Impact of mangrove forest recovery on coastal socio economic conditions on Rugemuk Village, Pantai Labu Subdistrict, Deli Serdang Regency

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Abstract. This study aims to analyse the impact of the recovery program on the dynamics of coastal community groups; mangrove forest area; types of catch biota that have economic value; availability of coastal agro-industry raw materials; employment opportunities and coastal household income. The data analysis method used is a comparative method namely the Wilcoxon Match Pairs Test with the t-test and Z-test. To analyse the area of mangrove forests using the map overlay method. The sampling method used was a simple random sampling method with 79 samples for hamlets 3 and 4. The results showed that there were significant differences in group dynamics, mangrove forest area, types of catch biota that were economically valuable, availability of coastal agro-industry raw materials, employment opportunities, income of coastal households before (2012) and after (2017) mangrove forest recovery programs.

1. Introduction
Mangroves are very productive ecosystems. Its existence is able to enrich biodiversity, produce a variety of commercial forest products, protect coastlines, and be able to support fisheries production in coastal areas. Mangroves have a unique adaptation system given the extreme environmental conditions, such as high salinity and unstable and inundated soils. Mangroves in Indonesia are the largest in the world, the area of mangroves in Indonesia is 3,112,989 m² or 22.6% of the total area of Mangroves in the world. But in recent years, anthropogenic factors have had an influence on this mangrove ecosystem. About 45% of mangroves in Indonesia have experienced severe degradation due to human activities. The amount of damage is expected to increase along with the growth and development of settlements in coastal areas [1].

Mangrove forests have high economic and ecological value, but are very vulnerable to damage if they are not wise in maintaining, preserving and managing them. The condition of mangrove forests in general has a heavy pressure as a result of the pressure of a prolonged mangrove crisis. In addition to being encroached upon and converted into, mangrove areas in several areas are now rife in restoration and rehabilitation activities. The activity was carried out to restore the condition of mangrove ecosystems that have been damaged so that the mangrove ecosystem can run its function properly. Rehabilitation efforts must involve all levels of society associated with mangrove areas [2].

The Rugemuk village actually has relatively high accessibility with existing growth centers. The distance from the Village to the District City is around 15 minutes, the Village to the Regency City is 1 hour, the distance from the Village to the Provincial City is 2.5 hours and the distance to Kuala Namo
International Airport is around 25 minutes. The total area of the Rugemuk Village in 2013 was around 300 ha or 3 km², with details of land use consisting of 25 ha of residential areas, 180 ha of rice fields, 9 ha of swamps, 13 ha of plantations, 25 ha of ponds, about 38 ha of mangrove forests and other uses 10 ha. Most (around 70%) of the mangrove forests in the area of the Rugemuk village for several years (2000 to 2013) suffered severe damage and continued to be converted into other uses such as settlements, farming, livestock and aquaculture. The physical impact of mangrove damage is the occurrence of strong abrasion on the entire coast and increased tidal flooding (rob) in the area. Damage to the mangrove area has affected various sectors of community life in the village of Rugemuk which results in a high level of poverty in the village. In 2013 the proportion of poor people in the Rugemuk Village reached 40% and was the highest among villages in the Deli Serdang Regency [3].

From 2013 to 2017, with the initiation of the Community Service Institute of the University of North Sumatra (USU's LPPM), mangrove areas have been restored through a comprehensive participatory approach that combines the biophysical recovery of mangroves, the institutional social approach and the economic approach through the development of mangrove-based agro-industries. For 4 years in a row the program was implemented through collaboration between institutions namely Universities, Regional Governments and Private parties. The mangrove recovery program is estimated to have an impact on the socio-economic surrounding communities. Therefore, in this regard it is necessary to conduct research related to the impact of the mangrove forest rehabilitation program on the socio-economic conditions of coastal communities in the village of Rugemuk.

2. Materials and method
The research location of the title of the thesis Impact of the Restoration of Mangrove Forests on the Socio-Economic Conditions of the Coastal Communities in the village of Rugemuk, Pantai Labu Subdistrict, Deli Serdang Regency was selected by purposive sampling. Rugemuk village was chosen by purposive sampling because it is the target location of the mangrove recovery program rolled out by the Higher Education Institutions (USU, UMSU, Medan State University) together with the Regional Government, NGOs and private participation based on community participation from early 2013 to the end of 2016 (early 2017). Prior to the implementation of the program, Rugemuk Village was a village in the coastal area of Deli Serdang Regency with the most severe condition of mangrove forest damage. The time for conducting this research is from May 2018 to June 2018. During this period, field data collection, data processing and data analysis have been carried out.

2.1. Techniques and data collection stages
In accordance with the objectives of the study, the population in this study were coastal communities whose lives were related to the presence of mangrove forests in the village of Rugemuk, Labu Subdistrict, Deli Serdang Regency. The population referred to in this study is the coastal communities of Hamlet 3 and Hamlet 4, Rugemuk Village that was targeted by the coastal recovery program in 2017 amounted to 381 households, and the sampling method used was the simple random sampling method or the sampling was done or selected one randomly (all have the same chance to be chosen) and if selected, cannot be chosen again. In this study random sampling begins with the preparation of a list of numbers and names of population members, namely coastal communities or residents of Hamlet 3 and Hamlet 4 of the Rugemuk Village. Next, a draw was made for these numbers, so that a large number of samples was chosen randomly. While determining the size/number of samples used in this study was determined using the Slovin method with the following equations:

\[ n = \frac{N}{1+Ne^2} \] (1)

Where:
n: Sample size
N: Total population
e: Error tolerance limit
\[ n = \frac{381}{1+381(0.1)^2} = 79 \]  

2.1.1. **Institutional coastal community dynamics.** Institutional/group dynamics in the village analysed by descriptive method, using indicators of the number of institutions/groups, types of institutions/groups, number of institutional/group members, institutional/group leadership patterns, institutional/group meeting activities, number of institutional/group programs that are beneficial to Public. Qualitatively, a respondent (sample) will evaluate the increase and decrease in group dynamics.

2.1.2. **Extent of mangrove forest.** The area of mangrove forest was analysed using descriptive method, assisted by the interpretation of area maps (especially land use maps) sourced from the ETM + Landsat-7 Satellite Image map with the 2012 and 2017 reporting years, and administrative maps sourced from Deli Serdang RTRWK. Meanwhile, for the analysis of the number of stands carried out descriptively supported by an inventory of mangrove species and calculation of the number of stands (both for the category of poles, saplings and seedlings). Sampling uses the line plots transect method and 3 random sample plots are taken with the assumption that the density is sparse, medium and tight with a size of 20 meters x 20 meters.

2.1.3. **Types of captured biota/economic value.** Types of catch biota / economic value of catch biota were analysed using descriptive methods by interviewing all samples and analysed by Wilcoxon match pairs. Qualitatively, there will also be an evaluation of the increase and decrease in types of capture biota / economic value by respondents (samples).

2.1.4. **Availability of coastal agro-industry raw materials.** The availability of coastal agro-industry raw materials from mangrove forests is done using descriptive methods by interviewing all samples and analysed with Wilcoxon match pairs. Agro-industrial raw materials in the village of Rugemuk are small shrimp for making shrimp paste / dried shrimp and dried dried shrimp. Qualitatively, there will also be an evaluation of the increase and decrease in the availability of raw materials for belacan agroindustry and dried shrimp by respondents (samples).

2.1.5. **Opportunity to work/try.** Work/business opportunities are analysed using descriptive methods, after an inventory of the types of activities or sources of income that arise from restored mangroves. Qualitative evaluation of respondents regarding the size of the opportunity to work / try related to conditions before and after mangrove recovery will also be conducted. Qualitatively, there will also be an evaluation of the increase and decrease in work / business opportunities or types of activities or sources of income by the respondent (sample).

2.1.6. **Coastal household income.** Coastal household income is the total income of heads of households and family members, both based on on-farm and off-farm activities. On-farm income is derived from capture fisheries, coastal aquaculture / aquaculture and agricultural farming (food crops and animal husbandry) as well as off-farm activities which include non-coastal aquaculture activities such as agroindustry, services and trade. Coastal business income or coastal agroindustry can be calculated by first calculating the cost of production and revenue of all coastal businesses carried out by coastal households. Analysis of production costs and the total revenue are calculated by the formulas:

\[ TC = FC + VC \]  

Where:
- \( TC \) = Total Cost (Rp)
- \( FC \) = Fixed Cost (Rp)
- \( VC \) = Variable Cost (Rp)
Where:
TR = Revenue from coastal businesses (Rp)
Y = Total Production (Kg)
Py = Price y (Rp. / Kg)

2.2. Comparing conditions before and mangrove
Data analysis methods used to test variable namely the dynamics of mangrove institutions / groups, types of capture biota / economic value, the availability of agro-industrial raw materials (shrimp) and the opportunity to work / try in the Rugemuk Village before and after the mangrove rehabilitation program is a comparative method namely the Wilcoxon Match Pairs Test. This technique is a refinement of the test mark. In the test, the magnitude of the difference between the positive and negative values is taken into account. This technique is used to test the comparative hypothesis of two samples that correlate if the data is ordinal (tiered) [4].

3. Results and discussion
In this section, further testing the hypothesis of whether the mangrove forest recovery program on the socio economic conditions of coastal communities in the village of Rugemuk impacts on group dynamics, mangrove forest area, types of catching biota, availability of coastal agro-industry raw materials, employment / business opportunities, coastal household income. Data analysis uses the Wilcoxon Signed-Rank Test, because the data to be tested differ in data from the year before the recovery program (before 2013) and after the recovery program (2013-2017). The outputs of the Wilcoxon Signed-Rank Test are presented in these following sub-subsections.

3.1. The impact of the forest recovery program on group dynamics in the Rugemuk Village
Table 1 shows that based on the Z value, the Zcount result is -6.742, while the Ztable with a probability \((\alpha / 2) = 2.5\%\) is -1.96 (the "-" sign has no effect). Furthermore, because the value of Zcount (-6.742) > Ztable (-1.96), the conclusion is that the H1 hypothesis stating that there is an increase in group dynamics as a result of the mangrove forest recovery program is accepted. Then Ho's hypothesis which states that there was no increase in the group dynamics of the impact of the mangrove forest recovery program was rejected.

| Text Statistics | Group Dynamic After-Group Dynamic Before | Z          |
|----------------|-----------------------------------------|------------|
| Asymp. Sig (2-tailed) | .000                                    |
| Based on negative ranks |                                       |
| Wilcoxon Signed Ranks Test | *Source: processed from primary data. 2018*

3.2. The impact of the mangrove forest recovery program on captured biota types/economical value Biota in Rugemuk Village
Table 2 shows that based on the Z value, the Zcount result is -8.153, while the Ztable with a probability \((\alpha / 2) = 2.5\%\) is -1.96 (the "-" sign has no effect). Furthermore, because the value of Zcount (-8.153) > Ztable (-1.96), the conclusion is that the H1 hypothesis stating there is an increase in the number of catching biota / economic value of the impact of the mangrove forest recovery program is accepted. Then Ho's hypothesis which states that there was no increase in the number of captured biota / economic value of the impact of the mangrove forest recovery program was rejected.
Table 2. Wilcoxon signed-rank test results impact of the mangrove forest recovery program on types of captured biota / economic value.

| Text Statistics | Biota catches after- Biota catches before |
|-----------------|------------------------------------------|
| Z               | -8.153                                   |
| Asymp. Sig (2-tailed) | .000                                    |
| Based on negative ranks |                                      |

Wilcoxon Signed Ranks Test; Source: processed from primary data. 2018

Thus from the results of different tests it can be summarized that the types of catch biota that have economic value after the mangrove forest recovery program are different or experience a significant increase compared to before the recovery program. These results are consistent with the results of research on the impact of mangrove forest damage conducted by Rosni (2009) which states that there are significant differences between the types of catches of fishermen before and after the occurrence of mangrove damage.

3.3. The impact of the mangrove forest recovery program on the availability of agro-industrial raw materials in Rugemuk Village

Table 3 shows that based on the Wilcoxon test, the Zcount result is -6.904, while the Ztable with a probability (α / 2) = 2.5% is equal to -1.96 (the "-") sign has no effect). Furthermore, because of Zcount (-6.904) > Ztable (-1.96), it can be concluded that Hypothesis H1 which states that there is an increase in the availability of coastal agro-industry raw materials due to the impact of the mangrove forest recovery program is received. Then Ho's hypothesis which states that there is no impact of the availability of agro-industrial raw materials on the mangrove forest recovery program is rejected.

Table 3. Wilcoxon signed-rank test results impact of the mangrove forest recovery program on availability of agro-industrial raw materials.

| Text Statistics | Availability of raw materials after-availability of raw materials before |
|-----------------|-------------------------------------------------|
| Z               | -6.904                                          |
| Asymp. Sig (2-tailed) | .000                                      |
| Based on negative ranks |                                      |

Wilcoxon Signed Ranks Test; Source: processed from primary data. 2018

Different test results can show that the availability of agro-industrial raw materials (in this case shrimp is meant) after the mangrove forest recovery program is different or has experienced a significant increase compared to before the recovery program. This is consistent with the results of the study of Paw and Chua (1989) who conducted research in the Philippines and found a relationship between mangrove ecosystems with fish resources or a positive relationship between the area and quality of mangroves and the catch of penaeid shrimp.

3.4. The impact of the mangrove forest recovery program on job/business opportunities in Rugemuk Village

Table 4 shows that based on the Wilcoxon test, the Zcount result is -7.448, while the Ztable with a probability (α / 2) = 2.5% is equal to -1.96 (the "-") sign has no effect). Furthermore, because the value of Zcount (-7.448)> Ztable (-1.96), it can be concluded that Hypothesis H1 which states there is an increase in the number of employment opportunities the impact of mangrove forest recovery programs is received. Then Ho's hypothesis which states that there was no increase in employment opportunities the impact of mangrove forest recovery programs was rejected.
Table 4. Wilcoxon signed-rank test results impact of the mangrove forest recovery program on job/business opportunities.

| Text Statistics | Job/business opportunities after- Job/Business Opportunities before |
|-----------------|--------------------------------------------------|
| Z               | -7.448                                           |
| Asymp. Sig (2-tailed) | .000                                              |
| Based on negative ranks |                                   |
| Wilcoxon Signed Ranks Test | Source : processed from primary data. 2018        |

Different test results can show that the opportunities for work / business after the mangrove forest recovery program are different or have increased significantly compared to before the recovery program. This is consistent with the results of research by [5] and [1] which states that there are significant differences between work / business opportunities before and after mangrove ecosystem damage occurs. With the condition of mangrove forests damaged, the opportunity to work and try decreases, conversely with the condition of mangrove forests recovering, the opportunity to work and try to also recover or increase.

3.5. The impact of the mangrove recovery program in household income in the Rugemuk Village

It can be seen that the average household income of fishermen per month before the mangrove recovery program is IDR 1,314,557.00 while after the mangrove recovery program is IDR 1,620,594.00. This means that fishermen household income per month after the mangrove recovery program has increased compared to before the mangrove recovery program. The increase occurred due to an increase in the productivity of the mangrove forest area (ecological use of mangroves) and increased employment opportunities.

Table 5. Comparison of fisherman household income per month before and mangrove recovery program.

| Income | Before (Rp/month) | After (Rp/month) |
|--------|------------------|------------------|
| Total  | 103,850,000      | 128,026,922      |
| Average| 1,314,557        | 1,620,594        |

However, to see the significance of differences in fishermen household income per month before and after the mangrove recovery program, a paired sample test was conducted, as follows

Table 6a. Average difference test results T-Test of income of coastal communities before (2012) and after (2017) impact of mangrove forest recovery.

| Paired Differences | Mean | Std. Deviation | Std Error Mean | 95% Confidence Interval of the Difference | Lower | Upper |
|--------------------|------|----------------|----------------|------------------------------------------|-------|-------|
| Pair income before program income after program | 306036.99024 | 416721.71420 | 46884.85587 | -399377.36812 | -212696.41236 |
Table 6b. Average difference test results T-Test of income of coastal communities before (2012) and after (2017) impact of mangrove forest recovery (Continue).

| Paired Differences | t | df | Sig.(2-tailed) |
|--------------------|---|----|---------------|
| Pair income before program income after program | 6.527 | 78 | .000 |

From Table 6a and 6b obtained t value of 6.527 with sig (2-tailed) of 0.000 or less than 0.05 then Ho: rejected and H1: accepted. It was concluded that there were significant or significant differences in coastal income in the village of Rugemuk before and after the mangrove forest recovery program. Different test results indicate that the household income of coastal communities after the mangrove forest recovery program is different or has increased significantly compared to before the recovery program. This is in accordance with the statement from [1] that the success of mangrove rehabilitation in Rembang Regency has an influence on the socio-economic conditions of coastal communities, namely improving community welfare through the use of mangroves ecologically and economically (utilization of aquatic biota).

3.6. Mangrove forest area and number of mangrove stand
The area of the mangrove forest that was analysed using the descriptive method was assisted by the interpretation of the area map (especially the land use map) sourced from the ETM + Landsat-7 Satellite Image map with the 2012 reporting year (before recovery) was 9 ha, whereas in the 2017 coverage year (after recovery) is 23.5 ha (Figure 1).

![Mangrove forest cover in Rugemuk Village increased by 23.5 ha.](image)

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The area of the mangrove forest that was analysed using the descriptive method was assisted by the interpretation of the area map (especially the land use map) sourced from the ETM + Landsat-7 Satellite Image map with the 2012 reporting year (before recovery) was 9 ha, whereas in the 2017 coverage year (after recovery) is 23.5 ha (Figure 1).

Figure 1. Mangrove forest cover in Rugemuk Village increased by 23.5 ha.

4. Conclusions
The mangrove forest recovery program has a significant impact on increasing the dynamics of coastal communities, the width of the mangrove forest, the type of catching biota / economic value, the availability of coastal agro-industry raw materials, employment/ business opportunities, household income in the village of Rugemuk.

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