Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States

Valuation and Accounting of Natural Capital for Green Economy (VANTAGE) Guidance Manual Series No. 2

Regional Seas Reports and Studies No. 193

United Nations Environment Programme

The *Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States* (SIDS) is an output of a joint initiative under UNEP entitled "Valuation and Accounting of Ecosystem Services of Small Island Developing States (SIDS): Operationalizing the Sustainability Path". The initiative is implemented by the Ecosystem Services Economics (ESE) Unit, the Marine and Coastal Ecosystems (MCE) Unit and Regional Seas Programme of the Division of Environmental Policy Implementation (DEPI), UNEP. The manual is developed as UNEP's Ecosystem Services Economics Guidance Manual Series No. 2 under the Valuation and Accounting of Natural Capital for Green Economy (VANTAGE) programme and Regional Seas Reports and Studies No. 193.

We regret any errors or omissions that may have been unwittingly made. Any comments or corrections can be sent to publications@unep.org.

This publication should be cited as:

Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States, UNEP, Ecosystem Services Economics Unit, Division of Environmental Policy Implementation (2014)

Leaders of the initiative: Pushpam Kumar, UNEP/ESE Unit/DEPI and Takehiro Nakamura, UNEP/MCE Unit/DEPI

Leading author: Paulo A.L.D. Nunes, WAVES, The World Bank

Contributing authors: Andrea Ghermandi, University of Haifa; Laura Onofri, University of Padua

Reviewers: Eric Mungatana, University of Pretoria; Harpinder Sandhu, Flinders University; Lalit Kumar, Delhi University; Mike Christie, Aberystwyth University; Luke Brander, Hong Kong University; Samia Sarkis, Government of Bermuda; Umiich Sengebau, Minister of National Resources, Environment and Tourism, Government of Palau; and Isabel Torres de Noronha, Future Ocean Alliance (FOA).

Editor: Deborah Kirby, DCPI, UNEP; Elizabeth Kemf

Acknowledgements to the UNEP team: Sun Cho; Levis Kavagi; Anne Ogoti; Ruth Watulo; Janet Opati; Suzannah Goss

Cover photo credit: © Lukas Kurtz/Lux Tonnerre, Flickr

Design: Catherine Kimeu/UNON

Printing: UNON Publishing Service Section, Nairobi, ISO 14001:2004-certified

ISBN: 978-92-807-3407-2

Job Number: DEP/1830/NA

D1 Number: 02339/100 copies

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Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States (SIDS)

Division of Environmental Policy Implementation
United Nations Environment Programme

Foreword

The need to support the green economy transition of small island developing states (SIDS) in order to build their climate change resilience and propel their development forward - sustainably and inclusively – is increasingly being recognized by both SIDS and the international community.

There is particularly strong interdependency between the natural environment and the economies of SIDS. For example, in the Federated States of Micronesia the contribution of fisheries to Gross Domestic Product amounts to 10 per cent. Exports are also largely supported by local ecosystems. Fifty-two per cent of the exports of the Caribbean island of Grenada are nutmeg, tuna, frozen albacore and cocoa beans. While in Trinidad and Tobago petroleum and natural gas represent 54 per cent of exports.

The *Guidance Manual on Valuation and Accounting of Ecosystem Services for Small Island Developing States* reveals the degree to which these and many other SIDS depend on ecosystem services, and provides policymakers with a reliable approach for capturing and accounting for the contribution of ecosystem services to national economic growth and prosperity.

One application that measures the impacts of ecosystem services on SIDS' coastal tourism found that a 1 per cent increase in the number of coastal protected areas is associated with a 2.9 per cent increase in the arrival of international coastal tourists - almost double that of global estimates.

The manual is filled with these and other findings that invite policymakers to see the protection of coastal areas and other natural assets as directly benefitting the economy.

The importance of adopting suitable development policies designed to overcome the specific vulnerabilities of SIDS and rehabilitate their fragile ecosystems were emphasized by the international community in the Barbados Programme of Action (BPoA), the Mauritius Strategy for further Implementation of the BPoA, and the Johannesburg Plan of Action.

This manual aims to enhance policymakers' understanding of the standardised methodology for the valuation and accounting of island ecosystem services, taking into consideration the unique environmental, socio-economic and capacity issues relevant to SIDS.

At UNEP, we aim to support the efforts of government and local communities, to overcome the vulnerabilities of SIDS by bringing the valuation and accounting of island ecosystem services into conventional decision-making frameworks of economic policies, and ultimately supporting SIDS policymakers' ability to facilitate a green economy transition.

Achim Steiner
UN-Under-Secretary-General and UNEP Executive Director

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Acknowledgement

Paulo A.L.D Nunes, The World Bank (Leading author)
Andrea Ghermandi, University of Haifa (Contributing author)
Laura Onofri, University of Padua (Contributing author)
Pushpam Kumar, UNEP
Takehiro Nakamura, UNEP
Glenn-Marie Lange, The World Bank
Rosimeiry Portela, Conservation International
Sonja Teelucksingh, Global Environmental Facility (GEF)
Eric Mungatana, University of Pretoria
Sun Cho, UNEP
Didier D. Etienne, Ministry of Environment and Energy, Seychelles
Keith Nichols, Caribbean Community Climate Change Centre (CCCCC)
John Agard, University of the West Indies
Mokshanand Dowarkasing, Prime Minister's Office, Mauritius
Leonard Nurse, University of the West Indies
Samia Sarkis, Government of Bermuda
Patrick S. Fong, University of the South Pacific, Suva
Patrick Watson, University of the West Indies
Charley G. Granvorka, University of the French West Indies and Guiana
Luke Brander, Hong Kong University
Lelei LeLaulu, International Finance Corporation
John Gowdy, Rensselaer Polytechnic Institute
Michael Christie, Aberystwyth University
Jean-Louis Weber, European Environment Agency (EEA) Scientific Committee
Lalit Kumar, Delhi University
Van Tai Nguyen, Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE)
Harpinder Sandhu, Flinders University
Isabel Torres de Noronha, Future Ocean Alliance (FOA)
Naeem Ibrahim, Environmental Protection Agency of Maldives
Nourudeen Jaffar, Central Statistics Office, Mauritius
Umiich Fleming Sengebau, Ministry of Natural Resources, Environment and Tourism, Palau
Aiyaz Sayed-Khaiyum, Ministry of Local Government, Urban Development, Housing and Environment, Fiji
Springer Cletus, Organization of American States
Yannick Beaudoin, GRID-Arendal
Hiroko Morita-Lou, United Nations Department for Economic and Social Affairs (UN-DESA)
Ivo Havinga, United Nations Statistics Division (UNSD)
Alessandra Alfieri, United Nations Statistics Division (UNSD)
Andy Hudson, UNDP
Tim Scott, UNDP
George Bouma, UNDP
Elliott Harris, UNEP
Maaike Jansen, UNEP

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Key messages

Valuation and accounting of island ecosystem services is fundamental to our ability to achieve sustainable green growth in Small Island Developing States (SIDS), also known as large ocean states.[i] SIDS are characterized *inter alia* by (a) a well-defined set of in situ socio-economic-cultural and governance conditions; (b) a population's clear perception and use of island ecosystem services; (c) high richness in natural capital; and (d) the delicate nature of the many ecosystems that support livelihoods and local economies. In this context, the *Guidance Manual on Valuation and Accounting of Ecosystem Services for SIDS* provides a methodological approach to "read" these conditions, and their respective implications, in terms of the selection, design and implementation of island ecosystem services valuation and accounting exercises. The process of ecosystem service valuation and accounting specifically for SIDS is fundamental to correct and tailor the use of the various techniques in this context.

From a technical and methodological point of view, this guidance manual also informs policymakers that there is no simple solution with respect to the valuation and accounting of ecosystem services for SIDS. The choice of the economic valuation and accounting technique is ultimately anchored in the type of economic-policy and the category of island ecosystem services that it targets, i.e. provisioning, regulating or cultural service. This manual gives policymakers a ranking of the most suitable valuation techniques for application in the context of SIDS – including monetary valuation techniques such as market prices, production function, travel costs, hedonic pricing, cost-based, stated preferences and value transfer as well as ecological production function (non-monetary valuation technique). A survey of the ecosystem service valuation literature in SIDS revealed that less than a quarter of the studies reviewed were commissioned by governments or governmental agencies. Among these, market demand and supply approaches, including the production function technique, are shown to be the most frequently used. This can be interpreted as signalling the strong degree of suitability of this technique to meet policy and management questions in SIDS. Tables 3.2, 3.3, and 3.4 provide an overall synthesis of the valuation techniques' applicability to SIDS (taking into account unique and relevant environmental, socio-economic and governance issues).

- The key methodological recommendations of this manual are presented with illustrative applications of valuation and accounting of island ecosystem services, through a comprehensive, step-by-step guide. The context of SIDS within which the valuation and accounting of island ecosystem services is undertaken, potentially affects every stage of the process: from the prioritization of the ecosystem services to be valued to the identification of the beneficiaries, and the validity of policy prescriptions and economic incentives.
- A step-by-step practical guide has been tested for island ecosystem service valuation and applied to monetary valuation techniques such as market prices, production functions, travel costs, hedonic pricing, cost-based, stated preferences, and value transfer; these have been adequately tailored to SIDS. A step-by-step guide for island ecosystem service accounts has also been developed to build experimental natural capital accounts for ecosystems and to create monetary ecosystem service accounts.
- This guide enables the provision of all the specific information that is needed for improving SIDS' policy makers' understanding of the use of valuation and accounting techniques in decision-making, therefore bringing island ecosystem services to conventional decision-making frameworks of fiscal, monetary and industrial policies, and ultimately backing up policymakers' ability to achieve sustainable green growth.
- From an economic-policy point of view, valuation and accounting of island ecosystem services can improve cost-benefit analysis and policy appraisal in SIDS. This information may support policy decisions regarding the level of investment in built infrastructure or capital (e.g. the expansion of a harbour for cruise liners) or/ and investments in nature infrastructure or capital (e.g. the creation of a marine protected area). In these cases, valuation of island ecosystem services is fundamental to shedding light on how much to invest, whilst managing natural resources efficiently and sustainably. This manual supports policymakers' ability to value island ecosystem services in cost-benefit analysis and policy appraisal in SIDS.

i. There are currently 32 small island developing states in three geographic regions: the Caribbean; the Pacific; and Africa, the Indian Ocean, the Mediterranean and the South China Sea (AIMS).

- Valuation and accounting of ecosystem services plays a key role in the formulation of Payment for Ecosystem Services (PES) schemes in SIDS. This manual provides technical guidance on how to design and structure a PES scheme for SIDS. The Green Fee in Palau, which incorporates economic valuation of island ecosystem services, is an example of such scheme.
- Valuation and accounting of island ecosystem services is also fundamental for their integration into SIDS' Systems of National Accounts (SNAs). Information regarding the contribution of ecosystem services, such as carbon storage, coastal protection and flood mitigation, is often missing from or invisible to national GDP. In coordination with the principles of the United National Statistical Commission, through its System of Environment and Economy Accounts (SEEA), this guidance manual fills this gap by supporting policy makers' abilities to produce data about a small island developing state's natural capital with respect to the environment and ecosystem services. In this way, it assists policymakers to develop better indicators for monitoring sustainable development and long-term economic growth. In addition, environmental and island ecosystem service accounting informs policymakers on how the poorest households use and depend heavily on natural capital.
- Finally, valuation and accounting of island ecosystem services produces information that can be used to fine-tune fiscal policies by changing the final market prices of some goods and services. This manual aids policymakers in revealing the dependency of their countries' economic sectors on island ecosystem services. Consequently, it can assist policymakers in designing schemes for taxes and subsidies aligned with the sustainable use of critical natural resources.

Acronyms

ABS	Australian Bureau of Statistics
AIMS	Atlantic, Indian Ocean, Mediterranean and South China Sea
AOSIS	The Alliance of Small Island States
BPoA	Barbados Programme of Action
CaMPAM	Caribbean Marine Protected Area Network and Forum
CBD	Convention on Biological Diversity
CFP	Coastal Fisheries Programme
DCBD	Dutch Caribbean Biodiversity Database
EEZ	Exclusive economic zone
EVRI	Environmental Valuation Reference Inventory
FAO	Food and Agriculture Organization
FFA	Forum Fisheries Agency
IOC	The Indian Ocean Commission
IPCC	Intergovernmental Panel on Climate Change
MPA(s)	Marine protected areas(s)
MSI	Mauritius Strategy for Further Implementation
NCA	Natural Capital Accounting
NCC	Natural Capital Committee
PEIN	Pacific Environment Information Network
PIMPAC	Pacific Islands Managed and Protected Areas Community
PIMRIS	Pacific Islands Marine Resources Information System
SEEA	System of Environmental-Economic Accounting
SIDS	Small island developing states
SNA	System of National Accounts
SOPAC	Secretariat of the Pacific Community Applied Geoscience and Technology Division
SPC	Secretariat of the Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
TEEB	The Economics of Ecosystems and Biodiversity
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WDI	The World Bank's World Development Indicators

> *"Natural accounting and valuation is not a fringe activity, but a cornerstone of the wealth of nations upon which sustainable, equitable and prosperous societies will be built."*
>
> *(Achim Steiner, VANTAGE Conference in Nairobi, 2013)*

1. Introduction to the guidance manual

1.1 Sustainable development in small island developing states

Small island developing states (SIDS), and small islands in general, are special cases for sustainable development. This was formally recognized by the international community at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 as set out in Agenda 21[1], which states: 'Small island developing states and islands supporting small communities are a special case both for environment and development. They are ecologically fragile and vulnerable. Their small size, limited resources, geographic dispersion and isolation from markets, place them at a disadvantage and prevent economies of scale.'

Since UNCED, there have been a number of developments regarding the sustainable development of SIDS. The 1994 Barbados[2] conference built on United Nations resolution 45/202 (21 December, 1990), which called on SIDS to adopt development policies that would make them more resilient and better able to protect and restore their fragile ecosystems.[3] At the same time, it appealed to the international community to support this aim and the Agenda 21 proposals.[4]

In the same year, the Barbados Programme of Action (BPoA) translated Agenda 21 into specific sustainable development actions for SIDS.[5] This plan was revised in 1999 (BPoA+5), and in 2005, the Mauritius Strategy for further Implementation (MSI) was adopted to ensure the take up of BPoA, Millennium Development Goals and other commitments included in the Johannesburg Plan of Action.[6]

Preparations for the Third Small Island Developing States Conference, 2014

In 2012, during the World Summit on Sustainable Development (Rio+20), the international community recognized that SIDS' progress towards achieving Millennium Development Goals and other international targets was inconsistent, especially in relation to reducing poverty and cutting national debt. At the same time, it recognized the threats climate change posed to SIDS, not least from the loss of land caused by rising sea levels.

With this in mind, and building on the BPoA and the MSI, the United Nations General Assembly called for a third international conference on SIDS in Samoa (1–3 September 2014).[7] As well as assessing how far they had got with the implementation of the BPoA/MSI, SIDS also addressed the post-2015 Agenda,[8] which looks to build on the BPoA/MSI and Samoa conference outcomes.[9]

The SIDS network is organized in various ways. The Economic Commission for Latin America and the Caribbean – Subregional Headquarters for the Caribbean is one of the coordinating bodies for SIDS in the Caribbean, with

1 Chapter 17, paragraph 124.
2 www.un-documents.net/a47r189.htm.
3 Idem.
4 Chapter 17, section G thereof, on the sustainable development of SIDS.
5 BPoA: http://islands.unep.ch/dsidspoa.htm.
6 Given the reduced and uneven progress of the implementation of the BPoA, the Johannesburg Plan of Action recommended the convening of an international meeting to review the implementation of the Programme of Action for the Sustainable Development of SIDS. Upon receipt of the recommendation, the United Nations General Assembly passed resolutions 57/262 and 58/213, which mandated the meeting to take place.
7 Idem.
8 For example, the regional preparatory reports cited in this section and the Report of the Expert Group Meeting on SIDS and the Post-2015 Agenda, United Nations Headquarters, New York, 23–24 April, 2013.
9 SIDS integrated and enabling cooperation framework for the Barbados Programme of Action and Mauritius Strategy for further Implementation (BPoA/MSI). Outcome of the Interregional preparatory meeting for the Third International Conference on SIDS, Bridgetown, Barbados, 26–28 August 2013.

support from other institutions such as the Commonwealth Secretariat. The Economic and Social Commission for Asia and the Pacific – Pacific Operations Centre coordinates SIDS in the Pacific, with support from the Pacific Islands Forum Secretariat and the South Pacific Regional Environment Programme.

However, the AIMS (Atlantic, Indian Ocean, Mediterranean and South China Sea) group does not have an equivalent coordinating body, although the Indian Ocean Commission in the Indian Ocean sub-region of AIMS partly fulfils this role.

A regional AIMS coordinating body would make it easier for SIDS in the area to access finance, share new technology and develop new skills. It could also help deliver a more consistent SIDS strategy and make it simpler for different SIDS to work in partnership with each other.[10]

Through these networks, SIDS promote numerous initiatives. Examples include the Global Island Partnership, the University Consortium of Small Island States, the Caribbean Challenge, the Western Indian Ocean Coastal Challenge and the Pacific Water Partnership on Sustainable Water Management.

They also lobby for change. The Alliance of Small Island States (AOSIS) is a coalition of small island and low-lying coastal states that share similar development challenges and concerns. AOSIS negotiates on behalf of SIDS within the United Nations.

1.2 Valuation and accounting of ecosystem services

Ecosystem services comprise four main categories: provisioning services – the supply of food, water and natural resources; regulating services – flood and disease control, air and water purification; cultural services – such as spiritual, recreational and cultural enrichment; and supporting services – such as nutrient cycling, that maintain the necessary conditions for life.

Ecosystem services rose up the agenda after the Millennium Ecosystem Assessment, an initiative launched in 2000 by the then United Nations Secretary-General Kofi Annan. Its main objectives were to evaluate the consequences of changing ecosystems for human well-being and to assess the scientific basis for any action needed to conserve them and promote their sustainable use.

The assessment, which consulted more than 1,300 experts worldwide, concluded that the benefits to people from ecosystems (such as clean water, food and flood mitigation) contribute fundamentally to human well-being.[11] It is vital therefore to improve the understanding of the role ecosystem services play in human livelihoods and economies, as well as to value and document their contribution to human well-being.

This approach has three important consequences. First, it allows the design of more cost-effective ecosystem management policies and therefore a more efficient allocation of natural resources. Second, the inclusion of ecosystem services within economic growth and development strategies encourages a more sustainable use of economic and natural resources. Third, the inclusion of ecosystem services within the equity and wealth distribution strategies of economic growth and development policies contributes to a more inclusive, sustainable global economy. Recognizing and measuring the value of ecosystem services is fundamental to achieving sustainable, inclusive development.

This is particularly true in SIDS where economies and populations rely heavily on the natural environment. Although the average land area of SIDS is about 24,000km^2, the average size of their exclusive economic zones (EEZs) is about 666,000km^2. This is because the surrounding ocean, which provides much of their food, employment (the fishing industry) and tourism, is included in the measurement (see Table 1.1).

For example, the contribution of fisheries to the gross domestic product of the Federated States of Micronesia is 10%. Tourism contributes more than 50% of gross domestic product to Antigua and Barbuda, Anguilla, the Republic of Seychelles and the Republic of Vanuatu. Thirty six per cent of the Independent State of Papua New Guinea's gross domestic product is generated by its agricultural sector.

10 Regional Preparatory Meeting of SIDS of the Atlantic Indian Ocean, the Mediterranean and South China Seas (AIMS). Outcome Document, 17–19 July 2013, Mahe, Seychelles. www.sids2014.org/content/documents/227AIMS%20final.pdf.

11 Millennium Ecosystem Assessment (2005)

Table 1.1: Statistics on selected small island developing states

Country	Country population (millions)	Land area (thousands km^2)	EEZ area (thousands km^2)	Coastline (km)	Main economic sector	Imports (percentage of gross domestic product)
Union of the Comoros	0.63	1.9	164.7	340	Vanilla, cloves, essential oils – 94% of exports	39
Grenada	0.11	0.3	26.2	121	Nutmeg, frozen albacore, tuna, cocoa beans – 52% of exports	67
Jamaica	2.68	10.9	263.3	1,022	Aluminium oxide and ores – 65% of exports	63
Republic of the Maldives	0.31	0.3	916.2	644	Tourism – 80% of exports	72
Republic of Mauritius	1.3	2.1	2,272.8	177	Sugar, tourism, textiles – 54.5% of exports	65
Independent State of Papua New Guinea	6.32	462.8	2,396.2	5,152	Silver, petroleum, copper and gold – 71% of exports	68
São Tomé and Príncipe	0.16	1.0	165.4	209	Cocoa – 93% of exports	N/A
Solomon Islands	0.5	28.9	1,597.5	5,313	Wood, tuna, cocoa – 77% of exports	44
Republic of Trinidad and Tobago	1.33	5.1	77.5	362	Petroleum, natural gas – 54% of exports	37
Republic of Vanuatu	0.23	12.2	827.9	2,528	Copra, seaweed, wood and meat – 76% of exports	58

Sources: The websites of UN-OHRLLS, FAO, the Sea Around Us Project and Index Mundi

SIDS' reliance on the natural world for economic security and the health of their populations demonstrates the importance of understanding and valuing the role ecosystem services play. However, the way national production is currently measured means their contributory value is often invisible, so analysts have to use a wide range of economic valuation techniques to generate useful data.

This manual provides guidance on how to use these techniques for SIDS. It shows how the institutional context determines the interaction between populations, the natural environment and ecosystems, which means that each economic valuation technique needs to be refined and adapted to the specific context within which it is being used. This allows analysts to measure the economic value of the selected ecosystem services and natural capital, and to then use the data to develop indicators for monitoring the progress of sustainable development in SIDS.

1.3 Why policymakers in small island developing states should use ecosystem service valuation and accounting

Policymakers undertake ecosystem services valuation and accounting to work out the contribution of the natural environment and its ecosystems to their country's gross domestic product and main economic sectors, including tourism, fisheries, mining and agriculture. This can be applied specifically to SIDS.

It gives ecosystem services a monetary value, allowing policymakers to compare their impacts on human welfare with those of other economic activities. For example, the tourism sector in Aruba, an island in the southern Caribbean Sea, contributed 26.5% to gross domestic product in 2012. Policymakers need to be able to estimate the contribution of ecosystem services to the sector and Aruba's gross domestic product. To measure this, analysts could quantify the contribution of the island's marine protected areas (MPAs) to the sector's economic activity and overall performance.

Including the value of ecosystem services in the tourism sector's growth and development strategies would allow Aruba to devise sustainable development plans for its tourism industry and better manage its ecosystem services.

The valuation and accounting of ecosystem services is fundamental to policymakers' success in achieving sustainable growth. In this context, valuation and accounting plays a key role in the accurate costing of ecosystem services and helps policymakers create payment-for-ecosystem schemes.

Policymakers are also interested in the valuation and accounting of ecosystem services for more specific reasons. First, they can use the data to improve cost-benefit analysis and policy appraisal. This information can be used to support policy decisions regarding the level of investment in built infrastructure/capital (e.g. a harbour expansion to accommodate cruise ships) and/or investments in natural infrastructure/capital (e.g. the creation of an MPA). In such cases, ecosystem services valuation is fundamental to determining how much investment is required to sustainably manage natural resources. Alternatively, policymakers can use valuation and accounting to compare different investment plans and/or policy proposals. Cost-benefit-analysis helps evaluate the pros and cons of each investment scenario, and takes into account the value of the ecosystem services under consideration.

Second, policymakers can use valuation and accounting to set compensation levels related to legal claims and natural resource damage assessments. Even if an oil spill damages a beach or remote island that has limited tourism or economic value, it still has an impact on the island's ecosystem services and natural resources. Analysts can express these consequences in monetary terms, which help policymakers make the case for compensation against those responsible for the damage. The non-economic impacts of an oil spill, such as the effects on human well-being, can also be quantified – the Exxon Valdez case is a seminal example of this.[12]

Third, the valuation of ecosystem services can be used for environmental and ecosystem services accounting, which can be integrated within the System of National Accounts (SNA). All countries rely on SNA but useful information is often missing or invisible, such as the depletion and degradation of natural capital – minerals, forests; environmental degradation – pollution, loss of agricultural productivity; and ecosystem services – carbon storage, coastal protection or flood mitigation. Environmental and ecosystem services accounting fills this gap and makes visible the contribution of ecosystem services to gross domestic product and citizens' livelihoods.

Environmental and ecosystem services accounting also contributes to the development of better indicators for monitoring sustainable development/long-term growth and can help policymakers determine whether gross domestic product-growth is sustainable or based mainly on natural capital and underlying ecosystem services.

It can also help them assess the value of competing land uses and determine the best way to balance tourism, agriculture, mining and other ecosystem services such as freshwater supply. Environmental and ecosystem services accounting can improve the management of coastal ecosystems by identifying who will benefit and how much should be invested in natural capital, such as MPAs. In this context, the Inclusive Wealth Index, led by the United Nations Environment Programme (UNEP), emphasizes the need to estimate all forms of wealth, including natural capital, in order to accurately assess the sustainability of economies and communities.

The United Nations Statistics Division, through its System of Environmental-Economic Accounting (known as SEEA 2012) and Experimental Ecosystems Accounts, takes the SNA to its logical conclusion by including indicators that better capture national and global sustainability trends. The World Bank's Wealth Accounting and the Valuation of Ecosystem Services (WAVES) programme supports countries willing to implement natural capital accounting and is helping the Republic of Botswana, Colombia, the Republic of Costa Rica, the Republic of Madagascar and the National Democratic Front of the Philippines establish natural capital accounts. This partnership comprises several United Nations agencies, governments, non-governmental organizations and scholars.

Fourth, the valuation and accounting of ecosystem services supports policies that encourage businesses to respect the environment and operate more sustainably, thereby enhancing their corporate reputations.

12 NOAA (1993).

The World Business Council for Sustainable Development-led Guide to Corporate Ecosystem Valuation gives businesses a better understanding of their impacts and dependency on ecosystem services (World Business Council for Sustainable Development, 2010) and shows them how they can benefit from adopting the guide.

Lastly, valuation and accounting produces information can be used to re-examine and fine-tune fiscal policies (e.g. taxes and subsidies). Changing the market prices of some goods and services, including labour and ecosystem services, can encourage more efficient resource use. For example, SIDS tax authorities could replace or reduce taxation on income, which is generated by capital or labour, and instead tax economic activities that impact negatively on ecosystems, ecosystem services and human well-being.

1.4 Structure of the guidance manual

This guidance manual is designed to help policymakers carry out ecosystem services valuation and accounting. The main concepts and techniques associated with ecosystem services valuation and accounting in SIDS are illustrated in 61 case studies. These examples are summarized in Tables 1.2 and 1.3, with further details available in Chapter 4. The manual also complements the economic valuation methodological framework presented in The Economics of Ecosystems and Biodiversity (TEEB), a global initiative focused on highlighting the economic benefits of biodiversity, and builds on its work by including ecosystem services accounting.

Table 1.2: Valuation studies of coastal and marine ecosystem services in small island developing states

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Windward Islands (DMA, LCA, VCT)	WTP by ecotourism dependent businesses for protection	US$65.3/year	CVM	Government (2003)
Tobago (TTO)	WTP for water quality improvement	i. US$44.09/person/year – snorkelers ii. US$13.85/person/year – non-snorkelers	CE	Research (2010)
Sint Eustatius (ANT)	i. Revenues from reef-associated tourism ii. Revenues from reef-associated fisheries	i. US$6,667,243/year ii. US$2,064,155/year	MP; PF	Non-governmental organization (2010)
Sint Maarten (ANT)	i. Total economic impacts from reef-associated fisheries ii. Total economic impacts from reef-associated tourism iii. Consumer surplus from reef-associated recreation	i. US$1,843,979/year ii. US$45,289,276/year iii. US$9,753,722/year	CVM; MP	Non-governmental organization (2010)
Buccoo Reef Marine Park (TTO)	NPV of WTP to prevent deterioration	i. US$1.2 million – quality reduced ii. US$2.5 million – no quality change iii. US$0.9 million – quality reduced + double users iv. US$1.7 million – no quality change + double users	CVM	Government (2000)
Coral reefs (TTO, LCA)	i. Total economic impacts from reef-associated tourism ii. Direct impact of fisheries iii. Avoided damage from coastal protection	i. US$43.5 million/year in TTO; US$91.6 million/year in LCA ii. US$0.7-US$1.1 million/ year in TTO; US$0.4-US$0.7 million/year in LCA iii. US$18-US$33 million/ year in TTO; US$28-US$50 million/year in LCA	ADC; MP	Non-governmental organization; International Organization (2008)

Table 1.2: Valuation studies of coastal and marine ecosystem services in small island developing states *(contd.)*

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Turks and Caicos Islands (IOT)	i. CS for reef-associated recreation ii. Value of reef-associated tourism iii. Coastal protection value iv. Value of reef-associated fisheries	i. US$11.36/person/day ii. US$9.8 million/year iii. US$16.9 million/year iv. US$3.7 million/year	MP	Government (2005)
Portland Bight Protected Area (JAM)	NPV of coral reefs and mangrove swamp services	i. US$18 million for biodiversity ii. US$4 million for carbon sequestration iii. US$19 million for fisheries iv. US$366,000 for coastal protection v. US$11 million for tourism vi. US$40.8-52.6 million for incremental benefits	MP; VT	Government (2000)
Six marine protected areas (SYC)	i. WTP for conservation projects ii. WTP for turtle tour iii. WTP for shark tour	i. US$4.87/trip ii. US$47.70/trip iii. US$54.73/trip	CVM; PF; TC	International Organization (2004)
St Vincent South Coast (VCT); Tobago Cays (TTO)	WTP for enhanced ecosystem services from MPAs	i. US$315,000-US$967,000/year for locals in VCT ii. US$8-US$13 million/year for tourists in VCT iii. US$26,000-US$709,000/year for locals in TTO iv. US$567,000-960,000 US$/year for tourists in TTO	CE; CVM	Government (2013)
Coral reefs and mangroves (BLZ)	Total contribution to the local economy	i. US$150-US$196 million US$/year for tourism ii. US$14-US$16 million US$/year for fisheries iii. US$231-US$347 million US$/year for coastal protection	ADC; MP	Research (2009)
Bonaire National Marine Park (ANT)	Market and non-market benefits of marine protection	i. US$23.2 million – revenues from dive-based tourism ii. US$325,000 – consumer surplus from diving	CVM; MP	International Organization (1993)
Coral reefs (JAM)	WTP for recreational use (user taxation)	US$130.07-US$165.15 per person	CVM	Research (2009)
Jardines de la Reina (CUB)	Total economic value of marine protected areas	i. US$59.5 million – with no formal administration ii. US$55.4 million – with National Park	CVM; MP; TC; VT	Non-governmental organization (2013)
Coral reefs (FJI)	WTP for coral reef conservation by Atlanta residents	US$0.18/person	CVM	Research (2009)
Sabana-Camagüey (CUB)	Value of mangrove conservation		MP	Research (2013)

Table 1.2: Valuation studies of coastal and marine ecosystem services in small island developing states *(contd.)*

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Montego Bay (JAM)	Ecosystem service values of Montego Bay	i. US$43.3-US$130.0 million NPV – coastal protection ii. US$210-US$630 million NPV – recreation and tourism iii. US$0.815-US$2.92 million NPV – nearshore fishery	ADC; MP	International Organization (1998)
Gladden Spit Marine Reserve (BLZ)	Values of coastal marine protected areas		CVM	Research (2010)
South east Trinidad (TTO)	Opportunity cost for fishermen from seismic surveys	US$1,667/fisherman	MP	Research (2013)
South Tarawa (KIR)	Replacement of reefs with concrete block gabions	US$241.92/ha/year	RP	Research (1982)
Tutuila, Ofu and Olosega	Value of preservation for locals and tourists	i. US$4,858,000/year for coral reefs ii. US$722,000/year for mangroves	CVM; MP; RP; VT	Government (2004)
Seychelles Marine National Parks	Tourists' WTP for visits to marine park (use values)	i. US$25.61/person/year – Sainte Anne ii. US$28.30/person/year – Port Launay iii. US$21.63/person/year – Baie Ternay iv. US$34.05/person/year – Curieuse v. US$36.65/person/year –Île Cocos, Île La Fouche, Ilot Plate	CVM	Research (2000)
Kosrae island (FSM)	Total economic value of mangroves	i. US$75.69/household/year – management tax ii. US$41.80 US$/household/ year – use permit	CVM; MP	Non-governmental organization (1998)
Navakavu (FJI)	Bequest value of traditional fishing ground	US$0.64-US$0.73/person/ week	CVM	Research (2009)
Bonaire National Marine Park (ANT)	Economic loss from decline in reef quality	i. US$64.723/person/year – decline to good quality ii. US$208.477/person/year – decline to medium quality iii. US$286.215/person/year – decline to poor quality	CE	Research (2007)
Coral reefs (NCL)	Total economic value of coral reefs	US$250-US$425 million/year	ADC; CVM; MP	Government (2010)
Five marine protected areas (VUT)	Average annual gross profit from five marine protected areas	US$11,042/year	ADC; MP; VT	Government (2011)
Caroni swamp (TTO)	CS for non-extractive recreation activities	i. US$80,462/year – bird-watching (locals) ii. US$80,510/year – bird-watching (tourists) iii. US$12,626/year – sport fishing and hunting	TC	Government (1980)

Table 1.2: Valuation studies of coastal and marine ecosystem services in small island developing states *(contd.)*

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Montego Bay (JAM)	WTP of tourists for entrance fee	US$739/person/trip	TC	Research (2009)
Coral reefs (BMU)	Added value to residential properties	US$6.8 million/year	HP	Research (2013)
Turks and Caicos Islands (IOT)	Improvement in wildlife viewing	US$5.64/person/trip	CE	Research (2002)
Montego Bay (JAM)	Total economic value of Montego Bay	i. US$315 million/year – NPV tourism and recreation ii. US$1.31 million/year – NPV fishing iii. US$65 million/year – NPV coastal protection	CVM; PF; MP	International Organization (1999)
11 marine managed areas (BLZ, FJI)	Average income from marine resources	i. US$1,291/household/ month – Belize ii. US$385/household/month – Fiji	MP	Non-governmental organization (2013)
Montego Bay (JAM); Curacao (ANT)	WTP to protect coral reef biodiversity	US$4.82/person/year	CVM	International Organization (2000)
Bonaire National Marine Park (ANT)	Divers' WTP for annual access to marine park	US$61-US$134/person	CVM	Research (2010)
Marine protected areas (BLZ)	WTP as entrance fee to MPA	US$9.53/person/trip	CVM	Research (2005)
Saipan island (MNP)	WTP for an increase in reef recreation	US$17.5/person/year	CE; HP; MP; VT	Government (2006)
Coral reefs (GUM)	Total economic value of coral reefs	i. US$94.63 million/year – tourism ii. US$8.69 million/year – diving and snorkelling iii. US$3.96 million/year – fisheries iv. US$9.60 million/year – amenity v. US$8.40 million/year – coastal protection vi. US$2.00 million/year – biodiversity	ADC; CE; PF; RP; TC	Government (2007)

Note: CVM = contingent valuation method; MP = market prices; RC = replacement cost; VT = value transfer; ADC = avoided damage cost; CE = choice experiment; HP = hedonic pricing; PF = production function; TC = travel cost method.

The manual comprises six chapters that can be read independently. Chapter 2 focuses on the valuation and accounting of island ecosystem services, and includes economic theory and methodology. This chapter makes the link between ecosystem services, economic value and economic valuation methodology, and analyses the relevance of each tool to specific ecosystem services.

Chapter 3 looks at the characteristics of SIDS and how these can affect the valuation and accounting process. SIDS have specific local socio-economic-cultural and governance characteristics, and this chapter explains how to incorporate these into the selection, design, testing and implementation of ecosystem services valuation and accounting. This process is fundamental to the correct use of the various ecosystem valuation techniques and to guarantee the efficacy of policy outcomes based on such measurements.

Chapter 4 presents a step-by-step guide to valuing SIDS' ecosystem services and provides a full set of estimates for the economic value of coastal, marine, terrestrial and freshwater ecosystems in selected SIDS, reviewing data from many different sources including Environmental Valuation Reference Inventory and World Resource Institute databases.

Table 1.3: Valuation studies of terrestrial and freshwater ecosystem services in small island developing states

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Nariva Swamp (TTO)	WTP for wetland protection	Monetary value not specified	CVM	Government (2004)
Rotorua Lakes (AIA)	WTP for lake water quality improvement	i. US$91.24/year – in Rotorua ii. US$11.85/year – in rest of Bay of Plenty	CVM	Non-governmental organization (2004)
Río Limpio; San Juan de la Maguana (DOM)	Mean WTP for agro-tourism	i. US$109 for organic farms ii. US$106 for conventional farms iii. US$186 for both systems	CVM	Government (2004)
Biodiversity hotspots (NCL)	Marginal value of land in biodiversity hotspots	i. US$5,473/ha for optimal search order ii. US$5,277/ha for random search order iii. US$5,056/ha for backwards search order	MP	Research (2006)
Montego Bay; Barbados National Park (JAM, BRB)	WTP to avoid quality degradation	i. US$44.3-US$233.8 – users of Barbados National Park ii. US$57.92 – non-users of Barbados National Park iii. US$24 – users of Montego Bay iv. US$215.8 – non-users of Montego Bay	CVM	Research (2000)
Entire Seychelles territory	Value of biodiversity-dependent services	i. US$56 million – tourism revenues ii. US$211,631 – entrance fees to protected areas iii. US$45 million – fisheries and mariculture iv. US$1.06 million – forestry v. US$211,631 – other plant and animal products vi. US$282,175 – shoreline protection	MP; RP	International Organization (1997)
Malakula and Erromango (VUT)	Non-users WTP for preservation of rainforest	i. US$37.70 – removal of unspecified bids ii. US$34.23 – unspecified bids as zero	CVM	Research (1996)
Río Mameyes, Río Fajardo (PRI)	WTP to preserve in-stream flows	i. US$27/household/year for Rio Mameyes ii. US$28/household/year for Rio Fajardo	CVM	Government; Research (1997)
Independent State of Papua New Guinea (PNG)	NPV of benefits of ecoforestry	i. US$33/ha – unsubsidized ecoforestry ii. US$146/ha – subsidized ecoforestry iii. US$135/ha logging – half proceeds invested iv. US$270/ha logging – all US$1,996/ha – oil palm	ADC; MP	Research (2002)

Table 1.3: Valuation studies of terrestrial and freshwater ecosystem services in small island developing states *(contd.)*

Study site	Valued scenario	Economic value	Valuation method	Commissioned (year)
Kahua (SLB)	WTP for development program	i. US$33/household/year – water quality increase ii. 29 US$/household/year – increase in food crops iii. US$11/household/year – increase in gue (rattan) production	CE	Non-governmental organization; Research (2011)
Caribbean National Forest (PRI)	WTP to visit the Caribbean National Forest	i. US$17-US$29/day/trip with TC method ii. US$109/day/trip with CVM	TC; CVM	Research (2007)
Port Moresby (PNG)	Existence and use value for tropical rainforests	i. US$39.22-US$95.61/ person/year – locals ii. US$3.59-US$8.34/person/ year – US community	CVM	International Organization (2001)
Various Islands (SYC)	WTP to protect from invasive alien species	US$64.5-US$68.2/person/ year	CVM	International Organization (2010)
Nariva Swamp (TTO)	Residents' WTP for conservation	US$56/household	CVM	Research (2005)
Deux Branches (DMA)	WTP to a conservation fund	i. US$57.1 million – separate groups ii. US$41.3 million – single group	CVM	Research (2010)
Various rainforest areas (VUT, PNG)	WTP for international rainforest conservation		CE	Research (2002)
El Yunque National Forest (PRI)	Visitors' trip values to rivers in NE Puerto Rico	i. US$96/person/trip – no waterfall or foot trails ii. US$138/person/trip – waterfall and foot trails	CVM	Research (2009)
Marine and terrestrial ecosystems (BLZ)	Total cruise-related expenditures	US$2,345/person	TC	Non-governmental organization; Research (2013)
Valdesia watershed (DOM)	Impacts of soil conservation programs	US$202,427 – private net present value	PF	Research (1985)
Laurent (HTI)	WTP for improved water supply	US$1.42/household/month	CVM	Research (1990)

Note: CVM = contingent valuation method; MP = market prices; RC = replacement cost; VT = value transfer; ADC = avoided damage cost; CE = choice experiment; HP = hedonic pricing; PF = production function; TC = travel cost method.

Chapter 5 contains a step-by-step guide to ecosystem services accounting for SIDS. This chapter contains two original studies on the physical and financial accounts of ecosystem services.

Chapter 6 reviews current initiatives and working groups that focus on ecosystem services valuation and accounting. In addition, it covers international initiatives that focus on ecosystem services and natural capital accounting, including WAVES.

Chapter 7 presents and analyses three case studies that demonstrate the importance of valuing ecosystem services to policy development in SIDS.

> *"Tastes are the unchallengeable axioms of a man's behaviour."*
>
> *(Becker and Stigler, American Economic Review, 1977)*

2. Valuation and accounting of island ecosystem services

2.1 Setting the scene

Economic activities, such as tourism and agriculture, generate income and profits, and support human livelihoods but can also damage ecosystems and their services – the benefits people obtain from ecosystems.[13] There is often a complex interplay between the two: for instance, giving over one hectare of agricultural land to nature would result in a loss of agricultural production and jobs but would increase the stock of natural capital.

It is therefore important to identify and value the trade-offs involved. This guidance manual demonstrates how to analyse and value trade-offs in economic terms (see Box 2.1).

First, analysts must identify the trade-offs involved in terms of changes in the quantity and quality ecosystem services supply. Second, they need to value the trade-offs in terms of their impacts on ecosystem services. Using the example above, this means the potential loss of agricultural production needs to be compared to the potential gain in ecosystem services benefits from the (marginal) increase in forest area. Policymakers can then use this information to help everyone affected by the changes to value the trade-offs and implement policies that promote sustainable development – deciding how much land should be used for forestry, for example.

In economics, benefits are identified using various indicators, ranging from profits to consumer surplus (see Box 2.2), and are typically measured and expressed in monetary terms. This is straightforward when there is an institution (market) where demand and supply interact. A variety of indicators are used to define market value, the most important being the exchange/market price.

Non-market values are more difficult to compute since there is no forum for trade to take place and no pricing mechanism. To assess non-market values, it is important to adopt economic valuation methodologies that mimic market behaviour in order to elicit stakeholders' preferences for the product or service in question, including expressing these in monetary terms (e.g. willingness-to-pay).

Box 2.1: The concept of trade-offs as a cornerstone for ecosystem service valuation

Economic valuation – attaching a value to costs and benefits – is fundamental to assessing the value of ecosystem services. Economic valuation is usually described in monetary terms but this is just one of many units of measurement. Analysts may adopt others, such as time or relative price (i.e. the value of goods expressed in terms of the value of other goods), which attach additional value and related costs and benefits, as indicated by the theoretical framework.

Economic valuation is not a 'generic', ad hoc attachment of monetary values to goods and services but the result of rigorous technical and theoretical analysis based on the behavioural assumptions of micro-economic theory.

Ecosystem services produce both market and non-market benefits, therefore economists use a wide range of tools including market and non-market valuation techniques. Before presenting and discussing the application of these in the context of small island development states (SIDS), here are some key definitions and classifications.

13 Millennium Ecosystem Assessment (2005).

2.2 Ecosystem services and economic valuation: the main concepts

This paragraph introduces some basic terms for defining and explaining technical economic and valuation concepts. The benefits of ecosystem services can be broken down into four[14] categories.

- **Provisioning services:** the benefits that ecosystems provide in the form of 'products' or 'goods' that are consumed by humans or used in the production of other goods. They include fish, nuts, timber, water and genetic resources.
- **Regulating services:** the benefits derived from an ecosystem's control of natural processes such as climate, disease, erosion, water quality and supply, pollination and protection from natural hazards such as storm and wave damage.
- **Cultural services:** the non-material benefits people obtain from ecosystems such as recreation, spiritual values and aesthetic enjoyment.
- **Supporting services:** biodiversity and natural processes such as nutrient cycling and primary production that maintain the other services.

The benefits of supporting services are derived from the other three and therefore should not be valued separately. Table 2.1 lists examples of ecosystem services with a particular focus on islands – i.e. island ecosystem services.

Box 2.2: Consumers, firms and policymakers: the main economic agents and ecosystem service beneficiaries

Even though the seminal work of US economist Gary Becker demonstrates that economic thinking can be applied to all facets of human behaviour, there are three main classical (or neoclassical) economic agent 'roles': consumers, producers and policymakers.

Consumers buy things because they enjoy doing so. Budget constraints 'contain' choice, which implies consumers have to choose one thing and give up something else. Modelling, mostly based on mathematics, suggests consumers will keep purchasing goods until the benefits of consumption equal the costs of consumption (giving up other goods, including money). The calculation of costs versus benefits is always done 'at the margin' – consumers try to maintain a balance between the two, with small refinements. While solving this problem, consumers create both the demand and lack of demand for goods.

The alter ego of the consumer is the producer (the business). The producer's objective is to maximize profits from producing and selling goods and services. Their constraint is production technology, which 'frames' and defines (potentially tradable) production output. Producers choose to supply goods up to the point where the benefits of selling (profits) equal the costs of production. While balancing these two factors, producers determine supply levels for goods and profits.

Consumers and producers interact in markets. From the (neoclassical) economist perspective, markets are the ideal place for the realization of individual objectives. In markets, consumers who want to buy (the desired amount of goods at the desired price) can do so; producers who want to supply (the desired amount of goods at the desired price) can also do so. Markets allow economic agents to fulfil their objectives, which is the main reason economists study market theory.

Trade-offs are often resolved and balanced in markets but not always. Markets can fail and so economic theory includes a third agent: the policymaker. They introduce controls and solve market failures, since their objective is to deliver and improve social welfare. The limitation, again, is budget constraint caused by a lack of resources. Policymakers also make choices by weighing up costs and benefits – by comparing additional benefits to additional costs.

14 TEEB (2010).

Table 2.1: Island ecosystem services

Ecosystem service		Examples
Provisioning services	Food	Food scarcity; Subsistence fishing; Human diet; Wild plants and animals; Food production mechanisms; Land-use changes; Navigation and marine coastal planning
	Raw material	Renewable biotic resources; Energy resources; Animal feed; Seabed minerals
	Genetic resources	Wild sources; Cultivated plants and domesticated animals; Genetic manipulation; Biotechnological research
	Medicinal resources	New chemicals, pharmaceutical drugs; New medical tools
	Habitat	Physical and biological mediated habitat, Land and marine coastal planning (natural parks, MPAs); fishing rotation and no-take zones
	Ornamental resources	Coral and other precious minerals; Fashion; Clothing; Ceremonies; Worship; Souvenirs; Collector´s items
Regulating services	Gas regulation	Anthropogenic disturbance; Climate change; Land-use changes; Regulation of CO_2/O_2 balance; Protection of the ozone layer; Regulation of SOx levels; Provision of clean, breathable air; Prevention of diseases
	Climate regulation	Deforestation; Reforestation; REDD; Droughts; Marine coastal planning
	Coastal protection	Flooding; Extreme events; Sea level rise; Storms; Droughts; Construction
	Water regulation	Natural irrigation patterns; Discharge and drainage changes; River regulation; Medium for transportation
	Water supply	Water storage; Water supply for households, agriculture and industry
	Soil retention	Vegetation cover changes; Root system changes; Soil stabilization; Erosion and sedimentation
	Soil formation	Flooding; Sea level rise; Restoration
	Nutrient regulation	Limiting nutrients; Healthy ecosystems; Greenhouse gas/climate and water regulation
	Waste regulation	Water purification; Organic/inorganic recycling
	Pollination	Land-use changes; Road development; Air quality; Pest and disease control
	Biological regulation	Pest and disease control
Cultural services	Recreation/Tourism	Places for relaxing, resting, refreshment; Activities: e.g. walking, hiking, camping, surfing etc.
	Aesthetics	Scenery and landscape; Seascape
	Science and education	Environmental education; Research; Excursions; Field laboratories; Publications
	Spiritual and historic	Ethical and heritage values

Source: TEEB (2010), adapted

In this context, ecosystem service valuation is defined as attaching a monetary value to ecosystem services and associated changes in their quantity and/or quality. These changes may be positive or negative and can therefore generate social costs and/or benefits. This information can be incorporated in policy-making to support sustainable development. For example, when assessing the economic value to SIDS of carbon sequestration by forests and oceans, analysts could assess its impact in terms of: changes to ocean acidification and the respective impacts on fish and aquaculture harvests; changes to climate regulation, including sea level rise and the subsequent coastal loss; and changes to natural habitats and the subsequent impacts on tourism. Figure 2.1 provides a conceptual framework for ecosystem services valuation.

Figure 2.1: Conceptual framework of valuing ecosystem services

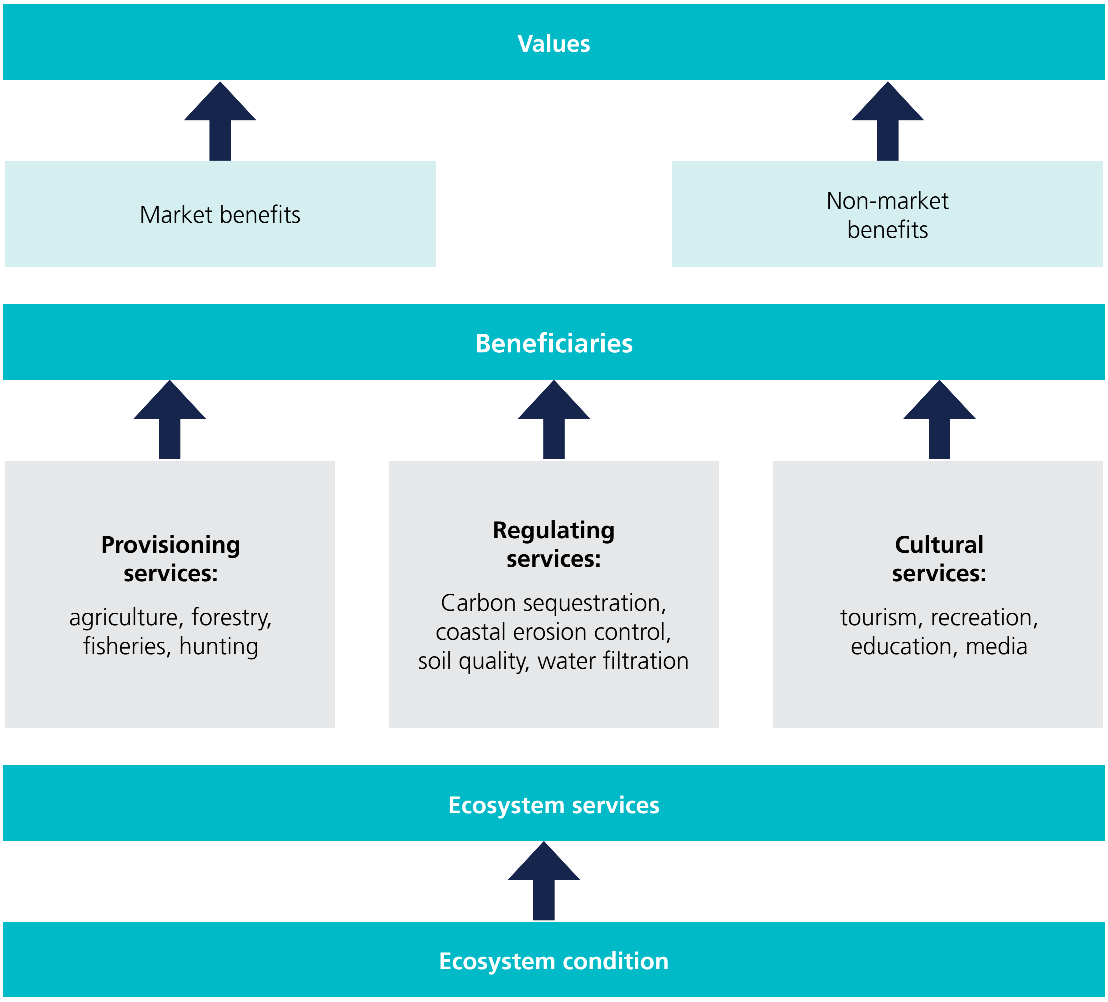


Figure 2.1 shows that ecosystem services produce both market and non-market benefits. Because most ecosystem services and environmental impacts do not have a monetary value expressed in a marketplace/market price, a diverse range of environmental valuation techniques has been developed over the past 20–30 years. Historically, this has been so that the economic worth of environmental assets and impacts can be assessed alongside other financial values to create policies that encourage more sustainable outcomes.

Figure 2.1 indicates that the beneficiaries, also referred to as the various groups that use the ecosystem services in question, are fundamental to ecosystem service valuation and accounting. It is therefore an anthropocentric exercise that has the ultimate objective of measuring the contribution of ecosystem services to human well-being and social welfare. Ecosystem services' value and their value to human well-being is denoted in Figure 2.1 by 'values'. Their economic value is dependent on the interaction between the specific ecosystem services under consideration and human well-being.

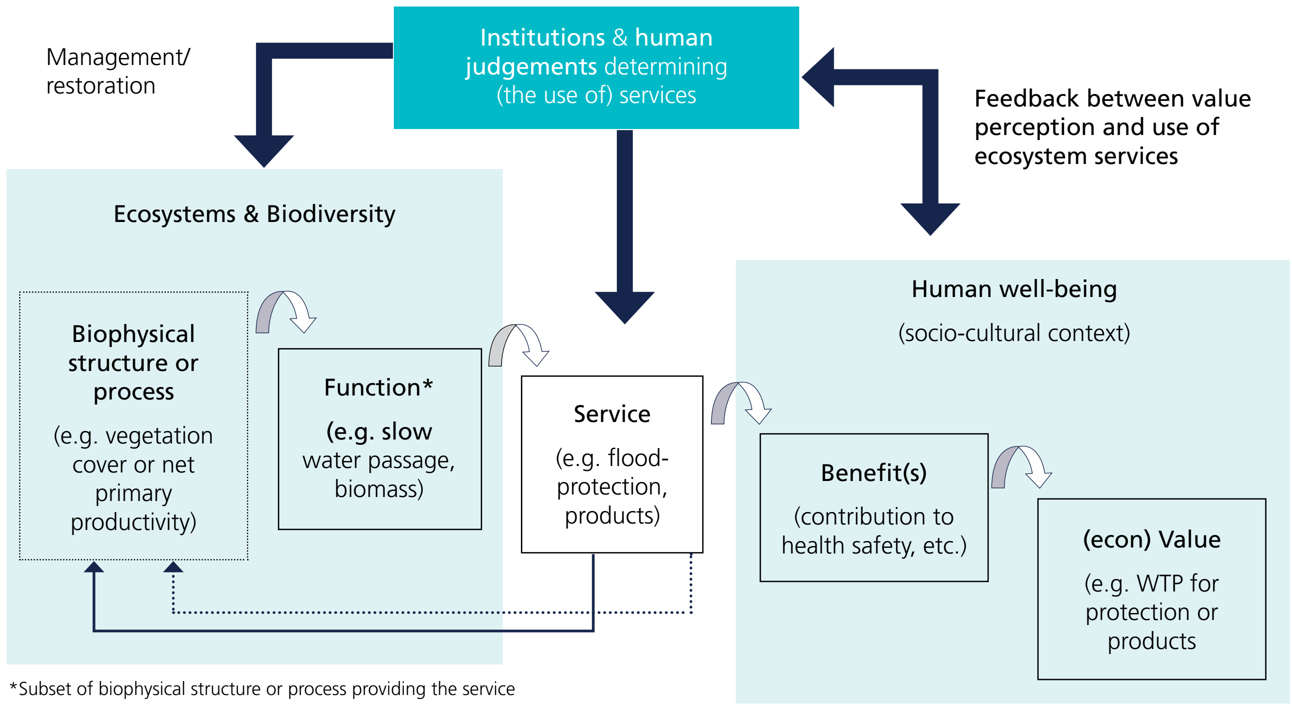
In this context, analysts need to identify, map and measure these impacts and their economic value. They could use a participatory approach involving selected stakeholders to identify and map the impacts on ecosystem services (see Chapter 4 for more details on the methodology).

Specific valuation tools can be used to assess the economic value of ecosystem services. Before looking at these tools in more detail, below are ways to identify and characterize the economic value of ecosystem services.

A widely used framework for attaching monetary value to ecosystem services is that of economic value. Figure 2.3 places ecosystem services into the following economic-value categories:

- **Direct-use values:** derived from raw materials and physical products, which are used directly for production, consumption and sale, such as those providing energy, shelter, foods, agricultural production, water supply, transport and recreational facilities.

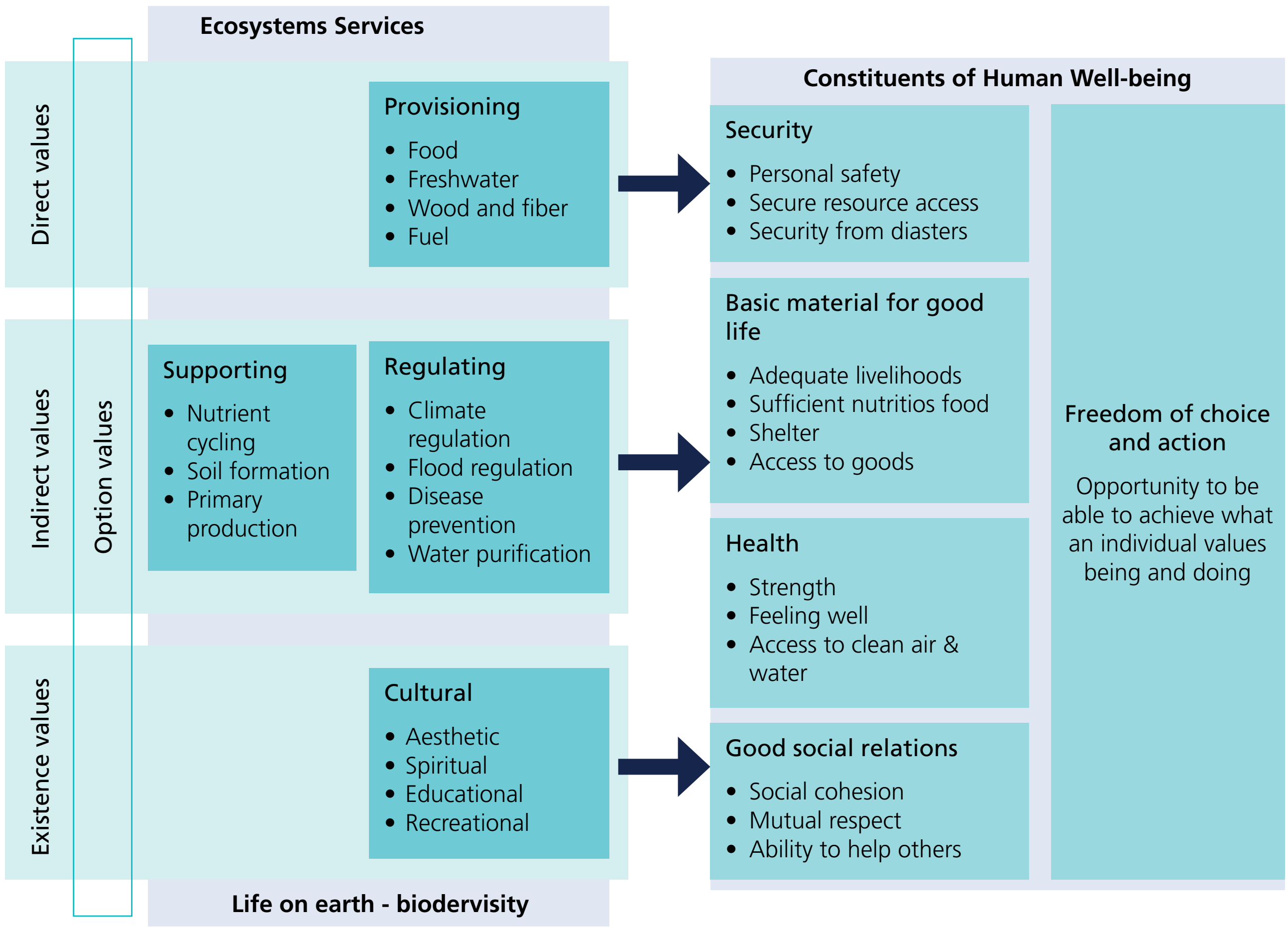
Figure 2.2: Ecosystem services and human well-being



*Subset of biophysical structure or process providing the service

Source: TEEB (2010)

Figure 2.3: Ecosystem services and economic value



Source: TEEB (2010)

- **Indirect-use values:** derived from ecological functions that maintain and protect natural and human systems through services such as the maintenance of water quality and flow, flood control and storm protection, nutrient retention and micro-climate stabilization, and the production and consumption activities they support.
- **Option values:** the 'premium' placed on maintaining habitats, species and genetic resources for future possible use, some of which may not be known at the time, such as leisure, commercial, industrial, agricultural and pharmaceutical applications.
- **Non-use values:** the value of ecosystems regardless of their current or future use, for cultural, spiritual, aesthetic, heritage and biodiversity purposes. They comprise 'existence', 'altruistic' and 'bequest' values.

2.3 Placing a value on ecosystem services in the context of policy appraisal

Analysts can measure the value of ecosystem services to human well-being using qualitative, quantitative or economic valuation approaches. Qualitative valuation typically involves describing the value as well as determining whether it is likely to be of high, medium or low economic value (e.g. the potential value of a biotechnological product not yet on the market). Quantitative valuation involves describing the value in terms of relevant quantitative information (e.g. the coastal area is used by 100 fishermen, who catch 160 tonnes of fish per year; coastal area protection in areas with good quality environmental and ecosystem services affects 5,000 local people who have jobs in the tourism sector). Monetary valuation involves placing a 'monetary' or 'dollar value' on ecosystem services (e.g. the coastal area generates US$1.4 million per year from fishing and generates about US$120 million per year for its inhabitants in income). Monetary and quantitative methodologies are discussed in detail in the following paragraph.

Monetary valuation methods

There are two main categories of monetary valuation techniques: market and non-market. The common denominator is that their respective economic values and associated range of estimates reflect the impact of changes to ecosystem services on human-wellbeing. Table 2.2 presents the full set of monetary valuation techniques and includes examples.

The only monetary valuation techniques that can estimate the non-market benefits of ecosystem services are contingent valuation and choice experiment. They use ad hoc questionnaires in which respondents are asked to state their preference for the ecosystem service under valuation. For this reason, these two techniques are also known as stated preferences approaches.

Economists can also estimate the non-market benefits of ecosystem services using value transfer techniques. These use monetary values from past valuation studies and transfer the respective economic values to the area under consideration.

Photo Credit: © mikigroup, Flickr

Table 2.2: Monetary-based ecosystem service valuation and accounting techniques

Approach/ Technique	Description	Examples
Supply-based		
Production function	Relates changes in the output of marketed goods and services to a measurable change in ecosystem goods and services	The reduction in fishery output as a result of clearing a mangrove swamp or salt marsh
Demand-based (market)		
Market prices	How much it costs to buy an ecosystem product or service or what its sales value is	The market price of timber, fish or water
Travel cost(*)	Using information on the amount of time and money people spend visiting an ecosystem for recreation or leisure purposes to calculate a value per visit	The transport and accommodation costs, entry fees and time spent visiting a national park
Hedonic pricing(*)	The difference in property prices or wages that can be ascribed to different ecosystem qualities or values	The difference in price between houses overlooking the sea or areas of natural beauty compared to similar ones that do not
Cost-based		
Replacement cost	The cost of replacing ecosystem goods or services with artificial or man-made products, infrastructure or technologies	The cost of coastal protection infrastructure after the loss of mangrove swamps and coastal wetlands
Mitigating or averting expenditure	The cost of mitigating or averting the negative effects of ecosystem services loss (similar to replacement costs)	The additional water treatment infrastructure required to maintain water-quality standards after the loss of natural wetlands
Avoided damage cost	The costs incurred to property, infrastructure and production when ecosystem services that protect economically valuable assets are lost, in terms of expenditure saved	The damage to roads, bridges, farms and property resulting from increased flooding after the loss of catchment-protecting forest
Demand-based (non-market)		
Contingent valuation	Identify ecosystem values by asking people directly what their willingness to pay for them or accept compensation for their loss is	How much would you be willing to contribute towards a fund to clean up and conserve a river?
Choice experiment	Presents a series of alternative resource or ecosystem use options, each defined by various attributes set at different levels (including price) and asks respondents to select which option (i.e. sets of attributes at different levels) they prefer	Respondents' preferences for conservation, recreational facilities and the educational attributes of natural woodlands
Value transfer		
Unit value	This technique uses average willingness-to-pay values taken from existing and similar studies, and adapts these to specific cases, taking into account key factors that characterize the two contexts, including income levels and the impacts on ecosystem services – i.e. the environmental impact	The average willingness-to-pay of recreational visitors to one beach area in Cuba applied to another similar beach in the country. If applied to a beach in another small island developing state, the value is converted using difference in gross domestic product/capita factor
WTP function	This technique uses the benefit or 'bid' function, a formula that describes the willingness-to-pay value in terms of key characteristics (e.g. environmental and socio-economic factors, such as incomes)	Insert specific site-related variables (e.g. average income, education levels) into the willingness-to-pay bid function for visitors to a beach in Cuba (policy site) calculated for a similar beach in another small island developing state (study site)
Meta analysis	This technique takes the results of a number of studies and analyses them in such a way that their variations in willingness-to-pay values can be explained	Analysis of many willingness-to-pay studies for beach recreation worldwide to identify trends in the key variables affecting willingness-to-pay values to establish a suitable value or macro-economic adjustments for the country being assessed

(*) Surrogate market method

In order to estimate the market benefits of ecosystem services, two main approaches are used: market demand/supply and cost-based. The latter uses market data to calculate the costs avoided by maintaining an ecosystem's condition and its provision of goods and services. The market demand/supply approach uses market data that expresses stakeholders' preferences for ecosystem services, including production and consumption decisions. Analysts might also use information from neighbouring markets to calculate the economic value of specific ecosystem services. These techniques are also known as surrogate market methods.

Quantitative valuation (non-monetary)

Quantitative valuation of ecosystem services is based on economic agents' behaviour and is therefore not linked to micro-econometric theory. A well-known example of this approach is the ecological production function – mathematical expressions that estimate the effects of changes in the structure, function and dynamics of an ecosystem on outputs that are directly relevant and useful to decision-makers. It is a biophysical evaluation technique and is not therefore dependent on socio-economic context. The valuation is expressed using non-monetary metrics. This technique is commonly used in land accounting to determine the size of land/coastal areas and the types of ecosystems present. This information is used to calculate the levels of ecosystem services and biodiversity required to offset their loss from damaged areas of similar habitat (see Table 2.3).

Table 2.3: Ecological production functions

Technique	Description	Examples
Habitat equivalent analysis	This technique uses an algorithm to determine the amount of environmental compensation required based on units of habitat damaged and created	The approach may determine that 3.5m^2 of coral reef needs to be restored for every 1m^2 of damaged coral reef
Ecosystem service analysis	The level of ecosystem service compensation required is based on biophysical units of the resources damaged and created	Five hundred trout need to be replaced in a river damaged by a pollution incident

Restoration or even the creation of natural habitats for the protection of biodiversity and provision of ecosystem services is at the heart of emergent economic activity. Recently, investment and development banks have started trying to strengthen economic development by using ecosystem services.[15] Their core mission is to offer a portfolio of ecosystem services investment options to other economic sectors. For example, a European-based oil-and-gas company's licence application to operate in the Republic of Trinidad and Tobago's exclusive economic zone (EEZ) might depend on its reputation and engagement in relation to ecosystem services.

It might also depend on the company's willingness to invest significantly in ecosystem services in the country, including the support of national environmental conservation programmes – e.g. supporting and respecting marine biological corridors in EEZ waters around the Republic of Trinidad and Tobago, and not using its ships in these areas. This increases competiveness among all companies bidding for licences.

When the valuation and accounting of ecosystem services is focused on the effects on human health, impacts can be measured using a number of metrics, such as loss of earnings and the social cost of illness.

A range of new tools is being developed to assist the implementation of ecosystem valuation studies. These include various innovative web-based and geographic information system-based approaches, often involving the use of both quantitative and monetary valuations. Some have been developed with public decision-making in mind (e.g. for governments assessing economic trade-offs, looking at the various net benefits to society from different policy actions or alternatives) while others have specific business applications. Geographic information systems can be useful tools to map economic aspects and environmental features (see Chapter 7). They can help illustrate assessments visually and assist with calculations, such as determining the precise area of habitat affected and the number of households or people within various distances of an impact.

15 Han et al. (2009).

2.4 Placing a value on ecosystem services in the context of environmental accounting

Gross domestic product, as accounted for in the System of National Accounts (SNA), includes only one part of economic performance – output. This indicator is widely recognized as a measure of economic growth but is a poor representation of the value of natural capital and ecosystem services. Natural capital is a critical asset, especially for remote countries such as SIDS where it can be responsible for a significant share of total national wealth.

In this context, it is in the interest of developing (and all other) countries to move beyond traditional gross domestic product accounting and to start including natural capital in their national accounts so they can make better economic decisions. However, while the concept of natural capital accounting has been around for more than 30 years, progress towards implementation has been slow. Historically, this has been for three main reasons: no demonstration of a clear policy link; a lack of internationally agreed methodology; and limited capacity in developing countries, arguably where it is needed most.

The recent lead from international organizations to propel 'Beyond-GDP' into the mainstream, which includes the Inclusive Wealth Report, led by UNEP, and the recent global partnership WAVES, has made a significant step towards achieving this vision. Another was the adoption in 2012 by the United Nations Statistical Commission of the SEEA Central Framework.[16] This inter-governmental-driven process provides analysts with the structure and principles to carry out natural and monetary accounting. SEEA – Central Framework is used, among other things, for land, soil, timber, and aquatic and water resources. As a result, there is currently renewed momentum to build capacity in countries to implement SEEA, to show the contribution of natural capital to national income and demonstrate its benefits to policymakers.

There is also an emerging demand to extend SEAA to ecosystem accounting, integrating ecosystems services and linking them to economic activity. In this context, the United Nations Statistical Commission, in collaboration with the Organization for Economic Cooperation and Development, the World Bank and the European Commission, recently released a White Paper on SEEA-Experimental Ecosystem Accounting.[17] Currently, there are discussions about how the different economic valuation methodologies can be best incorporated within an accounting context and the specific requirements this entails. For example, ecosystem services values calculated using contingent valuation techniques might be hard to integrate within national accounting principles.

This guidance manual contributes to the ongoing discourse by presenting a step-by-step guide for the valuation and accounting of ecosystem services in SIDS. The guide follows the SEEA-Central framework and is presented for both physical and monetary measures (see Chapter 5).

It is a powerful tool for green growth analysis as it provides environmental and resource efficiency indicators for SIDS' economies, indicators that monitor environmental assets and their role in the economy, and indicators that monitor environmentally-related activities and instruments, and their role in the economy. This guide also, therefore, helps policymakers identify who benefits from and bears the cost of environmental changes.

2.5 Degree of applicability of different techniques for the valuation and accounting of ecosystem services

In a seminal paper, Nunes and Van den Bergh (2001) identified three factors that influence the range of estimates of the value of biodiversity: the level of diversity under consideration; the biodiversity value type under assessment; and the valuation method applied. Using these assumptions, it is possible to identify three factors that influence the applicability of techniques for ecosystem valuation and accounting: the category of ecosystem services under consideration; the characteristics of the techniques; and whether the valuation exercise is focused on generating figures for ecosystem services accounting – i.e. for compiling SEEA.

Table 2.4 indicates the degree of applicability of ecosystem valuation and accounting techniques, and demonstrates there is no one-size-fits-all solution. The evidence shows that the use of a particular technique is dependent on both the nature of the ecosystem service under consideration as well as the ultimate objective of the measurement

16 SEEA (2012).
17 SEEA (2013).

Table 2.4: Applicability of the techniques for ecosystem service valuation and accounting

Ecosystem services	Market prices	Production function	Travel costs	Hedonic pricing	Cost-based	Stated preferences	Value transfer	Ecological production function
Provisioning	• / •	• / •			• / •			• / •
Regulating		• / •		• / o	• / •	• / o	• / o	• / •
Cultural	• / •	• / •	• / o			• / o	• / o	• / •

Note:
• Reads as 'strong applicability'
o Reads as 'weak applicability'; a blank reads as 'not-applicable '
The first mark refers to ecosystem service valuation in a welfare/human well-being setting; the second mark refers to ecosystem service valuation in an accounting setting (but not necessarily using a monetary metric).

exercise. When the ecosystem service valuation exercise is explicitly performed with ecosystem service accounting as the objective, the ecological production function fits neatly across the three categories of ecosystem services under consideration. This is because it is a biophysical evaluation technique and the respective values are universally agreed and recognized – thermodynamic laws are valid everywhere on the planet – and can thus easily be integrated with other physical measurements/indicators present in national accounts.

However, any valuation exercise should always be carried out within the context of the economic, sociological, political and cultural characteristics and idiosyncrasies of the study site, as well as its policy-making mechanisms.

Taken together, these characteristics define the institutional context and determine the interactions between local populations and the environment. They can affect every stage of the valuation exercise from the use of valuation tools to the efficacy of policy outcomes based on such measurements. Valuation studies that are carried out without acknowledging these characteristics and how they affect each step of the process run the risk of being irrelevant to the sustainable development of the country being assessed. The relationship between ecosystem services and human well-being in developing countries, and SIDS in particular, and the extent to which particular valuation tools are able to demonstrate this, are therefore matters that require particular attention. The analysis and evaluation of the applicability of the techniques for ecosystem services valuation and accounting is therefore also dependent on a fourth factor: the institutional context in which the ecosystem services valuation and accounting study is carried out. The next chapter explores this in more depth.

> *"To understand institutions one needs to know what they are, how and why they are crafted and sustained, and what consequences they generate in diverse settings."*
>
> *(Elinor Ostrom, Understanding Institutional Diversity, 2005)*

3. Critical analysis of techniques for the valuation and accounting of ecosystem services in small island developing states

3.1 Factors affecting ecosystem service perception, use and valuation in small island developing states

The Millennium Development Goals explicitly recognize sustainable development and its valuation as a key target for developing countries. While the techniques for valuing and managing ecosystem services have largely been created without any specific context in mind, their application is found mainly in the developed world.[18]

Before these techniques can be assessed, there needs to be better understanding of small island developing states (SIDS) and their ecosystem services.[19] This will help analysts determine how local populations view and value ecosystem services, and how to calculate the worth of this value and choose which valuation methods to use. It will also help them advise policymakers on how to ensure effective environmental management within a particular development context.

Figure 3.1 identifies the most influential factors in accurately carrying out and interpreting ecosystem services valuations for SIDS. These include poverty levels, rural subsistence-based livelihoods, common property, open resources, and weak governance and institutions (see Annex A for an in-depth analysis of each factor). They demonstrate that SIDS are diverse, with a broad range of characteristics.

For example, in terms of gross domestic product per capita, SIDS can be classified in four distinct income groups, ranging from low to high. Most SIDS (64%) fall into the middle-income category, Twenty-nine per cent are in the high-income category, while only 7% are classified as low-income countries. For example, in the Comoros, the Republic of Guinea-Bissau and the Republic of Haiti, about half the population lives on less than US$1.25/day (see Table 3.1).

SIDS are classified as three distinct geographic regions: Caribbean Islands, Pacific Islands, and Atlantic, Indian Ocean and South China Sea (AIMS). The AIMS group is diverse, ranging from high-income countries such as Singapore in the South China Sea to poor islands such as the Comoros.

National debt levels are an indication of SIDS's reputations in international financial markets and this can be used to assess their overall governance and institutional performance – a country with a solid governance and institutional record generally has better access to financial markets and debt facilities. The average national debt of SIDS is US$2.4 billion. Dominican Republic (US$15.4 billion), Jamaica (US$14.3 billion) and Papua New Guinea (US$12.6 billion) have the highest national debts; Sao Tome and Principe, Vanuatu and the Kingdom of Tonga have the lowest – about US$200 million each.[20]

This information determines which economic valuation technique to use. For instance, it would not be appropriate to use survey valuation techniques that offer payment for an ecosystem services management programme in SIDS with poor institutional and governance records; this would not be credible and would bias the economic

18 Christie et al. (2008).
19 Twyman (2001); Turnbull (2004); Hartter and Boston (2007); Teelucksingh and Nunes (2009); Teelucksingh et al. (2013).
20 UN-OHRLLS.

Figure 3.1: Small island developing states and ecosystem service valuation and accounting

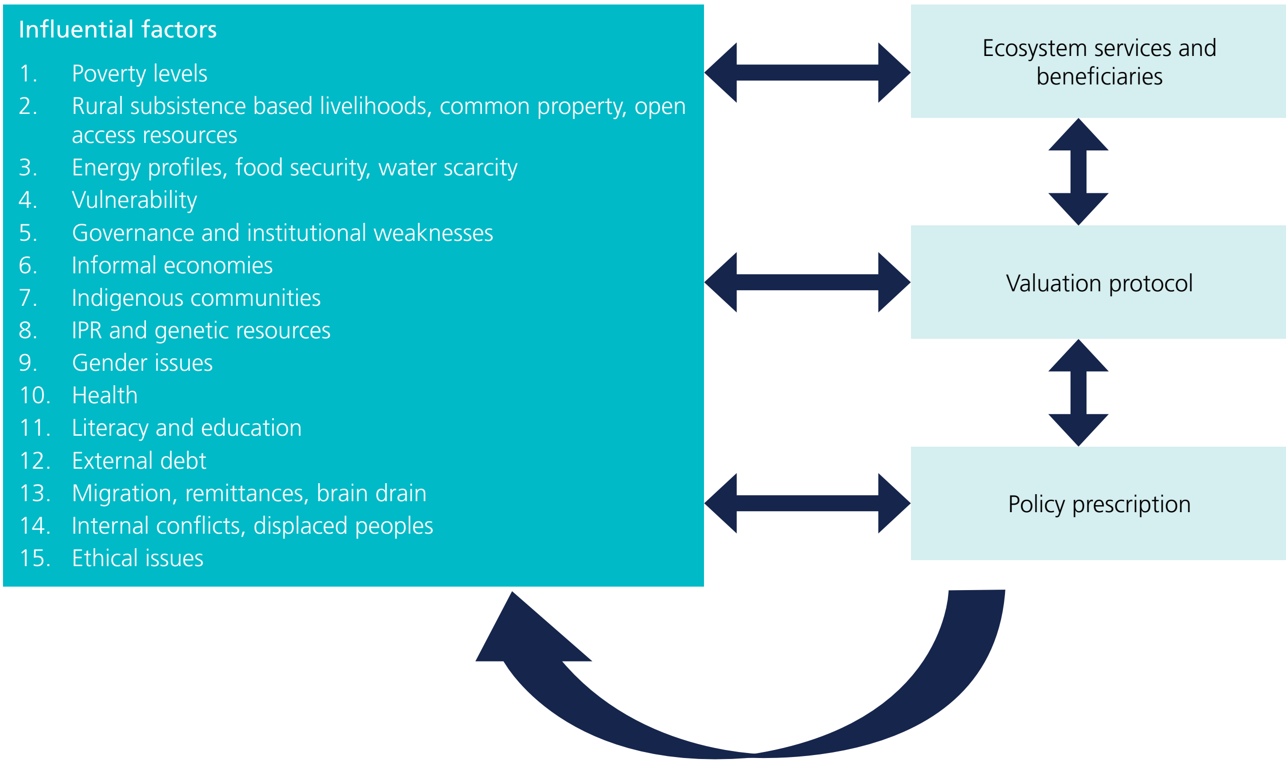


Table 3.1: Quantitative assessments in small island developing states

Low	Lower-middle	Upper-middle	High
- The Comoros - The Republic of Guinea-Bissau - The Republic of Haiti	- Belize - Cape Verde - Kiribati - Federated States of Micronesia - Papua New Guinea - Sao Tome and Principe - Solomon Islands - The Democratic Republic of Timor-Leste - The Independent State of Samoa - The Kingdom of Tonga - The Marshall Islands - The Republic of Fiji - The Republic of Guyana - Vanuatu	- American Samoa - Antigua and Barbuda - The Commonwealth of Dominica - The Cook Islands - Dominican Republic - Grenada - Jamaica - The Republic of Cuba - The Republic of Maldives - The Republic of Mauritius - The Republic of Palau - The Republic of Seychelles - The Republic of Suriname - Saint Lucia - St. Vincent and the Grenadines - Tuvalu	- Aruba - Bahamas - Barbados - French Polynesia - Georgia, Ukraine, Azerbaijan, Moldova Group (GUAM) - New Caledonia - Commonwealth of Puerto Rico - St. Kitts and Nevis - The Kingdom of Bahrain - The Republic of Singapore - The Republic of Trinidad and Tobago - US Virgin Islands

valuation exercise. In such cases, analysts are advised to develop ecosystems management programmes that involve international partners, including well-known non-governmental organizations that, preferably, have a respected, working record in the country in question.

Other factors can affect the effectiveness of the valuation method used. For example, a primary data collection method, such as contingent valuation, relies on access to communities and adequate literacy levels to collect written responses. Therefore, both the country's literacy profiles and gender hierarchy become relevant. These factors are critical when the beneficiaries are local, remote/distant communities, such as those in the Federated States of Micronesia.

On the other hand, factors such as the existence and size of the informal economy and participation levels of the targeted community become relevant when using economic valuation methods that rely on market data, such as market price and production function approaches. Where significant informal economies exist, estimates from methods that use market data are not reliable.

These factors determine the choice of value transfer method as they can identify similarities and differences in particular countries and therefore the relevance of specific valuation methods (see Annex B for more information on the statistical sources for a quantitative assessment of influential factors in SIDS).

They also help identify the priorities for ecosystem services valuation and accounting. For example, the extent to which the livelihoods of rural and fishing communities are subsistence-based is vital for identifying valuation priority areas, both in terms of ecosystem services as well as assessment of the extent of benefit-sharing/distribution schemes involving local communities. On the other hand, climate and environmental vulnerability – including land areas and populations living below five metres above sea level – are factors that indicate high priority for ecosystem services regulation, including nature-based, mitigation solutions to climate change, such as coastal protection. This is particularly true for the Republic of the Maldives, the Marshall Islands, Kiribati, the Republic of Suriname, the Cook Islands and the Bahamas, where more than 70% of land area and populations live below five metres above sea level.

The influence of these factors poses unique empirical challenges that can inhibit the valuation exercise, including distortion of the estimated results, and affect future policy proposals. In particular, the timeframe of the analysis is important. Analysis that takes place over longer time periods can be invalidated by structural breakdowns, such as the recent global financial crisis. While this is not an issue limited to SIDS, the risks can be greater in this context: consumer preference for a constant rate of consumption is hard to maintain within the constant flux of the world's economies and political events.

A significant gap between analysis and implementation on the ground also has implications for value transfer methodology. This is particularly relevant in SIDS where terrestrial and marine environments are often located close to urban and heavily populated areas, and therefore suffer unprecedented rates of ecosystem and biodiversity loss. This may indicate potential irreversible loss, so in this context, information on the economic value of ecosystem services from the valuation and accounting exercise can be interpreted in terms of insurance or option values – i.e. the cost of not preventing a specific ecosystem service for future generations.

These factors will also have policy and management implications in respect of the governance and institutional frameworks within which recommendations and prescriptions are made. Furthermore, national debt is a serious issue, especially for developing countries. High levels of national debt repayment significantly constrain policy implementation and the sustainable management of ecosystem services, and are likely to persist well beyond the valuation exercise.

SIDS' vulnerability to the impacts of global events can also determine the relevance of a valuation exercise, as well as the flexibility of management plans to adapt to such changes.

Because SIDS are so diverse, it is essential that analysts understand the interactions between ecosystem services and human well-being. Ecosystem services management practices and the ecosystem services valuation that precedes them, cannot be imported wholesale from the developed world to SIDS.

In this context, it is important to understand how these factors affect the relationship between ecosystem services and the local communities in SIDS. The next section discusses the characteristics of SIDS that influence the suitability of various valuation techniques and highlights the modifications required.

3.2 The impact of small island developing states on the selection, ranking and use of valuation techniques

SIDS are defined by a set of socio-economic-cultural and governance characteristics, which must be carefully evaluated on a case-by-case basis before proceeding with ecosystem services valuation and accounting.

This manual sets out ways of interpreting these SIDS-specific conditions and adapts the (non SIDS-specific) applicability criteria for the ecosystem services valuation and accounting techniques detailed in Table 3.2. It takes into account the geographic spread of those benefitting from ecosystem services, ranging from local, national, regional and global. It also includes the ecosystem services contribution to the well-being of communities in SIDS, with a particular focus on those that are subsistence-based. It uses the Likert scale, ranging from 'minimum', 'medium', 'strong', and 'very strong'. The manual proposes rating the suitability of economic valuation tools for SIDS by means of a quality assessment scale, ranging from a minimum, denoted by 'oooo', to a maximum, denoted by '••••'. A 'blank' indicates the valuation technique is not appropriate for SIDS.

Provisioning services

Provisioning services are very important to some SIDS, particularly in the context of poverty or a heavy reliance on rural-based subsistence livelihoods and agricultural sectors, as in the cases of the Comoros, the Republic of Guinea-Bissau, the Republic of Haiti and the Democratic Republic of Timor-Leste.

In these countries, a significant proportion of food services are related to subsistence fishing and farming, which means their respective economic values are often not captured in markets and prices. Therefore, analysts need to use alternatives to market valuation techniques, including ecological production function, to express the value of ecosystem services in terms of their contribution to subsistence farming and fishing (e.g. their contribution to daily calorie needs). Analysts can monetize this contribution using price information from traded goods and services that provide a similar calorific intake.

Bearing in mind the large marine areas of SIDS, marine resources present a significant potential economic value to their economies (e.g. seabed minerals, renewable marine biotic resources and animal feed). The economic value of most of these ecosystem services can be determined using market valuation techniques, including the value of mineral extraction (e.g. seabed mining) and fish harvesting (e.g. aquaculture). In addition, marine, and non-genetic/genetic and medicinal resources have a high economic value, as evidenced by the increasing number of material transfer contracts between countries and industry, including pharmaceutical, cosmetic and agricultural companies. Analysts can use the information in these contracts to value ecosystem services and calculate the royalties that countries are entitled to receive from companies once they have successfully developed commercial products (see Section 7.2 for an example of using material transfer contracts for the valuation and accounting of ecosystem services in SIDS).

The presence of indigenous communities, cultural norms and gender issues increases the complexity of ecosystem services valuation in SIDS. This is particularly evident when valuing food and raw material provisioning services for rural and remote communities where ecosystem services may contribute substantially to their livelihoods. Table 3.2 shows that market price, production function and cost-based methods are more appropriate ways of valuing provisioning services since most ecosystem services contribute to the functioning of existing markets and therefore should in theory show market influence.

For the same reason, ecosystem services accounting might be easier since these techniques produce monetary values that are recorded in national or sector accounts. However, when applied to some SIDS, production function valuation may be more suitable than market price valuation, especially when the provisioning services in question are used for internal consumption and support the livelihoods of rural and fishing communities.

Similar results can be obtained by including the impact of informal economies. In such cases, analysts can rely on production function techniques that relate the economic value of ecosystem services to an estimate of production function and the productivity of the relevant production sources. This is because production function is more closely based on the connection between the use of ecosystem services and produced outcomes (see Table 3.2).

Market price methodology also can be used to value provisioning services when ecosystem services are exchanged in a well-established market because it allows analysts to record the price of the transaction. This is particularly true in markets where outputs are linked to international prices – e.g. cocoa exports from São Tomé e Príncipe or coastal tourism services in the Republic of Maldives. For these reasons, the production function approach, as the most adaptable of the surveyed valuation techniques, is recommended for SIDS.

There are no particular difficulties using non-monetary valuation methods such as ecological production function in SIDS because they are based on extensive data sets and scientific modelling. Most of the analysis can be done by applying published scientific data to SIDS. For example, figures for the carbon sequestration capacity of mangrove swamps, tropical forests and wetlands are well known and can be applied to SIDS. The use of ecological production function surveys, which are important for assessing ecosystem services values, often involves significant investment in local human resources, including technical and scientific education as well as data observation and monitoring system development.

Table 3.2: Application of economic valuation techniques for provisioning services for SIDS

Economic value category	Beneficiaries/contribution to SIDS	Most suitable valuation techniques in SIDS
Food and raw material	National-Regional/Very strong	●●○○ MP ●●●○ PF NA TC NA HP ●●○○ CB NA SP NA VT ●●●○ EPF
Natural habitats	National-Global/Strong	NA MP ●●●○ PF NA TC NA HP ●●○○ CB NA SP NA VT ●●●○ EPF
Genetic, ornamental and medicinal resources	National-Regional/Medium-strong	●●○○ MP ●●●○ PF NA TC NA HP ●●○○ CB NA SP NA VT ●●●○ EPF

Notes: Market Prices (MP); Production Function (PF); Travel Cost (TC); Hedonic Pricing (HP); Cost-Based (CB); Stated Preferences (SP); Value Transfer (VT); Ecological Production Function (EPF); NA indicates the valuation technique under consideration is 'not applicable'

Regulating services

The importance to SIDS of ecosystem regulating services is categorized as 'local' to 'global' (see Table 3.3). Despite its implied scope, the latter category still recognizes the importance of regulating functions to human well-being to SIDS; indeed, they are vital to the livelihoods of their economies even though the benefits of these services can be international. Greenhouse gas regulation, including carbon dioxide[21], is a good example of this. Any activity that promotes carbon sequestration in SIDS – land-use management practices that promote tropical forest conservation, for example – is associated with higher levels of stored carbon. The costs are local but the benefits are global.

The use of production function and cost-based techniques may be problematic when addressing the valuation and accounting of regulating services in SIDS. First, information on mitigation, man-made infrastructure and their costs, is often not available. Where this information is available elsewhere, it cannot be directly applied to specific SIDS. Second, reparation costs by definition involve a subsequent action, often coordinated by public institutions. Weak governance and institutional structures can make the effective application of these methods additionally challenging.

The hedonic pricing and stated preferences methods, while theoretically applicable to the valuation of these groups of regulating services (albeit at different levels of performance), should be used with caution.

When beneficiaries are categorized as 'global', it is illogical to ask SIDS communities to value the full range of benefits – in the context of greenhouse gas and climate change regulation, for example. One solution is to approach the valuation of these benefits using stated preferences techniques. Weak governance and institutions may also hamper the use of these techniques since participants may not fully trust the public agency responsible for monitoring and controlling carbon emissions. This can lead to the misreporting of true preferences and potentially distort the economic value of ecosystem services.

21 In fact, the reduction of carbon dioxide concentrations is a textbook example of a global public good.

Table 3.3: Application of economic valuation techniques for regulating services for SIDS

Economic Value Category	Beneficiaries/Contribution to SIDS	Most suitable valuation techniques in SIDS
Gas regulation, including carbon	Global/Very strong	NA MP ●●●○ PF NA TC ○○○○ HP ●●○○ CB NA SP NA VT ●●●○ EPF
Climate regulation	Global/Strong	NA MP ●●●○ PF NA TC ○○○○ HP ●●○○ CB NA SP NA VT ●●●○ EPF
Coastal protection	Local-National/Very strong	NA MP ●●●○ PF NA TC ●●●○ HP ●●○○ CB ●●●○ SP ●●●● VT ●●●○ EPF
Water supply and regulation	Local/Very strong	○○○● MP ●●●○ PF NA TC ●●●○ HP ●●○○ CB ●●●● SP ●●●● VT ●●●○ EPF
Soil formation, nutrient and waste regulation	Local/Very strong	NA MP ●●●○ PF NA TC ●●○○ HP ●●○○ CB ●●●○ SP ●●●● VT ●●●○ EPF
Pollination and biological regulation	Local-National/Strong	NA MP ●●●○ PF NA TC NA HP ●●○○ CB NA SP NA VT ●●●○ EPF

Notes: Market Prices (MP); Production Function (PF); Travel Cost (TC); Hedonic Pricing (HP); Cost-based (CB); Stated preferences (SP); Value transfer (VT); Ecological Production Function (EPF); NA indicates the valuation technique under consideration is 'not applicable'

The stated preferences technique is less applicable to many of the regulation services in SIDS due to various factors, including unfamiliarity with the ecosystem service being valued, the lack of well-defined property rights and indigenous communities that do not accept monetary trade-offs (e.g. financial compensation or incentives) for a change in use of their lands, forests or seas. In these cases, analysts are advised to talk to communities to identify possible trade-off options and thus value their preferences.

There is one exception: when valuing the benefits of water supply and regulation. Everyone understands the value of this ecosystem service – e.g. how often water supplies are interrupted, tap-water quality and the importance of filtration. In addition, people directly experience the benefits of water supply and therefore make a direct association between value/price and service.

Analysts can use choice experiments to model and value these types of policy scenarios. Hedonic pricing is less efficient than theory suggests in this regard but is still applicable to situations where island ecosystem services mainly deliver substantial benefits to local communities in SIDS – when valuing coastal protection, water supply and regulation services by using land and housing market prices, for example.

The usefulness of hedonic pricing for SIDS increases when used in reference to the international real estate market – e.g. properties in Barbados listed in Sotheby's International Realty, where market prices include ecosystem services-based characteristics, including the location of properties and their proximity to amenities such as beaches and nature, and the risk of erosion or landslides.

As value transfer's usefulness remains the same when applied to SIDS, it is a very important tool in this context.

The ecological production function technique is effective because it uses extensive qualitative surveys, which play a significant role in supplying complementary information about the markets in SIDS. For example, in the context of land-based island ecosystem services, ecological production function is often associated with land management practices. One hectare of forest can be described in terms of its annual capacity to store carbon. Ecological production function shows that the loss of *x* hectares of forest is associated with the loss of *y* tonnes of carbon per year and therefore *x* hectares of forest is required to offset that loss.

Cultural services

Economic valuation of cultural services is possible using both market and non-market demand approaches, as well as value transfer techniques (see Table 3.4). Only stated preferences techniques are capable of quantifying non-use values. The decision to use these techniques should be based predominantly on the economic value of the cultural services under consideration. For instance, in order to work out the value of recreational activities, analysts can use tourism market data, including holiday prices, to make the calculation. In other instances, analysts can use data from surrogate markets, typically using travel costs and hedonic price techniques, to collect information about consumer behaviour and quantify the economic value of the cultural service under consideration – e.g. the recreational benefits of beach visits, sport fishing, swimming and sailing. Both examples are based on local prices and are therefore influenced by SIDS' characteristics, including informal economies, the lack of property rights enforcement and/or surrogate market structures.

Analysts can also use production function techniques to calculate what role a cultural service plays in, for instance, its popularity with tourists, and estimate its impact in terms of output – e.g. in terms of a country's cultural amenities and their relationship to the number of international visitors (see Chapter 7 for more information).

When it comes to the valuation of non-market cultural benefits, such as cultural heritage or the protection of a natural habitat fundamental to the survival of an animal species (such as the Scarlet Ibis in the Republic of Trinidad and Tobago), analysts can use the stated preferences approach, including the use of contingent and choice experiments. This technique has the potential to value intangible cultural ecosystem services, including the legacy and spiritual values associated with SIDS' rich heritages – e.g. the value of the Scarlet Ibis has outgrown moves to protect it and it is now a national symbol on flags on many public buildings, including the University of West Indies.

As mentioned previously, stated preferences techniques may not be as robust and reliable when applied to SIDS, since they are more susceptible to strategic answers in the surveys. Analysts must therefore test the questionnaires, adapting them to the institutional context in question. Such preparatory work is fundamental to ensuring the data obtained and the policies formed from it are robust.

Institutional characteristics, such as trust in local institutions, levels of tax evasion and the significance of informal economies, can play a significant role in weakening (or strengthening) the suitability of the stated preferences technique to specific contexts. Value transfer and ecological production function are equally suitable for general use and in SIDS. However, applying them to SIDS is only as effective as the quality of data they are based on.

Table 3.4: Applicability of the techniques for cultural services valuation in SIDS

Economic Value Category	Beneficiaries/Contribution to SIDS	Most suitable valuation techniques in SIDS	
Recreational	Local/Very strong	NA	Market Prices
		NA	Production Function
		●●●○	Travel Cost
		●●○○	Hedonic Pricing
		NA	Cost-based
		●●●○	Stated Preferences
		●●●●	Value Transfer
		●●●○	Ecological Production Function
Tourism, including eco-tourism	National /Very strong	●●○○	Market Prices
		●●●○	Production Function
		NA	Travel Cost
		NA	Hedonic Pricing
		NA	Cost-based
		●●●○	Stated Preferences
		●●●●	Value Transfer
		●●●○	Ecological Production Function
Legacy, spiritual and historical	Local-National/Medium-strong	NA	Market Prices
		NA	Production Function
		NA	Travel Cost
		NA	Hedonic Pricing
		NA	Cost-based
		●●●○	Stated Preferences
		●●●●	Value Transfer
		NA	Ecological Production Function

Notes: Market Prices (MP); Production Function (PF); Travel Cost (TC); Hedonic Pricing (HP); Cost-based (CB); Stated preferences (SP); Value transfer (VT); Ecological Production Function (EPF); NA indicates the valuation technique under consideration is 'not applicable'

Ecological production function remains unaffected by context – as a biophysical evaluation technique it is not dependent on socio-economic context. It continues to be an important and appropriate valuation tool for SIDS, and provides valuable information that informs the valuation process and complements other methodologies.

3.3 Conclusion

The valuation and accounting of ecosystem goods and services is complex but vital for SIDS. In summary:

- The institutional context within which valuation exercises are carried out can affect every stage of the process, so it is essential to understand its influence and map how it can affect valuation.
- Nunes and van den Bergh's work shows that by taking SIDS' unique characteristics into account, analysts can re-classify the suitability of many economic valuation techniques for use in island states.
- Of the monetary-focused techniques, production function, stated preferences and value transfer are important tools for use in SIDS, though care is needed in the design and execution of the valuation exercises. They are particularly useful for valuing fish and marine resources, as well as non-consumptive services such as tourism and coastal recreation.
- While Tables 3.2, 3.3 and 3.4 separate the valuation techniques into mutually exclusive sets, using a combination of methods can be effective. For example, while ecological production function does not produce monetary indicators, it provides useful insights into how ecosystem services are perceived and used, giving more accurate, rigorous and robust monetary estimates.

> *“The economic invisibility of Nature: the bad news is that Mother Nature’s back office is not quite working yet, so those invoices do not get issued, and we need to do something about this problem.”*
>
> *(Pavan Sukhdev, TED talks, 2011)*

4. Step-by-step guide on valuation techniques for small island developing states, with case studies

4.1 Practical steps for the economic valuation of island ecosystem services

The first step when carrying out an economic valuation is to identify the policy or environmental management strategy that needs addressing, and to use valuation and accounting methodology to collect the necessary data. This information allows analysts to devise various policy options and determine which trade-offs are relevant. This is central to economic valuation and shows the financial consequences of not implementing the necessary policies.

The second step is to identify those people and island ecosystem services affected by the policy in question, including those who benefit from them and those who don’t, and assess the consequences of redistributing these benefits.

This step also helps analysts identify the geographic areas and population groups they will be working with. For example, if they were working on setting up a marine protected area (MPA) in the Democratic Republic of Timor-Leste, they would start by first identifying which ecosystem services would be affected and how with and without the MPA. The valuation exercise would show how each scenario could affect the country’s inhabitants.

Step 3 is to plan the study. This involves collecting data and identifying where more information is needed, as well as determining the appropriate consultation process and methodology to use. It sets out when the study will take place, how long it will take and how much it will cost.

The final step is to perform the valuation itself. This uses information gathered from the previous steps and must be specifically adapted to small island developing states (SIDS). As mentioned in the previous chapter, the economic valuation technique is only effective for SIDS when local institutional and policy-making conditions are factored into the calculations.

The economic valuation techniques presented in this manual have therefore been modified, adapted and calibrated for application to SIDS (see Section 3). This section presents a step-by-step guide to each of the techniques[22] and includes case studies to illustrate their application.

4.2 Implementing the production function technique in small island developing states

From a micro-economic perspective, production function describes the relationship between inputs and outputs. Typically, inputs are the amount of labour, land and capital used in production. In the context of SIDS, the production function method estimates the value of island ecosystem services by assessing their contribution as additional inputs to the production of commercially marketed products. Island ecosystems services can also be assessed in terms of quality-based criteria that affect the productivity of other inputs. For example, tuna production can be described as the number of fishing vessels that use a certain type of net and the number of crew who operate in a given fishing area.

22 The step-by-step guide presented in this manual builds upon previous work by, among others, Van Beukering et al. (2007), Schuhmann (2012) and Waite et al. (2014).

Or, in another example, modelling the production function for tuna allows analysts to assess the impact of creating an MPA or no-take zone in, for example, the Republic of Palau's territorial waters, where tuna fishing is an important economic sector. An MPA may have an impact on the number of tuna caught or the number of fishermen needed to fish the quota. Analysts can work out the scale of the impact, which if positive is referred to as an efficiency gain. This method does not necessarily require market/price data since the economic value can be expressed in terms of the marginal productivity (or marginal product) of the selected output production – i.e. tuna fisheries. This technique is therefore highly applicable to SIDS. However, where market prices are available, analysts can express marginal productivity value in monetary terms, though this can be challenging because substantial amounts of data are needed. This can be overcome by seeking guidance from international experts, through training, capacity building, data sharing and by adopting a collegial approach to SIDS' national and local research institutions. The mains steps involved in applying the production function method are described in Table 4.1.

Table 4.1: Step-by-step valuation of island ecosystem services using the production function technique

Step 1: Policy scenario – specify the change in the quantity of the product or service *(e.g. the introduction of a no-take zone in the Republic of Palau)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *set up and attend meetings with the Republic of Palau's tuna-fishing communities*
Step 3: Identify the inputs that affect output production, and model production function using statistical analysis *Tasks for analysts:* - *collect data on the number of fisherman, the size of the fishing area, types of vessel used, MPAs*
Step 4: Estimate the production function using statistical analysis *Tasks for analysts:* - *calculate the marginal impact of the no-take zone on production*
Step 5: Calculate the change in revenue *Tasks for analysts:* - *calculate the monetary value of the marginal impact, measured before and after the introduction of the policy*

The use of the production function technique to assess the impact of forest management in the Valdesia watershed in the Dominican Republic[23] demonstrates its suitability for SIDS. This study estimated the impacts of forest management practices on soil erosion in the watershed (Step 1). The valuation exercises focused on the benefits experienced by farmers in four different slope categories, which were measured in terms of the net value of agricultural provisioning services (Step 2). Steps 3 and 4 identified the amount of arable land and pasture affected by soil erosion in different scenarios. Global soil-loss data and estimated soil-delivery ratios were used to predict long-term erosion in each slope category, both with and without improved forest management. The amount of land in crop agriculture and pasture in each land class was used to help determine changes to the net current value for farmers. Step 5 calculated the total benefit from improved forest management as DR$8.9 million (US$201,860) over 25 years. However, only farmers in the lowest slope category (3%-20% incline) were expected to benefit. Farmers in higher slope classes would experience a net loss due to the replacement of existing cropland with forestry or agroforestry.

4.3 Implementing demand-based (market) techniques in small island developing states

Market price

The most straightforward and commonly used method for valuing any product is to look at its market price. In competitive markets, where there are no distorting factors such as informal economies, taxes or subsidies, market price can be used to value the ecosystem service under consideration. This valuation technique is relatively simple, inexpensive and quick to apply as it makes use of generally available information on prices. However, it is necessary to take into account some of the characteristics specific to SIDS, such as the presence of informal economies or the substantial subsidies for some goods (e.g. water for domestic use), as these may hinder, if not render impossible,

23 Veloz et al. (1985).

Box 4.1: The production function technique – examples of its application in small island developing states

Wielgus et al. (2010) used the production function method to assess the contribution of coral reefs and mangroves to fishery production, as part of a study investigating their contribution to erosion control, fisheries and tourism in the **Dominican Republic**. The mean annual revenues from reef and mangrove-dependent fish were estimated to be US$16.6 million and US$9.1 million, respectively. This study received financial support from the MacArthur Foundation and SwedBio.

Bervoets (2010) applied the method to quantify the value that coral reefs in St Eustatius National Marine Park in the **Netherlands Antilles** provide to fisheries. The study relied on the results of a workshop during which fishermen were asked to answer questions on how much time they spent fishing, fishing costs and the sale prices of the most targeted marine species. Overall, revenues from reef-associated fisheries were estimated to be about US$2 million per year.

Ruitenbeek et al. (1999) employed a range of methods to assess the value of ecosystem services in Montego Bay, **Jamaica** to tourism, fisheries, coastal protection and pharmaceutical bioprospecting. A production function approach, based on the Cobb-Douglas model, was used to quantify the value of the island's biodiversity. Net present values estimated included tourism and recreation (US$315 million), fisheries (US$1.31 million) and coastal protection (US$65 million). The World Bank Research Committee funded the study.

the use of this technique. In such cases, the market price technique will capture the value of the subsidy as well as the product, distorting the results. Therefore, when working with this valuation technique in SIDS, analysts must first check whether there is a market price associated with the ecosystem service under consideration and second, verify whether the price is subject to distorting factors by investigating the market structure and the dynamics of price formation. The main steps involved in applying the market price technique for the valuation and accounting of ecosystem services in SIDS are set out in Table 4.2.

Table 4.2: A step-by-step valuation of island ecosystem services using the market price technique

Step 1: Policy scenario – specify the change in the quantity of the product or service *(e.g. the economic valuation of a management programme aimed at eliminating discards through changes to tuna fishery management practices in the Republic of Palau)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *meet tuna-fishing communities*
Step 3: Collect data on the relevant market price. Determine whether the price is distorted and, if necessary, correct distortions by finding comparable products or services at undistorted prices in similar economies *Tasks for analysts:* - *find data on tuna prices in the Republic of Palau, as well as in international markets*
Step 4: Multiply price by the change in quantity to determine the value of the change *Tasks for analysts:* - *find data on the current size of the tuna catch (business-as-usual) and calculate the projected quantity of tuna after the introduction of a no-discards fishery management practice and multiply this difference by the current price of tuna*

The market price technique was used to value marine ecosystem management in the Republic of Vanuatu.[24] This study focused on the impacts on subsistence fishing of establishing MPAs (Step 1) and was commissioned by the Coral Reef Initiatives for the Pacific. Changes in the catches per unit of effort were used as indicators of the fishing industry's productivity. The valuation exercise focused on the benefits to local fishermen from the ocean's provisioning services close to the MPA's boundary and at various distances from it, which were found out from a consultation (Step 2). Given the reliance on subsistence fishing, the study used the local market price of basic commercial food with the same protein equivalent as part of the valuation, rather than the market price of the

24 Pascal (2011).

fished species (Step 3). The annual gross profit from improved fisheries due to MPAs were estimated at US$11,000 per year – the average value of the five proposed protected areas (Step 4). Box 4.2 reviews other applications of the market price technique in SIDS.

Box 4.2: The market price technique: examples of its application in small island developing states

The National Research Institute of **Papua New Guinea** (Hunt, 2002) investigated the financial benefits of logging in small-scale, ecologically sustainable community forests, and concluded that they were comparable to the benefits to landowners of industrial logging. The estimated net present value of unsubsidized ecoforestry operations was estimated at between US$7 and US$33 per hectare depending on the choice of discount rate.

Dixon et al. (1993) evaluated the economic value of the Bonaire National Marine Park in the **Netherlands Antilles** in a World Bank study using financial analysis of private sector gross revenues from recreational activities. The analysis was restricted to revenues from scuba diving-based tourism, which is more dependent on the protection afforded by the park. The revenues were estimated to be US$23.2 million.

JacobsGIBB (2004) used a range of valuation methods to assess the economic value of coral reefs and mangroves in three locations in **American Samoa**. This study used the average retail price of fish to assess the direct benefits to subsistence and artisanal fisheries. The value of the coral reefs and mangrove forests to subsistence fishing was estimated to be US$572,000 and US$29,000 per year respectively. The authors also calculated producer surplus figures (by subtracting estimated production costs) and indirect benefits.

An International Union for Conservation of Nature study conducted by Emerton (1997) sought to establish the benefits of biodiversity in the **Republic of Seychelles** by valuing the production and consumption opportunities it provided, as well as the costs of biodiversity loss. Market prices for timber, forest produce, various fish species and entry fees to protected areas were used in the valuation. The largest revenues derived from tourism (US$158 million) and fisheries/mariculture (US$128 million).

Costello and Ward (2006) developed a methodology to calculate private-sector bioprospecting incentives and applied it to estimate the marginal value of land in various biodiversity hotspots, including **New Caledonia**, in a variety of scenarios. The marginal value of land was estimated to range between US$5,056-5,473 per hectare and the authors concluded that bioprospecting was unlikely to generate much private-sector conservation.

Samonte et al. (2013) addressed the importance of having proper governance in place for the successful implementation of MPAs. After conducting surveys in 11 locations in Latin America, the authors called for better consultation with stakeholders. The economic dependence on marine resources was measured in terms of the average monthly household income derived from them, which ranged from US$385 to US$1,291 per household per year in **Belize** and the **Republic of Fiji**, respectively. The Gordon and Betty Moore Foundation funded the study.

Travel cost

This technique estimates the economic value of recreational sites by assessing the generalized travel costs of visiting them.[25] The valuation is based on estimating a demand curve for the site in question using various economic and statistical models. For example, analysts could use the travel cost method to estimate the value of the recreational benefits of Trinidad's Northern Range, including leatherback sea turtle watching in Grand Riviere. Travel expenditure includes out-of pocket costs to reach Grand Riviere (e.g. petrol, payment for a local guide and to visit the site) as well as time costs (e.g. the value of the time spent by the visitor in the area). This information, as well as the number of times they visit the site, is obtained from questionnaires.

Since the travel cost method is dependent on visitor interviews and surveys, it is important to use different sampling strategies to ensure the statistical sample is representative (e.g. by carrying out the survey in different seasons and, if appropriate, with different sets of visitors, including domestic and international, in different areas and for the various uses of the site under consideration). In the case of Grand Riviere, and in SIDS more generally, this method is particularly effective since visits to national parks in these countries, including coral reef areas, incur costs such

25 Bockstael et al. (1991).

as equipment hire for diving and snorkelling, and transport. One-to-one interviews are advisable since it is the best way to ensure the questionnaires are completed. This makes the technique more expensive than others but it does generate data that would otherwise not be captured.

The use of the travel cost technique in SIDS is limited by the characteristics of the country in question. For instance, Tuvalu only has 24km of coastline and therefore the technique's usefulness may be limited, unless used to analyse the impacts of international tourism. The Federated States of Micronesia, on the other hand, has the longest coastline of all SIDS – more than 6,000km. Here, the travel cost technique could be applied to assess the recreational economic value of both domestic and international tourism. The main steps involved in applying the travel technique in SIDS are presented in Table 4.3.

Table 4.3: A step-by-step valuation of island ecosystem services using the travel cost technique

Step 1: Policy scenario – specify the change in quantity of the product or service *(e.g. the introduction of a night-time turtle-watch programme using guides from Grand Riviere)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *collect data on domestic and international visitors*
Step 3: Survey visitors to collect information about the costs of the visit, motives for the trip, frequency of visits, site attributes and socio-economic variables such as the tourist's place of origin, income, age and education - *develop an interactive questionnaire (e.g. on a tablet) to collect information on the number of domestic and international visitors, and the number of visits made during the past year*
Step 4: Calculate the average travel cost for recreational visitors using the round-trip travel distance, and the cost and travel times *Tasks for analysts:* - *find data on the cost of petrol per km, as well as the price of air travel, hotel accommodation and wages, as reported by respondents*
Step 5: Estimate the demand for visiting the site using statistical analysis and the data collected *Tasks for analysts:* - *estimate the demand for visiting the site that relates the number of site visits to the cost of visiting*
Step 6: Estimate the total economic benefit of the site to visitors *Tasks for analysts:* - *monetize reported travel costs by calculating the area under the demand curve*

The travel cost technique was used to estimate the value of recreational visits to the Caribbean National Forest (now known as El Yunque National Forest) in the **Commonwealth of Puerto Rico**[26]. The study investigated the total consumer surplus[27] of recreational activities, assuming no changes to the provision of the ecosystem service (Step 1). The valuation exercise focused on the benefits to domestic visitors from the forest's cultural services (Step 2). The study highlighted the problems that arise from the assumption of a continuous spatial market in the travel cost model when applied to islands or other isolated areas by comparing the willingness-to-pay per person per trip (obtained by analysing travel costs and using contingent valuation techniques).

An on-site survey was performed in 2005 that collected data from 11 different sites. This included the demographic of users, the distance travelled and the time spent doing so, and characteristics of the sites visited (Steps 3 and 4). A negative binomial distribution corrected for on-site sampling bias was used to analyse the collected data. Robust standard errors were calculated for each model coefficient. Responses from those whose visit to the site was not their main purpose were discarded (Step 5).

The travel cost method yielded a net willingness-to-pay per trip of US$17 for the corrected model and US$29 for the uncorrected version (Step 6). Analysts found a large discrepancy when comparing these to the results of the contingent valuation exercise (US$109 per trip), which can be attributed to the geographic limits of the Commonwealth of Puerto Rico. Box 4.3 reviews other applications of the travel cost technique in SIDS.

26 Loomis et al. (2007).
27 In other words, the additional amount above the actual price that the consumer would be willing to pay in order to protect a particular good or service from the impacts of ecosystem service loss.

Box 4.3: The travel cost technique: examples of its application in small island developing states

Reid-Grant and Bhat (2009) used a travel cost model to estimate the consumer surplus of tourists visiting the Montego Bay MPA in **Jamaica**. The consumer surplus was estimated at US$739 per visitor per trip, which led the authors to conclude that its conservation value exceeded the park's management costs. Florida International University funded the study

Seidl et al. (2013) used a travel cost approach to assess the preferences and spending patterns of cruise-ship passengers in **Belize** to help local decision-makers balance the recent rise in cruise-ship tourism with the country's historic reputation for ecotourism. On average, cruise-related expenditure (transportation and on-board spend) amounted to US$2,345 per person. The Belize Tourism Board funded this study, together with other international foundations and research institutions.

Wielgus et al. (2010) estimated the recreational value of the Jaragua, Bahoruco and Enriquillo national parks in the **Dominican Republic** using visitor surveys. The sample focused explicitly on those Dominican citizens visiting the parks primarily for marine-based recreation. In total, visitors spent about US$523,000 on stopovers between the place they began the trip and the national parks, and US$511,000 on lodging. They paid US$136,000 in total in park fees.

Hedonic pricing

As with the travel cost technique, hedonic pricing is a surrogated market method. It is based on the assumption that the market price of the product being assessed is based on various characteristics, including its environmental impact. Originally used in environmental economics, the application of hedonic pricing is usually associated with the use of statistical tools to assess the contribution of nearby environmental amenities, such as urban green areas or parks, to residential property prices.

When analysts use the technique in SIDS, it is assumed that the prices of the real-estate market under consideration take into account general features such as the number of bedrooms, the age of the property, neighbourhood characteristics (e.g. population demographics, crime, and school quality), and environmental attributes (e.g. air quality, proximity to flood areas, proximity to high risk beach erosion areas). Using specific statistical tools, analysts can isolate and capture the contribution of each of these characteristics to the market price of the property under consideration.

From an operational view point, hedonic pricing may be less relevant for small communities in SIDS, since its application requires the use of a large data set on houses, including the prices of properties sold, as well as information on other factors that may influence price. However, hedonic pricing does have significant potential for use in SIDS in urban settings and in areas where there is a high demand for property from international buyers. These are classified as dynamic markets and have more comprehensive real estate data. The main steps in applying the hedonic price technique are presented in Table 4.4.

Table 4.4: A step-by-step valuation of island ecosystem services using the hedonic pricing technique

Step 1: Policy scenario – specify the change in the quantity of the product or service *(e.g. the introduction of an ecosystem-based programme to mitigate beach and coastal erosion)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *meet domestic and international residents in coastal areas that are at varying risk of erosion*
Step 3: Collect data on residential properties in coastal areas, including the area being valued *Tasks for analysts:* - *collect real estate sales data, such as market price per square foot, geographic information system maps with information on beach and coastal erosion risks, population demographics, crime, education quality and other factors as identified by analysts*
Step 4: Estimate a hedonic price value that takes into account selected factors, including the risk of coastal erosion in the area where the house is located *Tasks for analysts:* - *estimate the hedonic function coefficients related to the risk of coastal erosion*

The hedonic pricing technique was used to quantify the potential losses to the Dominican Republic hotel industry from beach erosion[28] (Step 1). It focused on the benefits of ecosystem services to tourism operators (Step 2), in particular their revenue from renting hotel rooms with beach views, especially from international visitors. Publicly available online data on room prices was used to estimate the relationship between the price of hotel rooms and various accommodation attributes, including the width of the beach in front of the resort (Step 3). The width was included as one of the variables in the hedonic function, along with the resort's location, its size, its distance to the closest airport, its star rating and other characteristics. Three different specifications were tested: the results showed that over a period of 10 years current rates of beach erosion would result in revenue losses to the resorts of US$52–$100 million (Step 4). Box 4.4 illustrates another application of the hedonic pricing technique in SIDS.

Box 4.4: Hedonic pricing: an example of its application in small island developing states

Roelfsema et al. (forthcoming) estimated the benefits provided by coral reefs in Bermuda by analysing how much they added to the value of residential properties. This study used the distance from house to beach as a proxy for the coral reefs' value and concluded that proximity to a beach is not one of the main factors that drive house prices in Bermuda.

4.4 Implementing cost-based techniques tailored for small island developing states

Avoided damage cost

The cost-based-methods applicable to SIDS include two main techniques: replacement cost and avoided damage cost, also known as preventive expenditure technique. The latter's objective is to identify infrastructure and/or health costs caused by damage to ecosystems and the resulting loss of ecosystem services. Avoided damage cost should be seen as a minimum estimate of impact costs since it does not measure the consumer surplus. In the context of SIDS and climate change, the costs incurred to prevent damage would actually be adaptation costs since it is expenditure aimed at reducing climate change impacts (which may also include the loss of ecosystem services).

Care must therefore be taken when using the technique to carry out cost-benefit analysis of adaptation options. Furthermore, when applying it to SIDS, analysts need a range of data sets. These include information on the probability of ecosystem damage occurring in the country under consideration, which involves using historical geo-climatic data and storm records, and input from experts. Information on the value of the assets at risk, particularly data on property values, will also be needed.

Analysts must predict and quantify the extent of the damage under different scenarios, which is complex because it requires specific modelling tailored to the scale of the analysis. For these reasons, the application of this method to SIDS is recommended only when analysts are working in a multidisciplinary team that can address all the points mentioned above, which when taken together, make up the economic valuation exercise.

Replacement cost

As with avoided cost damage, the replacement cost technique is relatively simple to use and has the added advantage of being an objective valuation of an impact that has already occurred or is quantifiable. Use of this method relies on the availability of replacement or restoration measures and knowledge of their costs, and is therefore unlikely to be appropriate for valuing the impacts of irreplaceable/irreversible ecosystem services loss.[29] In addition to coastal protection, the replacement cost technique can be useful in SIDS when analysts are asked to value ecosystem services such as water supply, and storage and purification, which are provided naturally by forests and watersheds. Table 4.5 presents the main steps involved in the application of the replacement cost technique in SIDS.

28 Wielgus et al. (2010).

29 As before, analysts must be aware of the shortcomings of this technique: that actual replacement or restoration costs are not necessarily linked to an individual's willingness-to-pay to replace or restore something. For example, in the context of global climate change, the potential impacts of an increase in tropical storm frequency on the production of ecosystem services and the costs associated with restoring damaged areas may be less than a person's willingness-to-pay to avoid the tropical storm in the first place.

Table 4.5: A step-by-step valuation of island ecosystem services using the replacement cost technique

Step 1: Policy scenario: specify the change in the quantity of the product or service *(e.g. the introduction of an ecosystem-based programme to protect a wetland)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *identify existing water supply and purification services, and collect data on water use by inhabitants of the country under consideration*
Step 3: Identify the man-made products, infrastructure and technology that could replace the ecosystem service on a like-for-like basis *Tasks for analysts:* - *use consultation and experts to help identify the most suitable man-made products, as well as data on the initial investment and operation costs*
Step 4: Estimate the costs of the selected man-made replacement infrastructure/technology *Tasks for analysts:* - *calculate the annual costs of the selected alternative infrastructure/technology – a wastewater treatment plant, for example – using information from experts*

Replacement cost technique was used to value the benefits of coastal ecosystems in the Republic of Seychelles[30]. The study identified the value of coral reefs' and coastal vegetation's contribution to the protection of the shoreline from beach erosion (Step 1). These ecosystems were threatened by a combination of human and natural factors, so the valuation exercise focused on the benefits to the local population of this natural coastal protection (Step 2). The cost of preventing coastal erosion using rock-armouring protection was used to estimate the value of the ecosystem service (Step 3). The cost of building rock-armouring protection across the islands was estimated to cost US$770 million per year (Step 4). Box 4.5 reviews other applications of the replacement cost technique in SIDS.

Box 4.5: Replacement cost and avoided damage cost: examples of its application in small island developing states

JacobsGIBB (2004) used the replacement cost method to evaluate the indirect benefits of mangroves in **American Samoa**, namely the protection of the shoreline resources and assets from erosion and flooding. Benefits included savings from delaying the replacement of existing protection schemes or of implementing new ones. The mangroves in Pala Lagoon were estimated to provide shoreline protection worth US$135,000 per year.

Hunt (2002) used marginal damage costs to estimate the amount of carbon that would be released into the atmosphere in a study assessing the carbon sequestration benefits of ecoforestry in the **Independent State of Papua New Guinea.** The value of ecosystem services was expressed as the reduction of damage caused by future climate change. When the amount of carbon sequestered by ecoforestry was estimated at 25% of the original level, the benefits of ecoforestry were negative: between US$407 and US$529 per hectare.

Wielgus et al. (2010) used a wave-energy dissipation model to assess the contribution of coral reefs to preventing beach erosion in the **Dominican Republic.** The economic value of this service was estimated by assessing the avoided damage for seaside resorts over a 10-year period, expressed in the form of reduced revenues from the resulting drop in room prices associated with decreased beach width (estimated using the hedonic price technique).

Two studies conducted by Pascal (2010 and 2011) used the avoided damage cost method to value coastal protection services in **New Caledonia** and the **Republic of Vanuatu.**

Burke et al. (2008) valued the shoreline protection services provided by coral reefs in **Tobago** and **Saint Lucia.** He took into account various storm scenarios and used geographic information systems to identify vulnerable land areas and link them to relative property values. It valued shoreline protection services at between US$18 and US$33 million for Tobago and US$28–50 million for Saint Lucia in 2007. The United Nations Environment Programme, the Netherlands Ministry for Foreign Affairs and several other international organizations funded the study.

30 Emerton (1997).

4.5 Implementing demand-based (non-market) techniques tailored for small island developing states

Contingent valuation method

One important reason for using contingent and choice experiments in SIDS is that they can be used to calculate the economic worth of non-use values, which typically leave no 'behavioural market trace'. Both methods involve the design and implementation of questionnaires tailored specifically to the particular study. When using these methods, analysts create ad hoc data sets that are solely focused on the economic valuation of the selected environmental services. The use of the contingent valuation technique is characterized by the use of questionnaires that ask respondents to express their preferences in monetary terms, using willingness-to-pay (or willingness-to-accept) questions. Respondents are asked to say how much they would be willing to pay for specific changes to ecosystem services. This allows the changes to be valued even if they have not yet taken place, which allows hypothetical policy scenarios, or 'states of the world', to be created that lie outside current or past policies or levels of provision. Against this is the criticism that the values are purely hypothetical. Interviewing requires the use of specific strategies to guarantee that statistical samples are representative, as well as strong pre-testing of the questionnaire to make sure the proposed valuation exercise takes into account the institutional context of the country in question.

Choice experiment methods

The choice experiment technique is similar to contingent valuation, except that it emphasizes the market-behaviour aspect of the valuation exercise because it does not ask respondents to state how much they are willing to pay. In choice experiments, respondents are shown a set of alternatives and asked to choose one. The idea is that the choice and consumption of a product is described in terms of its characteristics, including the quantity and/or quality of the ecosystem service in question. One can therefore distinguish changes in the product's consumption by changes in combinations of its characteristics.

To carry out effective modelling, analysts must define each alternative's characteristics and attributes. This is particularly useful for policy decision analysis since alternative policies may result in different impacts on a set of indicators or characteristics. For this reason, many economists prefer this method to contingent valuation.

The respondent evaluates the alternatives and chooses a preferred option. Choice is based on evaluation of the trade-offs involved, including monetary value. Using the respondents' answers, analysts can express each of the various characteristics, including ecosystem services, in monetary terms.

Contingent valuation and choice experiments are suitable for use in SIDS as they are flexible and can be applied to most ecosystem services. However, their application is mainly recommended for the valuation of non-use benefits – e.g. existence and bequest values, including intangible cultural heritage. Their use is also recommended when data is scarce.

Their use in SIDS, when combined with the use of revealed preference approaches, notably production function and travel cost techniques, has significant advantages since it allows analysts to identify the economic value of the benefits that often characterize ecosystem services management policies as well as assess their application in SIDS. However, these techniques require a significant amount of time and money to collect the data since they use surveys, which are labour-intensive and expensive to carry out. The basic steps in applying contingent valuation and choice experiments are presented in Table 4.6.

The contingent valuation technique was used to investigate the potential of ecotourism as a way of financing the conservation of the Nariva Swamp in the Republic of Trinidad and Tobago[31] (Step 1). The development included measures to prevent harmful recreational activities, the creation of infrastructure for observing the local flora and fauna, the provision of educational material and the promotion of local employment. The valuation exercise focused on the potential benefits to all Trinidad residents (Step 2). Personal interviews were conducted in 515 households and respondents were asked whether they were willing to pay a lump sum for the protection of the wetland (Step 3). A logistic regression was used to identify each household's willingness-to-pay and results showed there was a willingness-to-pay average of US$56 (as an entrance fee) per household to protect the swamp from environmental degradation by encouraging the development of ecotourism (Step 4). Boxes 4.6 and 4.7 review other applications of the contingent valuation technique and choice experiments in SIDS.

31 Pemberton and Mader-Charles (2005).

Table 4.6: A step-by-step valuation of island ecosystem services using contingent valuation and choice experiments

Step 1: Policy scenario – specify the change in the quantity of the product or service *(e.g. introduction of an ecosystem-based programme to protect a wetland)* *Tasks for analysts:* - *formulate and describe an ecosystem services management scenario (contingent valuation)* - *identify and describe each characteristic and respective attribute levels that characterize each set of choices (choice experiments)*
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *identify which populations are affected by the proposed scenario*
Step 3: Design the survey *Tasks for analysts:* - *choose the type of survey that will be used (mail, telephone, face-to-face), describe the ecosystem service change (contingent valuation), develop the set of choices (i.e. what characteristics will respondents be required to choose between) and the payment mechanism (the monetary characteristic)* - *use focus groups and pre-testing to calibrate the questionnaire and test respondents' overall understanding of the valuation exercise*
Step 3: Survey implementation *Tasks for analysts:* - *develop a sampling strategy as it will not be possible to interview the entire population affected (this is often based on a random sampling plan from a statistically significant and representative sample of the population)*
Step 4: Analysing the results *Tasks for analysts:* - *both techniques involve the use of statistical software to estimate willingness-to-pay (contingent valuation) and the implicit price for the ecosystem service-related attribute (choice experiments). These estimates can then be scaled up to include the relevant populations in order to calculate a total value for the ecosystem services under different scenarios*

Box 4.6: Contingent valuation: examples of its application in small island developing states

Forest studies

A study commissioned by the Australian Centre for International Agricultural Research (Flatley and Bennett, 1996) explored the non-extractive and non-use values of rainforests in the Malekula and Erromango islands in the **Republic of Vanuatu.** The study specifically targeted Australian residents travelling on commercial airlines who visited the country but were unlikely to have been to the two islands. Their average willingness-to-pay for conservation was found to range from US$34.23 to US$37.70.

In a study comparing the stated preferences of residents in Port Moresby in the **Independent State of Papua New Guinea,** and Portland, Oregon, Manoka (2001) evaluated the willingness-to-pay for the preservation of an additional 5% of world's rainforest, based on current and future use values (existence value). He concluded that the Port Moresby respondents were more environmentally oriented. Their willingness-to-pay was estimated at US$39.22 to US$95.61 per person per year compared to US$3.59-8.34 in Portland.

A study funded by the Pew Charitable Trusts (Naylor and Drew, 1998) investigated the market values of mangrove swamps in Kosrae island, **Federated States of Micronesia,** along with existence and indirect use values. Local people were willing to pay substantially more for the latter. Poor households benefitted more from the mangroves but were willing to pay less to protect them. Overall, the household survey data suggested that local people were willing to pay between US$1 million and US$1.26 million per year to protect and use the swamps indefinitely.

Freshwater studies

Santiago and Loomis (2009) conducted a contingent valuation exercise to identify the natural features and recreation activities that most influence the willingness-to-pay of visitors to three rivers in north-eastern **Commonwealth of Puerto Rico.** The presence of waterfalls accounted for US$23 per person per trip and walking trails US$19 per person per trip. Managers could use this information to select the location of recreation sites to protect them from competing uses.

Box 4.6: Contingent valuation: examples of its application in small island developing states *(contd.)*

A report prepared for Environment Bay of Plenty in **New Zealand** by Bell and Yap (2004) explored the willingness-to-pay of local residents and Auckland anglers to improve the water quality in the Rotorua lakes (Anguilla), which was under threat from sewage from various sources, agricultural run-off and algal blooms. The study valued Rotorua inhabitants' willingness-to-pay at US$91.24 per year and the rest of the area's at US$11.85 per year, thus confirming the importance of the non-tangible assets of the lake ecosystem to respondents.

Ecotourism for domestic visitors is a viable way of financing wetland conservation. A contingent valuation study performed by Permberton and Mader-Charles (2005) in the Nariva Swamp **(Republic of Trinidad and Tobago)** showed that residents in Trinidad had a substantial willingness-to-pay (US$56 as an entrance fee) to protect the swamp from environmental degradation through ecotourism.

The swamp was also the subject of a study conducted by Allen (2004), which used one-to-one interviews and postal surveys to elicit the willingness-to-pay of residents in Trinidad and in Georgia, United States, for the protection of the swamp, including its non-use values. The study found similar environmental attitudes held by Trinidad and Georgia residents and concluded that non-use values are only a small factor in Trinidad citizens' willingness-to-pay for protection of the swamp. The Republic of Trinidad and Tobago Government commissioned the study.

In a study financed by the United States Department of Agriculture Forest Service and the International Institute of Tropical Forestry, González-Cabán and Loomis (1997) investigated the benefits of conserving river flows and of not building a dam in watercourses in the **Commonwealth of Puerto Rico.** The study revealed a willingness-to-pay of between US$27 and US$28 per household per year, which when extrapolated to the population of the **Commonwealth of Puerto Rico** totalled US$11.3-13 million.

Coral reef studies

A World Bank study (Spash et al., 2000) used the contingent valuation method to estimate the amenity and biodiversity values linked to coral reefs in Montego Bay **(Jamaica)** and Curaçao **(Netherlands Antilles).** Emphasis was placed on lexicographic preferences – i.e. where decision-makers are unwilling to accept any trade-offs for the loss of a product or service.

Thur (2010) investigated self-financing the protection of natural areas by charging user fees at Bonaire National Marine Park in the **Netherlands Antilles.** American scuba divers were interviewed in a postal survey. Depending on the question format used, mean willingness-to-pay for annual access ranged from US$61 to US$134 per year (2002). The study concluded that entrance fees could have been doubled without significant loss of visitors. The Delaware Sea Grant Program funded the study.

Brown et al. (2001) applied the contingent valuation method as part of a multi-stakeholder decision-making framework based on multi-criteria analysis. The authors argued that the approach was particularly useful for analysing trade-offs between multiple uses in complex settings such as MPAs. The methodology was applied to the Buccoo Reef marine park in the **Republic of Trinidad and Tobago.** Four scenarios were investigated, including reduced quality and doubling the current number of users.

Fonseca (2009) performed a postal contingent valuation survey of residents in Atlanta, United States to determine the non-use values they associated with the preservation of coral reefs in **Fiji.** The results suggested there was potential for groups far from areas at risk to work together to protect ecosystems through schemes such as the 'adopt-a-reef' programme in Fiji. After correcting for sample and response bias, the average respondent's willingness-to-pay was estimated to be US$0.18.

A study in **Belize** explored the role the Gladden Spit Marine Reserve played in supporting the fishing, tourism and recreation sectors as well as contributing to heritage and legacy values (Hargreaves-Allen, 2010). Current entrance fees were found to capture much of the consumer surplus generated and the inclusion of non-use values as a way of self-financing the reserve was recognized.

Edwards (2009) discussed the feasibility of generating revenues for financing ocean and coastal management in **Jamaica** by introducing visitor fees. The willingness-to-pay for recreational use in the form of a proposed tax on users ranged from US$130.07 and US$165.15. A low tax would have lead to a minimal reduction in visitors but would have generated adequate funding for environmental protection. The Latin American and Caribbean Environmental Economics Programme funded the study.

Box 4.6: Contingent valuation: examples of its application in small island developing states *(contd.)*

The Nature Foundation of St. Marteen funded a study to quantify the value of coral reefs in Sint Maarten, **Netherlands Antilles** to its tourist and fishing sectors. The study discussed the implications of the findings for policies aimed at establishing MPAs, the use of fines for damage to the reefs and an evaluation of redistributing the benefits of its ecosystem services, among others.

Marine studies

The study by Mathieu et al. (2000) analysed the economic value of recreation and non-use services in MPAs in the **Republic of Seychelles.** The sample population included tourists who had visited the park and those who had not. The willingness-to-pay estimates ranged from between US$21.63 per person per year at Baie Ternay to US$36.65 per person per year at Île Cocos. The implications of the study for policymakers trying to establish a pricing policy were discussed in detail.

Allport and Epperson (2003) explored the benefits of ecosystem conservation for ecotourism businesses in **Dominica, Saint Lucia,** and **St. Vincent and the Grenadines** in a contingent valuation study funded by USAID. Analysis of responses revealed an average willingness-to-pay of US$65.3 per person per year. The results of the study are available to policymakers and tourism officials for the design of training and environmental awareness programmes.

O'Garra (2009) focused on the assessment of the legacy values held by communities living close to traditional fishing grounds on the Coral Coast of **Fiji.** The study evaluated both monetary estimates of willingness-to-pay and travel time contributions, and calculated a legacy value of US$106.91 per household per year. The findings supported the notion that low-income groups may have strong non-use values that should be recognized in management decisions. The study was funded by the Institut de Recherche pour le Développement.

Multiple ecosystem services studies

Dharmaratne et al. (2000) investigated the potential for self-financing the Montego Bay marine park **(Jamaica)** and the Barbados National Park **(Barbados)** by capturing some of the benefits accrued to tourists in the form of use and passive values. They explored the viability of introducing user fees or establishing a system of voluntary contributions to a non-governmental organization in charge of park maintenance.

Catalino and Lizardo (2004) explored the positive impacts of agricultural land in the **Dominican Republic** by assessing the links between agriculture and tourism. Through a survey of non-resident visitors, they produced individual and aggregated willingness-to-pay estimates for different management scenarios and identified target population groups.

Pemberton et al. (2010) explored the issue of cultural bias in contingent valuation studies by investigating the preferences of four different social groups towards the protection of environmental resources threatened by copper mining in **Dominica.** Estimates were given for different willingness-to-pay scenarios related to farming systems, which would have resulted in the generation of an additional income of US$251 to US$364 million annually. The authors recommended caution in sampling social groups, especially in developing countries.

Mwebaze et al. (2010) aimed to assess the value of impacts of invasive alien species on the **Republic of Seychelles'** biodiversity, natural resources and economy. A contingent valuation survey was used to elicit the willingness-to-pay of tourists to fund conservation policies. Their mean willingness-to-pay was US$64-US$70 on top of their usual expenditure. The United Nations Development Programme – Global Environment Facility commissioned the study.

Box 4.7: The choice experiment technique: examples of its application in small island developing states

Parsons and Thur (2008) used a postal survey to determine the willingness-to-pay of US divers who had visited the Bonaire National Park in the **Netherlands Antilles** for varying levels of quality, including different degrees of visibility, species diversity and coral-cover percentage. Divers were asked how they would have altered their choice of trip had the quality of the coral reef system been different to that which they had experienced. The results indicated an average annual loss of US$45–US$192 per diver depending on what had changed.

The Australian Centre for International Agricultural Research funded a series of choice modelling studies with the purpose of exploring framing issues (e.g. the presentation or not of substitutes and reminders) in the context of environmental valuations. Rolfe et al. (2002) studied two applications of the technique to forests in the **Independent State of Papua New Guinea** and the **Republic of Vanuatu.**

Beharry-Borg and Scarpa (2010) applied the choice experiment methodology in the **Republic of Trinidad and Tobago** to the valuation of marine ecosystem services for local residents and tourists. The studied attributes were bathing water quality, water clarity, coastline development, the creation of MPAs, fish abundance, coral cover, beach litter and the number of boats. Results showed that the willingness-to-pay values among non-snorkellers and snorkellers were US$13.85 and US$44.09, respectively.

Kenter et al. (2011) explored the potential of participatory approaches in choice experiments. Working in the **Solomon Islands,** they identified deeply held community values connected with the forests and how a group-based approach, as opposed to individual surveys, could affect stated preferences. The initial willingness-to-pay for a number of tropical forest ecosystem services amounted to 30% of household income but after group discussions, key ecosystem services became priceless because participants were unwilling to trade them in the choice experiment scenarios, regardless of financial gain. Wild Earth, XminY and Aberystwyth University funded the study.

Rudd (2002) examined the non-extractive services provided by the increased size and abundance of the Caribbean spiny lobster *(Panulirus argus)* in MPAs in the Turks and Caicos Islands, in the **British West Indies.** The average willingness-to-pay for better wildlife viewing was estimated at US$5.64 per person per trip. The potential revenues associated with an increased interest in diving were explored as a possible way of sustaining local MPAs.

4.6 Implementing value transfer techniques tailored for small island developing states

The value transfer technique consists of using previous estimates from one area for another. Generally, the first site is known as the ‘study site’ and the second as the ‘policy site’. There are three possible forms of value transfer (or benefit transfer as it is often referred to): the transfer of an average willingness-to-pay estimate from one primary study (possibly adjusted for differences between the sites, such as the income per capita of the beneficiaries); transfer of the willingness-to-pay function; and transfer of willingness-to-pay estimates by aggregating other estimates.

The use of value transfer in SIDS is of particular interest since its quick to use and inexpensive. In order to guarantee statistical robustness and accuracy of the respective estimates, analysts have to check a set of initial conditions. First, the main ‘primary’ value of the ecosystem service at the study site must be theoretically and methodologically suitable. Second, the populations in the study and policy sites must be similar. Third, the difference between pre-policy and post-policy quality (or quantity) must be similar across both sites. Fourth, the study and policy sites must have similar environmental characteristics. Fifth, the distribution of property rights and other institutions must be similar across both sites. The accuracy of value transfer is questionable if any of these conditions are not met.

There are two general sources of error in the values estimated using value transfer: measurement errors associated with estimating the value at the study site(s) and errors arising from the transfer of study site values to the policy site. Both errors are present in all value transfer assessments. However, recent applied economic valuation literature has focused in particular on meta-analysis regression-based techniques because these offer the best opportunity for detecting and correcting errors. Value transfer studies are most effective when areas of uncertainty are identified and, where possible, quantified. Table 4.7 presents the main steps involved in the application of the value transfer technique.

Table 4.7: A step-by-step valuation of island ecosystem services using value transfer techniques

Step 1: Policy scenario – specify the change in quantity of the product or service *(e.g. introduction of an ecosystem-based programme to protect a wetland)* *Tasks for analysts:* - *formulate and describe an ecosystem service management scenario* - *identify existing, relevant studies to discover value data and respective valuation conditions, including the type of valuation technique used in the 'study site'.* Several comprehensive databases of valuation data are available. The most frequently used one is the Environmental Valuation Reference Inventory. Resources are also available for SIDS and island ecosystem services from the Marine Ecosystem Services Partnership, the World Resource Institute and the Dutch Caribbean dataset.
Step 2: Identify the ecosystem services and populations affected by the policy *Tasks for analysts:* - *examine water supply and purification services, and find data on the water use of the inhabitants of the country under consideration*
Step 3: Review and select available studies *Tasks for analysts:* - *review the quality of information in the primary valuation study and its applicability to the policy site* - *adjust and convert all the primary value estimates to a common monetary metric that allows the data to be compared*
Step 4: Transfer the benefit estimates *Tasks for analysts:* - *use statistical analysis to obtain estimates for the policy site. Analysts may choose unit value, willingness-to-pay value or the meta-analysis as benefit transfer technique*
Step 5: Value aggregation *Tasks for analysts:* - *identify the market/constituency for which the welfare impacts are relevant to obtain a measure of the total value for the policy site. In this scaling-up of the valuation exercise, analysts take into account the different parameters that determine its scope, including the extension of the ecosystem and the number households in the area, as well as possible substitutes for the affected products or services*

Value transfer techniques were used to investigate the consumer surplus from subsistence fishing, recreation activities and non-use benefits from the coral reefs and mangrove ecosystems of **American Samoa**[32] (Steps 1 and 2). The direct fishery consumer surplus was estimated by taking two values from coral reef fishing in the US and adjusting them according to the differences in per capita gross domestic product in American Samoa (Step 3).This gave a total direct fishery consumer surplus value of US$73,000 per year (Step 4). The average consumer surplus from a range of recreational activities (e.g. visitor and residents' snorkel trips) was estimated using values from the most similar studies (Step 3). The total annual snorkelling consumer surplus was calculated to be about US$45,000 per year (Step 4). Box 4.8 reviews other applications of the value transfer technique in SIDS.

4.7 Conclusion

The economic value of ecosystem services to SIDS is paramount, and it's therefore essential to be able to measure it accurately and with local contexts in mind. As this chapter shows, there are multiple economic valuation techniques that can be used in SIDS. Table 4.8 shows the frequency with which each one is used in practice, based on analysis of island ecosystem services valuation reports.

A demand-based approach is used to determine about 80% of economic values. Of these, contingent valuation and choice experiments are the most popular. In fact, non-market valuation studies represent 44% of the empirical work reviewed. Market prices (25.3%), cost-based (12.1%), travel cost (6.6%) and value transfer techniques (5.5%) make up the rest. Hedonic pricing and production are the least frequently used, each representing less than 4% of techniques used.

32 JacobsGIBB (2004).

Box 4.8: The value transfer technique: examples of its application in small island developing states

A study conducted by Cesar et al. (2000) assessed the economic value of services provided by terrestrial and marine ecosystems in the Portland Bight Protected Area in **Jamaica**. Direct, indirect and passive uses were assessed using various methodologies. An unadjusted unit value transfer technique from Thailand's Kanjanadit district was used to estimate the annual value of carbon sequestration in the protected area at US$45 million. A similar technique was used to assess the value of biodiversity for bioprospecting in two Indonesian national parks. The estimated annual value was found to be US$2 million.

Van Beukering et al. (2006) used value transfer to estimate the consumer surplus for recreational visits at the Saipan coral reefs in the **Commonwealth of the Northern Mariana Islands**. The study relied on a database of 47 coral reef-related valuation studies. The median of the estimates was US$4.48 per person per trip, with an average of US$9.23 per person per trip. The authors used the higher, latter estimate as the proxy for the consumer surplus in Saipan after discovering that high-income visitors from Japan dominated the local market. The annual consumer surplus was estimated at US$4.51 million. The US Department of the Interior and National Oceanographic and Atmospheric Administration funded the study.

Coral reefs and mangroves are the ecosystems most frequently submitted to economic valuation, representing 43% of the studies reviewed. Forests, freshwater and agriculture represent a third of the studies, while the rest (23%) focus on the valuation of combined ecosystems, including freshwater/agricultural land and coral/mangroves.

Table 4.8: Overview of the application of ecosystem services valuation in small island developing states

Valuation technique, ecosystem and island ecosystem services	Economic values	
	(Number of estimates)	(Percentage of total estimates)
Valuation technique		
Supply-based		3.3
Production function	3	
Demand-based (market)		35.2
Market prices	23	
Travel cost	6	
Hedonic pricing	3	
Cost-based		12.1
Replacement costs	3	
Avoided damage costs	8	
Demand-based (non-market)		44.0
Contingent valuation	32	
Choice experiments	8	
Value transfer		5.5
Meta-analysis	5	
Ecosystems		
Coral	25	27.5
Mangroves	14	15.4
Forest	16	17.6
Freshwater	11	12.1
Agriculture land	4	4.4
Multiple	21	23.1
Ecosystem service values		
Recreation	31	33.9
Extractives use (including timber, water, food)	21	22.9
Fishing	12	13.3
Non-use values	12	13.3
Soil erosion control	2	2.2
Shoreline protection	7	7.7
Protection of wildlife, vegetation and habitat	6	6.7

Photo Credit: © Aaron Vuola, UNEP

About one third of the studies focus on the economic valuation of recreation associated with ecosystem services, mainly beach activities in coral and marine-protected areas. Island ecosystem services that supply products including timber, water, food and fishing, constitute another third of valuation studies. The assessment of non-use values, including cultural heritage and legacy, represents about 14% of the studies, with only one valuation study focusing on education. Regulating services, such as soil erosion control, and the protection of the shoreline, wildlife, vegetation and habitat, represent 17% of the studies.

Less than a quarter of the studies reviewed were commissioned by national governments or government agencies, meaning that more than three-quarters were carried out without having policy change as a primary goal. In those studies specially commissioned to deliver clear policy objectives, the market demand-and-supply approach, including the production function technique, was the most widely used. This indicates the potential of this technique to address ecosystem services policy and management in SIDS.

From the policy viewpoint, one would expect more studies related to the economic valuation of shoreline protection as well as climate regulation, especially in relation to marine spatial planning and carbon sequestration (blue carbon). Exploring the use of market and financial incentives to promote the use of ecosystem-based solutions for climate-change mitigation may become of increasing interest to SIDS.

One policy priority is the assessment in monetary terms of the potential of forests, and marine and coastal ecosystems, in SIDS to capture and store carbon. Bearing in mind the size of SIDS' exclusive economic zones, the UN-REDD (United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) programme could be extended to marine and coastal ecosystems. Marine and coastal planning, including seabed management programmes, are of crucial policy importance to SIDS since they can mitigate climate change impacts by storing carbon. Other governments and corporations could trade these 'carbon credits' to meet their own targets. National and regional marine and coastal spatial planning could therefore become important financial resources for SIDS, as revenues could be re-invested in their natural and human resources. The evaluation of this potential requires further study, which this guidance manual can help deliver.

> *“If you torture the data enough, nature will always confess.”*
>
> *(Ronald Coase, University of Virginia, early 1960s)*

5. Step-by-step guide to ecosystem service accounting for small island developing states

5.1 State-of-the-art ecosystem services accounting

The recent adoption of the United Nations System for Environmental-Economic Accounts (SEEA) goes hand in hand with the broader acceptance of the need to implement natural capital accounting. This institution-driven demand also extends to ecosystem services accounting, which is hampered by the lack of an international standard.

There is currently a renewed drive by environment and finance ministries across the world to support experimental work on ecosystem services accounting because it can be used to inform decisions on the most effective ecosystem services management for enhancing individual and community well-being. This chapter presents a practical step-by-step guide based on the results of ecosystem accounting work currently being carried out in the Republic of Mauritius and the Republic of Madagascar.[33]

5.2 Experimental natural capital accounting of ecosystem services[34]

The United Nations Statistical Commission endorsed the SEEA Experimental Ecosystem Accounts in February 2013. Although there is not enough experience or evidence to adopt an international standard of comparable level to the System of National Accounts 2008 or the SEEA Part 1 2012 (the so-called Central Framework), the SEEA Experimental Ecosystem Accounts is a framework that countries can use.

Because ecosystem resilience is a central component of sustainable development and climate change adaptability, the Government of the Republic of Mauritius and the Indian Ocean Commission Islands project office launched a ecosystem natural capital accounting pilot in 2013 as part of its national Maurice Ile Durable sustainability strategy and the Small Island Developing States (SIDS) Mauritius Strategy in the Eastern and Southern Africa, and Indian Ocean (ESA-IO) region.

The project's first phase was time-limited and assessed the feasibility of ecosystem natural capital accounting using existing data in the Republic of Mauritius. The first outcomes were examined for statistical quality and policy relevance. The preliminary results presented below are illustrations of the kind of accounts that can be produced using existing data and official statistics. Note: they are the outcome of research, have no official status and are the author's responsibility. These results will be revised as part of the second phase of the project in the light of experience gained and additional data collected.

The project, directed by Statistics Mauritius and overseen by the Indian Ocean Commission's Islands office, worked with a number stakeholders and information-providers. Its success was largely due to the positive contribution of the various institutions involved, to their advice and expertise, and to Statistics Mauritius' capacity to carry out extensive data and statistics collection.

33 Although the Republic of Madagascar is not a small island developing state, the use of ecosystem services accounting there provides a solid case study of its use within an institutional context similar to that of many developing countries, including SIDS.

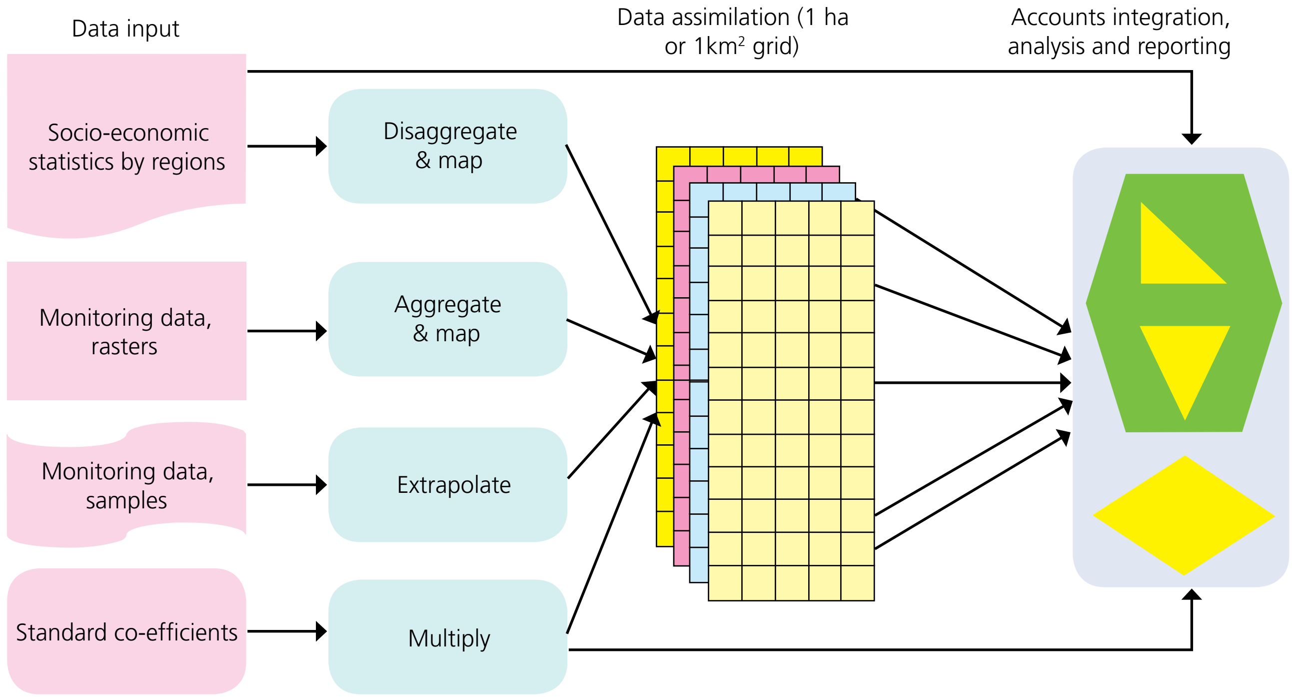
34 Sections 5.2 and 5.3 are based on the work of Jean-Louis Weber (2014).

The approach

The approach followed in the Republic of Mauritius was based on the SEEA principles and on practical steps to implement them in policy. They can be summarized as:

- Assess the physical condition of the ecosystems and their services as a priority: these give an important indication of an ecosystem's capacity to deliver services, as well as its degradation, existing state and potential for improvement. The valuation of important ecosystem services can then be carried out.
- Integrate ecosystem accounting into existing national and international social and economic accounting: internally, the inclusion of biomass and water productivity, and system integrity, including the measurement of habitat fragmentation, and biodiversity, helps identify the consequences of various actions taken. Integration into the System of National Accounts allows the calculation of ecosystem services benefits and the costs of restoring them by sector. Integration with broader demographic and social data is needed to assess the existing degree of access to ecosystem services.
- Ensure ecosystem accounting becomes part of policy-making, on a par with national accounting and social statistical analysis used by top officials, including prime ministers, economic and finance ministers, and other ministries and agencies. To be considered on a par with indicators such as gross domestic product, the employment rate, and private and national debt, ecosystem accounts need to deliver simple, meaningful, annually updated information that can be grasped by policymakers and is national in scope.
- Because of the above requirements, the accounting framework must be kept as simple as possible. The framework used in the Republic of Mauritius refers to the ecosystem as natural capital that delivers a range of services and needs to be maintained. Ecosystem capital is defined as comprised of three main functions and related services: biomass production, fresh water production and socio-cultural services that depend on healthy ecosystems. The accounts measure the overall capacity (capability) to deliver services sustainably. By combining biomass, water and socio-cultural services values in one indicator, the resulting data can be used to ascertain the condition of the ecosystem and predict the impact of any changes on all three services. This would not be possible when looking at each ecosystem service individually.
- Ecosystem capital accounts highlight various synergies and interactions. These are best observed using spatially explicit data rather than aggregated statistics. Ecosystem capital accounts are produced using statistical tools and geographical information systems.

Figure 5.1: The main data flows for compiling ecosystem capital accounts



Source: Weber (2014)

- Ecosystem capital accounting should make maximum use of existing monitoring data and official statistics for two reasons. The first is to benefit from data that's immediately available and doesn't need generating – from sources such as regular statistics collection, research projects and other reporting activities. For example, data on biomass carbon needs to be consistent with agriculture and forestry statistics, as well as Intergovernmental Panel on Climate Change (IPCC) national reporting estimates – the use of official statistics where possible gives confidence to policymakers. Second, the reuse of existing data avoids duplication of effort and costs.

The methodology

Ecosystem capital account methodology can be described as the processing of multiple datasets and their assimilation into a geographical grid to allow various combinations of variables (see Figure 5.1 and Table 5.1). A first account is established for land assets and changes, which covers inland territories as well as coastal waters where the seabed can be mapped (e.g. lagoons and coral reefs).

The land cover account is the basis on which the biomass/biocarbon, water and ecological infrastructure accounts are developed. These start with balances for stocks and flows, then estimate the scale of the accessible resource and its use. Finally, tables are created to summarise the ecosystem's condition. The approach to valuation in monetary accounts in this manual follows the methodology recommended by UNEP.

Table 5.1: A step-by-step guide to compiling physical ecosystem accounts

Step/Objective	Datasets/Accounts	Tasks for accountants
Step 1		
Create the data infrastructure needed for accounting	Geographical features/zonings: • Physical boundaries (coastline, river basins & sub-basins limits, climate zoning, elevation classes) • Administrative boundaries (municipalities, districts, regions) • Hydrological network, rivers, aquifers • Sea/fisheries zoning(s) • Regular grid(s) for accounting (1ha and 1km^2)	• Collect basic geographical information from relevant organizations to structure the physical accounts. Check their consistency (geometry, projection). Produce a set of regular grids (based on official geographical standards). • Create a database of ecosystem accounting units for terrestrial ecosystems, rivers, marine coastal units and other sea accounting units
Step 2		
Collect the basic datasets for ecosystem natural capital accounting	• Land cover and land cover changes (including marine coastal areas) • Meteorological data • Hydrological data • Soil data • Data on forest stocks and growth • Population data • Regular agriculture, forestry and fishery statistics • Data/statistics on water use • Indicators on species and systems biodiversity	• Produce a consistent multi-annual (10-20 year period) land cover map/database using satellite images and other sources (forest maps, cadastre, buildings and roads etc.) • Collect and organize the various datasets needed for accounting. Give official data sources priority (official statistics, meteorological data, hydrological data). Accounts produced for IPCC reporting, REDD+ and SEEA Water are important inputs. Satellite data is sometimes second best
Step 3		
Produce the four basic accounts for ecosystem natural capital accounting	• Land cover change accounts • Ecosystem carbon accounts • Ecosystem water accounts • Ecosystem integrity and functional services accounts	• Compile the accounts with basic data collected at step three, use additional data for specific items and physical data modelling • Geo-processing of datasets • Estimate of missing data • Integration of accounts
Step 4		
Functional analysis of ecosystem capital and services in physical units	• The accountability of economic sectors to ecosystem degradation/enhancement • The level of ecosystem degradation embedded in trading practices • The social demand for ecosystem services (by municipality, region etc.)	• Targeted, detailed analysis to be carried out with statistical offices, planning agencies, research institutions etc.

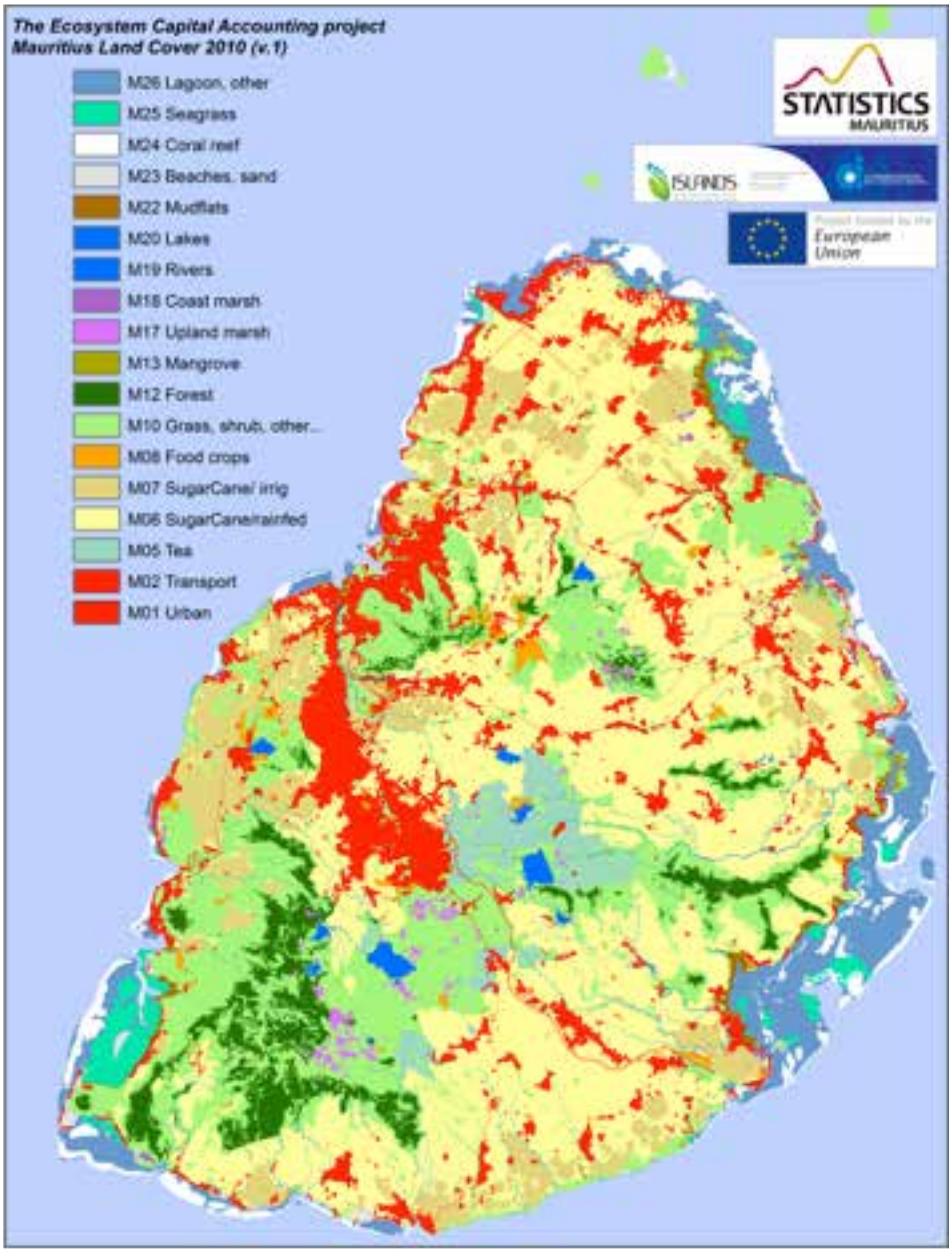
5.3 Principal results from the Republic of Mauritius case study

Beyond the proof of concept achieved by producing a first set of accounts for 2010 and some parts of the 2000 accounts, the results of the exercise are valuable. (Note: the results are provisional and require further validation and completion; they are presented for illustrative purposes only.)

Land cover and its changes from 2000 to 2010

Land cover is the basic component of ecosystem accounts. As no land cover map fit for accounting purposes was available at the time of the 2013 pilot, one was produced for buildings, roads, sugar cane, forests and environmentally sensitive areas using geographical datasets supplied by various project partners – it includes coastal lagoons with details of seagrass and coral cover. This map can be used to create further accounts, however, geographical datasets for earlier periods are not as comprehensive, which makes it difficult to assess land cover change for accounting purposes. One of the recommendations from the first accounting pilot was to produce a series of three to four land cover maps from satellite images at high resolution, from 1990 to the present day.

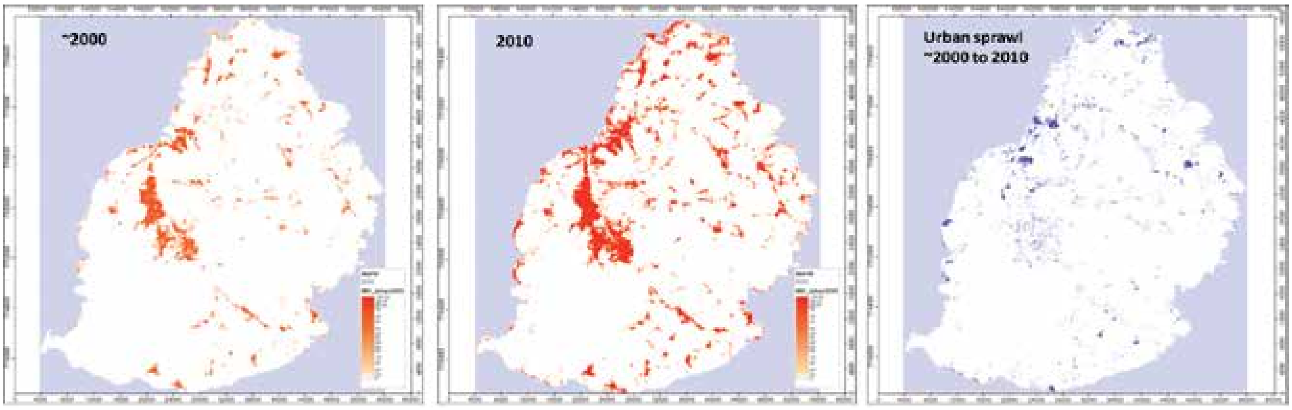
Figure 5.2: Republic of Mauritius land cover in 2010



Source: Weber (2014)

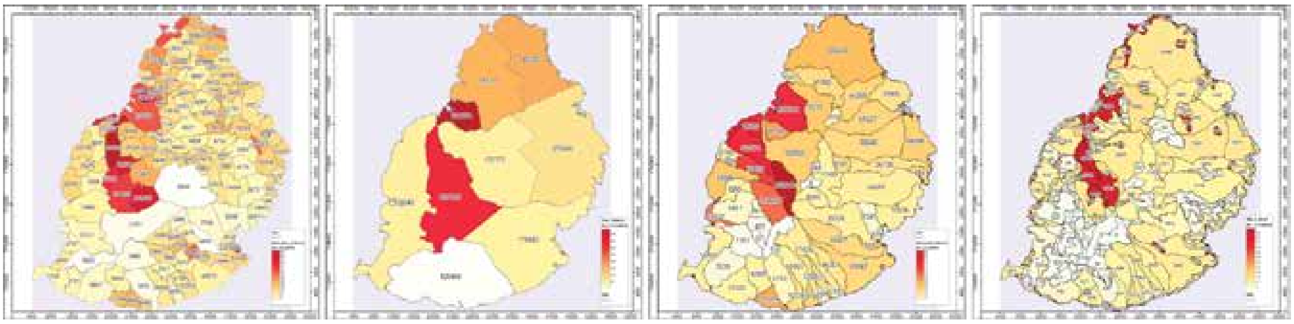
To determine the land cover change for urban areas, an old map was used but, as it happens, the maps of built-up areas have improved tremendously over recent years with the use of high-resolution satellite imagery. The difference between urban class in 2010 (in red on the land cover map, see Figure 5.3) and in about 2000 represents real change and the results of revision. It shows that although some urban development has taken place in that period, recorded land cover change has been exaggerated and is here presented only as an illustration of the and cover change that accounts for urban sprawl.

Figure 5.3: Urban and associated areas in Mauritius circa 2000 and 2010, showing urban sprawl



Land cover data is presented in geographical datasets that use grids (10m x 10m and 100m x 100m) at the most detailed level. These allow the computing of statistics and production of accounts (maps and tables) for various reporting units, such as municipalities, districts, coastal zones, river basins and socio-ecological landscapes (the specific analytical statistical units for ecosystem accounting) or any relevant zoning.

Figure 5.4: Statistical maps for Mauritius showing urban land cover in 2010



Note: From left to right – municipal council and village council areas; districts; river basins; socio-ecological landscape units

The biomass-carbon account

This account shows the capacity of ecosystems to produce biomass, and the ways in which it used (e.g. harvests), sterilized by man-made developments and destroyed by soil erosion and forest fires. Biomass is an important resource that supplies food, energy and fibrous materials. Biomass, as food, has to be shared by humans with nature; if it is not, ecosystems' capacity to keep producing biomass is harmed, which is economically unsustainable where only artificial inputs can temporarily make up the deficit. To be consistent with the IPCC's approach, biomass is accounted for in carbon data. The bio-carbon account calculates vegetation (mostly trees) and soil stocks. Stocks increase by photosynthesis – measured as the net primary production by vegetation – and decrease due to harvesting, the indirect effects of land use and natural occurrences.

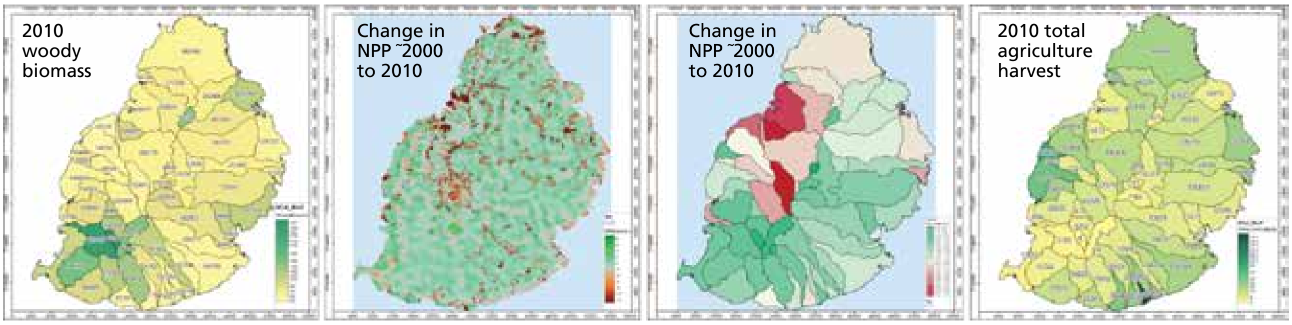
Woody biomass stocks in the Republic of Mauritius were estimated by combining satellite observations and Food and Agriculture Organization (FAO) forest statistics[35] – the forests are mostly located in the mountainous areas in

35 FRA (2010).

the south west of the island (see Figure 5.5). The measurement of net primary production by vegetation was made using data provided by NASA from its MODIS satellite and fine-tuned with higher resolution data on photosynthesis (vegetation index) and land cover (see Figure 5.5). This data is available annually.

The assessment of the net primary production change between 2000 and 2010 shows the overall situation is a contrast between local improvements, to the mountainous areas, in particular, and the severe impacts of urban sprawl.

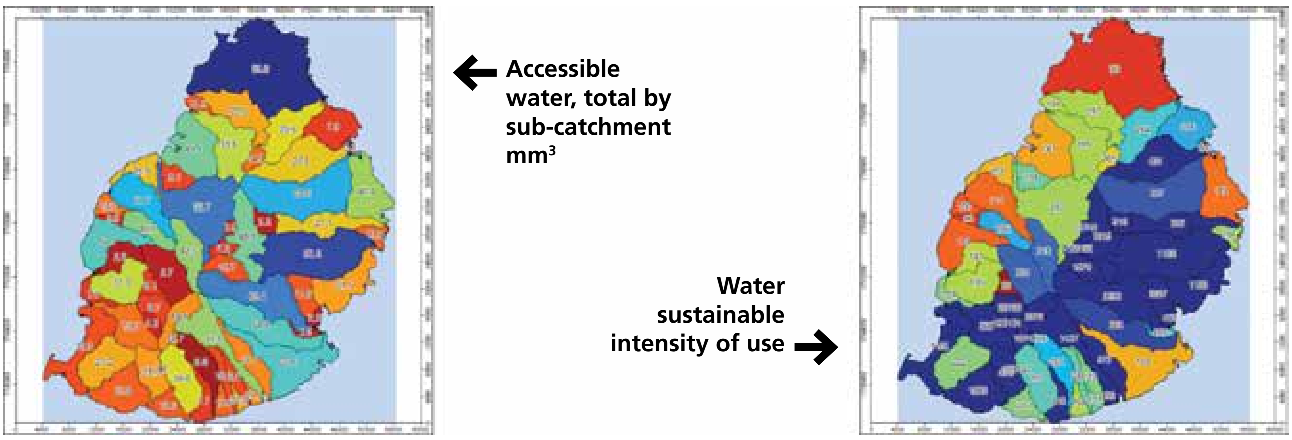
Figure 5.5: Stocks of woody biomass; changes in net primary production and total agricultural harvest in Mauritius, 2010



The ecosystem water account

This account can be considered an extension of the SEEA-Water account. The main difference is that water availability is assessed on a strict ecosystem-by-ecosystem basis, deducting water that is not exploitable (e.g. in the case of floods) alongside FAO AQUASTAT recommendations. Ecosystem water accounts are collated for those river and sub-basins where the hydrological systems can be consistently described. Water reserves are mainly aquifers and lakes/reservoirs, which play an important role in the Republic of Mauritius. Primary input data relates to rain and evapotranspiration. The main accounting indicators are total accessible water and the Water Sustainable Intensity of Use Index. (See Figure 5.6 for the ecosystem water account results for the Republic of Mauritius.)

Figure 5.6: Maps of water access and sustainable use in Mauritius



The Water Sustainable Intensity of Use index is the ratio of accessible water resources to the total abstraction of water, multiplied by 100. Index values below 100 mean there's a structural deficit and between 100 and 120, a vulnerability. The comparison between this index and one for water that is accessible by sub-catchments shows differences between the basins. The basins in the north and west, which benefit from abundant resources, have a poor sustainability index because of intensive irrigation. Other basins with fewer resources but less demand (e.g. those in the south west) have a better index.

The ecosystem infrastructure and species biodiversity account

The systems and species biodiversity account comprises two accounts that describe the state of an ecosystem's green infrastructure (landscapes, rivers and sea coastal zones) as well as changes in species biodiversity. Its purpose is to provide an indirect assessment of intangible ecosystem services. The landscape green infrastructure account is derived from land cover monitoring and mapping, where the various land-cover categories are weighted according to their environmental impacts (from 10 for urban settings to 100 for forests and wetlands). The Green Background Landscape Index indicator is part of the second step and is adjusted to take into account other ecological dimensions such as the nature value given by scientists and environmental agencies, and the disruption to landscape that can damage ecosystems and their services. The final index is called the Net Landscape Ecosystem Potential. This is an important indicator of an ecosystem's capacity to deliver intangible ecosystem services (see Figure 5.7).

Figure 5.7: The calculation of Net Landscape Ecosystem Potential (2010) by ecosystem units for Mauritius

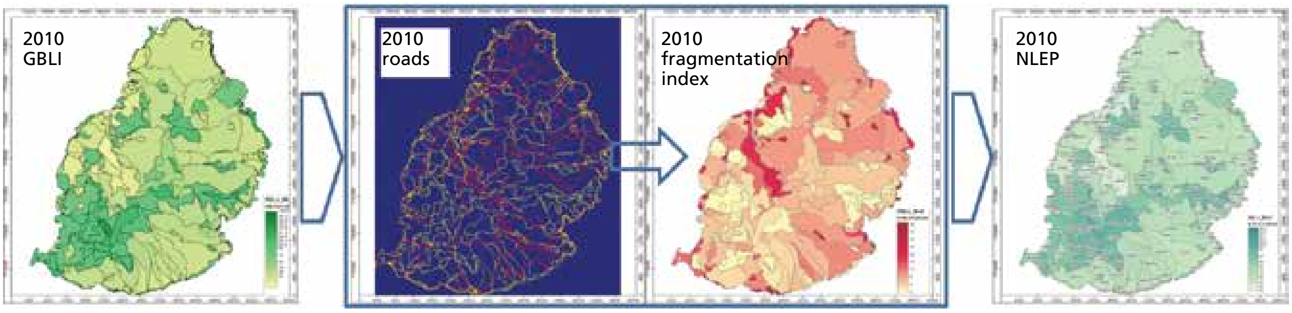


Figure 5.8: Ecosystem infrastructure functional services account (preliminary results)

Ecosystem infrastructure functional services account	Riviere Du rempart	Pamplemousses	Flacq	Moka	Grand prot	Plaines wilhems	Black river	Savanne	Port Louis	Total/Mean value
Area (ha)	14703	18019	29826	23512	26134	19839	25558	24758	3976	186325
Indexes (0-100 value per ha)										
Green Background Landscape Index (GBLI) 2000	43.4	41.7	49.7	55.6	50.1	53.4	61.0	53.7	58.6	51.9
Fragmentation index	8.6	9.8	7.3	6.2	6.9	7.9	5.1	5.1	6.9	6.9
Net Ecosystem Landscape Potential (NLEP) index 2000	39.7	37.6	46.0	52.1	46.6	49.2	57.9	51.0	54.5	48.4
Green Infrastructure Account										
GBL 2010/weighted ha	638105	751152	1481482	1307506	1309039	1069039	1559660	1330151	232911	9670145
NLEP 2010/weighted ha	583021	677761	1373059	1226033	1218167	976061	1479992	1262700	216727	9013521
Indexes (0-100 value per ha)										
Green Background Landscape Index (GBLI) 2000	42.0	40.6	49.2	55.1	49.8	52.4	60.5	53.5	50.7	51.1
Fragmentation index	8.6	9.8	7.3	6.2	6.9	7.9	5.1	5.1	6.9	6.9
Net Ecosystem Landscape Potential (NLEP) index 2010	38.4	36.7	45.6	51.6	46.4	48.2	57.4	50.8	47.2	47.7
Green Infrastructure Account										
GBL 2010/weighted ha	617999	732184	1468542	1294945	1301938	1039397	1547086	1324150	201660	9527900
NLEP 2010/weighted ha	564651	660647	1361066	1214254	1211558	956963	1468060	1257003	187648	8881851
Change in NLEP 2000-2010	**-18370**	**-17114**	**-11993**	**-11779**	**-6608**	**-19097**	**-11932**	**-5697**	**-29079**	**-131670**
Change in NLEP 2000-2010 %	**-3.15**	**-2.53**	**-0.87**	**-0.96**	**-0.54**	**-1.96**	**-0.81**	**-0.45**	**-13.42**	**-1.46**

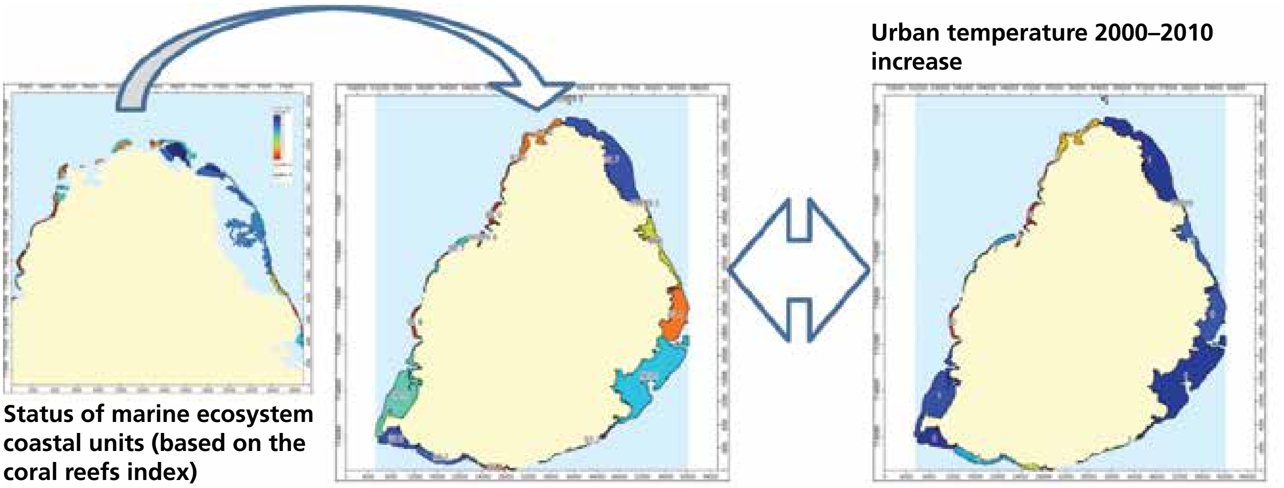
Source: Weber (2014)

The ecosystem capital accounting of coastal seas

Coastal areas play an important role in SIDS such as the Republic of Mauritius, particularly in relation to food supply, tourism and quality of life. Coastal areas, both land and sea, have suffered multiple pressures, and their inclusion in ecosystem/natural capital accounts is a priority. There is not much experience of carrying out accounting for the marine part of coastal areas but the ecosystem capital accounting methodology provides enough guidance to begin the process.

The starting point is to create a map and directory of costal marine ecosystems. Next, collect data on the current state of the ecosystems, any ongoing changes to them and any pressures they face (e.g. from fishing, tourism and urban temperatures – a synthetic measurement of the influence of urban areas upon neighbouring environments – in a systematic way) following the accounting framework. As a first test, the biodiversity of marine ecosystem coastal units – based on the coral reefs index — can be calculated (see Figure 5.9), as well as changes in urban temperatures.

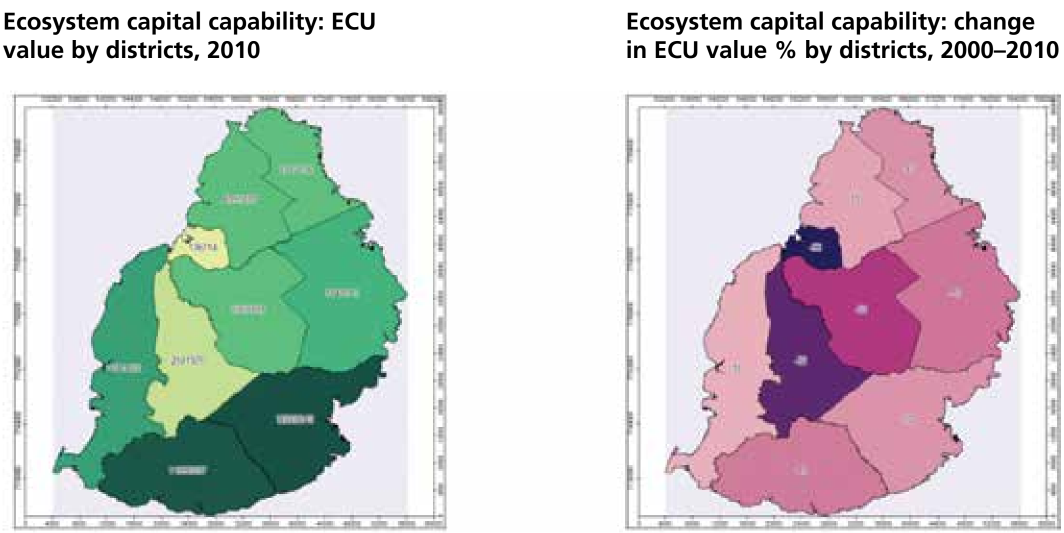
Figure 5.9: Biodiversity status of marine ecosystem coastal units



Calculation of an ecological value in ecosystem capability units

As proof of concept, the measurement of ecosystem capability capital in ecosystem coastal units was attempted in the Republic of Mauritius. Again, note the experimental character of the project and the provisional status of the data: for instance, there are concerns that the magnitude of the changes, trends and spatial distribution – an overall decline of 15% of the ecosystem coastal unit value – may have been overestimated. Figure 5.10 summarizes the degree of change by district.

Figure 5.10: Ecosystem capability capital



Next steps

Integrated ecosystem capital accounting is feasible using existing data in countries and/or from international programmes. Simplified, relevant accounts can be produced quickly. Accuracy can be improved with a second stage that fills in any gaps in information identified in the first test.

Ecosystem accounting requires the right information technology infrastructure, capacity building capability and governance structures. Accountants need a background in statistics, data management and geographic information systems. Cooperation with various agencies to obtain data and expertise is essential. The creation of shared environmental information systems is recommended.

The creation of integrated physical accounts should facilitate further work on assessment, modelling and ecosystem services valuation.

5.4 A step-by-step guide to experimental monetary ecosystem accounts[36]

This section presents the economic valuation methodology of ecosystem services in alignment with the System of National Accounting. This methodology uses the production function method (see Section 4). The idea is that ecosystem services are often used in the production of goods and services sold in world markets. Therefore, island ecosystem services play an important role in production and contribute to generating personal, corporate and national wealth.

Farmers, for instance, use freshwater to grow rice, which they sell in international markets. The revenue from rice sales is recorded in national accounts but the economic value of the freshwater (an ecosystem service) used by farmers to produce the rice is not.[37] This section introduces a methodology that traces the contribution of ecosystem services to economic activities, from production to national accounts. This is important because it allows the measurement of ecosystem services' contribution to national production and gross domestic product. Table 5.2 summarizes the suggested steps.

Step 1: Assess the contribution (technological) of ecosystem services to the production of goods and services

The first step measures the impact of ecosystem services within the wider economy using the production function technique. This describes the relationship between total output/production (e.g. tonnes of rice) and the number of production factors used to produce that output (e.g. labour of farmers, and machines). A general economic production function formula is: $Q = q(L; K; ES)$ where ecosystem services are included as production inputs.

The final output (Q) (e.g. rice) is produced using three components: labour (L), capital to purchase equipment (K) and the freshwater used to produce the rice (ES). Analysts should model the production function on a case-by-case basis, according to the economic and technical characteristics of the sector under consideration.[38] The main objective is to measure the marginal productivity of environmental system services (or marginal product).

The marginal productivity of an ecosystem service is an indication of how much production could be affected by a variation in ecosystem services (inputs). Using the rice example, the marginal productivity of freshwater in the rice sector indicates how production will be affected by a small increase in the use of water. In other words, analysts can calculate the impact of using an additional ecosystem services unit on total production.

At this point, analysts can estimate the value of the marginal productivity (or product) of the ecosystem service in question. This will show the economic and technological efficiency of the production process in the selected market or sector but not its economic worth (see Table 5.2).

36 This section is based on the work of Onofri et al. (2013).

37 The financial costs of water are only accounted for when there is a market for water, which is not usually the case. Independently of this, the economic contribution of freshwater to production is not measured in the accounts of the sector under consideration.

38 In this context, analysts should explore the use of alternative econometric functional forms to ensure the practical application of this function. The selection of the practical specification for the production function will depend on the overall econometric fit of the proposed functional form/algorithm – i.e. how closely it reproduces the observed market data, including the output levels of the economic sector and respective use of production factors (inputs).

Table 5.2: A step-by-step guide to including the economic valuation of ecosystem services in national accounting systems

Step/Objective	Economic instrument	Tasks for analysts
Step 1 Assess the technological impact of ecosystem services in the production of selected goods and services	Marginal productivity of the input: $MP_{ES} = \frac{\partial Q}{\partial ES}$	• Empirical estimate of Cobb-Douglas (or other types of economic production functions) • Empirical information provided by experts • Empirical information derived from the application of microeconomic theory
Step 2 Assess the economic impact, measured in monetary terms, of ecosystem services in the production of selected goods and services	Value of the marginal productivity of the ecosystem services(VMPES) = marginal revenues of the goods and services provided by the ecosystem and defined in equation (2) as $VMP_{ES} = \underbrace{P_Q}_{\text{Market price of the output/good or service}} \times \underbrace{\frac{\partial Q}{\partial ES}}_{\text{Marginal productivity of ES}}$	• Multiply output market prices by VMPES (*)
Step 3 Assess the monetary value of the sector(s) generated by the ecosystem services	Total revenues = VMP_{ES} multiplied by total market sales	Multiply the selected output market sales by marginal productivity value
Step 4 **Sectoral or/and national and/or country/local accounting** Record the total revenues of the selected goods and services in the national accounts. They should be registered in sector balance sheets		

Note: * The caveat when using market output prices is that there may be differences between the market and shadow prices (see Dasgupta, 2012)

Step 2: Assess the (economic) impact of ecosystem services on the production of goods and services

In order to measure the value of ecosystem services in monetary terms, analysts need to calculate the marginal productivity value of the ecosystem services in question. The value of marginal productivity is a measure of how much marginal revenue, obtained by the sale of additional output units, is affected by additional units of ecosystem services. Using the rice example, the marginal productivity value indicates how much farmers will earn if they increase their use of ecosystem services (freshwater) to produce more rice.

This indicator is calculated by multiplying the estimated marginal productivity of the input (obtained in Step 1) by the output's market price. It's a simple calculation but one grounded in micro-economic theory. The value of the marginal productivity of ecosystem services links the technological parts of production (where the ecosystem service is an input) to the profitability of production.

Step 3: Assess the monetary value of ecosystem services to the sector(s)

The third step scales-up the results obtained in previous steps and measures the contribution of ecosystem services to the selected markets and/or economic sectors in monetary terms. The calculation is simple; the value of the marginal productivity per unit of ecosystem services used in production (obtained in Step 2) is multiplied by the total amount of output sold in the market (e.g. the total amount of rice sold over a selected period). This value represents the total revenue generated by the ecosystem services and, therefore, the contribution of the ecosystem service(s) to the sector and national production.

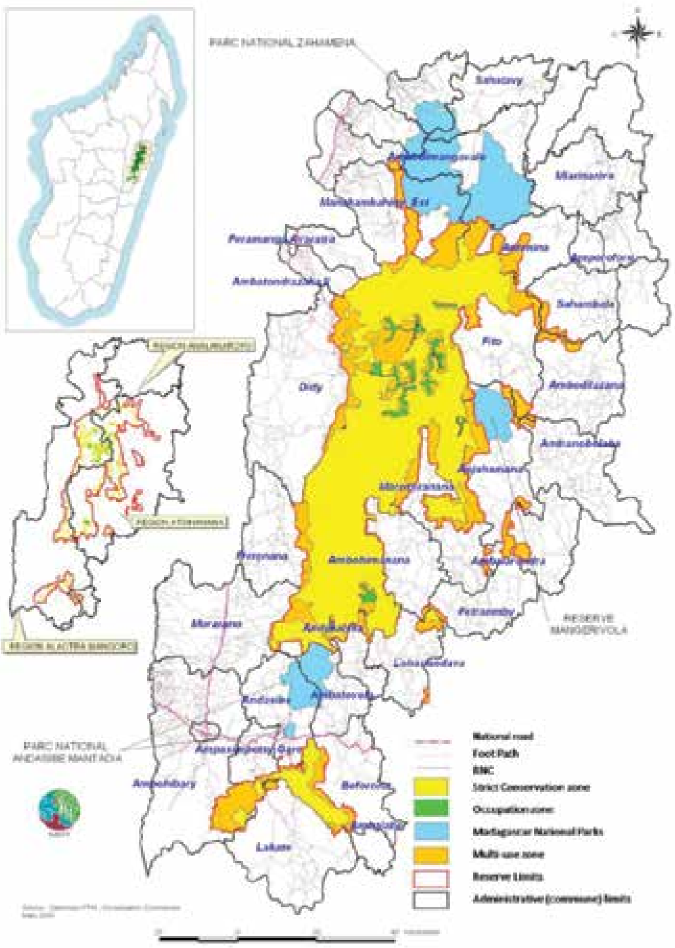
Step 4: Record the economic value of ecosystem services in national accounts

Finally, and only at this stage, analysts can transfer the aggregated monetary value of the ecosystem service for the sector/s into national accounts, in which the figures obtained in Step 3 should be easily traceable (or recordable). This value represents the total revenues produced by the ecosystem service[39] and is therefore the contribution of ecosystem services to sector and national production. This is an important measure of the productivity and profitability of natural capital.

5.5 Real-world application of the step-by-step guide: results from a pilot project in the Republic of Madagascar[40]

The pilot project used the methodology[41] to assess the value of freshwater to mining, agriculture and ecotourism — the country's important economic sectors — in the Ankeniheny-Zahamena Corridor (CAZ) in the Republic of Madagascar (see Figure 5.10 and Box 5.1). Freshwater was categorized as a production input (like others, including labour, land and capital) that contributed to the economic performance of the selected sectors in the study region. The pilot was carried out for three main reasons. First, there were no other studies that calculated the economic value of ecosystem services for the purpose of national accounting. Second, the results might be applicable to SIDS, since Madagascar is an island developing state, though not small. Third, there was a lack of available data so resident experts had to work closely with international colleagues. In this context, this manual offers maximum added value to analysts.

Figure 5.11: Map of the Ankeniheny-Zahamena forestry corridor, Madagascar



39 It is important to note that total revenues calculated using this methodology differed from those calculated by multiplying the total quantity of output sold by its market price.

40 The section presents an empirical application of the step-by-step guide set out in the previous paragraph. This section is technical, al though it has been simplified for all readers to understand.

41 This study is a good example of the application of the proposed methodology in similar conditions to those found in SIDS. The Republic of Madagascar is part of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES) partnership.

Box 5.1: Overview of the Ankeniheny-ZahamenaCorridor region, Madagascar

The Ankeniheny-Zahamena Corridor (CAZ) is a newly designated protected area in the east of the Republic of Madagascar in the province of Toamasina. It includes the districts of Ambatondrazaka, Moramanga, Ampasimanolotra, and Toamasina Rural. The CAZ has a surface area of 381,000ha, and its forests, wetlands, and rivers are home to more than 2,000 species of plants, many endemic to the region, as well as a great number of mammal species (including lemurs), amphibians and birds. It also comprises a range of land uses including agriculture, forest plantations, community-managed zones and villages, as well as five government-managed national parks and reserves, including Zahamena National Park, Zahamena Reserve, Andasibe-Mantadia National Park, Mangerivola Reserve and Analmazoatra Reserve.

CAZ is also home to nearly 350,000 people, mostly rural communities, who practise a mix of subsistence agriculture and cash-crop production as a basis for their livelihoods. Key revenue sources include rice, coffee, bananas, manioc, lychee, poultry and charcoal. Deforestation – primarily as a result of tavy (slash-and-burn) agriculture, as well other unsustainable and illegal uses such as small-scale illegal mining, illegal logging and hunting[42] – threaten the area's biodiversity and the livelihoods of the communities that depend on natural resources for subsistence. The main economic sectors in the region include agriculture, mining and ecotourism, all of which are highly dependent on water.

Source: Portela et al. (2012)

Step 1

In order to estimate the marginal productivity of freshwater, investigation of relevant production methods was needed to assess the current situation, gather the information needed to create a dataset and to define a production function specification for each sector under consideration. There was no official data for the domestic consumption of water in the CAZ region, or for agricultural or industrial uses, so the first step in computing water productivity in the three selected sectors was to collect data. Quality data is the necessary pre-requisite for the valuation of ecosystem services' impact on human activities in monetary terms and the inclusion of those values in national accounts.[43]

An ad hoc team of researchers involving national and international experts compiled the data, which was used to create different datasets for the selected economic sectors (see Tables C.1, C.2 and C.3 in Annex C for the data and selected variables used for empirical analysis).

The agricultural sector

Since agriculture in the region is primarily subsistence, a system of production functions was used that assumed different economic scales for rice and manioc cultivation and the management of households' poultry-yard (basse-cour). Agricultural production was modelled on a set of integrated production activities, where similar production inputs were used[44] (as described in equations 1–3 in Box 5.2).

Box 5.2: Estimating the production functions for rice, manioc and livestock in Madagascar

(1) Log (quantity of rice) =

$$\alpha_1 + \beta_{12} \log(\text{work}) + \beta_{13}\log(\text{land}) + \beta_{14}\log(\text{water}) + \beta_{15}\log(\text{sickle}) + u_1$$

(2) Log (quantity of manioc) =

$$\alpha_2 + \beta_{22} \log(\text{work}) + \beta_{23}\log(\text{land}) + \beta_{24}\log(\text{water}) + \beta_{25}\log(\text{sickle}) + u_2$$

(3) Log (number of animals) =

$$\alpha_3 + \beta_{32} \log(\text{work}) + \beta_{33}\log(\text{land}) + \beta_{34}\log(\text{water}) + \beta_{35}\log(\text{sickle}) + u_3$$

Source: Onofri et al. (2014)

42 USAID (2007).
43 USAID (2007).
44 See Griliches (1963) and Varian (1992).

The idea is that the production of rice, manioc and livestock depends on production factors such as human labour, land, tools, machinery, as well as freshwater. The model was estimated using the three-stage-least-squares routine.

The mining sector

Multinational company Ambatovy, a large-tonnage, long-life nickel and cobalt mining business, operates in the CAZ region. It has invested approximately US$5.5 billion, which is the largest-ever foreign investment in the country and one of the biggest in sub-Saharan Africa and the Indian Ocean region. The company will soon be among the largest lateritic nickel mining entities in the world.

Mining sector data for the valuation was gathered from different sources, including the company's website, documents, reports and experts' meetings.[45] In this case, the production function model became a couple of distinct log-linear models (see Box 5.3). The model was estimated using the ordinary least-squares-estimation technique.

Box 5.3: Estimating the production functions for cobalt and nickel in Madagascar

(1) Log (quantity of cobalt)

$$= \alpha_1 + \beta_{12}\log(\text{machinery}) + \beta_{13}\log(\text{energy}) + \beta_{14}\log(\text{work}) + \beta_{15}\log(\text{land}) + \beta_{16}\log(\text{water}) + \beta_{17}\log(\text{land}) + \beta_{7}\log(\text{primary material inputs}) + u_1$$

(2) Log (quantity of nickel)

$$= \alpha_2 + \beta_{22}\log(\text{machinery}) + \beta_{23}\log(\text{energy}) + \beta_{24}\log(\text{work}) + \beta_{25}\log(\text{land}) + \beta_{26}\log(\text{water}) + \beta_{27}\log(\text{land}) + \beta_{28}\log(\text{primary material inputs}) + u_2$$

Source: Onofri et al. (2014)

The ecotourism sector

There was not enough data to perform econometric modelling and analysis of the ecotourism sector's production function. Therefore, in order to be consistent with the selected analytical framework, the following was recommended. First, analysts assumed that water was the only input affecting total output (number of tourist arrivals) in a typical short-run analysis. (In a short run, a hotel manager does not adjust hotel capacity or dramatically change the number of employees in relation to the number of arrivals.) Alternatively, water use (e.g. showers and spas) changes directly with the number of arrivals, since the consumption of water is directly proportional to the number of tourists (see Box 5.4).

Box 5.4: Short-run production functions for ecotourism

(1) $Q = AW^{\alpha} Z^{\beta}$

Q represents the number of total arrivals at the selected destination; A is a technological parameter; W is the ecosystem service input (water); Z represents all other variables. According to this assumption, α equals 1 and β equals zero. The technological relationship can therefore be rewritten as a linear relationship, described by the slope in equation (2).

(2) $Q = AW$

In this case, the parameter A measures both average and marginal productivity, which are equal here. It is realistic to assume that an additional tourist will use about the same quantity of water as other eco-tourists.

Source: Onofri et al. (2014)

45 These include and reflect (i) Output measures – quantity in tonnes of the nickel, cobalt and ammonium sulphate produced per year, assuming a mine lifespan of 30 years. (ii) Input measures – labour measured in number of workers, machinery (measured in capital investment), water (measured in cubic metres), land (in hectares), raw materials (quantity of limestone, sulphur, ammonia used (measured in tonnes), energy (measured in kilowatts).

The second column in Table 5.3 presents the econometric estimates of the water marginal productivity in the agriculture, mining and ecotourism sectors (see Tables C.4, C.5 and C.6 in Annex C for more information).

Table 5.3: Economic valuation of fresh water in Madagascar

Economic sector	Marginal productivity	Monetary value of marginal productivity (US$ 2012)	Monetary value of the sector generated by water (million US$)
Mining			
Cobalt[a]	0.43	11,825	66.22
Nickel[a]	0.70	10,808	648.48
Agriculture			
Rice[a]	0.92	469	44.45
Ecotourism International/ longer stay[b]	0.96	134	19.04

Note: [a]The output of the cobalt, nickel and rice is expressed in tonnes; [b]the output of tourism is expressed in terms of the number of international tourists.

Estimates showed that the water marginal productivity was not the same across the three sectors. The marginal productivity of freshwater for the production of rice in the CAZ region equalled 0.92. This means that an increase of 10% in the use of water would increase rice production by 9.2%. The water marginal productivity for the production of nickel and cobalt were estimated to be 0.70 and 0.43, respectively. This means that a 10% increase in the use of water would increase nickel production by 7% and cobalt by 4.3%. The marginal productivity of water for ecotourism was 0.96, meaning that a 10% increase in water use would increase the number of tourist arrivals by 9.6%.

Steps 2 and 3

Next is the calculation of the economic value of the marginal productivity across the three selected sectors. Nickel and cobalt market prices were based on those from the London Metal Exchange (2012 British pounds converted to 2012 US dollars); the market price of rice was taken from the Observatory of Rice, Ministry of Agriculture, reported in 2010 Aryary, then converted into 2012 US dollars; the price of a night in a luxury room in an ecotourism hotel, reported in 2011 Aryary, was converted into 2012 US dollars. The marginal productivity values of the three sectors are presented in column 3 of Table 5.3.

The economic value, based on marginal valuation analysis, varied according to the economic sector the ecosystem was used by. When used in the mining sector, water had the highest productivity value. For one additional unit of water – here expressed as an additional cubic metre used in the production of cobalt – the marginal return value from the sale of an additional unit (tonne) of cobalt was US$11,825. Alternatively, this can be seen as a lost unit of water allocated to the production of cobalt. In this case, if an additional unit of water was not used to produce cobalt (e.g. it was allocated to an alternative sector or was no longer available, it would amount to losses of US$11,825. This value can therefore be interpreted as an opportunity cost. Total sector revenues were then calculated (see column 4 of Table 5.3). Cobalt total revenues in 2010, for instance, were about US$60 million; total rice revenues for the Toamasina region in 2010 equalled US$3.75 million.[46]

46 Given the experimental nature of this study, the results are preliminary and may need further in-depth analysis. However, by comparing the marginal revenues and selected market prices (e.g. rice and cobalt), the characteristics of those markets can be inferred. For instance, the price of rice per tonne in the Republic of Madagascar is around $US500 (FAO, 2012). The study estimated that the marginal revenues (the economic value of the marginal productivity of rice) are not far off the (actual) market price. In a long-run, perfect competition setting, marginal revenues equal market price and shadow price (see Dasgupta 2012), so its possible to find out information about the rice market structure in the selected area – i.e. the country's rice market is characterized by a (perfect) competition structure.

5.6 Conclusion

The study successfully demonstrates the use of experimental ecosystem accounting to calculate the economic value of ecosystem services in the marketplace. The methodology is based on strong economic theory: to assess the impact of 'nature' in markets, its necessary to measure nature as a production input in a broader process (e.g. as an input in a production function).

Scaling up the proposed methodology is simple because it follows the SEEA-recommended approach of adopting monetary values consistent with the principles of national accounting. Another strength of the proposed methodology is that it has now been used in the real world. Different approaches have been discussed previously (see Barbier (2011) for a survey) but none have been tested or enacted on the ground.

The econometric modelling of production functions allows for flexibility. Analysts can limit/extend the approach accordingly, in ways ranging from the introduction of other ecosystems to the simultaneous estimation of different production functions, both regionally and nationally, and from static to dynamic applications. This study also shows that the step-by-step approach is possible, even where there is relatively poor data.

Given the experimental nature of this exercise, a couple of caveats should be mentioned. First, the study does not integrate biophysical analysis and information. However, the economic value estimates and data elicited by this step-by-step approach can be combined with them. For instance, in the CAZ region, once the economic productivity of ecosystem services was identified and the efficiency of the system understood, the availability of the selected ecosystem service and/or the sustainability of its exploitation could be considered. Economic estimates can therefore be combined with biophysical information, especially for the purposes of policy design.

Second, the quality of any empirical study is always contingent on the quality of the data available/used. SEEA recommends investing in better data within a widely accepted and integrated measurement framework. The availability of quality data is an important precondition to analysis. By integrating estimates of ecosystem services within a framework of accepted economic data, this type of approach will encourage more of these sorts of studies to be carried out.

The step-by-step approach delivers solid, economic data (as set out in Table 5.3) that can be used in national statistics and accounts.

"The stars are aligned for small island developing states so we better take advantage of all the opportunities."

(H.E. Mr Baron Waqa, MP President, Nauru, AOSIS Leaders and Heads of Delegation meeting by the 68th United Nations, 2013)

6 Current initiatives and working groups with a focus on the valuation and accounting of island ecosystem services

6.1 Information platforms and their specific links to the valuation and accounting of ecosystem services

Before carrying out an island ecosystem services valuation exercise, it is fundamental that analysts have a comprehensive knowledge of the relevant techniques, literature and datasets, including monetary and non-monetary value information.

The datasets are of particular significance since these shape the empirical work and make it easier to apply ecosystem service valuation and accounting to small island developing states (SIDS). Analysts have two main options. They can carry out a new study, known in valuation literature as the 'primary valuation approach'. Or they can use existing valuation studies and adapt their estimates to the country in question — known as the 'value transfer valuation approach'.

Whichever they chose, analysts must spend time collecting data specific to the country they are assessing. This will help them carry out natural capital and ecosystem services accounting, particularly when using the value transfer approach. If analysts are carrying out a primary valuation study, they should check the newly created economic values against those in existing monetary valuation datasets.

This chapter reviews current SIDS initiatives and provides an overview of the regional working groups and resources, including biodiversity and other biophysical indicator databases. This chapter also reviews ongoing initiatives with a focus on the economic valuation and accounting of island ecosystem services, including monetary valuation datasets. It concludes with an overview of current ecosystem and natural capital accounting initiatives.

6.2 Regional working groups and resources, including small island developing state database platforms

Secretariat of the Pacific Community

Secretariat of the Pacific Community (SPC) is an international organization that works in public health, geo-science, agriculture, forestry, water resources, disaster management, fisheries, education, statistics, transport, energy and culture to help Pacific Island peoples achieve sustainable development. SPC's members are the 22 Pacific Island countries and territories that benefit from its ecosystem services, along with four of the original founding countries. Its headquarters are located in Nouméa, New Caledonia.

Box 6.1: Secretariat of the Pacific Community's vision

SPC's vision for the region is a secure and prosperous Pacific Community, whose people are educated and healthy, and who manage their resources in a sustainable way. Its members design SPC's work programme and all of its regional initiatives to support members' national policies and plans. The organization is owned and governed by its members, who come together at the Conference of the Pacific Community and the Committee of Representatives of Governments and Administrations to make decisions in a spirit of Pacific consensus.

The SPC division focused on fisheries, aquaculture and marine ecosystems is called FAME.[47] Its main objective is to provide SPC member countries and territories with the information they need to make informed decisions on the management of their aquatic resources, and to provide the tools and capacity they need to implement these decisions. FAME comprises two programmes: the Oceanic Fisheries Programme and the Coastal Fisheries Programme.[48]

The Coastal Fisheries Programme

The Coastal Fisheries Programme's (CFP) goal is to ensure that 'coastal fisheries, near-shore fisheries and aquaculture in Pacific Island Countries and Territories are managed and developed sustainably'. The CFP is made up of three divisions: aquaculture, near-shore fisheries development, and coastal fisheries science and management. The CFP helps Pacific Island Countries and Territories develop the capacity to assess, harvest, develop, manage and conserve their marine resources. It supports the sustainable development of the region's fisheries at subsistence, artisanal and small-and-medium scale commercial levels by providing assessment, development and management advice, technical assistance, and vocational national and regional scientific training, as well as the production and dissemination of information. In addition, the CFP collaborates with a range of partners across the region, including other regional and international organizations, non-governmental organizations, research and management institutions, Pacific Island Countries and Territories fisheries departments, the private sector, communities and other stakeholders in the marine sector. Cross-discipline issues, such as food security and climate change are addressed using a holistic approach where the CFP partners with other sections and programmes within the SPC as well as externally. CFP staff participate in all joint country strategy missions to Pacific Island Countries and Territories so that their coastal fisheries' priorities are captured and incorporated into the CFP sections' annual work plans. **www.spc.int/coastfish**

The Oceanic Fisheries Programme

The Oceanic Fisheries Programme is the Pacific Community's regional centre for tuna fisheries research, fishery monitoring, stock assessment and data management. It was established by the 1980 South Pacific Conference (as the Tuna and Billfish Assessment Programme) to continue and expand the work initiated by its predecessor project, the Skipjack Survey and Assessment Programme. The Oceanic Fisheries Programme provides scientific services relating to oceanic (primarily tuna) fisheries management to its membership. These services include fishery monitoring, data management, ecosystem and biological research relevant to the fisheries, stock assessment, and the evaluation of species and ecosystem-based management options. The most important programme outputs are information (e.g. reports on the status of fisheries, stocks and ecosystems), infrastructure (e.g. databases, monitoring programmes), advice (e.g. regarding appropriate levels of fishing), and national capacity building in SPC members. **www.spc.int/oceanfish**

Pacific Islands Marine Resources Information System

The Pacific Islands Marine Portal's main objective is to improve the Pacific Islands community's access to marine information. This portal is part of (PIMRIS), which includes ministerial and departmental libraries in most Pacific nations, as well as regional agencies based in Apia, the Independent State of Samoa (Secretariat of the Pacific Regional Environment Programme (SPREP)); Honiara, Solomon Islands (Forum Fisheries Agency (FFA)); Nouméa, New Caledonia (SPC); and Suva, the Republic of Fiji (SPC Applied Geoscience and Technology Division (SOPAC)). Representatives meet bi-annually to review progress, policies and objectives. Activities are overseen by the PIMRIS Coordination Unit, which is based at the School of Marine Studies of the University of the South Pacific, Suva, Fiji. **www.pimrisportal.org**

The Pacific Island Marine Portal has a set of e-resources available at www.pimrisportal.org including:

- Virtual Libraries and E-Repositories
- Global Marine Databases and Resource Centres
- Pacific Organizations and Institutions
- Pacific Country Profiles

47 www.spc.int/fame.
48 www.spc.int.

- Pacific Marine Protected Areas
- Pacific Marine Conventions, Treaties, and Legislation
- Maps , GIS Data and Ocean Observing Systems
- Training and Educational Resources
- Online Journals
- Regional Initiatives and Projects

Box 6.2: Pacific Islands Marine Resources Information System's vision

PIMRIS is a formal network of libraries and information centres within regional organizations and government agencies that focuses on the development of fisheries and marine resources in the Pacific. Its aim is to improve access to information on marine resources in the region by: collecting, cataloguing and preserving relevant documents in print and electronic formats, especially 'grey literature' (ephemeral, unpublished material); disseminating information via new products (reports, newsletters, posters, bibliographies, websites and databases) and services (literature searches, inter-library loans, question and answer services); supporting the development of regional libraries and information centres through training and technical assistance; and cooperating with similar networks and institutions throughout the world, including the International Association of Marine Science Libraries & Information Centres, Food and Agriculture Organization of the United Nations and the Indian Ocean Commission.

Box 6.3: Organizations operating in the Pacific that could focus on economic valuation

Forum Fisheries Agency

The Pacific Islands Forum Fisheries Agency (FFA) strengthens national capacity and regional solidarity so its 17 members can manage, control and develop their tuna fisheries now and in the future. Based in Honiara, Solomon Islands, FFA's 17 Pacific Island members are Australia, Cook Islands, Federated States of Micronesia, the Republic of Fiji, Kiribati, the Marshall Islands, Nauru, New Zealand, Niue, the Republic of Palau, the Independent State of Papua New Guinea, the Independent State of Samoa, Solomon Islands, Tokelau, the Kingdom of Tonga, Tuvalu and the Republic of Vanuatu. FFA was established to help countries sustainably manage fishery resources that fall within their 200-mile exclusive economic zones (EEZs). FFA is an advisory body providing expertise, technical assistance and other support to its members who make national decisions about their tuna resources and participate in regional decision-making on tuna management through agencies such as the Western and Central Pacific Fisheries Commission.

Western and Central Pacific Fisheries Commission

The Western and Central Pacific Fisheries Commission was established by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPF Convention) that entered into force on 19 June 2004. The Convention was concluded after six years of negotiation, which began in 1994. The period between the conclusion of the convention and its inception was taken up by a series of preparatory conferences that laid the foundations for the commission to begin its work. The WCPF Convention draws on many of the provisions of the United Nations Fish Stocks Agreement while, at the same time, reflecting the special political, socio-economic, geographical and environmental characteristics of the western and central Pacific Ocean region. The Western and Central Pacific Fisheries Commission Convention addresses problems in the management of high-seas fisheries resulting from unregulated fishing, over-capitalization, excess fleet capacity, vessel re-flagging to escape controls, insufficiently selective fishing tackle, unreliable databases, and insufficient multilateral cooperation in respect of the conservation and management of highly migratory fish stocks.

Pacific Environment Information Network (PEIN)

PEIN is a monthly digest of Pacific environmental news and developments gathered from global news sources and a regional network of Pacific environment officers. It is coordinated by the Secretariat of the Pacific Regional Environment Programme Library. PEIN's aims are to collect, store and disseminate scientific and technical information on environmental and development concerns in Pacific island countries and territories, and liaise and coordinate with other national, regional and international organizations to disseminate information and publications in the region.

The portal also has links to the latest marine news from Pacific regional organizations – SPC, FFA and SOPAC – as well as the Pacific Environment Information Network (PEIN) digest and latest PIMRIS newsletter (see Box 6.3 for more detailed descriptions of these regional organizations).

Secretariat of the Pacific Regional Environment Programme

The governments and administrations of the Pacific region charged the Secretariat of the Pacific Regional Environment Programme (SPREP) with the protection and sustainable development of the region's environment. SPREP is based in Apia in The Independent State of Samoa. Two SPREP programmes are of particular interest to SIDS: the Climate Change Programme and the Biodiversity and Ecosystems Management Programme (see Box 6.4 for more details).

Box 6.4: Secretariat of the Pacific Regional Environment programmes

The Climate Change Programme

The goal under the Climate Change Strategic Priority is that 'by 2015, all members will have strengthened capacity to respond to climate change through policy improvement, implementation of practical adaptation measures, strengthening ecosystem resilience to the impacts of climate change, and implementing initiatives aimed at achieving low-carbon development'.

Under this first strategic priority, the secretariat supports members in the planning and implementation of national adaptation strategies (pilot projects included) and integrates climate change considerations into national planning and development processes. The emphasis is on producing guidelines for the most appropriate and best practices in policy development and adaptation. The SPREP secretariat will lead the coordination of regional climate change policies and programmes through the Pacific Climate Change Roundtable, the Pacific Islands Framework for Action on Climate Change and the Council of Regional Organizations in the Pacific Coos Working Group on Climate Change. Working with donors, it will develop partnerships to implement adaptation and mitigation policies, and programmes in the region. Awareness and understanding of the potential impacts on communities and livelihoods is essential. The region's strategies and targets support education and awareness programmes as well as regional networks and information portals: these will improve the availability of climate change information to scientists, policymakers and decision-makers. It is also important to strengthen members' ability to engage in climate change negotiations, access international funding sources and meet their international responsibilities under the United Nations Framework Convention on Climate Change.

The Biodiversity and Ecosystems Management Programme

The secretariat will use the Biodiversity and Ecosystems Management Programme to focus on providing technical and advisory support to members on the design and implementation of National Biodiversity Strategic Action Plans (and their equivalents in territories). Better understanding of how healthy, effectively managed terrestrial and coastal ecosystems contribute to islands' resilience to climate change impacts will be an essential component of Pacific island climate change policies and adaptation measures. The cultural dimension of environmental concerns will be addressed by taking into consideration traditional biological knowledge and practices, and regional initiatives that encourage the conservation of natural and cultural heritage. The Biodiversity and Ecosystems Management Programme will also focus on improving species conservation and management by encouraging effective implementation of international agreements and supporting cost-effective regional programmes and policies. These include existing regional mechanisms such as the Action Strategy for Nature Conservation; Guidelines for Invasive Species Management in the Pacific; Islands Regional Marine Species Programme 2013–2017; Regional Shark Action Plan; Oceania Humpback Whale Recovery Plan; Pacific Islands Regional Guidelines for Whale and Dolphin Watching, and may require additional regional and national mechanisms to be developed.

In addition, SPREP holds a valuable e-resource portal – PEIN, which includes the Country Reports Directory. This is a directory of national reports for Pacific Island countries that provides analysts with a range of environmental indicators and national documents, produced by various environment programmes in the Pacific region. SPREP also publishes the Lessons Learned and Best Practices in Environment Management Directory, which contains examples from around the Pacific region and abroad. **www.sprep.org**

Pacific Islands Managed and Protected Areas Community

The Pacific Islands Managed and Protected Areas Community (PIMPAC) is a collaboration between site-based managers, non-governmental organizations, local communities, federal, state and territorial agencies, and other stakeholders working together to improve the use and management of protected areas in the US Pacific Islands and Freely Associated States. The PIMPAC coordinator is located in Kolonia, Pohnpei, Federated States of Micronesia. It builds partnerships between local Pacific Island experts and strengthens planning, implementation and evaluation initiatives to conserve the Pacific Islands' marine resources. PIMPAC hosts an online forum for sharing new information about local and regional programmes, finding existing PIMPAC documents that support its work, and encouraging peer-to-peer learning. It also provides information about site-specific initiatives happening in the PIMPAC region and an overview of PIMPAC activities. These are designed around five broad categories: training, partnership building, learning exchanges, information sharing and youth engagement. PIMPAC training activities focus on building the capacity of managers in the following areas: management planning, biological monitoring, socioeconomic monitoring, enforcement and compliance, and climate change adaptation. In recent years, these activities have included management-plan training, MPA staff exchanges, capacity-building programme development with academic institutions, and information sharing, regional initiatives and disseminating opportunities that could support PIMPAC members' work. **www.pimpac.org**

Indian Ocean Commission

The Indian Ocean Commission (IOC) comprises five members: four African, Caribbean and Pacific Group of States that are also members of the Common Market for Eastern and South Africa and/or are Southern African Development Community countries (the Comoros, Madagascar, the Republic of Mauritius, the Republic of Seychelles) and a remote European region, Réunion. IOC members have the economic and social resources to create opportunities, especially to boost trade. One of its four strategic axes focuses on blue and green regional growth, specialization and economic valuation. Here, IOC contributes to the development of sustainable practices in fisheries and agriculture – not only in terms of economic growth but also food security and sustainable development. Nevertheless, illegal fishing and biodiversity degradation threatens the sustainable management of natural resources in the Indian Ocean, especially those that are marine-based. The Indian Ocean is one of 34 biodiversity hotspots in the world threatened by human activity and climate change. IOC aims to preserve the environment while improving the welfare of the population. It also focuses on building capacity to deal with natural disasters – the southwest Indian Ocean basin is the third most exposed region to natural disasters in the world.**www.commissionoceanindien.org**

Box 6.5: Blue and green regional growth, specialization and economic valuation

This strategic axis of the Indian Ocean Commission (IOC) comprises a set of actions though initiatives such as the Indian Ocean Tuna Commission, the Regional Programme for Fisheries Monitoring and the Smart Fish Programme. The latter improves the food security of IOC member states by strengthening agricultural resilience and by developing the production of specific crops. All necessary measures to ensure sustainable food production, of sufficient amount and quality, are considered. IOC also strengthens and revitalizes support services connected to farmers' groups (plant protection, irrigation, control services, research) through networks established through regional projects. The World Bank has just granted US$1.1 million to the IOC to for the sustainable management of oceans and wildlife in the Africa region. This donation is part of a three-year collaboration with the Global Partnership for Oceans. The IOC will manage the fund on behalf of the Indian Ocean Tuna Commission and the Southwest Indian Ocean Fisheries Commission. Recipients of the funds will be able to improve the conservation and management of fisheries in the Indian Ocean Tuna Commission conventional zone, and promote fisheries management best practice in Southwest Indian Ocean Fisheries Commission member countries.

Caribbean Marine Protected Areas Management Network and Forum

The use of marine protected areas (MPAs) has become increasingly popular in the wider Caribbean region as a tool to improve ecosystems management, conserve marine biodiversity, address overfishing impacts, lessen conflicts between users of the ecosystem services and provide economic alternatives for local coastal communities. This has resulted in substantial knowledge on how to choose the best site, the best outreach approaches to use, effective management strategies and appropriate methods to evaluate their effectiveness. Difficulties in exchanging information about lessons learned due to the geographic, socioeconomic, and cultural complexities of the Caribbean region continue to hinder informed decision-making. At the same time, communication among professionals has become more important given the increasing scientific interest in the biophysical links across the region. In response, the Caribbean Marine Protected Area Network and Forum (CaMPAM) was created in 1997 under the framework of the Caribbean Environment Programme of UNEP and the Specially Protected Area and

Wildlife Protocol of the Cartagena Convention activities. Communication and training are at the core of CaMPAM's mission to implement the knowledge and lessons learned across the region. In addition, CaMPAM hosts a database detailing the numerous MPAs in the region, focusing on identity, legal, biophysical and management parameters. The database is becoming a standardized, detailed information resource for Caribbean MPAs, useful for those producing regional analyses and periodic reports. CaMPAM is coordinating verification work for the Caribbean Environment Programme and the Caribbean Challenge, which complements the database on MPAs in countries involved with the Caribbean Challenge. CaMPAM therefore relies on data provided by managers, government officials, non-governmental organizations and scientists associated with MPAs. **campam.gcfi.org**

Box 6.6: The Caribbean Environment Programme

The Caribbean Environment Programme is one of the UNEP-administered regional seas programmes. Its main objective is to promote regional cooperation for the protection and sustainable development of the marine environment of the Wider Caribbean region. The programme is managed by and for the countries of the Wider Caribbean Region through the Caribbean Action Plan (1981), which outlined regional environmental challenges. The action plan led to the 1983 adoption of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention), which provided the legal framework. The convention has been supplemented by three protocols addressing specific environmental issues: oil spills, specially protected areas, and wildlife and land-based sources and activities of marine pollution. The work is carried out through three main programmes: Assessment and Management of Environment Pollution, Specially Protected Areas and Wildlife, and Communication, Education, Training and Awareness. The Caribbean Environment Programme secretariat is based in Kingston, Jamaica.

The Coral Reef Marine Protected Areas of East Asia

The websites of Coral Reef MPAs of East Asia and Federated States of Micronesia are a concise, useful and up-to-date inventory of MPAs and MPA networks for coral reefs and related ecosystems, as well as associated information on the East Asia and Micronesia regions. The initial development phase of this resource was carried out between 2005 and 2007 as part of the International Coral Reef Initiative Secretariat's Plan of Action under Japan and the Republic of Palau's co-secretariat term, and updated the MPA Global database, currently part of the World Database on Protected Areas, and ReefBase. The second phase of the project – to update the data and make it easier to use – was carried out between 2008 and 2010. **mpa.reefbase.org**

Box 6.7: Coral reef and Marine Protected Area datasets

International Coral Reef Initiative

The International Coral Reef Initiative is a partnership between governments, international organizations, and non-governmental organizations. It strives to preserve coral reefs and related ecosystems by implementing Chapter 17 of Agenda 21, and other relevant international conventions and agreements. **www.icriforum.org**

World Database on Protected Areas

The World Database on Protected Areas is the most comprehensive global spatial dataset on marine and terrestrial protected areas currently available. Since 1981, UNEP-World Conservation Monitoring Centre, through its Protected Areas Programme, has been compiling this information and making it available to the global community. The World Database on Protected Areas is a joint project of UNEP and the International Union for Conservation of Nature (IUCN), and was produced by UNEP-World Conservation Monitoring Centre and the IUCN World Commission on Protected Areas, who worked with governments and non-governmental organizations. **www.wdpa.org**

ReefBase

ReefBase is the official database of the Global Coral Reef Monitoring Network and the International Coral Reef Action Network. It is housed at the WorldFish Center in Penang, Malaysia, with funding from the United Nations Foundation, and collects coral reef information in one place. It helps the analysis and monitoring of coral reef health, as well as the quality of life of reef-dependent people, and is used to support informed decisions about coral reef use and management. It includes: a global database of coral reefs – online data and information on the location, status, threats, monitoring and management of coral reefs in more than 120 countries and territories; coral reef maps – based on geographic information system data; publications/photo gallery – an online library of coral reef-related publications and literature, containing more than 25,000 references, including 5,498 downloadable publications and 4,253 coral reef-related photographs; and projects and partners – ReefBase is involved in a growing portfolio of coral reef projects, working with many organizations to improve coral reef data storage, analysis and sharing. **www.reefbase.org**

6.3 Online resources for the economic valuation of ecosystem services

The above regional initiatives and working groups have a particular focus on the compilation of data relevant to SIDS, which is fundamental to any economic valuation exercise in these countries. Additionally, analysts are advised to work with additional, complementary economic valuation datasets. When it comes to the economic valuation and accounting of a given island ecosystem service, this information is frequently not available or if it is, is not collected in a systematic way. To avoid this, analysts should work with datasets that are specifically designed for environmental economic valuation studies (see Table 6.1 for an overview of the available online primary valuation studies).

Table 6.1: Datasets of primary valuation values and monetary estimates

Database	Region	Website
ASEAN TEEB Valuation Database	Southeast Asia	www.lukebrander.com
CaseBase	All	www.fsd.nl/naturevaluation/73766/5/0/30
Ecosystem Service Valuation Database (ESVD)	All	www.es-partnership.org/esp/80763/5/0/50
Ecosystem Services Project Database	All	www.naturalcapitalproject.org/database.html
Ecosystem Valuation Toolkit	All	www.esvaluation.org/gap_analysis.php
Envalue	US and Australia	www.environment.nsw.gov.au/envalueapp/
Environmental Valuation Reference Inventory (EVRI)	All	www.evri.ca/Global/Splash.aspx
Marine Ecosystem Services Partnership Library	All	www.marineecosystemservices.org/explore
National Ocean Economics Program (NOEP)	All	www.oceaneconomics.org/nonmarket/NMsearch2.asp
Non-market Valuation Database	New Zealand	www2.lincoln.ac.nz/nonmarketvaluation/
ValueBaseSwe	Sweden	www.beijer.kva.se/valuebase.htm
Dutch Caribbean Biodiversity Database	Dutch Caribbean	www.dcbd.nl/

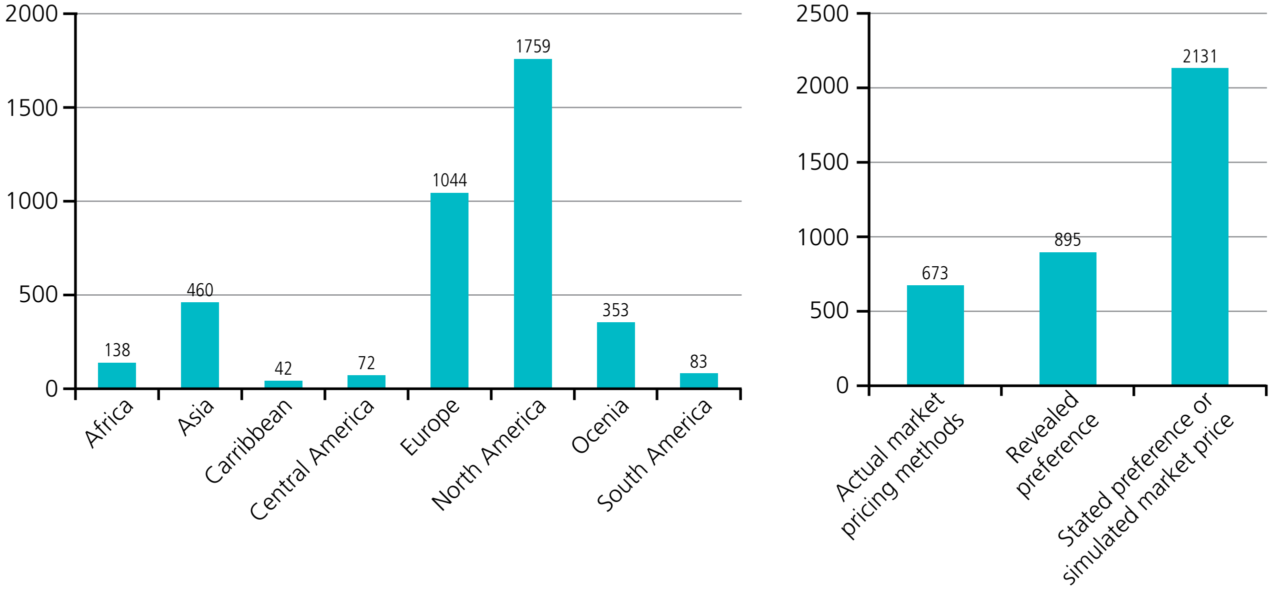
Source: Luke Brander (2013)

Given the scope of this guidance manual, the next section focuses on the Environmental Valuation Reference Inventory (EVRI), as it is the most comprehensive dataset that focuses on island ecosystem services valuation estimates.

Environmental Valuation Reference Inventory

Environmental Valuation Reference Inventory (EVRI) is a comprehensive inventory of more than 3,700 international studies. As Figure 6.1 shows, the database comprises 42 studies on the Caribbean, representing less than 2% of the dataset. Stated preference methods, including contingent valuation and choice experiments, are the most frequently recorded method, representing almost 60% of the sample.

Figure 6.1: Some statistics from the Environmental Valuation Reference Inventory



Source: EVRI

The EVRI database contains summaries of original studies, which are available in English, French and Spanish and other languages, and allows analysts to identify which ones can be applied to the country they are studying. There are six main categories of information with more than 30 fields. These are: Study Reference – basic bibliographic information; Study Area and Population Characteristics – information about the location of the study, along with population and site data; Environmental Focus Study – text and keyword fields that describe the environmental asset being valued, the stresses on the environment and the specific purpose of the study; Study Methods – technical information on the study, including the techniques used to arrive at the results; Estimated Values – the dollar values presented in the study, as well as specific units of measure.

The database helps decision-makers in government and industry, as well as academics, consultants and environmental groups, incorporate environmental valuation into cost-benefit analyses, environmental impact statements, project appraisals and studies on changes to environmental quality. It also provides guidance on how to transfer estimates to other sites, and there are various studies on the topic of benefit transfer. EVRI's scope is currently being widened to include additional valuation studies for many types of natural capital in all parts of the world. The plan is to compile economic valuation studies on SIDS in close alliance with the work developed in the region, as well the studies documented previously. This would supplement existing regional datasets that do not currently have this type of economic data. www.evri.ca

Regional and island ecosystem services-specific inventories

The Marine Ecosystem Services Partnership and the Dutch Caribbean Biodiversity Database (DCBD) contribute to many island ecosystem services economic valuation databases. This supplements the EVRI, since its data has a particular focus. The Marine Ecosystem Services Partnership is an online centre for information and communication on the uses of marine ecosystems around the world. This web-based portal has a library currently containing about 900 valuation studies on marine ecosystem services. The portal also contains links to organizations, forums and websites related to ecosystem services and their valuation, which allow analysts from all over the world to share information about marine ecosystem services and valuation. There are glossaries for terms related to ecosystem services and their valuation, and there is a useful collection of reports/papers on marine ecosystem services.

The DCBD focuses on the Dutch Caribbean region, where there is a lack of online data. DCBD is a central repository for all biodiversity-related research, monitoring data and information from the Dutch Caribbean. Its goal is to guarantee long-term data access and availability, facilitate international reporting and improve environmental management. The 'monitoring' section on the website provides a user-friendly database that hosts an extensive number of datasets on key conservation species, such as sea turtles, flamingos, tropicbirds, parrots, butterflies and many more. It also has geographic information system-based map functionality and a literature archive. Monitoring data can be plotted over specific base geographic information system maps, including vegetation, geological, soil, land use, protected areas and spatial zoning maps. DCBD's third section is a central archive containing research and monitoring reports, journal articles and other valuable documents concerning biodiversity in the Dutch Caribbean.

6.4 Initiatives on natural capital and ecosystem accounting

Efforts to link the environment and the economy, and to use the System of National Accounting (SNA) to measure natural capital, is at the heart of the System of Environmental-Economic Accounting (SEEA)(United Nations, 2012 – see Box 6.8). It brings data on the environment and its relationship to the economy into official national statistics. In this context, SEEA and its central framework is based on agreed concepts, definitions, classifications and accounting rules. SEEA-Central Framework was adopted as an international standard for Natural Capital Accounting (NCA). As an international statistical standard, SEEA now has the same status as SNA, from which key economic indicators such as gross domestic product emerge.

Box 6.8: The System of Environmental-Economic Accounting

The System of Environmental-Economic Accounting (SEEA) contains internationally agreed concepts, definitions, classifications, accounting rules and tables for producing globally comparable statistics on the environment and its relationship to the economy. The SEEA framework follows a similar accounting structure to the System of National Accounts (SNA) and uses concepts, definitions and classifications consistent with it to facilitate the integration of environmental and economic statistics.

The SEEA organizes statistical data to create indicators and descriptive statistics that monitor the interactions between the economy and the environment, and the state of the environment to inform better decision-making. The SEEA does not have one single headline indicator; rather it is a multi-purpose system that generates a wide range of statistics and indicators with many different potential analytical applications. It is a flexible system that can be adapted to countries' priorities and policy needs, while also providing a standardized framework, and common concepts, terms and definitions. The SEEA brochure provides additional information on the benefits of environmental accounting.

The United Nations Statistical Commission initiated a multi-year revision of SEEA in 2003. The SEEA consists of three parts: the Central Framework, which was adopted by the commission as the first international standard for environmental-economic accounting; Experimental Ecosystem Accounting and Applications; and Extensions of the SEEA. Sub-systems of the SEEA framework focus on specific resources or sectors, including energy, water, fisheries, land and ecosystems, and agriculture. These sub-systems are fully consistent with the overarching SEEA but provide further details on specific topics and try to build links between the accounting community and the experts in each specific subject area.

Source: www.unstats.un.org

Since there is now an international agreed NCA methodology, UNEP has been working on a set of initiatives focused on its implementation, using the SEEA-Central Framework as guidance.

The SEEA has two other parts: SEEA-Experimental Ecosystem Accounts, and SEEA-Extensions and Applications (see Box 6.9). Contrary to the SEEA-Central Framework, SEEA-Experimental Ecosystem Accounting is not an international standard and there is no expectation or requirement that countries implement ecosystem accounting within their official statistics. However, there are many ongoing initiatives currently testing alternative methodologies for ecosystem services accounting, including WAVES. WAVES is a global partnership that promotes sustainable development by ensuring that natural resource considerations are included in development planning and national economic accounts (see Box 6.9). There are also country-led experiments, including work by Canada, UK and Australia.

Australia's experience of ecosystem accounting

In recognition of its adoption of SEEA, the Australian Bureau of Statistics (ABS) produced Completing the Picture: Environmental Accounting in Practice.[49] This publication explains to decision-makers, policy analysts, scientists, industry and other groups how environmental accounting could be used and further developed in Australia. The

49 ABS (2012).

Box 6.9: Wealth Accounting and the Valuation of Ecosystem Services

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a World Bank-facilitated global partnership that incorporates natural capital accounting within a country's national accounting system and development planning. This global partnership brings together a coalition of United Nations' agencies, governments, international institutes, non-governmental organizations and academics to implement Natural Capital Accounting (NCA) where there are internationally agreed standards, and develop approaches for other ecosystem services accounting.

By working with central banks, and planning and finance ministries across the world to use NCA to include natural resources in development planning, UNEP hopes to encourage better informed decision-making for sustainable growth and long-term economic and well-being improvements. Its main objectives include: to help countries compile accounts that are relevant for policy-making and add to existing knowledge; develop approaches to ecosystem accounting methodology; establish a global platform for training and knowledge sharing; and build international consensus around natural capital accounting.

Botswana, Colombia, Costa Rica, Madagascar and the Philippines were the first countries to adopt natural capital accounting programmes that were endorsed at the highest level of their governments, with extensive technical support from WAVES. These countries established national steering committees, carried out stakeholder consultations, identified policy priorities and designed work plans that are now being implemented. Guatemala, Indonesia and Rwanda joined WAVES as core implementing countries in late 2013.

The countries' work plans include compiling accounts that follow SEEA-Central Framework guidelines, for natural resources such as forests, water and minerals, as well as experimental accounts for ecosystems such as watersheds and mangroves. WAVES has established a policy and technical experts committee to help develop and test methodologies for ecosystem accounting, which works closely with partners from United Nations agencies, national government agencies, academic institutions and non-governmental organizations.

Source: www.wavespartnership.org

document introduces SEEA and its potential uses, and describes what a regular set of environmental–economic accounts for Australia could look like. Chapter 1 introduces SEEA, briefly explaining its key features, while the following seven chapters provide examples of how SEEA can be applied to a range of public policy issues in Australia that cut across environmental and economic sectors. These are: Mitigating climate change (Chapter 2); Adapting to climate change (Chapter 3); Sustainability (Chapter 4); Managing the Great Barrier Reef Region (Chapter 5); Managing the Murray–Darling Basin (Chapter 6); Green growth (Chapter 7); and Solid waste management (Chapter 8). Each chapter can be read as a stand–alone section so there is some repetition of data. There is also an appendix containing the water and energy accounts ABS has already produced, as well as the natural resources included on the national balance sheet. This is complemented by other SEEA accounts at various stages of development. In some cases, the information presented in the tables is labelled 'experimental' to acknowledge that the results need more analysis. The tables show the potential for SEEA accounts to provide a combined environmental and economic framework. Resources permitting, ABS plans to continue to expand the programme, both in terms of the range of accounts produced and the frequency of their compilation. **www.abs.au**

Measuring Ecosystem Goods and Services: a Canadian project

In 2011, Statistics Canada received federal funding to develop experimental ecosystem accounts with the specific objective of supporting policy needs related to the valuation of ecosystem goods and services. The ensuing project, Measuring Ecosystems Goods and Services, involved a unique partnership between Statistics Canada and Environment Canada – the project co-leads – as well as Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, Natural Resources Canada, Parks Canada and Policy Horizons Canada. This report summarizes the findings of the project and analyses the quantity, quality and value of ecosystems and Measuring Ecosystems Goods and Services (in Canada (see Statistics Canada, 2013 for more information).

The development of the ecosystems goods and services geo-database, and land-cover analysis is used as the starting point to study the size of the ecosystems and their changes over time. In this context, the condition of the ecosystems is explored through several innovative indicators that report on human modifications to the landscape.

The conversion of natural landscape to agricultural land and settled areas quantifies the impact that anthropogenic disturbances have had on ecosystems.

According to the study, evergreen, deciduous and mixed-wood forest areas across the country decreased from 3.1 million to 3 million km^2 (a 4% decline) between 2001 and 2011.Built-up areas in and around cities and towns in southern Canada increased as a result of the transformation of cropland and forests – by 3,361km^2 between 2000 and 2011. During the same time period, large shifts in use from natural landscape to agricultural land occurred in the Upper South Saskatchewan (1,468km^2) and Thompson (973km^2) sub-drainage areas. Settled area increased considerably from 2000 to 2011 in the Lake Ontario and Niagara Peninsula sub-drainage area, which includes Toronto, mostly at the expense of agricultural land. The analysis of the distribution and size of natural land parcels shows how much change has occurred from increasing populations and associated geographical boundaries such as roads and transmission lines.

Ecosystem quality is further explored through a case study on the distribution of water purification potential in the boreal region. Lastly, biomass use is examined as a first step towards developing indicators that analyse whether human use of ecosystem services is sustainable. Valuation of ecosystems goods and services is approached from three angles. The first is market (monetary) valuation, which is explored through a fish-catch case study. In 2011, commercial fish landings on Canada's Atlantic and Pacific coasts totalled more than 850,000 tonnes and were valued at US$2.1 billion. In 2010, direct spending on recreational fishing trips by anglers was an estimated at $2.5 billion. Much of this expenditure can be attributed to ecosystems goods and services (e.g. fish, recreation). In 2006, commercial fishing, aquaculture and seafood-processing activities accounted for 14% of employment in coastal eco-districts on the east coast. On the west coast, the comparable figure was 4%.

Second, non-market monetary valuation is explored through a case study on the Thousand Islands National Park that provides experimental estimates of the annual value of its ecosystem services. The study analysed anthropogenic pressures, such as population and agricultural activities, and land cover for the Thousand Islands ecosystem and for a 100km buffer zone around it. Between 1981 and 2011, the population increased by 32%, the number of farms by 37% and farmland area by 28% in the Thousand Islands. These trends were mirrored in the 100km buffer zone: the population grew by 47%, while the number of farms and farmland area decreased by 39% and 23% respectively. The annual value of ecosystem goods and services provided by the park was estimated to be between US$11 million and US$13 million (2012). **www.statcan.gc.ca**

The UK's experience of ecosystem accounting

The Natural Capital Committee (NCC) was established in May 2012 as an independent advisory body to the UK Government. The NCC's purpose is to help society better recognize the value of nature and ensure this informs decision-making. This contributed to the UK Government's 2011 Natural Environment White Paper ambition to be 'the first generation to leave the natural environment of England in a better state than that it inherited'. The committee's role is to provide advice on when, where and how natural assets are being used unsustainably; advise the Government on how it should prioritize action to protect and improve natural capital so that public and private activity is focused where it will have greatest impact on improving well-being; and advise the Government on research priorities to improve future advice and decisions on protecting and enhancing natural capital.

The Committee's annual State of Natural Capital reports are one of the principal means through which it carries out its role. The Committee's first report, which was published in April 2013, presented evidence that significant economic and well-being benefits can be secured through better valuation and management of natural capital. The report set out a framework for what needs to be done to ensure this happens. In March 2014, the second report was published, which builds on the first report and provides an update on the committee's progress in several areas of its work. This report has three key messages for the Government and other interested parties (see Box 6.10).

For each message, NCC makes a recommendation.

i. The Government, as a matter of priority, must take steps to improve our understanding of natural assets, focusing on those that are not being used sustainably and are important for our well-being:
   - The Government prioritizes work to develop measures to monitor the state of natural assets directly, paying particular heed to potential thresholds.

Box 6.10: Key messages from the Natural Capital Committee for governments

i. Some assets are currently not being used sustainably. The benefits we derive from them are at risk, which has significant economic implications.

ii. There are substantial economic benefits to be gained from maintaining and improving natural assets. The benefits will be maximized if their full value is incorporated into decision-making.

iii. A long-term plan is necessary to maintain and improve natural capital, and thereby deliver well-being and economic growth.

Source: www.naturalcapitalinitiative.org.uk

- The Government, as a matter of urgency, develops and keeps an up-to-date risk register for natural capital, building on the work done by the NCC.
- Given the Government's endorsement of the Rio+20 outcomes, the Government demonstrates global leadership by working to mitigate England's impacts on international natural assets that underpin our economy.
- The Government and research councils address the research priorities identified by the NCC.
- The Government integrates the value of natural capital into decision-making to enhance taxpayers' value for money and to generate net benefits for society:

ii. The Government continues to support the important work being led by the Office for National Statistics to integrate natural capital accounting into the national accounts and looks for opportunities to speed this up where possible. The accounts need to be developed with policy application in mind.

- The Government fully incorporates natural capital costs and benefits into its decision-making tools and frameworks, in particular working with NCC to improve the Government's appraisal guidance. These tools should inform all policy development.
- Where there are clear net benefits for society, the Government incentivizes private investment in natural capital
- The Government endorses NCC's efforts to encourage organizations to incorporate natural capital into their accounts.

iii. The Government and interested parties endorse the NCC's proposed 25-year-plan to maintain and improve England's natural capital within this generation:

- The Government works with NCC and interested parties over the next year to shape the plan.
- The Government should incorporate natural capital into future iterations of its National Infrastructure Plan.

This report lays the foundation for the Committee's third State of Natural Capital report, which will be published in early 2015.**www.naturalcapitalinitiative.org.uk**

6.5 Conclusion

This chapter shows there is currently overarching governance for SIDS, and that communication, collaboration and the exchange of data and policy experience is shared and disseminated by many regional working groups. These initiatives do not, however, focus on the economic valuation of island ecosystem services and how to incorporate it into policy. This should be addressed by better linking ecosystem services valuation to regional working groups' missions and work programmes. In addition, economic valuation datasets are not specifically relevant to the economic valuation of ecosystem services in SIDS. Most existing economic valuation initiatives are not set up to provide information to decision-makers in government and business to help them include environmental factors in their policies. The exception is Envalue, which is the only policy-oriented dataset as commissioned and maintained by the New South Wales Government, Australia.

SIDS could provide information for an island ecosystem services, policy-oriented, valuation dataset, which reflects their specific priorities, and become pioneers of natural capital and ecosystem accounting that follows the principles of the System of National Accounting. However, with the exception of Mauritius, most current NCA initiatives are not taking place in SIDS. (Another exception is the Republic of Trinidad and Tobago as it is part of a pilot for Project for Ecosystem Services – see Box 6.11.)

Box 6.11: The Project for Ecosystem Services (ProEcoServ)

ProEcoServ is a Global Environmental Facility-funded umbrella project aimed at incorporating ecosystem services into resource management and decision-making. Its goal is to better integrate ecosystem assessment, scenario development and the economic valuation of ecosystem services within sustainable national development planning.

Building on studies undertaken as part of the Millennium Ecosystem Assessment (2005a), five countries will focus on site-specific assessments; close involvement of national and local stakeholders; and tools, models and methods to help decision-makers integrate ecosystem management into national development policies.

ProEcoServ combines three distinct but linked components: Support Tools for Policy Making – development and application of multi-scale and locally valid tools and decision support models for development planning and policy-making; Assistance for Policy Implementation – support for the application of ecosystem and ecosystem service management at national and transboundary levels; Bridge between Science and Policy – strengthening science-policy interaction to reinforce links between local and international actors, and bridge the gap between research results and policy application in developing countries and the international biodiversity arena.

Source: www.proecoserv.org

In this context, the gap between research results and policy application (see Box 6.1) refers to the coordination and integration of these initiatives into the valuation and accounting of SIDS' ecosystem services. A SIDS global partnership could focus on supporting valuation initiatives that support both private and public bodies to improve their decision-making. Such a platform could also facilitate the design of a long-term action plan, such as the UK's National Infrastructure Plan, and promote sustainable development with respect to natural capital, which is fundamental to SIDS' economies and the well-being of their populations.

Photo Credit: © MattJP, Flickr

> *"What we measure affects what we do; and if our measurements are flawed, decisions may be distorted."*
>
> *(Stiglitz, Sen and Fitoussi, Commission on the Measurement of Economic Performance and Social Progress, 2009)*

7 Policy application case studies

7.1 The use of economic valuation and accounting to support policy decisions in small island developing states

Ecosystems valuation and accounting is fundamental to policy-making. First, it allows policymakers to assess the economic and human cost of damage to, or overexploitation of ecosystems services.

Second, it helps them recognize the contribution of ecosystem services to national production and outputs. Development, industrial, and environmental management policies can only be effectively designed if the value of every input to production is measured. For instance, policymakers focusing on technical efficiency[50] might concentrate on the industrial use of a scarce resource in areas where the productivity of the relevant ecosystem service is high. Or, if their focus is on maximizing economic returns, policymakers might decide to use all of the resource in the production of a particular good or service, despite negative impacts on technical efficiency.

Third, once policymakers know the profitability of a given sector, they need to quantify how much is produced (using ecosystem services) and the economic returns that can be derived from it. Lastly, ecosystem services valuation and accounting can be used in conjunction with biophysical information. This provides data on the availability of a particular ecosystem service and/or the sustainability of its commercial exploitation. Both sources of information must be used to guarantee the sustainability of economic activities that use ecosystem services. Table 7.1 summarizes the above.

To inform policy responses in addressing these concerns, it is important to understand how valuable ecosystem services are to small island developing states' (SIDS) economies. This chapter presents several case studies that highlight the practical and policy importance of ecosystem services valuation and accounting.

Table 7.1: Policy implications of ecosystem services valuation and accounting

- Provides quantitative values of various benefits and costs
- Measures and quantifies the costs of not introducing policies
- Provides information on the degree of efficiency and profitability of a selected market/sector where ecosystem services are used in production
- Helps inform ecosystem services management
- Informs decisions on trade-offs
- Provides information that can be combined and compared with ecosystem biophysical accounting from a sustainable development perspective

7.2 Case studies on existing markets in small island developing states and their policy implications

Freshwater valuation and the measurement of trade-offs across economic sectors

Economic and accounting valuation methodologies involve a four-step protocol that starts from an estimate of the marginal productivity of freshwater in the production of selected market goods and finishes by recording the value in monetary terms for inclusion in national accounts. This information is useful for policymakers. Cobalt

50 Technical efficiency is the effectiveness with which a set of inputs is used to produce an output. A company is said to be technically efficient if it is producing the maximum output from the minimum quantity of inputs, such as labour, capital and technology.

production, for instance, presents diminishing returns, meaning that a small increase in freshwater use (e.g. 1%) corresponds to a less than proportional increase in the production of cobalt (0.43%). Cobalt production is therefore not technically efficient, and so the more cobalt that is produced, the larger (than proportional) the amount of freshwater needed. An ecosystem's equilibrium could therefore be disrupted by excessive exploitation of freshwater for cobalt production. The use of freshwater in agriculture, on the other hand, is more technically efficient; however, cobalt is more profitable than, say, rice. The trade-off policymakers face – ecosystem services conservation versus profitability – is thus clearly defined, which means they can choose options according to their agenda or preferred criteria. Policymakers need ecosystems valuation and accounting information to make these choices.

Coastal tourism markets and investment in natural capital

Tourism is an important driver of economic growth in SIDS. In a seminal study, Onofri and Nunes (2013) estimated and measured the impact of ecosystem services in tourist destinations worldwide. The authors identified two preference classes of tourists visiting coastal destinations. International tourists choose a particular coastal destination because they prefer cultural and natural environments. This is related to the extent of the country's coastal habitat and marine biodiversity (often located in coastal protected areas). Domestic tourists have a preference for beaches, with their size – determined by anthropogenic pressure, the built environment and climatic variables – a crucial factor. This information can be used to develop coastal tourism, as well as identify market-based policy instruments to finance environmental and cultural conservation within coastal communities.

For the purposes of this guidance manual, the 2013 study has been 'scaled down' to only include SIDS. The technical details (empirical modelling, estimation techniques and results) are presented in Annex D. The study shows that variables such as beach length and the number of coastal protected areas play a key role in identifying factors that affect international tourism demand in SIDS (see Table 7.2).

Table 7.2: The marginal impact of selected ecosystem services characteristics on coastal tourism in small island developing states

Economic sector	Marginal impact	
	Beach length[b]	Coastal protected areas[c]
International arrivals[a]	1.56	2.90

[a] = number of international arrivals to the country (UN-WTO)
[b] = kilometres of beach in the destination country (World Vector Shoreline, NOAA)
[c] = number of marine and coastal protected areas in the destination country (World Database on Marine Protected Areas)

The marginal impact for beach length is 1.56, which means that a 1% increase in length (measured in kilometres) drives a 1.56% increase in the number of international tourists visiting the coast. In SIDS therefore management of, and investment in beach length might be a good way of attracting tourists to the coast and boosting local economies. Beach length management, for example, could focus on promoting rigorous terrestrial and marine coastal planning so as to avoid further fragmentation of beaches caused by excessive commercial and residential exploitation of coastal areas.

In addition, the marginal impact of coastal protected areas on the number of international tourists visiting SIDS is estimated at 2.9. This means a 1% increase in the number of coastal protected areas drives a 2.9% increase in international visitors to the coast. The study shows that international tourists are attracted by the abundant coastal habitats and marine biodiversity of SIDS; this information can be used to create and implement tourism policies. This argument becomes even stronger when SIDS estimates are compared with global estimates:[51] globally, the estimated coefficient for 'coastal protected areas' equals 1.44; in SIDS, it is 2.9.

It is worth noting that many SIDS have the highest number of coastal and marine protected areas per country worldwide. The conservation and protection of coastal areas can therefore be interpreted as a good investment in attracting international tourists. One way to do this is to use market-based instruments. Policymakers can

51 See Onofri and Nunes (2013).

levy green taxes – payment for ecosystem services, such as airport arrivals tax, hotel taxation – that international tourists pay as a contribution to national management, and conservation programmes and initiatives. This type of taxation is both an incentive (tourists contribute to a product they benefit from and policymakers receive an income to protect it) and economically viable. Economic valuation results fully support the introduction of the Green Fee in the Republic of Palau (see Box 7.1).

Box 7.1: Green Fee in the Republic of Palau

The Republic of Palau is home to some of the world's greatest biodiversity, including 1,300 species and varieties of plants, fish and birds and 700 species of coral. The sustainable management of such rich natural resources involves a continuous, substantial investment in the environment. This is funded by a tourist departure tax, of which US$15 is the Green Fee. This initiative began in November 2009 and has since raised approximately US$1.5 million annually. The board of directors of the Protected Area Network manages the fund and the financing of local community conservation groups that look after the Republic of Palau's protected areas. 'A sustainable financing mechanism for protected areas, including wetlands, is something we all aspire to achieve. To see the advancing steps made by the Republic of Palau with the Green Fee and how it can help generate community action is to be congratulated – this is a very good model for others to follow,' said Joe Aitaro, former Protected Areas network coordinator at the Ministry of Natural Resources, Environment and Tourism, Republic of Palau. The money raised by the Green Fee also contributes to the Endowment Fund, which will help the Republic of Palau achieve its promise under the Micronesia Challenge. This is a commitment by the chief executives of the Federated States of Micronesia, the Marshall Islands, the Republic of Palau, the Northern Mariana Islands and GUAM to conserve at least 30% of the near-shore marine resources and 20% of the terrestrial resources across Micronesia by 2020. More recently, the Green Fee has been also used to improve the Republic of Palau's water and sewerage system. In 2012, it was increased to US$30, with 50% going to water and sewer operations. 'This is a success story for Palau,' said Umiich Sengebau, the country's Minister of Natural Resources, Environment and Tourism. 'The success of such a project really requires political will and support, as well as a community that is really aware of the funds and how they can help drive conservation efforts.'

Source: Republic of Palau national government website, 'Protected Areas Network of Palau' presentation of H.E Elbuchel Saddang, Minister of Finance, Republic of Palau, and personal communication from H.E Umiich Sengebau, Minister of Natural Resources, Environment and Tourism, Republic of Palau, technical workshop on valuation and accounting of ecosystem services of SIDS, New York, United Nations Headquarters

Although additional studies in each country are needed to define individual market characteristics, the evidence suggests ecosystem services can increase revenue/income and job creation in various sectors.

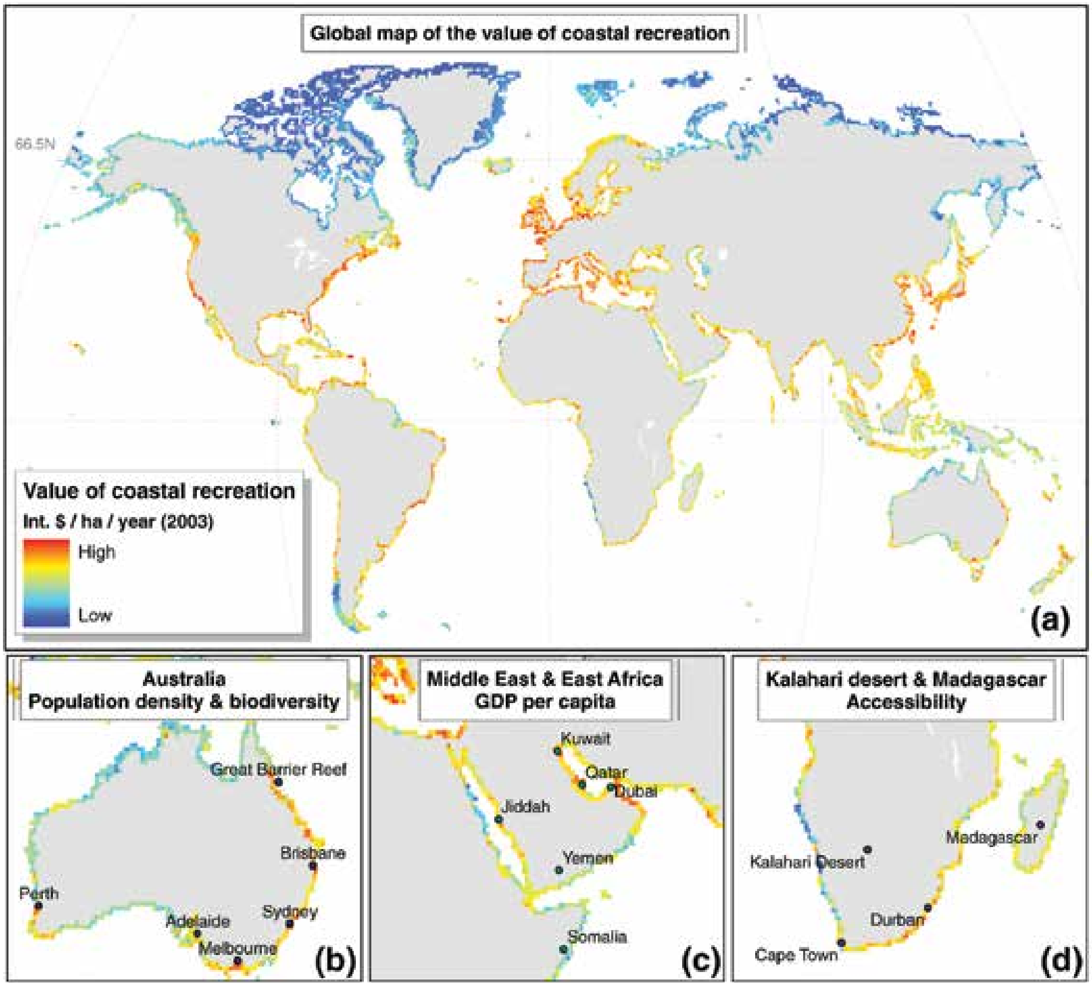
The use of geographically specific ecosystem services value maps and the communication of ecosystem services to stakeholders

This section uses geographically based econometric valuation analysis to create ecosystem services value maps, using the Ghermandi and Nunes (2013) study adapted to SIDS. First, a global database of primary valuation studies focusing on the recreational benefits of coastal ecosystems was created. Second, the characteristics of the built coastal environment (accessibility, anthropogenic pressure, human development level), natural coastal environment (presence of protected areas, ecosystems type, marine biodiversity), geo-climatic factors (temperature, precipitation) and socio-political context were added to the data. Third, a meta-analytical framework was built using geographic information systems, which defined the geography of the ecosystems being valued (see Annex E for additional technical information).

These were combined to create the first global map of coastal recreation valuation for SIDS. The three boxes (see Figure 7.1) contain three regional SIDS maps – i.e. AIMS, Caribbean and Pacific. They present the valuation results in more detail, and show how the valuation mechanism is geographically specific and how the size of the impact changes in each area.

The use of geographic information systems allows policymakers to identify the size and geographic distribution of coastal recreation, ecosystem services valuations in SIDS and provides a location-specific evaluation of the effect of variables such as population density, richness of marine biodiversity, anthropogenic pressure, human development and site accessibility.

Figure 7.1: Global and small island developing state maps showing the value of coastal recreation



The economic value maps can be used to inform policy, tell the public about the monetary value of ecosystem services, and integrate it into maritime and coastal spatial planning negotiations. The maps also play a crucial role in identifying and ranking coastal area conservation priorities from a socio-economic perspective. Furthermore, when combined with marine biodiversity indicators, analysts can map and classify each grid-cell level (e.g. high-high, low-low, high-low, low-high) with respect to economic value and marine biodiversity indicators. The combination of this information across different islands can also help identify priorities for the conservation of large coastal areas. Last, these maps are also important communication tools. Not only do they raise awareness – e.g. by identifying areas with high/low ecosystem services values – but also by informing policy debate, identifying communities that rely most on ecosystem services and determining the habitats and people affected.

7.3 Case studies involving emerging markets in small island developing states and how these can inform policy

In the context of ecosystem services valuation and accounting in SIDS, and associated policy-making, the biotechnology sector, which relies heavily on ecosystem services and natural resources, is important. The term biotechnology[52] refers to the use of living organisms or their products for commercial purposes. In fact, Colwell (1987) recommends that islands and small nations explore the potential of the marine biotechnology unique to their regions. Marine-derived pharmaceuticals, and the genetic engineering of marine and estuarine animals and plants for food production, have economic potential for island states. At the 2004 meeting of the United Nations

52 Biotechnology is the use of living systems and organisms to develop or make useful products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use." (United Nations Convention on Biological Diversity, Art. 2.) There are different types of biotechnologies: red refers to medical processes; green to agricultural processes; white to industrial processes; and blue biotechnology to marine and aquatic applications.

Organization for Industrial Development (UNIDO), it was recognized that: 'Biotechnology can bring to the Latin American and Caribbean region sustainable food production and a secure economic system, creating a competitive agrifood sector and generating additional rural incomes.'[53]

Biotechnology relies heavily on the use of ecosystem services as production inputs. However, the economic performance of the sector is often difficult to assess, value and measure, since it is still developing. Nonetheless, ecosystem services are used and accounted for in biotechnology applications through a contractual system discussed in the following sections. It is worth highlighting that the valuation and accounting of ecosystems services differs according to the levels of natural resources exploitation. Policymakers, therefore, need to consider the way ecosystem services are used so they can devise different valuation and accounting strategies.

Emerging biotechnology markets in small island developing states

Biotechnology comprises a broad spectrum of applications that include the development of new crop varieties that can adapt to climate change, disease and pest resistance, and promote food security; the development of new drugs; diagnoses of human diseases; the development of forensic practices through DNA fingerprinting; and gene therapy to treat hereditary conditions. There are several applications and success stories in SIDS – e.g. the creation of the Biotechnology Centre in the University of West Indies in the Republic of Trinidad and Tobago (see Annex F for a summary of biotechnological activities in SIDS).

Generally, however, it is hard to identify the policy instruments available to analysts to exploit the economic value of the biotechnology sector because, as they are emerging markets, ecosystem services valuation and accounting cannot be carried out.

One instrument that helps regulate access to, and the trade of, ecosystem services in relation to biotechnology in SIDS is the material transfer agreement. This type of agreement is the result of complex negotiations that occur between the ecosystem service 'provider' and the ecosystem services 'recipient', and regulates the access and exchange of genetic and biological material for research and development. An example is the memorandum of understanding (MoU) between French Polynesia and the Biocode Consortium.[54] It is worth noting that the MoU does not prescribe a monetary value; it only refers to the Convention of Biological Diversity (CBD) and the Bonn Convention for the sharing of non-monetary benefits. In this example, the benefits to the French Polynesian community are not necessarily to do with remuneration. In order to better understand the benefits of MTAs, Onofri (2014)[55] analysed all publically available MTAs, provided by the United Nations World Intellectual Property Organization and CBD (see Box 7.2 for information on the structure of the contract).

Box 7.2: The structure of material transfer agreements

In this sample, providers that contractually authorize access and trade resources are mainly governmental bodies (36%), national research centres and universities (55%). The rest include international public institutions and research organizations. All contracts are long-term (3–25 years) and 32% of the providers are from developing countries. Not all contracts mandate payment for resources, nor do they prescribe monetary/non- monetary rewards for allowing access to them.

In addition, MTAs include a variety of obligations (see Table 7.3). Only 46% of the contracts analysed contained an obligation to pay for access to/use of raw materials. In addition, 50% of the contracts included the possibility of sharing royalties in the event a new product was successfully commercialized and marketed. Forty-two per cent of the contracts contained an obligation to strengthen capacity – i.e. the contract provided for the transfer of scientific knowledge, expertise and technology from the recipient of the ecosystem service to the provider.

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53 Rangel-Aldao (2004).

54 This MoU also includes the University of California Berkeley and its Natural History Museums, the Centre National de la Recherche Scientifique and the Ecole Pratique des Hautes Etudes, the Association for Marine Exploration, the Florida Museum of Natural History, the Smithsonian Institution, the Institut de Recherche pour le Développement and the Muséum National de Histoire Naturelle in Paris. This is intended to create an exhaustive inventory of the genetic resources of Moorea Island in French Polynesia, including all terrestrial and marine species of wild fauna and flora, using the new genetic-barcoding approach. Samples are collected at the Moorea Ecostation and barcodes are obtained from partners' foreign laboratories and Biocode Consortium members (see Annex G for more information).

55 Material Transfer Agreements: an Economic Analysis, Ecological Economics vol. 107, p422–430.

Table 7.3: Examples of contract obligations

Contract provision/Description	%
Payment obligation • an obligation to pay for access to /the use of resources	46
Royalties-sharing obligation • the contract contains the possibility of sharing in case any products are commercialized and marketed	50
Capacity-strengthening obligation • the contract provides for the transfer of scientific knowledge, expertise and technology from the recipient to the provider. The capacity-strengthening obligation has different manifestations: everything from data, research and results-sharing to organizing training courses and teaching activities	42
Exclusivity obligation • the contract is exclusively between provider and recipient, and none of the parties can stipulate other (resource access/exchange) contracts with third parties	58
Acknowledgement obligation • an obligation to quote and acknowledge the provider and resource provenance in scientific publications, data collection and work derived from the study of the trades/accessed material	40
Reporting obligation • an obligation to periodically report to the provider about the research activities of the recipient	30
Confidentiality obligation • an obligation to use information/data/materials confidentially	22
Traceability obligation • an obligation to track all activities and scientific operations related to the study of the resource. In particular, the recipient shall maintain records concerning the handling, storage and physical movement of the samples, and provide such records to the provider	6
Returning the samples obligation • an obligation to return the material samples, once the contract duration is terminated	2
Maximize local economies obligation • an obligation to undertake all possible activities in order to contribute to the growth of local economies	10
Biodiversity preservation obligation • an obligation to undertake all possible activities to conserve biodiversity in the place from where the resource is taken	12
Create a market for the material and related products obligation • an obligation to undertake all possible activities to create a market for material and related products (usually agricultural seed)	6
Performance standards obligation • obligation to follow qualitative standards set by the provider in the performance of the scientific activity (e.g. the obligation to follow defined protocols and procedures for the sample collection)	4
Commercialization obligation • a variable obligation that is relevant if the contract provides for the recipient to commercialize the material/its derivative	14

Source: Onofri (2013)

Due to the lack of data and quantitative information about ecosystem services valuation and accounting, and in the absence of systematic and homogenous development of the sector, MTAs are relevant to policy-making in SIDS.

SIDS governments should stipulate capacity-strengthening obligations in MTAS, especially when negotiating the use of genetic material. This will benefit local populations, and although there may be economic benefits, these won't be the main component. However, if the monetary benefits are part of a contractual obligation, the country's institutional context should be taken into account.

It is vital, therefore, to identify all parties involved in such a financial deal: should local communities or national government (i.e. a more top-down approach) take on the role of provider? If there is no agreement on this matter, analysts can suggest payments-in-kind, including investment in ecosystems and infrastructure such as laboratories, hospitals and roads. Analysts could also explore the potential for royalty-sharing, and thus guarantee additional income in the event that any products are commercialized in the future.

Annex A

Factors affecting the perception, use and valuation of ecosystem services in developing countries

Poverty levels

The primary demarcation between the developed and the developing world is the presence and persistence of poverty – all issues developing countries face can be traced back to poverty. The Millennium Development Goals can be expressed in terms of a single overarching target – the ending of world poverty.[56] Poverty is usually expressed in terms of income inequality; extreme poverty is defined as those living on less than US$1.08 per day[57] but it is widely recognized as a complex issue with various causes and manifestations.

Furthermore, the relationship between poverty and environmental resources is controversial. The well-known and much-tested Kuznets curve defines an inverse relationship between income per capita and environmental degradation, though this does not empirically hold true for all environmental indicators.[58] It is a widely held and debated view that poverty is a major cause and effect of environmental problems,[59] due to a high rate of time preference and the resultant discounting of future incomes at extremely high rates.[60] The poor are often seen as compelled to exploit their surrounding environment for immediate and short-term survival,[61] including in marginal and protected areas. Thus, poorer segments of society can themselves become unwitting agents of environmental degradation. They are also the communities assumed to be most vulnerable to, and affected by, natural resource degradation.[62]

Poverty levels affect how communities value ecosystem services. The provisioning, regulating, and supporting of natural resources and cultural services have different values according to the poverty levels and their extent in the communities under study; this influences the choice of technique used to identify such values. Traditional thinking assumes that a high dependence on resources implies a high value is placed on provisioning services. This seems a reasonable hypothesis and some empirical investigations of this are discussed in the following section. However, it does not immediately follow that if use-values are high, non-use values are non-existent. Montgomery (2002) claims that public knowledge and preference for biodiversity are low even in developed countries, let alone developing ones. There has been little analysis of the importance of non-use values of the environment to communities in developing countries.[63] If they exist, and their magnitude can be estimated, they have significant policy implications for improving the well-being of poorer communities in developing countries.

It is essential to ascertain the levels of poverty in the country being studied before a valuation exercise is undertaken. First, poverty may have associated characteristics (such as literacy) that have specific consequences for the deployment of a particular valuation exercise. Second, if the aim of the valuation study is to alleviate poverty using resource management policies, it is futile to press ahead without better understanding how poverty levels affect the way resources and their uses are regarded.

Rural subsistence-based livelihoods, common property and open-access resources

Nearly 70% of populations in developing countries live in subsistence-based, rural communities.[64] This leads to pressure on, and degradation of, natural resources.[65] There is a great emphasis on agriculture as a source of rural income and employment in developing countries;[66] in Sub-Saharan Africa, for example, 58% of the total workforce is employed in agriculture.[67] Notwithstanding this, valuation studies overlook the value of the income from natural resources in developing countries and instead focus on the amenity values of developed countries.[68]

56 Millennium Development Goals Report (2008).
57 MDG Report (2008).
58 Dietz and Adger (2003); Casey et al. (2008).
59 Muphree (1993); Moseley (2001).
60 Dasgupta (1997); Heltberg (2002).
61 Sylwester (2004); Batabyal and Belabi (2006); Hartter and Boston (2007).
62 Brundtland Report (1987); Casey et al. (2008); Ghermandi and Nunes (2013).
63 Casey et al. (2008).
64 World Bank (2004); Hartter and Boston (2007).
65 Heltbery (2002); Sylwester (2004); Batabyal and Belabi (2006); Hartter and Boston (2007); Muhammed et al. (2008).
66 Batabyal and Belabi (2006); Editorial, Global Environmental Change 18 (2008).
67 United Nations Human Development Report (2007/08).
68 Deacon et al. (1998); Dasgupta (2001); Pattanayak and Buttry (2005).

In response to this research gap, there exists a recent and growing body of literature that attempts to quantify the relationship between communities and natural resources in developing countries.[69] These studies highlight the importance of natural resources in daily life, the vulnerability of communities if they are over-exploited and how effective resource management is essential to their future well-being. One conclusion from these studies is that as income rises, the percentage of it that depends directly on the resource declines. Fisher (2004), discussing the variation in resource-income share with total household income, points to a more controversial implication: that if resource collection (e.g. mining) is viewed as a low-wage activity that's avoided as income increases, resource management can help alleviate poverty but not reduce it. By contrast, Narain (2008), in a study on rural India, found that resource collection, far from being a low-wage activity, is in fact a productive source of income, capable of lifting pay above subsistence levels and thus reducing, rather than just alleviating poverty.

It is widely accepted that the resources relied upon by rural households in developing countries are common property (the commons)[70] – their degradation is a major problem for developing countries.[71] These resources, which are often under huge pressure, are mainly renewable – i.e. rangelands, agriculture, fisheries and forest resources.[72] Both these facts have implications for effective resource management and sustainable development, where both a profiling of the types of resources being exploited and existing property rights are essential.

Hazari and Kuma (2003) model the relationship between basic needs, property rights and the commons. They found that poorer households raid the commons to satisfy basic needs, while richer households do so to make profit. Therefore, reducing degradation of the commons involves a dual policy approach: alleviating poverty by meeting basic needs and enforcing property rights. Nahrain et al. (2008) point to the role of common property resources as a buffer for poor households from sudden drops in income. Goeschl and Igliori (2006) discuss the sustainability of different scenarios, in which indigenous communities exploit reserves, in the context of property rights. They point to the importance of researching property rights within the broader development context, rather than focusing on the best management of the targeted resource.

It is inevitable that a high dependence on open access or common property resources, together with a lack of, or improperly designed and enforced property rights can lead to conflicts over resource use and ownership. Management regimes designed to deal with such conflicts exist in many countries but they are seen as inferior to wide-ranging statutory ones and do not properly incorporate traditional management practices. Much research has been carried out on both the successes and failures of common property resources management in diverse societies around the developing world, with the aim of either replicating or avoiding the good and bad parts.[73] Quinn et al. (2007) discuss the community management practices of common property resources in 12 villages in Tanzania. They found the management regimes to be vulnerable (in particular when confronted by change) and highlighted the areas in which these could be strengthened (instead of replaced) by stronger institutions. They emphasized the importance of local context to the further study of this type of resources management.

Conflict over land-use and property rights can also be a problem when creating protected areas. Whereas such conservation efforts in developed countries generally involve in-situ and ex-situ measures that are geographically separate from local communities, in the developing world the poverty and population pressures on scarce land can change the dynamic.[74] Skonhoft (2007) points to rapid population growth as the major source of land-use conflict between wildlife conservation and rural development. Negative attitudes to wildlife conservation among local people stem from policies that attempt to displace rural communities, curtail traditional access to natural resources or prevent them from eliminating 'nuisance' wildlife that threatens their crops and livestock.[75]

Rural communities' livelihoods and their interaction with environmental resources are complex issues and are subject to a host of inter-connected social, economic and institutional characteristics.[76] It is therefore essential that, first, valuation studies are made of these interdependencies, and second, that the issues are researched and understood. Any valuation study on communities in developing countries must begin with analysis of the community's dependence on resources, and the status of existing property rights regimes. This informs the relative

69 Hartter and Boston (2007); Narain (2008).
70 Heltberg (2002); Quinn et al. (2007); Narain et al. (2008).
71 Hazari and Kumar (2003).
72 Batabyal and Belabi (2006).
73 Heltberg (2002).
74 O'Connor (2008).
75 Johannesen and Skonhoft (2005); Skonhoft (2007).
76 Hartter and Boston (2007).

value of ecosystem services and therefore the choice of the most appropriate valuation technique. Such a study can also inform the design of effective policy measures to sustainably manage resources and alleviate or eradicate poverty.

Energy profiles, food security and water scarcity

A basic requirement for social and economic development is access to modern energy.[77] Approximately 25% of the world's population has no access to electricity, and approximately 39% rely on biomass to meet cooking and heating needs; the latter is true for a staggering 80% of the population in Sub-Saharan Africa.[78] This has significant biodiversity implications when habitats such as woodlands and forests are relied on to fulfil such needs. A lack of energy access has significant impacts on the socio-economic conditions of rural people in developing countries and implications for how they interact with their surrounding environment and natural resources. Some of the main indicators of poverty and sustainable development are based on energy use frameworks.[79]

The relationship between energy and poverty reduction is significant but complex.[80] Food security is closely linked to energy consumption and is a major factor in natural resource consumption.[81] Improving access to energy can have a direct bearing on health, education, income and the environment.[82] In developing countries, women are responsible for the collection of fuel and water; as such, improvements to energy access can improve gender equality and women's empowerment (the fifth of the Sustainable Development Goals[83]). Improvements to energy access can also have significant consequences for the natural environment. It can alleviate pressure on biomass resources, including alleviating the pressure on biomass resources with immediate and long-term impacts locally, regionally and internationally.[84]

Taele (2007) outlines the energy profile of the Kingdom of Lesotho as representative of other Sub-Saharan African countries. Rural populations have poor access to energy resources, with biomass accounting for approximately 69% of national energy consumption. Wood is the main source but the pressure on resources from a growing population means communities also rely on supplementary fuel sources such as animal dung and agricultural residues. This has implications for deforestation, erosion and loss of soil fertility.

Water availability is also significant factor in an economy's development.[85] Directly affected by climate change, access to water is not a challenge faced by the developing world alone, but water stress and water security are particularly relevant to rural subsistence-based communities that are heavily dependent on agriculture and that lack water infrastructure. Water scarcity is likely to increase as climate change effects kick in: it is estimated that by 2080, the number of people facing water scarcity due to climate change could increase by 1.8 billion.[86]

Vulnerability

The degree to which a country is considered 'vulnerable' is another way of evaluating a country's developmental status. Vulnerability can be defined as the potential for loss due to a multitude of factors that include economic, geographic and socio-political.[87] In terms of economic vulnerability, the susceptibility of the economy to extreme events – whether external economic shocks or internal fragility – can be assessed; small island economies that are exposed to external markets can be particularly vulnerable in this respect. Geographically, countries can be vulnerable to extreme natural events. Socio-political factors refer to the vulnerability of local populations to internal conflicts.

These different measures of vulnerability also interact together to affect the impacts of each. Within the context of biodiversity valuation, it is vulnerability to environmental change, whether global or local, that is important. The vulnerability of developing countries to climate change in particular is an issue that has received a lot of research and policy focus recently.[88]

77 Saha (2003); Dias et al. (2006); Kanagawa and Nakata (2007); United Nations Human Development Report (2007/08).
78 Kanagawa and Nakata (2007); United Nations Human Development Report (2007/08).
79 Kemmler and Spreng (2007).
80 Kanagawa and Nakata (2007).
81 Hartter and Boston (2007).
82 Kanagawa and Nakata (2007).
83 http://sustainabledevelopment.un.org/sdgsproposal.html.
84 Saha (2003).
85 Turpie et al. (2008).
86 United Nations Human Development Report (2007/08).
87 Turvey (2007).
88 Turvey (2007).

Many of the factors already described play a role in, and are affected by, the degree to which a developing country is vulnerable. As mentioned previously, poorer households in rural communities use environmental resources as a buffer to sudden drops in income. Countries that are largely subsistence-agriculture based are economically vulnerable to water scarcity and extreme environmental conditions such as droughts or hurricanes.[89] Countries are vulnerable to changes in resource availability if food security is directly linked to natural resource consumption. However it is defined, the extent to which a country is economically and environmentally vulnerable can also be affected by foreign debt levels, which restrict its ability to respond financially to sudden changes.

The extent of a country's economic development can also affect its ability to respond to events. Clearly, extreme environmental events such as hurricanes do not affect developing countries alone. However, Noy (2009) finds that the consequences of hurricanes for developing economies are much greater than those for developed countries. The difference is that the recovery rates from such events differ significantly between the two.

The role that ecosystems can play in disaster reduction and mitigation must also be considered.[90]

Biodiversity valuation studies that have policy guidance as their main objective must take into account the vulnerability of both the community under study and the country within which the community resides. As they are able to capture the social, economic and environmental diversity of communities, local assessments of vulnerability are particularly important.[91] The complex relationships between local communities in developing countries and the biodiversity resources on which they rely affect, and are affected by, their degree of vulnerability.

Governance and institutional weaknesses

Good governance is recognized as one of the key factors in reducing poverty and stimulating economic development.[92] However, good governance as a concept, and the governance reforms that must take place in order to achieve it, can be unrealistic and can take too long to implement.[93] Hence the notion of 'good enough' governance, which defines minimum conditions of improved governance that are necessary for development and poverty reduction.[94]

Corruption and lobbying are two features of 'resource-curse hypothesis' literature. Natural resource curse theory suggests that countries abundant in natural resources experience slower economic growth than those with fewer resources. Davis and Tilton (2005) studied the resource curse in countries with mineral reserves, where political control of mining income not only increased economic inequality but also led to a decline in the quality of governing institutions.

Institutions in many developing countries are characteristically weak.[95] This has direct implications for environmental resource use and management. For example, Quinn et al. (2007) highlight the role of institutions in the management of common property resources. Institutional and government failures are one of the causes of environmental destruction – through the introduction of environmentally damaging policies or the inability to resolve competing objectives.[96] Skonhoft (2007) highlights weak institutions as one of the reasons for conflict over conservation and land use. Governance and institutional infrastructure also have a direct bearing on the effectiveness of international aid and donor agencies.[97]

Weak governance directly affects the impact of policies introduced as a result of environmental valuation – usually through a lack of action or implementation.[98] Indeed, institutional competence can often determine the success or failure of a policy response.[99] Gatzweiler (2006) suggests the different types of governance necessary for the organization and management of biodiversity conservation, and the effective delivery of the resultant ecosystem services. Many market-based incentive mechanisms for biodiversity conservation have been created in response to

89 Editorial, Global Environmental Change (2008).
90 Pérez-Maqeuo et al. (2007).
91 Editorial, Global Environmental Change (2008).
92 Pérez-Maqeuo et al. (2007).
93 Grindle (2004).
94 Grindle (2004); Fritz and Menocal (2007).
95 Grindle (2004).
96 Heltberg (2002).
97 Fritz and Menocal (2007).
98 O'Connor et al. (2008).
99 Millennium Ecosystem Assessment (2005); Engel et al. (2008).

weak government and institutional capacity in developing countries.[100] Biodiversity valuation exercises need to be conducted with knowledge of local political, social, economic and institutional frameworks. Analysts must then determine how best to embed these values into the decision-making process.

Informal economies

The notion of an 'informal sector' or 'informal economy' was first suggested by Arthur Lewis in his seminal 1954 paper, Economic Development with Unlimited Supplies of Labour. This dual sector, industrial/agricultural model noted that the large subsistence sectors of developing countries had an unlimited supply of labour that the industrial sector absorbs as economic growth occurs.

The informal economy, as its name suggests, can be defined as economic activities that are not, either in law or practice, officially covered by formal regulations.[101] It can sometimes be maligned as comprising mainly criminal activities but while it can include them, the majority of informal activities comprise legal goods and services.[102] Informal economies are a strong feature of many developing countries[103] and are related to many other factors discussed previously. Informal activities were initially seen as a means of alleviating poverty; weak governance allows them to thrive. Because they operate outside mainstream economic activity, informal activities are not covered by official economic and employment statistics; this has implications for any policy-making and analysis that is based on official figures. As a result, much research has been devoted to estimating the size of informal economies in developing countries.

The presence (in various sizes and guises) of informal economies can pose a huge challenge for biodiversity valuation and natural resource management. In countries where much economic activity is not reported, dependence on official economic statistics can be misleading. This has implications for valuation methods such as revealed preference, which rely on secondary data and reported statistics. A broader issue is working out to what extent the informal sector relies on ecosystem services and which values are important. Casey et al. (2008) argue that non-use values in the informal sector can be significant.

Indigenous communities

The issue of indigenous or traditional native communities that have had historical access to resources is not one limited to developing countries. In many developed countries, indigenous communities represent a small percentage of the overall population.[104] Goeschl and Igliori (2006) claim that indigenous peoples successfully manage many of the world's most important biodiversity areas.

The protection of indigenous rights to biological diversity is an issue of property rights over common resources. Such peoples tend to face discrimination, poverty, under-development and a lack of economic well-being[105], and so there exists large social disparity between indigenous and non-indigenous peoples.[106]

Many resource-use decisions in developing countries are based on traditional norms.[107] Furthermore, it is claimed that a large proportion of subsistence-based populations who exploit biodiversity for economic livelihoods are indigenous peoples – O'Connor (2008) asserts this in the context of forestry resource use, in particular. Casey (2008) highlights the importance of non-use values to indigenous peoples in Brazil. Sattout et al. (2007) point to the symbolic and cultural values associated with biodiversity resources in developing countries – this can be particularly true for indigenous communities.

There is a need for further study of indigenous communities' attitudes to, and uses of, resources in the developing world. Any resulting valuation exercises and policy advice should include respect for the human rights of indigenous peoples.

100 O'Connor et al. (2008).
101 Becker (2004).
102 Becker (2004).
103 Becker (2004).
104 Duncan (2003).
105 Duncan (2003).
106 United Nations Human Development Report (2007/08).
107 Quinn et al. (2007).

Intellectual property rights and genetic resources

Intellectual property rights are a major issue of debate in economic development literature.[108] The sovereignty of each state over its genetic resources, its ability to control access and its responsibility to negotiate the fair and equitable sharing of benefits resulting from their exploitation is explicitly recognized by the Convention on Biological Diversity (CBD).[109] By ruling out open access to genetic resources, the CBD has established that biodiversity value exists, which owners can negotiate.[110]

This can have a tremendous impact on developing countries, as a considerable amount of valuable genetic material is found in rural and indigenous communities in the developing world.[111] The conditions, not only of access but also of benefit sharing, become of paramount importance therefore. The CBD recognizes the role of indigenous communities and traditional lifestyles in the conservation and management of genetic resources. The state therefore has the responsibility to ensure the fair and equitable sharing of benefits, which some claim also increase biodiversity conservation.[112]

The issue of access to, and the sharing of, genetic resources is affected by many of the factors discussed here. The welfare of indigenous communities in the developing world can be affected in a number of ways including: by the role their traditional knowledge can play; by the benefits they can accrue from selling genetic resources; and by the disadvantages they face if they are denied access through loss of property rights.

The degree to which resource use exists within the informal sector also poses challenges for the equitable sharing of benefits. Benefit sharing becomes paramount if, in a country with poor governance and weak institutions, the nation is compensated in the agreement but corrupt officials take the income instead of passing it on to the rural communities where the resources are located. Communities' use of biodiversity for their immediate energy, food and water needs also becomes relevant if bio-prospecting and property rights arrangements prevent them from doing so.

Gender issues

Poverty has a gender as well as a geographical aspect.[113] Women comprise 70% of the world's population living in absolute poverty.[114] Where economically active, women in developing countries tend to operate more in the informal than the formal economy.[115] The third Millennium Development Goal is the promotion of gender equality and the empowerment of women.[116] There are a number of factors that restrict the participation of women in the productive (as opposed to the reproductive) economy.

Cultural norms can dictate their societal (household) roles, which often come with significant time burdens. The responsibility of these household duties can also fall to the female children, limiting their access to education and their future participation in the economy. The lack of time for rural household women and children is related to energy security, food sources and water scarcity. In developing countries, a lot of time is spent collecting potable water and fuel. Studies in developing countries show that women can spend between 28 and 35 hours per week collecting water. In Sub-Saharan Africa, a study estimated that women and girls could save hundreds of hours per year if they could source fuel and potable water from within a 30-minute walk of their homes.[117]

Property and inheritance rights can lead to limited access and control of resources. Deda and Rubian (2004) note that women hold title to less than 2% of the world's private land. Notwithstanding this, the participation of women in the agricultural sectors of developing countries is significant, constituting up to 80% of agricultural labour in some places.[118] In male-dominated societies where women use more resources, there can be considerable impacts on the type and effectiveness of the valuation method used. For example, in countries where local experts are most likely to be men, tools such as the Delphi method have limited relevance. Deda and Rubian (2004) looked

108 Trommetter (2005).
109 Nunes et al. (2007); Nunes and Markandya (2012).
110 Nunes et al. (2007).
111 Nunes and Markandya (2012).
112 Trommetter 2005, Nunes and Markandya (2012).
113 Alvarez et al. (2006).
114 Deda and Rubian (2004).
115 USAID (2006).
116 Millennium Development Goals Report (2008).
117 USAID (2006).
118 USAID (2006).

at consultations with men and subsequent policy interventions that came to nothing because the results were not passed on to the women, who were the main users of the resources.

The issue of property rights over genetic resources is also increasingly relevant. In developing countries, women often rely heavily on genetic resources for crop production and food security; they also have indigenous knowledge of biodiversity. As such, the patenting of resources and intellectual property rights in developing countries can both benefit from the involvement of women and affect their welfare. Alvarez et al. (2006) argue that existing social structures significantly affect the distribution of benefits from genetic research to women.

The CBD explicitly recognizes the vital role of women in the conservation and sustainable use of biodiversity. While it affirms the need for the full participation of women in biodiversity conservation and policy-making, there is little specific guidance on how to achieve these objectives.[119] There have been recent initiatives to examine gender issues within the context of biodiversity and analyse how women's participation can be secured and improved. The consensus is that women have an important role to play.[120] Lack of female participation in decision-making in national and international organizations, the lack of knowledge of women's biodiversity use in rural communities and the lack of policies to ensure the fair sharing of income from biodiversity continue to be matters that require urgent attention.

Health

The sixth Millennium Development Goal targets health issues, with the aim of combating HIV/AIDS, malaria and other major diseases such as tuberculosis.[121] The most serious disease is currently HIV/AIDS: more than 35 million people are currently living with HIV.[122] Developing countries, in addition to the other challenges they face, are hardest hit, with Sub-Saharan Africa in particular facing a severe crisis. Seventeen per cent of Zambia's population in the 15–49 age range is infected with HIV/AIDS – the world's highest infection rate.

This creates new levels of vulnerability in affected populations, and significant economic and social changes. As the workforce becomes increasingly depleted, economic productivity declines. There are significant social impacts as more and more households lose family members and are headed by children who sacrifice their own education to look after the victims, the younger members of the household and those orphaned by illness. Health crises make already vulnerable populations more vulnerable, and make them less resilient to environmental changes and external events.

In addition to pandemic crises, many developing countries lack adequate health care and services, which leads to morbidity, disability and death from otherwise curable ailments.

Health issues related to energy use, food security and water scarcity are also relevant, where the lack of access to potable water in particular can cause persistent ailments.

Literacy and education

Development can be seen in terms of economic growth or in terms of meeting human needs. The two are not unrelated, of course: it is often argued that the former is a necessary condition for the latter. However, the consideration of human needs directs focus more on the way growth is achieved, how it is distributed and how livelihoods are affected in the process.[123] The role of literacy in economic development is an interesting debate.

Anderson (1966) estimated that development requires an adult literacy rate of 40% (though the necessary role of other support systems is also discussed). Azariadis and Draden (1994), examining the developmental history of 32 countries between 1940 and 1980, concluded that where literacy was not present, rapid growth was not achieved. In 1964, UNESCO, the United Nations Development Programme, and the governments of 11 countries (the People's Democratic Republic of Algeria, the Republic of Ecuador, Federal Democratic Republic of Ethiopia, the Republic of Guinea, the Republic of India, Iran, the Republic of Madagascar, the Republic of Mali, Sudan, the Syrian Arab Republic, and the United Republic of Tanzania) engineered a unique international approach to tackling illiteracy

119 Deda and Rubian (2004); Alvarez et al. (2006).
120 Alvarez et al. (2006).
121 Human Development Report (2007/08).
122 www.amfar.org/worldwide-aids-stats/.
123 Paran and Williams (2007).

through the Experimental World Literacy Programme. The countries' subsequent lack of economic development shows that literacy is not the only causal factor.

Literacy can affect biodiversity valuation in developing countries in a number of ways. From a practical perspective, survey instruments that require basic literacy levels may be unusable in areas of illiteracy. From a methodological perspective, it is has been suggested that low levels of literacy can create a barrier to the valuing of complex environmental goods (though this is highly debatable).[124] From a philosophical perspective, literacy, as a basic human right, contributes to human well-being and should thus inform sustainable development policy decisions.

Foreign debt

Developing countries face varying levels of external debt, some of which is unsustainable. Debt payments can form a large part of a country's expenditure, which compromises its ability to tackle internal developmental and social challenges.

Migration, remittances and the brain-drain factor

Both intra- and inter-country migration are significant factors in developing countries. Intra-country movements from rural to urban settings increase urban environmental pressures; this is a worldwide phenomenon, not limited to developing countries. In developing countries, inter-country migration (both legal and illegal) is significant and is caused by poverty and a perceived lack of opportunity.[125] In this context, the role of remittances (money transfers by a foreign worker to their home country) can, in certain developing countries, play a huge factor in national economic development. In small island developing states (SIDS), migration and remittances are particularly important for domestic economies, accounting for significant percentages of gross domestic product. In the context of biodiversity valuation, migration and remittances within developing countries can change the socio-economic conditions in communities. The brain-drain phenomenon – the emigration of educated people – should also be recognized because it affects domestic research capacity.[126]

Internal conflicts and displaced peoples

Some developing countries face intense internal conflicts and the resultant mass movements of migrants and refugees — Sub-Saharan Africa, for example, is one of the most conflict-ridden areas in the world. Internal conflicts can affect communities' use of environmental resources in a number of ways: war zones can lead to significant environmental destruction; in the case of lucrative mineral resources, appropriation for personal gain can deny much of the population access to, or benefits from, resources; and the movement of displaced peoples can affect both the country in conflict and the country of refuge, where huge influxes of refugees can put significant strain on local environmental resources.

Ethical issues

There are a limited number of empirical studies on the ethics of research in developing countries.[127] Ethical norms and requirements differ depending on the types of studies being conducted; however it is generally accepted that the principles of 'informed consent' should be applied and upheld in all research.[128]

Informed consent in the context of developing countries has generated considerable theoretical debate. Some argue there may be contradictions between the principles of informed consent, and cultural norms and practices in developing countries; others question the competency of individuals to provide consent.[129] In certain contexts, oral consent is seen as more appropriate than written consent, particularly in situations where literacy (particularly in the language where the study is being carried out) is an issue.

Group approval and community consent is particularly important in developing countries. Some argue that the consent of a village leader instead of individual consent may be more appropriate.[130] Even if individuals are approached for their approval, an understanding of the decision-making hierarchy in communities is essential to

124 Christie et al. (2008).
125 Editorial, Global Environmental Change 18 (2008).
126 Christie et al. (2008).
127 Hyder and Wali (2006).
128 Hyder and Wali (2006); Newton and Appiah-Poku (2007).
129 Hyder and Wali (2006).
130 Hyder and Wali (2006).

ensure positive participation, as access can be given or denied by community leaders. Community consent should be seen as a complement to, rather than a replacement for, individual consent, with community consent sought first and individual consent sought second.[131]

An understanding of the relevant cultural norms when carrying out primary data collection in developing countries is essential. Not only is this important in terms of informed consent and ethical best practice but also in terms of gaining access to, and successfully interacting with, the communities with whom the valuation exercises are being conducted.

Photo Credit: © Aaron Vuola, UNEP

131 Newton and Appiah-Poku (2007).

Annex B

Databases

This annex aims to classify the quantitative rankings of factors discussed in the previous paragraph in reference to small island developing states (SIDS),[132] and thus identify where relevant statistics and indices need to be created or modified. For some of these factors, there exist qualitative rankings only; in other cases, subjective judgement may be applied.[133] However, for many of the issues discussed, it is possible to obtain a range of quantitative estimates.

Three databases in particular are useful: the United Nations Environment Programme GEO data portal, the Environmental Vulnerability Index, and the Millennium Development Goals indicators database. In addition, the World Bank's World Development Indicators (WDI) offer a variety of easily accessible, recent statistics on a range of topics that include balance of payments, development frameworks, environment, exchange rates and prices, external debt, financial statistics, government finance, national accounts, social indicators and trade. Within these datasets, it is possible to obtain calculations at regional and national scale that are relevant to some of the factors. The World Bank's EdsStats, HNPStats and GenderStats databases provide additional statistics. Many of the factors that are not highlighted (or indirectly referenced) by the WDI can be found in other, more subject-specific databases and publications of the World Bank and UNEP.

Using these databases, it is possible to populate most of Table B.1 (see below) with relevant status indicators per factor. However, it is sometimes the case that data for SIDS does not exist or is out of date. For example, vulnerability can be captured in selected case studies using a variety of specific indices and studies. Turvey (2007), for example, provides a comprehensive analysis of the types of vulnerability indices relevant to SIDS. These indicators are a good place to start in terms of gaining a better understanding of the local conditions and context within which a valuation study should be framed. Three of the factors are not directly or indirectly covered by these databases: governance and institutional weaknesses, and intellectual property rights and genetic resources.

Table B.1: Quantitative assessments of influential factors in small island developing states

Factor/Indicator	Source
Poverty levels	
• Human development index	UNDP
• Multi-dimensional poverty index	UNDP
• Poverty headcount ratio at the national poverty line	WDI
• Income share held by the poorest quintile of the population	WDI
• Percentage of population below the poverty line, rural and urban	MDG Indicators
• Percentage of urban population living in slums	MDG Indicators
Rural subsistence-based livelihoods, common property, open-access resources	
• Agricultural land	WDI
• Value added of the agricultural sector	WDI
• Total forest acreage	WDI
• Proportion of households with access to secure tenure	UN-HABITAT
• Total rural population (projection)	UN-DESA
Energy profiles, food security, water scarcity	
• Electric power consumption (KWh per capita)	WDI
• Energy use (kg of oil equivalent per capita)	WDI
• Proportion of population using solid fuel	MDG Indicators
• Percentage of the population with access to improved water sources	UN-WHO
• Renewable internal freshwater resources per capita	UN-WHO
• Prevalence of malnutrition in children under five	UNICEF
• Improved drinking water coverage, rural, urban and total	UN-WHO
• Internal renewable water resources per capita	MDG Indicators
• Percentage of undernourished population	MDG Indicators

132 All these factors and statistics are applicable to any country, developing or otherwise.

133 Indigenous communities, ethical issues and empirical challenges are not considered here as they do not require (and are not suitable for) quantitative ranking; instead the discussion of these factors in Annex A is meant to inform the valuation exercise relative to its specific context.

Factor/Indicator	Source
Vulnerability	
• Environmental vulnerability index	SOPAC-UNEP
• Case-study specific estimates available in academic literature	
Governance and institutional weaknesses	
• Not routinely monitored by international organizations	
• Case-study specific estimates available in academic literature	
Informal economies	
• Female urban informal sector employment	GenderStats
IPR and genetic resources	
• Not routinely monitored by international organizations	
• Case-study specific estimates available in academic literature	
Migration, remittances, brain-drain	
• Net migration	WDI
Internal conflicts, displaced peoples	
• Refugee population by country of asylum	UNHCR
• Refugee population by country of origin	UNHCR
Health	
• Life expectancy	WDI
• Child mortality rate	WDI
• Incidence, prevalence and death rates of tuberculosis	MDG Indicators
• Incidence, prevalence and death rates of malaria	MDG Indicators
• Percentage of population between 15-49 years infected with HIV	WDI
• HIV infections by gender	HNPStats
• AIDS deaths	MDG Indicators
• Children orphaned by HIV Aids	HNPStats
• Percentage of antiretroviral therapy coverage among people with advanced HIV	HNPStats
• Contraceptive prevalence in the 15-19 age group	HNPStats
• Percentage of urban population with access to sanitation facilities	WDI
• Improved sanitation coverage, rural, urban and total	UN-WHO
• Fertility rates	UN-WHO
• Adolescent fertility rates	WDI
• Percentage of births attended by skilled health staff	WDI
	WDI
Gender issues	
• Gender-related development index	UNSD
• Ratio of girls to boys in primary and secondary education	WDI
• Labour force participation rate by gender	UN-DESA
• Female urban informal sector employment	UN-DESA
• Gender parity index in primary, secondary and tertiary education	MDG Indicators
• Female-controlled households	HNPStats
Literacy and education	
• Adult literacy rates	UNESCO Stats
• Primary school completion rate	WDI
• Internet users per 100 people	WDI
• Net enrolment rates in primary and secondary education	UNESCO Stats
• Net enrolment in primary education by gender	MDG Indicators
• Internet users, personal computers per 100 population	MDG Indicators

Source: Teelucksingh and Nunes (2010), adapted

Informal economies can be added to this list, since the one indicator deemed relevant in Table B.1 does not give a complete picture of the size or status of a country's informal economy and the database is unavailable for most developing countries. These four factors may be undervalued or difficult to value at aggregate levels. Indicators may exist in academic publications for specific case study sites only.

There is a growing body of academic literature on empirical estimations of the size of informal economies in specific case studies in both developing and developed nations. Similarly, assessing intellectual property rights and genetic resources in developing countries has been the subject of recent research (see Section 7.3 for analysis of genetic resources in SIDS, including bioprospecting and biotech activities).

Corruption indices used by global watchdog organizations can help quantify the extent of governance and institutional weakness.

Photo Credit: © Taro Taylor, Flickr

Annex C

Economic variables and their Cobb Douglas estimates for the Ankeniheny-Zahamena Corridor, the Republic of Madagascar

Table C.1 provides an overview of the selected variables for the mining and agriculture sectors in the Ankeniheny-Zahamena Corridor (CAZ).

Table C.1: Data and selected variables used for empirical analysis

Economic sector variable	Description
Mining sector [a]	
Quantity/Output	Quantity of cobalt and nickel in tonnes produced per year
Labour	Total number of white- and blue-collar workers employed per year
Machinery	Machinery used in production, measured in capital investment per year
Energy	Total amount of electricity (in kW/h) used in production per year
Land	Total amount of land (in ha) devoted to mining per year
Water	Total amount of water (in m^3) used in production per year
Agriculture sector [b]	
Quantity/Output	Quantity in tonnes of produced rice, manioc, number of households' farm animals in 12 selected administrative areas within the CAZ per year
Labour	Number of farmers and/or breeders active in production per year
Sickle	Number of sickles used in production per year
Land	Total amount of land (in ha) devoted to agriculture/farming per year
Water	Total amount of water (in m^3) used in production per year

Source:

[a] Ambatovy Sustainability Report (2010); Ambatovy Supporting Growth and Development In Madagascar (2010); Ernst & Young Extractive Industries (2010) and Transparency Initiative, EITI, Madagascar

[b] Enquéte Périodique auprés de Ménage, Ministerè de l'Etat, Charge l'Economie et de l'Industrie (2010); Recensement De l'Agriculture, Ministére de l'Agriculture de l'Elevage et de la Peche (2005); Observatoire du Riz; Rapport Final, Renforcement de la Disponibilité et de l'Accès aux Statistiques Rizicoles: une contribution à l'initiative d'urgence pour le Riz en Afrique Subsaharienne (2010); Centre National de Recherche Appliquée au Développement Rural Service de la Statistique Agricole; Conservation International Madagascar Regional Development Plans

In the CAZ, the principal tourist attraction site is Andasibe Park, where indri lemurs and many autochthon flora and fauna species are protected. There are 19 hotels of different categories with a total of 454 beds. Table C.2 presents an overview of hotel supply in the CAZ.

Table C.2: Data on hospitality infrastructure in the CAZ

Hotel/Lodge	No. rooms	No. suites	No. bungalows	No. lodging	Total no. beds
Vakona Forest Lodge	0	0	26	26	42
Bezanozano	11	3	16	30	49
Andasibe	0	0	12	12	20
Feon'ny Ala	0	0	44	44	72
Site Eulophiella	0	10	7	17	28
Zama Meva	7	0	0	7	11
Espace Diamant	17	13	0	30	49
Hazavana	10	0	0	10	16
Tsara	5	1	0	6	10
Les Orchidees	7	0	0	7	11
Max'irene	26	0	0	26	42
Paradis Du Lac	0	9	0	9	15
Motel Restaurant Mialy	7	0	0	7	11
Rindra	9	0	4	13	21
Espace Mirindra	12	0	4	16	26
Diamant Vert	1	0	0	1	2
Manantena	2	0	0	2	3
Ny Aina Antanandava	2	0	0	2	3
Vohitsara	14	0	0	14	23
Total	130	36	113	279	454

Source: Portela et al. (2012) and based on figures from Moramamga Tourism Office and the World Tourism Organization

Using World Trade Organization data, which provides an average value of the number of beds per room nationally, the number of beds can be calculated, along with the number of tourists visiting per day and the annual water consumption per tourist in the CAZ. Taking into account (i) the total number of rooms across all hotels and lodges in the CAZ (ii) the World Trade Organization average number of beds per room (1.63 in the Republic of Madagascar) and (iii) Vakona Forest Lodge occupancy rates of 87.8%, 142,677 beds were occupied on average during 2010. Using average water consumption per dwelling per day for this region (see Portela et al. 2012), the total annual water demand per tourist in the CAZ ranges from 12,934 to 17,245 m^3 (see Table C.3).

Table C.3: Water consumption in the ecotourism sector in the CAZ

Hotel and lodges located in the CAZ	
Number of rooms	279
Number of beds	454
Occupancy rate (over 360 days)	87.8%
Overnight stay (average number of days per tourist)	4.6
Overnight stay (minimum and maximum number of days per tourist)	4.0 – 5.4
Average water consumption per tourist (m^3 per day)	0.96-1.28
Lower and upper estimates of total annual water (m^3)	12,934-17,245

Source: Portela et al. (2012) and based on data from Vakona Forest Lodge, and World Tourism Organization data for the Republic of Madagascar

Table C.4: Cobb-Douglas estimates for the rice, manioc and farm animals (all variables in logs)

Sector Production/Input variables	Coefficient estimate
(1) Rice	
Water	0.92***
Sickle	0.03
Work	0.17*
Land	0.09**
Constant	1.61*
R-squared	0.98
(2) Manioc	
Water	0.82***
Sickle	0.04
Work	0.10*
Land	0.35**
Constant	2.14
R-squared	0.96
(3) Farm animals	
Water	0.93***
Work	0.01*
Constant	8.63***
R-squared	0.98

*** = statistically significant at 1%; ** = statistically significant at 5%; * = statistically significant at 10%

Table C.5: Cobb-Douglas estimates for the mining sector (all variables in logs)

Nickel	Coefficient estimate
input variables	
Work	-0.260*
Land	0.59***
Machinery	-0.66***
Energy	0.05*
Primary_ materials	0.06**
Water	0.70***
Constant	24.82***
R-squared	0.40

*** statistically significant at 1%; ** statistically significant at 5%; * statistically significant at 10%

Table C.6: Cobb-Douglas estimates for the mining sector (all variables in logs)

Cobalt input variables	Coefficient estimate
input variables	
Work	0.49**
Land	0.10*
Machinery	0.15*
Energy	-0.48***
Primary materials	0.03**
Water	0.43**
Constant	8.91*
R-squared	0.28

*** statistically significant at 1%; ** statistically significant at 5%; * statistically significant at 10%

Annex D

Modelling tourism flows for small island developing states

The objective is to estimate the economic value of ecosystem services by calculating their impact on consumer behaviour. This is expressed in the level of tourism demand for small island developing states (SIDS) – i.e. the number of international arrivals – and can be used to design policies accordingly.

The empirical modelling strategy relies on the following behavioural reasoning: when selecting a coastal destination, tourists make choices for psychological reasons (i.e. preference for the destination, its attributes and characteristics) and economic reasons (i.e. budget and time constraints).

The final destination choice is based on a series of choices, which affect the type of tourism offered. Tourists can prefer the same destination – e.g. the coast – for different reasons,[134] and their choice will therefore shape the demand for coastal tourism. This demand can be split into segments because the same destination will be chosen for different characteristics and attributes.

In order to capture the complex behaviour behind tourist choices – horizontal differentiation and tourist demand segmentation – a general framework is used that allows different segments of demand for the same kind of destinations to be estimated. In particular, tourist behaviour is modelled in terms of a set of simultaneous, interdependent decisions using a three-stage (or higher) decision-making process. First, tourists choose what kind of destination they wish to visit. Second, they choose which 'touristic segment' they want to experience within the destination. Third, they estimate a budget, and determine the frequency and length of stay. The final destination is chosen after these factors are considered. This three-stage model is described in Box D.1.

Box D.1: Estimating coastal tourism flows

(M1) Coastal tourism flows =

f (preference for the destination's characteristics; ecosystem services-based attributes; total expenditure; tourism market structure)

(M2) Tourists' market expenditure =

f (macroeconomic context; tourism market structure; socioeconomic and demographic features of the destination country)

(M3) Preference for the characteristic of the coastal destination =

f (recreational, climatic, ecosystem services-attributes of the selected destination)

Source: Onofri and Nunes (2013)

Equation (M1) models 'coastal tourism flows' and describes the total number of arrivals in a country as a function of destination attributes and characteristics, including both natural and built environments, and the total tourist spend in coastal destinations.[135] It is worth highlighting that the preferences for destinations in this study are identified by the market transaction (e.g. the choice of destination and the trip to the location; expenditure at the destination). Equation (M2) models tourists' expenditure and describes it within the macroeconomic context, market structure and the demographic of the destination country.[136] Equation (M3) (or rather, the set of equations – one for each coastal tourism segment) models the 'preference for the characteristic/attributes of the coastal destination'. For each tourism segment, this is determined by the relationship between the coastal destination and a set of attributes and characteristics, including both natural and built environments. In this context, equation (M3), models the (horizontal) segmentation of tourist demand and the factors that influence tourists' preferences

134 This may depend on different factors, such as personal taste, fads and fashions, the marketing strategies of the destination country, recreational characteristics and attributes of the destination.

135 The function is modelled with minimal variables. It describes a relationship between the number of arrivals (quantity) and total expenditure on tourism (price) as a demand curve. It would be interesting (and more rigorous), if it were possible to include variables on tourists' income and on other prices (that describe demand function) and tourists' socio-economic circumstances.

136 The dataset refers to aggregated coastal tourism flows without identifying its composition in terms of source countries.

as to where they visit. Horizontal segments are, in fact, mostly generated by appreciation of the various attributes of the destination. There will be as many attribute-based factors as the demand segments analysts want to model. Estimates are made using the three-stage least squares routine (see Table D.1 and Table D.2 for the results).

Table D.1: Estimates of worldwide coastal tourism (segmented) demand

Specification	Number of observations	International coastal arrivals R-squared	Domestic coastal arrivals R-squared
Equation 1	124	0.67	0.48
Equation 2	124	0.79	0.78
Equation 3a	124	0.42	0.49
Equation 3b	124	0.55	0.53
		International coastal arrivals	Domestic coastal arrivals
Equation 1: (Logarithm) Coastal arrivals			
(Log) Total expenditure		0.37***	0.03***
(Log) Number of UNESCO sites		1.27***	0.07*
(Log) Number of coastal protected areas		1.44***	0.30*
(Log) Beach length		0.24*	2.47***
Constant		8.02***	4.41*
Equation 2: (Log) Total expenditure			
(Log) Destination gross domestic product per capita		0.86***	0.87***
Population density on the coast		0.08	0.03
Constant		0.81	0.70
Equation 3a: (Log) Beach length			
(Log) Annual average precipitation		-0.20*	- 0.26*
(Log) Harbour		-0.58***	-0.62***
Constant		2.77	1.02
Equation 3b: (Log) Number of coastal protected areas			
(Log) Annual average temperature		0.69***	0.70***
(Log) Annual average precipitation		-1.08***	-1.06***
Biodiversity index mammals		0.11*	0.01***
Biodiversity index birds		0.08***	0.09***
(Log) Reef area		0.30*	0.37*
(Log) Wetlands area		0.23***	0.23***
Constant		2.99***	3.00*

*** = statistically significant at 1%; * = statistically significant at 5%
Source: Onofri and Nunes (2013)

Table D.2: Estimates of small island developing states coastal tourism (segmented) demand

Specification	Number of observations	International coastal arrivals R-squared	Domestic coastal arrivals R-squared
Equation 1	31	0.67	0.62
Equation 2	31	0.51	0.50
Equation 3a	31	0.40	0.49
Equation 3b	31	0.45	0.29
		International coastal arrivals	Domestic coastal arrivals
Equation 1: (Logarithm) Coastal arrivals			
(Log) Total expenditure		0.78*	1.08***
(Log) Number of UNESCO sites		0.59	0.03
(Log) Number of coastal protected areas		2.90 *	0.65*
(Log) Beach length		1.56***	2.45***
Constant		2.60	12.84***
Equation 2: (Log) Total expenditure			
(Log) Destination gross domestic product per capita		1.45***	1.43*
Population density on the coast		0.03	0.08
Constant		-4.9	-4.9***
Equation 3a: (Log) Beach length			
(Log) Annual average precipitation		-0.80	- 0.54
(Log) Harbour		-0.06	-0.08
Constant		12.94*	11.00***
Equation 3b: (Log) Number of coastal protected areas			
(Log) Number of plants		0.04***	0.18*
(Log) Number of mammals		-0.44**	-0.50*
(Log) Number of birds		0.47***	0.46***
Constant		2.43	1.64

*** = statistically significant at 1%; * = statistically significant at 5%

Source: Original research

Countries: Antigua and Barbuda, the Commonwealth of the Bahamas, Barbados, the Republic of Cuba, the Dominican Republic, Jamaica, Grenada, the Republic of Haiti, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Saint Lucia, Sint Maarten, the Republic of Trinidad and Tobago, Anguilla, Aruba, Bermuda, Guadalupe, Martinique, Puerto Rico, British Virgin Islands, Belize, the Republic of Colombia, the Republic of Costa Rica, the Republic of Guatemala, the Republic of Guyana, the Republic of Honduras, Mexico, the Republic of Nicaragua, the Republic of Panama, the Republic of Suriname and the Bolivarian Republic of Venezuela.

Annex E

Using geographic information systems to create value maps

The geographic information system study relies on location-specific analysis of recreation sites and their context to complement the data available from primary valuation studies. With the exception of gross domestic product per capita and political stability, all variables were evaluated using geographic information system analysis within 20km of the site in question. The value of each variable was estimated as an average within the buffer zone, with the exception of the human development variable, which was calculated based on whether the majority of the segments in the zone were in low, medium or high-development areas (see Table E.1 for more information on the variables used).

Geographic scale must be determined when using the value transfer technique. This study demonstrates the use of the value transfer methodology to produce a raster map of coastal values with a resolution of 0.5 degrees, which corresponds to about 55km at the equator. Each of the raster map's coastal grid cells was treated as a policy site to which values were ascribed using value transfer methodology. This was estimated as follows:

$$\ln(y_i) = a + b_V X_{Vi} + b_S X_{Si} + b_C X_{Ci} + u_i$$

where $ln(y_i)$ is the natural logarithm of the endogenous variable measured in 2003 US$ purchasing power partity/ha/year; the subscript i is an index for the value observations; a is a constant term; b_V, b_S and b_C are vectors containing the coefficients of the explanatory variables X_V (valuation study characteristics), X_S (site characteristics), and X_C (context characteristics); and u is an error term that is assumed to be well-behaved (see Table E.2 for estimates).

To create a map of coastal recreation ecosystem services values it is necessary to populate each of the coastal grid cells. The value of the moderator variables in all coastal locations and at the required scale must be used. A series of layers representing each one of the geo-referenced moderator variables were prepared with consistent projection, spatial resolution and extension. The original layers were re-projected in the geographic coordinate system WGS1984 and converted to raster layers with a cell dimension of 0.5 degrees. The spatial variables in the model were evaluated at the level of each grid cell. The map is composed of 12,854 grid cells, each characterized by a unique estimate of the value of ecosystem services and which take into account local context (see Figure 7.1.)

Photo Credit: © Chris Favero, Flickr

Table E.1: Explanatory variables

Group	Variable	Units and measurement	Mean (SD)	N
Study variables (X_v)				
Valuation method	Choice experiment	Binary	0.07 (0.26)	18
	CVM – open ended	Binary	0.12 (0.32)	30
	CVM – other elicitation	Binary (omitted)	0.25 (0.43)	63
	TCM – individual and RUM	Binary	0.35 (0.48)	89
	TCM – zonal	Binary	0.11 (0.31)	28
	Contingent behaviour	Binary	0.10 (0.30)	25
Marginal/total value	WTP to avoid degradation	Binary	0.15 (0.36)	38
	WTP for improvement	Binary	0.32 (0.47)	82
	Total value at current status	Binary (omitted)	0.53 (0.50)	133
Unpublished		Binary	0.63 (0.48)	159
Year of primary data		Years after first valuation (1974)	23.9 (6.52)	253
Site variables (X_s)				
(Partially) protected area[a]		Binary	0.45 (0.50)	114
Ecosystem type	Beach	Binary	0.24 (0.43)	61
	Reef	Binary	0.21 (0.41)	53
	Mangrove	Binary	0.04 (0.20)	11
	Lagoon or coastal marsh	Binary	0.06 (0.24)	16
	Estuary	Binary	0.05 (0.22)	13
	Other coastal ecosystem	Binary (omitted)	0.39 (0.49)	99
Ecosystem service	Recreational fishing	Binary	0.40 (0.49)	101
	Non-extractive recreation	Binary	0.78 (0.42)	197
Context variables (X_c)				
GDP per capita[b]		2003 US$/year (PPP, ln)	10.0 (0.81)	253
Population density[c,d]		Inhabitants per km^2 (ln)	4.77 (1.75)	253
Anthropogenic pressurec,[e]		Nutrients concentration (ton/km^2/year, ln)	0.41 (2.85)	253
Marine biodiversityc,[f]		Shannon index of biodiversity	3.84 (1.64)	253
Accessibility[g]		Travel time to nearest large city (hours, ln)	4.53 (1.04)	253
Human development	Low development[c,h]	Binary	0.57 (0.50)	143
	Medium development[c,h]	Binary	0.09 (0.29)	23
	High development[c,h]	Binary (omitted)	0.34 (0.48)	87
Political stability[i]		Political stability index	2.92 (0.63)	253
Heating degree months[j]		Degrees Celsius	49.4 (40.3)	253
Max monthly precipitation[k]		mm of precipitation	1270 (634)	253

[a] Based on World Database on Protected Areas, 2009 (www.wdpa.org)
[b] At country level, state level for the US
[c] Within 20km from the valued site
[d] CIESIN, Gridded Population of the World, v.2 (sedac.ciesin.columbia.edu/plue/gpw)
[e] Source: Halpern et al. (2008)
[f] Source: Ocean Biogeographic Information System, OBIS (www.iobis.org)
[g] Source: European Commission, Global Accessibility Maps (bioval.jrc.ec.europa.eu/products/gam/)
[h] Source: GLOBIO project (www.globio.info)
[i] Source: Kaufmann et al. (2009)
[j] Calculated by the authors, based on data from Community Climate System Model (www.ccsm.ucar.edu)
[k] Maximum monthly precipitation 1979-1999 (http://archive.wri.org/pubs/pubs_dataset.cfm?PubID=3874)

Table E.2: Value estimates (per grid cell, coastal recreation ecosystem services values)

Variable	Coefficient	95% confidence interval		P-value
Constant	-7.987	-14.510	-1.465	0.017
CV – open ended	-0.944	-1.713	-0.174	0.016
TCM – zonal	1.862	1.089	2.635	0.000
TCM – individual & RUM	0.937	0.377	1.497	0.001
Contingent behaviour	-1.639	-2.432	-0.847	0.000
WTP for improvement	0.863	0.326	1.400	0.002
Unpublished	-1.312	-1.870	-0.754	0.000
Year of primary data	0.144	0.106	0.182	0.000
Estuary	1.050	-0.228	2.328	0.107
Beach	1.860	1.087	2.632	0.000
Reef	1.667	0.826	2.507	0.000
Recreational fishing	1.697	0.956	2.439	0.000
Non-extractive recreation	3.387	2.585	4.188	0.000
GDP per capita (ln)	0.470	0.051	0.889	0.028
Population density (ln)	0.454	0.156	0.751	0.003
Low human development	1.972	1.367	2.577	0.000
Anthropogenic pressure (ln)	-0.239	-0.327	-0.150	0.000
Accessibility (ln)	-0.534	-0.984	-0.085	0.020
Marine biodiversity	0.290	0.144	0.437	0.000
Heating degree months	-0.008	-0.016	0.001	0.092

Source: Ghermandi and Nunes (2013)

Annex F

Biotechnology activities in Caribbean and Pacific islands[137]

The Commonwealth of the Bahamas

Eleuthera Island, the 'bread basket' of the Bahamas, is a major supplier of bananas, citrus fruit and pineapples. The Ministry of Agriculture supports the development of tissue-culture facilities to assist the mass production of citrus fruits and root vegetables, and to conserve and produce native orchids and ornamental flowers.

Barbados

Agricultural programmes to improve yam species (*Discorea alata*) started in 1979 with an emphasis on maintaining the market value of the cultivar White Lisbon, which was being attacked by the viral disease internal brown spot. Today, more than one million kilogrammes of seedlings are distributed to farmers in 11 CARICOM countries. A 40% increase in crop yield has been obtained with the use of 'clean' plant stock. Vesicular-arbuscular mycorrhizae inoculants for use with red kidney beans (*Phaseolus vulgaris*), winged bean (*Psophocarpus tetragonolobus*) and moth beans (*Vigna aconitifolia*) have been developed.

Belize

The Ministry of Agriculture is developing improved planting stock of cassava, yams and coconut, and is bioconverting crop residue into livestock and shrimp feed. Belizean technical staff are trained at Centro Agronocquo de Investigacion Esperanza. Distribution of vaccines and development of monitored regional immunization programmes to control the spread of Hepatitis B in infants and young children, and to reduce the impact of long-term liver disease. UNICEF, and the Australian and New Zealand governments sponsor the Hepatitis B project.

The Cook Islands, the Republic of Fiji, the Kingdom of Tonga, the Independent State of Samoa, the Republic of Vanuatu, the Solomon Islands and the Federated States of Micronesia

Establishment of regional fruit-fly project to control and eradicate fruit-fly infestation in fresh fruit and vegetables; implementation of plant-protection measures and the development of quarantine expertise.

The Commonwealth of Dominica

Biocontrol measures have been employed in a Caribbean Agricultural Research and Development Institute-developed techpak to contain and eliminate the outbreak of bacterial leaf scorch caused by the fungus *Pythium myriotylum* in cocoyam (*tannia*) *Xanthosoma sagittifolium.*

The Dominican Republic

The Global Environment Fund project dealing with the identification, logging, cultivation and use of medicinal plants; The Global Environment Fund project focusing on developing alternative models for biogas production; La Fundación Nacional para el Desarrollo de la Juventud Rural supports a project that produces biogas from swine-herd waste using 10 biodigestors.

The Federated States of Micronesia, the Republic of Kiribati, Tuvalu

Biological control of the breadfruit mealy bug in the Pacific.

The Republic of Fiji

Sustainable and strategic control of gastrointestinal parasites of ruminants using urea-molasses blocks.

The Republic of Fiji, the Republic of Kiribati and the Solomon Islands

Pacific Island pearl-oyster resource development.

137 DaSilva and Taylor (2004).

The Republic of Fiji, the Solomon Islands and the Republic of Vanuatu

Vector-borne diseases control project to eradicate mosquito-borne diseases – malaria, dengue fever and filariasis – which are major health problems in the Pacific.

Grenada

The banana industry is one of the mainstays of the Grenadian economy. The industry contributes about 3% of gross domestic product. A facility was set up in 1992 at Mt. Whaldeal, St. George to control and contain the spread of Moko disease, and eradicate the cause, *Pseudomonas solanacearum*. More than 4,000 plantlets per month are produced and distributed to banana growers. The European Commission/WINBAN Moko Disease Control programme supports the nursery's work and prevents the spread of the disease to the Windward Islands, which produce 25% of the world's exports of nutmeg and mace.

The Republic of Guyana

The National Agricultural Research Institute, in collaboration with the Food and Agriculture Organization of the United Nations, produces shoots from dormant axillary pineapple buds (*Ananas comosus*). About 8,000 plantlets of citrus fruits and tuber crops are produced per year for farmers to use. The distribution of sweet potato, plantain, cassava and pineapple plantlets for farmers for use in National Agricultural Research Institute station plots at Parika is part of a national strategy to boost employment and export sales. Finally, the Republic of Guayana is also responsible for the production of 25% of the world's exports of nutmeg and mace (Myristica fragrans).

Jamaica

- The Scientific Research Council sponsors the Tissue Culture Research and Development project that deals with the production of virus-free planting stock of the Irish potato *Solanum tuberosum*. Other Tissue Culture Research and Development activities deal with the micro-propagation of ornamentals, food crops and orchids. Among the food crops, the focus is on the production of tissue-cultured planting stock of yam species – e.g. *Dioscorea cayenensis, D. rotundata, D. alata* and *D. trifida.*
- Development of culture protocols for the growth and multiplication of *Heliconia* species and other ornamentals such as orchids, *Anthurium*, and leatherleaf fern (*Rumohra adiantiformis*).
- Development of the mushroom industry, using oyster mushrooms *(Lentinus sajor-caju).*
- Tissue-culture protocols for the development and distribution of plantlets for use by farmers, have been developed for food and cash crops, and for cut-flowers and ornamentals: sweet potato (*Ipomoea batatas*); *Alpinia purpurata* (ginger lily-pink); cassava (*Manihot esculenta*); *Aechmea nudicaulis*; Dasheen (*Colocasia esculenta*); *Heliconia*; plantain (*Musa* species); *Mussaenda erythrophylla*; breadfruit (*Artocarpus altilis*); jackfruit (*A. heterophyllus*); carambola (*Averrhoa carambola*); yam bean (*Pachyrhizus erosus*); cacao (*Theobroma cacao*); pineapple (*Ananas comosus*); sugarcane (*Saccharum officinarum*).

The Republic of Kiribati

Biocontrol of breadfruit mealy bug has been accomplished in the outer atolls; development of ecological corridors for fisheries in coral atolls in the Pacific.

The Republic of Kiribati, Solomon Islands, Tuvalu

Biochemical analysis of tuna purse seining in the Pacific Islands region.

New Caledonia

Prevention of the spread of HIV/AIDS and its impact on the Kanak population through community-based prevention strategies and sex education.

Pacific Islands

HIV/AIDS prevention activities; prevention and treatment of lifestyle (non-communicable diseases) such as diabetes, hypertension and heart disease; delivery and supply of vaccines to the peoples of the Pacific through the UNICEF Vaccine Independence Initiative in collaboration with AusAID, with a focus on self-sufficient funding rather than donors.

Independent State of Papua New Guinea

Cultivation of wild edible mushrooms and the development of tissue cultures at the University of Papua New Guinea, in collaboration with UNESCO. Brokenil orchid project, funded by the Global Environment Fund, focuses on the propagation of wild orchids on a community-owned farm in Simbu Province.

The Independent State of Samoa

Use of used brewers' grains for composting. Locally known as molo, and in combination with chicken manure, the mix is employed as a soil conditioner to increase the organic content and matter of soil substrates. Laboratory work carried out at Alafua Campus, University of the South Pacific, in collaboration with UNESCO.

St. Kitts and Nevis

The Ministry of Agriculture supports a major agricultural diversification programme that develops the production of non-sugar agriculture and marine biotechnology. This strategy safeguards against volatility in the sugar exports market and complements the ongoing tissue-culture production of tuber crops.

St. Vincent and the Grenadines

The Chinese Technical Mission has introduced tissue culture for yams and orchids; the French Technical Mission provides assistance to develop greenhouses; the UNESCO Biotechnology Action Council has provided fellowship opportunities for training in the Republic of Trinidad and Tobago; support for research on the development of resistant pepper and tomato genotypes to bacterial spot disease caused by *Xanthomans campestris var. vesicaloria.*

Solomon Islands

The development of marine reserves to restore and manage tropical multi-species fisheries; large-scale village trials for producing giant clams.

The Republic of Trinidad & Tobago

The Department of Plant Science, St. Augustine Campus, University of the West Indies has pioneered plant tissue culture research with an emphasis on the rapid propagation and improvement of agricultural and horticultural crops of economic importance in the region. With Organization of American States sponsorship, teaching and research programmes focus on: the development of protocols for monitoring plant germplasm health and quality for economically significant species; ensuring the appropriate biocontrol and quarantine measures are in place to improve yam, sweet potatoes and cassava crop yields. Activities are carried out in cooperation with FAO, UNESCO, UNDP, the Ministry of Agriculture, the International Center for Tropical Agriculture, the French National Institute for Agricultural Research and the International Institute of Tropical Agriculture.

The Kingdom of Tonga

Focus on enhancing the sustainability of nutrient cycling in cropping and pasture systems; a producer, with the Republic of Vanuatu, of a high value, low bulk cash crop – vanilla (*Vanilla planifolia*).

The Republic of Vanuatu

Reef reseeding research looking at topshell (*Trochus niloticus*) in north Australia, east Indonesia and the Pacific.

Annex G

Material transfer agreement: French Polynesia and the Moorea Biocode Consortium

Table G.1 Terms of the memorandum of understanding

Parties	
Provider: French Polynesia	Recipient: Moorea Biocode Consortium

Purpose:
Research the biodiversity and ecological processes in Moorea to improve global scientific knowledge and to support local management and development initiatives, including training and public outreach activities in French Polynesia.

Objectives:

- To compile a comprehensive inventory of Moorea's genetic resources, including all species of wild fauna and flora – plants, animals, algae, fungi and some microbial groups (hereinafter referred to as the biotic inventory
- To test new technological and scientific approaches to the analysis of biodiversity patterns and ecological processes in general
- To make materials and information available to the research community

Type of genetic resource: Genetic resources, including all species of wild fauna and flora

Ex situ conditions: Yes

In situ conditions: Yes

Permitted uses under the contract: Transfer and use of genetic resources collected during the Moorea Biocode Project (hereinafter referred to as the material)

Permitted uses under agreement:

- To collect biological samples in accordance with the laws and regulations of French Polynesia
- To process and store material at the Moorea Ecostation and to transfer it to other laboratories and museums belonging to the Biocode Consortium, where various methods will be used to study the material, including morphological and molecular techniques such as 'genetic barcoding'
- To take all appropriate, reasonable and necessary measures to import the material in accordance with relevant laws and regulations, and to contain the material, its progeny or derivatives so as to prevent the release of invasive alien species
- To only use the material, its progeny or derivatives for the common good in scientific research, education and conservation
- Not to sell, distribute or use the material, its progeny or derivatives for profit or any other commercial application
- To make information about the samples, the location of materials and scientific results publicly available through the Biocode Portal, the websites of the Biocode Consortium members, and other global biodiversity information networks, including the Global Biodiversity Information Facility, the Consortium for the Barcode of Life and the Genbank
- To acknowledge origin of the material from French Polynesia and the contribution of the Moorea Biocode Project, and to make reference to the memorandum

Date: Not specified

Duration: Not specified

Parties	
Provider: French Polynesia	Recipient: Moorea Biocode Consortium

Renegotiation: Not specified

Contract price/payment: Not specified

Intellectual property rights: Not specified

Applicable laws and regulation

- Organic law n°2004-192 of 27 February 2004, concerning the self-governing status of French Polynesia and the law n°2004-193 of 27 February 2004 completing the self-governing status of French Polynesia
- Decree n°1355/PR of 19 April 2008 03017/PR modified, appointing the Vice President and the others ministers of the Government of French Polynesia and defining their responsibilities
- General agreement n°7.0879 of 24 October 2007 for cooperation between French Polynesia and the Regents of the University of California
- Convention on Biological Diversity, 5 June 1992
- Bonn Guidelines adopted at the World Summit on Sustainable Development, Johannesburg in 2002

Dispute Resolution: Not specified

PIC: Required

Non monetary benefit sharing: The benefits arising from use of the material in accordance with the Convention of Biological Diversity and the Bonn Guidelines to be shared fairly and equitably

Monetary benefit sharing: Not specified

Model contract/provisions: Not specified

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United Nations Environment Programme
P.O. Box 30552, 00100
Nairobi, Kenya
Tel: + 254-02-762 1234
Email: publications@unep.org
Web: www.unep.org

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