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Estimation of the value of direct use ecosystem services of Indawgyi Lake Wildlife Sanctuary in Myanmar

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Abstract: The study examines the direct use value of ecosystem services in the Indawgyi Lake Wildlife Sanctuary (ILWS) through the dependency of local villagers on ILWS and its recreational value. The values of local villagers' dependency on forest products were estimated using the market price valuation method. The results show that, in terms of monetary value, estimated tangible services (fishing, timber, fuel-wood, bamboo, water supply, non-timber forest products, and charcoal) are 4.68 million USD per year. Travel cost method was applied to calculate the recreation value of ILWS (i.e. the total consumer surplus of ILWS visitors). The estimated consumer surplus or per trip per visitor is 127 USD, and the total consumer surplus is 56.23 million USD per year. Besides, income, money spent during the trip (travel cost), gender and age were significantly related to the number of trips to ILWS. By combining the value of tangible services and intangible recreation, the estimated total direct use value of ILWS is 60.91 million USD per year. The results of this study can be useful in developing the lake's management and conservation programs.

Keywords: Ecosystem services, Indawgyi Lake Wildlife Sanctuary (ILWS), direct use, valuation, travel cost.

1. Introduction

An ecosystem includes plants, animals, and microorganism communities and the non-living environment interacting as a functional unit [1]. It supports different kinds of goods and services (ecosystem services) to human beings and their lives depend on these services [2]. All of the benefits people obtain from the ecosystem services are essential for human society including health, well-being, maintenance and development [3]. Ecosystem services can be divided into four main types, namely (1) provisioning services (food, water and energy), (2) regulating services (climate and disease control), (3) cultural services (spiritual fulfillment and recreation), and (4) supporting services (photosynthesis and soil formation) [1, 3-4]. All people rely on the ecosystems and their services of the earth. Due to the world population increasing rapidly, the demand for ecosystem services has grown significantly and led to their degradation. Rural people directly depending on these services and living in and around forest areas are generally poor [1, 5]. As a result of ecosystem services degradation, they will be the most vulnerable group. Moreover, it could also be the principal factor for causing poverty [1]. To sustain the ecosystems and their services, a great variety of species and populations are required. It is hoped that the restoration of the functions of ecosystems can be obtained through implementing suitable actions and plans in time [6].

Establishing protected areas is one of the basic solutions to conserve biodiversity, ecosystems and ecological processes. At present, many ecosystem services have undervalued or no financial values because of a lack of economic valuation practices [2]. Improving protected area management practices can be achieved through the recognizing of the values within the protected area system and evaluating the result of management [7]. Assessing forest incomes from protected areas (it also means assessing the value of ecosystem services in protected area) could be the option for reducing the impacts of people on protected areas and this could contribute in the formulation of specific conservation actions for them [8]. If the communities do not know the value of ecosystem services clearly and undervalue them, it can lead to destroying them without any conservation. As a result, finally, the ecosystem services will be deteriorated which will in turn negatively affect the communities that rely on these services.

Indawgyi Lake Wildlife Sanctuary (ILWS), one of the ASEAN Heritage Parks, is located in Monyin Township, Kachin State in northern Myanmar and the total area is 815 km^2. Geographic coordinates of the site are N 25° 07′ and E 96° 22′ [7]. ILWS became an ASEAN Heritage Park on 18 December 2003. It is also known as the most important wetland site and became the second ramsar site in Myanmar on 2 February 2016 in Myanmar. A total of 8922 households are living in 11 village tracts which include 38 villages [9]. 10 villages are situated on the fringe of the lake. As a wetland, it is mainly the source for fishing, grazing and agriculture. As ILWS includes the forest, wetland and aquatic ecosystems, many direct use ecosystem services can be found. Forest provides timber and bamboo for construction, furniture and handicraft for the local community. Fuel woods are the main energy sources of cooking for the local community. The local community can get some benefits by collecting Non-Timber Forest Products (NTFPs) such as bamboo shoots, fruits, vegetables, mushrooms, orchids, honey, medicinal plants, etc. ILWS also provides recreational value (bird watching and outdoor recreation (hiking, kayaking, bicycle tours and fishing) as a direct use ecosystem service [9].

As ILWS is crucial for the local community and the visitors coming for recreation, exposing its economic value would create more understanding on its significance to people. This study aims to estimate the direct use value of the ecosystem

services in ILWS. Not only the result of this study can lead to the awareness on the significance of its protection, it can also be used to support the decision making on ILWS management and conservation.

2. Method

ILWS provides both consumptive (timber, fuel wood, bamboo, bamboo shoot, mushrooms, honey, medicinal plants, fishing, water supply, etc.) and non-consumptive (recreation) values to local community and visitors as well. They all are included in direct use values. In this study, the total direct use value of ecosystem services of ILWS was calculated by combining the total value of tangible and intangible ecosystem services of ILWS as shown in Figure 1.

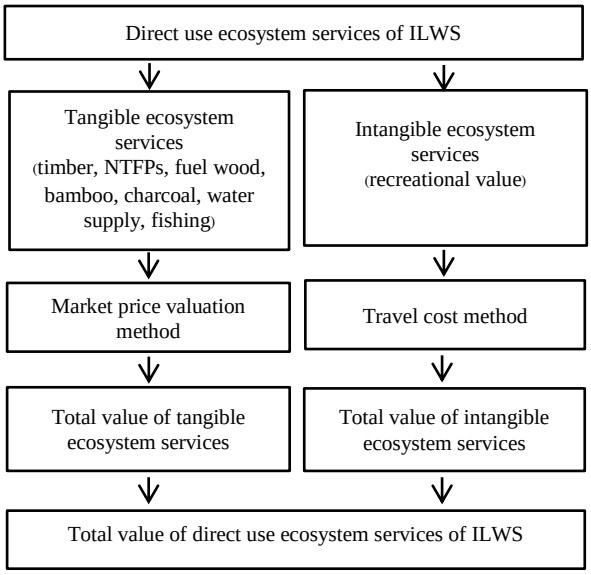

Figure 1. Flow diagram for estimating the total value of direct use ecosystem services of ILWS.

2.1 Calculation of the tangible ecosystem service values of ILWS

The market price method can be used to estimate the value of ecosystem goods and services which are bought and sold in the markets [10]. Price data of sold products in the market are available and easily understandable [11]. In this study, the economic value of tangible ecosystem services (timber, fuel wood, bamboo, non-timber forest products, water supply, fishing were calculated by equations (1-3) [12]. The values of the forest products (timber, fuel wood, bamboo, non-timber forest products) of ILWS were calculated by using equation (1) where, V_{FP} is the value of forest products (MMK) per year, A_i is the usage amount per household per year from forest product i (kg) and P_i is the mean value of product price based on the local market during the study time (MMK/kg).

$$V_{FP} = \sum A_i P_i \quad (1)$$

The value of the fishing in ILWS was calculated by using equation (2) where, V_{FH} is the value of fishing (MMK), N_{Pi} is the number of sold units (kg) and V_{Pi} is the average price per sold unit (MMK/kg).

$$V_{FH} = \sum N_{P_i} V_{P_i} \quad (2)$$

The value of the water supply of ILWS was calculated by using equation (3) where, VWP is the value of water supply (MMK), N_m is the average number of household who use water from ILWS, U_{aw} is the average water consumption per household per year (liter) and P_{mw} is the average regional price of water during the study time (MMK/liter).

$$VWP = N_m \, U_{aw} \, P_{mw} \quad (3)$$

2.2 Calculation of the intangible ecosystem service (recreational value) of ILWS

In order to measure the recreational value of ILWS, travel cost method can be applied [11]. It is a survey-based approach and it can estimate the recreational value of an ecosystem according to the money spent (e.g. travel costs, entry fee, accommodation, food, etc.) for the whole trip [10, 13, 14]. In this study, in order to calculate the recreational value of ILWS (consumer surplus or the area ABC in Figure 2), the demand function was estimated using multiple regression model as shown in equations (4) and (5), where r is the number of trips taken by an individual within a time period to the site (dependent variable), tc_r is the total cost of a trip to the particular site, which will include a person's travel expenses, access fees, equipment cost, accommodation, food, etc., variable y is individual income, β is the coefficient of the variables, and $z_1, \ldots, z_n$ is a vector of demographic variables such as occupation, gender, education, etc.

$$r = f(tc_r, y, z_1, \ldots, z_n) \quad (4)$$

$$r = Constant + \beta_{tc_r} tc_r + \beta_y y + \beta_{z_1} z_1 + \beta_{z_2} z_2 + \beta_{z_n} z_n \quad (5)$$

In Figure 2, the relationship between trips and trip cost can be seen. When trip cost increases, the number of trips decreases and vice versa.

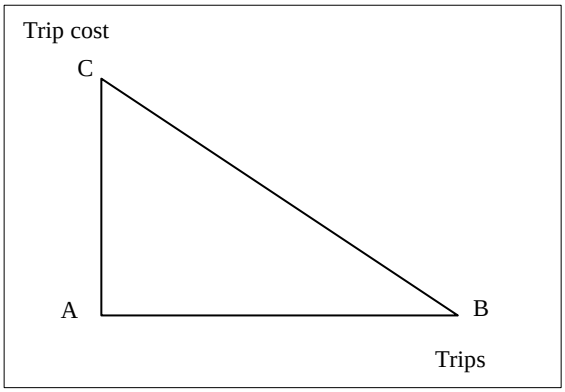

Figure 2. Relationship between number of trips and trip cost.

2.3 Data collection

Two sets of surveys were conducted. One set of the surveys was conducted among the villagers (local users) who live in the villages around ILWS to estimate the tangible direct use value of ecosystem in ILWS. Another set of the surveys was conducted among visitors who come to ILWS for a short stay to assess the intangible direct use value of ecosystem in ILWS. In this study, only the national visitors were focused on because there only a few international visitors coming to ILWS every year [9].

The following Tara Yamane formula (equation 6) was used to determine the sample size, where n is the sample size, N is the population size and e is the level of precision.

$$n = \frac{N}{1 + N\,(e)^2} \quad (6)$$

A 95% confidence level and P (significance level) = 0.5 are assumed for equation 6. In this equation, the level of precision like 3%, 5%, 7% and 10% can be used based on the

perception of the surveyor**.** If the level of percentage is greater and greater, the sample size will be smaller and smaller **[**15**].** In this study, 10% precision level was used for both villager and visitor surveys**.** Based on equation 6, 100 villagers **(**size of the population is 50,375**)** were interviewed**.** To calculate the sample size for visitors, there is no published data on national visitors for ILWS. However, according to the Table 1, the average number of visitors was 1,213 per day and 442,745 per year **[**16**].** Based on this data and Table 8 **(**Taro Yamane table**)** (Appendix), 204 visitors were selected and interviewed.

The number of interviewees in each village is defined based on the population size of the village**.** In this study, 19 households in Lonton (234 total households), 18 households in Lonesant (223 total households), 23 households in Hepu (285 total households), and 40 households in Nyaungbin (484 total households) were selected **[**9**]**.

Table 1. Daily domestic tourist arrival at ILWS.

Date	Number of visitors
21 November 2018	678
22 November 2018	1,528
23 December 2018	1,091
24 December 2018	1,467
25 December 2018	1,360
4 January 2019	1,154
Total	**7,278**

The first set of the questionnaire survey was administered to 100 households in four villages, namely, Lonton, Lonesant, Hepu and Nyaungbin which are located at the fringe of the lake (Figure 3). The interviewed villages were selected to cover all the areas of the lake. As shown in Figure 3, the villages are located as follows: Lonton (southwest), Lonesant (northeast), Hepu (southeast) and Nyanugbin (North). They are distributed around the lake. The local user respondents were asked about demographic information (age, religion, marital status, education, occupation, etc.), and benefits they got (timber, fuel wood, NTFPs, etc.) from ILWS in order to estimate the value of tangible forest products. Before conducting the interview, four events of local community leader interviews were also conducted in order to know general information about villages. After that, the questionnaires were completed with face to face interviews according to the suggestions of the village heads.

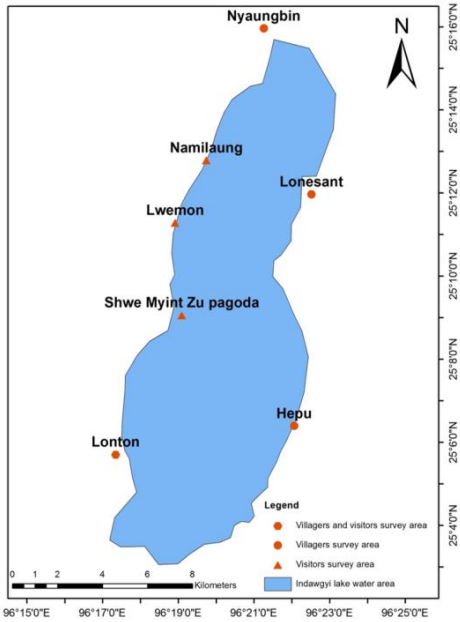

Figure 3. Map of the surveyed areas.

In the case of visitors, 204 national visitors were interviewed at four visitor attracting sites (Figure 3), namely, Indawgyi Environmental Education Center (Lonton village), Shwe Myint Zu Pagoda (Nampade village), nat (spirit) shrine which tells the story of Indawgyi lake (Lwemun village) and Aung Nyein Aye Chanthe Gyi bamboo Buddha image (Nanmilaung village) to estimate the recreational value of ILWS. They were also asked their demographic information and travel cost to the lake. On-site face to face and self-administered processes were applied. Questionnaires were composed of close-ended and open-ended questions Interviewees were purposively selected. Using simple random sampling method of which the basic principle is all samples have the same opportunity of selection [17].

3. Results and Discussion

3.1 The value of tangible direct use ecosystem services of ILWS

To estimate the values of ecosystem services of ILWS, the exchange rate considered is 1 USD equal to 1,524 MMK (Myanmar Kyat). According to the results, most of the respondents are aged between 40 to 49 (31%) followed by 30 to 39 (25%). The age groups between 20 to 29 and 50 to 59 are the same at 14% each while the age group 60 and above, and under 20 are only 10% and 6% respectively. There are 100 households with 610 members making the average family size as 6.10 members (Standard Deviation-SD = 1.96) per household.

The literacy status of the residents in the study area was also collected. About 7% and 6% have graduate and undergraduate education while 15% are high school level, and 33% are secondary school level. The remaining 39 % have the primary school level education. Regarding the occupation, agriculture is the major activity, accounting for 39% followed by fishery (32%). Out of the remaining, 20% are self-employed (shopkeepers), 3% are government staff and 6% are employed as other professionals such as general workers, retailer and mining workers.

During the survey, the residential status of the interviewees was also recorded, i.e. for how long the interviewees have lived in the study areas. The result showed that 69% of the households are native. Native means the people who have been living in the study area since they were born and until now. The remaining 31% of households moved to the study area with many reasons such as for doing agriculture, fishing and so on.

In the study area, timber is used for household needs, agriculture, fishery, etc. Most of the interviewed households used the timber in the range of 0.2 to 0.3 tonne per year, accounting for 51%. Only 19% of households used 1 tonne and above.

In the study area, all of the households use fuel wood for cooking. Some households use both fuel wood and charcoal for cooking. With regards to the fuel wood usage, about 38% and 33% of households used 1.5 to 2 tonne and 0.5 to 1 tonne per year, respectively.

According to the survey, many households use bamboo for different purposes including house construction, agriculture, etc. In ILWS, each household used the bamboo stem from 10 to 50 per year, accounting 58%.

In ILWS, all interviewed households used different NTFPs. Generally, most of the households bought NTFPs from collectors while a few households collected NTFPs for consumption, and some excessive products were sold in the local market .Mainly they used bamboo shoots, mushrooms, honey and medicines. Most of the households (51%) used the NTFPs which are equal with the value from 5,000 to 20,000 MMK per year.

In ILWS, fishing is the second most popular occupation of the local community. About 13% of households earned income by catching 110 to 150 kg fish per month. However, just only 2% caught from 160 to 200 kg per month. In the study area, a small percentage of households used the water from the lake for drinking and household use. They mostly used the water from the tube wells, 88%.

During the interview, almost all of the villagers answered that they also have responsibility to maintain ILWS. They are strongly willing to participate in the development programs. Currently, some of the villagers are the leaders and members of local community forestry user group. Moreover, almost all of the villagers have been participating in awareness programs organized by government or non-government organizations. It could lead to increase in their general knowledge on the environment. The forest department has been conducting awareness programs (at least 30 times per year) especially at villages and schools (primary, secondary and high schools).

3.1.1 Value of timber

The local price of one tonne (1,000 kg) of timber is 400,000 MMK (262.47 USD). The average timber usage per household was 0.383 tonne (383 kg) annually. Therefore, the estimated timber value from ILWS per household per year is 153,200 MMK (100.52 USD), and per person per year is 25,115 MMK (16.48 USD) by using the equation (1). These amounts are different from other studies. The annual incomes of the household from timber at two villages, Tone Nge and Hee Laung which are situated in Natma Taung National Park, Myanmar were 60,030 MMK (39.39 USD) and 85,670 MMK (56.21 USD) respectively [8]. These differences may be due to the situation of timber usage of people at different study areas. For example, in the current study area, fishery is the second most common occupation type, and the fishermen use timber frequently to repair of their boats. However, the major occupations of Tone Nge and Hee Laung villages are agriculture, livestock breeding and limited off-farm employment [8].

3.1.2 Value of bamboo stem

The result shows that the range of bamboo usage per household per year is from 10 to 200 stems with a mean value of 70 stems. In the study area, the average local market price per stem is 1,000 MMK (0.66 USD). Therefore, using the equation (1), the estimated value of bamboo per household per year is 70,000 MMK (45.93 USD), and per person per year is 11,475 MMK (7.53 USD). In the study area, households use bamboo for their house construction especially the walls (70% of households) and floors (45% of household) [18].

3.1.3 Value of fuel wood

Interviewed households (100) used 354 cars (two cars = 1 tonne = 1,000 kg) annually. The average local market price is 30,000 MMK (19.69 USD) for one car. Each household uses 1.77 tonnes (1,770 kg) per year and 0.29 tonnes (290 kg) per person per year. Therefore, using the equation (1), the estimated annual value of fuel wood provided from ILWS per household is 106,200 MMK (69.69 USD), and per person is 17,410 MMK (11.42 USD). In a similar study conducted in ILWS, the estimated fuel wood usage per person per year was 0.32 tonnes (320 kg) [18]. Though the fuel wood usage in study area is nearly the same during these years because they have been relying on the fuel wood for cooking instead of other fuel sources, the practice is not systematic and inefficient for wood consumption because of using traditional three-legged stoves [18]. Once again, this result is similar to the finding of other study. Per capital consumption of fuel wood in Myanmar were 0.30, 0.29 and 0.28 tonnes respectively in 1990, 2000 and 2015 [19]. However, other studies showed that the estimated value of fuel wood consumption per household was different. The annual fuel wood consumption per household was 4.08 tonnes (4080 kg) [20]. Moreover, the annual income of households from fuel wood at two villages, Tone Nge and Hee Laung which are situated in Natma Taung National Park, Myanmar as 197,325 MMK (129.48 USD) and 160,113 MMK (105.06 USD) per household [8]. It is due to the fact that the collection of fuel wood is the major income source of the Natma Taung area, but not in ILWS. One more thing that should be pointed out is that in the current study area, there was electricity access in some areas and they also used electricity (do not know exactly the percentage of households using electricity) but not at the Tone Nge and Hee Laung villages [8]. Charcoal is not the most common forest product for household daily use in the study area. A few households (11%) used charcoal for cooking; each household used 0.63 bags annually (average local market price is 3,000 MMK (1.97 USD) for one bag). Based on this amount and the local market price, the total value of charcoal provided from ILWS per household per year is 1,890 MMK (1.24 USD), and per person per year is 310 MMK (0.2 USD).

3.1.4 Value of non-timber forest products (NTFPs)

From equation (1), the value of NTFPs provided from ILWS per household per year is 21,865 MMK (14.35 USD), and per person per year is 3,585 MMK (2.35 USD). The income from the selling of NTFPs was approximately 21 USD per household per year [21]. However, in the current study the value comes from the average of both commercial and subsistence use. Moreover, the resulting value is different because of the products considered in estimating the value. While [21] considered mushrooms, vegetables, insects, animals, ant's eggs, honey, fuel-wood, and medicinal plants as NTFPs, the current study included NTFPs include only bamboo shoots, mushrooms, honey and medicinal plants.

3.1.5 Value of fishing

Each household catches 33.64 kg monthly and 302.74 kg annually. The average local market price is 1,250 MMK (0.82 USD) per kg. To calculate the annual average amount, only 9 months should be accounted for because, in the study area, the government officially announced that 3 months from April to June is the non-fishing period. Therefore, using equation (2), the estimated annual value in the fishing of ILWS per household per year is 378,425 MMK (248. 31 USD), and per person per year is 62,037 MMK (40.71 USD). However, a different result can be seen in the calculation based on the data supported by the Fishery Department (Indawgyi area); according to them, each household catches 9.32 kg per month. This is due to the fact that the data of Fishery Department is only collected from fish collectors (big sellers) who collect the fish from fishermen to sell at markets and only the data of commercial sale is included rather than subsistence use.

3.1.6 Value of water supply

Total water consumption per day was only 612 gallons (2,317 liter). On average, 6.12 gallons (23 liter) were used per household per day (2,233.8 gallons per year (8456 liter)). According to the interview, the average local price of water is 1,000 MMK (0.66 USD) per 30 gallons (114 liter). Therefore, using equation (3), the average value of water from ILWS per household per year is 74,453 MMK (44.68 USD), and per person per year is 12,205 MMK (7.32 USD). The result of the current study is totally different from the research conducted by [19] where most of the households (82%) used lake water for drinking and household use and the remaining 18% used the water from tube wells. One of the reasons for this may be due to

the changing of water quality because during the interview, most of the respondents said that water quality of the lake has deteriorated due to mining, waste disposed to the lake, etc.

3.2 The value of intangible direct use ecosystem services (recreational value) of ILWS

Most of the 204 visitors (121 males and 83 females) interviewed were in the age group between 20 to 29 (46%) and 30 to 39 (23%). The majority of the respondents' occupation was self-employment (71 respondents out of 204. The majority of respondents were graduates (36%) followed by high school (28%). Most of the visitors knew ILWS from their friends and relatives (68%). About 40% gathered information from online sources. The least percentages were from television (5%), magazine (1%), newspapers (2%) and others (5%).

Most of the visitors used private cars (44%) which included visitor's own cars and organized tour cars and motorbikes (40%). The respondents who used the motorcycles were not too far from ILWS, but they were all outside of ILWS. For example, they came from Myitkyina (180 km), Monyin (110 km), Hpakan (72 km), Hopin (53 km), etc.

The visitors can stay at different accommodation types in ILWS such as motel, guest house, homestay, relative's home, monasteries, etc. The interviews revealed that most of the visitors (67%) chose the guest houses for accommodation. However, based on the interviewer field survey experiences, there are not enough guest houses in the study area to accommodate all the visitors. For example, most of the visitors have to stay in the living room of the guest house when all of the bed rooms are full. Sometimes, when they arrive in a large tour group of more than 40 visitors, they face difficulties, especially in accommodation. The respondents' staying period in ILWS was varied and ranged from 1 to 10 days. Most of the respondents stayed in ILWS for one day (57%) while 23% spent 2 days. The average lenght of stay was 2 days.

The estimated trip cost of the visitors was also recorded. Trip cost includes the money spent for all purposes during the trip especially accommodation, food, transportation and souvenir. Selection of items in trip cost was based on the actual visitors spending during the trip. Almost all of the selected items were similar with other studies as shown in Table 2. The trip cost was varied based on many factors like the distance of the respondent's home to ILWS, the number of days stayed in ILWS, etc. The result showed that the trip cost was varied from approximately 10,000 MMK (7 USD) to 300,000 MMK (200 USD) during the trip. Table 3 and Table 4 show the description of the dependent and independent variables and their measurement values used in multiple linear regression.

Before the variables used in the regression, checking the relationship between independent variable was conducted by using Pearson's correlation (Table 5). According to the Table 5, among the four independent variables (gender, age, income and trip cost) used in regression have no correlation.

Table 6 shows the regression analysis of various independent factors on the number of trips taken by an individual within a time period to the site (dependent variable). The income is seen to be positively correlation with the number of trips ($p \leq 0.01$) which means that the number of trips will increase when the level of income increases. This seems quite intuitive and similar results were also shown by [22, 23, 24]. The age group is also positively correlation with the number of trips ($p \leq 0.01$), suggesting that the young people are traveling more than the old people. Especially the age group between 25-33 took more trips than the other age groups. However, money spent on the trip was negatively correlation with the number of trips ($p \leq 0.01$) which means that if the visitors used more money during the trip, the amount of the trips will be decreased. Once again, this result is similar to the findings of [22, 24, 25]. Moreover, the minus sign of the coefficient for the trip cost is also in agreement with the theory.

Table 2. Items considered in trip cost.

Author	Study area	Items
[14]	Slovakia	Accommodation, food, shopping, entrance fees, museums, transportation, sports
[23]	China	Travel cost, entrance fees, other expenses (eg: food, equipment, entertainment, etc.), time cost
[26]	Bangla-desh	Round trip cost, opportunity cost of round trip travel time, entrance fees

Table 3. Desription of the dependent and independent variables used in multple linear regression.

Variable name	Description	Variable type
Gender	Respondent sex	Binary
Age	Respondent age (year)	Continuous
Income	Income of respondent (USD)	Continuous
Trip cost	Money spent during the trip (USD)	Continuous
Number of trips	Number of trips taken by an individual during the past 12 months (trip)	Continuous

Table 4. Measurement values used in multiple linear regression.

Variable name	Minimum value	Maximum value	Mean value
Age (Year)	18	63.5	30.04
Income (USD)	0	519.29	209.32
Trip cost USD)	6.56	196.85	37.94
Number of trips (trip)	1	10	2.05

Table 5. Correlation among the independent variables.

	Gender	Age	Income	Trip cost
Gender	1	-0.020	-0.106	0.087
Age	-0.020	1	-0.093	0.106
Income	-0.106	-0.093	1	0.109
Trip cost	0.087	0.106	0.109	1

Table 6. Result of the multiple linear regression modeling (R^2 = 0.15).

Variables	Coefficients	Std. Error	*p*-Value
(Constant)	1.653	0.323	0.000
Gender	-0.411*	0.191	0.033
Age	0.023**	0.174	0.009
Income	0.002**	0.001	0.010
Trip cost	-0.013**	0.003	0.000

Notes: Dependent variable is the number of trips taken by an individual within a time period to the site; R Square represents how much influence does the independent variable have on dependent variable, ranked from 0 to 1; Standard Error (Std. Error) shows the standard deviation of the regression coefficients; *p*-Value means the confident level of the coefficients (≤ 0.01 is 99% confident level and ≤ 0.05 is 95% confident level); *Significant at the 0.05 level; **Significant at the 0.01 level.

According to the result of multiple regression analysis, the demand function can be written as follows:

$$r = 1.653 - 0.013\ trip\ cost - 0.411\ Gender + 0.023\ Age + 0.002\ Income \quad (7)$$

According to the result of demand function, the demand curve can be drawn as in Figure 4. In the figure, the area ABC is the consumer surplus of ILWS per individual per year, and its value is 260 USD. According to the Table 4, the average number of trips taken by an individual in the past 12 months was 2.05 trips. Therefore, the consumer surplus per trip to ILWS is 127 USD. The estimated domestic tourists' arrival to ILWS is 442,745 per year [16]. Therefore, estimated total consumer surplus or recreation value of ILWS is 56.23 million USD per year.

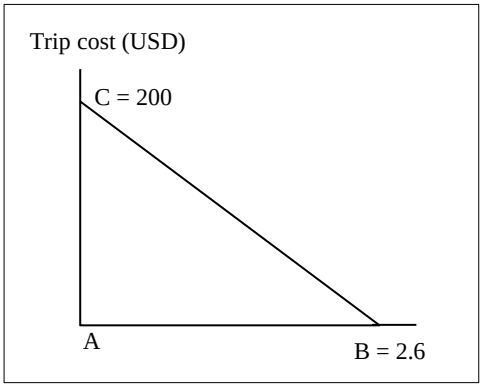

Figure 4. Consumer surplus

3.3 Total annual value of direct use ecosystem services of ILWS

The estimated direct use ecosystem services of ILWS are valued at 60.91 million USD as shown in Table 7. The value of Table 7 are coverted to the value of per h ousehold per year in Section 3.1 by multiplying with 8,922 because a total of 8,922 households are living in ILWS. Among the value of the services, recreational value is positioned in the first place followed by fishing. It could be due to the fact that ILWS is one of the places of attraction for visitors to the Kachin State in northern Myanmar. Visitors can enjoy with different recreational activities. The least benefit is from charcoal. It might also be because the households in study areas use only a small amount of charcoal for cooking, for which fuel wood is mostly used.

Table 7. Total annual direct use value of ILWS.

No.	Ecosystem services	Value/year (million USD)
1	Recreation	56.23
2	Fishing	2.22
3	Timber	0.90
4	Fuel wood	0.62
5	Bamboo	0.41
6	Water supply	0.39
7	NTFPs	0.13
8	Charcoal	0.01
Total		**60.91**

3.4 Willingness to pay of the visitors on accounting the entrance fees

At present, all visitors can access to ILWS without entrance fees. On the one hand, this situation is very convenient and fine for visitors. On the other hand, the government can serve and conserve ILWS in a sustainable way by using the revenue from the visitors' entrance fees. To test this idea further, the perception of visitors relating with the entrance fees was also collected. Proposed entrance fees were divided into 6 groups: (1) NO, (2) under 1,000 MMK, (3) 1,000 to under 3,000, (4) 3,000 to under 5,000, (5) 5,000 to under 10,000 and (6) 10,000 and above. "NO" means the respondents do not prefer to pay the entrance fees; they want to access the lake for free. According to the result, the most preferable amount for entrance fees was 1,000 to under 3,000 MMK (45%), and under 1,000 MMK (18%). On the other hand, about 14% of the respondents did not prefer to pay any entrance fees at all. Based on the results, 86% of the visitors were willing to pay entrance fees.

3.5 Accounting entrance fees and potential consumer surplus in next year

According to the Figure 5, if the trip cost increases, the number of trips will be decreased. For instance, if the trip cost is $tc_{r\ 1}$, the consumer surplus is the area CDE. However, when the trip cost is changed to tc_{r2}, the consumer surplus is also changed to the area ABC. To test this idea further, total consumer surplus was calculated by assuming the entrance fee of 1.32 USD (proposed by 45% of visitors). 14% of visitors do not want to pay for entrance fees. Therefore without consideration of 14% of visitors' information, the demand function can be written as follows:

$$r = 1.686 - 0.013\ trip\ cost - 0.500\ Gender + 0.021\ Age + 0.002\ Income \quad (8)$$

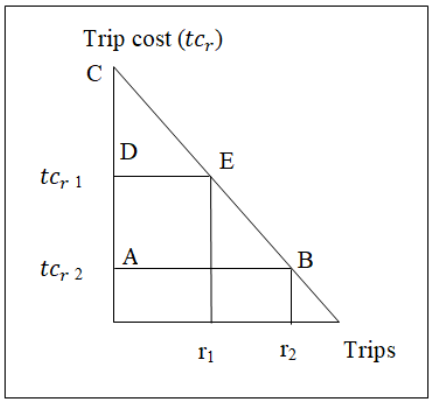

Figure 5. Relationship between trip cost and consumer surplus.

According to the result of demand function, the demand curve can be drawn as in Figure 6. In the figure, the area ABC is the consumer surplus of ILWS per individual per year, and its value is 240.66 USD. The average number of trips taken by an individual in the past 12 months was 2.1 trips. Therefore, the consumer surplus per trip to ILWS is 115 USD. The estimated domestic tourists' arrival to ILWS is 442,745 per year [16]. However, by assuming 14% of visitors who answered that thay do not want to pay for entrance fees will not visit to ILWS next year, after 14% of visitors' potential trips were subtracted from total trips of 442,745, the potential trips in the next year would be 380,761. Therefore, estimated total consumer surplus or recreation value of ILWS is 43.79 million USD per year. Therefore, the total consumer surplus of ILWS will decrease by 12.44 million USD in the next year.

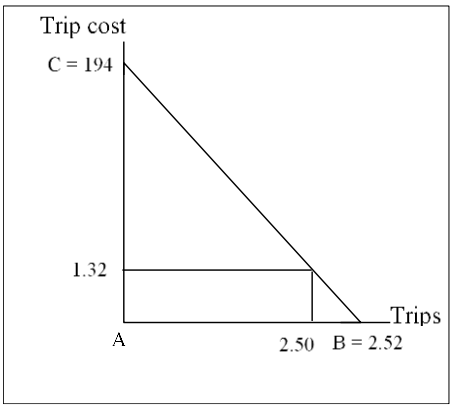

Figure 6. Potential consumer surplus with entrance fees 1.32 USD.

However, in the long term, generating extra income from entrance fees can help maintain the development of ILWS. For instance, as discussed in the previous section, guest houses in ILWS are limited. So, the additional revenue from entrance fees can be used for constructing more guest houses, and fees can be set as the low prices for visitors. In this way, win-win situation can be achieved in ILWS. Moreover, although the number of trips is reduced, it can also lead to the less flow of visitors resulting in less environmental impacts of visitors in ILWS.

3.6 Main reasons for visiting ILWS

In order to investigate the most influencing factors for visitors when deciding to visit ILWS, data on their activities of interests were also collected. According to the Figure 7, the historical significance of ILWS is the most influencing factor followed by easy to access to the lake. It is because historical sites like the Shwe Myint Zu Pagoda, one of the famous pagodas in Myanmar, are located within the lake. Some visitors are interested to visit ILWS for bird watching. Therefore, bird watching becomes the third influence on visitor choice. In addition, people who love to enjoy kayaking can easily rent a kayak from Indawgyi Environmental Education Center which is organized by cooperation among the Forest Department, Fauna and Flora International (FFI) and Inn Chit Thu (Lovers of the Lake) which is the local tourism initiative group. Some tourists enjoyed hiking, fishing and bicycling during their visit. According to the visitors' personal perception, the important sectors that need to be improved in the lake were also recorded (Figure 8).

3.7 Main drivers of ecosystem services in ILWS

Main drivers on degradation of ecosystem services in ILWS are illegal logging, overfishing, gold mining, waste disposal, fuel wood consumption, etc.

3.7.1 Illegal logging

Illegal logging leads to the deforestation in ILWS and it has been increasing [27]. One of the main reasons of increasing illegal logging is the conflict between the Kachin Independence Army (KIA) and Burmese government forces. KIA controlled the northernmost and western parts of the lake [28]. The sanctuary staff have difficulties to control these areas and leads to illegal logging. Moreover, one of the challenges of the government is providing limited staff. According to the Forest Department, currently, ILWS is managed by 23 staff. Moreover, the sanctuary itself is located in an isolated area and is accessible only by unpaved mountain road.

3.7.2 Gold mining

Mining is a challenge to fish production, water pollution and deforestation in ILWS. In ILWS, gold mines are operated along the inflow streams. Most of the mining companies are controlled by the Chinese. The mercury used in refining can lead to water and soil pollution due to increasing mercury contamination in water and soil [18]. According to the researcher's personal observation, the water in some of the inflow streams are yellow and dirty. It is clear that the chemicals released from mining will enter to the lake and lead to water pollution. Indawgyi Environmental Education Center also shows that sedimentation due to gold mining has affected on adjacent rice fields, aquatic plants and animals. Moreover, the forests are also destroyed due to mining.

3.7.3 Overfishing

The level of fishermen migration has been increased over the past decades in ILWS. The residential status of households in ILWS showed that 31% of households moved to ILWS with many reasons especially for agriculture and fishing. Fishery is the second most common occupation type (32% of households) and also the main sources of their income. As a result, it could lead to intensive fishing practices. These are the reasons of overfishing in ILWS. Apart from this, sometimes improper fishing methods such as using small gill net, electric shock and poison fishing, etc. are also the challenges of reducing fish production [18, 29]. There are 8 core zones, namely (1) Nam Mawkkan, (2) Lon Sant, (3) Shwe Taung Pagoda, (4) Mamon Kaing, (5) Lon Ton, (6) Shwe Myint Zu Pagoda, (7) Namni Laung, and (8) Nyanug Bin. Although fishing is not allowed in the core zone of ILWS, illegal fishing is commonly found in these zones [28].

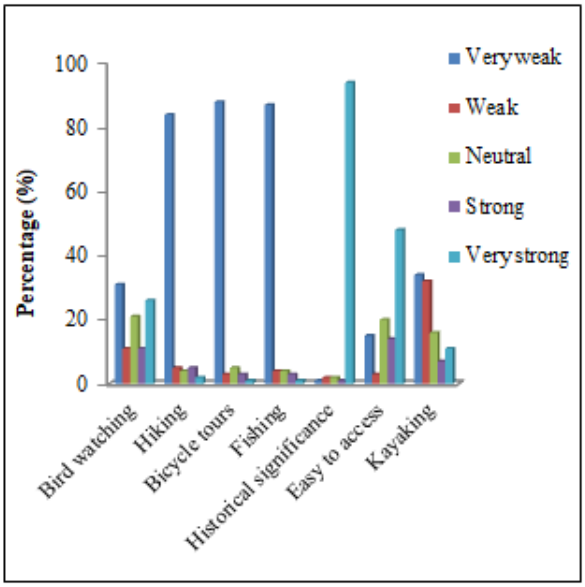

Figure 7. Main reasons for visiting ILWS.

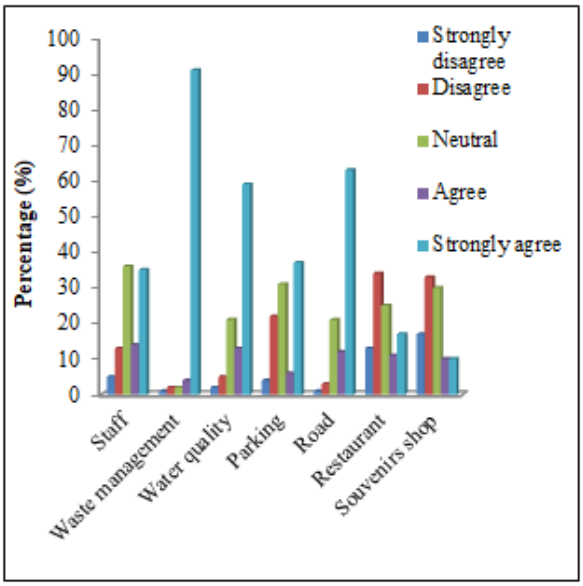

Figure 8. Things needed to improve in ILWS.

3.7.4 Waste disposal

Although some organizations such as Fauna and Flora International (FFI), Inn Chit Thu (local tourism initiative group), the Funeral Association (Parami), etc. provide the community-based waste management system in the Indawgyi area, waste problem is still a challenge in this area [18]. It is due to the lack of municipal waste collection systems and limited knowledge.

According to the researcher's personal observation, the households especially situated in the fringe of the lake discard their household wastes to the lake. One of the waste problems of the Indawgyi area is tourism. The data collection coincided with the time of Shwe Myint Zu annual pagoda festival which takes 7 to 10 days. Many visitors came to enjoy this festival. During the festival, although local community can obtain some amount of income from the visitors by selling of local souvenirs products and food, the amount of waste is increased. Although some of the waste bins are provided along the road to pagoda, some visitors disposed their wastes directly to the water body. Moreover, many shopkeepers also came to sell their products such as clothes, food, etc. at the festival and they disposed their wastes on the bank of the lake. These wastes can directly enter into the lake due to the run-off in the rainy season or even due to the flow of wind.

3.7.5 Fuel wood consumption

All of the interviewed households depend on the surrounding forests for construction, fuel wood and other purposes. Fuel wood consumption is negatively affected on deforestation. On the other hand, some people argue on this statement because they think that dead woods are collected for fuel wood [30]. According to the researcher's personal point of view, in the current study area, all of the households use the stem of the hard wood for fuel. It is definitely not dead wood because the woods are freshly cut wood and they are wet. To conclude, it is clear that fuel wood consumption is connected to deforestation in the Indawgyi area. Deforestation can lead to habitat loss, soil erosion, flooding, etc.

4. Policy Recommendations

According to the section 3.7, it is clear that there are many challenges on the degradation of ecosystem services in the Indawgyi area. Therefore, in this section, some recommendations were developed in accordance with the values of the ecosystem services in the previous section (3.3) and how can these values play a role in addressing these problems. Moreover, other necessary data were also recorded during the interviews in order to develop other possible recommendations as well.

- The values obtained in this study can be used when the areas of ILWS are transformed to other land use. For instance, these values can be used in estimation of deforestation cost which can be caused due to mining, illegal logging, etc., and the government can use this cost in case of deforestation compensation.
- The values can also be integrated in different decision-making tools such as cost-benefit analysis (CBA), life cycle assessment (LCA) or life cycle costing (LCC). For instance, when using the CBA, the value of ecosystem services can be compared with the estimated value of cost and benefits which include all activities and processes [31].
- The estimated value of ecosystem services in the current study will be useful in public awareness programs by informing how forest ecosystem services have multiple values and how much they provide to the local communities for their livelihoods. As a result, they will know the benefits of ecosystem services, and they can understand that these benefits will be lost if the forest is degraded.
- The information related with natural areas and national parks like ILWS should be better disseminated via television programs, magazines and newspapers because most of the visitors knew about the ILWS from their relatives and not so many from television, magazines and newspapers.
- The number of guest houses and other accommodation types like motel (at present, only one motel in the study area), home-stay should be increased in ILWS.
- According to the willingness to pay of visitors on accounting the entrance fees, most of the visitors prefer to pay the entrance fees from 1000 MMK (0.66 USD) up to 3,000 MMK (1.97 USD). Therefore, the government should attempt to maintain the quality of the recreational benefits in terms of sustainable ways by counting the entrance fees. However, one thing the government needs to consider is that the recreation value of ILWS will decrease by 7.48 million USD per year if the entrance fee of 1.32 USD is accounted.
- The government should try to cooperate with the local community at the implementation stages for development of awareness or other development programs because participation of the public or local communities is crucial. During the interviews, local villagers living around ILWS indicated that they are willing to participate in the development program because they think that they also have responsibility to conserve ILWS.
- The government should try to improve and promote ecotourism because visitors can enjoy kayaking, bird watching, fishing, etc. in and around ILWS. Improving the areas for bird watching and making easy to access of kayaking can be the way towards ecotourism development in the areas of ILWS because these activities are the main reasons when making decision for visiting ILWS.
- Appropriate waste management, road and increasing water quality are basic needs to maintain the quality of recreational benefits because, according to the perception of the visitors, waste management, road, water quality and staff are the most important sectors that need improvement in and around the lake.

5. Conclusions

This study estimates the value of direct use ecosystem services, including marketable and non-marketable services, in ILWS. In the case of marketable services, the study has revealed that fishing has the highest value followed by timber. In terms of non-marketable service (recreational value), the estimated consumer surplus or recreational value per trip per visitor is 127 USD. The estimated total annual direct use value of ILWS is 60.91 million USD.

This study indicates that sustainable management and conservation of the lake can be facilitated by developing suitable payment for entrance fees because, currently, all visitors can access ILWS without entrance fees. The result shows that most of the visitors are willing to pay entrance fees from 1,000 MMK (0.66 USD) up to 3,000 MMK (1.97 USD). However, one thing the government needs to consider is that the recreation value of ILWS will decrease by 12.44 million USD per year if the entrance fee of 1.32 USD is accounted.

Moreover, ecotourism development can be achieved in the study area because many environmental activities including bird watching, kayaking, biking and fishing can be done in ILWS.

The estimated values in this study might provide the basic background information for policy makers when designing management and conservation plans and strategies for the lake. Moreover, these results will be useful in public awareness programs by informing the value of forest ecosystem services in monetary terms and also how much benefit they provide to local communities for their basic needs such as foods, medicines, etc.

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Conflict of Interest

The authors state no conflict of interest.

Appendix

Table 8. Sample size for ±3%, ±5%, ±7% and ±10% precision levels where confidence level is 95% and P=0.5.

Size of population	Sample size (n) for precision (e) of			
	± 3%	± 5%	± 7%	±10%
500	A	222	145	83
600	A	240	152	86
700	A	255	158	88
800	A	267	163	89
900	A	277	166	90
1000	A	286	169	91
2000	714	333	185	95
3000	811	353	191	97
4000	870	364	194	98
5000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100
a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.				

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