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Economic Value of Mangrove Forest Products to Local Livelihood in Myanmar

Dr. Cho Cho San
Programme Officer, Department of Planning, Ministry of Agriculture, Livestock and Irrigation

INTRODUCTION

Populations of the world's tropical coastal zones have traditionally used mangrove resources for subsistence as well as commercial purposes. In Southeast Asia, mangrove region alone, 41% of plant species from mangroves are used for medicine, 25% for construction materials, 22% as food, 17% for ornamental use, and 12% as fuel (Giesen et al., 2007). Excessive extraction of mangrove resources associated with increasing population pressure is one of the common causes for mangrove exploitation. Valiela et al. (2001) estimated that overexploitation of mangroves for firewood and timber production between the 1980s and 1990s affected about 26% of the world's total mangroves.

Myanmar, where 8.8% of Southeast Asian mangroves are situated, is no exception to the problems of mangrove exploitation and degradation. The total area of mangroves, estimated at 531,000 ha in 1980, fell to 312,443 ha in 2010 (FD statistics, 2010). Annual loss of mangrove area over the period 1975 to 2005 was estimated at 1% (Giri et al., 2007). The causes of mangrove forest exploitation in Myanmar are identified as (unsustainable) firewood and charcoal production, misleading agriculture and aquaculture development policies in the mangroves areas, and inefficient and ineffective law enforcement for mangroves conservation (Ohn, 1992; Oo, 2002; Htun, 2009). Mangroves are a major source of firewood for the adjacent rural population, and for charcoal production for sale to the urban areas. Moreover, mangrove areas provide a wide range of the fisheries such as shrimps, fish, mud-crabs, and other aquatic and vegetative products. With the increasing population pressure, excessive and unsustainable extraction of such resources for immediate needs led to mangrove forest degradation.

In terms of forest management policies, the Forest Law 1992 and the Forest Act 1995 were promulgated for management and conservation purposes for all kinds of forests in the country. These forest laws establish protected forests, including the conservation of mangrove forests, and biodiversity. Under the forest laws, mangroves are protected forests and sometimes declared as forests to supply the fuel requirement, and for sustainable extraction of non-timber forest products. Specific laws for mangrove management are lacking. The important role of ecosystem services for subsistence and economic activities of human society has not been fully understood and mangroves are undervalued in private and public decision making related to their use and conservation. It is therefore necessary to evaluate and account for the role and value of mangrove ecosystems for the long-term benefit of human societies.

PROBLEM STATEMENT

Wunbaike Mangrove Forest in Rakhine State was declared a reserved forest during the time of the British

colonial period in 1930 to supply fuel wood to steamers for local transportation. It is one of the last largest mangrove areas in Myanmar and in Southeast Asia. The forest is composed of several deep and shallow creeks, large rivers, and mudflats, with sandy, muddy, and rocky bottoms. Moreover, it is rich in biodiversity with 72 species of mangrove fish and crustaceans, as well as 104 bird species and 70 flowering plant species including 34 mangrove species and 36 salt tolerant plant species (Soe, Myint and Stanley, 2011). Despite the reserved forest, local communities have traditionally used mangrove resources such as firewood, fishery products, and non-timber forest products for subsistence as well as for commercial production of charcoal, mud crab trading, and debarking of mangrove trees (Aye, 2007; Standley, 2011). Moreover, further encroachments were driven by increasing population pressure, the nation's rice production policy, the state shrimp farming expansion plan in 1980, and the Land Reclamation Policy in 1998. According to the Forest Law 1992, any encroachment within the reserved forest is illegal. The evidence of weak implementation of these law and conservation plans is revealed by the continuous mangrove destruction and conversion until 2011, according to the data of the Department of Agriculture (DOA). Sustainable management strategies are still divisive among different departments and stakeholders, and conservation is still less of priority. The economic value or long-term benefit of mangrove resources, at least the value of forest products that local people obtained directly from Wunbaike mangroves, was not recognized. Without this information, decisions about mangrove use will always underestimate the value of mangrove resource conservation. Dependence on the forest resources by the local households around these forests for subsistence and as the cash income source has large implications in designing conservation initiative and enforcement of forest management regulations.

The objective of this study was to provide information on the economic value of Wunbaike mangroves in terms of local direct use.

METHODOLOGY

The household survey was conducted in Yanbye Township by using structured questionnaires to collect primary data on extraction of forest products by local people. In this study, the purposive random sampling method was employed because of the lack of a sampling frame for the population of different forest users. Using the pre-tested questionnaire, the sample households from six village tracts in Yanbye Township, which are 10 km away from Wunbaike Mangrove Forest, were purposely selected to elicit data on the extent and nature of Forest product use. The final survey was done among 223 households in nine villages and in the mangrove forest and only 219 questionnaires were completed. The amount of each forest product collected and frequency of collection during a year, place of collection, and their opinion on the exploitation of the forest and difficulties of forest product extraction were collected. The information collected includes socio-economic characteristics of household, annual amount of firewood and NTFPs collected by household, market prices or purchasing prices of particular products, amount of labor used for each collection, means of collection and materials used, time of collection per year, place of collection, and distance from village to the place of collection. NTFPs in this study included mangrove fish, mud crab, nipa, honey, and vegetables that were collected by the households for their subsistence use. Their perceptions on the degradation of the NTFPs compared to the situation of five or ten years before were asked.

A detailed list of mangrove plant species and fish species in Wunbaike Mangroves Forest were documented in the reports of the FAO project. With the help of informants and focus group discussion, the species and type of NTFPs that local people used to harvest were identified during the time of the field survey. The data of forest products provided by the respondents were in terms of local measurement units; for instance, in the case of firewood collection, the respondents answered using the amount of firewood as the load of boats of different sizes or bundles of different sizes. Local measurement units were also used for products such as honey in a bottle, fish in a bundle, and crab in kilograms and vegetables in bundles. For the accuracy of estimation of the amount of forest products extracted, the researcher and informants conducted experiments during the preliminary survey to convert local measurement units to standard international units. For example, the amount of firewood that the respondents answered was in terms of bundles. The bundle of firewood they used to show the amount of firewood used by each household was examined and was converted to volume unit as m3.

DATA ANALYSIS

The analytical framework for each section was mainly composed of descriptive analysis, economic valuation and cost-benefit analysis for valuation and comparison purposes. Sensitivity analysis was carried out for the different time horizons and different discount rates. In the valuation of forest resources in benefit-cost analysis, the appropriate time horizon may be determined by the nature of the problem being evaluated and the alternative land uses are compared over the same period (Bishop, 1999). The assumption for the time horizon in this case was 15 years, 30 years and infinite time. Due to the absence of the productivity of the mangrove forest, the time horizon 15 years was assumed based on the information supported by the previous study of forest exploitation status reported by FAO (2011). The report stated that the existing situation of vegetative types and density of Wunbaike mangrove is vulnerable and will be totally exploited in 10-15 years if the existing resource extraction rate continues.

Discounting the benefit of forest resource was normally conducted in order to compare to the benefit of the other land uses. Godoy et al. (1993) stated that the most appropriate method is to use the estimate of the social discount rate. If there is no social discount rate, the market interest rate can be used. They also recommended using a discount rate of 4 to 5 % when there is no estimated social discount rate. Bishop (1999) also argues that, since the higher the discount rate the more likely is the extinction of biological resources, he recommends using a lower social discount rate where environmental concerns are important. Based on these sources, a 5% discount rate was chosen for sensitivity analysis. The interest rate on long-term deposits in the Central Bank, Agricultural Development Bank, Livestock and Fishery Enterprise Bank and other commercial banks is 8%. The social discount rate used in the context of irrigation and agricultural development projects in Myanmar ranges from 8% to 12%. Moreover, the local interest rates from different private lenders in the study area ranges from 5% to 12%. To reflect observed interest rates, the discount rates of 5%, 8%, and 12% are used for the sensitivity analysis, and it implies in comparison the benefit of forest to that of agricultural use.

The local households depend on the mangrove forest for various purposes such as food, construction materials, and fuel-wood for home consumption or for sale. The amount of extraction of different mangrove products and dependency of local households on the mangroves can vary among the households, and among different distances between the household and the forest.

RESULTS AND DISCUSSION

Mangrove product items and utilization pattern

Mangrove product items: The major forest items extracted by the local households included firewood, fish, shrimp, mud crab, Nipa, vegetables, and some medicinal plants. The type of mangrove trees that local people used to collect for firewood were Bruguierasexangula Loureiro, Bruguiera hainesii, Avicennia marina, Avicennia officinalis, Ceriops tagal, Kandelia candel, Rhizophora apiculata, Rhizophora mucronata Lamk., Sonneratia caseolaris (L.) Engl.and Xylocarpus moluccensis (L.). There were many plant species available from the WMF for use asvegetables and medicines. The vegetable species were Acrosticum aureum Linnaeus., Acanthus volubilis Wall., and Acrosticum speciosum Wild. For the analytical purpose, Acrostichum speciosum Wild. was taken because this species was commonly used as a vegetable and there was also some local market demand for it. However, some other plant species that are used for medicine or sweets were not included in this study because market price or surrogate price was not available and the amounts of these products were unquantifiable.

In case of fish species, the local people reported 17 species during the survey. The common fish species they caught were Mystus vittatus., Strongylura leiura., Lates calcarifer., Anodontostoma chacunda., Acentrogobius caninus., Pomadasys commersonni., Sargocentron rubrum., Zenarchopterus sp., Scolopsis vosmeri., Pseudorhombus arius., Drepane punctata., Satipinna wheeleri., Pomadasys olivaceum., Leiognathus bidus., Congresox talabon., Scolopsis vosmeri., and Terapon jarbua.

The other fishery products that people mostly harvest were mangrove mud crab (Scylla olivacea) and three shrimp species Penaeus indicus, Penaeus japonecus and Penaeus monodon. The species of bees for honey production were recorded as Apis dorsata, Apis florea and Apis indica.

Mangrove resource utilization pattern by local households: Table 1 presents the proportion of respondent households that harvest different forest products. More than 90% of survey respondents use mangrove firewood, fish, crab and vegetables from the Wunbaike Area. More than 80 % of the respondents

use mangrove fish and crab to sell for cash income. Fishing was a frequent activity to either get food for the daily meal or sometimes to get cash income. The number of mud crab collectors was relatively high because crab trading to China and different regions inside the country has recently expanded. The crab collectors can access the market easily in order to earn cash income. Firewood was the major source of fuel energy for cooking and heating for the local households in the study area. Some commercial activities such as brick making and charcoal production also need mangrove wood. More than 95 % of respondents use firewood for home use.

Table 1: Percentage of sample household that participate in forest products extraction

	% of household	% collect for sell	% collect for home consumption
Firewood	99.53	5	94.53
Fish	94.79	80.1	14.69
Shrimp	56.40	8	48.40
Crab	97.63	85.05	12.58
Nipa	29.38	0	29.38
Honey	50.24	20.2	30.04
Vegetables	99.53	50.2	49.33

Shrimp collectors and honey collectors accounted for 50 % of the respondents. Very few respondent households (29%) harvested Nipa leaves from the mangroves. The absence of sales of Nipa leaves reflects their use only for roofing purposes, and some of the local people made their own Nipa farm near the villages.

Value of mangrove products and contribution to local livelihood

Frequencies and time spent for mangrove product collection per year: The duration of time spent by the local households to collect forest products was initially estimated in terms of workday, i.e., 8 hours. For instance, collection of firewood may take the whole day but fishing for home consumption may take only 2-4 hours. However, they go more frequently for fishing than collecting firewood. Most of the households collect firewood during the agriculture off-season. Whenever the household members have spare time from farm work or housework, they usually go to the mangroves for fishing or collecting vegetables.

Time spent for collecting forest products varied with the household needs and seasonal availability of the products. The second column in Table 2depicted the average number of days per year for collection of forest products by respondent households. On the average, a household takes 8 days for firewood collection, 34 days for fishing, 46 days for crab catching, and for shrimp 22 days per year. Local people use honey for some medicinal purpose and average time of collection was only one day a year. Nipa harvest takes one day every three or four years on the average.

Quantity estimation of mangrove products harvested: The estimated average amount of firewood and other non-wood forest products harvested in a year are also stated in Table 2. The measurement units were different based on the type of forest products. The amount of firewood was estimated in terms of cubic-meter and fishery products and forest honey were estimated in terms of kilogram weight. Extraction of Nipa was estimated in terms of number of leaves and vegetables in bundles. The average annual extraction of firewood per household was 2.63 cubic meters. Consumption of fish by each household was also high at 36.96 kg per year and 48.72 kg for sale or barter. Each household collected mud crabs for sale that amounted to 230.75 kg, and for home consumption, that was 56 kg per year. Collection of Nipa leaves of each household was 86 leaves and forest honey was 1.2 kg annually.

Table 2: Average annual amount and gross value of mangrove products contributed to each household

Items	Frequency of Collection	Mean Quantity year^{-1}	Monetary Value (kyats/USD) year^{-1}	%

				Kyats	USD*	
Firewood	8.09 ±3.76	2.63 ±0.73	(cu-m)	21,097.9	24.82	5.1
Fish subsistence	31.45 ± 19.76	36.96 ±23.86	(kg)	27,097.9	32.06	6.5
Sell		48.72 ±39.54	(kg)	35,919.2	42.26	8.6
Shrimp	17.21 ± 23.70	16.08 ±21.9	(kg)	38,153.2	26.29	9.2
Crab subsistence	46.32 ± 23.51	56.93 ±47.1	(kg)	41,040.7	48.28	9.9
Sales		230.75±90.88	(kg)	230,399.9	271.06	55.3
Nipa	0.38 ± 0.66	86.11 ± 200.12	(leaves)	2,623.2	3.09	0.6
Honey	0.69 ± 0.78	1.20 ±1.41	(kg)	3,321.3	3.91	0.8
Vegetable	-*[1]	335.10 ± 182.02	(bundle)	16,755.2	19.71	4.0
Gross Value	17.21± 12.40			416,559.7 ±306,838.2	490.7 ±361.	100

*The USD value was calculated at 1 USD = 850 kyats(2011-12).

Value of forest products: Most of the forest products were valuated at the retail-purchasing price in the villages during the survey period 2011-2012. The mud crab was valued at the forest gate price at 1,000 kyats per kg because crab consumption or selling took place in the forest. Firewood was valued at the market price of 300 kyats for a bundle of 3 cubic feet in volume. The average market price of all fish species was used for valuation at 1,500 kyats per kg of fish. The value estimated in Table 2, thus reflected gross monetary income and it did not account for the costs of harvesting the products, mainly cost of labor.

The estimation of Mangrove forest categories in terms of money showed that 65% of the resources consisted of mangrove crab followed by fish (15%), shrimp (9%), firewood (5%), vegetable (4%), honey (0.8%), and nipa (0.6%). Each household collected mangrove resources valued at 416,559 kyats (490 USD) on average in a year. Resource extraction for selling was significantly higher compared to subsistence use in term of monetary value. Collection of mangrove crab was the main economic activity and it contributed more than half of total cash income. The benefit from fishing contributed 8.6 % share of total forest income.

The average annual value of firewood was estimated at 21,000 kyats (24.82 USD) per household. Mangrove fisheries contributed a large share of the value to the household amounting to total 388,000 kyats, of which the annual value flow from mud crab to each household was 287,243 kyats (337.93 USD), from fish 63,168 kyats (75.32 USD) and 38,153 kyats (26 USD) from shrimp respectively. The average annual value of nipa leave harvesting was 2.623 kyats (3.9 USD) while for forest honey and vegetable were estimated at 3,000 kyats (1.2 USD) and 16.8 thousand kyats (19.71 USD) per household.

The total annual gross value of fuel wood and NTFPs for each respondent household for 2011-2012 was estimated at 416,559 kyats (490 USD).

Contribution of mangrove resources to household total income

[1] In case of vegetables, *Acrostichum speciosum Wild.*is collected during the time of other activities in the forest or sometimes just picked up while walking to go back to the village and it is difficult to estimate precisely the time for collecting this item. In valuation procedure, we simply assigned value of this vegetable at retail purchasing price in the market.

Contribution of mangrove resource income to the total household income was analyzed to observe the dependency of local households on mangrove resources. In Table 3, the five income quintiles based on the annual total household income were arranged in ascending order to compare the absolute and relative forest income to the total household income.

The result showed that income from forest resource extraction contributes a considerable proportion of total household income. The income from forest resources increased by increasing the total annual household income in some cases. The extent of the dependence, however, varied with the different income quantiles. The lower-income groups grasped relatively higher proportions of their income from mangrove resources than the higher-income group. 37% of household total income was contributed by earnings from forest resources in case of lowest-income households.

Table 3: Contribution of total mangrove resource value to total household income

Income quantiles (low-high)	N	Mean household Income year^{-1}		Mean forest Income year^{-1}		Relative forest Income (%)
		Kyats	USD*	Kyats	USD*	
1	42	1,235,977.2	1,454.1	431,252.2	507.4	37%
2	42	1,836,842.8	2,161.0	350,441.0	412.3	19%
3	42	2,502,709.7	2,944.4	444,581.8	523.0	18%
4	43	3,422,867.7	4,026.9	472,584.1	556.0	14%
5	42	4,579,307.0	5,387.4	362,949.7	427.0	8%
Total	211	2,534,789.7	2,982.1	417,565.2	491.3	20%

*The USD value was calculated at 1 USD = 850 kyats(2011-12).

The other three quantiles of lower-income showed higher dependence on forest resources from 8% to 19%. In highest income groups, dependence on mangrove resource declined to 8% with the increased total household income. On the average 20% of total household income was contributed by income from mangrove resource extraction on average.

Allocation and value of household labor for mangrove resource extraction

Household labor allocation in forest products collection: Local households allocated their family labor for mangrove product extractions. The major part of the cost for collecting mangrove resources for subsistence or for sale was the cost of labor time involved. To estimate the opportunity cost of the collection of forest products, it was necessary to estimate the average labor distributed for collection of each product. The descriptive analysis results in amount of male and female family labor, and total labor involved for extraction of each forest resource item were presented in Table 4. Family labor for each forest item was calculated from the data o of male and female labor participating, times spent for collection and frequency of the collection of each resource in a year.

Table 4: Annual amount and value of labor used in forest product collection

Forest products	Frequency of collection	Labor (Person-day) per year			Value	
		Male	Female	Total	Kyats	USD*
Firewood	8.09 (3.76)	10.50 (5.51)	2.38 (3.81)	12.88 (6.31)	19,322.27	22.73
Fish	31.45 (19.76)	35.52 (25.90)	6.97 (20.26)	42.49 (30.35)	42,488.15	49.99
Shrimp	17.21 (23.70)	3.29 (4.22)	2.13 (2.07)	6.51 (5.58)	8,957.26	10.54
Crab	46.32 (23.51)	32.16 (31.17)	3.21 (10.84)	36.26 (32.95)	58,926.54	69.33
Nipa	0.38 (0.66)	0.43 (0.85)	0.26 (0.64)	0.69 (1.33)	1,037.91	1.22
Honey	0.69 (0.78)	0.43 (0.50)	0.07 (0.25)	0.67 (0.76)	1,327.01	1.56
Average total	17.21 ±12.40	79.03 ±40.44	15.02 ±14.21	88.36 ±47.48	131,021.94 ±73,382.94	154.14

*The USD value was calculated at 1 USD = 850 kyats.

The male family labor played a greater role in collection of each forest product than female family labor. The respondent households put more labor into collection of fishery products from the mangroves. The maximum labor used in collection of fish amounting 42 person-day per year on average, which was followed by the total labor for collection of crab, amounting to an average of 36.6 man days per year. Taken as a whole, each household spent 88.36 days per year in the collection of different mangrove forest items.

Valuation of Family Labor: The cost of labor was calculated based on the information at the time of collection and the seasonality of the forest products and local wage rate. The main activities in the study site were agriculture and collection of forest products especially fishery items. Most of the farmers collected firewood during the off-season of agriculture and the others NTFPs were collected in both off- and in- season.

The wage rate for off-season collection was used at 1,500 kyats/ day and for in-season at 2000 kyats per days using average labor wage rate for agriculture sector during 2011-2012 growing season. If the mangrove product was collected during leisure time, one third of the minimum wage rate was implied to impute the opportunity cost of labor[2]. The estimated labor costs for forest product collection are shown in Table 6.6. On the average, the family labor value for firewood collection was worth 19,000 kyats (22.73 USD), for fish collection was 42,000 kyats (49.99 USD), for shrimp, crabs and nipa collection was worth 8,957 kyats (10.54 USD), 58,926 kyats (69.33 USD), 1,037 kyats (1.22 USD) and 1,327 kyats (1.56 USD) respectively. Total annual value of labor shared for collection of firewood and NTFPs for 2011-2012 was estimated at 131,000 kyats (154 USD) per household.

Estimation of net benefit flow to local household

Net benefit flows to local household: The net benefit flow of resource extraction of Wunbaike mangroves to local household users was estimated as the net economic value, i.e. the gross value of firewood and NTFPs minus the gross cost of extraction. To get the accurate measure of marginal extraction cost, the cost of material used, the labor time spent, the temporal cost of resources should be included Gody (1993). In this analysis, we simply used the cost of labor time spent directly associated with harvesting each product as the cost of resource extraction. Local households used knives that can last for more than one generation and the depreciation cost is too small. The value of the fishing nets or crab catching nets they use is not evident to estimate.

[2] The wage rate during the leisure time should be valued at one third of daily wage rate (UNEP, 1994)

Taking the estimated gross value of forest products and the cost of labor time spent, the net benefit of NTFPs to the local forest user household was valued at 305,591 kyats (359 USD) for the single year of 2012 (Table 5).

Table 5: Net benefit of firewood and NTFPs extraction of each household 2011-2012

Net Benefit of firewood and NTFPs	Minimum	Maximum	Mean	Std. Deviation
Kyats per household	15,794.00 (18.58)	1,526,882.00 (1,796.33)	305,591.07 (359.52)	278,569.43
Kyats per hectare	1,780.68 (2.09	172,147.17 (202.53)	34,453.63 (40.53)	31,407.10

The values in the bracket are USD calculated at 1 USD = 850 kyats(2011-12).

Wunbaike Mangrove Forest was accessible from four Townships; Kyauk Phyu, Yanbye, Ann and Taung Goke Townships. However, there was no reliable data to represent the population of households that can be assumed as Wunbaike mangrove users.

The other point to be considered is that there will be variations in the extraction rate of NTFPs across the forest sites, different communities, and accessibility to the forest. In this regard, it is not consistent to use the estimate benchmark value of our survey to reflect the NTFPs value for the whole population of four townships. The study only emphasized the NTFPs value appropriated for mangrove user households in the five villages located within 10 kilometers from Wunbaike Mangrove Forest. The population of forest product collectors from six village tracts of Yanbye Township was estimated at 2,585 households (FAO report, 2011). For further aggregation analysis, we assumed the random sample in this study was representative for that population. To extrapolate the per hectare NTFP value, the assumption was made that the accessible catchment area was 22,928 ha. Therefore, the average net benefit of mangrove resource flow to the local community was estimated at 34,454 kyats (40.53 USD)/ha for the survey year of 2012.

Total net present value estimation

The economic value of a mangrove ecosystem as an asset is the sum of the discounted present values of all goods and services flow to the people to use. To estimate the present and net present values for Wunbaike mangroves, the stream of benefits from firewood and NTFPs flowing to local households or annual aggregate benefits had to be discounted to a common point in time, i.e. 2012. In this case, the potential net benefit from the mangroves was assumed to be constant over time.

Table 6 describes the present value of gross income from NTFPs and firewood per household calculated for different time horizons and at different discount rates. The present value of gross income per household estimated for a 15-year period ranged from 31 million kyats (3,731 USD), 26 million kyats (3,077 USD) and 24 million kyats (2,890 USD) at a 5%, 8% and 12% discount rate respectively. For the 30 year period, the estimated net presented value ranged from 46 million kyats (5,526 USD), 31 million kyats (3,731 USD) and 20 million (2,448 USD) at 5%, 8% and 12% discount rates, respectively.

The infinite period estimation at a discount rate of 5%, 8% and 12% showed the net present value at 61 million kyats (7190USD), 38 million kyats (4,493 USD), and 25 million kyats (2,999 USD) per household respectively.

Table 6. Net present value (gross) of firewood and NTFPs per household

Discount Rate (%)	NPV for 15 Years		NPV for 30 Years		NPV for Infinite Year	
	Kyat	USD*	Kyat	USD*	Kyat	USD*
5	3,171,930.78	3,731.68	4,697,683.72	5,526.69	6,111,821.35	7,190.38

8	2,615,700.23	3,077.29	3,171,930.78	3,731.68	3,819,888.34	4,493.99
12	2,461,592.27	2,895.99	2,081,339.35	2,448.63	2,546,592.23	2,995.99

*The USD value was calculated at 1 USD = 850 (2011-12)

Estimation of fuel wood and NTFP value for Wunbaike mangrove forest

To estimate the economic value of NTFPs derived from the Wunbaike mangrove forest, it was needed to extrapolate the benchmark values obtained from the survey and generalize for the mangrove forest as a whole, and to convert these values from per household to per hectare terms. This was also to facilitate comparison of per hectare direct use value of mangroves to the value of other alternative mangrove land use and to imply the forgone benefit of mangroves if they were converted to rice or shrimp farms. The aggregate total discounted net present value for the forest product collector population at different periods is presented in Table 7.

Table 7: Aggregate Net Present Value of firewood and NTFP for the forest user population in Yanbye Township in term of million kyat and USD per year

Discount Rate (%)	NPV for 15 Years		NPV for 30 Years		NPV for Infinite Year	
	Kyat	USD*	Kyat	USD*	Kyat	USD*
5	81,835.81	96.28	121,200.24	142.59	157,684.99	185.51
8	67,485.07	79.39	81,835.81	96.28	98,553.12	115.94
12	63,509.08	74.72	53,698.56	63.17	65,702.08	77.30

*The USD value was calculated at 1 USD = 850 kyats (2011-12)

The estimated net present value of firewood and NTFPs produced from the Wunbaike Mangrove forest for the15 year time period was 81,000 million kyats (96 million USD) at a 5% discount rate, 67,000 million kyats (79 million USD) at an 8% discount rate and 63,000 million kyats (63 million USD) at 12% discount rate.

At a 30-year time period, the net present value for the forest user population was worth 121,000 million kyats (142 million USD) at 5% discount rate, 81,000 million kyats (96 million USD) and 53,000 million kyats (63 million USD) at 8% and 12% discount rate, respectively. For the infinite year duration, the net present value of firewood and NTFPs for the Yanbye town ship was 157,000 million kyats (185 million USD), 98,000 million kyats (115 million USD) and 65,000 million kyats (77 million USD) at 5%, 8% and 12% discount rate, respectively.

The discounted net present value of firewood and NTFPs for one hectare of Wunbaike Mangrove Forest was estimated at a 5%, 8% and 12% discount for a 15-year period, 30 year time period and infinite year as in Table 8.

Table 8. Net present value of firewood and NTFPs for one-hectare Wunbaike mangroves

Discount Rate (%)	NPV for 15 Years		NPV for 30 Years		NPV for Infinite Year	
	Kyat	USD*	Kyat	USD*	Kyat	USD*
5	356,925.22	419.91	528,612.35	621.90	687,739.84	809.11
8	294,334.73	346.28	356,925.22	419.91	429,837.40	505.69
12	276,993.55	325.87	234,205.14	275.54	286,558.27	337.13

*The USD value was calculated at 1 USD = 850 kyats

The net present values of firewood and NTFPs harvested by local households were 3.57 million kyats (419 USD)/ha at 5% discount rate, 2.9 million kyats (346 USD) at 8% discount rate and 2.8 million kyats (325 USD) at 12% discount rate, respectively for the 15 year time horizon.

For a 30-year time horizon, the estimated net present value increased as 5 million kyats (621 USD)/ha at a 5% discount rate, 3.5 million kyats (420 USD)/ha at an 8% discount rate and 2.34 million kyats (275 USD)/ha at a 12% discount rate, respectively. If the assumption were made for infinite years, the estimated present value of firewood and NTFPs for local use would be 6.88 million kyats (809 USD)/ha, 4.3 million kyats (505 USD)/ha and 2.8 million kyats (337 USD)/ha at a 5%, 8% and 12% discount rate respectively.

DISCUSSION AND CONCLUSION

Mangrove utilization and local livelihood

Local households harvest a considerable quantity of mangrove resources from the Wunbaike area for their food and cash income at a subsistence level. Among the six mangrove products included in this study, firewood, and nipa leave were harvested for household use and fishery products were used in a varying amount to generate cash income. The amount of harvested firewood was almost at the same level as the national firewood consumption rate of 2.5 m3 per rural household of 5 members (Htun, 2009). Mangrove fish and mud crab were a primary source of cash income generation for local households. This factor highlights the importance of mangroves as the breeding ground for fisheries. Moreover, collection of mud crab contributed the largest share of total mangrove gross incomes. This finding is similar to other studies in Micronesia (Naylor and Drew, 1998), in Brazil (Glaser et al., 2010) and in Thailand (Sathirathai and Barbier, 2001). However, this could also be a site-specific situation. In Wunbaike mangroves, there were about ten crab collection centers, and crab trading near the Chinese border has increased in recent years. Easy access to the market place encouraged the local households to harvest mud crab almost the whole year round. However, compared to the other mangrove regions in the country, local households relied only on crab collecting in mangroves rather than practicing crab farming.

On the other hand, mangrove resource utilization is strongly related to the livelihood of local households. Harvesting mangrove resources is not a regular and full-time job for them, but local people rely on these activities for their subsistence needs. This research found that the total time of mangrove resource harvesting was on the average 88 working days per year per household. Estimation of annual average monetary value flow from the actual extraction of firewood and NTFPs was considerably high at 416,559 kyats (490 USD) per household. This value was much higher compare to the official statistic mean expenditure per capita in rural areas. These contributions, i.e. employment and income, were significant for the local livelihood because the study area falls in the region with a 44% poverty index and 34% unemployment rate.

Direct use value of Wunbaike mangroves

Mangrove ecosystem valuation has been conducted to prove that environmental issues are important for planning at the macroeconomic level, and to support the decision making process for efficient resource allocation at the microeconomic level (Winpenny (1991) cited in Gunawardena and Rowan, 2005). Valuation of mangrove products for the subsistence of local households is critical in determining the economic value of mangroves in developing countries, and valuation of NTFPs is sometimes sufficient to justify the conservation of the forestlands (Bishop, 1999). This research valued the local subsistence use of firewood and NTFPs from Wunbaike mangroves. Taking the result of net income analysis, the net benefit of mangrove forest products was 305,591 kyats (359 USD) per household or 34,153.63 kyats (40.53 USD) per hectare per single year estimation.

The economic value of forest resource per hectare was estimated under three scenarios. The value for a 15-year time horizon was tested assuming that the mangroves will be totally exploited over this period given the existing rate of utilization. For the assumption that the forest was partially conserved for sustainable use, the mangrove value was analyzed for 30 years, and for the infinite year duration, it was

analysed for the totally conserved situation. The results proved that economic value of the mangroves forest ranged from 2.77 to 3.57 million kyats (325.87 to 419.91 USD) for a 15-year time horizon at different discount rates. In addition, it was observed that this value could be doubled in the next 30 years or an infinite year period.

However, the results of the economic benefits of Wunbaike mangroves cannot be presumed to be consistent all the time because in the analysis only the primary data of mangrove resources harvested by the local households and their market prices during the time of survey was used. Seasonal variations of mangrove products availability and the market price variability of each product can occur with time.

Moreover, the values represent a lower-bound estimation. One of the reasons is because the research emphasized only the subsistence use of mangrove resources by user household population only in Yanbye Township. There are still other adjacent townships where there is potential use of Wunbaike mangrove resources by the local communities. Another reason was that the calculation was only for a few mangroves species that could be specified in terms of amounts and market price during the time of survey. There may be some other mangrove species that local people harvest and use sometimes.

The range of estimated annual total economic value represents the potential benefit of Wunbaike mangroves that pertains to the local households, and to indicate that the restoration and preservation of Wunbaike mangroves is an important issue for the local community. The aggregate annual values represent a considerable loss of mangrove value for the society as a whole in the region if no conservation program is established.

This information can at least inform the stakeholders to appreciate the value of Wunbaike mangroves and highlight the vision that any decision that permits the unsustainable use of mangrove forests will cause the loss of the welfare to society. Moreover, it can be used as an input into the policy decision-making process to keep a balance between local livelihood and mangrove conservation or to deliver outcomes that would be consistent with the benefit maximization and sustainable resource use. Furthermore, the result of this study may be transferred to other wetlands in Rakhine State and the other mangroves areas in Myanmar.

In case of the methodology used to estimate direct use value, the results of this study showed different values compared to other studies. It can be argued that the value results may vary with site and with respect to the specific purposes, the component of forest goods and services, coverage of area, population and utilization pattern, and the methodology used.

POLICY IMPLICATIONS

In general, the findings of this study demonstrate extractive direct use of mangrove forest products at subsistence level - play equally important roles in the livelihoods of the rural households in the Yanbye Township. All these activities had a great impact on the employment and poverty levels of the region. In fact, the study area is located in a region of limited development and in an impoverished area with a 44% poverty rate and 43.5 % unemployment rate. Given this situation, mangrove resource conservation can only be successful if it is accomplished with improvement in living conditions and livelihoods. Well designed, comprehensive policies will be needed to ensure economically, socially and environmentally sustainable mangrove management. Policy interventions with long-term benefits should be prioritized. The government should take more definite actions to conserve mangroves for long-term use. Valuation analyses results for different products of mangroves in this study should be used in discussion for decision-making process in any level relating to the management strategies for Wunbaike Mangrove Forest.

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