

An Estimation of the Value of Ecosystem Services in the Taung Thaman Lake: Production Function Approach

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The Taung Thaman Lake is the main water source in the Amarapura Township for agriculture and livelihoods. The aim of the study is to estimate the value of ecosystem services of the Taung Thaman Lake. The Cobb-Douglas production function is used for the analysis of the market prices and profit functions of agricultural products. In the market price analysis, oil seeds are the maximum profitability of total production among the three crop groups in the villages. The total economic value of the lake ecosystem is 839,15,000 kyat per year. The profit-function analysis shows that both the output and input prices are significant, whilst input prices are negative relations to profit. Therefore, the net income for the agricultural sector in the four villages (Oh Bo, Semihtun, Htantaw, and Taungthaman) depends mainly on the output and input prices of commodities.

Key Words: agricultural sector, market price and Cobb-Douglas production function analysis, profit function, net income, output and input price, total economic value

I. Introduction

Ecosystem services are the availability of natural resources and healthy ecological systems which produce valuable goods and services for the environment and the economy. Among various natural resources, the lakes provide direct and indirect values for improving human livelihoods. Taung Thaman Lake is one of the biggest reservoirs in Myanmar. It provides a wide range of goods and services which have economic values not only for locals but also for communities outside the lake area. The local population directly obtains ecosystem that benefits from the Lake ecosystem. Therefore, this study is based on the water supply of the ecosystem services which is provided by the Taung Thaman Lake.

1.1 Rationale of the Study

Ecosystem functions generate ecosystem services that support socioeconomic, livelihood, goods and services. Lake is one of the ecosystems; it provides many ranges of ecosystem services. There are four major lakes in Myanmar. They are Indawgyi in the Kachin State, Inle in the Shan State and Taung Thaman in the Mandalay Region and Rih Lake in the Chin State. Among these Lakes, the Taung Thaman Lake is the largest freshwater lake in Amarapura township. The renowned U Bein Bridge crosses the lake and attracts visitors from around the world. It provides water supply of cultivated land for Taungthaman village tracts. Taungthaman village tracts have income from farming in the Taung Thaman Lake area. In addition, it performs other ecosystem functions, including

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water regulation, water supply and flood control. At present, Taung Thaman Lake is dispersed and exposed by a variety of factors, including over fishing, chemical pollutant from industrial zone, waste disposal, water pollution and construction expansion. All these factors decrease the habits and capacity of the lake and cause the quality of the lake to decline.

The Taung Thaman Lake has a great opportunities and challenges for cultivated land, employment, goods and services sector. Therefore, this study examines the value of ecosystem services in the Taung Thaman Lake.

1.2 Objective of the Study

The objective of the study is to estimate the value of the ecosystem services of the Taung Thaman Lake in terms of money.

1.3 Method of Study

Both descriptive and analytic approaches based on the primary and secondary data. For the primary data, the villagers are selected by using simple random sampling (SRS) for the villages. Secondary data are collected from General Administrative Department, Ward and Village Tract Administration Office, Ministry of Agriculture, Livestock and Irrigation Department, Mandalay City Development Committee (MCDC), Department of Agricultural Land Management and Statistics and Department of Meteorology and Hydrology. Analytic approach is used in calculating the Cobb-Douglas production function approach.

1.4 Scope and Limitation of the Study

This study analyzes the value of ecosystem services in the Taung Thaman Lake from the period of 2016-2017 to 2018-19. For measuring the market-based approach, the collected data are used. Under the market-based approach, direct and indirect use value of the Lake's resources is explored through profit function approach. A total of 350 respondents were interviewed from 4 villages in the Taungthaman village tract (Oh Bo, Semihtun, Htantaw and Taungthaman), who depends on the Taung Thaman Lake water resource obtained from the ecosystem. Questionnaire includes the five sections.

1.5 Organization of the Study

This study is organized with five main sections. The first section is the introduction. In the second section, the literature review is presented. Section three is the historical background of Taungthaman village tracts. Section four is survey analysis and section five is the conclusion with findings and suggestion for the future Myanmar Lake ecosystem.

II. Literature Review

This literature reviews on theory, economic valuation and ecosystem services of the Lake. The benefit of ecosystem services is divided into four groups; provisioning, regulating, supporting, and enhancing cultural value. Therefore, the ecosystem of the lake can be classified into production, regulation, information, and habitat, which provide valuable goods and services for the local people (Barbier, 1994). The assessment of the lake's ecosystem services involves ecological mechanisms and processes in the functions of the ecosystem (de Groot et al., 2002).

Economic valuation includes the assignment of monetary values to changes in environmental services and functions. These values are effective prices. In valuing the ecosystem service, specific components are required to take into account. Particularly, total economic value (TEV) can be classified as use value (direct and indirect use value and option value) and non-use value. Direct use values are the goods and services which are directly consumed by users while indirect use values are the indirect benefits arising from ecological systems. The option value is for potential future uses and for future value of information. Non-use values include the values of bequest, altruist and existence that indicate the satisfaction, individuals derive from the knowledge in which biodiversity and ecosystem services are maintained (TEEB, 2010).

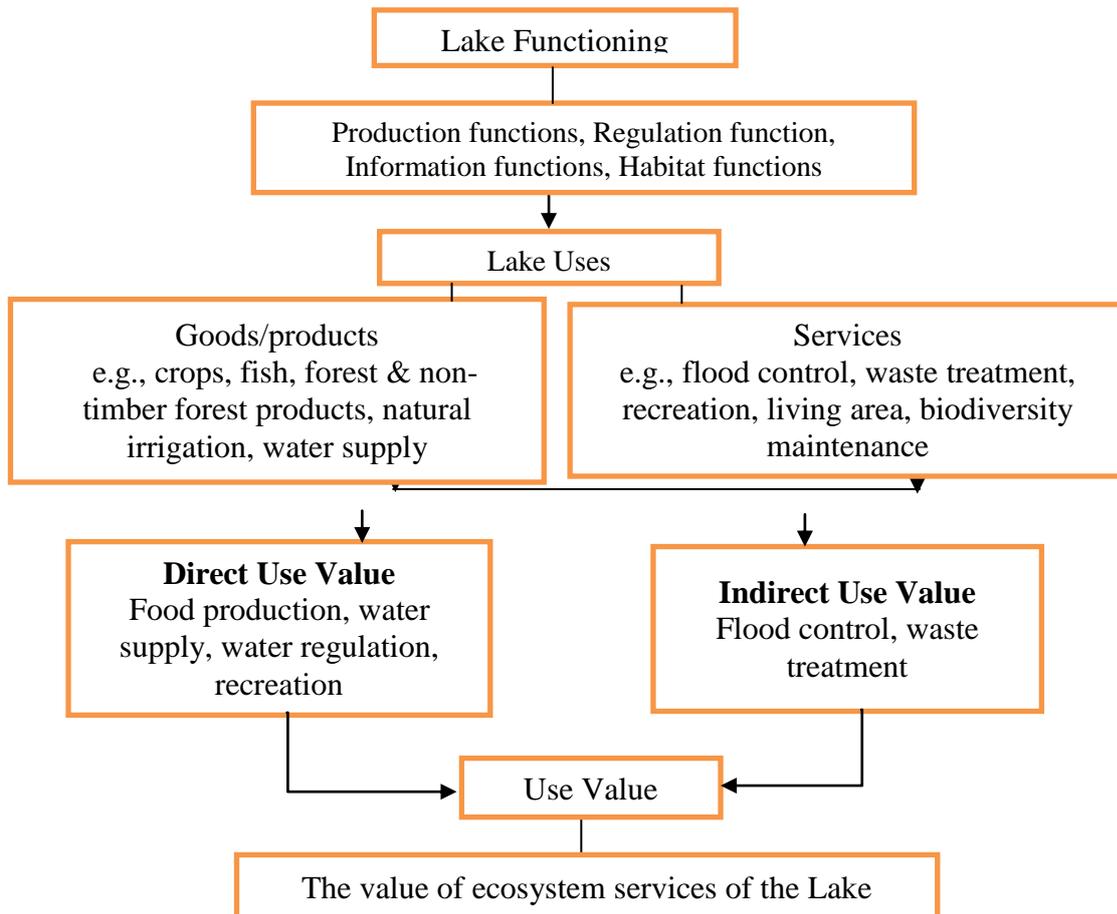
From the application of the TEV framework, the use values of the Lake are divided into direct use values, including the value of material production, entertainment and water supply and indirect use values, such as the value of water conservation, climate adjustment, biodiversity and culture education. Moreover, Lake ecosystem services are classified as ecology services, produce services and society services. Ecology services includes purification, water regulation, climate regulation, and habitat. And produce services are materials while society services consist of recreation and education (Li, T., and Gao, X., 2016)

Therefore, the importance of Lake ecosystem services is to be evaluated in order to link Lake function with Lake values (Turner, 2000). The Value of ecosystem services of the Lake is shown in Figure (2.1).

According to the figure, Lakes ecosystem consists of four ecosystem function- production, regulation, information, and habitat function. The production function that directly benefits local people from the biodiversity of the lake such as food production, raw material, water supply, water regulation and recreation is performed by lakes. The regulation functions that are critical processes in the ecosystem and support life systems are also done in the similar manner. These regulation functions provide several ecosystem services that have direct benefits such as water supply, water regulation, flood control and water quality improvement. The Lakes also make an information function which includes cultural heritage, scientific research, and recreation. In addition, lakes provide habitat function and support nursery and sanctuary areas. These functions provide goods and services, and generate direct and indirect benefits arising from direct

and indirect values. From these values, the use values are obtained and so, the value of ecosystem services of the lake can be assigned in terms of money.

Figure 2.1 The Value of Ecosystem Services of the Lake



Sources: Barbier (1994), Costanza et al. (1997), Turner et al. (2000), and de Groot et al. (2002).

In assigning these value, the various economic valuation techniques to estimate the monetary value of ecosystem services have been developed and employed. The International Union for Conservation of Nature (IUCN) classifies these as:

- (1) Market price-based approaches that value goods and services at their market prices. Market price valuation method, production functions, replacement cost, avoided damage cost, and opportunity cost are key methods.
- (2) Revealed preference methods, such as the travel cost method and hedonic pricing, value ecosystem services indirectly from the purchase prices of goods or services.
- (3) Stated preference methods, such as contingent valuation and choice experiments, estimate non-market values by employing individual stated behavior in hypothetical settings.

In this analysis, produce service in the Lake ecosystem is estimated by using market price valuation method, Cobb-Douglas production function and revealed preference methods

among the valuation techniques.

III. Historical Background of Taungthaman Village Tracts

Amarapura Township has nine wards and forty-two village tracts. Taungthaman village tracts is one of the village groups which depend on water supply from the Taung Thaman Lake for agriculture., There are four villages in Taungthaman village tracts: Oh Bo, Semihtun, Htantaw, and Taungthaman. It is situated between the latitudes of 21° 54' N and 22° 46' N and between the longitudes 96° 00' E and 96° 03' E. Many lands are used for agriculture, with a total area of 1911 acres. There are 776 acres of net cultivated land. It includes 339 acres of paddy, 154 acres of land for planting, 263 acres of alluvial field, and 20 acres of garden. In the central tropical zone of Myanmar, the climate in the village tracts of Taungthaman is extremely hot and dry. The hottest month was between 42.3°C and 43.3°C, in April, in 2015 and 2017. The coldest months were between 13.5°C and 19.5°C in January and February. The Taungthaman village tract has therefore been found to be slightly warm and cool. In the rainy days, inches of rainfall were (40) on average in the Taungthaman village tracts. In other years, no significant differences occurred apart from 2015 to 2017.

The Taungthaman village tracts in Amarapura Township have dark compact and sane myese. Around the lake and flat plain is the meadow alluvial soil. The pH value is roughly 7. The soil is suitable for growing rice, bean, groundnut, sesame, pulses, vegetables etc. Most of the cultivated land is based on natural rain and the Hsedawkyee, because there are occasional rainfalls in the central part of the Taungthaman village tracts. The water coming from the Hsedawkyee to these tracts is irrigated by four ways. One way is from Hsedawkyee to Mandalay canal, the second route from the Mandalay to the Tmotebso main drain, the third is from Tmotebso main drain to Tmotebso c ' drain, and the last is from the Tmotebso c ' drain to Taungthaman village tracts. Among the cultivated land (50) acres are grown by using water from Taung Thaman Lake. After the rainy season, native farmers cultivate Ayeyarmin, a kind of paddy, and on around 50 hectares of silty land, the banks of the Taung Thaman Lake when the water subsides in winter and in summer.

In 2019, there were 1720 households in total population of Taungthaman. village tracts. 519 households are in Oh Bo village, 174 in Semihtun village, 818 in Htantaw village and 209 in Taungthaman village.

Agriculture Sector

Agriculture is the main source of income in the study area. Paddy, groundnut, peas, corn, tomatoes, and vegetables are the main crops. There are six types of paddy which suitable cultivated land for the Taungthaman village tracts. They are Manawthukha, Hsinthwelat, Hsinnweyin, Yaybsinlonethwe, Shwethweyin and Ayeyarmin. In addition to different kinds of crops for oil; peanut, sesame and sunflower, various kinds of beans such as the green gram, blue phaseolus lanatus,

soya-bean, rice bean, seasonal vegetables, millet, corn, and rice bean for cattle are also grown within their capacity.

Since there is a double crop every year, rain paddy is cultivated mostly in the rainy season, and sesame in summer. During the rainy season, the cultivated lands dependent on rainfall and Hsedawkyee dam, are mainly used. During summer seasonal crops can be cultivated, including tomatoes, mustard, chinese kale and lettuce. Farmers grow crops during summer. At that time, they were depended on Taung Thaman Lake's water for cultivation.

Expenses, Income and Profit for Paddy Production

Farmers mainly grow rain paddy in the area of the Taungthaman village tracts and calculate the cost of production for one acre. According to the 2018-2019, estimated cost per acre of land reclamation paddy, dyke reparation, digging swampy canal, and canals around the field for paddy production (Ayeyarmin-seeder) is 120,000 kyats. Cost per acre of price of seeds, sowing the seed in water, covering the seeds, broadcasting seed, pulling out rice seedlings, and transplanting paddy for cultivation is 55,000 kyats. Cost per acre of Urea, T super, chemical fertilizer potted, insecticide, insecticide wages, and weeding for using material aid is estimated 100,000 kyats. Production costs per acre of harvesting, carrying a sheaf of paddy are 102,000 kyats. Therefore, total estimated cost per acre of paddy production (Ayeyarmin) in the Taungthaman village tract is 377,000 kyats and there are (339) paddy acres in the whole Taungthaman village tracts.

In 2018-2019, it was found that the cost of production per acre on other crops is estimated about 334,000 kyats for the production of groundnut, 150,500 kyats for sunflower, 200,200 kyats for sesame, and 142,000 kyats for red phaseolus lunatus production, 174,000 kyats for rice-beans, 144,500 kyats for soya-beans, and 150,000 kyats for green gram.

Manawthukha, Ayeyarmin and Shwethweyin are the types of paddy produced from the village of Taungthaman in 2018-2019. The selling price of Ayeyarmin, Shwethweyin, and Manawthukha is 10,500 kyats, 8,500 Kyats and 7,000 kyats per bushel respectively. The average rate of paddy production per acre is about 94 bushels. Therefore, the estimated revenue of paddy (Ayeyarmin) production per acre is 987,000 kyats.

The total profit per acre is 610,000 kyats, based on the difference in estimated revenue per acre of 987,000 kyats and estimated cost per acre of 377,000 kyats. In 2018 – 2019, there are (339) cultivated paddy acres in the whole villages, and total paddy production is (31,866) bushel. Therefore, estimated revenue amount of Ayeyarmin is (31,451,742,000) kyats and the estimated total paddy costs are (12,013,482,000) kyats. Thus, the whole village's total profit is (19,438,260,000) kyats.

IV. Survey Analysis

Taungthaman village tracts' agricultural sector was analyzed by the market price valuation method and Cobb-Douglas production functions based on the market price-based approach.

(1) Market Price Analysis

According to the market price method, the villagers' net income measures the difference between total income by selling and the total cost of production and use of goods.

The method for estimating the net income from the agricultural sector

$$NI = \sum (R_i - C_i)$$

Where; NI = Net income of villagers who rely on Lake resources

R_i = Total revenue earn from selling goods and services of i^{th} commodity

C_i = Total costs of producing the selling of goods of i^{th} commodity

Data are collected from the Ministry of Agriculture, Livestock, and Irrigation, the Taungthaman village tracts and the Mandalay Wholesale Centre. The results are analyzed by using the above equation to estimate net income for per acre of selected commodities.

Moreover, unit production cost, cost-revenue ratio, profit percentage and the profit margin can be calculated. Unit production cost is the total cost of a production run, divided by the number of units produced. The Cost-Revenue Ratio (CRR) is a way of comparing costs to revenue, which is also known as the efficiency relation. The result will be a percentage, which shows how much has been spent on producing one income unit, which lowers the percentage and makes revenue more efficiently. The percentage of profit is calculated as profit divided by costs (net income). The amount of return on investment can be estimated consequently. And the profit margin is a profit ratio, as net income divided by revenue.

The production rate per acre (basket), market price, revenue per acre, cost per acre*, cost-revenue ratio, net income, profit percentage (%), and profit margin of commodities can be calculated.

According to the calculation, three categories include three varieties of paddy; manawthukha, ayeyarmin and shwethweyin, eleven types of bean; butter bean, green gram, pigeon pea, chick pea, pea kyar, black gram, soya-bean, rice bean, red pharsalus lunates, blue pharsalus lunates and lablab bean and three kinds of oil seed; sesame, sunflower and groundnut. The rain-and-summer paddy, Ayeyarmin and Shwethweyin are grown by the Rice Intensification System (SRI) method. In 2018-2019, among these commodities, the profit percentage of return on investment and profit margin of the pea kyar is a loss in production due to low

quality of seeds, diseases, high costs of production and less total production per acre. Other commodities gain profitability per acre.

Table (4.1) shows the relationship between total cost, net income, total profit (%) of selected commodities; paddy, pulses, and oil seed in the study area.

Table (4.1) Relationship between Total Cost, Total Net Income, and Total Profit (%) of Paddy, Pulses and Oil Seed in the Study Area (2018-2019)

Type	Total Cost (Kyats)	Total Net Income (Kyats)	Total Profit (%)
Paddy	20,88,700	30,96,800	148.26
Pulses	17,75,500	22,81,900	128.52
Oil Seed	10,08,200	20,10,500	199.41

Source: Own Calculation (2019)

According to the table, the total cost of paddy is calculated on 6 acres, the pulses on 11 acres and oil seed on 5 acres. Among these three commodity groups, the group of oil seed represents the maximum profitability of the total production of the selected commodity, cultivated in the Taungthaman village tracts.

After the rainy seasons, in the winter and in summer, native farmers cultivate paddy, pulses and oil seed on 50 acres of silty soil on the banks of the Taung Thaman Lake. Summer paddy is cultivated in February, in September, pulses are cultivated, and groundnut is grown in November. Among these commodities, the maximum profitability commodities that rely on water supply of the lake are Ayeyarmin (Seeder), Butter bean and Groundnut.

Table (4.2) shows the production rate per acre (basket), market price, revenue per acre, cost per acre*, cost-revenue ratio, and net income of Ayeyarmin (Seeder), Butter bean and Groundnut in 2018-2019.

Table (4.2) Market Prices Analysis of Ayeyarmin (Seeder), Butter bean and Groundnut in 2018-2019

(Kyats)

Commodities	Production Rate per Acre* (basket)	Market Price	Revenue per Acre	Cost per Acre*	Cost-Revenue Ratio	Net Income
Ayeyarmin (seeder)	94	10,500	987,000	377,00	38.20	610,000
Butter bean	20	35,300	706,000	196,500	27.83	509,500
Groundnut	30	29,760	892,800	334,000	37.41	558,800

Source: * Ministry of Agriculture, Livestock and Irrigation Department, Market Price (1.5.2019) from Mandalay Wholesale Centre and Own Calculation

Therefore, three commodities can be calculated to a total economic value.

Total Economic Value for Ayeyarmin = Net Income per Acre * 50 Acre

6,10,000*50 =305,00,000 Kyat per year

Total Economic Value for Butter ben = Net Income per Acre * 50 Acre

5,09,500*50 =254,75,000 Kyat per year

Total Economic Value for Groundnut = Net Income per Acre * 50 Acre

558,800*50=279,40,000 Kyat per Year

Therefore,

Total Economic Value for three crops = 305,00,000+ 254,75,000+

279,40,000

= 839,15,000 Kyat per year

(2) Profit Function Analysis

The profit function shows the relationship between change input and change in output. It also indicates the maximum profit to be made by the firm from a fixed amount of resources. The function of profit is expressed:

$$PROF = f(K, L, \dots Vi.)$$

Where PROF is profit (which is the dependent variable), K and L are capital and labor inputs respectively. Certain inputs, such as land, can be included in this profit function. The amount of profit per period of the farm's output depends on the quantity of these variables used by the firm.

The importance of direct and indirect use value is defined through the resources' contribution to support current production and consumption in relation to their environmental and ecological services (Kong Spheak and Cheb Hoerm, 2016). This study used the profit function model to estimate the direct and indirect use value of the local people in terms of price of input, price of output, fixed factor, and environmental quality .

In this case of Cobb- Douglas function that can be written as;

$$Y_i = AL^{\beta_1} K^{\beta_2}$$

Therefore, one of the input factors can be stated in the relationship between profit and market situation by using the Cobb- Douglas production function. The villagers who rely on the Lake water resource are using the profit model as follows:

Prof_i = f (Price of Output, Price of Input, Fixed Factor, Environmental Quality)

$$PROF_i = \alpha P_i^{\beta_1} W_i^{\beta_2} K_i^{\beta_3} E_i^{\beta_4} e^\varepsilon$$

Where PROF_i = profit of the ith commodity that cultivated in the study area

P = Price of Output

W = Price of Input

K = Fixed Factor

E = Environmental quality

□ = Random error in Profit

Where, Environmental quality (E) is not directly measured. Therefore, three types of variable (temperature, rainfall, and water level) are used as proxy / instrument variables in the model rather than this variable (E).

This model, after taking logarithms, gives

$$\ln PROF = \ln \alpha + \beta_1 \ln P + \beta_2 \ln W + \beta_3 \ln K + \beta_4 \ln E + \varepsilon$$

$$\ln E = \ln T + \ln R + \ln pH$$

Where, T= Temperature (°C), R= Rainfall (inches), pH= water level (scale)

Therefore,

$$\ln PROF = \ln \alpha + \beta_1 \ln P + \beta_2 \ln W + \beta_3 \ln K + \beta_4 (\ln T + \ln R + \ln pH) + \varepsilon$$

This model is linear in the parameters α and β_i ($i = 1, 2, 3, 4$) and linear in the PROF, P, W, K and E logarithms. It can therefore be estimated using the Ordinary Least Square (OLS) method. Such models are called log-log, double log, or linear log model because of this linearity.

The SPSS Statistical Software calculates market analysis and Cobb-Douglas production function. Regression output is divided into two models in accordance with the position of the farmer, owner, and renter in the Cobb-Douglas production system. The rental cost of the land is compared to farmers who own the farm, with fixed costs which increases the costs. Consequently, the first model of regression does not consider the rental cost of land, but the second model of regression is that the farmer of this part does not have his own farm. So, rental cost of land is calculated in this model.

In addition, in February and July, summer and rain paddy are cultivated. In September, pulses are grown. In July and September, rain sesame and sunflower are cultivated and groundnut is grown in November. The maximum temperature, rainfall and pH levels are therefore measured and determined during the cultivated month.

Ayeyarmin is measured at maximum temperature 35.9 °C, rainfall 1.34 inches and pH level 7.1 scale. Butter bean is measured at maximum temperature 35.7 °C, rainfall 3.54 inches and pH level 7.5 scale. And groundnut is measured maximum temperature 32.2 °C, rainfall 0.08 inches and pH level 7.5 scale.

Table (4.3) shows estimated coefficient of ordinary least square regression analysis for ownership status (Owner).

According to the table, the slope, β_1 , is the change in the means PROF per unit, change in the output price (P) in a profit function of three independent variables, considering the effect of the input price (W), environmental quality (E). The price of output changes 1%, the profit changes 2.35%. These variables include the price of output and input are both significant levels, whereas the input price is a negative relation to profit.

Table (4.3) Estimated Coefficient of Ordinary Least Square Regression Analysis for Ownership Status (Owner)

	Unstandardized Coefficients	Standardized Coefficients
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	B	Std. Error	Beta	t	Sig
(Constant)	4.069	1.652		- 2.463	.024
LNOutput Price	2.347	.096	1.298	24.346	.000***
LnInput Price	-1.174	.159	-.420	-7.390	.000***
LNE	.018	.050	.015	.352	.729

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.991 ^a	.982	.978	.15756

Dependent Variable: LNProfit

Note: ***, **, * indicate statistical significance levels at 1%, 5% and 10%.

If Land's rental cost is 1,57,500 kyats for paddy, 50000 kyats for pulses and 150000 kyats for groundnut per acre in (2018-2019);

Table (4.4) shows estimated coefficient of ordinary least square regression Analysis for ownership status (Renter).

Table (4.4) Estimated Coefficient of Ordinary Least Square Regression Analysis for Ownership Status (Renter)

	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	-6.054	2.415		-2.506	.022
LNOutput Price	2.030	.113	1.123	18.040	.000***
LnInput Price	-.696	.176	-.224	3.951	.001**
LNE	.099	.070	.084	1.420	.173

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.980 ^a	.960	.953	.23157

Dependent Variable: LNProfit

Note: ***, **, * indicate statistical significance levels at 1%, 5% and 10%.

When the land is rented, land rental cost will be added to one independent variable, the price of input in the profit function. The price of input and output increases

by 1% and profit by 2.03%. The price of output is directly linked to profit among these variables, but the price of input is inversely related to profit. Then, the output and the price of input are also significantly affected. The profit would be reduced more than previous one if land rental costs were included in the input price. Therefore, in this study, the profit or net income of the villagers who depend on the agricultural sector is depend mainly on the price of output and input of these crops.

After 2018, socioeconomic pattern of Taungthaman village tracts had gradually changed from production sector to service sector.

Since 2015, Green City Co. Ltd and Taungthaman Thit Sar Company Ltd have bought land from the Taungthaman village tracts. The propose of project was to build the Taung Thaman Lake resort, cultural park, and tourist service area. Therefore, Taungthaman village tracts had changed their livelihoods dramatically, especially with money from land selling, they do small own business such as house rents, opening hostel, shops, stores, grocery shops , restaurants, mobile phone shop, tea shops, beauty salon, saving money in the bank, and revenue from bank interest. Some people who have no investment money have become painters, general workers, traders, vendors, and government officials.

Therefore, there have been significant changes in the livelihood pattern in village tracts surrounded by the Taung Thaman Lake. These changes occur positive effects, such as opportunities for employment in villages and higher revenues for urban development. On the other hand, it also has negative impacts, as fewer farms are significantly affected in the village development and transformed into service sectors, agricultural lands are reduced, and population patterns change due to migrants. In villages, the agricultural production is significantly affected. The negative consequences can lead to challenges of changes in the environment. Therefore, in consultation with international and local experts more work on environmental assessment should be considered for conservation.

V. Conclusion

Taung Thaman Lake is in the town of Amarapura, near to Mandalay. Taung Thaman Lake and U Bein Bridge, are famous for Myanmar's cultural heritage. The villagers living near the Taung Thaman area rely on the Lake for their lives. Traditional farming and informal jobs used to be livelihoods around the lake area. After 2000, the emergence and creation of fabric firms and establishment of Industrial Zones in the surrounding area of the Lake reduce water quality in the Lake. Several fish die-offs occurred in the lake since 2014 and around 10,000 fish died in September 2015. High water levels in the lake affect migratory birds' food sources which are sequentially exposed to tourism. Furthermore, the effects of climate change have also affected the lake ecosystem in recent years.

From the market price analyses, oil seed was found to be the most profitable in total production out of the three group crops in the village tracts. The farmers cultivated

Ayeyarmin, Butter bean and Groundnut on 50 acres from the Taung Thaman Lake water in both winter and summer. Thus, the total value of Ayeyarmin for the 50 acre is 305.00,000 K / Y, Butter bean is 254,75,000 K / Y and Groundnut is 279,40,000 K / Y, therefore, the total economic value for the three crops is 839.15,000 kyat/ year in 2018-2019. The price of output and input is both significant in the production / profit analysis, whereas the input price is inversely related to profit. If the land owned, the output price would change by 1%, the profits would change by 2.35%, if land rent, the output and input prices would change by 1%, the profit would vary by 2.03% and by 0.70%. The results showed that if land rents are included in the input price, the profit will be lower than the previous one. The villagers' profit and net income thus depend primarily on the price of output and input of commodity.

After 2018, there have been significant changes in the livelihood pattern of Taungthaman village tracts surrounded by the Taung Thaman Lake. The effects of these changes are positive and negative impact. Positive consequences are job opportunities in villages and increase revenues that are better for the urban development. Negative impacts are significantly affected, good areas are changed to service sectors, and agricultural land area is reduced.

Therefore, the present study concludes that, it estimates factor of production on the market-based approach under revealed preferences and; it does not include non-market approach under state preferences and travel cost method. For a well-being comparison, a new study is thus required for evaluating non-market-based preferences.

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**QUESTIONNAIRE FOR THE TAUNG THAMAN LAKE
(HOUSEHOLDS)**

SECTION 1: SOCIOECONOMIC INFORMATION

Socioeconomic questions may seem personal, but they are necessary because they help us analyze the results of this survey. Your responses shall be kept completely confidential.

1. Type of Family
1. Nuclear Family 2. Single Parent Family 3. Extended Family 4. Childless Family
2. Type of Business _____
3. Year of living/ business establishment in this area (past and present situation)_____
4. Head of Household _____
5. Age of Head of Household _____ years
6. Gender of the Head 1. Male 2. Female
7. Marital Status of the Head 1. Single 2. Married 3. Divorce 4. Others, please specify _____
8. Educational Attainment (highest level accomplished)
1.No Formal Schooling 2. Primary 3. Middle School 4. High School 5. College 6. Master or above
9. How many people are there in your household including you? _____
How many children are below 15 years old? _____
How many in your family, including yourself, is/are earning cash income?
10. Main Occupation of the household (1) Agriculture (2) Fishery (Aquaculture) (3) Fishery (Fresh Water) (4) Trading (5) Manufacturing (6) Others, please specify_____
11. Main Products of your business (1) Agro Based (2) Fishery (3) Other Food Products (4) Clothing &Fabric (5) Industrial Products (6) Raw Materials (7) Others, please specify _____
12. How much income did your household earn per month?

Equal or lower than 200,000 Ks	Between 200,001– 400,000 Ks.
Between 400,001 – 600,000 Ks.	Between 600,001 –800,000 Ks.
Between 800,001 – 1,000,000 Ks.	Between 1,000,001 – 1,200,000 Ks.
Between 1,200,001 – 1,400,000 Ks.	Above 1,400,000 Ks.
13. How much money did you spent for Household per month? (in Ks)
14. Do you own your land? 1. Yes 2. No
- 15.How do you use your land? _____

SECTION 2: ATTITUDE AND KNOWLEDGE QUESTIONS (Perception on Ecosystem)

16. Do you think the environment and natural resources in Myanmar are properly taken care of?

1. Yes _____ 2. No _____ 3. Do Not Know _____

17. What do you think are the **THREE MOST** serious issues related to nature and human impact on the natural resource and environmental problems (1 as most serious) in Myanmar?

Natural Resource & Environmental Problems	Rank 1	Rank 2	Rank 3
1. Air pollution			
2. Water pollution			
3. Solid waste management			
4. Endangered species conservation			
5. Deforestation			
6. Traffic noise/problems			
7. Enhanced greenhouse effect			
8. Others, please specify _____			

SECTION 3: QUESTIONS ABOUT TAUNG THAMAN LAKE

18. Do you know that Taung Thaman is Heritage Site in Myanmar? 1. Yes 2. No

19. How do you assess the environmental situation of Lake Site?

1. Better 2. Worse 3. Unchanged 4. Not Know

20. What aspects of this Lake do you value?

1. Peacefulness, scenic beauty, picnic 2. Bird watching 3. Storing valuable biodiversity 4. Unique views 5. Good getaway for the next generation 6. Educational values 7. Other, please specify _____

21. What kind of inconveniences do you face in this Lake?

1. Water Pollution at the site 2. Increase Waste Disposal in Lake 3. Difficult to do business 4. Experiencing Frequent Disasters 5. Other, please specify

22. Distance from Taung Thaman Lake _____

SECTION 4: Estimated Cost per Acre of Paddy, Pulses and Oilseed Production in Taungthaman Village Tracts. (2018-2019)

Sr.No	Subject	Unit	Quantity	Price (Kyats)	Total Costs (Kyat)
1.	Land reclamation, dyke reparation, digging swampy nal and canal around the fie				
2.	Cultivation Price of seeds, sowing the seed in ater, covering the seeds, roadcasting seed, pulling out rice edlings and transplanting paddy				
3.	Using material aid Urea, T super, potted of chemical ertilizer, insecticide, wages for secticide and weeding				
4.	Harvesting Carrying a sheaf of paddy, innowing paddy				
total Estimated Costs					

SECTION 5: Opportunities and Challenges of Taungthaman Village Tracts

23. Opportunities _____

24. Challenges _____
