Valuing The Potential Economic Value of Mangroves Resources in Setiu Wetlands, Terengganu, Malaysia: A Preliminary Findings

By

Mohd Azmi, M.I.[1]

Abstract

The Setiu Wetlands (SW) is one of the unique wetlands area in Malaysia which offers pristine beaches and rivers, mangrove forest area, and undisturbed nature parks. Apart from its diverse flora and fauna, mangrove forest in SW serves many ecological functions and benefits such as coastline protection, nursery ground for marine species as well as providing source of income to local communities with the availability of its non-timber forest products (NTFPs). To show how important of these benefits from the existence of SW, the full potential of its biodiversity composition need to be quantified. Environmental economists have suggested many methods for the valuation of resources and environmental services which basically stemmed from the concept of achieving the total economic value (TEV). In the context of economic valuation, the types of economic value to be estimated should be identified clearly according to its tangible or intangible benefits. This study focused on valuing the tangible benefits derived from the availability of mangrove resources (i.e. NTFPs) in the study site. By using market price-based valuation technique, the estimated total net benefits of mangrove resources in SW is estimated at RM 2,157.71 per hectare or RM 901,922.78 for the whole mangrove areas of SW.

Key Words: Setiu Wetlands, economic value, market price-based approach

[1] *Lecturer, Department of Foundation and Liberal Education, Centre for Foundation and Liberal Education, University of Malaysia, Terengganu*

Introduction

Wetlands are generally known to have highly productive ecosystems which provide many important benefits especially on the ecological function (e.g. flood protection, nutrient retention) besides providing a wide range of natural resources (Vithayaveroj, 2003).

In Malaysia, wetlands cover about 10% of her topographical area. One of the beautiful wetlands areas in Terengganu is the Setiu Wetlands (SW). SW is situated in the northeast of Terengganu and begins in Kampung Penarik where Sungai Setiu flows northward, parallel to the beach and reaches river mouth at Kuala Setiu Baharu. A lagoon exists north of this river mouth where many activities are centered in Gong Batu and stretches northward along the coastline to Kampung Beting Lintang. The scenic panorama of the wetlands begins from Mangkuk area and ends at Gong Batu or at

Kampung Beting Lintang. The mangrove forest can be seen on the left and while coconut trees and casuarinas on the right (Nakisah, 2003).

It is a unique wetlands area with nine inter-connected ecosystems; sea, beach, mudflat, lagoon, estuary, river, islands, coastal forest and mangrove forest and endowed with various diversity of flora and fauna (Nakisah and Fauziah, 2003). The wetlands ecosystem in SW covering a wetland basin of 23,000 hectares of land and 880 hectares of water body (Jamilah, 2013).

The fauna of Setiu Wetlands

The wetlands of Setiu endowed with many animal species which are associated with freshwater and marine ecosystem. Mangrove forests and seagrasses provide natural nursery grounds for the fish larvae and home for other animal species. Among the animal species that common to SW are oysters, red silt crab, annelid polychaete, mollusks, giant fresh water prawn, mudskipper, painted terrapin and two species of fish (i.e. *Sillago sp.* and *Moolgardo sp*.)(Anuar, 2003). Table 1 shows the division of common animal species that can be found in SW by invertebrate and vertebrate group.

Table 1. Common animal species found in SW

Invertebrate group	Vertebrate group
Oysters (*Isognomon sp.*)	Mudskipper (*Periopthalmus sp.*)
Red Silt Crab (*Paracleistostoma depressum)*	Painted terrapin (*Callagur borneonensis*)
Mollusk (*Clithon ovalanensis, Lacuna sp., Geloina sp., Subulina sp., Littorina sp*.)	Fish (*Sillago sp., Moolgardo sp*.)
Giant fresh water prawn (*Macrobrachium rosenbergii*)	

Source: Adapted from Anuar (2003)

The flora of Setiu Wetlands

Mangrove forest, with an area of 418 hectares, is dominated the Setiu lagoon. They can be seen mainly in the estuary of Sungai Setiu and on the riverbank of Sungai Chalok. Other forests fringing the Setiu mangrove are beach forest and seasonal freshwater swamp (Sulong and Siti Aishah, 2003). The mangrove ecosystems are known to provide both direct and indirect economic and social benefits to mankind.

Direct uses of mangrove ecosystems include commercial and subsistence extraction of timber and other forest products as well as harvesting of fishery products. Indirect benefits include serving as feeding and nursery grounds for coastal wildlife and fisheries, protection of coastal areas from storm surges, safeguarding against coastal erosion, stabilizing shorelines, flood mitigation, filtration

of nutrients, provides genetic resources and protection of the hinterland from saline intrusion (Saenger et al. 1983; Chan, 1995; Giri et al. 2011).

The SW has eight forest types or associations of mangroves. They are *Avicennia-Ceriops, Bruguiera, Bruguiera-Lumnitzera, Rhizophora, Melaleuca, Nypa, Nypa-Eugenia and mixed mangrove*. The classification is based on the existence of the dominant species of mangrove in one particular area of forest. Mixed mangrove has the largest distribution of 154 hectares of the total area while *Rhizophora* type occupies the smallest area, covering 11 hectares of mangrove areas (Sulong and Siti Aishah, 2003).

There are 63 mangrove species have been identified in the mangrove of Setiu lagoon. From the total species, 23 species are `exclusive mangroves', while another 38 species are `non-exclusive mangroves' and two associate species (see Lim, 2002). The dominant mangrove species found at Setiu lagoon are *Avicennia alba, Avicennia lanata, Ceriops decandra, Bruguiera sexangula, Bruguiera gymnorrhiza, Bruguiera cylindrical, Lumnitzera rasemosa, Rhizophora apiculata, Nypa frutricans, Excocaria agalloca* and *Heriteria littoralis* (Sulong and Siti Aishah, 2003).

Socio-economics activities in Setiu Wetlands

Most of local communities living adjacent to SW are said to rely upon the resources available in the area, especially from the mangrove forests, as their source of supplementary income. The SW mangrove forests can be found in 20 of 24 villages situated in SW (Sulong and Siti Aishah, 2003).

With the availability of wetlands soils and various flora and fauna, the socio-economics activities carried out in SW are wide-ranging. These activities include agriculture, aquaculture, timber and non-timber forest products (NTFPs) utilization, fishing and crab harvesting, small scale industries (i.e. manufacturing of Malaysian delicacy (*budu* and *belacan*), handicrafts, small scale farming, boat building) and eco-tourism. The majority of the population is involved in the fishing industry such as cage culture, pan culture, oyster culture, prawn culture, fresh water and salt water fishing although those activities are said to provide negative impacts to the quality of SW water (Nik Fuad et al. 2003; Norhayati et al. 2006; Hanum et al. 2012).

Generally, the whole ecosystem of wetlands is considered fragile, therefore any activities that could change the pristine status of the area including those that generate income to the local people should be conducted and managed properly in order to minimize damage to the ecosystem. Without supports from all the stakeholders (i.e. state government, NGOs, local communities) on the conservation and preservation measures of the wetlands, the resources could subject to extinction (Nakisah and Fauziah, 2003).

Problem statement

Despite their significant contribution to the environment and socio-economics of local communities, the fauna and flora of wetlands are always threatened by the urbanization and industrialization. According to Kamaruzaman and Dahlan (2008), most of mangrove areas in Terengganu are subjected to conversion into development and industrial area. Much of the mangrove areas around Kuala Terengganu has been converted to other land use options, leaving some remnants at Sungai Ibai, Sungai Terengganu and the lagoon wetland area at Batu Rakit.

The situation happened most probably because the authority or responsible party do not value wetland (or mangrove areas, specifically) goods and services in proper and accurate economic and monetary terms. Majority of people (including the stakeholders) are also not always aware of the values contributed by wetlands, directly or indirectly. This will lead to wrong evaluation on benefits and costs that wetlands can offer when comparing with other land-use options. Hence, the economists should provide objective evidence in terms of monetary and non-monetary benefits of wetlands to the policy maker and stakeholders in order to change their perception of waste lands on wetlands. A more comprehensive economic valuation of wetlands needs to be implemented as suggested by environmental and ecological economists to determine its actual overall value. The values determined, hopefully, could be used as a guideline for policy makers to make the best decision toward conservation and a sustainably managed of mangrove areas.

Objectives of the study

The main objective of this study is to discuss an applicable economic approach in valuing the SW resources. This study also attempted to estimate the potential economic value of mangroves resources in the study area.

The application of economic valuation

Economic valuation can be defined as the attempt to assign quantitative and monetary values to goods and services provided by environmental resources or systems, whether or not market prices are available. When market prices are not available (e.g. to value the flood control services, disaster mitigation services, erosion avoidance), the value is established by the willingness to pay for the good or service, whether any payment had been made or not (Lambert, 2003).

This method can assist economists, government, and society to predict the impact of economic decision and activities into environment and resources, and also estimate the monetary value of all economic benefits that a society derives from environmental resources (Nuva et al. 2009). Knowledge of resource economic values allows us to recognize the costs (i.e., lost resource values) associated with wetlands development and the long term benefits of wetlands protection (Leschine et al. 1997).

Generally, the evaluation process whether which project to choose (i.e. development or conservation) or policy to adopt, the advantages and disadvantages of the different choices need to be weighed up. Economists suggested various decision-making frameworks to facilitate this process. Some of the decision-making frameworks most widely used are (McNally and Mohd Shahwahid, 2002):

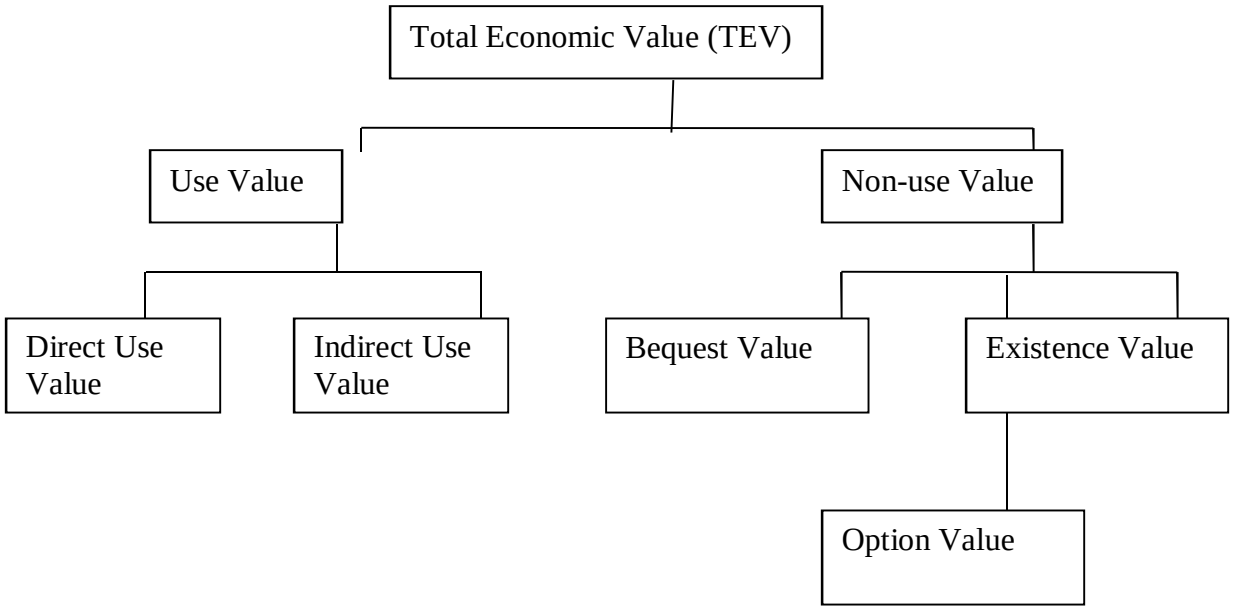
a) Cost-Benefit Analysis (CBA)
b) Cost-Effectiveness Analysis (CEA)
c) Multi-Criteria Analysis (MCA)
d) Environmental Impact Assessment (EIA)
e) Total Economic Value (TEV)

Total Economic Value (TEV) framework

The TEV is a general framework used to illustrate the overall values of a natural resource. It is an estimate of the total, rather than the incremental, value of resources to the society. This method is important in highlighting the value of the different components of resources and therefore the appropriate policies to capture them and influence attitudes and policies towards use and management of the resources (McNally and Mohd Shahwahid, 2002).

In this framework, the benefits derived from a natural resource can be divided into two main components, namely, the use value (instrumental value) and non-use value (instrinsic/passive value). The use value components are comprised of direct use value and indirect use value while the non-use value is further categorized into the bequest value, existence value and the option value. The explanation on each economic value under the TEV framework can be found in many literatures (see Barbier 1992; Pearce 1993; Munasinghe 1993, to name a few). The illustration of TEV framework is as shown by Figure 1.

Figure 1. A Taxonomy of economic values



Source: Adapted from Asafu-Adjaye (2000)

Direct use value (DUV)

The DUV refer to the productive or consumptive values of natural resource components of functions. The DUV may be marketed or non-marketed. The example of marketed DUV is timber resource which can be harvested and sold to consumers. On the other hand, the use of medicinal

plants collected from the forest resources by local communities is an example of non-marketed DUV (Mohd Azmi et al. 2002).

To estimate the DUV of certain resources, researchers should distinguish between two types of quantities, namely the inventory (the stock quantity in the forest) and the flow (the quantity actually used by the people) (Godoy et al. 1993). When the quantity multiplied by adjusted prices, they are known as potential value/stock value and realized (extracted) economic value (Awang Noor et al. 2002). This study is focused on estimating the potential value (stocking value) of mangroves resources in SW.

There are number of economic approaches that can be used to estimate the value of a natural resource. The choice of approach depends on the nature of the resources (i.e. goods and/or services) that need to be valued, the availability of data, time and budget. The five basic approaches/techniques to attaching economic values to a natural resource goods and services are (McNally and Mohd Shahwahid, 2002):

a) market price-based / market-based technique
b) surrogate market-based;
c) hypothetical market-based;
d) cost-based; and
e) benefits transfer

Market price-based valuation technique

The market price-based valuation technique should be adopted when the resource goods and services in question are/or could be transacted in formal markets. This method is commonly used to estimate the economic values of extractable resources such as timber, minerals and edible species. There are two category of methods are available under this approach namely, the residual method and the shadow prices (McNally and Mohd Shahwahid, 2002).

The residual method requires information about market prices, production costs and the profitability of the enterprise. Data on prices, elements of cost structure and appropriate profit margin can be collected from a market and/or household survey (Leschine et al. 1997; McNally and Mohd Shahwahid, 2002).

Research Methodology

Many literatures have suggested various ways in determining the economic value of a natural resource in question and they basically involve four stages of data collection, namely, resource inventory, productivity study, collection costs analysis and market survey (Mendelson, 1993).

Resource inventory is carried out to determine the distribution, density and other ecological and spatial characteristics of resources. Appropriate sample plots for the resource are required to determine and assess their growth and yield. In this study, the information of resource inventory of mangrove resources was gained from a recent study by Saidah Nusailah (2013).

The amount of output to be harvested from any resources can be estimated from the productivity study. The harvesting amount is basically depends on parts of resources (i.e. leaves, roots, stems, whole tree) used by the harvesters/consumers. From the harvesters' experiences, the amount of resources or resources' parts that can be gathered from an area of forest or in the form of per tree, per hectare or for a period of time can be estimated. With further technique and knowledge, a sustainable harvesting amount can be suggested (Mohd Azmi et al. 2002).

One of the important components in economic valuation is costing. The cost factors are needed to avoid underestimated value. When dealing with valuation of a natural resource in question, collection cost (i.e. wages, cost of equipment, transportation cost and others) needs to be estimated (Mendelson 1993; Mohd Azmi et al. 2002).

The resources with well defined markets (e.g. rattan, bamboo, medicinal plants) will provide direct market price of the products. However, the market price from the market survey should be adjusted in order to determine the farm-gate price (Mendelson 1993; Mohd Azmi et al. 2002).

The residual method: Computation procedure

In order to determine the total net benefits of mangrove resources that can be potentially harvested in SW, the equation suggested by Godoy et al. (1993) and Awang Noor et al. (2002) were used.

$$\text{SWR} = \sum_{i=1}^{n} Qi(Pi - Ci)$$

Where;

SWR = total net benefit of mangrove resources in SW
Qi = the quantity of resource extracted
Pi = the forest gate price of the resource (which may be equal to its price under competitive market conditions with no externalities)
Ci = average extraction cost of resource (including profit margin)
i = set of SW resources

Results

a) Resource inventory

Data on mangrove resources is based on study done by Saidah Nusailah (2013) on above-ground biomass estimation for *Brugueira* forest type at Pulau Rhu SW. Pulau Rhu is one of the 20 villages where mangrove forest types can be found in the SW area.

One of the steps in conducting the study was establishing the sampling plots to record the possible trees found in the mangrove area. Twenty sampling plots were established with a radius of 5.64 metres for adult/matured tree and subplot with a radius of 4 metres inside the main plot for sapling.

The interval between plots is 25 metres. The total area for main plot (matured trees) covered 100 m^2 while for the subplot (sapling trees), it covered 50 m^2. Types of species and height of the trees with diameter at breast height (DBH) ≥ 5 cm were recorded. For the saplings in the subplot, trees with height 1.5 metre at DBH less than 5 cm was recorded.

From the resource inventory, 13 mangrove families consisted of 18 mangrove tree species were recorded at the study site. List of the mangrove tree species found is as shown by Table 2.

Table 2. List of mangrove species found in Pulau Rhu, Setiu Wetlands

Category	Family	Species	Local name
Exclusive mangrove	Rhizophoraceae	*Bruguiera cylindrica*	Berus-berus
		Bruguiera gymnorrhiza	Tumu merah
		Rhizophora apiculata	Bakau minyak
		Ceriops decandra	Tengar
		Ceriops tagal	Tengar putih
	Avicenniaceae	*Avicennia alba*	Api-api putih
		Avicennia lanata	Api-api jambu
	Euphorbiaceae	*Exocaria agallocha*	Buta-buta
	Sterculiaceae	*Heritiera littoralis*	Dungun
	Sonneratiaceae	*Sonneratia alba*	Perepat
	Malvaceae	*Hibiscus tiliaceus*	Bebaru
	Meliaceae	*Xylocarpus granatum*	Nyireh bunga
Non-exclusive mangrove	Melastomataceae	*Memecyclon idule*	Delek air
	Combretaceae	*Terminalia catappa*	Ketapang
	Lecythidaceae	*Barritonia racemosa*	Putat ayam
	Celastraceae	*Salacia sp.*	Akar pelanduk
	Fabaceae	*Desmodium lambelatum*	Petai laut
	Sapindaceae	*Allophallus cobbe*	Pamaman

Source: Adapted from Saidah Nusailah (2013)

The species composition of each tree species is as shown in Table 3.

b) Economic uses of mangrove resources

Based on the resource inventory, common economic uses of each mangrove tree species can be derived and as shown by Table 4.

Table 4. Common economic uses of mangrove resources

Family	Species	Local name	Economic uses
Rhizophoraceae	*Bruguiera cylindrical*	Berus-berus	Household, foods
	Bruguiera gymnorrhiza	Tumu merah	Poles, charcoal, firewood, house ports, medicinal uses, foods, furniture
	Rhizophora apiculata	Bakau minyak	Charcoal, firewood, poles
	Ceriops decandra	Tengar	Poles
	Ceriops tagal	Tengar putih	Firewood, tannin, medicinal uses
Avicenniaceae	*Avicennia alba*	Api-api putih	Firewood
	Avicennia lanata	Api-api jambu	Tannin, medicinal uses
Euphorbiaceae	*Exocaria agallocha*	Buta-buta	Firewood, charcoal, medicinal uses
Sterculiaceae	*Heritiera littoralis*	Dungun	Firewood, charcoal, poles, medicinal uses, house and boat building, paper
Sonneratiaceae	*Sonneratia alba*	Perepat	Poles, firewood, food, house and boat building
Malvaceae	*Hibiscus tiliaceus*	Bebaru	House and boat building, medicinal uses
Meliaceae	*Xylocarpus granatum*	Nyireh bunga	Firewood, house and boat building, medicinal uses
Melastomataceae	*Memecyclon idule*	Delek air	Charcoal, house posts, medicinal uses
Combretaceae	*Terminalia catappa*	Ketapang	Food, household, ornamental
Lecythidaceae	*Barritonia racemosa*	Putat ayam	Medicinal uses
Celastraceae	*Salacia sp.*	Akar pelanduk	Food, medicinal uses
Fabaceae	*Desmodium lambelatum*	Petai laut	Charcoal, food, medicinal uses, ornamental
Sapindaceae	*Allophallus cobbe*	Pemaman	Firewood, medicinal uses

Source: Adapted from Faridah (2013)

By knowing the common economic uses, the potential (stocking) economic value of mangrove resources can be estimated using the residual method under the market price-based valuation technique.

Due to lack of information on the accurate market price and harvesting/collection/production cost of some mangrove resources, only the estimated total economic value of firewood, poles and charcoal are calculated. The computations of total economic value of selected economic products are as shown in Table 5, Table 6 and Table 7.

c) Estimated net benefits of mangrove resources in Setiu Wetlands

The estimated net benefits of mangrove resources in SW can be determined by the summation of each total economic value of selected products of mangroves tree species (Table 8).

Table 8. Estimated net benefits of SW's mangrove resources

Selected products of mangroves tree species	Total economic value (RM/ha)
Firewood	1,244.70
Poles	74.68
Charcoal	838.33
Estimated net benefits	**2,157.71**

By taking into account only three potential economic products of selected mangrove tree species of SW, it is estimated that the net benefits of SW's mangrove resources was RM 2,157.71 per hectare. To determine the estimated total net benefits of mangrove resources in SW, the estimated net benefits per hectare has been multiplied with the total mangrove area of SW (by assuming that the composition and distribution patterns of total mangrove resources in SW is similar to that in Pulau Rhu). By multiplying the above value with the SW mangrove area of 418 hectares (Sulong and Siti Aishah, 2003), the estimated total net benefits of SW's mangrove resources was at RM 901,922.78.

Conclusion

As one of the unique wetlands in Peninsular Malaysia, SW is expected to offer beautiful scenery and rich with diversity of flora and fauna associated with nine inter-connected ecosystems. The pristine ecosystems in SW, if sustainably managed will continuously provide resources and benefits (i.e. tangible and intangible) to the environment and support the livelihoods of local communities living adjacent to SW area.

Like other natural resources, wetlands or specifically, mangrove areas are always been threatened by massive development of urbanization and industrialization. The option of conserving and preserving the wetlands is rarely become a priority action since the policy makers always neglect the full benefits of wetlands because of the market failure problem.

Estimating the monetary value of wetland goods and services provides a means for understanding how investments in the protection or enhancement of wetlands resources can improve the welfare of society. Knowledge of wetlands resource values is crucial to recognize the costs (i.e., lost resource values) associated with wetlands development and the long term benefits of wetlands protection (Leschine et al. 1997).

The preliminary findings of this study in valuing the net benefits of mangrove resources showed that by using appropriate economic approach and method, as well as more comprehensive data, the accurate monetary estimation of natural resources in question can be determined.

Proper and comprehensive technique of economic valuations is a challenge in order to provide reasonable monetary estimates of market and non-market benefits of resources, especially forest areas, to the policy makers. With more reasonable value, the evaluation whether to conserve or to develop certain areas will become more justified and less bias in the future management perspective.

References

Anuar, H. 2003. Chapter 2: The fauna. In Nakisah, M.A. & Fauziah, A.H. (Eds.) *Setiu Wetlands: Tranquility amidst plenty*. Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu. Pp: 13-23.

Asafu-Adjaye, J. 2000. *Environmental Economics for Non-economists.* World Scientific Publishing Co. Pte. Ltd. 321 pp.

Awang Noor A.G., Mohd Azmi, M.I., Mohd Shahwahid, H.O., Salleh, M., Abdul Rahim, N. & Ahmad Fauzi, P. 2002. Cost incurred for the management of NTFPs and environmental services. In Abdul Rahim, N. (Ed.*), A Model Project for Cost Analysis to Achieve Sustainable Forest Management. Vol. 2 (Main Report).* Forest Research Institute Malaysia (FRIM) and International Tropical Timber Organization (ITTO). Pp: 167-248.

Barbier, E. 1992. *Valuing environmental functions: Tropical wetlands.* LEEC Discussion Paper 92-04. London Environment Economics Centre, London, UK

Chan, H.T. 1995. Sustainable management of mangrove ecosystems. *FRIM Reports No. 68, October 1995*. Forest Research Institute Malaysia (FRIM), Kepong, Kuala Lumpur. 7pp.

Choudhury, J.K. 1998. *Sustainable management of coastal mangrove forest development and social needs*. Unpublished paper. 19 pp.

Faridah, H. 2013. *The economic value of mangrove forests in Setiu Wetlands, Terengganu.* Report of Final Year Academic Project, Bachelor of Applied Science (Conservation and Management of Biodiversity), Faculty of Science and Technology, Universiti of Malaysia, Terengganu (UMT). 44 pp.

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

Godoy, R., Lubowski, R. & Markandya, A. 1993. A Method for the Economic Valuation of Non-Timber Tropical Forest Products. *Economic Botany, Vol. 47, No. 3 (Jul. - Sep., 1993)*. Pp. 220-233

Hanum, I.F., Kamziah, A.K. & Nurul Syida, S. 2012. Plant diversity and biomass of Marudu Bay Mangroves in Malaysia. *Pakistan Journal of Botany 44*: 151-156.

Jamilah, M.S. 2013. *Setiu wetlands state park: Challenging task for UMT*. INFOKUS UMT, September 2013, Bil. 46. Universiti Malaysia Terengganu (UMT). Pp: 12-15.

Kamaruzaman, J. & Dahlan, H.T. 2008. Managing sustainable mangrove forests in Peninsular Malaysia. *Journal of Sustainable Development. Vol. 1 No. 1 March 2008*. www.ccsenet.org. Pp: 88-96.

Lambert, A. 2003. *Economic valuation of wetlands: An important component of wetland management strategies at the river basin scale.* Unpublished paper. 10 pp.

Leschine, T.M., Wellman, K.F. & Green, T.H. 1997. *The economic value of wetlands: Wetlands' role in flood protection in Western Washington*. Ecology Publication No. 97-100, October 1997. University of Washington. 62 pp.

Lim, C.K. 2002. *Classification and distribution of mangrove forest in the north of Setiu, Terengganu using Aerial Photo Interpretation Technique*. Report of Final Year Academic Project, Bachelor of Science (Marine Science), Faculty of Science and Technology, KUSTEM. 86 pp.

Malaysian Timber Council (MTC). 2009. *Matang mangroves: A century of sustainable management.* Timber Malaysia, Vol. 15 No. 3, May-June 2009. Pp: 6-11.

McNally, R. & Mohd Shahwahid, H.O. 2002. *Environmental economics: A practical guide.* WWF-UK and Universiti Putra Malaysia (UPM). 126 pp.

Mendelson, R. 1993. Non-timber forest products. In Pancel, L. (Ed.), *Forestry Handbook, Vol. 2*. Springer-Verlag, Berlin., Pp: 1425-1448.

Mohd Azmi, M.I., Awang Noor, A.G., Mohd Shahwahid, H.O., Salleh, M., Abdul Rahim, N. & Ahmad Fauzi, P. 2002. Methods for the valuation of NTFPs and environmental services. In Abdul Rahim, N. (Ed*.), A Model Project for Cost Analysis to Achieve Sustainable Forest Management. Vol. 2 (Main Report).* Forest Research Institute Malaysia (FRIM) and International Tropical Timber Organization (ITTO). Pp: 115-166.

Munasinghe, M. 1993. *Environmental economics and sustainable development.* World Bank Environment Paper No. 3. The World Bank, Washington D.C.

Nakisah, M.A. 2003. Chapter 1: Introduction. In Nakisah, M.A. & Fauziah, A.H. (Eds.) *Setiu Wetlands: Tranquility amidst plenty*. Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu. Pp: 1-12.

Nakisah, M.A. & Fauziah, A.H. 2003. *Setiu Wetlands: Tranquility amidst plenty*. Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu. 105 pp.

Nik Fuad, N.M.K., Fauziah, A.H. & Fathilah, I. 2003. Chapter 6: Socio-economics and potential for eco-tourism. In Nakisah, M.A. & Fauziah, A.H. (Eds.) *Setiu Wetlands: Tranquility amidst plenty*. Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu. Pp: 77-103.

Norhayati, M.T., Hasra Masrifah, A.R., Mhd. Radzi, A. & Mohamad Kamil, A.R. 2006. Distribution and characterization of hydrocarbons in sediments of Setiu Wetlands, Terengganu: A preliminary study. *Malaysia Journal of Analytical Sciences, Vol 10, No 1 (2006)*: 177-184

Nuva, R., Mad Nasir, S., Alias, R. & Ahmad, S. 2009. Willingness to Pay towards the Conservation of Ecotourism Resources at Gunung Gede Pangrango National Park, West Java, Indonesia. *Journal of Sustainable Development. Vol. 2 No. 2. July 2009*. www.ccsenet.org. Pp: 173-186

Pearce, D.W. 1993. *Economic valuation and the natural world.* Earthscan Publication, London.

Saidah Nusailah, M. 2013. *The study of above-ground biomass estimation for Brugueira Forest Type at Pulau Rhu, Setiu Wetlands, Terengganu*. Report of Final Year Academic Project, Bachelor of Applied Science (Conservation and Management of Biodiversity), Faculty of Science and Technology, Universiti of Malaysia, Terengganu (UMT). 46 pp.

Saenger, P., Hegerl, E.J. & Davie, J.D.S. (Eds.). 1983. Global status of mangrove ecosystems. Commission on Ecological Papers No. 3, IUCN, Gland, Switzerland.

Sulong, I. & Siti Aishah, A. 2003. Chapter 3: The fauna. In Nakisah, M.A. & Fauziah, A.H. (Eds.) *Setiu Wetlands: Tranquility amidst plenty*. Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu. Pp: 24-49.

Vithayaveroj, T. 2003. *The valuation of fishery resources and existence value of seagrass beds: A case study of Pha Ngan Island, Surat Thani Province*. M.Sc. Thesis. Faculty of Environment and Resource Studies. Mahidol University, Thailand.

Table 3. Species composition of mangrove tree species in inventory survey of Pulau Rhu, Setiu Wetlands

Family	Species	No. of tree[1]	Tree per hectare[2]	No. of sapling[1]	Sapling per hectare[2]	Total composition per hectare[3]
Rhizophoraceae	*Bruguiera cylindrica*	182	910	204	2040	2950
	Bruguiera gymnorrhiza	150	750	29	290	1040
	Rhizophora apiculata	93	465	4	40	505
	Ceriops decandra	1	5	35	350	355
	Ceriops tagal	4	20	14	140	160
Avicenniaceae	*Avicennia alba*	15	75	0	0	75
	Avicennia lanata	1	5	1	10	15
Euphorbiaceae	*Exocaria agallocha*	74	370	18	180	550
Sterculiaceae	*Heritiera littoralis*	3	15	7	70	85
Sonneratiaceae	*Sonneratia alba*	1	5	0	0	5
Malvaceae	*Hibiscus tiliaceus*	10	50	33	330	380
Meliaceae	*Xylocarpus granatum*	45	225	3	30	255
Melastomataceae	*Memecyclon idule*	2	10	0	0	10
Combretaceae	*Terminalia catappa*	3	15	0	0	15
Lecythidaceae	*Barritonia racemosa*	0	0	1	10	10
Celastraceae	*Salacia sp.*	0	0	5	50	50
Fabaceae	*Desmodium*	0	0	9	90	90
Sapindaceae	*lambelatum*	0	0	1	10	10
	Allophallus cobbe					
Total		**584**	**2920**	**364**	**3640**	**6560**

Notes:
[1] Number of adults/matured trees and sapling found in the main and subplots
[2] Estimated adults/matured trees and sapling per hectare
[3] Estimated mangrove tree species composition per hectare derived from the summation of estimated adults/matured trees and sapling
Source: Adapted from Saidah Nusailah (2013)

Table 5. Economic valuation of firewood from mangrove trees per hectare in Setiu Wetlands

Species	**Local name**	**Average price of firewood (RM/bundle) A**	**Average cost of firewood (RM/bundle) B**	**Profit margin (RM/bundle) C**	**Economic value of firewood (RM/bundle) D = A-B-C**	**Total number of species (tree/ha)**	**Total number of bundles per hectare E**	**Total economic value of firewood (RM/ha) F = D x E**
Avicennia alba	Api-api putih	0.30	0.05	0.07	0.18	75	225	40.50
Allophallus cobbe	Pamaman	0.30	0.05	0.07	0.18	10	15	2.70
Bruguiera gymnorrhiza	Tumu merah	0.30	0.05	0.07	0.18	1040	2685	483.30
Ceriops tagal	Tengar putih	0.30	0.05	0.07	0.18	160	270	48.60
Exocaria agallocha	Buta-buta	0.30	0.05	0.07	0.18	550	1380	248.40
Heritiera littoralis	Dungun	0.30	0.05	0.07	0.18	85	150	27.00
Rhizophora apiculata	Bakau minyak	0.30	0.05	0.07	0.18	505	1455	261.90
Sonneratia alba	Perepat	0.30	0.05	0.07	0.18	5	15	2.70
Xylocarpus granatum	Nyireh bunga	0.30	0.05	0.07	0.18	255	720	129.60
Total economic value (RM/ha)								**1244.70**

Notes:

1) The value of A and B are based on field survey done by Faridah (2013)

2) Total number of bundles per hectare (E) is estimated from the inventory data of Saidah Nusailah (2013)

3) Profit margin = $\frac{\text{profit ratio x price of firewood per bundle}}{1 + \text{profit ratio}}$

Where, the profit ratio = 30% (Awang Noor et al. 2002)

Table 6. Economic valuation of poles from mangrove trees per hectare in Setiu Wetlands

Species	**Local name**	**Average price of poles (RM/unit) A**	**Average cost of poles (RM/unit) B**	**Profit margin (RM/unit) C**	**Economic value of poles (RM/unit) D = A-B-C**	**Total number of species (tree/ha)**	**Total number of poles per hectare E**	**Total economic value of poles (RM/ha) F = D x E**
Bruguiera gymnorrhiza	Tumu merah	4.50	0.05	1.04	3.41	1040	11.44	39.01
Ceriops decandra	Tengar	4.50	0.05	1.04	3.41	355	3.91	13.33
Rhizophora apiculata	Bakau minyak	4.50	0.05	1.04	3.41	505	5.56	18.96
Sonneratia alba	Perepat	4.50	0.05	1.04	3.41	5	0.055	0.19
Heritiera littoralis	Dungun	4.50	0.05	1.04	3.41	85	0.94	3.19
Total economic value (RM/ha)								**74.68**

Notes:

1) The value of A and B are based on field survey done by Faridah (2013)
2) Total number of poles per hectare (E) is estimated from the inventory data of Saidah Nusailah (2013) and information from Choudhury (1998)
3) Profit margin = $\frac{\text{profit ratio x price of poles per unit}}{1 + \text{profit ratio}}$

Where, the profit ratio = 30% (Awang Noor et al. 2002)

Table 7. Economic valuation of charcoal from mangrove trees per hectare in Setiu Wetlands

Species	**Local name**	**Average price of charcoal (RM/kg) A**	**Average cost of charcoal (RM/kg) B**	**Profit margin (RM/kg) C**	**Economic value of charcoal (RM/kg) D = A-B-C**	**Total number of greenwood (kg/ha)**	**Total number of charcoal (kg/ha) E**	**Total economic value of charcoal (RM/ha) F = D x E**
All related species	-	2.50	0.05	0.58	1.87	1724.25	448.31	838.33
Total economic value (RM/ha)								**838.33**

Notes:

1) The value of A and B are based on field survey done by Faridah (2013)

2) Total number of charcoal per hectare (E) is estimated from MTC (2009)

3) Profit margin = $\frac{\text{profit ratio x price of charcoal per kg}}{1 + \text{profit ratio}}$

Where, the profit ratio = 30% (Awang Noor et al. 2002)