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Ministry of Natural Resources and Environmental Conservation
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**Investigation of the Relationship Between Mangrove Plantation and the
Direct Use Ecosystem Services Value of Mangrove Ecosystem: Case Study
in Shwe-Thaung-Yan Sub Township, Patheingyi District of Ayeyarwady
Region in Myanmar**



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ပုသိမ်ခရိုင်၊ ဧရာဝတီတိုင်းဒေသကြီး)

ချစ်ဦးကို၊ လက်ထောက်ကထိက

သစ်တောနှင့် ပတ်ဝန်းကျင်ဆိုင်ရာတက္ကသိုလ်

စာတမ်းအကျဉ်း

ရွှေသောင်ယံကမ်းရိုးတန်းဧရိယာတွင် စိုက်ပျိုးမြေချဲ့ထွင်ခြင်း၊ မီးသွေးထုတ်ယူခြင်း၊ ထင်းထုတ်ယူခြင်းစသည့် လုပ်ဆောင်ချက်များကြောင့် ၎င်းဒေသရှိ ဒီရေတောများ ပျက်စီး ဆုံးရှုံးလျက်ရှိပါသည်။ ၎င်းဒေသရှိ ဒီရေတောဂေဟစနစ်များ စဉ်ဆက်မပြတ် ဖွံ့ဖြိုးတိုး တက်စေရေးအတွက် ဒီရေတောဂေဟစနစ်များ၏အရေးပါမှုကို တန်ဖိုးထားရန် နှင့် အလေးထားရန်လိုအပ်ပါသည်။ ဤသုတေသနလေ့လာချက်တွင် ဒီရေတောများ၏ စီးပွားရေး အရ အရေးပါမှုနှင့် အကျိုးကျေးဇူးကြီးမားပုံကို ဖော်ပြနိုင်ရန်နှင့် မီးမောင်းထိုး ပြနိုင်ရန် ဒီရေတောစိုက်ခင်းများတည်ထောင်ထားသည့်နေရာများရှိ ဒီရေတော ဂေဟ စနစ် အခြေခံသည့် တိုက်ရိုက်အထောက်အပံ့ပြု ဂေဟစနစ်ဝန်ဆောင်မှုများ၏ တန်ဖိုး နှင့် ဒီရေတော စိုက်ခင်းများတည်ထောင်မှုမရှိသေးသည့်နေရာများ၏ တန်ဖိုးများကို အဓိကထား နှိုင်းယှဉ် လေ့လာထားပါသည်။ ဤသုတေသနတွင် ဒီရေတော စိုက်ခင်းများ တည်ထောင်ထားသည့် နေရာကို **Study area** ဟုလည်းကောင်း၊ ဒီရေတော စိုက်ခင်းများ တည်ထောင်မှု မရှိသေး သည့်နေရာကို **Control area** ဟုလည်းကောင်း သုံးနှုန်းသွား မည်ဖြစ်ပါသည်။ သုတေသန လေ့လာသည့်နေရာမှာ ရွှေသောင်ယံမြို့နယ်ခွဲ၊ ပုသိမ်ခရိုင်၊ ဧရာဝတီတိုင်းဒေသကြီး၊ မြန်မာ နိုင်ငံတွင်ဖြစ်ပါသည်။ သုတေသနအတွက် လိုအပ်သည့် အချက်အလက်များကို **Study area** အတွက် သပွတ်ကန်ကျေးရွာ၊ ဝက်သေကျေးရွာ၊ သဲကျင်းကျေးရွာ၊ ကျူတောကျေးရွာ၊ ရွှေသောင်ယံမြို့ ရပ်ကွက် ၂ နှင့် ၃ တို့တွင် လည်းကောင်း၊ **Control area** အတွက် မသာကျေးရွာ၊ ကျူချောင်းကျေးရွာနှင့် နွယ်ညို ချောင်းကျေးရွာတို့တွင်လည်းကောင်း၊ စုစုပေါင်း အိမ်ထောင်စု ၁၉၆ စု တွင် စာရင်းများ ကောက်ယူခဲ့ပါသည်။ ရွှေသောင်ယံ ဧရိယာတွင် **Study area** ရှိ ဒီရေတော ဂေဟစနစ် အခြေခံသည့် တိုက်ရိုက် အထောက်အပံ့ ပြု ဂေဟစနစ်ဝန်ဆောင်မှုများ၏ တန်ဖိုးမှာ အိမ်ထောင်စုတစ်စု၊ တစ်နှစ်လျှင် စုစုပေါင်း ၁၈ သိန်းကျပ်ခန့် (အမေရိကန် ဒေါ်လာ ၁၀၀၀ ခန့်) ရှိပြီး **Control area** တွင် ၁၀ သိန်း ကျပ်ခန့် (အမေရိကန် ဒေါ်လာ ၆၀၀ ခန့်)

ရှိပါသည်။ ဤအချက်သည် ယခု သုတေသန၏ အဓိက **Hypothesis** ဖြစ်သည့် စိုက်ခင်းများရှိသည့်နေရာသည် စိုက်ခင်းမရှိသည့်နေရာထက် ဒီရေတောဂေဟစနစ် အခြေခံသည့် တိုက်ရိုက် အထောက်အပံ့ပြု ဂေဟစနစ် ဝန်ဆောင်မှု များ၏တန်ဖိုး ပိုများပြားရမည် ဟူသည့် အချက်ကို သေချာစေပါသည်။ ဤသုတေသနတွင် တွေ့ရှိသည့် အချက်အလက်များကို ဒီရေတောစိုက်ခင်းများ၏ တန်ဖိုးကိုနားလည်၍ မြန်မာနိုင်ငံအဝန်း ဒီရေတောစိုက်ခင်းများ ပိုမိုတိုးချဲ့စိုက်ပျိုးရန် လိုအပ်သည်ဆိုသည့် အချက်ကို နားလည်သဘောပေါက်စေရန် ဖြစ်ပါသည်။ ထို့အပြင် အစိုးရနှင့် အစိုးရ မဟုတ်သောအဖွဲ့အစည်းများအနေဖြင့် ဒီရေတောစိုက်ခင်းများ တည်ထောင်သည့် လုပ်ငန်းစဉ် များတွင် ရင်းနှီးမြှုပ်နှံမှုများ ပိုမိုထည့်ဝင်ရန် ဆုံးဖြတ်ချက်ချသည့်အခါ အထောက်အပံ့ ဖြစ်စေမည် ဖြစ်ပါသည်။

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Abstract

In Shwe-Thaung-Yan coastal areas, different kind of activities such as expansion of agriculture lands, charcoals production, fuel woods collection, etc. are challenges to mangrove forest. To achieve the sustainable conservation of mangrove ecosystem, understanding the value of mangrove ecosystem is crucial. To demonstrate the economic benefit of mangrove forests, the study compares the value of direct use value of mangroves in areas where there have been efforts to replant mangroves and areas where there have not been replanting. The study site is Shwe-Thaung-Yan area. Within the study site, interviews have been conducted with households in the study area, namely Tha Pot Kan village, Wet They village, Thel Gyin village, Kyu Taw village, Shwe-Thaung-Yan ward no. 2 and Shwe-Thaung-Yan ward no.3. and households in the control area, namely Ma Thar village, Kyun Chaung village and New Nyo Chaung village. Altogether 196 households were interviewed consisting of 163 households in the study area and 33 households in the control area. The study has revealed that the value of direct use ecosystem services per household per year in study area (villages with plantation) (MMK 1868970, USD 1000) is higher than the control area (villages in locations where there are no mangroves replanting and restoration efforts) (MMK 1085334, USD 600). This confirms the hypothesis that in Shwe-Thaung-Yan area the existence of mangroves can contribute to the increase in the direct use value of mangroves. The results of this study can be useful for decision makers to understand that mangrove plantation should establish across the country's delta region year by year. Moreover, the result relating with the benefits of mangrove ecosystem will also be useful as a basic information for government and NGO to determine or to increase the investment in mangrove plantation.

Keywords: Shwe-Thaung-Yan, direct use values, fishing, mangrove forest

Investigation of the Relationship Between Mangrove Plantation and the Direct Use Ecosystem Services Value of Mangrove Ecosystem: Case Study in Shwe-Thaung-Yan Sub Township, Patheingyi District of Ayeyarwady Region in Myanmar

1. Introduction

Myanmar, one of the most forested countries in the mainland South-east Asia, has forest cover about 42.19% (28.5 million hectares) in 2020 of the country's total land area (AFoCO, 2021). Forest ecosystems including mangroves provide not only income generating activities such as fish catching, shrimp collection, crab collection, etc. to local communities but also contribute to provisioning services (food, fuel wood, shelter, timber, etc.); regulating services (water purification, climate regulation, etc.); cultural services (spiritual, recreational, aesthetic, educational, etc.) and supporting services (biogeochemical cycling of organic and inorganic compounds; carbon, water, nitrogen, etc.). In addition, mangroves also provides habitat for various types of fish species and other animals. Mangroves can also protect from soil erosion, cyclones, storm surges, tsunamis, etc. (World Bank, 2020; Arifanti et al., 2022).

The position of Myanmar in deforestation status in the world is seventh. Between 1990 and 2020, forest cover has reduced from 57.9% to 42.19% (AFoCO, 2021). According to the Global Forest Watch (2022), due to the loss of forest cover from 2013 to 2021, it is equivalent to 1.42 Gt of CO₂ eq emissions. In case of mangrove forest degradation, since 2000, the rate of mangrove cover degradation is 14,619 hectares per year. Degradation of mangrove is particularly severe in Rakhine State, Ayeyawaddy Mega Delta and Tanintharyi Region because of the expansion of agricultural lands for rice cultivation. Estimated loss of mangrove ecosystem services values is US\$2.4 million per year due to mangrove forest degradation in Myanmar (World Bank, 2020). There are also many challenges for sustainable development of mangrove ecosystem and reducing forest degradation such as inadequate understating of the value and benefit of mangrove ecosystems, weakness of local people participation, the concentration of low-income families living next to the mangroves, increasing population, etc. (Arifanti et al., 2022).

Conservation of existing mangrove forests could raise the livelihood and socio-economic conditions of local community because increasing the productivity of fisheries can achieve by increasing mangrove forest (Eddy et al., 2016). Therefore, improvement program of local community could be one of the basic solutions to conserve biodiversity, ecosystems and ecological processes. Among the conditions for sustaining involvement of local communities on mangrove restoration is to create an understanding of the value of ecosystem services. This would provide incentives for sustainable use of mangrove forests.

Although the government has started to develop the nature-based ecotourism site in Shwe-Thaung-Yan Sub Township, Patheingyi District of Ayeyarwady region, the region is not yet as well-known for this type of tourism. However, in very near future, it is hope that this area will become the tourist attraction ecotourism site. To create the sustainable nature-based ecotourism site, conservation of the natural ecosystem should be planned in short-term and long-term plans. However, over the last few decades, the level of mangrove forest ecosystem in this area had been degraded by charcoal production and expansion of agriculture land, etc. (Win and Win, 2021). The degradation of mangrove ecosystem in this area has also been due to natural causes such as the Cyclone Mala in April 2006.

Since 2015, Worldview International Foundation (WIF) and Mangrove Service Network (MSN) cooperation with Forest Department has been involved in mangrove

plantation under the processes of restoration program in Shwe-Thaung-Yan area. It is clear that mangrove forest coverage in the area has been increasing. The sustainable production of fisheries could be achieved by conserving mangrove forest (Eddy et al., 2016). Aye et al. (2019) stated the mangrove forest degradation have negative impacts on the value of mangrove forest. To conclude, the income of ecosystem services-based households is contingent upon the conditions of the mangrove which is in turn partially dependent on the nature of its exploitation as well as restoration and replanting efforts. To prove this hypothesis, this study aims to compare the direct use value (only consumptive value such as fish catching, clam collection, crab collection, nipa palm leaves collection and fuel wood collection) between areas in the Shwe-Thaung-Yan where there have been efforts to replant mangroves and areas where there have not been replanting.

The purpose of this comparison is based on the hypothesis that the direct use values will be higher in areas where there have been investments in planting and restoring mangroves than areas where there have been no investments. This empirical evidence could provide the incentives for local communities to use resources within the mangroves in a sustainable manner. Apart from presenting the benefits of mangrove plantation program, the results of this study can also be used as a suggestion for the policy makers that mangrove plantation program are necessary and important to the sustainability of local communities' economy.

2. Objective

The objectives of this study are

- (1) to estimate the direct use values (consumptive values) of Shwe-Thaung-Yan area to investigate the socio-economic benefits of mangrove plantation for restoration program
- (2) to provide suggestion to policy makers for conservation of ecosystem services and for providing the basic needs of local communities in the study area

3. Methodology

3.1 Study area

Shwe-Thaung-Yan township is a beach city and a brand-new destination for leisure travelers with the abundance of marine coastal resources especially mangroves, seagrass meadows, coral reefs, sandy beaches and mudflats along the coastal region of the township. Shwe-Thaung-Yan township is located between Latitude 12.34° 15'72" North and longitude 94.29° 46' 27"East. The total areas of Shwe-Thaung-Yan Sub township is 462.2 square kilometers. The length of the coastline of Shwe-Thaung-Yan township is 12 miles and the mangrove forests in Shwe-Thaung-Yan coastal areas are being degraded and destroyed on a larger scale through the natural disturbance and anthropogenic activities such as transforming to agriculture lands, aquaculture ponds, salt ponds/lands, charcoals production and settlement areas etc., which are major causes of their degradation land loss of mangrove ecosystem.

In Shwe-Thaung-Yan area, mangrove forest can be found along the deltaic areas of the Magyi and Utto tidal creeks which has 16 miles in total. In the area, about 75% of mangroves had been degraded by charcoal production, expansion of agriculture land, etc. over last few decades (Myanmar Water Portal 2019, Win and Win 2021). In this area, Forest Department, Myanmar has established the mangrove forest organizing with Worldview International Foundation (WIF), Mangrove Service Network (MSN) and Worldview Myanmar Limited. The areas of established mangrove areas are 664.92 hectors in 2015,

297.86 hectares in 2018 and 470.52 hectares in 2019 respectively. Mangrove forest will establish continuously in the future.

3.2 Data collection

One of the selection criteria is that the selected villages should have households which rely on mangrove ecosystem for their income such as fishing, collection of mangrove forest products, etc.

In this study, there are two types of areas: one is called study area (villages where have been mangrove replanting and restoration efforts) and another one is control area (villages in locations where there are no mangroves replanting and restoration efforts) are considered to investigate the increasing of mangrove plantation has impacted on the value of mangrove ecosystem services.

For the study area, the selected villages to conduct interviews are Tha Pot Kan village, Wet They village, Thel Gyin village, Kyu Taw village, Shwe-Thaung-Yan ward no. 2 and Shwe-Thaung-Yan ward no.3. The plantation was established in 2015 near Shwe-Thaung-Yan ward no. 2 and 3. However, the plantation was established in 2018 near Tha Pot Kan, Wet They, Thel Gyin and Kyu Taw villages. Regarding control area, the selected villages are Ma Thar village, Kyun Chaung village and Nwe Nyo Chaung village (Table 1). The sample size was determined using Yamane's formula. Face-to-face interviews was conducted with the heads of 196 households in the villages and wards near Shwe-Thaung-Yan area. The number of households for interview in each village is defined based on the population size of the village (weighted sampling).

Table 1: Selected number of villages and households

No	Village/ Ward	Population	Selected number of households	Type of area
1	Shwe_Thaung-Yan ward no. 2	459	59	Study area
2	Shwe_Thaung-Yan ward no. 3	118	15	Study area
3	Tha Pot Kan	380	50	Study area
4	Wet They	100	13	Study area
5	Thel Gyin	100	13	Study area
6	Kyu Taw	100	13	Study area
7	Ma Thar	98	13	Control area
8	Kyun Chaung	90	12	Control area
9	Nwe Nyo Chaung	60	8	Control area
Total		1505	196	

Even though some of the villagers in the Study area do not fish in the mangrove but the fish species they catch could be those that depend on the mangroves in some parts of their live cycle. In principle, they can also be said to benefits from the ecosystem services provided by the mangroves. Therefore, as a part of the study, the villages and households who fish in the open sea were also selected for interview (Table 2).

Table 2: Selected number of villages and households who fish in the open sea.

No	Village	Population	Selected number of households	Fishing area
1	Shwe_Thaung-Yan ward no. 2	459	15	Open sea
2	Tha Pot Kan	380	15	Open sea
3	Thel Gyin	100	10	Open sea

Total	939	40
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The questionnaire includes open-ended and close-ended types. Demographic information (age, education, occupation, etc.), and benefits the respondents got (fishing products, nipa palm leaves, etc.) from Shwe Thaung Yan area was collected in order to investigate the influence of plantation for restoration program on the direct use value of mangrove ecosystem. Taking the suggestions of local village heads is important to know where the targeted respondents are living, when they are free to conduct the interview, etc. For questionnaires, snowball and quota sampling methods were applied. Snowball methods was used to find where households that satisfy our selection criteria. Quota sampling was used to define the sample population of each village (weighted sampling).

3.3 Relationship between mangrove plantation and the direct use value of mangrove ecosystem in Shwe-Thaung-Yan area

To test the hypothesis, the direct use value of mangrove ecosystem services in the study area (villages where have been mangrove replanting and restoration efforts) was compared with the control area (villages in locations where there are no mangroves replanting and restoration efforts) showed statistically by using two sample independent t test.

Part of the interview also requires the respondents to recall the amount of fishing products before plantation are higher than after plantation. To confirm this point, the respondents are requested to estimate the fishing amount before plantation (2015) and after plantation (2022). As the experiences of preliminary survey, it is clear that the respondents can estimate the amount of ecosystem services in 2015 (before plantation) and current time (after plantation). However, since these estimates are based on what the respondents can recall, its accuracies can no doubt be questioned.

3.4 Calculation of the direct use value (consumptive value) of ecosystem services in Shwe-Thaung-Yan area

The direct use values of the mangrove services (fish, clam, crab, nipa palm leaves, fuel wood) were calculated in the study. The value of fishing products including fish catching, clam collection and crab collection were calculated based on the estimation of respondents' income created by each fishing activities. If the respondents could not answer their income, they are requested to estimate the amount of monthly fishing products and then multiply by the local market price. In case of the value of nipa palm leaves was calculated by using market prices. To calculate the value of nipa palm leaves, the respondents are requested to estimate how much nipa palm leaves they use per month or per year, and then multiply by the local market price. The value of fuel wood collection was calculated based on the collected amount of fuel wood from mangrove forest and then multiply by the local market price. The value of seed collection was calculated based on the amount of income from seeds collection from mangrove forests, and then multiply by the local market price.

4. Results and discussion

4.1 Socio-economic profile of the respondent groups

In this study, 196 (148 were male and 48 were female) respondents was interviewed. The average age of the respondents is 38 years. In case of literacy status, most of the respondents have primary level (51%). Regarding the fishing activities among 196 respondents, crab collection is accounting for 60 % followed by clam collection (22%). Out of the remaining, 18 % are fish catching. According to the result, 26% of respondent have not

the boat for doing fishing activities while other 74% own one boat. These 26% of fishermen are sharing the boat with other boat owner in the same trip by paying some amount of money.

4.2 Relationship between mangrove plantation and the direct use values in Shwe-Thaung-Yan area

In this study, there are two types of area: one for study area (villages with plantation) and another one for control area (village without plantation) is considered to investigate the increasing of mangrove plantation has impacted on the value of mangrove ecosystem services. The estimated value of each activities including fish catching, crab collection, clam collection, etc. in the study area and the control area are shown in Table 3.

The result shows that the total estimated value of fish catching, crab collection, clam collection, fuelwood, nipa palm leaves and mangrove seed for the study area is around MMK 1,900,000 (USD 1000). In control area (villages without plantation), the value of these activities is around MMK 1085334 (USD 600). By comparing the value in all activities between two areas, the value of each activities is higher in study area than control area.

In this study, comparing the value of fuelwood in two areas have some limitations because the households live in plantation area do not collect and do not use the fuelwood from mangrove. The households cannot collect the fuelwood because they are not allowed to access the mangrove forest. They just allow for only fishing activities. The officers from Forest Department or the person from WIF who is assigned to manage the plantation have the responsibility and power to control, protect and manage the plantation. Moreover, the willingness to participate of local people who live in study area is also incredible. According to the interview, they thing that they also have the responsibility to conserve the mangrove forest. In addition, WIF have provided some incentive activities such as small business training such as making handicrafts, value adding to the local products, etc. together with awareness raising programs. Another reason why they do not collect the fuel wood from the mangrove forest is that there have tropical evergreen and mixed deciduous forests in the study area. So, especially they use and collect the fuelwood from these forests. So, the value of fuel wood in study area is 0. However, the value of fuel wood per household per year in control area is 36969 MMK (USD 21).

Table 3: Selected number of villages and households who fish in the open sea.

Ecosystem services	Study area (villages with plantation) (Myanmar kyats-MMK/year/household) (163 households)	Control area (villages without plantation) (Myanmar kyats- MMK /year/ household) (33 households)
Fish	437301	160000
Crab	940859	734545
Clam	418896	123636
Nipa palm leaves	69294	64848
Mangrove seeds	2620	2303
Total	1868970 (USD 1000)	1085334 (USD 600)

As a result of the independent t-test, there was significant difference in estimated total direct use value of ecosystem services ($t(194) = 5.45$, $p < 0.05$) between the study area (with plantation) (mean = 222589, SD = 73454) and control area (without plantation) (mean =

152000, SD = 24298). Therefore, this mean that that investments in replanting and restoring mangroves does lead to higher direct use value (which consist of fish catching, crab collection, clam collection, nipa palm leaves collection, mangrove seeds collection). The results consistent with a finding of another study that there has a positive correlation between increasing of mangrove forest area and the amount of fishing product (income) (Haris et al., 2013). This is also consistent with the Eddy et al, 2016 study which stated that the amount of fishing products such as fish and shrimps will produce by increasing the area of mangrove forest. The amount of fish and shrimp production is 287 kg/year per one hectare of natural mangrove forest. Moreover, according to the study in Gending subdistrict, Probolinggo, Indonesia in 2009, the value of fisheries production was 146 hectare of mangrove forest area may have Rp 3,478,802,500/year (Eddy et al., 2016). Moreover, World Bank (2020) also stated that one hectare of mangrove forest can provide around MMK 44000. According to the discussion of Forest Department, 1200 hectares of mangrove plantation were established since 2015 in Shwe-Thaung-Yan area.

4.3 The direct use value of ecosystem services in Shwe-Thaung-Yan area

4.3.1 Differences of income from fishery products between the study area and the control area

The average income or value of fishing including all fishing activities (fish catching, crab collection, clam collection) per household per month in Shwe-Thaung-Yan area is MMK 140000 (USD 78)¹ and per year is MMK 1,680,000 (933 USD). Regarding with the income of study area from fishing activities, it is MMK 1797056 (USD 998.36) while it is MMK 1,018,181 (USD 565.66) in control area.

However, almost all of the 196 respondents both in the study area and the control area said that the amount of fishing products in 2015 before plantation are higher than in 2022 (after plantation). Table 4.² This could be due to the error of respondent's perception and their behavior of interests during the surveys. The volume caught per household in 2022 could be lower due to the increasing of population in study area. In study area, the population had been increased during a few decades. In addition, this could also be due to the increasing number of fishermen in these areas. According to the survey, there was a few numbers of fishermen in 2015. However, as the results of local villagers, nowadays, these numbers are increased as double. Some respondents said that the number of fishermen is increasing during the COVID-19 pandemic because some villagers are coming back to home and joined the fishing activities for their income. To conclude, less amount of fishing products in 2022 by comparing 2015 could be due to the increasing of fishermen population and COVID-19 pandemic.

Moreover, the authors' personal point of view, although the amount of fishing products per household has decreased between before plantation (2015) and after plantation (2022), if combining the total amount of fishing products of all fishermen in 2022 and comparing with the amount of fishing products of all fishermen in 2015, the amount of fishing products in 2022 would be higher than those of in 2015 because the number of fishermen in 2022 is higher than those of in 2015. One more important thing could be due to the age of mangrove plantation. For instance, the amount of fishing products may not be affected by 7 years age of mangrove plantation.

¹ the exchange rate is USD 1 equal 1800 MMK (Myanmar Kyat)

² As a result of paired t-test, the amount of fishing products was significantly different (mean difference = 27, t (195) = 19, p <0.001) before plantation (2015) and after plantation (2022).

Table 4: The amount of fishing product per household per month

Fishing activities	Fishing product in kg (All 196 households)	
	2015	2022
Fish catching	28	19
Crab collection	35	25
Clam collection	30	23
Total	93	67

Whether the amount of fishing products in 2015 is higher than those of in 2022 or not, all respondents agreed on the point that investments in replanting and restoring mangroves have positive effects on the mangrove ecosystem. To conclude, the respondents assuming on the production rate of fishing product is higher in 2015 than 2022 might not be the true. The reasons could be the points discussed in the above.

4.3.1.1 Relationship between owning the boat and income level (fishing in mangrove forest)

In Shwe-Thaung-Yan area, the average income per household per month of fishermen who have the boat is MMK 150000 (USD 83). However, the average income of fishermen who have no boat is only MMK 98600 (USD 55). The people who have no boat are sharing the cost or paying some amount of money with the people who have the boat. Among 196 respondents, 50 respondents have no boats. According to the result of Pearson's correlation, a significant positive relationship ($r = 0.40$, $p < 0.01$) was observed between owning the boat and income level. It means that the fishermen who have the boat earned more income from fishing activities. Moreover, the fishermen who have no boat travelled within the accessible distance by walking. That is why, this is the main reason why the income level is different between two groups.

4.3.1.2 Relationship between owning the boat and income level (fishing in open sea)

The average monthly income of fishermen who fishing in open sea is MMK 360000 (USD 200) (minimum: MMK 150000 and maximum: MMK 700000). According to the result, among 40 respondents, only 2 fishermen have no boat. Another 38 have their own boat. These 2 fishermen are sharing the boat with other boat owner in the same trip by paying some amount of money. The average income per household per month of fishermen who have the boat is MMK 367000 (USD 203). However, the average income of fishermen who have no boat is MMK 225000 (USD 125).

4.3.2 The difference between direct use value from other timber and non-timber forest products from mangroves between the study area and the control area

In this study area, most of the households used nipa palm leaves as roof and wall in their houses. Not all the households collected these leaves by themselves. However, they bought it from other who collected these leaves and who own the plantation. Whatever bought it or sell it, the source of leaves is mangrove forest. Therefore, to estimate the value of

nipa palm leaves, the households which used the nipa palm leaves was considered in this study. The average value of nipa palm leaves per household per year in Shwe-Thaung-Yan area is MMK 70000 (USD 39). In control area, the average value of nipa palm leaves per household per year is MMK 69294 (USD 38.50) while it is MMK 64848 (USD 36.03) in control area.

Some households about 25% in study area collect mangrove seeds for income generation. However, the income created by this activity is very low. The estimated average value of mangrove seed collection per household per year in Shwe-Thaung-Yan area is MMK 2500 (USD 2). In control area, the average value of mangrove seed collection per household per year is MMK 2620 (USD 1.46) while it is 2303 (USD 1.28) in control area.

4.3.3 The difference between direct use value from mangroves between the study area and the control area

To conclude, the total estimated direct use values of mangrove ecosystem services in study area per household per year are shown in Table 5. The estimated total annual direct use value per household per year in Shwe-Thaung-Yan area is MMK 1758500 (USD 977), and fishing activities (fish catching, clam and crab collection) account the highest proportion of the value. In both of study area and control area, the total annual direct use value per household per year is 1868970 (USD 1000) and 1122303 (USD 600) respectively. Another study conducted in Bogalay Township, Ayeyawaddy Region, Myanmar also showed that fish and crab collection is the main contribution to local communities' livelihood (Aye et al., 2019). In their study, the average annual income or direct use value of mangrove forest per household per year was Kyats 1,119,957 (approximately US\$ 784). The difference of value between two studies is only USD 193. Moreover, it could also be due to products considered in value estimation (Ko et al., 2020). In their study (Ko's study), the forest products considered for value estimation were fish, crab, prawn and firewood, however, the current study considered fish, crab, clam, nipa palm leaves and mangrove seeds. In another study pointed out that the consideration of forest products may have effect on the total value of forest products. Because, although Wai (2017) conducted in the same study area as Aye et al. (2019), their considered forest products for value estimation is different, and the values were also different. In the study of Wai (2019), the main considered forest products were fuelwood, bamboo, nipa palm, rattan, medicinal products, fish and prawn, and the total direct use value of mangrove forest were USD 1498.

Table 5: Total annual direct use value of Shwe-Thaung-Yan area

No.	Ecosystem services	Average value/household/ year (MMK)		
		Study area	Control area	Average both groups
1	Fishing	1797056	1018181	1,680,000 (933 USD)
2	Nipa palm leaves	69294	64848	70000 (USD 39).
3	Mangrove seeds	2620	2303	2500 (USD 2)
Total		1868970 (USD 1000)	1085334 (USD 600)	1752500 (USD 973)

4.4 Main challenges of fishermen

The figure shows the perception of local fishermen on their basic needs such as fund, equipment (fishing net, boat, etc.) and small-scale income training. In figure, the highest number of respondents (176 fishermen) have selected the financial supports as the first

priority that they actually want from government and NGO if possible. Another 60 fishermen have selected getting equipment such as fishing net and boat as the first priority. They have chosen the small-scale business training as the low priority. In study area, there is no microfinance institutions to borrow the money. The results show that there are 52% of respondent have financial challenges. Currently, the fisherment who need the money borrow money from the other with high interest rate.

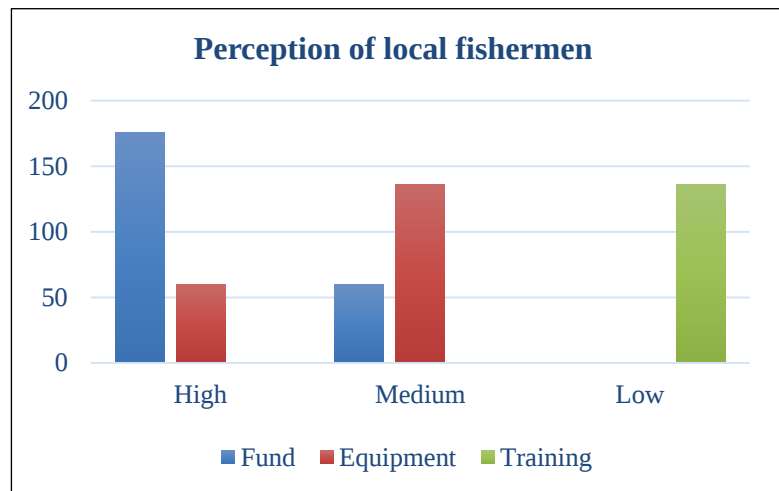


Figure . Willingness to accept of local fishermen on their basic needs

4.5 Recommendation

- According the result, the value of direct use ecosystem services in study area is higher than control area. The results can be used to prove the important of mangrove ecosystem in the livelihood of local community. If the community know the important of mangrove ecosystem, they will participate in the mangrove conservation activities.
- The estimated value of direct use ecosystem services of Shwe-Thaung-Yan area can be applied as a decision-making tool as an indication of the potential benefits that can be derived from investment in restoring and replanting degraded mangroves
- Based on the findings of this study, the government should establish the mangrove plantation across the country's delta region year by year because this study shows that increasing mangrove plantation has positive effects on the production of fishing products and other direct use value of the mangrove ecosystem.
- The result regarding the benefits of mangrove ecosystem will be useful as a basic information for NGO to determine or to increase the investment in mangrove plantation.
- In this study, only direct use values (consumptive value) of ecosystem services were estimated. More and researches in mangrove ecosystem services valuation to estimate all values of mangrove ecosystem services in study area are required.

5. Conclusion

The direct use values of ecosystem services mainly consumptive value are estimated in the study. The study has revealed that fishing activities including fish catching, crab

collection and clam collection) has the highest value (MMK 1,680,000 (933 USD)). In the study area, collection of mangrove seeds and nipa palm leaves also contribute to the local communities in household income. As a result, the estimated value of direct use ecosystem services of the study area is 1758500 (USD 977). In both of the study area and control area, the total annual direct use value per household per year in Shwe-Thaung-Yan area is 1868970 (USD 1000) and 1085334 (USD 600) respectively. By comparing the values between two areas, the values in study area is higher than those of in control area.

This study also shows that increasing mangrove plantation have influenced on the direct use value of mangrove ecosystem services in Shwe-Thaung-Yan area. By comparing the ecosystem services value in all activities such as fish catching, crab collection, clam collection, etc. between study area (with plantation) and the control area (villages in locations where there are no mangroves replanting and restoration efforts), the value of each activities is higher in study area than control area except the value of fuelwood because the households live in plantation area do not collect and do not use the fuelwood from mangrove.

However, there has one unexpected result in this study that the amount of fishing products (fish, crab, clam) was higher before plantation (2015) than after plantation (2022). It may be to some probabilities. For instance, it could be due to the increasing of population in study area in 2022 than 2015. Moreover, it could also be due to the insufficient lag time of mangrove plantation to recover enough.

The findings of this study might provide the basic background information for policy makers to understand the value of mangrove ecosystem and important of mangrove plantation. It can lead to increase the investment in mangrove restoration activities. Moreover, the results of this study can also be useful in public consultation programs to inform the value of mangrove services in terms of monetary unit, and it can lead to increase their knowledge on how much benefits they get from mangrove ecosystem and the economic losses that might be incurred if the mangroves and associated ecosystems services have been compromised.

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