

Neglected ecosystem services: Highlighting the socio-cultural perception of mangroves in decision-making processes



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ABSTRACT

Despite the increasing recognition of the need to conserve mangroves, degradation has continued during the last two decades due to ineffective and non-inclusive decision-making processes exclusively based on economic factors. The purpose of the present study is to give tools to mangrove conservation management and policy, exploring the sociocultural valuation of the ecosystem services of mangroves through a case study in northeastern Brazil, an area highly impacted by shrimp aquaculture. We used a mix of methods to complement ecosystem services identified in the academic literature with those perceived as such by local people. We analyzed these locally perceived mangrove services in relation to community livelihoods, and highlighted that local people identified four additional cultural services related to maintenance of Traditional Ecological Knowledge (TEK), creation and maintenance of social relationship, personal satisfaction and mental and physical relaxation. This demonstrates that local people have a symbolic relationship with the mangrove forest, which goes beyond the material approach normally used to evaluate ecosystem services. Such findings suggest that the socio-cultural dimension of mangrove services needs to be considered by policy-makers as an indispensable criterion for confronting the key challenges in coastal ecosystems conservation.

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1. Introduction

Mangroves are rich, diverse and complex ecosystems formed at the interface between terrestrial, estuarine and marine systems in coastal zones present in the tropical and subtropical regions of 123 countries (Barbier et al., 1997; Spalding et al., 2010). These ecosystems provide at least US \$1.6 billion each year in ecosystem services, supporting coastal livelihoods of communities with raw materials and food, coastal protection, soil erosion control, water purification, maintenance of fisheries, and carbon sequestration, as well as recreation, education and research (Constanza et al.,

1997; Barbier et al., 2011). They also provide cultural ecosystem services that are “non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences” (MEA, 2005a).

In spite of the cultural, ecological and economic importance of mangroves and legislation designed to protect these frontier ecosystems worldwide, mangroves are in serious decline. The mangrove ecosystems have been greatly reduced and fragmented over the last decades due to excessive exploitation and development (Giri et al., 2011). In the last twenty years, mangroves have suffered degradation and annual loss of between 0.16 and 0.39% due to rapid coastal development (Hamilton and Casey, 2016). Extensive loss has left degraded and highly fragmented mangroves in many parts of their global distribution (Giri et al., 2011; Hamilton and Casey, 2016) that may have limited potential to deliver services into the future (Barbier et al., 2011; Lee et al., 2014).

It has been estimated that 26% of mangrove forests worldwide have been degraded due to over-exploitation for fuel wood and

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timber production (Valiela et al., 2001). In addition 38% of degraded mangrove areas are estimated to have been transformed by industrial shrimp aquaculture (Ellison, 2008). The shrimp industry is one of the most important sources of mangrove degradation, producing a considerable reduction in the forested area (EJF, 2003; FAO, 2010). Brazil is one of the countries that has been severely affected by the shrimp aquaculture industry, which is the greatest threat to mangrove conservation in this area (Queiroz et al., 2013).

Human society has and will always be faced with the decision of how to manage ecosystems for sustainability. This is also true for the mangrove ecosystem that has often been converted to alternate use, based solely on economic consideration by policymakers (James et al., 2013). One main reason for mangrove deforestation is that wetlands throughout the world are still considered to have little or no value, or even sometimes to have a negative value (Mitsch and Gosselink, 1993). Probably the main problem in this sense is a lack of appreciation of the multiple ecological functions, products and services produced by these coastal wetlands (James et al., 2013). This has been a reason for their subsequent low priority level in decision-making processes resulting in the destruction or substantial modification of the ecosystem (Turner et al., 2000). Researchers who view mangrove management beyond the merely ecological or economic perspective have advocated the use of an ecosystem services framework that introduces the cultural perspective in order to achieve an integrated management of such coastal ecosystem services for human well-being (James et al., 2013; Thiagarajah et al., 2015; Hsieh et al., 2015).

This approach defines cultural ecosystem services as the interactions between environmental spaces (i.e. physical settings such as coasts, woodlands, allotments) and the cultural or recreational practices that take place within them. This places cultural ecosystem services in a geographic or place-based context. In this framework, cultural benefits (in terms of experiences), identities and capabilities are seen to arise from the mutually reinforcing relationships between environmental spaces and cultural practices (Fish et al., 2016). Thus, most of these services operate outside the market system and are integrally linked to the way of life, traditions and other values of the communities (NRC, 2004). Even though the cultural dimensions of well-being are multi-faceted and complex (Russell et al., 2013), many studies highlight the importance of taking into account the cultural benefits of the environment to human well-being in environmental decision making (e.g. Satz et al., 2013; Fish and Church, 2014). In this sense, the concept of cultural ecosystem services offers one powerful way of conveying that natural systems underpin a range of life-enriching and life-affirming benefits to people (Fish and Church, 2014). This approach presents some of the most compelling reasons for ecosystem conservation; these benefits are considered a fundamental component of all current ecosystem services frameworks (Chan et al., 2011). Neglecting the cultural services that ecosystems provide excludes considerations that often matter to vulnerable and otherwise underrepresented communities (Satz et al., 2013). It is thus of fundamental importance to understand how people perceive the mangroves, this being an essential element in making such social-ecological systems sustainable in the long-term perspective (Kittinger et al., 2012; Gould et al., 2014).

Despite their importance, cultural ecosystem services remain poorly understood as they are commonly subjective and have multi-faceted and complex dimensions (Russell et al., 2013). Much of the coastal wetland valuation literature is focused on the economic value, the social and cultural values not being directly ascribable to the ecological or the economic domain (Chiesura and De Groot, 2003). The complexity of the perception of landscape and well-being by the community should be considered in the ecosystem services quantification, even if the (quantitative) tools

used are new. A rigorous application of methods to quantify non-economic values of mangroves is still underdeveloped (James et al., 2013; Thiagarajah et al., 2015; Hsieh et al., 2015) and the decision-making process should not neglect the experience of the local population (Raheem et al., 2012).

In this sense, the concept of cultural ecosystem services offers a powerful way of conveying that natural systems underpin a range of life-enriching and benefits for people (Fish and Church, 2014). This approach presents some of the most compelling reasons for ecosystem conservation, being considered a fundamental component of all current ecosystem services frameworks (Chan et al., 2011). However, there is no doubt that this social value of coastal wetlands is seldom captured by policy and decision-making actors (Turner et al., 2000).

The purpose of the present study is to inform mangrove conservation policy by exploring the diversity of values of the ecosystem services provided by mangroves based on sociocultural perceptions. We present our analysis, from a community (bottom-up) perspective, through a case study in the Brazilian community of Cumbe, Ceará. Cumbe's traditional management of mangroves and the direct and extensive dependence of local livelihoods on these ecosystem services make this community an interesting and appropriate case study for the purposes of this research that can be adapted to other coastal communities around the world. To achieve this aim, we: 1) identify, characterize and value the ecosystem services of mangroves based on the existent literature and community perception, and 2) analyze how the ecosystem services of mangroves are embedded into community livelihoods. Our findings contribute to the understanding of mangrove sociocultural perception from an ecosystem service perspective and can provide management and policy tools for mangrove protection.

2. Methods

2.1. Study site description

The study was carried out at the Quilombola community of Cumbe (October to December 2011). Cumbe is located along the shores of the fluvio-marine system of the Jaguaribe River, in the Aracati municipality of the state of Ceará, Brazil (Fig. 1). The Jaguaribe River Basin is the largest in Ceará with an area of 72,645 km², occupying 50% of the territory. In the Jaguaribe Basin, 44.2% of the shrimp farms constructed in the Jaguaribe River, interfered directly with the mangrove ecosystem and 63.6% caused serious damage to the riparian forest (carnaubal palms), which is one of the most important ecosystems of NE Brazil primarily for the protection of areas of recharge (Queiroz et al., 2013).

This community has 621 inhabitants, whose livelihoods are directly dependent on mangroves. The main activities are fishing, gathering shellfish and collecting crabs in 'gamboas', these activities are carried out individually or in groups. Due to its geographical location, the community of Cumbe is furthest from the sea and therefore maintains a close relationship with the mangrove and the estuary.

In agreement with previous studies (Queiroz, 2007; Teixeira, 2008) the community of Cumbe has developed a traditional system of natural resources management through a relationship of respect, gratitude and complicity with nature. Cumbe maintains strong economic and symbolic ties with the land and the sea through continuous observation and accumulated knowledge of natural cycles based on fishing and other activities such as handicrafting.

The study followed the guidelines of the code of ethics of the International Society of Ethnobiology and the guidelines of the Ethical committees at both the *Universidade Federal do Ceará* and the *Universitat Autònoma de Barcelona*.

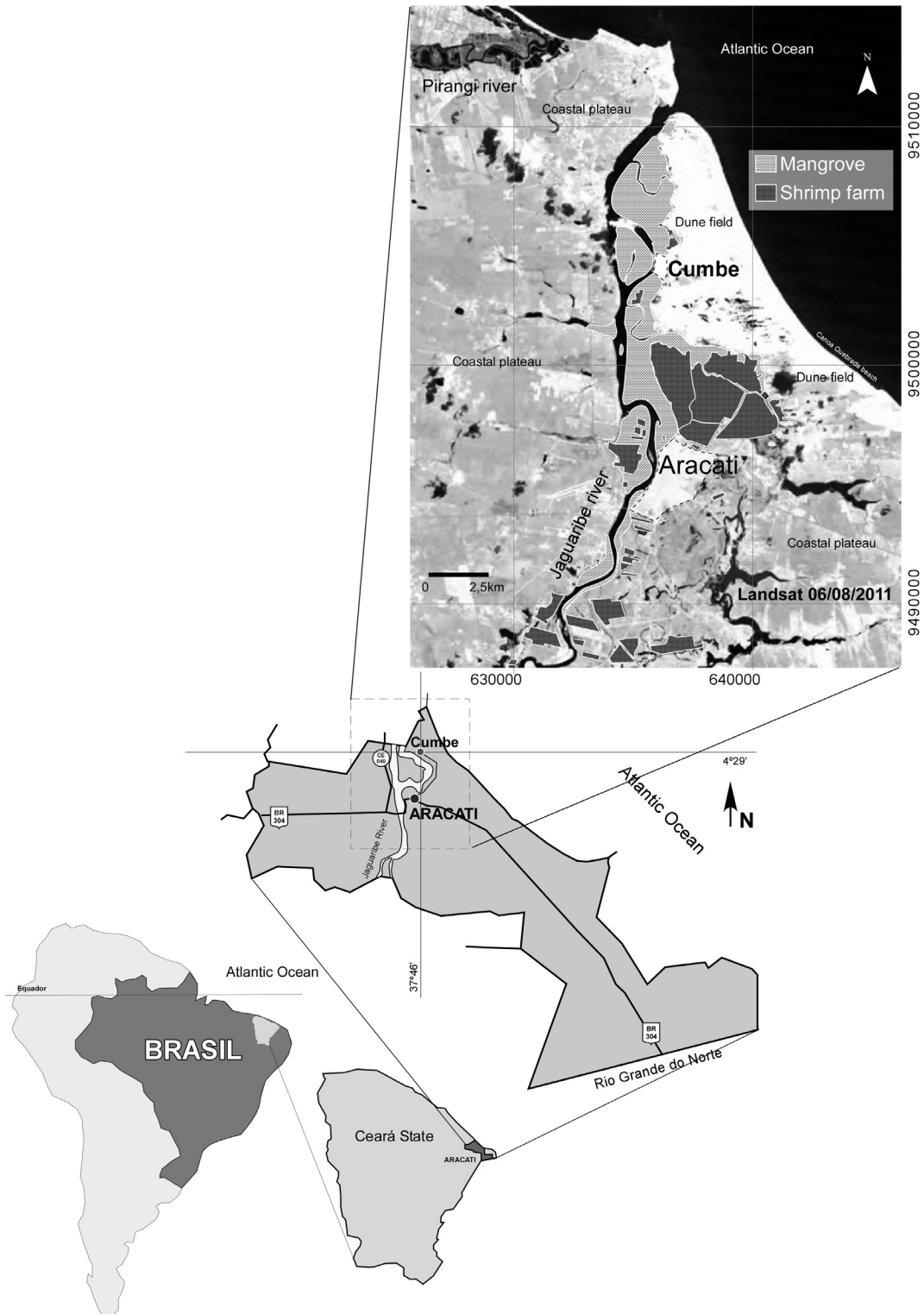


Fig. 1.

2.2. Sampling

We used purposive sampling to identify the population who traditionally worked directly in contact with mangroves in Cumbe community. These local adult users were the most experienced and knowledgeable in the management and use of mangroves. They potentially benefited – directly or indirectly – from any mangroves

ecosystem service in the study area, and thus could provide more nuanced information on the ES of mangroves. We identified them through the Municipal Health Secretary of Aracati, Brazil (SMS, 2010) and we compared our sample with data from the “Associação de Catadores e Marisqueiras do Cumbe”. Through this information we identified all of the fishers in Cumbe, in total 35 shellfish collectors and 45 crab collectors who were between 25 and 50 years old

Table 1
Orientation questions of focus group.

Focus group	Questions stimulus	Desired information
Group 1. Fisherwomen (shellfish gatherers)	How do women/man use the mangrove? For what purposes (commercial, cultural or subsistence) are the mangroves used? What are the benefits of these uses?	Types, objectives and benefits of the uses of mangrove ecosystem services performed by the fisherwomen and men
Group 2. Fishermen (gatherers of crabs, fish fishing, etc.)	Have these uses been changed throughout the history? What are these changes? If so, why have they changed? How have they influenced their lives? Are mangroves important?	Changes, causes and impacts of the flow of ecosystem services in the quality of life of fishers Importance (Symbolic and material) of the mangroves for the life of the fisherwomen and men

(altogether 80 people [13%] of the total population of Cumbe which is 641 persons).

2.3. Data collection and analysis

We adopted a non-economic valuation approach based on the socio-cultural perception of the importance of ecosystem services for human well-being (e.g. Calvet-Mir et al., 2012; Camps-Calvet et al., 2016). Socio-cultural valuation approaches are increasingly used in ES assessments (TEEB, 2010). We used *valuation surveys* (n = 80) to quantify the level of agreement of the group of respondents in Cumbe on the importance of the mangroves ES. The valuation surveys were based on the list of mangroves ES identified in the regional study of Meireles and Campos (2010) in the Northeast of Brazil, which is the most complete study providing context-specific information on the ES of mangroves in the study area. This was also complemented with a review of relevant publications in the field of ecosystem services (e.g., Constanza et al., 1997; De Groot et al., 2002; MEA, 2005b; TEEB, 2010) and mangroves' ecology (e.g., Schaeffer-Novelli, 1989; Barbier et al., 1997) (Appendix 1). These valuation surveys consider that most of the ecosystem services provided by mangroves have a social and cultural importance beyond the economic value. We used a Likert scale design (Bernard, 2005) so as the local users were asked to score an affirmation about each type of service numerically (0 = totally disagree, 5 = totally agree), for example: "Mangroves are important because they give quality food". To assess the different perceptions, photographs about the services were used to illustrate more complex concepts (like for example: "production and regulation of gases") (Appendix 1, Electronic Supplementary Material). Data collected through valuation surveys allowed us to estimate: the average value of each ecosystem service identified, the average value of each category of ecosystem services, the average value of all services (summed together), and the standardized relative importance of each category of ecosystem services of mangroves (average value of the category/maximum value the category could obtain). These estimations allowed us to identify the relative value of some categories in relation to others.

The *free listing* technique was used to identify the ecosystem services and their level of importance in community life (Bieling et al., 2014). Respondents were randomly selected from our list of 80 local users. Each respondent was asked the question "What does the mangrove mean to you?" We selected this question from a set of questions tested with local people out of our sample since the question was easily understood and it also provided the broadest range of answers. Responses were noted by the researchers in the same order in which they arose from the surveys so as to guarantee the priority order of each response. A total of 24 people (including 8 women shellfish collectors and 16 men crab collectors) were interviewed. We stopped the interviews when responses to new free listings began to repeat themselves (i.e., sat-

uration point; Bernard, 2005). The importance of the answers obtained in each list was calculated using the Saliency index, which categorizes and integrates the number of times that a response has been stated and the order in which it appeared (Borgatti, 1996). The responses were thereafter systematized, codified and entered into the ANTHROPAC software (Borgatti, 1996), generating a list of the perceived ecosystem services priority. With the purpose of organizing and interpreting the results, we listed in single categories those similar terms grouped by the program.

Focus groups were used to promote an open discussion of local users' opinions about their dependence on mangroves (Barbour and Kitzingen, 1999) (Table 1). We invited all men and women who were part of the group of local users (n = 80) initially identified. We conducted two meetings (one with shellfish collectors and other with crab collectors) of focus groups in order to identify and characterize the mangrove ecosystem services. We also made a systematic data collection on their daily experiences with mangroves management and their links to the ecosystem services of these forests. However, only a proportion of the local users attended the meeting (1/3 approximately).

Participant observation (Combessie, 2010) was conducted during our three-month stay in the community to improve our understanding of the community's social organization and way of life. We also engaged in informal talks and local celebrations with residents of Cumbe. We specifically observed the work performed by the group of local users in Cumbe in order to improve our understanding of the activities related to the provision of mangrove ecosystem services. All these observations were qualitatively recorded in the field notes in chronological order (Bernard, 2006). These notes allowed us to better interpret the responses obtained regarding perceptions of ecosystem services through the previously described data collection techniques. Furthermore, this participant observation was complemented with the first author's previous experience in the field since 2006 (Queiroz, 2007, 2014; Queiroz et al., 2013). Understanding the community dynamics over a period of time was an essential contribution to this research.

3. Results and discussion

3.1. Local valuation of mangrove services identified in the literature

For the valuation survey we identified 20 ecosystem services provided by mangroves: 11 regulation services, 1 habitat service, 3 provision services and 5 cultural services (Table 2).

Within a range from 0 to 5 the mangrove services were scored with an average value between 4 and 5. The total score locally assigned by our survey respondents to each type of ecosystem services should be interpreted as a relative average. The most valued ecosystem services were the regulation service of "production and regulation of gases" (4.93) followed by the provision service of

Table 2
Ecosystem services provided by mangroves identified in the literature review and by the Cumbe community informants.

Regulating Services				
Service	Characterization	Literature	Free Listing	Focus Groups
Regulation/Production of gases	Regulation of atmospheric chemical composition (balance of CO ₂ /O ₂ ; Levels of SO ₂).	X	X	X
Climate regulation	Global temperature, precipitation and other biological processes that mediate local and global climatic phenomena (regulate greenhouse effect)	X	X	X
Water supply	Water storage and retention (aquifer and reservoir dynamics)	X	X	X
Coastal protection against extremes	Buffering of ecosystem responses associated with environmental fluctuations (protection against storms, control of fine sediment production and controlled environmental variability by vegetation structure)	X		
Hydrological regulation	Regulation of hydrological flows integrated with watersheds (water for agricultural and industrial activities; transportation of people, food, etc.)	X		
Erosion control and sediment retention	Soil conservation within the ecosystem (prevention of slides and other processes of material removal)	X		
Soil formation	Soil formation process (weathering of rocks and accumulation of organic material).	X		
Nutrient cycling	Storage, internal recycling, processing and acquisition of nutrients (fixation of N, P and other elements of the nutrient cycle)	X		
Material and energy dissipation	Recuperation, removal and control of excess nutrients and organic compounds (control of contaminants)	X		
Pollination	Movement of gametes for population reproduction	X		
Biological control	Regulation of trophic dynamic of populations	X		
Biodiversity regulation	Biological interactions between organisms and with abiotic components of ecosystems	X	X	X
Habitat Services				
Service	Characterization	Literature	Free Listing	Focus Groups
Refuge	Habitat for resident and migratory populations (stopover, nursery and feeding areas for migratory birds)	X	X	X
Provisioning Services				
Service	Characterization	Literature	Free Listing	Focus Groups
Food production	Part of gross primary production transformed into food (fish, molluscs, crustaceans and subsistence of activities)	X	X	X
Primary production	Part of gross primary production transformed into materia prima (lumber, fuel and forage)	X	X	X
Genetic resources	Production of materials and biological products for medicine, scientific materials, acquisition of genes resistant to pests, and ornamental species.	X		
Cultural Services				
Service	Characterization	Literature	Free Listing	Focus Groups
Recreation/Tourism	Carrying out leisure activities (fishing, boat cruises meals with family and friends, games, etc.) and opportunities for various tourist activities	X	X	X
Aesthetics	The mangrove ecosystem as part of the coastal scenery	X	X	X
Inspiration for culture and art	Mangroves are motive and inspiration for artistic creations	X	X	X
Spiritual	Many fisher folk and indigenous communities recognize mangroves as a sacred space	X	X	X
Maintenance of traditional ecological knowledge	In mangroves traditional activities are carried out, which are important for maintenance of autochthonic and ancestral knowledge			X
Science and environmental education	Important spaces for development of scientific research and environmental education actions	X	X	X
Creation and maintenance of social relationships	In mangroves interpersonal relations are built and/or strengthened with people from the same community, neighboring communities and visitors		X	X
Personal satisfaction	The relation with mangroves generates sentiments of personal satisfaction for the communities, such as: strength to live, richness (not from a monetary point of view), pride and liberty		X	X
Mental and physical relaxation	Using mangroves for resting, reflection and/or physical activities for mental wellbeing and relaxation, functioning as therapy		X	X

Source: Schaeffer-Novelli (1989), Barbier et al. (1997), Constanza et al. (1997), De Groot et al. (2002), MEA (2005a,b), McLeod and Salm (2006), Rivera and Cortés (2007), Kumar (2010), Meireles and Campos (2010), De Groot et al. (2010), TEEB (2010).

“refuge for species” (4.86) and, with the same scores, “food production” (4.75) and “recreation/tourism” (4.75) (production and cultural services respectively) that were followed by another regulation service: “hydrology regulation” (4.70). The least valued ecosystem services were regulation services of “dissipation of material and energy” (3.47) that had an average value between 3 and 4 (Table 3).

The attribution of highest value given to the services “production and regulation of gases (i.e., oxygen)” and “biodiversity refuge”, and also to “hydrology regulation” might be a result of trainings and workshops implemented by NGOs to increase aware-

ness about conservation issues due to the presence of shrimp industries in the area. Such workshops promoted local people's knowledge about the importance of mangroves dynamics from an ecosystem perspective. For example, one of the fishermen stated that: “From the moment that the community began to participate in the training and encounters, the level of ecological awareness of the mangroves by the fishers of Cumbe has increased”. The ecosystem service “food production” was highly valued suggesting the importance of mangroves for the community livelihoods as traditional fishers, for instance, a women shellfish collectors stated during the focus group: “The mangrove is there to support all the families that

Table 3
Ecosystem services provided by mangroves identified in the literature.

Regulating services		
Service	Example of service	Average
		44,62
Regulation/Production of gases	Mangroves produce oxygen, the air that we breathe	4,93
Climate regulation	Mangroves help to maintain the regional temperature	4,54
Coastal protection	Mangroves contribute to coastal stability, functioning as a natural protection against natural phenomena (floods and storms)	4,46
Hydrological regulation	Mangroves regulate the entrance and exit of water in the Jaguaribe River	4,70
Erosion control and sediment retention	Mangroves prevent compaction and prevention of erosion	4,56
Soil formation	Mangroves are responsible for the soil formation process (accumulation of organic material)	4,30
Nutrient cycling	Mangroves are responsible for the transformation of organic material	4,54
Material and energy dissipation	Mangroves control pollutants	3,47
Pollination	Mangroves circulate gametes in reproducing populations	4,54
Biological control	Mangroves are home to many organisms of various species, which interact with each other	4,58
Habitat Services		
Service	Description of service	Average
		4,86
Refuge	Mangroves function as habitat for resident and migratory populations (welcoming migratory birds)	4,86
Provisioning services		
Service	Description of service	Average
		16,91
Food production	Mangroves provide quality food	4,75
Water supply	Mangroves are responsible for water storage in aquifers	4,40
Raw materials	Mangroves produce raw materials such as lumber, fuel and forage	4,55
Genetic resources	Mangroves produce biological products with medicinal uses	3,21
Cultural services		
Service	Description of service	Average
		22,36
Recreation/Tourism	Mangroves provide a space for carrying out recreational activities (ecotourism, sport fishing and other outdoor activities) and opportunities for various tourist activities	4,75
Enjoyment of scenery	Mangroves are part of coastal scenery	4,61
Inspiration for culture and art	Mangroves inspire artistic creation	4,21
Spiritual experience	Many communities of fishers and indigenous peoples recognize mangroves as sacred space	4,40
Science and environmental education	Mangroves are spaces for the development of scientific research and environmental education activities	4,39

Source: Schaeffer-Novelli (1989)¹, Barbier et al. (1997)², Constanza et al. (1997)³, De Groot et al. (2002)⁴, MEA (2005b)⁵, Meireles and Campos (2010)⁶, TEEB (2010)⁷.

may need it one day. Like a mother's heart, which always has space and food for one more".

The ES "Recreation/tourism" was highly valued due to fishers use of mangroves for highly valued outdoor activities such as swimming, sunbathing, and social gatherings. This is illustrated by the testimony of a women shellfish collectors during the focus group: "On Sundays, many people from the community go with their families to spend the day in the mangrove. Rarely do the families stay in the community. Everyone goes to the mangrove to enjoy the day of leisure, we do not like to be in the house and there is nowhere to go in the community, so everyone goes to the mangrove. Everyone stays there, on the edge of the river... catching fish, collecting crabs and oysters to eat right there. They make a bonfire, put the pot on the fire and make a collective meal. Thus, we have our leisure guaranteed with other relatives and other families of the neighboring communities". Similar results were found in other wetland ecosystems such as De Wieden (Netherlands) where local recreation was highlighted as a relevant ES (Hein et al., 2006). In Cumbe tourism facilities do not exist so far. However, fishers have foreseen the opportunity that ecotourism can give to the community in order to protect the mangroves and increase their household income as it already happens in other estuarine and coastal ecosystems (Barbier et al., 2011). During informal talks, various fishers stated that the com-

munity has great opportunities to develop ecotourism since it is located in a highly valued aesthetic place where the sea and the river merge.

3.2. Mangroves services locally perceived

Based on our free listings and focus groups we identified and characterized four additional ecosystem services of the mangroves to those previously identified in the literature of mangroves. Consequently, this is a relevant finding of our study. These ES (Table 2), categorized as cultural, are: 1. *Maintenance of traditional ecological knowledge*; 2. *Creation and maintenance of social relationships*; 3. *Personal satisfaction*; and 4. *Mental and physical relaxation*.

The service "maintenance of traditional ecological knowledge" was identified during the focus group meetings and refers to many different types of ecologically relevant information related to mangroves such as knowledge of how to harvest natural resources, through complex understandings of the functioning of the local ecosystem linked to cultural beliefs and religious views of human-environment relations (Berkes, 1999; Davis and Wagner, 2003). Since most TEK is accumulated through experiences of close contact with the natural environment, therefore locality plays a large part in shaping this knowledge (Davis and Wagner, 2003).

Table 4
Results of the free listing.^a

Item	Frequency (%)	Average Rank	Saliency
<i>High Saliency (s > 0,5) (n = 1)</i>			
All	75,0	1,11	0,724
<i>Average saliency Media (0,5 > s > 0,020) (n = 20)</i>			
Sustenance	70,8	2,53	0,486
Leisure	54,2	3,92	0,244
Work	41,7	2,70	0,248
Rent	25,0	1,50	0,229
Landscape	20,8	3,80	0,115
Food	20,8	4,80	0,094
Firewood	12,5	4,00	0,045
Fishing	12,5	3,33	0,073
Happiness	12,5	5,67	0,046
Health	8,3	3,00	0,042
Refuge	8,3	6,00	0,040
Health	4,2	2,00	0,038
Clean air	8,3	3,50	0,035
Nursery	4,2	4,00	0,030
Socialization	8,3	4,00	0,027
Relaxation	4,2	4,00	0,026
Tourism	4,2	3,00	0,021
Pride	4,2	4,00	0,021
Therapy	4,2	2,00	0,021
Honey	4,2	3,00	0,021
<i>Low Saliency (s < 0,020) (n = 7)</i>			
Exercise	4,2	6,00	0,016
Spirituality	4,2	9,00	0,011
Research	4,2	7,00	0,010
Biodiversity	4,2	8,00	0,009
Liberty	4,2	10,00	0,008
Clean water	4,2	9,00	0,005
Strength to life	4,2	11,00	0,004

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

This is illustrated by the testimony of a fisherman during the focus group: “We grew up knowing our survival was due to crab collection, we learned together from generation to generation and this knowledge has remained. Today I have many brothers that continue working in the mangroves”. Indeed, this ES provided by Cumbe mangroves seems to be rooted in the sociocultural identity based on fishing and other fisher activities as already shown in other similar communities in Brazil (Diegues, 2002). This TEK of mangroves is linked to the healthy functioning of the ecosystem and consequently its conservation (Barbier et al., 2011; Walters et al., 2008).

In this line the strong corpus of TEK found in Cumbe is connected with the second cultural ecosystem service perceived by fishers: *Creation and maintenance of social relationships* identified during the application of free listing for the term “socialization” (Table 4). This service means opportunities provided by mangroves that can promote personal social interactions with people who have the same or similar passion for appreciating, taking care of and restoring nature. Such social relationships are fundamental to maintain TEK (Berkes, 1999).

The mangrove service of “personal satisfaction” was based on the terms *strength to live, non-material wealth, pride, happiness and freedom* that informants mentioned in the free listing exercise (Table 4) and further explained in focus groups. For instance, one fisherman asserted: “The mangrove is freedom. My work in the mangroves is everything to me because I don’t worry about a boss”. His understanding of the words *freedom* and *lack of worries* were both related to personal satisfaction from working in the mangroves. To some respondents of the community, this service was related to a non-utilitarian and sentimental view of mangroves that contributes to their individual and/or collective fulfillment. Similarly, and

strongly related to human wellbeing, we identified the mangrove service “mental and physical relaxation” based on the words cited in the free listing: health (8,3%), relaxation (4,2%), therapy (4,2%) and exercise (4,2%). These results show that the community use mangroves in order to exercise and relax and thus contributing to physical and mental health. For the local population, mangroves were considered spaces for meditation and personal reflection, a place where they could feel well as an informant of the focus group explains: “the mangrove is the best home to hear the noise of the wind. It is a place for my thoughts; the truth is that at times in the city I get stressed, but I never get that way when I am in the mangrove”. Both testimonies are in line with studies of coastal environments evidencing that people living closer to the coast self-report higher levels of good health and personal fulfillment (Wheeler et al., 2012).

The fishers of the Cumbe also understand the importance of the complexity, biodiversity and landscape preservation as fundamental for their own lives and beyond as reflected by other terms cited in the free listing: *life, mother of all, all the good things, our world and everything* (Table 4). These terms, which were by far the most cited in first position of the free-listing and considered the most important, were categorized as “all” and were cited by 75% of the respondents. On average, this free listing category was in first position on the list (s = 0.724) but was not included as a different ES since it is a holistic view of mangroves that embeds all of them. For the population studied, the mangrove constituted a critical aspect of their world-view and their sense of belonging. During the focus group, for instance, a fisherman stated: “Mangroves represent everything for me, they are life; I feel privileged to be part of it, to live close to mangroves, to open my window and see a landscape that makes me feel well and happy, because it is from where I draw quality sustenance, for myself and my family”.

This holistic conception of mangroves held by the fishers of the Cumbe community links ecosystem functions, services and wellbeing, highlighting the prominent role of cultural services as other studies also emphasize (James et al., 2013; Bell et al., 2015; Hsieh et al., 2015; Thiagarajah et al., 2015). For instance, Bell et al. (2015) states that recreational use of the maritime environment is beneficial for physical and mental health.

4. Conclusions

Findings of the present study demonstrate the relevance of socio-cultural valuation of mangroves ES in management decision-making and the importance of taking into account local users’ perceptions in conservation policies.

Primarily this case study in Cumbe contributes to the advancement in the theoretical framework and methodological approach of socio-cultural valuation of the ecosystem services. Our study captures the importance of locally identified cultural services that are context specific for local communities who perceived them beyond their monetary value. To do that, research should employ valuation surveys and participatory methods such as focus groups and participant observation to gather information and actively involve target communities, and whose design should be informed by both international and local studies.

Secondly, our study also has implications for mangroves conservation. The fishers of the Cumbe community maintains strong symbolic ties with the land and the sea through continuous observation and interpretation of natural cycles for the sake of the sustainable management of mangroves. Such understanding and close relationship with mangroves leads, intentionally or unintentionally, to their environmental protection, as has been shown in other traditional communities (Walters, 2004). However, fisher’s understanding and perceptions of mangroves have not been considered

in past and current government management policies of the coastal area that have prioritized shrimp aquaculture over artisanal exploitation of mangroves, which has led to a degradation of mangrove habitat and resources (Queiroz et al., 2013). It is necessary, as highlighted in other coastal wetlands, to include the social value of these areas for policy and decision-making (James et al., 2013).

Such an approach responds to the United Nations Sustainable Development Goals of improving human well-being and promoting the conservation of marine ecosystems (United Nations, 2015) by contributing to an improved understanding of the complex interrelationships between social and natural systems and of the multiple dimensions of ecosystem services. We therefore suggest that mangroves conservation and management policy-making should embrace such complexity by considering community perceptions of landscape and well-being as an indispensable criterion for confronting the key challenges in the coastal ecosystems conservation.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ecoser.2017.06.013>.

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