Ecosystem Services 11 (2015) 67–75

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Valuation of marine and coastal ecosystem services as a tool for conservation: The case of Martinique in the Caribbean

Pierre Failler [a,*], Élise Pètre [a], Thomas Binet [a], Jean-Philippe Maréchal [b]

[a] Centre for the Economics and Management of Aquatic Resources (CEMARE), University of Portsmouth, St. George's Building, 141 High Street, Portsmouth PO1 2HY, United Kingdom

[b] Observatoire du Milieu Marin Martiniquais (OMMM), 97200 Fort-de-France, Martinique

ARTICLE INFO

Article history:
Received 6 March 2014
Received in revised form
6 October 2014
Accepted 25 October 2014
Available online 14 November 2014

Keywords:
Martinique
Coral reefs
Mangroves
Sea grass
Total economic value

ABSTRACT

Martinique possesses 55 km^2 of coral reefs, 50 km^2 of sea grass and 20 km^2 of mangroves. These three ecosystems produce services to a value estimated at 250 million € (M€)/year (valuation recently undertaken under the French initiative for Coral Reef Conservation—the IFRECOR program). It is estimated that around 60% of this value originates from direct uses such as recreational activities (diving, excursions, beach activities, etc.) tourism and fisheries. Ecosystem services (indirect uses) such as coastal protection, carbon sequestration, biomass production and water purification are significant since their total value reaches 94 M€ annually (38% of the total economic value). Non-use values linked to improvements in health of coastal ecosystems is estimated to be 10 M€/year. At the ecosystem level, sea grass and mangrove contribute the most (per km^2) to wealth creation (2.16 M €/km^2, 1.87 M €/km^2 respectively, against 1.78 M €/km^2 for coral reefs). They need, therefore, to benefit from protection and management measures in the same magnitude as coral reefs already receive. The valuation also shows that, due to policy inaction, the loss of value is about 2.5 M €/year, which urges politicians to develop a sound conservation policy.

1. Introduction

Ecosystem valuation finds its justification from the fact that, firstly, what nature produces on its own is not accounted at its true value and, secondly, that damage caused by humans is not recorded, since it is most often considered as *res nullius*. It is, therefore, important to put a price on what nature produces and a cost on what humanity spoils (Costanza et al., 1997; Bateman et al., 2013). In other words, nature should be looked at from an economical perspective (Arrow et al. 1999). For economists, this seems the only means to halt the loss of biodiversity (OECD, 2004; TEEB, 2009), notably that of coral reefs, mangroves and sea grasses (Cesar and van Beukering, 2004; Beaumont et al., 2008; Hilmi et al., 2014). Valuing nature thus makes biodiversity enter the field of public economy (with potential optimization of the choice of economic agents) and policy (efficiency of budget allocations).

The first objective of this article is to present an estimate of the total economic value (TEV) of the services provided by coral reefs and associated ecosystems (CRAE) of Martinique, expressed through a monetary equivalent (in €/km² when monetization is possible). The Millennium Ecosystem Assessment (2003) described Ecosystem services as the benefits people obtain from ecosystems, such as provisioning, regulating, supporting, and cultural services. The second objective of the article is to underlines the main elements to consider for the definition of conservation policies and valorisation of the CRAE and of their services.

The extent of the measures to be taken is suggested by the current health of the CRAE of the island. More than 20% of the reefs have disappeared in recent years, while the mangroves suffer from pollution of the rivers and the urbanization of the coastal zone (Schleupne, 2008; Saffache, 2009). Further, the sea grasses are increasingly prone to silting and pollution from various sources, including the chlordecone (Cabidoche et al., 2009). During the budgetary arbitrations on various decisional scales, these measures and more generally the public policies which will have to be implemented (in particular within the framework of the Martinique development scheme of the sea) in order to restore, protect and improve the ecological services of the CRAE, will of course, enter in competition with other political measurements in favour of road infrastructures, industrial development, housing and employment. To quantify the natural heritage is thus of primary importance in order to be able to offer a base of comparison with the other economic and social sectors, where public monies are invested. These have indeed been for a long time the

* Corresponding author. Tel.: +44 2392 848505; fax: +44 2392 848216.
E-mail address: pierre.failler@port.ac.uk (P. Failler).

http://dx.doi.org/10.1016/j.ecoser.2014.10.011
2212-0416/

subject of economic and/or social viability study. This work has been done through the French Initiative for the Protection of Coral Reefs (IFRECOR[1]).

The article begins with a description of the coral reefs of Martinique and their associated ecosystems. In particular, their surface, their characteristics and their health status are examined here. The services which they render, as well as the methods used for their quantification, are the subject of the second part. The results, specific to each use and non use of CRAE, are presented in the third part. The two following parts use the results to analyse current management measures and public policy more generally. Management options are defined using the wishes of the residents and the tourists, while the cost of the political inaction is quantified.

1.1. Health status of coral reefs, mangroves and sea grasses

Resulting from the geographical localization of the island in the inter-tropical zone, coral formations, mangroves and sea grasses develop along the coasts. The following map (cf. Fig. 1), presents the space distribution of the biotopes (sea grasses and mangroves) and biological communities (sets of living communities) constitutive of the littoral ecosystems and marine inhabitants of Martinique between 0 and 50 m of depth (OMMM, 2009), while the table below (cf. Table S1 in the supporting material part (SMP)) reveals their surface in km^2.

The total underwater surface represents 452.22 km^2, broken up into communities of bare movable sea floor (202.26 km^2 or 45% of total surface), algae (140.60 km^2 or 31%—primarily on the Atlantic fringe and the south-west of the littoral), coral (5.6 km^2 or 12% south of the island, the North-East of the Atlantic coast and the outer limit of the bay of Fort of France), mixed communities (0.25 ha or 0.6%), and of sponges and gorgonians (0.114 ha or 0.2%) as well as sea grass (4.974 ha or 11%). Out of the water, mangroves cover 20.63 km^2, of which the major part is localised in the bay of Fort of France.

Overall, the health of the marine ecosystems is alarming. More than 45% are regarded as degraded and 23% very degraded (cf. Fig. S1 in SMP). Less than one third of the ecosystems are considered to be in good ecological health and only 1% can be regarded as being in a very good state. With regard to the mangroves, no data relating to their health exists except an evaluation of the damage generated by the passage of Hurricane Dean, which states that the losses undergone by the settlements of the mangrove are rather variable, ranging from 13 to more than 90% of density (compared to data of 1997) (Imbert and Migeot, 2009). In 2009, another major event lead to the closure of river fisheries and fishing activity in bays, whose watersheds are polluted—the chlordecone pollution resulting from the use of this pesticide on banana plantations for decades. Despite its use being forbidden in 1993, harmful effects on the environment are still present.

The reefs undergo, in addition to environmental calamities, increasingly strong anthropic pressures. Pollution of agricultural, industrial and domestic origin, as well as physical degradation and hyper-sedimentation, weakens them a little more each day. Thus, more than 80% of the coral communities are regarded as degraded (including 44% that are classified as very degraded), primarily at a shallow depth. 20% are classified as in good health and only 1% meet the criteria of being in a very good ecological state (cf. Photograph 1 in the SMP for an illustration of the various health status of the coral communities).

Spatially, the coral ecosystems of the Atlantic coast in the south of the Caravel and those of the Bay of Fort de France are degraded, and have been observed as such since 1978 (Battistini, 1978). The southernmost reef in the south and the communities of the bay of Trinity present, also show signs of generalized degradation (see Photograph 2 in the SMP). The communities in good condition are today on the sea floor of the north-Caribbean littoral, to the south of Bay of Fort de France and on a few other sites (between Le Diamant and Saint-Anne and around the peninsula of La Caravelle). In recent years, the factors contributing most to the reduction of the coral cover are firstly the major episode of whitening of the second half of 2005 (having increased mortality by 15% in the coral communities of Martinique) and secondly, the propagation of coral diseases such as the “white plague” which resulted from the withering.

Sick reef communities were observed at the beginning of 2006. Mortality associated with the development of diseases was estimated at 15% on average in June 2006. The reefs of the south of the island suffered from the strong swells generated by the passage of hurricanes Dean in 2007 and Omar the following year. In a less visible and spectacular way, littoral pollution of anthropic origin (urban, industrial, agricultural wastes and pesticide residues such as chlordecone) is responsible for degradation of the coastal waters, and the clearing of land soils and urbanization as the origin of the excessive suspended particles (suspended elements and hyper-sedimentation), gradually reduce the physiological capacities of the corals enabling them to resist to natural aggressions (Rousseau, 2010). Thus, little by little, the dead coral is colonized by algae which benefit from the enrichment of the littoral waters and various nutrients to develop and proliferate (Legrand, 2009; Trégarot, 2010).

As well as reefs, mangroves are prone to specific and recurring aggressions of natural and anthropic origins, which deteriorate their ecological functions and reduce their surface (see Photograph 3 in the SMP). They are degraded in 2 manners: first, by an accumulation of macro waste between the roots of the mangroves trees that creates obstructions to the circulation of water and leads gradually to a draining of the marine part of the mangrove, limiting the development of young growth and; second, by urbanization, an encroachment and a clearing of the zones of the back mangrove.

Sea grasses are less degraded than the coral communities. Only 12% are considered very degraded and 49% degraded (see Fig. S1 in the SMP). They are overall in an acceptable ecological status, except for those present in bays and sheltered zones of the fringing reefs on the Atlantic coast (see Photographs 4 in the SMP). Their health improves when one moves away from the coast and towards the reef barrier. The sea grasses, for which the health is the best, are localised in the southern point of Martinique (OMMM, 2009).

Sea grasses undergo the same anthropic pressures as the coral reefs. One of the factors limiting the development of the sea grasses, in particular at depth, is the hyper-sedimentation (for instance in the Bay of Fort of France), and mechanical actions of anchors and chains of boats that tear off the roots of phanerogams. In the strongly eutrophicated sectors, the macro-algae develop quickly on the leaves of the phanerogams, which limits their growth.

2. Values and conceptual framework

The monetary value of an ecological service is measured by the tendency of a person to acquire it, decreased by its production cost. Thus, when nature provides ecological services, it is the willingness to pay of individuals which is likely to identify the value of the resources providing the service in question, whether there is real payment or not (Noël, 2006). In other words, the monetary value of the CRAE can be evaluated by the estimation of their contribution to commercial activities (which record costs and benefits) and to non-commercial activities (which record only

[1] A valuation of coral reefs and associated ecosystem is currently being carried out for all French overseas territories (2011–2015).