Socio-Economic Vulnerability Through The Lvi Approach (Livelihood Vulnerability Index) Towards Flood Disasters In The Coastal Area Of Bandar Lampung City

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Abstract. This study aims to analyze the social and economic vulnerability to the impacts of tidal flooding as a consequence of climate change in Bandar Lampung City, Lampung Province, Indonesia. Referring to Law No. 24 of 2007 on Disaster Management, this research identifies the factors contributing to the high risk of tidal flooding in the coastal areas of Bandar Lampung City. Lampung Province, particularly Bandar Lampung City, faces serious challenges related to natural disasters, especially tidal flooding caused by rising sea levels and climate change. This study utilizes the Livelihood Vulnerability Index (LVI) to measure the social and economic vulnerability of communities to the impacts of tidal flooding. The research results show that the overall LVI of the Bandar Lampung City coast is 0.25, which means that the level of vulnerability of people's livelihoods to flood disasters due to climate change is classified as vulnerable. The most vulnerable components are the natural disaster and climate variability components, as coastal areas are more susceptible to changes due to climate change and are most impacted when hit by disasters caused by climate change. Vulnerable components are also found in the socio-demographic components, livelihood strategies, social networks, and health. Based on this analysis, it is necessary to formulate policies to create sustainable economic development for the coastal communities of Bandar Lampung City.

Keywords: Livelihood Vulnerability Index, Coastal, Tidal Flood, Economy

1 Introduction

Based on Law No. 24 of 2007 concerning Disaster Management, it is stated that a disaster is an event or series of events that threaten and disrupt people's lives and livelihoods arising from both natural and/or non-natural factors and human factors that cause environmental losses and damage, property losses and psychological impacts. Natural disasters can also occur due to climate change where disasters that occur as a result of climate change are extreme floods and tidal waves [1]. Floods that occur due to climate change are due to increased high rainfall as a result of climate change [2]. Indonesia is one of the countries that is often hit by floods, this is due to tidal inundation, rising sea levels, river overflows due to high rainfall, and land

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subsidence caused by naturally formed young alluvial sediments, excessive groundwater extraction, and urbanization [3].

Lampung Province is one of the provinces in Indonesia that has a high flood risk level, it is recorded that 7 out of 15 districts/cities in Lampung Province have a high flood disaster risk index [4]. Bandar Lampung City has a high risk of natural disasters, including floods, landslides, high tides that cause rob, tsunamis, earthquakes, and drought. In addition, there is also the potential for abrasion, erosion, and sedimentation along the coastal area [5]. Tidal floods, which have recently become an annual threat in Bandar Lampung City, occur only a few times a year. This incident has involved a number of coastal areas, especially in Bumi Waras District, Panjang District, West Telukbetung District, South Telukbetung, and North Telukbetung. The coastal area of Bandar Lampung City is an area that has diverse natural resource potential, which stretches along Lampung Bay with a coastline of 27.01 km and a coastal area of 56.57 km2. In this area, various economic activities are concentrated, and it is a hub for the production and distribution of goods and port services with a scope of city, provincial, national, and even international services. One of the main activities in coastal areas is port activities (passenger, container and fisheries) namely as a means of supporting transportation, and other activities such as factories and tourism. The impacts of climate change, such as rising sea levels and tidal floods, can cause damage to infrastructure, abrasion in coastal areas, and the emergence of social disasters such as diseases due to weather anomalies [5]. Tidal floods, which are a phenomenon of rising sea levels due to climate change, can cause various major problems for economic activities in coastal areas. Tidal floods can inundate residential areas, ponds, and industrial areas, resulting in infrastructure damage, hampered economic activities, and significant financial losses. In addition, tidal floods can also disrupt industrial activities in coastal areas. Tidal floods can damage industrial equipment and infrastructure, and hamper the production and distribution of goods. This will cause financial losses for companies and result in job losses. Tidal floods can also disrupt trade and tourism activities in coastal areas. Tidal flooding can damage tourism infrastructure, such as hotels and restaurants, and make coastal areas unattractive to tourists. This will cause a decrease in income for business actors in the tourism sector. Overall, tidal flooding as a result of climate change can cause various major problems for economic activities in coastal areas. This needs to be a serious concern for the government and the community to take adaptation and mitigation steps to reduce the negative impacts of tidal flooding. Figure 1 shows the flood disaster risk index for Bandar Lampung City:

Disaster vulnerability is closely related to property damage and human losses, and high levels of disaster vulnerability can result in greater damage or longer recovery times [6]. In calculating the vulnerability of the population to climate change disasters (robbery floods), complex parameters are needed to identify the extent to which disasters affect the sustainability of the population in an area. The level of vulnerability is then used as analysis material for policy makers in forming disaster risk reduction strategies and economic planning on the coast of Bandar Lampung City. So this study aims to identify the Livelihood Vulnerability Index (LVI) in the Coastal Area of Bandar Lampung City.

2 Literature Review

2.1. Climate Change and The Impact

Climate change is defined as a significant change in the components that affect the climate, including: temperature, rain, wind. In the process, changes to these climate components take

place over a long period of time, such as 10 years or more [7]. Climate change results in quite fluctuating changes in temperature in Indonesia, based on BMKG [8], showing that the average annual temperature in Indonesia has a fairly extreme up and down trend.

Climate change that occurs not only affects changes in annual temperatures, climate change can also cause changes in rainfall, changes in rainfall that occur due to climate change are increasing, the intensity of rainfall due to climate change is in the range of 6-7% per degree of global warming [9]. Significant changes in rainfall have occurred in Indonesia, changes in rainfall have increased by 2 times since 2016. The increase in rainfall that occurs causes changes in the hydrological cycle [10], changes that occur in the hydrological cycle due to climate change also increase the potential for flooding which is quite significant [11], especially tidal flood.

2.2. Livelihood Vulnerability Index

Vulnerability is a condition where in a community or society there is a decrease in resilience caused by external influences that can threaten life, livelihoods, natural resources, infrastructure and welfare. Vulnerability is a function of the magnitude of change and the impact of a condition, a vulnerable system will not be able to cope with the impact of highly variable changes [12]. Vulnerability includes human decisions, values, governance, attitudes, and behaviors that shape situations where hazards have the potential to cause losses. Losses can be in the form of loss of life, social and business disruption, and property damage [13]. Meanwhile, vulnerability assessment is the process of measuring the level of vulnerability, both individuals and groups, men and women, and age groups based on physical, social (including policy), economic, and environmental aspects [14].

The Livelihood Vulnerability Index (LVI) is a tool developed to measure vulnerability to climate change in a specific area. In its application, the LVI components include socio-demographic aspects, livelihoods, social networks, health, food and water security, natural disasters, and climate variability. This index combines these data into a single composite index that allows for comparison of vulnerability between different areas. The results show that the LVI can be used to monitor vulnerability, allocate aid resources, and evaluate the effectiveness of programs or policies in areas with limited data [15].

2.3. Sustainable Economic Development

The concept of sustainable development has received various criticisms and different interpretations over time, and is one of the most frequently cited definitions in the literature. The essence of this concept comes from the Triple Bottom Line, which emphasizes the balance between three pillars: economic profit, social responsibility, and environmental preservation. True sustainable development can be achieved by balancing all three pillars [16].

Implicitly, this concept emphasizes two main aspects: the importance of considering the limitations of natural resources and the environment in development and consumption patterns, and the importance of the welfare of future generations [17]. Therefore, the principle of sustainable development includes three axioms: (a) treating the present and the future by placing positive value in the long term, (b) recognizing that environmental assets contribute to economic

well-being, and (c) understanding the constraints that arise from impacts on environmental assets.

3 Research Method

To measure social and economic vulnerability using the Livelihood Vulnerability Index (LVI) [15]. The components used consist of seven main components, namely: a) Socio-demographic (SDP) b) Livelihood strategy (LS) c) Health (H) d) Food (F) e) Water (W) f) Social networks (SN) : g) Natural disasters (ND) and Climate Variability.

The LVI components consist of several indicators or sub-components. Sub-components are developed based on the results of a literature review of each of its main components,as shown in Table 1. The LVI value in this study was calculated using the balanced weighted averaged approach. That "balanced weighted averaged is that each sub-component has the same contribution to the overall index, although each main component consists of a different number of sub-components"

Table 1. Livelihood Vulnerability Component [15].

Main Component	Sub-Component
Socio-Demographic Economy	Dependency ratio
	Percentage of female heads of households
	Average age of female heads of households
	Average monthly expenditure
Livelihood Strategy	Percentage of households with family members working out of town
	Percentage of households whose main income comes from agriculture
	Average classification index for agricultural sector livelihood (0.25-1)
Health	Average time taken to reach healthcare facilities
	Percentage of households with family members having chronic illnesses
Social Network	Average ratio of receiving: giving (range 0.5-2)
	Average ratio of borrowing money: lending money
	Percentage of households applying for assistance from the local government
Food	Percentage of households whose food source comes from their own agricultural land
	Average number of months households face food scarcity
	Percentage of households that do not store harvests
Water	Percentage of households using natural water sources
	Average time taken to reach a water source
	Percentage of households without consistent water supply
	The inverse of the average amount of water (in liters) stored per household
Natural Disasters and Climate Variability	Average number of rainy months in a year
	Percentage of households not receiving disaster warnings

Main Component	Sub-Component
	Percentage of households reporting losses due to climate change

Sub-components are calculated on different scales, so standardization is needed into an index so that it can be calculated as a whole. The composite index approach is used to convert the scale of each sub-component obtained from the life expectancy index [18]. The calculation of sub-components is as follows:

$$\text{Index Sb} = \frac{Sb - Smin}{Smax - Smin} \quad (1)$$

Sb is the value of the sub-component of region b, Smin is the value of the minimum and Smax is the maximum value of each sub-component determined based on the research area data. After standardization, the average value of the sub-components is calculated using the formula, to then calculate the value of the main component.

$$\text{Mb} = \frac{\sum_1^n \ indexs_{bi}}{n} \quad (2)$$

The Mb value is equal to one of the principal components in region b (SDP, LS, H, F, W, SN and ND). $\text{Index}_b i$ reflects the value of the sub-component indexed by i. The LVI value is obtained from the equation:

$$LVI_b = \frac{\sum_{i=1}^7 \ W_{M^i M_b}}{\sum_{i=1}^7 \ W_{M_i}} \quad (3)$$

This equation can also be written in the following equation:

$$LVI_b = \frac{W_{SDP}\ SDP_b + W_{LS} LS_b + W_H H_b + W_F F_b + W_W W_b + W_{SN} SN_b + W_{ND} ND_b}{W_{SDP} + W_{LS} + W_H + W_F + W_w W_{SN} + W_{ND}} \quad (4)$$

LVI_b is the vulnerability index value for a region b weighted by seven principal components. W_Mi is determined by the number of sub-components reflecting each principal component, which have equal contribution to the overall LVI [18]. The scale of the LVI value ranges from (Table 2)

Table 2. Livelihood Vulnerability Index Value Range [15]

Value	Category
0 – 0,2	Not Vulnerable

0,21 – 0,4	Vulnerable
0,41 – 0,5	Very Vulnerable

4 Discussion

The main components of the Livelihood Vulnerability Index (LVI) include socio-demographic economy, livelihood strategies, health, food, water, social networks, natural disasters, and climate variability. Each component consists of several indicators or sub-components, and each sub-component has a different scale size. Standardization is needed to equate and convert into an index to obtain a complete LVI index with a composite index. The results of standardization of each sub-component obtained based on a survey of 160 households are presented in the following table (Table 3):

Table 3. Livelihood Vulnerability Index Coastal Bandar Lampung

Main Components	District	Components Value	Coastal Bandar Lampung Components Value	Category
Socio-demographic Economy	Bumi Waras	0.45	**0.37**	Vulnerable
	Teluk Betung Selatan	0.36		
	Teluk Betung Timur	0.27		
	Panjang	0.40		
Livelihood Strategy	Bumi Waras	0.19	**0.23**	Vulnerable
	Teluk Betung Selatan	0.26		
	Teluk Betung Timur	0.37		
	Panjang	0.11		
Health	Bumi Waras	0.44	**0.28**	Vulnerable
	Teluk Betung Selatan	0.42		
	Teluk Betung Timur	0.00		
	Panjang	0.25		
Social Networks	Bumi Waras	0.40	**0.36**	Vulnerable
	Teluk Betung Selatan	0.23		

Main Components	District	Components Value	Coastal Bandar Lampung Components Value	Category
	Teluk Betung Timur	0.26		
	Panjang	0.56		
Food	Bumi Waras	0.01	**0.01**	Not Vulnerable
	Teluk Betung Selatan	0.00		
	Teluk Betung Timur	0.02		
	Panjang	0.00		
Water	Bumi Waras	0.18	**0.10**	Not Vulnerable
	Teluk Betung Selatan	0.06		
	Teluk Betung Timur	0.10		
	Panjang	0.04		
Natural Disaster and Climate Variability	Bumi Waras	0.43	**0.43**	Very Vulnerable
	Teluk Betung Selatan	0.38		
	Teluk Betung Timur	0.58		
	Panjang	0.33		
Coastal Bandar Lampung LVI			**0.25**	Vulnerable

Table 3 presents the LVI calculation results of all main components and each sub-component, the explanation of each component result is as follows:

1. Socio-demographic economy

   The LVI socio-demographic economic component index of the Coastal Bandar Lampung is 0.37. The index value is included in the vulnerable category because it is classified between 0.21 - 0.40 according to [15]. The vulnerability figures indicated by each component of the index value vary widely, the values showing moderate vulnerability in the East Teluk Betung area are 0.27 and in the South Teluk Betung area are 0.36, then the areas that are classified as very vulnerable are the Panjang area is 0.40 and the Bumi Waras area is 0.45. However, the sub-component value for the average age of women as heads of households is classified as more than very vulnerable in the Bumi Waras area, which is 0.725. [19] who conducted a meta-analysis of the differences in male and female productivity found that men are more

productive than women. [20] stated that increasing age is also related to decreased work ability, so it can affect individual work productivity.

2. Livelihood Strategy

   The livelihood strategy component index in the Bandar Lampung Coast shows a value of 0.23, which means it is classified as moderately vulnerable. The area whose main source of income comes from agriculture/fisheries with a value of 0.52 is East Teluk Betung. The value of the sub-component index is classified as very vulnerable in the coastal area component index of Bandar Lampung. Based on these calculations, families or households that only rely on the agriculture and fisheries sectors in their daily lives are very vulnerable to the impacts of climate change.

3. Health

   The health component of the Bandar Lampung Coastal Area shows a figure of 0.28. This means that the health component is included in the moderate category. The health sub-component consists of the distance of health facilities and the number of family members who have chronic diseases. The distance of households to health facilities is classified as very vulnerable in the Bumi Waras, South Teluk Betung and East Teluk Betung areas and takes a long time to get there. It can be concluded that in terms of health it is not very vulnerable to the impacts of climate change. [21] Travel time has an influence on access to health facilities where travel time to health facilities less than or equal to 30 minutes is more often accessed than travel time to health facilities more than 30 minutes.

4. Social Networks

   The social network component consists of the ratio of receiving and giving, borrowing and being borrowed, and submitting assistance to the government. The vulnerability figure indicated by the value component is 0.36. The ratio of families receiving assistance and loans shows a significant figure in the Panjang area of 1,571 dominated by the community receiving assistance from the Family Hope Program (PKH). [22] analyzed that the poverty alleviation program has helped the poor, but has not been able to overcome non-income problems. On the other hand Family Hope Program (PKH) policy is very effective in being given to the poor. This is evidenced by the decrease in the number of subsidy recipients each year.

5. Food

   Based on the survey conducted, the community in the coastal area of Bandar Lampung, the vulnerability figure in the food component shows a value of 0.01, which means that the coastal community of Bandar Lampung has moderate vulnerability to the impacts of climate change, another influencing factor is the percentage of people who depend on agricultural food sources showing no vulnerability, meaning that climate change does not affect the value of the community's food index component.

6. Water

   The coastal community of Bandar Lampung shows a level of non-vulnerability in the water component. The component index number is 0.01. However, the Bumi Waras area shows a very vulnerable level in the sub-component of the percentage of people using natural water sources to meet their daily water needs, which is 0.675. However,

overall the average time needed to get to the water source shows a figure of 0.00, meaning that access to the water component is very easy. And the percentage of households that do not have a consistent water supply is considered non-vulnerable with a value of 0.05. It can be concluded that natural disasters and climate change variability that occur in coastal areas do not affect the condition of the water component.

7. Natural Disaster and Climate Variability

   The value of the natural disaster component index and climate variability in coastal areas is categorized as high, which is 0.43. The vulnerability figure shown by each regional component shows a very vulnerable category, in the Bumi Waras area it is 0.43, in the Teluk Betung Selatan area it is 0.38, the Teluk Betung Timur area shows a value of 0.58 and the Panjangan area is 0.33. Communities living in coastal areas are classified as vulnerable to feeling the impacts of natural disasters and climate change. Very wide data shows the percentage of households that feel disadvantaged due to climate change. [23] the occurrence of climate change causes various damage to the physical environment, economic problems, and social communities in the coastal zone. The coastal area of Bandar Lampung is categorized as very vulnerable with a value of 0.75 in the Bumi Waras and Teluk Betung Selatas areas, 0.7 in the Teluk Betung Timur area.

5 Conclusion

This research present an analysis of the vulnerability of various districts within Bandar Lampung, specifically focusing on socio-demographic economy, livelihood strategies, health, social networks, food, water, and natural disaster/climate variability. Among the districts, Bumi Waras shows significant vulnerability across several components, particularly in socio-demographic economy, livelihood strategy, health, social networks, and natural disasters/climate variability. Similarly, Teluk Betung Selatan, Teluk Betung Timur, and Panjang also exhibit varying degrees of vulnerability, with notable concerns in natural disaster and climate variability.

In the context of sustainable economic development, these findings highlight the critical need for targeted interventions that address the vulnerabilities of these coastal communities. Sustainable development aims to balance economic growth with environmental protection and social equity. By focusing on reducing vulnerabilities in socio-demographic and economic aspects, enhancing livelihood strategies, and building resilient health and social networks, Bandar Lampung can work towards a more sustainable future. This approach not only improves the quality of life for residents but also ensures that development is inclusive, resilient to climate impacts, and capable of sustaining long-term economic growth.

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