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Analysis of Land Capability for Potential Disasters in Banjarnegara Regency, Central Java

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Abstract

Land capacity includes the physical components that influence the potential for disasters in an area. Land capacity classification can provide a systematic assessment of land through categories of characteristics that are potential as well as obstacles to its sustainable use. One example of inhibiting factor is disaster, so the aim of this research is to find out areas that are vulnerable and the level of regional capacity in dealing with natural disasters. The existence of a land capability classification can provide a systematic assessment of land so that it can categorise it as potential or obstacle to land use. This research method is scoring and weighting which is based on Public Planning and Public Housing (PUPR) Ministerial Decree No. 20 of 2007 combined with practical teaching materials for land use planning, Faculty Geography, Universitas Gadjah Mada. There are 4 data inputs, natural disaster maps, slope, rain intensity, and soil sensitivity to erosion. Each input has a variable range that varies on a scale at levels 1-5 with weight range of 0-100. The research location is in Banjarnegara Regency, Central Java. The results obtained are the level of regional capacity for natural disasters in each sub-district, including very low, low, medium, high and very high land capacity with different intensities in each region. Erosion and landslides and landslides are the ratio of disasters with a relatively large area compared to erosion disasters. Apart from that, areas that do not fall into either category are included in the category of areas that are safe from disasters.

Keywords: Disasters, Land Capabilities, Landslides, and Erosion.

Introduction Section

According to Law No. 24 of 2007, a disaster is an event or series of events that disrupt people's lives and livelihoods caused by natural factors and/or non-natural factors as well as human factors, resulting in human casualties, environmental damage, property loss and psychological impacts. Disasters occur suddenly and continuously which affect normal life patterns or damage ecosystems (Sutanto, 2012). According to UNISDR (2004), there are 4 aspects that are the basic parameters in disaster assessment, namely risk, vulnerability, hazard and capacity. Risk is the possibility of adverse impacts resulting from threats and/or vulnerabilities. Disaster risk can be reduced if capacity is increased or vulnerability is reduced, while disaster risk can increase if vulnerability is higher and capacity is lower (PUPR, 2017). Meanwhile, disaster risk assessment is an approach to show the potential negative impacts that may arise due to an existing potential disaster. The potential negative impact is also calculated by considering the level of vulnerability and capacity of the area. Apart from that, danger is a phenomenon that has the potential to damage physical objects, property, social and economic disruption, environmental damage, and even injury and loss of human life (UNISDR, 2004). The higher the resulting danger, the higher the resulting risk value. Furthermore, vulnerability is a condition determined by physical, social, environmental and economic factors that can increase the susceptibility (susceptibility) of a community group to the impact of a hazard. Vulnerability is caused by human activities (the result of physical, social, economic and environmental processes) which results in an increase in society's vulnerability to danger (Utomo & Supriharjo, 2012). Emergency and extraordinary measures are needed to help and save people and the environment if a disaster occurs. Specifically, the existence of disasters is greatly influenced by the characteristics of each land. One of these things is related to land use. According to Veldkam and Verburg (2004), land use is defined as every form of human interaction (interference) with land in order to fulfil their living needs, both materially and spiritually. Differences in the characteristics and physical and material properties of land also have implications for land capability, where these parameters attempt to assess land systematically and group it into several categories based on properties that constitute potential and obstacles to its sustainable use.

Land use is all kinds of human intervention, either permanently or skillfully, on a collection of natural and artificial resources, which are collectively called land, with the aim of meeting human needs (Malingreau, 1982). Land has different

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capabilities depending on its physical characteristics and influences the suitability of land use applied to that land. Land capacity is based on considering land biophysical factors in its management so that land degradation does not occur during use. According to Sys, Ranst E, and Debaveye, (1991), land capability implies the carrying capacity of the land, while land suitability implies land use. Land capability is the quality of land that is assessed as a whole. In relation to fulfilling human needs, capacity is defined as understanding the carrying capacity of land so that what influences land capacity is soil type or geomorphology, rainfall or climate, slope slope and area hazards. The existence of a land capability classification can provide a systematic assessment of land and put it into categories based on characteristics that constitute potential and obstacles to its sustainable use (Arsyad, 2010). In land capability classification, elements are used that take into account inhibiting factors in the form of natural disaster vulnerability, slope slope, landslide proneness, and soil sensitivity to erosion which have their respective weights so that a land capability classification is obtained based on the sum of each weight of the inhibiting factors, namely 1) 20-85 (Very High Land Capability), 2) 86-150 (High Land Capability, 3) 151-215 (Medium Land Capability), 4) 216-280 (Low Land Capability), and 5) 281-345 (Medium Land Capability). Very Low Land.

Land capability classification needs to pay attention to inhibiting factors. Factors inhibiting land capacity can be disasters. According to Law No. 24 of 2007, a disaster is an event or series of events that threatens and disrupts people's lives and livelihoods caused by either natural factors and/or non-natural factors or human factors, resulting in human casualties, environmental damage, property loss, and psychological impact. Emergency and extraordinary measures are needed to help and save people and the environment if a disaster occurs. Meanwhile, disaster management is all efforts that are realized in an activity or series of activities carried out to eliminate part or all of a disaster and its impacts and minimize the impact of a disaster (Carter, 2008).

Judging from the physical aspect, Banjarnegara Regency has a number of potential disaster risks, including landslides and erosion. The potential risk of erosion and landslides is closely related to the existence of rivers, structural hills and their relationship to human activities within them. Banjarnegara Regency has an area of 1,070 km2 consisting of 20 sub-districts, namely Banjarmangu, Banjarnegara, Batur, Bawang, Kalibening, Karangkobar, Madkara, Mandiraja, Pagedongan, Pagentan, Pandanarum, Pejawaran, Punggelan, Purwonegoro, Purworejo Klampok, Rakit, Sigaluh, Susukan, Wanadadi, and Wanayasa. Based on geological studies, 70% of the area of Banjarnegara Regency or 17 subdistricts is an area prone to landslides including Wanayasa (64.41 ha), Pagedongan (43.78 ha), Banjarnegara (38.84 ha), Bawang (18.65 ha) subdistricts. , Kalibening (1.21 ha), Karangkobar (3.58 ha), Pandanarum (21.34 ha), Susukan (4.03 ha), and Mandiraja (0.30 ha) (Prastowo, 2019). Natural factors such as high slopes, high rainfall, geological conditions are influencing factors in this region. The potential for landslide vulnerability in this area is increasing with the presence of infrastructure, namely buildings due to population density in areas that are vulnerable to landslides (Susanti, Miardini, & Harjadi, 2017).

Methods

a. *Data Collecting*

This research was conducted to determine areas that are vulnerable and vulnerable to natural disasters and to determine the level of regional capacity for various types of natural disasters. The data collection process was carried out by utilizing secondary data in the form of spatial data for Banjarnegara Regency, namely administrative and disaster shapefiles. Data from this research was also obtained from digital maps which were used to integrate information regarding topography, land cover and potential disasters.

b. *Data Processing*

The data that has been collected is then processed to obtain analysis results that can achieve the objectives of this research. Data processing was carried out using land capability classification guidelines based on Minister of Public Works and Public Housing Regulation Number 20 of 2017 combined with land use planning practicum teaching materials at the UGM Faculty of Geography. This classification combines several factors such as potential disasters that may occur, slope slope, rainfall intensity, and soil sensitivity to erosion. Slope data is analyzed to determine areas that have significant slope slopes. Slope slopes of more than 20 degrees are the main factor in the characteristics of landslide areas (Goma, Sunimbar, and Angin 2022). Apart from that, soil type is also evaluated to determine physical characteristics that can influence the land's ability to withstand potential disasters. Data processing was carried out using ArcGIS software which makes it possible to map the results of the analysis in the form of a thematic map to visualize information regarding the ability of land to potential disasters in Banjarnegara Regency. The results of data processing from ArcGIS are then processed in Microsoft Excel to get a more structured data display with the help of the pivot table feature.

c. *Data Analysis*

Data analysis carried out in this research used scoring, weighting and classification methods in accordance with Minister of Public Works and Public Housing Regulation Number 20 of 2007 with modifications combined with

standardization of land use planning practicum at the UGM Faculty of Geography which was then adjusted to the type of disaster and characteristics The physical research area is Banjarnegara. Each variable related to land capacity and disaster potential is given a special score based on its significance and contribution to the overall assessment. These scores are then weighted to reflect their relative importance in determining land capability. The following is a reference in determining scoring:

Table 1.1. Table of Data Scoring

Input	Score	Categorize/Range	Weight
Natural disaster map	1	Volcanic	20
	2	drought	40
	3	Erosion, Landslides, Floods	60
	4	Wind, Tsunami, Earthquake	80
Slope	1	0 - 8%	20
	2	8 - 15%	40
	3	15 - 25%	60
	4	25 - 40%	80
	5	>40%	100
Rain Intensity	1	≤13,5 mm/day	20
	2	13,6 - 20,7 mm/day	40
	3	20,7 - 27,7 mm/day	60
	4	27,7 - 34,8 mm/day	80
	5	>34,8 mm/day	100
Soil Sensitivity to Erosion	1	Aluvial, Gleisol, Planosol	15
	2	Latosol	30
	3	Mediterania	45
	4	Kambisol, Grumusol	60
	5	Regosol, Rendsina	75

Table 1.2. Classification of Land Capability

Total Score	Classification
20 - 85	Very high land capability class
86 - 150	High land capability class
151 - 215	Medium land capability class
216 - 280	Low land capability class
281 - 345	Very low land capability class

Result and Discussion

a. *Location Overview*

Banjarnegara Regency is a district located in Central Java Province. Administratively, Banjarnegara Regency to the east borders Wonosobo Regency, to the north it borders Batang and Pekalongan Regencies, to the west it borders Purbalingga Regency, and to the south it borders Kebumen Regency. Apart from that, based on smaller administrative levels, Banjarnegara Regency has 20 sub-districts, namely Banjarmangu, Banjarnegara, Batur, Bawang, Kalibening, Karangkobar, Madkara, Mandiraja, Pagedongan, Pagentan, Pandanarum, Pejawaran, Punggelan, Purwonegoro, Purworejo Klampok, Rakit, Sigaluh, Susukan, Wanadadi, and Wanayasa, as well as 12 sub-districts. 266 villages, 970 hamlets, and 1316 neighborhood units (RW), and 5451 neighborhood units (RT) (BPS, 2022).

Based on the visualization on the map (figure 2), it can be seen that areas with low elevations and the majority of which are associated with built-up land are in the 'Disaster Safe Area' category. Viewed from the perspective of analysis units per sub-district, it can be seen based on (figure 1) that the sub-district with the highest proportion of safety from disasters is Punggelan Sub-district with a total area of 7130.52 ha. On the other hand, the area with the lowest proportion of area safe from natural disasters is Pagedongan with an area of 45.68 ha. This represents that the level of disaster risk is still low. Normally the fewer sources and potential disasters there are, the lower the potential hazards and disaster risks resulting. In some sub-districts, there are no areas classified as disaster-prone areas, such as Pandanarum and Pejawaran sub-districts. This proves that the ratio of areas with potential for disaster in this district is very high.

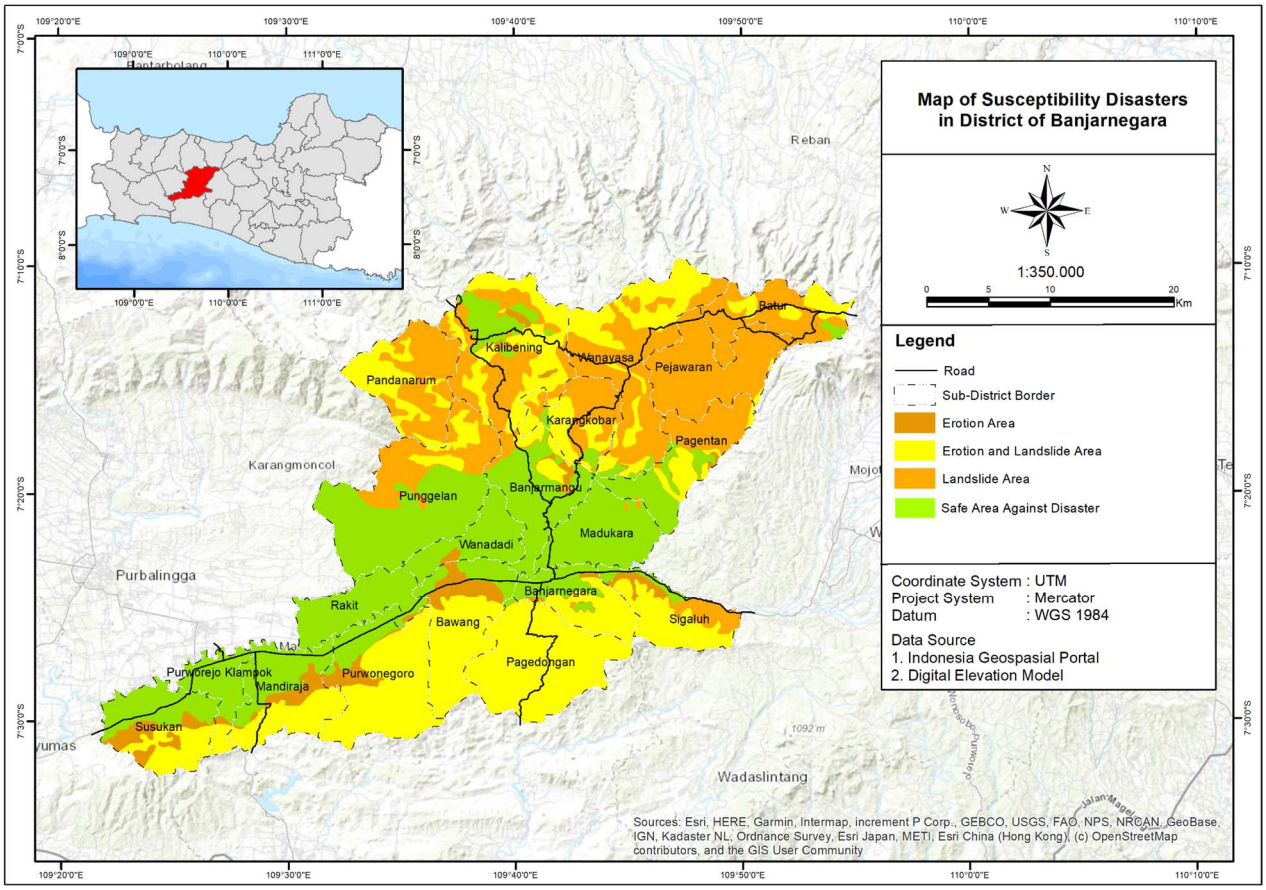

Fig 1. Map of Susceptibility in District of Banjarnegara

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1. *Potential Landslide Risk*

Apart from that, looking at the risk of landslides, it can be analyzed that the sub-district with the highest landslide risk area is Pejawaran District with a landslide risk area of 5856.47 ha. This condition can occur because the location of Pejawaran District is directly associated with the Kendal Mountains so it has rough topography. As a result, the majority of slopes in Pejawaran District are above 45 degrees. Several other sub-districts that have a fairly high level of disaster risk are Punggelan, Pandanarum and Kalibening sub-districts, the majority of which are associated with protected forest areas in the north. On the other hand, the area with the lowest level of landslide risk is Purwonegoro District. This is caused by the location of Purwonegoro District which has flat topography. Apart from that, the flat topography found in Purwonegoro District means that this location has an optimum function in moving towards the serviceability of an area with centrifugal movement throughout the area without any obstacles. Conditions like this are usually suitable for optimal cultivation areas. On the other hand, there are also areas that do not have a landslide risk, such as Bawang, Pagedongan, Purwonegoro, Purworejo Klampok and Wanadadi subdistricts.

2. *Potential Erosion Risk*

Furthermore, based on the risk of erosion disasters, it can be seen that the sub-district with the highest risk of erosion is Susukan Sub-district with the intensity of land affected by erosion covering an area of 1073.75 ha. This can happen because the location of Susukan District is in the southern area or the watershed outlet is in Banjarnegara Regency

so that many tributaries pass through the sub-district administration. As a result, the potential risk of erosion from rivers is also higher. On the other hand, the sub-district with the lowest erosion intensity is Pagedongan Sub-district with an area of 12.82. The low level of erosion could be caused by elevation or soil types that are relatively resistant to rain or river water. Apart from that, there are also several sub-districts that do not have the threat of erosion, including Batur, Madukara, Pandanarum, Pejawaran and Punggelan sub-districts.

3. Potential Risk of Erosion and Landslides

On the other hand, there are also areas that have both potentials, namely erosion and landslides which of course can produce intensity and combinations that are high risk. It can be seen that the sub-district with the highest risk of erosion and landslides is Pagedongan Sub-district with an area of 7933.62 ha. This is caused by the location being associated with a structural hill zone as well as a river, resulting in a risk from a combination of these two disaster source elements. On the other hand, the sub-district with the lowest risk of erosion and landslides is Rakit Sub-district with an area of 25.25 ha. Based on its location, this sub-district is relatively located in an area with flat topography and is not associated with too many watershed system tributaries in Banjarnegara Regency. On the other hand, the presence of a majority and relatively high population in Rakit District proves that this district has a low risk of landslides and erosion so it is safe to live in. Apart from that, there are also two other sub-districts that do not have a risk of erosion and landslides, namely Madukara and Wanadadi sub-districts.

b. *Land Capability*

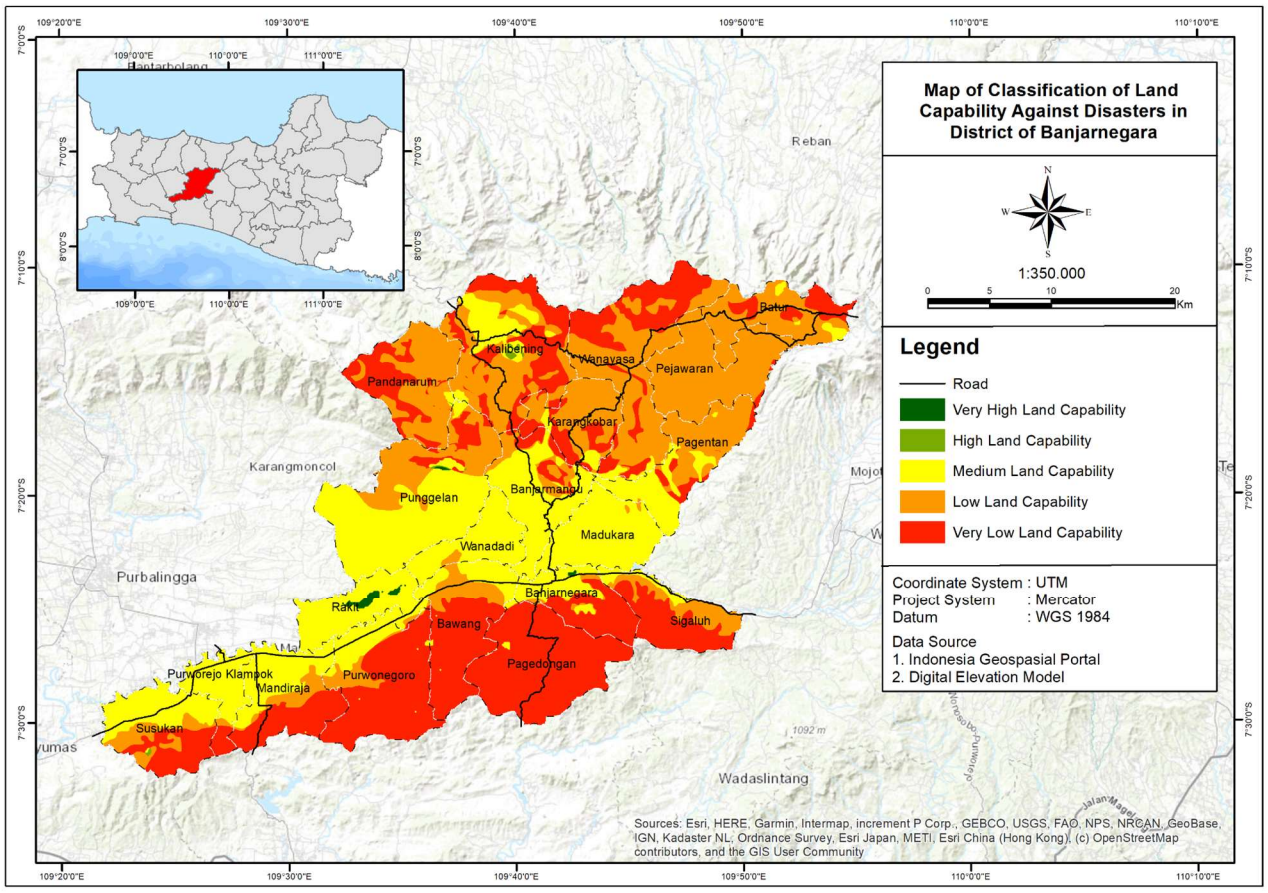

Fig 2. Map of Classification of Land Capability Against Disaster in District of Banjarnegara

The next parameter is land capacity. Basically, it implies the carrying capacity of the land, while land suitability implies land use. Land capability is the quality of land that is assessed as a whole so that it is closely related to environmental conditions in the relevant area. Specifically, land capability is divided into low, medium, high and very high land capability. Details classification are below (table 1.3).

Table 1.3. Table of the extent of natural disaster vulnerability for each sub-district in Banjarnegara Regency

Sub-District	Disaster in Banjarnegara (Ha)					Total
	Low Land Capability	Very High Land Capability	Medium Land Capability	High Land Capability	Very Low Land Capability	
Banjarmangu	805.74	-	3899.99	-	638.64	5344.37
Banjarnegara	191.15	21.33	1445.63		2030.20	33688.31
Batur	3199.42	-	239.22	-	1044.79	4483.44
Bawang	1070.50	-	1240.39	-	3752.83	6063.73
Kalibening	4334.15	-	1692.50	88.18	3328.04	9442.86
Karangkobar	2596.51	-	273.44	-	1077.68	3947.63
Madukara	42.53	-	4447.28	-	-	4489.81
Mandiraja	686.50	-	2583.08	-	2218.15	5487.73
Pagedongan	12.82	-	75.92	-	7903.39	7992.13
Pagentan	2763.69	-	1932.45	-	432.52	5128.66
Pandanarum	3735.54	-	69.17	2.43	1998.30	5805.44
Pejawaran	5856.47	-	-	-	85.71	5942.18
Punggelan	3211.18	24.63	7355.34	20.09	731.59	11343.00
Purwonegoro	649.83		1368.41		5618.95	7637.19
Purworejo Klampok	62.95	-	1945.31	-	360.66	2368.92
Rakit	59.30	209.76	3372.79		25.25	3667.10
Sigaluh	1311.26	-	502.09	-	2464.59	4277.94
Susukan	1067.02	-	2504.71	15.88	1668.41	5256.02
Wanadadi	116.07	-	2875.75	-	-	2991.82
Wanayasa	5601.92	-	277.07	-	3706.14	9585.13
Total	37374.55	255.72	38100.53	126.58	39085.84	114943.40

Based on the low land capacity classification, the area with the highest low land capacity classification is Pejawaran District with an area of 3856.47 ha. On the other hand, the sub-district with the lowest land capacity is Pagedongan Sub-district with an area of 12.82 ha. Furthermore, the highest land capacity is Pagedongan District with an area of 7903.39 ha, while the lowest is in Rakit District with an area of 25.25 ha. In general, land with very low and low levels of land capability generally has a large part of its area designated as protected areas, buffer areas. Protected areas are designated with the main function of protecting environmental sustainability which includes natural resources, artificial

resources and the nation's historical and cultural values in the interests of sustainable development. Meanwhile, the buffer area has a protective function and a cultivation function. This area is located between an area with a protected function and an area with a cultivation function. Types such as limited production forests, plantations (perennials), mixed gardens, and others of the same type. When building housing for residents in areas that have land capacity, of course they must pay attention to all aspects of disasters, whether by avoiding areas that are prone to disasters or can by creating buildings that are resistant to shocks and the threat of erosion. Details of classification in each sub-district are below (table 1.4)

Table 1.4. Table of land capacity classifications for natural disasters for each sub-district in Banjarnegara Regency

Sub-District	Disaster in Banjarnegara (Ha)				Total
	Safe From Disaster	Erosion	Erosion and Landslide	Landslide	
Banjarmangu	4082.92	183.72	682.20	395.53	5344.37
Banjarnegara	1466.96	159.21	2030.20	31.94	3688.31
Batur	162.21	-	1064.30	3256.93	4483.44
Bawang	1222.52	1070.50	3770.70	-	6063.73
Kalibening	1534.98	233.47	3810.66	3863.75	9442.86
Karangkobar	273.44	17.33	1491.75	2165.10	3947.63
Madukara	4447.28	-	-	42.53	4489.81
Mandiraja	2581.29	679.36	2219.94	7.14	5487.73
Pagedongan	45.68	12.82	7933.62	-	7992.13
Pagentan	1919.81	106.07	949.18	2153.60	5128.66
Pandanarum			2273.15	3532.28	5805.44
Pejawaran			85.71	5856.47	5942.18
Punggelan	7130.52		928.80	3283.68	11343.00
Purwonegoro	1347.81	648.63	5639.55	1.20	7637.19
Purworejo Klampok	1945.31	62.95	360.66	-	2368.92
Rakit	3582.55	59.30	25.25		3667.10
Sigaluh	502.09	373.79	2464.59	937.47	4277.94
Susukan	2496.78	1073.75	1676.34	9.15	5256.02
Wanadadi	2875.75	116.07	-	-	2991.82
Wanayasa	277.05	25.36	3803.09	5479.64	9585.13
Total	37894.96	4822.34	41209.71	31016.58	114943.60

The highest medium land capacity in Banjarnegara Regency is Punggelan District with an area of 2355.34 ha, while the smallest is Pandanarum District with an area of 69.17 ha. Furthermore, the largest upland capacity is in Kalibening District with an area of 88.18 ha, whereas the smallest is in Pejawaran with an area of 2.43 ha. Finally, for the very high land capacity classification, the largest is in Rakit District with an area of 209 ha, while the smallest is in Banjarnegara District with an area of 21.33 ha. Not all sub-districts have these three categories of land capacity because the level of disaster risk tends to be uneven. The capacity of this land has a disaster potential that is neither too high nor too low. Areas that have this land capacity can be designated as protected areas, buffer areas, annual plant cultivation areas, or seasonal crop and residential areas. Land capacity is high and very high, generally most of the area is designated for settlement. This is because the risk of potential disasters in the relevant areas is lower than in areas that have very low and low land capacity.

Conclusion

The sub-districts in Banjarnegara Regency have the potential for natural disasters, erosion, landslides, and erosion and landslides. The level of regional capacity for natural disasters in each sub-district in the Regency Banjarnegara varies, including very low, low, medium, high, and land capabilities very high with varying intensity in each region. Erosion and Landslides and landslides are a disaster with a relatively large area in comparison to an erosion disaster. In addition, areas that do not fall into either category are included categories of areas that are safe from disasters.

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References

Arsyad, Sitanala. (2010). Konservasi Tanah dan Air. Edisi Kedua. Bogor : IPB Press. Bahan Ajar Kesehatan Lingkungan, 2017. Metodologi Penelitian. Jurusan Kesehatan Lingkungan Poltekkes Kemenkes Jakarta II.

Badan Pusat Statistik. (2022). Kabupaten Banjarnegara dalam Angka 2022.

Carter W Nick, tt. (2008). Disaster Management A Disaster Manager's Handbook, ADB, Manila.

Malingreau, JP. & Rosalia Christiani. 1982. A Land cover / land use classification for Indonesia. Yogyakarta.

Prastowo Lugas. (2019). KAJIAN MITIGASI BENCANA TANAH LONGSOR BERDASARKAN PERMENDAGRI NO 33 TAHUN 2006 DI KABUPATEN BANJARNEGARA. Semarang: UNIVERSITAS NEGERI SEMARANG.
PUPR. (2017). PUSAT PENDIDIKAN DAN PELATIHAN SUMBER DAYA AIR DAN KONSTRUKSI. Modul 2 Manajemen.

Susanti, P. D., Miardini, A., & Harjadi, B. (2017). ANALISIS KERENTANAN TANAH LONGSOR SEBAGAI DASAR MITIGASI. Jurnal Penelitian Pengelolaan Daerah Aliran Sungai, 49-59.
Sys, I., Ranst E, Van, dan Debaveye, J. (1991). Land Evaluation: Part II Methods in Land Evaluation. Agriculture Publications. No. 7. General Administration for Development Cooperation. Brussels : Belgium, 70 – 76 pp.

Sunimbar, Angin, I. S., & Goma, E. I. (2022). Analisis Geologi Kejadian Longsor di Desa Wolotopo Kecamatan Detusoko Kabupaten Ende. *Jurnal Pendidikan Geografi*, 10 - 24.

Sutanto. (2012). Peranan K3 Dalam Manajemen Bencana. Semarang: Program Studi Diploma III Teknik Sipil Fakultas Teknik Universitas Diponegoro.

Undang-Undang Nomor 24 Tahun 2007 tentang Bencana.

UNISDR. Natural Disaster: Rich Countries Also Pay Their Toll. World Conference on Disaster Reduction.

Utomo, B. B., & Supriharjo, R. D. (2012). Pemintakatan Risiko Bencana Banjir Bandang di Kawasan Sepanjang Kali Sampean, Kabupaten Bondowoso. *JURNAL TEKNIK ITS Vol. 1, No. 1*.

Veldkamp, A., dan P.H. Verburg. (2004). Modeling Land Use Change and Environmental Impact: Introduction to the Spatial Issue. Journal of Environmental Management. 72 (1-2). Pp. 1-3.