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Regional Case Study

Study of Sensitivity Index for Landslide Disaster in Gunungpati Sub-district, Semarang City

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Abstract

Sensitivity is one of the parameters of the vulnerability in a disaster. Gunungpati Sub-district is one of the sub-districts that had a high-intensity landslide in Semarang city. Assessment of the sensitivity index to disasters is necessary to reduce vulnerabilities and to become a consideration for policy-taking factors in the emergence of disasters. The sensitivity index uses the population density, building density, sex ratio, dependency ratio, poverty rate, and education level. The method used is a weighted scoring method for each sensitivity variable. The sensitivity index of the Gunungpati Sub-district on landslide ranges from 2.6 - 2.8. Sensitivity levels of the Gunungpati Sub-district are classified into three classes there are little sensitive, moderately sensitive, and sensitive classes. Five villages have high sensitivity values. Special attention from the government is needed to increase the capacity of the population in terms of social and economic aspects to reduce the high sensitivity value in the area. Mitigation that can be done by the government related to the sensitivity of this area can be through policies such as capital assistance and training for vulnerable groups, equalization of employment, making policies, and strict control of development permits in areas at risk of landslides.

Keywords: Sensitivity; landslide; vulnerability; mitigation

1. Introduction

Semarang City is an area that has the potential to experience various types of disasters, especially hydrometeorological disasters. Semarang City in 2021, experienced an increase in natural disasters by 20.47% from the previous year with the most natural disasters being landslides (Regional Disaster Management Agency, 2021). Gunungpati Sub-district is the area with the highest intensity of landslides. In Gunungpati Sub-district, according to data from BPBD Semarang City, there were instances of houses being affected by landslides in 2021. For example, in Sadeng Village, 8 houses across three neighborhood associations (RT) were destroyed. Similarly, in 2022, the same area experienced another significant landslide, resulting in the destruction of 4 houses and recorded losses totaling 500 million rupiah. The impact arising from the landslide disaster needs to be seen in the level of sensitivity of the area to see what factors can be suppressed to minimize losses. Sensitivity itself is one of the forming parameters of disaster vulnerability in addition to exposure and adaptability (KLHK, 2018 & IPCC, 2007). Sensitivity in its understanding is the level of sensitivity of a system, influenced by pressure or disturbance either positively or negatively, environmental and socioeconomic conditions inherent in human and environmental systems before the disturbance occurs (Liu et al, 2013). Sensitivity is the degree to which a system can be affected, either negatively or favorably, by a stress stimulus or climate-related disturbance (IPCC, 2007). Turner et al. (2003) in their research mentioned that sensitivity consists of several

conditions, namely, community sensitivity conditions related to social capital such as population, economic structure, existing institutions in the community, and environmental sensitivity conditions that include water, soil, and weather conditions. mitigation of disasters such as landslides is often focused solely on efforts to strengthen building structures and physical problems (Flanagan et al., 2011). In the mitigation and recovery stages after a disaster, social vulnerability will be a very important domain. Therefore, to reduce disaster risk, it is appropriate to focus the study on the level of sensitivity of the area. The sensitivity of the community in Gunungpati Sub-district needs to be studied, considering that this area is prone to landslides and the number of losses due to landslides continues to increase. Therefore, there is a need for sensitivity mapping that can be used by various parties as a reference in disaster risk reduction efforts.

Previous studies have explored sensitivity as a component of vulnerability to various natural disasters, including floods, droughts, haze, and landslides (Nahdahliah, 2022; Hastanti and Purwanto, 2020; Raihanah, 2016; Wardhani, 2016). However, those studies specifically focuses on landslides in suburban areas characterized by high landslide intensity, buffering the central region of Semarang City. The assessment of the sensitivity index of this area can then be continued by looking at the distribution of areas that are sensitive to landslides. This sensitivity level mapping uses Geographic Information System (GIS) *tools*. The purpose of this research is to analyze the index value of the sensitivity level of the area to landslides in Gunungpati Sub-district, Semarang City. The result of this sensitivity index can see the spatial distribution of the sensitivity level of each village in Gunungpati Sub-district towards landslide. The mapping of sensitivity level also added land use of the build-up area more specifically the vulnerability level of the area to landslides.

2. Methods

Gunungpati is one of the sub-urban areas that is becoming increasingly developed over the years. The hilly and undulating morphology of the Gunungpati Sub-district already indicates the potential for landslide vulnerability. The frequency of landslides in the area also shows that the area is vulnerable to landslides. The data used to assess the sensitivity level is secondary data. The secondary data used include building density data, population density data, sex ratio, dependency ratio, and poverty rate obtained from monographic data in each Kelurahan in Gunungpati Subdistrict in 2023 and Integrated Social Welfare Data of Semarang City in 2023 obtained from the Semarang City Social Service.

In this research, the level of sensitivity will depend on the social and economic conditions of the region (Hizbaron, 201 & Tiyansyah, 2017). The variables measuring the sensitivity level of this research include the economic and social sectors where the variables include population density, building density, sex ratio, dependency ratio, poverty level, and education level. The building density variable is a reflection of the presence of the population, as well as the value of the building itself. A high building density indicates a large population and a large economic value of the building so that in the event of a disaster it will cause a high risk. Building and population density parameters are also included in the research (Nahdahliah, 2022; Hastanti and Purwanto, 2020; Rachmawati et.al., 2018). The sex ratio and dependency ratio are more to see the sensitivity of certain groups in the event of a disaster such as women and unproductive people (Nahdahliah, 2022 & Hastanti and Miardiani, 2021). Meanwhile, the poverty level will see how much potential impact will occur on poor families if a landslide occurs (Hastanti & Purwanto, 2020).

The method used to calculate the value of the sensitivity index to landslides is the scoring and weighting method for each parameter (Hastanti and Purwanto, 2020 & Hida, et al, 2020). This scoring method then summed up the scores and combined the statistical data for each parameter per village. The tabulated and scored data for each vulnerability component from this quantitative data can then be calculated as the index for each sensitivity component using the following equation (1)

$$\text{Sensitivity Index} = (0.3 * \text{Population Density}) + (0.3 * \text{Building Density}) + (0.1 * \text{Sex Ratio}) + (0.1 * \text{Poverty Level}) + (0.1 * \text{Dependency Ratio}) + (0.1 * \text{Education Level}) \quad (1)$$

The scoring and weighting tables for each parameter to identify the sensitivity level can be seen in table 1 below.

Table 1. Parameters of sensitivity level

No.	Parameters	Category	Scoring	Weight	Calculations
1	Population Density	<250 inhabitants/km²	Low (1)		(Total population / Area)
		250 - 499 inhabitants/km²	Medium (2)	30%	
		>500 inhabitants/km²	High (3)		
2	Building Density	<150 units/km²	Low (1)		(Number of Houses / Area)
		150 - 1000 units/km²	Medium (2)	30%	
		>1000 units /km²	High (3)		
3	Sex Ratio	<60 %	Low (1)	10%	(Total Male Population / Total Female Population) x 100)
		60% - 80 %	Medium (2)		
		>80 %	High (3)		
4	Poverty Level	<20 %	Low (1)	10%	(Number of poor families/total families) x 100
		20% - 40 %	Medium (2)		
		>40 %	High (3)		
5	Dependency Ratio	<50 %	Low (1)	10%	(Total population of unproductive age / total population of productive age) x 100
		50% - 80 %	Medium (2)		
		>80 %	High (3)		
6	Education Level	University	Low (1)	10%	Data on the majority of residents' latest education
		High School	Medium (2)		
		Junior High School	High (3)		

Source:
Nahdahliah (2022); Hastanti and Miardiani (2021); Hastanti and Purwanto (2020); Hartono (2020); Muawanah (2016); Efendi (2012) and; BNPB (2012) with modification.

The method used to create the landslide sensitivity map is by scoring each parameter. The sensitivity index value is expressed on the standard deviation (SD) of the average of all parameters. To get even results on sensitivity, the most extreme SD class is used where high sensitivity is ≥ +1.5 SD, while low sensitivity is ≤ -1.5 SD.

3. Result and Discussion

3.1 Landslide Sensitivity Parameters

3.1.1 Population Density of Gunungpati Subdistrict

Population density is one of the factors considered in disaster studies. The assumption is that if a landslide occurs, the potential for casualties in a dense settlement is very high. This was also conveyed by the high population density illustrating the high chance of casualties and property that threaten the survival of the community (Hapsoro, 2015). The total population and its density level in each village in Gunungpati Subdistrict can be seen in Table 2.

Table 2. Population density of each village in gunungpati subdistrict

No.	Village	Total Population	Area (km²)	Density people/km²	Level
1	Gunungpati	7,684	4.71	1631	High
2	Plalangan	4,255	3.37	1263	High

No.	Village	Total Population	Area (km^2)	Density people/km^2	Level
3	Sumurejo	6,968	3.58	1946	High
4	Pakintelan	6,234	3.62	1722	High
5	Mangunsari	5,923	3.33	1779	High
6	Patemon	6,066	3.44	1763	High
7	Ngijo	4,740	2.97	1596	High
8	Nongkosawit	5,689	3.17	1795	High
9	Cepoko	3,405	2.8	1216	High
10	Jatirejo	2,354	2.34	1006	High
11	Kandri	5,013	4.19	1196	High
12	Ponganan	6,072	2.59	2344	High
13	Kalisegoro	3,891	3.24	1201	High
14	Sekaran	9,075	5.98	1518	High
15	Sukorejo	15,064	4.42	3408	High
16	Sadeng	7,889	4.51	1749	High

Source:
Gunungpati Subdistrict Monographic Data Processing (2023)
Disdukcapil Semarang City (2023)

Based on population data processing, it was found that the population density of each village in Gunungpati Subdistrict is high. Almost all villages have densities above 1000 people/km^2 except Jatirejo Village, which has a density of 966 people/km^2. The high population density in all villages is because Gunungpati Sub-district is a sub-urban area of Semarang City and is adjacent to the center of Semarang Regency, Ungaran. In addition, the presence of universities in the Gunungpati Sub-district, namely UNNES and UNWAHAS, also attracts outsiders to come and settle down. These factors have led to a high population density in Gunungpati Sub-district.

The high population density poses a significant challenge in addressing landslides. This is because areas with higher population densities tend to be more susceptible to the impacts of landslides. Widodo and Imaduddina (2019) in their research mentioned that population density affects the assessment of landslide vulnerability, where the denser the population, the more vulnerable it is. This is also related to the number of victims who suffered losses due to landslides caused by ground movement. This is also described in the research results of Han, et al. (2021) which explains that the risk of population close to disaster-prone areas and has an intensity of frequent occurrence will further increase the number of victims in the area.

3.1.2 Building Density Level of Gunungpati Sub-district

Building density will usually be directly proportional to population density in an area. Sari et al. (2017) mentioned that landslide vulnerability in an area increases with the presence of infrastructure, namely buildings due to population density in landslide-prone areas. The building density variable is included in the sensitivity parameter because buildings are one of the things that will be affected if a landslide occurs and, will result in material losses such as the destruction of homes and businesses. In addition, the possibility of casualties in high building density will be very likely to occur.

The following are the results of data processing of building density for each village which can be seen in detail in Table 3.

Table 3. Building density level of each village in gunungpati subdistrict

No.	Village	Number of Settlements	Area (Km2)	Density unit/km^2	Level
1	Gunungpati	2298	4.71	488	Medium

No.	Village	Number of Settlements	Area (Km2)	Density unit/km²	Level
2	Plalangan	944	3.37	280	Medium
3	Sumurejo	925	3.58	258	Medium
4	Pakintelan	1172	3.62	324	Medium
5	Mangunsari	2735	3.33	821	Medium
6	Patemon	766	3.44	223	Medium
7	Ngijo	925	2.97	311	Medium
8	Nongkosawit	1719	3.17	542	Medium
9	Cepoko	855	2.8	305	Medium
10	Jatirejo	638	2.34	273	Medium
11	Kandri	1198	4.19	286	Medium
12	Ponganan	1883	2.59	727	Medium
13	Kalisegoro	1197	3.24	369	Medium
14	Sekaran	2003	5.98	335	Medium
15	Sukorejo	2768	4.42	626	Medium
16	Sadeng	1816	4.51	403	Medium

Source:
Gunungpati Sub-district Monographic Data Processing (2023)

Based on the results of data processing, it is found that the density of buildings in each urban village in Gunungpati Subdistrict is moderate. The lowest building density is in Patemon urban village with a density of 223 units/km² and the densest is in Mangunsari urban village with 821 units/km². Population growth in line with the increase in the number of buildings must certainly be a concern. If development does not pay attention to environmental planning and disaster-prone areas, especially landslides, it will certainly be very unwise so strict supervision is needed.

The relationship between building density and landslides is confirmed in the research of Qutieshat and Al-Assaf (2022) which shows that the higher the number of buildings or built-up areas, the higher the number of landslides in the area. Widodo and Imaduddina (2019) also found the same thing in vulnerability, the higher the building density, the more vulnerable the area is to landslides. This shows that the building density factor is very influential in the level of vulnerability, especially sensitivity.

3.1.3 Sex Ratio Gunungpati Sub-district

The sex ratio serves as an indicator within the sensitivity parameter, as the female population typically exhibits higher vulnerability compared to men. This vulnerability stems from physical differences, with women generally being physically weaker and less able to take action to protect themselves from landslides compared to men. Agustin (2014) mentioned that the female population has a higher risk of becoming victims of disasters. Hastanti and Miardiani (2021) also mentioned that the higher the sex ratio of the population, the higher the vulnerability to disasters. The following is the sex ratio data for each village in the Gunungpati Sub-district shown in table 4

Table 4. Sex ratio of each village in gunungpati subdistrict

No.	Village	Male	Female	Sex Ratio	Level
1	Gunungpati	3,800	3,884	97.8	High
2	Plalangan	2,083	2,172	95.9	High
3	Sumurejo	3,453	3,515	98.2	High
4	Pakintelan	3,165	3,069	103.1	High
5	Mangunsari	2,924	2,999	97.5	High
6	Patemon	3,067	2,999	102.3	High

7	Ngijo	2,355	2,385	98.7	High
8	Nongkosawit	2,807	2,882	97.4	High
9	Cepoko	1,737	1,668	104.1	High
10	Jatirejo	1,155	1,199	96.3	High
11	Kandri	2,531	2,482	102.0	High
12	Ponganan	3,096	2,976	104.0	High
13	Kalisegoro	1,943	1,948	99.7	High
14	Sekaran	4,552	4,523	100.6	High
15	Sukorejo	7,525	7,539	99.8	High
16	Sadeng	3,894	3,995	97.5	High

Source:
Gunungpati Sub-district Monographic Data Processing (2023)

The table shows that the sex ratio in all villages is high. The village with the highest sex ratio is Cepoko with a ratio of 104.1 and the lowest is Plalangan with 95.9. This high sex ratio indicates that there is a need to strengthen the capacity of the female population to reduce the impact that may arise during disasters. Increasing the capacity of women's roles in disasters can be done, among others, by increasing the ability to plan and take action to reduce the risks they have both through increasing capacity and reducing vulnerability as well as through monitoring, evaluating, and ensuring the sustainability of risk reduction efforts (Hastuti, 2016).

The high sex ratio class will affect the sensitivity of the area. According to research by Ashraf & Azad (2015) and Reyes & Lu (2015), the role of women in disasters is still small and women's skills as resources are generally ignored in the disaster management process both in the planning process, emergency, and relief, and post-disaster recovery so that it becomes one of the factors causing vulnerability and marginalization of the female gender in disasters.

Referring to these matters, it is necessary to take some capacity-building measures for the female population. Ananda et al. (2019) in their research mentioned the need for assistance and training starting from *assessment*, and planning, to the implementation of management programs. The involvement of women is expected to reduce sensitivity and add new views from the women's side regarding what needs to be prepared for their group when a disaster occurs.

3.1.4 Poverty Level

The economic capabilities of a group or individual will affect their level of sensitivity to disasters. Lal et al. (2009) mentioned that the vulnerability of the poor and the level of poverty will increase if a natural disaster occurs in the area. this can be because the poor do not have access to natural resources, physical assets, human capital, and financial resources are also important for the community's ability to face and recover from disasters (Carney, 1998).

Debortoli, Camarinha, Marengo, & Rodrigues, (2017) in Hastanti and Miardinai, (2021) also mentioned that the more the number of poor households, the more vulnerable to disasters, because poverty causes preparations against disaster risks to be weak, especially financial preparations (*saving money*) and foodstuffs. Preparedness by looking at poor households is a representative indicator in seeing the population's sensitivity to landslides.

The data used in this study uses the Integrated Social Welfare Data (DTKS) of Semarang City. DTKS is data that contains Social Welfare Service Providers (PPKS), Recipients of Social Assistance and Empowerment, and Potential Sources of Social Welfare (PSKS) and contains 40% of the population with the lowest social welfare status (Ministry of Social Affairs, 2019). This data is a reference for the Semarang City government to assist underprivileged families. Data on the number of poor households in each village in Gunungpati Sub-district can be seen in Table 5.

Table 5. Poverty level of each village in gunungpati subdistrict

No.	Village	Number of poor families	Total Families	Poverty (%)	Level
1	Gunungpati	1349	2710	49.8	High
2	Plalangan	539	1494	36.1	Medium
3	Sumurejo	1265	2203	57.4	High
4	Pakintelan	1427	1946	73.3	High
5	Mangunsari	910	1773	51.3	High
6	Patemon	942	1855	50.8	High
7	Ngijo	886	1615	54.9	High
8	Nongkosawit	746	1961	38.0	Medium
9	Cepoko	733	1112	65.9	High
10	Jatirejo	483	797	60.6	High
11	Kandri	805	1382	58.2	High
12	Ponganan	1325	2710	48.9	High
13	Kalisegoro	470	1237	38.0	Medium
14	Sekaran	1578	3022	52.2	High
15	Sukorejo	2134	4949	43.1	High
16	Sadeng	893	2760	32.4	Medium

Source:
Integrated Social Welfare Data Processing Semarang City (2023)
Semarang City Social Service (2023)

Based on the data in this table, it can be seen that the poverty rate in the villages of Gunungpati Subdistrict is medium and high. The village with the lowest poverty rate is Sadeng with 32.4% and the highest is Pakintelan with a percentage of 73.3 Meanwhile if seen only through the number of poor families, Sukorejo Village has the highest number with 2134 families. The three villages of Pakintelan, Cepoko, and Jatirejo, need more attention because more than half of the population is poor. This strongly suggests that the population in these villages is quite sensitive to landslides and their ability to recover takes a long time because they are made up of many poor families.

The existence of urban villages that have a high poverty rate should be of more concern. Desinta and Sitorus (2021) in their research show that the number of disasters simultaneously has a significant effect on the percentage of poor people. If proper handling is not carried out in poverty alleviation, the readiness and ability of the population to deal with disasters, the area will be more vulnerable if a landslide occurs.

3.1.5 Dependency Ratio

The dependency ratio focuses on assessing the vulnerability of specific groups during disasters, particularly the unproductive population. A high dependency ratio in an area indicates that the productive population shoulders the needs of this group. (Nurmasari et al., 2017). Their high sensitivity to disasters due to limited space and ability to save themselves is the reason why this population is vulnerable to disasters.

Table 6: Dependency ratio of each village in Gunungpati subdistrict

No.	Village	Non-productive age	Productive Age	Ratio (%)	Level
1	Gunungpati	2304	5380	42.83	Low
2	Plalangan	1314	2941	44.68	Low
3	Sumurejo	2017	4951	40.74	Low
4	Pakintelan	1892	4342	43.57	Low
5	Mangunsari	1816	4107	44.22	Low

No.	Village	Non-productive age	Productive Age	Ratio (%)	Level
6	Patemon	1831	4235	43.23	Low
7	Ngijo	1543	3197	48.26	Low
8	Nongkosawit	1633	4056	40.26	Low
9	Cepoko	1044	2361	44.22	Low
10	Jatirejo	735	1619	45.40	Low
11	Kandri	1473	3540	41.61	Low
12	Ponganan	1718	4354	39.46	Low
13	Kalisegoro	1172	2719	43.10	Low
14	Sekaran	2692	6383	42.17	Low
15	Sukorejo	4245	10819	39.24	Low
16	Sadeng	2311	5578	41.43	Low

Source:
Gunungpati Subdistrict Monographic Data Processing (2023)
Semarang City Disdukcapil (2023)

Based on the data in this table, it can be seen that the dependency ratios of the villages in the Gunungpati Sub-district are all at a low level. In almost all villages the ratio is around 40%. This shows that in each village there are more people of productive age (15-64 years) than those of non-productive age (0-14 years and 65 years and over). This condition of the area can be considered good because the large number of productive age groups compared to non-productive age groups will make it easier for residents there to mitigate when a disaster occurs both with a quick response to evacuation and after a disaster. So that the non-productive age group has fewer life-threatening risks. As a concern, in the research results of Nor Diana et al. (2021) the population group aged 65 years and over has a greater level of disaster risk because, in addition to being more vulnerable, they also need a lot of attention both physically and emotionally.

3.1.6 Education Level

Understanding the threat of landslides is necessary whether or not the area is prone to such disasters. This understanding and knowledge needs to be possessed so that in the event of a disaster, the population knows how to respond and save themselves. The level of education can be used as one of the factors that play a role in knowing how the condition of an area understands the threat of disaster and how to respond. Kantameni (2019) also mentioned that individuals with sufficient education will find it easier to understand whether a hazard will affect them or not. The assumption is that the higher the majority of a region's formal education level, the region will be better prepared to face threats and how to respond.

Gunungpati Sub-district is a developing area. Based on data obtained from the monograph of the Gunungpati Sub-district in 2022, it is found that there are still several villages where the majority of the population currently only completes primary education. The data used in this study is the majority of education completed by residents in the villages, which can be seen in the following table of education levels.

Table 7. Education level of each village in Gunungpati Subdistrict

No.	Village	Education	Level
1	Gunungpati	High school graduate	Medium
2	Plalangan	Elementary school graduate	Low
3	Sumurejo	High school graduate	Medium
4	Pakintelan	Elementary school graduate	Low
5	Mangunsari	High school graduate	Medium
6	Patemon	High school graduate	Medium

No.	Village	Education	Level
7	Ngijo	Junior high school graduate	Low
8	Nongkosawit	High school graduate	Medium
9	Cepoko	Elementary school graduate	Low
10	Jatirejo	Elementary school graduate	Low
11	Kandri	Junior high school graduate	Low
12	Ponganan	High school graduate	Medium
13	Kalisegoro	Elementary school graduate	Low
14	Sekaran	High school graduate	Medium
15	Sukorejo	High school graduate	Medium
16	Sadeng	High school graduate	Medium

Source:
Gunungpati Sub-district Monographic Data Year 2022

The large number of older generations who have not received sufficient formal education is one of the factors why there are still urban villages where the majority of people have only completed primary school. In addition, the large number of young people also contributes to the fact that the majority of the population has only completed primary school. Some urban villages have education levels up to senior high school and college, but the number is still inferior to the elementary and junior high school education groups. Nor Diana (2021) in her research states that this level of education is important in disaster, apart from being able to recognize the impact of disasters, it is also an indicator that with higher education you can get a decent income through a good job.

As explained earlier, the higher the education, the more prepared the population will be in responding to disasters, this will be related to the ability to capture existing information related to mitigation both from electronic media and counseling. These abilities that not all residents can capture this information. Blaike et al. (1994) also mentioned that individuals or groups who are ready to face disasters and can recover well come from a highly educated background. In addition, residents with a high level of education will be better able to manage finances or savings if at any time a landslide disaster occurs.

3.2 Level of Sensitivity to Landslide Disaster

The sensitivity level to landslides in this study can be determined by scoring and weighting analysis. Sensitivity parameters used are population density, building density, sex ratio, population dependency ratio, poverty level, and education level, which are then summed up for each village to obtain a total score. After identifying the data, the score of each parameter was multiplied by the weight in each village. The value of each parameter in each village can be seen in Table 8. The next step is to enter the value into the sensitivity index formula for each village to obtain the total score.

Table 8. Landslide sensitivity scoring for each village in Gunungpati Subdistrict

No.	Village	Sensitivity Parameter Value to Landslide Disaster					
		Population Density	Building Density	Sex Ratio	Population Dependency Ratio	Poverty Level	Education Level
1	Gunungpati	1.2	0.6	0.3	0.1	0.3	0.2
2	Plalangan	1.2	0.6	0.3	0.1	0.2	0.3
3	Sumurejo	1.2	0.6	0.3	0.1	0.3	0.2
4	Pakintelan	1.2	0.6	0.3	0.1	0.3	0.3
5	Mangunsari	1.2	0.6	0.3	0.1	0.3	0.2
6	Patemon	1.2	0.6	0.3	0.1	0.3	0.2
7	Ngijo	1.2	0.6	0.3	0.1	0.3	0.3
8	Nongkosawit	1.2	0.6	0.3	0.1	0.2	0.2

No.	Village	Sensitivity Parameter Value to Landslide Disaster					
		Population Density	Building Density	Sex Ratio	Population Dependency Ratio	Poverty Level	Education Level
9	Cepoko	1.2	0.6	0.3	0.1	0.3	0.3
10	Jatirejo	1.2	0.6	0.3	0.1	0.3	0.3
11	Kandri	1.2	0.6	0.3	0.1	0.3	0.3
12	Ponganan	1.2	0.6	0.3	0.1	0.3	0.2
13	Kalisegoro	1.2	0.6	0.3	0.1	0.2	0.3
14	Sekaran	1.2	0.6	0.3	0.1	0.3	0.2
15	Sukorejo	1.2	0.6	0.3	0.1	0.3	0.2
16	Sadeng	1.2	0.6	0.3	0.1	0.2	0.2

Sensitivity index values are expressed on standard deviation, with division using ±1.5 standard deviation from the mean value. So that the class obtained is as in Table 9, below:

Table 9. Sensitivity class of Gunungpati Sub-district Area

No.	Range	Classification
1	Not Sensitive	< 2.62
2	Little Sensitive	2.685 - 2.62
3	Moderately Sensitive	2.752 - 2.685
4	Sensitive	2.817 - 2.752
5	Highly Sensitive	> 2.817

The assessment of the landslide sensitivity index in the Gunungpati Sub-district can be shown in Table 12. The sensitivity index for landslides in Gunungpati ranges from 2.6 to 2.8. The sensitivity level of each village in the Gunungpati Sub-district is divided into three sensitivity classes: little sensitive, moderately sensitive, and sensitive. Areas with little sensitivity include 2 (two) urban villages including Nongkosawit and Sadeng. areas with a moderately level of sensitivity are located in 9 (nine) villages: Gunungpati, Sukorejo, Plalalangan, Sumurejo, Patemon, Ponganan, Sekaran. Meanwhile, areas with sensitive classes are located in 5 (five) villages: Jatirejo Pakintelan Ngijo, Cepoko, Kandri. The five villages have a class level that is in the sensitive class, there is a need for good handling so that undesirable things do not happen and there are no major losses or impacts in the event of a landslide.

Table 10. Landslide sensitivity index for each village in Gunungpati Subdistrict

No.	Village	Sensitivity Scoring Index Analysis Landslide Disaster	Sensitivity Level
1	Gunungpati	2.7	Moderately Sensitive
2	Plalangan	2.7	Moderately Sensitive
3	Sumurejo	2.7	Moderately Sensitive
4	Pakintelan	2.8	Sensitive
5	Mangunsari	2.7	Moderately Sensitive
6	Patemon	2.7	Moderately Sensitive
7	Ngijo	2.8	Sensitive
8	Nongkosawit	2.6	Little Sensitive
9	Cepoko	2.8	Sensitive
10	Jatirejo	2.8	Sensitive
11	Kandri	2.8	Sensitive
12	Ponganan	2.7	Moderately Sensitive
13	Kalisegoro	2.7	Moderately Sensitive

No.	Village	Sensitivity Scoring Index Analysis Landslide Disaster	Sensitivity Level
14	Sekaran	2.7	Moderately Sensitive
15	Sukorejo	2.7	Moderately Sensitive
16	Sadeng	2.6	Little Sensitive

Based on the results of the landslide sensitivity index assessment in Gunungpati Sub-district, an output can be made in the form of a sensitivity level classification map in Figure 1. The classification of the sensitivity level of Gunungpati Sub-district to landslides is divided into three classes which are little sensitive, moderately sensitive, and sensitive. This sensitivity index map uses build-up area from land use data to see to show in detail the level of sensitivity in each area

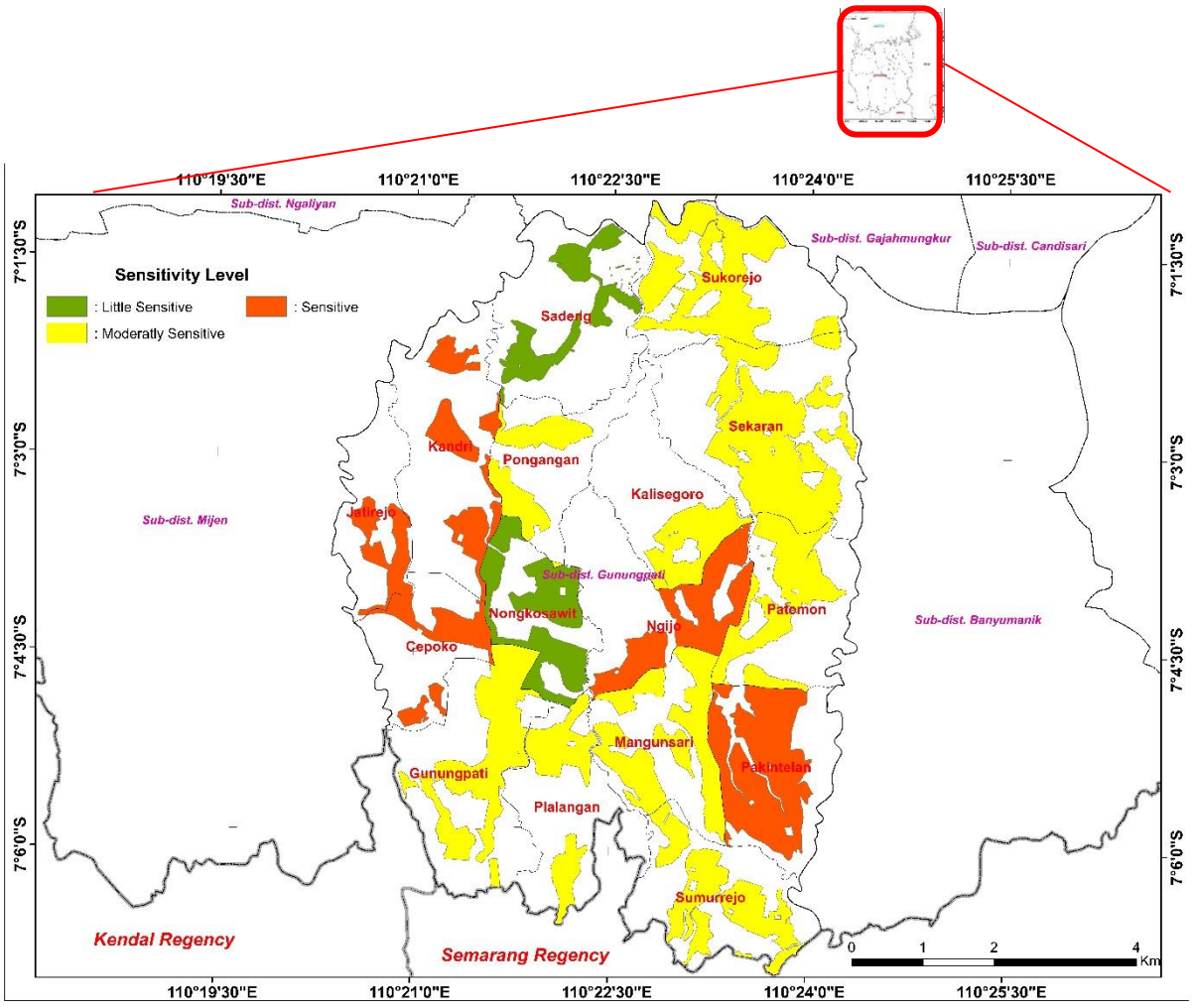

Figure 1. Sensitivity index level of landslide disaster in Gunungpati Sub-district map

The villages that are in the high sensitivity class when analyzed show that the area has almost the same characteristics, the difference is the poverty and education level in the five villages. The poverty rate is an economic parameter that can show whether the area is sensitive or not in the event of a disaster. If any of their residents are below poverty, then the ability of the area to deal with disasters is low. Since they are assumed to be a group that does not have a steady income and does not have savings, in the event of a disaster, this group cannot survive. Meanwhile, education level it can be assumed that the higher the level of education of the people in an area, the easier it is for them to receive public information and think long-term in dealing with unexpected things such as landslides, and it needs to be emphasized

that residents with a high level of education will be better able to manage finances or savings if at any time a landslide disaster occurs.

In general, based on the data obtained and processed, each village has the same characteristics, especially in the population or demographic sector. As can be seen in population density, sex ratio, and population dependency ratio, each village has an amount that is not so far from other villages. There are quite striking differences in population density in Sukorejo urban village, which has a high level of sensitivity compared to other urban villages. This is because the Sukorejo urban village area has a lot of housing and is the closest to the center of Semarang City. This is evidenced by the density of buildings there reaching 626 units/km2 or the second densest after Mangunsari with a density of 821 units/km2. This shows that one house can be occupied by several households.

Appropriate mitigation to reduce sensitivity can be targeted through a socialization approach and making rules that can prevent the emergence of casualties and material losses. The implementation of this mitigation certainly involves many parties from top to bottom such as BPBD, Bappeda, Social Service, Spatial Planning Service, Sub-districts, Villages, NGOs, volunteer groups, and youth groups. The collaboration of these various parties is very helpful in increasing the capacity of the region and population to deal with landslides that may occur at any time. The following is a table of mitigation efforts to reduce the sensitivity rate:

Table 11. Mitigation of the sensitivity of the area to landslides in Gunungpati Sub-district.

No.	Parameters	Mitigation
1	Sensitivity	1. Providing capital assistance to women's groups for business purposes 2. Provide assistance or compensation to vulnerable groups or elderly people 3. Providing capital assistance and business training for poor groups 4. Equalization of employment so that it is not focused on one region 5. Curbing permits for *cluster* housing development in disaster-prone areas. 6. Re-socialize the importance of 12 years of education.

Mitigation within this sensitivity parameter is closely related to strengthening the social and economic sectors of the community. The Semarang City government, through the Social Affairs Agency, has taken many mitigation measures. The Social Welfare Office of Semarang City has a specialized field that deals with issues related to disaster mitigation. Based on a brief interview with the Social Affairs Agency, they have assisted in strengthening the capacity of the community, both for the vulnerable and the poor. The Social Affairs Office itself also came down to help in handling aid when the disaster occurred and it was also confirmed by the village. These forms of assistance are quite optimal with the existence of programs from the Social Service.

The problem or obstacle in the implementation of non-structural mitigation programs is the lack of public awareness. Based on information from interviews, BPBD has conducted socialization about disasters but there are still people who are indifferent and do not care about the dangers that may arise from these disasters. As in the case of building houses in disaster-prone areas, the community has been educated that the area has often experienced landslides and there are even houses with cracked walls due to land movement, but the residents still live in the area. There is a need for assertiveness from the government in handling the problem of settlements in landslide-prone areas, considering that the losses incurred are not only material but also fatalities.

4. Conclusions

Assessment of the index of the level of sensitivity of the region to a disaster is quite important. This is because the sensitivity parameter is one of the factors to determine the level of vulnerability of an area, in addition to exposure and adaptation capacity. This sensitivity factor is also useful in planning and controlling landslide vulnerability in the area, especially in handling social and economic sectors.

Based on the results of the research, the level of sensitivity of the area to landslides in Gunungpati Sub-district, Semarang City is little sensitive, moderately sensitive, and sensitive. There are 5 (five) villages that have a high value and are in the sensitivity level, namely Jatirejo, Pakintelan, Ngijo, Cepoko, and Kandri. This condition shows that these areas in the event of a landslide will greatly affect the social and economic conditions of the local population. There is a need for special attention from the government to increase the capacity of the population to reduce the high sensitivity value in these areas.

Mitigation that can be done by the government related to the sensitivity of this area can be through policies such as capital assistance and training for vulnerable groups to increase their capacity as well as the need for equal distribution of employment not concentrated in one area. In addition, there is a need for strict policy and control on development permits in areas that are at risk of landslides to reduce potential losses. These mitigation measures can be taken into consideration and input into the development plan document of Semarang City by considering the sensitivity of the area to disasters in Gunungpati Sub-district.

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