

Modelling of coastal area management based on climate change adaptation in Bengkulu City

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Abstract. Climate change has had an impact on the environment and society In Indonesia. Delay in adaptation efforts will result in direct and indirect economic losses in 2100 of 2.5% of Gross Domestic Product (GDP). Climate change indicators such as surface temperature, rainfall (CH), sea surface temperature (SPL), sea level (TML), extreme climate events (ENSO, IOD/DMI, PIO/IPO), and extreme weather events (heavy rains, strong winds), and storm surges) will have potential impacts on related fields in the national development system, both in terms of economy, livelihoods, ecosystems, and special areas. Another impact is the increasing frequency of hydrometeorological disasters. This study focuses on the vulnerability of coastal areas using multiple decision-making methods and geographic information systems and remote sensing. The relationship between demography and climate change is carried out through literature review and observation. Observations were made in 19 sub-districts An appropriate strategy is needed to adapt to vulnerabilities, especially in coastal areas.

1 Introduction

1.1. Background

Predicted changes in climate such as the increase in surface temperature will have a direct impact on the lives of humans, plants, and animals. Especially for countries that have a hot summer heatwave that can cause fatalities. Even though Indonesia does not have a distinct summer season, the increase in temperature during the day can result in local heating so that the use of air conditioning becomes more frequent and increases the consumption of electrical energy. The increase in temperature is also suspected to cause excessive evapotranspiration in plants, forest fires, and the proliferation of insects more quickly and widely. In a report issued by the IPCC (Intergovernmental Panel on Climate Change)[1], it is stated that if climate change including changes in land and ocean surface temperatures continues, there will be an increase in the frequency and duration of heatwaves in the oceans. The report also states that human-caused global warming will have an impact on increasing the frequency and intensity of rainfall and the risk of drought in the Mediterranean region. The IPCC predicts that if there is an increase in global temperature of 1.5 °C. then that the number of species that are expected to be lost if there is a temperature increase of 2 °C is 18% insects, 16% plants, 8% vertebrates and is projected to decrease to 6% insects,

8 % of plants and 4% of vertebrates if there is an increase in temperature of 1.5 °C. Other impacts include loss of biodiversity, increased forest fires, extreme weather, and the spread of invasive species, pests, and diseases.

Various studies have concluded that the areas most affected by climate change are urban and coastal areas. Muhammad's research [2] mentions several impacts of climate change on the sea and coast, namely the increase in seawater temperature, sea-level rise, increased CO² entering the sea, and frequent tidal waves. This will have further repercussions. In his research, Joesidawati [3], stated that due to sea-level rise, the Tuban district is vulnerable to damage to coastal resources and economic losses. Ismail [4] studied the socio-economic parameters of climate change and found that coastal areas of Malaysia have high a vulnerability by looking at indicators of quality of life, economic value, and infrastructure.

Bengkulu, Bengkulu Selatan Regency is ranked as the 30th most vulnerable district in Indonesia Meanwhile, other regencies/cities in Bengkulu Province are not included in the 50 vulnerable areas. Figure 1 shows the areas in Bengkulu Province that are vulnerable to climate change. The status of areas with high vulnerability is in the highlands. While the coastal areas tend to have low-medium vulnerability. Research from Zamdal [5], states that climate change is damaging the coastal area of North Bengkulu with impacts including coastal forest degradation, abrasion, and landslides, mining excavations, conversion of coastal forests, settlements,

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damage to river mouths, traditional gold panning, ponds, seawater intrusion, and port lanes. In another study by Zamdial [6], 14 observation sites in Bengkulu City generally experienced coastal degradation due to abrasion, land conversion, and pollution.

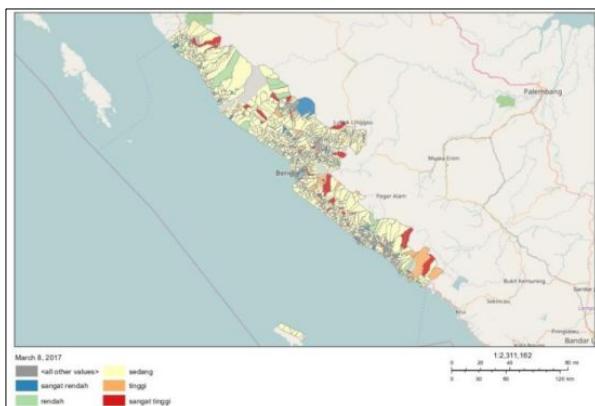


Fig 1. District/City Vulnerability Map in Bengkulu Province.

Vulnerability according to the Law of the Republic of Indonesia of 2007 concerning Disaster Management is a condition of a community or society that leads to or causes an inability to deal with the threat of disaster. Miladan [7] concludes that vulnerability assessment is an attempt to identify the impact of a disaster, both physically in the area and the socio-economic impact of the community. Joesidawati [3] defines vulnerability as the tendency of an entity to experience changes in the form of physical damage (marine ecosystems, coastlines, buildings, humans) or abstract concepts (society, economy, country, and so on). Vulnerability in coastal areas is a condition that will exacerbate the process of damage in coastal areas such as abrasion, sedimentation, or loss of coastal areas. Triatmodjo [8] also added the definition of vulnerability as damage to the residential environment, seawater quality, coral reefs, and mangrove forests.

1.2. Climate Change in Bengkulu City

Climate change in Bengkulu City will bring changes in sea surface temperature, surface temperature, and rainfall. Information from the National Aeronautics and Space Administration (LAPAN) through the SRIRAMA application has been assessed over a period of 30 years, between January 1989 and September 2021. In measurements from Malabero Fisherman Village with coordinates -3.79, 102.25 there was an increase in the increase in water surface temperature of the sea. In January 1989, the average temperature was around 301.83 K (28.68 °C), in January 2010, it was around 301.74 K (29.1 °C) and in January 2021, the temperature was at 302.28 K (29.13 °C). There is an increase in seawater temperature of 0.45 K (0.45 °C). For land surface temperatures in the Air Sebakul area (-3.83, 102.35, in 1991 it was around 299.5 K (26.35 °C) and there was an increase in temperature on the land surface by 0.67 K in 2021 so that the temperature became 300.17 K (27.02 °C).

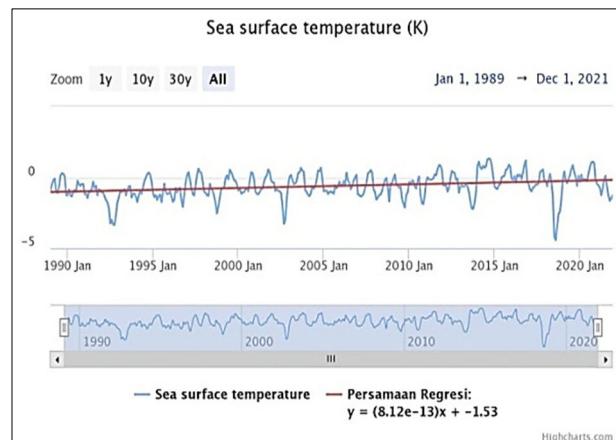


Fig. 2. Sea Surface Temperature (K) Period Jan 1989 – Sep 2021

In the rainfall parameter, there is a decrease in frequency. In January 1991, the average rainfall was 11.92 mm/day and this increased to 14.48 mm/day by 2021. Over a 30-year period, the highest rainfall observed in one day was 25.41 mm/day in October 2016. Anwar et al [9] concluded that some of the impacts of climate change are changes in rainfall patterns, shifts in seasons, and rising temperatures. Shifts also occur in the area affected by rain. This of course will disrupt cropping patterns for farmers.

Novianty, et al [10] found that the effects of climate change threaten the food security of coastal communities due to ocean acidification, physical damage to the shoreline (including building and infrastructure), and sea bleaching. This resulted in economic losses suffered by traditional fishermen reaching more than 73 trillion IDR. This condition can threaten the fisheries sector which has fishery potential consisting of demersal, pelagic, and tuna species [11]. Romdhon. MM [12] observed that in addition to fishing activities in the sea, there are also other activities, especially those carried out by women to supplement household income, including fish processing and fish marketing and trading around the house. From the form of this activity, it is concluded that fishermen's households in Bengkulu city are slightly above the poverty line. In Heryanti's research [13], fishermen start fishing at 16.00 (afternoon) and land at 06.00 (morning). It was concluded that there were various changes in the work of fishermen, especially in Pasar Bengkulu Village by collecting coal.

The process of change also occurs in the coastline in Bengkulu City. In Syukriani's study [14], changes in the shoreline caused abrasion of 19.41 Ha/year and sedimentation of 18.7 Ha/year. The areas that have experienced changes are mostly the meeting area between the river and the sea, namely the Kualo Estuary, Sungai Hitam Estuary, the Jenggalu River Estuary, and the Pulau Baai Harbour. From direct observation, there are several changes and damage that occurred on the coast of Bengkulu City. The worst damage was around the Taman Wisata Alam Pasir Putih Area and the Pulau Baai Area. The damage that occurs is in the form of damage to mangrove vegetation and coastal abrasion.



8.5Fig 3. Changes in the Bengkulu City Coastline in the Harbour Area of Baai Island Source Field Documentation, 2021

Looking at information from various sources, it is considered important to conduct further research on the vulnerability and capacity of the community in dealing with climate change in Bengkulu City considering the geographical location of Bengkulu City in the coastal area and dynamic demographic conditions. This is in line with Sinay's opinion [15] which states that demographic characteristics and cultural systems play an important role in adaptation.

1.3. Formulation of the problem

Climate change indicators of changes such as sea surface temperature, surface temperature, and rainfall will have an impact in the form of increasing the intensity of strong winds, storms, and extreme weather. Subsequent impacts will affect physical changes in coastal and urban areas. An analysis of vulnerability to climate change is very much needed down to the site/village/kelurahan level. Hence the formulation of the problem for this research: What is the impact of climate change on the coastal community of Bengkulu City?

2 Methodology

2.1. Description of the research area

Bengkulu City, which is located on the coast of the Indian Ocean, is the capital of Bengkulu Province, which is located between 3°45'-3°59' South Latitude and between 102°14'-102°22' East Longitude with an area of 151.7 km². Topographically, Bengkulu City is relatively flat and low lying with some areas located at a slope of 0-15% (14,224 ha) and 15-40% (228 ha). A total of 5 (five) sub-districts, namely Ratu Samban District, Ratu Agung District, Singaran Pati District, Sungai Serut District and Kampung Melayu District are areas that do not have slopes. In terms of an Indonesian total population of 265 million people in 2019, Bengkulu City is categorized as a medium city (100,000 to 500,000 people).

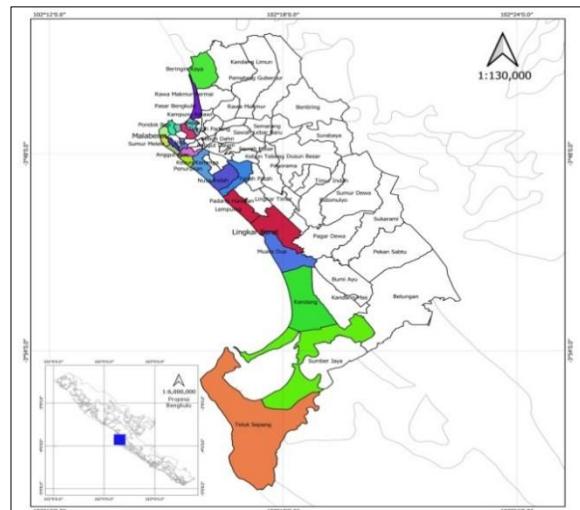


Fig. 4 Map of the Research Area in Bengkulu City

2.2. Source and data collection

The image data analysed were Landsat 5 TM images (acquired 27 July 1989, 25 May 1995,) and Landsat 8 OLI TIRS images (acquisition 8 August 2021) obtained through the website <https://earthexplorer.usgs.gov/> and field observations using Garmin Handheld GPS assistance. Other data are taken from various literature and official documents such as the Bengkulu City Spatial Planning Document, the Bengkulu Province Coastal Zone Management Plan Document, the Maritime Area Action Plan Document, and the National Action Plan for Climate Change Adaptation.

2.3. GIS and Remote Sensing

Observation of shoreline changes in the coastal city of Bengkulu through remote sensing (Path 125/Row 63) using Landsat 5 TM imagery (acquired 27 July 1989, 25 May 1995, 22 May 2005, 9 September 2005, 31 March 2010) and Landsat 8 OLI TIRS (acquired June 3, 2015, and September 21, 2021) and extracted using the Normalized Difference Water Index Method [[16]-[19]. The NDWI algorithm can be used to separate land and water. According to research [16], if the NDWI value is more than zero then it is categorized as water level while if it is less than zero then it is categorized as land.

$$NDWI = \frac{Green-NIR}{Green+NIR} \quad (1)$$

For NDWI processing, the Landsat 5 TM image has seven spectral channels as shown below:

1. Band 1 Visible (0.45 - 0.52 m), 30 m resolution, for soil/plant differentiation, coastal zone
2. Band 2 Visible (0.52 - 0.60 m), 30 m resolution, for vegetation
3. Band 3 Visible (0.63 - 0.69 m), 30 m resolution, for plant species differentiation
4. Band 4 Near-Infrared (0.76 - 0.90 m), 30 m resolution, for biomass

5. Band 5 Near-Infrared (1.55 - 1.75 m) 30 m resolution, for snow/cloud differentiation
6. Band 6 Thermal (10.40 - 12.50 m), 120 m resolution, thermal
7. Band 7 Mid-Infrared (2.08 - 2.35 m) 30 m resolution, for lithology

Meanwhile, the Landsat 8 OLI TIRS image, which was launched on February 11, 2011, has 2 sensors, namely the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). Band details on OLI sensor:

1. Band 1 Coastal/Aerosol, (0.435 – 0.451 m), 30 m resolution
2. Band 2 Blue (0.452 – 0.512 m), 30 m resolution
3. Band 3 Green (0.533 – 0.590 m), 30 m resolution
4. Band 4 Red (0.636 – 0.673 m), 30 m resolution
5. Band 5 Near-Infrared (0.851 – 0.879 m) 30 m resolution
6. Band 6 SWIR-1 (1,566 – 1,651 m), 30 m . resolution
7. Band 7 SWIR-2 (2.107 – 2,294 m), 30 m resolution
8. Panchromatic Band, (0.503 – 0.676 m), 15 m . resolution
9. Cirrus band, (1,363 – 1,384 m), 30 m resolution

Band details on TIRS sensor:

1. Band 10 TIRS-1, (10.60 – 11.19 μm), 100 m resolution
2. Band 11 TIRS-2, (11.50 -12.51 m), 100 m resolution

In NDWI processing, different channels are used. Landsat 5 imagery uses channel 2 (Visible) and channel 4 (Near Infrared), Landsat 8 uses channel 3 (Green) and Channel 5 (Near Infrared).

3 Data Processing

Image data obtained are overlaid to get the area of abrasion and sedimentation. Processing is done by comparing changes every year. Change results are tabulated for analysis.

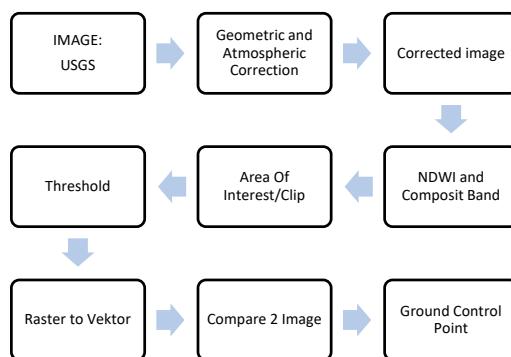


Fig 4. Data Processing

The image obtained from the USGS consists of various channels, then geometric and atmospheric corrections are carried out. The purpose of the correction is to change the reflectance value between objects on earth

and satellite image objects due to the effects of absorption, scattering, and atmospheric reflection. This correction was made through the Quantum GIS 3.18 Zurich software with the Semi-Auto Classification Plugin (SCP) plugin. In addition to the core channel, Landsat 5 and Landsat 8 also include several useful files for geometric, radiometric, and atmospheric corrections in the form of files with MTL or MTL codes as file extensions.

Furthermore, as a comparison, all channels in raster form on Landsat 5 TM and Landsat 8 OLI TIRS are combined through the Build Menu Raster menu. After merging, the processed raster files are then stacked to bring up variations of the Red Green Blue (RGB) channel as needed. For this study, the composite channel on Landsat 5 is a combination of channel 543 [16] and channel combination 564 for Landsat 8 OLI TIRS [14]

4 Results and Discussion

The coastal and marine area of Bengkulu City is an area that is home to various activities such as coastal forest ecosystem services, marine ecosystems, fishery resources, Small islands, and potential marine tourism services.

The mangrove forest ecosystem is not too wide with different positions. Some of the locations include TWA Pantai Panjang, Kandang Village, Pelabuhan Pulau Baai Area, Padang Serai and the Jenggalu River. The condition of mangrove degradation is caused by pond activities, settlements, and area development [6].

Based on the Maritime Regional Action Plan document issued by the Bengkulu Province Bapelitbang in 2017, the condition of the coastal area of Bengkulu City has decreased in quality and quantity. Zamdal identification [6] concluded that there was damage to coastal areas, especially at 14 locations, namely Pondok Besi Beach, Bangkahulu River Bridge Beach, Pasar Bengkulu Beach, Teluk Sepang Beach, Sungai Hitam Beach, Muara Sungai Bangkahulu Beach, Jakat Beach, Beach Malabero, Sumur Meleleh Beach, Samudera Ujung Beach, Panjang Beach, Sumber Jaya Beach, Muara Lempuing and Pasir Putih Beach.

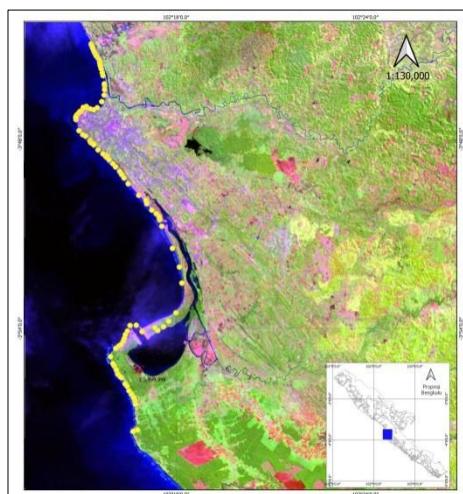


Fig. 5 Channel Combination 452 Landsat 5 the Year 1989 Bengkulu City.

Slightly different from the results of research with a focus on areas directly adjacent to the sea found that only six locations experienced severe degradation, namely Teluk Sepang Beach (sedimentation); Pantai Pelabuhan and Pelabuhan Area (abrasion); Pasir Putih Estuary (sedimentation and abrasion), Tapak Padri Beach sedimentation, Pasar Bengkulu Estuary sedimentation) and Sungai Hitam Beach Estuary (sedimentation).

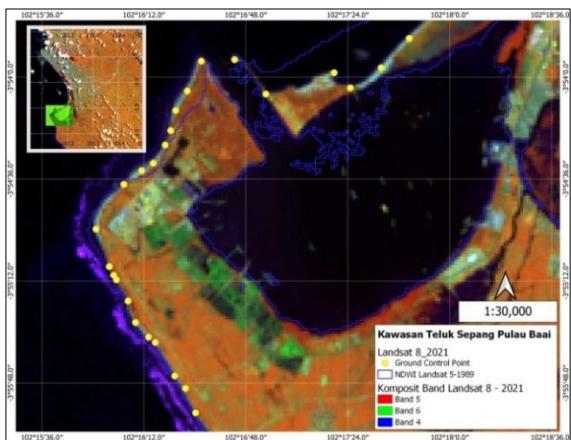


Fig 6. Overlay NDWI LS 5–1989 with Composite LS8-2021 – Teluk Sepang Area, Pulau Baai

Table 2. Sedimentation and abrasion

Periode	Abrasión (Ha)	Sedimentación (Ha)	Diferencia (ha)
1989 – 1995	0	0	0
1995 – 2000	80.626	27.931	52.695
2000 – 2005	35.807	26.960	8.847
2005 – 2010	27.466	21.158	6.309
2010 – 2015	245.737	23.811	221.927
2015 - 2021	11.480	19.899	-8.419
Amount	401.117	119.758	281.358
Average per years	12.53	3.74	8.79

Teluk Sepang Area and the Pulau Baai Ocean/Port are areas with a high rate of change compared to other areas. The biggest change in the form of abrasion occurred in the 2010 – 2015 period in the Pulau Baai Port Area of 245,737 ha as shown in Figure 6. This area was under pressure from activities such as coal and plantation products and activities in the Baai Island port area.

Meanwhile, sedimentation has occurred since the initial period of observation but with an average area that is not too large. Sedimentation occurs in Muara Pasir Putih Period 2010-2015 as shown in Figure 6. This area is not too much pressure because there is not too much activity.

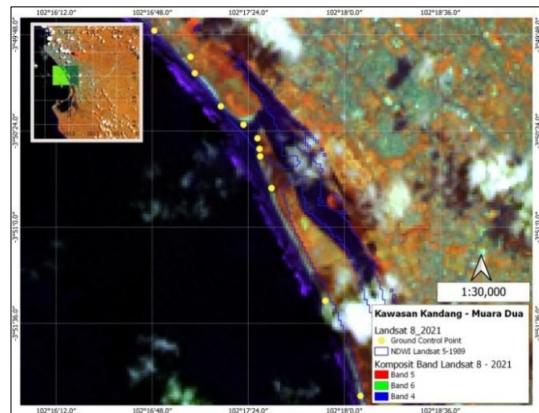


Fig 7. Overlay NDWI LS5 – 1989 with Composite LS8-2021 – Muara Pasir Putih Area

4.1. Vulnerability

Miladan [7] classifies vulnerability to climate change into five groups, namely physical vulnerability, socioeconomic vulnerability, population social vulnerability, environmental vulnerability, and regional economic vulnerability. A similar study was conducted by Choirunnisa [20] which classifies vulnerability into only three groups, namely physical vulnerability, social vulnerability, and economic vulnerability, while the environmental vulnerability is not included as vulnerability.

4.1.1. Physical aspect

The aspect of physical vulnerability is highly dependent on the existence of spatial management. If it is related to legality, the Regional Spatial Planning Document becomes appropriate in making adaptation efforts. Kelurahan Tengah Padang and Pondok Besi are the areas with the highest average population density of 1:80. Meanwhile, the lowest densities are Kelurahan Muara Dua and Kelurahan Teluk Sepang. This is because the two kelurahan have large areas and not too many residents. Conditions certainly create different vulnerabilities and solutions for each region.

In the flood event that affected Bengkulu Province in 2019, many infrastructures were not functioning due to floods and landslides, especially in coastal areas. The National Road, which connects Bengkulu City to West Sumatra, was inundated for some time by the water. As a result, all economic activities cannot run properly with an estimated loss of Rp. 144 billion [Source: <https://bnpb.go.id/infografis/infografis-bencana-gunung-dan-longsor-bengkulu>].

Residential buildings located in coastal areas may be vulnerable to climate change due to the selection of building materials and technology. The area of the Kampung Nelayan Sejahtera – Sumber Jaya Village is particularly vulnerable, it is classified as a medium slum area with an area of 47.42 ha and is an illegal area because it is owned by PT Pelindo [21]. Most of the buildings are permanent type and some are non-permanent buildings that border or are on the water's edge.

4.1.2. Aspects of socio-economic vulnerability

The total population in the study area is 80,869 people (Ministry of Home Affairs RI Data, accessed June 30, 2021) with a composition of 40,679 men (50.3%) and 40,190 women (49.7%). Based on the age group 0-14 years, there are 21,030 people, ages 15-69 years there are 58,082 people and those aged 70 years and over are 1,757 people. In addition, the number of people with disabilities for Bengkulu City in 2018 was 572 people (357 men and 215 women) <https://statistik.benngkuluprov.go.id/Sosial/disabilitas/2018>.

In the education sector, the largest group are not yet in school with 23,642 people (29.23 %) of the total population. Followed by high school graduates with 20,793 people (25.71%). Wahyudi et al's research [22] state that there is a significant relationship between knowledge of climate change and education level. Education is considered to affect mindset, knowledge, and abilities.

In terms of employment status, those directly related to climate change are fishermen with a population of 2,032 people (2.51% of the total population of 19 urban villages). The impact felt by fishermen by climate change is that they cannot go to the sea. While the rest are not directly related but do not rule out business sector groups that have activities on the coast. Such as a group of traders on the beach who are unable to carry out their economic activities or a decrease in the number of buyers and the flow of goods and services is hampered. Data from the Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia for 2010 – 2020 (https://statistik.kkp.go.id/home.php?m=prod_ikan_prov&i=2#panel-footer) states that in Bengkulu, there is an increase in the production of several fishery commodities. catch like snapper and grouper. The increase that occurred was quite significant as shown in Figure 8:

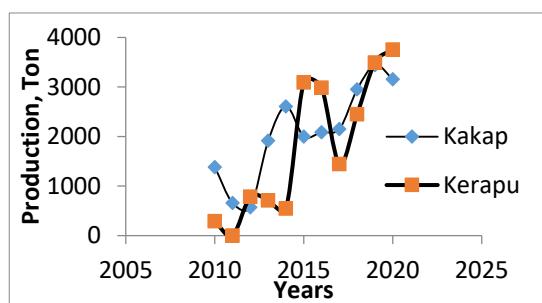


Fig. 8. Bengkulu Capture Fishery Production

As for Bengkulu City, snapper commodities in 2019 were 1,631 tons (47% of total provincial production) and grouper 2,451 tons (70% of total provincial production).

The Pulau Baai Port area is also a strategic area for the Bengkulu economy. Until May 2021, total recorded exports were US\$ 49.9 million (Source: <https://benngkulu.bps.go.id/indicator/8/45/1/value-eksport-provinsi-benngkulu-fob-free-onboard-port-island-baai-.html>).

The economic improvement in Bengkulu City also contributes to the variety of forms of the economy, shifting the economy into secondary and tertiary sectors

[23]. The economy is dominated by the accommodation sector, the food, and beverage sector, the real estate sector, and the education sector. So is the coastal area. The primary sector of fisheries, which is the backbone of the region, has begun to compete with tourism potential and its supporters. The decline in the primary sector also threatens the development of land conversion. Another study [24] states that the carrying capacity of the land for water supply is still in the conditionally sustainable category where the water demand does not exceed the availability of water.

4.1.3. Socio-cultural aspect

The results of Djafar's research in Laedyawati and Yuliani [25] stated that there was a change in attitudes and actions after various consulting was carried out to get information. The function of the extension is to mobilize the community (initiation), socialization (initial risk assessment), preparation, promotion, participation (support and community participation), and program dissemination. The condition of the community becomes vulnerable because they do not have the knowledge and there is no strategy because of the assumption that disasters are something that God decrees.

4.1.4. Environmental aspect

Mangrove vegetation has a function as an absorber of greenhouse gases (CO_2) from the atmosphere and is processed through photosynthesis into biomass in cells and tissues. In addition, it serves as a protector of coastal ecosystems from excessive accumulation of organic land [22]. The potential of mangroves in Bengkulu City is 214.62 ha (116.24 ha in the TWA Pantai Panjang and 98.38 ha outside the area) [23], this study also mentions tree vegetation and samplings that make up the mangrove ecosystem found only 9 species, namely *Rhizophora apiculata*, *Sonneratia alba*, *Bruguiera gymnoriza*, *Xylocarpus granatum*, *Avicennia alba*, *Hibiscus tiliaceus*, *Lumnitzera littorea*, *Ceriops tagal* and *Acrostichum aureum* with carbon content stored in the mangrove ecosystem stands of 18.53 tons/ha.

Residential areas on the coast are also vulnerable to the possible spread of climate-related disease vectors. Although in the research of Chandra and Nugraheni [26], it was concluded that there was no relationship between the incidence of DHF in Bengkulu City and wind speed because the data used did not use the variables of human behaviour and environmental conditions

4.2. Adaptation Effort

4.2.1. Climate change policy

Indonesia's transition policy towards a low-emissions and climate-resilient future outlined in Indonesia's Nationally Determined Contribution (NDC) document, includes an affirmation of strengthening the role of ProKlim as a climate resilience program at the local level. In the figure

below it can be seen that the components of adaptation cover the food sector, prevention, and preparedness including disease control.

Padang Serai Village, Kampung Melayu District is one example of a coastal area that follows the Proklam implementation initiated by the Ministry of Environment and Forestry of the Republic of Indonesia.

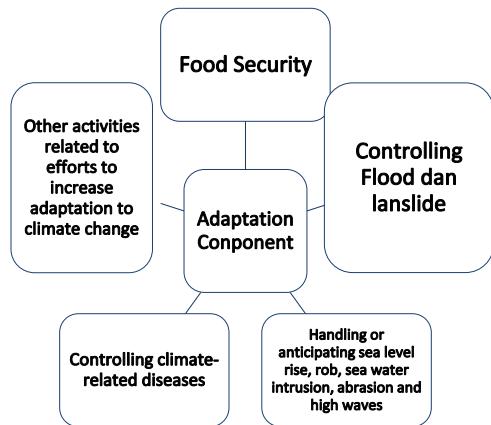


Fig 9. Components of Climate Adaptation Capacity

4.2.2. Strengthening local capacity

The diversification of catches in the Bengkulu city area is very diverse with a total of 108 varieties of fish and another marine biota [27] with export commodities in the form of tuna, skipjack, pomfret, grouper, snapper, white shrimp, tiger shrimp, lobster, and sea cucumber. Meanwhile, domestic marketing, includes tuna, mackerel, squid, octopus, squid, and others. Processed forms of fish include salted fish and fish meal. For this commodity, non-economic fish are generally used. Research from Romdhon [12] states that housewives can support their main income so that the average household in coastal areas is slightly above the poverty line.

The utilization of e-commerce is also a part of adaptation in the form of online marketing. Various platforms offered for free or paid can be an alternative in accelerating the distribution of fish catches and processed [28].

4.2.2. Knowledge management

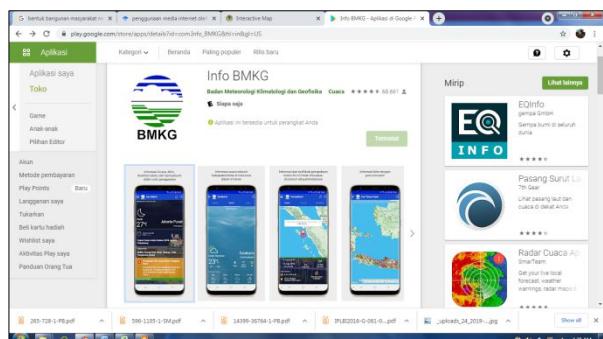


Fig 10. BMKG Apps

Information on climate and weather is a form of community preparedness and capacity. The role of BMKG as a data guardian in providing information on daily, monthly, and yearly weather conditions should be utilized by the community. Android-based applications can also access BMKG information through the Playstore. Information that can be accessed includes maritime weather, aviation weather, climate, air quality, earthquakes, and tsunamis. In addition, dissemination is also carried out via SMS or WA groups.

4.2.3. Institutional.

Synergy in solving climate change issues requires the role of all regional apparatus organizations. At the national level, through NDC commitments, the Government of Indonesia established a Directorate General of Climate Change unit under the Ministry of Environment and Forestry. At the Bengkulu Provincial Government level, there are units related to climate change such as the Marine Spatial Management Sector – Provincial Marine and Fisheries Service, Bengkulu Province Regional Disaster Management Agency, Bengkulu, Bengkulu Province Bappeda, and Other Local Government Organizations. This is of course realized through various regulations and the implementation of programs and activities.

Not only government organizations, but the participation of universities and the community also is a strategy in implementing climate change adaptation. As done by Bank Indonesia in 2012 by providing training on salted fish processing. This training will provide opportunities for fishermen to market their catch if they are unable to go to sea due to the weather.

5 Conclusion

The impacts of climate change in Bengkulu City include a decrease in rainfall, an increase in surface temperature, and changes in the coastline. Areas that are vulnerable to being affected are the Teluk Sepang, Pulau Baai, Malabero and Pasar Bengkulu. The forms of morphological changes are sedimentation and abrasion with the highest abrasion process occurring in the 2010-2015 period in the Baai Island area. This area is an area with diverse economic activities and is the key access point for imports and exports in Bengkulu Province.

Community participation is needed to enable adaptation to climate change by paying attention to the local wisdom of coastal communities and appropriate technology. The form of programs and activities that can be carried out can be in the form of core adaptation activities or other activities based on environmental management.

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