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DIRECTIONS FOR UTILIZATION OF SETTLEMENT LAND IN LANDSLIDE HAZARD AREAS (CASE STUDY: IN THE NORTHERN REGION OF BANJARNEGARA REGENCY)

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Abstrak. This research was conducted in the northern area of Banjarnegara Regency, based on the distribution map of potential landslide susceptibility issued by the Center for Volcanology and Geological Hazard Mitigation, the northern region of Banjarnegara Regency has a very high potential for landslides including Pandanarum, Kalibening, Karangkobar, Wanayasa, Pejawaran and Batur Districts. . This study aims to formulate the direction of land use for settlements, determine the suitability of the spatial plan, the direction of landslide disaster mitigation and determine the availability of land for the development of settlements in the Northern Region of Banjarnegara Regency. This research method uses quantitative analysis methods and qualitative descriptive analysis using ArcGIS software, namely by analyzing the landslide hazard index, landslide hazard vulnerability index, land capability, settlement land suitability, projection of residential land needs. The results of the study found that the landslide hazard level was Low, Medium and High with a total area of high landslide hazard class of 5.576 Ha, medium hazard area of 5.245 Ha and low hazard area of 17,238 Ha. The level of vulnerability to landslide hazards has a vulnerability level of Low, Medium and High with a total area of 5,871 Ha for low vulnerability, 4,815.7 for medium vulnerability and 133.6 Ha for high vulnerability. while the potential lives exposed to the danger of landslides is 21,763 people, the potential physical loss is Rp. 116.60.000.000,-, the potential economic loss is Rp. 19.602. The land capability in the northern area of Banjarnegara Regency has a Medium Development Capacity Zone class with an area of 4,689 Ha and Enough Development Capacity with an area of 33,695 Ha. The Suitability of Settlement Land has a Very Suitable category of 1,482 Ha (4%), an SUIT category of 16,576 Ha (43%), an Unsuitable category of 19,454 Ha (51%), and an Unsuitable category of 871 Ha (2%). The projection of residential land needs in 2040 found the need for residential land with a total area of 1,574 Ha and based on the results of the analysis of the direction of land use for settlement development in the northern area of Banjarnegara Regency, it has a total area of 5,790 Ha, with the level of conformity with the plan for the pattern of settlement space with the category of Appropriate for an area of 1,263 Ha. (52%) and the Unsuitable category covering an area of 1.181 Ha (48%). Landslide disaster mitigation directions for residential areas that are in the landslide-prone zone, namely for relocation are 10 Ha (2%), area protection directions are 132 Ha (23%) and adaptation directions are 436 Ha (75%). Based on the results of the analysis of the direction of land use for settlements in the northern region of Banjarnegara Regency, it is still sufficient with the availability of surplus land of 4,216 Ha.

Keywords: threat of landslide hazard; vulnerability to landslide hazard; disaster mitigation; land capability; land suitability; land use

I. INTRODUCTION

Geographically, Indonesia is country located in a disaster-prone area, so that spatial planning based on disaster mitigation is needed (Law No. 26, 2007 **[1]**). It is also in the path of the most active earthquake in the world because it is surrounded by the Pacific Ring of Fire and are on top of three continental plates colliding **[2]**. Spatial planning based on disaster mitigation can be interpreted as Spatial Planning which is positioned as one of the efforts or instruments for Disaster Risk Reduction. (Law No. 24, 2007 **[3]**). Based on the distribution map of potential landslide susceptibility issued by the Center for Volcanology and Geological Hazard Mitigation (PVMBG), the northern region of Banjarnegara Regency has a very high potential for landslides, including the Pandanarum, Kalibening, Karangkobar, Wanayasa, Pejawaran and Batur sub-districts. The area of the high ground movement vulnerability zone in the northern area is 13,634.62 hectares or 35.1% of the northern area of Banjarnegara Regency, the medium soil movement vulnerability zone is 16,353.47 hectares or 42.1% of the area, and the low soil movement vulnerability zone covering an area of 8,880.1 hectares or 22.8% of the northern area of Banjarnegara Regency.

In 2014, a landslide occurred which claimed many lives in Banjarnegara Regency. Based on data from the National Disaster Management Agency (BNPB **[4]**) it was recorded in Banjarnegara Regency in 2014 that 111 people died, 24 were injured and 3,132 people evacuated. As for material losses, 139 houses were heavily damaged, 1 house was moderately damaged and 1 house was lightly damaged, and the results of the recap of landslide disaster data from 2014 to 2018 occurred 96 times with a total number of 12,575 victims, 440 damaged houses and 4 public facility units. This landslide disaster is not without reason considering that there are about 20 sub-districts there that have medium-high

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

potential for landslides. There are several factors that cause disasters, namely the morphology of the disaster area and its surroundings, lithology with high water absorption capacity, and high and long rainfall, Naryanto **[5]**. In addition, errors in spatial allocation and management of disaster-prone areas are also the cause (Sulistyo **[6]**).

The purpose of this study is to analyze the level of threat of landslides and the level of vulnerability to landslides (social, physical, economic and environmental vulnera bilities), analyze land capabilities, analyze Settlement Land Suitability, analyze residential land needs. So that it can formulate directions for the use of residential land based on landslide disaster mitigation in the Northern Region of Banjarnegara Regency

The scope of this research includes:

1. Policy aspect by reviewing the Regional Spatial Plan (RTRW) of Bajarnegara Regency, namely by looking at the extent to which spatial policy has a role in disaster risk reduction,
2. Socio-economic aspects concerning the number and growth of the population as well as its economic activities,
3. Environmental aspects include land capability analysis which refers to Technical Guidelines for Analysis of Physical & Environmental, Economic and Socio-Cultural Aspects in the Preparation of Spatial Planning, Minister of Public Works Regulation No.20/Prt/M/2007 **[7]** and land suitability analysis based on literature studies.
4. The disaster aspect refers to the Regulation of the Head of the National Disaster Management Agency No. 2 of 2012 **[8]**, Regulation of the Head of the National Disaster Management Agency No. 4 of 2008 concerning Guidelines for Preparation of Disaster Management.
5. Aspects of Disaster Mitigation-Based Spatial Planning include directives on the use of residential land based on disaster mitigation by considering disaster aspects, land capability, land suitability, projection of residential land needs, and Banjarnegara Regency spatial plans.
6. The scope of the study area includes the sub-districts of Pandanarum, Kalibening, Karangkobar, Wanayasa, Pejawaran and Batur

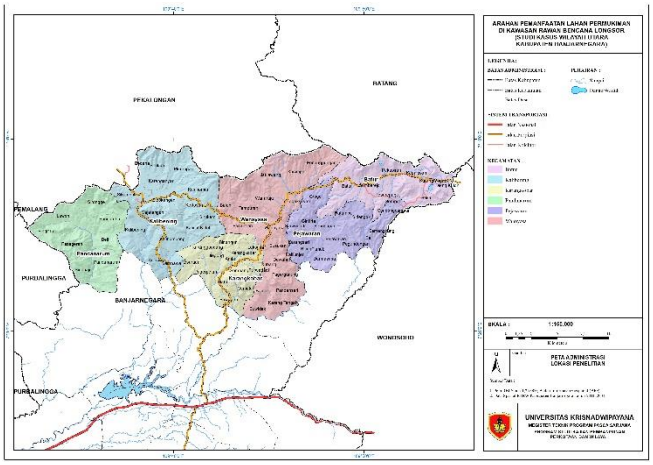

Figure 1. The scope of the study area

II. RESEARCH METHODS

Data collection methods include secondary data and primary data, the primary data in this study is to conduct field observations with visual photo taking techniques and observation of objects in the field. While secondary data, the authors obtained through institutional surveys and literature studies or library research, namely data collection methods by studying and collecting data (materials) from explanations of books, textual documentation of papers, and other available mass media sources. relation to the problems discussed in the writing of this final project.

The data carried out are:

1. Secondary Data Collection which includes data: social, economic, physical and environmental, to obtain initial information such as Village Potential Data (PODES) and Central Statistics Agency (BPS).
2. Spatial data such as maps of the Land Movement Vulnerability Zone and RTRW
3. Setting up a 1:25,000 . Base Map
4. Interpretation of 1:10,000 scale land use maps.
5. Thematic Map Setup

Analysis Methods Include:

A. Landslide Hazard Analysis

Landslide hazard assessment is carried out by identifying areas potentially affected by slope failure, calculating the probability of occurrence, and estimating the magnitude (area, volume, rate of movement) of the event (Petley **[9]**, 2010). The data that can be used in the preparation of landslide hazard maps are in the form of spatial data consisting of administrative data, 30 meter DEM and maps of soil movement vulnerability zones.

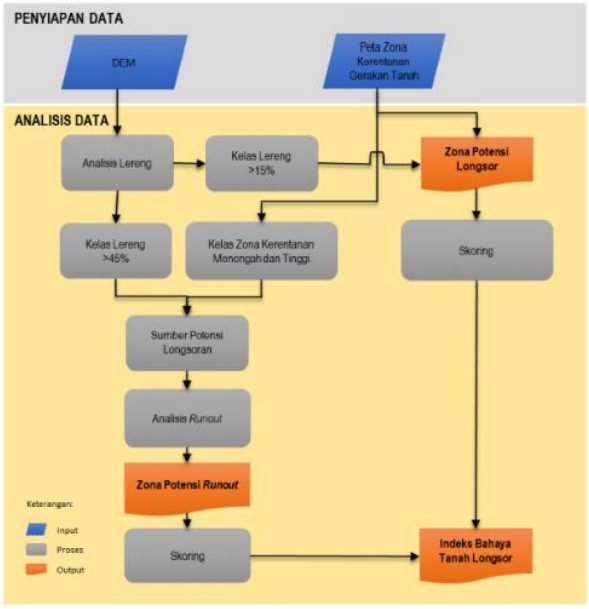

Figure 2. Flowchart of the Process for Making Landslide Hazard Index Map (BNPB **[10]**)

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

B. Vulnerability Analysis

Vulnerability analysis includes spatial analysis of social vulnerability, physical vulnerability, social vulnerability and environmental vulnerability. (Perka BNPB, 2012 **[8]**)

Social Vulnerability

In this study, the data used to calculate social vulnerability only uses population density data. In calculating population density, the data used is data on the number of residents per village divided by the area of settlements in a village, then each population density value is classified based on the social vulnerability parameter index. After that the population density polygon data is converted to a raster grid with a grid size of 30x30m. resulting in a social vulnerability index.

Physical Vulnerability

The parameters used for the physical vulnerability assessment include the number of houses, public facilities and critical facilities.

1. Houses: Based on the 2008 Village Potential (Podes) data, the average value of the population per house is 5 people/house, with reference to this figure the spatial distribution of the number of houses per grid (1 ha) can be analyzed using an approach based on the spatial distribution of density distribution. population.
2. Public Facilities: The parameter of public facilities (fasum) in the physical vulnerability study is the number of public facilities, namely buildings that function as public service places, which are potentially (vulnerable) to damage and cause losses in potential hazard areas in a village/kelurahan. The data on the distribution of public facilities used in this study is sourced from the toponym of RBI data on a scale of 1:25,000.
3. Critical Facilities: Critical facilities can be categorized as important types of infrastructure buildings that can malfunction when affected by a disaster. Types of fascism include airports, ports, power plants and others. The data on the distribution of critical facilities used in this study is sourced from the toponym of RBI data on a scale of 1:25,000.

Economic Vulnerability

1. GRDP contribution: The GRDP parameter in the economic vulnerability study is analyzed as the value of the sector's GRDP contribution related to productive land that can be directly impacted by disaster events. The GRDP of the productive land sector, especially the agricultural sector, can be measured and analyzed spatially with an approach to land use in an area. The types of agricultural sectors available in the GRDP data for each district/city can be compared with the land use/landcover data. Spatial analysis of the value of the contribution of GRDP for economic vulnerability can be carried out up to the village/kelurahan level.
2. Productive Land: The parameter of productive land in the economic vulnerability study is analyzed as the number of losses that can arise (potential) due to productive land which is generally agricultural land (food land, plantations, and inland fisheries) located in potentially affected areas (danger) disaster.

All processing of GRDP and Productive Land parameters were carried out on ArcGIS software with the results of each parameter being converted to a grid with a size of 30x30m.

Environmental Vulnerabilities

Environmental vulnerability consists of parameters of protected forest, natural forest, mangrove forest/mangrove, shrubs/shrubs, and swamp. Environmental vulnerability parameter analysis does not involve weighting between parameters because it is spatial data that does not intersect and can be directly available on land use/land cover data. Each parameter in the environmental vulnerability study is analyzed as the total area (Ha) of land with ecological functions that have the potential (affected) to experience damage due to being in a disaster (hazard) area.

Landslide Hazard Vulnerability Index

After all the data from the vulnerability component analysis are obtained, the next process is to create a vulnerability index map. The vulnerability index is a combination of all vulnerability components using the equation in the vulnerability component weight table with the syntax in ArcGIS software as follows:

FuzzyMembership((0.4 * "Social_Vulnerability Index100") + (0.25 * "Physical_Vulnerability Index100") + (0.25 * "Economic_Vulnerability Index100") + (0.10 * "Vulnerability_Environmental Index100"), FuzzyLinear(0, 0.4))

C. Land Capability Analysis

This analysis was conducted to find out how much land capacity can support efforts to use residential land. This land capability analysis is also to determine the physical factors of the land that are inhibiting and not hindering the effort to use land for settlements. The output of this analysis is in the form of a land capability class map (zoning) which consists of a possible area (development), a constraint area and a limitation area, which is an illustration of the level of land capability in the research area.

This land capability analysis intends to examine the level of land capability for residential areas in the study area based on basic physical aspects. This basic aspect is one of the materials needed in a city development plan. The physical aspects of the land capability in this analysis are known as the Land Capability Unit (SKL). Information on the physical aspects of the land capability in question and needed for settlement development are in the form of:

1. Land Morphological Capability Unit
2. Land Capability Unit Slope Stability
3. Land Capability Unit for Foundation Stability
4. Land Capability Unit Water Availability
5. Disaster Vulnerability Land Capability Unit
6. Unit of Land Drainage Capability
7. Land Capability Unit for Waste Disposal
8. Land Capability Unit Against Erosion
9. Land Capability Unit Ease of work

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

(Permen PU No. 20, 2007 **[7]**)

If the SKL above has been completed, then the next step is that all SKL maps that have been completed are scored and overlaid so that it will produce a map of the area's land capability.

D. Analysis of Settlement Land Suitability

The land suitability analysis method is the scoring method for each parameter class, then overlay the parameters and re-scoring for settlement land suitability analysis.

E. Analysis of Residential Land Use Directions

In the preparation of directives for the use of residential land, the results of the analysis are combined, such as: 1. Land Capability Analysis, 2. Analysis of the Suitability of Settlement Land, 3. Analysis of Landslide Hazards / Landslide Hazard Zone (ZRB), 4. Banjarnegara Regency Spatial Plan

F. Analysis of GAP with Banjarnegara Regency Spatial Plan

GAP analysis (gap analysis) is an analysis to see the suitability of land from the results between the analysis of the direction of residential land in the northern area of Banjarnegara Regency with the Spatial Pattern of the Banjarnegara Regency Spatial Plan (RTRW). This is done to find out whether the results of the direction of residential land in landslide-prone areas that have been carried out in the analysis of this research will later have differences in the spatial allocation in the spatial pattern plan that has been determined by Banjarnegara Regency.

G. Analysis of Landslide Disaster Mitigation Directions

This is an analysis to provide policy direction for disaster mitigation in residential areas, namely by looking at residential areas that are included in the landslide-prone zone (ZRB). Efforts to reduce the risk of landslides are through area relocation policies if they are in ZRB I (high), Protection through disaster mitigation infrastructure in ZRB II (medium) and Adaptation through zoning regulations or building infrastructure in disaster-prone areas at ZRB III (low).

H. Analysis of Population and Residential Land Capacity

The population analysis consists of an analysis of the population growth rate and the projected population which is calculated for the next 20 years, that is, until 2040 Population growth is the change in population over time, and can be calculated as the change in the number of individuals in a population using "per unit time" for measurement. Analysis of the population growth rate is sought to determine the increasing trend of population growth in an area or region.
In this study, to calculate the capacity of settlements based on the analysis of the direction of land use for settlements in each sub-district. So that it can be known whether the availability of residential land can be fulfilled for the next 20 years or not.

III. RESULTS AND DISCUSSION

Landslide Disaster Threats and Vulnerability

From the results of the analysis of the threat of landslides in the northern region of Banjarnegara Regency, there is a landslide prone zone of 73% of the study area, where the percentage for landslide hazard class consists of high hazard of 20%, medium hazard of 19% and low hazard of 61%. , this is in accordance with the results of field mapping conducted by Warnadi, W. **[11]**, that the landslide threat zone is concentrated in the Northern Region of Banjarnegara Regency. Landslide-prone zones in the Northern Region are in the range of 15-25% slopes of 5%, 25-40% slopes of 69% and >40% slopes of 27% of the area of landslide-prone zones, this indicates that the greater the level of erosion the greater the threat of landslides in the northern region of Banjarnegara, according to the results of the study. Istiadi & Priatna (2021) **[12]** stated that te physical characteristics of land with a slope of more than 60% have a vulnerability and a threat to the magnitude of landslides that occur. The condition of the soil structure that becomes a catalyst in this landslide disaster is related to the soil substrate, the amount of vegetation cover, land use, water infiltration, and water runoff when it rains.

The threat of landslide hazard certainly has an impact on social vulnerability (life), physical vulnerability (rupiah), economic vulnerability (rupiah) and environmental vulnerability (hectare) if the disaster occurs. From the results of the calculation of the level of social vulnerability, it threatens at least 21,763 people, of which 10% of the population in the Northern Region of Banjarnegara Regency, which is 223,036 people based on BPS data of Banjarnegara Regency in 2020, with the largest percentage of potential exposed lives in Pandanarum District, which is equal to 20% and the smallest percentage is in Pejawaran District, which is 3% of the total population in each sub-district. Meanwhile, for physical vulnerability to the threat of landslides in the northern region of Banjarnegara Regency, the potential for physical losses of Rp. 116,600,000,000 with the largest percentage is in Kalibening District, followed by Pandanarum, Wanayasa, Karangkobar, Batur Districts and the smallest is Pejawaran District.

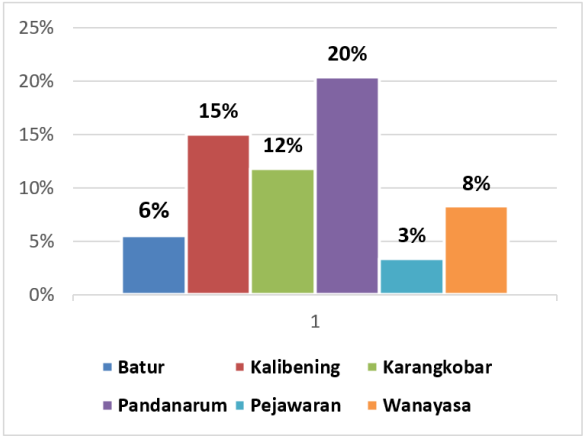

Figure 3. Potential lives exposed to the total population in each sub-district

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

For economic vulnerability in this study, the parameters used are the GRDP contribution in the food crops, plantation crops and horticultural crops sector, where the results of spatial calculations show the potential total economic loss of 19.6 trillion or 23% of the total GRDP of Banjarnegara Regency, which is 86 trillion. based on BPS data in 2020. For environmental vulnerability, there is a potential loss of 8,198 hectares or 68% of the total land cover area in the form of forests, shrubs, rivers and lakes in the Northern Region of Banjarnegara Regency. From the results of the spatial analysis of social, physical, economic and environmental vulnerabilities, the high vulnerability class is 133.6 hectares or 1%, the medium vulnerability class is 4815.7 hectares or 45% and the low vulnerability class is 5871.1 or 54 % of the total area of the landslide-prone zone.

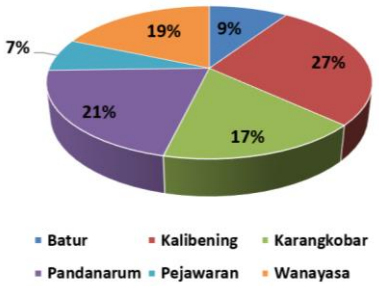

Figure 3. Percentage of potential physical loss

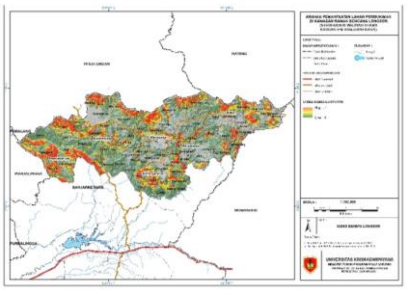

Figure 4. Landslide Hazard Index Map

From the results of the percentage of vulnerability above, it is also strengthened in the research conducted by Susanti **[13]** which states that the category that is very vulnerable to landslide hazards is in the sub-districts of Wanayasa, Karangkobar, Pandanarum and Kalibening.

Capabilities and Suitability of Settlement Land

The land capability in the Northern Region of Banjarnegara Regency has a medium development capability class of 4,689 hectares or 12% and sufficient development capacity of 33,695 hectares or 88%. If the ability of this land is overlaid with a map of the landslide-prone zone, the result is that in the medium development zone as a whole it turns out to be in a disaster-prone zone, meaning that the development of residential areas in the moderate development zone is very unlikely or limited to low disaster-prone zones. ZRB 3). As for the sufficient development zone, it turns out that only about 31% of the zone area is in the Non-ZRB zone, meaning that this area has the potential to be developed for the development of residential land directions, while the remaining 69% of the development zone area is quite included in the ZRB, meaning this area not safe enough for settlement development and has a threat of landslide hazard.

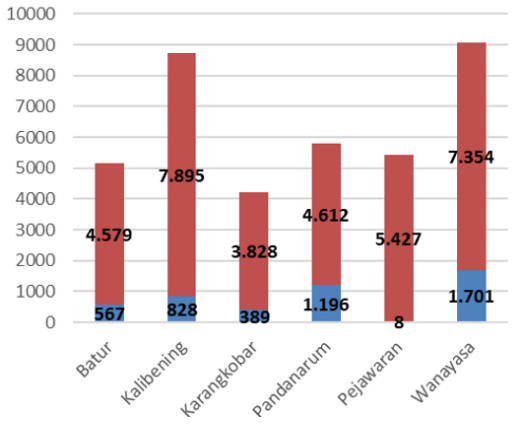

Figure 5. The area of land capacity of each district

From the results of the analysis, it can be concluded that the land capability is found to be 10,326 hectares of land or 27% of the northern area of Banjarnegara Regency, and the land area is land that is safe from the threat of landslides and can be developed for residential land direction. Meanwhile, from the analysis of the suitability of residential land, it was found that the very suitable class was 4%, the appropriate class was 43%, the less suitable class was 51% and the unsuitable class was 2%. If this land suitability is overlaid with a landslide-prone zone (ZRB), it is found that the suitability class is very suitable, 90% of the area is a Non-ZRB zone, and only 10% is included in the ZRB, while for the appropriate class, 48% of the area is a Non-ZRB zone. - ZRB and 52% goes into ZRB. For classes that are not suitable, 6% are included in the Non-ZRB zone and 94% are included in the ZRB, while for classes that are not appropriate, the whole area is included in the ZRB.

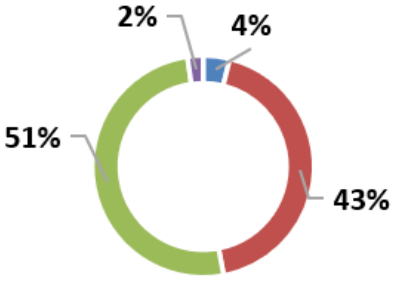

Figure 6. Percentage of suitability of residential land

From the results of the analysis, it can be concluded that the suitability of residential land in the very appropriate class and the appropriate class in Non-ZRB has an area of 9,208 or 24% of the total area in the northern region which is

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

an appropriate area for the development of residential land that is safe from the threat of landslides. . Meanwhile, from the results of research by Permana **[14]** it was found that the suitability of residential land in the entire Banjarnegara Regency was only 32.03%.

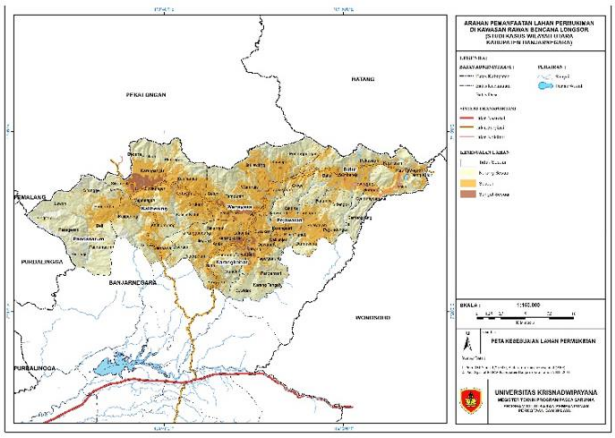

Figure 7. Land Capability Map

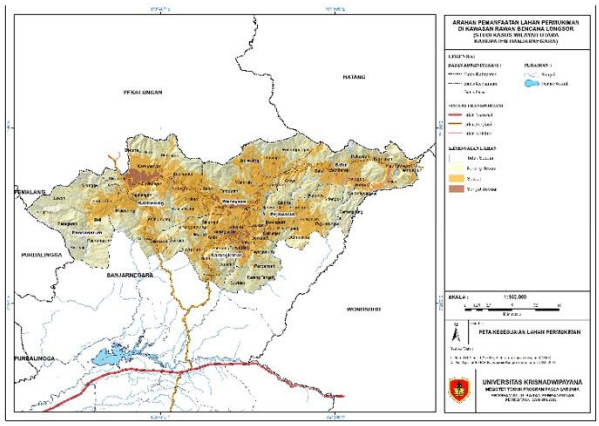

Figure 8. Map of Suitability of Settlement Land

Directions for Use of Settlement Land

The direction for the use of residential land in the Northern Region of Banjarnegara Regency was found to be 5,790 hectares or only 15% of the total area of the northern region of Banjarnegara Regency, where the existing condition of land use in the direction of land use for settlements is dominated by dry fields/fields of 60.18%. , settlements and places of activity 13.63%, shrubs 9.83%, more details can be seen in the table below.

From the table above, it can be seen that the direction of land use for settlements in the northern region of Banjarnegara Regency can be developed on land cover in the non-built land use typology of 85% and the built-up area typology of 15%.

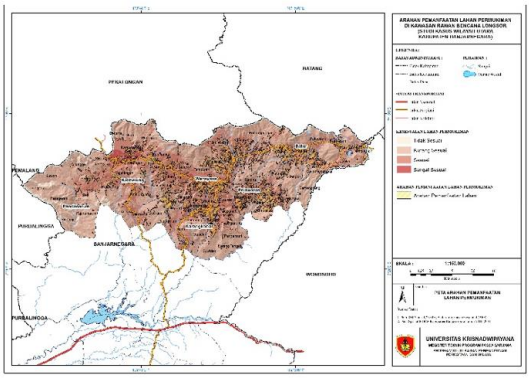

Figure 9. Directional Map for Settlement Land Use

The designation of settlements in the spatial pattern plan in the Northern Territory of Banjarnegara Regency is 2,444 hectares and when viewed from the suitability of the direction of residential land only 52% are appropriate, while 48% are not in accordance with the direction of residential land. So it can be concluded that the product of the Banjarnegara Regency spatial plan has not paid attention to the landslide disaster aspect.

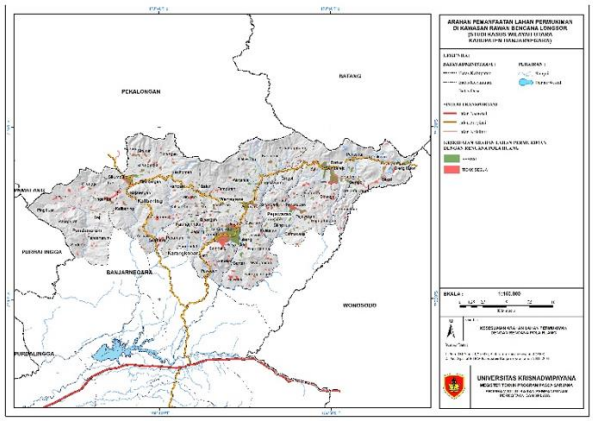

Figure 10. Map of Conformity of Settlement Spatial Pattern Plan with Settlement Land Utilization Direction

As for the direction of landslide disaster mitigation in the Northern Region of Banjarnegara Regency based on the overlay map of the landslide Hazard Zone (ZRB) with the use of existing residential land, it was found that the area of settlements within ZRB 1 was 10 Ha with recommendations for relocation directions to land locations that were safer from the threat of landslides. based on the recommended land use direction for settlements, for settlements located in ZRB 2 covering an area of 132 Ha with recommendations for disaster mitigation directions in the form of area protection and settlements located in ZRB 3 covering an area of 436 Ha with recommendations for disaster mitigation directions in the form of regional adaptation.

Volume 04, Number 02, September 2021, Page 42-49
e-ISSN: 2615-3750 ; p-ISSN: 2615-3769

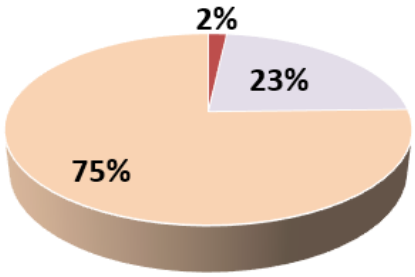

Figure 11. Percentage of Disaster Mitigation Directions in Landslide Hazard Zones

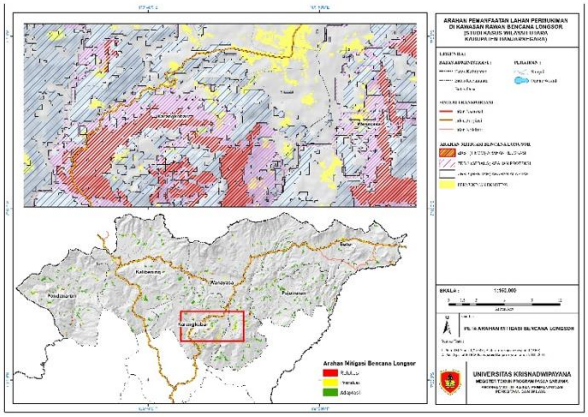

Figure 12. Longor Disaster Mitigation Direction Map

From the graph above, the percentage of landslide disaster mitigation directions in residential areas that are in the landslide Hazard Zone (ZRB), namely for relocation is found to be 2%, area protection directions are 23% and adaptation directions are 75%. While the results of the analysis of the projected needs for residential land in the Northern Region of Banjarnegara Regency in 2040 it was found that the need for residential land reached a total of 1,574 Ha, where the largest residential land requirement was in Kalibening District and the lowest residential land requirement was in Pandanarum District. Based on the results of demographic analysis and land use directions, the availability of land in the development of settlements that are safe from the danger of landslides in the Northern Region of Banjarnegara Regency is still sufficient with the largest area of land available for settlement in Wanayasa District and the lowest in Pandanarum District. In detail, the projected population, number of households (KK), residential land needs, area of settlement direction and the backlog of residential land can be seen in the table below:

IV. CONCLUSION

Based on the results of the analysis that has been carried out on the Directives for the Suitability of Settlement Land in Landslide Hazard Areas in the Northern Region of Banjarnegara Regency, among others The results of the study found that the landslide hazard level was MEDIUM and HIGH with a total area of high landslide hazard class of 5575.77 Ha and medium hazard area of 5244.66 Ha. While the vulnerability index to landslide hazard has LOW, MEDIUM and HIGH levels of vulnerability with a total area of 5,871 Ha for low vulnerability, 4,815.7 Ha for medium vulnerability and 133.6 Ha for high vulnerability. while the potential lives exposed to the danger of landslides is 21,763 people, the potential physical loss is Rp. 116.60.000.000,-, the potential economic loss is Rp. 19.602. The land capability in the northern area of Banjarnegara Regency has a MEDIUM DEVELOPMENT CAPABILITY Zone class with an area of 4,689 Ha and ENOUGH DEVELOPMENT CAPABILITIES with an area of 33,695 Ha. The results of the analysis of the suitability of residential land in the northern region of Banjarnegara Regency, the land area in the VERY APPROPRIATE category is 1,482 Ha (4%), the SUIT category is 16,576 Ha (43%), the INCOMPATIBLE category is 19,454 Ha (51%), and INCOMPATIBLE category covering an area of 871 Ha (2%). The projected need for residential land in 2040 found that the need for residential land with a total area of 1,574 Ha. From the results of the analysis of the direction of land use for settlement development in the Northern Region of Banjarnegara Regency, it has a total area of 5,790 Ha, with a level of conformity with the settlement pattern plan with an area of 1.263 Ha (52%) and an DISAPPOINTMENT category of 1,181 Ha (48%) . Landslide disaster mitigation directions for residential areas that are in the landslide Hazard Zone (ZRB), namely for relocation are found to be 10 Ha (2%), area protection directions are 132 Ha (23%) and adaptation directions are 436 Ha (75%) . The need for land for the development of settlements in the Northern Region of Banjarnegara Regency is still sufficient with the availability of surplus land of 4,216 Ha.

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