Economic valuation of the Hon Mun Marine Protected Area

Lessons for other marine parks in Vietnam

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Abstract

This report assesses the economic value of coral reefs in Vietnam's Hon Mun Marine Protected Area. It synthesises monetised values of reefs into a cost-benefit analysis for different MPA management scenarios; moreover it recommends a user fee system to achieve financial sustainability. The study was carried out in response to the growing need to establish and sustainably operate a marine protected area system in Vietnam. It was also undertaken to highlight the need for coral reef valuation to be given priority in marine resource conservation plans.

Our results show that the tourism benefit of coral reefs is key for MPA management and local livelihoods improvement. We prove that, in the long term, continued management would provide greater net benefits (particularly in terms of fisheries and tourism) than a 'no management' scenario. Yet to ensure future management, Hon Mun needs to develop its own sustainable and autonomous financing regime. One way to 'appropriate' the park's potential economic benefits is through a user-fee for eco-tourists.

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1. Introduction

Marine and coastal resources in Vietnam are under increasing threat from human activities (Burke, Selig and Spalding, 2002). One way to manage these threats is through Marine Protected Areas (MPAs), which safeguard valuable ecosystems within their confines. Despite the ecological and socio-economic benefits they provide, the management of MPAs is often severely constrained by both a lack funding and a poor relationship with communities living around (or within) them.

The biological and ecological dimensions of coral reefs have received increasing attention from policy makers in recent years; however, the economic values of coral reefs do not yet play a relevant role in the policy-making processes. Overall, efforts aimed at MPA management and coral reef conservation in Vietnam have been implemented without sufficient consideration of reefs' monetized value and MPAs' financial sustainability. Yet, these issues are crucially important for rational resource use and the sustainable management of MPAs. Policy makers seek answers to the following questions: what are the main economic activities associated with the Hon Mun MPA? Will active management of Hon Mun provide greater net economic benefits in the long term (compared to a 'no management' scenario)? How can these benefits be 'captured', both to fund MPA management and provide socio-economic stability for local communities?

An economic valuation of coral reefs can provide a framework for encouraging efficient allocation and use of resources in the context of social welfare based public policy. Economic valuations reveal the full cost of reef use, and thereby can provide decision-makers with justification to conserve and use coral reef resources in MPAs in a sustainable manner. They can help decision-makers make more informed choices between different activities, projects or programs by taking into account the full costs and benefits of using the reefs.

We estimated the economic value of coral reefs in the Hon Mun MPA through analysis of reef fisheries and reef-related tourism, as well as other services provided by reef ecosystems. To derive a decision-making framework for MPA management options, we compared the costs and benefits of an MPA management scenario to a 'no management' scenario. We established linkages between the economic value of coral reefs and a potential sustainable financing scheme, which would ensure the long-term management of the Hon Mun MPA.

Our results show that the tourism benefit of coral reefs is key for both park management and local livelihoods improvement. We prove that, in the long term, continued management would provide greater net benefits (particularly in terms of fisheries and tourism) than a 'no management' scenario. Yet to ensure future management, Hon Mun needs to develop its own sustainable and autonomous financing regime. One way to 'appropriate' the park's potential economic benefits is through a user-fee for eco-tourists. Subsequent revenues could be ploughed back into management of the park and its buffer zone, and could also support much-needed alternative livelihood schemes in the region.

2. Background

The Hon Mun MPA comprises eight islands, one large island, Hon Tre, and several small islands (Hon Mun, Hon Mot, Hon Tam, Hon Mieu, Hon Mat, Hon Cau and Hon Vung), all located in the south of Nha Trang Bay. The distance between the islands and the mainland ranges from several kilometers to about 15 kilometers, in the case of the furthermost islands. The MPA has a resident population of about 5,300 people who rely on its waters for commercial and subsistence fishing. Currently the area is also the focus of rapidly developing aquaculture, shipping and tourism.

The Hon Mun MPA is representative of Vietnam's south central bio-geographic zone and is comparable in terms of biodiversity to the global centre of coral diversity of Eastern Indonesia, the Philippines and the Spratly Islands. The site supports a variety of habitats and ecosystems including fringing coral reef, mangrove and seagrass beds with an adjacent deep-water upwelling. Recent surveys have counted around 350 species of reef building corals, 220 species of demersal fish, 106 species of molluscs, 18 species of echinoderms, and 62 species of algae and seagrass (Tuan V.S. *et al.*, 2002).

Hon Mun provides the mainstay of the tourism industry in the city of Nha Trang. There are 5 diving schools based in Nha Trang, which use the area around Hon Mun Island as their principal dive site. This site attracts more than 18,000 'dive days' and approximately 52,000 'snorkel days' per year. Fishing is also a major activity in the area: about 79% of household heads are fishers. The fisheries are still small scale in nature, and a variety of fishing gears are used. Most of the fishing boats are of low power (15 – 45 CV); they typically trawl in offshore waters and fish for squid by night. Inshore bottom trawling is also common. With small vessels and low-grade fishing gears, most fishing activities operate in shallow waters of less than 30m depth. Increasing numbers of fishing boats have gradually caused a depletion of marine resources, resulting in a decline of catch per unit effort. Smaller fish also increasingly dominate catch composition. In recent years, village-based aquaculture has developed (mostly of reef lobsters *Panulirus* spp. and groupers Serranidae). Lobster culture has become an important economic sector of the local area (IUCN, 2003). Aquaculture is a reef-dependent activity. Reef habitats provide refuge for lobster and grouper juveniles. Reefs also provide fish and shellfish, which are used as feed for lobster and grouper culture. Lobster and grouper culture are considered to be highly reef-dependent activities.

The establishment of the Hon Mun MPA was approved on 10 January 2001. A four-year MPA management project has received over US$2 million worth of funding, principally from international donors. This financial support has ensured sound management of its natural resources: it is recognized as a well-run MPA (ICEM, 2003). In the long term, managers need to know whether continued management would provide greater net benefits (particularly in terms of fisheries and tourism) than no management. They also need to identify how a sustainable and autonomous financing regime for the MPA can be developed.

3. The models

3.1 Analytical framework

This section builds on an economic valuation of the recreational aspects of coral reefs surrounding a small Vietnamese coastal island (Pham & Tran, 2002). This is part of a growing literature on the economics of coral reefs (Hodgson and Dixon, 1988; Spurgeon, 1992; Pendleton, 1995; Driml, 1999; Cesar, 2000; Cesar and van Beukering, 2003).

Total Economic Value is a basic concept for analyzing the economics of coral reefs. The Total Economic Value of an ecosystem is often used to express the value of all the goods and services it supports (Pearce and Turner, 1990; Pendleton, 1995). The Total Economic Value of coral reefs is taken as a function of "use" and "non-use" values. Use values comprise direct uses such as fisheries, recreation, education and building supplies; indirect uses or functions such as coastal protection and biological support; and option values that preserve options for future use. Non-use values consist of bequest values and existence values. Bequest values are the values associated with passing on natural assets intact to future generations. Existence values are often understood as the value of an ecosystem to humankind, irrespective of whether it is used or not (Cesar, 2000).

Table 3.1 Total Economic Value of coral reefs.

Total Economic Value				
Use values		Non-use values		
Direct use values	Indirect use values	Option values	Bequest values	Existence values
Extractive uses • Capture fisheries • Mariculture • Aquarium trade • Pharmaceutical • Building supplies *Non-extractive uses* • Recreation/tourism • Research/education • Aesthetic	*Biological supports to* • Sea birds • Turtles • Fisheries • Dugong • Other ecosystems *Physical protection* • Coastline • Flood control • Storm buffer *Global life-support* • Carbon store	Future direct and indirect uses	• Species • Habitats • 'Way of life' linked to traditional uses	• Threatened reefs habitat • Endangered species • Charismatic species • Aesthetic reefscapes

Source: adapted from Cesar (2000).

Direct local use values (attributed to the benefits generated through the use of coral reefs) were estimated on an annual basis. Two broad categories of use were considered: i) near-shore fisheries and ii) tourism. Indirect use values associated with coastal protection were not incorporated into the estimation because this function is negligible in the study site. This study focused on the two primary direct use values and avoided detailed examination of other minor local uses which are of less policy relevance. The study also estimated the non-use values of coral reefs – the conservation benefit of coral reefs that people value irrespective of whether they use it or not. The derived conservation benefit can be seen as a low estimation due to the so-called "nesting and part-whole effects" problem (Hanley, 2000, p. 242). These values combine to give a 'lower boundary' estimate of the TEV. The scope of this study did not allow for a separation of non-use values into parts, such as option, quasi-option, bequest and existence values.

Figure 3.1 shows the structure of the analytical tools used in the estimation of tourism values, fishery and aquaculture values and conservation values of Hon Mun's coral reefs. These values were then used in a cost-benefit analysis for two management options: a 'management scenario' and a 'no-management scenario'. The results of this analysis may help policy makers decide whether to continue managing the MPA after external financial support ends in 2005. The estimated economic values of the reefs are also essential to design an autonomous financing regime for the MPA.

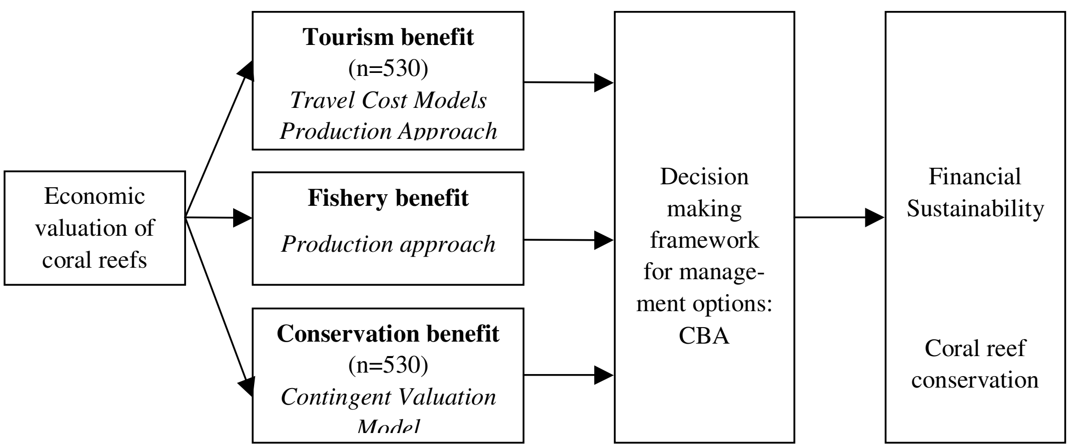

Figure 3.1 Analytical framework.

3.2 Tourism benefits: Travel Cost Models and the Production Approach

Recreational values associated with coral reefs have generally been estimated using two methods: the utility method and the production method (Cartier & Ruitenbeek, 2000). The utility approach is usually associated with the Travel Cost Method (TCM) and the Contingent Valuation Method (CVM) (see Hundloe, 1990; Leeworthy, 1991; Hodgson & Dixon, 1988; and de Groot, 1992 for applications). It seeks to measure consumer surplus generated by the recreation experience. The Production approach, which often uses the Effect on Production (EoP) method, aims to: i) estimate the producer surplus generated by a particular coral reef holiday destination and ii) estimate the difference in value of the productive output before and after the impact of a threat or a management intervention (Cesar, 2000). A branch of this approach, which is quite widely applied, is gross tourism value. Good examples of this can be seen in Hodgson and Dixon (1988), Cesar (1996), Driml (1999) and Gustavson (2000). The gross tourism value method has been criticized on two points: i) it ignores consumer surplus generated from reef-associated recreational activities and labor, capital costs of supplying the services and costs of environmental impacts; and ii) it does not present effective ways to solve the problem of multi-purpose trips. When a coral reef is just one element of a vacation, gross tourism revenue cannot be solely attributed to the reef (Cartier and Ruitenbeek, 2000). Moreover, calculating changes in productivity in physical terms between the 'with' and 'without' management scenarios is one of the main obstacles that EoP applications have to overcome (Cesar, 2000).

Given the common expectation of the important role of reef-associated recreational values, and the advantages and disadvantages of both the utility approach and production approach, this research employed i) the TCM to estimate the consumer surplus of the recreational experience and ii) the production approach to calculate the producer surplus. Economic theory affirms that the net social benefit of a good or service is equal to the sum of the producer surplus and consumer surplus (Boardman *et al.*, 1996). The net recreational benefits of coral reefs to society are therefore the sum of the consumer surplus of recreational reef-users and the producer surplus of reef-related service providers.

The consumer surplus equals users' willingness to pay to experience reefs minus actual reef-related expenditures for their trip. A demand curve for trips, which can be derived by the TCM, allows for the estimation of the consumer surplus. Another approach used to directly derive the consumer surplus is the contingent valuation method (Cesar, 2000). The producer surplus equals the producers' willingness to offer their services minus their actual costs of supplying the services. A supply curve of trips helps to estimate the producer surplus. In this study, we considered the value added of the direct and indirect expenditure related to reef-use activities.

From the various travel cost models (Haab & McConnel, 2002), the zonal travel cost model (ZTCM) and individual travel cost model (ITCM) were selected to estimate the consumer surplus of the recreational activities of coral reefs' users. The ZTCM divides the entire area from which visitors originate into a set of visitor zones and then defines the dependent variable as the visitor rate. The ITCM defines the dependent variable as the number of site visits made by each visitor over a specified period. Both the ZTCM and the ITCM[1] were applied to divers and snorkelers in the Hon Mun Marine Protected Area.

Zonal Travel Cost Model

The trip-generating function for the zonal model in this study is:

$$V_j / P_j = f(TC_j, INCOME_j) \tag{3.1}$$

where V_j is the total number of dive/snorkel excursions by individuals from zone *j* to Hon Mun per year; P_j is the population of the zone *j*; TCj is the travel cost from zone *j* to Hon Mun; $INCOME_j$ is average income of zone *j*.

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[1] We only present the ZTCM and its results in this paper because the estimates of parametric ITCM showed all its functional forms were not significant, implying the model cannot be applied for a site like the Hon Mun MPA.

The form of the demand function may be linear, semi-log, log-log, or quadratic. Given the demand function for visits to Hon Mun, consumer surplus was calculated using a similar integral formula to that of the ITCM.

With respect to domestic visitors, we divided the area around Hon Mun into zones 1 to 8, with each zone being at a greater distance from Hon Mun. For foreign visitors, the estimation of the recreational value of a site like Hon Mun is always a difficult task. The Hon Mun MPA is currently not a typical destination for foreign visitors wanting to experience coral reefs. Most of the foreign visitors who come to the Hon Mun MPA are multi-site travelers. We divided the origins of foreign visitors into 10 zones. The travel costs gradually increase from zone 1 to zone 10. The defining of zones here does not totally depend on distance from original country to Hon Mun; it is also based on travel costs which include transportation costs and time costs.

Production Approach

The production approach used in this research aimed to estimate the producer surplus of the producers who would have been willing to offer their services to divers/snorkelers (Cesar *et al.*, 2002). The benefits accrued by producers were calculated using the value added of the direct and indirect expenditures related to the reef activities.

Direct expenditure related to reef diving and snorkeling experiences includes boat tour tickets to the site (which cover diving/snorkeling equipment and services). Indirect expenditure includes transportation costs (both international and national), hotel costs and other costs.

To estimate the total value added of the reef-related activities, we have to assume a coefficient that reflects the share of profit over turnover of service providers. The recreational activities, directly and indirectly, have spill-over effects to the local economy through employment generation, development of secondary industries, and so on. The multiplier effect of the value added therefore needs to be taken into account. Since there has been no official calculation of the multiplier (from either government or academic sources), we assume it to be 1.5. This represents tourism's overall effect on Vietnam's economy, and was derived taking into account that the resources of Vietnam's economy are not fully employed[2].

3.3 Fishery and aquaculture benefits: The Production approach

The coral reef ecosystem is characterized by high biodiversity and productivity, and supports a diversity of demersal fish species, octopus, lobsters, molluscs etc. In the study area, coral reefs even support lobster and grouper cage culture, which are highly lucrative activities in Vietnam (IUCN Vietnam, 2003; Tuan L.A., 2002). Reef fisheries not only provide income, employment and foreign exchange but are also a major source of animal protein for local people.

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[2] The multiplier of a full employed economy is 1 – a perfect competitive economy that reaches the efficient equilibrium, implying no spill-over effects. The multiplier is greater than 1 when the resources like labor and capital are not fully employed.

Production valuation methods have been widely used to estimate the economic value of reef-associated fisheries. De Groot (1992) and Driml (1999) valued the benefits of fisheries in the Galapagos National Park and Great Barrier Reef MPA, respectively, using the gross financial value of harvested products and ignoring the ecological economic linkages. Hodgson and Dixon (1988), Cesar (1996) and McAllister (1988) tried to link reef quality to fishery productivity, and evaluate how this affected the production function. Cesar (1996) discusses factors that determine estimates of coral reef fishery values. Cartier and Ruitenbeek (2000) discuss three types of weakness of this production valuation method for reef fisheries. Firstly, the gross revenue of fisheries is usually assumed to represent their value, thereby ignoring the opportunity costs of capital and labor associated with fishing effort. Secondly, the dynamics of coral reef habitats are often simplified and even ignored. Lastly, if the approach bases harvest rates on some level of extraction effort, it may overestimate values and if its harvest rates stem from maximum sustainable yield, it will most likely underestimate the economic value.

In this study, we estimated the value added of reef-associated fisheries and aquaculture through calculations of the total gross value and costs, as well as labor inputs. The commercial fisheries data we collected included both offshore and near shore fisheries. Therefore, given our aim of estimating reef fisheries' value, we needed to determine the reef-dependence of these fisheries. The total gross value of reef fisheries is estimated based on reef dependence, fish catch and fish price (Cesar *et al.*, 2002). Another approach is to directly estimate the fisheries value per km^2 of reef by multiplying the annual potential reef fisheries yield per km^2 and the average market price of reef fish (Cesar, 1996).

Face-to-face survey interviews for households and focus group interviews were conducted to collect primary data, which included fishing-related information, and data on ornamental products collected from reefs. Secondary information was collected from the province's Department of Fisheries and from related reports by other researchers. Secondary data was also collected from daily records of fish buyers and sellers.

3.4 Contingent Valuation Model

We asked visitors to state their willingness to pay to ensure reefs were maintained in their current state in the Hon Mun Marine Protected Area. We also asked visitors about their willingness to pay for an improvement in coral quality. These questions formed part of the Contingent Valuation (CV) method, which was used, in conjunction with a payment card elicitation procedure, to determine the value of the site to visitors. These visitors were both international and domestic, though the sample was confined to those visitors who actually experienced the coral reefs during day excursions.

Questionnaire design

A questionnaire was designed that included three parts[3]: 1) the description of the hypothetical market, 2) questions to elicit value, and 3) questions to determine the respondent's socioeconomic characteristics.

The hypothetical markets

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[3] We combined the CVM and TCM questionnaires as one for a respondent.

The site information was given in the form of a short description. The context of the site has been described so that respondents have a clear understanding of the coral reef case study area, the benefits provided by the coral reefs, and the ecological importance of the marine ecosystem.

The WTP questions

We asked visitors (1) their willingness to contribute to a trust fund for coral biodiversity conservation and (2) their willingness to pay for a trip to Hon Mun. The first scenario implies the conservation of coral reef biodiversity through effective management. The MPA management committee has a trust fund set up for this purpose. Payment is based on an additional fee, above and beyond the usual expenses per diving/snorkeling excursion. We first determined respondents' willingness to contribute to a trust fund by asking: "*Would you be willing to pay a certain amount per dive/snorkel experience, in addition to the usual expenses, to fund this program for a healthier marine environment?*", and then the WTP question: "*What would be the maximum you would be willing to pay <u>per dive/snorkel experience</u>, in addition to the usual expenses, to fund this program for a healthier marine environment*". Through this latter question, the existence value of coral reefs was estimated. A debriefing question followed to help respondents explain the reasoning behind their response: this allowed the estimation of the tourism value of coral reefs. We presented the following hypothetical scenario "*there are some small islands a bit further away that have double the amount of coral cover and twice as many fish*" and then asked visitors "*How much extra money are you prepared to pay per dive/snorkel day to dive/snorkel in these areas?*".

Socio-economics

After the questions eliciting value, the interviewees were asked about their socio-economic characteristics, including employment status, household income, age, and education.

Survey design

A pre-test survey was performed with 30 people to identify areas where questions produced unexpected results and to define the bids in the payment card through open-ended questioning. Individual visitors were chosen as respondents for the interviews. A 'visitor' was defined as someone who used Hon Mun for diving/snorkeling. Villagers who lived within range of the islands were not included in the survey. Samples were taken using two approaches. The first approach involved directly interviewing divers/snorkelers. The second approach involved handing the questionnaire to visitors on boat trips and asking them to complete the forms. The sample population comprised Vietnam's urban dwellers because most Vietnamese tourists are from urban areas. Vietnamese in rural areas are too poor to afford the luxury of travelling.

The CV survey of divers and snorkelers was used to measure the value that this group places on specific coral reef conservation programs. If, compared to the cost of conducting these programs, the benefit estimate is biased downward because the existence value is omitted[4] and values from non-users of the reefs are not estimated, a more conservative estimate of value will emerge. The traditional econometric analysis of payment card CV data predicts annual values, but the estimator (which allows for the calculation of the value per capita) would be biased upwards because of sample selection (Hanley, 2000; Spash *et al.*, 2000). This is because those who place greater value on Hon Mun coral-related activities presumably visit more frequently.

The econometrics model

Following standard economic theory, we used the Hanemann (1984) approach[5] to define an indirect utility function

$$V(P, Y, S, Q) \tag{3.2}$$

that describes the maximum amount of utility an individual can derive from their income Y, given the price of a good P, and the level of provision of the non-market good Q. The individual's utility is assumed to depend on other demographic and economic factors, S. When answering the CV question, Hon Mun's divers/snorkelers are assumed to be comparing their utility at two levels of coral reef provision, Q^0 and Q^1. Respondents are assumed to be willing to pay some extra amount to experience the higher level of provision, Q^1. Thus we can write this amount as C in

$$V(Y, P, S, Q^0) = V(Y - C, P, S, Q^1) \text{ or } WTP = C = C(Q^0, Q^1, Y, P, S)\,. \tag{3.3}$$

Since we used the payment card approach to elicit interval data, we used the CDF of WTP to establish this probability

$$\Pr(B_L < C_i \le B_H) = F(B_H; a, \sigma^2, \rho) - F(B_L; a, \sigma^2, \rho)\,, \tag{3.4}$$

where B_L is the lower bid level, the next amount up on the payment card is B_H, a represents the mid-point of the distribution of the random variable C_i, σ^2 determines the spread of the distribution of C_i (scale parameter), and ρ is the height of the spike representing the probability that a respondent will have a zero utility change.

In this study, we used parametric estimation of mean WTP for interval data in conjunction with payment card elicitation approach. The prices in the payment card were treated as bids in the single-bounded dichotomous choice question, i.e. a respondent choosing a $3 price in the payment card was equivalent to that person saying 'Yes' with the $3 bid. Mean WTP was calculated using the same procedure for the single-bounded dichotomous choice (See Haab and McConnell, 2002, for a detailed description of model development and estimation of WTP).

3.5 Decision making framework for management options: a CBA

Policy makers are increasingly interested in the use of cost–benefit analysis tools to make decisions with regard to environmental issues. They need information on the bene-

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4 The non-use values, which are the aim of the CV estimate, comprise option value, bequest value and existence value.

5 Cameron (1988) favors an alternative approach: a bid function approach. With this approach we can directly specify a parametric assumption about the CDF for the individual's random WTP without deriving this from an explicit specification of the indirect utility function.

fits and costs of alternative scenarios. According to Cesar *et al.* (2002, p. 48), the overall approach (which is usually called the 'impact pathway approach') involves 4 main steps: (1) defining the study boundaries; (2) identifying the physical impacts that are economically significant; (3) quantifying the socio-economic effects; and (4) valuing these effects in monetary terms and conducting a sensitivity analysis. This is a typical cost–benefit analysis approach. The economic challenge is to address both the costs and benefits of reef management, within a context of ecological complexity (Cartier and Ruitenbeek, 1999).

The scenarios were determined through consultations with local policy makers, mainly those involved in the management of the MPA. Several coral reef management-related questions exist: what is the total economic value of the coral reef ecosystem, and under what management options? In other words, is it worth managing the coral reef? And who will gain or lose from the status quo? We selected two scenarios for investigation: with and without MPA management.

Figure 3.2 shows the conceptual net benefits of coral reefs over time. The proposed scenarios yield benefits and incur costs over their lifetimes. Graphically, we can directly compare the annual net benefits of the scenarios. To identify the magnitude of the total net benefits of scenarios, net present values (NPVs) are usually used. In each scenario, we know that not all benefits and costs can be expressed in monetary units: some can only be assessed qualitatively. In this study, the net benefits of coral reefs are defined as the value-added of coral-associated tourism service suppliers, consumer surplus of divers and snorkelers, spill-over effects of the MPA on the fishing industry, and the biodiversity values that visitors are willing to pay for.

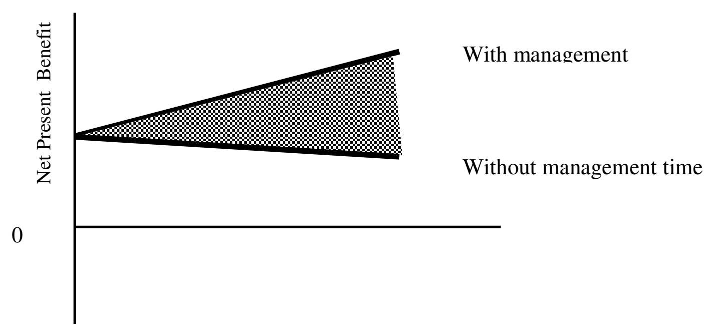

Figure 3.2 Conceptual net benefits of coral reefs overtime.

Management costs

Without management scenario

Given the fact that the Hon Mun MPA's current financial support will end in 2005, we assumed that there would be no equivalent management efforts after this date. [It's worth noting that before the establishment of the Hon Mun MPA, the local government used to invest in the Hon Mun area (based on its own domestic interests). This investment consisted of about US$28,000 per year, and focused on activities related to fisheries management, including aquaculture development (GEF, 1999).] The 'no management' scenario would address immediate national economic and social priorities, without protecting the important coral reef, mangrove and lagoon ecosystems, and thus without the incremental benefits to global biodiversity. The current enforcement levels would be reduced. The natural functions of coral reefs, therefore, would deteriorate, leading to a decline in the fishery industry in the long term. Eco-tourism would not be developed.

With management scenario

Under this scenario, financial investment is assumed to continue at current levels. The threats to coral reefs, such as destructive fisheries, coral mining, and unsustainable tourism will be controlled and stopped. Eco-tourism will be developed to its maximum allowable potential. The management of Hon Mun could clearly generate significant domestic benefits, especially from tourism. The hypothetical cost of operating Hon Mun as an MPA with the purpose of improving local communities' livelihoods, sustainable tourism development, and the conservation of marine biodiversity, is estimated at: US$230,500 start-up costs plus US$300,000 per year in operating costs (GEF, 1999). In this study, we considered the period from 2005 onwards, after financial support ends; as such, set-up costs were not taken into account. The new management scenario is based on the current MPA infrastructure. We assumed a time frame of 25 years, from 2005 to 2030, adapted from Beukering *et al.* (2003, p.6) who argued that "this period leaves enough time for the main environmental impacts to come into effect, while it is sufficiently short to estimate future development".

Assumptions regarding the tourism benefits flow

In the 'without management' scenario, we assumed divers would be more affected than snorkelers (and foreign snorkelers more affected than locals) by the end of the management regime (interview with Mr. Hung, diving guide of the Rainbow diving school in Nha Trang). The number of divers, who are able to know about negative changes in coral reef health, was assumed to decline sharply by 10% per year after 5 years without management and then level out from year 10th. Local snorkelers were assumed to be less concerned about the state of coral reefs and thus the number of local snorkelers would increase by 10% per year until the year 2015, and then level out. Foreign snorkelers were assumed to know about coral health. However, the number of trips to the area remains unchanged under this scenario due to general tourism industry growth. In conclusion, net annual benefits of divers and the related service providers decline after 2010. However, as the net benefits of the snorkeling components outweigh the benefits of the diving components, the total annual benefits of the 'without management' scenario still increase slightly over time. Although the coral reefs are not well conserved in this scenario, the rise in values can be explained by the continued growth of tourism at the site (full tourism capacity having not yet been reached).

It is clear that in the 'with management' scenario, the total annual benefits from coral-associated tourism grow quickly right after the introduction of new financial sources (in 2005). These financial sources come from beneficiaries (i.e. divers and snorkelers). However, we exclude the possibility that some tourists would protest against such user fees. This is because these protests are usually negligible and do not greatly affect the rise in total values (which are mainly due to more beautiful coral reefs and increasing numbers of tourists).

Assumptions regarding the fishery benefits flow

In the 'without management' scenario, the support coral reefs provide to fisheries is assumed to remain constant at the 2004 level. Although the MPA does not exist after 2005, the area still receives government financial support for resource protection activities, as well as support for lobster cage culture in terms of feed and seed. Fishery production levels may not decline; equally, they probably won't benefit from the spill-over effects of protection.[6]

In the Hon Mun MPA, fisheries are restricted in the no-take zones and frequently managed in the buffer zones and adjacent areas. Total fish catch outside the MPA may increase or decrease depending on the specific level of larval and adult spill-over effects (Cesar *et al.*, 2002). Continued MPA management would sustain the development of the spill-over effect (which began when the MPA was established in 2001).[7] We assumed the spill-over effect would be working by 2006 (after five years of protection), and would increase by 10% per year until the maximum value (100% capacity) was reached in 2015.

Assumptions regarding the conservation benefits flow

As mentioned, the estimation of conservation benefits depends on two main variables: average WTP of visitors and number of visitors to the site. In the 'without management' scenario, the annual biodiversity benefits (i.e. conservation values that visitors are willing to pay for an improved marine protected area), are zero because there is no improvement with no management. Management would attract more tourists and thus yield increasing biodiversity benefits over time, until reaching a maximum level in 2015.

4. Results

4.1 Tourism benefits

The Hon Mun Marine Protected Area is the most heavily used marine reserve in Vietnam (Nam, P.K. and Son T.V.H, 2001), currently attracting around 300,000 visitors per year. However, the number of visitors who directly use the coral reefs, by diving and snorkeling, is much lower. The annual number of dive days is 18,000 (4,500 and 13,500 for domestic and foreign visitors, respectively), served by 5 diving clubs based in Nha Trang city. The number of snorkel days is nearly threefold, approximately 52,000 per year (of which 36,400 are domestic and 15,600 are foreign visitor excursions).

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[6] This assumption was taken from personal communication with Truong Kinh, manager of the Hon Mun MPA and Ho Van Trung Thu, IUCN representative.

[7] As above.

Consumer surplus

Using the Zonal Travel Cost Models[8], we separately estimated consumer surpluses for domestic and foreign visitors. For domestic visitors, we divided the area around Hon Mun into 8 zones, each zone being further from the site. The four different functional forms were built up and tested for best fitness with the data. The log-linear model appears to be the best: all the variables are statistically significant, there is a high adjusted R-squared (0.91) and there are (perfectly) normally distributed disturbance terms. The coral-related tourism demand function in log-linear form is as follows:

$$\begin{array}{l} \ln(zvisitrate) = -4.16 - 0.077zcost + 0.0016zinc \\ (-6.89) \quad (-8.04) \qquad (4.07) \qquad \text{adjusted-}R^2 = 0.91 \end{array} \tag{4.1}$$

(t-ratios are in parentheses)

where *zvisitrate* is visitation rate of a zone, *zcost* is travel costs from a zone to the site and *zinc* represents the average income of a zone. The consumer surplus per person in each zone was calculated as the area under the demand curve and above the travel cost. The average consumer surplus per diver/snorkeler was VND 138,614.

The consumer surplus for foreign visitors was estimated using a similar procedure. However, a common problem associated with zonal TC models for foreign tourists is zoning. The Hon Mun MPA is currently not a typical destination for foreign visitors who want to experience coral reefs. So the individual TCM (based on the variant number of trips per individual to the site), cannot be applied to Hon Mun. Besides, most of the foreign visitors who come to the Hon Mun MPA are multi-site travellers. We divided the origins of foreign visitors into 10 zones. The travel costs gradually increase from zone 1 to zone 10. The defining of zones did not totally depend on distance from original country to Hon Mun, but also on travel costs (transportation costs and time costs). The linear-log coral-related tourism demand function was estimated:

$$\begin{array}{l} VR = 1.102 - 0.208 \ln(tc) \\ \qquad (0.01) \quad (0.02) \qquad\qquad \text{adjusted-}R^2 = 0.45 \end{array} \tag{4.2}$$

where *VR* is the visitation rate from a zone and *tc* is travel costs of tourists from that zone. The consumer surplus of foreign divers/snorkelers at the Hon Mun MPA is VND 1,076,460 per diver/snorkeler.

Producer surplus

The direct expenditure for diving and snorkeling experiences includes package tour tickets to the Hon Mun MPA. We assume only 25% of this expenditure can be considered ‘value-added’. The indirect expenditures for diving and snorkeling experiences include lodging costs and travel costs. For the international air fare we assume the value added is 3%. We also assume that local traveling and hotel accommodation yield the value added of 25%. The multiplier of these marine-related expenditures was assumed to

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[8] We also tried to estimate consumer surplus for domestic visitors using the Individual Travel Cost Model but almost all functional forms of the parametric model are not significant, i.e. R-squares are very low. So we have not presented these results in this paper.

be 1.5. Producer surplus or total value added is the sum of value added of expenditure (both direct and indirect) and the multiplier effect of these expenditures. The estimated producer surplus is VND 11,381 million for the diving industry and VND 17,056 million for the snorkeling industry.

Total tourism values

The welfare gain of visitors and value added for the economy from the reef-related recreation industry constitute the recreational benefits of Hon Mun's coral reefs for society. Table 2 summarizes the recreational benefits of coral reefs in Hon Mun from applied valuation techniques.

Table 4.1 Annual recreational benefits of coral reefs in Hon Mun.

Consumer surplus in million VND (US$)		Producer surplus in million VND (US$)			Total recreational benefits in million VND (US$)
Domestic visitors	Foreign visitors	Value added of direct expenditure	Value added of indirect expenditure	Multiplier effect	
5,669 (368,136)	31,323 (2,033,969)	9,071 (589,011)	9,888 (642,046)	9,479 (615,528)	65,430 (4,248,690)

4.2 Fishery benefits

As mentioned in section 3.3, we estimated the value added of reef-associated fisheries and aquaculture through calculations of the total gross value, as well as costs and labor inputs.

Catch fisheries

Table 4.2 shows reef fish density data for Hon Mun MPA, Con Dao National Park and Van Phong Bay in 2002 (measured by the LIT method) and corresponding market prices. The relative density of various fish families indicates low numbers of economically significant species for food and aquarium use (Tuan V.S. *et al.*, 2002).

Table 4.2 Density average of some families of fish (individuals/400m²) and their prices.

Families	Density average (individuals/400m²)	Typical price per piece* (VND)
Butterflyfishes	16.1	5,000
Surgeonfishes	1.84	5,000
Damselfishes	263.3	2,000
Angelfishes	34.9	5,000
Wrasses	35.2	3,000
Groupers	1.28	10,000
Sweetlips	0.72	5,000
Snapper	0	12,500
Rabbitfishes	9.8	5,000
Parrotfishes	41.6	5,000
No. Transects	16	

Source: Vo Si Tuan (2003), Nha Trang Institute of Oceanography (2004), price data from Uychiaoco *et al.* (2004).

* 2003 price.

The net fisheries value per km² of reef was estimated based on the annual potential fisheries yield per km², the average market price of reef fish per kilogram and data on effort and expenses incurred when capturing fish. The annual potential fisheries yield can be estimated as half the average reef fish standing stock (estimated through visual censuses when detailed stock data is not available) (Uychiaoco *et al.*, 2004 quoted from Schaefer, 1954). The average gross fisheries value of the reef is US$15,538 per km², determined by multiplying the annual potential fisheries yield per km² and the average price of fish shown in Table 3. Consultations with experts in the Hon Mun MPA indicated that the spill-over effect of the MPA is currently negligible. A possible reason is that the MPA was established in 2001 and any spill-over effects are yet to be observable. Therefore in this study, we gave the spill-over effect a value of zero.

Having considered various types of fishing gear (such as push net, purse seine, lift net, lobster seedling and diving) a recent survey by the Hon Mun MPA concluded that the gains from the main fishing season are about 70% of the gross fishing value (IUCN, 2003). We take this ratio to calculate the fishing costs, which are US$4,661 per km² of reef. The estimated value-added fishery value is US$ 1,740,256 per year, calculated from the gross fishery values, fishing costs and the total area of the MPA.

Lobster cage culture in the Hon Mun MPA is becoming a thriving industry. There are a total of 2,000 lobster cages, which produced around 128 tons[9] of lobster in 2003. The annual value-added of reef-based aquaculture was estimated by multiplying the net aquaculture income by the total annual aquaculture production. We estimated the total value added from coral reefs' support function for fisheries and aquaculture using the value added of each of these activities and their respective reef dependencies. Table 4 shows total values of reef-based fisheries and aquaculture in the Hon Mun MPA.

[9] 1 cage produces approximately 64 kg of lobster product.

Tabel 4.3 Total values of reef-based fisheries and aquaculture in the Hon Mun MPA.

	Quantity (tons)	Value added – million VND (thousands US$)	Reef dependence (%)	Value added (US$)
In shore fisheries	13,000-70,000 kg/ 1.26-2.50 km^2 *	1,740,256	100	1,740,256
Lobster	156	19,313 (1,254)	100	1,254,078
Grouper	Negligible[10]	0	-	0
Total	-			1,994,334

* Uychiaoco et al. 2004.

4.3 Conservation benefits

When eliciting WTP of visitors to conserve biodiversity through a trust fund, bid amounts ranged from VND 5,000 to more than VND 150,000 per dive/snorkel and from US$1 to more than US$10 per dive/snorkel for domestic and foreign respondents, respectively. 'Rejecters' represented 29.7% and 24.2% of domestic and foreign respondents, respectively.

Based on estimated parameters, the mean WTP per visit is estimated to be VND 48,288 (US$ 3.1) for domestic visitors and VND 60,830 (US$ 3.9) for foreign visitors. The total conservation value of Hon Mun's coral reefs was estimated to be approximately VND 1,975 million (US$ 128,245) for domestic visitors and VND 1,770 million (US$ 114,945) for foreign visitors.

Table 4.4 Parameter estimates of WTP for coral conservation.

Variable*	Local diver/snorkeler		Foreign diver/snorkeler	
	Parameter	p-value	Parameter	p-value
Constant	0.869	0.000	1.092	0.000
Bid	-0.018	0.000	-0.276	0.000
Log-likelihood	-278.3		-305.7	
Pseudo chi-square	0.069		0.095	

* We regressed the model with several functional forms that may include interactions of socio-economic characteristics. The results in the table are of the best fitted models.

4.4 Cost – Benefit Analysis

The total economic value of coral reefs in the Hon Mun MPA for one year (and its distribution) is given in Table 6. Tourism benefits account for the largest share, while local people receive the smallest share. Although the fishery benefit is enjoyed by local people, this benefit is decreasing and largely focused on rich fishermen who can afford to practice lobster culture. It may widen the rich-poor gap and lead to unsustainable use of reef resources.

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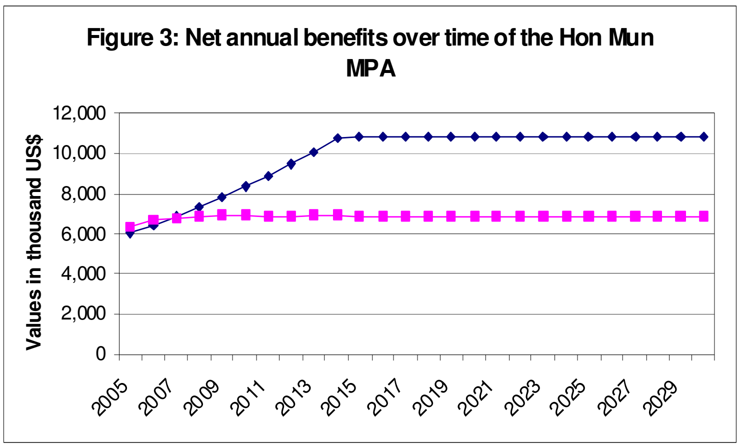
[10] Key informant interviews show that Hon Mun's water quality is not suitable for grouper cage culture, given groupers' susceptibility to disease.

Table 4.5 Total economic value of the Hon Mun MPA in million US$.

Tourism values		Fishery values		Conservation values		Total value
Consumer surplus	Producer surplus	Fishery	Aquaculture	Domestic	Foreigner	
2.40	1.84	1.74	1.25	0.13	0.11	7.47
56.8%		40.0%		3.2%		100%

Based on these estimated total economic values for one year, we derived the value for individual scenarios by aggregating the net benefits over time. Figure 3 shows the annual benefits gained for both the 'with management' and 'without management' scenarios ver the period 2005 – 2030.



Net benefits of the 'without management' scenario, surprisingly, slightly increase until 2015 and are then maintained. In the total economic value component, the tourism and fishery benefits of coral reefs for one year (at the present time) take the largest shares (51% and 46% respectively) and therefore will determine the trend of the benefit flow over time. While the fishery benefits remain unchanged over time, the tourism benefits increase due to the overall growth of the coastal tourism market irrespective of whether coral reefs are managed. As mentioned, this increase is mainly attributable to snorkelers who experience coral reefs but are not sensitive to changes in coral biodiversity. Numbers of divers decrease over time but this does not greatly affect the total values.

In the first two years of the analyzed period, the annual net benefits of the 'without management' scenario outweigh the benefits of the 'with management' scenario. This is due to the higher costs of the 'with management' scenario. Until 2015, the net benefits of the 'with manage

ment' scenario increase gradually. This is the result of two main effects: i) better functioning coral reefs that support tourism and fisheries and ii) the overall growth of Vietnam's coastal tourism industry (and that of Nha Trang in particular).

Based on the annual benefits of the scenarios and the choice of social discount rate, the net present values of the management scenarios can be calculated. Dagusta and Heal (1979) argue against a careless choice of social discount rate in a cost – benefit analysis. Sinden (1993) discusses whether to choose a specific social discount rate for environmental projects or not. Since the choice of discount rate is critical, a sensitivity analysis for the discount rate is normally applied in CBA. In this study, taking into account this problem, and to ensure a representative number for the net benefits, we used an average discount rate of 12% over the period 2005 - 2030 to calculate net present values of the scenarios. The net present value of the Hon Mun area over the period 2005 – 2015 is i) US$70.3 million under the 'with management' scenario and ii) US$53.8 million under the 'without management' scenario.

Table 4.6 Net present benefits and costs of management options for Hon Mun MPA.

Present Values (in US$ million)	Tourism benefit	Fishery benefit	Conservation benefit	Total Benefits	Costs	NPV
'With management' options	44.30	25.50	2.88	72.68	2.37	70.31
'Without management' options	30.47	23.64	0.00	54.12	0.22	53.89

Table 7 shows present benefits and costs of 'with' and 'without management' options for the period 2005 – 2030. As discussed above, the net present values of both options are positive. In this study, we defined the management option as marine protected area management. Hence, 'without management' means the marine protected area would not exist at the current site, but the site would still be under the management of local government. The main advantage of the MPA management scenario is tourism benefits. One of the biggest challenges facing the Hon Mun MPA is sustainable financing (Chu Tien Vinh *et al.*, 2003). A possible solution is to introduce a so-called "conservation fee" for coral reef users. The large tourism benefit implies grounds for this conservation fee. It is worth underlining that the tourism benefit comprises both consumer surplus and producer surplus. Only the "conservation fee" is attributed to or at least relates to the consumer surplus, while the benefits of producers are experienced by the transportation industry, hotels and restaurants, and diving schools. This implies that policy makers using this cost – benefit analysis must have a broad view of benefits and costs of the MPA. While the costs are easy to see as monetary outflows, the benefits of management are broader, for example additional profit for international travel agents or fisheries spill over effects benefiting fishermen; in addition, benefits are sometimes intangible, such as the consumer surplus of divers/snorkelers or use of resources by future generations etc.

5. Conclusions and policy implications

Reefs in Vietnam's Hon Mun MPA offer many diverse benefits to fishers, local communities, tourists, tourism industry operators, local authorities and civil society more broadly. Coral reef management efforts in the MPA have to capture the attention of this diverse range of stakeholders. Therefore, measuring and identifying equitable distribution strategies for these benefits is critical in the management of reef systems. Such information may serve as a basis for MPA performance indicators or management goals, and could ensure the sustainability of the resource. Information on values of reefs could also be used to predict the effect of different management strategies.

The Hon Mun MPA currently enjoys a US$ 2 million (largely international) funding programme, which is quite exceptional for a Vietnamese MPA. This external financing will soon come to an end, and alternative funding must be secured to guarantee the park's long-term future. In this study, the economic outcomes of two different policy scenarios were computer simulated in order to evaluate the long-term gains of park management. Impacts on tourism, fisheries, and biodiversity were considered individually, and then combined to generate an overall economic value for the scenarios.

The net benefits of the 'with management' scenario increase until 2015, after which they remain stable and considerably higher compared to the 'without management' scenario. This is a result of three main factors i) healthier marine ecosystems sustain more productive capture fisheries/aquaculture ii) preserved marine life (particularly reefs) attract greater numbers of tourists and ii) Vietnam's coastal tourism increases regardless of marine conservation initiatives (at least during the period under consideration).

Table 4.7 A proposed user fee scheme for Hon Mun MPA.

Type of tourists	Country of origin	Number of visitors	Service charge	Conservation fee	Combined amount	Total Revenue
Snorkelers	Vietnam	36,400	\$ 0.65	\$ 0.65	\$ 1.30	\$ 47,273
Divers	Vietnam	15,600	\$ 0.65	\$ 1.30	\$ 1.95	\$ 30,390
Other visitors	Vietnam	209,100	\$ 0.00	\$ 0.65	\$ 0.65	\$ 135,779
Snorkelers	Foreigners	4,500	\$ 1.95	\$ 0.65	\$ 2.60	\$ 11,688
Divers	Foreigners	13,500	\$ 1.95	\$ 1.30	\$ 3.25	\$ 43,831
Other visitors	Foreigners	20,900	\$ 0.00	\$ 1.30	\$ 1.30	\$ 27,143
Total		300,000				\$ 296,104

This study indicates that tourism will generate the greatest economic benefits for Hon Mun over the next two decades. Policy makers need to 'capture' a proportion of these benefits in order to fund operating costs and support communities who, as yet, do not sufficiently gain from marine conservation. One way of doing this is through a 'user-fee' for park visitors. Based on current visitor numbers, a user fee of US\$0.65 for non-divers and US\$1.30 for divers would raise almost US\$300,000: enough to adequately manage the MPA (Table 8).

A proportion of these funds could be allocated to improving income generation programmes for affected fishermen. Residents could also be encouraged to become involved in the tourism industry directly, for example if they were given subsidized jobs or appropriate training. Top down management is by no means made redundant by community involvement or by the development of tourism. Uncontrolled tourism development can itself cause ecological degradation. Equally, a community-based management approach will not deter illegal fishing in its entirety. As such, a regulatory approach to marine conservation still has a critical role to play. A user-fee is one prevalent way of appropriating the benefits of MPAs, as visitors are typically willing to contribute to park management. However, alternative revenue generating mechanisms might work more successfully in Vietnam's other MPAs, particularly those that are not popular tourist destinations. Funding opportunities include: government appropriations, levies, surcharges, leases and concessions, bio-prospecting, trust funds, donations, corporate sponsorship, debt-for-nature swaps and international donor contributions. All of these options (individually, or preferably in combination) could be explored by MPA management authorities along the coast. Without the socio-economic stability that this funding could provide, the long-term conservation of Vietnam's marine ecosystems is uncertain.

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