Cost-benefit analysis of community-based marine protected areas: Five case studies in Vanuatu

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Introduction

Community-based marine protected areas in the Pacific

In the Pacific, local populations, governments and other institutions are investing considerable effort into improving ways to sustainably manage coastal marine resources with inexpensive and strong performing tools (Bell et al. 2009; Mora et al. 2006).

For some stakeholders, community-based management of marine resources is proposed as one of the best options for securing the well being of both reefs and communities in the Pacific Islands (Johannes 2002; Johannes and Hickey 2004; Tawake and Aalbersberg 2002; UNEP 2004).

Community-based marine protected areas (MPAs) have experienced impressive development over the last decade (Aalbersberg et al. 2005). They usually form part of a larger management scheme referred to as a marine managed area (MMA), and more than 550 documented MMAs now exist in the Pacific (Govan 2009). Management is carried out primarily by the community through relevant user groups, and involves local and national institutions and private stakeholders.

Management rules such as fishing closures, temporary bans, size restrictions and gear controls can be diverse, and some are still based on traditional ecological knowledge (Cinner and Aswani 2007; Johannes 1998, 2002). In recognition of these characteristics, a regional term is used: locally managed marine area or LMMA.

From theory to reality: What do we really know about the benefits of MPAs to communities?

The benefits and distribution patterns expected from community-managed MPAs in the Pacific are little studied, as highlighted by a recent bibliographic study on socioeconomic and ecological impacts of MPAs in Pacific Island countries (Cohen et al. 2008). Although, a good deal has been written about what MPAs could or should do, few empirical studies demonstrate what they actually do for people (Mumby and Steneck 2008).

MPAs and the bilateral agencies in the Pacific

In the Pacific, development banks and bilateral agencies have used several intervention instruments for coral reef ecosystem management: direct support via a project grant approach, pilot programmes, trust funds, capacity building or alternative livelihood promotion. To illustrate, nearly 40 MMAs in 10 Pacific Island countries and territories have been directly supported in their start-up phase since 2005 (Oréade-Brèche 2008) by the Secretariat of the Pacific Community (SPC)–Coral Reef Initiative for the South Pacific (CRISP) project.

Project objectives

From the perspective of bilateral agencies, financial investment in small MPAs must be analysed from a double bottom line perspective: 1) impacts on economic growth and poverty reduction, and 2) impacts on world biodiversity.

One important criterion of these investments is the continuity of the intervention. The existence of local benefits and their distribution patterns are often identified as a successful factor for continuity, and projects should be marketable not only to donors but also to stakeholders and governments (UNEP 2004).

To respond to previous requirements and, at the same time possibly increasing the "stewardship" of projects to local stakeholders, an investment appraisal was conducted in select community-based MPAs in Vanuatu.

The research was designed to focus on observed and proven impacts of the MMA, and results came from intensive field study.

Methodology

General approach

The study monitored selected MPA impacts through a control-impact protocol on fishery yields and tourism revenues, and conducted a cost-benefit analysis (CBA) for each MPA and for each stakeholder (village level, national and international level). CBA results were then

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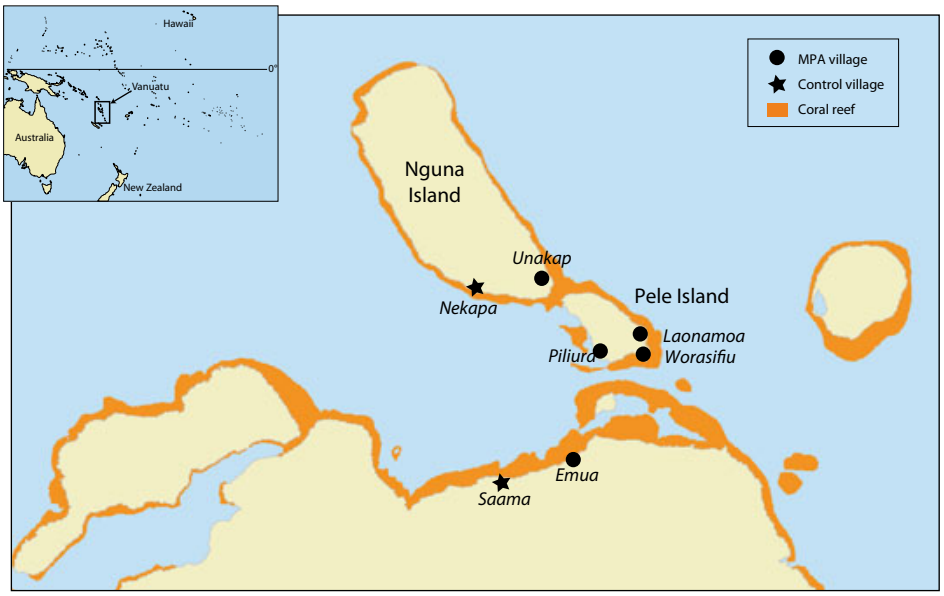


Figure 1. Location of villages, MPAs and control sites.

used to 1) compare the benefits of MPAs with the calculated annual village gross domestic product to give an idea of the relative importance of MPAs for villages, and 2) realise a financial analysis of MPA cash flows to present the internal rate of return and the return on investment for development banks.

Selection of MPA sites

Criteria

Five villages — each with an MPA — and two villages — both without an MPA — were selected in North Efate (Fig. 1 and Table 1). Each MPA site met the three following criteria: 1) a fringing coral reef was the dominant ecosystem; 2) the MPA had been managed and adequately enforced by communities for at least five years, with the reserve covering at least 10% of the fishing ground area[2] and, 3) fulfilled at least three of the six key success factors identified for community-based MPA (Pollnac and Crawford 2000). The key success factors met by the selected sites were: 1) population size and the village area are relatively small, 2) there is a visible level of community participation in decision-making, and 3) there is a continuing presence of the implementing agency.

Fishing activities

Each village has customary tenure of its fishing ground, from the shoreline to the end of the reef (Johannes 2002), and the size of the fishing ground varies from 0.5 km^2 to 1.5 km^2 (Table 1). Both subsistence and commercial fishing take place within the MPA, and fishing activity is evenly distributed across the population. Nonetheless, as described by several authors (Amos 2007; Bartlett et al. 2009; Hickey 2008), the commercial fishery is not developed as a formal activity, and represents a supplemental and irregular income to agricultural activities for most households.

The two main gear types used are 25-metre-long gillnets (7.2 units km^{-2}) and spearguns (6.4 units km^{-2}). These gear types usually target species that benefit from the protection that marine reserves offer (Russ and Alcala 1996), and include species from the families Scaridae, Acanthruridae and Serranidae. Other gear types that are used less regularly include cast nets (depending on the migration timing of some species), handlines (used from the shore or a canoe), hand collecting (common at low tide for Octopus sp. and shells), as well as some other traditional gear types (e.g. hand spear).

MPA and other fishery management rules

Every MMA is associated with a unique village. The size of an MPA within an MMA varies from 0.1 km^2 to 0.2 km^2, which is similar to most small MPAs in the Pacific (Govan 2009), and which represents an average of 15% of the reef fishing ground. The MPAs are all actively managed by villagers through an MPA committee or environment committee consisting of village members. Some MPAs are non-permanent closures, where periodic harvesting can occur for specific village events.

Other fishery management rules are also in place (e.g. on trochus, sea turtles, night spearfishing, specific rules to some species migration).

[2] This corresponds to the minimal time period and fishing ground size that allow for the effects of an MPA to be visible with regard to fishery yields (Gell and Roberts 2003)

Table 1. Socioecological context of the villages

	MPA sites					Control sites	
	Emua	**Piliura**	**Unakap**	**Laonamoa**	**Worasifiu**	**Nekapa**	**Saama**
Resident population	240	110	90	250	50	110	130
Number of private electricity generators per household	0.15	0.05	0.06	0.06	0.11	0.05	0.12
Monthly average household expenses (monetary and non-monetary) (Euros)	479	373	388	420	420	438	455
Monthly average non- monetary incomes (% total expenses)	31%	40%	40%	36%	36%	36%	31%
Tourism infrastructure (number of beds)	5	-	8	14	5	-	-
Dominant reef geomorphology	Intra-seas exposed fringing, forereef	Intra-seas exposed fringing, forereef	Ocean exposed fringing, forereef	Ocean exposed fringing, forereef	Intra-seas exposed fringing, reef flat	Intra-seas exposed fringing, forereef	Intra-seas exposed fringing, forereef
Fishing ground size (in km^2)	1.5	1.1	1.3	1.3	0.5	1.2	0.9
Demographic pressure on reef (inhabitants km^{-2})	157	102	71	188	104	92	144
Main fishing gear used	Net, speargun, handline	Net, speargun, handline	Speargun, handline	Speargun, handline	Speargun, handline	Net, speargun, handline	Net, speargun, handline
Fishing pressure index	3.1	3	1.35	3.75	3.65	3.05	3.25
MPA creation date	2005	2003	2003	2003	2003	-	-
MPA size (km^2)	0.24	0.13	0.12	0.14	0.13	-	-

Tourism activities

Small-scale rural tourism takes place in every village. Tourism activities include day tours, snorkel tours, scuba diving, staying in guesthouses, scientific tourism, and other activities associated with the previously named activities, such as restoration and the selling of handicrafts.

Guesthouses are small structures that cater to adventure and nature travelers. The houses are developed without external financing (except occasional aid) and can survive even with low occupancy rates because they do not borrow funds from banks and keep their costs very low. The majority of guesthouses are managed privately but some are owned and managed by the community.

Scientific tourism includes visits from researchers, non-governmental staff, or other professionals.

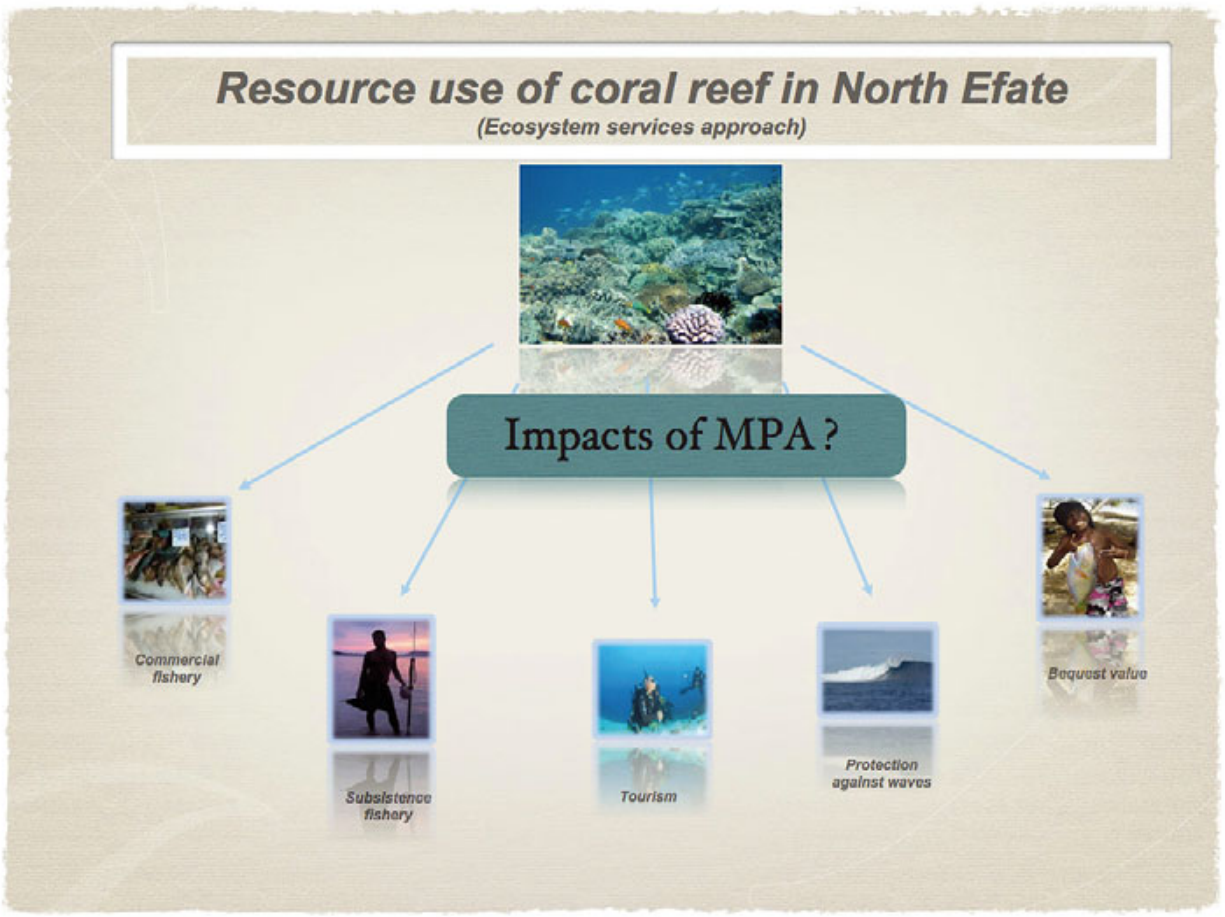
As confirmed by a study (Trip consultants 2008) that showed that around 8,000 international and domestic (non-affinity tourism)[3] visitors came to North Efate in 2007, this kind of tourism is in the start-up phase.

Validation of control sites

The control-impact approach is proposed by several authors (Balmford et al. 2008; Underwood 1994) as a way to solve the difficulty of separating and identifying MPA effects from site or context effects.

Two villages acting as control sites were chosen to be compared with selected MPA villages. The control sites were similar to MPA sites with regard to ecological attributes, fishing effort, tourism, and their socioeconomic context in order to make it possible to compare the various sites and identify MPA effects. Specific methods were

[3] Non-affinity tourists: tourists who have no family of friendship ties with their hosts.



employed to validate the degree of similarity of these previous factors: 1) a medium-scale approach (Clua et al. 2006) to compare fish habitat attributes; 2) the use of a synthetic fishing effort index; and 3) a household income and expenditure survey.

Several statistical tests were applied to data to determine factors such as distance from an MPA, substrate type, fishing pressure index, and tide cycle; and to identify their effects on catch per unit of effort (CPUE) due to the existence of the MPA.

Selected MPA impacts

An MPA can increase:

- subsistence food items, and commercial reef fisheries,
- underwater tourism and other tourism sectors,
- biodiversity,
- protection of coastlines from wave damage (due to the presence of a healthy coral reef), and
- social capital.

Valuation methods

Spatial perimeter of analysis

The spatial perimeter of MPA impacts took into account 1) spillover effects of an MPA,[4] 2) the area where use(s) take place (e.g. fishing grounds or dive sites), and 3) the residence of stakeholders (e.g. fishermen, tourism businesses).

Following the conclusions of different authors (Halpern 2003; Jennings et al. 2001; McClanaham and Graham 2005; Russ and Alcala 1998), and given the small size of the studied MPAs (less than 50 ha), it was assumed that the potential spillover area would cover a maximum of 1 km on either side of the MPA when the habitat was continuous. This spatial effect applies to the main local commercial reef fish species (Scaridae, Acanthuridae and Siganidae). Therefore, considering the size of the fishing grounds of the villages, it was found that most of the potential spillover effects from an MPA benefited mainly the village.

[4] Spillover effects refers to when marine resources are so plentiful within an MPA that they venture into surrounding areas where they can be caught by fishermen.

Quantification and valuation

The valuation of impacts is based on a two-step, bio-economic approach. The first step is to quantify MPA benefits (e.g. volume of additional extracted biomass). The second step is to calculate the monetary value of the impacts. The valuation is focused on the financial value of the impacts.

Data collection approaches for quantitative valuations

Data collection includes several techniques: interviews and questionnaires, focus group discussions, experimental fisheries, fishing logbooks and monitoring.

As reported on by several authors (Caddy 2000; Pickering et al. 2003), the impacts of an MPA on a fishery are usually small and their identification requires precise data. In this study, preference was given data collection through field observations and experiments instead of surveys when the objective was to gain quantitative data (e.g. fishery).

MPA impacts on fishery productivity (spillover effect)

CPUE (e.g. kg of fish captured per hour of a standard fishing effort) was chosen as an indicator of fish productivity. CPUE has been collected and differentiated by gear types in order to cope with the complexity of fisheries and multi-species fisheries. CPUE for gillnetting and spearfishing are collected in both MPA and control sites. Experimental fishing is used for gillnet fishery and fishing logbooks for spearfishing.

MPAs and how they affect tourism

For each type of tourism activity, the way in which an MPA affected visitation was assessed. During their stay in the village, most tourists can take advantage of several activities such as trekking, participating in cultural ceremonies, and relaxing on the beach.

Two methods were used to assess visitation: interviews with business owners to define the distribution of activities undertaken by tourists, and a tourism advertising images analysis (AIA) to estimate the weight that marine related activities had in their choice of destination.

AIA is a method that is based on the fact that tourists make their decision to come to a specific site on previous information received through advertising (Andersson 2007). AIA was realized through a counting of the number of images suggesting different activities or ecosystems.

Economic valuation

Classic economic valuation techniques were applied in order to valorise MPA impacts on added values of commercial fishery and tourism. For subsistence fishing, the monetary valuation was done in two steps. First, the protein equivalent of catches for the most representative fish species was estimated and then transformed into the equivalent weight and price of a basic commercial food item (canned tuna in this case).

Economic valuation of impacts on coastal protection and on bequest value[5] is described in detail in the technical report.

Results

The average investment per community-based MPA is EUR 2,400/ year (including amortising of setup costs). Investments for each of the five MPAs are in the range of EUR 5,000–19,000 for the initial investment phase (setup and assets), and EUR 900–4,000 for annual operational costs. Investment mainly comprised building capacity in villages (70% of operational costs).

Returns on investment are generally attractive, with a mean value of 1.8 after 5 years (SD = 0.9) and a potential of 5.4 (SD = 2.5) after 25 years.

MPAs have produced an average annual gross profit of around EUR 8,900 (SD = 3,000), which represent 7% of the total village gross domestic income. The previous result confirms the role of MPAs as a development tool for rural areas, and is a necessary (but not sufficient) condition to ensure their durability without external support.

Impacts on rural tourism and fisheries were the main sources of benefits (56% and 26% of annual benefits, respectively) and both sectors represent key sources of cash income and protein for villages (see Fig. 2).

Less visible in the economic valuation, MPAs have also had positive impacts on social capital, the protection against wave damage that a healthy ecosystem can provide, and the bequest value attached to the ecosystem.

Observed benefits of these small MPAs to the fishery sector included an increase in productivity for the principal gear types (estimated to vary from a 4% to a 33% increase in CPUE). Other observed effects included fish catches were more stable for each fishing trip, and the maximum fish size increased for villages with an MPA.

Benefits to tourism were evident for rural tourism (through guest house and day tours by family own-businesses). The importance of an MPA in the choice

[5] Bequest value: The current generation places value on ensuring the availability of biodiversity and ecosystem functioning to future generations. This is determined by a person's concern that future generations should have access to resources and opportunities. It indicates a perception of benefits from the knowledge that resources and opportunities are being passed to descendants. Source: http://www.coastalwiki.org/coastalwiki/Non-use_value:_bequest_value_and_existence_value

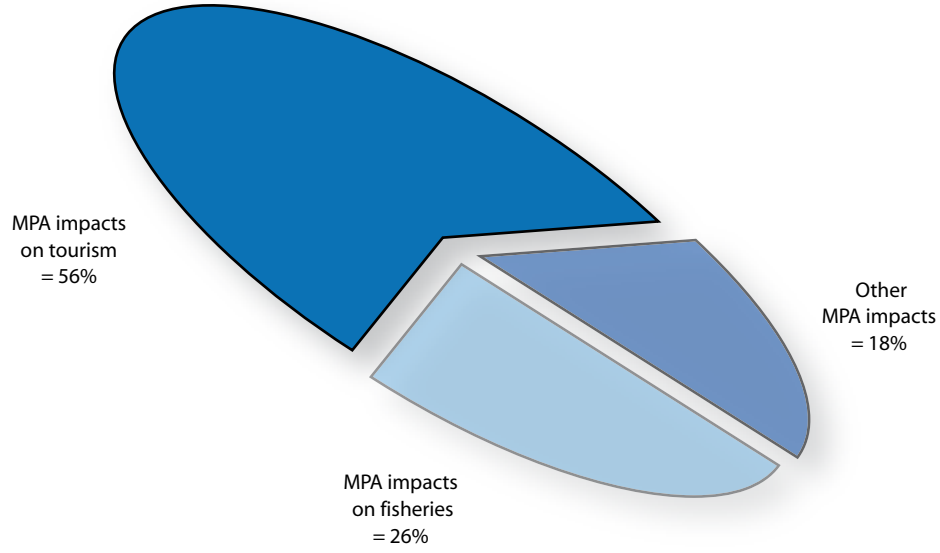


Figure 2.

MPA annual economic benefit distribution based on average benefits from five MPAs, 2009. Mean benefit per MPA = EUR 8,900 per year.

of tourism site was estimated to vary between 40% and 75%. In a similar way, it was observed that, on average, for 60% of visitors, at least one group member took part in some snorkeling activities.

On average, 70% of benefits were directed to the villages. The other 30% went to national stakeholders (mainly through tourism activities).

Nonetheless, the level of capital investment per MPA (equivalent to a mean annual of EUR 14,000 km^{-2} of protected area) must be analysed carefully. Not all investments in MPAs have been recuperated after the first five years, and for some, there is no return on investments (i.e. breaks even), even after 25 years of projections. This reflects a differential between the potential of a fishery and tourism business development for some villages, and the investment amount.

Also, there is no evidences that indicates MPAs have an influence on the level of maximum sustainable yield for a fishery, or for the maximum carrying capacity for tourism. Therefore, the hypothesis that an MPA can ensure sustainable benefits (from fisheries and tourism) at the intergenerational scale remains uncertain.

Furthermore, in a context of increasing fishing effort and rapid introduction of a market economy, questions may arise on the resilience of community-based governance and the role of the MPA as the primary tool for maintaining sustainable catches.

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The reefs at Nguna and Pele islands and the village of Unakap. Image: Nicolas Pascal.

a. A meeting of the MPA or environment village committee.
b. Cast net fishing at low tide in a zone opened to fishing.
c. A traditional sign indicating a tabu zone (no fishing).
All images: Nicolas Pascal.

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