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CRISP

Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

COMPONENT 3A - PROJECT 3A3
Improvement of socio-economics of coral reefs

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ECONOMIC STUDY

Economics of Coastal Zone Management in the Pacific

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Coral Reef InitiativeS for the Pacific
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The CRISP programme is implemented as part of the policy developed by the Secretariat of the Pacific Regional Environment Programme for a contribution to conservation and sustainable development of coral reefs in the Pacific.

The CRISP Coordinating Unit (CCU) was integrated into the Secretariat of the Pacific Community in April 2008 to insure maximum coordination and synergy in work relating to coral reef management in the region.

The Initiative for the Protection and Management of Coral Reefs in the Pacific (CRISP), sponsored by France and prepared by the French Development Agency (AFD) as part of an inter-ministerial project from 2002 onwards, aims to develop a vision for the future of these unique ecosystems and the communities that depend on them and to introduce strategies and projects to conserve their biodiversity, while developing the economic and environmental services that they provide both locally and globally. Also, it is designed as a factor for integration between developed countries (Australia, New Zealand, Japan and USA), French overseas territories and Pacific Island developing countries.

The CRISP Programme comprises three major components, which are:

Component 1A: Integrated Coastal Management and Watershed Management
- 1A1: Marine biodiversity conservation planning
- 1A2: Marine Protected Areas
- 1A3: Institutional strengthening and networking
- 1A4: Integrated coastal reef zone and watershed management

Component 2: Development of Coral Ecosystems
- 2A: Knowledge, monitoring and management of coral reef ecosytems
- 2B: Reef rehabilitation
- 2C: Bioprospection and marine active substances
- 2D: Development of regional data base (ReefBase Pacific)

Component 3: Programme Coordination and Development
- 3A: Institutional strengthening, technical support and extension
- 3B: Coordination, promotion and development of CRISP Programme

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COMPONENT 3A

Institutional strengthening, technical support and extension

PROJECT 3A-1:
Institutional support and strengthening of links with member countries

PROJECT 3A-2:
Support to governance through workshops and studies sites

PROJECT 3A-3:
Improvement of socio-economics of coral reefs

PROJECT 3A-4:
Technical and financial support to regional networks and database (GCRMN, SEM-Pasifika, ReefBase Pacific)

PROJECT 3A-5:
Disseminaton of knowledge and lessons learned sensitization of stakeholders

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Glossary

Beneficiary pays principle	People (beneficiaries) who benefit from the publically owned environmental goods or services must pay for their use
Consumptive	Direct utilization of goods and services by consumers, not including the use of means of production, such as machinery and factories
Demand	The quantity of 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 at 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 the production of one good or service is produced at the same time as the production of another
Marginal benefit	The incremental benefit received from a small increase in the consumption of a good or service
Marginal cost	The incremental cost generated from a small increase in the production of a 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 marginal cost of producing that quantity of good or service
Market failure	Situation where inefficient use of resources arise because the market price of a good or service does not reflect its true value of that good or service. Such failure arises where the property rights that govern use or access to a good or service are poorly defined
Net benefits	Net economic benefits less costs; technically measured as the sum of consumer surplus and producer surplus
Non-Consumptive	This is an indirect use that is non-extractive such as coral reef acting as a coastal protective barrier
Non-Use	Existence of goods and services for other reasons such as option to use in future or for cultural and spiritual reasons
Opportunity cost	The economic cost of an input or resource in its next best use; it's 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 defines any rights or obligations over access, use, management, benefits gained or costs in using that resource
Public good	A resource that is held by state or public, and is neither rival nor excludable
Rights creation	Establishment of a property rights regime where such rights do not exist, or are poorly defined – particularly enabling trade – to achieve an efficient allocation of resources
Rivalry	The extent to which enjoyment of a resource by one person diminishes the

	amount left for others to enjoy
Social discount rate	Rate of time preference expressed by society to bring a series of future cash flows to their present value
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 at a given market price
Rate of time preference	Expression of the degree to which people prefer to experience benefits now rather than later
Tragedy of the commons	A situation inefficient use of resources arising because of poorly defined property rights, especially because the rival, non-exclusive nature of common property resources creates few incentives for the individual to curb activities to benefit others

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Abbreviations Used

ADB	Asian Development Bank
CAP	Conservation Area Project
CPUE	Catch Per Unit Effort
CRISP	Coral Reef Initiative for the South Pacific
DECCW	Department of Climate Change and Water
DHW	Degree Heating Weeks
DPSIR	Driver- 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 the Conservation of Nature
IWP	International Waters Programme
LMMA	Locally Managed Marine Areas
MC	Marginal Cost
MCS	Monitoring, Control and Surveillance
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
PIROP	Pacific Islands Regional Ocean Policy
PNG	Papua New Guinea
POPs	Persistent Organic Pesticides
PTSs	Persistent Toxic Substances
SIDS	Small Island Developing States
SOPAC	South Pacific Applied Geoscience Commission
SPBCP	South Pacific Biodiversity Conservation Programme
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific regional Environment Programme
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme

Executive Summary

Pacific nations are experiencing a range of pressures on their coastal resources, from within the country and from international forces, which are leading to environmental degradation and loss of ecological and economic values, as well as increased vulnerability to climate change.

A number of interconnected socio-demographic, cultural, economic and institutional factors are key drivers of change, and are contributing to these pressures. In particular, Pacific countries are experiencing a transition from subsistence lifestyle and economies based on communal, traditional forms of barter exchanges, to economies increasingly based on financial and cash-based transactions. This transition is influenced by the increased need for cash for paying for goods and services beyond those used for subsistence, including education and health, increasing urbanisation, and trade. Migration from rural areas with their easier access to resources used in non-cash based economic exchanges, to urban areas based on cash transactions is also assisting this transition from subsistence to largely market-based economies.

Such changes are placing significant pressure on the coastal resources that play a fundamental role in supplying food, materials, and other resources for people. The shift from harvesting resources for direct local community consumption, to the need to harvest resources to sell for cash income has contributed to higher and, often ecologically unsustainable levels of exploitation, and environmental degradation.

Unsustainable use of coastal zone resources has been compounded by the failure of the market system to efficiently allocate many of these resources, as they typically are not privately-owned, and not bought and sold through market mechanisms, thus do not have market prices. In addition, inadequate government enforcement of regulations designed to prevent over-use, or degradation of coastal resources has contributed to resource depletion and degradation.

This report summarises the importance of coastal zone environments and resources for Pacific economies and communities, and drivers, pressures, and responses that contribute to unsustainable resource uses and environmental degradation. The report also examines incentives and motivations behind people's decisions and behaviour, which are often also at the root of much of the overexploitation and degradation cases of coastal resources and environment. Three analytical frameworks are used to explain such influences, forces, and processes, and are illustrated using three case studies, drawing on examples from the Pacific: unsustainable harvest of fisheries, pollution, and habitat destruction in the Pacific.

The Driver-Pressure-State-Impact-Response (DPSIR) framework describes key drivers of change in the social order in the Pacific countries, including population, urbanisation, globalisation, and monetisation of the local economies. It also helps to understand the causal, direct and indirect relationships, and interactions between such drivers, and the wide range of pressures resulting from socio-economic, institutional, cultural, ecological, and economic forces in the Pacific societies. Such drivers and pressures trigger human decisions and actions which determine the state of coastal environment through changes in resource exploitation practices, such as in fishing, extraction of costal aggregates, and the use of environment as waste disposal sites. The DPSIR framework also helps to identify reasons for recent trends in resource use, and the types of potential impacts, resulting from such changes.

The interaction between human responses to drivers and pressures of change and the environment, determines their impacts on the coastal environment, ultimately felt through ecological processes, including food web interactions, and ecosystem services. Ecosystem-Based Management (EBM) framework helps to understand the geographic scope, and the nature of ecological and environmental effects of such drivers, pressures, and human responses and actions. The EBM analytical framework recognises underlying ecological processes and connectivities within, and between ecosystems, helping to understand the interaction between human activities and biological resources, as well as human activities, and the state of the coastal environment.

Economic analytical framework on the other hand, helps to understand choices people make to meet their needs and aspirations, particularly in a market economic context, and how these determine the state of coastal resources and environments. Economic concepts, such as maximisation of individual profit/welfare, property rights, and market and non-market values underpin people's decisions about how resources are used, and even abused. The presence of private property ownership over certain coastal resources which are exchanged through market mechanisms, and have market prices reflecting the true value to society, provide incentives for their efficient use. On the other hand, many of the coastal resources and environments are public goods, and these by nature are often held in common by the state, or a communally. As such, these public goods and services are generally 'free for all', and there are perverse incentives for their overexploitation and degradation, particularly as the costs of doing so are often not directly borne by these users, but by others. Such behaviour is often at the root of what is generally known as market failures. Market failures result when market mechanisms cannot be relied on to generate the maximum social welfare because markets either do not exist, or the market prices of the goods do not reflect their full value.

To correct such market failures, governments and/or communities often introduce institutional rules to contain, and/or manage peoples' actions and behaviour; regulations, bans, or control of technology, etc., are examples of commonly-used command and control management instruments, commonly-used in the region. Such institutional designs themselves have not always produced the desired outcomes, resulting in what economists call institutional failures. The effectiveness of such instruments is also a subject of this report, using economics lenses. The report also examines how economic analytical framework, with its foundation on individual motivations, incentives, and behaviour/actions, can also help design appropriate management approaches to encourage more sustainable resource-use through market-based instruments. Key resource and environmental issues, such as pollution, habitat destruction, and unsustainable harvest of fisheries products, are used as case studies to illustrate how the economic analytical framework can help to, not only understand the underlying root causes of such problems, but also better design management systems, focusing on market-based instruments.

Review of various resource management efforts in the report also highlights that integrated-social-ecological-economics systems-thinking, such as those reflected in integrated catchment, integrated island management, as well as traditional forms of resource management, can play an important role in sustainable outcomes. The report concludes that the use of systems-based conceptual frameworks, DPSIR (Drivers-Pressure-State–Impact-Response), EBM (Ecosystem-Based Management), and Economic analytical frameworks, can play a valuable role in helping to develop successful coastal resource use and management in the Pacific, by building on traditional command and control, and customary resource management practices, as well as market-based instruments.

Chapter 1 Introduction

Pacific Island Countries (PICs) and territories are symbolized by the presence of the large number of small islands in the midst of the largest body of water in the world, the Pacific Ocean. They are also characterized by the natural beauty and the many vibrant cultures. The Pacific community prides itself on its ‘Pacific Way’ lifestyle where communal living and reciprocal social relationships are emphasized. The Pacific islands region is also going through rapid changes due to, in most cases, high population growth rates, globalization, and the changing needs and aspirations of the people, including increasing consumerism. While the Pacific people live in a modern world, they also have strong traditional 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 globalization, and market economic forces.

Such pressures are more obvious in the coastal areas of the region. Almost 100 percent of the Pacific Islanders (excluding those in Papua New Guinea), live within 100 kilometres of the coast, and 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 increasing emphasis on materialism have encouraged countries to emphasize 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 including: unsustainable harvesting of coastal fisheries 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. In addition, environmental impacts include loss of biodiversity effects of invasive species; degradation of land resources through unsustainable forestry; poor agricultural practices; excessive loss of forest land to alternative uses; climate variability; and sea level rise. Adaptation to climate change, disaster risk reduction and disaster management are being realized as key strategic responses to several of these environmental problems.

The 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 with coral reefs, the Pacific has the highest known diversity in the world (Wilkinson 2008). As a result, Pacific islands 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 economic development desired by local communities to meet their need for income for basic activities such as paying for children’s school fees and clothing, as well as for goods and services of material comfort. Governments also pursue economic development agendas, sometimes with little regard for biodiversity conservation, and sustainable development.

Many of the natural resources in Pacific Island Countries and Territories (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.

Such outcomes 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 similar: globalization, modernization, 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 maximization to individual maximization of household income. With increased emphasis on economic development, customary resource owners are pursuing private wealth maximization, 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 clam. In some cases, resource owners have been instrumental in the conversion of healthy ecosystems such as mangroves, into alternative uses such as tourism, and/or housing development.

It is also recognized that, although the details may vary between sectors within PICs as well as between PICs, there are many similarities in the underlying root causes, the nature of national level response, and the assistance provided by regional governmental agencies, and through international development partner support. This is regardless of which theme or sector is examined, as discussed in this report.

A key component of the root causes of many resource and environmental concerns is the focus on maximizing individual wealth in markets, where only some, but not all goods and services have market values, and are thus traded in a market place. Nevertheless, countries rely on the market to efficiently allocate scarce resources between competing uses and users, having 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 the environment 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 and 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 multifaceted resource and environmental problems occurring in PICTs. Such problems generally cannot effectively be addressed by a single government agency working within one sectoral legislative framework, and in the absence of governance arrangements that do not reflect key ecological connectivity.

PICs have acknowledged the limitations of relying only on conventional ‘command and control’ instruments, and education and awareness programmes to manage natural resources and environment. There is a slow but gradual shift to recognise that incentive-based instruments may also be needed if change in individual behaviour is to be achieved and resourced. For example, the 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 also led to overexploitation of coastal resources.

(Lal and Keen 2002) note the need to promote the use of natural resource economics to address these 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 held in Rarotonga in the Cook Islands 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 equally important to understand under what circumstances market-based instruments may not be relevant or effective, and to understand what 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 on the Pacific. Two additional analytical frameworks, the Drivers-Pressure-State-Impact-Response (DPSIR) and Ecosystem-Based Management (EBM) framework are also discussed, adopting a systems perspective.

The report, targeted at students and coastal zone managers with little or no background in economics, covers the following areas:

- An analysis of the effects of fundamental drivers and ecological connectivity, and root causes of coastal resource and environmental concerns, 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 concerns, and the potential role of market-based instruments in encouraging efficient and sustainable use of coastal resources; and
- An understanding of conditions, and circumstances where market-based instruments may not be relevant or effective, and what alternative management systems may be required to adequately address complex coastal resource and environmental management challenges.

1.1The Structure of the Report

The report is divided into two parts**. Part I** of the report (chapters 2-5) describes the current status and recent trends in the coastal resources and environment in the Pacific, and introduces the DPSIR, analytical framework, the EBM framework, and economic analytical framework.

In Part 1, Chapter 2, provides an overview of the economic importance of the coastal resources and activities to the PICTs, and summarises key current threats and issues. **Chapter 3** describes key elements of the DPSIR; and EBM analytical frameworks that help explain the broad changes in the coastal resources and the environment. **Chapter 4** considers key drivers of change behind fundamental transformations in Pacific societies, including monetization and globalization affecting the socio-cultural order, and its pressures on coastal resources. **Chapter 5** discusses economic analytical 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 market economy to help explain 'root causes' of the observed state of coastal resources, and the environment.

Part II of the report (Chapters 6 - 9) uses a combined DPSIR, EBM and Economics analytical framework to examine the current status of, and trends in key coastal resources and environments, and effectiveness of alternative management responses.

Chapter 6 of Part II examines the state of the inshore fisheries resources. **Chapter 7** discusses key economic dimensions of pollution, while **Chapter 8** examines the economics of habitat destruction and its effects**.** In each of these chapters, current management approaches and alternative market-based management approaches are also discussed, highlighting key challenges in both these approaches. **Chapter 9** discusses recent innovations experimented within the Pacific, before providing concluding remarks about the relevance of understanding the complex interrelationships between pressures, impacts and responses, underpinned by individual motivations and incentives when designing management responses. The report is targeted at students and coastal resource planners and managers in the region.

Chapter 2 Coastal Resources in the Pacific Islands Economies, and Threats and Issues

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, but influenced through underlying ecological connectivity by changes upstream, as well as forces within the marine environment itself.

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 economic perspective, use of a broader definition of coastal zone may be warranted – that is, 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 environment. Traditional societies usually recognized 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 and Young 2001), and through customary systems designed to manage their resources (Ruddle and Johannes 1983).

2.1Pacific People, Coastal Resources, and Livelihoods

With the exception of Papua New Guinea (PNG), almost 100 percent of Pacific Islanders live in coastal areas, and live off associated land and marine coastal resources. 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 nonliving environment interacting as a functional unit” (Millennium Ecosystem Assessment 2005). The diversity of inter-tidal and supra-tidal ecosystems consists of 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 and Territories 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 Is	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 ecosystems 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 formation of atolls, islets, and beaches. These reefs also support 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 of nutrients and cycling of nutrients, sustaining biodiversity, and maintaining water balance (Martinez, Intralawan et al. 2007).

The Millennium Ecosystem Assessment categorizes 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 (Figure 2.1).

Figure 2.1 Ecosystem Services and Their Linkages with Human Well-being

Source: (Millennium Ecosystem Assessment 2005)

Different coastal ecosystems provide many of the ecosystem services that support human wellbeing, as summarized 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, 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 the 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 the various components of the ecosystem. Therefore, human wellbeing is both directly and indirectly dependent on ecosystem integrity.

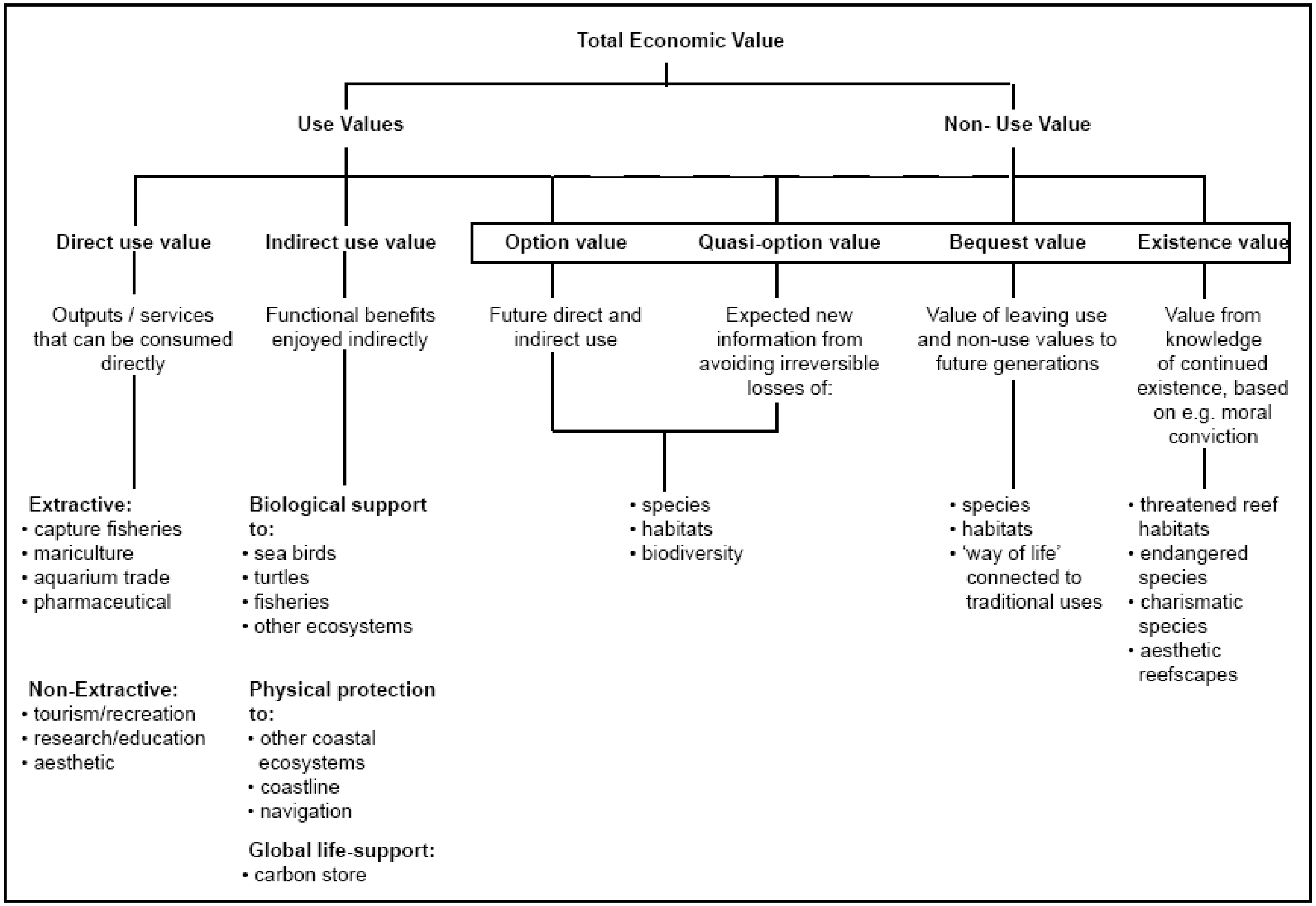
Table 2.2 Some Ecosystem Goods and Services offered by Tropical Coastal Ecosystems

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

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

Figure 2.2 Use and Non-use Values that Make Up Total Economic Value Associated with a Coastal Ecosystem



Source: Barton (1994 & Cesar (2000).

Table 2.3 Examples of Ecological Services Provided by Mangrove Ecosystems

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

Source: Adapte4d 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 livelihood of coastal populations. Coastal ecosystems, such as coral reefs, mangroves, and lagoons are, for example, 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 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 (table 2.4). Not only does economic wellbeing depend on the coastal zone, but human activities, in turn 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 Pacific Island Countries

Activities	Description
Fishing	Subsistence, artisanal, commercial fishing – trochus, beche-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
Ports and harbours	Facilitate 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 the PICs, either in terms of the percent contribution to national Gross Domestic Product (GDP), 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 (Seidel and Lal 2010).

2.2.1. Coastal Fisheries

Coastal waters contribute significantly to local economies, particularly subsistence and commercial fishing carried out in the lagoon, reef, deep-slope or shallow sea areas, with a growing contribution from mariculture in the 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. Coastal commercial fishing has produced a total of 44,700 mt in the region with a value of US$ 165.8 million in 2007, contributing on average 0.5% to regional GDP. On the other hand, the value of subsistence fisheries output is estimated to be $200 million as stated in table 2.5.

Table 2.5 Economic Value (GVP) of Fishing in the 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 and Lal 2010. *US$ at 2007 market prices

2.2.2. Coastal Commercial Fisheries

The value of regional coastal commercial fisheries was estimated to be $165.7 billion in 2007 across the Pacific, while the value of aquaculture was estimated to be $146.9 billion (Gillett 2009). National catches are significant in the national economy. For example, in Fiji, artisanal catch consisting of 5,994 tons of reef fish (67%) and invertebrates (33%) 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 F$54 million (Gillett 2009). High value commodities for exports have been beche 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 (F$14 million annually), beche de mer (F$8.6 million), trochus (F$1.7 million), deepwater snapper (F250,000), and live reef food fish (F$450,000), a total of about F$24.5 million per year (Hay and Sablan- Zebedy 2005); (Gillett 2009).

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

Aquaculture is dominated by pearl production in a number of countries, including French Polynesia, Cook Islands, and Fiji while shrimp farming is important in New Caledonia. *Eucheuma* spp. (seaweeds) has also been an important export commodity in Fiji and Kiribati. Tilapia, milkfish and giant clam are also cultivated for both subsistence food needs, and for sale at domestic market. 142.7 tons of tilapia worth F$712,300, 24.04 tons of freshwater prawns

(F$575,380), 13 tons of brackish water prawns (F$400,000) and 67 tons of seaweed (F$33,500) were recorded in Fiji in 2007 (Gillett 2009). 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 2009). The coastal commercial catch of 3,700 tons in Tonga in 2007 was estimated at T$22.8 million where as in Samoa, catch of approximately 4,129 tons was worth ST$51.2 million (Gillett 2009).

2.2.3. 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, Kronen et al. 2009). Typically, 10 to 20 times more people fish for subsistence than for commercial purposes, despite increased commercialization of coastal fisheries, supporting mainly urban dwellers.

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

Marine resources are one of the most vital sources of dietary protein with the average annual per capita consumption of 50 kg reef fish (Box 2.1) being significantly higher than the global average. Subsistence fishery still provides the great majority of dietary animal protein in the region (Bell, M.Kronen et al. 2009), with fish providing 50-90% of animal protein intake in rural areas and 40-80% in urban centres (Secretariat of the Pacific Community 2008). 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 Pacific Island Countries with limited possibilities for agriculture, particularly 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 the national economy 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 Income and Expenditure Survey (HIES) have provided some useful estimates of subsistence catches although the figures are however, believed to be lower than actual catches (Gillett 2009).

Gillett (2009) 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 a market price as shadow value. This contributes 0.6% 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, the greatest importance of subsistence fishing may lie in remote coral atoll islands, such as in Tokelau and Kiribati reference. Kiribati's subsistence catches are estimated to be worth US$28.6 million, corresponding to 22.5% of national GDP reference. In 15 of the PICTs, subsistence catch is still greater than coastal commercial fishing (Box 2.2). The values range from 100% in Tokelau to 35% in Tonga (Table 2.6) with an average of 70% retained for home consumption. In most PICTs, a large proportion of subsistence fish is caught by women using nets to fish from the beach, or to glean for invertebrates (Vunisea 1997), and thus providing food security in their communities.

Table 2.6 Subsistence Fishing in the 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 current 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 estimate reported 3000 individuals taking part in subsistence fishing in Fiji (Hand, Davis et al. 2005); this seems extremely low given the amount of catch levels, and the proximity of Pacific Islanders to the coast according to whom and why. (Gillet and

Lightfoot 2001) reported that 22% of the population in the Cook Islands, and 61% 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 based in nature and not known in monetary terms. 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 2000).

2.2.4. Tourism

The tourism industry is highly dependent on the quality of the coastal environment, and provides the islands with an estimated gross revenue of US$1 billion annually (World Bank 1999). A study on the economic impact of tourism in some Pacific Island Countries indicates that for every US$ 1 million of visitor expenditure in the region, US$660,000 of local wages/salary payments and other purchases are made from local economies in the region (Milne 2005). Thus, this would have greater indirect (flow-on) impacts on the local economies as tourism provides a source of employment, and a source of livelihoods.

The total regional [South Pacific Tourism Organization (SPTO) member countries] tourist expenditure in 2004 was US$ 1.5 billion, of which 32% was for labour and 38% 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% of this value ($94.6 million per year) and diving and snorkelling contributing to $8.7 million per year (Beukering, Wolfgang et al. 2007). Ecotourism is seen in many countries to provide an alternative source of income to extractive activities (Milne 2005).

2.2.5. Other Sectors

Maritime culture and tradition in the Pacific is also exhibited through a varied 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, Woodruff et al. 2006) estimated the value of coastal protection supported by coral reefs in the Marshall Islands to be within the range of US$3,000 to US$17,000 per meter.

While coastal areas are the most biologically diverse and economically productive areas which support Pacific island communities, they are also the most vulnerable, and are a constantly changing environment; changes that are triggered by the underlying drivers in the societies. These trends and threats are discussed next.

2.3. State of The Coastal Resources and the Environment

Assessments of sustainable development and environmental conditions and trends show that despite slow 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 urbanization, and a weakening of community-based decision making processes have negatively affected the sustainability of natural resource use, for example through pressures exerted by waste generated and land use changes (United Nations Environment Programme 2004).

Most coastal areas are experiencing a decline in coastal resources, even in the most isolated locations. Threats to coastal resources are increasing and pollution of the coastal environment 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 the coastal environment, such as tourism and fisheries or landfill, construction, and infrastructural development.

Climate change also poses an additional threat to the PICs through sea-level rise, more frequent and intense 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 (Asian Development Bank 2009). Increasing salinity of soils and drought, and declining fish stocks pose risk to food security and livelihoods of coastal communities.

A recent comprehensive study by the (Center for Ocean Solutions 2009) has reviewed scientific literature and impact assessments on the oceans, including the Pacific. Their findings support the many regional assessments of the state of the environment (Asian Development Bank 2009) (Thistlethwait and 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 PICs, threats of such impacts are common, and their effects can be observed with impacts that can be considered as ‘common’, ‘moderate’, and ‘severe’. There is a large variation in the types of effects, and the intensity of their impacts within a country, as well as between countries. Table 3.2, 3.3, and 3.4 provide detailed assessments of threats that exist or have the potential to pose a threat, and impacts that are already affecting, Micronesia, Melanesia, and Polynesia (Center for Ocean Solutions 2009).

What is apparent from the above concerns is that many of the issues are cross-cutting across sectors and disciplines, and raise different policy concerns at different levels of governance. Consequently, these issues cannot be dealt with a sectoral approach alone. Having some systematic understanding on how these are related and interdependent, requires 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 Moderate Impact Low Impact	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 & EXPLIOTATION												
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 Ocean Solutions 2010

Table 2.8 Melanesia Threats Based on Scientific Literature and Impact Assessment

✓Identified as Threat Severe Impact ■ Moderate Impact ■ Low Impact ■	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 Moderate Impact Low Impact	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 in the Pacific

The Pacific Island Countries have for some decades expressed concerns about these threats and deterioration in the status of the environment, 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 synthesized into "*the Pacific Way*" Report as the lead up to, and response to, the United Nations Conference on Environment and Development (UNCED) in 1992. *The Pacific Way* reflected the collective environmental concerns of Pacific Island Countries and Territories. 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 (Forum Secretariat 2004); (Forum Secretariat 2005).

There is a range of social, technological, economical, environmental and political/ institutional forces which can affect the continued functioning and status of the coastal ecosystems. Some of these are summarized 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 processes.

Table 3.1 Factors Influencing Biophysical Processes and 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

The purpose of this chapter is to examine the broader drivers of change in the Pacific society and understand how these have put increasing pressure on the coastal resources and environment, and understand the ecological processes through which the effects of human action are experienced. An integrated DPSIR_EBM framework for the Pacific is discussed after describing these individually.

3.1Driver-Pressure- State-Impact-Response Analytical Framework

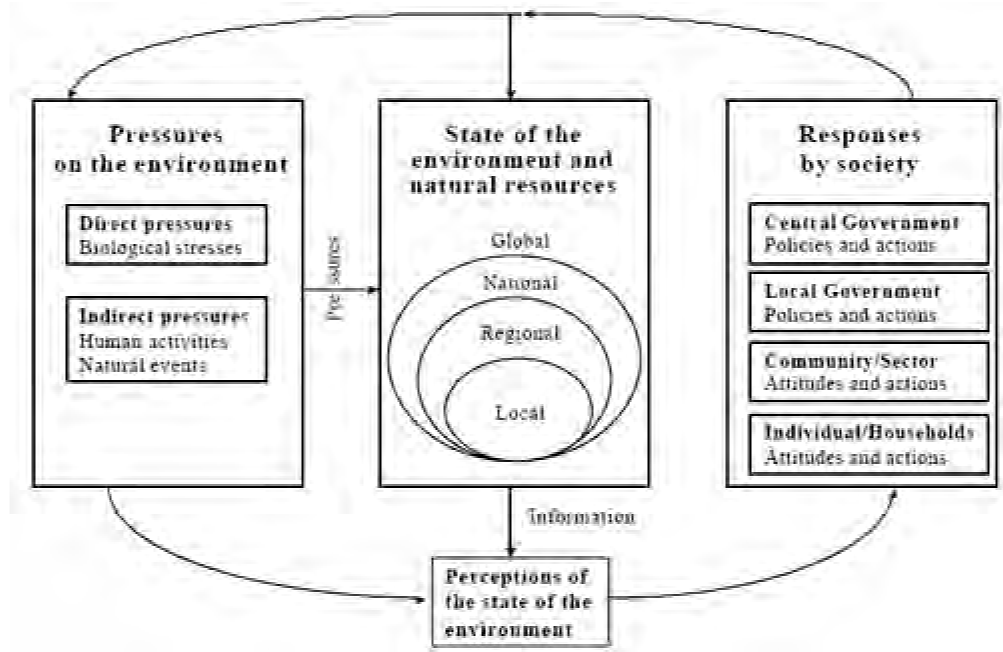
The Driver-Pressure-State-Impact-Response (DPSIR) is a conceptual framework which can be used to map and illustrate causal and indirect interrelationships between a wide range of socio-economic, institutional, demographic, environmental, and cultural trends and influences, and potential responses to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

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, globalization, urbanization, 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 salinization of soils
- *Responses*: changes in policy and management practices to mitigate the socioeconomic impacts of environmental degradation, such as better management of wastewater treatment, and improved agricultural practices. Two examples of use of the DPSIR models are shown in Figures 3.1 and 3.2

While essentially following the same path, there are several interpretations of the DPSIR framework. The Organisation for the European Co-operation and Development (OECD) ‘model’ (quoted in New Zealand Ministry for the Environment 2011), for example, 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



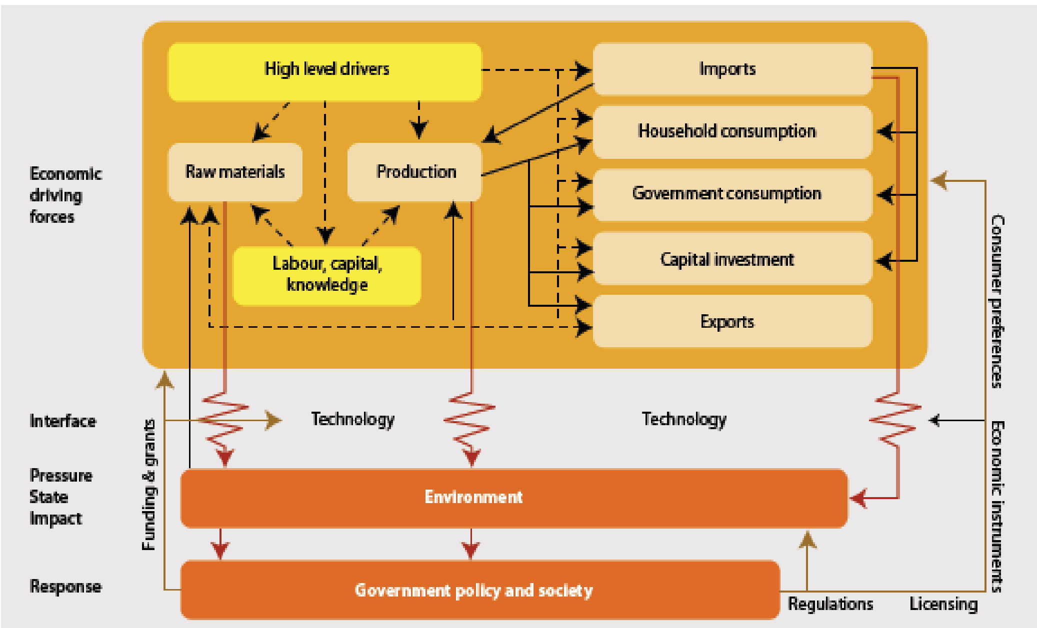
Source: New Zealand Ministry for the Environment (2011). The Pressure-State-Response framework. http://www.qualityplanning.org.nz/monitoring/intro-pressure-state-response-framework.php (accessed 23 March 2011).

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. The flow chart 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.

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

Figure 3.2 Driver-State-Pressure-Impact-Response Framework used in NSW



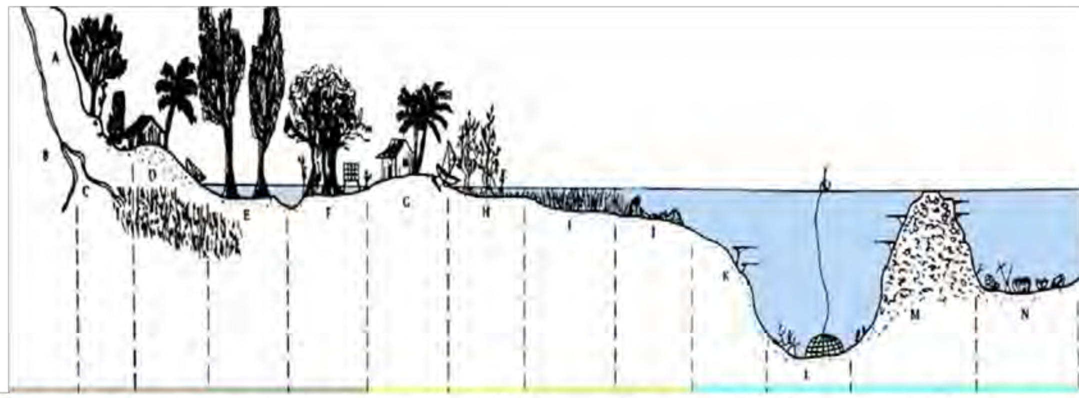
Source: Department of Environment, Climate Change and Water, NSW (2009) http://www.environment.nsw.gov.au/soe/soe2009/chapter1/

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

3.2. Ecosystem Based Management Framework

An ecosystem based management framework attempts to recognize 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 (figure 3.3).

Figure 3.3 Ecological Connectivity from 'Ridge-to Reef' Through the Physical and Ecological Forces



A: High Island; B: slopes; C: estuary; D: Coastal Flats; D: Tidal swamp; F closed mangroves;
G: Coral strand; H Open mangroves;; I seagrass; J: fringing reefs; K-L different parts of lagoon

Source: (Carpenter and J.E.Maragos 1989; Chape 2006).

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

Ecosystem-Based Management (EBM) framework advocates understanding the dynamics of, and interactions between, resources/environments, market, and society in identifying and designing management responses. It emphasises spatial and ecological connectivity in an area, and that the effects of activities, for example upstream, can affect the status of resources and the environment downstream, including on the coastal ecosystems. The EBM framework also recognizes the biological and ecological dynamics of species and resources targeted by humans, and how these also affect other species through the food chain, and food web relationships in an environment. The EBM framework also includes market forces, as well as benefits associated with many environmental goods and services for which there are no observable market values (Box 3.1).

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 our natural resources. The Ecological Society of America has identified eight key elements of the EBM (Box 1), guided by four key principles.

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 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 programs.

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.

In at least the last two decades, several studies have specifically made assessed changes to and impacts on, coastal environments. Land use changes, urbanization, 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, Tabunakawai et al. 2007); (Fisk 2007); (Bakineti 2005), research under the Coral Reef Initiative for the South Pacific (CRISP) such as (Buliruarua and Fenemor 2010); (Guilbeaux, Parras et al. 2008), 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).

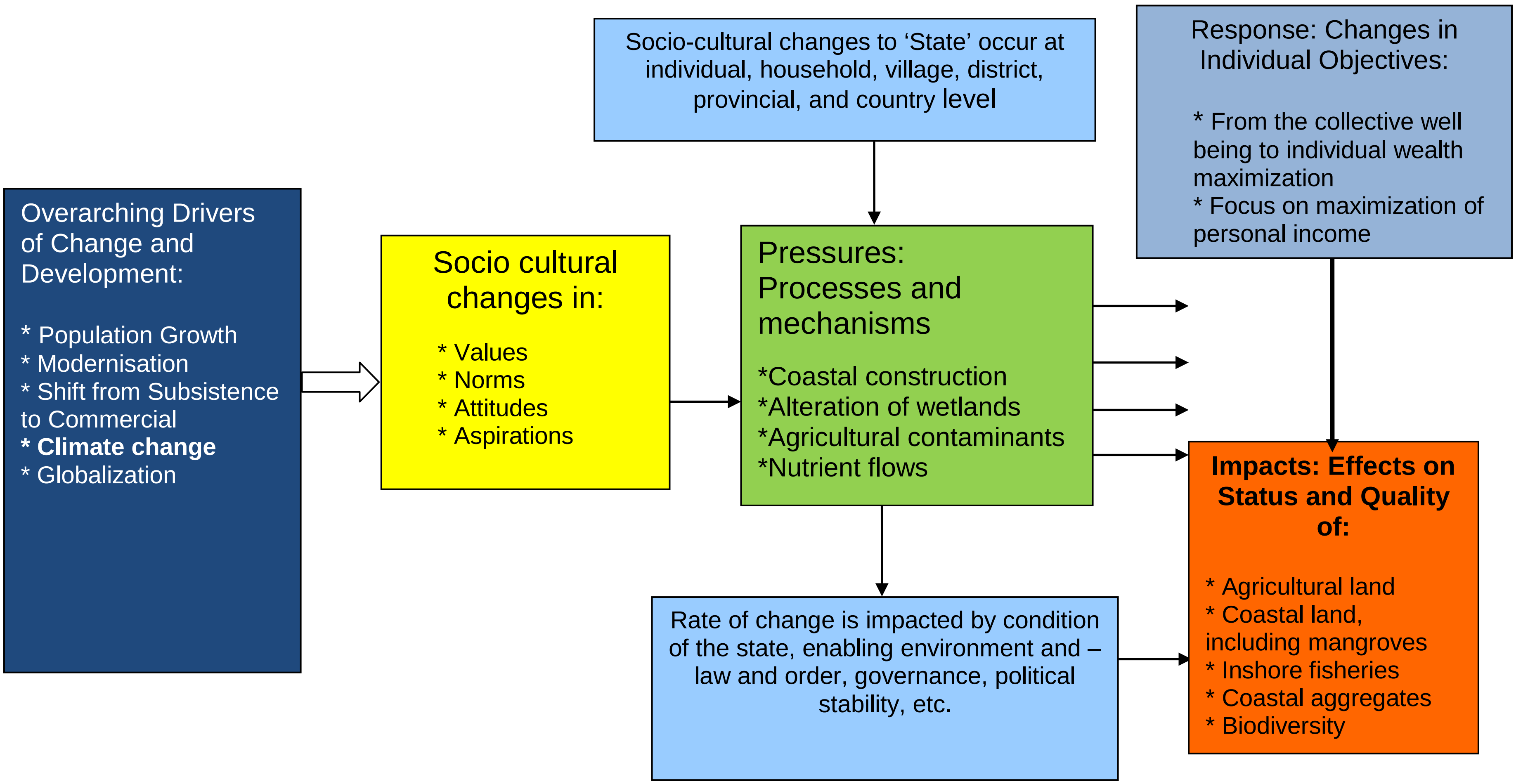
EBM framework can help to systematically identify and analyse, amongst other things, drivers and causes of observed resource and environment status, and to identify and assess alternative management strategies at national, regional, and local levels. The emphasis though is more on the ecosystem and ecosystem functioning. Given their importance, the principles of EBM are adopted in various regional policies, frameworks of action, and/or plans already endorsed by the region (see for example, Pacific Islands Regional Ocean Policy (PIROP) (Secretariat of the Pacific Community 2005); Fisheries Ecosystem-Based Management (Preston 2009), (Fletcher 2006).

3.3. An Integrated DPSIR-EBM Analytical Framework

A combined DPSIR-EBM framework provides a rich analytical framework to analyze and understand the broad drivers, interrelationships, and the 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. In the case of the Pacific, as discussed in Chapter 4, a DPSIR framework can be used to understand the effects of recent changes in communities, such as the effects of monetisation of the economy, and the changes in lifestyles and values which can be seen to create new pressures on coastal zone environments. Much of these changes result in the changed incentives focusing on maximising individual wealth creation and accumulation in a market economy, which as seen in Chapter 5, unleashes other forces that cause major resource and environmental problems.

Figure 3.4 illustrates the influence of overall broad drivers, and the pressure placed on the socio-cultural, political, and natural coastal environment factors. Therefore, addressing coastal environmental problems requires the broader understanding of the drivers and pressures, and its impacts on the state of the environment in the context of Pacific islands. This can then enable critical evaluation of the policy response, and its adequacy.

Figure 3.4 Drivers, Pressures, State, Impacts and Response Framework for the Pacific (adapted from (Jones and Holzknecht 2007))



Chapter 4 Key Drivers and Pressures on Coastal Resources in the Pacific

Pacific Island Countries are exposed to many broad changes in their societies, brought about by forces not only within the domestic boundaries but also globally. Monetization, globalization, population growth, and urbanization are major drivers of recent development experience in the Pacific islands. Such drivers place considerable pressure on the societies, both in terms of pressure on already scarce natural resources, but also changes in socio-cultural order. The pressures are expected to be compounded by the effects of climate change, affecting all sectors and all aspects of lifestyle, particularly in the coastal areas, manifested through ecological, social, and economic connectivities in society.

4.1 Key Drivers: Monetization and Globalization (Modernization) and Socio-Cultural Order

Pacific island countries have gone through major economic transformations since colonization and modernization. The countries have changed from a subsistence economy based on barter system to a market based economy, subject to market economic forces. This together with greater integration with the global systems, in terms of market economic trade, communication and people movement, has meant that the countries are also subject to greater influences that affect the traditional social-cultural order.

Increased monetization of the local economies, and an increase in focus on increasing individual wealth are seen as key changes in the underlying social-cultural order, including weakening of the traditional social systems of control (Jones and Holzknecht 2007). Changes to the socio-cultural order brought about by competing lifestyles, the social weakening of kin groups and extended families, and other change factors, raises the question about the effectiveness of traditional and modern institutions to deal with current resource issues.

Often such situations result in overharvest of coastal resources, but also increase 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 long term strategic objectives such as sustainable resource use.

As people become dependent on access to cash (for imported goods, school or health fees etc.), there is greater pressure to sell food products, rather than directly consume it within the household. The income obtained from the produce sales may be spent on buying food of higher, or even lower nutritional quality; such changes in dietary habits may have health impacts. There is loss of self-sufficient food production and traditional knowledge attached to self-reliant strategies, and increased nutritional vulnerability. 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, resulting from a disregard of traditional systems, as well as centralized management and control of coastal resources, has led to areas of depletion of resources, loss of biodiversity, and degraded ecosystems such as in Tarawa (Kiribati), Funafuti (Tuvalu), and Tonga. Some centralized coastal management systems have had limited success, or failed due to poor monitoring and enforcement. Through time, this has also led to unclear resource access rights which have compounded matters. 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.

4.1.1. Population Growth

In PICs, the 2006 population was approximately 9.1 million persons, and growing around 2% per annum for the region since 2000[1] (Secretariat of the Pacific Community 2007) with large variability from country to country. Population growth rates have increased strongly in Melanesia and some Micronesia countries, while in Polynesia they have only grown marginally. In some Polynesian countries, such as Niue, they have declined. Of the 2006 population, some 2.18 million people, or 24% of the Pacific island population live in towns and cities. In Melanesia, Fiji has been the exception with its 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 (Secretariat of the Pacific Community 2007). With the population increases, the pressures on the domestic resources increases, causing major 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 provided by the coasts.

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[2]	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

[1] See SPC Haberkorn, G. 'Pacific Urbanisation Stocktake'. 2006.
[2] Age estimates obtained from Gerald Haberkorn, SPC, July, 2007.

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

4.1.2. Urbanization

Urbanization is a driver of change, putting pressure on resources, as well as changes in attitudes and values. In 2006, some 24% of Pacific island populations were living in towns and cities (Haberkorn 2006). As noted by Haberkorn and Lal (2007), not including PNG which holds two thirds (6.2 million persons) of the Pacific island population, the Pacific urban-based population represents 46% of the total population in the region. Some 13% 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% of their Census population living in urban areas, and increasing rapidly through urban-rural migration (Jones and Holzknecht 2007). Urban growth rates in many island countries and territories in the region 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 Vava’u Islands to Tongatapu (Thistlethwait and Votow 1992). Similarly, population pressure is higher in the urban centres of atoll islands, such as Tarawa and Majuro, increasing significant pressures on the limited coastal resources.

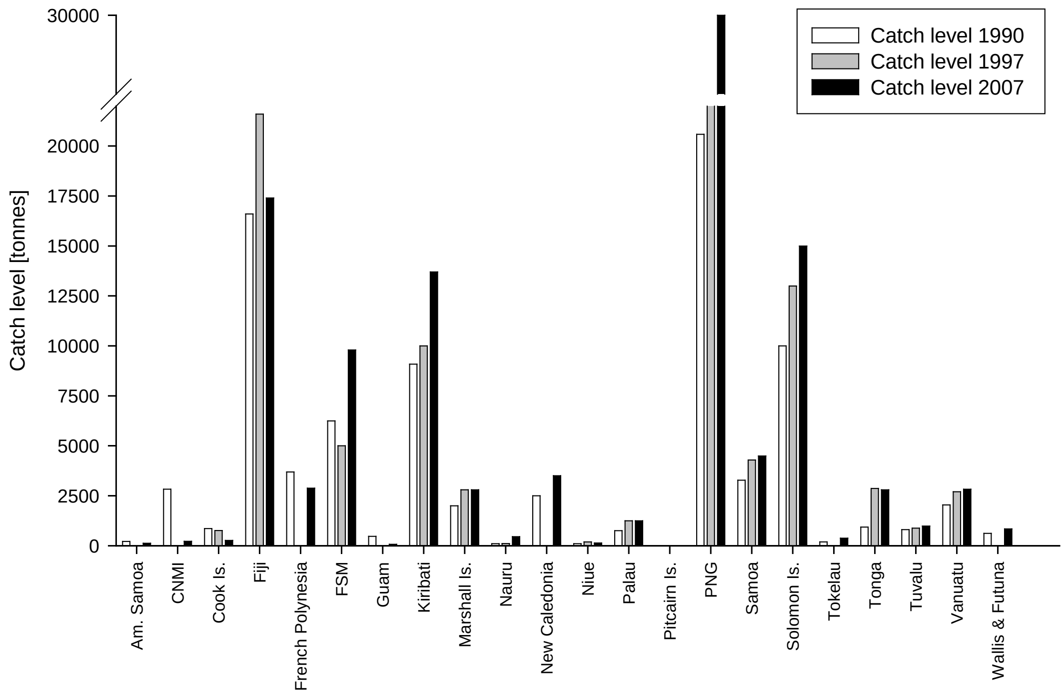
4.2. Pressures

Combined effects of population growth, globalization, and monetization are changing lifestyle in the Pacific, and the effects are multi-dimensional, and affect the use and management of natural resources, such as fisheries and forestry agriculture (table 2.8).

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

In some regions, a bigger proportion of the catch is already being sold, rather than consumed locally. In the early 1990s, 80% of the total coastal catches in the Pacific were retained for subsistence consumption; that is approximately 84,000 mt, caught for subsistence purposes, and valued at US$ 180 million (Dalzell, Adams et al. 1996). About 15 years later, only 60% of catches were still kept for home consumption (Gillett 2009). Figure 4.1 illustrates the changes in subsistence yield in some of the Pacific island countries over a period of 17 years.

Figure 4.1 Changes in Subsistence Catch Levels Between 1990 Until 2007



Source: Data based on Gillett and Lightfoot 2001 & Gillett 2009a quoted in Seidel and Lal 2010

The transition is more pronounced in urban areas close to market outlets, whereas in rural areas non-market-based subsistence fishing prevails (Kronen, Sauni et al. 2006). Access to modern fishing equipment and motorized fibreglass boats have also increased catches, and contributed to increased pressure on stocks via local overfishing (e.g. Newton et al 2007). Overharvesting of fisheries resources is discussed in the next chapter.

Rapid growth in urban populations has led to 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 increase 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, pollution, and habitat destruction are discussed in Part II.

4.2.1. Invasive Species

A negative effect of globalisation is the introduction of invasive species via the movement of people and cargo. With changing lifestyles and increasing consumerism, the Pacific islanders heavily rely on imports for their material goods. Furthermore, with globalisation, there is 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 (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, which 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 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 in 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 (Secretariat of the Pacific Regional Environment Programme 2010).

Invasive species have negative impacts on the resources people rely upon for their livelihood, 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 (Secretariat of the Pacific Regional Environment Programme 2010). A recent example of invasive species in Fiji is given in the box below. 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 costs of eradication are likely to be far greater than initially anticipated.

Box 4.1 Article from "The Fiji Times" on the 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: (Rina 2010) Monday, April 12, 2010

4.3. Multiple Stressors

The effects of the combination of the underlying drivers of change, and the pressures they create on the coastal resources, 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.

Growing populations and greater need for cash incomes, and changing consumption patterns have, as we have seen earlier, lead 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 effect 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 providing 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 such as timber harvesting, crop production, and animal husbandry also affect costal 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 PICS 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: (1) conflicts among users over the use, or non-use of particular coastal areas; and (2) conflicts between government agencies administering programmes relating to coastal areas. Users can be direct, actual users (such as fishers, 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: (1) competition for coastal space; (2) adverse effects of one use on another; (3) adverse effects on ecosystems; and (4) 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 and 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 potential impacts of climate change as a major driver of change which will affect all spectrums of lives in a country. The countries are concerned about the increased frequency and intensity of extreme weather events due to global climate change (IPCC 2007). The increasing severity of events such as El Nińo and La Nińa may lead to longer periods of drought, and heavier rainfall and flooding (IPCC 2007).

These impacts will create greater economic hardship, and increase the incidence of poverty, loss of employment and other social problems. Recent cost assessments of disasters – cyclones and flooding in the Pacific, illustrate the severe and widespread impacts of such disasters on human well-being (Betterncourt, Croad 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 World Bank (2000). Of these disasters, cyclones accounted for 76% of the reported events, accounting for almost 90% of total costs, and 79% of fatalities (Lal, Kinch et al. 2009). Storm surges and floods cause general devastation from the effects of winds and high waves. Impacts of disasters occur during or immediately after events, such as damage to crops and buildings, and subsequently over time, such as rises in water levels, and increases in vector-borne diseases. In Vanuatu for example, Cyclone Ivy affected 90% of water resources, 70% of roads, 60% of health infrastructure, and over 80% of food. Recently, one out of the fifty floods in Fiji alone caused damage of about $24 million in the sugar belt (Lal 2010), with about $330 million in the Nadi and Ba urban areas, including the private sector (Ambrose 2009; Holland 2009).

Countries heavily reliant on primary production sectors 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 23-54% of national GDP, with most economies relying on just a few commodities. The 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. The National Oceanic and Atmospheric Administration/National Environmental Satellite Data and Information Service (NOAA/NESDIS) satellite monitoring revealed bleaching effects, and a record high temperature of 16% heating weeks (DHW) around the Phoenix Islands, between August 2002 and March 2003. Surveys indicated close to 100% coral mortality in the lagoon of Kanton Atoll, and 62% mortality on the outer leeward reef slopes of the island, as well as elsewhere throughout the Phoenix Islands. Though, the flow of effects on the coastal fisheries and tourism is not known, it is clear that the supply of fisheries, as well as the suitability of the coastal areas for ecotourism, would be affected.

In summary, the broad drivers of change in the Pacific are having significant impacts on coastal resources and environment. However, while the DPSIR framework can help understand the effects of broad drivers, there are practical difficulties in identifying direct causal relationships between high-level drivers and environmental change. High-level drivers tend to have indirect effects. These drivers affect the scale and composition of economic activity, which in turn varies the pressure on the environment. There are also generally many drivers affecting the same form of pressure, making it difficult to isolate their individual influences. To understand such root causes and to bring about change in human behaviour and actions, a more detailed assessment of the motivations and incentives that influence individual decisions, behaviours and actions, is required. This will be discussed in the **Chapter 5**.

Figure 4.2 Some Driving Forces, Pressures, Impacts, and Responses Relating to the Coastal Zone

Driving forces

Socio-economic
Population growth, modernization, globalisation, new economic activities, e.g. tourism

Cultural
Exposure to new global information technologies & media

Environmental
Climate change

Institutional
Treaties, donor requirements for economic restructuring of industries & for promotion of export earning sectors

Pressure

Socio-economic
Need for cash for family expenses, changes to cash cropping away from subsistence

Cultural
Questioning of traditional governance structures & leadership authority

Environmental
Increase in fisher numbers, increasing pressure on fish stocks and coastal resources (incl. beach minerals), use of destructive fishing practices

Institutional
Pressure for reform of governance & administrative structures & increased transparency

State

Socio-economic
Subsistence agriculture & fishing activities in many communities, with some export-oriented primary production, tourism in coastal zone

Cultural
Community/ family structure, traditional customs, including taboos, peer pressure influencing maintenance of norms attitudes & aspirations

Environmental
Fish abundance, live coral cover, sea urchin populations, climatic conditions

Institutional
Nature of governance arrangements for coastal zone resources, law & order, political stability, property rights, etc.

Impact

Socio-economic
Shifts from subsistence to market-based economy with focus on maximisation of personal income, migration to urban areas for cash employment, unemployment /poverty following decline in local community/ extended family support systems

Cultural
Shifts at local provincial, & country level, from collective well-being to individual wealth maximization, leading to shifts in socio-cultural order & need for money to pay for goods & services, increased, conflict/ exclusion

Environmental
Clearing of coastal lands, including

Response

Socio-economic & Cultural
Socio-economic & cultural management initiatives for local management of resources, e.g. locally-managed marine areas, taboo areas

Institutional responses
Legislative responses to resource degradation, e.g. regulations, economic instruments, education & awareness, capacity building.

Lack of adequate response due to strong traditional and cultural attitudes, inability to enforce and monitor, policies lack of political will

Chapter 5 Economic Analytical Framework: Key Concepts and Root Cause Analysis of Coastal Zone Issues

Each stage of economic activity is affected by high-level drivers which include population demographics, monetization/globalisation and technology. Each stage of economic activity affects the environment through the technology/pressure/state/impact relationship (illustrated by the solid red lines in figure 3.1). For example, coastal fish may be used as an input into fish processing or consumed directly by households. This however, is affected by the market supply and demand of inputs, such as fuel prices which are affected by the broader drivers in society, such as the influence of global 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 (New South Wales State of the Environment (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 forces.

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 item (good or service) under consideration, and the benefits they bestow on the local community. Such issues are in the domain of discipline of economics. 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 incentives, and decisions and behaviour.

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

- Goods and services
- Individual preferences and values
- Markets, market supply and demand, and market values

- Markets, and non-market values and coastal environment y
- Property rights and incentives
- Public goods

For a more detailed investigation of the issues, see Lal and Holland (2010)

5.1Goods and Services

In chapter 2, goods and services supported by ecosystems were discussed in terms of what Millennium Ecosystem Assessment (MEA) described as supporting services, provisioning services, regulating services, and cultural services (Millennium Ecosystem Assessment 2005). From an economics perspective, these same services which are valued by humans are discussed 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 at the market, or exported can be considered as commodities. Ecotourism experiences such 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 and 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 thus are consumed 'for free' because no money is exchanged to enjoy them. 'Free' environmental goods and services are 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 and 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 exist 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 under 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 use of an area for recreation. Indirect uses of goods and service occur when people benefit from it, such as ecosystem services like water purification, or coastal protection. Direct and indirect uses of goods and services may be marketed or non-marketed as shown in figure 2.2 for coral reefs.

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

5.2. Individual Preferences and Values

Each one of us make choices based on our preferences, and what we are willing to sacrifice to fulfil that choice, particularly as a typical consumer is constrained by their income, or the time at hand to fulfil their desire.

By considering the consumer preferences, their willingness to sacrifice money or time, and their resource endowments, allows us to determine the choices that would maximize the consumer's welfare or satisfaction. In making choices, the consumer often ranks his or her consumption choices based on the levels of satisfaction derived from different combinations of goods and services. Utility is the satisfaction a person receives from the consumption of a good or services or from participation in an activity. Happiness, joy, contentment, or pleasure might all be substituted for satisfaction in the definition of utility (McKenzie and Dwight 2006).

The sum of individual preferences and their willingness to pay for each quantity of a commodity determine the market demand for that commodity.

In economic terms, we also 'consume' things that we do not like, such as a polluted river from industrial discharge. For example, consider a typical situation where a government has to decide whether to close a manufacturing industry that employs about 500 people, or accept some health risks associated with use of polluted water from the river. In this case, one commodity makes the society better off (employment), and the other that decreases the societal welfare because of the government's decision. In this instance, more pollution means society is worse off.

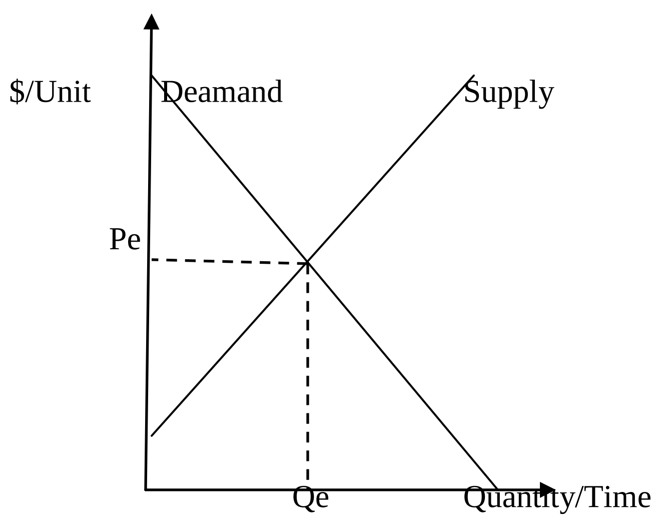
5.3. Markets, Market Supply and Demand, and Market Values

The market system is a mode of organization in which resource allocation is determined by 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 the supply and demand is therefore 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, often price is 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, a 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.

The price system induces self-interested parties to make choices in their own interests. Quantity demanded increases with decrease in price while quantity supplied increases with 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 quantity supplied is equal to quantity demanded, and the market price represents an equilibrium between peoples willing to pay, and their willingness to accept and supply the goods required.

Figure 5.1 Equilibrium Price and Quantity



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, income of the consumer, tastes, preferences, and other social factors. Likewise, there are also many determinants of supply by producers which may include things like price of inputs, cost of production and technology, number of suppliers and so on. See Lal and Holland 2010 for more detailed treatment of these effects.

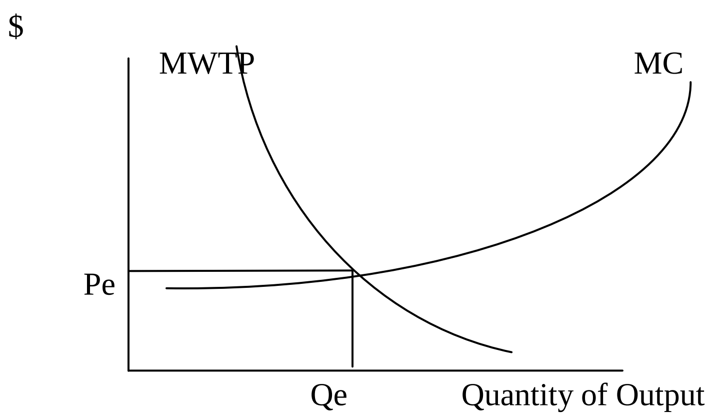
5.4. Market and Non-Market Values, and Coastal Environment

Many coastal resources are not directly traded (such as biodiversity and coastal protection), and therefore, does not have a price similar to those goods and services that are traded in the market (such as logs). Thus, there are no price signals for consumers to consider in the decisions to use/consume the environmental goods and services, resulting in their inefficient uses. One way of thinking about inefficiency is in terms of missed opportunities. If 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, we must consider all the social values, market and non-market values, and consequences of economic decisions, in particular 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 and 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.

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: labour, raw materials, energy, machinery, and so on. These are the private costs, illustrated by the graph marginal private costs, which in a market equilibrium condition is sloping upwards. Figure 5.2 shows the socially efficient rate of output.

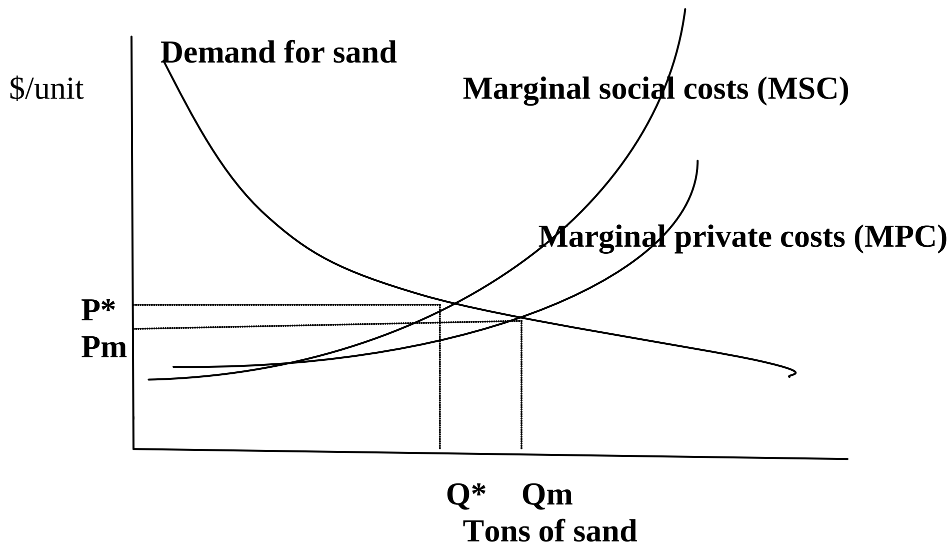
Figure 5.2 Socially Efficient Rate of Output



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. 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. The presence of negative externalities result 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 cause negative externalities on their neighbour when the removal of sand in one place causes the erosion down current, affecting their neighbour's house foundation. Because sand is a **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 be borne by people who live along the coastal areas. This practice is commonly known as the **tragedy of the commons,** where the coastal sand is seen as an open access resource, where everyone has equal access, but no one has the incentive to protect and sustainably utilize 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 the beaches that benefit the rest of the community and public. Similarly positive externalities are created when some country conserves their genetic materials, or preserves rare species of plants and animals that may be accessible by other countries, for the benefit of farmers in their country. Likewise, often we see that the 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 utilize the recreational parks, but have little or no incentive to establish and maintain one for themselves because the good, the recreational park, is not 'owned' by them, and thus others cannot be excluded from its use, as discussed below. Such positive externalities too, are often unpaid for, and thus do not create 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 failures.

5.5. Property Rights and Economic Incentives

Market mechanism works best when property rights are well defined. 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** 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, like in a market economy, this facilitates best use of the resource, generating maximum benefits for society as well.

Several key resource 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. A rival good is when its use by one person reduces the ability of others to 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. Whether a good or service is "excludable", and whether it is "rival", physically determines if it is possible to privately own environmental goods and services, and thus to use them 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 incentives individuals will have for its sustainable use over time; the shorter the duration of "use rights", the greater the incentive to mine the resources for the immediate gain. Similarly, when rights are transferable, then owners can sell their resources, thus allowing its use in alternative ventures.

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 make them better off. The owners have an incentive to make informed decisions about which uses of the goods and services will optimize their benefits, because these can be appropriated. 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 enforced, and transferable (Lal and 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 maximize their individual benefits, and negotiated and market transactions can maximize aggregate welfare (efficient allocation of that resource).

5.6. 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 these all 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 because 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 Marine-Protected Area 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.

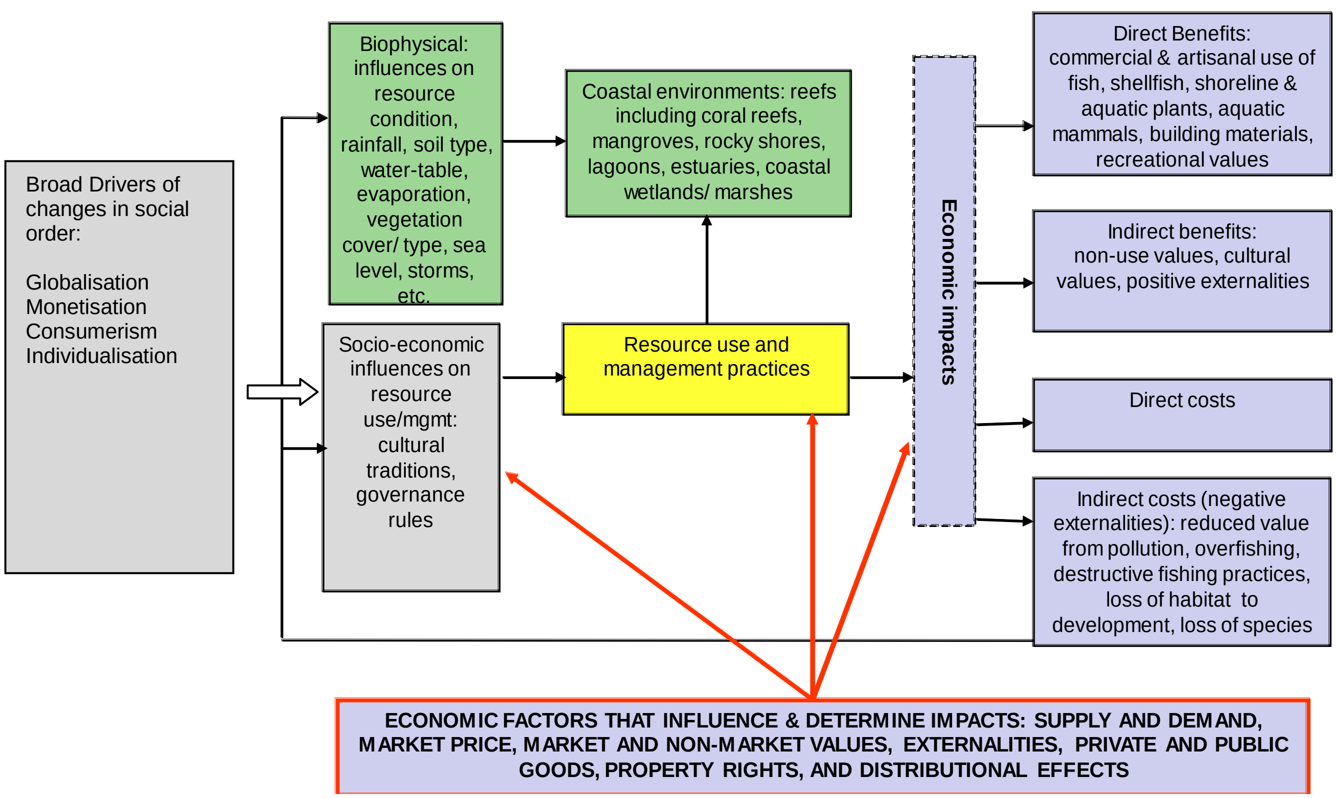
In conclusion, the economic concepts discussed in this section are useful in understanding the dynamics of markets and market mechanisms. They also help understand when markets may, or may not exist, and what motivation and incentives they create for people to conserve, protect and/or, preserve environmental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

5.7. Section I Concluding Remarks

Chapters 1-5 provide an overview of pressures on coastal ecosystems generated by the underlying drivers of change, such as population growth, monetisation, and modernization, across all levels of society: national, community, and local. They also help understand the geographical, ecological, and temporal dimensions of the impacts of resource uses. The two analytical frameworks, DPSIR and EBM, help understand the interaction across and between pressures, impacts, and broad-level responses. At the core of these pressures, impacts are what motivate individuals in their actions, for which basic market and resource, and environmental economics analytical framework was used. The economics of coastal zone essentially means identifying factors that influence and motivate individual behaviour and attitude towards sustainable use of the environmental goods and services that have both private and public goods characteristics. On the other hand, the key microeconomic driving forces determining the state of resource, environment, and individual motivations are the market supply and demand signals that affect production and consumption sectors. The aggregate of individual producer and consumer decisions make up the outcome of natural resource uses.

Figure 5.4 provides a schematic illustration of the interactions between the biophysical, social, and cultural factors influencing the coastal environment, and the impacts in terms of costs and benefits which are the major determinants of individual decisions. The core concepts of individual benefits and costs borne by individual actors and decision-makers provide the link between understanding the higher-level drivers and the coastal resource outcomes observed on the ground.

Figure 5.4 Influences on Coastal Environments and Resource Uses: Integrated DPSIR, EBM and Economics Analytical Framework



Source: Adapted from Nicholas Conner 2008

Part II

Case Studies: Application of Integrated DPSIR-EBM Economic Analytical Framework to Key Coastal Resource and Environment Management in the Pacific

Chapter 5 described how private incentives and motivations influenced peoples' subsistence and commercial uses of resources. Such incentives and motivations themselves are influenced by higher-level drivers of change - such as monetization of the Pacific economy, globalization and modernization, and urbanization, as discussed in chapters 2 - 4. This section aims to demonstrate the integrative nature of the global, national, and local forces, market and non-market goods, and services that in turn determine human behaviour, actions, and attitudes towards the coastal environment. The degree to which these social drivers affect peoples' incentives is strongly dependent upon the type of institutional governance systems that circumscribe human action. It also discusses effectiveness of key institutional designs to address coastal resource and environmental issues, and how these could be strengthened by explicitly considering such overarching drivers, and individual incentives and behaviour.

Three environmental issues are first discussed: overfishing (Chapter 6), coastal pollution (Chapter 7) and habitat destruction (Chapter 8), before discussing where economic considerations have been explicitly considered in the Pacific, and providing some concluding remarks about the role of integrative approach to coastal resource management (chapter 9).

Chapter 6 Fisheries: Effects, Outcomes and Responses

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

The Centre for Oceanic Solutions (2009) has identified commercial and industrial fishing as having an overall ‘severe’ impact in 40 countries and territories in the Pacific. Unsustainable resource use throughout the Pacific reduces fish stocks, limiting fish catches and, often causing ecological shifts that further reduce biodiversity and productivity. Artisanal and subsistence fishing suffer when local needs are greater than local supply, causing displacement of fishing activity, reduced income, and insecure food supply. Habitat destruction exacerbates overfishing by reducing fishable areas and productivity. Increased demand due to increase in population growth, expansion of export markets, availability and access to improved technology, and the increased desire for cash to meet individual growing material needs, underpin the socio-cultural change which translates to influence individual aspirations and motivations to maximise personal wealth and income. This directly puts pressure on the resources such as fisheries to meet the individual demands, thus collectively threatening its present sustainability.

This chapter focuses on the fisheries sector in the Pacific to discuss how the broader drivers of social change in the region directly impact the status of resources, its availability, and indirectly impact the coastal environment, and its goods and services through externality effects.

6.1Coastal Fisheries Problems Identified

Most coastal fisheries in the Pacific island region are over exploited (South, Skelton et al. 2004.); (Secretariat of the Pacific Community 2009). A recent review of literature by (Newton, Cote et al. 2007) suggests that possibly 55% of all PICTs have overexploited their coral reef fisheries, although this statistic is uncertain due to limited data [see (Kinch, Anderson et al. 2010) (Kinch, Purcell et al. 2008). A 2003 survey conducted by the SPC summarized key problems in regional coastal fisheries (King, Fa'asili 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.

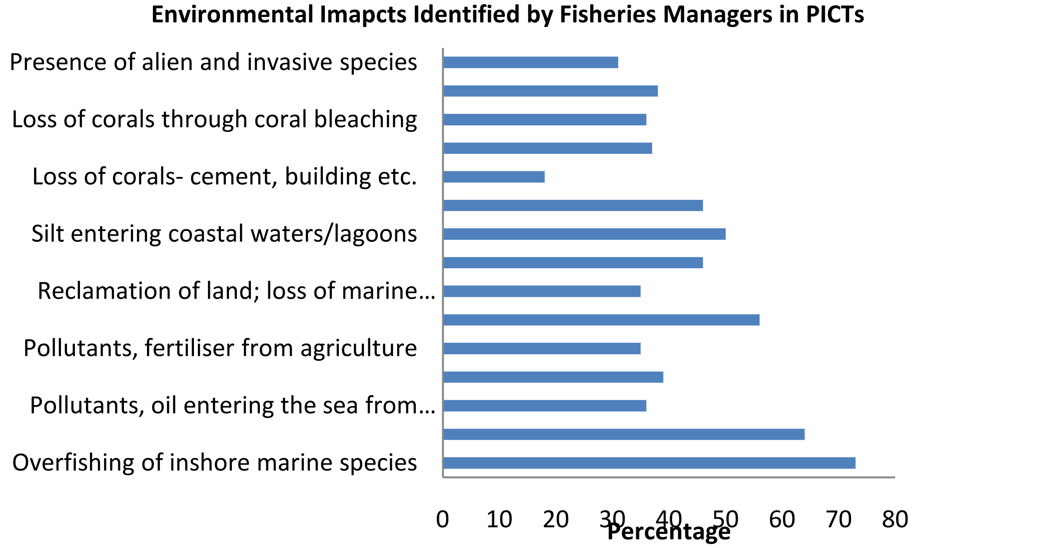
Table 6.1 Most Important Commercial Fishing Issues Identified by Countries

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, Fa'asili et al. 2003)

In a more recent survey summarized 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 1981) and (Johannes, Ruddle et al. 1991); bonefish, milkfish, and parrotfish in the Cook Islands and various grouper stocks in French Polynesia (Richards, L.J.Bell et al. 1994; Tuaopepe 2005). Overharvesting of invertebrates, and in particular gastropods created crisis in many places due to declining exports, and their significance for shell value in the ornamental shell trade (Tuaopepe 2005).

Figure 6.1 Fisheries Environmental Impacts in PICTs



Source: SPC 2008.

At the country level, similar forces of change can also be observed. For example in Fiji, (Jennings and 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 and Lock 1996). An Asian Development Bank (ADB) study states that of approximately 400 *qoliqoli* (fishing rights areas), 250 are fully developed, and around 70 per cent of these are over-exploited (Hand, Davis et al. 2005).

As a consequence of the monetization of the rural sector, local motivations are changing and, on occasion, are negatively impacting inshore coastal fisheries. Rural communities who used to engage in subsistence fishing only, are now increasingly using modern gear to increase their catch for cash. 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, 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 loss of many commercially-important food fish such as humphead wrasse, deep sea snappers, giant clams, trochus, Beche-de-mer, and green snails in many Pacific islands (see for example: (Wright and Hill 1993). Overfishing has been due to a number of reasons ranging from increase in demand due to increase in population, improvement 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 also is 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% 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% of the total Bêche-de-mer catch was white Teatfish, but by 2002, this species accounted for only 2% 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, a 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 and 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 indicate 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 ration. 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 2000)

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 and Schug 2002)

The direct economic and social impact of unsustainable fishing practices are reduced food security and livelihoods for people dependent on fisheries resources. Indirect impacts include poor nutrition and increased social conflict. Empirical information about such impacts has not been documented to our knowledge though, 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 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 Section 1.

6.2. Increased Demand and Overfishing Causing Decline of Fish Stock Due to Externalities

Market demand describes the relationship between quantities demanded, for example, of fish at certain prices for a society at a particular point in time. The shift in market demand for coastal resources, such as fish products, are 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 globalization and modernization.

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

The effects of individual behaviour unintentionally impacts on the overall fisheries and fish species, causing fishing-related externalities. The common types of fishing externalities are stock, crowding, and technical, and these generally have negative effects and occur where fishers can freely enter and capture a resource. Where a voluntary agreement of co-operation does not exist, resource users do not consider the external effects imposed on others (Seijo, Defeo et al. 1998).

Stock externality occurs when increased effort through, for example, entry of new vessels reduces the fish stock, and hence increasing the overall harvesting costs. Fishers do not consider these costs because they are only taking into account their private fishing costs, ignoring the external costs imposed to others by stock reduction. 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, Cummings et al. 2002).

Increased fishing efforts also may result in crowding externality, which occurs when effort is not evenly distributed, either in time, or on the fishing ground. These externalities over time increase the marginal cost of harvesting, resulting in fishers sequentially harvesting most accessible reef patches and reef flats, and then gradually moving further afield into deeper ocean areas. For example, experiences in harvesting beche-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 beche de mer. Areas closer to urban centres also have localized 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 6.3.

Figure: 6.3Fishers continue to use scuba gear to dive for *Bêche-de-mer*

Photo: Vina Ram-Bidesi

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

For example, many subsistence fisheries exist in the near shore areas close to the coast while the artisanal fishery is 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, the 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, a negative externality for 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 region, even where management measures, such as size limits, export permits, and areas closures, are in place. In Kiribati, Tuvalu and Tonga for example, coastal fishery is centrally regulated, but the local people are free to fish anywhere they like. In other countries such as Fiji, and the Solomon Islands, and parts of Vanuatu, although traditional resource management systems exist in which local people belonging to the clan group have fishing rights, in some instances, these are not effectively enforced due to weak local governance. Those fishers that harvest the resources operate almost identical to those under the open access situations which eventually lead to similar outcomes.

In such cases, the impact of lack-of or ineffective regulations means that fishers continue to harvest because the revenue they receive exceeds their fishing costs, and they still can 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 to the cost, and most, if not all fishers will begin to make losses if they continue any further fishing effort.

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

6.3. Government Responses - Subsidies

With increasing population, governments often try to encourage economic growth by encouraging locals to shift from just-subsistence fishing towards commercial harvest.

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 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 the deep water snappers that aggregate on sea mounts. The fishery boomed with the introduction of Food and Agriculture Organization (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 slow growth rates and low 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 the groupers and giant clams. They are often faced with an inelastic demand curve which means that any changes in price do not lead to proportional changes in demand. Therefore, when stocks are declining, due to scarcity, market prices are still high, and so fishers often continue improving technology 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, fishery is no longer viable, but holds a greater chance of a total extinction. The case of giant clam (*Tridanca gigas)* provides a good example of such a fishery in the Pacific Islands.

It also appears that many reef species have low natural mortality rates, and therefore may be more vulnerable to over-exploitation (Williams et al., 1995). Coleman et al. (1999) suggests that the low natural mortality rates imply that only a small portion of the biomass (perhaps as low as 10 per cent) can be harvested annually. 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 and 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 decrease 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 and Schug 2002).

6.5. Property Rights, Market Failure, and The Tragedy of The Commons

Property rights characteristics describe the nature of incentives people have in the use of resources. For example, many fish that swim in the ocean can be targeted by multiple individuals (they cannot be excluded from trying) but – once caught – are gone forever. The nature of fish as such a ‘common property resource’ means that there are few incentives not to overfish. 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 needs. In other words, the rights to the fish in the ocean depend on the kind of accessibility or rules that regulate the access, and use of the resources.

A market solution to overfishing would work best when property rights are well defined, such as attempted through individual transferable quotas, combined with total allowable catch in an industry that captures the biological and ecological characteristics of the biological species. In the case of **common property resource systems** (managed in common), varying levels of efficiency and sustainability can be achieved, depending on the rules that emerge from collective decision-making, such as seen in the case of coastal communities with traditional fishing or use rights. The easy access to resources, lack of effective enforcement, and lack of clearly-defined rights, lead to fishery harm (negative externality) and demonstrate how the actions of one fisher, impact the operations of others. This leads to an inefficient allocation of coastal resources, and creates a 'market failure' in economic terms.

Like many Pacific fisheries, open access resources tend to be both resource-inefficient (that is, too costly), and unsustainable in the way they are used because of the common–property-resources nature of the fish. Problems often arise when access to the fishery is unrestricted. Open-access resources create two kinds of external costs: one 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. The other cost 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 overfished the stock. When too many fishers have unlimited access to the same common-pool 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 rent. The profit levels would, however, attracting other operators to the fishery, eventually lead 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 impact of unsustainable fishing practices are the 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 a 'crowbar' 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 of limit as to where fishers can catch, and the number of nets they can use.

Source: (Ram-Bidesi and 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. They may, thus continue to re-offend. Secondly, 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 benefits directly derived by the government management authority in enforcement of the legislation.

A large majority of fishers in rural areas lack knowledge and awareness on regulations, or even have the benefit of fisheries extension service. *Beche de mer* and trochus are regulated by size and export license. However, observations at local municipal markets in Fiji show that smaller sizes are sold at the local markets in fresh form, while legal sizes 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. Imposing restrictions on gear, such as mesh-size limitation, ban of efficient gear, such as scuba gear, or 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 increase effort further. Such regulations, not only impose higher costs for governments, in terms of monitoring and enforcement, but also are inefficient measures from fishers' perspectives as they do not optimize resource rent, but raise fishers cost instead.

When conventional command and control management becomes ineffective, fisheries 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, while the operations of others impose an externality on the operations of individual operator, he or she has no incentive to control effort, and follow management rules because of the characteristics and nature of the fishing ground.

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

Examples of policy response (Johannes, Ruddle et al 1991); (Lal and Holland 2010) show that centralized command, and control mechanisms can be ineffective on their own because of weak property rights and lack of incentives for sustainable behaviour. The problems are essentially economically-driven social changes that require understanding of the integrative nature of the problems 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 the property rights certain and clearly defined, allowing communities to have exclusive fishing and use rights (Hviding 1996); (Johannes, Ruddle et al. 1991); (Kuemlangan 2004). Some examples of fisheries management under the community-based systems of resource management are discussed in chapter 8 which attempts to address the integrative nature by the application of systems approach through ecosystem-based management.

Chapter 7 Pollution Effects, Outcomes and Responses

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

The presence of pollutants in the environment often directly and indirectly affects the ecosystems, resulting in habitat destruction, declines in natural beauty, loss of biological diversity, and the ability of the environment to support human needs and aspirations. In atoll island states, the problem is further compounded by the porous nature of the islands, leading to increased pollution of surface and ground water. Polluters impose costs (negative externalities) on society through unpleasant or harmful pollution. Internalizing the externality effects means placing responsibility on polluters to either pay for damage or change their behaviour to reduce or minimize damaging effects. These are the subjects of this chapter, focusing on source and 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 their effects on human lives, and the health of ecosystems. Usually, pollution is discussed in terms of either the types of pollutants, and/or sources of pollutants, and solid wastes, industrial wastes, plastic marine debris, dumping of toxic material and oil spills, and urban runoffs, as well as pollutants from sewage (table 7.1). Empirical information about the volume of such wastes, regional or even at 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. Some pollutants also have long-term consequences.

The presence of non-biodegradable substances such as bottles, plastics, heavy metals like lead, and PCBs (poly chlorinated 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 and Seneca 2001)

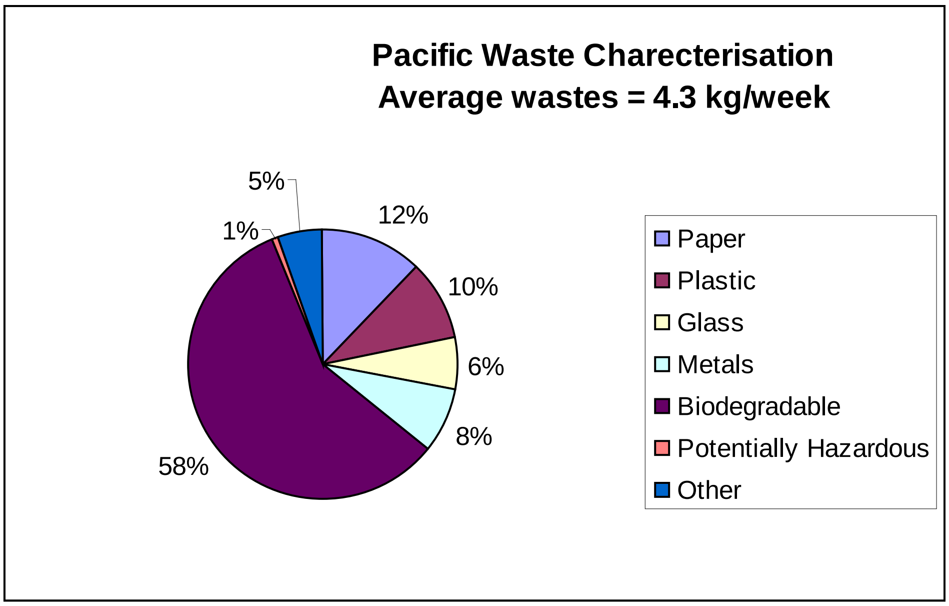
Each Pacific Island Country also has to regularly deal with the disposal of toxic waste such as – hospital and hazardous waste, including persistent toxic substances (PTSs) and persistent organic pesticides (POPs). With changing lifestyles and increased use of modern vehicles and computers, an increase in electronic and automotive waste with a long 'shelf life' is also expected. Electronic waste, or E-waste, including personal computers, monitors and televisions, contain toxic chemicals such as lead and brominated fire retardants. On the other hand, automotive wastes include lead-acid car batteries, used oils, and brake pads containing asbestos, which can have serious human health impacts if disturbed.

Shipping is a source of marine pollution, in terms of the impacts of vessels, ports, shipbuilding and repair facilities, oil storage and bunkering facilities. Ballast water, ship waste, and marine spills pose further challenge to fragile Pacific environments. All marine life has a planktonic stage in its life cycle, and therefore has the potential to be transported in ballast. Cases such as the zebra mussel infestation in the great lakes of North America, jellyfish in Eastern Europe inland seas, and North Pacific starfish in Australia have caused major ecological damage, and multi-million dollar economic costs (Secretariat of the Pacific Regional Environment Programme 2010). There is also potential risk 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 also happen to be major source of revenue for the countries. Many of these vessels are old; a significant number end up being abandoned. 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.

At the household level, pollution from poorly disposed solid and liquid wastes is the major issue, affecting the health of freshwater and coastal ecosystem, as well as human health. The majority of the household waste in the Pacific is recyclable materials and organic waste. In total, regionally, 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 percent (SPREP and 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, Tabunakawai 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), smallness of the island states and, in most cases, limited land and the 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 effluent, more urban-based and their lifestyle changes, including an increase in consumerism.

Pollution of solid waste 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 and Takau (2006) report that each household in Tonga produces approximately a tonne of solid waste per year, some of which is indiscriminately dumped on roadsides, waterways, and coastal mangrove areas. The effects of which 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 a year, or about $340 per household per year (Lal and Takau 2006).

Likewise, poor human and animal waste 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 centralized reticulated sanitation system and almost 90 percent 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, Saloa 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 then mean 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 A$0.5 million per year (Lal, Saloa 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 on ciguatera outbreaks indicate a temporal link between ciguatera diseases in humans, and algal blooms (Chateau-Degat and M.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 (Per.Comm N. Roi, 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 cost of fish rises (due to cost of supply), because it has to be sought from elsewhere.

The economic costs of such effects of human and animal wastes can be large. In the Cook Islands, for example, water shed pollution from septic tank leakage, fertilizer runoff, herbicide and pesticide runoff, livestock and animal waste is estimated to result in estimated costs to the community of NZ$2,900 per year per household, or NZ$7.4 million per year (Hajkowicz and 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% of GDP for the Cook Islands (Hajkowicz and 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 often does not impinge back on 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.

7.2.1. Individual Household Waste

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 waste in the environment thus, do no incentive to reduce dumping, because it does not directly impact them. This can be demonstrated using the concepts of private benefits, compared to public cost. 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 throw away the rubbish. In most cases, this would be much lower than the costs faced by other people such as the numerous local fishers who end up with contaminated fish, or lower catches. The real social costs of dumping are therefore, higher than private costs borne by the polluter, as illustrated in figure 5. 2. Consequently, there is an overuse of coastal areas as dumping sites (figure 7.3).

Figure 7.3 Overuse of Coastal Areas for Waste Disposal

Photo: Vina Ram-Bidesi

7.2.2. Pollution Producing Industry

The damage to coastal ecosystems caused by pollution resulting from industrial production can also be illustrated in terms of ‘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 those faced just by the producer. For example, the Fiji Sugar Corporation produces sugar for domestic and export markets. But it also produces waste water as a by-product which is discharged in the local river system. The waste water 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 what the private costs to producers are.

Box 7.1 Social Costs of Pollution

The economic impacts of pollution on other industries and people can take several forms, such as loss in business, unemployment, increased costs related to recreational activities along the coastal areas, increased health costs, and loss in 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 without pollution, less the sum of consumer and producer surplus with pollution.

Loss of consumer surplus can result from a decrease in demand of goods and services associated with the coastal area affected by the polluting industry. This may occur when, for example, people switch to other substitutes after the scare of eating contaminated fish. This would a decline in the quantity of fish demanded at each market price. As demand decreases, and supply remains the same, a decline in the producer surplus that accrues to the operators also occurs.

Often, pollution also reduces the producer surplus with reduction in supply because of eventual decline in productivity in other commercial activities. Pollution, such as waste dumped into coastal areas, suffocates fish and other invertebrates, thus increasing mortality which in turn reduces the availability of fish. Likewise, with reduction in supply, price is shifted upwards which reduces the consumer surplus, and with reduced supply, the producer surplus would also be reduced. Adverse economic effects and losses due to pollution can be categorized as supply effects when changes in the abundance and distribution of economically important fish and shellfish occur. For example, in Bikinibeu, in South Tarawa where the household waste is most concentrated, there is significant coral reef damage, and most corals are dead, hence the fishery associated with this is also non-existent. The supply effects of pollution is thus measured in terms of use and non-use values discussed in chapter 2, associated with different goods and services, associated with the geographic area affected by the polluting industry.

The presence of pollutants in the environment also often depreciates the services that flow over time from the environment, and economic losses from coastal pollution may 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 and Holland 2010 for further discussion). In theory, efficient allocation of resources occurs when the present value of net benefits is maximized, environmentally this may not be an acceptable outcome. Over time, the cumulative effects of pollution can reach unacceptable threshold levels if waste is not properly disposed, particularly when the market prices of the commodities do not reflect the true cost of their production.

For example, in the case of mining, such as nickel in New Caledonia, or gold in Fiji, or copper in PNG, there is often water and air pollution through tailings, and release of sulphur dioxide from the smelters. Efficient quantity of mineral production would decline over time if marginal social cost of damages increase. The waterways and farms would be damaged as mining activities continue. The price of minerals would rise over time, not only because of scarcity, but also reflecting on the rise in social cost of production, because of damage to the surrounding environments. Because clean environment does not have a market price, market mechanism cannot be relied on to result in economically efficient outcomes, resulting in market failures. Stock pollutants can also create a burden for the future generations by using up resources, and by passing on damage that would remain well after the benefits have been reduced.

7.3. Pollution and Market Failure

Pollution can also be explained in terms of market failure (Choe and Fraser 1998; Lal and 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 process waste, and a market for clean environment does not exist, and the price of a clean environment is essentially treated as zero (being provided ‘for free’). If polluters were made to foot the cost of polluting the environment, either the good would become more expensive to consumers or less of it could be produced.

Correcting market failure means, either forcing producers not to generate pollution, or forcing them to absorb the pollution costs themselves to essentially reap what they sow. The effect would be a fall in the quantity of goods, and thus level of pollutant produced and an increase in the market price, and a decrease in the profitability of production.
When a government enacts arrangements to make polluters face the costs of their pollution, they essentially implement the ‘polluter pays’, or ‘impactor pays’ principle (*e*.g. (Panayotou 1998). By forcing polluters to face their own costs, polluters face the choice either avoiding generating waste in the first place (to avoid having to face the cost), or ‘face the music’, and bear the cost of their waste (say, by arranging for its disposal).

Conversely, when persons affected by pollution are forced to pay for, for example, waste collection and disposal to create a ‘clean environment’, this can be seen as beneficiaries paying for the benefit s/he enjoys. This principle was used in Tonga to introduce waste collection and disposal fees (Box 7.1).

Box. 7.1 Application of 'Beneficiary' or 'Impactor Pays' Principle for Solid Waste Management in Tongatapu, Tonga

Individual Tongatapu households produce approximately a tonne of household waste per year, 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 is $3.10, with most households (95 per cent) 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, it 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 et al. 2006

Making polluters, or beneficiaries pay would not necessarily mean no pollution. Preservation of the environment in its pristine condition is not possible where production is needed. In reality, any form of commercial and social activity, even human existence on this earth, cannot occur without affecting some form of environmental change. As a result, pollution can never be totally eliminated in a society that extensively engages in production. Nevertheless, that production must 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 reduce the level of pollution, or forcing them to absorb the pollution costs themselves to essentially reap what they sow, as discussed next.

7.4. Management Responses

Many Pacific Island Countries have developed their *National Environmental Management Policy and Strategy*, and sector-specific legislations 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 piece meal, 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 is 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 which includes a fixed charge for household garbage collection.

Incentive driven schemes where user fees are charged based on the amount of waste generated, provides the incentive for households to minimize waste, such as in the case of waste management in Samoa. Tip fee is another example, where a fee based on the amount of waste brought to the landfill site is applied at the point of entry at the landfill.

Some countries have begun to use environmental levy on 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 internalize their externality cost of plastic bags disposed in the environment.

Other countries, such as the Cook Islands, have introduced environmental levies on foreign tourists (Box 7.2). This levy is included as part of a passenger's departure tax, or fee charged on cruise ships based on passenger numbers.

Box 7.2 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 would make an otherwise discarded item to be converted from waste to a commodity, and creates 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 for recycling beer bottles in Fiji. In Yap and Kosrae States of the Federated States of Micronesia, a $0.06 is charged 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 7.3.

Box.7.3 Deposit- Refund Programme in Kiribati

A deposit/refund system on aluminium cans, plastic bottles, and car batteries exists. A small deposit is paid on purchase and 80% of this is re-paid 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.

(Richards 2009)

Reduction in wastes can also be encouraged through the use of subsidies often used to encourage the use of appropriate technology that helps reduce the level of pollutants, and thus externality costs. For example, in Tuvalu, the use of flush toilets and poor septic tanks results in the contamination of the ground water from human wastes. If Funafuti government subsidised the use of compost toilets, and compost toilets became socially acceptable, Tuvalu would have made a savings of almost 2 million Australian dollars a year in the externality costs, in terms of human health effects and, poor drinking water (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 specialized 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.

In conclusion, DPSIR analytical framework helps understand the broad societal drivers, like globalisation, modernisation, and consumerism that are behind changes in lifestyle, and thus increase pollution and degradation of the environment. The EBM framework helps understand the geographic and temporal boundaries, and nature of the environmental effects of pollution. It is the economics paradigms and analytical frameworks that help us better understand the root causes of increased pollution. Presence of private goods, public goods, markets for tradable commodities, and environmental goods and services with no market prices, also help us understand why there is excessive pollution, and why market-based instruments, reflecting the ‘polluter pays’ or ‘beneficiary pays’ principles, can help target incentives and motivations behind human behaviour to reduce pollution.

However, ecological economists would be the first ones to acknowledge that markets and market instruments cannot address all pollution issues. Environmental goods and services that do not have a well-functioning market would require additional policy measures, such as regulatory standards to ensure that pollution levels do not exceed the environmental threshold limits. Market mechanisms do not function well in economically efficient and environmentally acceptable outcomes, particularly when pollutants have long shelf lives, and accumulate over time, and/or have high costs, even if at low probabilities of the costs being realised. 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 and non-government, and community stakeholders, as discussed in Chapter 9.

Chapter 8 Economics of Habitat Destruction

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 parts of the ecosystem are overexploited and/or drastically altered. Alternatively, degradation or destruction can occur if pollution and/or invasive species change the dynamics of the ecosystem.

Increasing population, globalisation, and monetisation in the Pacific, as discussed earlier is focusing significant social changes where there has been growing need for income, and greater emphasis on material wealth. With such changes in social order, coastal ecosystems, such as mangroves and other coastal habitats, are under constant pressure for their overexploitations and/or reclamations for hotels, industrial sites, and human settlements. Coastal habitats are also impacted upon by the effects of 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 vulnerability of coastal communities.

The rate of change in the environment is also influenced by the governance arrangements, and national development goals, and the focus on rapid economic growth. In many instances, as individuals attempt to meet their private benefits, habitat degradation and conversion is common once again as they ignore externality costs imposed on others.

The coastal ecosystems, its biodiversity, and natural resources are seen as natural capital that underpins economies, societies, and individual wellbeing, particularly in small island developing states in the Pacific with limited land-based resources (see table 2.1). The value of its various benefits is however, often overlooked or poorly understood, particularly as many of these do not have market values. As a result, they 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.

8.1Economic Rationale for Loss and Degradation of Habitats

The development process can be seen as the reallocation of the initial portfolio of capital assets in order to generate alternative preferred flow of goods and services (Swanson 1995). 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 changed in the types of preferred housing, the demand for construction material has increased. Such construction materials are harvested 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 with a much higher cost, such as through imports.

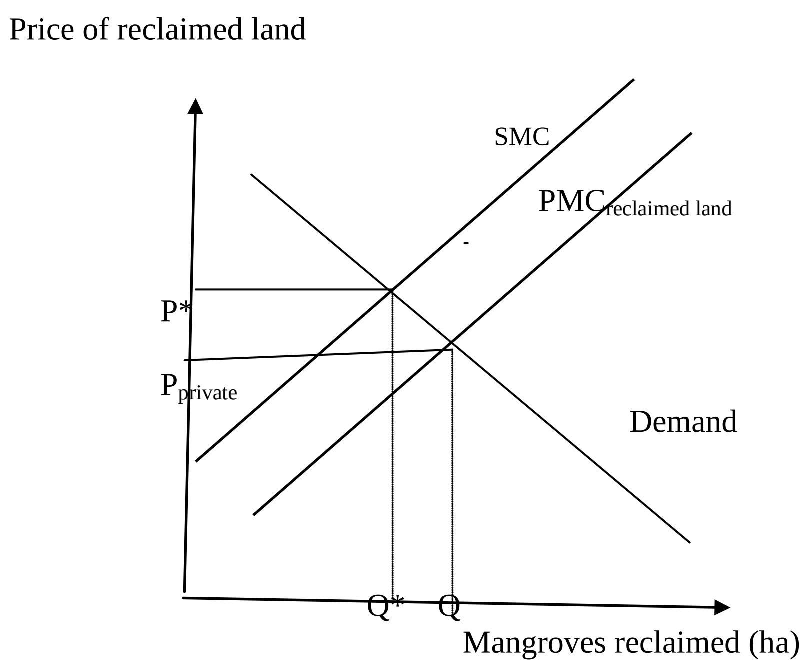
Figure 8.1 Reclamation of coastal area for tourism development

Photo: Vina Ram-Bidesi

In Fiji, habitat destruction initially was associated with conversion of mangroves during the 20th century, undertaken primarily to create land for sugarcane and rice farming, and aquaculture. Later on in the late 20th century, large scale coastal habitat destruction has been for tourism, and industrial developments (figure 8.1). Such conversions were allowed, noting that these geographical areas on the land-water interface areas were 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 the habitat. Mangrove forests are important ecosystems that provide direct and indirect benefits, both in-site and offsite. Much of these goods and services provided by mangroves are non-marketed, and therefore their values are under-estimated when making decisions about its conversion into alternative uses. Thus the decisions to reclaim mangroves for alternative uses can once again be explained in terms of private benefits of reclamation, and, for example, do not include considerations of externality costs of costal fisheries. Similar arguments can be also used to explain excessive harvest of coastal aggregates, and subsequent destruction of coastal habitats in many PICs.

Figure 8.2 Reclamation of Mangrove Habitats and Negative Externality



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 the price of reclaimed land was zero. The externality costs associated with the reclamation, in terms of foregone forestry and fisheries was estimated to $53,000 a year. While the cost of reclamation alone was $181,000 (Lal 1990).

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 personal communication May 2010).

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, a society may choose to allow reclamation of the mangrove foreshore for these high-valued uses. However, it may not be acceptable on social grounds when the foregone losses in the forestry and fisheries goods and services are borne by one community, and the benefits of reclamation are derived by a usually wealthier individual. Alternatively, from an ecological perspective, this may not be a desirable outcome, particularly when it involves increased exposure to coastal hazards, or loss of biodiversity, of which future values are unknown.

8.1.1. Degradation of Ecosystems

Even where total reclamation of habitats is not involved, selective harvest 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% of its total harvest to be *Pometia* or *Calophyllum* with diameters over 60 cm) has caused considerable erosion, land degradation, and loss of biodiversity (Thistlethwait and Votaw 1992).

PICs' environments are already fragile and vulnerable due to their small size with 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 Red-List provides most up-to-date collated information for PICs, biodiversity of PICs' regions is generally either limited in accuracy and scope, out of date, or poorly documented (Kinch, Anderson et al. 2010); (South, Skelton et al. 2004), (Secretariat of the Pacific Community 2009). 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, Anderson et al. 2010). Only approximately 5% of the 233 described fish species in the Pacific islands region have been assessed (and in only six PICs), and of these, 22% are listed as threatened (Pippard 2009.); (Kinch, Anderson et al. 2010). Using International Union for the Conservation of Nature's (IUCN's) Red List categories and criteria, the following table 8.1 shows the number of red-listed species groups for 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							

Furthermore, ecosystem dynamics and its sustainability, and assessing the extent of its degradation, require a detailed understanding of the relationship between species and their habitats. Box 8.2 shows why sensitivity to ecosystem dynamics is important. Add to this absence of adequate empirical information about the relationship between changes in ecological conditions, and the economic values associated with the respective goods and services.

Box 8.2 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): 152-153.

8.1.2. Effect of Rate of Time Preference

The decision to degrade the environment, convert coastal lands into alternative uses, or to conserve the environment today, can be understood in terms of rate-of-time preference of people for consumption, as compared to conserving it for future, or the discount rate. A higher rate of time preference implies a person has preference for consumption today, as compared with benefits 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 collapse of the economy, even if continued economic growth and permanent preservation is possible (Swanson 1995).

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

A relatively higher return on financial capital compared with the growth of the natural asset, is likely to result in a lower stock of capital retained in the form of natural assets. Many examples of coastal development projects exists throughout the coastal areas in PICs where mangroves and seagrass beds and inter-tidal flats have given way to reclamation of land to accommodate industrial development, or hotel development.

In situations such as aggregate mining for construction of their homes, individuals discount the future much more when they decide to mine the coastal foreshores, even when they know that their action may cause erosion of their own foreshores later and/or downstream, causing negative externalities.

The shift from subsistence to semi-subsistence, to cash economies, and/or changed lifestyles ultimately falls on the environment and the resources, as summarised in table 8.2, which outlines possible environmental damages, and economic effects resulting from degradation of coastal habitats.

8.1.3. Supply of Biodiversity Conservation

Looking at the issue from the perspective of the supply of long-term conservation, a developer does not have the financial incentives for long-term conservation of biological diversity on land that does not belong to them. In such a situation of public goods, 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 (Box 8.1)

Box 8.1 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 is 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 global goods, conferring international benefits.

Under the Samoan Constitution, Uafato village own the forest area where the *ifilele* stand grows. Until recently, this was targeted for building timber, carving crafts and firewood; however, the logging rates were estimated to be unsustainable, due to the weak nature of the 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 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. The international and regional community, on the other hand, may derive existence and future option 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. 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. The efficient allocation maximises the net benefits which is 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 curves intersects the supply, MC curve, and charged their respective prices.

But usually public goods are undersupplied, if left to individuals (Q_A, or Q_B) as illustrated in figure 8.3.

If consumer A is charged according to its demand price P_a (=OA), and consumer B is charged P_b (=OB), then both consumers will be satisfied with the efficient allocation (maximise 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 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 (Tietenberg 2006).

Source Lal and Holland 2010

Figure 8.3 Supplying Biodiversity as a Public Good

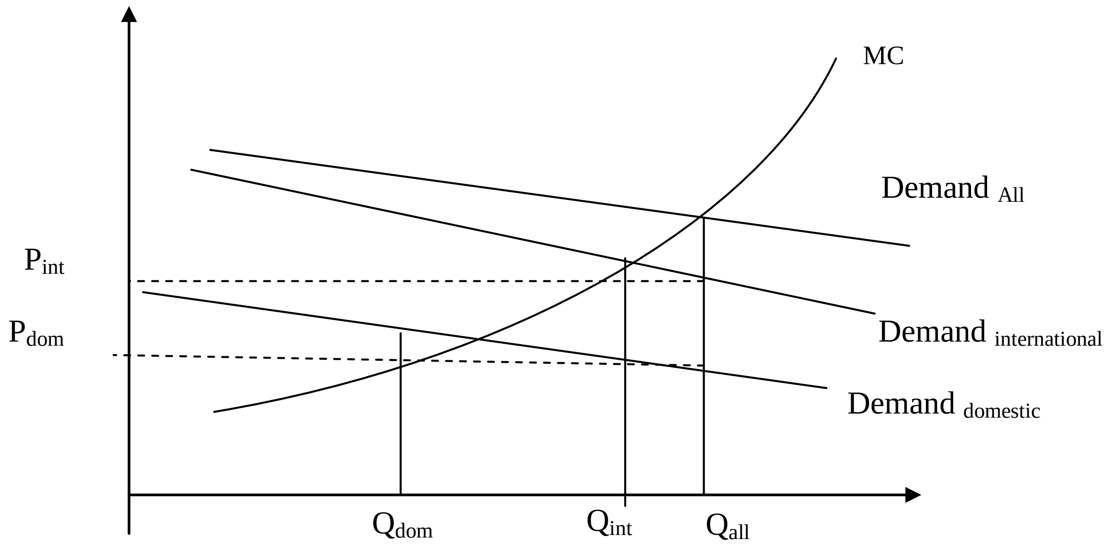


Table 8.2. Damages, Economic Activities, and Possible Economics Effects Attributable to Degradation of Coastal Habitats

Damages	Economic Activities Impacted	Possible Economic Effects	Loss 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 mortality and fish kills	Subsistence and commercial fisheries, local markets	Value of forgone harvest, decline in economic rent, increased production cost, opportunity cost of fishers that exit, 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	Increase incidence of gastrointestinal disease, number of increase 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 smell	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 & Seneca 2001			

8.2. Commonly Used Management – Command and Control Approaches

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, top-down command and control approach, and community-based management. Both these approaches when examined from the economics lenses are highly informative.

8.2.1. Top-Down 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 approach has taken the form of legislations and associated regulations and bylaws, either imposing total prohibition and/or putting a control on outputs (and thus the level of degradation on the habitat), and/or inputs. These essentially, as discussed in the case of fisheries management, could increase the 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, too, 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 to control environmental quality. Essentially, with the use of EIAs, governments hope to proactively identify environmental impacts with the intention to help change the project design, such that the environmental impacts are minimised. However, EIAs are typically used in cases involving large development projects; but even then the requirements of an EIA have been just a first step. In a number of cases the implementation has been "on paper", and less transparent where the developer has financed the EIA assessment as a political requirement only. Governments do not have resources for an appraisal or follow-up of the development activities ,or to ensure that the recommendations of the reports are taken into consideration.

Several examples of failed coastal projects are evident in the Pacific where an EIA was either not done, or if conducted, it 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, together with the Fisheries Department. The project was a total disaster with no prawns, and permanent removal of mangroves. The land has now turned into a wasteland, and lies barren with very poor soil that will require several million dollars again for rehabilitation (Lal 1990).

In an effort to proactively better utilise and manage natural resources, most of the governments have also focused on developing their national environmental plans and strategies. Programmes on biodiversity protection through action strategy for nature conservation now plays a key role in promoting biodiversity conservation, 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 and 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 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 one that sets the policy agenda.

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

8.2.2. Community-Based Marine Managed Areas (MMAs)

In response to the several, not so successful top-down management, cases focus shifted towards community-based conservation projects, usually drawing on traditional resource management systems, and communal resource ‘ownership’. In these projects, the emphasis has been on empowering the local resource owners and communities in identifying the issues, analyzing the problem, and identifying management options, and then selecting the preferred options and institutional rules for managing the protected area, including *tabu*. Initially, community-based projects did not have any legal or formal status. In more recent times though, effort has been made to build on the informal customary system to give more formal legislative foundation, such as in the Cook Islands and Samoa.

Ra'ui System in the Cook Islands

The Ra'ui is a traditional resource management system that creates a 'marine reserve', or a protected area in the Cook Islands. Under a Ra'ui system, the traditional chief in essence, places control on the quantity of harvest in response to declining stocks of fish, or in expectation of the need for increased effort for some social reason. Such a system thus allows stocks to recover, and/or prevent stocks from extinction. Because the control is placed at the local level, monitoring and enforcement is locally sanctioned, and thus increasing the changes 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. It does indirectly recognise such systems by way of practice of traditional custom though, 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, minimizing 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 led to the deterioration of 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.

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. To give the traditional rules formal recognition, these are incorporated into village by-laws, and thus after traditional mechanisms, village chiefs could take the matter to court when rules are disregarded and offences are serious enough. The rules are easily monitored and enforced at the local village level, like in the case of the top-down centralized fisheries management situation. Villagers are though free to engage in their own income generating activities and thus have the incentive to maximize their income within the rules stipulated under the traditional management system. The village by-laws thus represent an effective fisheries management tool for addressing conservation and management problems, implementing enforcement, and monitoring the fishing activity of village residents.

Community-based projects are not always successful though(Baines, Hannam et al. 2002). This has been particularly the case when projects have been externally driven with the protection of biological diversity as the main objective, and the benefits of the project are diffused, where the direct link between conservation and individual welfare was tenuous. Often such projects 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 the members of the community. Since most of the land and coastal resources are customarily owned, and in many countries these have not been formally surveyed and demarcated, boundaries are often disputed, even if communities' claim 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, and/or rent seeking behaviour (Lal and Keen 2002; Lal and Holland 2010). (See box 8.3).

Box 8.2 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 a rich biodiversity, and thus a high ecological value. 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 Utwe–Walung Conservation Area Project (CAP) was developed under the South Pacific Biodiversity Conservation Programme (SPBCP).

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. Walung villagers lost interest because of lack of benefits flowing to them. The tourist centre that was intended to generate ecotourism income, being sited in Utwe, created some resentment among the Walung residents. Second, many of the Utwe-based ecotourism traverses were the more pristine mangrove areas of Walung (SPREP 2001, p. 11), which seemed to add to the resentment felt by Walung residents. Third, there was an apparent lack of project activities in Walung. Fourth, 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 and Keen 2002) .

8.2.3. Bottom up: Locally-Managed Marine Areas (LMMAs)

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

The LMMA adopts a multipronged approach to environment management:

- community's aspirations, capacity, resources, and perceptions of benefits of participating in resource conservation strategies are usually the starting point of the LMMA process
- raising awareness amongst the local communities about conservation, and building their capacity in environment management
- adopt stakeholder-based decision-making processes to design management of their LMMA, extending their traditional decision-making system; stakeholders may comprise of members of land-owning groups, traditional leaders, and government representatives, conservation organizations, elected-decision makers, women and youth representatives
- adopt 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
- local system of monitoring , control and surveillance (MCS)
- engage with adjacent communities, thus extending the LMMA to reflect ecological connectivity and increase the scale, and potential for conservation
- 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 role. 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 organizations 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, Tawake et al. 2009). Some villages have formally become part of the LMMA network, and 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, Tawake et al. 2009).

The strength of 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 i 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 in a local area 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 the communal resources for the communal good. As the management depends on local processes, the strength of traditional leadership, the ease of consensus building in the community are also important. (Govan, Tawake et al. 2009) also notes that the level of external support is also an important consideration for local participation in the LMMA.

However, the evolutionary nature of the LMMA approach may limit the overall effectiveness of the approach. For example, stakeholders managing the implementation of LMMAs may find the opportunity costs of their engagement is 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 the LMMA processes.

The self-sustainability of the LMMA framework is yet to be determined, particularly when the conservation objectives are achieved, but the question is what happens to those people whose fishing areas are displaced and whose livelihoods are directly affected. Alternative livelihood opportunities need to be identified, and pursued as providing 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 by 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, 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, creates an externality on the effectiveness of LMMA (see Govan, Tawake et al 2009 for further discussion).

8.2.4. Integrated Island Resource Management

In contrast to LMMA 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. The project involves collaboration between 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, Breckwoldt 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 6 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, Breckwoldt 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 of a stone breakwater to prevent coastal erosion
- Coastal reforestation by replanting mangroves
- Monitoring of wildfire
- Installing smokeless stoves to reduce firewood requirements
- Protecting of 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 incomes 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 externality costs, and benefits of 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 minimization of the scope for conflict. Monitoring and enforcement costs would also be minimized, 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-sustainable, after development partner support and external funding has withdrawn, and the management institutions are build 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.

8.2.5. Large Scale Network of Protected Area: The Micronesia Challenge

More recently, there has been a push towards establishing a network of protected area, essentially hoping to ban degradation, and loss of biological diversity all together.

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

Such declarations of reserves essentially would put restrictions on the use, and thus expect to control habitat degradation. As seen earlier, their effectiveness will depend on the ability to monitor and enforce such restrictions. 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 is also developing their own sustainable finance.

As the benefits of the conservation of the biodiversity 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 through the creation of the 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

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.

9.1Use of Economic Instruments : User Fees

Many countries in the region have 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, revenue raised have been hypothecated towards the management of the protected areas (Lal and Holland 2010).

Box 9.1 Examples of Using Economic Instruments for Biodiversity Conservation

In the Cook Islands, the government introduced in 1994 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 the 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. 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 and 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, the Rivers Fiji Co. established in 1997 adventure tours to rural highlands, and coastal areas of Navua. The three villages involved work 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 the land owners. In addition, the annual payment for the 50 year lease on the 17 kilometre corridor of conservation area is paid directly to the Native Land Trust Board, which represents the interests of the traditional land owners (Lal and Holland 2010).

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

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 World Bank, though regularly use benefit cost analysis of their projects as standard tool to make more informed choices. Such economic analysis supported by regional organisations, while providing valuable information for externally funded projects, the economic benefit cost analysis is generally not an integral part of resource and environment management decisions in the Pacific (Lal 2004); (Lal 2003); (Lal, Kinch et al. 2009).

9.2.1. Waste and Water Catchment Management

A regional integrated approach to marine resource management under the International Waters Programme (IWP) was initiated by SPREP in 2000. This project aimed to look at marine resource management by focusing on the coastal and oceanic components as an integrated approach. The Coastal Programme considered three overarching trans-boundary concerns: 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 (eg. [(Hajkowicz, Tellames et al. 2005); (Lal, Saloa et al. 2006); (Lal and Takau 2006)]. Benefit cost analysis in Tonga helped to better understand and appreciate the environmental costs and benefits of waste management, and introduce appropriate charges for waste collection from residential areas. An economic valuation of water resources in the Cook Islands (Hajkowicz and Okotai 2006) helped to gain required community and government support for a more coordinated and cooperative approach towards natural resource management. The cost benefit analysis also provided basic information for raising awareness through a strategic communication campaign (Holland and 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 and Cerelala 2005) and in Solomon Islands (Lal and Kinch 2005), examined 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 incentives to switch to mariculture of coral products for aquarium trade because the net benefits of cultured products were only a fraction of what could be earned from the wild.

However, despite such results, the NGOs still continue to promote mariculture of live coral and rock.

Throughout the region, there are many examples of such benefit cost analysis of individual projects, but the practice has not been mainstreamed, nor have the governments, NGOs, and other institutions been able to scale up replicate management practices, or continue with the projects because of limited funding, capacity, and/or limited, or no follow up of the project (Holland 2009; and Lal 2009).

Nonetheless, a recent analysis (Lal 2009) 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, for projects to be successful, economic considerations must be explicitly included, and systematically integrated during the entire project development process, and not at the tail end of a project. Lal 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 project and policy design stages.

Although national capacity in resource and environmental economics may be limited, broader appreciation of the importance of economic analysis to underpin 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 can be demonstrated, governments can be more willing to embrace economics mainstreaming, as illustrated by the following quote from the Secretary of the Ministry of Finance, observed during the Development Coordinating Committee meeting where the results of the study on the economic costs of poor human waste management in Tuvalu, was 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).

9.2.2. 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. Such goods and services as discussed earlier are over exploited, or undersupplied. In an effort to encourage the internalization of the values of such environmental goods and services, SOPAC has, over time supported benefit cost analysis of project and policy options, involving non-living resources, such as coastal aggregate mining, and disaster risk management (Ambrose 2009); (Holland 2008); (Holland and Woodruff 2008); (Holland 2009); (Holland and Woodruff 2006); (Holland 2008); (Holland and Parakoti 2006); (Woodruff and Holland 2008). Such projects included, for example, the feasibility assessments 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 has been add-on sub-activities to externally funded projects to assist PICs 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 nonliving resources. In most situations, PICs do not have institutional settings where such benefit costs analyses are an explicit element of project cycle assessments, underpinning key development decisions. Nonetheless, such studies have generated valuable information, for mainly advocacy purposes, if not to support key policy decisions.

9.2.3. Disaster Risk Management and Climate Change Adaptation

Benefit cost analysis, and other forms of economic analyses are usually undertaken, or required by development partners, such as 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 (Asian Development Bank 2005); (Asian Development Bank 2010; World Bank 2010); (World Bank 2000).

The PICs have acknowledged that climate change is a development issue which requires a systems approach, covering different aspects of life, including those based on coastal areas. Many of the economic analyses of coastal adaptation measures have generally been done to support decisions for development assistance, without necessarily economic consideration becoming mainstreamed at the national level. There is little, or no capacity in country, or limited capacity at best in the region to undertake economic cost analysis of disasters, climate change, and/or adaptation options as an integral part of the national decision-making processes (Lal, Kinch et al. 2009).

The World Bank proposes both top-down and bottom-up approaches that involve community participation (Bettencourt, Croad 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, the 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 (Asian Development Bank 2009).

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 minimize 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.

9.3. Concluding Remarks

Coastal management is a complex concern because the social, political, economic, and physical factors all 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 Analytical framework helps to understand, 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 the problems also enables managers at all levels to address some of the root causes, and consequences of individual and collective actions.

As shown in the various chapters of this report, there is much concern about the rapidly changing nature of the coastal habitats which increases, not only the physical vulnerability, but also increases economic risks, and the ability of the coastal environments to support 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 the traditional resource management systems with moderns scientific knowledge, 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 that had existed previously in the traditional context of resource management in the Pacific Island societies, such as the concept of "vanua'.

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, 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, ban of harvest, and control of output 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 the 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.

Community-based resource management systems dependency of 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 aspects, as well as on legal and institutional aspects remains fundamental to address 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 sustainable financing for implementing and sustaining management efforts. The use of MPAs for biodiversity conservation for example, while is a useful tool for management of stocks, and in the rehabilitation of degraded habitats, sustainable financing is 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)

Integrated DPSIR-EBM and Economic 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 to address 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 harmonization, 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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