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ANALYSIS OF FLOOD VULNERABILITY INDICATORS IN THE BENGAWAN JERO RIVER FLOW REGION, TURI DISTRICT, LAMONGAN REGENCY

Dwi Kartikasari[1], Nur Azizah Affandy[1], Zulkifli Lubis[1], M. Hanief Abdillah[1]
[1]Universitas Islam Lamongan, Veteran number 53 A, Lamongan, Indonesia

dkartika27unisla.ac.id (+62 857-8009-8408) ; habdillah85@gmail.com

ABSTRACT

Natural disasters are events that are always faced by humans, one of the disasters that occur due to rain is flooding. Floods are also caused by several factors that arise due to natural and human activities themselves. One area, namely the Turi sub-district, is also included in the flood impact in the Bengawan Jero watershed. The main cause is heavy rain for hours and the lack of existing catchment areas and the overflow of reservoirs. This study aims to determine the level of flood vulnerability by analysis of 4 indicators. The method used is the analysis of vulnerability parameters according to BNPB 2012, by taking primary data and secondary data. Primary data include observations, interviews, and documentation while secondary data includes data on the inundation of flood-affected areas, data on poor people, and data on residents affected by floods from several agencies. related. The results of the study show the calculation of the largest percentage value of social vulnerability in Kepudibener Village. The percentage value is 12.9, and the score is 1 in the High-class category. The greatest physical vulnerability value is in Putat Kumpul Village with a total score of 0.700 for the medium class category. Environmental vulnerability scores Total Average score 0.466 category medium class. The value of Economic Vulnerability totals an average score of 0.733 for the medium class category. Total Flood Vulnerability Value is based on the sum of Social, Physical, Environmental, and Economic Vulnerability Values. From the calculation of the largest value in Kepudibener Village with the percentage of IKS 5.16%, IKE 0.18%, IKF 0.13%, IKL 0.05, with a total score of 5.52 for the High-Class Category.

KEYWORDS: *Floods, Vulnerability Indicators, Turi District, Lamongan Regency*

1 INTRODUCTION

Natural disasters are events that are always faced by humans, one of the disasters that occur due to rain is flooding. Floods are also caused by several factors that arise due to nature and human activities themselves (Sugiyanto & Kodoati, 2002). Indonesia is a country with a tropical climate with two seasons, namely the dry season and the rainy season. These climatic conditions combined with the relatively diverse surface topography and rock conditions, both physically and chemically, can produce fertile soil conditions. On the other hand, this condition can cause several bad consequences for humans, such as hydro-meteorological disasters such as floods, landslides, forest fires, and droughts. In the Lamongan Regency area, there are areas that are also often prone to disasters, namely floods. This area has a land level lower than the surrounding area,

including lower than the height of the Bengawan Solo River. This is what causes the area to become flooded every year or the so-called Begawan Jero area. One area, namely the Turi sub-district, is also included in the flood impact in the Bengawan Jero watershed. The main causes are heavy rains for hours and the lack of existing catchment areas and the overflow of reservoirs. As a result, puddles that arise in the road area are very disturbing for motorized vehicles, and economic facilities are constrained to be slow. One of them is the risk of a vehicle breaking down due to high waterlogging. People's access to schools, offices, and others is also disrupted and many roads are damaged and have potholes after the flood. Ponds/rice fields which are the livelihoods of local farmers are constrained. From the existing problems, research can be carried out to calculate the level of flood indicators in the Bengawan Jero watershed, Turi District, Lamongan Regency.

2 MATERIALS AND METHODS

2.1 Definition of Disaster

Definition of Disaster Based on (Law No. 4 of 2007) a disaster is an event or series of events that can come anytime and anywhere unexpectedly that can threaten and disrupt human survival and livelihoods due to natural and non-natural factors as well as human factors, resulting in the emergence of casualties and even all living things in the affected area as well as environmental damage, property losses, and psychological impacts

2.2 Flood

According to (Suripin, 2002) is a condition where the overflow of water in the overflow channel/drainage inundates the surrounding area (flood plain), if there is an overflow of water caused by a lack of channel cross-sectional capacity.

2.3 Flood Vulnerability

Explanation of vulnerability theory according to Regulation of the Head of BNPB No. 2 of 2012 Vulnerability maps can be divided into social, economic, physical, and ecological/environmental vulnerabilities. Vulnerability can be defined as what is exposed including human life (social vulnerability), economic area, physical structure, and ecological/environmental area. Each Indicator used in the vulnerability analysis is primarily exposure information. In two cases information was included on the composition of exposures (such as population density, sex ratio, poverty ratio, disability ratio, and age group ratio). Sources of information used for vulnerability analysis mainly come from BPS reports (provinces/districts in figures, PODES, , PPLS, and PDRB) and basic map information from Bakosurtanal (land use, road network, and location of public facilities). Ideally, tabular information from BPS reaches the village level. the composition of the vulnerability indicators is shown below.

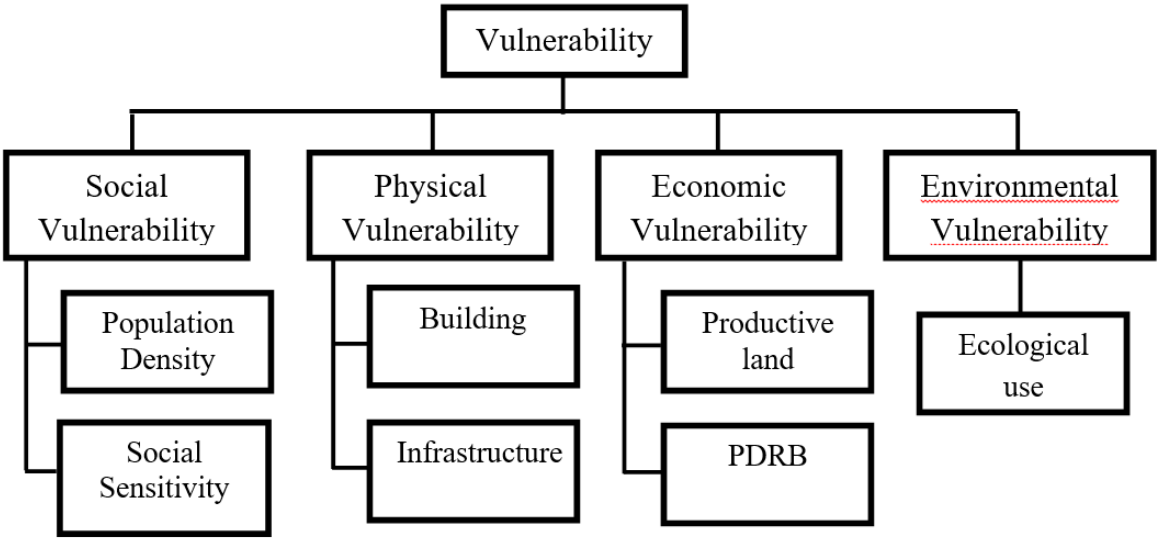

Figure 1. Composition of vulnerability analysis
Source: Head of BNPB Regulation No. 2 of 2012

The Turi sub-district is an area prone to flooding in 6 villages, namely Putat Kumpul Village, Kemlagi lor Village, Pomahanjanggan Village, Kepudibener Village, Gedongboyountung Village, Bambang Village is the lowest area so that more puddles of water accumulate.

2.4 Data Collection Techniques

The method used for vulnerability data analysis is the calculation of 4 target indicators, namely Social, Physical, Economic, and Environmental. By taking primary data and secondary Data Primary data required include:

1. Observation
2. Interview
3. Documentation Secondary

Data required includes:

1. Data inundation of flood-affected areas (Source: Turi District Office).
2. Population Data (BPS Sub-district of Turi Book in 2020 figures)
3. Data on poor families and people with disabilities (Source: Social Service of Lamongan Regency)

2.5 Data Analysis Techniques

Table 1. Vulnerability indicator class value

Class	Weight %	Score
Height	100 %	0,3333
Currently		0,6667
Low		1

Source: Head of BNPB Regulation No. 2 of 2012

Table 2. Social vulnerability indicator table

Population Density 60%	Low <500 People / Km²	Currently >500 - 1000 People / Km²	High >1000 People / Km²	Score
Gender Ratio 10 % Poverty Ratio 10 % Disabled People Ratio 10 % Age Group Ratio 10 %	< 20 %	> 20 – 40 %	> 40 %	Class max score

Source: Head of BNPB Regulation No. 2 of 2012

$$VS = 0{,}6\ \frac{\log\left[\frac{PD}{0{,}01}\right]}{\log\left[\frac{100}{0{,}01}\right]} + (0{,}1 \text{ x GR}) + (0{,}1 \text{ x PR}) + (0{,}1 \text{ x DPR}) + (\ 0{,}1 \text{ x AGR}\ ) \quad (1)$$

Table 3. Physical vulnerability indicator table

Parameter	Weight %	Class			Score
		Low	Currently	High	
House	40%	<400 jt.	400 – 500 jt.	>500 Jt.	class max score
Public Facilities / Road	30%	<500 jt.	500 – 1 M	>1 M	
Critical facilities	30%	<500 jt.	500 – 1 M	>1 M	

Source: Head of BNPB Regulation No. 2 of 2012

$$Vf : (0{,}4 \text{ x Score House}) + (0{,}3 \text{ x Score Public Facilities / Road}) + (0{,}3 \text{ x Score Critical facilities}) \quad (2)$$

Table 4. Economic vulnerability indicator table

Parameter	Weight %	Class			Score
		Low	Currently	High	
Productive land	60 %	<50 jt.	50 – 200 jt.	>200 Jt.	class max score
PDRB	40 %	<100 jt.	100 – 300 Jt.	>300 Jt	

Source: Head of BNPB Regulation No. 2 of 2012

$$VE: (0{,}6\ x\ Score\ Productive\ Land) + (0{,}4\ x\ Score\ PDRB) \quad (3)$$

Table 5. Environmental vulnerability indicator table

Parameter	Weight %	Class			Score
		Low	Currently	High	
Protected Forest	10 %	<20 Ha.	20 – 50 Ha.	>50 Ha.	class max score
Natural Forest	30 %	<25 Ha.	25 – 75 Ha.	>5 Ha.	
Bush	20 %	<10 Ha.	10 – 30 Ha.	>30 Ha.	
Ricefield	20 %	<20 Ha.	10 – 30 Ha.	>30 Ha.	
Plantation	20 %	<25 Ha.	25 – 50 Ha.	>50 Ha.	

Source: Head of BNPB Regulation No. 2 of 2012

$$VL: (0{,}1\ x\ Score\ \text{Protected Forest}) + (0{,}3\ x\ Score\ \text{Natural Forest}) + (0{,}2\ x\ Score\ Bush) + (0{,}2\ + Score\ Ricefield) + (0{,}2\ x\ Plantation) \quad (4)$$

$$VHB = (0{,}4\ \text{x VS}) + (0{,}25\ x\ VE) + (0{,}25\ x\ Vf + (0{,}1\ x\ VL) \quad (5)$$

3 RESULTS AND DISCUSSION

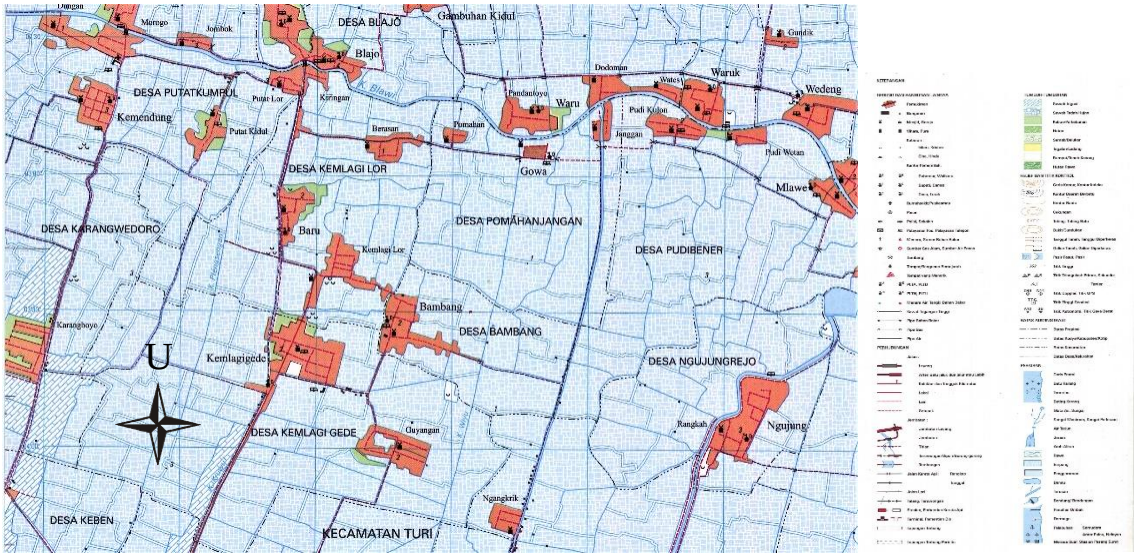

Figure 2. Map of Village Areas Affected by Floods in Turi District
Source: Topographical map of Indonesia, Lamongan Regency (2022)

Turi Subdistrict is located in the north of Lamongan Regency with 19 villages and is still included in the productive land. According to data from the Turi District report, the lower area includes the Bengawan Jero watershed which is the authority of the

Bengawan Solo BBWS. Every rainy season, the flow of water in the Bengawan Jero/Kali Blawi watershed always overflows and inundates the banks and rises to the road surface and even settlements. The discharge stream from Gondang Reservoir will go directly to Kruwul Rivers 1 and 2 which flow to Blawi River. Efforts from the Government for flood-prone areas are to provide warning symbols of flood disasters as shown in Figure 3.

Figure 3. Symbol of Preparedness for Flood Prone Areas
Source: Research result (2022)

The flood-prone areas installed in Kemlagilor and Pomahanjanggan villages aim to provide notifications to the public to be more alert in dealing with flood disasters in the Turi sub-district area. Analysis and Observation of flood-prone areas carried out following the problem formulation to determine flood vulnerability according to Head of BNPB Regulation No. 2 of 2012

Table 6. Analysis of Social Vulnerability Indicators in Turi District

No.	Village	0,6 x Population Density	0,1 x Gender Ratio	0,1 x Poverty Ratio	0,1 x Disabled People Ratio	0,1 x Age Group	Social Vulnerability Score
1.	Putat Kumpul	1310,8	1,0	34,1	0,1	49,9	9,8
2.	Kemlagi lor	1796,9	1,1	38,0	0,1	56,8	10,9
3.	Pomahanjanggan	1146,7	1,0	49,4	0,0	56,5	12
4.	Kepudibener	1204,7	1,1	55,4	0,0	59,8	12,9
5.	Gedongboyountung	1043,3	1,0	34,6	0,1	53,9	10,2
6.	Bambang	1008,6	1,0	34,6	0,4	55,6	10,4

Source: Research result (2022)

From the calculation of Social Vulnerability Indicators in 6 Villages, Turi Subdistrict, Lamonan Regency, calculated from the BPS Book report for 2020, population data and

poverty data from the Social Service, obtained the largest value in Kepudibenda Village, a score of 1 in the high-class category.

Table 7. Analysis of Physical Vulnerability Indicators in Turi District

No	Village	Physical vulnerability			Physical vulnerability Score
		0,4 x House	0,3 x Public Facilities / Road	0,3 x Critical facilities	
1.	Putat Kumpul	0,4000	0,2001	0,0999	0,700
2.	Kemlagi lor	0,1332	0,3000	0,0999	0,533
3.	Pomahanjanggan	0,1332	0,0999	0,0999	0,333
4.	Kepudibener	0,1332	0,3000	0,0999	0,533
5.	Gedongboyountung	0,1332	0,0999	0,0999	0,333
6.	Bambang	0,1332	0,0999	0,0999	0,333

Source: Research result (2022)

The calculation of Physical Vulnerability Indicators in 6 Villages, Turi Subdistrict, Lamongan Regency, is calculated from the flood report in the Subdistrict data column of affected houses, public facilities, and critical facilities multiplied by the price of losses based on the results of interviews, the largest value is Putat Kumpul Village with a score of 0.700 including the Medium class category.

Table 8. Analysis of Economic Vulnerability Indicators in Turi District

No.	Village	Economic Vulnerability		
		0,6 x Productive land	0,4 x PDRB	Economic vulnerability Score
1.	Putat Kumpul	0,6	0,133	0,733
2.	Kemlagi lor	0,6	0,133	0,733
3.	Pomahanjanggan	0,6	0,133	0,733
4.	Kepudibener	0,6	0,133	0,733
5.	Gedongboyountung	0,6	0,133	0,733
6.	Bambang	0,6	0,133	0,733

Source: Research result (2022)

From the calculation of Economic Vulnerability Indicators in 6 Villages, Turi District, Lamongan Regency, calculated from the BPS report, the land productivity data column multiplied by food commodity prices/kg, the average value is obtained with a score of 0.733 including the medium class category.

Table 9. Analysis of Environmental Vulnerability Indicators in Turi District

No.	Village	Environmental Vulnerability					Environmental Vulnerability Score
		0,1 x Protected Forest	0,3 x Natural Forest	0,2 x Bush	0,2 x Ricefield	0,2 x Plantation	
1.	Putat Kumpul	0,033	0,099	0,066	0,2	0,066	0,466
2.	Kemlagi lor	0,033	0,099	0,066	0,2	0,066	0,466
3.	Pomahanjanggan	0,033	0,099	0,066	0,2	0,066	0,466
4.	Kepudibener	0,033	0,099	0,066	0,2	0,066	0,466
5.	Gedongboyountung	0,033	0,099	0,066	0,2	0,066	0,466
6.	Bambang	0,033	0,099	0,066	0,2	0,066	0,466

Source: Research result (2022)

From the calculation of Environmental Vulnerability Indicators in 6 Villages, Turi Subdistrict, Lamongan Regency, calculated from the environmental aspect of the flood report in Turi Subdistrict, it was obtained an average value with a score of 0.466 including the low-class category.

Table 10. Analysis of Flood Vulnerability Indicators in Turi District

No.	Village	Flood Vulnerability Indicator				Flood Vulnerability Score
		0,4 x VS	0,25 x VE	0,25 x VP	0,1 x VL	
1.	Putat Kumpul	3,92	0,18	0,18	0,05	4,33
2.	Kemlagi lor	4,36	0,18	0,13	0,05	4,73
3.	Pomahanjanggan	4,78	0,18	0,08	0,05	5,10
4.	Kepudibener	5,16	0,18	0,13	0,05	5,52
5.	Gedongboyountung	4,09	0,18	0,08	0,05	4,40
6.	Bambang	4,16	0,18	0,08	0,05	4,48

Source: Research result (2022)

From the calculation of Environmental Vulnerability Indicators in 6 Villages, Turi Subdistrict, Lamongan Regency, the total Flood Vulnerability Value is the sum of the Social, Physical, Environmental, and Economic Vulnerability Values. From the calculation of the largest value in Kepudibener Village with a percentage of IKS 5.16, IKE 0.18, IKF 0.13, IKL 0.05, with a total flood vulnerability value of 5.52 in the High-Class Category.

4 CONCLUSION

From the results and discussion obtained, the following conclusions are obtained: The level of flood vulnerability in 6 villages, Turi sub-district, Lamongan regency according to the categories in the Head of BNPB Regulation No. 2 of 2012 are:

The level of Social Vulnerability is calculated from the sum of the calculation of population density, sex ratio, the ratio of disabled people, and the ratio of age groups. From the calculation of the largest percentage value in Kepudibener Village, the percentage value is 12.9, and the score is 1 in the High-class category.

Physical Vulnerability Levels and Physical Vulnerability Values are obtained from data on affected houses, public facilities, and critical facilities during a flood with building and road criteria. From the calculation of the largest percentage value in Putat Kumpul Village with 0.4% House Percentage, 0.2% Public Facilities, Critical Facilities 0.099%, total score 0.700 category Medium class.

Environmental Vulnerability Level, Environmental Vulnerability Value obtained from sub-district flood report data from the land area with units of hectares with the majority of rice fields/ponds from the calculation obtained the percentage value of Protected Forests 0.033%, Natural Forests 0.099%, Shrubs 0.066%, Rice Fields 0.2%, Plantation 0.066%, obtained an average score of 0.466 for the medium class category.

Economic Vulnerability Level, Economic Vulnerability Value is obtained from BPS sub-district data from land productivity according to commodity prices per kg and GRDP adjusted by class weight. From the calculation of the percentage value of productive land 0.6%, GRDP 0.133%, the average score is 0.733 Medium class category.

Flood Vulnerability Level, Total Flood Vulnerability Value based on the summation of Social, Physical, Environmental, and Economic Vulnerability Values. From the calculation of the largest value in Kepudibener Village with the percentage of IKS 5.16%, IKE 0.18%, IKF 0.13%, IKL 0.05%, with a total score of 5.52 for the High-Class Category.

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