Strategies for Determining Priority Area for Mitigation of Landslide Disaster in Semarang City

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Abstract. The purpose of this study is to examine how to determine priority areas for an implementation of landslide mitigation based on disaster risk assessment in Semarang city Central Java. The results of the interviews with the employees of BPPD Semarang city indicate that in mitigation landslide disaster to the sub-district level or to the village, officers do not have clear guidelines on which region should be socialized about landslide disaster first or as a priority. To determine the level of landslide risk variation, there needs to be threat data, vulnerability and community capacity. The availability of threat data, vulnerability, and community capacity is useful in determining priority areas for disaster mitigation implementation. Analytical technique used in this research is map overlay with ArcGIS 10.3 program. Data on threats, vulnerabilities and community capacities are mapped, then overlaid to produce landslide risk maps. Furthermore, landslide risk maps are covered with population density maps or settlement density maps to obtain priority areas for landslide mitigation. Areas with a very high risk of landslide disaster occupy the priority 1, followed by areas with the high landslide risk as priority 2 and areas with the risk of landslide disaster are in the 3rd priority.

Keywords: priority area; landslide mitigation; disaster; Semarang City

I. INTRODUCTION

The result of the researcher's interview with BPDB officers of Semarang city shows that, in case of the mitigation of landslide disaster in the level of sub-district or village, they have not had clear guidelines about which area should come first or become the priority. The reason is, it is impossible for them to visit every sub-district or village in order to socialize landslide disaster due to the limitation of cost, manpower, and time availability. Thus, there needs to be a scale of area priority that must get socialization about landslide for the mitigation of disaster. In this case, what is attempted by BPDB officers and the community can purposely reach the target.

The implementation of disaster mitigation must be set in a priority scale, due to varying population or settlements density with different risk of avalanche (landslide). In order to be able to determine the priority area, first, we need to determine the level of landslide risk there. Meanwhile, to determine the level of landslide risk, we need to know the variations of threat, vulnerability and community capacity in certain area [1]. Based on the level of landslide risk overlaid, we are able to determine a priority area for disaster mitigation.

Disaster, as a matter of fact is a misfortune that gives a huge loss to the community. It is destructive, detrimental, and a long-time recovery. [2]. The definition is emphasized more in Laws Number 24 tahun 2007 [3] about disaster prevention; a disaster is an occurrence or a series of incident threatening people's lives and livelihood due to the factors, both natural and non-natural, such as human factor, environmental destruction, loss of possessions, and psychological effect.

Agus Rahmat (2006), as cited in Purnomo Hadi's book [4] stated that, Disaster Risk Management is an entire activity covering the aspect of design and disaster prevention before, during and after the disaster happens. Disaster risk management, also known as the cycle of disaster risk management is aimed to: (a) prevent the loss of human life, (b) decrease human's sufferings, (c) provide information to community and authorities about risks of disaster. Some aspects included in the program of PRB activity are readiness, mitigation, emergency response, recovery, and reconstruction.

Mitigation of disaster is carried out to minimize the risks of disaster for people living in disaster prone-area. Mitigation of risk is a part of efforts to decrease disaster risk, such as minimizing community's loss due to disaster. The time for disaster mitigation covers all actions conducted before it happens. This includes actions for decreasing long term risks of disaster.

Regulation of the Minister of Internal Affairs (Permendagri) No. 33 Year 2006 [5] on General guidelines of disaster mitigation, stated that several policies that need to carried out in disaster mitigation, namely; (a) Disaster mitigation attempt needs to build the same perception for all parties, both authorities and communities, which actions are guided in general

guidelines, implementation instruction, and permanent procedures issued by the relevant agency in accordance with the respective task force of the unit; (b) Disaster mitigation implementation is carried out in an integrated and coordinated manner involving all the potential of the government and the community; (c) Preventive efforts must be prioritized in order to minimize damage and casualties; (d) Mobilizing power or competence through collaboration with all parties by means of community empowerment and its campaigns.

The Department of Public Works **[6]** defined a landslide as a process of earths or rocks mass displacement which slopes from its original position (so that it is separated from the settled part) due to gravity effect rotately and translationally. According to the Directorate of Geology and Environmental Management **[7]**, what is meant by land movement (slide) is a product of slope balance disturbance process causing earth mass and rocks to move down. Landslide is a process of earth mass or rocks movement with incline direction from its original position, so that it is separated from the settled part, and due to gravity, it moves rotately and translationally **[8].**

The problem arising with regard to the implementation of disaster mitigation is how to determine priority areas for the implementation based on the assessment of landslide disaster risk in the city of Semarang. This case finally raises the research objective, that is to analyze how to determine priority area for the implementation of landslide disaster mitigation based on the assessment of landslide disaster risk in the city of Semarang.

II. RESEARCH METHODS

With the purpose of determining the variation of level landslide risk, it is required to have data on threats, vulnerability and community capacity. The availability of data on threats, vulnerability and community capacity is very useful in determining the priority area for the implementation of disaster mitigation.

Analytical Technic applied in this research is Overlay map using ArcGIS 10.3 program. The data on threats, vulnerability and community capacity are mapped, then overlaid to produce the map of landslide disaster risk. Next, it is overlaid again with a map of population density or settlement density to have the priority area for landslide disaster mitigation. The area with a *very high* landslide disaster risk is put as the 1st priority, followed by an area with a *high* landslide disaster risk as 2nd priority, and an area with a *medium* landslide disaster risk as 3rd priority. Priority class for the implementation of landslide mitigation is divided into 7. Class 1 is the highest priority and class 7 is the lowest priority.

III. RESULTS

This research on *strategies for determining priority areas for mitigation of landslide disaster* is conducted in Semarang. Geographically, it is positioned in between 109^0 35' – 110^0 50 'East Longitude and 6^0 50' – 7^0 10' South Latitude. Samples are taken from several locations that are prone to landslide.

The city of Semarang is chosen to be the location of research, for it is one of the provincial capitals in Indonesia with a high population density, and various potential of disasters, for example landslide. A prone to landslide region, not to mention the high rainfalls has caused frequent landslides, in which the results are great losses of belongings, even human's life. Various conditions of regions with different levels of landslide hazards require more attentions, including by socializing landslide mitigation to minimize the loss because of the landslide.

Priority area for the implementation of disaster mitigation is an analysis result based on the disaster risk assessment, that is *overlaid* with the population density in Semarang city.

TABLE 1. TOTAL OF FIELD UNITS DATA AND PRIORITY CLASS ALONG WITH THE AREA IN SEMARANG CITY

Sub-district	Priority Class													
	1	Area of	2	Area of	3	Area of	4	Area of	5	Area of	6	Area of	7	Area of
Banyumanik	6	41,72	10	190,15	33	961,31	58	866,55	8	55,79	0	0,00	0	0,00
Candisari	1	12,91	3	4,57	21	214,72	13	419,33	0	0,00	0	0,00	0	0,00
Gajah Mungkur	0	0,00	0	0,00	28	227,19	19	551,99	6	6,06	0	0,00	0	0,00
Gunung Pati	0	0,00	8	69,26	43	285,87	155	3371,99	90	1935,27	11	238,96	0	0,00
Mijen	0	0,00	6	36,08	30	1170,22	31	757,65	27	1941,64	34	972,38	2	13,03
Ngaliyan	1	3,11	2	0,98	18	388,52	30	1978,37	23	1133,32	4	585,82	0	0,00
Semarang Barat	0	0,00	0	0,00	29	251,48	15	228,15	10	120,45	0	0,00	0	0,00
Tembalang	2	37,71	8	42,21	54	1128,28	54	1249,50	21	292,18	0	0,00	0	0,00
	10	95,45	37	343,24	256	4627,61	375	9423,53	185	5484,72	49	1797,16	2	13,03

Source: Analysis result of Research Data (2017-2018)

After the analysis, the *overlay* between disaster risk map and Semarang population density map, the completion is 914 field units in area of 21.784,74 ha (56,66% of Semarang administrative area). Mitigation priority class based on the highest number of field unit (the most) is in priority class 4, for 375 field units with the area of 9.423,53 ha (24,51% of Semarang administrative area). Meanwhile, the lowest number of field unit (the least) is in class 7, for 2 field units with the area of 13,03 ha (0,03% of Semarang administrative area).
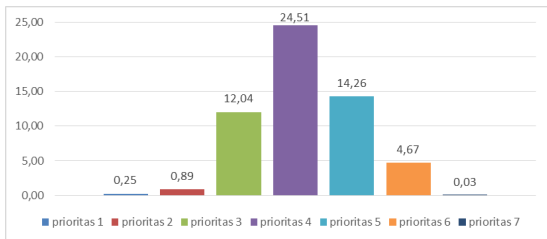

Fig. 1. Percentage area graph of priority area for mitigating landslide toward the admnistrative area of Semarang (Source: Analysis Result of Research data 2017-2018)

1st class priority for implementing mitigation of landslide disaster is the category to have the main attention. 1st class priority in this research consist of 10 field units, covering an area of 95,45 Ha (0,25 % of administrative area of Semarang city). This class covers 4 sub-districts, they are Banyumanik with an area of 41,72 Ha, Tembalang with 37,71 Ha, Candisari with 12,91 Ha, and Ngaliyan with an area of 3,11 Ha.
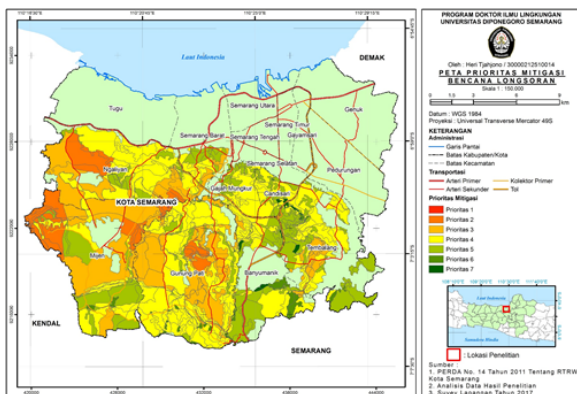

Fig. 2. Map of prioritas for the implementation of disaster mitigation in the city of Semarang

Next, this map below will present the result of the research from several sub-districts belonging to 1st class priority in the city of Semarang, namely Banyumanik, Candisari, Tembalang, and Ngaliyan sub-districts. The distribution of the priority area of landslide mitigation implementation in Semarang is shown in detail on this map

Banyumanik sub-district has a priority area of 2.115,52 ha (5,50% of administrative area of Semarang city) for the implementation disaster mitigation. Based on the field unit, the priority for implementing disaster mitigation is dominated by a priority class 4 with 58 field units of 866,55 ha. From the data of the priority class area recorded in the administration, Pudak Payung village has the largest priority area of 540,35 ha (25,54% of administrative area of Banyumanik sub-district). The sub-district does not have priority class 6 and 7. Thus, priority class 5 is the lowest priority in Banyumanik sub-district.

In this sub-district, Banyumanik, priority class 1 covers 5 village regions. They are Banyumanik village with an area of 9,34 Ha, Padang Sari with 12,68 Ha, Ngesrep village with 6,47 Ha, Srondol Kulon with 12,07 Ha, and Srondol wetan village with an area of 1,17 Ha. During the implementation of landslide mitigation, 1st class priority should get the first of the attentions. This class should be prioritized if a program of disaster mitigation in Banyumanik sub-district is carried out. 1st priority class has a high risk of landslide in addition to its population density. In case of a landslide disaster occurred in this area, it will undergo the most of losses compared to other priority classes. The graph below shows an illustration of priority class in Banyumanik sub-district from priority class 5 to 1.
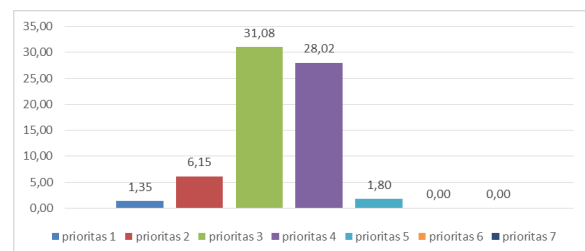

Fig. 3. Graph of priority area percentage for landslide mitigation towards administrative area of Banyumanik sub-district (Source: Analysis result of research data 2017-2018)

Candisari sub-district has a priority area of 651,53 ha (1,69% of administrative area of Semarang city) for the implementation disaster mitigation. Based on the field unit, the priority for implementing disaster mitigation is dominated by priority class 3 with 21 field units of 214,72 ha. From the data of the priority class area recorded in the administration, Karang Anyar Gunung village has the largest priority area of 141,70 ha (21,43% of administrative area of Candisari sub-district). There are no priority classes 5,6, and 7 in this sub-district, so the lowest priority class is 4.

Priority class 1 in Candisari includes 1 village region, that is the village of Karanganyar Gunung with an area of 12,91 Ha. In case of the implementation of disaster mitigation occurred, the priority class 1 must become the first consideration. This class must also be prioritized whenever the socialization program of landslide disaster mitigation is carried out in Candisari.

The graph below shows an illustration of priority class in Candisari sub-district, consisting of priority class 4 to 1.
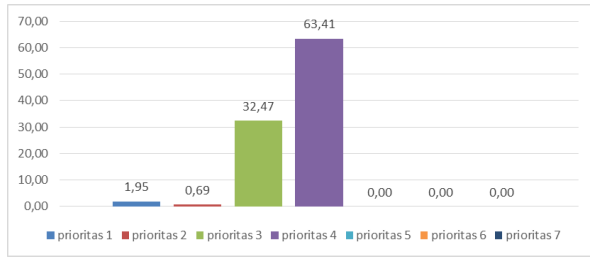

Fig. 4 Graph of priority area percentage for landslide mitigation towards administrative area of Candisari sub-district (Source: Analysis result of research data 2017-2018)

Ngaliyan sub-district has a priority area of 4.090,12 ha (10,64% of administrative area of Semarang city) for the implementation disaster mitigation. Based on the field unit, the priority for implementing disaster mitigation is dominated by the priority class 4 with 30 field units of 1.978,27 ha. From the data of the priority class area recorded in the administration, Podorejo village has the largest priority area of 730,95 ha (16,28% of administrative area of Ngaliyan sub-district). The sub-district has no priority class 7, thus, the lowest is priority class 6, and the highest is class 1.

The 1st class priority in Ngaliyan sub-district covers only village region 1, Bringin village with an area of 3,11 Ha. In the implementation of landslide disaster mitigation, priority class 1 should be the first to get attention. This class must also be prioritized if there is a program of socialization of landslide disaster mitigation.

The priority class 6 to 1 in Ngaliyan sub-district is illustrated in the graph below.
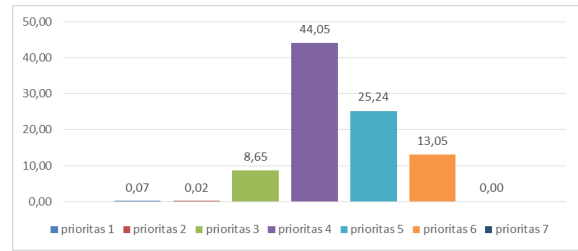

Fig. 5. Graph of the priority area percentage for landslide mitigation towards administrative area of Ngaliyan sub-district (Source: Analysis result of research data 2017-2018)

Tembalang sub-district has a priority area of 2.749,89 ha (7,15% of administrative area of Semarang city) for the implementation disaster mitigation. Based on the field unit, the priority for implementing disaster mitigation is dominated by the priority class 3 with 54 field units of 1.128,28 ha, and the priority 4 with 54 field unit of 1.249,50 ha. From the data of the priority class area recorded in the administration, Rowosari village has the largest priority area of 525,49 ha (12,68% of administrative area of Tembalang sub-district). The sub-district does not have the priority class 6 and 7. This makes the priority class 5 as the lowest class, and the highest is priority class 1.

In Tembalang sub-district, the 1st priority class covers 2 village regions, namely Jangli village with an area of 19,27 Ha, and Tembalang village with 18,44 Ha. During the implementation of landslide mitigation, 1st class priority should get the first of the attentions. This class should be prioritized if a program of disaster mitigation in Tembalang sub-district is carried out.

TABLE 2. TOTAL DATA OF FIELD UNITS FOR EACH PRIORITY CLASS AND THE COVERED AREA IN TEMBALANG SUB-DISTRICT

Village	Priority Class													
	1	Area of	2	Area of	3	Area of	4	Area of	5	Area of	6	Area of	7	Area of
Bulusan	0	0,00	2	0,30	1	23,09	11	90,72	7	169,83	0	0,00	0	0,00
Jangli	1	19,27	2	14,33	10	190,94	2	65,34	0	0,00	0	0,00	0	0,00
Kedungmundu	0	0,00	0	0,00	0	0,00	4	102,03	0	0,00	0	0,00	0	0,00
Kramas	0	0,00	0	0,00	3	1,69	3	52,18	13	122,31	0	0,00	0	0,00
Mangunharjo	0	0,00	0	0,00	3	35,01	5	188,67	0	0,00	0	0,00	0	0,00
Meteseh	0	0,00	1	0,07	9	31,63	10	142,22	0	0,00	0	0,00	0	0,00
Rowosari	0	0,00	1	26,83	7	474,11	2	24,54	0	0,00	0	0,00	0	0,00
Sambiroto	0	0,00	1	0,64	5	2,31	6	155,11	0	0,00	0	0,00	0	0,00
Sendangguwo	0	0,00	0	0,00	2	17,24	2	50,77	1	0,03	0	0,00	0	0,00
Sendangmulyo	0	0,00	0	0,00	7	23,24	2	180,96	0	0,00	0	0,00	0	0,00
Tandang	0	0,00	0	0,00	1	42,18	2	147,00	0	0,00	0	0,00	0	0,00
Tembalang	1	18,44	1	0,04	6	286,84	5	49,95	0	0,00	0	0,00	0	0,00
	2	37,71	8	42,21	54	1128,28	54	1249,50	21	292,18	0	0,00	0	0,00

Source: Analysis Result of Research Data (2017-2018)

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Illustration of priority area for landslide mitigation in Tembalang sub-district, consisting of the 5th priority class to the 1st priority class, is shown in the graph below:
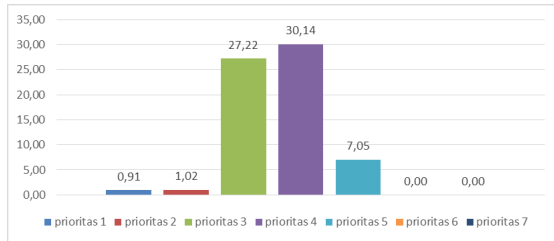

Fig. 6. Graph of priority area percentage for landslide mitigation towards the administrative area
of Tembalang sub-district (Source: Analysis result of research data 2017-2018)

IV. DISCUSSION

The 1st class priority for the implementation of disaster mitigation is a class that must get the main attention. The 1st class priority in this research consists of 10 field units, covering an area of 95,45 Ha (0,25 % of administrative area of Semarang city). This class covers 4 sub-districts, they are Banyumanik with an area of 41,72 Ha, Tembalang with 37,71 Ha, Candisari with 12,91 Ha, and Ngaliyan with an area of 3,11 Ha. During the implementation of landslide mitigation, the 1st class priority should get the first of the attentions. This class should be prioritized if a program of disaster mitigation is carried out. The reason is, this class has a high risk of landslide completed with the high population density. Therefore, if a landslide disaster occurs, this particular class may suffer the greatest loss or damages compared to other priority classes.

The 2nd priority class is a class that should get the 2nd attention after the priority 1 area gets the socialization for implementation of landslide disaster. The 2nd priority class covers 6 sub-districts in the researched area, including Banyumanik with an area of 190,15 Ha, Gunungpati with 69,26 Ha, Tembalang with 42,21 Ha, Mijen with 36,08 Ha, Candisari sub-district with 4,57 Ha, and Ngaliyan with an area of 0,98 Ha.

The 1st class of priority area must be prioritized during the implementation of disaster mitigation socialization. After completing the socialization for the 1st class, the next class to have the same socialization is the 2nd priority class. Completing this, we shall move to the 3rd, 4th and so on.

V. CONCLUSION AND RECOMMENDATION

The availability of threat data, vulnerability, and community capacity is useful in determining the priority areas for disaster mitigation implementation. Data on threats, vulnerabilities and community capacities are mapped, then overlaid to produce landslide risk maps. Furthermore, landslide risk maps are covered with the population density maps or the settlement density maps to obtain priority areas for landslide mitigation.

During the implementation of landslide mitigation, 1st class priority should get the first of the attentions. This class should be prioritized if a program of disaster mitigation is carried out. The reason is, this class has a high risk of landslide completed with a high population density.

1st class of priority area must be prioritized during the implementation of disaster mitigation socialization. After completing the socialization for the 1st class, the next class to have the same socialization is 2nd priority class. Completing this, we shall move to 3rd, 4th and so on.

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