Economics of Coastal Zone Management in the Pacific

Vina Ram-Bidesi, Padma Narsey Lal, and Nicholas Conner

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FOREWORD

Coastal Zone management is a much debated subject in the discourse about sustainable development in the South Pacific region. This is hardly surprising, considering the importance of coastal zones for the livelihood of families and communities throughout the Pacific. Ongoing degradation of coastal resources and the damage from regular extreme climate events is causing much concern to those involved in developing adaptation strategies for dealing with the impact of climate change in the region.

A vast quantity of research, consultancy and workshop reports are available on coastal zone management and one might be tempted to ask what yet another publication on this subject can add. This book is different in that it captures the integration of ecological and economic concepts and principles to inform management decisions. It has special relevance to the Pacific Island states.

The book specifically deals with the analysis of the effects of the fundamental drivers, ecological connectivity, and root causes of coastal resource and environmental challenges using key economic concepts, principles and paradigms. The application of economic concepts to understand the causes of coastal zone degradation and overuse is fundamental as it allows policy makers to understand underlying issues and the incentives required for changing human behaviour.

In addition, the book provides an analysis of the management implications of the economic drivers, influences and root causes of observed coastal resource and environmental impacts, and the potential role of market-based instruments in encouraging efficient and sustainable use of coastal resources. There is always debate about the use of market-based instruments to advocate solutions to environmental degradation. The book, while providing the arguments for its use, also provides a useful discussion of circumstances where market-based instruments may not work and where alternative management systems may be used.

The book is a welcome initiative which provides a new perspective on the understanding and management of coastal zones in the Pacific. The use of Drivers-Pressure-State-Impact-Response (DPSIR) and Ecosystem-Based Management (EBM), together with resource economics, to analyse natural resource and environmental management concerns in the region would enhance the understanding of the issues in the region.

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December 2011

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Glossary

Beneficiary pays principle	People (beneficiaries) who benefit from publicly-owned environmental goods or services must pay for their use
Consumptive use	Direct utilisation of goods and services by consumers; this does not include the use of means of production, such as machinery and factories
Demand	The quantity of a good or service that a person or a firm is willing to consume at a certain price. The demand curve illustrates the relationship between quantity of good demanded and a given market price
Impactor/ polluter pays principles	People (impactors/polluters) who use environmental goods or services in a way that is harmful should pay for the environmental costs that they cause
Joint production	Where one good or service is produced at the same time as another good or service
Marginal benefit	The incremental benefit received from the production or consumption of an additional unit of good or service
Marginal cost	The incremental cost in the production of a unit of good or service
Market equilibrium	The situation where quantity supplied just equals quantity demanded, and the marginal benefit of consuming that good or service equals the marginal cost of producing that quantity of good or service
Market failure	A situation where inefficient use of resources arises because the market price of a good or service does not reflect the true value of that good or service. Market failure may arise for example, where the property rights that govern use or access to a good or service are poorly defined; or where government provides subsidy towards the production of a good or service
Net benefits	Economic benefits less economic costs; technically measured as the sum of consumer surplus and producer surplus
Non-consumptive	This is a use that is non-extractive, such as a coral reef acting as a coastal protective barrier
Non-use	A 'use' of goods and services that reflect for example cultural or spiritual values, or option of use in the future
Opportunity cost	The economic cost of an input or resource in its next best use; measured as the foregone economic value from using a resource (such as labour, capital or land) to produce an alternative good or service instead
Private good	A good that is rival and excludable, and often owned by individuals or firms
Profit	Total revenue minus all costs, including depreciation
Property rights	The bundle of rights, obligations and entitlements that people have over a resource. This term defines any rights or obligations over access, use, management, as well as benefits gained or costs incurred in using that resource
Public good	A resource that is often held by the State, community or the public, and is neither rival nor excludable
Rights creation	Establishment of a property rights regime over resources where such rights do not exist or are poorly defined. Rights are created in order to encourage efficient use and allocation of resources through trade)
Rivalry	The extent to which enjoyment of a resource by one person diminishes the amount left for others to enjoy; non-rivalrous goods are those where use and the resource does not affect the enjoyment derived by others, such as environmental beauty.
Social discount rate	Rate of time preference expressed by society that reflect the discounted value of future earnings
Supply	The quantity of a good or service that a firm or individual wishes to sell at a certain price. The supply curve illustrates the relationship between quantity of good supplied, and a given market price, and it also reflects the relationship between quantity supplied and the marginal cost of each additional unit of good supplied.
Rate of time preference	Expression of the degree to which people prefer to experience benefits now rather than later
Tragedy of the commons	Arises in situations where individuals do not have incentives to curb their respective activities, resulting in over use and or inefficient uses of resources. Such a situation usually arises where property rights over resources are poorly defined, or communally owned and thus is subject to open access.
Vulnerability	This is a function of risks to which people may be exposed, the sensitivity of their livelihood system to those risks, and their ability to adapt to, cope with, or recover from the impacts of an external 'shock' to their livelihoods
Livelihood	A livelihood comprises the capabilities, assets (material and social) and activities required for a means of living
Sustainable livelihood	When a livelihood can cope with and recover from, stresses and shocks and maintain or enhance its capabilities and assets both now and in the future while not undermining the natural resource base

Acronyms

ADB	Asian Development Bank
CAP	Conservation Area Project
CPUE	Catch per Unit Effort
CRISP	Coral Reef Initiative for the South Pacific
DECCW	Department of Environment, Climate Change and Water
DHW	Degree Heating Weeks
DPSIR	Drivers-Pressure-State-Impact-Response
EBM	Ecosystem-Based Management
EIA	Environmental Impact Assessment
EPF	Environment Protection Fund
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HIES	Household Income and Expenditure Survey
IOI	International Ocean Institute - Pacific Islands
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWP	International Waters Programme
LMMA	Locally Managed Marine Areas
MC	Marginal Cost
MEA	Millennium Ecosystem Assessment
MPA	Marine Protected Area
MWTP	Marginal Willingness to Pay
NGO	Non-Governmental Organisation
NOAA/NESDIS	The National Oceanic and Atmospheric Administration/ National Environmental Satellite Data and Information Service
OECD	The Organisation for the European Co-operation and Development
PICs	Pacific Island Countries
PICTs	Pacific Island Countries and Territories
PIF	Pacific Islands Forum
PIFS	Pacific Islands Forum Secretariat
PIROP	Pacific Islands Regional Ocean Policy
PNG	Papua New Guinea
SIDS	Small Island Developing States
SOPAC	South Pacific Applied Geoscience Commission
SPBCP	South Pacific Biodiversity Conservation Programme
SPC	Secretariat of the Pacific Community
SLA	Sustainable Livelihoods Approach
SPREP	Secretariat of the Pacific Regional Environment Programme
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme

CHAPTER 1

Introduction

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Vatukarasa Village: a typical coastal village on the Coral Coast of Viti Levu, Fiji.

Pacific Island Countries and Territories (PICTs) are symbolised by the presence of a large number of small islands in the midst of the largest body of water in the world, the Pacific Ocean. PICTs are also characterised by their natural beauty and vibrant cultures. The Pacific community prides itself on its '*Pacific Way*' of living, where communal living and reciprocal social relationships are emphasised. The Pacific islands region is also experiencing rapid changes due to, in most cases, high population growth rates, globalisation, and the changing needs and aspirations of its people, including increasing consumerism. While the Pacific people live in a modern world, they also have strong social ties and are influenced by their cultural traditions. This traditional system is nevertheless gradually weakening, particularly as it is often at odds with the pressures of individualism encouraged by globalisation and market economic forces.

Such pressures are particularly observed in the coastal areas of the region, where almost 100 per cent of the Pacific Islanders (excluding those in Papua New Guinea) live within 100 kilometres of the coast. The majority of the island economies depend on subsistence and commercial uses of coastal (terrestrial and marine) resources, including fisheries, coastal mining and tourism. Growing populations and an increasing emphasis on materialism have encouraged countries to emphasise economic development goals, with often cursory regard for their impact on the environment, and social equity.

Over the last decade or so, a common set of resource and environmental issues have become apparent in the Pacific islands, including unsustainable harvesting of coastal fishery resources, degradation of coastal and marine ecosystems such as mangroves, coral reefs and seagrass beds, increasing solid waste, and groundwater pollution from human and animal waste. Environmental impacts also include loss of biodiversity from the effects of invasive species, degradation of land resources through unsustainable forestry and poor agricultural practices, excessive conversion of forest land to alternative uses, climate variability, and sea level rise.

These developments conflict with the image of Pacific environments as being amongst the last remaining unspoilt natural environments globally; renowned for ecologically diverse habitats and landscapes, high biodiversity values, and high endemism. In some cases, such as coral reefs, the Pacific has the highest known diversity in the world (Wilkinson 2008). As a result, Pacific island nations are under continuing international pressure to act to protect their biodiversity and natural ecosystems in the global interest. These international calls for protection of key species and their habitats are however, often at odds with the economic development desired by local communities to meet their need for income to pay for basic activities such as paying for children's school fees and clothing, as well as to purchase commercially available goods and services for material comfort. Governments also pursue economic development agendas, sometimes with little regard for biodiversity conservation and sustainable development. Many of the natural resources in PICTs are communally owned, often with boundaries which are not clearly defined or formally recorded, creating unique challenges in the use and management of natural resources in a modern world.

Threats from sea level rise are exacerbated along the shoreline in Choiseul, Solomon Islands.

Such situations are common throughout the region, although the nature and extent of environmental problems may vary within a country, as well as between countries. Similarly the drivers for change are also very alike; i.e. globalisation, modernisation, and increasing population. These drivers affect the values, attitudes, and aspirations of individuals and communities at large, and are leading to a shift from subsistence and collective welfare maximisation to individual maximisation of household income. With increased emphasis on economic development, customary resource owners are pursuing private wealth maximisation, even at the expense of the wellbeing of their own community. In many cases, this has resulted in overharvesting of inshore fisheries resources such as bêche-de-mer, trochus, and giant clams. In some cases, resource owners have been instrumental in the conversion of healthy ecosystems such as mangroves, into alternative uses such as for tourism, and/or housing development.

It is also recognised that, although details may vary between sectors within as well as between PICTs, there are many similarities in the underlying root causes, the nature of national level response, and the assistance provided by regional governmental agencies and international development partners. These similarities can be found, regardless of which theme or sector is examined, as discussed in this book.

A key component of the root causes of many resource and environmental concerns in the region is the focus on maximising individual wealth in situations, where only some, but not all, goods and services have market values, and are thus not traded in a market place. Countries rely on the market to efficiently allocate scarce resources between competing uses and users, with market price as the common monetary measure of their value. Where goods and services such as marine fish stocks, clean environments, intact mangrove ecosystems, and biodiversity do not have a monetary tag, market mechanisms cannot be relied on to allocate these resources to their most valued use. Under these circumstances, over-use of resources and environmental degradation are common. Conversely, there is commonly little interest in protection or enhancement of publicly-owned resources and environments by individuals because the cost of such action will be borne by individuals, but the benefits will be enjoyed by the public at large. In the past, agencies in PICTs have tended to focus on command and control policy measures, awareness-raising, and education strategies to control and manage natural resource use and environmental protection. However, these approaches have not always been effective for several reasons.

National programmes and policies often suffer from weak government administrative arrangements for dealing with the multi-faceted resource and environmental problems occurring in PICTs. Such problems generally cannot be addressed effectively by a single government agency working within one sectoral legislative framework, and in the absence of governance arrangements that do not reflect key ecological connections.

PICTs have acknowledged the limitations of relying only on conventional 'command and control' instruments and education and awareness programmes for managing natural resources and environments. There is a slow but gradual shift towards recognising that incentive-based instruments may also be needed if change in individual behaviour is to be achieved and resourced. For example, Pacific Island Forum leaders at the Pacific Islands Forum Leaders Meeting in Va'vau, Tonga, in November 2007 called for "… identifying and accessing alternative financial resources for waste management, including the use of economic instruments (e.g. user charges)." Although not yet very common, there is evidence that some governments and communities are, for example, introducing user charges for entry into locally managed Marine Protected Areas (MPAs), obtaining payments for ecosystem services and imposing pollution fees. However, at the same time, countries are also known for distortionary subsidies in some resource sectors that have led to overexploitation of coastal resources.

Lal & Keen (2002) note the relevance of using natural resource economics to address such resource use and management problems, observing the need to "…assist environmental officials, national, and fiscal planners in taking stock of economic implications of environmental impacts" of development. Interest in economics and financial analysis has also increased with the hope of finding alternative financing mechanisms for resource and environmental management (Woodruff 2007). In addition, participants at the Nature Conservation Conference in the Pacific in Rarotonga in 2002, identified economic valuation of natural resources as one of the key strategies needed in the region to encourage environmental conservation (Lal 2003).

Before using economic valuation of natural resources as a strategy to promote environmental conservation, or developing such economic-based management instruments, it is important to understand the basic principles of economics as they apply to coastal resource use and management, as well as to understand the strength of market-based management approaches. It is also useful to understand the circumstances under which market-based instruments may not be relevant or effective, and to understand which alternative management systems may be required to adequately address complex coastal resource and environmental management challenges. Such an understanding needs to be seen in the context of a broader systems-based perspective of pressures, impacts, and responses relating to management of the natural resources and environments of the coastal zone in the Pacific. In addition to this systems-based perspective, two other analytical frameworks, the Drivers-Pressure-State-Impact-Response (DPSIR) and Ecosystem-Based Management (EBM) frameworks are discussed in the book, together with resource and environmental economics, to analyse natural resource and environmental management concerns in the region.

The book provides:

- an analysis of the effects of fundamental drivers, ecological connectivity, and root causes of coastal resource and environmental challenges, using key economic concepts, principles and paradigms;
- an analysis of the management implications of the economic drivers, influences and root causes of observed coastal resource and environmental impacts, and the potential role of market-based instruments in encouraging efficient and sustainable use of coastal resources; and
- a discussion of the conditions and circumstances where market-based instruments may not be relevant or effective, and which alternative management systems may be required to adequately address complex coastal resource and environmental management challenges.

The intended audience for the book is students and coastal zone managers with little or no background in economics.

The book is structured as follows:

Chapters 2 to 5 describe the current status of, and recent trends in, coastal resources and environments in the Pacific. The DPSIR analytical framework, the EBM framework, and the economic analysis framework are also introduced. Chapter 2 provides an overview of the economic importance of coastal resources and resource use for PICTs, and summarises key current threats and issues. Chapter 3 describes key elements of the DPSIR and EBM analytical frameworks which help explain the broad changes in coastal resources and the environment. Chapter 4 considers key drivers of change behind fundamental transformations in Pacific societies, including monetisation and globalisation affecting the socio-cultural order, and its pressures on coastal resources. Chapter 5 describes an economic analysis framework, focusing on key resource and environmental economics concepts such as supply and demand, market and non-market values, and property rights in the context of the market economy to help explain 'root causes' of the observed state of coastal resources, and environments.

Chapters 6 to 9 use a combined DPSIR, EBM and economic framework to examine the current status of, and trends in, key coastal resources and environments, and the potential effectiveness of a range of management responses. Chapter 6 examines economics of fisheries resource harvesting. Chapter 7 discusses key economic dimensions of pollution, while Chapter 8 examines the economics of habitat destruction and its effects. Each of these chapters considers current management approaches and alternative market-based management approaches, and discusses key challenges from both these approaches. Chapter 9 describes recent innovative approaches to coastal resource management innovation in the Pacific. This discussion is followed by concluding remarks on the importance of understanding the complex interrelationship between pressures, impacts and responses, and the role of individual motivations and incentives, when designing coastal resource management.

CHAPTER 2

Coastal Resources and Pacific Island Economies: Issues and Threats

©Vina Ram-Bidesi

Hotel and marina development in Nadi, Fiji.

Healthy marine and coastal environments are fundamental to the long-term sustainability of island societies, as well as providing the basis for their livelihoods and economic development. The 22 PICTs comprise about 550,000 km^2 of land, spread across 29 million km^2 of the Pacific Ocean. With the exception of mainland Papua New Guinea, all the countries have large ocean areas compared to their land mass (Table 2.1). Entire islands and communities influence, or are influenced by, the biophysical characteristics, human activities, and ecological processes that occur in coastal catchments, coastal lands, and coastal waters. When viewed from an ecosystem perspective, the coastal zone can be regarded as the transition zone between land and sea, and influenced by changes upstream as well as forces within the marine environment itself through ecological connectivity.

More specifically, the coastal zones of tropical island countries would include some, if not all physical features, such as river deltas, coastal plains, wetlands, beaches, reefs, mangrove forests, seagrass beds, lagoons, and other coastal features. However, the limits to coastal zones are arbitrarily defined and, as Harvey (2006) states: “There is no clear definition of the ‘coast’ in coastal management”. Definitions become broader as they become more inclusive of catchment-related or marine-related physical processes which impact on the boundary zone between sea and land (Harvey 2006). From an economics perspective, use of a broader definition of the coastal zone may be warranted (i.e. a ‘ridge to reef’ perspective), since many activities in the catchment area could have externality effects on the use and management of coastal resources and environments.

Traditional societies usually recognised such ecological linkages, as well as the social and cultural dimensions of their lifestyle, as reflected in key traditional concepts used by indigenous people such as *vanua, whenua, fenua* (Lal & Young 2001), and through customary systems designed to manage their resources (Ruddle & Johannes 1983).

2.1 Pacific people, coastal resources, and livelihoods

With the exception of Papua New Guinea (PNG), almost 100 per cent of Pacific islanders live in coastal areas and depend on associated land and marine coastal resources for their livelihood. While in most countries, the majority of population live along the coasts in rural areas, gradually a larger proportion of the people now reside in urban centres which too, are mainly coastal (Table 2.1).

Coastal areas encompass diverse ecosystems supporting a variety of living and non-living resources. An ecosystem is defined by the Millennium Ecosystem Assessment as: “…a dynamic complex of plant, animal, and micro-organism communities, and the non-living environment, interacting as a functional unit” (Millennium Ecosystem Assessment 2005). The diversity of inter-tidal and supra-tidal ecosystems covers coral reefs and reef flats, mangrove swamps, wetlands, coastal littoral forests, and rocky and sandy beaches that are home to numerous coastal flora and fauna species. Sub-tidal marine ecosystems include lagoons and fringing and barrier reefs that include a large variety of marine species, including finfish, shellfish, seaweeds and crustaceans.

Table 2.1 Selected PICTs: Population and physical characteristics.

Country	Land Area (km^2)	Exclusive Economic Zone (km^2)	Length of Coastline (km)	Population (000) (mid 2008)	% Urban Population
American Samoa	200	390,000	116	66	93
Cook Islands	237	1,830,000	120	13	72
Fiji	18,333	1,290,000	1,129	837	54
French Polynesia	3,521	5,030,000	1,147	266	52
Guam	541	218,000	153	176	95

Kiribati	811	3,550,000	1,143	97	54
Marshall Islands	181	2,131,000	370	63	76
Federated States of Micronesia	701	2,978,000	6,112	112	23
Nauru	21	320,000	30	10	100
New Caledonia	19,103	1,740,000	1,249	245	66
Niue	259	390,000	64	2	38
Northern Mariana Islands	471	1,823,000	1,482	87	97
Palau	488	629,000	1,519	21	70
Papua New Guinea	462,243	3,121,000	5,152	6,458	13
Samoa	2,935	120,000	403	179	23
Solomon Islands	28,370	1,340,000	5,313	507	18
Tonga	688	700,000	419	101	25
Tuvalu	26	900,000	24	10	50
Vanuatu	12,190	680,000	2,528	232	24

Source: http://chartsbin.com/view/ofv.Coastlines of Countries, UN/ESCAP 2008; Population Data Sheet, 2008.

These coastal areas provide many ecosystem services that support human wellbeing. For example, seagrass beds and mangrove habitats are important habitats for spawning, nursery, and feeding grounds for a number of species. In many tropical small islands, coral reefs constitute the primary coastal protection structures, and provide sand for the formation of atolls, islets, and beaches. Reefs also provide a critically important source of food and employment for coastal communities throughout the Pacific. Many ecosystems also provide other functions, including protection against extreme events such as storms and hurricanes, storage and cycling of nutrients, sustaining biodiversity, and maintaining water balance (Martinez et. al 2007).

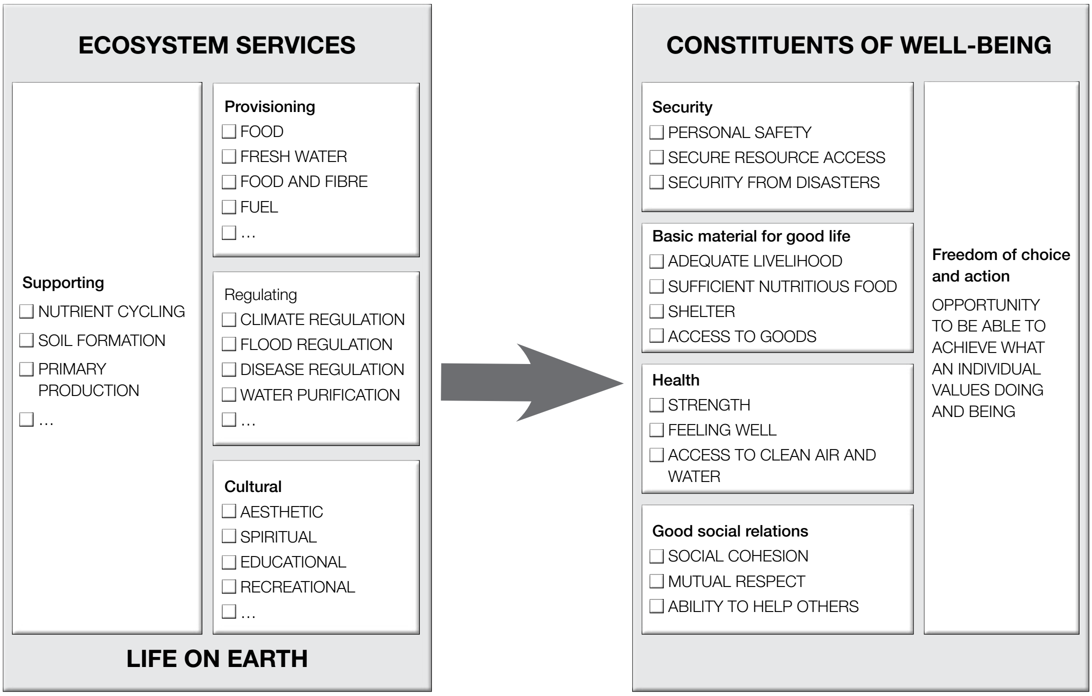
The Millennium Ecosystem Assessment categorises these functions as:

- *provisioning services*, such as providing items like food, water, timber and fibre;
- *regulating services* that affect climate, floods, disease, wastes and water quality;
- *cultural services* that provide recreational, aesthetic and spiritual benefits; and
- *supporting services* such as soil formation, photosynthesis and nutrient cycling (see Figure 2.1).

Different coastal ecosystems provide varying levels of different ecosystem services, as summarised in Table 2.2. These ecosystem services support direct and indirect consumptive and non-consumptive uses, and environmental ‘non-uses’. Some of these have market values, that is, they can be bought and sold through the market mechanism, while others, such as cultural values, may not have market values. They all are part of different types of economic values placed on coastal ecosystems, such as coral reefs, by humans (Figure 2.2). Table 2.3 gives examples of the different types of ecosystem services supported by, for example, mangrove ecosystems.

The status and the supply of the above goods and services however, depend on the maintenance of intricate relationships between and within the various components of the ecosystem. Therefore, human wellbeing is both directly and indirectly dependent on ecosystem integrity.

Figure 2.1 Ecosystem services and their linkages with human well-being.



Source: Millennium Ecosystem Assessment (2005).

Different categories of Ecosystems Services affects human well being to varying degrees. For example, Provisioning Services would greatly determine the nature of 'Basic material' for good life and health. Its impact on 'Good social relations' will be indirect through traditional practices. On the other hand, 'Cultural' category of ecosystem services will have a large influence on the 'Good social relations' but only marginally affect 'Basic material for good life'.

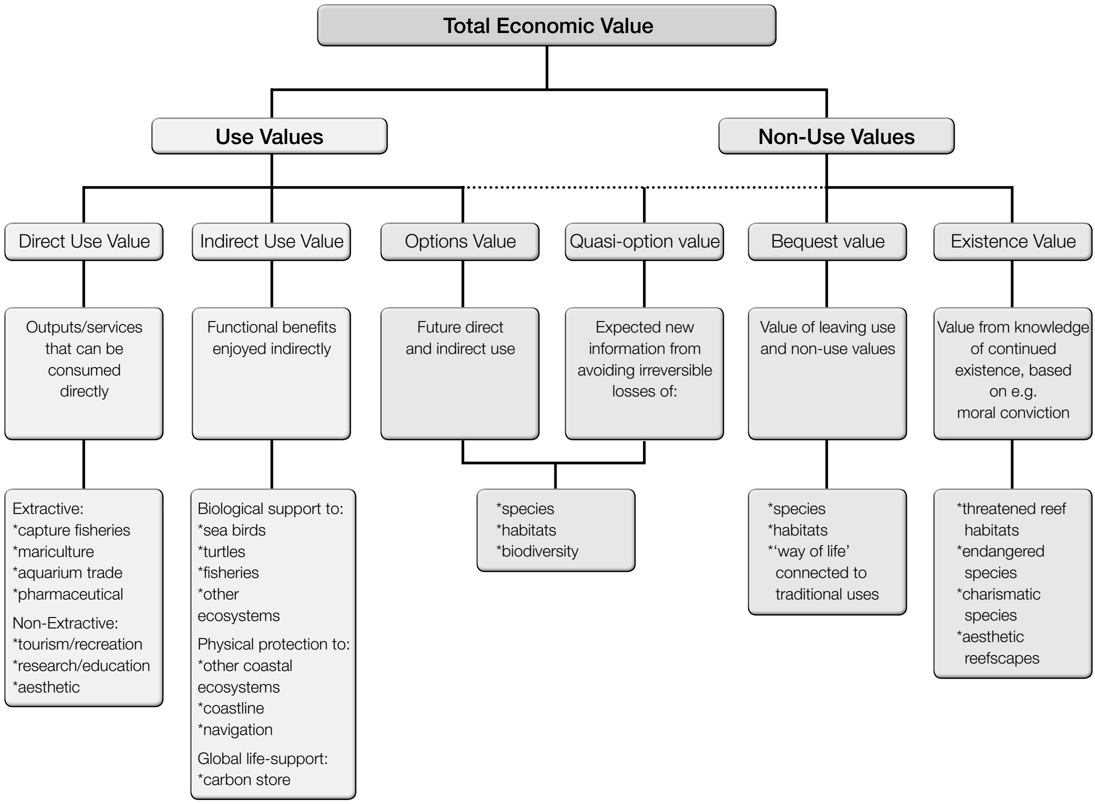
Table 2.2 Some ecosystem goods and services supported by tropical coastal ecosystems.

Ecosystem types	GR	CR	DR	WR	WS	EC	SF	NC	WT	P	BC	H	FP	RM	GN	REC	CUL	SP
Open scrub lands	x			x		x	x		x	x	x		x					
Sandy shores			x			x				x	x	x						x
Coral reefs			x						x			x	x	x	x	x	x	x
Mangroves			x					x	x			x	x	x	x	x	x	x
Seagrass beds								x						x				x
Coastal shelf								x			x		x	x	x	x		
Estuaries			x					x			x	x	x	x	x	x	x	x
Swamp-flood plain		x	x	x	x				x			x	x	x	x	x	x	x

GR - Gas regulation
CR - Climate regulation
DR - Disturbance regulation
WR - Water regulation
WS - Water supply
EC - Erosion control
SF - Soil formation
NC - Nutrient cycling
WT - Waste treatment
P - Pollination
BC - Biological control
H - Habitat/ refugia
FP - Food production
RM - Raw materials
GN - Genetic resources
REC- recreation
CUL- cultural
SP - Storm protection

Source: Adapted from Martinez et al (2007: 261) and the ecosystem service classification used in the Millennium Ecosystem Assessment (2005).

Figure 2.2 Use and Non-use Values comprising Total Economic Value associated with a Coastal Ecosystem.



Source: Barton (1994) & Cesar (2000).

In rural coastal areas community recreation is often undervalued.

Table 2.3 Examples of ecological services provided by mangrove ecosystems.

Provisioning services		Supporting services	Regulating services	Cultural services
Fuel Firewood Charcoal Alcohol Construction timber for scaffolds and heavy construction Beams, poles, flooring, panelling, etc. Boat building Dock piling Thatch, matting Fishing Poles for fish traps Fish-attracting shelters Fishing floats Fish poison Tannins for net and line preservation Food and beverages Fish, crustaceans, molluscs, other fauna vegetables from propagules, fruit and leaves Condiments from bark Sugar Honey Cooking oil	Tea substitutes Alcohol Vinegar Fermented drinks Household items Furniture Glue Wax Household utensils Incense Matchsticks Textiles, leather Fur, skins Synthetic fibres (e.g. rayon) Dye for cloth Tannins for leather preservation Other products Fish, shellfish and mangrove roots for aquarium trade Medicines from bark, leaves, fruits and seeds Fodder for cattle, goats and camels Fertilisers Lime Paper Raw material for handicraft Cigarette wrappers	Biophysical support to other coastal ecosystems Provision of nursery, breeding and feeding grounds Maintenance of biodiversity and genetic resources Storage and recycling of organic matter, nutrients and Pollutants Production of oxygen Sink for carbon dioxide	Protection against floods, hurricanes and tidal waves Control of shoreline and riverbank erosion Influence on local and global climate Export of organic matter and nutrients Biological regulation of ecosystem processes and functions Biological maintenance of resilience Topsoil formation, maintenance of fertility Water catchment and groundwater recharge	Heritage values Cultural, spiritual and religious values Artistic inspiration Educational and scientific information Recreation and tourism

Source: Adapted from Ronnback (1999).

2.2 The economic importance of coastal areas

With a few exceptions in high islands, the coastal zone (including coastal land and marine resources) supports subsistence and commercial activities, and is vital for the maintenance of sustainable livelihoods and enhancing food security for coastal populations in the Pacific. For example, coastal ecosystems, such as coral reefs, mangroves, and lagoons are fundamental for subsistence and commercial fisheries, as well as for the tourism sector. Virtually all key towns and urban centres in the Pacific, including centres of industrial and commercial development, are as mentioned above located in coastal areas. Trade is essentially seaborne in the Pacific, which not only provides ease of international transportation, but also facilitates intra-regional trade amongst the islands that are scattered over vast areas of ocean. In some smaller islands, inter-island shipping remains the only means of access and communication to the outside world. Pacific islanders heavily depend on their coastal areas for economic and social wellbeing related to subsistence, commercial and cultural activities and sub-activities (see Table 2.4). Not only does economic wellbeing or securing livelihood strategies depend on the coastal zone, but human activities, in turn also influence the health of the ecosystems which contribute to this wellbeing through the impact of the market economy, property rights regimes, and social, cultural and institutional structures and arrangements.

Table 2.4 Typical economic activities in the coastal areas of PICTs.

Activities	Description
Fishing	Subsistence, artisanal, commercial fishing: trochus, bêche-de-mer, finfish, invertebrates, shellfish, aquarium fish
Aquaculture	Pearls, seaweeds, milkfish, live rock
Tourism	Hotels, resorts, handicraft, sporting activities - golfing, tennis, hospitality services, food and beverage
Recreation	Sports and adventure fishing, snorkelling, diving, whale and dolphin watching, yachting, sailing, wind surfing, kayaking , sunbathing, beach pools
Agriculture	Variety of fruits and vegetables, rice farming, roots crops
Beach mining	Sand and gravel extraction, coral harvesting
Forestry	Mangrove cutting, coastal timber extracting for firewood and construction
Water	Drinking, household use, desalination plants, industrial cooling, septic tank flushing
Marine reserves	Marine Protected Areas, sanctuaries, coastal and marine parks
Research	Education and training, scientific knowledge
Shipping	Inter-island, regional and international transportation
Ports and harbours	Facilitation of imports and exports, storage, border control
Settlements	Infrastructure and services, reclamation and industrial development
Industrial outfall	Agricultural run-off, factory outlets
Urban sewage	Household sewage dump sites
Coastal construction	Seawalls, piers, jetties

However, the total economic contribution of coastal resources in PICTs, either in terms of the per cent contribution to national Gross Domestic Product (GDP) or sectoral gross value product, or in terms of the net economic contribution, is largely not known. Nevertheless, some sector-specific information can be found. This information is briefly described below, drawing extensively on an IUCN report prepared by Seidel & Lal (2010).

Coastal fisheries

Coastal waters contribute significantly to local economies, particularly subsistence and commercial fishing carried out in lagoon, reef, deep-slope or shallow sea areas, with a growing contribution being made by mariculture in inshore waters. A small proportion of reef fish is also traded in the live reef food fish trade.

Coastal fisheries provide valuable employment, household income, and food for the Pacific island people. In 2007, coastal commercial fishing produced a total of 44,700 mt in the region with a value of US$165.8 million, contributing on average 0.5 per cent to regional GDP. On the other hand, the value of subsistence fisheries output was estimated to be $200 million as shown in Table 2.5.

Table 2.5 Economic value (GVP) of fishing in PICTs.

Fishing Activities	Gross Value of Product (GVP)*	As % of Regional GDP
Commercial inshore fishery	165.7 million	0.5%
Mariculture	145 million	0.5%
Subsistence fishing	200.4 million	0.6%
Total	**521 million**	

Source: Seidel & Lal (2010)
*US$ at 2007 market prices.

Coastal commercial fisheries

The value of regional coastal commercial fisheries was estimated to be $165.7 million in 2007 across the Pacific, while the value of aquaculture was estimated to be $146.9 million (Gillett 2009b). National catches are significant for national economies. For example, in Fiji, an artisanal catch, consisting of 5,994 tons of reef fish (67 per cent) and invertebrates (33 per cent) were recorded in 2005, with an estimated value of FJ$27 million (Fiji Fisheries Division 2007), while in 2007, the coastal commercial catch of 9,500 tons was estimated at FJ$54 million (Gillett 2009b). High-value commodities for exports have been bêche-de-mer, trochus, and live reef fishes, and in more recent years, aquarium fish and live rock. The principal exports from coastal fisheries in 2003 from Fiji were marine aquarium products (FJ$14 million annually), bêche-de-mer (FJ$8.6 million), trochus (FJ$1.7 million), deepwater snapper (FJ$250,000), and live reef food fish (FJ$450,000), a total of about FJ$24.5 million per year (Gillett 2009b; Hay & Zebedy 2005) .

The aquarium trade has also been significant for a number of countries such as the Solomon Islands, Fiji, Tonga and Kiribati. The aquarium trade in the Solomon Islands for example, accounts for 4 per cent of the international coral trade (Lal & Kinch 2005; Wabnitz et. al 2003). Almost 70 species of live coral are regularly exported from the Solomon Islands together with 19 species of dead coral (Kinch 2004; Lal & Kinch 2005).

Aquaculture is dominated by pearl production in a number of countries, including French Polynesia, the Cook Islands and Fiji, while shrimp farming is important in New Caledonia. *Eucheuma* species (seaweeds) have also been an important export commodity in Fiji and Kiribati. Tilapia, milkfish and giant clams are also cultivated for both subsistence food needs, and for sale at domestic market. In 2007 Fiji recorded 142.7 tons of tilapia worth FJ$712,300, 24.04 tons of freshwater prawns (FJ$575,380), 13 tons of brackish water prawns (FJ$400,000) and 67 tons of seaweed (FJ$33,500) (Gillett 2009b). Exports of coral and shells from the Solomon Islands were estimated to be SI$1,307,000 in 2006, while shark fin exports were valued at SI$90,000 (Gillett 2009b). The coastal commercial catch of 3,700 tons in Tonga in 2007 was estimated to be worth T$22.8 million while in Samoa, a catch of approximately 4,129 tons was worth ST$51.2 million (Gillett 2009b).

Coastal subsistence fishing

Coastal or inshore fishing for home consumption plays a vital role in Pacific islanders' lifestyles and provides food security throughout the PICTs (Bell et. al 2009). Typically, 10 to 20 times more people fish for subsistence than for commercial purposes, despite increased commercialisation of coastal fisheries, supporting mainly urban dwellers.

Marine resources are one of the most important sources of dietary protein in the region; with the average annual per capita consumption of 50 kg reef fish being significantly higher than the global average (see Box 2.1). Subsistence fishing still provides the great majority of dietary animal protein in the Pacific islands, with fish providing 50–90 per cent of animal protein intake in rural areas and 40–80 per cent in urban centres. Most of the protein intake by rural people comes from subsistence production, where per capita consumption often exceeds 50 kg per year, compared to the global average of 16.4 kg. This is particularly the case in PICTs with limited possibilities for agriculture, such as atolls and low lying island states where land is limited and communities rely on the coastal waters for food supply.

The relative importance of subsistence fisheries to national economies is not known, as this sector is not surveyed across the country and values of subsistence catch are often based on localised socio-economic case studies. Nevertheless, household

Box 2.1
Annual per Capita fish consumption in PICTs

Tuvalu	110.7 kg
Samoa	87.4 kg
Niue	79.3 kg
French Polynesia	70.3 kg
FSM	69.3 kg
Kiribati	62.2 kg
Nauru	55.8 kg
Cook Islands	34.9 kg
New Caledonia	33.4 kg
Palau	33.4 kg
Solomon Islands	33.0 kg
Fiji	20.7 kg
Tonga	20.3 kg
Vanuatu	20.3 kg
PNG	13.0 kg
Average	50 kg

Source: adapted from Seidel & Lal (2010)

Income and Expenditure Surveys (HIES) have provided some useful estimates of subsistence catches although, the figures are believed to be lower than actual catches (Gillett 2009a).

Gillett (2009a) has compiled those values together with re-estimations of socioeconomic surveys recently undertaken by Secretariat of the Pacific Community (SPC) under the Pacific Regional Oceanic and Coastal Fisheries Development Programme (PROCFISH) project (www.spc.int). In 2007, total estimates of subsistence catch levels were 110,000 mt, valued at US$200.4 million using market price as shadow value. This contributes 0.6 per cent to regional GDP. Not surprisingly, PNG and Fiji, with large populations, were estimated to produce the highest amount of subsistence production.

On the other hand, subsistence fishing is of the greatest importance in the region in remote coral atoll islands, such as in Tuvalu and Kiribati (Bell et. al 2009). Kiribati's subsistence catches are estimated to be worth US$28.6 million, corresponding to 22.5 per cent of national GDP reference. In 15 of the PICTs, subsistence catch is still greater than coastal commercial fishing (Box 2.1). Catch values range from 100 per cent in Tokelau to 35 per cent in Tonga (see Table 2.6) with an average of 70 per cent retained for home consumption. In most PICTs, a large proportion of subsistence fish is caught by women, using nets who fish close to the coast or glean for invertebrates (Vunisea 1997), thus providing food security for their communities.

Table 2.6 Subsistence fishing in PICTs.

PICT	Catch volume [mt]	Catch value [US$]*	% GDP contribution	% of coastal fishing
American Samoa	120	478,000	0.1%	77%
CNMI	220	631,700	0.1%	49%
Cook Islands	267	1,250,000	0.6%	67%
Fiji	17,400	33,812,500	1.2%	65%
French Polynesia	2,880	13,208,276	0.2%	42%
FSM	9,800	15,732,000	6.7%	78%
Guam	70	217,000	0.0%	61%
Kiribati	13,700	28,571,429	22.5%	66%
Marshall Islands	2,800	4,312,000	2.9%	75%
Nauru	450	661,345	3.1%	69%
New Caledonia	3,500	15,770,115	0.2%	72%
Niue	140	617,647	6.2%	93%
Palau	1,250	2,511,000	1.5%	59%
Pitcairn Islands	7	36,765	n.a.	58%
PNG	30,000	35,472,973	0.6%	84%
Samoa	4,495	14,903,842	2.7%	52%
Solomon Islands	15,000	10,980,392	2.6%	82%
Tokelau	375	711,397	n.a.	100%
Tonga	2,800	6,182,178	2.4%	43%
Tuvalu	989	2,232,686	12.7%	81%
Vanuatu	2,830	5,740,385	1.1%	84%
Wallis & Futuna	840	6,333,333	3.4%	87%
Total	109,933	200,366,961	-	-
Average (country)	4,997	9,107,589	0.6%	71%

Source: adapted from Gillett (2009).
* In 2007 market prices.

Subsistence fishing is also an important part of rural employment, although the number of individuals or households participating in subsistence fishing has not been comprehensively assessed for many countries. One study reported 3,000 individuals taking part in subsistence fishing in Fiji (Hand et. al 2005); this figure seems extremely low given the amount of catch levels and the proximity of Pacific islanders to the coast, given that many of the islands are entirely coastal in nature. Gillett and Lightfoot (2001) reported that 22 per cent of the population in the Cook Islands, and 61 per cent of fishing households in Kiribati engaged in subsistence fishing.

Subsistence fishing is a source of protein and of important dietary value, as well as cultural importance, and is central to the Pacific island way of life. The social and cultural values associated with subsistence fishing are essentially non-market in nature and usually not considered in monetary terms. A limited assessment by the World Bank estimated the protein equivalent value of subsistence fishing to be about US$6.7 million in Fiji, US$18 million in Kiribati, US$13.9 million in the Solomon Islands, and US$14.7 million in Vanuatu (World Bank 2000a).

Tourism

The tourism industry is highly dependent on the quality of the coastal environment, and provides PICTs with an estimated gross revenue of US$1 billion annually (World Bank 1999). A study on the economic impact of tourism in selected PICTs indicates that for every US$1 million of expenditure made by visitors to the region, US$660,000 in local wages/salary payments and other purchases accrue to local economies in the region (Milne 2005). This expenditure will have consequential flow-on impacts on the local economies as tourism provides a source of employment, and a source of livelihoods.

The total regional tourist expenditure in South Pacific Tourism Organisation (SPTO) member countries in 2004 was US$ 1.5 billion, of which 32 per cent was for labour and 38 per cent for materials. There are currently 12 Pacific island member countries and the SPTO has adopted a trading name as ‘South-Pacific Travel’. The potential for generating downstream benefits from coastal tourism-related activities is high, considering the various types of activities that are being promoted, ranging from snorkelling, scuba diving, sports fishing and surfing, to selling locally-made produce, handicrafts, food and beverages. For example, in 2007, the value of Guam’s reefs was estimated at $127.3 million per year, with tourism accounting for approximately 75 per cent of this value ($94.6 million per year), and diving and snorkelling contributing $8.7 million per year (Beukering et. al 2007). Ecotourism is seen in many countries as providing an alternative source of income to extractive activities (Milne 2005).

Other sectors

Maritime culture and tradition in the Pacific are also exhibited through a range of tourism-related skills such as navigational skills, canoe-building, aquatic sports, taboos and totems, all of which are associated with the cultural and social values of the coastal and marine environment.

Coral reefs and mangroves also act as natural protective barriers against strong wave action. McKenzie et. al (2006b) estimated the value of coastal protection supported by coral reefs in the Marshall Islands to be between US$3,000 to US$17,000 per metre.

While coastal areas are the most biologically diverse and economically productive areas which support Pacific island communities, they are also the most vulnerable. The quality and values of coastal environments are under continual threat from a range of underlying socio-economic forces which operate in Pacific societies. These forces and threats are discussed in the following section.

2.3 The state of coastal resources and environments

Assessments of sustainable development, environmental conditions and trends in the region show that despite low economic growth, environmental pressures associated with economic activities and population growth have been unsustainably high. At the same time, the erosion of traditional lifestyles, rapid urbanisation, and a weakening of community-based decision-making processes have negatively affected the sustainability of natural resource use, for example, through impacts associated with waste disposal and land use changes (UNEP 2004).

Most coastal areas in the Pacific are experiencing a decline in coastal resources, even in the most isolated locations. Threats to coastal resources are increasing and pollution of coastal environments has been perceived to be the fastest rising threat to coastal resources (World Bank 1999). Other threats stem from the competing and multiple uses of coastal environments, such as tourism and fisheries or landfill, construction and infrastructural development.

Climate change also poses an additional threat to PICTs through sea-level rise. In addition, the frequency of severe tropical storms and flooding, prolonged periods of drought, bleaching of coral reefs, increasing scarcity of fresh water resources, and a higher incidence of vector-borne diseases is also increasing (ADB 2009a). Increasing salinity of soils and drought, and declining fish stocks pose risk to food security and the livelihoods of coastal communities.

A recent comprehensive study by the US based Center for Ocean Solutions (2009) reviewed scientific literature and impact assessments, relating to the world's oceans, including the Pacific. Their findings support the many regional assessments of the state of the environment (ADB 2009a; Thistlethwait & Votaw 1992). Such impacts are generally described in terms of the following categories, in addition to the climate change:

- Overfishing and exploitation
- Pollution
- Habitat destruction
- Invasive species
- Multiple stressors

Throughout the PICTs, such impacts are common, and their effects are observed in terms of 'common', 'moderate', and 'severe' degrees of threat. There is a large variation in the type and intensity of impacts within a country, as well as between countries. Tables 2.7, 2.8 and 2.9 provide detailed assessments of threats and impacts affecting Micronesia, Melanesia, and Polynesia (Center for Ocean Solutions 2009).

It is apparent from the above discussion that many of the threats and impacts identified cut across several sectors and disciplines, and raise different policy concerns at different levels of governance. Consequently, these issues cannot be dealt with through a sectoral approach alone. A systematic understanding of the relationship and interdependence between these threats and impacts will require the application of an integrated approach to coastal resource management, as discussed in the next chapter.

Table 2.7 Micronesia: threats based on scientific literature and impact assessment.

Identified as Threat ✓
Severe Impact (dark shading)
Moderate Impact (medium shading)
Low Impact (light shading)

	Northern Marianas		FSM		Nauru		Kiribati		Marshall Islands		Palau	
	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impacts
POLLUTION												
Land-based chemicals												
Fishing lines/nets												
Nutrients				Severe			✓	Moderate			✓	Severe
Oil spills & antifouling chemicals	✓	Low	✓	Moderate		Low	✓	Low	✓	Low	✓	Low
Radionuclide									✓	Severe		
Solid waste disposal			✓	Severe							✓	Moderate
Thermal												
Ocean waste & toxic dumping			✓	Moderate					✓	Moderate		
HABITAT DESTRUCTION												
Anchor damage	✓	Moderate									✓	Low
Aquaculture: coastal modification												
Coastal development/land reclamation	✓	Moderate		Moderate							✓	Moderate
Destruction fishing			✓	Moderate							✓	Moderate
Dredging			✓	Moderate	✓	Moderate					✓	Low
Marine recreation												
Land-based sedimentation			✓	Severe							✓	Severe
Ship groundings			✓	Low							✓	Low
Typhoons, cyclones/hurricanes & storm surge	✓	Severe	✓	Severe							✓	Severe
Wrecks/military equipment	✓	Moderate	✓	Low								
OVERFISHING & EXPLOITATION												
Aquaria trade									✓	Moderate	✓	Low
Artisanal/recreational/subsistence fishing			✓	Severe			✓	Moderate	✓	Moderate		Severe
Commercial fishing	✓	Severe	✓	Severe			✓	Moderate	✓	Severe		Severe
CLIMATE CHANGE												
Sea-level rise	✓	Moderate	✓	Severe		Moderate	✓	Severe	✓	Severe		
Sea surface temperature	✓	Severe					✓	Severe	✓	Severe	✓	Severe
INVASIVES												
Invasive species (different vectors)	✓	Moderate									✓	Low

Source: adapted from Center for Ocean Solutions (2010).

Table 2.8 Melanesia: threats based on scientific literature and impact assessment.

Identified as Threat ✓ Severe Impact (dark shading) Moderate Impact (medium shading) Low Impact (light shading)	Fiji		New Caledonia		Papua New Guinea		Solomon Islands		Vanuatu	
	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact
POLLUTION										
Aquaculture wastewater	✓	Low	✓	Moderate		Moderate				
Land-based chemicals	✓	Moderate	✓	Moderate						
Fishing lines/nets	✓				✓	Moderate				
Nutrients	✓	Moderate	✓	Severe		Low				
Offshore oil/mining					✓	Moderate				
Oil spills & antifouling chemicals	✓	Moderate	✓	Moderate			✓	Moderate	✓	Low
Radionuclide					✓	Severe				
Solid waste disposal	✓	Moderate								
Thermal										
Ocean waste & toxic dumping	✓	Moderate	✓	Moderate					✓	Low
HABITAT DESTRUCTION										
Anchor damage										
Aquaculture: coastal modification			✓	Moderate						
Coastal development/land reclamation	✓	Severe	✓	Severe		Moderate				
Destruction fishing	✓	Low					✓	Moderate		
Dredging										
Marine recreation	✓	Low			✓	Severe				
Land-based sedimentation	✓	Moderate	✓	Moderate			✓	Severe		Moderate
Ship groundings										
Tsunamis			✓	Severe	✓	Moderate				
Typhoons, cyclones/hurricanes & storm surge			✓	Severe					✓	Moderate
Wrecks/military equipment					✓	Moderate				
OVERFISHING & EXPLOITATION										
Aquaria trade	✓	Moderate					✓	Moderate	✓	Low
Artisanal/recreational/subsistence fishing	✓	Severe	✓	Moderate		Severe			✓	Moderate
By-catch & discharge							✓	Moderate		
Commercial fishing		Severe	✓	Moderate	✓	Severe		Severe	✓	Moderate
CLIMATE CHANGE										
Acidification										
Sea-level rise	✓	Moderate					✓	Moderate	✓	Moderate
Sea surface temperature	✓	Severe	✓	Severe		Low			✓	Moderate
INVASIVES										
Invasive species (different vectors)									✓	Moderate

Source: adapted from Ocean Solutions (2009).

Table 2.9 Polynesia: threats based on scientific literature and impact assessment.

Identified as Threat ✓
Severe Impact (dark shading)
Moderate Impact (medium shading)
Low Impact (light shading)

	American Samoa		Cook Islands		French Polynesia		Niue		Samoa		Tokelau		Tonga		Tuvalu	
	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact	Threats	Impact
POLLUTION																
Aquaculture wastewater			✓	Low	✓	Moderate										
Land-based chemicals	✓	Severe			✓	Moderate										
Fishing lines/nets																
Nutrients	✓	Severe	✓	Moderate		Severe										
Offshore oil/mining																
Oil spills & antifouling chemicals	✓	Moderate	✓	Low		Moderate	✓	Low			✓	Low		Low		
Radionuclide					✓	Moderate										
Solid waste disposal			✓	Low												
Thermal															✓	Low
Ocean waste & toxic dumping	✓	Severe			✓	Moderate									✓	Severe
HABITAT DESTRUCTION																
Anchor damage																
Aquaculture: coastal modification					✓	Moderate										
Coastal development/land reclamation	✓	Severe	✓	Moderate		Severe					✓	Severe	✓	Severe		
Destruction fishing									✓	Moderate						
Dredging													✓	Low		
Marine recreation																
Land-based sedimentation	✓	Low	✓	Low		Moderate										
Ship groundings																
Tsunamis					✓	Severe										
Typhoons, cyclones/hurricanes & storm surge		Low			✓	Severe	✓	Moderate							✓	Severe
Wrecks/military equipment																
OVERFISHING & EXPLOITATION																
Aquaria trade													✓	Moderate		
Artisanal/recreational/subsistence fishing	✓	Low	✓	Low		Moderate				Severe			✓	Low		Severe
By-catch & discharge	✓	Low														
Commercial fishing	✓	Low			✓	Moderate							✓	Low		
CLIMATE CHANGE																
Acidification	✓	Low											✓	Severe	✓	Severe
Sea-level rise	✓	Low	✓	Severe						Moderate	✓	Severe				
Sea surface temperature	✓	Low	✓	Low		Severe				Moderate						
INVASIVES																
Invasive species (different vectors)	✓	Low														

Source: adapted from Ocean Solutions (2009).

CHAPTER 3

An Analytical Framework for Understanding the State of Coastal Resources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Coastal protection using wire mesh observed in places like Namatakula Village on the Coral Coast in Fiji.

For some decades, PICTs have expressed concerns about the threats discussed in Chapter 2 and the deterioration in the status of coastal environments and associated ecosystems and resources. Starting with the National State of Environment Reports and National Environment Management Strategy reports of the 1980s and early 1990s, a number of studies have described threats and pressures affecting Pacific island environments and communities, including impacts on key habitats such as mangroves, coral reefs, and seagrass beds. These reports were synthesised into The Pacific Way report as the lead up to, and response to, the United Nations Conference on Environment and Development (UNCED) in 1992 (SPREP 1992).

The Pacific Way reflected the collective environmental concerns of PICTs. Although progress has been made in tackling some environmental problems, many of the original concerns still remain valid. In addition, new problems and issues have emerged since the production of the 'Pacific Way' as highlighted in the Pacific islands submission to the World Summit on Sustainable Development in Mauritius in 2002, and more recently in the background papers prepared for the Pacific Plan (PIFS 2004; 2005).

A range of social, technological, economical, environmental and political/institutional forces can affect the continued functioning and status of coastal ecosystems. Some of these forces are summarised in Table 3.1 below. The forces act at different levels, with different degrees of influence determined by the nature and the dynamics of underlying ecological and social processes.

Table 3.1 Factors influencing biophysical processes in catchment environments.

Type	Examples
Social/cultural	• Demographic trends in surroundings areas • Changes in socio-cultural orders, value systems, as well as social capital, i.e. changes in networks and community values
Technological	• Changes in recreational and commercial fishing technology leading to greater efficiency and catchability • Changes to recreational technology (e.g. jet-skis) • Improved access, by either improved access roads or greater numbers of off-terrain vehicles
Economic	• Changing use-values such as an expanding recreational sector, increasing tourism (domestic and international) • Decline in commercial harvesting due to, for example, competition from imports • Changes in input prices • Changes in non-use values, i.e. existence and option values • Resource constraints, including available expertise
Environmental	• Climate change • Extreme climatic events (e.g. storms and floods) • Anthropogenic environmental factors such as point source and non-point source pollution in upstream catchments
Political/institutional	• Changes to national fisheries management and marine biodiversity policies • Changing social and economic objectives of agencies and government (e.g. ecologically sustainable development) • Unexpected legal developments • Restructuring of managerial institutions

Source: Conner (2009).

The purpose of this chapter is to examine the broader drivers of change in Pacific society and to discuss how these drivers put increasing pressure on coastal resources and environments. The chapter also considers how the ecological processes impact on human activities and also how effects of human action on these ecological processes are experienced. An integrated DPSIR-EBM framework for the Pacific is discussed after describing these pressures in turn.

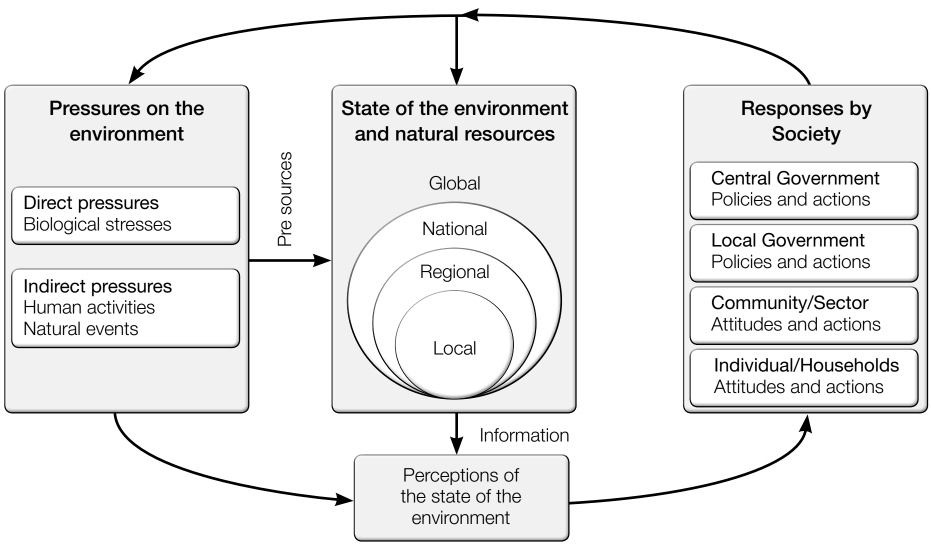
3.1 Drivers-Pressure-State-Impact-Response conceptual framework

The Drivers-Pressure-State-Impact-Response (DPSIR), at times also referred to as Driving Forces-Pressure-State-Impact-Response, framework can be used to map and illustrate causal and indirect interrelationships between a wide range of socio-economic, institutional, demographic, environmental, and cultural trends and influences, and potential responses to these trends and influences and their impacts; see, for example (Fehling 2009; Kuldna et. al 2009; Mateus & Campuzano 2008; Turner et. al 2000).

The key components of the DPSIR framework in the context of coastal zone are:

- Drivers: changes in large-scale socio-economic conditions and sectoral trends, such as large-scale changes to human population dynamics, globalisation, urbanisation, and development in the industrial sectors in the coastal zone
- Pressures: processes and mechanisms provoking changes in the natural environment, such as coastal construction, altering coastal wetlands or the introduction of agricultural contaminants and nutrients into the coastal watershed
- State: environmental or ecological changes as a result of the imposed pressures, generally illustrated using a set of readily determined parameters or environmental quality indicators. Examples include enhanced sedimentation in lagoons, decline in the biodiversity of salt marshes, and saline intrusion into groundwater
- Impacts: measurable changes in social and economic benefits and values, resulting from environmental changes, such as decline in coastal fisheries due to sedimentation, decline in property values, resulting from coastal erosion, and loss in agricultural income from salinisation of soils
- Responses: changes in policy and management practices to mitigate the socio-economic impacts of environmental degradation, such as better management of wastewater treatment, and improved agricultural practices. Two examples of use of the DPSIR frameworks are illustrated in Figures 3.1 and 3.2. While essentially following the same path, there are several interpretations of the DPSIR framework. For example, The Organisation for the European Co-operation and Development (OECD) 'model' (quoted in New Zealand Ministry for the Environment 2011) explicitly emphasises the importance of perceptions of the state of the environment in influencing responses to undesirable changes (Figure 3.1) .

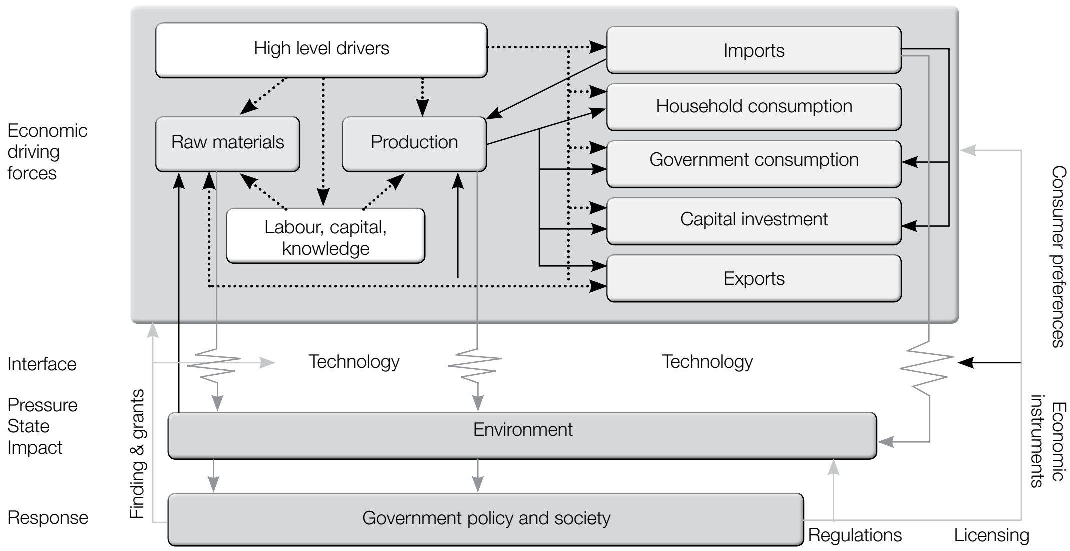
Figure 3.1 OECD pressure-state-response framework.



Source: New Zealand Ministry for the Environment (2011).

The OECD model conceptualises that biological stresses and human activities exert pressures on the environment, changing the quality and quantity of natural resources. These changes alter the state, or condition of the environment. The human responses to these changes include any organised behaviour which aims to reduce, prevent, or mitigate undesirable changes. Figure 3.1 shows the relationships between the state of the environment, pressures on the environment, perceptions of the state of the environment and responses by society to those perceptions.

Figure 3.2 Drivers-pressure-state-impact response framework used in NSW.



Source: Department of Environment, Climate Change and Water, NSW (2009).
http://www.environment.nsw.gov.au/soe/soe2009/chapter1/

The New South Wales Department of Environment, Climate Change and Water (DECCW) has applied a similar drivers-pressure-state-impact-response framework to consider interrelationships at various levels (see Figure 3.2). It notes that each stage of economic activity is affected by high-level drivers which in a developed country, such as Australia, include population demographics, incomes, interest rates, exchange rates, prices and technology. The effects of such drivers are manifested through each stage of economic activity (the solid lines in Figure 3.2).

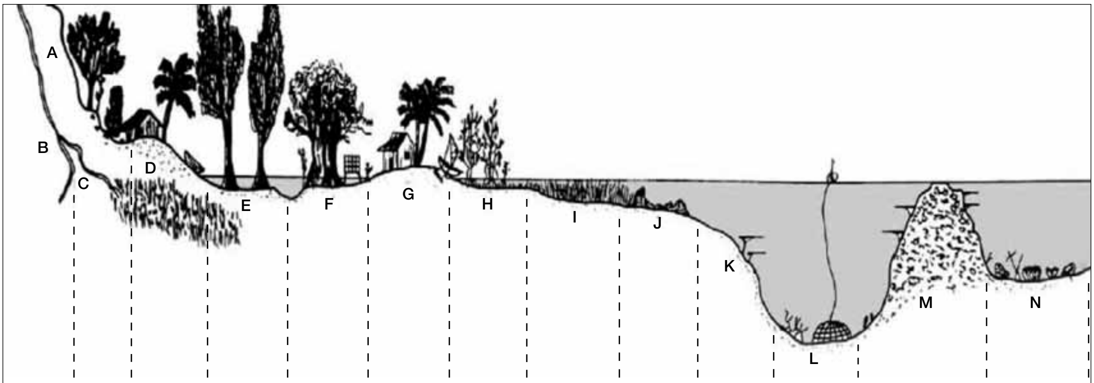
For example, population growth would put pressure on raw materials, which are used as an input in production, and imports may be used in production or consumed directly by households. Each stage of economic activity affects the environment through the technology pressure-state-impact relationship (the solid lines). There are also other influences of one component on another (the dotted lines). For example, technology can influence the capital available to firms to produce output, while interest rates can influence the level of investment in the economy. The level of demand for the end uses of production also influences future raw material extraction and production. Therefore, there are interrelationships between all stages of economic activity.

As discussed in the next chapter, most communities in the Pacific are undergoing significant transformational changes brought about by major drivers such as monetisation, globalisation, and urbanisation.

3.2 Ecosystem-Based Management framework

An Ecosystem-Based Management framework attempts to recognise key underlying ecological processes that influence and determine the spatial and temporal effects of human activities, manifested through physical process, as well as ecological food web relationships (see Figure 3.3).

Figure 3.3 Ecological connectivity from 'Ridge-to Reef' through physical and ecological forces.



A: High Island; **B**: Slopes; **C**: Estuary; **D:** Coastal flats; **E**: Tidal swamp; **F**: Closed mangroves; **G**: Coral strand; **H**: Open mangroves; **I**: Seagrass; **J**: Fringing reefs; **K-L**: Different parts of lagoon; **M**: Reef; **N**: Outer reef

Source: Carpenter and Maragos (1989) and Chape (2006).

For example, deforestation uphill ('A' in Figure 3.3), combined with precipitation, generates silt dislodgement which travels downstream (from 'B' to 'L') and can be deposited along the way in estuaries, seagrass beds and coral reefs, causing high turbidity, affecting productivity and resulting in habitat destruction. Such environmental changes are then experienced throughout the food chain, resulting in a decline in coastal fisheries (King et. al 2003; Kronen et. al 2006).

Use of an Ecosystem-Based Management (EBM) framework involves understanding the dynamics of, and interactions between, resources/environments, markets, and society in identifying and designing management responses. This approach emphasises the spatial and ecological connectivity of an area, and shows how activities in one area can affect the status of resources and the environment elsewhere, for example how upstream activities can affect downstream environments, including coastal ecosystems. The application of EBM framework has been used to demonstrate how coastal stresses can have effects on things that are directly in the influence or control of coastal managers (Wilkinson & Brodie 2011). The EBM framework considers the biological and ecological dynamics of species and resources targeted by humans, and how these dynamics affect other species through trophic relationships in an environment. The EBM framework also takes account of market forces, as well as benefits associated with many environmental goods and services for which there are no observable market values (see Box 3.1).

Over the last twenty years or so, a number of studies have specifically assessed the effects of various types of drivers on coastal environments. Land use changes, urbanisation, and coastal developments represent some of the most crucial threats to the extremely fragile coastal environments of Pacific islands. These studies include 'Voices from the Village' World Bank (1999), country specific reports under SPREP's International Waters Project, such as Lal et. al (2007); Fisk (2007); Bakineti (2005); research under the Coral Reef Initiative for the South Pacific (CRISP) such as, (Guilbeaux et. al 2008); (Buliruarua & Fenemor 2010) and studies and technical reports by South Pacific Applied Geoscience Commission (SOPAC) such as (Holland 2008) and (ADB 2004). Such threats can be understood from an ecological perspective (Figure 3.3).

An EBM framework can help to systematically identify and, amongst other things, analyse drivers and causes of observed resource and environment status, as well as identify and assess alternative management strategies at national, regional and local levels. However, EBM places a greater emphasis on ecosystems and ecosystem-functioning. Given their importance, the principles of EBM have been adopted in various regional policies, frameworks for action, and/or plans already endorsed by regional bodies; for example in the Pacific Islands Regional Ocean Policy [PIROP], by SPREP (2005) and in fisheries Ecosystem-Based Management (Fletcher 2006; Preston 2009).

Box 3.1
Ecosystem-Based Management

EBM is a process that integrates biological, social, and economic factors into a comprehensive strategy aimed at protecting and enhancing sustainability, diversity, and productivity of natural resources. The Ecological Society of America has identified eight key elements of the EBM.

Core elements

1. Sustainability: Ecosystem management does not focus primarily on deliverables, but rather regards intergenerational sustainability as a precondition.
2. Goals: Ecosystem management establishes measurable goals that specify future processes and outcomes necessary for sustainability.
3. Sound ecological models and understanding: Ecosystem management relies on research performed at all levels of the ecological organization.
4. Complex and connectedness: Ecosystem management recognizes that biological diversity and structural complexity strengthen ecosystems against disturbance and supply the genetic resources necessary to adapt to long-term change.
5. The dynamic character of ecosystems: Recognizing that change and evolution are inherent in ecosystem sustainability, ecosystem management avoids attempts to freeze ecosystems in a particular state of configuration.
6. Context and scale: Ecosystem processes operate over a wide range of spatial and temporal scales, and their behaviour at any given location is greatly affected by surrounding systems. Thus, there is no single appropriate scale or timeframe for management.
7. Humans as ecosystem components: Ecosystem management values the active role of humans in achieving sustainable management goals.
8. Adaptability and accountability: Ecosystem management acknowledges that current knowledge and paradigms of ecosystem functions are provisional, incomplete and subject to change. Management approaches must be viewed as hypotheses to be tested by research and monitoring programmes.

Source: Ecological Society of America 2005 'Principles of Ecosystem-Based Management' and 'Overview of Ecosystem-Based Management' http://www.michigan.gov/dnr Accessed 30 October 2005.

Protecting marine biodiversity through MPAs in the Phoenix Islands in Kiribati.

3.3 An integrated DPSIR-EBM analytical framework

A combined DPSIR-EBM approach provides a rich analytical framework to analyse the broad drivers, interrelationships, and effects of ecological, social and economic forces, and interactions within a market economy. Possible high-level policy responses to these drivers and forces can be examined, using this combined framework. As discussed in Chapter 4, the DPSIR framework can be used to understand the effects of recent changes in Pacific communities, such as the effects of monetisation of the economy and changes in lifestyles and values which can be seen to create new pressures on coastal zone environments. Many of these changes result in incentives which focus on maximising individual wealth creation and accumulation in a market economy, or by securing livelihood resources through strengthening the ‘capital’ base which, as seen in Chapter 5, unleashes other forces that cause major resource and environmental problems.

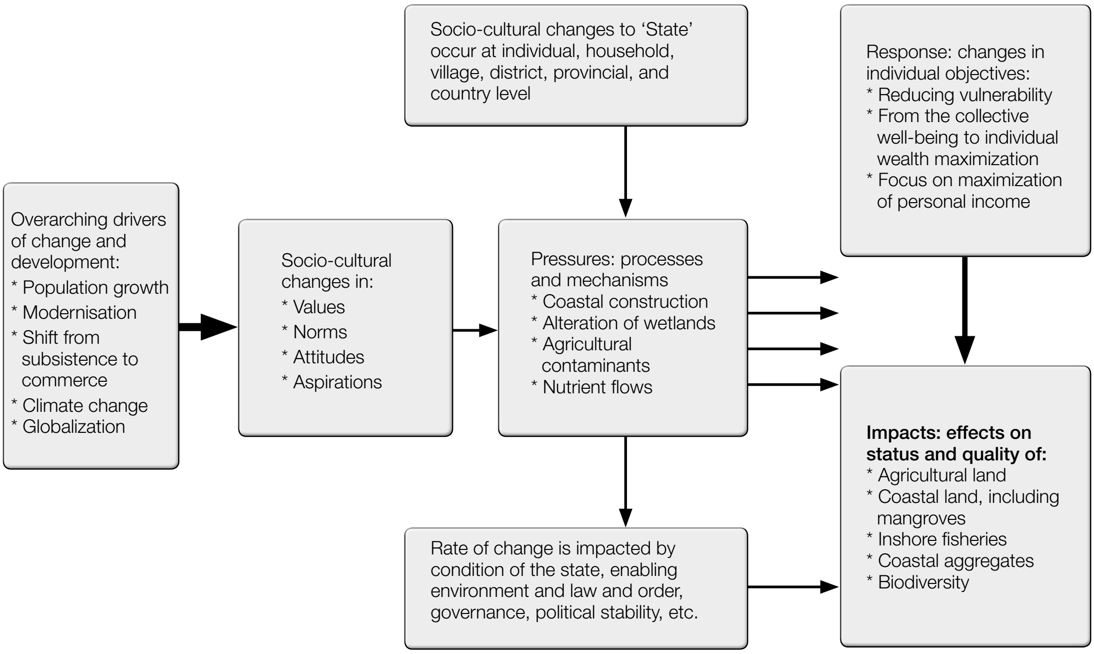
Kronen et al (2010) argue that the key driver for change in coastal fisheries is the degree of accessibility to alternative livelihoods. This can be conceptualised at the household level within the Sustainable Livelihoods Framework (SFL). The three key dimensions of SLF are livelihood assets, the vulnerability context and techniques and strategies for intervention. By building assets, individuals and households develop the capacity to cope with challenges they encounter in attempting to meet their needs. These assets consist of human, natural, financial, physical and social capital to improve individual and community well-being. The factors that contribute to poverty and changing individual circumstances are therefore, affected by broader contexts seen as ‘shocks’ that are external to the household.

This approach has become prominent in recent development programmes that aim to reduce poverty and vulnerability in communities engaged in small scale industrial production, agriculture and fisheries. Agencies have given different degrees of emphasis to the different components but the principles, components and interrelationships between the components are essentially the same. For example, UNDP considers it as Sustainable Human Development Framework, FAO considers it as people-centred development, while the UK Department for International Development (DFID) has labelled it as the Sustainable Livelihoods Framework. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets, both now and in the future (Department for International Development 1999). These mirror the drivers, pressure and state context discussed earlier under the DPSIR framework. The techniques and strategies for interventions are therefore, seen as responses under the DPSIR framework.

A livelihood is sustainable if people are able to maintain or improve their standard of living related to well-being and income or other human development goals, reduce their vulnerability to external shocks and trends and ensure their activities are compatible with maintaining the natural resource base (Allison & Horemans 2006). Maintenance of natural resources becomes an integral part of the Sustainable Livelihoods Approach and achieving its goals in an effective and efficient way can be argued to be embedded in the DPSIR-EBM framework.

Figure 3.4 illustrates the influence of overall broad drivers, and the pressure placed on the socio-cultural, political, and natural coastal environmental factors. Therefore, addressing coastal environmental problems requires a broader understanding of these drivers and pressures, and their impacts on the state of Pacific island coastal environments. This understanding can then help in critical evaluation of the policy response and in determining its adequacy.

Figure 3.4 Drivers, pressures, state, impacts and response framework for the Pacific.



Source: Adapted from Jones & Holzknecht (2007).

CHAPTER 4

Key Drivers and Pressures on Coastal Resources in the Pacific

©Sailesh Sen

Influence of globalisation symbolised by container ships at the Suva Wharf, Fiji.

Pacific Island Countries (PICs) are exposed to many broad changes in their societies, brought about by forces not only within the domestic boundaries, but also globally. Monetisation, globalisation, population growth, and urbanisation are major drivers of recent development experiences in the Pacific islands. Such drivers place considerable pressure on Pacific societies, both in terms of pressures on already scarce natural resources, but also in changes to the socio-cultural order. These pressures and changes are expected to be compounded by the effects of climate change on all sectors and all aspects of life, particularly in coastal areas, manifested through ecological, social and economic connections in society.

4.1 Key drivers: monetisation, urbanisation and population growth

PICTs have experienced major economic transformations since colonisation and as part of the process of modernisation. Countries have changed from subsistence economies based on barter systems to market-based economies subject to market forces (albeit in many cases operating under imperfect conditions). This gradual transition to market-based economies has been accompanied by greater integration into global economic systems, reflected in changes in trade patterns, communications and labour mobility. Such changes mean that countries are now subject to greater external forces of influence on their traditional social and cultural structures.

Monetisation and globalisation

Increased monetisation of local economies and a growing focus on increasing individual wealth are seen as key changes to the underlying social-cultural order, and are weakening traditional social systems of control (Jones & Holzknecht 2007). The reduced influence of kin group and extended family socio-economic structures may mean that traditional institutions are increasingly unable to deal with current resource management issues.

These factors may lead to social conflicts amongst community members by encouraging different and competing interests. For example, some members of a community may support tourism development while other groups may support commercial fisheries or conversion of coastal land for industrial development. Such conflicting interests create uncertainty, and encourage communities to take risks to meet their short-term needs, rather than focusing on longer-term strategic objectives such as sustainable resource use.

As people become dependent on access to cash e.g. for imported goods, school fees or health expenses, there is greater pressure to (over) harvest food resources for sale, rather than to harvest food for direct household consumption. The income obtained from sales of produce may be spent on buying cheaper food with lower nutritional quality. Increased dependence on purchased, less nutritious food can lead to lifestyle changes, loss of self-sufficient food production and traditional knowledge attached to self-reliant strategies, increased nutritional vulnerability, and increased incidence of poor health and communicable diseases. Declining self-reliance, combined with lack of alternative income sources has also led to an increase in poverty levels.

In some Pacific island countries, the loss of traditional resource management systems and weak centralised management and control of coastal resources has led to depletion of resources and degradation of ecosystems, as observed in Tarawa (Kiribati), Funafuti (Tuvalu) and Tonga. Some centralised coastal management systems have had only limited success, or failed due to poor monitoring and enforcement. Often, governments do not have adequate resources or capability to carry out the enforcement and monitoring activities needed to limit the otherwise unmanaged pressures on fish stocks and other coastal resources and environments. Over time, poor management approaches further contribute to resource depletion and ecosystem degradation.

Population growth

The population of PICTs was estimated to be around 10 million at June 2011.[1] The region has been growing at a rate of around two per cent per annum since 2000 (SPC 2007), but with large variability from country to country.[2] Population growth rates have increased strongly in Melanesia and some Micronesian countries, while in Polynesia they have only grown marginally. In some Polynesian countries, such as Niue, the population has declined because of out-migration. In contrast to other Melanesian counties, Fiji has had a low growth rate. If current trends continue, the population of the Pacific region will double in 40 years, placing further demand on land, as well as services and infrastructure (SPC 2007). Given such population increases, there will be greater pressures on the limited natural resources such as land, fisheries, and other natural endowments, either through direct increases in effort, or indirectly through increased demand for the goods and services obtained from coastal environments. Population indicators for selected PICTs are shown in Table 4.1.

Table 4.1 PIC key population indicators – Pacific Islands Forum (PIF) member countries.

Sub Region and PIC	Year of Last Census	Population Estimate 2006	Population Estimate 2010	Population Estimate 2015	Population 15 & under 2007	Annual Population Growth Rate
Melanesia						
PNG	2000	6,167,108	6,741,000	7,461,903	49%	2.7
Solomon Islands	1999	487,237	535,661	694,543	50%	2.8
Vanuatu	1999	221,417	245,241	278,059	50%	2.6
Fiji Islands	1996	775,077	854,921	891,729	43%	0.8
Polynesia						
Cook Islands	2001	13,572	12,549	11,543	41%	-3.7
Niue	2001	1,591	1,448	1,307	36%	-3.8
Tonga	1996	99,298	100,530	102,834	49%	0.3
Samoa	2001	185,234	191,492	199,537	52%	0.9
Tuvalu	2002	9,652	9,687	9,681	44%	0.5
Micronesia						
Kiribati	2005	93,705	100,915	110,499,	47%	1.8
Marshall Islands	1999	55,981	58,291	60,149	53%	1.5
FSM	2000	110,210	112,814	116,071	50%	0.2
Nauru	2002	10,131	10,257	10,585	48%	0.3
Palau	2000	20,044	20,483	21,027	31%	0.8

Source: SPC (2007).

Urbanisation

Urbanisation is a driver of change, putting pressure on resources, as well as influencing attitudes and values. In 2006, some 24 per cent of the Pacific island population was living in towns and cities (Haberkorn 2006). As noted by Haberkorn and Lal (2007), the Pacific urban-based population represents 46 per cent of the total population in the region (excluding PNG which holds two thirds [6.2 million persons] of the Pacific island population. It should be noted that some 13 per cent of the PNG population [804,000 people] is urban, which is more than the entire population of Polynesia [650,000], or Micronesia [540,000]). Almost three quarters of the PICs have over 30 per cent of their census population living in urban areas and increasing rapidly through urban-rural migration (Jones & Holzknecht 2007). Urban growth rates in many PICTs are much higher than national population growth rates. For example in Tonga, urban growth is nine times higher than national population growth because of internal migration from Ha'apai and the Vava'u

[1] http//:www.spc.int/sdp/

[2] See Haberkorn, G. 'Pacific Urbanisation Stocktake' 2006

Islands to Tongatapu (Thistlethwait & Votow 1992). Similarly, population pressure is higher in the urban centres of atoll islands, such as Tarawa and Majuro, increasing already significant pressures on the limited coastal resources.

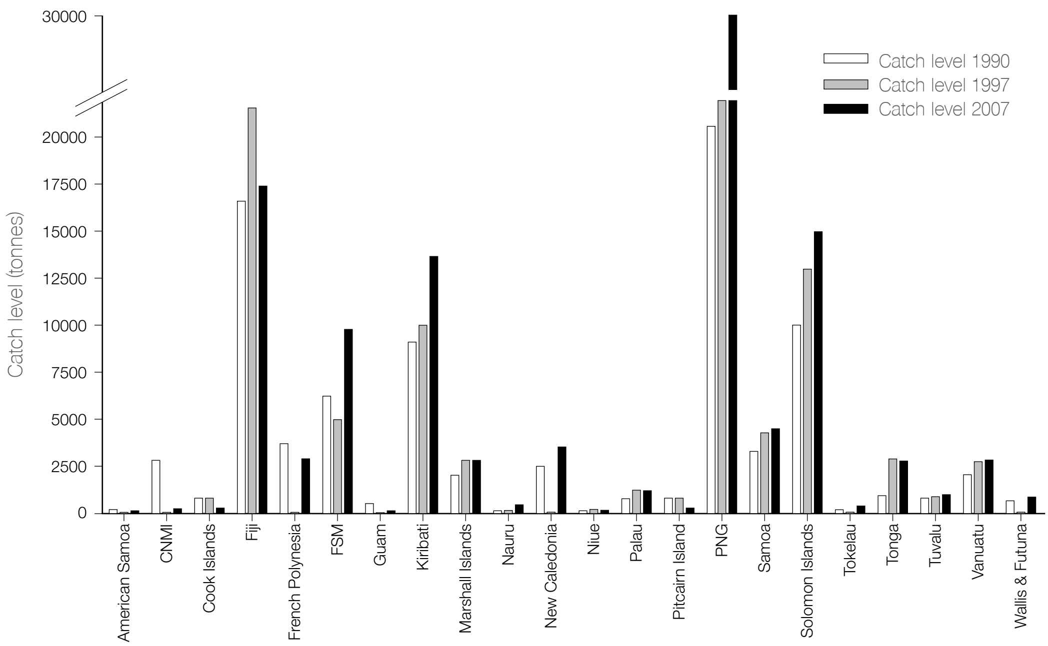
4.2 Pressures

The combined effects of population growth, globalisation and monetization are changing ways of life in the Pacific, with multi-dimensional impacts which are affecting the use and management of natural resources, such as fisheries, forestry and agriculture (see Tables 2.7 to 2.9).

The introduction of the cash economy and increasing globalisation as mentioned earlier, have led to an increasing demand for money. The need for money to meet the basic needs of the families, such as school fees, uniforms and medical expenses, has encouraged families to look for opportunities to earn cash income. Further, where there are rights to coastal resources, people have turned to commercial fishing. In recent years, there has been a major shift from subsistence to commercial fishing, as seen by the increase in recorded catches throughout the Pacific.

In some regions, a higher proportion of the catch is already being sold, rather than consumed locally. In the early 1990s, 80 per cent of the total coastal catches in the Pacific were retained for subsistence consumption; i.e. approximately 84,000 mt, was caught for subsistence purposes at an estimated value of US$180 million (Dalzell et. al 1996). Some 15 years later, only 60 per cent of catches were retained for home consumption (Gillett 2009a). Figure 4.1 illustrates the changes in subsistence yield in some Pacific island countries over a 17-year period.

Figure 4.1 Changes in subsistence catch levels between 1990 and 2007.



Source: Data based on Gillett & Lightfoot (2001); Gillett (2009) quoted in Seidel & Lal (2010).

The transition from subsistence to commercial catch is more pronounced in urban areas close to market outlets, whereas in rural areas non-market-based subsistence fishing prevails (Kronen et. al 2006). Access to modern fishing equipment and motorised fibreglass boats have also increased catches and contributed to increased pressure on stocks via local overfishing (e.g. Newton et. al 2007).

N.B. overharvesting of fisheries resources is discussed in Chapter 6.

Rapid growth in urban populations has led to a decline in coastal resources through destruction of coastal habitats, such as mangrove ecosystems, coral reefs and seagrass beds, and through improper disposal of sewage and other solid waste, and industrial discharges. Land reclamation, and increases in deforestation to accommodate new settlements and industrial activities have led to increased sedimentation from construction activities. Population pressure has often led to improper land-use practices and over-exploitation of fisheries resources, resulting in overall degradation of coastal environments, and loss of biodiversity. In the case of agriculture, for example, a focus on cash cropping had resulted in more intensive cultivation, and mono-cropping on already scarce land. Crop production often expands on to marginal lands that are susceptible to erosion. Land degradation also occurs due to loss of forest cover and continuous use of pesticides and fertilizers that ultimately lead to pollution and sedimentation. The key impacts on coastal fisheries, i.e. pollution, and habitat destruction, are discussed in Chapters 7 and 8.

Invasive species

One negative effect of globalisation is the introduction of invasive species via the movement of people and cargo. With changing lifestyles and increasing consumerism, Pacific islanders are becoming and have become heavily reliant on imports for their material goods. Furthermore, globalisation is encouraging a large movement of Pacific islanders between islands and metropolitan counties. With such movement of people and cargo, together with the development of international tourism, some Pacific islands have experienced the introduction of invasive species. Invasive species can belong to any group of flora and fauna, and include plants, mammals (e.g. rats, mongooses), insects (e.g. ants, mosquitoes), molluscs (snails) and diseases agents, and can be invasive in aquatic, marine and terrestrial environments, affecting local biodiversity. Invasive vines can smother forest canopies, reducing the production of flowers and fruits that fruit bats and native birds depend on, and cause heavy losses in commercial forestry plantations.

The Pacific region is one of the world's centres of biological diversity. The western Pacific has the highest marine diversity in the world, with up to 3,000 different species possibly existing on a single reef (Tuaopepe 2005). The evolution of island biogeography has led to high endemism in terrestrial species, particularly on larger islands, while some smaller islands have extremely low diversity and little or no endemism. However, such islands have a high rate of species endangerment and are particularly vulnerable to the impact of introduced species. Invasive alien species are the principal cause of extinctions of native biodiversity on land and pose the greatest threat to remaining terrestrial biodiversity in the Pacific. In some cases, some species were introduced deliberately for home aquariums and gardens, agriculture and/or aquaculture and have spread to the islands' ecosystems, causing significant damage (Center for Ocean Solutions 2009).

The 2009 Ocean Solutions study states that marine invasives were identified as being severe threats in at least 18 locations. These invasive species can adversely affect the habitats they invade, ecologically and economically, and can alter the functions of entire ecosystems (Center for Ocean Solutions 2009). For example, after World War II, brown tree snakes were introduced to Guam's forests, leading to a decline in Guam's native bird population. The snakes climb across electricity supply wires as they hunt for birds, and can cause costly power outrages (SPREP 2010).

Invasive species have negative impacts on the resources people rely upon for their livelihoods, i.e. food, clean water and shelter. Some invasive species can damage buildings and bridges and other structures, or can reduce the tourist potential of an area by damaging the environment and other attractions (SPREP 2010). A recent example of invasive species in Fiji is given in Box 4.1. The example clearly demonstrates how untreated timber used in storage of goods imported from overseas has led to a major disaster with loss of homes and crops, and temporary displacement of people. The Fiji government has sought outside technical assistance to eradicate this termite infestation; however the costs of eradication are likely to be far greater than initially anticipated.

Box 4.1
Termite infestation in Lautoka, Fiji - homes eaten

A termite outbreak in Lautoka has forced at least one family to abandon their home and several others to constantly repair their homes to prevent them from collapsing. For the past two years, residents of Tavakubu have been plagued by termite infestations and have spent thousands of dollars to repair damaged wooden frames eaten by the termites.

Residents said the termites now feed on cassava and the roots of coconut trees. Acting Quarantine Department director Ilaitia Boa said the team assigned to look into the case had sent termite samples to Australia. “It’s an exotic species, and is new to Fiji. We don’t know much about it, and the results from Australia will help us determine more details of the termite and how it can be controlled,” he said. A government survey identified 74 infested houses; however, residents believe this has increased to 90.

Source: The Fiji Times, April 12, 2010.

4.3 Multiple stressors

The effects of the combination of the underlying drivers of change and the pressures they create on coastal resources as shown in Figure 4.2 can be serious. Populations of ecologically and economically important species can collapse when marine life is subjected to multiple stressors, including pollution, habitat destruction, overfishing and climate change.

With growing populations, increasing need for cash incomes and changing consumption patterns have, as discussed above, led to more intensive cultivation of land for food and industrial crop production. More intensive cultivation has involved conversion of wetlands and forests to agricultural production and pollution of water resources from agrochemical runoff. Coastal development activities, such as building structures, dredging, reclamation and mining can significantly affect the ecology and resources of the coastal zone and the functioning of coastal processes. For example, development activities in beach areas can change patterns of sediment transport or alter inshore current systems; and reclamation for agriculture or industrial development can affect the functioning of wetlands through reduced freshwater inflows, and through changes in water circulation. Similarly, industrial development in coastal areas can decrease the biological productivity of wetlands through the effects of industrial pollutants, including heavy metals and by changing water circulation and temperature patterns.

Removal of mangrove forests to create housing and areas for infrastructure can change the biophysical functions of mangrove ecosystems, which provide buffers for storm impact and provide nursery habitats for juvenile fish. Dredging for port infrastructure development also damages coral reefs. Land uses in upland areas and in land adjacent to the coast used for timber harvesting, crop production and animal husbandry can also affect coastal environments through generating increasing sediment, pesticides and pollution levels which affect river systems and estuaries. Such changes also create conditions for increased vulnerability to natural disasters. Since all PICTs have limited capacity to cope with natural disasters, this vulnerability will be further exacerbated by climate change.

Different uses of coastal environments, such as commercial fishing, tourism or aggregate mining may also conflict with, or adversely affect one another. Two major types of conflicts related to coastal resources include: (i) conflicts among users over the use or non-use of particular coastal areas; and (ii) conflicts between government agencies administering programmes, relating to coastal areas. Users can be direct, actual users (such as fishers or beach miners) and indirect or potential users (such as environmental groups, communities living in other areas, and future generations). Some obvious conflicts among users involve: (i) competition for coastal space; (ii) adverse effects of one use upon another; (iii) adverse effects on ecosystems; and (iv) effects on onshore systems through, for example, competition for land for settlements and industries (Miles 1991).

Conflicts also occur among government agencies that administer activities in coastal areas, including interagency conflicts [among agencies at the same level of government, whether national, provincial or local]and intergovernmental conflicts [among different levels of government] (Cicin-Sain & Knecht 1998). A variety of reasons underpin these conflicts, such as lack of information and communication, different legal mandates, differences in training or personnel and differences in social and cultural value systems.

4.4 Climate Change

There is increasing concern in Pacific islands about the impacts of climate change as a major driver which will affect all spectrums of lives in a country. PICTs are concerned about the increased frequency and or intensity of extreme weather events due to global climate change, longer periods of drought and heavier rainfall and flooding (IPCC 2007). Such effects are expected to cause greater economic hardship, increase the incidence of poverty, loss of employment and other social problems. Recent cost assessments of disasters (i.e. cyclones and flooding in the Pacific, illustrate the severe and widespread impacts of such disasters on human well-being (Betterncourt et. al 2006; Holland 2009; Lal 2010). Between 1950 and 2004, the Pacific experienced 207 natural disaster events and incurred over US$6 billion in damages, according to the World Bank (2000). Of these disasters, cyclones accounted for 76 per cent of the reported events, accounting for almost 90 per cent of total costs and 79 per cent of fatalities (Lal et. al 2009a). Storm surges and floods cause general devastation from the effects of winds and high waves. Impacts of disasters, such (Ambrose 2009; Holland 2009) as damage to crops and buildings occur during or immediately after events, and subsequently over time, such as rises in water levels, and increases in vector-borne diseases. In Vanuatu, for example, Cyclone Ivy affected 90 per cent of water resources, 70 per cent of roads, and 60 per cent of health infrastructure and over 80 per cent of food production. Recently, one-in-50 year flood event in 2009 caused damage of about $24 million in the sugar belt in Fiji (Lal 2010), with about $330 million damage in the Nadi and Ba urban areas. Such impacts are projected to be exacerbated under climate change.

Countries which rely heavily on primary production are particularly sensitive to the effects of natural disasters. This is especially the case for those Pacific islands where agriculture, forestry, fisheries and nature-based tourism account for between 23 to 54 per cent of national GDP with most economies relying on just a few commodities. Tourism and the coastal fisheries are particularly vulnerable to the effects of increasing sea surface temperature and ocean acidification. Increases in sea surface temperatures due to global warming can have a devastating effect on coral reef ecosystems. Satellite monitoring by the National Oceanic and Atmospheric Administration/National Environmental Satellite Data and Information Service (NOAA/NESDIS) revealed bleaching effects and a record increase in temperature around the Phoenix Islands between August 2002 and March 2003. The surveys indicated close to 100 per cent coral mortality in the lagoon of Kanton Atoll, and 62 per cent mortality on the outer leeward reef slopes of the island, as well as elsewhere, throughout the Phoenix Islands. Although the flow-on effects on coastal fisheries and tourism are not known, it is clear that the supply of fisheries, as well as the suitability of the coastal areas for ecotourism would have been affected.

In summary, the broad drivers of change in the Pacific are having significant impacts on coastal resources and environments. Although the DPSIR and EBM frameworks can help illustrate the effects of broad drivers and the scope of effects, there are practical difficulties in identifying direct causal relationships between high-level drivers and environmental changes. In addition, there may be different drivers influencing the same type of pressure, thus isolating the effect of an individual driver will not be straightforward. A more detailed assessment of the motivations and incentives that influence individual decisions, behaviours and actions will be required to understand such root causes and to bring about change in human behaviour and actions. This issue will be discussed in Chapter 5.

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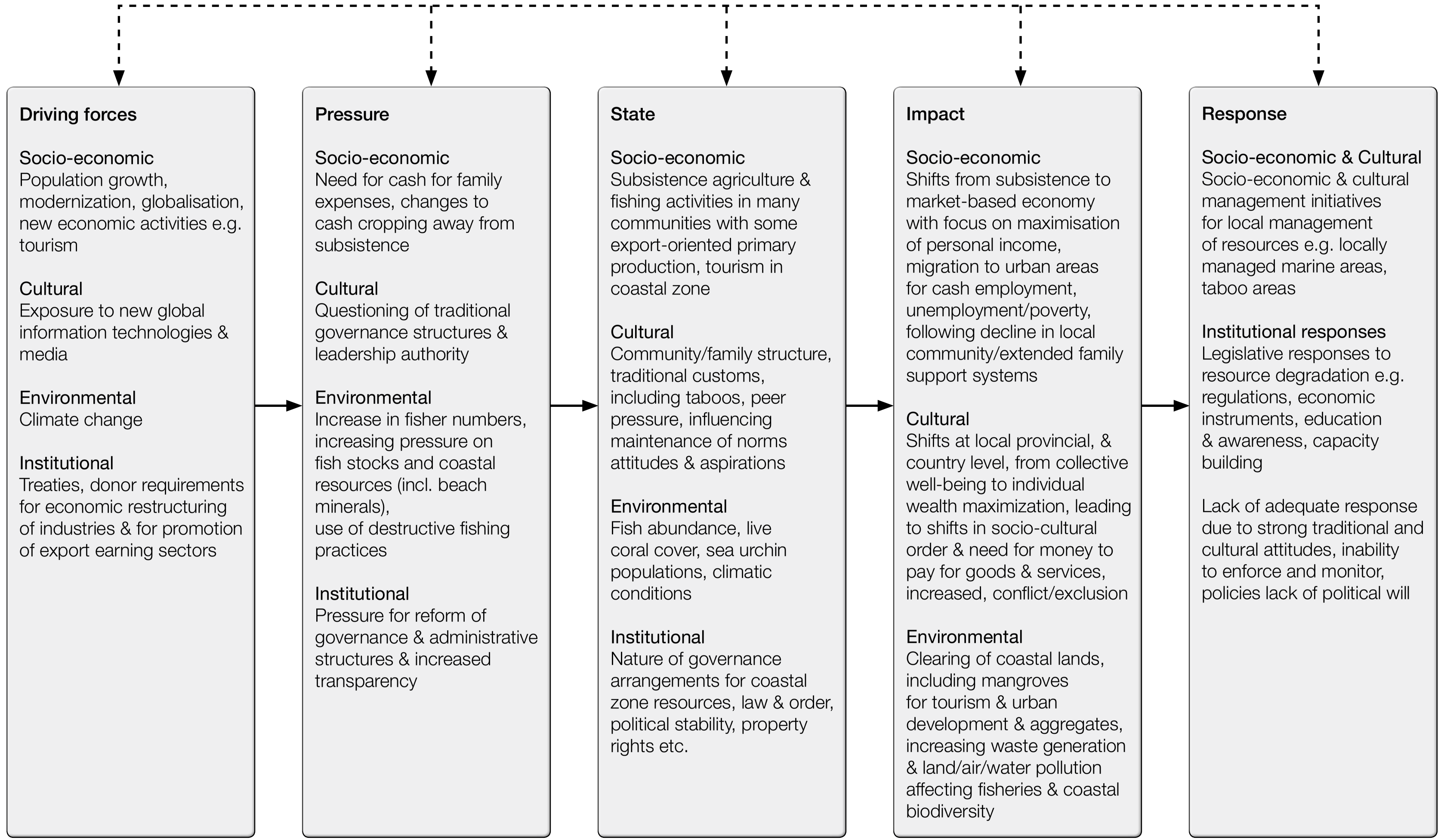
Strong wind and tidal action cause destruction to seawall in Tarawa, Kiribati.

Figure 4.2 Some driving forces, pressures, impacts, and responses relating to the coastal zone.



CHAPTER 5

Economic Analysis Framework: Key Concepts and Root Cause Analysis of Coastal Zone Issues

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Vuda Marina built by excavating coral reef area in Lautoka, Fiji.

Each stage of economic activity is affected by high-level drivers, including population demographics, monetisation/globalisation and technology, and the ecological connectivities. Each stage of economic activity can also affect the environment through the technology/pressure/state/impact relationship shown in Figure 3.2. For example, coastal fish stocks may be used as an input into fish processing or consumed directly by households. The choice of use however, will be affected by the market supply and demand of inputs, such as fuel, which are in turn influenced by broader drivers in society, such as the global demand and fuel prices.

There are, nevertheless, practical difficulties in identifying direct causal relationships between high-level drivers, and the state of the resources and environmental change (DECCW 2009). High-level drivers tend to affect different aspects of society, and thus have multifaceted effects and affect the scale and composition of economic activity which, in turn, varies the pressure on the environment. There are also many drivers, in general, affecting the same form of pressure, making it difficult to isolate their individual influences. In some cases, there is also a lack of reliable data on the state of natural resources which hampers the process of mapping economic drivers to environmental conditions. However, it may be possible to further investigate the drivers and effects at the micro (household) level, using key economic concepts.

Underlying individual decisions and actions are influenced by market supply and demand through market prices. Other influences that affect individual decisions include the type of coastal zone goods or services under consideration and the benefits the use of these goods and services bestow on the local community. Such issues are in the domain of the economics discipline. In particular, microeconomics can be used to delve deeper into threats, pressures, and other impacts, affecting mangroves, coral reefs and other coastal resources by focusing on individual motivations and behaviour.

This chapter provides an explanation of key basic economic concepts that are useful in analysing the root causes behind observed environment conditions, and in understanding the economic context of coastal zone management and resources, sustainable issues, and relevant management responses that target basic incentives and motivations of individuals and firms.

These economic concepts relate to:

- goods and services;
- individual preferences and values;
- markets, market supply and demand, and market values;
- markets, and non-market values and coastal environment;
- property rights and incentives; and
- public goods.

Only a brief discussion is provided here. For a more detailed investigation of the concepts in the context of the Pacific, see Lal & Holland (2010).

5.1 Goods and services

In Chapter 2, goods and services supported by ecosystems were discussed in terms of the Millennium Ecosystem Assessment (MEA) categorisation of supporting services, provisioning services, regulating services and cultural services (Millennium Ecosystem Assessment 2005). From an economics perspective, these categories of services can be seen in terms of market and non-market goods and services. Goods and services that are exchanged through markets are generally known as ‘commodities’. Fish, coral, or sea shells that are sold in local/domestic markets, or exported can be considered commodities. Ecotourism experiences, such as snorkelling on coral reef patches, whale watching and canoeing down a river can also be regarded as commodities when they are supplied by ecotourism operators and bought and ‘consumed’ by tourists (Lal & Holland 2010). Because these goods and services are exchanged through markets, they are termed ‘market goods and services’.

In the coastal environment, not every good and service valued by humans is exchanged through markets. Some goods and services are used directly from the environment, and are thus consumed ‘for free’ because no money is exchanged to enjoy them. ‘Free’ environmental goods and services include fish caught from the ocean for food, coastal protection by mangrove and reef systems, and allocation for waste dumping [such as river or sea] (Lal & Holland 2010). Because there is no exchange through markets, these are known as ‘non-market’ goods and services.

Many examples of non-market goods and services can be found in subsistence economies where crops produced by family members, or fish (often caught by women and children) are consumed. If some of these commodities are sold at the market, or along the road side, they are termed as market goods. When a family member helps a fellow villager build a canoe without any payment, his labour is considered as a non-marketed service. However, if a wage is paid for the service, then it is considered as a marketed service within a cash economy.

Direct uses of goods or services occur when people actively seek to use the goods and services, such as consumption of food, firewood for fuel, or for recreation. Indirect uses of goods and services occur when people consequently benefit from their use, for example in the case of ecosystem services, such as water purification or coastal protection. Direct and indirect uses of goods and services may be marketed or non-marketed, as was shown for coral reefs in Figure 2.2.

Whether a good or service is marketed or not determines the extent to which people will choose to use that good or service within a market economy. It also determines how much people are willing to invest to supply that good or service to the market. What people choose depends on their individual motivation.

5.2 Individual preferences and values

Each person usually makes choices based on their preferences and what they are willing to sacrifice to fulfil that choice, particularly as a typical consumer. They make such choices constrained by their incomes or the time at hand to fulfil their desires.

Consumers’ preferences, their willingness to sacrifice money or time, and their resource endowments will determine the choices they make to maximise their welfare or satisfaction. In making choices, consumers often rank their consumption choices on the basis of the levels of satisfaction they will derive from different combinations of goods and services. The satisfaction a person receives from the consumption of a good or service or from participation in an activity is known as their ‘utility’. Happiness, joy, contentment, or pleasure might all be substituted for satisfaction in the definition of utility (McKenzie & Dwight 2006a). The sum of individual preferences and willingness to pay for each quantity of a commodity determines the market demand for that commodity.

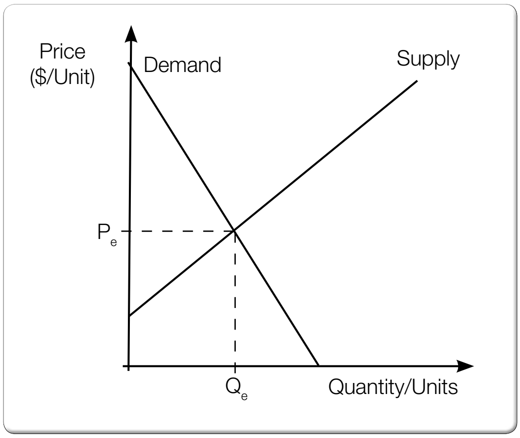
In economic terms, people also ‘consume’ things that they do not receive any benefits from and may be disadvantaged by, such as a pollution of rivers from industrial discharges. Governments frequently face situations where a government policy which leads to increased individual utility may also lead to decreased utility. For example, a government may have to decide whether to close a (polluting) manufacturing industry that employs about 500 people, or accept that there will be health risks associated with use of water supplies polluted by effluent from the industry. In this case, one commodity (employment) will make society better off (compared to no employment) whilst the other commodity (pollution) will decrease the welfare of society through increased health risks.

Markets, market supply and demand, and market values

The market system is a mode of organisation where resource allocation is determined by the independent decisions and actions of individual consumers and producers, and where businesses also interact to determine the allocation of scarce resources amongst competing uses and coordinate their actions. It also presents a situation of exchange relationships where buyers and sellers not only engage in trading goods and services, but also in transferring rights to them. The free interaction between supply and demand is known as the market system, and market prices act as signals between what consumers are willing to pay to consume the commodity, and what suppliers are willing to accept to supply or deliver the commodity. With normal goods, consumers are willing to pay less and less for each additional unit of commodity they consume. On the other hand, producers will be willing to produce more, as long as the price is higher.

In a market exchange, price is often seen as the medium of exchange and so the relationship between the quantities of goods supplied and demanded is seen in relation to its price only. Where the quantity demanded across a market equals the quantity supplied at that market, equilibrium is reached and a market price, "P_e", is also set. This also represents an efficient outcome from the point of view of society as a whole, as illustrated in Figure 5.1.

Figure 5.1 Equilibrium price, quantity demanded and supplied.



The price system induces self-interested parties to make choices in their own interests. The quantity demanded increases with a decrease in price, while the quantity supplied rises with an increase in price. Because the demand for a good or service by an individual person is represented by that person's own demand curve, the total demand for a good or service over an entire market is the summation of all individual demand curves. Likewise, the supply curves of all individual producers or suppliers added together in a market would represent the market supply curve. Equilibrium is achieved where the quantity supplied is equal to the quantity demanded, and the market price represents equilibrium between people's willingness to pay, and their willingness to accept and supply the goods required.

An increase in demand increases market prices, and conversely when there is an increase in supply, such as when there is a glut of produce, market price decreases.

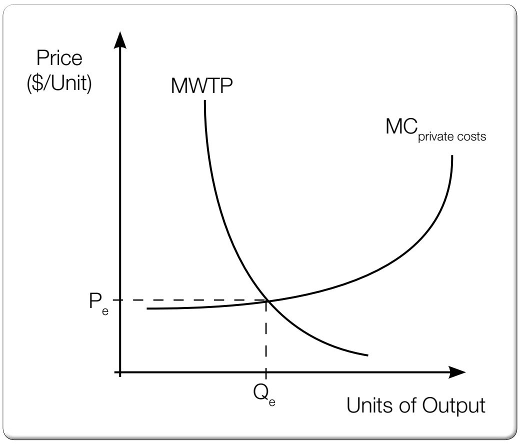
There are many factors that affect an individual's demand for a particular good or service. These may include things like the price of close substitutes, the income of the consumer, tastes, preferences, and other social factors. Similarly, there are also many determinants of supply for producers, including the price of inputs, the costs of production and technology, the number of suppliers and so on [See Lal & Holland (2010) for a more detailed discussion of these effects].

5.3 Market and non-market values and coastal environments

Many coastal resources, such as biodiversity and coastal protection, are not directly traded and therefore, do not have a price similar to those goods and services that are traded in the market. Thus, there are no price signals for consumers to consider in their decisions to use/consume the environmental goods and services. This lack of price signals leads to economically inefficient resource use. One way of thinking about inefficiency is in terms of missed opportunities. If use of a resource is wasteful in some way, then opportunities are being lost; eliminating that waste (or inefficiency) can bring net benefits to society. A producer or group of producers may be judged to be financially efficient, as long as they have low financial costs, and are making a profit. However, to evaluate the social performance of these operators, it is necessary to consider all the social values, market and non-market values, and consequences of economic decisions, in particular the environmental consequences.

The main idea behind economic efficiency is that there should be a balance between the broader economic value of what is produced and the value of what is used up to produce it (Field & Field 2002). In other words, in a market economy where all goods and services are marketed, there should be a balance between willingness to pay and the marginal cost of production. The marginal willingness to pay must represent accurately all of the value that people in the society place on the item.

Figure 5.2 Socially efficient rate of output.

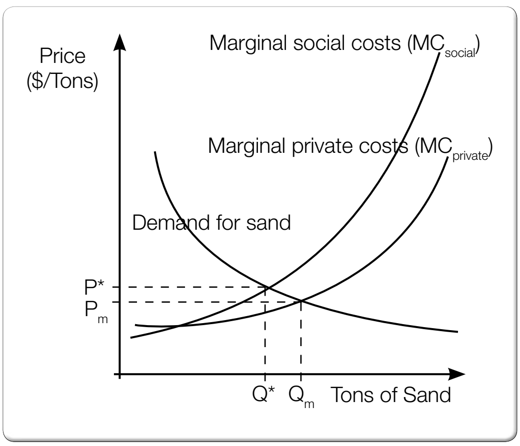


When producers in a market economy make decisions about what and how much to produce, they normally take into account the price of what they expect for their produce and the cost of items for which they will have to pay: i.e. labour, raw materials, energy, and machinery and so on. These are the private costs, as illustrated in the Figure 5.2 as the curve MC (marginal private costs), which in a market equilibrium condition is sloping upwards. Figure 5.2 shows the privately efficient rate of output as the intersection of the curves MWTP and MC.

In many production operations however, there are other types of costs that, while representing a true cost to society, do not show up in the producer's profit and loss. These are external costs for the producer, but these costs are borne by the society (i.e. as 'negative externalities'). One of the major external costs of many production systems is waste disposal. If the production is to be socially efficient, then it must take both private and social costs into account.

Negative externalities occur when an individual does not bear the full cost of his or her action imposed on others as illustrated in Figure 5.3. The presence of negative externalities results in an over-use of a good or service that also causes the production of the other unwanted outputs. For example, if a person extracts coastal sand for building their home, he/she may also impose negative externalities on their neighbour when the removal of sand in one place causes the erosion down current, affecting their neighbour's house foundations. Because sand is an economic good, available free of charge, people tend to take as much as possible. The only constraint they face is time and technological limitation. Increased removal of coastal sand can lead to higher risks from erosion that would otherwise be borne by people living in coastal areas. This practice is commonly known as the 'tragedy of the commons', where the coastal sand is seen as an open access resource to which everyone has equal access, but no one has the incentive to protect and sustainably utilise the resource.

Figure 5.3 External costs and market outcomes.



Some actions generate external benefits that may not be felt by the person undertaking the actions. These are external benefits or 'positive externalities'. An example of a positive externality is when a few members of a community clean up and tidy the village compound that improves the sanitation condition of the whole village. At times, women's groups take initiatives to re-plant mangroves and clean up beaches, so benefiting the rest of the community and the public. Similarly, positive externalities are created when some countries conserve their genetic materials or preserve rare species of plants and animals that may be accessible by other countries, but for the benefit of farmers in their country.

Likewise, often we see that private supply of recreational parks is not common in the many island countries, even though many people spend their leisure time on the beaches. This is because people wish to utilise the recreational parks but have little or no incentive to establish and maintain one for themselves because the good, i.e. the recreational park, is not 'owned' by them and thus, others cannot be excluded from its use as discussed below. Such positive externalities are also often unpaid for and thus, there are few or no incentives for people to provide extra units of conservation, unless of course markets were created for such positive externalities.

For many environmental resources, there is likely to be a substantial difference between expressed market values and social values. When this occurs, consumers and producers do not take into account all the costs and benefits of their decisions, resulting in either over use or undersupply of goods and services, resulting in market failure.

5.4 Property rights and economic incentives

Property rights refer to a bundle of entitlements defining the owner's rights, privileges, and limitations for use of the resources. An owner of a resource with a well-defined property right, such as a private property right, has a powerful incentive to use that resource in its most profitable venture because a decline in the value of that resource presents a personal loss. When goods with well-defined property rights are exchanged, as in a market economy, this exchange facilitates the best use of the resource, generating maximum benefits for society as well.

Several key resources and institutional characteristics define the nature of property rights, including excludability, rivalry, divisibility, and durability. Excludability of a good or service refers to the ability of people to prevent others from enjoying it for free. A good or service is thus excludable when it is physically and legally possible and practical to prevent others from using it. Many examples of excludable goods exist in coastal areas where people are able to prevent others from their use and enjoyment, such as fenced areas of coastal land, or fishing areas with enforceable and exclusive fishing rights. Rival goods occur when one person's use of the good reduces the ability of others to also enjoy it. Many extractive industries, such as fisheries, coral extraction, cutting of mangroves, and mining of sand are examples of rival goods. Many environmental goods or services are non-rival because they continue to be available, even though they are already used or enjoyed by others. Biodiversity, clean air and sunlight are examples of non-rival goods and services. The excludable and/or rival nature of environmental goods and services will determine if they can be privately owned and thus, would be allocated efficiently through markets.

Private properties are often held in perpetuity while leased resources have a limited duration of 'exclusive' use. The duration of tenure is also an important determinant of incentives to use the resources efficiently. The longer the duration of 'use rights,' the greater the incentive individuals will have for sustainable use of the resource over time; the shorter the duration of 'use rights', the greater the incentive to mine the resources for immediate gain. Similarly, when rights are transferable, owners can sell their resources, thus allowing their use for alternative purposes.

Private goods lend themselves to the development of well-defined property rights because they are rival, durable, divisible and excludable. The owners of private goods will use the good or service, or give them to others to use, only in ways that will make them better off. Owners of private goods have an incentive to make informed decisions about which uses of the goods and services will optimise their benefits because they can appropriate these benefits themselves. Well-defined property rights are necessary for effective negotiations and market transactions to occur, and for resource use to be efficient. The efficient use of goods and services can thus be encouraged by ensuring the rights are durable, enforceable and transferable (Lal & Holland 2010). As long as access and use rights over a resource are clearly defined and recognized by law, people have incentives to use the resources to maximise their individual benefits, and negotiated and market transactions can maximise aggregate welfare (from efficient allocation of the resource).

5.5 Public goods

In contrast to private goods, public goods are 'non-rival,' in that one person's consumption of a product does not reduce the amount available to other consumers. Public goods are also 'non-excludable' since it is difficult or usually impossible to exclude any person or group from obtaining the benefits they provide. As there is generally no direct relationship between the cost of supply and the consumption of public goods, market prices cannot easily be used in determining their allocation. Many such non-rival and non-excludable goods are 'owned' by states and, in these cases, governments decide on the amounts of such products to provide, and require individuals to pay for them through taxation.

Environmental resources that are considered as public goods are clean water, clean air and biological diversity, and all these are non-excludable and indivisible.

In between the extremes of public or private goods, there are other goods that have varying degrees of excludability and divisibility. Resources that are non-rival but excludable are known as club goods. Club goods often result in situations where it is too expensive for individuals to maintain a good but, collectively, individuals are able to pay for the good. The excludable nature of club goods enables the owners to charge non-owners access fees thereby, creating a market. Entry to a MPA managed by a local community could be regarded as a club good as, upon payment of a fee, entry to eco-tourism resorts is permissible.

In conclusion, the economic concepts discussed in this section are useful in understanding the dynamics of markets and market mechanisms. These concepts also help illustrate when markets may, or may not exist and what motivation and incentives markets can create for people to conserve, protect and/or preserve environmental resources. In other words, a knowledge of markets can help determine why some policies maybe more effective than others, or where a market may need some external intervention to function. The application of these economic concepts to key coastal resource and environmental management issues, together with the DPSIR and EBM conceptual frameworks, is discussed next.

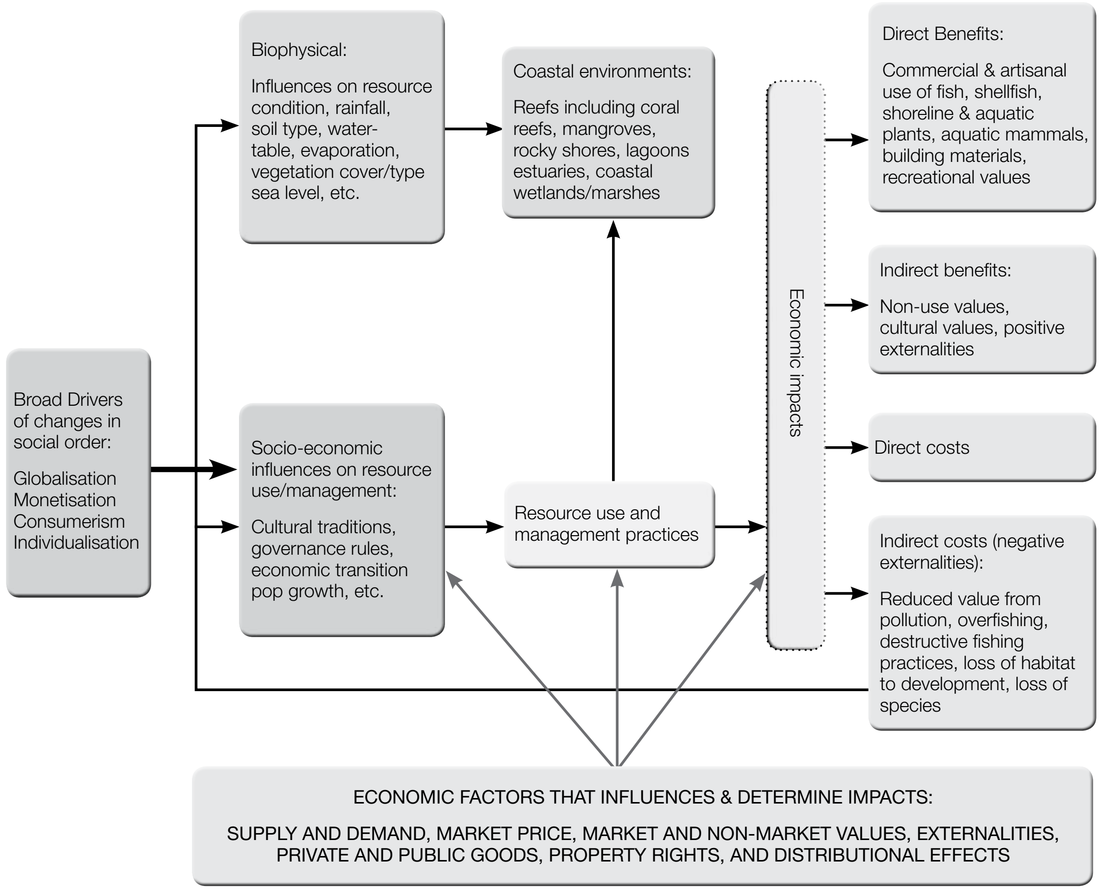
Concluding remarks for chapters 1 to 5

Chapters 1 through 5 have provided an overview of pressures on coastal ecosystems generated by the underlying drivers of change, such as population growth, monetisation and modernisation across all levels of society at national, community and local levels. These chapters considered the geographical, ecological, and temporal dimensions of the impacts of resource uses and described two analytical frameworks, DPSIR and EBM which can be used to explain interactions across and between pressures, impacts and broad-level responses.

At the core of these pressures and impacts are forces which motivate individual decisions and actions. These decisions and actions are considered in terms of an economic analysis framework which illustrates how key economic concepts can be used to identify factors that influence individual behaviour and attitudes towards the use of environmental goods and services that have both private and public good characteristics. On the other hand, the key microeconomic driving forces determining the state of resources and environments and individual motivations are the market supply and demand signals which influence production and consumption. The aggregate of individual producer and consumer decisions makes up the ensuing use of natural resources.

Figure 5.4 illustrates the relationship between biophysical, social, and cultural factors influencing coastal environments and their impacts, seen in terms of the costs and benefits which determine individual decisions. The core concepts of direct and indirect costs borne by individual actors and decision-makers provide a framework for relating higher-level drivers to coastal resource outcomes on the ground.

Figure 5.4 Influences on coastal environments and resource uses: integrated DPSIR, EBM and economic analysis framework.



Source: Adapted from Conner (2009).

CHAPTER 6

Fisheries: Effects, Outcomes and Responses

©Sailesh Sen

People selling fish at the Suva Muncipal Market in Fiji.

The high consumption of fish by many Pacific island countries underscores the vital contribution of fish for food security in the Pacific (Bell et. al 2009; Gillett & Cartwright 2010). However, increases in demand for fish in urban centres puts pressure on rural communities to harvest resources for both subsistence and commercial use so increasing the risk of overfishing and reducing the availability of fresh fish in rural areas (Newton et. al 2007).

The Center for Oceanic Solutions (2009) has identified commercial and industrial fishing as having an overall ‘severe’ impact in 40 countries and territories across the Pacific. Unsustainable fishing throughout the Pacific reduces fish stocks, limiting fish catches and often causing changes to ecosystems which further reduce biodiversity and productivity. Artisanal and subsistence fishing activity suffer when local needs are greater than local supply, causing displacement of fishing activity and reducing income and secure food supplies. Habitat destruction exacerbates overfishing by reducing fishable areas and productivity.

Increased demand for fish resources from population growth, expansion of export markets, use of improved catch technology and an increasing desire for cash to meet individual growing material needs underpins socio-cultural changes which encourage individual aspirations and motivations to maximise personal income.

This chapter focuses on the fisheries sector in the Pacific in order to show how the broader drivers of social change in the region directly affect the status and availability of resources and how they indirectly impact on coastal environments and the goods and services they provide through externality effects.

6.1 Coastal fisheries problems identified

Most coastal fisheries in the Pacific island region are over-exploited (SPC 2009; South et. al 2004). A recent review of literature by (Newton et. al 2007) suggests that possibly 55 per cent of all PICTs have overexploited their coral reef fisheries, although this statistic is uncertain due to limited data; see (Kinch et. al 2008; Kinch et. al 2010). A survey conducted by the SPC in 2003 summarized key problems in regional coastal fisheries (King et. al 2003). The summary of the survey in Table 6.1 shows the percentage of countries, identifying particular impacts, relating to commercial fishing as priority concerns.

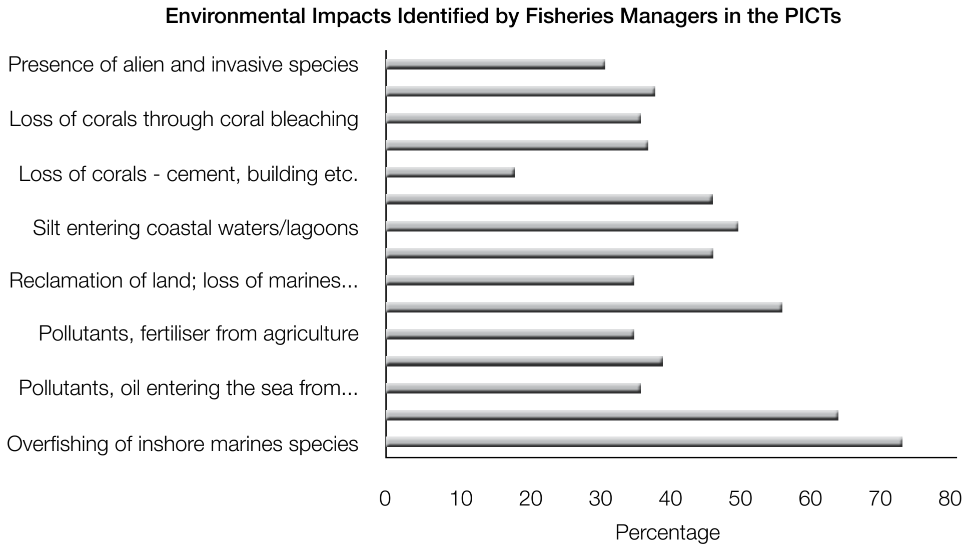
Table 6.1 Most important commercial fishing issues identified by countries.

Commercial fishing issues	% of Countries identifying impact as most important concerns
Over-exploitation of marine species	78%
Inadequate or out-dated fisheries regulations	50%
Inadequate enforcement of fisheries regulations	50%
Lack of capacity in the country – stock assessment, data collection	50%
Destructive fishing methods – explosives, breaking corals	39%
Overly efficient fishing methods – night diving, small mesh size nets, scuba gear	22%
Overlap between national/provincial/island responsibilities	17%
Shift from subsistence to commercial fishing	11%
Ciguatera fish poisoning	11%
Illegal fishing by foreign vessels	6%

Source: King et al (2003).

A more recent survey summarised in Figure 6.1 shows that overfishing is still seen as the dominant environmental issue, followed by sewage pollution (Ruddle 2008), causing major declines in coastal fish stocks and flows. Examples of decline of reef and lagoon stocks in Palau have been noted in (Johannes et. al 1981; Johannes et. al 1991); and declines in bonefish, milkfish, and parrotfish in the Cook Islands and various grouper stocks in French Polynesia noted in (Richards et. al 1994; Tuaopepe 2005). Overharvesting of invertebrates and, in particular, gastropods has led to a crisis in some areas due to lost income from declining seafood and ornamental shell exports (Tuaopepe 2005).

Figure 6.1 Fisheries environmental impacts in PICTs.



Source: SPC (2008).

Similar forces of change can also be observed at the country level. For example, in Fiji, Jennings & Lock (1996) state that many of Fiji's inshore reef fisheries are now threatened by over-fishing, destructive and illegal fishing and pollution. Excessive removal of fish species used for food from coral reefs results in significant ecological changes to coral reef communities (Jennings & Lock 1996). Of approximately 400 qoliqoli (fishing rights areas), 250 are fully developed and around 70 per cent of these are over-exploited (Hand et. al 2005).

As a consequence of the monetisation of the rural sector, local motivations are changing and are negatively affecting inshore coastal fisheries. Rural communities which used to engage in subsistence fishing only are now increasingly using modern gear to increase their catch for cash sale. However, such catches are often unrecorded. Consequently, despite numerous studies of reef fisheries in Fiji, the current status of reef-associated fisheries at the national level is still uncertain due to the lack of dependable data on subsistence fisheries (Teh et. al 2009). Subsistence estimates are out-dated and comprehensive assessment is lacking because of the enormous resources required to carry out such exercises.

Overfishing has resulted in the loss of many commercially-important food fish such as humphead wrasse, deep sea snappers, giant clams, trochus, bêche-de-mer, and green snails in many Pacific islands [see for example Wright & Hill (1993)]. Overfishing has been due to a number of reasons, ranging from increase demand from population growth, improvements in technology and easy access to fishing grounds. Breakdown of traditional forms of resource management as well as inadequate regulations and lack of enforcement, not to mention the biological characteristics of some of the fauna species (see Box 6.1) are also reasons for overfishing.

Box 6.1
Examples of overfishing in the Pacific

6.1.a Impact of rising prices and over fishing of bêche-de-mer in Marovo Lagoon, Solomon Islands

In the Solomon Islands, bêche-de-mer is a multi-million dollar industry and it is second only to tuna as the country's most valuable marine resource. Bêche-de-mer, or sea cucumber, is highly regarded by Asians as a delicacy with powerful qualities as a traditional medicine and aphrodisiac. In addition, bêche-de-mer is also an important source of protein for the Solomon Islanders. Solomon Islanders have one of the highest per capita seafood consumption rates in the world with over 80 per cent of the population deriving their protein from marine resources, including bêche-de-mer.

Bêche-de-mer is an important source of livelihood for coastal villagers and because of the ease of harvesting, processing and storing, bêche-de-mer has become one of the largest sources of cash in many coastal communities throughout the Solomon Islands. Increased demand for bêche-de-mer and higher prices has, in recent years, encouraged over-harvest and a decline in stock of some species. In 1991, the White Teatfish was valued at SB$30 a kilo, but today it fetches about SB$220 – 270 a kilo. With increasing price, the Teatfish has been over-harvested to the extent that its catch has recently decreased.

In 1999, for example, more than 50 per cent of the total bêche-de-mer catch was white Teatfish, but by 2002, this species accounted for only two per cent of the total catch, due largely to overfishing. In fact, catches and exports have fallen from 715 tonnes in 1992 to less than half this figure in 2005.

Rising prices have also led to an increase in dangerous fishing practices. It is noted that: "Ten years ago people were happy to free dive or simply collect the sea cucumbers at low tide. Now, people are night diving with torches, using weighted 'bombs' with steel barbs, and even using dredges to harvest from deeper waters" (Ramofafia, bêche-de-mer specialist, Marovo Lagoon quoted in Menzies 2005). The growing use of 'hookah', or diving, using air compressors and long hoses has been noted to have contributed to a growing number of deaths in the Western Province.

Source: Adapted from Steve Menzies, IWP Project Media release 7 July 2005, www.sprep.org; 29th October 2005; quoted in Lal & Holland (2010).

6.1.b Decline in finfish resources in Tarawa Lagoon

A comparison of fisheries data collected during 1992/1993 with data collected in 1977 indicates large changes in important finfish resources in Tarawa Lagoon. The historically important Bone fish (Albula glossodonta), like other important coastal fishery species, demonstrated decline in the catch per unit effort, proportion of catch, mean length, weight and sex ratio. Several finfish aggregations and migrations have ceased and/or changed migratory patterns. The predominant causes appear to be habitat loss and overfishing. Increased use of monofilament gill nets and boats with outboard engines and the decline in use of traditional fishing methods, have been suggested as reasons for the decline.

Source: Beets (2010).

6.1.c Exploitation of pearl shells

Pearl oyster resources in the Pacific islands appear to be especially vulnerable to overfishing and long-term depletion, due to its biological characteristics. For example, over a hundred tons of black-lipped pearl oysters were taken from the population on Pearl and Hermes Reef in the Hawaiian Islands in 1927. The population has not recovered after more than 60 years, and only a few shells were found during a recent survey (Landman et. al 2001; Moffitt 1994). Similar collapses or severe depletion of pearl shell fisheries have been reported at Penrhyn and Suwarrow Atolls in the Cook Islands (Sims 1992), at Abaiang (Preston et. al 1992) in French Polynesia (Intes 1986) and on Kiritimati Island in the Line Islands (Sims et. al 1989).

Source: Cited in Dalzell & Schug (2002).

The direct economic and social impacts of unsustainable fishing practices are reduced food security and livelihoods for people dependent on coastal resources. Indirect impacts include poor nutrition and increased social conflict. Empirical information about such impacts does not appear to have been documented as many Pacific island countries do not collect such information. Scientific studies on stock assessment of generally multi-species coastal fisheries are also limited. This problem is further exacerbated by the interaction of a multiplicity of other factors and forces, operating within these economies and societies in transition. Some of these factors and forces could be explained, as discussed below, in terms of key economic concepts examined in Chapter 5, above.

6.2 Increased demand and overfishing

Market demand describes the relationship between quantities (for example, fish) demanded by a society at certain prices at a particular point in time. The shift in market demand for coastal resources, such as fish products is due to domestic population increases, development of export markets for high value commodities and changes in dietary habits as more varieties of commodities become available with the influence of globalisation and modernisation.

When population increases, the quantity of fish demanded at a given price would be greater and ceterus paribus, the price of fish would be expected to increase. This price increase would motivate people to go out and fish harder. In many cases, coastal communities have easy access to coastal fishing grounds and it is relatively easy to increase their fishing effort because of limited alternative choices thus, exerting additional pressure on fish stocks. This increased pressure is a frequent outcome in spite of their being some existing form of fisheries management, such as regulations, restricting fish size or fishing methods. Similar shifts occur when the market demand increases due to new export markets being created, such as a demand for aquarium fish or trochus shells, or from changes in dietary habits due to the increased understanding about the health benefits of protein-rich fish diets. Increased demand leads to increases in prices which motivate other fishers to enter the fishery. Therefore, increase in price leads to increases in quantity supplied.

The effects of individual behaviour unintentionally impact on fisheries and fish species, causing fishing-related externalities. The common types of fishing externalities are stock, crowding and technical externalities (see below), and these generally have negative effects and occur where fishers can freely enter and capture a resource. Where a voluntary agreement for co-operation does not exist, resource users do not consider the external effects they may be imposing on others.

Stock externalities occur when increased fishing effort (for example from the entry of new vessels into the fishery) reduces fish stocks, consequentially increasing the overall harvesting costs (Seijo et. al 1998). Fishers do not consider these costs because they are only taking into account their private fishing costs, ignoring the external costs they impose on others by reducing fish stocks. With such increases in fishing costs, catch-per-unit-of-effort also decreases. In Fiji, emperor species (*Lethrinus*) and mullet (*Muligidae*) have been overfished and the bumphead parrotfish (Bolbonetopon) has been fished to local extinction in most areas (Sulu et. al 2002).

Increased fishing efforts also may result in crowding externalities which occur when effort is not evenly distributed, either in time, or spatially in the fishing grounds. These externalities increase the marginal cost of harvesting over time, resulting in fishers sequentially harvesting the most accessible reef patches and reef flats and then gradually moving further afield into deeper ocean areas. For example, experiences in harvesting bêche-de-mer and trochus shells throughout the Pacific show that localized areas of depletion have been common. As shallower waters get depleted, fishers use better technology, such as scuba gear to dive deeper for bêche-de-mer. Areas closer to urban centres also have localised over-exploitation because people depend on fisheries for both food and income, and generally have access to better technologies than rural communities thus, concentrating their effort within localized areas. The continuing use of scuba gear, despite being banned is shown in Figure 6.2.

Technological externalities arise when changes in fishing gear alter the population structure and dynamics of target fish species and associated by-catch, imposing negative effects on other fishers, and affecting the abundance of incidental species which might constitute the target of other fisheries (Seijo et. al 1998). The outcome of crowding and technological externalities is essentially an economic one, with increased costs of fishing imposed by one group on the other, affecting the supply of fish and above normal profits generated from the fishery.

Figure 6.2 Fishers continue to use scuba gear to dive for bêche-de-mer.

For example, many subsistence fisheries exist in near-shore areas close to the coast, while artisanal fisheries are generally carried out in the deeper lagoon, outer reef slopes, and in the open oceanic environments. Thus, the two categories of fisheries often exploit different components of the population of the same species. While artisanal fishers target fish in deeper waters, exploiting the adult stock, subsistence fishers tend to target juvenile stock in shallower waters. An increase of subsistence fishing pressure can cause recruitment overfishing which would reduce the stock available for the artisanal fishers in the subsequent period thus, causing a negative externality for the artisanal fishery. An increase in artisanal fishing effort can, on the other hand, diminish the spawning stock which would subsequently affect the recruitment and thus, stock available to subsistence fishery.

Such overfishing can be seen throughout the Pacific, even where management measures, such as size limits, export permits and areas closures are in place. In Kiribati, Tuvalu and Tonga for example, coastal fisheries are centrally regulated, but local people are free to fish anywhere they like. In other countries such as Fiji, the Solomon Islands and parts of Vanuatu, traditional resource management systems exist in which local people, belonging to a clan group, have fishing rights. However in some instances, these rights are not effectively enforced due to weak local governance where local fishers operate almost identical conditions to fishers, using the open access resource, eventually leading to a similar outcome of overfishing.

In such cases, the impact of a lack of or ineffective regulations means that fishers continue to harvest because the revenue they receive exceeds their fishing costs and they can still make net profits. The outcome is that more fishing pressure will be placed on the fishery, and it will eventually reach a point where revenue will just equal the cost, and most, if not all fishers will begin to make losses if they continue any further fishing effort.

The responses of individuals and governments and the impact of these responses can be better understood by examining some of their underlying root causes, such as government policies, including subsidies, biological growth rates and the nature of property rights.

6.3 Government responses - subsidies

Governments may try to promote economic growth by encouraging local communities to shift from subsistence fishing activity to commercial scale harvesting through provision of subsidy. When there are low supplies of fish and demand is high, governments are often under pressure to assist fishers with better vessels and gear so that they can move to other fishing areas, or target species that are still abundant. In some instances, fishers improve their technology but continue targeting the same stock and remain in the same fishing grounds. Improvement of fishing and gear technology produces short-term benefits because it improves the catch-per-unit-of-effort thus, reducing the cost of the fishing operation. However, if new technology is introduced when stocks are close to maximum sustainable limits, then this can lead the fishery to over-exploitation and near collapse.

An example of such a fishery is the bumphead parrotfish (*Bolbometopon*) in many parts of Fiji, and deep water snappers that aggregate on sea mounts. This fishery boomed with the introduction of subsidised Food and Agriculture Organisation (FAO)-designed half-cabin launches, but collapsed within less than 10 years.

6.4 Effects of natural biological growth rates

The effect of major drivers, such as fishing technologies and increased population pressures on fish stocks is further exacerbated by the slow growth rates of some species and high natural mortality.

Species that are slow-growing are more vulnerable to fishing pressure, especially when they are highly sought after and have high values, such as groupers and giant clams. These products often exhibit an inelastic demand curve, which means that any changes in price do not lead to proportional changes in demand. Therefore, when stocks are declining, market prices are still high due to scarcity factor, and so fishers often continue their intensive fishing until a point is reached where stock collapses. The sustainable yield curve has a sharp drop from a high-yield level to a very low-yield level. With such a small level of population, a species will no longer be viable, and will have a greater chance of total extinction. The case of Giant Clam (*Tridanca gigas*) provides a good example of such a fishery in the Pacific islands. The overharvesting of turtles throughout the Pacific is another example of the effect on a slow growing species.

Furthermore, several important species groups such as emperors, soldierfish and groupers reach maturity between the thirtieth to fiftieth percentile of their lifespan (Dalzell & Schug 2002). In multi-species, coral reef fisheries (in which the fishing effort is usually common, and different species are concurrently targeted and taken) are among the largest and most vulnerable species and face rapid local reductions in biomass, including decreases in the numbers of mature individuals. They may become over-fished while the less vulnerable, small species are harvested at levels below the maximum possible catch (Dalzell & Schug 2002).

It also appears that many reef species have high natural mortality rates and therefore, may be more vulnerable to over-exploitation (Williams et. al 1995). Coleman et. al (1999) suggest that high natural mortality rates imply that only a small portion of the biomass (perhaps as low as 10 per cent) can be sustainably harvested annually.

Sea Cucumber - A sedentary species that is highly vulnerable to fishing pressure.

6.5 Property rights, market failure, and *The Tragedy of the Commons*

The particular characteristics of property rights determine the way that people make decisions about using natural resources. For example, ocean fish are a 'common property resource' which can be targeted by multiple individuals who cannot be excluded from attempting to harvest these stocks. The nature of the ocean as a common property resource means that there are few incentives for fishers not to overfish stocks. Any fish not caught by one fisher, might simply get caught by another. The result is that there are few incentives to conserve stocks for the greater good or for the future as there is no certainty that the action of the responsible fisher will be respected by others.

Unless there are management measures that can address the excludability issue, people will not have the incentive to use the resources in a sustainable manner. Instead, they will be focusing on meeting their immediate and short-term goals. In other words, rights to the fish in the ocean depend on the kind of accessibility or rules that regulate the access and use of the resources.

In the case of communal property resource systems (i.e. those managed in common), varying levels of efficiency and sustainability can be achieved, depending on the rules that emerge from collective decision-making, such as can be seen in the case of coastal communities with traditional fishing or use rights. Alternatively, as discussed in the next section, a market solution to overfishing would work best when property rights are well defined, such as through individual transferable quotas combined with total allowable catch in an industry that captures the biological and ecological characteristics of the species.

Easy access to resources, a lack of effective enforcement and a lack of clearly-defined rights create negative externalities and determine how the actions of one fisher can affect the operations of others. This leads to an inefficient allocation of coastal resources and creates a 'market failure'.

Like many open access resources, Pacific fisheries tend to be both resource-inefficient (that is, too costly), and unsustainable in the way they are used because of the common property resource nature of the fish stocks. Problems often arise when access to the fishery is unrestricted. Open-access resources create two kinds of external costs (negative externalities). The first kind of external cost is that faced by the current generation, reflecting the fact that too much effort and excess capacity is invested in the fishery because there are too many fishers chasing the same fish.

Women carrying out subsistence fishing in Kubulau, Vanua Levu.

The second type of externality is intergenerational, reflecting the additional cost that future generations have to spend in additional time and resources to harvest the few fish remaining after present generations have overfished the stock. When too many fishers have unlimited access to the same fishery, the property rights to the fish are no longer efficiently defined. Individually, each boat will receive a profit equal to its share of the economic rent or total profits from the fishery. The profit levels would however, attract other operators to the fishery, eventually leading to increased costs and the dissipation of profits.

The coastal fishery in Tarawa is seen as a common-property resource for I-Kiribati. It is a typical example of a fishery where enforcement is minimal and people are free to fish wherever they like thus, operating more like an open access fishery. The interaction of increasing population, weak property rights and poor governance has led to overfishing (Box 6.2). The direct economic and social impacts of unsustainable fishing practices are a decline in food security and livelihoods for people dependent on fisheries resources.

Box 6.2
Te ororo fishing in Kiribati

Increasing population pressure and demand for resources have led to areas of over-exploitation in the Tarawa lagoon. Fishers from South Tarawa and Betio fish on the reefs of North Tarawa and go as far as Abaiang and Maiana. These fishers are also seen to be better equipped with gear and technology, including better boats than traditionally used in pure subsistence activities. A recent study reveals that most commercial fishers that target reef fish use long gill nets (multiple gill nets joined together) and heavy metal rods such as crowbars to scare schools of Bonefish and other reef fish into their nets. This method is locally known as *te ororo*, where fishers encircle reef patches with fishing nets, then dive and spear fish trapped inside the nets. The fishing method is not only indiscriminate but also destructive to the reef ecosystem. This practice is becoming more widespread because there is no control or limit to where fishers can operate and the number of nets they can use.

Source: Ram-Bidesi & Petaia (2010).

6.6 Management responses

In many Pacific islands, commercial coastal fisheries are managed by the central government through a licensing system, while semi-subsistence and subsistence fishery is virtually unregulated. In addition to licensing, there are also size limits imposed, area and seasonal closures, export licenses and gear restrictions. Often, fines are prescribed for any violations. In most cases, these fines are nominal and do not act as an effective deterrent for fishers. For example, in Fiji, if a fisher is found guilty of using dynamite, he would be fined $1000. In most cases, when dynamite is used, the offender still benefits more from acting against the law, even after paying the penalty. Thus, they may continue to re-offend. In addition, the chances of being caught are limited because governments frequently lack adequate resources to monitor, or effectively enforce legislation. The monitoring, control and surveillance costs are higher than the benefits directly derived by the government management authority from enforcing the legislation.

A large majority of fishers in rural areas often do not have the knowledge and awareness about regulations, or have the benefit of fisheries extension services. Even if they may be aware of such regulations, the community members may choose to ignore them to reap short-term gains, particularly when the regulations are not enforced thus resulting in government failure. Bêche-de-mer and trochus, for example, are regulated for size. However, observations at local municipal markets in Fiji show that smaller sizes are sold at the local markets. On the other hand, export sales, which require export licences are closely monitored and enforced, ensuring only legal-sized products are processed for export.

Often command and control forms of coastal regulation are not sufficient on their own to prevent unsustainable fishing, making fisheries management ineffective. Restrictions on gear, such as mesh-size limitation, banning efficient gear such as scuba gear, or limiting the number of hooks are intended to improve the biological productivity of stocks. However, fishers resort to other measures that are unregulated, such as use of larger nets and fish finders, or further increase fishing effort. Such regulations not only impose higher monitoring and enforcement costs for governments, but are also economically inefficient as they do not optimize resource rent, but raise fishers cost instead.

When conventional command and control management becomes ineffective, fishers operate more like open-access fisheries. In this case, the individual fisher is mainly interested in his or her own private benefits and costs because he or she has no control over the operations of others. Therefore, when the operations of others impose an externality on an individual operator, he or she has no incentive to control effort and follow management rules because of the characteristics and nature of the fishing grounds.

Fisheries are an important coastal resource for Pacific islanders but, as shown in this chapter, additional pressure from unsustainable fishing, and/or over-exploitation of fisheries resources occurs in the Pacific due to overarching drivers of social change, the growing need for cash incomes and desire for a modern way of life. Such impacts on coastal resources, in turn, are threatening the ability of ecosystems to support the needs of the region. The individual desire to accumulate wealth also contributes to the breakdown of the traditional systems of social control (Crocombe 1972; South et. al 2004.), compounding management challenges.

Examples of policy responses (Johannes et. al 1991; Lal & Holland 2010) show that centralised command and control mechanisms can be ineffective on their own because of weak property rights and lack of incentives for sustainable behaviour. Environmental impacts essentially result from economically-driven social changes. Understanding the impact of these changes requires an appreciation of interrelated issues which extend beyond spatial, temporal and sectoral boundaries.

Coastal fisheries are more likely to have a sound basis for fisheries management if they are under community-based fisheries management, with certain and clearly defined property rights which allow communities to have exclusive fishing and use rights (Hviding 1996; Johannes et. al 1991; Kuemlangan 2004). Some examples of fisheries management under community-based systems of resource management are discussed in Chapter 8 which considers how systems-based approaches can be implemented through Ecosystem-Based Management.

CHAPTER 7

Pollution Effects, Outcomes and Responses

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Broken bottles and plastics pose threats to marine life.

Pollution is a growing concern in the Pacific with population increases, expansion of markets, the liberalisation of trade and new varieties of goods and services becoming available. These factors, combined with increases in purchasing power through the cash economy, paid employment, changing lifestyles and increased consumerism, result in the production of large volumes of waste, often exceeding the absorptive capacity of the local environment.

The presence of pollutants in the environment often directly and indirectly affects ecosystems, resulting in habitat destruction, a decline in natural beauty, loss of biological diversity and the inability of the environment to support human needs and aspirations. The problem is further compounded in atoll island states by the porous nature of the islands, leading to increased pollution of ground water. Polluters impose costs (negative externalities) on society through unpleasant or harmful pollution. Internalising the externality effects means placing responsibility on polluters to either pay for the damage they cause or change their behaviour to reduce or minimise damaging effects. This chapter focuses on source and root causes of pollution and pollution control from an economic perspective.

7.1 Types of pollution and threats and pressures

Like people from other parts of the world, Pacific islanders are concerned about pollution and its effects on human lives and the health of ecosystems. Pollution is typically considered in terms of either the type and/or sources of pollutants, such as solid waste, industrial waste, plastic marine debris, dumping of toxic material and oil spills and urban runoff, as well as pollutants from sewage (Table 7.1). Empirical information about the volume of such wastes, at the regional or even the country level is often limited, although such pollutants are considered to pose ‘moderate’ to ‘severe’ threats to the environment and human health (Center for Ocean Solutions 2009) as summarised in Table 2.8.

The presence of non-biodegradable substances such as bottles, plastics, heavy metals like lead and PCBs (polychlorinated biphenyls) is a common problem in urban coastal areas throughout the Pacific islands. The environment has very little or no absorptive capacity for these forms of materials. This type of pollution is known as ‘stock pollution’ which accumulates in the environment over time and causes damage.

Table 7.1 General categories of marine pollutants.

Categories	Examples	Sources
Oxygen-demanding substances	Waste materials, sewage, sludge, primary/raw sewage	Sewage treatment plants, industrial waste, septic systems, vessel sewage
Nutrients	Nitrogen, phosphorous	Sewage treatment plants: effluent discharge, agricultural runoff, septic system runoff
Suspended solids	Particulate matter, e.g. sewage sludge, dredged material (sediment)	Sewage treatment plants, harbour/ channel dredging
Pathogens	Bacteria (coliform, streptococcus), viruses (hepatitis), parasites (nematodes), fungi	Sewage treatment plants: salmonella, effluent, combined sewage overflows, agricultural runoff, septic systems runoff
Organic chemicals and metals (Toxicants)	Metals (mercury, lead, cadmium, tin), Petroleum hydrocarbons (alkanes, cycloalkanes, aromatic hydrocarbons – organic compounds (halogenated hydrocarbons, chlorinated hydrocarbons, PCBs, DDT, dioxin)	Manufacturers: industrial wastes/ sludge, petroleum products, agricultural pesticides runoff, vessel and tanker spills/discharges
Solid waste, plastics	Metal cans, glass bottles, plastic bags, bottles, balloons	Recreational boats, combined sewer outflows, landfills, negligent waste disposal

Source: Clark (1996); Ofiara & Seneca (2001).

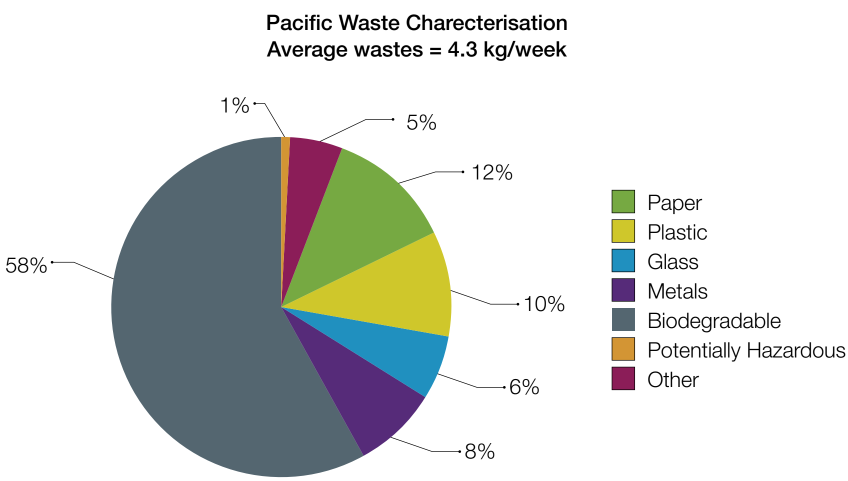
Each Pacific island country also has to regularly deal with the disposal of toxic waste such as hospital and hazardous waste, including Persistent Toxic Substances (PTSs) and Persistent Organic Pesticides (POPs). An increase in electronic and automotive waste with a long shelf life is also expected with changing lifestyles and increased use of vehicles and computers. Electronic waste, or E-waste, including personal computers, monitors and televisions, contains toxic chemicals such as lead and brominated fire retardants. Automotive wastes include lead-acid car batteries, used oils and brake pads containing asbestos, which can have serious human health impacts if disturbed.

Shipping industry provides to a major source of marine pollution from ports, shipbuilding and repair facilities, oil storage and bunkering facilities. Ballast water, ship waste, and marine spills pose further challenge to fragile Pacific environments. Much marine life has a planktonic stage in its life cycle and therefore, has the potential to be transported in ballast. Introduction and establishment of invasive species, such as the zebra mussel in the great lakes of North America, jellyfish in Eastern European inland seas, and the North Pacific starfish in Australia have caused major ecological damage with multi-million dollar economic costs (SPREP 2010). There are also potential risks to human life, health and safety through the introduction of toxic dinoflagellates and infectious diseases.

A particular concern for many Pacific island countries is that the region is a major fishing ground for many foreign fishing vessels which are a major source of revenue for these countries. Some of the vessels spend long periods at sea, or anchor in lagoons and do not enter ports. Monitoring and enforcement of their waste management measures is difficult. Similarly, many shipping routes to the American continent from Asia and Australasia fall within the zones of Pacific island countries. Many of these ships are bulk carriers of oil and other chemicals and hazardous and toxic materials thus, posing potential risks to Pacific marine and coastal environments.

The major pollution issue at the household level is pollution from poorly disposed solid and liquid wastes, affecting the health of freshwater and coastal ecosystems, as well as human health. The majority of household waste in the Pacific is recyclable materials and organic waste. In the region as a whole, recyclable materials such as glass, paper, plastics, and metals account for about a third or 615,000 tonnes of all wastes, while biodegradable organic waste, including sewage sludge and septage forms about a 1.75 million tonnes or 58 per cent (SPREP & UNEP 2005: 7–8). Figure 7.1 shows the composition of household solid waste per person, per week in the Pacific.

Figure 7.1 Composition of household solid wastes (per person/week), 2005.



Source: Based on Raj (2000); Sinclair Knight & Menz (2000).

On a per capita basis, solid waste production in the region varies from about 2 kg per week/capita in Kiribati to 7 kg per week/capita in Fiji; this is equivalent to about 0.5 kg per day/capita (Lal et. al 2007). While a Pacific islander may produce only about a quarter of the waste that an urban-based Australian generates (1.87 kg per capita/day (SPREP and UNEP 2005: 15), the small size of the island states and the limited land and availability of suitable landfill sites, create a serious challenge for the Pacific Small Island Developing States (SIDS). The challenge is expected to become even more acute in the future as Pacific societies become more affluent and urban-based and their lifestyle changes, including an increase in consumerism.

Solid waste pollution not only affects the aesthetics of beaches and coastal areas, but can also create a hazardous Solid waste pollution not only affects the aesthetics of beaches and coastal areas, but can also create a hazardous environment for vessel navigation thus, affecting trade and commerce and reducing tourism income and recreational opportunities; the cost of which can be quite significant as was experienced in Tonga. In this case, Lal & Takau (2006) report that each household in Tonga produces approximately a tonne of solid waste per year, some of which is indiscriminately dumped along roadsides, waterways and coastal mangrove areas. The effects of this include the development of water-borne diseases such as diarrhoea, dysentery and other gastrointestinal illnesses, as well as loss in aesthetic values, with tourists reporting seeing wastes disposed of in public areas as one of the unwelcomed experiences of their stay in Tonga. The economic cost of poor solid waste management in Tongatapu was estimated to be about $5.6 million per year, or about $340 per household per year (Lal & Takau 2006).

Likewise, poor human and animal waste and wastewater management is a source of human health problems, as well as increased levels of nutrients, toxins and chemicals which eventually can cause disease outbreaks and changes to the food web.

In many countries, there is no centralised reticulated sanitation system, and almost 90 per cent of human waste management depends on on-site, usually septic-based, systems. On-site sanitation facilities are often poorly sited due to the limited availability of land. In atoll islands particularly, septic sewage systems do not usually provide the necessary level of treatment of raw sewage. Instead, they become a major source of groundwater and lagoon pollution, as experienced in places like Tuvalu and Kiribati (Lal et. al 2006). The costs of poor waste management, in terms of contaminated drinking water, flooding and water borne and water related diseases such as diahorrea and skin infections, is often very significant. Secondary effects of sickness cause loss of productivity, absenteeism at work, and eventual national economic loss. As an example, the direct and indirect economic costs of poor sanitation on the island of Funafuti, Tuvalu have been estimated at almost AU$0.5 million per year (Lal et. al 2006).

While nutrients ‘enrich’ waters, they can also cause phytoplankton blooms and eutrophication which in turn, can exacerbate the development of toxins (Center for Ocean Solutions 2009), as was experienced in Tahiti and the Cook Islands. In Tahiti (the largest and most populated island in French Polynesia), studies of ciguatera outbreaks indicate a temporal link between ciguatera diseases in humans and algal blooms (Chateau-Degat & Chinain 2005). Similarly, in the Cook Islands, terrestrial run-off has been associated with increased incidences of ciguatera poisoning. Local people often avoid eating fish from local areas (Noroa Roi, Cook Islands Marine Resources Department: pers. comm., July 2010) and therefore, fish is either sought from the outer islands of Northern Cooks, or imported. Not only is there a health cost associated with consuming poisonous fish, but also the price of fish rises (due to increased cost of supply as fish has to be sought from elsewhere.

The economic costs of such effects from human and animal wastes can be large. In the Cook Islands, for example, watershed pollution from septic tank leakage, fertilizer runoff, herbicide and pesticide runoff, livestock and animal waste is estimated to result in costs to the community of around NZ$2,900 per year per household, or NZ$7.4 million per year (Hajkowicz & Okotai 2006). These costs, among other things, relate to healthcare and illness, loss of income from fisheries and tourism costs and purchase of bottled water which consumes around 3.12 per cent of GDP for the Cook Islands (Hajkowicz & Okotai 2006).

7.2 Pollution and pollution control from an economics perspective

The cost of indiscriminate waste disposal by individuals and firms in public places is generally not borne by the person or entity committing the act. Instead, individuals dump their household waste in public places, while companies may produce pollution as a by-product of production, and it is the broader community that suffers the result.

Individual household waste

Pollution generates externality costs. When waste is dumped in a mangrove habitat, pollution may reduce the quality and quantity of fisheries products harvested by subsistence or commercial fishers, while the person dumping the garbage may not directly bear the full costs of pollution and continue dumping the rubbish.

People disposing of waste in the environment thus, have no incentive to reduce dumping because they are not directly affected by the impacts of the dumped waste. This can be demonstrated through the concepts of private benefits, compared to public costs. In this case, any person dumping garbage in public places, personally, only faces private costs in terms of the time and effort they invest to dispose of the rubbish. In most cases, these private costs would be much lower than the costs imposed on other people (the social costs), such as the impacts on local fishers from catches of contaminated fish or lower catches. The real social costs of dumping are therefore, higher than private costs borne by the polluter, as illustrated earlier in Figure 7.2. Consequently, there is an overuse of coastal areas as dumping sites (see Figure 7.2).

Figure 7.2 Coastal areas are commonly used as dumping grounds for household and industrial waste.

Industrial Pollution

The damage to coastal ecosystems from industrial pollution can also be illustrated in terms of the 'marginal' externality costs due to pollution (effluent), jointly produced with a commercial product. In this case, the costs of producing processed food, for example, are more than the costs borne the producer alone. For example, the Fiji Sugar Corporation produces sugar for domestic and export markets. However, the corporation also produces wastewater as a by-product which is discharged in the local river system. This wastewater often causes fish kills because of depletion of oxygen content in rivers from chemical oxygen demand (Lal 2008). The occurrence of pollution means that the social costs (see Box 7.1) are higher than the private costs incurred by producers.

Box 7.1
The social cost of pollution

The economic impacts of pollution on other industries and people can take several forms, such as loss of business, unemployment, increased costs related to reduction in recreational activities along coastal areas, increased health costs and loss of livelihoods. Losses are measured through changes in welfare associated with these other activities, which can be defined as the change in the sum of consumer surplus and producer surplus associated with no pollution, minus the sum of consumer and producer surplus' with pollution.

Loss of consumer surplus can result from a decrease in demand for goods and services associated with the coastal area affected by the polluting industry. This may occur when, for example, people replace fish with other types of food supplies to avoid eating fish they fear have been contaminated by pollution. This substitution would cause a decline in the quantity of fish demanded at each market price. As demand decreases and supply remains the same, the producer surplus accruing to operators will also decline.

Pollution, such as waste dumped into coastal areas, suffocates fish and other invertebrates thus, increasing mortality which, in turn, reduces the availability of fish. As supply declines, the supply curve will be shifted upwards so reducing consumer surplus. With reduced supply, producer surplus would also decrease. Adverse economic effects and losses due to pollution can be categorised as supply effects when changes in the abundance and distribution of economically important fish and shellfish occur. For example, in Bikenibeu in South Tarawa where household waste is most concentrated, there is significant coral reef damage and most corals are dead hence, the fishery associated with this area is also non-existent. The supply effects of pollution are thus, measured in terms of use and non-use values for different goods and services, as discussed in chapter 2, and related to the geographic area affected by the polluting industry.

The presence of pollutants in the environment may also lead to a decline in the quality and volume of services that flow over time from the environment. Economic losses from coastal pollution may also depend on the nature of pollution. For example, excessive levels of industrial organic wastes or bacteria and marine debris can result in short-term acute damages to coastal environments. Contamination of water and bottom sediments with toxic substances can result in long-term chronic damages to coastal environments, such as in the case of rivers that flow through the industrial zones of most urban towns throughout the high islands of the Pacific.

The temporal dimension of such economic costs would be explicitly considered by adjusting future costs to present values, using rates of time preference or discount rates [see Lal & Holland (2010), for a further discussion]. In theory, efficient allocation of resources occurs when the present value of net benefits is maximised however, this may not be an acceptable environmental outcome. Over time, the cumulative effects of pollution can reach unacceptable threshold levels if waste is not properly disposed of, particularly when the market prices of the commodities involved do not reflect the true cost of their production.

For example, in the case of nickel mining in New Caledonia, gold mining in Fiji, or copper mining in PNG water and air pollution occur from tailings and release of sulphur dioxide from smelters. Efficiency in mineral production would decline over time if the marginal social damage costs increase. Waterways and farms would be damaged as mining activities continue. The price of minerals would rise over time through scarcity, but is also related to the increasing social costs of production, related to damage to surrounding environments. Since clean environments do not have a market price, the market mechanism cannot be relied on to produce an economically efficient outcome, leading to market failure. Stock pollutants can also create a burden for the future generations by using up resources, and by passing on damage costs that would continue long after the benefits have been obtained.

7.3 Pollution and market failure

Pollution can also be explained in terms of market failure (Choe & Fraser 1998; Lal & Holland 2010). Market failure occurs where market mechanisms does not result in an efficient outcome. This occurs, for example, in the case of production systems that also produce waste, and where a market for clean environment does not exist and where the price of maintaining or providing a clean environment is essentially zero (being provided 'for free'). If polluters were made to bear the cost of polluting the environment, the good would either become more expensive to consumers or less of it would be produced. Correcting market failure means, either forcing producers not to generate pollution, or forcing them to absorb the pollution costs themselves. The effect would be a fall in the quantity of goods and thus, the level of the pollutant produced and an increase in the market price, as well as a decrease in the profitability of production.

When a government enacts arrangements to make polluters bear the costs of the pollution they generate, governments are essentially applying the 'polluter pays' or 'impactor pays' principle; see for example Pananyotou (1998). By forcing polluters to face their own costs, polluters face the choice of either avoiding generating waste in the first place (to avoid having to face the cost) or to incur the cost of their waste they produce (for example by arranging for its disposal).

Conversely, when persons affected by pollution are forced to pay for waste collection and disposal to create a 'clean environment', this can be seen as beneficiaries paying for the benefit they enjoy. This principle was used in Tonga to introduce waste collection and disposal fees (Box 7.2).

Box 7.2
Application of 'beneficiary' or 'impactor pays' principle to solid waste management in Tongatapu, Tonga

Individual Tongatapu households produce approximately a tonne of household waste per year, the majority of which comprises recyclable material. The direct and indirect economic costs associated with solid wastes are estimated to annually cost from $140 to $340 per household, or $2.80 to $6.50 per week, of which the loss in aesthetic value was the most important economic loss, followed by potential foregone earnings from recyclable products and then the cost of bottled water.

A contingent valuation assessment suggested an average willingness to pay per household for improved waste management of $3.10, with 95 per cent of households willing to pay between $2.80 and $3.30 per week for improved solid waste management.

This amount is almost equivalent to the unit cost of collection and disposal, as well as maintenance of the new landfill site developed under an Australian-funded project, assuming a full cost recovery policy was adopted. If households practiced recycling, they would have earned an average annual income of $120. Each household could still expect to have a net financial earning of $30 per year. If the economic value of a litter-free environment was also explicitly considered, Tongan households could expect to have a net economic gain of about $100 per year, or close to $2 per week.

Source: Lal & Takau (2006).

Making polluters or beneficiaries pay would not necessarily mean there would be no pollution. Preservation of the environment in its pristine condition is not possible where production occurs. In reality, any form of commercial and social activity, even human existence on this earth, cannot occur without causing some form of environmental change. As a result, pollution can never be totally eliminated in a society that extensively engages in production. Nevertheless, production can, at least, be sustainable and the level of resulting environmental degradation, tolerable. If externality costs were actually absorbed by the producer, either the good would become more expensive to consumers, or less of it could be produced. Correcting pollution means, either forcing producers not to generate or to reduce the level of pollution, or making producers absorb the pollution costs themselves.

7.4 Management responses

Many Pacific island countries have developed a *National Environmental Management Policy and Strategy*, and sector-specific legislation to guide their sustainable environmental management efforts, including effective governance of their coastal and marine resources, and ecosystems. Pollution control is usually attempted through standard command and control instruments, either banning the discharge or disposal of wastes in the environment, or regulating the level of pollutants permissible under law. However, such controls have generally been piecemeal, and implemented by different levels of government and sectors without coordination. For example, solid waste management in urban areas falls under local government or municipalities, as does human waste disposal. However, rural areas are not usually covered by local governments and often, there is no control or management of wastes.

More recently, some Pacific island countries have introduced market-based instruments, initially as a revenue-raising instrument to cover operational costs and fund waste management programmes. Waste generation fees, such as a fixed user fee are commonly used by many municipalities. The fee is usually unrelated to the volume, weight, or type of waste that is disposed. The fee charged is an attempt to recover collection and disposal costs incurred and it does not necessarily encourage the reduction of waste at source. This method has been used in Tonga where a flat fee of $10 per month per household is charged (Richards 2009). Likewise in Fiji, a city rate is paid annually to the local government and includes a fixed charge for household garbage collection.

Market-based schemes where the user fee is based on the amount of waste generated, provide an incentive for households to minimize waste, as in the case of waste management in Samoa. Tip fees are another example of a situation where a fee based on the amount of waste brought to the landfill site is applied at the point of entry to the landfill.

Some countries have begun to apply environmental levies to non-recyclable wastes, such as non-returnable bottles and plastics or even bulky items, such as cars. The green bag user pay scheme in Kiribati is an example of such an environment levy used to reduce the use and thus, the disposal of plastic bags in South Tarawa, Kiribati. The principle of 'polluter pays' is applied in an effort to make people internalise the external costs of plastic bags disposed in the environment.

Other countries, such as the Cook Islands have introduced environmental levies on foreign tourists (Box 7.3). This levy is included as part of a passenger's departure tax, or is a fee charged on cruise ships, based on passenger numbers.

Box 7.3
Environmental levy in the Cook Islands

In 1994, the Cook Islands government passed an amendment to its departure tax law, requiring the payment of an additional NZ$5 on the departure tax for everyone over 12 years from 1998. This money was paid directly into an Environment Protection Fund (EPF) which has successfully channelled significant funds over the years into conservation and environmental initiatives. As long as there is travel out of the Cook Islands to international destinations, the EPF will be regenerated from the departure tax thereby, ensuring a measure of sustainability for the fund.

Source: Richards (2009).

A deposit refund system can be used for collection of recyclable and reusable materials, such as beverage containers, glass, aluminium cans and PET bottles. Attaching a value to waste would convert a discarded item to a commodity and create market forces that encourage recycling behaviour and separation of waste. Implementation of deposit refund programmes provides opportunities and incentives for the involvement of the private sector, such as collectors.

A number of examples of this practice exist throughout the Pacific, for example the beverage bottle collectors who recycle beer bottles in Fiji. In Yap and Kosrae States of the Federated States of Micronesia, a charge of $0.06 is applied as a deposit fee for every aluminium, glass and PET cooking oil container. $0.05 is refunded for every container that is brought to the designated collection centre. A similar practice also exists in Kiribati, as shown in Box 7.4.

Box 7.4
A deposit - refund programme in Kiribati

A deposit/refund system on aluminium cans, plastic bottles, and car batteries exists in Kiribati. A small deposit is paid on purchase and 80 per cent of this is repaid when materials are returned to privately-operated depots. The recycling operator pays all costs associated with processing, handling and shipping, but recovers the value of materials sold. The government provides the operator with the money to pay the refund and the balance is used for any subsidies needed to pay for exporting the items for overseas recycling. This practice means that Kiribati has less waste going to its expensive landfill, less litter, and a source of income for unemployed.

Source: Richards (2009).

Reduction in wastes can also be encouraged through the use of subsidies to encourage the use of appropriate technology that helps reduce the level of pollutants and thus, external costs. For example, in Tuvalu, the use of flush toilets and poor septic tanks results in the contamination of ground water from human wastes. If the Funafuti Government subsidised the use of compost toilets, and compost toilets became socially acceptable, Tuvalu would make a savings of almost $AU2 million a year in reduced external costs associated with human health effects and poor drinking water quality (Lal et. al 2006). Other market-based instruments include tax incentives or subsidies which aim to create the right market environment for the private sector to participate in waste management. These may include, for example, duty-free concessions on imports of specialised waste management equipment, such as wood chippers or compactors, and tax exemptions or subsidies for new waste recycling ventures. On the other hand, disincentive taxes could be imposed on items used that are not recyclable, or where excessive use could be discouraged where the demand is price elastic.

A new 'state of art' landfill in Naboro which replaced the original Suva dumpsite in a coastal mangrove area.

In conclusion, use of a DPSIR analytical framework can help to illustrate broad societal drivers like globalisation, modernisation and consumerism that influence changes in lifestyle which lead to increased pollution and environmental degradation. The EBM framework helps explain geographic and temporal boundaries and the nature of the environmental effects of pollution. Economics concepts and analytical frameworks help in understanding the root causes of increased pollution. The presence of private goods, public goods, markets for tradable commodities and environmental goods and services with no market prices also help explain why there is excessive pollution and why market-based instruments based on 'polluter pays' or 'beneficiary pays' principles can be used to provide incentives and influence human behaviour to reduce pollution.

Nevertheless, environmental and resource economists would readily acknowledge that markets and market instruments cannot address all environmental issues. Environmental goods and services that are not allocated through well-functioning markets would require additional policy measures, such as regulatory standards to ensure that pollution levels do not exceed environmental threshold limits. Market mechanisms do not necessarily deliver economically efficient and environmentally acceptable outcomes, particularly when pollutants have long persistence and accumulate over time. Market instruments may not work when governance and governments are weak. An integrated approach to pollution control is thus, necessary for strengthening institutional designs that bring together market-based and command and control instruments and involve different levels of society and government, non-government and community stakeholders, as discussed in Chapter 9.

CHAPTER 8

Economics of Habitat Destruction

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Extensive destruction of mangrove ecosystem in the greater Suva Area, Fiji.

Degradation and conversion of natural habitats for other uses are a growing concern in the Pacific, albeit largely in urban and peri-urban areas. Degradation or destruction of natural habitats can occur when ecosystems are overexploited and/or drastically altered. Alternatively, degradation or destruction can occur if pollution and/or invasive species change the dynamics of the ecosystem.

As discussed earlier, increasing population, globalisation, and monetisation in the Pacific is leading to significant social changes, especially where accompanied by a growing need for income and a greater emphasis on material wealth. With such changes in social order, coastal ecosystems such as mangroves and other coastal habitats are under constant pressure from overexploitation and/or reclamation for hotels, industrial sites and human settlements. Coastal habitats are also affected by land-based activities, such as soil erosion, pesticide and nutrient runoffs.

Disturbance and degradation of coastal ecosystems such as mangroves, seagrass beds and coral reefs affect hydro-physical dynamics in the system which, in turn affect the supply of various ecosystem services such as nutrient and sediment filtering, nutrient cycling, primary and secondary productivity and the goods and services that are valued by humans. The socio-economic impacts of damage to coastal environments include increased economic and social losses from physical damage, reduced food security and loss of income from fishing, reduced tourism and other coastal and recreational activities. Significant changes in ecosystem services increase the vulnerability of coastal communities. The rate of change in coastal environments is also influenced by governance arrangements and national development goals, and a focus on rapid economic growth. In many instances, as individuals attempt to maximise their private benefits, they impose external costs on others, leading to habitat degradation and conversion.

The biodiversity and natural resources of coastal environments constitute the natural capital that underpins economies, societies, and individual wellbeing in the Pacific Islands; particularly in small island-developing states with limited land-based resources (see Table 2.1). However, the economic value of the various benefits provided by coastal environments is often overlooked or poorly understood, particularly as many of these benefits do not have market values. As a result, these benefits are rarely taken fully into account through economic signals in the market, or in day-to-day decision-making by businesses or people, nor indeed reflected adequately in the accounts of society (European Community 2008). This chapter focuses on root causes, consequences and responses to habitat degradation and loss of biodiversity from an economic perspective.

8.1 Economic rationale for loss and degradation of habitats

The development process can be seen as a reallocation of the initial portfolio of capital assets in order to generate alternative preferred flow of goods and services (Swanson 1995b). Conversion of natural environments into alternative uses thus, reflects the decision by the developer as to his/her preferred choice of flow of services (natural, physical and/or financial). Thus, in a market environment, the economic rationale behind the loss in valuable habitats and associated ecosystem goods and services can be seen in terms of the role of presence of public goods, poorly defined property rights and the absence of markets and market prices for many of the goods and services supported by such habitats.

In the Marshall Islands, for example, as population has increased and there have been changes in preferences in housing type, the demand for construction material has increased. Such construction materials are extracted from coastal areas where sand and aggregates are freely available as public goods and at minimal costs; people have easy access to the coastal areas because the beaches are a common property resource, where rules for extraction are either non-existent or not enforced.

While sand and aggregates in coastal areas can be replenished, high rates of extraction can lead to serious decline, habitat destruction and severe erosion problems. In the case of Majuro, no close substitute is available or where a substitute could be obtained, it would be at a much higher cost, such as through imports.

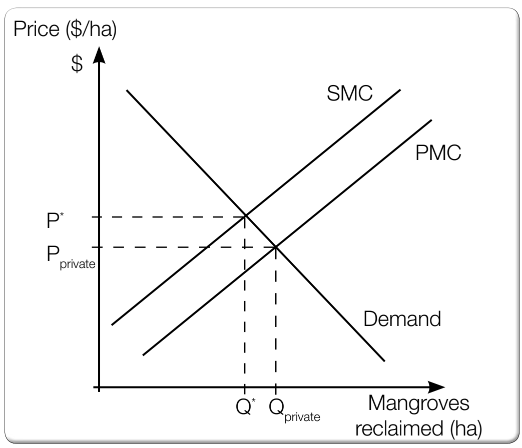
Figure 8.1 Reclamation of coastal area for tourism development in Momi, Fiji.

In Fiji, habitat destruction was originally associated with conversion of mangroves during the 20th Century, initially during the colonial period and then during early periods, following independence in the 1970s, undertaken primarily to create land for sugarcane and rice farming and aquaculture (Lal 1990). In the later part of the 1980s, large scale coastal habitat destruction has occurred from tourism and industrial developments (Figure 8.1). Such conversions were allowed by the government since the geographical areas on the land-water interface are not owned by any private individuals, thus there was no market for mangrove wetland habitats.

This is not to say that the mangrove ecosystems were not valued for the different goods and services supported by mangrove habitats. Mangrove forests are important ecosystems that provide direct and indirect benefits, both on-site and offsite. Many of the goods and services provided by mangroves are non-marketed and therefore, their values are under-estimated when making decisions about their conversion into alternative uses. In Fiji, the lack of clarity over property rights associated with mangrove forests in coastal areas has further added to this problem in Fiji (Lal 1990). Thus, the decisions to reclaim mangroves for alternative uses can once again be explained in terms of the private benefits of reclamation, without including the external cost considerations of coastal fisheries as shown in figure 8.2 where the social marginal cost (SMC) is much higher than private cost. Similar arguments can also be used to explain excessive harvest of coastal aggregates and subsequent destruction of coastal habitats in many PICs.

In the case of the mangrove reclamation of Fiji, unfortunately, neither sugarcane farming nor shrimp farming was viable on the reclaimed land, and reclaimed land has not been put to any use; effectively making the price of reclaimed land, zero. The externality costs associated with this reclamation, in terms of foregone forestry and fisheries were estimated at FJ$53,000 a year, while the cost of reclamation, alone, was FJ$181,000 (Lal 1990).

Figure 8.2 Reclamation of mangrove habitats and negative externalities.



In other cases, the value of mangrove reclaimed land for industrial development, tourism or waterfront housing developments was found to be very high and thus, could not compete with the in situ uses of mangroves for forestry, fisheries and even other ecosystem services. This has been the case in Fiji (Lal 1990) and Vanuatu (Francis Hickey, Vanuatu Cultural Centre: Per. Comm. May 2010).

A society may choose to allow reclamation of the mangrove foreshore for these high-valued uses on pure economic efficiency grounds, and when all ecosystems services have been accounted for and valued, and found to be less than the economic value associated with the alternative use. However, this may not be acceptable on social grounds when the foregone losses from forestry and fisheries are borne by one community, and the benefits of reclamation are obtained by a usually wealthier individual. Also, from a biophysical perspective, this reclamation may not be a desirable outcome, particularly when it involves increased exposure to coastal hazards or loss of biodiversity, the future values of which are unknown.

Degradation of ecosystems

Even where total reclamation of habitats is not involved, selective harvesting of species can result in eventual species extinction when the rate of harvest is greater than the rate of growth. Selective removal and destruction of particular species can also cause changes in many ecosystem services, causing additional externality costs. In the Solomon Islands, excessive selective logging of preferred species, sizes and grades (one logging company, for example, reported 83 per cent of its total harvest included *Pometia* sp. and/or *Calophyllum* sp. with diameters over 60 cm) has caused considerable erosion, land degradation and loss of biodiversity (Thistlethwait & Votaw 1992).

The environments of PICTs are already fragile and vulnerable due to their small size and increased pressure on natural resources and biodiversity. However, information about species diversity, extinction and ecosystem changes in the Pacific is poor at best. It is noted that even though the International Union for the Conservation of Nature (IUCN) Red-List provides most up-to-date collated information for PICTs, information on biodiversity in the region is generally either limited in accuracy and scope, out of date, or poorly documented (Kinch et. al 2010; SPC 2009; South et. al 2004.). Gaps exists for many coastal zone fauna and flora groups, such as seaweeds, mangroves, seagrass, marine invertebrates, such as echinoderms (starfish, sea cucumbers, sea urchins), sponges, worms, seahorses, pipefish and shore fishes such as damsel and parrotfish (Kinch et. al 2010). Only approximately five per cent of the 233 described fish species in the Pacific islands region have been assessed (and in only six PICTs), and of these, 22 per cent are listed as threatened (Kinch et. al 2010; Pippard 2009). Using IUCN Red List categories and criteria, Table 8.1 below shows the number of red-listed species groups in PICTs.

Table 8.1 Number of Red-Listed species groups for PICTs.

	Finfish	Coral	Birds	Sharks	Mammals	Turtles	Total
American Samoa	5	52	7	2		2	??
CNMI	5	47	6	2	3	1	??68
Cook Is	3	25	9	5	1	1	44
Fiji	5	87	2	4	2	3	103
French Polynesia	6	26	14	7	1	1	55
FSM	7	104	5	6	1	3	126
Guam	4	0	7	1		2	14
Kiribati	5	72	4	3	1	1	86
Marshall Is	4	66	5	4	2	1	82
Nauru	4	62	1	4	2		72
New Caledonia	7	83	7	15	3	1	116
Niue	4	23	8	2	2	1	40
Palau	6	97	2	5	3	2	115

Pitcairn Is	3	10	5	4	2		24
PNG	7	157	3	20	3	4	196
Samoa	5	51	1	5	1	1	65
Solomon Is	7	134	4	6	2	3	156
Tokelau	4	31	1	2		1	39
Tonga	6	33	3	3	1	1	47
Tuvalu	4	70	1	4	2	1	82
Vanuatu	6	78	1	6	3	2	96
Wallis & Futuna	4	57	8	1			70

Source: Kinch et al (2010).

Understanding ecosystem dynamics and sustainability and assessing the extent of ecosystem degradation requires a detailed understanding of the relationship between species and their habitats. Box 8.1 shows why sensitivity to ecosystem dynamics is important. Such an understanding also requires adequate empirical information about the relationship between changes in ecological conditions and the economic values associated with the associated goods and services.

Box 8.1
Sensitivity to ecosystem dynamics

Conserving biodiversity requires some sensitivity to how species interact with each other. An ecological community is neither a house of cards that falls apart when one species becomes extinct, nor a bag of independent particles. Communities have many keystone species in them, species whose removal leads to the loss of further species. Predators, pollinators, tree-hole borers, decomposers and so forth can all have a role in which other species depend on them, either for creating a resource, providing access to a resource, or ameliorating the impact of a predator or superior competitor.

Source: Roughgarden (1995).

Effect of rate of time preference

The decision to degrade an environment, convert coastal lands into alternative uses, or conserve the environment today can be understood in terms of the rate-of-time preferenc, or discount rate of people for consumption of a good or service, compared to conserving it for the future. A higher rate of time preference implies a person has a strong preference for consumption today, compared with consumption in the future; that is, the person has a high discount rate for the future. A high discount rate can lead to complete depletion of preserved or existing environments, with huge habitat losses and economic collapse, even if continued economic growth and permanent preservation is possible (Swanson 1995a).

Furthermore, when people are indifferent about conserving natural assets or converting these into, say financial assets in the bank, then they may decide to harvest and sell natural capital and put the income into the bank to grow at the market interest rate. Alternatively, a person may decide to convert natural habitat into physical assets, such as industrial development or tourist hotels which can provide higher returns. That is, people may be happy to substitute between different uses of a resource, depending on the relative returns from different forms of capital.

A relatively higher return on financial capital, compared with the growth of the natural asset would be likely to result in a lower stock of capital, being retained in the form of natural assets. Many examples of coastal development projects exist throughout the coastal areas in PICTs where mangroves and seagrass beds and inter-tidal flats have given way to reclamation of land for industrial development or for hotel development. In situations where individuals mine coastal aggregates for house construction, even when they know that their actions may subsequently cause erosion of their local foreshores and/or downstream areas, they are imposing negative externalities which suggest that they are discounting the future much more than if they retained these areas for their value as natural assets.

The shift from subsistence to semi-subsistence and to cash economies and/or changed lifestyles ultimately affect environments and resources, summarised in Table 8.2 below, outlining possible environmental damages and economic effects, resulting from degradation of coastal habitats.

Supply of biodiversity conservation

From the perspective of the supply of biodiversity conservation over the long term, there is no financial incentive for developers to ensure that conservation occurs on their own land or on public land. Under such situations where public goods exist, people cannot be assured of deriving the full benefits of providing public goods, due to the issues of exclusivity, enforceability and divisibility, as discussed in Chapter 5. A good example of this is the loss of biodiversity in Samoa due to excessive logging (see Box 8.2).

Box 8.2
Loss of biodiversity due to logging in Samoa

Uafato is a remote village on the main island of Samoa. The area contains a significant stand of ifilele trees which are otherwise degraded in most areas. The protection of the stand is considered to be globally significant and important for the protection of regional biodiversity. The ifilele can be considered as global goods in that, they confer international benefits.

Under the Samoan Constitution, Uafato village own the forest area where the ifilele stand grows. Until recently, this was used for timber for buildings, craft carvings and firewood; however, logging rates were estimated to be unsustainable due to the weak nature of the existing communal property rights. Eventually, the area was declared a conservation area, using funds provided under the South Pacific Biodiversity Conservation Programme with only carvers being permitted to log the trees. This arrangement protects the biodiversity and representativeness of the trees. An external fund was established to carry out this task in order to ensure sustainability.

Until the biodiversity conservation solution was reached, the original property rights system had several weaknesses in relation to exclusivity, enforceability and divisibility which created incentives for excessive logging.

Biodiversity conservation is seen as a public good. The cost of conserving ifilele would be borne by the land owners who have to forgo the harvest of trees for their own use. On the other hand, the international and regional community may derive existence and future options value from the conservation, without having to bear any costs for the benefits they derive. They would free-ride on the sacrifices made by the ifilele owners.

This can be illustrated once again, using the supply and demand curves for biodiversity illustrated in Figure 8.3. The market demand curve is represented by vertical summation of the two individual demand curves (A+B). This is because everyone can simultaneously consume the same amount of biological diversity. The market demand is the sum of the individual amounts of money each one is willing to pay for biodiversity protection. An efficient allocation will maximise the net benefits represented by the portion of the area under the market demand curve, above the Marginal Cost (MC) curve. The allocation that maximises net benefits is Q_{all}, where collective demand curve intersects the supply, (MC curve above the demand curve ($Demand_{all}$), and the respective prices are charged.

However, public goods are usually undersupplied if left to individuals or countries only, as illustrated in Figure 8.3.

If consumer A is charged according to the demand price OA, and consumer B is charged OB, then both consumers will be satisfied with the efficient allocation (maximising their net benefits given the prices). Although an efficient pricing system exists, it is very difficult to implement because this requires charging a different price to each consumer. This is because biodiversity as an ecosystem service is not excludable where consumer preferences cannot be easily revealed. Therefore, the producer could not possibly know what price to charge.

Inefficiency results because each person is able to become a free-rider on the other’s contribution. A free rider is someone who derives the benefits from a commodity without contributing to its supply. Because of the consumption indivisibility and non-excludability property of the public good (ecosystem service), consumers receive the benefits of biodiversity protection (purchased) by other people. This tends to diminish incentives to contribute and the contributions are not sufficiently large enough to finance the efficient amount of the public good therefore, it would be undersupplied.

Source: Lal & Holland (2010).

Figure 8.3 Supplying biodiversity as a public good.

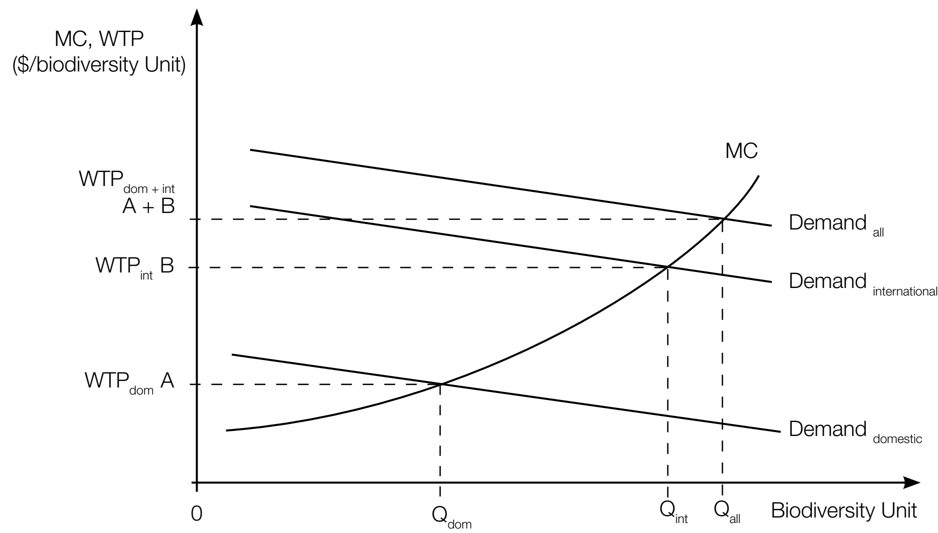


Table 8.2 Damages, economic activities, and possible economics effects attributable to degradation of coastal habitats.

Damages	Economic Activities Impacted	Possible Economic Effects	Loss of Economic Value, Welfare Losses
Damage to Habitat			
Decrease in productivity and biological value e.g. coastal areas near urban centres	Subsistence and commercial fisheries, recreational users, consumers of fish and marine products	Decrease in value of production/ biomass; decrease in Catch Per Unit Effort (CPUE); increase in effort, increase cost per unit of output; decrease economic surplus	Lost value from declining productivity; lost value from declining services; decrease in producer surplus, rent, and consumer surplus
Damage to fish and invertebrates: increase in mortality and fish kills	Subsistence and commercial fisheries, local markets	Value of forgone harvest, decline in economic rent, increased production cost, existing opportunity cost of fishing activity, lost market value of portion of products/fish killed	Lost producer surplus from forgone harvests, increased production costs to alternative fishing areas, lost consumer surplus from decrease in supply and higher prices
Disease and abnormalities	Subsistence and commercial fisheries	Demand effects: possible decrease in local demand e.g. contaminated shellfish; possible decrease in price and revenue	Lost producer surplus from increased cost of sale and decrease in demand
Abundance and distribution	Subsistence and commercial fisheries, recreational fishery	Decline in CPUE, decline in revenue, decline in economic surplus, increase in production cost to offset reduction in abundance	Decrease in producer surplus, decrease in supply, increase in effort, decrease in economic surplus, and non-use values
Damage to Public Health			
Pathogens in water, metals, mercury in fish	Public health	Increased incidence of gastrointestinal disease, increased number of cases; cost of medical treatment, sick days at work, value of lost earnings, value of lost productivity to employer	Cost of medical treatment, value of lost earnings, or value of lost economic surplus to avoid illness; discounted cost of medical treatment, present value of lost earnings, present value of lost productivity

Damage to Beach Use			
Debris, plastic bags, garbage wash-up, leading to algal blooms	Public health, recreational activities, travel and tourism	Possible increase in congestion cost at unaffected beaches due to increased use; decrease in local tourism, decrease in demand, economic surplus and revenue in communities affected by the area	Net loss if producer surplus associated with affected communities exceeds gains in producer surplus associated with unaffected communities
Noxious or foul smells	Public and private property	Aesthetic: reduced economic surplus due to smell, decreased demand for housing	Reduced value of amenities associated with property in close proximity to contaminated sites

Source: Adapted from Ofiara &d Seneca (2001).

8.2 Commonly used management approaches for biodiversity conservation

Conservation of biological diversity and ecosystem protection has been at the core of much of the environment agenda in the region for decades. Essentially, two types of approaches have been used, a top-down command and control approach, and community-based management. These approaches are described below.

Top-down command and control management

The most direct approach used to manage habitat destruction and biodiversity conservation has been through the use of legislative controls, using regulations and institutional processes. Creating a legislative framework allows governments to manage environments and resources by setting safeguards, in terms of conditions, constraints and limitations on resource use and access. This process involved establishing environment authorities to develop legislation and administer environmental programmes.

Command and control approaches have taken the form of legislation and associated regulations and by-laws, either imposing total prohibition and/or putting a control on outputs (and thus, the level of degradation on the habitat) and/or inputs. As discussed above, in the case of fisheries, management these could essentially increase marginal costs. In the case of control on inputs, the effects may be negligible if there is no substitution of inputs. Such restrictions on inputs and outputs may not have much of an impact on the status of the environment if the commodity is inelastic to changes in price.

Governments throughout the region also commonly use Environmental Impact Assessments (EIAs) as a means of controlling environmental quality. Essentially, governments use EIAs to try to proactively identify environmental impacts, with the intention of helping to change the design of the intended development in ways that minimise its environmental impacts. Although EIAs are typically used in cases involving large development projects, the assessments are often regarded by developers as just a formality. In a number of cases, the EIAs requirements have been 'on paper' only, and the approval processes have not been transparent, particularly when developers go through the administrative requirement only. Governments also do not have adequate resources or technical capacity to carry out ex-post appraisals of the development activities, or to ensure that the recommendations of the EIA reviews are adequately taken into consideration.

There are several examples of failed coastal projects in the Pacific where an EIA was either not done, or was not comprehensive enough to minimise environmental degradation. An example of such a project with irreversible consequences is the removal of large areas of mangroves in Ravi Ravi, northwest of Viti Levu Island in Fiji. Mangroves were converted into aquaculture ponds for prawn farming without proper assessment of soil conditions. Several million dollars of aid funds were put into the development and maintenance of the farms by different donors and the Fisheries Department. The project ended up with disastrous outcome, not only did the country lose valuable mangroves, but no prawn farming was possible because of the development of acid sulphate soil conditions. The land has now become a barren wasteland with very poor soil that will require several million dollars to rehabilitate (Lal 1990).

In an effort to develop more proactive approaches to the management of natural resources, most governments in the region have focused on developing national environmental plans and strategies. Programmes on biodiversity protection under the Pacific Action Strategy for Nature Conservation now play a key role in promoting biodiversity conservation in the region, following the signing of the Convention on Biological Diversity and international support provided for the development of National Biodiversity Strategic Action Plans (NBSAPs). NBSAPs included strategies for the declaration of national parks, including marine-protected areas, management of turtles and species recovery programmes for endemic and endangered species such as birds and control of invasive species (Thistlethwait & Votaw 1992).

The effectiveness of such efforts appear to be related to institutional capacity as well as the relative status of the agency in the government administrative hierarchy, i.e. whether the agency operates at departmental level or at Ministerial level. In countries where agencies operate at the Ministerial level, agencies appear to have attracted greater funding, have a more effective institutional structure and have progressed initiatives in more varied areas of environment management than those environment authorities which operate at the departmental level. In the latter case, legislative reforms and policy change has been much slower because the lower departmental level is more or less a policy implementing agency rather than a body that sets policy agendas.

For example, in Micronesian countries environment management legislation was implemented by environment protection agencies established at a Ministerial level. In Fiji, on the other hand, until the environment agency was established at a departmental level, the legislative reform process had been much slower. Commonly, most countries lack the capacity and necessary resources to effectively implement their environment legislations. Despite developing legislative and regulatory frameworks, effective implementation of environmental policies under command and control approaches is undermined, and therefore ineffective. Monitoring and enforcement are constrained by lack of necessary resources, such as enforcement officers and the judicial process is slow with limited technical expertise for dealing with environmental offences. Offenders continue to violate legislation, either because they are unaware of compliance requirements, or because they know that they can increase private benefits without being apprehended and penalised. The effectiveness of command and control approaches thus, also depends on adequate institutional capacity to monitor and enforce the relevant regulations and violations appropriately penalised.

Community-based Marine Managed Areas

In response to the several, not-so-successful top-down management cases, focus has shifted towards community-based conservation projects which usually draw on traditional resource management systems and communal resource ‘ownership’ or communal property rights system. In these projects, the emphasis has been on empowering local resource owners and communities to identify key issues, analyse problems, identify management options and then select the preferred options and institutional rules for managing the protected area in question, including using *tabu*. Initially, community-based projects did not have any legal or formal status. However, efforts have recently been made to build on informal customary systems to create a more formal legislative foundation, such as has occurred in the Cook Islands and Samoa, as described below.

The *Ra'u*i system in the Cook Islands

The *Ra'ui* is a traditional resource management system in the Cook Islands that creates a ‘marine reserve’ or a protected area. Under a *Ra'ui* system, the traditional chief essentially places controls on the quantity of the resource that can be harvested, in response to declining fish stocks, or in the expectation of the need for increased effort for some social reason. Such a system allows stocks to recover and/or prevents stocks from extinction. Because the control is placed at the local level, monitoring and enforcement is locally sanctioned thus, increasing the chances of effective control. Compliance with the *Ra'ui* is achieved through basic awareness and the use of traditional authority to require respect for custom.

The Rarotonga Local Government Act (1997), the Outer Islands Local Government Act (1987), and the Marine Resources Act (2005) accord powers to the Island Councils to pass by-laws for the management of fisheries. These institutional structures provide a legal framework for governance. The legal system however, does not specifically acknowledge traditional fishing rights or ownership and thus, in essence, does not create formal property rights. However, it does indirectly recognise such systems by way of practice of traditional custom by giving authority to the Island Councils and the *Vaka* Council. The Cook Island's Environment Act 2003 also promotes the establishment of protected areas, such as the *Ra'ui* as a form of community-based fisheries management. However, regulating the exploitation of resources outside the *Ra'ui* is also essential to secure the sustainable use of those resources and to maintain the ecological integrity of the coastal marine environment.

Community-based management of protected areas, based on delegation of powers to traditional leaders and district councils can thus, help to promote an integrated approach to resource management, even if the local property rights may not have legal standing. Local area management plans can nonetheless be used to implement such integrated approaches by coordinating activities, such as the extraction of nearby resources, minimising pollution and promoting nature-based tourism-related activities. However, the motivation for establishment and management of *Ra'ui* can be undermined if the surrounding areas are unregulated and remain open access.

Village by-laws in community-based fisheries management in Samoa

Increasing use of destructive fishing practices in Samoa has led to the deterioration of communally owned fishing grounds and a serious decline in fisheries resources. The government of Samoa responded to these impacts by decentralising coastal fisheries management by building on *Fa'a* Samoa, or the 'Samoan Way'. *Fa'a* Samoa is a customary form of social grouping and decision-making where the chief plays an important role in the village council (*fono*). The council of chiefs set village policies and impose traditional punishments on villagers for violation of rules over communally owned resources.

The decisions of the village *fono* are based on the principles of social justice, customs and usage, and traditional fines are imposed by the village *fono* on offenders, such as payment of pigs, taro and other food crops. These traditional rules are incorporated into village by-laws to give them formal recognition and thus, if traditional rules are disregarded or offences are serious enough, village chiefs can take the matter to a court for determination. The traditional rules are easily monitored and enforced at the local village level, unlike in the case of top-down centralised fisheries management arrangements. Villagers are free to engage in their own income-generating activities and thus, have the incentive to maximise their income within the rules, stipulated under the traditional management system. The village by-laws represent an effective fisheries management tool for addressing conservation and management problems, implementing enforcement and monitoring the fishing activity of village residents.

However, community-based projects are not always successful (Baines et. al 2002). This has particularly been the case in projects that have been externally driven with the protection of biological diversity as the main objective, and where the benefits of the project have been diffused because there is only a tenuous link between conservation and individual welfare. Often such projects have included ecotourism as an afterthought and thus, little attention had been placed on key issues, such as individual incentives, free-rider problems and inequitable distribution of income between members of the community involved often resulting in institutional failure. In many countries, much of the land and coastal resources are customarily owned and have not been formally surveyed and demarcated thus, boundaries are often disputed, even if a community's claim of ownership over the resource may be known. At times, disputes arise because of people's tendency to free-ride on other people's efforts, principle agency behaviour and/or rent seeking (Lal & Keen 2002; Lal & Holland 2010) [See Box 8.3].

Box 8.3
Community-based conservation area management project: a case of inequitable distribution and conflict, Kosrae

The Utwe-Walung conservation area is located on the south-west island of Kosrae. The area contains the most pristine mangroves, marine and wetland ecosystems on the island, and possibly in the Federated States of Micronesia. It contains unique and deep marine lakes that link the Utwe and Walung harbours. The area has rich biodiversity and thus, a high ecological value. The Utwe-Walung Conservation Area Project (CAP) was developed under the South Pacific Biodiversity Conservation Programme (SPBCP) with the help of external agencies, such as the University of Hawaii Sea Grant Program, the Nature Conservancy, and the South Pacific Regional Environment Programme.

The objectives of the protected area were to maintain the diversity and abundance of living things, incorporating sustainable development initiatives, such as ecotourism. Mangrove and island tours were developed and marketed in cooperation with the Kosrae Village Resort and other key stakeholders, such as representatives from the Utwe and Walung villages.

The project was not entirely successful, resulting in:

- a false sense of exclusive ownership of the CAP by an elite group (especially from Utwe) - rent seeking
- a lack of genuine community participation and involvement in the CAP decision-making
- marginalisation of the Walung community from the CAP decision-making and activities

The project led to tension and friction between the two communities. Firstly, Walung villagers lost interest because of lack of benefits flowing to them. The tourist centre that was intended to generate ecotourism income, being situated in Utwe, created some resentment among the Walung residents. Secondly, many of the Utwe-based ecotourism tours traversed the more pristine mangrove areas of Walung (SPREP 2001, p.11) which seemed to add to the resentment felt by Walung residents. Thirdly, there was an apparent lack of project activities in Walung. Fourthly, there was a lack of benefits flowing to Walung. These reasons are frequently cited as ‘the root cause [of] the waning interest in this community [Walung] in the CAP.

Source: SPREP (2000); SPREP (2001); Lal & Keen (2002).

Bottom up: Locally-Managed Marine Areas (LMMAs)

The Locally Managed Marine Area approach (LMMA) is based on the concept of a ‘marine-managed area’, as opposed to a ‘marine-protected area’; the latter is often seen to suggest a sense of permanence and total exclusion of human activity. The LMMA approach incorporates the idea of an adaptive approach to local management of the environment. It may not necessarily have any legal standing.

The LMMA approach uses a multi-pronged approach to environment management:

- identifying a community’s aspirations, capacity, resources and perceptions of benefits of participating in resource conservation strategies, usually as the starting point of the LMMA process
- raising awareness amongst the local communities about conservation and building their capacity in environment management
- adopting stakeholder-based decision-making processes to design management of their LMMA, extending their traditional decision-making system (stakeholders may comprise members of land-owning groups, traditional leaders and government representatives, conservation organisations, elected decision-makers, women and youth representatives)
- adopting a diversity of management tools, essentially similar to ones used in top-down MPAs but in their own local context, using instruments, such as creation of ‘no take’ areas, marine reserves, sanctuaries, species-specific harvest refugia and effort controls (LMMA tools may also involve reduction in the issuing of fishing licences, gear restriction and bans on destructive fishing practices)
- using local system of monitoring, control and surveillance (MCS)
- engaging with adjacent communities thus, extending the LMMA to reflect ecological connectivity and increase the scale and potential for conservation
- using information-based management, including empowering local community members in the use of simple methods of conducting surveys, stock assessments and monitoring, with external resource persons playing advisory roles. Communities, however, may not always necessarily choose a conservation site based on science advice; practical and logistical considerations are also important

The concept of LMMAs is spreading throughout the region although, with different degrees of success. In Fiji, a national network of Non-Governmental Organizations (NGOs) and government and other institutional organisations are promoting LMMA as the main basis for managing coastal fisheries resources. More than 200 villages over 14 provinces have established some form of community-based resource management (Govan et. al 2009). Some villages have formally become part of the LMMA network and their areas are locally known as FLMMA (Fiji's Locally-Managed Marine Areas), while other villages are practicing some form of traditional resource management, albeit, with varying degrees of success.

The main driver encouraging introduction of a LMMA approach is the desire of communities to maintain or improve livelihoods, often in response to perceived threats to food security or local economic revenue (Govan et. al 2009). The strength of the LMMA approach lies in its dependence on traditional ecological knowledge, culture, custom and leadership. LMMA also provides a forum for reviving and strengthening traditional governance systems at the local level, while benefiting from the more contemporary management measures based on sound scientific investigations. The essentially community-driven nature of the LMMA approach enables communities to make decisions that will help to improve community welfare and long-term sustainability.

The success of LMMA approach is likely to depend on the level of dependence on the natural resources in question and thus, the nature of incentives locals have to participate and invest their energy in, conserving communal resources for the communal good. As the management depends on local processes, the strength of traditional leadership and the ease of consensus building in the community are also important. The level of external support is also an important consideration for local participation in the LMMA (Govan et. al 2009).

However, the voluntary nature of the LMMA approach may limit its overall effectiveness. For example, stakeholders managing the implementation of LMMAs may find the opportunity costs of their engagement are high, as they face additional costs from the slow pace of development, the need for frequent site visits, evolving community attitudes, and shifts in the distribution of costs and benefits among community members. Such issues have not been adequately considered in LMMA approaches.

The self-sustaining nature of the LMMA approach is yet to be determined, particularly when the intended conservation objectives are achieved. A key question will be, what will happen to those people whose fishing areas are displaced and whose livelihoods are directly affected by the LMMA? Alternative livelihood opportunities need to be identified and pursued to provide the necessary incentive mechanism for people to adhere to conservation rules.

The LMMA approach is also seen as a biological model that ensures stock conservation in designated areas. However, LMMAs often do not have authority to manage potential impacts on the marine-managed area which occur outside the MMA boundaries. This lack of control may undermine the efforts of community members. Poaching outside of MMAs or free-riding has been a common problem for management of LMMAs. The rights of communities are limited to their designated fishing areas, and only those communities that agree to implement LMMA can establish protected areas. The neighbouring communities that are not part of LMMA network and those from outside the community continue to either poach at night or increase fishing effort just outside of the protected areas. This therefore, limits the potential effectiveness of LMMAs [see Govan et. al (2009) for further discussion].

Integrated island resource management

In contrast to the LMMA approach which has largely focused on coastal areas, some effort is currently being made to take a more holistic island-based management approach, such as on Gau Island in Fiji. The project involves collaboration between the International Ocean Institute (IOI) - Pacific Islands, village committees in Gau and other research partners. The project engages local communities in the management of their environmental resources as a basis for sustainable development (Veitayaki et. al 2010).

Following awareness workshops carried out as part of the project, the villages have produced their own action plans, involving declaration of 'no-take' areas in six villages and settlements. The village plans have been endorsed by all villages involved and form the basis of resource management plans for the entire island. In addition to determining their own development strategies, local communities are also encouraged to learn and benefit from outside experiences, such as adopting better scientific advice. In a number of cases, local communities have formed committees to look after resource management issues, as well as village development in general (Veitayaki et. al 2010). Projects undertaken by communities range from resource conservation and waste management to alternative livelihoods, and include the following:

- establishing no-take marine areas
- constructing a stone breakwater to prevent coastal erosion
- coastal reforestation by replanting mangroves
- monitoring of wildfire
- installing smokeless stoves to reduce firewood requirements
- protecting the water catchment by maintaining forest cover
- planting pandanus for making mats as an alternative income source
- managing village waste and effluent discharge through digging pits, improving drainage and sorting and composting waste
- planting taro and cutting copra as alternative income sources to reduce fishing pressure
- engaging youth in cattle farming to diversify economic activity

The Gau Island project aims to bring about an integrated approach to island development and management, adopting the concept of 'ridge to reef' through various projects. Such an approach would help communities to consider the negative and positive externalities associated with different activities without necessarily explicitly undertaking benefit-cost analysis. Adopting a bottom-up approach to management would also help ensure equitable distribution of benefits, as well as minimise the potential for conflict. Monitoring and enforcement costs would also be reduced thus, encouraging the communities to move towards efficient and sustainable use of their resources, particularly when the marine environment is a public good. Co-operative approaches, such as networks of protected areas and joint management regime for enforcement and monitoring, can be more cost-effective.

It is also hoped that such community-based projects will be self-sustaining after development partner support and external funding is withdrawn and management institutions are built on local customs and traditions. It is however, too early to assess the effectiveness of such an approach, including the effectiveness of individual development and/or management strategies, particularly when a range of activities are being carried out under the project.

Reimaanlok Framework for management of coral reef biodiversity in the Marshall Islands

Marshall Islands comprise of 29 low-lying coral atolls scattered over a vast ocean area and has some of the most pristine coral reefs systems in the world. These have become threatened by factors such as climate change and sea-level rise, increased urbanisation and loss of traditional subsistence lifestyle (Govan 2011). Marshall Islands has been faced with the challenge to meet local needs and, at the same time, meet the international commitment to establish a national protected area network.

A range of conservation initiatives have been implemented in the past with varying degrees of success. As a result, the local communities decided there was a need for an over-arching framework for conservation area planning that could provide the direction for national agencies on how to engage local communities and international donors.

To address the need, a *Reimaanlak* ("looking to the future together" in Marshallese) was developed as an overarching national framework with various stakeholders and with a series of workshops and consultations as part of capacity building. The *Reimaanlak* is seen as a 'hybrid' approach to resource management which combines the strengths of coastal communities together with modern planning. In this national process, it was decided that priority conservation sites would not be identified because "the biodiversity of each atoll is important to those people who live on it, all atolls have areas worth conserving and only community and landowners of the atoll have the right to decide which sites they will conserve" (Govan 2011).

The incentive of local people to protect their local areas that are important to them would depend on how well informed they are about the resources and potential benefits from protection, and what benefits can accrue to them directly and indirectly from protection.

Large scale network of protected area: The Micronesia challenge

There has recently been a push in the region to establish large networks of protected areas with the aim of implementing comprehensive programmes to prevent resource degradation and loss of biological diversity. The Micronesia Challenge, for example, was launched in 2006 as a commitment by leaders of the five Micronesian countries: the Federated States of Micronesia, Palau, the Marshall Islands, Guam, and the Northern Mariana Islands. Under the Challenge, the five countries have agreed to conserve at least 30 per cent of the near-shore marine resources (and 20 per cent of the terrestrial resources across Micronesia by 2020) [see http//www.nature.org], essentially by:

- identifying the locations with the most biodiversity and biggest threats that need protection;
- establishing protected-area networks, guided by scientific information and developing management plans for those sites; and
- training local people and communities to protect marine and coastal areas.

As part of its commitment to the Challenge, Palau has developed a comprehensive protected-area network plan, and has identified Lake Ngardok (which supplies drinking water to the capital) as its first site and the State of Yap in FSM has created the Nimpal Channel as a marine conservation area.

Such declarations of reserves essentially would put restrictions on resource use with the aim of controlling habitat degradation. As seen earlier, their effectiveness will depend on the extent to which such restrictions can be monitored and enforced. It will also depend on the how people dependent on those resources are compensated. That is, the nature of incentives created to ensure that people keep out of the area and yet be able to meet their income needs and development aspirations. The operational framework of the Micronesian Conservation Trust fund will be a critical factor in the success of the Micronesian Challenge. Each of the countries involved are also developing their own approach to sustainable financing for conservation initiatives.

As the benefits of biodiversity conservation in these countries are also global, the Micronesian Challenge countries are hoping to draw on the 'beneficiary pays' principle, and attract international financing, as well as creating a Conservation Trust Fund. The success of the Challenge in conserving the biological diversity of the sub-region would thus, depend on the extent to which these countries are able to capture the economic values associated with the international public good and the incentives created locally to conserve the resources, as well as the costs and benefits of monitoring and enforcing the regulation.

CHAPTER 9

Coastal Zone Management: Integrating Economic Considerations

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Mangrove replanting can help protect coastlines.

Governments and communities have recently begun to explicitly consider economic dimensions in natural resource management, particularly in the use of user/polluter fees and consideration of externality costs in benefit cost analysis.

9.1 Use of economic instruments

Many countries in the region have, as discussed earlier, recently introduced user fees for national parks, marine parks and waste management, essentially applying 'user pays' or 'beneficiary pays' principles (Box 9.1). While the focus of such user fees have been on revenue raising rather than controlling effort, in some cases, the revenue raised has been hypothecated towards the management of the protected areas (Lal & Holland 2010).

Box 9.1
Examples of using economic instruments for biodiversity conservation

In the Cook Islands in 1994, the government introduced an environment departure tax to be deposited in the Environment Protection Fund. (In 2000, this environmental departure tax was worth NZ$5 of a total departure tax of NZ$25.) Although the revenue from the tax went into general revenue, it was earmarked (or 'hypothecated') for activities to conserve and protect the natural environment. More specifically, the funds were hypothecated for the protection of the reef and foreshore, soil conservation and the protection of land and sea.

The Republic of Palau introduced diver fees, whereby divers pay a weekly user fee of $15 to the local authorities concerned. Of the collected fees, 50 per cent is used to protect and preserve the area, and the other 50 per cent is used to compensate the local population for restricting other uses of the resource. This dive fee has raised $40 000 per year, on average, and has been used to improve local environmental and social conditions (Levett & McNally 2003).

User or access fees can work well for small communities that own natural resources and that wish to manage the exploitation of the associated goods and services.

In Fiji in 1997, the Rivers Fiji Co. established adventure tours to rural highlands and coastal areas of Navua. The three villages involved worked with the tour company and set up the Upper Navua conservation area. They also introduced user fees with part of the payments being paid directly to land owners. In addition, the annual payment for a 50-year lease on the 17 kilometre corridor of the conservation area is paid directly to the Native Land Trust Board which represents the interests of the traditional land owners (Lal & Holland 2010).

Similar private sector-community partnerships can also be found along the Coral Coast in Fiji, where coral replanting projects associated with the tourism industry, not only help in rehabilitation of degraded habitats, but also serve as a means of generating income from tourists who pay to plant corals.

Source: Lal & Holland (2010).

9.2 Use of economic analysis to make informed choices

Economic analysis has been primarily promoted and/or used in regional projects, particularly in relation to water and waste management and disaster management. Development partners, such as ADB and the World Bank, regularly use cost-benefit analysis of their projects as a standard tool to make more informed choices. Although such economic analysis provides valuable information for externally-funded projects and is supported by regional organisations, cost-benefit analysis is generally not an integral part of resource and environment management decision-making in the Pacific (Lal 2003; Lal 2004; Lal et. al 2009a).

Waste and water catchment management

A regional integrated approach to marine resource management was initiated by SPREP in 2000 under the International Waters Programme (IWP). This programme examined marine resource management through incorporating coastal and oceanic components into an integrated approach. The Coastal Programme considered three overarching trans-boundary concerns, i.e. degradation of water quality, unsustainable use of living and non-living resources, and degradation of critical habitats.

A project cycle approach was used to identify the main drivers of coastal issues and to determine the root causes of the problems and appropriate management responses needed. The IWP addressed environmental issues through a number of strategies, ranging from capacity building, identifying cost-effective policy reforms, and carrying out cost-benefit analysis of coastal activities to better inform policy decisions.

Cost-benefit analysis was used as a diagnostic tool to gain a better understanding of the causes of environmental degradation and its social and economic consequences in several studies (Hajkowicz et. al 2005; Lal et. al 2006; Lal & Takau 2006). Cost-benefit analysis in Tonga helped to better identify and explain the environmental costs and benefits of waste management and the value of introducing appropriate charges for waste collection from residential areas. An economic valuation of water resources in the Cook Islands (Hajkowicz & Okotai 2006) helped to gain required community and government support for a more coordinated and cooperative approach to natural resource management. The cost-benefit analysis also provided basic information for raising awareness through a strategic communication campaign (Holland & Parakoti 2006).

Similarly, cost-benefit analysis was used by an international NGO, the Foundation for the South Pacific International, to generate information for advocacy purposes, targeting the harvest of live coral and rock for aquarium trade. Case studies in Fiji (Lal & Cerelala 2005) and in the Solomon Islands (Lal & Kinch 2005) assessed the net benefits of harvesting aquarium trade products in the wild, as compared with the net benefits derived from cultured products. In both cases, the results showed that locals will have little incentive to switch to mariculture of coral products for the aquarium trade because the net benefits of cultured products were only a fraction of what could be earned from harvesting the coral from the wild. However, despite such results, the NGOs still continue to promote mariculture of live coral and rock.

There are many examples of cost-benefit analysis of individual projects throughout the region, but the practice has not been mainstreamed, nor have governments, NGOs, and other institutions been able to adapt and apply cost-benefit analysis approaches to larger projects and programmes because of limited funding, capacity, and/or limited or no follow up of the project (Holland 2009; Lal et. al 2009b).

Nonetheless, a recent analysis by Lal & Holland (2011) of two waste management case studies supported by IWP reaffirmed that, even if regional policies on mainstreaming economics in environmental management processes have been agreed to at the Forum Leaders level, economic considerations must be explicitly included in projects for them to be successful. Economic considerations need to be systematically integrated into the entire project development process and not at the tail end of a project. Lal & Holland (2011)) also notes that it is important that resource and environmental economics expertise are sought for the initial 'problem-root cause-solution' analyses stages, as well as at the project and policy design stages.

Although national capacity in resource and environmental economics may be limited, broader appreciation of the importance of economic analysis in underpinning resource and environmental management decisions can be enhanced through well-designed and implemented economics analysis used to inform government policies, such as those in Tonga and Tuvalu. Basic understanding can also be acquired relatively easily through 'hands on' and targeted short training courses. Once the power of economics is demonstrated, governments may be more willing to embrace mainstreaming economics, as illustrated by the following observation made by the Secretary of the Ministry of Finance, during the Development Coordinating Committee meeting where the results of the study on the economic costs of poor human waste management in Tuvalu, were presented:

> ….projects in Tuvalu should follow the same path, encouraging the introduction of BCA [in other resource management projects]. (IWP Tuvalu, personal communication between PMU Natural Resource Economist, and the National Coordinator, reported in Holland (2006): p 31).

9.3 Economics of coastal protection and disaster assessment

Many coastal goods and services are poorly priced or do not have a monetary value because they are not traded and therefore, their values are not appreciated. As discussed earlier, such goods and services are over-exploited or undersupplied. In an effort to encourage the internalisation of the values of such environmental goods and services, over time SOPAC has supported cost-benefit analysis of project and policy options, involving non-living resources, such as coastal aggregate mining, and disaster risk management (Holland 2008; Holland & Parakoti 2006; Holland & Woodruff 2006; 2008). Such projects included, for example, a feasibility assessment of lagoon dredging and aggregate mining (Greer Consulting Services 2007) and economic assessments of the costs of floods and flood management options (Holland 2009).

Usually, such exercises have been add-on sub-activities to externally-funded projects to assist PICTs to better understand the environmental costs of poor resource management, and to make informed decisions on the choice of appropriate environmental policy options related to non-living resources. In most situations, PICTs do not have institutional arrangements for enabling such cost-benefit analyses to be an explicit element of project cycle assessments which underpin key development decisions. Nonetheless, such studies have generated valuable information for mainly advocacy purposes, if not to support key policy decisions.

9.4 Disaster risk management and climate change adaptation

Cost-benefit analysis and other forms of economic analyses are usually undertaken or required by development partners such as the ADB and World Bank before they provide grants or loans. Most recently, these have been observed in projects related to disaster risk management and climate change, including climate proofing of infrastructure projects (ADB 2005; 2010; World Bank 2000b 2010).

PICTs have acknowledged that climate change is a development issue which requires a systems approach to address the potential impacts on different aspects of life, including livelihoods dependant on coastal areas. Many of the economic analyses of coastal adaptation measures produced have been carried out to support decisions for development assistance, without economic considerations necessarily becoming mainstreamed at the national level. There is little or no capacity in countries, or at best, limited capacity in the region to undertake economic cost-benefit analysis of disasters, climate change, and/or adaptation options as an integral part of the national decision-making processes (Lal et. al 2009a).

The World Bank proposes both top-down and bottom-up approaches that involve community participation (Bettencourt et al 2006). Building on the traditional customary practices of communities can provide an effective basis for hazard risk management. For example, obtaining the agreement of communities to voluntarily agree to create setback lines from the high water mark may be more successful than governments attempting to impose command and control measures, such as zoning restrictions. Therefore, there are very close synergies between addressing coastal zone management issues and addressing climate change adaptation issues. For example, risk management for natural hazards is cost-effective when it is integrated at an early stage into investment plans, particularly if risk management leads to damage from disaster events being averted. This though, will not be without challenge as, in the Pacific there are some critical knowledge and institutional gaps (ADB 2009b).

In addition, incorporating environmental standards and safeguards, and adapting the structural design aspects of projects to minimize risk and damage, are essential elements of adaptation and mitigation measures to reduce long-term risks from climate change. Such measures can improve the viability of investment projects to support economic development. It is important for Pacific countries to recognise the need for long-term strategic planning, using available advances in technology to minimise long-term risks and damage from climate change. From an economic perspective, climate change mitigation and adaption is about taking a systems view of drivers, impacts and responses, as well as incentives and other factors that influence people's adaptive behaviour towards risks.

Concluding remarks

Coastal management is a complex concern because social, political, economic and physical factors simultaneously have an impact on the environment. These occur at different levels of governance and, in turn, influence how policy decisions are made and implemented. Using the integrated DPSIR, EBM and Economic Analysis framework helps to explain, not only the broad drivers of change in the Pacific, but also the impacts, responses and the underlying root causes of environmental problems, such as ecosystem degradation, over harvest, loss of biological diversity, and pollution. Using an economic approach to these issues also enables managers at all levels to address some of the root causes and consequences of individual and collective actions (Lal & Holland 2011).

As shown in the various chapters of this book, there is much concern about the rapidly changing nature of coastal environments. The rate of such changes increases the physical vulnerability of coastal areas, their economic risks and their support for human livelihoods. Therefore, an effective approach to addressing coastal management issues requires an integration of sciences, disciplines, sectors and institutions, such as blending elements of traditional resource management systems with modern scientific knowledge and linking policy from national plans to practical community and industry implementation. Indeed, some examples of projects that seem to be effective are those that have integrated the holistic approach, such as those highlighted in Govan (2011) that had existed previously in the traditional context of resource management in the Pacific island societies, such as explained by the concept of '*vanua*' in Fiji, '*fenua*' in Tuvalu, and '*enua*' in the Cook Islands.

A diverse range of coastal management approaches has been used by governments and communities in the Pacific islands. These approaches are influenced by the type of resources in question, the problems or issues arising, the scale of operation, the available governance arrangements, the capacity and resources at hand for implementation, the urgency of the matter and the time horizon in question.

Although command and control approaches to coastal resource management, such as MPA declarations, bans of harvest and control of outputs and inputs, have been the norm, their effectiveness depends on compliance and enforcement is necessary. However, difficulties in determining appropriate penalties for non-compliance with regulations, and the costs of implementing effective monitoring and enforcement often limit their ability to achieve their policy and management objectives. While a number of Pacific island countries have developed comprehensive environmental legal frameworks, enforcement has lagged behind. The case of community-based fisheries management in Samoa and the Cook Islands demonstrates that customary rules and local village by-laws are area-specific and may be more practical to implement than centrally-managed regulations. The incentive to cheat is much lower at the local level, compared to national implementation where enforcement remains a problem and offenders can avoid detection and prosecution.

The dependency of community-based resource management systems on local leadership and governance indicates that consultation with local people is a necessary process in coastal management. Local communities are the main actors and recipients of change in coastal areas. Raising awareness and informing communities about coastal science and policy matters and addressing scientific and economic, as well as legal and institutional aspects, remains fundamental to addressing coastal zone issues. Any coastal-related decision-making, either by an individual, a community, or a government is dependent on their knowledge, level of awareness and information at hand, as well as the existence of sustainable financing for implementing and sustaining management efforts. For example, although the use of MPAs for biodiversity conservation is a useful tool for management of stocks and rehabilitation of degraded habitats, sustainable financing is still required for monitoring. On the other hand, where community groups are displaced from protected areas, alternative livelihoods must be considered as a means to gain support and endorsement of change, as considered in the Gau Integrated Island Management Project.

Ultimately, to bring about and sustain a desired change, incentive-based policies can facilitate the transition from unsustainable to sustainable activities, after taking into account all, direct and indirect market and non-market costs and benefits of using natural resources. Tietenberg (2006) outlines five principles which provide the framework for using economic incentives to manage this transition:

- all users of environmental resources should pay their full cost to ensure a level playing field between those resources that damage the environment and those that do not (full-cost principle)
- all environmental policies should be implemented in a cost-effective manner to ensure that maximum environmental quality is received for the expenditure (cost-effectiveness principle)
- rights over environmental resources should be designed in such a manner as to promote equitable stewardship (property rights principle)
- all current uses of resources should be compatible with the needs of future generations and the present-value criterion should be used, only to choose among allocations that meet this sustainability test (sustainability principle)
- everyone should be kept as informed as is practical about the environmental consequences of current decisions to allow people to participate as fully as possible in the transition to sustainable development (information principle)

An integrated DPSIR, EBM and economic analysis framework can help provide valuable information on the net benefits of different policy and project choices. There are indeed a number of ongoing activities in the region that address some aspect of coastal management problems. Much effort has been focused on planning (to meet donor and external requirements) general capacity building, or addressing short-term measures, such as specific infrastructural needs. There is a need to further build on these initiatives with a longer time horizon and through a more systematic and integrated approach which builds directly upon a country's strategic needs. This can not only ensure effective coordination and harmonisation, but also make best use of regional and national institutions for administrative efficiency and outcomes that meet Pacific island peoples' needs and aspirations in the long term.

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Index

About the Book

Economists working on coastal zone management in the Pacific – whether that be to address flooding, pollution, fishing or biodiversity protection – have conventionally had to trawl through disparate sources of literature to find information on the causes of coastal problems and how to address them. This unusual book synthesises a wide diversity of information on economic pressures on the coastal sector across a range of sectors, highlighting examples of impacts and providing a rationale for their responses, all from an economic perspective. Part text book, part case study, this document provides a useful reference document for researchers, academics and project managers dealing with the coastal environment. Keep this book on your shelf – you will want to use it........ Paula Holland, Resource Economist, SOPAC.

Excellent resource for all who want to learn more about the challenges of Coastal Zone Management in the Pacific. Very good introduction into many aspects of coastal zone management as well as the various drivers and pressures coastal zones are exposed to. The book is full of illustrations and tables that provide good examples to gain a better understanding of the issues. Highly recommended for students as well as others who are looking for a comprehensive and easy to read textbook on the matter........ Eberhard Weber, Economic Geographer, School of Geography, Earth Science and Environment, USP.

Would be a useful supplementary text to students of Environmental and Resource Economics……. Jagdish Bhati, Resource Economist, Department of Economics, USP.

The book captures the integration of ecological and economic concepts and principles to inform management decisions. It is a welcome initiative which provides a new perspective on the understanding and management of coastal zones in the Pacific……. Biman Prasad, Dean, Faculty of Business and Economics and Professor of Economics, USP.

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