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Mapping of Flood Potential in Urban Areas in Kemuning District, Palembang City and its Surroundings

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KEYWORDS
Mapping, Flooding, Watershed Flows, Bendung River

ABSTRACT

The objectives of this study are Analyzing land use and river networks in the Kemuning sub-district area, Analyzing areas that have the potential to be flooded in the Kemuning area, especially the Simpang Polda and Reja Pipeline Palembang, Analyzing the area of land use affected by the presence of flood inundation in the Simpang Polda area and its surroundings. This study uses survey and recapitulation methods of data collection obtained from secondary data from several agencies related to Floods and Watershed Flows in the Bendung River area, Kemuning District in Palembang City. Land use maps and river network systems based on the results of the analysis still have swamps or open spaces so that they can be used for infiltration. The magnitude of the potential flood inundation can be seen from the map based on a field inventory with 14 inundation location points. Based on the calculation of the rainy season with a 2-year period, the condition of the river catchment area is still in a safe condition. will remain in the period 5,10,25,50,100 in the category of flood hazard. The land area based on the analysis affected by the flood is 845 ha or 8.45 km or 23% of the area of Kemuning sub-district of 36.97 km. Factors that affect the height of inundation or flooding in the upstream, middle and downstream, both land geography, land structure, and drainage system, are changes in land use from swamps to moderate housing.

INTRODUCTION

Floods are disasters that often hit, especially urban areas, so they can harm human activities and other living things. The first step in predicting flooding with hydrological modeling. The main function of the river is as contained in Government Regulation Number 38/2011 concerning rivers is as a medium to meet water needs in household activities, agriculture, environmental sanitation, industry, tourism, sports, defense, fisheries, power generation, and transportation. Flood disasters are natural events that can occur at any time and often result in the loss of life and property. Losses due to floods can be in the form of damage to buildings, loss of valuables, to losses that result in them not being able to go to work and school. Floods cannot be prevented, but they can be controlled and mitigated by the impact of the losses they cause (Abunyewah et al., 2023; Handayani et al., 2019; Krongthaeo et al., 2021; Sawangnate et al., 2022; Suharini & Kurniawan, 2021).

The city of Palembang as the capital of South Sumatra province, is located in the position of 104 '37 -104 '52' E and 2 '52'- 3' 05 LS which is developing rapidly, but in the midst of these developments the city of Palembang is always hit by a flood of problems. The current flood phenomenon Events do not only occur in the rainy season, but if it rains with a duration of only 3 hours, it can cause flooding. This condition is very severe and disrupts the activities of the people of Palembang Various efforts have been made, but these efforts have not been optimal in dealing with flood problems. These efforts are in the form of drainage channel maintenance, to blast the river into a city cross, various studies related to urban flood control, construction of fiber flood control facilities, several rules have been issued for flood control. This effort turned out to be less fast with the development of the city. The city of South Palembang has a land height that tends to be flat, while the higher location is in the North Palembang area (Fitri, 2019; Mutaqin, 2023; Syarifudin, 2017).

The city of Palembang has 108 tributaries. There are 4 major rivers that cross the city of Palembang, namely the Musi River, the Komering River, the Ogan River, and the Keramasan River. Of the 4 large rivers above the Musi River, the largest river with an average width of 504 meters and a maximum width of 1,350 meters is around Kemaro Island. Palembang based on the division of the area there are 21 sub-watersheds, but only 18 sub-watersheds in Palembang City that flow directly into the major rivers in the city of Palembang, namely the sub-watersheds of Rengas Lacak, Gandus, Lambidaro, Boang, Sekanak, Bendung, Lawang Kidul, Buah, Juaro, Batang, Sei Lincah, Keramasan, Kertapati, Kedukan Ulu, Aur, Sriguna, Jakabaring and Plaju. One of the causes of flooding in Palembang City is the influence of flow discharge from 18 sub-watersheds that flow directly into the Musi River in Palembang City (Alaminie et al., 2023; Filianoti et al., 2020; Firdaus et al., 2022; Nikhil Teja et al., 2023; Xu et al., 2023).

The Bendung River is part of the Musi Watershed. The Bendung River has the characteristics of a river structure with a length of about 5 km, a river width of up to 70 m and a depth of about 10 m. Currently, this river is threatened with a decline in quality, both physical, chemical and biological.

The Urban Drainage System is one of the components of urban infrastructure that is very closely related to spatial planning. Flood disasters that often hit most regions and cities in Indonesia are caused by the chaos of spatial planning. This analysis can be carried out by utilizing Geographic Information System technology and the availability of digital data for regional areas or on a global scale resulting from scanning regional maps, satellite photos, drainage channel profiles and drainage buildings required before the planning of drainage facilities (Andri Supriadi & Teddy Oswari, 2020; Supriadi & Oswari, 2020).

Changes in land use cause changes in the condition of watershed flood discharge. As a result of land conversion, rainwater that falls has more potential to become a surface flow than to be absorbed by the soil surface (Azizi et al., 2021; Emam et al., 2016; Kabeja et al., 2020; Priyambodoho et al., 2022). Changes in environmental conditions in the drainage area can be in the form of reduced water infiltration into the soil. Reduced water infiltration into the soil occurs due to changes in the structure of the upper soil layer and/or the conversion of land functions from vegetated land to less vegetated land (Alhalangy, 2023; He et al., 2022; Hu & Li, 2021; Izotov & Afonin, 2020). One of the methods of handling floods is by making a water infiltration pond. A water infiltration pond is a lake made in a residential area. In addition to permeating water into the ground, it also functions as a recreational place for residential residents. However, this type has obstacles, because it requires a fairly large area of land.

Currents can occur due to bursts in the area to the right or left of the river because the river channel does not have enough capacity for the flow rate through. Flooding is not only experienced by urban areas located in lowlands, but even experienced areas also located in highlands. Flooding or inundation in an area occurs when the system that functions to accommodate inundation is unable to accommodate the discharge flow, it is the result of three possibilities: the capacity of the system to decrease the rate of water flow increases, or a combination of both. Understanding the system here is a drainage network system in an area. While a drainage system in general can be interpreted as a series of waterways that function to reduce and/or eliminate excess water (flooding) of an area or land, so that the soil can function optimally, so that the drainage system is an engineering of regional infrastructure to overcome flooding (Syarifudin, 2017).

RESEARCH METHODS

This study uses survey and recapitulation methods of data collection obtained from secondary data from several agencies related to Floods and Watershed Flows in the Bendung River area, Kemuning District in Palembang City. In this study in the Kemuning District area of Palembang city, data was obtained in the following form:

1. Administrative Boundaries of Villages and Districts.
2. Land Use and Spatial Patterns
3. River Conditions or Flow Distribution.
4. Location of Inundation or Flood Affected.

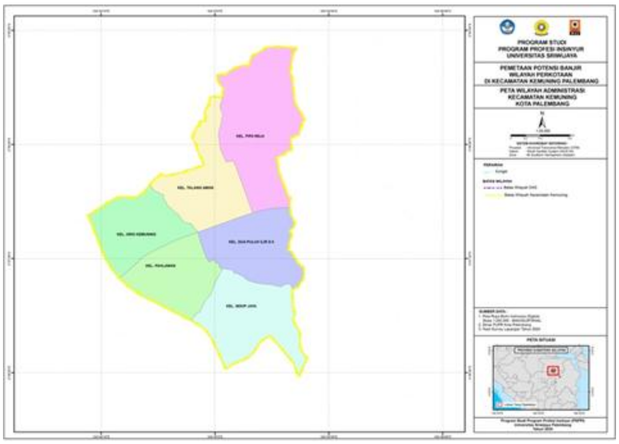

Figure 1. Map of the Kemuning Region Administration.

In this study, the data used is divided into primary and secondary data. Primary data was obtained through direct observation in the field and documentation in several areas as an accuracy test. Secondary data is in the form of flood parameter data such as slope, soil type, land use, river network obtained from Bappedalitbang and the Palembang City PUPR Office.

Data collection is carried out in the inventory unit (data collection) to obtain relevant data. The main information includes data on river area units, hydrology, irrigation areas, water resources data, and data on the condition of other flood inundation locations.

Most of the time that will be used in this study will be indoors. This is due to the computational process to obtain databases and programming which will take a considerable amount of time. The activities that will be carried out in the office are literature studies and data processing and analysis. For primary data analysis, it must fulfill several activities as follows, namely: preliminary survey, field inventory survey, and map making.

The data analysis technique used in this study is an overlay technique with weighting and scoring to calculate the data and determine its ranking. Weighting and scoring analysis techniques are used to assign a value to each parameter attribute. This makes it possible to identify areas prone to flooding by using maps of soil type, rainfall, land use, land contours, and river buffers. Then, a score is given for each parameter in its class. The process of making flood-prone maps is also included with the values of the parameters. The flood-prone map is a combination of each parameter by overlaying with weighting and scoring.

Channel Analysis

The amount of rainwater discharge and dirty water in an area must be drained immediately so as not to cause waterlogging. To be able to drain water, a channel is needed that can accommodate the water to the shelter. The water storage can be in the form of rivers, ponds, and so on. The capacity of the channel is highly dependent on the shape, slope and roughness of the channel. So, the storage capacity must be based on the amount of rainwater discharge and discharge of discharge.

Channel Cross Section Shape

In determining the shape and dimensions of the channel to be used in the construction of new channels and in the cross-section repair activities of existing channels, one of the important things that need to be considered is the availability of land. Maybe in rural areas building canals with a large capacity is not a problem because of the large amount of vacant land, but in densely populated urban areas it can certainly be a significant problem because of limited land. Therefore, the cross-section of urban drainage channels and highways is recommended to follow the best hydraulic cross-section, which is a cross-section that has the smallest area for a given discharge or has the smallest wet circumference with maximum delivery. The dimensions of the channel must be capable of flowing the plan discharge or in other words the flowing discharge must be equal to or greater than the plan discharge. To prevent the water level from overflowing, it is necessary to have a height guard in the channel, namely the vertical distance from the top of the channel to the water surface at the planned discharge condition. There are generally several types of channel cross-sections, including trapezoidal shapes, quadrangles, triangles, semicircles.

RESULTS AND DISCUSSION

Technical Analysis

Based on the results of data analysis and mapping of flood-prone areas in Kemuning District, especially in Sungai Bendung and reviews at several location points that are flood-prone zones. The city of Palembang, which is located at 2°59′27.99"S 104°45′24.24" East Latitude and 104°45′24.24" East Longitude geographically, is recorded to have an area of 525.48 square km or 40.061 ha with an altitude varying between 0 – 8 meters above sea level is one of the causes of frequent flooding potential in this region.

Based on the classification of the District Administration, especially Kemuning District, a delineation map of the research location was produced as below.

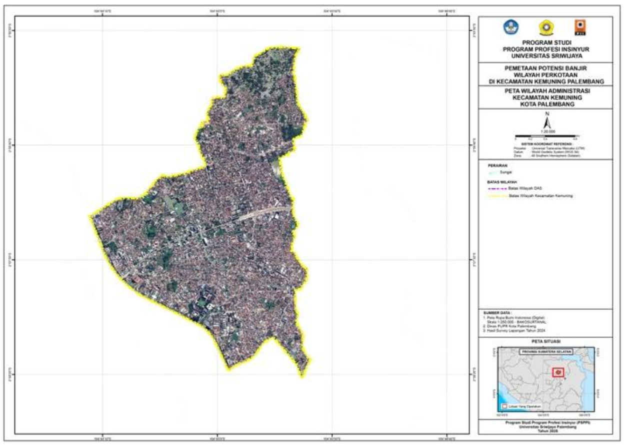

Figure 2. Map of Kemuning District

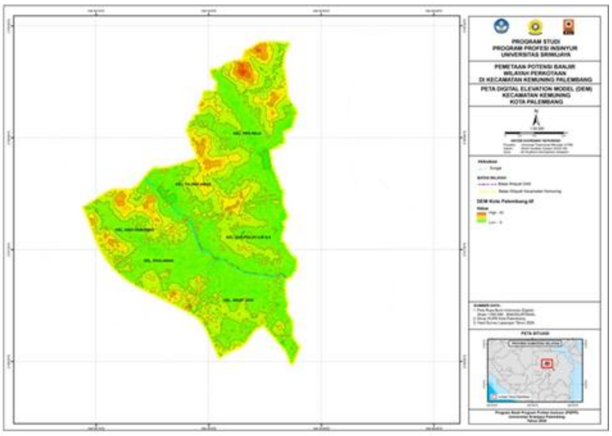

Figure 3. Map of Kemuning District DEM

The map above shows that the eastern part to the South is relatively low near the Bendung River Flow while in the western part with a topographic condition tends to be hilly such as in East Ilir 1 and West Ilir 1 Districts. As a result, floods are more dominant in Kemuning and Ilir Timur III Districts due to overflow of water that is held back by hilly areas so that they do not form runoff. The area of each village based on the sub-district in Kemuning District varies, administratively the total area of Kemuning District is recorded at 9.00 km2 consisting of 6 (six) villages. In addition to the Kemuning District area that is affected by the overflow and ebb and flow of the Bendung River, namely Ilir Timur I and Ilir Timur III Districts.

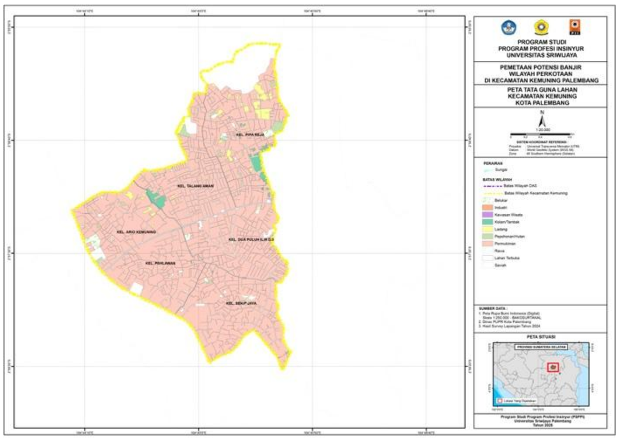

Figure 4. Land Use Map of Kemuning District

Based on the land use map, the land condition is ± 95% of the Kemuning sub-district area is Solid Housing with a flow efficiency of 0.60-0.75. The higher the surface flow coefficient, the lower the soil's ability to absorb rainwater, in addition to that a high flow coefficient can disrupt the groundwater balance and potentially cause flooding. While ± 5% is a catchment area in the form of retention ponds, parks, etc., in other words, the Kemuning sub-district area has a problem of lack of catchment area which should be at least 15% if one area is densely populated. If it rains in the condition that the river water recedes is still in a safe condition, still below the capacity of the river. If it rains in high tide river water conditions, it will cause overflow because the peak discharge condition exceeds the river capacity at high tide. This condition requires flood control, both raising embankments, adding retention pond points, folder systems, and pumping, although there are obstacles with land that need to be released and relocated, besides that it can also be done to make channels under the road that function as water flow or infiltration can also be used as a water bank or ground tank which functions as a way to increase space for water.

Mapping of Flood Inundation Locations

Location: Kemuning District, Palembang City, Area Area (9.00 km2. The results of field identification are 8 inundation locations spread across the Kemuning sub-district area in 2022 (source. The PUPR Office for Natural Resources of Palembang City) is depicted on the map below.

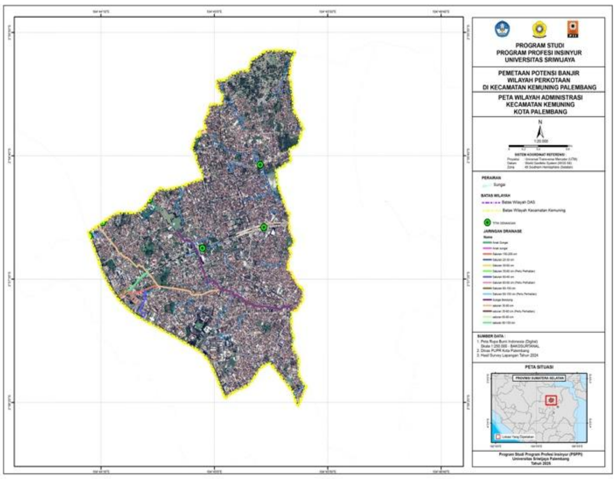

Figure 5. Map of Inundation Location Points

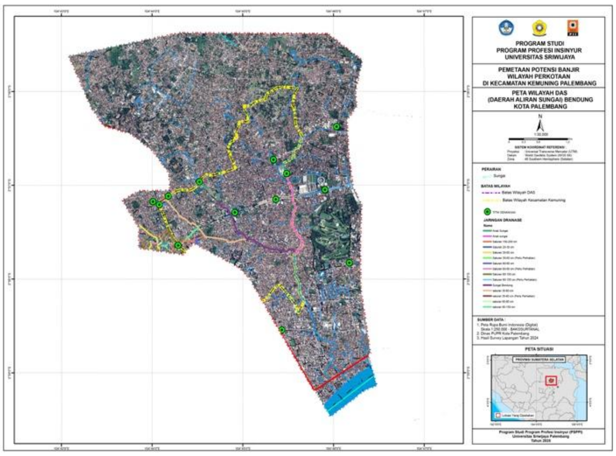

Figure 6. Map of inundation location points in the dam watershed

The Location Point was analyzed based on the results of an inventory with local residents and the database of the Palembang City PUPR office. The results of this location point are marked as the location point of the inundation can be seen in figure 5 and figure 6. Kemuning District, especially Pipa Reja Village, is an area with a high risk of flooding because it is a basin area, while Talang Aman District is an area with the lowest flood risk because the location area is still in swampy condition and there is a retention pond. At the location of the research at the intersection of the police and its surroundings, you can see figure 7 which is the meeting point of the water runoff in the wide Demang area, Kasnariansyah, and in front of IGM Palembang University which flows into the retention pond and then goes to Jalan Basuki Rahmat finally to the dam river with a distance of ±2.6 km and to get to the Musi river must go through a distance of ±6.2 km so that several pump points are needed to accelerate the flow.

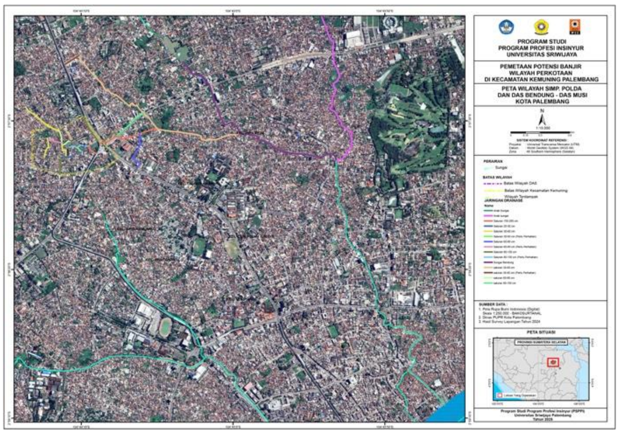

Figure 7. Simp Drainage Distribution. Polda and its surroundings

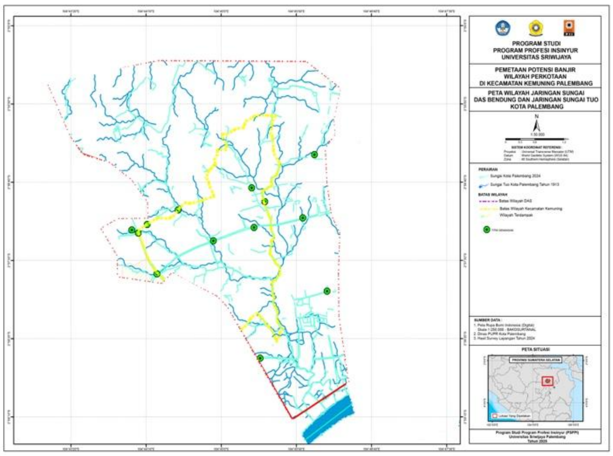

Figure 8. Map of the TUO Dam and river watershed network in 1931

The river network of the city of Palembang has been reduced since 1931. The map of the river network, especially in the Dam watershed, on the Tuo river can be seen in figure 8, there are several river networks that have changed their function into residential areas. Based on the DEM Map and the Tuo River Network, the potential for inundation/flooding in the Palembang city area, especially the dam watershed, will increase if there is no implementation of a Regional Regulation that regulates the development, control, and use of swamps in Palembang City. Changes in the polar of space and the licensing arrangements of housing development have an important effect on the loss of river flows and narrowing of channels. The potential point of flooding can be seen in figure 9.

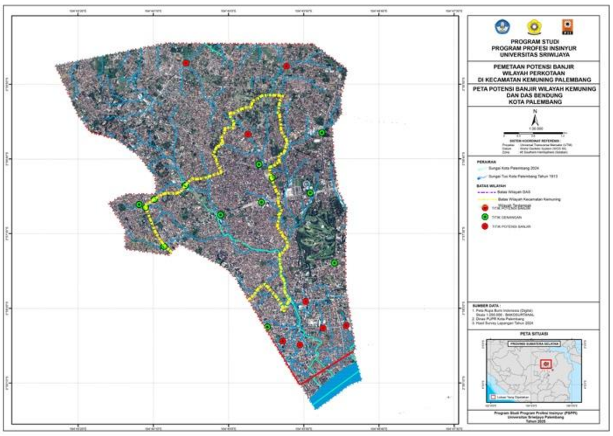

Figure 9. Map of Flood Potential and Drainage Distribution Simp. Polda and its surroundings.

There are several solutions that can be found to overcome the potential for flooding and reduce flood points by adding retention pond points or water banks specifically for the Kemuning area that requires ± 10% or 90 hectares of land.

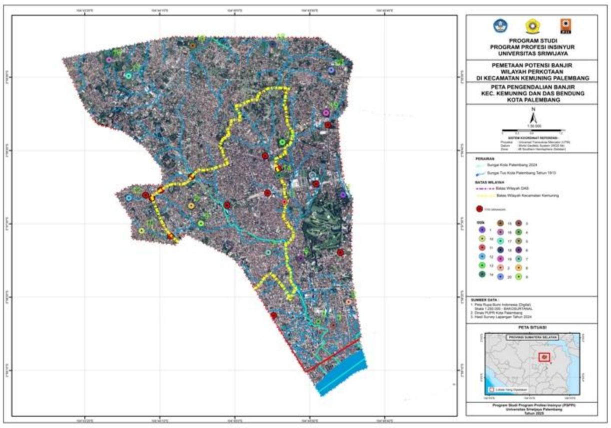

Figure 10. Mapping of Flood Area Control in the Form of Satellite Imagery

Based on the image above, it can be explained in table 1 below, related to the area of the plan and the volume of capacity that can be used as a flood control plan in the dam watershed area.

Table.1 Retention Pool Point Plan

Point	Mitigation	Information
1	Retention Pond	4.8 HA capacity (160,000 m3) Estimated 4 Ha x 4 m Depth
2	Retention Pond	1.32 HA Capacity (52,000 m3) Estimated 1.3 x 4 m Depth
3	Retention Pond	1.32 HA Capacity (52,000 m3) Estimated 1.3 x 4 m Depth
4	Retention Pond	0.47 HA Capacity (1,600 m3) Estimated 0.4 x 4 m Depth
5	Retention Pond	0.47 HA Capacity (1,600 m3) Estimated 0.4 x 4 m Depth
6	Retention Pond	1.68 HA Capacity (6,400 m3) Estimated 1.6 x 4 m Depth
7	Retention Pond	1.66 HA capacity (64,000 m3) Estimated 1.6 x 4 m Depth
8	Retention Pond	3.04 HA Capacity (120,000 m3) Estimated 3 Ha x 4 m Depth
9	Retention Pond	2.83 HA capacity (112,000 m3) Estimated 2.8 Ha x 4 m Depth
10	Retention Pond	0.90 HA Capacity (32,000 m3) Estimated 0.8 Ha x 4 m Depth
11	Retention Pond	1.54 HA Capacity (60,000 m3) Estimated 1.5 Ha x 4 m Depth
12	Retention Pond	2.02 HA capacity (80,000 m3) Estimated 2 Ha x 4 m Depth
13	Retention Pond	5.30 HA capacity (200,000 m3) Estimated 5 Ha x 4 m Depth

Point	Mitigation	Information
14	Retention Pond	2.55 HA Capacity (100,000 m3) Estimated 2.5 Ha x 4 m Depth
15	Retention Pond	6.96 HA Capacity (276,000 m3) Estimated 6.9 Ha x 4 m Depth
16	Retention Pond	18.68 HA Capacity (720,000 m3) Estimated 18 Ha x 4 m Depth
17	Retention Pond	5.29 HA Capacity (200,000 m3) Estimated 5 Ha x 4 m Depth
18	Retention Pond	8.49 HA Capacity (320,000 m3) Estimated 8 Ha x 4 m Depth
19	Retention Pond	2.93 HA capacity (100,000 m3) Estimated 2.5 Ha x 4 m Depth
20	Retention Pond	2.18 HA capacity (80,000 m3) Estimated 2 Ha x 4 m Depth

One of the steps that can be taken in addition to the creation of retention ponds and pumping is the creation of channels with a water bank system, especially in the densely populated Pipa reja area, sekip jaya, around Jl. Kasnariansyah which is adjacent to the retention pond of the police intersection, etc. With a system of making channels under the road body with a precast system using a box culvert measuring 1.5 m x 2.0 m and specifically every 5 meters a control basin is made with a uditch installation system and precast concrete plates or iron plates as an entry point for maintenance and as infiltration holes. Sketch of the plan to make a water bank as shown in figure 11, The use of precasts to facilitate the work and not use a long time and by paying attention to the elevation and flow direction to the retention pond that is ready to be pumped.

Figure 11. The concept of a channel under the road as well as a Water Bank

CONCLUSION

Land use maps and river network analyses indicate that *swamps* and open spaces in the study area could still serve as sites for infiltration or retention ponds; however, the predominance of dense *housing*, commercial, and public areas in the region suggests a high risk of water ponding unless flood control measures are implemented according to regulatory standards. Field inventories mapped eight inundation points, with flood intensity influenced by topographic gradients, subsurface stratigraphy, and drainage system effectiveness, all factors linked to land use changes from *swamps* to medium-density *residential* development. Proposed solutions include constructing retention ponds with pumping at 20 locations and installing channel embankments along narrow roads with channel capacities of 0.3–0.6 m^3/s. *Flood Location Mapping* based on field data revealed that certain parameters were omitted due to data limitations, so future studies should focus on a more defined area to yield more precise results and analysis.

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