Spatial Analysis of Rehabilitation Efforts for the Labor-intensive National Economic Recovery Program for Mangrove Planting (Case Study in the Coastal District of Ngombol, Purworejo)

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Abstract
Purworejo Regency has a narrow mangrove area along the Slope 2 River to the mouth of the Jali River with a wide area 100.22 ha, and 64.24 ha are in Ngombol District. This mangrove habitat is under pressure and degraded due to the development of shrimp farming and agricultural land. Many attempts to plant mangroves have been made but have always failed. In 2020 mangrove rehabilitation will be carried out through the National Mangrove Labor Intensive PEN program covering an area of 18,709 ha. One of the Mangrove Work-Intensive PEN activities was carried out in Ngombol District, namely in Wero Village, Pagak Village and Malang Village covering an area of 48 ha. However, the planting activity also failed. This study aims to (1) map the distribution of mangroves on the coast of Ngombol District; (2) carry out a spatial analysis of Mangrove Labor-Intensive PEN locations based on their land use, and identify the factors that cause failure of mangrove rehabilitation. Mapping of mangroves and land use was carried out through visual interpretation of Pleiades PMS satellite imagery with a spatial resolution of 0.5 m recorded on 30 July 2020. Sampling was carried out by purposive sampling. Spatial analysis was carried out through overlapping maps of rehabilitation locations and land use maps. The results of the study obtained a mangrove map with a scale of 1:10,000 with a mangrove distribution area of 40.13 ha. The results of the spatial analysis on the Mangrove Planting Labor-Intensive PEN rehabilitation location against the Land Use Map found that the planting location was located in mangrove land use (21.57 ha), former ponds (0.94 ha), vacant land (0.43 ha), grass / bush (12.73 ha), rainfed rice fields (2.71 ha) and rivers (9.63 ha). Several factors contributed to the failure of rehabilitation, including: the very short time for implementing rehabilitation activities, resulting in a lack of planning; plant type incompatibility; disrupted tidal cycle due to sediment in the estuary; flooding of the area around the river due to silting of the river; annual large inundation floods and community understanding that is still weak on the importance of mangroves and a lack of coordination between sectors. The results of this study serve as input for rehabilitation activity organizers so that future rehabilitation activities can be more targeted and successful.

Kata kunci: Mangrove, Rehabilitation, PEN Padat Karya Mangrove

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1. Introduction

Indonesia is an archipelagic country with the richest mangrove species in the world. The current area of Indonesian mangroves is 3.36 million ha (KLHK 2021) or around 24.52% of the world's total mangrove area of 13.7 million ha (Bunting et al. 2018). This area continues to decrease due to changes in land use and land use as well as degradation. The high pressure of population activities on mangrove ecosystems makes this environment vulnerable to degradation (Siburian and Haba 2016). The condition of the mangrove ecosystem is very dynamic and changes to the area covered can reflect the environmental conditions in which it grows (Field 1999).

Purworejo Regency has a thin mangrove area along the Slope 2 River. The area of mangroves in Purworejo Regency based on the 2021 National Mangrove Map is 100.22 ha, and an area of 64.24 ha is in Ngombol District (BPDASHL SOP 2020) as shown in figure 1. As we know, the coast of Ngombol sub-district also has the potential for aquaculture development shrimp ponds (Triyatmo 2001). Shrimp Vannamei It is very popular with the people because it has a high economic value and is an export commodity to Japan and Taiwan (Biantara et al., 2016). In addition, the development of agricultural land in this region also puts pressure on the mangrove habitat.

The high economic value of coastal areas often creates community conflicts due to land use struggles. One of the conflicts that occurred was triggered by the disposal of pond waste into the Slope 2 River, which polluted rice fields and rivers which resulted in a decrease in soil fertility, causing 40% of the population's rice fields to no longer be planted and resulting in silting of the river (Setwan 2021).

Various efforts to restore the mangrove ecosystem, from planting to rehabilitation, have been carried out in the coastal District of Ngombo. Recovery efforts by planting mangroves have been carried out from 2016 to 2019 by the Environment and Forestry Service of Central Java Province and NGOs. Planting was carried out along the banks of the Slope 2 River, but it often failed (Komangjo 2020).

In 2020 the Ministry of Environment and Forestry (KLHK) through the Mangrove Planting Mangrove Planting National Economic Recovery (PEN) Program. This activity aims to restore the mangrove ecosystem as well as support the state financial policy program by absorbing a sizable workforce. The basis for implementing this Mangrove Work-Intensive PEN is Government Regulation Number 43 of 2020 concerning Amendments to Government Regulation Number 23 of 2020 concerning Implementation of the National Economic Recovery Program in the Context of Supporting State Financial Policies for Handling a Pandemic Coronavirus Disease 2019 (Covid-19) and/or Facing Threats that Endanger the National Economy and/or Financial System Stability as well as Saving the National Economy. Mangrove Planting Mangrove Intensive PEN activities through mangrove rehabilitation covering an area of 18,709 ha nationally and absorbing a national workforce of 1,779,248 working days (HOK) (BPDASHL SOP 2020).

One of the locations for mangrove rehabilitation is the coastal area of Ngombol District, Purworejo Regency. Planting was carried out in three villages, namely Wero Village covering an area of 18 ha, Pagak Village and Malang Village each covering an area of 15 ha. The labor-intensive PEN activity for Mangrove Planting, which cost a lot of money, also failed.
Based on the Regional Regulation of Purworejo Regency Number 10 of 2021 concerning Spatial Planning, it is stated that the coastal area of Ngombol District includes areas with mangroves which are designated areas for protection of mangrove ecosystems. Utilization and management for protection and conservation purposes, green open space activities, construction of limited infrastructure for disaster prevention and management as well as activities that have ecological and aesthetic value in the area. However, the reality on the ground is that land use is not in accordance with the spatial planning guidelines that have been stipulated.

Research related to labor-intensive PEN rehabilitation efforts for planting mangroves in research areas has never been done before. Bearing in mind the importance of restoring mangrove ecosystems for the preservation of mangroves and the survival of coastal communities in Ngombo District, a study is needed to find out the causes of failure of rehabilitation and how to overcome them. The benefits of this research will later be used as input for rehabilitation activity organizers in planning activities so that they are more targeted in choosing locations. So the aims of this research are (1) to map the condition of the leftmost mangroves in the coastal area of Ngombol District; (2) carry out a spatial analysis of Mangrove Labor-Intensive PEN locations based on their land use and the factors that cause failure of mangrove rehabilitation.

2. Method

This research is located on the coast of Ngombol District, Purworejo Regency covering three villages namely Wero Village, Pagak Village and Malang Village. As the unit of analysis, the boundaries of the Mangrove Labor-Intensive PEN rehabilitation area are used. The materials needed in this research include the 0.5 m resolution Pleiades PMS image recorded on 30 July 2020 which will be used to identify and map mangrove distribution and land use in the study area. Digital Topographical Map 1:25,000 scale, National Mangrove Map 1:25,000 scale, Mangrove Work-Intensive PEN Rehabilitation Location Map 1:10,000 scale, and laws and regulations related to mangrove management. Mangrove mapping refers to SNI 7717:2020 regarding the specifications of mangrove geospatial information. The Mangrove Map and Land Use Map were obtained from the results of a visual interpretation of the PMS Pleiades Image. Determination of samples by purposive sampling using 60 samples for mangrove accuracy test and 43 for land use accuracy test samples. The accuracy test uses the confusion matrix, while to calculate the level of accuracy of the interpretation results, Sutanto's formula (1986) is used, which is the ratio between the number of correct objects divided by the number of samples. Spatial analysis was carried out by overlaying the Mangrove Planting Labor-Intensive PEN Rehabilitation Map with the Land Use Map resulting from the mapping. Field observations and descriptive analysis were carried out to determine the factors causing the failure of mangrove rehabilitation. Map of Mangrove Planting Labor Intensive PEN rehabilitation locations in the study area is presented in Figure 1 and Figure 2. A research flowchart is presented in Figure 3.
Figure 1. Research location (Google Earth Pro 2022)

Figure 2. Mangrove PEN Rehabilitation location in Ngombol District
3. Result and Discussion

A. Mangrove Conditions in the Coastal District of Ngombol

The results of the mapping of mangroves visually using the PMS Pleiades Image obtained a 1:10,000 scale Mangrove Map in the study area. The characteristics of the mangroves that grow in the study area are estuarine mangroves that grow along the Slope River 2. The natural types of mangroves that grow in the study area are white bells, golden acrostic, and Acanthus ilicifolius. While the type Rhizophora mucronata and Bruguiera gymnorrhiza are planted mangroves. The spread of mangroves getting closer to the mouth of the Jali River is getting thicker. So that the mangroves in Malang Village are denser than the mangroves that grow in Pagak Village and Wero Village. The condition of the mangroves that grow in the villages of Pagak and Wero are stunted and less fertile due to polluted and nitrified river conditions. The total area of mangroves in the study area is 40.13 Ha (presented in Figure 4). PMS Pleiades imagery is very good for mapping mangrove cover because it has a high spatial resolution of 0.5 m so it can present mangrove objects more clearly. High spatial image resolution, being able to show larger object sizes in a small land cover class can produce high-accuracy mapping (Kamal, Phinn, and Johansen 2015). However, the appearance of mangroves in the pile and sapling classes that grow together with other vegetation/shrubs is difficult to distinguish from the image so it requires field checks.
B. Land Use Conditions

The pattern of land use in the study area from the coast to the land begins with a stretch of beach sand, followed by a row of shrimp ponds on a sand dune landform. Then in the swale area there are rivers and mangrove habitat, and agricultural land and in the Gisik shoal landform are used for settlements and agricultural land.

The classification of land use in Malang Village, Pagak Village and Wero Village refers to SNI 7645:2010 concerning Classification of Land Cover (National Standardization Agency 2010). The results of the mapping are in the form of a 1:10,000 scale land use map derived from land cover information. There are 24 classes of land use, namely: rain-fed rice fields, shrimp ponds, mangroves, mixed gardens, vacant land used for ponds, beach sand, grass/shrubs, rivers, settlements, fields/mallows, vacant land, fish ponds, beach tourism, shrubs cemeteries, village offices, schools, mosques, prayer rooms, food stalls, Islamic boarding schools, roads and fields. A comparison of the area of land use is presented in a bar chart in Figure 5. Land use is a dynamic parameter and is always changing and can be used as a measure of land degradation (Talakua and Rafael M 2018).

Mangrove habitat coexists with the use of agricultural land (rainfed rice fields, fields/tegal) and ponds, so changes in the area of one of them will affect the area of the other (Tanjung, Khakhim, and Rustadi 2017). Most of the mangroves grow along the Slope 2 River. The mangrove seeds are carried by the river flow and grow scattered over rain-fed rice fields, empty land, former ponds and river bodies. The distribution of land use in the study area is presented in Figure 6.
**Figure 5.** Comparison of Area of Landuse

<table>
<thead>
<tr>
<th>LAND USE CLASS</th>
<th>AREA (HA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Former Pond</td>
<td>29.88</td>
</tr>
<tr>
<td>Village Office</td>
<td>39.07</td>
</tr>
<tr>
<td>Mixed Office</td>
<td>10.57</td>
</tr>
<tr>
<td>Farm/Tegal</td>
<td>9.19</td>
</tr>
<tr>
<td>Empty Land</td>
<td>0.03</td>
</tr>
<tr>
<td>Field</td>
<td>0.47</td>
</tr>
<tr>
<td>Grave</td>
<td>40.13</td>
</tr>
<tr>
<td>Mangrove</td>
<td>0.05</td>
</tr>
<tr>
<td>Mosque</td>
<td>11.62</td>
</tr>
<tr>
<td>Beach</td>
<td>0.04</td>
</tr>
<tr>
<td>Settlement</td>
<td>15.57</td>
</tr>
<tr>
<td>Shrub</td>
<td>0.06</td>
</tr>
<tr>
<td>Fish Pond</td>
<td>2.76</td>
</tr>
<tr>
<td>Shrimp</td>
<td>141.4</td>
</tr>
<tr>
<td>Fish Auction/road</td>
<td>0.04</td>
</tr>
<tr>
<td>Food Stalls</td>
<td>0.17</td>
</tr>
<tr>
<td>Inten Beach</td>
<td>0.02</td>
</tr>
</tbody>
</table>

**Figure 6.** Land Use Map
C. Spatial Analysis of Rehabilitation Sites

In general, the Mangrove Labor-Intensive PEN planting locations in the villages of Malang, Pagak and Wero are along the banks and bodies of the Slope 2 River. Many of the plants resulting from mangrove rehabilitation have died. From the results of the overlapping between the rehabilitation locations and the land use map, it was found that there were 6 types of land use, including: former ponds, vacant land, mangroves, grass/shrubs, rainfed rice fields, rivers. The area and distribution are presented in Figure 7. In general, the selection of mangrove rehabilitation locations was appropriate, namely in mangrove habitat on the banks of the Slope 2 River.

Figure 7. Distribution of Land Use in PEN Mangrove Planting Locations. The condition of dead mangrove rehabilitation plants on land use: (a) river bodies, (b) shrub/grass, (c) rainfed rice fields.
Based on Regional Regulation no. 10 of 2021 concerning the RTRW for Purworejo Regency, the coastal area of Ngombol District is intended for the development of pond fishery cultivation and agriculture. It's just that its current development has expanded to bring pressure on mangrove habitat. As a result of this land use pressure, mangroves are increasingly degraded, some of them experience drought and die. On the other hand, people are increasingly interested in developing shrimp pond cultivation. Some farmers who have capital have started to switch to becoming fish farmers and leaving rain-fed rice fields to become abandoned land.

Mangroves provide enormous environmental services, namely protecting the shoreline against waves and wind, regulating sedimentation, retaining nutrients, improving water quality, controlling seawater intrusion, microclimate stability, and providing habitat for biota (Kusmana 2009). However, the community has done a lot of damage to the ecosystem, land conversion is one of the main causes of loss of mangrove ecosystems (Arifanti et al. 2021). Rehabilitation is one of the efforts to accelerate the recovery of mangrove ecosystems, but if it is not balanced with proper enforcement of regulations and spatial management, it will not work.

D. Factors Affecting Rehabilitation Failure

The Mangrove Work-Intensive PEN program, especially in the villages of Malang, Pagak and Wero, was implemented in a short time, namely for four months from September-December 2020. This led to a lack of planning both in determining the location and determining the type of plant. This activity also does not begin with a physical study of the land such as determining the suitability of mangrove land. The condition of the Covid-19 pandemic caused rehabilitation efforts to experience obstacles because they had to maintain health protocols so as to minimize coordination between parties. Limited time causes less optimal activity planning efforts.

Selection of seeds / seeds *Rhizophora mucronata* and *Bruguiera gymnorrhiza* be the main alternative. The considerations are because these seeds are more adaptive to environmental conditions, their availability is abundant, they are easy to breed without waiting for the fruit season and the price is cheap. Mangrove rehabilitation is carried out
in monoculture, even though this can eliminate ecological functions and reduce species richness (Rahmania et al. 2019).

Seeing the spatial conditions of the location, the choice of planting site was appropriate because it is a mangrove habitat. In general *Rhizophora mucronata* it can be planted at the rehabilitation site because the area has the appropriate physical conditions, namely being on a flat riverbank and always inundated by the tides. *Rhizophora mucronata* also more tolerant of inundation than other mangrove species (Noor, Khazali, and Suryadiputra 1999). Otherwise election *Bruguiera gymnorrhiza* needs to be reviewed because this plant is best planted in locations that have low salinity and is dry and in soil with good aeration (Yuwono 2016). But if still forced to plant *Bruguiera gymnorrhiza* preferably planted in pond embankments. To increase the percentage of rehabilitation success, it is best to plant mangroves using the same type as the mangroves that grow naturally in the area, namely *Sonneratia alba*.

The coastal area of Cilacap or the Indian Ocean has a double daily inclined mixed tidal type, namely tides that occur twice in a day and twice in a day but sometimes there is one high and one low tide with different heights and times (Haryono and Narni 2004). The average monthly tidal height is 1.37 m. the highest average water level is 2.295 m and the lowest is 0.494 m (BIG 2022). Mangrove habitats on the banks of the Slope 2 River are always submerged in water, especially during the rainy season and at the same time as high tides it always causes inundation to inundate the rainfed rice fields around it. Mangrove planting was carried out at the beginning of the rainy season, namely October 2020. At the beginning of November 2020 there was a large inundation flood which lasted more than 15 days. This massive flood had not subsided before the sediments at the mouth of the Jali River were dredged using heavy equipment. This flood usually occurs every year at the beginning of the rainy season. Mangrove plants that have just been planted are not able to survive in inundation conditions for too long. The 15-day inundation has caused the mangrove seedlings to dry out and die. The height and frequency of inundation affect the soil organic matter content. Prolonged submergence causes negative oxidation-reduction potential, which results in anoxic soils (Sharma et al. 2014).

A small proportion of mangrove seedlings that are still alive are those in areas that have variations in inundation, for example in bunds or empty land, former ponds. The inundation flood factor is the main cause of rehabilitation failure in the study area.

Community involvement in the implementation of rehabilitation is very important. The aim of implementing the Mangrove Work-Intensive PEN program is not only to restore the mangrove ecosystem, but also to absorb as much labor as possible. When the plants died due to inundated floods, there was no effort from the community to carry out embroidery independently. Communities in the villages of Malang, Pagak and Wero do not yet understand the benefits of mangroves which can be processed into various products such as flour, coffee, syrup and so on. So far, there has been no socialization and training related to the processing of non-timber mangrove forest products from either the government or non-governmental organizations (NGOs). The community is more interested in managing shrimp ponds with more promising results. The lack of intersectoral coordination, the absence of clear regional administrators and low law enforcement also contributed to the failure of mangrove rehabilitation in the study area.
4. Conclusion

The condition of the mangroves at the study site covers an area of 40.13 ha which are scattered along the Slope 2 River and some are scattered in rainfed rice fields and abandoned former ponds. The results of the spatial analysis of the Mangrove Planting Labor-Intensive PEN rehabilitation location against the Land Use Map show that the planting location is located in mangrove land use (21.57 ha), former ponds (0.94 ha), vacant land (0.43 ha), grass/shrubs (12.73 ha), rainfed rice fields (2.71 ha) and rivers (9.63 ha). Several factors contributed to the failure of rehabilitation, including: the very short time for implementing rehabilitation activities, resulting in a lack of planning; plant type incompatibility; disrupted tidal cycle due to sediment in the estuary; flooding of the area around the river due to silting of the river; annual large inundation floods that hit more than 15 days and the community's understanding is still weak on the importance of mangroves and the lack of coordination between sectors.

5. References

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