



# Linking User-Perception Diversity on Ecosystems Services to the Inception of Coastal Governance Regime Transformation

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In this paper we explore the challenges for transforming a wide and fragmented coastal governance system toward an ecosystem-based regime by translating shared values of nature into radically novel territorial development policies at highly disputed seascapes. We report an official coastal management institutional experiment in South Brazil, where direct ecosystem users (fishers, miners, mariculture, tourism and leisure, and aquatic transport agents and researchers) perception and classification of ecosystem services (ES) was assessed during 19 collaborative sectoral workshops held with 178 participants from six coastal cities surrounding Babitonga Bay estuarine and coastal ecosystems (Santa Catarina state, South Brazil). Participants collectively enlisted the benefits, rights and resources (or services) they obtain from these ecosystems, rendering a total of 285 citations coded to conventional ES scientific typologies (127 ES grouped in 5 types and 31 subtypes). We explore patterns in ES classificatory profiles, highlighting ecosystem user's salient identities and exploring how they shape political actions in relation to the implementation of an ecosystem-based management regime. Food (provisioning service), tourism/leisure, employment, work and income (cultural services) as well as transportation (e.g. vessels, ports and navigation) (cultural/people's services) are perceived by all user groups, and hence consist the core set of perceived shared values amongst direct ecosystem users to inform future transformation narratives. Differences in perception of values amongst user groups combined with high levels of power asymmetry and fragmentation in decision-making, are steering the analyzed system toward an unsustainable pathway. The governance regime has been largely favoring subsets of services and unfair distribution of benefits, disregarding a more diverse array of real economic interests, and potential ecological knowledge contributions. Our integrative and deliberative ES valuation approach advances understanding of critical features of the scoping phase of ES assessment initiatives in coastal zones. We provide empirically grounded and theoretically informed suggestions for the promotion of local knowledge integration

through combination of methods that supports transformational research agendas. This paper establishes new groundwork to fulfilling alternative visions for the regional social-ecological system transformation to a more socially and ecologically coherent and equitable development trajectory.

**Keywords:** perception, ecosystem-based management, shared values, social-ecological system, stakeholders, Brazil

## INTRODUCTION

### Ecosystem Services Assessments on the Crossroads

Ecosystem services (ES) are commonly defined as benefits obtained from the environment by humans and are critical to human survival, livelihoods, well-being, and quality of life (Millennium Ecosystem Assessment [MEA], 2005). Understanding and integrating the diversity of human perceptions and agency on coastal and marine seascapes and related ES into governance processes remains a critical challenge to avoid escalating conflicts over marine resources in the Anthropocene (Folke, 2006; Lique et al., 2013; Aswani et al., 2017). Our society lives a dilemma. While we depend on coastal-marine ES and states actively promote the ocean as the new global economic development and growth frontier (Bennett et al., 2019), anthropogenic factors have already affected their resilience and, therefore, are increasingly compromising sustained availability of these services at regional levels (Gattuso et al., 2018).

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

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

Since the worldwide boom in ES conceptual research and application following the Millennium Ecosystem Assessment in 2005, the link between ES and environmental governance has been widely discussed (Abson et al., 2014;

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

### Facing the Practical Challenges of Integrated and Deliberative Valuation Approaches

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

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

Valuation is not a last nor optional step in ES assessments, but span over multiple steps – from the choice of value types and of terminology, selection of social actors to engage with, methodological decisions (tools and measurement units), and choice of which ES are to be included in research (Martín-López et al., 2013; Jacobs et al., 2016; Boeraeve et al., 2018). Further attention should also be placed on participatory methods capable of recording less tangible cultural ES and non-material values (Raymond et al., 2009; Milcu et al., 2013; Fish et al., 2016; Boeraeve et al., 2018), and including them alongside other services in governance processes that embeds the diversity of perceptions in transformations toward sustainability (Chan et al., 2012; Larson et al., 2013; Jacobs et al., 2016). The driving rationale

is that integrating peoples' values and perceptions into planning may allow for the build-up of more effective and compatible science-policy exchange, by matching the multiplicity of uses by different actors with the maintenance of ES through more equitable processes and outcomes (Larson et al., 2013).

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

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

## Transforming Coastal-Marine Social-Ecological Systems

The accelerating crisis in common pool environmental resources worldwide has impelled recent scholarship to understand and inspire the achievement of lasting change in the way SES are organized (Gunderson and Holling, 2002; Folke et al., 2010;

Patterson et al., 2017). More now than ever in human history, transformative change is urgently needed in how people and institutions interact with coastal systems (Glaser et al., 2012). In the context of our research, we highlight the pressing challenge for rapid shifts in how coastal and marine governance evolves, toward regimes that can deliver more socially and ecologically coherent outcomes (Young, 2010; Westley et al., 2011, 2013). The inception (step-zero) of radically novel area-based interventions is one of the most critical challenges of any given coastal-marine SES trajectory (Chuenpagdee et al., 2013).

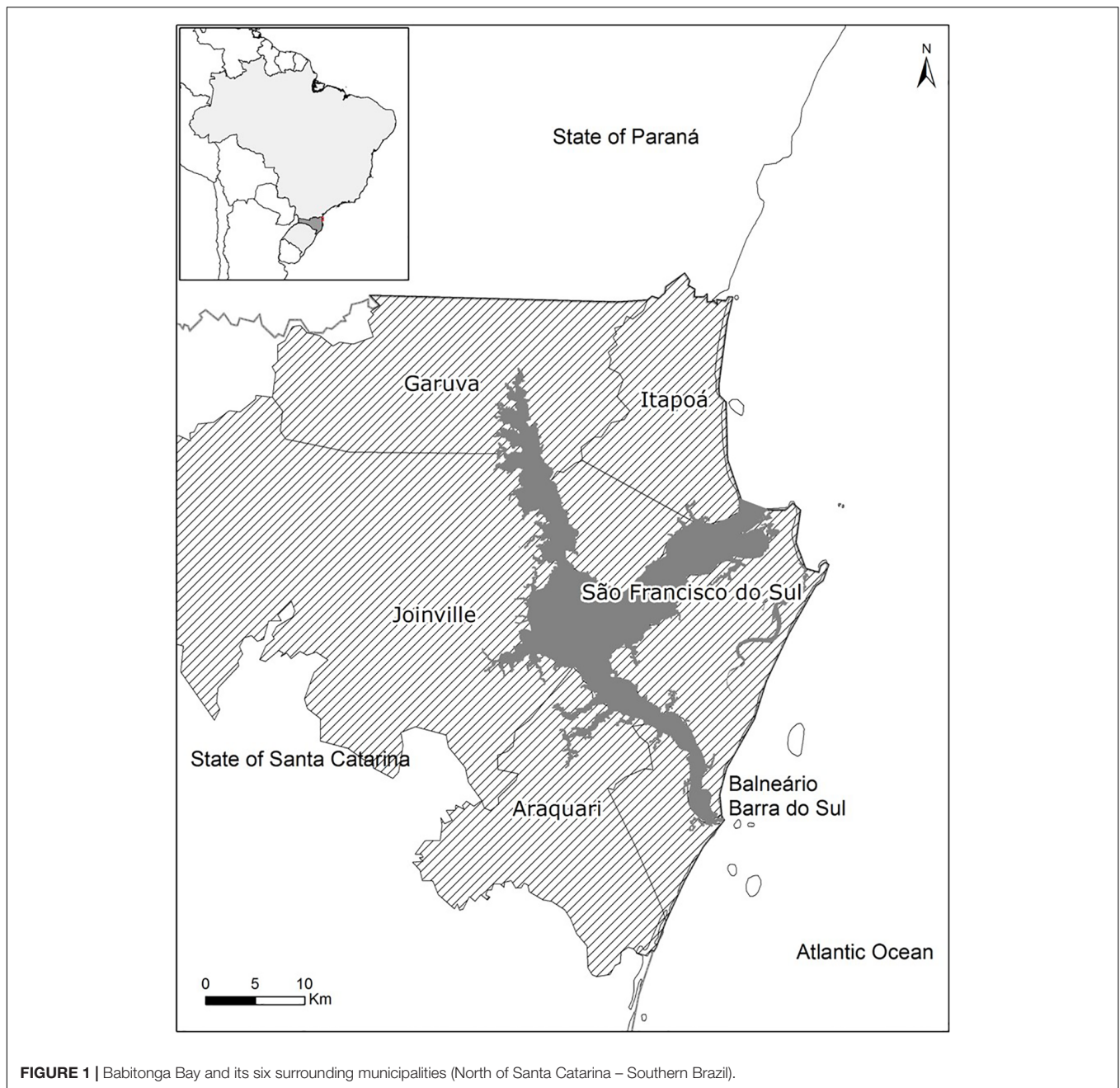
For instance, most countries have developed national marine protected areas (MPAs) frameworks to promote a range of area-based marine management objectives including spatially and temporally sustainable resource management. Given that only about 3% of all oceans are governed by MPAs, a real big challenge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

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

## MATERIALS AND METHODS

### Driving Social-Ecological Transformations in Babitonga Bay

Babitonga Bay is on the northern coast of the state of Santa Catarina (Brazil). It is surrounded by six coastal municipalities (Figure 1) and includes the largest metropolitan region of the state, around the city of Joinville (about one million inhabitants).



The estuarine system has an area 1400 km<sup>2</sup>, and the largest mangrove area in southern Brazil, with 130 km<sup>2</sup> (Barros et al., 2008), or 75% of the state mangrove cover (MMA, 2002). This estuary connects to the ocean through one channel with an extension of 1.7 km, and also comprises sandy beaches, 83 islands, stone slabs, and sand banks (Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis [IBAMA], 1998).

The ecological functions of Babitonga Bay allow the survival of several species, temporary (migrant) or resident, including 28 endangered or particularly valued commercial fishes (Gerhardinger et al., 2006; Gerhardinger et al., in press) and the critically endangered porpoise (*Pontoporia blainvillei*;

Cremer and Simões-Lopes, 2005). The Bay houses diverse activities, such as agriculture, tourism and leisure, mariculture, fisheries, and port and industrial activities (Barros et al., 2008). Due to the urbanization, port activities, and the discharge of untreated sewage, some areas are highly polluted and contaminated by fecal sterols (Martins et al., 2014) and organic matter (Barros et al., 2010). Both inner and outer-bay coastal seascapes are used by over 1,700 fishers from the six surrounding municipalities. Other direct users are related to two ports, two sand mining companies, mariculture (aquaculture parks), and tourism and leisure operators, including marinas. The sharing of the area by different users generates pressures and



conflicts on the ecosystem. The power asymmetry and the fragility of over a handful of ongoing environmental licensing processes of large coastal infrastructure (e.g. new ports) offers a “. . . *perfect atmosphere for political speculation and unethical bargaining* [of territorial rights] . . . *and proliferation of fallacious information* . . .”, also reflecting the lack of integration of local actors’ perceptions toward a more equitable development scenario (Gerhardinger et al., 2018a).

Since 2015, collaborative activities have been developed in coastal cities around Babitonga Bay through a growing network of over 60 organizations involved in socio-environmental projects, mobilizing direct and indirect resource users, governmental and NGOs into a novel coastal governance architecture for the area (Gerhardinger et al., 2018b). Gerhardinger et al. (2018b) have recently analyzed the Babitonga Bay SES trajectory, suggesting that recent interventions have put the SES on the move toward transformation, i.e. tipping the SES to a “hazy-to-transparent” phase of the SES following Westley’s et al. (2013) theory of transformative agency (TAT). Even though a comprehensive toolbox for integrated coastal management policies were already available to local decision-makers, before the project started, the SES was suffering with the ruling of a largely fragmented and sectoral governing approach reported above.

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

## Selection of Participants

Research co-design started in June 2015 with a workshop with researchers, representatives of national and municipal public agencies (Instituto Chico Mendes de Conservação da Biodiversidade – ICMBio, Instituto Brasileiro do Meio Ambiente e Recursos Naturais – IBAMA, local governments) and socio-environmental organizations. Through this workshop, engagement with five groups of direct ecosystem users were deliberately prioritized: artisanal fishers, mariculture agents (oyster and mussel cultivation), aquatic transport agents (representatives from the port, collective maritime transportation companies, barge, and petroleum transportation companies), miners and, tourism and leisure agents (marinas, passenger boats, owners of sports fishing boats).

The strategies for selection of workshop participants sought to guarantee representativeness of groups and varied according to number of people/institutions in each group, in each of the six municipalities surrounding Babitonga Bay (see **Supplementary Appendix S1**, with the detailed description of group selection and mobilization).

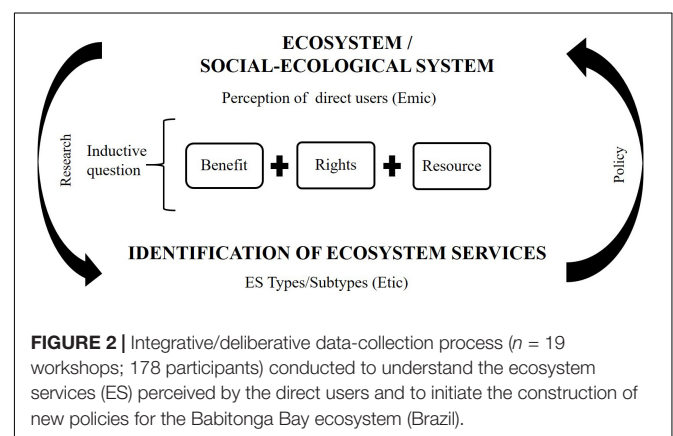
## Data Collection

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

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

## Data Analysis

Our analysis sought to contrast local classificatory systems (emic: the perspective of investigated social groups/informants) with scientific knowledge (etic: perspective of researchers) (Posey, 1987), thus transforming and encoding popular knowledge about the environment based on scientific theories, into



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

ongoing decision-making processes. Therefore, we contrast local knowledge with the Millennium Ecosystem Assessment concept of ES as “*benefits obtained from the environment by humans*” (Millennium Ecosystem Assessment [MEA], 2005); and the four basic types of ES (provisioning, regulating, supporting, and cultural). All citations recorded during participatory workshops were systematized, categorized and counted as responses to benefit, access right or resource. We standardized citations, coding them into groups of similar meanings. For example, *bathing* and *swimming* were considered swimming; *employment* and *work* as employment; *fun* and *outings* as leisure; *forest* and *bush* as vegetation. During the coding process, we acknowledged that the MEA’s framework did not fully accommodate the diversity of human-environment relationships (see also Wallace, 2007; Oliveira and Berkes, 2014). Kenter et al. (2016) notes that straight classification of cultural ES as benefits is often problematic (i.e. they can be intangible, experiential, and identity-based or idiosyncratic), raising particular axiological and ontological issues that calls for deliberative and non-monetary valuation approaches. Therefore, we adapted Raymond et al. (2009) refinement of the Posey (1987) typology; hence, when accessing emic perceptions, we used a “people’s” services subtype within Cultural ESs that enabled the full consideration of the local ecological knowledge of the users, about the services they report from the ecosystem. People’s ES are considered here as cultural benefits derived from human agency. They refer to values and threats to the ecosystem, as informed by workshop attendants, but not straightforwardly falling in the conventional ES Cultural category. Thus, our dataset was coded in the following types of ES: provisioning, regulating, supporting, cultural, and cultural/people’s as a special type of cultural ES (Table 1).

## RESULTS

The 19 workshops with direct Babitonga Ecosystem users and researchers mobilized 178 participants (see **Supplementary Appendix S1**). We obtained a total of 285 ES citations (average of 15 citations per workshop), 210 were in response to the word Benefit (Average = 11/workshop), 57 in response to Access Rights (Average = 3/workshop), and 18 elicited by the word Resource (Average = 0.95/workshop).

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

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

We identified a total of 31 ES subtypes, including: Regulating = 3; Supporting = 3; Provisioning = 5; Cultural = 20; Cultural/People’s = 9 (Table 2). During the ES type and

**TABLE 1** | Definitions of types of ecosystem services used in this article, adapted from Raymond et al. (2009) and Costanza et al. (2017).

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

subtype assignment process, we took several steps to harmonize classifications with overlapping meaning and avoid typological misrepresentations in further analysis. Therefore, ten citations were disregarded because they were similar to others mentioned under different inductive stimuli. We removed citations such as “quality of life” ( $n = 7$ ), “well-being” ( $n = 1$ ) and “health” ( $n = 2$ ) in response to inductions with the word “benefit” ( $n = 8$ ) and “access rights” ( $n = 2$ ), because they resulted from the combination of subsets of benefits pertaining to all categories. Citations could be assigned to two types of ES, for example, mariculture and agriculture were classified as a provisioning in the food subtype and in “*People*” as a source of income, for producing food from man-made production and cultivation structures rather than simply extracting what is produced in nature.

We obtained a total of 317 classifications (the 270 citations plus 52 citations that were assigned to more than one subtypes). Among the 31 subtypes, eight presented only one citation (Table 2).

Cultural and cultural/people (62% of all classifications) and provisioning (29%) were the most cited types of ES overall. The former was the most frequent type to all but fishers who cited more provisioning ESs (Figure 3). Regulating and supporting services accounted for the lowest numbers of classifications. They were seldom referred by direct users other than by researchers,

**TABLE 2** | Structure of Ecosystem Services classification profiles by direct resource users (N = number of workshops) of Babitonga Bay (Santa Catarina, Brazil).

| Ecosystem service type                                 | Ecosystem service subtype                    | Researchers<br>N = 1 | Fishers<br>N = 9 | Mariculture<br>N = 1 | Tourism and leisure<br>N = 5 | Mining<br>N = 2 | Aquatic transport<br>N = 1 |
|--|--|----------------------|------------------|----------------------|------------------------------|-----------------|----------------------------|
| Supporting   | 1. Maintenance of life cycle                 | 3                    | 0.7              | 1                    | 0.2                          | 0.5             |                            |
|  | 2. Maintenance of genetic diversity          | 1                    | 0.1              |                      | 0.6                          |                 |                            |
|  | 3. Nutrient cycling                          | 1                    |                  |                      |                              |                 |                            |
| Regulating   | 4. Air quality                               | 1                    | 0.2              |                      | 0.2                          | 0.5             |                            |
|  | 5. Climate regulation                        | 1                    |                  |                      |                              |                 |                            |
| Provisioning   | 6. Regulation of erosion                     |                      |                  |                      |                              | 0.5             |                            |
|  | 7. Food                                      | 3                    | 5                | 2                    | 1                            | 1               | 1                          |
|  | 8. Genetic resources                         | 2                    | 5                | 1                    | 0.6                          |                 |                            |
|  | 9. Water                                     | 1                    | 0.1              | 1                    | 0.4                          | 0.5             |                            |
|  | 10. Mineral resources                        | 1                    | 0.2              |                      |                              | 1.5             |                            |
| Cultural   | 11. Geomorphologic resources                 |                      |                  |                      |                              |                 | 1                          |
|  | 12. Leisure and tourism                      | 3                    | 0.9              | 3                    | 2.4                          | 3.5             | 2                          |
|  | 13. Cultural and historical patrimony        | 3                    | 0.7              | 1                    | 0.4                          | 1               |                            |
|  | 14. Legacy and existence                     |                      | 0.4              | 2                    | 1.2                          | 0.5             |                            |
|  | 15. Aesthetic, inspiration and contemplation | 2                    | 0.7              |                      | 0.6                          | 1               |                            |
|  | 16. Sense of place                           | 1                    | 0.6              |                      | 0.2                          | 0.5             |                            |
|  | 17. Education and knowledge system           |                      |                  |                      | 0.2                          |                 | 1                          |
|  | 18. Livelihood                               |                      | 0.1              |                      | 0.4                          |                 | 1                          |
|  | 19. Social relations                         | 1                    |                  |                      | 0.2                          |                 | 1                          |
|  | 20. Communication and information            | 1                    | 0.1              |                      | 0.2                          |                 |                            |
|  | 21. Hunting                                  |                      |                  |                      |                              | 0.5             |                            |
| Cultural/People's                                      | 22. Spirituality                             |                      | 0.1              |                      |                              |                 |                            |
|  | 23. Economic viability                       | 2                    | 5.2              | 3                    | 0.6                          | 1               | 1                          |
|  | 24. Infrastructure and logistics             | 3                    | 0.8              | 2                    | 2.6                          | 1.5             | 2                          |
|  | 25. Assistentialism                          |                      | 0.7              |                      |                              |                 |                            |
|  | 26. Planning                                 |                      | 0.2              |                      | 0.8                          |                 |                            |
|  | 27. Strategic geographic position            |                      |                  |                      | 0.2                          |                 | 2                          |
|  | 28. Supporting institution and legislation   |                      | 0.1              |                      |                              | 1.5             |                            |
|  | 29. Financing                                |                      | 0.2              |                      |                              |                 |                            |
|  | 30. Opportunity                              |                      | 0.1              |                      |                              |                 |                            |
|  | 31. Politics                                 |                      |                  |                      | 0.2                          |                 |                            |
| Grayscale of average number of citations per workshop: |  | [0 - 0,5]            | [0,5 - 1]        | [1 - 1,5]            | [1,5 - 2,5]                  | [2,5 - 3,5]     | >3,5                       |

who mentioned several of such types as important ESs. Aquatic transport agents did not refer to any regulating and supporting ES, while mariculture agents did not mention regulating services.

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

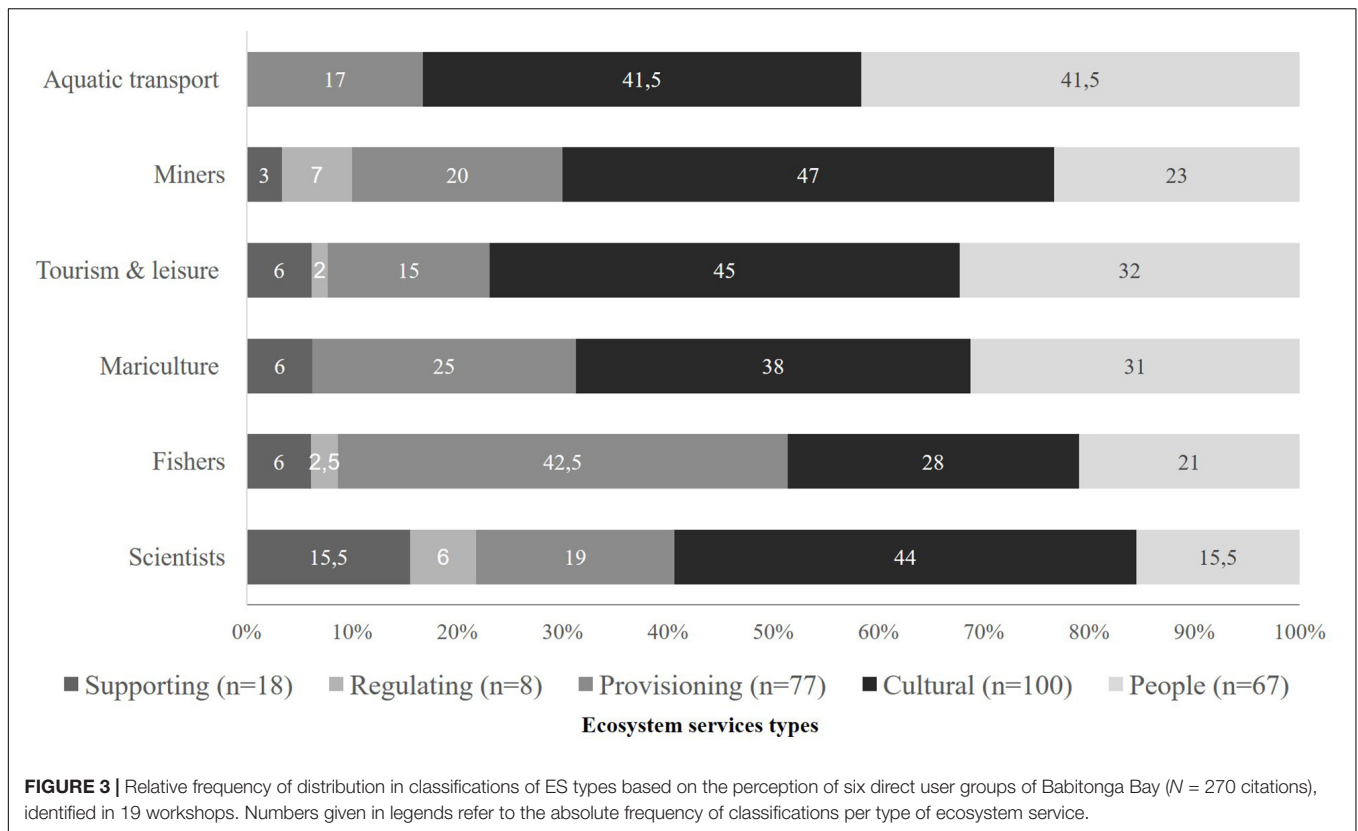
In terms of number of ES subtypes classifications, fishers and tourism and leisure agents cited a larger array of services (22 and 20 subtypes, respectively), followed by researchers and miners (17 and 15 subtypes). Mariculture and aquatic transport agents displayed a narrower ES subtype classification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

Fishers were the user group citing more provisioning services of food (subtype 7;  $n = 58$ ) and genetic resources (subtype 8;  $n = 55$ ), i.e. they cited many species names for fish, mollusks, and bivalves perceived as benefits from the Babitonga

ecosystem. The group of researchers identified services across the range of ES types used in the analysis. Tourism and leisure agents are characterized by a greater reference to ES belonging to cultural subtypes leisure and tourism (subtype 12), legacy and existence (subtype 14), esthetic inspiration and contemplation (subtype 15).

Several ES subtypes are not shared amongst user groups, because they were cited by only a particular user group (**Table 2**). For example, nutrient cycling and climate regulation were cited only by researchers; aquatic transport agents were the only citing a geomorphological resource; miners were the only citing regulation of erosion and hunting; fishers were the only citing spirituality, assistentialism, and funding opportunities and; tourism and leisure agents were the only citing politics as a service obtained from their ecosystem.

On the other hand, our informants perceived several shared services. For instance, food (provisioning), tourism and leisure (cultural), economic viability (e.g. employment, work, and income) and infrastructure/logistics (e.g. transport, vessels, ports, and navigation) (both cultural/people ESs) are shared values by



all user groups. Interestingly, three ES subtypes (maintenance of life cycle; water quality and; cultural and historical patrimony) were mentioned by all user groups, with the exception of aquatic transport agents which were also the only group not citing any supporting nor regulating services.

## DISCUSSION

### Mapping Patterns in Ecosystem Service Perception Profiles

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

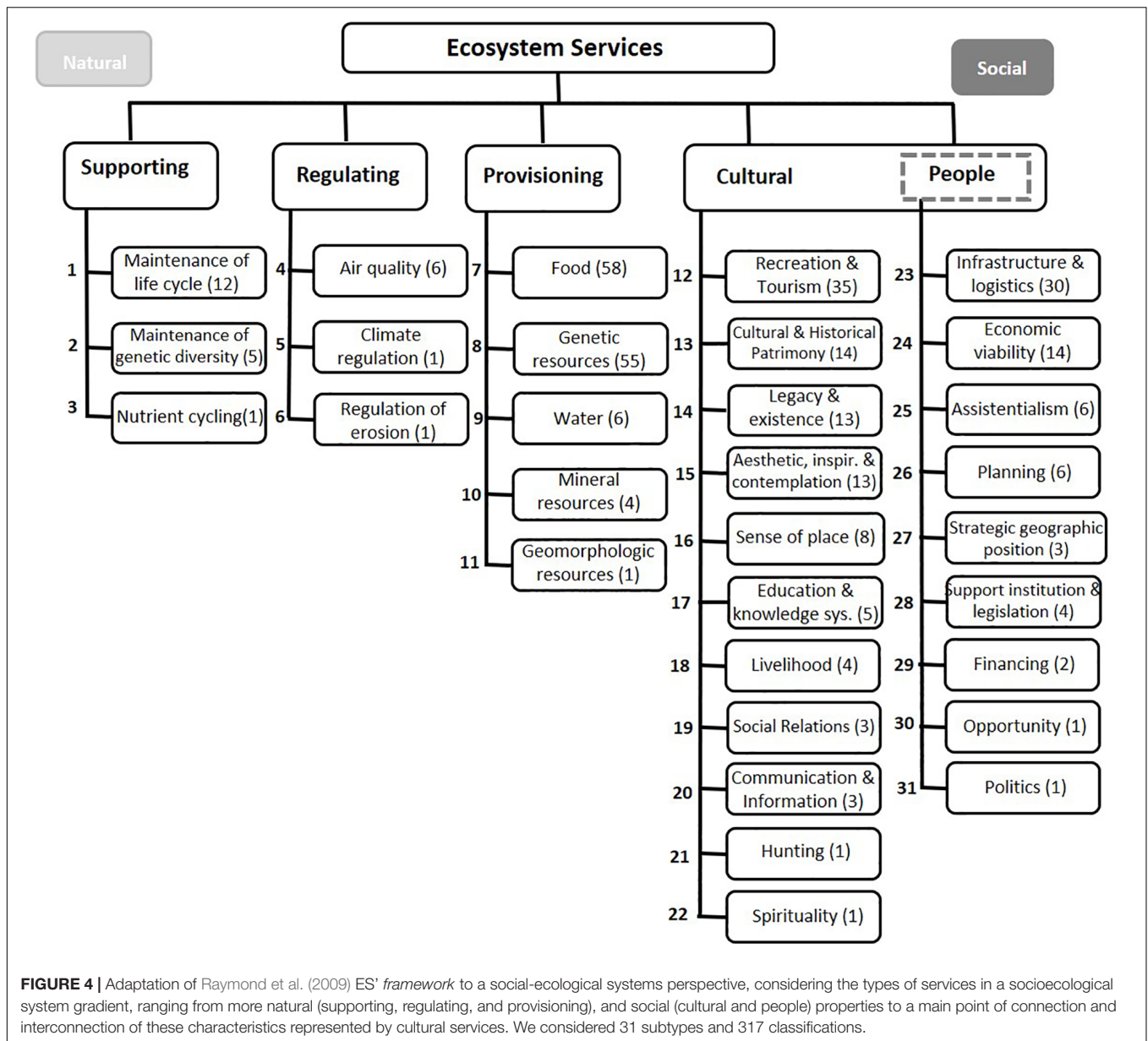
The ES subtypes we recorded derive from human interactions within the Babitonga Bay environment, where users create and use tools in a cosmological relationship with the natural, non-human components of this ecosystem. Daily cultural practice shapes environmental spaces and are in turn enabled by them generating cultural goods, this whole process enabling cultural ecosystem benefits (Fish et al., 2016). Recent research highlights the importance of cultural services in relation to other ES types (Chan et al., 2012) – since all citizens use and benefit from cultural services, regardless of their economic activity, i.e. leisure,

contemplation of the landscape, sense of place, and cultural traditions are largely available to all people, independent of their economic activity.

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

Regulating and supporting services were the least mentioned in our study, a pattern also found in other ES perception studies (Raymond et al., 2009; Casado-Arzuaga et al., 2013; McNally et al., 2016). These, ESs were not at all mentioned by





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

Indeed, Oliveira and Berkes (2014) showed that fishers in Rio de Janeiro do not perceive regulating and supporting services as benefits, but rather as a natural environmental condition.

Similarly, it is more evident for people to cite access to clean water as a benefit, than the cleaning process it goes through (Fisher et al., 2009). Therefore, we suggest that such services could be accessed by explicitly probing questions related to specified processes such as climate change (amount of rainfall, drought), water dynamics and flow, role of the mangroves in the ecosystem, and role of different environments in generating life.

Nevertheless, inferences may still be advanced on the variance and similarities amongst ES perception profiles. For instance, we suggest that ESs subtypes cited by only a particular user group, offers an identity marker that differentiate that group and are derived from peculiarities of ES that may define the socioeconomic activity itself. For example, only researchers, who are generally aware of ES and sustainability discussions, referred to nutrient cycling and climate regulation. Similarly, only aquatic

transport agents cited the natural depth of channel as ESs because of their dependence on navigation channels to operate large ships. Fishers were the only group concerned with spirituality probably as a reflection of their intimate, direct relationship with the aquatic world.

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

## Implications to Coastal-Marine Ecosystem Service Assessments

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

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

This study did not adopt the conventional bidirectional model where ecosystem properties or functions and provisioning services are on the supply-side, while sociocultural or social system domain on a demand-side (see Costanza and Folke, 1997; Martín-López et al., 2013; Felipe-Lucia et al., 2015). Our results enacts a conceptual model that regards humans as an integral part of the ecosystem, and not simply an outside force enjoying services produced by nature (Figure 5). We thus offer a co-evolutionary gradient from ecosystem processes less-to-more human-agency dominated types of services (following the notion that boundaries between SES are artificial and arbitrary- Berkes and Folke, 1998). We do consider that supporting and regulating services are associated to the biophysical domain, similar to

Martín-López et al. (2013), since they exist independently of the human presence in the ecosystem and are basic foundations for the entire natural system. However, our approach differs from the above authors whom placed humans separate to the “ecosystem.”

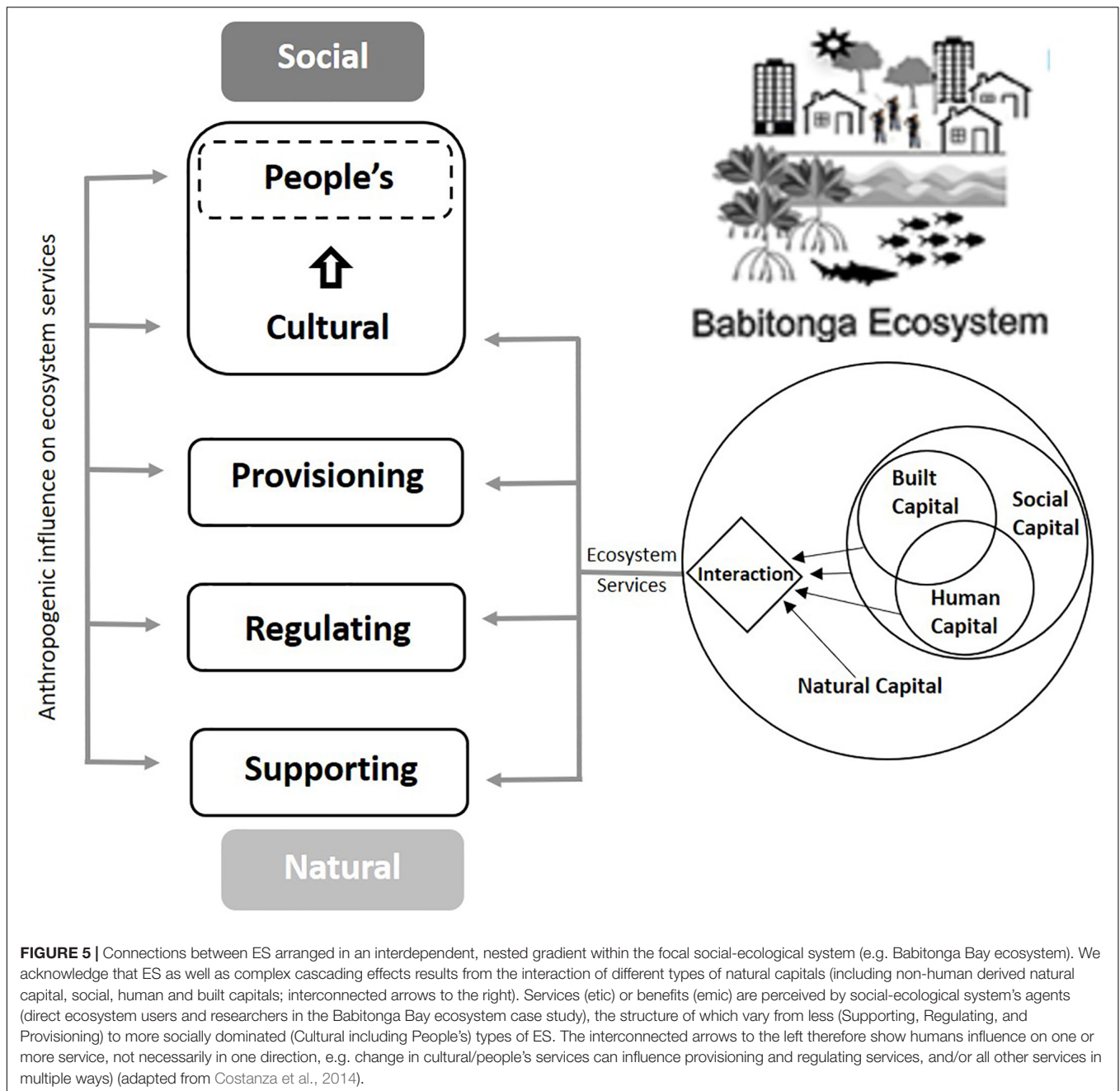
Our model also highlights the existence of feedbacks and trade-offs across the spectrum of ESs rendering further complexity to ES assessments. For instance, the socioeconomic significance of benefits and the meaning people place on the services may have diverse underlying relationships (Oliveira and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

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

## Implications to Coastal-Marine Ecosystem-Based Policymaking

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

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



process). Our paper describes actors' ES perception diversity, and the implications for developing a territorially bonded "shared values" discourse and practice process. One that is inclusive of ecosystem actors' unique identities and potential contributions, but also embracing a more holistic and inter-dependent view of the ecosystem and its component parts. We noted that perceptions on ES varies according to one's cultural background and, therefore, there is a constant risk of falling into models that privileges the mindsets of those (usually more powerful) humans involved in decision-making. Hence the need to remain watchful and discerning, because power ultimately influences the allocation of and degree to which individuals and groups

may be capable of accessing ESs (Felipe-Lucia et al., 2015). Enacting the perceptions of different actors' through deliberative approaches can, therefore, help deepen societal understanding of ecosystem (including cultural) services and steer more equitable management processes (Otero et al., 2013).

Secondly, integrated valuation should (ii) combine methods, disciplines and approaches to enable understanding and thus hopefully increase mutual capacity, ownership, trust, and long-term success. We suggest that the integrative nature of ES assessments approaches calls deliberative methods, because integration will most effectively emerge naturally through the realization of the place and role of each other actor group in the

future making of the SES. Our ES perception profiles may become a valuable social learning tool because they help contextualize the interplay between ecological knowledge and power in policy making turning the realization of these relationships more explicit in deliberative processes. For instance, some patterns across the spectrum of ES perception profiles, when brought to the table and discussed by resource users, will be seen as proxies of potential conflicts or divergence of expectations in terms of future visions for the SES.

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

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

Paramount to our on-going transformation is for research-action projects to continue creating room for a more diverse ES perception base to confront current dominant views of Babitonga’s vocation for ports. Envisioning a more diverse identity for this SES where all ecosystem actors can prosper is perhaps the key desirable idea to inspire future social learning. For instance, empowering less powerful and hence represented

groups in territorial development policies, such as fishers, mariculture, tourism and leisure agents, should be regarded as priority targets by external agents willing to support their collective action and political organization. Given the lack of socio-political organization these groups are known for locally, strategies such as citizen-science and self-monitoring the health and productivity of the aquatic environment seems to be good starting points – to connect their experiential knowledge of the aquatic ecosystem through evidence-based agendas will enact their authority in the operations of new knowledge-building, problem-solving and decision-making stances (such as the emerging PBG multi-stakeholder platform). This is where an important aggregate of shared values discourse made explicit through our results meets practice, with the potential to frame the terms for future ecologic-economic zoning discussions in Babitonga Bay.

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

## CONCLUSION

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

Our paper also reinforces the importance of cultural services, because regardless of the economic activity performed, every citizen benefit from them even though they are rarely properly valued and considered in management and development.



The overvaluing of a specific subset of ES, usually associated with the interests of a smaller and more empowered social group, is among the main causes of civilizational crises. ES studies thus have the noble and challenging role of imbuing collaborative and integrated strategies of territorial planning with greater distributional justice. This could be achieved through valuation strategies capable of building alternative visions for sustainability that are based on values that are shared amongst actors, but also sensitive to the identities of more vulnerable stakeholders.

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

## ETHICS STATEMENT

This research was approved by the Ethics Committee of Federal University of Santa Catarina (CAAE 42938115.1.0000.0118).

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## AUTHOR CONTRIBUTIONS

DH, LG, and NH designed workshop methodology and wrote the manuscript. DH and LG performed the workshops. DH analyzed the datas.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2020.00083/full#supplementary-material>

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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