The Analysis of Vulnerability and Resilience Level of Das Samin Downstream Society in Facing Flood Disaster in Spatial Perspectic

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Abstract. The purpose of this research is to map the level of flood vulnerability and to know the level of resilience of Das Samin community in facing flood disaster. Mapping of flood prone areas is one of the non-structural flood control methods, while the twenty first century flood prevention paradigm is making harmony communities with floods. Analysis of flood prone areas using scoring with the help of Geographic Information System on four parameters of vulnerability that is Rainfall, Land Use, Soil Type and Slope Tilt. While resilience level analysis using resilience scale from Carron-Davidson Resilience scale with 25 questions obtained with questionnaires. The results of the flood vulnerability parameter data include Rainfall (1000 - 1.500, 1500-2000 mm/year), Land Use (Rice and Settlement), Soil Type (Gromosol, mediteran and alluvial) and Slope (0-2%) so that the result is Das Samin Downstream area has a level of vulnerability very high. While the resilience of the community with questionnaires of 50 respondents in the results that the community Das Samin Downstream has a very high resistance in the face of flooding average 117,28 so is very resistance.

1. Introduction

Indonesia is an area prone to and potentially natural disasters such as floods, floods caused by overflowing water flow through river cliffs and causing permanent inundation. Flood is one of the processes in the stages of river formation. When the area that should only be reserved for the river is used by humans then that's when the flood that was previously referred to as a natural phenomenon turned into a natural disaster [1][2].

Indonesia is a country that has a very high disaster potential. In the period of January to February 2013 alone, floods hit almost all regions in Indonesia [3]. With predictable time, flood disaster should be anticipated so that loss of property and casualties can be minimized. However, the limited ability of disaster management from pre-disaster, during disaster and post-disaster, makes flood always an unresolved classic problem. (www.lipi.com).

Flood is a river flow event that is relatively larger than normal due to rain down in the upstream or in a certain place continuously, so that cannot be accommodated by the existing river channel, the water overflows out and inundate the surrounding area [2][4].

Based on the results of the study of disaster occurrence data that occurred in recent years shows that hydro meteorological disasters such as floods often threaten in the Samin River Basin area [5][6]. The Samin watershed is part of the upstream Bengawan Solo river basin which is one of the 108 critical watersheds in Indonesia based on Ministry of Forestry Decree No. 328/Menhut-II/2009. The current

condition of the Samin watershed is critically indicated by the amount of erosion and sedimentation that potentially floods occur. The impact that is felt deeply in economic terms as experienced by most people who may not have time to save their property during the flood is Damage to house building, threat of crop failure and psychological impact. Psychological impacts such as stress and shock due to their possessions disappeared due to floods, traumas, and so on which not only felt by the general public, but also large or small companies are also disturbed by the flood. The delivery of raw materials and the distribution of products cannot run smoothly, consequently large losses cannot be avoided. Even in Indonesia, although the timing of floods varies almost all regions experience significant harm. Losses and damage from floods account for two-thirds of all-natural disasters occurring [1][7][8].

Flood disaster control techniques have been undertaken by the government so far, but still dominated by structural approaches (technical buildings) and non-structural approaches to socio-economic, but still rarely touch on the resilience of society. Disaster events experienced by individuals, received as a stimulus that provides experience and affect the level of readiness of a person in the face of disaster. Disasters will provide learning processes that benefit individuals in shaping preparedness behavior. The learning process is reflected through the preparatory steps taken by the community, so as to minimize the victims and the psychological impact of the disaster. This readiness behavior is also supported by the individual's ability to bounce back from the trauma events that have occurred. This ability is then referred to as resilience [9] [10].

Resilience is an illustration of the process and outcome of success adapting to difficult circumstances or challenging life experiences, especially those with high levels of stress or traumatic events. Resilience is the ability to cope and adapt to severe events or problems that occur in life. Persisting in a state of distress and even dealing with adversity or trauma experienced in his life. Resilience is an indicator of the sustainability of a person's life that lives in difficult situations. When a person is in a difficult situation one tends to be depressed and at a critical time.

Resilience is principally concerned not only with a person or a community that has been affected by a disaster. Because resilience also covers before the disaster occurs. If resilience is in the aftermath of a disaster event, it would include part of a temporary recovery and response if before the disaster becomes a subset of mitigation and preparedness. The level of resilience a person will provide preparedness for a person or society in the face of the disaster that will occur. Similarly, the level of resilience of a person or society determines how to recover and respond to disasters. Therefore, for a person or society with a low resilience level, the person or community is not only vulnerable to disasters but will also slow recovery after the disaster [11].

This study aims to determine the level of flood vulnerability and the level of community resilience in areas prone to flooding Das Samin. The vulnerability in the research is used as a bridge of researchers to conduct more in-depth study of flood-affected areas, in addition to the objectives of this study, the availability of spatial information on flood prone areas and the level of community resilience in the flood-prone areas of Das Samin [12].

2. Literature Review

Flood is the process of overflowing the flow of water in the river channel over the river bank (over top bank). Floods are often distinguished by inundation from the angle of water movement. Inundation is caused more by water that flows slowly or even stagnant.

Basically, flooding is caused by overflow of water that occurs in the channel or river. Can happen anywhere, in high places and low places. As the water falls to the surface of the earth in the form of rain, the water will flow to the lower place through the channels or rivers in the form of a partial surface stream will enter into the soil (infiltration) and some of it will evaporate into the air (Evapotranspiration).

Insecurity and vulnerability are two different things. Vulnerability is a condition of a community or society that leads or causes an inability to deal with disaster threats. Vulnerability of the region into two types: biophysical vulnerability and social vulnerability. Biophysical vulnerability is a vulnerability associated with the built environment. While social vulnerability is a vulnerability that is related to social, economic and political conditions that affect the occurrence of disaster. Then the definition of

disaster vulnerability is a geological, biological, hydrological, climatological, geographical, social, cultural, political, economic, and technological conditions in a region for a period of time, to reduce ability, prevent, dampen, achieve readiness to respond to adverse impacts Certain hazards.

Flood vulnerability is a condition that describes whether or not an area affected by flood is based on natural factors affecting flood, such as meteorological factor (rainfall intensity, rainfall distribution, rain frequency and duration of rain) and characteristics of Rainfall Areas (DAS) such as slope, altitude, soil texture, drainage density and land use.

In this study the researchers used four indicators in determining the level of flood vulnerability are: Rainfall, Slope, Soil Type, and Land Use.

2.1. Rainfall
Areas that have high rainfall then the area will be more influential on the incidence of flooding. The higher the rainfall the higher the vulnerability score. Table 1 scores for the rainfall thickness parameter.

Table 1. Rainfall Parameter Score

No.	Class	Number Rainfall Parameter (mm/year)	Score
1	Very wet	> 3.000	5
2	Wet	2.501 – 3.000	4
3	Medium	2.001 – 2.500	3
4	Dry	1.501 – 2.000	2
5	Very Dry	< 1.500	1

2.2. Slope
The inclination of the slope is a degree of surface altitude affecting the infiltration rate. Slope Classification is explained in Table 2.

Table 2. Score Slope Parameters

No.	Slope	Grayscale	Score
1.	0-8 %	is flat area and ramps	5
2.	8-15 %	is a bumpy area until hilly	4
3.	15-25 %	is hilly area	3
4.	25-40 %	is hilly to mountainous area	2
5.	>40 %	is a mountainous area	1

2.3. Type of soil
The soil comes from weathering rocks with the aid of organisms, forming a unique body covering rocks. The process of soil formation is known as " pedogenesis ". This unique process forms the soil as a natural body made up of layers or called the soil horizon. Each horizon tells about the origin and processes of physics, chemistry, and biology that the body of the land has gone through. The soil type affects the strength of water to seep into the soil, the smaller the pores of the soil the harder the water enters the soil, the vice versa the larger the pores of the soil the ability to absorb more water, thus not affecting the flood. Table 3 is a score for soil types.

Table 3. Scores of Land Type Parameters

No.	Type of Soil	Score
1	Alluvial glei, Planosol, Hydromorphic grey	1
2	Latosol	2
3	Brown forest soil, mediteran	3
4	Andosol, laterite, gromosol, kezina	3
5	Regosol, litosol, gromosol, renzina	5

2.4. Land Use
Land use is closely linked to human activities and land resources. The rapidly increasing population has resulted in high utilization of land resources. Land use of an area affects the hydrology of the area and

changes in land use means changing the type and proportion of land cover which further affects the hydrology. It can be said that the vegetation cover changes affect the surface runoff characteristics (runo ff).

Table 4. Scores of Land Use Parameters

No.	Class	Score
1	Water Body (Lake, Pond and River)	5
2	Mangrove and Rice Forest	4
3	Settlements and Grasslands	3
4	mixed gardens	2
5	Forest	1

2.5. Flood Disturbed Area

Mapping of flood prone areas is an effort to present data in the form of numbers or writings about the distribution of floods into the form of maps so that the distribution of data can be directly known easily and quickly. Mapping of the spread of flood areas is known by scoring and overlaying of each parameter. Mapping of flood-prone areas is made by means of data that have been obtained are: rainfall, slope, soil type, and land use, and added with high flood, long flood, and the frequency of floods that ever happened that has done. For giving the value (score) adjusted to the influence or potential occurrence, so that the parameters that have the potential for the flood then the greatest price, while the parameters that have the potential for a small flood then the price is small. For weighting each parameter determining flood vulnerability is assumed to be the same. This means that each flood determinant parameter has the same effect on flood vulnerability. To determine the classification of flood vulnerability, then the summation of each flood parameter is rainfall, slope, soil type, and land use. After the sum, then grouped according to the classification level of vulnerability. Overlay is done after each data that has been scored and weighted. The result of overlay in the form of map prone to flood. To present data indicating the spatial distribution or location of its data properties, this information should be indicated in the form of a map.

Vulnerability analysis using spatial analysis by doing thematic overlays (overlay) to obtain the vulnerability index with the following formula:

Nkb = Ch + K + Jt + P
Nkb: flood vulnerability value
Ch: average rainfall
K: slope / slope
Jt: Soil type
P: land cover

The total sum of these values is information in the form of category level indicators, which are safe, low, medium and high, as shown in Table 5.

Table 5. Indicators of flood vulnerability levels

No.	Number weighted values	Flood prone level
1	4 - 8	Safe
2	9 – 12	Low
3	13 – 16	Medium
4	17 - 20	Height

3. Methods

3.1. Research Area

This research was conducted in flood prone area of Das Samin Hilir in Sukoharjo Regency especially in flood affected areas in Tegalmade Village, Pandeyan Village, Pranan Village, Bugel Village and Ngombakan Village.

The research method used in this research is descriptive qualitative method hope is obtained empirical data/factual about level of vulnerability and resilience level of society downstream das samin in facing flood. The administrative research map can be seen in figure 1.
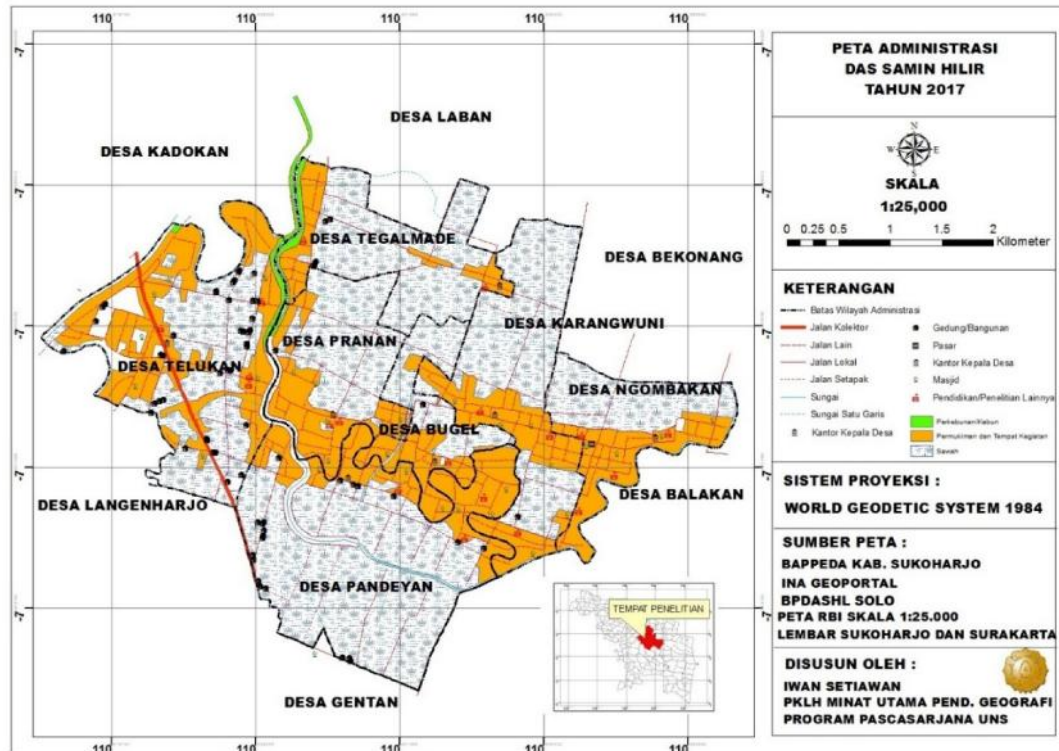

Figure 1. Administratif Research Map

3.2. Data collection technique

3.2.1. Observation. Observation data includes observation of boundaries and depth of flood identified from stagnant or inundated spots on walls or roads and forms of protection against floods such as embankments, gutters and sluices.

3.2.2. Interview
Interviews were used to identify the chronology of flood events such as (when floods, flood depths, puddle lengths, flooding and flooding).

3.2.3. Questionnaire. Questionnaires used in this study were used to determine the level of resilience of flood victims in downstream samin dams, Questionnaire preparation based on the relic level measurement according to Connor-Davidson Resilience Scale (CD-RISC), there are 25 indicators to determine the level of resilience of flood victims in das Samin. The scale, made in 5 ranges of response options, are: (1) No (2) Rarely (3) Sometimes (4) Often (5) Yes.

3.2.4. Documentation. Data analysis of flood vulnerability measured in this study used 4 indicators of vulnerability i.e. rainfall, slope, soil type, and land use, data / indicators obtained from relevant agencies or from supporting documents of the 4 indicators are then performed Overlay and scoring by using GIS application (Geographic Information System) so as to produce a map of Flood Rate in Samin Hilir Basin. Data analysis to determine the resilience level of Samin Hilir Watershed population using Resilience questionnaire from Carron and Davidson scale (CD-RISC) with 25 items of question then each item question is given a score of at least 1 and maximum 5 so the lowest score is 25 and the highest score is 125. Then from the scores are analyzed with parameters.

Table 6. Resilience score parameters

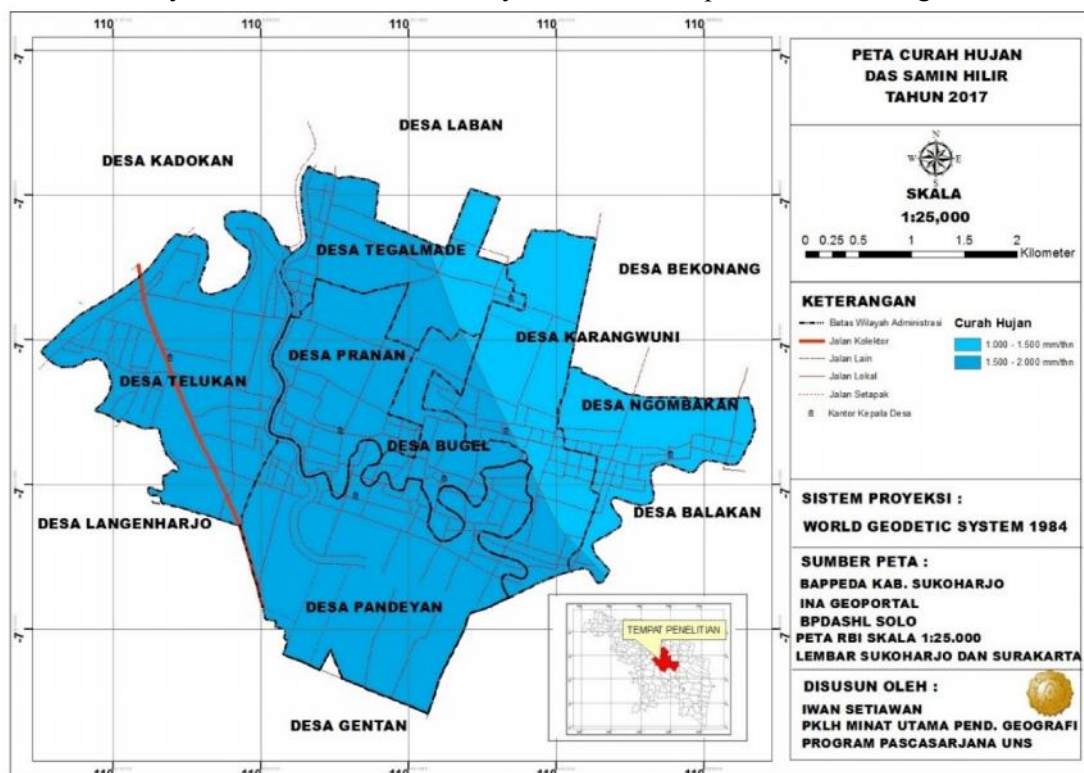| No	Parameter	Value Score
1	Very No Resilience	25 - 45
2	No Resilience	46 - 65
3	Rather Resilience	66 – 85
4	Resilience	86 – 105
5	Highly Resilient	106 - 125

3.3. Sampling

Samples are some members of the selected population using certain procedures so that they are expected to represent the population. In this study the sampling using Random Sampling. Sampling using Random Sampling technique is done to overcome the limitations of time, effort and cost but not reduce the prevalence rate and data obtained. Because of using Random Sampling method, there are several criteria in determining the respondent's population, among others: Respondent must be above 17, Respondent has experienced flood, Respondent has been living in Das Samin Hilir for at least 3 years. The number of samples to be taken as many as 50 respondents, each village taken 10 respondents.

4. Results and Discussion

Based on data analysis done by overlay some data that is Rainfall, Slope, Soil Type and Land Use in get result as follows.

4.1. Rainfall

Based on rainfall in Das Samin Hilir it is found that the average rainfall in Das Samin Hilir is between 1000 -1,500 mm / year and 1,500- 2,000 mm / year. Rainfall map can be seen in figure 2.

Figure 2. Rainfall Map

4.2. Slope

Based on slope data (Figure 3), it is found that the slope of slope in Das Samin downstream is 2% so it is included in flat category.
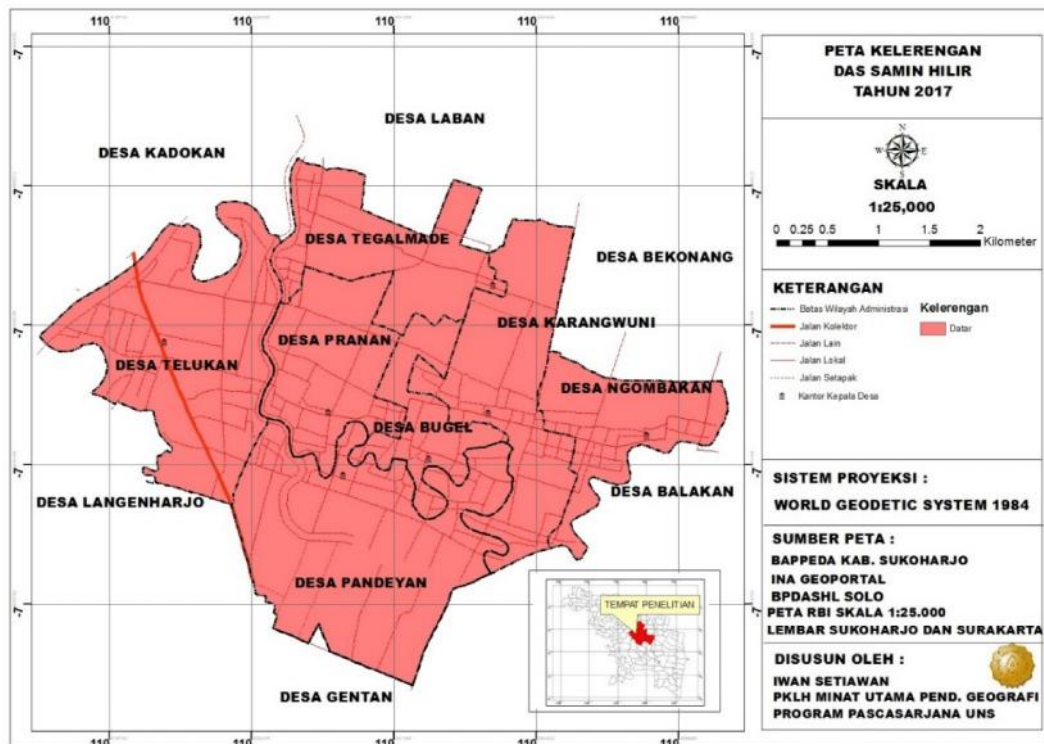
Figure 3. Slope Map

4.3. *Type of soil*

Based on data of soil type in get data that type of soil in Das Samin downstream mostly dominated by Gromosol, Mediteran and Alluvial.
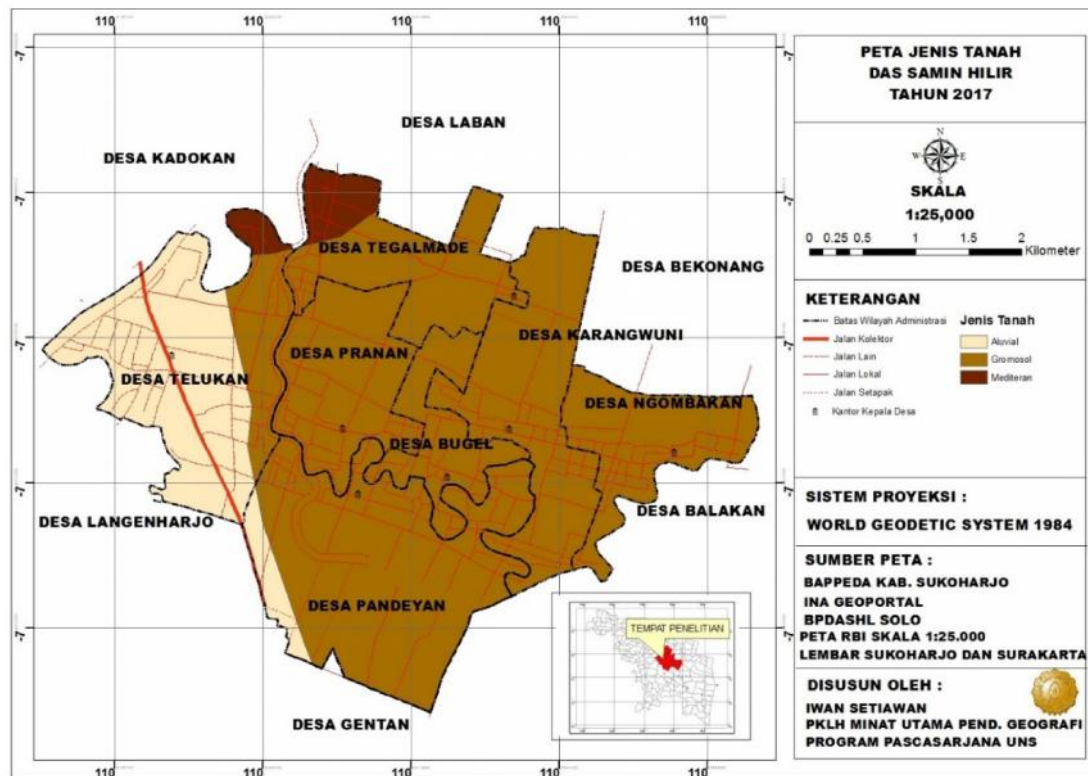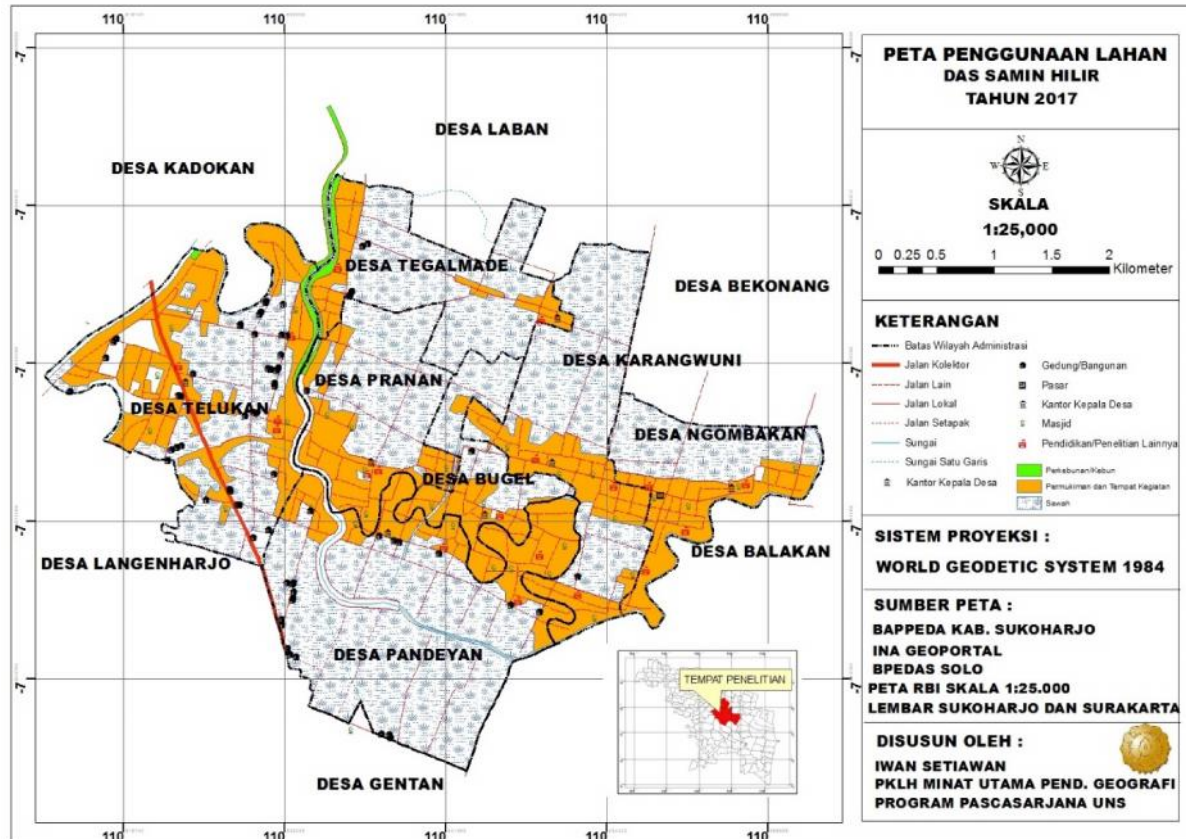

Figure 4. Type of Soil

4.4. Land Use

Based on Rupa Bumi Indonesia map and data from Bappeda Sukoharjo Das Samin Hilir dominated by settlement, rice field, and plantation.

Figure 5. Land Use

4.5. Map of Flood Hazard in Das Samin

After getting the data of 4 indicators causing floods in Das Samin Hilir include rainfall, slope, soil type, and land use, overlay is done and it is concluded that Das Samin Hilir is included in the category of Flood Hazard Area but flood in Das Samin Hilir Including the type of flood shipment, as seen from several indicators that are not high rainfall both in the downstream and upstream, land use is dominated by rice fields and settlements, soil type gromosol capable of absorbing water and slope flat slope so that water cannot flow quickly , This is what causes the Das Samin Hilir area prone to floods, coupled with the dysfunction of water gateways in the sub Das Samin which when the flood is not open, causing water inundated in the homes of residents around sub das samin. Red is a village that is often flooded, while the color pink is a village that rarely stagnant water.
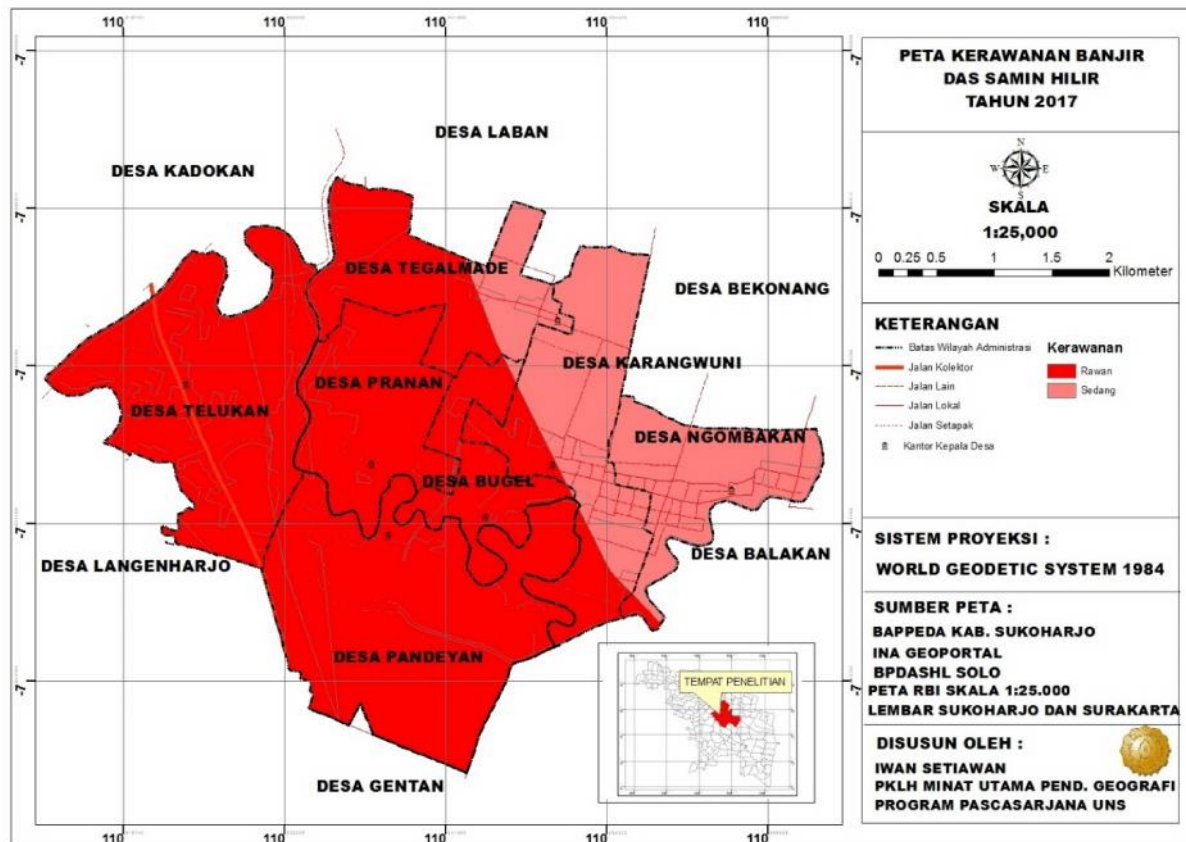
Figure 6. Map of Flood Hazard

5. Conclusions

Potential level of vulnerability in Das Samin Hilir consists of 2 classes that are vulnerable and moderate, where classification is vulnerable in 4 villages namely tegalmade village, pandeyan village, bugel village, and pranan village. As for the village ngombakan pertained moderate from flood threat. For the resilience level it is found that the resilience of the people in the five villages is high because the people are able to adapt to the flood, when it rains 5 hours, the people in 5 villages are ready to alert by telephone their sister in Das Samin upstream and middle, preparing food, making house levels, and making placemat from wood.

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