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# Mangrove conservation as an abrasion strategy risk reduction based on ecosystem in the coastal area of the Rembang Regency

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## **Abstract.**

Rembang Regency is one of the regencies located in coastal areas which have abundant marine. Rembang Regency is a coastal area that has abundant marine resource potential, besides that there are also threats of coastal abrasion and high erosion, so that efforts are needed to reduce the risk of coastal abrasion. Efforts to reduce abrasion risks carried out are ecosystem-based or Ecosystem-Based Disaster Risk Reduction (EcoDRR) through mangrove conservation. The purpose of this study was to determine mangrove conservation activities as a form of EcoDRR in Rembang Regency. Observation of the mangrove ecosystem is carried out by field observations, as well as secondary data collection. Interviews were conducted with communities, mangrove managers, and local governments to determine the extent to which EcoDRR with mangrove forest conservation had been carried out, as well as benefits and problems. The method used is descriptive explorative. The results showed that the types of abrasion mitigation efforts carried out in Rembang Regency based on natural ecosystems were more effective than artificial ecosystems. Disaster reduction efforts are based on natural ecosystems such as maximizing the presence of mangroves and the ecosystem in them.

## **1. Introduction**

Rembang Regency is one of the coastal areas of Central Java that is prone to disasters. High score index and available in the 22<sup>nd</sup> national reference vulnerability rating that are vulnerable to coastal and abrasion disasters [1]. This condition is not only affected by the contour conditions of Rembang Regency, but also by wind patterns and Javanese Sea wave patterns. The Rembang Coastal Area to Tuban Regency is geologically and geomorphologically, is a coastal area of limestone (karst) with silt from the river and empties into the sea. Wind and flow patterns will push upstream waves towards Rembang which is formed towards the Jepara Peninsula, the Center for decentralization.

Rembang Regency is located on the north coast of Central Java and has throughout coastline of more than 60 km. Disaster problems in the Coastal Area of Rembang Regency are abrasion. Abrasion is mainly in the District of Rembang, District of Sluke, District of Lasem, District of Kragan, and District of Sarang. The problem in mitigation efforts is the especially salt ponds and settlements ([rembangkab.go.id](http://rembangkab.go.id)). The condition of the north coast of Java without the retention of both natural and artificial waves will be very easily eroded due to the scour of tidal waves [2].



Disasters in coastal areas can be caused by various activities including human activities, such as development and natural factors. One of human activities are a major factor in the occurrence of pressures in coastal areas that cause disasters. Coastal areas also have different characteristics, physical conditions and problems. These differences result in different management actions taken, especially in disaster risk reduction. Disaster risk reduction activities are carried out today with Ecosystem-based Disaster Risk Reduction (EcoDRR) or structural reduction in vegetative forms [3].

Abrasion is a coastal erosion process that is caused by destructive ocean waves and ocean currents. Abrasion or other words commonly called coastal erosion. Damage to the coastline is due to disruption of the natural balance of the area on the beach. This abrasion can occur because of several factors, among others, natural factors, human factors, and one to prevent the occurrence of abrasion, namely planting mangrove forests. Some natural factors that can cause abrasion, among others, winds that blow over the ocean causing waves and ocean currents that have the power to erode a coastal area [4].

Mitigation is divided into two, namely structural mitigation and non-structural mitigation. Structural mitigation is an action to reduce the impact caused by disasters physically, such as infrastructure development in order to minimize the impact and use of technology approaches. Non-structural mitigation is an action related to policy, knowledge development, including among others capacity building of communities through emergency planning [5].

The power of large storms that speed up the beach process. Abrasion besides the factors that can also be caused by human factors, such as sand mining, which is done because mining is very important for coastal abrasion which can cause the drainage of sea sand and is very necessary for the direction and speed of ocean currents because it will hit the coast. [6], to the extent that he said, as for how to prevent abrasion, namely:

- 1.1 Mangrove tree planting,
- 1.2 Smart Mangrove trees or other types of trees,
- 1.3 planting trees in the coastal forest.

Forms of coastal protection with mangroves are included in the Ecosystem-Based Risk Reduction (Eco-DRR) system, namely disaster management using conservation methods. Mangrove forests are one of the coastal ecosystems that are widely used as wave dampers, and also habitat for coastal biota ecosystems. This ecosystem is directly related to natural factors, such as the character of oceanography, fluvial, climate change, and human factors, for example the use of land use and environmental sanitation. Managing ecosystems will reduce the threat to the danger and increase community resilience [7].

Coastal areas that have muddy soil types are often considered not to provide economic benefits, so that a lot of coastal land is converted as pond and then reclaimed. Beach reclamation is used for the benefits of industry, ports, power plants, and several other purposes that have been carried out on the coast of Rembang Regency. The reclamation location adjacent to the location of mangrove ecosystems will indirectly affect the life of the ecosystem. Errors in planting mangroves can also pose a threat of abrasion within a certain period. Mangrove vegetation planted in the moorings of residents ponds is an improper method of planting. Inappropriate planting will make the mangrove function as a natural barrier (abrasion) of the lost wave. Mangroves should be planted in groups or clumped so that the roots of the plants are stronger to resist abrasion in the coastal areas [8].

Pasarbanggi mangrove area is one of the coastal tourism objects in Rembang Regency. The high level of development and development of coastal tourism objects located around Pasarbanggi mangrove area has resulted in a degradation of coastal land in the surrounding area. This then affects the mangrove area, this demanding the community to mitigate potential disasters in coastal areas, especially in the Pasarbanggi mangrove area.

Previous research on abrasion disaster mitigation in Central Java's north coast especially abrasion in Tegal, Semarang and Demak was carried out by [9]. Based on the coastal characteristics between Rembang Regency and several regencies in the Pantura region, Central Java has almost the same character. The results of the study show that the handling of abrasion is using coastal safeguards and planting mangroves along the coast. Physical buildings have limited usage life, so the emphasis on

disaster risk reduction efforts is carried out using risks. This is a number of protective structures that cannot survive because some buildings are destroyed.

Basically, the coastal zone needs to meet the demands of all stakeholders ranging from traditional local communities, administrators, academic researchers etc. The concept of coastal area management needs to be applied with the support of spatial decision support tools taken from satellite data including national programs on inter-sectoral approaches. A series of disasters have reminded the need to have regulatory steps through a workable approach [10]. High-impact events have shown the risk of flooding faced by exposed coastal areas. The abrasion risk of coastal areas can also be due to climate change and economic development [11].

Based on this series of events, in general a research question arises, "How does the form of mangrove conservation take place in Pasarbanggi Beach area face abrasion?". This question can be used as a basis for the use of environmental adaptation in the region. This research has a similar reason for the coastal area of Pasarbanggi beach in Rembang Regency.

## 2. Methodology

Rembang Regency is one of the regions in Central Java Province which is traversed by the north Java coast road (pantura line). Rembang Regency is located at coordinates  $111^{\circ} 00' - 111^{\circ} 30'$  BT and  $06^{\circ} 30' - 07^{\circ} 60'$  LS. Rembang Regency has administrative boundaries, namely the North, bordering the Java Sea, bordering Blora Regency in the south, Pati Regency in the west, and Tuban Regency in the east. The focus of research is on the coast in Rembang Regency.

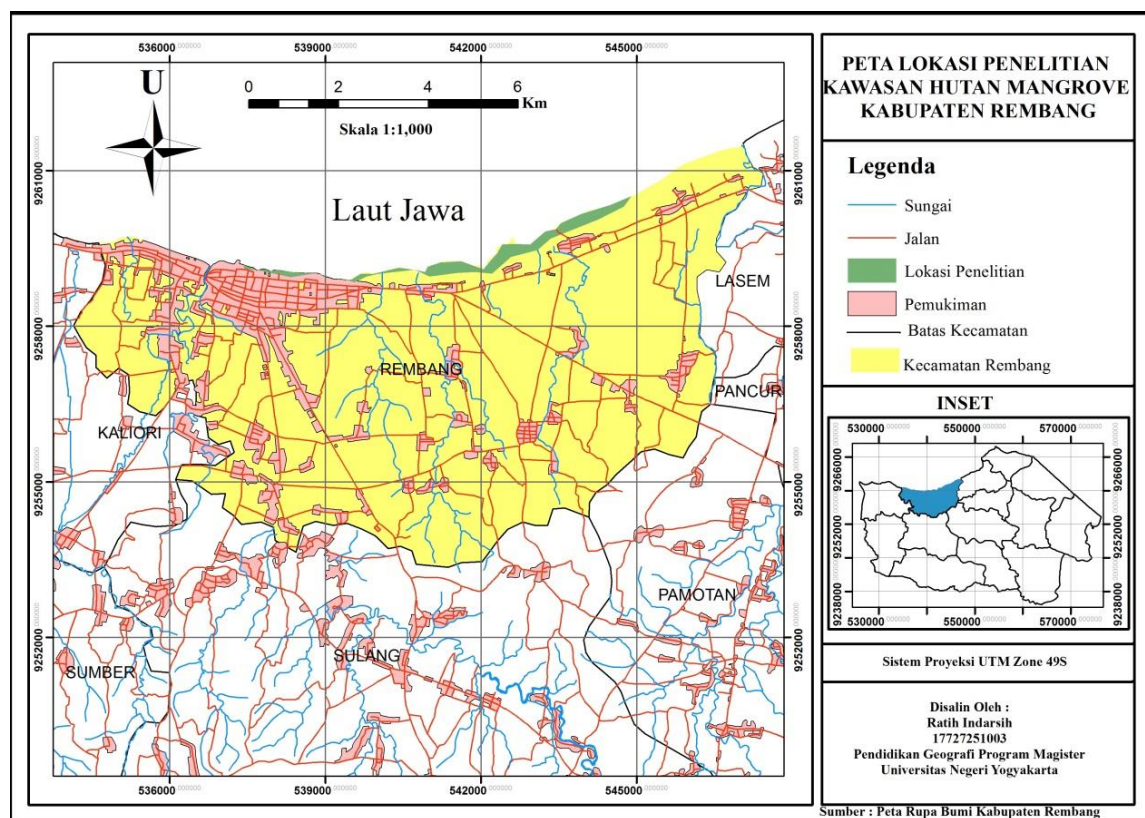


Figure 1. Locations research of Mangrove in Rembang Regency

Data collection methods in this study use secondary data analysis and field observation. Secondary data obtained from abrasion and tidal event data, damage data, disaster management data, and coastal water and social characteristics data. Interviews were also carried out on the community, Non-Governmental Organizations (LSM) to determine the extent to which EcoDRR with mangrove

conservation has been implemented, including its use and problems. Field observations were carried out to validate the results of interviews and also to determine the condition of mangroves at the research location. The documentation taken is a form of adaptation made by local residents and the government. The results obtained are then analyzed descriptively exploratively to determine the type of strategy to reduce the impact of abrasion, the extent to which EcoDRR runs and the benefits obtained and what constraints are obtained.

### **3. Results and Discussions**

#### **3.1 Potential Abrasion Disaster in Rembang Regency**

Degradation of coastal areas from chronic actions by humans threatens security, livelihoods, overall economic development and the welfare of coastal communities. Large or small disasters affecting coastal communities are a reminder that coastal communities must be able to minimize the occurrence of disasters. Community resilience development is the most effective solution to reduce the long-term impacts of coastal hazards to increase the capacity of coastal communities [12].

Abrasion is a negative impact caused by climate change. Indonesia as an archipelago has a vulnerability to the risk of abrasion. One of the provinces in Indonesia that has high vulnerability is Central Java Province. Abrasion in Central Java Province is largely caused by natural processes [13]. Abrasion in the northern Central Java Province caused damage to mangrove ecosystems, seaweed, coral reefs and ponds [14]. Abrasion on the coast of the island [15].

Disaster risk is affected by danger, vulnerability, and community capacity. Dangers are caused by beach processes, which are interactions between winds, waves, currents, tides, sediment transport, and human activities. Abrasion waves through the process of breaking waves that affect the coast. Waves affects the beach current, and the current functions as a medium sediment transport. Longshore current cause of abrasion and accretion, because this current moves parallel to the coastline [16]. In addition to natural factors, coastal hazards are also caused by factors of human activity in coastal areas. Beach erosion occurs as a result of human activities and natural phenomena. Coastal erosion causes significant economic and ecological problems [17].

The high risk level caused by abrasion requires serious handling so as not to damage the coastal environment. One way that can be done to minimize the risk of abrasion is to make mitigation efforts. Mitigation is grouped into two, namely structural mitigation and non-structural mitigation. Structural mitigation is an effort to reduce disaster risk by carrying out development such as the construction of taluds, gabions and so on. Non-structural mitigation is an effort to reduce disaster risk by increasing community capacity, such as socialization, simulations, and so on. Structural mitigation efforts are more widely applied in several regions in Indonesia to reduce the risk of abrasion [18].

Rembang Regency, as one of the areas that has a high risk of abrasion. Data from the Environment Agency (BLH) records abrasion events over the past two years, including along the Karangjahe coast to Nyamplung beach, Kragan sub-district, and Sarang sub-district experienced severe abrasion. As for the data of damage suffered, namely damage to the conditions of the coastal, several houses that were badly damaged and dozens of houses were lightly damaged, and several public facilities such as mushollah, food stalls, and local fisherman posts. The Regent intervenes in dealing with abrasion disasters by implementing several forms of structural and non-structural mitigation efforts. This form of structural mitigation against abrasion consists of mechanical and vegetative methods. One of the structural mitigation efforts carried out is by arranging limestone on the Rembang coast and planting mangroves. Mangrove planting is being carried out intensively by the government and the people of Rembang Regency.

#### **3.2 Management of Abrasion Disasters in the Coastal District of Rembang**

Capacity building can be done by integrating local and scientific knowledge in disaster risk reduction by using methods to encourage knowledge exchange and this two-way dialogue is a difficult but

important task. Participatory mapping can help in promoting integrative disaster risk reduction through the large involvement of various stakeholders [19].

The general purpose of coastal management is to avoid development in disaster-prone areas, ensure that natural systems function properly, and protect life, including in managing disasters [20]. Disaster management activities include a series of planning and mitigation before a disaster, when a disaster occurs, and after a disaster. Disaster management aims to reduce risk through capacity building and reduce vulnerabilities and hazards in areas both in physical and community aspects in the context of sustainable development [21].

The response in the face of disasters is carried out in three forms, namely, shifting objects from vulnerable areas (backwards), remaining in vulnerable areas and accommodation, and security of vulnerable areas (protection) [22]. Forms of frequency response (protection) in food management have been carried out in several districts of Rembang, both through hard structures and soft structures. Disaster management through hard structures is carried out by building coastal structures, such as the installation of groynes, breakwaters, dikes, and others. Some Rembang coastal areas that use this method, Sarang Subdistrict, Kragan District, and Tasik Agung Port.

Sustainable development needs to consider ecosystem conditions that govern, so that nature and life within it can coexist and sustainably. Therefore, began to apply the concept of ecosystem-based disasters (Eco-DRR) in various regions, including in the Coastal District of Rembang. Forms of coastal protection with mangrove maintenance are included in the application of Eco-DRR. Mangrove ecosystems consist of transitional ecosystems between land and sea. It is seen in sub-tropical areas along protected beaches and river mouths which are plant communities visited by several types of mangrove trees. This coastal plant is able to grow and develop in tidal areas according to the level of salinity, duration of inundation, substrate, and the morphology of the beach. Mangroves can be found in areas along river mouths, or areas that are numerous by river flow factors and areas that are usually more free by sea air. Mangrove ecosystems are ecosystems that have enormous benefits in terms of ecology, economics and social aspects [23].

### 3.3 EcoDRR with Mangrove Conservation in Rembang District

One of the tropical ecosystems that is being developed as one of disaster management is the mangrove ecosystem. Ecosystem-Based Management (EBM) that is to understand broadly, recognize connections, and try to maintain ecosystem elements and every process that connects them [24]. The management concept can also be used as the basis for ecosystem-based disaster management or commonly known as Ecosystem Based Disaster Risk Reduction (Eco-DRR) [25]. Ecosystems that are used as the basis of development also have various benefits that can be felt by communities around the ecosystem. The benefits provided by eco-economy are varied, either direct benefits or indirect benefits.

The benefits of ecosystem protection can also be applied in ecosystem-based disaster risk management (Eco-DRR). An ecosystem approach is defined as an integrated management strategy of sustainable use of land, water and conservation resources in an ecosystem. With such an important function, the existence of mangrove ecosystems must be a part of consideration in the development and spatial planning of coastal areas, therefore an appropriate conservation strategy is needed so that all physical, social and economic activities can run in harmony and harmony.

The paradigm of disaster management has now shifted from physical based disaster management to ecosystems or environmental based disaster management. Ecosystems that have a very good role in abrasion disaster management efforts are mangrove ecosystems. Mangroves are one type of plant along the coastline, sea, or river that has ecological, physical, economic and social functions. Ecologically mangroves are able to produce fertilized marine waters. Mangroves has an average high primary productivity, mangroves can maintain the sustainability of fish, shellfish and other populations. The physical benefits of mangroves are as coastline guards, accelerating the formation of new land, storm and wave wind absorbers, protection from abrasion, mudguards, and sediment traps [26].



Mangrove ecosystems cannot be arbitrarily grow and breed. A good mangrove ecosystem is usually developed in forms protected from ocean waves. Sediments from rivers and seas will be deposited and form tidal flats. The Java Sea is a sea that has relatively calm wave currents with shallow depths, thus supporting the process of developing mangrove ecosystems [27].



Figure 2. Mangrove stands in Pasarbanggi Rembang

The conversion of mangrove land functions is increasingly prevalent due to increasing land requirements. The need for land in coastal areas causes changes in mangrove land use to function as ponds, settlements, trade and services, the port industry, and so on. The consequences that will arise are the disruption of the mangrove ecosystem which is then no longer able to play a role in disaster risk reduction. The mangrove management, both the government and the surrounding community, has made efforts to plant mangroves in coastal areas for various purposes, namely economic, tourism, education and coastal area mitigation.

Forests and mangrove vegetation are natural belts that protect the coast. The mangrove ecosystem in Pasarbanggi Village, Rembang Regency is one of the best in Pantura. Mangroves in these locations are a combination of natural mangroves and rehabilitation results [28]. Mangrove thickness at some points between 29.87 to 218.64 meters, mangrove forests in prone to other abrasions [29].

The Rembang coastal area began to develop into a tourism and beach area although it was still managed independently by the community. The negative impact is the lack of attention to environmental planning and management due to the absence of tourism activities. If this is allowed to continue, natural and abrasive natural processes are increasingly occurring and disasters.

Coastal areas that have a typology of sandy and rocky beaches are relatively safe against the threat of abrasion. Although relatively relatively safe, sandy coastal typologies are also prone to abrasion threats. Several locations in the Rembang district that has a coastal coastal typology are Sluke Subdistrict prone to abrasion. Sandy beach vegetation such as pine cones and ketapang make abrasion susceptibility at these locations increase. Making abrasion-retaining buildings encountered when conducting surveys is still not maximal in dealing with the threat of abrasion. Unlike the appearance found along the coast of Caruban Beach, Rembang Regency still has a natural barrier in the form of shrimp fir vegetation lined up along the coast. The location is relatively safe against abrasion because the beach sand erosion can be minimized by the shrimp fir [30].

These activities, especially for coastal abrasion in Rembang Regency, have been made to the main priority. This is done because of the widespread amount of food in Rembang Regency which usually takes place in an annual cycle. The Coastal District of Rembang uses mangroves as a barrier to ponds and breakwaters, and also is used as objects of tourist attraction by applying the principle of ecotourism. The principle of ecotourism allows people who are able to maintain the condition of

mangroves in sustainability. Success of mangroves in life Rembang District can be seen at certain locations or points that start planting mangroves. These locations include markets Banggi, Wates, Dasun, Bonang, and several other areas.

Management of mangrove areas in Rembang Regency as a reduction in abrasion risk by applying the principle of ecotourism. In addition to being able to reduce the impact of the abrasion disaster, this activity is also able to maintain the stability of the mangrove ecosystem as well as the realization of a sustainable tourist destination. This management has begun to be implemented in 1999, which began with the participation of local people who were often affected by abrasion. The community felt that using embankments could not last long, so the idea arose to develop mangroves that existed on the shores of the coast at that time. Up to now, the mangrove area in Rembang Regency besides being a tourist destination is also the goal of researchers to develop their knowledge.

#### 4. Conclusion

Risk reduction of abrasion in Rembang Regency is a form of structural and non-structural mitigation. Structural mitigation is used in the form of mechanical and vegetative techniques. Mechanical techniques used in the form of abrasion restraint with limestone, abrasion barrier with Andesite stones, taluds, buis, sandbags and cube-shaped coastal buildings. Vegetative non-structural methods used in the form of planting and Mangrove conservation.

Abrasion disaster mitigation uses structural methods to consider coastal typologies and socio-economic conditions of the community. The socio-economic condition of the community is also determinant in the effort to mitigate abrasion. High socio-economic community will apply a reduction in the risk of abrasion at a high cost, such as applying the talud as a disaster mitigation effort. Communities with a low socioeconomic level will implement abrasion risk reduction efforts with the lowest possible cost emphasis, namely using a sack filled with sand.

The emphasis is on the implementation of Eco-DRR, and ecosystem-based disaster risk reduction activity. Eco-DRR is applied in the coastal area of Rembang Regency by conserving mangrove forests. The application of Eco-DRR in Rembang Regency is classified as successful, some mangrove conservation areas are now used as ecotourism-based tourism objects. Pasarbanggi is one of the mangrove areas which is said to be successful in terms of returning mangrove ecosystems. The success of implementing Eco-DRR can be seen from the good coordination between stakeholders and the good condition of mangrove forests in the region.

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