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Serviços ecossistêmicos e suas vulnerabilidades às Mudanças Climáticas: Desafios e oportunidades para a gestão ecossistêmica de praias

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Dissertação apresentada ao Programa de Pós-Graduação em Energia do Instituto de Energia e Ambiente (PROCAM) da Universidade de São Paulo para a obtenção do título de Mestre em Ciências.

Orientador: Prof. Dr. Alexander Turra
Co-orientador: Prof. Dr. Paulo Sinisgalli

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"(...) um dia eu ainda vou me redimir por inteiro do pecado do intelectualismo. Se Deus quiser. Não vou ter mais necessidade de falar nada, de ficar pensando em termos descontrários de tudo para tentar explicar às pessoas (...) que eu não estou querendo ser dono da verdade, que eu não estou querendo fazer sozinho uma obra que é de todos nós e de mais alguém: que é o tempo, o verdadeiro grande alquimista. Aquele que realmente transforma tudo. Um pequenino grão de areia, é o que eu sou."

(Gilberto Gil - Introdução da música "Iansã" ao vivo na USP, 1975)

RESUMO

CORRÊA, Marina Ribeiro. **Serviços ecossistêmicos e suas vulnerabilidades às Mudanças Climáticas: Desafios e oportunidades para a gestão ecossistêmica de praias**. 2021. 114 f. Dissertação (Mestrado em Ciência Ambiental) – Instituto de Energia e Ambiente, Universidade de São Paulo, São Paulo, 2021.

As mudanças ambientais globais, como as Mudanças Climáticas (MC), e seus efeitos sobre os complexos ecossistemas costeiros e oceânicos, têm levado ao desenvolvimento de novas estratégias de gestão, como a Gestão Baseada em Ecossistemas (GBE): uma abordagem sistêmica, adaptativa e com perspectiva de longo prazo. Uma das estratégias de implementação da GBE é diagnosticar vulnerabilidades socioecológicas e responder a elas com antecedência, podendo, assim, ser operacionalizada a partir da manutenção da provisão de longo-prazo de Serviços Ecossistêmicos (SE). Na América Latina e Caribe (AL&C) a implementação de novos modelos de gestão, como a GBE, é especialmente requerida para garantir a sustentabilidade das praias. Entretanto, para que se transforme uma gestão no sentido da abordagem ecossistêmica deve-se entender quais fatores existentes podem ser catalisadores ou barreiras dessa mudança. Nesse sentido, também se faz necessário investigar o contexto aplicado da gestão em nível local, reforçando o papel que os atores governamentais locais podem ter nessa transformação da gestão de praias. Porém a AL&C e o ecossistema praial carecem de estudos empíricos e teóricos sobre a implementação da GBE. Assim, o objetivo da presente dissertação foi contribuir com a discussão sobre a implementação da GBE em praias, trazendo, principalmente, aportes para o contexto da AL&C e para sua implementação em nível local. No primeiro capítulo foi feita uma reflexão geral sobre as oportunidades da incorporação da GBE na gestão de praias e os desafios para sua implementação na AL&C. Os outros dois capítulos utilizaram um estudo de caso na AL&C para investigar como a percepção dos gestores governamentais locais sobre a vulnerabilidade dos SE pode influenciar na transformação da gestão de praias local no sentido da GBE. Por meio de técnicas como levantamento e revisão documental (de políticas públicas, normas legais e literatura científica), workshops com gestores governamentais locais, análise de redes sociais e análise do conteúdo, a dissertação ampliou o conhecimento sobre a implementação da GBE em ecossistemas praiais, fornecendo subsídios para seu manejo sustentável, principalmente na gestão local e na AL&C. Portanto, junto à uma reflexão sobre as oportunidades da incorporação da GBE na gestão de praias e as possíveis barreiras e catalisadores para sua implementação na AL&C, a análise da percepção dos gestores governamentais locais sobre a vulnerabilidade dos SE reforçou a importância desses atores para a implementação da GBE e não apenas trouxe quais esclarecimentos conceituais são necessários em termos da abordagem ecossistêmica em praias, como também foi uma oportunidade de cooperação entre pesquisadores e gestores na adaptação do atual sistema de governança.

PALAVRAS-CHAVE: Tomadores de decisão; Gestão Costeira; Abordagem Ecossistêmica; Praias arenosas; Zona Costeira.

ABSTRACT

CORRÊA, Marina Ribeiro. **Serviços ecossistêmicos e suas vulnerabilidades às Mudanças Climáticas: Desafios e oportunidades para a gestão ecossistêmica de praias**. 2021. 114 f. Dissertação (Mestrado em Ciência Ambiental) – Instituto de Energia e Ambiente, Universidade de São Paulo, São Paulo, 2021.

Global changes, such as Climate Change, and its effects on the complex coastal ecosystems have led to the development of new management strategies, such as Ecosystem-Based Management (EBM): a holistic and adaptive approach to diagnose socio-ecological vulnerabilities and early respond to them. EBM can be operationalized based on the maintenance of the long-term provision of Ecosystem Services (ES). In Latin America and the Caribbean (LA&C), the search for new management strategies, such as EBM, is especially required to ensure beach sustainability. In order to transform management practices towards EBM, however, it is necessary to understand the catalysts and barriers to this change. For the beach management transformation toward sustainability, the context of the local level management must be investigated, reinforcing the role of local government actors. However, there is a lack of empirical and theoretical studies on the EBM implementation for both in LA&C and beach management. The aim of this dissertation was to contribute to the discussion on the EBM implementation on beaches, bringing inputs to its implementation at the local level and to the LA&C context. The first chapter reflected on opportunities for incorporating EBM in beach management and the challenges for its implementation in LA&C. The other two chapters utilized a case study at LA&C to investigate how the local government managers' perceptions about the ES vulnerabilities can influence the transformation of local beach management towards EBM. Through techniques such as survey and document review (of public policies, legal norms, and scientific literature), workshops with local government managers, social network analysis, and content analysis, the dissertation expanded the knowledge about EBM implementation in beach ecosystems, providing subsidies for beach sustainable management, mainly in local management and LA&C. Therefore, along with a reflection on the possible barriers and catalysts for EBM implementation, the analysis of the local government managers' perceptions on the vulnerability of SE brought relevant theoretical contributions to understand the applied dimension of EBM implementation on beaches, with potential for application to other ecosystems.

KEYWORDS: Decision-Makers; Coastal Management; Ecosystem Approach; Sandy Beaches; Coastal Zone.

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LISTA DE ABREVIATURAS E SIGLAS

AL&C	América Latina e Caribe
BES	Beach Ecosystem Services
CPGN	Current Perceived Governance Network
DGN	Desired Governance Network
EBM	Ecosystem-Based Management
ES	Ecosystem Services
GBE	Gestão Baseada em Ecossistemas
GCI	Gestão Costeira Integrada
LA&C	Latin America and the Caribbean
LNP	Litoral Norte Paulista
MC	Mudanças Climáticas
SE	Serviços Ecossistêmicos
SES	Social-ecological systems
SNA	Social Network Analysis

Sumário

INTRODUÇÃO GERAL

Os ambientes costeiros provêm uma série de benefícios para o bem-estar humano (McLeod; Leslie, 2009), porém são afetados por pressões e impactos negativos decorrentes das atividades antrópicas (Halpern et al., 2008; Curtin; Prellezo, 2010). As mudanças climáticas (MC) são um sinal proeminente das alterações provocadas pelo ser humano no ambiente global e que geram transformações em ecossistemas costeiros (Steffen et al., 2011; IPCC, 2014). Nesse ritmo de transformações, estima-se que quanto mais o mundo muda, menor a chance de que abordagens rígidas de gestão sejam bem-sucedidas na busca de soluções ou remediações (Chapin III; Kofinas; Folke, 2009).

Os modelos rígidos de gestão estão pautados na transposição da abordagem disciplinar, focada em manter um conjunto estreito de recursos e em controlar possíveis mudanças (Folke et al., 2005; Chapin III; Kofinas; Folke, 2009). Além de não assumirem o ser humano como parte de um sistema socioecológico[1] (Folke, 2003; Chapin III; Kofinas; Folke, 2009), esses modelos não levam em conta a inclusão de múltiplos setores da sociedade na tomada de decisão para lidar com as mudanças ambientais (Crona et al., 2011). Assim, são considerados reducionistas e incapazes de garantir a integridade dos ecossistemas marinhos e oceânicos e manter a provisão de benefícios para o bem-estar humano no longo prazo (Curtin; Prellezo, 2010; McLeod; Leslie, 2009; DeLauer et al., 2014).

Diante desse cenário e de motivações originadas na Conferência das Nações Unidas sobre o Meio Ambiente (Conferência de Estocolmo, 1972), debates sobre novas formas de desenvolvimento e gestão emergiram com repercussões para a zona costeira (Cicin-Sain, 1993). Essas novas formas de gestão contrapõem sistemas convencionais e incorporam a necessidade de restaurar e manter a saúde dos ecossistemas em longo prazo (Leslie; McLeod, 2007; Long; Charles; Stephenson, 2015). Neste debate, evidencia-se a importância de gerir os oceanos e a zona costeira a partir da Gestão Baseada em Ecossistemas (GBE)[2] (McLeod; Leslie, 2009).

A GBE tem como meta manter o ecossistema em uma condição saudável, produtiva e resiliente para que ele possa prover benefícios ao bem-estar humano em longo prazo (McLeod;

[1] Sistemas Socioecológicos: sistemas em que os humanos dependem de recursos e serviços providos pelos ecossistemas e, ao mesmo tempo, a dinâmica dos ecossistemas é influenciada, em diferentes graus, pelas atividades antrópicas (Berkes et al., 2003), refletindo a interação entre os processos ecológicos (inclusive físicos) e sociais.

[2] Embora GBE, abordagem ecossistêmica e 'ecosystem stewardship' não sejam conceitos sinônimos, eles compartilham os mesmos princípios e, quando aplicados na prática, geralmente levam a resultados de gestão semelhantes (Kirkfeldt, 2019). Para melhor discutir os resultados da presente pesquisa, esses conceitos foram usados como sinônimos.

Leslie, 2009). Para atingir seu objetivo a GBE prevê a participação e colaboração de um conjunto diversificado de atores na gestão (Bodin, Sandström; Crona, 2017; McLeod; Leslie, 2009). Entre outras características, a GBE trata o oceano e a zona costeira como sistemas socioecológicos, além de considerar e responder às mudanças ambientais (e.g., MC) (Chapin III; Kofinas; Folke, 2009; McLeod; Leslie, 2009). Portanto, este modelo de gestão é uma abordagem holística e adaptativa (Long; Charles; Stephenson, 2015), reconhecendo o sistema a ser gerido como resultado da dinâmica de longo prazo da interconexão entre os sistemas físico, social e ecológico (Chapin III; Kofinas; Folke, 2009).

A GBE é vista internacionalmente como uma das melhores práticas para a governança e gestão do oceano (Espinosa-Romero et al., 2011) e sua implementação é considerada necessária para a manutenção da estrutura e do funcionamento do oceano e da zona costeira (Tallis et al., 2010). Dessa maneira, o interesse na GBE e em sua aplicação está crescendo gradualmente também em países em desenvolvimento (Christie et al., 2009; Tallis et al., 2010). Atualmente, as discussões acerca deste modelo de gestão concentram-se em entender como implementá-lo e operacionalizá-lo (Arkema; Abramson; Dewsbury, 2006; Berkes, 2012).

Para que se transforme uma gestão no sentido da abordagem ecossistêmica, deve-se entender quais fatores (atores, instituições etc.) são catalisadores ou barreiras dessa mudança (Kelly; Ellis; Flannery, 2018). Se a implementação da GBE for um afastamento radical da gestão existente, ela pode originar resistência e afetar o equilíbrio delicado entre fazer algo diferente e manter os processos de gerenciamento atuais (Christie et al., 2009; Leslie et al., 2015). Desta maneira, para implementar a GBE é necessário que o contexto aplicado da gestão em nível local seja estudado e compreendido (Christie et al., 2009; Sardá et al., 2014; Leslie et al., 2015).

Dentre os ecossistemas costeiros, as praias arenosas são o ambiente dominante na maior parte das regiões temperadas e tropicais (McLachlan; Brown, 2006). As praias proveem diversos benefícios ao bem-estar humano (Sardá; Lozoya, 2018). Ao promover transformações nesses ecossistemas, as mudanças ambientais (e.g., MC) e impactos antrópicos estão afetando (e continuarão afetando) diretamente o bem-estar humano garantido pelas praias (Defeo et al., 2009). Assim, a implementação de abordagens reducionistas tradicionais também não vem tendo sucesso neste ecossistema (Botero, Williams e Cabrera, 2015).

As praias também podem ser entendidas como um sistema socioecológico, porém a conservação de suas características e processos físicos e ecológicos não costuma fazer parte de sua gestão (Schlacher et al., 2008). Historicamente, a gestão de praias foca em poucos benefícios providos por este ecossistema e é caracterizada pelo baixo envolvimento de

diferentes atores (Ariza; Jiménez; Sardá, 2008; Sardá et al., 2015; Williams; Micallef, 2009). Ainda, de maneira geral, os impactos de longo prazo (e.g., MC) são tipicamente ignorados em sua gestão (Williams; Micallef, 2009). Dessa maneira, a implementação da GBE neste ambiente é um passo fundamental para garantir sua sustentabilidade (Sardá et al., 2015). Entretanto, nos últimos anos, não foi vista uma melhoria substancial nos processos de gestão de praias e a perspectiva da abordagem ecossistêmica é raramente aplicada, com uma profunda lacuna entre a teoria e a prática de gestão ambiental (Katsanevakis et al., 2011; Sardá et al., 2015).

Apesar da pesquisa em estratégias de gestão de praias e conservação deste ecossistema serem pouco presentes na literatura (*c.f.*, Nel et al., 2014), a prática da GBE na gestão de praias depende do desenvolvimento de estratégias de gestão que sustentem sua implementação (Sardá; Lozoya, 2018). Uma das estratégias para implementar a GBE é utilizar o conceito de Serviços Ecossistêmicos (SE) para operacionalizá-la (Granek et al., 2010; McLeod; Leslie, 2009; O'Higgins; Lago; Dewitt, 2020; Tallis et al., 2010). SE são as contribuições do ecossistema que fornecem benefícios ao bem-estar humano (Potschin; Haines-Young, 2016). Ao ser utilizada na GBE, a abordagem de SE coloca como objetivo de gestão a manutenção do funcionamento do ecossistema para garantir a provisão de longo prazo de SE (Chapin III; Kofinas; Folke, 2009; O'Higgins; Lago; Dewitt, 2020; Sardá et al., 2015).

Avaliações sobre as mudanças na provisão de SE em cenários futuros de mudanças ambientais são importantes elementos que podem subsidiar a tomada de decisão na gestão de praias (Balvanera et al., 2012). Somada à abordagem de SE, a implementação da GBE pode, portanto, utilizar a abordagem de análise e redução de vulnerabilidades (Chapin III; Kofinas; Folke, 2009). Vulnerabilidades são descritas como uma função de três elementos sobrepostos: exposição, sensibilidade e capacidade adaptativa (Chapin III; Kofinas; Folke, 2009). Embora as medidas de gestão não possam controlar a ocorrência e exposição a um evento exógeno (e.g., mudanças ambientais ou impactos das MC), elas podem lidar com as transformações causadas pelos fatores exógenos no sistema socioecológicos e com as respostas do sistema para lidar com estas transformações (O'Higgins; O'Dwyer, 2019).

As estratégias de gestão com objetivo de reduzir as vulnerabilidades podem, portanto, utilizar a dinâmica de longo prazo da provisão de SE para definir medidas de adaptação que visem a diminuição da sensibilidade do sistema socioecológico (i.e., grau em que o sistema será impactado (ou alterado) (Berrouet; Machado; Villegas-Palácio, 2018). Ao mesmo tempo, as estratégias que visam reduzir vulnerabilidades podem adotar medidas que proporcionem o aumento da capacidade adaptativa para lidar com as consequências das mudanças ambientais no sistema socioecológico (Adger et al., 2003; Chapin III; Kofinas; Folke, 2009). A capacidade

adaptativa pode ser considerada a capacidade de um grupo de atores de agir coletivamente para resolver problemas (Chapin III; Kofinas; Folke, 2009). Assim, o aumento da capacidade adaptativa pode ser entendido como o aprimoramento das redes de governança[3] a partir da colaboração entre diferentes setores sociais e níveis administrativos, criando oportunidades para melhor atender a complexidade e mudanças nos sistemas socioecológicos (Bodin, Sandström; Crona, 2017; Chapin III; Kofinas; Folke, 2009; O'Higgins; Lago; Dewitt, 2020).

Se a conexão entre as mudanças no funcionamento do ecossistema e suas consequências no bem-estar humano não for bem conhecida ou reconhecida, o processo de tomada de decisão não implementará as medidas necessárias para lidar com tais mudanças e garantir o fornecimento de SE no longo prazo e os benefícios resultantes (Dee et al., 2017; Berrouet; Machado; Villegas-Palácio, 2018). Portanto, para a implementação da GBE, é necessário estabelecer uma visão sistêmica que englobe a conexão entre o bem-estar humano e o funcionamento de longo prazo do ecossistema (i.e. estrutura, processos e respostas às mudanças) (Arkema; Abramson; Dewsbury, 2006; Christie et al., 2009; Granek et al., 2010; Sardá; Lozoya, 2018). Ainda, ela depende do gerenciamento e manutenção das redes de governança para promover a colaboração entre os diversos atores envolvidos no sistema socioecológico (Imperial, 1999). Nesse sentido é compreendido o papel dos especialistas e do conhecimento científico (como um entre os diversos atores e tipos de conhecimento nessa dinâmica) para capacitar gestores e auxiliar na transição para modelos novos de gestão (e.g., GBE) (Arkema; Abramson; Dewsbury, 2006; Leslie et al., 2015; Folke et al., 2005; Waltner-Toews; Kay, 2005; Hopkins; Bailly, 2013).

Durante o processo de implementação de GBE, portanto, deve-se considerar 'onde os tomadores de decisão estão' e sua capacidade de adquirir novas perspectivas (DeLauer et al., 2014; Russel; Jordan; Turnpenny, 2016). Para obter essa informação, a percepção dos gestores sobre a vulnerabilidade dos SE pode ser acessada, visto que, segundo Beyerl, Putz e Breckwoldt (2016, p. 4), percepção é "a forma subjetiva como as pessoas vivenciam, pensam sobre e entendem alguém ou algo". Assim, para aplicar a abordagem da vulnerabilidade introduzida na GBE é necessário, entre outros elementos, entender como os gestores percebem as ligações entre as dimensões humana e social e as vias causais que moldam o fornecimento de longo prazo de SE e seus benefícios para o bem-estar humano (i.e., sensibilidade dos SE). Ainda, se

[3] Redes de governança: é uma estrutura de rede social única, em um ponto no tempo, onde um conjunto de atores ("nós") com atributos distintos (por exemplo, percepções, informações, poder), e que podem estar conectados (ou não) por caminhos pelos quais as interações ocorrem ("laços"), lidam com uma questão em comum (Cohen; Evans; Mills, 2012).

faz necessário acessar a capacidade adaptativa percebida destes gestores (*c.f.*, Grothmann; Patt, 2005), que pode ser entendida como a maneira com a qual eles percebem as possíveis mudanças na rede de governança para melhor lidar com as mudanças ambientais e implementar a GBE.

A gestão da praia geralmente ocorre em nível local (ou seja, a praia ou o município) (McLachlan; Defeo, 2017; Williams; Micallef, 2009) e a implementação da GBE depende igualmente da prática de gestão nesse nível (e.g., governos municipais) (Christie et al., 2009; Leslie et al., 2015). Portanto, os atores do governo local podem ter um papel fundamental na implementação da GBE (e.g., em praias) (Sardá; Lozoya, 2018; Sandström; Bodin; Crona, 2015). Dessa maneira, se faz necessário investigar como a percepção dos atuais gestores governamentais locais de praias sobre a vulnerabilidade dos SE pode interferir na transformação da gestão de praias no sentido da GBE. Para tanto, é necessário determinar uma mudança de longo-prazo central a ser considerada na implementação da GBE em praias em nível local.

Sendo os processos físicos primordiais para a dinâmica da praia (McLachlan; Defeo, 2017), o cenário de mudança de longo-prazo premente a ser considerado em praias é o desaparecimento ou diminuição das praias devido a erosão costeira intensificada pelas MC e crescimento urbano descontrolado (McLachlan; Defeo, 2017; McLachlan et al., 2013). Este impacto é induzido globalmente, mas depende de respostas da gestão local e regional (McLachlan; Defeo, 2017), sendo um bom exemplo a ser utilizado para investigar a percepção dos atuais gestores governamentais locais de praias sobre a vulnerabilidade de SE para a implementação da GBE (Figura 1).

A implementação de uma abordagem mais sustentável na gestão de praias é especialmente requerida em países da América Latina e Caribe (AL&C), nos quais as ameaças às praias e seu modelo de gestão reforçam a discussão quanto à inadequação de métodos reducionistas tradicionalmente empregados para a solução de problemas complexos (Botero; Williams; Cabrera, 2015). Assim, o objetivo dessa dissertação foi investigar como o contexto da gestão de praias na AL&C e a percepção dos gestores interferem na implementação da abordagem ecossistêmica, principalmente em nível local.

A partir de uma abordagem indutiva, essa dissertação ampliou o conhecimento sobre a implementação da GBE em ecossistemas praiais, fornecendo subsídios para seu manejo sustentável, principalmente na gestão local e na América Latina e Caribe. Por ser resultado da interação da aluna com grupos de pesquisa, os capítulos desta dissertação foram delineados pela aluna e escritos em colaboração com autores de diferentes institutos de pesquisa e países. A dissertação focou em três pontos específicos que foram abordados separadamente, em forma de artigos científicos, nos três capítulos que a compõem.

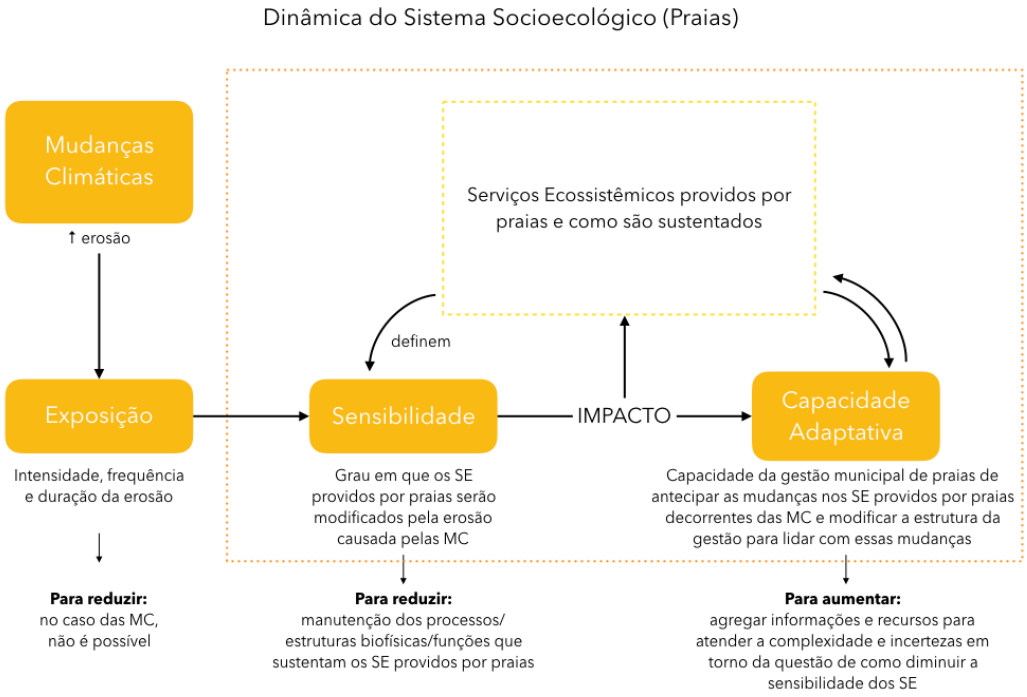

Figura 1. Modelo conceitual representando a abordagem de redução de vulnerabilidades das praias às Mudanças Climáticas utilizando o conceito "Serviços Ecossistêmicos" e sua sustentação como ferramenta de comunicação para a conexão entre a dimensão humana e ecológica de um sistema (Adaptação: Chapin III; Kofinas; Folke, 2009, p. 21).

No Capítulo I foi feito um ensaio com reflexões sobre as oportunidades da incorporação da GBE na gestão de praias e as possíveis barreiras e catalisadores para sua implementação na AL&C. A fim de trazer mais referências sobre o contexto da gestão de praias na região, este capítulo foi escrito em colaboração com o orientador da aluna e pesquisadores de diferentes países da AL&C especialistas em praias e sua gestão.

Nos Capítulos II e III a gestão de praias do Litoral Norte do Estado de São Paulo (LNP) foi utilizada como estudo de caso para investigar como a percepção dos atuais gestores municipais de praias sobre as vulnerabilidades dos SE pode influenciar a implementação da GBE em nível local. A coleta de dados foi feita a partir de uma oficina participativa realizada individualmente com onze Secretarias Municipais que atuam na gestão de praias do LNP (Figura 2). A descrição da oficina, a seleção das Secretarias Municipais e gestores que fizeram parte do estudo, o tratamento e análise dos dados e as informações sobre aprovação de um comitê de ética podem ser encontradas na metodologia e apêndices dos Capítulos II e III.

No Capítulo II foi avaliado como a percepção dos gestores sobre a sensibilidade dos SE (i.e. dinâmica da provisão de SE frente às mudanças ambientais de longo prazo) pode ser utilizada para melhorar a interface ciência-gestão para a implementação da GBE. O Capítulo II foi escrito em colaboração com o orientador, coorientador e outras duas pesquisadores do

projeto de pesquisa “Governança ambiental da macrometrópole paulista face à variabilidade climática” (MacroAmb, FAPESP: 2015/03804-9), cuja aluna também era integrante.

No Capítulo III foi analisado como a capacidade adaptativa percebida dos gestores para garantir a provisão dos SE (i.e. as transformações necessárias na rede de governança para garantir a provisão de SE frente às mudanças ambientais de longo-prazo) pode ser um gargalo crítico para a implementação de GBE. O Capítulo III foi escrito em colaboração com o orientador, pesquisadoras do projeto MacroAmb e pesquisadores do Leibniz Center for Tropical Marine Research, instituto de pesquisa no qual a aluna fez intercâmbio durante o mestrado, a fim de analisar e discutir os dados coletados referentes à percepção da rede de governança de sistemas socioecológicos.

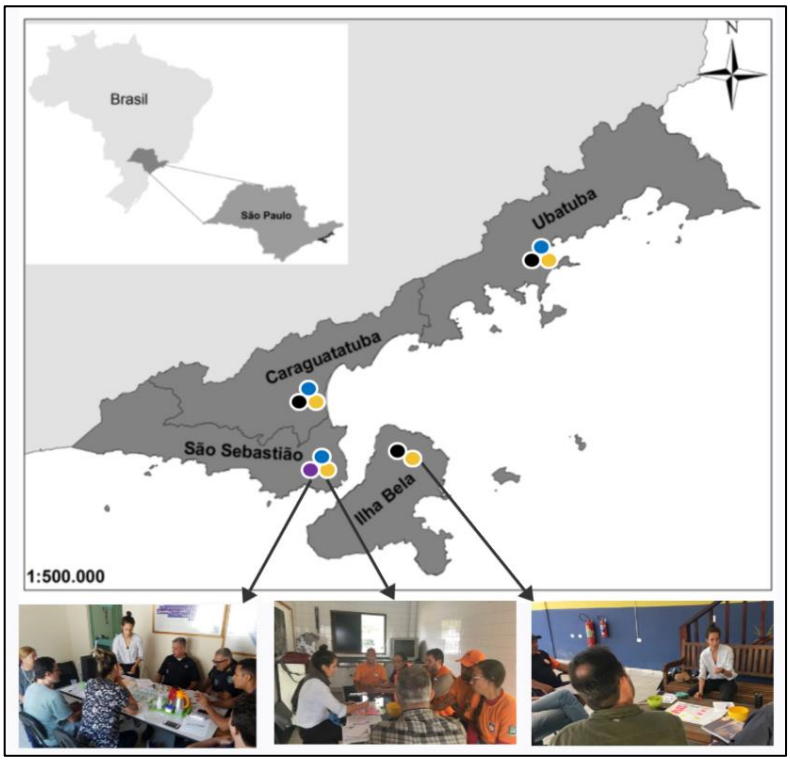

Figura 2. Mapa do Litoral Norte do Estado de São Paulo, Brasil, com os quatro municípios que compõe a região: São Sebastião, Caraguatatuba, Ubatuba e Ilhabela. Os círculos de diferentes cores representam as Secretarias Municipais com as quais foram aplicadas a oficina para a coleta de dados (Amarelo: Defesa Civil | Preto: Planejamento Urbano | Azul: Meio Ambiente | Roxo: Gestão de Praias). As fotos exemplificam três das onze oficinas realizadas para investigar a percepção dos gestores sobre as vulnerabilidades dos Serviços Ecossistêmicos e posteriormente discutir suas implicações para a implementação da Gestão Baseada em Ecossistemas.

REFERÊNCIAS

ADGER, W.N. Social aspects of adaptive capacity. In: SMITH, J.B.; KLEIN, R.J.T.; HUQ, S. (eds.). **Climate Change, Adaptive Capacity and Development**. London, UK: Imperial College Press, 2003. p. 29-49.

ARIZA, E.; JIMÉNEZ, J.A.; SARDÁ, R. A critical assessment of beach management on the Catalan coast. **Ocean & Coastal Management**, v. 51, n. 2, p. 141-160, 2008.

ARKEMA, K.K.; ABRAMSON, S.C.; DEWSBURY, B.M. Marine Ecosystem-Based Management: from characterization to implementation. **Frontiers in Ecology and the Environment**, v. 4, n. 10, p. 525-32, 2006.

BALVANERA, P.; URIARTE, M.; ALMEIDA-LEÑERO, L.; ALTESOR, A.; DECLERCK, F.; GARDNER, T.; HALL, J.; LARA, A.; LATERRA, P.; PEÑA-CLAROS, M.; MATOS, D.M.S.; VOGL, A.L.; ROMERO-DUQUE, L.P.; ARREOLA, L.F.; CARO-BORRERO, A.P.; GALLEGO, F.; JAIN, M.; LITTLE, C.; XAVIER, R.O.; PARUELO, J.M.; PEINADO, J.E.; POORTER, L.; ASCARRUNZ, N.; CORREA, F.; CUNHA-SANTINO, M.B.; HERNÁNDEZ-SÁNCHEZ, A.P.; VALLEJOS, M. Ecosystem services research in Latin America: The state of the art. **Ecosystem Services**, v. 2, p. 56-70, 2012.

BERKES, F. Implementing ecosystem-based management: evolution or revolution? **Fish & Fisheries**, v. 13, n.4, p. 465-476, 2012.

BERKES, F.; COLDING, J.; FOLKE C. (eds). Navigating social-ecological systems: building resilience for complexity and change. Cambridge, UK: Cambridge University Press, 2013. 416 p.

BERROUET, L.M., MACHADO, J., & VILLEGAS-PALÁCIO, C. Vulnerability of socio-ecological systems: A conceptual Framework. **Ecological Indicators**, v .84, p. 632-647, 2018.

BEYERL, K.; PUTZ, O.; BRECKWOLDT, A. The role of perceptions for community-based marine resource management. **Frontiers in Marine Science**, v. 3, n. 238, 2016.

BODIN, Ö.; SANDSTRÖM, A.; CRONA, B. Collaborative networks for effective ecosystem-based management: A set of working hypotheses. **Policy Studies Journal**, v. 45, n. 2, p. 289-314, 2017.

BOTERO, C.M.; WILLIAMS, A.T.; CABRERA, J.A. Advances in beach management in Latin America: overview from certification schemes. In: FINKL, C.: MAKOWSKI C. (eds.) **Environmental Management and Governance**. Coastal Research Library. Springer, 2015. v. 8, p. 33-63.

CHAPIN III, F.S.; KOFINAS, G.P.; FOLKE, C. (eds.). **Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world**. New York, NY: Springer-Verlag, 2009. 401 p.

CHRISTIE, P.; POLLNAC, R.B.; ORACION, E.G.; SABONSOLIN, A.; DIAZ, R.; PIETRI, A. Back to basics: an empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. **Ocean & Coastal Management**, v. 37, n. 3-4, p. 349-373, 2009.

CICIN-SAIN, B. Sustainable development and integrated coastal management. **Ocean & Coastal Management**. v.21, p.11-43, 1993.

COHEN, P.J.; EVANS, L.S.; MILLS, M. Social networks supporting governance of coastal ecosystems in Solomon Islands. **Conservation Letters**, v. 5, n. 5, p. 376-386, 2012.

CRONA, B.; ERNSTSON, H.; PRELL, C.; REED, M.; HUBACEK, K. Combining social network approaches with social theories to improve understanding of natural resource governance. In: BODIN, Ö.; PRELL, C. (eds). **Social networks and natural resource management**: uncovering the social fabric of environmental governance. Cambridge, UK: Cambridge University Press, 2011. p. 44-71.

CURTIN, R.; PRELLEZO, R. Understanding marine ecosystem based management: a literature review. **Marine Policy**, v. 34, n. 5, p. 821-830, 2010.

DEE, L.E.; ALLESINA, S.; BONN, A.; EKLÖF, A.; GAINES, S.D.; HINES, J.; JACOB, U.; MCDONNALD-MADDEN, E.; POSSINGHAM, H.; SCHRÖTER, M.; THOMPSON, R.M. Operationalizing Network Theory for Ecosystem Service Assessments. **Trends in Ecology & Evolution**, v.32, n. 2, p. 118-130, 2017.

DEFEO, O.; MCLACHLAN, A.; SCHOEMAN, D.S.; SCHLACHER, T.A.; DUGAN, J.; JONES, A.; LASTRA, M.; SCAPINI, F. Threats to sandy beach ecosystems: a review. **Estuarine, Coastal and Shelf Science**, v. 8, n. 1, p. 1-12, 2009.

DELAUER, V.G.; ROSENBERG, A.A.; POPP, N.C.; HILEY, D.R.; FEURT, C. The complexity of the practice of ecosystem-based management. **Integral Review**, v.10, n.1, p. 1-28, 2014.

ESPINOSA-ROMERO, M.J.; CHAN, K.M.; MCDANIELS, T.; DALMER, D.M. Structuring decision-making for ecosystem-based management. **Marine Policy**, v. 35, n. 5, p. 575-583, 2011.

FOLKE, C. Freshwater for resilience: a shift in thinking. **Philosophical Transactions of the Royal Society of London**. Series B: Biological Sciences, v. 358, p. 2027-2036, 2003.

FOLKE, C.; HAHN, T.; OLSSON, P.; NORBERG, J. Adaptive governance of social-ecological systems. **Annual Review of Environment and Resources**, v. 30, p. 441-473, 2005.

GRANEK, E.F.; POLASKY, S.; KAPPEL, C.V.; REED, D.J.; STOMS, D.M.; KOCH, E.W.; KENNEDY, C.J.; CRAMER, L.A.; HACKER, S.D.; BARBIER, E.B.; ASWANI, S.; RUCKELSHAUS, M.; PERILLO, G.M.E.; SILLIMAN, B.R.; MUTHIGA, N.; BAEL, D.; WOLANSKI, E. Ecosystem services as a common language for coastal ecosystem-based management. **Conservation Biology**, v. 24, n. 1, p. 207-216, 2010.

GROTHMANN, T.; PATT, A. Adaptive capacity and human cognition: The process of individual adaptation to climate change. **Global Environmental Change**, v. 15, n. 3, p. 199-213, 2005.

HALPERN, B.S.; WALBRIDGE, S.; SELKOE, K.A.; KAPPEL, C.V.; MICHELI, F.; D'AGROSA, C.; BRUNO, J.F.; CASEY, K.S.; EBERT, C.; FOX, H.E.; FUJITA, R.; HEINEMANN, D.; LENIHAN, H.S.; MADIN, E.M.P.; PERRY, M.T.; SELIG, E.R.; SPALDING, M.; STENECK, R.; WATSON, R. A global map of human impact on marine ecosystems. **Science**, v. 319, n. 5865, p. 948-952, 2008.

HOPKINS, T.S.; BAILLY, D. The role of science in the transition to sustainability: the systems approach framework for integrated coastal zone management. In: MOKSNESS, E.; DAHL, E.; STØTTRUP, J. (eds). **Global Challenge in Integrated Coastal Zone Management.** Oxford, UK: John Wiley & Sons, 2013. p. 1-18.

IMPERIAL, M.T. Institutional analysis and ecosystem-based management: The institutional analysis and development framework. **Environmental Management**, v. 24, n. 4, p. 449-465, 1999.

IPCC (Intergovernmental Panel on Climate Change). Climate Change 2014: Impacts, Adaptation and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the **Fifth Assessment Report of the Intergovernmental Panel on Climate Change**. Cambridge, UK: Cambridge University Press, 2014. 688 p.

KATSANEVAKIS, S.; STELZENMÜLLER, V.; SOUTH, A.; SØRENSEN, K.; JONES, P.J.S.; KERR, S.; BADALAMENTI, F.; ANAGNOSTOU, C.; BREEN, P.; CHUST, G.; D'ANNA, G.; DUJIN, M.; FILATOVA, T.; FIORENTINO, F.; HULSMAN, H.; JOHNSON, K.; KARAGEORGIS, A.P.; KRÖNCKE, I.; MIRTO, S.; PIPITONE, C.; PORTELLI, S.; QIU, W.; REISS, H.; SAKELLARIOU, D.; SALOMIDI, M.; VAN HOOL, L.; VASSILOPOULOU, V.; VEGA FERNÁNDEZ, T.; VÖGE, S.; WEBER, A.; ZENETOS, A.; TER HOFSTEDE, R. Ecosystem-based marine spatial management: review of concepts, policies, tools and critical issues. **Ocean & Coastal Management**, v. 51, n. 11, p. 807-820, 2011.

KELLY, C.; ELLIS, G.; FLANNERY, W. Conceptualising change in marine governance: Learning from transition management. **Marine Policy**, v. 95, p. 24-35, 2018.

KIRKFELDT, T.S. An ocean of concepts: Why choosing between ecosystem-based management, ecosystem-based approach and ecosystem approach makes a difference. **Marine Policy**, v. 106, p. 103541, 2019.

LESLIE, H.; SIEVANEN, L.; CRAWFORD, T.G.; GRUBY, R.; VILLANUEVA-AZNAR, H.C.; CAMPBELL, L.M. Learning from ecosystem-based management in practice. **Ocean & Coastal Management**, v. 43, n. 5, p. 471-497, 2015.

LESLIE, H.M.; MCLEOD, K.L. Confronting the challenges of implementing marine ecosystem-based management. **Frontiers in Ecology and the Environment**, v. 5, n. 10, p. 540-548, 2007.

LONG, R.D.; CHARLES, A.; STEPHENSON, R.L. Key principles of marine ecosystem-based management. **Marine Policy**, v. 57, p. 53-60, 2015.

MCLACHLAN, A., DEFEO, O., JARAMILLO, E., SHORT, A. 2013. Sandy beach conservation and recreation: guidelines for optimizing management strategies for multi-purpose use. **Ocean & Coastal Management**, v. 71, p. 256-268, 2013.

MCLACHLAN, A.; BROWN, A. (eds). Sandy beaches as ecosystems. Amsterdam, NL: Elsevier Science Publishers, 2006. 373 p.

MCLACHLAN, A.; DEFEO, O. **The Ecology of Sandy Shores**. 3rd ed. Cambridge, MA: Academic Press, 2017. 572 p.

MCLEOD, K.L.; LESLIE, M. **Ecosystem-based management for the oceans**. Washington, DC: Island Press, 2009. 392 p.

NEL, R.; CAMPBELL, E.E.; HARRIS, L.; HAUSER, L.; SCHOEMAN, D.S.; MCLACHLAN, A.; DU PREEZ, D.R.; BEZUIDENHOUT, K.; SCHLACHER, T.A. The status of sandy beach science: Past trends, progress, and possible futures. **Estuarine, Coastal and Shelf Science**, v. 150, Part A, p. 1-10, 2014.

O'HIGGINS, T.G.; LAGO, M.; DEWITT, T.H. (eds.). **Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity**: Theory, tools and applications. Cham: Springer, 2020. 580 p.

O'HIGGINS, T.G.; O'DWYER, B. A vulnerability framework to protect coastal social ecological systems. **Anthropocene Coasts**, v. 2, n. 1, p. 279-292, 2019.

POTSCHIN, M.; HAINES-YOUNG, R. Defining and measuring ecosystem services. In: POTSCHIN, M.; HAINES-YOUNG, R.; FISH, R.; TURNER, R.K. (eds). **Routledge Handbook of Ecosystem Services**. London, UK: Routledge, 2016. Chapter 3, p. 25-44.

RUSSEL, D.; JORDAN, A.; TURNPENNY, J. The use of ecosystem services knowledge in policy-making: Drawing lessons and adjusting expectations. In: POTSCHIN, M.; HAINES-YOUNG, R.; FISH, R.; TURNER, R.K. (eds.). **Routledge Handbook of Ecosystem Services**. London, UK: Routledge, 2016. p. 586-596.

SANDSTRÖM, A.; BODIN, Ö.; CRONA, B. Network governance from the top—the case of ecosystem-based coastal and marine management. **Marine Policy**, v. 55, p. 57-63, 2015.

SARDÁ, R.; LOZOYA, J.P. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

SARDÁ, R.; O'HIGGINS, T.G.; CORMIER, R.; DIEDRICH, A.; TINTORÉ, J. A proposed ecosystem-based management system for marine waters: linking the theory of environmental policy to the practice of environmental management. **Ecology and Society**, v. 19, n. 4, 2014.

SARDÁ, R.; VALLS, J.F.; PINTÓ, J.; ARIZA, E.; LOZOYA, J.P.; FRAGUELL, R.M.; MARTÍ, C.; RUCABADO, J.; RAMIS, J.; JIMENEZ, J.A. Towards a new integrated beach management system: the ecosystem-based management system for beaches. **Ocean & Coastal Management**, v. 118, Part B, p. 167-177, 2015.

SCHLACHER, T.A.; SCHOEMAN, D.S.; DUGAN, J.; LASTRA, M.; JONES, A.; SCAPINI, F.; MCLACHLAN, A. Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts. **Marine Ecology,** v. 29, n. s1, p. 70-90, 2008.

STEFFEN, W.; PERSSON, Å.; DEUTSCH, L.; ZALASIEWICZ, J.; WILLIAMS, M.; RICHARDSON, K.; CRUMLEY, C.; CRUTZEN, P.; FOLKE, C.; GORDON, L.; MOLINA, M.; RAMANATHAN, V.; ROCKSTRÖM, SCHEFFER, M.; SCHELLNHUBER, H.J.; SVEDIN, U. The Anthropocene: From global change to planetary stewardship. **Ambio**, v. 40, n. 7, p. 739-761, 2011.

TALLIS, H.; LEVIN, P.S.; RUCKELSHAUS, M.; LESTER, S.E.; MCLEOD, K.L.; FLUHARTY, D.L.; HALPERN, B.S. The many faces of ecosystem-based management: making the process work today in real places. **Marine Policy**, v. 34, n. 2, p. 340-348, 2010.

WALTNER-TOEWS, D.; KAY, J. The evolution of an ecosystem approach: the diamond schematic and an adaptive methodology for ecosystem sustainability and health. **Ecology and Society**, v. 10, n. 1, p. 38, 2005.

WILLIAMS, A.T.; MICALLEF, A. **Beach Management**: Principles and Practice. London, UK: Routledge, 2009. 480 p.

CAPÍTULO I: Desafios para promoção da abordagem ecossistêmica à gestão de praias na América Latina e Caribe

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RESUMO

A complexidade das mudanças globais e seus efeitos nos sistemas socioecológicos motivam o desenvolvimento de abordagens de gestão mais integradas e inovadoras para equilibrar as relações sociedade-natureza. Com o desafio de suprir demandas globais e considerar impactos locais, a Gestão Baseada em Ecossistemas (GBE) aparece como uma estratégia de avaliação e ação com potencial de qualificar as interações socioecológicas. Nesse sentido, as praias arenosas surgem como um importante e complexo sistema socioecológico cuja gestão é historicamente realizada de forma reducionista, imediatista, fragmentada e tecnocrática, o que são desafios para a implementação da GBE. Dessa forma, esse artigo visou discutir as oportunidades de incorporar a GBE na gestão de praias e os desafios para sua implementação na América Latina e Caribe (AL&C). Assim, observa-se que a GBE pode orientar a adequação dos processos da gestão de praias. Apesar dos desafios enfrentados na AL&C, sua implementação é uma ferramenta a ser fortalecida na região por meio da transdisciplinaridade e cooperação internacional para promover a sustentabilidade das praias.

Palavras-chave: Gestão Costeira; Sustentabilidade; Praias arenosas; América do Sul; América Central

ABSTRACT

The complexity of global changes and their effects on social-ecological systems motivate the development of more integrated and innovative management approaches to balance the society-nature relationship. With the challenge of meeting global demands and considering local impacts, Ecosystem-Based Management (EBM) emerges as an assessment-action strategy with potential to qualify social-ecological interactions. In this sense, sandy beaches stand as an important and complex social-ecological system in which management has been historically characterized by a reductionist, immediatist, fragmented and technocratic approach, which is one of the challenges for EBM implementation. This article aims to discuss the opportunities to incorporate the EBM in beach management and the challenges to its implementation in Latin America and the Caribbean (LA&C). EBM can guide the beach management processes in order to achieve sustainability. Despite the challenges faced at LA&C, EBM implementation must be strengthened in the region to support beach sustainability through the promotion of transdisciplinarity and international cooperation.

Keywords: Coastal management; Sustainability; Sandy Beaches; South America; Central America

1. CONTEXTO

Ecossistemas costeiros e marinhos proveem uma série de benefícios para o bem-estar humano (McLeod; Leslie, 2009; Sardá; Lozoya, 2018; Blythe et al., 2020), compondo um panorama de interações que afetam e são induzidas pelo ser humano (Curtin; Prellezo, 2010; Halpern et al., 2019). As mudanças provocadas pelas atividades humanas nesses ecossistemas são observadas em nível global (IPCC, 2018; IPBES, 2019) e vêm se intensificando em ritmo acelerado (Halpern et al., 2019). Essas mudanças diminuem a chance de sucesso de abordagens rígidas de gestão (Chapin III; Kofinas; Folke, 2009) e motivam a busca por novas estratégias de promoção da sustentabilidade que considerem a complexidade inerente aos sistemas socioecológicos[4] (Berkes; Folke, 1994).

Dentre os ecossistemas costeiros, as praias – depósitos sedimentares formados pela ação de ondas e marés sobre a geomorfologia costeira (McLachlan; Defeo, 2017) – detêm um importante papel socioecológico (Schlacher et al., 2014; Sardá et al., 2015). Elas oferecem diversos serviços ecossistêmicos (SE)[5] relacionados à provisão de alimento; regulação biológica (e.g., manutenção da biodiversidade, de recursos genéticos, área de reprodução, crescimento, descanso e alimentação para diversas espécies); regulação atmosférica e do clima (e.g., sequestro de carbono); controle de doenças humanas; proteção contra inundações e proteção da costa (e.g., diminuição de risco de desastres em eventos de ondas extremas); reciclagem de nutrientes e filtragem de água; promoção de cultura, recreação, educação, pesquisa, saúde humana (Defeo et al., 2009; Schlacher et al., 2014; UNEP, 2016; Sardá; Lozoya, 2018). Apesar da relevância das praias para o bem-estar humano, seus SE vêm sendo comprometidos por ameaças antrópicas que ocorrem em múltiplas escalas (Defeo et al., 2009; Harris et al., 2015; Fanini et al., 2020) (Figura 1). Inseridas na transição entre o domínio terrestre e marinho e sujeitas a impactos derivados de usos que ocorrem tanto nesses dois domínios como em seu próprio território, as praias são consideradas um ecossistema em risco (Defeo et al., 2009; Fanini et al., 2020).

[4] **Sistema socioecológico**, ou Sistema Social-Ecológico Acoplado, como usado por McLeod e Leslie (2009), é um termo usado para descrever um sistema homem-natureza dinâmico, intrinsecamente relacionado e co-evolutivo, onde é reconhecida a complexidade e a variabilidade das características ecológicas, econômicas, culturais e institucionais inerentes aos ecossistemas e sociedades (Berkes; Folke, 1994). Nestes sistemas, as interações entre a dimensão social e natural ocorrem em múltiplas escalas (geográfica, organizacional) e são intermediadas pelos SE (McLeod; Leslie, 2009, p. 4-5).

[5] **Serviços Ecossistêmicos** são as contribuições do ecossistema que fornecem benefícios ao bem-estar humano (Potschin; Haines-Young, 2016).

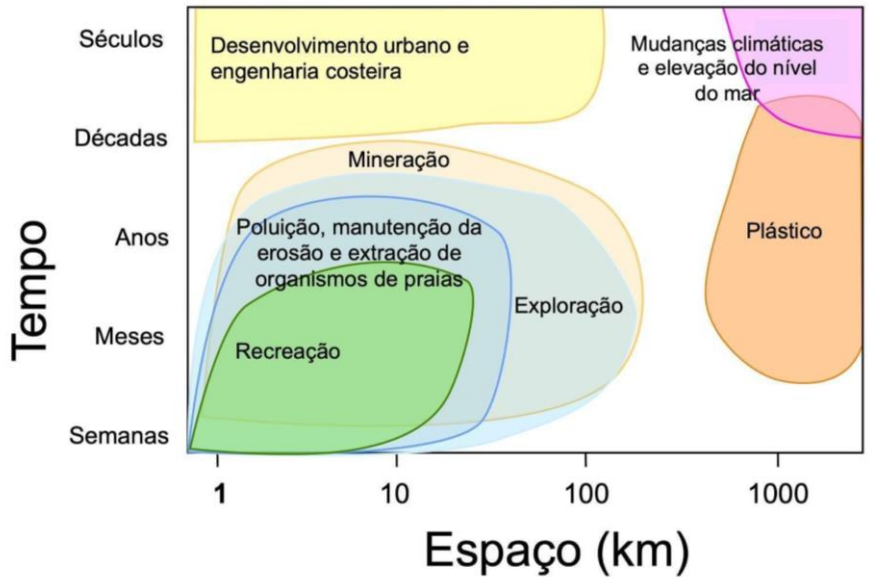


Figura 1. Modelo conceitual e esquemático mostrando as múltiplas escalas e níveis das ameaças antrópicas que afetam o ecossistema praial. As marcações de diferentes cores indicam a extensão potencial de ameaças individuais em cada escala (Traduzida de McLachlan; Defeo, 2017).

Adicionalmente, a gestão e governança não adequadas ou integradas dessas ameaças podem agravar os impactos às praias (James, 2000). Reconhecer que muitos problemas têm causas que abrangem várias escalas e níveis e de que há necessidade que suas soluções sejam igualmente abrangentes é cada vez mais necessário (Cash et al., 2006). Por exemplo, a poluição tem fontes múltiplas relacionadas a atividades terrestres adjacentes às praias (como a urbanização e alteração da linha de costa), regiões distantes delas (como no caso de sistema de gestão de resíduos e saneamento deficiente ao longo das bacias hidrográficas) e atividades no mar (a exemplo do tráfego marítimo; extração mineral offshore) (UNEP, 2016).

Com uma costa de cerca de 72.182 km de extensão (Reguero; Méndez; Losada, 2013), apresentando diferentes condições climáticas, oceanográficas e feições geológicas (Silva et al., 2014), os 46 países costeiros e insulares da América Latina e Caribe (AL&C) possuem a maioria dos ecossistemas costeiros existentes no planeta (Barragán, 2001). Dentre eles, o ambiente praial se destaca por ocupar, historicamente, o maior nicho no mercado do turismo (UNEP, 2016). As praias da AL&C são internacionalmente reconhecidas por sua diversidade e beleza, sendo apreciadas por visitantes do mundo inteiro que desfrutam de seu uso direto e indireto, o que lhes confere uma importância econômica estratégica (Barragán, 2001; Botero; Williams; Cabrera, 2015).

Além de espaço para recreação e socialização (Botero; Cabrera; Zielinski, 2018), as praias na AL&C contribuem para a segurança alimentar e subsistência de populações tradicionais ao suportar manifestações culturais, como a coleta de alimento (Defeo; de Alava,

1995; Barragán, 2001; Turra et al., 2016). Dada a vulnerabilidade da AL&C a desastres naturais como inundações e furacões (Montero; Milanés, 2020), as praias também desempenham uma função importante de proteção costeira na região (Silva et al., 2014; UNEP, 2016). Ainda, esse ambiente fornece outros SE que não estão diretamente relacionados aos usos humanos como os de regulação climática, manutenção da diversidade genética e provisão de habitat para diversas espécies (Sardá; Lozoya, 2018). Esse conjunto de SE evidencia a importância socioecológica das praias na AL&C. Entretanto, o cenário da AL&C não é diferente do restante do globo, visto que o aumento das taxas de crescimento populacional na zona costeira, as alterações de uso do solo[6], a escalada da erosão costeira, o aumento do turismo em massa, a poluição, a perda de biodiversidade e as mudanças climáticas, ameaçam seriamente este ambiente (Barragán-Muñoz, 2020; UNEP, 2016).

As ameaças às praias na AL&C reforçam a discussão quanto à inadequação de métodos reducionistas tradicionalmente empregados para a solução de problemas complexos (Botero; Williams; Cabrera, 2015). Nesse sentido, é imperativo que a gestão promova a sustentabilidade das praias, considerando a manutenção da biodiversidade e dos SE e confrontando a fragmentação da gestão (Sardá et al., 2015). Esse tipo de abordagem holística é particularmente relevante nos países da AL&C, onde a desigualdade para acessar e controlar recursos naturais provoca o aumento da degradação ambiental e da vulnerabilidade de grupos sociais (Baud et al., 2000).

Dessa maneira, possíveis soluções requerem o envolvimento de diferentes setores (por exemplo, turístico, meio ambiente, planejamento urbano, entre outros), grupos sociais (como governo, sociedade civil e setor privado) e níveis jurisdicionais (de cooperações internacionais a níveis mais locais) que lidam com as diversas escalas espaciais (da praia ao continente e planeta) e temporais (considerando intervalos curtos a seculares) relacionadas às ameaças que incidem sobre este ambiente. Essa abordagem permite que a gestão de praias seja entendida como transescalar e multinível (Figura 2).

Considerando o esforço dos países da AL&C em gradualmente implementar diferentes modelos de gestão de praias baseados em modos de governança[7] (Botero; Milanés, 2015) e marcos legais nacionais e internacionais (Barragán, 2001; Botero; Williams; Cabrera, 2015; Barragán-Muñoz, 2020), este ensaio visa discutir a importância e os desafios da incorporação

[6] A **mudança no uso do solo** é um conceito que engloba uma série de eventos, processos e ações que levam a mudanças ambientais. Refere-se principalmente a urbanização e construção/ mineração (UNEP, 2016).

[7] **Governança** é um sistema social voltado a orientar o comportamento coletivo em direção aos resultados desejados e longe dos resultados indesejáveis. Um sistema de governança é um conjunto de elementos que inclui arranjos institucionais e atores, que formam o núcleo desse sistema, mas que também inclui elementos cognitivos, culturais e tecnológicos (Young, 2017).

da Gestão Baseada em Ecossistemas (GBE) na gestão de praias na AL&C. Primeiramente é apresentado o que é a GBE e como ela se relaciona com os processos de gestão de praias arenosas. Em seguida, discute-se o que é importante para implementá-la e que desafios e oportunidades de sua implementação são relevantes para a gestão de praias da AL&C.

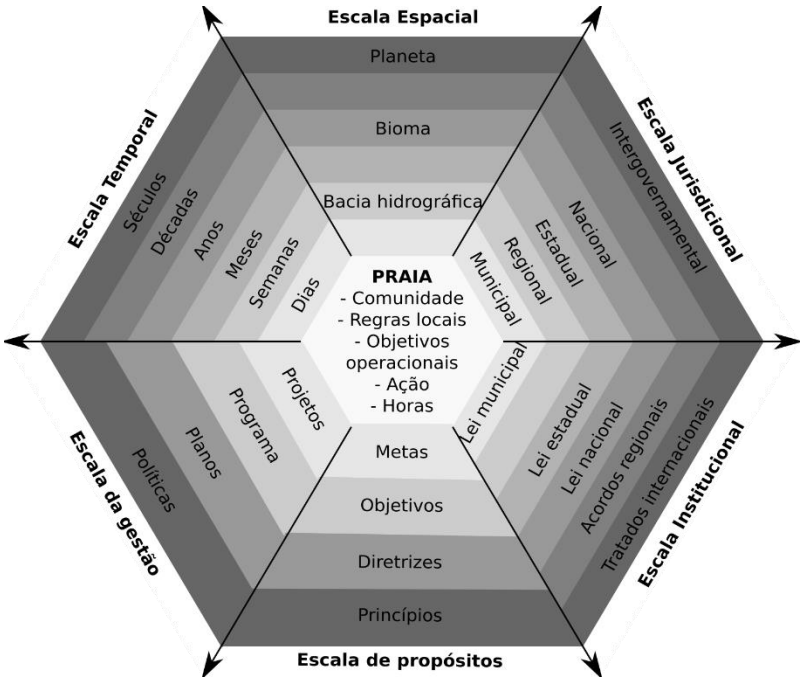


Figura 2. Representação das diferentes escalas e níveis a serem considerados na gestão de praia em uma abordagem transescalar (Elaborada pelos autores).

2. A GESTÃO BASEADA EM ECOSSISTEMAS

Há mais de dez anos é discutido o fomento a novas formas de governança que contraponham sistemas de gestão convencionais para as regiões marinhas e costeiras (Long; Charles; Stephenson, 2015). Para além de uma governança vertical baseada em ações de governo, há vários tipos de estruturas e redes de governança que se relacionam com a GBE, como a governança política (Botero; Milanés, 2015), governança econômica, estratégica ou de gestão de negócios (Williamson, 1996), governança urbana (Porras, 2018) e governança local (Botero et al., 2017). Elas são integradas no contexto da gestão pública (Kickert et al., 1997), políticas públicas ou redes de políticas (Zurbriggen, 2003), nas quais há um interesse crescente por analisar tendências para estruturas de governança mais horizontais, como “governança sem governo” ou “governança global” (Quintero-Castellanos, 2017), que pressupõem uma maior integração entre os diferentes matizes da tomada de decisão sem necessariamente uma coordenação *top-down* governamental.

Essa discussão ganhou escala em conferências, acordos, metas e levantamentos globais que assumem a complexidade e a interdependência dos processos socioecológicos, como os esforços do Painel Intergovernamental sobre Mudanças Climáticas (IPCC, 2018), da Plataforma Intergovernamental para a Biodiversidade e os Serviços dos Ecossistemas (IPBES, 2019), das estratégias da Agenda 2030 (UN, 2015) e da Década da Ciência Oceânica para o Desenvolvimento Sustentável (UNESCO, 2020), promovidas pela Organização das Nações Unidas. Na institucionalização de agendas globais de governança entende-se a importância atribuída à incorporação da GBE na gestão dos ecossistemas oceânicos e costeiros (CBD, 2004; UN, 2012).

A GBE é definida por Long, Charles e Stephenson (2015, p. 59) como:

> [...] uma abordagem interdisciplinar que equilibra os princípios ecológicos, sociais e de governança em escalas temporais e espaciais em uma área geográfica distinta para uso sustentável de recursos. Conhecimento científico e monitoramento efetivo são usados para reconhecer as conexões, integridade e biodiversidade dentro de um ecossistema, juntamente com a sua natureza dinâmica e incertezas associadas. A GBE reconhece o sistema como socioecológico, [...] onde as decisões refletem a escolha da sociedade. (tradução dos autores)

A GBE tem como meta manter o ecossistema em uma condição saudável, produtiva e resiliente, fundamentando-se na busca por um processo de gestão holístico e adaptativo (CBD, 2004; Long; Charles; Stephenson, 2015). A partir do entendimento da zona costeira como um sistema socioecológico complexo, a GBE preza tanto pela diversidade de conhecimentos para lidar com as incertezas e a imprevisibilidade associadas, como pelo dinamismo dos ecossistemas costeiros e oceânicos e particularidades dos sistemas sociais e de gestão relacionados (CBD, 2004; Arkema; Abramson; Dewsbury, 2006; McLeod; Leslie, 2009; Curtin; Prellezo, 2010; Long; Charles; Stephenson, 2015). Nesse processo, a GBE considera os atributos particulares do sistema socioecológico, definindo os limites para a gestão operacionalmente e não condicionando-os a delimitações geopolíticas (CBD, 2004; Curtin; Prellezo, 2010) e reconhece a relevância do conhecimento científico interdisciplinar para subsidiar a gestão (Leslie et al., 2015).

Em última instância, implementar a GBE significa transformar a forma como as pessoas se relacionam e interferem nos ecossistemas (McLeod; Leslie, 2009), promovendo mudança no sistema de governança. Assim, é necessária uma visão integrada, na qual a diversidade de atores aumente a capacidade em lidar positivamente com as mudanças (Chapin III; Kofinas; Folke, 2009). Tal diversidade também é importante para assegurar o potencial de promover um sistema

de governança que considere as interações entre os ambientes terrestre e marinho e o papel de diferentes instituições e competências sobrepostas nesses espaços (Pittman; Armitage, 2016) garantindo o funcionamento ecológico. Tal visão demanda comunicação, colaboração e coordenação entre os diferentes níveis e setores da gestão e da sociedade (Arkema; Abramson; Dewsbury, 2006; Christie et al., 2009; Tallis et al., 2010; Leslie et al., 2015; Marshak et al., 2017), endossando ampla participação social no processo de tomada de decisão. Ainda, no processo de implementação da GBE e de mudança no sistema de governança, as políticas públicas têm um papel fundamental, pois garantem a segurança jurídico-institucional das propostas de gestão (Araujo, 2018; Gelcich et al., 2018). Para tanto, é necessária a criação de políticas mais coesas e integradas que visem a conservação dos SE frente aos impactos transescalares e multiníveis que os acometem (Rosenberg; McLeod, 2005; Gelcich et al., 2018).

A prática da GBE engloba uma compreensão transversal dos atuais problemas e desafios da sustentabilidade, norteada pela produção conjunta de conhecimento, entendimento de escalas e transdisciplinaridade[8], o que ressalta, entre outros fatores, a necessidade da integração ciência-política e o papel de liderança de cientistas em alguns registros de sua implementação (Leslie et al., 2015). Promover a transdisciplinaridade, no entanto, implica em integrar universos cujos princípios e práticas são distintos (Xavier; Gonçalves, 2019) e demanda novas formas de produção do conhecimento que conectem epistemologias e códigos de diferentes disciplinas científicas entre si e a processos sociais e de tomada de decisão (Luks; Siebenhüner, 2007). Além de avançarem na discussão epistemológica da ciência, tais abordagens têm o potencial adicional de promover e fortalecer arranjos institucionais e a participação social na gestão (Grilli et al., 2019).

A GBE oferece oportunidades inovadoras para a sustentabilidade das praias ao trazer uma visão holística e diversificada que atende às necessidades específicas do ecossistema praial (Sardá et al., 2015) (Tabela 1). No processo de implementação da GBE em praias, a identificação de ameaças ao ecossistema pode revelar alterações nos processos e funções ecossistêmicas e na provisão dos SE (Harris et al., 2015; Enriquez-Acevedo et al., 2018), além de destacar aspectos da gestão que devem ser melhorados para não comprometer o funcionamento do ecossistema e a multiplicidade de seus usos (Botero; Cabrera; Zielinski, 2018).

[8] **Transdisciplinaridade** relaciona-se ao envolvimento de cientistas de diferentes áreas do conhecimento e de não cientistas no processo de produção do conhecimento (Luks; Siebenhüner, 2007).

3. A GESTÃO DE PRAIAS NA AMÉRICA LATINA E CARIBE E OS DESAFIOS PARA A IMPLEMENTAÇÃO DA GBE

A maioria dos países costeiros da AL&C (n = 26) possui algum tipo de política ou estratégia setorial relevante para a Gestão Costeira Integrada[9] (GCI) (Barragán-Muñoz, 2020), o que pode ser promissor para a implementação da GBE em praias, visto que ambas compartilham princípios relacionados à integração, participação e gestão adaptativa (Arkema; Abramson; Dewsbury, 2006) e podem ser complementares. Ainda assim, a implementação da GBE deve considerar o contexto anterior à sua implementação, pois, se representar um afastamento radical do modelo de gestão existente, ela pode gerar resistência e afetar o equilíbrio delicado entre alterar os princípios da gestão e manter processos em prática (Christie et al., 2009; Leslie et al., 2015).

O compartilhamento de princípios com a GCI e o alinhamento dos países da AL&C com acordos e tratados internacionais baseados na abordagem ecossistêmica, indicam o potencial para promoção da GBE (Gelcich et al., 2009; Araujo, 2018). No entanto, apenas dois países da AL&C fazem referência a princípios da GBE em suas políticas de gestão costeira (Barragán-Muñoz, 2020) e, mesmo nessas condições, a inclusão de tais princípios em normas e acordos nos diversos níveis institucionais, bem como sua aplicação na prática da gestão, ainda representam desafios (Gelcich et al., 2009; Araujo, 2018). Tais desafios são proeminentes em países em desenvolvimento, pois estes enfrentam desafios adicionais para gerir ecossistemas costeiros complexos, como pressão do setor privado, escassez de recursos econômicos, capacidade institucional limitada, treinamento técnico inadequado dos gestores e forte influência de estratégias que reforçam a fragmentação da gestão (Botero; Williams; Cabrera, 2015; Vélez; García; Tenorio, 2018).

A instabilidade política, Estados fracos, governos corruptos, grande desigualdade social, participação social incipiente ou nula e a economia baseada em recursos naturais para exportação também são apontados como desafios para implementação e manutenção da GBE nos trópicos (Christie et al., 2009). Essa situação é agravada pela ausência de políticas de Estado que possam munir e manter a GBE com investimento e apoio institucional a longo prazo (Tallis et al., 2010). Esse cenário, com poucas exceções (Cabrera et al., 2009), também ocorre na gestão de praias da AL&C, onde programas governamentais são criados para serem implantados no

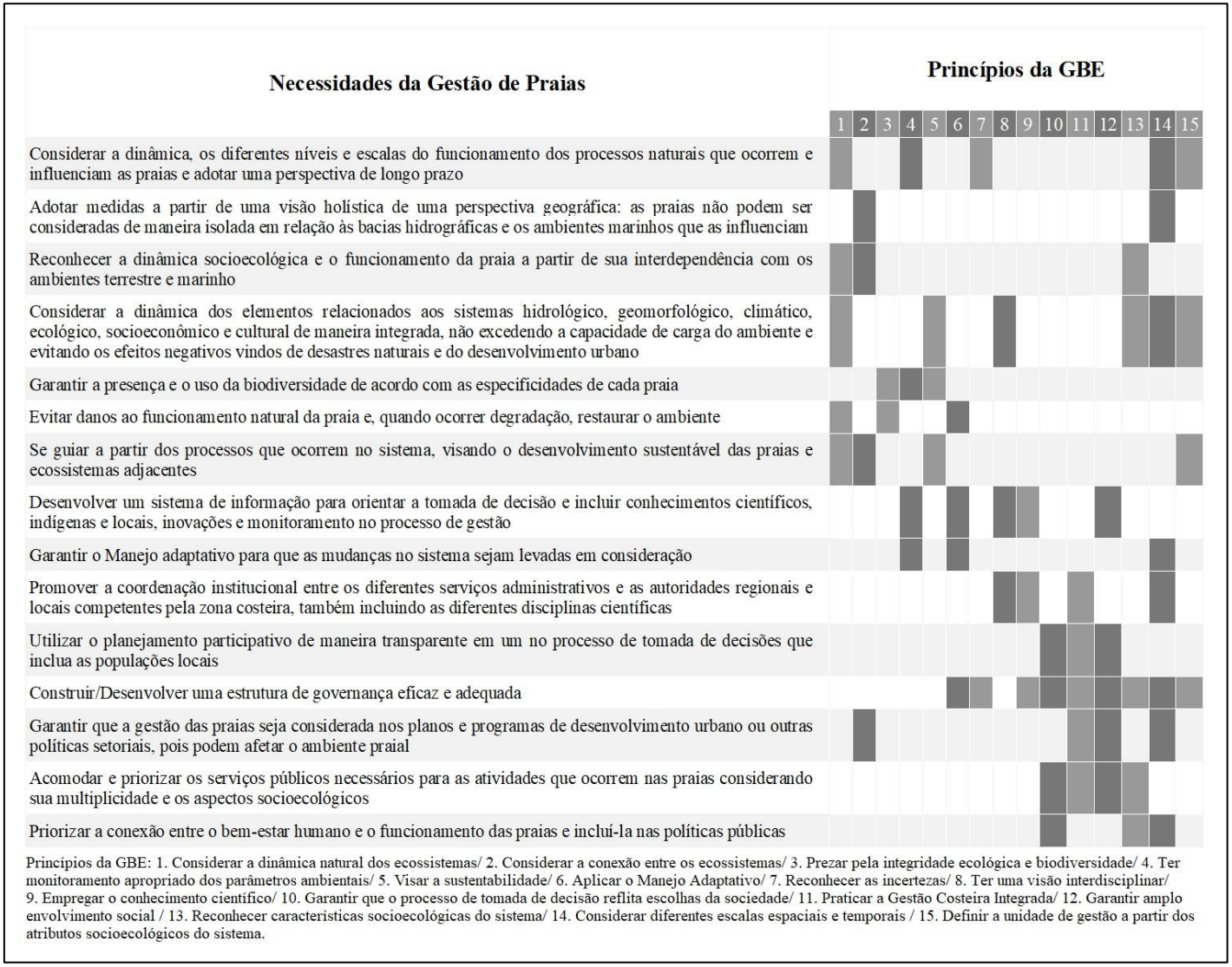
[9] **Gestão Costeira Integrada (GCI)** equivale a uma proposta adaptativa, participativa e integrativa de gestão que é focada em gerenciar as atividades humanas, considerando a dimensão natural e envolvendo diferentes setores, conhecimentos, instituições e governos, garantindo sua consistência interna às propostas (Cicin-Sain; Knecht, 1998).

período do mandato de seus proponentes, de modo que, quando efetivados, acabam sendo realizados em curto prazo, a partir de decisões centralizadas, reducionistas e setorizadas (Botero; Williams; Cabrera, 2015).

Além da importância geral da participação social na implementação e manutenção da GBE em praias (Sardá et al., 2015), na AL&C a maioria dos países classificam as praias como bens de uso público (Barragán, 2001; Barragán-Munõz 2020), o que reforça a importância da tomada de decisão de forma participativa e plural, incluindo os diferentes setores da sociedade (Botero; Díaz, 2009). Alcançar tal cenário e promover a gestão participativa, entretanto, pode representar um desafio intrínseco na AL&C, a exemplo do Brasil, onde atores sociais e governamentais nem sempre detêm as habilidades, os meios ou mesmo a disposição para tomar parte em processos de tomada de decisão (Seixas et al., 2019).

A falta de conhecimento científico acerca da dinâmica dos sistemas socioecológicos e dos efeitos da gestão no próprio ecossistema é outra barreira para a implementação da GBE (Marshak et al., 2017; James, 2020). O ambiente praial é um tema pouco explorado na literatura científica mundial e costuma ser abordado em trabalhos mais disciplinares, desvinculados de processos de gestão (Nel et al., 2014; Fanini et al., 2020) e com pouca descrição das conexões entre os diversos componentes dos ecossistemas e suas interações (*feedback loop*) (James, 2000; Gelcich et al., 2009). A AL&C é uma região importante no desenvolvimento da pesquisa relacionada a sistemas socioecológicos e interação ciência-política, com um crescimento recente de estudos acerca da gestão de praias, incluindo temas ligados à GBE, gestão de riscos, geomorfologia ou governança (Botero; Cervantes; Finkl, 2018). Porém, ainda há a necessidade de integrar as diferentes disciplinas e grupos de pesquisa (Baud et al., 2000; Grilli et al., 2019; Xavier; Gonçalves, 2019). Ademais, a instabilidade política e econômica na região tem o potencial de prejudicar o desenvolvimento científico (Ciocca; Delgado, 2017) e sua possível tradução em políticas públicas. Estudos sobre SE vêm crescendo em número na AL&C (Enriquez-Acevedo et al., 2018), no entanto de forma pouco balanceada considerando temas abordados, a exemplo dos poucos estudos com foco em praias (Botero; Williams; Cabrera, 2015) e de estudos que conectem processos ecológicos à provisão de SE (Balvanera et al., 2012) e à produção científica dos diferentes países.

Tabela 1. Relação entre as necessidades da gestão de praias e os princípios da Gestão Baseada em Ecossistemas (GBE). Necessidades da gestão de praias de acordo com Sardá e colaboradores (2015) e princípios da GBE estabelecidos por Long, Charles e Stephenson (2015) (Traduzida e adaptada de Sardá et al., 2015).



Princípios da GBE: 1. Considerar a dinâmica natural dos ecossistemas/ 2. Considerar a conexão entre os ecossistemas/ 3. Prezar pela integridade ecológica e biodiversidade/ 4. Ter monitoramento apropriado dos parâmetros ambientais/ 5. Visar a sustentabilidade/ 6. Aplicar o Manejo Adaptativo/ 7. Reconhecer as incertezas/ 8. Ter uma visão interdisciplinar/ 9. Empregar o conhecimento científico/ 10. Garantir que o processo de tomada de decisão reflita escolhas da sociedade/ 11. Praticar a Gestão Costeira Integrada/ 12. Garantir amplo envolvimento social / 13. Reconhecer características socioecológicas do sistema/ 14. Considerar diferentes escalas espaciais e temporais / 15. Definir a unidade de gestão a partir dos atributos socioecológicos do sistema.

O desafio da produção de conhecimento também permeia a disponibilização das informações e a aplicação do conhecimento produzido para subsidiar mudanças regulatórias e institucionais (como falta de robustez legal; ausência de regulamentação local; sobreposição de competências; responsabilidades desconectadas) (Leslie et al., 2015) e propostas de objetivos operacionais para a gestão (Arkema; Abramson; Dewsbury, 2006). Mesmo quando os dados científicos são abundantes e disponíveis, estruturas de governança frágeis e centradas na institucionalidade pública podem obstruir o compartilhamento e o acesso a dados relacionados à implementação da GBE ou mesmo limitar sua aplicação na gestão (Tallis et al., 2010; Leslie et al., 2015).

A região carece, ainda, de estudos empíricos e teóricos sobre a própria implementação da GBE. Exemplos de implementação da GBE são majoritariamente oriundos de países desenvolvidos e baseados em estratégias coordenadas pelo governo, exigindo novos planos de gestão e a integração entre os órgãos (Gelcich et al., 2009). Entretanto, quando se analisa a gestão de praias na AL&C, entende-se que a implementação da GBE conduzida pelo governo pode não ser suficiente para superar os múltiplos desafios de ordens e níveis variados que existem na região (Figura 3).

Figura 3. Desafios a serem considerados para a implementação da Gestão Baseada em Ecossistemas (GBE) na gestão de praias nos países da América Latina & Caribe (Elaborada pelos autores).

No contexto da AL&C, a consolidação de diretrizes que superem os desafios apresentados para a implementação da GBE pode fortalecer a rede regional e internacional, favorecendo a troca de experiências e de conhecimento. Mesmo que em estágios diferentes, a aplicação da GBE na AL&C, promovida por iniciativas que focam no incentivo à participação social (Gelcich et al., 2009; Seixas et al., 2019) e reforcem as conexões do sistema sociedade-natureza (relacionados à questão dos SE) (Balvanera et al., 2012), é uma realidade que pode ser transposta para a gestão de praias. Espera-se que a troca de experiência entre os diversos países

em cooperação possa beneficiar os múltiplos atores envolvidos e dar volume ao controle social para lidar com os desafios ambientais relacionados à gestão de praias.

4. CONSIDERAÇÕES FINAIS SOBRE A GBE EM PRAIAS NA AL&C

Apesar das disparidades existentes entre os países, no fim do século XX a gestão costeira na região da AL&C sinalizava novas tendências de integração e evidenciava desafios comuns como o baixo reconhecimento público e institucional, recursos limitados (financeiros e humanos) e pouca informação científica (Barragán, 2001; Barragán-Muñoz, 2020). Duas décadas depois, avanços na gestão e fomento à implementação da GCI ocorreram na maioria dos países costeiros da AL&C. No entanto, muitos dos desafios perduram, em especial a disparidade entre os diferentes países (Barragán-Muñoz, 2020). Sendo a gestão integrada das praias uma aplicação da GCI em nível local (Botero; Díaz, 2009), é lógico supor que essa enfrenta, se não os mesmos, desafios mais complexos dadas as particularidades desse ambiente e as diversas escalas que o afetam.

A necessidade de aquisição de dados contínuos sobre os processos, efeitos cumulativos e forçantes do ambiente praial como sistema socioecológico (Harris et al., 2015; James, 2000), se faz imperativa na gestão de praias da AL&C, como se pode concluir a partir de sua caracterização. O estabelecimento de parcerias, agendas comuns e cooperação entre os países da região pode contribuir para aprimorar e aprofundar o conhecimento regional sobre a implementação da GBE em países em desenvolvimento e contornar os problemas de produção e aplicação do conhecimento científico. Espera-se que a abordagem integrada aplicada em projetos de cooperação promova avanços na promoção da GBE na AL&C nas próximas décadas (Muñoz-Sevilla; Le Bail, 2017). Exemplos regionais, como a Rede PROPLAYAS e a Rede IBERMAR (Rede Iberoamericana de Manejo Costeiro Integrado), vêm sendo apontados como relevantes na promoção da ciência e do conhecimento sobre gestão de praias e para a superação dos desafios relacionados à interface ciência-política (Lahsen et al., 2013). Dessa maneira, promover a incorporação da GBE na gestão de praias na AL&C é uma ferramenta a ser fortalecida para a promoção da transdisciplinaridade e, consequentemente, a sustentabilidade das praias.

Ademais, a interação ciência-gestão também pode desenvolver a capacidade institucional e técnica para a tomada de decisão na AL&C. Ao favorecer a capacitação e a transdiciplinaridade, a implementação da GBE pode orientar a escolha de parâmetros sistêmicos para a análise crítica e adequação dos processos de gestão para cada contexto, bem como no fortalecimento da interação ciência-gestão e da gestão participativa de praias. Deve-se considerar o estímulo ao

interesse de órgãos públicos de diferentes níveis na implementação de abordagens descentralizadas e transparentes, o que pode resultar na formulação de políticas que respondam às escolhas da sociedade e contribuam para a sustentabilidade do ecossistema praial.

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6. REFERÊNCIAS

ARAUJO, F.C.B. Desafios à adoção da abordagem ecossistêmica como instrumento jurídico para a gestão de recursos marinhos na zona costeira brasileira. In: OLIVEIRA, C.C.; GALINDO, G.R.B.; SILVA, S.T.; MONT'ALVERNE, T.C.F. (orgs.). **Meio Ambiente Marinho e Direito**: A gestão sustentável dos recursos marinhos na zona costeira e no espaço marinho. Curitiba, PR: Juruá Ed., 2018. v. 2, p. 61-84.

ARKEMA, K.K.; ABRAMSON, S.C.; DEWSBURY, B.M. Marine Ecosystem-Based Management: from characterization to implementation. **Frontiers in Ecology and the Environment**, v. 4, n. 10, p. 525-32, 2006.

BALVANERA, P.; URIARTE, M.; ALMEIDA-LEÑERO, L.; ALTESOR, A.; DECLERCK, F.; GARDNER, T.; HALL, J.; LARA, A.; LATERRA, P.; PEÑA-CLAROS, M.; MATOS, D.M.S.; VOGL, A.L.; ROMERO-DUQUE, L.P.; ARREOLA, L.F.; CARO-BORRERO, A.P.; GALLEGO, F.; JAIN, M.; LITTLE, C.; XAVIER, R.O.; PARUELO, J.M.; PEINADO, J.E.; POORTER, L.; ASCARRUNZ, N.; CORREA, F.; CUNHA-SANTINO, M.B.; HERNÁNDEZ-SÁNCHEZ, A.P.; VALLEJOS, M. Ecosystem services research in Latin America: The state of the art. **Ecosystem Services**, v. 2, p. 56-70, 2012.

BARRAGÁN-MUÑOZ, J.M. Progress of coastal management in Latin America and the Caribbean. **Ocean & Coastal Management**, v. 184, 2020.

BARRAGÁN, J.M. The coasts of Latin America at the end of the century. **Journal of Coastal Research**, v. 17, n. 4, p. 885-99, 2001.

BAUD, M. State-building and borderlands in Latin America. In: DIJCK, P.V.; OUWENEEL, A.; ZOOMERS, A. (eds.). **Fronteras: Towards a Borderless Latin America.** Amsterdam: CEDLA Latin American Studies 87, 2000. p. 41-82.

BERKES, F.; FOLKE, C. Linking social and ecological systems for resilience and sustainability. **Beijer Discussion Paper Series**. v. 5, n. 52, p. 1-23, 1994.

BLYTHE, J.; ARMITAGE, D.; ALONSO, G.; CAMPBELL, D.; DIAS, A.C.E.; EPSTEIN, G.; MARSCHKE, M.; NAYAK, P. Frontiers in coastal well-being and ecosystem services research: a systematic review. **Ocean & Coastal Management**, v. 185, p. 105028, 2020.

BOTERO, C.M.; ARRIZABALAGA-FAL, M.; MILANÉS-BATISTA, C.; VIVAS-CORTÉS, O. Indicadores de gobernabilidad para la gestión del riesgo costero en Colombia. **Revista Luna Azul**, v. 45, p. 227-251, 2017.

BOTERO, C.M.; CABRERA, J.A.; ZIELINSKI, S. Tourist Beaches. In: FINKL, C.; MAKOWSKI, C. (eds.). **Encyclopedia of Coastal Science**. Encyclopedia of Earth Sciences Series. Cham: Springer, 2018.

BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24. 960 p.

BOTERO, C.M.; DÍAZ, L.H. La playa como espacio costero particular en la Gestión Integrada Costera, revisión desde la bibliografía especializada. **Revista Medio Ambiente, Turismo y Sustentabilidad**, v. 2, p. 99-107, 2009.

BOTERO, C.M.; MILANÉS, C. (eds.). **Aportes para la Gobernanza Marino-Costera**: Gestión del riesgo, gobernabilidad y distritos costeros. Bogotá, Colombia: Universidad Sergio Arboleda, 2015. 554 p.

BOTERO, C.M.; WILLIAMS, A.T.; CABRERA, J.A. Advances in beach management in Latin America: overview from certification schemes. In: FINKL, C.: MAKOWSKI C. (eds.) **Environmental Management and Governance**. Coastal Research Library. Springer, 2015. v. 8, p. 33-63.

CABRERA, J.A.; ORELLANES, O.; LÓPEZ, L.; MENA, A.; ALMEIDA, M.; ROJAS, L.; FRANCISCO, G.; ARMAR, Y.; MORENO, M.L. Evaluación del programa de manejo integrado de la playa de Varadero (Cuba): 7 años de experiencias y retos. **Revista Medio Ambiente, Sustentabilidad y Turismo**, v. 2, p. 67-79, 2009.

CASH, D.W.; ADGER, W.N.; BERKES, F.; LEBEL, L.; OLSSON, P.; PRITCHARD, L.; YOUNG, O. Scale and cross-scale dynamics: Governance and information in a multilevel world. **Ecology and Society**, v. 11, n. 2, p. 8, 2006.

CBD (CONVENTION ON BIOLOGICAL DIVERSITY). **The Ecosystem Approach, Guidelines.** Montreal: CBD, 2004. 50 p. Disponível em: <https://www.cbd.int/doc/publications/ea-text-en.pdf>. Acesso em Fev. 2020.

CHAPIN III, F.S.; KOFINAS, G.P.; FOLKE, C. (eds.). **Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world**. New York, NY: Springer-Verlag, 2009. 401p.

CHRISTIE, P.; POLLNAC, R.B.; ORACION, E.G.; SABONSOLIN, A.; DIAZ, R.; PIETRI, A. Back to basics: an empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. **Ocean & Coastal Management**, v. 37, n. 3-4, p. 349-373, 2009.

CICIN-SAIN, B.; KNECHT, R.W. **Integrated Coastal and Ocean Management**: Concepts and Practices. Washington, DC: Island Press, 1998.

CIOCCA, D.R.; DELGADO, G. The reality of scientific research in Latin America; an insider's perspective. **Cell Stress and Chaperones**, v. 22, n. 6, p. 847-852, 2017.

CURTIN, R.; PRELLEZO, R. Understanding marine ecosystem based management: a literature review. **Marine Policy**, v. 34, n. 5, p. 821-830, 2010.

DEFEO, O.; DE ALAVA, A. Effects of human activities on long-term trends in sandy beach populations: the wedge clam Donax hanleyanus in Uruguay. **Marine Ecology Progress Series**, v. 123, p. 73-82, 1995.

DEFEO, O.; MCLACHLAN, A.; SCHOEMAN, D.S.; SCHLACHER, T.A.; DUGAN, J.; JONES, A.; LASTRA, M.; SCAPINI, F. Threats to sandy beach ecosystems: a review. **Estuarine, Coastal and Shelf Science**, v. 8, n. 1, p. 1-12, 2009.

ENRIQUEZ-ACEVEDO, T.; BOTERO, C.M.; CANTERO-RODELO, R.; PERTUZ, A.; SUAREZ, A. Willingness to pay for Beach Ecosystem Services: The case study of three Colombian beaches. **Ocean & Coastal Management**, v. 161, p. 96-104, 2018.

FANINI, L.; DEFEO, O.; ELLIOTT, M. Advances in sandy beach research – Local and global perspectives. **Estuarine, Coastal and Shelf Science**, v. 234, p. 106646, 2020.

GELCICH, S.; DEFEO, O.; IRIBARNE, O.; CARPIO, G.D.; DUBOIS, R.; HORTA, S.; ISACCH, J.P.; GODOY, N.; PEÑALOZA, P.C.; CASTILLA, J.C. Marine ecosystem-based management in the Southern Cone of South America: Stakeholder perceptions and lessons for implementation. **Marine Policy**, v. 33, n. 5, p. 801-806, 2009.

GELCICH, S.; REYES-MENDY, F.; ARRIAGADA, R.; CASTILLO, B. Assessing the implementation of marine ecosystem based management into national policies: Insights from agenda setting and policy responses. **Marine Policy**, v. 92, p. 40-47, 2018.

GRILLI, N.M.; XAVIER, L.Y.; JACOBI, P.R.; TURRA, A. Integrated science for coastal management: Discussion on a local empirical basis. **Ocean & Coastal Management**, v. 167, p. 219-228, 2019.

HALPERN, B.S.; FRAZIER, M.; AFFLERBACH, J.; LOWNDES, J.S.; MICHELI, F.; O'HARA, C.; SCARBOROUGH, C.; SELKOE, K.A. Recent pace of change in human impact on the world's ocean. **Scientific Reports**, v. 9, n. 1, p. 11609, 2019.

HARRIS, L.; NELL, R.; HOLNESS, S.; SCHOEMAN, D. Quantifying cumulative threats to sandy beach ecosystems: a tool to guide ecosystem-based management beyond coastal reserves. **Ocean & Coastal Management**, v. 110, p. 12-24, 2015.

IPBES (INTERGOVERNMENTAL SCIENCE-POLICY PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES). **Global Assessment Report on Biodiversity and Ecosystem Services**: Summary for Policymakers. Bonn, Germany: IPBES, 2019. 56 p. Disponível em: <https://ipbes.net/global-assessment>. Acesso em Fev. 2020.

IPCC (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE). **Special Report on the Ocean and Cryosphere in a Changing Climate**. 2018. Disponível em: <https://www.ipcc.ch/srocc/>. Acesso em Fev. 2020.

JAMES, R.J. From beaches to beach environments: linking the ecology, human-use and management of beaches in Australia. **Ocean & Coastal Management**, v. 43, p. 495-514, 2000.

KICKERT, W.J.M.; KLIJN, E.H.; KOPPENJAN, J.F.M. **Managing Complex Networks: Strategies for the Public Sector**. London, UK: Sage, 1997. 224 p.

LAHSEN, M.; BUSTAMANTE, M.M.C.; SWAP, R.; MCNIE, E.; OMETTO, J.P.H.B.; SCHOR, T.; TIESSEN, H.; ANDELMAN, S.; ANNEGARN, H. The contributions of regional knowledge networks researching environmental changes in Latin America and Africa: a synthesis of what they can do and why they can be policy relevant. **Ecology and Society**, v. 18, n. 3, p. 14, 2013.

LESLIE, H.; SIEVANEN, L.; CRAWFORD, T.G.; GRUBY, R.; VILLANUEVA-AZNAR, H.C.; CAMPBELL, L.M. Learning from ecosystem-based management in practice. **Ocean & Coastal Management**, v. 43, n. 5, p. 471-497, 2015.

LONG, R.D.; CHARLES, A.; STEPHENSON, R.L. Key principles of marine ecosystem-based management. **Marine Policy**, v. 57, p. 53-60, 2015.

LUKS, F.; SIEBENHÜNER, B. Transdisciplinarity for social learning? The contribution of the German socio-ecological research initiative to sustainability governance. **Ecological Economy**, v. 63, n. 2-3, p. 418-426, 2007.

MARSHAK, A.R.; LINK, J.S.; SHUFORD, R.; MONACO, M.E.; JOHANNESEN, E.; BIANCHI, G.; ANDERSON, M.R.; OLSEN, E.; SMITH, D.C.; SCHMIDT, J.O.; DICKEY-COLLAS, M. International perceptions of an integrated, multi-sectoral, ecosystem approach to management. **ICES Journal of Marine Science**, v. 74, n. 1, p. 414-420, 2017.

MCLACHLAN, A.; DEFEO, O. **The Ecology of Sandy Shores**. 3rd ed. Cambridge, MA: Academic Press, 2017. 572 p.

MCLEOD, K.L.; LESLIE, M. **Ecosystem-based management for the oceans**. Washington, DC: Island Press, 2009. 392 p.

MONTERO, P.; MILANÉS C.B. Social perception of coastal risk in the face of hurricanes in the southeastern region of Cuba. **Ocean & Coastal Management**, v. 184, n. 1, p. 105010, 2020.

MUÑOZ SEVILLA, N. P.; LE BAIL, M. Latin American and Caribbean regional perspective on Ecosystem Based Management (EBM) of Large Marine Ecosystems goods and services. **Environmental Development**, v. 22, p. 9-17, 2017.

NEL, R.; CAMPBELL, E.E.; HARRIS, L.; HAUSER, L.; SCHOEMAN, D.S.; MCLACHLAN, A.; DU PREEZ, D.R.; BEZUIDENHOUT, K.; SCHLACHER, T.A. The status of sandy beach science: Past trends, progress, and possible futures. **Estuarine, Coastal and Shelf Science**, v. 150, Part A, p. 1-10, 2014.

PITTMAN, J.; ARMITAGE, D. Governance across the land-sea interface: a systematic review. **Environmental Science & Policy**, v. 64, p. 9-17, 2016.

PORRAS, F. Modelo canónico, problemas fundamentales y gobernanza urbana. **Revista de Filosofía Open Insight**, v. 9, n. 15, p. 11-44, 2018.

POTSCHIN, M.; HAINES-YOUNG, R. Defining and measuring ecosystem services. In: POTSCHIN, M.; HAINES-YOUNG, R.; FISH, R.; TURNER, R.K. (eds). **Routledge Handbook of Ecosystem Services**. London, UK: Routledge, 2016. Chapter 3, p. 25-44.

QUINTERO-CASTELLANOS, C.E. Gobernanza y teoría de las organizaciones. **Perfiles Latinoamericanos**, v. 25, n. 50, p. 39-57, 2017.

REGUERO, B.G.; MÉNDEZ, F.J.; LOSADA, I.J. Variability of multivariate wave climate in Latin America and the Caribbean. **Global and Planetary Change**, v. 100, p. 70-84, 2013.

ROSENBERG, A.A.; MCLEOD, K.L. Implementing ecosystem-based approaches to management for the conservation of ecosystem services. **Marine Ecology Progress Series**, v. 300, p. 270-274, 2005.

SARDÁ, R.; LOZOYA, J.P. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

SARDÁ, R.; VALLS, J.F.; PINTÓ, J.; ARIZA, E.; LOZOYA, J.P.; FRAGUELL, R.M.; MARTÍ, C.; RUCABADO, J.; RAMIS, J.; JIMENEZ, J.A. Towards a new integrated beach management system: the ecosystem-based management system for beaches. **Ocean & Coastal Management**, v. 118, Part B, p. 167-177, 2015.

SCHLACHER, T.A.; JONES, A.R.; DUGAN, J.E.; WESTON, M.A.; HARRIS, L.; SCHOEMAN, D.S.; HUBBARD, D.M.; SCAPINI, F.; NEL, R.; LASTRA, M.; MCLACHLAN, A.; PETERSON, C.H. Open-coast sandy beaches and coastal dunes. In: MASLO, B.; LOCKWOOD, J.L. (eds.). **Coastal Conservation**. Cambridge: Cambridge University Press, 2014. Chapter 3, p. 37-94.

SEIXAS, C.S.; DAVIDSON-HUNT, I.; KALIKOSKI, D.C.; DAVY, B.; BERKES, F.; CASTRO, F.; MEDEIROS, R.P.; MINTE-VERA, C.V.; ARAUJO, L.G. Collaborative coastal management in Brazil: Advancements, challenges and opportunities. In: SALAS, S.; BARRAGÁN-PALADINES, M.J.; CHUENPAGDEE, R. (eds.). **Viability and Sustainability of Small-Scale Fisheries in Latin America and the Caribbean**. MARE Publication Series. Cham: Springer, 2019. v. 19, p. 425-451.

SILVA, R.; MARTÍNEZ, M.L.; HESP, P.A.; CATALÁN, P.; OSORIO, A.F.; MARTELL, R.; FOSSATI, M.; MIOT DA SILVA, G.; MARIÑO-TAPIA, I.; PEREIRA, P.; CIENFUEGOS, R.; KLEIN, A.; GOVAERE, G. Present and future challenges of coastal erosion in Latin America. **Journal of Coastal Research**, v. 71, n. 1, p. 1-16, 2014.

TALLIS, H.; LEVIN, P.S.; RUCKELSHAUS, M.; LESTER, S.E.; MCLEOD, K.L.; FLUHARTY, D.L.; HALPERN, B.S. The many faces of ecosystem-based management: making the process work today in real places. **Marine Policy**, v. 34, n. 2, p. 340-348, 2010.

TURRA, A.; XAVIER, L.Y.; POMBO, M.; PASCHOAL, C.C.; DENADAI, M.R. Assessment of recreational harvesting of the trigonal clam *Tivela mactroides*: Socioeconomic aspects and environmental perception. **Fisheries Research**, v. 174, p. 58-67, 2016.

UN (UNITED NATIONS). **The Future We Want**. Resolution A/RES/66/288, Set. 2012, p. 20-22. Disponível em: <www.un.org/ga/search/view_doc.asp?symbol=A/RES/66/288&Lang=E>. Acesso em Fev. 2020.

UN (UNITED NATIONS). **Transforming Our World:** The 2030 Agenda for Sustainable Development. Resolution A/RES/70/1, Set. 2015. Disponível em: <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>. Acesso em Fev. 2020.

UNEP (UNITED NATIONS ENVIRONMENT PROGRAMME). **GEO-6: Regional Assessment for Latin America and the Caribbean**. Nairobi, Kenya. 2016. Disponível em: <https://www.unenvironment.org/resources/assessment/geo-6-regional-assessment-latin-america-and-caribbean> Acesso em Fev. 2020.

UNESCO (UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION). **The Science We Need for the Ocean We Want**: The United Nations Decade of Ocean Science for Sustainable Development (2021-2030). Paris, 2020. Disponível em: <https://unesdoc.unesco.org/ark:/48223/pf0000265198>. Acesso em Dez. 2020.

VÉLEZ, J.M.M.; GARCÍA, S.B.; TENORIO, A.E. Policies in coastal wetlands: Key challenges. **Environmental Science & Policy**, v. 88, p. 72-82, 2017.

WILLIAMSON, O.E. **The Mechanisms of Governance**. New York, NY: Oxford University Press, 1996. 429 p.

XAVIER, L.Y.; GONÇALVES, L.R. Ciência e política: desafios e oportunidades para gestão do território macrometropolitano. In: TORRES, P.; JACOBI, P.R.; BARBI, F.; GONÇALVES, L. (orgs.). **Governança e Planejamento Ambiental**: adaptação e políticas públicas na Macrometrópole Paulista. 1 ed. Rio de Janeiro, RJ: Letra Capital Editora, 2019. p. 82-89.

YOUNG, O.R. **Governing Complex Systems**: Social Capital for the Anthropocene. Cambridge, MA: The MIT Press, 2017. 279 p.

ZURBRIGGEN, C. **Las redes de políticas públicas**. Una revisión teórica. Colección Documentos Sistema Político y Gobernabilidad Democrática. Barcelona: Institut Internacional de Gobernabilitat de Catalunya, 2003.

CAPÍTULO II: Perception of local managers on beach socio-ecological systems: evidence of a gap for Ecosystem-Based Management implementation

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ABSTRACT

The Ecosystem-Based Management (EBM) implementation relies on decision-making to acknowledge the connection between human well-being and the long-term ecosystem functioning, framing a social-ecological system (SES). Beach sustainability depends on management to cope with environmental changes and guarantee the long-term provision of Ecosystem Services (ES). This study investigates local government beach managers' perceptions of four municipalities of the Northern Coast of São Paulo State (Brazil). Utilizing the ES cascade-model in a workshop, we encourage the beach managers to visualize beaches as SES and share their perceptions on the beach functioning, the long-term ES supply, and derived benefits. The proposed theoretical structure was useful to identify which complementary conceptual enlightenments are needed by the managers and which approaches can be applied to improve local EBM implementation. We argue that managers' perceptions about the long-term ES provision can be an operational tool to introduce scientific and participative principles into EBM practice. Although our findings are focused on beach managers' perceptions, the approach can support local EBM implementation in other coastal ecosystems.

Keywords: Ecosystem approach; Social-ecological systems; Science-Practice gap; Sandy beaches; Coastal management.

RESUMO

A implementação da Gestão Baseada em Ecossistemas (GBE) depende que os tomadores de decisão reconheçam a conexão entre o bem-estar humano e o funcionamento de longo prazo do ecossistema (i.e. sistemas socioecológicos). A sustentabilidade das praias depende de uma gestão que lide com as mudanças ambientais e garanta a prestação a longo prazo de Serviços Ecossistêmicos (SE). Este estudo investigou a percepção de gestores municipais de praias de quatro municípios do Litoral Norte do Estado de São Paulo (Brasil). Utilizando o modelo de cascata de SE em um workshop, encorajamos os gestores de praia a visualizar as praias como sistemas socioecológicos e compartilhar suas percepções sobre seu funcionamento, o fornecimento de longo prazo de SE e os consequentes benefícios para o bem-estar humano. A estrutura teórica proposta foi útil para identificar quais esclarecimentos conceituais complementares são necessários aos gestores e quais abordagens podem ser aplicadas para melhorar a implementação da GBE em praias localmente. Argumentamos que as percepções dos gestores sobre a provisão de longo prazo de SE podem ser uma ferramenta operacional para introduzir princípios científicos na prática GBE. Embora nossas descobertas se concentrem nas percepções dos gestores de praia, a abordagem pode apoiar a implementação local de GBE em outros ecossistemas.

Palavras-chave: Abordagem ecossistêmica; Sistemas socioecológicos; Lacuna entre ciência e prática; Gestão costeira.

1. INTRODUCTION

Ecosystem-based management (EBM) diverges from traditional management, especially by the acknowledgment of coupled and dynamic human-nature systems (i.e., social-ecological systems, SES) (McLeod; Leslie, 2009; O'Higgins; Lago; Dewitt, 2020). This approach is internationally recognized as one of the best practices for managing marine ecosystems (O'Higgins; Lago; Dewitt, 2020); however, its implementation is not straightforward (Link; Browman, 2017).

EBM implementation relies upon bringing new frameworks and building new practices on the existing management approach (Christie et al., 2009; Leslie et al., 2015). It depends, among other things, on the establishment of a systemic perspective regarding the connection between human well-being and the long-term ecosystem functioning (i.e., structure, processes, and responses to change) (Arkema; Abramson; Dewsbury, 2006; Christie et al., 2009; Granek et al., 2010; Sardá; Lozoya, 2018). However, integrating human and ecological dimensions into decision-making depends on the imperative translation of scientific knowledge (Arkema; Abramson; Dewsbury, 2006; Granek et al., 2010; O'Higgins; Lago; Dewitt, 2020), which is a significant challenge for EBM implementation (Leslie et al., 2015).

Similar to EBM, Ecosystem Services (ES), as we are adopting here, are the outputs from an ecosystem that contribute directly to human well-being (Potschin; Haines-Young, 2016). ES-oriented management enriches science capability to improve, influence, and support decision-making by pointing out opportunities for knowledge exchange (Fisher; Turner; Morling, 2009; Saarikoski et al., 2018). Framed as a strategy to safeguard the long-term delivery of environmental sustainability and human welfare, EBM implementation into coastal areas can be ES-orientated (McLeod; Leslie, 2009; Granek et al., 2010; Leslie et al., 2015; Sardá et al., 2015; O'Higgins; Lago; Dewitt, 2020).

However, the allusion to the ES concept into decision-making hinges on pairing with pre-existing knowledge and expertise of managers (Saarikoski et al., 2018). The way decision-makers perceive the ES shapes the decisions that will impact the long-term ecological integrity and benefits to human well-being, determining the effectiveness and sustainability of the management measures (Asah et al., 2014). According to Beyerl, Putz and Breckwoldt (2016, p. 4), perception is "(…) the subjective way people experience, think about and understand someone or something". Perception, therefore, can be utilized as a tool to establish the status of the current management and investigate which aspects can facilitate or challenge the implementation of new approaches (e.g., EBM) (Bennet, 2016).

Beaches provide a wide range of ES (Sardá; Lozoya, 2018). Human-induced impacts (e.g., climate change, human activities, urban growth) affect ecological and social processes, threatening beach sustainability (McLachlan; Defeo, 2017). Due to the beach SES's complexity, the implementation of traditional reductionist management approaches has been unsuccessful (Botero; Williams; Cabrera, 2015). By recognizing beaches as SES and coping with long-term environmental changes, EBM provides a new and appropriate approach for beach management (Sardá et al., 2015). However, experiences of EBM implementation in beaches are still incipient and understudied (Sardá; Lozoya, 2018).

Evaluations of the ES provision transformations can support the decision-making and planning in beaches under environmental change scenarios (Balvanera et al., 2012). If the connection between changes in the ecosystem functioning and their consequences on human well-being is not well-known by managers, the necessary measures to cope with such changes and guarantee the long-term ES supply will be underestimated (Berrouet; Machado; Villegas-Palácio, 2018). EBM implementation in beaches, therefore, relies upon managers to perceive and prioritize the linkages between the human and social dimensions and the causal pathways shaping the long-term supply of ES and its benefits to human well-being.

Long-term changes in the beach system centrally include the coastal squeeze phenomena (i.e., beach disappearing due to coastal erosion and sea-level rise), which is exacerbated by uncontrolled urban growth and climate change (McLachlan; Defeo, 2017; McLachlan et al., 2013). As traditional beach management, EBM equally depends on actions taken at the local level, which can be improved and qualified by local government actors (Christie et al., 2009; Leslie et al., 2015; Sardá; Lozoya, 2018). To cope with climate change impacts on beaches also depends on local management measures (McLachlan; Defeo, 2017), making an interesting case to investigate EBM implementation in beaches.

To address the potentialities and limitations of the EBM implementation to beach management, we assessed how beach managers' perceptions about beach functioning and the long-term ES supply might strengthen the science-practice interface for EBM implementation. We analyzed how local beach managers: (1) Prioritize the benefits of beaches to human well-being; (2) Perceive the nexus of beach ecosystem structure and functioning (i.e., biophysical structures and processes) with Beach Ecosystem Services and, later, benefits to human well-being; (3) Perceive how long-term changes (i.e., increase in coastal erosion due to climate change) in the beach ecosystem are translated into changes in human well-being (i.e., loss of benefits).

2. METHODS

2.1. Study Site

Brazil has one of the longest coastlines worldwide. Vast stretches of the Brazilian coast are beaches that provide fundamental ES but are subject to cumulative and synergistic threats that challenge its management (Amaral et al., 2016; Xavier et al., in press). Recently, the Brazilian federal government has transferred management rights and responsibilities to municipalities[10] (i.e., beach management decentralization process). It is not mandatory but an opportunity for local governments to be the central actors of beach management (Scherer et al., 2020). Simultaneously with the municipalization processes, the Federal government is encouraging the implementation of ES-based municipal policies and beach management strategies to cope with long-term environmental changes, such as climate change (Brasil, 2018).

The North Coast of São Paulo State (in Portuguese, Litoral Norte Paulista – LNP) is known for its social-environmental relevance and has an urbanization process strongly attached to its beaches (Santos; Turra, 2017). This region's economy relies upon beach quality, and, consequently, on beach ES (BES) provision. The four municipalities of the LNP (i.e., São Sebastião, Ubatuba, Ilhabela, and Caraguatatuba) are committed to taking over the management of their beaches. These municipalities face common vulnerabilities, such as climate change-induced impacts (Simões et al., 2017). At the local level, sectorized municipal offices held distinct beach management activities. Despite the local institutional arrangement, these municipalities need to establish long-term strategic planning and local leadership to cover a changing environment (Simões et al., 2017). The LNP, therefore, represents a compelling site to study how local beach managers' perceptions can improve or impair EBM implementation.

2.2. Study framework

The "ES cascade-model" was developed to clarify and structure how ES can describe interactions between humans and nature, strengthening the science-practice interface (Potschin; Haines-Young, 2016). It attempts to capture the prevailing view that there is a link, with a series of intermediate stages, between ecological and biophysical structures and the elements of human well-being (Potschin; Haines-Young, 2016). Although this model does not represent the entire ES paradigm, it brings a systemic perspective and simplifies its complexity (Potschin-Young et al., 2018), making it approachable for managers. The ES cascade-model was applied

[10] Municipal level is the lowest administrative level in Brazil, hereafter described as "local" (see http://www.brazil.gov.br/government/how-the-government-works).

in a Workshop to encourage local beach managers to visualize beaches as SES and share their perceptions on the beach functioning, the long-term ES supply and derived benefits.

Following Moser and Tribbia (2006), we broadly defined beach managers as local government officers concerned with civil society safety, environmental protection, public infrastructure, and the development of coastal areas near beaches. The Workshop participants were chosen to capture an overview of the LNP municipal beach managers' perceptions. In each of the four LNP municipalities, we selected the three municipal government offices most involved in beach management (e.g., Civil Defense Office, Urban Planning Office, Environment Office). For more information on the participants' setting, see Corrêa and collaborators (*in press*) supporting information (Appendix 2, Chapter III).

Eleven Workshop sessions (each one with groups of 3-5 beach managers from the same Municipal Office) were carried out: three in Caraguatatuba, Ubatuba, and São Sebastião, and two in Ilhabela. We placed a canvas with the ES cascade-model developed by Potschin and Haines-Young (2016) in front of each group of managers and explained the ES-cascade model. With the facilitation of two people, the groups of participants collectively filled the ES cascade-model during the workshops. Their perceptions were registered in cards allocated in the canvas after discussion and consensus by each group. In order to fill the ES cascade-model, a four-step procedure was established (Figure 1). The sessions were carried out in June-July 2019, were voice-recorded, and all participants signed an informed consent form (approved by the Brazilian Ethics Committee, Plataforma Brasil: 3.337.019).

2.3. Data treatment and Analysis

We transcribed the records and combined the results of all workshops for a qualitative analysis of the integrated cascade-model. No prior assumptions about the managers' responses were made, determining an inductive approach (Asah et al., 2014). The cards and arrows filled in the ES cascade-model during each Workshop and the managers' narratives (steps 1-3) were interpreted and categorized into open coded descriptors. The discussion carried by the managers in step 4 was also interpreted and matched with the main descriptors of the previous steps or categorized into new descriptors. In order to facilitate the analysis, descriptors were classified by level of recognition: Usually cited (9 to 11 municipal offices), *Frequently* cited (6 to 8 municipal offices), *Occasionally* cited (3 to 5 municipal offices), and *Rarely* cited (1 to 2 municipal offices). The responses were allocated into one or more descriptors (for details about the data treatment see Supporting Information – Appendix 1, Chapter II).

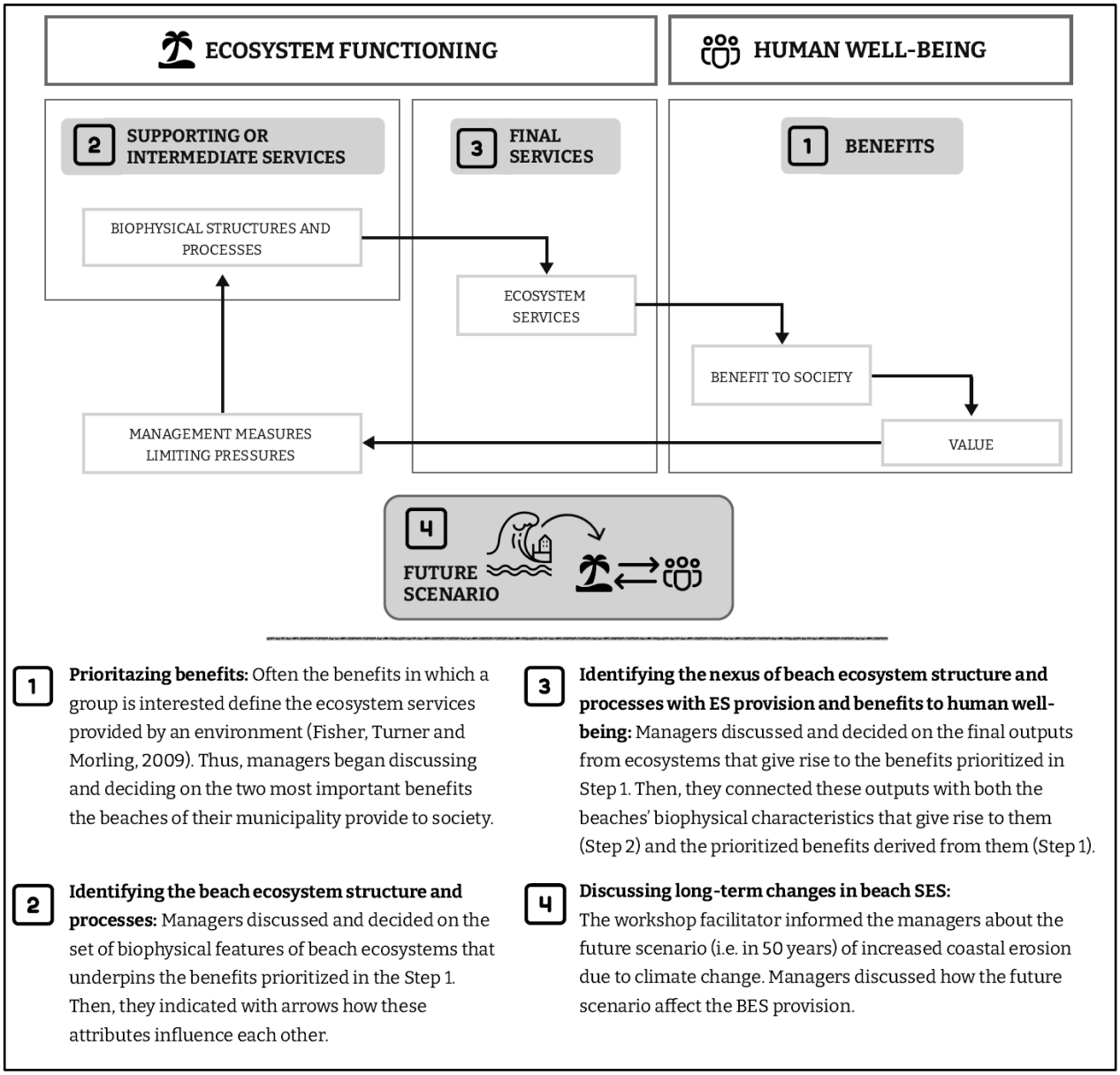

Figure 1. An adapted version of the ES "Cascade-model" (Potschin; Haines-Young, 2016) with the four steps of the workshop held with the local beach managers. The cascade-model represents how ecosystems can promote human well-being. Human well-being is represented by the benefits (i.e., features that interfere in people's well-being) which can be valued (Step 1). The ecosystem functioning is represented by "*Supporting or Intermediate Services*" and "*Final Services*". The "*Supporting or intermediate services*" are the set of ecological structures and processes that generate a "*Final Service"* (Step 2). The "*Final Services*" are the final output from the ecosystem and directly contribute to human well-being (i.e., Ecosystem Services) (Step 3). Step 4 how the future scenario of climate change would pressure the beach ecosystems and affect the provision of ES. The model assumes that human impact on the ecosystem functioning varies according to benefit value (or prioritization), since it determines the management measures limiting the pressures on the ecosystem. Source: Authors' summary of the process.

3. RESULTS

Utilizing the ES cascade-model (Potschin; Haines-Young, 2016), we mapped local government beach managers' perceptions about the long-term provision of BES and their derived benefits (Figure 2).

3.1. Prioritization of the benefits to human well being provided by beaches

The prioritization of the benefits was summarized into 5 descriptors: "Sustainable Beaches" (*n* = 1), "Food Provision" (*n* = 1), "Cultural identity" (*n* = 2), "Physical and Mental Health" (*n* = 5), and "Tourism and Leisure" (*n* = 13). The latter was the only benefit prioritized by all the municipal offices and got a higher score because two groups of managers prioritized tourism and leisure as separate benefits (Figure 2).

3.2. Perception of the nexus among beach ecosystem features with BES and benefits to human well-being

This section describes the managers' perceptions regarding the beach ecosystem features and processes, their connections with the final services, and with the prioritized benefits to human well-being. It will be presented in three dimensions: "Beach Abiotic System", "Beach Biotic System" and "Beach Ecosystem". The descriptors only perceived in the discussion about long-term changes in the ES provision (step 4, dashed lines in Figure 2) will be described in the next section (3.3).

3.2.1. Beach Abiotic System

The managers identified 7 descriptors that, in their view, are the beach abiotic system features. Most descriptors were perceived in the majority of workshops, such as "River Mouth", "Hydrodynamics", and "Landform" that were *usually* perceived, and "Seasonality", "Wind Dynamics", and "Tide" that were *frequently* perceived. Only the "Sediment transport" descriptor was *occasionally* identified when not considering the long-term perspective (Figure 2).

The participants also perceived connections among the descriptors, framing the beach abiotic system functioning. The connection of "Hydrodynamics" to "Sediment transport" was *occasionally* perceived, as well as the connection from "River Mouth" to "Sediment Transport". Although the "Wind Dynamics" was not perceived as directly related to the "Sediment Transport", it was *frequently* connected to "Hydrodynamics" and *occasionally* perceived as influenced by "Seasonality". The same indirect relation occurs with the "Landform", since it

was *usually* perceived to affect both “Hydrodynamics” and “Wind Dynamics” and *rarely* perceived to affect “River Mouth”. Although the “Tides” descriptor was perceived as part of the “Beach Abiotic System” it was not connected with other descriptors (Figure 2).

Managers perceived the interaction among all beach abiotic features (i.e., “Beach Abiotic System” descriptor, *usually* perceived), as providing all the *Final Services* derivative from the abiotic system. The “Beach Abiotic System” descriptor was *frequently* perceived as supporting “Diversity of beach types”, “Access to the Sea” and “Scenic Beauty”. The “Beach Abiotic System” was *rarely* perceived as supporting “Filtration and purification of the seawater” (Figure 2).

The *Final Services* provided by the beach abiotic system were perceived as supporting all the prioritized benefits. “Sustainable Beaches” and “Food Provision” were perceived as supported by “Filtration and Purification of the seawater”. “Cultural identity” was perceived as supported by “Diversity of beach types”, “Access to the Sea” and “Scenic Beauty”. “Physical and Mental Health” was perceived as supported by “Access to the Sea” and “Scenic Beauty”. And “Tourism and Leisure” was perceived as supported by all the *Final Services* provided by the “Beach Abiotic System” descriptor (Figure 2). The abiotic system was also perceived supporting the provision of benefits through its connections with the biotic system.

3.2.2. Beach Biotic System

Differently from the abiotic system, managers did not perceive the interactions among beach biotic features as a new descriptor. However, three descriptors are related to the beach biotic system, and only one was perceived at the majority of the workshops: “Diversity of Living Beings” (*usually* perceived), “Food Chain” (*occasionally* perceived), and “Nutrient Cycling” (*rarely* perceived). The influence of the beach abiotic system upon the beach biotic system features was only perceived through the “Diversity of Living Beings” descriptor. Although the least part of the managers (max. *occasionally*) perceived in detail how the abiotic system affects the biotic system (i.e., the influence from “Hydrodynamics”, “Seasonality”, and “River Mouth” descriptors), the connection from the “Beach Abiotic System” descriptor to “Diversity of Living Beings” was *frequently* perceived (Figure 2).

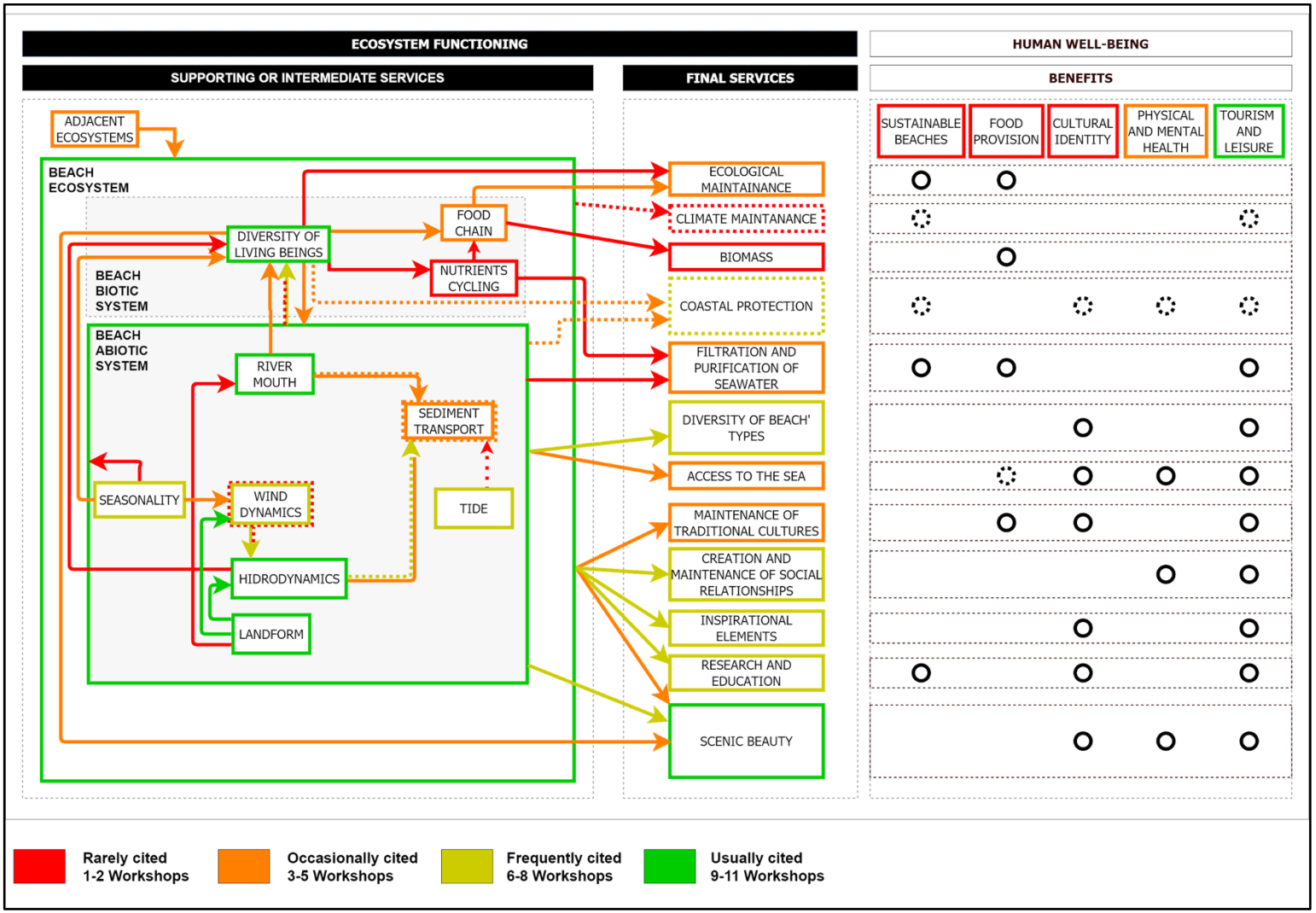

Figure 2. Beach managers' perceptions regarding the ES cascade-model applied to beaches as SES. The colored rectangles represent the "Benefit", "Support or intermediate service" or "Final service" descriptors perceived by the managers. The arrows represent the perceived connections among the descriptors. The colors represent how often the descriptors or connections were perceived. The circles represent a perceived connection between the "Final services" and the prioritized "Benefits". The dashed lines indicate descriptors and connections only perceived in the discussion about long-term changes in the ES provision (step 4). Source: Authors' summary.

The perceived beach biotic features and connections were perceived as providing Final Services. The descriptor “Food Chain” was *occasionally* connected to the *Final Service* “Ecological Maintenance”. The connection from “Diversity of Living Beings” to the *Final Service* “Scenic Beauty” was *occasionally* perceived. The descriptor “Food Chain” was *rarely* perceived as connected to the *Final Service* “Biomass”. And the link from “Nutrient Cycling" to “Filtration and Purification of Seawater” *Final Service* was *rarely* perceived (Figure 2).

The *Final Services* provided by the beach biotic system were perceived as supporting all the prioritized benefits. “Beach sustainability” was perceived as supported by the descriptors “Ecological Maintenance” and “Filtration and Purification of the Seawater”. “Food Provision” was perceived as supported by the descriptors “Ecological Maintenance”, “Biomass” and “Filtration and Purification of the seawater”. “Cultural Identity”, “Physical and Mental Health” and “Tourism and Leisure” were perceived as supported by the “Scenic Beauty” Final Service (Figure 2).

3.2.3. Beach Ecosystem

The managers usually grouped all the interactions among the beach biophysical components (i.e., “Beach Ecosystem” descriptor) to determine the provision of some of the *Final Services*. The “Beach Ecosystem” descriptor was perceived as providing the following *Final Services*: “Maintenance of Traditional Cultures” (*occasionally*), “Creation and Maintenance of social relationships” (*frequently*), “Inspirational elements” (*frequently*), “Research and Education” (*frequently*) and “Scenic Beauty” (*frequently*). The *Final Services* provided by the “Beach Ecosystem” descriptor were perceived as influencing all the prioritized benefits. Moreover, managers *occasionally* perceived the influence from the descriptor “Adjacent Ecosystem” in the “Beach Ecosystem” (Figure 2).

3.3. Perception of how long-term changes in the ecological beach system are translated into changes in human well-being

Nine groups of managers perceived the consequences of the long-term changes in the beach abiotic system. They indicated the following consequences of the long-term changes in the beach ecosystem: diminished beaches and beach disappearing (e.g., “It seems that there won’t be beaches in 50 years from now”; “With the increased coastal erosion it [beaches] will diminish, the sandy shoreline will gradually be reduced”). Two groups of managers did not feel confident to explain how the increased coastal erosion would affect the perceived benefits: “For us, all of this still is very new. Despite the fact that we know the term [climate change],

everything here seems normal, and we are not used to dealing with it on a daily basis"; "This phenomenon is happening, and we still have to study it in order to fully understand it".

The LNP beach managers perceived new descriptors and connections in the ES cascade-model during the long-term perspective discussion (step 4). The *Final Services* "Coastal protection" and "Climate maintenance" and the connection from "Tide" to "Sediment transport" are examples. New connections among the beach functioning and the benefits provided were also established: the benefits "Tourism and Leisure", "Physical and Mental Health", "Sustainable Beach" and "Cultural Identity" were perceived to be supported by the "Coastal protection" descriptor. The benefits "Sustainable Beach" and "Tourism and Leisure" were perceived to be supported by the "Climate Maintenance" descriptor. The benefit "Food Provision" was perceived to be supported by the "Access to the Sea" descriptor. In addition, some groups of managers perceived descriptors and connections that had already been perceived by other groups during the steps 1-3, such as: "Sediment transport", "Wind dynamics", and the connections from "River Mouth" to "Sediment Transport"; from "Wind Dynamics" to "Hydrodynamics"; from "Hydrodynamics" to "Sediment Transport"; and from "Beach Abiotic System" to "Diversity of Living Beings" (see the dashed lines in Figure 2).

In addition to the perception of new descriptors and connections, the beach managers also reinforced their understanding of the long-term causal pathways within the beach SES when explaining how the increased erosion due to climate change would affect all the prioritized benefits. The "Food Provision" was *rarely* perceived to be affected due to loss in the fishery (i.e., the "Biomass" *Final Service* descriptor), and due to loss of the "Access to the Sea". The "Cultural Identity" descriptor was *rarely* perceived to be affected by the loss of "Scenic Beauty". The "Physical and Mental Health" descriptor was *occasionally* perceived to be affected by the loss of the "Access to the Sea" and "Creation and Maintenance of Social Relationships". The "Tourism and Leisure" descriptor was *frequently* perceived to be affected by the loss of the "Scenic Beauty", "Access to the Sea", and "Creation and Maintenance of Social Relationships".

4. DISCUSSION

4.1. Prioritization of the benefits to human well-being provided by beaches

Tourism is commonly considered the most significant (Sardá; Lozoya, 2018) and studied (Nel et al., 2014) aspect of beaches. Sustaining activities that provide physical and mental health, tourism represents the majority of beaches' recreational activities (Sardá; Lozoya, 2018; Checon et al., *in press*). Since LNP beach managers mostly prioritize recreational activities, they might safeguard this aspect and disregard others equally relevant. Currently, this scenario is observed in beach management worldwide (Sardá; Lozoya, 2018).

EBM implementation in beaches, however, depends on managers considering beaches as SES and maintaining their biophysical integrity to ensure the provision of a wide range of ES and benefits (Sardá et al., 2015). Thus, the implementation of a holistic management approach in the LNP nowadays depends on the few managers who prioritized benefits unrelated to recreational activities. Their views are safeguarding other functional aspects of beaches, such as the *Final Services* "Biomass", "Ecological Maintenance" and "Climate Maintenance" (see Figure 2). This fact reinforces the necessity of including other sectors of the society on the decision-making process for EBM implementation.

4.2. Perception of the nexus among beach ecosystem features with BES and benefits to human well-being

4.2.1. Beach Abiotic System

Beaches are physically controlled systems (McLachlan; Defeo, 2017). Beach dynamics respond to wave-tide-wind conditions that shape sediment transport (McLachlan et al., 2013). A critical measure to promote sustainable beach management is to safeguard the sand budget (or sand storage) (McLachlan; Defeo, 2017). Most of the fundamental components and connections within the beach abiotic system were perceived by the majority of the managers. However, managers overlooked essential aspects such as the "Sediment Transport" descriptor and the influence of tides.

The beach abiotic system provides ES (Sardá; Lozoya, 2018; Checon et al., *in press*). The interaction among beach abiotic components defines different beach morphodynamic types that allow a diverse set of human uses (McLachlan et al., 2013; Harris et al., 2014). The movement of waves and tides upon the sand provides seawater filtration (McLachlan et al., 2013; McLachlan; Defeo, 2017). Through sediment transport, beaches dissipate waves and wind, reducing their damages in adjacent urbanized areas and/or ecosystems (McLachlan; Defeo, 2017; Sardá; Lozoya, 2018; Checon et al., *in press*). Beaches also provide access to the

sea for recreational activities and small-scale fisheries, which varies with the abiotic factors features (e.g., lower energy beaches will be safer for bathing and for accessing the beach by boat) (McLachlan et al., 2013; Checon et al., *in press*). Beach landscape is also considered a source of aesthetic appreciation and inspiration (Sardá; Lozoya, 2018). Managers seem to perceive the importance of the abiotic system to human well-being: almost all these ES were frequently perceived. However, both ES with a closer relation to sediment transport processes (i.e., Coastal protection and Seawater filtration) were less (or not) perceived by the managers in the short-term perspective.

The beach abiotic system regulates the beach dynamics and must be considered in beach management measures (McLachlan; Defeo, 2017). Managers perceived all the abiotic system's final services as the outcome of the interactions among fundamental abiotic components, setting a systemic view. Therefore, the LNP managers' perception of the abiotic beach system and its connection with human well-being is a suitable opportunity to better discuss the beach abiotic system's importance and functioning for EBM implementation. In this process, it is imperative to consider features that were overlooked by the majority of the managers and enhance the LNP managers' awareness about the importance of the tides, and the influence of the "Sediment transport" descriptor and the ES provided by it.

4.2.2. Beach Biotic System

Beach species' dynamics are mostly regulated by the beach abiotic conditions (McLachlan; Defeo, 2017). Beach management measures must be assisted with linked information about biodiversity, species distribution, and ecosystem functions (Harris et al., 2014; McLachlan; Defeo, 2017). Few managers could explain how the abiotic system influences the biotic system. However, most of the managers perceived the importance of the abiotic system for the biotic system functioning, pointing out an opportunity to better discuss the relationship among both systems, as required by EBM.

Beach biodiversity provides the basis for ecological processes, ecosystem resilience, and long-term ES provision (Harris et al., 2014). Guarantee biodiversity, therefore, is an EBM principle and must be a beach management goal (Sardá et al., 2015). It is not possible to affirm that the managers perceived the biodiversity concept and its complexity. Yet, if extended for all managers, their perception about the beach biotic system descriptors can be a starting point for providing conceptual enlightenment about the biodiversity concept and its importance for beach sustainability.

Sandy beaches have a fundamental role as a shelter for juvenile invertebrates and fisheries (i.e., nursery ground) (McLachlan et al., 2013; Checon et al., *in press*). Beaches are also breeding grounds of iconic species of birds and turtles (McLachlan et al., 2013) and provide functional biological control that enhances ecological resilience and avoids other degradation processes (Sardá; Lozoya, 2018). The "biological functional control" process was explained when the descriptor "Food Chain" was connected to the Final Service "Ecological Maintenance" (see supplementary material - Appendix 1, Chapter II). However, 'Nursery ground' and 'Breeding ground' ES were not perceived by the managers. Nevertheless, this poses an opportunity to bring the LNP managers closer to these concepts and enhance their conceptual knowledge of the biotic system's importance for beach management.

Beach ecosystems can also provide fishery resources and conditions for growing food and maintaining the biomass of exploited species (McLachlan; Defeo, 2017; Sardá; Lozoya, 2018; Checon et al., *in press*). This ecosystem also provides mineralization of organic matter and nutrient recycling which promotes the filtration of the seawater, influencing its quality for recreational activities (McLachlan et al., 2013; Sardá; Lozoya, 2018). The beach biotic system sequesters and stores carbon (Sardá; Lozoya, 2018). Moreover, the dune vegetation enhances the protection against storms, wind, and wave damage on adjacent ecosystems or urbanized areas (McLachlan; Defeo, 2017; McLachlan et al., 2013; Checon et al., *in press*). Almost all these ES were perceived by the managers, pointing to a perception about the beach biotic system's importance to human well-being. However, at first, the last two ES were not perceived by the managers.

In Latin America, the importance of the biotic system to human well-being is well established, but the ES supply and delivery is much less known (Balvanera et al., 2012). Accordingly, the LNP managers perceived that the provision of the prioritized benefits depends on the beach biotic system, but they overlooked the ES provided by this beach system. Also, the majority of connections and descriptors exclusively related to the biotic system were perceived by a few groups of beach managers (see Figure 2). Managers, therefore, overlooked critical features of the beach biotic system and ES provided, pointing to the need to leverage their conceptual knowledge about this system to achieve EBM requirements.

4.2.3. Beach Ecosystem

Besides recreational activities and aesthetic appreciation, beaches support environmental education and research activities (Checon et al., *in press*). Beaches are also ground for spiritual experiences and the creation of a sense of belonging, increasing people's

connection with nature and promoting ocean literacy (Sardá; Lozoya, 2018; Checon et al., *in press*). The perception of the majority of the managers about these cultural ES is an opportunity to promote collaboration with other stakeholders and acquire behavior compliance for management measures (Asah et al., 2014), a fundamental aspect of EBM implementation in beaches (Sardá et al., 2015).

Beaches are connected to other ecosystems: they import and export organic matter through food webs and their local conditions (e.g., salinity, sediment budget) can be affected by the adjacent ecosystems (McLachlan et al., 2013; Checon et al., *in press*). When looking for the maintenance of beach ecological integrity, as supported by EBM, beach management must consider its connectivity to the watershed and marine ecosystems (Sardá et al., 2015; Checon et al., *in press*). If disseminated among all managers, the perception about the influence of the adjacent ecosystems in beaches can promote integrated management practices and support the ecosystem integrity proposed by EBM (Checon et al., *in press*).

EBM implementation requires recognizing that the dynamics of the beach biotic, abiotic, and social systems are integrated (Sardá et al., 2015). When perceiving the provision of ES as supported by the interaction among all components of the beach system, the majority of the managers showed a holistic view. This sets a good starting point to better discuss EBM implementation. However, some features and connections within the beach ecosystem were overlooked by the managers (as outlined in the beach biotic and beach abiotic sessions), requiring collaborative processes to ensure conceptual knowledge exchange among local managers themselves, and with other stakeholders.

4.3. Perception of how long-term changes in the ecological beach system are translated into changes in human well-being

Although the increased erosion due to climate change is one of the biggest concerns regarding anthropogenic pressures threatening beaches (McLachlan; Defeo, 2017; McLachlan et al., 2013), few beaches are severely eroding in the LNP region (Souza, 2012). The LNP context might explain why managers only perceived some descriptors and connections in the long-term scenario (step 4). Studies with government actors in French Polynesia also found them not perceiving climate change as a present-day problem (Terorotua et al., 2020).

Practical measures to deal with a changing environment, however, depend on public authorities to understand its current and future impacts in the managed territory (Terorotua et al., 2020). The LNP beaches have a high risk of erosion due to climate change (Souza, 2012), yet, fundamental beach features, processes, and ES were overlooked by the managers before

the discussion involving their long-term perspective. Since short-term needs are often prioritized in decision-making related to coastal ES maintenance (Simpson et al., 2016), the manager's lack of perception can be a major challenge for implementing EBM. For example, the "Coastal protection" descriptor was only perceived in the long-term perspective; however, without long-term spatial planning ensuring the sand budget and the dune vegetation, this ES will no longer be provided (McLachlan; Defeo, 2017).

Climate change shifts the wave climates and increases storm events and the sea level, consequently intensifying the erosion impacts on beaches and resulting in beach recession and impacts on the biotic system (McLachlan et al., 2013; Checon et al., *in press*). Accordingly, the participants indicated "diminished beaches" and "beach disappearing" as consequences of climate change. Moreover, the perception of the new descriptors and the managers' long-term narratives (step 4) are associated with these perceived consequences, indicating awareness of the causal pathway within the beach SES. This sets an opportunity for establishing with the managers the importance of developing long-term planning to cope with a changing environment, as supported by EBM. However, again it is necessary to consider that part of the managers could not explain the climate change impacts on the beach SES or did not perceive new descriptors that were overlooked before. This barrier reinforces the precondition to promote knowledge exchanges among local managers to enable the opportunities for EBM implementation leveraged by their perceptions.

5. EBM IMPLEMENTATION IN BEACHES AND THE SCIENCE-PRACTICE INTERFACE

To promote EBM implementation in beaches and guarantee beach sustainability, it is necessary, among other things, that managers understand the nature and complexity of the long-term coastal processes and beach ecology (Botero; Williams; Cabrera, 2015; McLachlan; Defeo, 2017; Sardá et al., 2015). The implementation or maintenance of policies, programs, and projects in Brazilian beach management is hampered by the lack of personal expertise, among other things (Xavier et al., *in press*). Therefore, strengthening the science-practice interface is fundamental for establishing sustainable beach management in Brazil (e.g., EBM implementation) (Amaral et al., 2016). However, informing the decision-makers does not necessarily lead to more informed decisions; thus, implementing EBM must consider "where the decision-makers are at" and their capacity to acquire and implement new perspectives (DeLauer et al, 2014; Saarikoski et al., 2018).

A multi-level decentralized system (i.e., Brazil) is an opportunity to implement EBM since local managers have the possibility to address environmental changes by guiding, adapting, and improving ongoing beach management through a holistic approach (Xavier et al., *in press*). Collectively, local beach managers have the potential to implement EBM, but knowledge gaps remain and need to be filled. Local managers require support to go further and implement EBM. For that matter, the theoretical structuration of the long-term dynamics of BES provision was useful to identify which complementary conceptual enlightenments are needed for EBM implementation in beaches. The ES concept dates back to the '80s and, since then, the academic literature has grown, and the concept has evolved. Although the cascade model was utilized to assess the managers' perceptions about the nexus of beach ecosystem functioning and human well-being, other conceptual frameworks might also be explored to address the potentialities and limitations of the EBM implementation (e.g., 'nature's contributions to people', proposed by the Intergovernmental Platform on Biodiversity and Ecosystem Services, *c.f.* Pascual et al., 2017).

The recognized descriptors and connections of the beach functioning, long-term BES supply and derived benefits, however, were not perceived by all the local beach managers' groups: they perceived different features and connections of the beach SES long-term dynamics. In fact, few descriptors and connections were usually perceived (e.g., tourism and leisure were the only benefits that all managers prioritized; not all managers perceived the influence of adjacent ecosystems, or new descriptors in the long-term perspective, see Figure 2). The materialization of the local government beach managers' potential for EBM implementation, therefore, can only be promoted with a regional discussion connecting managers from different municipalities and with different sectoral views.

The beach managers from different LNP municipalities do not consider each other for beach management strategies, depending on a facilitator to foster their perception of themselves as a regional group (Corrêa et al., *in press – Chapter III*). Integration with researchers can ensure that managers understand the critical ecosystem features and the provided ES (Fisher; Turner; Morling, 2009; Potschin; Haines-Young, 2016). Researchers can act as facilitators for beach managers to reinforce their leadership role in the local EBM implementation process (Corrêa et al., *in press – Chapter III*). However, research gaps about beach ecosystems, and beach conservation and management also limit further conceptual advances (Nel et al., 2014).

The transdisciplinary approach[11], therefore, is an opportunity for collaboration among researchers and managers to co-produce knowledge, apply ES into practice, and provide conceptual enlightenment for EBM implementation (Leslie et al., 2015; Saarikoski et al., 2018). One way to advance and foster collaborations among stakeholders, mostly managers and experts is through diagnostic tools (i.e., DPSIR; DIET, DAPSI(W)R and others) that enable the integration of institutions in a dialogic, participatory, and interactive process to incorporate ES and to secure social-ecological justice and well-being (Gonçalves et al, 2020).

Future studies should also investigate the perception of other stakeholders about the long-term BES provision and prioritized benefits (Simpson et al., 2016). These other perceptions can increase multiple-stakeholder participation to enable a successful EBM implementation (McLeod; Leslie, 2009; Leslie et al., 2015; Sardá et al., 2015). At the regional level, the LNP municipalities are integrated into participative environmental decision-making bodies for the regional coastal, watershed, and protected areas management (Santos; Turra, 2017). Thus, EBM implementation in the LNP can be improved through these decision-making bodies, ensuring the connection among beach managers from different municipalities, researchers, and other stakeholders to discuss a holistic approach for beach management.

Local realities influence the outcomes of translating scientific results into real changes, shaping EBM in practice (Leslie et al., 2015). Before implementing conservation initiatives to fit the managers' needs, making sense of perceptions is to recognize that science must integrate the scientific knowledge into management (Gelcich; O'Keeffe, 2016). EBM implementation can use ES as a tool to make decision-makers better perceive the connections between human well-being and ecosystem integrity (O'Higgins; Lago; Dewitt, 2020). The perception of the local government beach managers about the BES provision's long-term dynamics allowed the visualization and structuration of beaches as the SES within which advice is required and decisions are made during EBM implementation. It demonstrated the potential role of local government managers for EBM implementation in beaches but also the necessity of promoting collaborative processes to materialize this potential. Although applied in beaches, this approach helps fill a gap of operational tools to make scientific principles easier to put into practice and to further implement EBM in other ecosystems (Arkema; Abramson; Dewsbury, 2006). It also reinforced the importance of dialogue and participatory approaches to avoid panaceas and reduce the problem of fit in environmental policies and management (Gonçalves et al. 2020).

[11] Transdisciplinarity involves non-scientists and researchers from different areas in the knowledge production process (Luks; Siebenhüner, 2007).

6. ACKNOWLEDGEMENTS

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7. REFERENCES

AMARAL, A.C.Z; CORTE, G.N; ROSA FILHO, J.S.; DENADAI, M.R.; COLLING, L.A.; BORZONE, C.; VELOSO, V.; OMENA, E.P.; ZALMON, I.R.; ROCHA-BARREIRA, C.A.; SOUZA, J.R.B; ROSA, L.C.; ALMEIDA, T.C.M. Brazilian sandy beaches: Characteristics, ecosystem services, impacts, knowledge, and priorities. **Brazilian Journal of Oceanography**, v. 64, n. Spe2, p. 5-16, 2016.

ARKEMA, K.K.; ABRAMSON, S.C.; DEWSBURY, B.M. Marine Ecosystem-Based Management: from characterization to implementation. **Frontiers in Ecology and the Environment**, v. 4, n. 10, p. 525-32, 2006.

ASAH, S.T.; GUERRY, A.D.; BLAHNA, D.J.; LAWLER, J.J. Perception, acquisition and use of ecosystem services: Human behavior, and ecosystem management and policy implications. **Ecosystem Services**, v. 10, p. 180-186, 2014.

BALVANERA, P.; URIARTE, M.; ALMEIDA-LEÑERO, L.; ALTESOR, A.; DECLERCK, F.; GARDNER, T.; HALL, J.; LARA, A.; LATERRA, P.; PEÑA-CLAROS, M.; MATOS, D.M.S.; VOGL, A.L.; ROMERO-DUQUE, L.P.; ARREOLA, L.F.; CARO-BORRERO, A.P.; GALLEGO, F.; JAIN, M.; LITTLE, C.; XAVIER, R.O.; PARUELO, J.M.; PEINADO, J.E.; POORTER, L.; ASCARRUNZ, N.; CORREA, F.; CUNHA-SANTINO, M.B.; HERNÁNDEZ-SÁNCHEZ, A.P.; VALLEJOS, M. Ecosystem services research in Latin America: The state of the art. **Ecosystem Services**, v. 2, p. 56-70, 2012.

BENNET, N.J. Using perceptions as evidence to improve conservation and environmental management. **Conservation Biology**, v. 30, p. 582-592, 2016.

BERROUET, L.M.; MACHADO, J.; VILLEGAS-PALÁCIO, C. Vulnerability of socio-ecological systems: A conceptual Framework. **Ecological Indicators**, v. 84, p. 632-647, 2018.

BEYERL, K.; PUTZ, O.; BRECKWOLDT, A. The role of perceptions for community-based marine resource management. **Frontiers in Marine Science**, v. 3, n. 238, 2016.

BOTERO, C.M.; WILLIAMS, A.T.; CABRERA, J.A. Advances in beach management in Latin America: overview from certification schemes. In: FINKL, C.: MAKOWSKI C. (eds.) **Environmental Management and Governance**. Coastal Research Library. Springer, 2015. v. 8, p. 33-63.

BRASIL. Ministério do Meio Ambiente. Gabinete do Ministro. Portaria nº 76, de 26 de março de 2018. Institutes the National Program for Coastline Conservation. **Diário Oficial da União**, Brasília, 28 mar. 2018, nº 60, Section 1, p. 161.

CHECON, H.H.; XAVIER, L.Y.; GONÇALVES, L.R. Ecosystem services of sandy beaches. In: AMARAL, C.Z.; CORTE, G.N.; CHECON, H.H (eds.). **Brazilian Sandy Beaches**. New York, NY: Springer, *in press*.

CHRISTIE, P.; POLLNAC, R.B.; ORACION, E.G.; SABONSOLIN, A.; DIAZ, R.; PIETRI, A. Back to basics: an empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. **Ocean & Coastal Management**, v. 37, n. 3-4, p. 349-373, 2009.

CORRÊA, M.R.; XAVIER, L.Y.; HOLZKÄMPER, E.M.; ANDRADE, M.M.; TURRA, A.; GLASER, M. Shifting shores and shoring shifts—How can beach managers lead transformative change? A study on challenges and opportunities for Ecosystem-Based Management. **Human Ecology Review**, *in press*.

DELAUER, V.G.; ROSENBERG, A.A.; POPP, N.C.; HILEY, D.R.; FEURT, C. The complexity of the practice of ecosystem-based management. **Integral Review**, v. 10, n. 1, p. 1-28, 2014.

FISHER, B.; TURNER, R.K.; MORLING, P. Defining and classifying ecosystem services for decision making. **Ecological Economics**, v. 68, n. 3, p. 643-653, 2009.

GELCICH, S.; O'KEEFFE, J. Emerging frontiers in perceptions research for aquatic conservation. **Aquatic Conservation:** Marine and Freshwater Ecosystems, v. 26, n. 5, p. 986-994, 2016.

GONÇALVES, L. R., OLIVEIRA, M.; TURRA, A. Assessing the Complexity of social-ecological systems: taking stock of the cross-scale dependence. **Sustainability**, v. 12, n.15, p.6236, 2020.

GRANEK, E.F.; POLASKY, S.; KAPPEL, C.V.; REED, D.J.; STOMS, D.M.; KOCH, E.W.; KENNEDY, C.J.; CRAMER, L.A.; HACKER, S.D.; BARBIER, E.B.; ASWANI, S.; RUCKELSHAUS, M.; PERILLO, G.M.E.; SILLIMAN, B.R.; MUTHIGA, N.; BAEL, D.; WOLANSKI, E. Ecosystem services as a common language for coastal ecosystem-based management. **Conservation Biology**, v. 24, n. 1, p. 207-216, 2010.

HARRIS, L.; NEL, R.; HOLNESS, S.; SINK, K.; SCHOEMAN, D. Setting conservation targets for sandy beach ecosystems. **Estuarine, Coastal and Shelf Science**, v. 150, p. 45-57, 2014.

LESLIE, H.; SIEVANEN, L.; CRAWFORD, T.G.; GRUBY, R.; VILLANUEVA-AZNAR, H.C.; CAMPBELL, L.M. Learning from ecosystem-based management in practice. **Coastal Management**, v. 43, n. 5, p. 471-497, 2015.

LINK, J.S.; BROWMAN, H.I. Operationalizing and implementing ecosystem-based management. **ICES Journal of Marine Science**, v. 74, n. 1, p. 379-381, 2017.

LUKS, F.; SIEBENHÜNER, B. Transdisciplinarity for social learning? The contribution of the German socio-ecological research initiative to sustainability governance. **Ecological Economics**, v. 63, n. 2-3, p. 418-426, 2007.

MCLACHLAN, A.; DEFEO, O. **The Ecology of Sandy Shores**. 3rd ed. Cambridge, MA: Academic Press, 2017. 572 p.

MCLACHLAN, A.; DEFEO, O.; JARAMILLO, E.; SHORT, A. Sandy beach conservation and recreation: guidelines for optimizing management strategies for multi-purpose use. **Ocean & Coastal Management**, v. 71, p. 256-268, 2013.

MCLEOD, K.L.; LESLIE, M. **Ecosystem-based management for the oceans**. Washington, DC: Island Press, 2009. 392 p.

MOSER, S.C.; TRIBBIA, J. Vulnerability to inundation and climate change impacts in California: Coastal managers' attitudes and perceptions. **Marine Technology Society**, v. 40, n. 3, p. 4-13, 2006.

NEL, R.; CAMPBELL, E.E.; HARRIS, L.; HAUSER, L.; SCHOEMAN, D.S.; MCLACHLAN, A.; DU PREEZ, D.R.; BEZUIDENHOUT, K.; SCHLACHER, T.A. The status of sandy beach science: Past trends, progress, and possible futures. **Estuarine, Coastal and Shelf Science**, v. 150, Part A, p. 1-10, 2014.

O'HIGGINS, T.G.; LAGO, M.; DEWITT, T.H. (eds.). **Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity**: Theory, tools and applications. Cham: Springer, 2020. 580 p.

PASCUAL, U.; BALVANERA, P.; DÍAZ, S.; PATAKI, G.; ROTH, E.; STENSEKE, M.; WATSON, R.T.; DESSANE, E.B.; ISLAR, M.; KELEMEN, E.; MARIS, V.; QUAAS, M.; SUBRAMANIAN, S.M.; WITTMER, H.; ADLAN, A.; AHN, S.; AL-HAFEDH, Y.; 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.; HOUDER, J.; KEUNE, H.; HUMAR, 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.; TAGI, N. Valuing nature's

contributions to people: the IPBES approach. C**urrent Opinion in Environmental Sustainability**, v. 26-27, p. 7-16, 2017.

POTSCHIN-YOUNG, M.; HAINES-YOUNG, R.; GÖRG, C.; HEINK, U.; JAX, K.; SCHLEYER, C. Understanding the role of conceptual frameworks: Reading the ecosystem service cascade. **Ecosystem Services**, v. 29, p. 428-440, 2018.

POTSCHIN, M.; HAINES-YOUNG, R. Defining and measuring ecosystem services. In: POTSCHIN, M.; HAINES-YOUNG, R.; FISH, R.; TURNER, R.K. (eds.). **Routledge Handbook of Ecosystem Services**. London, UK: Routledge, 2016. Chapter 3, p. 25-44.

SAARIKOSKI, H.; PRIMMER, E.; SAARELA, S.R.; ANTUNES, P.; ASZALÓS, R.; BARÓ, F.; BERRY, P.; BLANKO, G.G.; GOMÉZ-BAGGETHUN, E.; CARVALHO, L.; DICK, J.; DUNFORD, R.; HANZU, M.; HARRISON, P.A.; IZAKOVICOVA, Z.; KERTÉSZ, M.; KOPPEROINEN, L.; KÖHLER, B.; LANGEMEYER, J.; LAPOLA, D.; LIQUETE, C.; LUQUE, S.; MEDERLY, P.; NIEMELÄ, J.; PALOMO, I.; PASTUR, G.M.; PERI, P.L.; PREDA, E.; PRIESS, J.A.; SANTOS, R.; SCHLEYER, C.; TURKELBOOM, F.; VADINEANU, A.; VERHEYDEN, W.; VIKSTRÖM, S.; YOUNG, J. Institutional challenges in putting ecosystem service knowledge in practice. **Ecosystem Services**, v. 29, p. 579-598, 2018.

SANTOS, C.; TURRA, A. (orgs.). **Rumos da Sustentabilidade Costeira**: visão do Litoral Norte Paulista. São Paulo, SP: Instituto Oceanográfico da Universidade de São Paulo, 2017.

SARDÁ, R.; LOZOYA, J.P. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

SARDÁ, R.; VALLS, J.F.; PINTÓ, J.; ARIZA, E.; LOZOYA, J.P.; FRAGUELL, R.M.; MARTÍ, C.; RUCABADO, J.; RAMIS, J.; JIMENEZ, J.A. Towards a new integrated beach management system: the ecosystem-based management system for beaches. **Ocean & Coastal Management**, v. 118, Part B, p. 167-177, 2015.

SCHERER, M.E.G.; NICOLODI, J.L.; COSTA, M.F.; CORRIANI, N.R.; GONÇALVES, R.K.; CRISTIANO, S.C.; RAMOS, B.; CAMARGO, J.M.; SOUZA, V.A.; FISCHER, L.O.; SARDINHA, G.; MATTOS, M.P.S.; PFUETZENREUTER, A. Under new management. **Journal of Coastal Research**, v. 95, n. SI, p. 945-952, 2020.

SIMÕES, E.; JUNIOR, W.C.; FREITAS, D.M.; MILLS, M.; IWAMA, A.Y.; GONÇALVES, I.; OLIVATO, D.; FIDELMAN, P. Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil. **Regional Environmental Change**, v. 17, n. 6, p. 1739-1750, 2017.

SIMPSON, S.; BROWN, G.; PETERSON, A.; JOHNSTONE, R. Stakeholder perspectives for coastal ecosystem services and influences on value integration in policy. **Ocean & Coastal Management**, v. 126, p. 9-21, 2016.

SOUZA, C.R.G. Praias arenosas oceânicas do estado de São Paulo (Brasil): síntese dos conhecimentos sobre morfodinâmica, sedimentologia, transporte costeiro e erosão costeira. **Revista do Departamento de Geologia**, Volume Especial RDG 30 anos, p. 307-371, 2012.

TEROROTUA, H.; DUVAT, V.K.E.; MASPATAUD, A.; OURIQUA, J. Assessing Perception of Climate Change by Representatives of Public Authorities and Designing Coastal Climate Services: Lessons Learnt from French Polynesia. **Frontiers in Marine Science**, v. 7, p. 160, 2020.

XAVIER, L.Y.; GONÇALVES, L.R.; OLIVEIRA, M.; CORRÊA, M.R.; MALINCONICO, N.; POLETTE, M.; TURRA, A. Beach management and conservation in Brazil. In: AMARAL, A.C.Z., CORTE, G.N.; CHECON, H.H. (eds.). **Brazilian Sandy Beaches**. New York, NY: Springer, *in press*.

8. SUPPORTING INFORMATION

APPENDIX 1: Detailed methods

The cards and arrows filled in the ES cascade-model during each Workshop and the managers' narratives (steps 1-3) were interpreted and categorized into open coded descriptors. The discussion carried by the managers in step 4 was also interpreted and matched with the main descriptors of the previous steps or categorized into new descriptors. The terms "Processes", "Functions" (i.e., Supporting or intermediate services), "Services'" (i.e., *Final Services*), and "Benefits" present in the original ES cascade are thematic labels, and the limits between them depend on specific situations (Haines-Young; Potschin, 2011). Therefore, the descriptors categorized along with the categories "Processes", "Functions", "Services", and "Benefits" were accommodated in the category that most of the participants recognized (Table 1).

Table 1. Descriptors of the workshop responses by the managers and examples of the cards filled by the managers during the workshop and/or managers' speech during the workshop. Descriptors or connections with no specific examples were defined here through an interpretation of the workshop discussion. Source: Authors' summary.

Benefits				
Descriptor	**Examples of cards filled by the managers**	**Definition**	**Total nº of citations**	**Nº of Citations only in a long-term perspective**
Sustainable beaches	"Beach with quality"; "Long-term environmental balance".	To be sure that beaches will continue existing and providing human well-being. Feeling of security about the future.	1	0
Food provision	"Food", "Fisheries"	Beaches provide the resource to be fished and conditions for growing food (Checon et al., *in press*; Sardá; Lozoya, 2018).	1	0
Cultural Identity	"Cultural identity of traditional communities"; "Presence of traditional communities".	Beaches provide a sense of place, or sense of belonging (Sardá; Lozoya, 2018).	2	0
Physical and mental health	"Physical and mental health"; "Mental comfort"; "Quality of life"; "Relaxation"; "Peace of mind"; "Sense of freedom"; "Sports activities".	Beaches provide opportunities for improving mental and physical health (Sardá; Lozoya, 2018)	5	0
Tourism and leisure	"Tourism"; "Leisure"; "Tourism income"; "Sports practice and events"; "Recreational activities"; "Recreational gathering of species"	Tourists go to the beach generally motivated by a sense of well-being and quality of life (Checon et al., *in press*).	13	0

Supporting or Intermediate Services				
Descriptor	**Examples of cards filled by the managers**	**Definition**	**Total nº of citations**	**Nº of Citations only in a long-term perspective**
River Mouths	"River Mouth"; "River"; "Waterfall"	Some Brazilian sandy beaches have mouths of rivers that flow into the sea.	9	0
Sediment Transport	"Sediment Transport"; "Sediment budget"; "The dynamics of the beach itself tries to establish a balance, when sediment is deposited, the waves can bring it back."; "When you do a construction near the beach, it changes the sediment transport and the whole beach can change. Sometimes, other beaches of the region can change as well."	Sandy beaches are an accumulation of sediment in the shore shaped by the land-ocean interaction (McLachlan et al., 2013).	11	6
Wind dynamics	"Wind"; "Sea breeze"; "Weather front"; "Atmospheric pressure".	Beach dynamics respond to wave-tide-wind conditions that shape sediment transport (McLachlan et al., 2013).	9	2
Hydrodynamics	"Wave dynamics"; "Sea movement"; "Waves"; "Undulation", "Storm Surge"; "Sea current"; "Sea Stream".	Beach dynamics respond to wave-tide-wind conditions that shape sediment transport (McLachlan et al., 2013).	11	0
Landform	"Geographic features"; "Geomorphological condition"; "Geological formation"; "Geology"; "Geomorphology"; "Land Relief"	Each beach has different landform features, both in the sea and in the land (e.g., Headland; sheltered beaches; islands, etc.)	10	0
Tide	"Tide"	Beach dynamics respond to wave-tide-wind conditions that shape sediment transport (McLachlan et al., 2013).	7	0
Seasonality	"Seasonality"; "Changes in climate"; "Changes in temperature".	Changes in the beach feature according to the seasons.	7	0
Beach Abiotic system	-	Group of all abiotic' attributes. Utilized when managers themselves grouped all perceived beach abiotic features and connections.	11	0

Diversity of Living beings	"Biodiversity"; "Animals"; "Living beings"; "Vegetation"; "Shells"; "Fauna and Flora"; "Marine life"; "Microorganisms".	The beach biotic system consists of two ecological systems, one marine and other terrestrial (McLachlan; Defeo, 2018). Both the ecological systems have high biodiversity and are inhabited by endangered and iconic species (McLachlan et al., 2013; Checon et al., *in press*).	11	0
Food chain	"Food chain"; "Microorganisms sustain the food chain"; "Primary Production"	Beach systems can support three food webs: (1) a food web constituted by interstitial organisms (bacteria, protozoans, and meiofauna); (2) a microbial loop in the surf zone (phytoplankton, bacteria, and protozoans); and (3) a macroscopic food web structured by macrofauna, zooplankton, fishes and birds (Bergamino; Lercari; Defeo, 2011)	3	0
Nutrients cycling	"Cycling organic matter"; "Microrganisms feed on bad things, produced by humans, that end up on the beach"	Interstitial assemblages mineralize organic matter and recycle nutrients (McLachlan; Defeo, 2018)	2	0
Beach Ecosystem	-	Group of all beach' attributes. Utilized when managers themselves grouped all perceived beach features (biotic and abiotic).	9	0
Adjacent ecosystems	Mangroves; Rocky shores; Rainforest; Adjacent Beaches	Surrounding ecosystems.	5	0

Final Ecosystem Services

Descriptor	Examples of cards filled by the managers and/or managers' narratives	Definition	Total nº of citations	Nº of Citations post-CC scenario
Ecological maintenance	Ecological maintenance; Healthy Food chain; Beach Quality	Beaches provide biological functional control that enhances ecological resilience and avoids further degradation processes (Sardá; Lozoya, 2018).	3	0
Biomass	Presence of diverse fauna and flora; Presence of fishery species	Beaches can maintain the biomass of exploited species (McLachlan; Defeo, 2018; Sardá; Lozoya, 2018)	2	0
Climate Maintenance	Climate maintenance;	Beaches can improve the climate conditions near them and provide services of carbon sequestration and storage (Sardá; Lozoya, 2018).	2	2
Filtration and purification of seawater	Filtration and purification of seawater; seawater quality; "The sea, sand and fauna	Beaches store dissolved nutrients and export the re-mineralized nutrient (Checon et al., *in press*)	4	0

	take away a lot of pollution out for us".			
Diversity of Beach' types	Variation into beach characteristics; diversity of beach conditions; Beach Morphology diversity.	Beaches have different morphodynamic types that allow for diverse human use of this environment (McLachlan et al., 2013).	8	0
Coastal protection	Coastal protection against storms, waves, and wind action; Beaches provide a barrier against the force of waves.	Beaches act dissipating waves, consequently reducing storm and wave damages in surrounding urbanized areas (McLachlan; Defeo, 2018; Sardá; Lozoya, 2018).	7	7
Opportunities for research and Education	Knowledge production; Knowledge that can be used by schools and scientists; Environmental education; Study and research; Research and monitoring.	Beaches support environmental education and research activities (Checon et al., *in press*).	7	0
Maintenance of traditional cultures	Maintenance of traditional cultures; Cultural heritage.	The maintenance of the coastal communities' identity depends on the activities practiced on beaches.	4	0
Creation and Maintenance of social relationships	Social relationships; Interaction between people; Democratic access.	Beaches are a locality where people interact with each other.	8	0
Scenic beauty	Attractiveness; Beautiful landscape; uniqueness of the sea; Visual beauty; Contemplation of nature; Beautiful and diverse marine life (or fauna).	Aesthetic appreciation and inspiration for culture, art, and design. Beach ecosystem and landscapes have been the source of inspiration for art and cultures (Sardá; Lozoya, 2018)	10	0
Inspirational elements	Elements with spiritual meaning; Spiritual practices; Feeling of freedom; Maintenance of contact with nature; Maintenance of the man-nature relationship.	Beaches are grounds for the development of practices of religious and spiritual significance (Checon et al., *in press*; Sardá; Lozoya, 2018)	6	0
Access to the sea	Access to the sea; Possibility to dive in the sea;	Beaches provide access to the sea for small-scale fisheries and recreation activities (Checon et al., *in press*).	6	0

Connections (Arrows) I: Supporting Services x Supporting Services				
Descriptors		**Data details**		
Source	**Target**	**Example of Managers' narrative detailing the connection**	**Total nº of citations**	**Nº of Citations post-CC scenario**
River Mouths	Sediment Transport	"Rivers transport sediment from the land to the sea" "When a place that receives water from a river, stops receiving it, it changes the sediment budget" "Rivers increase the deposit of sediment on the beach" "The land sediment brought by the river can change the morphology of the beaches, such as the place of the river mouth, the relief, and the marine soil"	8	3
River Mouths	Diversity of Living beings	"Rivers carry organic matter that supports marine life at the beaches" "Rivers endure the coastal vegetation"	3	0
Wind dynamics	Hydrodynamics	"The wind influences the water because it generates waves. If the wind ends, it cannot catch a wave. The sea gets rough" "The wind forms the wave trains, which are pushed to the continent. The waves arrive in the sand, on the continental bench, are formed and break near the beach" "The wind influences sea currents" "Changes in the atmospheric pressure produce wind that intensifies the wave and generates the Storm Surge"	8	1
Hydrodynamics	Diversity of Living beings	"Ocean current carries the plankton. The plankton is the basis of the food chain and sustains marine life." "Erosion is associated with the storm surge, and it removes vegetation from the beaches"	2	0
Hydrodynamics	Sediment Transport	"The storm surge intensifies beach erosion" "The sea, or the sea currents, take sand from one area [of the beach] to another" "Sea currents carry sand [from one beach to another]" "Waves deposit sediment on the beach and also remove it" "There are points where the sand is removed and there are points where the sand is deposited."	11	7
Seasonality	Wind dynamics	"Depending on the season the wind changes"	3	0
Seasonality	Diversity of Living beings	"Climate affects the species that are at the beach"	3	0

Seasonality	Beach Ecosystem	“The whole beach changes throughout the year”	1	0
Nutrients cycling	Food chain	"Processing organic matter, they [microorganisms] increase the availability of food [for the Food chain]"	1	0
Tide	Diversity of Living beings	“Many animals depend on the dynamics of the tide”	1	0
Tide	Sediment Transport	“When the tide rises it transports the sediment towards the beach”	3	3
Landform	Hydrodynamics	“The bay reduces the impact of waves that arrive with more intensity” “Geography will determine how the wave reaches the beach, also affecting the sediment transport” “Depending on the land relief, the beach will have different waves” “Land relief changes currents” “The sand bench influences the waves. If there is no efficient sand exchange, it influences the quality and occurrence of the waves for surfing, for example.”	9	0
Landform	Wind dynamics	“The sea channel [between Ilhabela and São Sebastião] makes the wind stronger and sometimes damages the city”	5	0
Landform	River Mouth	“The landform defines if the river mouth is at the beach or not.”	1	0
Beach abiotic system	Diversity of Living beings	“Marine life varies according to the characteristics of the place. Example: some beaches’ endemic species only exist because of the specific characteristics of the place.” “It [Beach abiotic system] affects ecological interactions. For example, if a beach that is spawning ground changes structurally due to coastal erosion it might no longer fulfill that previous ecological role, changing its biodiversity”	8	2
Diversity of Living beings	Food chain	"Food chains depend on biodiversity"	3	0
Diversity of Living beings	Abiotic system	“Marine life impacts beach morphology"	3	0
Diversity of Living beings	Nutrients cycling	“Microorganisms feed on the terrestrial organic matter”;	1	0
Adjacent Ecosystems	Beach Ecosystem	“The beaches depend on the organic matter and sediments that come from the forest [Atlantic rainforest]” “Beaches influence each other” “Beaches depend on and influence other ecosystems”	5	0

Connection (Arrows) II: Support Services x Final Services				
Descriptors		**Data details**		
Source	**Target**	**Example of Managers' narratives detailing the connection**	**Total nº of citations**	**Nº of Citations post-CC scenario**
Diversity of Living beings	Scenic beauty	"Beautiful and diverse marine life (or fauna)"	5	0
Diversity of Living beings	Ecological Maintenance	"It must be present for the [biotic] system to keep working"; "Support of the species life cycles"	3	0
Diversity of Living beings	Coastal Protection	"The vegetation protects the beach from the loss of sediment"; "Vegetation holds the sand"	4	4
Food chain	Biomass	"Primary Production allows the presence of marine life"	2	0
Food chain	Ecological Maintenance	"Maintain the balance on beach ecological systems"; "Regulate it [beach ecological systems]".	3	0
Nutrients cycling	Filtration and purification of seawater	"When they [microorganisms] eat the bad things that humans throw away, they help to improve the seawater quality." "[Microorganisms] Processing organic matter"	2	0
Beach Abiotic System	Filtration and purification of seawater	"Movement of the sea and sand filtrate the seawater"	2	0
Beach abiotic system	Access to the sea	"The possibility of going to the beach and diving in the sea depends on the physical characteristics of the beach." "Storm surge, wind, rain, coastal occupations, among other things, favor this narrowing [of the beach] and reduce the access for recreational activities"	6	0
Beach abiotic system	Diversity of Beach' types	"We have beaches with different characteristics that can be used by different interests. This variety is possible because of the many possibilities of combinations among the attributes that beaches can have." "There are many types of beaches… wild beaches, calm beaches… beaches with rivers… all these [abiotic] characteristics dictate it [diversity of beach types]."	8	0
Beach abiotic system	Scenic Beauty	"It [The physical characteristics of the beach] form a diversity of scenario sets that allows the users to choose which beach they want to appreciate." "[when you are at the beach] it is beautiful"	6	0

Beach abiotic system	Coastal protection	"This effect of the beach as an agent of coastal protection, and wave dissipation protect us"	3	3
Beach Ecosystem	Creation and Maintenance of social relationships	Beaches must be working as a system in order to provide this ecosystem service.	4	0
Beach Ecosystem	Maintenance of traditional cultures	Beaches must be working as a system in order to provide this ecosystem service.	2	0
Beach Ecosystem	Inspirational elements	The beach attribute that provides this ecosystem service varies according to the user. Thus, the only way to connect it to the beach support/ intermediate services is to consider the Beach Ecosystem.	4	0
Beach Ecosystem	Scenic Beauty	The beach attribute that provides this ecosystem service varies according to the user. Thus, the only way to connect it to the beach support/ intermediate services is to consider the Beach Ecosystem.	5	0
Beach Ecosystem	Climate Maintenance	Beaches must be working as a system in order to provide this ecosystem service through carbon sequestration and heat trades among ocean and land.	0	1
Beach Ecosystem	Research and Education	The beach attribute that provides this ecosystem service varies according to the user. Thus, the only way to connect it to the beach support/ intermediate services is to consider the Beach Ecosystem.	7	0

Connections (Arrows) III: Final Services x Benefits

Descriptors		**Data details**		
Source	**Target**	**Example of Managers' narratives detailing the connection. Definition**	**Total nº of citations**	**Nº of Citations post-CC scenario**
Creation and Maintenance of social relationships	Tourism and Leisure	"People go to the beach to have fun with friends and family"	4	0
Creation and Maintenance of social relationships	Physical and mental health	"We all need to see dear ones to be healthy"	1	0
Maintenance of traditional cultures	Tourism and Leisure	"Tourists like to visit the communities or buy fish directly from fishermen when they visit here [the municipality]"	2	0
Maintenance of traditional cultures	Cultural identity	"In order for them [traditional communities] to identify and maintain their own culture, it is necessary for them to be able to do the daily activities they are used to. Part of these activities happen at the beaches"	1	0

Maintenance of traditional cultures	Food provision	“Fishing gears and strategies allow [traditional] communities to obtain food.”	1	0
Inspirational elements	Tourism and Leisure	“People visit the beach to perform rituals or connect with nature”	4	0
Inspirational elements	Cultural identity	“They are very connected with the sea; it is part of who they are.”	1	0
Opportunities for research and Education	Tourism and Leisure	Research and education support sustainable tourism and leisure activities.	5	0
Opportunities for research and Education	Beach sustainability	Research and education support the sustainable management of beaches.	1	0
Research and Education	Cultural identity	Research and education reinforce the importance of maintaining cultural identity	2	0
Filtration and purification of seawater	Tourism and Leisure	Tourism and leisure activities depend on seawater quality.	2	0
Filtration and purification of seawater	Food provision	Proper food depends on seawater quality.	1	0
Filtration and purification of seawater	Beach sustainability	Beaches as a system depend on the seawater quality.	1	0
Coastal Protection	Tourism and Leisure	Functioning beaches protect the urban infrastructure and return to a healthy state. Therefore, it supports the continuity of tourism and leisure activities.	5	5
Coastal Protection	Physical and mental health	“We see the tide rising on the beach but not reaching the avenue or the houses close to it. With beach retreat, things would be different.”	2	2
Coastal Protection	Cultural Identity	“Their [traditional people] communities depend on it”.	0	1
Coastal Protection	Beach Sustainability	“It [coastal protection] is part of the beach functioning”	0	1
Diversity of Beach’ types	Tourism and Leisure	“Almost every month when a storm surge happens, the river goes up a lot, and the wind and rain become very intense, in a short period of time. This changes the beaches for a long period of time and directly affects its use.” “Different people like different kinds of beaches. If we have a lot of types of beaches, more tourists will come.”	8	0
Diversity of Beach’ types	Cultural identity	“Traditional communities use varied types of beaches for different purposes”	2	0

Scenic Beauty	Tourism and Leisure	"People go to the beach to appreciate the view or the sunset at the sea" "The coastal erosion makes beaches ugly, decreasing the tourism"	11	0
Scenic Beauty	Physical and mental health	"You can look at the sea and feel better"	2	0
Scenic Beauty	Cultural identity	"Appreciate and look at the environment is part of the daily routine of the traditional communities"	1	0
Access	Tourism and Leisure	"It [coastal erosion] also limits access to the sea and makes it less attractive."	2	0
Access	Physical and mental health	"Diving in the sea increases the quality of life"	2	0
Access	Cultural identity	"The traditional communities use the beach as an access to the sea, and fishermen unload the fisheries at it."	2	0
Biomass	Food Provision	Fishing depends on the abundant presence of marine life.	1	0
Ecological maintenance	Beach sustainability	Beaches depend on their ecological functioning.	1	0
Climate Maintenance	Tourism and Leisure	"Considering the worst-case scenario [the beaches disappearing because of climate change], the tourism here will no longer exist."	0	1
Climate Maintenance	Sustainable Beaches	"Beaches might disappear because of the climate change"	0	1

REFERENCES

BERGAMINO, L.; LERCARI, D.; DEFEO, O. Food web structure of sandy beaches: Temporal and spatial variation using stable isotope analysis. **Estuarine, Coastal and Shelf Science**, 2011, v. 91, n. 4, p. 536-543.

CHECON, H.H.; XAVIER, L.Y.; GONÇALVES, L.R. Ecosystem services of sandy beaches. In: AMARAL, C.Z.; CORTE, G.N.; CHECON, H.H (eds.). **Brazilian Sandy Beaches**. New York, NY: Springer, *in press*.

HAINES-YOUNG, R.; POTSCHIN, M. **Common international classification of ecosystem services (CICES)**: 2011 Update. Nottingham, UK: Report to the European Environmental Agency, 2011.

MCLACHLAN, A.; DEFEO, O. **The Ecology of Sandy Shores**. 3rd ed. Cambridge, MA: Academic Press, 2017. 572 p.

MCLACHLAN, A.; DEFEO, O.; JARAMILLO, E.; SHORT, A. Sandy beach conservation and recreation: guidelines for optimizing management strategies for multi-purpose use. **Ocean & Coastal Management**, v. 71, p. 256-268, 2013.

SARDÁ, R.; LOZOYA, J.P.L. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

CAPÍTULO III: Shifting shores and shoring shifts – How can beach managers lead transformative change? A study on challenges and opportunities for ecosystem-based management

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ABSTRACT

Beaches provide a range of ecosystem services (ES). They are increasingly impacted by climate change, among other stressors. Ecosystem-Based Management (EBM) is an approach to cope with a changing environment and ensure long-term ES provision. Local managers may facilitate beach EBM implementation by integrating it into existing governance systems. However, their role in EBM implementation needs clarifying. This paper assesses local government beach managers' perceptions and visions of improvement for the beach ES governance network to face a changing environment. We present a structural analysis of data from the Northern Coast of São Paulo State (Brazil) and discuss opportunities and challenges for a regional EBM implementation. Our results point to the local beach managers as potential leaders of transformations towards sustainability.

Keywords: Ecosystem Approach; Governance network; Net-Map; Social Network Analysis; Sandy Beaches.

RESUMO

As praias oferecem uma grande variedade de serviços ecossistêmicos (SE) e estes são cada vez mais impactados pelas mudanças climáticas. A Gestão Baseada em Ecossistemas (GBE) é uma abordagem de gestão que lida com as mudanças no ambiente para garantir o fornecimento de longo-prazo de SE. Os gestores locais podem facilitar a implementação da GBE em praias integrando-a aos sistemas de governança vigentes. No entanto, o papel dos gestores na implementação da GBE precisa ser esclarecido. Este artigo avalia as percepções dos gestores de praia do governo local sobre as redes de governança de SE providos pelas praias e as melhorias necessárias para enfrentar um ambiente em mudança. Apresentamos uma análise estrutural de dados do Litoral Norte do Estado de São Paulo (Brasil) e discutimos as oportunidades e desafios para a implementação de uma GBE em nível regional. Nossos resultados apontam os gestores de praia locais como potenciais líderes de transformações em direção à sustentabilidade.

Palavras-chave: Gestão ecossistêmica; Governança em Redes; Net-Map; Análise de redes sociais; Praias Arenosas.

1. CONTEXT

Beaches provide a range of benefits for human well-being (Sardá; Lozoya, 2018) but human-induced impacts (e.g., climate change, human activities, pollution, engineering structures) transform beach-related ecological and social processes, threatening their sustainability (McLachlan; Defeo, 2017). To cope with the changing environment, beach management requires effective, collaborative, and inclusive governance structures (Sardá et al., 2015). Analyzing the web of social relations (i.e., social networks) that constitute the governance system) can help to identify how to improve it (Bodin, 2017; Bodin; Crona, 2009).

Environmental governance can be seen as a system of "actor-networks at all levels of human society (from local to global) that are set up to steer societies towards (…) adapting to global and local environmental change (…) within the normative context of sustainable development" (Biermann et al., 2010, p. 279). A governance network is a unique set of actors, or "nodes", with distinct attributes (e.g., perceptions, information, power), which may be connected to one another (or not) by pathways through which interactions take place, known as "ties", dealing with a common problem (Cohen; Evans; Mills, 2012). In addition to the multi-actor structure, the analysis of environmental governance networks needs to consider administrative borders and how administrative units fit (or don't) with ecosystem dynamics (Bodin, 2017; Carlsson; Sandström, 2007). Environmental governance studies often describe the social processes that promote governance networks for sustainability, but with less regard to ecosystem functioning (*c.f.* Bodin, 2017). The advance of beach governance should recognize both ecosystems functioning and the involved social networks.

Ecosystem-based management (EBM)[12] responds to environmental change (e.g., climate change) to steer multilevel social ecological systems[13] dynamics toward sustainability (Chapin III; Kofinas; Folke, 2009; McLeod; Leslie, 2009; Sardá et al., 2015; Wamsler; Luederitz; Brink, 2014); a desirable approach for beach management (Corrêa et al., *in press – Chapter I*; Sardá et al., 2015; Sardá; Lozoya, 2018). EBM is rooted in the connections between human well-being and ecosystem functioning (McLeod; Leslie, 2009; Sardá et al., 2015). The ecosystem services (ES) concept (i.e., ecosystem contributions that provide human well-being)

[12] Although EBM and ecosystem approach are not synonymous concepts, they share the same principles and when applied in practice they often lead to similar outcomes (Kirkfeldt, 2019). In order to better discuss the results of the present research, these concepts were used synonymously.

[13] Socio-ecological systems: coupled, coevolving, and dynamic human–nature systems, with reciprocal and interdependent feedback (e.g., McLeod; Leslie, 2009). We use the terms socio-ecological and social- ecological (e.g., publications by Carl Folke and colleagues of the Stockholm Resilience Centre) synonymously.

operationalizes this idea (Granek et al., 2010; McLeod; Leslie, 2009; O'Higgins; Lago; Dewitt, 2020; Sardá et al., 2015; Tallis et al., 2010) with a focus on conserving ecosystem functioning to ensure long-term ES provision (Chapin III; Kofinas; Folke, 2009; O'Higgins; Lago; Dewitt, 2020; Sardá et al., 2015).

EBM promotes sustainability by eliciting longer term planning in line with ecosystem dynamics (Chapin III; Kofinas; Folke, 2009; McLeod; Leslie, 2009). It embraces the "adaptive capacity" concept—that is, the ability of humans to manage a changing environment, including their capacity to adjust social networks (Adger, 2003; Chapin III; Kofinas; Folke, 2009; O'Higgins; Lago; Dewitt, 2020). Good governance is one of the preconditions for EBM implementation (O'Higgins; Lago; Dewitt, 2020) and includes building and managing ES governance networks of holistically understood social ecological dynamics (Imperial, 1999).

However, EBM implementation for beaches is incipient, at best, and understudied (Sardá; Lozoya, 2018). To promote the transformation toward innovative and sustainable forms of environmental governance such as EBM for beaches, critical contextual opportunities and barriers (e.g., stakeholders, networks) need to be identified (Aswani et al., 2012; Christie et al., 2009; Kelly; Ellis; Flannery, 2018). This paper investigates two barriers to EBM implementation for beaches. Both are related to governance processes and structures.

The first barrier is to overcome current undesirable governance structures. EBM envisages the engagement of a diverse set of stakeholders (Bodin; Sandström; Crona, 2017; McLeod; Leslie, 2009). Existing governance systems, however, can hamper innovative EBM implementation (Glaser et al., 2018; O'Higgins; Lago; Dewitt, 2020; Tallis et al., 2010): a variety of context-specific features may be obstructive (e.g., governance networks) (Bodin; Sandström; Crona, 2017; Smythe; Thompson; Garcia-Quijano, 2014; Wamsler; Luederitz; Brink, 2014). Beach management is historically characterized by low stakeholder involvement, fragmented governance, and little regard for ecological features (Sardá et al., 2015; Williams; Micallef, 2009). These issues manifest in undesirable resilient structures (Glaser et al., 2018) that reduce management's capacity to redirect toward sustainability-enhancing management systems such as EBM (Arkema; Abramson; Dewsbury, 2006; Leslie et al., 2015). Beach management and governance need to innovate structurally and procedurally to ensure the long-term provision of beach ecosystem services (BES) (Sardá et al., 2015).

The second barrier is to fit governance to multilevel ecosystem dynamics. EBM implementation on any spatial level depends heavily on the local governance context (e.g., social participation, interinstitutional collaboration) (Christie et al., 2009; Leslie et al., 2015). Beach management usually focuses on the local level—the beach or the municipality (McLachlan;

Defeo, 2017; Williams; Micallef, 2009)—but deals with multilevel biophysical processes and impacts (McLachlan; Defeo, 2017). To implement EBM, beach management must operate in a multilevel governance system that addresses all social ecological system levels that affect beaches, including watersheds (Corrêa et al., *in press – Chapter I*; Sardá et al., 2015), and consider administrative levels beyond the local to promote beach sustainability (Sardá et al., 2015).

To tackle these EBM implementation barriers, a central actor can orchestrate collaboration among multiple stakeholders and administrative levels (Bodin; Sandström; Crona, 2017). Local government officials are potential leaders for EBM implementation (Sandström; Bodin; Crona, 2015). By "weaving"—that is, actively developing a collaborative social network among different social groups—they can promote ecosystem fit and break undesirable resilient features (Carlsson; Sandström, 2007; Sandström; Bodin; Crona, 2015). However, more information is needed on how local government actors may be able to weave networks (e.g., ES governance networks) to support a transformation towards EBM (Sandström; Bodin; Crona, 2015).

Network weaving is shaped by network actors and by their perceptions (Glaser et al., 2018; Holzkämper, 2017). According to Beyerl, Putz and Breckwoldt (2016, p. 4), perception is "the subjective way people experience, think about and understand someone or something". Understanding what local government actors perceive as the changes needed in beach governance networks to safeguard long-term ES is part of the assessment of these central actors' ability to cope with social ecological change (i.e., perceived adaptive capacity, Grothmann; Patt, 2005). Local beach management actors' perceptions of the network transformations necessary for dealing with a changing environment, therefore, might be a critical "bottleneck" for EBM implementation. We target two questions: (i) As possible leaders of change, how do local government managers perceive needed long-term improvements in their BES governance networks under conditions of ecosystem change? (ii) Can their perceptions promote a fit between the governance structure and beach dynamics?

We adopt an inductive approach using the Net-Map method (Schiffer & Hauck, 2010) and social network analysis (SNA) to investigate the perceptions of municipal beach managers of four municipalities of the northern coast of São Paulo state, Brazil, a region in need of local coastal leadership to cope with ongoing changes (Simões et al., 2017)[14]. SNA is a tool to

[14] In Brazil, the municipal level is the lowest administrative level, hereafter described as "local" (see www.brazil.gov.br/government/how-the-government-works).

characterize relationships among actors (Freeman, 2004) and has been used to better understand environmental governance structures and EBM implementation processes (Bodin; Sandström; Crona, 2017; Smythe; Thompson; Garcia-Quijano, 2014). Our analysis centers on the two identified barriers to EBM implementation (undesirable resilient structures and governance misfit). We identify perception patterns and discuss their implications for beach management as well as opportunities and challenges for EBM implementation. The article concludes by reflecting on the role of local beach managers as leaders of change towards sustainable system dynamics in Brazil and other coastal regions across the world, especially those with decentralized management.

2. METHODS

2.1. Study site

Brazil has one of the longest coastlines worldwide, where beaches provide essential ES subjected to complex, cumulative threats, including climate change (Amaral et al., 2016; Ministério do Meio Ambiente, 2018; Xavier et al., *in press*). Implementing EBM in Brazilian beach management has the potential to guide, adapt, and improve current structures and processes in a holistic manner (Xavier et al., *in press*). Beach management in Brazil also faces challenges for EBM implementation including low stakeholder involvement, fragmented governance, and lack of multilevel governance processes (Corrêa et al., *in press*; Xavier et al., *in press*).

Brazilian beach management occurs at the municipal level but is regulated by higher level legislation (Xavier et al., *in press*). Currently, the federal government is transferring management rights and responsibilities to municipalities, in a decentralization process to ensure the sustainable use of the coastal zone and more participatory beach management (Scherer et al., 2020; Xavier et al., *in press*). This is an opportunity for local governments to become central actors in beach management with increased autonomy and power (Scherer et al., 2020). In line with municipalization, the National Plan of Climate Change Adaptation encourages the inclusion of ES-based strategies in municipal policies and beach management (Ministério do Meio Ambiente, 2018). This creates a new scope for local government actors to weave networks (e.g., ES governance networks) to support EBM implementation.

The north coast of São Paulo state (Litoral Norte Paulista—LNP) is a compelling site to study the improvement of beach governance networks to implement EBM. The LNP urbanization process is mainly related to tourism and leisure (Santos; Turra, 2017): both depend on beach quality and long-term beach ES (BES) provision. The four LNP municipalities (São

Sebastião, Ubatuba, Ilhabela, and Caraguatatuba) are committed to or in the process of assuming the management of their beaches. They share resources and face common social–ecological vulnerabilities, such as climate change–induced impacts like increased coastal erosion (Santos; Turra, 2017; Simões et al., 2017). At the regional level, the municipalities are integrated into environmental decision-making bodies (i.e., council bodies—composed of multiple sectors and governance levels). These discuss and implement a common management strategy for the regional coastal, watershed, and protected areas management (Santos; Turra, 2017) but they do not discuss beach management, which is implemented by the municipalities[15]. Local municipalities still need to establish long-term and inclusive strategic planning and local leadership to cope with the changing environment (Simões et al., 2017).

2.2. Data collection

Net-Map (Schiffer; Hauck, 2010) is a group dynamic tool for collecting data on social network perceptions. As actors achieve a greater understanding of their networks, they can identify what network changes are needed for specific aims, such as EBM implementation. We applied an adapted Net-Map method developed by Glaser et al. (2018) to visualize municipal beach managers' perceptions of current relations among those dealing with BES governance in the LNP region, and their ideas for needed improvements in social network structure and functioning to ensure long-term BES provision under a changing environment.

Long-term change in the beach system centrally includes the coastal squeeze phenomenon, caused by climate change and uncontrolled urban growth, resulting in beaches eroding and disappearing (McLachlan; Defeo, 2017). These are globally induced impacts that demand local and regional management (McLachlan; Defeo, 2017). Beach managers are government officers: they are concerned with civil society safety, environmental protection, public infrastructure, and the development of areas close to beaches (Moser; Tribbia, 2006). In Brazil, beach management is often performed by different municipal government offices. In each of the four LNP municipalities, we approached the three municipal government offices that were most involved in beach sustainability (for further information Net-Map participants see Supporting Information – Appendix 3, Chapter III).

We conducted 11 Net-Map sessions (each with 3-5 beach managers): three in Caraguatatuba (C1, C2, C3), Ubatuba (U1, U2, U3), and São Sebastião (SS1, SS2, SS3), and

[15] This information comes from two workshops carried out with the main LNP Council bodies to discuss beach management. The workshops were held by a bigger research project that includes the present research. The data still is unpublished.

two at Ilhabela (I1, I2), yielding 22 networks (11 representing the current scenario and 11 visualizing a desirable future). Sessions carried out in June-July 2019, were voice-recorded and filmed. This research was approved by the Brazilian Ethics Committee (Plataforma Brasil: 3.337.019), and all participants signed an informed consent form. The sessions followed a six-step procedure (Figure 1).

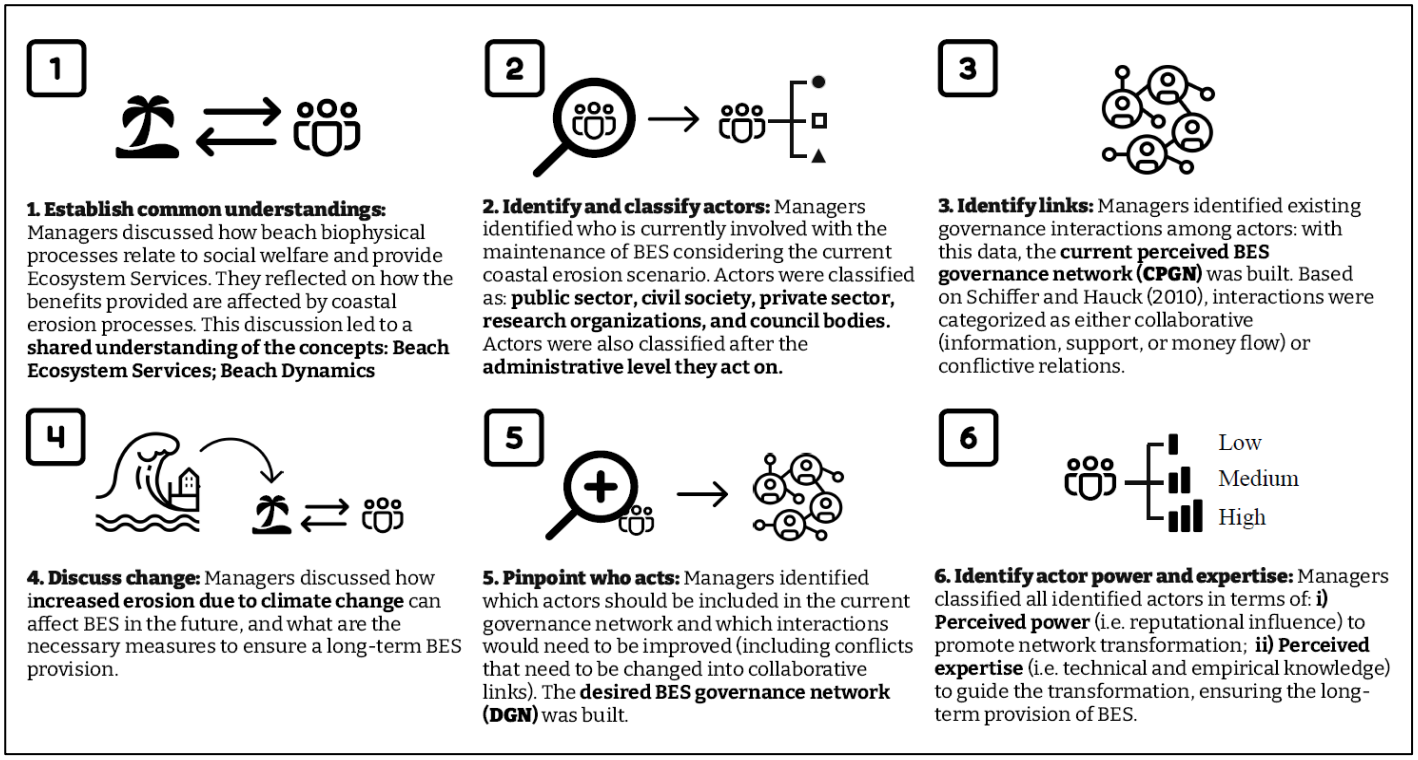

Figure 1. The six-step procedure adopted in the Net-Map sessions performed in this study. Source: Authors' summary of the process.

2.3. Data analysis

We digitized the network data for further computerized visual and mathematical analysis, including the application of SNA metrics on the resulting governance network (detailed information on data treatment is provided in Appendix 3, Chapter III). We restricted our analysis to collaborative relations since not all informants were comfortable discussing conflicts. With this analysis, we identified the envisioned changes in the BES governance network. Using UCINET 6 (Borgatti; Everett; Freeman, 2002), we analyzed the perceived BES governance networks and how positive change was envisioned (i.e., transformations in the governance network perceived as necessary to ensure the provision of BES). We examined current perceived governance networks (CPGN) and desired governance networks (DGN) for differences and similarities. We investigated how interactions between administrative levels in

the DGN were perceived. The following paragraphs outline the network metrics on two barriers for EBM: current governance structures and governance fit with ecosystem dynamics.

2.3.1. Barrier 1: Overcome current undesirable governance structures

Actor diversity promotes collaborative governance and EBM implementation (Arkema; Abramson; Dewsbury, 2006; Bodin; Sandström; Crona, 2017; McLeod; Leslie, 2009), while the links among actor categories enact the exchanges of knowledge and resources needed to achieve collaborative governance for EBM implementation (Bodin; Sandström; Crona, 2017; Smythe; Thompson; Garcia-Quijano, 2014). Governance network structure and composition can indicate the ability of actors to overcome challenges for EBM implementation (Bodin; Sandström; Crona, 2017). Network metrics were chosen to assess the perceived diversity of actors and links among actor categories (Table 1).

We compared CPGN and DGN, investigating differences in desired change patterns using the concepts of "collaborative heterogeneity" and "coordinated heterogeneity" (Bodin; Sandström; Crona, 2017) for the network structure considered as needed for effective EBM implementation (Table 2).

Table 1. Network metrics on actor diversity, links among actor categories, and how these differ between CPGN and DGN.

	Network metrics	**Description**
Actor diversity and influence	Network composition	"Actor categories" are defined in step 2 of Figure 1. We determined the proportion of each actor category in each network
	Perceived influence (i.e., power and expertise) of each actor category	For both "perceived power" and "perceived expertise," the most frequently attributed strength level ("Low," "Medium," or "High") was used for each actor category.
Link among actor categories	Homophily / Heterophily (Bodin, 2017)	The degree of connectivity across actor categories. Homophily/heterophily varies between –1 and 1, where –1 represents complete homophily (connection only between actors of the same category) and 1 complete heterophily (connection only between actors of different categories)
	Network fragmentation (Coleman, 1990; Holzkämper, 2017)	The extent to which actors have access to information and knowledge, measured by the fraction of node pairs that are (un)reachable in a network. Fragmentation is 0 when all nodes are connected and 1 when all nodes are isolated: networks are fragmented (scores 1–0.7), balanced (scores 0.6–0.4), or connected (scores 0.3–0).
	Network centralization (Carlsson; Sandström, 2007; Holzkämper, 2017; Sørensen; Torfing, 2016)	The extent to which network relations and power are centralized with one or more key/focal actors, showing whether different degrees of fragmentation are associated with a high level of cooperation (low fragmentation) or with hierarchical coordination (high fragmentation). Distinguishes between centralized (scores 1–0.7),

	decentralized (scores 0.6–0.4) and distributed (scores 0.3–0) networks.

Note: CPGN = current perceived governance network; DGN = desired governance network. Source: Authors' summary. See also citations throughout the table.

Table 2. Change patterns examined to analyze beach managers' perceptions of needed governance network changes to ensure BES. In each type of network change, fragmentation decreases or stays constant (as "connected" or "balanced"), envisioning increased collaboration among actors. Change patterns differ in with whom (homo-/heterophily) and how (self-organized/coordinated) actors should ideally connect.

Change pattern	Network indicators	Type of envisioned network change
Self-organized Heterophily	- Increase in Heterophily - Centralization was maintained as "decentralized".	Increased cooperation among actors of different categories is promoted in a collaborative environment.
Coordinated Heterophily	- Increase in Heterophily - Centralization increased and changed from "decentralized" to "centralized"	A central actor (the Net-Map respondent) promotes increased collaboration through hierarchical coordination connecting actors of different categories.
Self-organized Homophily	- Increase in Homophily - Centralization was maintained as "decentralized"	Increased cooperation among actors of the same category is promoted in a collaborative environment.
Coordinated Homophily	- Increase in Heterophily - Centralization increased and changed from "decentralized" to "centralized".	Hierarchical coordination promotes connection among actors of the same category. A central actor (the Net-map respondent) links to 'sub-groups' of actors of mostly the same category, promoting a collaborative process.

Note: BES = beach ecosystem services. Source: Authors' summary, after Bodin, Sandström and Crona (2017).

2.3.2. Barrier 2: Fit governance to multi-level ecosystem dynamics

EBM implementation aims to improve the fit between governance systems and ecosystems by collaboration across administrative units and levels (Smythe; Thompson; Garcia-Quijano, 2014). Two additional aspects were analyzed to assess opportunities and challenges for multi-level collaboration:

1. How the participants perceived the connections of their local governance networks to the other municipalities. This was indicated by their perceptions of (1) the presence of actors from other LNP municipalities; and (2) the presence of actors from higher administrative levels.
2. How the participants perceived the participation of different administrative levels in governance network transformation. The analysis of the perceived expertise and power made for the actor category was replied focusing on the different administrative levels.

3. RESULTS

3.1. Barrier 1: Overcome current governance structures

3.1.1. Network composition

LPN beach managers identified all five actor categories (research organizations, council bodies, private sector, civil society, and public sector) (Figure 2). All municipal offices named actors from the public sector, civil society, and the private sector, while four municipal offices (SS2, SS3, I1, and I2) did not include council bodies and/or research organizations in their CPGNs or DGNs. The proportion of actors from the public sector reached 60 percent or more in almost all CPGNs, outweighing all other actor categories (Figure 2). There were more actors in almost all DGNs (except for SS3) than in CPGNs.

Actor category representation differed between CPGNs and DGNs (Figure 3). Public sector representation was lower in most DGNs, in all municipalities. Civil society representation was constant or higher in most DGNs, and at least one municipal office per municipality pointed to the need of increasing it. The representation of research organizations increased in most DGNs in all studied municipalities. Qualitative data supported this: research organizations were generally considered important for capacitation and knowledge exchange (Figure 3).

Perceptions of expertise and power to guide transformation varied by actor category (Table 3).

Table 3. The perceived expertise and power of actor categories to promote and guide the desired changes in the governance networks towards long-term BES provision.

	Research organization	Council bodies	Private sector	Civil society	Public sector
Perceived expertise	High	High	Low	Low	Medium
Perceived power	Low	High	High	Low	High

Note: BES = beach ecosystem services. Source: Authors' summary.

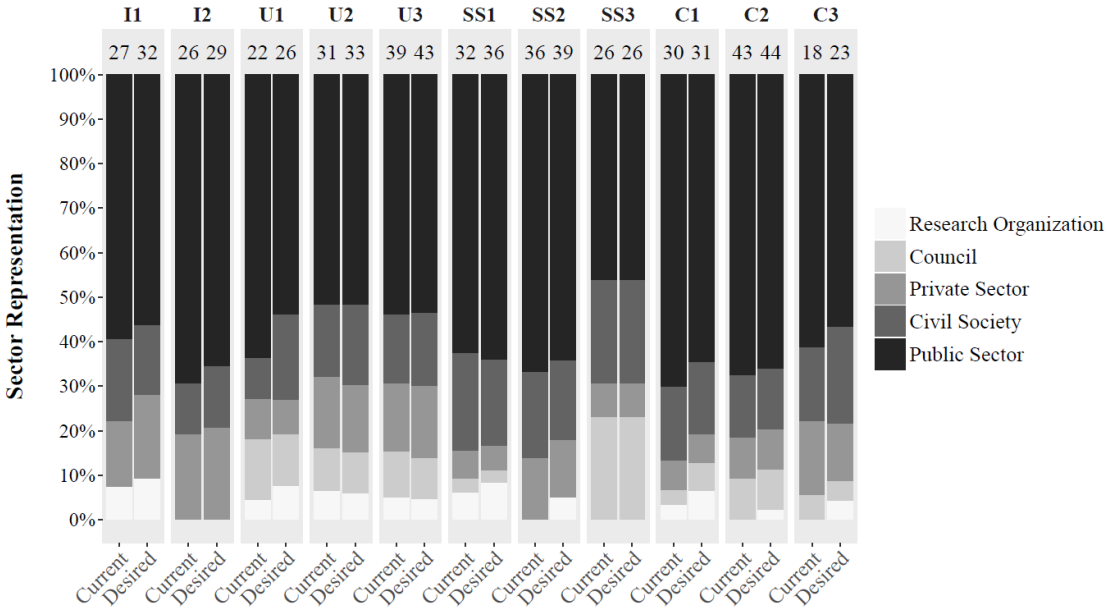

Figure 2. Overview of perceived governance network composition (actor categories: research organization, council, private sector, civil society, public sector). Y-axis indicates percent of actor category. X-axis indicates the governance network (current/desired) for each municipal office (I-Ilhabela; U-Ubatuba; SS-São Sebastião; C-Caraguatatuba). The number above the bar indicates how many actors were named in the network. Source: Authors' summary.

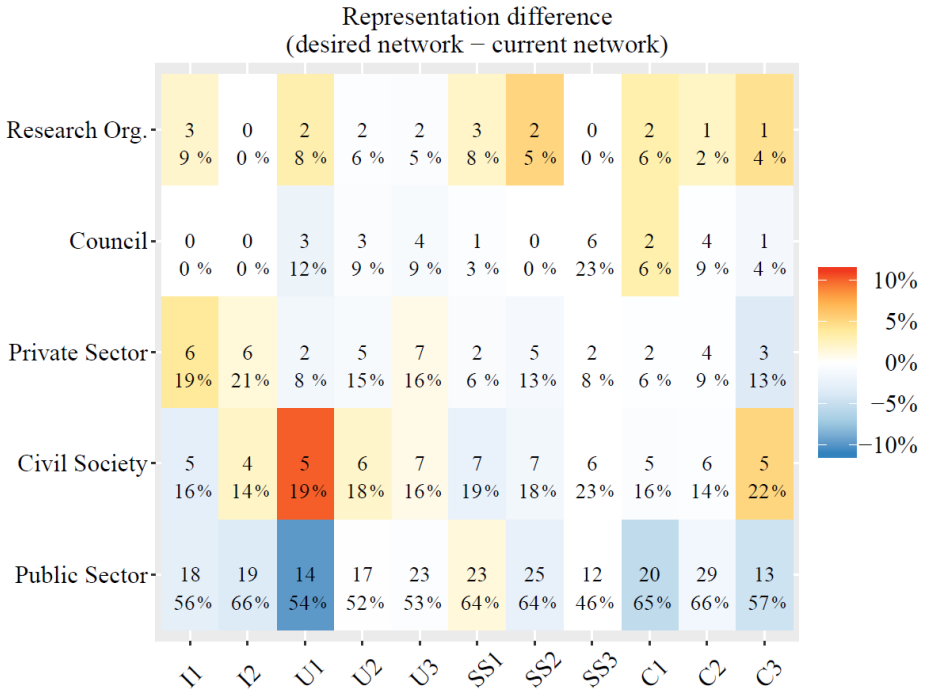

Figure 3. Actor categories' representation (in percent) in current CPGNs and DGNs. Y-axis shows actor categories (research organization, council, private sector, civil society, public sector). X-axis represents the municipal offices (I-Ilhabela; U-Ubatuba; SS-São Sebastião; C-Caraguatatuba). Color scale indicates the difference (percent) between DGN and CPGN by category. The numbers inside the boxes indicate the absolute number (top) and representation percent (bottom) by category in each DNG. Source: Authors' summary.

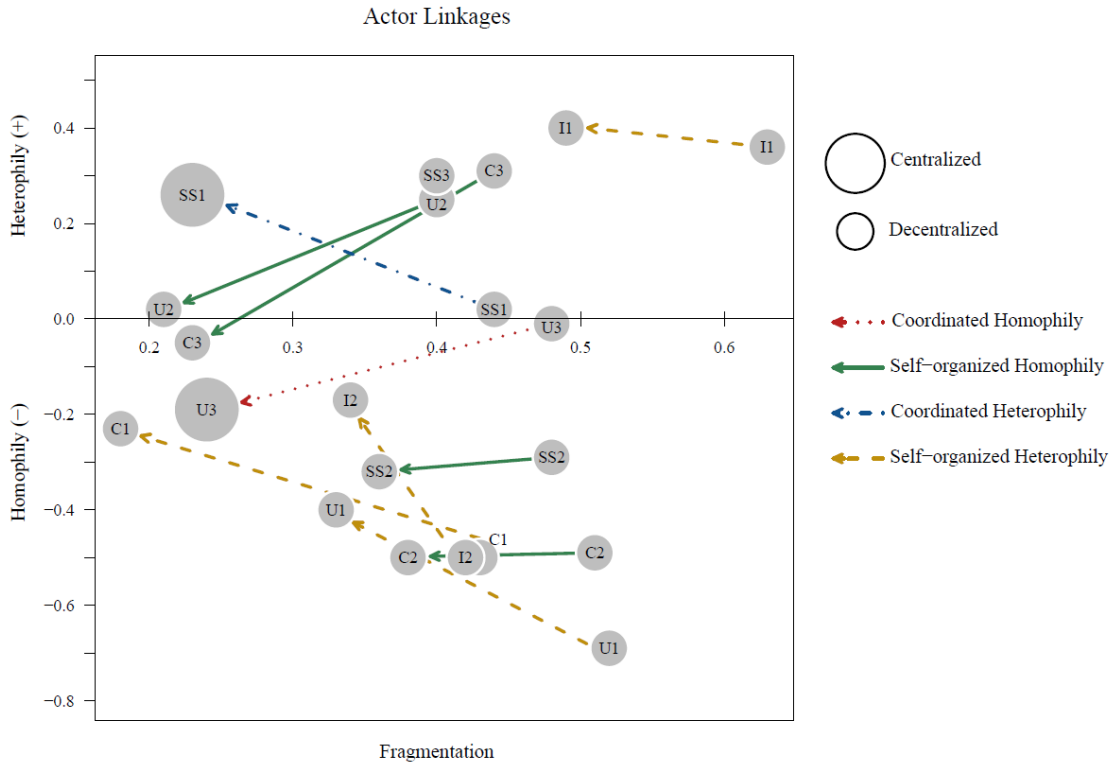

Figure 4. Governance networks of study municipalities (circles: I-Ilhabela; U-Ubatuba; SS-São Sebastião; C-Caraguatatuba). Circle size represents the centralization metric. Arrows point to the desired ES governance network configuration. Y-axis shows homophily/heterophily, X-axis fragmentation. Four patterns of envisioned change from CPGN to DGN to ensure BES: coordinated homophily; self-organized homophily; coordinated heterophily; self-organized heterophily. Source: Authors' summary.

3.2. Barrier 2: Fit governance to multi-level ecosystem dynamics

In all the municipalities, at least one municipal office named actors from higher administrative levels as endowed with high expertise and power (Table 4). Each Net-Map group only perceived their own municipality as a network actor at the local level: stakeholders from other municipalities were not mentioned. The beach managers perceived municipal actors as having low expertise, while regional, state, and federal level actors were seen as having high expertise. Although all administrative levels were associated with a high level of power to promote desired transformations in the governance network, the federal and state governments were generally seen as exerting their relatively high power through formal command, without spaces for participation in decision-making (e.g., "as a municipality, we cannot change how it works").

Table 4. Perceived expertise and power of administrative actors at different levels for guiding governance network changes towards long-term BES provision.

	Municipal	Regional	State	Federal
Actors perceived by all municipalities	None	Nongovernmental organization who operates regionally (civil society actor) (*n* = 8)	State environmental surveillance agency (*n* = 8), State Civil Defense (*n* = 5), State Public Prosecution Office (*n* = 7)	Navy (*n* = 8), governmental actor with authority on beach territories (*n* = 5)
Perceived expertise	Low	High	High	High
Perceived power	High	High	High	High

Note: BES = beach ecosystem services. Source: Authors' summary.

4. DISCUSSION

We mapped municipal government actors' perceptions of current governance network structure and changes needed to ensure BES provision, and then discussed the implications of these perceptions, highlighting opportunities and challenges for EBM implementation for beaches under conditions of change.

4.1. Barrier 1: Overcome current governance structures

Actor diversity is an important asset for EBM implementation (Bodin; Sandström; Crona, 2017; Smythe; Thompson; Garcia-Quijano, 2014), especially in beaches, due to their multiple uses (Sardá et al., 2015). The involvement of varied backgrounds increases the available pool of knowledge, experiences, and resources (Bodin; Sandström; Crona, 2017; Carlsson; Sandström, 2007; Smythe; Thompson; Garcia-Quijano, 2014). The more diverse an environmental governance network, the more adaptability to local particularities and potential for innovative management it generates (Holzkämper, 2017). Diversity, therefore, benefits EBM implementation by improving the capacity to manage social ecological change and uncertainty (Chapin III; Kofinas; Folke, 2009). Although the public sector was the dominant category, its lower representation on DGNs indicates that beach managers recognized the need to increase network diversity beyond the government sector.

Civil society involvement in governance networks can increase the legitimacy of decision-making and improve governance effectiveness (Carlsson; Sandström, 2007). Beaches support a wide range of uses, often by the private sector, which must thus be involved (Sardá

et al., 2015; Williams; Micallef, 2009). City councils can support EBM implementation by endorsing the participation of the private sector and civil society, and trigger changes at formal planning stages, for instance by promoting seminars and funding projects (Wamsler; Luederitz; Brink, 2014). Along with locally grounded, empirical knowledge, scientific knowledge is fundamental for EBM implementation (Arkema; Abramson; Dewsbury, 2006; McLeod; Leslie, 2009), and must be improved in the LNP region (Simões et al., 2017). Our Net-Map participants aimed to increase nongovernmental sector participation (e.g., civil society, research organizations) in beach management. They also perceived the private sector, council bodies, and research organizations as endowed with the high power and/or expertise needed to promote desired changes. By shifting beach governance toward desired constellations, the government may thus enable a successful EBM implementation within multi-actor co-management.

Actor diversity is an asset to EBM implementation, but it requires a network structure that enables actors of different sectors to interact in a cohesive (i.e., with low fragmentation, see Coleman, 1990) and collaborative governance network (Bodin; Sandström; Crona, 2017; Smythe; Thompson; Garcia-Quijano, 2014). Decreased fragmentation enhances the exchange of resources (Bodin; Crona, 2009), enabling responses to complex environmental challenges (Bodin; Sandström; Crona, 2017; Bodin; Crona, 2009; Smythe; Thompson; Garcia-Quijano, 2014) and supporting a network's overall adaptive capacity and resilience (Bodin; Crona, 2009). Since fragmentation is a major challenge for sustainability in marine governance (Kelly; Ellis; Flannery, 2018), the participants' desire for decreased fragmentation in their beach management networks is another opportunity for EBM implementation.

Brazil's beach management faces discontinuities in management programs and public policies due to personnel changes associated with newly elected governments, and also because procedural practices are often not formalized (Xavier et al., *in press*). Managers stated that "a limiting issue [for the changes in the governance network] is the discontinuation of projects. Every time a new government initiates its mandate, the ongoing projects are delayed". A decrease in network fragmentation increases the stability of the network (Carlsson; Sandström, 2007), which might enable the managers to better deal with sudden changes in beach management and support EBM implementation.

EBM implementation requires networks that connect different sectors (Bodin; Sandström; Crona, 2017; Sardá et al., 2015), which depends on trust and collective action (Bodin; Sandström; Crona, 2017). Trust can be improved by social ties among actors with similar backgrounds (Bodin; Crona, 2009; Holzkämper, 2017), such as perceived by the "homophily" types of change. However, actors who only interact within their own social group

might experience a homogenization of assets and ideas (Bodin, 2017). “Self-organized homophily”, therefore, may not include the exchange of knowledge and resources required by EBM, while the “coordinated homophily” approach envisions a central actor linking mostly homogeneous “subgroups”, thereby connecting different sectors of society.

The heterophily-oriented change also supports cooperation between actors of different sectors of society. Developing cooperation between actors with different backgrounds, however, requires resources that, if absent, can hamper EBM implementation processes (Bodin; Sandström; Crona, 2017). In our Brazilian study area, local beach managers’ desire for governance with increased heterophily is challenged by a lack of resources and skills, such as lack of public participation, knowledge, and power-sharing, and difficulties in engaging stakeholders (Corrêa et al., *in press – Chapter I*; Xavier et al., *in press*). LNP beach management will require coordination to benefit from actor diversity. A leader with a central network position can promote interaction between different social sectors thus facilitating the collaborative governance needed for EBM implementation (Bodin; Sandström; Crona, 2017). High levels of centralization are associated with better coordination among diverse actors (Smythe; Thompson; Garcia-Quijano, 2014), which can render decision-making more efficient (Carlsson; Sandström, 2007). The “coordinated homophily” type of network change might thus best promote knowledge exchange and coordination for EBM implementation.

Only one municipal office envisioned “coordinated homophily” as a needed network change. Reasons for this range from feasibility considerations to individual perceptions of good governance or network knowledge. At the same time, some sectors of society were not perceived at all by individual municipalities or were seen as having either no power or no expertise for governance network transformation. For example, although research organizations were perceived only as providers of information and knowledge (i.e., high expertise and low power), several cases have shown that researchers can foster the participation of other social actors in coastal management (e.g., Araça Bay, and RESEX-CT Bragança, *c.f.*, Glaser et al., 2020), thus improving governance (Carlsson; Sandström, 2007). The near absence of these visions among LNP beach managers might hamper the likelihood of EBM implementation seizing the opportunities generated by the recognized need for increasing actor diversity and network interactions.

4.2. Barrier 2: Fit governance with multi-level ecosystem dynamics

Beach management occurs mostly at the local level (Williams; Micallef, 2009), but deals with multilevel biophysical processes (McLachlan; Defeo, 2017). Connecting managers beyond the boundaries of their municipal territories is likely to improve the management of ecosystems that cross administrative borders (Bodin, 2017). An intermunicipal collaborative network that creates horizontal connectivity between localities sharing the same beach systems can better account for ecosystem dynamics in EBM implementation (Christie et al., 2009; Eisma-Osorio et al., 2009; Wamsler; Luederitz; Brink, 2014).

Local-to-local (i.e., intermunicipal) collaboration in EBM can increase stakeholder participation and the exchange of information and resources to enhance local formal institutions, coastal law enforcement, and the implementation of new approaches (Eisma-Osorio et al., 2009). It can also foster watershed-level coordination (Wamsler; Luederitz; Brink, 2014), necessary for sustainable beach management (Sardá et al., 2015). In Brazil, intermunicipal collaboration has increased local municipalities' innovation capacity and their power to negotiate with state and federal governments (Grin, 2019). Intermunicipal collaboration would address further challenges pointed out by LNP beach managers: the perceived low expertise and relatively low power of the municipal level, and the continuation of projects and plans beyond single electoral periods. Additionally, intermunicipal collaboration is fundamental for enhancing social–environmental fit and promoting the municipalities as a regional group.

EBM implementation that links local municipalities may be motivated by three main perceptions among ecosystem managers: (1) there is a natural biophysical interdependence in ecosystem functioning (Bodin, 2017); (2) local municipalities affect each other; and (3) local municipalities share issues and resource bases (e.g., financial, infrastructure) (Eisma-Osorio et al., 2009). In the LNP region, we found no indication that managers held any of these perceptions. Net-Map participants included actors from other municipalities in neither their perceived (CPGN) nor desired (DGN) networks. Although some of their perceptions might hamper EBM implementation, municipal officers also envisioned opportunities for EBM implementation in the governance network. If municipalities are to succeed in seeing themselves as a regional group, their perceptions will be a base for overcoming the challenges for EBM implementation in the region. It seems unlikely that, without external influence, the LNP municipalities will establish an intermunicipal network to exchange and share resources such as information, knowledge, experiences, and perceptions.

Actors from higher administrative levels might be needed to horizontally connect the municipalities and promote exchange between them. Gorris (2015), for example, found low horizontal connectivity between local administrative units in large marine protected areas in both northeast Brazil and Indonesian South Sulawesi. In the Net-Maps conducted in our study, higher level actors were seen as having high power and expertise to promote the envisioned BES governance network. Their coordination of actors across administrative boundaries can promote a better fit between collaborative network structures and multi-level ecosystem dynamics (Bodin, 2017). Thus, coordinated actions to implement EBM locally and regionally can increase the adaptive capacity of governance (Christie et al., 2009; Österblom et al., 2010).

The regional level is fundamental for connecting multiple system levels and scales that influence ecosystem dynamics (Glaser; Glaeser, 2014). Regional council bodies can connect municipalities, and also connect with higher level government actors to obtain financial and technical training or education support, increase social–ecological fit, and promote political continuity for EBM implementation (Eisma-Osorio et al., 2009). In the LNP, regional council bodies already connect all municipalities, state, and federal actors from all sectors of society (Santos; Turra, 2017). Although their decisions affect beach management, the LNP council bodies do not discuss beach management. This lack of focus on beaches may explain why the regional councils were not identified as BES network actors by several of the Net-Map participants. However, when identified by the participants, the regional council bodies, and some of their member organizations including regional nongovernmental organizations (NGOs), research organizations, and higher-level public-sector actors, were ascribed high power and expertise. This perception might foster the regional council bodies' role in integrating key actors. The LNP council bodies, in partnership with higher level authorities, regional NGOs, and research organizations, could support discussions on regional EBM-based beach management through intermunicipal, multilevel, and multi-sector collaboration.

5. LOCAL MANAGERS AS LEADERS OF EBM IMPLEMENTATION

Our Net-Map participants provided an important picture of beach management in the LNP region. All beach managers saw the need to increase diversity and collaboration in governance networks. They perceived both the local and regional levels as endowed with a high level of power, and therefore as potentially effective in promoting the transformations needed for the long-term provision of BES. These perceptions provide a point of departure to develop strategies for beach management challenges, such as discontinuity in management and public

policies, lack of inclusive social participation, and the science–practice gap. In a collaborative framework, a leader ensures the effective exchange of information, resources, and knowledge and facilitates collaboration among multiple sectors (Bodin; Sandström; Crona, 2017; Simões et al., 2017). This study demonstrates that local government managers envision network changes that might support local EBM implementation and that they can thus be regarded as potential local leaders for such a venture.

However, given the low degree of perceived horizontal connectivity between the municipalities of the LNP region, beach managers might require a facilitator to enhance their skills and expertise and to foster their perception of themselves as a regional group. The participating beach managers' lack of shared interests or identity reduces their potential as leaders for EBM implementation. Their perceptions of BES governance improvement might undermine the fit between governance and environmental dynamics of the beaches of the study region, and hamper the horizontal, intermunicipal exchange of knowledge that is needed to seize the potentials revealed by the beach managers' perception patterns.

This study revealed the willingness of managers to better involve research organizations in the governance network, allowing researchers to act as facilitators for beach managers to establish their leadership role. Partnerships to capacitate and empower local managers and to enhance knowledge exchange with key actors (e.g., regional council bodies) would promote long-term BES provision based on effective EBM implementation. Future perception studies might extend to other beach management stakeholders' understandings of governance and management and thus lay additional foundations for increasing stakeholder collaboration for EBM. Moreover, the link types (information, support, resources, and conflicts) between actor categories might be analyzed separately to clarify their role in EBM implementation.

Our use of Net-Map and SNA methodologies in the EBM context facilitated cooperation between researchers and managers in adapting management practices. This study demonstrates how local government managers' perceptions of the necessary improvements to the ES governance network are a critical precondition for EBM implementation. We focused on the perceptions of beach managers as primary ecosystem governance actors, a focus that can also support EBM implementation in other types of ecosystems. As humanity's impact on nature becomes ever more dominant, the focus on collaborative governance networks we develop in this study is likely to gain wider relevance. Since other contextual conditions are also critical for EBM implementation, further research is needed on public policies, institutions, usable knowledge, information basis, and innovation uptake.

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7. REFERENCES

ADGER, W.N. Social aspects of adaptive capacity. In: SMITH, J.B.; KLEIN, R.J.T.; HUQ, S. (eds.). **Climate Change, Adaptive Capacity and Development**. London, UK: Imperial College Press, 2003. p. 29-49.

AMARAL, A.C.Z; CORTE, G.N; ROSA FILHO, J.S.; DENADAI, M.R.; COLLING, L.A.; BORZONE, C.; VELOSO, V.; OMENA, E.P.; ZALMON, I.R.; ROCHA-BARREIRA, C.A.; SOUZA, J.R.B; ROSA, L.C.; ALMEIDA, T.C.M. Brazilian sandy beaches: Characteristics, ecosystem services, impacts, knowledge, and priorities. **Brazilian Journal of Oceanography**, v. 64, n. Spe2, p. 5-16, 2016.

ARKEMA, K.K.; ABRAMSON, S.C.; DEWSBURY, B.M. Marine Ecosystem-Based Management: from characterization to implementation. **Frontiers in Ecology and the Environment**, v. 4, n. 10, p. 525-32, 2006.

ASWANI, S.; CHRISTIE, P.; MUTHIGA, N.A.; MAHON, R.; PRIMAVERA, J.H., CRAMER, L.A.; BARBIER, E.B.; GRANEK, E.F.; KENNEDY, C.J.; WOLANSKI, E.; HACKER, S. The way forward with ecosystem-based management in tropical contexts: Reconciling with existing management systems. **Marine Policy**, v. 36, n. 1, p. 1-10, 2012.

BEYERL, K.; PUTZ, O.; BRECKWOLDT, A. The role of perceptions for community-based marine resource management. **Frontiers in Marine Science**, v. 3, n. 238, 2016.

BIERMANN, F.; BETSILL, M.M.; GUPTA, J.; KANIE, N.; LEBEL, L.; LIVERMAN, D.; SCHROEDER, H.; SIEBENHÜNER, B.; ZONDERVAN, R. Earth system governance: A research framework. **International Environmental Agreements**: Politics, Law, and Economics, v. 10, n. 4, p. 277-298, 2010.

BODIN, Ö. Collaborative environmental governance: Achieving collective action in social-ecological systems. **Science**, v. 357, n. 6352, eaan1114, 2017.

BODIN, Ö.; CRONA, B.I. The role of social networks in natural resource governance: What relational patterns make a difference? **Global Environmental Change**, v. 19, n. 3, p. 366-374, 2009.

BODIN, Ö.; SANDSTRÖM, A.; CRONA, B. Collaborative networks for effective ecosystem-based management: A set of working hypotheses. **Policy Studies Journal**, v. 45, n. 2, p. 289-314, 2017.

BORGATTI, S.P.; EVERETT, M.G.; FREEMAN, L. **UCINET for Windows**: Software for social network analysis. Harvard, MA: Analytic Technologies, 2002. Disponível em: <sites.google.com/site/ucinetsoftware/home>.

CARLSSON, L.; SANDSTRÖM, A. Network governance of the commons. **International Journal of the Commons**, v. 2, n. 1, p. 33-54, 2007.

CHAPIN III, F.S.; KOFINAS, G.P.; FOLKE, C. (eds.). **Principles of ecosystem stewardship: Resilience-based natural resource management in a changing world**. New York, NY: Springer-Verlag, 2009. 401 p.

CHRISTIE, P.; POLLNAC, R.B.; ORACION, E.G.; SABONSOLIN, A.; DIAZ, R.; PIETRI, A. Back to basics: an empirical study demonstrating the importance of local-level dynamics for the success of tropical marine ecosystem-based management. **Ocean & Coastal Management**, v. 37, n. 3-4, p. 349-373, 2009.

COHEN, P.J.; EVANS, L.S.; MILLS, M. Social networks supporting governance of coastal ecosystems in Solomon Islands. **Conservation Letters**, v. 5, n. 5, p. 376-386, 2012.

COLEMAN, J.S. **Foundations of Social Theory**. Harvard, MA: Harvard University Press, 1990. 1024 p.

CORRÊA, M.R.; XAVIER, L.Y.; GONÇALVES, L.R.; ANDRADE, M.M.; OLIVEIRA, M.; MALINCONICO, N.; BOTERO, C.M.; MILANÉS, C.; MONTERO, O.P.; DEFEO, O.; TURRA, A. Desafios para promoção da abordagem ecossistêmica à gestão de praias na América Latina e Caribe. **Revista Estudos Avançados**, *in press*.

EISMA-OSORIO, R.L.; AMOLO, R.C.; MAYPA, A.P.; WHITE, A.T.; CHRISTIE, P. Scaling up local government initiatives toward ecosystem-based fisheries management in Southeast Cebu Island, Philippines. **Coastal Management**, v. 37, n. 3-4, p. 291-307, 2009.

FREEMAN, L. **The Development of Social Network Analysis**: A study in the Sociology of Science. Vancouver, BC: Empirical Press, 2004. 218 p.

GLASER, M.; BARBOZA, R.S.L.; BORGES, R.; BLANDTT, L.; GERHARDINGER, L.C.; FERREIRA, B.P.; MARQUES, S.; GONÇALVES, L.R.; XAVIER, L.Y.; TURRA, A. Trajectory of social participation in Brazilian coastal and ocean management. In: GLAESER, B.; GLASER, M. (eds.). **Coastal Management Revisited**: Towards Sustainable Human-Nature Relations. New York, NY: Elsevier, 2020.

GLASER, M.; GLAESER, B. Towards a framework for cross-scale and multi-level analysis of coastal and marine social-ecological systems dynamics. **Regional Environmental Change**, v. 14, p. 2039-2052, 2014.

GLASER, M.; GORRIS, P.; FERREIRA, B.P.; BRECKWOLDT, A. Analysing ecosystem user perceptions of the governance interactions surrounding a Brazilian near-shore coral reef. **Sustainability**, v. 10, n. 5, p. 1464, 2018.

GORRIS, P. **Entangled? Linking governance systems for regional-scale coral reef management**: Analysis of case studies in Brazil and Indonesia. Tese (Doutorado) – Leibniz Center for Tropical Marine Ecology. Düsseldorf: Jacobs University, 2015. Disponível em: <nbn-resolving.org/urn:nbn:de:gbv:579-opus-1002112>.

GRANEK, E.F.; POLASKY, S.; KAPPEL, C.V.; REED, D.J.; STOMS, D.M.; KOCH, E.W.; KENNEDY, C.J.; CRAMER, L.A.; HACKER, S.D.; BARBIER, E.B.; ASWANI, S.; RUCKELSHAUS, M.; PERILLO, G.M.E.; SILLIMAN, B.R.; MUTHIGA, N.; BAEL, D.; WOLANSKI, E. Ecosystem services as a common language for coastal ecosystem-based management. **Conservation Biology**, v. 24, n. 1, p. 207-216, 2010.

GRIN, E.J. Federalismo, governança e cooperação intermunicipal no Brasil: um balanço da literatura. In: CARNEIRO, J.M.B.; BRITO, E.S. (eds.). **Consórcios Intermunicipais e Políticas Públicas Regionais**. São Paulo, SP: Oficina Municipal, 2019. Cap. 3, p. 37-54.

GROTHMANN, T.; PATT, A. Adaptive capacity and human cognition: The process of individual adaptation to climate change. **Global Environmental Change**, v. 15, n. 3, p. 199-213, 2005.

HOLZKÄMPER, E.M. **Comparing realities. Analysis of stakeholders' perceptions relating to the governance network of a MPA** – the case of the Coral Coast Environmental Protection Area, Brazil. Dissertação (Mestrado) – Leibniz Center for Tropical Marine Ecology. Bremen: University of Bremen, 2017.

IMPERIAL, M.T. Institutional analysis and ecosystem-based management: The institutional analysis and development framework. **Environmental Management**, v. 24, n. 4, p. 449-465, 1999.

KELLY, C.; ELLIS, G.; FLANNERY, W. Conceptualising change in marine governance: Learning from transition management. **Marine Policy**, v. 95, p. 24-35, 2018.

KIRKFELDT, T.S. An ocean of concepts: Why choosing between ecosystem-based management, ecosystem-based approach and ecosystem approach makes a difference. **Marine Policy**, v. 106, p. 103541, 2019.

LESLIE, H.; SIEVANEN, L.; CRAWFORD, T.G.; GRUBY, R.; VILLANUEVA-AZNAR, H.C.; CAMPBELL, L.M. Learning from ecosystem-based management in practice. **Ocean & Coastal Management**, v. 43, n. 5, p. 471-497, 2015.

MCLACHLAN, A.; DEFEO, O. **The Ecology of Sandy Shores**. 3rd ed. Cambridge, MA: Academic Press, 2017. 572 p.

MCLEOD, K.L.; LESLIE, M. **Ecosystem-based management for the oceans**. Washington, DC: Island Press, 2009. 392 p.

MINISTÉRIO DO MEIO AMBIENTE. Portaria nº 76, de 26 de março de 2018. Institui o Programa Nacional para Conservação da Linha de Costa. **Diário Oficial da União**, Brasília, DF, 28 mar. 2018. Nº 60, Seção 1, p. 161. Disponível em: <www.ibama.gov.br/sophia/cnia/legislacao/MMA/PT0076-260318.pdf>.

MOSER, S.C.; TRIBBIA, J. Vulnerability to inundation and climate change impacts in California: Coastal managers' attitudes and perceptions. **Marine Technology Society**, v. 40, n. 3, p. 4-13, 2006.

O'HIGGINS, T.G.; LAGO, M.; DEWITT, T.H. (eds.). **Ecosystem-Based Management, Ecosystem Services and Aquatic Biodiversity**: Theory, tools and applications. Cham: Springer, 2020. 580 p.

ÖSTERBLOM, H.; GÅRDMARK, A., BERGSTRÖM, L.; MÜLLER-KARULIS, B.; FOLKE, C.; LINDEGREN, M.; CASINI, M.; OLSSON, P.; DIEKMANN, R.; BLENCKNER, T.; HUMBORG, C.; MÖLLMANN, C. Making the ecosystem approach – can regime shifts in ecological- and governance systems facilitate the transition? **Marine Policy**, v. 34, n. 6, p. 1290-1299, 2010.

SANDSTRÖM, A.; BODIN, Ö.; CRONA, B. Network governance from the top—the case of ecosystem-based coastal and marine management. **Marine Policy**, v. 55, p. 57-63, 2015.

SANTOS, C.; TURRA, A. (orgs.). **Rumos da Sustentabilidade Costeira**: visão do Litoral Norte Paulista. São Paulo, SP: Instituto Oceanográfico da Universidade de São Paulo, 2017.

SARDÁ, R.; LOZOYA, J.P. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

SARDÁ, R.; VALLS, J.F.; PINTÓ, J.; ARIZA, E.; LOZOYA, J.P.; FRAGUELL, R.M.; MARTÍ, C.; RUCABADO, J.; RAMIS, J.; JIMENEZ, J.A. Towards a new integrated beach management system: the ecosystem-based management system for beaches. **Ocean & Coastal Management**, v. 118, Part B, p. 167-177, 2015.

SCHERER, M.E.G.; NICOLODI, J.L.; COSTA, M.F.; CORRIANI, N.R.; GONÇALVES, R.K.; CRISTIANO, S.C.; RAMOS, B.; CAMARGO, J.M.; SOUZA, V.A.; FISCHER, L.O.; SARDINHA, G.; MATTOS, M.P.S.; PFUETZENREUTER, A. Under new management. **Journal of Coastal Research**, v. 95, n. SI, p. 945-952, 2020.

SCHIFFER, E.; HAUCK, J. Net-Map: Collecting social network data and facilitating network learning through participatory influence network mapping. **Field Methods**, v. 22, n. 3, p. 231-249, 2010.

SIMÕES, E.; SOUSA JUNIOR, W.C.; FREITAS, D.M.; MILLS, M.; IWAMA, A.Y.; GONÇALVES, I.; OLIVATO, D.; FIDELMAN, P. Barriers and opportunities for adapting to climate change on the North Coast of São Paulo, Brazil. **Regional Environmental Change**, v. 17, p. 1739-1750, 2017.

SMYTHE, T.C.; THOMPSON, R.; GARCIA-QUIJANO, C. The inner workings of collaboration in marine ecosystem-based management: A social network analysis approach. **Marine Policy**, v. 50, Part A, p. 117-125, 2014.

SØRENSEN, E.; TORFING, J. Political leadership in the age of interactive governance: Reflections on the political aspects of metagovernance. In: EDELENBOS, J.; VAN MEERKERK, I. (eds.). **Critical Reflections on Interactive Governance**: self-organization and participation in public governance. Cheltenham: Edward Elgar Publishing, 2016. Chapter 21, p. 444-466.

TALLIS, H.; LEVIN, P.S.; RUCKELSHAUS, M.; LESTER, S.E.; MCLEOD, K.L.; FLUHARTY, D.L.; HALPERN, B.S. The many faces of ecosystem-based management: making the process work today in real places. **Marine Policy**, v. 34, n. 2, p. 340-348, 2010.

WAMSLER, C.; LUEDERITZ, C.; BRINK, E. Local levers for change: Mainstreaming ecosystem-based adaptation into municipal planning to foster sustainability transitions. **Global Environmental Change**, v. 29, p. 189-201, 2014.

WILLIAMS, A.T.; MICALLEF, A. **Beach Management**: Principles and Practice. London, UK: Routledge, 2009. 480 p.

XAVIER, L.Y.; GONÇALVES, L.R.; OLIVEIRA, M.; CORRÊA, M.R.; MALINCONICO, N.; POLETTE, M.; TURRA, A. Beach management and conservation in Brazil. In: AMARAL, A.C.Z., CORTE, G.N.; CHECON, H.H. (eds.). **Brazilian Sandy Beaches**. New York, NY: Springer, *in press*.

8. SUPPORTING INFORMATION

APPENDIX 2: Determining participants

Beach managers are government officers concerned with civil society safety, environmental protection, public structure, and the development of coastal areas close to beaches (Moser; Tribbia, 2006). In Brazil, the beach managers can be permanent public officers - who hold their public sector positions when political mandates change, carrying knowledge and experience about the organization functioning, and technical knowledge. As part of a technical team, beach managers often provide important knowledge to guide decision-making. Beach managers can also be temporary officers who work during a single electoral mandate and, as a municipal officer, are responsible for final decision-making in this period. These non-permanent municipal officers can also be part of the technical team but are usually more involved with political decision-making. For this research, we set up Net-Map sessions with the municipal officer and with at least two permanent members of the technical teams working in the selected Municipal Offices of the LNP municipalities.

In order to develop a list of selection criteria, we reviewed municipal policies concerning the administrative structure and competences of the Municipal Offices in the four municipal governments in the LNP region (Ilhabela, Caraguatatuba, São Sebastião, and Ubatuba) matching relevant terms with those used in the formulation of policies. This policy review resulted in the following list of nine terms related to beach management: 1. vulnerability reduction; 2. Monitoring; 3. disaster prevention; 4. sustainability; 5. planning; 6. integration of sectors; 7. Beaches; 8. climate change; and 9. erosion. We compared these nine terms on the list with the mandates of all government offices in the LNP region and selected those offices where mandates matched the selection criteria. Additionally, we reviewed national public policies associated with the terms “beach”, “shoreline” (“orla”) and “climate change”. We identified the municipal government actors quoted in these policies and thus were able to cross-check our selection of Municipal Offices and obtain data on which municipal governmental bodies are formally responsible for beach management in the LNP region. Of the twelve offices contacted, eleven responded. Table presents an overview of the eleven offices (and their tasks) selected for conducting Net-Map sessions.

Table 5. List of Municipal Government Offices associated with beach management which attended the group interviews

Municipality	Municipal office*	Municipal offices' official tasks	Code
Ilhabela	Civil Defense Office	Plan, coordinate, and execute activities and studies to prevent conditions of vulnerability and threats caused by situations of public calamities and disasters that put people's lives and well-being at risk.	I1
	Urban planning, public works, and Housing development	Formulate, execute, and evaluate the Municipal Policy for Urban Development and Housing. Among other assignments, this office aims to understand and prevent the impacts of urban growth in the environment as well as to identify and promote opportunities for sustainable urban development in the municipality.	I2
Ubatuba	Civil Defense Office	Communicate and coordinate studies to track situations of risk for the population's well-being (e.g., natural disasters), as well as develop action plans to deal with risks.	U1
	Urban planning Office	Formulate, execute, and evaluate the Municipal Policy for Urban Development and urbanization projects. Among other assignments, this office aims to understand and prevent the impacts of urban growth on the environment. It also aims to ensure the regulations of areas that belong to Federal entities.	U2
	Environment Office	Organize, plan, and guide the municipality's environmental policy. This office aims to attend the environmental demands of the city. In partnership with the Urban Planning Office and other offices, this office aims to ensure the protection, conservation, and recovery of the environment, as well as to promote sustainable actions in the municipality.	U3
São Sebastião	Civil Defense Office	Assess and prevent disasters, vulnerabilities, and risks to which the municipality is subjected to. This office is responsible for planning institutional activities, providing human resources (training courses), developing scientific-technological studies, mobilizing, monitoring, and alerting the municipality, and providing logistical support to disasters.	SS1
	Beach management Office	Not specified in the legislation.	SS2
	Environment Office	Develop studies, actions, and activities related to the protection, conservation, and recovery of the environment. This office is responsible for including all sectors of the society and the different Municipal Offices in the promotion of environmentally sustainable actions in the municipality.	SS3
Caraguatatuba	Civil Defense Office	Develop and implement policies and plans that promote the protection of the citizens' well-being against disasters. This office articulates and integrates government agencies and society, aiming to organize and expand the adaptive capacity of the municipality to prevent and address environmental risks within it.	C1
	Urban Planning Office	Develop, study, and revitalize the municipal urban planning, legislation, and projects, ensuring the preservation of the natural environment and population well-being.	C2
	Fisheries, Aquaculture and Environment Office	Promote the integration of Municipal Offices, citizens, research institutions, State and Union actions, and knowledge with respect to the planning of use, conservation, recovery, and protection of the environment. Among other assignments, this office is responsible for advising and offers training about the environment and its sustainable use, with a holistic, scientific, and participatory approach that considers the interdependence of the natural, socioeconomic, and cultural environment.	C3

* Note: Denominations of offices translated to English by authors.

APPENDIX 3: Data treatment (Net-Map)

1. Actors were grouped to generate a simplified overview of all the networks. For example, divisions of the Environmental Municipal Office were grouped as “Environmental Municipal Office”.
2. Relations (links) were classified as either “collaborative relations” or “conflict relations” thus allowing for the construction of two co-existing networks: the “governance collaboration network” and the “governance conflict network”.
3. To represent participants’ assessment that some relations “need improvement”, two procedures were adopted:
   a. Existing “collaborative relations” (CPGN) that were marked as “need improvement” (in DGN) received a weight of 1 in CPGN, while all other relations were weighted as 2 (indicating a stronger link);
   b. Existing “conflicts” (CPGN) that were marked as “need improvement” (in DGN) were disregarded in collaborative CPGN (only positive links were represented) and considered in DGN as “new” positive links.

CONSIDERAÇÕES FINAIS

A implementação da Gestão Baseada em Ecossistemas (GBE) em praias é um passo fundamental para garantir a sustentabilidade deste ecossistema (Sardá et al., 2015). Esse cenário é exacerbado em países da América Latina e Caribe (AL&C), nos quais as ameaças às praias reforçam a discussão quanto à inadequação de métodos reducionistas de gestão (Botero; Williams; Cabrera, 2015). Para que se transforme uma gestão no sentido da abordagem ecossistêmica, deve-se entender quais fatores são catalisadores ou barreiras dessa mudança (Kelly; Ellis; Flannery, 2018). Nesse sentido, se faz necessário investigar o contexto aplicado da gestão em nível local para a implementação da GBE (Leslie et al., 2015), reforçando o possível papel que os atores governamentais locais podem ter nessa transformação (Sardá; Lozoya, 2018).

Este estudo teve como objetivo contribuir com a discussão sobre a implementação da GBE em praias, trazendo, principalmente, aportes para o contexto da AL&C e para sua implementação em nível local. No primeiro capítulo foi feita uma reflexão geral sobre as oportunidades da incorporação da GBE na gestão de praias e os desafios para sua implementação na AL&C. Os outros dois capítulos utilizaram um estudo de caso no Litoral Norte Paulista (Brasil), no qual os gestores governamentais locais são atores centrais na gestão de praias, para investigar como a visão desses gestores de praias sobre a vulnerabilidade dos Serviços Ecossistêmicos (SE) no cenário de mudanças de longo-prazo (i.e. Mudanças Climáticas) pode influenciar na transformação da gestão de praias local no sentido da GBE. A visão dos gestores de praia sobre a vulnerabilidade dos SE foi analisada sob duas perspectivas principais: (1) Como eles percebem a sensibilidade dos SE (i.e. a dinâmica da provisão de SE frente às mudanças ambientais de longo prazo); e (2) Como eles percebem a capacidade adaptativa da gestão para a manutenção de longo-prazo dos SE (i.e. as transformações necessárias nas redes de governança para a manutenção de longo prazo da provisão de SE).

Observou-se que a GBE pode orientar a adequação dos processos da gestão de praias e sua implementação, sendo uma abordagem a ser fortalecida na região da AL&C. Em termos gerais, a implementação da GBE na AL&C tem que enfrentar barreiras exógenas (e.g. incentivos à gestão fragmentada), desafios institucionais (e.g. falta de treinamento técnico e processos participativos enfraquecidos), desafios regionais (e.g. instabilidade política e descontinuidade de planos de gestão, disparidade regional), desafios econômicos (e.g. recursos escassos, economias baseadas na exploração de recursos naturais para exportação) e desafios na produção de conhecimento (e.g. descontinuidade dos programas de pesquisa e falta de

incentivos à produção interdisciplinar). A região carece, ainda, de estudos empíricos e teóricos sobre a própria implementação da GBE.

Para enfrentar essas barreiras, reforçou-se a oportunidade gerada pelos aprendizados da implementação da Gestão Costeira Integrada na AL&C a partir da cooperação entre os países da região. Ainda, foi destacada a importância da AL&C na pesquisa de sistemas socioecológicos, SE e interação ciência-política como uma oportunidade para aprimorar e aprofundar o conhecimento sobre os processos de implementação da GBE nas praias, principalmente a partir das redes regionais que promovem integração entre ciência-gestão. Finalmente, reforçou-se a necessidade de aprimorar e implementar abordagens transdisciplinares para favorecer a capacitação de gestores e a co-criação de conhecimento, orientando os processos de gestão de praias na AL&C para abordagens sistêmicas, descentralizadas, participativas e transparentes, como a GBE.

Quando analisada a gestão de praias na AL&C, entende-se que a implementação da GBE conduzida pelo governo pode não ser suficiente para superar os múltiplos desafios de ordens e níveis variados que existem na região. Porém, ao analisarmos como a visão dos gestores governamentais locais sobre a vulnerabilidade dos SE pode influenciar na implementação da GBE em praias no nível local, eles foram entendidos como líderes potenciais no processo de transformação da gestão de praias no sentido da GBE. Coletivamente os gestores de praias apresentaram uma visão sistêmica, perceberam os caminhos causais de longo-prazo ao longo do sistema socioecológico das praias e trouxeram uma percepção oportuna para uma gestão mais integrada, coesa, participativa e adaptativa. Os gestores perceberam a necessidade de mudanças nas redes de governança que podem dar suporte para a implementação da GBE em nível local, aumentando sua capacidade adaptativa e servindo de base para desenvolver estratégias que enfrentem a descontinuidade dos planos de gestão e políticas públicas, o enfraquecimento de processos participativos e que aproximem a relação entre ciência e gestão, desafios encontrados na AL&C.

Porém, há uma fragilidade no potencial dos gestores governamentais locais como líderes da implementação da GBE. Para que o seu papel se materialize como oportunidade para a implementação da GBE em praias, é preciso estabelecer uma conexão, ou integração, entre os gestores dos diferentes municípios, formando uma rede intermunicipal. Ao propiciar o compartilhamento das visões que os gestores dos diferentes municípios tiveram, que, se somadas, são oportunas para a implementação da GBE em praias no nível local, esta integração regional propiciará um aprimoramento das habilidades e conhecimentos de todos os gestores no sentido da sustentabilidade. Ainda, com a integração regional, a transformação da gestão

atual de praias poderá envolver todos os processos ecossistêmicos dos quais as praias dependem, se aproximando ainda mais dos princípios da GBE. Ao mesmo tempo, a integração regional pode viabilizar o empoderamento dos gestores locais para lidar com questões político-econômicas que envolvem níveis administrativos mais altos (e.g. regionais, estaduais e federais) e foram identificadas como barreiras para a implementação da GBE na AL&C.

Não obstante, os gestores de praias também necessitam do fortalecimento da relação ciência-gestão. Isso porque, mesmo coletivamente, a visão dos gestores sobre a dinâmica da provisão de SE frente às mudanças ambientais de longo prazo teve lacunas em termos da abordagem ecossistêmica. Dessa maneira, entende-se a necessidade de promover a capacitação dos gestores de praia e aprimorar a troca de conhecimento com outros atores-chave, propiciando a implementação da GBE de maneira efetiva. Nesse sentido, foi reforçada a importância de abordagens transdisciplinares para promover a implementação da GBE em praias da AL&C também em âmbito local.

No estudo de caso analisado no Litoral Norte Paulista, os gestores governamentais municipais são responsáveis pela gestão de praias no seu território. Foram identificadas quais lacunas de conhecimento acerca da dinâmica de longo prazo das praias como sistemas socioecológicos existem na percepção dos gestores. Também foi compreendido o papel fundamental dos pesquisadores e dos fóruns regionais (e.g. Área de Proteção Ambiental Marinha do Litoral Norte e Comitê de Bacias Hidrográficas do Litoral Norte) como facilitadores da implementação da GBE em praias no nível local para materializar as oportunidades trazidas pela percepção dos gestores ao terem o potencial de promover a integração regional e fortalecer a relação entre ciência e gestão. Assim, foram dados subsídios para o manejo sustentável das praias na região, fortalecendo a implementação da GBE.

Junto à uma reflexão sobre as oportunidades da incorporação da GBE na gestão de praias e as possíveis barreiras e catalisadores para sua implementação na AL&C, a análise da percepção dos gestores governamentais locais sobre a vulnerabilidade dos SE trouxe aportes teóricos relevantes para entender a dimensão aplicada da implementação da GBE em praias da região. Essa ferramenta reforçou a importância dos gestores governamentais locais e trouxe não apenas quais esclarecimentos conceituais complementares são necessários em termos da abordagem ecossistêmica em praias, como também foi uma oportunidade de cooperação entre pesquisadores e gestores na adaptação do atual sistema de governança. No caso da AL&C, a aplicação dessa ferramenta também evidenciou caminhos para enfrentar alguns dos desafios encontrados para a transformação da gestão de praias no sentido da GBE. Dessa maneira, a percepção dos gestores governamentais locais pode ser entendida como uma precondição crítica

a ser analisada para a implementação da GBE localmente em praias e mais amplamente ao se pensar em uma estratégia *bottom-up* de transformação da gestão no sentido da sustentabilidade.

Uma vez que outras precondições contextuais também são críticas para a implementação da GBE, mais pesquisas sobre políticas públicas, instrumentos de gestão, instituições, conhecimento utilizável e absorção de inovações são necessárias na AL&C. Estudos futuros também devem aprofundar a reflexão aqui trazida e investigar a influência da percepção da sensibilidade dos SE na capacidade adaptativa percebida. Ainda, se faz necessário investigar a percepção de outros possíveis atores-chave para a implementação da GBE em praias sobre a vulnerabilidade dos SE, encontrando, assim, outros caminhos, fragilidades e possíveis conflitos para a implementação da GBE localmente, na AL&C e em outras regiões.

REFERÊNCIAS

BOTERO, C.M.; WILLIAMS, A.T.; CABRERA, J.A. Advances in beach management in Latin America: overview from certification schemes. In: FINKL, C.: MAKOWSKI C. (eds.) **Environmental Management and Governance**. Coastal Research Library. New York: Springer, 2015. v. 8, p. 33-63.

KELLY, C.; ELLIS, G.; FLANNERY, W. Conceptualising change in marine governance: Learning from transition management. **Marine Policy**, v. 95, p. 24-35, 2018.

LESLIE, H.; SIEVANEN, L.; CRAWFORD, T.G.; GRUBY, R.; VILLANUEVA-AZNAR, H.C.; CAMPBELL, L.M. Learning from ecosystem-based management in practice. **Ocean & Coastal Management**, v. 43, n. 5, p. 471-497, 2015.

SARDÁ, R.; LOZOYA, J.P.L. A DEcision MAking (DEMA) tool to be used in Ecosystem-Based Management System (EBMS) applications. In: BOTERO, C.M.; CERVANTES, O.; FINKL, C.W. (eds.) **Beach Management Tools – Concepts, Methodologies and Case Studies**. Coastal Research Library. Cham: Springer, 2018. v. 24, p. 21-40.

SARDÁ, R.; VALLS, J.F.; PINTÓ, J.; ARIZA, E.; LOZOYA, J.P.; FRAGUELL, R.M.; MARTÍ, C.; RUCABADO, J.; RAMIS, J.; JIMENEZ, J.A. Towards a new integrated beach management system: the ecosystem-based management system for beaches. **Ocean & Coastal Management**, v. 118, Part B, p. 167-177, 2015.