The Economics of Ecosystems and Biodiversity for Southeast Asia (ASEAN TEEB)

Scoping Study

9 November 2012

ASEAN CENTRE FOR BIODIVERSITY

Foreign & Commonwealth Office

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

asean

Authors/Consultants
Dr. Luke Brander and Dr. Florian Eppink

Year of Publication: 2015

The Economics of Ecosystems and Biodiversity for Southeast Asia
(ASEAN TEEB)

Scoping Study

9 November 2012

Acknowledgements

The ASEAN TEEB scoping study has been prepared with support and input from numerous organisations and individuals. Thang Dinh Dang (Ho Chi Minh City University of Economics) provided assistance in collecting and reviewing valuation studies of ecosystem services in Southeast Asia. Dr. Pham Khanh Nam (Ho Chi Minh City University of Economics) provided input to the case study on the Hon Mun marine protected area, Nha Trang Bay, Vietnam. Prof. Dr. Pieter van Beukering (Institute for Environmental Studies, VU University Amsterdam) provided input to the case study on the Leuser ecosystem, Sumatra, Indonesia. Alfred Wagtendonk (Institute for Environmental Studies, VU University Amsterdam) conducted the GIS analyses underlying the case studies on mangroves and coral reefs. Jenny Mihaly (ReefCheck) provided data on visitor numbers to coral reefs in Southeast Asia for the case study on coral reefs. Suggestions for case studies for a full ASEAN TEEB study were received from a large number of contributors including ACB National Contact Points, ASEAN Senior Officials on the Environment, and participants of the ACB Advisory Board meeting (Siem Reap, August, 2012). Case study suggestions were also received from Edmund Rico (Flora Fauna International - FFI), Caroline Piñon (World Agroforestry Centre - ICRAF), Kharmina Paola Anit (International Rice Research Institute - IRRI), Yumiko Kura (WorldFish Center), and Anna Paddenburg (WWF). Useful comments on the report were received from Mr. Neville Ash (Division of Environmental Policy Implementation), Dr. Lena Chan (Singapore National Parks Board), Dr. Theresa Mundita Lim (Philippines Department of Environment and Natural Resources) and the participants of the side event on ASEAN TEEB at the Convention on Biological Diversity, 11th Conference of Parties (Hyderabad, October 2012).

Table of Contents

Executive summary	1
Introduction	2
Background	2
The Economics of Ecosystems and Biodiversity (TEEB)	3
Gathering evidence on the value of ecosystem services for SE Asia	6
Introduction	6
Database of ecosystem service valuation studies for SE Asia	6
Overview of ecosystem service values for SE Asia	6
Identification of key ecosystems and ecosystem services	10
Key ongoing initiatives in Southeast Asia	10
Case studies	13
Mangrove ecosystem service values	13
Coral reef ecosystem service values	20
Leuser forest ecosystem, Sumatra, Indonesia	25
Hon Mun marine protected area, Nha Trang Bay, Vietnam	30
Identification and recommendations for future ASEAN TEEB studies	32
Appendix 1: Overview of economic valuation methods	35
Appendix 2: Bibliography of ecosystem service valuation studies for SE Asia	37
Appendix 3: Value transfer method used in the mangrove and coral reef case studies	46

Executive summary

- The objective of the ASEAN TEEB study is to pursue the mainstreaming process of the economics of ecosystems and biodiversity through the assessment and valuation of key ecosystems and services in Southeast Asia and assist ASEAN member states to develop green growth economies.

- The aims of the scoping study are to: 1. Gather and review the existing evidence on the value of ecosystem services in Southeast Asia, and to identify key critical ecosystems and ecosystems services in Southeast Asia; 2. Conduct an initial set of case studies to highlight the value of ecosystem services; 3. Identify and recommend policy relevant case studies in ASEAN Member States to be conducted in a future full ASEAN TEEB study.

- There is a substantial existing body of evidence on the value of ecosystem services in Southeast Asia. 182 studies that address the valuation of ecosystem services in Southeast Asia have been collected and organised in a database. This resource is available at www.aseanbiodiversity.org/. These studies provide 787 separate value estimates of ecosystem service values. The geographic distribution of this information is uneven, with a large number of studies for Indonesia, the Philippines, Thailand, Malaysia and Vietnam, but none for Brunei and Myanmar.

- Forests have been by far the most extensively studied ecosystem in Southeast Asia, followed by wetlands, coastal ecosystems (combinations of coral reefs, mangroves, and sea-grasses), and mangroves. Provisioning services, particularly food and raw materials, have been the most extensively valued, along with cultural services, particularly for the opportunities provided by nature areas for recreation and tourism. Regulating services, such as flood and storm protection, have received relatively little attention, although these ecosystem services are likely to increase in importance over time in the context of climate change.

- The four case studies presented in the Scoping Study highlight the importance of key ecosystems in Southeast Asia. The case studies are conducted at different scales (regional, provincial, and local) and address ecosystem services from mangroves, coral reefs, and forests. The purpose of these case studies is to illustrate how information on the economic value of natural capital can draw attention to the need for conservation, the trade-offs involved, and the design of policy instruments to aid and finance conservation.

- The case study on mangroves presents a "business-as-usual" scenario of the loss in area of mangroves in Southeast Asia over the period 2000-2050 and estimates the reduction in the value of two ecosystem services: coastal protection and habitat/nursery support for fisheries. The estimated foregone annual benefits in 2050 for Southeast Asia as whole are US$ 2.2 billion.

- The case study on coral reefs also examines a business-as-usual scenario of loss in coral reefs in Southeast Asia for the period 2000-2050. The annual lost value of reef related fisheries is estimated to be approximately US$ 5.6 billion in 2050.

- The case study on the Leuser forest ecosystem in Sumatra, Indonesia highlights the distribution of ecosystem service benefits across different stakeholders and the trade-off between short term gains for some versus larger long term losses for others.

- The case study on the Hon Mun marine protected area (MPA) in Vietnam illustrates the potential impact of information on the economic values of ecosystem services to improve decision making regarding nature conservation and finance. On the basis of valuation studies on the MPA, the recommendation to introduce a user fee that is earmarked for use by the MPA has been adopted and the MPA is now partially self-financed.

- Suggestions for future policy relevant TEEB studies have been elicited from environment officials in the ASEAN Member States. The suggested cases for a full ASEAN TEEB study cover a wide spectrum of environmental and policy contexts from the provision of urban green space to the financing of protected forests and wetlands.

Introduction

Background

Global economic growth over the past 50 years had been accompanied by decline in natural capital and the ability of ecosystems to sustain services. Global GDP more than doubled since 1981 but 60% of the world's ecosystems have also been degraded and GHG emissions are five times more than what the earth can absorb. These issues have never been more prominent in Southeast Asia. With over 580 million people highly reliant on the resources provided by forest, agricultural, coastal and marine ecosystems, taking urgent action to manage natural resources, build resilience and adapt to climate change has become compelling.

A growth strategy with low environmental impacts (green growth) has emerged as the most feasible development path. The strategy highlights the need for wider accounting and realistic valuation of the natural resources and ecosystem services contribution to human well-being while at the same time addressing climate change issues. The conduct of an ASEAN study on The Economics of Ecosystems and Biodiversity (TEEB) is a significant next step for mainstreaming green growth in the development processes of the region. Using the UNEP TEEB study as the foundation, the study will build sufficient evidence and basis for policy makers and technical officers on the imperatives for proper valuation of ecosystems services as a means to better manage natural resources and environmental impacts including climate change.

The objective of the ASEAN TEEB study is to pursue the mainstreaming process of the economics of ecosystems and biodiversity through conduct of assessment and valuation of key ecosystems in Southeast Asia and their services and assist ASEAN member states to develop green growth economies.

With this purpose, the ASEAN Centre for Biodiversity, with support from the United Kingdom Foreign and Commonwealth Office (UK FCO) and follow-up support from the German Agency for International Development (GIZ), initiated a scoping study for ASEAN TEEB. The aims of the scoping study are to: 1. Gather and review the existing evidence on the value of ecosystem services in Southeast Asia, and to identify key critical ecosystems and ecosystems services in South East Asia; 2. Conduct an initial set of case studies to highlight the value of ecosystem services; 3. Identify and recommend policy relevant case studies in ASEAN Member States to be conducted in a future full ASEAN TEEB study. The results of the scoping study are presented in this report.

The Economics of Ecosystems and Biodiversity (TEEB)

This section provides an introduction to the TEEB initiative, approach and key publications. Following on the success of the Millennium Ecosystem Assessment (MA), The Economics of Ecosystems and Biodiversity (TEEB) was started in 2007 by the environment ministers of the G8+5 countries who wanted to "initiate the process of analysing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation."

Four reports constitute the outcome of the TEEB study. One, Ecological and Economic Foundations, presents the scientific state of the art of measuring ecological processes and setting an economic price for them (TEEB 2010a). The other three reports target audiences that are or could be thinking about integrating ecological change into decision making, namely businesses, national policy makers and local policy makers (TEEB 2011a; TEEB 2011b; TEEB 2012).

TEEB recognises three tiers for using economic valuation of ecosystems and biodiversity (TEEB 2010b). The first is recognising value or a qualitative acknowledgement of the benefits that ecosystems and biodiversity provide. The second tier is demonstrating value and requires quantifying ecosystem services in monetary terms. The third and final tier is capturing value, which consists of a detailed economic analysis for policies that provide incentives for ecosystem conservation.

For each situation the need for detail in the economic assessment of ecosystems and biodiversity will be different. In some cases recognising value may be sufficient to trigger conservation efforts, whereas other cases may be too complex for such a solution. A full economic assessment may be needed to align the interests of all parties that benefit from an ecosystem under such conditions.

The following sections will present the framework that TEEB (2012) outlines for economic assessments of conservation and development decisions in a local and regional setting. The framework is illustrated with examples of ongoing projects in Southeast Asia.

A framework for assessing the economics of ecosystem change

The assessment framework outlined in the TEEB report for local and regional policy makers can achieve a variety of goals. One is to make people in general and policy makers in particular explicitly aware of the benefits they get from natural resources. Many ecosystem services are taken for granted, such as the benefits of a stable climate but also of going out to fish or collect wood for a fire. Another goal is to illustrate whose livelihoods will be affected by a change in ecosystems. The loss of a large section of mangrove forest may be lamentable to those who value its biodiversity, but the landowner who acquired the rights to develop the area is unlikely to accept a delay or decrease in his return on investment.

Understanding of who stands to gain and who is likely to lose from a change in the rules governing ecosystems is crucial to policy makers. The requirements for such understanding will differ from case to case. Although a variety of frameworks for qualitative evaluation and economic valuation of ecosystems exists, here we will focus on a framework suitable for demonstrating and capturing economic value.

In brief, the rationale for economic valuation of natural resources and ecosystem services is as follows. Ecosystem services contribute substantially to human welfare and in some cases are fundamental to sustaining life (e.g. climate regulation). The natural resources from which these services flow are, however, finite and cannot necessarily be regenerated or replaced. With the global human population expected to reach 10 billion and consumption per capita increasing over time, it is highly likely that human use of natural resources will outstrip their availability (i.e. human use of the environment will be unsustainable). These simple realities of resource limitation mean that choices have to be made between alternative uses of available resources; and every time a decision is made to do one thing, this is also a decision not to do another. In other words, we are implicitly placing values on each option. This valuation is unavoidable and is the essence of decision making. So if valuation of alternative resource uses is unavoidable in making decisions, it is arguably better to make these values explicit and ensure that they are well informed in order to aid decision making. The economic valuation of natural resources and ecosystem services attempts to do this.

The framework described in TEEB (2012) consists of 6 steps, here shortened to five. These steps are:

1. Specify and agree on the problem
2. Identify which ecosystem services are relevant
3. Define information needs and select appropriate methods
4. Assess expected changes and risks for the flow of ecosystem services
5. Identify distributional impacts of policy options

Step 1 ensures that a conflict between conservation and economic or infrastructural development is properly defined and that the right parties are involved in resolving the conflict. If dive tour operators are seeing a reduction in dive trip bookings, they might blame fishermen who practice dynamite fishing and damage the coral reef. The fishermen on the other hand may claim they do not use dynamite often and are more worried about a trend of ever smaller fish landings.

It is important to define the problem in a way that all parties have an interest in its resolution. The key to the example above may be to focus on the diversity and size of fish population, which requires a healthy reef and is important to both dive tour operators and fishermen.

Another point to clear is whether all parties understand coral reef ecology enough to consider root causes of fish and coral reef decline they had not previously contemplated. If they do not, then the parties' willingness to learn and explore the problem further should be assessed. The ultimate goal of an open discussion is to make all parties accept that even if everyone has an interest in maintaining the status-quo, they may also have an interest in a change that contributes to a sustainable future.

Step 2, selecting relevant ecosystem services, is an important part of making all parties explicitly aware of the benefits from a natural resource they may have enjoyed implicitly before. An example would be someone who regularly takes his son to catch one or two fishes from a nearby mangrove. This activity may in fact cover a range of ecosystem services: food (the fish for dinner), recreation (spending time as a family) and education (learning about fish, fishing and mangroves).

Basing its approach on the Millenium Ecosystem Assessment (MA, 2005), TEEB (2010a) developed a classification system that comprises 22 ecosystem services (shown in Table 1). Selecting which ecosystem services to include is a crucial step in any assessment. The choice may affect study complexity, the number of parties that should be involved and the design of potential policy solutions. An assessment should therefore strive to be as complete as possible, but without generating unnecessary complexity or breaking its time and funding constraints.

Step 3, deciding on the information needs and the assessment method, determines to a large extent the effort required for the assessment. This step is to some extent informed by previous steps. If a mangrove wetland is suffering from sedimentation caused by upstream deforestation, the spatial and temporal scales relevant to a solution will be different from a case where the main problem is that too much fuelwood is being gathered from the area.

Similarly the type of assessment required, be it purely qualitative or quantitative and economic, may be determined in part by the problem definition and the needs of the parties involved.

Table 1. TEEB classification of ecosystem services

Provisioning services	**Regulating services**	**Habitat services**	**Cultural and amenity services**
Food	Air quality regulation	Maintenance of life cycles of migratory species	Aesthetic information
Water	Climate regulation		Recreation & tourism
Raw materials	Moderation of extreme events	Maintenance of genetic diversity	Inspiration for culture & art
Genetic resources	Regulation of water flows		Spiritual experience
Medicinal resources	Waste treatment		Information for cognitive development
Ornamental resources	Erosion prevention		
	Maintenance of soil fertility		
	Pollination		
	Biological control		

The focus of this report lies with economic and quantitative assessments, but these are not necessarily required in all situations. Nonetheless, developing an effective policy will always require a way of determining the relative importance of ecosystem services. Otherwise the policy may emphasise irrelevant behaviour and lead to non-compliance and unnecessary costs.

Step 4 entails the assessment of the changes in ecosystem services that can be expected from available policy options. This step relies on a good understanding of the interactions between human behaviour and the ecological processes underlying ecosystem services. It is recommended at this stage to get outside help if needed to provide the required level of expertise.

This step also requires the formulation of scenarios that describe the impact of drivers and policies on ecosystem services in the area. A status-quo or baseline scenario with little conservation may be contrasted with one or more scenarios that include higher conservation efforts (Balmford et al. 2008). Contrasting scenarios are crucial to identifying the differences between one policy decision and another, as well as identifying potential risks inherent to each decision.

Step 5 is the identification of the distributional impacts of policies. Assessing economic changes builds on the previous step by translating ecological change into economic value. There are several methods for economic valuation, each with its own benefits in terms of reliability, cost and speed. Appendix 1 provides a summary overview of the available valuation methods. Like step 4 it is recommended that the economic assessment part of a study is performed by experts, in order to prevent wrong methods or techniques being chosen.

An overview of distributional effects can be used to identify parties that will benefit or not from policy changes, as well as any disproportionalities in gains and losses. This information is invaluable for policy makers, who may want to protect the poorest members of society from excessive costs. Policies may be tweaked to reflect differences in gains and losses or, if it is found that all policy options are insufficient, redeveloped altogether.

References

Balmford, Andrew, Ana S.L. Rodrigues, Matt Walpole, Patrick ten Brink, Marianne Kettunen, Leon Braat, and Rudolf S. de Groot. 2008. The Economics of Ecosystems and Biodiversity: Scoping the Science. Cambridge: European Commission.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

TEEB. 2010a. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. London: Earthscan. http://www.teebweb.org/EcologicalandEconomicFoundation/tabid/1018/Default.aspx.

TEEB. 2010b. Mainstreaming the Economics of Nature: A Synthesis of the Approach, Conclusions and Recommendations of TEEB. Malta: Progress Press.

TEEB. 2011a. The Economics of Ecosystems and Biodiversity in Business and Enterprise. London: Earthscan.

TEEB. 2011b. The Economics of Ecosystems and Biodiversity in National and International Policy Making. London: Earthscan.

TEEB. 2012. The Economics of Ecosystems and Biodiversity in Local and Regional Policy and Management. London: Earthscan.

Gathering evidence on the value of ecosystem services for SE Asia

Summary

There is a substantial existing body of evidence on the value of ecosystem services in Southeast Asia. 182 studies that address the valuation of ecosystem services in Southeast Asia have been collected and organised in a database. These studies provide 787 separate value estimates of ecosystem service values. A bibliography of these studies is provided in Appendix 2 of this report. The geographic distribution of this information is uneven, with a large number of studies for Indonesia, the Philippines, Thailand, Malaysia and Vietnam, but none for Brunei and Myanmar. Forests have been by far the most extensively studied ecosystem, followed by wetlands, coastal ecosystems (combinations of coral reefs, mangroves, and sea-grasses), and mangroves. Provisioning services, particularly food and raw materials, have been the most extensively valued, along with cultural services, particularly for the opportunities provided by nature areas for recreation and tourism. Regulating services, such as flood and storm protection, have received relatively little attention, although these are likely to increase in importance over time in the context of climate change.

Introduction

This section provides an overview of existing studies on the value of ecosystem services in Southeast Asia. A considerable number of studies and information on the economic importance of ecosystems and natura capital is available for the region. Here we draw together this information and provide a comprehensive bibliography of ecosystem service valuation studies for Southeast Asia. We use this overview to identify key ecosystems and services in Southeast Asia and to identify gaps in the currently available information. It is the intention that future work on the economics of ecosystems and biodiversity builds on the existing knowledge base. This section also provides a brief overview of several key on-going initiatives in the region that in part address the economic value of ecosystem services.

Database of ecosystem service valuation studies for SE Asia

The collection of studies that address the valuation of ecosystem services in Southeast Asia was pursued along two avenues. First, an extensive search was conducted of academic journals, online databases, project reports and websites for relevant studies. Second, a Call for Evidence was launched requesting that researchers, NGOs, and government agencies in the region submit any available studies to the ASEAN TEEB Scoping Study.

In total, 182 separate relevant studies have been collected and screened. The full list of studies is provided in Appendix 2. Summary information on these studies has been entered into a database. The database together with copies of collected studies will be made available on the ACB website. The database contains fields on:

- Study identification number (assigned when the study was obtained)
- Value estimate identification number
- Name of lead author(s)
- Year of Publication
- Title of Study
- Objective of Study
- Funding source
- Country
- Location description (including longitude and latitude)
- Scale of the study site (local, province, national, regional)
- Name of ecosystem (where relevant)
- Type of ecosystem(s)
- Ecosystem service(s) analysed (TEEB classification)
- Valuation method(s)
- Value estimate (original currency and units)
- Units (e.g. currency, per person, hectare, month, year etc.)
- Quality score (qualitative assessment of the study)

It is important to note that many of the studies that have been reviewed report more than one value estimate. Studies may describe multiple study sites, ecosystem types, ecosystem services, and valuation methods. The database therefore contains information on each value estimate as well as each study. From the 182 reviewed studies we obtain 787 separate value estimates (i.e., an average of just over four value estimate from each study).

Overview of ecosystem service values for SE Asia

This section provides an overview of the information contained in the database of

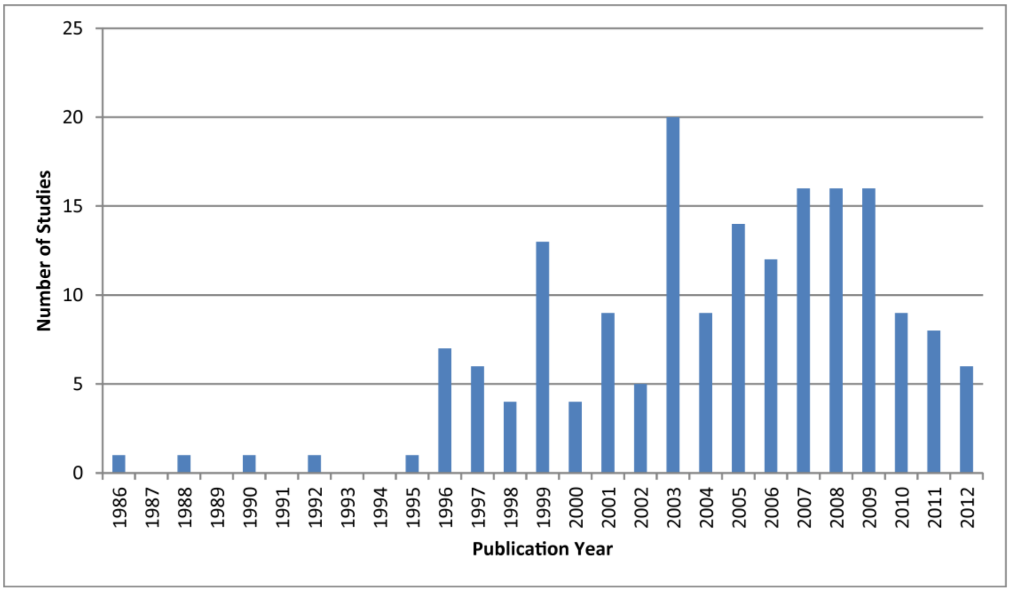

Figure 1. Number of ecosystem service valuation studies published in each year 1986-2012

ecosystem service values for Southeast Asia. The following figures provide a summary description of the studies that are included in the database. Figure 1 presents the number of studies addressing valuation of ecosystem services in SE Asia published in each year for the period 1986-2012. The number of studies conducted and published in each year is clearly increasing over time, suggesting that the available evidence is rapidly expanding and developing. The ASEAN TEEB scoping study is therefore conducted at a useful juncture to take stock of this information, identify gaps and develop directions for future research.

Figure 2 presents a map of the locations where valuation studies have been conducted. It should be noted that the locations indicated on the map are approximate and that the symbols used to indicate location do not represent the size of each study site. It is evident from the map that some regions have been the subject of extensive research and others have not. For example, there are a substantial number of study sites in peninsular Malaysia but very few in East Malaysia.

Figure 3 presents the number of studies for each ASEAN member state (MS). Clearly some countries have been the subject of much greater research effort on ecosystem service valuation than others. Understandably, given differences in research capacity and resources, there are more studies available for the larger MS

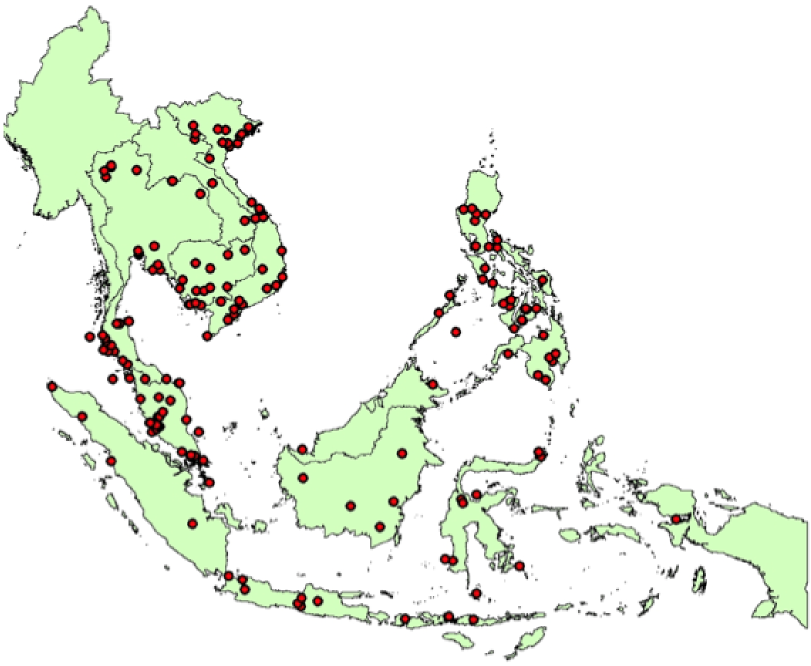

Figure 2. Location of valuation study sites in ASEAN Member States

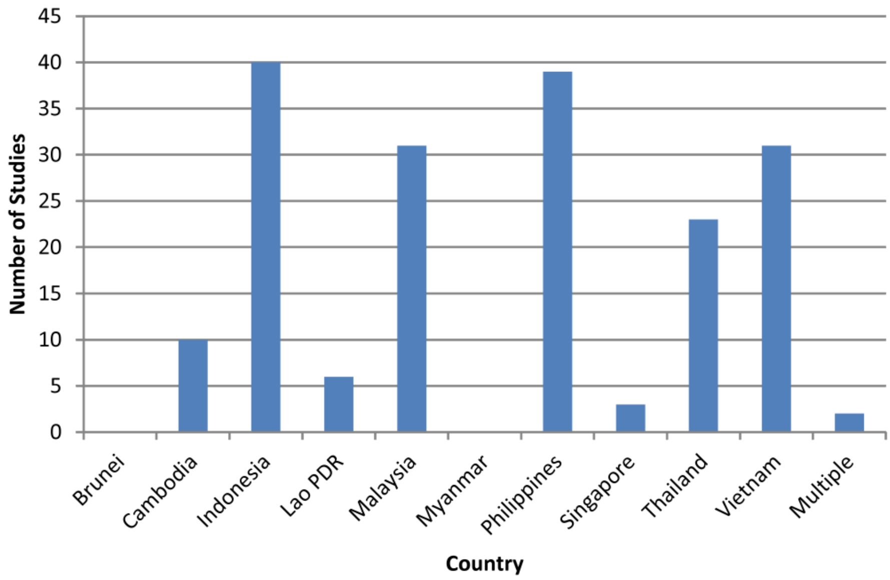

Figure 3. Number of ecosystem service valuation studies for each ASEAN member state

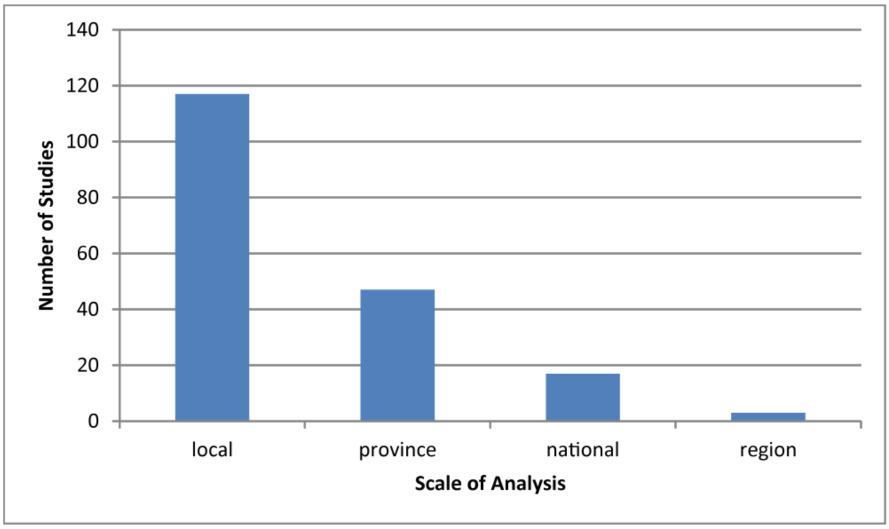

Figure 4. Number of ecosystem service valuation studies for each scale of analysis.

(Indonesia, Malaysia, the Philippines, Vietnam) and fewer for the smaller MS. At present, the database of studies does not contain any valuation estimates for Brunei or Myanmar. There are only two studies that have taken a wider regional approach and assessed the value of ecosystems across multiple countries.

Regarding the scale at which ecosystem service valuations have been conducted in the reviewed studies, most assessments are conducted at a local scale (i.e., they have examined the value of ecosystem services for an individual ecosystem, watershed, or protected area) – see Figure 4. The number of studies declines with increasing scale of analysis; there are a relatively large number of provincial scale assessments by very few national or regional scale studies.

Figure 5 presents the number of value estimates (not studies) that examine each ecosystem type. Forests have been by far the most extensively studied ecosystem, followed by wetlands, coastal ecosystems (combinations of coral reefs, mangroves, and sea-grasses), and mangroves. Fresh water ecosystems such as lakes and rivers have received relatively little attention. This is possibly a reflection of the level of policy concern across these ecosystem types, i.e. that the loss of forests and coastal ecosystems are of greatest concern.

Regarding the coverage of ecosystem services[1], we find that provisioning services, particularly food and raw materials such as timber and fuelwood, have been the most extensively valued (see Figure 6). There are also a considerable number of value estimates for cultural services, particularly for the opportunities provided by natural areas for recreation and tourism. In

[1] The ecosystem services reported in each study have been classified according to the TEEB categorisation. See Table 3.2, Chapter 3 in Kumar (Ed.), 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London and Washington.

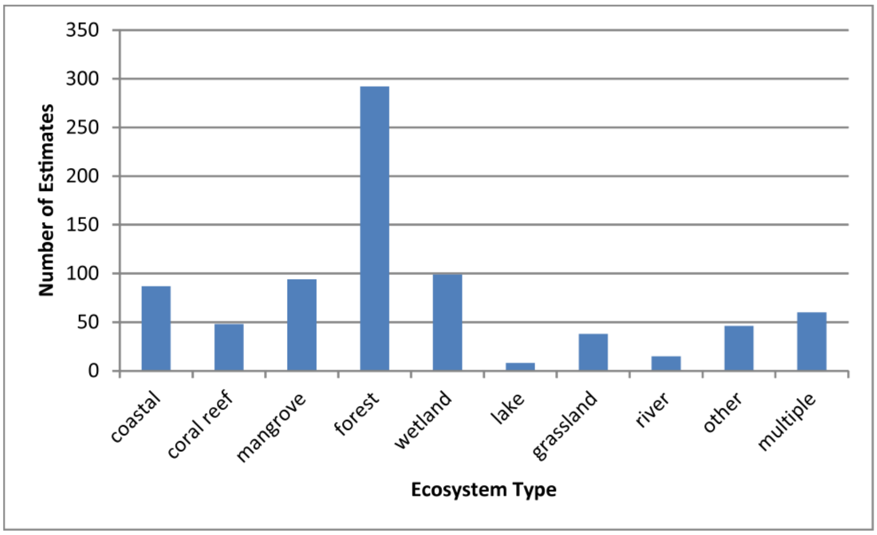

Figure 5. Number of ecosystem service value estimates for each ecosystem type.

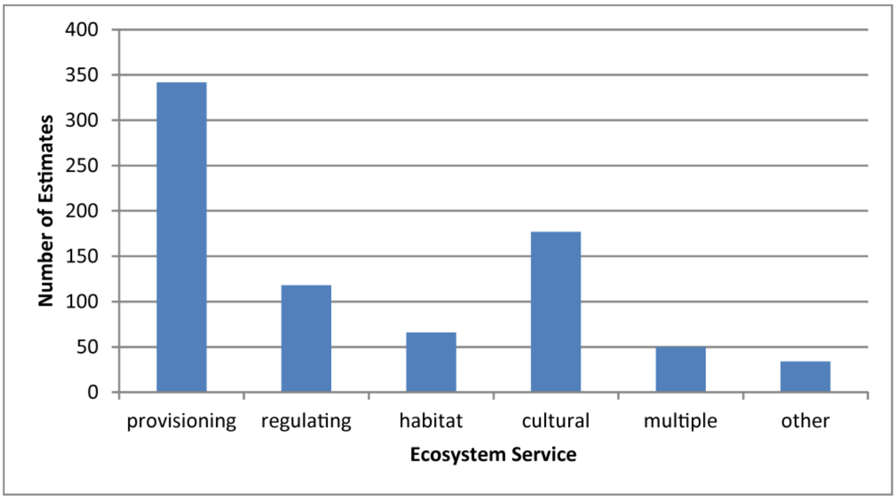

Figure 6. Number of valuation estimates for each ecosystem service.

addition, there are numerous estimates of the values associated with preserving biodiversity and ecosystems for their own sake or to ensure their existence for the enjoyment of future generations (36 value estimates for these so-called non-use values). Regulating services have been less widely assessed and valued; the most frequently valued are climate regulation (42 value estimates for carbon storage or sequestration) and the moderation of extreme events (38 value estimates for storm and flood protection). Regarding habitat services, there are a substantial number of value estimates specifically for the nursery function for fisheries provided by mangroves and coral reefs (64 value estimates). Quite a considerable number of estimates are for multiple ecosystem services or the Total Economic Value of the ecosystem (i.e. a bundle of services provided by an individual ecosystem).

Finally, in terms of the valuation methods that have been employed to estimate ecosystem service values, Figure 7 shows that the use of market prices has been the most frequently applied method. This method is typically used to value provisioning services. Value transfer, i.e. the use of existing information on the value of an ecosystem service from another study site to estimate the value at a new policy site, has also been used extensively. This method can be practical and inexpensive for estimating ecosystem service values to inform decision making, but can be questionable in terms of accuracy. When viewed from the perspective of assessing the available stock of knowledge on ecosystem service values, a high proportion of value transfer estimates does not represent additional new data but is simply a reuse of existing information. The contingent valuation method has been used in a large number of cases to value recreational and tourist services. The large “other” category represented in Figure 6 includes estimates for which it is not clear what valuation method was used.

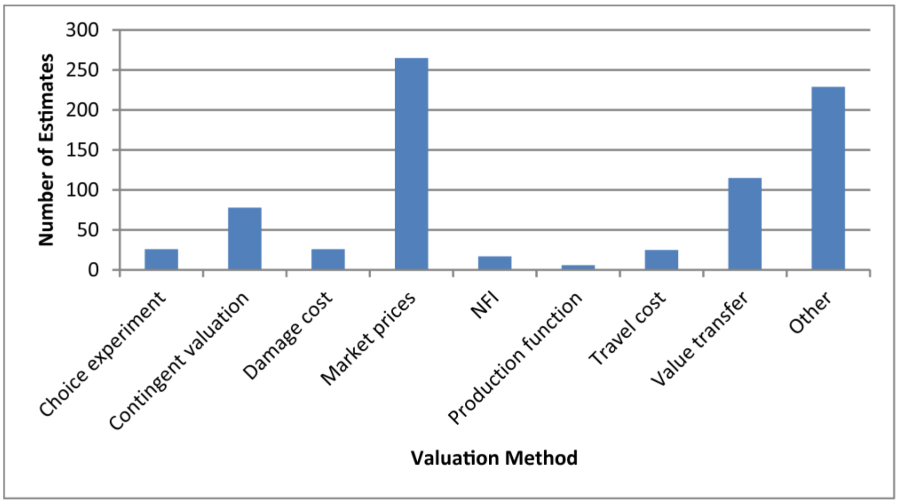

Figure 7. Number of valuation estimates obtained from each valuation method.

Identification of key ecosystems and ecosystem services

The above review of the existing assessments of ecosystem service values provides a basis for identifying the key ecosystems and ecosystem services to the region.

From Figure 5 it is observed that forests and coastal ecosystems (coral reefs, mangroves and sea grasses) have been the most extensively studied, presumably reflecting high policy concern for the degradation of these ecosystems in the ASEAN region. The case studies to be conducted for the full ASEAN TEEB study should therefore reflect this in order to provide information on the most generally critical ecosystems. Freshwater ecosystems, such as rivers and lakes have received relatively little attention although in several important cases (e.g. the Mekong) they are recognised as facing severe threats to their ecological functioning.

Regarding the identification of key ecosystem services, Figure 6 indicates that the most frequently assessed are provisioning (food and raw materials) and cultural (recreational/ tourism services and biodiversity preservation). Regulating services, such as flood and storm protection, have received relatively little attention, although these are likely to increase in importance over time in the context of climate change. It is possibly the case that the selection of ecosystem services assessed in existing studies reflects other factors than the degree of policy concern or relative economic importance. It is the case that recreation/tourism and provisioning services (largely estimated through market prices) are relatively easy to value, and for that reason are better represented in the available data. The relatively sparse information on regulating services, which are generally more difficult to value, therefore represents a gap in the available knowledge, which should be addressed in the ASEAN TEEB scoping study.

A substantial number of the ecosystems sites that have been assessed are national parks or protected areas. This provides the opportunity to make comparisons between the values of ecosystem services provided by ecosystems that are protected and those that are not. This may provide evidence of the benefits of protection. Such a comparison may also indicate the trade-offs involved in establishing protected area, i.e. that the provision of some ecosystem services are enhanced (e.g., watershed protection, biodiversity preservation) and others are restricted (e.g., extraction of food and raw materials).

This analysis provides an initial identification of the ecosystems and services that are of policy concern and have subsequently been the subject of ecosystem valuation assessment. It should be noted that this is a region-wide assessment and that at local scales, other priorities with regard to ecosystems and services may hold.

Key ongoing initiatives in Southeast Asia

This section provides a brief introduction to a number of key ongoing initiatives in Southeast Asia that in part address the economic value of ecosystem services. Results from these initiatives are expected over the coming years.

The value of water in the Mekong basin: Balancing multiple uses and benefits (WorldFish Center)

This project, started in 2010, will look at the socio-economic impact of hydropower dams on various Mekong tributaries in Lao PDR, Cambodia and Viet Nam. To date, dams and reservoirs have been developed primarily to maximize the

value of water for single sector interests and have often overlooked or underestimated the negative implications on other values of water for fisheries, riparian communities, and the environment.

To meet competing demands for water use while protecting ecosystem functions and the livelihoods of local communities is a major challenge for sustainable economic development in the Mekong Basin. It is necessary to incorporate priorities of different stakeholder groups using participatory processes and to highlight that water usage decisions are likely to result in a positive impact on some users and a negative impact on others. This generates useful insights for resource managers and decision-makers at various levels, and can help policy debates to be more constructive.

The water valuation framework is being tested in three case study areas in Cambodia, Lao PDR, and Viet Nam that are experiencing different stages of hydropower development. The project will first assess the total economic value of water at the case study sites, based on household survey data at the immediate impact zone of the hydropower dam (300-350 households), as well as the review of secondary data and literature. Two types of methodologies are used for valuation: The changes of productivity methodology and a type of revealed preference methodologies. Then the project will estimate the changes in various water uses and values as result of change in water management regimes. Although the monetization exercise will focus on selected direct use values of the water, other types of locally significant water values are also documented and quantified as much as possible, based on the household survey.

The project hopes to ultimately provide improved information on the variety of water values (and, in particular, the integrated social, environmental and economic value to different user groups), which will lead to improved management and planning in ways that better reflect the actual multi-use/multi-user nature of water resources. This will, in turn, lead to fairer and more equitable development opportunities for all water users across the countries within the Mekong Basin.

The project is planned to run until August 2013.

http://www.worldfishcenter.org/our-research/ongoing-projects/the-value-of-water-mekong-basin

Project for ecosystem services (ISPONRE)

The Project for ecosystem services (ProEcoServ) aims to bundle ecosystem services and integrate ecosystem services into resource management and improve sustainable national development planning. Viet Nam is one of the countries where this effort is piloted. ProEcoServ – Viet Nam started in 2011 will perform valuation and integration of ecosystem services into decision making in the Ca Mau National Park in the Mekong delta.

The Mekong delta provides many ecosystem services including coastal protection, erosion prevention, water provision and regulation, habitat services, and the provision of food and raw materials. In the last fifteen years, however, short-term economic targets and inappropriate management have dramatically changed and weakened the ecosystem services in the Ca Mau National Park. An important process in this regard is the conversion of mangrove forests into aquaculture ponds. The necessary deforestation and diversion of salt water into the mangrove system for shrimp farming strongly alters ecological functions and ecosystem services upon which local human welfare ultimately depends.

ProEcoServ will develop various tools for mainstreaming ecosystem services in policy making and to develop and apply multi-scale and locally valid tools and decision support models in policy making. The overall goal of the project is to better integrate ecosystem assessment, scenario development and economic valuation of ecosystem services into sustainable development planning.

http://www.proecoserv.org/

Enhancing the Economics of Biodiversity and Ecosystem Services in Thailand / Southeast Asia - EcoBest (Thai National Parks, Wildlife and Plants Conservation Department)

The EcoBest project started in 2011 with the objective to reduce land biodiversity loss in South East Asian countries for the benefit of local communities. The project aims to improve the use of economic and financial tools in decision making and management of protected areas and buffer zones. National and regional transfer of knowledge is used for capacity building and information sharing about best practices.

The project team is on the verge of launching a toolkit for developing economic and financial tools. This toolkit has been developed based on experiences in the pilot sites, one of which is in Lao PDR and three are in Thailand. Together with training and regional competence centers, this toolkit can help revise draft legislation and policy on economic and financial tools and secure long-term funding for biodiversity conservation.

The project is intended to run until February 2015.

http://www.teeb-sea.info/

Heart of Borneo

This is a large, ongoing initiative in the large forest area located across the borders of Brunei, Indonesia and Malaysia. It collects scientifically sound data and uses community empowerment and capacity building tools to achieve its mission to protect the Heart of Borneo rainforest from further destruction. The Heart of Bornea initiative works closely with local communities in many of its projects when collecting data about the ecology and traditional uses of the forest.

http://www.heartofborneo.org/

Coral Triangle Intiative

The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) is an ongoing multilateral partnership between the governments of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste. The initiative aims to guide the use of marine resources towards a more sustainable use patterns and ultimately to establish a fully functioning and effectively managed region-wide Coral Triangle Marine Protected Areas System.

http://www.coraltriangleinitiative.org

Rewarding Upland Poor for the Environmental Services they provide (World Agroforestry Centre)

One of the study sites of the RUPES project is the Municipality of Lantapan, a river valley between the Mt. Kitanglad Range Natural Park and the Manupali river. The area has a very high biodiversity which attracts tourists and also holds spiritual meaning for the indigenous people. Several rivers and creeks run from Mt. Kitanglad through Lantapan into a reservoir that feeds the hydropower station of the National Power Corporation (NPC).

Agricultural has expanded enormously in Lantapan in the past decade, and commercial farming has pushed smallholders to marginal lands on the slopes of Mt. Kitanglad. Deforestion on these slopes causes soil erosion and the overall increase in agricultural activity means the water supply can no longer meet the needs of all water users in Lantapan. Reduced water flow and enormous silt deposits have severely reduced the lifespan of the hydropower reservoir.

In 2009, the Municipality of Lantapan enacted an Ordinance that encourages farmers to adopt farming practices that help protect the watershed and its services. Based upon this institional framework negotiations have begun with NPC for it to implement and fund a reward mechanism for watershed services. Funding for a reforestation effort has been secured and a process has been set in motion to distribute a share of the entry fees collected from tourists to the local communities.

http://www.worldagroforestry.org/sea/rupes

Wealth Accounting and Valuation of Ecosystem Services

Wealth Accounting and the Valuation of Ecosystem Services (WAVES) is a global partnership that aims to promote sustainable development by ensuring that the national accounts used to measure and plan for economic growth include the value of natural resources. This global partnership brings together a broad coalition of UN agencies, governments, international institutes, non-government organisations and academics to implement environmental accounting where there are internationally agreed standards, and to develop standard approaches for other ecosystem service accounts.

The key objectives of WAVES is to implement environmental accounting in five countries and incorporate these into national policy analysis and development planning; develop internationally-agreed guidelines for ecosystem accounting; spread environmental accounting through a global partnership.

The WAVES initiative for the Philippines is intended to introduce an enhanced green accounting approach that includes developing a macro-level indicator of long term sustainability of economic growth; generating detailed information on environment and natural resources at the levels of economic sectors and key social groups that would inform economic, environmental and natural resources management decisions and policies inclusive of equity and growth concerns; increasing the capacity for accounting of ecosystem services.

The implementation phase of this initiative is expected to run until 2015.

http://www.wavespartnership.org/waves/

Case studies

Summary

- The four case studies presented in the ASEAN TEEB scoping study highlight the importance of key ecosystems in Southeast Asia. The case studies are conducted at different scales (regional, provincial, and local) and address ecosystem services from mangroves, coral reefs, and forests. The purpose of these case studies is to illustrate how information on the economic value of natural capital can draw attention to the need for conservation, the trade-offs involved, and the design of policy instruments to aid and finance conservation.

- The case study on mangroves presents a "business-as-usual" scenario of the loss in area of mangroves in Southeast Asia over the period 2000-2050 and estimates the reduction in the value of two ecosystem services: coastal protection and habitat/ nursery support for fisheries. The estimated foregone annual benefits in 2050 for Southeast Asia as whole are US$ 2.2 billion.

- The case study on coral reefs also examines a business-as-usual scenario of loss in coral reefs in Southeast Asia for the period 2000-2050. The annual lost value of reef related fisheries is estimated to be approximately US$ 5.6 billion in 2050.

- The case study on the Leuser forest ecosystem in Sumatra, Indonesia highlights the distribution of ecosystem service benefits across different stakeholders and the trade-off between short term gains for some versus larger long term losses for others.

- The case study on the Hon Mun marine protected area (MPA) in Vietnam illustrates the potential impact of information on the economic values of ecosystem services to improve decision making regarding nature conservation and finance. The recommendation to introduce a user fee that is earmarked for use by the MPA has been adopted and the MPA is now partially self-financed.

Mangrove ecosystem service values

Summary

This case study examines the value of ecosystem services provided by mangroves in Southeast Asia. Mangroves provide a number valuable ecosystem services, such as coastal protection and nursery habitat for fisheries, but face serious threats from conversion to agriculture and aquaculture. In this case study we assess the value of lost mangrove ecosystem services over the period 2000-2050 under a "business-as-usual" scenario. The estimated foregone annual benefits in 2050 for the ASEAN region as whole are US$ 2.2 billion (95% prediction interval US$ 1.6 – 2.8 billion). At a country level, the annual value of foregone mangrove ecosystem services in 2050 follows the pattern of loss of area, with Indonesia expected to suffer the highest losses: US$ 1.7 billion per year (95% prediction interval US$ 1.2 – 2.2 billion). Malaysia is estimated to suffer the second highest losses in mangrove ecosystem service values: US$ 279 million per year (95% prediction interval of US$ 228 – 330 million). The expected losses in mangrove extent and associated services are economically significant and warrant the consideration of conservation and restoration programmes.

Introduction

Mangroves[2] provide a number valuable ecosystem services that contribute to human wellbeing, including provisioning (e.g., timber, fuel wood, and charcoal), regulating (e.g., flood, storm and erosion control; prevention of salt water intrusion), habitat (e.g., breeding, spawning and nursery habitat for commercial fish species; biodiversity), and cultural services (e.g., recreation, aesthetic, non-use) (Spaninks and van Beukering, 1997; UNEP, 2006; TEEB, 2010). Many of these ecosystem services have the characteristics of 'public goods' such that the people who benefit cannot be excluded from receiving the service provided (e.g., habitat and nursery service supporting fisheries); and that the level of consumption by one beneficiary does not reduce the level of service received by another (e.g., coastal protection and storm buffering). Due to these characteristics, the potential for private incentives to sustainably manage mangrove ecosystem services is limited and markets for such services do not exist. In other words, there is a 'market failure' and by their inherent nature, mangrove ecosystem services are under supplied by the market system.

[2]The term mangrove is loosely used to describe a wide variety of trees and shrubs (around 80 species), that share characteristics of being adapted to conditions of high salinity, low oxygen and changing water levels (Saenger et al., 1983). The mangrove biome dominates tropical and sub-tropical coastlines between latitudes 32°N and 38°S and covers approximately 22 million hectares. Around 28% of global mangroves are located in Southeast Asia with Indonesia alone accounting for 25%.

As a result, mangroves are generally undervalued in both private and public decision-making relating to their use, conservation and restoration. The lack of understanding of, and information on, the values of mangrove ecosystem services has generally led to their omission in public decision making. Without information on the economic value of mangrove ecosystem services that can be compared directly against the economic value of alternative public investments, the importance of mangroves as natural capital tends to be ignored. A number of studies have developed and applied methods to calculate the monetary value of specific mangroves ecosystems in Southeast Asia (e.g., Ahmad, 1984; Barbier, 1994; Bann, 1999). Although these studies provide some insight into the range of values that may be assigned to the ecosystem services provided by mangroves, they are all context specific and do not provide a more general overview of the values of mangroves in the region.

Mangroves throughout the world face a number of threats, including pollution, deforestation, fragmentation, and sea-level rise (Giri et al., 2011). The main drivers underlying these threats are increasing populations and development in coastal areas and climate change. Mangroves are being converted to other land uses such as aquaculture ponds, urban developments, agriculture and infrastructure. In Southeast Asia there has been large scale conversion of mangrove forests to shrimp farms (Barbier et al., 2011).

The aim of this case study is to provide an estimate of the value of the change in ecosystem services provision due to the loss of mangrove area in Southeast Asia under a business as usual scenario for the period 2000-2050. This estimate represents the benefits foregone by not maintaining the stock of mangroves or equivalently the cost of policy inaction to conserve this stock of natural capital.

The case study is organised as follows, the next secion sets out the selected methodology for estimating the value of ecosystem services from mangroves in Southeast Asia; the third section describes the collection and preparation of value data; the fourth section presents a meta-analysis of mangrove values and estimates a value function; the fifth section applies the value function to estimate site specific values and presents the aggregated results at a national level; the final section provides a discussion of the results.

Methodology

1. The methodology used in this case study for estimating the foregone value of ecosystem services due to change in the extent of mangroves in Southeast Asia over the period 2000-2050 follows the following steps:

2. Meta-analysis of monetary estimates of mangrove ecosystem service values and estimation of a value function that relates ecosystem service value to the characteristics of the ecosystem and its surroundings.

3. Develop a database of mangrove ecosystems in Southeast Asia containing information on the variables included in the value function estimated in step 1.

4. Develop a baseline scenario for the change in the spatial extent of mangrove ecosystems in Southeast Asia for the period 2000-2050. This baseline scenario is spatially variable to reflect variation in pressures on mangrove ecosystems.

5. Combine the models and data generated in steps 1-3 to produce estimates of the value of the loss in mangrove ecosystem services under the baseline scenario. This approach allows the estimation of spatially variable site or patch specific values that reflect the characteristics and context of each mangrove patch.

More detail on the value transfer approach is provided in Appendix 3.

Mangrove value data and meta-analysis

Description of mangrove value data

For the purposes of conducting a meta-analysis of mangrove ecosystem service values, we collected mangrove valuation studies through online journal databases, libraries, online valuation reference inventories and contact with authors. In total 41 studies were collected that contain sufficient information to be included in a statistical meta-analysis. From the 41 selected studies we are able to obtain 130 separate value estimates. The locations of the study sites included in the data are presented in Figure 8, illustrating that some regions are better represented in the data than others. Southeast Asian mangroves are well represented in the data. There are 14 estimates for North America, 18 for Latin America, 21 for South Asia, 61 for Southeast Asia, 11 for Africa wetlands, and 5 for Oceania.

Figure 8. Location of mangrove valuation study sites.

The range of ecosystem services represented in the collected studies includes provisioning services (fish, fuel wood, materials) and regulating services (coastal protection, flood prevention, water quality), possibly reflecting the most important services in the contexts of the individual studies. There are gaps in coverage of the wider range of ecosystem services as defined by the Millennium Ecosystem Assessment (MA, 2005) or The Economics of Ecosystems and Biodiversity (TEEB, 2010). In particular it should be noted that the value of cultural services provided by mangroves is not represented in literature underlying our database. The values that are transferred in this case study can only reflect those that are available in the literature and so our valuation results represent only a partial set of ecosystem services. In order to allow direct comparison of study results, all value estimates are standardised to US$ per hectare per year at 2007 price levels.

Meta-analysis of mangrove values

This section describes the meta-regression analysis and estimated value function for mangrove ecosystem services. The dependent variable in the meta-regression is the mangrove value in US$ per hectare per year in 2007 prices. The average mangrove value in the sample is 4,185 USD/ha/annum and the median is 239 USD/ha/annum. The variables used to explain variation in value include the characteristics of each mangrove site (area, ecosystem services provided), characteristics of the bio-physical context of each mangrove (area of other mangroves, fragmentation), and the socio-economic characteristics of the population of ecosystem service beneficiaries (income and population size).

The definition of each variable and the results for the estimated meta-regression are given in Table 2. The adjusted R2 statistic indicates that 45% of the variation in the dependent variable is explained by the explanatory variables.

Regarding the dummy variables indicating the service that is valued, the estimated coefficients for coastal protection, water quality and fisheries are all positive and statistically significant, indicating that the value of these services are higher than the value of extracted mangrove materials (the omitted category variable). The estimated coefficient for fuel wood extraction is negative and statistically significant, indicating that the extraction of fuel wood has a lower value than the extraction of other materials.

The estimated coefficient on mangrove area is negative and statistically significant, which is evidence of diminishing returns to scale for mangrove size, i.e. the value per hectare is lower in larger mangroves than in smaller mangroves. In other words, adding a hectare to a large mangrove is of lower value than adding a hectare to a small mangrove. It is important to understand that the total value of a mangrove increases with its size but at a diminishing rate as the per hectare value decreases. In other words there is a non-linear (concave) relationship between total area and total value. The estimated coefficient shows an inelastic relationship between area and value, in which a 10% change increase in area results in a 3.4% decrease in per hectare value.

The variable measuring the abundance of other mangroves in the vicinity of the valued sites is found to have a positive effect on wetland value. As the area of other mangroves increases, the value per hectare of the valued site tends to also increase. In other words, there is a non-linear

Table 2. Mangrove value function

Variable	Variable definition	Coefficient[1]	S.E.
Value (dependent)	US$/ha/year (ln)		
Constant		-0.590	2.193
Coastal protection	Dummy variable for Coastal protection ES	1.456***	0.491
Water quality	Dummy variable for water quality ES	1.714**	0.752
Fisheries	Dummy variable for fisheries ES	0.860**	0.355
Fuel wood	Dummy variable for fuel wood ES	-1.085**	0.437
Mangrove area	Area of wetland study site (ha; ln)	-0.343***	0.065
Mangrove abundance	Total area of mangroves within 50 km (km^2 ; ln)	0.248***	0.082
Roads	Length of roads within 50 km (km; ln)	-0.312*	0.175
GDP per capita	GDP per capita (USD; ln)	0.785***	0.174
Population	Population within 50 km (ln)	0.284*	0.149
N	130		
Adjusted R^2	0.45		

[1] Statistical significance is indicated with ***, ** and * for the 1, 5 and 10% level respectively.

(convex) relationship between the area of other proximate mangroves and total value of each study site. This can be interpreted as the effect of complementarity between mangrove patches; as mangroves become more abundant within a given region, their productivity increases. This suggests that isolated patches of mangrove tend to be of lower value than more intact contiguous mangrove systems. This is possibly related to the services coastal protection and habitat and nursery support to fisheries, for which productivity increases in larger mangrove systems. The estimated elasticity indicates that a 10% increase in the area of other mangroves results in a 2.5% increase in mangrove value per hectare. The estimated coefficient on road density is negative and statically significant, with the implication that a 10% increase in the density of roads is associated with a 3.1% decrease in mangrove value. This suggests that the fragmentation of mangroves and surrounding landscape does have negative effects on the provision of ecosystem services. The selected scale of measurement for these two variables is for a 50 km radius from each study site based on the significantly higher explanatory power of the variables in the regression at this scale.

The two variables representing the socio-economic characteristics of beneficiaries both follow prior expectations. The estimated coefficient on the population variable is positive and statistically significant, indicating that mangrove ecosystem service values are higher in areas with larger populations. The positive effect of population on the value of mangrove ecosystem services relates to market size or demand for services. A larger population in the vicinity of a mangrove means that more people benefit from the ecosystem services that it provides. A 10% increase in population results in a 2.8% increase in mangrove value per hectare. The population variable is also found to be best measured at a scale of 50 km radius from each study site. The positive effect of the income variable (GDP per capita) indicates that mangrove ecosystem services have higher values in countries with higher incomes. GDP per capita has a positive but less than proportional relationship with mangrove value – suggesting an inelastic effect of income on the value of mangrove ecosystem services. A 10% increase in GDP per capita results in a 7.9% increase in value per hectare.

This meta-regression model provides the value function that we use to estimate the change in value of ecosystem services due to the change in the stock of mangroves in Southeast Asia under a business-as-usual scenario.

Valuation of mangrove change in Southeast Asia 2000-2050

To define a baseline scenario for mangrove change for the period 2000-2050, we make use of the results of the IMAGE-GLOBIO integrated assessment model (Alkemade et al., 2009; PBL, 2010).[3] This baseline scenario has previously been used to assess the cost of policy inaction to halt global biodiversity loss (Braat and ten Brink, 2008). Using spatially differentiated change factors derived from the IMAGE-GLOBIO model and patch level data on mangroves from the UNEP World Conservation Monitoring Centre (described in Giri et al., 2010), we calculate the change in area of each patch of mangrove for the period 2000-2050. The areas of mangrove in 2000 and 2050 in each ASEAN Member State is presented in Figure 9.

For each of the 1,230 mangrove patches in Southeast Asia that are included in the UNEP-WCMC database, spatial data is used to obtain information on the site characteristics (mangrove size), bio-physical context (mangrove abundance and road density within 50 km) and socio-economic characteristics of beneficiaries (GDP per capita, population within 50 km). At the level of individual patches of mangrove, patch specific parameter values are then substituted into the meta-analytic value function to estimate values per unit area (USD/ha/annum). These estimates are then used to calculate the value of the projected change in area of each patch. Lower and upper bound values are calculated using the 95% prediction intervals for each wetland site, which are computed using the method proposed by Osborne (2000). The prediction intervals provide an indication of the precision with which the estimated value function can predict out-of-sample values. They do not, however, reflect a number of other sources of uncertainty in the analysis, including inaccuracies in the land use data used to construct the database of Southeast Asian mangrove sites and the assumptions used to describe the baseline change in the extent and spatial distribution of mangroves.

The values of foregone mangrove ecosystem services, aggregated to the country level, are presented in Table 3 and Figure 10. Comparing the 2000 stock of mangroves to the projected 2050 stock, the annual value of lost ecosystem services from mangroves in Southeast Asia is estimated to be approximately US$ 2.16 billion in 2050 (2007 prices), with a 95% prediction interval of US$ 1.58 – 2.76 billion. To put this value in perspective, the current gross value of marine aquaculture in Souteast Asia is approximately US$ 1 billion per year (FAO 2010). Assuming a linear time profile of these losses between 2000 and 2050, the present value of the stream of lost ecosystem services is US$ 40 billion using a 1% discount rate and US$ 17 billion using a 4% discount rate. This is the cumulative value of the foregone ecosystem services due to mangrove loss that is expected to occur each year over the period 2000-2050. The loss of ecosystem services is not valued only for the year in which the mangrove area is lost but for every subsequent year up to the time horizon of the analysis (i.e., 2050).

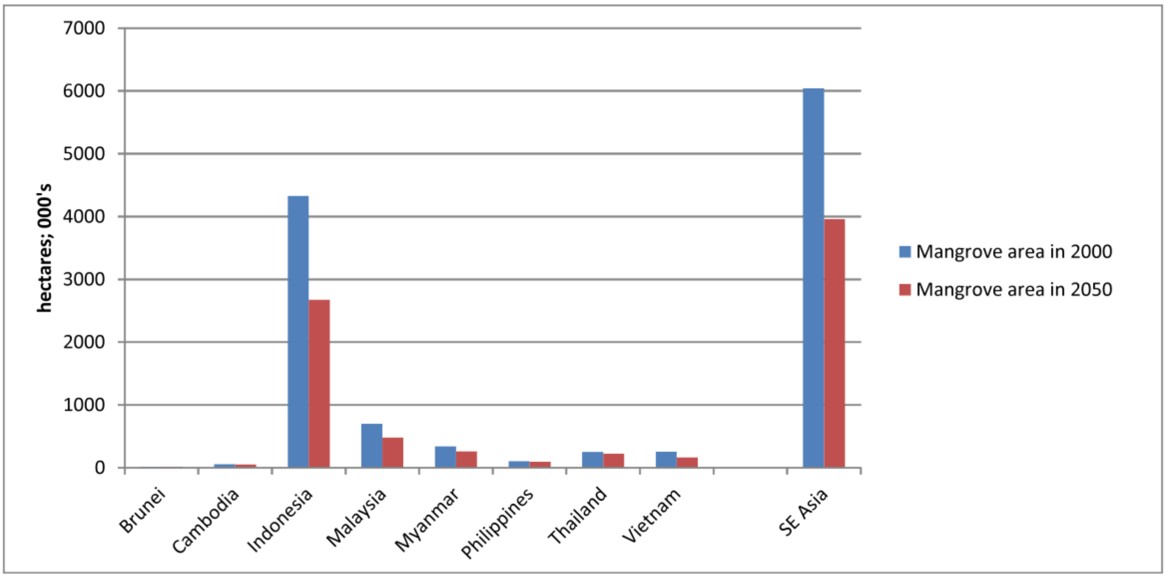

Figure 9. Total area of mangroves in 2000 and 2050.

[3]GLOBIO is a modelling framework developed to calculate the impact of five environmental drivers on terrestrial biodiversity. GLOBIO is based on cause-effect relationships derived from the literature and uses spatial information on environmental drivers as input. This input is mainly derived from the Integrated Model to Assess the Global Environment (IMAGE). Projections for environmental drivers are based on the OECD Environmental Outlook (OECD, 2008) and cover the period 2000-2050.

Table 3. Change in mangrove area and value in Southeast Asia by country 2000-2050

Country	Mangrove area in 2000 (ha; 000's)	Change in mangrove area 2000-2050 (ha; 000's)	Total value change (US$/annum; millions)	PI 95% Low (US$/annum ; millions)	PI 95% High (US$/annum ; millions)
Brunei	16	-1	-4	-4	-4
Cambodia	54	-4	-2	-1	-2
Indonesia	4,329	-1,656	-1,728	-1,239	-2,241
Malaysia	699	-220	-279	-228	-330
Myanmar	338	-80	-50	-36	-64
Philippines	102	-6	-11	-10	-12
Thailand	250	-25	-36	-32	-41
Vietnam	254	-90	-48	-33	-64
Total	6,042	-2,082	-2,158	-1,582	-2,759

At a country level, the annual value of foregone mangrove ecosystem services in 2050 follows the pattern of loss of area, with Indonesia expected to suffer the highest losses; US$ 1.7 billion per year with a 95% prediction interval of US$ 1.2 – 2.2 billion. Malaysia is estimated to suffer the second highest losses in mangrove ecosystem service values; US$ 279 million per year with a 95% prediction interval of US$ 228 – 330 million.

Discussion

This case study provides an estimate of the value of foregone ecosystem services from mangroves in Southeast Asia under a baseline scenario for the period 2000-2050. This value is estimated by combining a meta-analytic value function for mangrove ecosystem services with spatial data on individual mangrove ecosystems to produce site specific values, which are aggregated to the country level. For the ASEAN region as a whole, the annual value of ecosystem services lost due to the declining area of mangroves is estimated to be over US$ 2 billion in 2050.

The inclusion of spatial variables describing the context of individual mangrove patches is shown to be important in accounting for variation in ecosystem service values. We find evidence that mangrove areas are complements, i.e. that the value of individual mangroves are enhanced when there is a larger extent of other mangrove patches in the surrounding area. This has important implications for mangrove conservation strategies and suggests that the

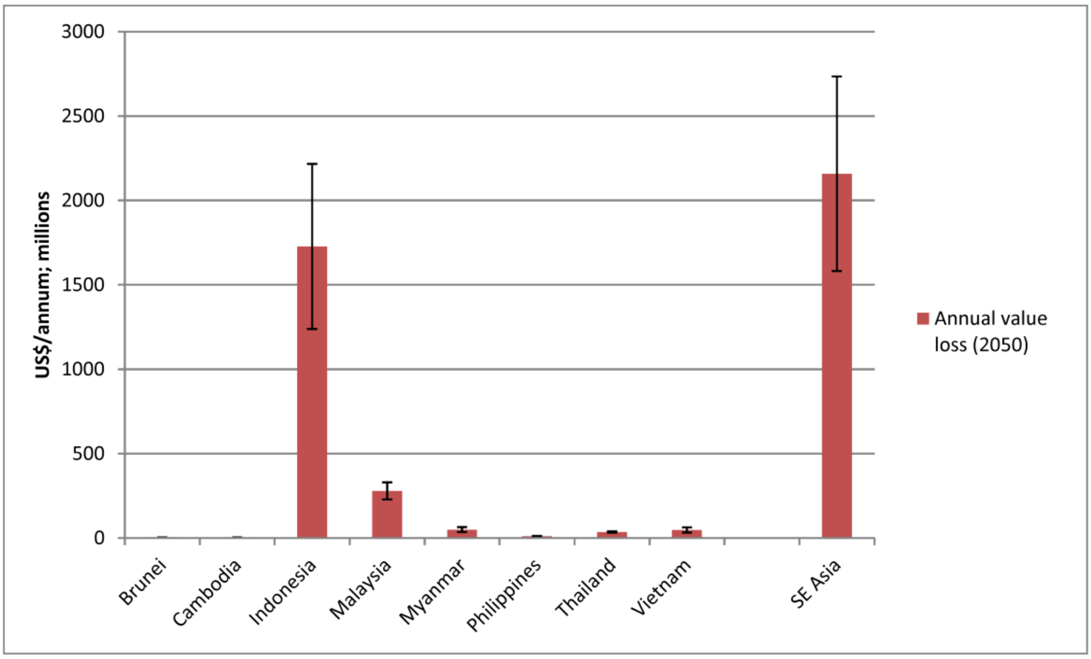

Figure 10. Value of lost mangroves in 2050

preservation of contiguous areas is preferable to patches that are spatially dispersed.

We also find that the fragmentation of mangroves and their surroundings by road infrastructure has a negative effect on the value of mangrove ecosystem services. Increasing the accessibility of mangrove areas appears to degrade the services they provide. This might particularly be the case for the coastal protection and fisheries habitat and nursery services, which are off-site services that do not require access to the mangrove itself. Mangrove conservation efforts should therefore aim to mitigate the impacts of fragmentation by transport infrastructure.

References

Ahmad N., 1984. Some aspects of economic resources of Sundarban mangrove forest of Bangladesh. In: Soepadimo E., Rao A.N., and Macintosh D.J. (Eds.), Proceedings of the Asian Symposium on Mangrove Environment, Research and Management. Kuala Lumpur, pp. 644–651.

Alkemade, R., van Oorschot, M., Miles, L., Nellemann, C., Bakkenes, M., and ten Brink, B., 2009. GLOBIO3: A framework to investigate options for reducing global terrestrial biodiversity loss. Ecosystems 12: 374-390.

Bann, C., 1999. A Contingent Valuation of the Mangroves of Benut, Johor State, Malaysia. Report to the Johor State Forestry Department, Malaysia.

Barbier, E.B., 1994. Valuing environmental functions: tropical wetlands. Land Economics, 70: 155-173.

Barbier, E.B., Hacker, S.D., Kennedy, C., Koch, E.W., Stier, A.C., and Silliman, B.R., 2011. The value of estuarine and coastal ecosystem services. Ecological Monographs 81:169–193.

Braat, L. and ten Brink, P. (eds.), 2008. The cost of policy inaction: The case of not meeting the 2010 biodiversity target. Report for the European Commission, DG Environment, Brussels.

FAO, 2010. Food and Agricultural Organisation Yearbook. http://www.fao.org/fishery/statistics/en

Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J. and Duke, N., 2011. Status and distribution of mangrove forests of the world using earth observation satellite data. Global Ecology and Biogeography, 20: 154–159.

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being: Current State and Trends. Island, Washington, DC, chap. 19.

OECD, 2008. OECD Environmental Outlook to 2030. OECD, Paris.

PBL, 2010. Rethinking Global Biodiversity Strategies: Exploring Structural Changes in Production and Consumption to Reduce Biodiversity Loss. Netherlands Environmental Assessment Agency, Bilthoven.

Saenger, P., Hegerl, E.J. and Davie, J.D.S (eds.), 1983. Global status of mangrove ecosystems by the Working Group on Mangrove Ecosystems of the IUCN Commission on Ecology in cooperation with the United Nations Environment Programme and the World Wildlife Fund. The Environmentalist, vol. 3, supp. 3: 1-88.

Spaninks, F. and Beukering, P.V., 1997. Economic valuation of mangrove ecosystems: potential and limitations. CREED Working Paper 14.

TEEB, 2010. The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

UNEP, 2006. Marine and Coastal Ecosystems and Human Well-Being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment. UN Environment Programme, Nairobi.

Coral reef ecosystem service values

Summary

This case study examines the value of coral reef ecosystem services in Southeast Asia. It provides estimates of the forgone value of reef related fisheries and tourism due to loss of coral reefs under a "business-as-usual" scenario of increasing threats over the period 2000-2050. The impacts on fisheries and tourism are analysed separately using meta-analyses of the valuation literature. For Southeast Asia as a whole, the annual loss in value of reef related fisheries is approximately US$ 6 billion in 2050. The present value of the impact on fisheries for the period 2000-2050 is estimated to be approximately US$ 57.98 billion. These losses are suffered largely by Indonesia and the Philippines.

Introduction

Southeast Asia has the most extensive and diverse coral reefs in the world. They cover approximately 70,000 km2, which is 28 percent of the global total area of coral reef (Burke et al., 2011). Within the region, the Coral Triangle contains 76% of all known coral species and hosts 37% of all known coral reef fish species.[4]

Coral reefs of Southeast Asia are highly productive ecosystems that provide a variety of valuable goods and services to local populations (UNEP, 2006; Burke et al., 2011). These goods and services include coastal protection, habitat/nursery functions for commercial and subsistence fisheries, recreational/tourism opportunities, and the welfare associated with the existence of diverse natural ecosystems. Despite the provision of multiple valuable services, the coral reefs of Southeast Asia are the most threatened in the world (Burke et al., 2011). The threats are both local and global in origin and include non-sustainable fishing practices; sedimentation; pollution and waste; mining and dredging; damaging tourism practices; invasive alien species; climate change related increases in temperature and sea-level (Cesar, 2000); and ocean acidification due to higher concentrations of CO2 in the atmosphere (Veron et al, 2009). In addition, natural threats such as disease and the occurrence of outbreaks of dominant species are compounded by weakened ecosystem functioning (Burke et al, 2011).

Given the range and serious nature of threats to the ecological integrity of coral reefs, there is a need for information on the value of welfare losses associated with a decline in the provision of ecosystem services (Millennium Ecosystem Assessment, 2005). Information on the value of coral reef ecosystem services can be used in a number of different policy making contexts including the justification for establishing marine protected areas, determination of compensation payments for damage to coral reefs, setting of user fees for access to protected areas, cost-benefit analysis of conservation and restoration measures, and advocacy regarding the economic importance of functioning marine ecosystems (Van Beukering et al., 2007).

The aim of this case study is to provide an estimate of the loss in value of coral reef ecosystem services resulting from loss in coral reef area under a business-as-usual scenario for the period 2000-2050. The ecosystem services that we examine are the provision of recreation/tourism opportunities and the habitat and nursery support for commercial fisheries.

The structure of the case study report is as follows: the next section provides a general description of the value transfer method used; the third section presents the data, analysis and results of coral reef tourism values; the fourth section presents the data, analysis and results of coral reef related fisheries; and the final section provides a discussion of the findings.

Methodology

The methodology used in this case study for estimating the foregone value of ecosystem services due to loss of coral reefs in Southeast Asia over the period 2000-2050 follows a similar approach to that used in the case study on mangroves. The methodology employs a value transfer approach using the following steps:

1. Estimates value functions for coral reef ecosystem service values through meta-analyses of existing monetary estimates. The value functions relate ecosystem service value to the characteristics of the ecosystem and its surroundings.

2. Develop a database of coral reef ecosystems in Southeast Asia containing information on the variables included in the value function estimated in step 1.

3. Develop a baseline scenario for the change in the quality and spatial extent of coral reef

[4]The Coral Triangle is an area of tropical marine environment containing exceptionally high marine biodiversity. The area incorporates marine waters of Indonesia, Malaysia, the Philippines, as well as Papua New Guinea, the Solomon Islands and Timor-Leste.

ecosystems in Southeast Asia for the period 2000-2050. This baseline scenario is spatially variable to reflect variation in pressures on coral reef ecosystems.

4. Combine the models and data generated in steps 1-3 to produce estimates of the value of the loss in coral reef ecosystem services under the baseline scenario. This approach allows the estimation of spatially variable site or patch specific values that reflect the characteristics and context of each coral reef.

In this case study we estimate separate value functions for the two ecosystem services addressed: reef related fisheries and tourism. The reason for doing this is that the factors that determine the value of one ecosystem service will not necessarily be the same as those that determine the value of another. For example, the accessibility of an area likely to be important to tourism at a coral reef but might be irrelevant or even have negative effects for the value of fisheries supported by a coral reef. In addition, analysing tourism and fisheries values separately allows the units in which values are transferred to be defined differently. For fisheries, we estimate the value of reef related fisheries per hectare of coral cover and multiply this by the change in area of coral reef under the selected future scenario. For tourism, we estimate the value per recreational visit and multiply this by the estimated number of visitors to each coral reef site under the selected future scenario.

Value of coral reef fisheries

Coral reef fisheries value data

The coral reef value dataset used in this case study to estimate value functions for coral reef ecosystem services is an extension of the data described in Brander et al. (2007) and Brander et al. (forthcoming). This data has been extended to include a number of recent coral reef valuation studies.

For the valuation of the role that coral reefs play in supporting commercial fisheries, we reviewed 31 studies that provided sufficient information for inclusion in the database and meta-analysis. From these 31 studies we were able to obtain a total sample of 35 estimates of the value of coral reef related fisheries. Separate value estimates from a study were included if they represent different study sites or valuation methods. These characteristics of value estimates can be explicitly controlled for in the meta-analysis.

The studies included in our analysis were published between the years 1992 and 2012. The geographic distribution of study sites is presented in Figure 11. Southeast Asia is relatively well represented in the data with 10 valuation estimates. The source of the remaining estimates are 3 from the Caribbean, 9 from the United States, 3 from the Indian Ocean, 6 from Australia and 4 from the Pacific.

Regarding the methods that have been used to estimate the value of coral reefs in supporting commercial fisheries, we observe that the most commonly used method is to estimate the net factor income from the fisheries. Net factor income is calculated as the gross revenue from a reef related fishery minus the costs. In other words it provides an estimate of the profit or producer surplus from the fishery assigns this value to the coral reef. The secondly most frequently used valuation method is to calculate the gross revenue of a reef related fishery. This approach obviously over-estimates the contribution of the reef as an input to a fishery.

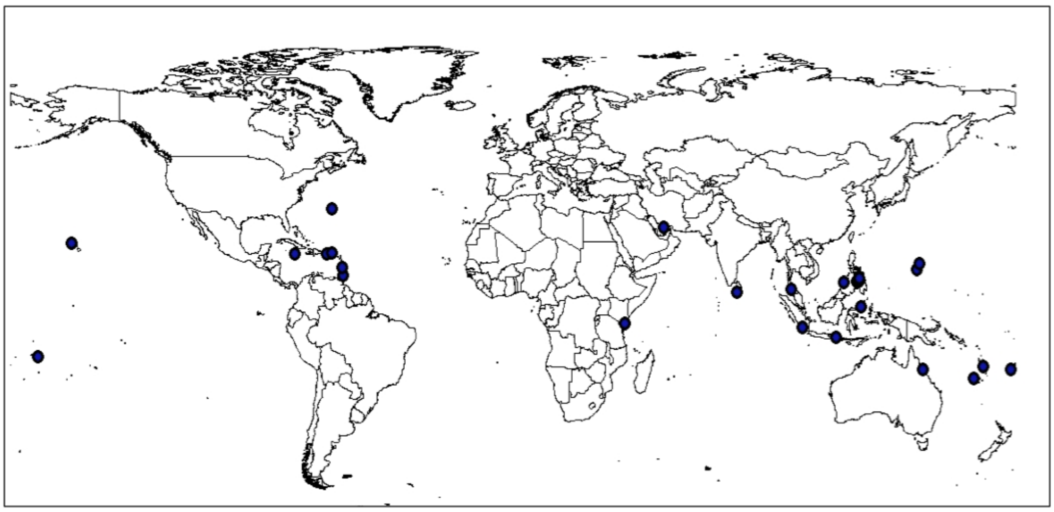

Figure 11. Location of coral reef fisheries valuation study sites.

The data on the value of reef related fisheries has been standardised to a common currency, year of value and units. This is US$ in 2007 prices, per year, per hectare of coral cover. The average value for the sample of estimates is US$ 2, 826 and the median value is US$ 605.

Meta-analysis of coral reef fisheries values

This section describes the meta-analysis and estimated value function for coral reef related fisheries. The explanatory variables included in the value function are the area of coral cover at each study site, the population living within a 50 km radius of the study site, a dummy variable indicating whether the estimate is for Southeast Asia or not, and a dummy variable indicating whether the estimate is of producer surplus or some other measure of economic welfare. The results of the meta-analysis are presented in Table 4.The negative coefficient on the area of coral cover indicates diminishing returns to scale, i.e. that the value to reef related fisheries of adding an additional hectare to a large area of coral reef is lower than adding a hectare to a small coral reef. The negative effect of the population variable indicates that reef related fisheries have higher values in areas where population is lower. This may reflect the impact of population related pressures, e.g. sedimentation and pollution, on the quality and functioning of coral reefs in supporting fisheries. The variable indicating that a coral reef is located in Southeast Asia is positive, which indicates that the value of reef related fisheries in this region tends to be higher than for other regions. It should be noted, however, that we do not have any measurement of whether the level of fishing at each of the study sites in the database is at or above a long term sustainable level. It might be the case that fisheries yield per hectare of coral reef is higher in Southeast Asia but that this is above a sustainable yield. The variable indicating that the value estimate is for the producer surplus measure of welfare show that methods that produce is measure tend to be lower than other methods (e.g. that estimate gross revenues). This is expected given that the estimation of gross revenues without accounting for the costs of other inputs to a fishery is likely to overestimate the value of coral reefs as an input.

The adjusted R2 for the meta-regression is relatively low (0.25) indicating that the estimated model only explains 25% of variation in coral reef values. There are clearly a number of important factors that influence the value of coral reef related fisheries that are not captured by the set of explanatory variables used in the value function. We therefore cautiously use the estimated value function to transfer values to business-as-usual changes in the extent of coral cover and show the uncertainties in this estimate.

Valuation of fisheries impacts from coral reef change in Southeast Asia 2000-2050

To define a baseline scenario for coral reef change for the period 2000-2050, we make use of the results of Reefs at Risk Revisited assessment (Burke et al., 2011). This assessment provides a spatially explicit projection of the degree to which coral reefs are threatened. The threats included in the Reefs at Risk Revisited assessment are coastal development, watershed based pollution, marine based pollution and damage, overfishing and destructive fishing, thermal stress, and ocean acidification. These local and global threats are combined into an integrated index representing the degree to

Table 4. Coral reef fisheries value function

Variable	Variable definition	Coefficient[1]	S.E.[2]
Constant		9.570***	1.263
Coral reef area	Area of coral reef study site (ha; ln)	-0.275*	0.108
Population	Population within 50 km (ln)	-0.145	0.091
Souteast Asia	Dummy variable for Southeast Asia	1.588*	0.617
Producer surplus	Dummy variable for producer surplus	-0.927	0.512
N	35		
Adjusted R^2	0.25		

[1] Statistical significance is indicated with ***, ** and * for the 1, 5 and 10% level respectively.

[2] Heteroskedasticity consistent standard errors.

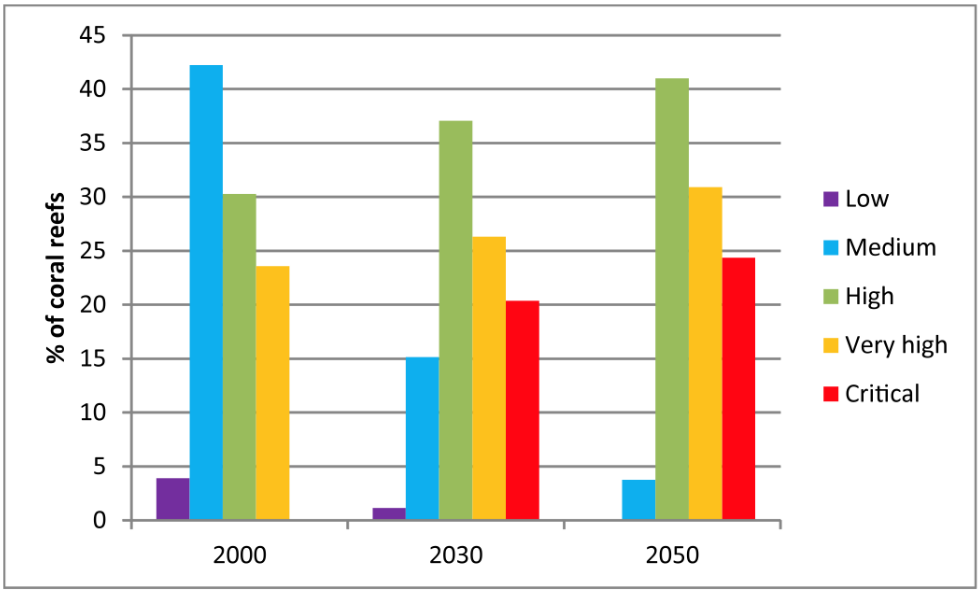

Figure 12. Level of threat to coral reefs in Southeast Asia 2000, 2030, 2050. Source: Burke et al. (2011).

which coral reefs are threatened. Threat levels are classified as low, medium, high, very high, or critical. Figure 12 represents the change in the degree of threat to coral reefs in Southeast Asia over the period 2000-2050. It shows that the proportion of coral reefs in the low or medium threat categories declines over time whereas the proportion of coral reefs that are highly, very highly or critically threatened increases dramatically. We use spatially differentiated change factors derived from the Reefs at Risk Revisited integrated threat data combined with patch level data on coral reefs from the UNEP World Conservation Monitoring Centre (described in Giri et al., 2010) to calculate the change in area of each patch of coral reef for the period 2000-2050.

For each of the 5,290 coral reef patches in Southeast Asia that are included in the UNEP-WCMC database, spatial data is used to obtain information on the area of coral reef and the population within 50 km. At the level of individual patches of coral reef, patch specific parameter values are then substituted into the meta-analytic value function to estimate values per unit area (USD/ha/annum). These estimates are then used to calculate the value of the projected change in the area of each patch. Lower and upper bound values are calculated using the 95% prediction intervals for each coral reef, which are computed using the method proposed by Osborne (2000). The prediction intervals provide an indication of the precision with which the estimated value function can predict out-of-sample values.

The values of foregone coral reef related fisheries, aggregated to the country level, are presented in Table 5. Comparing the 2000 stock

Table 5. Annual loss in value of reef related fisheries in Southeast Asia in 2050

Country	*Loss fisheries value (US$/annum; millions)*	*PI 95% Low (US$/annum; millions)*	*PI 95% High (US$/annum; millions)*
Brunei	*23*	*14*	*33*
Cambodia	*2*	*1*	*2*
Indonesia	*2,737*	*2,593*	*2,882*
Malaysia	*196*	*156*	*235*
Myanmar	*79*	*69*	*90*
Philippines	*2,213*	*1,975*	*2,450*
Singapore	*4*	*3*	*4*
Thailand	*108*	*104*	*112*
Vietnam	*279*	*237*	*321*
Total	*5,639*	*5,151*	*6,129*

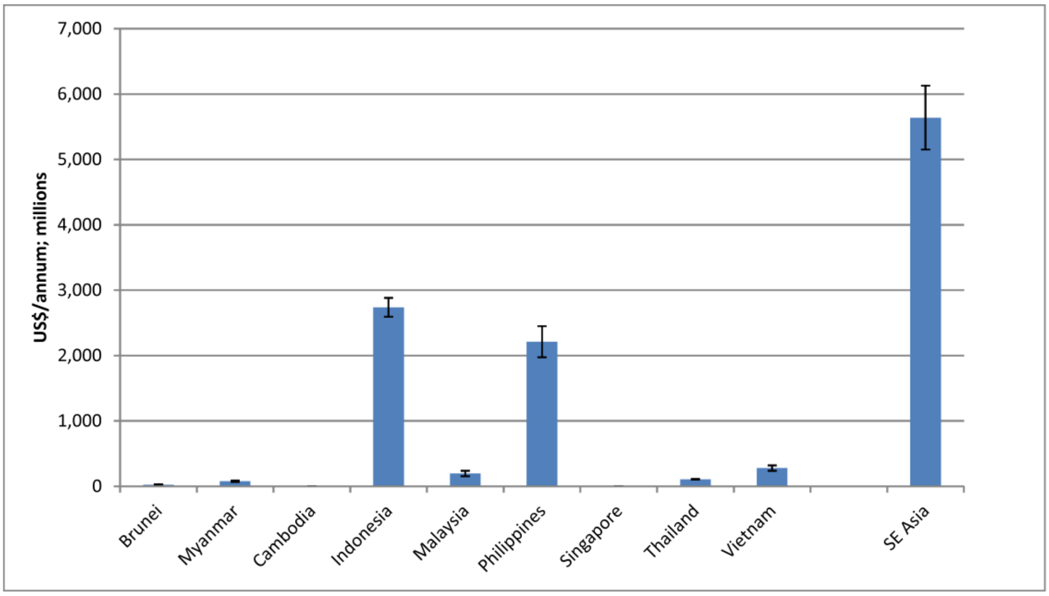

Figure 13. Lost value of reef related fisheries in 2050.

of coral reefs to the projected 2050 stock, the annual value of reef related fisheries in Southeast Asia is estimated to lowered by approximately US$ 5.64 billion in 2050 (2007 prices), with a 95% prediction interval of US$ 5.15 – 6.13 billion. To put this value in perspective, the current gross value of marine aquaculture in Souteast Asia is approximately US$ 1 billion per year (FAO 2010). The present value of losses over this period (i.e. the sum of annual losses discounted over the period 2000-2050) is estimated to be approximately US$ 57.98 billion (95% prediction interval US$ 52.87 – 63.11 billion). The present value is calculated by assuming a linear time profile of losses between 2000 and 2030 (2030 is the only intermediate year for which we have data) and between 2030-2050, and using a discount rate of 4%. This is the cumulative value of the foregone fisheries value due to coral reef loss that is expected to occur each year over the period 2000-2050. The loss of habitat and nursery support to fisheries is not valued only for the year in which the coral reef area is lost but also for every subsequent year that it would have provided this ecosystem service, up until the time horizon of the analysis (2050).

The value of lost reef related fisheries in 2050 due to the decline in coral cover over the period 2000-2050 is represented in Figure 13. It shows that the countries expected to suffer the highest losses are Indonesia (US$ 2.7 billion) and the Philippines (US$ 2.2 billion).

Discussion

This case study provides an estimate of the value of foregone value of reef related fisheries due to the decline in coral reef area in Southeast Asia under a baseline scenario for the period 2000-2050. This value is estimated by combining a meta-analytic value function for coral reef supported fisheries with spatial data on individual coral reef ecosystems to produce site specific values, which are aggregated to the country level. The results show that for Southeast Asia as a whole, the annual value of the impact on fisheries from losing coral reefs is approaching US$ 6 billion in 2050. This loss is mainly suffered by Indonesia and the Philippines.

The results of this case study show that there is a substantial economic impact of allowing coral reef degradation in Southeast Asia. Moreover, it is important to note that this estimate is only for the impact of coral reef degradation on reef related fisheries. The impacts on other ecosystem services provided by coral reefs, such as coastal protection and recreation/tourism are likely to also be substantial. Coral reefs are an important natural capital asset for Southeast Asia but are highly imperilled, not least by local threats such as overfishing and harmful fishing practices (Burke et al., 2011). There is evidently a need for better conservation and management of coral reef resources to avoid substantial economic losses in the future.

References

Brander, L.M., Beukering van, P., and Cesar, H.S.J. (2007) The recreational value of coral reefs: a meta-analysis. Ecological Economics 63, 209-218.

Brander, L.M., Rehdanz, K., Tol, R.S.J. and van Beukering, P. (forthcoming). The economic impact of ocean acidification on coral reefs. Climate Change Economics.

Burke, L., Reytar, K., Spalding, M., and Perry, A. (eds.), (2011). Reefs at Risk Revisited. World Resources Institute, Washington D.C.
Cesar, H.S.J. (2000). Coral reefs: their functions, threats and economic value. In: Cesar, H.S.J. (Ed.), Collected Essays on the Economics of Coral Reefs. CORDIO, Sweden.
Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J. and Duke, N., 2011. Status and distribution of mangrove forests of the world using earth observation satellite data. Global Ecology and Biogeography, 20: 154–159.
Osborne, J.W., 2000. Prediction in Multiple Regression. Practical Assessment, Research & Evaluation, 7. ISSN 1531-7714.
UNEP, 2006. Marine and Coastal Ecosystems and Human Well-Being: A Synthesis Report Based on the Findings of the Millennium Ecosystem Assessment. UN Environment Programme, Nairobi.
Veron, J.E.N., Hoegh-Guldberg, O., Lenton, T.M., Lough, J.M., Obura, D.O., Pearce-Kelly, P., Sheppard, C.R.C., Spalding, M., Stafford-Smith, M.G., and Rogers, A.D., (2009) The coral reef crisis: The critical importance of <350 ppm CO2. Marine Pollution Bulletin 58: 1428–1436.
Van Beukering, P., Brander, L., Tompkins, E. and McKenzie, E., (2007) Valuing the Environment in Small Islands - An Environmental Economics Toolkit. Joint Nature Conservation Committee (JNCC), Peterborough, p.128.

Leuser forest ecosystem, Sumatra, Indonesia

Summary

This case study describes the value of a broad set of ecosystem services provided by the Leuser forest ecosystem in Sumatra, Indonesia. The case study highlights the distribution of ecosystem service benefits across different stakeholders and the trade-off between short term gains for some versus larger long term losses for others. The analysis shows that the net benefits of conservation outweigh the net benefits of deforestation in the long-run. Although the economic case for conservation is clear, there remain many challenges in protecting the Leuser ecosystem.

Introduction

This case study describes the Leuser ecosystem, which has been studied in quite some detail over the years. The case description draws together information from various reports and academic publications (Van Beukering et al. 2003; Van Beukering et al. 2009; BPKEL 2009; PEM Consult 2010) as well as various online sources, such as the Leuser Ecosystem Management Authority (BPKEL) and WWF Indonesia websites.

Site description

The Leuser forest ecosystem in North Sumatra (Indonesia) is 25,000 km2. The area is mostly characterised by montane tropical rainforest, but also comprises freshwater swamp forest, peat swamp forest, mangrove forest and other ecosystems. Within the Leuser ecosystem the Gunung Leuser National Park (GLNP) – an ASEAN Heritage Park – forms a protected core with an area of 7,927 km2. Figure 14 presents a map with the location and boundaries of the Leuser forest ecosystem

The Leuser ecosystem is one of the two remaining homes of the Sumatran Orangutan (Pongo abelii). Other mammals that can be found here are the Sumatran Elephant (Elephas maximus sumatranus), the Sumatran Tiger (Panthera tigris sumatrae), the Sumatran rhinoceros (Dicerorhinus sumatrensis). These species are categorised as critically endangered by IUCN but other species in the Leuser ecosystem such as the Siamang (Symphalangus syndactylus) and the Mainland Serow (Capricornis milneedwardsii) are at risk as well.

The GLNP is part of the Tropical Rainforest Heritage of Sumatra, a UNESCO World Heritage

Site together with Kerinci Seblat National Park and Bukit Barisan Selatan National Park. Within GLNP there is the Ketambe research station which is tasked with researching the primates of GLNP.

Unsustainable activities and resource use

Until the 1980's there was no noteworthy environmental degradation in the Leuser ecosystem. In part this was because very few people lived in the Leuser ecosystem. Even today, there are only a small number of human settlements with sizeable populations in the area. In the late 1980's, however, logging concessions were granted to parties who were external to the Leuser area and did not have the deep cultural connection with it that indigenous people did. The logging encouraged many local inhabitants to abandon their traditional ways of life and start (illegal) logging themselves.

The roads and trails needed for logging made logging much easier, and the harvesting of non-timber forest products and animals as well. The extraction of rattan, damar resin and rhino horn quickly reached unsustainable levels. Before these developments occured the population of the Sumatran rhinoceros may have been thousands strong. Today it is estimated that less than a hundred individual rhinos are left.

Several other charismatic animal species have come under severe pressure from developments in the Leuser ecosystem. Habitat for the Sumatran orangutan is in decline and becoming fragmented as primary lowland forest is cleared for agriculture and oil plantations. As developments encroach upon elephant trails there is a potential for conflict between humans and the Sumatran elephant which is often resolved by killing elephants. The Sumatran tiger may be at risk for similar reasons, as a declining habitat forces it to hunt livestock. Residents protect their property by killing tigers, but they are unaware that unchecked livestock populations are detrimental to the forest ecosystem and biodiversity.

The rivers of the Leuser ecosystem were an abundant source of food until, also in the 1980's, fishermen started using poison to achieve larger catches with less effort. The effects of this destructive fishing technique are still being felt today. The river ecosystems have not yet recovered, fish populations are comparatively small and as a result the fishing sector has suffered.

Destruction and overextraction of resources in the Leuser ecosystem have put the cultural and biological wealth of the area at risk. Yet other, less observable effects have taken place as well, as diminished forests have become less able to regulate water flows, reduce soil erosion and provide local households and entrepeneurs with income from forest resources and tourism.

Figure 13. Lost value of reef related fisheries in 2050.

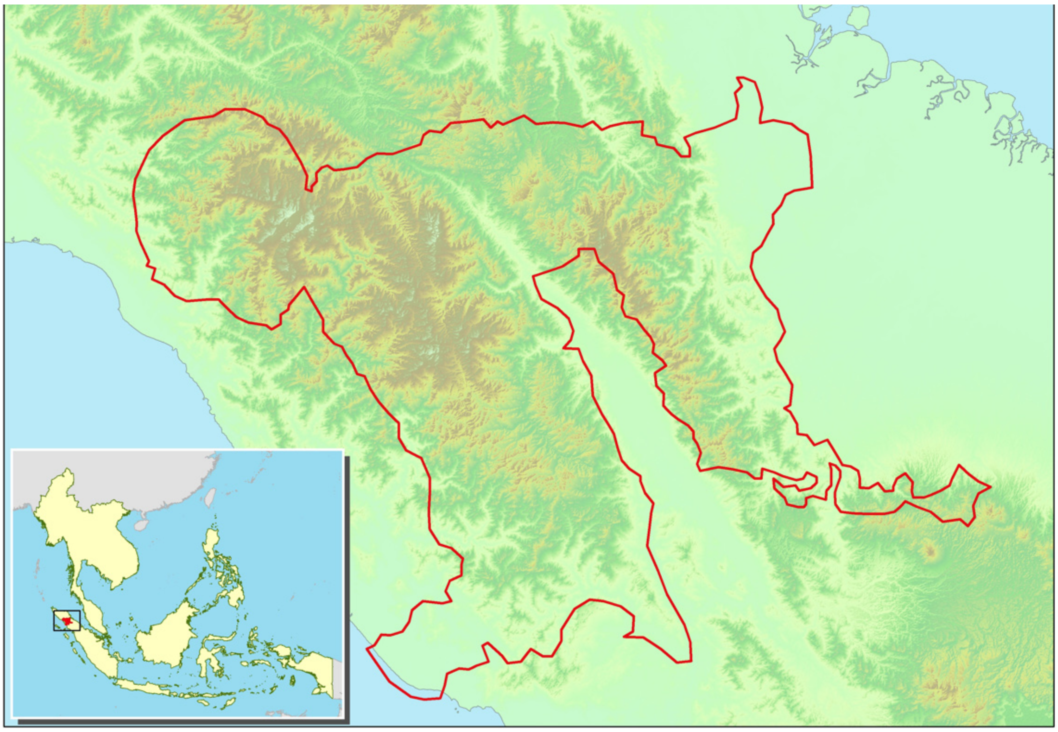

Figure 14. Location of the Leuser forest ecosystem.

Economic valuation of ecosystem services

Van Beukering et al. (2003) identified a number of ecosystem services provided by the Leuser ecosystem and performed an economic valuation, an effort updated in 2009 in support of the Green Economic Development and Investment Strategy for Aceh Province (Van Beukering et al. 2009). Underlying these economic valuations is a dynamic model with a set of scenarios and their impacts on ecosystem services. The results from the 2009 study are discussed here.

Table 6 presents the ecosystem services that are provided by the Leuser ecosystem and compares the services as identified by Van Beukering et al. (2003; 2009) with the TEEB classification of ecosystem services. The difference between the two lists is due to the fact that the two studies of the Leuser ecosystem services are tailored to distinct user groups within the Leuser ecosystem, whereas the TEEB classification is generic. Note how some ecosystem services in the left-hand column of Table 1 represent two or more ecosystem services in the right-hand side column.

A reduced water supply affects households and industry alike in terms of drinking water and interruptions to production processes. Given that the water supply is likely to be suspended annually, water may have to be brought in from elsewhere using costly infrastructure. By comparing scenarios Van Beukering et al. (2009) estimate the economic benefits of conserving the Leuser ecosystem over the benefits of continuing with current deforestation rates to be US$ 2,785 million measured over a period of 30 years (US$ 93 million annually on average) using a discount rate of 3.5%.5

Fisheries may depend on a range of forest ecosystem services for their functioning and Van Beukering et al. (2009) approximate an aggregate market value of the fishing sector. Over a 30-year time period ecosystem services provided by the Leuser ecosystem contribute as much as US$ 950 million to the fishing sector (US$ 30 million annually on average).

The range of ecosystem services that support agriculture and plantations in the Leuser ecosystem is estimated by summing the market value of the production of rice, fruit and vegetables, and palm oil. By forcing producers to incur extra costs for, e.g., fertilizers, the value of ecosystem services in a conserved Leuser ecosystem is estimated to be US$ 1,300 million for a 30-year period (US$ 40 million annually on average).

The value of tourism depends greatly on the splendour and abundance of the natural resources on offer. Because of the low number of tourists that visit the Leuser ecosystem, the added value of conserving the forest in terms of money spent locally by tourists is low. But international visitors display a high willingness to pay an entrance fee to the area or to make a donation to preserve the characteristic biodiversity of the Leuser ecosystem. Up to US$ 108 million annually could be raised if the deforestation of the Leuser ecosystem were halted.

The value of the the climate regulating services of the Leuser ecosystem depends in part on whether international markets for carbon will recognise the contribution of avoided deforestion to carbon sequestration. Assuming this will be so Van Beukering et al. (2009) estimate the value of this ecosystem service to be US$ 1,749 million over a 30-year period (US$ 56 million annually).

The economic value of logging if the Leuser ecosystem is to be fully conserved is naturally very low. In fact, because timber will still be

Table 6. Ecosystem services of the Leuser ecosystem

Van Beukering et al. (2003; 2009)	TEEB classification
Water supply	Water
Fishery	Food
Flood and drought prevention	Moderation of extreme events; Regulation of water flows
Agriculture and plantations	Maintenance of soil fertility; Pollination; Biological control
Hydro-electricity	Erosion prevention
Tourism	Opportunities for recreation & tourism
Biodiversity	Habitat services
Carbon sequestration	Climate regulation
Fire prevention	Moderation of extreme events
Non-timber forest products	Raw materials; Medicinal resources; Ornamental resources
Timber	Raw materials

[5]The discount rate to use in such exercises is a much-discussed topic in economics and will significantly affect results.

Table 7. The economic value of ecosystem services in the Leuser ecosystem over a 30-year period (million US$)

	Deforestation scenario	Conservation scenario	Additional benefit of conservation
Water supply	1,059	2,487	1,428
Fishery	2,025	2,490	465
Flood prevention	1,622	1,860	238
Agriculture	3,512	3,991	479
Hydro-electricity	15	26	11
Tourism	25	139	114
Biodiversity	103	582	479
Carbon sequestration	0	1,217	1,217
Fire prevention	183	225	42
Non-timber forest products	161	391	230
Timber	3,308	0	-3,308
Total	*12,013*	*13,408*	*1,395*

Source: Van Beukering et al. (2009)

The estimated value of all the ecosystem services studied by Van Beukering et al. (2009) is shown in

required in the region it will have to be imported and so lead to costs. The economic value of continued deforestation will, however, drop in the near future as primary forest is depleted. Over a 30-year period the value of logging is estimated to be US$ 4,634 million (US$ 149 million annually on average).

The estimated value of all the ecosystem services studied by Van Beukering et al. (2009) is shown in Table 7. It shows that at a discount rate of 3.5% the benefits of conserving the Leuser ecosystem, its ecosystem services and its biodiversity vastly outweigh the benefits of deforestion. The time profile of the benefits of deforestation and conservation are different, with conservation delivering higher benefits over the long-run (see Figure 15). Crucially the result that the long-run value of all ecosystem services outweighs that of logging remains true up to a fairly high discount rate of 8% and even then the value of conservation is not much less than that of deforestation. The reason is that a conserved Leuser ecosystem will continue to supply ecosystem services, whereas a fully deforested Leuser ecosystem is ecologically collapsed and can provide very few services.

Current policy situation and challenges

It is not possible to assess to what extent the original study by Van Beukering et al. (2003) affected policy making in the Leuser ecosystem. Assuming that intentions of conservation were already present at the time, this study may well have strengthened the position of proponents of conservation by showing that conservation makes sense economically and socially.

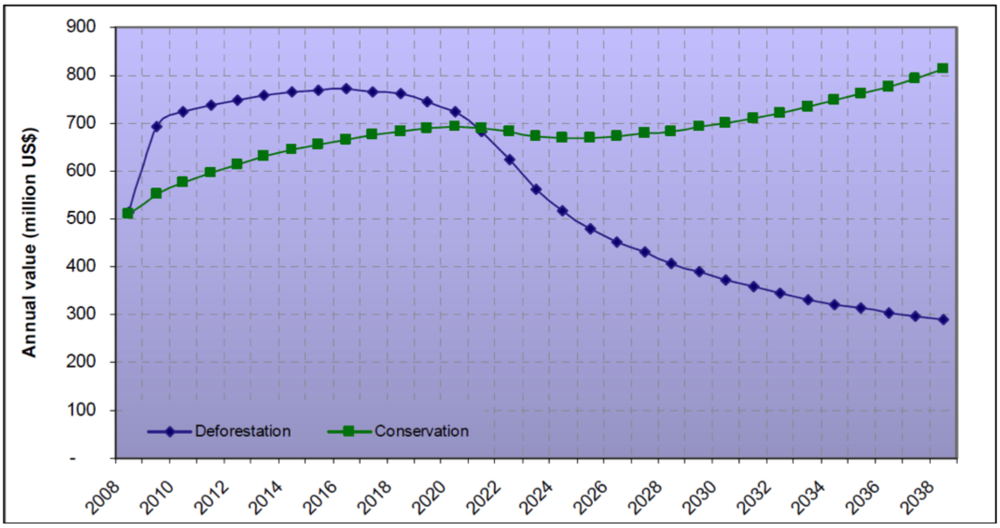

Figure 15. Net annual benefits of deforestation and conservation over time. Source: van Beukering et al. (2009).

A number of initiatives towards conservation have been taken. Aside from the Indonesian Selective Felling and Replantation (TPTI) system that applies to logging concessions since 1989, the Governor of Aceh, Governor Irwandi Yusuf has endorsed a Green Development and Investment Strategy for Aceh Province. The aim of this strategic vision is to conserve 3.1 million hectares of forest and to develop a revenue stream based on the ecosystem services the forest supplies. Local governments are to be involved in the management of forests in their jurisdiction.

For a variety of reasons this great vision has not come to pass. Sustainable use of natural resources requires good governance as well as adequate monitoring and enforcement efforts. For all these aspects, BPKEL (2009) describes challenges that face a sustainable future for the Leuser ecosystem.

One major concern is that responsibility for the management of the Leuser ecosystem is shared by many administrative institutions. This leads to overlapping or conflicting local developments plans, and the Provincial Spatial Plan does not yet reflect that the Leuser ecosystem has legally been declared a National Strategic Area, including the limitations on development that flow from this status.

Furthermore, property rights throughout the area can be poorly defined which opens the door to corruption and assorted illegal activities in the Leuser ecosystem. The promise of short-term profits is very tempting for district administrations when formulating development strategies, whereas individuals who illegally clear a patch of forest to stake a claim to it often perceive the forest as a free resource. Sensitive to criticisms of infringing on the rights of indigenous people, the government tends to refrain from enforcing the illegality of such claims. Monitoring and enforcement are instrumental in stopping such practices, but the available funding is inadequate.

In line with the Green Development and Investment Strategy for Aceh Province, BPKEL suggests switching revenue streams away from logging and plantations while acknowledging that capturing these values may be difficult. Ecosystem services that may be capitalised at some point in the future are tourism, water supply and carbon sequestration. The institutional design of such benefit capture and the subsequent distribution of benefits is currently unclear. It would appear that a fair and equitable use of the revenues from ecosystem services requires significant educational and institutional effort.

Ultimately 85% of the Leuser ecosystem is to be strictly protected with only non-extractive activities allowed. This includes eco-tourism and the study of the growth processes of plants for commercial deployment outside the Leuser ecosystem.

References

van Beukering, Pieter J.H, Herman S.J Cesar, and Marco A Janssen. 2003. "Economic Valuation of the Leuser National Park on Sumatra, Indonesia." Ecological Economics 44 (1) (February): 43–62. doi:10.1016/S0921-8009(02)00224-0.

van Beukering, Pieter J.H., Kenneth Grogan, Sofie Louise Hansfort, and Daniel Seager. 2009. An Economic Valuation of Aceh's Forests: The Road Towards Sustainable Development. R-09/14. Amsterdam: Institute for Environmental Studies.

BPKEL. 2009. Management Plan for the Leuser Ecosystem, Wilayah Aceh (2009-2014). Banda Aceh: BPKEL.

PEM Consult. 2010. Technical Proposal Feasibility Study: Maintaining One of Asia's Largest Carbon Sinks - the Leuser Ecosystem. Düsseldorf: PEM Consult.

Hon Mun marine protected area, Nha Trang Bay, Vietnam

Summary

This case study describes the Hon Mun marine protected area (MPA) in Nha Trang Bay, Khanh Hoa province, Vietnam. The case study provides an illustration of the potential impact of information on the economic values of ecosystem services in improving decision making regarding nature conservation and finance. The recommendation to introduce a user fee that is earmarked for use by the MPA has been adopted and the MPA is now partially self-financed.

Introduction

Marine and coastal resources in SE Asia are under increasing threat from human activities. One way to manage these threats is through Marine Protected Areas (MPAs), which safeguard valuable ecosystems within their confines. Despite the ecological and socio-economic benefits they provide, the management of MPAs is often severely constrained by both a lack of funding and a poor relationship with communities living around (or within) them.

The Hon Mun MPA in Nha Thrang Bay, Vietnam, provides an example of how information and recommendations from an economic valuation study of ecosystem services helped to establish a well-functioning and sustainably financed MPA.

Site description

The Hon Mun Islands are located in the south of Nha Trang Bay and lie about eight kilometres from the shore. The Hon Mun Islands are defined as a group of small islands, namely Hon Mot, Hon Tam, Hon Mieu, Hon Mun and part of Hon Tre. Figure 16 presents a map showing the location of the Hon Mun MPA.

According to the Vietnam Biodiversity Action Plan (Tran, 1998), the area has the highest level of marine biodiversity in Vietnam. The Institute of Oceanography (1998) in Nha Trang records the area as having the second highest rating for marine biodiversity in the region, with only slightly less diversity (65 genera) than the Indo-Pacific centre of diversity (70 genera).

Economic valuation of ecosystem services

The ecosystems of the Hon Mun Islands support and provide a number of economically valuable services including commercial fisheries, bird nests, tourism, education and research. These have been assessed in a number of studies (Nam and Son, 2001; Nam and Son, 2005; Nam et al., 2005, Nam et al., 2006)

Recreational activities at the islands include snorkeling, scuba diving, boating, jet skiing, sun bathing, swimming and visiting fishing villages. Coral reefs and ornamental fishes are features peculiar to the Hon Mun Islands compared to other recreational sites, but they only attract about ten per cent of the visitors (under scuba diving). Water sports like boating, sailing and jet skiing are also not very popular.

Using the zonal travel cost model (ZTCM), the linear and semi-log demand curves for domestic visits to Hon Mun were plotted. The semi-log demand curve was chosen, as the linear form was skewed with autocorrelation and heteroscedasticity problems. The recreational value of the Hon Mun Islands from domestic visitors in the year 2000 was estimated at US$ 3.9 million, of which the recreational benefit or consumer surplus was US$ 1.5 million. Similarly, a demand curve for Hon Mun foreign visitors was plotted but in linear form. The recreational value from foreign visitors in the year 2000 was US$ 13.9 million, of which the consumer surplus was US$ 1.6 million. Therefore, the recreational value of the Hon Mun Islands is estimated to be US$ 17.9 million annually, of which Hon Mun's consumer surplus is estimated at US$ 3.1 million, based on the year 2000's statistics.

Using the Contingent Valuation Method, the willingness to pay (WTP) for funding a Marine Protected Area (MPA) project for the Hon Mun Islands was estimated to be US$ 400,000 annually. The WTP per Vietnamese visitor is US$ 1.2 and per foreign visitor, it is US$ 1.9.

The annual monetary recreational value of the Hon Mun Islands is approximately US$ 17.9 million. This is the value that the islands yield every year for the economy. However, this is not the revenue of Hon Mun. This value is distributed firstly, in the form of the consumer surplus of visitors who have gained recreational benefit at Hon Mun and then, in terms of prices paid, to transportation companies and agents for service providers such as hotels, restaurants, and tourist agencies. A very small part of the estimated recreational value of Hon Mun is given to the local economy through expenditures on food and accommodation in Nha Trang, tourist boat tickets, and services on the islands.

Policy situation

Up to 2001, the Hon Mun Islands could be described as a freely accessible public park managed by the local government.

The results of the valuation studies indicate that tourists derive large benefits from visiting Hon Mun and that there is scope for the introduction of a visitor entrance fee in order to establish a management and conservation fund for the islands. The results of the contingent valuation survey revealed, however, that nearly half of the survey respondents were unwilling to contribute to such a fund, due to scepticism that it would be well managed. This suggests that, while the revenue potential exists, it can only be realized if tourists feel that their payment will translate into improved management.

An inital source of funding for improved management was provided by internation donor agencies. On 10 January 2001 the Hon Mun Pilot Marine Protected Area was established by the approval of the Government of Vietnam, the Global Environment Fund (GEF), the World Bank (WB), the Government of Denmark and the World Conservation Union (IUCN). The four-year pilot project was funded by over USD 2 million. The pilot project had four main objectives: 1. To manage and plan the MPA with the participation of all involved parties; 2. To ameliorate unsustainable use of marine biodiversity with poverty alleviation through the development of sustainable fisheries and new aquaculture employment opportunities; 3. To raise the capacity for the successful development and implementation of the MPA through community empowerment by way of relevant training courses provided; 4. To monitor and assess the management of the project on a regular basis.

This financial support allowed the establishment of the MPA and ensured sound management of its natural resources. In the long term, continued management would provide greater net benefits (particularly in terms of fisheries and tourism) than a 'no management' scenario. Yet to ensure future management, Hon Mun needs to develop its own sustainable and autonomous financing regime.The best way to 'appropriate' Hon Mun's potential economic benefits would be through a user-fee for eco-tourists. Subsequent revenues could be ploughed back into management of the park and its buffer zone.

A visitor fee for the core zone of the MPA was introduced in December 2009 (Decision No. 23/2009/NQ-HDND). The fee is variable depending on the activities of the visitor: US$ 2 for snorkelling and scuba diving and US$ 0.5 for other activities (e.g. glass bottomed boats). The revenue from the fee nominally belongs to the provincial treasury but is 100% earmarked for use by the MPA. Total revenue from the visitor fee in 2011 was US$ 66,000 , which constitutes approximately 40% of the total annual budget of the MPA. The remaining budget for the MPA is provided by the provincial government.

The role of the information provided by the earlier valuation studies in shaping policy development and the introduction of the visitor fee is difficult to gauge. There is anecdotal evidence that the presentation of the research findings and recommendations for an earmarked visitor fee at a conference for policy makers in 2006 played a role in introducing the idea to policy makers.

Current ecological status and future threats

The Hon Mun MPA is recognised as being successful in restricting some activities that are harmful to the marine environment, in particular over-fishing. A recent survey of the ecological status of the Nha Trang Bay showed that the rate of degradation of the marine environment has slowed since 2000. In general there has been a slight decrease in live coral cover (currently 20%) but with different patterns in different areas of the bay (information specifically on the Hon Mun MPA is not reported). The density and size of reef fish has not increased but the diversity of reef fish has been maintained. Based on this observation it is concluded that the potential for natural restoration if high if effective management is continued. A recent study of the impacts on commercial fisheries from the establishment of Hon Mun MPA and another MPA in Khanh Hoa province suggests that there has been a substantial positive effect on fisheries (Huyen, 2010).

A number of important threats to the quality of the marine environment, however, persist and are developing. The large scale expansion of tourist developments in the Nha Trang Bay poses a significant threat, mainly due to increased quantities of waste and pollution in the bay. Although increasing tourism represents an opportunity for economic development in the area, it also poses a threat to the long term quality of the environment on which tourism ultimately depends. A further threat to the marine environment within the MPA is from aquaculture production, which is currently ineffectively managed.

References

Nam P.K. and Son T.V.H., (2001). Analysis of the Recreational Value of the Coral-surrounded Hon Mun Islands in Vietnam. Research Report, 58 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore.

Nam P K, Son T V H (2005). Recreational Value of the Coral Surrounding the Hon Mun Islands in Vietnam: A Travel Cost and Contingent Valuation Study. In: Ahmed M, Chong C K, Cesar H (eds) Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs, 84–107, WorldFish Center Conference.

Nam P.K., Son T.V.H., Cesar H., and Pollnac R., (2005). Financial sustainability of the Hon Mun Marine Protected Area: Lessons for other marine parks in Vietnam. PREM Working Paper, Poverty Reduction and Environmental Management (PREM), Institute for Environmental Studies, Vrije Universiteit: Amsterdam, The Netherlands.

Identification and recommendations for future ASEAN TEEB studies

The ASEAN Centre for Biodiversity (ACB) and partners intend to coordinate a full ASEAN TEEB study that will undertake in-depth assessments of critical ecosystems and ecosystem services in the ASEAN Member States. The process of identifying potential case study sites for this full ASEAN TEEB assessment is initiated in the Scoping Study.

The overarching criterion for the identification of potential future TEEB studies is the requirement that they are policy relevant. Case studies describe situations with a clear conflict between conservation of ecosystems/biodiversity and economic/infrastructure development. Furthermore, it is preferable that the case studies describe a situation in which a policy decision is imminent, but not yet made. In such cases, a TEEB assessment can provide useful information to assist decision making. Examples of potential decision making contexts include cost-benefit analysis of go/no-go development options; or the identification and setting up of financing options for protected areas.

Initial suggestions for potential TEEB studies have been elicited from environment officials in the ASEAN Member States, including ACB National Contact Points and ASEAN Senior Officials on the Environment, and from researchers and NGOs with experience of the region. Brief summaries of the suggesed case studies for each AMS are provided in Table 8. This preliminary list of potential case studies should not be viewed as comprehensive or complete at this stage. The identification of potential case studies is an ongoing process that continues beyond the scoping study. The final selection of case studies to be undertaken in the full ASEAN TEEB study will be made through consultation with AMS, based on the technical and policy merits of each study and the applicable resource constraints.

The preliminary list of potential case studies for a full ASEAN TEEB study encompasses a wide diversity of ecosystem types, ecosystem services, threats, policy contexts and scales of analysis. The ecosystems that have been proposed for study include principally forests,

Table 8. Proposed cases for a full ASEAN TEEB study

	Case study site	Ecosystems and services	Threats	Policy context
Brunei	Heart of Borneo	Forested watersheds. Reduction in floods and damage to infrastructure, river sedimentation, soil erosion, nutrients availability in soils	Deforestation	Limited quantitative work at the scale of a river basin/ watershed to prove or disprove the links between well managed ecosystems in mid to upstream areas and the provision of services downstream
Indonesia	Karst ecosystems (multiple sites)	Karst ecosystems contain high levels of biodiversity and potential for ecotourism	Industrial extraction of material for the production of cement and paint	The introduction and enforcement of laws on the extraction of materials from karst regions has progressed but areas of high biodiversity are still threatened.
Lao PDR	Nam Ha protected area	Mix of ecosystems (forests, woodlands and rivers) supporting high biodiversity	Encroachment	ASEAN Heritage Park since 2005
Malaysia	Ramsar wetlands	Six Ramsar sites with different characteristics but all important for biodiversity	No long term financing for management and conservation	Initial recommendations for PES and other financing mechanism but no implementation
Myanmar	Proposed AHP in northern Myanmar	Forest with high and unclassified biodiversity. Ecotourism potential	Conversion to agriculture; lack of enforcement and capacity for management	Protected areas are now under responsibility of local government but without management capacities
Philippines	Mount Mantalingahan protected area, Palawan	Forest habitat with significant biodiversity. Watershed for rivers supplying lowland agriculture. Carbon storage.	Mining of minerals (nickel)	Conflict between protection status and mining concessions

	Case study site	Ecosystems and services	Threats	Policy context
Philippines	Samar Island Natural Park, Eastern Visayas	Lowland tropical forests, brushlands, grasslands, wetlands and karst formations. Biodiversity, water supply, carbon storage, and ecotourism	Mineral exploration concessions (bauxite, copper and manganese) overlap with the park	The protected status of the park has not yet been finalised
	Mt. Malindang	Montane forest types, watershed, coastal. Resource use (water, food, raw materials), cultural, recreation, biodiversity	Lowland agriculture, extraction of natural resources (timber, mineral ore), riverine and urban water quality deterioration	Pilot for PES and discussion about site management organisation
	Southern Sierra Madre mountain range	Montane forest, coastal marine. High biodiversity, flood protection	Mineral extraction, residential development, hydropower dams	Designation of the area unclear, management claimed by many parties
Singapore	Urban green space	Health benefits of urban green space	Urban expansion	
	Chek Jawa wetland	Mangrove, seagrass, coral, coastal hill forest. Endemic biodiversity, recreation, education	Urban expansion	
	Sungei Buloh - Mandai	Mangrove, mudflats. Endemic biodiversity, recreation, education	Urban expansion, building of dams and canals	Site preserved as long as national interests permit
Thailand	Green cities	Green urban space and environmental management. Urban environment and resource use (water, waste)	High rates of urbanisation and city growth	Green cities legislation introduced, which specifically requires the use of economic incentives
Vietnam	Cat Ba-Hai Phong National Park	Montane forest, wetland forests, mangroves, corals reefs and cave systems. High biodiversity, recreation and tourism		
	Tam Giang-Cau Hai lagoon system	Lagoon, estuaries, mudflats, swamps, mangroves and seagrasses. Nursery service for commercial and subsistence fisheries, flood control, salt water intrusion, water supply and quality	Water quality deterioration due to aquaculture, agriculture (elevated levels of pesticides and coliform) and oil spills	
Vietnam	Mekong river delta, Vietnam	Flood plain. Agriculture conversion from low intensity to high crop production	Increased frequency and scale of flooding	Alternative approaches to flood control using different designs of dyke
	O Lau river delta wetland restoration	Freshwater wetlands. Biodiversity, habitat and nursery for fisheries.	Water pollution, oil spills, salt water intrusion, over exploitation of area for agriculture, aquaculture and fisheries.	
	Pu Mat National Park	Forests. Biodiversity	Dam building, trade in endangered species	There is a growing realisation by the Vietnamese media and politicians of the value that people place on conservation of Vietnamese biodiversity

wetlands, urban green space. The threats that have been identified include mining, encroachment and urban expansion. The threat posed by urban expansion to natural areas and the provision of ecosystem services has not been extensively addressed in the existing valuation studies for Southeast Asia. The policy contexts of the proposed case studies is also diverse and includes decision making on the establishment of areas with protected status, financing of existing protected areas, and the need for information on developing recognition of biodiversity conservation values in Southeast Asia.

After the case study sites have been selected the implementation of the TEEB assessments should be considered. The Introduction of this report describes the TEEB framework in general terms, but the framework details will have to be worked out for each case study individually. As Seppelt et al. (2011) show, such localisation has lead to a great diversity of ecosystem service assessments. This diversity in turn makes it difficult to assess the robustness of the assessments and their usefulness for policy making (Eppink et al. 2012). So far, however, very few large-scale ecosystem service projects have been designed with such coordination in mind. If this can be achieved for the ASEAN TEEB study it may push ecosystem service science in Southeast Asia to the forefront of the field.

An assessment of ecosystem services that adheres to the TEEB recommendations unites science and policy. The required scientific expertise broadly comprises natural and socio-economic scientists. A more detailed list can be specified once the case study goals and local conditions have been outlined by relevant stakeholders. In order to maximise the scientific capacity building potential of the full study, national researchers should conduct aspects of the assessments where possible. Ideally, these scientists will have demonstrable experience with their planned role in the TEEB assessment. The TEEB Secretariat maintains a network of experts who can be engaged to provide general or specific support where needed.

The political ambitions of the case studies in the full ASEAN TEEB study should be clarified upfront through a deliberative process. Capturing value, the most complex type of TEEB assessment that involves the development and implementation of economic policy instruments, may not be possible if political support is lacking. In that case, an assessment to demonstrate value may be conducted as a long-run strategy towards the development of sustainable development policies. In either case it should be clear that a TEEB assessment is more than a one-time scientific exercise. It requires regular exchanges between scientists, policy makers and stakeholders over a period of time that may extend beyond the intial duration of the ASEAN TEEB study.

The ultimate goal for Southeast Asian countries is to develop green growth strategies, i.e. development paths that unite nature conservation and economic development. The preliminary inventory presented in this section shows case study sites that have the potential to achieve that union. The ASEAN TEEB study, properly executed, will unlock that potential.

References

Eppink, Florian V., Andreas Werntze, Stephan Mäs, Alexander Popp, and Ralf Seppelt. 2012. “Land Management and Ecosystem Services: How Collaborative Research Programmes Can Support Better Policies.” GAIA - Ecological Perspectives for Science and Society 21 (1): 55–63.

Seppelt, Ralf, Carsten F. Dormann, Florian V. Eppink, Sven Lautenbach, and Stefan Schmidt. 2011. “A Quantitative Review of Ecosystem Service Studies: Approaches, Shortcomings and the Road Ahead.” Journal of Applied Ecology: 630–636.

Appendix 1: Overview of economic valuation methods

Economists have developed a variety of methods for estimating the value of goods whose market prices are either imperfect reflections of that value or non-existent. These methods are designed to span the range of valuation challenges raised by the application of economic analyses to the complexity of the natural environment. Application guidelines are available in detail in a number of existing reviews. See for example, Barbier (2007), Bateman et al., (2002), Freeman (2003), Hanley and Barbier (2009), Heal et al. (2005), Pagiola et al. (2004), and van Beukering et al. (2007).

Table A1. Valuation methods, typical applications, examples and limitations

Valuation method	Approach	Applications	Example ES	Limitations
Market prices	Use prices directly observed in markets	ES that are traded directly in markets	Timber and fuel wood from forests; clean water from wetlands	Market prices can be distorted e.g. by subsidies. Most ES not traded in markets
Public pricing	Use public expenditure or monetary incentives (taxes/ subsidies) for ES as indicator of value	ES for which there are public expenditures	Watershed protection to provide drinking water; Purchase of land for protected area	No direct link to preferences of beneficiaries
Replacement cost	Estimate cost of replacing ES with man-made service	ES that have a man-made equivalent that could be used and provides similar benefits to the environmental service.	Coastal protection by dunes; water storage and filtration by wetlands	No direct relation to ES benefits. Over-estimates value if society is not prepared to pay for man-made replacement. Under-estimates value if man-made replacement does not provide all of the benefits of the original ecosystem.
Restoration cost	Estimate cost of restoring degraded ecosystems to ensure provision of ES	Any ES that can be provided by restored ecosystems	Coastal protection by dunes; water storage and filtration by wetlands	No direct relation to ES benefits. Over-estimates value if society is not prepared to pay for restoration. Under-estimates value if restoration does not provide all of the benefits of the original ecosystem.
Damage cost avoided	Estimate damage avoided due to ecosystem service	Ecosystems that provide storm or flood protection to houses or other assets	Coastal protection by dunes; river flow control by wetlands	Difficult to relate damage levels to ecosystem quality.
Net factor income	Revenue from sales of environment-related good minus cost of other inputs	Ecosystems that provide an input in the production of a marketed good	Filtration of water by wetlands; commercial fisheries supported by coastal wetlands	Tendency to over-estimate values since method attributes all normal profit to the ES
Production function	Estimate value of ES as input in production of marketed good	Ecosystems that provide an input in the production of a marketed good	Soil quality or water quality as an input to agricultural production	Technically difficult. High data requirements
Hedonic pricing	Estimate influence of environmental characteristics on price of marketed goods	Environmental characteristics that vary across goods (usually houses)	Urban open space; air quality	Technically difficult. High data requirements
Travel cost	Use data on travel costs and visit rates to estimate demand for recreation sites	Recreation sites	Outdoor open access recreation	Technically difficult. High data requirements

Valuation method	Approach	Applications	Example ES	Limitations
Contingent valuation	Ask people to state their willingness to pay for an ES through surveys	All ES	Species loss; natural areas; air quality; water quality landscape aesthetics	Expensive and technically difficult to implement. Prone to biases in design and analysis
Choice modelling	Ask people to make trade-offs between ES and other goods to elicit willingness to pay	All ES	Species loss; natural areas; air quality; water quality; landscape aesthetics	Expensive and technically difficult to implement. Prone to biases in design and analysis
Group valuation	Ask groups of stakeholders to state their willing-ness to pay for an ES through group discussion	All ES	Species loss; natural areas; air quality; water quality; landscape aesthetics	Prone to biases due to group dynamics

References

Barbier, E.B., 2007. Valuing ecosystem services as productive inputs. Economic Policy 22 (49): 177–229.

Bateman, I. J., Carson, R. T., Day, B., Hanemann, M., Hanley, N., Hett, T., Jones-Lee, M., Loomes, G., Mourato, S., Özdemiroglu, E., Pearce, D. W., Sugden, R., Swanson, J., 2002. Economic Valuation with Stated Preference Techniques: A Manual, Edward Elgar, Cheltenham.

Freeman III, A. M. (2003), The Measurement of Environmental and Resource Values: Theories and Methods. Washington D.C.: Resources for the Future.

Hanley, N. and Barbier E., 2009. Pricing Nature Cost–Benefit Analysis and Environmental Policy. Edward Elgar, Cheltenham.

Heal G.M., Barbier E.B., Boyle K.J., Covich A.P., Gloss S.P., Hershner C.H., Hoehn J.P., Pringle C.M., Polasky S., Segerson K., Shrader-Frechette K., 2005. Valuing ecosystem services: toward better environmental decision making. The National Academies Press, Washington D.C.

Pagiola S., Ritter K.v, Bishop J.T., 2004. How much is an ecosystem worth? Assessing the economic value of conservation. The World Bank, Washington D.C.

Van Beukering, P., Brander, L.M., Tompkins, E., and McKenzie, E. (2007). Valuing the environment in small islands: An environmental economics toolkit. Joint Nature Conservation Committee, Peterborough, UK.

Appendix 2: Bibliography of ecosystem service valuation studies for SE Asia

Ahmad S A (2009) Visitors' Willingness to Pay for an entrance fee: A Case Study of Marine Parks in Malaysia. Ph.D Thesis, University of Glasgow.

Ahmed M, Umali G M, Chong C K, Rull M F, Garcia M C (2005) Valuing the Recreational and Conservation Benefits of Coral Reefs in Bolinao, Philippines. In: Ahmed M, Chong C K, Cesar H (eds) Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs, 126–139, WorldFish Center.

Amalia M (2010) Designing a Choice Modelling Survey to Value the Health and Environmental Impacts of Air Pollution from the Transport Sector in the Jakarta Metropolitan Area. Research Report, 62 pages, Environment and Economics Program for South East Asia (EEPSEA).

Amponin J A R, Bennagen E C, Hess S, dela Cruz J D S (2007) Willingness to Pay for watershed protection in Tuguegarao City, Philippines. PREM Working Paper: PREM07/06, 51 pages, Institute for Environmental Studies/Vrije Universiteit.

Arin T, Kramer R A (2002) Divers' willingness to pay to visit marine sanctuaries: An exploratory study. Ocean and Coastal Management 45:171–183. doi: 10.1016/S0964-5691(02)00049-2.

Asafu-Adjaye J, Tapsuwan S (2008) A contingent valuation study of scuba diving benefits: Case study in Mu Ko Similan Marine National Park, Thailand. Tourism Management 29:1122–1130. doi: 10.1016/j.tourman.2008.02.005.

Azmi M I M, Cullen R, Bigsby H, Noor A G A (2009) The Existence Value of Peat Swamp Forestin Peninsular Malaysia. Paper presented at the 2009 NZARES Conference Tahuna Conference Centre: Nelson, New Zealand, August 27–28, 2009

Bacalso R T M (2007) The Use of Alternative Scenarios from an Ecosystem-based model simulation of the Danajon Bank Municipal Fisheries as Input to evaluating fisheries management objectives in a Choice Experiment. Master's Thesis, CEBU College, Univeristy of The P

Bann C (1996) Maximising the Economic and Ecological Benefits of Ecotourism in Malaysia: A Case Study of Kampung Kuantan Fireflies. Project Report, 22 pages, WWF: Tabung Alam Malaysia

Bann C (1996) Maximising the Economic and Ecological Benefits of Ecotourism in Malaysia: A Case Study of the Kinabatangan River, Sabah. Project Report, 45 pages, WWF: Tabung Alam Malaysia

Bann C (1997) An Economic Analysis of Tropical Forest Land Use Options, Ratanakiri Province, Cambodia. Research Report, 73 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Bann C (1999) A Contingent Valuation of the Mangroves of Benut, Johor State, Malaysia. Research paper, 87 pages, Johor State Forestry Department /DANCED/Darudec: Preparation of an Integrated Management Plan for the Sustainable Use of the Johor Mangrove Forest

Bann, C. (1997) An Economic Analysis of Alternative Mangrove Management Strategies in Koh Kong Province, Cambodia. Research Report, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Barbier E B, Koch E W, Silliman B R, Hacker S D, Wolanski E, Primavera J, Granek E F, Polasky S, Aswani S, Cramer L A, Stoms D M, Kennedy C J, Bael D, Kappel C V, Perillo G M E, Reed D J (2008) Coastal Ecosystem–Based Management with Nonlinear Ecological Functions

Barkmann J, Glenk K, Keil A, Leemhuis C, Dietrich N, Gerold G, Marggraf R (2008) Confronting unfamiliarity with ecosystem functions: The case for an ecosystem service approach to environmental valuation with stated preference methods. Ecological Economics 65:48–62

Barkmann, J, Dietrich N, de Vries K, Gerold G, Glenk K, Keil A, Faust H, Leemhuis C, Marggraf R (2006) Confronting unfamiliarity with ecosystem functions: The case for an ecosystem service approach to environmental valuation with stated preference methods. In: Glenk K (2006) Economic Valuation of Bi

Be and Dung (1999) Economic and Environmental Impacts of Rice-shrimp farming systems in the Mekong Delta. In: Francisco H, Glover D (eds) Economy & Environment: Case studies in Vietnam, 223–251, International Development Research Centre (IDRC), Singapore

Bennagen M E C (2003) Estimation of Environmental Damages from Mining Pollution: The Marinduque Mining Accident. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Bennagen E C, Nepomuceno G, Covar R (2002) Solid Waste Segregation and Recycling in Metro Manila: Household Attitudes and Behavior. Research Report, 50 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore

bin Ramlan M A, Radam A, Yacob M R, Yahya N A (2011) Willingness to pay towards the sustainability of Forest Research Institute Malaysia's (FRIM's) canopy walkway. International Journal of Business, Management and Social Sciences 2(3):85–92

Burke L, Selig E, Spalding M (2002) Reefs at Risk in Southeast Asia. World Resources Institute: Washington DC 20002, USA

Butry D T, Pattanayak S K (2001) Economic Impacts of Tropical Forest Conservation: The Case of Logger Households around Ruteng Park. Working paper, 16 pages, Research Triangle Institute

Cadiz P L, Calumpong H P (2000) Analysis of revenues from ecotourism in Apo Island, Negros Oriental, Philippines. In: Proceedings 9th International Coral Reef Symposium: Bali, Indonesia 23-27 October 2000, Vol. 2

Calderon M M, Camacho L D, Carandang M G, Dizon J T, Rebugio L L, Tolentino N L (2004) A water user fee for households in Metro Manila, Philippines. Research Report, 69 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Campos M A, Pantoja B R, Manalili N M, Bravo M R (2003) Economic Evaluation of Fishery Policies in Lamon Bay, Quezon, Philippines. Research Report, 46 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Cesar H (2002) The Biodiversity benefits of Coral reef Ecosystems: Values and Markets. OECD Working papers, 38 pages, Working Party on Global and Structural Policies/Working Group on Economic Aspects of Biodiversity: Organisation for Economic Co-operation and Development (OECD)

Cesar H S J (1996) Economic analysis of Indonesian coral reefs. Working Paper Series 'Work in Progress', 97 pages, The World Bank: Washington DC

Cheesman J, Bennett J, Son T V H (2008) Estimating household water demand using revealed and contingent behaviors: Evidence from Vietnam. Water Resources Research 44: W11428. doi:10.1029/2007WR006265.

Choe K, Whittington D, Lauria D T (1996) The economic benefits of surface water quality improvements in developing countries: A case study of Davao, Philippines. Land Economics 72(4):519–37

Christiernsson A (2003) An Economic Valuation of the Coral Reefs at Phi Phi Island: A Travel Cost Approach. Master's Thesis, Lulea University of Technology

Chuenpagdee R (1998) Damage Schedules for Thai Coastal Areas: An Alternative Approach to Assessing Environmental Values. Research Report, 33 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore

Curran L M, Trigg S N, McDonald A K, Astiani D, Hardiono Y M, Siregar P, Caniago I, Kasischke E (2004) Lowland Forest Loss in Protected Areas of Indonesian Borneo. Science 303:1000–1003

Cushman C (2004) External costs from increased island visitation: Case study from Southern Thai Islands. Research report, 4 pages, Department of Resource Economics, University of Massachusetts

Danh V T (2007) Economic Value of Groundwater Protection in the Mekong Delta. CAULES-DANIDA Project Research Report, 39 pages

Dararath Y, Top N, Lic V (2011) Rubber Plantation Development in Cambodia: At What Cost?. Research Report, 47 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Davison G W H (1997) Economic Valuations and Costing of Animal Diversity. Seminar Paper, 15 pages, WWF: Tabung Alam Malaysia

de Lopez T T, Vibol K, Proeung S, Dareth P, Thea S, Sarina C, Song S, Chantha V, Vandy N, Bunly L, Sinoeun C (2001) Policy Options for Cambodia's Ream National Park: A Stakeholder and Economic Analysis. Research Report, 78 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore

de los Angeles M S, Francisco S R, Francisco H A (2003) Economic Analysis of Land Use Allocation for the Samar Island Forest Reserve. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Dirhamsyah (2007) An economic valuation of seagrass ecosystems in East Bintan, Riau Archipelago, Indonesia. Oseanologi don Lirnnologi di Indonesia 33:257–270

Do T N (2007) Impacts of Dykes on Wetland Values in Vietnam's Mekong River Delta: A Case Study in the Plain of Reeds. Research Report, 51 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Do T N and Bennett J (2007) Willingness to pay for wetland improvement in Vietnam's Mekong River Delta. Paper presented at 51st Annual Conference, Australian Agricultural and Resource Economics Society, February 2007

Do T N, Bennett J (2005) An Economic Valuation of Wetlands in Vietnam's Mekong Delta: a case study of direct use values in Camau Province. Working papers Environmental Management and Development Occasional Papers, Environmental Management and Development Programme

Do T N, Bennett J (2007) Estimating Wetland Biodiversity Values: A choice modeling application in Vietnam's Mekong River Delta. Economics and Environment Network Working Paper: EEN0704, 42 pages, Australian National University

Do T N, Bennett J (2007) Would wetland biodiversity conservation improve social welfare? A case study in Vietnam's Mekong River Delta. Paper presented at GMSARN International Conference on Sustainable Development: Challenges and Opportunities for GMS 12-14 Dec. 20

Doshi A, Pascoe S, Thébaud O, Thomas C R, Setiasih N, Hong J T C, True J, Schuttenberg H Z, Heron S F (2012) Loss of economic value from coral bleaching in S.E. Asia. In: Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012 (22D Economic valuation and market-

Dung N H, Thien T C, Hong N V, Loc N T, Minh D V, Thau T D, Nguyen H T L, Phong N T, Son T T (1999) Impact of Agro-Chemical Use on Productivity and Health in Vietnam. Research Report, 69 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore

Emerton L (ed) (2005) Values and Rewards: Counting and Capturing Ecosystem Water Services for Sustainable Development. IUCN Water, Nature and Economics Technical Paper No.1, IUCN (The World Conservation Union): Ecosystems and Livelihoods Group Asia.

Erdmann M V, Merrill P R, Arsyad I, Mongdong M (2003) Developing a diversified portfolio of sustainable financing options for Bunaken National Marine Park. Paper presented at the 5th World Parks Congress: Sustainable Finance Stream, Durban, South Africa, September 2003

Fatah L, Udiansyah (2009) An Assessment of Forest Management Options For Preventing Forest Fire In Indonesia. Research Report, 44 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Finney C E, Western S (1986) An Economic Analysis of Environmental Protection and Management: An Example from the Philippines. The Environmentalist 6(1):45–61

Francisco H A (2004) Economic Analysis of Allocating Forest and Forest Lands: Total Economic Value Approach. Philippine Environmental Governance (EcoGov) Project, The Department of Environment and Natural Resources-United States Agency for International Development's (DENR-USAID)

Francisco H A, Rivera M N, Perino E A, Florido L V, Castillo E T, Ebora J B, Siapno F E (2003) Pricing of Philippine Grassland Resources. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Francisco H A, Tardeo K, Antonio D D V D (2003) The Oil spill incident in Lingayen Gulf: Valuation of losses and conflict resolution analysis. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Ghani A N A, Shahwahid M, Rusli M, Shukri M, Hanum F, Zakaria M (1999) Economic Valuation of Forest Goods and Services of Ayer Hitam Forest, Puchong, Selangor Pertanika. Journal of Tropical Agricultural Science 22(2):147–160

Gilbert A J, Janssen R (1997) The use of environmental functions to evaluate management strategies for the Pagbilao Mangrove Forest. Working Paper No 15, 51 pages, The programme of Collaborative Research in the Economics of Environment and Development (CREED)

Glenk K, Barkmann J, Marggraf R (2006) Locally Perceived Values of Biological Diversity in Indonesia – a Choice Experiment Approach. In: Glenk K (2006) Economic Valuation of Biological Diversity: Exploring Non-market Perspectives in the Vicinity of the Lore-Lindu National Park in Indonesia's Central

Glenk K, Barkmann J, Marggraf R (2006) Unveiling regional preferences for biological diversity in Central Sulawesi: a choice experiment approach. In: Glenk K (2006) Economic Valuation of Biological Diversity: Exploring Non-market Perspectives in the Vicinity of the Lore-Lindu National Park in Indone

Glenk K, Barkmann J, Schwarze S, Zeller M, Marggraf R (2006) Differential Influence of Relative Poverty on Preferences for Ecosystem Services: Evidence from Rural Indonesia. Paper presented at the International Association of Agricultural Economists Conference, Gold Coast, Australia, August 12–18, 2

Hai N T, Thanh T D (1999) Using The Travel Cost Method To Evaluate The Tourism Benefits Of Cuc Phuong National Park. In: Francisco H, Glover D (eds) Economy & Environment: Case studies in Vietnam, 121–150, International Development Research Centre (IDRC), Singapore

Hakim A R (2010) Measuring The Economic Value of Natural Attractions in Rawapening, Semarang District, Indonesia. Journal of American Science 6(10):791–794

Hakim A R, Subanti S, Tambunan M (2011) Economic Valuation of Nature-Based Tourism Object in Rawapening, Indonesia: An Application of Travel Cost and Contingent Valuation Method. Journal of Sustainable Development 4(2):91–101

Hang T T T, An N T N (1999) An Economic Analysis of The Can Gio Mangrove Scheme in Ho Chi Minh City. In: Francisco H, Glover D (eds) Economy & Environment: Case studies in Vietnam, 205–221, International Development Research Centre (IDRC), Singapore

Hanum I F, Pius P, Ghani A N A (1999) Economic Valuation of Tree Species Diversity at Ayer Hitam Forest, Selangor, Peninsular Malaysia. Pertanika Journal of Tropical Agricultural Science 22(2):167–170

Hanum I F, Simin M, Ghani A N A (1999) Tree Species Diversity and Economic Value of a Watershed Forest in Ulu Muda Forest Reserve, Kedah. Pertanika Journal of Tropical Agricultural Science 22(1):63–68

Harder D S, Labao R, Santos F I (2006) Saving the Philippine Eagle: How Much would It Cost and are Filipinos Willing to Pay for It?. Research Report, 59 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Hargreaves-Allen V (2004) Estimating the Total Economic Value of Coral Reefs for Residents of Sampela, a Bajau Community in Wakatobi Marine National, Sulawesi: A Case Study. Master's Thesis, University of London

Harris N L, Petrova S, Stolle F, Brown S (2008) Identifying optimal areas for REDD intervention: East Kalimantan, Indonesia as a case study. Environmental Research Letters 3:035006 (11pp). doi:10.1088/1748-9326/3/3/035006

Hatfield Cousultants (2009) Final Economic Valuation Report for Air Hitam Sanitary Landfill Case Study Site in Puchong, Selangor, Malaysia. Research Report. Regional Capacity Buiding Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia. The World Bank Group:

Hatfield Cousultants (2009) Final Economic Valuation Report for MEA Facility Case Study Site in Samut Prakan, Thailand. Research Report. Regional Capacity Buiding Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia. The World Bank Group: Washington, USA

Hatfield Cousultants (2009) Final Economic Valuation Report for Sambour EDC Warehouse Site, Cambodia. Research Report, Regional Capacity Buiding Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia. The World Bank Group: Washington, USA

Hatfield Cousultants (2009) Final Economic Valuation Report for Sok Pa Loung EDL Workshop Site, Lao PDR. Research Report. Regional Capacity Buiding Program for Health Risk Management of Persistent Organic Pollutants (POPs) in South East Asia. The World Bank Group: Washington, USA

Hoa D L, Ly N T Y (2009) Willingness to Pay for the Preservation of Lo Go – Xa Mat National Park in Vietnam. Research Report, 27 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Hodgson G, Dixon J A (1988) Logging Versus Fisheries and Tourism in Palawan: An Environmental and Economic Analysis. Paper No.7, 95 pages, Occasional Papers of the East-West Environment and Policy Institute, East-West Center: USA

ICEM (International Centre for Environmental Management) (2003) Field Studies: Economic benefits of protected areas. Lower Mekong Protected Areas and Development Review: Indooroopilly, Queensland, Australia

Indab A L (2007) Willingness to Pay for Whale Shark Conservation in Sorsogon, Philippines. Research Report, 44 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Indab A L, Guzman A I, Bagarinao R T (2003) An Effluent Charge for Sarangani Bay, Philippines: An Ex-ante Assessment. Research Report, 55 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore

Isangkura A (1998) Environmental Valuation: An Entrance Fee System for National Parks in Thailand EEPSEA. Research Report, 30 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

IUCN (The World Conservation Union) __ Counting the Environmental Costs of Natural Disasters: Evaluating Tsunami-Related Damages to Coastal Ecosystems in Thailand. Report, 35 pages, Ecosystems and Livelihoods Group Asia, The World Conservation Union (IUCN): Colombo, Sri Lanka

IUCN (The World Conservation Union) __ Ecological and socio-economic values of Mangrove ecosystems in tsunami affected areas: Rapid ecological-economic-livelihood assessment of Ban Naca and Ban Bangman in Ranong Province, Thailand.

Jack B K, Leimona B, Ferraro P J (2008) A Revealed Preference Approach to Estimating Supply Curves for Ecosystem Services: Use of Auctions to Set Payments for Soil Erosion Control in Indonesia. Conservation Biology 23(2):359–367

Janssen R, Padilla J E (1999) Preservation or Conversion? Valuation and Evaluation of a Mangrove Forest in the Philippines. Environmental and Resource Economics 14:297–331

Jensen A (2009) Valuation of non-timber forest products value chains. Rorest Policy and Economics 11(1): 34–41

Jin J, Indab A, Nabangchang O, Thuy T D, Harder D, Subade R F (2010) Valuing marine turtle conservation: A cross-country study in Asian cities. Ecological Economics 69:2020–2026

Jugado R S E (2010) Economic Valuation of Conserving Endangered Species and Their Habitats in the North Western Panay Peninsula, Central Philippines. EEPSEA Research Report, 40 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Juhrbandt J (2010) Economic valuation of land use change - A case study on rainforest conversion and agroforestry intensification in Central Sulawesi, Indonesia. Ph.D's Dissertation, Georg-August-Universität Göttingen: Göttingen, Germany

Kallesøe M F, Bambaradeniya C N B, Iftikhar U A, Ranasinghe T, Miththapala S (2008) Linking Coastal Ecosystems and Human Well-Being: Learning from conceptual frameworks and empirical results. Research Report, 49 pages, Ecosystems and Livelihoods Group, IUCN (The W

Khai H V (2011) The Costs of Industrial Water Pollution on Rice Production in Vietnam. Research Report, 52 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Kham T N, Thuy L X (1999) An Economic Analysis of Agroforestry Systems in Central Vietnam. In: Francisco H, Glover D (eds) Economy & Environment: Case studies in Vietnam, 173–203, International Development Research Centre (IDRC), Singapore

Kiratikarnkul S (2008) A Critical Analysis of Alternative Approaches to Deal with Animal Waste Externalities in Thailand's Pig Farms. Ramkhamhaeng University International Journal 2(2):95–111

Koeshendrajana S, Cacho O (2001) Management Options for the Inland Fisheries Resource in South Sumatra, Indonesia: I Bioeconomic Model. Working Paper Series in Agricultural and Resource Economics No. 2001-2, 26 pages, University of New England

Kuchelmeister G (2003) Participatory Economic Evaluation - Experience in Forest Valuation with Villagers in Vietnam. Presentation accepted for the Frontiers 2 Conference: European Applications in Ecological Economics, 12-15 February 2003: Tenerife, Canary Islands,

Kumari K (1995) An Environmental and Economic Assessment of Forest Management Options: A Case Study on Malaysia. Environmental Economics Series, no. 26. Environmental Department, The World Bank: Washington D.C., U.S.A

Kumari K (1996) An Application of the Incremental Cost Framework to Biodiversity Conservation: A Wetland Case Study in Malaysia. CSERGE Working Paper GEC 96-15, The Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia and University College London and

Kusuma I D (2005) Economic Valuation Of Natural Resource Management: A Case Study Of The Benuaq Dayak Tribe In Kalimantan, Indonesia. Ph.D's Thesis, the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College

Leong P C, Zakaria M, Mohd A (2005) Contingent Valuation of a Malaysian Highland Forest: Non-market Benefits Accrued to Local Residents. Journal of Applied Sciences 5(5):916–919

Lingkubi O, Leitch J A (1996) Economic Assessment of Soil Conservation Demonstration Plots in Tondano Watershed, North Sulawesi, Indonesia. Canadian Water Resources Journal: 21(4) 403–414

Lizada J C (2010) Direct use value of environmental damages due to oil spill in the coastal areas: The Cases of Semirara and Guimaras Islands, Philippines. Paper presented at the 11th National Convention on Statistics (NCS): EDSA Shangri-La Hotel, Singapore, October 4-5, 2010

Luangmany D, Voravong S, Thanthathep K K, Souphonphacdy D, Baylatry M (2009) Valuing Environmental Services Using Contingent Valuation Method. Research Report, 44 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Mai P T X, Hai T Q, Thinh K V (1999) Valuation of Non-Timber Forest Products in Luong Son District, Hoa Binh Province. In: Francisco H, Glover D (eds) Economy & Environment: Case studies in Vietnam, 151–172, International Development Research Centre (IDRC), Singapore

Marikan D A A, Radam A, binti Joh Zakaria S B (2006) The Economics of Recreational Park Conservation: A Case Study Of Bako National Park. Staff Paper 4/2006, 24 pages, Faculty of Economics and Management, University Putra Malaysia

Midora L, Anggraeni D (2006) Economic Valuation of Watershed Services Batang Gadis National Park, Mandailing Natal, North Sumatra, Indonesia. Research report, 62 pages, Conservation International – Indonesia: Jakarta

Mingsarn Kaosa-ard M, Theodore Panayotou; J.R. Deshazo 1995 Green Finance Valuation and Financing of Khao Yai National Park in Thailand. Policy Brief, 4 pages

Montenegro L O, Diola A G, Remedio E M (2005) The Environmental Costs of Coastal Reclamation in Metro Cebu, Philippines. Research Report, 65 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Muhamad S, Sanusi N, Kamil N F N M 2012 Recreation Demand and Economic Value of Redang Island, Malaysia. Paper presented at the 2nd Congress of the East Asian Association of Environmental and Resource Economics: Bandung, Indonesia on February 2–4, 2012

Muong S (2004) Avoiding Adverse Health Impacts from Contaminated Vegetables: Options for Three Wetlands in Phnom Penh, Cambodia. Research Report, 46 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Murniati, Padmanaba M, Basuki I (2008) Rorest Resources Utilization Value of the Communities Living in and around Gunung Lumut Protection Forest, East Kalimantan. Journal of Forestry Research 5(2):147–171

Nabangchang O (2003) A Cost-Benefit Analysis of Resettlement Policy: A Case Study of Ob Luang National Park, Northern Thailand. Research Report, 56 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Nabangchang O (2008) Private Contributions Towards the Provision of Public Goods: The Conservation of Thailand's Endangered Species. Research Report, 40 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Nam P K, Son T V H (2001) Analysis of the Recreational Value of the Coral-surrounded Hon Mun Islands in Vietnam. Research Report, 58 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Nam P K, Son T V H (2004) Household Demand for Improved Water Services in Ho Chi Minh City: A Comparison of Contingent Valuation and Choice Modelling Estimates. Research Report, 23 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Nam P K, Son T V H (2005) Recreational Value of the Coral Surrounding the Hon Mun Islands in Vietnam: A Travel Cost and Contingent Valuation Study. In: Ahmed M, Chong C K, Cesar H (eds) Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs, 84–107, WorldFish Center Conference.

Nam P K, Son T V H, Cesar H, Pollnac R (2005) Financial sustainability of the Hon Mun Marine Protected Area: Lessons for other marine parks in Vietnam. PREM Working Paper, Poverty Reduction and Environmental Management (PREM), Institute for Environmental Studies, Vrije Universiteit: Amsterdam, The Netherlands

Naz A C C, Naz M T N (2006) Modeling Choices for Ecological Solid Waste Management in Suburban Municipalities: User Fees in Tuba, Philippines. Research Report, 46 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore

Ng W, Mendelsohn R (2005) The economic impact of sea level rise on nonmarket lands in Singapore. Ambio 35(6):289–296

Ng W, Mendelsohn R (2005) The impact of sea level rise on Singapore. Environment and Development Economics 10:201–215. DOI: 10.1017/S1355770X04001706

Nga D T, Schuyt K (2005) Economic Benefits of the A'Vuong Watershed in Vietnam to Indigenous Ka Tu People. Research Report, 41 pages, the WWF Indochina Programme Office: Hanoi/ Gland

Nhuan M T, Ninh N H, Huy L Q, Sam D D, Ha T H, Thanh N C, Oanh B K, Nga D T, Son N N, Du N Q (2003) Economic Valuation of Demonstration Wetland Sites in Vietnam. Research Report, 62 pages, Vietnam Wetland Component

Noor A G A, Faridah-Hanum I, Marina T I T (2008) Relationship between Economic Value and Species Diversity of Timber Resources in a Hill Forest in Peninsular Malaysia. Journal of Sustainable Development 1(2):17–26

Nurfatriani F, Muttaquin Z (2008) The Economic Value of Water for Commercial Use in Upper Brantas Sub-Watershed. Journal of Forestry Research 5(2):75–89

Nuva R, Shamsudin M N, Radam A, Shuib A (2009) Willingness to Pay towards the Conservation of Ecotourism Resources at Gunung Gede Pangrango National Park, West Java, Indonesia. Journal of Sustainable Development 2(2):173–186

Othman J, Bennett J, Blamey R (2004) Environmental values and resource management options: a choice modelling experience in Malaysia. Environment and Development Economics 9:803–824. DOI: 10.1017/S1355770X04001718

Othman J, Rahajeng A (?) Economic Valuation of Recreational Attributes: Case of Nature and Culture-Based Tourism in Malaysia and Indonesia. Research report, 19 pages

Othman M H S (1990) A Preliminary Economic Valuation of Wetland Plant Species in Peninsular Malaysia. AWB Report No. 67d, AWB/WWFM (World Wildlife Fund for Nature –Malaysia): Kuala Lumpur, Malaysia

Padilla J E, Janssen R (1996) Extended Benefit-Cost Analysis Of Management Alternatives: Pagbilao Mangrove Forest. Journal of Philippine Development 23(2):339–363

Padilla J E, Morales A C (2003) Evaluation of Fisheries Management Alternatives for Lingayen Gulf. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Pattanayak S K, Kramer R A (2001) Pricing ecological services: Willingness to pay for drought mitigation from watershed protection in eastern Indonesia. Water Resources Research 37(3):771–778

Pattanayak S K, Kramer R A (2001) Worth of watersheds: a producer surplus approach for valuing drought mitigation in Eastern Indonesia. Environment and Development Economics 6:123–146

Pattanayak S, Mercer D E (1998) Valuing soil conservation benefits of agroforestry: contour hedgerows in the Eastern Visayas, Philippines. Agricultural Economics 18:31–46

Pek C, Tee C, Ng P (2010) A Contingent Valuation Estimation of Hill Recreational and Services Values in Malaysia. Working paper, 13 pages, Munich Personal RePEc Archive

Pet-Soede C, Cesar H S J, Pet J S (1999) An economic analysis of blast fishing on Indonesian coral reefs. Environmental Conservation 26(2):83–93

Phan D V, Chung V T, Kinh T S, Sang L V, Vinh M K (2000) Định giá Kinh tế rừng ngập mặn Cần Giờ, Thành phố Hồ Chí Minh (Economic Valuation of Can Gio Mangrove Forest in Ho Chi Minh City). Báo cáo nghiên cứu điển hình (Case Study Report), 28 pages,

Predo C D (2003) Land Use Decisions under risk for Degraded Grasslands in Claveria, Northern Mindanao. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Rab M A, Navy H, Ahmed M, Seng K, Viner K (2006) Socioeconomics and Values of Resources in Great Lake-Tonle Sap and Mekong-Bassac area; Results from a sample survey in Kampong Chhnang, Siem Reap and Kandal Provinces, Cambodia. WorldFish Center Discussion Series No

Raharjo M, Awatara I G P D (2012) Economic Valuation of Water Resources Conservation Area in Surakarta city. Paper presented at the Annual Conference of Asia-Pacific Economic Association, Nanyang Technological University, Singapore, June 28–29, 2012

Rahim A, Shahwahid M, Zariyawati M A (2009) A Comparison Analysis of Logging Cost Between Conventional and Reduce Impact Logging Practices. International Journal of Economics and Management 3(2):354–366

Rahim N N R N A, Shamsudin M N, Ghani A N A, Radam A, Manaf L A, Kaffashi S, Mohamed N (2012) Economic Valution of Integrated Solid Waste Management in Kota Bharu, Kelantan. Journal of Applied Sciences forth coming

Rosales R M P (2006) Estimating Appropriate Fines for Ship Grounding Violations in Tubbataha Reef National Marine Park. Conservation International-Philippines: Quezon City 1101, Philipines

Rosales R M P, Francisco H A (2003) Estimating Non-Use Values Of The Samar Island Forest Reserve. In: Francisco H A, de los Angeles M S (eds) Economy and Environment: Selected Readings in the Philippines, EDM Press

Rosales R, Kallesoe M, Gerrard P, Muangchanh P, Phomtavong S, Khamsomphou S (2005) Balancing the Returns to Catchment Management: The Economic Value of Conserving Natural Forests in Sekong, Lao PDR. IUCN Water, Nature and Economics Technical Paper No. 5, IUCN (The

Ruitenbeek H J (1992) Mangrove Management: An Economic Analysis of Management Options with a Focus on Bintuni Bay, Irian Jaya. EMDI Environmental Reports, 53 pages, Environmental Management, Development in Indonesia Project (EMDI): Jakarta and Halifax

Samdin Z (2008) Willingness to Pay in Taman Negara: A Contingent Valuation Method. International Journal of Economics and Management 2(1):81–94

Samdin Z, Aziz Y A, Radam A, Yacob M R (2010) Factors Influencing the Willingness to Pay for Entrance Permit: The Evidence from Taman Negara National Park. Journal of Sustainable Development 3(3):212–220

Samonte-Tan G P B, White A T, Tercero M A, Diviva J, Tabara E, Caballes C (2007) Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines. Coastal Management 35:319–338

Samonte-Tan G P B, White A T, Tercero M A, Diviva J, Tabara E, Caballes C (2007) Economic valuation of coastal and marine resources: Bohol Marine Triangle, Philippines. Coastal Management 35:319–338

Saragih B (2011) Economic value of non-timber forest products among Paser Indigenous People of East Kalimantan .Ph.D's Thesis, University of Leiden
Sathirathai S, Barbier E B (2001) Valuing mangrove conservation in Southern Thailand. Contemporary Economic Policy 19(2):109–122
Sathirathai, S. (1997) Economic Valuation of Mangroves and the Roles of Local Communities in the Conservation of Natural Resources: Case Study of Surat Thani, South of Thailand. Research Report no. rr1998061, Economy and Environment
Seenprachawong U (2001) An Economic Analysis of Coral Reefs in the Andaman Sea of Thailand. Research Report, 42 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore
Seenprachawong U (2003) Economic valuation of coral reefs at Phi Phi Islands, Thailand. International Journal of Global Environmental Issues 3(1):104–114
Seenprachawong U (2006) Economic Valuation of Cultural Heritage: A Case Study of Historic Temples in Thailand. Research Report, 49 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore
Seenprachawong U (2008) An Economic Valuation of Coastal Ecosystems in Phang Nga Bay, Thailand. NIDA Economic Review 3 (2):27–45
Shahwahid H O M, Noor A G A, Rahim N A, Zulkifli Y, Ragame U (1997) Economic Benefits of Watershed Protection and Trade-off with Timber Production: A Case Study in Malaysia. Research Report, 41 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore
Soussan J, Sam C (2011) The Values of Land Resources in the Cardamom Mountains of Cambodia. Final Report, 19 pages, Stockholm Environment Institute
Stolton S, Mansourian S, Dudley N (2010) Valuing Protected Areas The International Bank for Reconstruction and Development. The World Bank. Washington, D.C. 20433, U.S.A.
Subade R F (2005) Valuing Biodiversity Conservation in a World Heritage Site: Citizens' Non-use Values for Tubbataha Reefs National Marine Park, Philippines. Research Report, 68 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore
Subade R F (2007) Mechanisms to capture economic values of marine biodiversity: The case of Tubbataha Reefs UNESCO World Heritage Site, Philippines. Marine Policy 31:135–142
Syahdin A F, Patunru A A (2012) Economic Valuation of World Heritage Site: A Case Study of Chandi Borobudur. Paper presented at the 2nd Congress of the East Asian Association of Environmental and Resource Economics, Bandung, Indonesia, February 2–4, 2012
Tapvong C, Kruavan J (1999) Water Quality Improvements: A Contingent Valuation Study of the Chao Phraya River. Research Report, 45 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore
Thampapillai D J (2011) The Economic valuation of urban ecosystem services. Working Paper No. LKYSPP11-03, 13 pages, Working Paper Series of Lee Kuan Yew School of Public Policy, National University of Singapore: Bukit Timah, Singapore
The B D, Ngoc H B (2006) Payments for Environmental Services in Vietnam: Assessing an Economic Approach to Sustainable Forest Management. Research Report, 41 pages, Environment and Economics Program for South East Asia (EEPSEA): Singapore
Thuy T D (2007) WTP for Conservation of Vietnamese Rhino. Research Report, 40 pages, Economy and Environment Program for Southeast Asia (EEPSEA): Singapore
To P X, Dressler W H, Mahanty S, Pham T T, Zingerli C (2012) The Prospects for Payment for Ecosystem Services (PES) in Vietnam: A Look at Three Payment Schemes. Human Ecology 40:237–249. DOI 10.1007/s10745-012-9480-9
Tri N H, Adger W N, Kelly P M (1998) Natural resource management in mitigating climate impacts: the example of mangrove restoration in Vietnam. Global Environmental Change 8(1):49–61
Tri N H, Hong P N, Nhuong D V, Manh N T, Tuan L X, Anh P H, Tho N H, Cuc N K, Le Giang L H, Chinh N T, Tuan L D (2000) Valuation of the Mangrove Ecosystem in Can Gio Mangrove Biosphere Reserve, Vietnam. Final Report UNESCO/MAB Project, 24 pages, The Vietnam MAB N
Tuan T H, Navrud S (2007) Valuing cultural heritage in developing countries: comparing and pooling contingent valuation and choice modelling estimates. Environmental and Resource Economics 38:51–69. DOI 10.1007/s10640-006-9056-5
Tuan T H, Xuan M V, Nam D, Navrud S (2008) Valuing direct use values of wetlands: A case study of Tam Giang-Cau Hai lagoon wetland in Vietnam. Research Report, 32 pages

van Beukering P J H, Scherl L M, Sultanian E, Leisher C, Fry J (2007) Case study 3: Bunaken National Marine Park (Indonesia): The Role of Marine Protected Areas in Contributing to Poverty Reduction. In: Leisher C, van Beukering P, Scherl L M (eds) Nature's Investment Bank, How Marine Protected Areas

van Beukering P, Cacatian J, Stellinga J, Sultanian E, Leisher C (2007) Case study 4: Apo Island (Philippines) The Role of Marine Protected Areas in Reducing Poverty. In: Leisher C, van Beukering P, Scherl L M (eds) Nature's Investment Bank, How Marine Protected Areas Contribute to Poverty Reduction

van Beukering P, Cesar H S J, Janssen M A (2003) Economic valuation of the Leuser National Park on Sumatra, Indonesia. Ecological Economics 44:43–62

van Beukering P, Grogan K, Hansfort S L, Seager D (2009) An Economic Valuation of Aceh's forests: The road towards sustainable development. Report number R-09/14, Institute for Environmental Studies, Vrije Universiteit: Amsterdam, The Netherlands

van Beukering P, Schaafsma M, Davies O, Oskolokaite I (2008) The economic value of peatland resources within the Central Kalimantan Peatland Project in Indonesia: Perceptions of local communities. Report E-08/05, 84 pages, The Central Kalimantan Peatlands Project (CKPP), Institute for Environmental

Vicente J A, Cerezo R B (2010) The Socio-Economic Contributions of Marine Protected Areas to the Fisherfolk of Lingayen Gulf, Northwestern Philippines. International Journal of Environmental Research 4(3):479–490

Vista A B (2012) Estimating the Recreational value of Taal Volcano Protected Landscape, Philippines using Benefit Transfer. Paper presented at the 2nd Congress of the East Asian Association of Environmental and Resource Economics, Bandung, Indonesia, February 2–4,

Walpole M J, Goodwin H J, Ward K G R (2001) Pricing Policy for Tourism in Protected Areas: Lessons from Komodo National Park, Indonesia. Conservation Biology 15(1):218–227

Waluyo H, Sadikin S R, Gustami, Whiting P (2005) An economic valuation of biodiversity in the karst area of Maros, south Sulawesi, Indonesia. Biodiversity 6(2):24–26

White A T, Ross M, Flores M (2000) Benefits and Costs of Coral reef and Wetland management, Olango Island, Philippines. CRMP document number: 04-CRM/2000, 17 pages, Coastal Resource Management Project

Whiting P G, Irham (2002) Bunaken National Park: Visitor Survey. Collaborative Environmental Project in Indonesia

Yacob M R, Radam A, Rawi S B (2009) Valuing Ecotourism and Conservation Benefits in Marine Parks: The Case of Redang Island, Malaysia. The International Journal of Applied Economics and Finance 3(1):12–21

Yacob M R, Radam A, Samdin Z (2011) Willingness to Pay for Domestic Water Service Improvements in Selangor, Malaysia: A Choice Modeling Approach. International Business and Management 2(2):30–39

Yacob M R, Radam A, Shuib A (2009) A Contingent Valuation Study of Marine Parks Ecotourism: The Case of Pulau Payar and Pulau Redang in Malaysia. Journal of Sustainable Development: 95–105

Yacob M R, Radam A, Wahidin K, Shuib A (2009) Congtingent Valuation of Ecotourism in Marine Parks, Malaysia: Implication for Sustainable Marine Park Revenue and Ecotourism Management. World Applied Sciences Journal 7(12):1474–1481

Yeo B H (2005) The Recreational Benefits of Coral Reefs: A Case Study of Pulau Payar Marine Park, Kedah, Malaysia. In: Ahmed M, Chong C K, Cesar H (eds) Economic Valuation and Policy Priorities for Sustainable Management of Coral Reefs. WorldFish Center Conference

Appendix 3: Value transfer method used in the mangrove and coral reef case studies

Value transfer is the procedure of estimating the value of an ecosystem (or goods and services from an ecosystem) by applying an existing valuation estimate for a similar ecosystem (Navrud and Ready, 2007). The ecosystem of current policy interest is often called the "policy site" and the ecosystem from which the value estimate is transferred is called the "study site". This procedure is also known as benefit transfer but since the values being transferred may also be estimates of costs or damages, the term value transfer is arguably more appropriate (Brouwer, 2000).

The use of value transfer to provide information for decision making has a number of advantages over conducting primary research to estimate ecosystem values. From a practical point of view it is generally less expensive and time consuming than conducting primary research. Value transfer can also be applied on a scale that would be unfeasible for primary research in terms of valuing large numbers of sites across multiple countries. Value transfer also has the methodological attraction of providing consistency in the estimation of values across policy sites (Rosenberger and Stanley, 2006).

The transfer of values using a meta-analytic value function, in which policy site characteristics are plugged into a value function estimated from the results of multiple primary studies, appears to offer the most promising means to explicitly control for the specific characteristics of each policy site in the transfer process. By utilising information from multiple studies, a meta-analytic value function includes greater variation in both site characteristics (e.g. size, service provision) and context characteristics (e.g. abundance of other mangrove sites, number and income of beneficiaries) that cannot be generated from a single primary valuation study.

Meta-analysis is a method of synthesizing the results of multiple studies that examine the same phenomenon, through the identification of a common effect, which is then 'explained' using regression techniques in a meta-regression model (Stanley, 2001). Meta-analysis was first proposed as a research synthesis method by Glass (1976) and has since been developed and applied in many fields of research, not least in the area of environmental economics (Nelson and Kennedy, 2009). It is widely recognised that the large and expanding literature on the economic value of ecosystem services has become difficult to interpret and that there is a need for research synthesis techniques, and in particular statistical meta-analysis, to aggregate results and insights (Stanley, 2001; Smith and Pattanayak, 2002; Bateman and Jones, 2003). In addition to identifying consensus across studies, meta-analysis also provides a basis for transferring values from studied sites to new policy sites (Rosenberger and Phipps 2007). It is for this purpose that we develop the meta-analysis presented in this report.

An important consideration in estimating the value of changes to a biome across a large geographic area, such as we propose to do in this case study, is that changes in the stock of the resource may affect the unit values of each individual patch. Localised changes in the extent of an individual ecosystem may be adequately valued in isolation from the rest of the stock of the resource, which is implicitly assumed to be constant. When valuing simultaneous changes in multiple ecosystem sites within a region (e.g., changes in mangrove extent in Southeast Asia for the period 2000-2050), it is arguably not sufficient to estimate the value of individual ecosystem sites and aggregate without accounting for the changes that are occurring across the stock of the resource. We therefore follow the method proposed by Brander et al. (2011) to include spatial information in the meta-analytic value function on the abundance of mangrove ecosystems in the broader surroundings of each study site. This variable is intended to capture the effect of changes in the availability of substitute or complementary mangrove sites in the vicinity of each mangrove patch. In addition, a number of other characteristics of each case study location derived from spatial data are included in the analyses as potential determinants of ecosystem value.

References

Bateman, I.J., and Jones, A.P., 2003. Contrasting conventional with multi-level modeling approaches to meta-analysis: expectation consistency in U.K. woodland recreation values. Land Economics 79: 235–258.

Brander, L.M., Brauer, I., Gerdes, H., Ghermandi, A., Kuik, O., Markandya, A., Navrud, S., Nunes, P.A.L.D., Schaafsma, M., Vos, H. and Wagtendonk, A., 2011. Using meta-analysis and GIS for value transfer and scaling up: Valuing climate change induced losses of European wetlands. Environmental and Resource Economics. DOI: 10.1007/s10640-011-9535-1.

Brouwer, R., 2000. Environmental value transfer: state of the art and future prospects. Ecological Economics, 32: 137-152.

Glass, G.V., 1976. Primary, secondary, and meta-analysis of research. Educational Researcher, 5: 3-8.

Navrud, S., and Ready, R., 2007. Environmental Value Transfer: Issues and Methods. Springer, Dordrecht.

Rosenberger, R.S., and Phipps, T.T., 2007. Correspondence and convergence in benefit transfer accuracy: A meta-analytic review of the literature. In: Navrud, S. and Ready, R. (eds.), Environmental Values Transfer: Issues and Methods. Springer, Dordrecht.

Rosenberger, R.S., and Stanley, T.D., 2006. Measurement, generalization, and publication: Sources of error in benefit transfers and their management. Ecological Economics 60: 372–378.

Smith, V.K., and Pattanayak, S.K., 2002. Is meta-analysis a Noah's Ark for non-market valuation? Environmental and Resource Economics, 22: 271–296.

Stanley, T. D., 2001. Wheat from chaff: meta-analysis as quantitative literature review. Journal of Economic Perspectives, 15: 131–150.