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Effects of Nipa-Nipa Regulation Pond on Flood Control of Tallo River

Effects of Nipa-Nipa Regulation Pond on Flood Control of Tallo River

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Abstract. The Nipa- Nipa Regulation Ponds are a flood control building for Makassar City and its surroundings due to the overflow of Tallo River downstream with an operating system to accommodate air. Regulation pond is only able to accommodate part of the peak flood discharge which caused Tallo River to overflow. For this reason, an analysis is carried out on how the influence of the Nipa – Nipa Regulation Pond on flood control of the downstream Tallo River is carried out. The analytical method used is a hydraulic analysis with the help of the HEC-RAS application. Based on the results of the 2D HEC – RAS numerical simulation mapped for the downstream area of Nipa - Nipa Regulation Pond, it is obtained that regulation can reduce surface runoff due to the overflow of the Lower Tallo River for Q2 by 183.97 Ha (35.59 %), Q5 271 .85 Ha (37.19 %), Q10 was 249.35 Ha (28.50 %), Q20 was 291.63 Ha (28.18 %), and Q25 was 300.67 Ha (28.08%). From these results, it can also be seen that the current condition of the Nipa – Nipa Regulation Pond is the most effective way to deal with flooding downstream of Tallo River at the five-year return period (Q5).

1. Introduction

Water is a basic human need. Its use to support human life is felt to be growing day by day. Starting from eating and drinking and sanitation to the production of industrial goods, lighting and irrigation, many rely on the potential of water sources, including river water, ground water, and so on [1].

According to the Aqueduct Global Flood Analyzer analysis, Indonesia is a country with the 6th largest population affected by floods in the world, which is around 640,000 people every year. Based on data from the National Disaster Management Agency (BNPB), floods are the most frequent disasters in Indonesia with 464 flood events every year. Floods accompanied by landslides are the 6th most frequent disaster in Indonesia with 32 events every year. There are three main factors causing floods and landslides that are most highlighted, namely reduced tree cover, extreme weather, and topographical conditions of the Watershed (DAS) [2].

Flooding is a condition where water cannot be accommodated in the drain channel (River Trench) or the water flow is blocked in the drain channel, so that water overflows and inundates the surrounding area [3].

The problem of flooding in Makassar City is still one of the main things that the government must pay attention to. Makassar city area is crossed by 3 rivers between Jeneberang River, Tallo River, and Pampang River. The Tallo River is one of the rivers that crosses Gowa Regency, Maros Regency and Makassar City with a catchment area or watershed (DAS) of 406.97 km2. In the rainy season with high

rainfall coincides with the occurrence of the highest tides from the Makassar Strait which stems the flow of the Tallo River at the estuary with the existing river cross section unable to accommodate the flow discharge that comes from upstream so that overflows of water inundate residential areas and agricultural land that occur every year.

The study results of the Jeneberang River Basin Development Master Project through "Detailed Design of Flood Control for Makassar City and Its Surroundings" in 2004 have created a flood control program for the Tallo River to control flooding in Makassar City and its surroundings such as Flood Embankments, River Normalization and Nipa Nipa Regulation Ponds. The Nipa Nipa Regulation Ponds construction began in December 2015 until December 2019.

The Nipa Nipa Regulation Pond is one of the flood control building facilities to control flooding in Makassar City and Maros Regency due to the overflow of the Tallo River in the downstream with an operating system to accommodate water entering through side channel spillway buildings during a temporary peak of flooding and drains it back into the Tallo River through the control gate and/or water pump after the rain stops.

The Nipa Nipa Regulation Pond is only able to partially reduce the peak flood discharge that can cause the Tallo River to overflow. For this reason, research is carried out on the importance of knowing the influence of the Nipa Nipa Regulation Pond on the Flood Control of the Tallo River.

2. Material and Methods

In this study, The Nipa-Nipa Regulation Pond is located on the border of Maros Regency – Makassar City – Gowa Regency, South Sulawesi Province at location coordinates: 119.52065923o East Longitude and 5.16503546oLS. The Nipa – Nipa Regulation Pond is located on the right side of the Tallo River, precisely after the fork of the Upper Tallo River and the Mangalarang River to the Nipa – Nipa Bridge.

This study uses hydrological data in the form of flood hydrographs to obtain design discharge and topographic data in the form of river cross-section data and DEMNAS. The National DEM is built from several data sources including IFSAR data (5m resolution), TERRASAR-X (5m resolution) and ALOS PALSAR (11.25m resolution), by adding the stereo-plotting Masspoint data. The spatial resolution of DEMNAS is 0.27-arcsecond, using the EGM2008 vertical datum [4].

In this study, to determine the effect of the nipa-nipa regulation pond on the downstream tallo river, a hydraulic analysis was carried out with a 2D flood simulation model using the HEC-RAS 6.1.0 application which has been integrated with RAS Mapper. The Hec-Ras 2D numerical model of non-permanent flow combines the mass conservation equation or continuity with the diffusion-wave equation to calculate the elevation of the water surface at a point in time [5]. From the results of the flood simulation, it will be described using ArcGIS 10.8 software to determine the area affected by flooding before and after the regulation pond.

3. Result and Discussion

From the hydrological data, it is obtained that the flood discharge at each return period in each sub-watershed is as follows in the Upper Tallo sub-watershed, namely Q2 max of 92.9 m^3/s, Q5 max of 146.1 m^3/s, Q10 max of 183.5 m^3/s , Q20 max is 220.5 m^3/s, Q25 max is 232.5 m^3/s, and in the Mangalarang sub-watershed, Q2 max is 150.4 m^3/s, Q5 max is 231.2 m^3/s, Q10 max is 289.2 m^3/s, Q20 max of 347.4 m^3/s, Q25 max of 366.4 m^3/s. From the flood discharge data, input into the 2D flood simulation in the HEC-RAS application to determine the effect of the nipa-nipa regulation pond on the downstream tallo river.

The flood simulation in this study uses the Diffusion Wave Equation Set method with a computation interval of 1 minute where the components in the Unsteady Flow Analysis are used to obtain flood inundation every time it returns. Simulation results and pictures of flood-affected areas can be seen in the following figure.

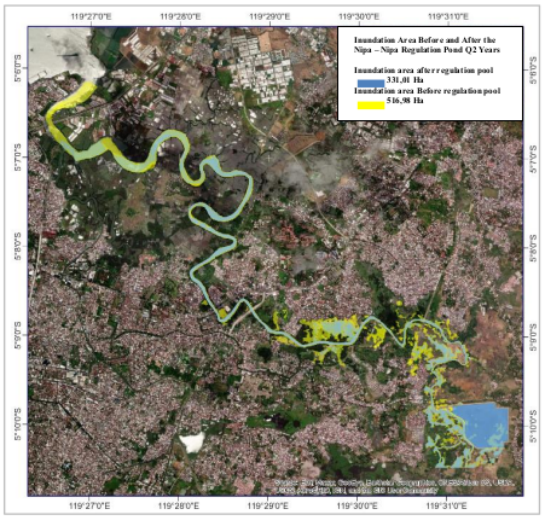

Figure 1. Inundation Area Before and After the Nipa – Nipa Regulation Pond Q2 Years

From the results of the picture above, the area of the flood inundation before the pond was 516.98 Ha and after the pond was 331.01 Ha, so that it can be obtained that there is a reduction in the affected area of 183.97 Ha (35.59%).

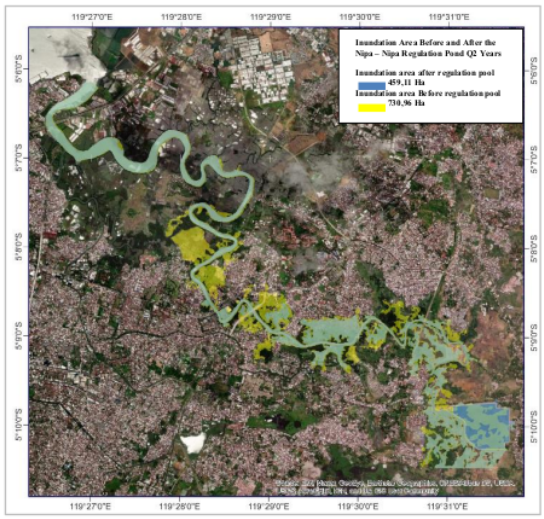

Figure 2. Inundation Area Before and After The Nipa – Nipa Regulation Pond Q5 Years

From the results of the image above, the area of the flood inundation before the pond was 730.96 Ha and after the pond was 459.11 Ha, so it can be obtained that there is a reduction in the affected area of 271.85 Ha (37.19%).

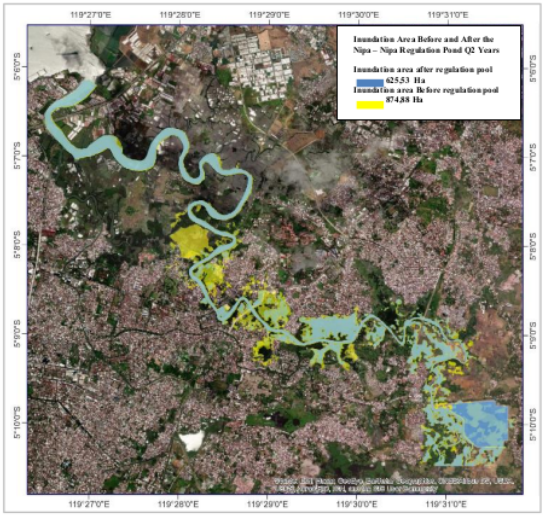

Figure 3. Inundation Area Before and After the Nipa – Nipa Regulation Pond Q10 Years

From the results of the image above, the area of the flood inundation before the pond was 874.88 Ha and after the pond was 625.53 Ha, so that it can be obtained a reduction in the affected area of 249.35 (28.50 %).

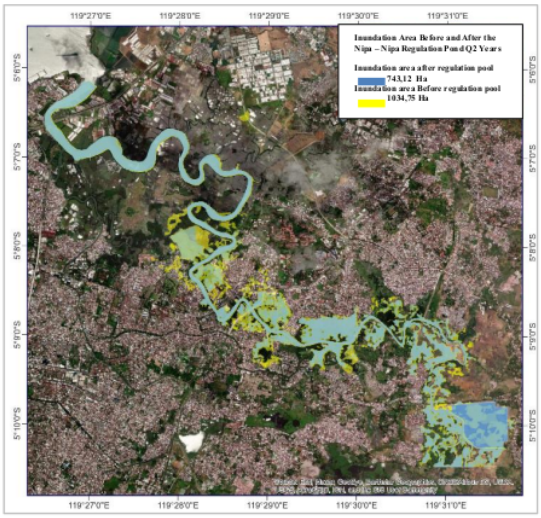

Figure 4. Inundation Area Before and After the Nipa – Nipa Regulation Pond Q20 Years

From the results of the picture above, the area of the flood inundation before the pond was 1034.75 Ha and after the pond was 743.12 Ha, so that it can be obtained that there is a reduction in the affected area of 291.63 Ha (28.18%).

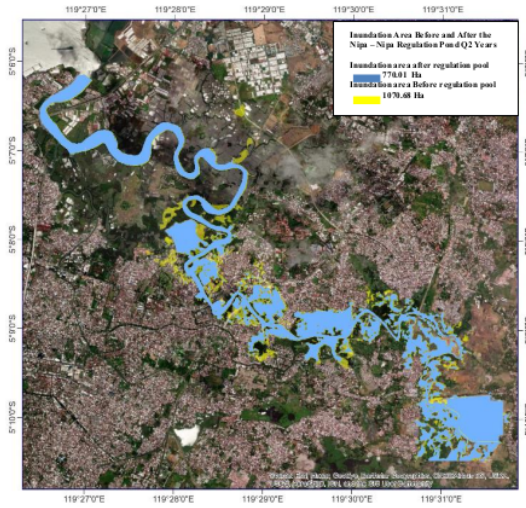

Figure 5. Inundation Area Before and After The Nipa – Nipa Regulation Pond Q25 Years

From the results of the picture above, the area of the flood inundation before the pond was 1070.68 Ha and after the pond was 770.01 Ha, so it can be obtained that there is a reduction in the affected area by 300.67 Ha (28.08%).

The results of the 2D HEC-RAS numerical simulation in this study were verified using data on the Tallo River Flood Monitoring that occurred on 7 – 8 February 2019 (before the Nipa – Nipa Regulation Pond) and 5 – 6 March 2020 (after the Nipa Regulation Pond). -Nipa which shows a reduction in surface runoff by 33.48%. However, the analysis results obtained a reduction in surface runoff by 28.08% - 37.19%. Using the Mean Abolute Percentage Error (MAPE) approach, the percentage error value between field events was obtained and the results of the analysis are 11.08 - 16.1%.Based on the meaning of the MAPE value with a value range of 10-20%, the ability of the simulation model can be said to be good [6].

4. Conclusion

Based on the results of the 2D HEC – RAS numerical simulation mapped for the downstream area of the Nipa - Nipa Regulation Pond, it is obtained that the regulation pond can reduce surface runoff due to the overflow of the Lower Tallo River for Q2 by 183.97 Ha (35.59 %), Q5 of 271.85 Ha (37.19 %), Q10 of 249.35 Ha (28.5 %), Q20 of 291.63 Ha (28.18 %), and Q25 of 300.67 Ha (28.08%). From these results, it can also be seen that the current condition of the Nipa – Nipa Regulation Pond is the most effective way to deal with flooding downstream of the Tallo River at the five-year return period (Q5).

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