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Vulnerability analysis of coastal communities in Merauke as impact of climate change

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Abstract. The coastal area of Merauke is already experiencing the impact of climate change which causes community vulnerability which can lead to structural poverty. The purpose of the study conducted in the coastal area of Merauke Regency with a sample of 2 observation areas namely Merauke and Naukenjerai Districts using a qualitative research approach with survey methods. Research data were collected using questionnaires and in-depth interviews with expert respondents who have competencies related to the topic being studied. Data were analyzed using vulnerability analysis which measures exposure, sensitivity, and resilience in community groups who work as fishermen, farmers, and become fishermen/farmers, traders, and transportation workers. The results of the study indicate that the groups of people who have vulnerability as a result of climate change are fishermen and farmers. The level of vulnerability is caused by pressure from natural resources, namely tidal water disasters and floods due to high rainfall intensity which has an impact on the loss of income and work of the community. While the highest level of pressure caused by human activities, namely from sand excavation and land conversion into settlements and public facilities, population growth, and activities to dispose of garbage and household waste on the coast have the biggest impact on decreasing the carrying capacity of the region, coastal ecosystems, reducing livelihoods. livelihoods and sources of income.

Keywords: resilience, vulnerability, climate change, coastal

1. Introduction

The management of coastal areas in Indonesia has been mandated in the 1945 Constitution that the Republic of Indonesia provides protection and empowerment of fishermen, independence, usefulness, togetherness, integration, openness, efficiency-justice, sustainability, welfare, local wisdom, and the preservation of environmental functions [1]. Management of coastal areas can promote the values embedded in indigenous peoples and local communities who have made natural resources a part of their



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lives [2]. However, the results of the study Voyer et al., (2017) shows that there are groups of people who use coastal areas that often ignore local cultural values [3] that prioritize the environment to be part of the social order of society. Natural resources are used to increase people's prosperity while still prioritizing environmental balance so that natural resources have a role as a capital for people's economic growth and as a support for the living system [4] and a sustainable environment [5] to reduce social and economic vulnerability [6].

Community-based natural resource management is one form that is widely used in several regions to improve the adaptive capacity of the community to environmental changes by looking at various endogenous and exogenous factors such as technical, financial, legal factors, which can be seen from livelihood, political, and environmental factors. Social, economic, scale, knowledge, community, and cultural aspects involve values and ethics involving multiple stakeholders [7–11]. The social and economic development of the community cannot be separated from the contribution of maintaining coastal ecosystems. One of the models that can be used is Integrated Coastal Area Management by emphasizing strengthening the capacity of development actors and local communities to remain relevant in formulating eco-centric policies in coastal resource management [12]. The development of coastal communities to face socio-economic changes in the future by increasing the capacity of local communities through community empowerment by improving the partnership system can overcome socio-economic pressures so that the community can be independent [13,14].

Coastal zones can be considered inherently vulnerable because of their sensitive ecosystems, geomorphological, and complexities, and the clustering of many social, economic, and sometimes conflicting activities. The tourism sector in urban areas gets more attention than in rural areas which can increase the demographic pressure of coastal areas which are very sensitive to change. By using a matrix that relates the level of exploitation and adaptive capacity of vulnerability. This approach contributes to the effective use of metrics and Integrated Coastal Vulnerability Assessment Diagrams and can guide coastal management actions [15]. Meanwhile, according to Pricope, Joanne and Lauren, (2019) to overcome the impact of a change in coastal areas in the future, an integrated social and economic vulnerability model at the geographic area level can be developed using census data to measure the populations-based on social variability [16].

Based on the above phenomenon, Merauke is one of the areas facing the risk of global climate change, especially coastal communities as a result of carbon emissions by reducing mangrove forests [17,18]. Data on the area of Merauke mangrove forest in 2005 covering an area of 216,196 hectares based on satellite imagery [19] Meanwhile, according to 2009 data from Bakorsurtanal, Merauke Regency has 293,061.159 hectares of mangrove land. However, different data revealed in the 2011 RTRWK data contained in the Land-use Planning book supporting low emission development of Merauke Regency in 2017 that the Merauke mangrove forest area is 216,001.95 Ha or 6.98% of the Merauke forest area. One of the reasons for the fluctuating area of the Merauke mangrove forest is the area management system that has not been integrated between related parties [20]. Damage to mangrove areas disrupts natural coastal ecosystems which can result in a decrease in fishery resources and cause low incomes for traditional fishermen [21,22]. Efforts to develop a low emission development strategy in Merauke using the principle of sustainability have not been able to run optimally [23]. For this reason, the purpose of the research carried out in this paper is analysing the level of vulnerability in community groups on the Merauke coast which was taken in the Merauke and Naukenjerai districts. This paper describes the level of vulnerability and impact on the ecological, social, and economic dimensions of coastal community groups and the causes that occur so that they can be used as recommendations for implementing sustainable development in coastal areas to improve community welfare.

2. Method

The research framework uses qualitative research with a survey method approach. The research was carried out in the coastal area of Merauke by taking 2 sample areas in Merauke District and Naukenjerai District as research observation areas. Research data were collected using questionnaires and in-depth interviews using a structured list of questions from expert respondents.

Vulnerability analysis using the vulnerability index published by the IPCC (2001), which is used in determining the vulnerability index to disturbances or shocks related to climate change [24] by reviewing the conduct of the community in the culture of the coastal community. The vulnerability analysis is formulated as an accumulation of the level of exposure, the level of sensitivity, and adaptive capacity, which is formulated as follows:

$$Vulnerability = f(Exposure, sensitivity, Adaptive Capacity) \quad (1)$$

Based on the phenomena that occurred in Merauke Regency, the determinants of vulnerability, the main components, and indicators used in the study are presented in Table 1.

Table 1. Determinants, main components and indicators of vulnerability index assessment

No	Determinants of Vulnerability	Main component	Indicator
1	<i>Exposure</i>	Inundation rise Resource Degradation Population income decline	Inundation rate rise Land degradation rate The rate of decline in population productivity
2	<i>Sensitivity</i>	Livelihood dependence on the coast Land use rights The dependence of social life on the coast	Percentage of population whose livelihoods depend on coastal resources Percentage of the population claimed as individuals such as rice fields, fields, and yards The ratio of the population relying on water transportation: land
3	<i>Resilience</i>	Interaction factor	<ul style="list-style-type: none"> • Learn to live with change and uncertainty • Nurturing diversity for resilience • Combine different types of knowledge to learn • Create opportunities for socio-ecological self-organization towards sustainability.

The exposure value is measured by the level of exposure between 0-3, namely 0 (not exposed); 1 (slightly exposed); 2 (sufficiently exposed); 3 (highly exposed). The sensitivity value is measured by the level of synchronicity between 0-3, namely 0 (not sensitive); 1 (slightly sensitive); 2 (quite sensitive); 3 (very sensitive). Meanwhile, adaptation capacity refers to the four interaction factors developed by Folke related to socio-ecological adaptation [25]. The value of adaptive capacity is measured by the level of adaptation between values 0 – 3, namely 0 (not adaptive); 1 (slightly adaptive); 2 (quite adaptive); 3 (highly adaptive).

3. Result and discussion

3.1. Level of the vulnerability of coastal communities

Developing countries are under threat from unsustainable global and national changes and can create vulnerabilities that change social, economic, and ecological conditions. Social and ecological conditions of the community [26]. Vulnerability analysis is carried out to identify the characteristics of the community both individually/groups in anticipating/dealing/fighting against environmental changes such as natural disasters and natural damage due to human activities. In addition, it can also identify the community's inability to cope with losses, damage, and disturbances that arise as a result of a threat,

both short-term and long-term. Vulnerability is the degree of loss or damage that may occur due to extreme events that cause disasters or ecological conditions that cannot perform their normal functions. Vulnerability analysis measures exposure, sensitivity, and resilience factors in livelihood groups that are vulnerable to direct changes in natural resources. The results of the vulnerability analysis in coastal areas in the respondent group in the coastal areas of Merauke and Naukenjerai Districts are presented in Table 2.

Table 2. Vulnerability analysis on the coast of Merauke and Naukenjerai Districts, Merauke District.

No	Factor	District					
		Merauke			Naukenjerai		
		1	2	3	1	2	3
1		<i>Exposure</i>					
	Rob	0.55	0.55	0	0.55	0.45	0.45
	Land resource degradation	0.45	0.55	0	0.55	0.45	0.45
	Population Income Decrease	0.45	0.55	0.45	0.45	0.45	0.55
	Average Amount	0.48	0.55	0.15	0.52	0.45	0.48
2		<i>Sensitivities</i>					
	Coastal Livelihood Dependence	0.55	0	0.45	0	0.54	0
	Residents who claim the location of the waters	0.55	0	0.55	0.45	0.45	0.55
	The ratio of the population relying on transportation	0	0	0.55	0.55	0.55	0
	Average Amount	0.37	0	0.52	0.33	0.51	0.18
3		<i>Resilience</i>					
	Ability to learn to live with change and uncertainty	0.45	0.55	0.45	0.55	0.55	0.55
	Ability to develop various means for reorganization and renewal	0.45	0.55	0.45	0.45	0.45	0.55
	Ability to coordinate various kinds of knowledge	0	0.45	0.54	0.45	0.55	0.45
	Ability to create opportunities for self-organization	0.45	0.55	0	0.55	0.55	0.45
	Average Amount	0.34	0.53	0.36	0.50	0.53	0.50
	Total Vulnerability (E + S – Ac)	0.51	0.03	0.31	0.35	0.44	0.17

Note: 1. Fishermen; 2. Farmers; 3. Services (farmers/fishermen, traders, transportation).

Based on the results of data analysis on the level of vulnerability to community groups in the coastal areas of Merauke and Naukenjerai Districts which is presented in Table 2, it shows the level of vulnerability in community groups based on the dominant occupation in the two different coastal areas. Community groups in coastal areas with the highest level of vulnerability are fishermen, then community groups who work in the service sector such as farm labourers and fishermen, and traders. The fishing communities in Merauke District depend on coastal natural resources for their livelihoods, which are influenced by the condition of the coastal ecosystem itself. This is because the condition of the coastal ecosystem provides valuable ecosystem services for the community [27–29]. It is like what happened in Bulgaria [30]. Seasonal fish production causes fishermen's income to be uncertain. Fishermen in Merauke District do not farm because Merauke District is an urban area, so land for agriculture in the coastal area is limited and land has been used for development as a result of the expansion of the urban area.

Meanwhile, the people in Naukenjerai District can anticipate environmental changes. People always live side by side with nature and manage natural resources by prioritizing local wisdom from culture handed down from their ancestors. In addition, the Naukenjerai area is included in a protected area, which is designated as a national park area. The management of the national park area prioritizes local wisdom to maintain the natural ecosystem within the Wasur National Park area itself. Based on the results of the analysis, that in Naukenjerai, coastal community groups that have a level of vulnerability to change and the ability to face environmental uncertainty are farmers and fishermen (rice cultivation and gardening). This is in line with what happened in Kupang City [31].

The condition and dynamics of coastal waters in both districts are strongly influenced by human activities that accelerate land degradation in the coastal areas, thus affecting the aquatic ecosystems on

the coast. For this reason, increasing knowledge of coastal communities and ease of access to facilities and infrastructure need to be improved [32]. However, the high dependence on ecosystems by communities can change and degrade ecosystems at an alarming rate [29].

3.2. Identification of pressure and disturbances causing vulnerability

The process of interaction of ecological or natural and social systems in the research area in addition to supporting the development of the social system of the people who live and depend on their natural resources, but also produces various forms of pressure that can limit and even destroy the social system during the lives of coastal communities.

Natural pressures will affect the lives of people living in coastal areas. The impacts felt by the community such as loss of assets, jobs, income, increasing fishing operational costs, and business uncertainty. Some of the natural pressures identified on the coast of the research area are as follows: 1) tidal water disaster, 2) high rainfall intensity floods, 3) land-use change, 4) fishing area conflicts. The risk impact of vulnerable groups against natural pressures in coastal and marine areas on the coastal communities of the research area, namely Merauke and Naukenjerai districts is presented in Table 3.

Table 3. Risk impact of vulnerable groups on coastal and marine natural stresses on coastal communities in Merauke and Naukenjerai Districts.

No.	Vulnerable group	Natural Pressure			
		tidal water disaster	Flood	Land-use change	Territorial conflict
1	Fisherman/farmer	1,2,3,5,6,7	1,2,3,4,5,6,7	1,2,3,7	2,7
2	Farm laborer/fisherman labor	2,3,5,7	2,5,7	2	0
3	Service	2,5,6,7	2,5,6,7	3,6,7	0
4	Trader	2,5,6,7	2,3,6,7	5,6	2
5	General public	2,5,7	1,2,3,4,5,6,7	3,6,7	0

Note : Risk impact : 0. No impact; 1. Losing a job; 2. Loss of income; 3. Loss of assets; 4. Losing life; 5. Increase the risk of work; 6. Increased operational costs; 7. Increase uncertainty.

The results of field observations show that natural pressure poses a threat to vulnerable groups of coastal communities. Table 3. shows that the groups that are most vulnerable to pressure from changes in coastal natural conditions are fishermen and farmers, especially during tidal waves and floods caused by high-intensity rains in coastal areas. Natural pressures such as tidal water disasters, floods, land-use changes, and regional conflicts have the highest risk impact, namely job loss, loss of income, and increased uncertainty. This is because the people in the research area depend on their families for their livelihood from coastal water resources, both fishery, and non-fishery. Meanwhile, the vulnerable groups who will feel the impact of risk from the pressure of natural change are the labour group. Coastal communities with the main job as fishermen are greatly affected by the fishing season. Community labour groups in coastal areas based on survey results in the field that natural pressures in coastal areas will have an impact on loss of community income, especially for groups of farmworkers and fishermen, namely loss of income. Farmworkers and fishermen will lose their income if there is a high tidal wave on the mainland and floods because they cannot find fish and agricultural land is flooded during high rainfall and high tides. In addition, changes in land use in the coastal area of Merauke from the results of field surveys have a direct impact on groups of fishermen, farmers, and labourers. Changes in the use of coastal land, especially mangrove forests as one of the protected areas that have an important function to become an ecology in and behind the mangrove forest area. Changes in mangrove forests on the coast of Merauke for changes in land use by the community for the expansion of population growth settlements and infrastructure development for the community. The same thing is in line with the results

of research in the coastal village of Subang Regency, that the causes of changes in coastal land use are the increase in population, settlements, and infrastructure [33].

Natural pressures that often occur and become an interesting issue in Papua in general and Merauke, in particular, are regional conflicts. The territorial conflicts in question are conflicts overfishing areas and land ownership. This is the trigger for developing into an ecological-political issue that becomes sensitive in the implementation of development. Ecology-politics can develop as a result of the complexity of the problem of the relationship between humans and nature [34]. In addition to natural pressures that occur on the coast, there are human pressures both individually and in groups on resources in the coastal areas in the research area, namely the Merauke and Naukenjerai districts which cause coastal environmental degradation which will reduce the quality of life of the people living around them. Some of the human activities that can have a risk impact on nature are presented in Table 4.

Table 4. Community pressure on natural resources in the coastal areas of Merauke and Nukenjerai Districts.

Function	Impact on natural resources Interest	Public Pressure			
		1	2	3	4
Ecology	The decline in the carrying capacity of the region	√	√	√	√
	Decreased carrying capacity for coastal ecosystem life	√	√	√	√
	Decreased land resources	-	√		√
	Declining water quality	-	-	√	√
	The Decline in coastal aesthetics	√	-	√	√
Economy	Decreased biodiversity	√	√	-	√
	Decreased sources of livelihood	√	√	√	√
Social	Decreased sources of income	√	√	√	√
	Public welfare	-	√	-	√
	Life system support	-	√	-	√
	Law enforcement	√	√	√	√

Note*: 1. Population growth; 2. Land conversion; 3. Dispose of garbage and waste to the coast; 4. Sand excavation

Human pressure both individually and in groups in the coastal area that has an impact on all ecological, economic and social functions, namely the excavation of sand on the coast in both Merauke and Naukenjerai districts. Past sand excavation activities still have an impact that is felt by the community today. Sand excavation in coastal areas is not only carried out on the coast but is carried out in the yard of houses containing sand. These community activities are dominated by local communities who have customary land rights on the coast. This happened in both study areas, but in Naukenjerai it caused the resettlement of settlements to the mainland. This was stated by the head of Kampung Onggaya:

"...In the past, this village was on the beach which you are now looking at. We have moved the pole or honey on the beach because the location had been eroded by the waves. I think that every year the abrasion can be 3 meters and maybe the village we live in now will be exhausted if we don't take precautions from now on..."

The increase in population, both from the rate of increase in family members and the addition of new residents, will have an impact on the increasing competition for livelihoods which has an impact on the economic sector and the ecology of the region. Likewise, the activity of throwing garbage on the coast will cause the fastest environment to pile up garbage. The research coastal area has the potential to develop the coastal tourism sector which can bring in a source of community income by selling on the coast and even selling catches to visitors who come for tours. There is a need for integrated waste management education so that garbage and household waste are not dumped into the sand which will be carried to the sea during high tides.

4. Conclusion

The research concludes that climate change has a major impact on fishing communities and farmers. Dependence on land and water resources on the coast causes the high vulnerability. Natural pressure factors that cause high are tidal water disasters, high-intensity floods, and land conversion due to tidal water degradation which causes loss of income and jobs, as well as increasing fishery business risks. Meanwhile, human pressure that causes vulnerability is the excavation of sand and the conversion of land into settlements and infrastructure development for the community. To reduce the risk of the vulnerability of coastal communities as a result of climate change, it is necessary to carry out several activity scenarios, namely the rehabilitation of coastal areas by planting mangroves by involving the community and diversifying livelihood sources based on natural resources.

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