Economic valuation of mangrove ecosystem services in Vanuatu

Case study of Crab Bay (Malekula Is.) and Eratap (Efate Is.)

Summary report

September 2014

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Author: Nicolas Pascal, Environmental economist, USR 3278 - CRIOBE (EPHE/CNRS), Insular Research Center and Environment Observatory, Université de Perpignan Via Domitia, Perpignan, France, Papetoai, Mooréa, Polynésie Française. nicolas.pascal@criobe.pf

The method described in the report annexes is based on a working paper coordinated by the author with Michel Allenbach (UNC), Thomas Binet and Pierre Failler (CEMARE), Julien Hardelin (MEEDTL/SEEI/ERNR1), Arthur Katossky (CGDD/SEEI/ERNR3), Elen Lemaître-Curri (MEEDTL/SEEI/ERNR1), Gilbert David (IRD), Philippe Méral (IRD), Mahé Charles (AAMP) and Jean-Baptiste Marre (CRIOBE).

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Available from: IUCN (International Union for Conservation of Nature)
Oceania Regional Office
Private Mail Bag
5 Ma'afu Street
Suva, Fiji Islands.
Tel +679 3319084, Fax +679 3100128
oceania@iucn.org
www.iucn.org/oceania

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CRIOBE EPHE-CNRS POLYNESIE

IRCP
Institut des Récifs Coralliens du Pacifique
Institute for Pacific Coral Reefs

DEPARTMENT OF ENVIRONMENTAL PROTECTION & CONSERVATION

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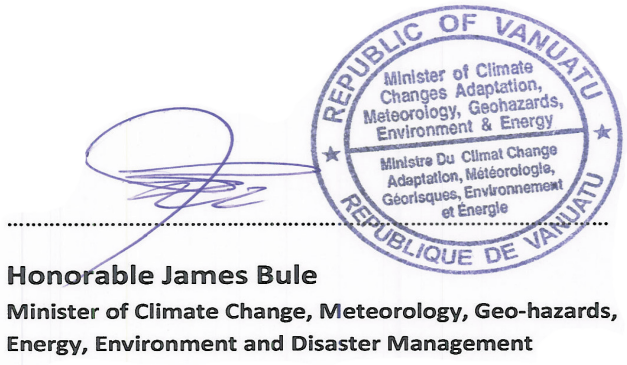
Foreword

How much are our mangroves worth? Do we convert or don't we? Will the benefits of converting mangroves for economic development outweigh the costs? These are just some of the questions that policy makers and decision-makers such as I have to grapple with when considering development proposals. I am delighted at the production of this report which will provide us with a tool to help shape policy supporting mangrove management and allow us to make informed decisions on the use of our mangrove resources in Vanuatu.

Mangrove ecosystems play an extremely important role in our communities because of the goods that they provide in the production of wood for fuel and construction, the invertebrates and finfish for subsistence and commercial fisheries but also the services provided in coastal protection from storm surges, bioremediation, sediment trapping and carbon sequestration in mangrove soils mitigating climate change. This study assesses the Total Economic Value (TEX) of nine ecosystem services and is extremely informative because it also identifies the main beneficiaries of these services and therefore those that will be likely impacted by any new policy regarding the use of mangroves. This is the first time that an economic valuation of mangrove services has been conducted in Vanuatu. This summary report highlights the key findings of the study. The full technical report provides the details regarding methods used, data analysis and discussion of findings.

This work is a very timely one given the increasing pressure on mangroves in Vanuatu from infrastructure development, meeting housing needs and ensuring food security for a growing population.

Such pressures are not unique to Vanuatu therefore I have no doubt that this report will be extensively cited in years to come particularly for any future work done in the Pacific region. I am confident that this report will serve as a benchmark for other resource valuation studies and hope that it will not be the last for Vanuatu.



Honorable James Bule
Minister of Climate Change, Meteorology, Geo-hazards, Energy, Environment and Disaster Management

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This project would not have been possible without the support of the Vanuatu Government Department of Environment Protection and Conservation, which provided supervision and assistance. Coordinating the MESCAL project in Vanuatu, Rolenas Baereleo was also essential to the study's success.

We acknowledge Milika Sobey from IUCN ORO (International Union for Conservation of Nature's Oceania Regional Office)—who is coordinating the German funded MESCAL project—for her financial support and making possible this study.We also acknowledge the Vanuatu Government departments that met with us, particularly the Department of Fisheries, the Department of Lands, Survey and Registry, the Department of Forestry and the Malampa Province.

Undertaking more than 500 surveys in 20 villages in a limited time was a challenge. Difficulties in the field mean the data collection team needed patience and self-confidence. I, Molu Bulu, thank the team: Ms Donna Kalfatak, Ms Primrose Malosu, Mr Trinison Tari, Mr Reedly Tari, Mrs Rolenas Baereleo, Mr Tony Kanas, Mr Philip Koroka, Mr Rodson Aru, Mr Peter Kalmasing, Mr Fred Numa, Mr Jonah Spetly, Mr Josen Ritson, Mr Mark Leonie, Ms Susan Tahi and Mr Ruben Morry. And I, Nicolas, acknowledge the capacity of Molu Bulu to face field realities with my remote support. We especially thank the 480 households surveyed in the 20 communities of both demonstration sites. These households shared their time with the survey team, along with their knowledge from their use of the mangroves and fisheries.

Photo: © IUCN\Milika Sobey

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At a glance...

Study objectives and context

This study aimed to determine an economic value of nine mangrove ecosystem services (figure A) at two sites in Vanuatu: Crab Bay and Eratap. It is part of the MESCAL project, which looks to address the main challenges to mangrove management and conservation. Specifically, the study contributes to MESCAL outcome 1 (National baseline information about climate change scenarios, use and values of mangroves and associated ecosystems) and outcome 4 (Increased awareness, advocacy and capacity development).

In response to market failures, economic valuation of mangrove ecosystem services (ES) is viewed as a promising approach. We undertook the ES valuation to raise awareness among decision makers, policy makers and the public of the environment's benefits for society. From that awareness, we intend for the valuation to strengthen support for environment regulation and resource management. At the same time, this study can be part of a monitoring routine to inform management with economic indicators—a case of being able to better manage what we can measure.

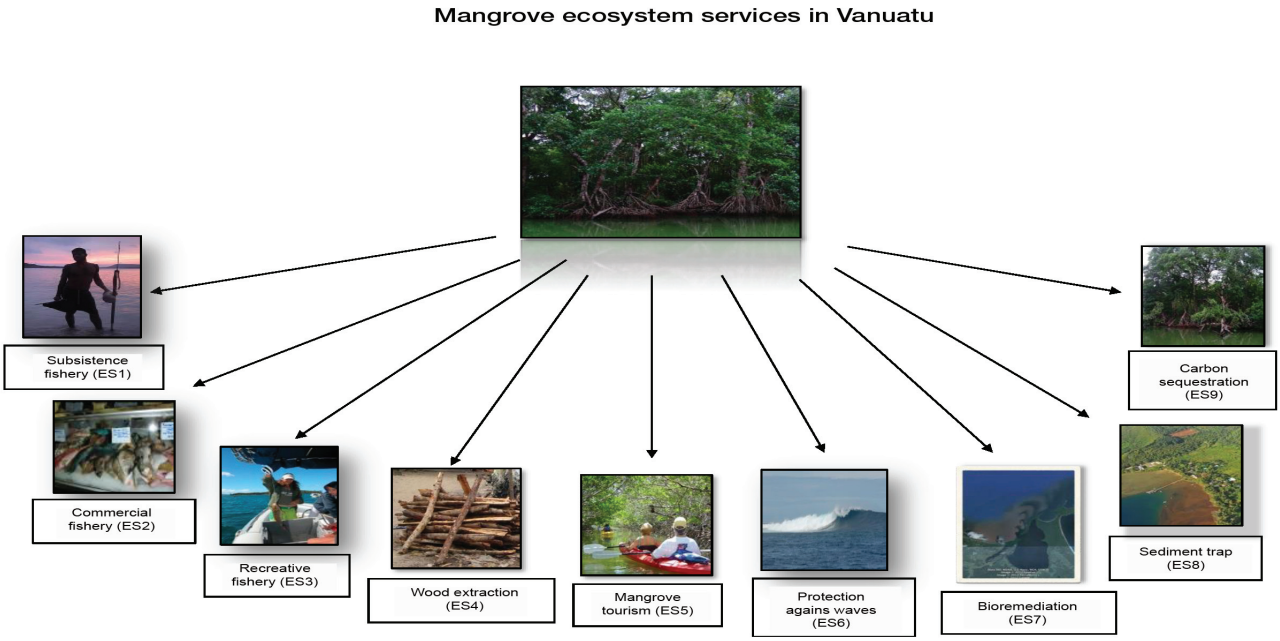

FIGURE A: Mangrove ecosystem services in Vanuatu

In summary, the study used literature review, expert opinion and surveys to establish an economic value for each of the nine ES at each of the two sites, and then a consolidated ES value for each of the two sites:

- We conducted field surveys to determine the cultural and commercial uses of mangrove resources (subsistence and/or commercial artisanal fisheries, firewood, timber, medicine etc.) to assess their economic values. The survey team questioned the villages of Crab Bay (16 villages and plantation settlements on Malekula Island) and Eratap (10 settlements on Efate Island), which each comprise 10–50 households with a mean household size of five persons (generally an extended family). The Crab Bay population totals 750 people and Eratap totals 240 people, approximately.

- We conducted a desktop review of indirect mangrove uses (coastal protection, water treatment, sediment trapping and carbon sequestration), to assess the economic values of those uses too.

For this study, we used the MESCAL mangrove baseline vegetation mapping study conducted in 2012 in Crab Bay and Eratap. The MESCAL mapping study found the common back boundary mangrove species at this study's two sites is *H. litoralis* and the common offshore mangrove is *R. stylosa*. Its baseline maps show the total area of mangroves from offshore to the high water mark and to the back boundary species of mangroves is 135.5 hectares and 31.2 hectares in Crab Bay/Amal and Eratap respectively (Vanuatu Department of Environment and Conservation).

What we found

What is the value of the ecosystem services?

We found the following total economic values for the nine ecosystem services (ES1–ES9, figure A) in the two mangrove systems:

- In Crab Bay in 2012, mangroves (136.5 hectares) produced ES worth an estimated Vt53 million (equivalent to US$586 000). This total comprised ES values ranging from Vt36 million to Vt70 million.
- In Eratap in 2012, the mangroves (31.2 hectares) produced ES worth an estimated Vt24 million (equivalent to US$266 000). This total comprised ES values ranging from Vt17 million to Vt31 million.

For comparing sites, these valuations are equivalent to ES worth Vt386 000 per year per hectare (US$4300 per year per hectare) in Crab Bay and Vt768 000 per year per hectare (US$8500 per year per hectare) in Eratap.

In Crab Bay, the principal ES in economic terms are carbon sequestration (ES9), the proteins from subsistence fishery (ES1), the commercial fishery (ES2) and wood extraction (ES4), which add up to 99 per cent of the mangroves' total value (figure B). Coastal protection is the other ES in Crab Bay. In Eratap, the principal ES are carbon sequestration (ES9), the proteins from subsistence fishery (ES1), the revenue from tourism linked to mangroves (ES5), and the avoided costs from coastal protection against flood (ES6), which add up to 87 per cent of the total value (figure C). Commercial fishery (ES2), wood extraction (ES4) and recreational fishery (ES3) are the other ES in Eratap.

Table A shows the main study results, which are described in the final report.

$US	CRAB BAY			ERATAP		
	min	*max*	*average*	*min*	*max*	*average*
ES1 Subsistence fishery	67 722	90 600	79 161	30 311	43 700	37 006
ES2 Commercial fishery	32 933	61 633	47 283	10 344	24 756	17 550
ES3 Recreational fishery	Service non-existent			800	1 200	1 000
ES4 Wood extraction	27 467	51 000	39 233	11 778	21 867	16 822
ES5 Mangrove tourism	Service non-existent			35 378	58 967	47 172
ES6 Coastal protection	4 156	7 133	5 644	34 833	59 722	47 278
ES7 Bioremediation	Service almost negligible			Service almost negligible		
ES8 Sediment trap	Service almost negligible			Service almost negligible		
ES9 Carbon sequestration	265 489	563 333	414 411	68 922	130 000	99 461
Total	297 111	773 700	585 733	192 367	340 211	266 289
Total per hectare	2914	5 668	4 291	6 166	10 904	8 535

TABLE A: Economic valuation of ecosystem services of Crab Bay and Eratap mangroves in 2012.

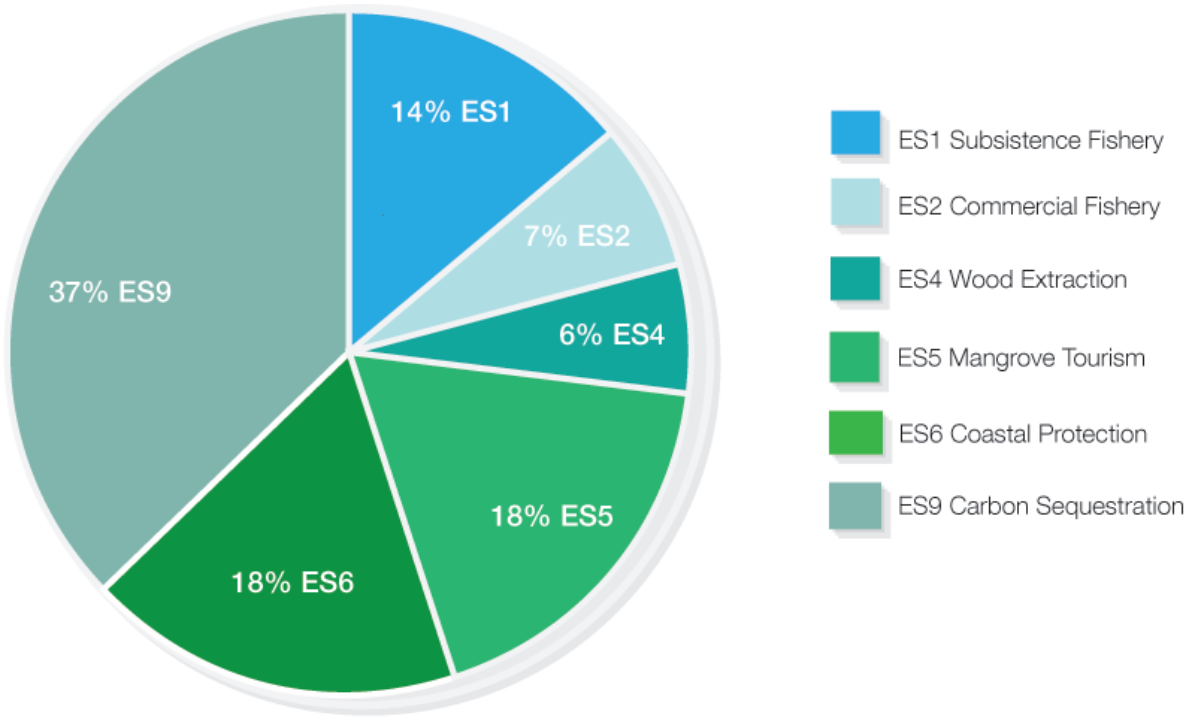

FIGURE B: Distribution of estimated total (Vt 53 million) in Crab Bay, 2012.

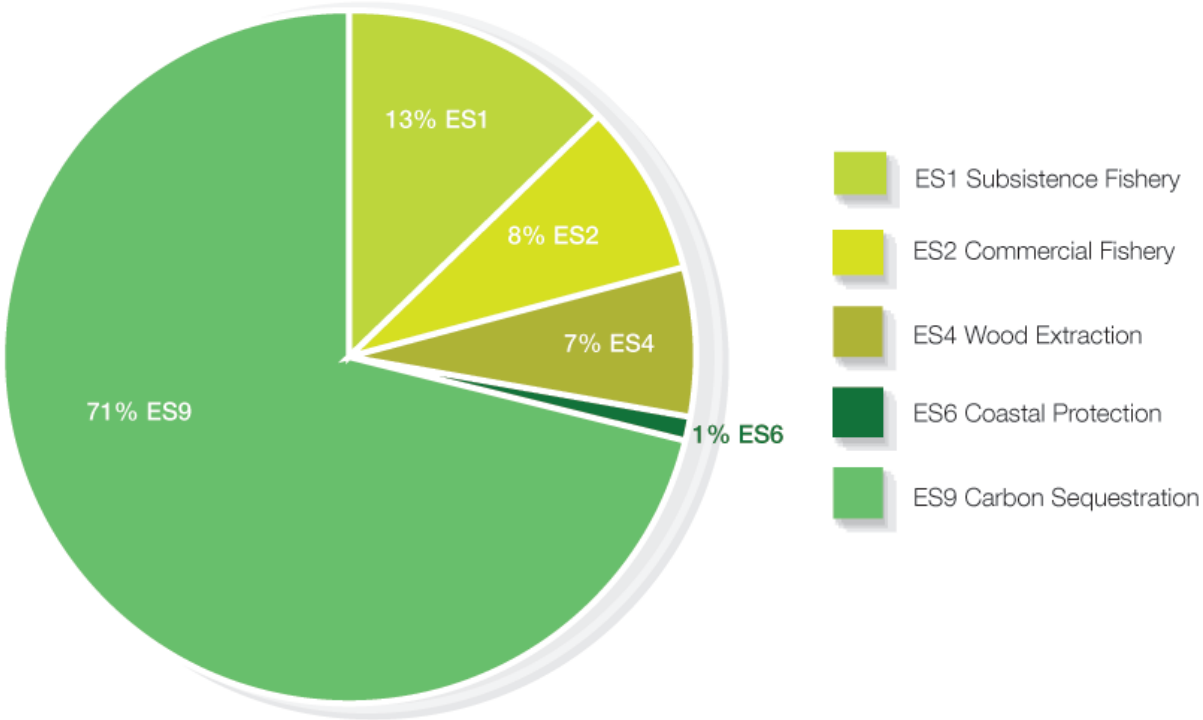

FIGURE C: Distribution of estimated total (Vt 24 million) in Eratap, 2012.

Who benefits from the ecosystem services?

The following groups benefit most from mangrove ES in Crab Bay and Eratap (Figure D and E):

- fishermen of the commercial artisanal fishery (300 in Crab Bay, 50 in Eratap)
- local families for whom fishing in the mangroves and on the reef is a source of regular protein (160 households in Crab Bay, 80 households in Eratap)
- local families benefiting from firewood and construction material (150 households in Crab Bay, 45 in Eratap)
- entrepreneurs in Eratap proposing mangrove tourism (two businesses, 800 tourists per year)
- real estate owners protected from coastal flooding (two tourism resorts in Eratap, covering a total area of 3000 m2), as well as plantation owners (300 hectares in Crab Bay)
- tourism entrepreneurs in Eratap whose business depends on the quality of lagoon water and beach formation (two businesses, 21 jobs, 11 500 tourists per year)
- the global community, which benefits from carbon sequestration and biodiversity.

In total, nearly 800 people depend on one or more of the mangrove ES in Crab Bay, as do 400 in Eratap.

What did we observe from the survey?

For Malekula Island, the majority of income earnings are derived from agricultural products, fish and handicrafts. The mangrove resources thus provide a majority of services needed by the locals, such as food security, shelter and housing means, and financial support. But for Eratap locals, little income is generated from the mangroves because the urban centre of Port Vila (on the same island) presents many other means of generating income. Eratap villagers thus use the majority of their mangrove resources for consumption and sell a lesser percentage for income.

In summary, the surveyed villages depend on the mangrove ecosystem for their sustainable livelihood, because it satisfies their basic needs of food and shelter. The crabs, shells and fish ensure food security for the villages, especially those without stable salaries (the majority of villagers). In the context of fluctuating market prices, this ecosystem service of free food supply benefits the village.

Further, the majority of the people depend on agriculture for income, but the seasonal nature of their produce means income is not consistent. So, the mangrove ecosystem also serves as a backup means of earning income.

About the study

The MESCAL context

Most Pacific Island territories face challenges such as:

i. increased fish demand from human population growth; the human population is estimated to increase by 50 per cent by 2030, with projected food requirements well in excess of what coastal areas are currently likely to produce without significantly improved management and productivity (Bell et al. 2009)
ii. the rapid introduction of a market economy with its associated rural migration, loss of traditional customs and urban poverty (Cinner and Aswani 2007)
iii. a small island context with limited economic options (Beukering et al. 2007)
iv. potential climate change effects on the islands' marine ecosystem services (Knowlton 2000).

Reinforcing these challenges, the Pacific Islands' national budgets are usually small and face considerable demands to meet human development priorities such as health, education and food production. This context means mangrove ecosystems in the Pacific Islands are under threat from overharvesting, degradation and land reclamation. The threat continues despite the mangroves being renowned for providing services that Pacific people highly value. Weak governance, a disconnect between formal and traditional management systems, limited baseline information, weakening traditional management, a lack of awareness, and limited capacity are some of the key challenges for mangroves management and conservation in the Pacific.

The MESCAL project was developed under the Pacific Mangrove Initiative to address these key challenges. Adopting an Ecosystem based Management (EbM) approach, the project focuses on finding stakeholder based solutions supported by scientific evidence and traditional knowledge to influence decision making positively at all levels of governance. It aims to help climate-proof coastal communities and sustain livelihoods by promoting investments in mangrove and associated coastal ecosystems in the five participating countries: Fiji, Samoa, Solomon Islands, Tonga and Vanuatu.

Our objectives

This study's total economic valuation (TEV) of mangrove ES has informative objectives. TEV is defined as the sum of the consumer surplus and the producer surplus of all the services of direct use, indirect use and non-use (as explained in the 'The theory behind our method' section of the Final Report). Decision makers understand you can't manage what you don't measure (Seidl et al. 2011). For this reason, TEV estimates help decision makers manage an ES portfolio. They also help identify the main beneficiaries from the ecosystem processes, and thus who will be the socioeconomic groups affected by a particular policy.

In summary, our objectives were to produce clear informative valuations to raise decision makers' and the public's awareness about the environment's condition. We want the valuations to strengthen support for environment and resource management actions, and to inform management with economic indicators.

What we valued

This study focused on economic valuation of mangrove ES in two locations in Vanuatu (figures D and E). Specifically, the study team conducted field surveys to determine the cultural and commercial uses of mangrove resources (subsistence and/or commercial artisanal fisheries, firewood, timber, medicine etc.) and assess their economic values. The team also conducted a desktop review of indirect uses of mangrove ecosystems (coastal protection, water treatment, sediment trapping and carbon sequestration) and assessed the economic values of those uses too.

The most common definition of ecosystem services are 'services that human populations derive, directly or indirectly from ecosystem functions' (Costanza et al., 1997) or, more simply, 'services that people obtain from ecosystems' (Boyd and Banzhaf 2007) (MEA 2003). The Millennium Ecosystem Assessment defines an ecosystem as 'a dynamic complex of plant, animal, and micro-organism communities, and the non-living environment interacting as a functional unit' (MEA 2003).

How we valued the ecosystem services

Table B summarises the different methods that we used for a monetary valuation of ES1–ES9. For detailed information, please see the Final Report for a classification of ecosystem services (annex 1) and a breakdown of the valuation by ES and site (annexes 2–7).

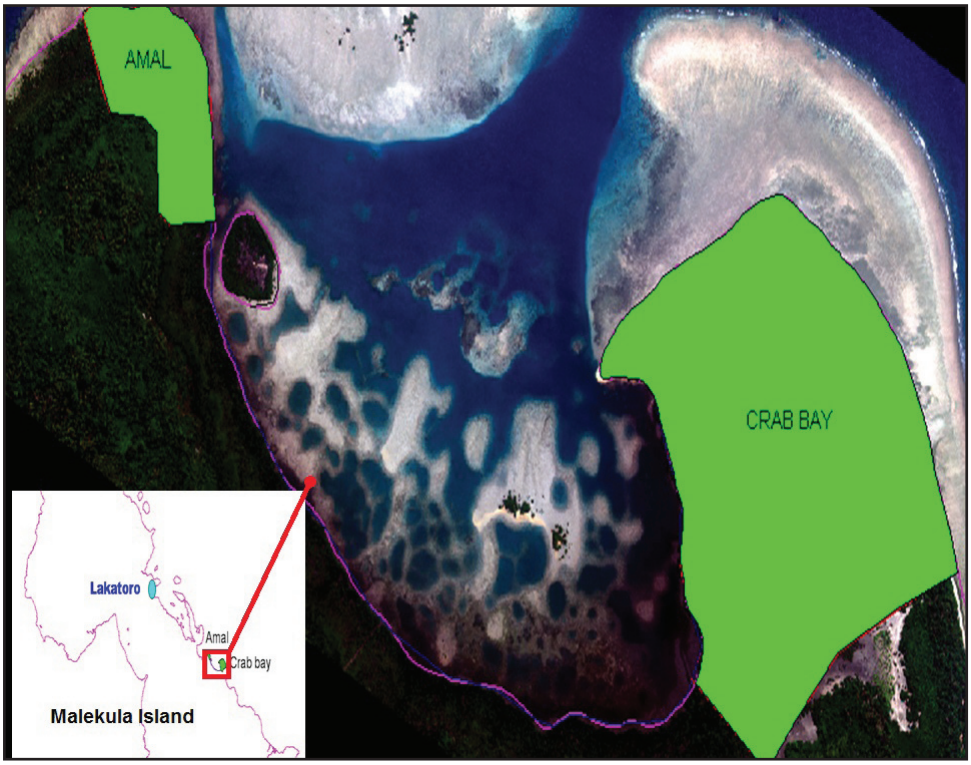

FIGURE D:
Crab Bay study site (Malekula Island).

Adapted from: Kanas, T (unpub.) Report on Mangrove Baseline Surveys and Mapping of Three Pilot Sites (Eratap, Amal and Crab Bay). Department of Lands, Surveying and Registry. Ministry of Lands and Natural Resources, Vanuatu.

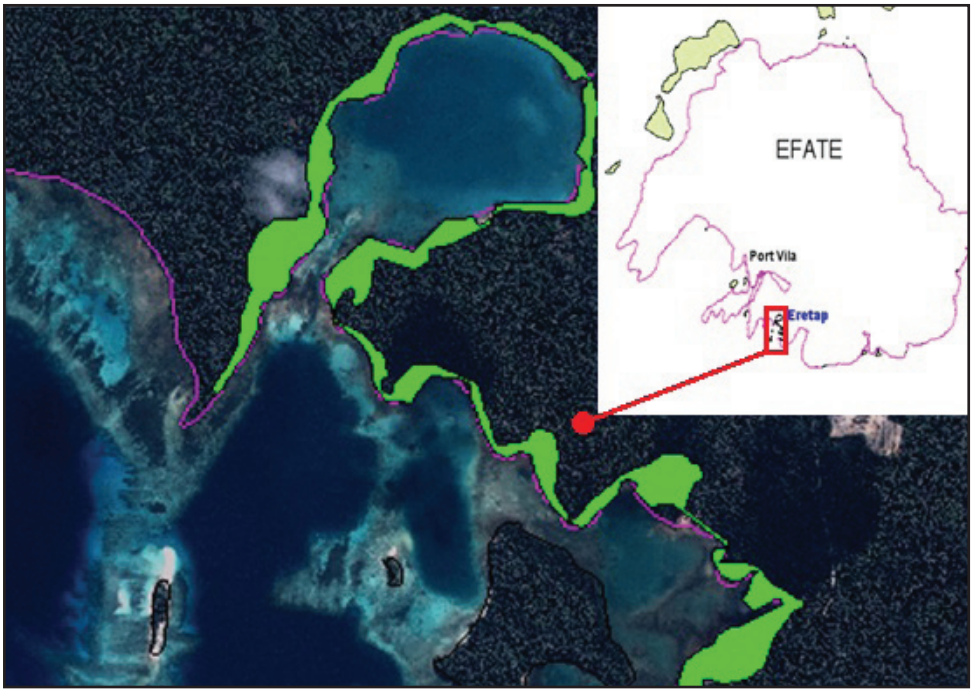

FIGURE E:
Eratap study site (Efate Island).

Adapted from: Kanas, T (unpub.) Report on Mangrove Baseline Surveys and Mapping of Three Pilot Sites (Eratap, Amal and Crab Bay). Department of Lands, Surveying and Registry. Ministry of Lands and Natural Resources, Vanuatu.

TABLE B: Summary of methods for valuing mangrove ES1-ES9

Services	Evaluation method	Service quantification	Spatial perimeter	Turn over	Intermediary costs	Multiplier
Subsistence fishery (ES1)	Producer surplus	Catch volumes (kg) of coastal species	Catch in mangroves and ontogenic migration (spillover area around the mangroves)	Replacement price of protein equivalent	Intermediary costs of fishery and distribution circuit	Weighting factor
Coastal fishery (ES2) (professional and non professional)	Business Expenditure Survey (BES) with fishermen			Final consumer prices	Intermediary costs of fishery	Fishery sector and distribution
	Producer surplus	Catch volumes (kg) of coastal species				
Recreational coastal fishery (ES3)	Producer surplus	Catch volumes (kg) of coastal species		Final consumer prices + elasticity factor	Intermediary costs of fishery and distribution circuit	Fishery sector and distribution
Wood extraction (ES4)	Producer surplus	Volume of wood extracted per type of use	Mangrove zone	Market price		
Medicine use (ES4)	Producer surplus	Volumes of active ingredient extracted per type of use	Mangrove zone	Replacement costs		
Mangrove toursim (day tours, guided visits) (ES5)	Producer surplus	Visits	Mangrove zone	Price of services	Intermediary costs of activity	Intermediary costs of activity
	Business Expenditure Survey (BES) with tourism operators					
Associated expenses linked to activities in mangroves (ES5)	Producer surplus	Quantification and segmentation of tourists per category of use	Tourism zones	Local expenses (accomodation, food, local transport) + international transport	Intermediary costs of activity	Intermediary costs of activity
	BES and surveys with users					
	Advertising Image Analysis					
Coastal protection (ES6)	Biophysical and oceanographic model	Coastal zone in potential flooding zone (probability)	Coastal protection zone (back of mangroves)	Real estate values		
	Damage costs avoided	Contribution of mangroves to coastal protection				
		Urbanized area and damage valuation				
Bio-remediation (ES7)	Biophysical model	Quantification of nutrient charge and water treatment	Mangrove zone	Replacement costs of water treatment unit		
	Replacement costs					
Sediment trap (ES8)	Biophysical and oceanographic model	Quantification of sediment charge and spatial dispersion	Mangrove zone and sea current regime	Replacement costs or damage costs avoided on tourism activities		
	Replacement costs or damage costs avoided on tourism activities					
Carbon sequestration (ES9)	Market price	Quantification of carbon annual sequestration and CO2 eq. trapped in soil	Mangrove zone	Market Price or OTC for mangrove CER		
Biodiversity credits (ES 10)	Market option price	Specific biodiversity indicators	Mangrove zone	Due diligence agreement for mangrove		
Non-use value (existence) (ES11)	Willingness to pay		Villages closed to mangroves, tourists, urban inhabitants			

How we conducted the surveys

The study team conducted a socioeconomic survey of how the Crab Bay and Eratap villages use their mangrove ecosystems. The team used three separate questionnaires: one survey focused on crabs, one on mangroves and one on reef fish. For more detailed information, please see annex 8 of the Final Report.

In Crab Bay, surveying began on 4 September and ended on 12 September 2012, with the help of seven locals, an officer from the Vanuatu Government Department of Environment Protection and Conservation, and a contracted resource environmental assistant. A total of 15 villages hosted the team. Despite a few field difficulties, the villagers were very helpful and the survey was successful. In Eratap, surveying began on 24 September and ended on 10 October 2012; the longer period of data collection there was due to community related issues. In the field, the survey team encountered three main issues: difficulty with transportation for the long distances between villages on Malekula; low attendance at group discussions and a lack of cooperation in interviews, which the responsible locals in Eratap organised; and additional expenses (from some villagers expecting accommodation and lunch, which put pressure on the team's limited budget).

Sampling

To randomly select village households for interview, the study team accounted for houses near the mangroves and those further away, for fishing and non-fishing households, and for different religious beliefs (such as a taboo against eating crab). The main hindrance to the survey was some villagers' unwillingness to be interviewed. The total number of valid surveys was 482 (Table C).

Questionaires (no.)	Eratap	Amal/Crab Bay
Household crab	29	130
Mangroves	29	137
Reef fish	29	128
Total	87	395

TABLE C: Completed data entries

Our recommendations

After presenting the study results to the officers of the Vanuatu Government Department of Environment Protection and Conservation, we identified the following two recommendations:

1. Regulation and policies addressing mangroves management and conservation should reflect the importance of the mangroves' benefits and value. Specifically, compensation for anthropogenic damages to mangroves (e.g. destruction, contamination, partial clearing) should account for the nine ES identified in this study. MESCAL outcome 2 includes having a 'Policy and legislative review, so that loop holes and gaps in existing separate policies and regulations that lightly address mangrove ecosystems can be addressed'. Additionally, the Vanuatu Government should assign a policy, or incorporate legislation into the existing Environmental Management and Conservation Act, that will govern and set laws on mangrove forests to prevent further destruction or differently manage it. Given the main principle of compensation is 'no nature loss', every mangrove destroyed should be compensated for by a mangrove of similar characteristics (in kind) and in the proximity (in site). Compensation can be made through restoration, re-seeding or conservation of existing mangroves, and it is always the responsibility of the developers. The ratio of compensation applied accounts for ecological differences, recovery time and the risks of ecological engineering. Payments for damages are made only when the developers do not have the technical capacity to subcontract the compensation measures. In this case, one option is to pay the compensation amount to a structure regulated by the government. Most international organisations recommend this approach but many countries are still exploring it. The wetland compensation banks in the United States are one illustration of such a mechanism.

2. The Vanuatu Government should incorporate the study findings in a policy brief to convince policy makers to better support mangroves management. Clear communication of ES beneficiaries, values and policy needs should contribute to this 'inform & convince' objective. The Vanuatu Government's Environment, Fisheries and Lands departments, non-government organisations and bilateral agencies might use the results in their communication and strategy. With the same objective, identifying the rate of mangroves degradation will help make a concrete case for strengthening mangroves management.

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INTERNATIONAL UNION FOR CONSERVATION OF NATURE

OCEANIA REGIONAL OFFICE
Private Mail Bag
5 Ma'afu Street
Suva, Fiji Islands
oceania@iucn.org
Tel: +679 3319084
Fax: +679 3100128
www.iucn.org/oceania