PHYSICAL CHARACTERISTICS AND DISASTER RISK PERCEPTION CORRELATION AT BANTUL REGENCY[1]

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Abstract

This paper analyses the correlation between vulnerable areas and resident's risk perception. For such purpose, it uses descriptive and correlation analysis. The mapping of the vulnerable area is based on the vulnerability levels, which were analyzed with the Geographical Information System (GIS). The GIS and correlation analysis show that education level and income rate of the respondents have negative correlations with level of vulnerability in the area. The perception index has a positive correlation with level of vulnerable in the area. These results are different from the degree of the risk averse variable that does not significantly correlate with the level of hazardous area.

Keywords: earthquake risk perception, economic valuation, GIS
JEL Classification Numbers: Q54, R29

Abstrak

Makalah ini menganalisis korelasi antara daerah yang rentan bencana dan persepsi mereka terhadap risiko.Penelitian ini menggunakan metode analisis deskriptif dan korelasi. Pemetaan daerah rawan didasarkan pada tingkat kerentanan, yang dianalisis dengan Sistem Informasi Geografis (SIG). Hasil analisis menunjukkan bahwa tingkat pendidikan dan tingkat pendapatan responden memiliki korelasi negatif dengan tingkat kerentanan di daerah. Indeks Persepsi memiliki korelasi positif dengan tingkat kerentanan suatu daerah. Hasil ini berbeda dengan tingkat risiko variabel yang tidak signifikan berkorelasi dengan tingkat daerah bahaya.

Keywords: Persepsi risiko gempa bumi, penilaian ekonomi, SIG
JEL Classification Numbers: Q54, R29

INTRODUCTION

The mapping of the areas that are categorized as hazard areas in Indonesia is important to be conducted. Potential disaster that threaten Indonesia are not only the disaster of hydrometeorology such as floods, tornados, and droughts, but also the types of risks categorized as catastrophic disasters, such as earthquakes, tsunamis, and volcanic eruptions.

Material losses caused by earthquakes are usually immense. The earthquake disaster in Indonesia in 2006 reached 3.134 billion US dollars. Thousands of families lost family members and shelters. According to the World Bankthe earthquake caused the deaths of 5716 people in succession of the event on May 27, 2006.

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Presumably, huge losses caused by disasters in recent history have not been a valuable lesson for a majority of the countries in the world. Several countries are unprepared for disaster risk management in the case of natural disasters. Disaster risk management should be done considering the tremendous potential that is very harmful.

Changes in the Indonesian disaster management paradigm should consider the disasters in both 2004 and 2006. Disasters formerly were regarded as inevitable events that are beyond the reach of human beings, whereas today people start to learn how to manage disaster risks, so that the impact of disasters can be reduced or even eliminated One fundamental change in the paradigm on disaster risk is that community can cope with the disaster risk (hazard, community vulnerability, and the lack of capacity).

Indonesia has two major problems in disaster risk management. The first problem is the low level of public awareness in disaster risk management. The second problem is the paradigm of policy makers (government), which has not reformed yet, as evidenced by most of the development plans, which do not contain any environment disaster risk management measures. Ideally, public and government should build a team and work tightly together on this issue. The first step in a cooperation could be realized by optimizing the understanding of the community engagement process, by capacity building, incorporating risk assessment, and technical support (Haifani, 2008).

This paper conducted an analysis of the relationship between the physical vulnerability of a region and the people who inhabit the risk perception on its region. Based on the research of Gravitiani and Suryanto et al. (2011), the willingness of households to mitigate their area is relatively low, despite the potential losses they face. Most people still believe that natural hazards were natural events that could not be resisted. When they get struck by an event of a disaster, caused by natural hazards, the event would be received as destiny. The people accept the event sincerely as they believe that it is deemed by the will of God.

The focused of this research could be classified into two categories; first, mapping the vulnerability of the population that potentially is affected by the negative impact of earthquakes; second, to show the correlation between risk perception, social variables, and economic variables to the vulnerability of the region.

Identification on the correlation of physical vulnerability and disaster risk perception, especially in Indonesia was still rare. The perception of risk was closely linked to the experience of the individual or the community who faced the risk. This study used a descriptive quantitative approach, the physical vulnerability variables correlated with risk perception variables (affected experience, the level of vulnerability, the magnitude of the impact, the level of understanding, the degree of rejection of risk), demographic variables (age, number of children, education level), and economic variables (income level) on the vulnerability of the region.

Besides using a correlation analysis, this study also relied on physical vulnerability mapping of a region. This paper uses GIS to perform the mapping. GIS techniques for mapping the vulnerability of area had been done by Parson et al. (2004), and Cowell and Zeng (2003). The use of GIS methods is also carried out as they had done in the study of landslides (Sare, 2009) and floods (Marchiavelli, 2008). The analyses in this study are about the level of vulnerability, perception, and the capacity of communities, associated with the vulnerability of the correlation. The difference to Suryanto et al. (2011) is the use of analytical techniques performed. Suryanto et al. (2011) used the multiple regression analysis, whereas in this study the technique of correlation analysis was used.

This study was expected to strengthen the previous research on disasters. The research carried out before had not been able to explain, whether the perception of risk due to the high threat of danger or not, most of previous research were still limited on the relationship between risk perception and mitigation behavior. As a contribution, this study tries to clarify, whether there is a correlation between the physical vulnerability of an area with risk perception.

An environmental disaster is a phenomenon, which involves three components. The first component is the natural, the second component is the human, and the third component is the community (social) component. Analysis of the disaster cannot be separated from the discussion of the three components. The theory used in this study is Human Ecology, the theory that describes the relationship between human interactions and the environment. The Disaster Risk Management Theory contains information, how human efforts can reduce the risk of losses caused by the environment, in this case a disaster. The valuation of the non-market economic theory is a theory developed in the field of environmental economics in attempt to provide a monetary value on the environment, especially as there is no market value.

A review of studies conducted previously focussed on the explanation of individual behavior to mitigate. Conclusions of previous studies resulted in two major groups. The first group is the tendency that the behavior of individuals in the face of disaster risk is less concerned, while the other group lead to the conclusion that the behavior of individuals or communities are likely risk averse.

Simmons et al. (2002) showed that individuals tend to want to do the preparation to reduce the risk in the future. They assumed that cyclones in Gulf Coast Town are events that tend to recur. Actually, preparations have been made, among others, by strengthening homes and providing dedicated space for security, for themselves and their families. Research of Simmons and Kruse (2000) also resulted in a similar conclusion, namely the tendency of individuals or communitiesto be willing to reduce the risks. The conclusion in their research was that the type of home that is equipped with protection against catastrophic risk is more salable.

Research of Morone and Ozdemir (2006), and Suryanto et al. (2011) also resulted in a similar conclusion. Anticipation of the types of disasters, such as earthquake risk, to strengthen their homes more powerful than moving to another place where is low vulnerable relatively. Morone and Ozdemir (2006) concluded that individuals tend to show risk averse behavior, which was evident from the insurance held by the public.

Ozdemir (2000) tried to examine the relationship between perceptions of risk and willingness to pay (WTP) for mitigation. Research results showed among others: the impact of perceived influence on WTP, variable degrees of risk aversion did not affect the WTP, attitudes positively affect precaution, having of children also has a positive effect, while gender, age, and experience have no effect on WTP. Onculer (2002) conducted a similar study as Chinn (2005), and Ozdemir and Kruse (2005). Onculer (2002) conducted a study on the perception of risk and the magnitude of WTP. Some of the variables investigated are the perception of risk, attitudes toward coded building, the role of experience, a dynamic group, and socioeconomic factors, such as budget constraints and social networking. Research of Chinn (2005) and Onculer (2002) have complemented the study of Ozdemir (2000), who tried to explain the behavior of the protection of individuals against insurance companies. However, the use of experimental methods was considered less able to describe the perception of the individual, especially the experience of psychological impact of natural disasters.

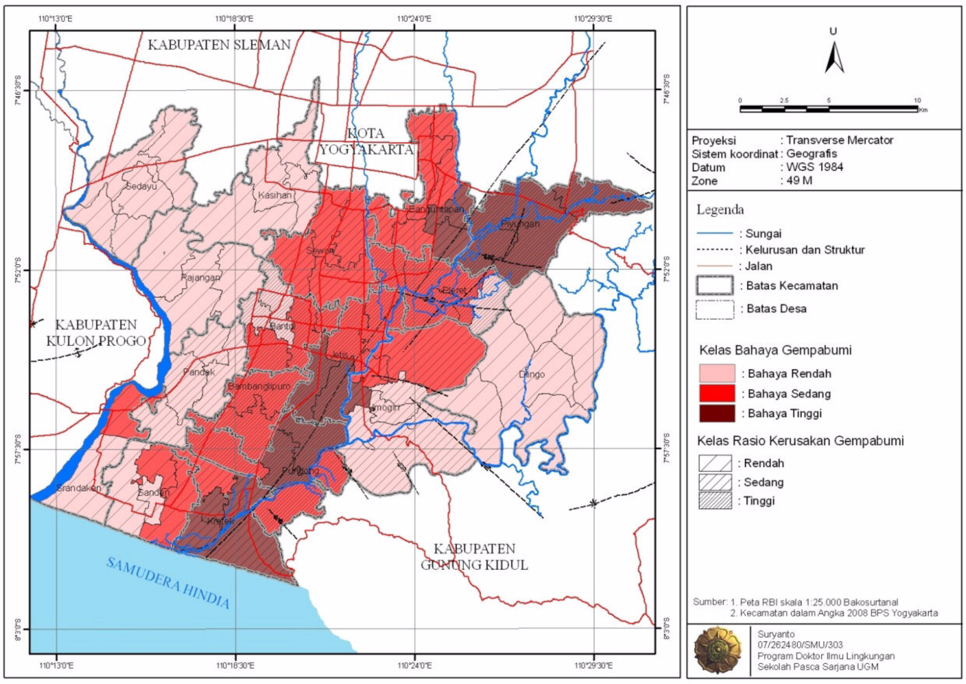
Other studies on disasters, especially the use of GIS was conducted by Parson et al. (2004), Rashed (2003), Dai, et al. (2003), Cowell and Zeng (2003), and Zerger (2002). This GIS application is descriptive and covers only as the areas of potential disasters especially physical vulnerability variables. The combination of demographic variables, social, and economic conditions will describe the study area, but on this merger has not been much effort made, at least in these studies.

METHODS

The data used are primary and secondary data. The primary data was obtained directly from the data source. The secondary data were obtained from the World Bank report, Provincial Government of DIY, local government regions, and municipalities in the province of DIY, National Board of Disasters (BNPB), Indonesian Society for Disaster Management (MPBI), and related institutions. Secondary data analysis was as useful as the materials were necessary for the purpose of the first study, because they wanted to determine the level of vulnerability and the level of ability of communities to cope with disasters. The second research objective required primary data to investigate the relationship insecurity and the perception of the respondents region.

The population in this study are all heads of families in Bantul, who live in the high vulnerable area or in vulnerable areas and low vulnerable area to earthquake disasters. The determination of the characteristics of vulnerability criteria in the DIY area are based on studies using seismic vulnerability zone microzonation by Daryono et al. (2009). The total population includes all heads of families in the district of Bantul. BPS number of heads of families in Bantul is 215.685 households.

The sample in this study is devided in three groups. The first group consists of the heads of families living in the area that is very vulnerable to earthquakes, while the second goup consists of the heads of fam ilies living in classified earthquake-prone areas, and the third group consists of heads of families living in the less vulnerable area.



Source: Suryanto, et al. 2011.

Explanation: The damage ratio is the proportion of the number of homes that were severely damaged; amplification is shaking levels at a site may be increased, or amplified, by focusing of seismic energy caused by the geometry of the sediment velocity structure, such as basin subsurface topography, or by surface topography.

Low vulnerability	Low of Ratio Damage
Middle vulnerability	Middle of Ratio Damage
High vulnerability	High of Ratio Damage

Figure 1: Determination of Sample Areas by Map microzonation and Damage Ratio

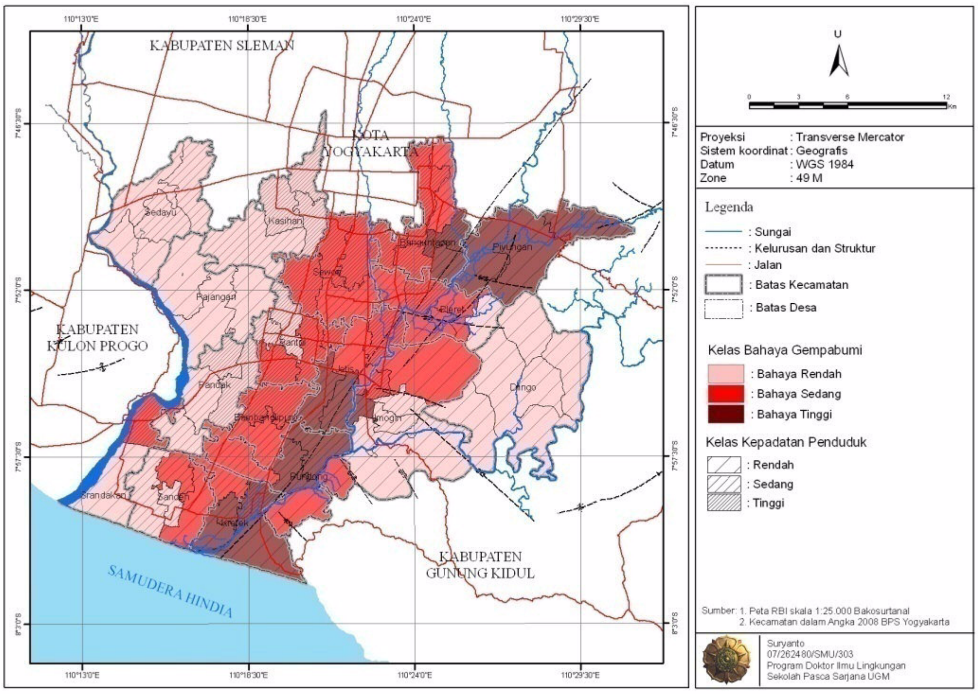
The sampling method used in this study is a multistage cluster sampling method. This method was used to obtain a sample with a phased manner according to predefined clusters. The reason for using cluster sampling is the need for economic efficiency, which can not be obtained if researchers use a simple random sample, and the sample frame for the unavailability of certain elements.

The method used to obtain primary data was a survey method with interview techniques (direct interview) supported by a list of questions or questionnaires (appendix).

Descriptive analysis was an attempt to describe the whole condition of the object of study. The analysis was performed based on the analysis of how disaster risk is faced by the community. The use of GIS in this study is expected to enable to strengthen its relationship with a particular analysis of spatial variables (Zerger, 2002). Correlation was used to determine the relationship of the individual's perception of the disaster risk on the level of the vulnerability of the region.

RESULTS

The level of vulnerability to the risk of earthquakes could be classified into two groups: vulnerability due to population density and vulnerability due to the density of settlement. The results of overlaid area and the population density are known after developing characteristics of the vulnerability map. The districts of Banguntapan were districts that had a high population density and were including hazard areas, similar to the Jetis and Bambanglipuro district. The review of the vulnerability level is based on the residential density, which could be seen from the map of overlay among the maps which show the level of physical vulnerability, of damage ratio, and of land use. Based on the results of the overlay was known that some of the villages, which potentially have vulnerabilities, were some villages in Banguntapan district, Jetis district, and Bantul district.



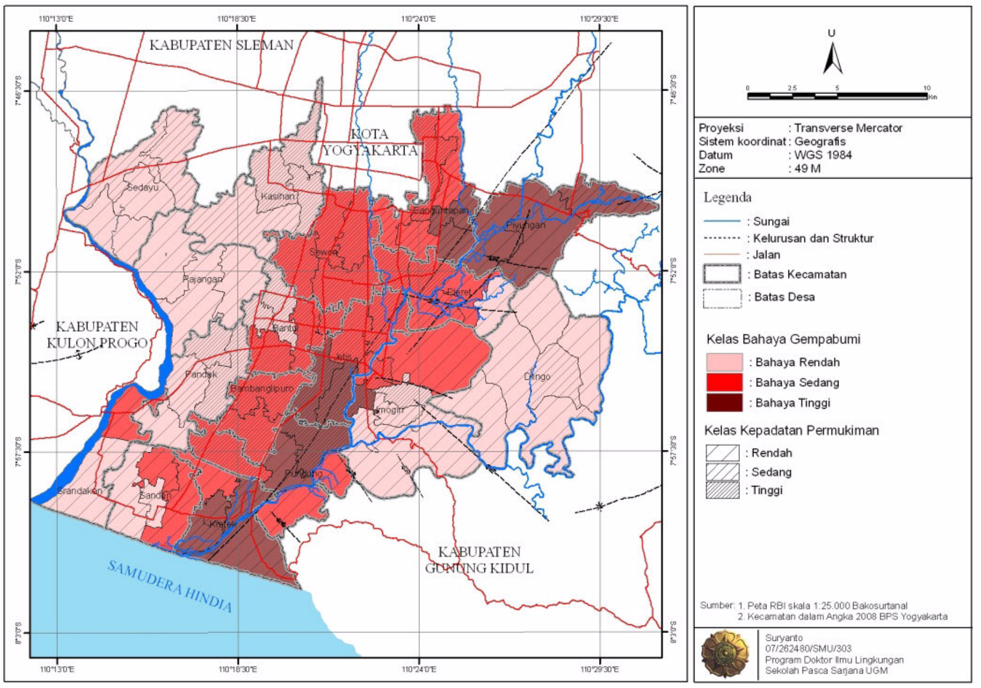
Explanation:

Low vulnerability — Low density population

Middle vulnerability — Middle density population

High vulnerability — High density population

Figure2: Vulnerability Area and Density of Population



Explanation:

Low vulnerability — Low density settlement

Middle vulnerability — Middle density settlement

High vulnerability — High density settlement

Figure 3: Vulnerability Area and Density of Settlement

Table 1: Cross Tabulation Perception Index and Vulnerability Area Index

Area	Annotation	Perception Index			
		1-1,99	2-2,99	3-4	Total
Low Vulnerability	Amount	8	97	25	130
	% in Regions	6.15	74.62	19.23	100
	% Total	2.03	24.56	6.33	33
Middle Vulnerability	Amount	4	84	42	130
	% in Regions	3.08	64.62	32.31	100
	% Total	1.01	21.27	10.63	33
High Vulnerability	Amount	7	79	49	135
	% in Regions	5.19	58.52	36.30	100
	% Total	1.77	20.00	12.41	34
Total	Jumlah	19	260	116	395
	% in Regions	4.81	65.82	29.37	100
Chi Squares (χ^2)	Pearson Distribution	110.513 (significant at level 5%)			

The findings reinforce the results of GIS analysis of Daryono et al. (2009), which stated that there was a close correlation between the index of seismic vulnerability and the ratio of the house damage. Therefore, the earthquake disaster risk was determined not only by the distance to the hypocenter of the earthquake but also influenced by the magnitude, the effect of soil layers, and repeated periods.

The perception index value was calculated based on the average score of question items: (1) the perception of the earthquake impact, (2) the perception of the confidence level in the earthquake-resistant housing, (3) perceptions of control capabilities, (4) perceptions of the local government role, and (5) the perception of the role of the central government. Table 1 shows that people who live in a very vulnerable area had a lower perception index than people who live in vulnerable areas (moderate impact). The lowest perception index to risk of disaster was in the least vulnerable area.

The education level was one of the important variables in disaster risk management. Education was a component that could reduce the risk. It is determined to a community capacity level. Table 2 presents information on the education level attained by the respondent.

The results of cross tabulation showed that the level of education. which was completed successfully by most respondents who live in the vulnerable area, is elementary school with 45.19 percent. The respondents who completed high school education were 28.39 percent, and respondents who completed junior high school (SMP) were on 15.56 percent. The identification of the educational level in the low vulnerable and middle vulnerable areas showed a similar trend If the majority of respondents in less vulnerable areas had completed their educational level in high school (31.54 percent), the respondents who lived in vulnerable area were also mostly high school graduates (40.77 percent). In less vulnerable areas, the second largest number of respondents, who have completed education at the elementary school level, was at 20.77 percent and secondary school at 20.77 percent. In middle Vulnerable areas also occupied the second largest number of respondents who had completed primary school education (22.31 percent) and junior high school (25.38 percent). In less vulnerable areas, most of respondents completed their education level at diploma, undergraduated, and graduated levels.

Results of cross tabulations also clarify the description of the level of education in the research area. The level of the highest successfully attended education in the high vulnerable region was elementary school (61 of 135 respondents), in the vulnerable region it was high school (53 of 130 respondents) and in least vulnerable area it was also at the high school level (40 of 130 respondents).

The capacity of community to reduce the risk was also determined population of resident income level, therefore it is very important in disaster risk management. Low income levels of the population increase the level of disaster risk. Low capacity levels correlate positively with the poverty level of the population. When a community belong to category were poor their capability tend powerless to reduce the risk were relatively powerless. Table 3 contains the cross tabulation between the income levels of the population and the level of vulnerability of the region.

The Chi-square analysis showed that the proportion of income levels in the three groups of regions differed significantly. Most respondents in less vulnerable areas appeared to have incomes between 1.000.000 IDR and 2.500.000 IDR which reached 50 percent of total respondents. Respondents who have an income of less than 500.000 IDR relatively high at around 26.15 percent. The distribution of the income level of the respondents was relatively equal in the vulnerable area, the difference between low income and high income was not significant. The heads of households have an income between 1.000.000 IDR and 2.500.000 IDR same with households who earning less than 500.000 IDR per month, or approximately 27.69 percent. The income level of respondents who lived in a high vulnerable areawas mostly between 500.000 IDR and 1.000.000 IDR(51.85 percent), followed by the group of respondents who earned between 1.000.000 IDR and. 2.500.000 IDR (34.17 percent). The respondents with low income groups under 500.000 IDR was equal to 13.33 percent.

Table 2: Cross Tabulation between Education Level and Vulnerability Area

Area		Education Level							Amount
		No school	Elementary	Junior High School	High School	Diploma	Under graduated	Graduated	
Low Vulnerability	Amount	3	27	27	41	23	8	1	130
	% in the area	2.31	20.77	20.77	31.54	17.69	6.15	0.77	100
	% Total	0.76	6.84	6.84	10.38	5.82	2.03	0.25	32.91
Middle Vulnerability	Amount	2	29	33	53	11	1	1	130
	% in the area	1.54	22.31	25.38	40.77	8.46	0.77	0.77	100
	% Total	0.51	7.34	8.35	13.42	2.78	0.25	0.25	32.91
High Vulnerability	Amount	5	61	21	39	7	2	0	135
	% in the area	3.70	45.19	15.56	28.89	5.19	1.48	0.00	100
	% Total	1.27	15.44	5.32	9.87	1.77	0.51	0.00	34.18
Total	Amount	10	117	81	133	41	11	2	395
	% Total	2.53	29.62	20.51	33.67	10.38	2.78	0.51	100
Chi Squared (χ^2)	Pearson Distribution	43,981 (significant at 5% level)							

Table 3: Cross Tabulation VulnerabilityArea and Income Level

Area		Income Level per Month					
		1	2	3	4	5	Total
Low Vulnerability	Amount	34	15	65	15	1	130
	% in the area	26.15	11.54	50.00	11.54	0.77	100
	% Total	8.61	3.80	16.46	3.80	0.25	32.91
Middle Vulnerability	Amount	36	42	36	16	0	130
	% in the area	27.69	32.31	27.69	12.31	0.00	100
	% Total	9.11	10.63	9.11	4.05	0.00	32.91
High Vulnerability	Amount	18	70	46	1	0	135
	% in the area	13.33	51.85	34.07	0.74	0.00	100
	% Total	4.56	17.72	11.65	0.25	0.00	34.18
Total	Amount	88	127	147	32	1	395
	% Total	22.28	32.15	37.22	8.10	0.25	100
Chi Squared (χ^2)	Pearson Distribution	98,74 (significant in level 5%)					

Annotation: 1= Less than Rp. 500,000,-; 2= Rp. 500,000-Rp.1,000,000; 3=Rp. 1,000,000-2,500,000; 4=Rp.2.500.000-Rp.5.000.000; 5= more than Rp. 5.000.000,-

According to Table 3, the average income level of households in the high vulnerable, vulnerable, and less vulnerable area is relatively different. Household income levels in the high vulnerable area were lower than in the other two areas. The average income of respondents who live in the highly vulnerable region ranked third under the other two categories. Within one month, the head of household residing in the high vulnerable area generates maximum 1.240.000 IDR, in the vulnerable region 1.350.000 IDR, and in the less vulnerable area it is 1.560.000 IDR per month.

The theory of Expected Utility (EU) according to the von Neumann-Morgenstern principle states that individuals are growing niches to maximize utility. In the EU theory, an investigation of the level of rejection of risk becomes important. The higher the degree of risk aversion is, the easier it is to involve the community actively in the risk management program. The lower the level of risk aversion of the community, the more difficult it is to actively involve them.

Table 4 presents the cross tabulation between the degrees of risk aversion that were classified according to the vulnerability of the region. The classification of the degrees of risk aversion categories were divided into four categories: very low, low, medium, and high. Respondents with a very low degree of aversion were the highest number in all category areas. The number of respondents who belong to this group reached 80 percent in all regions. The area which classified as highly vulnerable to disasters should have a higher degree of risk aversion than the other two groups of regions.

The experience of the earthquake disaster on May 27, 2006 did not increase the degree of risk aversion significantly. The Chi-square analysis in Table 4 showed that the proportion of the degree of risk aversion in the three categories were statistically in a different area. The degree of risk aversion have been measured by amount of rejection risk instrument that they have. Most respondents have only one among the six instruments rejection risk (87.9 % in High Vulnerable area).

The low degree of aversion to risk is a consequence of their perception that the importance of mitigation was also low. Table 4 showed that the degree of risk aversion in the high vulnerable category was for most of them on a low level. The areas have been classified in the category of medium impact and less, their risk averse tend not too high but they were still better than respondents who lived in the high vulnerable area.

Table 4: Degree of Risk Aversion and Vulnerability Area

Area		Risk Aversion				
		Very Low	Low	Medium	High	Total
Low Vulnerability	Amount	110	8	11	1	130
	% in the area	84.62	6.15	8.46	0.77	100
	% Total	27.85	2.03	2.78	0.25	32.91
Average Vulnerability	Amount	105	20	4	1	130
	% in the area	80.77	15.38	3.08	0.77	100
	% Total	26.58	5.06	1.01	0.25	32.91
High Vulnerability	Amount	118	12	3	2	135
	% in the area	87.41	8.89	2.22	1.48	100
	% Total	29.87	3.04	0.76	0.51	34.18
Total	amount	333	40	18	4	395
	% Total	84.30	10.13	4.56	1.01	100
Chi Squared (χ^2)	Pearson Distribution	13,262 (significant at 5%)				

Table 5: Correlation of Vulnerability Area and Perceptions Varibles

Variables	Vulnerability Area	Significant
Perception Index	0,102	0,043*
Education Level	-0,250	0,000**
Income Level	-0,154	0,002**
Risk Aversion	-0,055	2,770
WTP	0,425	0,000**

Ket: **) significant at level 0,01, *) significant at level 0,05

The second purpose of the research was to analyze the correlation of the perception variables, social variables, economic variables, and the level of willingness to mitigate Theestimated results were summarized and presented in Table 5.

The variables that had a significant correlation between the variables of risk perception and the vulnerability of the region was the level of income, perception index, and the WTP mitigation. The risk aversion variable did not have a significant correlation with the vulnerability level of the region. This result showed that residents, who live in the high vulnerable area did not have a degree of the same high sensitive aversion as the community who lived in the less vulnerable area. The level of income and level of education has a negative correlation with the level of vulnerability. This means that the more vulnerable the area, the lower the level of education and income.

CONCLUSION

The GIS analysis showed that the vulnerable areas in the Bantul region actually have a high population density and a high residential density. The vulnerability is characterized by its alluvial and fluvial plains. These areas were concentrated between the Sentolo mountains and the Baturagung hills, classified as urban areas, and the centers of economical and governmental activities. Based on the results of cross tabulation: (1) the perception of the community who lived in the high vulnerable area appeared to have a higher index of risk perception than the community who lived in other regions, (2) the lowest level of education on average was found in the high vulnerable region, (3) the lowest average level of income was found in the high vulnerable region, and (4) the lowest level of risk aversion of the community was also found in the high vulnerable area.

The correlation analysis showed that the variables of the risk perception index, income level, and education level showed a significant correlation to the level of the vulnerability of the region. The degree of risk aversion did not show a significant correlation on the level of the vulnerability of the region. Therefore, the population living in vulnerable areas have low level of willingness to avoid the risk.

Disaster risk management was based on the ability of the community to utilize the conclusion of the study. As an example: increasing the income and education level of the population, which will reduce the level of vulnerability of the population to the risk of disaster. The degree of the risk aversion in the high vulnerable region needs to be improved to increase the awareness of disaster risk.

Disaster risk management based on the community needs an active role of both local and central governments. As long as the level of awareness was still low, efforts to realize risk management will be difficult.

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