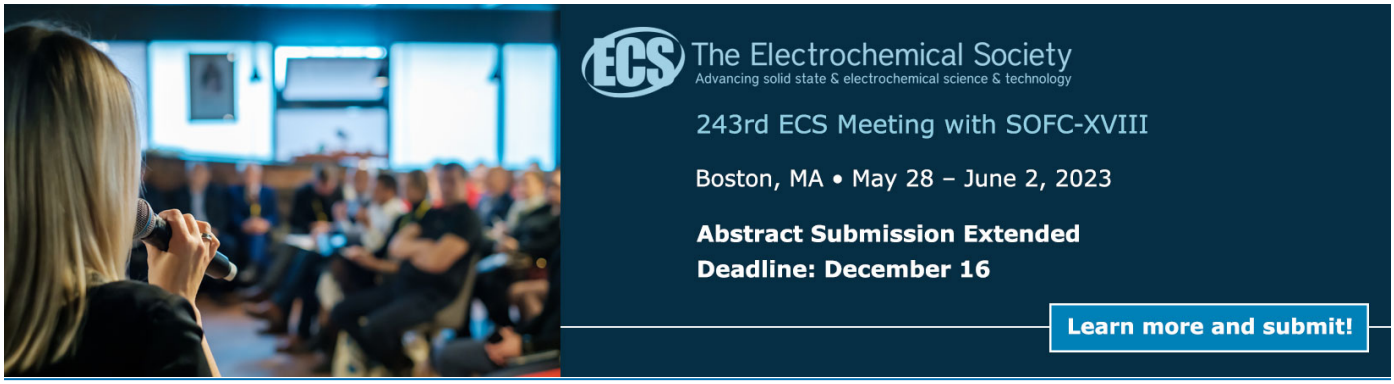
Analysis of flood prone areas in the Walanae Watershed, Dua Boccoe District, Bone Regency



Analysis of flood prone areas in the Walanae Watershed, Dua Boccoe District, Bone Regency

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Abstract. This research is important to do to improve flood disaster management in the Walanae Watershed, with the aim of researching and analyzing the most effective appropriate land use to reduce the risk of flooding and damage. This research was carried out in the Walanae Watershed, Dua Boccoe District, Bone Regency, South Sulawesi Province. Appropriate land use that is most effective in reducing the risk of flooding and damage is analyzed descriptively qualitatively with the Overlay approach. Assuming that the process produces data from the findings in the form of field observations. The impact of appropriate land use that is most effective in reducing the risk of flooding and damage is measured using the basic physical condition analysis method, this superimpose analysis is used to determine flood-prone areas based on several aspects and a qualitative descriptive analysis will clearly describe the impacts that have been caused by floods. The results showed that there are 8 sub-districts/villages that have the potential for flooding, including Unyi Village, Uloe Village, Pekkasalo Village, Kampoti Village, Tocina Village, Tawaroe Village, Solo Village, and Matajang Village. With an area of 131 km^2, and an existing inundation height of ±100–200 cm and an inundation period of 10 hours, Dua Boccoe Subdistrict has the potential to be affected by flooding. Floods in Dua Boccoe Subdistrict are caused by internal factors: Topography, Drainage Infrastructure, Building Density, and Land Use and others as well as external factors: Topography, and Shipment Floods.

1. Introduction

Flood disaster is a natural phenomenon that occurs in areas that are flowed by many rivers. Flood is a relatively high flow of water and is not accommodated by a river channel or channel [1]. The intensity in a place and the number of locations in a year is about 40% among other natural disasters. Even in certain places, flooding is an annual routine. The location of the incident can be urban or rural, developing countries or even developed countries [2]. According to the Ministry of Public Works, flooding is a relatively high flow of water on the surface of the ground and cannot be accommodated by drainage channels or rivers, so that it overflows to the right and left and causes inundation/flows in amounts exceeding normal and resulting in losses to humans [3]. Flood is a flow/puddle of water that

causes material, economic or even loss of life [4]. Flood disaster is a natural phenomenon, which occurs because it is triggered by natural processes and uncontrolled human activities in exploiting nature wildly. Natural processes are highly dependent on rainfall conditions, groundwater system, geological structure, rock types, geomorphology, and land topography. While human activity is related to behavior in exploiting nature for human welfare, so it will tend to damage the environment, if carried out with high intensity and less controlled [5]. Flood disasters can occur at any time and often result in loss of life and property. Flood events cannot be prevented, but can only be controlled and the impact of the losses they cause can be reduced. The number of flood disasters shows that the problem of flooding is a serious problem and requires productive steps to reduce the danger of flooding. Flood events, both large and small scale, should be used as learning materials. To overcome the flood problem as in the cases above, both central and regional governments must play an active role, not only solving problems and post-flood victims, but also taking preventive measures so that flood intensity can be reduced through various policies related to land/regional resources [6].

Various problems related to flooding and many other applications prove that these problems can be solved through detailed planning and project studies of flood prone areas. Determining flood-prone areas is very important for decision makers for planning or managing activities [7]. Proper land use planning measures are the most effective way to reduce the risk of flooding and damage. For this reason, land use planning that is appropriate and in accordance with considering disaster aspects, especially floods is important to be carried out and integrated into spatial planning. Dua Boccoe sub-district is a sub-district in Bone Regency which has been frequently hit by floods for the last 20 years [8]. The sub-districts in the north are Bone Regency, which borders on the northern part of Wajo Regency, and four sub-districts in the west, namely Ajangale District and Amali District, in the south it borders on Tellusiattingnge District, and in the east with Cenrana District. With an area of Dua Boccoe District, which is 14,490 km^2, which consists of 22 sub-districts/villages. Besides, because of the geographical condition of this sub-district, it is located in a low area so that it is often hit by floods from Soppeng Regency and Wajo Regency which are in a slightly higher geographical position.

If the rainfall is high then automatically part of this sub-district will be flooded. In the west of Unyi Village, Uloe Village, and Tawaroe Village, there is Ujung Lake in the form of swamps and the Unyi River in the east which divides Uloe Village and Unyi Village. The Unyi River empties into the Walanae River Basin. If the villages in the Mount Able area (Cabbeng Village) have high rainfall, the Unyi River will overflow. Under these conditions, the Unyi River Flood was held back in Uloe Village because the Walanae River Basin was no longer able to accommodate those who also received flood shipments from Soppeng and Wajo. The Walanae Watershed consists of 7 (seven) Sub-Watersheds, namely; Batu Puteh, Malanroe, Mario, Minraleng, Sanrego, and Walanae. Of the seven sub-watersheds, most of them have an elongated shape, only the Malanroe and Walanae Hilir sub-watersheds have a radial shape. Meanwhile, the flow pattern is dominated by a medium dendritic pattern with the lowest flow density 72 m/ha (downstream walanae) and the highest 318.74 m/ha (middle walanae). With an average river flow upstream of 243.50 m^3/second and 91.87 m^3/second downstream [9]. Looking at the chronology of the flood disaster, flooding in Bone Regency, especially Dua Boccoe Subdistrict, was caused by 3 (three) factors according to the Regional Disaster Management Agency (BPBD) of Bone Regency, namely high rainfall, sending flooding, and silting of the Walanae River Basin. The Walanae River that crosses the Bone Regency area needs to be normalized, especially the Cenranae River area to the Bone Bay, including the revitalization of small swamps along the left and right of the watershed. If this is done, it can minimize flooding and erosion rates along the Walanae River Basin.

2. Methodology

This research is descriptive qualitative or applied research which includes survey research, namely research that aims to describe the level of flood vulnerability in the Walanae River Basin, Dua Boccoe District, Bone Regency, which is currently occurring and the possibility of future occurrences. Researchers took the study location as the object of research, namely because in Dua Boccoe Subdistrict is an area that often occurs periodic flooding disasters which are usually caused by the overflow of the

Walanae River Basin and bad habits of the community which often cause floods to occur at the research location.

The types of data collected are divided into two types, namely primary and secondary data. Primary data is data obtained from the original source or the first source through direct observation to obtain the required information or data. Primary data needed include: 1) Land use/existing data and 2) Altitude conditions and causes of flooding from the results of community observations. The secondary data, namely data obtained or collected by visiting places or institutions related to research. This secondary data can be in the form of literature, documents, and reports related to the research conducted. Secondary data needed include:

a. Topography and slope
b. Soil type, rainfall conditions, and land use.
c. Flood characteristics
d. Population Demographic Data of Dua Boccoe Subdistrict.
e. Maps that support research

The collected data will then be analyzed through two methods, namely:

a. Analysis of basic physical conditions, is used to analyze data by describing the state of natural physical conditions that occur in the research area to be further classified based on the objectives achieved. Analysis of the natural physical conditions of the research area, including topography and slope analysis, soil types, rainfall conditions.
b. This superimpose analysis is used to determine flood-prone areas based on several aspects, including slope, soil infiltration classification, rainfall intensity and land use patterns in an area based on ratings and weighting, while the procedure for assigning grades and weights refers to previous studies as well as the Ministry of Public Works guidelines.
c. Qualitative descriptive analysis will clearly describe the impact that has been caused by the flood disaster in Dua Boccoe District from the results of field observations. This analysis is also used to analyze data by describing the state of the observation area according to the data obtained, while descriptive qualitative analysis is used to analyze land use and physical conditions such as topography, slope and hydrology and flood characteristics. This analysis is also used to determine the direction of flood disaster mitigation in Dua Boccoe District, Bone Regency.

From the results of the analysis, the classification of the level of flood vulnerability was obtained with the lowest score of 36 and the highest score of 65. The classification of the level of flood vulnerability was obtained by the formula (equation 1):

$$K_i = \frac{65-36}{5} = 5{,}8 \quad (1)$$

Based on the results of the calculation of the flood susceptibility class interval, it is obtained that the flood susceptibility class interval is 5, it is known that:

a. Non-prone score = 36 – 40
b. Score less prone = 41 – 45
c. Score rather vulnerable = 46 – 50
d. Prone score = 51 – 55
e. Very vulnerable score = >56

3. Result and discussion

3.1. Area Physical Condition

3.1.1. Topography. Based on the results of contour data and field observations, the topographical conditions of Dua Boccoe Subdistrict are low-lying areas with an altitude of <200 meters above sea level (masl), a slope of 0 - 15%, with relatively flat topographic conditions, causing Dua Boccoe District to susceptible to flooding. Low topography is one of the causes of flooding, because runoff water will go to a lower place as the nature of water.

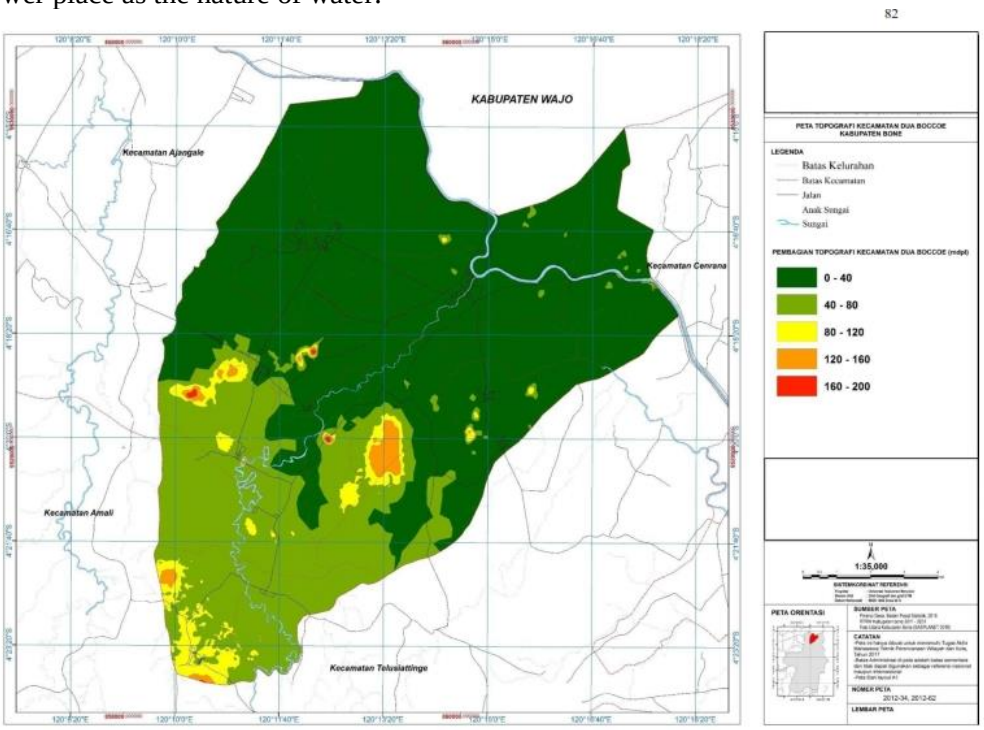

Figure 1. Topographic Zoning Map of District Dua Boccoe.

3.1.2. Geology and Soil Structure. The geological condition of Dua Boccoe District includes the type of soil on the surface of Dua Boccoe District, namely Alluvial soil type. The type of soil in the Dua Boccoe District is a very dense soil type and it is very difficult to absorb water to the layer below it. This causes only a small amount of water that flows or puddles on the surface of the soil to be absorbed. The density of the soil also affects the level of inundation.

Dua Boccoe Subdistrict has geological conditions composed of sedimentary and volcanic rocks as a result of the formation of material originating from Mount Latimojong. The rock types in Dua Boccoe Subdistrict are very influential in increasing waterlogging in the basin areas, alluvial sand and river deposits consisting of breccias and conglomerates will cause quite high sedimentation and can shallow the Walanae river flow.

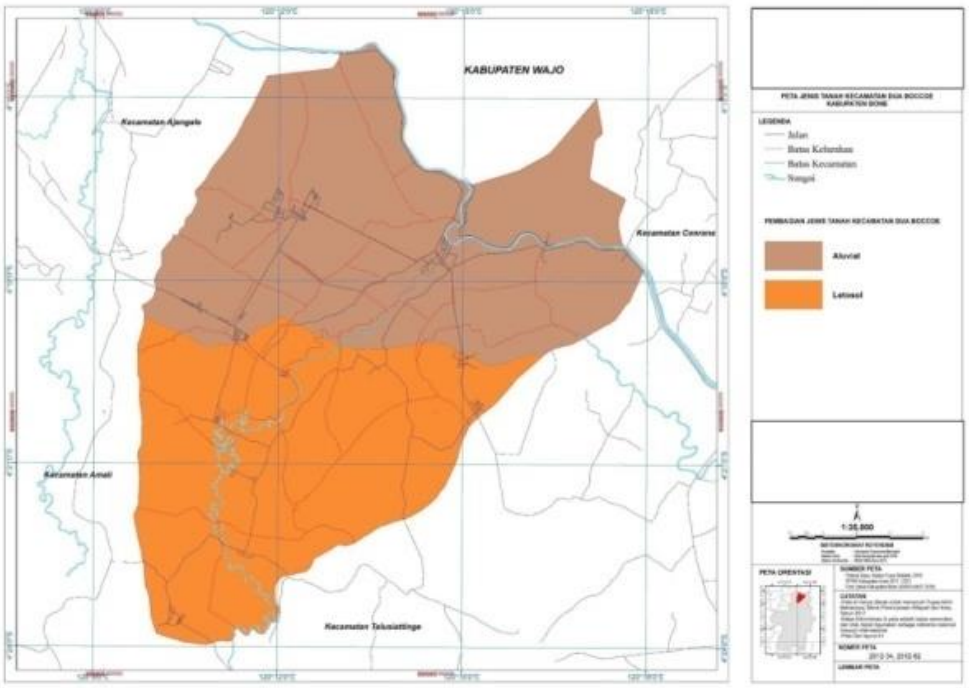

Figure 2. Zoning Map of Soil Types in Dua Boccoe district

3.1.3. Climatology. The climate condition of Dua Boccoe Subdistrict is a tropical climate with two seasons, namely the dry season and the rainy season. The condition of the average rainfall per year is 2000mm–3000 mm, the highest rainfall occurs in December–February. Flooding is also influenced by rainfall conditions in areas around Dua Boccoe District, such as Wajo Regency and Soppeng Regency. The research area has an icon of moderately high rainfall in December–February to May–July, so it is necessary to watch out for floods in that month.

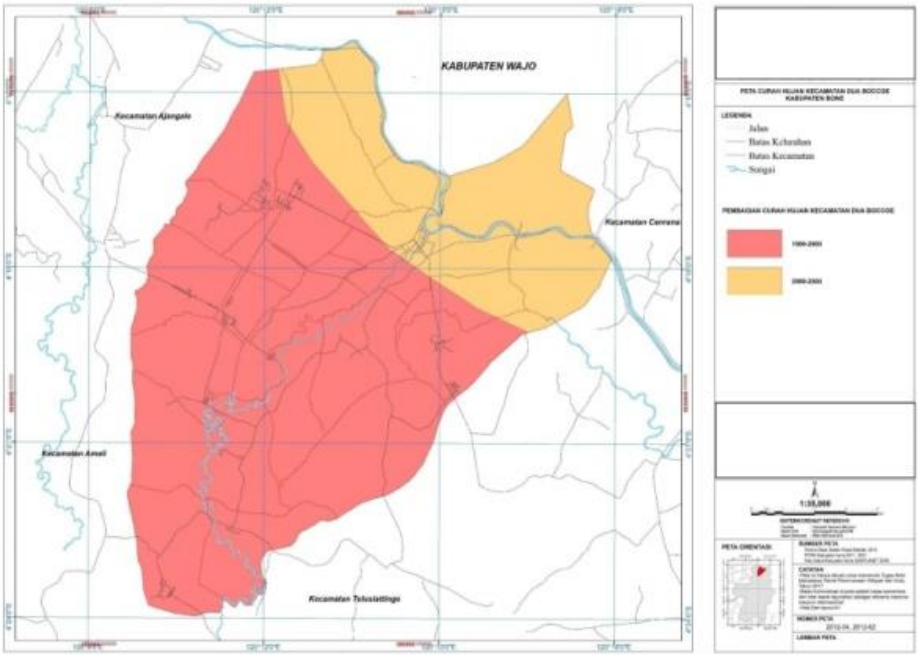

Figure 3. Rainfall Zoning Map in Dua Boccoe District.

3.1.4. Hydrology and Water Resources. Hydrological conditions in Dua Boccoe Sub-district with surface water originating from the Walanae River Basin with a length of 15,763 km, and the Unyi River and the presence of swamps in several villages whose inundation properties occur permanently and periodically. This type of bird feather pattern is called bird feather because the shape of the flow of its tributaries resembles the bones of a bird's feather. The tributaries flow directly into the main river. The overflow of water from the river that occurs every time it rains with moderate to high intensity causes the areas of Dua Boccoe District to experience quite high inundation.

The existence of swamps in Dua Boccoe Sub-district with an area of 2420,684 ha which functions as a cathment area is quite beneficial as an area that will accommodate rainwater runoff and river water overflow, so its existence is very important and must be maintained. will be immediately inundated by residential areas or built-up areas in the Dua Boccoe District.

3.1.5. Land Use. The land use in Dua Boccoe District changes every year. This is influenced by the activities and growth of the number of people who inhabit the area. Land use in Dua Boccoe District consists of settlements (2.8%), rice fields (35.1%), mixed gardens (46.9%), swamps (15.2%), and fields (0.1%). The increasing population will be followed by the increasing demand for land for settlements. With the change in land use from open land to built up land to meet the needs of the population, it will have an impact on decreasing water catchment areas, causing an increase in the amount of rainwater runoff and further heightening the inundation that occurs.

The land use in Dua Boccoe District is diverse. This condition makes Dua Boccoe Subdistrict relatively dense and quite congested so that it is necessary to control the use of space, especially around locations that have a fairly high level of building density and the need for clear regulations in land use, especially locations that have open spaces. to keep the Dua Boccoe District still has an open space that functions as a water catchment area and water catchment area.

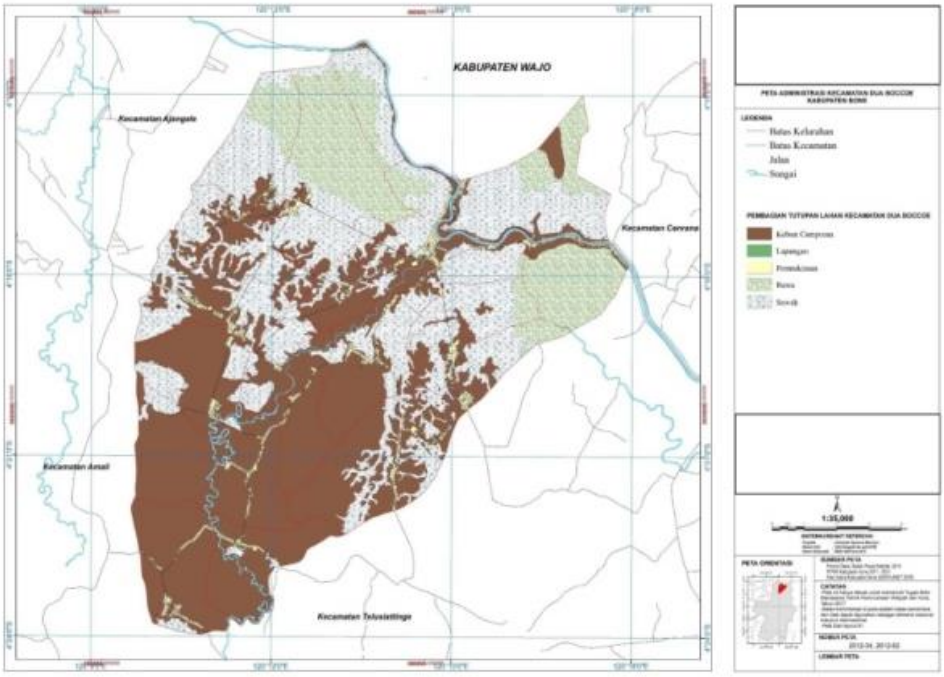

Figure 4. Map of Land Cover Zoning in Dua Boccoe District.

3.2. Superimpose Analysis

Superimpose analysis is one of the analytical tools used to determine the level of flood susceptibility in Dua Boccoe District, Bone Regency which consists of 22 sub-districts/villages using basic physical condition data in the area, where the data consists of Rainfall Intensity, Slope Slope, Soil Infiltration, and Land Use. Based on the flood susceptibility interval class, there are 5 classifications of the level of flood vulnerability in the sub-district Dua Boccoe, as in the table below.

Table 1. Flood Disaster Interval Class in Dua Boccoe District from the Overlay Process.

No	Level Vulnerability	Score	Area (km^2)	Percentage (%)
1	Very Vulnerable	>56	131.1	16.6
2	Vulnerable	51-55	234.4	29.8
3	Slightly Vulnerable	46-50	160.0	20.3
4	Less Vulnerable	41-45	123.3	15.6
5	Not Prone	36-40	139.0	17.6

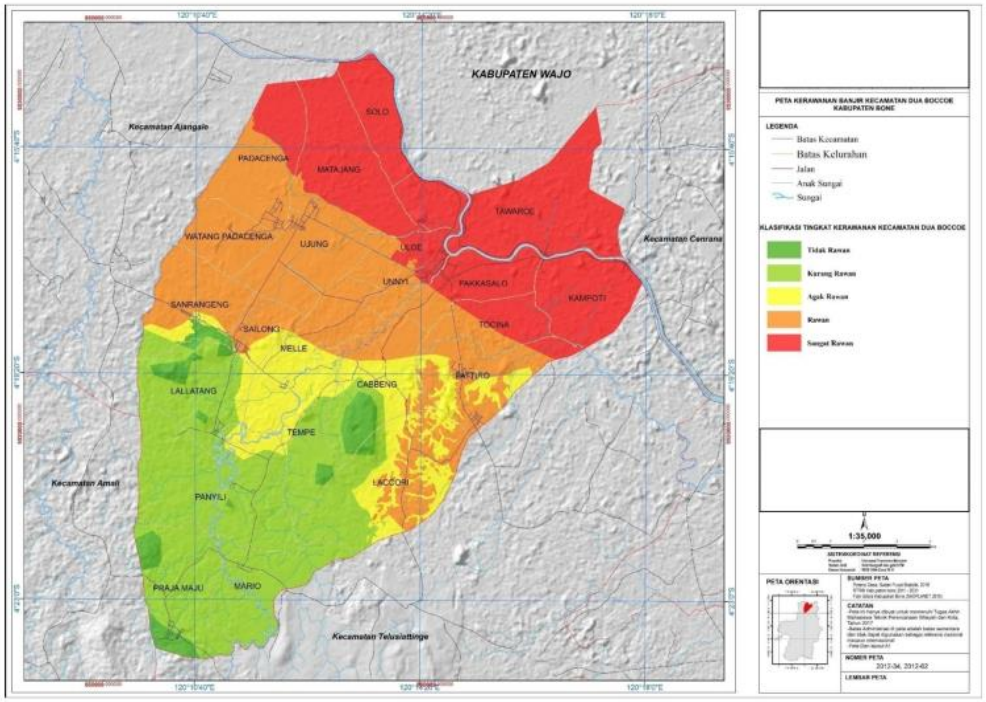

Figure 5. Map of Classification of Flood Hazard Levels in Dua Boccoe. District.

Based on the results of the analysis using the overlay method on ArcGIS, it can be seen in Figure 5 that the flood area with low flood susceptibility (not vulnerable) has an area of +139.0 Km^2 or 17.6% of the area of Dua Boccoe District (very vulnerable) has an area of +131.1 km^2 or about 16.6% of the area of Dua Boccoe District, Bone Regency, which consists of Unyi Village, Uloe Village, Pakkasalo Village, Kampoti Village, Tocina Village, Tawaroe Village, Solo Village, and Matajang Village.

4. Conclusion

Analysis of flood prone areas in the Walanae Watershed, Dua Boccoe District, Bone Regency has successfully. The data shows that the area with a level of vulnerability to a bit vulnerable is 160.0 km^2 (20.3%) on 5 villages, the areas with a vulnerable level are 234.4 (29.8%) on 7 villages, and the areas with a very vulnerable are 131 km^2 (16.6%) on 8 villages. Floods in Dua Boccoe Subdistrict were caused by internal factors (topography, drainage infrastructure, building density, and land use) and the external factors (shipment floods). In generally, floods that occur in the study area are caused by external factors.

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