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Human dimensions of marine protected areas and small-scale fisheries management: A review of the interpretations

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A B S T R A C T

Scientists and managers increasingly recognize the need to address the human dimensions (HD) of planning and managing marine systems, but it remains unclear what these dimensions entail. This paper presents an analysis of the state of the art of interpretations and uses of the term HD in the context of marine protected areas (MPA) and small-scale fisheries (SSF). Based on previously established descriptors, including the coexistence of MPAs and SSFs, we conduct a literature review of 92 peer-reviewed papers. Thirty-five components of HD are categorized into five categories: governance, economic, cultural, political and social. Despite multiple interpretations, the notion of HD has a specific meaning that involves attitudes, perceptions, beliefs and preferences and indicates different human uses and compliance (or lack of compliance) with conservation rules. We find that the number of papers published per year has generally been increasing, and most papers are found in journals related to natural sciences. The low incidence of these studies in human and social science journals may generate an imbalance since themes such as gender or poverty, are scarce. Overly narrow conceptions can create blind spots that reinforce command and control approaches despite the emergence of holistic approaches. Despite the inevitable overlap among some themes, these 35 components of HD can be used as variables and as a starting point to guide managers and researchers. A precise definition of HD and its components can also support the embodiment of international guidelines, policies and management regulations into decision-making arenas and management tools.

1. Introduction

Small-scale fisheries (SSF) and marine protected areas (MPA) management have recently begun a transition towards more inclusive and broader approaches. Such transition derived from the criticism of the overcentralized [1] and biologically driven conventional management [2–4]; negative social impacts [5], and low local level support [6]; institutional failures and ineffective management [3,7–9]. On the other hand, the recent approaches include taking a more comprehensive and interdisciplinary approach [10], being ecosystem-based [11–13], and encompassing human dimensions [14–16]. Contributions arise from efforts to understand aspects such as changes in ecosystems [17], the social impacts of conservation and resource management [18,19], human well-being [20], and the performance of fisheries and governance of marine protected areas (MPAs) [21–25]. According to Liu et al. [26], significant advances also come from the increasing recognition of the complex nature of the coupled human and social systems linked through space and time.

Despite requirements for a more integrated approach, natural sciences and bioeconomic models [27,28] are the prevailing scientific background of resource management and conservation [16,29–31]. The primary focus remains the ecological outcomes and advantages for biological recovery [16,32,33]. However, this focus misrepresents several social issues related to natural resource management, such as environmental injustices, the loss of cultural identity, and the erosion of customary governance systems [34,35], and, ultimately, human rights [36]. Consequently, conflicts tend to increase when human and social dimensions are poorly addressed [26,37,38].

The intersection of natural and social sciences for marine resource management has been portrayed in the literature with a variety of broad terms that include, but are not limited to, the environmental social sciences [39–41], conservation social science [14] and the human dimensions of fisheries and marine protected areas [42–44]. Despite some similarities and differences in their epistemologies, concepts, definitions, and applications, the literature highlights the insufficient presence and contribution of the social sciences, which could provide a better understanding and evaluation of the performance of marine resource management and governance. Additionally, the commons theory [45,

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46] and the social-ecological systems perspective [47] provide important insights into the necessity of social sciences and human dimensions to foster robust resource management.

The use of "human dimensions" (HD) as an overarching term to encompass aspects of the human and social systems is recent. Explorations of the term came from debates on climate change [48], wildlife management [49,50], bycatch management [51], and MPAs and small-scale fisheries (SSFs) [21,34,52,53]. The creation of the International Human Dimensions Program on Global Environmental Change (IHDP) in 1996 was a milestone for the consolidation of HD research. The developments defining and implementing ecosystem management approaches gradually included HD [14,42,54].

The emergence of ecosystem approaches has played an important role in uncovering HD [55]. Szaro et al. [56] refer to HD as essential information for the ecosystem approach, which provides a comprehensive, integrated understanding of the environment. An approach or strategy based on HD values integrative, interdisciplinary, and participatory management through a better balance between human and ecological factors [42,57–60]. Additionally, international agreements such as the UN Convention on Biological Diversity and the UN/FAO Code of Conduct for Responsible Fisheries made the ecosystem approach the "key vehicle" for developing and improving fisheries and MPAs and for biodiversity management [44]. "The Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication" [57] and the "Sustainable Development Goals" [61] emphasized the need to address gender issues, social justice, poverty, and food security as primary objectives in promoting sustainability.

The use of HD has become fashionable in the literature. As a consequence, according to Spalding et al. [62], inaccuracy in the study of HD occurs, leading to "less imaginative and less important (work) than it should or could be." There are many varied and even divergent interpretations of the term [15,16,63,64]. The more meanings added, the more blurred the picture becomes. The literature typically revolves around cultural, economic, institutional, political, and social aspects, which signals the need for a concise interpretation. Bennet et al. [14] refer to HD as a bridging term across disciplines with a varied audience, including non-specialists in the field of social sciences.

To better understand the HD of marine and coastal conservation systems, some authors have analyzed their components [15,16,63,64]. Sowman et al. [65] provided an initial description and guidelines for HD categories and components. However, the literature still lacks a well-defined category of HD. The increasing use of HD in political arenas also highlights the concern for a more precise definition of HD and its primary components. Thereby, if HD will be the umbrella category for social and human issues, precision is required in order to allow for evaluating its implementation and performance.

Acknowledging that the term HD carries distinct meanings and is informed by different disciplines such as ecology and social sciences, we conducted a review of the literature to describe the state of the art of HD within MPAs and SSFs. We focused on defining where and when the term HD is used, who is using it, and definitions in use. Finally, we provide an analytical framework to define better, understand, and effectively apply the interpretations of HD in the context of MPAs and SSFs.

The contexts of MPAs and SSFs are interlaced. The degree of overlap between these two different governance streams (i.e., conservation and fisheries) has increased because neither can achieve its objectives alone [66–68]. We aim to increase understanding of the use and interpretation of HD in MPAs and SSFs for several reasons [14,69,70]. First, MPAs are considered one of the most well-accepted management tools in oceans governance as well as a governance framework [34,71]. Second, criticism of the implementation of MPAs highlights a lack of concern for different HD [72]. Third, fisheries and MPA management are commonly considered together [52]. MPAs have also been recognized as a tool in fisheries management [66,67].

We focused on SSFs and consequently omitted commercial and industrial fisheries from the search parameters. The discussion of HD is typical of SSFs and subsistence fishing villages and is the core of the current international guidelines to secure rights for minority people. We assume that the sustainability of SSFs is part of the so-called primary fisheries management. Fostering social and ecological resilience and promoting food security and poverty reduction for communities are minimum requirements [7]. Addressing HD components, such as gender and cultural values properly, is a priority from a primary fisheries management perspective. The literature on MPAs and SSFs notes that social factors, not ecological or physical factors, are the primary determinants of conservation success [21,32,73,74]. Furthermore, the coexistence of MPAs and SSFs is a dilemma that needs to be studied and analyzed [68].

We consider a more precise description of HD would provide a framework to better evaluate the extent of HD uptake in the context of SSFs and MPAs research and policy. It can also provide guidance on how to embody international guidelines, policies, and management regulations into the decision-making arenas and management tools. The paper begins with an overview of the methods, followed by the results and discussion. We briefly discuss the influences and effects of the expansion of the interpretations on HD across the conservation agenda and why and how this term came to the forefront. Finally, we conclude by advocating for a richer conception of HD that is predicated on the broader intellectual engagement of different academic disciplines.

2. Methodology

The literature review was conducted based on a four-stage process previously tested in other studies [75–77]: (1) elaboration of questions to guide the review; (2) definition of the search protocol (databases and search words); (3) article selection based on predetermined criteria; and (4) analysis and synthesis of the remaining literature. The review consisted of examining a body of literature based on *a priori* criteria, specific objectives and transparent sampling.

In the first stage, after defining the objectives and guiding questions (Fig. 1), we researched the Scopus and Web of Science (WoS) databases due to their representation of journals concerning environmental management, governance and natural and social sciences.

The search words that outlined the analytical approach included descriptors and synonyms related to marine and coastal protected and conservation areas, small-scale fishing and ecosystem-based approaches to fisheries management (Table S1). We did not examine the authors' definitions or criteria for defining SSFs. Despite possible bias, we did not apply any exclusion criteria based on the definition and scale of SSFs. We acknowledge that by adopting this perspective, potential HD may be misrepresented, especially with regard to commercial fisheries. However, our study relied on the descriptions and use of HD in the context of SSFs and MPAs.

We searched for the term "human dimension" and its singular form. The descriptor may have omitted relevant publications concerning human and social aspects of coastal and marine management. However, for the purpose of this research, the explicit use of the human dimension was essential to explore its interpretations.

In the third stage, we selected only peer-reviewed articles as a way to reduce bias and ensure the quality of the data. We did not apply any temporal search boundaries to cover all the existing literature. Our research protocol resulted in 95 and 84 articles in the WoS and Scopus databases, respectively. After removing duplicates (n = 73) and non-peer-reviewed articles (n = 14), the final sample consisted of 92 articles (Table S2).

In the final stage (4), we organized the remaining literature (n = 92) using the software QSR NVivo 11 (Mac Platform) for qualitative analysis. In the first phase, we classified data according to the date of publication, publishing journal, Journal of Citation Reports (JCR) subject categories, type of research, case study location, academic background of the authors (when given) and implicit or explicit use of the term HD.

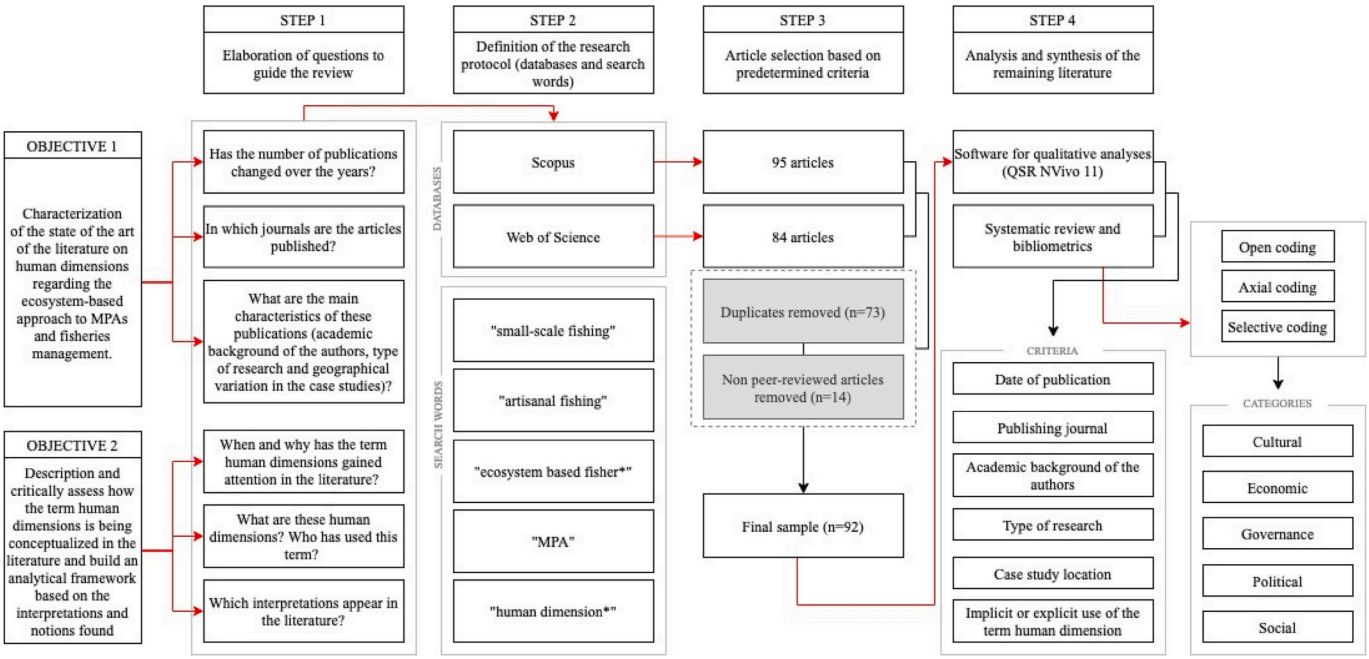

Fig. 1. Flowchart of study objectives and key analytical considerations of data processing. All the searched words can be found in Table S1 in the Supplementary Data section.

Regarding the type of research, we categorized papers as empirical (articles that involved the collection of primary data), theoretical with case studies (articles that did not report methods of data gathering and analysis), or exclusively theoretical and syntheses (articles that presented a broader view of special issues published by journals).

We identified the academic background of the first, second and last authors for each paper based on their highest degree (doctorate or master's). We grouped authors' academic backgrounds into three categories: natural sciences, social sciences, or interdisciplinary sciences. We classified authors' degrees into disciplines such as biology, zoology, marine sciences, fisheries, and ecology as natural sciences (e.g., an author with a PhD in statistics fit into the natural sciences category). We classified as social sciences the non-natural science branches of study that include anthropology, sociology, politics, arts & humanities, law, economics and philosophy. Under interdisciplinary sciences we grouped sustainability science [78], academic degrees in multidisciplinary programs (environmental studies and natural resources management) and disciplines such as geography and agroecology.

We collected data on authors' degrees from the websites of research institutions and professional résumés available online, including professional networks for scientists and researchers such as ResearchGate. When this information was not available, we requested it directly from the authors via email. For the analyses that included the authors' background as a variable, seven of the 238 authors were dismissed due to a lack of information, for a total n = 231. A focus solely on the highest degree may have narrowed our understanding of the authors' contribution to the field. However, our analysis was limited to describing which professionals (based on their formal background) were using and describing the HD of MPA and SSFs.

After reading all the sampled papers, we first coded the data to fit Sowman's [65] five broad HD categories: cultural, economic, governance, political and social. Sowman's [65] guidelines also provided a list of HD that we assigned as HD components. To encompass the numerous and varied meanings of HD, when necessary, we adapted and/or created new components.

The second phase of the data analysis chiefly involved descriptive statistics by quantifying the variables considered in this research. Based on the descriptions of HD, we analyzed the data using an empirical (based on the occurrence frequency of the interpretations) and critical approach that sought to establish an author's perspective on the results.

3. Results

3.1. The state of the literature

We examined 92 papers published between 2000 and 2016, of which 51% were published from 2013 (Fig. 2). We assigned four periods to describe the distribution of the number of papers on HD: the "first draft period" (2000–2004 - 5 papers); the "emerging period" (2005–2009 - 12 papers); the "consolidation period" (2010–2013 - 40 papers); and the "policy influence period" (2014–2016 - 35 papers). We determined the

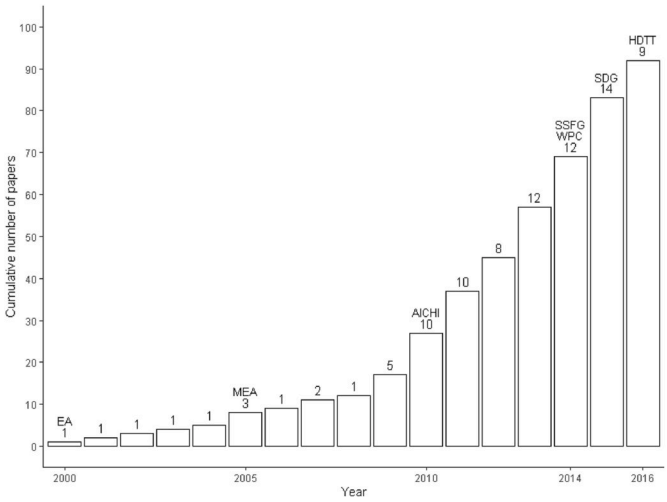

Fig. 2. Cumulative number of papers published per year. EA: ecosystem approach; MEA: Millennium ecosystem assessment; AICHI: Aichi Conservation Goals; WPC: 2014 World Park Congress; SSFG: Small-Scale Fisheries Guidelines; SDG: UN Sustainable Development Goals; HDTT: Human Dimensions Think Tank. Number of papers in each year on top of the bars. Note: research conducted in August 2016.

periods according to global institutional frameworks related to fisheries and MPAs. The last two periods account for 82% (n = 92) of the sampled papers.

Forty-two percent of journals (n = 52) published two or more papers (Fig. S1). JCR attributed twenty-four subject categories to the sampled journals. Seventy-seven percent (n = 97) corresponded to environmental sciences, marine and freshwater biology, biology, ecology, fisheries, environmental studies, oceanography and biodiversity conservation. Environmental sciences represented the most frequent JCR subject category (18%, n = 97), whereas social sciences and the humanities accounted for 11% and were limited to seven journals.

Empirical papers and theoretical papers with case studies were the most frequent (n = 92, 69%); of these, 25 did not report the methods of data collection and analysis. Theoretical papers accounted for 21% of the total, followed by synthesis papers (10%). Forty-five percent (n = 64) of the empirical papers (including the theoretical papers with case studies) included case studies performed in the United States (22%), Chile (18%) and South Africa (5%).

Interdisciplinary sciences were the main background of 46% of the authors (n = 231), whereas natural and social sciences accounted for 37% and 16%, respectively. Papers with interdisciplinary coauthorship, whose authors belonged to at least two areas of study, corresponded to 54% of the published papers.

3.2. The interpretations of HD

The term HD received many different interpretations (see Table 1 for examples). Approximately 61% (n = 92) of the papers did not present an explicit definition of HD. Citation of HD occurred three or fewer times in 52% (n = 92), and HD was mentioned only as a keyword in 15% of the papers.

We allocated thirty-five components of HD into Sowman's [65] five categories (cultural, economic, governance, political and social). We added seven new components and reclassified and adapted the other five and six components for clarity and accuracy of the results. By coding the interpretations of HD in the sampled papers, we designed descriptors to assign the papers to the HD components (Table 2).

Economics and governance were the most frequent categories of HD. Social HD were mentioned least often among the interpretations (Fig. 3). Among the ten most frequent components, six belonged to the governance ("policies and laws", "institutional arrangements", "stakeholder participation") and economic ("costs and benefits", "ecosystem goods and services", "sustainable livelihoods") HD categories. The least frequent components included the social ("gender", "poverty", "employment", "food security"), political ("tenure", "ethics and mores", "funding and investment", "rights to access and manage resources"), cultural ("sense of place and displacement") and governance ("community organization") HD components. The overall most frequent HD components were "history and context" (n = 74), "policies and laws" (n = 71) and "attitudes, perceptions, beliefs, preferences" (n = 68). However, "gender" (n = 4), "ethics and mores", "tenure", "poverty" (n = 15), "employment" (n = 18) were the least-cited HD components.

Table 1
Selected interpretations of human dimensions: explanations of the topics under this term considered by the papers revised. The definitions are presented in chronological order of publication. Check references on Table S2.

Definitions	Source
"It becomes increasingly clear that attention must be given to the human dimension of LMEs[a], represented by the socio-economic and governance modules."	(Juda and Hennessey, 2001)
"Nine specific human dimension elements inherent in the Sea Grant model are described in the context of holistic management of large marine ecosystems: mission congruence; continuity, adaptability, effectiveness, engagement, objectivity, efficiency, regionality and networked organization."	(Baird, 2005)
"This paper explores ten human dimensions that are basic to the acceptance and ultimate success of MPAs: objectives and attitudes, 'entry points' for introducing MPAs, attachment to place, meaningful participation, effective governance, the 'people side' of knowledge, the role of rights, concerns about displacement, MPA costs and benefits, and the bigger picture around MPAs".	(Charles and Wilson, 2009)
"Including other social dimensions, such as community attitudes, beliefs, leadership (…) considering social dimensions in addition to economic cost could make MPAs more locally relevant."	(Ban et al., 2011)
"Subsequently, the role that human decisions and behavior ('human dimensions') play in affecting the outcome of fisheries and MPA management efforts is commonly overlooked."	(Teh and Teh, 2011)
"We define human dimensions as the ways in which individuals, communities, and societies interact with, affect, and are affected by natural ecosystems and environmental change through time."	(Kittinger et al., 2012)
"Social dimensions in aquaculture operations can be difficult to capture, e.g., emotional ownership of the sea/coastal area by local residents/stakeholders and the social and cultural values that drive this ownership."	(Krause et al., 2015)
"Social scientists should help to scope the range of social, political, economic, and institutional processes, meanings, and values relevant to LMPA[b] systems in diverse contexts."	(Gruby et al., 2016)

[a] Large marine ecosystems.
[b] Large marine protected areas.

4. Discussion

4.1. The construction of HD interpretations

The literature reflects diverse and inconsistent interpretations of HD. HD was referred to as a concept, as a set of indicators and parameters, as dimensions of social-ecological systems, or only as a term that encompasses a plurality of disciplines and concepts from social and interdisciplinary sciences in natural resource management. The construction of the interpretations of HD, as an overarching term for all human and social issues, results from both academic and policy arenas. Initial developments of interpretations of HD ("first draft period") were associated with the ecosystem approach and inconsistent mentions in literature. The increase in the number of publications sets the "emerging period". With more direct use, HD consolidated into scientific arenas, reflected on the number of papers published ("consolidation period"). Recent years have led to the recognition and use of HD in several institutional frameworks ("policy influence period") to address SSFs and MPA management and governance.

The "policy influence period" refers to the most prominent period in terms of the average number of publications per year. Furthermore, interpretations of HD peaked with developments from forums and frameworks that highlighted HD in the context of the ecosystem approach and sustainable development (Fig. 2). International conventions and guidelines, such as the "UN/FAO Code of Conduct for Responsible Fisheries", the "UN Sustainable Development Goals", and the "Convention on Biological Diversity", set the pace for the emergence of HD. Also, the need for integrating fisheries and marine protected areas on the conservation agenda resulted in the HD think tank [79] (HDTT, Fig. 2). According to Christie et al. [34], HDTT designed a scope and a shared research agenda (an initial list of guiding questions) for the HD of large MPAs.

The ecosystem approach is the conduit for implementing principles, strategies and actions proposed in these international forums. The policy influence period reflects efforts to develop and implement the ecosystem approach to fisheries and MPAs [15,44]. The ecosystem approach is a strategy for integrating conservation and sustainable use through different definitions: ecosystem management [56], ecosystem-based management [13], and an ecosystem approach [80]. This plethora of definitions applies different considerations of how people are internal or

Table 2
Components of human dimensions described from the literature review. The identified components were arranged based on the human dimensions categories proposed by Sowman [65] and adapted by the authors, and they are ordered according to the number of articles in which the selected component was mentioned at least once. The components created for this study are marked with (*); those reclassified are marked with (^{R}); and those adapted are marked with (^{A}).

HD components	Description of identified components	Articles (n = 92)
Governance		
Policies and laws	Formal and legal rule systems, restrictions, regulatory efforts, legal instruments and legislation.	71
Institutional arrangements	Informal norms, rules in use, values at all levels, rules of the game, social structures, bridging organizations, what is acceptable or forbidden, resource management regimes, common rules, norms and sanctions.	67
Stakeholder participation	Participation, involvement, inclusion, engagement, different perceptions and stakeholder perspectives.	63
Conflicts^{R}	Use and user conflicts, stakeholder conflicts, research conflicts and between users and researchers, conflict resolution mechanisms, conflicts of interest, and conflictive scenario.	54
Enforcement and compliance	Control, surveillance, resistance, opposition, noncompliance, enforcement, accomplishment and execution.	51
Information flow and communication	Information, information exchange, information diffusion, information sharing, communication and dialogue.	40
Community organization	Mobilization and organization of individuals and groups (e.g., collective action, view, self-organization), bottom-up planning, local management and place-based management.	19
Economic		
Costs and benefits^{R}	Trade-offs, cost-effectiveness and positive and negative impacts. These can be between different interests and priorities, between long-term and short-term time horizons and between benefits at one spatial scale and costs at another.	61
Ecosystem goods and services	Resource sustainability, dependence on resources and the support of human well-being (e.g., provisioning, regulating, cultural and supporting services).	60
Sustainable livelihoods	Household subsistence patterns, livelihood strategies and diversification, alternative livelihood and way of life.	55
Income and assets	Revenue, economic development, economic incentives, economic metrics, economic growth, economic loss and loss of a capital asset.	48
Markets, nonmarket value and trade	Market value, nonmarket value, nonuse value: nonconsumptive values (existence/option), aesthetic value (the value of an object as a "work of art"), existence value (the value of knowing the resource exists in a certain condition), option value (the option of being able to use the resource in the future) and bequest value (the value of ensuring the resource will be available for future generations).	46
Social		
Attitudes, perceptions, beliefs and preferences	Human behavior, worldviews, willingness, personal motivations, personal norms, human responses, decisions and choices.	68
Human uses, activities and pressures*	Mapping use patterns, human activities, depletion of resources and human activities as impacts.	58
Well-being*	Material, relational and psychological: safety/security, health and education, satisfaction, recreation, good or bad feelings/relations, freedom, quality of life, basic material needs and psychological dimensions.	47
Goals, needs and aspirations^{A}	Clear objectives and needs that inherently reflect social demands, social priorities, human concerns and societal problems.	47
Demographics*	Group or individual-scale variables (e.g., age, level of education, family size, ethnicity, occupational status, and social class), population density, migrations and number of users.	42
Social capital*	Building trust, social relations, social cohesion, social bonds, reciprocity, social interactions and social networks.	40
Social vulnerabilities and resilience^{A}	Risks, hardships, opportunities and diversified strategies.	32
Food security^{R}	Food access, food availability, food supply, food shortages, lack of food, food use, nutritional needs, malnutrition, resource dependence and food insecurity.	28
Employment^{R}	Positive and negative impacts on employment, employment opportunities, decent work and unemployment.	18
Poverty^{R}	Poverty reduction needs, poverty alleviation, widespread poverty, poverty traps, poorest regions, poor populations and countries, marginalized communities, benefits to the poor and impoverishment.	18
Gender^{A}	Gender roles, gender relations, gender equity and gendered subject positions.	04
Political		
Power relations*	Competing interests, authority, power sharing, political will and motivations.	55
Equity and justice^{A}	Equal opportunities, equal access, social inequalities, marginalized people, social and environmental justice and distributions and redistributions of benefits and costs.	39
Representation and legitimacy	Leadership, representative advisory groups and social acceptance.	32
Rights to access and manage resources	Formal or informal property rights, exclusion from access and natural resource management and allocation rights.	30
Funding and investment*	Donations, donor-funded, financial networks, financial resources, public or private support for funding, governmental financing, financing mechanisms, funding uncertainties, foreign investments, funding shortfalls and secure funds.	30
Ethics and mores*	Conservation ethics, ethical rules, conformance to general morality, ethical context and rationality.	15
Tenure	Access, use and control of resource systems that communities have historically developed, traditional tenure boundaries, national system of marine tenure that allocates user rights and property ownership.	15
Cultural		
History and context^{A}	Contextual conditions, social factors, context as an external causal variable, infrastructure changes, modes and relation of production, technological factors, context-specific and macro context.	74
		40

(*continued on next page*)

Table 2 (*continued*)

HD components	Description of identified components	Articles (n = 92)
Cultural values and cultural heritage	Identity, self-determination, traditional culture, cultural significance, cultural seascapes, cultural values, folklore, religion and spiritual practices.	
Traditional and local knowledge	Other sources of knowledge: indigenous and local communities.	38
Customary fishing practices and rights	Traditions, cultural festivals, historical use patterns, fishing expertise, historical rights, existence value of traditional practices, intergenerational pedagogy and symbolic rite.	34
Sense of place and displacement[A]	Displacement and attachment from a sociocultural perspective (special place) or economic (extraction of resources), affective experiences and local ownership.	21

external to ecosystems and, consequently, the extent of use of the components of HD. HD are structural elements for the ecosystem approach to fisheries and MPAs [44]. Pitcher [81] argues that HD should be part of a set of fisheries management objectives to solve fishery crises. When defining the primary fisheries objectives, Cochrane et al. [7] stress the need to address components of HD such as food security and poverty alleviation.

Natural and interdisciplinary scientists primarily constructed HD in the natural and environmental sciences arenas. Social scientists (16%, n = 231) and social science journals (11%, n = 52) are poorly represented in the interpretations of HD, while interdisciplinary scientists (46%, n = 231) are the main players. Despite the recognition of the intertwined nature of social-ecological systems (SES) [59], the comprehensive incorporation of social issues depends on better integration with social scientists. Such an integration can overcome what Spalding et al. [62] describe as poorly creative studies on HD. The authors argue that the social sciences have consolidated theories, concepts and frameworks to analyze social phenomena. The need for an interdisciplinary approach demands a joint analytical construction that engages social, natural and interdisciplinary scientists. In their definition, HD refer to the "complex web of human processes as they relate to non-human, natural resources, broadly encapsulated within the social sciences and humanities".

The management of marine ecosystems is beginning to incorporate interdisciplinary approaches that seek to integrate human and ecological dimensions [11,16,82–84]. However, authors agree that social sciences remain peripheral in discussions of environmental conservation [74,85–87]. Jacques [88] stresses that social sciences have been "co-opted" by natural science agendas, funding, and personnel. Wynveen et al. [89] highlight the relatively small social science staff working in marine resource management agencies.

From the perspective of Social Sciences, management performance needs reconsideration. For example, Gruby et al. [63] argues that newness and limited empirical social sciences undermines any attribution of value to Large Marine Protected Areas. Dalton et al. [90] argues that HD are a missed layer in spatial planning. Nevertheless, these few social scientists have raised questions about management effectiveness, social justice, and agent-based models of human decision making [30,32,91–93]. To cope with the complex adaptive behavior of coupled human and social systems, we must think outside the box by building interdisciplinary teams [94]. Disciplinary and isolated research teams can hinder the success of interdisciplinary collaborations by misrepresenting or poorly addressing crucial HD (see Fig. 3).

Although the term "HD" is somewhat intuitive, HD interpretations are still vague and immature, with different meanings in different disciplines. The management of social-ecological systems requires cooperation among different scientific disciplines, epistemologies and social science methods that might not be familiar to professionals trained in biology and ecology [95–97]. Castree et al. [98], p. 766] argue that we might "sow the seeds of something new" and move from "a certain 'style' of HD research". For the authors, it's an opportunity to physical/natural scientists revisit their "conception of the nature and role of disciplines that study the human aspects of the human–environment drama". Also, those who are not physical scientists, "should openly recognize that they do not together speak for the environmental social sciences and humanities in toto". "Breaking the walls" of disciplinary and isolated research are minimal requirement for the advance of HD research and implementation and policy and management.

4.2. The prevailing and the missing HD components

Conservation, policy and natural resource management were the predominant topics in the journals. The interpretations of HD led the discourse to interdisciplinary arenas (e.g., decision-making arenas of resource use and biodiversity conservation) and audiences. The most frequent HD components are relevant parameters in the field. For example, "policies and laws", "institutional arrangements", "stakeholder participation", and "power relations" have been consistently discussed among commons theory scholars [45,99]. Consolidated research on ecosystem services ("ecosystem good and services") [100] and on sustainable livelihood approaches ("sustainable livelihoods") [101] also drive attention to interdisciplinary audiences and incorporate some HD components in their frameworks. The most frequent HD components relate to those approaches and provide answers for how people interact and influence the performance of decision-making in SSFs and MPAs. For Bennet and Roth [122], such HD components received more attention because they are instrumental to conservation and management actions.

On the other side, why are gender, poverty, employment and food security among the least common HD components? We argue for three reasons for such an asymmetry found in results. First, novelty in relating human rights and well-being [20,104] to the conservation and fisheries management. Robust management and governance are commonly understood as the ability to make the rules work in relation to the right to control and access resources [105–107,131]. With poor concern about the social and cultural diversity embedded in small-scale fisheries, rights-based fisheries management may fail [36]. Therefore, these crucial (and poorly represented in the sample) HD components rely on a better connection between conventional objectives of fisheries management (control and access rights) and perspectives such as human rights-based fisheries management [104,108] that stress the need to take HD more consistently. The integration of human rights to SSF and MPA management has a political push from recent international UN conventions and agreements ("policy influence period"), but still immature among scientific arenas. The increased influence of SSF Guidelines on policy and recent efforts to evaluate its implementation may provide increased uptake on the HD components. However, linking "human rights" to fisheries management may still be uncomfortable ground for certain decision-making arenas [109].

Second, such HD components have been constructed in disciplines and theories from social sciences, less familiar to interdisciplinary and natural scientists. For example, Kawarazuka et al. [110] explored challenges and opportunities to integrate gender in social-ecological resilience analysis. Among their conclusions, such analysis weakly engages gender theory and methodology. Bennet and Roth [103] advocate for more significant investment and mindful engagement of social sciences in order to achieve the transformative potential of conservation. Besides achieving a more comprehensive approach to HD, engaging social sciences and social scientists creates opportunities for better management and governance outcomes.

Third, imprecision in research design and analytical frameworks fail to address HD [62]. For example, Frangoudes et al. [108] argue that a lack of priority in policy-making and ethical, epistemological, and methodological issues undermine the importance of gender in fisheries.

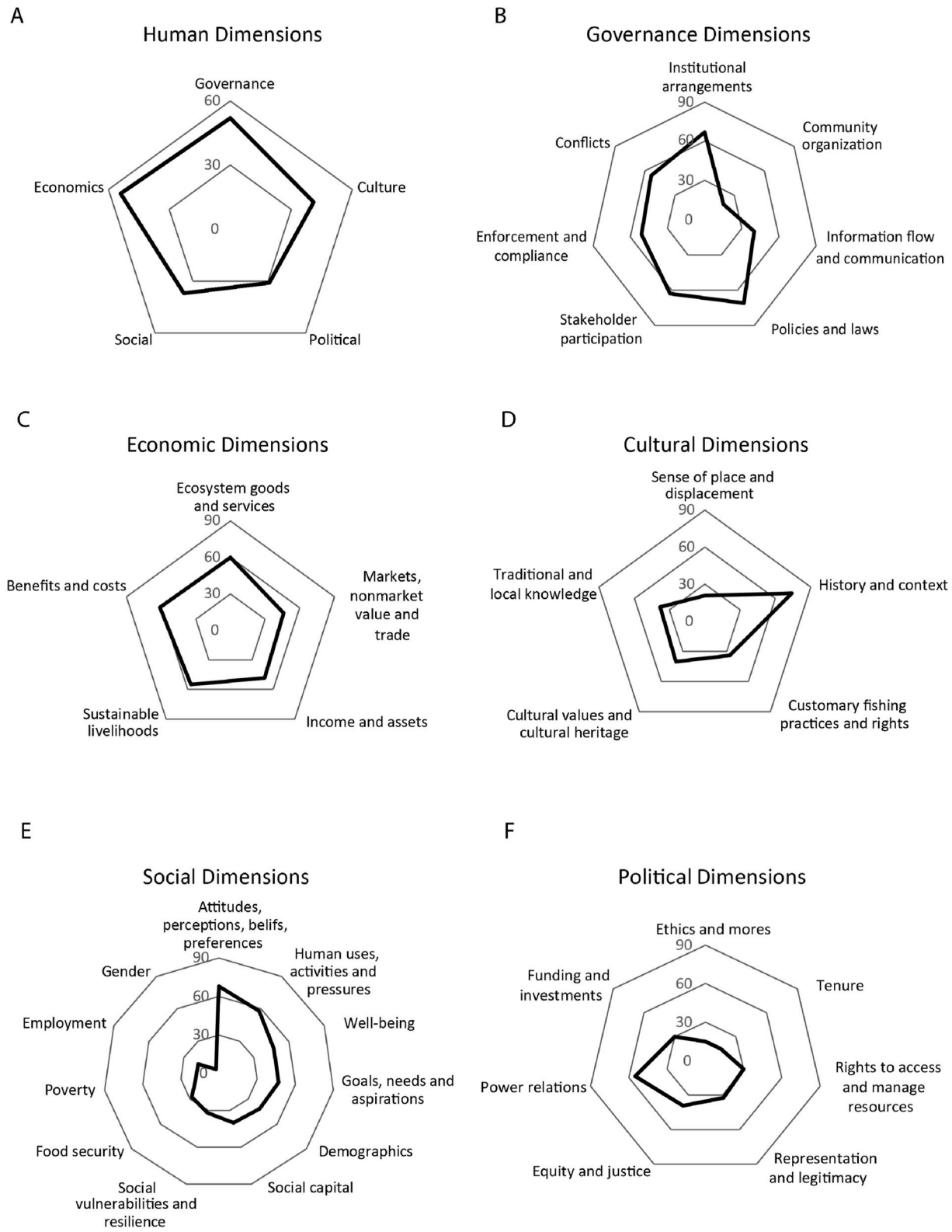

Fig. 3. Radar graphs of the human dimensions categories according to the frequencies of the described components: (A) Human Dimensions, (B) Governance Dimensions, (C) Economic Dimensions, (D) Cultural Dimensions, (E) Social Dimensions, and (F) Political Dimensions.

The authors argue, for example, that the general lack of sex-disaggregated data affect quantitative analysis and generate gender blind fisheries. Kleiber et al. [111] reviewed 106 case studies describing women in fisheries. They highlighted how the perpetuation of biased sampling overlooked women's importance to fisheries. Besides gender blind, authors also mention gender evaporation, when, despite been considered as a variable, gender is missed along with the investigation. Such a situation occurs when researchers are not familiar with gender methods. Concerning poverty studies, for example, despite the evidence on the importance of small-scale fisheries to reduce poverty,

inconsistent conclusions or findings reveal gaps that require further attention, such as the implications of social and equity issues to food security and poverty alleviation [112].

And fourth, considering the profile of HD interpreters, the integration of human and ecological dimensions for analyzing complex systems such as SSF and MPA may be another reason. Beyond limitations in researchers' background or research teams to account for interdisciplinary research, modelling such dynamics is also challenging [113]. Limitations in designing the social research methods (data gathering and results), even among interdisciplinary scientists, reinforce the low frequent HD components.

4.3. HD components as a framework

We advocate for a consideration to a set of HD that could provide a more consistent support to implement and to evaluate the ecosystem approaches. The evaluation of success or failure in managing MPAs depends on how success is defined, and it is necessary to transcend conventional biological indicators [114,133]. Recent efforts have defined indicators to measure and monitor HD emphasizing the noneconomic components of ecosystems [70,95,115]. The use of the HD components in a framework can support, for example, a more comprehensive analysis on if and how HD is effectively part of the oceans governance policies and tools. Moreover, operationalizing information for fisheries and MPA management requires the identification of appropriate HD components and the development of long-term baseline datasets [64,74,116].

The 35 HD components provide a set of indicators that contribute to an interdisciplinary approach to conservation social science [14] in the context of ecosystem approaches to fisheries and MPAs. Overlap and redundancy in some HD components occurred. However, redundancy is a reflection of the richness of authors' interpretations and the diversity of explanations because HD encapsulate a complex web of issues, themes and questions.

For example, all three of the most-cited components ("history and context", "policies and laws" and "attitudes, perceptions, beliefs, and preferences") highlight the intersection of culture and conservation. The "history and context" (n = 74, see Table 2) stress that the relationship between people and nature cannot be measured only in ecological terms [64,117]. The cultural component "sense of place and displacement" (n = 21) is fundamental not only because of its ecological or even economic efficacy, but also because of its emotional importance to people [115,118,119]. Thus, the value of employing HD in ecosystem management approach is not merely in its schematic utility for bioecological success; it is also a normative context for legitimizing the intrinsic value of fishing practices to local people and communities. The "policies and laws" component (n = 71) may be linked to institutional frameworks in a bilateral process of influencing policy and nurturing science to establish the HD approach, as exemplified by HDTT, for example. Science and technology can internalize and reproduce specific values without seeming to Ref. [120]. The "attitudes, perceptions, beliefs, and preferences" component *(n = 68)* is closely tied to encouraging pro-environmental behavior and gaining the support of communities that are impacted by regulations: "We not only have to consider what types of biological outcomes are desired but also plan for what sort of human responses are preferable" [121] (p. 537).

The buy-in of the HD is not limited to academic concerns. It also relies on the implications for SSF and MPA management. For example, let us consider a hypothetical scenario in which managers are engaged in a process of designing regional fisheries management. For such scenario, we also assume that the development of fisheries regulation prioritizes bioeconomic efficiency [122,123] and governance performance [124,132]. Such trajectory undermines crucial HD components we identified, such as, for example, the local sense of place, attachment to the ecosystem, and poverty (which are poorly represented in our study). As outcomes of that perspective, we would expect a) the prevalence of fishery regulations (e.g., total allowance catches, designation of MPAs or fishery exclusion zones in coastal areas and nursery grounds) that are better suited to enforce and control regional and commercial fisheries [125], not small-scale fisheries [126,127]; b) the collapse or disappearance of local and small-scale fisheries, with their own systems of regulations, technological diversity and cultural values; c) increased social inequalities [128] that affect, among others, women's access to fundamental human rights such as work and nutrition; and d) a more extreme condition, when management fails, of overexploitation and the collapse of local and regional fisheries [4]. Although this scenario sounds catastrophic, a close look at developing countries' current fisheries and the historical development of commercial fisheries in developed countries reveals several similarities. In fact, this is a precise description of the "mullet fishery" in Brazil, in which the prioritization of commercial purse seine vessels in the last 30 years led to the disappearance and collapse of several estuarine and coastal subsistence and small-scale fisheries.

On the other hand, the low incidence of the term HD in human and social science journals may generate an imbalance since themes that are usually addressed in social sciences, such as gender *(n = 4)*, employment *(n = 18)*, poverty *(n = 18)*, ethics and mores and *(n = 15)* and tenure *(n = 15)* are scarce [129]. But, to achieve ecological sustainability, it is necessary to guarantee social sustainability [51] and, in relation to MPAs, reconciling fisheries and marine conservation objectives is crucial [66].

Several of the most frequent HD components (Table 2), such as "policy and laws" (n = 71), "institutional arrangements" (n = 67) and "enforcement and compliance" (n = 51), are related to human behavior and compliance (or lack of compliance) with conservation rules. Focus on making rules work undermines the need for understanding the potential benefits of conservation action for the local people [29,31,32,38]. That limits resource management to a command and control perspective, shifting environmental issues from the political to the law enforcement spheres [130]. Some governments (for example, in Brazil) employ military environmental police, whose mission is to ensure compliance with environmental legislation. The literature we reviewed argues for a fundamental shift from a mostly technocratic and regulatory approach based on natural sciences to one that recognizes not only the intrinsic value of nature but also the intrinsic value of "culture" and "beliefs" to local communities [117].

By outlining essential HD components, we give support to actions related to monitoring and evaluating how policies and guidelines are implemented and how robust they are or can be. The use of the term HD is not the only approach to address the human and social issues related to ecosystem dynamics. HD are increasingly present in recent debates on the implementation of conservation and resource management policies and in the international guidelines that provide directions for the implementation of human rights in fisheries and MPAs.

5. Conclusions

The interactions between societies and ecosystems are not novel in science. Journals, papers, books, and other forms of communication have described the field. However, we call attention to recent efforts to encompass the so-called HD as an overarching term to be addressed in integrated management approaches. Ecosystem management approaches use different terms (e.g., ecosystem approach to fisheries, ecosystem-based management, ecosystem-based fisheries management) and take a more holistic perspective. Such a perspective is required when managing complex systems such as fisheries and marine protected areas. We are experiencing an increasing implementation of ecosystem management approach definitions and applications. How can we precisely define HD in such a way that international guidelines, policies, and management regulations accurately embody the decision-making arenas and management tools?

Our literature review identifies two lines of interpretations of HD.

First, HD are overly described through aspects of human behavior, such as uses, attitudes, and perceptions, as a means to ensure buy-in by fishers and their compliance with conservation measures. Human dimension components that stress the need to ensure human rights, blue justice and problems such as gender issues, poverty alleviation and food security are under-represented in the sample. This limited conception of HD virtually ignores basic social problems and misuses the already rich construction developed by social sciences.

Marine protected areas and small-scale fisheries have overlapping interfaces in their own contexts for the implementation of ecosystem management approaches. International guidelines and regional-national environmental policies require such implementation. The MPA institutional framework is considered crucial for regulating marine resource use and biodiversity conservation. Fisheries are treated as disturbance drivers, and small-scale fishers are the most vulnerable social group for marine ecosystem transformations. When HD are poorly addressed, narrow conceptions of HD can create blind spots that reinforce command and control approaches. This may lead to more inequalities and vulnerabilities and ultimately to the loss of resilience and to undesired trajectories, especially when HD remain (intentionally or not) invisible.

As a second line of interpretation, we designed an analytical framework to encompass, describe and evaluate the use and outcomes of HD in the management and governance of SSFs and MPAs. The 35 components identified from HD categories can act as variables as well as performance indicators to guide managers and researchers. When drawing new MPAs or evaluating their performance after implementation or when regulating fisheries, multidisciplinary teams and interdisciplinary projects can explore operational and/or analytical pathways to better encompass HD components. By bringing poverty alleviation, food security and gender equity to the table, social scientists can play leading roles in decision-making. More comprehensive definitions of HD as well as effective changes in conservation practices can flourish in the discourses of science and management.

In recent years, discussions have emerged on the importance of the interaction of human and ecological dimensions for decision-making. Contributions to merging these dimensions are also relevant. Our study joins those efforts by combining critical HD that should be more precisely addressed. These components can be applied, tested, and further evaluated in terms of their feasibility as indicators or outcomes for the robust management and governance of small-scale fisheries and marine protected areas.

CRediT authorship contribution statement

Giovanna C. Barreto: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing, Visualization. **Maikon Di Domenico:** Conceptualization, Methodology, Validation, Formal analysis, Resources, Data curation, Writing - original draft, Writing - review & editing, Supervision. **Rodrigo Pereira Medeiros:** Conceptualization, Methodology, Validation, Formal analysis, Resources, Data curation, Writing - original draft, Writing - review & editing, Supervision, Project administration.

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Appendix A. Supplementary data

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