

HIGH SPATIAL RESOLUTION IMAGERY WORLD VIEW 2-A FOR TSUNAMI VULNERABILITY MAPPING USING SPATIAL MULTICRITERIA EVALUATION (SMCE) : CASE STUDY PANGANDARAN REGENCY

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ABSTRACT

Pangandaran Village is a vulnerable village to tsunami disaster as happened to 2006 with tsunami-earthquakegenic type. This is caused by the meeting of oceanic plates and continental plates located in the south of Java Island . This study aims to map the degree of vulnerability to tsunami disaster by taking into account the parameters of physical , social and economic vulnerability . WorldView 2 A imagery is used to map building density , road network , and distance from shoreline to land , as a parameter of physical vulnerability . The social vulnerability parameter consists of the number of dependency on life , as well as the parameters of economic vulnerability consisting of economic area and minimum wage of work sourced from local village government . Analysis of various parameters was done by Spatial Multi-Criteria Evaluation (SMCE) method because it was expected to produce a balanced decision . The results showed that West Pangandaran Hamlet had high vulnerability value , while the other two hamlet's had medium and low vulnerability value .

Keywords: tsunami-earthquakegenic, SMCE, Vulnerability, WorldView 2A, Pangandaran

1. INTRODUCTION

Pangandaran is a district in West Java Province located in the south of Java Island. Geographically Pangandaran Regency is at 108 ° 30 'to 108 ° 40 "East Longitude and 7 ° 40'20" to 70 50'20" 'South Latitude. Pangandaran is directly adjacent to the Indian Ocean. Based on Regional Disaster Management Agency data, Pangandaran had experienced a tsunami disaster in July 17, 2006 with a strength of 6.8 SR which caused 659 casualties. Reflecting from the study, this research examines the vulnerability in Pangandaran. Vulnerability mapping of settlements was conducted in Pangandaran Village located in the tombolo and settlement areas in the northern part. The total area of this village is 667.87 ha. 137.87 ha utilized for settlement, and 530 ha as nature reserve. In general, Pangandaran village is located in lowland and coastal areas with an altitude of 0-25 m above sea level about 18%, on a relatively flat coastal area with a slope of 0 - 3 degrees, an average temperature of 27 degrees Celsius.

Tsunami is a series of giant waves of ocean waves that appear due to a shift in the seabed due to earthquakes (BNPB No.8 Year 2011). Tsunami waves that ever occurred in Indonesia reached 26 meters (Istianto, et al. 2003). Tsunamis are not caused by wind. Tsunami is one type of natural disaster that occurs in coastal areas.

Vulnerability is the degree of ability of a system or part of a system to be able to react with a dangerous event (Usamah, et al, 2014). According to BAKORNAS PB (2007) in Danianti and Sariffuddin (2015) vulnerability is a condition of society that leads or causes an inability to deal with the threat of danger. Meanwhile, according to UN / ISDR (2005) in Jaswadi, dkk (2012) vulnerability as a condition determined by physical, social, economic and environmental factors or processes, which can increase the vulnerability of a community to the impact of hazards. Factors affecting vulnerability include being in hazardous locations (volcanic slopes, in the vicinity of river embankments, in unstable slopes, etc.), poverty, rural to urban migration, environmental degradation and degradation, rapid population growth, changes culture, and lack of information and awareness (UNDP / UNDRO, 1992) in Jaswadi, et al (2012).

In this research, from the condition of Pangandaran area adjacent to coastal area and vulnerability study area are in keo, hence vulnerability seen from physical aspect, social, and economy. Physical vulnerability describes the condition and number of buildings with density results in threatened areas. Social demographic vulnerability describes the characteristics of the population in the affected areas. The indicators include population size, age-old age ratio so as to obtain productive and non productive age information. Economic vulnerability describes the level of economic fragility in the face of threats, in this case using the parameters of income and distribution of work / profession.

This research uses a quantitative approach with spatial analysis techniques, such as SMCE (Spatial Multi Criteria Evaluation) in ILWIS. SMCE is one of decision making techniques by considering the importance (priority) of certain criteria (Sharifi, Mohammed and Retsios, 2004). The advantages of SMCE analysis is that it is able to integrate spatial data with non-spatial data such as statistical data and field survey data. So that new information can be generated that shows spatial distribution of phenomena.

Spatial Multi-criteria Evaluation (SMCE) is a framework, which defines the concept of evaluation as a mixture of representation, assessment and quality check connected with a given policy problem, based on a specified objective (Munda, 2008). SMCE aims to foster transparency, reflection and learning in MCA decision processes, simultaneously integrating political, socio-economic, as well as ecological, cultural and technological dimensions of the problem. For the purpose of obtaining evaluation criteria, SMCE examines stakeholders' objectives and expectations, trying to avoid as much as possible a technocratic approach.

2. OBJECTIVE

The aim of this research is :

1. Knowing the level of vulnerability to tsunami disaster through three factors: physical vulnerability, social vulnerability and economic vulnerability.
2. Determine the location of vulnerability levels that are divided into high, medium and low vulnerability.

3. METHODOLOGY

3.3 SMCE Execution

The evaluation of the physical vulnerability parameters is used as a block of settlement settlements. Social vulnerability is based on dependency numbers that are divided into high, low and moderate dependencies. Economic vulnerability uses economic, economic and non-economic functions as well as District Minimum Wages where people who have above average earnings are considered capable, and those on average are considered incapable.

The standardization process is required to facilitate the risk assessment analysis (Abella and Westen, 2007). Standardization is done by taking into account the minimum value. If the minimum value of a data has absolute 0 then the maximum method is used, while if it has no absolute value then the interval method is used (Wibowo, 2015). The vulnerability curve used in this study is linear curve. Then the result is a vulnerability value that has a value of 0 to 1.

Determination of weights for each criterion using pairwise comparison. Pairwise Comparison is used because this method refers to each process comparing each paired variance to judge which of each variant has better performance. (Oswaldo, 2014).

4. RESULTS

The parameters of physical vulnerability are weighted according to their degree of effect on the material loss determined by the pair-wise method. The weighting for each parameter is determined by the operator. The highest weight is the density of buildings because the buildings in this area is a solid building and vertical buildings are vulnerable when exposed to tsunami waves, the weight of the building density of this physical vulnerability is 0.66. Furthermore, the distance from the beach, which is bounded by zone buffers 100 meters, 300 meters and 500 meters. The weight of the distance from this beach is 0.19. the last parameter on the physical vulnerability of the road network, the path has the lowest weight because the road is considered the most recently affected with a value of 0.16.

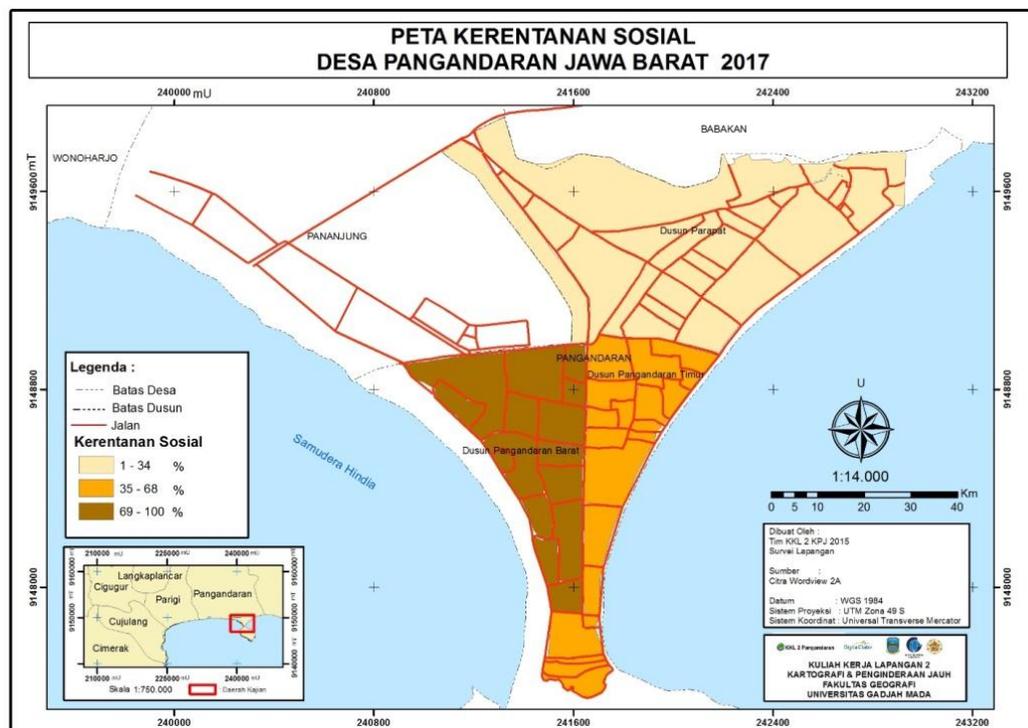


4.1 Physically Vulnerability Map

The result of the mapping of physical vulnerability, indicating that West Pangandaran hamlet is generally categorized as medium vulnerability. East Pangandaran hamlet there is a category of high to low vulnerability because in the village of East Pangandaran rare building. Parapat hamlet belongs to the lowest vulnerability category among the two other hamlets because there is still a lot of vacant land and its distance is relatively far from the beach.

Social vulnerability is processed into dependency ratio. The higher the dependency ratio indicates the higher burden that the productive age population has to pay for the lives of unproductive and unproductive populations, meaning that the higher the dependency ratio the more vulnerable to the tsunami disaster. High population density leads to higher vulnerability because it can cause a lot of casualties in the event of a disaster. The weight for this social vulnerability parameter has a value of 1.00 because it is a single parameter.

The results of social vulnerability mapping indicate that the Western Pangandaran hamlet includes high vulnerability, followed by the Eastern Pangandaran hamlet, and the lowest vulnerability of Parapat hamlet. This is caused by high population density in West Pangandaran hamlet to the lowest in Parapat village. In addition, dependency ratio in West Pangandaran hamlet is highest, Pangandaran hamlet is second, and last is Parapat hamlet. The high dependency ratio in Western Pangandaran hamlet is due to the large number of non productive age population compared to the productive age population which can be affected by the birth rate.

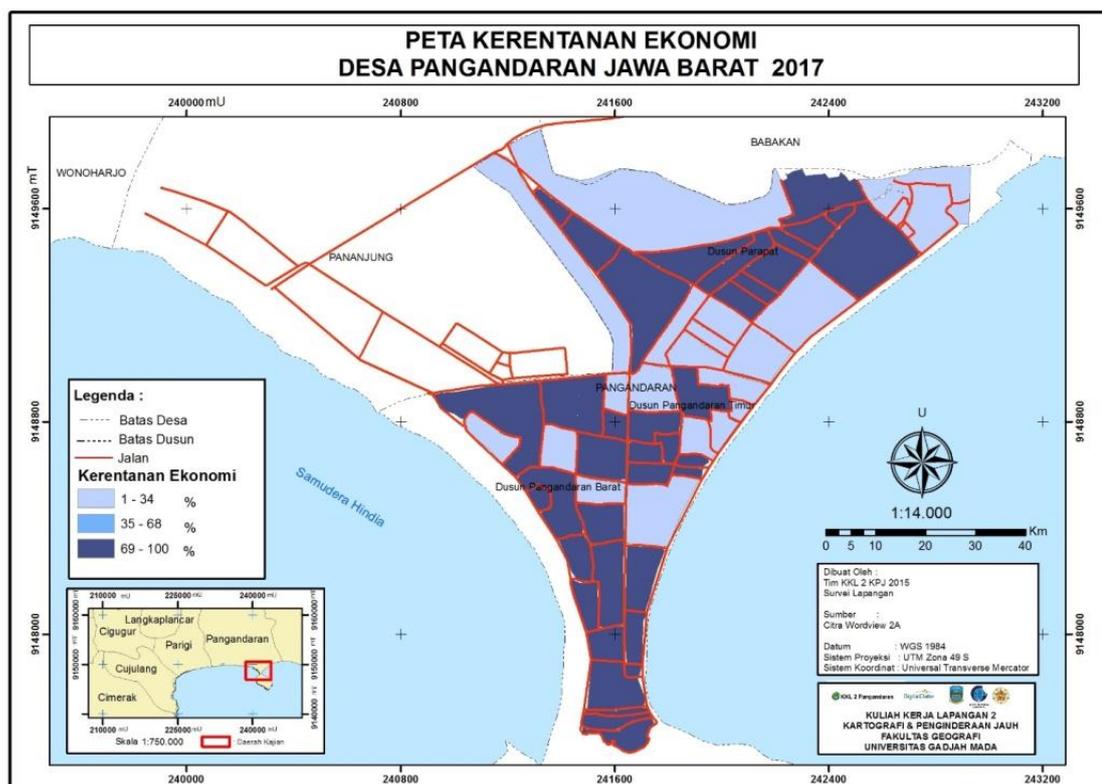


4.2 Social Vulnerability Map

Economic vulnerability is linked to building blocks with economic functions as well as people's incomes. Economic functions such as hotel blocks and shopping blocks, in the

event of a tsunami, have a direct impact on the economic activities of the community as it may lead to the temporary disruption of people's economic activity. The weight for this economic function is 0.25. The economic vulnerability parameter associated with District Minimum Wage is a benchmark for the welfare of the local people to meet their daily needs. People who are earning less than MSE are vulnerable in the event of a tsunami, as the recovery of their economies takes a long time and is generally given funding from other parties, while people living on MSEs can recover their economies faster. The weights for the Kabupaten Minimum Wage are 0.75 higher than the parameters of the economic function area.

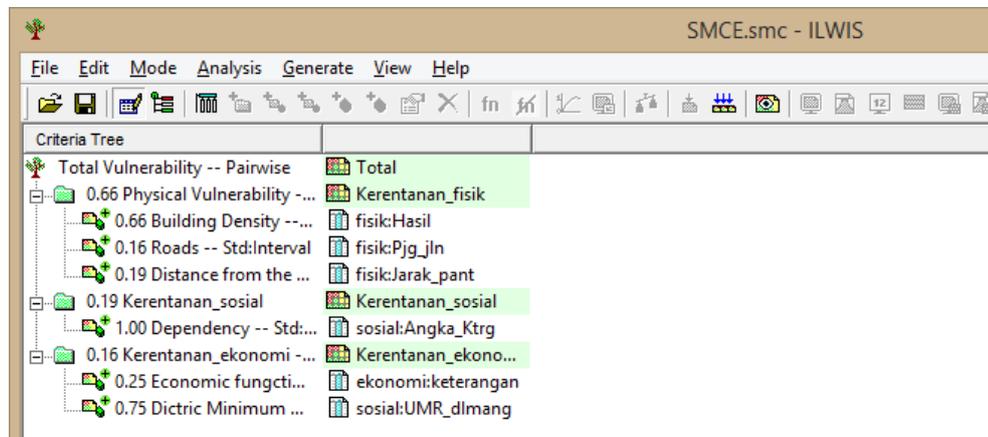
The result of mapping of economic vulnerability shows that West Pangandaran Hamlet belongs to high vulnerability category because seen from its economic function block, more than two other hamlets. In addition to the economic function block, income also affects economic vulnerability, the income of the people in the West Pangandaran hamlet are mostly small traders with income below Regency Minimum Wage, whereas in Parapat Hamlet is largely a building block with economic function, the vulnerability of the economy and the area of Parapat hamlet is still in the form of open land.



4.3 Economic Vulnerability Map

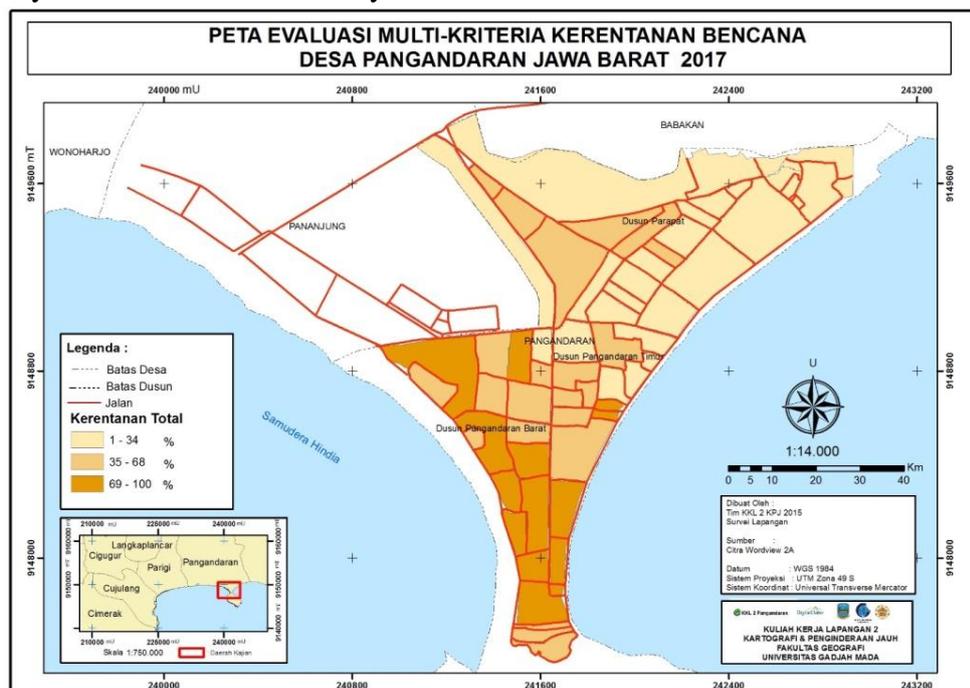
The three parameters of physical vulnerability, economic vulnerability and social vulnerability are then re-weighted using pairwise comparison. Pair-wise comparison is the basic concept of AHP (Analytical Hierarchical Process) that is by comparing criteria with one criterion to another to obtain results in the form of problem solving. AHP itself is one of the multi-criteria decision-making methods developed by Prof. Thomas L. Saaty in the 1970s (Teknomo, 2010). The pair-wise comparison method in this vulnerability mapping is part of the spatial multi-criteria evaluation which is a

commonly dispensed AHP method of ILWIS software (Shomat et al., 2017). The result of weighting of these three parameters is shown in Figure 3.1.



4.4 Criteria Tree

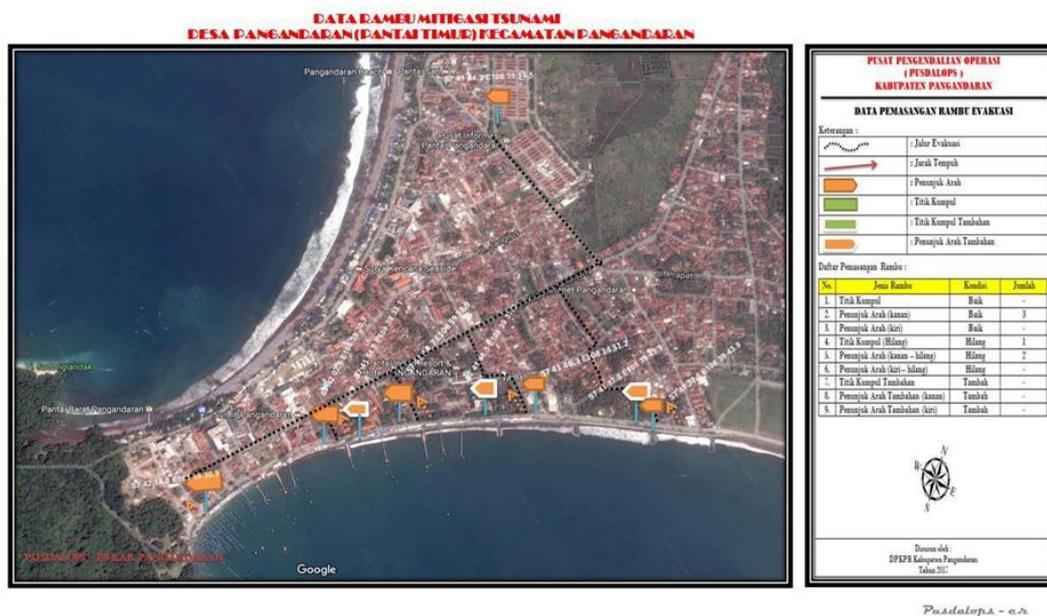
These physical, social, and economic vulnerability mappings are combined into a total vulnerability. The results show that the western Pangandaran hamlet belongs to the highest vulnerability category, second order is East Pangandaran Hamlet, and the lowest vulnerability is Parapat Hamlet. Seen from the building blocks, West Pangandaran hamlet mostly have building blocks with high vulnerability category, East Pangandaran hamlet mostly have building blocks with medium vulnerability category, and Parapat hamlet mostly have building blocks with low vulnerability category. This is because West Pangandaran hamlet has high physical, social and economic vulnerability, so that West Pangandaran is the most vulnerable category for tsunami disaster, and Parapat hamlet is a hamlet with low vulnerability category, because the three aspects of its vulnerability indicate low vulnerability.



4.5 Disaster Vulnerability Map

This vulnerability mapping can be used as a first step in tsunami disaster mitigation in Pangandaran Village to reduce physical, social and economic losses, where disaster mitigation in the most vulnerable hamlet of West Pangandaran Hamlet is prioritized by not neglecting the other two hamlets, especially East Pangandaran hamlet is equally located in the key.

The risk of losses due to the potential tsunami disaster in Pangandaran Village located in this keo area can be reduced by mitigating the tsunami disaster to a safer evacuation route in accordance with existing mitigation measures, which indicate that the mitigation path in the event of a tsunami in the village Pangandaran is heading to the Nature Reserve area in the south. This is because the area of the Nature Reserve is an area that has a relief higher than the area which has a relief bano flat on the west side, east and north so that the area of Nature Reserve is a relatively safer place when compared with the surrounding area.



5.5 Disaster Mitigation Sign

Source: Fire and Disaster Prevention Agency of Pangandaran Regency

5. CONCLUSION AND DISCUSSION

1. The direct impact is on the physical parameters so that the physical vulnerability has the highest vulnerability value that is 0.66. While social vulnerability has a value of 0.19, followed by economic vulnerability 0.16. But this result is operator assumption to condition in field.
2. Pangandaran Village consists of 3 hamlets, that is West Pangandaran hamlet, east pangandaran hamlet, and prapat hamlet. Based on the physical, social, and economic parameters, west pangandaran hamlet is the highest vulnerability category because its parameters show high vulnerability value. east pangandaran hamlet belongs to medium vulnerability category, and Parapat hamlet belongs to low vulnerability category.

6. RECOMMENDATION

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