Chapter 15
Sociocultural Valuation of Mangroves: Subsidies for Public Policies Towards the Conservation of Brazilian Coastal Wetlands

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15.1 Introduction

Mangroves are rich, diverse, and complex ecosystems 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, carbon sequestration, and recreation, education, and research possibilities (Costanza et al. 1997; Barbier et al. 2011). Some worldwide assessments have considered mangroves as a subset of other coastal ecosystems in the economic evaluations of ecosystem services (ES). However, the contribution of mangrove ecosystems to the aggregate economic value is often hard to disentangle. The possible pitfall in

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such large-scale studies is that there is considerable overlap with several other ecosystem types, possibly leading to double counting. For instance, mangroves are either combined with tidal marshes (wetlands) in Costanza et al. (2014) or divided into "tropical forests," "coastal systems," and "coastal wetlands" in de Groot et al. (2012).

In South America, mangroves have been exploited by society for thousands of years, but it has been in the last 400 years when a systematic transformation of these wetlands has taken place (López-Angarita et al. 2016). The mangroves that we now see are far different from the original ones, being in general younger and less structured and biodiverse (Valiela et al. 2001). In fact, this is a long story of interaction, marked by profound transformation over the last few centuries due to the shift from pre-Columbian to colonial management. Since 1990, despite the increasingly positive attitude towards mangroves and their inclusion in protected areas and conservation policies, mangrove cover has continued to decline due to expanding human activities (e.g., agriculture, aquaculture, and coastal development), even in the presence of laws prohibiting their removal (López-Angarita et al. 2016). Remnant mangroves are severely threatened, with up to 40% of the mangrove plant species being susceptible to extinction in some regions (Polidoro et al. 2010). This loss and degradation may seriously undermine the ability of mangroves to provide valuable ES for present and future generations (Feller et al. 2010). Alongi (2002) predicted that in the 25 years following his study, shrimp aquaculture, together with overfishing and other intensive practices, would be the greatest threats to mangrove conservation. Duke et al. (2007) reinforced this point of view, setting out a very bleak prospect for one of the world's greatest providers of biodiversity and ecosystem services at local and global levels. Stemming this loss is urgent and requires better management of intact and damaged mangrove ecosystems, including restoration efforts. It also calls for systematic assessments of current "stocks" and "flows" of ES to ensure the sustainable use of these resources (Bateman et al. 2013). Since mangroves have not received their due share of conservation, these ecosystems have been greatly reduced and fragmented over the last decades due to excessive exploitation and "human development" (Giri et al. 2011).

Despite the cultural, ecological, and economic importance of mangroves and legislation designed to protect this frontier, land-to-sea transitional ecosystems worldwide, these forests are in serious decline. Over the last 20 years, mangroves have suffered degradation and an 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 the world (Giri et al. 2011; Hamilton and Casey 2016). These fragments may have limited potential to deliver services in the future (Barbier et al. 2011; Lee et al. 2014).

Brazil is one of the countries that has been severely affected by shrimp farming, which represents the greatest threat to the country's mangrove conservation (Queiroz et al. 2013a). During the last 40 years, industrial shrimp farming in Brazil has experienced intense growth. The first shrimp culture experiments were carried out at the beginning of the 1970s, but they have failed due to technical problems and a lack of appropriate knowledge. At the end of the 1990s, the activity expanded rapidly, and shrimp farming became a relevant export industry, due to government assistance, public-bank financing, university technical collaboration, and legislative permissiveness. The vertiginous growth of the industry has been accompanied by a profound transformation in natural resources, causing the degradation of mangroves. Behind the numbers and high shrimp-production rates for export lies a context of conversion of extensive coastal areas (fragile and fundamental environmental systems like wetlands and mangroves) into production zones (shrimp farms), generating social, economic, and environmental impacts (Barbier and Strand 1998; Rönnbäck 1999; Polidoro et al. 2010). In the present chapter, we will present a brief description of how the ecosystem services have been evaluated under the economy's lenses, what is the relevance of cultural and non-tangible ecosystem services, and how they have been managed in Brazil. The chapter also discusses the noncompatibility of the industrial exploitation of mangroves (especially by the shrimp farm industry) with the maintenance of the local economy and biodiversity.

15.2 Ecosystem Services: The Sociocultural Approach

Over the past few decades, increasing efforts addressed the topic of the link between ecosystems and human well-being. Gradually, humans began to perceive (and forcefully face) that changes imposed on nature by their activities provoke effects, direct or indirect, on all components of well-being. From these perceptions, the concept of ecosystem services (ES) arose, aiming at bringing to light the relationships between people and nature embedded in daily life and to mobilize environmental conservation and management. ES have been defined as the direct and indirect contributions of ecosystems to human well-being: in synthesis, ES are benefits people obtained from nature, directly enjoyed, consumed, or used (Paoli et al. 2017). From this original definition, the concept has been later applied and interpreted in multiple and often contested ways and raised several significant questions of scientific and ethical nature (Jax et al. 2013).

Ecosystem services are essential for human well-being, but the links between ecosystem services and human well-being are complex, diverse, context-dependent, and complicated by the need to consider different spatial and temporal scales to assess them properly (Paoli et al. 2017). 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; López-Angarita et al. 2016). Probably the main problem in this sense is a lack of appreciation of the multiple functions of the ecosystem and associated services (James et al. 2013; Arias-González et al. 2017). Several services have been estimated for mangroves (see Table 15.1), being those related with direct economic benefits or with biogeochemical cycles – these counting

Table 15.1 Ecosystem services provided by mangroves identified in the literature review and by Cumbe community informants

Services	Characterization
Regulation/production of gases	Regulation of atmospheric chemical composition: SO_2 levels, CO_2/O_2 balance.
Climate regulation	Global temperature, precipitation, and biological processes that mediate local and global climatic phenomena (greenhouse effect).
Water supply	Water storage and retention (aquifer and reservoir dynamics).
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).
Hydrological regulation	Regulation of hydrological flows integrated with watersheds (water for agricultural and industrial activities; transportation of people, food, etc.).
Erosion control and sediment retention	Soil conservation within the ecosystem (prevention of slides and other processes of material removal).
Soil formation	Soil formation process (weathering of rocks and accumulation of organic material).
Nutrient cycling	Storage, internal recycling, processing, and acquisition of nutrients (fixation of N, P, and other elements of the nutrient cycle).
Material and energy dissipation	Recuperation, removal, and control of excess nutrients and organic compounds (control of contaminants).
Pollination	Movement of gametes for population reproduction.
Biological control	Regulation of trophic dynamic of populations.
Biodiversity regulation	Biological interactions between organisms and with abiotic components of ecosystems.
Refuge	Habitat for resident and migratory populations (stopover, nursery, and feeding areas for migratory birds).
Food production	Part of gross primary production transformed into food (fish, mollusks, crustaceans, and subsistence of activities).
Primary production	Part of gross primary production transformed into raw materials (lumber, fuel, and forage).
Genetic resources	Production of materials and biological products for medicine, scientific materials, acquisition of genes resistant to pests, and ornamental species.
Recreation/tourism	Carrying out leisure activities (fishing, boat cruises meals with family and friends, games, etc.) and opportunities for various tourist activities.
Aesthetics	Mangroves as part of the coastal scenery.
Inspiration for culture and art	Mangroves are the motive and inspiration for artistic creations.
Spiritual	Many fisherfolk and indigenous communities recognize mangroves as sacred.
Maintenance of traditional ecological knowledge	In mangroves, traditional activities are carried out, which are important for the maintenance of autochthonic and ancestral knowledge.

(continued)

Table 15.1 (continued)

Services	Characterization
Science and environmental education	Important spaces for the development of scientific research and environmental education actions.
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.
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.
Mental and physical relaxation	Using mangroves for resting, reflection, and/or physical activities for mental well-being and relaxation, functioning as therapy.

The results were obtained in the Cumbe community, with community participation in the definition of ecological services and compared with the scientific literature (Queiroz et al. 2017)
Modified from Queiroz et al. (2017)
Sources: Schaeffer-Novelli (1989), Barbier et al. (1997), Costanza et al. (1997), De Groot et al. (2002), MEA (2005a, b), McLeod and Salm (2006), Rivera and Cortés (2007), Kumar (2010), De Groot et al. (2010), Meireles and Campos (2010), and Fransan-Sanchez (2019)

with much more accurate calculations in literature (Saenger 1999; Walters et al. 2008; Hussain and Badola 2010; Warren-Rhodes et al. 2011).

Mangroves, however, also provide cultural ecosystem services that are defined by MEA (2005a) as "non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences." This approach defines cultural ES 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 ES in a geographic or site-specific context. In this framework, cultural benefits (in terms of experiences), identities, and capabilities are seen to arise from the mutually reinforcing relationships between the environment and the 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 community-specific values (NRC 2004). Even though the cultural dimensions of well-being are multifaceted and complex (Russell et al. 2013), many studies highlight the importance of considering the cultural benefits of the environment to human well-being in environmental decision-making (e.g., Satz et al. 2013; 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 ES frameworks (Chan et al. 2011). Neglecting cultural services provided by ecosystems excludes considerations that often matter to vulnerable and otherwise underrepresented communities (Satz et al. 2013; Queiroz et al. 2017). It is thus of fundamental importance to understand how people perceive mangroves and to use this vision as another essential element in making such social-ecological systems sustainable in the long-term perspective (Kittinger et al. 2012; Gould et al. 2014; Queiroz et al. 2017).

Despite the abovementioned, cultural ES remains poorly understood as they are commonly subjective and have multifaceted and complex dimensions (Russell et al. 2013). Much of the coastal wetland valuation literature is focused on 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 service quantification, even if the quantitative tools used are new (Queiroz et al. 2017). A rigorous application of methods to quantify noneconomic values of mangroves is still lacking (James et al. 2013; Thiagarajah et al. 2015; Hsieh et al. 2015). Besides, decision-making processes should not neglect the experience of local communities (Raheem et al. 2012; Peres et al. 2016). In this sense, the concept of cultural ES offers a powerful way of conveying that natural systems underpin a range of benefits for the 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 ES 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).

15.3 Calculating the Importance of Local Economy: The Fisheries Example

Another problem to be faced towards mangrove sustainability is the understanding of the real impact of local economies in mangrove ecosystems and the surrounding areas. How important are, for example, artisanal fisheries in the local context? Can we reliably calculate it? Small-scale fishing (SSF), significant in mangrove areas, is a highly productive sector accounting for more than 50% of the world's annual fish catch (FAO 2017). Concerning local communities, SSF plays a dynamic and diversified economic role, is typically respectful of local natural resources, and seeks sustainable habitat exploitation. They incorporate the values and traditions of the areas where they happen, favoring cohesive social processes that contribute to global cultural enrichment (FAO 2017). Although their importance has been demonstrated, artisanal fisheries are disappearing in many places (Tesfamichael et al. 2014). This is especially evident in coastal areas near large urban areas, where ca. 50% of the human population lives (Small and Nicholls 2003). Strategies for managing and recognizing the importance of artisanal fisheries are still very weak, once information is scarce or even nonexistent (Salas et al. 2007).

The local economies of traditional communities obey their logic but are nevertheless relevant to the capitalist societies in which they operate. Many authors stress that traditional communities are important agents in nature conservation (e.g., Saenger 1999; Rönnbäck et al. 2007), and so it is with mangroves and traditional communities. This reflects another important aspect of traditional cultures, which is an approach to natural resource management that is marked by respect for the system's natural cycles and exploitation that considers the capacity of animal and plant species for recuperation (Hussain and Badola 2010). Monocultures such as shrimp aquaculture have led to relegation of the traditional economy to a second and third level compared to the alleged progress associated with intensive shrimp farming (López-Angarita et al. 2016). In Brazil, thousands of families survive on artisanal fishing, but little is known about how and how much they contribute to the economic sustainability of local populations (Diele et al. 2005; Aburto-Oropeza et al. 2008; Walters et al. 2008; Hussain and Badola 2010). Data on artisanal fisheries are sparse, incomplete, and biased, and their position within a country's economic and social framework being very difficult to ascertain (Hussain and Badola 2010; Hellebrandt et al. 2014). That is the main reason for the invisibility of this economic sector.

Brazil is now facing a complicated fisheries scenario, in which biodiversity and renewable resources are threatened by the lack of appropriate management policies (Amaral and Jablonski 2005; Pinheiro et al. 2015). Some efforts to recognize the economic and social role of artisanal fishing have been made, including the creation of the Fisheries and Aquaculture Especial Secretariat (SEAP) in 2003. SEAP's main objective was establishing sustainable measures for exploring marine and fluvial renewable resources. Despite the measures adopted since 2000, efforts have not been regular, and the work has not yielded an ordered and effective body of data, especially for artisanal fisheries (Dias-Neto and Dias 2015). Data on Brazil's artisanal fisheries show that the sector is responsible for ca. 65% of the country's seafood production, employing 957,000 people (99.2% of the officially registered fishermen in the country) (IBAMA 2007; MPA 2012). Precise and reliable (comparable) data are, however, almost nonexistent, and understanding the current importance of this sector requires semiquantitative tools.

In fact, there are very few studies based on direct monitoring using economic and social tools, but there is a consensus that they are urgently needed to understand the potential loss of tangible and nontangible ES (Saenger 1999; Queiroz et al. 2017). Coastal communities are economically dependent on artisanal fishing (Kuhl and Sheridan 2009; Hussain and Badola 2010), but it is important to highlight that fishermen's know-how and practices are essential in any attempt to preserve the ecosystem because they are the people who best understand the seasonal cycles of renewable resources and the system's carrying capacity (Yates and Schoeman 2014). However, most of the time their voice is disregarded in top-down management and strategies (Saenger 1999). Mangroves are fundamental to the way of life of traditional communities (Diegues and Arruda 2001; Kuhl and Sheridan 2009; Hussain and Badola 2010; Queiroz et al. 2017), but the economy generated by local people working on the place (e.g., artisanal fisheries) is almost invisible in the official statistics (Queiroz et al. 2020). Artisanal fishing in Latin America is mostly maintained by the efforts of fishermen rather than through the support of official bodies (Acosta 1996). This is a low-investment economic sector that generates a variety of activities while producing food for local and regional markets. One of the few studies that include an in-depth economic evaluation of artisanal fisheries (and other services) is the one by Hussain and Badola (2010). The authors calculated that in areas surrounded by mangroves, income may be as high as US$ 44 per work hour. In areas where mangroves are not present, the rate drops to US$ 3 per hour. Nonetheless, care needs to be taken when considering these numbers, as each community is different, and the renewable resources may differ widely.

15.4 Exploitation of Mangroves for Aquaculture and Other Monocultures

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 human use, based solely on economic consideration by policymakers (James et al. 2013). People tend to forget that mangrove ecosystem conservation deserves special attention because of the number of people living within 10 km of significant mangrove areas, estimated to be 120 million by 2015 globally (UNEP 2014). The bulk of this population resides in developing countries in Latin America, Asia, and West and East Africa and is significantly dependent on mangrove resources for daily sustenance and livelihood.

Approximately 26% of mangrove forests worldwide are degraded due to overexploitation for fuelwood and timber production (Valiela et al. 2001). On the other hand, 38% of degraded mangrove areas are attributed to the conversion to industrial shrimp aquaculture (Ellison 2008), which makes this industry one of the most important causes for mangrove degradation and suppression (FAO 2010). In Brazil, the shrimp industry is considered the greatest threat to mangrove conservation (Queiroz et al. 2013a).

The shrimp industry argued that its expansion in tropical and subtropical areas would increase the supply of food, decrease the pressure on fish stocks, increase foreign exchange earnings, and provide food for countries in need, developing the policy idea of the "Blue Revolution" (Costa-Pierce 2002). Shrimp aquaculture has emerged as a major cause of the destruction of mangroves, coastal landscapes, and the transformation of livelihoods in areas where there has been intensive development (Barbier and Strand 1998; Rönnbäck 1999; Alongi 2002; Shanahan et al. 2003; Polidoro et al. 2010; Queiroz et al. 2013b; Queiroz 2014). The results on mangrove and adjacent ecosystems seem to be linked to poverty, food insecurity, displacement of communities, and pollution of drinking water, as well as poor conditions and impacts on the health of workers in the shrimp industry itself (Bailey 1988; Beveridge et al. 1994; Flaherty and Karnjanakesorn 1995; Dewalt et al. 1996; Stonich et al. 1997; Stanley 1998; Kautsky et al. 2000). This industry favors the destruction of habitats formerly used for artisanal fishery by reducing the possibility to perform extractive subsistence activities, endangering food security, and transforming the dynamics of life in traditional communities (EMBRAPA 2004; IBAMA 2005; Meireles et al. 2007; Meireles and Queiroz 2010; Warren-Rhodes et al. 2011; Montserrat 2011; Montserrat et al. 2011; Queiroz 2014).

Traditional cultures develop a small-scale commodity mode of production, opposite from the capitalist mode of shrimp production. For example, in the case of industrial aquaculture, the workforce but also nature itself becomes a commodity, transforming the broad perception of the mangrove habitat. These two societies (industrial and artisanal) have different rationales, presenting a set of social goals, which are consciously and differently developed to achieve a very distant set of objectives. One mode of production is oriented for monetary profit (aquaculture), where traditional collective solidarity disappears and therefore natural resources are degraded. The other (artisanal fisheries/collection) still belongs to a society whose goal is the maintenance of that collective solidarity and not the accumulation of assets and income. In this way of life, the natural resources on which they depend upon are preserved (Godelier 1984). Therefore, between these two types of society, there is a fundamental difference in the conception and representation of nature and its resources.

In Brazil, the average productivity of farmed shrimp reached 6084 kg/ha/year in 2003 (ABCC 2004; Rocha et al. 2004). Dote Sá (2010) established the average productivity of 12,194 kg/ha/year for shrimp farming developed in the environment of Jaguaribe River (Ceará State) which is higher than that of any Brazilian state, including Ceará itself (7676 kg/ha/year) (ABCC 2004; Rocha et al. 2004) (see Chap. 3, Map 5). If shrimp are sold at 2.34 EUR/kg, the economic profit generated from the commercialization of shrimp would be about 28,533 EUR/ha/year. When comparing this value with the economic gains generated by mangroves per hectare at 7120 EUR/ha/year, it is possible to conclude that in the very short term, the shrimp industry seems very appealing. However, part of the mangrove is deeply affected by this type of activity (see below), and the distribution of benefits is much lower among the community. Profits generated per hectare of shrimp farm are difficult to match by the economic values that a hectare of mangrove can provide, being apparently superior. It is widely recognized that shrimp aquaculture generates medium-term environmental damage of high importance because they must physically occupy and displace part of the natural resources of an area. This process of occupation and installation produces a range of biochemical changes in the ground, causing soil waterproofing and making them unusable (Alongi 2002; Shanahan et al. 2003; IBAMA 2005; Rivera-Ferre 2009; Polidoro et al. 2010; Queiroz et al. 2013a).

Many reasons make shrimp overexploitation and mangrove conservation noncompatible. For example, it is well known that mangroves are breeding grounds for many commercially important fish species (Robertson and Duke 1990). Wild shrimp spend a considerable amount of their life cycle within estuaries. The estuarine habitat provides nutrient-rich waters, and the mangrove rhizosphere provides shelter from predators. Any disturbance to this ecosystem by mangrove conversion results in a smaller fish population and lower incomes for fisherfolks and the health of the ecosystem (Spaninks and Van Beukering 1997). Several studies estimated that nearly 80% of fish catches in tropical coastal areas are directly or indirectly related to mangrove health (Costanza et al. 1997; Field et al. 1998; Sathirathai 2003; Ellison 2008; Polidoro et al. 2010). If we consider mangrove ES that gives economic benefit, it can be argued that their economic value would be estimated at ca. 10,000 EUR/ha/

year (Costanza et al. 1997). The lack of ownership and clear land-use policies, as well as the underestimation of other services nonvisible with conventional tools, has made mangroves vulnerable to an economy based on short-term economic growth. This is a common fact not only in this case but in many others where the opinion of traditional communities is not taken into consideration (Yates and Schoeman 2014).

Predatory practices, especially those related to achieving high productivity per hectare, have been widely adopted by aquaculture ventures and have generated social and environmental impacts with disastrous results, widely studied in Brazil (IBAMA 2005; EMBRAPA 2004; Queiroz et al. 2013a; Queiroz 2014; Lacerda et al. 2021). The search for high productivity in this context is revealing the true essence of the shrimp industry. While shrimp farms achieve temporary high productivity, they generate impacts such as the inevitable release of exotic species – in Brazil shrimp farming is based on exotic species (Lacerda et al. 2021) – competition with native species, and release of untreated effluents into water bodies, thus causing the decline of local species' stocks and making artisanal fishing unfeasible, thus causing the impoverishment of communities and jeopardizing their livelihoods.

In this context, the shrimp industry, behind the high productivity figures reported from its marketing, hides an unsustainable practice revealed when examined from the socio-ecological point of view. The development of this activity involves outsourcing high costs to society and the environment – disease, pollution, and poverty – while a minority appropriates the profits obtained, thus establishing a serious ecological and environmental conflict and reproducing environmental injustice (Martínez-Alier 2007; Acselrad et al. 2009; Meireles and Queiroz 2010). Furthermore, they lie about their own productivity when numbers demonstrate a decrease in terms of productivity and benefits. Queiroz et al. (2013a) showed that the official numbers presented by the shrimp aquaculture in the state of Ceará were virtually impossible, because the productivity repeated in different years the same number, rounded to the higher during several years. The opacity of the data given by this industry makes its practice not only difficult but also questionable.

Another point to consider is that this type of activity is favoring exclusively small societal groups at the expense of the impoverishment of traditional communities, reflecting a model characterized by the concentration of power and the appropriation of spaces and natural resources – that is the basis of environmental injustice. Traditional communities are led to territorial exclusion and insecurity caused by the impossibility of continuing traditional practices (Shanahan et al. 2003; C-CONDEM 2007; Montserrat 2011; Montserrat et al. 2011).

15.5 The Coast of Ceará State as Case Study

The shrimp aquaculture industry in NE Brazilian mangroves (e.g., Ceará State) developed upon *apicuns* (i.e., salt flats), drastically reducing fluvial and coastal mangrove forests (Table 15.2 and Figs. 15.1 and 15.2). Data shows that the shrimp industry expansion is the main driver for mangrove regression in this region

Table 15.2 Observed area of mangrove forests, salt flats, and shrimp pond in the state of Ceará, Northeast Brazil

	Mangrove forests (ha)			Salt flats (ha)			Shrimp ponds (ha)		
Estuary[a]	–1988	1988–1998	1998–2008	–1988	1988–1998	1998–2008	–1988	1988–1998	1998–2008
Timonha/Ubatuba	4,652.05	4,844.26	5,220.12	3.954.00	3,883.09	3,332.07	947.06	1,022.89	1,295.80
Remédios	446.88	587.02	536.14	1,345.94	1,239.91	921.06	0	0	484.05
Coreaú	3,281.78	3,432.34	3,626.31	3,416.13	2,991.88	1,848.66	416.70	799.41	1,486.39
Acaraú/Zumbi	3,266.75	3,673.36	3,448.15	3,711.93	3,205.11	2,553.28	154.11	309.10	1,768.33
Aracatimirim	68.54	134.75	137.65	379.18	352.14	329.42	0	0	33.41
Aracatiacu	931.03	743.20	844.20	714.48	900.03	461.29	0	0	309.59
Mundaú	1,254.95	1,028.58	1,205.46	660.98	595.68	389.70	0	148.21	311.07
Curu	91.09	91.44	132.00	134.35	128.44	65.26	0	0	465.79
Ceará	790.83	825.44	1,066.47	420.32	510.73	269.11	189.70	203.66	169.02
Cocó	857.16	728.84	905.25	210.43	102.86	64.89	129.18	72.15	53.61
Pacoti	570.49	608.00	850.09	452.18	385.79	275.02	0	44.41	14.91
Mal Cozinhado	63.92	52.86	69.54	154.78	143.96	166.44	72.65	73.83	72.90
Choró	109.96	90.85	113.17	571.72	654.72	442.87	109.89	91.79	349.45
Pirangi	209.23	174.19	160.44	3,079.84	3,127.91	2,010.95	971.10	1,017.32	1,485.02
Jaguaribe	995.37	885.10	994.41	528.97	366.67	365.64	688.23	957.80	1,811.29
Barra Grande	109.14	80.64	87.51	180.94	99.96	70.26	466.36	592.56	618.14
Total	17,699.17	17,980.87	19,396.91	19,916.10	18,688.88	13,565.92	4,144.98	5,333.13	10,728.77

Sources: AQUASIS (internal document); Thiers et al. (2017)
[a]See Fig. 15.1 and Chap. 3, Map 5 for the locations

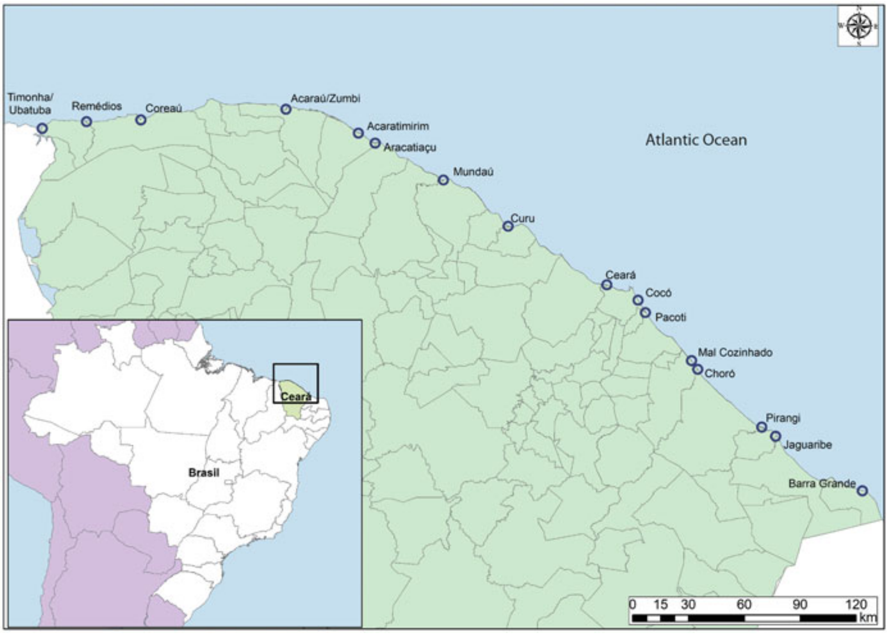

Fig. 15.1 Estuaries of mangrove occurrence in the state of Ceará listed in Table 15.2. (Source: research database)

(Fig. 15.3). Thiers et al. (2017) found a discrepancy between official data and the data acquired through diverse methods and algorithms used to analyze the system's transformation. In fact, such changes deeply affected many traditional communities socially and economically, such as the Quilombo do Cumbe (Aracati, CE), increasing land ownership conflicts (Leroy and Meireles 2013). The quality of life of shrimp aquaculture workers is another worrisome aspect of this industry, including poor work conditions. In some cases, human rights violations have taken place (Meireles and Queiroz 2010; Queiroz 2014) (Fig. 15.3).

The Quilombo do Cumbe (Fig. 15.2) community has been practicing their own traditional management of mangroves on which their livelihoods depend; this makes this community an interesting case study. The research by Queiroz (2014) and Queiroz et al. (2017) identified and characterized the value of mangrove ES based on both the existent literature and the community perception and analyzed how these ES are embedded into the community's livelihood.

The abovementioned community has 621 inhabitants, whose livelihoods directly depend on mangroves. Their main activities are fishing, gathering shellfish (gleaning) and collecting crabs, developing a natural resources management system through a close relationship to natural cycles, and bordering a somewhat complicity

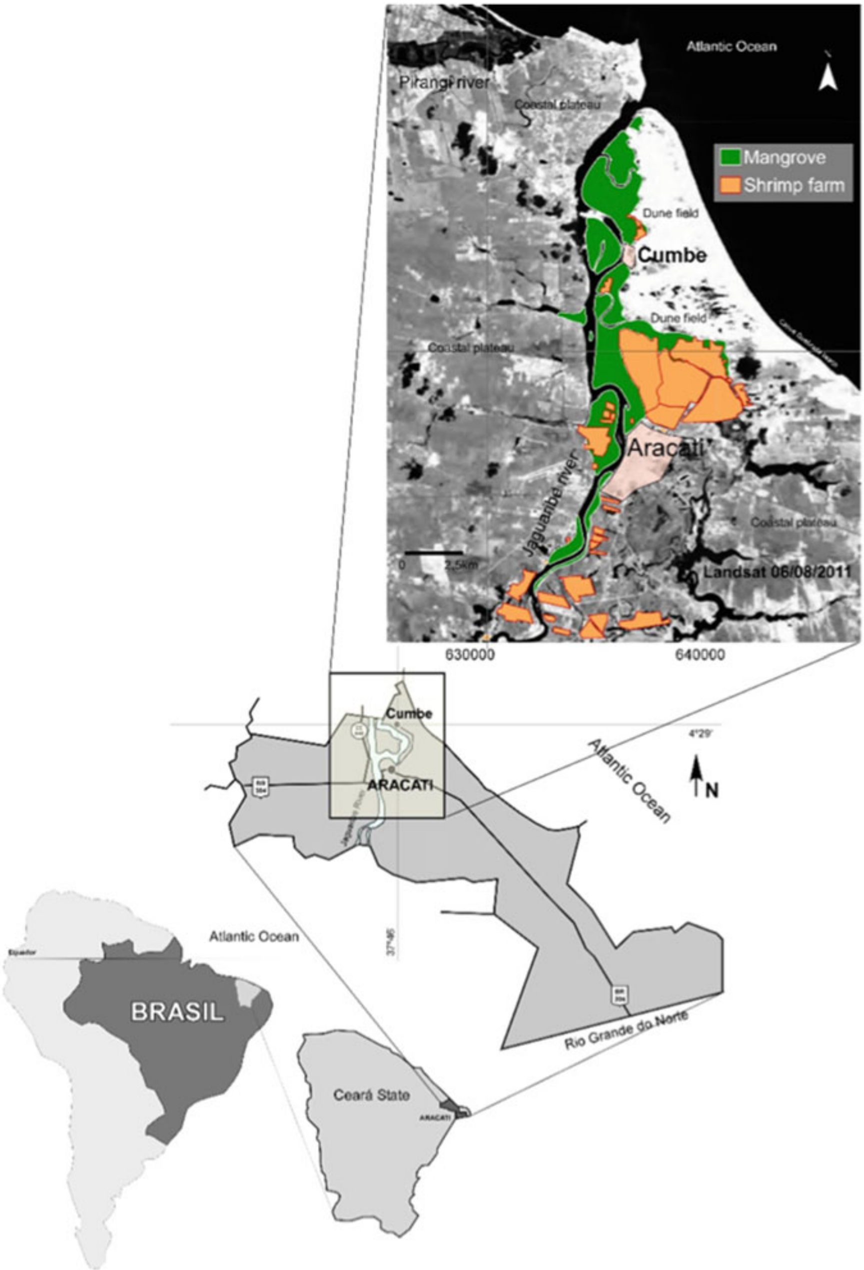

Fig. 15.2 Location of the Quilombo do Cumbe, Ceará State, Brazil. Green, mangrove forest; orange, shrimp aquaculture ponds

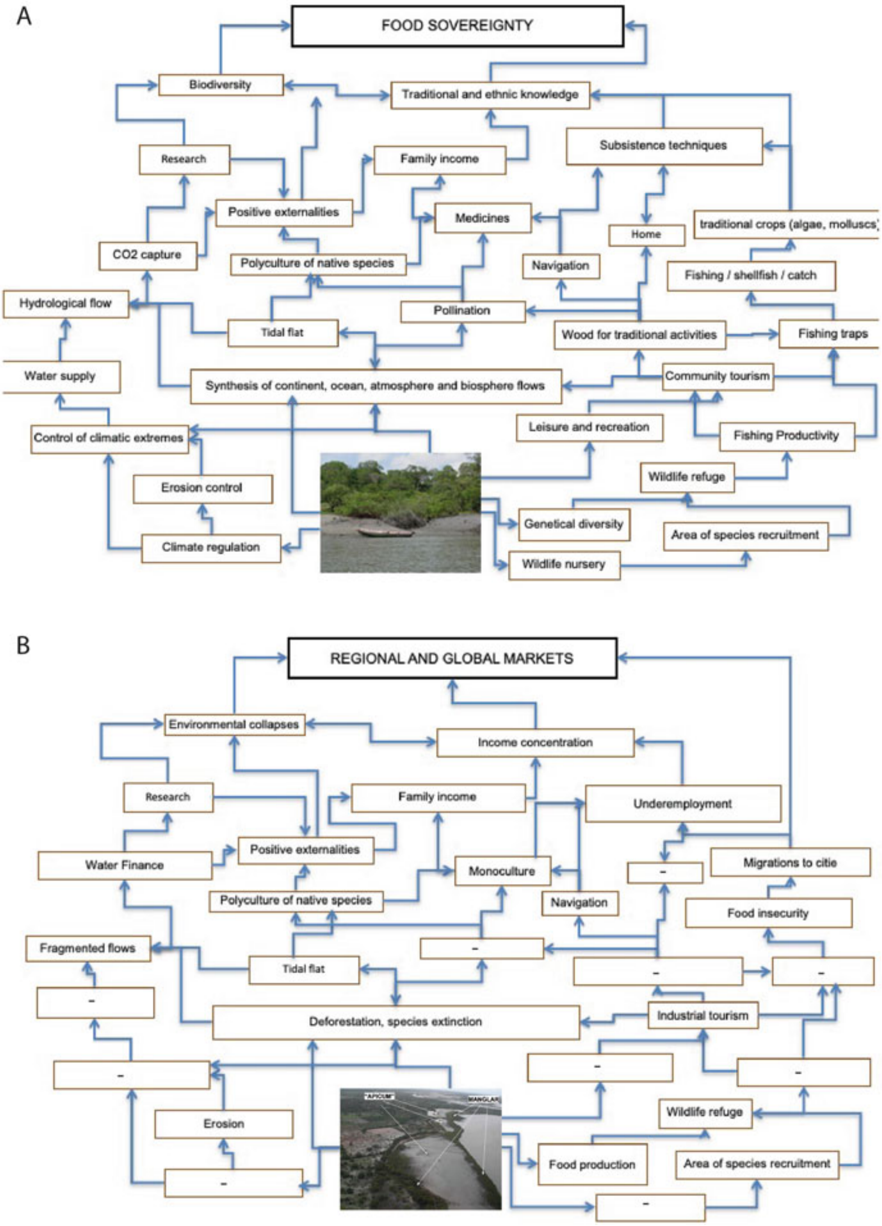

Fig. 15.3 Main mangrove ecosystem services and functions related with food sovereignty (**a**); threats to mangroves converted for shrimp farming (with extinct or fragmented components) (**b**). (Source: Queiroz et al. 2013a)

with nature. These "quilombolas"[1] maintain strong economic and symbolic ties with land and sea through continuous observation and accumulated knowledge. The Jaguaribe River basin, in which Quilombo do Cumbe is located, is the largest river basin in Ceará with an area of 72,645 km^2. A large portion of all local shrimp farms (44.2%) directly affected the mangroves; 63.6% of the farms caused serious damage to the riparian forest of endemic carnaúba palms (*Copernicia prunifera*) (Queiroz et al. 2013b).

It was thus possible to describe a set of ecosystem services altered by mangrove degradation (Fig. 15.2). Queiroz et al. (2017) demonstrated that societal relationships were altered and that the community dynamics were broken after the ingress of the shrimp farming industry. Interestingly, this study identified the joy of locals being closely linked to the proximity to the forest. For the *quilombolas*, mangroves were considered spaces for meditation and reflection: "The mangrove is the best place to hear the noise of the wind. It is a place for my thoughts. The truth is that at times I get stressed in the city, but I never get that way when I am in the mangrove." The testimony is in line with studies on coastal environments evidencing that people living closer to the coast self-report higher levels of health and personal fulfillment (e.g., Wheeler et al. 2012). For the studied community, the mangrove constituted a critical aspect of their worldview and their sense of belonging. A fisherman stated: "Mangroves mean everything to me, they are life. I feel privileged to be part of it, to live close to it, to open my window and see this landscape makes me feel well and happy because it is from where I draw sustenance for myself and my family." This perception of mangroves held by the fishermen of the Quilombo do Cumbe links ecosystem functions, services, and well-being, highlighting the prominent role of cultural services (James et al. 2013; Bell et al. 2015; Hsieh et al. 2015; Thiagarajah et al. 2015).

Another important point to highlight is the loss of food sovereignty caused by shrimp farming. It has been demonstrated in this area that the earnings of people living from fisheries or clam harvesting are potentially higher than those of people working on shrimp ponds (Queiroz 2014). The search for excessive productivity in a short-elapsed time causes systemic collapse and inhibits other future uses of this system (Alongi 2002). The shrimp aquaculture industry has often been presented as "one of the most lucrative economical activities" in Brazil, but the truth is that no more than 5% of the benefits return to the local people (Queiroz 2014). The decline and the consequences of the business failure, with the inevitable abandonment of the shrimp ponds, came without reaching the expected earnings for the investors. The main problem was that the coastal and fluvial communities lost the mangrove ecosystem welfare, their economic inputs, and part of their ways of living. The

[1] Up to a hundred years later from the signing of the Áurea Law (Lei Áurea) that freed the enslaved in Brazil, *quilombos* were considered places with large concentrations of enslaved African or Afro-Brazilians who rebelled against and escape from the colonial regime. With the Federal Constitution of 1988, the term *quilombo* had its concept expanded so that today it is considered any area occupied by communities that remain from the former *quilombos*. Source: http://www.palmares.gov.br/?p=19099 (accessed on June 2021).

food sovereign has been deeply affected by this boom-and-bust industry (Acselrad et al. 2009). Overall, the NE of Brazil has been considered an emblematic case study of an exponential monoculture that is bound to fail in its structure, but not without spoiling a rich, complex coastal landscape.

15.6 Final Remarks

This chapter intended to show the relevance of social and cultural valuation of mangrove ES in management and decision-making and the importance of considering local users' perceptions in conservation policies. Primarily the case study in Quilombo do Cumbe contributes to the advancement in the theoretical framework and methodological approach of sociocultural valuation of the ecosystem services. The study captured the importance of locally identified cultural services that are context-specific, in such a community that sees beyond monetary value. In order to accomplish that, further research should employ valuation surveys and participatory methods such as focus groups and participant observation to gather information and actively involve target communities – whose design should be informed by both international and local studies. Furthermore, such studies have implications for mangrove conservation. The fishers of the Quilombo do Cumbe community maintain strong symbolic ties with land and 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 lead, intentionally or unintentionally, to their environmental protection, as it has been shown in other areas (Walters 2004). Nevertheless, fishers' comprehension and perceptions of mangroves have not been considered in past and current government management policies in the coastal area. Instead, shrimp aquaculture has been prioritized over artisanal mangrove exploitation, which led to rapid degradation of mangrove habitat and resources (Queiroz et al. 2013b). It is necessary, as highlighted in other coastal wetlands, to include social value in 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). We, therefore, suggest that mangrove conservation and management should embrace such complexity by considering community perceptions of ecosystems and well-being as an indispensable criterion for confronting the key challenges in conservation.

The chapter aimed at demonstrating that economic goods derived from direct extraction of natural resources can be as important as other types of exploitation such as shrimp aquaculture (Rönnbäck 1999). A rigorous application of methods to capture noneconomic values is still lacking and decision-making processes should not neglect the experience of autochthonous populations (Raheem et al. 2012).

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