UNIVERSIDADE FEDERAL DE SANTA CATARINA
CENTRO DE CIÊNCIAS BIOLÓGICAS
PROGRAMA DE PÓS-GRADUAÇÃO EM ECOLOGIA

Dannieli Firme Herbst

Título: Percepções e dimensões espaciais do uso dos serviços ecossistêmicos: subsídios para análise de risco e gestão do Ecossistema Babitonga

Florianópolis
2020

Dannieli Firme Herbst

Título: Percepções e dimensões espaciais do uso dos serviços ecossistêmicos: subsídios para análise de risco e gestão do Ecossistema Babitonga

Tese submetida ao Programa de Pós-Graduação em Ecologia da Universidade Federal de Santa Catarina para a obtenção do título de doutora em ecologia
Orientador: Prof., Dr(a). Natalia Hanazaki

Florianópolis
2020

Ficha de identificação da obra elaborada pelo autor,
através do Programa de Geração Automática da Biblioteca Universitária da UFSC.

Herbst, Dannieli Firme
Percepções e dimensões espaciais do uso dos serviços ecossistêmicos: subsídios para análise de risco e gestão do Ecossistema Babitonga / Dannieli Firme Herbst ; orientador, Natalia Hanazaki, 2020.
106 p.

Tese (doutorado) - Universidade Federal de Santa Catarina, Centro de Ciências Biológicas, Programa de Pós Graduação em Ecologia, Florianópolis, 2020.

Inclui referências.

1. Ecologia. 2. serviços ecossistêmicos. 3. análise de risco. 4. conflitos. 5. percepção. I. Hanazaki, Natalia. II. Universidade Federal de Santa Catarina. Programa de Pós Graduação em Ecologia. III. Título.

Dannieli Firme Herbst Gerhardinger

Título: **Percepções e dimensões espaciais do uso dos serviços ecossistêmicos: subsídios para análise de risco e gestão do Ecossistema Babitonga**

O presente trabalho em nível de doutorado foi avaliado e aprovado por banca examinadora composta pelos seguintes membros:

Prof.(a), Priscila Fabiana Macedo Lopes, Dr.(a)
Universidade Federal do Rio Grande do Norte

Prof.(a) Marta Jussara Cremer, Dr.(a)
Universidade Federal de Santa Catarina

Prof.(a) Michele de Sá Dechoum, Dr.(a)
Universidade Federal de Santa Catarina

Certificamos que esta é a **versão original e final** do trabalho de conclusão que foi julgado adequado para obtenção do título de doutor em Ecologia.

Documento assinado digitalmente
Andrea Santarosa Freire
Data: 28/05/2020 19:22:52-0300
CPF: 844.565.237-00

Andrea Santarosa Freire

Documento assinado digitalmente
Natalia Hanazaki
Data: 27/05/2020 10:42:54-0300
CPF: 160.730.008-71

Prof.(a) Natalia Hanazaki, Dr.(a)
Orientador(a)

Florianópolis, 2020

Este trabalho é dedicado à minha filha Inaê e todos os amigos do Projeto Babitonga Ativa

AGRADECIMENTOS

Eis que chega ao fim, uma grande jornada, regada de aprendizados e desafios. A tese está longe de ser a dos meus sonhos, mas completamente dentro dos limites, das capacidades e realidades postas pelo universo para este período da minha vida. Apesar dos desafios, e de finalizar com atraso, foi um processo incrível e digo: nunca fiz tanta coisa na minha vida, como nestes anos de doutorado! O processo foi muito além de acadêmico e em busca por um título, parece que foi uma vida inteira dentro dele. Assim, agradeço a todos que fizeram parte desta infinidade de aprendizados adquiridos ao longo destes anos:

- À Natalia, minha orientadora, toda minha gratidão por confiar, me apoiar e enfrentar junto comigo os desafios desta jornada regada de incertezas, adaptações e mudanças. Passamos, várias vezes pela teoria da resiliência e ciclo de Holling, na prática;
- Ao meu marido, Leopoldo, que acompanhou de mão dada cada oportunidade, ideia, catarse, desespero, retomada de fôlego e aprendizado, desde a concepção do projeto até a conclusão da tese. Você foi essencial neste processo, seja nas horas de discussão que me tiraram do buraco ou nas horas me jogou um pouquinho mais nele (rsrs);
- À equipe do projeto Babitonga Ativa (Fabiano Grecco, Suelen Cunha, Leopoldo Gerhardinger, Daniele Alves Vila-Nova, Mirella Cursino, Marcio Novais, Maiti Fontana, Arthur Paganini, Alessandra Pfuetzenreuter, Letícia Haak e Marta Cremer) que são os grandes amigos e companheiros de luta. Eles que sonharam e lutaram comigo para que os dados da tese fossem coletados com qualidade e seriedade, e para buscarmos uma forma de empregá-los na prática, com respeito e cautela para com as pessoas envolvidas e com o ambiente natural. Foi íncrivel a experiência de ter meu doutorado vinculado a este projeto maravilhoso. Em especial agradeço ao Fabiano Grecco que não mediu esforços ou exitou de estar presente em todo o processo e discussão vinculada às oficinas e tese, seja na concepção, planejamento, mobilização, realização das oficinas e análise de dados;
- À minha amiga pesquisadora Daniele Vila Nova, que atuou informalmente como co-orientadora e esteve junto comigo desde o início. Todos os passos dados, todos os potenciais e problemas na tese foram compartilhados e ajustados contigo. Agradeço de todo coração a paciência e incansável busca de construirmos um

processo transparente, inclusivo, inovador, desafiador e tão cheio de detalhes e qualidade;

- A todos os envolvidos com as oficinas: participantes, lideranças que nos ajudaram nas mobilizações, os responsáveis por todos espaços que abriram suas portas e nos acolheram para que elas fossem realizadas nos seis municípios de entorno da Babitonga. O envolvimento e participação de vocês que tornou a obtenção destes dados possível e é o que poderá fazer deste ecossistema um exemplo a ser seguido, na busca de melhorias ambientais e para qualidade de vida;
- Aos avaliadores do projeto, qualificação e tese, que contribuiram para construção e melhorias da tese e dos artigos: Milton Asmus, Fabio Daura-Jorge, Marta Cremer, Marion Glaser, Michele Dechoum e Priscila Lopes.
- Ao Ministério Público Federal que concedeu suporte financeiro e apoio na busca de credibilidade junto aos envolvidos no projeto Babitonga Ativa;
- À Univille, principalmente na pessoa da professora Marta Cremer, que abriu portas para obtermos auxílio com a administração e aumento da visibilidade do Projeto Babtonga Ativa;
- Ao amigo Alexandre Marcel pelas conversas inspiradoras e regadas de ideias, insigths e vontade de fazer milhares de coisas;
- A minha Inaê que foi gerada junto às ideias aqui apresentadas. Ela que teve que ficar sem a mamãe em alguns momentos para que esta tese nascesse. O processo de ser mãe no meio do doutorado gerou um desgate físico e emocional enorme, principalmente por ficar dividida na necessidade de atenção e bases sólidas de amor que uma criança requer e por estar no meio de um mar de ideias e não conseguir concretizar, em escrita, o turbilhão e velocidade de pensamentos que vinha na cabeça. Foi pela Inaê que abri mão te ter a tese dos meus sonhos, porque o sonho de sua existência é maior do que a obtenção do título de doutora. Não é fácil pensar tanto com os hormônios a flor da pele, definitivamente! Mas foi lindo, especial, maravilhoso, aproveitei de perto cada segundo da vida deste ser que transforma minha vida todos os dias. Foi aos trancos e barrancos que fechei esta tese com vontade de curtir ela a cada instante, mas eu consegui;
- À minha família, que me apoiou sempre na loucura e ideias de fazer milhares de coisas ao mesmo tempo. Agradecimento especial para mãe, pai, irmã, sogra e cunhada Elisa que me ajudaram nos cuidados com a Inâe para finalizar e escrever a tese.

- Agradeço aos amigos e colegas de laboratório que ajudaram nas entrevistas com pescadores, para coleta de dados que não entraram na tese (Renata Poderoso, Eduardo, Bruno Castro, Maira e Marília). Apesar de não conseguir escrever todos os artigos para apresentar neste momento, a energia e tempo que vocês dispenderam foram muito válidas e contribuiram muito com os aprendizados ao longo do processo de me tornar doutora
- Por fim, à Capes pela bolsa de doutorado;

Com certeza muitos outros nomes que contribuiram direta e indiretamente para esta conquista não estão mencionados acima, mas deixo registrada a minha gratidão a todos que ajudaram e torceram pela minha conquista.

RESUMO

Estudos sobre serviços ecossistêmicos vêm crescendo em todo o mundo, tendo o conceito e aplicações evoluido no sentido de permitir abordagens ecossistêmicas que integrem diferentes sistemas de conhecimento e busquem conectar com a gestão. A presente tese identifica e mapeia o uso de serviços ecossistêmicos, com base na percepção dos usuários diretos do ecossistema Babitonga (pescadores, maricultores, agentes de turismo e recreação, agentes de transporte aquaviário e mineradores de areia), bem como identifica os conflitos e pressões, decorrentes dos usos para o ecossistema e demais usuários. O primeiro capítulo da Tese investigou a percepção de usuários diretos sobre os serviços ecossistêmicos obtidos do ecossistema Babitonga, norte de Santa Catarina, e explorou como transformar este sistema de governança costeiro a partir de uma perspectiva ecossistêmica dos valores compartilhados da natureza. O segundo capítulo, além de mapear as atividades e usos dos serviços ecossistêmicos, descreveu e analisou os conflitos, as cadeias de impacto e os riscos decorrentes de múltiplos usos diretos, no ecossistema como um todo e em três diferentes habitats: manguezais, fundo rochoso consolidado (lages) e coluna d'água. Os dados apresentados foram coletados de forma colaborativa e integrativa a partir de três ciclos de oficinas com os usuários diretos do ecossistema (39 oficinas). No primeiro capítulo obtivemos 285 citações, categorizadas em 127 serviços ecossistêmicos diferentes e 31 subcategorias, codificadas em tipologias convencionais de serviços ecossistêmicos). Os serviços: alimento (provisão) e turismo e lazer (cultural) foram percebidos por todos os grupos de usuários, destacando-se como serviços de valor compartilhado. Foram observadas diferenças de percepção entre grupos. Atualmente as políticas públicas, fragmentadas e baseadas em interesses econômicos, supervalorizam alguns serviços, sem considerar a manutenção dos usos/ atividades e qualidade de vida de todos os usuários e da população do ecossistema, o que gera assimetrias de poder e usos insustentáveis. No segundo capítulo mapeamos 28 atividades realizadas no ecossistema, destacando o uso de 10 tipos de serviços ecossistêmicos: quatro de provisão (ex. alimento, areia e óleo) e seis culturais (ex. navegação, turismo, beleza cênica e pesca esportiva). As áreas mais utilizadas coincidem com as áreas com maior quantidade de conflitos. Pescadores e agentes de Turismo e recreação são os setores mais envolvidos em conflitos e ambos recebem pressões de todos os outros grupos de usuários. Todos os habitats analisados estão sob alto risco. Na busca de alternativas para alcançar um sistema socioecológico mais coerente e equitativo social e ecologicamente, os dois capítulos trazem caminhos e recomendações para uma agenda de gestão transformativa e baseada no ecossistema. Ambos capítulos ressaltam a relevância dos valores compartilhados (alimento e turismo). O acesso às percepções de diferentes usuários a partir de uma mesma metodologia foi essencial para indicar caminhos, as atividades e os tipos de uso que devem ser priorizados no processo de gestão a partir da avaliação de risco dos habitats e do ecossistema como um todo: a pesca, maricultura e as atividades do turismo e recreação. Ao final, apresentamos contribuições da Tese no desenvolvimento teórico-metodológico do campo de pesquisa e aplicações da abordagem de serviços ecossistêmicos.

Palavras chaves: Percepção, Sistema socioecológico, Gestão com base ecossistêmica, Usuários diretos, Conflitos.

ABSTRACT

Ecosystem services studied have been increasing around the world, and the concept and applications evolved to allow ecosystem-based approaches that integrate different knowledge systems and seek to increase the understanding and response of decision-makers to their management needs. This thesis aimed to identify and map the use of ecosystem services, based on the perception of direct users of the Babitonga ecosystem (fishers, mariculture, tourism and recreation, water transport and sand miners agents), as well as to identify the conflicts and pressures arising from uses of the ecosystem and other users in an ecosystem-based approach. The Thesis is organized in two chapters. The first investigated the perception of direct users about ecosystem services obtained from the Babitonga ecosystem, North of Santa Catarina state coast, and explored how to transform this coastal governance system with the opportunity of ecosystem-based management and by translating shared values from nature. The second, in addition to mapping the activities and uses of ecosystem services, described and analyzed the impacts chains, conflicts and risks arising from multiple direct uses on the ecosystem as a whole and in three different habitats: mangroves, consolidated rocky bottom (submerged outcrops) and water column. The data were collected collaboratively and integratively with the direct users of the ecosystem during three workshop cycles (39 workshops). In the first chapter we obtained 285 citations, categorized into 127 different ecosystem services and 31 subcategories, encoded in conventional typologies of ecosystem services). The services: food (provision) and tourism and leisure (cultural) were perceived by all user groups, standing out as services of shared value. Differences in perception were observed between groups. Currently, fragmented policies based on economic interests overvalue some services, without considering the maintenance of the uses / activities and quality of life of all users and the population of the ecosystem, which generates power asymmetries and unsustainable uses. In the second chapter we mapped 28 activities carried out in the ecosystem, highlighting the use of 10 types of ecosystem services: four provisioning services (e.g., food, sand and oil) and six cultural services (e.g., navigation, tourism, scenic beauty and sport fishing). The most used areas coincide with the areas with the most conflict. Fishermen and tourism and recreation agents are the sectors most involved in conflict and both receive pressures from all other user groups. All three habitats analyzed are at high risk. In the search for alternatives to achieve a more coherent and socially and ecologically equitable social and ecological system, the two chapters provide paths and recommendations for a transformative and ecosystem-based management agenda. This thesis highlight the relevance of shared values (food and tourism). Access to the perceptions of different users from the same methodology was essential to indicate paths, activities and types of use that should be prioritized in the management process from the risk assessment of habitats and the ecosystem as a whole: fishing, mariculture and tourism and recreation activities. Finally, we present Thesis contributions in the theoretical-methodological development of the research field and applications of the ecosystem services approach.

Keywords: Perception, Socioecological system, Ecosystem based-manangement, Direct users, Conflicts.

LISTA DE FIGURAS

Capítulo 1 – Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation

LISTA DE TABELAS

Capítulo 1- Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation

Capítulo 2 - Integrated and deliberative multidimensional assessment of a subtropical coastal-marine ecosystem (Babitonga bay, Brazil)

Considerações finais

LISTA DE ABREVIATURAS E SIGLAS

PEM – Planejamento Espacial Marinho

MEA - Millenium Ecosystem Assessment

SE – Serviços Ecossistêmicos

IPBES - Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

NCP - Nature's Contributions to People

PAN - Plano de Ação Nacional

MMA - Ministério do Meio Ambiente

PBA - Projeto Babitonga Ativa

GI-GERCO - Grupo de Integração do Gerenciamento Costeiro

CIRM- Comissão Interministerial de Recursos do Mar

GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit

HRA - Habitat Risk Assessment

HEM - Human Ecology Mapping

ES – Ecosystem service

SES - Social-Ecological Systems

OECM - Other Effective Area Based Conservation Measures

CBD – Convention of Biological Biodiversity

TAT - Theory of Transformative Agency

PBG - Pro-Babitonga Group

ICMBio - Instituto Chico Mendes de Conservação da Biodiversidade

IBAMA - Instituto Brasileiro do Meio Ambiente e Recursos Naturais

NGOS – Non governamental Organizations

EBM - Ecosystem-Based Management

MSP - Marine Spatial Planning

PU – Planning Units

DNPM - Department of National Mineral Production

SUMÁRIO

1. INTRODUÇÃO GERAL

Ambientes costeiros e marinhos provém múltiplos benefícios e serviços ecossistêmicos, como proteção de margens contra tempestades, produção de alimento pela pesca e aquicultura, turismo, recreação, beleza cênica, energia, entre outros (Guerry *et al.,* 2012; Wyatt *et al.*, 2017). Porém, em todo o mundo, os oceanos vêm passando por intensas mudanças e perda da biodiversidade associada à perda de serviços ecossistêmicos, o que diminui a capacidade dos ecossistemas marinhos em prover alimento, manter a qualidade da água e se recuperar de perturbações (Worm et al., 2006).

A sobre-exploração de recursos naturais, associada à estratificação econômica (inequidade no uso do recurso e distribuição de renda), normalmente conduz os sistemas socioecológicos a regimes insustentáveis de uso dos recursos, com consequentes colapsos (Motesharrei *et al*., 2014). Atualmente, muitas áreas urbanas no mundo estão em torno de regiões costeiras e estuarinas (Higgins *et al*., 2010), o que aumenta o uso, a pressão e efeitos cumulativos sobre estes ambientes e seus serviços ecossistêmicos (Halpern *et al*., 2008). Este processo de aglomeração em regiões costeiras compromete o ecossistema e prejudica o bem-estar social (Barragán e Andrés, 2015).

Na intenção de lidar com o aumento dos impactos humanos nos ecossistemas, e a alta complexidade inerente à gestão dos múltiplos usos dos serviços ecossistêmicos, muitos pesquisadores, gestores e outros atores ("stakeholders") vem preconizando a aplicação de abordagens de gestão com base no ecossistema ('Ecosystem-Based Management' - EBM) (Arkema *et al*., 2006; Leslie e McLeod, 2007; UNEP, 2011; Wyatt *et al*., 2017). Esta é uma abordagem holística que busca considerar o impacto cumulativo de diferentes atividades e setores, sem focar em uma única espécie, setor, atividade ou preocupação (UNEP, 2011; WWF, 2014).

Dada a complexidade de sistemas socioecológicos costeiros-marinhos e a lacuna entre teoria e prática, implementar abordagens integradas e com base no ecossistema ainda desafia cientistas e tomadores-de-decisão mundialmente (Garcia-Onetti *et al*., 2018). De maneira geral, as políticas públicas e regimes de governança costeira e marinha vem operando de modo predominantemente fragmentado e sem capacidade de conter o aumento de desigualdades e injustiças socioeconômicas (Gerhardinger et al., 2018a; Kelly *et al*., 2018). Além disso, muitos ainda ignoram ou ocultam abordagens ecossistêmicas (Costanza *et al.*, 2014) e processos efetivos de implementação ainda estão em estágios iniciais (Guerry *et al.,* 2015).

Pesquisas sobre serviços ecossistêmicos tem destacado a importância da conectividade espacial entre os ecossistemas e seus beneficiários (Bagstad *et al*., 2012). Além disso, a acumulação de conhecimento em maior escala temporal e espacial se faz necessária, pois diferentes habitats podem contribuir ecologicamente para a persistência e funcionamento de outros habitats (Higgins *et al*., 2010). Desta maneira, nas últimas décadas um grande esforço vem sendo empreendido para desenvolver ferramentas para operacionalizar a abordagem ecossistêmica no planejamento do espaço marinho. De acordo com a UNESCO, o Planejamento Espacial Marinho é um processo público de análise e alocação espacial e temporal das atividades humanas em áreas marinhas, para conquistar objetivos ecológicos, econômicos e sociais que são usualmente especificados a partir de um processo político (Douvere e Ehler, 2009). De acordo com Foley et al. (2010), o objetivo central do processo de PEM é ajudar e melhorar a manutenção de serviços ecossistêmicos. Arkema *et al*., 2015, por sua vez, considera a gestão com base ecossistêmica um importante pilar para o desenvolvimento do PEM.

A operacionalização dos enfoques teórico-metodológicos sobre serviços ecossistêmicos também compartilha do desafio e busca facilitar o emprego de uma abordagem de gestão ecossistêmica, nos auxiliando a lidar com a complexidade inerente aos sistemas socioecologicos costeiro-marinhos. Nos últimos 20 anos, o número de projetos e publicações com abordagens de serviços ecossistêmicos aumentou consideravelmente, principalmente após a contribuição da Avaliação Ecossistêmica do Milênio ('Millenium Ecosystem Assessment' – MEA) em 2005 (Braat e De Groot, 2012; Liquete *et al.,* 2013; Abson *et al*, 2014; McDonough *et al.,* 2017). O MEA (2005) conceituou serviços ecossistêmicos como os benefícios obtidos do ambiente pelo ser humano, para gerar qualidade de vida, sendo categorizados em quatro categorias: provisão, regulação, suporte e cultural. No entanto, para alguns autores, o conceito e a categorização apresentados no *framework* do MEA não acomodam adequadamente as relações ser humano-ambiente (Wallace, 2007; Oliveira e Berkes, 2014).

Diferentes autores discutem os sistemas classificatórios de Serviços Ecossistêmicos (SE), as diferenças entre abordagens e percepções entre os atores, bem como a aplicação prática em medidas de gestão (Wallace, 2007; Martin-Lopez *et al*., 2014; Costanza *et al.,* 2014; McDonough *et al.,* 2017; Small *et al.,* 2017).

Questionamentos e reflexões neste sentido se fazem necessários quando trabalhamos com enfoques analíticos que se propõem a seguir a abordagem baseada em ecossistemas, pois buscam agregar clareza conceitual e metodológica para lidar com a complexidade e a dificuldade de entender as conexões e relações que ocorrem nos sistemas socioecológicos. Porém, ainda mais importante do que buscar um enquadramento ideal para empregar a teoria, é desenvolver aplicações coerentes para os desafios associados às práticas de gestão.

No intuito de incluir diferentes sistemas de conhecimentos, visões de mundo e atores na discussão e aplicação de serviços ecossistêmicos, foi criada em 2012 uma 'Plataforma Intergovernamental para biodiversidade e Serviços Ecossistêmicos' – 'Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services' (IPBES) (Díaz *et al.,* 2015). O relatório da avaliação que considera o resultado de três anos iniciais de trabalho (2012-2015) afirmou que a humanidade sabe o que deve fazer, mas é preciso agir para deter e reverter o uso insustentável da natureza (IPBES, 2018).

Após mais de uma década de exploração e aplicação do enfoque de SEs proposto pelo MEA (2005), publicações recentes de pesquisadores envolvidos no IPBES apresentaram uma proposta com uma base conceitual alternativa, a partir de um framework denominado 'Contribuições da Natureza para as Pessoas' - Nature's Contributions to People (NCP, Pascual et al., 2017; Díaz et al., 2018). A publicação deste framework (Díaz et al., 2018) vem gerando intenso debate acadêmico (Braat, 2018; Peterson *et al*., 2018; Kenter, 2018). Em particular, destacamos o editorial de Peterson *et al*. (2018) na revista '*Ecology and Society'* voltado a debater estas diferentes perspectivas, que também serviu como norteador na elaboração teórica desta Tese.

A leitura crítica da literatura mais recente sobre SEs mostra que desde a preparação inicial desta Tese, em 2014, do desenvolvimento teórico-metodológico e a definição dos contornos de inovação do enfoque de pesquisa delineado, tangenciamos vários pontos que são hoje alvo central de tensionamentos e inovações teóricas e metodológicas. O objetivo geral da Tese foi identificar e mapear o uso de serviços ecossistêmicos, com base na percepção dos usuários diretos do ecossistema, bem como identificar os conflitos e consequências, decorrentes dos usos para o ecossistema e demais usuários, em uma abordagem ecossistêmica. A Tese articula pontes entre as diferentes perspectivas tanto no nível teórico/conceitual sobre como integrar diferentes percepções entre usuários diretos dos SEs (Capítulo 1), como metodológicas (Capítulo 2), a partir da operacionalização do enfoque de SEs em uma perspectiva real de planejamento territorial intermunicipal.

A estrutura desta tese oferece um aporte de teoria e prática com base em um processo participativo, inclusivo e deliberativo, no intuito de avançar em uma gestão com base ecossistêmica no litoral centro-norte de Santa Catarina. O uso de conhecimentos locais, a partir de atores com diferentes visões de mundo, interesses junto ao entendimento de quais serviços são mais importantes para indivíduos, grupos ou sociedade, de forma geral, nos permite avançar em busca de indicativos do que é prioritário considerar em propostas de manejo e garantir o uso a longo prazo, a fim de manter a saúde e equidade na alocação e acesso dos serviços ecossistêmicos.

1.1 A escolha da Baía Babitonga

O incipiente processo de gestão compartilhada da porção aquática do complexo estuarino-costeiro no entorno da baía Babitonga ('Ecossistema Babitonga' *cf.* Gerhardinger *et al*., 2017) foi escolhido como alvo da pesquisa empírica desta Tese, por meio da aplicação das bases conceituais apresentadas acima: serviços ecossistêmicos, gestão ecossistêmica e planejamento espacial marinho. Este ecossistema destaca-se no Brasil e principalmente no estado de Santa Catarina: i) pela sua relevância ecológica - demonstrada em oito decretos e Planos Nacionais de conservação (ex. Planos de Ação Nacionais - PAN -Toninhas, -Pequenos Cetáceos, -Corais, -Elasmobrânquios e - Manguezais) e a Portaria Nº 9 de 2007 do Ministério do Meio Ambiente - MMA, que identificou as *Áreas Prioritárias para a Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira*, onde a Baía Babitonga foi indicada como prioridade de ação extremamente alta); ii) por abrigar o maior manguezal do estado (IBAMA, 1998); iii) pela alta produtividade do complexo estuarino da região; iv) por abranger uma região de grande crescimento urbano e industrial e; v) pelo interesse econômico para instalação de empreendimentos de grande porte tais como portos, estaleiro, entre outros (Gerhardinger *et al.,* 2017; 2018a).

O Ecossistema Babitonga, até 2015, apresentava um processo de gestão costeira e marinha fragmentada em todos os níveis federativos (municipal, estadual e federal). Consideramos que a ausência de uma gestão compartilhada do ambiente marinho intensifica o processo de perda de biodiversidade e os prejuízos para as atividades econômicas que dependem dos serviços fornecidos. Paralelamente ao desenvolvimento do projeto de Teses, foi aprovado o Projeto Babitonga Ativa (PBA) em Edital do Ministério Público Federal, e a sua implementação iniciada sob liderança da Universidade da Região de Joinville (Univille). Desde então, o PBA vem facilitando a integração de diferentes atores sociais e tomadores de decisão, por meio da formação do Grupo Pró Babitonga e respectivos Planos de Governabilidade Ecossistêmica (www.babitongaativa.com/bibliografia). O projeto vem promovendo uma agenda de pesquisa, planejamento estratégico e mobilização social para viabilizar a gestão participativa com base no Ecossistema Babitonga. Neste contexto, ao longo do desenvolvimento da Tese e do PBA foi possível uma convergência entre a experimentação teórica de uma pesquisa acadêmica e aplicação do conceito de serviços ecossistêmicos em processos de gestão, que são desafios necessários mundialmente (Ruckelshaus et al., 2015; García-Onetti et al., 2018).

Neste sentido, os dados aqui apresentados já foram apresentados aos participantes das oficinas e tomadores de decisão, por meio de apresentação oral e diagnóstico socioeconômico/socioambiental (Gerhardinger *et al*., 2017; 2018b) para inserção dos resultados nas discussões e governança do ecossistema. Deste modo, os artigos que sustentam esta Tese, e respectivas análises e reflexões, tanto alimentam como foram alimentados de um intenso processo de aprendizagem social que nasceu e está vigente no território desde então.

Durante a sua implementação, o PBA chamou a atenção de tomadores-de-decisão em nível federal (Gerhardinger *et al*., 2019), tornando-se um caso demonstrativo para o uso de SEs em um processo de Planejamento Espacial Marinho (PEM) costeiro no Brasil (coerente com a Ação 17 do Plano de Ação Federal para a Zona Costeira 2017-2019, MMA, 2017). Parte dos resultados e análises preliminares associados aos produtos desta Tese (Gerhardinger et al., 2016; 2017; 2018) já foram também apresentados ao Grupo de Integração do Gerenciamento Costeiro (GI-GERCO), entidade colegiada federal subordinada a CIRM (Comissão Interministerial de Recursos do Mar); ao Projeto Terramar, desenvolvido pelo Ministério do Meio Ambiente com aporte da agência de cooperação alemã GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit); e está sendo apresentado como estudo de caso no Relatório Estratégico sobre a Meta de Aichi 11 da Convenção de Diversidade Biológica (‘White Paper’) que está em fase final de editoração pelo Ministério do Meio Ambiente em parceria com a ONU Ambiente.

As abordagens espaciais utilizadas também nos permitiram atuar como "beta tester" na construção dos passos necessários ao processo de Planejamento Marinho do "Projeto NatCap Marine Planning Concierge" (THE NATURAL CAPITAL, 2017). Este projeto está vinculado ao grupo desenvolvedor do software Invest, que foi utilizado para análises do capítulo 2 da tese ('Overlap Analysis Model' e 'Habitat Risk Assessment Model'). Ambas as análises, Análise de sobreposição (Overlap Analysis) e Avaliações de risco de habitats (Habitat Risk Assessment- HRA) são ferramentas importantes para auxiliar processos de gestão em ecossistemas com múltiplos usos, conflitos e influências sobre os habitats. A HRA ajuda a priorizar áreas e estratégias efetivas de gestão (Arkema et al., 2014; Wyatt et al., 2017) além de ser uma ferramenta importante para gestão com base ecossistêmica (Hare *et al*., 2016).

1.2 A estruturação dos capítulos da Tese

O processo de pesquisa empírica e participativa no litoral norte de Santa Catarina está reportado em dois artigos inter-relacionados. O primeiro, intitulado "Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation" (Cap. 1), está publicado na revista 'Frontiers in Marine Science', e o segundo (Cap. 2), intitulado "Integrated and deliberative multidimensional assessment of a subtropical coastal-marine ecosystem (Babitonga bay, Brazil)", foi submetido e aprovado para publicação na revista 'Ocean and Coastal Manangement'.

Todos os dados da tese foram coletados a partir de oficinas participativas realizadas com usuários diretos do ecossistema ("stakeholders"), incluindo: pescadores, maricultores, agentes de turismo e lazer, agentes de transporte aquaviário, mineradores e pesquisadores do ecossistema Babitonga. Nas três etapas de oficinas (39 oficinas), utilizamos metodologias híbridas, seguindo a abordagem do 'Human Ecology Mapping' (HEM) de McLain e colaboradores (2013), juntamente com o enfoque de serviços ecossistêmicos do MEA (2005) e os utilizados por Raymond *et al.* (2009) e Costanza *et al*. (2014). O HEM consiste na combinação de três abordagens: ocupação e uso dos recursos, conhecimento ecológico local e; sentido de pertencimento local. Este enfoque aponta a necessidade de incorporar valores socioculturais e os usos humanos nos mapeamentos participativos, a fim de gerar dados consistentes para um estilo de planejamento e gestão baseado numa visão ecossistêmica. De acordo com McLain e colaboradores (2013), a opção de combinar diferentes enfoques teórico-metodológicos oferece o potencial de produzir conhecimentos multi-escalares e multi-dimensionais necessários para gerir ecossistemas complexos.

Inicialmente, delineamos as principais razões que colocam as avaliações de serviços ecossistêmicos em uma encruzilhada teórica-metolodógica e prática (Cap. 1), após mais de dez anos de desenvolvimento deste campo de pesquisa e políticas públicas (MEA, 2005), incluindo: o reflexo do uso do termo 'benefício' no conceito de serviços ecossistêmicos, frente ao entendimento de diferentes atores, com diferentes visões de mundo; o enquadramento dos resultados das percepções dentro das categorias classificatórias de SE; o enquadramento de serviços ecossistêmicos em sistemas socioecológicos; o efeito cascata entre tipos de serviços sob influências de usos humanos e compatibilização de um processo de alocação e acesso com justiça e equidade. Os resultados desse capítulo demonstram que as fronteiras entre sistema natural (não humano) e social são tênues e que a abordagem de sistemas socioecológicos é um importante fio condutor, pois ações da natureza e humanas moldam a disponibilidade e qualidade dos serviços ecossistêmicos, dentro de um efeito cascata entre os diferentes tipos.

No segundo artigo (Cap. 2), mapeamos as atividades/usos diretos realizados no ecossistema e as relacionamos com os serviços ecossistêmicos. Além disso, fizemos uma análise espacial dos efeitos cumulativos de tais atividades (análise de risco de habitat) a fim de demonstrar o quanto as atividades comprometem os habitats e a gestão de valores compartilhados.

A partir de resultados de três ciclos de oficinas participativas (primeiro - 18 oficinas e 153 participantes, segundo - 14 oficinas e 128 participantes e terceiro - oficinas e 90 participantes), mapeamos 28 atividades realizadas no ecossistema e 10 serviços acessados pelos usuários diretos do ecossistema (6 culturais e 4 de provisão); bem como os 44 conflitos por uso do espaço e as consequências das atividades/setor identificadas para o ecossistema e para os setores entre si.

Nossas análises indicaram duas variáveis críticas para ressaltar a operacionalização da abordagem espacial de planejamento: a consideração de conflitos de uso direto do espaço e o cálculo dos riscos aos diferentes habitats aquáticos. Argumentamos então que a combinação destes resultados e abordagens deveria contribuir para navegar uma transformação no sistema de governança costeiro na região estudada, a partir de um processo transparente e coerente do ponto de vista teórico-metodológico mas também socialmente justo e equitativo de alocação dos serviços ecossistêmicos para esta e futuras gerações.

Neste artigo, as ferramentas de análise espacial utilizadas foram aplicadas pela primeira vez no Brasil. Essa abordagem permitiu uma avaliação abrangente e com base ecossistêmica, capaz de reconhecer a multiplicidade de usos dos serviços ecossistêmicos e os riscos que estes usos trazem a habitats ecologicamente importantes e inclusive para as atividades econômicas realizadas no ecossistema. Permitiu, também, uma visualização dos principais problemas relacionados ao uso compartilhado do ecossistema, para visualizar alguns caminhos para uma gestão costeira e integrada com objetivos ecológicos, econômicos e sociais responsáveis.

CAPÍTULO 1

Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation

(Ligando a diversidade de percepção de usuários sobre serviços ecossistêmicos para a incepção da transformação de regimes de transformação da governança costeira)

Artigo publicado na Revista Frontiers in Marine Science
(ISSN: 2296-7745; DOI: 10.3389/fmars.2020.00083)

Retrato de diferentes usos do Ecossistema Babitonga: pescador artesanal e navio de container a caminho do porto. "Contrastes na Babitonga" - Foto capturada na Praia do Forte por Marcio José Novaes em 29 de fevereiro de 2020.

Capítulo 1: Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation

Dannieli F. Herbst[1,2], Leopoldo Cavaleri Gerhardinger[3] and Natalia Hanazaki[1, 4]

[1]Programa de Pós-Graduação em Ecologia – Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil

[2]Projeto Babitonga Ativa – Universidade da Região de Joinville, SC, Brazil

[3]Instituto Oceanográfico, Universidade de São Paulo, SP, Brazil

[4]Departamento de Ecologia e Zoologia, ECZ/CCB, Universidade Federal de Santa Catarina, Campus Trindade, Florianópolis/SC, Brazil

*danniherbst@gmail.com

Correspondence: danniherbst@gmail.com

Abstract

In this paper we explore the challenges for transforming a wide and fragmented coastal governance system towards an ecosystem-based regime by translating shared values of nature into radically novel territorial development policies at highly disputed seascapes. We report an official coastal management institutional experiment in South Brazil, where the way direct ecosystem users (fishers, miners, mariculture, tourism and leisure, aquatic transport agents and researchers) perceive and classify ecosystem services was assessed during 19 collaborative sectoral workshops held with 178 participants from six coastal cities surrounding Babitonga bay estuarine and coastal ecosystems (Santa Catarina state, South Brazil). Participants collectively enlisted the benefits, rights and resources (or services) they obtain from these ecosystems, rendering a total of 285 citations coded to conventional ecosystem services scientific typologies (127 ecosystem services grouped in 5 types and 31 subtypes). We explore patterns in ecosystem services classificatory profiles, highlighting ecosystem user's salient identities and exploring how they shape political actions in relation to an ecosystem-based normative perspective. Food (provisioning service) and tourism and leisure (cultural service) are perceived by all user groups hence consist of a core set of perceived shared value amongst direct ecosystem users to inform future transformation narratives. Differences in perception of values amongst user groups combined with high levels of power asymmetry and fragmentation in decision-making, are steering the analyzed system towards an unsustainable social-ecological pathway. While the governance regime has been largely favoring subsets of services and unfair distribution of benefits, disregarding a more diverse array of real economic interests and potential ecological knowledge contributions. Our integrative and deliberative ecosystem services valuation approach advances understanding of critical features of the scoping phase of ecosystem services assessment initiatives in the coastal zone. We therefore provide empirically grounded and theoretically informed suggestions for the promotion of local knowledge integration through combination of methods that supports transformational research agendas. We ultimately hope to have established new groundwork to fulfilling alternative visions for the regional social-ecological system transformation to a more socially and ecologically coherent and equitable development trajectory.

Key-words: perception; ecosystem-based management; shared values; social-ecological system; stakeholders; Brazil.

1. Introduction

1.1 Ecosystem services assessments on the crossroads

Ecosystem services (ES) are critical to human survival, livelihoods, well-being, and quality of life. Understanding and integrating the diversity of human perceptions and agency on coastal and marine seascapes and related ES into governance processes remains a critical challenge to avoid escalating conflicts over marine resources in the Anthropocene (Folke, 2006; Liquete et al., 2013; Aswani et al., 2017). Our society lives a dilemma. While we depend on coastal-marine ES and states actively promote the ocean as the new global economic development and growth frontier (Bennett et al., 2019), anthropogenic factors have already affected their resilience and, therefore, are increasingly compromising sustained availability of these services at regional levels (Gattuso et al., 2018).

Coastal Social-Ecological Systems (SES) are interface regions, rendering them higher complexity to govern a variety of dynamic, highly uncertain socioeconomic, political and biophysical interactions and flows (Zaucha et al., 2016). These features, and the high levels of historical path dependency and self-identification in land-sea territories, most often hinder the much needed, rapid transformations in their prevailing development paradigms (Zaucha et al., 2016).

The complexities of coastal-marine systems thus require regarding them as coupled SES, an interdisciplinary approach that regards separations between the social and natural systems as artificial and arbitrary (Berkes and Folke, 1998). Thereby, understanding how human perception-driven standpoints relate to ES is an important part of understanding SES dynamics and complexity, *i.e.* since preference of certain services may affect their availability and the very structure of ecosystems into the future. This requires acknowledging humans and human agency as an integral, embedded part of ecosystems and therefore highlighting their perception, interaction, joy, and interference capacities, as natural ecosystem processes: a *humans-in-ecosystems* perspective (Davidson-Hunt & Berkes, 2003). This approach considers humans as both co-producers and consumers of ES (Raymond *et al*., 2017) that, in turn, result from the combination or interaction of natural (including human, social and built) capitals (Costanza et al., 2017).

Since the worldwide boom in ES conceptual research and application following the Millennium Ecosystem Assessment in 2005, the link between ES and environmental governance has been widely discussed (Abson et al., 2014; McDonough et al., 2017). Ever since, worldwide application and development of the ES toolboxes by several organizations, for initiatives aimed primarily at conducting services valuation assessments have increased tremendously. But challenges in the science and application of ESs remain, such as conflicting terminology, classification schemes, research methods and reporting requirements (McDonough et al., 2017). It is within this diversity of understanding and application realm that scientists have continuously pursued development of alternative frameworks, with the ultimate intent of improving and adjusting ES concepts and typologies for practical application (Costanza et al., 2017; Díaz et al., 2018).

1.2 Facing the practical challenges of integrated and deliberative valuation approaches

Our paper combines integrative (of diverse values) and deliberative (participatory reasoning and awareness-building) elements in research-design, to generate collective understanding about shared values of nature and build practical knowledge for sustainability in a highly disputed seascape. This is in accordance with strong, recent calls by the International Panel for Biodiversity and Ecosystem Services (IPBES) for the evolution of frameworks that are better able to accommodate alternative worldviews and bridge scientific with local/indigenous ecological knowledge systems (DíDaz et al., 2015).

Costanza et al. (2017) argue that ecosystem users should ideally collaborate in ES modelling and scenario planning through transdisciplinary teams and strategies, in order to assure relevancy of application in real policy contexts at multiple time and space scales. Consistency will partly evolve from further understanding the underlying determinants of how a "shared value" is socially constructed and represented in ES assessments and policy arenas (Vatn, 2009).

Valuation is not a last nor optional step in ES assessments, but span over multiple steps - from the choice of value types and of terminology, selection of social actors to engage with, methodological decisions (tools and measurement units), and choice of which ES are to be included in research (Martín-López et al., 2013; Jacobs et al., 2016; Boeraeve et al., 2018). Further attention should also be placed on participatory methods capable of recording less tangible cultural ES and nonmaterial values (Raymond et al., 2009; Milcu et al., 2013; Fish et al., 2016; Boeraeve et al., 2018), and including them alongside other services in governance processes that embeds the diversity of perceptions in transformations towards sustainability (Chan et al., 2012; Larson et al., 2013; Jacobs et al., 2016). The driving rationale is that by integrating peoples' values and perceptions into planning may allow for the build-up of more effective and compatible science-policy exchange, by matching the multiplicity of uses by different actors with the maintenance of ecosystem services through more equitable processes and outcomes (Larson et al., 2013).

Nonetheless, few studies characterize how the ES concept articulates with local ecological knowledge systems Oliveira and Berkes, 2014). Perception can be defined as an experiential process where organisms (in this case humans) see, test and feel the components of a lived moment (Whyte, 1977); or the process of translation and reconstruction of brain stimuli and signals captured and encoded by sensations (Morin, 2000). Some of the earliest ES models already acknowledged how just a small percentage of ES are usually perceived and therefore valued by humans (e.g., Costanza and Folke, 1997). We now know that the diversity and structure of patterns in human perception of nature can vary according to the types of ecosystems analyzed (Costanza, 2000; Casado-Arzuaga et al., 2013), age and education of people involved (Blayac et al., 2014), social position and occupation (Oliveira and Berkes, 2014), all factors affecting methodological options underpinning ES research (McNally et al., 2016; Simpson et al., 2016).

Jacobs et al. (2016) makes a strong case for integrative valuation approaches and actually proposes a new valuation school aimed at integrating diverse values of nature in resource and land use decisions. They outline the key challenges that need to be overcome by this emerging science-policy field, which we summarize in the following eight challenges: developing a strong interdisciplinary basis (1); combination (2) and application of appropriate (3) methods; ethical consideration about the impact of research for embedded sociopolitical (4) and governance realities (5); the challenge of communicating complexity and uncertainty about values of nature to stakeholders and decision-makers (6); issues of equity and power asymmetries (certain values benefit actors with more power) (7) and; the higher costs and breadth of time- and data-consuming nature of such research processes (which might be seen as less efficient) (8). Studies seeking to face such challenges are under development in several places, but they most often do not address all the challenges at once (Jacobs et al., 2016). While challenges 4 and 5 are given structural properties of SES and as such modifying them are perhaps to be regarded as long-term research-policy outcomes; all others stand as options that can be embedded in inter- and transdisciplinary research design early on their inception in real SES. Our paper reports a highly interdisciplinary, on-going research-action project attempting to consider all such project design challenges to face real structural transformations in sociopolitical and governance features of a coastal-estuarine SES in the long-run.

1.3 Transforming coastal-marine social-ecological systems

The accelerating crisis in common pool environmental resources worldwide has impelled recent scholarship to understand and inspire the achievement of lasting change in the way SES are organized (Gunderson and Holling, 2002; Folke et al., 2010; Patterson et al., 2017). More now than ever in human history, transformative change is urgently needed in how people and institutions interact with coastal systems (Glaser et al., 2012). In the context of our research, we highlight the pressing challenge for rapid shifts in how coastal and marine governance evolves, towards regimes that can deliver more socially and ecologically coherent outcomes (Young, 2010; Westley et al., 2011, 2013). The inception (step-zero) of radically novel area-based interventions is one of the most critical challenges of any given coastal-marine SES trajectory (Chuenpagdee et al., 2013).

For instance, most countries have developed national marine protected areas (MPAs) frameworks to promote a range of area-based marine management objectives including spatially and temporally sustainable resource management. Given that only about 3% of all oceans are governed by MPAs, a real big challenge for marine conservation goes beyond improving effectiveness of existing MPA systems; but also to create new ones and broadly increase capacities to govern coastal-marine systems beyond MPAs through 'Other Effective Area Based Conservation Measures' (OECMs) (Laffoley et al., 2017). OECMs are defined as: "*a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values*"(CBD Recommendation No 22/5, July 2018). This resonates with recent calls for the planning of networks of MPAs to be consciously promoted as "policy experiments" (Fox et al., 2013) by research-action projects, through continual models of stakeholder engagement and social learning (Reid et al., 2016) that includes coastal-marine areas within and between formally designated MPAs.

In face of the above challenges in ES-based research and policy - this paper analyses the Babitonga bay estuarine SES (South Brazil) study case, one that has been undergoing rapid transformation in the way it is governed and therefore has been endorsed by the Brazilian state as "policy experiment" – to our knowledge the first pilot marine OECMs in the country. We will explore how diverse patterns in perception of values of nature by direct ecosystem users, affects the inception of new, territorially bonded "shared values" discourse as a key feature for the transformation of the currently fragmented towards an ecosystem-based coastal governance regime. Our paper will highlight the lessons learned in relation to critical features of the scoping phase of coastal-marine ES assessments and, more broadly, the potential contribution of integrative and deliberative ES valuation approaches to coastal-marine ecosystem-based policy-making.

2. Methods

2.1 Driving social-ecological transformations in Babitonga bay

Babitonga bay is on the northern coast of the state of Santa Catarina (Brazil). It is surrounded by six coastal municipalities (Fig. 1) and includes the largest metropolitan region of the state, around the city of Joinville (about one million inhabitants). The estuarine system has an area 1400 km², and the largest mangrove area in southern Brazil, with 130 km² (Grace et al., 2008), or 75% of the state mangrove cover (MMA, 2002). This estuary connects to the ocean through one channel with an extension of 1.7km, and also comprises sandy beaches, 83 islands, stone slabs, and sand banks (IBAMA, 1998).

The ecological functions of Babitonga bay allows the survival of several species, temporary (migrant) or resident, including 28 endangered or particularly valued commercial fishes (Gerhardinger et al., 2006; Gerhardinger et al., *in press*) and the critically endangered porpoise (*Pontoporia blainvillei*; Cremer and Simões-Lopes, 2005). The Bay houses diverse activities, such as agriculture, tourism and leisure, mariculture, fisheries, and port and industrial activities (Barros et al., 2008). Due to the urbanization, port activities, and the discharge of untreated sewage, some areas are highly polluted and contaminated by fecal sterols (Martins et al., 2014) and organic matter (Barros et al., 2010). Both inner and outer-bay coastal seascapes are used by over 1,700 fishers from the six surrounding municipalities. Other direct users are related to two ports, two sand mining companies, mariculture (aquaculture parks), and tourism and leisure operators, including marinas. The sharing of the area by different users generates pressures and conflicts in on the ecosystem. The power asymmetry and the fragility of over a handful of ongoing environmental licensing processes of large coastal infrastructure (e.g., new ports) offers a '*…perfect atmosphere for political speculation and unethical bargaining* [of territorial rights] *…and proliferation of fallacious information…*", also reflecting the lack of integration of local actors' perceptions towards a more equitable development scenario (Gerhardinger et al., 2018a).

Since 2015, collaborative activities have been developed in coastal cities around Babitonga Bay through a growing network of over 60 organizations involved in socio-environmental projects, mobilizing direct and indirect resource users, governmental and NGOs into a novel coastal governance architecture for the area (Gerhardinger et al., 2018b). Gerhardinger et al. (2018b) have recently analyzed the Babitonga bay SES trajectory, suggesting that recent interventions have put the SES on the move towards transformation, *i.e.* tipping the SES to a "hazy-to-transparent" phase of the SES following Westley's et al. (2018) Theory of Transformative Agency (TAT). Even though a comprehensive toolbox for integrated coastal management policies were already available to local decision-makers, before the project started, the SES was suffering with the ruling of a largely fragmented and sectoral governing approach reported above.

Three years later, a humans-in ecosystem-based vision for Babitonga bay area-based governance is now being pursued by members of a newly stablished, autonomous multi-stakeholder forum named Pro-Babitonga Group (PBG). This forum is formed by representatives of public and societal sectors and have been endorsed by Brazil's Federal Action Plan for the Coastal Zone as a regional integrated coastal management policy experiment. Gerhardinger et al. (2018b) suggests the very existence and operation of PBG indicates that old ways of governing are losing dominance, and institutions and beliefs are opening to reinterpretation in a novel system which enables the exchange of ideas, evaluation of scenarios and definition of new ecosystem-based governance trajectories. This very special policy condition offers a rare opportunity to translate the diversity of resource user perceptions on ES in the crafting of a new, more socially and ecologically equitable and coherent vision for the future of the SES.

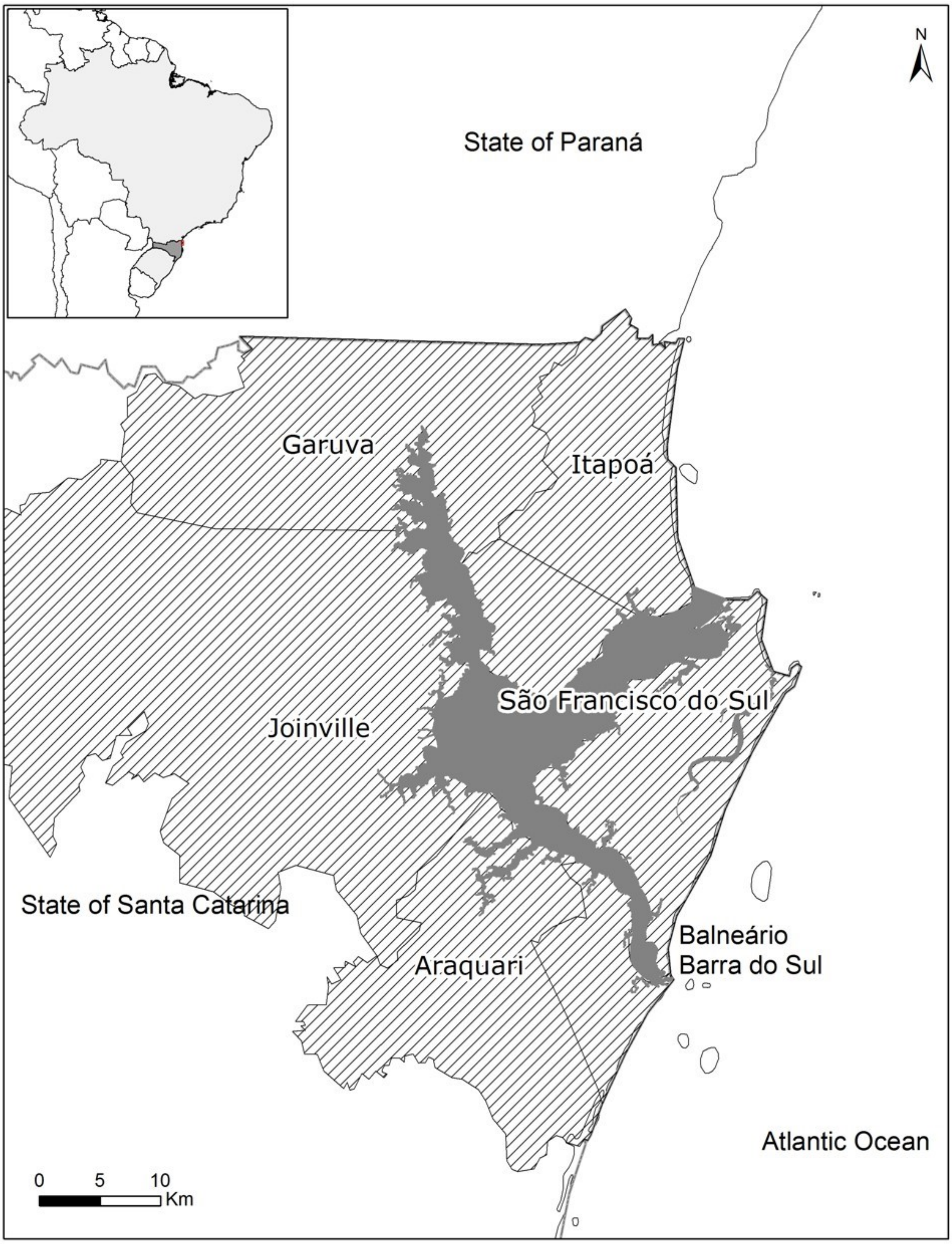


FIG 1: Babitonga Bay and its six surrounding municipalities (North of Santa Catarina – Southern Brazil).

2.2 Selection of participants

Research co-design started in June 2015 with a workshop with researchers, representatives of national and municipal public agencies (Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio, Instituto Brasileiro do Meio Ambiente e

Recursos Naturais - IBAMA, local governments) and socio-environmental organizations. Through this workshop, engagement with five groups of direct ecosystem users were deliberately prioritized: artisanal fishers, mariculture agents (oyster and mussel cultivation), aquatic transport agents (representatives from the port, collective maritime transportation companies, barge, and petroleum transportation companies), miners, tourism and leisure agents (marinas, passenger boats, owners of sports fishing boats).

The strategies for selection of workshop participants sought to guarantee representativeness of groups and varied according to number of people/institutions in each group, in each of the six municipalities surrounding Babitonga Bay (see Supplemental Material, Appendix I, with the detailed description of group selection and mobilization).

2.3 Data collection

This paper reports the results from the first round of an ongoing ecosystem-based marine spatial planning workshop series, a process driven by non-state actors during the early implementation-phase of a continual and long-term multi-actor engagement model (Reid et al., 2016). Participatory data-collection workshops were designed and replicated with all five direct Babitonga bay ecosystem users and researchers in separate sessions, in each municipality, after prior informed consent of the participants. All the workshops followed the same methodology with a minimum of two facilitators.

In order to elicit ES types and to understand how the groups perceive ES from the socioecological system, we used the inductive word 'Benefit' (Fig.2) - referring to the product that nature provides for humans, and because some researchers consider it to be synonymous of ES (e.g., MEA, 2005). During preliminary assessments, local fishers' responses to 'Benefit' enacted their perception of governmental benefits (e.g., insurances, retirement). Therefore, we used the complimentary inductions "Access Rights" and "Resource" (in respective order) to expand the identification of ES. Thus, participants were invited to argue about the benefits they obtain from nature where they live, what are their access rights and what resources they use. The first mention of every citation was recorded on notecards and organized in a panel board below each inductive word heading.

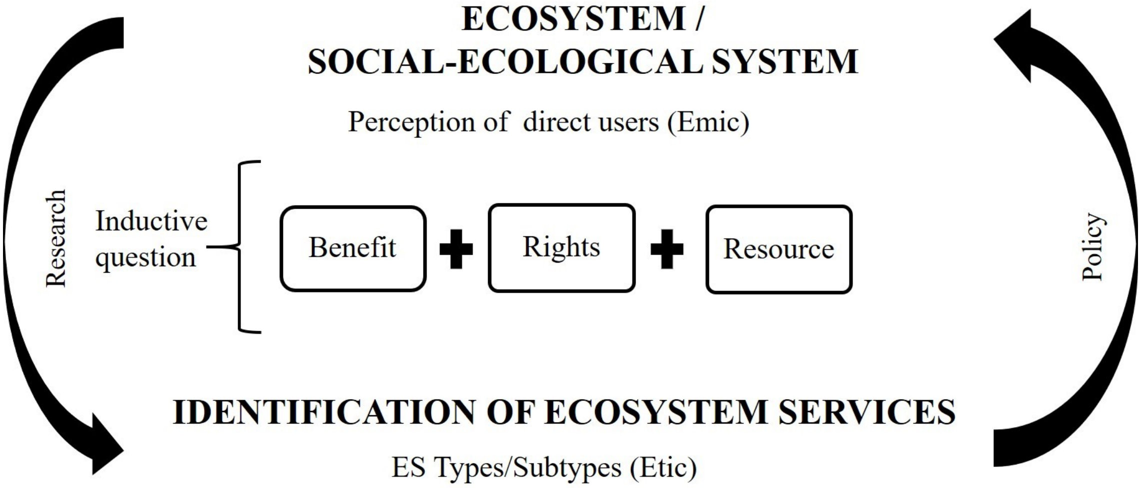


FIG 2: Integrative/ deliberative data-collection process (n=19 workshops; 178 participants) conducted to understand the ecosystem services perceived by the direct users and to initiate the construction of new policies for the Babitonga bay ecosystem (Brazil).

2.4 Data Analysis

Our analysis sought to contrast local classificatory systems (emic: the perspective of investigated social groups/informants) with scientific knowledge (etic: perspective of researchers) (Posey, 1987), thus transforming and encoding popular knowledge about the environment based on scientific theories, into ongoing decision-making processes. Therefore, we contrast local knowledge with the Millennium Ecosystem Assessment concept of ecosystem services (ES) as '*benefits obtained from the environment by humans*' (MEA, 2005); and the four basic types of ES (provisioning, regulating, supporting and cultural). All citations recorded during participatory workshops were systematized, categorized and counted as responses to benefit, access right or resource. We standardized citations, coding them into groups of similar meanings. For example, *bathing* and *swimming* were considered swimming; *employment* and *work* as employment; *fun* and *outings* as leisure; *forest* and *bush* as vegetation. During the coding process, we acknowledged that the MEA's framework did not fully accommodate the diversity of human-environment relationships (see also Wallace, 2007; Oliveira and Berkes, 2014). Kenter et al. (2016) notes that straight classification of cultural ES as benefits is often problematic (*i.e.* they can be intangible, experiential, identity-based or idiosyncratic), raising particular axiological and ontological issues that calls for deliberative and non-monetary valuation approaches. Therefore, we adapted Raymond and collaborators' (2009) refinement of the MEA (2005) typology; hence, when accessing emic perceptions, we used a 'people's' services subtype within Cultural ESs that enabled the full consideration of the local ecological knowledge of the users, about the services they report from the ecosystem. People's ES are considered here as cultural benefits derived from human agency. They refer to values and threats to the ecosystem, as informed by workshop attendants, but not straightforwardly falling in conventional ES Cultural category. Thus, our dataset was coded in the following types of ES: provisioning, regulating, supporting, cultural, and cultural/people's as a special type of cultural ES (Table I).

Table I: Definitions of types of ecosystem services used in this article, adapted from Raymond et al. (2009) and Costanza et al. (2017).

Service Type	Definition
Supporting	The very structure that supports life and all other services, they are basic ecosystem processes such as soil formation, primary productivity, biogeochemistry, nutrient cycling and provisioning of habitat;
Regulating	Derives from the combination of natural with built, human, and social capital to produce flood control, storm protection, water regulation, human disease regulation, water purification, air quality maintenance, pollination, pest control, and climate control;
Provisioning	Derives from the combination of natural with built, human, and social capital to produce and extract food, timber, fiber, or other ''provisioning" benefits;
Cultural	Derives from the combination of natural capital with built, human, and social capital to produce recreation (*e.g.* beach, swimming, boat touring), aesthetic (scenic beauty, landscape), knowledge (information and education), cultural identity (*e.g.* fishing, diversity of local traditions), sense of place (*e.g.* satisfaction and pleasure to live in a given place), legacy (*e.g.* taking what one need for sustenance and survival, services for future generations) or other 'cultural' benefits
Cultural/People's	Human beings are regarded as agents that transforms and generates benefits in the ecosystem (including natural and social properties). Therefore, we use this category to embrace cultural benefits directly derived from human agency in social-ecological system and constructions in nature: physical structures enabling direct access to services (*e.g.* logistics, boats, ports, industries, roads, shipyards), sharing an economic (*e.g.* job creation, income generation, profiting) and social organization purpose (*e.g.* institutions, laws such as closed fishing season and retirement, political dynamics, supervision).

3. Results

The 19 workshops with direct Babitonga Ecosystem users and researchers mobilized 178 participants (see Supplemental Material– Appendix I). We obtained a total of 285 ES citations (average of 15 citations per workshop), 210 were in response to the word Benefit (Average=11/workshop), 57 in response to Access Rights (Average=3/workshop), and 18 elicited by the word Resource (Average= 0.95/workshop).

The use of three complementary inductions therefore contributed to increase the overall number of citations - even though we excluded repetitions leading to gradual exhaustion of new valid citations. Researchers were outstandingly above average in total number of citations in a single workshop (n=37).

The citations were coded into 127 distinct ESs, the richest being: leisure (n=13), tourism (n=12), fish (n=11), water (n=9), fisheries (n=9), navigation (n=8), crabs (n=7), and survival, food, air, oyster and navigability (n=5 each). We obtained 45 (16%) citations of fish or crustacean species, representing at least 16 different species.

We identified a total of 31 ES subtypes, including: Regulating=3; Supporting=3; Provisioning=5; Cultural=20; Cultural/People's=9 (Table II). During the ES type and subtype assignment process, we toke several steps to harmonize classifications with overlapping meaning and avoid typological misrepresentations in further analysis. Therefore, ten citations were disregarded because they were similar to others mentioned under different inductive stimuli. We removed citations such as 'quality of life' (n= 7), 'well-being' (n= 1) and 'health' (n= 2) in response to inductions with the word 'benefit' (n= 8) and 'access rights' (n= 2), because they resulted from the combination of subsets of benefits pertaining to all categories. Citations could be assigned to two types of ES, for example, mariculture and agriculture were classified as a provisioning in the food subtype and in '*People*' as a source of income, for producing food from man-made production and cultivation structures rather than simply extracting what is produced in nature.

We obtained a total of 317 classifications (the 270 citations plus 52 citations that were assigned to more than one subtypes). Among the 31 subtypes, eight presented only one citation (Table II and Fig 4).

Cultural and cultural/people (62% of all classifications) and provisioning (29%) were the most cited types of ES overall. The former was the most frequent type to all but fishers who cited more provisioning ESs (Fig. 3). Regulating and supporting services accounted for the lowest numbers of classifications. They were seldom referred by direct users other than by researchers, who mentioned several of such types as important ESs. Aquatic transport agents did not refer to any regulating and supporting ES, while mariculture agents did not mention regulating services.

We adapted the *framework* from Raymond et al. (2009) including a gradient of ES. On the left side (Fig. 4), we show ESs predominantly deriving from non-human natural ecosystem processes, while salience of the social system is depicted with increasing dominance to the right. Classifications into cultural services reflect the main interconnections between human and non-human natural ES processes (Fig. 4).

In terms of number of ES subtypes classifications, fishers and tourism and leisure agents cited a larger array of services (22 and 20 subtypes, respectively), followed by researchers and miners (17 and 15 subtypes). Mariculture and aquatic transport agents displayed a narrower ES subtype classification profile with only nine subtypes.

Fishers were the user group citing more provisioning services of food (subtype 7; n=58) and genetic resources (subtype 8; n= 55), i.e. they cited many species names for fish, mollusks, and bivalves perceived as benefits from the Babitonga ecosystem. The group of researchers identified services across the range of ES types used in the analysis. Tourism and leisure agents are characterized by a greater reference to ES belonging to cultural subtypes leisure and tourism (subtype 12), legacy and existence (subtype 14), aesthetic inspiration and contemplation (subtype 15).

Several ES subtypes are not shared amongst user groups, because they were cited by only a particular user group (Table II). For example, nutrient cycling and climate regulation were cited only by researchers; aquatic transport agents were the only citing a geomorphological resource; miners were the only citing regulation of erosion and hunting; fishers were the only citing spirituality, assistentialism, and funding opportunities and; tourism and leisure agents were the only citing politics as a service obtained from their ecosystem.

On the other hand, our informants perceived several shared services. For instance, food (provisioning), tourism and leisure (cultural), economic viability (*e.g.,* employment, work and income) and infrastructure/logistics (*e.g.,* transport, vessels, ports, navigation) (both cultural/people ESs) are shared values by all user groups. Interestingly, three ES subtypes (maintenance of life cycle; water quality and; cultural & historical patrimony) were mentioned by all user groups, with the exception of aquatic transport agents which were also the only group not citing any supporting nor regulating services.

Table II: Structure of Ecosystem Services classification profiles by direct resource users (N=number of workshops) of Babitonga bay (Santa Catarina, Brazil).

Ecosystem Service Type	**Ecosystem Service Subtype**	**Researchers N=1**	**Fishers N=9**	**Mariculture N=1**	**Tourism & leisure N=5**	**Mining N=2**	**Aquatic transport N=1**
Supporting	**1.** Maintenance of life cycle	3	0.7	1	0.2	0.5	
	2. Maintenance of genetic diversity	1	0.1		0.6		
	3. Nutrient cycling	1					
Regulating	**4.** Air quality	1	0.2		0.2	0.5	
	5. Climate regulation	1					
	6. Regulation of erosion					0.5	
Provisioning	**7.** Food	3	5	2	1	1	1
	8. Genetic resources	2	5	1	0.6		
	9. Water	1	0.1	1	0.4	0.5	
	10. Mineral resources	1	0.2			1.5	
	11. Geomorphologic resources						1
Cultural	**12.** Leisure & tourism	3	0.9	3	2.4	3.5	2
	13. Cultural & historical patrimony	3	0.7	1	0.4	1	
	14. Legacy & existence		0.4	2	1.2	0.5	
	15. Aesthetic, inspiration & contemplation	2	0.7		0.6	1	
	16. Sense of place	1	0.6		0.2	0.5	
	17. Education & knowledge system	3			0.2		1

	18. Livelihood		0.1		0.4		1
	19. Social relations	1			0.2		1
	20. Communication & information	1	0.1		0.2		
	21. Hunting					0.5	
	22. Spirituality		0,1				
	23. Economic viability	2	5.2	3	0.6	1	1
	24. Infrastructure & logistics	3	0.8	2	2.6	1.5	2
	25. Assistentialism		0.7				
	26. Planning		0.2		0.8		
Cultural/ People´s	**27.** Strategic geographic position				0.2		2
	28. Supporting institution & legislation		0.1			1.5	
	29. Financing		0.2				
	30. Opportunity		0.1				
	31. Politics				0.2		
Grayscale of average number of citations per workshop:		]0 - 0,5]	]0,5 - 1]	]1 - 1,5]	]1,5 - 2,5]	]2,5 - 3,5]	>3,5

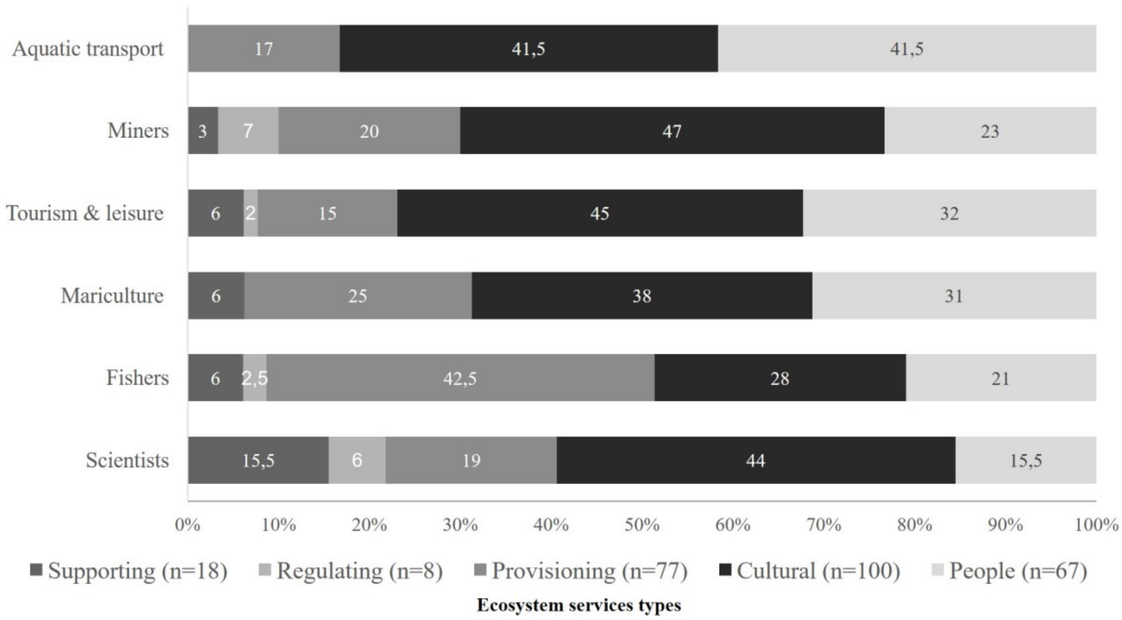


FIG. 3 Relative frequency of distribution in classifications of ecosystem services types based on the perception of six direct user groups of Babitonga bay (N=270 citations), identified in 19 workshops. Numbers given in legends refer to the absolute frequency of classifications per type of ecosystem service.

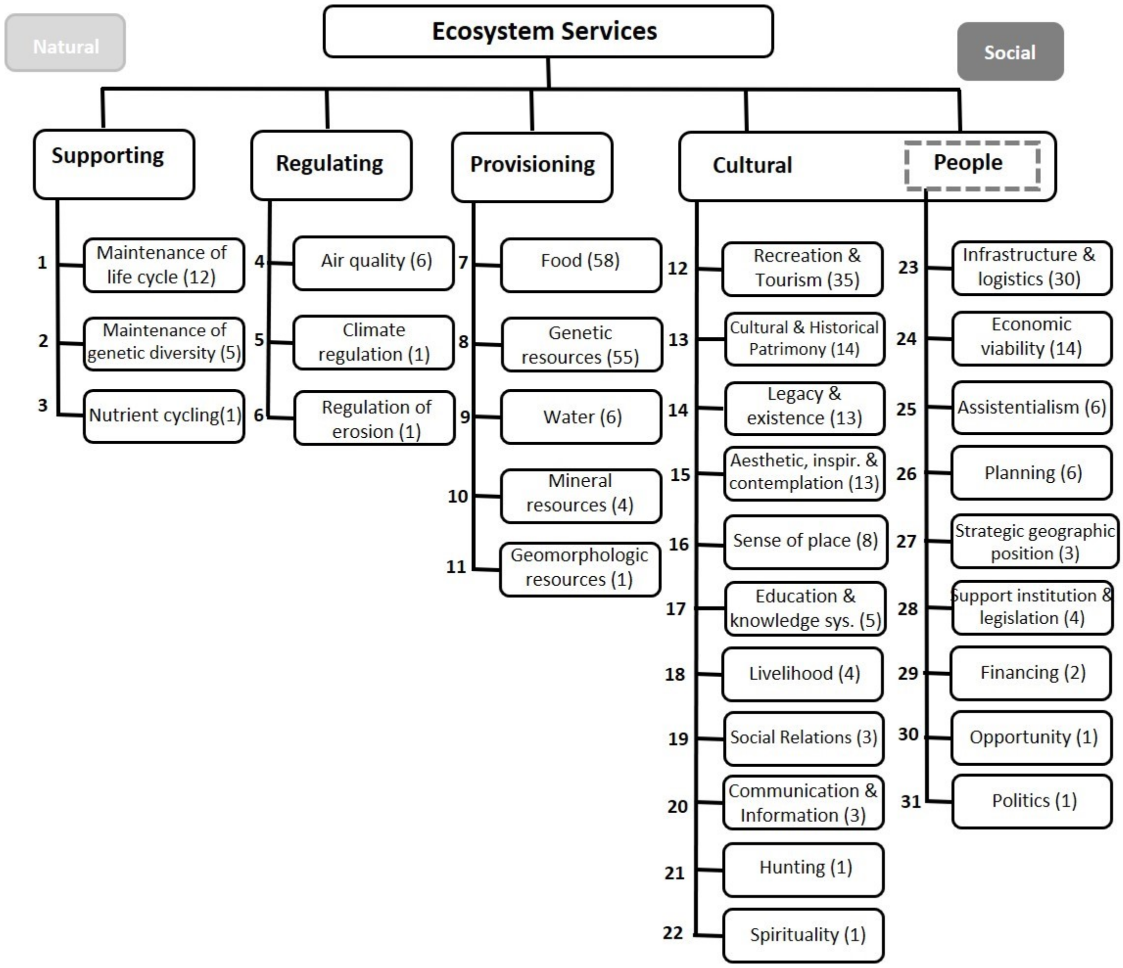


FIG. 4: Adaptation of Raymond et al. (2009) ecosystem services' *framework* to a social-ecological systems perspective, considering the types of services in a socioecological system gradient, ranging from more natural (supporting, regulating, and provisioning) and social (cultural and people) properties to a main point of connection and interconnection of these characteristics represented by cultural services. We considered 31 subtypes and 317 classifications.

4. Discussion

4.1 Mapping patterns in ecosystem service perception profiles

McNally et al. (2016) observed that different actors tend to assign priorities to ES that are more related to their way of life. Our results outline the structural differences amongst ES profiles perceived by each user group. However, while Hein and collaborators (2006) hypothesize that local actors would indicate more 'provisioning' and 'supporting' ES; most of our classifications fell under the categories cultural (62%) and provisioning services (29%).

The ES subtypes we recorded derive from human interactions within the Babitonga bay environment, where users create and use tools in a cosmological relationship with the natural, non-human components of this ecosystem. Daily cultural practice shapes environmental spaces and are in turn enabled by them generating cultural goods, this whole process enabling cultural ecosystem benefits (Fish et al., 2016).

All citizens use and benefit from cultural services, regardless of their economic activity, since leisure, contemplation of the landscape, sense of place, and cultural traditions are largely available to all people, independent of their economic activity. Recent research on the perception of different social actors highlight the importance of cultural services in relation to other ES types (Chan et al., 2012).

All ecosystem users valued provisioning services to some extent. But fishers, more than any other group, outstandingly valued this type of ESs through several species of fish mentioned as vivid demonstration of the richness of their local ecological knowledge about and ethnotaxonomy of aquatic life. Most provisioning services were either classified as food and/or genetic resources, obtained through commercial or sport fishing activity by most users, and through mariculture activity. Provisioning and cultural ESs are intimately linked, i.e. fishing as a noticeable example has strong bonds with cultural benefits: it can be an economic or recreational activity (Boyd and Banzhaf, 2007), it is a traditional practice enabling a differentiated livelihood, and may be associated with spiritual, therapeutic, feelings of belonging, satisfaction and survival issues. The very existence of provisioning services impels humans to develop cultural structures and practices to extract, plant, and interact with the ecosystem. When provisioning services become scarce, we'll see associated changes in cultural practices, interfering with the way people deal with the environment. In this case, there may be changes in cultural services, and consequently an impulse to develop new structures (technologies and constructions) that intensifies or improve the use of provisioning services (cross-ES feedbacks).

Regulating and supporting services were the least mentioned in our study, a pattern also found in other ES perception studies (Raymond et al., 2009; Casado-Arzuaga et al., 2013; McNally et al*.,* 2016). These ESs were not at all mentioned by aquatic transport agents - probably because this group work in indoor environments and their economic activity (port and navigation) do not depend directly on the health of the aquatic environment in order to be productive? While this might be a reasonable inference, it does not entirely explain why regulating and supporting ESs were not abundantly cited by other users that have an intimate relationship with the sea such as fishers and mariculture agents. These ES types are often considered indirect benefits (Costanza et al., 1997) and regarded as processes and operating mechanisms of nature; thus not generally noted in perception studies possibly because they are not easily recorded through inductive methods used.

Indeed, Oliveira and Berkes (2014) showed that fishers in Rio de Janeiro do not perceive regulating and supporting services as benefits, but rather as a natural environmental condition. Similarly, it is more evident for people to cite access to clean water as a benefit, than the cleaning process it goes through (Fisher et al., 2009). Therefore, we suggest that such services could be accessed explicitly probing questions related to specified processes such as climate change (amount of rainfall, drought), water dynamics and flow, role of the mangroves in the ecosystem, role of different environments in generating life.

Nevertheless, inferences may still be advanced on the variance and similarities amongst of ES perception profiles. For instance, we suggest that ESs subtypes cited by only a particular user group, offers an identity marker that differentiate that group and are derived from peculiarities of ES that may define the socioeconomic activity itself. For example, only researchers, who are generally aware of ES and sustainability discussions, referred to nutrient cycling and climate regulation. Similarly, only aquatic transport agents cited the natural depth of channel as ESs because of their dependence on navigation channels to operate large ships. Fishers were the only concerned with spirituality probably as a reflection of their intimate, direct relationship with the aquatic world.

Our ES perception profiles highlight the benefits that are important for the daily routines and social well-being of all investigated direct ecosystem users and hence to be regarded as shared values. ESs such as provisioning of food by the ecosystem, and cultural benefits such as tourism and leisure, employment, work and income as well as cultural/people's services such as transport, vessels, ports and navigation - should bare special place in the development of sustainability policies. However, our results also show other ESs of critical importance cited by amongst all user groups. The more powerful actors in our study case, the aquatic transport agents, were the only group which did not consider maintenance of life cycle, water quality and cultural & historical patrimony. This may signal lower engagement with issues concerning aquatic ecosystem health.

4.2 Implications to coastal-marine ecosystem service assessments

Abson et al. (2014) found that the highest percentage of studies in ecosystem services were empirical studies of natural science and valuation; and that interdisciplinary studies are still incipient and are mainly related to the dynamics of knowledge systems about services and their political mechanisms. Other studies are overly focusing on monetary values (Richardson et al., 2015), and in many cases, services of extreme importance such as cultural services, are neglected because they are intangible and difficult to assess (Chan et al., 2012). For Jacobs et al. (2016), designing more integrative ES assessment methods has been a pressing but difficult challenge, given usual reliance on varying but hard to conciliate assumptions, axioms and pre-analytical frameworks.

By using complimentary inductive words (benefits, rights and resources) and accommodating cultural/people's services in our framework, our analysis enabled the integration of informants' (emic) perspectives of the ecosystem and positioned humans as both service providers and consumers. Ecosystem services thus emerged as perceptions of complex interactions between the biophysical environment, ecological processes, and human interventions (Mouchet et al., 2014; Bennett et al., 2015).

This study did not adopt the conventional bidirectional model where ecosystem properties or functions and provisioning services are on the supply-side, while sociocultural or social system domain on a demand-side (see Costanza and Folke, 1997; Martín-López et al., 2013 and Felipe-Lucia et al., 2015). Our results instead are based on a conceptual model that regards humans as an integral part of the ecosystem, and not simply an outside force enjoying services produced by nature (Fig. 5). We thus offer a co-evolutionary gradient from ecosystem processes less-to-more human-agency dominated types of services (following the notion that boundaries between social-ecological systems are artificial and arbitrary- Berkes and Folke, 1998). We do consider that supporting and regulating services are associated to the biophysical domain, likewise Martín-López et al. (2013), since they exist independently of the human presence in the ecosystem and are basic foundations for the entire natural system. However, our approach differs from the above authors whom placed humans separate of the 'ecosystem'.

Our model also highlights the existence of feedbacks and trade-offs across the spectrum of ESs rendering further complexity to ES assessments. For instance, the socioeconomic significance of benefits and the meaning people place on the services may have diverse underlying relationships (Oliveira and Berkes 2014), *e.g.*, they can be classified into multiple types of services as shown in the case of several possible linkages between food provisioning (fish) and diverse possible cultural services immanent in the act of fishing. Human-induced changes in one type or subset of ESs may also trigger cascading effects on the availability of other ESs in the socioecological system gradient (Fig. 5). For instance, the construction of oyster and mussel aquaculture parks, in a given area, directly engages with environmental features to produce food (provisioning service). While benefits are generated, poor management may cause harmful externalities through pollution by increased organic matter, plastic disposal, and disturbance of traditional navigation pathways. These can in turn affect the capacity of the ecosystem to regulate, support and provide other services, including cultural benefits.

Peterson et al. (2018) have pointed the main advances and shortfalls of the so-called Nature's Contributions to People Framework in relation to conventional ESs approaches (NCP, Díaz et al., 2018). Our ethnoecological lenses is highly sensitive to cultural context as a cross-cutting factor shaping human perception of nature and quality of life – which is also a major NCP advancement in the opinion of Peterson et al. (2018). Meanwhile, our humans-in social-ecological systems approach does not emphasizes linear or one-directional flows of contributions from nature to people – which is a major shortfall of the NCP according to these authors.

4.3 Implications to coastal-marine ecosystem-based policymaking

This paper contributes to the 'new valuation school' described in Jacobs et al. (2016), by exploring the integration of nature's diverse values in ecosystem-based governance initiatives - when "public goods" (instead of "individualistic preferences") are at stake in coastal-marine policy-building processes. Our research addresses three major features suggested by ES literature for the evolution of integrated valuation (Ruckelshaus et al., 2015; Fischer et al., 2015; Bennett, 2017; Boeraeve et al., 2018; Peterson et al., 2018): i) inclusive of local/traditional knowledge systems; ii) based on integrative methods and; iii) supportive of experimental learning. They particularly concern the inception (early-stage) of ES assessment agendas, i.e. purpose definition and the scoping process (Jacobs et al., 2016). Next, we explore these features on the light of the main science-policy insights gained in the Babitonga study case.

The literature highlights that integrated valuation should (i) use local knowledge systems to enhance research design and improve its societal relevance (inclusionary of hidden values and power asymmetry as part of an iterative science-policy process).

Our paper describes actors' ES perception diversity, and the implications for developing a territorially bonded "shared values" discourse and practice process. One that is inclusive of ecosystem actors' unique identities and potential contributions, but also embracing a more holistic and inter-dependent view of the ecosystem and its component parts. We noted that perceptions on ES varies according to one's cultural background and, because governance is made by humans, there is a constant risk of falling into models that privileges the mindsets of those (usually more powerful) humans involved in decision-making. Hence all actors at a given participatory process need to remain watchful and discerning, because power ultimately influence (how and what information matters) the allocation of and degree to which individuals and groups may be capable of accessing ESs (Felipe-Lucia et al., 2015). Enacting the perceptions of different actors' through deliberative approaches can, therefore, help deepen societal understanding of ecosystem (including cultural) services. It can also help steer more symmetrical contexts for actors' engagement in more equitable management processes and trade-off analysis to support sustainable territorial development scenarios (Otero et al., 2013).

Secondly, integrated valuation should (ii) combine methods, disciplines and approaches to enable understanding and thus hopefully increase mutual capacity, ownership, trust, and long-term success. We suggest that the integrative nature of ES assessments approaches should optimally be matched with deliberative methods. Influencing changes in the very structure of SES (ex., sociopolitical and governance features) is not something that it is done through use of sophisticated interdisciplinary frameworks and technologies alone. Integration is not something done by one nor a handful of thoughtful researchers but will hopefully emerge naturally through the realization of the place and role of each other actor group in the future making of the SES. Our ES perception profiles are a valuable social learning tool. Their appreciation may contextualize the interplay between ecological knowledge and power in policy making turning the realization of these relationships more explicit in deliberative processes. For instance, we argue that some patterns across the spectrum of ES perception profiles, when brought to the table and discussed by resource users, will be seen as proxies of potential conflicts or divergence of expectations in terms of future visions for the SES.

Our results therefore set higher standards for upcoming blue economy debates in Babitonga bay and across Brazil. They will thus hopefully challenge neoclassical monetary valuations, individualistic non-monetary approaches, and development of non-monetary/socio-cultural valuation as a separate research domain (Kenter, 2016). Conventional economic thinking narrows its very definition of value to elements people perceive as direct benefit and are willing to pay for (Costanza et al., 2017). These are predominant approaches in ES studies, which can result in several key ES ignored and/or undervalued, incentivizing policies to maximize a select few services ("cherry-picking") based on data availability and ease of quantification (McDonough et al., 2017) - with consequent socially and ecologically undesired effects (Kull et al., 2015).

Finally, integrated valuation should also (iii) enable reflexivity and experimentation through sets of new scientific parameters for future policy evaluation. Our research is embedded in a "transformations in the making" SES opportunity context at the Babitonga bay ecosystem level (Gerhardinger et al., 2018b). While our workshop participants are slowly becoming aware and engaged in the reflection about and uptake of the data generated by each cycle of participatory planning series. The results presented in this paper already places us (researchers) in a much better position to represent their values, worldviews and expectations in transformative policy making. In this regard, Gerhardinger et al. (2018b) application of Westley's et al. (2013) TAT (Theory of Transformative Agency) provides us specific-phase recommendations of institutional entrepreneurship strategies, skills, actions and types of agency required for fulfilling the vision of and navigating towards an ecosystem-based governance regime at Babitonga bay ecosystem. TAT tells us it is critical to encourage the proliferation of ideas and the recombination of resources in new forms (e.g., building networks, making room for desirable emergent self-organization); that we should help a new dominant design to emerge by encouraging the dropping off of some ideas and linking those that are agreed offer a viable alternative platform and; that we should enable resource mobilization through leveraging and brokering (e.g., identifying opportunities, engaging the emerging energy of the system, working through networks and partnerships, connecting ideas and resources). What these prescriptions means in practice?

Paramount to our on-going transformation is for research-action projects to continue creating room for a more diverse ES perception base to confront current dominant views of Babitonga's vocation for ports. Envisioning a more diverse identity for this SES where all ecosystem actors can prosper is perhaps the key desirable idea to inspire future social learning. Empowering less powerful and hence represented groups in territorial development policies, such as fishers, mariculture, tourism and leisure agents, should be regarded as priority target groups by external agents willing to support their collective action and political organization. Given the lack of socio-political organization these groups are known for locally, strategies such as citizen-science and self-monitoring the health and productivity of the aquatic environment seems to be good starting points – to connect their experiential knowledge of the aquatic ecosystem through evidence-based agendas will enact their authority in the operations of new knowledge-building, problem-solving and decision-making stances (such as the emerging PBG multi-stakeholder platform). This is where the core aggregate of shared values discourse made explicit through our results meets practice, with the potential to frame the terms for future ecologic-economic zoning discussions in Babitonga bay. Again, reflexive learning about divergent, possibly conflicting values and ecological knowledge complementarities might level-off the planning field and place stakeholders in a better position to shape more socially and ecologically coherent futures.

Timing is critical here because in the upcoming years, the collective action energy of less influential actors could be fully drawn to a reactive agenda, i.e. if massive dredging operations are authorized by the triggering of the installation phase of new ports and a shipyard, the quality of the water may immediately drop and severely affect fishing and aquaculture operations (Gerhardinger et al., 2018a). For instance, fishers are facing the risk of not being able to maintain the very own existence of artisanal fisheries as a viable activity. Unfortunately, this is not an isolated circumstance, but a widespread example of the unfair trade-offs effects generated by fragmented licensing of coastal infrastructure (e.g., new ports), exacerbated by the greater social and political vulnerability and marginalization of small-scale fisheries in Brazilian developmental policies (ICSF, 2016).

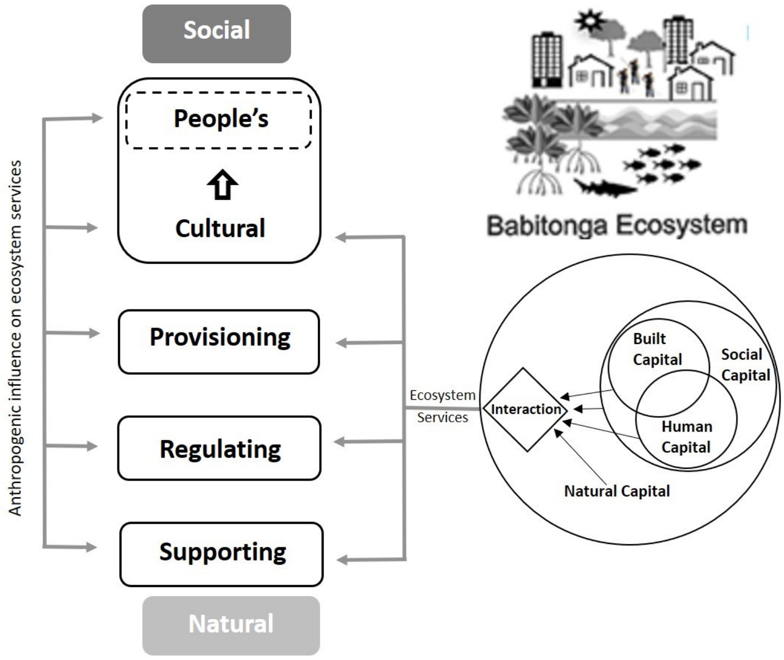


FIG. 5: Connections between ecosystem services arranged in an interdependent, nested gradient within the focal social-ecological system (arrows pointing from the bottom up) (*e.g.*, Babitonga bay ecosystem). We acknowledge that ecosystem services as well as complex cascading effects results from the interaction of different types of natural capitals (including non-human derived natural capital, social, human and built capitals; interconnected arrows to the right). Services (etic) or benefits (emic) are perceived by social-ecological system's agents (direct ecosystem users and researchers in the Babitonga bay ecosystem case study), the structure of which vary from less (Supporting, Regulating and Provisioning) to more socially dominated (Cultural including People's) types of ecosystem services. The interconnected arrows to the left therefore show humans influence on one or more service, not necessarily in one direction, *e.g.* change in cultural/ people's services can influence provisioning and regulating services, and/or all other services in multiple ways).

5. Conclusions

Our analysis demonstrates that even before the criticisms on the use of the word 'benefit' in the definition of ESs (a synonym of ES to some), it was capable of eliciting the essence of ES from different direct ecosystem actors' perspective. Our integrative and deliberative approach encompassed, in addition, the words 'rights' and 'resources' thus broadening the diversity of typologies assessed and required consideration by the political system in governance and territorial development initiatives. Since ES is an academic-scientific definition to be used in management processes and public policies, researchers need to be aware of its limitations when conducting research involving different social actors. Thus, we argue that the formal definition of ES should be broadened to consider a wider range of services than what is currently contemplated in conventional ES studies, such as 'benefits produced and obtained within the socioecological system'. This is a fundamental notion since humans can both use and produce ESs, as well as positively and negatively influence its availability and quality.

Our paper also reinforces the importance of cultural services, because regardless of the economic activity performed, every citizen benefit from them even though they are rarely properly valued and considered in management and developmental. The overvaluing of a specific subset of ES, usually associated with the interests of a smaller and more empowered social group, is among the main causes of civilizational crises. ES studies thus have the noble and challenging role of imbuing collaborative and integrated strategies of territorial planning with greater distributional justice. This could be achieved through valuation strategies capable of building alternative visions for sustainability that are based on values that are shared amongst actors, but also sensitive to the identities of more vulnerable stakeholders.

Our results therefore seriously challenge dominant patterns of neoliberal styles of planning by exploring a scalable and replicable approach to symmetrically contextualize in marine policy, the structure of perceived services by a wide range of economic agents - from more powerful (mining and transport agents) to less influential (small-scale fisheries and mariculture). We set new terms for strategic, hopefully transformative, social learning to take place; by translating the diversity of direct ecosystem users' perceptions into a more coherent and integrated approach to ES that may hopefully lead towards more inclusive, equitable and ecocentric policymaking of disputed seascapes.

6. Acknowledgments

We are grateful to all workshop participants for their contribution and lively discussions. We thank M. Glaser, F. Daura-Jorge, M. Dechoum, M. Cremer and P. Lopes for insightful comments on the manuscript, D.A. Vila-Nova helped with the construction of the map, and F.G. de Carvalho and A. Marcel for constructive dialogues. Thanks to CAPES for providing a PhD scholarship to D.F.H., CNPq for a research productivity scholarship to N.H. (309613/2015-9), FAPESP for a post-doc scholarship to L.C.G. (2016/26158-8) and Babitonga Ativa Project (Regional University of Joinville / Federal Public Ministry) for financial and human resources supporting the workshops.

7. Author Contributions Statement

DFH, LCG and NH designed workshop methodology, DFH and LCG performed the workshops, DFH analized data, DFH, LCG and NH wrote the article.

8. References

Abson, D.J., von Wehrden, H., Baumgartner, S., Fischer, J., Hanspach, J., Hardtle, W., et al. (2014). Ecosystem services as a boundary object for sustainability. Ecol. Econ. 103, 29-37. doi:10.1016/j.ecolecon.2014.04.012

Aswani, S., Basurto, X., Ferse, S., Glaser, M., Campbell, L., Cinner, J.E., Dalton, T., et al. (2017). Marine resource management and conservation in the Anthropocene. Environ. Conserv. 1-11. doi:10.1017/S0376892917000431

Barros, G.V., Martinelli, L.A., Novais, T.M.O., Ometto, J.P.H.B., Zuppi, G.M. (2010). Stable isotopes of bulk organic matter to trace carbon and nitrogen dynamics in an estuarine ecosystem of Babitonga Bay (Santa Catarina, Brazil). Science of the total environment. 408, 2226:2232. doi:10.1016/j.scitotenv.2010.01.060

Barros Grace, V., Mas-pla, J., Oliveira Novais, T., Sacchi, E., Zuppi, G. M., Grace, V. B., et al. (2008). Hydrological mixing and geochemical processes characterization in an estuarine/mangrove system using environmental tracers in Babitonga Bay (Santa Catarina, Brazil). Cont. Shelf Res. 28, 682–695. doi:10.1016/j.csr.2007.12.006.

Bennett, N.J., Cisneros-Montemayor, A.M., Blythe, J., et al. (2019). Towards a sustainable and equitable blue economy. Nature Sustainability. 2, 991–993. doi:10.1038/s41893-019-0404-1

Bennett, E. M. (2017). Research frontiers in ecosystem service science. Ecosystems. 20(1):31-37. doi:10.1007/s10021-016-0049-0

Bennett, E.M., Cramer, W., Begossi, A., Cundill, G., Diaz, S., Egoh, B.N., et al. (2015). Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. Environmental Sustainability. 14, 76-85. doi:10.1016/j.cosust.2015.03.007

Berkes, F., Folke, C. (1998). "Linking Social and Ecological Systems for resilience and sustainability". In: Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge, UK: Cambridge University Press p. 1- 23.

Blayac, T., Mathé, S., Rey-Valette, H., Fontaine, P. (2014). Perceptions of the services provided by pond fish farming in Lorraine (France). Ecological Economics. 108, 115-123. doi:10.1016/j.ecolecon.2014.10.007

Boeraeve, F., Dufrene, M., De Vreese, R., Jacobs, S., Pipart, N., Turkelboom, F., et al. (2018). Participatory identification and selection of ecosystem services: building on field experiences. Ecology and Society. 23, 0- 27. doi:10.5751/ES-10087-230227

Boyd, J., Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. Ecological Economics. 63 (2-3), 616-626. doi:10.1016/j.ecolecon.2007.01.002

Casado-Arzuaga, I.; Madariaga, I.; Onaindia, M. (2013). Perception, demand and user contribution to ecosystem services in Bilbao Metropolitan Greenbelt. Journal of Environmental Management. 129, 33 -43.

Chan, K.M.A, Chan, A.D., Guerry, P.B., Klain, S., Satterfield, T., Basurto, X., et al. (2012). Where are Cultural and Social in Ecosystem Services? A Framework for

Constructive Engagement. BioScience. 62 (8), 744- 756. doi: 10.1525/bio.2012.62.8.7
Chuenpagdee, R., Pascual-Fernández, J. J., Szeliánszky, E., Luis Alegret, J., Fraga, J., and Jentoft, S. (2013). Marine protected areas: re-thinking their inception. Mar. Pol. 39, 234–240. doi: 10.1016/j.marpol.2012.10.016
Costanza, R. (2000). Social goals and the valuation of ecosystem services. Ecosystems. 3 (1), 4-10. doi: 10.1007/s100210000002
Costanza, R., Folke, C. (1997). Valuing ecosystem services with efficiency, fairness, and sustainability as goals. In: Daily, G.C. (Ed.), Nature's Services: Societal dependence on natural ecosystems. Press, Island, Covelo, California. pp. 49–68.
Costanza, R., d´Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., etal. (1997). The value of the world´s ecosystem services and natural capital. Nature. 387, 253-260.
Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., et al. (2017). Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosystem services. 28, 1-16. doi.org/10.1016/j.ecoser.2017.09.008
Costanza, R., de Groot, R., Sutton, P., van den Ploeg, S., Anderson, S.J., Kubiszewski, I., et al. (2014). Changes in the global value of ecosystem services. Global Environmental Change.26, 152-158. doi:10.1016/j.gloenvcha.2014.04.002
Cremer, M.J., Simão-Lopes, P.C. (2005). The occurrence of Pontoporia blainvillei (Gervais & d´Orbigny) (Cetacea, Pontoporiidae) in an estuarine area in southern Brazil. Revista brasileira de Zoologia. 22(3), 717-723. doi:10.1590/S0101-81752005000300032
Davidson-Hunt, I.J.; Berkes, F. 2003. Nature and society through the lens of resilience: toward a human-in-ecosystem perspective. In: Berkes, F., Colding, J., Folke, C. (Eds.), Navigating Social–Ecological Systems: Building Resilience for Complexity and Change. Cambridge University Press, Cambridge, UK.
Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., et al. (2018). Assessing nature's contributions to people. Science. 359(6373), 270–272. doi: 10.1126/science.aap8826
Felipe-Lucia, M.R., Martín-López, B., Lavorel, S., Berraquero-Díaz, L., Escalera-Reyes, J., Comín, F.A. (2015). Ecosystem services flows: Why stakeholders' power relationships matter. PlosOne. 10(7), 1-21. doi:10.1371/journal.pone.0132232
Fischer, J., Gardner, T. A., Bennett, E. M., Balvanera, P., Biggs, R., Carpenter, S., et al. (2015). Advancing sustainability through mainstreaming a social-ecological systems perspective. Current Opinion in Environmental Sustainability. 14, 144-149. doi: 10.1016/j.cosust.2015.06.00
Fish, R., Church, A., Winter, M. (2016). Conceptualizing Cultural Ecosystem Services: A Novel Framework for Research and Critical Engagement. Ecosystem Services. 21, 208–217. doi:10.1016/j.ecoser.2016.09.002
Fisher, B., Turner, R K., Morling, P. (2009). Defining and classifying ecosystem services for decision making. Ecological Economics. 68, 6 4 3– 653. doi:10.1016/j.ecolecon.2008.09.014
Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. Global Environmental Change. 16, 353- 367. doi:10.1016/j.gloenvcha.2006.04.002
Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., and Chapin, T. (2010). Resilience Thinking : Integrating Resilience , Adaptability and. Ecol. Soc. 15.

Fox, E., Poncelet, E., Connor, D., Vasques, J., Ugoretz, J., McCreary, S., et al. (2013). Adapting stakeholder processes to region-specific challenges in marine protected area network planning. Ocean Coast. Manage. 74, 24–33. 5. doi: 10.1016/j.ocecoaman.2012.07.008
Gattuso, J.P., Magnan, A.K., Boop, L., Cheung, W.W.L., Duarte, C.M., Hinkel, J. et al. (2018). Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems. Frontiers in Marine Science. doi.org/10.3389/fmars.2018.00337
Gerhardinger, L.C., Bertoncini, A.A, Hostim-Silva, M., Medeiros, R.P., Marenzi, R.C. (2006). Local Ecological Knowledge on the Goliath Grouper *Epinephelus itajara*. Neotropical Ichthyology, 4, 441-450. doi:10.1590/S1679-62252006000400008
Gerhardinger, L.C., de Carvalho, F.G., Haak, L., Herbst, D.F., Poderoso, R. A. (2018a) Planning Blues: Tenure rights fade under unjust 'blue planning'. Samudra Reports. Vol 78: 42. Available at: https://www.icsf.net/en/samudra/article/EN/78-4334-Planning-Blues.html
Gerhardinger L.C., Gorris, P. Gonçalves L.R., Herbst D.F., Vila-Nova D.A., De Carvalho F.G., Glaser M., Zondervan R. Glavovic B.C. (2018b). Healing Brazil's Blue Amazon: The role of knowledge networks in nurturing cross-scale transformations at the frontlines of ocean sustainability. Frontiers in Marine Science. 4, 395. doi:10.3389/fmars.2017.00395
Gerhardinger, L.C., Herbst, D.F., Cunha, S., Duarte, M. In press. Diagnóstico da Ictiofauna do Ecossistema Babitonga. Revista CEPSUL: Conservação e Biodiversidade Marinha.
Glaser, M., Ratter, B. M. W., Krause, G., and Welp, M. (2012). "New approaches to the analysis of human-nature relations," in Human-Nature Interactions in the Anthropocene: Potentials of Social-Ecological Systems Analysis, eds M. Glaser, G. Krause, B. M. W. Ratter, and M. Welp (New York, NY; Abington: Routledge). 3–12.
Gunderson, L., and Holling, C. S. (2002). Panarchy: Understanding Transformations in Human and Natural Systems. Washington, DC: Island Press.
Hein, L.; van Koppen, K. de Groot, R.S.; van Ierland, E.C. (2006). Spatial scales, stakeholders and the valuation of ecosystem services. Ecological Economics. 57, 209-228. doi.org/10.1016/j.ecolecon.2005.04.005
Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis. (1998). Proteção e controle de ecossistemas costeiros: manguezal da Baía Babitonga. Brasília, IBAMA, Coleção Meio Ambiente, Séries estudo pesca.146p.
ICSF – International Collective in Support of Fish Workers. (2016). Vital Fisheries: Setting pathways for the implementation of International Guidelines for Small-Scale Fisheries in Brazil. 32p.
Jacobs, S.; Dendoncker, N., Martín-López, B, Barton, D.N., Gomez-Baggethun, E., Boeraeve, F., et al. (2016). A New Valuation School: Integrating Diverse Values of Nature in Resource and Land Use Decisions. Ecosystem Services. 22, 213–20. doi:10.1016/j.ecoser.2016.11.007
Kenter, J.O. (2016). Editorial: Shared, plural and cultural values. Ecosystem Services. 21, 175–183. doi:10.1016/j.ecoser.2016.10.010
Kenter, J.O., Bryce, R., Christie, M., Cooper, N., Hockley, N., Irvine, K.N., Fazey, I., O'Brien, L., Orchard-Webb, J., Ravenscroft, N., Raymond, C.M., Reed, M.S., Tett, P., Watson, V. (2016). Shared values and deliberative valuation: Future directions. Ecosystem Services. 21, 358–371. doi:10.1016/j.ecoser.2016.10.006
Kull, C.A., de Sartre, X.A., Castro-Larranaga, M. (2015). The political ecology of ecosystem services. Geoforum 61, 122–134. doi:10.1016/ j.geoforum.2015.03.004

Laffoley, D., Dudley, N., Jonas, H., MacKinnon, D., MacKinnon, K., Hockings, M., et al. (2017). An introduction to 'other effective area-based conservation measures' under Aichi Target 11 of the Convention on Biological Diversity: Origin, interpretation and emerging ocean issues. Aquat. Conserv. Mar. Freshw. Ecosyst. 27, 130–137. doi:10.1002/aqc.2783.

Larson, S., De Freitas, D.M., Hicks, C.C. (2013). Sense of place as a determinant of people's attitudes towards the environment: implications for natural resources management and planning in the Great Barrier Reef. Australasian Journal of Environmental Management. 117, 226–234. doi:10.1016/j.jenvman.2012.11.035.

Liquete, C., Piroddi, C., Drakou, E.G., Gurney, L., Katsanevakis, S., Charef, A, Egoh, B. (2013). Current status and future prospects for the assessment of marine and coastal ecosystem eervices: A systematic review. PlosOne. 8(7), 1-15. doi: 10.1371/journal.pone.0067737

Martín-López, B.; Gómez-Baggethun, E.; García-Llorente, M.; Montes, C. (2013). Trade-offs across value domains in ecosystem services assessment. Ecological Indicators. 37, 220-228. doi: 10.1016/j.ecolind.2013.03.003

Martins, C.C., Cabral, A.C., Barbosa-Cintra, S.C.T., Dauner, A.L.L., Souza, F.M. (2014). An integrated evaluation of molecular marker indices and linear alkylbenzenes (LABs) to measure sewage input in a subtropical estuary (Babitonga Bay, Brazil). Environmental Pollution. 188, 71-80. doi: 10.1016/j.envpol.2014.01.022

McNally, C.G., Gold, A., Pollnac, R.B., Kiwango, H.R. (2016). Stakeholder perception of ecosystem services of the Wami River and Estuary. Ecology and Society. 21:3, 0-34. doi: 10.5751/ES-08611-210334

Mcdonough, K., Hutchinson, S., Moore, T., Hutchinson, J.M.S. (2017). Analysis of publication trends in ecosystem services research. Ecosystem Services. 25, 82–88. doi: 10.1016/j.ecoser.2017.03.022

Milcu, A.I., Hanspach, J., Abson, D., Fischer, J. (2013). Cultural ecosystem services: a literature review and prospects for future research. Ecology and Society. 18:3, 0-44. doi: 10.5751/ES-05790-180344

Millennium Ecosystem Assessment (MEA). (2005). Ecosystems and human well-being: Wetlands and water synthesis. World Resources Institute, Washington, D.C., USA.

MMA. (2002). Avaliação e Ações Prioritárias para a Conservação da Biodiversidade das Zonas Costeira e Marinha. Ministério do Meio Ambiente. Brasília: MMA / SBF, 72p.

Morin, E. (2000). Os sete saberes necessários à educação do futuro. 2. ed. São Paulo: Editora Cortez. 118p.

Mouchet, M.A., Lamarque, P., Martín-López, B., Crouzat, E., Gos, P., Byczek, C., Lavorel, S. (2014). An interdisciplinary methodological guide for quantifying associations between ecosystem services. Global Environmental Change. 28, 389-395.

Oliveira, L.E.C., Berkes, F. (2014). What value São Pedro´s procession? Ecosystem services from local people perceptions. Ecological Economics. 127,114-121. doi: 10.1016/j.ecolecon.2014.08.008

Otero, I., Boada, M., Tabara J.D. (2013). Social-ecological heritage and the conservation of Mediterranean landscapes under global change. A case study in Olzinelles (Catalonia). L Use Policy. 30, 25–37. doi:10.1016/j.landusepol.2012.02.005

Patterson, J., Schulz, K., Vervoort, J., van der Hel, S., Widerberg, O., Adler, C., et al. (2017). Exploring the governance and politics of transformations

towards sustainability. Environ. Innov. Soc. Transitions. 24, 1–16. doi: 10.1016/j.eist.2016.09.001
Peterson, G. D.; Harmackova, Z. V.; Meacham, M.; Queiroz, C.; Jiménez Aceituno, A.; Kuiper, J. J.; Malmborg, K.; Sitas, N. E. and Bennett E. M. (2018). Welcoming different perspectives in IPBES: "Nature's contributions to people" and "Ecosystem services". Ecology and Society. 23, 1:39. doi:10.5751/ES-10134-230139
Posey, D. (1987). Introdução - etnobiologia: teoria e prática. In: RIBEIRO, Berta (Coord./Org.). Suma etnológica brasileira. 1 etnologia. Petrópolis: Vozes/FINEP.
Raymond, M.C., Bryan, B. A., MacDonald, D.H., Cast, A., Strathearn, S., Grandgirard, A., Kalivas, T. (2009). Mapping community values for natural capital and ecosystem services. Ecological Economics. 68, 1301-1315. doi: 10.1016/j.ecolecon.2008.12.006
Raymond, C.M, Giusti, M., Barthel, S. (2017). An embodied perspective on the co-production of cultural ecosystem services: toward embodied ecosystems. Journal of Environmental Planning and Management. Doi: 10.1080/09640568.2017.13112300
Reid, R.S., Nkedianye, D., Said, M.Y., Kaelo, D., Neselle, M., Makui, O., Onetu, L., Kiruswa, S., Kamuaro, N.O., Kristjanson, P., Ogutu, J., BurnSilver, S.B., Goldman, M.J., Boone, R.B., Galvin, K.A., Dickson, N.M., Clark, W.C. (2016). Evolution of models to support community and policy action with science: Balancing pastoral livelihoods and wildlife conservation in savannas of East Africa. Proc. Natl. Acad. Sci. 113, 4579–4584. doi.org/10.1073/pnas.0900313106
Richardson, L.; Loomis, J.; Kroeger, T.; Casey, F. (2015). The Role of Benefit Transfer in Ecosystem Service Valuation. Ecological Economics. 115, 51–58.
Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Rickerrs, T., Bhagabati, N., Wood, S.A., Bernhardt, J. (2015). Notes from the Field: Lessons Learned from Using Ecosystem Service Approaches to Inform Real-World Decisions. Ecological Economics. 115, 11–21. doi: 10.1016/j.ecolecon.2013.07.009
Simpson, S.; Brown, G.; Peterson, A.; Jonstone, R. (2016). Stakeholders perspectives for coastal ecosystem services and influences on value integration in policy. Ocean and Coastal Management. 126, 9-21. doi: 10.1016/j.ocecoaman.2016.03.009
Vatn, A. (2009). An institutional analysis of methods for environmental appraisal. Ecological Economics. 68, 2207–2215. doi: 10.1016/j.ecolecon.2009.04.005
Wallace, K. J. (2007). Classification of ecosystem services: Problems and solutions. Biological Conservation. 39, 235–246. doi: 10.1016/j.biocon.2007.07.015
Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., et al. (2011). Tipping toward sustainability: emerging pathways of transformation. AMBIO 40, 762–780. doi: 10.1007/s13280-011-0186-9
Westley, F. R., Tjornbo, O., Schultz, L., Olsson, P., Folke, C., Crona, B., et al. (2013). A theory of transformative agency in linked social-ecological systems. Ecol. Soc. 18:27. doi: 10.5751/ES-05072-180327
Whyte, A.V.T. (1977). *Guidelines for field studies in environmental perception*. International Council of Scientific Unions, Scientific Committee on Problems of the Environment Unesco, Paris. 117p.
Young, O. R. (2010). Institutional dynamics: resilience, vulnerability and adaptation in environmental and resource regimes. Glob. Environ. Change 20, 378–385. doi: 10.1016/j.gloenvcha.2009.10.001

Zaucha, J., Conides, A., Klaoudatos, D., Norén, K. (2016). Can the ecosystem services concept help in enhancing the resilience of land-sea social ecological systems? Ocean ans Coastal Management. 124, 33-41. doi:10.1016/j.ocecoaman.2016.01.015

CAPÍTULO 2

Integrated and deliberative multidimensional assessment of a subtropical coastal-marine ecosystem (Babitonga bay, Brazil)

(Avaliação Integrada e deliberativa multidimensional de um Ecossistema Subtropical Costeiro-marinho (Babitonga bay, Brazil)

Artigo aceito na Revista *Ocean and Coastal Management*



Demonstração das três etapas de oficinas. Etapa 1/2015: Pescadores de São Francisco do Sul (Centro), Etapa 2/2016: Pescadores de São Francisco do Sul (Vila da Glória) e Etapa 3/2017: Reunião intersetorial. Acervo de imagens do Projeto Babitonga Ativa.

Capítulo 2: Integrated and deliberative multidimensional assessment of a subtropical coastal-marine ecosystem (Babitonga bay, Brazil)

Dannieli F. Herbst[1], Daniele Alves Vila-Nova[2], Fabiano Grecco de Carvalho[2], Leopoldo Cavaleri Gerhardinger[3], Natalia Hanazaki[1,4]

[1]Programa de Pós-Graduação em Ecologia – Universidade Federal de Santa Catarina, Florianópolis, SC, Brazil

[2]Projeto Babitonga Ativa – Universidade da Região de Joinville, SC, Brazil

[3]Instituto Oceanográfico, Universidade de São Paulo, SP, Brazil

[4]Departamento de Ecologia e Zoologia, ECZ/CCB, Universidade Federal de Santa Catarina, Campus Trindade, Florianópolis/SC, Brazil

*danniherbst@gmail.com

Correspondence: danniherbst@gmail.com

Abstract

We investigate the operationalization of an integrated and deliberative multidimensional assessment (distribution of socioeconomic activities across marine spaces, risk to ecosystem levels, pressures on ecosystem services, and conflicts) in a Brazilian subtropical coastal-estuarine social-ecological system that is currently changing from a fragmented and sectoral governance system towards an ecosystem-based regime. Based on the perception of five direct ecosystem user groups (aquatic transport, tourism and recreation, mariculture, mining, and fisheries) we explored how the multidimensional assessment approach may inform ecologically coherent and socially equitable coastal governance and development. We conducted three cycles of participatory planning workshops (n=39) with all groups: to map uses and activities across 7 contextually different planning units; to identify conflicts; and to assess the spatial distribution of risks to the ecosystem. We mapped the spatial distribution of 28 activities that directly generate provisioning and cultural ecosystem services (ES), and their associated indirect impact-chains on all ESs types and affected users. A total of 44 conflicts (32 inter- and 12 intra-sectoral) were discussed, and were higher in more intensely used areas. A habitat risk assessment scaled-up an ecosystem-level understanding of areas in need of urgent management. Important habitats (mangroves, submerged rocky outcrops, soft bottoms, water column) are facing high levels of risk; and a significant heterogeneity in spatial distribution of risk justifies radically alternative, contextually-based management and development measures to challenge the status quo. We conclude that the ecosystem services will likely continue to benefit present and future generations if an ecosystem-based management approach is consistently adopted with five sets of priorities: 1) advance plural valuation mechanisms with awareness of pressure-levels on the ecosystem; 2) manage conflicts while creating synergies amongst existing activities across space; 3) avoid expansion of pressure on ecologically sensitive areas; 4) consolidate the emerging novel democratic governance mechanism; and 5) explore the transferability approach's potential to scale-up coastal governance transformation in Brazil.

Key-words: ecosystem-based management; risk; fisheries; direct users; conflicts.

1. Introduction

Coastal-marine environments provide a wide range of ecosystem services (ESs) that are targeted benefits of distinct human-use interests (Liquete et al., 2013). Besides the high relevance of tropical estuarine social-ecological systems (Bauer et al., 2013), their associated ESs are being rapidly modified and lost in the past decades. Therefore, a global call for action in support of the adoption of principles of coastal-marine ecosystem-based management (EBM) approaches echoes in different political, institutional and socio-ecological contexts and scales (Long et al., 2015; Langlet and Rayfuse, 2019). In sustainability science, responses to these calls translates in increasing interest in transdisciplinary and transformational research initiatives (Arbo et al., 2018; Jacobs et al., 2020); given their potential to respond and transform the reality of complex social-ecological systems to be governed by diverse (often divergent) epistemologies and perceptions of nature (Horcea-Milcu et al., 2020; Eelderink et al., 2020). New management paradigms should acknowledge the multiple connections sustaining and distinguishing an ecosystem, including values and services provided by such ecosystem, the accumulated impacts and risks, the multiple and often competing management objectives, as well as the need to embrace change and foster social learning and adaptation from wide scale strategies to local contexts (UNEP, 2011; UN Environment, 2018).

In situ biodiversity protection at a local scale (Korpinen and Andersen, 2016; Gattuso et al., 2018) offers a critically important set of solutions. Hence adopting 'area-based management' approaches offer promising measures to advance in this direction, e.g. see Other Effective Area-Based Conservation Measures (OECMs: CDB

Recommendation No 22/5, July 2018). Area-based management integrates an array of coastal-marine management instruments with a high potential to transversally promote the Sustainable Development Goals in coastal-marine policies (UN Environment, 2018).

While growing interest in area-based governance is noted across the UN system, how to operationalize an integrated ecosystem and risk assessments linked to equitable processes of allocation of access to marine space (e.g., through EBM marine spatial planning - MSP) are still areas for much theoretical and methodological development (Laffoley et al., 2017; IUCN WCPA, 2019; Jacobs et al., 2020) and critical debate (Peterson et al., 2018; Clarke and Flannery et al., 2019). The valuation of 'ecosystem services' – the benefits obtained from the environment by humans that are critical to human survival, livelihoods, well-being, and quality of life (MEA, 2005) - has been strongly encouraged as a mean to introduce ecosystem notions within the coastal-marine public policy-building sphere (Simpson et al., 2016). For instance, the notion of ESs can be crucial in studies and debates about estuarine environments, because it allows for a common language to explore the interconnectedness of ESs and the limits of biosphere, and facilitate learning by decision-makers and the general public about complexity in an integrated and adaptive perspective (Zaucha et al., 2016; Kenter et al., 2016; Costanza et al., 2017). Similarly, integrated assessments of risk offer decision makers a measure of the degree to which coastal and marine habitats are exposed to human activities, as well as the habitat-specific consequence of that exposure for the delivery of ESs (Natural Capital, 2017).

Therefore, the application of ecosystem-based Marine Spatial Planning (MSP) to improve ocean governability requires, inevitably, that decision-making is informed about: the distribution of values and uses of services; the pressures and associated impact chains (Borgwardt et al., 2019) on ESs and affected users, conflicts and risks; as well as of relations of power and conflict emerging from shared use and disputes over ESs (Jentoft, 2017; Gerhardinger et al., 2019; Herbst et al., 2020). Transdisciplinary sustainability research supports direct engagement of social actors and socioeconomic to render prioritization and planning processes robust and socially acceptable, and hence are better able to balance economic efficiency with consideration for intra- and intergenerational equity (Koehn et al., 2013; Werner et al., 2014).

However, several authors indicate that few are the examples of plural valuation processes going beyond a reductionist and disciplinary attribution of values to specific commodities that establish monetized ‘market values’ and thus optimally fosters unjust neoliberal models of economic development (Kull *et al*., 2015; McDonough *et al*., 2017; Jacobs et al., 2020). Research focusing only in the relationship between certain uses and a subset of species, or in the consequences of a single economic activity or sector to the ecosystem are limited because they ignore other effects and synergies that can potentially affect the ecosystem as a whole (Leslie e McLeod, 2007; UNEP, 2011). Spatialized socioeconomic and ecological data is also often not readily available in developing countries, such as Brazil, which increases the importance of participatory seascape mapping approaches (Gerhardinger et al., 2010) in order to create momentum in area-based management in coastal and marine territories. Furthermore, there are also still only a few published analyses of case studies and analytical approaches on the application of integrated assessments of risks derived from multiple uses to marine habitats, and even less on deliberative approaches (Arkema et al., 2014; Knights et al., 2015; Borja et al., 2016; Singh et al., 2017; Wyatt et al., 2017).

These gaps still limit our capacity to understand the subjacent mechanisms of impacts to marine ecosystems and the social phenomenon of building and managing shared values of nature (Jacobs et al., 2016; Jacobs et al., 2020). We confront these challenges by exploring the outcomes of a transdisciplinary sustainability research initiative that combined integrated (e.g., inter-sectoral) and deliberative (widely discussed amongst social actors) risk, space use, conflict and ecosystem services assessments in a project co-designed with users of an intermunicipal ecosystem that is undergoing coastal governance transformation towards an EBM regime: the Babitonga Bay (Santa Catarina state, South Brazil) (Gerhardinger et al., 2018b).

Herbst et al. (2020) presented a diversity of perceptions on ESs and shared values amongst Babitonga ecosystem direct resource users. These authors and Gerhardinger et al. (2017) showed that the predominant economic thinking combined with asymmetrical power relations have propelled incoherent and unfair public policies in the past. In this paper, we will spatially describe and analyze the multiple direct spatial uses (activities), their associated ESs, pressures, conflicts and risks posed to the aquatic ecosystem. We critically assess the application of the multidimensional approach to provide guidance on how to steer transformation of a currently fragmented and sectoral system towards an ecosystem-based regime.

2. Methods

2.1. Study area: Babitonga bay

The case study encompasses a total area of approximately 1,115.28 km, including 177.30 km² of mangrove vegetation and 856.19 km² of marine aquatic environments (spanning from the inner bay waters towards the ocean down to 20m deep, from the mouth of Saí-Guacú river to the North; to the mouth of Itapocú river to the south) (Gerhardinger et al., 2017). This is a very important nursery ground for commercial fisheries (eg. Drumers and shrimps) and endangered marine species (eg. Groupers and porpoises) in the South Brazil (Gerhardinger et al., 2020) and encompasses the largest mangrove area of Santa Catarina state (IBAMA, 1998). We engaged direct ecosystem users of all six municipalities neighboring the Babitonga bay, a metropolitan region of about 700,000 inhabitants (IBGE, 2016). Herbst et al. (2020) conducted a consultation with Babitonga bay direct ecosystem users to identify what they perceive as the core set of shared values: food, tourism/leisure, employment, work and income as well as transportation (e.g. vessels, ports and navigation) - were perceived as important by all user groups.

The Babitonga Ecosystem has been divided in eight Planning Units (PUs) given their common ecological, social and economic features (Fig. 1 – below and Table 1 – Supplementary Material). Such division enabled the prioritization of work in seven PUs and identification and subsequent mobilization of most relevant actors from each municipality in order to collaboratively identify and assess the conflicts and potential pressures to the ecosystem. PU Nº 8 was not considered a priority because it lies within a no-use state park hence was considered to be already subjected to protected area authority management.

Before 2015, the Babitonga Ecosystem was under no integrated nor participative EBM regime. The inception of a coastal governability initiative is marked by the Babitonga Ativa project (www.babitongaativa.com) which derives from a partnership between the Federal Public Ministry (MPF), the University of Joinville Region (UNIVILLE) and the Sea Memories Collective network. One major outcome of the project was the initiation of a multi-sectoral collegiate forum to advance area-based EBM, with representation of public, socio-economic and social-environmental segments, the Pró-Babitonga Group - PBG (Gerhardinger et al., 2017).

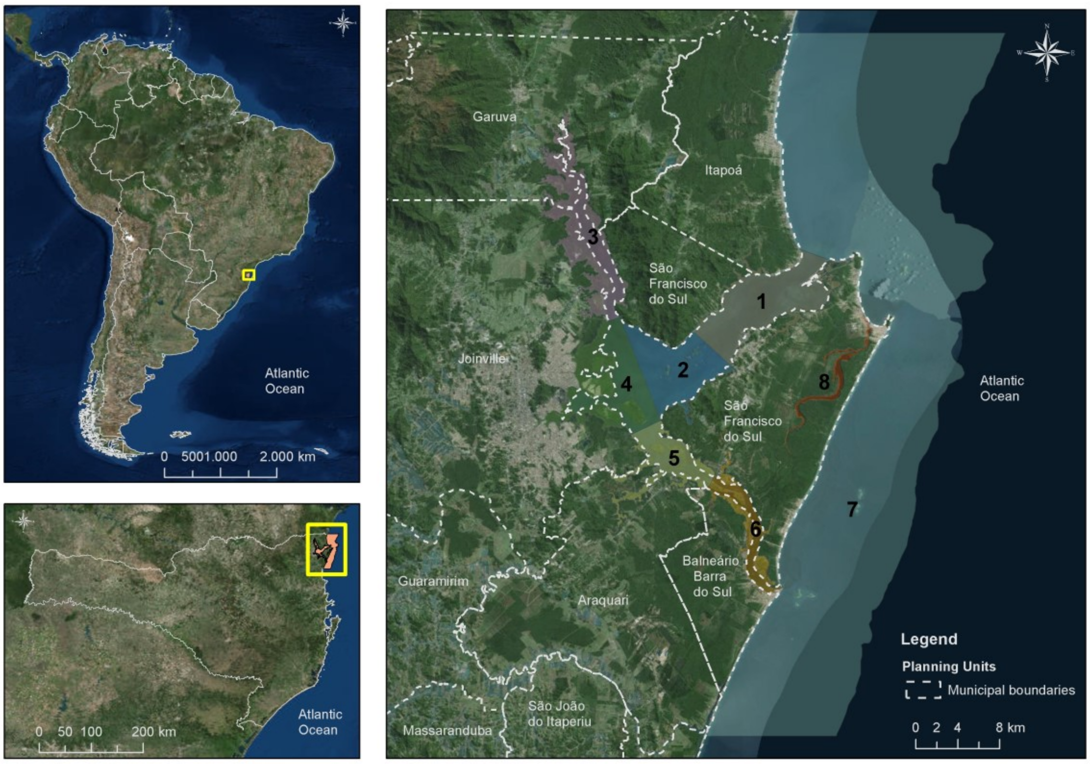


Fig. 1: Map of study area and the Planning Units (PUs): 1) Entry of the Bay, 2) Central islands, 3) Palmital River, 4) Coastal Joinville, 5) Linguado Chanel – Araquari, 6) Linguado Chanel - Barra do Sul, 7) Marine, 8) Acaraí River.

2.2 Workshop sample & design

Co-design of workshop cycles and criteria for participation occurred in a highly collaborative fashion (for additional detail see 'selection of participants' in Herbst et al., 2020). This process prioritized direct ecosystem actors using resources for economic and/or subsistence purposes, including aquatic transport (ports, ferry and public transport boats), tourism and recreation (marinas, small leisure boats and lodgings focusing sports-fishing activities), mariculture (oysters and mussels cultive), sand mining and artisanal fisheries agents. We approached the maximum possible number of formal representatives of resource users, in every city around Babitonga Bay.

Three participatory workshop cycles were conducted. The first two were undertaken separately with each direct user group across all six coastal municipalities (not all users are present at every city – see first column of Table 2 - Supplementary Material). In the third cycle, representatives of each user group were invited to jointly take part in one inter-sectoral workshop per PU (Table 2 – Supplementary Material). Furthermore, for the third cycle representatives from the Pro-Babitonga Group (composed by public, socioeconomic and social-environmental segments) were also invited to participate. The focus of the third cycle was to: widen general understanding of the planning process; increase mutual learning about the outcomes and to contribute with ideas for alternative governance measures in the mid and long run. All invited companies and institutions related to direct users were invited. In relation to fisheries, given historical exclusion and poor representation in coastal planning (Gerhardinger et al., 2018a), we also sought to mobilize the most knowledgeable fishers in every municipality as well as the representatives of local fishers' associations.

2.3 Data collection

Local ecological knowledge and perceptions were collected in workshops hosted by at least two facilitators, each cycle with a different methodology. The first cycle (September to December 2015) aimed at the identification of perceived ecosystem services (Herbst et al., 2020) and mapping of activities undertaken by direct resource users. We used a printed satellite image of the Babitonga Ecosystem (1.266m x 0.9m) with a transparent plastic sheet above, where participants were invited to draw the areas they use (points, polygons and/or lines) and to enumerate them with written legends. For higher precision, geomorphologic references were indicated to help the territorial contextualization of drawings.

The second workshop cycle (September to December 2016) aimed at communicating back the results of the former cycle and to hand-out maps of their activities per user group at each city for critical feedback. In the occasion, participants could use the opportunity to increase their understanding about spatial data and make complementary remarks and/or adjustments in the information provided by each activity and use of the ecosystem. After this initial step, we collectively investigated the presence of conflicts, regarded as the circumstances in which two or more users are interested and dispute the same space and/or natural resource.

After receiving feedback from prior cycles, the third cycle (October 2017 to March 2018) gathered representatives of all active sectors in workshops at each of the seven investigated PUs. During workshops, each sector separately discussed and filled tables with information about their perception on the frequency of activities - disturbance (where 3- stands for annual or not frequent; 2- occurring many times per year and; 1-

every week or day) and the intensity rating of each sectoral activity on the ecosystem, using the following standardized weighting degrees:

- 0- Activity does not affect the quality and productivity of ecosystem and does not require immediate management concerns;
- 1- Activity can be affecting the quality and productivity of ecosystem and requires attention;
- 2- Activity is intense and shows signs that it is already affecting the quality and productivity of ecosystem and requires management actions;
- 3- Activity perceived to have crossed tolerable limits and is already putting the ecosystem and/or continuity of the activity at risk requiring urgent management actions.

The intensity weight of all activities was assessed individually, *e.g.* all twelve fisheries activities/modalities (gear/target-species) were assigned separate weights. For every activity, the groups also outlined the range of pressures they posed to the aquatic environment and to each other sector, prompted by a pre-defined comprehensive list of 23 possible pressures (Table III- Supplementary Material).

2.4. Data processing and analysis

We built a matrix of habitats and ecosystem services to each PU (following Asmus et al. 2015; Scherer and Asmus, 2016; and Herbst et al., 2020) in order to associate activities to respective ESs used, and to describe the presssures affecting them. We used the Millennium Ecosystem Assessment concept of ecosystem services (ES) as 'benefits obtained from the environment by humans' (MEA, 2005) and its four basic types of ES (provisioning, regulating, supporting and cultural).

All plastic sheets were photographed at a 90-degree angle for digital archiving, and the spatial data was scanned and systematized in a GIS (shapefiles) using ArcGIS (version 10.5). We built thematic maps of use to each workshop (per sector and municipality) (see webgis at: www.babitongaativa.com). Shapefiles of formally licensed areas (mining, ports and mariculture) were built from data provided by the Department of National Mineral Production (DNPM) and the Santa Catarina Agropecuarian and Rural Extension Research Company (EPAGRI).

We performed a cumulative risk and effects analysis of the ecosystem using Natural Capital's (2017) Habitat Risk Assessment (HRA) model which combines different layers of habitats and human stressors (activities) to assess the potential cumulative risk of such activities over the ecosystem in general and on specific habitats. The HRA model used is part of an 'open source' package named InVEST (Arkema et al., 2014, Cabral et al., 2015) to provide guidance on the selection of spatial priorities and strategies for effective implementation of EBM (Werner et al., 2014); *e.g*. advancing the zoning process through better spatial assessment and hence decisions concerning the allocation of economic activities across the ecosystem (Arkema et al., 2015; Wyatt et al., 2017).

Risk intensity maps were built on calculations of the sum of exposures (E) and consequences (C) of each ecosystem grid to activities and habitats (Arkema et al., 2014; Wyatt et al., 2017). A database matrix of habitats and stressors is used to calculate exposures and consequences. Risk increase with the number of co-occurring habitats and activities at a given area. The model calculates the cumulative effect by multiplying the sums of E and C by grid, by habitat and in the ecosystem as a whole; and the risk assessment calculates the Euclidean distance based on the sums of E and C by grid, by habitat and in the ecosystem as a whole. For this analysis we considered spatial data (shapefiles) of three habitats: mangroves, submerged rocky outcrops and soft bottoms/water layer; as well as data on human activities reported by direct ecosystem users during the first and second workshop cycles. We chose these three habitats because of their importance in maintaining ecosystem services, aiming the quality of ecological, economic and social benefits obtained.

A total of 28 human uses/activities were considered for the HRA. The calculation of consequences (C) considers data on habitat (rates of recruitment, mortality, connectivity and recovery time) and stressors of each activity (frequency of disturbance, change in area rating and change in structure rating). With the exception of frequency of disturbance, all other ratings were based upon scientific literature. The calculation of exposure (E), in turn, considered ratings for temporal overlap, management effectiveness and intensity. The intensity rating of each activity (stressor) was assigned based on the average weight reported by users themselves at every PU inter-sectoral workshop. We considered every management effectiveness level equal 0 (without management effectiveness), given the low governability of the ecosystem. We standardized the confidence (Data Quality) of used data with weight 2, in order to acknowledge possible imprecisions of data derived from user perception. An influence area (buffer – 0 to 1000 m) for every activity was also adopted.

The HRA output maps show the risk to each habitat and to habitats altogether, where it is possible to visualize the areas classified as high, medium or low risk based on the risk of one or cumulative effect of multiple activities (Arkema et al., 2014). High risk refers to grids achieving a cumulative risk over >66% of the maximum possible combination of stressors reported to each habitat (2.8 for Euclidian distance); medium risk refers to rates between 33-66% of possible cumulative total and; low risk for rates inferior to <33% (Arkema et al., 2014, Natural Capital, 2017).

As way to guide the assignment of effects of each activity to the ecosystem and the associated weights, we have undertaken an exercise with other researchers which provided weights and a list of all pressures of activities on the aquatic ecosystem and users affected. The result was that resource users' and scientists' knowledge were quite similar and in some cases resource users had given higher weights and listed even more pressures.

The conflicts identified in the second workshop cycle were analyzed qualitatively, by direct user group sector in each PU. The pressures enlisted to each activity by all direct users were quantified in relation to the ecosystem and to other user groups. Data related to conflicts and pressures are presented in a network graph.

The number of pressures of a given sectoral activity is not necessarily equivalent to the significance of impact and risk it poses to the ecosystem – hence we also use the HRA analysis to evaluate the different effects of activities in the ecosystem. We linked perceived pressures to affected ESs types (Table 3- Supplementary material) at each habitat and PU, and used a Sankey graph (https://rawgraphs.io/) to explore their relationships with sectoral activities.

3. Results

3.1 Activities, uses and ecosystem services accessed

A total of 39 workshops were undertaken in the first (n=18 and 153 participants), second (n=14 and 128 participants) and third (n=7 and 90 participants) cycles. Our collaborative mapping rendered 28 socioeconomic activities associated to mariculture (n=1), mining (n=1), artisanal fishing (n=12), tourism and recreation (n=7) and aquatic transport (n=7) (Table 1; Layers of single activities maps - Supplementary Material).

The 28 activities facilitate access by direct and indirect users to 10 ESs (Table 1), including six cultural (e.g., navigation/transport/n=22 activities, contemplation and aesthetics/n=10 activities, and leisure and recreation activities/n=7 activities) and four provisioning ESs (e.g., food related activities/n=15 activities). Activities with higher degree of intensity on the ecosystem (weight >2) and which require management measures according to the informant perception were: shrimp harvesting, anchored fishing, beach seine, *Gerival* shrimp fishing, shrimp fishing with bottom-trawling, tourism and ports stop-over. No activities were perceived to be associated to intensity 3 (requiring urgent management measures).

Table 1: Economic activities undertaken by direct user groups (n=28), with associated weights (activity intensity) and sites (Planning Unit – PU) in Babitonga Ecosystem and ecosystem services (ESs) accessed by direct (D) and indirect (I) users. ESs types and subtypes following MEA (2005).

Sector	Activity	Ecosystem services directly accessed	Service type	PU	Users	Activity intensity
Mariculture	Aquaculture of mollusks (mussels and oysters)	Navigation and food	Provisioning and cultural	1, 2, and 7	Maricultore agents (D) and tourist population (I)	1
Mining	Sand mining	Sand (geological resource) and navigation	Provisioning and cultural	3	Mining agents (D) and population (I)	1
Artisanal fisheries	Harvesting of mollusks (mangrove and rocky oyster and mussel species)			1, 2, 3, 4, 5 and 6		1
	Mangrove crab harvesting			1, 2, 3, 4, 5 and 6		2
	Surface gillnet fishing			All		1
	Bottom gillnet fishing			1, 2, 3, 4 and 7		2
	Line fishing			All		1
	Castnet fishing			All	Fishers (D), Population/tourists (I)	0
	Longline fishing			2		1
	Beach seine fishing			7		2
	'Gerival' shrimp fishing			1, 2, 4 abd 5		2
	Bottom trawling for shrimps			1 and 7		2
	Shrimp seine fishing			2 and 6		1
	Swimming crab fishing	Food (various fish), navigation	Provisioning and cultural	1, 2, 3, 4, 5 and 6		0

Tourism and recreation	Marinas (boat trips)	Navigation, leisure and recreation, contemplation and aesthetics	Cultural	1, 2, 3, 4 and 6	Marina owners (D) and population (I)	2
	Sportsfishing	Recreation and leisure, navigation, contemplation and aesthetics, food	Cultural and provisioning	All	Boat and lodging owners (D), tourists and population (I)	1
	Boat tours	Leisure and recreation, navigation, contemplation and aesthetics	Cultural	1, 2, 3, 4, 6 and 7	Boat owners (D), tourists and population (I);	1
	Gastronomy tourism	Leisure and recreation, historical heritage and cultural; contemplation and aesthetics	Cultural	4	Boat owners (D), tourists and population (I)	1
	Diving/shelter/spearfishing	Leisure and recreation, contemplation and aesthetics (scenic beauty), food	Cultural and provisioning	2 and 7	Boat owners (D), tourists and population (I)	1
	Tourism stop-over	Bathing and swimming, leisure and recreation, contemplation and aesthetic (scenic beauty)	Cultural	1 and 2	Boat owners (D), tourists and population (I)	2
	Environmental education (school boat)	Educational knowledge and value systems, navigation, contemplation and aesthetics, sense of belonging, historical heritage and cultural, leisure and recreation	Cultural	6	Boat owners (D), tourists and population (I)	0
	Tourism anchorage stop-over vessels	Contemplation and aesthetics, logistic support	Cultural	1 and 7	Tourism and recreation agentes and companies that support port activity (D)	1
Aquatic transport	Port in operation	Navigation/transport	Cultural	1	State government (public), private enterpreneurs, workers (logistics and other services) (D)	2
	Access channel	Geological resources (natural channel), navigation	Provisioning and cultural	1 and 7	Ports (D)	1
	Public transport	Navigation/transport, contemplation and aesthetics	Cultural	1	Transport companies (D), tourists and population (I)	1

	Ferry boat	Navigation/transport, contemplation and aesthetics	Cultural	2 and 3	Transport companies (D), tourists and population (I)	1
	Oil ship anchorage buoy	Energy (oil), navigation/transport	Provisioning and Cultural	7	Oil and gas industry (D)	1
	Submerged oil pipes	Energy (oil), navigation/transport	Provisioning and Cultural	1 and 7	Oil and gas industry (D)	1

Legends: Planning Units (PUs): 1) Entry of the Bay, 2) Central islands, 3) Palmital River, 4) Coastal Joinville, 5) Linguado Chanel – Araquari, 6) Linguado Chanel - Barra do Sul, 7) Marine.

3.2. Conflicts for space use by direct ecosystem users

Several activities enlisted in Table 1 occur in the same space and time frames by users from different municipalities and sectors sharing the coastal-marine environment (see Table 2 – Supplementary material). No PU has all 5 sectors present at the same time (Fig. 1 – Supplementary Material). While mining occurs in only one PU, mariculture is present in four, aquatic transport agents in five, fishing activities and tourism and recreation occur in all PUs. The PUs with highest number of activities are the Entry of the Bay (n=21), Central Islands (n=17) and Marine (n=16).

Areas shared by the largest number of operating activities and sectors has probably more disputed ESs, more potential for inter- and intra-sectoral conflicts, and presence of impact chains (on ESs and direct users).

A conflict might have been assigned to more than one PU. A total of 78 conflicts were recorded, of which 34 were not considered either because they were too superficial/lacked minimum characterization (n=8), they reported on conflicts with indirect users (n=20) or they were rather considered descriptions of problems (n=6). Amongst conflicts with indirect users we highlight those with law enforcement agencies; those with organizations responsible for licensing or registering activities; and those with newly proposed ports that are still pursuing their licenses to build their plants in the ecosystem, *e.g.* we identified 9 new port projects under environmental licensing in Babitonga bay whose pre-planning phases are already concerning local citizens and direct ecosystem users, because they are located in the Entry of the Bay or in the Central Islands, where many socioeconomic activities are already in place.

Amongst the reported problems we highlight pollution, wrong dates for official fishing seasonal closures and possible impacts brought by major infrastructure projects still being licensed in the area. Even though these problems do not fit our definition of conflicts generated by direct use, they were perceived as potential risks affecting the ecosystem and direct users' socioeconomic activities; hence they present potential conflicts in future use of the seascape and thus must also be taken into account. Our definition of conflicts rendered the identification of a total of 44 conflicts amongst direct user groups (Fig.5).

Amongst 44 conflicts, 32 are inter and 12 intra-sectoral (Fig. 2). The fisheries sector is involved with 86% of identified conflicts (n=38). Conflicts amongst fishers relates to illegal fishing (use of irregular gillnets and mesh sizes, lack of fishing permits, and amateur fishing). We recorded the largest amount of conflicts (n=18) between fishing and tourism and recreation agents, which disputes fishing resources, fishing sites and navigation pathways. These are the most abundant users of the ecosystem, they undertake the largest number of activities throughout a wider range of areas which also implied in a higher number of workshops organized to represent their views. The absence of conflicts between mining, mariculture and aquatic transport agents largely derives from the fact these activities do not occur in the same PUs. Two reported conflict types cannot be associated to a particular user (thus are non-identified – NI), including the stealing of production from mariculture fields and stealing of signaling light bulbs from official navigation channels giving access to ports.

25 out of 44 conflicts occur at only one PU and the others occur in two to five PUs depending on the area used by the activities. PUs with highest numbers of conflicts were: Entry of the Bay (n=18), Palmital Channel (n=14), Central Islands (n=12), Marine (n=9), Coastal Joinville (n=8) and Linguado – Araquari and Balneário Barra do Sul (both with n=5).

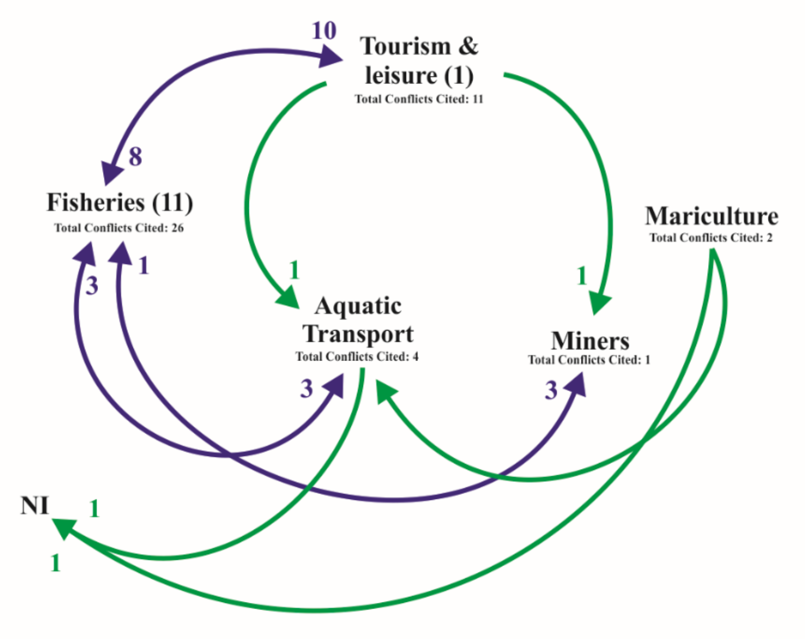


Fig. 2: Perceived inter- and intra-sectoral conflict relationships amongst direct users of Babitonga Ecosystem. Total number of (intra- plus intersectoral) conflicts cited by direct users of Babitonga Ecosystem, is described below each sector label. Number in parenthesis refers to intra-sectoral conflicts, numbers in the tip of edges refers to intersectoral conflicts. Blue edges are bidirectional, where two sectors are in a mutually reported conflict relationship). Green edges are unidirectional, where only one user group reported a conflict with another group. NI are non-identified user groups.

3.3. Risk and pressure of activities to the ecosystem and affected direct user groups

The pressures from direct and indirect activities to the marine environment and their cumulative impacts generates risks to different habitats and to the ecosystem as a whole. The identification, mapping and attribution of weight for different activities by direct users themselves allowed for the spatial assessment of risk they pose to the marine habitats and ecosystem (Fig. 3).

The PUs with highest number of high-risk areas (>66% of total possible risk value) from activities undertaken by direct users are: Coastal Joinville, Entry of the Bay, Central Islands and Palmital Channel (Fig. 3a). The PUs with higher risks (red grids) coincides with PUs with the highest number of reported direct use activities. Areas in dark green (no risk at all) are associated to areas where there is no exposure to direct user activity (*e.g.*, areas nearby the city of Joinville and areas outside what we have considered as the Babitonga Ecosystem – depths over 20m on the marine PU). It is also important to note that not only the Central Islands PU presents higher-risks, but also shows salient spatial variation (heterogeneity) of risk including some of the areas with the lowest ranking inside the bay.

When considering the risks to different habitat types assessed, we found a similar cumulative risk between soft bottoms (0-18.91 – Fig. 3b) and mangroves (0-19.92 – Fig. 3c) and, both differing significantly to the cumulative risks facing submerged rocky reefs (7.07-4.18 – Fig. 3d). In mangroves (Fig. 4c), we noted that their frontal parts are facing higher risks in some PUs (Central Islands, Coastal Joinville, Palmital Chanel and Linguado – Araquari). All areas of submerged rocky reefs (Fig. 3d) are under risk and those at the Entry of the Bay scored higher risks, probably because of the closeness to an intense port activity. In relation to soft bottoms (Fig.3b), those PUs facing higher risk are Coastal Joinville, Entry of the Bay, Central Islands and Palmital Channel. With the exception of the Marine PU, all other presented high-risk areas.

Even though the analysed activities focuses on provisioning and cultural ESs (direct services), their inadequate or ilegal operations may as well cause a series of pressures on regulating and supporting ESs (indirect services) – Fig.4. We must note, however, that the most frequently cited pressures (e.g. 6, 5, 9, 7 and 20) can reflect the higher number of activities from a specific sector and/or number of workshops performed with those sectors, and thus do not necessarily imply greater impact to the ecosystem. Alternatively, a much less frequently cited pressures (e.g., 14, 16, 17) can be more or as much as impactful as those more frequently mentioned during our workshops. Nevertheless, Figure 4 shows the Central Islands PU with the highest number of affected ESs (for all types of services), followed by the Marine and Entry of Bay.

Besides posing risks to the ecosystem and its specific habitats, direct users' activities also affect and pose intra- and intersectoral pressures (Fig. 5). Three sectors are challenged with intra-sectoral impacts: fishing, tourism and recreation and aquatic transport agents. Fisheries and tourism and recreation agents are the only groups suffering negative pressures from all other sectors. The fisheries sector, although receiving the pressures of all sectors, reportedly generate pressures only towards two other sectors: tourism and recreation and aquatic transport. Tourism and recreation and aquatic transport agents are the only sectors generating pressures to all other direct ecosystem users.

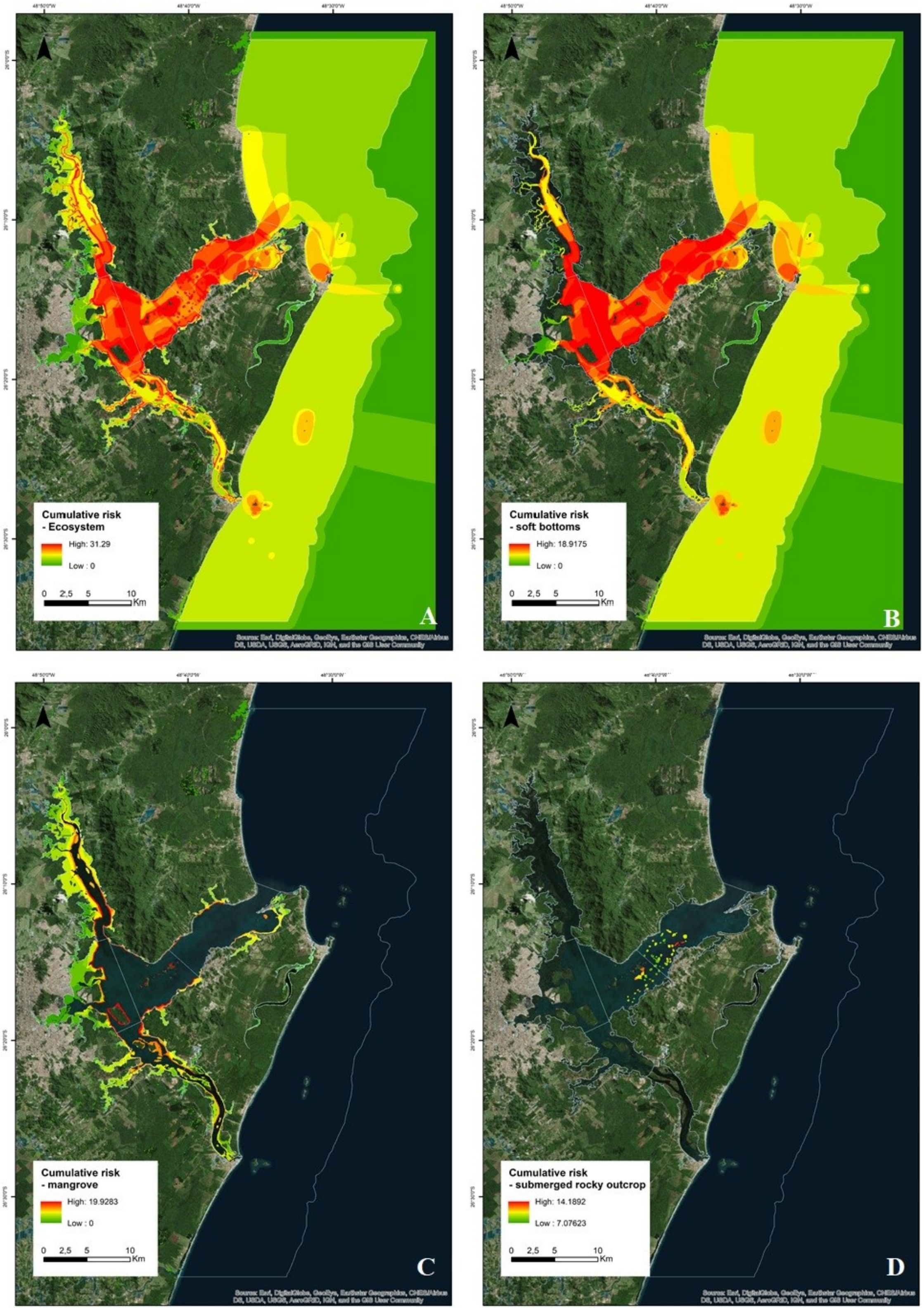


Fig. 3: a) Risk assessment map from activities undertaken by direct users of Babitonga Ecosystem (Santa Catarina, Brazil); b) Habitat risk assessment model for Babitonga Ecosystem habitats: b) soft bottoms c) mangroves; and d) submerged rocky reefs/outcrops.

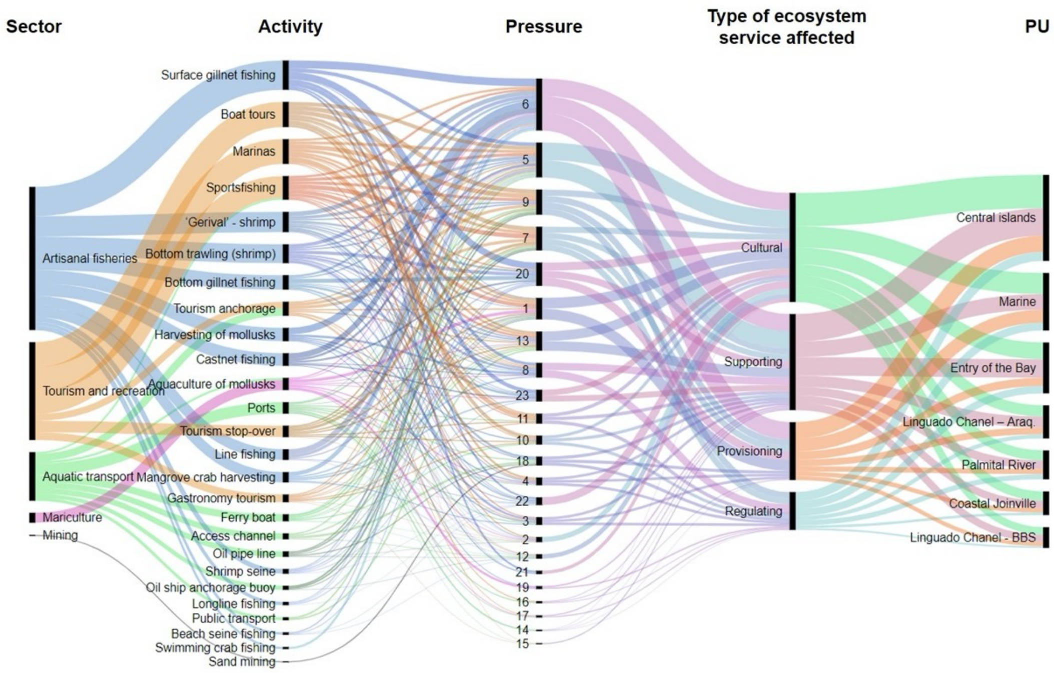


Fig. 4: Sankey graph exploring perceived impact chains on ecosystem services and other affected users by each direct use activity of Babitonga bay ecosystem (see the list with further detail on 23 pressures in Table 3 - Supplementary Material). Pressures types: 1) solid waste; 2) visual pollution; 3) stress to aquatic life generated by suspension of particulate sediments; 4) changes in hydrodynamics; 5) higher aquatic traffic; 6) overfishing; 7) water pollution; 8) degeneration of nursery grounds; 9) oil spill; 10) coastal erosion; 11) coastal deforestation; 12) exclusion of access to other sector; 13) sound pollution; 14) alteration/loss of consolidated bottoms; 15) light pollution; 16) fertilizer pollution; 17) direct invasion of exotic species; 18) alteration/loss of soft bottoms; 19) indirect facilitation of exotic species; 20) fisheries bycatch; 21) obstruction of navigation channels; 22) loss of fishing grounds; 23) loss of fishing gears.

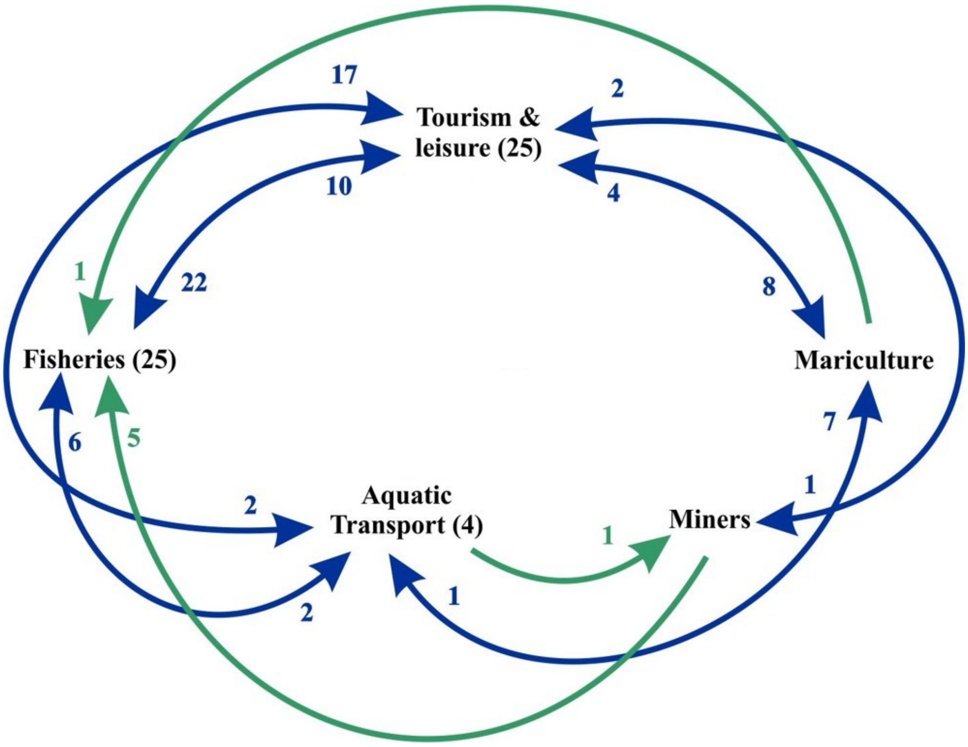


Fig. 5: Network of pressure distribution amongst sectors. Sum of the pressures of all activities within the same user group (numbers in parenthesis), between user groups (blue and green edges and numbers at their tips). Blue edges are bi-directional (when two user groups produce mutual pressure) and green edges represents unidirectional pressure (when only one sector reports a pressure from another).

4. Discussion

Our paper demonstrates that the integrative and deliberative approach undertaken can hopefully imbue Babitonga bay intermunicipal coastal governance dynamics with all the three key dimensions of EBM interactional structures (Rockmann et al., 2015): legitimacy in participatory process, credibility in knowledge production and salience in scientific inputs. While coastal management usually suffers from limited levels of stakeholder participation in Brazil (Glaser et al., in press), the level of direct user involvement in a subnational MSP process achieved in our case study has not been matched elsewhere in the country (Gerhardinger et al., 2019). The outcomes of three workshop cycles now constitute a key component of Pro Babitonga Group's knowledge assets and have indeed been used to steer territorial planning and conflict resolution.

Our data offer stakeholders an opportunity to represent their socioeconomic activities in a more symmetric MSP playing field, which should be a critical feature of socially equitable and environmentally sustainable blue economy arenas (Larson et al., 2013; Cohen et al., 2019; Bennett et al., 2019). We will explore next how the adoption of our pluralistic assessment may support decision-making processes aimed at resolving conflicts; establishing more effectively management and conservation measures (Machado et al., 2019); and ultimately avoid feeding neoliberal economic development approaches (Kull et al., 2015; MacDonough et al., 20017; Herbst et al., 2020).

4.1 Multiple uses of marine ecosystem services

Direct use socioeconomic activities undertaken in the studied aquatic ecosystem enables access to direct ESs such as provisioning and cultural, following the findings of Herbst et al. (2020). These authors noted that food (provisioning service), tourism/leisure, employment, work and income as well as transportation (e.g. vessels, ports and navigation) (cultural services) forms the core set of commonly perceived shared values of nature. This is noteworthy and speaks to Martin's et al. (2016) concerns with the poor representation of coastal-marine cultural ecosystem services in Latin American studies. In our study, the role of cultural services was outstanding, largely because of our highly participative and qualitative methodological choices. Indeed, Martin et al. (2016) argued that such approaches would be more effective in identifying cultural services and in the assessment of shared values in public territories.

Even though the ESs accessed directly by economic activities are provisioning and cultural, they necessarily mobilize and affect natural ecosystem processes and functions, supporting and regulating services given cascading social-ecological dynamics (La Notte et al., 2017; Herbst et al., 2020). Although supporting and regulating services are often seen as 'invisible' or less perceived by users in comparison to other services (Raymond et al., 2009; Casado-Arzuaga et al., 2013; Oliveira and Berkes, 2014; McNally et al., 2016), they are essential to well-functioning ecosystems. Therefore, they are often considered intermediaries in the pursue of final ESs such as seafood, a critically important provisioning service for human well-being (Fischer et al., 2009). Indeed, negative impacts in regulating and supporting ESs (e.g., lower quality of water and marine life productivity due to pollution) can generate pressures and risks to economic activities, specific habitats and to the ecosystem in general.

Maes et al. (2012) indicated that provisioning ESs might be quantified and mapped directly in relation to other types of ESs and highlighted scientists' role in the assessment of those that might be degenerated in space, beyond directly used ESs. Herbst et al. (2020) research, in turn, acknowledged indirect ESs (e.g., regulating and supporting) were not easily recorded in their exploration of direct ecosystem user perception; suggesting they could be elicited by probing informants' questions about specified natural processes, e.g., climate change, variation in rainfall, drought, water dynamics, role of the different environments in generating life. In addition, we propose that a fuller representation of direct users' perception on the ecosystem (e.g., recording perceptions on regulating and supporting ESs) benefits from exploration of their perception on how their activities relates to ecosystem services and pressures. We have shown in Fig. 4 the complex web of possible trade-offs narratives it may possibly enact in future social learning activities to be conducted with stakeholders navigating the transformation towards an EBM regime.

4.2 Conflict in use of space

Our results show that even though one sector generates pressure to others, they are not necessarily in conflict. While this shows the possibility of spatial co-existence of users; it can also be a proxy of higher risks through cumulative impacts on indirect ESs. Conflicts are generally created by disputes over space and resources. Nevertheless, PUs with higher number of co-existing activities and sectors are also those with a higher amount of identified conflicts (Entry of the Bay, Central Islands, Marine and Palmital Channel).

These are particularly important areas for fisheries, tourism and recreation agents and should receive appropriate management attention because: they share the highest weights of intensity of use on the ecosystem; higher number of conflicts and pressure to intra- and intersectoral use of the aquatic space; and because these sectors were consistently reported to be operating in a disorderly, free-access regime, even by their own peers. In the context above, it is worth highlighting that: 1) together with mariculture agents, these sectors facilitate access to the highest quantity of the most important shared values for all direct and indirect users (seafood and leisure); 2) these activities encompass the largest part of the population in terms of distribution of income (largest number of economically dependent families across all six municipalities) and; 3) they have the largest potential to mutually synergize good practices in terms of how one sector can leverage and favour the valuing of others (given the touristic attractiveness of coastal cities). An aggravating factor, however, is that both sectors are heavily suffering the consequences of policies that risk further priviledging the development of other most powerful direct user groups, e.g., various large costal infrastructure projects such as ports and shipyards are under advanced licensing stages at the Central Islands PU.

Disputes for ESs and sea space are closely linked, a process most often imbued with asymmetrical power relations affecting their fair distribution amongst sectors (Bennet et al., 2015; Jacobs et al., 2016). The spatial data has now been especially important to best represent the plethora of activities performed by less politically influential ecosystem users such as artisanal fisheries and tourism and recreation agents. Besides the existence of specific sectoral legislation, these groups are operating arguably at an open access regime due to very limited enforcement and very low levels of cohesion in political representation at existing coastal management fora. Aquatic transport (ports/oil and gas industry), mining (the most powerful) and mariculture agents, alternatively, can only operate under previously delimited and licensed areas, which facilitates mapping, acknowledgement and enforcement/adaptation of their areas of interest.

Rossini et al. (2016) argues the municipality of São Francisco do Sul has been wasting its potential of cultural tourism because of the exaggerated focus on beach tourism at the Marine PU. Policies aimed at increasing the visibility of cultural tourism practices would build upon the potential of shared values. For instance, involving fishers in joint activities with other sectors, preserving the historical and natural patrimonies of the region (cultural heritage, tourism, scenic beauty, amongst others) go potentially well along with the integration of provisioning ESs such as local seafood and gastronomy.

Fisheries are present across the entire ecosystem, and the fishing grounds at the Central Islands PU are shared by fishers from several communities (De Carvalho et al., 2011; Serafini et al., 2014; Gerhardinger et al., 2017). This highlights the importance of this PU in terms of supply of fishing resources, but also the potential conflicts and hence need of management interventions. Furthermore, this PU has a unique scenic beauty, which is already explored by tourism and recreation boats and the operation of the Ferry Boat taking people to gastronomic journeys in restaurants on the bayside.

Fisheries are also the most conflicting activity in the ecosystem, involved with 86% of all identified conflicts. Although formal rules do exist to regulate fisheries (e.g., types of gear, minimum size limits, seasonal closures, etc), they have not been effective mainly because lack of enforcement, basic harvesting statistics, control of the number and legitimacy of fishing licenses and the ever-higher number of non-professional fishers competing with artisanal fishers. The lack of engaged and committed leadership in artisanal fisheries representation in the public sphere and a high level of paternalistic behavior (e.g., reliance on governmental subsidies and political influence of powerful port actors) increases the complexity of fisheries management institutions in this social-ecological system (Serafini et al., 2014). This situation is putting at risk the resilience of fish stocks and degradation of essential fish habitats (Gerhardinger et al., 2020), affecting commercial as well as sport fishing which is also a very important socioeconomic activity in Babitonga bay.

An alternative to minimize conflicts would be to place limits to recreational fishers while incentivizing local projects to enable social learning, stewardship, and empowering artisanal fishers to engage in fisheries self-monitoring schemes and more cohesive representation at regional planning stances (specially in Entry of the Bay, Palmital Channel and Central Islands PUs). Increasing surveillance on illegal fisheries will also decrease opportunistic behavior by ‘weekend’ amateur fishers that compete with traditional artisanal fisherfolk.

Port activities are subjected to licensing and thus prone to official delimitation and regular inspection. Both sand mining and port activities involves periodic dredging (the later to keep appropriate depths in navigation routes), overlap with traditional fishing grounds, impact on the landscape scenery, and generate pollution from fertilizers and soy residues during loading/unloading of grain cargo. All these factors generate conflicts with mariculture, fisheries, and tourism and recreation sectors, which heavily rely on a healthy and productive aquatic environment.

Brazil has been facing a rapid increase in the number of aquatic transport infrastructure projects undergoing fragmented licensing processes. However, the fragmentation and disconnect of licensing to sectoral plans, or even lack of MSP at the national level, creates an atmosphere of political speculation, lobbying and bargaining in favor of traditionally powerful private actors (Gerhardinger et al., 2018a). Wilmsmeier and Monios (2016) argued that the Port of Itapoá, which is located at the entry of Babitonga Bay, stands as a symbol of the challenging mission of obtaining appropriate licenses at the municipal, state, national and international levels. This port has taken 18 years to be built, and after high investments have become a 'green field' port. Nevertheless, conflicts between this particular port and local fisherfolk has been severe and even been judicialized at various occasions. As of today, the licensing of some ports is conducted by the state of Santa Catarina environmental agency, while others by the federal environmental agency, and no cumulative impact assessments have been attempted between or within agencies where the rule is to technically assess each project proposal in isolation (Gerhardinger et al., 2018b). If not for the high-hopes placed at PBG on the transformation of Babitonga bay governance towards an EBM-regime, the future of local communities (including other direct ecosystem users) would unfortunately be left to face an even higher speculative, mis-informed and hence unsustainable pathway.

4.3 Risk analysis

Our spatially-based risk analysis informs spatial prioritization of management actions, eliciting critical considerations aiming at the reduction of exposure of certain habitats and users to undesirable consequences (Arkema et al., 2014). For instance, risks currently posed to mangrove and submerged rocky reefs by direct use, can bring loss of ESs and directly hinder fishing activities, and indirectly prejudice aquaculture, tourism and recreation. Mangroves and rocky bottoms are highly relevant to fisheries productivity (Barbier et al., 2008). Tognella-de-Rosa et al. (2006) highlighted that, in Brazil, several mangroves are considered of no value and their use and value are underestimated while facing the consequences of high political, social and economic interest and pressure. These authors argued that further loss of mangrove forests at Babitonga bay would generate severe loss of natural capital, to be felt by coastal citizens across the bay. Beyond the harvesting of shellfish and crustaceans (which renders concrete provisioning services), mangroves are important for environmental buffering, nutrient cycling, coastal protection, sewage treatment and carbon sequestration, amongst other services (Tognela de Rosa et al., 2006; Rovai et al., 2012).

We also highlight the urgent need for conserving the Central Islands PU (Table I-Supplementary Material, Fig. 4). Beyond their productivity for local fisheries, and opportunities for tourism and recreation, this is a highly ecologically important area for two sympatric species of small cetaceans (grey-dolphin *Sotalia guianensis* and the critically endangered porpoise *Pontoporia blainvillei*) (Cremer et al., 2011; 2012; Hardt et al., 2013) and reef fishes (endangered dusky and critically endangered goliath groupers - *Epinephelus marginatus* and *E. itajara*, respectively; Gerhardinger et al., 2009; Gerhardinger et al., 2020). Furthermore, the presence of several islands creates a highly intrincated geography of calm sandy beaches and rocky reef shores that are essential fish habitats for several commercially important species in South Brazil (Gerhardinger et al., 2020). Duarte (2011) has also noted that specific places within the Central Islands and Entry of the Bay PUs are highly important priority conservation zones, given that their lower hydrodynamics favours the retention of particles playing a critical role in the recruitment of fish larvae.

The new ports being proposed to the Central Islands PU can potentially generate severe loss or alteration of habitat (e.g., removal of submerged rocky reefs through underwater explosions and dredging of new navigation channels), exacerbating already existing conflicts such as the high levels of siltation and turbidity (Gerhardinger et al., 2017). We therefore suggest that future trade-off analyses should be urgently performed to enable the use of the integrated risk assessment presented herein in jointly assessing the implications of developmental scenarios posed by all environmental licensing processes by state agencies at municipal, state and federal levels. Our results show that a more sustainable option from an aquatic ecosystem standpoint, would be the allocation of new or expanded port infra-structure avoiding further alterations of socially and ecologically important habitats. The Entry of the Bay PU, for instance, is already heavily used by port activity and, therefore, possesses the adequate channel depth and regular dredging activities to maintain them stable. Even though this allocation might increase cumulative impact at this PU, the social-ecological impact related to the aquatic portion would be lower than if the installation of new ports occurred at the Central Islands PU (Gerhardinger et al., 2018a) which holds key ecological functions and heterogeneous risk levels (highly ecologically important areas still facing low risk). This alternative would avoid further explosion of submerged rocks and increase in long-term dredging requirements, because no new deep channels would have to be opened. Moreover, no further pressures and risks to adjacent mangroves of high ecological relevance would be posed. Finally, socioeconomic activities of the main producers of shared values to society such as seafood and tourism (fishers, tourism and mariculture agents) would not be directly prejudiced (Herbst et al., 2020).

Finally, we note some limitations in the application of HRA that should be given further consideration. Given that HRA model presumes additive effects of pressures (Crain et al., 2008; Cabral et al., 2015), we suggest that the potential synergistic and/or antagonistic effects of human activities be considered in future analysis. Interpretation of our HRA risk maps should also acknowledge that indirect risks also affect the ecosystem, despite the fact they were not considered in the spatial analysis. For instance, the lack of spatial information on high levels of siltation and land-based pollution at Coastal Joinville and Linguado Channel – Araquari PUs renders the level of risk low to those areas (Fig. 3 a, b and c) – even though the real risks may be high and even affect the potential flow of benefits from those areas to some potential users. Arkema et al. (2014) also argued that the rate of risk is relative and possibly areas depicting lower risk are not free from degradation. In Babitonga bay, for instance, a vast mangrove area (837 ha) was affected by severe mortality rates of white mangrove (*Avicennia schauriana*) at the Coastal Joinville PU, which has been linked to the invasion of teak caterpillars (*Hyblaea puera* – January 2016) in biologically stressed mangroves growing over chemically polluted sediments (Kilka, 2017; Kilka et al., 2019).

5. **Conclusions**

Our combined integrated and deliberative multidimentional assessment of space-use, risk, conflict and pressure/impact chains (on ES and direct users) consists of the most comprehensive spatial analysis ever undertaken at the Babitonga bay ecosystem level. Nevertheless, the results of such approach should be cautiously interpreted through concomitant/iterative consideration of contextual social-ecological dynamics at each PU and whole ecosystem levels; and considering the limitations of the method (e.g., concerning the impacts of indirect uses on the social-ecological system).

Our approach offers a contribution towards the implementation of EBM principles in the coastal governance regime because: it allows for inter- and transdisciplinary consideration of multiple connections in a coupled social-ecological system; it supports scaling-up governance to an appropriate ecosystem level while rationally reflecting upon contextual differences at each PU; it sets the groundwork for future adaptive management to deal with the uncertainty; it operationalises a trully integrated assessment of the social-ecological system and; it allows for the inclusion of diverse activities and associated interests and perceptions through deliberative practice and social learning.

In order to steer transformation of the currently fragmented and sectoral system towards EBM and to promote a healthy and resilient aquatic ecosystem, we therefore emphasize the urgency for applied ESs research that **(1)** *advance combined plural valuation and social awareness of pressure-levels on the ecosystem aiming at maintaining the quality, supply and multiples uses of ESs.* The Babitonga bay case study highlights the key importance of shared values such as fish (seafood) and tourism, ESs that flow to society facilitated by economic activities such as fisheries, mariculture and tourism and leisure agents. We highlight the critical importance of advancing trade-off analysis of direct and indirect (e.g., terrestrially-based) uses of ESs (specially regulating and supporting ESs) aiming at an even more comprehensive assessment of interdependencies and overview of the implications of different development scenarios in the long-run.

We have also identified the pressing need to **(2)** *manage conflicts while creating synergies amongst existing activities across space, specially to minimize risks to more ecologically sensitive and productive areas.* In this regard, the mapping of fishing and tourism areas (not available to decision-makers in the past) can support formal acknowledgement of traditional fishing territories and tourism hotspots, hence helping the resolution of conflicts (specially in Entry of the Bay, Palmital Channel and Central Islands PUs). We highlight the importance of managing commercial and recreational fisheries, and the need for developing the potential synergies between small-scale fishers, mariculture and tourism agents in terms of mutually benefiting incentives to local seafood produce and gastronomy. For instance, the more organized, culturally sensitive and supported the tourism sector is, the more vigorous the region's economy may become in relation to shared values of nature The above offers a pathway to help the social-ecological system evolve under the lines of equitability and justice and find an alternative pathway to the currently priviledged track leading to massive (and misplaced) port-based infrastructure and industrial development to please foreign interests.

We suggest that decision makers and state and federal-level environmental licensing agencies should **(3)** *avoid expansion of pressures to ecologically sensitive / lower risk areas* (e.g., *Central Islands PU), whilst priviledging the allocation of new activities (e.g., expansion of port infrastructure) to structurally altered areas (e.g., the Entry of the Bay PU already holds deep manmade navigation channels and regular dredging operations).* While all PUs encompasses ecologically relevant areas, the Central Islands PU's attributes are a crucial spot in need of management attention, because of its high habitat heterogeneity (with both high and low human use areas), essential habitat for commercially relevant fish and small resident cetaceans, thus its strategic importance for sustaining activities may be based on shared values of nature in the perception of direct users (fishing, tourism, and mariculture). Our results show that new port infrastructure development in the Entry of the Bay would be sounder given that this PU has already been turned fit for purpose (with deeper channels and regular dredging operations already enabling the operation of ports in Itapoá and São Francisco do Sul municipalities).

In face of the highly political and institutionally unstable atmosphere currently driving environmental governance in Brazil, we suggest that state agencies must ***(4)*** *consolidate emerging novel integrated and democratic governance mechanisms involving all social segments currently pursuing political representation at the ecosystem-level (e.g., Pro-Babitonga Group)*. While our results are currently being scrutinized by representatives of direct and indirect user groups at PBG and are thus able to feed more ecologically coherent and socially embedded policy outcomes; the group is still often challenged by top-down, highly centralized and fragmented governance decisions at municipal, state and federal levels.

Finally, the subnational case study presented in this paper has a potential to feed the innovation of marine spatial planning at a national level, hence we urge authorities to: **(5*)*** *explore the transferability potential of the integrated and deliberative (space-use, risk, conflict, impacts chains and ecosystem services) assessment approach to scale-up coastal governance transformation in Brazil in other coastal areas suffering from fragmented and unfair policy-making*. Our results are fully compatible with state of Santa Catarina's incipient attempts to develop an economic-ecologic zoning for the coastal zone. Moreover, our approach highlights critical ecological and socioeconomic features in decision-making and can therefore inspire the implementation of existing and new mandates in integrated coastal management, watershed management and marine and coastal protected areas elsewhere in Brazil. Our combined integrated and deliberative multidimensional method are highly replicable and have a potential to inform national efforts to advance the implementation of novel area-based approaches such as 'Other Effective Area Based Conservations Measures' through national marine legislation and associated governance strategies.

6. Acknowledgements

We thank the Babitonga Ativa Project executive team which supported intense activities of social mobilization and production of all workshops (specially Suelen M. C. Beeck, Maiti Fontana, Alessandra Pfuetzenreuter, Arthur Paganini, Mirela Cursino and Letícia Haak). We are indebted to all workshop participants that inspired us during the present collaborative research and all associated institutions for their support with workspace, logistics and/or mobilization of their constituencies. We thank Celso Voos for the mangrove shapefiles, for Marta Cremer to opening the doors of Univille for the Babitonga Ativa project proposal, and to Rebecca Borges for helping with the conceptualization of the early research ideas. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001. We acknowledge the sponsorship of a CAPES scholarship to D.F.H and CNPq to a productivity scholarship to N.H. (309613/2015-9); and FAPESP for a post-doctoral scholarship to L.C.G. (2016/26158-8). D.V.N. thanks the ESRI Conservation Program for providing ArcGIS license. The Babitonga Ativa project was funded by a public call hosted by the Federal Public Ministry (Joinville) and implemented by the Regional University of Joinville (Univille).

7. References

Aliaume, C., Zerbi, A., Miller, J.M., North Carolina, 1997. Nursery habitat and diet of juvenile Centropomus species in Puerto Rico estuaries. Gulf Mex. Sci. 15, 77–87. https://doi.org/10.18785/goms.1502.03

Amaral, A.C.Z., Corte, G.N., Filho, J.S.R., Denadai, M.R., Colling, L.A., Borzone, C., Veloso, V., Omena, E.P., Zalmon, I.R., Rocha-Barreira, C. de A., de Souza, J.R.B., da Rosa, L.C., de Almeida, T.C.M., 2016. Brazilian sandy beaches: Characteristics, ecosystem services, impacts, knowledge and priorities. Brazilian J. Oceanogr. 64, 5–16. https://doi.org/10.1590/S1679-875920160933064sp2

Arbo, P., Knol, M., Linke, S., St. Martin, K. 2018. The transformation of the oceans and the future of marine social science, Marit. Stud. 17, 295–304. https://doi.org/10.1007/s40152-018-0117-5

Arkema, K.K., Verutes, G.M., Wood, S.A., Clarke-Samuels, C., Rosado, S., Canto, M., Rosenthal, A., Ruckelshaus, M., Guannel, G., Toft, J., Faries, J., Silver, J.M., Griffin, R., Guerry, A.D., 2015. Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. Proc. Natl. Acad. Sci. U. S. A. 112, 7390–7395. https://doi.org/10.1073/pnas.1406483112

Arkema, K.K., Verutes, G., Bernhardt, J.R., Clarke, C., Rosado, S., Canto, M., Wood, S.A., Ruckelshaus, M., Rosenthal, A., McField, M., De Zegher, J., 2014. Assessing habitat risk from human activities to inform coastal and marine spatial planning: A demonstration in Belize. Environ. Res. Lett. 9. https://doi.org/10.1088/1748-9326/9/11/114016

Asmus, M.L. et al. (2015). Planilha de Ecossistemas e Serviços para o Baixo Estuário da Lagoa dos Patos (BELP). In: Conde, D., Polette, M., Asmus, M. Risk, perception and vulnerability to Climate Change in wetland dependent coastal communities in the Southern Cone of Latin America. Final Report. IDRC Climate Change and Water program Project 6923001.

Barbier, E.B., Koch, E.W., Silliman, B.R., Hacker, S.D., Wolanski, E., Primavera, J., Granek, E.F., Polasky, S., Aswani, S., Cramer, L.A., Stoms, D.M., Kennedy, C.J., Bael, D., Kappel, C.V, Perillo, G.M.E., Reed, D.J.2008. Coastal Ecosystem-Based Management with Nonlinear Ecological Functions and Values. Science, 319(5861), 321-323

Bauer, J.E., Cai, W., Raymond, P.A., Bianchi, T.S., Hopkinson, C.S., Regnier, P.A.G., 2013. The changing carbon cycle of the coastal ocean. Nature. 504, 61-70. https://doi.org/10.1038/nature12857

Bennett, N.J., Govan, H., Satterfield, T. 2015. Ocean grabbing, Marine Policy. 57, 61–68. https://doi.org/10.1016/j.marpol.2015.03.026

Bennett, N.J., Cisneros-Montemayor, A.M., Blythe, J., Silver, J.J., Singh, G., Andrews, N., Calò, A., Christie, P., Di Franco, A., Finkbeiner, E.M., Gelcich, S., Guidetti, P., Harper, S., Hotte, N., Kittinger, J.N., Le Billon, P., Lister, J., López de la Lama, R., McKinley, E., Scholtens, J., Solås, A., Sowman, M., Talloni-Álvarez, N., Teh, L.C.L., Voyer, M., Sumaila, U.R. 2019. Towards a sustainable and equitable blue economy, Nat. Sustain. https://doi.org/10.1038/s41893-019-0404-1.

Blanco, J., Dendoncker, N., Barnaud, C., Sirami, C. 2019. Ecosystem disservices matter: Towards their systematic integration within ecosystem service research and policy, Ecosyst. Serv. 36, 100913. https://doi.org/10.1016/j.ecoser.2019.100913.

Borgwardt, F., Robinson, L., Trauner, D., Teixeira, H., Nogueira, A.J.A., Lillebø, A.I., Piet, G., Kuemmerlen, M., O'Higgins, T., McDonald, H., Arevalo-Torres, J., Barbosa, A.L., Iglesias-Campos, A., Hein, T., Culhane, F., 2019. Exploring variability in environmental impact risk from human activities across aquatic ecosystems. Sci. Total Environ. 652, 1396–1408. https://doi.org/10.1016/j.scitotenv.2018.10.339

Borja, Á., Elliott, M., Andersen, J.H., Berg, T., Carstensen, J., Halpern, B.S., Heiskanen, A.-S., Korpinen, S., Lowndes, J.S.S., Martin, G., Rodriguez-Ezpeleta, N., Borja, A., Elliott, M., Andersen, J.H., Berg, T., Carstensen, J., Halpern, B.S., Heiskanen, A.-S., Korpinen, S., Lowndes, J.S.S., Martin, G., Rodriguez-Ezpeleta, N., 2016. Overview of Integrative Assessment of Marine Systems: The Ecosystem Approach in Practice. Front. Mar. Sci. 3, 1–20. https://doi.org/10.3389/fmars.2016.00020

Cabral, P., Levrel, H., Schoenn, J., Thiébaut, E., Le Mao, P., Mongruel, R., Rollet, C., Dedieu, K., Carrier, S., Morisseau, F., Daures, F., 2015. Marine habitats ecosystem service potential: A vulnerability approach in the Normand-Breton (Saint Malo) Gulf, France. Ecosyst. Serv. 16, 306–318. https://doi.org/10.1016/j.ecoser.2014.09.007

Casado-Arzuaga, I., Madariaga, I., Onaindia, M., 2013. Perception, demand and user contribution to ecosystem services inthe Bilbao Metropolitan Greenbelt. J. Environ. Manage. 129, 33–43. https://doi.org/10.1016/j.jenvman.2013.05.059

Clarke, J., Flannery, W. 2019. The post-political nature of marine spatial planning and modalities for its re-politicisation, J. Environ. Policy Plan. 1–14. https://doi.org/10.1080/1523908X.2019.1680276

Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., Grasso, M., 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosyst. Serv. 28, 1–16. https://doi.org/10.1016/j.ecoser.2017.09.008

Crain, C.M., Kroeker, K., Halpern, B.S., 2008. Interactive and cumulative effects of multiple human stressors in marine systems. Ecol. Lett. 11, 1304–1315. https://doi.org/10.1111/j.1461-0248.2008.01253.x

Cremer, M.J., Hardt, F.A.S., Tonello, A.J., Simões-Lopes, P.C., 2011. Distribution and status of the Guiana dolphin Sotalia guianensis (Cetacea, Delphinidae) population in Babitonga Bay, Southern Brazil. Zool. Stud. 50, 327–337.

Cremer, M.J., Pinheiro, P.C., Simões-Lopes, P.C., 2012. Prey consumed by Guiana dolphin Sotalia guianensis (Cetacea, Delphinidae) and franciscana dolphin Pontoporia blainvillei (Cetacea, Pontoporiidae) in an estuarine environment in southern Brazil. Iheringia. Série Zool. 102, 131–137. https://doi.org/10.1590/s0073-47212012000200003

Cremer, M.J.; Morales, P.R.D.; Oliveira, T.M.N. 2006. Diagnóstico Ambiental da Baía da Babitonga. Joinville, SC: UNIVILLE.

Cremer, M.J.; Holz, A.C.; Sartori, C.M.; Schulze, B.; Paitach, R.L.; Simões-lopes, P.C. 2017. Behavior and Ecology of Endangered Species Living Together: Long-Term Monitoring of Resident Sympatric Dolphin Populations. Chapter in M.R. Rossi-Santos, C.W. Finkl (eds.), Advances in Marine Vertebrate Research in Latin America, Coastal Research Library 22, 477–508.

Cohen, E.H. Allison, N.L. Andrew, J. Cinner, L.S. Evans, M. Fabinyi, L.R. Garces, S.J. Hall, C.C. Hicks, T.P. Hughes, S. Jentoft, D.J. Mills, R. Masu, E.K. Mbaru, B.D. Ratner, Securing a Just Space for Small-Scale Fisheries in the Blue Economy, Front. Mar. Sci. 6 (2019) 1–8. https://doi.org/10.3389/fmars.2019.00171.

Correa, M.F.M.; Pinheiro, P.C.; Almeida, H.K.; Kersten, M.; Lienstadt, J.; Vollhath, F. 2006. Diagnóstico ambiental da ictiofauna. In: Cremer, M.J., Morales, P.R.D., Oliveira, T.M.N. Diagnóstico Ambiental da Baía da Babitonga. Joinville, SC: UNIVILLE, 2006, 158-186.

De Carvalho, F.G.; Gerhardinger, L.C.; Cursino, M.; Serafini, T.Z. 2011. Mapeamento Participativo dos Recursos Pesqueiros na Área de Influência do Terminal Marítimo Mar Azul - Porção Sul do Eixo Central da Baía Babitonga (Relatório).

Duarte, M.C. 2011. Ictioplâncton da baía da Babitonga (SC, Brasil): instrumento para a definição de áreas prioritárias para a conservação. Dissertação em Ciência e Tecnologia Ambiental Universidade do Vale do Itajaí. 125p.

Eelderink, M., Vervoort, J. M., van Laerhoven, F. 2020. Using participatory action research to operationalize critical systems thinking in social-ecological systems. Ecology and Society 25(1):16. https://doi.org/10.5751/ES-11369-250116

Fava, I. R. S. 2016. Caracterização e setorização das ilhas da Baía Babitonga, Santa Catarina. Joinville, 33 p. (Monografia de Graduação. Departamento de Ciências Biológicas, UNIVILLE).

Ferreira, C.E.L.; Gonçalves, J.E.A.; Coutinho, R. 2000. Comunity structure of fishes habitat and habitat complexity on a tropical rocky shore. Enviromental Biology of Fishes 61: 353-369. Kluwer Academic Publishers.

Fletcher, S., Saunders, J., Herbert, R., Roberts, C., Dawson, K. 2012. Description of the ecosystem services provided by broad-scale habitats and features of conservation importance that are likely to be protected by Marine Protected Areas in the Marine Conservation Zone Project area. Natural England Commissioned Reports, Number 088, 154 p.

Fernandes, E., Mello, R., Bastos, L.C., 2015. Decision support method contribution to generate interactive maps of suggestion for land use by using the concept of soft decision tree: case of island of São Francisco do Sul, Brazil. J. Urban Plannejament Development, v. 1, p. 0401-4043.https://doi.org/10.1061/(ASCE)UP.1943-5444.0000212.

Fish, R., Church, A., Winter, M., 2016. Conceptualising cultural ecosystem services: A novel framework for research and critical engagement. Ecosyst. Serv. 21, 208–217. https://doi.org/10.1016/j.ecoser.2016.09.002

Gattuso, J.-P., Magnan, A.K., Bopp, L., Cheung, W.W.L., Duarte, C.M., Hinkel, J., Mcleod, E., Micheli, F., Oschlies, A., Williamson, P., Billé, R., Chalastani, V.I., Gates, R.D., Irisson, J.-O., Middelburg, J.J., Pörtner, H.-O., Rau, G.H., 2018. Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems. Front. Mar. Sci. 5. https://doi.org/10.3389/fmars.2018.00337

Gerhardinger, L.C., Hostim-Silva, M., R.P.R.P. Medeiros, R.P., Matarezi, J., Bertoncini, Á.A., Freitas, M.O., Ferreira, B.P. 2009. Fishers' resource mapping and goliath grouper Epinephelus itajara (Serranidae) conservation in Brazil, Neotrop. Ichthyol. 7, 93–102. http://www.scielo.br/scielo.php?pid=S1679-62252009000100012&script=sci_arttext&tlng=e!n (accessed August 18, 2011)

Gerhardinger, L.C., de Carvalho, F.G., Haak, L., Herbst, D.F., Poderoso, R. A. (2018a) Planning Blues: Tenure rights fade under unjust 'blue planning'. Samudra Reports. 78: 42. Available at: https://www.icsf.net/en/samudra/article/EN/78-4334-Planning-Blues.html

Gerhardinger, L.C., Gorris, P., Gonçalves, L.R., Herbst, D.F., Vila-Nova, D.A., De Carvalho, F.G., Glaser, M., Zondervan, R., Glavovic, B.C., 2018b. Healing Brazil's Blue Amazon: The role of knowledge networks in nurturing cross-scale transformations at the frontlines of ocean sustainability. Front. Mar. Sci. 4. https://doi.org/10.3389/fmars.2017.00395

Gerhardinger, L.C., Quesada-Silva, M., Gonçalves, L.R., Turra, A., 2019. Unveiling the genesis of a marine spatial planning arena in Brazil. Ocean Coast. Manag. 179, 104825. https://doi.org/10.1016/j.ocecoaman.2019.104825

Gerhardinger, L.C.; Godoy, E.A.; Dapper, C.G.; Campos, R.; Marchioro, G.B.; Sforza, R.; Polette, M. 2010. Mapeamento participativo da paisagem marinha no Brasil: experiências e perspectivas. In: Albuquerque, U.P.; Lucena, R.; Cunha, Luiz Vital Fernandes Cruz da. (Org.). Métodos e Técnicas na Pesquisa Etnobiológica e Etnoecológica. Recife: NUPEEA,

Gerhardinger, L. C.; Freitas, R. R.; Carvalho, F. G.; Herbst, D. F.; Mergen, B.; Cunha, S.; Cremer, M. J.; Vila-nova, D.; Pfuetzenreuter, A.; Haak, L. 2017 Diagnóstico Socioambiental do Ecossistema Babitonga.

Gerhardinger, L.C., Herbst, D.F., Cunha, S., Duarte, M. 2020. Diagnóstico da Ictiofauna do Ecossistema Babitonga. Revista CEPSUL: Conservação e Biodiversidade Marinha.

Glaser, M., Roberta, B., Gerhardinger, L.Cavaleri; Padovani, B.F., Marquez, S., Gonçalves, L., Turra, A. In press. Trajectory of ecosystem user participation in Brazilian coastal management. In: Navigating towards sustainable Human-Nature Relations - Coastal management revisited (Editors: Bernhard Glaeser and Marion Glaser). Elsevier (planned for 2020).

Grace, V.B.; Mas-Pla, J.; Novais, T.O.; Sacchi, E.; Zuppi, G.M. 2008. Hydrological mixing and geochimical process characterization in an estuarine/mangrove system using environmental tracers in Babitonga Bay (Santa Catarina, Brazil). Continental Shelf Research. Vol 28, 682–695.

Grose, A.V., Hillebrand, C.C., Cremer, M.J., 2013. Diversidade e abundância sazonal da avifauna em duas planícies de maré no estuário da baía da Babitonga , norte de Santa Catarina. Lheringia, série Zool. 103, 5–11. https://doi.org/10.1590/S0073-47212013000100001

Hardt, F.A.S., Cremer, M.J., Tonello-Junior, A.J., Buffa, G., Bellantte, A., Buscaino, G., Mazzola, S., Barreto, A.S., Martinelli, L.A., Zuppi, G.M., 2013. Use of carbon and nitrogen stable isotopes to study the feeding ecology of small coastal cetacean populations in southern Brazil. Biota Neotrop. 13, 90–98. https://doi.org/10.1590/S1676-06032013000400009

Herbst, D.F., Gerhardinger, L.C., Hanazaki, N. 2020. Linking user-perception diversity on ecosystems services to the inception of coastal governance regime transformation. Frontiers in Marine Science 7:83 https://doi.org/10.3389/fmars.2020.00083.

Horcea-Milcu, A.-I., Martín-López, B., Lam, D. P. M., Lang, D. J. 2020. Research pathways to foster transformation: linking sustainability science and social-ecological systems research. Ecology and Society 25,1:13. https://doi.org/10.5751/ES-11332-250113

Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis. 1998. Proteção e controle de ecossistemas costeiros: manguezal da Baía Babitonga. Brasília, IBAMA, Coleção Meio Ambiente, Séries estudo pesca.146p.

IUCN WCPA, 2019. Guidelines for Recognising and Reporting Other Effective Area-based Conservation Measures. IUCN, Switzerland.

IBGE. 2016. Estimativas da população residente para os municípios e para as unidades da federação. Available at < https://www.ibge.gov.br/estatisticas-novoportal/sociais/populacao/9103-estimativasdepopulacao.html?edicao=9112&t=resultados> Access feb 2019.

Jacobs, S., Dendoncker, N., Martín-López, B., Barton, D.N., Gomez-Baggethun, E., Boeraeve, F., McGrath, F.L., Vierikko, K., Geneletti, D., Sevecke, K.J., Pipart, N., Primmer, E., Mederly, P., Schmidt, S., Aragão, A., Baral, H., Bark, R.H., Briceno, T., Brogna, D., Cabral, P., De Vreese, R., Liquete, C., Mueller, H., Peh, K.S.H., Phelan, A., Rincón, A.R., Rogers, S.H., Turkelboom, F., Van Reeth, W., van Zanten, B.T., Wam, H.K., Washbourn, C.L., 2016. A new valuation school: Integrating diverse values of nature in resource and land use decisions. Ecosyst. Serv. 22, 213–220. https://doi.org/10.1016/j.ecoser.2016.11.007

Jacobs, S., Zafra-Calvo, N., Gonzalez-Jimenez, D., Guibrunet, L., Benessaiah, K., Berghöfer, A., Chaves-Chaparro, J., Díaz, S., Gomez-Baggethun, E., Lele, S., Martín-López, B., Masterson, V.A., Merçon, J., Moersberger, H., Muraca, B., Norström, A., O'Farrell, P., Ordonez, J.C., Prieur-Richard, A.-H., Rincón-Ruiz, A., Sitas, N., Subramanian, S.M., Tadesse, W., van Noordwijk, M., Pascual, U., Balvanera, P. 2020. Use your power for good: plural valuation of nature – the Oaxaca statement, Glob. Sustain. 3. e8. https://doi.org/10.1017/sus.2020.2

Jentoft, S., 2017. Small-scale fisheries within maritime spatial planning: knowledge integration and power. J. Environ. Policy Plan. 19, 266–278. https://doi.org/10.1080/1523908X.2017.1304210

Kenter, J.O., Bryce, R., Christie, M., Cooper, N., Hockley, N., Irvine, K.N., Fazey, I., O'Brien, L., Orchard-Webb, J., Ravenscroft, N., Raymond, C.M., Reed, M.S., Tett, P., Watson, V., 2016. Shared values and deliberative valuation: Future directions. Ecosyst. Serv. 21, 358–371. https://doi.org/10.1016/j.ecoser.2016.10.006

Kilka, R.V. 2017. Monitoramento do desfoliamento e da mortalidade de manguezais na Baía da Babitonga-SC. Relatório final enviado ao Ministério Público de Joinville. São Francisco do Sul, Instituto Vidamar. 70p

Kilka, R.V., Melo-Júnior, J.C.F., Esemann-Quadros, K., Larcher, L., Pfuetzenreuter, A. 2019. Os manguezais e marismas da Baía Babitonga uma síntese. Revista CEPSUL: Conservação e Biodiversidade Marinha, 16 p.

Knights, A.M., Piet, G.J., Jongbloed, R.H., Tamis, J.E., White, L., Akoglu, E., Boicenco, L., Churilova, T., Kryvenko, O., Fleming-Lehtinen, V., Leppanen, J.M., Galil, B.S., Goodsir, F., Goren, M., Margonski, P., Moncheva, S., Oguz, T., Papadopoulou, K.N., Setälä, O., Smith, C.J., Stefanova, K., Timofte, F., Robinson, L.A., 2015. An exposure-effect approach for evaluating ecosystem-wide risks from human activities. ICES J. Mar. Sci. 72, 1105–1115. https://doi.org/10.1093/icesjms/fsu245

Koehn, J.Z., Reineman, D.R., Kittinger, J.N., 2013. Progress and promise in spatial human dimensions research for ecosystem-based ocean planning. Mar. Policy 42, 31–38. https://doi.org/10.1016/j.marpol.2013.01.015

Korpinen, S., Andersen, J.H., 2016. A Global Review of Cumulative Pressure and Impact Assessments in Marine Environments. Front. Mar. Sci. 3, 1–11. https://doi.org/10.3389/fmars.2016.00153

Kull, C.A., Arnauld de Sartre, X., Castro-Larrañaga, M., 2015. The political ecology of ecosystem services. Geoforum 61, 122–134. https://doi.org/10.1016/j.geoforum.2015.03.004

La Notte, A., D'Amato, D., Mäkinen, H., Paracchini, M.L., Liquete, C., Egoh, B., Geneletti, D., Crossman, N.D., 2017. Ecosystem services classification: A systems ecology perspective of the cascade framework. Ecol. Indic. 74, 392–402. https://doi.org/10.1016/j.ecolind.2016.11.030

Laffoley, D., Dudley, N., Jonas, H., MacKinnon, D., MacKinnon, K., Hockings, M., Woodley, S., 2017. An introduction to 'other effective area-based conservation measures' under Aichi Target 11 of the Convention on Biological Diversity: Origin, interpretation and emerging ocean issues. Aquat. Conserv. Mar. Freshw. Ecosyst. 27, 130–137. https://doi.org/10.1002/aqc.2783

Langlet, D., Rayfuse, R., 2019. The Ecosystem Approach in Ocean Planning and Governance. Brill Nijhoff, Leiden/Boston. https://doi.org/10.1163/9789004332287

Larson, S., De Freitas, D.M., Hicks, C.C., Freitas, D.M. De, Hicks, C.C., 2013. Sense of place as a determinant of people's attitudes towards the environment: Implications for natural resources management and planning in the Great Barrier Reef, Australia. J. Environ. Manage. 117, 226–234. https://doi.org/10.1016/j.jenvman.2012.11.035

Leslie, H.M., McLeod, K.L., 2007. Confronting the challenges of implementing marine ecosystem-based management. Front. Ecol. Environ. 5, 540–548. https://doi.org/10.1890/060093

Liquete, C., Piroddi, C., Drakou, E.G., Gurney, L., Katsanevakis, S., Charef, A., Egoh, B. 2013. Current Status and Future Prospects for the Assessment of Marine and Coastal Ecosystem Services: A Systematic Review, PLoS One. 8 https://doi.org/10.1371/journal.pone.0067737.

Long, R.D., Charles, A., Stephenson R.L. 2015. Key principles of marine ecosystem-based management, Mar. Policy. 57:53–60. https://doi.org/10.1016/j.marpol.2015.01.013

Lopes, G.R., Gomes, C.H.A. de M., Tureck, C.R., de Melo, C.M.R., 2013. Growth of crassostrea gasar cultured in marine and estuary environments in Brazilian waters. Pesqui. Agropecu. Bras. 48, 975–982. https://doi.org/10.1590/S0100-204X2013000800024

Machado, A.M. da S., Daura-Jorge, F.G., Herbst, D.F., Simões-Lopes, P.C., Ingram, S.N., Castilho, P.V. de, Peroni, N., 2019. Artisanal fishers' perceptions of the ecosystem services derived from a dolphin-human cooperative fishing interaction in southern Brazil. Ocean Coast. Manag. 173, 148–156. https://doi.org/10.1016/j.ocecoaman.2019.03.003

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J.P., Grizzetti, B., Drakou, E.G., Notte, A. La, Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L., Bidoglio, G., 2012. Mapping ecosystem services for policy support and decision making in the European Union. Ecosyst. Serv. 1, 31–39. https://doi.org/10.1016/j.ecoser.2012.06.004

Martin, C.L., Momtaz, S., Gaston, T., Moltschaniwskyj, N.A., 2016. A systematic quantitative review of coastal and marine cultural ecosystem services: Current status and future research. Mar. Policy 74, 25–32. https://doi.org/10.1016/j.marpol.2016.09.004

Mcdonough, K., Hutchinson, S., Moore, T., Hutchinson, J.M.S., 2017. Analysis of publication trends in ecosystem services research. Ecosyst. Serv. 25, 82–88. https://doi.org/10.1016/j.ecoser.2017.03.022

Mcnally, C.G., Gold, A.J., Pollnac, R.B., Kiwango, H.R., 2016. Stakeholder perceptions of ecosystem services of the Wami River and 21.

Millenium Ecosystem Assessment (MEA). 2005. "Ecosystems and Human Well-Being: Synthesis", p. 155.

Oliveira, E. L., Berkes, F. 2014. What value São Pedro' s procession ? Ecosystem services from local people' s perceptions 107, 114–121.

Oliveira, F.A., 2006. Estudo do aporte sedimentar em suspensão na Baía da Babitonga sob a ótica da geomorfologia, 285 p. Doctoral Thesis. Departamento de Geografia, Letras e Ciências Humanas da Universidade de São Paulo.

Raymond, C.M., Giusti, M., Barthel, S., 2018. An embodied perspective on the co-production of cultural ecosystem services: toward embodied ecosystems. J. Environ. Plan. Manag. 61, 778–799. https://doi.org/10.1080/09640568.2017.1312300

Rossini, D.D.M., Tricárico, L.T., Tomelin, C.A., 2016. O Português Centro Histórico de São Francisco do Sul (BR): um atributo para o turismo cultural. Interações (Campo Gd. 17, 110–125. https://doi.org/10.20435/1518-70122016111

Rovai, A.S., Soriano-Sierra, E.J., Pagliosa, P.R., Cintrón, G., Schaeffer-Novelli, Y., Menghini, R.P., Coelho-Jr, C., Horta, P.A., Lewis, R.R., Simonassi, J.C., Alves, J.A.A., Boscatto, F., Dutra, S.J., 2012. Secondary succession impairment in restored mangroves. Wetl. Ecol. Manag. 20, 447–459. https://doi.org/10.1007/s11273-012-9269-z

Santos, A.A.; Costa, S.W.,2015. Resultados da maricultura catarinense em 2014. Laranjeiras: Panorama da Aquicultura, V.25, n.149, p 36–41.

Scherer, M.E.G., Asmus, M.L. 2016. Ecosystem-Based Knowledge and Management as a tool for Integrated Coastal and Ocean Management: A Brazilian Initiative. In: Vila-Concejo, A.; Bruce, E.; Kennedy, D.M., and McCarroll, R.J. (eds.), Proceedings of the 14th International 146 Coastal Symposium (Sydney, Australia). Journal of Coastal Research, Special Issue, No. 75, Coconut Creek (Florida), ISSN 0749-0208.

Scholes, R., Biggs, R., Palm, C., Duraiappah, A., 2010. Assessing state and trends in ecosystem services and human well-being. Ecosyst. Hum. Well-Being A Man. Assess. Pract. 115–150.

Serafini, T.Z., Andriguetto Filho, J.M., Pierri, N., 2014. Subsídios para a gestão compartilhada da pesca na Baía da Babitonga (SC, Brasil). Brazilian J. Aquat. Sci. Technol. 18, 99–111. https://doi.org/10.14210/bjast.v18n1.p99-111

Simpson, S., Brown, G., Peterson, A., Johnstone, R., 2016. Stakeholder perspectives for coastal ecosystem services and influences on value integration in policy. Ocean Coast. Manag. 126, 9–21. https://doi.org/10.1016/j.ocecoaman.2016.03.009

Singh, G.G., Sinner, J., Ellis, J., Kandlikar, M., Halpern, B.S., Satter, T., Chan, K.M.A., 2017. Mechanisms and risk of cumulative impacts to coastal ecosystem services: An expert elicitation approach 199, 229–241. https://doi.org/10.1016/j.jenvman.2017.05.032

Tognella-de-Rosa, M.M.P., Cunha, S.R., Soares, M.L.G., Schaeffer-Novelli, Y., Lugli, D.O., Paulo, D.S., Paulo, S., Bay, B., Tognella-de-Rosa, M.M.P., Schaeffer-Novelli, Y., 2006. Mangrove Evaluation-An Essay. J. Coast. Res. 2004, 1219–1224.

The Natural Capital Project (Natural Capital). 2017. Habitat Risk Assessment. InVEST documentation (3.6.0).http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/habitat_risk_assessment.html#hra-preprocessor

UN Environment (2018). Applying marine and coastal area-based management approaches to achieve multiple Sustainable Development Goal Targets: Summary for Policy Makers. UN Regional Seas Reports and Studies No. 206

UNEP. 2011. Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide. Agardy, T., Davis, J., Sherwood, K., Vestergaard, O. UNEP Regional Seas Reports and Studies No. 189

Vieira, C.V. 2008. Mapeamento geológico costeiro e evolução Paleogeográfica do setor oriental da folha Garuva, Nordeste de Santa Catarina, Brasil**.** Dissertação. Programa de Pós-graduação em Geografia, área de concentração Utilização e Conservação de Recursos Naturais, do Centro de Filosofia e Ciências Humanas da Universidade Federal de Santa Catarina, 171 p.

Werner, S.R., Spurgeon, J.P.G., Isaksen, G.H., Smith, J.P., Springer, N.K., Gettleson, D.A., N'Guessan, L., Dupont, J.M., 2014. Rapid prioritization of marine ecosystem services and ecosystem indicators. Mar. Policy 50, 178–189. https://doi.org/10.1016/j.marpol.2014.03.020

Wilmsmeier, G., Monios, J., 2016. Institutional structure and agency in the governance of spatial diversification of port system evolution in Latin America. J. Transp. Geogr. 51, 294–307. https://doi.org/10.1016/j.jtrangeo.2015.02.004

Wyatt, K.H., Griffin, R., Guerry, A.D., Ruckelshaus, M., Fogarty, M., Arkema, K.K., 2017. Habitat risk assessment for regional ocean planning in the U.S. Northeast and Mid-Atlantic. PLoS One 12, 1–20. https://doi.org/10.1371/journal.pone.0188776

Zaucha, J., Conides, A., Klaoudatos, D., Norén, K., 2016. Can the ecosystem services concept help in enhancing the resilience of land-sea social-ecological systems? Ocean Coast. Manag. 124, 33–41. https://doi.org/10.1016/j.ocecoaman.2016.01.015

Considerações finais

Apresentamos abaixo (Tabela I) uma síntese das contribuições desta tese dentro das discussões atuais em torno de serviços ecossistêmicos e das Contribuições da Nauteza para as pessoas 'Nature Contributions to People (NCP)', com base na análise feita por Peterson *et al.* (2018).

Tabela I: Contribuições da Tese no desenvolvimento teórico-metodológico do campo de pesquisa e aplicações da abordagem de serviços ecossistêmicos.

"Welcoming different perspectives in IPBES: 'Nature's contributions to people' and 'Ecosystem services'" (Peterson et al., 2018)	**Contribuições da Tese**
Avanços do framework do NCP	
• Ressalta a importância do contexto cultural, como um fator transversal que molda a percepção humana da natureza e a boa qualidade de vida; • Se abrir para outras opções de tipos de contribuições na natureza para melhorar o enfrentamento de variação e surpresa, "mais que o conceito relativamente estático de serviços ecossistêmicos";	• Empregamos uma abordagem de pesquisa etnoecológica ao processo participativo de construção conceitual de benefícios, direitos e recursos obtidos da natureza, com base em um enfoque de SE. A destacar reflexões sobre a categoria cultural (pg. XX) e o efeito cascata da interferência humana nos serviços ecossistêmicos; • Ressaltamos a conciliação do conceito e enfoque de SE com uma perspectiva *humans-in-ecosystems* (e.g., Davidson-Hunt e Berkes, 2003) de sistemas socioecológicos, o que ajuda a lidar com a complexidade dos atributos sociais e naturais (não humanos).
Deficits do framework do NCP	
• Substituição de ecossistema por natureza subestima a extensão em que os processos socioecológicos estão moldando os ecossistemas; • Ao promover aspectos particulares das relações humanos-natureza, deixa de fora outros aspectos cruciais que foram identificadas como fronteiras da pesquisa em SE; • Fluxo unidirecional da natureza para as pessoas diminui a complexidade, as conexões de longa distância, os conflitos e a não linearidade;	• Enfrentamos este desafio conceitual ao apresentar a perspectiva de sistemas socioecológicos dentro de uma abordagem ecossistêmica (cap. 1 e 2), na qual o ser humano faz parte do mesmo (human-in), sendo também parte da dimensão natural; • No cap. 1 (Fig. 6), propomos a imagem de um efeito cascata articulando de forma sistêmica as relações entre diferentes categorias de SE dentro de um determinado SSE (fluxo multidirecional), onde a influência humana pode ser positiva ou negativa, não linear e não

	unidirecional bem como mecanismos do Sistema natural (não humano) também influencia positiva e negativamente as respostas humanas e sociais;
Fronteiras de desenvolvimento teórico-metodológico do campo dos SE	
• Dinâmicas temporais e espaciais não-lineares • Distribuição dos serviços ecossistêmicos • Co-produção de serviços ecossistêmicos • Design da pesquisa	• No capítulo 2 buscamos trabalhar o uso do espaço e os efeitos de tais usos no ecossistema ao longo do tempo, a partir da avaliação de risco do ecossistema e habitats a partir de múltiplos usos; • Ao entender como se dá os usos atuais dos serviços ecossistêmicos (cap. 2), apresentamos diretrizes e oportunidades para que o processo político seja responsável com a possibilidade de (re)alocação adequada de usos do espaço e dos serviços ecossistêmicos a partir de novas políticas de zoneamenco ecológico-econômico para a região, ressaltando uma alocação e acesso justa, equitativa e que transforme também os conflitos entre diferentes atores em oportunidades de desenvolvimento sustentável; • Ao mesmo tempo que as pessoas impactam e geram riscos aos serviços ecossistêmicos (cap. 2), são capazes de construir novos serviços, manejar e gerir os usos, atividades e o ecossistema de forma a otimizar a manutenção e o fornecimento dos serviços ecossistêmicos sejam eles intermediários ou finais (cap. 1). As influências humanas positivas destacadas no enfoque de efeito cascata entre SEs em um SSE (Fig. 6; cap. 1) ressalta o aspecto de co-produção na abordagem de serviços ecossistêmicos;
Reinvidicações e conflitos	
• Geração de tensão entre pesquisadores e risco de dividir opiniões • Envolvimento de partes interessadas visões de mundo e tomadores de decisão- negligência dos avanços do framework de SE;	• Embora em conflitos sobre a possibilidade de melhor aceitabilidade dos enfoques, os grupos que vem trabalhando com ambos vem obtendo conquistas em processos de gestão. Por este motivo, vemos a necessidade de avançarmos na integração dos potenciais das abordagens em

• Entendimento da abordagem como substitutiva e polarização da comunidade científica;	busca de uma proposta mais abrangente e inclusiva; • Vimos a abordagem dos enfoques de serviços ecossistêmicos e do NCP não como excludentes, mas sim com possibilidades complementares, pois a abordagem e enfoque utilizado em nosso estudo possui interface com as duas abordagens. De toda forma, concordarmos que as polarizações geradas podem também atuar negativamente para as partes e silenciar vozes menos ponderosas que poderiam vir a somar com o processo de integração das potencialidades de ambos os enfoques.
Construindo pontes	
• Construir conhecimento prático para a sustentabilidade requer abordagens para lidar com o pluralismo e criar pontes entre diferentes formas de pensar; • Sistema de conhecimento ponte deve atuar além da síntese, com mobilização, tradução, negociação e aplicação do conhecimento	• Nosso estudo de caso atuou com base etnoecológica na busca de: respeitar diferentes formas de conhecimento e visões de mundo; abranger o pluralismo de usuários e interesses econômicos, avaliar como as diferentes formas de pensar e impactos gerados podem levar o ecossistema para a insustentabilidade e intensificar os riscos;

Mais especificamente, em relação ao caso estudado, no campo teórico e conceitual observamos que, apesar de soar antropocêntrico, o termo 'benefício' dá abertura para trabalhar o conceito de serviços ecossistêmicos e inserir a teoria de forma facilitada no campo de compreensão de diferentes atores. Durante o processo das oficinas, vimos que os usuários estão preocupados se irão sofrer perdas com a possibilidade da gestão.

Assim, a consideração e valorização das suas percepções no processo de construção e análise do ecossistema (inicialmente a partir da identificação e mapeamento de serviços), conferiu legitimidade ao processo e auxiliou o entendimento e articulação de aspectos fundamentais da teoria na prática.

A exposição dos usuários diretos às abordagens de serviços ecossistêmicos os fez perceber os benefícios gerados pela natureza de uma maneira holística. Além disto, mostrou que para continuar obtendo os benefícios (serviços ecossistêmicos), seria necessário gerir e manter outros tipos de serviços, que muitas vezes não percebidos tão facilmente (principalmente de regulação e suporte). Esta combinação de uma abordagem integrativa e deliberativa foi essencial para entender os valores compartilhados e construir o conhecimento prático para sustentabilidade.

A apropriada tradução e entendimento dos tipos e relações entre serviços ecossistêmicos (Capítulo 1: Fig. 6) pode auxiliar nas contribuições conscientes das pessoas para a natureza e consequentemente contribuições mais efetivas e rentáveis da natureza para as pessoas.

Somente a partir da compreensão e dada a importância dos serviços entre os diferentes atores, é que poderemos buscar êxito na negociação e aplicação de diferentes tipos de conhecimentos nas tomadas de decisão.

Uma das principais conclusões desta tese e o principal ponto de ligação entre os dois artigos está nos resultados obtidos participativamente sobre a relevância dos valores compartilhados (alimento e turismo) (Cap. 1). O acesso às percepções de diferentes usuários a partir de uma mesma metodologia foi essencial para indicar caminhos, as atividades e os tipos de uso que devem ser priorizados no processo de gestão a partir da avaliação de risco dos habitats e do ecossistema como um todo (cap. 2): a pesca, maricultura e as atividades do turismo e recreação.

Nossos resultados demonstram que, obedecidas as legislações vigentes e manejadas as atividades de pesca, maricultura e turismo e recreação; poderá haver mitigação dos conflitos e dos impactos que ocorrem atualmente no ecossistema.

Para diminuir os riscos ao ecossistema é necessário priorizar o manejo de atividades já realizadas, e não permitir atividades altamente impactantes em áreas sensíveis, como a região das ilhas centrais (cap. 2). Desta forma, é possível uma alocação e acesso de serviços ecossistêmicos justa para obtermos um sistema socioecológico coerente, inclusivo e equitativo.

O atual cenário de gestão do ecossistema investigado apresenta brechas nas legislações e falta de fiscalização, o que torna o acesso aos serviços ecossistêmicos totalmente aberto (para qualquer um, em qualquer circunstância e momento). Esta condição aumenta a dificuldade em manejar o uso e manutenção de habitats, espécies e serviços ecossistêmicos a longo prazo.

Concluímos que resultados dos mapeamentos obtidos nesta tese, construídos pautados na participação social e com base ecossistêmica (cap. 2), possuem grande potencial para alimentar um processo de Planejamento Espacial Marinho. Os dados aqui apresentados são compatíveis com os dados do Zoneamento Ecológico Econômico (ZEE) e Gerenciamento Costeiro Estadual. Desta forma, há uma oportunidade de integração dos dados dentro do processo de Planejamento Espacial Marinho, pois o ZEE da região está sob inquérito civil dada a baixa qualidade da participação social e mudanças no zoneamento realizados ao longo do percurso de condução do processo para beneficiar empreendimentos específicos. Mesmo com esta oportunidade, no campo de tomada de decisão, destacamos a dificuldade de aderência e responsividade do Governo do Estado para integrar e tornar efetivos o uso dos dados aqui apresentados. Apesar de todo o esforço empregado para evoluirmos nesta proposta, e da alta participação social do processo, o cenário político estadual e nacional atualmente é frágil e oculto, dada a gestão fragmentada e oportunista. Além da não responsividade, a presença de assimetrias de poder é capaz de moldar as ações políticas (que inclui processos de licenciamento) levando ao boicote do processo participativo.

Assim, destacamos a necessidade de novas avaliações para a gestão integrada do território. Os atores envolvidos com o Grupo Pró Babitonga devem aproveitar o potencial do processo de mobilização social que vem ocorrendo, pois a morosidade de implementação de ações de gestão geram desinteresse e desistência de participação social, dificultando a continuidade do processo de construção e de aprendizado mútuo.

Por fim, nossa experiência mobilizou e traduziu os conhecimentos relacionados aos serviços ecossistêmicos para a aplicação direta em processos de gestão variados no território, mesmo sem uma ancoragem legal definida para o Grupo Pró Babitonga. Assim, a experiência conduzida na baía Babitonga pode encorajar outras iniciativas a lidar com a complexidade e avançarem em abordagens de gestão ecossistêmicas.

Referências

Abson, D.J., Wehrden, H. Von, Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A.M., Lang, D.J., Martens, P., Walmsley, D., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A.M., Lang, D.J., Martens, P., Walmsley, D., 2014. Ecosystem services as a boundary object for sustainability. Ecol. Econ. 103, 29–37. https://doi.org/10.1016/j.ecolecon.2014.04.012

Anastasiou, E., Lorentz, K.O., Stein, G.J., Mitchell, P.D., 2014. Prehistoric schistosomiasis parasite found in the Middle East. Lancet Infect. Dis. 14, 553–554. https://doi.org/10.1016/S1473-3099(14)70794-7

Arkema, K.K., Abramson, S.C., Dewsbury, B.M., 2006. Marine ecosystem-based management : from characterization to implementation. Front. Ecol. Environ. 4, 525–532.

Arkema, K.K., Verutes, G.M., Wood, S.A., Clarke-Samuels, C., Rosado, S., Canto, M., Rosenthal, A., Ruckelshaus, M., Guannel, G., Toft, J., Faries, J., Silver, J.M., Griffin, R., Guerry, A.D., 2015. Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. Proc. Natl. Acad. Sci. U. S. A. 112, 7390–7395. https://doi.org/10.1073/pnas.1406483112

Arkema, K.K., Verutes, G., Bernhardt, J.R., Clarke, C., Rosado, S., Canto, M., Wood, S.A., Ruckelshaus, M., Rosenthal, A., McField, M., De Zegher, J., 2014. Assessing habitat risk from human activities to inform coastal and marine spatial planning: A demonstration in Belize. Environ. Res. Lett. 9. https://doi.org/10.1088/1748-9326/9/11/114016

Bagstad, K.J., Johnson, G.W., Voigt, B., Villa, F., 2013. Spatial dynamics of ecosystem service flows: A comprehensive approach to quantifying actual services. Ecosyst. Serv. 4, 117–125. https://doi.org/10.1016/j.ecoser.2012.07.012

Braat, L.C., 2018. Five reasons why the Science publication "Assessing nature's contributions to people" (Diaz et al. 2018) would not have been accepted in Ecosystem Services. Ecosyst. Serv. 30, A1–A2. https://doi.org/10.1016/j.ecoser.2018.02.002

Braat, L.C., de Groot, R., 2012. The ecosystem services agenda:bridging the worlds of natural science and economics, conservation and development, and public and private policy. Ecosyst. Serv. 1, 4–15. https://doi.org/10.1016/j.ecoser.2012.07.011

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. Glob. Environ. Chang. 26, 152–158. https://doi.org/10.1016/j.gloenvcha.2014.04.002

De Oliveira, L.E.C., Berkes, F., 2014. What value São Pedro's procession? Ecosystem services from local people's perceptions. Ecol. Econ. https://doi.org/10.1016/j.ecolecon.2014.08.008

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J.R., Arico, S., Báldi, A., Bartuska, A., Baste, I.A., Bilgin, A., Brondizio, E., Chan, K.M.A., Figueroa, V.E., Duraiappah, A., Fischer, M., Hill, R., Koetz, T., Leadley, P., Lyver, P., Mace, G.M., Martin-Lopez, B., Okumura, M., Pacheco, D., Pascual, U., Pérez, E.S., Reyers, B., Roth, E., Saito, O., Scholes, R.J., Sharma, N., Tallis, H., Thaman, R., Watson, R., Yahara, T., Hamid, Z.A., Akosim, C., Al-Hafedh, Y., Allahverdiyev, R., Amankwah, E., Asah, T.S., Asfaw, Z., Bartus, G., Brooks, A.L., Caillaux, J., Dalle, G., Darnaedi, D., Driver, A., Erpul, G., Escobar-Eyzaguirre, P., Failler, P., Fouda, A.M.M., Fu, B., Gundimeda, H., Hashimoto, S., Homer, F., Lavorel, S., Lichtenstein, G., Mala, W.A., Mandivenyi, W., Matczak, P., Mbizvo, C., Mehrdadi, M., Metzger, J.P., Mikissa, J.B., Moller, H., Mooney, H.A., Mumby, P., Nagendra, H., Nesshover, C., Oteng-Yeboah, A.A., Pataki, G., Roué, M., Rubis, J., Schultz, M., Smith, P., Sumaila, R., Takeuchi, K., Thomas, S., Verma, M., Yeo-Chang, Y., Zlatanova, D., 2015. The IPBES Conceptual Framework - connecting nature and people. Curr. Opin. Environ. Sustain. 14, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R.T., Molnár, Z., Hill, R., Chan, K.M.A., Baste, I.A., Brauman, K.A., Polasky, S., Church, A., Lonsdale, M., Larigauderie, A., Leadley, P.W., Van Oudenhoven, A.P.E., Van Der Plaat, F., Schröter, M., Lavorel, S., Aumeeruddy-Thomas, Y., Bukvareva, E., Davies, K., Demissew, S., Erpul, G., Failler, P., Guerra, C.A., Hewitt, C.L., Keune, H., Lindley, S., Shirayama, Y., 2018. Assessing nature's contributions to people_Supl Mat. Science (80-.). 359, 270–272. https://doi.org/10.1126/science.aap8826

Douvere, F., Ehler, C.N., 2009. New perspectives on sea use management: Initial findings from European experience with marine spatial planning. J. Environ. Manage. 90, 77–88. https://doi.org/10.1016/j.jenvman.2008.07.004

Foley, M.M., Armsby, M.H., Prahler, E.E., Caldwell, M.M.R., Ashley, L., Kittinger, J.N., Crowder, L.B., Levin, P.S., Foley, M.M., Armsby, M.H., Prahler, E.E., Caldwell, M.M.R., Erickson, A.L.A.A.L., Kittinger, J.N., Crowder, L.B., Levin, P.S., Ashley, L., Foley, M.M., Armsby, M.H., Prahler, E.E., Caldwell, M.M.R., Erickson, A.L.A.A.L., Ashley, L., Kittinger, J.N., Crowder, L.B., Levin, P.S., Foley, M.M., Armsby, M.H., Prahler, E.E., Caldwell, M.M.R., Erickson, A.L.A.A.L., Kittinger, J.N., Crowder, L.B., Levin, P.S., Ashley, L., 2013. Improving Ocean Management through the Use of Ecological Principles and Integrated Ecosystem Assessments. Bioscience 63, 619–631. https://doi.org/10.1525/bio.2013.63.8.5

García-Onetti, J., Scherer, M.E.G., Barragán, J.M., 2018. Integrated and ecosystemic approaches for bridging the gap between environmental management and port management. J. Environ. Manage. 206, 615–624. https://doi.org/10.1016/j.jenvman.2017.11.004

Gerhardinger, L.C., de Carvalho, F.G., Haak, L., Herbst, D.F., Poderoso, R.A., 2017. Planning Blues: Tenure rights fade under unjust "blue planning". Samudra Rep. 78, 42.

Gerhardinger, L.C., Gorris, P., Gonçalves, L.R., Herbst, D.F., Vila-Nova, D.A., De Carvalho, F.G., Glaser, M., Zondervan, R., Glavovic, B.C., 2018. Healing Brazil's Blue Amazon: The Role of Knowledge Networks in Nurturing Cross-Scale Transformations at the Frontlines of Ocean Sustainability. Front. Mar. Sci. 4. https://doi.org/10.3389/fmars.2017.00395

Gerhardinger, L.C., Herbst, D.F., Cunha, S., Duarte, M. In press. Diagnóstico da Ictiofauna do Ecossistema Babitonga. Revista CEPSUL: Conservação e Biodiversidade Marinha.

Gerhardinger, L.C., Paganini, A., Voos, C., Herbst, D.F., De Carvalho, F.G., Vieira, J.V., Cremer, M.J., Fontana, M., Silva, M.C., Freitas, R.R., Cunha, S. 2016. Oportunidades para o monitoramento Integrado do Ecossistema Babitonga (Santa Catarina, Brasil).

Gerhardinger, L.C., Quesada-Silva, M., Gonçalves, L.R., Turra, A., 2019. Unveiling the genesis of a marine spatial planning arena in Brazil. Ocean Coast. Manag. 179, 104825. https://doi.org/10.1016/j.ocecoaman.2019.104825

Guerry, A.D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G.C., Griffin, R., Ruckelshaus, M., Bateman, I.J., Duraiappah, A., Elmqvist, T., Feldman, M.W., Folke, C., Hoekstra, J., Kareiva, P.M., Keeler, B.L., Li, S., McKenzie, E., Ouyang, Z., Reyers, B., Ricketts, T.H., Rockström, J., Tallis, H., Vira, B., 2015. Natural capital and ecosystem services informing decisions: From promise to practice. Proc. Natl. Acad. Sci. U. S. A. 112, 7348–7355. https://doi.org/10.1073/pnas.1503751112

Guerry, A.D., Ruckelshaus, M.H., Arkema, K.K., Bernhardt, J.R., Guannel, G., Kim, C.K., Marsik, M., Papenfus, M., Toft, J.E., Verutes, G., Wood, S.A., Beck, M., Chan, F., Chan, K.M.A., Gelfenbaum, G., Gold, B.D., Halpern, B.S., Labiosa, W.B., Lester, S.E., Levin, P.S., McField, M., Pinsky, M.L., Plummer, M., Polasky, S., Ruggiero, P., Sutherland, D.A., Tallis, H., Day, A., Spencer, J., 2012. Modeling benefits from nature: Using ecosystem services to inform coastal and marine spatial planning. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 8, 107–121. https://doi.org/10.1080/21513732.2011.647835

Hare, J.A., Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., Alexander, M.A., Scott, J.D., Alade, L., Bell, R.J., Chute, A.S., Curti, K.L., Curtis, T.H., Kircheis, D., Kocik, J.F., Lucey, S.M., McCandless, C.T., Milke, L.M., Richardson, D.E., Robillard, E., Walsh, H.J., McManus, M.C., Marancik, K.E., Griswold, C.A., 2016. A vulnerability assessment of fish and invertebrates to climate change on the northeast u.s. continental shelf. PLoS One 11, 1–30. https://doi.org/10.1371/journal.pone.0146756

Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis. (1998). Proteção e controle de ecossistemas costeiros: manguezal da Baía Babitonga. Brasília, IBAMA, Coleção Meio Ambiente, Séries estudo pesca.146p.

Kelly, C., Ellis, G., Flannery, W., 2018. Conceptualising change in marine governance: Learning from Transition Management. Mar. Policy 95, 24–35. https://doi.org/10.1016/j.marpol.2018.06.023

Kenter, J.O., 2018. IPBES: Don't throw out the baby whilst keeping the bathwater; Put people's values central, not nature's contributions. Ecosyst. Serv. 33, 40–43. https://doi.org/10.1016/j.ecoser.2018.08.002

Leslie, H.M., McLeod, K.L., 2007. Confronting the challenges of implementing marine ecosystem-based management. Front. Ecol. Environ. 5, 540–548. https://doi.org/10.1890/060093

Liquete, C., Piroddi, C., Drakou, E.G., Gurney, L., Katsanevakis, S., Charef, A., Egoh, B., 2013. Current Status and Future Prospects for the Assessment of Marine and Coastal Ecosystem Services: A Systematic Review. PLoS One 8. https://doi.org/10.1371/journal.pone.0067737

Martín-López, B., Gómez-Baggethun, E., García-Llorente, M., Montes, C., 2014. Trade-offs across value-domains in ecosystem services assessment. Ecol. Indic. 37, 220–228. https://doi.org/10.1016/j.ecolind.2013.03.003

Mcdonough, K., Hutchinson, S., Moore, T., Hutchinson, J.M.S., 2017. Analysis of publication trends in ecosystem services research. Ecosyst. Serv. 25, 82–88. https://doi.org/10.1016/j.ecoser.2017.03.022

Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and human well-being: Wetlands and water synthesis. World Resources Institute, Washington, D.C., USA.

Ministério do Meio Ambiente (MMA). 2017. IV Plano de Ação Federal para a Zona Costeira (2017-2019). 37 pgs.

McLain, R., Poe, M., Biedenweg, K., Cerveny, L., Besser, D., Blahna, D., 2013. Making Sense of Human Ecology Mapping: An Overview of Approaches to

Integrating Socio-Spatial Data into Environmental Planning. Hum. Ecol. 41, 651–665. https://doi.org/10.1007/s10745-013-9573-0
Motesharrei, S., Rivas, J., Kalnay, E., 2014. Human and nature dynamics (HANDY): Modeling inequality and use of resources in the collapse or sustainability of societies. Ecol. Econ. 101, 90–102. https://doi.org/10.1016/j.ecolecon.2014.02.014
O'Higgins, T.G., Ferraro, S.P., Dantin, D.D., Jordan, S.J., Chintala, M.M., 2010. Habitat scale mapping of fisheries ecosystem service values in estuaries. Ecol. Soc. 15.
Pascual, U., Balvanera, P., Díaz, S., Pataki, G., Roth, E., Stenseke, M., Watson, R.T., Başak Dessane, E., Islar, M., Kelemen, E., Maris, V., Quaas, M., Subramanian, S.M., Wittmer, H., Adlan, A., Ahn, S.E., Al-Hafedh, Y.S., Amankwah, E., Asah, S.T., Berry, P., Bilgin, A., Breslow, S.J., Bullock, C., Cáceres, D., Daly-Hassen, H., Figueroa, E., Golden, C.D., Gómez-Baggethun, E., González-Jiménez, D., Houdet, J., Keune, H., Kumar, R., Ma, K., May, P.H., Mead, A., O'Farrell, P., Pandit, R., Pengue, W., Pichis-Madruga, R., Popa, F., Preston, S., Pacheco-Balanza, D., Saarikoski, H., Strassburg, B.B., van den Belt, M., Verma, M., Wickson, F., Yagi, N., 2017. Valuing nature's contributions to people: the IPBES approach. Curr. Opin. Environ. Sustain. https://doi.org/10.1016/j.cosust.2016.12.006
Peterson, G.D., Meacham, M., 2018. Welcoming different perspectives in IPBES : " Nature ' s contributions to people " and " Ecosystem services " Welcoming different perspectives in IPBES : " Nature ' s contributions to people " and " Ecosystem services " 23. https://doi.org/10.5751/ES-10134-230139
Raymond, C.M., Bryan, B.A., MacDonald, D.H., Cast, A., Strathearn, S., Grandgirard, A., Kalivas, T., 2009. Mapping community values for natural capital and ecosystem services. Ecol. Econ. 68, 1301–1315. https://doi.org/10.1016/j.ecolecon.2008.12.006
Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S.A., Bernhardt, J., 2015. Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. Ecol. Econ. 115, 11–21. https://doi.org/10.1016/j.ecolecon.2013.07.009

Small, N., Munday, M., Durance, I., 2017. The challenge of valuing ecosystem services that have no material benefits. Glob. Environ. Chang. 44, 57–67. https://doi.org/10.1016/j.gloenvcha.2017.03.005
THE NATURAL CAPITAL PROJECT (Natural Capital). 2017. Habitat Risk Assessment. InVEST documentation (3.6.0).http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/habitat_risk_assessment.html#hra-preprocessor
UNEP. 2011. Taking Steps toward Marine and Coastal Ecosystem-Based Management - An Introductory Guide. Agardy, T., Davis, J., Sherwood, K., Vestergaard, O. UNEP Regional Seas Reports and Studies No. 189
Wallace, K.J., 2007. Classification of ecosystem services : Problems and solutions 9. https://doi.org/10.1016/j.biocon.2007.07.015
Worm, B., Barbier, E.B., Beaumont, N., Duffy, J.E., Folke, C., Halpern, B.S., Jackson, J.B.C., Lotze, H.K., Micheli, F., Palumbi, S.R., Sala, E., Selkoe, K.A., Stachowicz, J.J., Watson, R., 2006. Impacts of biodiversity loss on ocean ecosystem services. Science (80-.). 314, 787–790. https://doi.org/10.1126/science.1132294

Wyatt, K.H., Griffin, R., Guerry, A.D., Ruckelshaus, M., Fogarty, M., Arkema, K.K., 2017. Habitat risk assessment for regional ocean planning in the U.S. Northeast and Mid-Atlantic. PLoS One 12, 1–20. https://doi.org/10.1371/journal.pone.0188776

CAP. 1 - Appendix I – SUPPLEMENTARY MATERIAL

We present here the process of mobilization of the user groups of direct resources of the Babitonga Bay/Santa Catarina (Brazil) and the participation of each group in the workshops conducted from September 2015 to May 2016. The number of workshops varied according to the existence of the groups in the municipalities around Babitonga Bay and with the participation of guests. The number of participants is per user group, not per workshop. ARA – Araquari, BBS- Balneário Barra do Sul, GAR- Garuva, ITA-Itapoá, JOI- Joinville and SFS – São Francisco do Sul.

Direct user group	**Municipalities**	**Form of mobilization**	**No. Workshops**	**No. of guests/ No. participants**
Mariculture agents	SFS	All the mariculture agents were invited to the workshop, in a meeting presenting the proposal and also by phone call and email;	1	25/4
Artisanal Fishermen	SFS*, ITA, GAR, JOI, ARA e BBS	The presidents of the municipal colonies of Itapoá, Garuva, São Francisco helped us with invitations. For SFS, ARA and BBS we went to the fishing communities and handed out printed invitations to the fishermen explaining the proposal;	9	225/105
Tourism and recreation agents	SFS, BBS, JOI, GAR, ITA**	It includes the representatives of all the marinas, tour boats and inns with sports fishing boats. The invitations were done through telephone and email;	5	63/29
Aquatic transport agents	Intermunicipal	Representatives of ferry boats and collective transports (ferry boat and boats) from all operating ports with licenses or those requesting licenses were invited in person and by letter;	1	10/12****
Miners***	JOI	Companies that operate in the extraction of mineral resources, mainly sand. Invitations made by telephone and email;	2	3/3
Researchers	Intermunicipal	Includes researchers conducting or that have conducted studies in the Babitonga Bay. Invitations made by telephone calls or email;	1	50/25
Total			19	376/178

* São Francisco do Sul is the city with the highest number of fishers and with the largest territory in contact with Babitonga bay, including terrestrial and insular areas in both sides of the bay. For this reason, and because of low participation rates in the first workshop (n=6) and the need to attend to minimum representation levels of the sector, we conducted more than one workshop in this municipality (n=4). For the second workshop we left responsibility for mobilization of fishers to the fishing guild's president, but only him showed up and he did not wanted to inform how many people he invited; ** As the tourism and recreational sector had few representatives in Itapoá city, we extended invitations for representatives of other cities (São Francisco do Sul) that could not attend the workshop in their location. *** Two mining companies are currently operating in Babitonga bay, but one did not accepted taking part of the same workshop with the presence of the other company and, thus, we had to facilitate two separate workshops.****10 institutions were invited, some were represented by more than one individual.

CAP. 2 - SUPPLEMENTARY MATERIAL

Tables

Table 1: The eight Planning Units (PUs) at Babitonga Ecosystem (Santa Catarina state, Brazil).

Planning Unit	Description	**Area (km²)**
Palmital River Chanel	Highly influenced by freshwater; includes 67 sedimentary islands, and the largest and most conserved mangrove areas; hence is highly relevant for recruitment and growth of commercially targeted fishes such as Snooks *Centropomus* spp. (Aliaume et al. 1997; Oliveira 2006; Grace et al. 2008; Vieira 2008; Fava 2016).	58.852
Linguado Chanel – Araquari segment	Connected with the inner bay, upstream of the closing of Linguado channel, hence the area most affected by siltation; important feeding ground for seabirds and fish. Grose et. al (2013).	31.504
Linguado Chanel - Barra do Sul segment	Connected with the sea, downstream of the closing of Linguado channel, hence has changed geomorphologically and biologically with the reduction of hydrodynamics; siltation in the channel's mouth to the sea offers risks to navigation; internal areas are used for nautical sports, small-scale and recreational fisheries; important recruiting and growth area for several fish species; has been zoned for aquaculture but no such use have ben yet initiated locally. (Cremer et al., 2006; Correa et al., 2006).	24.967
Entry of the Bay	Intense boat and ship traffic used by all licensed port activities; have the largest aquaculture parks in North coast of Santa Catarina state (oysters *Crassostrea* spp and mussels *Perna perna*); highly used by small-scale fisheries; ecologically relevant due to occurrence of mangroves and freshwater inputs from well-preserved rivers. Santos e Costa (2015).	63.899
Acaraí River	It lays within a protected area (State Park) and encompass ecologically sensitive areas which justifies largely restrictive human uses; has important archeological sites; ineffective management. Due to its distinct management regime, this PU was not considered in the analyses. (Fernandes et al., 2015).	5.100
Marine segment	Shallow coastal marine areas down to 20m deep; small-scale fishing fleet operates with irregular incursions of industrial fishing vessels; used by merchant navy ships awaiting liberation to unload at local ports; several sandy beaches providing economically relevant ecosystem services specially in warmer seasons. (Amaral et al., 2016; Gerhardinger et al., 2017).	856.33 8
Coastal Joinville segment	Closest to the largest urbanized, industrialized and populated areas of Santa Catarina state (Joinville city); suffers directly from sewage discharge in incoming rivers; important area for navigation and small-scale fisheries. Gerhardinger et. al (2017).	65.735

Central Islands	Area highly ecologically and aesthetically relevant, sheltering submerged rocky outcrops and a rich marine fauna, recruitment and reproduction of fish across its tidal plains, mangroves and shallow sandy beaches; shelters critically endangered species of fish (goliath Groupers *Epinephelus itajara*), porpoise (*Pontoporia blainvillei*) and grey-dolphins (*Sotalia guianensis*), and is an important area for shrimp production (*Litopenaeus schmitti*) and artisanal fisheries; used by people from all cities for tourism and leisure; several new private ports are being proposed to the area and are currently facing technically controversial environmental licensing processes. (Ferreira et al., 2001; Fletcher et al., 2012; Cremer et al., 2017; Gerhardinger et al., 2017)	45.617

Table 2: Presence of direct ecosystem user groups per city (first and second workshop cycles) and per Planning Unit (third workshop cycle).

Direct users/municipality	**Planning Unit (PU)**	**Entry of the Bay**	**Central Islands**	**Palmital River Chanel**	**Coastal Joinville segment**	**Linguado Chanel / Araquari**	**Linguado Chanel / Barra do Sul**	**Marine**
Aquatic transport		X	X	X				X
Tourism - Barra do Sul							X	X
Tourism - Garuva		X	X	X	X	X		X
Tourism - Itapoá		X	X	X				X
Tourism - Joinville		X	X	X	X			X
Tourism - São Francisco do Sul		X	X	X	X	X		X
Sand mining				X				
Mariculture - Barra do Sul							X	X
Mariculture - São Francisco do Sul		X	X				X	X
Artisanal fisheries - Araquari			X		X	X		
Artisanal fisheries - Barra do Sul							X	X
Artisanal fisheries - Garuva		X	X	X	X			
Artisanal fisheries - Itapoá		X						X
Artisanal fisheries - Joinville		X	X	X	X	X		
Artisanal fisheries - São Francisco do Sul*		X	X	X	X	X		X
Total user groups / PU		10	10	9	7	5	4	11

* São Francisco do Sul is the city with the largest territory in contact with Babitonga bay and higher number of active fishers. Therefore, the first cycle encompassed four workshops in this municipality in order to achieve better representation of the sector.

Table 3: List of pressures and examples of associated impact chains on ecosystem services and direct user groups.

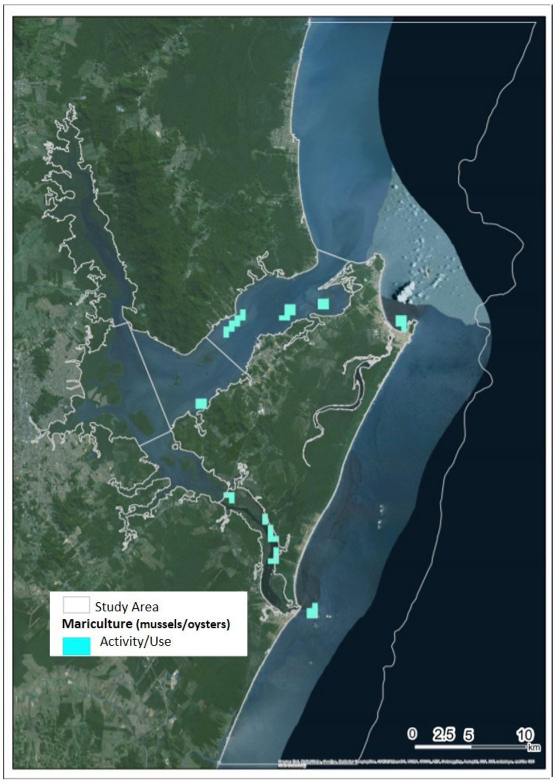
Number	Pressure	Ecosystem service type	Affected ecosystem services	Direct ecosystem users affected
1	Solid waste	Provisioning and cultural	Individuals of different species (genetic resources), water quality, aesthetics and contemplation, food	All users
2	Visual pollution	Cultural	Aesthetics and contemplation	Tourism and recreation agents
3	Stress to aquatic life generated by suspension of particulate sediments	Supporting, regulating and provisioning	Maintenance of life cycle and genetic diversity, genetic resources, water regulation, food, nutrient cycling, primary production	Artisanal fisheries
4	Changes in hydrodynamics	Supporting, regulating and provisioning	Maintenance of life cycle, maintenance of genetic diversity, genetic resource, food, water quality	Artisanal fisheries, maricuture, tourism and recreation agents, aquatic transport
5	Higher aquatic traffic	Supporting and cultural	Social relations, maintenance of life cycle	Artisanal fisheries, tourism and recreation agents, aquatic transport
6	Overfishing	Supporting, provisioning and cultural	Sport fishing, food, maintenance of genetic diversity, nutrient cycling	Artisanal fisheries, tourism and recreation agents
7	Water pollution	Supporting, regulating. provisioning, cultural	Maintenance of life cycle, maintenance of genetic diversity, genetic resource, water regulation, food, nutrient cycling, primary production	Artisanal fisheries, maricuture, tourism and recreation agents, aquatic transport
8	Degradation of nursery grounds	Supporting and regulating	Maintenance of genetic diversity, maintenance of life cycle, regulation of pests and diseases, nutrient cycling	Artisanal fisheries
9	Oil spill	Supporting, regulating, provisioning and cultural	Maintenance of genetic diversity, maintenance of life cycle, genetic resource, water regulation, food, nutrient cycling, primary production	Artisanal fisheries, maricuture, tourism and recreation agentes, aquatic transport
10	Coastal mangroves erosion	Regulating, supporting and cultural	Regulation of erosion, nutrient cycling, aesthetics and contemplation	Artisanal fisheries, maricuture, tourism and recreation agents
11	Coastal deforestation	Regulating, supporting and cultural	Regulation of erosion, nutrient cycling, photosynthesis (carbon sequestration), aesthetics, maintenance of life cycle,	Artisanal fisheries, maricuture, tourism and recreation agents

			maintenance of genetic diversity	
12	Exclusion of areas to another sector	Cultural	Social relations	Artisanal fisheries, tourism and recreation agentes, aquatic transport
13	Sound pollution	Supporting and cultural	Aesthetics and contemplation, maintenance of life cycle	Artisanal fisheries, tourism and recreation agents
14	Alteration/loss of consolidated bottoms	Supporting, regulating, provisioning and cultural	Maintenance of life cycle, maintenance of genetic diversity, genetic resource, water regulation, food, nutrient cycling, primary production, aesthetics, social relations	Artisanal fisheries, tourism and recreation agents
15	Light pollution	Supporting	Maintenance of life cycle, maintenance of genetic diversity	Artisanal fisheries, tourism and recreation agents
16	Fertilizer pollution	Supporting, regulating and provisioning	Maintenance of life cycle, maintenance of genetic diversity, genetic resources, water regulation, food, nutrient cycling, primary production	Artisanal fisheries
17	Direct invasion of exotic species	Supporting and regulating	Pest regulation, maintenance of life cycle, maintenance of genetic diversity	Artisanal fisheries
18	Alteration/loss of soft bottoms	Supporting, regulating and provisioning	Maintenance of life cycle, maintenance of genetic diversity, genetic resource, water regulation, food, nutrient cycling, primary production	Artisanal fisheries, maricuture, tourism and recreation agents
19	Indirect facilitation of exotic species	Supporting and regulating	Regulation of pests, maintenance of life cycle, maintenance of genetic diversity	Artisanal fisheries
20	Fisheries bycatch	Supporting, provisioning and cultural	Maintenance of life cycle, maintenance of genetic diversity, sport-fishing	Artisanal fisheries, tourism and recreation agents
21	Obstruction of navigation channels	Cultural	Social relations	Artisanal fisheries, tourism and recreation agents, aquatic transport
22	Loss of fishing grounds	Cultural	Social relations	Artisanal fisheries
23	Loss of fishing gears (ghost-fishing)	Supporting and cultural	Maintenance of life cycle, maintenance of genetic diversity, nutrient cycling, aesthetic and contemplation, sport- fishing	Artisanal fisheries, tourism and recreation agents, aquatic transport

Layers of single activities maps

Layers built during workshops, as they were presented back and discussed with resource users in the following workshop cycle (on-line geographic information system available at: https://www.babitongaativa.com).While in the case of fisheries layers are shown by exploited resource herein, our risk analysis was performed using layers by each fisheries modality.

Mariculture (mussels and oysters)

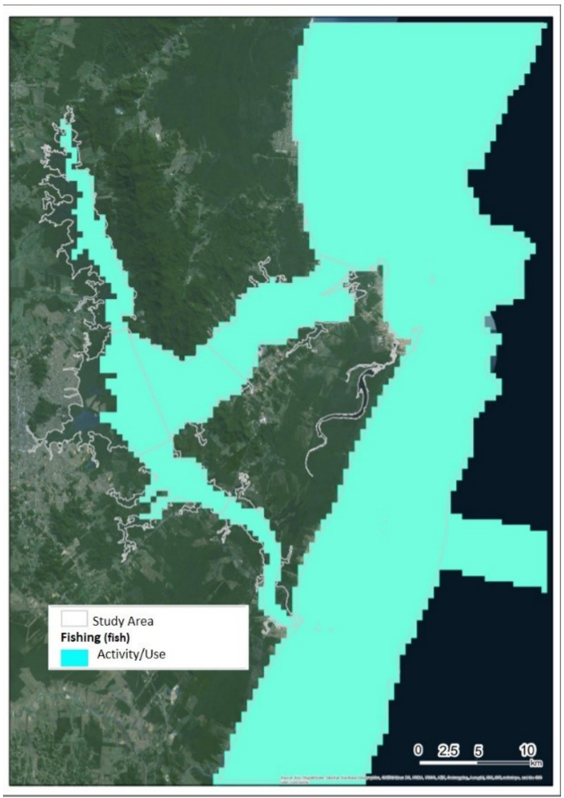


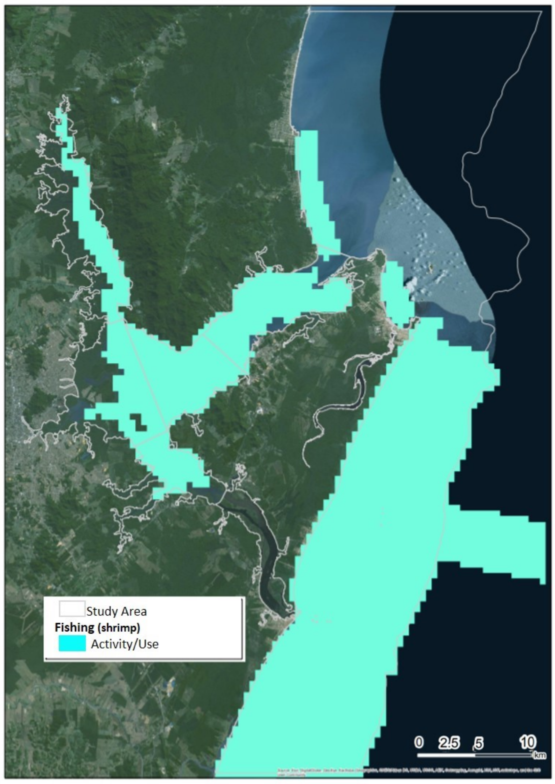
Mining

Artisanal fisheries

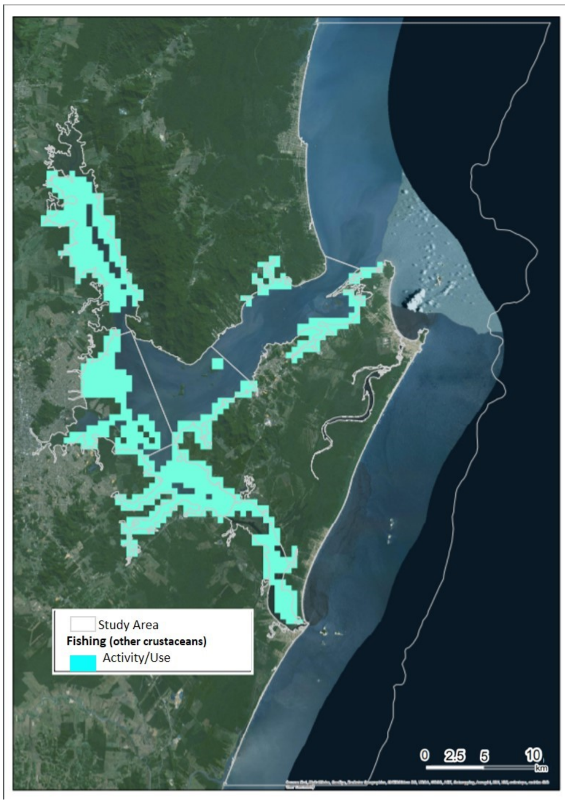
Finfish fisheries - Six Activities (Surface gillnet, Bottom gillnet, Line, Castnet, Longline, Beach seine)

Shrimp fisheries – Three Activities (Gerival, Bottom trawling, Shrimp seine)

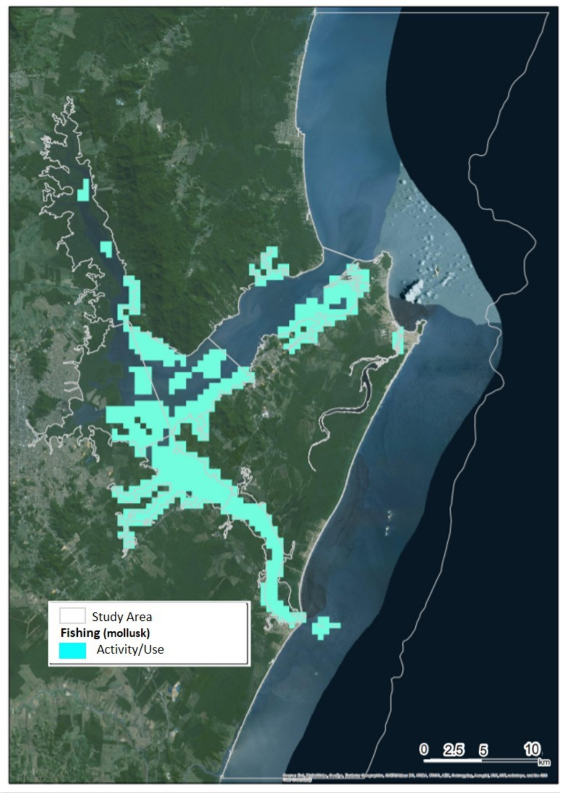




Other crustaceans (Mangrove crab harvesting, Swimming crab fishing)



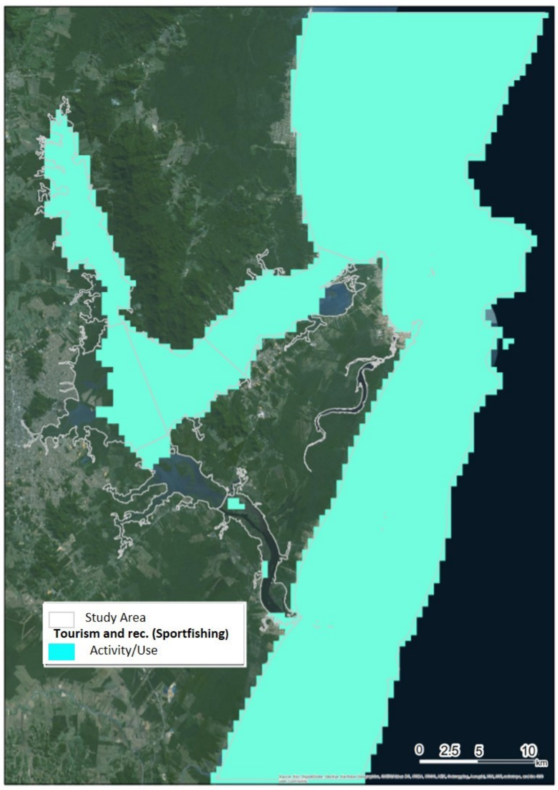
Harvesting of mollusks



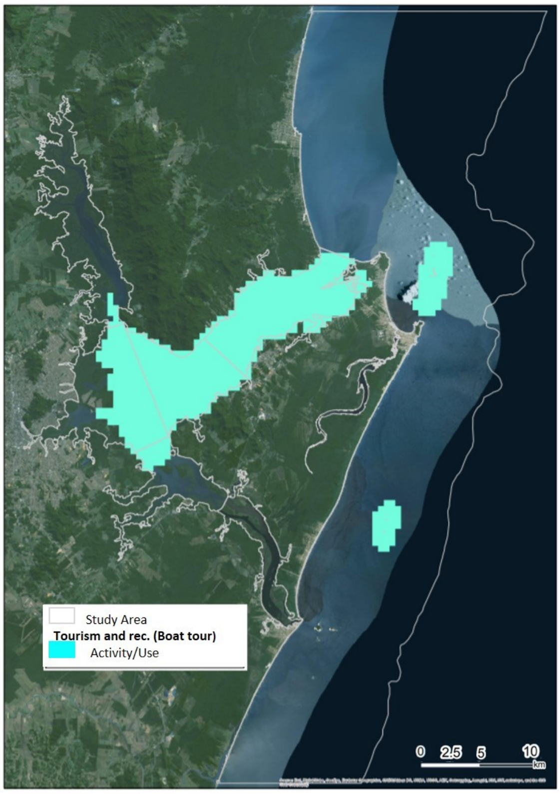
Tourism and recreation

Marinas (boat trip)

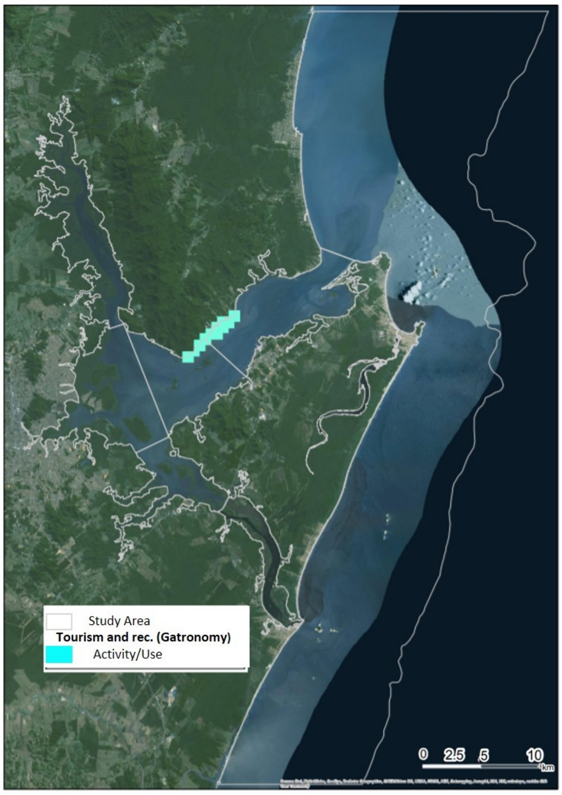
Sportfishing



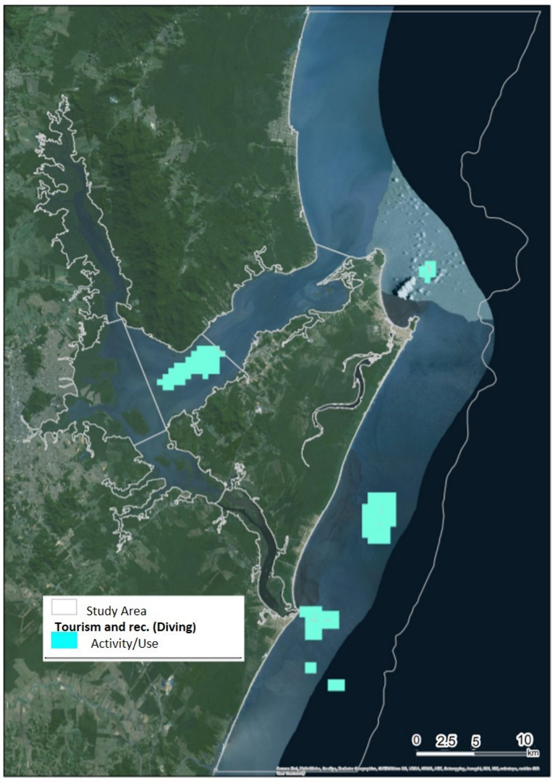
Boat tour



Gastronomy

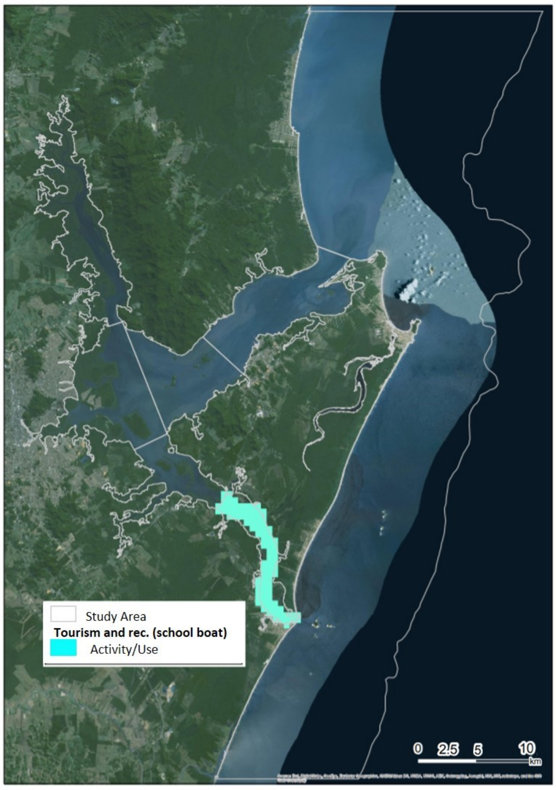


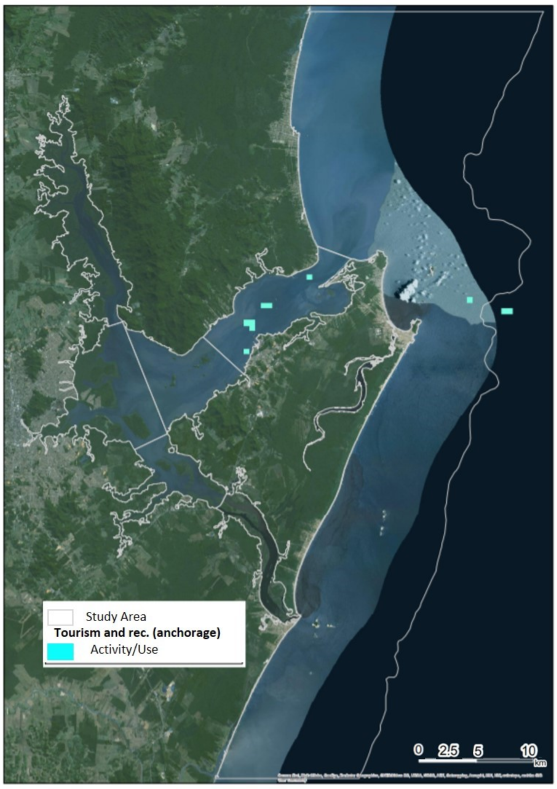
Diving/ shelter/spearfishing



Tourism Stop-over

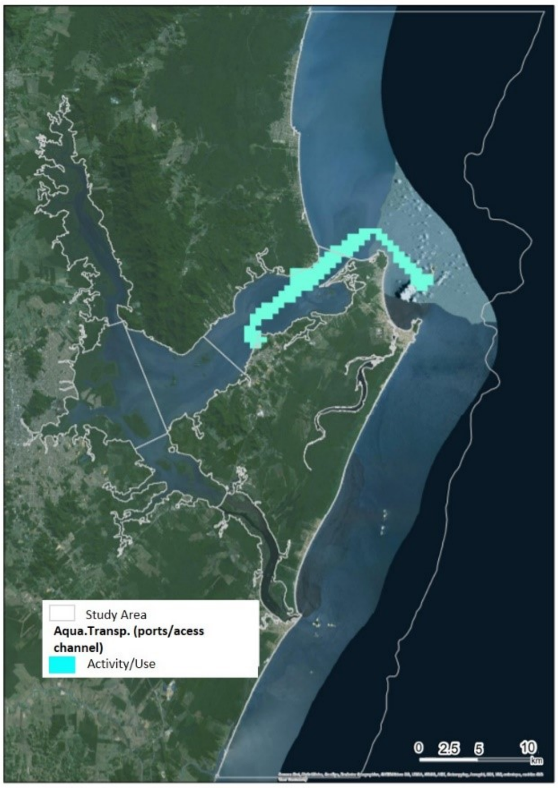
Environmental education (school boat) Tourism anchorage stop-over vessels



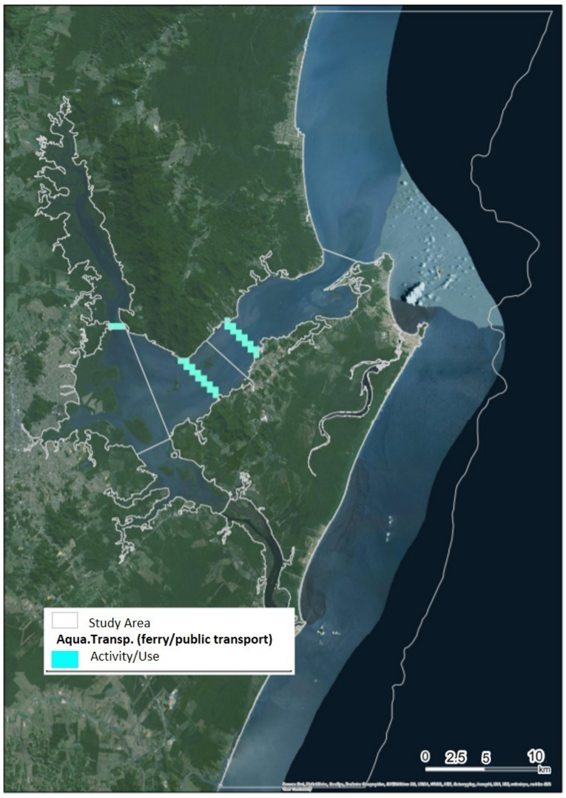


Aquatic transport

Ports and acess channel Oil ship anchorage buoy and oil pipes



Ferry and public transport



Figure

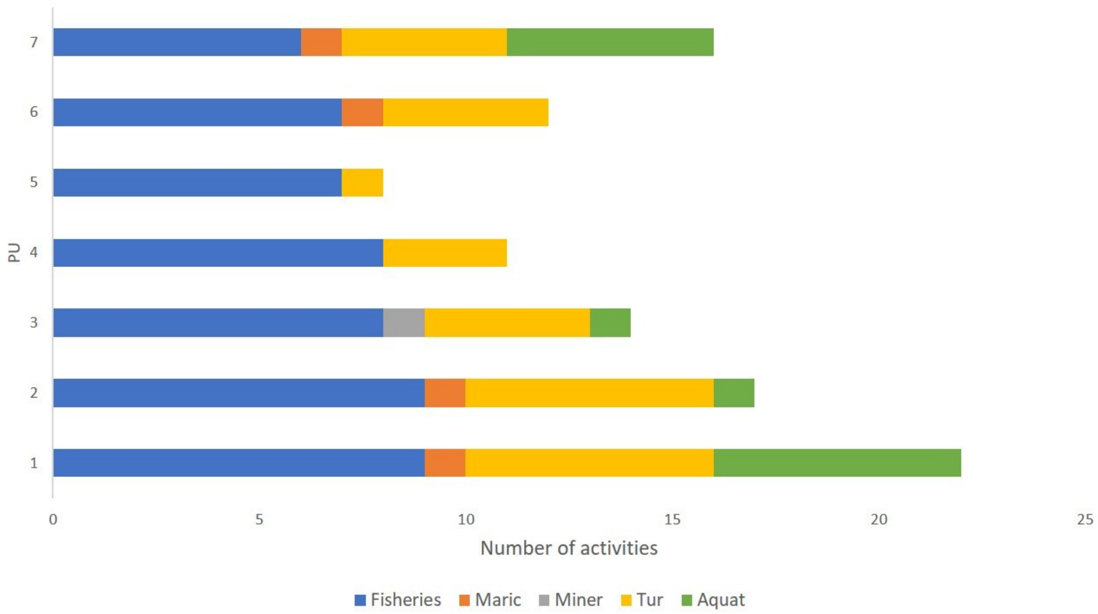


Fig. 1: Number of activities by each sector operating in Babitonga Ecosystem Planning Units: (PU): 1) Entry of the Bay, 2) Central islands, 3) Palmital River, 4) Coastal Joinville, 5) Linguado Chanel – Araquari, 6) Linguado Chanel - Barra do Sul, 7) Marine.