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Community livelihood vulnerability level in northern and southern coastal area of Java, Indonesia

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Abstract. Climate change has an adverse effect on the coastal area. When sea level is rising, it will lead to more frequent sea tides, flood, and abrasion. This condition will make the coastal communities, especially fishermen and traders, become vulnerable. This research aims to examine the social-economics vulnerability of coastal communities, especially fishermen and traders in Northern and Southern Java coastal area, which related to climate change. The data is collected from 216 respondents from the coastal area. The data is analysed using Livelihood Vulnerability Index (LVI) and, Livelihood Vulnerability Index – Intergovernmental Panel of Climate Change (LVI-IPCC). LVI analysis shows that the condition of coastal communities can be considered as vulnerable. However, based on LVI-IPCC analysis, the coastal communities are not vulnerable.

1. Introduction

Indonesia is one of the largest archipelago countries with more than 17,000 islands and 80,000 kilometres coastline [1]. This condition has placed Indonesia in a vulnerable position to the climate change, especially in term of sea level. IPCC [2] shows that starting on the 19th century global temperature has rose for 0.74° C, in average and will keep increasing up to 4.5° C. These uprising will affect sea level because of the meltdown in arctic icebergs. The effect can be seen in term of increased coverage of sea tides flood. In a long term, more and more small islands will disappear due to increased sea level. This condition will threaten the coastal communities' life. Moreover, the rise in sea level will also change the sea wave, increasing the frequency of sea tides flood, and destroying mangrove, which will lead to abrasion. Coastal areas are vulnerable to the effect of climate change, especially in term of sea level. This is mainly because Indonesian coastal area is characterized with high settlement density with crowded activities, such as salt farming, docking area, and tourism area as well.

Beach abrasion is the shrinkage in coastline from its previous position [3]. In general, 40 percent of total Indonesian coastline is damaged due to abrasion. In average, every year, 2-10 metres of coastline vanished as an effect of abrasion. Beach abrasion is caused by two main factors: an increase in sea level as the effect of global warming and the destruction of mangrove ecosystem. Both factors are caused by human activities. Other factors that contribute to the destruction of Indonesian beach, besides abrasion, are geological aspect, wave power, and whirlwind.

Northern and Southern Java coastal area is vulnerable to abrasion and tsunamis. Moreover, worse abrasion also adds to the vulnerability of both areas. This condition triggers the vulnerability of the coastal communities. Fishermen in coastal area mostly have several specific problems related to their livelihood, such as:



- a. Crucial ecosystem problem. Fish availability, which depend on season aspect, as well as fishermen's courage and safety in catching fishes, which depend heavily in wind condition and sea waves.
- b. Fish is one of food ingredients that can get easily rotten if not distributed immediately. This make the fishermen have to accept the price set by wholesaler.

The objective of this research is to analyze the vulnerability of fishermen who live in Northern and Southern Java coastal area, as well as trader in the same area, as a result of climate change.

2. Methodology

2.1. Location of the research

The location of research is a certain place where researcher collecting respondents' data needed. For the southern Java coastal area, Bantul Regency is chosen as the location of research. The data is collected from several beaches in this Regency such as Parangtritis, Depok, Kwaru, and Pantai Baru. Meanwhile, for the northern Java coastal area Demak Regency (Morosari Beach and Purworejo village coast) and Semarang City (Maron beach, Marina beach, Tambak Mulyo, and Tambak Rejo) are chosen for survey.

2.2. Research types

This research uses quantitative descriptive approach. This approach aims to describe the facts and the nature of the population in certain areas in a systematic, factual, and accurate manner.

2.3. Data Source

Data source refer to any source that can give the information about the data needed in this research. Data can be divided into two categories based on the source: primary data and secondary data. Primary data is the data collected directly as the result of observation, interview, or distributed questionnaire. Secondary data is the data collected from other parties (institution or organization) database.

The respondents in this research are traders and fishermen in northern and southern Java coastal area, specifically in Bantul Regency, Demak Regency, and Semarang City. The secondary data used in this research is average rainfall intensity in the three areas. The secondary data is obtained from BPS. The data of average air temperatures in three areas in five consecutive years is obtained from NCDC.

2.4. Methods and data analysis

2.4.1. Vulnerability index.

2.4.1.1. Livelihood Vulnerability Index (LVI) approach.

The Livelihood Vulnerability Index (LVI) in this research is developed by Hahn et al. (2009), which consist of seven main components, namely Social Demographic Profile (SDP), Livelihood Strategy (LS), Health (H), Social Network (SN), Food (F), Water (W), Natural Disaster (ND), and Climate Variability.

The LVI indicators as presented above are developed into several indicators or sub-components based on the literature review of its main component. LVI in this research is calculated using the balanced weighted average approach [4]. By using this measurement, each of the sub-components will have the same contribution to the overall index, even though each of the main component consist of a number of different sub-components.

Each sub-component is calculated using different scale, thus the result should be standardized to be converted into a more general index. By converting the result into an index, the overall result can be calculated. Therefore, to convert the scale of each sub-component obtained from the life expectancy index [5], a composite index approach is used with the following calculations:

$$Index\ S_b = \frac{S_b - S_{min}}{S_{max} - S_{min}} \quad (1)$$

Notes:

S_b = the value of the sub component in the region of b,

S_{\min} = the minimum value of each sub-component, determined from the data of study sites.

S_{\max} = the maximum value of each sub-component, determined from the data of study sites - standardized.

The mean value of sub-components is calculated using the following equation. After that, the value of main components is calculated.

$$Mb = \frac{\sum_i^n indeks_{b,i}}{n} \quad (2)$$

Notes:

M_b = one of main component in the region of b (SDP, LS, H, F, W, SN, and ND).

Index b_i = value of sub-components indexed by i.

The value of LVI is obtained based on the equation as follow:

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

The equation can be written as follows:

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

Source: Hahn et al. (2009) [6]

Notes:

LVI_b = vulnerability index value for one of b region, weighted from seven main components.

W_{M_i} = the amount of sub components that reflects all of the main component with the same contributor for the overall LVI [4].

The scale of LVI values ranges from:

- 0 – 0.2 = Not vulnerable
- 0.21 – 0.4 = Vulnerable/Moderate
- 0.41 – 0.5 = Very vulnerable

2.4.1.2. LVI – IPCC approach (Livelihood Vulnerability Index – Intergovernmental Panel of Climate Change).

LVI-IPCC index is an alternative option to calculate LVI by combining the definition of vulnerability according to IPCC. The exposure of this research population is measured using the number of flood occurred for the last five consecutive years. Climate variability is measured using the average of standard deviation of the maximum and minimum value of monthly air temperature for the last five years. The adaptive capacity is measured using demographic profile in each area such as number of female as the head of family, occupation, and social network (percentage of household that provide support to their neighbor). Sensitivity is measured using the status of food availability, water condition, and health level in a certain area. Table 1. Explains the method in computing LVI-IPCC.

The main difference between LVI-IPCC and LVI is in the integration of its main component. Different from the separation of main component in LVI computation, in LVI IPCC, the components will be grouped based on the category of plans, thus the formula is as follows:

$$CF_d = \frac{\sum_{i=1}^n W_{M_i} M_{di}}{\sum_{i=1}^n W_{M_i}} \quad (5)$$

Notes:

CF_d = definition of IPCC contributor factors (exposure, sensitivity or adaptive capacity) for region of d (the northern and southern coast of Java),

M_{di} = main component of the d-region which indexed by i

W_{M_i} = the weighted value of main components, and is the amount of each main components contributor factor.

The combination of the three contributor factors is calculated using the following equation:

$$LVI - IPCC_d = (e_d - a_d) * S_d \quad (6)$$

LVI-IPCC_d is the index of LVI in the region of d, which reflected from vulnerability framework of IPCC.

Notes:

e = score of d region (same as the main component in natural disaster and climate variability),

a = score of adaptive capacity in the region of d (weighted from average of main component in social-demography, livelihood strategy, and social network)

s = score of sensitivity in the region of d (weighted from of main component in health, food and water).

The scale of LVI-IPCC between -1 and (-0.4) refer to 'not vulnerable', -0.41 – 0.3 refer to 'moderate', and 0.31 - 1 which refer to 'very vulnerable'.

Main component and sub-component of Livelihood Vulnerability Index (LVI) design developed by Hahn *et al.* (2009) [6] are:

1. Socio Demographic : dependency ratio, percentage of female head of household, percentage of households where head of household never attended school, percentage of a household with family members need assistance
2. Livelihood : percentage of a households whose family members work outside the community/ outside the city, percentage of a households who depend on agriculture as their main source of income, average index of livelihood agricultural diversification
3. Health : percentage of a households whose have average time required to go to a health facility, percentage of a households with chronic illness in family members
4. Social network : the mean value of aids accepted : ratio of aids given (range : 0.5-2), Average debt: ratio of money lending (range 0.5-2), and percentage of a households whose did not go to the local government to ask for support in the past year
5. Food : percentage of families who depend on family farming for food, average of months households experienced food shortages, Percentage of households that do not store crops
6. Water : percentage of households using natural water sources, Average time required to go to natural water source (minutes), Percentage of households with no consistent water supply, inverse of average number (in liters) of water stored per household
7. Natural disasters and climate variability: average amount of flood, and hurricane in the last 5 years, percentage of households not receiving a climate warning, percentage of households suffers death and being victim due to the natural disaster in the last 5 years, Standard deviation of average monthly temperature based on daily maximum temperature, average standard deviation of monthly temperature based on daily minimum temperature, Standard deviation from the average monthly rainfall.

Table 1. Contributing factor of vulnerability in IPCC.

Factor contributor of vulnerability	Main components
Exposure	Natural disasters and climate Variability
Adaptive Capacity	Social-demography profile Livelihood strategy Social Network
Sensitivity	Health, Food, Water

Source: [6]

3. Result and Discussion

3.1. LVI result for the southern coast of Java

The result of standardized sub-components and calculation of the LVI index on 114 respondents show that the vulnerability level of the respondent can be categorized as vulnerable in facing the climate change, the score for each component is shown in the table 2.

Table 2. Index of sub-component, main component, and total LVI.

Sub-component	Composite Index of		Index of Main Component	Category			
	Sub-component	Main Component					
Socio-demography							
Number of dependency	0.252	profile	0.242	Vulnerable			
Percentage of women as head of Household	0.088						
The average age of female head of household	0.766						
The head of household has no Education	0.096						
Households whose members need Help	0.009						
Percentage of households with members working outside the City	0.158				Livelihood strategy	0.384	Vulnerable
Percentage of households whose main sources of income still depend on the agricultural sector	0.684						
Average index of farm livelihood classification (range: 0.20 – 1)	0.310						
Average time required (minutes)	0.236	Health	0.158	Not Vulnerable			
Percentage of households whose family members have chronic illness	0.079	Food	0.459	Very Vulnerable			
Percentage of households with the most food sources are from their own farmland	0.816						
Average number of households in a month that has food shortage(range: 0-12)	0.007						
Percentage of households that do not store crops	0.553						
Percentage of households utilizing natural water resources	0.921				Water	0.244	Vulnerable
Average time required to go to water source (minutes)	0.025						
Percentage of households with consistent water supply	0.026						
The inverse to average amount of water (in litres) stored per household (range:> 0-1)	0.002						
Average receive: ratio of receiving (range: 0-15)	0.459	Social Network	0.599	Very vulnerable			
Average borrow: ratio of money lending (range: 0.5 - 2)	0.409						
Percentage of households who have never gone to local government to seek for support in the past year	0.930						
Natural disasters and climate							
The average amount of flood							

Sub-component	Composite Index of		Index of Main Component	Category
	Sub-component	Main Component		
disaster over the last 5 years	0.391	variability	0.353	Vulnerable
Percentage of households who do not receive warnings about the arrival of flood disasters	0.670			
Percentage of households suffering flood in the last 5 years	0			
Average standard deviation of monthly temperature based on daily maximum temperature	0.514			
Average standard deviation of monthly temperature based on daily minimum temperature	0.115			
The average value of standard deviation from the average rainfall per month	0.428			
Value of LVI				

Table 2 shows the result of LVI computation for all components (main components and sub-components). The LVI value for southern Java coastal area is 0.348, which shows that the fishermen and traders in the area is vulnerable to climate change. Moreover, we find that Bantul Regency is the most vulnerable area to tides flood because of climate change.

3.2. LVI-IPCC (Livelihood Vulnerability Index-Intergovernmental of Climate Change) approach

LVI-IPCC is an alternative method developed from LVI as the proxy of community livelihoods vulnerability caused by the climate change. The scale from -1 - (-0.4) which refer to 'not vulnerable', - 0.41 - 0.3 which refer to 'vulnerable/moderate', and 0.31 - 1 which refer to 'highly vulnerable'.

Table 3. The calculation of contributing factors in LVI-IPCC for Bantul Regency.

Factor contributor of IPCC for vulnerability	Index of main component	Weight of sub-component	Value of factor contributor	Category
Exposure	0.353	6	0.353	Very Vulnerable
Adaptive capacity	4.159	11	0.378	
- Socio-demographic	0.242	5		Vulnerable
- Livelihood strategy	0.384	3		
- Social network	0.599	3		
Sensitivity	2.669	9	0.296	
- Health	0.158	2		
- Food	0.459	3		
- Water	0.244	4		
LVI-IPCC Index Value			-0.007	Not Vulnerable

The overall value of LVI-IPCC is -0.007. This value indicates that fishermen and traders livelihood in southern Yogyakarta is not vulnerable to sea tides flood, which caused by climate change. This result is differing from the LVI result because in LVI-IPCC there is an integration of several components into one formula. The exposure index for natural disaster is lower than adaptation capacity index (social-demographic, living strategy, and social network), thus the result of LVI-IPCC has a negative value and not vulnerable.

Therefore, it can be concluded that southern Java coastal communities' livelihood is vulnerable based on LVI result. However, based on LVI-IPCC southern Java coastal communities' livelihood is not vulnerable. This difference is due to some integration in the

components of LVI. Generally, LVI measures the average of each component, while in LVI-IPCC the components are integrated into three main components and measured using different formula (LVI-IPCC formula).

3.3. The Analysis of Livelihood Vulnerability Index (LVI) result in the northern coast of Java

The result of LVI computation on the survey data of northern Java coastal communities shows that the fishermen and traders livelihood is vulnerable to climate change. The value of each component is presented on the following table 4.

Table 4. Index of sub-component, main component, and total LVI.

Sub-component	Composite Index of Sub-component	Index of Main Component		Category
		Main Component	Component	
Number of dependency	0.214	demographic Profile	0.213	Vulnerable
Percentage of female head of household	0.029			
The average age of female head of household	0.559			
The head of household has no education	0.108			
Households whose members need Help	0.157			
Percentage of households with members working outside the city	0.314	Livelihood strategy	0.390	Vulnerable
Percentage of households whose main sources of income still depend on the agricultural sector	0.578			
Average index of farm livelihood classification (range: 0.20 - 1)	0.278			
Average time required (minutes)	0.250	Health	0.199	Not vulnerable
Percentage of households whose family members have chronic illness	0.147			
Percentage of households with the most food sources are from their own farmland	0.892	Food	0.474	Very vulnerable
Average number of households in a month that has a difficulty to eat (range: 0-12)	0.002			
Percentage of households that do not store crops	0.529			
Percentage of households utilizing natural water resources	0.892	Water	0.236	Vulnerable

Average time required to go to water source (minutes)	0.039			
Percentage of households with consistent water supply	0.00			
The inverse of average amount of water (in litres) stored per household (range > 0-1)	0.011			
Average receive: ratio of receiving (range: 0-15)	0.389	Social network	0.563	Very vulnerable
Average borrow: ratio of money lending (range: 0.5 - 2)	0.428			
Percentage of households who have never gone to local government to seek for support in the past year	0.873			
The average amount of flood disaster in the last 5 years	0.121	Natural disasters and climate variability	0.436	Very vulnerable
Percentage of households who do not receive warnings about the arrival of flood disasters	0.922			
Percentage of households suffering flood disaster over the last 5 years	0.147			
Average standard deviation of monthly temperature based on daily maximum temperature	0.552			
Average standard deviation of monthly temperature based on daily minimum temperature	0.421			
The average value of standard deviation from the average rainfall per month	0.455			
Value of LVI			0.359	Vulnerable

The calculation of LVI, including its main components and sub-components is presented in Table 4. The overall LVI index for the northern Java coast area is 0.359. This result indicates that fisherman and trader in the northern Java coast area, especially Demak Regency and Semarang City is vulnerable to climate change.

3.4. LVI-IPCC approach

LVI-IPCC is an alternative method developed from the Livelihood Vulnerability Index (LVI) to make the proxy of community livelihoods vulnerability on the effects of climate change. The scale of LVI-IPCC is ranged from -1 – (-0.4) as not vulnerable, -0.41 – 0.3 as vulnerable or moderate, and 0.31 - 1 as very vulnerable.

Table 5. The calculation of contributing factors in LVI-IPCC for Semarang City and Demak Regency.

Factor contributor of IPCC for vulnerability	Index of main component	Weight of sub-Component	Value of factor contributor	Category
Exposure	0.436	6	0.436	Very vulnerable

Adaptive capacity				Very vulnerable
- Social-demography	0.213	5		
- Livelihood strategy	0.390	3		
- Social network	0.563	3		
Sensitivity	2.776	9	0.308	Very vulnerable
- Health	0.199	2		
- Food	0.474	3		
- Water	0.236	4		
Index value of LVI-IPCC			0.024	Vulnerable

The overall value generated from the calculation of LVI-IPCC method is 0.024. This value indicates that fishermen and traders livelihood, in northern Java coast area, who suffer abrasion due to the climate change, is vulnerable.

4. Conclusion

The objective of this research is to identify the regions in northern and southern coast zone of Java that suffer abrasion, due to the climate change and to calculate the social-economy vulnerability of the society who lives in the northern or southern coast zone of Java. The conclusions drawn based on the result of calculations in the study are stated as follows:

- a. Based on the analysis of LVI result, traders' and fishermen livelihood vulnerability level can be categorized as 'vulnerable' with an index value of 0.348 while based on the LVI-IPCC it can be categorized as 'not vulnerable' with an index value of -.007
- b. Based on the analysis of traders and fishermen livelihood vulnerability, using LVI, it shows that the vulnerability level of traders and fishermen in northern coast of Java can be categorized as 'vulnerable' with index value of 0.359 while based on LVI-IPCC it can be categorized as 'not vulnerable' with index value of 0.024

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by Evi Gravitiani

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The value of LVI is obtained based on the equation as follow:

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

The equation can be written as follows:

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

Source: Hahn et al. (2009) [6]

Notes:

LVI_b = vulnerability index value for one of b region, weighted from seven main components.
 W_{M_i} = the amount of sub components that reflects all of the main component with the same contributor for the overall LVI [4].
 The scale of LVI values ranges from:
 a. 0 – 0.2 = Not vulnerable
 b. 0.21 – 0.4 = Vulnerable/Moderate
 c. 0.41 – 0.5 = Very vulnerable

2.4.1.2. LVI – IPCC approach (Livelihood Vulnerability Index – Intergovernmental Panel of Climate Change).

LVI-IPCC index is an alternative option to calculate LVI by combining the definition of vulnerability according to IPCC. The exposure of this research population is measured using the number of flood occurred for the last five consecutive years. Climate variability is measured using the average of standard deviation of the maximum and minimum value of monthly air temperature for the last five years. The adaptive capacity is measured using demographic profile in each area such as number of female as the head of family, occupation, and social network (percentage of household that provide support to their neighbor). Sensitivity is measured using the status of food availability, water condition, and health level in a certain area. Table 1. Explains the method in computing LVI-IPCC.

The main difference between LVI-IPCC and LVI is in the integration of its main component. Different from the separation of main component in LVI computation, in LVI IPCC, the components will be grouped based on the category of plans, thus the formula is as follows:

$$CF_d = \frac{\sum_{i=1}^n W_{M_i} M_{di}}{\sum_{i=1}^n W_{M_i}} \quad (5)$$

Notes:

CF_d = definition of IPCC contributor factors (exposure, sensitivity or adaptive capacity) for region of d (the northern and southern coast of Java).
 M_{di} = main component of the d-region which indexed by i
 W_{M_i} = the weighted value of main components, and is the amount of each main components contributor factor.

The combination of the three contributor factors is calculated using the following equation:

$$LVI - IPCC_d = (e_d - a_d) * S_d \quad (6)$$

LVI-IPCC_d is the index of LVI in the region of d, which reflected from vulnerability framework of IPCC.

Notes:

- e = score of d region (same as the main component in natural disaster and climate variability),
 a = score of adaptive capacity in the region of d (weighted from average of main component in social-demography, livelihood strategy, and social network)
 s = score of sensitivity in the region of d (weighted from of main component in health, food and water).

The scale of LVI-IPCC between -1 and (-0.4) refer to 'not vulnerable', -0.41 – 0.3 refer to 'moderate', and 0.31 - 1 which refer to 'very vulnerable'.

Main component and sub-component of Livelihood Vulnerability Index (LVI) design developed by Hahn *et al.* (2009) [6] are:

1. Socio Demographic : dependency ratio, percentage of female head of household, percentage of households where head of household never attended school, percentage of a household with family member need assistance
2. Livelihood : percentage of a households whose family members work outside the community/ outside the city, percentage of a households who depend on agriculture as their main source of income, average index of livelihood agricultural diversification
3. Health : percentage of a households whose have average time required to go to a health facility, percentage of a households with chronic illness in family members
4. Social network : the mean value of aids accepted: ratio of aids given (range : 0.5-2), Average debt: ratio of money lending (range 0.5-2), and percentage of a households whose did not go to the local government to ask for support in the last year
5. Food : percentage of families who depend on farming for food, average of months households experienced food shortages, Percentage of households that do not store crops
6. Water : percentage of households using natural water sources, Average time required to go to natural water source (minutes), Percentage of households with no consistent water supply, reverse of average number (in liters) of water stored per household
7. Natural disasters and climate variability: average amount of flood, and hurricane in the last 5 years, percentage of households not receiving a climate warning, percentage of households suffers death and being victim due to the natural disaster in the last 5 years, Standard deviation of average monthly temperature based on daily maximum temperature, average standard deviation of monthly temperature based on daily minimum temperature, Standard deviation from the average monthly rainfall.

Table 1. Contributing factor of vulnerability in IPCC.

Factor contributor of vulnerability	Main components
Exposure	Natural disasters and climate Variability
Adaptive Capacity	Social-demography profile Livelihood strategy Social Network
Sensitivity	Health, Food, Water

Source: [6]

3. Result and Discussion

3.1. LVI result for the southern coast of Java

The result of standardized sub-components and calculation of the LVI index on 114 respondents show that the vulnerability level of the respondent can be categorized as vulnerable in facing the climate change, the score for each component is shown in the table 2.

Table 2. Index of sub-component, main component, and total LVI.

Sub-component	Composite Index of Sub-component	Index of Main Component	Index of Main Component	Category
Socio-demography				
Number of dependency	0.252	profile	0.242	Vulnerable
Percentage of women as head of Household	0.088			
The average age of female head of household	0.766			
The head of household has no Education	0.096			
Households whose members need help	0.009			
Percentage of households with members working outside the City	0.158			
Percentage of households whose main sources of income still depend on the agricultural sector	0.684			
Average index of farm livelihood classification (range: 0.20 – 1)	0.310			
Average time required (minutes)	0.236	Health	0.158	Not Vulnerable
Percentage of households whose family members have chronic illness	0.079	Food	0.459	Very Vulnerable
Percentage of households with the most food sources are from their own farmland	0.816			
Average number of households in a month that has food shortage (range: 0-12)	0.007			
Percentage of households that do not store crops	0.553			
Percentage of households utilizing natural water resources	0.921	Water	0.244	Vulnerable
Average time required to go to water source (minutes)	0.025			
Percentage of households with consistent water supply	0.026	Social Network	0.599	Very vulnerable
The inverse to average amount of water (in litres) stored per household (range > 0-1)	0.002			
Average receive: ratio of receiving (range: 0-15)	0.459			
Average borrow: ratio of money lending (range: 0.5 - 2)	0.409			
Percentage of households who have never gone to local government to seek for support in the past year	0.930			
Natural disasters and climate				
The average amount of flood				

Sub-component	Composite Index of		Index of Main Component	Category
	Sub-component	Main Component		
³² disaster over the last 5 years	0.391	variability	0.353	Vulnerable
Percentage of households who do not receive warnings about the ³¹ arrival of flood disasters	0.670			
Percentage of households suffering flood in the last 5 years	0			
Average standard deviation of monthly temperature based on daily maximum temperature	0.514			
Average standard deviation of monthly temperature based on daily minimum temperature	0.115			
The average value of standard deviation from the average rainfall per month	0.428			
Value of LVI			0.348	Vulnerable

Table 2 shows the result of LVI computation for all components (main components and sub-components). The LVI value for southern Java coastal area is 0.348, which shows that the fishermen and traders in the area is vulnerable to climate change. Moreover, we find that Bantul Regency is the most vulnerable area to tides flood because of climate change.

3.2. LVI-IPCC (¹⁷ *Livelihood Vulnerability Index-Intergovernmental of Climate Change*) approach

LVI-IPCC is an alternative method developed from LVI as the proxy of community livelihoods vulnerability caused by the climate change. The scale from -1 - (-0.4) which refer to 'not vulnerable', -0.41 - 0.3 which refer to 'vulnerable/moderate', and 0.31 - 1 which refer to 'highly vulnerable'.

Table 3. The calculation of contributing factors in LVI-IPCC for Bantul Regency.

Factor contributor of IPCC for vulnerability	Index of main component	Weight of sub-component	Value of factor contributor	Category
Exposure	0.353	6	0.353	Very Vulnerable
Adaptive capacity	4.159	11	0.378	Very Vulnerable
- Socio-demographic	0.242	5		
- Livelihood strategy	0.384	3		
- Social network	0.599	3		
Sensitivity	2.669	9	0.296	Vulnerable
- Health	0.158	2		
- Food	0.459	3		
- Water	0.244	4		
LVI-IPCC Index Value			-0.007	Not Vulnerable

The overall value of LVI-IPCC is -0.007. This value indicates that fishermen and traders livelihood in southern Yogyakarta is not vulnerable to sea tides flood, which caused by climate change. This result is differing from the LVI result because in LVI-IPCC there is an integration of several components into one formula. The exposure index for natural disaster is lower than adaptation capacity index (social-demographic, living strategy, and social network), thus the result of LVI-IPCC has a negative value and not vulnerable.

Therefore, it can be concluded that southern Java coastal communities' livelihood is vulnerable based on LVI result. However, based on LVI-IPCC southern Java coastal communities' livelihood is not vulnerable. This difference is due to some integration in the

components of LVI. Generally, LVI measures the average of each component, while in LVI-IPCC the components are integrated into three main components and measured using different formula (LVI-IPCC formula).

3.3. The Analysis of ³⁶ *Livelihood Vulnerability Index (LVI) result in the northern coast of Java*

The result of LVI computation on the survey data of northern Java coastal communities shows that the fishermen and traders livelihood is vulnerable to climate change. The value of each component is presented on the following table 4.

Table 4. Index of sub-component, main component, and total LVI.

Sub-component	Composite Index of Sub-component	Index of Main Component		Category
		Main Component	Component	
Number of dependency	0.214	demographic Profile	0.213	Vulnerable
Percentage of female head of household	0.029			
The average age of female head of household	0.559			
The head of household has no education	0.108			
Households whose members need help	0.157	Livelihood		
Percentage of households with members working outside the city	0.314	strategy	0.390	Vulnerable
Percentage of households whose main sources of income still depend on the agricultural sector	0.578			
Average index of farm livelihood classification (range: 0.20 - 1)	0.278			
Average time required (minutes)	0.250	Health	0.199	Not vulnerable
Percentage of households whose family members have chronic illness	0.147			
Percentage of households with the most food sources are from their own farmland	0.892	Food	0.474	Very vulnerable
Average number of households in a month that has a difficulty to eat (range: 0-12)	0.002			
Percentage of households that do not store crops	0.529			
Percentage of households utilizing natural water resources	0.892	Water	0.236	Vulnerable

Average time required to go to water source (minutes)	0.039			
Percentage of households with consistent water supply	0.00			
The inverse of average amount of water (in litres) stored per household (range > 0-1)	0.011			
Average receive: ratio of receiving (range: 0-15)	0.389	Social network	0.563	Very vulnerable
Average borrow: ratio of money lending (range: 0.5 - 2)	0.428			
Percentage of households who have never gone to local government to seek for support in the past year	0.873			
The average amount of flood disaster in the last 5 years	0.121	Natural disasters and climate variability	0.436	Very vulnerable
Percentage of households who do not receive warnings about the arrival of flood disasters	0.922			
Percentage of households suffering flood disaster over the last 5 years	0.147			
Average standard deviation of monthly temperature based on daily maximum temperature	0.552			
Average standard deviation of monthly temperature based on daily minimum temperature	0.421			
The average value of standard deviation from the average rainfall per month	0.455			
Value of LVI		0.359		Vulnerable

The calculation of LVI, including its main components and sub-components is presented in Table 4. The overall LVI index for the northern Java coast area is 0.359. This result indicates that fisherman and trader in the northern Java coast area, especially Demak Regency and Semarang City is vulnerable to climate change.

3.4. LVI-IPCC approach

LVI-IPCC is an alternative method developed from the Livelihood Vulnerability Index (LVI) to make the proxy of community livelihoods vulnerability on the effects of climate change. The scale of LVI-IPCC is ranged from -1 – (-0.4) as not vulnerable, -0.41 – 0.3 as vulnerable or moderate, and 0.31 - 1 as very vulnerable.

Table 5. The calculation of contributing factors in LVI-IPCC for Semarang City and Demak Regency.

Factor contributor of IPCC for vulnerability	Index of main component	Weight of sub-Component	Value of factor contributor	Category
Exposure	0.436	6	0.436	Very vulnerable

Adaptive capacity				Very vulnerable
- Social-demography	0.213	5		
- Livelihood strategy	0.390	3		
- Social network	0.563	3		
Sensitivity	2.776	9	0.308	Very vulnerable
- Health	0.199	2		
- Food	0.474	3		
- Water	0.236	4		
Index value of LVI-IPCC			0.024	Vulnerable

The overall value generated from the calculation of LVI-IPCC method is 0.024. This value indicates that fishermen and traders livelihood, in northern Java coast area, who suffer abrasion due to the climate change, is vulnerable.

4. Conclusion

The objective of this research is to identify the regions in northern and southern coast zone of Java that suffer abrasion, due to the climate change and to calculate the social-economy vulnerability of the society who lives in the northern or southern coast zone of Java. The conclusions drawn based on the result of calculations in the study are stated as follows:

- Based on the analysis of LVI result, traders' and fishermen livelihood vulnerability level can be categorized as 'vulnerable' with an index value of 0.348 while based on the LVI-IPCC it can be categorized as 'not vulnerable' with an index value of -.007
- Based on the analysis of traders and fishermen livelihood vulnerability, using LVI, it shows that the vulnerability level of traders and fishermen in northern coast of Java can be categorized as 'vulnerable' with index value of 0.359 while based on LVI-IPCC it can be categorized as 'not vulnerable' with index value of 0.024

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