

Identification of Flood Management due to Overflow Based on Geographics Information System (GIS) in Bandar Lampung City

Herman HN*

Mayor of Bandar Lampung, Indonesia Email: hermanhn171@gmail.com

Abstract

Increasing the population in a city will increase the number of developments so that it will reduce water catchment areas. Of course this will have an impact on increasing the number of flood-prone areas, such as the city of Bandar Lampung, Indonesia. A flood-prone area is an area which at certain times can be affected or inundated by flood water. For this reason, it is necessary to determine in advance the criteria for flood vulnerability so that they can be used as the basis for flood management, preparedness for flood disasters, and reconstruction of the construction of embankments or other flood control structures in handling the flood disaster.

Keywords: Drainage system; flood; Geographics Information System.

1. Introduction

The rapid development of information technology in Indonesia, even in the world, has brought new changes to society in carrying out their daily activities. Both individual activities and activities of a group / agency / institution. Technological progress is something that cannot be avoided in this life, because technological progress will run in accordance with scientific advances [1,2].

^{*} Corresponding author.

The development of this technology causes the public to have a tendency towards something digital, which is fast, precise, and accurate both in terms of time, location and information contained in the digital system [3]. Even technological progress has now become an indicator of a country's progress [1]. In addition to the digital system which is currently experiencing development, the population has also increased. The existence of this phenomenon also demands large amounts of water resources, for household, industrial, irrigation and other purposes [4,5]. The use of this water will certainly require a systematic and integrated disposal system, especially in urban areas [6]. The increase in the amount of water caused by continuous rain sometimes becomes a problem in a city that is not a good drainage system [7]. This also happened in one of the cities in Indonesia, namely Bandar Lampung City. Drainage is one of the technical measures to reduce excess water, both from rainwater, seepage, and excess irrigation water in a land / area so that the land / area can function optimally [8]. Drainage is one of the important components of urban infrastructure that tackles flood and waterlogging problems [8,9,10,11,12]. The formulation of the problem of the Bandar Lampung City drainage supply system is about how to improve the drainage system that meets the needs of the city and how to make information about the source of the problem so far in the city of Bandar Lampung where floods or overflowing rivers often occur. The number of flood spots spread during the rainy season with high intensity. The distribution of flood spots is seen in Figure 1. If calculated from the population, urbanization has occurred due to the advancement of Bandar Lampung City in the last 5 years. Of course this is a separate problem related to city drainage because urban land cover has resulted in smaller catchment areas. The existence of this problem certainly needs to be overcome, even with the current technology. This is because basically technological progress is one of the innovations achieved by humans. The main objective is to provide convenience in every activity and solve problems previously faced [1,13,14]. With the concept of this goal, its use needs to be maximized for all kinds of human needs, one of which is to solve the drainage problem that occurs in the city of Bandar Lampung. This study is digital based with the Geographics Information System (GIS) and field surveys. So that the strategy so that information on digital-based urban drainage problems reaches stakeholders or the government can be a reference for further handling. Geographical Information System is a method that can be used to map the level of vulnerability to floods [15].



Figure 1: Flood Map of Bandar Lampung City in 2016

Some of the things that limit the problem in this study are that the research was carried out only to provide information about urban drainage, the source of the drainage system problems, the scope of this study was only in the city of Bandar Lampung and used the analysis carried out, namely by calculating the flow rate and river section and the analysis carried out only to determine the quantity and distribution of groundwater as a model of groundwater infiltration in the city of Bandar Lampung. According to Mair and his colleagues [16], drainage means draining, draining, removing, or diverting water. In general, drainage is defined as a series of water structures that function to reduce and / or remove excess water from an area or land, so that the land can be used optimally. Drainage is also defined as an attempt to control groundwater quality in terms of salinity. Drainage is a way to dispose of excess unwanted water in an area, as well as ways to overcome the effects caused by this excess water [17].

2. Materials and Methods

2.1 Study Area

Based on geographical location, Bandar Lampung City is located at 5020 'to 5030' south latitude and 105028 'to 105037' east longitude. To the south, Bandar Lampung is directly adjacent to the Lampung Bay. South Lampung Regency flanks the city of Bandar Lampung to the east and north. While the west is bordered by Pesawaran Regency. The area of Bandar Lampung City is 0.57 percent of the total area of Lampung Province, which is 197.22 km². The city of Bandar Lampung has a fairly small area compared to other districts, in addition to Metro City. Bandar Lampung is located at an average height of 77.08 meters above sea level, with the Kemiling area as the highest district having an altitude of 125 meters above sea level. Meanwhile, the lowest

sub-district with an altitude of only 25 meters above sea level is Panjang District. During 2013, the number of rainy days in this region recorded at five BMG stations reached an average of 95 rainy days, where the average rainfall was 201.7 mm and the highest rainfall was 652.3 mm occurred at the beginning of the year, namely the month January.



Figure 2: Administrative Map of Bandar Lampung City

2.2 Drainage Management Sharing System

From the physical condition of the city, the drainage system area is divided according to the existing drainage flow direction and divided into 4 drainage zone systems, namely 1) system I (Teluk Betung Zone); 2) system II (Zone Tanjung Karang); 3) system III (Zone Panjang); 4) system IV (Zone Kandis). Sampling using questionnaires to field data in the form of interviews with residents of former flood locations, field observations due to high water levels, namely inundation of buildings and trees, are very supportive in determining this criterion. So that it can be studied more deeply about the prevention of these hazards by managing drainage and the type to be used. Secondary data to complement this research were obtained from related agencies or bodies related to the theme of this research, including the Public Works and Public Housing, Housing, Settlement Areas and Natural Resources Management in Lampung Province, Development of Environmental Sanitation Systems for Housing in Lampung Province, Meteorology and Geophysics Agency and Regional Development Planning

Agency of Bandar Lampung City.

3. Results and Disscusion

When viewed from the topographical conditions of the city of Bandar Lampung which are hilly and have a steep slope, ideally this condition is very favorable because the drainage system can flow naturally following gravity from the channel to the next primary channel. In this natural ideal condition, the city of Bandar Lampung is spared from flooding and inundation. The highest regional condition in the city of Bandar Lampung is the Kemiling District area, has an altitude of + 200 - 300 masl above sea level and is in the upstream area of the Way Kuala watershed, while Bandar Lampung has a sea bay that can accommodate river overflows. In fact, for more than 6 years, most of the sub-districts in the city of Bandar Lampung have several locations of inundation with the frequency of occurring more than or equal to 5 times per year with almost the same locations.



Figure 3: Slope Map of Bandar Lampung City

However, along with the development of the city which directly affects land use change, as well as the increasing population, the problem of flooding and inundation is a consequence that must be faced by the City of Bandar Lampung. This can be seen from the economic growth in the city of Bandar Lampung per year, an increase in the number of urbanized residents per year, and an increase in the number of investors who attend in the form of building hotel facilities per year. So that practically the city of Bandar Lampung becomes the capital

of choice for business, tourism, education and investment for the welfare of its people.

Field survey results from 2016 to 2017 showed that the causes of standing water that generally occur are as follows.

- a) Stagnant water on the protocol road. This is because the road elevation is uneven and there are basins, especially in bridges, over rivers that cut the road. This is because the topography of the location is difficult to make roads with flat elevations. It is likely that the initial topography was a fairly deep basin.
- b) The occurrence of a change in the type of channel due to the construction of shops that is growing rapidly everywhere, such as the original open channel type to a closed channel with concrete and the absence of inlet or manholes to enter the channel;
- c) The occurrence of inundation in the residential area due to the channel capacity being smaller than the flood discharge that occurred, or due to road culverts which are covered with sediment or garbage, or the absence of drainage channels;
- d) There are many buildings on the banks of the river, thus narrowing the cross-sectional area of the river. The elevation of the left and right embankments of the river did not overcome flooding, and even prevented water on the left and right of the river in the form of a basin / valley, from entering the river, which resulted in the collapse of the embankment, especially around the bends of the Way Awi and Way Balau rivers.

Regardless of the northern part of the city, especially Kedaton and Sukarame Districts, previous studies have divided the Bandar Lampung City drainage into three drainage systems, namely the Teluk Betung System, the Tanjung Karang System, and the Panjang System. Based on the results of the field visit, it can be informed that in the North, which is currently growing rapidly (especially housing), begins with several small rivers / drainages that flow to the North, namely to Way Sekampung. To avoid flooding problems in the future, this area needs serious attention. Therefore, it is suggested that the study area be divided into four drainage zone systems as follows (see Figure 4).

- a) System 1 (Teluk Betung Zone), includes: drainage in the Teluk Betung area which flows its water to the Way Kuala river as the main drain, including Way Kemiling, Way Calling, Way Langkapura, Way Kedaton, Way Balau, Way Halim, Way Durian Payung, Way Simpur, Way Awi and its branches, Way Panengah, and Way Peace;
- b) System II (Tanjung Karang Zone), consisting of several rivers, namely Way Kuripan (Way SimpangKanan, Way Simpang kiri, Way Betung), Way Kupang, Way Kunyit and Way Bakung;
- c) System III (Long Zone), which includes drainage that flows into the rivers Way Lunik Kanan, Way Lunik Kiri, Way Pidada, Way Galih Panjang, and Way Srengsem, which is a flat area drainage zone in the downstream area causing flooding.
- d) System IV (Kandis Zone), covering areas in the Kedaton area and parts of the western region of Sukarame, in this zone the main drainage will discharge into the Way Kandis 1 Way Kandis 2 and Way Kandis 3 rivers.



Figure 4: Study Locations with Four Distributions of the Flood Point Monitoring Area System

The problem of flooding / standing water in urban areas is resolved by means of urban drainage and flood control that is good and well organized. To avoid misunderstanding, the existing river / canal system will first be classified as a flood control system or urban drainage. In accordance with the Decree of the Minister of Public Works No. 239/1987, in the city of Bandar Lampung there are at least five rivers that can be categorized as flood control, namely Way Kuripan, Way Balau, Way Pidada, Way Galih Panjang and Way Srengsem. However, considering the relatively small percentage of Way Balau, Way Pidada and Way Srengsem catchment areas outside the city area, in this study only Way Kuripan and Way Galih Panjang were categorized as flood controllers. Rainfall is one of the most important variables in the analysis of water balance or water balance in a watershed or an area. Bandar Lampung City has four rain stations namely Pahoman, Sumur Putri, Sumberejo and Sukarame. Each of these stations has a station code, namely PH-001 for Pahoman, PH-003 for Sukarame, PH-004 for Sumur Putri and PH-005 for Sumberejo. The location of the rainfall can be seen in Figure 5.As for the annual rainfall data from the four stations it can be seen in Figure 6.From this graph, it can be seen that in 2010 and 2011 had the highest annual rainfall of the years. other.







Figure 6: Graph of Average Annual Rainfall from Four Stations

The flood management approach is directed at handling and structuring the area around the site by making policies and determining areas for settlement facilities, structuring drainage channels and constructing flood protection / embankments if necessary. This handling approach is carried out at the level of policies and laws that are elaborated in regional regulations or higher legislation. In determining this policy, it examines the socio-economic, cultural, environmental and political conditions. The drainage system management approach in relation to flood control and mitigation will be influenced by various factors including a) environmental boundary conditions; b) hydraulic parameters; c) geotechnical parameters. The above parameters will be analyzed based on the data obtained from the field survey results in the form of hydrological, hydraulics, soil / geological mechanics, and environmental parameters, so that the existing parameters will be planned and designed an appropriate and useful drainage structure. From the results of the survey on the location of the flood points, under the Tanjung Karang System, the Teluk Betung System, and the Panjang System, it will flow into the Java Sea via Way Sekampung. This can be seen from the topography of Bandar Lampung City (see Figure 3). From the results of research and survey on drainage conditions (can be seen in table 1) shows that the percentage of drainage is in good condition in the city of Bandar Lampung.

Locatio n	Settlement Area (m ²)	Runoff Coefficie nt	Rain Intensit y	Water dischar ge (m ³ /s)	Water discharg e (m ³ /hou r)	Information	Priori ty Scale	Handling
Locatio n 1 Raden Gunawa n 2 Street, Rajabas a	Stagnant water as much as 45,000 m ² , building houses and facilities around 400 units with a population of around 1,600 people	0.6	40,394	1.485	5,345.8 7	The basin and drainage areas are not ordered, and there is no direction of flow. The dimensions of the channel are inadequate, especially at the meeting or crossing of channels and culverts	Main priori ty	Constructio n of permanent drainage and regulation of drainage direction
Locatio n 2 Ikan Pari Street	Stagnant water 7,300 m ² The number of houses is around 100 units, with a population of around 400 million with 239.5 meters long and 3 meters wide	0.6	40,394	0.0531	191.08	The primary channel overflows and drainage can accommodate the flow rate The elevation of the settlement of the left and right sides of the primary channel is	Secon d priori ty	Normalizati on of primary drainage channels Environme ntal drainage

Table 1: Percentage of Drainage in Bandar Lampung City in 2016 - 2019

						lower		
Locatio n 3 Pancor Mas Street	Stagnant water 2,500 m ² The number of houses and other facilities is around 54 units, neighborhoo d roads are 154 meters long and 2.5 meters wide, with a population of 200 people	0.6	40,394	0.0349	125.642	The primary drain overflowed and the drainage lock was lost	Third priori ty	River normalizati on with sediment dredging as the primary channel Water gate repair and environmen tal (tertiary) drainage repair
Locatio n 4 Baru Village	Water pool 1,800 m ² The number of houses and other facilities is around 40 units, neighborhoo d roads are 55 meters long and 2.5 meters wide, with a population of 160 people	0.6	40,394	0.0194	69.8	There is no sluice gate in the channel leading to the river which can cause the water to turn back There are only 5 houses that do not have tertiary drainage	Fourt h priori ty	Normalizati on of rivers with sediment dredging Constructio n of floodgates and constructio n of environmen tal (tertiary) drainage channels

Determination of criteria for good, medium and bad conditions based on Government Regulation PU No. 45 of 2007, where the area of damage is divided by the area of the total volume. From the results of the survey and using GIS, the data obtained are as in Table 1. Table 1 shows that there are several locations or zones that need to be improved. From the existing urban drainage system, the number of drainage improvements in Bandar Lampung is around 27% of the existing drainage area. So that it will make the city a metropolitan city that is free from flooding.

4. Conclusion

The capacity of the drainage channel is the ability of the channel / drainage system to accommodate the flood discharge that occurs, this flood discharge is the calculation result of the collected hydrological analysis. Broadly speaking, the drainage capacity of the Bandar Lampung City drainage is still able to accommodate the flood discharge that occurred, but there are several existing channels that need serious attention because they are not able to accommodate the flood discharge that has occurred, there are indeed several cases that occur because

the channel is silting / silting. accumulation of mud / garbage, damage to channels and because in several places along the riverbanks / drainage channels it is used for social, community and personal needs. Strategic issues for flood or inundation management are:

- a) Increasing institutional capacity, namely by establishing a flood control UPT in the planning, investment and management and maintenance of existing drainage channels.
- b) Regional regulations (Perda) that regulate the distribution of authority and responsibility for drainage management, given that the drainage problem is quite complex. Apart from that, other regulations are related to the preservation of the function of wetlands as a water catchment sector, permit for development in riverbanks and floodplains, determination of river boundaries and drainage channels, guidelines for the preparation of drainage master plans, planning, implementation and operation and maintenance.
- c) Budget allocation for construction and operational and maintenance costs within the framework of flood control, the implementation of which is carried out in stages.
- d) The need to maintain water catchment areas, especially for housing construction that will open new land, so it is necessary to construct infiltration wells or create retention ponds. And this is one of the conditions for obtaining a construction permit.

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