatl, que ocupaban el treceavo cielo; Huehuetéotl o Xiutecuhtli; dios viejo, señor del fuego y de año que ocupaban el centro del nivel terrestre, y la pareja ya mencionada del Mictlan (Matos, 2014).

Matos menciona que queda claro que los dioses fueron quienes crearon el universo y al hombre mismo y define cosmovisión la manera en que estos pueblos concebían el orden universal. Una manera de definirla podría ser "este conjunto de ideas y de pensamientos, este orden estructurado de concebir el lugar que los dioses, los astros, la Tierra y el hombre mismo tienen en el universo, y la explicación de que ello se deriva, es lo que denominamos cosmovisión" (Matos, 2014).

Portilla menciona la interpretación de las principales ideas cosmológicas nahuas de Sostelle (1940) que interpreta su mundo espacio-temporal. "Así el pensamiento cosmológico mexicano no distingue radicalmente el espacio y el tiempo; se rehúsa sobre todo a concebir al espacio como un medio neutro y homogéneo independiente del desenvolvimiento de la duración. Está se mueve a través de medios heterogéneos y singulares, cuyas características particulares se suceden de acuerdo con un ritmo determinado y de una manera cíclica. Para el pensamiento mexicano no hay espacio y un tiempo, sino espacios-tiempos donde se hunden y se impregnan continuamente de cualidades propias los fenómenos naturales y los actos humanos. Cada lugar-instante, complejo de sitio y acontecimiento, determina de manera irresistible todo lo que se encuentra en él." (Portilla, 2016).

Lo anterior permite definir que la cosmovisión indígena estaba basada en hechos (naturales) y que el ser humano se veía dentro del cosmos por lo tanto de su entorno y las actividades sociales y económicas estaban sujetas a los fenómenos naturales y a los recursos que provee definidas en el calendario de 18 meses.

Conclusiones

Lo anterior vislumbra que la forma de pensamiento económico clásico no toma en cuenta al ser humano dentro de los procesos naturales, sino se ve fuera del sistema y no considera los límites biofísicos del planeta. La teoría de la renta está basada en la extracción y en la abundancia ilimitada de los recursos es incompatible con los procesos naturales y retomando una cita de David Ricardo "con una cierta cantidad de materiales, y con la ayuda de la presión atmosférica, de la elasticidad del vapor, los motores pueden desempeñar trabajo y abreviar el esfuerzo humano en una gran proporción; pero ningún cargo se hace por el uso de esas ayudas naturales, debido a que son inagotables y se hallan a disposición del hombre". De la misma el concepto de la renta absoluta no considera los ciclos naturales o los límites biofísicos del planeta, solo la tenencia de la propiedad y la fertilidad de la tierra.

La escuela marginalista retoma el concepto de la renta transformado en la subjetividad del consumo en la satisfacción y en la escasez siendo los bienes ilimitados no poseen valor alguno. La teoría marginalista parte del supuesto ilimitado de los recursos naturales (ausencia de externalidades ambientales), ignora los límites biofísicos y los ciclos naturales del planeta. Además de considerar a la tierra (bajo la actividad agrícola o de renta) como un solo factor de producción y considerar al ser humano fuera de los ciclos naturales.

En contra parte la cosmovisión indígena en específico náhuatl parte su pensamiento en la creación del cosmos y que el ser humano es parte de él. El pensamiento indígena estaba basado en explicaciones verdaderas (hechos cósmicos) de los ciclos naturales, el ambiente y el cosmos. Por ende sus acciones (relaciones) económicas y sociales estaban basadas bajo este pensamiento. Y la pregunta es ¿se ha perdido esa forma de pensamiento o se encuentra intrínsecamente en las acciones (relaciones) económicas y sociales en la actualidad? Y la respuesta es no, estás relaciones económicas y sociales se siguen reproduciendo después de casi 500 años de la conquista de Tenochtitan. Está forma de pensamiento indígena genera sustento para el ser humano (bienes y servicios), respeta los ciclos naturales y promueve la ayuda mutua (producción comunitaria) como por ejemplo la producción de maíz o de tamales (Mie, 2018 y Saldaña, 2018). Está forma de pensamiento orienta a solucionar problemas actuales por ejemplo el manejo de agua (SEMARNAT, 2016) y espacios de organización como el Congreso Nacional Indígena (CNI, 2018) que incluye a pueblos, naciones y tribus originarios del país.

Hay que retomar de esta manera la cosmovisión indígena como alternativa para estar en armonía con la naturaleza, con una economía comunitaria y solidaria para trascender en el tiempo y que sea fundamento teórico para la solución de la triple crisis económica, ecológica y social.

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Significados*

Cipactli o cipatli. "El lagarto negro", cipactli, "lagarto"; tlīltic, "negro".

Cipactónatl. Espíritu de lagarto. cipactli, "lagarto"; tonalli, "espíritu".

Huehuetéotl. Huehueh-teotl, "dios-viejo"

Huitzilopochtli. "Colibrí azul a la izquierda". Fue la principal deidad de los mexicas, asociado con el sol y la guerra.

Macehuales. Eran la clase social que estaba por encima de los esclavos y jerárquicamente estaban por debajo de los pipiltín (señores) o nobles.

Mictlan. Infierno o en el infierno.

Mictlancíhuatl. La mujer que se ocupa de los muertos.

Mictlantecuhtli. "Señor del mictlán" o "señor del lugar de los muertos".

Nemontemi. Que servía para designar los cinco días suplementarios del año.

Omecíhuatl. Dos señora ome "dos"; cihuatl, "señora".

Ometéotl. Dos dioses. ome "dos"; teo-tl, "dios".

Oxomoco. "Resina de dos pinos", oxitl, resina; ome, "dos"; ocotl, "pino". Mujer de Cipactonal, tal vez la misma divinidad que la Venus mexicana.

Quetzalcóatl. "Serpiente emplumada"; quetzal, "'pluma"; coatl, "'serpiente". Dios del aire, representado bajo la serpiente, emblema de los vientos y de los torbellinos, recubierta de plumas de quetzalli, que representaban los céfiros y las nubes ligeras.

Tenochtitlan. Te, "piedra"; noch, "tuna" y ti-tlan, "lugar donde abunda algo". Capital del imperio mexicano fundada en 1325 por Tenoch hoy México.

Tepepulco. Montículo situado en la laguna de Texcoco, sobre la cual se inmolaba a lactantes en la gran fiesta que se verificaba a principios de cada año en honor a los dioses de la lluvia.

Texcoco. Tlacolt, "Jarilla" esto se refiere a la planta que brota en terreno llano texcalli, "peñasco o risco", por lo que su traducción probablemente sea "en la jarilla de los riscos".

Tezcatlipoca. "Espejo negro que humea", tezcatl, "espejo"; tliltic, "negro"; poctli, "humo". Es el señor del cielo y de la tierra, fuente de vida, tutela y amparo del hombre, origen del poder y la felicidad, dueño de las batallas, omnipresente, fuerte e invisible.

Tlamatinime. Sabio, juicioso, hábil, doctor, muy instruido.

Tlatelolco. Tlatelli, "terraza" o se deriva de xaltiloll que se refiere a "punto arenoso" o "en el lugar del montón de arena". Barrio no de México en que habitaban comerciantes y tenía un gran mercado (tianquiztli) de la ciudad, plaza notable por su inmensa extensión su perfecta distribución y sus hermosos pórticos.

Tonacacíhuatl. "Señora del sustento'", tonacayotl, "sustento"; cihuatl, señora.

Tonacatecuhtli. "Señor del sustento'', tonacayotl, "sustento"; tecuhtli, "señor", es el dios mexica de la creación y de la fertilidad.

Xiutecuhtli. "Señor de la hierba", xihuitl," hierba"; tecuhtli, "señor" en la mitología mexica, es el espíritu del fuego y el calor.

*Tomado de:

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VI. AGROECOLOGY AND SUSTAINABLE FOOD SYSTEMS

Agricultura Ecológica y Soberanía Alimentaria en México: El potencial para producir maíz y frijol bajo sistemas de producción ecológica

Darío Alejandro Escobar Moreno*

Introducción

La agricultura es una de las actividades con mayor huella ecológica, sólo detrás de la extracción y consumo de hidrocarburos (Footprintnetwork, 2018), pero al mismo tiempo, es una de las actividades con mayor potencial para mitigar los impactos ambientales que provoca.

Por su parte, el concepto de Soberanía Alimentaria ha estado adquiriendo cada vez mayor relevancia en diversos foros nacionales e internacionales, e incluso se ha colocado como un concepto guía de la política alimentaria de algunos países, que considero muy pertinente para el caso mexicano en la coyuntura actual.

En este artículo, presento una estimación del potencial que tiene la agricultura mexicana para producir alimentos básicos a partir de sistemas de agricultura ecológica, tomando como estudios de caso el maíz en Oaxaca y el frijol en Zacatecas, vinculándolo a la noción de Soberanía Alimentaria, en el marco de una posible reforma significativa de la política agroalimentaria de México durante los próximos años.

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1. El estado actual de la producción de alimentos básicos en México

Durante más de 30 años los gobiernos federales de México han impulsado una política económica de apertura hacia los mercados internacionales basada en las nociones que dictan las doctrinas económicas de corte neoliberal. Como consecuencia, a la fecha se tienen firmados 11 tratados de libre comercio con diferentes países y bloques regionales. En dicho contexto, la agricultura mexicana es uno de los sectores que mayor sensibilidad han mostrado ante la apertura de la economía mexicana, y la que, con mayor claridad ha mostrado sus indeseables consecuencias para los grandes perjudicados, que han sido los pequeños y medianos productores de alimentos básicos.

Varias investigaciones ya han dado cuenta de los perjuicios de la apertura comercial mexicana (Appendini, 2001; Scott, 2010; Steffen y Tarrío, 2010; Rubio, 2014), y todos coinciden en que los productores de granos básicos han sido de los que han llevado la peor parte.

> *"La crisis en que viven los pequeños productores ejidales de granos, los ha conducido a construir diferentes estrategias que involucran desde la emigración y el trabajo asalariado, hasta el ingente esfuerzo por mejorar sus condiciones de producción para poder permanecer como productores campesinos en un mundo que los desecha" (Steffen y Tarrío, 2010: 32)*

Por lo que respecta a la creciente dependencia alimentaria del comercio internacional, entre los años de 2016 y 2017 el país importó el 36% de maíz, 95% de arroz, 89% de soya, 68% de trigo, 50% de carne de cerdo y 37% de lácteos (La Jornada del Campo del 16 de junio de 2018). Tenemos el primer lugar como importadores de leche en polvo, y de maíz importamos 15.3 millones de toneladas durante el año 2017 (SAGARPA, 2018).

La dependencia alimentaria[1]–que como promedio se ubica en 40% en el sector de granos- resulta más grave debido a las tendencias alcistas de los precios agrícolas en el mercado internacional: así, mientras las importaciones de maíz que en 1998 eran a razón de 120 dólares por tonelada, en 2008 ascendieron hasta los 261 dólares por tonelada (FAO, 2011, citado en Ramírez y Flores, 2012), si bien en lo que va del año 2018 los precios internacionales del maíz han oscilado alrededor de los 150 dólares por tonelada (ASERCA, 2018), dichos precios siguen expuestos, ya no solo a las incertidumbres climáticas que caracterizan a la producción agrícola, sino que ahora cada vez más a los procesos de especulación financiera en los mercados bursátiles.

Por otra parte, seguimos manteniendo altos niveles de pobreza alimentaria[2] en México, ya que conforme a los datos de CONEVAL (2017) hay 24.6 millones de habitantes en esta condición, de los cuales 17.4% se encuentran en el campo; el 7.6% de la población se ubica en pobreza multidimensional extrema, es decir, que sus ingresos se encuentran por debajo de la línea de bienestar mínimo, que se define por el costo de la canasta básica alimentaria, y además presentan tres o más de las carencias sociales. Desde una perspectiva más amplia, 46.3% de la población en México se encuentra en situación de pobreza multidimensional, lo que significa que perciben ingresos inferiores a la línea de bienestar, definida por el costo de la canasta básica alimentaria y no alimentaria, además, presentan al menos una de seis carencias

1 Se refiere al porcentaje de alimentos consumidos en México que provienen de las importaciones de otros países.

2 De acuerdo con CONEVAL la pobreza alimentaria se refiere a aquellas familias cuyos ingresos no son suficientes para comprar la canasta básica de alimentos que requieren.

sociales: rezago educativo, acceso a servicios de salud, a la seguridad social, calidad y espacios de la vivienda, a los servicios básicos de la vivienda y a la alimentación (Gordillo, 2013).

Por lo anterior, planteo que en México tenemos un grave problema de producción, distribución y consumo de alimentos básicos.

2. Seguridad vs Soberanía alimentaria

En México, como en otros países, están en disputa dos concepciones sobre cómo se deben procurar los alimentos para la población: una es desde la perspectiva de la Seguridad Alimentaria (SeA) y la otra desde la Soberanía Alimentaria (SoA). La búsqueda de la SeA parte de reconocer el derecho de toda persona a la alimentación, garantizando la disponibilidad, el acceso y el uso adecuado de los alimentos; sin embargo, no distingue la procedencia de los mismos, ni sus condiciones de producción y distribución (Loveday-Brown, 2013 citado por Jarosz, 2014). Por su parte, la concepción de la SoA antepone el derecho de las personas, no sólo a una alimentación adecuada, sino también a decidir sobre sus recursos, su producción y su consumo, así como el de los países a definir su propia política de agricultura y alimentación (Desmaris, 2007).

> *"La seguridad alimentaria existe cuando todas las personas tienen, en todo momento, acceso físico, social y económico a alimentos suficientes, inocuos y nutritivos que satisfacen sus necesidades energéticas diarias y preferencias alimentarias para llevar una vida activa y sana. – La Cumbre Mundial sobre la Alimentación (1996)" (FAO, 2011)*

La SoA representa una postura crítica a las actuales políticas agrarias liberalizadoras y de alimentación (Caro, 2010). En el Foro de Roma llevado a cabo en el año 2002, se definió de la siguiente forma:

> *"… el derecho de los pueblos, comunidades y países a definir sus propias políticas agrícolas, laborales, pesqueras, alimentarias y de tierra de forma que sean ecológica, social, económica y culturalmente apropiadas a sus circunstancias únicas. Esto incluye el verdadero derecho a la alimentación y a la producción de alimentos, lo que significa que todos los pueblos tienen el derecho a una alimentación inocua, nutritiva y culturalmente apropiada, y a los recursos para la producción de alimentos y a la capacidad para mantenerse a sí mismos y a sus sociedades." (Ortega-Cerdà y Rivera-Ferre, 2010:55).*

Algunos autores han llegado a plantear que ambas nociones pueden verse como complementarias (Gordillo y Méndez, 2013), pero en este artículo asumo la postura que considera que existe una diferencia de fondo entre ambos nociones, ya que mientras que la primera no cuestiona el funcionamiento actual del sistema agroalimentario dominante a escala mundial, la segunda aparece como una crítica frontal de dicho sistema, al que antepone un modelo basado en la producción de alimentos a partir de los recursos y capacidades productivas de cada país y sus comunidades.

En la SoA, las políticas relativas a producción y comercio agropecuario se perciben desde un enfoque de derecho en diferentes ámbitos, esto es, desde el que tiene el productor rural de producir sus alimentos en función de sus necesidades, costumbres y en su territorio (Caro, 2010 y Desmaris, 2007) hasta el que tienen aquellos sectores que están involucrados en la comercialización y distribución de alimentos, así como los consumidores. También señala la necesidad de modificar el comportamiento actual de los mercados agrícolas, favoreciendo a los internos y regulando la apertura comercial internacional, excluyéndolos de los tratados internacionales de libre comercio. Es decir, que las prácticas y políticas comerciales sirvan a los derechos de la población para disponer de métodos y productos alimenticios inocuos, nutritivos y ecológicamente sustentables (La Vía Campesina, 2007 y Rosset, 2003).

No comparto la idea de que México debe "recuperar la soberanía alimentaria" (Valero-Flores, 2009), ya que no se puede hablar de recuperar algo que nunca se ha tenido. Quienes sostienen tal planteamiento, refieren que durante las décadas de los cuarenta y hasta los setenta del siglo pasado, México era exportador de alimentos, y que consecuentemente, se "garantizaba" la SoA.

> *"…Durante ese largo período, la balanza comercial agropecuaria tuvo un saldo positivo, pasó de 352 mdd en 1960 a 600 mdd en 1965, y para 1970 logró ascender a 392 mdd. La tasa media de producción agrícola fue de 4.9% en 1960-1970, contra un incremento poblacional del 3.5%, es decir, la soberanía alimentaria estaba, en los hechos, plenamente garantizada" (Valero-Flores, 2009: 80)*

Nada más alejado de la idea de SoA que pensar que por el hecho de que un país es exportador de alimentos satisface, al mismo tiempo, las necesidades alimentarias de su población. Abundan ejemplos de países que al mismo tiempo que son exportadores de alimentos, mantienen a su población malnutrida, e incluso padeciendo hambre. América Latina es vivo ejemplo de esta paradoja, siendo una región que ha incrementado significativamente sus exportaciones agroalimentarias en los años recientes, la prevalencia de población con hambre se mantiene en torno al 6% (FAO, 2015).

> *"Efectivamente, América Latina y el Caribe contribuye con el 55% de las exportaciones de soya del mundo, el 45% de las exportaciones de azúcares, el 39 % de las exportaciones de café, el 27% de carnes de aves y cerca de un quinto de las ventas mundiales de maíz y carnes, además de aportar con cerca del 10% de las exportaciones mundiales de trigo y arroz" (FAO, 2015:12)*

La idea de SoA que comparto, debe tomar fundamento en el artículo 25 de la Declaración Universal de los Derechos Humanos (ONU, 2017) que a la letra dice:

> *"Toda persona tiene derecho a un nivel de vida adecuado que le asegure, así como a su familia, la salud y el bienestar, y en especial la alimentación, el vestido, la vivienda, la asistencia médica y los servicios sociales necesarios; tiene asimismo derecho a los seguros en caso de desempleo, enfermedad, invalidez, viudez, vejez u otros casos de pérdida de sus medios de subsistencia por circunstancias independientes de su voluntad" (ONU, 2017: 7)*

> México desde el año 2011 tiene establecido en su constitución política el derecho a la alimentación de todos los mexicanos. Sin embargo, a la fecha tal dicho derecho no se cumple para un amplío segmento de la población.

Dentro de la concepción de SoA considero que es necesario vincular la calidad de los alimentos a que los mismos provengan de sistemas de producción sustentables, y en particular, de la agricultura ecológica campesina y familiar, ello garantizaría que los alimentos tengan elevados estándares de calidad, al menos por lo que se refiere a los siguientes aspectos: a) Nulo contenido de residuos químicos (especialmente de fertilizantes y pesticidas), b) Protección de ecosistemas, c) Conservación y fomento de la agrobiodiversidad, d) Manejo sostenible del suelo y agua, f) Uso de semillas nativas, culturalmente arraigadas a las regiones y g) Fomento de los mercados y la economía local.

3. Agricultura convencional vs ecológica

Entre las críticas más conocidas al modelo de agricultura convencional están: la eliminación de la diversidad biológica al abrir áreas para la agricultura, y la severa disminución de la propia diversidad biológica manejada al interior de los sistemas de producción al implantar monocultivos de "alta productividad"[3] , la sustitución de los flujos ecológicos de materia y energía dentro del propio sistema por la inyección de materia y energía externa a través de los insumos agroindustriales (semillas, fertilizantes, pesticidas), y la desestructuración de los suelos y su erosión física y biológica a través agresivos procesos de labranza con maquinaria y por la disposición de agroquímicos.

Se trata, además, de un modelo de agricultura que depende de la provisión de sus insumos básicos, como las semillas mejoradas, los fertilizantes y pesticidas, así como de la maquinaria agrícola, y otros insumos, de grandes empresas que constituyen verdaderos oligopolios transnacionales, a quienes va a parar una gran proporción de los beneficios económicos que genera la agricultura a escala mundial, quedando los productores primarios muchas veces endeudados con estos consorcios transnacionales, al grado de verse obligados a vender sus tierras y ser expulsados de las mismas.

Por lo que respecta a la distribución de la producción y el consumo, es una agricultura que tiende a promover la especialización productiva en lugares, desde los que se desplaza la producción para ser consumida en prácticamente cualquier parte del planeta, lo que conlleva a la estandarización de los llamados commodities agrícolas, y a generar grandes costos energéticos por el desplazamiento de la producción desde las regiones productoras hacia las diversas zonas de consumo.

> *"Desde el principio, la ciencia agrícola estadounidense estuvo orientada a aumentar al máximo la productividad de aquel factor que más limitaciones ponía al desarrollo de la economía estadounidense: la mano de obra. Así la mecanización temprana de las prácticas agrícolas condujo inexorablemente al monocultivo, pese a la disminución en productividad por unidad de área que ocasione la mecanización. La ciencia agronómica se concentró entonces en las variedades y en la densidad de la siembra que debían aplicarse al monocultivo, y luego en los fertilizantes químicos que permitirían reemplazar a las prácticas de fertilización más laboriosas (tales como la aplicación de estiércol y la rotación de cultivos) por un simple compuesto químico". (Rosset, 1997: 4)*

La lógica de la especialización productiva como mecanismo para obtener ventajas en los mercados, se trasladó a la agricultura a través de la instauración y fomento a la producción, casi exclusiva, de monocultivos comerciales. Cuando un productor convencional siembra un monocultivo, automáticamente trata de eliminar cualquier otra especie vegetal que le represente competencia, y con ello elimina la mayor parte de la diversidad biológica vegetal de la parcela. Además, todos los animales, insectos y microorganismos que se presentan en el cultivo en cuestión, son percibidos como plagas, por lo que éstos son combatidos a través del uso de pesticidas, u otros métodos igualmente agresivos, los cuales eliminan tanto a los organismos que son problemáticos para el cultivo, como los que no lo son. Lo anterior le permite otorgar condiciones excepcionales de desarrollo al monocultivo, de tal manera que éste alcance la mayor productividad física posible expresada en rendimiento por hectárea, sin embargo, ello se hace a un costo ecológico y monetario muy elevado.

3 Cabe aclarar que la "alta productividad" sólo se busca en términos del rendimiento físico del producto agrícola que interesa cosechar, pero no necesariamente implica una alta productividad en términos del manejo de la energía del sistema, o del volumen de biomasa total cosechada.

"En años recientes, las estadísticas sobre el uso de pesticidas en todo el mundo son de 3 mil millones de kgs empleados anualmente (Pimentel, 2005), con una tasa anual de crecimiento del mercado global de pesticidas de alrededor del 11% entre 1960 y 1995" (FAO, 1997 citado por Ghimire and Woodward, 2013: 73)

Los monocultivos de la agricultura convencional no pueden tender, de manera natural, a ningún equilibrio ecológico, ya que ellos mismos representan un desequilibrio radical del ecosistema, por el contrario, para mantenerse en desarrollo requieren de la constante inyección de insumos exógenos en la forma de fertilizantes y pesticidas, o bien prácticas culturales mecanizadas. Puesto que dichos insumos son producidos de manera industrial, y generalmente a partir de componentes químicos derivados del petróleo y de minerales, por una parte, proveen al monocultivo de ciertos nutrientes que necesita para su desarrollo, y le dan protección contra plagas y enfermedades, pero por otro, deja residuos químicos en la planta, el suelo y el agua, deteriorando la calidad ecológica de estos recursos productivos. Además, la disposición de sus envases, generalmente de plástico, se hace la mayoría de las veces en el contorno inmediato de las parcelas o, en el mejor de los casos, en los basureros locales, representando otra fuente de contaminación por plásticos hacia el ambiente.

El monocultivo en grandes extensiones de terreno y la tendencia al ahorro de mano de obra han impuesto el empleo de maquinaria como componente tecnológico fundamental de estos sistemas de producción, lo que, combinado con los residuos químicos del empleo de fertilizantes y pesticidas en los suelos, modifican radicalmente la estructura física y microbiológica que les da vida. El suelo, en estos sistemas de producción es simplemente el sustrato que sirve de soporte al monocultivo y como medio para el suministro de los insumos que requiere su desarrollo.

La pulverización a la que es sometido el suelo a través de la elevada mecanización que caracteriza a los sistemas de producción agrícola convencional (subsoleo, barbecho, rastreo y surcado, entre otros) es una de las causas más importantes de los fuertes procesos de erosión que ciclo tras ciclo se presentan en los suelos agrícolas.

La agricultura ecológica surge como oposición al modelo de la agricultura convencional y se propone producir alimentos, y otros productos del campo, a partir de prácticas que sean amigables con el medio ambiente, que produzcan alimentos de alta calidad cultural, y que eviten la dependencia de los insumos de grandes empresas transnacionales y la estandarización de commodities.

Por lo que se refiere a las prácticas agrícolas, éstas se adaptan a las condiciones del ecosistema, respetando ciclos naturales, e induciendo todas aquellas interacciones que beneficien el desarrollo de los cultivos, y demás plantas y animales que tienen presencia en el agroecosistema, protegiendo el suelo de la erosión, y del manejo excesivo. A diferencia del modelo convencional, se promueve el desarrollo de la diversidad biológica cultivada y no cultivada, pero si manejada, por ejemplo, a través de la siembra de policultivos asociados, que se benefician de relaciones simbióticas entre las especies cultivadas y de las relaciones de los cultivos con la propia fauna y flora silvestre, las cuales también son aprovechadas como productos de la parcela y el ecosistema, o bien, son percibidas como parte del manejo del policultivo.

Se procura aprovechar la mayor cantidad de recursos locales disponibles y depender en la menor medida posible de insumos externos a la unidad de producción y/o la comunidad, por lo que la producción de compostas y lixiviados a partir de los propios residuos de materia orgánica y estiércoles es una práctica común, así cómo el empleo de semillas nativas, muy bien adaptadas a las condiciones de los entornos locales. En lugar de recurrir a la compra de pesticidas, los problemas de desequilibrio del agroecosistema, por plantas y animales no cultivadas, se tratan de resolver a través de prácticas culturales o la aplicación de preparados naturales.

Por lo que se refiere a la distribución y consumo de la producción, ésta en primer lugar se destina al autoconsumo de las familias de los propios productores, lo que a su vez constituye uno de los más adecuados mecanismos para garantizar la calidad e inocuidad de los alimentos. Los excedentes no consumidos por las familias productoras se destinan al abasto de los mercados locales y regionales, con ello se evita el transporte de los mismos a largas distancias, y sus consecuentes implicaciones en el consumo de hidrocarburos. Cabe señalar que existen nichos de mercado para ciertos productos que se encuentran vinculados a la exportación, bajo modalidades de agricultura orgánica y/o campesina.

El rescate de los conocimientos locales y ancestrales sobre las prácticas agrícolas sostenibles es fundamental, y se conjugan con conocimientos técnicos y científicos de vanguardia, que inciden en el mejor aprovechamiento de las semillas nativas, los recursos locales para producir abonos, las prácticas culturales para proteger el suelo y el agua, así como para la conservación y procesamiento de los alimentos, de tal manera que resulten más inocuos y nutritivos.

Es decir, bajo este modelo de agricultura, se conservan los recursos naturales, se utilizan los recursos productivos locales, se recuperan los conocimientos locales, mismos que se conjugan con conocimientos técnicos y científicos, y se tiene prioridad en abastecer a las familias productoras, y los mercados locales y regionales, con productos de alta calidad ambiental y cultural.

4. El potencial productivo del maíz y el frijol bajos sistemas de agricultura ecológica

El maíz es el principal cultivo de México desde épocas precolombinas. México es su centro de origen y mayor diversidad (Eubanks, 2001) y el proceso de co-evolución entre el maíz y la sociedad rural mexicana lleva alrededor de 8000 años ininterrumpidos (Warman, 1988).

Actualmente se cultiva maíz en prácticamente todo el país, en una superficie de poco más de 7.5 millones de hectáreas, con una producción de alrededor de 22 millones de toneladas (SIAP-SAGARPA, 2018a), y esa producción es insuficiente para abastecer la demanda nacional que se ubica en torno de los 36 millones de toneladas, por lo que durante el año 2017 México rompió su máximo con poco más de 15 millones de toneladas importadas (SIAP-SAGARPA, 2018b).

La creciente importación de maíz para un país que es su centro de origen y mayor diversidad, y que mantiene al maíz como principal cultivo y alimento, es sumamente preocupante para muchos, no así para los tomadores de decisiones que justifican este hecho bajo el argumento de que el maíz que se importa es más barato que el que se produce en el país. Efectivamente, durante los primeros meses de 2018 el precio internacional del maíz rondó entre los \$2 y los \$3 (MXN) por kilogramo, mientras que en México el precio medio rural del maíz osciló entre los \$3.5 y los \$5 (MXN) por kilogramo (InfoASERCA, 2018). Sin embrago, desde esa perspectiva economicista, el maíz se está valorando simple y llanamente como un bien estandarizado, es decir como un *commodity*, y se dejan de lado todos los criterios ambientales, sociales y culturales que tiene el maíz en México.

En México tenemos por lo menos 60 diferentes razas de maíz nativo, con miles de tipos, cada uno está muy bien adaptado a la región en la que se produce en términos ambientales y culturales. Por ello es posible encontrar maíz que se siembra muy cerca de las costas tropicales, húmedas y secas del país, a nivel del mar, así como otros que se cultivan a más de 3,000 metros sobre el nivel del mar; maíces que pueden ser cosechados tres meses después de su siembra y otros que requieren más de 11 meses para su cosecha; maíces blancos, amarillos, negros, morados, rojos, multicolores, tenemos una gran agrobiodiversidad de maíces nativos. Ello se explica, en buena medida, por la arraigada cultura campesina, caracterizada por seleccionar aquellos tipos de maíz que satisfacen alguna, o varias de sus necesidades, y a que constantemente los campesinos mexicanos intercambias sus semillas, y con ello dan vitalidad a sus cultivos de maíz nativo, es decir, la diversidad de los maíces nativos mexicanos es también una clara expresión de las interacciones sociales de nuestras poblaciones campesinas. Hay, por lo tanto, un valor social campesino directamente vinculado al cultivo del maíz en México.

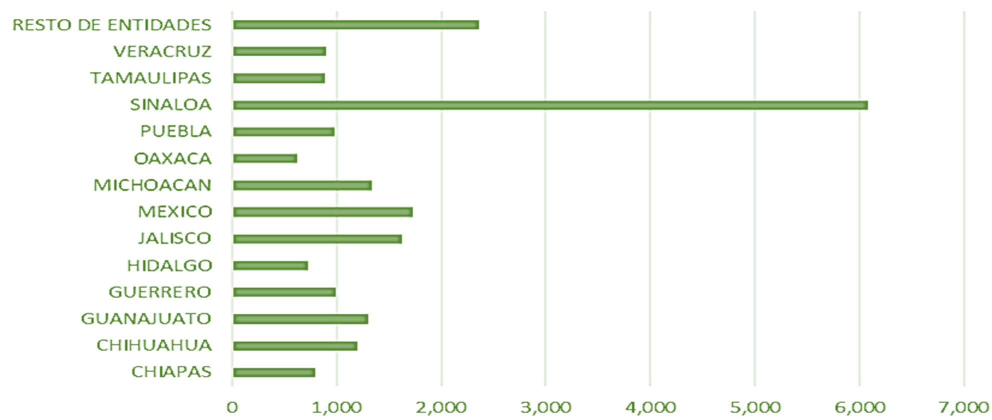
La comida mexicana es patrimonio cultural de la humanidad, y dicho patrimonio se cimenta en los más de 600 platillos y bebidas que se preparan en México con base en el maíz (Zorrilla, 1982). Cada región de México tiene algún platillo o bebida tradicional elaborado con algún tipo de maíz nativo, que le da esa característica cultural específica al alimento o bebida. Sin duda, la cultura de los alimentos tradicionales con base en el maíz es lo que ha permitido que se mantengan bajo cultivo muchos tipos de maíces, los cuales por razones puramente económicas ya se habrían dejado de sembrar desde hace décadas. Pero los maíces son mucho más que alimento en México, se utilizan como materiales de construcción, medicina tradicional, elaboración de artesanías, juguetes para niños, y ellos son parte de muchas celebraciones y rituales, para los cuáles se mantienen tipos muy específicos de maíces, entre otros usos.

Todos estos valores ambientales, sociales y culturales del maíz han sido menospreciados por los tomadores de decisiones que han apostado a considerar toda esta riqueza como equiparable a un *commodity* asequible a un precio internacional bajo, pero que oculta enromes costos ambientales y subsidios.

4.1 Oaxaca y el maíz

El estado de Oaxaca, en el sur de México, se mantienen bajo cultivo por lo menos 35 razas de maíces nativos (Aragón, 1989). Ello es posible gracias a una combinación de factores tales como su diversidad ambiental, la prevalencia de 16 grupos indígenas, y una riqueza cultural de la que el maíz forma parte fundamental. Sin embargo, Oaxaca es un estado que no produce suficiente maíz para abastecer su demanda, por lo que anualmente alrededor de 200,000 ton son llevadas de otras partes (Álvarez, 2012).

GRÁFICA 1. PRINCIPALES ENTIDADES PRODUCTORAS DE MAÍZ 2017
(MILES DE TONELADAS)



Fuente: elaborado con datos del SIAP (SIAP-SAGARPA, 2018).

Si bien Oaxaca es el 5to estado productor de maíz en México, reúne características especiales para estimar el potencial que tienen los sistemas de producción ecológica, como las siguientes: a) Diversidad ambiental, b) Diversidad cultural, c) Gran importancia del autoconsumo de maíces nativos, d) Diversidad de usos del maíz (comidas, bebidas, rituales), e) Creciente demanda de maíz, y f) Insuficiencia de la producción para satisfacer su demanda.

En Oaxaca hay aproximadamente 380 mil familias campesinas que cultivan maíz en alrededor de 550 mil hectáreas, con un rendimiento promedio de 1.3 ton/ha. Se estima que la producción de los últimos 10 años ha oscilado entre las 600 y 650 mil toneladas, por lo que se genera anualmente un déficit en la producción de maíz de alrededor de 200 mil toneladas, con respecto al maíz que se consume en la entidad (850 mil toneladas anuales).

Los resultados de los proyectos del manejo participativo de los sistemas de producción de maíz, y de la *milpa*[4] , llevado a cabo por investigadores del CRUS-Chapingo muestran que es posible incrementar el rendimiento de estos sistemas a 8 ton/ha en promedio, y ello es posible por lo menos en una superficie estimada de 120,000 hectáreas, por lo que es factible, tan solo en esta superficie con potencial, obtener hasta 960,000 ton de maíz, suficiente para abastecer el total de la demanda anual de maíz en Oaxaca, bajos sistemas de producción ecológica.

4.2 Zacatecas y el frijol

Por lo que se refiere al frijol, también México es centro de origen y diversidad, pero a diferencia del maíz, hay varios centros de origen del frijol en el mundo. De las 150 especies de frijol que se han identificado a nivel mundial, en México tenemos 50 (CONABIO, 2018), de ellas se derivan cientos de variedades, pero las que se cultivan de manera comercial son aproximadamente 70 (FIRCO, 2018).

4 La milpa es un policultivo característico de la región mesoamericana y de origen prehispánico, que conjuga el cultivo del maíz con frijol, calabaza, chiles y toda una gama de combinaciones con árboles frutales, forrajes y otras plantas útiles como los agaves.

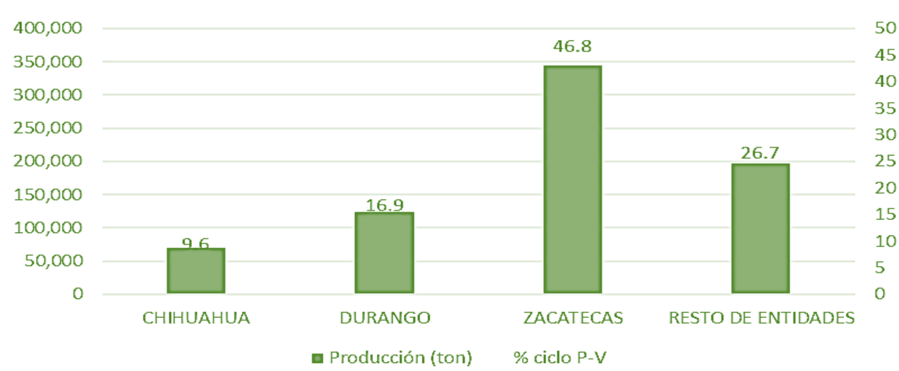
Los frijoles silvestres siguen siendo parte de los ecosistemas naturales del país en bastas regiones del sur, centro y occidente, y junto con el maíz, hay evidencia de que su cultivo se remonta a más de 8 mil años. El frijol, al igual que el maíz, se siembra prácticamente en todo el territorio nacional, y su consumo forman parte importante de la dieta alimentaria de la mayoría de la población desde épocas prehispánicas.

Actualmente, el estado de Zacatecas, ubicado en la región centro norte de México, es el principal estado productor de frijol bajo la modalidad de temporal durante el ciclo Primavera-Verano, en dónde se cultivan por lo menos 20 diferentes variedades y un gran número no definido de tipos de semillas criollas.

En Zacatecas hay aproximadamente 70 mil productores que cultivan anualmente 650 mil hectáreas de frijol, con un rendimiento promedio de 615 kgs/ha. La producción anual es de aproximadamente 400 mil toneladas, y la mayor parte de la producción abastece los mercados del centro y sur del país.

INIFAP-Zacatecas (2003) estimó que hay aproximadamente 380 mil hectáreas con potencial productivo para frijol de temporal en Zacatecas. Parcelas experimentales en la franja agrícola zacatecana, han probado que, con mejores prácticas agrícolas como el mejoramiento participativo (campesino/técnico/científico) de las semillas nativas, la labranza de conservación, mejoras en la densidad de siembra y el uso de abonos, es posible incrementar los rendimientos bajo sistemas de agricultura ecológica en un 30% en un lapso de tres años y con posibilidades de seguirlo incrementando en años posteriores.

GRÁFICA 2. PRINCIPALES ESTADOS PRODUCTORES DE FRIJOL DE TEMPORAL CICLO P-V (2017)



Fuente: elaborado con datos del SIAP (SIAP-SAGARPA, 2018).

En las zonas temporaleras con potencial productivo de Zacatecas es posible obtener una producción ecológica de frijol de aproximadamente 456 mil toneladas anuales, conservando mejor el suelo, la biodiversidad agrícola, y enfrentando de mejor manera las incertidumbres en el ciclo del temporal que se pronostican como consecuencia del cambio climático en la región.

4.3 Lineamientos para el diseño de políticas públicas

Con las estimaciones presentadas para los casos del maíz y el frijol, en los estados de Oaxaca y Zacatecas respectivamente, es evidente que se dispone de un amplio potencial para producir maíz y frijol bajo sistemas de agricultura ecológica. Si bien no se pueden extrapolar estos resultados al resto de las entidades del país, por las particularidades de cada una, es plausible prever que existe el potencial a nivel nacional para satisfacer adecuadamente la demanda de estos alimentos para los próximos años. Ello depende, en buena medida, de la adopción de políticas públicas claramente orientadas a la promoción de una agricultura ecológica para la Soberanía Alimentaria.

En primer lugar, es necesario el respeto a la autonomía y determinación de las comunidades y organizaciones campesinas, que durante décadas han estado sometidas a un paternalismo clientelar por parte del estado mexicano. Son las propias comunidades campesinas, y sus organizaciones, las que mejor que nadie conoce las necesidades y aspiraciones de sus agremiados, y ellos conocen sus recursos productivos, conservan los conocimientos ancestrales, y tienen claridad sobre sus aspiraciones para mejorar su calidad de vida. Por lo tanto, el diseño de las políticas públicas debería hacerse a partir de dichas aspiraciones, y sin pretender la homogenización de políticas estandarizadas a nivel nacional.

Desde la perspectiva productiva se requiere de políticas públicas que tengan por objetivos lo siguiente: a) Producir alimentos de alta calidad ambiental y cultural, que contribuyan a mejorar la alimentación de la población y a alcanzar la Soberanía Alimentaria, b) Que los alimentos sean producidos en sistemas de agricultura ecológica, c) Que los principales beneficiarios sean los productores agrícolas de pequeña y mediana escala y sus familias, los consumidores de las regiones productoras, y los consumidores de bajos ingresos de las áreas urbanas del país.

En relación a las políticas orientadas a la promoción de la producción agrícola, estás deben estar orientadas a: a) la recuperación de suelos agrícolas a través de un manejo ecológico de los sistemas de producción, b) mejorar el aprovechamiento del agua de lluvia a través del desarrollo de sistemas de captación y almacenamiento de agua a pequeña y mediana escala, c) mejoramiento participativo (productores/técnicos/científicos) de semillas nativas, d) garantizar la asesoría técnica de calidad y permanente en la comunidades rurales, e) el diseño innovador de sistemas agrosilvopastoriles, agropastoriles, de policultivos asociados, y de monocultivos, con manejo ecológico de abonos, y bioles.

También es indispensable tener políticas dirigidas al acopio y distribución de la producción, ya que es en esta fase en la que interviene una gran cantidad de intermediarios, y en la que se quedan los mayores márgenes de comercialización de los productos básicos, por ello, se debe impulsar: a) el establecimiento de un sistema de planeación de siembras y cosechas, b) esquemas eficientes de distribución local, regional y nacional de los excedentes comercializables, c) rehabilitación y modernización de los sistemas regionales de almacenamiento a través de agentes públicos y privados, d) establecimiento de precios de garantía, o de referencia, y e) promoción de convenios entre las organizaciones campesinas con instituciones públicas y privadas, para abastecer los comedores de éstas con alimentos provenientes de las cosechas nacionales.

Por último, pero no menos importante, son las políticas orientadas a fomentar el consumo de alimentos sanos y de alta calidad ambiental y cultural. Para ello, se debe de establecer lo siguiente: a) un programa nacional de educación para el consumo responsable de alimentos, b) convenios con la industria agroalimentaria y restaurantera para que desarrollen productos cuyo insumo sean las cosechas de los sistemas de agricultura ecológica, c) fomento de ferias de la buena alimentación, en las que los alimentos que provengan de los sistemas ecológicos campesinos sean la base de la preparación de comidas típicas y nuevos productos de la agroindustria alimentaria.

Conclusiones

México tiene el potencial para producir satisfactoriamente suficiente maíz y frijol para toda su población a partir de sistemas de agricultura ecológica campesina, tal como lo he mostrado con los casos del maíz en Oaxaca y el frijol en Zacatecas.

La insuficiencia de la producción nacional de estos cultivos no es, en lo esencial, un problema de carencia de recursos productivos o técnicos, sino fundamentalmente de política económica, y por lo tanto, dependerá de la voluntad política revertir dicha dependencia alimentaria.

El impulso de la producción de maíz y frijol en sistemas de agricultura ecológica campesina ofrece un conjunto de beneficios para la sociedad mexicana, entre los que destacan los siguientes: aprovechamiento de las capacidades productivas subutilizadas en el campo (conocimientos, tierra, semillas, tecnologías), las cuales se potenciaría con el conocimiento técnico y científico; producción de alimentos de alta calidad ambiental, cultural e inocuos; autoabasto de alimentos básicos en las propias comunidades campesinas y abasto de los mercados locales y regionales; abasto de alimentos de alta calidad para diversas instituciones públicas y privadas, así como a mercados urbanos; conservación de recursos productivos, tales como la tierra, el agua, la agrobiodiversidad y los valiosos conocimientos ancestrales de nuestras poblaciones campesinas; y la revalorización de campo mexicano como proveedor de alimentos, preservador de la naturaleza y de recursos productivos, así como de la ancestral cultura rural mexicana que tanto nos enorgullece.

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La certificación orgánica participativa en el tianguis orgánico Chapingo, México: avances y retos desde la mirada de la agroecología

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Introducción

El Tianguis Orgánico Chapingo inició como una propuesta de enlazar la producción orgánica y el consumo local de alimentos sanos en la región aledaña a la Universidad Autónoma Chapingo en noviembre, 2003. A partir de 2005 se iniciaron los primeros esfuerzos para certificar de forma alternativa los productos orgánicos ahí ofrecidos, conformando el primer esfuerzo nacional de lo que hoy se conoce como certificación participativa. La investigación se documentó a través de 5 estudios de caso (visitas a unidades de producción y entrevistas semiestructuradas) a productores del Tianguis (mercado) Orgánico Chapingo, las principales fortalezas y limitaciones de la certificación orgánica participativa de acuerdo a los lineamientos nacionales de producción orgánica. Las fortalezas identificadas son el intercambio de conocimientos valiosos entre los productores y el comité de certificación, una revisión estricta del comité para que los productos ofrecidos en el mercado cumplan con los requisitos.

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Las limitaciones incluyen la falta de tiempo para que los miembros del comité participen en las visitas; falta de conocimiento sobre algunas secciones importantes de los estándares por parte de los productores, y dificultad para mantener los registros de producción y ventas. El costo estimado del trabajo voluntario para la certificación fue de $10,569 pesos mexicanos por unidad de producción y un total para todo el mercado de $306,501 pesos por año. La certificación participativa representa contribuciones a la agroecología mediante la conexión de dos enlaces valiosos a su crecimiento: los consumidores y los productores, al favorecer sistemas de producción sanos, locales, biodiversos, participativos y de economía solidaria.

La agricultura orgánica es un sistema de producción que mantiene y mejora la salud de los suelos, los ecosistemas y las personas. Se basa fundamentalmente en los procesos ecológicos, la biodiversidad y los ciclos adaptados a las condiciones locales, sin usar insumos que tengan efectos adversos. La agricultura orgánica combina tradición, innovación y ciencia para favorecer el medio ambiente y promover relaciones justas (IFOAM, 2016: 1). Este tipo de agricultura prohíbe el uso de plaguicidas y fertilizantes de síntesis química, organismos modificados genéticamente, aguas negras, radiación y aditivos peligrosos en los alimentos; a cambio emplea abonos naturales como compostas, vermicompostas, harinas de rocas y bioles, preparados a base de plantas y minerales para el manejo de las plagas y enfermedades; se basa principalmente en cultivar un suelo sano, para obtener plantas sanas y con ello gente sana.

Se tienen dos formas reconocidas de certificación orgánica, la certificación formal, de agencia o de tercera parte; y la certificación participativa conocida como certificación alternativa, o los Sistemas Participativos de Garantía (SPG's) como los denomina la Federación Internacional de Movimientos de Agricultura Orgánica (IFOAM). La certificación participativa es un proceso colectivo entre productores, consumidores y otros actores, que garantiza la calidad orgánica y sana de productos locales, generados a pequeña escala, basado en relaciones de confianza y que promueven los compromisos de salud, ecología, equidad y certidumbre ambiental. Está dirigida a productores y/o procesadores de pequeña escala: productores individuales, productores familiares, pequeños grupos de productores que destinan su producción al autoconsumo, así como para al mercado local, regional y nacional (REDAC, 2016: 24-25).

La certificación participativa se diferencia de la certificación de agencia porque cumple con las normas orgánicas, mantiene procedimientos de verificación simples, mínima burocracia, costos mínimos y normalmente incluyen un proceso educacional y de control social que involucra a los actores de la cadena productiva (productores y consumidores). La certificación participativa normalmente no tiene un costo directo al productor, tiene características distintas a los Sistemas Internos de Control (SIC) que son parte de la certificación de agencia y no tienen como meta la exportación de los alimentos (Gómez, 2006:3).

Algunos sistemas participativos de garantía incluyen declaraciones juradas de los productores, uso de sellos de organizaciones de productores/o de consumidores o de ONG`s (p.e. Keystone, Ecovida, etc), la garantía del nombre de una tienda, y algunos otros se someten a procesos de revisión con normas orgánicas muy estrictas, que incluyen, por ejemplo, normas sociales (IFOAM, 2007: 3-4). A nivel mundial más de 3 mil productores han establecido sistemas participativos, cubriendo 50 mil ha, siendo lideres Namibia, Estados Unidos, India, México, Bolivia, Australia y Brasil (Kirchner, 2015:134-136).

En México, la Ley de Productos Orgánicos en el Artículo 24 reconoce la certificación orgánica participativa, especificando que solo procede para la producción familiar o para pequeños productores organizados siempre y cuando vendan directamente al consumidor y dentro del país (Diario Oficial de la Federación, 2013:39).

Académicos, alumnos y administrativos apostaron al establecimiento del Tianguis Orgánico Chapingo el 15 de noviembre del 2003 con la visión de ser un medio promotor de la agricultura orgánica, tener venta directa entre productores y consumidores, desarrollar el mercado interno (local y regional) de productos orgánicos con la misión de establecer un espacio de vinculación y enlace con la Universidad Autónoma Chapingo en el entorno regional (Gómez, *et al.,* 2004:6). El Tianguis Orgánico Chapingo (TOCh) forma parte de la Red Mexicana de Tianguis y Mercados Orgánicos (REDAC), y está integrado por 29 productores que anualmente deben cumplir con la certificación de los productos orgánicos mediante las visitas de acompañamiento del comité de certificación participativa quienes se encargan de realizar todos los trámites y la programación de las visitas dándose el intercambio de experiencias, la asesoría técnica y la capacitación directa entre los productores, consumidores e investigadores; siendo una alternativa de aprendizaje de ambas partes para mejorar la calidad de los productos que se ofertan dentro del TOCh y reafirmar los lazos de confianza.

El objetivo del presente estudio fue analizar el proceso de certificación participativa del Tianguis Orgánico Chapingo para detectar sus fortalezas y limitantes; así mismo analizar cómo este esquema de certificación promueve la Agroecología y el empoderamiento.

1. Metodología

La presente investigación se realizó con productores del Tianguis Orgánico Chapingo (TOCh), ubicado en Texcoco; Estado de México en el periodo de febrero a octubre, 2016. De un total de 30 productores y unidades de producción que participan en el Tianguis Orgánico Chapingo se seleccionaron 5 al azar para analizar como estudios de casos. Se realizaron visitas a las unidades de producción para cotejar su cumplimiento con base a los Lineamientos de la Producción Orgánica, y se aplicaron entrevistas semiestructuradas para detectar las fortalezas, oportunidades, debilidades y amenazas (Análisis FODA) del sistema de certificación participativo instrumentado. Posteriormente los resultados se analizaron y discutieron con base a la literatura encontrada.

2. Resultados y Discusión

2.1 Grado de Cumplimiento de las Normas Orgánicas

En el Cuadro 1 se observa como de los 15 parámetros más importantes evaluados se cumple con la mayoría de los requerimientos que pide la normatividad orgánica a través de los Lineamientos de Operación Orgánica de las Actividades Agropecuarias. El 100% de los productores cumplen con los Lineamientos para la Operación Orgánica son los siguientes: todos han pasado por el proceso de transición, no utilizan agroquímicos, ni aguas residuales, hacen conservación de agua y suelo, protegen el suelo con cubierta vegetal, usan rotaciones y asociaciones de cultivo, tienen manejo ecológico de plagas, enfermedades y arvenses, diversidad en el agroecosistema, manejo postcosecha adecuado, ingredientes de la materia prima permitidos en la lista nacional, limpieza en el área de procesados, protección e integridad orgánica (en cosecha, almacenamiento y transporte).

CUADRO 1. GRADO DE CUMPLIMIENTO DE LOS LINEAMIENTOS ORGÁNICOS EN MÉXICO EN EL TIANGUIS ORGÁNICO CHAPINGO

Cumplimiento de los puntos orgánicos de control	Caso 1. Agrícola y procesado	Caso 2. Agrícola, pecuario y procesados	Caso 3. Agrícola	Caso 4. Agrícola y procesados	Caso 5. Apícola
No utilización de sustancias prohibidas (uso de semillas tratadas, plaguicidas, OMG, nanotecnología, aguas residuales, etc.)	Sí	Sí	Sí	Parcialmente (semillas)	Sí
Medidas preventivas de contaminación	Sí	Parcialmente	Sí	Sí	No
Conservación de agua y suelo	Sí	Sí	Sí	Sí	N/A
Suelo con cubierta vegetal	Sí	Sí	Sí	Sí	N/A
Uso de rotaciones de cultivos	Sí	Sí	Sí	Parcialmente	N/A
Compostaje adecuado	No	Sí	No	No	N/A
Respeto al # de días de aplicación de estiércol crudo o sin compostear antes de realizar la cosecha	Sí	No	Sí	Sí	N/A
Manejo ecológico de arvenses, enfermedades y plagas	Sí	Sí	Sí	Sí	N/A
Diversidad en el agroecosistema	Sí	Sí	Sí	Sí	N/A
Volumen de la cosecha congruente con lo ofertado	Sí	Sí	Sí	No	N/A
Manejo post-cosecha adecuado	Sí	Sí	Sí	Sí	N/A
Ingredientes orgánicos como materia prima	Sí	Sí	N/A	Sí	N/A
Limpieza en el área del proceso	Sí	Sí	N/A	Sí	Sí
Protección de integridad orgánica (cosecha, almacenamiento y transporte)	Sí	Sí	Sí	Sí	Sí
Elaboración de bitácoras (actividades/ventas)	No	Sí	No	No	No

Fuente: elaboración propia en base al trabajo de campo, 2016 y en los Lineamientos para la Operación Orgánica de las Actividades Agropecuarias (Diario Oficial de la Federación, 2013).
N/A. No aplica.

Se observó que se tienen las siguientes áreas de oportunidad a mejorar: 3 de los 5 productores agrícolas no cumplen con la elaboración adecuada de composta (relación C/N, medición de la temperatura y darle por lo menos 5 volteos). Es necesario seguir brindándoles asesoría, talleres de composteo prácticos y proporcionarles manuales o trípticos didácticos.

Dos de los cuatro productores que ofertan alimentos procesados o empacados no cumplen con el etiquetado correcto y deben seguir las siguientes recomendaciones si, son: 1) 100% productos orgánicos conteniendo hasta un 5% de ingredientes libres de sustancias prohibidas y se encuentren en la lista de ingredientes permitidos en los Lineamientos; 2) productos elaborados con ingredientes orgánicos (especificando que ingredientes) cuando los productos contengan el 70% de ingredientes producidos orgánicamente excluyendo agua y sal (sin contener sulfitos y el otro 30% de los ingredientes agrícolas pueden ser producidos no orgánicamente u otras substancias que estén permitidos en la lista de los Anexos de los Lineamientos); 3) productos con menos del 70% de ingredientes orgánicos, no pueden portar la leyenda de orgánicos y sólo en la lista de ingredientes en la parte trasera del producto se puede especificar cuáles ingredientes son orgánicos.

La mayoría de los productores aún tienen problemas en el registro de información en bitácoras de actividades y ventas, elementos importantes para identificar la trazabilidad de todos los productos orgánicos.

Después de este análisis se puede observar que se tiene que seguir trabajando para cumplir con todos los Lineamientos en las diferentes áreas productivas, sin embargo es valuable el esfuerzo de los productores y del comité de certificación participativa del TOCh que trabaja activamente para que se siga cumpliendo con la normatividad teniendo en cuenta que falta mucho por hacer y mejorar en cuestión del movimiento orgánico en México, principalmente en el reconocimiento de este tipo de certificación y en las limitaciones, algunas muy rigurosas (p.e. poner letreros para identificar la unidad orgánica de producción, llevar registro de cada metro cuadrado en términos de qué semilla se empleó, cuánto se sembró, cuánto se cosechó, dónde se comercializó, lo cual se complica en particular para unidades de producción pequeñas, pero muy diversificadas, algunas tienen en un cuarto de hectárea más de 50 cultivos), y otras sin explicación técnica que hay dentro de los Lineamientos.

2.2 Análisis FODA de la certificación participativa

En el análisis de las Fortalezas, Oportunidades, Debilidades y Amenazas (FODA) se encontró que entre las principales fortalezas de la certificación participativa del TOCh se tiene el reconocimiento de esta alternativa de certificación en la Ley de Productos Orgánicos que se reglamenta mediante los Lineamientos de Operación Orgánica en México y que el comité de CP incluye a los consumidores en su proceso de certificación. Entre las debilidades se encuentra el tiempo limitado que tiene el comité para la certificación participativa; para algunos productores lo ven como un proceso poco flexible y estricto sobretodo por la falta de conocimiento de Lineamientos. En las oportunidades encontramos el prestigio y financiamiento que podría seguir brindando la Universidad Autónoma Chapingo, que es un referente de la certificación participativa a nivel nacional; y por último en las amenazas el tianguis alternativo a las afueras del TOCh que disminuye las ventas de los productores que cumplen con la certificación y se presenta como una competencia desleal (Cuadro 2).

La certificación del TOCh sigue siendo un proceso en construcción que últimamente se ha venido mejorando con la intervención de la UACh, sin embargo, a nivel normativo nacional se requiere de mayor flexibilidad y adecuación de los protocolos de revisión y normas de acuerdo al tipo de producción; en este caso local, diversificada y familiar.

CUADRO 2. ANÁLISIS FODA DE LA CERTIFICACIÓN PARTICIPATIVA EN EL TOCH

Fortalezas	Debilidades
- La Ley de productos orgánicos reconoce el proceso de CP en el Artículo 24 para comercializar en el mercado nacional. - La REDAC ha contado con sus propios estándares reconocidos a nivel mundial en el 2011 en la Familia de Estándares de IFOAM en los cuales se basó el comité de certificación participativa del TOCh durante varios años. - La certificación participativa es una experiencia exitosa en el Tianguis Orgánico Chapingo que opera desde el 2006, siendo una referencia nacional. - El comité de certificación del TOCh se integra por productores, consumidores y catedráticos e investigadores de la UACh con experiencia en la producción orgánica y la CP en México. - Reconocimiento de la certificación participativa por parte de los consumidores al no exigir un sello de agencia como garantía de la producción orgánica, basándose en la confianza y el respaldo que le proporciona la Universidad Autónoma Chapingo. - El comité de CP realiza las visitas de acompañamiento para que todos los productores que integran el TOCh estén certificados. - En las visitas de acompañamiento a las unidades de producción se tienen mecanismos de retroalimentación entre los integrantes del comité y los productores, que permiten mejorar las prácticas orgánicas empleadas. - Los miembros del comité de la CP tienen control de los productos de cada integrante del tianguis, por ejemplo si un productor oferta un alimento que no está certificado, automáticamente se da de baja hasta que el comité vaya a verificar el producto. - Los puntos orgánicos de control positivos que cumplen los productores de esta investigación son: pasaron por el proceso de transición, fincas biodiversas con uso de diferentes técnicas agroecológicas, asociaciones y rotaciones de cultivo, barreras de amortiguamiento, manejo ecológico de plagas, enfermedades y arvenses, fuentes de agua limpia, limpieza en las labores post cosecha y protección de la integridad orgánica de los productos procesados. - Financiamiento en el 2016 con proyectos de la Universidad Autónoma Chapingo para actividades de la certificación participativa, adquisición de mobiliario, promoción, difusión, etc., que se gestiona a través del Centro de Investigaciones Interdisciplinarias para el Desarrollo Rural Integral (CIIDRI).	- Tiempo limitado de los integrantes del comité de certificación participativa para las visitas de acompañamiento. - El proceso de CP de acuerdo a la normativa en México no es flexible, pues no toma en cuenta el tipo de productor, el entorno social y ambiental. - No todos los integrantes del comité de CP (consumidores y productores) entienden totalmente los Lineamientos para la Operación Orgánica por los términos técnicos que se utilizan. - 3 de los 5 productores que elaboran compostas no cumplen en su totalidad lo que solicitan los Lineamientos: cálculo de los materiales para la relación C/N, toma de temperatura y 5 volteos. - 3 de los 5 productores visitados utilizan estiércol semifresco sin respetar los días previos a su incorporación en las hortalizas (al menos 120 días antes de la cosecha). - 4 de los 5 productores visitados en el 2016 no tenían las bitácoras de actividades y de ventas. - Se tiene problemas para el correcto etiquetado de procesados. - Se requieren en promedio 1885 horas de trabajo voluntario con cinco miembros del comité para llevar a cabo la certificación participativa de todos los productores del TOCh con un costo estimado de $306 501 pesos mexicanos anuales. - El esquema de certificación participativa quedó muy limitado en el Reglamento de la Ley de Productos Orgánicos y en los Lineamientos para la Operación Orgánica, dificultando su ejecución. - La CP no ha logrado el reconocimiento internacional que pueda abrir el destino de los productos orgánicos nacionales hacia otros países con este sistema de certificación.

Oportunidades	Amenazas
- La experiencia del TOCh en la certificación participativa es un ejemplo de la funcionalidad que se tiene como alternativa de certificación que pueden adoptar otros nuevos tianguis en el país y a nivel internacional. - Posibilidad de apoyo técnico y económico continuo y constante al Tianguis y al proceso de certificación participativa por parte de la UACh aprovechando las capacidades de investigadores y estudiantes que se pueden formar en el ámbito de la producción orgánica.	- El tianguis alternativo instalado afuera del TOCh aprovecha los días de venta del mercado para vender productos convencionales como orgánicos, creando competencia desleal, lo que puede desacreditar la reputación del tianguis. - El Gobierno Federal podría dejar de reconocer la certificación participativa en caso de que no tener disposición política y apoyo hacia esta forma de certificación.

Fuente: elaboración propia con datos de campo, 2016.

2.3 Costo del trabajo voluntario: el aporte del colectivo

Se realizó un cálculo del valor del trabajo voluntario en la certificación del TOCh de los 29 productores, obteniéndose que se requieren **235.77 días** con jornadas de ocho horas y un costo total estimado de **$306, 501 pesos mexicanos**, con un costo promedio por productor de **$10 569 pesos (8.13 días)**. Ver Cuadro 3, donde se utilizó el costo de inspección en una agencia de certificación por día como referencia (pues parece más adecuado para poder comparar las diferencias entre la certificación de agencia y participativa en términos del aporte económico del trabajo voluntario). Normalmente algunos de los gastos de la certificación participativa en el TOCh corren a cuenta del Centro de Investigaciones Interdisciplinarias para el Desarrollo Rural Integral (CIIDRI) que forma parte de la Universidad Autónoma Chapingo, la comida y en ocasiones el transporte es pagado por los propios productores a certificar. En ésta evaluación no se consideraron estos costos pues el objetivo era medir el valor económico del trabajo voluntario.

En contraparte en un estudio de CP en el TOCh realizado por Kaufmann (2016:59) menciona que el tiempo y costo de certificación participativa para los 29 productores con cinco personas sería de 306.24 días con un costo para el tianguis de $484,456.3 pesos mexicanos incluyendo un monto por el tiempo voluntario según el actor involucrado (dos técnicos: $535.72, un consumidor $443.33 y dos productores: $602.9, con un total de $1 581.95 pesos mexicanos/día), los gastos de operación: hospedaje, comidas, papelería, transporte y dictaminación, lo anterior con una estimación en base a cuatro visitas realizadas. El costo promedio por productor fue de 10.56 días y el costo de $16, 705.39 pesos mexicanos. Realizando la comparación entre dicha investigación y la presente las diferencias se dan por el monto asignado por día, y que Kaufmann (2016: 59) incluyó el costo de hospedaje y alimentación.

CUADRO 3. TIEMPO Y COSTOS DEL TRABAJO VOLUNTARIO EN LA CERTIFICACIÓN PARTICIPATIVA EN UNIDADES DE PRODUCCIÓN SELECCIONADAS DEL TOCH

Tiempo por visita estimado (horas)	Tiempo en dictamen (horas)	Tiempo total/ unidad de producción (horas)	Tiempo estimado (horas) # de integrantes		*Costo estimado con 3 miembros del comité (días x costo)	*Costo estimado con 5 miembros del comité
			3 personas	5 personas		
Unidad 1: 6	0.5	6.5	19.5	32.5	2.44x1300= $3 172	4.06x1300= $5 278
Unidad 2: 30	1	31	93	155	11.63x1300= $15 119	19.38x1300= $25 194
Unidad 3: 9	0.5	9.5	28.5	47.5	3.56x1300= $4 628	5.94x1300= $7 722
Unidad 4: 8	0.5	8.5	25.5	42.5	3.19x1300= $4 147	5.31x1300= $6 903
Unidad 5: 9	0.5	9.5	28.5	47.5	3.56x1300= $4 628	5.94x1300= $7 722
Promedio (1 caso): 12.4	0.6	65	39	65	4.88x1300= $6 344	8.13x1300= $10 569
Para los 29 productores del TOCh 359.6	17.4	377	1 131	1 885	141.52x1300= $183 976	235.77x1300= $306 501

*Costo en la agencia de certificación por un día laboral: Certimex: 1300 pesos por 8 horas.

Fuente: elaboración propia con datos de campo, 2016.

En cuanto a los costos estimados por un organismo de certificación de agencia que incluyen costos de inspección, viáticos del inspector, transporte, gastos administrativos, y la cuota de certificación por cada programa de certificación. De acuerdo con Blas, (s/a: 5), el costo para un productor sería de 1300 USD equivalente a 27, 300 pesos mexicanos, dejando toda la responsabilidad en un agente externo y no al colectivo como es el caso de la certificación participativa.

Otro ejemplo claro de los costos por una certificadora es el caso de Metrocert para hortalizas y hongos la tarifa fija anual era de $ 1, 500. 00 dólares basándose en el número de días/hombre necesarios para revisar la superficie a certificar y en el número de hectáreas; para predios de 1-5 has era de $ 1, 600 dólares + gastos (Metrocert, 2013:1), condicionando otro tipo de factores para elevar la tarifa.

En el mercado virtual del Jilote ubicado en Jalisco, el comité de certificación participativa recibe una remuneración, cada productor realiza una aportación de $2 000 más viáticos por la visita para el proceso de certificación. Otro ejemplo es el Tianguis Orgánico de San Miguel de Allende (TOSMA), en el cual el comité de certificación recibe $550 por productor y visita de acompañamiento para cubrir los gastos relacionados con esta actividad, el monitoreo lo realizan anualmente mediante la renovación del convenio de cooperación y visita a la unidad de producción (REDAC, 2015: 24 y 33).

A pesar de que los productores aporten algunos recursos económicos para la certificación participativa, la evidencia empírica de este estudio muestra que los costos son mayores a estas aportaciones reportadas por la literatura. Empero el costo del trabajo voluntario ($10,569 pesos) es menor a lo cobrado por una agencia de certificación; $27,300 pesos (Blas, s/a) y $32,000 pesos mexicanos (Metrocert, 2013), pues representa un tercio del costo.

En un estudio de la Red Mexicana de Tianguis y Mercados Orgánicos por Nelson (2012:164-190) menciona que el 55% de los productores ha participado como miembros del comité de certificación participativa; y solo se han involucrado en el proceso de certificación el 10% de los consumidores; los retos que plantea son la falta de tiempo y falta de conocimiento debido a que mucha gente (productores y consumidores) sienten que no tienen suficiente conocimiento y experiencia para participar en los comités de certificación participativa.

A los productores que forman parte del TOCh no se les cobra una cuota específica para la CP, es una de las ventajas que tienen al relacionarse con una institución educativa, por tener técnicos y personal interesado en que se cumpla con la normatividad orgánica, además de la conformación del comité de CP en el cual se involucran consumidores, estudiantes, productores y otros actores que brindan su tiempo para certificar los alimentos que se consumen dentro del tianguis.

Nelson *et al.*, (2008:20) mencionan que el proceso de certificación participativa no está exento de problemas y limitaciones. Uno de los desafíos que más resalta es que se realiza por medio de una base de voluntarios. Esto tiene restricciones en cuanto al tiempo que las personas puedan dedicar al proceso. Además, muchos participantes van y vienen, quitando consistencia y continuidad al comité de certificación. Sin embargo, en el caso del TOCh se tienen integrantes con antigüedad dentro del comité de certificación que con el tiempo van adquiriendo experiencia en las visitas de acompañamiento lo que fortalece el proceso de certificación participativa (Nelson, *et. al.*, 2016: 384).

2.4 Aporte de la certificación participativa en el crecimiento de la Agroecología

> *"Los sistemas de producción que tienen como base la agroecología (ciencia y práctica) son biodiversos, resilientes, eficientes energéticamente, socialmente justos y constituyen la base de una estrategia de soberanía energética, alimentaria y productiva. La sustentabilidad y la resiliencia se consiguen promoviendo la diversidad y la complejidad de los sistemas agrícolas a través de los policultivos, rotaciones, agroforestería, el uso de semillas autóctonas y de las razas locales de ganado, fomentando enemigos naturales de las plagas, el uso de compostas y de abonos verdes para mejorar la materia orgánica del suelo optimizando su actividad biológica y capacidad de retención de agua. La agroecología está basada en el conocimiento de la gente y en conocimientos científicos que privilegian los productos y mercados locales" (Red de comida sana y cercana, 2013: s/p).*

La certificación participativa establece procesos participativos que articulan y fomentan el encuentro de personas implicadas en generar modelos de producción y consumo vinculados a la agroecología y la soberanía alimentaria, y se convierten en herramientas mucho más amplias y con mayor riqueza al estar construidas por y para las bases sociales (Torremocha, 2012:56). Lo anterior coincide con lo encontrado en la presente investigación, pues para llevar a cabo la certificación participativa en el Tianguis Orgánico Chapingo se fomenta la participación a través de talleres participativos, incluyendo a los consumidores, basándose en la reglamentación interna del tianguis y dando como resultado la generación de confianza para demostrar que se venden verdaderamente productos orgánicos verificados por un comité plural que incluye productores, consumidores, investigadores y estudiantes.

La agroecología permite percibir la producción y el consumo de los alimentos de forma diferente, construyendo mayor participación del consumidor que como menciona Escalona (2009:448), no solo es un agente económico, sino un actor social que interviene con otros productores, técnicos y alumnos en la certificación y valoración del esfuerzo que se realiza para tener productos orgánicos que dan confianza, son amigables con el ambiente y proporcionan una sensación saludable.

La confianza es uno de los principios fundamentales para garantizar el funcionamiento de los Sistemas Participativos de Garantía. Los agentes interesados deben creer en la veracidad de lo certificado a través del Sistema para prolongar su implicación en el mismo (Boza, 2013:34). En ésta investigación los productores manifestaron percibir la influencia de la Agroecología en la forma en que aplican las prácticas agroecológicas, lo que les permite a su vez cumplir con los Lineamientos para la Operación Orgánica. A pesar de lo anterior, en las encuestas, los productores manifestaron que para ellos lo más importante eran las relaciones sociales que entablaban con los consumidores, al brindarles la confianza de que lo que les vende son productos orgánicos que pasaron por un proceso de revisión donde también participan representantes consumidores.

Gliessman, 2015 citado por Gómez (2016: s/p), expresa que en el nivel 4 de los procesos de conversión agroecológica es necesario reconectar las partes más importantes del sistema alimentario involucrando a productores y consumidores, a través del desarrollo de redes alimentarias alternativas: mercados locales, cooperativas, redes de consumidores, etc. Ver Cuadro 4. De acuerdo a lo anterior el esfuerzo de los productores en ofrecer alimentos sanos, no se queda con un simple intercambio de productos en el TOCh, sino en un proceso que permite hacer crecer la Agroecología en la región.

CUADRO 4. NIVELES EN EL PROCESO DE CONVERSIÓN AGROECOLÓGICA

Nivel 1	Aumentar la eficiencia en el uso de insumos, reduciendo así, el uso de insumos costosos, escasos o ambientalmente dañinos.
Nivel 2	Substitución de insumos y prácticas convencionales con alternativas.
Nivel 3	Re-diseño de agroecosistemas para que funcionen con base a un nuevo grupo de procesos ecológicos.
Nivel 4	Reconectar las partes más importantes del sistema alimentario, productores y consumidores; a través del desarrollo de redes alimentarias alternativas (mercados locales, agricultura urbana, redes de consumidores, etc.).
Nivel 5	Con los 4 niveles anteriores basados en resiliencia, participación, relocalización, justicia social. No sólo es justo socialmente, también ayuda a restaurar y proteger los ecosistemas.

Fuente: Gliessman (2015) citado por Gómez (2016: s/p).

De los objetivos sobresalientes que se tienen en el TOCh es contar con un punto de encuentro de comercialización directo (productores y consumidores), con una producción orgánica local, reconectando la alimentación con la naturaleza y la difusión de las actividades educativas, culturales y de aprendizaje (talleres, cursos y visitas a las granjas), que motivan a los visitantes a intercambiar ideas facilitando la interacción entre los distintos actores.

Los tianguis orgánicos son lugares que expresan procesos (individuales que transitan a lo colectivo) que intentan la construcción de poder social, por medio de proyectos que se comparten: "La construcción del poder social comienza en la familia, en la edificación de un hogar autosuficiente, seguro y sano, que comparte con muchos otros una misma micro-política doméstica" (García, 2015:181).

Dentro del TOCh se facilita la generación de circuitos comerciales cortos, una de las modalidades de economía ecológica, con la agrupación de los productores que a lo largo del tiempo han tratado de diversificar la canasta básica con alimentos sanos, limpios, tradicionales y con mayor sabor, donde se promueve la economía solidaria, la cultura, la sana convivencia, los talleres de aprendizaje y que se ha mantenido con la participación de varias generaciones de productores (hijos, nietos y abuelos). Además es un espacio que brinda la sensación de felicidad donde no solo favorece al consumidor que busca los múltiples beneficios nutricionales con los productos orgánicos, sino también a los productores que encuentran el sustento básico para su seguridad y soberanía alimentaria generando recursos económicos a través de su esfuerzo en la producción donde conservan los conocimientos tradicionales y que además tienen la credibilidad porque son controlados bajo los Lineamientos orgánicos, lo cual no les genera costos directos mediante la certificación participativa.

Morales (2011:88-89) menciona que para el crecimiento de la Agroecología se requiere un escalonamiento agroecológico con las siguientes dimensiones: Dimensión uno: Conexión con otros productores agroecológicos, instituciones públicas y privadas; Dimensión dos: Articulación entre sistemas de conocimientos (diferentes tipos de saberes); Dimensión tres: Relación con mercados diferentes, alternativos, etc. Analizando el caso del TOCh se ven reflejadas las dimensiones anteriores pues se tiene una conexión de los pequeños y medianos productores con investigadores, técnicos y alumnos de una institución educativa (UACh); donde se busca el amalgamiento del conocimiento científico con los saberes tradicionales creando propuestas organizativas para promover una cultura productiva local donde el tianguis es un eje integrador en la parte económica, pero también en la parte social, haciendo crecer la Agroecología en el ámbito local y regional.

2.5 Empoderamiento de la certificación participativa

Entre los factores clave para lograr la certificación participativa se tienen: responsabilidad, interés, participación y respeto hacia los métodos de producción orgánica por parte de los productores, lo anterior implica ver a la certificación participativa como un **proceso social** y no sólo el cumplimiento de los estándares técnicos.

El grado de empoderamiento que han tenido los productores del TOCh es aún incipiente, pues tratan de cumplir con lo básico con relación al reglamento interno que tienen en el tianguis y a los Lineamientos Orgánicos, apegándose a la instrumentación de prácticas agroecológicas, sin el uso de productos prohibidos por la agricultura orgánica, como agroquímicos, transgénicos, radiación, aguas negras, etc., lo cual tampoco son procesos y acciones fáciles de llevar a la práctica; pues muchos agricultores en el país lo han intentado y no lo han logrado.

En cuanto a los consumidores el empoderamiento se ha trabajado con los diversos talleres que se brindan dentro del TOCh, constantemente se promueve se involucren en el comité de certificación participativa para que poco a poco se logre un mayor conocimiento de lo que implica tener en sus manos un producto orgánico y que se valore a un más el esfuerzo que se dedica en las áreas de producción mediante la experiencia de ser parte del comité de certificación; además eso también influye en disminuir el conflicto de interés si sólo participaran productores en el comité.

A pesar de lo anterior, se requiere seguir trabajando en la sensibilización y capacitación de los productores para el mejoramiento de sus prácticas orgánicas, se mejoren procesos como el de composteo, fechas de aplicación de estiércoles, etiquetado, y bitácoras que son puntos orgánicos de control que año con año aparecen como áreas de mejora en los dictámenes de la certificación participativa. Sin embargo, cabe mencionarse también que incluso en las certificaciones a través de las agencias ningún productor cumple al 100% con los puntos orgánicos de control; y siempre obtienen no conformidades o recomendaciones, viéndose a la certificación como un proceso de mejora continua.

Nelson (2012:164-190), menciona que el 88% de los consumidores encuestados en varios tianguis de la Red Mexicana de Tianguis y Mercados Orgánicos manifestaron que les gustaba la idea de un sistema de certificación para complementar la confianza que tienen hacia los productores. En cuanto al conocimiento y participación en la CP por parte de los dos eslabones clave (agricultores y consumidores), el 90% de los productores sabía lo que implicaba ésta certificación, mientras que el 30% tenía solo algunas nociones de lo que significa, el 45% de los productores había participado como miembros en el comité de CP y sólo un 10% de los consumidores. El 82.5% de los productores encuestados tenía más confianza en la certificación participativa en comparación con la certificación de agencia porque la gente ve directamente como están cultivando y criando a los animales. Sin embargo, los consumidores dieron más valor al contacto directo con los productores para preguntar sobre el origen de los productos.

En este sentido la certificación participativa es un mecanismo que fortalece las relaciones de confianza, la autonomía y la coordinación de los productores y consumidores, que con apoyo de la Universidad Autónoma Chapingo (CIIDRI) permiten una mejor organización del proceso de certificación, además del apoyo económico que brinda la universidad para que las visitas y el proceso pueda realizarse.

Conclusiones

La certificación participativa en el Tianguis Orgánico Chapingo es una experiencia exitosa que opera desde 2005 y se considera una referencia a nivel nacional. El éxito lo ha logrado por la integración en el comité de certificación por expertos en la agricultura orgánica en México (catedráticos de la UACh), productores y consumidores, éstos últimos actores clave, pues realzan la confianza que se tiene de éste proceso brindando mejoras a través de experiencias e investigaciones que se tienen en otros tianguis dentro y fuera de México.

El comité de certificación participativa del TOCh garantiza la calidad y procedencia de los productos orgánicos mediante la certificación con un modelo horizontal, flexible, abierto, y local, que además promueve la biodiversidad, la protección de semillas criollas, la participación social en los procesos de comercialización y la influencia de la agroecología en la parte técnica mediante la aplicación de prácticas agroecológicas.

En la certificación participativa cada año el productor debe hacer mejoras en su unidad de producción indicadas en el dictamen, siendo la certificación un proceso de mejora continua, que, con ayuda del comité certificador, integrado por los productores, consumidores e investigadores, se fortalece poco a poco en México, de forma contraria al modelo certificador exportador.

Esta investigación arrojó datos interesantes en la medición del aporte del trabajo voluntario en sistemas de producción locales, pequeños y diversificados; éste costo corresponde a un tercio del valor que tendrían que pagar los pequeños productores en caso de solicitar la certificación a través de una agencia certificadora.

La certificación participativa es un proceso donde predomina la confianza, los valores, y el aprendizaje colectivo (intercambio de saberes) entre los diferentes actores que participan, promoviendo el empoderamiento de los productores sobre sus procesos productivos y favoreciendo el desarrollo de la Agroecología, como un modelo alternativo de producción y consumo.

La certificación participativa apuesta a romper la nociva relación de que los productos orgánicos deben ser costosos por el hecho de que deben de pagar una certificación onerosa; al contrario, si la participación permite la verificación de la producción local, diversificada y orgánica, ésta puede ser accesible, además de favorecer procesos de empoderamiento por parte de los productores y consumidores y otros actores afines; todo lo anterior en beneficio del crecimiento de la Agroecología.

La certificación participativa en el Tianguis Orgánico Chapingo, a través de sus actores, productores, consumidores e investigadores promueve el crecimiento y escalonamiento de la Agroecología en la región de Texcoco, al favorecer sistemas de producción sanos, locales, biodiversos y participativos, lo que muestra un ejemplo exitoso de economía ecológica.

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Análisis de los modelos agrícolas y los sistemas agroalimentarios en América Latina y en La Argentina: una mirada propositiva frente al actual enfoque global

Walter Pengue*

Introducción

Desde una perspectiva integral, los bienes y servicios de la naturaleza son la base de los sistemas agrícolas y del sistema alimentario mundial. Actualmente la enorme presión y demanda de recursos naturales y los cambios de uso del suelo, están generando una degradación de tierras sin precedentes.

A lo largo de la historia humana, la agricultura ha co-evolucionado y se ha desarrollado junto con las diferentes civilizaciones, las cuales expandieron y diversificaron los sistemas alimentarios. Por otro lado, estas mismas civilizaciones colapsaron en algunos casos, justamente por la irrefrenable demanda de recursos en especial tierras y bosques. Entre las diferentes actividades humanas, la agricultura es la que demanda más tierra, agua y biodiversidad, necesarias para mantener el sistema agroproductivo funcionando. Dependiendo de las prácticas de manejo, tecnologías y agronomías implementadas, es posible mejorar o degradar el agroecosistema que le contiene. Los sistemas agrícolas representan un continuo de modelos, que van desde la agricultura tradicional hasta la agricultura moderna, co-evolucionando constantemente con la sociedad, interactuando e influenciándose mutuamente. Los cultivos y las pasturas, con la diversidad de integraciones y configuraciones que pueden tomar, son un componente especial de los sistemas agrícolas.

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En los últimos años, el rol del capital financiero en todas las etapas de la agricultura y de los sistemas alimentarios ha comenzado a hacerse notorio. Este proceso ha traído beneficios para algunos sectores, pero también ha generado tensiones irresueltas. Sin embargo, actualmente existen serias distorsiones tanto en el sector agrícola como en toda la cadena de producción de alimentos. La llegada de inversiones, que apuntan a la compra ilimitada de tierra y agua (*landgrabbing*), en especial en los países en vías de desarrollo (África y América Latina), han producido distorsiones en el sistema productivo, creando ganadores y perdedores, especialmente entre los agricultores, campesinos, indígenas y la población joven y anciana de estas comunidades, que ven perdido sus espacios de vida o bien no pueden acceder a escalas mínimas para la producción de sus propios alimentos.

Ciertas externalidades empiezan a hacerse evidentes cuando se analizan las transferencias de materiales y cambios en las reservas de recursos, relevantes no solo desde un punto de vista productivo, pero también desde las perspectivas ecológica, social y económica. Las huellas y la mochilas ecológicas, junto con los flujos de agua y suelo virtuales, representan invisibles que están comenzando a ser tenidos en cuenta local, regional y globalmente.

El crecimiento de las ciudades y de su demanda de recursos, junto con el incremento de los ingresos y el ascenso de las clases medias urbanas, están transformando los sistemas alimentarios e impactando en la salud humana. Las ciudades son puntos clave; en ellas yace la oportunidad de guiar los sistemas agrícolas y alimentarios hacia caminos sostenibles.

El sistema agroalimentario es complejo y opera a distintas escalas. El alcance de su influencia aún no está claro, con efectos que van desde impactos en la salud humana hasta la concentración de mercados en los sistemas alimentarios. La volatilidad de los precios amenaza tanto a productores como a consumidores, a la vez que importantes ganancias son generadas por grupos concentrados, con creciente control sobre acciones y tendencias de mercado. La estructura generada alrededor de recientes poderes del sistema alimentario global debe ser reformada.

La creciente movilidad social demanda acceso a recursos naturales, resolución de conflictos ambientales, mejora de los sistemas alimentarios y de la calidad nutricional de la comida. Estas tendencias incluyen movimientos relacionados con la tierra y nuevos movimientos urbanos, que promueven prácticas sustentables, dietas saludables y la integración de comunidades urbanas y rurales.

Existen sistemas productivos que usan menos agroquímicos, promoviendo la integración de la producción y apuntando a mercados locales, muchos de los cuales están basados en principios agroecológicos que desalientan el uso de químicos y fertilizantes sintéticos.

1. Los Sistemas agrícolas

Desde hace unos 10.000 años, las sociedades neolíticas comenzaron a cultivar plantas y tener animales en cautiverio, con el objetivo de multiplicarlos y usar sus productos. Al mismo tiempo, las plantas y animales seleccionados fueron domesticados en un proceso que transformó ecosistemas naturales en sistemas agrícolas, cambiando continuamente a partir de sus formas originales (Mazoyer y Roudart, 2010). Este movimiento inicial desde la caza y la recolección hacia la agricultura dio lugar a la primera gran revolución que cambiaría la historia, sociedad y economía humana.

La invención de la agricultura y de la domesticación de animales permitió la creación y el crecimiento de asentamientos humanos y la diversificación de actividades humanas, creando aldeas, pueblos y ciudades gracias a los excedentes de biomasa. Desde entonces, las zonas rurales y las ciudades han coevolucionado, convirtiéndose en sistemas conectados. El sector rural provee productos primarios, servicios ambientales y trabajo humano al sector urbano, y recibe productos procesados y servicios a cambio.

La ciudad vive, se nutre y se desarrolla en función de los productos y el aporte del campo. Y este crece y evoluciona en función de las inyecciones de recursos económicos, nuevas tecnologías, innovación y conocimiento que generalmente es producido en mayor cuantía en las ciudades. Más del 75/80 % del conocimiento, tecnologías e innovación se producen en las ciudades.

Históricamente, sistemas rural-urbanos emergieron en varias regiones del planeta de manera independiente, creando condiciones para el desarrollo de culturas humanas que utilizaron su nuevo tiempo libre para realizar importantes descubrimientos, como el manejo del agua, la conservación de materiales crudos, la escritura, y otros desarrollos culturales. Sin embargo, muchas civilizaciones gestionaron mal sus recursos naturales, generando pérdidas de suelo y fertilidad que disminuyeron la capacidad de carga de flora, fauna y por supuesto, de la propia población humana. Estas civilizaciones con sistemas menos sostenibles decayeron, desaparecieron o evolucionaron en otros tipos de organización social.

Los sistemas agrícolas son un continuo de numerosas variantes y combinaciones de agrobiodiversidad, recursos naturales, clima y sistemas culturales que co-evolucionaron a lo largo de la historia humana y fueron el soporte de su desarrollo. Un sistema agrícola es un ensamble de componentes que están unidos por algún tipo de interacción e interdependencia, y que opera dentro de límites determinados para lograr un objetivo agrícola específico (FAO, 1997). Este objetivo producto, va desde la producción de un alimento a cualquier otro producto utilizado por ejemplo actualmente para la producción de bioenergía, biomateriales, infraestructura, etc.

Los sistemas agrícolas implican una integración de componentes como recursos naturales, energía, trabajo, comercio, finanzas, recursos genéticos, nutrición, equipamiento y riesgos, que operan como un sistema. Las interacciones, entonces, entre componentes de un sistema pueden llegar a ser más importantes que la forma en que cada componente funciona en sí mismo. Las interacciones de los distintos componentes del sistema agrícola producen diferentes bienes, servicios, residuos sólidos, emisiones, efluentes, energía y servicios ecosistémicos. Este agregado de valor ocurre a lo largo de flujos al interior de los sistemas eco-agroalimentarios, que construyen (o agotan) los cuatro capitales (humano, social, físico y natural) (TEEB, 2015). Por ejemplo, el agregado de valor a partir de flujos nutricionales de los sistemas agrícolas puede llevar a un aumento en el capital humano en la forma de una mejora en la salud y el bienestar del individuo (TEEB, 2015).

2. La naturaleza como base de los sistemas agrícolas

A pesar del gran progreso de las nuevas formas de producción agrícola (como la bioingeniería, hidroponia y otras tecnologías modernas), la agricultura está, todavía (y lo será por mucho tiempo sin nos atenemos a los escenarios posibles con el conocimiento que tenemos actualmente), sostenida por recursos naturales básicos: suelo, agua y biodiversidad. Los sistemas agrícolas están conectados, en general, a sistemas alimentarios, que además de necesitar recursos básicos demandan otros tipos de recursos usados de diferentes maneras. Y además estos sistemas generan un conjunto de externalidades que de una u otra forma, impactan sobre el ambiente y la sociedad.

Como indica el Panel de los Recursos de Naciones Unidas Ambiente (2016) es necesario un amplio rango de recursos naturales para las variadas actividades de los sistemas alimentarios (Tabla 1). La participación relativa de un recurso en el sistema alimentario puede cambiar mucho: el suelo, por ejemplo, es necesario principalmente en actividades agrícolas, mientras que el uso de combustibles fósiles está mucho más repartido a lo largo de todo el sistema alimentario.

Lo mismo sucede con la apropiación de biomasa y su captura en los distintos procesos del sistema de transformación. En este caso, la mayor incidencia se produce en la primera etapa, en la agricultura, con la captura y transformación de la energía sola en química y esta en biomasa consumible por la sociedad y las otras especies.

Otros recursos naturales, como el hierro y otros minerales, son necesarios para las numerosas herramientas y máquinas usadas a lo largo de todo el rango de actividades del sistema alimentario. La Tabla 1 muestra varios de los recursos naturales necesarios para las actividades del sistema alimentario en todas sus etapas, desde la producción a la gestión de los residuos. El uso de minerales y productos sintéticos (como plásticos) para el embalaje es, ciertamente, otro punto importante; es claro que el papel, cartón, plástico, acero y aluminio usados en esta actividad tienen impactos negativos en un amplio rango de recursos naturales. Por ejemplo, alrededor del 17% del aluminio en Europa se usa con dicho fin (WHO, UNDP, 2009). La basura marina (mucha de la cual deriva del embalaje de alimentos) es una amenaza seria a la biodiversidad.

TABLA 1. FUNCIONES DE RECURSOS NATURALES USADAS PARA ACTIVIDADES DEL SISTEMA ALIMENTARIO

Recursos naturales	Producción de alimento	Procesado y embalaje e alimento	Distribución y venta de alimentos	Consumo de alimentos	Gestión de residuos
Recursos renovables					
Tierra, suelos y paisaje	Cultivos, pasturas y caza	Terrenos para fábricas	Terrenos para transporte y almacenamiento infraestructura, negocios		Terrenos para rellenos sanitarios
	*****	*	*		*
Agua	Irrigación, cultura	Lavado, cocina		Cocina	Recolección de vertido y residuos
	*****	*		*	*
Biodiversidad y servicios ecosistématicos	Polinización, control de plagas, regulación de nutrientes	Biomasa apra papel y cartón	Ganado para transporte	Variedad de alimentos, carbón y madera para cocinar	Microorganismos para ayudar en la descomposición
	****	*	*	**	**
Recursos genéticos	*****	*	*	**	**
Recursos no renovables					
Minerales	P,K, etc, para fertilizantes y alimento para ganado, cal, (escalado), maquinaria	Hierro, aluminio, estaño, caolín, otros recursos para embalaje	Hierro y otros recursos apra transporte e infraestructura	Hierro y otros recursos para cocinar y almanecar, equipamiento	Hierro y otros recursos para incineración
	*****	**	**	*	*
Combustibles fósiles	Producción de agroquímicos, maquinaria	Para limpieza, secado, procesado, embalaje	Para transporte y almacenaje, congelado y enfriado, calefacción e iluminación de negocios	Cocina y limpieza	Recolección, reciclaje, purificación
	****	**	***	*	*

Fuente: Panel Internacional de Recursos (UNEP), 2016.

3. Diversidad de los sistemas agrícolas del mundo

La diversidad agrícola es el resultado de la co-evolución, en tiempo y espacio, de las sociedades humanas y los ecosistemas a través de la práctica de la agricultura, desplegada con diferentes patrones de uso de recursos y trayectorias de desarrollo (Ploeg y Ventura, 2014). La heterogeneidad de los sistemas agropecuarios refleja, de muchas formas, la diversidad de respuestas sociales, económicas y ecológicas para adaptarse a condiciones cambiantes en diferentes escenarios (Ploeg, 2010).

Los sistemas agrícolas conllevan aspectos claves relacionados con la biodiversidad, que incluyen no sólo el número de especies disponibles, sino también el uso de ecosistemas o prácticas culturales implementadas por una comunidad particular en un contexto temporal y espacial específicos. En este sentido, la agrobiodiversidad de los sistemas agrícolas comprende cuatro dimensiones principales: biológica, ecológica, social y cultural. Como las cuatro patas de una mesa, si una de estas es descuidada las otras se desestabilizarán.

3.1 La evolución de los sistemas agrícolas

Los sistemas agrícolas son presentados como un grupo de diferentes formas locales, evolucionando y cambiando a través del tiempo y el espacio. Exhiben gran diversidad, explicada no sólo por sus diferentes potencialidades o restricciones ambientales, sino también por sus prácticas sociales, culturales y económicas específicas.

Por otro lado, incluso considerando esta diversidad, es posible verificar que los sistemas agrícolas de una región en particular, en un momento dado, son lo suficientemente similares como para enmarcarse en un grupo relativamente homogéneo.

La innovación al interior de los sistemas agrícolas ha dado lugar a la especialización, donde un sistema domina sobre otro. Por ejemplo, muchos sistemas agrícolas se especializan en ganadería, mientras que otros se enfocan en cultivos u otras prácticas específicas en función de las restricciones naturales, intercambiando sus diferentes productos animales o vegetales eventualmente.

Los distintos sistemas agrícolas han evolucionado según su ambiente y escenario social particulares, la disponibilidad de recursos naturales e innovación tecnológica. Ciertas especializaciones y sistemas diversificados son ejemplos interesantes de esto, desde cultivos extensivos y sus múltiples variaciones, hasta pasturas, policultivos (como las milpas en México o las chakras en el Ecuador), sistemas que integran animales y plantas (por ejemplo arroz, búfalos y peces en Vietnam), o sistemas silvopastoriles (Colombia) o la deheza en España, entre muchos otros.

Los sistemas agrícolas también han ingresado en las ciudades, donde se promueven distintas prácticas: desde la agricultura urbana y periurbana (Pengue 2017), hasta jardines verticales o en terrazas, sistemas hidropónicos y, más recientemente, acuapónicos (que utilizan peces y sus heces como fertilizantes naturales). Además de producir alimentos, muchos de estos sistemas recuperan servicios ecosistémicos de otra forma perdidos en espacios urbanos, mejoran la seguridad alimentaria y reducen el impacto ambiental de la agricultura convencional o de industrias periféricas.

3.2 Propósitos de los sistemas agrícolas actuales

Los sistemas agrícolas han cambiado en las últimas décadas, de la mano de innovaciones permanentes. Hoy en día podemos encontrar una amplia diversidad de agroecosistemas que producen biomasa con diferentes propósitos, desde comida hasta energía, biomateriales y otros, con distintos niveles de uso de insumos externos, conocimiento y capital. Estos sistemas van desde la agricultura industrial especializada (es decir, monocultivo), hasta sistemas agropecuarios diversificados y agroecológicos (IPES, 2006), cada uno aprovechando diferentes tecnologías y conocimientos.

Los sistemas agrícolas futuros deberán hacer frente a: (a) cambio climático y secuestro de carbono, (b) restauración de ecosistemas degradados y (c) la transición desde sistemas agrícolas dependientes del petróleo hacia sistemas ecológicos integrados y descentralizados, susceptibles a las nuevas prioridades relacionadas con la disponibilidad de agua y las capacidades del suelo. Por lo tanto, estos sistemas tendrán gran complejidad y diversidad biológica y social.

El contexto socioeconómico en el cual operan los agricultores y los formuladores de políticas ambientales y agrícolas está distorsionado por externalidades significativas, tanto negativas como positivas. Efectivamente, la mayoría de los principales impactos en la salud humana, ecosistemas, tierras agrícolas, agua y mares, causados por diferentes tipos de sistemas agrícolas y alimentarios, son económicamente invisibles y no reciben la atención que merecen por parte de los tomadores de decisiones (TEEB, 2015). A pesar de los daños producidos, los análisis de estos impactos comienzan a reflejarse en las cuentas nacionales de los países a través, siquiera parcialmente, de los costos derivados en la atención de la salud primaria y crónica, como respuesta sea a la contaminación por agroquímicos como a las distoriones actuales de un sistema alimentario, que ya no alimenta ni nutre.

4. El agroecosistema: un ecosistema transformado. Algunas definiciones.

Un "ecosistema" implica un complejo dinámico de comunidades de plantas, animales y microorganismos y su ambiente no vivo, interactuando como una unidad funcional (Artículo 2 del Convenio de Biodiversidad, CBD).

Un agroecosistema es un ecosistema transformado. Un agroecosistema es un "sistema biológico y de recursos naturales manejado por humanos con el fin principal de producir alimentos, así como otros bienes no alimentarios y servicios ambientales valiosos para la sociedad" (PAGE, 2000).

Los sistemas agrícolas son agroecosistemas que representan un continuo de numerosas variantes y combinaciones de agrobiodiversidad y prácticas culturales y sociales.

La interacción de los diferentes componentes del sistema agrícola producen distintos bienes, servicios, residuos sólidos, emisiones, efluentes, energía y servicios ecosistémicos.

Los sistemas agrícolas son parte de procesos geológicos, biológicos y sociales que tienen lugar en la biósfera; su evaluación debe tener en cuenta estas interdependencias. El actual análisis científico de la agricultura es fragmentario, enfocándose en la interpretación económica del espacio ocupado por una única cultura, ignorando su relación con el ambiente local y global y organizaciones sociales.

La humanidad ha transformado las reservas y los flujos de materiales en el planeta, y es un hecho aceptado que tenemos la capacidad de interferir en varios sistemas globales (Rockstrom *et al.*, 2009).

La dominación humana del espacio terrestre ha crecido enormemente, al punto que los sistemas agrícolas ocupan la mayor parte del espacio geográfico disponible para la producción de biomasa para el sostén de poblaciones de flora, fauna y seres humanos. Si bien hay sistemas tradicionales que han sobrevivido en ciertas regiones, e incluso han crecido en algunas, con menos usos externos e intensivos de insumos, en general la agricultura ha tendido cada vez más a alejarse del uso de recursos renovables y a avanzar hacia el uso de recursos no renovables.

Los cambios en la dieta humana y la Batalla por la Proteína (Pengue 2000), dada en la enorme transformación en el consumo de proteína vegetal hacia la animal, está generando una transformación sin precedentes sobre la faz de la tierra y así la ganadería global (todo tipo de carnes, leche, huevos), consumida de manera irrefrenable por las ascendentes clases sociales, se ha convertido en una amenaza real tanto a la especie humana como hacia las otras especies.

5. Sistemas agrícolas

Básicamente, los sistemas alimentarios son sistemas de producción que usan recursos naturales, los combinan con energía solar y producen comida. La productividad y estabilidad en el tiempo de estos sistemas se relaciona directamente con la posibilidad de garantizar la seguridad alimentaria, tener un dieta diversificada y mejorar el valor nutricional de los productos consumidos por las sociedades.

Un sistema agrícola puede ser definido como un establecimiento con un área terrestre en la cual se producen diferentes cultivos y ganados, manejados por familias o empresas. A mayor escala espacial, se puede definir un sistema agrícola como el área terrestre, en una región, distrito o paisaje, que produce un *commodity* particular o diversos cultivos asociados. Las clasificación de los sistemas agrícolas tiene una larga historia, aunque aún hoy no hay un método genérico verdaderamente exhaustivo y que pueda servir a todos los fines de una clasificación. Las clasificaciones existentes se basan en una amplia variedad de factores y se diferencian marcadamente en cuanto a utilidad, nivel de detalle y propósito. Tipologías para sistemas agrícolas y agropecuarios han sido desarrolladas desde 1936, considerando distintas perspectivas en el uso del suelo, demanda de agua, trabajo y otros, pero casi ninguna incorpora una visión global o una integración de los sistemas agrícolas como un todo.

Las clasificaciones han abarcado variables como el grado de cultivo, los tipos de cultivos, irrigados vs. de secano (Ruthenberg, 1980), comercialización, ubicación, agro-ecología (Grigg, 1972; Whittlesesy, 1936), movimientos animales (Dixon et al, 2001), agua de lluvia (FAO; Seré y Steinfeld, 1996), sostenibilidad del suelo, insumos y tecnología (Fischer *et al.*, 2002), densidad e intensidad de cultivos, agregado de unidades espaciales (Wint et al., 1997), demandas animales y sistemas mixtos (FAO, 2011), capacidad de uso del suelo (UNEP, 2016), nivel ecólogico (Fresco y Westphal, 1986) o focalizados en sistemas alimentarios (HLPE, 2016), entre otros. Investigación reciente tiene en cuenta insumos externos y servicios ecosistémicos, clasificando en: sistemas agrícolas basados en insumos químicos externos, sistemas agrícolas basados en insumos biológicos y sistemas agrícolas basados en biodiversidad (por ejemplo INRA de Francia) (Therond, 2017).

Los principales sistemas agrícolas son cultivos y pasturas. Un sistema de cultivo se define como una disposición de poblaciones de cultivos que transforman energía solar, nutrientes, agua y otros insumos en biomasa útil. Los cultivos del sistema pueden ser de diferentes especies y variedades, pero sólo constituyen un sistema de cultivo si son manejados como una unidad (Fresco y Wetphal, 1988). En términos de sistemas agrícolas es necesario distinguir entre un sinnúmero de sistemas diferentes, que, en el contexto global, representan un continuo de sistemas muy ricos y diversos.

Los sistemas agrícolas pueden ser clasificados por diferentes tipologías (Whittlesesy, 1936; Grigg, 1972; Ruthenberg, 1980; Fresco y Westphal, 1986; FAO; Seré y Steinfeld, 1996; Wint *et al.*, 1997; Dixon *et al.*, 2001; Fischer *et al.*, 2002; FAO, 2011; UNEP, 2016; HLPE, 2016).

A los fines del presente documento podemos mencionar: sistemas de pastoreo, sistemas mixtos y sistemas de cultivos (teniendo en cuenta aspectos como capacidades del suelo, insumos externos, agua y escala).

Los sistemas de pastoreo (pasturas/sabanas) pueden dividirse en cuatro categorías generales: pequeña escala, pastoral, convencional y ganadería, el sistema que implica el uso más intensivo de recursos. A nivel mundial, hay una transición gradual desde sistemas de pastoreo muy extensivos a intensivos.

En cuanto a sistemas mixtos, podemos encontrar una combinación de tipologías que van desde prácticas tradicionales o de rotación (por ejemplo cultivo/ganado), hasta técnicas con bajo nivel de insumos externos como agricultura orgánica, en balcones o urbana, permacultura u otras prácticas basadas en principios agroecológicos (Altieri, 1995).

Los sistemas de cultivo comprenden en la actualidad cerca del 10% (alrededor de 1,500 millones de hectáreas) de la tierra mundial, mientras que el área agrícola total ocupa alrededor del 33% de la superficie terrestre mundial (alrededor de 4,900 millones de hectáreas). Un porcentaje importante lo lleva claramente la ganadería, lechería y la producción de huevos.

Nuevos métodos, como hidroponia, acuaponia (agua/peces/plantas) o intensificación ecológica, están emergiendo en el nuevo escenario agrícola; en todos los casos los fines que se buscan son aumentar la eficiencia en el uso de recursos, reducir el impacto ambiental y mejorar la salud de los cultivos.

6. Sistemas de producción agropecuaria

HLPE (2016) muestra una simplificación de los sistemas que permite lidiar con los desafíos presentados por modelos agrícolas, que varían considerablemente entre países, sistemas agrícolas y a través del tiempo. La ganadería es la actividad con mayor uso de recursos de tierra. En el 2013, con casi 3,400 millones de hectáreas, las praderas y pasturas representaban el 26% del área terrestre global (es decir, de la superficie terrestre no cubierta por hielo) (FAO STAT). FAO estima que entre un tercio y un 40% del suelo arable mundial se utiliza para la producción de cultivos forrajeros (FAO, Global Livestock Environmental Model – GLEAM). Entre praderas, pasturas y tierras para cultivos forrajeros se ocupa el 80% de la tierra agrícola total.

A grandes rasgos podemos encontrar cuatro grandes sistemas de producción de ganado (HLPE, 2016): sistemas mixtos de explotación agrícola en pequeña escala, sistemas pastoriles, sistemas de pastoreo comercial y sistemas de cría intensiva de ganado. Los sistemas basados en plantas se reúnen en una quinta categoría según su relación potencial con sistemas ganaderos.

Los sistemas de pequeña escala incluyen los sistemas mixtos, de transpatio e intermedio (HLPE, 2016). Los sistemas mixtos de explotación agrícola de pequeña escala combinan ganado y cultivos en la misma granja. Se pueden encontrar en todos los países del mundo, pero están más concentrados en Asia, Latinoamérica y África. Los sistemas agrícolas diversificados desarrollados por estos pequeños productores suelen caracterizarse por la presencia de diferentes especies de animales y razas multipropósito, que integran sistemas holísticos con manejo orgánico o agroecológico.

Los sistemas pastoriles son el resultado de un proceso de coevolución entre poblaciones y su ambiente. Estos han desarrollado una variedad de modos de tenencia de la tierra y manejo, fuertemente relacionados con la movilidad, el uso de recursos comunes y la habilidad de los animales para convertir vegetación local en comida y energía. El pastoreo es importante a nivel global por las poblaciones humanas que sostiene, el alimento y los servicios ecológicos que provee, sus contribuciones económicas a algunas de las regiones más pobres del planeta, y el aporte a la supervivencia de civilizaciones antiguas (Nori y Davies, 2007; WISP, 2008).

Los sistemas comerciales de pastoreo pueden encontrarse tanto en países desarrollados como subdesarrollados, en áreas cubiertas por pastizales, pero también en fronteras donde las pasturas se expanden hacia bosques o selvas, como en la Selva Amazónica en Brasil. Los países latinoamericanos se pueden caracterizar por tener un pequeño número de productores comerciales que concentran la mayor parte de la producción agropecuaria, en coexistencia con un número mucho mayor de pequeñas granjas.

Los sistemas de cría intensiva de ganado incluyen los sistemas "industriales" y los "feedlots". Los sistemas de cría intensiva de ganado son los más típicos para la producción porcina y avícola, y están presentes en todas las regiones del mundo, sobre todo en países de ingresos altos y economías emergentes. Los sistemas intensivos sin tierra se encuentran alrededor de conglomerados urbanos en Asia del Este y Sudeste y de Latinomérica, o cerca de las principales áreas de producción o importación de alimento para animales en Europa o Norteamérica. Según la ONU, las Operaciones Concentradas de Alimentación Animal (CAFOs) dan cuenta a nivel global del 72% de la producción avícola, 42% de la producción de huevos y 55% de la producción porcina. En el 2000 se estimaba que había 15,000 millones de cabezas de ganado en el mundo (según el Worldwatch Institute). Para el 2016 la cifra había ascendido a alrededor de 24,000 millones, con la mayor parte de los huevos, carne de pollo y cerdo producidas en granjas intensivas (Harvey *et al.*, 2017).

Hoy en día existe un cambio en la demanda de algunos tipos de proteínas (de origen vegetal, relacionado con, por ejemplo, soja y animales, ganado en particular). La tendencia creciente es el reemplazo de una por la otra. El mercado de proteína animal global aumenta, pero a diferentes ritmos en diferentes regiones. Mientras que en Europa y EEUU el incremento se está estancando, las economías emergentes representan cerca del 80% del crecimiento estimado para el 2022. El mayor crecimiento será en China e India debido al aumento de sus clases medias. En China, más de la mitad de los cerdos aún se produce en pequeñas granjas, aunque esto está cambiando rápidamente. Las mismas inversiones en tecnología y capital que dominan la producción de ganado en los países desarrollados está llegando a países en desarrollo, integrándose a cadenas productivas globales.

El productor actual más notable es la India gracias a su producción de carne de búfalo, la cual se ha casi multiplicado entre 2010 y 2013. La India está ingresando en el mercado mundial, donde el 25% de la carne roja es carne de búfalo proveniente de dicho continente (Chemnitz, 2014).

A nivel internacional hay una expansión de la producción de pescado. Según la FAO (2012), la acuicultura es "el cultivo de organismos acuáticos incluyendo peces, moluscos, crustáceos y plantas acuáticas". La acuicultura podría relacionarse con los sistemas agrícolas y el cambio de uso del suelo. En las últimas dos décadas, un crecimiento dramático en dicha producción ha impulsado el consumo promedio de pescado y productos pesqueros a nivel global. La transición hacia un mayor consumo relativo de especies de cría en comparación con peces silvestres llegó a un hito en el 2014 cuando el aporte de la cría de peces a la demanda de pescado para consumo humano superó al de la pesca por primera vez.

De una producción total de 167 millones de toneladas en 2014, las capturas terrestres representaron 11,9 millones de toneladas y la acuicultura llegó a 47,1 millones. 63,8% del total de la acuicultura fue terrestre (FAO, 2014). Con un crecimiento continuo en la producción de pescado (principalmente por la acuicultura desde los 90´s ya que la producción pesquera había llegado a un meseta), mejoras en la eficiencia productiva y en los canales de distribución, la producción de pescado del mundo ha aumentado casi ocho veces desde 1950 (HLPE, 2014). Las plantas y productos no comestibles acuáticos cultivados, cuando son considerados, representan alrededor de 125,000 millones de dólares (UNEP, 2013). La acuicultura es también la actividad de producción de alimentos basados en proteína animal de crecimiento más rápido del mundo (FAO, 2012).

7. Conexiones y Sistemas agrícolas integrados

Los sistemas agrícolas interactúan entre sí y se influencian mutuamente, en respuesta a, en la mayoría de los casos, cambios en la demanda. La oferta de alimento es, por lo tanto, sostenida por una serie de sistemas agrícolas y de producción animal, cuyo producto es destinado al consumo directo, local o internacional, cada uno con sus pautas específicas. En ciertos lugares, los sistemas tradicionales de agricultura ofrecen sus productos principalmente a través de mercados locales o especiales, mientras que en otros predominan los sistemas agrícolas modernos, proveyendo comida a sistema locales o a largas cadenas alimentarias globales.

Actualmente, sobre todo por la preocupación por el componente de los agroquímicos de los sistemas agrícolas modernos, ha emergido una demanda pública creciente por formas de producción que eviten el uso de dichos productos en sus sistemas productivos, proyectando hacia sistemas agrícolas sostenibles.

No existe una definición oficial de "agricultura sostenible". Sin embargo, el término ha sido descrito por la FAO (2002) de la siguiente manera: "la agricultura sostenible implica el manejo exitoso de los recursos agrícolas para satisfacer las necesidades humanas, manteniendo o mejorando la calidad ambiental y conservando los recursos naturales para generaciones futuras".

Los sistemas agrícolas sostenibles comprenden aquellos relacionados con producciones específicas que no usan agroquímicos sintéticos, reducen la fertilización mineral a un mínimo, promueven el control biológico de plagas y enfermedades y se enfocan en la certificación (UNEP, 2013), como los reconocidos como sistemas orgánicos o biodinámicos por IFOAM (Federación Internacional de Movimientos de Agricultura Orgánica), o los sistemas basados en la producción agroecológica y respaldados por reconocimiento social, particularmente populares en países latinoamericanos (por ejemplo por movimientos sociales como MAELA o Vía Campesina, de escala global).

8. Regímenes alimentarios y su contexto histórico

Los sistemas alimentarios suelen ser entendidos, en un marco histórico y comparativo, como regímenes alimentarios. Por definición, un régimen alimentario es "una estructura de producción y consumo de alimentos gobernada por normas a escala global" (Friedman, 1993). El concepto de régimen alimentario (McMichael, 2009) permite hacer un re-enfoque desde el commodity como un objeto hacia el commodity como una relación, con determinadas relaciones geopolíticas, sociales, ecológicas y nutricionales, en momentos históricos significativos. Friedman y McMichael (1989) sostienen que estos regímenes dependen de factores que van desde "relaciones internacionales de producción y consumo de alimentos, a modos de acumulación, distinguiendo a grandes rasgos períodos de transformación capitalista desde 1870".

Los regímenes alimentarios se caracterizan por fuerzas contradictorias del Estado, negocios y movimientos sociales, marcando el rol cambiante de la agricultura en el desarrollo de la economía mundial (capitalista) (Friedmann y McMichaesl, 1989).

Bernstein (2015) define ocho aspectos clave de los regímenes alimentarios: el sistema estatal internacional; las divisiones internacionales del trabajo y los patrones de comercio; las "reglas" y las legitimaciones discursivas (ideológicas) de los diferentes regímenes alimentarios; las relaciones entre la agricultura y la industria, incluyendo los cambios técnicos y ambientales en la agricultura; las formas dominantes de capital y sus modos de acumulación; fuerzas sociales (más allá de los capitales y estados); las tensiones y contradicciones del régimen alimentario específico; y las transiciones entre regímenes alimentarios. Estas configuraciones generan períodos estables o de consolidación (así como períodos de transición)de acumulación de capital, asociados con el poder geopolítico y formas de producción agrícola y consumo (McMichael, 2009).

En la historia del capitalismo mundial se han registrado hasta la fecha tres regímenes principales. El período Colonial o el régimen alimentario Imperial (1870-1914), sosteniendo la "fábrica del mundo" Británica y las emergentes naciones liberales de Europa con importaciones tropicales, así como importaciones de granos y ganado de los estados colonos (EEUU, Canadá, Australia). El Período de Desarrollo o el régimen alimentario Intensivo centrado en EEUU (1945-1973), que redirigió los excedentes de comida de EEUU a estados postcoloniales, asegurando su lealtad política, en especial como barreras al supuesto avance del comunismo.

La Globalización o Período Corporativo (1973 al presente) es todavía un régimen emergente que incorporó nuevas regiones en el complejo de la proteína animal trasnacional (BRICS), desarrolló cadenas de suministro de frutas frescas, vegetales y pescado para consumidores privilegiados, expulsó pequeños agricultores de la tierra y generó contra-movimientos como los de la Soberanía Alimentaria, la Vía Campesina, el MAELA, el Movimiento Slow Food, Agricultores Apoyados por la Comunidad, y la producción orgánica local y de pequeña escala.

9. Desafíos y deficiencias clave de los sistemas alimentarios actuales

No falta comida en el mundo desde al menos las últimas tres décadas. Aunque el mundo aún hoy en día tiene recurrentes crisis alimentarias. La cuestión distributiva y la competencia por biomasa con distintos fines, está produciendo un importante descalabro global. En el mundo actual la comida se ha convertido en una mercancía que se mueve en el sistema económico como cualquier otro bien o servicio. Esto genera una serie de desigualdades y distorsiones que afectan a toda la cadena de producción y consumo de alimentos.

Para la pequeña parte del mundo que puede abastecerse de alimentos en calidad nutricional y accesibilidad hay una prioridad que se sustenta en mantener el acceso permanente e irrestricto a los alimentos.

Pero no obstante ello, para garantizar su cantidad y calidad nutricional, primero es necesario admitir que no hay un reconocimiento del derecho a una nutrición adecuada, que existen desbalances a lo largo de todas las cadenas alimentarias, los efectos del comercio y las distorsiones creadas por los mercados, la importancia del ingreso como medio para asegurar una dieta balanceada y los crecientes conflictos de intereses y tensiones respecto del uso de los recursos y productos relacionados.

El derecho humano a la alimentación adecuada establece siete principios que deberían gobernar los procesos de toma de decisión e implementación: Participación, Responsabilidad, No-discriminación, Transparencia, Dignidad Humana, Empoderamiento y Estado de Derecho (HLPE, 2017; FAO, 2011).

El poder a lo largo de los sistemas alimentarios, particularmente a nivel nacional, necesita ser re-balanceado (HLPE, 2017). En la actualidad hay muchas luchas de poder en los sistemas alimentarios que modelan la gobernanza alimentaria global.

La progresiva concentración de poder económico en manos de las corporaciones trasnacionales de alimentos en las últimas décadas ha limitado el espacio de la política local y el poder de gobiernos locales y nacionales. A su vez, esto ha reducido la habilidad del gobierno para proteger y promover el derecho a la alimentación adecuada de su gente (HLPE, 2017).

A medida que crece la concentración del mercado, las políticas de competencia se hacen más importantes. Las regulaciones nacionales deberían impedir la creación de carteles, el mal uso de posiciones dominantes y la formación de monopolios – ya sea mediante su prohibición o imponiendo condiciones a las compañías. Una crítica particular es que las políticas de competencia se enfocan sólo en los intereses de los consumidores. Se asume que la competencia sólo funciona si los precios son bajos. Pero este no es necesariamente el caso – la competencia en cuanto a la calidad puede resultar en precios más altos. En cambio, la política debería fortalecer la posición de negociación de los productores y asegurar el cumplimiento de estándares sociales y ecológicos mínimos a lo largo de toda la cadena. Esto incluye garantizar que las negociaciones salariales generen salarios justos y adecuados para vivir (Food Atlas, 2017) y el desarrollo de la vida plena de los agricultores y los trabajadores.

Los actores locales podrían jugar un papel relevante en el balance de esta concentración global. La ganadora del Premio Nobel Elinor Ostrom, ha estado demostrando por las últimas dos décadas cómo diferentes aspectos de los usuarios, instituciones, recursos y el contexto pueden facilitar, o no, la cooperación local. Hay varias razones por las que las comunidades pueden ser administradores eficaces (Angelsen, 2000) para gestionar recursos a nivel local.

El poder de mercado de las compañías está reflejado en sus volúmenes de ventas, su influencia en precios y en los estándares que fijan para sus proveedores. Estos suelen estar formulados de forma tan específica que restringen la entrada al mercado, excluyendo productores más pequeños que deben "nadar contra la corriente". En adición, grandes compañías ganan enorme influencia en muchos países porque emplean decenas o cientos de miles de personas, y pueden, por lo tanto, modelar las condiciones sociales y ambientales del lugar (AgriFood Atlas, 2017).

En algunos casos, como un oxímoron, las importaciones y exportaciones de una compañía esconden el verdadero costo del alimento y otras implicancias locales o internacionales. En los EEUU, por ejemplo, sólo por motivos económicos, una compañía podría importar 41,209 toneladas métricas de café tostado y exportar un número similar (42,277) en el mismo año; lo mismo sucede con el poroto verde (26,967 exportado/32,544 importado), papa (365,350/324,479) o azúcar refinada (70,820/83,038) (Adbusters, 2004) y cientos de otros productos.

10. Producción de alimentos, escasez de alimentos, acceso a los alimentos y gobernanza en un mundo complejo

En tiempos pasados recientes, la crisis alimentaria mundial (2007-2008) (Weinberder *et al.*, 2009) ha alertado al mundo sobre la degradación de los servicios ecosistémicos y sobre la falta de una apropiada gobernanza del sistema alimentario, señalando también cambios profundos que están emergiendo en el sistema alimentario. El impacto producido sobre la clase media global afectada, generó una crisis de gobernanza que aún ha dejado aturdido al sistema político internacional.

Del lado de la oferta, la creciente competencia por tierra, energía y agua llevó como dijímos al agotamiento de recursos, si bien esto depende de los diferentes sistemas de producción de alimentos.

Del lado de la demanda, la segunda ola de urbanización mundial, los cambios de hábitos alimentarios, el ascenso de la clase media y de los ingresos, el abaratamiento de la comida chatarra, la occidentalización de la alimentación, ya ha transformado las formas en que se produce, comercializa y compra la comida (UNEP, 2014). Mil millones de personas se van a la cama con hambre, otros mil millones sufren malnutrición y otros mil millones sobreconsumen alimentos, que destruyen sus cuerpos y sus vidas (TEEB, 2015).

En las últimas décadas, el poder y la gobernanza de la cadena alimentaria se ha desviado y comienza a ser dominado por las grandes cadenas internacionales de alimentos.

Entre los principales factores que definen la gobernanza se encuentran el debate de leyes, y el acceso a la tierra y a los recursos naturales. Es en este punto en que las leyes e instituciones legales pueden mitigar los peligros de la desigualdad y promover mayor justicia en la gobernanza alimentaria (Kennedy y Lijeblad, 2016) si los gobiernos en todos los niveles, estuvieran decididos en garantizar alimentos en calidad nutricional, cantidad y balance adecuados para toda su población.

La gobernanza de los sistemas alimentarios ha cambiado dramáticamente en los últimos 50-60 años a causa de la liberalización de los mercados agrícolas y financieros que empezó en la década de los ochenta y de los procesos de transformación y consolidación de la cadena alimentaria y la reducción del aparato estatal. Desde las últimas tres décadas, y en especial hoy en día, actores no estatales dominan muchos de los sistemas alimentarios globales (Panel Internacional de Recursos, 2016).

La combinación del crecimiento de los ingresos y de la urbanización está cambiando claramente la naturaleza de las dietas (Msangi y Rosegrant, 2009). La población urbanizada consume menos alimentos básicos y más productos procesados y animales (Rosegrant *et al.*, 2001). Esto implica más papas para comida rápida, más granos para alimento de ganado y más azúcar para el procesado y manufactura de alimentos (Fischer *et al.*, 2009; OECD-FAO, 2010). Y la atracción por tales alimentos, el aumento en tamaño de los productos y los platos, promueven de manera recurrente que la población coma más y mucho menos balanceado.

Muchos de los cambios estructurales en las dietas están ocurriendo en países en desarrollo, dado que las dietas en países desarrollados ya son altas en alimentos procesados y animales. Por ejemplo, los tres grupos de productos animales (carne, leche y huevos), aceites vegetales y azúcar proveen, en la actualidad, alrededor del 29% del alimento total en países en desarrollo (en términos calóricos). Se estima que su aporte aumentará al 35% en 2030 y al 37% en 2050, mientras que su porcentaje en países industrializados ha rondado el 48% por varias décadas. Comparando directamente el consumo de carne: en el 2008 se consumió 80 kg per cápita de carne en países desarrollados, frente a 29kg en países en desarrollo (Alexandratos, 2009). Proyecciones al 2050 estiman un incremento a 103 y 44kg respectivamente (FAO, 2006). En la Argentina, sumando entre productos bovinos, avícolas, porcinos y ovinos se consumieron en 2017, 118,4 kilos per cápita/año.

En conjunto, las proyecciones para el consumo mundial de alimentos preveen un aumento total del 10% en las calorías promedio ingeridas por persona entre el 2005 y 2050. Se espera que alrededor del 5% de la población todavía padezca de desnutrición crónica en dicho año (Alexandratos, 2009). Bruinsma (2009) ha predicho un aumento de 71 Mha de tierra arables necesarias para cubrir dichas demandas crecientes de comida y de alimento (para animales). Se estima una expansión del 12% en países en desarrollo, especialmente en el África Subsahariana (64 Mha) y Latinoamérica (52 Mha), mientras que se espera una disminución del 6% en países desarrollados. Fischer (2009) también proyecta un aumento del 12% de la tierra cultivada en los países en desarrollo, pero estima la expansión total en alrededor de 124 Mha entre 2010 y 2050. Ninguno de estos escenarios considera a los biocombustibles, biomateriales o cambios en las demandas de otras o futuras industrias, lo que haría por supuesto presión por una expansión de consumo de tierras mayor, si las contabilizaríamos.

Las dietas están cambiando en todos lados. Esto implica, en concreto, un desplazamiento desde las proteínas vegetales hacia las proteínas animales. Como vengo advirtiendo, esta "batalla por la proteína" está cambiando la faz de la tierra (Pengue, 2005). Un modelo de producción de comida más diversa está siendo reemplazado por la agricultura extensiva de cultivos para generar alimento para animales o peces, en gran parte destinados a Europa y China. Como resultado de esto, la población pobre ya no puede producir o costear las dietas diversas que tenían antes: proteínas tradicionales de alta calidad producidas en pasturas menos intensivas, desplazadas por cultivos comerciales como soja (Rosin, Stock y Campbell, 2012) o maíz.

Las tendencias generalizadas incluyen una disminución en el consumo de granos gruesos, cereales básicos y legumbres, y un aumento del consumo de alimentos animales, azúcar, sal, grasas y aceites, granos refinados y alimentos procesados (IFPRI, 2017). La publicidad, las brutales campañas de marketing para "comer y tomar más" y el comercio están produciendo efectos significativos que transforman hábitos tradicionales saludables en no saludables. Las compañías internacionales están llegando con sus lógicas y productos a lugares ocultos e impactando en estos hábitos. En Brasil, Nestlé ha financiado a una barcaza para crear un "supermercado flotante" que venda golosinas y postre de chocolate en la selva (Garfield, 2017), o la venta de gaseosas en Chiapas, cuando no es más fácil encontrar agua gratuita, cambiando hábitos hacia las bebidas cola y saborizadas (Agerholm, 2017).

HLPE (2017) incorpora una tipología que cubre tanto las cadenas de abastecimiento de alimentos como los entornos alimentarios, con el propósito de identificar fortalezas y debilidades de cada uno de los tres tipos de sistemas definidos por HLPE: sistemas alimentarios tradicionales, sistemas mixtos y sistemas modernos (Tabla 2).

TABLA 2. SISTEMAS ALIMENTARIOS Y SUS CADENAS DE ABASTECIMIENTO

Cadenas de suministros de alimentos	Sistemas alimentarios tradicionales	Sistemas alimentarios mixtos	Sistemas alimentarios modernos
Producción (disponibilidad)	Los alimentos son producidos principalmente por pequeños agricultores en la zona y la mayoría de los alimentos disponibles son locales y estacionales.	La producción de alimentos tiene lugar en pequeñas explotaciones agrícolas y explotaciones más grandes y más alejadas. Hay un mayor acceso a los alimentos fuera de su estación más común.	Se produce una amplia variedad de alimentos en explotaciones agrícolas de tamaños desde pequeñas hasta industriales. La producción es mundial, por lo que hay alimentos disponibles de todas partes y en cualquier momento.
Almacenamiento y distribución	Debido a la falta de carreteras adecuadas, el transporte de los alimentos es dificultoso y lento, lo que ocasiona desperdicio de alimentos. Dado que las instalaciones de almacenamiento son deficientes y carecen de almacenamiento frigorífico, resulta difícil almacenar los alimentos, especialmente los alimentos perecederos, lo que ocasiona preocupaciones relacionadas con la inocuidad de los alimentos y los desperdicios	Hay mejoras en la infraestructura con mejores carreteras e instalaciones de almacenamiento, así como un mayor acceso a almacenamiento frigorífico; no obstante, el acceso a todas ellas no es equitativo, especialmente para la población rural pobre.	Las carreteras e instalaciones de almacenamiento modernas y el almacenamiento frigorífico permiten transportar los alimentos grandes distancias y almacenarlos en forma inocua durante períodos prolongados con facilidad.
Elaboración y envasado	Hay procesos de elaboración básica disponibles, como secado de frutas, molienda de harina o elaboración de productos lácteos. El envasado es escaso o limitado.	Hay mejoras en la infraestructura con mejores carreteras e instalaciones de almacenamiento, así como un mayor acceso a almacenamiento frigorífico; no obstante, el acceso a todas ellas no es equitativo, especialmente para la población rural pobre.	Las carreteras e instalaciones de almacenamiento modernas y el almacenamiento frigorífico permiten transportar los alimentos grandes distancias y almacenarlos en forma inocua durante períodos prolongados con facilidad.

Venta al por menor y comercialización	La baja diversidad y densidad de opciones de venta de alimentos al por menor conduce a una marcada dependencia de los quioscos informales y los mercados de productos frescos.	Hay una mayor diversidad de bodegas, tiendas de barrio y mercados informales y formales. Hay un mayor acceso a comidas que se consumen fuera de casa, tales como comida callejera y comidas rápidas.	Hay una gran diversidad y densidad de “puntos de entrada de alimentos”, que incluyen todas las opciones de los restantes sistemas, así como supermercados e hipermercados más grandes, comida rápida informal y restaurantes elegantes.
Entornos alimentarios	**Sistemas alimentarios tradicionales**	**Sistemas alimentarios mixtos**	**Sistemas alimentarios modernos**
Disponibilidad y acceso físico (cercanía)	Hay una mayor densidad de mercados informales locales, pero las mayores distancias para acceder a los mercados y las carreteras deficientes o inexistentes hacen que los desplazamientos sean dificultosos y prolongados.	Sigue existiendo una alta densidad de mercados informales, pero también hay un mayor número de mercados formales. Surgen mejores carreteras y un mejor acceso para los vehículos, lo que aumenta el acceso de los consumidores a diferentes alimentos. Sin embargo, los consumidores de ingresos bajos a menudo tienen menos acceso al transporte.	Se depende de mercados formales situados en las cercanías, de fácil acceso. Las zonas de ingresos bajos frecuentemente pueden calificarse como desiertos de alimentos o pantanos de alimentos.
Acceso económico	Los alimentos representan una porción elevada del presupuesto familiar. Los alimentos básicos tienden a ser menos caros que los alimentos de origen animal, que tienden a ser más caros	Los alimentos ejercen demandas moderadas en el presupuesto familiar. Los alimentos básicos son baratos, mientras que los alimentos de origen animal y los productos perecederos son caros. Muchos alimentos con un alto grado de elaboración y las comidas de preparación rápida son baratos.	Los alimentos representan una menor demanda del presupuesto familiar. El precio de los alimentos básicos es más bajo en relación con los alimentos de origen animal y los alimentos perecederos, pero la diferencia es menos marcada que en los otros sistemas. Dado que hay más opciones, los artículos especiales (por ejemplo, orgánicos o de producción local) tienden a ser más caros.
Promoción, publicidad e información	Muy poca promoción, con la excepción de los esfuerzos de algunas empresas multinacionales. Pósters, letreros en quioscos y edificios, algunos carteles. Muy poca información en cuanto al etiquetado y las directrices. La información se difunde principalmente por medio de educación en materia de nutrición a cargo de la salud pública	La promoción de marcas y los anuncios son más comunes, en medios tales como carteles, medios impresos, radio, televisión e Internet. Se proporciona un poco de información, así como se incluyen etiquetas en los productos y en las estanterías de las tiendas. Las directrices dietéticas están disponibles, pero con un acceso escaso o sin ningún acceso en algunas zonas.	Alto nivel de promoción de alimentos a través de canales de medios múltiples. Comercialización dirigida a grupos específicos (por ejemplo, los niños). Alto nivel de información en las etiquetas, las estanterías de las tiendas y los menús. Alto nivel de información de campañas de salud pública.

Calidad e inocuidad de los alimentos	Bajo nivel de control de la calidad e inocuidad de los alimentos. Prácticamente no hay almacenamiento frigorífico. Menor demanda de ingredientes de calidad.	Hay controles de la calidad e inocuidad de los alimentos, pero frecuentemente no se observan. La observancia de la inocuidad de los alimentos frecuentemente se limita a los alimentos elaborados y envasados de marca. Hay almacenamiento frigorífico, pero no es fiable. Hay listas de ingredientes en los alimentos, pero se hace menos hincapié en atributos como "natural" u "orgánico".	Las normas de inocuidad de los alimentos se observan y supervisan estrictamente. El almacenamiento frigorífico está generalizado y es fiable. Se presentan listas de ingredientes normalizadas. Demanda de alimentos producidos y animales criados de determinadas formas que respeten la sostenibilidad y las prácticas de bienestar de los animales.

Fuente: HLPE, 2017: 43.

11. Comercio internacional y sistemas alimentarios. Servicios y flujos visibles e invisibles

Por siglos, los países han contado con que el mercado internacional de commodities agrícolas y alimentarios les suplementara y complementara su producción doméstica. La distribución despareja de los recursos de tierra y la influencia de las zonas climáticas en la capacidad de cultivar plantas o tener animales derivó en el comercio al interior de y entre continentes.

El sistema agroalimentario es una integración de diferentes sistemas que incorpora aspectos ambientales, culturales, sociales y económicos, así como las transferencias de materiales entre dichos sistemas. Y que mueve alimentos de una parte a otra del mundo.

La distancia y el tonelaje de los cargamentos de comida ha aumentado a nivel mundial en las últimas décadas. Por ejemplo, la distancia a la que viajaba la comida al principio del siglo XXI había aumentado un 50% en el Reino Unido y 25% en Estados Unidos de la distancia que recorría en la década de los 80´(Halweil, 2002). Este incremento en el transporte de alimentos no sólo ha tenido impactos negativos en el costo de logística y en el ambiente, sino que también ha potenciado el riesgo para la calidad del alimento, su inocuidad, seguridad y trazabilidad.

La logística se refiere al movimiento (para enviar o recibir) y almacenamiento de bienes (alimentos, animales u otros bienes agrícolas) y a los accesos financieros y de información asociados. Dado que la logística es una actividad importante que requiere de uso extensivo de recursos humanos y materiales, afectando a la economía nacional, países desarrollados como Reino Unido y EEUU han prestado atención a la mejora tecnológica y a la gestión de las actividades logísticas y sus costos como un porcentaje del producto bruto interno (Bosona, 2013).

Por otro lado, en los países en desarrollo las infraestrcuturas de transporte disponibles son relativamente pobres y son comunes destrucciones físicas por inundaciones, conflictos locales o regionales, y falta de mantenimiento apropiado. Los servicios logísticos inadecuados están asociados no sólo con pérdidas de producto, sino también con la contaminación de alimentos y propagación de enfermedades en diferentes etapas de la cadena de distribución de alimentos. Si bien el alcance de los riesgos de la logística en agricultura es más amplio, aquí nos centraremos en sus principales riesgos en las cadenas de distribución de alimentos y animales.

En muchos países, especialmente países pobres, hay una pérdida de alimentos considerable por deterioro en fincas por falta de capacidad de almacenamiento así como por falta de capacidad de transporte del producto hasta plantas procesadoras o mercados inmeditamente después de su cosecha. En algunos casos, los servicios de transporte disponibles pueden ser interrumpidos por daños en rutas causados por inundaciones o conflictos armados, llevando a pérdidas de producto por deterioro, robo o daño total. En Uganda, por ejemplo, productores de lácteos se vieron forzados a interrumpir la comercialización de su leche por una inundación en el 2007 (Choudhary, 2011).

Las pérdidas de alimento relacionadas con la logística son altas en países de bajos ingresos, mientras que, comparativamente, las pérdidas en el nivel de consumo son mayores en países de altos ingresos. En el África Subsahariana alrededor del 8% de la producción de cereales, 15% de la producción de lácteos y más del 35% de los productos de frutas y verduras se pierden por problemas relacionados con la logística (Gustavsson et al., 2011). Sólo en países asiáticos industrializados (Japón, China y Corea del Norte) hay pérdidas de alrededor del 15% (142 millones de toneladas por año) de frutas y verduras por problemas relacionados con la logística. Por ejemplo, lastimaduras por pinchazos (por contenedores o embalaje inadecuados), impactos (por malos caminos y comportamiento de los conductores), compresión (por llenado excesivo de contenedores y por carga inapropiada), y vibración (por malos caminos y comportamiento de los conductores), así como exposición a altas o bajas temperaturas, humedad, contaminantes químicos e insectos, son causas principales de daños a frutas y vegetales relacionados con logística.

Según información de la FAO, las pérdidas globales de pescado causadas por deterioro son significativas, sumando alrededor de 10-12 millones de toneladas por año. En Latinoamérica y Asia del Sur y Sureste se pierde aproximadamente 25% de los productos de pescado y mariscos por problemas relacionados con la logística, porque tienen lugar altos niveles de deterioro durante su distribución. De manera similar, las pérdidas de productos lácteos relacionadas con la logística son significativas (más del 10%) en países en desarrollo. La inhabilidad para comercializar productos lácteos durante la temporada de lluvias, falta de transporte adecuado y cadena de frío durante la estación cálida, la provisión de electricidad errática a procesadores y de leche y frigoríficos son algunas causas de las pérdidas de productos lácteos.

Los riesgos relacionados con la logística también ocurren en el transporte de los animales productores de alimentos. Se sabe que el transporte de ganado es estresante y nocivo, lo cual lleva a pérdidas de producción y del bienestar animal. Por ejemplo, en EEUU alrededor de 80,000 cerdos mueren por año durante el proceso de transporte (Greger, 2007). Un caso de estudio en Ghana indica que más del 16% de la pérdida del ingreso esperado sucede por muertes y enfermedad o heridas del ganado durante el transporte desde las granjas hasta el mercado de ganado y mataderos (Frimpong et al., 2012). Un caso de estudio similar en Etiopía Central (Bulitta et al., 2012) indicó que durante el transporte de ganado desde la granja hasta el mercado central más del 45% de los animales eran afectados (ya sea robados, muertos o lastimados).

Conclusiones

La actividad agrícola -producción de cultivos alimenticios, comida para animales, carne, huevos, leche, fibras, biomateriales y biocombustibles- ha transformado la capacidad de la Tierra para sustentar a la gente, pero, al mismo tiempo, ha tenido un impacto mayor sobre el resto de la diversidad biológica que cualquier otra actividad humana. La agricultura es, de lejos, la principal causa de deforestación en los trópicos y ya ha reemplazado alrededor del 70% de los pastizales del mundo, 50% de las sabanas y 45% de los bosques caducifolios de clima templado (Balmford, Green y Phalan, 2012). El último reporte del IPBES Naciones Unidas Ambiente (2018) sobre Degradación de Tierras y Regional sobre Américas, entre otros, lanzado en Cartagena de Indias, alerta claramente sobre estos impactos de los cuales la agricultura y el sistema alimentario tienen directa responsabilidad.

En términos de las proyecciones del Banco Mundial (2015), se estima que la demanda de alimentos aumentará en por lo menos un 20% a nivel mundial en los próximos 15 años, con una concentración de la expansión en África y Asia. El mundo puede producir más comida y asegurar que se use más eficiente y equitativamente. Nuevamente el problema es de distribución y sería muy positivo que los políticos locales dejen de utilizar argumentos directamente mentirosos, basados en los dictados de empresas inescrupulosas que presionan por seguir instalando el discurso del hambre en el mundo. Cuando se sabe que el problema es de distribución y de la pésima alimentación que se promueve dar a la propia población. Es por ello, que para lograr cambios sustantivos en el sistema alimentario mundial, se necesita una estrategia global, multifacética y conectada, para asegurar una seguridad alimentaria sostenible y equitativa (Godfray et al., 2010).

Las dietas cambiantes, expansión de la clase media, ingresos crecientes, urbanización en países en desarrollo y migración rural son factores claves que presionan el sistema alimentario. Una segunda ola de urbanización está modelando la demanda y oferta de alimentos a diferentes niveles y con diversos efectos.

Es necesario lograr una mejor integración, mediante un abordaje de sistemas eco-agroalimentarios para lograr seguridad y soberanía alimentaria dentro de un uso sostenible de recursos naturales y relaciones culturales a escalas local, regional y global.

La incorporación de un abordaje holístico para los sistemas eco-agroalimentarios implica un reconocimiento de que la diversidad de valores de la naturaleza y sus contribuciones a la calidad de vida de la gente están asociados con diferentes contextos culturales e institucionales (Pascual et al., 2017). Esto es especialmente relevante para la integración de los sistemas agrícolas y el valor agregado a través de la cadena.

Hay suficiente alimento para todos en el planeta hoy en día, sin embargo casi 800 millones de personas sufren hambre. Hacer frente al hambre y a la malnutrición no se reduce a aumentar la producción de comida, sino que también incluye aumentar los ingresos, crear sistemas alimentarios resilientes y reforzar mercados para que la gente pueda acceder a alimentos seguros y nutritivos, incluso si una crisis impide que cultiven lo suficiente ellos mismos.

Algunos países han tomado un abordaje integral al reconocer que la seguridad alimentaria continúa siendo central para lograr los Objetivos del Desarrollo Sostenible (ODS). El alimento -la forma en que se cultiva, produce, comercia, transporta, procesa, almacena y vende- es la conexión fundamental entre la gente y el planeta, y el camino hacia un crecimiento económico e inclusivo.

En todo el mundo, los recursos naturales se están degradando, los ecosistemas están sometidos a estrés y se está perdiendo la diversidad biológica. El cambio climático es una amenaza extra para la producción global de alimentos (FAO, 2016). Estos son los cambios a ser considerados.

La seguridad alimentaria y nutricional son los temas centrales de muchos de los ODS (Objetivos del Desarrollo Sostenible 2015-2030 Naciones Unidas), en los cuales se plasma un compromiso de mantener la integridad de los sistemas de la Tierra a la vez que se aborda la demanda de recursos impulsada por los requerimientos del sistema alimentario.

La identificación de los factores que generan impactos y sus posteriores consecuencias en el sistema agroalimentario global conlleva la necesidad de un abordaje de sistemas complejos.

Incorporar flujos intangibles y stocks (Pengue y Feinstein 2013) al análisis del sistema económico contribuirá al reconocimiento integrador de su valor, la mejora en el manejo de recursos estratégicos, como suelo y agua, nacional y global, y potenciar la estabilidad de los sistemas agrícolas y alimentarios.

El rol de los ciudadanos y de los Estados hacia un cambio radical en los sistemas agrícolas y alimentarios globales es crucial. Los sistemas alimentarios globales de hoy en día presentan distorsiones que se reflejan en hambre y en excesos alimentarios y serios trastornos y enfermedades evitables.

La inversión en educación ambiental y nutricional, junto con la promoción de un cambio hacia una dieta sana y nutritiva es esencial. Los productores de alimento deben ser reconocidos socialmente en su relevante servicio a la sociedad. Las tendencias hacia alimentos nutritivos y menores niveles de insumos externos deben ser valorados por la sociedad en base a su valor completo.

Los gobiernos de los países que apuntan a restaurar una agricultura saludable y que promueven dietas nutritivas y culturalmente arraigadas deben liderar el cambio en los sistemas alimentarios globales. Las corporaciones también tienen un rol a cumplir, pero el cambio debe ser direccionado por los Estados. Organizaciones sociales de consumidores, usuarios, agricultores y otras ONGs, cada una con sus demandas sociales y ambientales específicas, también tienen un rol a cumplir para cambiar hábitos sociales actuales a escalas tanto nacional como global.

Políticas públicas, tecnología y posibilidades de inversión pueden potenciar la promoción hacia sistemas alimentarios sostenibles, creando oportunidades para todos los productores, consumidores, corporaciones y países.

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Ecological economics and agroecology: a touch of radicalism applied to Brazil*

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Introduction

For the past four decades, a group of social activists in Brazil, with different perspectives, have been trying to develop a path for agriculture that aims to be ecologically sound, economically viable and socially fair. These attempts have been a voyage in unknown and somewhat rough seas. There was a clear perception that what was being learnt in the agricultural colleges and prescribed by the agricultural technicians was only partially applied by farms, especially those with less economic advantage, and was therefore not quite right. Its critics, and even enthusiasts admitted there were side effects, such as environmental contamination and health hazard from pesticides, perceived the results of the spread of modern technologies all over the country as generally negative. This criticism prompted a search for an alternative agricultural path, this has since evolved into what has come to be known as a 'sustainable agriculture'.

Although the need for a sustainable agriculture is generally accepted, perceptions of what it is can be very different. They range either from visions of a new 'green revolution', to the complete rejection of modern technologies. These differences are not limited to technological options, but extend also to debates about whether, in a context that favoured large-scale agriculture (Gonçalves Neto, 1997, Gonçalves, 1999), policies towards smallholding farms should seek to make them economically viable or merely regard them as a social problem.

To answer this question, 'Agroecology' has been proposed, developing an agriculture based on ecological systems principles but addressing the socio-economic issues from the perspective of the small-scale, poorer, peasant, indigenous or traditional family farm sector including "Quilombolas", a grouping of descendants of black slavers in Brazil.

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The initiatives of promoting Agroecology among these farmers are coupled with the development of organizations that can support them as well as promote the well-being of such populations.

This paper is an effort to describe and assess the achievements and challenges, based on the context of southern Brazil, but also in experiences, and discussions from Brazil and Latin America, more generally of current efforts in the pursuit of a sustainable agricultural system supported by peasant, indigenous, traditional or family farmers organisations. Its reports are based on the findings of some studies conducted in the state of Rio Grande do Sul (RS), which is the most southerly of the states of Brazil.

1. Sustainable agriculture

Environmental crisis is not a new theme in the history of human civilisation. However, what is novel and disturbing at the present time is the dimension and intensity of such problems. In recognising this problem there is a consensus among many different schools of thought. The discussion has focused on how to achieve what has been called 'Sustainable Development' (WCED, 1987), where there are many different views, varying from not being possible to complete feasibility.

Agriculture's contribution to solving the environmental crisis could be addressed by the development of sustainable agricultural systems, where sustainable management of natural resources is a key aspect. These systems take a number of forms such as biological, organic, ecological, and biodynamic agriculture. Nowadays these forms of agriculture are increasingly being adopted in different regions of the world.

The idea of sustainable agriculture revolves around using available biophysical and human resources to achieve good yields, increasing the use of internal resources and/or minimizing the use of external resources (Pretty, 1996). However, there are many other definitions and conflicting approaches to sustainability in agriculture (Burton et al., 1998; Pretty, 2008). The concept of sustainable agriculture can be regarded as a combination of views which are opposed to what is considered to be the unsustainable path of the so-called 'conventional' or 'modern' agriculture.

2. Alternative attempts to sustain agriculture

The unsustainability of this conventional path of agriculture have given rise to concerns among farmers, consumers, scientists, general public and governments about the suitability of the conventional methods of modern agriculture. Consequently these problems have led to a series of attempts towards changing the path of agriculture (Shepherd 1998; World Bank, 2008). They share many similarities but have some differences that might allow diversity. The main divisions of alternative approaches to develop a sustainable agriculture could be listed as: Biodynamic farming; Ecological Agriculture; Natural farming; Organic farming, Permaculture and the Low External Input Sustainable Agriculture (LEISA) concept (Reijntjes, *et al.*, 1992; Souza Filho, 2008).

These attempts to sustainable agriculture aim to preserve ecosystems by encouraging production that attends the needs of a human population using as much as possible local, renewable resources.

Among them, Organic Farming is an early concept, preceding other environmentally aware approaches to agriculture. In this approach, consideration is given to the way in which nature's environmental systems behave and attempts to integrate these processes into the agricultural system (Rigby and Caceres, 2001). Although organic agriculture claims to be more than only 'environmentally-friendly' and aims to achieve 'justice' and 'responsibility' (Rigby and Bown, 2003), there are broader approaches that look more intensively at the interrelation with society.

This may be typified by the case of Agroecology in Latin America and Brazil, which aims to study agricultural systems not only from an ecological perspective, but also including a strong socio-economic perspective, also looking at how indigenous agricultural systems adapt to local ecological conditions (Altieri et all., 1996).

In the present research, Agroecology, is the most important concept since it is the option adopted by NGOs and farmers' ecological groups. Besides, Agroecology was the paradigm officially adopted by the Rio Grande do Sul state government and by EMATER (a state agricultural extension agency), between 1999 and 2002, and again, with PT state government took place between 2011-2014 (Paulus, 2011). It is necessary to clarify that in this perspective, agroecology is seen as the scientific basis for the development of agriculture systems based on ecological process, and the practice of this agriculture is named ecological agriculture, or agriculture ecologically based (Caporal and Costabeber, 2002).

However, Agroecology, in a more restrictive or field orientated way, can also be defined as:

> *"The application of ecological concepts and principles to the design and management of sustainable agroecosystems. [sustainable agroecosystems are]... in most general sense a version of sustained yield - the condition to harvest biomass from a system in perpetuity because the ability of the system to renew itself or be renewed is not compromised " (Gliessman, 1997, p.13).*

Physically an agroecosystem can be limited to any unit of interest such as a region, group of farms, a farm, or a part of it. Their spatial limits are arbitrary and represent a definition of agroecosystems in hierarchy that go from the single plant/animal and its surrounding environment up to an overall socio-economic system (Conway and Barbier, 1990), it highlights the interaction between ecological, and farm systems, with the overall system.

As the physical boundaries of agroecosystems are arbitrary, it is possibly better to clarify the relationships between systems in the hierarchy and to apply the agroecosystem concept to a more restricted, and somehow manageable, unit of analysis, such as a farm, a farm field or a group of farms, making clear the relationships within the systems and between the different levels (Hess *et al.*, 2000).

The agroecosystem is a unit of analysis and conceptually it may be defined in terms of an ecosystem that relates to matters outside of its boundaries and with other natural and socio-economic systems.

3. The political ecology of sustainable agriculture in Brazil and Rio Grande do Sul (RS) state

In Brazil, attempting to confront the process of 'conservative modernisation' of agriculture, and its social and environmental problems, several civil society organizations started to promote the 'alternative agriculture'. According to Almeida (1998), the meaning of alternative agriculture in Brazil has its roots in the economic and political alternative discourse that took place especially after the 1968 student movements in Europe. It was a movement against a capitalist model viewed as economically unfair, politically centralized and anti-nature. It encompassed an anti-capitalist, ecological and civil society contestation of the dominant political powers. These ideas came to Brazil in the earlier 1970s and were part of the ecological movement that grew in the eighties (Almeida, 1998).

The intention of those organizations was mainly to help smallholding farmers and protect the environment. Several NGOs were set up to deal with this process since government research and extension programmes did not give priority to environmentally friendly technologies (Romeiro, 2011). This characteristic of a NGO-led process is not unique in Brazil, several other Latin American countries have experienced similar situations where attempts to support small-scale farming and approaches in pursuit of a sustainable agriculture is being done mainly by NGOs (Bebbington, 1999; Norgaard and Sikor, 1999; Clades, 2011). The alternative techniques that have been developed and supported by NGOs and governments institutions include for instance non-tillage cultivation, use of green manure, organic fertilizers, biofertilizers, biological fixation of Nitrogen, biological pest control, integrated pest management, pollution control, and preservation of biodiversity and genetic resources (MMA, 1999). This body of techniques developed into a more basic set of principles capable of wider adaptation to local contexts, as did the social perception about it. The 'alternative agriculture' became known and generally accepted as the 'sustainable agriculture' paradigm (MMA, 1999).

With the evolution of alternative agriculture into sustainable agriculture, its pioneers were able to identify a more widely acceptable scientific base, without however losing social commitment. The defined scientific base of this new agricultural paradigm has been mainly, in the Brazilian and especially in RS case, that of Agroecology (Almeida, 2003).

Outside the academia, governmental research and extension agencies, there rose pragmatic movements that developed techniques adapted to the conditions of local farmers agroecosystems, thus adapted to social, economic and ecological conditions. These were mainly connected with NGOs works and proposals (dal Sóglio and Lemos, 2009).

An important feature that became prominent in Latin America in the 1980s is the recognition of popular knowledge and its ability to manage agroecosystem in a more sustainable manner. Farmers that have being living in the environment for long developed technical adaptations that can be characterized as sources of traditional knowledge that differ from the science developed in academia but are as much valuable. The dialogue between these different sources of knowledge became one of the constitutive assumptions of agroecological movement.

Chambers (1994) argues that the local, practical knowledge developed on daily basis by farmers can amplify and qualify scientific knowledge, improving practices of rural development.

The option for Agroecology as a sustainable agricultural path carries within it an explicit option to reinforce agricultural systems that are peasant based. This is due to a social commitment to the poor in the rural areas. Besides, it includes a belief that indigenous and traditional agricultural systems have been adapted closely to ecologically natural systems, a characteristic that has kept them as a basis of most agricultural practices worldwide, providing a strong component of sustainability (Gliessman, 2001). In terms of social sustainability, peasants are viewed as a more equitable form of production within capitalism. These were the relative self-sufficiency, a logic reproduction of family work force in opposition a logic of profit, production based upon family work force and biological energy (human and animals), the use of smallholding areas, and the diversification of peasants' agriculture (Fernández, 1995; Ploeg, 2008).

The Agroeocological proposal tends to distinguish and to privilege indigenous and peasant forms of agriculture (Almeida, 2003). This reinforces the 'peasant' identity of small-scale farming or family farms. The peasant 'nature' provides the basis for reaction against modernisation and a possible alternative to rural development. This was clear, for instance, in the Rio Grande do Sul state policies for rural development during the Workers Party (PT) administrations, between 1999 and 2002, and from 2011 to 2014 (Paulus, 2011), and more generally, although in a more limited scope, in Brazil during the period of 2003 to 2015.

The adoption of sustainable agriculture was aimed to sustain not only the environment, but to foster a rural development option that would be based on peasant and indigenous and traditional groups of rural people in order to promote social justice. It would be an opposite route to that taken by modernisation and the neo-liberal path, and should be based on the elements of technological and cultural resistance that were endogenous and specific to each community (Sevilla-Guzmán, 2001). This idea has its roots again in Chayanovian's vision of a technical superiority of peasants co-operatively organised as an independent class (Bernstein and Byres, 2001) that make them a socially and economically viable option for rural development. This is certainly an oversimplification of the technological alternatives and social process behind the sustainable agriculture movement in Brazil. In fact, one may better consider the existence of much sustainable agriculture based on ecological processes in opposition to an "industrialised" agriculture.

However, the aim here is to characterize Agroecology as a socially rooted option as opposed to the more biologically centred sustainable agriculture movements, which are mainly concerned with the production of 'clean' products, without using chemical synthetic products (Fernández, 1995). In short, the evolution from alternative agriculture to Agroecology may well represent reaction against the perceived negative effects of modernisation of agriculture in the family farm,/peasant sector. The incorporation of these environmentally sound technologies had the overall objective of reinforcing the rural population against exodus and impoverishment. It could also count on the support of urban sectors that are more sensitive of social problems, looking for a better quality food, protecting the environment and aware of the problems caused by conventional agriculture technologies. Although one could think that such environmental concerns would be an issue for wealthy people or affluent nations it is also present in the struggle for life by the poor, and very often mixed with social movements (Martinez-Alier, 2002). For instance Brazilian landless Movement (MST) has declared its choice for Agroecology, as well as the Via Campesina.

More recently, governmental institutions such as EMBRAPA, the national agriculture research corporation, a federal agency and EMATER, state agencies for agriculture extension and technical assistance, in different Brazilian states, have joined this proposal and developed programmes to support Agroecologicaly based farming (Romeiro, 2011; Paulus, 2011), which became a productive model for a sustainable rural development and a governmental policy since more than a decade ago:

> *"In the federal domain,…, this discourse also began permeating actions for the agrarian reform and family farming … increasingly more profound since 2003, with the election of Lula, particularly regarding the technical assistance and rural extension fields, whose orientation by agroecology became a political strategy" (Schneider, 2007: 15).*

In practical terms the government sets up policies to achieve these aims, such as credit for agroecological production projects trough the family farming credit programme (PRONAF), which included a special credit for agroeocological production, and the institutional food acquisitions programme (PAA) and the programme of acquisitions of food for public schools (PNAE). The two latter include the commercialisation of raw and agro-industrialized ecological products (Gotuzzo, 2009). The Brazilian government intends to presented the National Policy of Agroecology and Organic production (PNAPO), in the aftermath of the Summit of the Earth on RIO 2012, which has been chosen by Food and Agriculture organization of United Nations (FAO) for the Future Policy Award 2018, as one of the best policies for sustainable food and agriculture production systems (FAO, 2018). More than an economic proposal they were a political challenger to the overall political structure. However, since the impeachment of Brazilian elected president, Dilma Roussef, in 2016, "the political strategy of Agroecology" (and organic production) in practical terms was abandoned by the new government due its political and ideological perspective, and it is under threat due to the results of the 2018 general election.

Besides, the importance of the above mentioned efforts towards Agroecology, or ecologically based agricultural production, it is necessary to stress that they probably could not be accomplished entirely, were not for a channel of communication between, NGOs, social movements, some governmental agencies, and peasant farmers. These networks started to be constructed very early in the processes, their basis were farmer groups, associations and new cooperatives. They also started with the perspective of supportting peasant farming and, initially, some of them may not have been entirely committed to Agroecology. Others began originally as an association of agroecological farmers, however what they have in common is that these new organizations tried to act differently from traditional giants cooperatives, a model that entered in crisis in Brazil, leaving many farmers in disbelief of cooperation itself. These new initiatives tried to organize based on what is being called the principles of solidarity economy.

What is regarded in this paper as "solidarity economy" is occurring on the social practices of some tens (maybe hundreds) of millions of people from peripheral countries. Associative entrepreneurship that rises from adverse economic situations and that relies on a technological arrangement anchored in social practices marked by the solidarity, in a combination of non-capitalist values and alternative economic models. It embraces associative enterprises where the ownership, the labour, the management and the economic results are shared by the members of the enterprise prioritising to pay back the effort of the group leaving the individual capital remuneration in a second level of importance (Singer, 2002; 2005; ANTEAG, 2005; Cruz, 2006; Cruz, 2012).

The symbiosis of these two movements are creating some novelty in the social movement. They are organizations of peasant or family farmers that are promoting an agriculture based on ecological processes, scientifically supported by Agroecology, and organized in accordance with the principles of solidarity economy. The process of actively market construction through the agroecological networks can exemplify that.

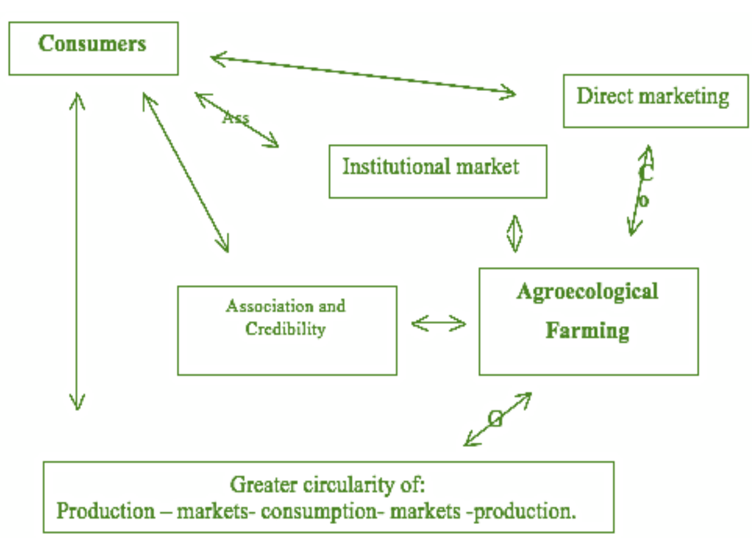
4. Agroecological networks

Analysing the process of alternative 'networks' in the family farming's access to markets, policies and institutions are necessary to acknowledge the importance of 'global networks' in this structural change (Schmidt, 2003), such as the worldwide movement of environmental sustainability and the sustainable agriculture movement. However, in order to grassroot these movements, a local network has to be developed. In the Brazilian case, the main stakeholders of this process of promoting alternatives networks for sustainable agriculture – which includes alternative channels of commercialization and a participatory certification process – are the solidarity economics associations and cooperatives who support the agroecological farmers (figure 1).

Based on that networking farmers and consumers are actively constructing, not only markets but alternatives to the marginal exclusion within capitalism that can be understood by the analysis of nested Markets (Ploeg, 2016).

That is one of the routes of the "Agroecology Radicalism", to be based on the real needs, struggles and options of many thousands of impoverished people that in other ways would not have a place in the capitalist mode of production, neither a minimum decent and meaningful life.

FIGURE 1. NETWORK FOR SUSTAINABLE AGRICULTURE



The other source of radicalism may come from academia or the theoretical formulation of Agroecology. As expressed above, the concept was initially understood mainly as a scientific paradigm, however, another approach has been developed. Currently there is still an approach of agroecology as a science, or a scientific discipline, an approach that searches for explanations or theoretical interpretations of empirical analysis, besides of practices of agricultural and livestock production on organic or ecological basis, but also as a social movement stressing the organization of rural social groups grounded in the disputes towards the strength of agroecological agendas, as described by Wenzel, et al (2009) in their seminal paper. In an opposite direction Sevillla-Guzmán and Woodgate (2013) argue that these facets of Agroecology are bonded together and can not be split, furthermore, they seem to be on a path of radical opposition to the capitalist system and on a way to the construction of more sustainable productions, distribution and consumption systems, but only if it maintains its unity identity and alliance with social movements (Sevillla-Guzmán and Woodgate, 1997; 2013).

Such construction is based on beliefs expressed by agroecological farmers (supported by many other activists), and they are pervasive in all the process, regarding that the agroecological farmer is not only an adopter but a 'translator' and a creator of a technological and social process. This results in different levels of agroecology adoption and also of cooperation among the farmers and theirs (and others) institutions (Fernandes and Woodhouse, 2008; Silva and Fernandes, 2016).

5. Agroecology and Ecological Economics

The ecological economics perspective can be anchored in the seminal work done by Georgescu-Roegen, The Entropy Law and the Economic Process (1971), where Georgescu presents the interpretation of the economic process under the view of thermodynamics and the limitations imposed by the entropy. The demonstration given by him is that the economic system is not isolated but it is, in fact, an open subsystem of the biosphere and, due to that, under the rule of thermodynamics laws (Cavalcanti, 2018). Thus, an inherited consequence is that an infinite economic growth is not possible, in this finite system (Boulding, 1966, Daly, 2005).

In order to solve this problem, Ecological Economists, followers of Georgescu's ideas, advocate that the way for sustainability goes through the substitution of economic growth for qualitative improvement of stocks and flows (Costanza and Daly, 1992; Daly and Farley, 2004). In this perspective, to achieve sustainability, it is necessary needs to achieve a steady economic state, where institutional and technological innovations are still necessary, but with the technology still being limited by the second law of thermodynamics (Daly, 1995). To replace economic growth for qualitative improvements in the composition of stocks and flows, the market mechanism is not enough, and societal agreements about the scale of the economy are essential in order to preserve intact the level of Natural Capital that is perceived as complementary, not substitute, for human-made capital. This is understood as the perspective of strong sustainability (Romeiro, 2001).

In its turn, Agroecology uses a methodology that comprises bottom-up, participatory and systemic approaches, and a co-evolutionary perspective, similar to the principles of ecological economics (Norgaard and Sikor, 1999). Widely accepted definitions of sustainable agriculture agree that it has to encompass three dimensions: environmental, related to the idea of ‘sustainability as stewardship’; Social ,where equity is the key property of agroecosystems considered, and economic viability, which, in its micro level, generally means farm economic viability, but also accepts that natural capital stock should not be depleted, agreeing with the ecological economics notion of strong sustainability, which is also present in many analysis of sustainable agriculture (Ozkaynak *et al.,* 2002; Segnestman *et al.,* 2002; Van der Weff and Petit, 2002).

Thus, one can find similar roots in their critics to the conventional approach to economic and agricultural development, but as alternatives, they may differ in their ways of putting in to practice sustainability approaches. Agroecology claims to be the sustainable agriculture of the impoverished, a point that strengths its proposal and which may be lacking in the more general, or conservative (Barkin et al, 2012) theoretical stream and political proposal of Ecological Economics.

The predominant view of Ecological Economics may have been able to formulate a consistent critic and a viable alternative model (Muller, 2008) and also able to construct the basis for a post-normal science approach (Romeiro, 2001), including alternative policies formulation (Daly and Farley, 2004; Daly 2005; Muller, 2008). However, despite these theoretical and methodological efforts, Ecological Economics seems to lack an alternative to overcome the political impossibility (Daly, 2005) of replacing the growth mania of conventional economics and its policies (Latouche, 2009).

If it is possible to use a comparative analysis approach (Ploeg, 2011) to understand the differences between these two trajectories, one could argue that into the Ecological Economics side there is a lack of interaction, perhaps commitment, with social movements of any type, including the Environmental Movement in a broader sense.

It seems that the formulations of “mainstream” Ecological Economics tend to not differentiate among groups in society and do not address class struggles or political power within societies and or among regions and countries. It is not to say that it is perceived as politically neutral but its main argument may lack strength enough to address the differences among social groups and the different consequences for them regarding the environmental, economic and social crises that the world is facing. To not to be unfair, many of these subjects have been addressed in the Ecological Economics perspective, but their importance is not as relevant as other themes, generally related to conventional economic theory, and more representatives in the International and regional societies meetings, and also in publications such as the scientific journal Ecological Economics (Elsevier) (Barkin *et al.,* 2012).

It is arguable that it is exactly the strength that Agroecology has been able to achieve. It is the amalgam among science, policy, and practice (Sevilla-Guzman and Woodgate, 2013) that gives power to it allowing Agroecology to become a political alternative to agriculture and to a rural sustainable development.

Having that stated, it is necessary to acknowledge that there are streams in Ecological Economics thought that tend to formulate its theoretical analysis and obtaining its political outcomes from the perspective of social movements. The alternatives visions of Ecological Economics described by Barkin et al. (2012) as critical and radical. According to them the vision of Ecological Economics are influenced by some factors. One factor is the differences in the academic and geopolitical context of the reflections about sustainability in regional societies, members of the International Society of Ecological Economics. Besides and more important is the ideological factor that assumes the free market economy as the model to be proposed. That would influence Ecological Economics to tend to its more conservative version. In doing that, Ecological Economics distances itself from its original aim of being an ecological interpretation of economics (Cavalcanty, 2018). In a sense, an ecological lens through which one could read the economic and social life to understand its connections with the environment.

In contrast, the critical and radical version (Barkin *et al.,* 2012) have in common as the starting point the eco-marxism, arguing that it is not possible to avoid the power analysis in the context of environmental crisis, they use the methodological materialism to describe and confront it.

One main author in the critical stream is Martinez-Alier, whom may be used in order to illustrate this category. He considers that all the ecological conflict is a distributive conflict and thus must be dealt with in the same frame that the Marxist analysis dealt with class structure, in terms of the ownership of the means of production that allowed the owning class to get surplus value from the exploited ones. The ownership of environmental assets (and its services) allows the dominant class to deprive poor population and nations from its benefits and the accumulation of it in the hands of richer groups and nations, despite the inverse relationship in terms of availability of natural resources. In consequence, the poor ones are left with only the effects of environmental degradation. That situation creates an ecological debt from the Global North with the Global South nations and its poor populations. In order to solve this conflict, there are no mediations possible, and the way forward is through the activism of social and environmental movements, a Political Ecology expression of the more traditional Political Economy (Martinez-Alier, 2002).

In this sense Agroecology and Ecological Economics critical perspective seem to converge in a proposal that sees Global South countries needing to break up the dependency of North countries, regarding science, technology, culture and production systems, looking for indigenous or local systems of production and consumption to replace the ones that reinforce the foreigner dependency. They seem to argue for another frame for organizations and policies, which would only be achieved by the mobilization of social movements. This is in accordance with a Political Ecology approach, from the critical perspective of Ecological Economics, and also with what has been described above, as the political ecology of agroecological movements in Rio Grande do Sul and Brazil.

However, that does not seem to be enough for the radical Ecological Economics critic. Considering the views of one of its main author, Enrique Leff, one may have a glimpse of that perspective.

Although also coming from an eco-Marxist origin and closer to the critical perspective, he also opposes to a more traditional Marxist analysis of the environmental crisis, considering the traditional categories of Marxism too much schematic for understanding the complex new relations among economic, social, cultural and environmental process that are based for sustainable production (Leff, 2006). Even more, He understands that the rationale behind the ecological economics itself, still too economistic and a new rationale, based on other systems of value, is needed to construct a new relationship between humanity and nature that can be sustainable (Leff, 2006).

This strikes the core of the economic theories, and perhaps the organization of the economic system. According to that, in order to build sustainable human nature relationships and sustainable systems of production and consumption a new system of value has to replace the theory of marginal utility, based on individual preferences, but also the exclusive labour theory of value.

Agroecology and its association with solidarity economics, certainly based its theoretical views and practices on the labour theory of value, and uses it seeking to achieve equity as a critical issue in the social dimension of sustainability, but also a more balanced relation between labour and capital (Human-made), with the subordination of the latter to the former in the economic dimension. However, as expressed in many views of peasant farmers, indigenous people and traditional communities, this is not the only, and perhaps not the main value perceived by them to maintaining agroecological agroecosystems (Petersen et al., 2017) or to make the transition from conventional to agroecological systems (Fernandes and Woodhouse, 2008).

One could argue that this is the whole economic value, avoiding the chrematistic view of economics (Martinez-Alier, 1998, Muller, 2007)), but it is clearer the expression of other values that are not economic. It can be typified, at a macro level, by the inclusion in the constitutions of two Latin American countries, with strong indigenous heritage, Bolivia and Equator, of the rights of nature, meaning that nature has its own rights apart from human considerations. It is a major recognition of nature intrinsic value and it is incommensurable. Considering that it is arguable that other more pluralistic systems of values are needed to be taken into consideration.

That is currently in the agroecological experiences (Petersen et al., 2017) were farmers and farmers groups do consider the economy of its production, as their life depends upon that, but also consider, and sometimes prioritise, other sources of value (Fernandes and Woodhouse, 2008; Silva and Fernandes, 2016; Petersen et al., 2017). Among this other sources of value one could mention the indigenous views of mother earth, prevailing in many cultures, as the reason for environmental preservation, the efforts for self-sufficiency in food, the links between producing own food and health, the preservation of local culture, the empowerment of woman, youth and children, among others, but perhaps as important as these all, a sense of their own identity that accompanies agroecological farmers (Silva and Fernandes, 2016). Thus, a series of cultural values that come from other perspectives other than a single economic valuation.

A single economic approach, not considering other values, is the critique of the radical Ecological Economics, that considers the economic rational, even in a more ecological perspective (Leff, 2006). Such a vision is misleading efforts to the emancipation of the poor populations of Global South countries. For instance, the two countries mentioned above, but also Brazil and other Latin American countries, had gone recently through several governments that could be classified as left wing. In order to foster the Development, they had actions that are against the rights declared in their constitutions and against the emancipation of their own people. Mimicking the projects of capitalist development and using a traditional Marxist discourse of developing productive forces, to justify it, the left wing government allowed the exploitation of indigenous and peasant land on "sacred places" in Bolivia and Equator, foreign investments in mining in Argentina (Gudynas, 2017), or construction of large dams in forested areas, with deprivation of indigenous and traditional, local, population in Brazil, such as the Belo Monte dan constructed by PT government in Amazonia. That may not be regarded just as an opportunistic approach, perhaps is more a case of misinterpretation of the reality by the use of the wrong lens, the lens of a single economic rational, even in a Marxist perspective.

The alternative view would propose an alternative development path, considering the needs of the whole country population, but also the views and ways of the local population that controlled and have been managing sustainably the areas for centuries. This alternate development path (Leff, 2006) is closer to theoretical perspectives of sustainability as the way to satisfy not only material, but also spiritual needs of people without damaging the environmental condition (Masera et al., 1999) considering the submission of any economic development as the ideal of people's happiness, as in Buttan index of Happines, and thus related to other cosmos-visions, such as the ones from indigenous Latin Americans, Asian Buddhist, in the above mentioned cases, than to the one from occidental philosophy, but that could also be related to a more true Christian view such as in the Laudatto Si (Cavalcanti, 2018).

It is easily related to the visions of Agroecology as a movement, promoting a new rural development approach that considers the needs of rural and urban population, regarding food security and safeness, but also regarding a meaningful life, that is plenty of citizenship, solidarity, and spiritual aims. In these subjects, the political ecology of Agroecology goes much further than the simply proposal of an economic development alternative or even to a reductionist process of only controlling the means of production. In fact, it aims the whole integration of our life with nature, with respect of cultural values, improving the sense of embeddedness and belonging to nature (Silva and Fernandes, 2016) that can create new perspectives for life and genuine happiness.

Regarding to the Gordian not placed by entropy, which is that according to the second law of thermodynamics, the economic process, and life as a whole, is creating a sort of energetic flow in direction to disruption that could lead us to the end of human civilization on earth (Georgescu-Roegan, 1971), Negentropy is proposed (Leff, 2006) as the use of biosocioenergy to revert the process of entropy. As an example, he describes the use of solar energy through photosynthesis in sustainable agriculture systems, such as in agroecological systems, as ways to generate Negentropy.

The experiences of Agroecology and its uses of what – in a more conservative view of ecological economics – has been called natural and social capital, to promote more sustainable systems of production (Fernandes and Woodhouse, 2008; Galicia-Gallardo *et al.*, 2018) in different countries in Latin America, and worldwide (Altieri *et al.*, 2017), are expressions of uses of cultural values allied to biodiversity, to generate environmental protector and energy efficient agricultural systems, able to promote social equity and economic efficiency (Fernandes and Pascual, 2015) in accordance with has been described by the radical ecological economics. Furthermore, it seems to be a way to face the political impossibility of Ecological Economics (Daly, 2015) as well as the Biophysical impossibility of any economy to grow infinitely (Georgescu-Roegan, 1971).

Conclusion

The paper attempts to create a theoretical symbiosis between ecological economics and Agroecology. However, it argues that this theoretical proximity really happens between agroecology and the radical version of ecological economics, as their roots are similar, and from that proximity, its is possible to harvest better fruits, such as an ecological vision of economics and an ecological vision of agriculture, a political economy and political ecology approach. Besides, a perspective of constructing sustainable systems of production, not just regulating or reforming it, but by promoting a radical change on them, aiming in doing so that they become more effective in promoting real changes in the direction of more sustainable societies, attaining all the people and nature "Bien Vivir".

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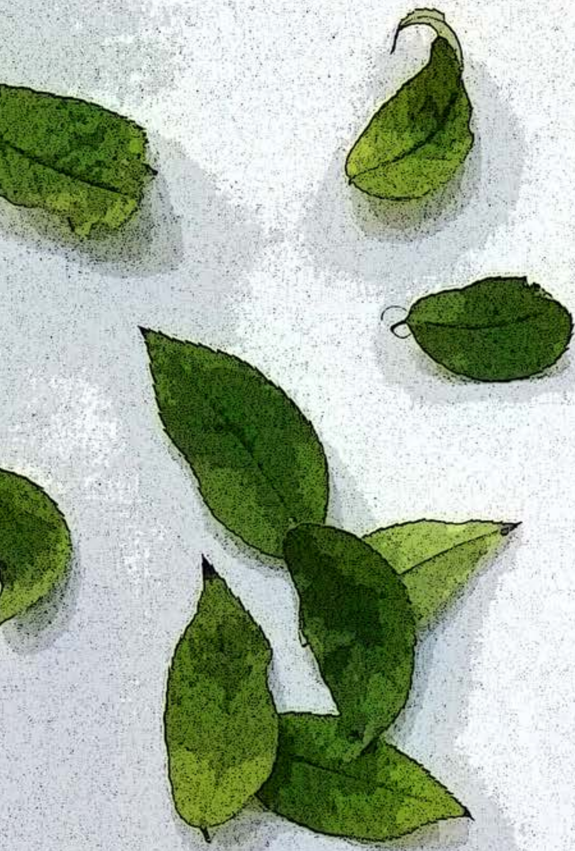
This collection of essays presented at the XV International Congress of the International Society for Ecological Economics in Puebla, Mexico, starts from the recognition of the global damage and disruption resulting from the abuse of the use of natural resources, and the impacts on the environment caused by the excessive and complex consumption of modern societies, which has marginalized innumerable rural communities. It lends particular attention to the responses of diverse groups of actors that have reacted with theoretical and productive proposals, as well as with social movements and confrontations for the defense of territories that are being impacted at the local level with global repercussions. The book is organized in six important themes in the debate between the reigning economic system and its environmental and social effects: paradigms, energy, ecosystem services, sustainability, social conflicts, and food systems.



Esta compilación de ensayos presentados en el XV Congreso Internacional de la Sociedad Internacional de Economía Ecológica en Puebla, México, parte de reconocer el deterioro y la perturbación global que ha derivado del abuso en la utilización de los recursos naturales y de los impactos sobre el ambiente, causados por el excesivo y complejo consumo de las sociedades modernas que ha dejado al margen a innumerables comunidades rurales. Se centra particularmente en las respuestas de diversos grupos de actores que han reaccionado con propuestas teóricas y productivas, así como con manifestaciones sociales y de confrontación en defensa de territorios que se ven impactados a nivel local con repercusiones a nivel global. El libro se organiza en torno a seis temas generales que se consideran centrales en el debate entre el modelo económico vigente y las repercusiones ambientales y sociales: paradigmas, energía, servicios ecosistémicos, sustentabilidad, conflictos sociales, y sistemas alimentarios.