

An Overview of Problems and Issues of Coral Reef Management¹

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Abstract

This paper considers issues and problems of coral reef management for coastal communities. In particular, it looks at the links between coral reef management and livelihood dependence, poverty and the vulnerability of coastal communities. It also focuses on the risks and impacts of various scales of threat to coral reefs, and how these could affect the livelihoods of coastal communities.

The management of coral reefs can be influenced by valuation studies that reflect various forms of perceived and realized benefits from coral reefs. The paper describes how various methods to value and determine policy for coral reef management are used, with reference to a number of papers in this volume. Institutional issues of devolution and decentralized policy-making are considered with respect to the empowerment of economically poor coastal communities. In particular, there is a focus on the legal frameworks that help or hinder local stakeholders access resources and maintain their livelihoods. The paper concludes that research methods that improve people's understanding of coastal livelihoods, and that incorporate associated values should be encouraged. It further concludes that policy instruments and management tools that empower local stakeholders and support the livelihoods base of coastal communities dependent on coral reefs should be promoted.

Introduction

Coral reefs are a vital natural resource found in tropical waters throughout the world (Spalding et al. 2001). They are important not only to adjacent coastal communities, where they are often a source of livelihood, but also to national and international communities, where they contribute in various ways to oceanic production and deliver other significant benefits related to their role in tourism, recreation and coastal protection, and as indicators for climate change and waste treatment, to name a few (Fabres⁵). As more research findings indicate that the species richness and biodiversity contained in

reef ecosystems may not regenerate once destroyed, the conservation of coral reefs has become a major concern.⁶ Further, people dependent on coral reefs are some of the most vulnerable groups in many coastal and island communities, because reef and reef-based resources are often their primary means of food production, source of income and livelihood (Alcala 1988; Gomez et al. 1994; White 1987). In Southeast Asia, the South Pacific, parts of South Asia, East Africa and the Caribbean, where a high proportion of people live in coastal areas, an estimated one billion people currently depend on fish catches from shallow coastal waters dominated by coral reefs

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⁵ References cited in this paper without year of publication are contained in these proceedings.

⁶ Although coral reefs represent less than 0.2 per cent of the total area of oceans it is believed that there are more species per unit area of coral reef than in any other ecosystem. Spalding, et al. (2001) reported that coral reefs support more than one million species of marine life, sustain tourism industries and provide food for islanders throughout the tropics. While the total area of coral reefs is unknown to date, it is estimated to exceed 600 000 km².

(Whittingham et al. 2003). Declining reef health and coral cover lead not only to loss of income from recreational and fishing activities for coastal communities who have few or no livelihood alternatives, but also have far-reaching national and international consequences affecting the fragile marine ecosystem and its diverse bounties (Burke et al. 2002).

Coral reefs are known to be among the most biologically productive and diverse ecosystems in the world, home to thousands of species of plants and animals, less than one tenth of which have been identified (Birkeland 1997; Serageldin 1998). The reef ecosystem provides habitat and food sources for a variety of marine organisms. The sheer diversity and beauty of these systems draws many tourists to areas around coral reefs, and the resulting income from tourism has increasingly become an integral part of many coastal communities' livelihood. Coral reef fisheries are a vital source of food, income and livelihood to coastal populations, and are also critical to the economic health of many coastal nations (Burke et al. 2002). Fish now constitute 22 per cent of world exports of agricultural commodities. With a total value of over US\$50 billion, they are the most exported agricultural product (Ahmed et al. 2003). The potential annual yield of coral reef fisheries worldwide has been estimated at nine million tonnes (reported in Birkeland 1997). It is, however, the attraction and bounty of coral reefs that leads to threats to these fragile ecosystems. Many of the world's coral reefs are over-fished and/or subject to destructive practices, such as irresponsible tourism or the use of dynamite or cyanide in fish harvesting. Added to this are the severe pressures of human-induced pollution and sedimentation caused by marine and coastal development, and by industrial and agricultural practices far inland.

Coral communities are extremely sensitive to pollution and can only survive within small ranges of salinity, temperature and sunlight. They are also sensitive to the changing climate. A 1998 survey indicated that 16 per cent of the world's reefs were destroyed during that year's El Nino event (Wilkinson 2000). Divers at locations on the Great Barrier Reef, in the Philippines, the Seychelles, Tanzania and Jamaica reported that 70 per cent or more of the

corals had been bleached (Williams 1999). Overall, the focus of research has largely been on the total area of reefs destroyed due to climate change. No estimates of the impact of climate change-induced coral bleaching on the livelihoods of coastal communities have been made. Future research needs to focus on the impact of coral bleaching on the livelihoods of coastal communities, and to estimate the total loss of value caused by climate change.

The major stakeholders related to coral reefs are those people living adjacent to the reef, whose livelihood revolves around the direct extraction, processing and sale of reef resources, and whose homes and land are sheltered by the reefs from wave action (Whittingham et al. 2003). However, these people, and stakeholders in general, have diverse professional interests, and may at times include fishers, local communities, tourists, tourism industry operators, governments, local authorities, and civil society, all of whom are concerned with the management of coral reefs. The issue of coral reef management has captured the attention of this diverse range of stakeholders because reefs offer many diverse "values"⁷ and benefits (many of which are non-market and unpriced). Thus, measuring and identifying the equitable distribution strategies for these values are critical factors in the management of reef systems. Such information may be a basis for management goals or performance indicators under certain policies, and help synthesize stakeholders' goals and ensure the sustainability of the resource (Zhang). This information could also be used to predict the likely impacts of different management strategies on various stakeholder groups.

The purpose of this paper is to provide an overview of the problems and issues of coral reefs relating to their sustainable management, and to identify the values and benefits from coral reefs. The paper also serves as an introduction to the other papers in these Proceedings. Jointly, we hope to identify and explore the links between economic and social values of coral reefs, national policies, and community and stakeholder participation, and hence assist the development of more efficient approaches to the sustainable management of coral reef ecosystems. The following sections of

⁷The term "value(s)" herein refers to all values supported by the coral reef ecosystem, including production and functional values, values derived from services provided, and social, cultural, optional, bequest and existence values. The term itself does not necessarily imply economic value, although we try to make the case that all of the above can be considered in economic terms.

this paper will discuss the values of coral reefs, the main issues in sustainable management of coral reefs, priorities for and links between research and practice, and the optimal direction for future research.

Main issues and priorities in the sustainable management of coral reefs

For thousands of years people have coexisted with coral reef ecosystems, enjoying the products, functions, services, protection, and contribution to coastal culture and lifestyle provided by these wonderfully diverse communities. However, increasingly, coral reef sites are reported to be at risk of damage arising from human-induced change. Talbot and Wilkinson (2001) reported that already 11 per cent of all coral reefs have been totally destroyed or damaged beyond recovery, and that a further 16 per cent were destroyed in 1998 by climate-change-related coral bleaching. They also reported that, without effective management, another 30 per cent of the world's reefs would become seriously depleted in the next 20 to 40 years. Bryant et al. (1998) observed that, in 1998, of the world's reefs at risk, 27 per cent (67 900 km²) were at high risk, while 31 per cent and 42 per cent (79 000 km² and 108 400 km²), respectively, were at medium and low risk.

Figure 1 shows the major threat factors to coral reefs. These can be classified as natural or human-induced. Besides fishing- and shipping-related activities, land-based activities such as land clearing, coastal development and agricultural activities are among the major causes of destruction to coral reef ecosystems. Talbot and Wilkinson (2001) cited the three major human stresses to coral reefs as sediment, inorganic and organic pollution, and over-fishing. Various other studies have reported that sediments and nutrients are among the greatest human-induced threats affecting coral reefs and tropical coastal ecosystems (Johannes 1975; Rogers 1983; Birkeland 1997). Birkeland (1997) noted: "Approximately 75 to 80 per cent of the sediment entering the world's ocean (from the Arctic to the Antarctic) comes off land in the tropical western Pacific, with half the global sediment discharge coming off continental high islands ..."

Soil erosion and transport of sediment to the coastal marine ecosystems has increased

tremendously in past decades due to farming practices, irrigation schemes, and other types of human activities (Doolette and Margarith 1990). Increased sedimentation and nutrient inputs have probably caused broad-scale changes in the biotic communities of coastal regions (Birkeland 1997).

Bryant et al. (1998) classify human-induced threats in four categories, namely: (1) coastal development; (2) over-exploitation and destructive fishing; (3) impacts of inland pollution and erosion; and (4) marine pollution. Analysis of data on 800 sites documented by ReefBase (Version 2) confirms that 80 per cent of degradation is, indeed, caused by human-induced factors. Globally, 36 per cent of all reefs were classified as threatened by over-exploitation, 30 per cent by coastal development, 22 per cent by inland pollution and erosion, and 12 per cent by marine pollution (Birkeland 1997).

The impacts of human-induced threats can be broadly classified into: (1) impacts on the bio-physical condition of the reef, as determined by the reef's health and measured by the percentage of reef damaged and/or dead, reduced biodiversity and reduced fisheries abundance; and (2) impacts on coastal communities and reef users, measured by reduction in fishing and tourism activities, increase in expenses for shoreline protection, and greater vulnerability

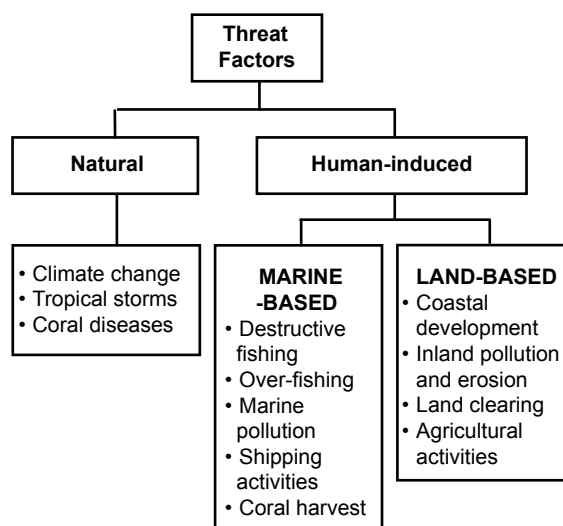


Figure 1. Natural and human-induced threats to coral reef ecosystems (Adapted and modified from Bryant et al. 1998)

of local communities due to loss of income, loss of employment, loss of livelihood and higher incidence of poverty and malnutrition (Lokina).

Damage to coral reefs is occurring at an alarming rate. It has been quantified using indicators in a number of studies (Johannes 1975; Hatcher et al. 1989; Doolette and Margarath 1990; Rogers 1983, 1990; Birkeland 1997; Bryant et al. 1998; Wilkinson 2000; Talbot and Wilkinson 2001). Their findings have brought about a surge of interest in the management of coral reefs, partially because of the variety of values reefs support. However, most policy decisions either dismiss these values or include misleading accounts of the value contained within healthy reef systems. An important policy priority is to highlight these values and present them accurately to policy-makers so as to foster better-informed management decisions (Lal; White; Lokina; Fabres; Figueroa). Incorporating stakeholder groups and coastal communities in research efforts and policy formulation will enhance the legitimacy of policy by enabling participation and education (Kuperan and Sutinen 1998). Legitimizing policy, in turn, increases compliance with regulations. Compliance to and monitoring of these regulations by adjacent communities and direct beneficiaries are essential if coral reefs are to be managed sustainably, especially when it is recognized that these groups are among the largest threats to reef survival. Further, educating beneficiaries about the values supported by coral reefs will increase global awareness and raise the issue of sustainable management of coral reefs on the policy agenda.

Values of coral reefs

As human society has increased, so too has the importance of coral reefs, with the diverse social and economic values of coral reefs being provided to distant as well as adjacent communities (Fabres). These values include marketable values (associated with products, functions and services), and non-marketable values (associated with opportunity, cultural significance, bequest and simple existence). All of these values can and should be considered in economic terms and used to guide the management of coral reefs. Despite the fact that

coastal development and landuse decisions affect coral reef ecosystems and the ability of the reefs to provide services and benefits for human welfare, in most cases, decisions are made without considering the potential damage to coral reef ecosystems. For example, decisions about land clearing or logging often do not consider sedimentation, which damages the reef ecosystem. Thus, it is important for decision-makers to understand the need to consider what values to identify and assess when new developments are planned on islands and in coastal areas, and how these developments will influence coral reefs.

The values of reefs can be measured by methods broadly categorized as “revealed”, and “stated” preference (see Bennett for explanation). Revealed preference values are observable transactions with a “behavioral trail” (Bateman et al. 2002). It is well recognized that the values generated by coral reefs should be evaluated in terms of the goods and services they provide. To most coastal communities, coral reef fisheries are an important source of food and income for local populations. For example, in the Philippines, coral reefs supply between 11 and 29 per cent of the total fisheries production.⁸ Reef ecosystems also provide values from tourism, recreation, scientific research, and by way of their educational, medicinal and pharmaceutical uses. Economists also argue that non-use and intrinsic values provided by coral reef ecosystems, such as aesthetic, option and bequest values, should not be neglected. These values can only be measured by stated preference techniques because there are no observable market transactions for them, and they have no “behavioral trail” – that is, they have no effect on consumption patterns that lead to observable changes in the price or quantity of a resource traded (Bateman et al. 2002).

This section focuses on two main issues in the economic valuation of coral reefs. The first relates to identification, quantification and measurement of the economic values of coral reefs using revealed and stated preference techniques; the second to the varying determinants and concepts involved in dealing with the economic valuation of coral reefs.

⁸ From “ICRI country report: Philippines”, p. 1.

Identification, quantification and measurement

When discussing the economic values of coral reefs it is necessary to identify and quantify the values, and to identify standard practices for their measurement. That is, what are all of the values that coral reefs support, and what methods do we have to quantify these values?

As noted above, coral reefs are economically valuable through their direct and indirect use (the products, functions and services they offer) as well as intrinsically. They provide direct monetary value through the extraction and trade of resources and through recreation (Nam and Son), now and in the future. They also deliver social and cultural values to coastal communities; natural barriers and buffers to environmental hazards; intrinsic value to humans by virtue of their existence; and value for future generations (see Figure 2 for economic values supported by coral reefs).

To represent accurately the total economic value of coral reefs, all of these factors should be considered (see Cesar and Chong, Spurgeon, Lal and Yeo for more on the concept of total economic value). A variety of methods can be used to estimate these values (Dixon 1998; Spurgeon 1992; Cesar and Chong). Where goods and services traded in a market result in a net producer surplus (revealed), the net factor income (NFI) method is the most appropriate (Ngazy et al.). The NFI method estimates the physical relationship between the coral reef area and economic activity. When estimating producer surplus, the replacement cost (RC) method can also be used. Here, considering the cost of providing marketable goods and services by alternate means generates a value attributable to the reef. However, there is some debate about whether or not this technique is misleading because producers do not necessarily use the alternative presented (Anderson and Rockel 1991; Woodward and Wui 2001). Nevertheless, the fact remains that the coral reef system is providing these goods and services that are of some value to coastal communities, and that damage to the system will affect these goods and services and the potential producer surplus generated from them. Therefore, this value should also be taken into account when estimating the total value of the system.

Non-market values are a little more complicated to estimate, as they do not rely on objective indicators of value. There are a few techniques that have been established to deal with this (see Bennett; Woodward and Wui 2001). Common methods used for non-market ecosystem valuation include the travel cost (TC) method (Nam and Son; Ahmed et al. 2003) to implicitly value recreation (Freeman 1993); hedonic pricing (HP); and the contingent valuation method (CVM) (Bennett; Seenprachawong; Ahmed et al. 2003; Yeo; Ngazy et al.; Woodward; and Wui 2001). The subjective nature of these methods causes substantial variability in outcomes (discussed in Freeman 1993), but they, at least, provide an avenue to estimate the non-market values supported by coral reefs. With consistent design and methodology, coral reef valuation studies will benefit from the use of these techniques in that they will be able to compare the relative value of non-market goods and services across sites, and better approximate the total value afforded by reef systems.

Varying determinants and concepts

Once the types of values offered by coral reefs and the methods to estimate them have been determined, it is necessary to look at issues that may influence the data collected. This is especially true for the less objective non-market valuation indicators. These often rely on personal interviews with respondents, based on hypothetical market scenarios, and estimates of willingness-to-pay for or accept certain conditions placed on the natural resources by management. The fact that coral reefs support a diversity of values raises at least two important issues which should be kept in mind when conducting valuation studies in any multiple use area. These issues include the different stakeholders involved; and the consistency of knowledge about the values the system supports.

The first issue, the many different stakeholders who use reefs for a variety of reasons, is especially troublesome because of the often considerable economic disparity between stakeholder groups. Researchers must be aware that this disparity exists if they are to get an accurate picture of the economic value provided by the reefs to all users. Contingent valuation relies on the respondent's willingness to pay for or accept conditions described in the hypo-

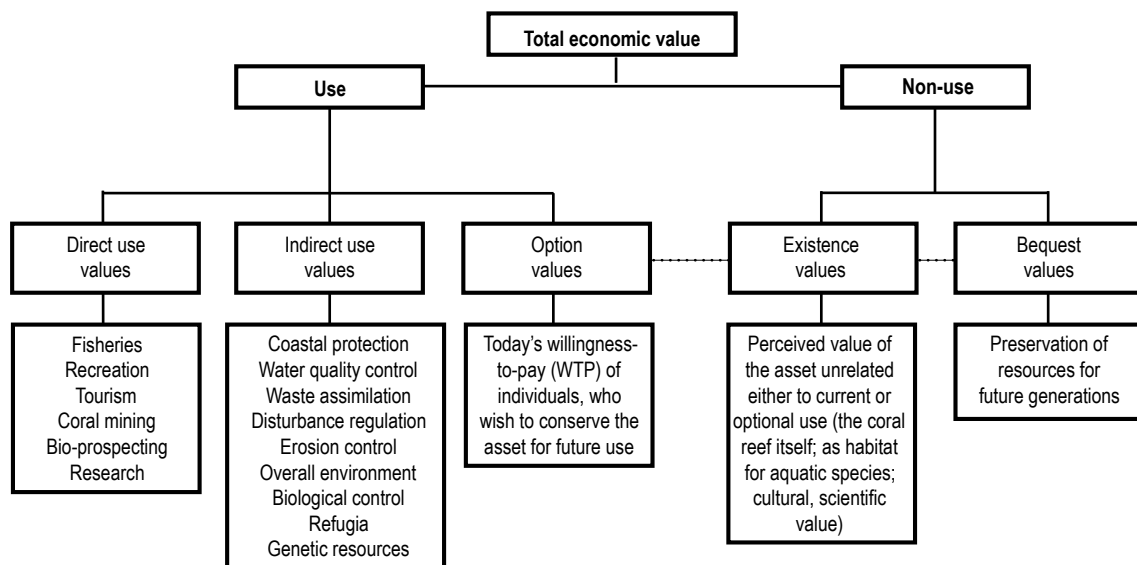


Figure 2. Total economic value of coral reefs (Adapted from Payoyo 1994; Woodward and Wui 2001; and Costanza et al. 1997)

thetical scenario. Choices are made based on the respondent's perceived value of the resources. The amount a respondent is willing to pay often depends on the amount they are "able and willing" to pay (Freeman 1993). Consider a dive tourist and a subsistence fisher placing a dollar value on the existence of coral reefs. The values they place on this will most definitely be different because of the likely socioeconomic disparity, and the difference in the relative importance of the resource to the respondents. Cultural differences between stakeholder groups may also affect the economic value placed on certain goods and services provided by reefs. Social and cultural values, for example, may be viewed differently by different stakeholders and may be a source of considerable variability (see Spurgeon for a description of potential stakeholder roles in management).

The second constraint, the diversity in the conceptualization and appreciation of the values provided by coral reefs, is easier to deal with but still requires considerable attention. An understanding of the values supported by coral reefs may be lacking among resource users and other beneficiaries because many of the values are either taken for granted (coastal/storm protection, waste assimilation), simply unknown (see, for example, Nam and Son), or not considered in economic terms by users (global biodiversity, climate change indicators). These factors must be taken into account when researching the value people ascribe to coral reefs, as people who are more familiar with the

types of values and those who consider more values, in economic terms will be likely to offer higher estimates. The fact that people are not familiar with the causal relationship between certain coral reef goods, services and functions and the economy does not mean that the relationship does not exist. However, estimates gathered through coral reef valuation studies that do not recognize the encumbering effect(s) of this lack of knowledge will misrepresent the total economic value of the system. Often this realization comes after the goods, services or functions disappear, by which time it is too late to save the resource, and other strategies must be employed to deal with the created needs. Contingent valuation research can deal with this problem by educating respondents about the multiplicity of values supported by coral reef systems. This assumes, however, that researchers themselves are aware of these values and are capable of explaining the link between the condition of the reef and the local economy.

Another area of concern relates to the spatial scale of coral reef influence (see Figure 3). Humans value coral reefs on three broad spatial scales – the local, national and international levels. The types of goods, services and functions valued differ at these spatial scales, as do the impacts of policy on the economic value of coral reefs. (Moosa; Walling; Weru; see White for coral reef management approaches at different scales.)

At the local community level, coral reefs may be valuable because they are a source of livelihood and subsistence, a part of peoples' lifestyle and a socio-cultural aspect of their life. As poor people's dependence on coral reefs may take the form of subsistence or lifestyle activities, many of the transactions carried out do not enter into the national cash economy (IMM Ltd. 2002). For example, in the South Pacific, 80 per cent of the total coastal fisheries production is from subsistence fishing, and slightly under half of the total annual commercial catch originates on coral reefs (Dalzell et al. 1995). A priority in coral reef management, therefore, lies in the assessment of "vulnerability" of coastal communities or stakeholders – how much of their livelihoods is dependent on coral reef ecosystems. The relative value of coral reef resources to coastal individuals is often extremely high because livelihood largely depends on the health of the reef. (At the same time, it is also important to measure the resilience and adaptability of coral reefs and coastal communities to stressors that may affect resources.) As options become available and accessible, the relative value of coral reefs to the livelihood of individuals in coastal communities decreases (see figure 4). This says nothing about the absolute value of coral reefs; it simply indicates the relative importance of the system to coastal communities with or without livelihood options.

To the national government, coral reef systems are a natural resource with direct input to the national gross domestic product (or GDP) through activities such as tourism and international fish trading. This requires governments to make trade-offs between sectors; for example, either to ban logging in order to conserve the biodiversity values of reef eco-

systems, or to generate income from logging activities that degrade reef ecosystems. Thus, governments need to set priorities on the various activities in different sectors – in this context, on those activities that specifically affect coral reef health, including coastal development, industrialization, agriculture and logging. Economic valuation can help set these priorities by providing a base from which the optimal use of the nations' resources for national economic development can be ensured.

Globally, the indirect market values of reefs lie in the contribution they make to world fisheries by acting as an aggregating device and providing habitats of particular importance for many marine species. Further, some small island states exist primarily because of the protection from erosion, storms and flooding provided by coral reefs. Reefs also have significant impacts on and contribute to nature and biodiversity conservation, to the conservation of the global environment, and to the world, by acting as an indicator for global climate patterns.

All of these factors must be considered when conducting economic valuation studies of coral reefs and estimating how they would be affected by specific management decisions (Figure 5). They can also be used to predict and quantify the impact of new policy decisions on individual stakeholder groups and on the collective communities that rely on coral reef goods/services/functions. Such an approach allows for equitable consideration of the allocation of resources derived from coral reefs under particular policy directions. It also clarifies the ramifications of sectoral trade-offs that may be necessary, and considers the effect(s) of policy decisions in a broader spatial context.

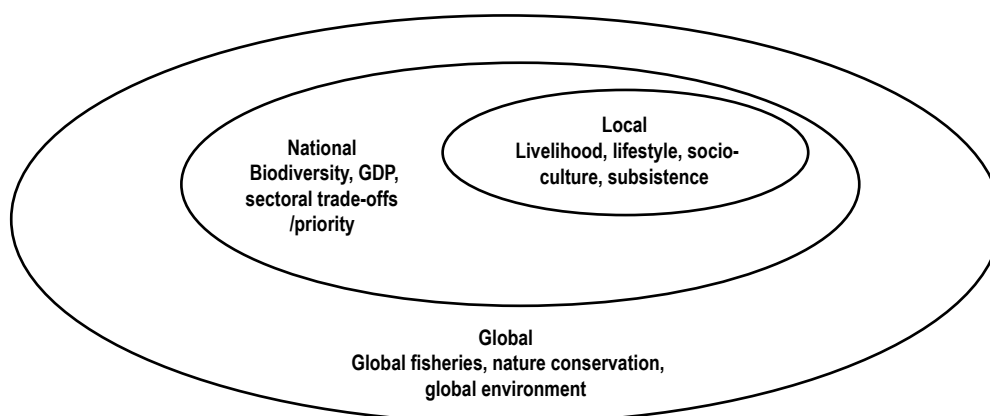


Figure 3. Values of coral reefs, different contexts and levels

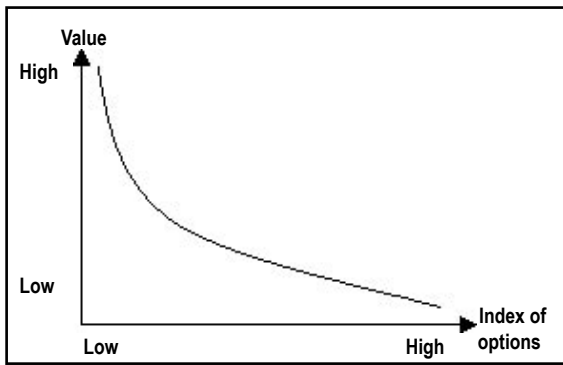


Figure 4. Value of coral reefs changes with options for livelihood

Future research directions

It is clear thus far that economic values of coral reefs should be incorporated in policy formulation processes – that these values should include the relative values perceived by different stakeholders, in particular local communities, that rely on coral reef ecosystems for their livelihoods. Policies should also look into ways of appropriating these values through the equitable use and sharing of resources. Therefore, future research relating to policies and institutions for coral reef management should look more closely into stakeholder participation in the management of these multiple use resources (Figure 5).

Guidelines for standard valuation techniques are necessary to help researchers or reef managers come up with better estimates of the total value of the resources, based on both use and non-use values. The effectiveness of policy instruments in the management of coral reef

ecosystems should be examined to better understand the factors contributing to the success or failure of reef management. The effectiveness and legitimacy of policy would be better understood if research were based on stakeholder participation in the management of resources (see Figure 5).

To ensure the sustainable management of coral reefs, greater participation of users and stakeholders in the decision-making processes, with particular interest in formulating policies, must be encouraged. Increased emphasis on stakeholder participation in research activities on coral reefs would lead to increased knowledge and awareness among coastal communities. Through a participatory approach, coastal communities would have more opportunities to provide feedback on economic, environmental, social and institutional interventions designed by the local authorities or government. Stakeholder participation would also help to promote consensus building and, through the knowledge acquired on the economic value of coral reefs, be more likely to lead to increased legitimacy and compliance (Kuperan and Sutinen 1998).

This would identify value sets and priority sites needing immediate conservation or protection. Economic valuation also provides a good basis for developing policy options.

At the same time, a participatory approach encouraging community participation and awareness in decision-making processes would lead to the empowerment of poorer stakeholders.

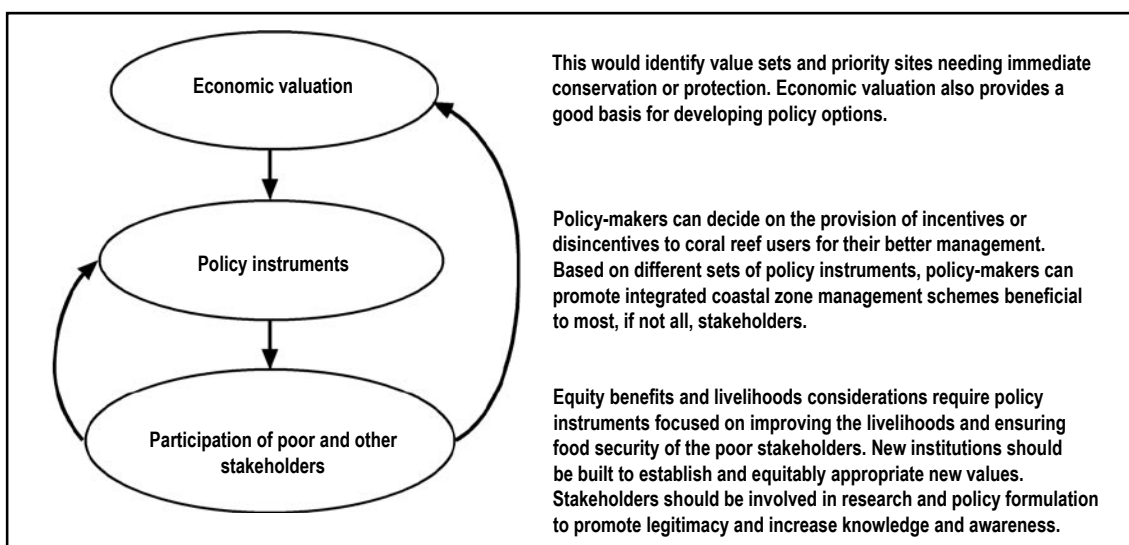


Figure 5. The role of economic valuation in coral reef policy

This would offer them a stronger platform from which to participate in the negotiation of property rights, resource rights, and rules and sanctions with regards to the natural resources (coral reefs) on which they depend. Researchers, planners and policy-makers should, as much as possible, identify conditions for choices that benefit entire communities while ensuring the equity of different stakeholders.

Summary

Economic valuation is a useful tool for coral reef management, but studies need to be conducted in a more thorough and cohesive fashion. Specifically, more values should be considered in order to better estimate the total economic value of coral reefs; common methods should be established and used to increase comparability across studies; and the conditions and input of multiple and participating stakeholders must be taken into account to establish equitable and legitimate policy.

The research on understanding and assessing policies for the sustainable management of coral reefs should incorporate the following three inter-related approaches:

- economic valuation, which attempts to capture many of the economic values supported by coral reefs, to set priorities for the use of coral reefs, and to suggest policy options for reef management based on economic drivers;
- application of policy instruments that promote integrated coastal zone management by creating awareness among all stakeholders of the economic effects of specific management options designed to better manage the coral reefs; and
- participation of stakeholders, including poor coastal communities, with a focus on increasing awareness of the economic goods, services and functions provided by reefs; encouragement of livelihood security; the building of new institutions; the establishment of values for coral reefs; and the potential for poverty alleviation through the equitable use of coral reef resources.

These Proceedings include some of the most recent work on the economic valuation of coral reefs. The Proceedings first outline the importance of valuation in coral reef management, and then provide studies that look at the economic input of coral reefs in

specific areas. Following this, the proceedings move into more general policy and management measures and explore the role of economic valuation in this context. The Conference identified many areas for research. These are outlined in the last section of these Proceedings. Coral reefs provide us with a plethora of values through goods, services, functions, and through their existence. What is needed is a cohesive approach to identifying and quantifying these values and using these estimates to develop and implement positive and sustainable policy.

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