

# Mangrove in Bedono Village: Past, Present and Future

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**Abstract.** Bedono Village is experiencing environmental problems due to land use, so that the mangroves area is converted into ponds and villages. On the other hand, this change causes erosion, loss of hundreds of hectares of land, disturbing the livelihoods. This study aimed to analyze the type and area of mangroves in Bedono Village. The mangrove data were obtained from field studies by exploration. Each location was chosen subjectively to determine the station based on mangrove species information. After that, the plot was determined. The mangrove area was processed based on high-resolution imagery data from 2015 to 2020. Based on the identification, six types of mangroves were found in Bedono Village, Demak. Meanwhile, the mangrove area in Bedono Village has decreased from 2015 to 2020. The efforts made by the community in replanting mangroves have been successful based on indicators of mangrove areas. For this reason, the effort that must be done now and in the future is to maintain the existence of mangroves by properly implementing existing regulations

## 1 Introduction

The coastal area is a very dynamic area, with various physical processes, including sea-level rise, land subsidence, erosion, and sedimentation. All these processes influence the development of coastal landscape forms, which is sometimes beneficial, such as a land increase for land use purposes. However, it can also result in pressure on coastal areas leading to land loss due to erosion [1].

The pressure on the coastal zone makes coastal areas need priority in sustainable monitoring management [2]. One of the coastal areas is Bedono Village, Sayung District, Demak Regency. Bedono Village is experiencing environmental problems due to changes in land use (conversion) of mangroves due to pressure from the community. The mangrove land is converted into ponds and villages [3]. On the other hand, this change in land use has become one of the causes of erosion on the Bedono coast. Hundreds of hectares of land have been lost, disturbing the livelihoods of Bedono Village, Sayung, Demak [4].

The coastal area of Bedono Village, Sayung, Demak, is a lowland area dominated by settlements, aquaculture, and agriculture. This condition causes some people to depend on the fisheries sector for their livelihood. The reduction of mangrove forests will lead to coastal erosion. On the other hand, coastal erosion has a significant impact on reducing mangrove

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areas influenced by ecological, social, economic, and cultural factors of the local community [5]. Anticipation and rehabilitation must be carried out due to mangrove forest reduction and damage so that the coastal area can be sustainable.

Efforts were made to anticipate the widespread erosion that occurred in the coastal area of Bedono village by replanting mangroves by the community from the 2000s to the present. The purpose of writing this article is to investigate 1) the changes in mangroves of Bedono Village from 2010 to 2020, 2) the success rate of mangrove replanting efforts carried out by the community based on the extent of mangroves, 3) the efforts made to maintain the sustainability of the mangrove ecosystem.

## **2 Method**

This research design is descriptive exploratory, which is research about a condition by systematically, factually, and accurately regarding facts, characteristics and examining the relationship between the phenomena being investigated. The method includes preliminary study, determination of the observation area sample collection and data analysis. Each step is described as follow: Preliminary studies.

This step is to obtain the general condition of mangrove vegetation and environmental factors to determine the study area based on the mangrove community.

### **2.1 Determination of the observation area**

After identifying the data of coastline changes, a field survey was conducted as a form of location verification. It is to make sure of the correctness of the position and the existence of the location.

### **2.2 Sample collection**

#### *2.2.1 Mangrove*

##### *2.2.1.1 Area determination*

Area determination was carried out through exploration to obtain mangrove species that can represent the research site. Furthermore, in each observation area, stands were determined subjectively based on mangrove density, and transects were determined for each stand. The length of the transect starts from the coast to the land. Furthermore, in each area, sample collection was carried out at 0-20 m, 21-40 m, 41-50 m, and so on. Vegetation data were taken using the quadratic method with a size of 20 x 20 meters to observe trees/poles located on the right and left of the transect. In each plot, a smaller plot was made with 5 x 5 meters to measure the saplings/saplings. At the seedling level, data were collected from each 2 x 2-meter plot placed on 5 x 5-meter plots [6]. Moreover, certain zones in the mangrove ecosystem that have unique characteristics were observed. Descriptive methods then analyzed the observations obtained.

### *2.2.1.2 Mangrove area calculation*

The calculation of area used secondary and primary data. For primary data, the area of mangroves was obtained from the results of the photo image; then, it was processed with ArcGIS software. The position of the mangroves was determined and calculated. ArcGIS digitization results and mangrove area calculations for 2015 and 2020 were compiled in a table/matrix containing the year and area of the mangrove. Based on the matrix, the area of mangroves can be determined each year. From the results of the calculation of mangrove area in 2015 and 2020, it can be seen that the change in mangrove area experienced an increase or decrease in mangrove area from 2015 to 2020.

### *2.2.1.3 Social data*

Social data of Bedono village since the 2000s has been explored by in-depth interviews with the community. We selected community samples with who understand the history of Bedono village.

## **2.3 Data Analysis**

The result analysis of the study was carried out with a qualitative descriptive study of mangrove species. In contrast, the mangrove area was obtained based on ArcGIS 10.1 in 2015 and 2020. Furthermore, they compiled a model for the conservation of mangrove ecosystems in the form of a fishbone based on the identification of the efforts made by the community from 2000 to the present.

## **3 Research Results and Discussion**

### **3.1 The Condition of Bedono Village, Sayung, Demak**

Based on the depth interview, it is known that Bedono Village is one of the villages in Sayung District, Demak. Bedono Village is a village with fertile soil. This is evidenced by the existence of all kinds of plants growing in Bedono Village. The soil fertility in Bedono Village has made many farmers from other villages rent land or work on the rice fields in Bedono Village. Furthermore, along the coast of Bedono Village, there are also productive ponds, which adds to the complete picture of the welfare of the people of Bedono Village.

Geographically, Bedono Village has an area of 739 hectares. The land in Bedono Village is used for settlements, rice fields, moor, gardens, and ponds. Most of the residents of Bedono Village make a living as farmers, fishponds, fishers, and other services. However, the development in the neighbouring area (Semarang city) that juts into the sea has a huge impact, especially coastal erosion, natural damage, and tidal overflows (rob) that inundate areas in Sayung sub-district in general, including Bedono Village. This situation has made the area which used to be an area for agricultural, and aquaculture uses sink due to the overflow of tidal water (Participant 1, personal communication, October 25, 2020)



**Fig. 1.** One of the houses left by the occupants because of the overflow of tidal water.

The tidal water that inundated Bedono Village in 2017 reached 631.31 hectares. It almost covered the entire area of Bedono Village and is widespread in several villages in Sayung District, Demak. Due to tidal flooding and erosion, two hamlets, Tambaksari, consisting of 84 families from 1999 to 2000, moved to Purwosari and Rejosari Villages. A total of 206 heads of families from 2006 to 2007 moved to Sidogemah and Gemulak villages.

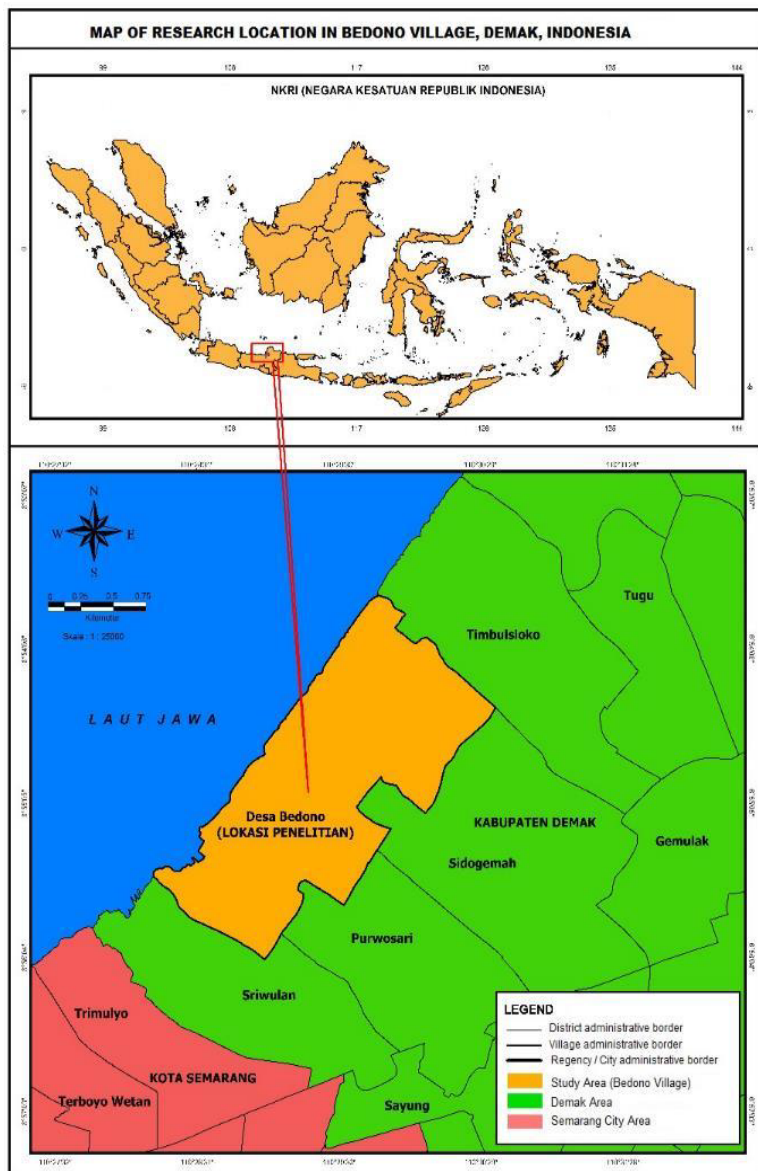
Several efforts to cope with tidal water have been carried out by making embankments by the community. However, they have not overcome the problem because the tidal overflow is increasing, and the embankments are often broken. Increasingly with the years, the area affected by the tidal wave also increases.

In 2004, efforts were made to overcome tidal water by planting mangroves by the residents. Based on the information from the community, it is estimated that there are around 13 types of mangroves planted. The community formed an organization called the Marine Mangrove Group or Komunitas Mangrove Bahari (KMB) to coordinate planting activities. Mangrove planting has received a welcome from the community and government agencies, both domestic and foreign, such as OISCA (Japan). The support from the government and OISCA since 2004 has been beneficial in efforts to reduce erosion that has occurred in Bedono Village through planting mangroves, although the species planted are dominated by *Rhizophora* (Participant 2, personal communication, October 25, 2020).

The existence of mangroves provides benefits to the community. Apart from being a protector from erosion, the presence of mangroves provides other benefits, including increasing the number of fish, crab, or shellfish species because mangroves are a place for these organisms to live. Moreover, with the presence of mangroves, the bird species found in the mangrove area are also increasing.

However, the presence of mangroves creates a conflict of interest in the community. For example, mangroves, especially the wood, which can be used for fuel, charcoal, or animal feed, create opportunities for people to cut down, which ultimately causes mangrove damage. Furthermore, the presence of birds in the mangrove area is an attraction for bird shooters to shoot in the mangrove area, so that it disturbs and threatens the presence of birds in Bedono Village. On the other hand, the abundance of animal species with economic value creates conflicts/struggles in the use of economic value species wealth

because there are people from outside Bedono who take fish and shellfish using non-environmentally friendly tools. In contrast, the people around Bedono use traditional tools.



**Fig. 2.** Locations of mangrove planting in Bedono Village.



**Fig. 3.** Mangrove planting in 2012 (source: KMB Archives, 2019).

The existence of problems that arose led to the idea of protecting the community and village officials. Environmental protection measures are intended to protect mangrove areas and protect the community's economy through Village Regulations. The regulation made were not only for protection but also sanctions for the community that committed violations. However, the implementation in the field initially encountered obstacles. However, gradually it was accepted by the wider community. The existence of local knowledge of the community in mangrove protection through the regulations made the mangroves in Bedono Village sustainable. However, from year to year, the mangrove area was decreasing due to the waves of seawater.



**Fig. 4.** Two years old Mangrove growth in 2013 (source: KMB Archives, 2019)

### 3.2 Mangrove in Bedono Village

Based on identification in the field, six types of mangroves were found in Bedono Village, Sayung, Demak.

#### 3.2.1 A. Types of Mangrove

Data collection found six types of mangroves included in the low-risk category based on IUCN. These types of mangroves are described in Table 1.

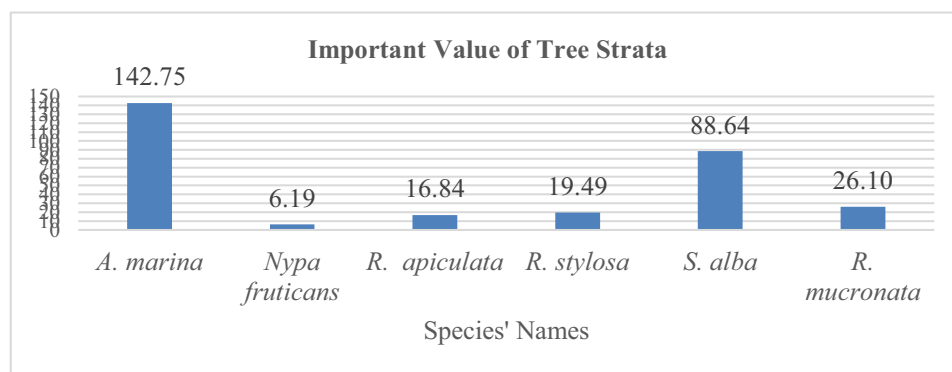
**Table 1.** List of mangrove species in Bedono Village, Sayung, Demak and status on the IUCN red list.

Mangrove Type	Status in IUCN	Information
<i>Avicennia alba</i>	LC	Low risk
<i>Avicennia marina</i>	LC	Low risk
<i>Rhizophora mucronata</i>	LC	Low risk
<i>Rhizophora apiculata</i>	LC	Low risk
<i>Rhizophora stylosa</i>	LC	Low risk
<i>Nypa fruticans</i>	LC	Low risk

Based on the data in Table 1, it can be seen that the mangrove species found in Bedono Village are those that have been included in the list of the International Union for Conservation of Nature (IUCN), even though they have a low-risk status.

#### 3.2.2 Mangrove Composition

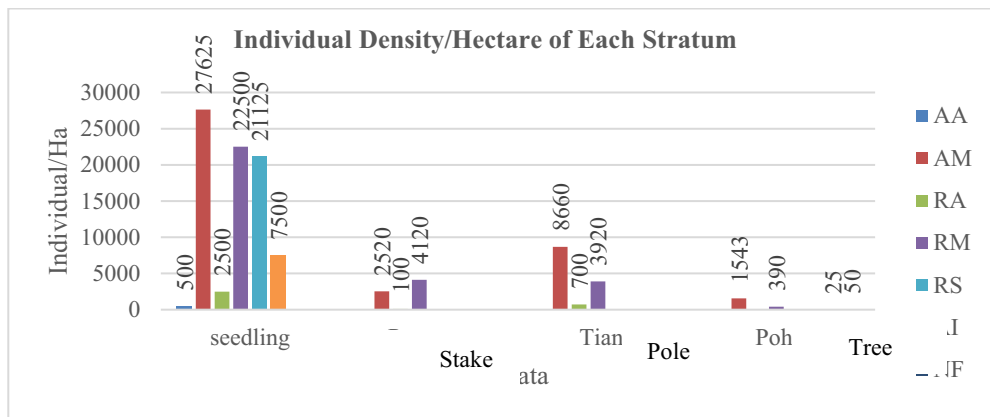
The mangrove tree in Bedono Village is dominated by *A. marina*, *S. alba*, *R. mucronate*, *R. stylosa*, *R. apiculata* and *N. fruticans*. Based on the results of mangrove identification, the importance of each mangrove species in Bedono Village can be determined as follows:



**Fig. 5.** Important Value of Mangrove Tree Stratra in Bedono Village in 2020.

Figure 5 shows that *A. marina* has an important value in tree strata, which is followed by *S. alba* and *R. mucronata*. While for individual density, depicted in Figure 6.

Based on Figure 5 and Figure 6, we believe that the *Avicennia marina* species have higher importance than do other species and have a higher regeneration rate than do other species.



**Fig. 6.** Mangrove Density in 2020.

### 3.2.3 Mangrove Area

Based on the results of satellite image processing in 2015 and 2020, data in Figures 7 and 8 were obtained. Each year is represented in different colors to emphasize its clarity. Red color represents mangrove growth in 2015, while green color represents mangrove in 2020.



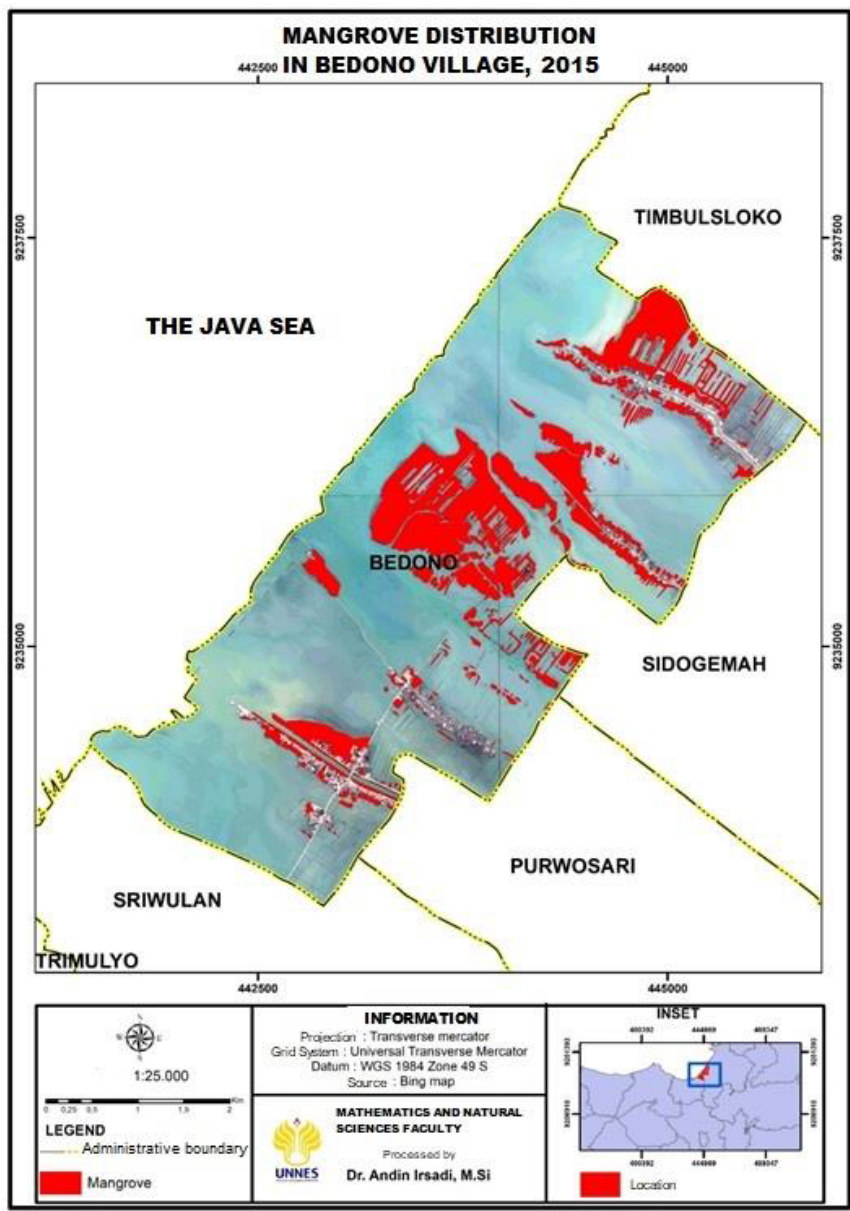
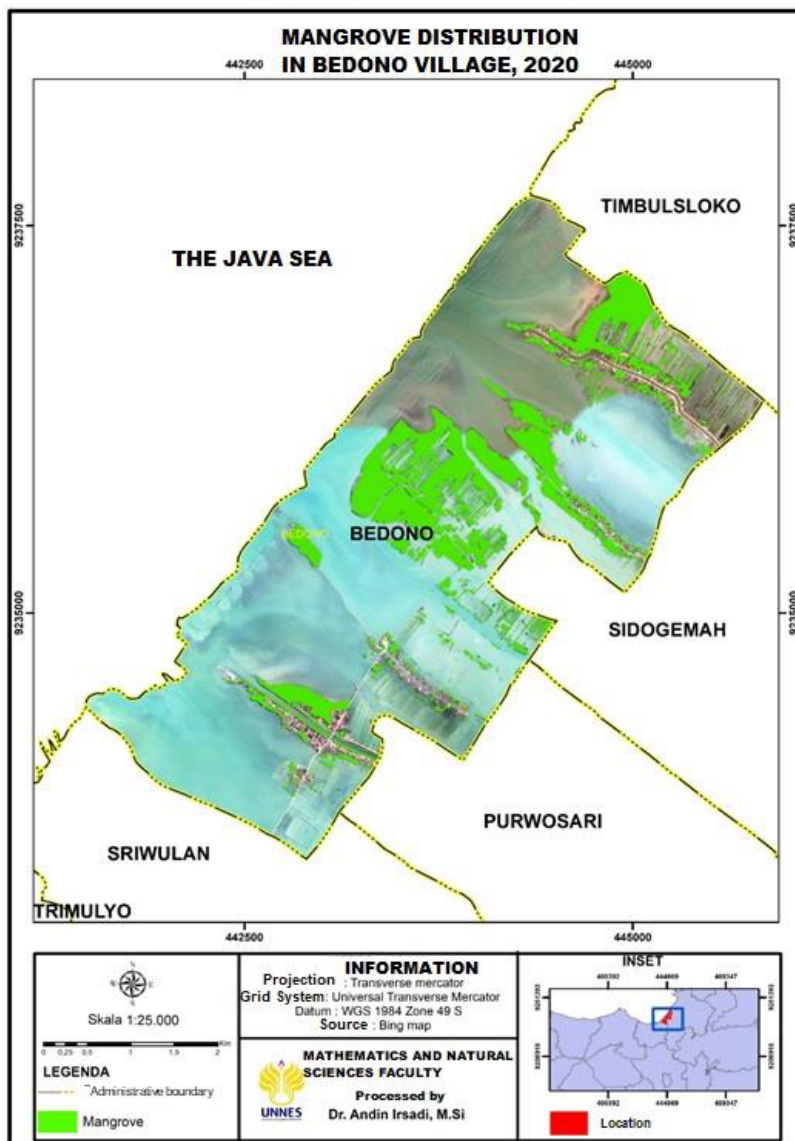


Fig. 7. Map of mangrove forest distribution in Bedono village in 2015.



**Fig. 8.** Map of the distribution of the mangrove forest in Bedono village in 2020.

Based on calculations using ArcGIS, the mangrove area from 2015 to 2020 has decreased as in Table 2.

**Table 2.** Result of calculation of mangrove area in 2015 and 2020.

Year	Area (Ha)
2015	115.42
2020	110.57

Table 2 proves that the mangrove area since 2015 and 2020 has decreased. The decline in mangrove area can be caused, one of which is due to natural factors such as erosion due to high waves [1].

### 3.3 Discussion

The awareness of Bedono Village people of environmental conservation was triggered by an increase in sea level (tidal water). The threat of tidal flooding was triggered by the construction of the Tanjung Mas port, coastal reclamation, and the extension of the breakwater [7, 8], resulting in changes in current patterns that hit fishponds and settlements. Additionally, sea waves hitting the coast in the Bedono area causes erosion around the Bedono beach [9]. This fact makes people try to be able to overcome these threats.

The community has made several efforts, such as building protective embankments, but due to continuous waves, the water can still inundate the area on the coast of Bedono. The community tries to plant mangroves based on information and assistance from the local government and non-governmental organizations (NGOs) about the importance of mangroves for the coast.

The research results revealed six types of mangroves that live in Bedono Village (Table 1), more than the results of previous studies. This is because this study employed a combination of exploration methods based on local community knowledge and transects. Moreover, the mangrove succession data in Bedono Village also showed a good trend because the growth of seedlings was high and varied in species. Furthermore, the mangrove ecosystem in Bedono Village is important because the types of mangroves in the ecosystem are in the low-risk category based on the IUCN red list data. Even though this species is a low-risk category, if it is not protected and properly used, it can threaten its existence. Hence, the management of the mangrove ecosystem in Bedono Village needs to be managed and evaluated regularly, including information on the type and area of mangroves synergistically from various components of society, including academics through research supported by data through satellite imagery.

The image mapping results show that the total area of mangroves from 2015 to 2020 has decreased. Based on the results of field identification, the types of mangroves on the coast have suffered a lot of damage and death due to logging or nature. This is because the mangrove ecosystem is prone to disturbances due to erosion. The disturbance that causes mangroves to decrease is due to waves or human factors such as logging. For this reason, it is still necessary to carry out further studies related to the area of the ecosystem which has decreased. However, the community's effort to protect and preserve the mangrove ecosystem is still being carried out through planting efforts.

The planting activities carried out by the community provide many benefits for the people in Bedono Village. The benefits can be in the form of direct benefits such as the abundance of coastal animals to catch or indirect benefits, including protection from strong winds [5]. On the other hand, the existence of the mangrove ecosystem can cause conflicts of interest between communities, especially those who traditionally use mangroves and those that use modern tools, which are considered to cause problems related to marine product sustainability. To overcome the emergence of conflict in the community, based on knowledge about the environment from the community, the community and village officials together formulate village regulations as a form of protection for mangroves. Several essential points in the village regulation include: 1) the protection and utilization of mangrove ecosystems carried out jointly between the community and government officials, 2) the protection of the community's economy regarding the use of mangroves, 3) the important role of the community in protecting the mangrove ecosystem. Compared to village regulations in the

surrounding villages, the regulation formulated by Bedono Village is relatively better based on the substance of the rules, which are not only environmental protection but also the protection of the economic rights of the community. The existence of village regulation and its proper implementation can become a starting point in protecting mangrove ecosystems in the future, especially in combining local community knowledge [10, 11] and policies from the government. However, it is no less important to improve community perceptions in sustainable mangrove management [12], such as ecosystem development for ecotourism activities [13]. In short, a model for developing a sustainable mangrove ecosystem in Bedono Village, Sayung, Demak can be made as Figure 9.

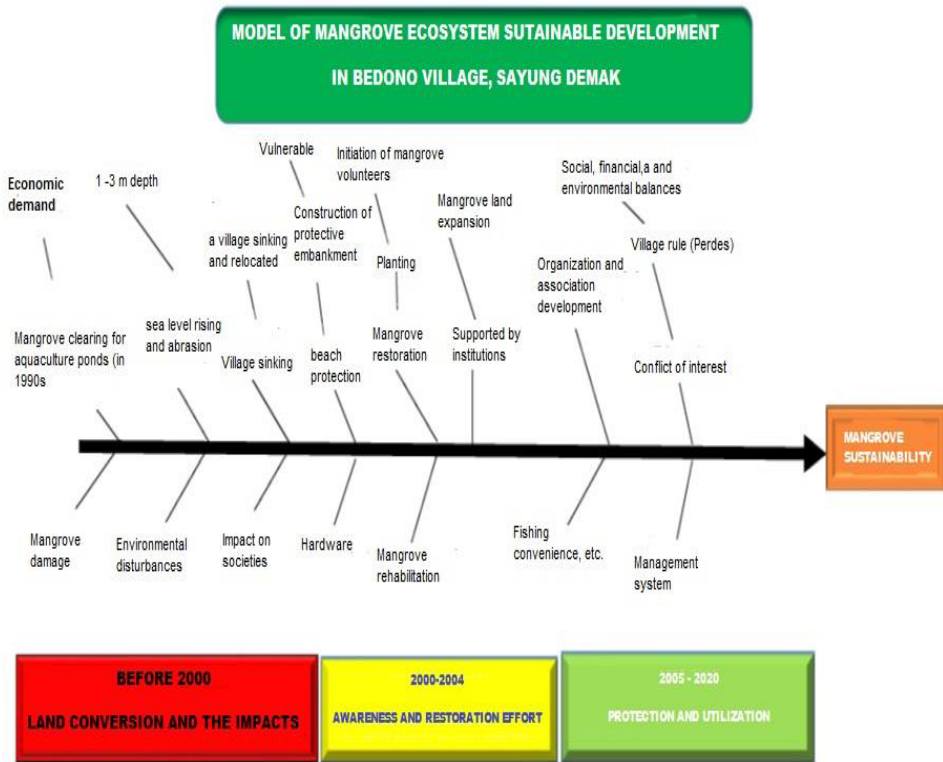


Fig. 9. Model of sustainable mangrove development in Bedono Village

Figure 9 visualizes that in the coastal area of Bedono Village, there was a change in land use for aquaculture and fisheries since before 2000 with no efforts protecting the coast, resulting in environmental damage and erosion. To overcome this, countermeasures were done by making coastal protection dikes, but they were often damaged. Since the 2004s, mangroves have been planted and have developed well. The existence of the mangrove ecosystem is crucial and a coastal protector; now, it has also developed into ecotourism. This condition makes it essential for the mangrove ecosystem to be preserved because its existence helps protect the coast, but tourist attractions also provide a carbon cycle that goes well [14].

The existence of village regulations that accommodate existing knowledge in the community is an essential means of protecting the mangrove ecosystem in Bedono Village. The implications that arise in the protection of mangrove ecosystems include the large number and density of species and a natural succession process that goes well. This shows that the local knowledge of the community in the preservation of the mangrove ecosystem in Bedono Village has a vital role. However, sometimes the direct implications are not obtained by the community, for example, the existence of animals like birds [15].

This proves that the presence of mangroves in Bedono Village is suitable and supports the existence of birds so that mangroves in Bedono Village have significant benefits in protecting the beach and the presence of birds that are naturally present and protected in the mangrove ecosystem in Bedono Village. The existence of mangroves in Bedono Village also has significant benefits for the community, especially in coastal protection and natural benefits in the presence of birds. This adds to the importance of the existence of the mangrove ecosystem, so it must be supported by good local knowledge of the community in protecting the mangrove ecosystem in the future.

## 4 Conclusion

The results showed that the area of the mangrove ecosystem in Bedono village since 2010 has decreased. The efforts made by the community in replanting mangroves have been successful based on indicators of mangrove area. For this reason, the effort that must be done now and in the future is to maintain the existence of mangroves by properly implementing existing regulations.

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