

Landslide Community Resilience: An Examination of Six Neighbourhoods in Sukorejo, Semarang

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Landslide community resilience: an examination of six neighborhoods in Sukorejo, Semarang

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Abstract. Semarang city has been facing a severe landslide disaster due to climate change and rapid urbanization. Community resilience, in turn, is an indispensable aspect that may help the city to mitigate the greater risk of landslide. This research aimed to assess community resilience in the most frequent landslide hazardous area in Semarang, which is Sukorejo. This research employed a quantitative approach to measure the level of community resilience in the form of an index (scale of 0-1). As a proxy, there were four variables adopted in this study: psychological, social capital and demography, economic, and access to facilities. The result showed that the highest resilience level is in the aspect of social capital and demography (0.63), while the lowest is the economic aspect (0.43). The neighborhoods with higher economic scores are likely to have lower social capital and demography score; while they have a high score in the psychological aspect. The aggregate (*regency* level) community resilience score for Sukorejo is 0.58. This score attests that the community has reached a moderate level of resiliency; hence, it needs improvement, mostly in the aspect of economic welfare. Leveraging community resilience that comprises of improvement in economic readiness would be strategically vital.

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1. Introduction

The notion of resilience has been popular in urban and regional planning discourse, at least in the past two decades. Resilience can be defined as the ability of a system to survive and return to its original state, shortly after experiencing a shock [1]. Resilience is embedded within the discussion on climate change as the phenomena have been leading to increasing disaster events across the world. Jabareen [2] further elaborated on resilience theory to be applied in the practice of regional and city planning. Davoudi et al. [3] have developed a model so-called as the adaptive cycle to understand the stages experienced by a system to turn out to be resilience. Accordingly, the resilience theory is translated into a resilient city concept that includes climate change and disaster essential elements to be moreover accommodated as strategic issues in the planning process. City resilience is the capacity of individuals, communities, institutions, entrepreneurs, and systems in cities to survive and adapt to the various shocks and pressures experienced [4].

Community resilience is a critical aspect of promoting city resilience [5]. Resiliency at the community level is crucial since it may reduce the risk of the disaster to befall. Community resilience is apprehended as the ability of the community to reduce the negative impact of a disturbance. Chandler [6] believed that community resilience is an adaptive and transformative process. Singh-Peterson [7] moreover added that community resilience is a critical approach that may help planners to gain valuable information in developing neighborhood-level plans appropriately. There are several



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dimensions in community resilience, namely adaptive capacity, self-organization, and self-securing agency [8, 9]. The importance of community resilience⁴ has a significant impact on people's safety, especially for those who live in disaster-prone areas. According to the United Nations Office for Disaster Risk Reduction (UNISDR) [10], the impact of disasters caused by natural hazards will continue to increase, leading to a higher level of vulnerability. Therefore, communities need to increase their capacity to deal with possible risks. The communities should not entirely depend on the external supports and should have the ability to act with their own resources to minimize damage and losses caused by disasters.

This research aimed to assess community resilience to landslides in six different neighborhoods in Sukorejo, Semarang. The six neighborhoods undergo similar landslide risks with individually distinct socio-economic characteristics. The community's ability to survive consists of several interconnected aspects. There are psychological, social capital and demography, economic capacity, and the ability to access public services or facilities [11]. The psychological aspect is the sense of the individual dimension. It is related to how the community responds and acts against the disaster risk. Social capital is the ability of community members to work collectively and create social cohesion in their environment. Access to facilities implies the ability of the community to access public services, which include access to educational facilities, health facilities, roads, water resources, transportation, and communication. The disaster risk in this study is the landslides that befell the people of Sukorejo, Semarang.

Semarang City has various topography from the coast to the hills. As a result of that unique topography, Semarang faces several problems that hinder the development of the city, including various natural disasters such as floods and landslides. Landslides occur a lot in the hilly part of Semarang, including Sukorejo in the Gunungpati area. Gunungpati is an alternative area chosen to develop settlements as the impact of Semarang City that proliferates. As the city center has been overcrowded and developed into commercial use, people consider moving towards the outskirts. According to Dewi & Rudiarto [12], from 2003 to 2014, the land conversion in Gunungpati reached 28.02 Ha or increased by 10.5% from the existing built-up area. 24% of the district is in the buffer zone, which could bring a negative impact on the environment and endanger settlement, including the Sukorejo area.

2. Research method

This research employed a quantitative method to assess community resilience in Sukorejo, Semarang. Data is collected from 70 household questionnaires that were distributed to neighborhood so-called as RW¹. There were six RWs to observe: RW 01, 05, 06, 07, 10, and 11. Four variables and 32 indicators were observed. Table 1 shows data and indicators used for measuring community resilience in the landslide-prone area, Sukorejo, Semarang.

¹RukunWarga (RW), or urban-village community. The head of RW is the representative of local people, yet not the government representative.

Table 1. Community resilience indicators used in the study.

No	Aspects	Indicators	Sources
1	Psychological	Disaster concerns; Activities hampered; Perception of risks; Disaster experience; Preparedness; Desire to move	Arbon, 2014 [13]; Rangwala, 2018 [14]
2	Social & Demography	Attachment to place; Desire to stay; Neighborhood interaction; Frequency of social activities; Development and voting participation; Number of productive age population; the Population based on education and employment	Hernández, 2016 [15]; International Federation of Red Cross and Red Crescent Societies, 2014 [16]
3	Economic	Family income; Number of family members employed; Alternative job; Access to aid; Insurance and saving	Arana, 2016 [17]
4	Infrastructure	Phone ownership; Access to the internet; Open space; Road infrastructure; Water source; Distance to the public facility; Transportation	Rangwala, 2018 [14]

The assessment utilized a resilience radar framework developed by Bolte [18], which calculates each resilience indicator with a value from 0.00 to 1.00. The step is repeated for each indicator and results in aspect score, neighborhood (RW) score, and aggregate (Kelurahan²) resilience score. The following explains an example of calculating the index for one indicator.

Table 2. Example of resilience index calculation.

Family Income	%	Value	Score
>420 USD	7%	1.00	0.07
280-420 USD	11%	0.67	0.07
140-280 USD	36%	0.33	0.12
<140 USD	46%	0.00	0.00
Indicator Score			0.2625

Family income is one of the indicators in the economic aspect. The higher the income, the higher the household resilience score in the economic aspect. Therefore, answer (d. >6 million rupiahs) will get 1.00 and the answer (a. <140 USD) is scored 0.00. The score is adjusted by divide the maximum score (1.00) with the number of answers choice. In the example above, there are four answers choices, so that the value for each answer respectively is 1.00, 0.67, 0.33 and 0.00. There are 32 questions for the questionnaires which include six questions for the psychological aspect, nine questions for social-demographic, six questions for economic perspective and 11 questions for infrastructure aspects.

3. Results and discussion

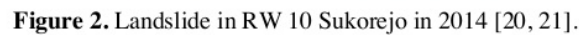
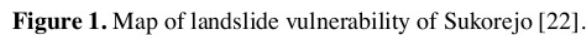
3.1. The impacts of landslide in Sukorejo

There are 30 landslide occurrences in Sukorejo in 2013-2018. According to Soemantri [19], Kaligarang Fault divides Semarang City from North to South. Geological research confirmed that the fault was still active tectonically. Sukorejo Village is located in the fault area, make it vulnerable to tectonic movements. Apart from the geological perspective, the type of soil also affects landslides that occur in Sukorejo. The type of soil in Sukorejo is mostly Mediterranean soil that contains a high level of lime and does not have a compact shape.

Based on data 2013-2018, Figure 1 describes landslide vulnerability in Sukorejo, explicating that most of the area categorized as high risk to the landslide. Landslide commonly befalls in the rainy season, notably more damaging during heavy rain with strong winds. This landslide disaster began

² or urban village is the lowest level of the administrative area in Indonesia, headed by civil servants appointed by the respective local government

The landslide has caused severe losses and damage to the Sukorejo communities; fortunately, there has been no incident with casualties. The losses are mostly physical such as damage to houses and infrastructure. The worst landslide incident that hit Sukorejo Village was a landslide in Trangkil Baru Housing, which occurred in January 2014. At least 32 houses collapsed due to landslide. The landslide followed heavy rain with strong winds. As a result, 32 families had to evacuate and move for three months. Besides, one in RW 10 damaged several electricity poles in the vicinity [21].



Calculation by the resilience radar method resulted in the aggregated resilience index of the Sukorejo community. The overall score was obtained from the analysis of 32 indicators. Every indicator then categorized into psychological, social capital and demography, economic, and access to facilities, which results in a score. These four aspects represent distinctive fields that explain the main features of each neighborhood. Table 3 exhibits the community resilience index of Sukorejo community.

Table 3. Community resilience index Sukorejo.

No	Aspects	Score
1	Psychological	0.608
2	Social capital and Demography	0.634
3	Economic	0.431
4	Access to Facility	0.680
Community Resilience Index		0.588

The resilience index of the Sukorejo community for landslides is 0.588. The highest value is access to facilities with a value of 0.680. The increase in infrastructure and development that continues to be optimized by the government is one result of why this aspect score higher compared to others. Meanwhile, the value for social capital and demography is equal to 0.634. Intense social interaction throughout the Sukorejo community and highly active community work play a significant role in this assessment. The psychological aspect score is 0.608, lower than social capital and demography. Individual concern to the risk of landslides in this residential area is presumed low. As much as 79% of the residents are aware of the landslide risk, but only 44% make an effort to alleviate the negative impact. The aspect which has the lowest score is the economy with a score of 0.431. This value is much lower than the three other aspects. Economic welfare is a problem for the Sukorejo communities since 46% of the household's income is below the minimum wage standard based on Semarang City Government (± 140 USD). Irregular and uncertainty in their jobs also worsen the economic condition.

3.3 Community resilience assessment in neighborhood level (RW)

This research conducts a community resilience assessment at the neighborhood level (RW). The main idea behind conducting this analysis was to examine if there is any impact on the resilience level regarding the type of neighborhood. All the six RWs got similar exposure in the landslide risks but a significant difference in the economic, social, and physical aspects. The RWs were also categorized based on the number of landslide events that happened over the past five years. RW 6 and RW 7 were categorized as high-intensity landslide area, RW 1 and 10 were moderate intensity, while RW 5 and 11 were classified as low-intensity landslide area. Community resilience assessment in the RW level was caused by the four aspects, which are psychological, social capital and demography, economic, and access to the facility. The way inhabitants face the risk of landslides differs from one to the other. Various aspects influence how every individual cope with disaster risk, but neighborhood commonly plays an important role. Table 4 explains the psychological aspect of every neighborhood in terms of dealing with the landslide risk.

Table 4. Characteristics of RWs in the psychological aspect.

High-Intensity Landslide	RW 6	RW 7
Landslide exposure and settlement area	• Smaller areas, landslide hazards cover the overall area.	• Wider area, landslide hazards cover only in particular areas.
Community awareness	• Community awareness of the landslide hazards is higher.	• Lower awareness from the community.
Economy condition	• The inhabitants are mostly underprivileged, cannot carry out disaster management independently.	• The inhabitants are low to the middle class; some have carried out disaster management by themselves.
Moderate Intensity Landslide	RW 1	RW 10
Landslide frequency	• Higher frequency of landslides, higher awareness of the people.	• Fewer landslide events, the community has not prioritized landslide management.
Establishment of settlement	• Old settlements (est. 1970) that have more experience dealing with landslides.	• Newer settlements (est. 1990), the experience of fewer landslides.
Low-Intensity Landslide	RW 5	RW 11
Landslide frequency	• The frequency of landslides is higher so that people are more alert to hazard.	• Fewer landslide disasters, the community has not prioritized landslide management.
Area of Settlement	• Wider area, experience a higher frequency of landslide.	• Smaller area, experience fewer frequency of landslide.

Social capital plays an essential role in building community resilience. This aspect refers to how people within the community connect and their capacity to shape social cohesion. A community that is more connected to each other tend to have greater resilience level [5]. Table 5 shows the characteristics of the neighborhoods in Sukorejo based on its social capital and demography aspect.

Table5. Characteristics of RWs in social and demographic aspects.

High-Intensity Landslide	RW 6	RW 7
Density of settlements	• The Deliksari Village area is more crowded; the interaction between residents is closer; there are more frequent social activities.	• The Kalialang Baru Village area is less dense than RW 6, the interaction between residents is more distant, less frequent social activities.
Number of working populations	• More unemployed residents, more people spend time at home and with neighbors.	• Most residents are working full time, less time spent in the neighborhood.
Moderate Intensity Landslide	RW 1	RW 10
Density of settlements	• The denser settlement, low to middle-income families, stronger social bonds.	• The less-dense settlement, dominated with middle-income families, weaker social bonds
Participation level and age of the population	• More active in planning and/or development, more elderly population.	• Not fully participated in the planning and/or development, younger population.
Low-Intensity Landslide	RW 5	RW 11
Density of settlements	• The more crowded settlement, stronger social bonds.	• The less crowded settlement, weaker social bonds.
Participation level	• More active in the development, older adults, and extended family, community leaders have greater influence.	• Lower participation in development, most of the inhabitants are young families, community leaders have less influence.

Indicators that include in the aspect of social capital are as follows; reasons to stay, the intensity of social activities, level of interaction with neighbors, and participation in planning and/or development.

Meanwhile, demography refers to indicators that show the demographic composition within the community include the working population, level of education, and jobs.

Besides social capital, economic welfare also plays a significant role. The economic aspect is seen as the most significant aspect in terms of resilience. The economic condition has a robust correlation with the results of community resilience assessment. This aspect looks at the financial capability of the community. Indicators to measure the economic aspects are as follows; employment rates, income per month, insurance, investment capabilities, and access to financial aid. It is essential to comprehend how household allocates their money for an emergency fund. This ability is useful to anticipate losses caused by disasters. Table 6 exposes the economic condition of six neighborhoods examined in this study.

Table 6. Characteristics of RWs in the economic aspect.

High-Intensity Landslide	RW 6	RW 7
Working population	<ul style="list-style-type: none"> The high rate of unemployment. 	<ul style="list-style-type: none"> Most of the residents are working even though not full-time jobs (construction workers, laborers).
Type of livelihood and total income	<ul style="list-style-type: none"> Low job variations, most of them are laborers and traders; only have temporary jobs, and the average income is meager. 	<ul style="list-style-type: none"> There is a variety of work that is quite diverse (labor, services, employees); higher average income.
Moderate Intensity Landslide	RW 1	RW 10
Productive age population	<ul style="list-style-type: none"> A large number of non-productive age population (over 60 years) who is unemployed. 	<ul style="list-style-type: none"> The population of productive age is very high; most of the population is employed.
Type of livelihood	<ul style="list-style-type: none"> Community livelihoods include labor, services, and private employees. Labor and service income is not fixed, below the minimum wage standard. 	<ul style="list-style-type: none"> Most people work as lecturers, civil servants, and private employees with middle to high income.
Low-Intensity Landslide	RW 5	RW 11
Alternative jobs	<ul style="list-style-type: none"> Many people have temporary jobs such as labor and services, so they have alternative jobs. 	<ul style="list-style-type: none"> Most people work as full-time employees, so they do not have alternative jobs.
Government aid	<ul style="list-style-type: none"> The existence of the village and some poor communities often receive assistance from the government. 	<ul style="list-style-type: none"> People with middle inhabit the residential area to upper economic conditions which rarely get government assistance.

Access to the facility describes the ability of the community to reduce the negative impact of disasters in physical form. The physical capability is seen from two perspectives, which are community facilities and individual and household facilities. Community facilities are infrastructure provided by the government and used by the public, such as roads, clean water, waste management, and other infrastructures. Meanwhile, cellphone ownership, access to the internet, and availability of open space in the house describe individual and household facilities. Ownership of mobile phones and the ability to access the internet are physical forms of community resilience that are carried out by individuals. In the context of reducing disaster risks, mobile phones and internet access are valuable things to get information quickly. The information includes evacuation routes, emergency alert and emergency calls to ask for help.

Table 7. Characteristics of RWs in the facility aspect.

High-Intensity Landslide	RW 6	RW 7
Topography	<ul style="list-style-type: none"> Steep slope conditions in the settlement cause road pavement to be quickly damaged, particularly during the rainy season. 	<ul style="list-style-type: none"> The settlement is located in flat terrain; road pavement is more resistant, more accessible to the area.
Public transport	<ul style="list-style-type: none"> Access to the main road is complicated, and there is no public transportation. 	<ul style="list-style-type: none"> Access to the main road is more comfortable and bypassed by public transportation routes.
Moderate Intensity Landslide	RW 1	RW 10
Road condition	<ul style="list-style-type: none"> Road conditions are often damaged; only 50% of the area is covered with pavements. 	<ul style="list-style-type: none"> Better road conditions with 100% area surveyed use asphalt pavements.
Private vehicle ownership	<ul style="list-style-type: none"> Most of the population do not have private vehicles; only 40% of households have private vehicles. 	<ul style="list-style-type: none"> The high rate of private vehicle ownership. 70% of households have private vehicles.
Low-Intensity Landslide	RW 5	RW 11
Private open space	<ul style="list-style-type: none"> Lower rate of private open space available. Only 42% of households have an open space in their houses. 	<ul style="list-style-type: none"> Higher rate of private open space availability. 87.5% of the community have small open space around their houses.
Road condition	<ul style="list-style-type: none"> In some locations, there is still a damaged and unpaved road. 	<ul style="list-style-type: none"> All roads have asphalt pavement.

3.4 Aggregate results and discussion

Landslide community resilience of the Sukorejo community varies in value depending on the landslide exposure level and indicators used. In the neighborhood level analysis, some RWs have a higher value in economic and facilities, and some others are higher in social capital and demography. Further interpretations use a comparison of the resilience index value based on its landslide intensity. After assessing the resilience index at the sub-district level, and six RWs selected in the study area, the overall value for the community resilience index in Sukorejo was gathered. Figure 3 shows the result.

Based on findings from previous studies related to disaster resilience, as explained by Campanella [23], the level of disaster exposure has an inversely proportional value to the level of community resilience. The higher disaster hazard exposes a region, the lower the resilience value of the community exposed. However, based on Figure 3, there is no linear correlation between the level of disaster intensity and the value of community resilience. RW 10 as a neighborhood with a moderate level of landslide risks, has a greater resilience value than RW 5 and RW 11, which have lower levels of disaster risks. It is also supported by the results of the community resilience index of RW 7. This neighborhood is considered as a high-intensity landslide, but RW 7 has a higher resilience value than RW 5, which is located in low-risk areas. These findings indicate that landslides frequency or disaster risk level is not the central aspect that affects community resilience.

Another finding in the neighborhood-level (RW) assessment shows that the neighborhood with higher economic score tends to have lower social capital and demography score. While those who have a high economic score also score high in the psychological aspect. This score shows the importance of economic welfare to achieve community resilience. We can see that the economic score for the community in RW 6 is 0.31, and the psychological score is 0.45. So does in RW 1, the economic score is 0.41, and the psychological score is 0.55. A community that has higher economic capacity tends to be more prepared psychologically. They have resources e.g. insurance, investment, and an emergency fund that is prepared to face an emergency prompted by disasters. Most of the community (79%) is aware of landslides risk that affecting their area, but only 44% make an effort to overcome the negative impacts.

The aggregate community resilience score shows that the Sukorejo community has reached a certain level of resiliency but still needs improvement in some aspects.



Figure3. Overall community resilience score of Sukorejo to landslides.

4. Conclusion

This study revealed landslide community resilience in Sukorejo, Semarang from four different aspects. Assessment of the community resilience, in general, comprised of two levels, village level (Kelurahan/sub-district Sukorejo) and the level right underneath sub-district, that is neighborhood level (RW). The total score of landslide community resilience in Sukorejo is 0.58, where access to the facility has the highest score and economic aspect scores lowest compared to the whole aspects. The results of community resilience assessment at the neighborhood (RW) level varies among the six areas. It is crucial to understand whether specific criteria in each neighborhood could influence the community resilience score. There are three groups in the RW-level assessment, which are high, moderate, and low-intensity landslides neighborhoods. From the results, we found that the level of hazard is ¹⁹ the central aspect that influences the resilience score. The economic score has a significant contribution to the overall community resilience, but the score is the lowest among all assessments, both in the village and neighborhood level. This output emphasizes the importance of increasing the economic capacities of the Sukorejo community.

Although almost all Sukorejo communities own obstacles in the economic aspect, some of the neighborhoods also gain low scores in social capital. There are two main general categories based on the assessment result. The first category is neighborhoods that have a strong economic aspect but a lack of social capital. The other group shows areas with a high level of social capital but poor economic conditions. The government can use this information to plan better disaster-resilient neighborhoods. It will need a different approach and resources to optimize every community's resilience level. Increasing community resilience is a great asset to bring under control climate change impact and also a form of disaster management. These conditions need to be considered by relevant stakeholders, especially the government, to pay more attention to the development of settlements, especially for the low-middle income people, have to consider the aspects of disaster mitigation,

environmental suitability, and the welfare of the community. Successful in accommodating these aspects could help to establish a more

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