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Economic valuation of a traditional fishing ground on the coral coast in Fiji

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ABSTRACT

In Fiji, economic valuation has not yet been adopted as an aid to coastal resource management. Given increasing pressures on its coastal resources, particularly near urban centres, valuation of these resources may be crucial to assist decision-making at all levels. This paper presents estimates of the economic value of the main goods and services provided by the coastal ecosystems in a traditional Fijian fishing ground near the capital, Suva. Using catch surveys, a CV survey and secondary data sources, the value of fisheries, bequest value and coastal protection function provided by the coral reefs and mangroves within this area are estimated to provide net benefits of just over FJ$3m (US$1,795,000) per year. The coastal protection provided by the coral reefs and mangroves makes up the largest component of the total economic value (55%) followed by fisheries (44%). Bequest values only make up 1% of the TEV. However, if compared to household income, bequest values are significant, representing 6.8% of stated income. This is comparable to average expenditures on durable household goods and heating and lighting.

1. Introduction

Coastal ecosystems are a crucial input to livelihoods in South Pacific countries such as Fiji, where about 90% of the population lives on or near the coast (APN, 2002). Coral reefs, mangroves and seagrasses provide habitats, nurseries and food for reef fisheries, usually the main source of protein for local subsistence consumption (Dalzell et al., 1996). They also provide protection from tropical storms, as well as opportunities for recreation and cultural activities, amongst other benefits.

However, despite the many benefits that coastal communities in the South Pacific receive from their local marine ecosystems, these are often ignored by policy-makers interested in poverty alleviation. Traditionally, in most less developed economy contexts, policy-makers have tended to focus on increasing income as a means to poverty alleviation (Kahn, 2005). Despite recent advances in development models to include additional indicators of poverty such as literacy rates, life expectancy and environmental quality, the focus on income (or GDP per capita) remains central to poverty alleviation efforts in many LDEs in the South Pacific.

Although more income is probably a good thing, the focus on increasing income may, in some cases, have a negative effect. In subsistence-based communities, the provision of incentives (e.g. loans, infrastructure, extension services, subsidies etc) to stimulate the production of marketed goods may lead to over-extraction of resources, increased reliance on markets for food, and in some cases, cultural breakdown. This latter is particularly found to occur in some countries of the South Pacific, such as Fiji and the Solomon Islands, where there are cultural obligations to re-distribute money amongst the community; in Fiji these obligations are known as *kere kere*. Despite the social intentions of these cultural obligations, they unfortunately can lead to perverse incentives, such as a refusal to work, lavish expenses on consumables, or in some cases, emigration from the village. In a review of 43 alternative livelihood projects implemented in ten countries of the South Pacific, O'Garra (2007) found that successful income-generation projects tended to occur in communities with strong leaders and social cohesiveness. In these cases, any rivalries and demands for money (reciprocity obligation) that arose between households engaged in the income-generating projects were mediated by the leader and the rest of the community.

Due to these increasing pressures on coastal resources, local leaders, as well as supporting organisations and institutions, such as the Native Land Trust Board (NLTB), are facing a number of decisions as to how to proceed with the utilisation and management of their resources: should local communities continue harvesting as usual? Should they actively protect their coastal resources through the establishment of Marine Protected Areas? Should there be a push to stimulate alternative livelihoods, such as coral harvesting, or coastal-based tourism?

In order for these questions to be properly addressed, a first step is to estimate the net flow of benefits currently being derived from

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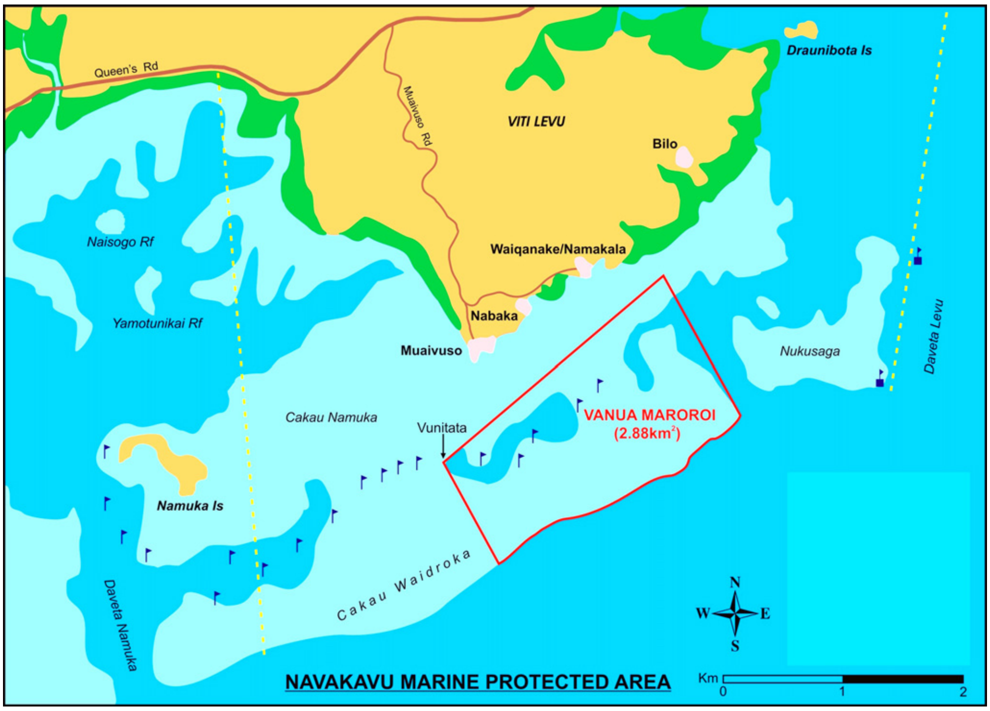

Fig. 1. Map of Navakavu traditional fishing grounds.

the coastal ecosystems in question. This means valuing not just the marketed ecosystem services, but those that are not marketed as well. This is a particularly important in the context of less developed economies where many – if not most – types of natural capital and ecosystem services do not show up in market transactions. Valuation of the total flow of benefits may show decision-makers the true value of resource and the potential losses if the resource is over-exploited or destroyed.

To date there have been only three economic valuations associated with coastal resources in Fiji. Two of these (Lal and Cerala, 2005; Sauni et al., 2005) value the extraction of live coral for the aquarium trade. However, these studies only estimate the financial revenue to local villagers from coral reef harvest; environmental and social impacts are not assessed. Lal (1990) uses market prices to estimate the benefits from mangrove forests in terms of their contribution to fisheries, wood production, and traditional uses (the value of the waste assimilation function of mangroves is also assessed, but for some reason, not incorporated into the TEV). Results indicate that mangroves in Fiji provide an annual service of FJ$29,200/km.

The aim of this paper is to present estimates of the economic value of the main goods and services provided by the coastal ecosystems in a traditional Fijian fishing ground. The site chosen for this study is the Navakavu fishing ground, located near Suva. This

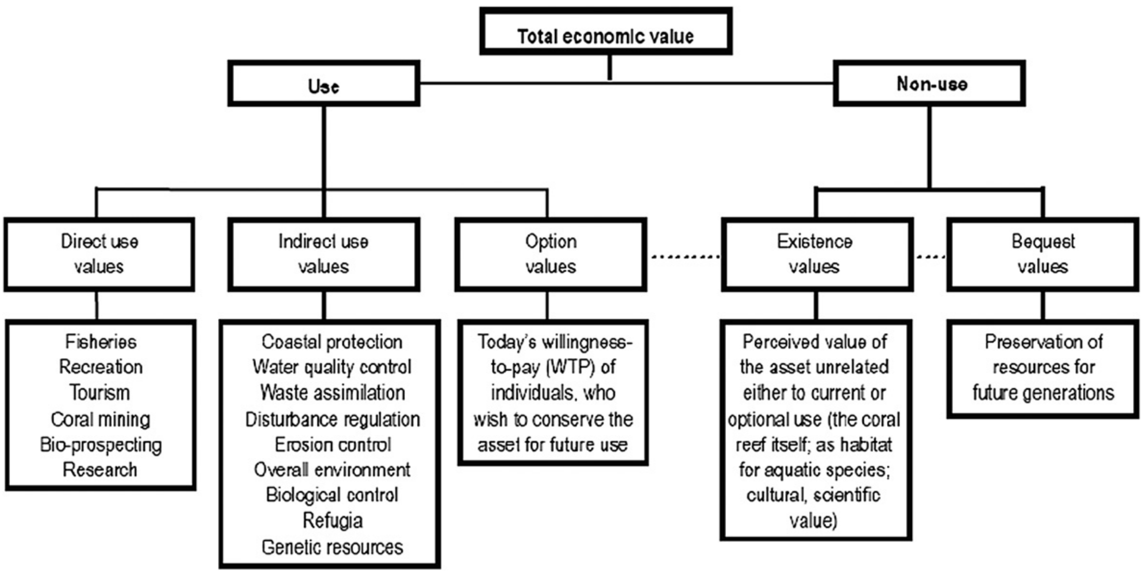

Fig. 2. Total economic value of coral reefs (taken from Cesar and Chong, 2004).

traditional fishing ground is held under customary fishing tenure by four villages in the area. The present study purports to measure the total ecosystem value (or '*value at risk*') of the fishing grounds. Given the dearth of valuation studies associated with coastal resources in Fiji (and indeed, the South Pacific in general), the present study will represent a significant contribution to the literature.

2. Site description

The Navakavu fishing grounds are located around the Muaivuso peninsula, 13 km west of Suva, in the province of Rewa. There are four villages on the peninsula: Muaivuso, Nabaka, Waiqanake and Namakala, with a total residential population, in 2007, of around 600 inhabitants (Beukering et al., 2007). The land around these villages is owned by the villages themselves, which together form a '*yavusa*' - this refers to a clan and its land and waters. The *yavusa* Navakavu covers 580 km^2 of land, and 18.5 km^2 of coastal waters. Although the *yavusa* may incorporate coastal waters within their boundaries (extending from the shore to the seaward limit of the reef), local villagers only have customary fishing rights to these coastal waters (know as '*iqoliqoli*'), rather than outright ownership (Fig. 1).

The Muaivuso peninsula is surrounded by a fringing coral reef, mangroves, and remnants of coastal littoral forest. These are shown in Fig. 1. The yellow dotted line indicates the demarcation of the traditional fishing grounds. The solid red indicates the MPA, where all fishing and other extractive activities are prohibited. The light blue areas represent coral reefs and the green areas are mangroves.

Fiji is one of the more developed economies in the South Pacific, depending mostly on tourism, agriculture (mainly sugar), fisheries and foreign remittances for its earnings. Even so, subsistence agriculture and fishing remain an important way of life for most Fijian households. This is also true of the Navakavu villages, where subsistence living is still practiced by most households (Fong and Aalbersberg, 2010). Despite their proximity to Suva, the average household income per month in Navakavu (in 2007) was less than half of the Fijian average (US$251 equivalent versus US$508 equivalent) (Beukering et al., 2007).

3. Total economic valuation approach

The economic value of all the goods and services provided by an ecosystem make up the TEV of an ecosystem. Fig. 2 shows a standard illustration of the breakdown of TEV into its various categories of value, for coral reefs.

Different coastal ecosystems will have different combinations of use and non-use values. Thus, some coastal areas may have high recreation values, whilst others are not used for recreation at all. It is up to the researcher to identify the particular goods and services provided by a particular study area.

Using existing studies (Kronen, 2004; Thaman and Tamata, 1999), and expert opinion from individuals who have carried out work in the area,[1] the most important goods/services provided by the coral reef and mangrove ecosystems within the Navakavu fishing grounds were identified as: *fisheries* (commercial and subsistence), and *coastal protection* afforded by coral reefs and mangroves from storms and flooding. The *waste assimilation* function of mangroves (whereby organic nutrients, such as those from human and animal waste, may be retained and recycled by mangroves) was also highlighted as a potential problem. However, given the potential for double-counting (e.g. the value of cleaner water may turn up in the economic value for fisheries), the author has opted not to incorporate this value into the TEV reported in this paper.[2]

Table 1
Key goods/services in Navakavu fishing grounds & valuation tools used.

Key goods and services	Valuation tool	Data collection
Direct extractive use		
Fisheries (commercial)	Production approach	Catch survey in villages, and market prices from secondary sources
Fisheries (subsistence)	Production approach	Catch survey in villages, and market prices from secondary sources
Indirect use		
Coastal protection	Benefits transfer	Secondary data on cost of protection
Non-use		
Bequest value	CV	Surveys in villages

In addition, *bequest values* were identified as key values during the pre-pilot interviews with villagers. Bequest values represent the value attached to preserving an ecosystem for use by future generations, independent of one's own use of the ecosystem. In Fiji, land-owning groups are bound by kinship ties, and land is considered to be handed down by their ancestors. They in turn must pass the land onto future generations (Abramson, 2000). There is value, therefore, to current generations, of being able to pass on land to future generations (see McLeod, 2000).

The key goods and services provided by the Navakavu fishing grounds are listed in Table 1. In addition, Table 1 lists the valuation tools used to estimate the economic value of each good/service, and the data collection approaches used. These are described in Section 4. It is worth noting that the relative contribution of the different ecosystems to some of the goods/services listed cannot be easily separated out. For this reason, most economic values in this study will be estimated for combined ecosystems, unless otherwise stated.

In the present study we are estimating what Gustavson (2000) calls the 'value at risk'.[3] This represents the total value that would be lost *if the resource were completely degraded*. The assumption is that, in the absence of new management interventions or new threats to the resource, the benefits currently received from reefs and mangroves will not change. However, the Navakavu fishing grounds have actually been subject to management interventions: in 2002 it became a Locally Managed Marine Area (LMMA), involving cessation of certain unsustainable activities such as mangrove wood-cutting and the use of fish poison to catch fish. In addition, a Marine Protected Area (MPA) has been in place since 2004. This is essentially a "no-take zone", where all fishing is banned. Thus, the present study will provide a baseline TEV for goods and services of the ecosystems *4 years after the establishment of a LMMA* and *2 years after the establishment of a Marine Protected Area*. This is as close as a baseline analysis as can be provided, given that no other economic data has been collected prior to this study. A

[1] Prof. Randy Thaman, Department of Geography, USP; Semisi Meo, Institute of Applied Sciences and FLMMA Network, USP; Dr. Mecki Kronen, Community Fisheries Scientist, South Pacific Commission; Isoa Korovulavula, Institute of Applied Sciences, USP.

[2] Note that in O'Garra (2007) the waste assimilation value was estimated using benefits transfer and incorporated into the TEV. However, it has not been included for this paper, given the very real potential for double-counting.

[3] It is important to note that the 'value at risk' estimated here does *not* represent the potential rent owed to local communities by other users of the fishing grounds (e.g. resorts), unless it is completely degraded as a result of its use. The issue of appropriate compensation for use of local land and fishing grounds has caused serious friction between the tourism industry and land-owners in Fiji, hence the importance of this caveat.

review of the literature on spillover effects[4] of MPAs, however, suggests that positive spillover effects are observed only after a minimum of 5 years (e.g. Christie, 2005; Roberts et al., 2001; McClanahan and Mangi, 2000). Thus, the economic data estimated in this study may be considered adequate as a pre-MPA baseline.

Most of the benefits and costs associated with the use and management of the Navakavu coastal resources accrue to the local community. Other users might include researchers (e.g. University of the South Pacific) and the global community (e.g. biodiversity and carbon sequestration benefits). Due to resource limitations, however, this study will focus on valuing the range of benefits provided by the Navakavu coastal ecosystems to *local villages*, as well as the full costs of resource-use by these villages.

4. Study design

This section provides an overview of the study design and the data collection process. Fisheries catch data and bequest values were collected using surveys, which are described below. Market prices for fish and invertebrates were obtained from secondary sources (Korovulavula et al., 2006). Coastal protection values were estimated using values from various secondary sources.

4.1. Valuation of fisheries

Fisheries are typically valued using a *production approach* – this involves estimating the total revenue from fishing (using market prices) and subtracting the costs incurred. Although potentially simple to use, production approaches usually fail to account for consumer surplus. Furthermore, the analysis of catch data depends on the availability of reliable and systematic fisheries data. To date, the only catch data for the area consists of two small-scale socio-economic surveys (e.g. Cakacaka, 2008; Kronen, 2004). These involved snapshot surveys of catch activity. The present study aims to add to the existing studies by generating primary catch data using a household questionnaire.

The household questionnaire was carried out with the heads of household, or their spouse. The pilot version was developed using information gleaned through pre-pilot interviews carried out in the field in October 2006. The questionnaire was piloted in the field one week later, with the assistance of two trained locals, and changes incorporated into the final version. The final household questionnaire established: socio-demographic characteristics of the respondent (e.g. gender, age, education levels) and their household (e.g. number of people living in household, family composition); livelihood activities of the respondent and the household; wealth indicators of the household (e.g. cash income, savings, tv-ownership etc); and individual attitudes towards the fishing grounds.

The questionnaire also included two sections addressing fishing activities in the Navkavu fishing grounds. The first section established general fishing activities (average fishing effort per household; fishing grounds; gear used; frequently harvested species). The second section aimed to measure the catch (fish and invertebrates) harvested *during the last trip*. For this section, interviewers were required to record: the type, number and average size of fish or invertebrate species caught,[5] and how these were used (whether they were sold, consumed and/or given as gifts). Size data was obtained with the aid of a ruler. This process was repeated for each species in each household's catch. Preferably, the interviewer would help to count and measure the fish themselves; however, it was not always possible for them to see the catch (for example, if the last fishing trip had been 2 days before) so in these cases data was gathered based on the respondent's memory. Although this is a limitation of the study, there were insufficient resources to allow for data collection at landing sites.

Conversion of length to weight data for finfish was carried out using length-weight (LW) ratios set out in FishBase (www.fishbase.org).[6] The measurement of invertebrate weights from length or width data is more complex, and very little has been published in this area. Thus, LW ratios were obtained through an extensive trawl of journals and internet search engines, and in most cases, proxy values were used. Details of proxy values used are found in Annex 1 of O'Garra (2007).

Using market prices for finfish and shellfish, the catch from the last trip was valued. This value was used to estimate gross benefits associated with fisheries (see Section 5.2.5 for assumptions used to estimate this value). Costs were deducted, using data obtained using the household questionnaire on capital and running costs associated with fishing activities (i.e. boat ownership and cost, maintenance costs, gear ownership and costs, and labour costs), and net fisheries value estimated.

4.2. Valuation of bequest value

Given the lack of a market for non-use values, bequest values can only be measured using stated preference survey methods, such as contingent valuation (CV). CV involves a questionnaire in which respondents are presented with a hypothetical market for the good being valued. They are then asked for their willingness to pay (WTP) - or their willingness to accept (WTA) - for the good. There have been very few studies to directly estimate bequest value, and only one study to date has estimated bequest value associated with the marine environment. In this study, Hargreaves-Allen (2004) used a CV survey to estimate the bequest value associated with coral reefs in the Wakatobi Marine Park in Sulawesi, amongst local villagers. The bequest value was estimated at Rp412,000/km^2 (Present Value of Rp91 million), a fifth of that associated with all the reef's benefits.

In the present study, a CV tool was administered to individual respondents using an individual questionnaire. This was a shorter version of the household questionnaire, described above; all questions relating to the household were omitted. Thus, the individual questionnaire established: socio-economic characteristics of the respondent; attitudes towards the fishing grounds, and the CV question. The household questionnaire also contained a CV question.

The CV question aimed to establish how much money respondents were willing to contribute towards the conservation of the Navakavu fishing grounds for future generations, *independent of their own use of the resource*. Firstly, respondents were reminded of the benefits that the fishing grounds provide them (e.g. fish, protection from storms etc), and reminded that good management ensures continued benefits. Then they were presented with the following scenario: "*I would now like you to imagine that there was a threat to the marine environment in the Navakavu iqoliqoli. Imagine that this threat could destroy the marine environment.*" They were then asked to imagine that, in order to prevent this destruction, the community decided to close off the *iqoliqoli* to everyone. At this stage, interviewers were required to ask respondents if they

[4] Spillover effects refer to the net movement of fish from inside a no-take zone to outside the NTZ, where they may contribute to fisheries.

[5] Catch data was measured in terms of length (for finfish, bivalves) and diameter (for beche-de-mer) or maximum carapace width (for crabs), according to specifications set out in http://www.fao.org/docrep/003/F0752E/F0752E03.htm.

[6] Weight of fish is estimated from length data, using the equation: $W = a \cdot L^b$, where *a* and *b* are constants that are specific to individual fish species. The values of *a* and *b* can be obtained from FishBase.

understood the scenario. Any questions were explained using standard answers that were agreed-upon during interviewer training. Respondents were then asked to imagine that *even if they couldn't use the iqoliqoli* anymore, they still had the same amount of food and income from other activities. Again, interviewers were required to check that respondents understood the scenario. Finally, respondents were asked to imagine that this restriction on their use of the fishing grounds were to last their lifetime, but that future generations would definitely be able to use it for all activities. They were also advised however, that for future generations to be able to use it, the community would need to give money and time towards conservation efforts.

Respondents were then asked whether they would be willing to contribute some come money to help towards the recovery and conservation of the fishing grounds.[7] Those who said yes were asked for their WTP each month, using a payment ladder with monetary values (starting at zero and increasing to $100). Any zero WTP responses were followed up with an open-ended question, asking why they were not willing to pay. Finally, respondents were asked whether they found this question hard. Surprisingly, very few admitted to finding it difficult (20%); this does not correspond with findings in the CV literature on extent of task difficulty associated with this method.

4.3. Valuation of coastal protection function

Benefits transfer involves transferring estimates of non-market values from one study to another. This is the approach used to estimate the economic value of the coastal protection function of the Navakavu ecosystems. A review of the literature reveals a lack of available evidence on coastal protection expenditures in Fiji (Section 5.4 summarises the values found in the literature). The most appropriate study is an unpublished report on based in the Marshall Islands – also a Pacific island. Thus, benefit transfer estimates for this function of the coastal ecosystems will be potentially subject to considerable error. However, the estimates may at least provide *some indication* of the scale of the benefits associated with coastal protection in the Navakavu area.

4.4. Net annual and net present values

Economic estimates in this paper are presented as annual net values. Additionally, net annual values are discounted over a 99-year time horizon, to illustrate the net present value (NPV) of the coastal resource to the Navakavu community. Use of a 99-year time horizon may be considered akin to a flow of net benefits over an infinite time stream (as the additional benefits each year will become negligible over time).

Discount rates used in marine resource valuations range between 5% and 15% (Gustavson, 2000), whilst the most commonly used discount rate for environmental and development projects throughout the South Pacific is 10% (Holland, 2008). This paper will therefore present results using a 10% discount rate (details on NPV estimated using a 5% and 15% discount rate can be found in O'Garra, 2007; these estimates are not presented her for ease of reading). Where relevant, values were adjusted to inflation using the Consumer Purchasing Index (FIBS, 2006a). The exchange rate used is FJ$1.72 to US$1 (using September 2006 exchange rate, FIBS (2006b)). From henceforth, only the US$ equivalent value will be presented.

[7] Respondents were also asked whether they would be willing to contribute time instead of money, and a payment ladder with discrete time amounts used to elicit values. These results have not been included here for lack of space; however they can be found in O'Garra, 2007, 2009.

Table 2
Household socio-economic characteristics.

Variable	Household Sample Statistics ($n = 118$)
Household size (mean number of people)	5.27 (2.33)[a]
Number of females >15 yrs old per household (mean)	1.99 (1.47)
Number of males >15 yrs old per household (mean)	1.91 (1.07)
Gross annual household income (mean FJ$)[a]	2921 (2451) (US$1698)
% Households with savings	63.6
Household savings (mean FJ$)+[b]	375.22 (469.6) (US$218.15)
% Households receive remittance	11.9
% Households own a television	69.8
% Households own a boat	11.0

[a] Figures in brackets are standard deviations.
[b] Income and savings taken as mid-interval of income/savings categories.

4.5. Data collection

The final household and individual surveys were carried out in mid-December 2006. This involved a rigorous one-day training programme, in which a total of 12 individuals from the *yavusa* Navakavu were trained to carry out the interviews. The use of locals as interviewers was a requirement set by the local committee. This constraint presented an opportunity to assess the relative value of using highly qualified interviewers, as is usually recommended for CV studies (Whittington, 2002). Overall, the main problem identified was the significant amount of missing data in returned questionnaires. As a result, there were a number of unusable questionnaires: 10 household questionnaires (8% of total) and 34 individual questionnaires (34%) were not useable. Overall, despite the amount of missing data, the quality of the final data produced was acceptable.

Overall, a total of 118 household questionnaires (averaging 75 min/questionnaire) and 86 individual questionnaires (45 min/questionnaire) were completed. The researcher collected the completed questionnaires at the end of each day, and went through each questionnaire with each interviewer. Validation of data produced was carried out on two occasions by the researcher, who verified answers given in randomly selected questionnaires ($n = 5$) with respondents.

Survey length is an issue in this study,[8] although the main problem with long surveys is non-response bias (i.e. respondents abandoning the survey half-way), which leads to incomplete data sets. As noted above, incomplete surveys were dropped from the study, so this should not affect data quality. It is important to note that rural Fijians do not have the pressures that urban dwellers might have on their time, and in actual fact, most villagers of the area were eager to participate in the survey and answer questions about their day-to-day activities. The real concern here is respondent fatigue, which can lead to respondents answering questions quickly and without thought. This is an accepted limitation of the study.

5. Results

5.1. Sample description

Table 2 presents summary socio-economic characteristics of all the households interviewed for this study. As results show, there are on average just over 5 residents per household. Mean annual

[8] I thank an anonymous reviewer for raising thanonymous revieweris point.

Table 3
Individual socio-economic characteristics.

Variable	Household survey ($n = 118$)	Individual survey ($n = 86$)	All individuals ($n = 204$)
Gender (% male)	54	48.8	52.0
Age	43.3 (14.03)[a]	31.7 (12.8)	38.4 (14.67)
Highest education level (%)			
Primary	36.5	33.7	35.3
Secondary school yr 10 (16 yrs old)	43.5	29.1	37.3
Secondary school yr 12 (18 yrs old)	17.4	33.7	24.4
University	2.61	3.49	2.99
% Migrated to *yavusa* Navakavu from other place of origin	61.2	40.7	52.5

[a] Figures in brackets are standard deviations.

household income is FJ$2921 (US$1698) and 64% of households have savings, averaging FJ$375 (US$218.15). Most households own televisions, but surprisingly, only 11% own boats.

Most households engage in fishing (88.1%), growing crops (76.3%) and/or gleaning (70.3%). Half of all households (49.5%) engage in 4 or more livelihood activities; only 3% of households engage in only one livelihood activity. Diversification is a typical strategy adopted by rural communities, such as the Navakavu community (Allison and Ellis, 2005), and is reflected in these statistics. The livelihood activity that generates the most cash and food, overall, is salaried work in Suva (32% of households) followed by fishing (27%) and gleaning (20%).

Table 3 presents summary socio-economic statistics for all individual respondents interviewed for this study. Statistics are presented separately for individual respondents to the household survey (heads of household or their spouses) and respondents to the individual survey (randomly selected individuals over 21 years of age), as well as in aggregate for all individual respondents.

On average, the sample was 52% male, with an average age of 38.4 years. The household survey sample was significantly older than the individual survey sample at the 1% level. This is expected, given that heads of household (or their spouses) are usually older members of the community. Education levels also differ significantly between samples: 37.2% of individual survey respondents have completed a minimum of secondary school year 12 education compared to 19.5% of household survey respondents. This difference (significant at the 1% level) is most likely due to the construction of the road in 1994, which increased accessibility of the younger members of the community to secondary schools in the capital.[9]

In order to ascertain the *main* reason that respondents value their traditional fishing grounds, all respondents were presented with four statements reflecting the main reasons (identified through pre-pilots) for protecting the fishing grounds, and were asked to indicate which reason they mostly agreed with. The distribution of results, in Fig. 3, clearly shows that the bequest motive ('for future generations') is the main motivation for protecting the marine resource for most respondents (78.2%).

5.2. Fisheries valuation

5.2.1. General fishing activity

Results from the household survey indicate that almost all ($n = 111$; 94% of sample) of the interviewed households engage in fishing/gleaning activities in the area. Of these, 53.2% fish for 7 or more months a year. On average, fishers go on fishing trips 79.3 days per year (equivalent to fishing every 4–5 days). There are on average 2 fishers per household and of all interviewed respondents, the proportion of males to females who fish or collect seafood from the Navakavu fishing grounds is almost identical (49.7% male, 50.3% female). Households mostly fish along the reef (55% of households) and in the lagoon area (48.7%). Only 6% of households fish/glean around the mangrove area. The most frequently used fishing gear is the handline (47.8% of households use this), followed by nets (39.6%) and spears (24.3%).

5.2.2. Valuation of catch from last trip

In this section we present catch data based on the last fishing trip that respondents went on. This data will be used as the basis for the economic valuation of fisheries resources associated with the Navakavu fishing grounds.

Respondents were first asked when was the last time *anyone* in their household had gone fishing and/or gleaning. Most households ($n = 39$; 35.5% of all fishing households) had last gone fishing/gleaning between 2 and 7 days ago. On average, 1.51 household members went fishing on the last fishing trip.

Table 4 presents the catch composition, by family, for finfish caught during the last fishing trip. Inspection of results indicates that Lethrinids (common name: Emperor) accounted for most of the finfish catch by weight (50.4% of the total finfish catch). Carangids (common name: Trevally) made up the second-most harvested finfish family (11.5%). A more detailed breakdown by species is available in O'Garra, 2007.

These results tentatively confirm findings in Kronen (2004),[10] and Cakacaka (2008), in which Lethrinids were also found to make up a major portion of the finfish catch. However, Cakacaka (2008) found that the *most* harvested finfish species by weight was *Rastreglier* spp. (Chub mackerel) (45.8% of the total finfish weight). In the present study, this species makes up less than 2% of the total catch by weight. Furthermore, trevallys and rabbit fish – making up 20% of total catch - are not even listed as major contributors to finfish catch in Cakacaka (2008). These differences are most likely due to seasonal variation. Pelagic species (i.e. species living in open waters), such as Chub mackerel, tend to exhibit strong seasonality; they are more abundant in the winter months (especially March to July), which is when Cakacaka (2008) carried out the study. The present study was carried out in December (low season for this species). Other species to exhibit seasonality include pelagics such as mullet (high season is August to September), and reef fish such as rabbit fish (November to December). Seasonality is incorporated into the economic estimates produced for this study (see Section 5.2.3).

Column 4 of Table 4 presents market prices for different finfish families. These prices are used to estimate the gross economic value of the finfish catch from the last trip.[11] As can be observed, the gross economic value from the Lethrinid catch accounted for over half (56%) of the total value of the fin fisheries.

Table 5 presents summary catch results for invertebrates (by family or species), as well as market prices, and estimated gross economic benefits. As can be observed, *Tripneustes gratilla* (sea urchin) dominates the overall invertebrate catch by a wide margin: 80% of the total invertebrate catch is made up by this species. It is

[9] There are no secondary schools in the *yavusa* Navakavu; there is a primary school which all children in the four villages attend.

[10] Note that fish catch was not actually measured in Kronen (2004). Instead, fishers were asked to recall the approximate amounts they harvested throughout the year.

[11] Gross economic value of fish/invertebrates catch from last trip = total weight caught during last trip (per family) (kg) x average price per family (FJ$/kg).

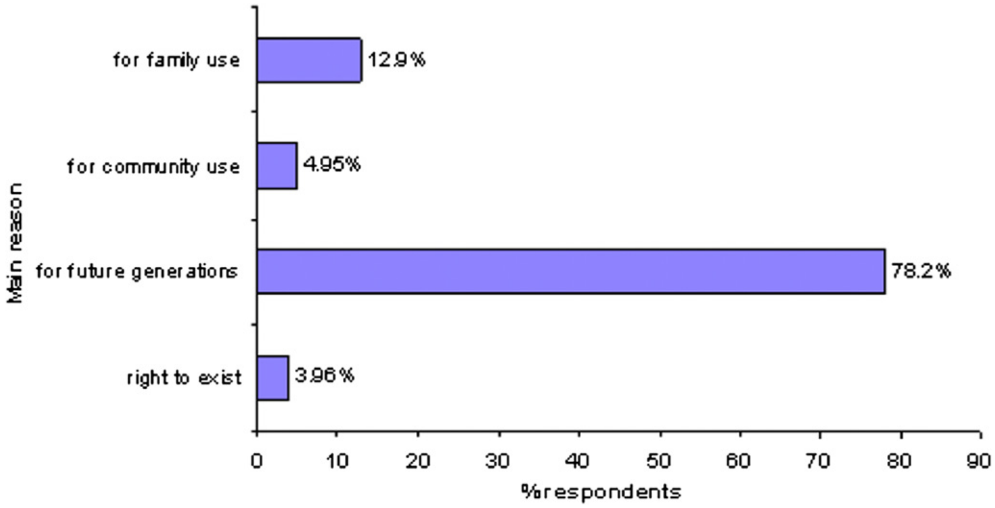

Fig. 3. Main reason for protecting the environment in the Navakavu traditional fishing grounds.

suggested that the high urchin abundance in the Navakavu fishing grounds might be a sign of poor reef health (Dumas et al., 2007). If this were to be the case, then the economic value of the fishing grounds may actually decrease over the next few years. This is an area that would require further research.

Data on market prices for invertebrates was less available than for finfish. As a result, the market price of some species has been proxied by market prices for other species for which there is data (detailed in Table 5). Using these prices, Column 5 in Table 5 presents gross economic benefits for invertebrate catch during one trip.

Overall, results indicate that the total gross economic benefits associated with the last trip made by 111 interviewed fishing households, comes to FJ$11,645, of which 53% is attributable to invertebrate catch and 48% to finfish catch.

In order to calculate the flow of gross economic benefits from fishing over time, two key assumptions have been made. These are:

1. That the catch data collected in this survey (for one fishing trip) is representative of catches throughout the year for *all reef fish* and for *most invertebrate species*. This assumption has its limitations, as most species exhibit some seasonal variation. Seasonal variability has been incorporated only for pelagic species, which exhibit strong seasonality, and for *Tripneustes gratilla* (sea urchin). This is discussed below.
2. That the catch during this year is representative of catches over the next 99 years.

5.2.3. Incorporating seasonal variation

Pelagic species such as mackerel and mullet are seasonal; both are more abundant in the during the winter months (May–September). The harvest of sea urchins is also seasonal, mostly taking place during the summer months (November–February). This seasonality has been incorporated into the analysis using time-series catch and/or abundance data from studies carried out in Thailand (Boonragsa, 1987), Zanzibar (Mwebaza-Ndawula, 1990) and Australia (Virgona et al., 1998). Unfortunately no studies were identified that were based in Fiji. Using data from these studies it was estimated that catches of Chub mackerel are approximately

Table 4
Gross economic benefits per finfish family (based on one fishing trip).

Fish family	Common name	Weight of catch per fish family (kg)	Average price (US$/kg)[a]	Gross benefits per fish family (US$)
Lethrinidae	Emperor	945.7	3.17	2996.55
Carangidae	Trevally	216.7	2.56	554.35
Siganidae	Rabbit fish	202.1	2.56	517.00
Scaridae	Parrot fish	181.3	2.56	463.79
Lutjanidae	Snapper	148.9	2.56	380.91
Muglidae	Mullet	85.7	2.27	194.32
Scombridae	Tunas & mackerel	34.5	2.27	78.23
Hemirhamphidae	Halfbeak	29.5	1.45	42.88
Serranidae	Grouper	16.4	3.17	51.97
Mullidae	Goatfish	13.1	2.56	33.51
Gerreidae	Silver biddy	3.27	1.45	4.76
Acanthuridae	Surgeonfish	0.38	2.27	0.86
Total		1975.3		$5,319.12

[a] Source of finfish prices: Korovulavula et al. (2006); Fijian prices converted to US$ using exchange rate of US$1 to FJ$1.72.

Table 5
Gross economic benefits per invertebrate taxa (based on one fishing trip).

Invertebrate taxa	Common name	Weight of catch per invertebrate taxa (kg)	Average price (US$/kg)[a]	Gross benefits per invert taxa (US$)
Echinoidea (*Tripneustes gratilla*)	Urchin	1570.2	1.29[b]	2028.68
Holothuria fuscogilva	White teatfish	58.43	34.88	2038.26
Other holothuria	beche-de-mer	76.65	11.72	897.97
Portunidae	Mud crab	132.21	5.58	737.15
Octopididae.	Octopus	54.27	3.48	189.00
Arcidae	Bivalve	39.29	2.35[c]	92.51
Trochus niloticus	Topshell	24.27	3.87[d]	93.98
Aplysiidae	Sea hare	21.2	11.72[e]	248.36
Total				$6,325.90

[a] Source: of invertebrate prices: Korovulavula et al (2006); Fijian prices converted to US$ using exchange rate of US$1 to FJ$1.72.
[b] Assuming price of US$2.90/basket (average 15 urchins per basket, 0.15 kg per urchin).
[c] Price of oysters used as proxy.
[d] Price of giant clam used as proxy.
[e] Price of "other holothuria" used as proxy.

Table 6
Gross economic value of different uses of catch.

	For sale	Household consumption	Gifts (to family, community etc)
% Total catch	57.3	24.6	18.2
Gross annual economic value (US$)	475,063	212,245	150,892

Percentages may not add up due to rounding up of values.

five times greater during the high season.[12] Mullet catch variability was also found to be five times greater during the high season. Data on seasonal variation in abundance of sea urchins was not found. Hence, *it will be assumed that the urchin catch is five times greater during high season.*

5.2.4. Present value of catch

Using these assumptions, we can proceed to estimate the gross economic benefits from fishing/gleaning activities in the Navakavu fishing grounds over time. Using the average number of fishing trips made per household (79.3 trips/year), the total annual catch for *non-seasonal fisheries* comes to 139,370.7 kg/year. Add to this the total weight of seasonal fisheries (75,828.2 kg/year), and the total annual catch comes to 215,198.8 kg/year. The gross economic benefits from fishing/gleaning activities for all fisheries are valued at US$829,080/year. This amounts to US$7469/household/year.

The PV of the Navakavu fisheries is estimated at US$9,223,872 (over a 99-year time horizon, $i = 10\%$). This estimate represents the full economic value (before deduction of costs) of all fish and invertebrates extracted by the local community from the Navakavu fishing grounds, based on current 2006 prices. However, not all of this is sold in the market; in fact, only 57.3% is exchanged for money.

Table 6 summarises the relative gross economic value of the main uses to which the fish/invertebrates are put. The gross income from the sale of fish/invertebrates comes to US$475,062/year, which amounts to US$4280/household/year.

If we compare this gross household annual cash income of US$4280 from fisheries, with the average household annual income of (FJ$2689) US$1563 (see Table 2), it is clear that there is a large difference between these values. Although the costs of fishing have yet to be deducted from the gross benefits, fishing is very much a low impact activity in this area involving very simple technologies, so it is unlikely that the costs will be very high.

There are a number of possible explanations for this difference between the estimated revenue from the sale of fish/invertebrate catches per household, and the reported average income per household: 1) the estimate of US$4280 is an overestimate, due to inadequate assumptions made about invertebrate LW ratios and/or prices, as well as assumptions about the representativeness of the reported catch for catches throughout the year. 2) The prices used to convert catch weight into economic values are not appropriate. 3) There has been misreporting of catches or even more likely, misreporting of average income values. It is considered that many respondents might prefer to under-report their true income, especially to other members of their community such as the interviewers. Fijian culture requires village and community members to share their wealth and make donations towards traditional obligations (e.g. funerals, weddings) (Crocombe, 2001), hence it is not altogether unlikely that the full extent of a household's wealth is not revealed. This is an issue that must be taken into account in future survey studies.

[12] For more detailed information on how seasonality was incorporated into the analysis, see O'Garra, 2007.

5.2.5. Fishing/gleaning costs

In order to obtain the Net Present Value of fisheries over time, we must deduct costs associated with fishing and gleaning. The main costs include: capital assets (boats, engines and fishing gear), operating and maintenance costs, and labour costs. Results from the household survey indicate that only thirteen households own boats. Most boats are wooden, ranging in price from US$48 to over US$580. Only two households own fibreglass boats (with engines), priced at just under US$7000. No other boat type was recorded. Boat costs have been adjusted to current 2006 FJ$ (and converted to US$).

The total estimated costs of fishing gear (taking into account price per unit, number of households that own the gear and average lifetime per fishing gear type) come to FJ$2523/year. The most frequently owned fishing gear was the handline: 47% of all fishing households owned a handline. This is followed by nets (40% own nets) and spears (24% own spears).

Running costs associated with fishing/gleaning activities include: maintenance costs for boats, fuel costs (boat engines) and the opportunity cost of labour. Using data from the household surveys, the average expenditure on maintenance costs for boats comes to US$285/household/year. Fuel costs come to US$853/household ($n = 2$) per year. The opportunity costs of labour are equivalent to the potential earnings foregone in another income-generating activity. It has been assumed here that the opportunity costs of labour are equivalent to FJ$0.95/hour (US$0.55/hour), the average wage in Fiji for unskilled workers (FIBS, 2007). Using this value, the opportunity cost of labour on fishing is estimated at US$285/household/year (based on an average of 345 person hours spent per year fishing/gleaning, and average of 1.5 household members fishing at anyone time).

Overall, the total value of running costs (including the opportunity costs of labour) associated with fishing/gleaning activities in the area come to US$38,814 for all fishing households per year, equivalent to an average of US$349/household/year. Most (82%) of this value is composed of the opportunity cost of labour; actual expenditures come to only US$64/household/year. Thus, costs associated with fishing represent 8% of the gross benefits from fishing (and actual expenditures represent only 1.4% of gross fishing benefits).

5.2.6. Net present value of fisheries

Table 7 presents annual estimates of gross benefits, costs and net benefits from fishing activities in the Navakavu fishing grounds. It also presents estimates of the PV of benefits and costs associated with fisheries, and the NPV of fisheries (99-year time horizon, 10% discount rate). As figures indicate, costs represent only a small proportion (about 5%) of the NPV estimates. This is due to the low capital intensity of fishing activities in the *yavusa* Navakavu. Overall, the annual value of the Navkavau fisheries is estimated as US$790,266/year, and the NPV is about ten times the magnitude (US$8,692,298).

Table 7
NPV for fisheries from the Navakavu traditional fishing grounds.

	Economic estimates (US$)
Gross annual benefits (based on 2006 data)	829,080
PV of benefits over 99-year period ($i = 10\%$)	9,119,221
Gross annual costs (based on 2006 data)	38,814
PV of costs over 99-year period ($i = 10\%$)	426,923
Net annual benefits (based on 2006 data)	790,266
NPV over 99-year period ($i = 10\%$)	8,692,298

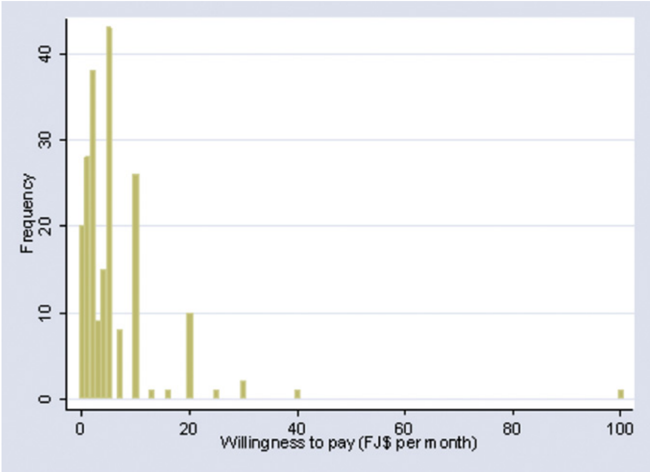

Fig. 4. WTP towards conservation of the traditional fishing grounds for future generations (FJ$/month).

5.3. Bequest value

The results presented in this section are based on a sample of 204 respondents from all four villages, including the 118 heads of household who completed the household questionnaire and 86 individuals who completed the individual questionnaire. This represents 63% of the total adult population of the *yavusa* Navakavu.[13]

All respondents were asked whether they would be willing to pay to help in the recovery and conservation of the Navakavu fishing grounds for use by future generations, *even if this means they cannot use it themselves*. Those who were willing to pay were asked how much they were willing to pay *per month*, using a payment ladder. Fig. 4 presents the distribution of results.

Results in Fig. 4 show that the distribution is skewed to the right. This is typical of WTP distributions and is due to the preferences of respondents who have high WTP. Removal of the FJ$100 outlier does not significantly affect the mean. The distribution also shows that there are 20 respondents (9.8% of sample) who stated zero WTP towards conservation of the traditional fishing grounds for future generations. Of these, 6% ($n = 12$) gave 'protest' zero values.[14] These responses were dropped from the analysis.

It is suggested that the relatively low rate of zero WTP responses in the present study is the consequence of a cultural practice of donating and sharing gifts, money and other goods to the community, church and family members (Crocombe, 2001). As observed during the pilot surveys, the elicitation of WTP was neither controversial nor new to respondents. This suggests that, contrary to some expert opinion, CV methods may be appropriate in developing countries if respondents are used to donating money or other goods towards public or communal goods or services.

Overall, statistics indicate that mean WTP towards conservation of the Navakavu fishing grounds for future generations comes to FJ$6.13/individual/month, equivalent to US$42.77 (FJ$73.56)/individual/year, or US$13,685 (FJ$23,539)/year for all households. The PV of the bequest value associated with the Navakavu fishing grounds is estimated as US$150,530 (99-year time horizon, $i = 10\%$). Thus, bequest values come to just under 2% of the fisheries value (fisheries value presented in Section 5.2.6). This might be considered somewhat low if we consider that the bequest motive was identified by most respondents (78.2%) as the main motivation for protecting the marine resource (see Fig. 3). It is probably more appropriate, however, to compare bid amounts to average household income.

Assuming there are 2.5 individuals of adult age (over 21) per household, bequest values come to US$106.92 (FJ$183.92)/household, which is 6.8% of reported mean household income (reported in Table 2). This is a significant proportion of the household budget, comparable to average expenditures on alcohol and tobacco (6.13% of budget for the average Fijian household), durable household goods (6.52%) and clothing and footwear (5.36%) (FIBS, 2006c).[15] However, as noted in Section 5.2.4, stated average income is significantly lower than the estimated benefits from selling fish per household (which comes to US$4216/year, if we deduct actual expenditures on capital and running costs). In this case, bequest values represent just under 3% of the estimated net benefits from selling fish per household. This may still be considered a significant proportion of income, only marginally lower than expenditures on heating and lighting (4.9% of household budget) (FIBS, 2006c).

The theoretical validity of these values was tested using an interval regression; explanatory variables expected to influence WTP included: wealth indicators (income, savings, house construction materials, TV-ownership), familiarity with the resource being valued, the number of children in the household and a strong bequest motive. Results indicate that income is a significant determinant of WTP (although only at the 10% level). Other key determinants of WTP include: gender (men are willing to pay more than women), age (older respondents are willing to pay more), education (respondents with a minimum of secondary school education are willing to pay more) and whether the respondent works in Suva (this latter is a good proxy for individual earning-capacity).

Surprisingly, the bequest motive is not significant in the regression. It is suggested that this might reflect lexicographic preferences of respondents with strong bequest motives; summary statistics reveal that 95% of zero WTP responses were given by respondents who had a strong bequest motive for conserving the fishing grounds (63% of which were identified as protests). Lexicographic preferences are often found for goods to which respondents attribute inviolable rights (Spash et al., 2000). Given the nature of the relationship between Fijian communities and their land and traditional fishing grounds, it is considered very likely that these zero bids represent lexicographic preferences. Future research in this area might be able to confirm this suggestion.

Overall, despite the lack of significance of the bequest motive, the results conform to theoretical expectations, thus tentatively supporting the theoretical validity of the estimates presented here. For a more detailed analysis of the bequest values, see O'Garra (2009).

5.4. Value of coastal protection

The coral reefs and mangroves in the Navakavu fishing grounds offer significant protection to the land from the impacts of storms and flooding. Cyclones and tropical storms occur frequently in this part of the world, averaging 7–8 cyclones per year (SOPAC, 2006). The most recent was Cyclone Gene in January 2008 which caused flooding and damage across the main island of Viti Levu, including the capital, Suva.

[13] There are about 320 individuals of adult age (over 21) in the *yavusa* Navakavu (based on 2.5 individuals over 21 years of age per household, and 127 households in the yavusa Navakavu).

[14] Protest responses included: "I was not informed about this", "I don't know where my money will go", "I don't agree with the idea of giving money" and "I prefer to donate time rather than money".

[15] Expenditure on food comes to 35.36% of the household budget (FIBS, 2006b).

In order to estimate the economic value of the coastal protection function of coral reefs and mangroves in Navakavu, a benefits transfer approach was used. A review of the literature yielded no coastal protection estimates for Fiji. Estimates from other countries range from US$5000-US$25,000 per km^2 of coral reef year (coral reefs in Indonesia (Cesar, 1996)) to over US$800,000 per km of coastline protected by coral reefs in Sri Lanka (Berg et al., 1998). Coastal protection values for mangroves are scarce in the literature, and range from a very low US$300/km^2/yr for Indonesia (Ruitenbeek, 1994) to just under US$300,000/km^2/yr for Thailand (Sathirathai, 1998). Costanza et al. (1997a) estimate the value of the coastal protection function of coral reefs *and* mangroves, by transferring values from various other studies from different parts of the world.[16] They value the coastal protection provided by reefs at US$275,000 per km^2 of reef per year, and the value of mangroves at US$183,900 per km^2 of mangrove per year (1996 prices). This is equivalent to US$353,300 per km^2 of reef per year and US$236,292 per km^2 of mangrove per year, in current 2006 prices.

Closer to Fiji, a study of the cost of coastal protection structures was carried out for the Majuro Atoll in the Marshall Islands by McKenzie et al. (2005). They estimated the expenditure on coastal walls to range between US$3000 and US$17,500 per metre, depending on the materials and structures used (using 2005 prices). These values include capital expenditures, maintenance costs and assume a 25-year lifetime. Using the mid point of this range of values, the value of coastal protection in McKenzie et al. (2005) comes to a significant US$410,000 per km per year (current 2006 prices).

The present study will use the lower-bound estimate of US$3000/metre (or US$123,840/km/yr) from McKenzie et al. (2005), to estimate the value of coastal protection provided by the Navakavu coral reefs and mangroves. The reason for using this lower-bound estimate is because the values in McKenzie et al. (2005) have been estimated for highly eroded coasts, where dredging, quarrying and beach-mining are serious issues, and where very little coastal vegetation remains. Furthermore, the Majuro Atoll is a low-lying atoll with an average land elevation of under 2.4 m. Thus, it is considered that the estimates in McKenzie et al. (2005) are likely to overestimate the contribution of coral reefs and mangroves to coastal protection in the Navakavu context.

In order to estimate the coastal protection value of the Navakavu reef and mangroves, we need to make an assumption about the length of the coastal protection structure needed to provide the same amount of protection as these natural buffers. For this purpose, assume that the structure would need to go round the Muaivuso peninsula – this would have a length of about 8 km. Thus, annual costs associated with coastal protection provided by the Navakavu reefs and mangroves come to US$990,721.[17] The present value (over a 99-year time horizon, 10% discount rate) is estimated at US$10,897,139.

The relative contribution of the mangroves to the coastal protection value may be estimated using the annual coastal protection value of FJ$250,000/km^2 (equivalent to US$145,349/km^2 in current 2006 prices) of mangrove, quoted in the Fiji Biodiversity Strategy Action Plan (Agrawala et al., 2003). About 1 km^2 of the Navakavu fishing grounds consists of mangroves; hence the coastal protection value associated with mangroves comes to FJ$164,581/year (PV = FJ$1,810,258), equivalent to 17% of the total coastal protection value.

Table 8
Economic values to local community of coastal resources in the Navakavu traditional fishing grounds.

Component of TEV	Economic value per year (US$)	PV over 99-year period ($i = 10\%$) (US$)
Fisheries	790,266	8,692,298
Bequest value	13,685	150,530
Coastal protection	990,721	10,897,140
Total	1,794,673	19,739,968

6. Total economic value

The TEV of the Navakavu traditional fishing grounds to local villages can now be estimated by adding up the fisheries, bequest and coastal protection values. This assumes that the TEV is equivalent to the sum of its components. This assumption has its limitations, as most goods and services provided by any ecosystem are closely interlinked - hence, the value of one particular good or service may show up in the valuations of other goods and services. Bearing this in mind, it is considered that the values presented in Table 8 provide an indication of the relative scale of the benefits accruing to the local Navakavu community from the coastal ecosystems within their traditional fishing grounds.

As results indicate, the most significant value is that associated with the coastal protection function of the Navakavu coastal ecosystems: 55% of the TEV is attributable to this function. Fisheries are the next most important good provided by the Navakavu fishing grounds, making up 44% of the TEV. Bequest values account for only 1% of the TEV. However, if compared to household income, bequest values are significant, representing 6.8% of stated income. This is comparable to average expenditures on durable household goods and heating and lighting (see O'Garra, 2009).

It must be noted that the relative contribution of the coastal protection function to the TEV of the Navakavu coastal ecosystems should be taken with caution, given the potential error involved in transferring values from one study to another. Nonetheless, this value is broadly indicative, in terms of scale, of the relative contribution made by different components of coastal ecosystems in the Navakavu fishing grounds to the economic value of the ecosystem. Fisheries are typically considered the main benefit provided by these ecosystems to local communities; the results in this report confirm that they are indeed significant. However, coastal protection is also important, and should be accounted for in policy decisions both at the local level and government level.

7. Sensitivity analysis

Due to the number of assumptions made in this study, a sensitivity analysis was carried out on the results in order to assess the influence of the various assumptions made on the final valuations. This involved modifying one assumption at a time (known as *partial sensitivity analysis*). The key parameters that were modified thus include: catch rates (assumed to remain constant over time), the estimated average weight of *Tripnesutes gratilla* (the most harvested species by number and weight) and the length of coastal protection structures required to provide equivalent coastal protection. Results suggest that altering these parameters does not alter the final valuations in any major way (i.e. the relative scale of economic estimates is not significantly different). For results of sensitivity analysis see O'Garra, 2007.

[16] Coastal protection values for coral reefs are estimated using 2 Philippine-based studies; coastal protection values for mangroves are estimated using data associated with tidal marshes from 4 US-based studies and 1 UK-based study, as well as 1 study specifically dealing with mangroves (in Malaysia) (Costanza et al., 1997b).

[17] This value has not been adjusted for income effects, as there is a negligible difference between the Gross National Income (GNI) per capita for Fiji and that for the Marshall Islands (see World Bank, 2007).

8. Conclusions

This study has estimated the TEV of the coastal ecosystems within the Navakavu area in the southeast of Fiji, on the Muaivuso Peninsula, 13 km from the capital of Suva. The key goods and services provided by the coral reefs, lagoon and mangroves in this area were identified as: fisheries, bequest value and coastal protection. The economic values estimated in this study accrue to local communities only.

Assuming that the TEV of an ecosystem is equivalent to the sum of its parts, then the TEV of the coastal ecosystems within the Navakavu traditional fishing grounds (which cover an area of 18.5 km^2) comes to US$1,795,000 per year. The PV of the coastal ecosystems, over a 99-year time horizon comes to just under US$20m (using a 10% discount rate). The coastal protection provided by the coral reefs and mangroves make up the largest component of the TEV (55%) followed by fisheries (44% of the TEV). Bequest values, although identified as important values to local villagers, only made up 1% of the TEV.

These figures should provide some indication to decision-makers as to how to proceed with the management and utilisation of the Navakavu coastal resources. It is clear from the results that the mangroves and coral reefs in the Navakavu area provide a valuable coastal protection function, which policy-makers would do well to conserve (hence precluding any option of coral mining). Fisheries are valued at about US$800,000 per year, also a significant value. However, it is worth considering that the benefits from recreational activities associated with the coastal area (including snorkelling and diving) might yield greater benefits than fishing. Recreation and tourism values associated with coral reefs are usually very high, and are typically the most important direct and indirect use values associated with reefs (Moberg and Folke, 1999). Given the Navakavu villages' proximity to Suva, this option might be attractive to visitors in the area. Of course, coral reef-based tourism is highly dependent on the quality and state of the reefs, which might be compromised by the proximity to the capital. This particular option, as well as other management and utilisation options (e.g. coral harvesting, establishment of a Marine Protected Area), can be assessed more thoroughly by taking into account the benefits currently provided by the coastal ecosystems as estimated in this paper.

This study contributes to the existing literature (namely, Lal, 1990) on economic valuation of coastal resources in Fiji, and is the first study to address the TEV of coral reefs in this Pacific island. Furthermore, it is the first study to value a traditional Fijian fishing ground or '*iqloqoli*'. It is hoped that it will lead to further studies of a similar nature; this will allow for a detailed economic evaluation of Fiji's marine resources.

However, a number of limitations apply to the results presented here: firstly, the catch data used in this study as the basis for economic valuation of fisheries was based on catch from one trip per household. A more accurate representation of fish catches might have been obtained through systematic collection of catch data from several trips per household over a year. The approach used here, however, was dictated by resource constraints. A second limitation of this study was associated with the collection of length (or diameter) data for invertebrates. The lack of length/diameter-weight ratios for many invertebrate species made the estimation of weight very difficult, and the use of proxies can be subject to a large potential error. Future studies would preferably collect weight data directly, for both finfish and invertebrates, thus avoiding the use of L–W ratios. This would require interviewers to directly collect catch data at landing points (again, this was not possible due to resource constraints).

Thirdly, the use of local villagers to carry out the interviews was not considered the best approach to the collection of data. This is mostly because the surveys were complex, and included some CV questions that require a high level of training for appropriate delivery. However, this was a condition set by the Navakavu committee, in order for the study to be carried out. Finally, due a lack of adequate data and expert opinion on the impacts of the LMMA management interventions on the ecosystem goods and services, it was not possible to assess the change in economic value of the resources. It is considered that this would be a valuable exercise that would provide very useful information on the economic benefits from the establishment of LMMAs in Fiji.

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