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Flood Analysis of Bila River with Mathematical Models

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Abstract. The Bila River is one of the rivers in South Sulawesi, especially in Sidrap Regency which almost every year experience river overflows that cause flooding in the area around the river and cause losses to the community trying to analyze the flood of the river Bila with a mathematical model. The method used is to perform hydrological calculations with the help of the HEC-HMS application and simulation of flood discharge with the help of the HEC-RAS application. The results obtained are based on the results of running the HEC-RAS application with a design flood discharge of $Q_{20 \text{ yr}} = 1518.10 \text{ m}^3/\text{s}$. Recommendations for handling the flood of the Bila . River in the short, medium, and long, namely the addition of top embankments at the point of overflow, installation of control gates on tributaries and construction of retention ponds. Short and medium term amounted to 812.57 Ha and for long term handling amounted to 829.26 Ha.

1. Introduction

Indonesia is a country where almost every year floods occur in several areas, especially in densely populated areas. Floods can occur due to high rainfall intensity, construction of structures along riverbanks, obstructed river water flow due to garbage and lack of catchment areas in upstream areas [1]. Floods and puddles in residential areas still occur in many cities in Indonesia[2]. Population growth has a hydrological effect on land use, groundwater recharge and flood runoff [3].

Floods are one of the natural disasters that need to be controlled so that the impact of losses can be minimized. Floods can cause considerable losses such as property losses and loss of life, so flooding should be handled seriously [4].

Bila River is one of the rivers in South Sulawesi which is located in Sidrap district. The overflowing of the Bila river is a factor causing floods that occur almost every year in Sidrap Regency [5]. Based on previous research, the main causes of flooding were the breaking of a number of embankments along the riverbanks, and deforestation in the Bila watershed. Floods occur 1-2 times a year with a long inundation for 1-3 days, the inundation height ranges from 1-2 m which can harm the community both in terms of health, property, and from an economic point of view, flood events also result in a decrease in crop yields and even crop failure. [6].

Floods that occurred due to the overflow of the Bila river and caused 921 housing units and 3,790 hectares of rice fields to be flooded in 6 sub-districts including Panca Lautang sub-district, Tellu Limpoë sub-district, Maritengngae sub-district, Watang Sidenreng sub-district, Dua Pitue sub-district and Pitu Riawa sub-district. [7]

To reduce the impact of flood disasters that are at risk of occurring on the banks of the Bila River, researchers try to analyze the flooding of the Bila river with a mathematical model.



2. Materials and Methods

Location The research was conducted in the Bila River, Sidrap Regency, South Sulawesi Province. Hydraulic tracking for flood analysis is carried out for 2 km, starting at the confluence of the Bulucenrana River and the Bila River or at coordinates $3^{\circ}52'49.82''\text{LS}$ and $120^{\circ} 0'32.07''\text{E}$ to $3^{\circ}56'18.85''\text{LS}$ and $119^{\circ}57' 29.81''\text{BT}$.

The data needed in the work of this thesis are as follows:

- 1) River cross-section data
- 2) Topographic data.
- 3) Rainfall data
- 4) Soil type data
- 5) Land use data

The analysis is carried out on the required data, namely rainfall data, topographic data, hydrometric network (rain stations), and river cross-section data. In the process of data analysis, the researchers analyzed the condition of the flood control structures and performed hydrological and hydraulic analysis to assess the performance of the Bila River flood control structures.

Hydrological analysis uses data taken from related agencies in the form of rainfall data, hydrometric network (rain stations), and topographic data. From these data will be analyzed to obtain the design flood discharge. Hydraulic Analysis and Water Level Profile Analysis Using the HEC-RAS Application with the required data in the form of river cross-section data and design flood discharge data.

3. Result and Discussion

3.1. Bila River Flood Discharge

River design flood discharge when obtained from the results of hydrological analysis using the HSS SCS method using the HEC-HMS application

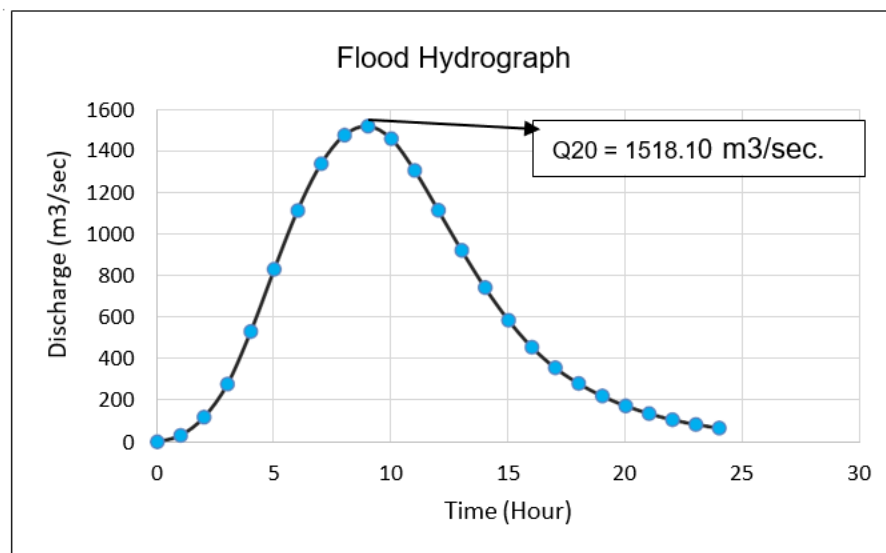


Figure 1. Flood Hydrograph

From the results of the analysis, it is found that the flood discharge every time it returns with a max Q20 of 1518.10 m3/s after the flood discharge is obtained, a 2D HEC-RAS simulation will be carried out to find out areas affected by flooding due to river overflow.

3.2. Analysis of the Bila River flood with a mathematical model

Flood analysis with a mathematical model in this study uses a 2D flood simulation on the HEC-RAS application. The flood simulation was carried out using the Unsteady Flow Analysis, the Diffusion Wave

Method, with a one second calculation interval to obtain areas affected by flooding due to overflowing rivers, which can be seen in Figure 2.

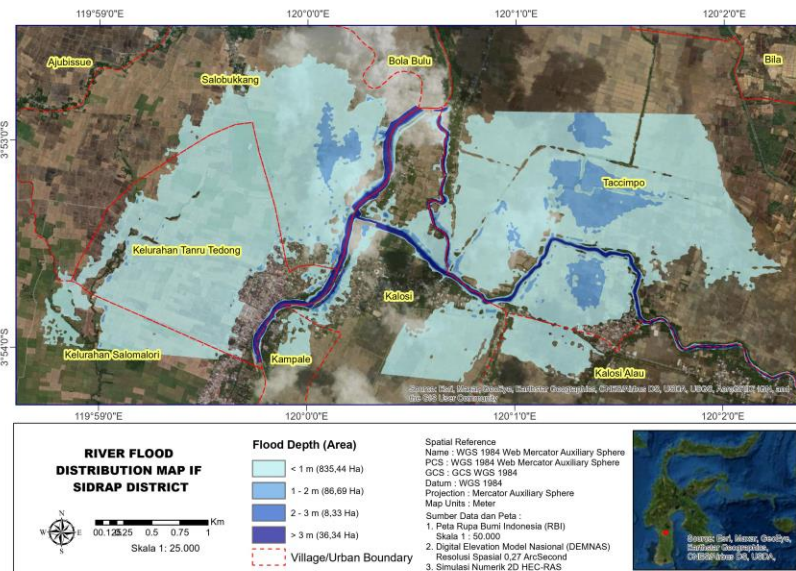


Figure 2. Map of the Distribution of the Bila River Flood in Sidrap Regency

Based on Figure 2, the area that was inundated due to the Bila River flood can be seen in the following table

Table 1. Area Affected by Bila River Flood

No.	Village	Area (Ha)
1	alola Village	6.09
2	ogi Village	1.13
3	alosi Alau Village	31.62
4	ampale . Village	11.14
5	alomalori Kelurahan Village	42.28
6	anru Tedong Village	212.07
7	alosi Village	90.68
8	alobukkang Village	170.41
9	accimpo Desa Village	401.39
Total		966,80

Based on the results of flood simulations and field surveys, it is very necessary to handle the point that causes flooding to reduce losses due to flood disasters. Recommendations for flood control in rivers can be seen in Figure 3.

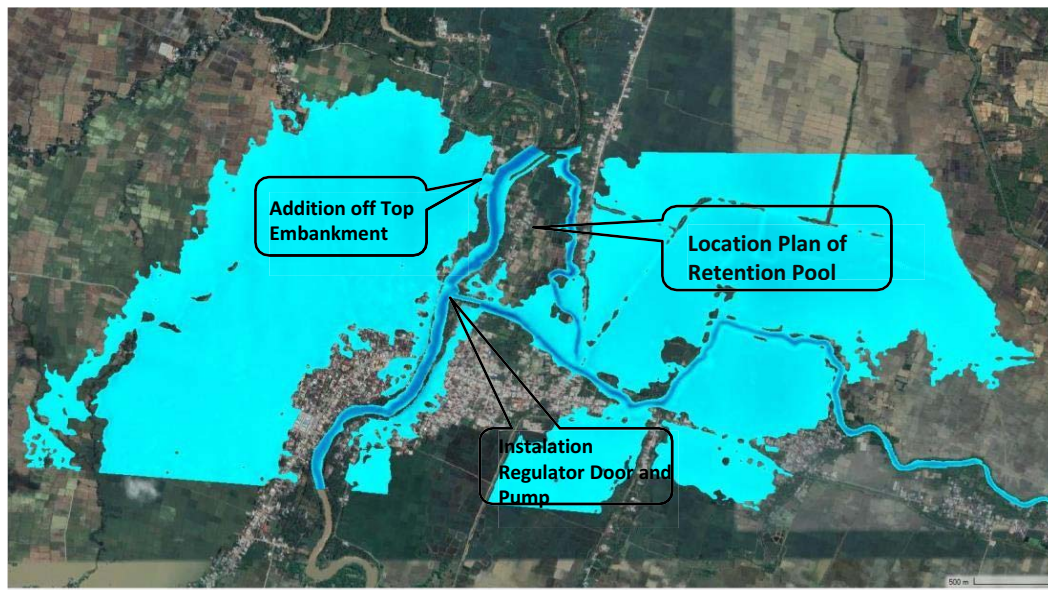


Figure 3. The Bila River Flood Management Recommendation Plan

Recommendations for handling the Bila River flood are divided into short, medium, and long time spans. For short and medium term management, the priority is to add a top embankment and install a control gate on one of the tributaries of the Bila River. Based on public information that most of the flooding is caused by the entry of the Main Bila River's flood discharge into its tributaries, it is very necessary to build a control gate so that when the flood discharge comes the door is closed and the flood will continue to flow downstream. For the long term, the proposed recommendation is the creation of a retention pond by utilizing the old river channel to temporarily accommodate flood discharge and also reduce the discharge that leads downstream, namely Lake Tempe, considering the complexity of the flood problem in the lake.

The results of the flood simulation analysis with short, medium, and long term flood management can be seen in Figures 3 and

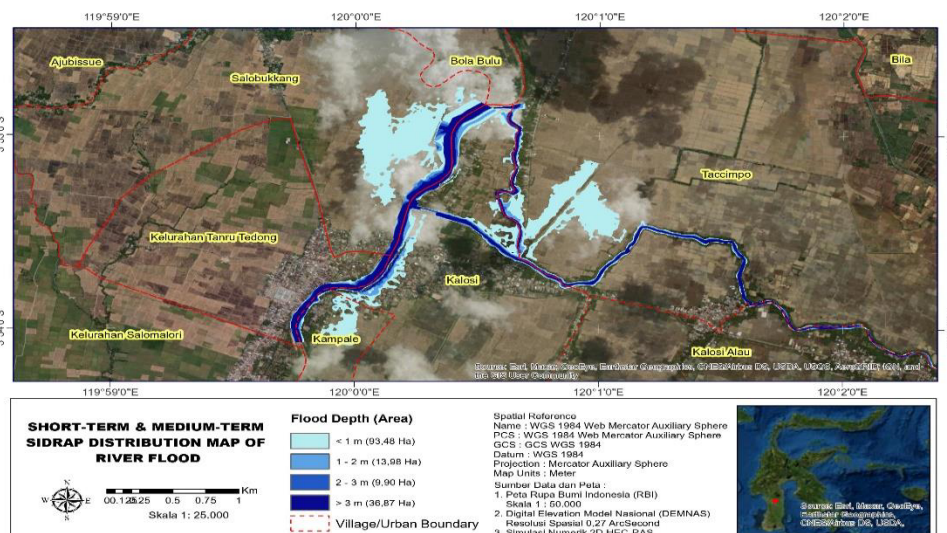


Figure 4. Flood distribution map with short and medium term management

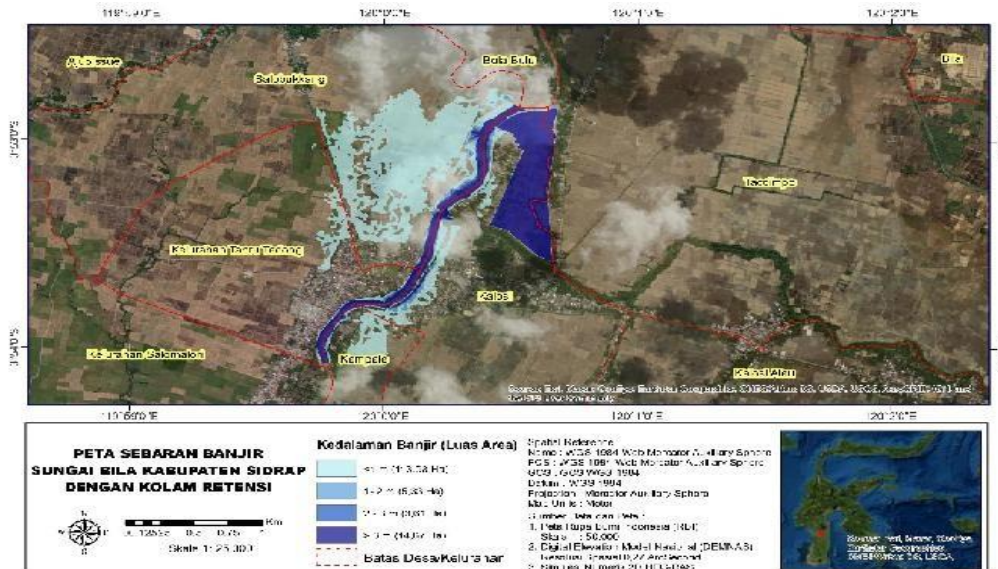


Figure 5. Flood distribution map with long-term management

Based on picture 4 and 5, it can be seen that the difference in flood-affected areas before and after the handling is carried out, for more details, see the following table:

Table 2. Areas Affected by River Floods Before and After Handling

No.	Village	Area Affected Before Handling (Ha)	Area Affected by Short and Medium Term Management (Ha)	Length of Affected Area (Ha)
1	Kalola Village	6.09	2.15	-
2	Sogi Village	1.13	-	-
3	Kalosi Alau Village	31.62	2.83	-
4	Kampale . Village	11.14	9.09	11.48
5	Salomalori Village	42.28	-	-
6	Tanru Tedong Village	212.07	6.87	13.06
7	Kalosi Village	90.68	34.70	18.31
8	Salobukkang Village	170.41	50.87	94.68
9	Taccimpo Village	401.39	47.71	-
Total		966,80	154.23	137.54

Based on Table 2 above, the total area of inundation that can be reduced from short and medium term treatment is 812.57 Ha and for long term treatment is 829.26 Ha.

4. Conclusion

- 1) The flood discharge that enters the Bila River is divided from the Bulucenrana River and the Bila Hulu River with a flood discharge of $Q_{20} = 1518.10$ m³/sec.
- 2) The overflow of the Bila River caused 9 villages/kelurahan to be affected by flooding, namely Kalola Village (6.09 Ha), Sogi Village (1.13 Ha), Kalosi Alau Village (31.62 Ha), Kampale Village (11.14 km²), Kelurahan Salomalori (42.27 Ha), Tanru Tedong Village (212.07 Ha), Kalosi Village (90.68 Ha), Salobukkang Village (170.41 Ha), and Taccimpo Village (401.39 Ha). So the total area affected is 966.80 Ha.
- 3) Recommendations for handling to overcome the Bila River flooding within the short, medium, and length, namely the addition of top embankments at the point of overflow, installation of control gates on tributaries and construction of retention ponds. short and medium term of 812.57 Ha and for long term handling of 829.26 Ha.

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