INDUSTRIAL SHRIMP AQUACULTURE AND MANGROVE ECOSYSTEMS

A multidimensional analysis of a socio-enviromental conflict in Brazil

Phd Thesis
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Industrial shrimp aquaculture and mangrove ecosystems:

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"...o povo daí vive de pegar caranguejo... e com sua carne feita de lama fazer a carne do seu corpo e a do corpo de seus filhos."

(Castro 2003)

À Cilene, Ivan e Filipe, minha família, pelo amor e apoio incondicional.

Aos povos do mar e do mangue em luta, especialmente às companheiras e companheiros das Comunidades do Cumbe e Curra Velho.

Abstract

In the past 40 years, industrial shrimp aquaculture developed with economic incentives from governments, public and private agencies and International Financial Institutions (IFIs) - including the World Bank, the International Monetary Fund, the Food and Agriculture Organization of the United Nations (FAO) and the food industry. The target was achieving economic growth based on exports of large volumes of food, reducing the pressure on marine wildlife populations and thereby alleviating the poverty in developing countries. Extensive political and economic aid along with legislative permissiveness has promoted this economic activity which, growing exponentially in a short period of time. This fast growth of industrial shrimp farming has generated increasing criticism due to its consequences, which include the conversion and expropriation of wetlands such as mangroves, causing a decreasing flow of ecosystem services available for society in general and local communities in particular. The aquaculture industry has converted a high percentage of coastal areas of developing tropical countries into properties for shrimp farming for export. This situation has resulted in numerous conflicts around the world, where local people have chosen to challenge the processes of accumulation by dispossession and have organized to resist, leading to environmental struggles which have been increasingly supported by organizations and movements demanding environmental justice. During the last few decades, a particular example of this conflict has developed in coastal area of Brazil, where a large percentage of mangroves areas have been deforested for the development of shrimp aquaculture. This thesis aims to clarify and analyze the environmental degradation and socio-environmental conflict caused by industrial shrimp farming in Brazil from the perspective of political ecology, seeking to link different levels of analysis - local, national and global - in several key dimensions to achieve a political and environmental, a social and an economic understanding. The political and environmental dimension illustrates the history of privatization of coastal ecosystems by industrial shrimp aquaculture with a diagnosis of the social and environmental impacts on the Jaguaribe river basin (Ceará, Brazil), and its

close relationship with the political and economic context of national shrimp industry development. The social dimension is analyzed making and approach to the community perception of the fishermen, employing a combination of social methodologies (participant observation, free listings, focus groups, surveys, monitoring, etc.) which have shown that, beyond the physical link, there is a symbolic relationship between the services provided by mangroves and the welfare of fishing communities. This factor is not considered by decision makers at various levels. Finally, the economic dimension, studied via a monitoring of two fishing communities (Cumbe and Curral Velho in Ceará, Brazil), shows the collective economic viability and the traditional principles of solidarity that the artisanal fisheries are based on. It also demonstrates their incompatibility with shrimp aquaculture dedicated to the accumulation of assets and income. This multidimensional analysis concludes that the impact of the development of shrimp aquaculture in Brazil, has a profound transformation of natural resources causing degradation of ecosystems, threatening food security and sovereignty and causing the impoverishment of traditional communities. This combination of effects caused a serious socio-environmental conflict, repeated in the tropics of the developing countries of Asia, Latin America and Africa. The investigative tools developed in this study can be easily extrapolated to other systems such as aiding in the understanding and solving of other environmental conflicts, providing multidimensional information to the decision-making processes to achieve a sustainable and integrated management of coastal areas.

Key words: Shrimp Aquaculture, mangrove ecosystem, ecosystem services, artisanal fisheries, coastal management, environmental justice, social-environmental Conflict, Political Ecology, Brazil.

Resumen

En los últimos 40 años, la acuicultura industrial de camarones (la camaronicultura) se ha desarrollado con el incentivo de los gobiernos, agencias de desarrollo e Instituciones Financieras Internacionales (IFIs) – como el Banco Mundial y el Fondo Monetario Internacional –, la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO) e industria agroalimentaria como medio para alcanzar un crecimiento económico basado en las exportaciones de grandes volúmenes de alimentos, disminuyendo la presión sobre las poblaciones salvajes marinas, aliviando de este modo la pobreza en los países en desarrollo. El fuerte apoyo político, económico y la permisividad legislativa, impulsó esta actividad económica que en un breve periodo de tiempo ha tenido un vertiginoso crecimiento. Esta actividad generó crecientes críticas por sus consecuencias, incluida la conversión y la expropiación de tierras húmedas como los manglares, causando la disminución del flujo de los servicios ecosistémicos generados para la humanidad en general y para las comunidades locales en particular. La acuicultura industrial ha convertido un gran porcentaje de los territorios costeros de los países tropicales en vías de desarrollo en fincas para cultivo de camarones para la exportación. Esta situación se ha traducido en numerosos conflictos en todo el mundo, donde las poblaciones locales han elegido desafiar los procesos de acumulación por desposesión y se organizan para resistir, dando lugar a conflictos socioambientales cada vez más apoyados por organizaciones y movimientos de Justicia Ambiental. Durante las últimas décadas, un caso particular de este conflicto se ha desarrollado en zona costera de Brasil, donde un gran porcentaje de los manglares, se han deforestado para el desarrollo de la acuicultura del camarón. Frente a este contexto, la presente tesis pretende arrojar luz y analizar la degradación ambiental y el conflicto socioambiental causado por la acuicultura industrial de camarones en Brasil desde la perspectiva de la Ecología Política, buscando vincular diferentes niveles de análisis - local, nacional y mundial - en distintas dimensiones claves para su comprensión: político-ambiental,

social y económica. La dimensión político-ambiental, revela la trayectoria de privatización de los ecosistemas costeros por la acuicultura industrial de los camarones a partir de un diagnóstico de los impactos socioambientales en la cuenca del río Jaguaribe (Ceará, Brasil) y su estrecha relación con el contexto político y económico del desarrollo nacional del camaroneo. La dimensión social, a partir de la percepción comunitaria de los pescadores y de la combinación de metodologías sociales (observación participante, *free listings*, grupos focales, encuestas, seguimientos, etc.), demuestra que más allá de una vinculación material, existe una vinculación simbólica entre los servicios que proporcionan los manglares y el bienestar de las comunidades de pescadores, factores no considerados por los diferentes estamentos que toman decisiones a diversos niveles. Por último, la dimensión económica, a partir de un seguimiento a dos comunidades de pescadores (Cumbe y Curral Velho, en Ceará, Brasil), determina la viabilidad económica y principios de solidaridad tradicional colectiva que se basan la pesca artesanal y su incompatibilidad con la camaronicultura, direccionada a la acumulación de bienes e ingresos. Este análisis multidimensional concluye que el desarrollo de la acuicultura del camarón en Brasil, ha venido acompañado por una huella de profunda transformación de los recursos naturales causando la degradación de los ecosistemas, poniendo en peligro la seguridad y soberanía alimentaria y causando el empobrecimiento de las comunidades tradicionales. Un combinado que ha promovido un grave conflicto socioambiental, que se repite en las zonas tropicales de los países en vías de desarrollo de Asia, América Latina y África. Las herramientas construidas pueden ser extrapoladas a otros sistemas para ayudar a entender y resolver otros conflictos socioambientales, aportando informaciones multidimensionales a los procesos de toma de decisión para una gestión sostenible e integrada de la zona costera.

Palabras clave: Acuicultura del camarón, ecosistema manglar, servicios ecosistémicos, pesca artesanal, gestión costera, Justicia Ambiental, Conflicto socioambiental, Ecología Política, Brasil.

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Lista de Abreviaciones

ABCC	Associação Brasileira de Criadores de Camarão
ACCC	Associação Cearense de Criadores de Camarão
ADC	Associação de Desenvolvimento do Cumbe
ANPEGE	Associação Nacional de Pós-Graduação e Pesquisa em Geografia
APA	Área de Preservação Ambiental
BNB	Banco do Nordeste
C-CONDEM	Coordinadora Nacional para la Defensa del Ecosistema Manglar del Ecuador
COMPESCAL	Comercio de Pescado Aracatiense Ltda
CONAMA	Conselho Nacional do Meio Ambiente
CsF	Programa Ciencias sem Fronteiras
EJF	Environmental Justice Foundation
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária
FAO	Organización de las Naciones Unidas para la Alimentación y la Agricultura
FAS	Fundació Autònoma Solidària
FDZCC	Fórum em Defesa da Zona Costera do Ceará
GEC Brasil	Grupo de Estudios sobre la Zona Costera de Brasil
IBAMA	Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis
ICSF	International Centre for Social Franchising
ICTA	Institut de Ciència i Tecnologia Ambitentals
IFIs	Instituciones Financieras Internacionales
IMNV	Infectious Mionecrosis Virus
INPE	Instituto Nacional de Pesquisas Espaciais
LABOMAR	Instituto de Ciências do Mar
RBJA	Rede Brasileira de Justiça Ambiental
RMI	RedManglar Internacional
RMMB	Rede Mangue Mar Brasil
SEMACE	Superintendência Estadual do Meio Ambiente
SMS	Secretaria Municipal de Saúde
SSNC	Swedish Society for Nature Conservation
TEEB	The Economics of Ecosystems and Biodiversity
UAB	Universitat Autònoma de Barcelona
UECE	Universidade Estadual do Ceará
UFC	Universiade Federal do Ceará
UNEP	United Nations Environment Programme

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Prólogo

> *"Yo escribo para quienes no pueden leerme. Los de abajo, los que esperan desde hace siglos en la cola de la historia, no saben leer o no tienen con qué."*
>
> (Galeano 2000)

Conocer el *lugar* de donde vengo para construir esta tesis, es decir, mi *rincón del mundo* (Bachelard 2003), es importante para que el lector entienda mis motivaciones y mi encuentro con el objeto de investigación. Después de concluir una graduación en Ingeniería de Pesca en 2004, realicé un voluntariado en el Instituto Terramar[1]. Esta oportunidad me acercó a la realidad conflictiva, una realidad que marca la vida de las comunidades tradicionales, donde mujeres y hombres se fortalecen en la lucha diaria por el derecho de existir de forma digna. Estos hombres y mujeres enfrentan las consecuencias socioambientales del modelo de desarrollo dominante, un modelo que destina los daños ambientales a las poblaciones más vulnerables, reflejando la concentración de poder en la apropiación de los recursos.

Más allá de una vivencia, esta experiencia laboral representó una invitación para una renovación como profesional, investigadora y ser humano en movimiento. Fue ése el motivo de mi regreso a la universidad, pero con una nueva dirección académica: salir de la Ingeniera de Pesca, experta en construir fincas camaroneras y servir al capital, para asumir un nuevo *lugar* como investigadora en las Ciencias Ambientales y en el movimiento ambientalista en Brasil y América Latina. A lo largo de los últimos 10 años, estuve involucrada en muchas actividades e investigaciones, principalmente relacionadas al conflicto camaronero. De éstas, me gustaría destacar: la asesoría a las comunidades de

1 El Instituto Terramar es una organización no gubernamental, sin fines de lucro, del campo popular democrático que actúa en la zona costa de Ceará, visando el desarrollo humano con Justicia Ambiental, ciudadanía, participación política, autonomía de los grupos organizados y el fortalecimiento de la identidad cultural de las comunidades tradicional de Ceará.

Cumbe y Curral Velho en las zonas de conflicto durante 4 años; la participación en el *Fórum em Defesa da Zona Costera do Ceará* (FDZCC); la de ejercer la secretaria de la *Rede Mangue Mar Brasil* (RMMB); por último, la participación en el *Grupo de Trabajo sobre Racismo Ambiental* en la *Rede Brasileira de Justiça Ambiental* (RBJA) y miembro del Consejo de la *RedManglar Internacional* (RMI)[2]. En paralelo a estas actividades también estuve dentro de la academia realizando investigaciones sobre el mismo tema, como la realización del máster en Desarrollo en Medio Ambiente en la *Universidade Federal do Ceará* (UFC) en el cual elaboré una tesina sobre los impactos socioambientales de la acuicultura de camarones de modo de vida comunitario (Queiroz 2007), o, junto con el codirector de esta tesis, publicar el libro *La Certificación de la Camaronicultura en Brasil – El manto verde de la destruición*.

Frente a todas estas experiencias (personales y profesionales), vividas a lo largo de estos años, junto a las comunidades costeras, movimientos sociales y organizaciones sociales en defensa de los manglares, nació la motivación para volver una vez más al ámbito académico para desarrollar un proyecto de tesis doctoral sobre el conflicto camaronero en zona costera de Brasil, a partir de nuevas perspectivas teóricas y metodológicas. Para lograrlo, he elegido el *Institut de Ciència i Tecnologia Ambientals (ICTA) (ICTA/UAB)* ya que es un centro de investigación especializado en el ámbito de las Ciencias Ambientales que viene logrando un reconocimiento internacional por la elaboración de investigaciones en el campo transdisciplinar, haciendo critica a la economía convencional y buscando explicitar los conflictos socioambientales considerando los aspectos políticos, ambientales, económicos, sociales y culturales coherentes con las bases teóricas de la Económica Ecológica y Ecología Política. Este proyecto se desarrolló con el apoyo de la *Agencia Española de Cooperación Internacional para el Desarrollo (AECID)*, Programa Ciência Sem Fronteiras (CsF) del Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Becas Bric de mobilidade de

[2] La RedManglar Internacional para la Defensa de los Ecosistemas Marino Costeros y la Vida Comunitaria es una articulación de organizaciones de base comunitaria y local; organizaciones de la sociedad civil organizada, comités comunitarios y grupos de pescadores y campesinos. La RMI está conformada actualmente por la representación de 10 países latinoamericanos (Brasil, Colombia, Cuba, Ecuador, El Salvador, Guatemala, Honduras, México, Perú, Venezuela).

profesores y Fundació Autònoma Solidària, que han dado soporte financiero durante los 4 años de trabajo.

Para lograr alcanzar los objetivos planteados y una mayor eficiencia en la realización de los 3 trabajos de campo en Brasil, hemos creado un convenio de cooperación entre el *Institut de Ciències i Tecnologia Ambientals* (ICTA) de la *Universitat Autònoma de Barcelona* (UAB) y el Laboratório de Cartografia Digital e Climatologia e Recursos Hídricos do Departamento de Geografia da Universidade Federal do Ceará en el que se desarrolla un intercambio de informaciones, cooperación y soporte técnico durante las visitas. Durante el periodo de esta tesis, además contamos con la imprescindible colaboración de 13 estudiantes españoles de la carrera de Ciencias Ambientales que fueron responsables de la recolección de datos, utilizados para elaboración de esta tesis pero también para construcción de sus proyectos de fin de carrera.

Más allá de contribuir con mi formación académica y personal, la construcción de esta tesis representó también la formación académica y personal de jóvenes investigadores que se han dedicado con ahínco a las actividades realizadas en otro país, probando un contexto de vida muy distinto al suyo. Fue ésta la construcción de una experiencia positiva de intercambio de saberes entre universidades en Brasil y España y, principalmente, la producción colectiva de conocimiento que será transformada en una herramienta de lucha para la conservación de los manglares no solo de Brasil pero, sino en un futuro espero que de otras realidades. Con la finalidad última de que esta tesis represente una contribución significativa en la "praxis de la Justicia Ambiental – como lucha de las poblaciones para que sean respetadas y/o reestablecidos su lazo y su integración con el medio ambiente" (Leroy 2010).

Introducción

En los últimos 40 años, la acuicultura industrial de camarones[3] (la camaronicultura) se ha desarrollado como punta de lanza de la llamada "Blue revolution" (Bardach 1997, Naylor et al. 1998, Stonich y Bailey 2000, Costa-Pierce 2002). Es ésta una actividad económica que ha sido promovida por los gobiernos, agencias de desarrollo e Instituciones Financieras Internacionales (IFIs) – como el Banco Mundial y el Fondo Monetario Internacional –, la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO) e industria agroalimentaria como medio para alcanzar un crecimiento económico basado en las exportaciones de grandes volúmenes de alimentos disminuyendo la presión sobre las poblaciones salvajes marinas, aliviando además de este modo la pobreza en los países en desarrollo (EJF 2003, FAO 2008, Rivera-Ferre 2009).

La producción acuícola mundial ha crecido sustancialmente en los últimos diez años alcanzando 66,6 millones de toneladas en 2012 (FAO 2014) en comparación con los algo más de 2,5 millones de toneladas en 1970 (FAO 2010). Los datos revelan que de los años '90 hasta mediados del 2000, la acuicultura de camarones ha crecido de un 3 a un 54% anual. La producción de camarones representa, de hecho, el 73,3% de la producción mundial de crustáceos (FAO 2010). Países como Myanmar han pasado de producir una tonelada al año (1990) a más de 30.000 toneladas al año (2004), mientras que otros como China han pasado de unas 185.000 toneladas a casi un millón en el mismo periodo (Rivera-Ferre 2009).

[3] El término camarón usado a lo largo de esta tesis es el mismo término a menudo usado por otros autores como langostino tropical, scampi, camarón gigante, gambas o camarón tigre. No hace referencia en ningún momento a la "gamba de mar" o camarón silvestre. La industria del camarón, de la que se trata, es aquella que se dedica a la cría y cultivo en cautiverio de este crustáceo, dedicado casi en su totalidad para la exportación a los países del Norte (C-CONDEM 2009, SSNC 2011).

El fuerte apoyo político, económico y la permisividad legislativa, impulsó esta actividad económica que en un breve periodo de tiempo ha tenido un vertiginoso crecimiento. Sin embargo, este crecimiento ha obedecido de forma contraria sus principios iniciales de producir alimento para aliviar la pobreza, ya que, en el momento de mayor crecimiento, el 99% de esta producción realizada en países en vías de desarrollo era exportada a Europa, Japón y EE.UU (Páez-Osuna 2001). Países de Asia, América Latina y África eligieron o se vieron presionados por las instituciones internacionales a promover a través de políticas que tienden a favorecer a las grandes corporaciones y a una lógica emprendedora de expansión agresiva (Bailey 1988, Stonich y Bailey 2000, Hall 2004).

Aun reconociendo sus beneficios económicos, el crecimiento explosivo del cultivo de camarón ha generado crecientes críticas por sus consecuencias, incluida la conversión y la expropiación de tierras húmedas como los manglares, la disminución de la seguridad alimentaria, la marginación de las comunidades costeras y su migración a los centros urbanos. Según las estimaciones más fiables, a partir de este acelerado crecimiento, de 1 a 1.5 millones de hectáreas de áreas costeras fueron convertidas en cultivos de camarones, principalmente en China, Tailandia, India, Indonesia, Filipinas, Malasia, Brasil, Ecuador, México, Honduras, Panamá y Nicaragua (Senarath y Visvanathan 2001). Este desarrollo ha sido acompañado por una huella de explotación secuencial de los recursos naturales (Capitulo I), lo que ha causado la degradación de los ecosistemas costeros, principalmente la del ecosistema manglar. A su vez, esto ha causado la disminución del flujo de los servicios ecosistémicos generados para la humanidad en general y para las comunidades locales en particular (Barbier y Strand 1998, Rönnbäck 1999, Polidoro et al. 2010).

Esta situación se ha traducido en numerosos conflictos en todo el mundo (Primavera 1997, Stonich y Bailey 2000), siendo en algunos casos las poblaciones locales las que han elegido desafiar el desarrollo de la camaronicultura. Muchas comunidades se han organizado para resistir, dando lugar a conflictos socioambientales cada vez más evidentes, apoyados e investigados por organizaciones y movimientos por Justicia Ambiental (Stonich y Vandergeest 2001, EJF 2003, 2004, 2006, Ocampo-Thomason

2006, Greenpeace 2003, C-CONDEM 2009, Martínez-Alier 2009). De acuerdo con Schlosberg (2007), la Justicia Ambiental es el tratamiento justo y la participación significativa de todas las personas, independientemente de su raza, color, origen nacional, cultura, educación o ingreso con respecto al desarrollo y la aplicación de leyes, reglamentos y políticas ambientales.

El manglar es de hecho un ecosistema rico, diverso y complejo formado en la interfaz entre los sistemas terrestres, estuarinos y marinos cercanos a la zona costera de 123 países en las regiones tropicales y subtropicales del planeta (Spalding et al. 2010). Este biotopo alberga varios servicios ecosistémicos que incluyen entre otros la protección contra las inundaciones y ciclones, el control de nutrientes, el procesamiento de la materia orgánica, el control de la sedimentación, una elevada biodiversidad y, sobre todo, el albergar una gran cantidad de especies pesqueras de forma temporal o permanente (Spalding et al. 2010). Este último punto ha sido ampliamente demostrado (Laegdsgaard and Johnson 2001, Nagelkerkelen et al. 2002, Dorensbosch et al. 2004), siendo crucial para entender el valor de la pesca artesanal e industrial que puede tener en sus alrededores el manglar (Aburto-Oropeza et al. 2008).

De hecho se ha calculado que, por lo bajo, el aporte económico de los manglares para el desarrollo económico de las regiones costeras tropicales es de unos US$ 1.6 billones al año en servicios ecosistémicos, estimándose que casi el 80% de las capturas de peces zonas costeras tropicales cercanas al manglar son directa o indirectamente dependientes de su compleja red de lagunas y canales (Costanza et al. 1997, Field 1998, Ellison 2008, Polidoro et al. 2010). Más allá de los servicios ecosistémicos de función ecológica y económica, los manglares son responsables de servicios de tipo cultural generando beneficios intangibles para la humanidad, tanto a nivel local como general.

Se estima actualmente que la superficie mundial de manglares es de unos 150.000 km^2 (Spalding et al. 2010). Cerca de 35.600 kilómetros cuadrados (alrededor de 23% de los manglares y humedales) se perdieron entre 1980 y 2005 debido a las crecientes presiones de los desarrollos urbanos e industriales a lo largo de las zonas costeras, en combinación con el cambio climático y el aumento del nivel del mar (FAO 2007). Estudios

más recientes demuestran que la deforestación de los manglares en el mundo ha crecido a un ritmo de 3-5 veces respecto al origen de su explotación, lo que significa que una cuarta parte de los manglares del planeta se han perdido, produciendo unas pérdidas económicas llegan a $ 42 mil millones al año (contabilizando todos los servicios ecosistémicos que se han podido cuantificar, UNEP 2014).

Los cálculos más conservadores indican una pérdida de un 1% de la superficie de los manglares anual, siendo otros cálculos cercanos incluso al 8%. Se estima que once de las 70 especies de este tipo de arbusto (un 16% del total) están en estado crítico pudiendo desaparecer en menos de una década en especial en zonas de la costa Atlántica y Pacífica del continente americano (Polidoro et al. 2010). Teniendo en cuenta su ritmo acelerado de pérdida, las previsiones de algunos autores auguran una desaparición total si se sigue a este ritmo para dentro de unos 100 años (Alongi 2002, Valiela et al. 2001). El 38% de la pérdida de área bosque de manglar es atribuida a la acuicultura industrial de camarones, estando directamente relacionada con la disminución de los servicios ecosistémicos producidos (Ellison 2008, Polidoro et al. 2010).

A pesar de la existencia de leyes ambientales que protegen los manglares, estas políticas fueron débilmente defendidas a la luz del crecimiento impulsado por las exportaciones y la demanda mundial de camarón. Esta situación condujo la conversión de zonas costeras de uso común en granjas privadas, lo que resulta en la degradación ambiental, impactos generalizados al bienestar y como consecuencia la promoción de diferentes *conflictos sociambientales* (Stonich y Vandergeest 2001, EJF 2003, Gunawardena y Rowan 2005).

La acuicultura industrial ha convertido un gran porcentaje de los territorios costeros de los países tropicales en vías de desarrollo en fincas para cultivo de camarones para exportación. Se configurando como una actividad industrial que causa la reestructuración de la geografía física y humana de amplias áreas junto a cambios institucionales y una desintegración comunal, transformando las relaciones entre espacios locales, nacionales e internacionales (Stonich y Bailey 2000).

Contexto Teórico

Las sociedades humanas, desde tiempos inmemorables, han estado vinculadas con la naturaleza con una dinámica productiva que se estableció en torno a los recursos naturales a partir de la invención de la agricultura y la domesticación de animales hace unos 10 mil años. Las actividades integraban al hombre con la naturaleza en una relación en la que éste, si bien incidía en el proceso productivo y en los ecosistemas, se adaptaba a su entorno respetándose en la mayoría de los casos a la capacidad de producción y reproducción de las plantas, los animales y el medio ambiente (Giarracca y Teubal 2010).

Para Leff (2003), a lo largo de la historia, lo natural era lo que tenía "derecho de ser". En la actualidad, la naturaleza se ha convertido en objeto de dominio de las ciencias y de la producción, al tiempo que fue externalizada del sistema económico. Con ello, la naturaleza ha sido cosificada, es decir, ha perdido su esencia natural, desarraigada de su complejidad ecológica y convertida en materia prima de un proceso económico donde los recursos naturales se han vuelto simples objetos para la explotación del capital. En una era llamada por O´Connor (1993) de economía ecologizada en la que la naturaleza ha dejado de ser parte del proceso de trabajo para ser codificada en términos del capital, transmutándose, generalizando y ampliando los modos de valorización económica de la naturaleza.

A partir de la era Moderna y la Revolución Industrial, y particularmente con la intensificación del capitalismo en el siglo XX, las necesidades de transformación de la naturaleza fueron extendiéndose en términos cuantitativos y geográficos. La carrera por el desarrollo tecnológico y la expansión geográfica en busca de nuevos espacios para la extracción de insumos destinados a la producción de mercancías dada una explosión demográfica y el cambio en la política productiva, hicieron que la explotación de los ecosistemas fuese exponencial y siempre más agrasiva. A su vez, hubo una apertura de ámbitos de inversión más rentables y la ampliación de mercados donde colocar los productos excedentes (Galafassi y Composto 2013).

En la actualidad, el desarrollo del capitalismo a escala internacional (entendido por algunos autores como un proceso de *acumulación por desposesión* contrapuesto a lo que

tradicionalmente constituía el proceso de acumulación expansiva del capital, Giarranca y Teubal 2010, Lobos 2013) es un proceso que Harvey (2003) caracteriza como extremadamente vinculado a la:

> *"Mercantilización y privatización de la tierra; la expulsión forzosa de las poblaciones campesinas; la conversión de diversas formas de derechos de propiedad –común, colectiva, estatal, etc. – en derechos de propiedad exclusivos; la supresión del derecho a los bienes comunes; la transformación de la fuerza de trabajo en mercancías y la supresión de formas de producción y consumo alternativos; los procesos coloniales, neocoloniales e imperiales de apropiación de activos, incluyendo los recursos naturales (…)."*

En este marco, los territorios de América Latina liberados para el capital – es decir, cercados para usufructo privado – constituyen un proceso privilegiado de obtención de materias primas baratas, que convierte la naturaleza en un mero recurso para ser explotado al servicio de la acumulación de dicho capital (Gudynas 2009, Galafassi 2012). Tomando en consideración a la mundialización como proceso de cambio en los patrones de acumulación a nivel gobal, Giarraca y Teubal (2010) ponen de relieve que la característica distintiva de la actualidad capitalista es la sumisión de nuevas espacialidades y temporalidades a la lógica del capital. En el caso sudamericano contemporáneo eso ha venido implicando la primacía de la acumulación por desposesión como forma de aprehensión de nuevos territorios y recursos a la lógica del capital.

Se ha de aclarar que ambos procesos se encuentran inmersos en una lógica impuesta en América latina: el neoliberalismo, a partir del cual "los bienes públicos en poder del Estado fueron lanzados al mercado para que el capital sobreacumulado pudiera invertir, reformar y especular con ellos" (Harvey 2003). Es así que, gracias a la liberalización y privatización de los bienes públicos, se ha entrado en un nuevo período de cercamiento de los bienes comunales a favor del capital privado o de acumulación *por desposesión* (Harvey 2003, Calafassi y Composto 2013).

De este modo, en el nuevo milenio, América Latina se encuentra sumergida bajo un nuevo ciclo de extracción y producción industrial instaurado a partir de la apertura y puesta en disponibilidad de los territorios y recursos naturales como objeto de la

reapropiación y reasignación general de flujos y procesos productivos del capital (Aráoz 2013).

Esto se expresa sobre todo por aumentos en las extracciones de minerales, hidrocarburos y diferentes cultivos intensivos. Lo que Gudynas (2013, 2014) define como un caso particular de extracción de recursos naturales, caracterizado por extraerlos en grandes volúmenes o bajo procedimientos de alta intensidad, está orientado sobre todo a la exportación de materias primas o con un tipo de procesamiento mínimo (también identificados como *commodities*). Bajo el extractivismo, persiste la fragmentación territorial en áreas desterritorializadas, generándose un entramado de enclaves y conexiones a los mercados globales, que agravan las tensiones territoriales. Los cambios territoriales generados, aunque pueden ser localizados, son profundos, ya que modifican la configuración del espacio, los actores que lo construyen y sus formas de relación con el entorno (Bebbington y Hinojosa Valencia 2007).

Esto ha generado una situación en la economía mundial que ha forjado una (re)configuración en la división internacional del trabajo y el riesgo, donde los países ricos en recursos naturales, como Brasil y toda América Latina, refuerzan su posición en el comercio internacional como proveedores de *commodities* (Pereira 2010).

Las cadenas productivas tales como la agroindustria son responsables de mantener un superávit comercial y, al mismo tiempo, de generar una socialización de impactos que afectan a los ecosistemas, las formas de economía y sociedad tradicionales, la calidad de vida y la salud en los territorios involucrados en los procesos productivos (Henriques & Porto 2013). Lo que provoca grandes efectos de desestabilización de las actividades en las tierras tradicionalmente ocupadas generando distintos tipos de disputas, resistencias y conflictos frente, dejando de ser casos excepcionales y aislados (Acselrad 2009, Aráoz 2013, Gudynas 2014).

Dicho de otra forma, el desarrollo de dichas actividades inviabiliza la posibilidad de que otras actividades se mantengan. En estos casos, espacios productivos privatizados transmiten los efectos nocivos, las externalidades de sus prácticas para el medio ambiente común (Acselrad 2004, 2009). Esto significa que detrás de cada tonelada de

soja, hierro, acero, aluminio o camarón exportados hay un rastro de transformación en términos de ecosistemas y las poblaciones afectadas, incluidas las personas que viven en los bosques de frontera agrícola y rural y la exploración de minerales, que muchas veces ni siquiera se cuantifican.

Para Acselrad et al. (2009), la apropiación de aéreas tradicionalmente ocupadas por comunidades ("formas de apropiación no-capitalista de la naturaleza") por grandes corporaciones empresariales, representa una aproximación que genera procesos de continua destrucción de la naturaleza. Este tipo de procesos, a veces muy agresivos, inviabilizan los modos vida comunitarios basados en un tipo de aproximación más en harmonía con la naturaleza. De este modo, la expansión de la producción de *commodities* choca con la territorialidad de grupos que tienen en la base de los recursos su elemento fundamental para el mantenimiento y sostenibilidad del ámbito sociocultural. En varios de estos casos, sea por la acción del Estado o por las consecuencias de las actividades económicas direccionadas a la acumulación de capital, la sostenibilidad de las prácticas de reproducción material y simbólica de las diferentes poblaciones se ven amenazadas (Zhouri y Klemens 2010).

El avance de la explotación minera, petrolera o los monocultivos para exportación desencadenan profundos impactos territoriales (Henriques y Porto 2012). La intensificación del desarrollo de estas actividades genera enclaves productivos que están conectados por corredores de transporte o de energía con otras zonas del país y orientados hacia la exportación. En este contexto, los gobiernos asignan bloques de exploración y explotación que ignoran la distribución y modo de gestión de los territorios tal y como estaba planteada antes de la introducción de este nuevo sistema económico, reconocidos por pueblos indígenas o comunidades tradicionales (Gudynas 2009). Es lo que Leff (2006) caracteriza como tiempos diferenciados en los territorios, donde la población reclama y busca reconstruir sus modos y medios de vida. En ese territorio, la población configura sus identidades a partir de sus formas culturales de valoración de los recursos ambientales y la creación de nuevas estrategias de reapropiación de la naturaleza. Hay distintos escenarios de respuesta, pero en ellos las poblaciones locales se

ven obligadas a trasladarse a las zonas urbanas en busca de alternativas económicas para subsistir.

Frente al proceso de cambio de una economía basada en la explotación local y artesanal del territorio respecto a la industrial dictada por los movimientos de las grandes empresas, la privatización de los manglares de uso comunal para la construcción de los estanques de camarón se configura como otro proceso más de "acumulación por desposesión" (Veuthey y Gerber 2012, Latorre 2014). Así, las grandes áreas de tierras costeras y extensiones de mar abierto, bajo el control jurídico del Estado y/o sobre los cuales las comunidades locales poseían derechos consuetudinarios de acceso, son entregadas a los intereses industriales de los camaroneros o de la captura del pescado. Por lo tanto, el desarrollo de camaronicultura es fruto del moderno movimiento de cercamiento (enclosures) caracterizado por la expulsión de las tierras costeras y del mar de las personas que tradicionalmente conseguían sustento por medio de estos recursos naturales (Kurien 1992, Martínez-Alier 2007, 2009, Beitl 2012).

Esta situación se ha traducido en numerosos conflictos en todo el mundo (Primavera 1997, Stonich y Bailey 2000, C-CONDEM 2009, EJF 2003), donde poblaciones locales han elegido desafiar los procesos de acumulación por desposesión y se organizan para resistir, dando lugar a conflictos socioambientales cada vez más apoyadas por organizaciones y movimientos de Justicia Ambiental (EJF 2003, 2004, 2006, Ocampo-Thomason 2006, Martínez-Alier 2009, Greenpeace 2003, Latorre 2014).

Martínez-Alier (2007) también define este conflicto socioambiental como un ejemplo de conflicto ecológico-distributivo, que en la visión crítica defendida por la Ecología Política y los movimientos por justicia ambiental indican que la explotación de los recursos naturales y los conflictos socioambientales se distribuyen de forma desigual entre países, territorios y poblaciones. La distribución ecológica designa "las asimetrías o desigualdades sociales, espaciales, temporales en el uso que hacen los humanos de los recursos y servicios ecosistémicos, comercializados o no, es decir, la disminución de los recursos naturales (incluyendo la pérdida de biodiversidad) y las cargas de la contaminación" (Martínez-Alier 1997).

De acuerdo con Martínez-Alier (2009), diversos valores e intereses entran en el juego del conflicto entre la conservación del manglar y la producción del camarón. El conflicto entre camaroneros y el manglar, considerando las diferencias culturales, presenta una fisionomía distinta en diversas partes del mundo. Con todo, tiene raíces estructurales comunes. Tratándose de un conflicto de distribución ecológica, o sea un conflicto sobre derechos o títulos ambientales, ha de relacionarse con las pérdidas del acceso a los recursos y servicios ecosistémicos, vinculados con la carga de contaminación y la socialización de los peligros ambientales.

Durante las últimas décadas, un caso particular de este conflicto se ha desarrollado en zona costera de Brasil, donde gran porcentaje de los bosques de manglares de los humedales costeros brasileños, se han despejado para el desarrollo de la acuicultura del camarón (EMBRAPA 2004, IBAMA 2005, Meireles et al. 2007, Meireles & Queiroz 2010, Queiroz et al. 2013).

Esta problemática ha sido elegida como propósito de muchas investigaciones, siendo este tema caracterizado a partir de varios enfoques. Veuthey y Gerber (2012) se han dedicado a explicar cómo evoluciona los estudios sobre el conflicto camaronero identificando las dimensiones que carecen de informaciones para su análisis complejo. Partiendo de la Economía Ambiental, el desarrollo acuícola fue analizado por el valor de los servicios ecosistémicos de los manglares perdidos, por medio de análisis coste-beneficio que buscaban evaluar el valor por hectárea de mangue en términos de servicios ecosistémicos prestados (Primavera 1997, Rönnbäck 1999, Barbier y Sathirathai 2004). Otros estudios han sugerido métodos multi-critério como alternativa para análisis de este conflicto (Gilbert y Janssen 1998, Nickerson 1999). En la década de 1990, se establece una literatura más política orientada a la ecología que ha estudiado las desigualdades en los beneficios de la cría de camarones, así como el acceso político a los manglares (Wester y Lee 1992, Dewalt et al. 1996, Naylor et al. 1998, Flaherty et al. 1999, Huitric et al. 2002, Lopes 2008).

Pero de forma efectiva, pocos son las investigaciones académicas que siguen las reflexiones elaboradas por Stonich y Bailey (2000) y Rivera-Ferre (2009) que revelan lo

que hay por detrás del desarrollo acuícola y explican cómo la política de acuicultura se ha constituido, ha sido promovida y sus conexiones locales, nacionales e internacionales. Tampoco se ha seguido el hilo conector de estudios como los de Cruz-Torres (2000) y Martínez-Alier (2007, 2009), que ubican los sujetos sociales involucrados en el conflicto camaronero en el centro de la elaboración del conocimiento (Veuthey y Gerber 2012). Otras fuentes de informaciones surgen de los movimientos por justicia ambiental de varias partes de mundo como Honduras, Brasil, Ecuador, Filipinas, India y otros países (ICSF 1995, 2000, EJF 2003, 2004, 2006, Greenpeace 2003, ICSF 2008, C-CONDEM, 2009, SSNC 2011, Montserrat 2011a, Montserrat 2011b). Aun siendo estudios relevantes, el tema sigue mereciendo atención científica por su complejidad. Entendiendo que un sistema es complejo cuando los aspectos relevantes de un problema particular, no puede ser capturado cuando se utiliza una única perspectiva de análisis (O'Connor et al. 1996, Funtowicz et al. 1999).

Frente a estas carencias, existe una demanda urgente de realización de investigaciones con enfoques menos reduccionistas que vinculan y que entienden los conflictos a diferentes niveles y dimensiones de análisis. Para Martínez-Alier (2009) y Robbins (2012), la amplia gama de postulados teóricos y metodológicos que enmarca la Ecología Política que se ha consolidado una herramienta teórica y analítica que busca una mejor comprensión de los problemas dicotómicos entre sociedad y ambiente. Se ha presentado como un enfoque interdisciplinario estratégico para analizar los conflictos socioambientales pues permite develar la producción de escenarios en los que los procesos crecientes de vulnerabilidad de los territorios y las comunidades locales (Henriques y Porto 2013).

Objetivo general

Esta tesis pretende arrojar luz y analizar la degradación ambiental y el conflicto socioambiental causado por la acuicultura industrial de camarones en Brasil desde la perspectiva de la Ecología Política. Se busca vincular diferentes niveles - local, nacional y mundial - en distintas dimensiones claves para su comprensión: político-ambiental, social y económica.

Objetivos específicos y estructura de la tesis

Las tres dimensiones de análisis (político-ambiental, social y económica) con sus obejtivos específicos conforman los tres capítulos (artículos) que estructuran esta tesis.

Dimensión político-ambiental (Capítulo I)

En la literatura producida sobre la camaronicultura, hay muchas investigaciones concretas sobre los impactos ambientales negativos de la implantación de las fincas para producción de los camarones como mecanismo de desarrollo (Rivera-Ferre 2009). Por ejemplo, los estudios realizados en los países donde esta actividad se ha desarrollado [Tailandia (Huitric et al. 2002, Braaten y Flaherty 2001), Bangladesh (Deb 1998); Indonésia (Rönnbäck 2003), Índia (Bhatta y Bhat 1998), Sri-Lanka (Senarath y Visvanathan 2001); Honduras (Dewalt et al. 1996), México (Páez-Ozuma et al. 1998, Alonso-Pérez et al. 2003, Paez-Osuna et al. 2003)] tienen una extensa literatura respecto a este tipo de conflictos. Sin embargo, aún existen pocos estudios sobre los graves impactos sociales y cómo se desarrollan los crecientes conflictos socioambientales que a menudo se generan entre las comunidades y la actividad acuícola (Montserrat 2011b). En Brasil, aunque existan muchas investigaciones sobre la degradación ambiental causada por el camaroneo, identificamos la carencia de herramientas para analizar la evolución de la degradación de los manglares a lo largo del tiempo, vinculando los niveles de degradación ambiental al contexto político y económica en el cuál esta inserido el país para la construcción de análisis más profundas y complejas sobre este conflicto. Frente a esta demanda, el presente capítulo busca contestar las siguientes preguntas de investigación:

- ¿Cómo el camaroneo ha sido promovido en Brasil y como se ha inserido en el mercado y en la lógica de la economía acuícola mundial?
- ¿Qué tipo de degradación ambiental es causada por la camaronicultura y cómo ha evolucionado a lo largo de la historia en Brasil?

El objetivo es entender la dimensión político-ambiental (Capitulo 2) y analizar el proceso de inserción de Brasil en el mercado y en la lógica de la economía acuícola

mundial que se encuentra detrás de un contexto de degradación ambiental y conflicto reproductor de *injusticias ambientales*. Para alcanzar este objetivo se ha construido: 1. El contexto político y económico del desarrollo nacional del camaroneo en Brasil, por medio de una revisión bibliográfica del desarrollo acuícola en Brasil teniendo como base la literatura científica sobre el tema, los documentos oficiales del estado, informes técnicos producidos por las organizaciones del movimiento por Justicia Ambiental y grupos de estudios de las universidades en Brasil que denuncian el carácter socialmente desigual de las condiciones de acceso a la protección ambiental, a nivel local, nacional y global, y 2. Un diagnóstico de los impactos socioambientales de la camaronicultura presentando los aspectos relacionados con la producción de la actividad en Brasil, construido por medio de un estudio de la evolución espaciotemporal del manglar a partir de las imágenes satelitales del río Jaguaribe (Ceará, Brasil), una de las regiones más afectadas por el camaroneo en Brasil.

Dimensión social (Capítulo II)

La dimensión social de esta tesis (Capitulo III) fue construida partiendo del concepto de que las comunidades costeras de pescadores desarrollan actividades artesanales en estrecha relación con el medio natural. Son "*culturas nativas que* han acumulado una enorme base de conocimientos relacionados con las características y procesos naturales de sus tierras a través de la experiencia directa" (Gregory Cajete 1999, Antone 2013).

Estos pueblos desarrollan distintos usos y actividades en los ecosistemas y se benefician de sus servicios, como en el caso de los manglares, por la pesca y recolecta de mariscos tal y como describe Farley et al. (2010) o Aburto-Oropeza et al. (2008). Las personas se identifican, valoran y perciben de distintas formas los servicios ecosistémicos generados por los manglares, un valor que, a largo plazo, ha demostrado ser más valioso que una explotación que puede durar a lo sumo unos 10-15 años como es la del camaroneo intensivo (Mumby et al. 2004, Aburto-Oropeza et al. 2008). Sin embargo, estos usos y valores (simbólicos y materiales) y la propia vinculación que estos pueblos establecen con los manglares son poco visibles y a veces por completo ignorados en la literatura científica y en el proceso de toma de decisiones para gestión de los

ecosistemas manglares que a lo largo de los últimos años ha sido transformado en fincas para producción de camarones.

En este sentido el objetivo que se plantea en este capítulo es demostrar el vínculo (material y simbólico) entre los servicios prestados por el ecosistemas de manglar y el bienestar de las comunidades pesqueras artesanales, a partir de una metodología que se basa en una profunda revisión de la literatura e investigación de campo en la comunidad de Cumbe (Aracati, Ceará, Brasil), combinando varias técnicas para la recolección de información, incluyendo la observación participante, *free listings*, grupos focales y encuestas de valoración para contestar las siguientes preguntas de investigación:

- ¿Cómo identifican, caracterizan y valoran las comunidades tradicionales los servicios ecosistémicos generados por los manglares?
- ¿Cómo están vinculados y se incorporan estos servicios en el modo de vida comunitario?
- ¿Por qué deben ser considerados el punto de vista autóctono en los procesos de toma de decisiones?

Dimensión económica (Capítulo III)

La lógica de la exportación agroindustrial como es el caso de la acuicultura industrial se inspira en el rendimiento cuantitativo y cualitativo del cultivo, con el objetivo de la productividad, la competitividad y la rentabilidad en la lógica del mercado mundial. Sus significados están asociados a criterios como la eficiencia, la regularidad, velocidad, precisión, control y previsión del producto. La lógica relacionada con las actividades tradicionales está inspirada en todo lo que crea y sostiene el modo de vida de los grupos sociales con el fin de alcanzar la soberanía alimentaria y la calidad de vida, lo que implica el cuidado de la conservación de la biodiversidad de los ecosistemas de los que dependen. Sus significados están relacionados con criterios tales como la sostenibilidad – el cuidado en mantener las condiciones, relaciones y significados que generan, sostienen y dan sentido a las formas de vida en el territorio. La economía local de las comunidades tradicionales obedece a otra lógica pero igualmente es una economía que tiene una gran importancia en el seno de la sociedad capitalista en que se desarrolla y la relación de sus

practicantes en el manglar sirve para proteger este ecosistema, ya que las comunidades tradicionales son consideradas como importantes agentes para la protección de las áreas naturales (Rönnbäck et al. 2007).

Cuando se hace una comparación y análisis más profundo de estas dos economías se puede identificar que ellas obedecen a dos lógicas distintas. El gran problema no es sólo el hecho de que el modo de producción capitalista está degradando el modo de vida de las comunidades tradicionales y haciendo desaparecer sus actividades económicas existentes desde hace siglos, sino también que la economía tradicional está gravemente infravalorada e invisibilizada. Los que apoyan a la acuicultura abogan por el rápido y lucrativo potencial económico, lo que ha llevado a relegar la economía tradicional a un segundo y tercer plano frente a un teórico progreso dado por la explotación intensiva del camaroneo (Diele et al. 2005, Aburto-Oropeza et al. 2008, Walters et al. 2008). Hay por tanto una priorización del camaroneo y una desvalorización de la pesca artesanal. Esto pasa por varios motivos, principalmente por el hecho de que las ganancias generadas por la extracción artesanal son por lo general invisibles a los ojos del Estado, no son contabilizadas a nivel institucional, lo que impide una justa comparación entre el modelo económico tradicional e industrial. Las comunidades tradicionales carecen de datos sobre sus actividades económicas, ya que en su modo de vida, está pautando en la cultura oral y los registros escritos son muchas veces olvidados. Frente a esta realidad, las principales preguntas que se plantean son:

- ¿Cuáles son los beneficios económicos producidos por la pesca artesanal desarrollada en los manglares en términos comparables con la industria camaronera?
- ¿Cuál es la contribución a nivel de comunidad de este tipo de actividad artesanal y cómo se relaciona con el bienestar de los pueblos que dependen del manglar?
- ¿Cuáles son las diferencias de este tipo de actividad frente a una explotación intensiva que degrada el ecosistema hasta hacerla incompatible con cualquier otra fuente de ingreso económico?

Para contestar nuestras preguntas de investigación se hizo un seguimiento económico de la pesca artesanal para obtener una aproximación de la ganancia monetaria proveniente de diferentes tipos de pesca artesanal, contrastándola con la camaronicultura industrial, a partir de dos trabajos de campo realizados en las comunidades de Cumbe y Curra Velho, Ceará, Brasil. Las informaciones fueron obtenidas por medio de revisión de literatura preliminar y algunas técnicas de recolecta de datos como: tablas de seguimiento, zonificación, entrevistas y cuestionarios realizados con los pescadores y pescadores de las dos comunidades estudiadas.

La Figura 1 representa un esquema resumen para mejor comprender como se ha estructurado esta tesis.

ESTRUCTURA DE LA TESIS: ANALISIS MULTIDIMENSIONAL DEL CONFLICTO CAMARONERO EN BRASIL			
INTRODUCCION Contexto Teórico Objetivos Estructura de la Tesis			
DIMENSIONES	Politico-Amiental	Social	Económica
ESTRUCTURA	CAPITULO I (Artículo 1)	CAPITULO II (Artículo 2)	CAPITULO III (Artículo 3)
AREAS DE ESTUDIO	Cuenca del Rio Jaguaribe, Ceará	Cumbe, Aracati	Cumbe, Aracati
FUENTES DE INFOMACIONES	Documentos oficiales del Estado	Trabajo de campo 2012 (Cumbe) 2013 (Curral Velho)	Trabajo de campo 2011
METODOLOGIA	Revisión de literatura	Revisión de literatura Observación participante Free listings Grupos focales Encuestas de valoración	Revisión de literatura Tablas de seguimiento Zonificación Entrevistas Cuestionarios
Conclusiones y reflexiones finales			

Figura 1. Estructura de la tesis.

Punto de partida: contexto local

En primer lugar, este análisis multidimensional pretende evidenciar que la dimensión político-ambiental del conflicto camaronero no puede ser evaluada de modo separado de la dimensión social y económica. Se demuestra también su efectividad, en la medida en que se considera no solamente la participación, sino que también incorpora de forma integral la perspectiva de los grupos sociales potencialmente afectados. Esto nos permitió elaborar reflexiones sobre el conflicto camaroneo en Brasil a partir de una perspectiva raramente considerada: la perspectiva multidimensional y de los grupos sociales afectados, en este caso las comunidades tradicionales de pescadores.

Este análisis multidimensional tiene como punto de partida tres trabajos de campo realizados en las comunidades tradicionales de Cumbe y Curral Velho, zona costera de Ceará, Brasil, en el estado de Ceará, Brasil (Figura 2), debido su relación con el camaroneo durante los últimos veinte años. A partir de una combinación de metodologías sociales, estos trabajos de campo fueron realizados ubicando las dos comunidades en el centro de la elaboración del conocimiento y con la colaboración de diez estudiantes de la carrera de Ciencias Ambientales y que hacían parte del *Grupo de Estudios sobre la zona costera de Brasil (GEC Brasil)* del *Institut de Ciència i Tecnologia Ambitentals (ICTA/UAB)*. A partir de los resultados obtenidos en los tres trabajados de campo se ha producido esta tesis y seis trabajos de fin de carrera Betorz et al. (2012), Carol et al. (2012), Burriel (2012), Dominguez et al. (2014), Briansò et al. (2014) y Serra-Pompei et al. (2014).

Figura 2. Localización del área de estudio en las comunidades de Cumbe y Curral Velho, Ceará, Brasil.

Las comunidades de Cumbe y Curral Velho están ubicadas en dos zonas donde se ha demostrado una profunda transformación de los manglares en las últimas décadas causada por el desarrollo de la acuicultura industrial de camarones (EMBRAPA 2004, IBAMA 2005, Queiroz 2007, Meireles et al. 2007, Queiroz et al. 2013). Estas comunidades de pescadores y pescadoras, igual que otras comunidades tradicionales que forman parte de la zona costera de Brasil, se han visto inmersas en grandes procesos de transformación de su territorio debido la degradación ambiental y los conflictos socioambientales generados a partir de la llegada de nuevas actividades industriales, especialmente la llegada de la camaronicultura.

La comunidad de Cumbe está ubicada en la planicie fluvio-marina del río Jaguaribe, municipio de Aracati en el estado de Ceará, Brasil. Cumbe está ubicada a la derecha de la desembocadura de la cuenca del Río Jaguaribe se sitúa en la *Área de Preservação Ambiental (APA)* de Canoa Quebrada, región de Aracati. El Jaguaribe es el mayor río del estado con un área de 72.645 km², ocupando el 50% del territorio de Ceará. Debido a situación geográfica, la comunidad de Cumbe está más alejada del mar y por lo tanto mantiene una relación más estrecha con el manglar y con el estuario, caracterizándose como una comunidad agricultores, artesanos pero las actividades principales son la pesca de peces en las gamboas, recolecta de mariscos y recolecta de cangrejos (Queiroz 2007). El total de la población de la comunidad de Cumbe es de 621 habitantes distribuidas en 155 familias y corresponde al 0,9% de la población de Aracati, que es de 69.159 habitantes (SMS 2012).

Los primeros cultivos acuícolas en Cumbe fueron desarrollados por algunos moradores locales en el ano de 1985. Pero solamente en 1998, la *Associação de Desenvolvimento do Cumbe (ADC)*, logró el apoyo de otros habitantes de la comunidad con la justificación del discurso de "generación de empleo y renta", financiación del *Banco do Nordeste (BNB)* e incorporación en el sistema integrado de la región ofrecido por el grupo COMPESCAL.

El grupo COMPESCAL (Comercio de Pescado Aracatiense Ltda) es un gran conglomerado de empresas que, además de trabajar con la producción, comercialización y procesamiento de camarones, actúa también en distintas áreas: sector de distribución de bebidas, gas, transporte y representación de cargas, serrería y muebles, construcción civil, ventas de automóviles y de piezas de automóviles, entretenimiento, agropecuaria, energía alternativa y comunicación (con dos emisoras de radio). Genera aproximadamente 2.000 empleos directos. En 2001 el grupo alcanzó altos niveles de producción porque convencían pequeños acuicultores a participar de los sistemas integrados de producción de camarón, donde el grupo abastecía de insumos — larvas, insumos básicos, piensos, fertilizantes, calcáreo, equipos y asistencia técnica — y los pequeños productores se quedaba solamente con los costos iniciales para la construcción de las piscinas, con su manutención y con el compromiso de vender toda su producción a

COMPESCAL por un valor "especificado" por el propio grupo. En seguida la producción fue destinada a la exportación. De esta forma el negocio del camarón en el área baja de la cuenca del rio Jaguaribe alcanzó una producción de ocho toneladas por hectárea/año, el doble de la media brasileña y un record absoluto a nivel mundial (Araújo 2006).

Con el apoyo de parte considerable de la población de Cumbe, la financiación pública y la participación en este sistema integrado de producción, la camaronicultura en Cumbe ganó fuerzas pasando a ocupar rápidamente parte significativa del territorio como resultado de un procesodel sistema de producción, causando profundos impactos: transformación del paisaje, ocupación del suelo, deforestación de manglar, desagüe de efluentes sin tratamiento, bloqueo del acceso a las zonas de pesca por desvío de las rutas habituales. Estos impactos amenazaban las fuentes de supervivencia y sometieron a la comunidad a un contexto de profunda degradación ambiental e impactos sociales que amenazaron y alteraron significativamente la dinámica de vida de la población local (Meireles & Tupimanbá 2005, Meireles et al. 2007, Queiroz 2007, Texeira 2008, Meireles & Queiroz 2010, Carol et al. 2012, Burriel 2012).

En la otra punta de la zona costera de Ceará está ubicada la comunidad de Curral Velho, en la planicie litoranea del municipio de Acaraú en el estado de Ceará, Brasil. La comunidad está delimitada por el océano atlántico en el norte en la Playa de Arpoeiras y los municipios de Acaraú y Itarema, al Oeste y al Este respectivamente. Curral Velho es una comunidad que se divide en 03 zonas distintas: Curral Velho de Cima, Curral Velho de Baixo y Curral Velho Honórios. Por su situación geográfica, Curral Velho se caracteriza por ser una comunidad conocida por pescadores del manglar, pescadores del mar, agricultores y artesanos. El total de la población de Curral Velho es de 2.663 habitantes que pertenecen a 707 familias y corresponde al 4,6% de la población de Acaraú, que es de 57.551 habitantes (SMS 2013). Tradicionalmente las familias de la comunidad viven de la agricultura, artesanías, pero principalmente de la pesca de peces en la plataforma continental y/o en las gamboas y recolecta de mariscos, caracterizando una relación íntima con el ecosistema de manglar.

En Curral Velho, la camaronicultura llegó a finales de los años 90, desarrollada de forma diferente en las 3 zonas de la comunidad: Curral Velho de Cima (localizada próxima al centro urbano del municIpio), Curral Velho de Baixo (es la parte de la comunidad ubicada en la zona donde las fincas camaroneras se han instalado, cerca de las residencias) y Curral Velho Honórios (es la parte de la comunidad que ha logrado frenar la entrada de las camaronicultura).

A lo largo de los años, algunos estudios (Meireles & Silva 2003, IBAMA 2005, Meireles et al. 2007, FDZCC 2009, Joca Martins 2014,) revelaron los impactos de la camaronicultura a partir de las denuncias de los pescadores de Curral Velho que describen que muchos caminos tradicionales a las zonas de pesca ya no podían ser utilizados, ya que, con la instalación de las granjas camaroneras, una parte considerable de zona de manglares fue cercada. Durante todas las horas del día, habían guardias armados lo que llevó a unos cambios en la dinámica de la comunidad. Los pescadores comenzaron a caminar en grupos, utilizando otros caminos para acceder las zonas de pesca y también evitaban pescar por la noche (Dominguez et al. 2014).

Las familias también se quejaron de que las otras actividades tradicionales que se desarrollaban en la comunidad fueron amenazadas. Para la implantación de las fincas, fueron deforestados bosques de palma de *carnauba,* reduciéndolos a materia prima para fabricación de las artesanías. La agricultura familiar, a su vez, también se ha visto afectada con la salinización de las fuentes de agua subterráneas (estanques y pozos artesianos). La pesca y el marisqueo han sufrido y sufren una disminución de la cantidad de pescado y la contaminación de los manglares, debido a la liberación de los efluentes provenientes de las fincas después de los ciclos de producción del camarón, ha afectado de forma clara la productividad de la zona (Meireles & Silva 2003, Meireles et al. 2007, Joca Martins 2014, Dominguez et al. 2014).

Chapter I

- Shrimp aquaculture in the federal state of Ceará, 1970-2012: Trends after mangrove forest privatization in Brazil.

Queiroz, L., Rossi, S., Meireles, A.J.A., Coelho, C. 2013a. Shrimp aquaculture in the state of Ceará, 1970-2012: Trends in mangrove forest privatization in Brazil. Ocean & Coastal Management 73: 54-62 (DOI: 10.1016/j.ocecoaman.2012.11.009).

Queiroz L., Meireles A.JA. and Rossi, S. 2013b. Camaronicultura en Ceará (1970-2012): la trayectoria de privatización de los manglares en Brasil. Fortaleza: Mercator (in press).

Abstract

During the last 40 years, industrial shrimp farming in Brazil has experienced intense development. The first shrimp culture experiments were carried out at the beginning of the 1970s, but due to technical problems and a lack of exact knowledge they were not very successful. At the end of the 1990s, the activity expanded rapidly and shrimp farming became a relevant export industry, due to government assistance, public-bank financing, university technical collaboration and legislative permissiveness. The vertiginous growth of the industry has been accompanied by a profound transformation of natural resources, causing the degradation of the mangrove ecosystem. The objective of this study is to conduct an integral and in-depth analysis of the evolution of the industrial shrimp farming in Brazil, based on a review of the national political and economic context of the aquaculture activity, and also an evaluation of the environmental impacts of shrimp farming in the watershed of the Jaguaribe River, Ceará (NE Brazil). This analysis begins with the initiation of intensive large-scale farming for export, taking into account the synthesis of environmental processes to analyze the socio-environmental impacts. We studied the areas used for the construction of shrimp farms, located in coastal and estuarine systems and with tidal connections, linking the transformation of the system with the, geo-environmental evolution of the impacted zones, mainly the mangrove ecosystem. The final objective of this work is to propose an integral model of management for the appropriate use of mangroves in Brazil and other systems with analogous problems.

Key words: Shrimp Aquaculture, mangrove, ecosystem services, socio-environmental impacts, coastal management.

Introduction

Aquaculture has been promoted to achieve strong economic growth based on food exports and to alleviate poverty in developing countries while decreasing the pressure on wild marine populations (the so-called "blue revolution," (Bardach 1997, Stonich and Bailey 2000, Costa-Pierce 2002). This "blue revolution" (Austin 1993, Naylor et al. 2000) began to develop intensively in tropical zones of Asia, Latin America and, more recently, in Africa. The original "blue revolution", previously practiced in an extensive form in Asia for nearly 4000 years (Arana 1999), has been transformed, with extensive political and economic support, into the more intensive form adopted by the world agro-industrial food systems. Following the same logic as in other animal production systems, aquaculture has been converted into an activity that is highly dependent on the globalised industrial market.

World aquaculture production has grown substantially in the last ten years, reaching 52.5 million tonnes in 2008, compared with the more than 2.5 million tonnes in 1970 (FAO 2010). Production grew from 0.7 kilos/capita/year in 1970 to more than 7.8 kilos/ capita/year in 2008, growing on average 6.6%/year. Shrimp aquaculture is one of the stronger facets of the blue revolution. From the 1990s to the mid-2000s, the shrimp farming industry has grown each year between 3 and 54% relative to the previous year (FAO 2010). Peneids (shrimp and prawns) aquaculture alone has made up 73.3% of world crustacean aquaculture production (FAO 2010). Countries such as Myanmar transformed this industry from one tonne/year (1990) to more than 30,000 tonnes/year (2004), while others such as China have increased their productivity from 185,000 tonnes to almost a million in the same period (Rivera-Ferre 2009). Almost 99% of shrimp production comes from developing countries, but the majority is exported to Europe, Japan and the USA (Páez-Osuna 2001).

According to recent estimates, 1 to 1.5 million hectares of coastal areas have been converted to shrimp farms, mainly in China, Thailand, India, Indonesia, the Philippines, Malaysia, Brazil, Ecuador, Mexico, Honduras, Panama and Nicaragua (Senarath and Visvanathan 2001). Shrimp monoculture has been carried out in these countries without regulations or laws in many cases, and its steep growth in recent years has been accompanied by a heavy ecological footprint on natural resources and landscape, especially on mangrove ecosystems (Páez-Osuna 2001).

The first shrimp cultivation experiments in Brazil were carried out in the early 1970's. It was only towards the end of the 1990's, however, that a rapid expansion of the activity took place and it became a relevant export industry, reaching its highest level of production in 2004 (ABCC 2004). In order to reach this level of development, shrimp aquaculture occupied an area of more than 15,000 ha, in contrast to 4320 ha in 1998, a growth rate higher than 300% (1998-2010) (Figure 3). Even more dramatic was the growth in production, with a rate of 2400% during the same period. Brazil became the largest producer in Latin America and occupied sixth place in global production (ABCC 2004).

In 2004 the *Associação Brasileira de Criadores de Camarão (ABCC)* envisioned continuity in this trend in aquaculture growth, predicting area coverage of 30,000 ha by 2007. However, with the decrease in the value of the dollar and, toward the end of 2003, the spread of the Infectious Myonecrosis Virus (IMNV) the activity stagnated (ABCC 2005). Following successive decreases in shrimp aquaculture production in 2003 and 2004, the shrimp industry began to fall into steep decline. In the federal state of Ceará, the accumulated decrease of exports was 65%. Faced with export difficulties, the sector stated that in 2010 practically all production would be absorbed by the domestic market, and this increase in domestic demand continued during the following years (ABCC 2010). The data from 2010 (Figure 3) was estimated by the ABCC and may be overvalued.

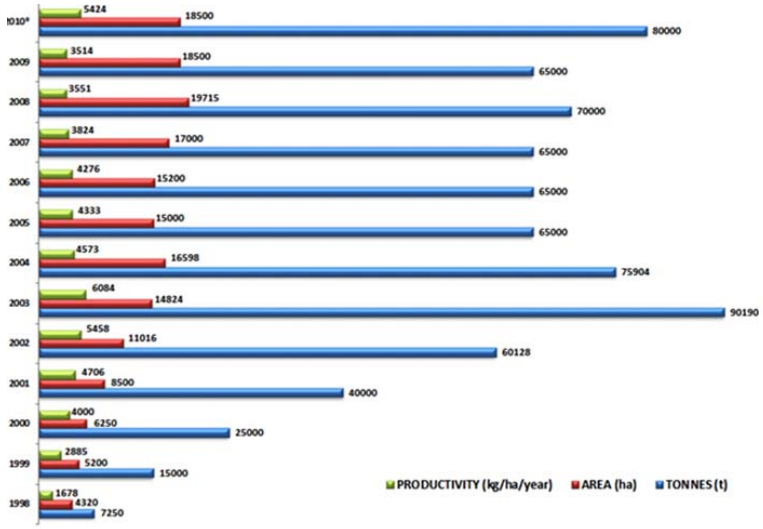

Figure 3. Shrimp production in Brazil 1998-2010 (ABCC 2010).

Behind the numbers and high shrimp-production rates for export, lies a context of conversion of extensive coastal areas (fragile and fundamental environmental systems like wetlands and mangroves), into production zones (shrimp farms), generating social, economic and environmental impacts (Barbier and Strand 1998, Rönnbäck 1999, Polidoro et al. 2010). The extension and magnitude of environmental impacts vary according to the geographic and environmental conditions of each place, but a severe degradation and transformation of habitats has been demonstrated. These habitats have a very important role in the regenerative capacity of natural environments, water consumption, generation and treatment of effluents, and other environmental, social and economic characteristics (Braaten and Flaherty 2001, Huitric et al. 2002, Alonso-Pérez et al. 2003).

Mangroves are a rich, diverse and complex ecosystem formed at the interface between terrestrial, estuarine, and marine systems near the coastal zone of 123 countries in tropical and subtropical regions of the planet (Spalding et al. 2010). This biotope is responsible for many ecosystem services which include, among others, protection against floods and cyclones, control of nutrients, processing of organic material, control of sedimentation, biodiversity environments, and above all, temporary and permanent nursery grounds for a large quantity of fishery species (Spalding et al. 2010). The last point has been widely demonstrated (Laegdsgaard and Johnson 2001, Nagelkerken et al. 2002), being crucial in order to understand the value of the artisanal and industrial fishing that can occur in mangrove areas (Aburto-Oropeza et al. 2008). Adding to these services, its ability to bind large quantities of carbon from the atmosphere in the above ground biomass and sediment is considered to be one of the largest carbon sinks on the planet.

Current estimates of global area covered by mangrove are about 150,000 km2 (Spalding et al. 2010). Around 35,600 km2 (about 23% of mangroves and wetlands) were lost between 1980 and 2005 due to the growing pressure of urban and industrial development along coastal zones, in combination with climate change and sea level rise (FAO 2007). 38% of degraded mangrove areas are attributed to industrial shrimp aquaculture, being directly related to decreases in their ecosystem services (Ellison 2008, Polidoro et al. 2010). Very conservative calculations indicate a 1% loss of mangrove

area/year, while other calculations reach up to 8%. It has been shown that 11 of the 70 mangrove species (16%) are in a critical condition and may disappear in less than a decade, especially in the Atlantic and Pacific coastal zones of the Americas (Polidoro et al. 2010). Taking into account this accelerated rate of loss, the predictions of some authors foresee a disappearance of all mangrove species within 100 years (Valiela et al. 2001, Alongi 2002).

Although research has been carried out on the impact of shrimp farming on mangroves, an easy and manageable tool is required to create a long term series of studies to help quantify the real impact of intensive aquaculture. This is the first work which includes a long term series of shrimp farming development study through satellite data in Ceará, Brazil, from 1970 to 2011. The study area is the watershed of the Jaguaribe River (Figure 4). The watershed area is 72,645 km^2 (occupying 50% of the state area). Its area contains 80 municipalities with one-third of the population of Ceará (IBGE 2010). The economic activities carried out throughout the Jaguaribe watershed range from small family farming, traditional fishing, and garbage dump extraction, to industrial shrimp farming (Souza Filho et al. 2003).

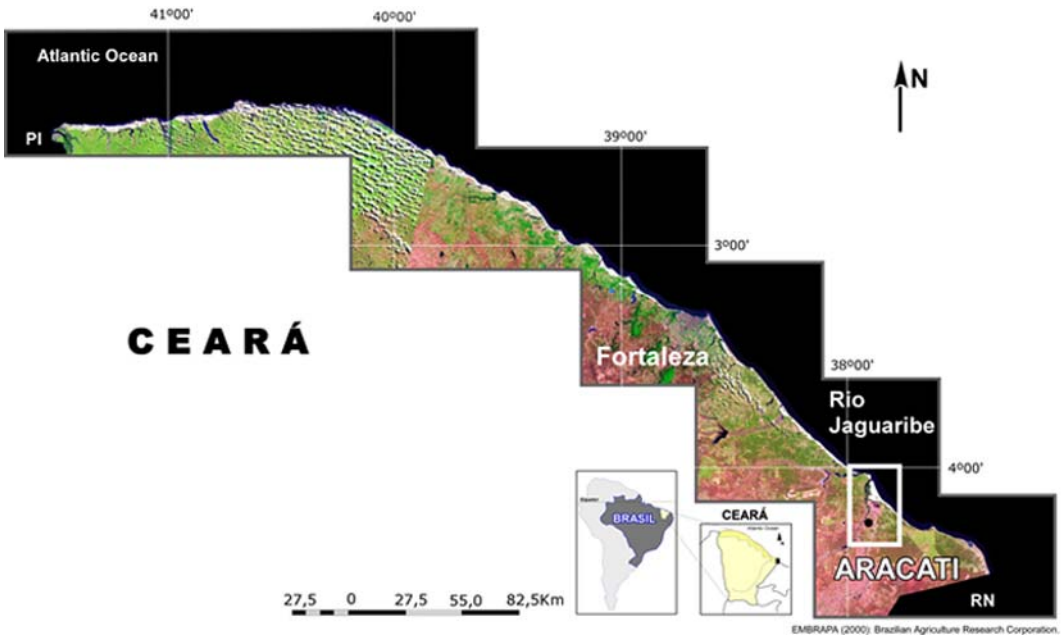

Figure 4. Area of study. Source: www.embrapa.gov.br.

We applied two different approaches: 1. Reconstruction of the national political and economic context of the shrimp monoculture intensification and 2. Characterization of the environmental impacts associated with shrimp farming in mangroves of the Jaguaribe River. In the first part, we show the evolution of production in Brazil mainly beginning in 1997, a historic point in the production of shrimp by means of intensive cultures for large-scale export (EMBRAPA 2004, IBAMA 2005) by means of official documents and statistics. In the second part we consider the importance of salt flats and their relation with other associated coastal ecosystems by means of correlations with transport and deposition of sediments, oscillations of the tides, fresh water inputs (subterranean, fluvial and pluvial) and seasonality (Meireles et al. 2007).

The work is intended to be a clear example to be applied to other similarly affected areas in which the political context may be different but the result (the degradation of mangrove systems for the intensive shrimp aquaculture) is the same.

Methodology

The methodology of the present study is divided in two different parts: 1. An integrated literature/document analysis of the industrial shrimp aquaculture development in Brazil, and 2. A survey of the case study area through the SIG methodology and the implementation of aquaculture and environmental data.

Reconstruction of the political and economic context

The literature/document analysis gathers historical information of the shrimp production from the beginning of intensive crops in 1997 up to 2010. To reach this target we made a literature review with the various sources of information: 1. Government: review of the plans and strategies of the federal and state governments for the development of public policies for aquaculture and studies on the social and environmental impacts caused by environmental agencies (EMBRAPA 2004, IBAMA 2005). 2. Scientific publications on aquaculture development in Brazil and its social and environmental impacts on coastal communities and traditional territories mainly produced by the universities of Ceará: Universidade Federal do Ceará (UFC), *Instituto de Ciências do Mar (Labomar)* and

Universidade Estadual do Ceará (UECE) 3. Business (aquaculture production sector): *Associação Brasileira de Criadores de Camarão (ABCC)/Associação Cearense de Criadores de Camarão (ACCC)*. 4. Community/social movement information: the allegations made by the communities involved in the conflict generated by the shrimp aquaculture expansion.

Survey of the area of shrimp farms in the watershed of the Jaguaribe River, Ceará, Brazil

The spatial-temporal evolution of mangroves was analyzed using satellite images (Landsat TM5, bands 1-7, color 5R, 4G and 3B), with 30 m resolution. Aquaculture activities were detected, and could be easily recognized in the image set, generating the composition of the database for the characterization of environmental impacts.

The field data were used for the elaboration of thematic maps (geologic, geomorphic and plant cover) at the Digital and Climatological Cartography and Hydrologic Resources laboratories of the Department of Geography of the Federal University of Ceará (UFC), Brazil. To compose the models and the synthesis of collected data, diagram blocks were elaborated with mapped themes. Environmental impacts were introduced into these models. In order to quantify the impact analysis, the characterization of the flux of material and energy was elaborated by marking the boundaries of the geo-environmental units in two coastal systems and the characterization of the sediment transport agents. Based on the observed intervention of shrimp ponds in geo-environmental and eco-dynamic processes, planning and management suggestions were developed for this aquaculture activity in the Brazilian coastal zone.

Areas impacted by shrimp farm production were surveyed in the Jaguaribe River estuary. Geo-environmental and eco-dynamic processes were defined in the salt flat sectors and related to the flux of material and energy that make up the structure of the mangrove ecosystem.

Results

Reconstruction of the political and economic context

During the last 42 years, the shrimp farming sector in Brazil has evolved from experimental production on extensive farms of autochthonous species to the creation of an extremely flexible institutional and infrastructural system, designed to promote rapid expansion of aquaculture with maximum profit. During these years, the shrimp farming industry has developed in four stages.

The first stage began in the 1970s in the state of Rio Grande do Norte, when the country carried out the first experimental cultures. Shrimp aquaculture then became a business in the 1980s, using the exotic species Panaeus japonicus. At this time, the sector needed to reach a more economically acceptable production rate and faced the lack of adaptation of P. japonicus to low salinities. The aquaculture farmers changed their plans and started to experiment with native species, such as Panaeus subtilis, Panaeus schmitti, Panaeus brasiliensis y Panaeuspaulensis (BRASIL 2010). Productivity, as well as the profits obtained, continued to be low, which provoked the deactivation and reconversion of the shrimp farms into salt ponds in several regions of NE Brazil because of the difficulty of managing production systems.

The second stage of shrimp farming development in Brazil began when a technological package (optimum aquaculture conditions, life cycles, study of potential diseases, genetic variability, etc.), focused on fostering the industry was introduced. From around 1997-2003, the country had the ideal conditions to obtain accelerated aquaculture growth. In the following years, the mastering of the reproductive cycle and post-larva production technology resulted in self-sufficiency and regularization of the supply, consolidating the technology in the farms. The country no longer had to depend on the importation of post-larvae, which had been vectors of disease and fraught with irregular supply, resulting in negative performance outcomes (Rocha 2011).

The NE of Brazil possesses scientific development as well as ideal edaphoclimatic conditions, both in terms of topographical, hydrological characteristics, for shrimp

farming. The university technical collaboration: ideal conditions with extensive areas of estuary, good quality of coastal waters, tropical climate, government assistance, public-bank financing and legislative permissiveness enabled the shrimp farming to grow during this period, introducing the Pacific shrimp in Brazil on a large scale.

In order to reach a high level of biomass growth, shrimp farms bought extensive lands in the Brazilian coastal zone: from 3500 ha of farms installed in 1997 to more than 15,000 ha in 2004, representing an increase of more than 300% (ABCC 2005). Even more significant was the rise in production, which in 2003 reached 90,190 tonnes, an increase of 2400% in relation to 1997. Of this production, 70% was for export. This period is known as the shrimp farming "boom", driven forward by the increase in the exchange rate of the national currency with the dollar, making the external market more attractive (ABCC 2005, Meireles et al. 2007).

In 2004 there was a decrease in export production volume. by 19,405 tonnes in the north west zone and, in Rio Grande do Norte, shrimp production in 2003 was 37,473, decreasing to 30,807 tonnes in 2004. At this time, exports decreased by 65% in Ceará. The rates reached their lowest levels in 2006, when national production did not exceed the production reached by Rio Grande Norte alone in 2003, with a volume of approximately 34,000 tonnes (Meireles and Silva 2003).

In only three years, exports dropped from US$ 244.5 million in 2003 (with 61,000 tonnes) to US$ 154.4 million in 2006 (37% less). The data demonstrate that the intentions of the shrimp farmers to reach 157,000 tonnes in 2005 with a value of US$ 450 million were badly estimated ABCC). According to the data from the first half of 2005, exports were estimated at US$ 283 million less than predicted by the ABCC.

Survey of increase in shrimp farm area

According to the survey carried out by the *Superintendência Estadual de Meio Ambiente (SEMACE)*, 245 shrimp farms were identified within the watersheds of the state of Ceará (IBAMA 2005), occupying an area of 6069.97 ha. The data reported by ABCC in contrast for 2005 were 3804 ha. 84.1% of those farms had impacts directly related to mangrove

loss, such as environmental damage to mangrove fauna and flora and salt flat sectors (Meireles and Silva 2003). Figure 5 represents a synthesis of the characteristic geo-environmental units throughout the estuarine system of the Jaguaribe River and how they were occupied by shrimp production units. Also characterized are the impacts related to access roads, larva and post-larva growing ponds, storage and drainage canals, sedimentation ponds, laboratories and tool/material storage.

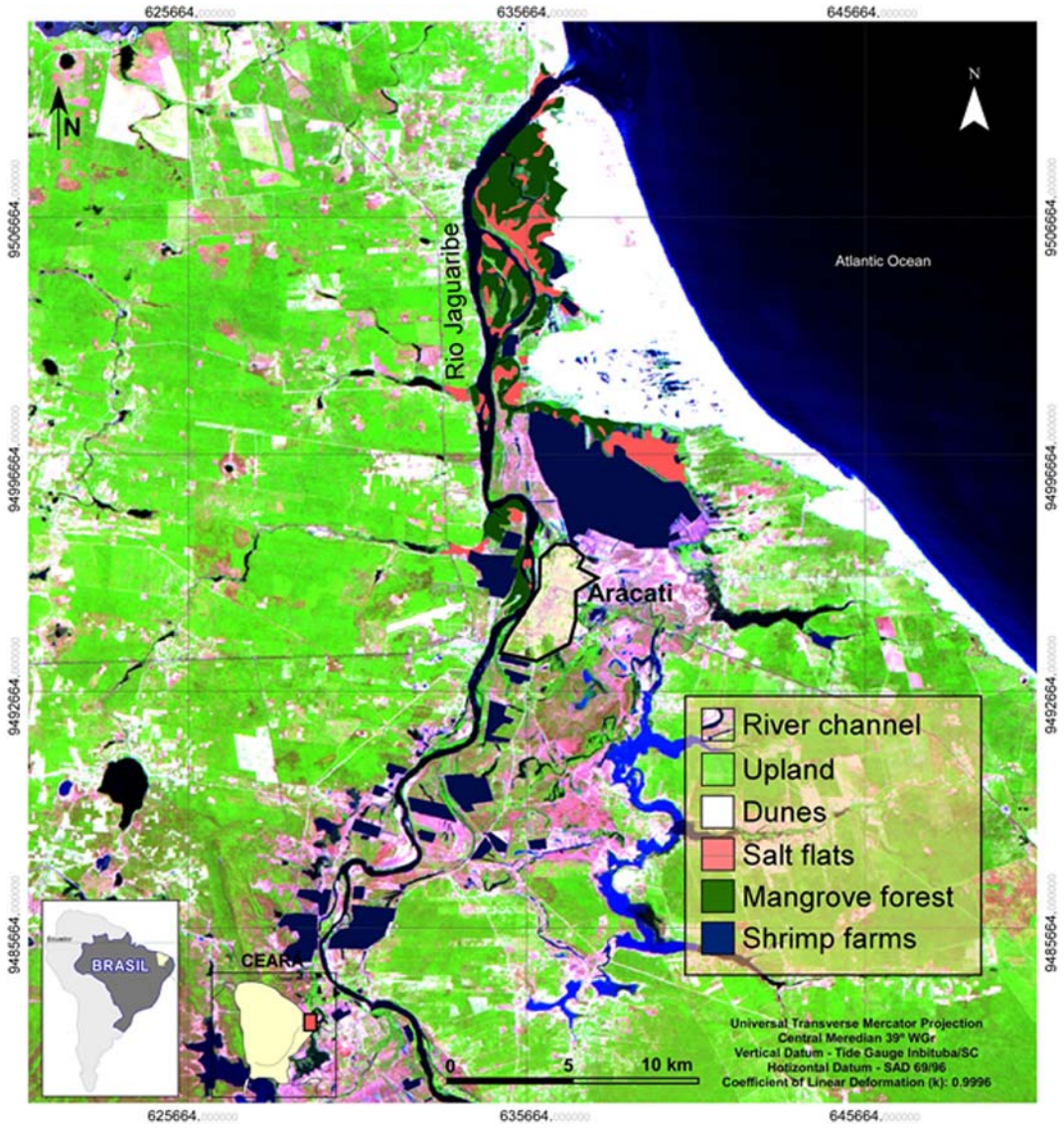

Figure 5. Estuarine system of the Jaguaribe River and its principle environmental components. Source: National Institute for Space Research (INPE), satellite image Landsat TM 5, March 2008.

Of all the farms licensed by the *State Superintendent of the Environment (SEMACE)*, it was verified that 84% had direct impacts on the mangrove ecosystem (mangrove fauna and flora, salt flats); 25.3% cut down carnaubal palm forests and 13.9% occupied areas previously destined for subsistence agriculture. Throughout the watershed there was an increase in the area of shrimp farms from 295 to 1985 ha, with a decrease in mangrove forests in 1999 and a slight increase afterwards (probably related to the occupation of mangrove in former areas of abandoned farms and salt flat sectors colonized by the forest). Figure 6 presents the occupation of the mangrove ecosystem through the period studied, where there is a significant increase in shrimp farm areas, occupying ecosystem sectors related with vegetation and salt flats.

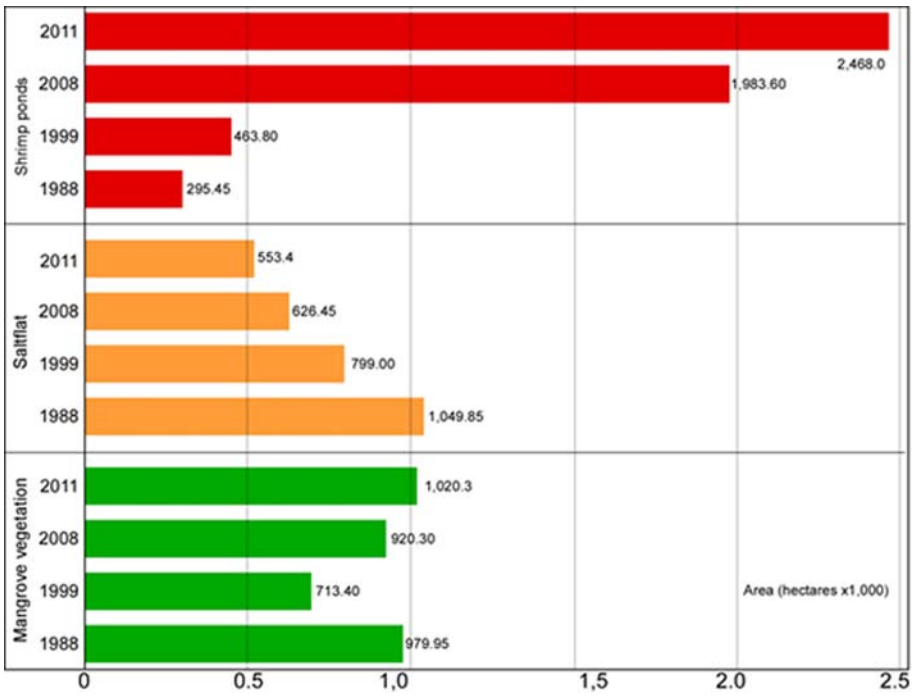

Figure 6. Occupation of the mangrove ecosystem related with vegetation and salt flats through the period studied (1988-2011).

According to the *Superintendência Estadual de Meio Ambiente (SEMACE)*, 44.2% of the shrimp farms constructed in the Jaguaribe River, interfered directly with the mangrove ecosystem and 63.6% caused serious damage to the riparian forest (carnaubal palms), which is one of the most important ecosystems of NE Brazil primarily for the protection of aquifer recharge (IBAMA 2005). Figure 7 shows the synthesis of the

occupation process, and the relation between the increase in shrimp farms and decrease in vegetation cover and salt flats. These results also demonstrate that the mangrove occupation was related to the substitution of environmental components with extensive aquaculture.

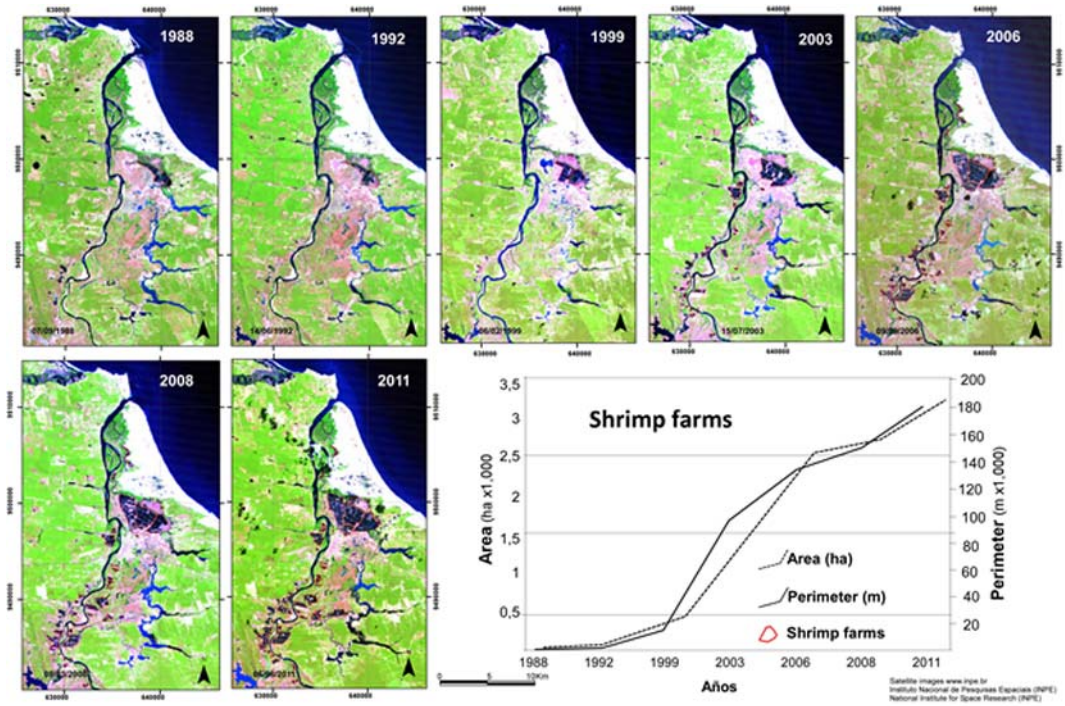

Figure 7. Evolution of mangrove forests and shrimp farms along the Jaguaribe River estuary (Meireles and Tupinambá 2005, Meireles and Queiroz 2010).

The Figure 8 represents a synthesis of the characteristic geo-environmental units along the estuarine system of the Jaguaribe River and how they were occupied by the shrimp production units. Also characterized were the impacts related to the access roads, larva and post-larval phase tanks, storage and drainage canals, sedimentation ponds, laboratories and tool/material storage. Additionally, the impact on biodiversity caused by the dissemination of exotic species was also identified. The farms do not have efficient security mechanisms to prevent the invasion of the exotic shrimp L. vannamei which is harmful to Brazilian mangroves (Meireles and Tupinambá 2005, Meireles and Queiroz 2010). In addition, contaminated effluents directly affect the biology of native species. According to Figure 8, the environmental impacts identified in the Rio Jaguaribe caused by shrimp aquaculture were:

1. Geo-environmental and eco-dynamic decharacterization of the mangrove ecosystem by deforestation (mangrove carnaubal palms, etc.); 2. Deforestation of riparian zones associated with the lateral areas of mangrove salt flats; 3. Waterproofing of soils near urban areas and fishing villages, destroying aquifer recharge areas; 4. Risk of aquifer salinization due to the occupation of extensive recharge areas; 5. Blocking of the tides, preventing access to water (nutrients and seeds) in areas with mangrove vegetation and in salt flat sectors; 6. Hindering the entrance of fresh water originating from the aquifer (water renovation cycle and leaching of salts) in the internal eco-dynamic of the salt flat, and, consequently, for the estuary; 7. Transformation of mangrove vegetation (and salt flats); structural changes (loss of sedimentary material and compaction); 8. Erosion of the shrimp pond slopes (pluvial action and contact with daily tidal oscillations) and destruction of mangrove vegetation and slat flat areas; 9. Direct discharge of effluents in the creeks; 10. Death of vegetation (mangroves, carnaubal forest and caatinga), probably resulting from the infiltration of brackish water and blockage of lateral exchanges with the implantation of polders and infrastructure.

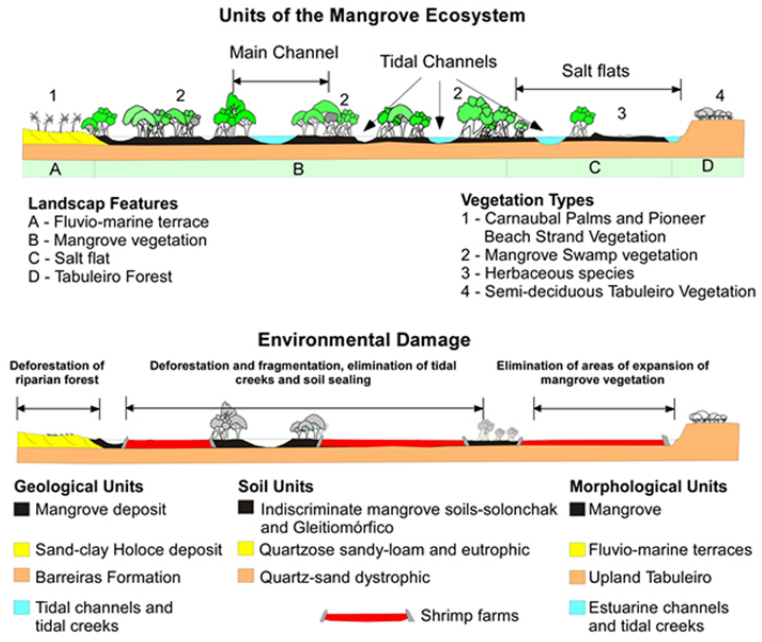

Figure 8. Mangrove ecosystem units and geological, geo-morphological, soil characteristics, landscape units and vegetation types. Associations were also made regarding the principle environmental impacts related to the introduction of the shrimp farms (Meireles and Tupinambá 2005, Meireles and Queiroz 2010).

Discussion

The technique that we have used to evaluate the changes in the altered area caused by the presence of shrimp farms proves to be adequate for making a good landscape evaluation. It is easy to use and can be combined with shrimp production data, including the downward trends that in this case have been detected in the state of Ceará in recent years.

In the 1990s, intensive shrimp production started to develop in Ceará. In only 10 years (1998-2008), the activity had already developed in eight municipalities, corresponding to 48% of the entire cultivated area in the state and was responsible for more than 80% of the total shrimp production in that zone of Brazil. Of the 6069.97 ha of shrimp production, the Jaguaribe watershed region was responsible for 3294.88 ha during this period (including shrimp farms in fluvial systems, far from the estuary). In the lower Jaguaribe, the ponds were first installed on the river margins, where salt flats and mangrove trees were located. There was a great boom in shrimp production, causing large transformations in the ecological equilibrium in a short period of time (Meireles and Silva 2003, IBAMA 2005).

Economic activities that follow different programs of development are taking place on the same estuarine system of the Jaguaribe River watershed. Shrimp aquaculture obeys the logic of appropriation of space generating socio-environmental consequences and compromising the flux of ecosystem services produced by mangroves. Through field research it was possible to verify that the logic of aquaculture collides with the forms of use and community perception of the land (family agriculture, fishing, crafts, etc.) that are intimately related to the socialization of the group. This point follows the principles of reciprocity and community more than competition and individualism. The communities that live in small villages along the shores of the fluvio-marine system of the Jaguaribe River depend on the state of conservation of the mangroves and other ecosystems interconnected with them for their survival (Queiroz L., personal observation). In the Philippines, it has been shown that the profound changes provoked by the disappearance of mangroves (from 400,000 ha around 1920 to less than 100,000

at the beginning of 2000) have provoked important changes including the perception of the environment by the inhabitants of these zones (Farley et al. 2010). Vietnam is another example in which many communities have seen radical changes in their modus vivendi due to the shrimp farming industry having replaced artisanal fishing and mangrove organisms with this type of intensive culture (Lan 2009). The conflicts in this region of SE Asia have been due, above all, to top down decision-making in which the necessities of the people who work (and live) directly from mangrove resources have not been taken into consideration (Lan 2009).

In the lower Jaguaribe River watershed coastal communities of artisanal fisheries also develop activities such as agriculture and crafts, establishing another type of relationship with nature. These communities carry out various activities in the mangroves, benefitting from their ecosystem services, for example fishing and shellfish collecting (Aburto-Oropeza et al. 2008, Farley et al. 2010]. These community values and perceptions may be generated by mangroves in different ways, and may be lost with the intensive shrimp farming exploitation that may last a maximum total of 10 to 15 years (Mumby et al. 2004, Aburto-Oropeza et al. 2008).

In the case of Brazil, the growth of the aquaculture sector was associated with the occupation of the mangrove ecosystem, generating important socio-environmental impacts. Even so it was impossible to guarantee the sustainability of the activity. These socio-environmental impacts, the privatization of water and common-use public lands, the expulsion of ancestral fisherfolk and indigenous populations, the systematic deforestation of mangroves, the contamination of water, the decrease in the quantity of fish stocks and the salinization of aquifers, together with the degradation of biodiversity which engenders cumulative effects, may impact the food sovereignty of the communities which find their source of subsistence in mangroves (Polidoro et al. 2010). The situation is very similar, as has been observed, to other places where the identified impacts and their diagnosis due to the intense development of the shrimp farming industry have accelerated (Kautsky et al. 2000, Primavera 2006). As demonstrated in the present study, aquaculture growth in Ceará was especially fast in terms of the disappearance and degradation of mangroves compared to other areas of Brazil and

even the rest of the world, although more data is required regarding how it will impact the economic dynamics of the communities of the zone.

In the mid 2000s a retreat in the construction of shrimp farms and production for export was detected. The activity's economic crisis was generated by an accumulation of socio-environmental impacts, as these impacts resulted from a production that the system could not tolerate, just as has been demonstrated in other studies (Rivera-Ferre 2009). In order to produce more biomass in less time there was an increase in the levels of water pollution in the estuaries, fragmentation of the mangrove ecosystem and the spread of viral diseases introduced by shrimp (EMBRAPA 2004). For this reason, the shrimp industry, previously presented as one of the most lucrative of the national economy, began to collapse. Recently it has worsened due to the reduction in exports and, consequently, to the abandonment of farms.

The uncontrolled activity is due mainly to the avalanche of farms without environmental permits. The first legal instrument of national scope did not appear until 2002, with Resolution 312 [of the *National Environmental Council (CONAMA)*]. Farms were also placed in permanent preservation areas, promoting optimism in the producers, to the point that ABCC (ABCC 2005) stated that the objective was to be the leader of the global market, reaching production equivalent to US$ 1.5 billion by the year 2010. Contrary to the predictions, the value of exports was much lower, reaching US$ 57.6 million. The productive chain degraded rapidly, generating as a consequence financial losses and unemployment due to the rapid decline of an industry that had often been proclaimed as the promoter of the financial redemption of the poorest states of the country.

With the data obtained concerning the economic dimension of shrimp production in mangrove areas, it was possible to confirm that the rapid growth unleashed the collapse of the activity throughout the Jaguaribe River estuary. As environmental responses, accumulated impacts in the ecosystems (water quality and biodiversity loss) and in the communities along the fluvio-marine system (substitution of extractive activities for shrimp monoculture) have been defined. A succession of environmental and

social damage has not yet been quantified in order to thoroughly examine the public policy decisions locally (estuaries) and regionally (watersheds) in order to measure the economic activities and promote the recuperation of the environmental systems responsible for the bases of productivity of the wetlands and food sovereignty.

Social and environmental externalities need public policies that aimed at the effective management of fluvial, mixed and marine systems (Naylor et al. 2000). Each activity should be measured from the perspective of the advance in new technologies, local alternatives, definition of accumulated impacts; and using the precaution principle, equity and an evaluation of actual social benefit, so that the environmental and economic benefit of the shrimp monoculture in mangroves can be performed.

The present study associates the rapid growth of shrimp farming in Brazil with the clear degradation of the mangrove system. The example of the state of Ceará produced through a cartographic study (a tool that can be easily used anywhere in the world) is very useful for quantifying the replacement of mangroves with shrimp farms.

The rapid evolution of shrimp farms against mangrove ecosystems has minimized the availability of ecosystem services, compromising the socio-environmental sustainability of the coastal zone of Brazil for the medium-and long-term. The impacts are present not only from the environmental point of view but also from a social and economic one, including an increase in poverty, lack of land and food insecurity, displacement of communities, contamination of potable water, poor working conditions, health and education impacts, and the violation of human rights.

Chapter II

Neglected ecosystem services: challenges for integrating non-material benefits of mangroves in decision-making processes in Cumbe (Ceará, Brazil).

Queiroz L., Rossi S., Calvet-Mir L., Betorz S.G., Bachelor J.P., and Meireles A.J.A. 2014. Neglected ecosystem services: challenges for integrating non-material benefits of mangroves in decision-making processes in Cumbe (Ceará, Brasil). Status: in preparation to Journal Biodiversity and Conservation..

Queiroz L., Meireles A.J.A., Rossi S. 2013c. Serviços Ecosistêmicos Costeiros e Comunidades Tradicionais (Coastal Ecosystem Services and Traditional communities). Revista da Associação Nacional de Pós-Graduação e Pesquisa em Geografia (ANPEGE) 8: 145-159. (DOI: 10.5418/RA2012.0810.0010) (Anexo IX).

Betorz, S. G., Mercader, A. T, Carol, M. J., Salvà, J. P. 2012. Evaluación Ambiental de la Acuicultura de Camarón sobre el ecosistema Manglar en el tramo bajo del río Jaguaribe. Universitat Autònoma de Barcelona (UAB) - Master Work. 123 pp

Abstract

Mangroves are responsible for many essential ecosystem services (ESs). Nevertheless, during the last decades they have experienced high levels of deterioration principally caused by shrimp aquaculture. The final target of the present study is to produce knowledge on the importance of ESs of mangroves from the community perspective using data collection techniques including participant observation, free listings, focus groups and valuation surveys, a combination of social methodologies employed in Cumbe, Ceará (Brazil). The presented results show that for the conservation of mangroves it is necessary to study and take into account its services from the autochthonous community point of view. These local communities maintain a direct relationship with the ecosystem and will potentially be directly affected by changing the management of mangroves. The above mentioned populations recognize different services and have an existential relationship with the mangrove forest, beyond the material perception normally used to evaluate ESs. In fact, we demonstrate that this ecosystem also maintains a symbolic connection with the people living nearby. This relationship is classified by the interviewed people as a main driver of happiness and life force. On the basis of our results we developed recommendations for improved mangrove management, including strengthening participation of traditional communities in the construction of knowledge and in decision-making processes in elaborating policies for the management of mangroves.

Keywords: Ecosystems services, Mangrove, Shrimp aquaculture, Decision-making, Coastal Management.

Introduction

Ecosystems perform a variety of functions and services that sustain and satisfy human societies (Daily 1997, MA 2005, TEEB 2010). Ecosystems services (ESs) are the benefits by which ecosystems contribute to make the life of humanity not only possible but worth living through personal fulfilment (MA 2005). There is an explicit link between interacting biophysical and human systems (MA 2005, Balvanera and Cotler 2007), because through their functions and services, ecosystems provide water, food, energy, raw materials and other so called provisioning services. In addition, ecosystems provide society with ecological regulation services including climate, flooding and disease regulation, water quality, water cycle regulation and CO_2 sequestration (Norberg 1999, Chee 2004, MA 2005). Last but not least ecosystems also provide diverse non-material benefits, in terms of recreational, educational, spiritual, and others that are difficult to quantify and have thus been largely neglected (Chan et al. 2012). We need urgently to produce an effective tool in order to quantify knowledge about community perception of ESs in mangroves and other ecosystems.

Mangroves are rich, diverse and complex ecosystems formed at the interface between terrestrial, estuarine and marine systems near the coastal zone, present in tropical and subtropical regions of 123 countries of the planet (Barbier et al. 1997, Spalding et al. 2010). These ecotones (border ecosystems) are essential for the conservation of biological diversity, providing habitats, egg-laying zones, nurseries and nutrients for different plants and animals, making them vital for the survival of many commercial species (FAO 2007). It is estimated that up to 80% of fish catch in tropical coastal zones are directly or indirectly dependent on mangroves. Mangroves also have a close connection with coral reef systems (Field 1998, Ellison 2008, Polidoro et al. 2010) and are responsible for the generation of many other ecosystem services (Costanza et al. 1997, Field 1998, Ellison 2008, Polidoro et al. 2010).

In spite of the social, cultural, ecological and economic importance of mangroves and legislation designed to protect them, these ecosystems continue to be degraded and are being lost at an alarming rate (Turner et al. 2000, Carol et al. 2012, Chapter I, Queiroz

et al. 2013b, Serra-Pompei et al. 2014). According to the *Food and Agriculture Organization (FAO)* around 35,600 km^2 were lost between 1980 and 2005 (FAO 2007). As an example of this fast deterioration, Rivera-Ferre (2009) points out that in the periods with highest rates of destruction, 82% of mangroves were lost in Honduras in 1965-1995, and 72% in Brazil in 1972-1991. It is predicted that in the 25 years following his study shrimp aquaculture, in conjunction with overexploitation of fisheries will be the greatest threats to mangrove conservation (Alongi 2002). At present the shrimp industry is one of the greatest sources of transformation of this type of ecosystem, producing a considerable regression of its area and ecosystem degradation (EJF 2003, Polidoro et al. 2010, FAO 2010, Chapter I, Queiroz et al. 2013b).

It is important for the integrated management of coastal systems to fully understand the ecological, economic, social and cultural ESs. However, studies so far have prioritized the ecological and economic ones (Quétier et al. 2007), often at the expense of the consideration of social and cultural values. This is despite the evidence that social and cultural ESs can be of primary importance for the autochthonous and diverse populations exploiting and living in said ecosystems (Farber et al. 2002, Chiesura and de Groot 2003, Kronen 2004, Martín-López et al. 2008, Chan et al. 2012). These factors are difficult to evaluate, partly because of the lack of adequate tools, but also due to not including consultation with the people that link their way of life with this ecosystem in previous studies (Quétier 2007). Furthermore, the link between communities and nature, which has a strong influence on psychological and individual well-being, remains hidden in the majority of conventional methods of ESs studies (Chee 2004).

This context has generated the necessity of local-scale identification and monitoring of ESs, incorporating the symbolic and material importance for traditional communities within decision-making processes, as an alternative for appropriate and less vulnerable coastal management (Daily 1997, Metzger et al. 2006). In fact, local communities should also be considered as active managers of the ecosystems upon which they depend (Folke et al. 2006).

This research is aimed at demonstrating the link (symbolic and material) between the services provided by mangrove ecosystems and the well-being of artisanal fishing communities, based on data obtained in the community of Cumbe, Ceará, Brazil. To achieve this objective, we 1) identify, characterize and valuate the ecosystem services of mangroves based on community perception and the existent literature, and 2) analyze how the ESs of mangroves are linked and incorporated into the community way of life, and why we should take the autochthonous point of view in the decision making processes.

Methods

Study Area

The study was carried out at the community of Cumbe, municipality of Aracati, state of Ceará, a community located along the margin of the Jaguaribe River (Figure 1). The Jaguaribe is the largest river in the state of Ceará (Brazil), with an area of 72,645 km^2, occupying 50% of the territory where economic activities go from small family agriculture, traditional fishing, to industrial activities such as shrimp aquaculture (Chapter I).

Data collection and analysis

This study was divided in two phases: (1) in-depth literature review and (2) field research combining several techniques for information collection, including participant observation, free listings, focus groups and evaluation surveys.

Literature review

An in-depth literature review on ecosystem services provided by mangroves was carried out following the classification variants of The Economics of Ecosystems and Biodiversity (Kumar 2010) to divide ecosystem services into four main categories: regulation, habitat, production, and cultural services. The results of the in-depth literature review were contrasted with the ESs that were later identified and characterized during the field research based on community perception. As a final result of this literature review we constructed Table 1.

Regulation Services				
Service	Characterization	Literature	Free Listings	Focus Groups
Regulation/Production of gases	Regulation of atmospheric chemical composition (balance of CO_2/O_2; Levels of SO_2).	X	X	X
Climate regulation	Global temperature, precipitation and other biological processes that mediate local and global climatic phenomena (regulate greenhouse effect).	X	X	X
Water supply	Water storage and retention (aquifer and reservoir dynamics)	X	X	X
Coastal protection against extremes	Buffering of ecosystem responses associated with environmental fluctuations (protection against storms, control of fine sediment production and controlled environmental variabilities by vegetation structure).	X		
Hydrological regulation	Regulation of hydrological flows integrated with watersheds (water for agricultural and industrial activities; transportation of people, food, etc.).	X		
Buffering of the predicted consequences of global warming.	Estuarine systems act as systems responsible for maintenance of buffering properties of projected effects of average temperature increase and sea level rise.	X		
Erosion control and sediment retention	Soil conservation within the ecosystem (prevention of slides and other processes of material removal)	X		
Soil formation	Soil formation process (weathering of rocks and accumulation of organic material).	X		
Nutrient cycling	Storage, internal recycling, processing and acquisition of nutrients (fixation of N, P and other elements of the nutrient cycle).	X		
Material and energy dissipation	Recuperation, removal and control of excess nutrients and organic compounds (control of contaminants).	X		
Pollination	Movement of gametes for population reproduction.	X		
Biological control	Regulation of trophic dynamic of populations.	X		
Biodiversity regulation	Biological interactions between organisms and with abiotic components of ecosystems.	X	X	X
Habitat services				
Service	Characterization	Literature	Free Listings	Focus Groups
Refuge	Habitat for resident and migratory populations (stopover, nursery and feeding areas for migratory birds)	X	X	X
Production services				

Service	Characterization	Literature	Free Listings	Focus Groups
Food production	Part of gross primary production transformed into food (fish, molluscs, crustaceans and subsistence of activities).	X	X	X
Primary production	Part of gross primary production transformed into *materia prima* (lumber, fuel and forage).	X	X	X
Genetic resources	Production of materials and biological products for medicine, scientific materials, acquisition of genes resistant to pests, and ornamental species.	X		
Cultural Services				
Service	Characterization	Literature	Free Listings	Focus Groups
Recreation	Carrying out leisure activities (fishing, boat cruises meals with family and friends, games, etc.)	X	X	X
Tourism	Opportunities for various tourist activities: ecotourism, research tourism, sport fishing and other outdoor activities that do or do not generate income.	X	X	X
Aesthetics	The mangrove ecosystem as part of the coastal scenery.	X	X	X
Inspiration for culture and art	Mangroves are motive and inspiration for artistic creations.	X	X	X
Spiritual	Many fisherfolk and indigenous communities recognize mangroves as a sacred space.	X	X	X
Maintenance of traditional ecological knowledge	In mangroves traditional activities are carried out, which are important for maintenance of autochthonic and ancestral knowledge.			X
Science and environmental education	Important spaces for development of scientific research and environmental education actions.	X	X	X
Creation and maintenance of social relationships	In mangroves interpersonal relations are built and/or strengthened with people from the same community, neighboring communities and visitors.		X	X
Personal satisfaction	The relation with mangroves generates sentiments of personal satisfaction for the communities, such as: strength to live, richness (not from a monetary point of view), pride and liberty.		X	X
Mental recreation, physical recreation, leisure and hobby	The communities use mangroves for carrying out physical activities (exercise) and relaxation, functioning as therapy.	X	X	X

Table 1. Ecosystem services provided by mangroves and sources of identification. Source: Schaeffer-Novelli 1989, Barbier et al. 1997, Costanza et al. 1997; de Groot et al. 2002, MA 2003, MA 2005, Mcleod and Salm 2006, Rivera and Cortés 2007, Kumar 2010, Meireles and Campos 2010.

Field data sampling

Data were collected from October to December 2011 in the community of Cumbe (Figure 1) using participant observation, free listings, focus groups and a survey. *Participant observation* was conducted between October and December 2011 in the community of Cumbe with the objective of establishing contact with the community and improving our understanding of the community's social organization and way of life. This technique allowed researchers to be in contact with the village people of Cumbe daily to gain a better understanding of their relationship with the mangroves. Participant observation was also important in order to better interpret the responses obtained through the other data collection techniques (Taylor and Bodgan 1994).

Sampling

Research was conducted with the fisherfolk group of 35 women shellfish and 45 men crab collectors (13% of the total population of Cumbe), who are defined as a community sector depending both directly and indirectly on mangroves' ESs. From this group we interviewed different people depending on our sampling strategy. We conducted free listings with 24 people of the fisher group. Free listing informants were between 25 and 50 years old and included 8 women shellfish and 16 men crab collectors. Our sample for the focus group included 11 shellfish collectors and 14 crab collectors. It represents about 30% of the total fisherfolk community. The surveys were carried out in the last stage of the field research to evaluate the ESs of the mangroves in a participatory and community way. The surveys were conducted between October and November 2011 with the fisher folk group of Cumbe (35 women shellfish and 45 men crab collectors), which are defined as a community sector depending directly and indirectly on ESs of mangroves.

Free listings techniques were used to identify the ESs and their level of importance in community life (Weller 1998). For each one of the interviewed people of the fishing community, we asked the question "What does the mangrove mean to you?" The responses were noted by the researchers in the same order in which they arose from the surveys in order to guarantee the priority order of each response. People were interviewed until responses to new surveys began to repeat themselves (saturation point;

Bernard 2005). From each list the importance of the answers obtained, was calculated using the Salience index, which relates and integrates the number of times that a response has been stated and the order in which it has appeared (Borgatti 1996). The responses were thereafter systematized, codified and entered into the software ANTHROPAC (Borgatti 1996), generating a list of ecosystem services (ESs) by order of priority based on the perception of people interviewed. In order to organize and interpret the results, the program group with similar terms was listed in a single category, and added to the results table of the free listing.

Focus groups, a group interview modality that is open and structured with orientation questions (Barbour and Kitzinger 1999), was held with a) shellfish collector women and b) crab collector men and fishermen. The objective of the focus groups was to identify and characterize the ESs of the mangroves and their uses according to the specific perception of the fishermen and fisherwomen that live in close relationship with the mangrove ecosystem. From this group activity we gained understanding of the community experience, the ESs of mangroves and the links between the two. Through these group interviews, we captured individual and collective opinions. The key of this technique lies in the promotion of open discussion of opinions about a theme that was moderated by the researchers (Annex II).

On the basis of our results, we built a table of ESs of mangroves identified by community perception (Table 1). We classified the sources of information as: *literature* (when the identification source was literature review), *free listings* (when the ecosystem service was identified via the construction of open lists), and *focus groups* (when the ESs were identified during the focus group meetings).

Valuation surveys (Annex I), most ESs produced by mangroves operate outside of the market system and are strongly linked to the way of life, traditions and other types of values of the community (NRC 2004) therefore we conducted a non-economic valuation based on socio-cultural perception of the importance of the ESs for human well-being of the community of Cumbe (Calvet-Mir et al. 2012). Valuation surveys were used to 1. average the value of each ecosystem service; 2. average the value of each category of

ecosystem services; 3. average the value of all services; and 4. assess the relative importance of each category of ecosystem services. The survey model used was based on a design of the Likert scale (Bernard 2005) with the objective of evaluating the agreement of the fisherfolk about the declarations on the importance of the ESs of mangroves. An affirmation about a service was made to the survey participants. For example: "Mangroves are important because they give quality food." Next they were asked to rate this affirmation numerically (0=disagree totally, 5=agree totally), at the individual level. The ESs present in the valuation survey were extracted from the list of ESs of mangroves obtained in the literature review (Table 1). The relative importance of each category of ecosystem services was standardized (average value of the category/maximum value the category could obtain). These estimations allowed us to identify the relative value of some categories in relation to others.

Results

Identification and characterization of ecosystem services (ESs)

As a result of the in-depth bibliographic review, we identified 23 ecosystem services (ESs) provided by mangroves: 13 regulation services, 1 habitat services, 3 production services and 6 cultural services (Table 1).

Based on our fieldwork we identified and characterized four additional ESs of the mangroves that we classed as cultural services: 1. Maintenance of traditional ecological knowledge; 2. Creation and maintenance of social relationships; 3. Personal satisfaction and 4. Mental recreation, physical recreation, leisure and hobby (Table 1). The service "maintenance of traditional ecological knowledge" was identified during the focus group meetings and is characterized by the testimony of a fisherman: "*my father raised me and my 12 brothers from products generated by the mangroves. We grew up knowing our survival was due to crab collection, we learned with him and from generation after generation that knowledge has remained. Today I have many brothers that continue working in the mangroves*." The service "creation and maintenance of social relations" was identified during the focus group meetings as well as during the application of free listing for the term "socialization".

In accordance with the results of the free listings (Table 2) the following words were cited: *strength to live*, *wealth* (not from a monetary point of view), *pride*, *happiness* and *freedom.* In order to better interpret the results, these words were organized in Table 1 as a new ESs of "*personal satisfaction*". As an example, we have testimony of one fisherman during the meeting of the focus groups: "*The mangrove is freedom. My work in the mangroves is everything because I don't worry about my boss".* Starting with this definition, one was able to deepen the significance of the word *freedom*, understood by the fisher folk to be related to personal well-being. Therefore, for the community the ESs of mangroves makes reference to the community use of the mangroves with sentimental intention and personal satisfaction.

Item	Frequency (%)	Average Rank	Salience
High Salience (s > 0,5) (n= 1)			
All	75,0	1,11	0,724
Salience Media (0,5> s > 0,020) (n= 20)			
Sustenance	70,8	2,53	0,486
Leisure	54,2	3,92	0,244
Work	41,7	2,70	0,248
Rent	25,0	1,50	0,229
Landscape	20,8	3,80	0,115
Food	20,8	4,80	0,094
Firewood	12,5	4,00	0,045
Fishing	12,5	3,33	0,073
Happiness	12,5	5,67	0,046
Wealth	8,3	3,00	0,042
Refuge	8,3	6,00	0,040
Health	4,2	2,00	0,038
Clean air	8,3	3,50	0,035
Nursery	4,2	4,00	0,030
Socialization	8,3	4,00	0,027
Relaxation	4,2	4,00	0,026
Tourism	4,2	3,00	0,021
Pride	4,2	4,00	0,021
Therapy	4,2	2,00	0,021
Honey	4,2	3,00	0,021
Low Salience (s < 0,020) (n= 7)			
Exercise	4,2	6,00	0,016
Spirituality	4,2	9,00	0,011
Research	4,2	7,00	0,010
Biodiversity	4,2	8,00	0,009

Liberty	4,2	10,00	0,008
Clean water	4,2	9,00	0,005
Strength	4,2	11,00	0,004

Table 2. Results of the free listings[4]. Source: field research.

Similarly, we identified the new ESs "mental recreation, physical recreation, leisure and hobby" based on the words cited in the free listings: health, relaxation, therapy and exercise, providing evidence that the mangroves contribute to physical and mental health. These results demonstrate that the communities use mangroves in order to exercise and relax. For the local population, the forests are considered spaces for meditation and personal reflection, a place where one feels well: "*the mangrove is the best home to hear the noise of the wind. It is a place for my thoughts. The truth is that at times in the city I get stressed, but I never get that way when I am in the mangroves.*"

Other words cited in the free listings include: *life, mother of all, all the good things, our world* and *everything* (Table 2). These terms were categorized as "*all*" and were cited by 75% of the surveys and appeared, on average, in first position on the list (s=0.724). For the population studied, the mangrove constitutes a critical aspect of their world-view and their sense of belonging. During the focal group meetings during which a fisherman stated that: *"Mangroves represent everything for me, they are life. I feel privileged to be part of it, to live close to mangroves, to open my window and see a landscape that makes me feel well and happy because it is from them that I draw quality sustenance for me and my family."*

Our results show that there are differences between the ESs tourism and recreation, as perceived by local informants and have been listed separately in the category of cultural services. Tourism carried out in the mangroves is perceived as work that generates profit. Recreation (also identified as leisure) is a traditional activity that is highly valued by families during weekends or during days off but it is does not generate profit.

[4] Salience (s) takes into account the frequency (F) and the average rank of one single item. Frequency is the percentage appearance of a response independently of the place in which the subjects have taken it into account; Average Rank expresses the place in which the response has appeared (Borgatti 1996).

Valuation of ecosystem services (ESs) of mangroves

Within a range of zero to five, 21 (91.3%) of the ESs were scored with an average value between 4 and 5 (Table 3). The other three ecosystem services (ESs) (13.04%) had an average value between 3 and 4 (Table 3). The total score of each category should be viewed as a relative average. The most valued ES was the "*production and regulation of gases" followed by "refuge for species,*" and next, with the same scores was "*food production*" and "*recreation/tourism*," followed by the ESs of "*hydrology regulation*." The least valued environmental service, but equally with a score of 3.21 was "*production of energy resources,*" preceded by "*dissipation of material and energy*" and "*buffering of predicted consequences of global warming.*" The relative importance of each category of ESs suggests that the subjects give a similar value to cultural services (0.89), provisioning services (0.83), and regulation services (0.88).

Regulation services		
Service	Example of service	Average 52,86
Regulation/Production of gases	Mangroves produce oxygen, the air that we breathe.	4,93
Climate regulation	Mangroves help to maintain the regional temperature.	4,54
Coastal protection	Mangroves contribute to coastal stability, functioning as a natural protection against natural phenomena (floods and storms).	4,46
Hydrological regulation	Mangroves regulate the entrance and exit of water in the Jaguaribe River.	4,70
Buffering of the consequences of global warming	Mangroves contribute to buffering the consequences of global warming, for example, they keep the rainy season constant from year to year.	3,82
Water supply	Mangroves are responsible for water storage in aquifers.	4,40
Erosion control and sediment retention	Mangroves prevent landslides.	4,56
Soil formation	Mangroves are responsible for the soil formation process (accumulation of organic material).	4,30
Nutrient cycling	Mangroves are responsible for the transformation of organic material.	4,54
Material and energy dissipation	Mangroves control pollutants.	3,47
Pollination	Mangroves circulate gametes in reproducing populations.	4,54
Biological control	Mangroves are home to many organisms of various species, which interact with each other.	4,58
Habitat services		
Service	Description of service	Average 4,86

Refuge	Mangroves function as habitat for resident and migratory populations (welcoming to migratory birds)	4,86
Production services		
Service	Description of service	Average 12,52
Food production	Mangroves provide quality food.	4,75
Primary production	Mangroves produce *materia prima* such as lumber, fuel and forage.	4,55
Genetic resources	Mangroves produce biological products with medicinal uses.	3,21
Cultural services		
Service	Description of service	Average 22.36
Recreation/Tourism	Mangroves provide a space for carrying out recreational activities (ecotourism, sport fishing and other outdoor activities).	4,75
Enjoyment of scenery	Mangroves are part of coastal scenery.	4,61
Inspiration for culture and art	Mangroves inspire artistic creation.	4,21
Spiritual experience	Many communities of fisherfolk and indigenous peoples recognize mangroves as sacred space.	4,40
Science and environmental education	Mangroves are spaces for the development of scientific research and environmental education activities.	4,39

Table 3. Community valuation of ecosystem services provided by mangroves. Source: adaptation of valuation survey used by Calvet-Mir et al. (2012) used for community valuation of ecosystem services (ESs) of home gardens.

Discussion

Community perception of the importance of cultural ecosystem services of mangroves

Our results suggest that the studied community identifies, characterizes and values mangroves in multiple ways, linking benefiting from ESs directly to both material and symbolic aspects. The community of Cumbe identifies mangroves as a space for traditional knowledge production and maintenance based on associated activities, including artisanal fishing (for fish, mollusk and crustacean collection), logging, collection of honey and medicinal plants, in addition to recreational activities and tourism. This result suggests that the artisanal fishing communities are characterized by a way of life where the relationship with the mangroves (and nearby ecosystems) constitutes a core foundation of their culture.

Thus, the fisher folk of Cumbe depend on the flow of ESs for the maintenance of their world-view and traditional way of life. By the identification of other cultural ESs not considered by the scientific literature, such as "maintenance of traditional ecological knowledge", "creation and maintenance of social relationships" and "personal satisfaction" the community relates the use of mangroves with a therapeutic, sentimental and personal purpose and intention. For the population of Cumbe and many other indigenous communities, the mangroves are associated and recognized as sacred space (Aguirre-Muñoz and Mendoza-Alfaro 2009). This perception adds to that of a place of work in which they are living, find relaxation and socialization. As they themselves describe it: "the mangroves mean all." The "all" literally stated in the results is related with their sense of place, community and belonging and the level of satisfaction that is generated from the mangroves, encompassing words of profound personal significance relative to the symbolic, immaterial and ancestral relationships that the community and mangroves establish, directly influencing their well-being (Butler and Oluoch Kosura 2006).

Our results are consistent with previous research suggesting that the cultural category of ESs contributed by mangroves is the least developed by the scientific literature (see e.g. Chan et al. 2012), since they recognize few of the cultural ESs, which are vital for traditional communities. Normally these services are mentioned as additional services provided by natural systems and analyzed superficially or analyzed generally as "non-commercial services" (Zhang et al. 2007). Interestingly, the present work is the first to highlight the importance of an ecosystem as an essential part of the life of the autochthonous people as a whole system, because they consider that mangrove is important not only for fishing, harvesting or even protection from hurricanes, but to their perception of nature and happiness.

Community evaluation of ESs of mangroves

A vital linkage between the mangrove ecosystem and the basic living needs of the local community is clear from the high values given by the studied population to the ESs provided by the mangroves. This link is manifested by means of particular forms of resource management that do not directly seek to obtain profit but rather a social and

cultural production of wellbeing, as well as perceptions and representations in relation to the natural world characterized by the idea of association with nature and dependence on its natural cycles. What the people that live from this ecosystem think can be very different from what is conceptualized by conventional economists. There is an ecological perception (identification with nature) that is generating a kind of value of ESs which is not contemplated by conventional tools for economic analysis (Kumar and Kumar 2008).

The traditions, perceptions, values, and functions evaluated in the Cumbe community are thus clearly outside the market system. The attribution of highest value given to the services "*production and regulation of gases*" and "*refuge*" proves traditional knowledge about the importance of these ESs, not only for their own community but in a wider sense for humanity and for the equilibrium of other related ecosystems. Also highly valued was the ESs "*food production*," demonstrating the importance of mangroves for community livelihood.

The culture of Cumbe's community like that of other communities is a traditional one. This culture belongs to a mode of production based on reciprocity rather than market logic, close to the primary source of food and well being because of its proximity to the mangroves. This is comparable for example, to the artisanal fishery in Tonga, where the fish for sale are only part of the complex puzzle of interpersonal relations, based in part on the voluntary and free donation of the product (Kronen 2004). In the above mentioned example, there is a transition from the traditions of exploiting the resource as social monetary exchange to a market system, which can lead to the loss of sense of value of a series of behaviour patterns related to the health of the ecosystem itself. In this community an inseparable link exists between humankind and nature, since the environment is "*the essential medium for social survival, source of life and cultural identity*" (Cunha 1992).

In fact, according to O'Brien and Leichenko (2003), the knowledge of social and cultural aspects of ESs is very limited, and the perception, evaluation and appropriation that the actual social actors make of them have been absent in the study of these ESs. It

is possible to make such quantifications, but the tools to be employed, as we have tried to demonstrate, are different from the conventional tools used up to now.

The survey method of community evaluation was a complementary method to the usual economic method for evaluating mangroves. Since the latter mostly considers individual willingness to pay for an ESs, the ultimate contribution of non pecuniary richness of mangroves if often undervalued (Munda 1996, O'Connor 2000, Chee 2004). An example is the case of the perception of complexity in rural environments in northern Europe, where forests mixed with diverse types of cultivated crops are perceived by the people as higher valued, rejecting the landscape composed of industrial monocultures (van Berkel and Verburg 2012). In the case of similar studies conducted in Irian Java (Indonesia), it has been shown that where there are strong ecological links between native populations and their surrounding habitat, severe restrictions on industrial activities based on logging (or shrimp aquaculture) are in place (Ruitenbeek 1994).

This implies that the clash of two economies, based on a different perception of mangroves (shrimp aquaculture and artisanal exploitation of mangroves) will be understood only by an evaluation able to capture the importance of ESs for local communities beyond their monetary value and taking into account the participation of the affected communities. The will balance the scales and give more objectivity to the possible decisions regarding the expansion of the former.

One of the most important findings of this study is the identification of a significant gap in the scientific literature in relation to cultural ESs with emphasis on identity, including maintenance of traditional knowledge, community, social relationships, personal satisfaction and freedom and physical and mental health.

In agreement with previous works (EMBRAPA 2004, IBAMA 2005, Meireles et al. 2007, Meireles and Queiroz 2010, Chapter I, Queiroz et al. 2013b), and based on the results of the work carried out in the community of Cumbe, we suggest that the studied communities have developed a traditional system of natural resources management through a relationship of respect, gratitude and complicity with nature. This presents itself as a direct cause of environmental protection in the locations in which the

traditional communities live. The complexity of the perception of landscape and well being have to be considered in the ESs quantification, even if the used (quantitative) tools are new and far from the economically standardized ones.

These communities have developed particular forms of natural resource management that do not directly seek profit, but social and cultural compensation. In this mental scheme, there are a series of perceptions and representations in relation to the natural world characterized by the idea of association with nature and dependence on natural cycles that should be taken into account when we evaluate the potential ESs that they offer.

Our results shed light on the symbolic dimension of ESs and on what they represent for the life of the peoples that live in close relationship with mangrove management, this a complex and multifaceted process that should consider the link between natural surroundings and the local communities and their level of satisfaction and view these as indispensable criteria for confronting the key challenges for mangrove conservation. The long-term benefits of mangroves for local communities outweigh those produced in the short term by industrial aquaculture, such as that for shrimp (Farley et al. 2010), but the lack of clear property and land-use laws, and undervaluation of other non-visible services with conventional valuation tools has made them vulnerable to an economy based on the economic power of short-term vision. Furthermore, mangroves are not isolated from the rest of the surrounding systems; on the contrary, they are a key part for their functioning (Alongi 2002).

It is thus essential to recognize that the diverse types of use and traditional occupation of mangroves are often not compatible with market relationships or the privatization of land, as they are understood today. These evaluations are related to conservation, protection and preservation of the dynamics and biodiversity and ecological functioning of natural systems. Continuity should be provided for material and energy flux, and community life (Acselrad et al. 2009, Meireles and Queiroz 2010). Some of the main results from this research are likely to be easy to extrapolate to other places in which local communities exploit ecosystems in conflict with other sources of short-

term economic benefit with marked loss of ecological and social values that often go unaccounted for in decision-making processes regarding land use change.

The present study thus contributes to a significant advance in the theoretical-methodological area of ecosystem services (ESs) when analysis of different types of links between society and wetlands are proposed, considering: 1) the participation of traditional communities in the construction of ecological knowledge to characterize ESs; 2) the multiple and often irreducible values of ESs; and 3) alternative proposals of evaluation of ESs that consider community perception in a non-monetary perspective. As a general conclusion, it has already been demonstrated that the economic goods derived from the direct extraction of natural resources can be as important as other types of exploitation such as shrimp aquaculture (Röanback 1999), but that a rigorous application of methods to capture non-economic values is still underdeveloped and the decision-making process should not neglect the experience of the autochthonous population (Raheem et al. 2012).

Chapter III

Industrial Aquaculture vs. Artisanal fisheries: Comparative analysis between two economies in the state of Ceará, Brazil.

Betorz, S. G., Mercader, A. T, Carol, M. J., Salvà, J. P. 2012. Evaluación Ambiental de la Acuicultura de Camarón sobre el ecosistema Manglar en el tramo bajo del río Jaguaribe. Universitat Autònoma de Barcelona (UAB). Trabajo de fin de carrera. 123 pp.

Burriel, M. C. 2012. L'altra cara del progr'es: estudi multidimensional sobre les conseqüències de les activitats d'explotació intensiva sobre les activitats derivades de les economies tradicionals a la comunitat de Cumbe, Brasil. Universitat Autònoma de Barcelona (UAB) - Master Work. 147 pp.

Dominguez, J. C., Monraba, J. A., Briansò, M. M., Serra-Pompei, C., Vide-Pifarre, D. 2014. Estudio económico sobre la pesca artesanal y análisis de sus diferencias con la acuicultura del camarón. Universitat Autònoma de Barcelona (UAB). Trabajo de fin de carrera. 106 pp.

Abstract

Traditional communities situated near to the coastal wetlands have developed a way of life adapted to living with the mangrove system, benefiting from its ecosystem services with various uses and activities (firewood extraction and artisanal fisheries based on the collection of crab and seafood, etc.). However recent history has seen the prioritization of industrial shrimp farming and a devaluation of these traditional activities, especially fishing and artisanal collection. We have identified that this happens mainly due to the fact that the profits generated by artisanal exploitation are usually invisible to the eyes of the state and are not accounted for at the institutional level, which prevents a fair comparison between traditional and industrial economic models. This paper aims to carry out an economic monitoring of artisanal fisheries to achieve an approximation of the economic gain from different types of this of activity and to contrast with industrial shrimp farming. To achieve this, we have carried out two field work campaigns in the communities of Cumbe and Curral Velho, in the state of Ceará (Brazil), using a combination of techniques for collecting data (tracking tables, interviews, zoning and questionnaires). From the results obtained it was concluded that the fishing by the communities studied is a type of artisanal economy which is not only feasible but competes directly with industrial aquaculture and is incompatible with it, due to various factors related to the use of the mangrove itself. It is also an activity that can be considered almost invisible to the State, as the official statistics undervalue or simply fail to count this economy. Therefore artisanal fishing is an unconsidered economic activity when it comes to processes of forming coastal management policies. The results presented in this study should be considered as an example which can be extrapolated from, in which we found that it is essential to identify, encourage and affirm which activities are compatible with maintaining the proper functioning of productive ecosystems, their biodiversity and the sustained provision of a wide range of ecosystem services, as in the case of artisanal fisheries.

Keywords: Artisanal fishing, industrial shrimp aquaculture, Ecosystem Services, mangroves, coastal management.

Introduction

Human welfare and poverty reduction depends on obtaining basic materials for a decent life, health, good social relations, security and freedom of choice and action. These basic variables are obtained, in many cases, through the services produced by ecosystems that sustain and fulfill human societies (Daily 1997, MA 2005, TEEB 2010).

However, in the last 50 years the majority of ecosystems have been strongly transformed into intensive production systems of goods: woods, forests and natural grasslands have been converted into agricultural systems for food production, deteriorating and / or reducing their capacity to provide various services to humanity that came from a healthy ecosystem (Balvanera and Cotler 2007).

Wetlands have not been spared the intense transformation mainly caused by agricultural systems such as plant monocultures and aquaculture. Mangroves, as a particular case, despite legislation designed to protect them and all their socio-environmental and economic importance, still rank as one of the most degraded ecosystems on Earth, being lost at an alarming rate and reaching high levels of deterioration in recent decades, especially due to intensive shrimp production (Ellison 2008, Queiroz et al. 2013, Polidoro et al. 2010).

Mangroves are recognized as one of the richest and most productive ecosystems on Earth, formed at the interface between land, sea and estuaries in coastal areas of 123 countries in tropical and subtropical regions (Barbier et al., systems, estuarine, 1997, Spalding et al. 2010). These frontier systems are essential for the conservation of biological diversity, providing refuge, spawning, nursery and feeding habitats, as well as nutrients for different organisms. A wide range of animals and other organisms depend on the balance in the ecosystem of these coastal forests, being the function of mangroves vital in the marine food chain for the survival of many populations (FAO 2007). It has been estimated that up to 80% of the catch of fish in tropical coastal areas is directly or indirectly dependent on mangroves, when there is a close connection between these wetlands and coral reef systems (Field 1998, Alongi 2002).

The deforestation rate of mangroves has risen by 3-5 times, up to the present day, a quarter part of the mangrove forest on the planet has been lost (UNEP 2014). From the economic point of view, there are many examples that illustrate that the value of intact wetlands, is significantly higher than the value of such wetlands converted for intensive farming or altered in any way, blocking the natural flows of matter and energy. For example, areas of intact mangroves in Thailand have at present a total net economic value -calculated on the economic contribution of both marketed products, like fish, and non-marketed services, such as protection from storm damage and carbon-sequestration - of at least $ 1000 per hectare (and possibly as high as $ 36,000 per hectare) compared with about $ 200 per hectare when converted to shrimp farms (MA 2005). Costanza et al. (1997), Field (1998) and Polidoro et al. (2010) have estimated that the ecosystem services such wetlands generate at a minimum an economic value all over the world of about $ 1.6 trillion a year. The conversion of wetlands is never economically justified; these figures illustrate the fact that many of the economic and social benefits that come directly from the wetlands have not been considered by the decision makers when deciding the policy management of these coastal areas. When an overall calculation of the economic losses are carried out, taking into account basic ecosystem services, they reach some $ 42 billion annually (UNEP 2014).

The shrimp industry has argued that its expansion in tropical and subtropical areas would increase the supply of food, decrease the pressure on fish stocks, increase foreign exchange earnings and provide food for poor countries, developing the policy ideas of the "Blue Revolution" (Costa-Pierce 2002). Currently this industry produces one of the most important internationally traded aquaculture related goods. In most of the countries of Asia, Latin America and Africa, shrimp monoculture has been planned without regulation or order, and its very rapid growth in recent years has been accompanied by a sequential exploitation of natural resources. Shrimp aquaculture has emerged as a major (if not the main) cause of the destruction of large areas of mangroves, coastal landscapes and the transformation of livelihoods in areas where there has been intensive development (Barbier and Strand 1998; Rönnbäck 1999, Alongi 2002, EJF 2003 and Polidoro et al. 2010, Chapter I).

Several studies show how the worldwide shrimp industry has evolved to occupy coastal areas, especially the area of mangroves. This activity minimizes the production of ecosystem goods and services and compromises in the medium and long-term the natural and social wealth in the countries where it is developing intensively. The result, due to both socio-environmental problems, is increased poverty, food insecurity, displacement of communities, and pollution of drinking water, as well as poor conditions and impacts on the health of workers in the shrimp industry itself (Bailey 1988, Beveridge et al. 1994, Flaherty and Karnjanakesorn 1995, Dewalt et al. 1996, Stonichetal 1997, Stanley 1998, Kautsky et al. 2000).

One of the most significant socio-environmental impacts of shrimp farming is the destruction of habitats formerly used for the development of artisanal fishery, reducing the possibility of performing extractive subsistence activities, endangering food sovereignty and transforming the dynamics of life in traditional communities (EMBRAPA 2004, IBAMA 2005, Meireles et al. 2007, Meireles and Queiroz 2010, Warren-Rhodes et al. 2011, Montserrat et al. 2011, Chapter II, Queiroz et al. 2013b, Queiroz et al. 2013c).

These communities maintain a lifestyle based on traditional activities by establishing a close relationship with nature. They are people adapted to live with the mangrove system, exploiting different uses, activities, and benefiting from ecosystem services, such as wood fuel, artisanal fishing and collecting shellfish and crab (Aburto-Oropeza et al. 2008, Farley et al. 2010, Warren Rhodes 2011). They continue traditional cultures that are associated with the modes of production of pre-capitalist societies where work has not yet become a commodity, their market dependence already exists, but has not been completed. These communities have developed special ways of managing natural resources that do not directly seek profit, but instead cultural and social production, establishing another kind of perception in relation to the natural world marked by the idea of association with nature and its cycles of dependency (Diegues 1983).

These traditional cultures develop in a small scale commodity mode of production, being different from those associated with the capitalist mode of production. For

example, the case of industrial aquaculture, in which not only the workforce, but nature itself becomes a commodity, has transformed the perception of the habitat. These two societies have different rationales, presenting a set of social goals which are consciously and differently developed to achieve a set of objectives. One mode of production is oriented for monetary profit (aquaculture), where traditional collective solidarity disappears and therefore natural resources are degraded. The other (artisanal fisheries/collection) still belongs to a society whose ultimate goal is the maintenance of that collective solidarity and not the accumulation of assets and income. In this way of life, the natural resources on which they depend for their survival (Godelier 1984) are preserved. Therefore between these two types of society there is a fundamental difference in the conception and representation of nature and its resources.

The local economy of traditional communities obeys another logic but nevertheless is very important within the capitalist society in which it operates. The relation that its practitioners have with the mangrove serves to protect that ecosystem, so the traditional communities are considered important agents for the protection of natural areas (Rönnbäck et al. 2007). This reflects another important aspect of these traditional cultures: the existence of natural resource management marked by respect for natural cycles in the system and exploitation within the capacity for recuperation of species of animals and plants used. These management systems are not only traditional forms of economic exploitation of natural resources, but reveal a set of knowledge acquired from older tradition, inherited through the myths and symbols that lead to the maintenance and sustainable use of natural ecosystems (Pereira and Diegues 2010, Chapter II).

It is urgent to consider the fact that the ways of life of traditional communities should not disappear. The main reason why they are not considered and prioritized when implementing new economic activities in coastal areas is because they are not valued in the proper way by stakeholders. On a deeper analysis, the basis of the problem can be identified as not only the fact that the capitalist mode of production is degrading the traditional lifestyle and has been wiping out their existing economic activities for centuries, but also that this traditional economy is severely undervalued and made invisible. Supporters of aquaculture claim a quick and lucrative economic potential,

which has led to a relegation of the traditional economy to a second and third level compared to the theoretical progress given by the intensive exploitation of shrimp farming (Diele et al. 2005, Aburto-Oropeza et al. 2008, Walters et al. 2008).

Proceeds from artisanal gathering are usually invisible to the state; they are not recognized or counted at the institutional level, which prevents a fair comparison between traditional and industrial economic models. The main problem is that traditional communities lack data on their economic activities, so the comparison with shrimp aquaculture or other industrial exploitations is not possible. For example, we know that thousands of families survive from artisanal fisheries but little is known about how and how much they contribute economically from the viewpoint of the economic sustainability of local populations. It is therefore essential to estimate the monetary contribution of this type of activity in order to make a fair comparison with the numbers provided by the industrial shrimp farming, and be able to compare profit figures per hectare (or square meter).

The purpose of this paper is making an accurate economic assessment of certain activities of extracting renewable resources (fish, crabs and shellfish) directly or indirectly related to the mangrove or adjacent systems. The main questions proposed are: 1) What are the economic benefits produced by artisanal fisheries developed in the mangroves on a comparable basis with the shrimp industry? 2) What is the level of community contribution to this type of artisan activity and how does it relate to the welfare of the people who depend on mangrove? 3) What is the difference between this type of activity and the intensive exploitation which degrades the ecosystem so much that it is made incompatible with any other source of income?

To answer our research questions an economic monitoring of artisanal fisheries was carried out in order to achieve an approximation of the economic gain from different types of artisanal fisheries in contrast with that of industrial shrimp farming. To develop and achieve our objectives, a field research program was chosen in the traditional communities of Cumbe and Curra Velho, in the state of Ceará (Brazil), which will be the

basis of the analysis, due to their differences especially in their relation to shrimp farming during the last twenty years.

Methodology

This monitoring was conducted in the communities of Cumbe and Curral Velho. Cumbe community is located in the estuary of the river Jaguaribe, in Aracati municipality in the state of Ceará, Brazil (Figure 1) in the right area of the mouth of the Rio Jaguaribe in the Environmental Preservation Area of (APA) of Canoa Quebrada, Aracati region. The Jaguaribe is the largest river in the state with an area of 72,645 square kilometers, occupying 50% of the territory of Ceará (Araújo 2006).

Due to its geographical location the Cumbe community is far away from the sea and therefore maintains a closer relationship with the mangrove and the estuary. They are described as a community of fishermen, farmers and artisans (Queiroz, 2007). The total population of the community of Cumbe is 621 inhabitants distributed in 155 families and is 0.9% of the population of Aracati, which is of 69,159 inhabitants (SMS 2012).

The other studied locality, Curral Velho, is a community located in the municipality of Acaraú, on the coastal plain in the state of Ceará, Brazil (Figure 1). The village is bordered on the north by the Arpoeiras beach on the Atlantic Ocean, and the municipalities Acaraú and Itarema, to the west and east respectively. Curral Velho is a community that is divided into 3 distinct zones: Curral Velho de Cima, Nun Nun Velho and Velho de Baixo Honórios. Given its geographical location, Curral Velho is a community known for fishing the mangroves, sea fishing, and for its farmers and artisans. The total population of Curral Velho is 2,663, belonging to 707 families and making up 4.6% of the population of Acaraú, which is 57.551 inhabitants (SMS 2013).

Monitoring of the Cumbe fishing community.

In Cumbe two types of research were carried out. The first aimed at comprehensively quantifying the scale of the artisanal fishing from information about the species of fish, crabs and shellfish caught or collected, quantities in kilograms and the location of the fishing grounds. The group chosen for realization of this study was composed of 45

fishing workers and 27 crab and shellfish harvesters. The area chosen for the monitoring was a fishing area of 2166ha, 544ha of river, plus 1622ha of mangrove. These people were monitored using tracking tables. The non-complete information was supplemented with the application of semi-open questionnaires (Table 4).

Monitoring	Community	Type of Artisan Fishing	Ecosystem	Instruments for information collection	Information monitored	Sample
First Monitoring (October, November and December 2011)	Cumbe	Fishing	Mangrove (Gamboa)	Tracking table (Annex III)	Economic gain generated by the artisanal fisheries (€ / month)	35 fish fishing workers
					Number of fish / crabs, species and location. (kilos or units / month)	
		Crabs and shellfish harvesting		Semi-open questionnaires (Annex IV)	Average salary of artisanal / crab harvesting workers (€ / month)	35 fish fishing workers 20 shellfish harvesters
Second Monitoring (2012)		Crab harvesting Shellfish harvesting	Mangrove	Zoning Interviews (Annex VI and VII)	Total production of crabs (€ / ha) Families held directly of artisanal fishing in the mangrove Economic profit generated by artisanal fisheries (crabs / seafood) (€ / month) Average salary of artisanal / crab fishermen (€ / month) Time value of labor in artisanal fishing / crab (€ / hour)	42 crab harvesters 17 shellfish harvesters
Third Monitoring (October, November and December 2013)		Fish fishing	Continental Shelf	Tracking table (Annex III)	Total fish production (Kg/day) Characteristics of	17 fish fishing workers (23% of total populatio n)

	Curral Velho	Shellfish harvesting	Mangrove (Gamboas)	Semi-open questionnaires (Annex V)	fishing group or individual Destination of catches (sale / consumption) Amount of catch	56 fish fishing workers 9 shellfish harvesters

Table 4. Methodological table with the desired information, the techniques used and analyzed samples.

The second monitoring carried out in Cumbe aimed to generate information on the total average production of crabs in the area of study, the number of people and families supported directly from the harvesting of crabs (*Ucides cordatus and Cardisoma guanhumi*) and shellfish (*Mytella charruana*) money per month from the sale of crabs and shellfish and the average salary of harvesters (per month). The group of fishing workers who participated in the monitoring was 42 crab collectors (those who go gathering more than three days per week and at least 6 months per year) and 17 shellfish harvesters in the study area. The Cumbe community occupies an area of approximately 400 hectares located in the central part of the area's mangrove zone on the lower river Jaguaribe. This area is 2.6 km wide and 1.5 km long and runs perpendicular to the river. This monitoring was also carried out on the basis of the methodology explained in Table 4.

To obtain the data on the total production of crabs the different mangrove productivity in three different areas of study has been taken as a measure and has been multiplied for the mangrove areas. Because each area has a different population density, this provides a production level for each of the three different zones (Figure 9). This data was obtained using the environmental quality indicator that tells us the number of crabs larger than four centimeters present per square meter (Burriel 2012). Considering that the saleable crab catch is bigger than 4 cm., such individuals were included as potentially productive. Choice of the zoning criteria has been based on observations of the territory and the information provided by the fishing workers of the region themselves. To meet the objectives we chose a territory representing the different habitats and different degrees of degradation of the mangrove compared to shrimp farms (Betorz et al. 2012, Burriel 2012). With these premises, a region of 400 hectares which included three

different levels of significant degradation caused by human action (urbanization and aquaculture farms) (Burriel 2012) was selected.

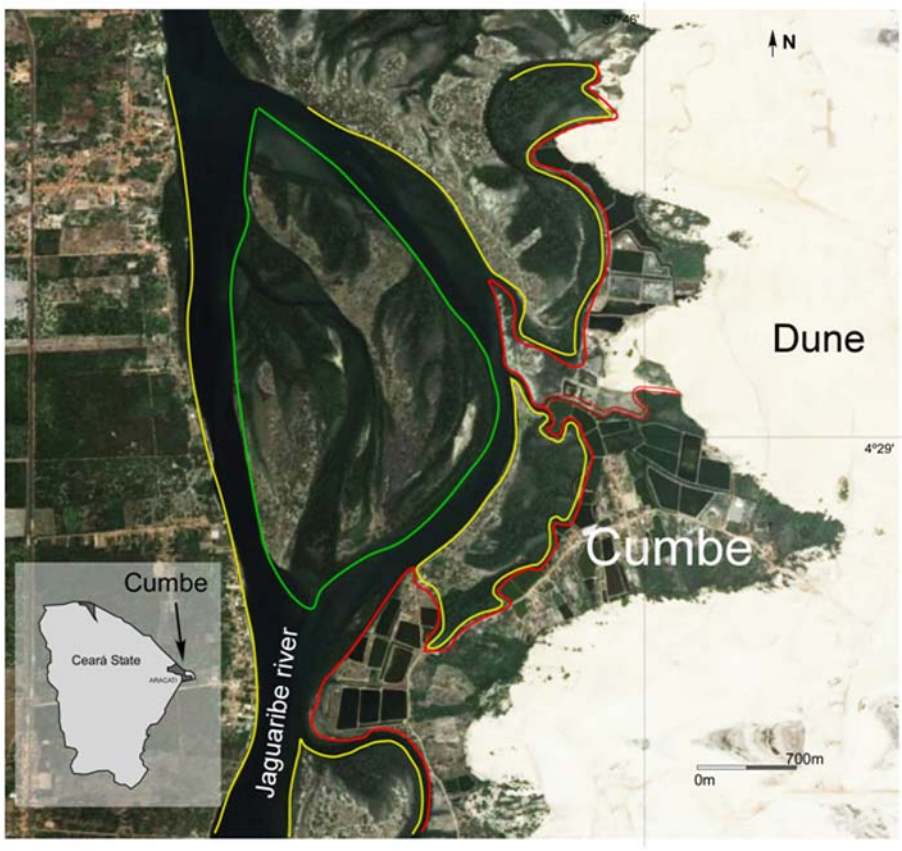

Figure 9. Study area divided into three zones with different anthropogenic pressure and degradation gradient: low pressure (green zone), intermediate pressure (yellow area) and high pressure (red zone).

The total number of families who are dependent on mangrove is associated with the number working in artisanal harvesting of crabs and shellfish. Therefore, the results refer to a representation of the total but not strictly to the total population of Cumbe, as there are other economic activities not directly related to the mangrove system. Some other activities directly related to the mangrove will not be counted in the results such as the collection of wood for building houses and for provide heat, collecting honey, crafts etc. Information gathering was conducted by interviews with crabs and shellfish harvesters.

Monitoring of artisanal fisheries in Curral Velho

The third monitoring of artisanal fisheries was made in Curral Velho considering fishing workers of the area (coast and continental shelf) and the shellfish harvesters in the gamboa areas to obtain an approximation of economic profit generated by these two types of fishing craft near the mangrove. The following information was collected: Tracking tables, zoning, interviews and questionnaires (Table 5).

Analysis and processing of data

The information on tracking the fishing workers was systematized in Microsoft Excel tables and analyzed to extract absolute values, averages and percentages. Economic data obtained from monitoring conducted in 1 and 2 in Cumbe and the third monitoring made in Curral Velho are presented in Euros[5].

Results

There is a sector of the Cumbe community dedicated to artisanal fishing as the main economic activity. This group is composed of 45 fishermen (fish and crabs) and 27 shellfish harvesters. These represent 11.5% of the total population of the community.

There are large differences in the earnings of different fishing workers in the area considered (Table 2). During the three monitored months, the 1st and 2nd had higher revenues compared to the 3rd. This can be explained because the 3rd month was December, a month with more celebrations and holidays in which fisher people do not go to fish so frequently in the mangroves. From the calculation of the average economic gain during the 3 months of research, we found the value of € 12,557 / month generated by artisanal fisheries in the mangrove of Cumbe, from the collection of crabs and finfish.

Fishermen	Total
month 1	14.217
month 2	14.224
month 3	9.231

Table 5. Economic gain generated by artisanal fisheries (crabs and fish).

[5] All the values obtained in Monitoring 1 and 2 were converted to euros: I euro =2.56034 BRL. Consulted on 24/05/2012 http://www.xe.com/ucc/convert/?Amount=1&From=EUR&To=BRL

Table 6 shows the average salary of fishing workers per month. The calculations gave an average value of 369 €/month from fishing for fish and collecting crabs.

	Month 1	Month 2	Month 3	Total (€/month)
Average Fisherman ± stdev	418 ± 237	418 ± 192	271 ± 188	1108 ± 481

Table 6. Average economic gain per fisherman (€ / month).

Tables 4 and 5 show the quantities counted of fish and crabs caught in the 3 months by the same group of fishing workers (35 in total). A total of 130,337 crabs (43,445 pcs./Month) and 1,931 kg of fish (643 kg/month) were caught within the 3 months of the investigation.

Months	Month1	Month2	Month 3	TOTAL (Units)
Number of crabs (Pcs.)	46.191	50.858	33.288	130.337

Table 7.Production of crabs (pcs./month)

To get an approximation of the real income from artisanal fishing, three types of scenarios are assumed: 1 Fishing workers sell 100% of their catch, total direct earnings would be € 37,672.94; 2 fishing workers sell 50% of their catch, total direct earnings would be € 18,836.47 and 3 they sell 25% of their catch with total direct earnings of € 9,418.24.

To identify the total economic gain generated by the artisanal fisheries in Cumbe, considering this time also the collection of shellfish, semi-open questionnaires were filled in by 35 fish fishing workers (81% of all fish fishing workers) and 20 shellfish collectors (74% of total). As a result we found the total economic gain received by fishing workers in Cumbe to be € 103,438 / year, taking artisanal fishing of crabs, fish and shellfish together, that is € 8,619 / month. The results of the second monitoring in Cumbe showed that the value of a well preserved hectare of mangrove from the production of crabs is 0.71 € / m2, i.e. € 7,120 / ha. This value was obtained from measurements of different mangrove productivity in three different areas of study in the community.

Of the 155 families in Cumbe, 44 families (27%) are dependent on artisanal fishing in the mangrove. People get the products that can be used either for own consumption, to market generating income for their families or to exchange with other families for other commodities (Table 8). It should be noted that these data have been obtained only for people who are dedicated to the collection of crab and shellfish, but there are several other types of mangrove resource extraction (finfish, firewood, etc.) from which other families in the community depend. Therefore this result is possibly undervalued and the percentage of families who depend directly or indirectly on mangroves could be even higher.

	Total Cumbe families	Total of people Maintained	Total of families Maintained
Quantities (Units.)	155	144	43 (27% of the total population of Cumbe)

Table 8. Persons living directly from the revenue generated by the collection of crabs and shellfish.

The second monitoring campaign made in Cumbe indicates another value of financial gain: € 20,985/month, the money related to artisanal fisheries in Cumbe mangrove taking into account only the collection of crabs and shellfish (42 crab collectors and 17 shellfish) and not the caught fish (Table 9). The values obtained from each of the species have been added, obtaining the total economic value as economic profit generated by the harvesting of crab and seafood (€/month).

	Individuals or kg/month	Price (€)	€/month
Ucides cordatus	80.560	0,24	19.334
Cardisoma guanhumi	2.760	0,4	1.104
Mytella charruana	2.280	2,4	547
TOTAL			20.985

Table 9. Economic gain generated by artisanal fisheries in Cumbe mangrove (€/month).

From the data of Table 10 it can seen that, on average, each crab collector can earn a salary of 508 €/month (*Ucides cordatus*) and 360 €/month (*Cardisoma guanhumi*).

	Individuals/Week/Fisherperson	Individual/Month	€/Individual	€/Month
Ucides cordatus	4530	2120	0,24	508
Cardisoma guanhumi	225	900	0,40	360

Table 10. Average monthly salary obtained from the sale of crabs (€/m2).

For Ucides cordatus harvesters, people worked on average 5 hours a day for 4.6 days a week, working 23 hours / week (€ 127.20 / week or € 5.53 / hour of work).

Three results of economic profit generated from artisanal fisheries in Cumbe can be deduced: 1. economic gain generated by catching fish and crabs (€ 12,557/month) obtained from daily monitoring of 35 fisher people ; 2. Economic gain generated by catching fish, crabs and shellfish (€ 103,438/year or € 8,619/month) obtained from semi-open questionnaires conducted with 35 male and 20 female fishing workers. Income was calculated from crab and shellfish collection (€ 20,985/month) from the daily monitoring conducted with 42 crab collectors and 17 shellfish harvesters (Annex 1 and 2). It can be seen that the data can vary depending on the method applied and according to the fishing activity carried out.

The results of monitoring conducted in Curral Velho 3 showed that the artisanal fisheries sector in this community is made up of 99 people divided between fish fishing workers (fishing on the continental shelf and in the gamboa areas) and shellfish collectors and representing 3.7% of the population total Curral Velho (Annex VIII). Economic profit generated from this sector of artisanal fisheries on the continental shelf amounts to € 11,428/month, but it is noteworthy that 19% (2204 €) of this value is used for consumption or exchange within the community. The monitoring has also demonstrated that there are differences in the economic profit generated by artisanal fisheries in Curral Velho between that from work done individually or in groups (Table 10 and 11).

	Total fishing (€)	Total of Fishing workers	Days	Total (€/fishing worker)	Total (€/fishing worker/business day)	Total (€/fishing worker/calendar days)	Total (fishing worker/month)
individual	13.099	7	42	1871	45	21	624
Group	21.186	38	16	558	34	6	186
TOTAL	34.285	45	58	2150	51	13	405

Table 11. Economic gain generated by artisanal individual and group fisheries in Curral Velho (€ / month).

Table 12 shows more accurately the benefit to each individual or group of fishing workers per working day. Over a period of three months individual fishers worked 42 days to earn € 1,871, which means receiving € 624 / month (45 € / hour). Fishers working in groups worked 16 days to earn € 558, which is € 186 / month (34 € / hour).

Destination	Total (€/month) fishing worker	Total (€/month) Group of fishing workers	Total General	%
Sold	3.179	6.043	9.223	80
Self consumption	1.186	1.018	2.204	19
Total	4.366	7.061	11.428	100

Table 12. Total economic profit generated by artisanal fisheries in Curral Velho (€ / month).

Discussion

This is the first study in which an assessment of the economy based on the artisanal extraction of natural resources arising directly or indirectly from mangroves (fish, crab or shellfish) is compared directly with the exploitation of shrimp farms in the same ecosystem. The data showed that not only is this type of work economically viable but that it competes directly with industrial aquaculture. Importantly, one of the conclusions arising is that both economies are incompatible due to factors related to the use of the mangrove itself.

Economic benefits produced by artisanal fisheries carried out in the mangroves and their relationship to the way of life of traditional communities

From the present data it can be deduced that there is a close economic dependence of these communities on artisanal fishing. These communities are characterized by a way of associating with mangroves (and nearby ecosystems), inherited by the culture of their populations. However, even if mangroves are responsible for the way of life of traditional communities in this and other places (as have suggested, Diegues and Arruda 2001, Chapter II), the entire economy generated by artisanal fisher people is almost invisible at the State level within the official statistics, being clearly undervalued: artisanal fishing is an unconsidered economic activity in the processes of coastal management policies.

In the present study it has been identified that 72 people of the community of Cumbe (43 families,27% of total population) depend directly on artisanal fishing in the mangrove as their main economic activity. All workers together generated an economic gain of € 8,619 / month on average, which means that they receive a salary of 369 € / month per person. Curral Velho is very similar, the artisanal fisheries being more strongly dependent on the coast and continental shelf. We have identified 99 people from the Curral Velho community having artisanal fishing as their main economic activity (26 families or 3.7% of the total population), who generate together an economic gain which comes on average to € 11,428 / month (salaries of 624 € /month for individual fishing worker and 558 € / month for group of fishing workers). In both communities, approximately 20% of the economic gains are invested in the community or family for own consumption (or to exchange with other families for other goods), 80% of the catch being sold.

When we compare the income of artisanal fishermen with the average income of workers in the shrimp industry, we find that the fishing workers earn 33 € / day working less hours than shrimp farm workers. Shrimp workers work an average of 8 hours a day (22 days per month) to earn an average of 269 € / month, which means earning 12 € / day (Dominguez et al. 2014). These data show that the fishing workers not only earn a higher salary than those employed in the shrimp industry, but also enjoy a much superior quality of life in the coastal mangrove forest.

These results also show that a fishing worker can double the value of the minimum wage working in artisanal fisheries, without taking into consideration other types of fishing operations, or of the part of the catch kept for own consumption or other activities that they develop in parallel and are complementary to fishing, such as handicrafts and agriculture.

As well as having a very decent income, according to surveys that have been made and personal observation and other work in Cumbe and Curral Velho (Betorz et al. 2012, Queiroz et al. 2013c, Dominguez et al. 2014, Chapter II), most people working in artisanal fisheries are very proud and happy in their work. These people value not only economic

benefits received but also the fact that working in the mangroves means more freedom. "*I am proud to be a collector of crabs (...) we are free, free to decide how and how much we want to work, and that makes us responsible. Mangroves are our bank and we decide when we get the money, we owe nobody but Him*." (Testimony of one of the fishing worker from Cumbe). On the other hand people who are engaged in activities related to shrimp aquaculture do not describe their employment in sentimental terms, as may be the case from workers in the artisanal extractive economy, but use concepts like "*it is progress*," "*its secure money*" or "*artisanal fishing is out of date*."

The results achieved confirmed the economic potential of the mangrove and showed how the distribution of income in the town is very important when assessing either economy, without even taking into account other kinds of perceptions and values that in fact can and should be quantified, but with new approaches (Queiroz et al. 2013c, Chapter II). It is suggested that the economic benefits generated by artisanal fisheries in terms of market from the sale of the products are very significant, representing a valuable contribution to the economic sustainability of traditional communities living in coastal areas. Beyond the economic benefits other invisible benefits have been identified that do not fit into the logic of the present markets. The benefits of the consumption for the fishermen's families or the exchange of fishing products for other goods between families, together with the economic benefits in terms of the market, move the economy in traditional communities and become the basis for their survival. For example, in the communities studied along the coastal zone there are children with older siblings who after school pass some time in the mangroves and catch some crabs and / or oysters for food, or for example when people go fishing together as a family and everything collected or fished stays at home or is given away. In the general accountancy of the Brazilian State, such benefits are not considered, but they are basic to make coexistence possible in the rural society they belong to (Kronen 2004, Walter et al 2008, Warren-Rhodes 2011). Recently it has been shown that access to the mangrove ecosystem through artisanal fishing has not only a material and economic importance (physical access) but also a symbolic one, because not having access to this natural system can be

not just a real problem for survival but also for the self realization of the fishing workers or social group (Butler and Oluoch Kosura 2006, Queiroz et al. 2014).

Many studies report the relationship between people and the natural environment and how forests attribute values to the population generating an ever stronger emotional meaning, beyond spirituality and mysticism (Schmithüsen 1999). For all these reasons it can be argued that people who live in the traditional economy in rural communities, experience labor and social welfare, both because of their incomes and due to the positive assessment that they make of everything around their working lives which seems to be more significant than the valuation made by shrimp farm workers. According to studies by Betorz et al. (2012) and Chapter II, the perception and linking that aquaculture workers and fisher people have with mangroves and their surroundings are very different. The perception of aquaculture workers is a monetary logic. In this way of thinking, the greatest benefit is taken only by entrepreneurs and investors, resulting in an exclusively monetary view of the connection with nature. Artisanal fishermen have a perception that is also due to a monetary logic (because it is also the mangrove that provides economic gains to guarantee the survival of their families) but one that is distinct from the logic of capitalism: beyond the material benefits, intangible symbolic and ancestral links are established between communities and the natural world, directly influencing their welfare. Put another way, it is a relationship that they assert generates economic gain but also generates happiness and freedom, a relationship that is a fundamental base of the maintenance of the traditional way of life of fishing communities.

Thus, we understand that the mangrove ecosystem is a communal usufruct. If artisanal fishing continues to obey a common, collective and community logic, which, in contrast to industrial logic, has both a material and immaterial form, communities can benefit from the mangrove in the long-term (Firmo et al. 2012).

Furthermore, it is shown that both types of exploitation (artisanal fisheries and aquaculture industry) are incompatible. For the Cumbe community we demonstrated that the deletion of 1ha of mangroves for the construction of shrimp farms would mean

the loss of € 7,120 / ha only for the fall in the flow of ecosystem services of artisanal crabbing, without considering all other fishing activities developed there and other services provided by mangroves. This is a very high value and shows the great capacity of this ecosystem.

Following this reasoning, in north-eastern Brazil every hectare of mangrove destroyed in Suape (Pernambuco, Brazil) would mean the loss of € 3 million per year. This calculation represents the economic benefits of ecosystem services such as fisheries, tourism, the retention of carbon from the atmosphere, containment of erosion, biological purification and landing area for migratory birds among others (Walters et al. 2008).

In Brazil in 2003, the average productivity of farmed shrimp reached 6,084 kg / ha per year (ABCC 2004, Rocha et al. 2004). Dote Sá (2010) established the average productivity of 12,194 kg / ha / year for shrimp farming developed in the environment of Jaguaribe river (Ceará, Brazil) which is higher than that of any Brazilian State, including Ceará itself (7,676 kg / ha) (ABCC 2004, Rocha et al. 2004). If shrimp are sold at a price of 2.34 € / kg, the economic profit generated from the commercialization of shrimp would be about € 28,533 / ha / year. When we compare this value with the economic gains generated by mangroves per hectare at 7,120 € / ha, we conclude that in the very short term, the shrimp industry seems very appealing. However, part of the mangrove is deeply affected by this type of activity (see below), and the distribution of benefits is much lower among the community.

Profits generated per hectare of shrimp farm are difficult to match by the economic values that a hectare of mangrove can provide, being apparently superior. But it's widely recognized that shrimp aquaculture generates medium-term environmental damage of high importance, first as they have to physically occupy part of the natural resources of an area. This process of occupation and installation produces a variety of chemical and biological changes in the ground, causing waterproofing of soils and making them unusable (Alongi 2002, EJF 2003, IBAMA 2005, Rivera-Ferre 2009, Polidoro et al. 2010, Queiroz et al. 2013b).

It is known that mangroves are breeding grounds for many commercially important fish species (Robertson and Duke 1990). For example: shrimp start life in the open sea and after several stages of growth the larvae move to estuarine waters where they remain for some time; the estuarine habitat provides nutrient-rich substances, and mangroves provide protection from predators. Any disturbance to this ecosystem by mangrove conversion results in less fish population and lower incomes for fisher people (Spaninks and Van Beukering 1997).

It has been estimated that at a minimum, the economic contribution of ecosystem services produced by mangroves for economic development in tropical coastal regions is about $ 1.6 billion a year. In several studies, it is also estimated that nearly 80% of fish catches in tropical coastal areas which are connected directly or indirectly dependent on mangroves depends on the habitat health (Costanza et al. 1997, Field 1998, Ellison 2008, Polidoro 2010). If we consider the ecosystem services of mangroves that give some kind of economic benefit, it can be argued that their economic value would be estimated at about 10,000 € per ha / year approximately (Costanza et al. 1998).

In the case of Cumbe severe incompatibility can be demonstrated between shrimp farming and artisanal fishing. The second monitoring results show Cumbe achieved more than twice the production of crabs in the B (0.66 € / m2) and C (0.71 € / m2) areas classified as moderately and slightly degraded, than in the area (€ 0.32 $ / m2) ranked as most affected by human action (Burriel 2012). The more degraded the mangrove habitat or the more human pressure put on it, the less the production of crab per square meter, which decreases considerably. It has also been demonstrated in the study area that there is a gradient of anthropogenic influence due to shrimp farming (Betorz et al. 2012, Burriel 2012). The closer to the farms, the more the disruption in the structure of mangrove soil organic matter and the higher the mortality of filter feeders such as oysters. Crabs may be affected by this factor (as well as by greater accessibility due to the proximity to the town), which makes their extraction levels different by region. This implies that the less degraded areas provide up to € 0.66 / m2, while the most affected by shrimp farms only 0.32 € / m2 (Burriel 2012). These data, match up with the literature that states that the mangroves near the disturbed areas are younger, are more poorly structured and are less bio-diverse (Alongi 2002). A study conducted in the Gulf of California showed that the mangrove area produced a large amount of food each year (Aburto-Oropeza et al. 2008),

without calculating in that paper the benefits of providing food taken by whole community ecosystem (seafood, firewood, etc.). Therefore, we see that artisanal activity is the real alternative to a defectively planned exploitation that is highly aggressive to the environment.

Industrial aquaculture vs. artisanal fisheries: factors to be taken into account not covered by the current management models.

The economic benefits of mangrove in the long term are much greater than those produced in the very short term by an industrial shrimp aquaculture (Farley et al. 2010), but the lack of ownership and of clear laws on use planning, as well as an underestimation of other services not visible with conventional tools has made the mangrove vulnerable to an economy based on short-term economic power.

Predatory practices, especially those related to achieving high productivity per hectare, have been widely adopted by aquaculture ventures and have generated social and environmental impacts with disastrous results, which have been widely studied in the region (IBAMA 2005, Embrapa 2004, Queiroz et al. 2013b, Chapter I). The search for high productivity in this context is revealing the true essence of shrimp agribusiness. While shrimp farms achieve (temporary) high productivity they generate impacts such as "involuntary" release of exotic species, competition with native species and release of untreated effluents into water bodies, thus causing the decline of fish stocks and making artisanal fishing unfeasible, causing the impoverishment of communities and putting the source of survival of families at risk.

In this context, shrimp agribusiness, behind the figures reported from the marketing of high productivity, hides an unsustainable practice when examined from the social and environmental viewpoint. The development of this activity involves outsourcing high costs to society and the environment - disease, pollution and poverty - while a minority appropriates the profits obtained, thus establishing a serious ecological and environmental conflict and reproducing environmental injustice (Martínez-Alier 2007, 2009, Acselrad et al. 2009, Meireles and Queiroz 2010).

This type of activity, as it is carried out, favors small groups at the expense of the impoverishment of traditional communities, reflecting a model characterized by the concentration of power and the appropriation of spaces and natural resources that is responsible for the proliferation of environmental injustice. It is a process that subjects the traditional communities to territorial exclusion and insecurity caused by the impossibility of continuing the traditional activities supporting their way of life (EJF 2003, Montserrat et al. 2011a, Montserrat et al. 2011b, C-CONDEM 2009).

Alongi (2002) predicted that in the 25 years following his study, shrimp aquaculture, together with overfishing, would be the greatest threats to mangrove conservation. That same conclusion was reached at Duke (2007), leaving a very bleak prospect for one of the most biodiversity providers of ecosystem services, at local and global level, on the entire planet. The equation is complex: it has given privilege to the possibility of achieving profits at the expense of others and has favored short-term profits at the expense of those in the medium and long term. The final question is which model is wanted for the future: one of immediate benefits without regard to the potential environmental and social damage, or one of long term benefits, preserving traditional cultures and ecosystems?

Based on this study we consider this severe deterioration of ecosystems must be brought to a halt, mitigated, and even put into reverse by studies capable of generating accurate information on the actual state of the ecosystem along coastal areas. To achieve this, we must consider this study as an example to be extrapolated from, in which we find that it is essential to indentify, encourage and affirm activities which are compatible with maintaining the proper functioning of productive ecosystems, their biodiversity and the sustained provision of a wide range of ecosystem services, as in the case of artisanal fisheries. It is essential to give visibility to data that remains obscure, incomplete and poorly calculated. And most importantly, this information should reach all levels of society, especially the managers responsible for the elaboration of public policies.

Conclusiones y reflexiones finales

A partir de la base teórica construida en la introducción y los resultados y reflexiones producidas en las dimensiones político-ambiental, social y económica de esta tesis, fue posible concluir que:

En los últimos 40 años, las subvenciones del gobierno, el financiamiento de los bancos públicos, la colaboración técnica de las universidades y la permisividad legislativa, fueron los factores fundamentales para la promoción de la acuicultura industrial del camarón en Brasil, convirtiéndose en una industria relevante de exportación. Con un fuerte apoyo político, económico y técnico, la camaronicultura, que debería obedecer sus principios y cumplir sus objetivos como ejemplo de política pública para mejoría de la calidad de vida y reducción de la pobreza, ha tenido un vertiginoso crecimiento acompañado por una huella ecológica de transformación en los recursos naturales, causando la degradación de los ecosistemas costeros, especialmente de los manglares.

La rápida evolución de las fincas camaroneras en la costa de Brasil ha avanzado en detrimento de los ecosistemas costeros, minimizando la disponibilidad de servicios ecosistémicos, comprometiendo a medio y largo plazo la sostenibilidad socioambiental de la zona costera brasileña. Por lo tanto, esta industria acuícola se configura como una actividad que genera impactos que abarcan desde un deterioro impacto ambiental directo (transformación de ecosistemas) hasta un sensible cambio social que incluye el aumento de la pobreza, la falta de tierras, la inseguridad alimentaria, el desplazamiento de comunidades, la contaminación de agua potable, las malas condiciones de trabajo, los impactos sobre la salud, la calidad de vida (entendida como bienestar dentro de un entorno natural) y en algunos casos la violación de los derechos humanos.

Los territorios donde la camaronicultura se ha desarrollado en Brasil estaban ocupados desde hacía mucho tiempo por comunidades tradicionales. Estas comunidades viven dentro de un sistema de manejo artesanal de los manglares por medio de una

relación de respeto, gratitud y complicidad con la naturaleza, lo que se presenta como causa directa de la preservación ambiental de los ecosistemas con los cuales se relacionan. A pesar de que la explosión demográfica y el ánimo lucrativo de determinados sectores también pueden provocar el colapso de los stocks de diversos recursos ambientales de forma local, los habitantes de esta zona no parecen haber llegado a una explotación tan exhaustiva de los recursos como para poner en riesgo su propio medio de subsistencia. Por lo tanto, son comunidades que mantienen con los manglares una vinculación material (por ejemplo, a partir de la pesca en estos humedales), pero también simbólica: estas poblaciones perciben los ecosistemas como espacios sagrados, generadores de satisfacción personal y calidad de vida. Sin embargo, a partir de nuestros resultados identificamos que la percepción comunitaria de los servicios generados por los manglares y la importante vinculación (material y simbólica) entre las poblaciones y este ecosistema ha sido desconsiderada por la literatura y en los procesos de toma de decisión entre la conservación de los ecosistemas y el desarrollo de acuícola.

Un ejemplo de esta importante vinculación material entre los manglares y las comunidades está evidenciado por la estrecha dependencia económica de las comunidades con los manglares a partir de las actividades extractivas, principalmente a partir de la pesca artesanal. Esto caracteriza un modo de vida basado en la pesca en los manglares (y ecosistemas cercanos), una actividad económica que tiene una gran importancia en el seno de la sociedad capitalista pero que se desarrolla a partir de otros principios de producción de dinero, relación de trabajo y un tipo muy diferente de relación establecida con la extracción de recursos naturales. Debido a que la relación de sus practicantes en el manglar sirve para proteger este ecosistema, las comunidades tradicionales son consideradas como importantes agentes para la protección de las áreas de las que extraen sus recursos.

De este modo, se puede concluir que la acuicultura industrial y la pesca artesanal obedecen a dos lógicas distintas y la gran problemática no es sólo el hecho de que el modo de producción capitalista está degradando el modo de vida de estas comunidades tradicionales, haciendo desaparecer sus actividades económicas existentes desde hace

siglos, sino que su economía está gravemente infravalorada e invisibilizada en las estadísticas oficiales a nivel de Estado. Esto hace que la pesca artesanal, desconsiderada como una actividad económica significativa en los procesos de toma de decisión de las políticas de gestión costera, no sea reconocida como un valor real de generación de capital y bienestar (calidad de vida) frente a las estructuras gubernamentales.

Estos hechos nos llevan a concluir que las comunidades tradicionales son discriminadas por su identidad sociocultural. Se impide seguir reproduciendo su modo de vida, substituido en este caso por el modelo de camaronicultura predatorio que se expande sin tener en cuenta las consecuencias ecológicas y sociales. Como ha sido comentado anteriormente, "en nombre de una concepción industrial del progreso, las explotaciones a nivel industrial desestructuran las condiciones materiales de existencia de grupos socio-culturales, destruyéndose los derechos de estos grupos que están inseridos en formas sociales de producción no-capitalistas" (Acselrad et al. 2009).

Al estar caracterizado el proceso de expansión de la camaronicultura en Brasil por la misma lógica de expansión de otras fronteras agrícolas y extractivistas de la sociedad brasileña y otros países en vías de desarrollo (basada en un modelo de ocupación del espacio y de uso de los recursos naturales generador de degradación ambiental y de elevados costes sociales) la utilidad de este trabajo de tesis se ve reforzado al considerar métodos y preguntas que normalmente no se están desarrollando en este tipo de aproximaciones a la explotación del sistema. El actual modelo económico se empeña en crecer rápidamente generando divisas para el país a partir de una elevada lucratividad a corto plazo (privatizando los ecosistemas de uso comunal), revelándose una actividad más basada en el modelo cortoplacista de producción de *commodities* destinado a la exportación, contrario a la preservación de ecosistemas y el respeto por las personas que viven en las zonas afectadas.

El camaroneo en Brasil ha funcionado más como un proceso de "*acumulación por desposesión*", similar al proceso identificado en otros países de América Latina, Ásia y Africa (Veuthey y Gerber 2012, Latorre 2014), que como una política de consenso. Su desarrollo en la costa brasileña también ha sido reconocido como fruto del moderno

movimiento de cercamiento (enclosures) caracterizado por la expulsión de comunidades tradicionales de sus territorios en los que vivían (Kurien 1992, Martínez-Alier 2007, 2009, Beitl 2012, Latorre 2014).

De este modo, la actividad acuícola desarrollada en Brasil, tal y como está planteada y desarrollada, se ha demostrado insostenible desde el punto de vista social y ambiental, pues su desarrollo implica la externalización o transferencia de costes, a la sociedad y al medio ambiente. Mientras una minoría logra los lucros producidos, generándose un grave conflicto socioambiental, reproductor de injusticias ambientales, la gran mayoría de las personas que habitan la zona ven transformados sus paisajes, recursos y modos de vida. El Estado ha seguido desempeñando un papel de supervisión y de regulación, pero lo hizo cada vez más en nombre del capital, moviéndose significativamente lejos de un modelo de bienestar de desarrollo común, lo que implicó un alejamiento en atender las demandas de derechos de la colectividad, atendiendo sólo a determinadas demandas individuales. En este sentido y de acuerdo con Rivera-Ferre (2009), si el desarrollo se percibe como un proceso a través del cual la sociedad alcanza mejor calidad de vida, las políticas acuícolas actuales adoptadas, en Brasil y en otros países, deberían urgentemente ser revisadas y reconsideradas por los organismos nacionales e internacionales, por el sistema agroalimentario y por los gobiernos de los diferentes estados. Las políticas requieren de una aproximación integral y no únicamente sectorial, por lo que deben revisarse, entre otras, la planificación territorial (asegurando un acceso justo a los recursos naturales), los criterios de asignación de derechos de explotación, las políticas de desarrollo, las políticas de apoyo a la actividad productiva a escala nacional y los procesos de negociación de acuerdos comerciales internacionales (Acselrad et al. 2009, Rivera-Ferre 2009).

Con base en estas conclusiones se ha comprobado que no es posible analizar la degradación ambiental y el conflicto socioambiental camaronero para alcanzar una decisión entre cultivar camarones o conservar los manglares a partir de una mirada unidireccional o basada en una lógica reduccionista. Para una toma de decisión coherente es fundamental la construcción de métodos multidimensionales con más alternativas y criterios de análisis que arrojen luz a cuestiones invisibles y que colabore

con la evaluación compleja de cuestiones intricadas en este conflicto, puesto que en el contexto de las comunidades de pescadores, como es el caso de Brasil, existen cuestiones y vínculos asociados al manejo de los manglares, que también necesitan ser incorporados en la tomada de decisión. Dicho de otra forma, las actividades tal y como están planteadas hoy en día son incompatibles, porque la generación de recurso (camarón) con la metodología utilizada es del todo incompatible con el mantenimiento de los ecosistemas y los hábitos de las poblaciones autóctonas. Para generar un producto a tan gran escala es necesario utilizar una cantidad de energía y materia que erosionan el ecosistema manglar hasta tal punto de hacerlo inservible para cualquier otro uso que no sea la acuicultura, destruyendo la complejidad y diversidad que mantienen a un importante sector de la población.

Con base en los principios y prácticas de la Justicia Ambiental, en los estudios realizados por Montserrat (2011a) y Acselrad et al. (2009) y a partir de los resultados obtenidos en la presente tesis doctoral, llegamos a la conclusión que para la construcción de procesos de toma de decisión más justos y equitativos que colaboren para una gestión costera sostenible, algunas acciones deberían ser tomadas en cuenta:

- Reorientar las políticas acuícolas pensadas por los gobiernos y organismos internacionales, buscando asegurar que ningún grupo social soporte una parcela desproporcional de las consecuencias socioambientales negativas de las operaciones económicas, decisiones políticas federales, estaduales, locales, así como de la ausencia u omisión de tales políticas;
- Permitir un dialogo inclusivo y democrático entre los distintos sectores de la población durante los procesos de construcción y definición de tales políticas, sin obviar o menospreciar la posición de los sectores más desfavorecidos;
- Asegurar que estas políticas incorporen una visión transversal, que incluya los diferentes servicios generados por los ecosistemas y sus vinculaciones (material y simbólica) con la sociedad, no solo el beneficio real de un sector muy restringido del lugar en el que se van a aplicar los cambios;

- Garantizar el acceso justo y equitativo, directo o indirecto, a los recursos ambientales.
- Aplicación equitativa de la ley, como instrumentos que contribuyen en la construcción de procesos de toma de decisión mas justos frente al impacto ecológico, social y económico de las transformaciones por venir. Ha de garantizarse el acceso justo y equitativo a las informaciones que van a afectar a los intereses sobre el uso de los recursos ambientales y ha de ser también transparente desde el principio. El conocimiento de los procesos de degradación y la localización de las fuentes de riesgos ambientales para la población autóctona también deben de ser claro y planteado de forma justa;
- Ha de construirse un planeamiento territorial integrando, valorando y promocionando las actividades tradicionales las cuales generan un menor impacto y alcanzan una mayor distribución de renta per cápita. De esa forma también se ofrecen las condiciones para que las informaciones sobre los usos tradicionales de los recursos ambientales sean valorizados, renovados y reinterpretados, para adaptarlos mejor a nuevas situaciones emergentes;
- Se tiene que favorecer la construcción y fortalecimiento de sujetos colectivos: las organizaciones locales y movimientos de pescadores locales y nacionales han de poder expresar su opinión y han de ser informados de forma adecuada para que sean los protagonistas en la producción del conocimiento sobre sus realidades y en la construcción de modelos alternativos de desarrollo que garantizan la democratización del acceso a los recursos ambientales y sostenibilidad de su uso.

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Anexos

Anexo I. Modelo de las encuestas de valoración realizadas en Cumbe, Aracati. Fuente: Betorz et al. (2012).

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VALORAÇÃO PARTICIPATIVA DOS SERVIÇOS ECOSSISTEMICOS DOS MANGUEZAIS NA COMUNIDADE DO CUMBE, ARACATI, CEARÁ, BRASIL.

DATA:_____ AMOSTRADOR:_____

Atenção: Esta pesquisa faz parte das atividades do projeto de pesquisa em Ciência e Tecnologia Ambiental, sendo a identidade do respondente e as informações fornecidas mantidas em completo sigilo e usadas apenas para fins de pesquisa.

Indentificação		
Nome e sobrenome		
Idade		
Sexo	0: mulher 1: homem	

Entrevista de valoração:

Será apresentada uma afirmação sobre cada serviço ambiental e o entrevistado deverá valorar a afirmação entre: 0 = se está totalmente em desacordo com a afirmação e 5= se está totalmente de acordo.

Função de Regulação		
Serviço	Exemplo de serviço	Valoração (0 - 5)
Produção e Regulação de gases	Os manguezais produzem oxigênio, o ar que a gente respira.	
Regulação do clima	Os manguezais ajudam a manter a temperatura da região.	
Proteção da costa	Os manguezais contribuem para estabilidade costeira funcionando como uma barreira natural de proteção contra fenômenos naturais (deslizamentos, enchentes, tsunamis, etc.).	
Regulação hidrológica	Os manguezais regulam a entrada e saída de água do estuário do Rio Jaguaribe.	

Amortecimento das consequências do aquecimento global	Os manguezais contribuem para diminuir os efeitos das mudanças climáticas, por exemplo, fazem com que o período de chuvas se mantenha constante ao longo dos anos.	
Suplemento de agua	Os manguezais são responsáveis por reserva de água debaixo do solo.	
Controle da erosão e retenção de sedimentos	Os manguezais previnem os deslizamentos.	
Formação de solos	Os manguezais são responsáveis pelo processo de formação do solo (praias, croas, etc.)	
Ciclagem de nutrientes	Os manguezais são responsáveis pela transformação da matéria morta em matéria viva (surgimento de novos seres vivos).	
Dissipador de matéria e energia	Os manguezais fazem o controle de contaminantes.	
Polinização	Os manguezais ajudam a circulação de ovos e larvas para reprodução das populações.	
Controle biológico	Nos manguezais existem muitos organismos de diferentes espécies que se relacionam entre eles.	
Função de hábitat		
Serviço	Exemplo do serviço	Valoração (0-5)
Refúgio	Os manguezais funcionam como abrigo para muitas espécies que já vivem nos manguezais e para espécies o que são migratórias (por exemplo, acolhida de aves migratórias);	
Função de produção		
Serviço	Exemplo do serviço	Valoração (0-5)
Produção de alimento	Os manguezais produzem alimento de qualidade.	
Produção de matéria prima	Os manguezais produzem matérias primas como madeira.	
Recursos genéticos	Os manguezais produzem produtos biológicos que são utilizados na medicina.	
Função Cultural		
Serviço	Exemplo do serviço	Valoração (0-5)
Recreação	Os manguezais geram oportunidades para atividades recreacionais (ecoturismo, pesca esportiva e outras atividades ao ar livre).	
Contemplação da paisagem	Os manguezais são responsáveis pela composição da paisagem costeira.	
Inspiração para cultura e arte	Os manguezais constituem um motivo de inspiração para criações artísticas.	
Espiritual	Os manguezais funcionam como um espaço sagrado.	
Manutenção do conhecimento ecológico tradicional	Os manguezais funcionam como um espaço onde as comunidades mantém seus conhecimentos tradicionais.	
Ciência e educação ambiental	Nos manguezais se desenvolvem investigações científicas e ações de educação ambiental.	
Criação e manutenção das relações socais.	Os manguezais funcionam como um espaço onde se fortalecem as amizades da própria comunidade e se criam novas amizades.	

Anexo II. Preguntas de orientación e informaciones deseadas en la reunión con los grupos focales. Fuente: Betorz et al. (2012).

Grupos Focales	Preguntas estímulo	Informaciones deseadas
Mujeres pescadoras (recolectoras de mariscos)	¿Como las mujeres utilizan el manglar? ¿Para que fin utilizan los manglares (comercial, cultural o de sustento)? ¿Cuales son los beneficios de estos usos?	Tipos, objetivos y beneficios de los usos de los servicios ecosistémicos de los manglares realizados por las pescadoras.
	¿A lo largo de la historia, estos usos han sufrido cambios? ¿Cuáles son estos cambios? ¿Si han sufrido cambios, por que? ¿Cómo han influido en su vida?	Cambios, causas e impactos en los flujos de los servicios ecosistémicos en la calidad de vida de las pescadoras.
	¿Los manglares son importantes?	Importancia (simbólica y material) de los manglares para la vida de las pescadoras.
Hombres pescadores (recolectores de cangrejos, pesca de peces, etc.)	¿Como los hombres utilizan el manglar? ¿Para que fin utilizan los manglares (comercial, cultural o de sustento)? ¿Cuales son los beneficios de estos usos?	Tipos, objetivos e beneficios de los usos de los servicios ecosistémicos de los manglares realizados por los pescadores.
	¿A lo largo de la historia, estos usos han sufrido cambios? ¿Cuáles son estos cambios? ¿Si han sufrido cambios, por que? ¿Cómo han influido en su vida?	Cambios, causas e impactos en los flujos de los servicios ecosistémicos en la calidad de vida de los pescadores.
	¿Los manglares son importantes?	Importancia (simbólica y material) de los manglares para la vida de los pescadores.

Anexo III. Modelo de las tablas de seguimiento de la pesca artesanal usadas en las comunidades de Cumbe y Curral Velho. Fuente: Betorz et al. (2012) y Dominguez et al. (2014).

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Seguimiento de la pesca artesana

Identificação
N° da entrevista:_____
Pesquisador(a): _____

Arte de pesca:

Grupo:

Arte de pesca:

Grupo:

PEIXE	Quantidade vendida (kg)	Quantidade consumida (kg)	Quantidade total (Kg)	PEIXE	Quantidade vendida (kg)	Quantidade consumida (kg)	Quantidade total (Kg)

Anexo IV. Modelo de cuestionario semi-abierto usado para la construcción del seguimiento de la pesca artensanal en Cumbe, Aracati. Fuente: Betorz et al. (2012).

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Universidad Autònoma de Barcelona (UAB)

QUESTIONARIO SEMI-ABERTO SOBRE A PESCA ARTESANAL NA COMUNIDADE DO CUMBE, ARACATI, BRASIL.

DATA:_____ AMOSTRADOR:_____

Atenção: Esta pesquisa faz parte das atividades do projeto de pesquisa em Ciência e Tecnologia Ambiental, sendo a identidade do respondente e as informações fornecidas mantidas em completo sigilo e usadas apenas para fins de pesquisa.

Indentificação		
Nome e sobrenome		
Idade		
Sexo	0: mulher 1: homem	

1. Quais as principais atividades exercidas? 1: Pesca de peixe, 2:Cata de caranguejo, 3: Coleta de marisco; 4.Agricultura, 5:Artesania, 6:Comércio, 6: Construção, 7:Turismo, 8: Carnicicultura, 9: Eólicas.	
2. Qual sua ocupação principal? 1: Pescador de peixe, 2: Catador de caranguejo, 3: Catador de marisco; 4: Beneficiamento do pescado; 5: Agricultura, 6: Artesania, 7: Comércio, 8: Construção, 9: Turismo, 10: Carnicicultura, 11: Eólicas.	
3. Quais são as artes de pesca que utilizada? 1: Ratueira; 2: Ramo, 3: Redinha, 4: Braço; 5. Jerere; 6: Anzol, 7: Curral de pesca, 8: Rede de espera, 9: Tarrafa.	
4. Onde pescam? 1: Cumbe; 2: Canavieira; 3: Arrumbado; 4: Ilha do Pinto; 5. Ilha Grande; 6: Remansso; 7. Rio Jaguaribe.	
5. Quantos dias da semana pescam? 1: 1 dia; 2: 2 dias; 3: 3 dias; 4: 4 dias; 5: 5 dias; 6: 6 dias; 7: 7 dias.	
6. Quantos meses ao ano trabalha no mangue?	

1: 1 mês; 2: 2 meses; 3: 3 meses; 4: 4 meses; 5: 5 meses; 6: 6 meses; 7: 7 meses; 8: 8 meses; 9: 9 meses; 10: 10 meses; 11:11meses; 12:12meses	
7. Qual sua renda mensal gerada pela pesca?	
8. Quantas pessoas da família trabalham na pesca e contribuem na renda familiar?	
9. Ao longo do tempo, sua actividade no manguezal sofreu alguma mudança? 1: Si; 2: No (Si NO, ir para pregunta 14)	
10. Quais eram as artes de pesca utilizadas antes? 1: Ratueira; 2: Ramo, 3: Redinha, 4: Braço; 5. Jerere; 6: Anzol, 7: Curral de pesca, 8: Rede de espera, 9: Tarrafa.	
11. Onde pescava antes? 1: Cumbe; 2: Canavieira; 3: Arrumbado; 4: Ilha do Pinto; 5. Ilha Grande; 6: Remansso; 7. Rio Jaguaribe.	
12. Quantos dias da semana pescava antes? 1: 1 dia; 2: 2 dias; 3: 3 dias; 4: 4 dias; 5: 5 dias; 6: 6 dias; 7: 7 dias.	
13. Quantos meses ao ano você trabalhava no mangue? 1: 1 mes; 2: 2 meses; 3: 3 meses; 4: 4 meses; 5: 5 meses; 6: 6 meses; 7: 7 meses; 8: 8 meses; 9: 9 meses; 10: 10 meses; 11:11meses; 12:12meses	
14. Você considera que a produtividade do manguezal tem variado nos últimos 10 anos? 1: Sim 2: Não	
15. Se a resposta for não, porque?	
16. Comparando a produtividade do manguezal (antes e depois da mortandade), a produtividade: 1: tem diminuido; 2: tem aumentado. 3: se manteve igual.	
17. Para que mais você usa os manguezais? 1. Pesca de peixe; 2. Cata de caranguejo; 3. Coleta mariscos; 4. Agricultura; 5. Coleta de lenha para fogo; 6. Corte de lenha para fazer carvão; 7. Corte de madeira para construção; 8. Corte de madeira para construção de apretechos de pesca; 9. Coleta de plantas medicinais; 10. Coleta de mel; 11. Extração de areia; 12. Uso da água para irrigação; 13. Caça de animais e pássaros; 14. Criações artísticas; 15. Contemplar a paisagem; 15. Lazer/recreação; 16. Relaxamento; 17. Experiência religiosa; 18. Criar novas amizades e/ou fortalecer as relações pessoais. 19. Fazer exercícios físicos. 20. Manter a cultura local.	
18. O manguezal é um ecossistema importante para a vida da comunidade do Cumbe? 0: não; 1:sim; 2: não sabe.	
19. Os manguezais podem oferecer serviços ecosistêmicos? 0: não; 1:sim; 2: não sabe.	

Anexo V. Modelo de cuestionario semi-abierto usado para la construcción del seguimiento de la pesca artensanal en Curral Velho, Acaraú. Fuente: Dominguez et al. (2014).

Institut de Ciència i Tecnologia Ambientals (ICTA)

Universidad Autònoma de Barcelona (UAB)

QUESTIONARIO SEMI-ABERTO SOBRE A PESCA ARTESANAL NA COMUNIDADE DE CURRAL VELHO, ACARAÚ.

Identificação
Nº da entrevista:_____
Pesquisador(a): _____

Atenção: Esta pesquisa faz parte das atividades do projeto de pesquisa em Ciência e Tecnologia Ambiental, sendo a identidade do respondente e as informações fornecidas mantidas em completo sigilo e usadas apenas para fins de pesquisa.

1. DADOS DO PESCADOR/A			
1.1 Nome e sobrenome			
1.2 Apelido		1.3 Idade	
1.4 Sexo	M: mulher H: homem		

☐ 1.5 - Estado civil: (1) casado (2) solteiro (3) divorciado (4) viúvo (5) junto

☐ 1.6 - Escolaridade: (1) Não sabe ler (2) Ensino primário incompleto (3) Ensino primário completo (4) Ensino fundamental incompleto (5) Ensino fundamental completo (6) Ensino superior incompleto (7) Ensino superior completo (8) Outros: _____

1.7 - Quantos filhos tem?

1.8 - Quantas pessoas moram na sua casa?

1.9 - Realiza atividades além da pesca?

1.10 - Se sim, quais?

2. DADOS DA PESCA

2.1 - Quais as cinco espécies mais pescadas?

NOME VULGAR	ONDE PESCA?	QUAL MELHOR ARTE PESCA?	QUANDO SE PESCA MAIS?	VAI PESCAR SOZINHO OU EM GRUPO?

2.2 - Quantos dias na semana pesca?

2.3 - Quantas horas pesca por dia?

2.4 - Qual sua renda por semana gerada pela pesca?

2.5 - Qual sua renda por mês gerada pela pesca?

2.6 - Quantas pessoas da família trabalham na pesca e contribuem na renda familiar?

3. MUDANCA NA ATIVIDADE DA PESCA

3.1 - Ao longo do tempo, sua atividade de pesca sofreu alguma mudança?

Se sim, quais?

3.2 - Houve mudança nas espécies pescadas?

3.3 - Houve mudança no tempo de trabalho?

3.4 - Houve mudança no local?

3.5 - Houve mudança na arte de pesca utilizada?

3.6 - Houve mudança na sua renda?

3.7 - Porque aconteceram estas mudanças?

3.8 - Porque você escolheu suo oficio?

3.8 - Observações:

Anexo VI. Tabla de los resultados de las entrevistas del seguimiento realizado con las pescadoras de Cumbe, Aracati. Fuente: Burriel (2012).

Pescadora	Nombre	Edad	Kg/semana	Meses/año	Dias/semana	Horas/dia	Descocamiento	Zona más utilizada	Personas mantenidas	Marido pescador
01.	Dulcimeire	47	25	6	4	8h	Barca con motor	Boca do Cumbe	4	Si
02.	Auxiliadora	52	20	6	5	8h	Barca	Remanso	7	Si
03.	Daniela	36	35	6	5	8h	Barca	Remanso	6	Si
04.	Jessica	20	25	6	3	8h	Barca con motor	Aracati	3	Si
05.	Celia	27	40	6	4	8h	Barca con motor	Aracati	5	Si
06.	Sonia	52	60	6	4	8h	Barca con motor	Aracati	9	Si
07.	Leninha	30	20	6	3	8h	Barca con motor	Aracati	4	Si
08.	Leninha	44	35	6	5	8h	Barca	Remanso	6	Si
09.	Cleomar	37	45	6	5	8h	A pie	Boca do Cumbe	5	Si
10.	Luciana	33	55	6	4	8h	Barca	Boca do Cumbe	3	Si
11.	Viviane	22	30	6	4	8h	Barca con motor	Aracati	3	No
12.	Lidiane	27	50	6	3	8h	Barca con motor	Aracati	5	Si
13.	Edileuza	40	20	6	3	8h	Barca	Remanso	5	Si
14.	Gracilda	71	20	6	3	8h	Barca	Remanso	3	Si
15.	Nega	21	20	6	4	8h	Barca con motor	Remanso	3	Si
16.	Marta	39	50	6	4	8h	Barca	Remanso	6	Si
17.	Francisca	40	20	6	3	8h	A pie	Cumbe	4	Si
Total		**37,5**	**570**	**6**	**3,9**	**8h**			**81**	

Anexo VII. Tabla de los resultados de las entrevistas del seguimiento realizado con los recolectores de cangrejos de Cumbe, Aracati. Fuente: Burriel (2012).

	Recolector	Edad	Especie	Cantidad/semana	Meses/año	Dias/semana	Horas/día	Desplazamiento	Técnica	Personas mantenidas
01.	Ronaldo	31	*Cardisoma guanhumi*	200	10	5	4	Barca a motor	Ratonera	3
02.	Carlinhos	46	*Cardisoma guanhumi*	250	10	6	4	Barca a motor	Ratonera	3
03.	Euclides	76	*Cardisoma guanhumi*	100	10	5	3	Barca a motor	Ratonera	2
04.	Titino	62	*Cardisoma guanhumi*	140	9	4	4	Bicicleta y barca (sin motor)	Ratonera	5
Total		**215**		**690**	**39**	**20**	**15**			**13**
Mitad		**53,75**		**172,5**	**9,75**	**5**	**3,75**			**3,25**
05.	Edvan	50	*Ucides Cordatus*	600	8	6	6	Barca a motor	Ramo	4
06.	Francisco	31	*Ucides Cordatus*	800	9	5	8	Barca a motor	Redinha	1
07.	Perninha	26	*Ucides Cordatus*	500	9	6	5	Barca a motor	Redinha	3
08.	Sapiroco	41	*Ucides Cordatus*	800	10	6	7	Bicicleta y Kayak	Ramo	4
09.	Raimundinho	47	*Ucides Cordatus*	800	9	5	5	Bicicleta	Brazo	4
10.	Titico	44	*Ucides Cordatus*	700	8	5	5	Bicicleta	Redinha	2
11.	Valdery	45	*Ucides Cordatus*	500	10	4	6	Barca a motor	Ramo	6
12.	Fernandinho	24	*Ucides Cordatus*	600	9	5	6	Bicicleta y barca (sin motor)	Ramo	3
13.	Zé Arildo	55	*Ucides Cordatus*	500	9	5	6	Bicicleta	Ramo	1
14.	Raimundo	36	*Ucides Cordatus*	500	8	5	4	Bicicleta	Ramo	3
15.	Naudinho	39	*Ucides Cordatus*	400	7	5	4	Bicicleta	Brazo	3
16.	Fernando	45	*Ucides Cordatus*	500	9	6	3	Barca (sin motor)	Redinha	5
17.	Lafí	18	*Ucides Cordatus*	400	10	5	3	Barca a motor	Brazo	4
18.	Tapiriba	34	*Ucides Cordatus*	600	8	4	5	Bicicleta	Ratonera	2
19.	Paulinho	29	*Ucides Cordatus*	450	10	5	5	Barca (sin motor)	Ramo	4
20.	Joãozinho	39	*Ucides Cordatus*	500	9	5	4	Barca a motor	Ratonera	5
21.	Abedias	22	*Ucides Cordatus*	550	8	4	5	Bicicleta	Brazo	1
22.	Véi	19	*Ucides Cordatus*	600	9	4	3	Bicicleta y Kayak	Ramo	3

23.	Dedé	29	*Ucides Cordatus*	480	8	5	4	Barca a motor	Ramo	6
24.	Everardo	38	*Ucides Cordatus*	400	9	6	6	Bicicleta	Redinha	3
25.	Chin	44	*Ucides Cordatus*	500	10	5	6	Bicicleta y Kayak	Brazo	4
26.	Chino	42	*Ucides Cordatus*	480	9	4	4	Barca a motor	Redinha	3
27.	Lorin	38	*Ucides Cordatus*	300	10	4	5	Bicicleta	Brazo	1
28.	Garrincha	53	*Ucides Cordatus*	500	8	3	5	Barca a motor	Ramo	4
29.	Clóves	30	*Ucides Cordatus*	500	9	3	7	Bicicleta	Ramo/Redinha	3
30.	Cristiano	32	*Ucides Cordatus*	400	8	4	5	Bicicleta	Ramo	4
31.	Pretinho	19	*Ucides Cordatus*	600	7	3	4	Barca a motor	Ramo	6
32.	Gogó	19	*Ucides Cordatus*	400	10	6	4	bicicleta y barca a motor	Redinha	4
33.	Francisco	32	*Ucides Cordatus*	550	9	3	4	Barca a motor	Ramo	2
34.	León	25	*Ucides Cordatus*	600	9	5	6	Bicicleta	Redinha	5
35.	Miguel	29	*Ucides Cordatus*	500	8	5	7	Bicicleta	Ramo	5
36.	Manuel	59	*Ucides Cordatus*	480	9	4	4	Bicicleta	Ramo	5
37.	Sonson	46	*Ucides Cordatus*	650	10	4	5	Moto y barca a motor	Redinha	3
38.	Fabiano	27	*Ucides Cordatus*	600	6	5	7	Bicicleta	Redinha	3
39.	Loro	30	*Ucides Cordatus*	400	7	4	4	Moto y barca a motor	Ramo	1
40.	Narcelio	27	*Ucides Cordatus*	500	10	5	6	Bicicleta	Brazo	2
41.	José	45	*Ucides Cordatus*	600	9	4	4	Barca (sin motor)	Brazo/Ramo	4
42.	Jero	32	*Ucides Cordatus*	400	8	4	4	Bicicleta	Ramo	3
Total *Ucides Cordatus*		1340		20140	332	176	191			129
Mitad *Ucides Cordatus*		35,26		530	8,74	4,63	5,03			3,39

Anexo VIII. Resultados del seguimiento de la pesca artesanal en Curral Velho, Acaraú. Fuente: Dominguez et al. (2014).

	Total de Reales generados.	
	R$	%
Vendido	80244,35	80,71
Consumido	19182,10	19,29
Total	99426,45	100,00

	Pesca individual, Reales generados.		
	Manzuá	Curral	Total
Vendido	1824,00	25839,50	27663,50
Consumido	440,00	9884,50	10324,50
Total	2264,00	35724,00	37988,00
	Pesca individual, Reales generados por persona.		
	Manzuá	Curral	Total
Vendido	1824,00	4306,58	3951,93
Consumido	440,00	1647,42	1474,93
Total	2264,00	5954,00	5426,86
	Pesca individual, días trabajados.		
	Manzuá	Curral	Total
Días	17	275,00	292,00
Días/Persona	17	45,83	41,71
	Pesca individual, Reales generados por persona y día.		
	Manzuá	Curral	Total
Vendido	107,29	93,96	94,74
Consumido	25,88	35,94	35,36
Total	133,18	129,91	130,10

	Pesca grupal, Reales generados.				
	Pesca de línea	Red	Manzuá	Curral	Total
Vendido	27961,35	1285,50	8961,00	14373,00	52580,85
Consumido	4865,00	335,00	2850,60	807,00	8857,60
Total	32826,35	1620,50	11811,60	15180,00	61438,45
	Pesca grupal, Reales generados por persona.				
	Pesca de línea	Red	Manzuá	Curral	Total
Vendido	2796,14	642,75	497,83	4791,00	1383,71
Consumido	486,50	167,50	158,37	269,00	233,09

Total	3282,64	810,25	656,20	5060,00	1616,80

	Pesca grupal, días trabajados.				
	Pesca de línea	Red	Manzuá	Curral	Total
Días	18,00	18,00	73,00	68,00	177,00
Días/Persona	9,00	18,00	14,60	22,67	16,09

	Pesca grupal, Reales generados por persona y día.				
	Pesca de línea	Red	Manzuá	Curral	Total
Vendido	310,68	35,71	34,10	211,37	85,99
Consumido	54,06	9,31	10,85	11,87	14,49
Total	364,74	45,01	44,95	223,24	100,48

Pesca individual, distribución participantes por métodos de pesca. Fuente:		
Manzuá	Curral	Total
1	6	7

	Pesca grupal, distribución participantes por métodos de pesca.				
	Pesca de línea	Red	Manzuá	Curral	Total
Grupos	2	1	5	3	11
Individuos	10	2	18	8	38

Anexo IX. Artículo I (Capitulo I) publicado en la revista Ocean & Coastal Management.

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Shrimp aquaculture in the federal state of Ceará, 1970–2012: Trends after mangrove forest privatization in Brazil

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ABSTRACT

During the last 40 years, industrial shrimp farming in Brazil has experienced intense development. The first shrimp culture experiments were carried out at the beginning of the 1970s, but due to technical problems and a lack of exact knowledge they were not very successful. At the end of the 1990s, the activity expanded rapidly and shrimp farming became a relevant export industry, due to government assistance, public-bank financing, university technical collaboration and legislative permissiveness. The vertiginous growth of the industry has been accompanied by a profound transformation of natural resources, causing the degradation of the mangrove ecosystem. The objective of this study is to conduct an integral and in-depth analysis of the evolution of the industrial shrimp farming in Brazil, based on a review of the national political and economic context of the aquaculture activity, and also an evaluation of the environmental impacts of shrimp farming in the watershed of the Jaguaribe River, Ceará (NE Brazil). This analysis begins with the initiation of intensive large-scale farming for export, taking into account the synthesis of environmental processes to analyse the socio-environmental impacts.

We studied the areas used for the construction of shrimp farms, located in coastal and estuarine systems and with tidal connections, linking the transformation of the system with the, geo-environmental evolution of the impacted zones, mainly the mangrove ecosystem. The final objective of this work is to propose an integral model of management for the appropriate use of mangroves in Brazil and other systems with analogous problems.

1. Introduction

Aquaculture has been promoted to reach strong economic growth based on food export alleviating poverty in developing countries while decreasing the pressure on wild marine populations (the so-called "*blue revolution*," [Bardach, 1997; Stonich and Bailey, 2000; Costa-Pierce, 2002]). The *"blue revolution"* (Austin, 1993; Naylor et al., 2000) began to develop intensively in tropical zones of Asia, Latin America and, more recently, Africa. The *"blue revolution"*, previously practiced in an extensive form in Asia for nearly 4000 years (Arana, 1999), has been transformed, with strong political and economic support, into a more intensive form adopted by the world agro-industrial food systems. Following the same logic of other animal production systems, aquaculture has been converted into an activity that is highly dependent on the globalised industrial market.

World aquaculture production has grown substantially in the last ten years, reaching 52.5 million tonnes in 2008, compared with the more than 2.5 million tonnes in 1970 (FAO, 2010). Production grew from 0.7 kilos/capita/year in 1970 to more than 7.8 kilos/capita/year in 2008, growing on average 6.6%/year. One of the stronger points of the *blue revolution* is shrimp aquaculture. From the 1990s to the mid-2000s, the shrimp farming industry has grown each year between 3 and 54% relative to the previous year (FAO, 2010). Peneids (shrimp and prawns) aquaculture alone has comprised 73.3% of the world crustacean aquaculture production (FAO, 2010). Countries such as Myanmar transformed this industry from one tonne/year (1990) to more than 30,000 tonnes/year (2004), while others such as China have increased their productivity from 185,000 tonnes to almost a million in the same period (Rivera-Ferre, 2009). Almost 99% of shrimp production comes from developing countries, but the majority is exported to Europe, Japan and USA (Paez-Osuna, 2001).

According to recent estimates, 1 to 1.5 million hectares of coastal areas were converted to shrimp farms, mainly in China, Thailand, India, Indonesia, the Philippines, Malaysia, Brazil, Ecuador, Mexico,

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Honduras, Panama and Nicaragua (Senarath and Visvanathan, 2001). Shrimp monoculture has been carried out in these countries without regulations or laws in many cases, and its steep growth in recent years has been accompanied by an ecological footprint on natural resources and landscape, especially in mangrove ecosystems (Paez-Osuna, 2001).

The first shrimp cultivation experiments in Brazil were carried out in the early 1970's. It was only towards the end of the 1990's, however, that rapid expansion of the activity took place and it became a relevant export industry, reaching its highest level of production in 2004 (ABCC, 2004). In order to reach this level of development, shrimp aquaculture occupied an area of more than 15,000 ha, in contrast to 4320 ha in 1998, a growth rate higher than 300% (1998–2010) (Fig. 1). Even more dramatic was the growth in production, with a rate of 2400% during the same period. Brazil became the largest producer in Latin America and occupied sixth place in global production (ABCC, 2004).

In 2004 the Associação Brasileira de Criadores de Camarão (ABCC) envisioned continuity in this trend in aquaculture growth, predicting area coverage of 30,000 ha by 2007. However, with the decrease in the value of the dollar and, toward the end of 2003, the spread of the Infectious Myonecrosis Virus, IMNV, the activity stagnated (ABCC, 2005). Following successive decreases in shrimp aquaculture production in 2003 and 2004, the shrimp industry began to fall into steep decline. In the federal state of Ceará, the accumulated decrease of exports was 65%. Faced with export difficulties, the sector stated that in 2010 practically all production would be absorbed by the domestic market, and this increase in domestic demand continued during the following years (ABCC, 2010). The data from 2010 (Fig. 1) was estimated by the ABCC and may be overvalued.

Behind the numbers and high shrimp-production rates for export, lies a context of conversion of extensive coastal areas (fragile and fundamental environmental systems like wetlands and mangroves), into production zones (shrimp farms), generating social, economic and environmental impacts (Barbier and Strand, 1998; Ronnback, 1999; Polidoro et al., 2010). The extension and magnitude of environmental impacts vary according to the geographic and environmental conditions of each place, but a strong degradation and transformation of habitats has been demonstrated. These habitats have a very important role in the regenerative capacity of natural environments, water consumption, generation and treatment of effluents, and other environmental, social and economic characteristics (Braaten and Flaherty, 2001; Huitric et al., 2002; Alonso-Perez et al., 2003).

Mangroves are a rich, diverse and complex ecosystem formed at the interface between terrestrial, estuarine, and marine systems near the coastal zone of 123 countries in tropical and subtropical regions of the planet (Spalding et al., 2010). This biotope is responsible for several ecosystem services which include, among others, protection against floods and cyclones, control of nutrients, processing of organic material, control of sedimentation, biodiversity environments, and above all, temporary and permanent nursery grounds for a large quantity of fishery species (Spalding

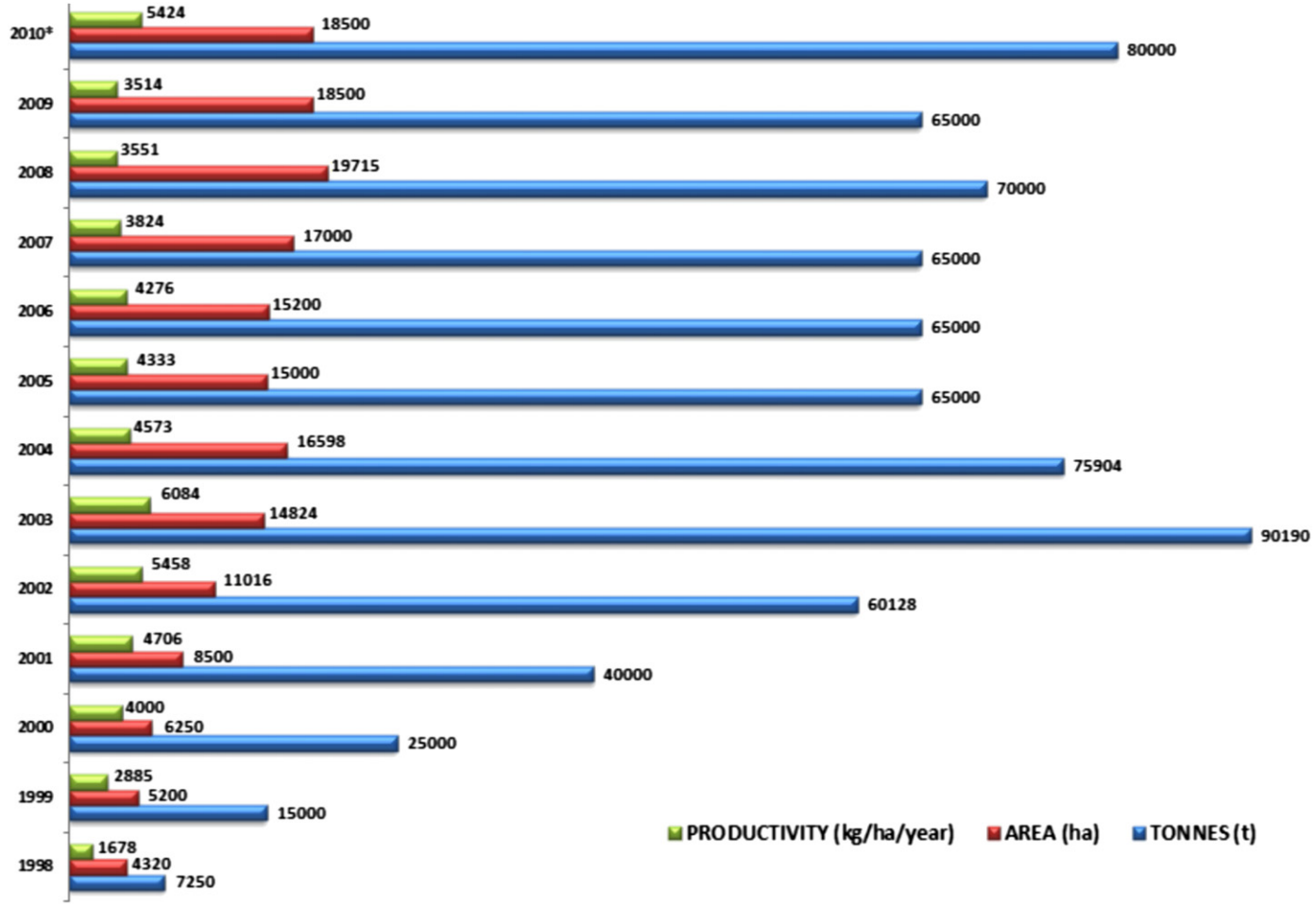

Fig. 1. Shrimp production in Brazil 1998–2010 (ABCC, 2010).

et al., 2010). The last point has been widely demonstrated (Laegdsgaard and Johnson, 2001; Nagelkerke et al., 2002), being crucial in order to understand the value of the artisanal and industrial fishing that can occur in mangrove areas (Aburto-Oropeza et al., 2008). Adding to these services, the ability to bind large carbon from the atmosphere in its aboveground biomass in the sediment is considered one of the largest carbon sink on the planet.

Current estimates of global mangrove area are about 150,000 km^2 (Spalding et al., 2010). Around 35,600 km^2 (about 23% of mangroves and wetlands) were lost between 1980 and 2005 due to the growing pressure of urban and industrial development along coastal zones, in combination with climate change and sea level rise (FAO, 2007). 38% of degraded mangrove areas are attributed to industrial shrimp aquaculture, being directly related with decreases in its ecosystem services (Ellison, 2008; Polidoro et al., 2010). Very conservative calculations indicate a 1% loss of mangrove area/year, while other calculations reach up to 8%. It has been shown that 11 of the 70 mangrove species (16%) are in a critical condition and may disappear in less than a decade, especially in the Atlantic and Pacific coastal zones of the Americas (Polidoro et al., 2010). Taking into account this accelerated rate of loss, the predictions of some authors foresee a disappearance of all mangrove species within 100 years (Valiela et al., 2001; Alongi, 2002).

Although research has been carried out on the impact of shrimp farming on mangroves, an easy and manageable tool is required to make long-time series which help to quantify the real impact of intensive aquaculture. This is the first work in which there is a long-time series of shrimp farming development through satellite data in Ceará, Brazil, from 1970 to 2011. The study area is the watershed of the Jaguaribe River (Fig. 2). The watershed area is 72,645 km^2 (occupying 50% of the state area). Its area contains 80 municipalities with one-third of the population of Ceará (IBGE, 2010). The economic activities carried out throughout the Jaguaribe watershed range from small family farming, traditional fishing, and garbage dumps, to industrial shrimp farming (Souza Filho et al., 2003).

We applied two different approaches: 1. Reconstruction of the national political and economic context of the shrimp monoculture intensification and 2. Characterisation of the environmental impacts associated with shrimp farming in mangroves of the Jaguaribe River. In the first part, we show the evolution of production in Brazil mainly beginning in 1997, a historic point in the production of shrimp by means of intensive cultures for large-scale export (EMBRAPA, 2004; IBAMA, 2005) by means of official documents and statistics. In the second part we consider the importance of salt flats and their relation with other associated coastal ecosystems by means of correlations with transport and deposition of sediments, oscillations of the tides, fresh water inputs (subterranean, fluvial and pluvial) and seasonality (Meireles et al., 2007).

The work is intended to be a clear example to be applied to other similarly affected areas in which the political context may be different but the result (the degradation of mangrove systems for the intensive shrimp aquaculture) is the same.

2. Methodology

The methodology of the present study is divided in two different parts: 1) An integrated literature/document analysis of the industrial shrimp aquaculture development in Brazil, and 2) Survey of the case study area through the SIG methodology and the implementation of aquaculture and environmental data.

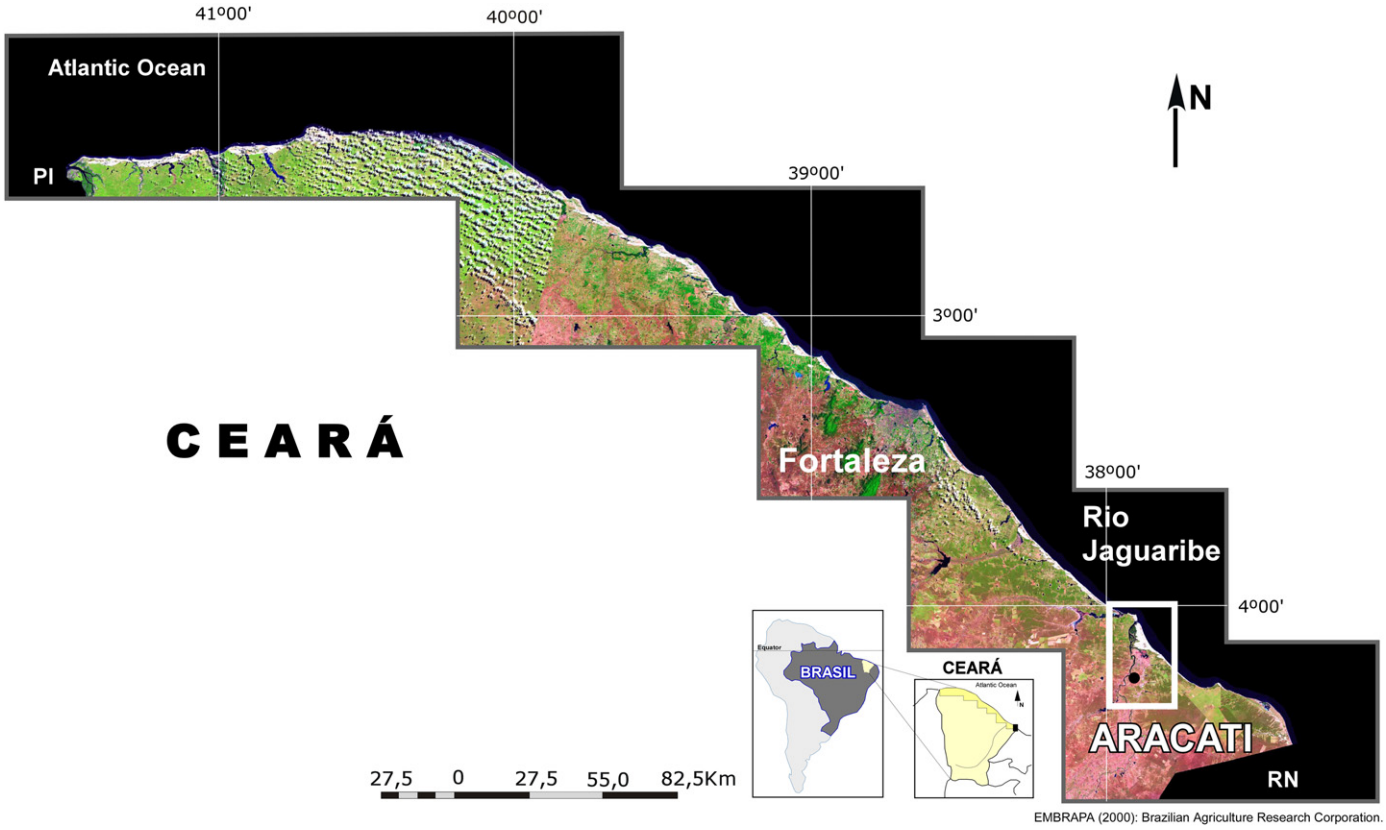

Fig. 2. Area of study. Source: www.embrapa.gov.br.

2.1. Reconstruction of the political and economic context

The literature/document analysis gathers historical information of the shrimp production from the beginning of intensive crops in 1997 up to 2010. To reach this target we made a literature review with the various sources of information: 1. Government: review of the plans and strategies of the federal and state governments for the development of public policies for aquaculture and studies on the social and environmental impacts caused by environmental agencies (EMBRAPA, 2004; IBAMA, 2005) 2. Scientific publications on aquaculture development in Brazil and its social and environmental impacts on coastal communities and traditional territories mainly produced by the universities of Ceará: Universidade Federal do Ceará (UFC), Instituto de Ciencias do Mar (Labomar) and Universidade Estadual do Ceará (UECE) 3. Business (aquaculture production sector): Associação Brasileira de Criadores de Camarão (ABCC)/Associação Cearense de Criadores de Camarão (ACCC) 4. Community/social movement information: the allegations made by the communities involved in the conflict generated by the shrimp aquaculture expansion.

2.2. Survey of the area of shrimp farms in the watershed of the Jaguaribe River, Ceará, NE Brazil

The spatial-temporal evolution of mangroves was analysed using satellite images (Landsat TM5, bands 1–7, colour 5R, 4G and 3B), with 30 m resolution. Aquaculture activities were detected, and could be easily recognised in the image set, generating the composition of the data base for the characterisation of environmental impacts.

The field data were used for the elaboration of thematic maps (geologic, geomorphic and plant cover) at the Digital and Climatological Cartography and Hydrologic Resources laboratories of the Department of Geography of the Federal University of Ceará (UFC), Brazil. To compose the models and the synthesis of collected data, diagram blocks were elaborated with mapped themes. Environmental impacts were introduced into these models. In order to quantify the impact analysis, the characterisation of the flux of material and energy was elaborated by marking the boundaries of the geo-environmental units in two coastal systems and the characterisation of the sediment transport agents. Based on the observed intervention of shrimp ponds in geo-environmental and eco-dynamic processes, planning and management suggestions were developed for this aquaculture activity in the Brazilian coastal zone.

Areas impacted by shrimp farm production were surveyed in the Jaguribe River estuary. Geo-environmental and eco-dynamic processes were defined in the salt flat sectors and related with the flux of material and energy that make up the structure of the mangrove ecosystem.

3. Results

3.1. Reconstruction of the political and economic context

During the last 42 years, the shrimp farming sector in Brazil has evolved from experimental production on extensive farms of autochthonous species to the creation of an extremely flexible institutional and infrastructural mark, designed to promote rapid expansion of aquaculture with maximum profit. During these years, the shrimp farming industry has developed in four stages.

The first stage began in the 1970s in the state of Rio Grande do Norte, when the country carried out the first experimental cultures. The shrimp aquaculture then became a business in the 1980s, using the exotic species *Panaeus japonicus*. At this time, the sector needed to reach a more economically acceptable production rate and faced the lack of adaptation of *P. japonicus* to low salinities. The aquaculturists changed their plans and started to experiment with native species, such as *Panaeus subtilis*, *Panaeus schmitti*, *Panaeus brasiliensis* y *Panaeuspaulensis* (BRASIL, 2010). Productivity, as well as the profits obtained, continued to be low, which provoked the deactivation and reconversion of the shrimp farms into salt ponds in several regions of NE Brazil because of the difficulty of managing production systems.

The second stage of shrimp farming development in Brazil began when a technological package (optimum aquaculture conditions, life cycles, study of potential diseases, genetic variability, etc.), focused on fostering the industry was introduced. From around 1997–2003, the country had the ideal conditions to obtain accelerated aquaculture growth. In the following years, the mastering of the reproductive cycle and post-larva production technology resulted in self-sufficiency and regularisation of the supply, consolidating the technology in the farms. The country no longer had to depend on the importation of post-larvae, which had been vectors of disease and fraught with irregular supply, resulting in negative performance outcomes (Paiva Rocha, 2011).

The NE of Brazil possesses scientific development as well as ideal edaphoclimatic conditions, both in terms of topographical, hydrological characteristics, for shrimp farming. The university technical collaboration: ideal conditions as extensive areas of estuary, good quality of coastal waters and tropical climate, government assistance, public-bank financing and legislative permissiveness enabled the shrimp farming to grow during this period, introducing the Pacific shrimp in Brazil on a large scale.

In order to reach a high level of biomass growth, shrimp farms bought extensive lands in the Brazilian coastal zone: from 3500 ha of farms installed in 1997 to more than 15,000 ha in 2004, representing an increase of more than 300% (ABCC, 2005). Even more significant was the rise in production, which in 2003 reached 90,190 tonnes, an increase of 2400% in relation to 1997. Of this production, 70% was for export. This period is known as the shrimp farming *"boom"*, driven forward by the increase in the exchange rate of the national currency with the dollar, making the external market more attractive (Meireles et al., 2007; ABCC, 2005).

In 2004 there was a decrease in export production volume. by 19,405 tonnes in the north west zone and, in Rio Grande do Norte, shrimp production in 2003 was 37,473, decreasing to 30,807 tonnes in 2004. At this time, exports decreased by 65% in Ceará. The rates reached their lowest levels in 2006, when national production did not pass the production reached by Rio Grande Norte alone in 2003, with a volume of approximately 34,000 tonnes (Meireles and Vicente da Silva, 2003).

In only three years, exports dropped from US$ 244.5 million in 2003 (with 61,000 tonnes) to US$ 154.4 million in 2006 (37% less). The data demonstrate that the intentions of the shrimp farmers to reach 157,000 tonnes in 2005 with a value of US$ 450 million were badly estimated ABCC). According to the data from the first half of 2005, exports were estimated at US$ 283 million less than predicted by the ABCC.

3.2. Survey of increase in shrimp farm area

According to the survey carried out by the Superintendência Estadual de Meio Ambiente (SEMACE), 245 shrimp farms were identified within the watersheds of the state of Ceará (IBAMA, 2005), occupying an area of 6069.97 ha. The data reported by ABCC in contrast for 2005 were 3804 ha. 84.1% of the those farms had impacts directly related with mangrove loss, such as environmental damage to mangrove fauna and flora and salt flat sectors (Meireles and Vicente da Silva, 2003). The Fig. 3 represents

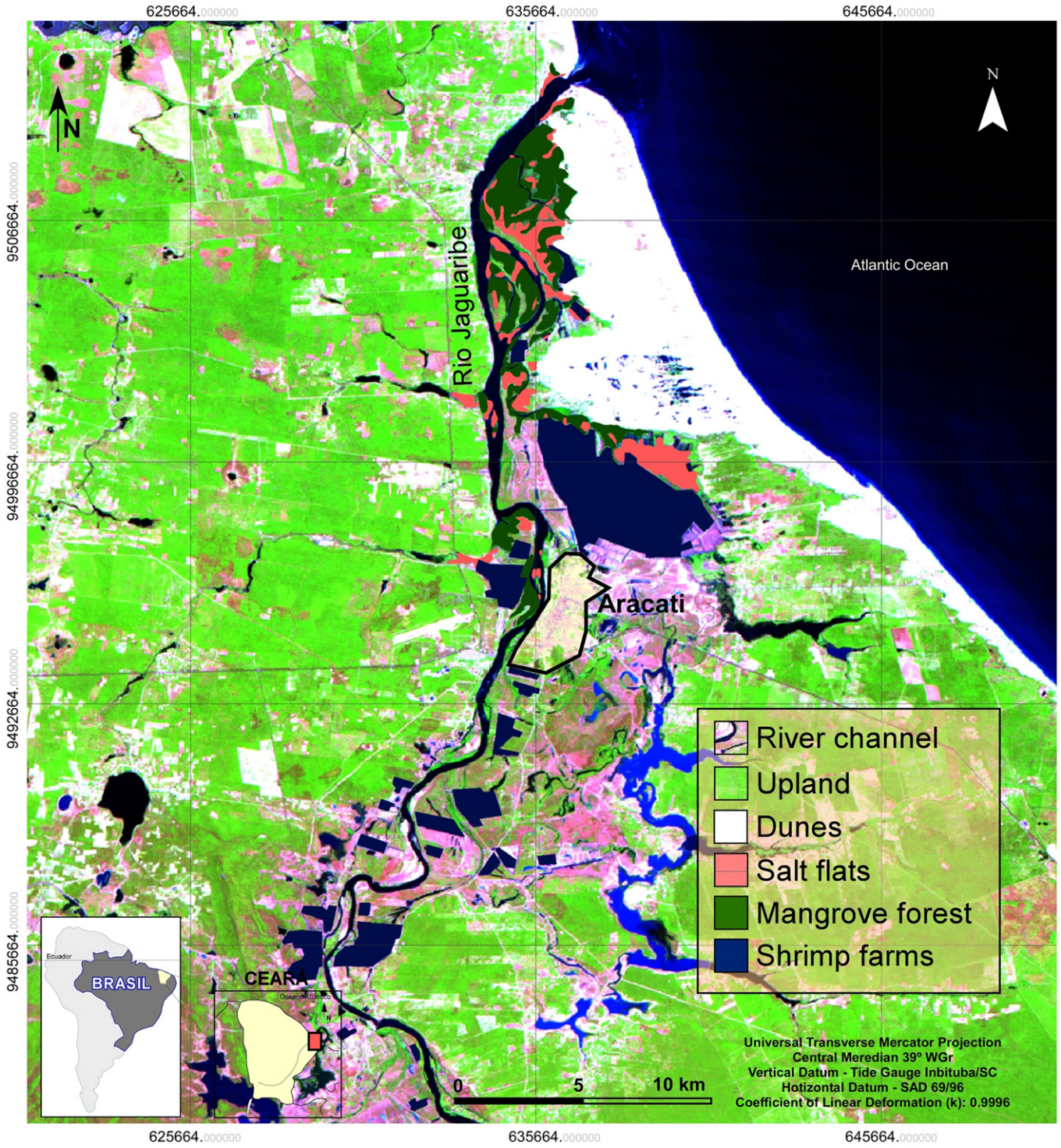

Fig. 3. Estuarine system of the Jaguaribe River and its principle environmental components. (Source: National Institute for Space Research (INPE), satellite image Landsat TM 5, 8 March 2008).

a synthesis of the characteristic geo-environmental units throughout the estuarine system of the Jaguaribe River and how they were occupied by shrimp production units. Also characterised are the impacts related to access roads, larva and post-larva growing ponds, storage and drainage canals, sedimentation ponds, laboratories and tool/material storage.

Of all the farms licenced by the State Superintendent of the Environment (SEMACE), it was verified that 84% had direct impacts on the mangrove ecosystem (mangrove fauna and flora, salt flats); 25.3% cut down carnaubal palm forests and 13.9% occupied areas previously destined for subsistence agriculture. Throughout the watershed there was an increase in the area of shrimp farms from 295 to 1985 ha, with a decrease in mangrove forests in 1999 and a slight increase in area (probably related to the occupation of mangrove in former areas of abandoned farms and salt flat sectors colonised by the forest). Fig. 4 presents the occupation of the

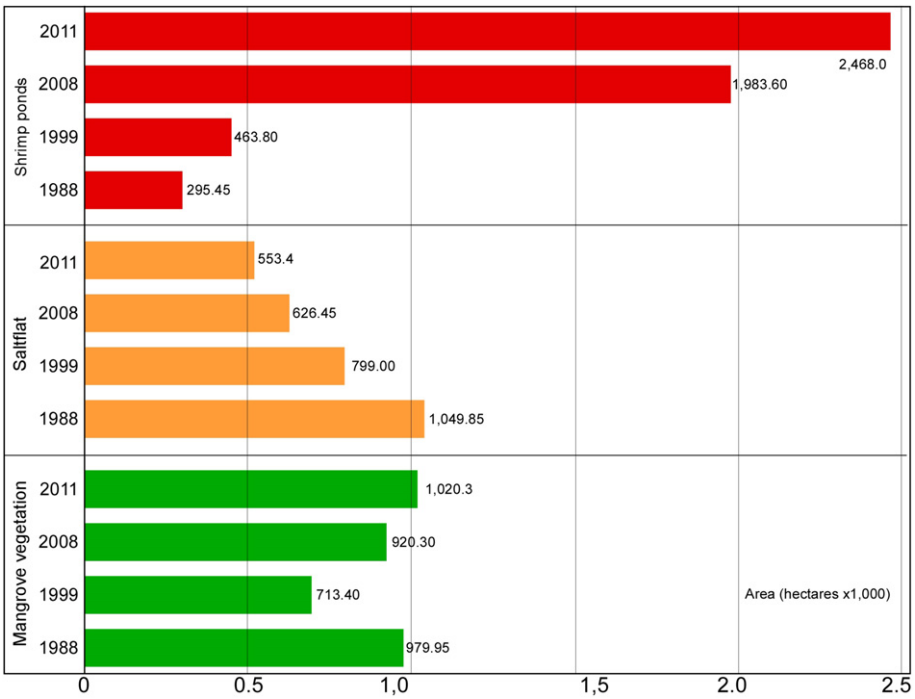

Fig. 4. Occupation of the mangrove ecosystem related with vegetation and salt flats through the period studied (1988–2011).

mangrove ecosystem through the period studied, where there is a significant increase in shrimp farm areas, occupying ecosystem sectors related with vegetation and salt flats.

According to the Superintendência Estadual de Meio Ambiente (SEMACE), 44.2% of the shrimp farms constructed in the Jaguaribe River, interfered directly with the mangrove ecosystem and 63.6% caused serious damage to the riparian forest (carnaubal palms), which is one of the most important ecosystems of NE Brazil primarily for the protection of areas of recharge (IBAMA, 2005). Fig. 5 shows the synthesis of the occupation process, and the relation between the increase in shrimp farms and decrease in vegetation cover and salt flats. These results also demonstrate that the mangrove occupation was related to the substitution of environmental components with extensive aquaculture.

Fig. 6 represents a synthesis of the characteristic geo-environmental units along the estuarine system of the Jaguaribe River and how they were occupied by the shrimp production units. Also characterised were the impacts related to the access roads, larva and post-larval phase tanks, storage and drainage canals, sedimentation ponds, laboratories and tool/material storage. Additionally, the impact on biodiversity caused by the dissemination of exotic species was also identified. The farms do not have efficient security mechanisms to prevent the invasion of the exotic shrimp L. vannamei which is harmful to Brazilian mangroves (Meireles and Queiroz, 2010; Meireles and Tupinambá, 2005). In addition, contaminated effluents directly affect the biology of native species.

According to Fig. 6, the environmental impacts identified in the Rio Jaguaribe caused by shrimp aquaculture were:

1. Geo-environmental and eco-dynamic decharacterization of the mangrove ecosystem by deforestation (mangrove carnaubal palms, etc.);
2. Deforestation of riparian zones associated with the lateral areas of mangrove salt flats;
3. Impermeabilization of soils near urban areas and fishing villages, destroying aquifer recharge areas;
4. Risk of aquifer salinization due to the occupation of extensive recharge areas;
5. Blocking of the tides, preventing access to water (nutrients and seeds) in areas with mangrove vegetation and in salt flat sectors;
6. Hindering the entrance of fresh water originating from the aquifer (water renovation cycle and leaching of salts) in the internal eco-dynamic of the salt flat, and, consequently, for the estuary.
7. Transformation of mangrove vegetation (and salt flats); structural changes (loss of sedimentary material and compaction).
8. Erosion of the shrimp pond slopes (pluvial action and contact with daily tidal oscillations) and destruction of mangrove vegetation and slat flat areas;
9. Direct discharge of effluents in the creeks;
10. Death of vegetation (mangroves, carnaubal forest and caatinga), probably resulting from the infiltration of brackish water and blockage of lateral exchanges with the implantation of polders and infrastructure.

4. Discussion

The technique that we have used to evaluate the changes in the altered area caused by the presence of shrimp farms proves to be adequate for making a good landscape evaluation. It is easy to use and can be combined with shrimp production data, including the downward trends that in this case have been detected in the state of Ceará in recent years.

In the 1990s, intensive shrimp production started to be developed in Ceará. In only 10 years (1998–2008), the activity had already developed in eight municipalities, corresponding to 48% of the entire cultivated area in the state and being responsible for more than 80% of the total shrimp production in that zone of Brazil. Of the 6069.97 ha of shrimp production, the Jaguaribe watershed region was responsible for 3294.88 ha during this period (including shrimp farms in fluvial systems, far from the estuary). In the lower Jaguaribe, the ponds were first installed in the river margins, where

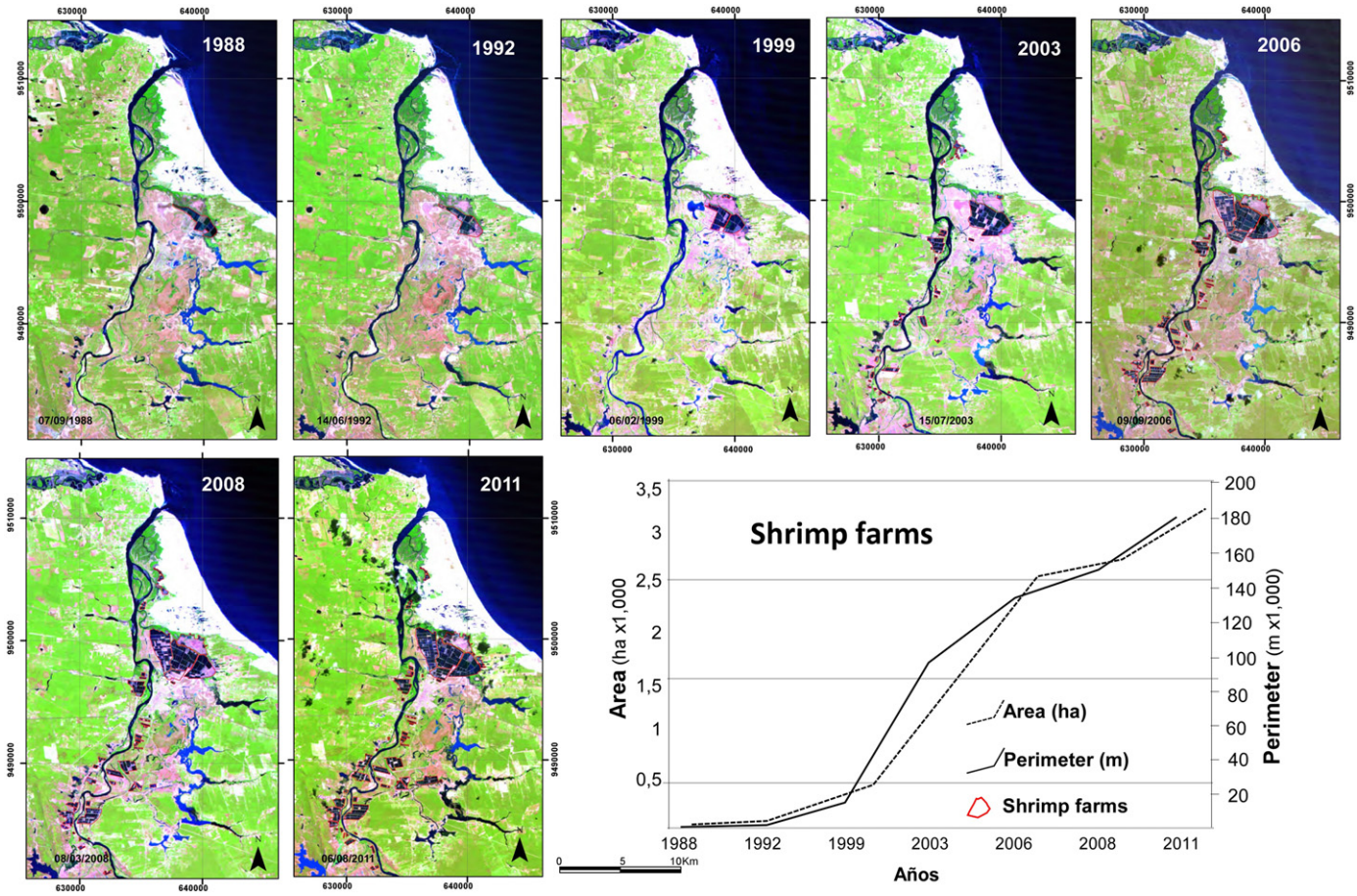

Fig. 5. Evolution of mangrove forests and shrimp farms along the Jaguaribe River estuary (Meireles and Tupinambá, 2005; Meireles and Queiroz, 2010).

salt flats and mangrove trees were located. There was a great *boom* in shrimp production, causing large transformations in the ecological equilibrium in a short period of time (IBAMA, 2005; Meireles and Vicente da Silva, 2003).

Economic activities that follow different programs of development are taking place on the same estuarine system of the Jaguaribe River watershed. Shrimp aquaculture obeys the logic of appropriation of space generating socio-environmental consequences and compromising the flux of ecosystem services produced by mangroves. Through field research it was possible to verify that the logic of aquaculture collides with the forms of use and community perception of the land (family agriculture, fishing, crafts, etc.) that are intimately related to the socialisation of the group. This point follows the principles of reciprocity and community more than competition and individualism. The communities – in small villages and living along the shores of the fluvio-marine system of the Jaguaribe River – depend on the state of conservation of the mangroves and other ecosystems interconnected with them for their survival (Queiroz personal observation). In the Philippines, it has been shown that the profound changes provoked by the disappearance of mangroves (from 400,000 ha around 1920 to less than 100,000 at the beginning of 2000) have provoked important changes including the perception of the environment by the inhabitants of these zones (Farley et al., 2010). Vietnam is another example in which many communities have seen radical changes in their *modus vivendi* due to the shrimp farming industry having replaced artisanal fishing and mangrove organisms with this type of intensive culture (Lan, 2009). The conflicts in this region of SE Asia have been due, above all, to a top-down decision in which the necessities of the people who work (and live) directly from mangrove resources have not been taken into consideration (Lan, 2009).

In the lower Jaguaribe River watershed coastal communities of artisanal fisheries also develop activities such as agriculture and crafts, establishing another type of relationship with nature. They are communities that develop different uses and activities in the mangroves, benefitting from their ecosystem services, for example fishing and shellfish collecting (Aburto-Oropeza et al., 2008; Farley et al., 2010]. These community values and perceptions may be generated by mangroves in different ways, and may be lost with the intensive shrimp farming exploitation that may last a maximum total of 10–15 years (Aburto-Oropeza et al., 2008; Mumby et al., 2004).

In the case of Brazil, the growth of the aquiculture sector was associated with the occupation of the mangrove ecosystem, generating important socio-environmental impacts. Yet, it was impossible to guarantee the sustainability of the activity. These socio-environmental impacts – privatization of water and common-use public lands, the expulsion of ancestral fisher folk and indigenous populations, the systematic deforestation of mangroves, the contamination of water, the decrease in the quantity of fish stocks and the salinization of aquifers – together with the degradation of biodiversity which engenders cumulative effects, may impact the food sovereignty of the communities which find their source of subsistence in mangroves (Polidoro et al., 2010). The situation is very similar, as has been observed, to other places where the identified impacts and their diagnosis due to the intense development of the shrimp farming industry was accelerated

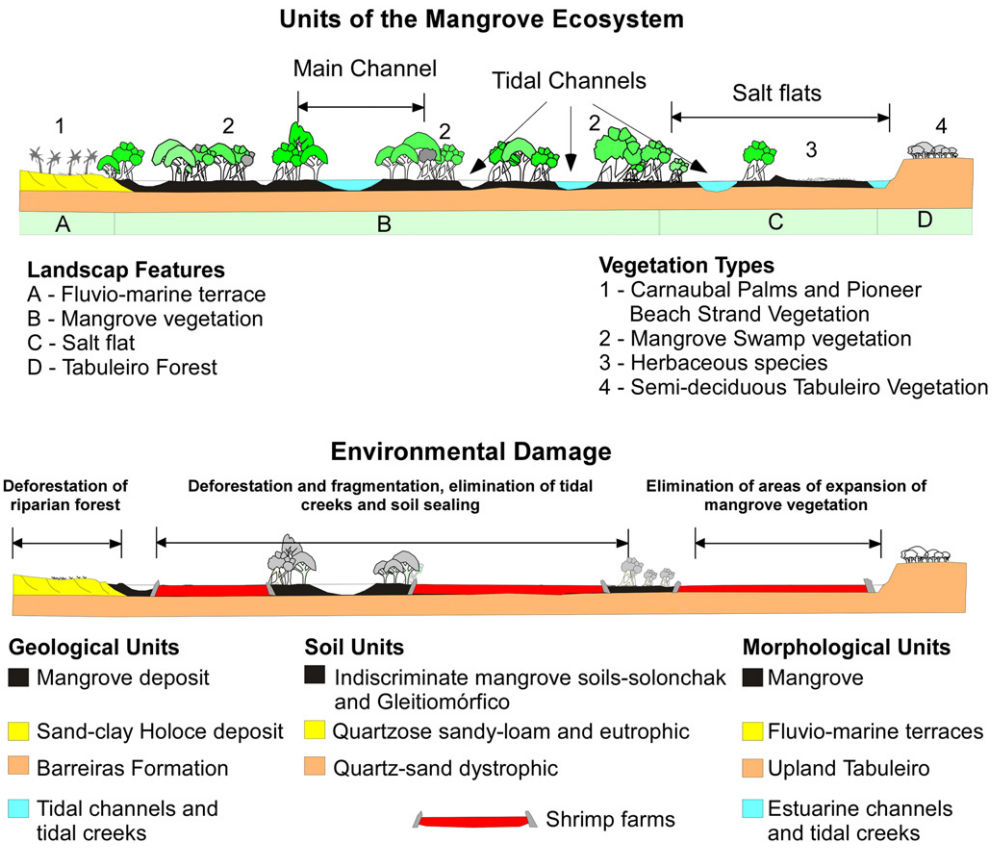

Fig. 6. Mangrove ecosystem units and geological, geo-morphological, soil characteristics, landscape units and vegetation types. Associations were also made regarding the principle environmental impacts related with the introduction of the shrimp farms (Meireles and Tupinambá, 2005; Meireles and Queiroz, 2010).

(Kautsky et al., 2000; Primavera, 2006). As demonstrated in the present study, aquaculture growth in Ceará was especially fast in terms of the disappearance and degradation of mangroves compared to other areas of Brazil and even the rest of the world, although more data is required regarding how it will impact the economic dynamics of the communities of the zone.

In the mid-2000s a retreat in the construction of shrimp farms and production for export was detected. The activity's economic crisis was generated by an accumulation of socio-environmental impacts, as these impacts resulted from a production that the system could not tolerate, just as has been demonstrated in other studies (Rivera-Ferre, 2009). In order to produce more biomass in less time there was an increase in the levels of water pollution in the estuaries, fragmentation of the mangrove ecosystem and the spread of viral diseases introduced by shrimp (EMBRAPA, 2004). For this reason, the shrimp industry, previously presented as one of the most lucrative of the national economy, began to collapse. Recently it has worsened due to the reduction in exports and, consequently, to the abandonment of farms.

The uncontrolled activity is due mainly to the avalanche of farms without environmental permits. The first legal instrument of national scope did not appear until 2002, with Resolution 312 [of the National Environmental Council (CONAMA)]. Farms were also placed in permanent preservation areas, promoting optimism in the producers, to the point that ABCC (ABCC, 2005) stated that the objective was to be the leader of the global market, reaching production equivalent to US$ 1.5 billion by the year 2010. Contrary to the predictions, the value of exports was much lower, reaching US$ 57.6 million. The productive chain degraded rapidly, generating as a consequence financial losses and unemployment due to the rapid decline of an industry that many times was defined as the promoter of the financial redemption of the poorest states of the country.

With the data obtained concerning the economic dimension of shrimp production in mangrove areas, it was possible to confirm that the rapid growth unleashed the collapse of the activity throughout the Jaguaribe River estuary. As environmental responses, accumulated impacts in the ecosystems (water quality and biodiversity loss) and in the communities along the fluvio-marine system (substitution of extractive activities for shrimp monoculture) have been defined. A sequence of environmental and social damage has not yet been quantified in order to thoroughly examine the public policy suggestions locally (estuaries) and regionally (watersheds) in order to measure the economic activities and promote the recuperation of the environmental systems responsible for the bases of productivity of the wetlands and food sovereignty.

Social and environmental externalities need public policies that are aimed at the effective management of fluvial, mixed and marine systems (Naylor et al., 2000). One activity should be measured from the perspective of the advance in new technologies, local alternatives, definition of accumulated impacts; and using the precaution principle and equity, an evaluation of actual social benefit, as well as the environmental and economic benefit of the shrimp monoculture in mangroves can be performed.

The present study associates the rapid growth of shrimp farming in Brazil with the clear degradation of the mangrove system. The example of the state of Ceará produced through a cartographic study (a tool that can be easily used anywhere in the world) is very

useful for quantifying the replacement of mangroves with shrimp farms.

The rapid evolution of shrimp farms against mangrove ecosystems minimised the availability of services, compromising the socio-environmental sustainability of the coastal zone of Brazil for the medium-and long-term. The impacts are present not only from the environmental point of view but also from a social and economic one, including an increase in poverty, lack of land and food insecurity, displacement of communities, contamination of potable water, poor working conditions, health and education impacts, and in some countries the violation of human rights.

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SERVIÇOS ECOSSISTÊMICOS COSTEIROS E COMUNIDADES TRADICIONAIS

coastal ecosystem services and traditional communities

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Resumo

Nas últimas décadas, a despeito de sua importância socioambiental, cultural e econômica, muitos ecossistemas costeiros têm alcançado altos níveis de deterioro. Uma degradação causada principalmente pelo desenvolvimento de atividades industriais, a exemplo do cultivo de camarão em cativeiro (principal ameaça aos manguezais) e da produção de energia eólica (ameaça aos sistemas dunares), que reduzem o fluxo de serviços ecossistêmicos (SE) prestados pela natureza à sociedade. Isto se deve ao fato de que durante a definição das políticas de gestão costeira, desde um ponto de vista de sistema complexo, multidimensional e vinculados ao modo de vida das comunidades tradicionais, são desconsiderados frente às potenciais vantagens econômicas das atividades industriais. Este artigo lança luz sobre a vinculação entre os serviços ecossistêmicos e o bem-estar das comunidades tradicionais e faz uma reflexão sobre os critérios indispensáveis que devem ser considerados para o avanço da gestão dos ecossistemas.

Palavras-chave: Serviços ecossistêmicos, Manguezais, Aquicultura, Energia eólica, Percepção ambiental.

Abstract

In the last decades, many coastal ecosystems have achieved high levels of deterioration despite their ecological, cultural and economic importance. The degradation is caused mainly by the development of industrial activities like shrimp farming (the main threat to mangroves) and wind energy (a threat to dune systems), reducing the flow of ecosystem services (ES) provided by nature. This is due to the fact that to make a proper definition of coastal management policies, the ES, from the point of view of the complex and multidimensional system connected to the livelihoods of traditional and ethnic communities are undervalued compared to possible advantages of industrial activities. Such activities are considered more profitable in a short time economical approach. This article focus on the links between ecosystem services (mangroves and dunes) and the wellbeing of traditional communities.

Key words: Ecosystem services of mangroves, Aquaculture, Wind energy, Environmental perception.

Resumen

En las últimas décadas, a pesar de su importancia ecológica, cultural y económica, muchos ecosistemas costeros han alcanzado altos niveles de deterioro. La degradación está causada principalmente por el desarrollo de monocultivos industriales, como el cultivo de camarones (principal amenaza a los manglares) y la producción de energía eólica (amenaza para los sistemas de dunares) que reducen el flujo de servicios ecosistémicos (SE) proporcionados por la naturaleza. Esto se debe al hecho de que durante la definición de las políticas de gestión costera, los SE, desde el punto de vista del sistema, complejo, multidimensional y vinculado a los medios de vida de las comunidades tradicionales, no son considerados ni debidamente evaluados frente a las posibles ventajas de las actividades industriales. Este artículo arroja luz sobre los vínculos entre los SE de los manglares y dunas y el bienestar de las comunidades autóctonas.

Palabras clave: Servicios ecosistémicos de los manglares, Acuicultura, Energía eólica, Percepción ambiental.

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INTRODUÇÃO

O estudo sobre os Serviços Ecossistêmicos (SE) adquiriu um impulso significativo a partir de 2001, durante o desenvolvimento do programa científico internacional denominado "Avaliação dos Ecossistemas do Milênio" (MEA, 2005). Sendo os SE definidos como "os benefícios que brindam os ecossistemas para fazer a vida da humanidade não só fisicamente possível, mas também digna de ser vivida" (COSTANZA, 2000; MEA, 2003). Esta definição, mesmo sendo básica em relação à complexidade dos processos e estruturas necessárias para que um serviço seja produzido (e possa ser aproveitado pela sociedade), se faz explícito o vínculo entre sistemas biofísicos e sistemas humanos, ambos interagindo de forma dinâmica com os ecossistemas (BALVANERA e COTLER, 2009).

A conversão de ecossis¬temas naturais em monocultivos agrícolas (entre outras atividades industriais) tem conduzido um incremento de alguns serviços, como o de provisão (como produção de alimento), à custa do comprometimento de outros componentes ambientais – qualidade da água, solo e perda de biodiversidade, entre outros – além dos de regulação e culturais (VITOUSEK et al., 1997). Sendo o conjunto destes SE prestados à sociedade transformados (impactos socioambientais), com consequências diretas na prosperidade da sociedade e não somente em sua economia, mas também na saúde, influenciando diretamente o nível de bem-estar social (MONTES e SALAS, 2007; MEA, 2005).

Esta lógica, quando inserida nos territórios de comunidades tradicionais e étnicas, interfere diretamente no fluxo de SE prestados pelos ecossistemas costeiros à sociedade, a exemplo da influência sobre a alteração da produtividade dos mares, das funções intrínsecas dos ecossistemas costeiros (biodiversidade, aquíferos, entre outras) (IPCC, 2007). No que se refere à vinculação e a importância dos SE para a manutenção do modo de vida e relações cosmológicas de grupos ancestrais com a biodiversidade, são comumente desconsideradas ou invisibilizadas dentro do processo de gestão dos ecossistemas (SALZMAN et al., 2001; MICHAELIDOU et al., 2002; DEUTSCH et al., 2003).

Estas relações advindas das distintas formas de apropriação dos territórios promovem conflitos socioambientais. De acordo com Acselrad et al. (2009), são relacionados com a privatização dos recursos e apropriação de sistemas ambientais utilizados pelas comunidades ("formas de apropriação não-capitalista da natureza") e decorrentes de processos de "contínua destruição da natureza":

> A introdução, em tais áreas, de monoculturas e pastagens, projetos viários, barragens, atividades mineradoras, etc. provoca grandes efeitos de desestabilização das atividades nas terras tradicionalmente ocupadas. Trata-se, portanto, dos casos em que, em certas combinações de atividades, o meio ambiente transmite impactos indesejáveis (as ditas "externalidades") que podem fazer com que o desenvolvimento de uma atividade comprometa a possibilidade de outras atividades se manterem. Nesses casos, espaços produtivos privados transmitem os efeitos nocivos de suas práticas para o meio ambiente comum. (ACSELRAD et al., 2009, p.74).

No estado do Ceará, estudos demonstram danos socioambientais de elevada magnitude nos ecossistemas costeiros. Constataram que nas últimas décadas, em parte, foram relacionados aos espaços litorâneos das comunidades tradicionais e étnicas, onde se desenvolvem atividades artesanais, de subsistência e extrativistas (QUEIROZ et al., 2013; MEIRELES et al., 2007; CAROL et al., 2012; BETROZ et al, 2012; CARRANZA, et al., 2012; MONTÓN et al., 2012). Estas comunidades realizam distintos usos dos ecossistemas costeiros e marinhos, vinculadas aos processos naturais regidos pelos fluxos de matéria e energia entre as dunas e os manguezais, beneficiando-se de seus SE, como, por exemplo, a pesca e coleta de mariscos, acesso à água dos aquíferos, tal e como descreve Farley (2010) e Aburto-Oropenza (2008). Desta forma, um sentido socioambiental dos SE, quando a natureza representa elementos construtivos das relações de subsistência e demais vínculos simbólicos e materiais com o território.

No que se refere à utilização dos manguezais, foi possível evidenciar que as atividades de subsistência, em longo prazo, são mais "valiosa" do que uma exploração entre 10-15 anos, a exemplo

monocultura de camarão em cativeiro (carcinicultura intensiva) (MUMBY et al., 2004; ABURTO--OROPEZA et al., 2008). Desta forma, constata-se que o avanço no conhecimento da distribuição e formas de apropriação dos SE se torna urgente para orientar decisões no encaminhamento de ações e medias para a gestão dos ecossistemas (DAILY e MATSON, 2008). E considerados para a composição de indicadores de qualidade e capacidade dos ecossistema para a produção de benefícios à sociedade (EGOH et al., 2007). É evidente que as funções ambientais desses territórios são potencializadas desde abordagens associadas à avaliação da equidade ambiental (FASE, 2010).

Frente a este contexto, foi possível observar reduzido conhecimento sobre a vinculação entre os SE e o bem-estar das comunidades tradicionais, possivelmente devido ausência destes sujeitos (inequidade socioambiental) no processo de avaliação das múltiplas relações e práticas tradicionais. Condicionantes fundamentais para assegurar seus territórios e a gestão adequada dos ecossistemas. Sendo estes os principais desafios para planejamento de uso sustentável dos ecossistemas (BRYERS, 2000).

Nesse sentido, este artigo lança luz sobre os vínculos das comunidades tradicionais com as dunas e manguezais e faz uma reflexão sobre os critérios indispensáveis para o avanço da gestão dos ecossistemas: i) a multidimensionalidade e complexidade dos serviços ecossistêmicos, ou seja, considerar, além dos aspectos ecológicos e biológicos já historicamente privilegiado neste campo, os aspectos sociais, culturais e psicológicos da provisão de serviços ecossistêmicos; ii) a percepção ambiental das comunidades tradicionais sobre sua relação (material e simbólica) com os SE e; iii) a participação destas comunidades na construção do conhecimento e no processo de tomada de decisão, já que elas percebem e se relacionam de diferentes formas com os ecossistemas.

SERVIÇOS ECOSSISTÊMICOS DOS MANGUEZAIS

As zonas húmidas, incluindo os manguezais, estão entre os ecossistemas mais produtivos da terra (BARBIER et al., 1997). Estas áreas proporcionam SE de elevada importância para a humanidade, como por exemplo, a produção de alimento ou amortecimento das consequências previstas pelo aquecimento global (Tabla 1). O manguezal, como caso particular, é um ecossistema rico, diverso e complexo formado na interfase entre os sistemas terrestres, estuarinos e marinhos, presente nas regiões tropicais e subtropicais de 123 países do planeta (BARBIER et al., 1997; SPALDING et al., 2010).

Frente a multidimensionalidade de todos estes serviços, se torna evidente que sistemas de fronteira são essenciais para a conservação da diversidade biológica, proporcionando habitats, zonas de desova, proteção, viveiros, nutrientes para diferentes animais, entre outros. Uma ampla diversidade de animais e outros organismos vivos dependem dos processos ecossistêmicos destes bosques costeiros, sendo a função dos manguezais na cadeia alimentar marinha vital para a sobrevivência de muitas populações (FAO, 2007). Estima-se que 80% das capturas mundiais de peixes em zonas costeiras tropicais são dependentes dos manguezais e dos sistemas de arrecifes coralinos (FIELD, 1998; ELLISON, 2008; POLIDORO, 2010). Dentro de uma perspectiva monetária, foi calculado que, como mínimo, o aporte econômico dos SE produzidos pelos manguezais é de aproximadamente US$ 1.6 bilhões ao ano (FIELD, 1998; ELLISON, 2008; POLIDORO, 2010).

Para além dos serviços de regulação, produção e habitat, já bastante estudados, os resultados de investigações mais recentes realizadas a partir da percepção humana dos SE dos manguezais, apontam para serviços culturais e uma nova categoria denominada de serviços psicológicos. Tais dimensões socioambientais destes sistemas costeiros foram subestimadas pela literatura científica, mais ainda quando voltados para definir os processos de gestão costeira. Tais serviços foram definidos de modo a evidenciar as vinculações simbólica e material entre os SE e as comunidades tradicionais e étnicas.

Estes novos serviços foram relacionados ao acesso material aos manguezais (usufruto coletivo e individual dos componentes ambientais) e, principalmente, à dimensão simbólica – relações cul-

turais inseridas na apropriação coletiva e individual do território – da provisão de SE. Desta forma, foi evidenciada a vinculação dos sistemas naturais com as comunidades tradicionais. Foi possível constar que os manguezais são responsáveis pelo serviço cultural de "criação e manutenção das relações sociais", estando relacionado à construção e manutenção das relações interpessoais da própria comunidade, entre comunidades vizinhas e visitantes. Outro serviço cultural identificado foi o de manutenção do conhecimento ecológico tradicional, como afirma um dos pescadores entrevistado: "Meu pai criou a mim e a meus doze irmãos dos produtos gerados pelo manguezal. Nós crescemos vendo ele sobreviver da coleta de caranguejo, aprendemos com ele e de geração em geração fica o conhecimento. Hoje tenho muitos irmãos que ainda seguem trabalhando nos manguezais." (pescador, comunidade do Cumbe, Aracati/CE). Uma evidência de que nos manguezais se desenvolvem atividades tradicionais (cata do caranguejo, pesca de peixes na gamboa, mariscagem, entre outras), e que existe um conhecimento tradicional que é transmitido de geração em geração, se configurando em importante sistema ambiental para a manutenção destes conhecimentos autóctones e ancestrais.

Foi possível evidenciar que os manguezais foram responsáveis por serviços de bem-estar, desta forma, provedores de felicidade, que é uma categoria de SE identificada pelas comunidades tradicionais. Este serviço foi definido por estar relacionado aos sentimentos de satisfação pessoal tal como: força para viver, riqueza (não de um ponto de vista monetário, mas da possibilidade de acesso aos recursos gerados pela natureza), orgulho (de poder trabalhar com a atividade de pesca no manguezal) e liberdade (de não ter um patrão, liberdade de exercer seu trabalho sem imposição de regras): "O manguezal é liberdade. Meu trabalho no manguezal é tudo porque não tenho preocupação com chefe (…). Tenho liberdade, porque no meu trabalho eu sou meu próprio chefe" (pescadora da comunidade do Cumbe, Aracati/CE). Além da felicidade, a categoria de serviços bem-estar dos manguezais, também promove saúde (física e mental), se configurando como mais um vínculo que consolida as relações entre as comunidades e os ecossistemas. Estas relações foram materializadas quando o ecossistema manguezal foi definido como importante para a realização de atividades físicas e de lazer e para práticas de relaxamento, atuando como um ambiente terapêutico: "O manguezal é o melhor lugar para escutar o vento. É um lugar para pensar. Na verdade, é que às vezes, na cidade, fico estressado, entretanto, eu nunca fico assim quando estou no manguezal" (pescador da Comunidade do Cumbe, Aracati/CE). Os depoimentos evidenciaram profundas relações simbólicas, culturais e materiais (sistemas naturais) com o território, diante das manifestações da natureza que asseguram qualidade de vida, e que normalmente não são inseridos como "critérios" para a definição de políticas públicas, alocação e licenciamentos de empreendimentos industriais.

Mesmo frente a toda esta importância e uma legislação elaborada para protegê-los, os manguezais seguem figurando como um dos ecossistemas costeiros mais degradados e alterados (perda de biodiversidade) a um ritmo intenso (TURNER et al., 2000; QUEIROZ et al., 2013). Segundo a Organização das Nações Unidas para a Agricultura e Alimentação (FAO), as perdas de manguezais têm sido consideráveis e continuam em ritmo acelerado. Cerca de 35.600 quilômetros quadrados foram perdidos entre 1980 e 2005 em todo o planeta (FAO, 2007). A indústria do camarão tem sido uma das principais causadoras das transformações e degradação dos manguezais (EJF, 2003; POLIDORO et al., 2010; FAO, 2010; QUEIROZ et al., op cit.), produzindo uma regressão considerável de sua superfície.

AQUICULTURA INDUSTRIAL DE CAMARÃO: O CASO DA PRIVATIZAÇÃO DOS MANGUEZAIS.

A aquicultura é uma atividade econômica que tem sido promovida como meio de alcançar crescimento econômico através das exportações de alimentos, diminuir as pressões sobre as populações marinhas selvagens e aliviar a pobreza de regiões em processo desenvolvimento (BARDACH, 1997; NAYLOR et al., 2000; STONICH E BAILEY, 2000; COSTA-PIERCE, 2003).

Desde os anos 1990 a meados de 2000 a indústria camaroneira se desenvolveu como ponta de lança da "Blue Revolution" (Revolução Azul refere-se á gestão das águas, uma expressão equivalente á Revolução Verde) e tem até 54% anual, segundo a localização e condições legislativas. Esta vertiginosa atividade econômica de produção de camarões foi responsável por 73,3% da produção mundial de crustáceos (FAO, 2010). Constatou-se que 99% do cultivo de camarão é realizado em países em processo de desenvolvimento, entretanto, a maior parte desta produção é destinada à exportação para a Europa, Japão e Estados Unidos da América do Norte (PÁEZ-OZUNA, 2001).

Segundo estimativas recentes, de 1 a 1.5 milhões de hectares de áreas costeiras foram convertidas em cultivos de camarões, principalmente na China, Tailândia, Índia, Indonésia, Filipinas, Malásia, Brasil, Equador, México, Honduras, Panamá e Nicarágua (SENARATH e VISVANATHAN, 2001). Na maior parte destes países, o monocultivo de camarões tem sido planificado sem regulamentação, sem ordenamento e o vertiginoso crescimento tem sido responsável pela degradação sequencial dos sistemas ambientais costeiros, principalmente do ecossistema manguezal (diminuição do fluxo de SE produzidos) (BARBIER e STRAND, 1998; RÖNNBACK, 1999; EJF, 2003; POLIDORO et al 2010; QUEIROZ et al., 2013).

Estudos realizados por Rivera-Ferre (2009) apontam diferentes períodos e porcentagens de destruição de manguezais, por exemplo, os períodos de destruição mais elevados foram em Honduras (1965-1995) de 82% e no Brasil (1973-1991) com 72% de destruição de superfície de manguezais. Alongi (2002) previu que em 25 anos posteriores a seu estudo, a aquicultura de camarão, conjuntamente com a sobre pesca, serão as maiores ameaças para a conservação dos manguezais.

No caso do Brasil, os manguezais cobrem aproximadamente uma área de 13.400 km2, que corresponde a 9% do ecossistema manguezal que existe no planeta. Nos estados do Maranhão e Pará se encontra a maior franja de manguezais do mundo que representa 57% do total de manguezais do país (SOUZA-FILHO, 2003). Os impactos socioambientais, com seus efeitos cumulativos, afetaram a qualidade ambiental das bacias hidrográficas, o que coloca em risco a soberania alimentar das comunidades que tem no manguezal sua fonte de subsistência (MEIRELES e QUEIROZ, 2010; MEIRELES et al., 2007; IBAMA, 2005; EMBRAPA, 2004; QUEIROZ et al., 2013; BETORZ et al., 2012; CAROL et al., 2012).

CAMPOS DE DUNAS E SEUS SERVIÇOS ECOSSISTÊMICOS

Os campos de dunas representam um dos principais elementos morfológicos do litoral e ocorrem associados aos demais componentes da planície costeira. Em conjunto com as com as praias, falésias, estuários, lagoas e lagunas, terraços marinhos e pontais, constituem um complexo conjunto de morfologias e ecossistemas responsáveis pela estruturação paisagística do litoral e pela geração de fluxos ecossistêmicos de importância socioambiental, cultural e econômica.

As dunas fazem parte das restingas, que são consideradas áreas de preservação permanente para a sua função ambiental de preservar os recursos hídricos, a paisagem, a dinâmica geológica, a biodiversidade, fluxo gênico de fauna e flora; proteção do solo e assegurar o bem-estar das populações humanas (AQUASIS, 2003).

Apesar desta proteção jurídica, constatou-se que o desenvolvimento de atividades não planejadas em campos de dunas vem modificando a dinâmica, transporte e morfologia dunar, a exemplo da fixação artificial, exploração mineral, desvio dos corpos dunares, retirada das areias para amenizar os impactos de avanço sobre vias de acesso, loteamentos, áreas agrícolas e mais recentemente a implantação de parques de energia eólica poderão acelerar a movimentação, incrementar riscos de soterramento e acelerar a erosão costeira (AQUASIS, 2003; MEIRELES et al., 2013).

No estado do Ceará, a condição topográfica e disponibilidade dos ventos amplamente favoráveis para as usinas eólicas foram definidas ao longo da planície costeira. Como componente desta unidade geoambiental, as dunas estão sendo licenciadas através de Relatórios Ambientais Simplificados

(RAS), para a instalação e operação dos aerogeradores e demais equipamentos de distribuição da energia elétrica, manutenção e monitoramento das usinas eólicas.

Ao mesmo tempo em que o Ceará é o estado que carrega a distinção de ser o 5º estado mais pobre no Brasil por indicador de desenvolvimento humano (IDH), se tornou o centro da indústria do vento no Brasil com mais de 550 MW de energia eólica instalada (ANEEL, 1998). Localizado no extremo nordeste do país, produz a maior quantidade de energia eólica do Brasil. Isto devido processos de licenciamento facilitados através do RAS, condição topográfica e disponibilidade dos ventos amplamente favoráveis para a instalação das usinas eólicas.

Apesar de ser uma alternativa de produção de energia renovável, ou seja, "energia limpa", nos últimos anos, começou a gerar problemas relacionados com a degradação ambiental e interferir na dinâmica territorial das comunidades tradicionais. A implantação dos parques para produção deste tipo de energia em campos de dunas tem causado impactos socioambientais e consequentemente gerado danos irreversíveis à escala humana. Ao serem instalados sobre os campos de dunas (principalmente dunas móveis) causam uma transformação do fluxo de SE dos quais depende a vida cotidiana das comunidades tradicionais vizinhas (MEIRELES et al., 2013).

A implantação das usinas eólicas sobre os campos de dunas, a exemplo do realizado nas dunas da Taíba e Cumbe/Canoa Quebrada foi, grosso modo, associada aos fatores altitude em relação ao nível do mar e disponibilidade dos ventos mais efetivos (MEIRELES, 2011). Em média, as dunas do estado do Ceará encontram-se a 50 m de altitude em relação à linha de praia e com velocidade média dos ventos superior a 8 m/s (BRASIL, 2002). Desta forma, o principal indicar locacional é possivelmente relacionado com a altitude da superfície receptora dos aerogeradores, em detrimento da degradação ambiental dos demais componentes morfológicos e ecossistemas associados aos campos de dunas.

O conjunto de impactos ambientais poderá interferir no controle da erosão costeira, dinâmica hidrostática e disponibilidade de água doce, supressão de habitats, extinção de lagoas costeiras e alterações da paisagem vinculadas aos aspectos cênicos e de lazer (CHEN et al., 2004; FRANCISCO, 2004; RUZ e MEUR-FERE, 2004; MARTINEZ et al., 2006; MCGRANAHAN et al., 2007; IPCC, 2007). Impactos potencializados quando estes sistemas ambientais estão relacionados aos fluxos de SE inseridos no cotidiano das comunidades tradicionais e étnicas, quando no trato de suas relações de subsistência e de bem-estar social.

INDICADORES DE SERVIÇOS ECOSSISTÊMICOS DOS MANGUEZAIS E CAMPOS DE DUNAS VINCULADOS AO MODO DE VIDA COMUNITÁRIA.

A diversidade de espécies resultante, disponibilidade dos territórios para as relações extrativistas, áreas húmicas e aporte de sedimentos para a zona costeira (dinâmica entre as dunas e os estuários), em parte explorada pelas comunidades tradicionais, foram à base geoambiental e cultural para definição dos serviços ambientais e seus vínculos entre a dinâmica dos manguezais e dunas. Estes componentes da planície costeira, em conjunto com as formas de uso e ocupação definidas e estruturadas pelas relações ancestrais, proporcionaram a espacialização dos principais serviços, etapa inicial da elaboração de abordagens interdisciplinares para a gestão adequada.

No quadro 1 consta a síntese dos principais SE definidos para os manguezais e dunas. Foram sistematizados desde a realização das atividades de campo para a elaboração do diagnóstico ambiental dos impactos ambientais associados à carcinicultura e implantação dos parques eólicos no litoral cearense (IBAMA, 2005; QUEIROZ, et al., 2013; MEIRELES, 2011). Os serviços definidos, diante dos componentes naturais de domínio comunitário, levaram em conta as práticas sociais construídas nas diversas manifestações dos fluxos de matéria e energia.

Quadro 1 - Serviços Ecossistêmicos dos Manguezais e Regulação

Regulação			
Serviço	**Caracterização e vínculos comunitários**	**Manguezais**	**Dunas**
Regulação e Produção de gases	Regulação da composição química atmosférica (balance de CO_2/O_2; níveis de SO_2). Produz gases nas fases de decomposição da matéria orgânica, produção de metano e demais compostos através das fases de oxidação e redução. Base de complexas relações bioquímicas para a cadeia alimentar e produtividade primária dos ecossistemas de domínio comunitário (manguezais).	**X**	–
Controle biológico	Regulação da dinâmica trófica de populações. Complexa cadeia alimentar com biodiversidade inserida nas atividades tradicionais de pescadores, indígenas, marisqueiras e ribeirinhos.	**X**	–
Regulação do clima	Regulação da temperatura global, precipitação e processos biológicos mediadores de fenômenos climáticos locais e globais (regula o efeito estufa). Ameniza as condições climáticas locais através das rajadas de vento direcionadas pelo canal estuarino e bosque de mangue, influência no microclima, evapotranspiração e fotossíntese.	**X**	**X**
Suplemento de água	Armazenamento e retenção da água (dinâmica dos aquíferos e reservatórios). Conjunto de aquíferos associados aos componentes morfológicos do sistema costeiro. Regula as propriedades físico-químicas através dos níveis de salinidade e densidade entre os aquíferos. Disponível para as comunidades tradicionais através de poços e quando o lençol freático aflora origina lagoas interdunares e sobre o tabuleiro. Fluxo subterrâneo de água doce na direção dos vales estuarinos.	**X**	**X**
Proteção da costa contra extremos (climáticos, deslizamentos, enchentes)	Amortecimento e integridade das respostas ecossistêmicas associadas às flutuações ambientais (proteção contra tormentas, enchentes, controle na produção de sedimentos finos e variabilidades ambientais das estruturas pedológica e vegetacional); capacitância. Produção e distribuição de sedimentos ao longo dos promontórios e canis estuarinos; dinâmica da cobertura vegetal e controle da erosão. Fluxos de matéria e energia consumidos e dissipados através da relação com os demais componentes geoambientais e ecodinâmicos.	**X**	**X**
Regulação hidrológica	Atua nos fluxos hidrológicos integrados com as bacias hidrográficas (água para atividades agrícolas e industriais, transporte) e os aquíferos dunar. Os eventos de elevada turbulência nas bacias hidrográficas são amortecidos e distribuídos sobre o bosque de mangue e setores de apicum; sazonalidade climática integrada com as atividades de subsistência ao longo da bacia hidrográfica (plantio de vazantes, pesca e mariscagem); interliga as comunidades litorâneas através dos canais estuarinos e gamboas. As dunas são relacionadas aos aquíferos com reservas estratégicas de água (zonas de recarga).	**X**	**X**
Amortecimento das consequências previstas pelo aquecimento global	Os complexos estuarinos atuam como sistemas responsáveis pela manutenção das propriedades amortecedoras dos efeitos projetados pelo aumento da temperatura média e subida do nível do mar (erosão costeira, incremento dos extremos climáticos associados às precipitações pluviométricas, salinização do lençol freático e mudanças na dinâmica de produção e distribuição de nutrientes, entre outros). As dunas fornecem sedimentos nos setores de *bypassing* de areia (promontórios e canais estuarinos) para a faixa de praia efetivando controle erosivo. Controle da disponibilidade de água doce, do aporte de sedimentos para as gamboas e manutenção dos portos das jangadas e dos barcos.	**X**	**X**
Controle da erosão e retenção de sedimentos	Conservação do solo dentro do ecossistema (prevenção de deslizamentos e outros processos de remoção de materiais). Fonte de sedimentos para a deriva litorânea e amortecimento de eventos extremos. Produção de sedimentos através da dinâmica interna dos canais com a evolução dos bancos de areia. Desenvolvimento das flechas de areia dispostas nas desembocaduras dos complexos estuarinos. Disponibilidade sazonal de areia sistemas fluviomarinhos e praial. Paisagem resguardada para atividades tradicionais de pesca, moradia e lazer.	**X**	**X**

Formação de solo	Através do intemperismo e transporte de materiais derivados das rochas do embasamento cristalino à montante, matéria orgânica e de biodetritos. Evolução pedológica relacionada com a dinâmica de aporte e distribuição de sedimentos provenientes da bacia hidrográfica e dos demais fluxos de matéria e energia definidos na planície costeira. Contribuição diferenciada e relacionada com acesso das dunas aos complexos estuarinos e deriva litorânea. Base dos vínculos das atividades tradicionais com os ecossistemas associados aos manguezais e campos de dunas (vazantes, roçados, quintais produtivos, entre outras atividades).	X	X
Ciclagem de nutrientes	Armazenamento, ciclagem interna, processamento e aquisição de nutrientes (fixação de N, P e outros elementos do ciclo de nutrientes). Os complexos estuarinos, áreas úmidas associadas e os campos de dunas fixas integram-se para a produção de nutrientes representando a base da biodiversidade regional. Atividades extrativistas de acordo com a sazonalidade climática vinculada aos fluxos nos setores de apicum, salgados, lagoas costeiras e interdunares.	X	X
Dissipador de matéria e energia	Recuperação, remoção e controle do excesso de nutrientes e compostos orgânicos (controle de poluentes). A dinâmica das marés e correntes marinhas interligam os complexos estuarinos, efetivando a distribuição de nutrientes e suporte à biodiversidade. A dinâmica dos ventos possibilita transporte de areia produzindo corpos dunares e zonas de deflação, desencadeando sistemas lacustres interdunares, sedimentos para os bancos e flechas de areia nos sistemas estuarinos. A sazonalidade é apropriada pelas comunidades para as atividades de pesca, mariscagem e plantios de subsistência (relações cosmológicas).	X	X
Polinização	Movimento de gametas para a reprodução de populações. Os fluxos de matéria e energia proporcionam interconexões entre os ecossistemas com elevado potencial de produção e distribuição de plântulas e polens (predominantemente pelos fluxos eólico, fluvial, fluviomarinho e deriva litorânea). As dunas fixas intervêm na definição dos corredores ecológicos entre os tabuleiros e estuários. Atividades extrativistas	X	X
SERVIÇO DE HÁBITAT			
Serviço	**Caracterização e vínculos comunitários**	**MANGUEZAIS**	**DUNAS**
Refúgio de vida silvestre	Habitat para populações residentes e migratórias (acolhida de aves migratórias). Os complexos estuarinos estão associados à elevada diversidade de avifauna; suporte ecossistêmico para as aves migratórias. Utilizado pelo peixe-boi marinho para alimentação, reprodução e refúgio. As dunas fixas resguardam complexos vegetacionais arbóreos densos, com elevada biodiversidade. Sistemas ambientais vinculados aos processos extrativistas.	X	X
SERVIÇO DE PRODUÇÃO			
Serviço	**Caracterização e vínculos comunitários**	**MANGUEZAIS**	**DUNAS**
Produção de alimento	Parte da produção primária bruta transformada em alimento (peixes, moluscos) com as atividades de pesca e agricultura de subsistência. Conjunto de componentes ecológicos (bosque de mangue, apicum/ planícies hipersalinas e lagoas) vinculados à produção de componentes bioquímicos para a produção e distribuição de nutrientes para uma diversificada fauna e flora. Atividades humanas inseridas na complexa cadeia alimentar que envolve localmente os estuários. Interação das atividades de produção de alimento realizada através da interconexão entre o baixo e médio curso fluvial. A cadeia alimentar vinculada aos manguezais e dunas fixas (as lagoas interdunares inseridas na cadeia alimentar) promovem relações extrativistas e de produção e alimento.	X	X
Produção primária	Parte da produção primária bruta transformada em matéria prima (madeira, combustível e forragem). Reações geoambientais e ecodinâmicas associadas à formação, disseminação e consumo (produção de matéria orgânica) do bosque de mangue e demais componentes florísticos existentes no apicum. Vínculos complexos com a produção pesqueira, aves migratórias, peixe-boi marinho. Base da permanência dos grupos sociais que encontram na produtividade dos manguezais a soberania alimentar[1].	X	X
Recursos genéticos	Produção de materiais e produtos biológicos para medicina, material científico, obtenção de genes resistentes a pragas e espécies ornamentais. Usos tradicionais da fauna e flora. Abordagem integrada evidenciando os complexos estuarinos. Usos tradicionais da fauna e flora.	X	X
SERVIÇO CULTURAL			
Serviço	**Caracterização e vínculos comunitários**	**MANGUEZAIS**	**DUNAS**
Recreação	Oportunidades para atividades recreacionais e lazer: passeio de barco, comidas coletivas, jogos, , trilhas ecológicas, entre outras. Atividades relacionadas com caminhadas entre as dunas e os estuários para contemplar a dinâmica morfológica, diversidade de paisagens, os usos comunitários do território (e impactos ambientais) e biodiversidade.	X	X

Turismo	Atividades turísticas que funcionam como geração de renda (ecoturismo, pesca esportiva e outras atividades ao ar livre). Comunidades inseridas em redes nacionais e internacionais de turismo comunitário	X	X
Paisagem	Os sistemas ambientais manguezal e dunas compõe a paisagem costeira. Os processos dinâmicos, associados às diversidades de usos evidenciam a integração entre os componentes socioambientais e econômicos da planície costeira.	X	X
Inspiração para cultura e arte	Os manguezais e os campos de dunas se configuram como motivo e inspiração para criações artísticas.	X	X
Espiritual	Foram registas percepções cosmológicas que reforçam vínculos comunitários com as manifestações da natureza, além de espaços sagrados.	X	X
Ciência e educação ambiental	Os manguezais e os campos de dunas se configuram como importantes espaços para o desenvolvimento de investigações científicas e ações de educação ambiental.	X	X
Criação e manutenção das relações sociais	No manguezal, nas práticas de utilização dos sistemas ambientais constroem-se relações interpessoais fortalecidas entre as pessoas da própria comunidade, entre pessoas das comunidades vizinhas e visitantes.	X	–
Manutenção do conhecimento ecológico tradicional	Nos manguezais se desenvolvem atividades tradicionais (trabalho, costumes, tradições, etc.) se configurando assim como importantes espaços para a manutenção dos conhecimentos autóctones.	X	–
Felicidade	Registros das relações simbólicas e de ancestralidade no usufruto dos sistemas ambientais promovem sentimentos de satisfação pessoal tais como: força para viver, riqueza, orgulho e liberdade.	X	–
Saúde (física e mental)	Percepção das comunidades de pescadores, marisqueira, ribeirinhas e visitantes e turistas diante das relações de vivência com as manifestações de biodiversidade e diversidade de paisagens (canais, gamboas, bosques e apicum) quando utilizadas para desenvolver atividades físicas (exercícios) e para relaxar funcionando como uma terapia.	X	–

1 Conceito de Soberania Alimentar aqui entendido como o direito das comunidades tradicionais e étnicas de definir suas políticas agropecuárias, extrativistas e de produzir alimentos a nível local.

Fonte: SCHAEFFER-NOVELLI, 1989; BARBIER et al., 1997; CONSTANZA et al., 1997; DE GROOT et al., 2002; MEA, 2003; 2005; 2007; 2010; de MCLEOD e SALM, 2006; RIVERA e CORTÉS, 2007; KUMAR, 2010; MEIRELES e CAMPOS, 2010; CAROL et al., 2012; BETROZ et al, 2012; CARRANZA, et al., 2012; MONTÓN et al., 2012; QUEIROZ et al. (submetido).
(–) Relações potenciais, mas não registradas para os campos de dunas.

Esta diversidade de componentes naturais dos manguezais e dunas foi definida diante das manifestações dos grupos sociais que os utilizam enquanto territórios de subsistência e ancestralidade. Diante destas possibilidades entre usufruto dos sistemas ecológicos e a existência de "recursos" ambientais para a criação de camarão em cativeiro e usinas eólicas, foram produzidos conflitos ambientais. De acordo com Laschefski (2011), tais conflitos podem ser vistos como consequência da expansão do "espaço ambiental" de grupos privilegiados à custa de grupos marginalizados, processo gerador de injustiça ambiental. Revelam-se, segundo Leff (2009), quando as práticas tradicionais de cultivo adaptadas às estruturas ecológicas dos trópicos, diante de transformações da natureza fundadas em práticas de monocultura destinadas a satisfazer as demandas do mercado externo, interferem na "capacidade produtiva dos ecossistemas tropicais e a riqueza de suas populações". Desta forma os processos ecossistêmicos estão relacionados com a lógica regida pela dinâmica comunitária, suas tradições, percepções e valores, funcionando, em grande parte, como um sistema não pertencente às relações de mercado.

CONSIDERAÇÕES FINAIS

As culturas das comunidades tradicionais não se desenvolvem dentro de um modo de produção estritamente mercantil. Um exemplo é a utilização dos recursos pesqueiros artesanais em Tonga, onde o pescado vendido é só uma parte do complexo quebra-cabeça das relações interpessoais baseadas, em parte na doação voluntária e gratuita dos produtos (KRONEN, 2004). Neste caso se

está dando uma transição entre a tradição de explorar o recurso como moeda de troca social a uma puramente econômica e industrializada, ao que pode fazer com que se perca o sentido de valor de uma série de pautas comportamentais relacionadas com a saúde do próprio ecossistema. As comunidades estabelecem com a natureza uma vinculação vital, já que o meio ambiente significa "o meio de sobrevivência social, fonte de vida e identidade cultural" (CUNHA,1992).

Nesta lógica, existe uma série de percepções e representações em relação ao mundo natural caracterizadas pela ideia de associação com a natureza e dependência de seus ciclos naturais que devem ser levadas em consideração quando valoramos os potenciais SE que oferecem a natureza. Em Irian Java (Indonésia), estudos demonstram que onde existem fortes vínculos simbólicos e materiais entre as comunidades locais e o habitat circundante se produz severas restrições às atividades industriais baseadas na exploração da madeira (ou a aquicultura de camarões) (RUITENBEEK, 1994). Isto implica que o choque de duas economias associadas a diferentes percepções e vinculações com a natureza, como a exemplo da aquicultura de camarão e a exploração artesanal do manguezal (pesca, captura de caranguejos, extração de marisco ou madeira, etc.), vão se confrontar e somente uma valoração, que vai além do aspecto puramente econômico, na qual se considere a participação do setor autóctone afetado, poderá equilibrar a balança e dar mais objetividade as possíveis decisões sobre a expansão da primeira. Entretanto, levar em conta a definição das relações comunitárias com os manguezais e as dunas demonstrou ser complexa, pois os saberes, subjetividades diante do conhecimento das manifestações dos processos ecológicos e práticas de manejo, foram completamente inseridas na dinâmica dos fluxos das marés e dos ventos. Desta forma, e de acordo com Leff (2009), a organização cultural de cada formação social regula a utilização dos recursos para satisfazer a necessidade de seus membros.

Constatou-se que o acesso aos ecossistemas é material (acesso físico aos sistemas naturais), cultural e simbólico (psicológico), uma vez que promovem a satisfação e bem-estar das pessoas e grupos sociais (BUTLER e OLUOCH KOSURA, 2006). Os vínculos entre as comunidades e os ecossistemas costeiros revelaram-se vitais e sustentados pela qualidade dos sistemas naturais. Estes vínculos manifestaram-se por meio das formas particulares de manejo dos sistemas naturais e valores ecológicos, definindo paradigmas alternativos e contra-hegemônicos para a sustentabilidade. E que não buscam diretamente obter lucro, mas a reprodução social e cultural, como também as percepções e representações em relação ao mundo natural caracterizadas pela associação com a natureza e dependência de seus ciclos naturais ("cosmovivências").

Esta concepção e forma de relacionar-se com a natureza comprovaram que as comunidades tradicionais estabeleceram vinculação completamente distinta ao que é preconizado por uma relação economicista convencional. De acordo com Kumar e Kumar (2008), a percepção ambiental, identificação com a natureza e as relações estabelecidas com os SE, comumente, não são contempladas pelas ferramentas convencionais de investigação. O caso da percepção da complexidade em ambientes rurais no norte da Europa, onde as comunidades entendem com mais valorados os sistemas ambientais que integram os bosques com diversos tipos de cultivos, rechaçando de pronto as paisagens compostas por monocultivos industriais (VAN BERKEL e VERBURG, 2012).

Para além de uma relação não mercantil, estas comunidades se vinculam de forma simbólica e material aos ecossistemas desenvolvendo um sistema tradicional de cultivo e manejo por meio de uma relação de respeito, gratidão e cumplicidade com a natureza, fato que se apresenta como causa direta da conservação ambiental das localidades nas quais vivem estas comunidades (MARQUES, 2001). São formas particulares, com vínculos ancestrais, de manejo dos sistemas naturais (não buscando diretamente obter lucro), para o bem-estar social e cultural.

Francis e Hester (1990) descreveram os jardins urbanos como um espaço de ação que requer envolvimento direto e íntimo e que proporciona relaxamento e alívio das tarefas diárias. Sendo o manejo dos jardins a construção de uma relação entre indivíduos e natureza que produz efeitos terapêuticos, pois reduz o estresse e contribui para o bem-estar psicológico. Nesse sentido pode-

mos fazer uma comparação com a relação das populações com os manguezais, campos de dunas e outros sistemas naturais já que esta relação gera bem-estar, sentimento de paz e tranquilidade e proporciona fascinação (KAPLAN, 1973; 1983). Entretanto, O`Brien e Leichenko (2003) afirmam que o conhecimento de muitos aspectos sociais e psicológicos da geração de SE é limitado. A percepção, valoração e apropriação dos SE feita pelos próprios sujeitos sociais locais tem estado ausente nos estudos sobre os sistemas naturais. As ferramentas a serem utilizadas para captar as múltiplas dimensões, como demonstrado, são diferentes das convencionais. Desta forma, a percepção comunitária de SE deverá ser considerada como uma fonte de conhecimento essencial para a conservação dos ecossistemas costeiros.

Nesse sentido, foi possível definir os critérios indispensáveis para o avanço da gestão dos ecossistemas: i) a multidimensionalidade e complexidade dos serviços ecossistêmicos, ou seja, considerar além dos aspectos ecológicos e biológicos já historicamente privilegiado neste campo, os aspectos sociais, culturais e psicológicos da provisão de serviços ecossistêmicos; ii) a percepção ambiental das comunidades tradicionais sobre sua vinculação (material e simbólica) com os SE e; iii) a participação destas comunidades na construção do conhecimento e nos processo de tomada de decisão (equidade socioambiental), já que elas percebem e se relacionam de diferentes formas com os serviços que oferecem os ecossistemas.

Ressalta-se que os SE foram posicionados diante de duas racionalidades, enquanto concepções de desenvolvimento: i) hegemônica - imposição de estabelecimentos industriais e a expansão dos setores de comércio e dos serviços como aceleradores do crescimento e, ii) das comunidades locais - melhoramento das condições da vida a partir das potencialidades culturais, sociais e ambientais no local (LASCHEFSKI, 2011).

Foi possível demonstrar que os SE são funções ecológicas e sociais indissociáveis das dunas e dos manguezais. E que representam construções sociais ao inserirem-se nas relações tradicionais e extrativistas de grupos sociais com vínculos ancestrais com a diversidade de paisagens e biodiversidade destes componentes da natureza. Foram evidenciados e abordados neste estudo de modo a não configurar como elementos para ações de gestão que têm como base financeirizar os SE; como posto pela lógica de compensar as emissões no mercado de carbono (p.ex. Redução das Emissões por Desmatamento e Degradação florestal REDD+) para "descarbonizar" a economia. Desta forma, as dunas móveis e fixas e os bosques de manguezais representam territórios-ecossistemas.

Portanto, ao considerar estes elementos ambientais, sociais e culturais nas reflexões sobre as distintas formas de apropriação dos SE, será possível reorientar o processo de tomada de decisão para uma gestão costeira efetiva. E, segundo Daily (1997), para que a humanidade possa dispor de seus bens e serviços em suas várias dimensões, sejam elas simbólicas e materiais. Desde uma perspectiva da equidade socioambiental como componente fundante para a conservação dos ecossistemas e a garantia dos territórios das comunidades tradicionais e étnicas.

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Reunión de los Grupos Focales (Pescadores). Foto: Aida Tapia

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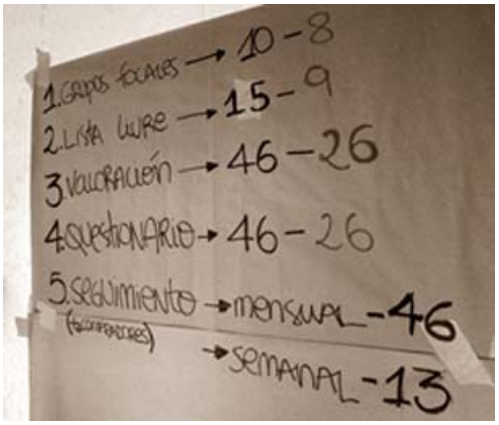

Recolecta de datos. Foto: Luciana Queiroz

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Ubicación de las fincas cerca de las residencias, salinización de acuíferos de agua dulce. Foto: Luciana Queiroz.