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Study of the Benefits of Mangrove Conservation on Hydrometeorological Disaster Mitigation Effort in the Coastal Area, Banda Aceh City

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Abstract

The city of Banda Aceh, which is a city affected by the Hydrometeorological Disaster in 2004, still has a high level of sea waves and coastal abrasion. Still, conservation of mangrove plants as a mitigation measure has not been carried out optimally due to a lack of public awareness and priority of the government's performance program plan. This study will describe a study related to the benefits of mangrove plants as an appropriate mitigation effort according to the geographical conditions of Banda Aceh City. Based on this research, it is hoped that the government and the community will understand the importance of preserving and conserving mangroves to improve the safety and security of the people in the city's coastal areas. This study uses qualitative methods based on primary and secondary data from previous journal research and data from agencies related to hydrometeorological disaster management. The results obtained are based on the data collected. Considering the study of the benefits of mangroves, the coastal city of Banda Aceh is vital for the conservation of mangrove plants as a mitigation measure for high waves and coastal abrasion.

Keywords
Hydrometeorology; mitigation; mangroves

I. Introduction

Urban is a central area where all local community activities in the life of the nation and state are carried out. The growth of infrastructure and population capacity also has a reasonably high rate. This makes it more difficult for cities to adapt to their natural surroundings than districts, sub-districts, and villages, so they have an increased risk of Natural Hazards. According to the United Nations International Strategy for Disaster Reduction (UN-ISDR), the threats can be grouped into geological hazards (geological hazards), hydrometeorological hazards (hydrometeorological hazards), biological hazards (biological hazards), technological hazards (technological hazards), and environmental degradation (environmental degradation).

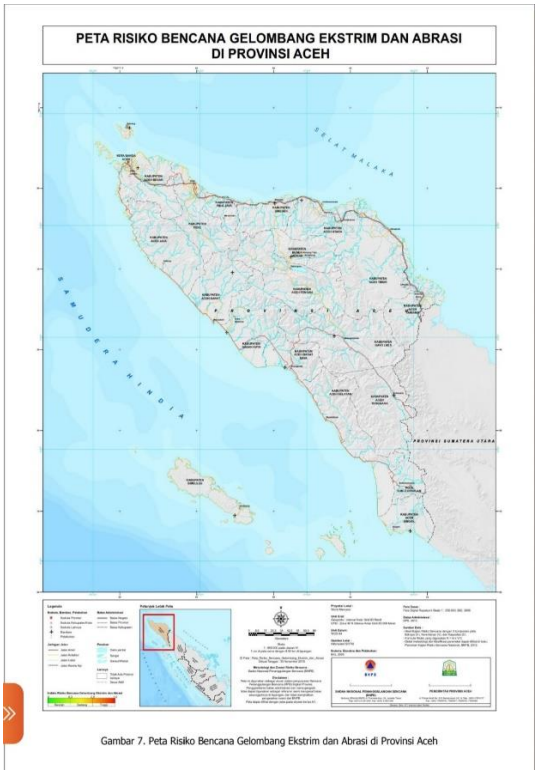
To deal with these various threats, it is necessary to have open spatial management adaptive to nature and environmentally friendly as a Natural Hazard preventive measure. Therefore, the Aceh Provincial Environment and Forestry Service have an Organizational Structure and Work Procedure that addresses urban environmental management. It is hoped that it can anticipate these treaties so that the Aceh Government can carry out its development program to improve the welfare and security of the community effectively and efficiently according to the target. And program targets are contained in the RPJM and the Regional RPJP.

According to Nova Iriansyah (2019), the Government of Aceh today officially started cooperation in the preparation of the Aceh Green Growth Plan together with development partners and stakeholders. He hopes that this RPH will assist in the long-term and medium-term planning of economic development that improves welfare without neglecting environmental sustainability.

The program is contained in the Aceh RPJM 2017-2022, namely Green Growth in the "Great Aceh" Vision, to utilize Aceh's Natural Resources to increase environmentally sound economic growth. This green growth plan is built through public, private, and community partnerships with a sustainable landscape and commodity approach in line with the UN Sustainable Development Goals (SDGs) and Indonesia's commitment to the Paris Agreement's Nationally Determined Contribution (NDC).

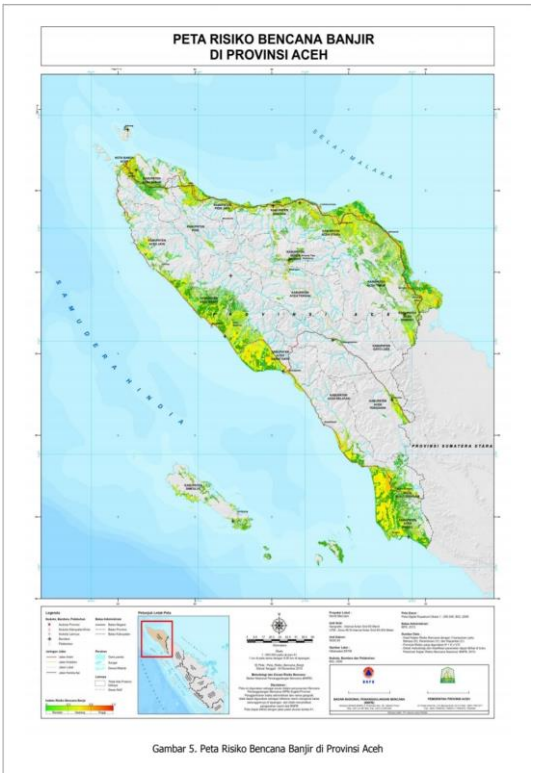
As the center of the Aceh government, which has experienced post-tsunami reconstruction in 2004, the city of Banda Aceh still has several problems related to natural disasters in coastal areas, namely extreme waves and abrasion flooding-ROB.

This can be seen in the Disaster Risk Map contained in the 2016-2020 Aceh Disaster Risk Assessment Guidelines below;



Source: Aceh Disaster Risk Assessment Guidelines for 2016-2022

Figure 1. *Disaster Risk Map of Extreme Waves and Abrasion of Aceh Province*



Source: Aceh Disaster Risk Assessment Guidelines for 2016-2022

Figure 2. *Aceh Province Flood Risk Map*

Quantitative Data from the Disaster Risk Assessment Index presents that the results of the vulnerability (vulnerability) of Banda Aceh City to Rob-Flood Disasters and Extreme Wave Disasters and Abrasion enter the High and Medium stage class according to the general guidelines for disaster risk assessment parameters in the graph as follows;

Table 1. Potential Populations Exposed to Extreme Waves and Abrasion Disasters

KABUPATEN/KOTA	JUMLAH PENDUDUK TERPAPAR (Jiwa)	KELOMPOK RENTAN (Jiwa)			KELAS
		KELOMPOK UMUR RENTAN	PENDUDUK MISKIN	PENDUDUK CACAT	
1. SIMEULUE	10.614	1.645	3.086	82	TINGGI
2. ACEH SINGKIL	6.379	1.047	1.480	32	TINGGI
3. ACEH SELATAN	22.598	3.272	4.397	193	TINGGI
4. ACEH TIMUR	1.826	284	465	19	TINGGI
5. ACEH BARAT	6.797	962	1.854	26	TINGGI
6. ACEH BESAR	6.077	966	1.445	66	TINGGI
7. PIDIE	11.444	1.856	4.063	75	TINGGI
8. BIREUEN	2.832	423	820	31	TINGGI
9. ACEH UTARA	8.390	1.261	2.607	56	TINGGI
10. ACEH BARAT DAYA	4.559	669	1.300	54	TINGGI
11. ACEH TAMIANG	-	-	-	-	RENDAH
12. NAGAN RAYA	1.121	167	337	11	TINGGI
13. ACEH JAYA	4.776	785	1.014	30	TINGGI
14. PIDIE JAYA	3.311	551	1.107	46	TINGGI
15. BANDA ACEH	899	117	75	3	TINGGI
16. SABANG	8.783	1.467	2.200	274	TINGGI
17. LANGSA	1.102	151	174	6	RENDAH
18. LHOKSEUMAWE	19.707	2.722	3.049	95	TINGGI
PROVINSI ACEH	**121.215**	**18.345**	**29.473**	**1.099**	**TINGGI**

Source: Aceh Disaster Risk Assessment Guidelines for 2016-2022

The KRB Guidelines also attach that the potential losses from extreme wave and abrasion disasters based on the table above consist of physical and economic losses and losses from hectares of land/environmental damage due to intense wave and abrasion disasters. The total physical and financial loss is 5,000 trillion Rupiah and is in the high class, while the actual environmental damage is 11,398 ha and is in the High category. Based on the background of urgency and gap analysis, this study will examine the benefits of mangrove plants in hydrometeorological disaster mitigation efforts carried out by DLHK, BPBA, and the Non-Governmental Organization of the Sumatran Elephant Foundation (YAGASU) in disaster risk reduction with the locus of Banda Aceh City as the center of the provincial government. Aceh.

II. Research Method

This research was carried out in 2 SKPAs that have a scope of performance in the coastal area of Banda Aceh City, including; DLHK (Department of Environment and Forestry) as the location for the implementation of field practice III and BPBA (Aceh Disaster Management Agency). These agencies play a role in mitigating hydrometeorological disasters through the urgency of the research. This study uses a quantitative method with a descriptive research design from literature studies and field surveys. Data retrieval is done by gathering sources of information in the form of primary data, namely direct interviews and field documentation, and secondary data sourced from previous research and documents from related agencies.

III. Results and Discussion

Global climate change has a significant impact on the entire population in various countries. This invites international attention to cooperate in handling global climate issues due to climate exchange in the 13th Sustainable Development Goals (SDGs) with the Climate Action program. The most significant impact on world climate change is caused by Global Warming caused by the depletion of the earth's ozone layer as a guardian of the earth's surface temperature conditions. This has the effect of melting ice at the poles of the planet, resulting in rising sea levels towards the mainland, which is used as a place for population development activities in various countries.

Global climate change, increasing population growth, and human-caused vulnerabilities have caused significant changes to coastal communities worldwide (McMichael, 2014; Levy and Patz, 2015). These changes make coastal areas have a high level of exposure to sea-level rise caused by climate change and exacerbated by other coastal hazards such as; storms, coastal erosion, tidal flooding, and tsunamis. These hazards pose a significant threat to coastal communities' physical, social, and economic aspects (UNESCO, 2012; Neuman et al., 2015; Bevaqcua and Zhang, 2018).

The city of Banda Aceh has a sloping topography, so it is very vulnerable to rising sea levels. A sea-level rise of 7 mm per year for 100 years causes 11% of the Banda Aceh City area to be submerged by tidal flooding (Tursina et al., 2017; Al'ala et al., 2017). Without any mitigation measures related to these conditions, losses that occur as in the 2016-2022 Aceh KRB Document will continue to increase, and various sustainable development programs towards "Great Aceh" will be hampered by the hydrometeorology hazard. The danger can be explained by the data presented by BPBD Aceh as follows;

Table 2. Potential Populations Exposed to Extreme Waves and Abrasion Disasters in Aceh Province

KABUPATEN/KOTA	JUMLAH PENDUDUK TERPAPAR (Jiwa)	KELOMPOK RENTAN (Jiwa)			KELAS
		KELOMPOK UMUR RENTAN	PENDUDUK MISKIN	PENDUDUK CACAT	
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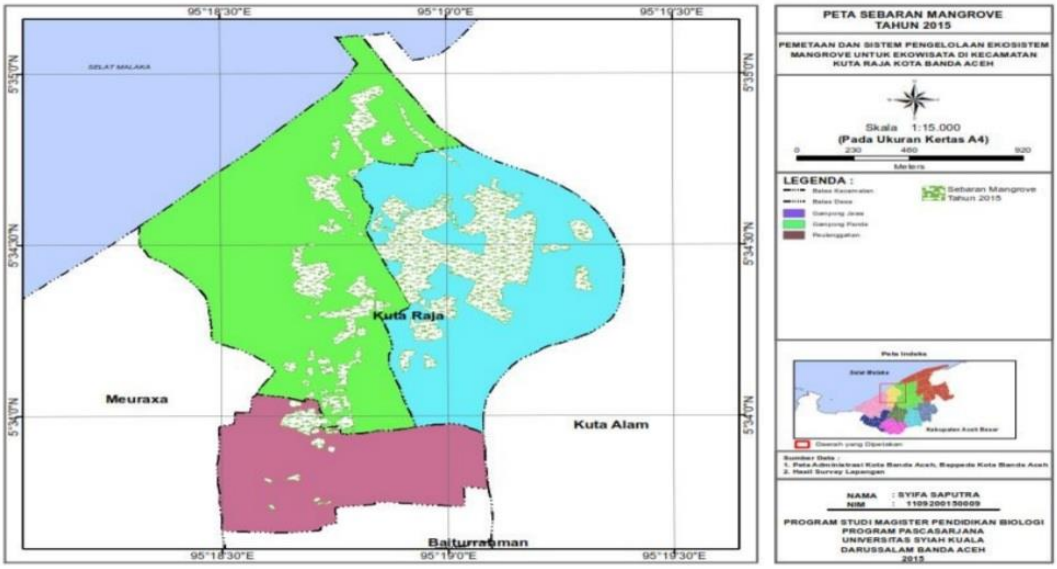
PROVINSI ACEH	**121.215**	**18.345**	**29.473**	**1.099**	**TINGGI**

Source: Aceh Disaster Risk Assessment Guidelines for 2016-2022

From the table, it is known that Banda Aceh City has a high level of risk of extreme waves and abrasion, so it has the potential to threaten the security and safety of people in coastal areas. Various efforts have been made in disaster mitigation measures carried out by the Aceh OPD, one of which is the Aceh Environment and Forestry Service in the field of environmental management by actively conserving mangroves in 4 sub-districts directly adjacent to the sea, namely Meuraxa, Kuta Raja, Kuta Alam, and Syiah Kuala.

Mangrove plants live in coastal ecosystems with tropical and sub-tropical climates located on the coastlines of various islands in the world, one of which is the Indonesian archipelago. Mangrove ecosystems play an essential role as coastal protection from abrasion and high waves, the danger of tidal flooding, and carbon binders that cause Global Warming, which can threaten the survival of other creatures on the earth's surface. The regulations that apply in the conservation of Mangrove Plants are attached to the Minister of Home Affairs No. 26 of 1997 concerning mangrove green lanes and Presidential Decree no. 32 of 1990 concerning Management of Protected Areas. The regulation explains that in implementing conservation, it is necessary to pay attention to wave strength, tidal height, wind strength, coastal structure, sandy land use conditions, settlement density, and the population's socioeconomic status.

Therefore, Mangrove Conservation is necessary for mitigation in coastal areas, one of which is the City of Banda Aceh. The distribution conditions of Mangrove Plants in Kuta Raja District, which is an area of Banda Aceh City, can be seen on the following map;



Source: Banda Aceh City Administration Map, Banda Aceh City Bapedda and Field Survey
Figure 3. *Map of Mangrove Distribution in Kuta Raja District, Banda Aceh City*

The data is the distribution of rehabilitation for mangrove conservation taken in 2015 after the 2004 tsunami. This can be seen from the field survey, which shows that there are additional types of Mangrove Plants to 18 kinds of Mangrove Plants deliberately planted to maintain the damaged mangrove ecosystem. In conservation activities, mangrove density needs to be considered because it affects the resistance to coastal waves. The current condition of mangrove density can be seen in the following table;

Table 3. Mangrove Conditions in the Work Area of BPDASHL Krueng Aceh Aceh Province in 2020

No	County/City	Density Class			NOTE
		Rare Mangroves	Dense Mangroves	Medium Mangrove	
(1)	(2)	(3)	(4)	(5)	
1	Simeulue	65	379	740	Cm
2	Aceh Singkil	96	439	437	Cm
3	Aceh Selatan	-	-	-	Cm
4	Aceh Tenggara	-	-	-	Cm
5	Aceh Timur	3,878	215	3,539	Cm
6	Aceh Tengah	-	-	-	Cm
7	Aceh Barat	4	-	-	Cm
8	Aceh Besar	20	3	5	Cm
9	Pidie	20	31	93	Cm
10	Bireuen	-	-	-	Cm
11	Aceh Utara	62	16	29	Cm
12	Aceh Barat Daya	-	-	-	Cm
13	Gayo Lues	-	-	-	Cm
14	Aceh Tamiang	9,964	933	2,071	Cm
15	Nagan Raya	-	-	-	Cm
16	Aceh Jaya	88	109	45	Cm
17	Bener Meriah	-	-	-	Cm
18	Pidie Jaya	28	10	89	Cm

19	**Banda Aceh**	**44**	**10**	**34**	**Cm**
20	Sabang	12	1	1	Cm
21	Langsa	4,179	1	284	Cm
22	Lhokseumawe	-	-	-	Cm
23	Subulussalam	-	-	-	Cm

Description: (-) no data
Source: Watershed Management Center and Protected Forest (BPDASHL) Krueng Aceh

There are several benefits of mangrove conservation in disaster mitigation in coastal areas, including;

1. Mangrove Plants as Protectors of the Coastal Area

As a hydrological channel, the coastal area plays a vital role in supporting life for living things, the topography of the sloping plains. So good environmental management is needed in its direction so that the surrounding community can appropriately use the utilization of natural resources owned without threatening the safety and security of the community. One of the management efforts is carried out by conserving mangrove plants which have a life support function on the coast.

Mangrove forests also have a role in the hydrological system of watersheds (DAS) and the hydrological cycle of coastal areas. The mangrove forest area on the banks of the river functions as a buffer for the water system in the downstream region (Windiani, 2010). In controlling coastal abrasion, there is a process of breaking the kinetic energy of ocean waves by mangrove plants which causes a reduction in the range of tides to the mainland (Suryana, 2018).

Not only that, erecting mangroves can reduce the flow of tidal waves and the speed of sea breezes as the cause of coastal abrasion. One study reported that the tide's reach is reduced by more than 60% in locations with a mangrove forest width of 100 m. Based on these data, it is presented that mangroves play an essential role in protecting the coast as a mitigation measure for high waves and abrasion.

The Banda Aceh City Government has carried out countermeasures to protect the coast by stacking stones as a break from high waves at the beach. However, the drawback of this effort is that the brunt of the waves quickly erodes the rock layers. At the same time, the support with mangrove plants has better resistance. It is coupled with various benefits generated in other sectors for the habitat of coastal living creatures. It can be used in the tourism sector to increase the local community economy. (Amar, interview, 20 May 2022)

2. Mangroves as carbon sinks cause sea-level rise due to Global Warming.

Various studies explain that Mangrove plants play a role in maintaining the world's climate-related to global warming. This issue is a matter that has received attention to be handled by the international community in the 13th SDGs regarding "Climate Exchange." One of the steps taken is carbon trading (Carbon Trading) carried out by carbon-producing countries with absorbing countries. This makes countries with tropical and sub-tropical climates as forest habitats such as Indonesia, participate in activities related to controlling the gas release. Carbon in various countries.

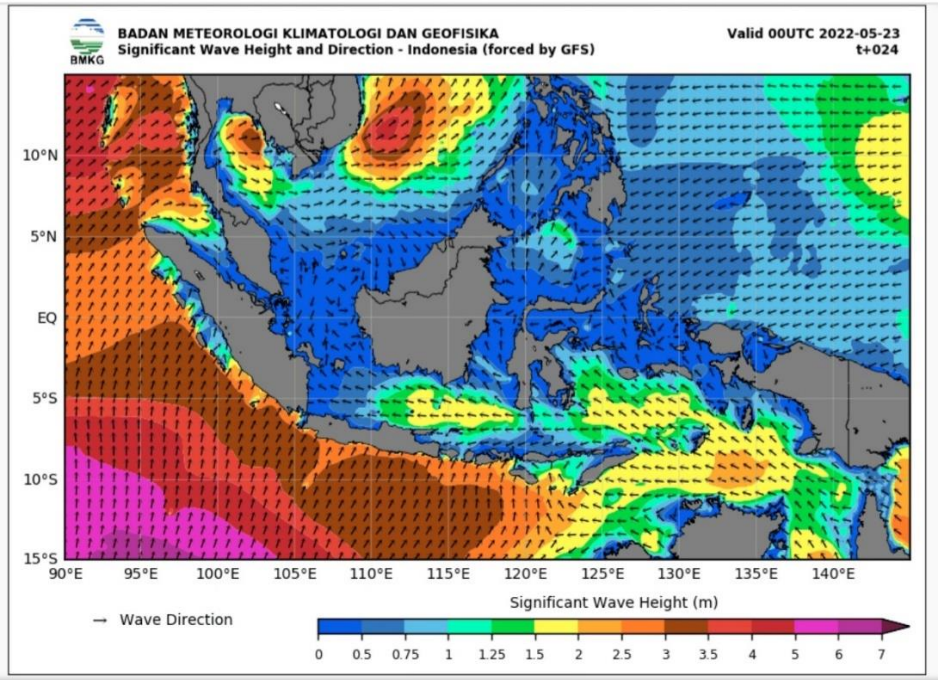
One of the studies on carbon sequestration by mangroves was carried out by Hairiah and Rahayu (2007) and Komiyama et al. (2008), who reported that the mangrove ecosystem has a vital role in reducing the effects of greenhouse gases as climate change mitigation because it can reduce CO2 through the "sequestration mechanism. ", namely the absorption of carbon from the atmosphere and its storage in the form of biomass. Each

hectare of a mangrove ecosystem can store four times more carbon than other ecosystems (Daniel et al., 2011). This is in line with the results of previous studies, which reported that mangrove plants have an excellent ability to absorb carbon, even reaching 296 tons/ha (Siddique et al., 2012; Alemaheyu et al., 2014).

The increased release of carbon causes global warming into the air, which causes the thinning of the ozone layer, or the greenhouse effect causes the melting of ice in the polar parts of the world. This has resulted in rising sea levels in various parts of the world, including archipelagic countries such as Indonesia. The effect is an increase in coastal abrasion and extreme waves in the coastal area. Researchers who have carried out satellite altimeter measurements of sea-level rise state that sea levels increase by approximately 1 mm per year and will always increase. By 2080, it is estimated that the sea level will increase to 4.2 mm per year. A professor named Jonathan Bamber from Bristol University's School of Geographical sciences said that global sea-level rise could result in the loss of 1.79 million square kilometers of land, lead to a food production crisis, and increase the potential for migration of 187 million people.

Based on the results of interviews conducted by the Head of the Forest and Land Rehabilitation Section regarding the problem of reforestation of mangrove planting, the condition of the community is that they do not realize the importance of conserving mangroves; this is because the land rights in coastal areas are still owned by the community and are not owned by the government. This is indicated by the large number of community development infrastructure developments on the coast, such as housing, restaurants, and cafes commonly found around the coast. Thus reducing the spread of mangrove plants and making it difficult for the government to reforestation.

The condition shows that the high waves in Banda Aceh City, directly adjacent to the Indian Ocean have high wave levels and wind intensity than the eastern part of Indonesia. This can be seen from the observations of the Meteorology and Climatology Agency of Aceh Province as follows;



Source: Meteorology and Geophysics Agency

Figure 4. *Wave Height Forecast Map*

Based on the data contained above and correlated with the benefits of mangrove plants, it can be concluded that Banda Aceh City is an area that has a high vulnerability to Abrasion Disasters and Coastal High Waves. So, based on the study of the benefits of Mangrove Plants described in this study, it can educate the public that Mangrove Conservation is very important in mitigating Hydrometeorological Natural Disasters in the Area.

IV. Conclusion

Based on this research, it is known that Banda Aceh City is an area that is very suitable for mangrove conservation. This can be seen from the data obtained regarding the problems and geographical conditions. With this study of mangrove plants, it is hoped that it can benefit government problem-solving in efforts to mitigate hydrometeorological disasters and benefit communities around the coast. Community contributions to disaster management agencies such as DLHK and BPBA are very much needed, considering their participation and support are required to implement this mitigation program. So good education and socialization steps are needed between the government, academics, and the community to improve the security and safety of the people in the coastal areas of Banda Aceh City.

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