Guide for Rapid Economic Valuation of Wetland Ecosystem Services




Ministry of the Environment
Japan

Suggested citation: Merriman, J.C., Murata, N., (2016) Guide for Rapid Economic Valuation of Wetland Ecosystem Services. BirdLife International Tokyo, Japan.

Chapter 1	Merriman, J.C., Peh, K.S-H. (2016) Introduction
Chapter 2	Merriman, J.C., Murata, N. (2016) Steps for measurement
Chapter 3	Murata, N., Merriman, J.C., Iwabuchi, T., (2016) Methods for economic valuation
Chapter 4	Merriman, J.C., Murata, N. (2016) Next steps
Chapter 5	Murata, N., Merriman, J.C., Le, T.T., Nguyen, T.K.H.,(2016) Case study – Thai Thuy Wetland, Vietnam
Chapter 6	Peh, K.S-H., Merriman, J.C., Dae We Aung, T., Theint, S.M., Murata, N., Suzue, K. (2015) Case study – Moeyungyi Wetland, Myanmar

This guide is prepared based on Toolkit for Ecosystem Service Assessment (TESSA).

Citation:

Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., Stattersfield, A. J., Thomas, D. H. L., Walpole, M. and Birch, J. C. (2014) Toolkit for Ecosystem Service Site-based Assessments (TESSA). Version 1.2 Available at: http://www.birdlife.org/datazone/info/estoolkit.

Photos provided by: BirdLife International, BANCA and Viet Nature

SUMMARY

Over the past decade, several large-scale international studies, such as the Millennium Ecosystem Assessment and The Economics of Ecosystems and Biodiversity, have emphasised the importance of biodiversity conservation due to the benefits (known as ecosystem services) that nature provides to people. Through these and other studies, wetland ecosystems have often been highlighted for their important functional roles in providing clean water, reducing the risk of flooding and in supporting the livelihoods of numerous people worldwide. One global study estimated that the economic value of wetlands is \$3.4 billion yr^{-1} based on the variety of services these ecosystems provide for human well-being (Schuyt and Brander 2004). Much of this value is over-looked when it comes to decision-making about land use in wetlands because these values do not appear in national financial accounts. Thus, over half of the world's wetlands have been degraded or destroyed in the last century, with Asia being one of the most impacted regions globally (Davidoson 2014).

The aim of this guide is to introduce a simple and rapid method for assessing economic value of wetlands for non-experts of economic valuation. It can be utilized to understand the overall concepts and steps for economic valuation, as well as demonstrating that wetlands have economic value for the purpose of awareness raising and decision making. This guidance is compiled based on the Toolkit for Ecosystem Service Assessment (TESSA; Peh et al 2014) but developed specifically for wetland ecosystems and includes experiences from the implementation of two cases in Myanmar and Vietnam. The methods extracted and adapted from TESSA aim to minimise the amount of field work and statistical work involved. The use of simple methods reduces costs (time, resources), but with a lower accuracy of the results. Hence this guide is for carrying out an introductory ecosystem services assessment only. If more detailed valuation and analysis is required, refer to Chapter 4, TESSA and other published valuation approaches. Chapter 1 introduces wetland ecosystems and the concept of economic valuation. Chapter 2 illustrates steps for measurement of the economic value of ecosystem services, and methods for valuing certain ecosystem services are explained in Chapter 3. The ecosystem services covered in this guide are; 1) harvested wild goods, 2) cultivated goods, 3) water services (water provision, water quality improvement), 4) global climate regulation and 5) disaster risk reduction. Chapter 4 addressed the importance of using a comparative approach to valuation to aid decision-making and finally Chapter 5 presents a case study from Thai Thuy wetland in Vietnam and Chapter 6 demonstrates how the simple comparative approach can be used, presenting a case study of Moeyungyi wetland in Myanmar.

TABLE OF CONTENTS

SUMMARY 1
TABLE OF CONTENTS 2
1 INTRODUCTION 4
1.1 Wetland ecosystems 4
1.2 Ecosystem services from wetlands 5
1.3 Why value wetlands? 6
1.4 Economic valuation and its characteristics 6
2 STEPS FOR MEASUREMENT 8
2.1 Preliminary work 9
2.2 Preliminary Scoping Appraisal 10
2.3 Method selection and data acquisition 11
2.4 Analysis and communication 12
2.5 Cautions and limitations 12
3 METHODS FOR ECONOMIC VALUATION 13
3.1 Harvested wild goods and cultivated goods 13
3.2 Water services 15
3.3 Nature-based recreation 17
3.4 Global climate regulation 17
3.5 Disaster Risk Reduction 20
4 Next Steps 21
4.1 The importance of comparative valuation 21
4.2 Alternative methods for valuation 22
5 CASE STUDY - Thai Thuy Wetland, Vietnam 24
5.1 Thai Thuy Wetland site information 26
5.2 Objective of the project 26
5.3 Economic Valuation approach 27
5.3.1 Preliminary scoping appraisal 27

5.3.2 Data collection and economic valuation 27
5.4 Limitations 30
5.5 Conclusion 31
6 CASE STUDY - Moeyungyi Wetland, Myanmar 32
6.1 Moeyungyi Wetland site information 34
6.2 Objective of the project 36
6.3 Step and methods of valuation 36
6.3.1 Preliminary scoping appraisal 36
6.3.2 Alternative state 37
6.3.3 Field work and data collection 38
6.3.4 Economic Valuation 39
6.4 Limitations 43
6.5 Conclusion 44
GLOSSARY 46
REFERENCES 48
APPENDICES 50
Appendix 1. Example questionnaire form for harvesting wild goods 50
Appendix 2. Example questionnaire form for cultivated goods 52
Appendix 3. Example questionnaire form for water use 55
Appendix 4. Example questionnaire form for nature-based recreation 59

1 INTRODUCTION

1.1 Wetland ecosystems

Wetlands are defined as areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres, according to the Ramsar Convention. They are highly productive, complex, dynamic, ecologically sensitive and adaptive systems, supporting significant biological diversity.

Globally, wetlands cover approximately 12.8 million km^2 (8.5%) of the Earth's land area, of which inland wetlands cover at least 9.5 million km^2 (Finlayson et al. 1999). However, in the last century, it is estimated that almost half of the world's wetland area has been lost (Davidoson 2014; UNWWAP 2003). Millennium Ecosystem Assessment (2005) identified that the major direct drivers are infrastructure development, land conversion, water withdrawal, eutrophication and pollution, overharvesting and overexploitation, and the introduction of invasive alien species; and the main indirect drivers have been population growth and increasing economic development. Although the rate of wetland habitat loss has slowed in some region such as Europe and North America, some geographic areas, especially Asia continue to convert large tracts of wetland habitat into other land uses (Davidoson 2014).

Due to their complex nature, the functions that are lost when wetland areas are converted are often irreversible (Mitsch and Gosselink 2000). The continued degradation and conversion of wetlands to other land uses is not just impacting on biodiversity but also on the livelihoods of people living in and around wetlands and the wider human population. Action is needed both internationally and within nations to halt the loss of such a unique and important habitat for both biodiversity and people alike.

The Ramsar Convention

The Ramsar Convention on Wetlands of International Importance is an intergovernmental agreement that was established in 1971 in the town of Ramsar, Iran. It provides a framework for national and international action for the conservation of wetlands. As of 2016 there are 169 contracting parties that are committed to the Convention's mission of "*the conservation and wise use*[1] *of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world*". The objective of the Convention is thus to conserve wetlands for the benefits of people and nature.

[1] Wise use is defined as "the maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development"

1.2 Ecosystem services from wetlands

Ecosystem services are the aspects of ecosystems that, actively or passively, produce human well-being (Fisher et al. 2009). These services are derived from ecological processes that occur within ecosystems such as nutrient cycling and soil formation (Figure 1), which when combined with some form of human input (such as labour or processing), result in benefits to people.

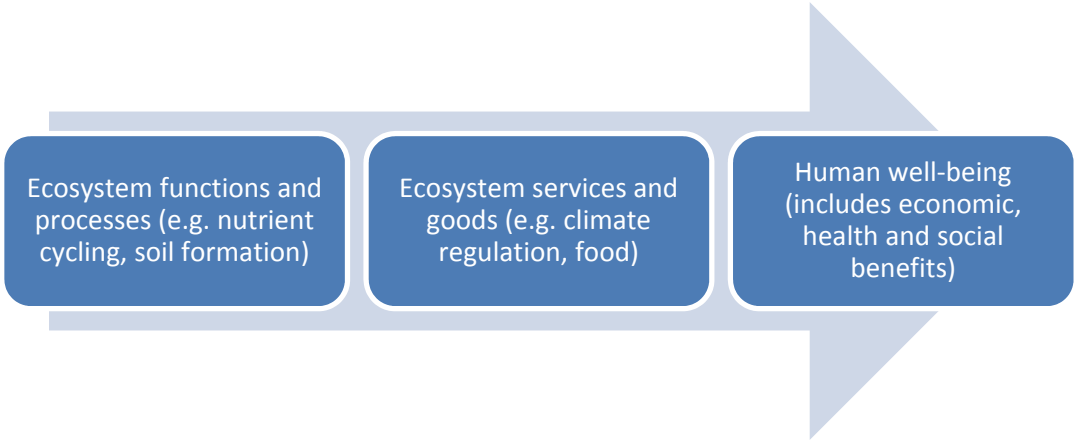


Figure 1. Conceptual framework of ecosystem services. Ecosystem services are produced as a result of ecosystem functions and processes and in turn provide goods and other benefits for human well-being. Ecosystem services represent non-use and non-material outputs from ecosystems (such as bequest values and spiritual values) as well as direct use values.

Table 1. Inland wetland ecosystem services (adapted from Russi et al., 2013)

Ecosystem service	Role of wetland structure / function
Erosion control	Capture of sediments and soil retention
Flood protection	Regulation of the flow of water; water storage capacity
Water provision	Regular supply of water due to ability to store water in a reservoir; groundwater recharge
Water purification	Natural filtration through nutrient uptake; retention of particles and pollutants
Food	Habitat for fish, molluscs, other plants and animal species used for food
Raw materials (fibre, fuel)	Habitat for grasses, and other plants used for fibre and fuel
Spiritual / cultural values	Many cultures have spiritual values and religious practises associated with wetlands
Nature-based recreation and tourism	Aesthetic features of wetlands; open water; habitats for biodiversity
Carbon storage and sequestration	Vegetation and soils capture carbon dioxide and other greenhouse gases from the atmosphere
Local climate regulation	Water bodies are able to stabilise local temperatures. The microclimate at wetlands is often lower than surrounding areas

Many of the benefits that people derive from ecosystems are dependent on water and wetlands are integral to the global water cycle upon which all of life depends. The complex interactions of wetlands with the surrounding landscape underpin important ecosystem functions and processes. They provide, regulate and purify water so that it can be used for domestic purposes (drinking, cooking, cleaning etc.) and for industry. Wetlands also have an important role in the cultural identity of people and in spiritual practices and beliefs. They contribute to local climate control, erosion reduction and underpin a suite of economic industries such as inland fisheries, harvesting of raw materials, tourism and agricultural production which rely on the provision of water (see Table 1).

1.3 Why value wetlands?

The socio-economic benefits from wetlands have been over-looked and under-valued which has resulted in widespread modification, degradation, over-exploitation and conversion of wetlands habitats in favour of land uses that are more 'productive' yet in the long-term often lead to detrimental impacts and economic costs.

Given current trends in the loss of wetlands and the potentially huge ecological, social and economic impacts, it is becoming increasingly realised that the diverse values of wetlands need to be better understood, communicated and incorporated into decision-making. Combining improved understanding of biophysical interactions, socio-economic dependencies and valuation of the benefits that wetlands provide to people can lead to better implementation of conservation, wise use and restoration.

1.4 Economic valuation and its characteristics

Valuation is simply a process to aid decision-making because it involves trading off the worth of something against another. Hence, economic value is measured by what someone is willing to give up in other goods and services in order to obtain a good, service, or state of the world. Currently, most decisions are made on the basis of measures of manufactured and financial capital (a proxy for value) and overlook the other forms of capital, most importantly, natural capital[2] which is the foundation of all other types of capital (Figure 2). Informed decision-making therefore needs to incorporate the contribution of natural capital and ecosystem services to human well-being. One way of doing this is through economic valuation which enables some of the value of ecosystems and biodiversity to be presented in an accessible and policy-relevant way.

[2] Natural capital is defined as the world's stocks of natural assets which include geology, soil, air, water and all living things. It is from this natural capital that humans derive ecosystem services, which support all human life.

There are five types of sustainable capital from where we derive the goods and services we need to improve the quality of our lives. Natural capital underpins all other forms of capital from which we derive our well-being. (Source: Forum for the Future)

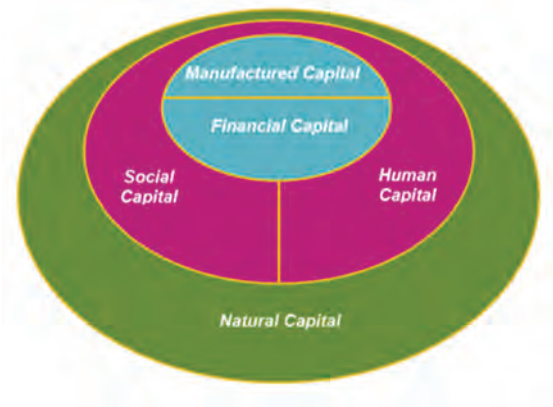
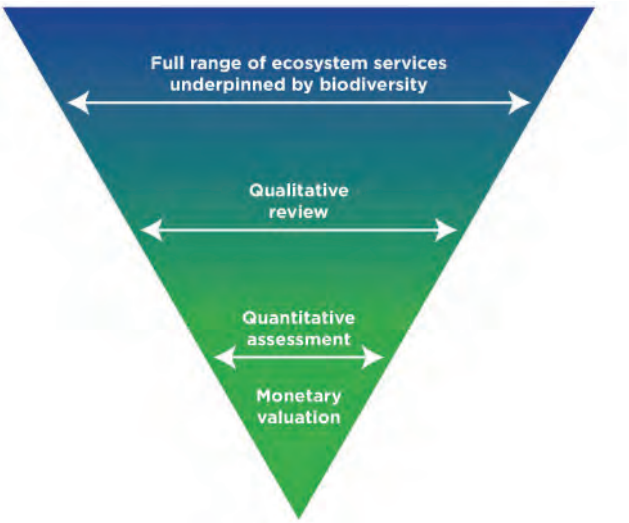


Figure 2. The five capitals model extracted from Porritt (2007)

However, this type of valuation can only capture part of the total value of ecosystems (Figure 3). Although economic valuation can be a useful metric, care should be taken not to overlook other important values to society that cannot be quantified or measured in this way. For example, ecosystems provide important livelihood benefits to communities, which may or may not be substantial in terms of financial rewards, but which are vital to sustaining their way of life such as ethical, cultural and other traditional values. It is arguable that these benefits cannot be adequately captured in an economic framework. However, with appropriate caveats an economic approach serves to increase the visibility of many - otherwise overlooked - values of nature and presents them for inclusion in decision-making about land use change and its impacts on people.



It is important to use a range of methods to assess the value and importance of the full range of ecosystem services underpinned by biodiversity.

Figure 3. The limitations to measuring ecosystem services. Adapted from TEEB, 2010.

2 STEPS FOR MEASUREMENT

The steps for measurement of ecosystem services introduced in this guide are as follows.

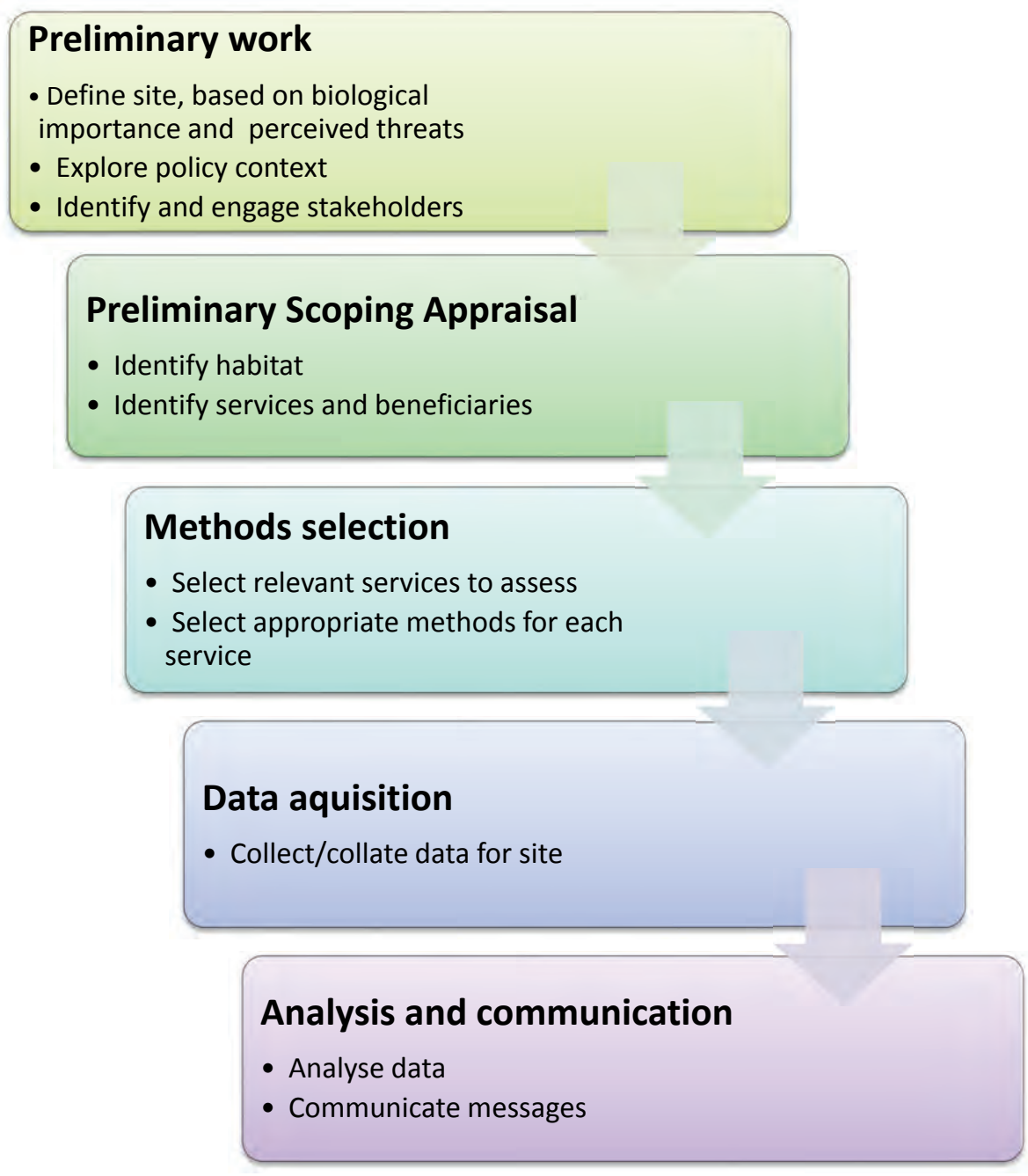


Figure 4. The steps for measurement of ecosystem services (adapted from TESSA, 2014).

2.1 Preliminary work

- Set clear objectives

For economic valuation, the first step is to set clear objectives for the valuation.

- Why do you want to do an economic valuation?
- How will the information be used?
- Who are you communicating to?
- What type of information are your audience interested in?

The way you carry out the study will depend on the objectives and how you communicate the results will depend on the audience.

Example: objective of valuation

- To get an initial understanding of the value of the ecosystem services

- To raise awareness of the importance of ecosystem services among local stakeholders by demonstrating economic value

- To use as information for land use decision-making

- Define site, based on biological importance and perceived threats

In accordance with the objectives for the valuation, select the site. A site is an operative or potential management unit with a defined boundary such as a protected area, community forest, farm co-operative, Important Bird and Biodiversity Area (IBA) etc.

A map is needed in order to define the boundary and also identify the habitat type and the area that each habitat covers.

- Identify and engage stakeholders

Identifying the stakeholders (e.g. local community, site managers, NGOs, government, farmers, traders etc.) is crucial for understanding the site, identifying key ecosystem services and who benefits from the ecosystem services. Engaging stakeholders is also important for validating the final results.

- Collect available information and existing data on the site

In order to get background information regarding the site, exploring the available information is necessary (e.g. previous studies on ecosystem services, natural resources data, data held by government officials about the site and it's use).

Example: Background information

- Explore policy context: Understanding and clarifying of the policy context can help you to identify who are the targets for communication.

- Socio-economic overview: The information helps to understand how the site is used and who benefits from ecosystem services.

- Biodiversity and key threats: Information on biodiversity helps to identify the value of the site for biodiversity conservation. Biodiversity underpins the provision of ecosystem services and so is an important factor to include.

2.2 Preliminary Scoping Appraisal

- Identify habitats

Many (but not all) ecosystem services are delivered at the habitat level and associated directly with particular land cover. Examples of the habitat types in wetland ecosystems are; open lake, marsh, mudflat, mangrove forest, rice field, aqua culture pond, etc.

- Calculate the area of each habitat type

If there is no appropriate map showing the land use and habitat type of the defined site, a satellite image from Google Earth helps to understand the land use and habitat type and can be used to estimate the area of each habitat type. Asking local people is also useful to understand the area.

- Identify ecosystem services

Wetlands can provide a wide range of ecosystem services. Table 2 shows the typical example of the ecosystem services derived from each habitat type. In order to understand the actual use of ecosystem services, collecting information from the stakeholders is important.

Table 2. Typical examples of the major ecosystem services and habitat type:

Ecosystem services (Benefits)		Open lake	Marsh	Mangrove	Mudflat	Rice field
Harvested wild goods	Food (fish, shellfish, crab, see weed etc.)	✓	✓	✓	✓	
	Fibre (straw, lotus etc.)		✓	✓		
	Natural medicines		(✓)	(✓)		
	Energy (timber, charcoal etc.)			✓		
Cultivated goods	Food (rice, fish, shrimp, clam, see weed, salt etc.)	✓	✓	✓	✓	✓
	Feed for livestock (grass, fish, molluscs etc.)	✓	✓			(✓)
Water	Provision (domestic use, irrigation etc.)	✓	✓			
	Purification	✓	✓	✓	✓	
Nature based recreation	Tourism, birdwatching etc.	✓	✓	✓	✓	(✓)
Global climate regulation	Carbon storage	✓	✓	✓	✓	(✓)
Disaster risk reduction	Flood prevention etc.	✓	✓	✓	(✓)	✓

(✓)…shows possible benefit but not very typical in the indicated habitat

For economic valuation, it is important to know what kind of ecosystem services are delivered from the site. To keep the approach simple, select the top five services (according to importance for stakeholders) and less important ecosystem services can be excluded from the valuation.

- Identify the beneficiaries

After selecting ecosystem services for valuation, the beneficiaries need to be identified to understand how ecosystem services are used.

2.3 Method selection and data acquisition

An appropriate valuation method is selected for each ecosystem service. Data is collected by using the simple methods explained in Chapter 3. In order to simplify the valuation, it is recommended to make best use of existing data. Previous research is also applicable. If there is no existing data or only some of the information needed is available, interview key stakeholders or conduct a questionnaire with the beneficiaries.

As the economic value in this method is presented as an annual amount, the user will need to convert the estimated values to annual ones if they are measured for a different period of time.

2.4 Analysis and communication

Analyse and prepare the data for communication according to the study objective. Communication style is designed to suit the objective and the audience. It is likely that users will want to communicate their results to different target audiences, including for example, local people living in or near a site, local provincial or national officials/decision-makers/politicians/government, NGO members, the general public etc. These different audiences will have different levels of understanding about biodiversity conservation, ecosystem services and the relationship between them. It is therefore important that users identify what level of detail is appropriate.

2.5 Cautions and limitations

There is need for caution in the interpretation of ecosystem services data, particularly when rapid approaches are used. Since only some of the ecosystem services can be measured, the result will be subject to errors, bias and it is often best to present a range of values rather than one single estimate. Usually the results will represent a minimum estimate and incomplete estimate of the benefits provided by a site.

Caution in interpretation

- ✓ The economic valuation should be taken with caution due to that currently, only limited ecosystem services can be measured.
  - ➢ The economic values of only major ecosystem services are measured and minor services might be excluded.
  - ➢ The fundamental ecosystem services such as biodiversity, soil formation are not covered since those services cannot be measured with monetary value.
  - ➢ Intangible services such as authentic values of landscape and spiritual values are also not covered by the valuation although these services may be greatly significant and even more important than those capable of being quantified and monetised.
- ✓ The monetary value will vary year by year along with the market situation.
- ✓ It is uncertain that the estimated value would be maintained at the same level in future since the valuation does not include the sustainability of resource use.
- ✓ Using a rapid approach often incorporates bias into the results such as sampling bias. Sound scientific approaches should be used wherever possible.

3 METHODS FOR ECONOMIC VALUATION

In this chapter, simple valuation methods for major ecosystem services are introduced. The ecosystem services covered are

1) harvested wild goods
2) cultivated goods
3) water services (water provision, water quality improvement)
4) global climate regulation
5) disaster risk reduction

3.1 Harvested wild goods and cultivated goods

Although the harvested wild goods and cultivated goods are different, the following calculation can be used for both.

Calculation

Economic value = (A) x ((B) –(C))

Case 1: Calculation using annual gross harvested/cultivated amount

(A) Annual gross harvested/cultivated amount (e.g. tonnes/year)

(B) Unit price of the good (e.g. USD/tonne)

(C) Unit cost for harvesting/cultivating the good (e.g. USD/tonne)

Case 2: Calculation using total harvested/cultivated area

(A) Total harvested area (e.g. ha)

(B) Annual income per unit area (e.g. USD/ha/year)

(C) Annual cost per unit area (e.g. USD/ha/year)

Case 3: Calculation using total household number

(A) Total households who harvest/cultivate the good (e.g. households)

(B) Annual income per household from harvesting/cultivating the good (e.g. USD/household/year)

*If the good is for subsistence use, estimate with market price.

(C) Annual cost per household from harvesting/cultivating the good (e.g. USD/household/year)

Annual gross harvested/cultivated amount should be the total amount of the good harvested from the site. To know this it is necessary to find out who is harvesting within the area and how much. A stakeholder meeting can determine this.

The cost includes all costs for harvesting or cultivating the good; example cost items are shown in table 3.

Table 3. Typical cost items and guidance for the calculation

Cost item	Guidance for the calculation
Initial investment cost	- Initial investment cost should be converted to the annual cost by dividing with the depreciation period.
Equipment cost	- If any tools or equipment have a lifetime of more than one year, divide the initial purchase cost by the expected lifetime and add typical annual repair/maintenance cost.
Operating cost	- Operating cost and maintenance cost should be converted to annual mean cost.
Salary for hired labour	- Seasonal hired labour should be converted to annual mean cost.
Family labour	- For the economic valuation, family labour cost is deducted as an opportunity cost in order to capture the net benefit from ecosystem services. The labour cost is estimated by using the appropriate wage such as hired labour, market average wage or legal minimum wage depending on the local situation. - In case the family members are unable to engage in other jobs due to high unemployment rate in the market, or old aged people who are unable to work for other jobs, the family labour cost is not deducted as a cost.

If there is existing research or statistical data relevant for the area that you are interested in such as a government report, such data can be used and any missing information can be collected by survey. The style of the survey can be market survey, interviews with key stakeholders, or questionnaires from local people, depending on the project period, available resource, and local condition. For conducting interview or questionnaire survey, refer to the guidance and question forms prepared in TESSA (refers to Appendix 1 and 2; or see Peh et al. 2014).

Note:

- ✓ In case that interview survey or questionnaire survey is conducted to collect information such as income and cost, the precision level is dependent on the sample size.

- ✓ If the harvesting period or cultivated period is longer or shorter than one year, the annual mean income and cost is used for the calculation.
- ✓ Where collecting price and cost information through interviews and questionnaires, the mean value of the answers needs to be used.
- ✓ Caution is needed for units which are used locally to quantify the product, and the conversion between the local unit and the relevant metric unit should be clearly defined.
- ✓ This method does not reflect the sustainability of the current activities. It is also important to collect information about changes of harvested/cultivated volume or time spent for harvesting/cultivating during recent decades to understand whether unsustainable use might be a problem.

3.2 Water services

The major water services can be divided into water provision and water quality improvement. Flood protection function is covered in section 3.5.

- Water provision for domestic use

If the beneficiaries can use water from the site free of charge or cheaper compared to the water provision from another source, the difference between the costs can be considered as benefit from the ecosystem service.

Calculation

Economic value = (A) x ((B) – (C))

Case 1: Calculation using total amount of water use from the site

(A) Gross annual amount of water use from the site (e.g. tonne/year)

(B) Unit price for water from an alternative source (e.g. USD/tonne)

(C) Unit cost for current water use (e.g. USD/tonne)

Case 2: Calculation using total households using the water from the site

(A) Total households using the water from the site (e.g. household)

(B) Annual price for water from the alternative source per household (e.g. USD/household/year)
*(B) = (Unit price for water from the alternative source) x (Annual volume of water use per household)

(C) Annual cost for water use per household (e.g. USD/household/year)

Previous research and statistical data can be used if available. If there is no existing data, a simple questionnaire or interview needs to be conducted. The template of the questionnaire is provided by TESSA (refer to Appendix 3; or see Peh et al. 2014)

Note:

- ✓ Value of water for other uses (e.g. irrigation water) can also be calculated if it is possible to estimate the water use as above for irrigation purposes only. Refer the case study in Myanmar in section 6.3.4.
- ✓ If the volume of the water use varies seasonally, the annual mean value of water volume should be used.

- Water quality improvement

A specific method for water quality improvement is not covered in this guide since the water inflow and outflow are often complicated and difficult to measure in a rapid way for wetlands. However, the concepts of valuation are introduced here.

For economic valuation, replacement cost or avoided cost can be ways of measuring the value of water quality improvement by wetlands (Tuner et al., 2008). For example, if users of water have to build a water purification plant to avoid consumption of poor quality water, the cost of the plant represents the replacement cost (i.e. an estimate of value) for this service.

In order to measure the contribution of a wetland site to water quality improvement, data on water quality of upstream and downstream of the whole wetland is necessary. It is possible to take water samples from the inflow and outflow to the wetland using simple water testing kits. If water quality improves, then this could be attributed to the wetland natural filtration function. An alternative method involves estimating the capacity of living organisms such as clams, microalgae and bacteria to carry out this purification function in some sample areas and converting this to the capacity of the whole site.

Construction and operation costs of a water purification plant having the same capacity can also be transferred as the value of the ecosystem service.

For rapid and simple valuation in a limited period, use of previous research or statistical data is recommended as the water flow of wetland is often complicated and it is difficult to capture the contribution.

3.3 Nature-based recreation

The annual value of nature-based recreation is estimated from the direct expenditure of visitors to the site.

Calculation

Economic value = (A) x (B)

(A) Annual total number of visitors (e.g people)

(B) Expenditure per visitor (e.g USD/people)

The annual number of visitors is needed to estimate the value of nature-based recreation. This could be obtained from a central office, ticket counter or by surveys (see TESSA for details). Expenditure such as tour package costs including the site visit, cost of transport, accommodation, food and other supplies should be included. This information is rarely available from previous studies so interview or questionnaire survey is needed. The questionnaire form is available from TESSA (refer to Appendix 4; or see Peh et al. 2014).

Note;

- ✓ The expenditure includes tour package costs, transportation, accommodation, expenditure on any food or supplies, hiring guides and entrance fees.
- ✓ Calculate separately for international visitors and domestic visitors since their expenditure often differ greatly.
- ✓ If tourists visit other places, the general cost for the travel such as airfare and transportation cost for whole trip should be divided by the total days of the travel and include the portion for the required days to visit the site.
- ✓ If there is a seasonal difference in the visitor numbers, annual mean value is used for the calculation.
- ✓ Actual expenditure is a conservative estimate of the actual tourism value of the wetland. Willingness-to-pay surveys would identify the additional non-market value that people attribute to the site for the benefit of nature-based recreation and this would be useful for more detailed valuation.

3.4 Global climate regulation

Wetlands contribute to regulating the global climate through storage of carbon. Habitat estimates for the amount of carbon stored and suggested prices of carbon are prepared in this guide to aid simple calculation. This guide does not provide a method for

greenhouse gas sequestration / emissions which is more complex to derive. See TESSA for details on how to estimate greenhouse gas sequestration / emissions.

Calculation

Economic value = (A) x (B)

(A) Total amount of carbon stored in the site (tonne)
(B) Unit price of the carbon (USD/tonne)

(A) is estimated by summing the carbon stored in each habitat type:
For example, if the site is combined from open lake and marshes, the calculation is as follows.

(A) =(Area[ha] of open lake) x (carbon storage[MgC] of open lake) +
(Area[ha] of marshes) x (carbon storage[MgC] of marshes)

Note:

- ✓ The unit for carbon is "MgC", tonnes of carbon.
- ✓ In order to simplify the method, carbon storage in different tropical wetland habitats is provided in table 4 prepared using tables from "IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands". For the wetland in other climate region, refer to the each reference.

Table 4. Carbon storage estimates per hectare for simple calculations for tropical climate

Habitat Type / Climate (tropical)*	Carbon storage (MgC/ha) Dry	Moist	Wet	Montane	Reference
Mangrove forest	820.8				(1)(2)(3)(4)(5)
Intertidal mudflat	88.0				(6)(7)
Salt farm	88.0				(6)(7)
Aquaculture	88.0				(6)(7)
Open lake	22.0	68.0	49.0	82.0	(8)(9)
Inland marshes	121.0	167.0	148.0	181.0	(8)(9)
Paddy field	31.0	77.0	58.0	91.0	(8)(9)

*Climate classification is determined as follows;
If mean annual temperature >18, and ≤ 7 days of frost/year, tropical;
if elevation >1000m, montane; if mean annual precipitation (MAP) >2000mm, wet; if MAP >1000m, moist; otherwise, dry (2006 IPCC Guidelines for National Greenhouse Gas Inventories. Figure 3A.5.2)

Reference:
(1) Above-ground biomass (AGB) of mangroves - tropical wet: 192Mg/ha (IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Table 4.3)

(2) Carbon fraction of above-ground biomass (AGB) in mangroves: 45.1% (IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Table 4.2)
(3) Ratio of below-ground biomass to above-ground biomass in mangroves - tropical wet: 0.49 (IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Table 4.5)
(4) Carbon stored in litter: 0.7Mg/ha and dead wood: 10.7Mg/ha (IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Table 4.7)
(5) Ave. total soil carbon for oceanic mangroves = 680.4 MgC/ha (Donato et al. 2011)
(6) Dead wood in converted area: default value of 0 (IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. 4.2.2.2)
(7) HAC tropical wet soil: 44Mg/ha (IPCC 2006 vol4 ch2 table 2.3); doubled as the value is for the top 30cm soil, where 50% of total soil carbon is stored (IPCC in Good Practice Guidance for Land use, Land-use Change, and Forestry (eds Penman, J. et al.) (Institute for Global Environmental Strategies, 2003))
(8) Aboveground, belowground, litter, and dead wood carbon from Anderson-Teixeira and deLucia (2010)
(9) Tropical soil carbon from IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Table 5.2

If there is more appropriate research data from the site available, or from sites that are geographically and biophysically similar, that data can be adopted for the calculation instead of the table 4. General guidance for the calculation is as follows:

1. Estimate the above-ground live biomass (AGB) per hectare of each habitat type, by referring to the existing research and convert it to carbon by multiplying by 0.5 which is the conversion factor from biomass to carbon.
2. Estimate below-ground carbon per hectare of each habitat type by using the estimate ratio of above ground to below group biomass using existing research for the habitat type.
3. Carbon in litter, dead wood and soil are estimated per hectare of each habitat type by using existing research.
4. Sum the carbon stored above-ground, below-ground, litter, dead wood and soil to have a total carbon storage in MgC/ha for each habitat type.
5. Multiply the MgC/ha by the total number of hectares of the relevant habitat type.
6. Sum the total carbon for each habitat type to calculate the total carbon of the site.
7. Value can be estimated by multiplying the carbon volume by a chosen carbon price.

Note:

- ✓ By using published data, the carbon storage figures provided are rough estimates based on average values from a range of sources. To obtain more accurate results, field work is necessary. See TESSA for field methods (Peh et al. 2014)
- ✓ There is no fixed price of carbon and the market price is highly variable.

Table 5 shows some examples of the carbon price.

Table 5. Some examples of carbon price from different sources

Scheme	Price	unit
Plan Vivo	$ 31.69	MgC in 2016
Verified Carbon Standard (VCS)	$ 122.29	MgC in 2016
EU Emissions Trading System (ETS)	$ 8.58	MgC in 2016

*The price of Plan Vivo and VCS is the price adjusted to 2016 from 2014 by using the inflation rate of 1.015914 (IMF inflation rate 2014-2016, available from International Monetary Fund, World Economic Outlook Database, April 2015)

*The price of EU ETS is converted to US$ from UK£: £5.61 x 0.65416 (mean exchange rate in 2015 available from http://www.oanda.com/currency/average)

3.5 Disaster Risk Reduction

If a wetland ecosystem plays a role in disaster risk reduction such as flood control, or storm surge protection and wave attenuation at the coastal area, it performs a service of disaster risk reduction. The value of this service can be estimated by using the avoided damage costs method. The cost of the avoided damage is the prevented cost of repairing houses and equipment, loss of the farmland or aquaculture, loss of domestic animals etc. Alternatively, the cost of maintaining man-made flood protection defences can be used as a substitute for the ecosystem service value of natural wetlands where the wetland has been degraded or destroyed.

However it is often difficult to estimate how much the wetland ecosystem contributes towards disaster risk reduction without collecting detailed data at the site. If there is research for other similar sites, these result can be used by as a benefit transfer approach.

Calculation

Economic value = ((A) x (B)) x (C)

(A) Total households likely damaged by disaster without the wetland ecosystem or with degraded ecosystem (e.g. household)

(B) Estimated cost of damage per household (USD/household)

(C) Rate of incidence of disaster (e.g. 1 in 25 years = annual value 1/25)

4 Next Steps

4.1 The importance of comparative valuation

This guide introduces a rapid methodological approach and it was prepared by simplifying and adapting methods from TESSA –Toolkit for Ecosystem Service Site-based Assessment (Peh et al. 2014). The toolkit currently covers five classes of ecosystem services i.e. water services, harvested wild goods, cultivated goods, nature-based recreation and climate regulation services. In TESSA, the step-by-step process for measurement is designed as a decision key and each process is explained with more detail and includes some additional methods beyond those provided here. Therefore, the use of TESSA is recommended for users who would like to conduct more precise valuation of ecosystem services.

Another key feature of TESSA is that it is designed for valuing the difference in ecosystem services between two alternative states of the site. This is usually the current state and a plausible alternative state where a decision has resulted in an alternative land use of the site (See Figure 5). For example, the ecosystem services would be estimated for a wetland site under current conservation protection compared with that same site without protection and where expansion of aquaculture has occurred.

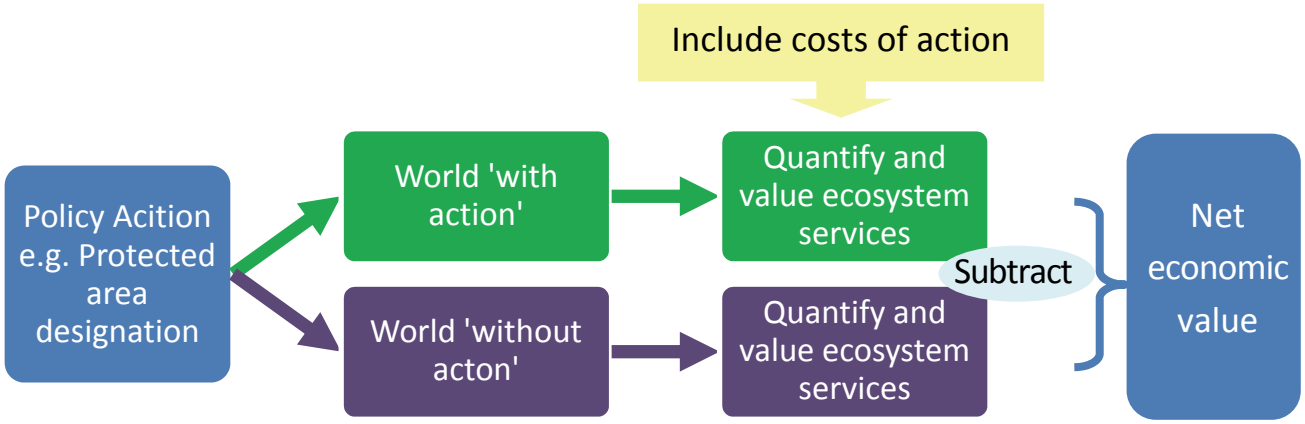


Figure 5. Illustration of how to do a comparative evaluation (adapted from Balmford et al. 2008).

To make effective decisions, it is important to know the difference between the amount of the ecosystem services provided by a site in its current state compared to a plausible alternative one (e.g. protected area vs. agricultural use, reclamation etc.) where the habitat is converted, or in which resources are unsustainably exploited. This gives the

net benefit of the conservation state of the ecosystem. For more information refer to TESSA, Peh et al. 2014).

It is recommended that users of this guide refer to TESSA so as to conduct a comparative assessment of ecosystem services for the site in order to present net benefit values rather than gross values.

4.2 Alternative methods for valuation

Table 6 provides a list of various tools for evaluation of ecosystem services. For users who would like to conduct evaluation of ecosystem services with other methods, the better known ones are compared in the list. Note that not all of these methods are freely available.

Table 6. Comparison of various tools for evaluation of ecosystem services

Tool	Qualitative	Quantitative	Time demand	Specialist software needed	Level of Technical expertise	Scalability	Economic valuation	Comparative approach
ARIES (Assessment and Research Infrastructure for Ecosystem)		✓	*High*	✓	*Law - High*	*Landscape*	✓	
Co$ting Nature		✓	*Law*	✓	*Law*	*Landscape*		✓
ESR (Corporate Ecosystem Services Review)	✓		*Law*	✓	*Law - Moderate*	*Various*		✓
InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs)		✓	*Moderate - High*	✓	*High*	*Landscape*	✓	✓
LUCI (Land Utilization & Capability Indicator)		✓	*Moderate*	✓	*Law - Moderate*	*Various*		✓
MIMES (Multi-scale Integrated Models of Ecosystem Services)		✓	*High*	✓	*High*	*Various*	✓	✓
PA-BAT (Protected Areas Benefit Assessment)	✓	(✓)	*Moderate*		*Law*	*Site scale*	(✓)	
SolVES (Social Values for Ecosystem Services)		✓	*Law - High*	✓	*Moderate*	*Landscape*		
TESSA (Toolkit for Ecosystem Service at Site-based Assessment)	✓	✓	*Law*		*Law - Moderate*	*Site scale*	✓	✓
WRAP (Wetland Resources Action Planning)	✓	✓	*Moderate*		*High*	*Site scale / Landscape*		

Reference:

Bagstad, K.J., D. Semmens, S. Waage, and R. Winthrop. (2013) A comparative assessment of tools for ecosystem services quantification and valuation. Ecosystem Services e5: 27-39

Peh et al. (2013) TESSA: A toolkit for rapid assessment of ecosystem services at sites of biodiversity conservation importance Ecosystem Services e5: 51-57

5 CASE STUDY – Thai Thuy Wetland, Vietnam

Summary of the site and valuation

- Site name: Thai Thuy
  (Red river delta region)
- Location: Thai Binh, Vietnam
- Area of the site: 6,981 ha
- Protected status: unprotected
- Project period for valuation:
  November 2015 to March 2016

Table 1. Land use and the area of Thai Thuy wetland

Land use	Area (ha)
Aquaculture (intensive)	1,182
Aquaculture (semi natural)	62
Aquaculture (semi natural with mangrove)	167
Salt farm	50
Mangrove forest	1,754
Intertidal mudflat	3,766
Total land use of Thai Thuy IBA	**6,981**

Table 2. The result of the valuation of the ecosystem services

Ecosystem service		Annual value (million USD)
Harvested wild goods		**2.23**
Fish harvesting		1.37
Shellfish harvesting		0.89
Cultivated goods		**11.66**
Semi natural aquaculture		0.58
Intensive aquaculture		8.93
Clam culture		1.93
Salt production		0.22
Disaster risk reduction		**1.05**
Total	**Annual value**	**14.94**
Climate regulation	**One off stock value**	**60.26**

*The economic value of a small subset was estimated using a rapid methodological approach and caution for the interpretation is needed (see 5.4 Limitations)

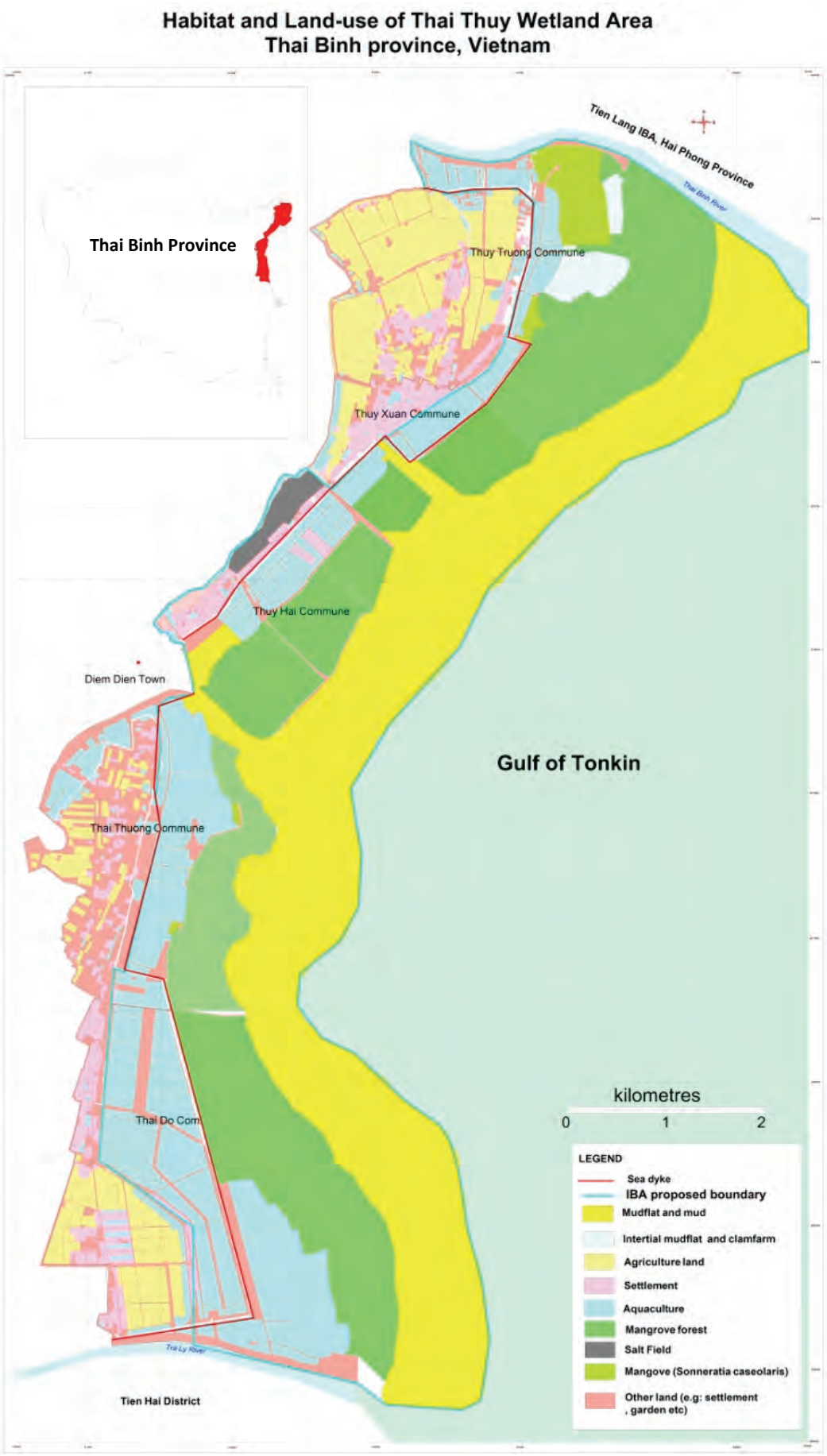


Figure 1. Map of land use of Thai Thuy wetland

5.1 Thai Thuy Wetland site information

Characteristic of the wetland

Thai Thuy wetland is one of the key wetland sites in the Red River Delta and it is identified as an Important Bird & Biodiversity Area (IBA). Thai Thuy district has 16 km of coastline and is bordered by the Tra Ly river to the south and Thai Binh river to the north. The IBA site covers 6,981 ha of the coastal area and is bisected by the Diem Ho river. To the south of the Thai Binh river mouth are located extensive areas of mudflats, farmed as a result of deposition sediment. To the west lies an area of salt pans and adjacent to the Tra Ly river is a region of aquaculture ponds.

Thai Thuy wetland provides various significant benefits. Local communities living in five villages located near the IBA harvest food from the wetland. The mangroves provide a protection function from storms for local communities and the global benefit of climate regulation. The wetland also conducts water purification. There are wetland benefits to wildlife as well; it provides a home for migratory and residential birds, amphibians, fish, insects and aquatic plants etc. Among the waterbirds, the site supports threatened species including Spoon-billed Sandpiper (CR), Baer's Pochard (CR) and Black-faced Spoonbill (EN).

Major threats to the wetland

The following activities are major threats to the wetland. In order to receive benefits derived from the wetland, such activities need to be monitored and controlled in a sustainable way.

- Electric shock fishing : it causes overexploitation of fish resources
- Industrial and agricultural water pollution: contamination of the water affects human health and threatens the existing biologically diverse plant and animal species.

Socio-economic overview/Legal status

Since the area is recognized as globally significant for the biodiversity and ecosystem services, the Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE) under the Ministry of Natural Resource and Environment (MONRE) has a project aimed at establishing new wetland conservation reserves in Thai Binh and Thua Thien Hue to ensure the integration of wetland conservation into wider linked wetland landscapes.

5.2 Objective of the project

The objective of this study was to undertake a pilot assessment of the economic value of the Thai Thuy Wetland in Vietnam to demonstrate the range of benefits that Thai Thuy wetland provides to people. The purpose of this was to promote awareness of the importance of the wetland by communicating the results of the assessment to local stakeholders and decision-makers with a view to promote an establishment of a protected area of Thai Thuy.

5.3 Economic Valuation approach

5.3.1 Preliminary scoping appraisal

The economic value of a small subset of the ecosystem services provided by Thai Thuy wetland was estimated using a rapid methodological approach. Due to the limited project period and resources, available data and information was used and necessary additional information was collected from simple interviews. Existing data was provided by the Thai Thuy District Report submitted to District People's Committee in 2015.

The IBA boundary was used for the survey since there is no legal boundary for the area. Topographically, the coast line of Thai Thuy district is separated by 2 rivers namely Tra Ly river and Thai Binh river, and it is easy for the local people to understand the boundary.

The map on p.25 shows the land use of the site and the area of each habitat type was calculated according to the land use as shown in Table 1 in p.24.

A key stakeholders workshop was held on 12 January 2016 for introducing the project and collecting related information. The discussion identified the ecosystem services provided by Thai Thuy wetland as shown in Table 3. The services in the brackets were excluded from the economic valuation due to the small number of people involved in the activity or lack of data available (in the case of water purification).

Table 3. Ecosystem services derived from Thai Thuy wetland

Ecosystem Services	Items
Harvested wild goods	Fish, Shellfish
Cultivated goods	Fish and shrimp aquaculture, Clam culture, Salt production, (Sea weed culture, Bee honey)
Water purification	(Water purification of mudflat)
Nature-based recreation	(Visiting and bird watching at mudflat)
Climate regulation	Carbon sequestration function of wetland
Disaster risk reduction	Protective benefit of mangrove

5.3.2 Data collection and economic valuation

In this project, only major ecosystem services with available information were selected for the valuation. Information on shellfish harvest and aquaculture was collected by using a questionnaire form provided by TESSA. The data related to climate regulation and disaster risk reduction was gathered from published literature. All values were estimated in 2016 US dollars using an exchange rate of VND22,300 = 1 USD.

Harvested wild goods

- Wild Fish

Data on wild fish capture was available from Thai Thuy district report and the gross income in 2015 was VND 348.31 billion. Based on the cost information of Bureau of Agriculture and Rural Development, the estimation of all cost for wild fishing is about 60-65% of the income. A conservative estimate of 65% of the income was adopted as the cost i.e. VND 226,402 million. The annual net benefit for whole volume of landing at Thai Thuy district was estimated as $5.47 million (VND 121,909 million).

There is no physical boundary in marine areas and the value of harvested wild fish is not necessary derived only from the site within the boundary of the assessment. However, the fish species caught are known to benefit from the mangrove habitat during their life cycle. The site therefore contributes to the production of wild fish, and the value of this contribution was estimated as 25% according to previous research (Samonte-Tan, 2007). Therefore, the site contribution of the annual net benefit of the wild fish harvesting was estimated as $ 1.37 million (VND 30,477 million).

- Shellfish

The net benefit of shellfish was estimated based on a simple interview survey of shellfish collectors in Thai Thuy. During the cold and wet season from December to March, local people collect about 48 tonnes and during the hot and dry season from April to November, the collected amount is about 480 tonnes. The price of the shellfish is about VND 50 million/tonne; therefore, the annual gross value is about VND 26.4 billion. The collection effort was estimated as 132,000 person/day. Although the most of the collectors are women and children when off school days and weekends, the opportunity cost of family labour was valued at the legal minimum wage in 2015 (VND2,150,000/month). The costs of equipment and transport were estimated at zero since the harvesting method is simple and the middlemen purchase the shellfish at the seaside. The annual net benefit was estimated as $ 0.87 million (VND19,305 million).

Cultivated goods

- Aquaculture

There are two types of the aquaculture method, one is “semi-natural aquaculture” and the other is “intensive aquaculture”. The fish and shrimps from semi-natural aquaculture are cultivated within large ponds and are fed naturally by controlling the water gate with tides. On the contrary, for intensive aquaculture, feed is purchased and provided to fishes manually and the dissolved oxygen rate in the pond is controlled since the density of the fish is high in smaller ponds compared to semi-natural aquaculture ponds. Thus the yield per hectare of intensive aquaculture is much larger than semi-natural aquaculture.

Since previous data was not available for the estimation, simple interviews were conducted with two owners of each semi-natural aquaculture and intensive aquaculture. The interviews were conducted by using the forms prepared by TESSA. The opportunity cost of family labour was valued at the legal minimum wage in 2015 (VND2,150,000/month).

For the semi-natural aquaculture, mean value of the net benefit per hectare was estimated as $2,524 (VND56.28 million). The total area of semi-natural aquaculture is 229 ha and the total

annual net benefit was estimated as $ 577,947 (VND 12,888 million).The mean value of the net benefit per hectare for intensive aquaculture was $ 7,558 (VND 168.54 million). The total area of intensive aquaculture is 1182.19 ha and the total annual net benefit was estimated as $8.93 million (VND 199,242 million).

Due to the limited sample size, the values are estimates only and should be taken with caution. For more accurate estimation, further survey is necessary.

- Clam culture

The gross value and cost information was recorded in the Thai Thuy District report respectively VND 297.5 million and 237 million per hectare per 20 months (in 2013) since the production cycle of clam is 20 months. By converting the figures to the annual value, the annual net benefit is VND 36.3 million per hectare. The total area of clam culture is 1,184 hectare; therefore, the annual net benefit was estimated as $1.93 million (VND 42,979 million).

- Salt production

According to the Thai Thuy District report, gross annual income was VND 7,016 million (in 2014). The cost information of salt production was collected from an owner of the salt farm who participated in the workshop. The initial and equipment cost for 0.036ha for 5 years is about VND 5-8 million. In order to estimate a conservative value we applied as cost of VND 8 million and deducted this from the gross income. The family labour for salt farming was not deducted since most of them are elderly people or who are unable to engage in other jobs. Therefore, the annual net benefit of the salt production was estimated as $ 0.22 million (VND 4,807 million).

If the family labour cost was estimated at the legal minimum wage with the working days of half a year excluding the rainy days, the annual net benefit would be minus $0.36 million (minus VND8,041 million). Although the cost calculation is very rough, it would explain the situation that the some of the salt farm area has been converted to aquaculture ponds and currently, some owners are waiting for the permission to convert their land to aquaculture ponds since the revenue from salt farming is not profitable.

Disaster risk reduction

The mangrove belt has a role of wave attenuation during typhoons or storm surges. The value was estimated by using previous research undertaken by the International Federation of Red Cross and Red Crescent Societies in a report entitled “Case study: Mangrove plantation in Viet Nam: measuring impact and cost benefit”. According to the report, the mangrove has protective benefit of $15,330,243 for the coast line of 7.5 km in Thai Thuy from 1994 to 2025. The protective benefit includes shoreline and river bank protection, reduced disaster-induced non-material losses, reduced disaster-induced material losses, reduced disaster-induced indirect losses, reduced costs in sea-dyke maintenance. Currently, there is 16km of the coast line of Thai Thuy covered by mangrove so the annual benefit for 16 km was estimated as $1.05 million (VND 23,526 million).

Global climate regulation

Global climate change mitigation was estimated based on carbon stocks. The total areas of different habitat types were identified from the land use map. Estimates of carbon stocks in the above-ground biomass, below-ground biomass, litter, dead wood and soil for mangroves and aquaculture were taken from IPCC 2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Carbon storage of the site was estimated at over 1,901,465 MgC. The most significant carbon stock occurs in mangrove soils.

There is no fixed price of carbon and the market price is highly variable. In this survey, the price of Plan Vivo certification ($31.69 MgC, in 2016) was used for the calculation. This is the price that a buyer would pay for carbon credits from the Plan Vivo certification scheme, if there was to be a carbon trade project established at Thai Thuy. The price of $31.69 MgC in 2016 was adjusted from 2014 price based on the IMF inflation rate (2015). The estimated value was $ 60.26 million (VND 1,343,801million) by using the price of Plan Vivo.

Harvesting shellfish in mudflat

Intensive aquaculture ponds

Salt farm

Mangrove forest

5.4 Limitations

The value of ecosystem services at Thai Thuy were estimated based on existing data and simple interview surveys. Since only some of the major ecosystem services were selected for the survey, this is a minimum estimate. There is also need for caution in the interpretation.

- ✓ Economic values are estimates only and should be taken with caution due to the limited sample size in the surveys.
- ✓ Minor services such as bee honey and harvesting sea grasses were excluded.
- ✓ Water purification function was excluded since difficult to estimate, although it is an important function for purifying sea water.
- ✓ The fundamental ecosystem services such as biodiversity, soil formation are not covered in the valuation since those services cannot be measured with monetary value.
- ✓ The monetary value will vary year by year along with the market situation.
- ✓ It is uncertain that the estimated value would be maintained at the same level in future since the survey did not include the sustainability of resource use.

5.5 Conclusion

Despite the above caution, Thai Thuy wetland provides multiple benefits, some of which can be estimated using economic valuation (Refer to table 2 in p.24). The total annual benefit of the ecosystem services was estimated as $14.94 million plus $ 60.26 million of carbon storage function, which is a one-off stored value. The overview of the beneficiaries is shown in the table 4.

Table 4. Beneficiaries of ecosystem services derived from Thai Thuy wetland

Economic benefit	Beneficiary population	Number of beneficiaries
Harvested wild goods		
Fishing	Fishermen	<1,618 people
Shellfish collection	Women and children	Unknown
Cultivated goods		
Semi-natural aquaculture	Owners of the ponds, hired people	Unknown
Intensive aquaculture	Owners of the ponds, hired people	Unknown
Clam culture	Owners of the clam culture, hired people	308 households
Salt production	Owners of the salt farm	664 people
Disaster risk reduction	Coast adjacent dwellers and owners of aquaculture pond	Unknown
Climate regulation	Global population	Unknown

As explained in 5.4 Limitations, this valuation estimate should be viewed as a rapid, preliminary assessment only. The overall objective was to highlight the benefits that the Thai Thuy wetland provides to people for the purposes of raising awareness about the importance of the wetland. It is also aimed at promoting the area to be designated with conservation status. The valuation result demonstrates that there are important values that need to be incorporated into any future decision-making about the wetland and wider landscape development activities that may impact upon it.

6 CASE STUDY – Moeyungyi Wetland, Myanmar

Summary of the site and valuation

- Site name: Moeyungy Wetland
- Location: Bago, Myanmar
- Area of the site: 10,360 ha
- Protected status:
  -Ramsar site
  -Wetland Wildlife Sanctuary(WWS)
- Project period for valuation:
  November 2014 to March 2015

Table 1. Land cover of the site at the driest and the wettest period of the year

Land use	Area (ha) in current state		Area (ha) in alternative state	
	Dry season	Wet season	Dry season	Wet season
Paddy	800	0	1100	0
Marshes	8524	7252	8224	7252
Open water body	1036	3108	1036	3108
Total	**10360**	**10360**	**10360**	**10360**

Table 2. The result of the valuation of the ecosystem services

Ecosystem service		Annual value (million USD) in current state	Annual value (million USD) in alternative state	Difference (million USD)
Water		**8.5**	**8.58**	**+0.08**
	Irrigation water	0.08	0.16	+0.08
	Domestic use	7.99	7.99	
	Flood protection function	0.46	0.46	
Harvested wild goods		**16.2**	**16.2**	
	Fish production	15.36	15.36	
	Buffalo grazing	0.77	0.77	
	Molluscs for duck food	0.08	0.08	
	Lotus stalk harvest	0.02	0.02	
Cultivated goods (Rice)		**0.44**	**0.60**	**+0.16**
Nature-based Recreation		**0.07**	**0.07**	
GHG Emission		**-3.1**	**-3.1**	
Management cost		**-0.02**	**-0.02**	
Total	**Annual value**	**22.1**	**22.34**	**+0.24**
Carbon Storage	**One-off value**	**91.6**	**91.6**	

*The economic value of a small subset of ecosystem services was estimated using TESSA. Caution for the interpretation is needed (see 6.4 Limitations)

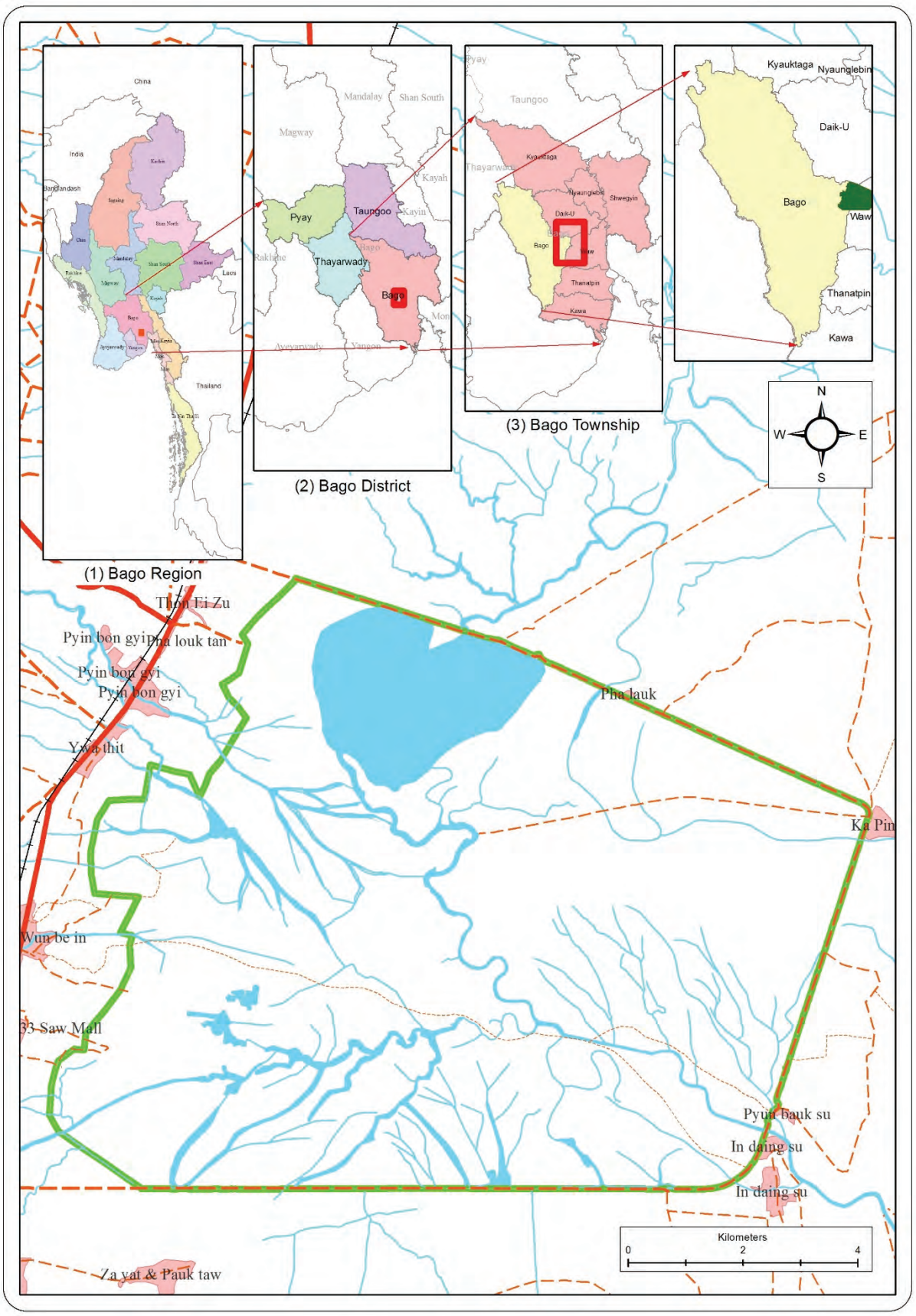


Figure1. Land Map of Moeyungyi Wetland

6.1 Moeyungyi Wetland site information

Characteristics of the wetland

Moeyungyi Wetland Wildlife Sanctuary (WWS) is located in the administrative region of Bago in Myanmar (Figure 1), 25 km north-northeast of Bago town, east of the Yangon to Mandalay highway and 24 km west of the Sittuang river. The average annual rainfall is 3,200 mm and the wet months are June to September (though most rain falls in July and August). The Sanctuary covers 10,360 ha, 82% of which is freshwater marshes, 10% is permanently covered by the lake and 8% is cultivated land in the dry season (rice paddies). At the end of the wet season, water covers the whole site and in the dry season it recedes again.

Moeyungyi lake is a man-made reservoir that was constructed in 1873-1878 to store water for irrigation and to use as an embankment for flood protection. During the dry season, storage water from Moeyungyi wetland is fed into Bago-Sittaung Canal not only for transportation (mainly of timber) but also for irrigating seasonal paddy fields. During the wet season, the lake serves as flood protection (Irrigation Department, Bago Region, 2014). Its main function now is to provide water flows to downstream areas under rice cultivation. There are seven natural creeks flowing into Moeyungyi Lake during the wet season. In the dry season Moeyungyi wetland is recharged with water from several upstream dams (Irrigation Department, Bago Region, 2014). There are three major outflows with three sluices in the eastern bund that drain water downstream to the Sittaung river.

The Sanctuary is an important site for a wide range of wildlife including many resident and migratory bird species. Moeyungyi WWS qualifies as an Important Bird and Biodiversity Area (IBA) due to the presence of critically endangered birds species and significant congregations of migratory species. Herpetofauna, mammals, insects and fish are other important animal taxa found within the site with a high diversity of plant species also being present.

Socio economic overview

The wetland is surrounded by 17 villages with an estimated population of 65,000 people in 12,000 households (Bago and Waw Township Administrative Offices, 2014).

According to previous survey data collected by Biodiversity and Nature Conservation Association (BANCA) from eight of the villages (BANCA, 2014), most people derive their livelihoods from either fishing or agriculture (rice cultivation) directly associated with the Moeyungyi WWS. The average daily household income is 3001 – 6000 MMK (US $3-6) and 77% of the population is reported to be directly dependent on the wetland for their livelihood (BANCA, 2014). According to the interview survey of BANCA, in some villages, drinking water is predominately taken directly from the lake without treatment. Many socio-economic activities occur on the lake and around it, including fishing, water buffalo and cattle grazing, cultivation of rice for subsistence use, harvesting of the padoma lotus and duck-rearing.

Small scale industry is also an important component of the communities' livelihood. It includes, rice milling, and industry for Ngapi (shrimp paste), cheroot (tobacco), lotus textiles and dried stalks of pein (Taro, *Colocasia esculenta)*.

Fishing on Moeyungyi lake

Rice planting along Moeyungyi

The boardwalk at Moeyungyi WWS

Children viewing the wildlife

Key threats

Moeyungyi WWS is managed by the Nature and Wildlife Conservation Division (NWCD) under the Ministry of Environmental Conservation and Forestry (MOECAF). The wetland was designated as a bird sanctuary in 1986 and was given Ramsar status in 2004. Despite conservation action at the site by the park warden and NGOs such as BANCA the condition of the wetland is very unfavourable and threats remain high (BirdLife International, 2015).

The following activities are the major threats to the wetland.

- Electric shock fishing : it causes overexploitation of fish resources
- Water overuse : huge water withdrawal is necessary particularly during the summer time
- Use of fertilizer and pesticides: contamination of the water can affect human health and threatens the existing biologically diverse plant and animal species.
- Land encroachment for paddy field: over wetland area reduces the extent of the wetland and increases the level of water pollution

- There are also several activities affecting the biodiversity such as bird hunting / bird trapping with nets / trading of turtles and snakes etc.

In order to receive the benefit derived from the wetland, such activities need to be monitored and managed in a sustainable way.

6.2 Objective of the project

The objective of this study was to undertake a pilot assessment of the economic value of the Moeyungyi Wetland in Myanmar to demonstrate the range of benefits that Moeyungyi wetland provides to people. The purpose of this was to promote awareness of the importance of the wetland by communicating the results of the assessment to local stakeholders and decision-makers. During a period of rapid developmental change in Myanmar, it is important that market and non-market values are recognised and incorporated into decision-making.

6.3 Step and methods of valuation

6.3.1 Preliminary scoping appraisal

The Moeyungyi WWS ecosystem services values were first identified and then quantitatively assessed under the current management regime. The data from the immediately adjacent rice paddy was used to estimate what the ecosystem service value of this wetland area would be if further expansion of rice cultivation were to occur (the plausible alternative state). This study built on available data from previous rapid assessment studies on the biological and socio-economic status of the Moeyungyi Wetland, conducted by teams of scientists from BANCA collaborating with researchers from Bago University, local villagers and staff from Moeyungyi, over the period from 24th February to 2nd March 2014.

Preparatory meetings were held from 18 to 22 December 2014. During the meetings, existing information and data was collated and the feasibility of this assessment was discussed. In order to collect the necessary information for this assessment under the restricted circumstances, two scoping workshops and two group interviews were designed. A preliminary scoping workshop of key stakeholders involved at Moeyungyi WWS was then convened on 6 and 7 February 2015. The participants included government staff from the Environmental Conservation Department, Irrigation Department, Department of Agriculture, Department of Fisheries, Moeyungyi Park Warden Office (under management of the Nature and Wildlife Conservation Division; NWCD of the Forest Department, the Township Administrative Office of Bago and Waw Township and representatives from eight of the 17 villages around Moeyungyi WWS. This scoping exercise identified the main ecosystem services provided by Moeyungyi WWS as (1) global climate change mitigation in terms of carbon storage; (2) nature-based recreation; (3) flood protection; (4) provisioning of water; (5) provisioning of wild goods; and (6) rice production during the dry season. General information on fishing activities and rice cultivation was then gathered by using questionnaire form provided by TESSA.

Preliminary scoping workshop

Group discussion in the workshop

6.3.2 Alternative state

To understand the benefit that Moeyungyi WWS provides through ecosystems services it is necessary to compare these services to those that would be provided if the WWS was somehow different. This can be referred to as the 'plausible alternative state' and is specific to the local situation at the site.

At Moeyungyi WWS, the Irrigation Department releases water from the wetland to the downstream area around Bago for irrigation in December each year (Figure 2). This enables 16,520 ha of rice paddy to be cultivated in this area during the dry season. The flow of water into Moeyungyi WWS from the upstream catchment maintains the water level of the permanent Moeyungyi lake at 7m.

Given the aspiration of Myanmar to become a major rice exporting nation (Pratruangkrai 2015), the Irrigation Department has the intention to increase the export of water from Moeyungyi WWS for rice cultivation (Myint Soe, U., Irrigation Department, pers comm). It is likely that the area of paddy supported by the water from Moeyungyi WWS will be doubled in the near future. In consultation with local stakeholders, we therefore anticipate that the most plausible alternative state for the WWS would be the increase in area of paddy cultivation downstream at Bago by 100% (i.e. to 33,040 ha).

Figure 2. Location of Bago town in relation to the Moeyungyi WWS. Water is released in December each year via the Bago-Sittuang canal.

Assuming a constant in-flow from upstream, the level of the Moeyungyi Lake would be likely to decrease under this alternative state. This is based on an event which occurred in 2013, when a major in-flow canal was blocked by soil erosion, leading to a fall of water levels to 5.8 m while the Irrigation Department maintained the annual supply of water for irrigation outside Moeyungyi WWS during that year. Some conservation practitioners and staff from the Nature

and Wildlife Conservation Division have raised their concern that the newly-exposed marshland aggravated by the reduction of water is likely to attract further rice paddy cultivation. Therefore, a comparative assessment of the ecosystem services provided by Moeyungyi WWS in its current state and in its most likely alternative state was carried out, in order to elucidate the trade-offs between the increased provisioning of water for irrigation downstream and the current management regime.

6.3.3 Field work and data collection

Based on the expert opinion of BANCA staff and the preliminary scoping workshop, harvested wild goods (fish, aquatic plants for buffalo grazing, molluscs and lotus stalks), water provision (for domestic use and irrigation), flood protection, nature-based recreation and global climate change mitigation in terms of carbon storage were identified as key ecosystem services to measure. These services delivered by Moeyungyi WWS in its current state (i.e. with the present irrigation regime) and in its alternative state with more water use for irrigation (referred to as 'alternative irrigation regime') were assessed by using TESSA. Thus, the evaluation of the alternative state includes all ecosystem services measured in the current state, as well as significant increase in some services that the alternative would provide (e.g. use of water for irrigation and rice production). All values were estimated in 2014 US dollars using an exchange rate of 1000 Burmese Kyat = 1 USD.

Using a topographic map of Moeyungyi WWS, stakeholders estimated how the land use within the wetland would change if the rice paddies irrigated by the water from the wetland were to be doubled, from 16,520 ha to 33,040 ha, during the dry season (Table 1 on p.32). They reported that 1,100 ha of the newly-exposed marshland caused by the drop in water levels would be converted to rice paddy. To measure the rice production that would be delivered under this alternative state, paddies around the wetland were selected, as they best represented the paddies within the wetland. In consultation with BANCA, two villages were selected for the household surveys to gather data on the quantity and net value of fish and rice harvest: (1) Pyin Pon Gyi, located northwest of Moeyungyi WWS and (2) Kapin, northeast of Moeyungyi WWS. These villages – where a majority of households either harvest fish from the wetland or grow rice – reflected the socio-economic characteristics of all 17 villages around the wetland. Information on other harvested wild goods (buffalo grazing, molluscs and lotus harvesting) was provided by staff of NWCD.

Gathering of villagers for household questionnaire survey

Reporting of results from the focus group discussions

6.3.4 Economic Valuation

Global climate change mitigation

Global climate change mitigation was estimated based on changes in carbon stocks between the two states (current irrigation regime; alternative irrigation regime). The total areas of different habitat types in both the current and alternative state were identified through consultation with local experts. Estimates of carbon stocks in the above-ground biomass, below-ground biomass, litter and dead wood for paddy and marshes were taken from Anderson-Teixeira and DeLucia (2010). The substrate at the bottom of the open water body and the soils of paddy and marshes were considered as inland wetland mineral soils, 'gleysols' (IPCC, 2013) and their unit value for carbon stocks was from the Intergovernmental Panel on Climate Change (IPCC) tier 1 database (IPCC, 2013). The total carbon stock of the wetland was estimated to be the weighted average of the values between the dry (eight months) and the wet seasons (four months). The overall economic value of these carbon stocks and how it differed between states was estimated using the US Government social cost value of carbon from 2007 (Greenspan Bell and Callan 2011) at $88.50 MgC and adjusted to 2014 prices based on the GDP deflator index given by the International Monetary Fund (2015).

Carbon storage in the current state is estimated at over 1.03 million tonnes (Mg) for Moeyungyi WWS (based on weighted average between dry and wet seasons). As a result of conversion of marshes to paddy in the alternative state, carbon storage would decrease by an estimated 2% to 1.02 million Mg which results in the potential loss in stock value of $1.60 million.

Nevertheless, the estimates of carbon stocks for the current and alternative states were subject to wide nominal errors, and the broad estimate ranges do not indicate the significance of the change. Therefore, no benefit of avoided carbon loss is assumed under the current state.

Greenhouse gases emission costs

Greenhouse gases emissions (carbon dioxide, CO_2; methane, CH_4; and nitrous oxide, N_2O) for the wetland under the current and alternative irrigation regimes were assessed based on unit values from Anderson-Teixeira and DeLucia (2010), Kemenes *et al*. (2011) and Soumis *et al*. (2004). The net emission of each gas (in tonnes ha^{-1} y^{-1}) was converted to tonnes CO_2 equivalents (CO_{2eq}) ha^{-1} y^{-1}. The sum of all CO_2, CH_4 and N_2O emitted by the wetland and CH_4 from buffalo in the wetland gave a net global warming potential (over 100 years – GWP_{100}) ha^{-1} y^{-1} under each state. These values are also expressed as a total value of tonnes CO_{2eq} y^{-1} for the whole wetland. The standard convention of positive values indicating net atmospheric warming was applied. A monetary value of overall greenhouse gas fluxes was then estimated using a range of carbon values and presented here using the US Government social cost value of carbon from 2007 (Greenspan Bell and Callan 2011) at $88.50 $Mg^{-1}C$, adjusted to 2014 prices based on the GDP deflator index given by the International Monetary Fund (2015).

Net greenhouse gases emitted in the current state are estimated at 130,000 Mg CO_{2eq} annually (based on weighted average between dry and wet seasons; for these values). In the alternative

state, net emissions of greenhouse gases would increase by an estimated 0.5%. Given the wide nominal errors of the estimates of net greenhouse gases emissions for both states, it is conservatively assumed that there was no benefit of avoided greenhouse gases emissions under the current state.

Water provision

- Domestic use

Previous surveys conducted by BANCA (2014) found that 52% of the households in 8 villages around the wetland used the water directly from Moeyungyi WWS for domestic purposes. Therefore it was estimated that 6,240 households around Moeyungyi WWS rely on the water from the wetland. Household questionnaires were conducted across two villages to gather data on the quantity of water from the wetland used directly for domestic purposes (for interview questions was prepared based on the form provided TESSA). In total 22 interviews were conducted.

The annual amount of water from Moeyungyi WWS collected by an average household for domestic use was estimated at 145,513 (±24,938) litters. The mean annual value of this benefit was calculated as $1,280 (± 219) per household, based on the price of water sold in the village ($0.04 per gallon). Hence the annual net economic value of water from the wetland for domestic use was estimated to be $7.99 million. All respondents reported that water from the wetland is abundant throughout the year, and that they have never experienced any shortage of this resource. Therefore, based on our assumptions, we don't expect the alternative irrigation scheme to have a significant impact on the current water supply from the wetland and its value for domestic use.

- Irrigation

An important function of Moeyungyi WWS is to store water for the irrigation of rice paddies around the region. During the dry period each year, the wetland supports one season of rice farming in 16,520 ha of paddies. In addition, the wetland also irrigates the rice paddies within the site (800 ha). We estimated its value as the cost for irrigating these paddies if the water from the wetland were not available. Based on the price of water for irrigation from a nearby dam, we estimated the annual net benefit of irrigation as $83,400. With an expansion of rice paddies both within (1,100 ha) and outside the wetland (33,039 ha), the annual net benefit was estimated to be $164,000 under the alternative state.

- Flood mitigation

The low-lying paddies adjacent to Moeyungyi WWS are at risk of serious floods if the embankments fail during the wet season from June to September. Rice paddies have no flood storage capacity but the wetland was built with a storage capacity of 17.3 million m^3 (Irrigation Department, 2015). According to the Irrigation Department, the flood storage capacity of Moeyungyi WWS has the potential to protect 16,200 ha of rice paddies in the area. The total annual value of flood protection benefit was estimated as the annual value of the avoided damage to wet season rice paddies. No property would be directly affected by flood damage as houses are built on stilts or above flood

water level. Hence we multiplied the mean net value per ha for one season of rice cultivation by the total area protected from floods used for wet season paddy and deducted the costs of annual maintenance of the embankments ($32,000 annually according to staff from the Irrigation Department) to estimate the net annual flood protection benefit as $458,000. The alternative state of the wetland would provide the same flood protection benefit.

Harvested wild goods

- Fishing

At the preliminary scoping workshop, the village representatives identified fish as the most important wild product harvested from the wetland at community level. Thirty-three household questionnaires (the interview questions were prepared based on TESSA) were conducted across two villages to gather data on the quantity and net value of harvest from fishing activities. The participating households with income derived mainly from fishing activities within the wetland were randomly chosen by the village chiefs. The mean net value per household for fishing was calculated, and then applied to the estimated total number of households that harvest fish from the wetland. The opportunity cost of family labour was valued at 'market rate' since there was a high seasonal demand for labour.

The mean net value of fish per household was estimated as $3,360 (± 300). The mean net value of fish per household was not significantly different between the two villages. Based on Park Warden Office data, there were 4577 households around Moeyungyi WWS harvesting fish at the wetland. Hence the annual net economic benefit from fish harvesting was estimated as $15.4 million. The annual net benefit of fish harvesting under the alternative state is assumed to remain the same as the drop in water level is unlikely to be significant enough to change the fish population.

- Lotus harvesting

Each day over a period of nine months a year, a total of 20 people are allowed to harvest lotus stalks in Moeyungyi WWS; this takes place from July to March. Data on the annual net value of harvest was gathered from staff of Moeyungyi WWS Park Warden Office. We estimated that 4.86 million lotus stalks were harvested annually from the wetland. As the harvesting method is simple and the stalks are processed locally, the costs of harvesting and transport were valued at zero. The annual net benefit of lotus harvesting was estimated as $19,400 for both current and alternative states.

- Molluscs

Based on the data from Park Warden Office, a total of 34,200 ducks are allowed to feed on the molluscs in Moeyungyi WWS throughout the year. We estimated its value as the annual cost of the molluscs consumed by these ducks. Based on information of the total amount of molluscs (expressed in terms of bags) required by 1,000 ducks per day and the cost per bag from the same source, the annual net benefit of duck feeding on the wetland was estimated as $74,900. There is

no difference in the annual net benefit provided by the molluscs in the wetland for the alternative state.

- Buffalo grazing

Buffalo grazing is carried out in Moeyungyi WWS for eight months from October to May. Based on data from the Park Warden Office, a total of 5,375 buffalo grazed on the wetland annually. We estimated its value as the annual cost of the grass consumed by these buffalo. Based on information from Moeyungyi staff, the amount of grass (expressed in terms of bundles) a buffalo consumes daily and the cost per bundle, the annual net benefit of grazing on the wetland was estimated as $774,000. The same annual net benefit of buffalo grazing was also associated with the alternative state as the number of grazing buffalo allowed to graze into the wetland would be maintained.

Duck rearing on the lake

Buffalo inside the wetland

Nature-based recreation

The opportunity to view wetland birds, to walk on the board walk in the marshes and to take a boat ride into the open lake attracts domestic visitors and international tourists to Moeyungyi WWS. The annual value of nature-based recreation was estimated from the direct expenditure by visitors to the site and the 2012-2013 records of visitor numbers from the Park Warden Office. We carried out a field survey at the entrance of the sanctuary on four days (5 – 8 February 2015) during dry season. We used a questionnaire survey to obtain information on distance travelled, mode of transport, accommodation, and expenditure in the shop and restaurant (interview questions were prepared based on the form provided in TESSA).

We interviewed 47 individuals and counted a total of 274 visitors. Most of the visitors (97%) were domestic day-trippers from within the region and international tourists represented 3% only. Based on the data from the Moeyungyi WWS Park Warden Office, a total of 7,334 people visited Moeyungyi WWS in 2012-2013 (7,031 domestic visitors; 303 international tourists).

From the total reported expenditure on travel, food and drinks, the annual recreation revenue from the national visitors was estimated to be $19,300. The annual recreation revenue from the international tourists was estimated as $54,200. The overall annual recreation revenue was

estimated at $74,000 with the majority of the annual revenue (74%) from the international tourists. Note that this is likely to be a conservative estimate of the actual tourism value of the wetland as we did not include a willingness-to-pay survey in this assessment which would identify the additional value (beyond actual amount of money spent) that people attribute to the site for the benefit of nature-based recreation. It was assumed that all respondents would visit the area if it was under the alternative state – as the area affected by the paddy encroachment was relatively small and remote.

Rice cultivation

At the preliminary scoping workshop, rice was identified to be the only cultivated product in the area. Twelve household questionnaires (for the interview questions, we used the TESSA form) were conducted across two villages to gather data on the quantity and net value of harvest for the paddy adjacent to the wetland. The respondents from these farming households were randomly selected by the village chiefs. The mean net value for rice was calculated and applied to the total harvested area in the current state and the expected harvested area in the alternative state. Costs for water, equipment and processing were subtracted from the total and the opportunity cost of family labour was valued at 'market rate' since there was a high seasonal demand for labour.

Based on a previous survey conducted by BANCA (BANCA, 2014), it was estimated that 27% (weighted mean of eight villages) of the households farm paddies. The mean net value of rice cultivation adjacent to the wetland was estimated as $548 (± 114) per ha. The areas within the wetland encroached by rice paddies during dry season under the current and alternative states were estimated as 800 ha and 1,100 ha, respectively. The annual net economic benefit from rice cultivation within the wetland under the current management regime was estimated as $438,000 whilst the annual net benefit of farming rice within the wetland under the alternative management regime was $603,000.

Management costs

Information on annual management costs of Moeyungyi WWS which included salaries for 12 full-time and three part-time staff, and operational costs was obtained from Moeyungyi WWS Park Warden Office. This on-going management cost of the wetland was estimated to be a total of $22,300 y^{-1}.

6.4 Limitations

Given that rapid nature of this study, there are several limitations of the study.

- ✓ Firstly, it should be noted that the overall valuation will be conservative. We have included only a limited range of services that could be easily measured. Therefore we had to omit benefits such as those relating to health, or cultural services (exception of recreation) that are likely to be provided by Moeyungyi WWS simply because we could not measure them.
- ✓ One of the most significant omissions is the valuation of water quality. Local rice farmers apply fertilisers and pesticides and the input of agrochemicals to the surface water is likely to be impacting on the overall water quality of the wetland, though we were unable to explore this

because the wetland has numerous tributaries upstream which makes water quality studies complex to undertake when there are time and budget limitations.

- ✓ We were also unable to make an assessment of the sustainability of the current rate of harvesting of wild goods from the wetland. Although data from BANCA's assessment in 2014 suggests that overall biodiversity is relatively stable, this has not been directly assessed in terms of the quantity and quality of harvested goods over time. Additionally, illegal harvesting methods – such as electric shock fishing – are reported to be having devastating effects on certain populations (BANCA, 2014).
- ✓ The valuation of nature-based recreation is a conservative estimate as we looked only at the actual spend of visitors (revealed preference) and did not include a willingness to pay survey (which would provide information on additional value not currently captured). It is also possible that the value of nature-based recreation will increase over time due to the increasing number of tourists visiting Myanmar. However, with the increased benefits may also come some costs as uncontrolled tourism can have negative impacts on habitats and species. Our study did not assess this aspect of change over time.
- ✓ Finally, the results have varying levels of uncertainty related to the accuracy and precision of the data. More surveys would improve this estimate.

6.5 Conclusion

The overall net benefit generated from annual ecosystem service flows at Moeyungyi WWS, minus management costs, is estimated at $22,100,000. The carbon stock is estimated at $91,600,000. The overall net benefit generated from annual ecosystem service flows (water for irrigation and rice production) associated with an increase in water use for irrigation, minus the management costs, was $245,000 (see table 2 on p.32). According to our estimates, and the limited scope of this study, the alternative irrigation regime would not reduce benefits to local people or global beneficiaries.

However, this initial result should be considered with caution due to a number of impacts that could occur outside of the wetland and the limitation mentioned in Section 6.4. The recharge of the water in Moeyungyi depends on the constant in-flow of water from natural creeks and upstream dams. Land use change upstream, such as logging, could cause siltation in the tributaries upstream; which in turn would reduce the in-flow rate. If more water is being extracted for irrigation downstream, it will be challenging to maintain the water level. Similarly, land clearing upstream also causes serious soil erosion that could block the major in-flow canal, as happened in 2013. If this were to occur again under the alternative irrigation regime, the water could drop to an unprecedented low level which may be harmful to the flora and fauna. There would also be a significant increase in carbon emissions resulting from the expansion of rice cultivation downstream in Bago township. Since we were just looking at the economic valuation of the WWS this impact was not included as part of the study, but is an important consideration from a landscape perspective. Therefore, the broader implications of the potential to increase withdrawal of water from Moeyungyi WWS associated with agro-irrigation need to be assessed in relation to land use management in the wider landscape.

This is the first study to estimate some of the economic values provided by the Moeyungyi wetland and perhaps the first such assessment of a wetland in Myanmar. It demonstrates the vital

importance of conserving this wetland for the 12,000 households that derive direct benefits from it (food, fibre, irrigation water, free grazing land), the users downstream to whom water is released in the dry season for rice paddy cultivation, and the global community in terms of its role in contributing to global climate regulation and the tourism and recreation values associated with viewing the unique biodiversity.

This approach was chosen for its relatively simple methods, which enable rapid collection of locally-relevant, site-scale data – relevant to decisions being made regarding the management of the wetland (such as by the Irrigation Department of the Ministry of Agriculture and Irrigation and the MOECAF). The results should be viewed as a rapid, preliminary assessment only. The overall objective was to highlight the benefits that the Moeyungyi WWS provides to people for the purposes of raising awareness about the importance of the wetland. It also demonstrates that there are important values that need to be incorporated into any future decision-making about the wetland and wider landscape development activities that may impact upon it.

GLOSSARY

Biodiversity (a contraction of 'biological diversity') – The variability among living organisms, including those that inhabit terrestrial, marine and other aquatic ecosystems, and the ecological interactions of which they are a part. Biodiversity includes diversity within species, between species, and between ecosystems.

Biomass – The mass of tissues in living organisms in a population, ecosystem, or spatial unit.

Carbon – A non-metallic element existing in different forms and occurring in carbon dioxide, coal, oil, and all organic compounds.

Carbon sequestration – The process of increasing the carbon content of a reservoir other than the atmosphere.

Cultural (ecosystem) services – The non-material benefits people obtain from ecosystems, for example through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience, including e.g. knowledge systems, social relations, and aesthetic values.

Economic valuation – Economic value is measured by the most someone is willing to give up in other goods and services in order to obtain a good, service, or state of the world.

Ecosystem – A dynamic complex of living communities and their non-living environmental components, interacting as a functional unit.

Ecosystem service – 'the aspects of ecosystems utilized (actively and passively) to produce human well-being' (Fisher et al. 2009). These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services (such as nutrient cycling) that maintain the conditions for life on Earth. The concept of 'ecosystem goods and services' is synonymous with ecosystem services.

Gross value – The total value without deductions; such as the amount of sales, salary, profit, etc. before taking deductions for expenses, taxes, or other costs (as distinct from net value).

Important Bird and Biodiversity area (IBA) – IBAs are identified using internationally agreed criteria applied locally by BirdLife Partners and other experts for globally and regionally threatened species, species with highly restricted ranges, bird communities restricted to biomes and internationally important congregations of birds.

Net value –Refers to the amount left after all deductions are made. For example, the net value of wheat would be the price obtained from sale minus the costs for production, marketing, transport and labour plus any other subtractions (such as subsidies).

Stakeholder – A person, group or organisation that has a stake (interest), investment or share in something (e.g. local community, site managers, NGOs, government, farmers, traders etc.). In this context this would be in relation to the decisions and activities surrounding a particular site.

Sustainable – (in relation to the environment) Capable of being maintained at a steady level without exhausting natural resources so that an ecosystem may yield continuous benefits to present populations and future generations without causing ecological damage. Thus, sustainability is a characteristic or state whereby the needs of the present and local population can be met without compromising the ability of future generations or populations in other locations to meet their needs.

Valuation – The process of expressing a value for a particular service in a certain context (e.g. of decision-making) usually in terms of something that can be counted, often money, but also through methods and measures from other disciplines (e.g. sociology, ecology). See also Value.

Value – The contribution of an action or object to user specific goals, objectives, or conditions. See also Valuation.

-The definitions are quoted from TESSA (Peh et al. 2014)

REFERENCES

Anderson-Teixeira K.J. and De Lucia E.H. 2010. The greenhouse gas value of ecosystems. Global Change Biology, 17, 425-438.

Bagstad, K.J., D. Semmens, S. Waage, and R. Winthrop. (2013) A comparative assessment of tools for ecosystem services quantification and valuation. Ecosystem Services e5: 27-39

Balmford, A., Rodrigues, A.S.L., Walpole, M., ten Brink, P., Kettunen, M., Braat, L., de Groot, R., 2008. The Economics of Biodiversity and Ecosystems: Scoping the Science. Cambridge, UK: European Commission.

BANCA. 2014. Biodiversity and Socio-Economic Assessment on Moeyungyi Wetland Wildlife Sanctuary.

BirdLife International. 2005. Important Bird Areas and potential Ramsar Sites in Asia. Cambridge, UK: BirdLife International.

BirdLife International. 2015. Important Bird & Biodiversity Area monitoring data: Moyingyi (Myanmar). Downloaded from WBDB (internal BirdLife database) on 11/03/2015 (see also public IBA factsheet at http://www.birdlife.org/datazone/site/search).

Davidoson, N. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. Marine and Freshwater Research, 65(10), 934-942

Finlayson, C. M., Davidson, N. C., Spiers, A. G. and Stevenson, N. J. 1999. Global wetland inventory – current status and future priorities Marine and Freshwater Research 50(8) 717 – 727

Fisher, B., Costanza, R., Turner, R.K. and Morling, P. 2009. Defining and classifying ecosystem services for decision making. Ecological Economics 68 643-653

Greenspan Bell R. and Callan D. 2011. More than meets the eye: the social cost of carbon in U.S. climate policy, in plain English. Policy brief. World Resources Institute, Washington, DC.

International Federation of Red Cross and Red Crescent Societies. “Case study: Mangrove plantation in Viet Nam: measuring impact and cost benefit” Available at http://www.ifrc.org/Global/Publications/disasters/reducing_risks/Case-study-Vietnam.pdf (accessed 2 November 2015)

International Monetary Fund, World Economic Outlook Database 2015. Available at http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/index.aspx (accessed 5 March 2015).

Intergovernmental Panel on Climate Change. 2013. Adoption and Acceptance of the “2013 Supplement to the 20006 Guidelines” – Accepted report. Task Force on National Greenhouse Gas Inventories of the IPCC, WMO and UNEP.

Irrigation Department. 2015. Mo Yin Gyi Lake. Ministry of Agriculture and Irrigation, Bago region, Bago.

Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: wetlands and water. Available at http://www.millenniumassessment.org/documents/document.358.aspx.pdf [Accessed 24 March 2016]

Mitsch, W.J., & Gosselink, J.G. 2000. The value of wetlands: importance of scale and landscape setting Ecological Economics 35 (1) p 25-33.

Peh, K. S.-H., Balmford, A. P., Bradbury, R. B., Brown, C., Butchart, S. H. M., Hughes, F. M. R., Stattersfield, A. J., Thomas, D. H. L., Walpole, M. and Birch, J. C. 2014. Toolkit for Ecosystem Service Site-based Assessments (TESSA). Version 1.2 Available at: http://www.birdlife.org/datazone/info/estoolkit.

Peh K.S.-H., Balmford A.P., Bradbury R.B., Brown C., Butchart S.H.M., Hughes F.M.R. et al. 2014. TESSA: a toolkit for rapid assessment of ecosystem services at sites of biodiversity importance. Ecosystem Services, 5, 51-57.

Pratruangkrai P. 2015. Investors eye Myanmar's rich potential for rice growing. The Nation. Porritt, J., 2007. Capitalism as if the World Matters. Earthscan.

Russi D., ten Brink P., Farmer A., Badura, T., Coates D., Förster J., Kumar R. and Davidson N. 2013. The Economics of Ecosystems and Biodiversity for Water and Wetlands. IEEP, London and Brussels; Ramsar Secretariat, Gland.

Samonte-Tan G. 2007. Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines, Coastal Management, 35: p319–338

Schuyt, K., And Brander, L. 2004. The Economic Values of the World's Wetlands. Gland/Amsterdam, WWF. Available at http://www.unwater.org/downloads/wetlandsbrochurefinal.pdf [Accessed 15 March 2016]

Soumis N. , Duchemin É., Canuel R. and Lucotte M. 2004. Greenhouse gas emissions from reservoirs of the western United States. Global Biochemical Cycles, 18, GB3022.

TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Turner, R. K., Georgiou, S. and Fisher, B. 2008. Valuing ecosystem services: the case of multi-functional wetlands. Earthscan. London.

UNWWAP (United Nations World Water Assessment Programme). 2003. Water for People, Water for Life. Available at: http://unesdoc.unesco.org/images/0012/001297/129726e.pdf [Accessed on 05 March 2015]

APPENDICES

Appendix 1. Example questionnaire form for harvesting wild goods

*Please use these questions for guidance only. Depending on the site, you may need to change the specifics. The symbol ⭘ indicates items necessary to be filled out with full, clear answers.

Name/number of respondent			
Date			
Location/name of village			
Are the questions being answered per individual, household or business?			
Name of product (*if more than 3 products, use additional forms)*			
Quantity and value of product			
a. Total quantity collected from the site in last 12 months* ⭘			
b. Local Unit ⭘			
c. Conversion to metric unit (local units per kg) ⭘			
d. Percentage for own use			
e. Percentage sold/ bartered			
f. Average price obtained per unit** ⭘			
Family labour			
g. Annual time taken by respondent and family members (unpaid) to harvest and process the product (person days)* ⭘			
Hired labour			
h. Annual input of hired labour for harvesting and processing (person days)* ⭘			
i. Typical daily wage rate paid for hired labour			
Equipment costs* **			
j. What capital items (tools, materials, equipment) do you need for harvesting and processing this product? ⭘			
k. How long do you expect each of these tools etc. to last? ⭘			
l. How much did each item cost to buy? ⭘			
Transport and marketing costs			
m. What are the annual costs of transporting and marketing this product?* ⭘			

* If respondents find it difficult to recall accurately the harvest for the past 12 months, then break these questions down. For example, ask for the harvest on a monthly basis (and then add these figures up yourself, to get an annual total). Do the same for each of these questions (price, inputs of labour, costs of equipment and other inputs, etc.).
****** If the individual respondent does not sell the product they gather, but others do, then apply the mean price recorded from other respondents.
*** If any tools or equipment have a lifetime of more than one year, divide the initial purchase cost by their expected lifetime and add typical repair/maintenance costs. If tools are not specifically used/purchased for this product but are for general use, apply a sensible percentage of their cost/maintenance.

Feed for respondent's own livestock

If wild harvested feed for harvesters' own livestock was identified as one of the most important harvested wild goods then ask each respondent the following questions.

The value of the service that the land provides to livestock is determined from the value of the feed it provides for them. Here we are focus only on wild harvested feed (not cultivated feed).			
In the last 12 months, did you feed any livestock with wild harvested feed obtained from the site? ⭘			
If yes, what and how many animals do you own (sheep, goats, cows, chickens, etc.)? ⭘			
For each animal type, approximately **what percentage** of their feed did you obtain from wild harvest at the site? ⭘			
What is the **estimated value** of that feed? (i.e. how much would it cost you to replace that feed if you had to buy it from someone else, or if you had to replace it with another kind of animal feed?) ⭘			

Appendix 2. Example questionnaire form for cultivated goods

*Please use these questions for guidance only. Depending on the site, you may need to change the specifics. The symbol ⭘ indicates items necessary to be filled out with full, clear answers.

General information				
Name/number of respondent				
If appropriate include one or more questions which allow you to differentiate respondents according to the key factors affecting receipt of benefits. You may want to ask this at the end of the questionnaire, once they feel more comfortable about the content of the questionnaire. *E.g.* Household size / Education / Ethnicity / Age / Marital status / Wealth status				
Date				
Location/name of village				
Are the questions being answered per individual, or household, or business?				

Crops					
It is important here that you only focus on **up to five** cultivated goods identified as most important in the stakeholder workshop. If any livestock are among the top five cultivated goods then complete section 3.					
What is your **<u>total</u>** size of the land you farm in the area (use local units of area if appropriate):					
Which of the top five cultivated goods do you grow? ⭘ Please answer the column of questions for each one in turn, giving answers for the past year and all the land you farm in the area.*					
Unit of measurement for that crop ⭘					
Last year, how much of that crop did you produce? ⭘					
Last year, what was the average price obtained per unit**?⭘					
Percentage for own use					
Percentage sold/ bartered					

Did you, or family members, spend (unpaid) time cultivating / harvesting / processing this crop? (Yes/No)					
If yes, how many person-days did you or your family spend cultivating /harvesting / processing this crop last year*?⭘					
Did you hire people to cultivate / harvest / process this crop? (Yes/No)					
If yes, how many person-days did hired people spend cultivating / harvesting / processing this crop last year*? ⭘					
What is the average daily wage rate you paid these hired people (outside of any reciprocal arrangements)?					
What is the cost of other inputs for this crop (seed, fertiliser, pesticide, water, fuel for machinery)*? ⭘					
What capital items (tools, materials or equipment) do you need for cultivating/ harvesting/ processing this crop? (e.g. tools, machinery)? ⭘					
How long do you expect each of these tools / machines to last (years)***? ⭘					
How much did each tool / machine cost to buy? ⭘					
Last year, what was spent on transporting and marketing this crop*?⭘					
If the crop is a perennial crop (e.g. fruit trees, vines, nut bushes, perennial herbs) ask the following:					
How much did it cost to establish the crop (e.g. plants, stakes, labour)? ⭘					
For how many years will the crop remain productive? ⭘					

Livestock****			
It is important to find out the value of livestock as a contribution to cultivated goods. The value of the service that the land provides to livestock is determined from the value of all the feed it provides them.			
Do you have any livestock?			
If yes, what? ⭘			
How many of each type did you have on average last year*? ⭘			
What percentage of the total food that these animals needed last year* came from the area*****? Think about all the food they ate (including pasture, fodder crops, hay, food waste, etc.)⭘			
What is the value of that feed? (i.e. how much would it cost you to replace that feed with purchased alternatives?) ⭘			

* If respondents find it difficult to recall cultivation details accurately for the past 12 months or for all the land they farm in the area, then break these questions down. For example, ask about the harvest on a monthly basis, and ask how many months the harvest lasts (and then add these figures up yourself, to get an annual total). If necessary you could do the same for each field the cultivator uses, and then add the answers up to get a total for their entire farm.

****** If the individual respondent does not sell what they cultivate but others do, then apply the mean price recorded from other respondents.

*** If any tools or equipment have a lifetime of more than one year, divide the initial purchase cost by their expected lifetime and add typical repair/maintenance costs. If tools are not specifically used/purchased for producing this particular good but are for general use, apply a sensible percentage to their purchase and maintenance cost.

**** Only complete this section for livestock whose feed is identified as among the top 5 most important cultivated goods. Complete a separate column for each form of livestock which is among these top 5.

********* Here you are asking the respondent about <u>all</u> the animal feed they obtain from the current area or the alternative state that you are studying, i.e. not just from their farm. This may include cultivated feed crops, crop residues, pasture, browse cut from hedgerows and field margins.

Appendix 3. Example questionnaire form for water use

*Please use these questions for guidance only. Depending on the site, you may need to change the specifics.

<table>
<tr><td colspan="14">1. Personal information</td></tr>
<tr><td>Occupation:</td><td colspan="13">Age:</td></tr>
<tr><td>Gender:</td><td colspan="13">Number of people in household:
adults ____ children_____</td></tr>
<tr><td colspan="14">2. Source, use and importance of freshwater</td></tr>
<tr><td>2.1) Where does your water come from?

Note: Answer will tell us if water used by the Household (HH) comes from site of interest</td><td colspan="13">[Respondent to list all the sources. Interviewer to assign to the categories below]

From springs, well, borehole
From a piped supply or tap
From rainwater
From river, stream, dam, lake, pond
Other (please specify)</td></tr>
<tr><td>Determine here, using the information supplied in 2.1, whether the source of water used at the HH is from the site</td><td colspan="13">☐ water is supplied by the site
☐ water is not supplied by the site*
☐ don’t know
*Do not continue with the questionnaire if this is the case</td></tr>
<tr><td rowspan="8">2.2) Which of the above sources do you use for each of your uses?

Note: If there are several sources for each use, record the details, e.g. seasonality</td><td>Main uses (tick all that apply)</td><td colspan="6">Sources (In wet season)</td><td colspan="6">Sources (In dry season)</td></tr>
<tr><td>Irrigation of crops</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>Water for livestock</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>Drinking (domestic use)</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>Cooking & washing (domestic use)</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>Sanitation (domestic use)</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>Other uses (please specify) .....</td><td colspan="6"></td><td colspan="6"></td></tr>
<tr><td>2.3) For each of the water sources mentioned above, how does the provision of water meet your demand on a month by month basis?
Use the following keys:
+ more water than is needed
– not enough water
O about right</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

2.4) If your usual source of water runs dry or becomes unavailable, what are the alternative sources of supply? (State 'none' if this is the case) Note: Refer to question 2.2 for regular sources of supply in wet and dry season	***Main uses (tick all that apply)***	***Alternative sources (In wet season)***	***Alternative sources (In dry season)***
	Irrigation of crops		
	Water for livestock		
	Drinking (domestic use)		
	Cooking & washing (domestic use)		
	Sanitation (domestic use)		
	Other uses (please specify)		
2.5) What is your most important water supply source and what is it used for? Note: Main reason is crucial. E.g. a source can be important because there is no alternative supply	*[Refer to list above and ask respondent to name one and its main reason]*		
3. Freshwater quantity and seasonal use			
3.1) Do you know how much water you use per month/day for each of the uses mentioned above?	YES / NO *If no go to 3.2* *If yes go to 3.4*		
3.2) How many buckets or containers do you use per day (wet season)? What size are these?			
3.3) If you have no water supply in your home, how much time do you spend collecting water each time you draw some off/visit the source?			
3.4) How much water do you use (litres or other stated unit) for each of the uses listed above?	Total quantity *(ask first)* Breakdown for each use *(if known - %, proportion, fraction…..)*		

3.5) Does your household use less water in dry seasons? If yes, how much less?	o Yes, we use.... *[enter an actual amount or proportion or percentage]* o No
4. Payment for water	
4.1) Do you pay for your water?	YES / NO *If no, go to section 5.*
4.2) How much do you pay? Note: You can potentially use this in two ways - to put an economic value on water use, to work out what quantity of water is used.	For drinking water supply (per month/per unit) ..... For HEP energy (per month) ..... For other use (please specify) .....
4.3) Do you pay a fixed price per unit used, or per year, or other? What is the price?	*[If unknown by HH, ask water company – if there is one supplying this HH)*
5. Land use change and resulting impacts on water-related ecosystem services	
5.1) Have you ever had problems of too little water since living in this area? In your opinion, what was the cause? What was the impact of this?	*[describe when – year, month, duration – cause and effect]*
5.2) Have you ever had problems of too much water since living in this area? In your opinion, what was the cause? What was the impact of this?	*[describe when – year, month, duration – cause and effect]*
5.3) If the amount of water in the rivers supplied by *the site of interest* was to increase, how would this affect you? Indicate whether there are any increased expenditures or increased time spent; and if possible, quantify how much.	

5.4) Have you ever had problems with the water quality of your drinking water supply since living here? In your opinion, what was the cause? What was the impact of this? Indicate whether there are any increased expenditures or increased time spent; and if possible, quantify how much.	Odour / Taste / Illness *Others (please specify).....* *[describe when – year, month, duration – cause and effect]*
5.5) Have you noticed any change in the colour or amount of sediment in the water during the time you have lived here? In your opinion, what was the cause? What was the impact of this? Indicate whether there are any increased expenditures or increased time spent; and if possible, quantify how much.	*[Increased, no change or decreased]* *[describe when – year, month, duration – cause and effect]*
5.6) If the amount of sediment in the rivers supplied *by <u>the site of interest</u>* was to increase, how would this affect you?	
5.7) Have you noticed any change in the water availability in the time you have lived here? In your opinion, what was the cause? What was the impact of this? Indicate whether there are any increased expenditures, or increased time spent, and if possible, quantify how much.	

Appendix 4. Example questionnaire form for nature-based recreation

*Please use these questions for guidance only. Depending on the site, you may need to change the specifics. The symbol ✪ indicates items necessary to be filled out with full, clear answers.

Site name					
Respondent number					
Date					
Location interviewed (e.g. entrance gate)					
If appropriate include one or more questions which allow you to differentiate respondents according to the key factors affecting receipt of benefits. You may want to ask this at the end of the questionnaire once they feel more comfortable about the content of the questionnaire. *E.g.*Income / Education / Ethnicity / Age / Marital status					
What kind of visitor?	International tourist			National visitor	
Sex	Male			Female	
Age	<18	18-29	30-49	50-69	70+
How far away do you live? [Either a place or a distance in miles or km]					
	Foreign country (please indicate which country)				
International tourists only					
a. How many days will you spend away from home whilst on this trip? ✪					
b. How many people are you travelling with in your group? ✪					
c. In total, how much money do you expect to spend on the whole of your trip - locally (within 10 km of the site), elsewhere in the country, and in other countries? Include your travel costs of getting here. ✪	(per person or per group – state which) Local spend National spend International				

d. How many days will you spend at this site during your trip? ⭘		
e. Please rank the activities listed in order of importance as your reason for visiting this site ⭘ (1 = highest importance)	Viewing/appreciating forest, nature or wildlife _____ Cultural, spiritual (visiting religious or spiritual sites, museums, etc.) ____ Exercise or sport ____ Time with family or friends _____ Other (please specify) _____ (e.g. picnic, education…)	
f. Imagine if the site was arable farmland with no remaining trees other than the small hedges separating fields. Would you still come here for these activities?		
National visitors only		
g. How many times have you visited this site in the last year? ⭘ _____		
h. How many people are you travelling with in your group? ⭘		
i. In total, how much money do you expect to spend on the whole of your trip – locally (within 10 km of the site), and elsewhere in the country? Include things like entrance fees, food, accommodation, transport and fuel. ⭘	(per person or per group – state which) Local spend National spend	
j. Please rank the activities listed in order of importance as your reason for visiting this site ⭘ (1 = highest importance)	Viewing/appreciating forest, nature or wildlife _____ Cultural, spiritual (visiting religious or spiritual sites, museums, etc.) ____ Exercise or sport ____ Time with family or friends _____ Other (please specify) _____ (e.g. picnic, education…)	
k. Imagine if the site was arable farmland with no remaining trees other than the small hedges separating fields. Would you still come here for these activities?	Yes	No
Reliability of respondent/other notes		

Ministry of the Environment, Japan 2016