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Impact of Drainage Problems in the City of Jakarta

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ABSTRACT. The need for land use in Jakarta can be a contributing factor to the reduced function of infiltration and water flow, resulting in changes and problems in the drainage system. It is suspected that downstream areas such as Jakarta are unable to accommodate excess water, because there may be problems with the drains or drainage systems. This study aims to determine the impact of drainage problems and to find out how to solve drainage problems in Jakarta. The method used in this research is a qualitative method with a descriptive approach carried out by studying the literature and distributing questionnaires. The research sample is residents of the Greater Jakarta area, especially Jakarta. The results showed that the problems that occurred in the operational drainage system were influenced by factors of rain intensity, catchment area, population growth, and environmental factors. A problematic drainage system causes flooding. To solve problems in the drainage system, namely by optimizing the drainage function, mapping the drainage area, making storage tanks and filters, implementing environmentally friendly drainage or Eco drainage, and normalizing and cleaning the drainage system.

Keywords: Floods, Urban Problems, Drainage Systems, Water Discharge.

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1. Introduction

Water is an important resource and has a big role in life. Water is needed to fulfill most of the necessities of life. Water needs to be absorbed and flowed to keep it not collected at one point. Water flow can be helped by drainage. Drainage is a water disposal system designed to remove or reduce excess water from a place, so that the water in that place can function optimally (Harahap et al., 2020). The drainage system is a system to drain water from a place to a lower place, where the drainage system helps water that cannot enter or cannot be absorbed directly into the soil.

However, in urban areas that have high population growth, there are many land use changes that have been converted to facilities and infrastructure such as housing, buildings, infrastructure, buildings, and others. So that it is possible to add new problems, especially environmental problems. Environmental problems in urban areas are no longer a surprise, especially in the Jakarta area. Jakarta is a metropolitan area, where a lot of activities are centered in the area and the population growth are high. Based on the DKI Jakarta Provincial Statistical Management Agency (2020), the population growth rate of DKI Jakarta in 2019 is 1.19 percent. To meet the needs of a growing population in Jakarta, of course, land use by changing land functions from green open spaces to settlements has great potential.

The need for land use in Jakarta can be a contributing factor to the reduced function of infiltration and water flow, resulting in changes and problems in the drainage system. It is suspected that downstream areas such as Jakarta are unable to accommodate excess water, because there may be problems with the drains or drainage systems. To identify problems in drainage, an assessment of the service level of urban drainage is required. The level of urban drainage service is the level of ability of urban drainage channels and their buildings to accommodate and drain surface water so that it does not cause standing water (Andayani dkk., 2012). Therefore, this research was conducted to determine the impact of drainage problems and to find out how to solve drainage problems in Jakarta.

2. Materials and Methods

2.1 Methods

In this study, qualitative method is used with a descriptive approach. Descriptive qualitative is used by presenting information obtained from previous literature studies, a qualitative approach is used because in this study depth is a priority. Data collection was carried out by reviewing literature and distributing questionnaires. Literature study that reviews several journals and books discussing drainage and flooding. Questionnaires were distributed by giving questions to several respondents. The method of collecting questionnaire data in this study is Cluster Sampling (Area Sampling), where the questionnaire is distributed to several people from the Jabodetabek area, then for the research sample by taking data from respondents from Jakarta.

2.2 Location

The location in this study is in the Jakarta area. The research location was chosen because it is an area that has problems with the drainage system. Geographically, Jakarta is located between 1060 58'18 "East Longitude and 50 19'12" LS up to 6023'54 "LS. The location of Jakarta is bordering Bogor

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Regency and Depok City in the south, bordered by Bekasi City and Bekasi Regency in the east, and bordered by Tangerang City and Tangerang Regency in the west. Of these areas, Jakarta is the area most likely to be the lowest, because its altitude and sea level are very short.

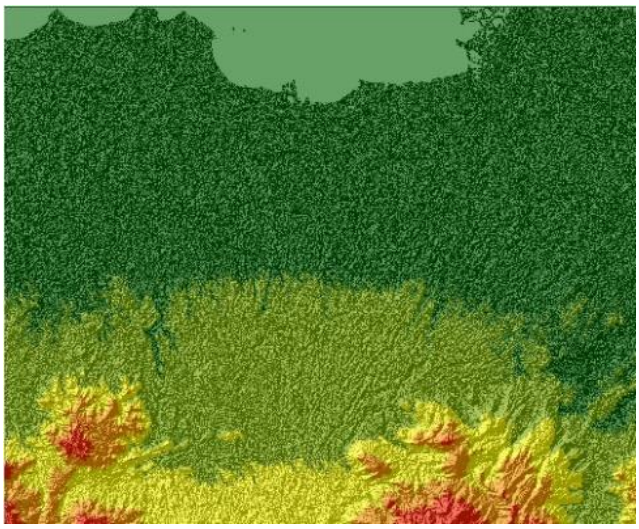

Fig.1 Jakarta and Surrounding Elevation Map

3. Result and Discussion

3.1 Drainage

Drainage is a system for disposing of water directly by nature or by human assistance from a certain area to the ground or in the ground. Jakarta is a low-lying area and is included in the downstream area when compared to the surrounding areas such as Bogor which is included in the upstream area. Thus, in order to maintain the optimal and smooth flow of water through the drainage system in Jakarta, it is necessary to optimize and manage a good and sufficient drainage system.

There are about 13 main river flows that originate from the area around Jakarta which play a role as the lifeblood of Jakarta. In theory, the existence of 13 rivers is beneficial for the City of Jakarta, which is an area that is lower than its surroundings.

Fig.2 Map of River Distribution in Jakarta and Its Surroundings

3.2 Drainage Functions in Urban

According to the Minister of Public Works Decree No. 233 of 1987, the city drainage is a water disposal network that can be used to divide parts of the city administration area and urban areas from standing water. In Nurhamidin dkk., (2015), the drainage system in cities is divided into 4, namely drying, draining, controlling, and absorbing water. The drainage system of the city acts as a drain and drain the rainwater from an urban area, which includes housing, industry and commerce, schools, hospitals, and other places that are part of city facilities (Novriantidkk., 2017).

3.3 Impact of Problems on the Drainage Channel Operational System

Based on the distribution of standing water in DKI Jakarta in Figure 3, it can be shown that the existing drainage system in Jakarta has various problems with its drainage, such as the inability to drain air runoff, unavailability of drainage in some areas, disconnection with the urban drainage system, unmanageable drainage, and quality. Drainage construction that can generate negative impacts.

Therefore, the existence of a drainage system is very important in an urban environment. The existence of drainage system in urban areas can provide various benefits, such as health benefits, water excess or overflow, and preventing groundwater contamination by waste. Drainage is an important component in the spatial infrastructure of regional infrastructure that has many benefits, so we must protect the drainage system and maintain it as well as possible. The management of the drainage system must be well managed, so that the operation and practice of the drainage system in draining air can be smooth and optimal. Because, the absence of a proper and optimal drainage system management can cause various negative impacts or problems, first on the environment.

If there are problems that hinder the operation of the drainage system it can cause problems or negative impacts. One of the most frequent impacts due to the drainage system, especially in urban areas like Jakarta, is flooding. Flood is a disaster where water overflows to the land and is caused by natural conditions and anthropogenic activities. Floods are influenced by several factors including extreme climatic factors (extreme rain), decreased watershed carrying capacity, planning and implementation errors, socio-hydrological factors, and faulty drainage concept factors (Maryono, 2014).

From the results of distributing questionnaires related to the impact of the flood disaster, it was obtained that 50 respondents were residents of Jabodetabek. Of these, 20 respondents have experienced flooding and 30 others have never experienced flooding. Respondents who experienced flooding were 20 people, of which 10 resided in Jakarta and 10 people resided in Bogor/Depok/Tangerang/Bekasi. Of the 10 respondents who had experienced flooding and came from Jakarta, all were disturbed by the flood. There are various impacts resulting from the flood. For example, houses that are flooded have suffered a lot of damage and of course become dirty, making it uncomfortable to carry out activities in the house. Floods also have an impact on human psychology. People who are affected by the flood feel panic and anxious, because their thoughts and feelings are not focused, especially if they don't get immediate help and assistance. Floods also cause other problems such as blackouts, difficulty in getting clean water, dead internet, obstruction of various transportation and accommodation, and obstruction of roads

which can add to congestion. Thus, the community experiences various kinds of obstacles in carrying out all activities that are usually carried out daily, such as many people who cannot go to work or school because of impassable roads constrained various transportation and accommodation, as well as obstruction of roads that can increase congestion. Thus, the community experiences various kinds of obstacles in carrying out all activities that are usually carried out daily, such as many people who cannot go to work or school because of impassable roads constrained various transportation and accommodation, as well as obstruction of roads that can increase congestion. Thus, the community experiences various kinds of obstacles in carrying out all activities that are usually carried out daily, such as many people who cannot go to work or school because of impassable roads.

When the floods recede, the roads that are affected by the flood will be damaged. Floods can cause many roads to be potholed due to erosion of water during a flood. The impact of the flood affects everything in the affected area, the ecological function is also affected by the flood, many fallen trees and damaged ecosystems. The occurrence of flooding has a negative and detrimental impact on all environmental components.

Fig.3 Map of the Distribution of Inundation in DKI Jakarta in 2019

Source: Drainage Information System (2020)

3.4 Factors Affecting Drainage System

1) Rain Intensity

Rain intensity is the amount of rain in height or volume per unit time (Harahap dkk., 2020). The amount of rain intensity depends on the length and frequency of rain. The results show that the intensity of the rain is obtained by analyzing the rain data. The length of time it rains is related to concentration time. Rain intensity can be used in analyzing the hydrology of a drainage. The high rainfall results in an increase in the water level downstream and makes the drainage channel to accommodate a larger water mass or water discharge. If a drainage experiences problems and the operation is not optimal, it can cause water overflow.

Table 1. Daily Rainfall

No.	Daily Rainfall in the Jakarta Area as of October 11, 2020	
	Territory	Rainfall (mm)
1	ARG Ciganjur	109.0
2	Upper Crutches	109.0
3	SunterHulu	109.0
4	ARG LebakBulus	81.6
5	AWS TMII	64.6
6	Sunday market	53.0
7	Kedoya	51.1
8	Angke Hulu	47.0
9	ARG Tomang	26.0
10	Rubber	25.0
11	Halim PK	18.0
12	Pakubuwono	14.0
13	Cideng Pump	14.0
14	East Setiabudi	12.0
15	Jasmine Reservoir	21.0

Source: BMKG (2020).

Based on Table 1 data obtained from BMKG (2020), it shows that the highest rainfall of 109.00 mm with very heavy rain intensity occurs in the ARG Ciganjur, Krukut Hulu, and Sunter Hulu areas. Meanwhile, the lowest rainfall was 21.00 mm with moderate rain intensity in the Melati Reservoir area. This rainfall will affect the water level of the drainage channels in the area.

Table 2. Water Level Limit

No	Water Gate	Alert Limit		
		Standby III	Standbay II	Standbay I
1	Bendung Katulampa	81 ~ 150	151 ~ 200	≥ 201
2	Pos Depok	201 ~ 270	271 ~ 350	≥ 351
3	PA Manggarai	751 ~ 850	851 ~ 950	≥ 951
4	PA Karet	451 ~ 550	551 ~ 600	≥ 601
5	Pos Krukut Hulu	151 ~ 250	251 ~ 300	≥ 301
6	Pos Pesanggrahan	151 ~ 250	251 ~ 350	≥ 351
7	Pos Angke Hulu	151 ~ 250	251 ~ 300	≥ 301
8	Waduk Pluit	-51 ~ 0	1 ~ 45	≥ 46
9	Pasar Ikan	171 ~ 200	201 ~ 250	≥ 251
10	Pos Cipinang Hulu	151 ~ 200	201 ~ 250	≥ 251
11	Pos Sunter Hulu	141 ~ 200	201 ~ 250	≥ 251
12	PA Pulo Gadung	551 ~ 700	701 ~ 770	≥ 771

Source: BPBD DKI Jakarta (2020)

Based on Table 2 data obtained from BPBD DKI Jakarta (2020), it is known that the water level is limited according to the alert level, where the floodgate that can accommodate the lowest water is Pluit Reservoir, with the highest water level at standby level 1 which is approximately the same as 46. Meanwhile, the floodgate that can accommodate the highest water is PA Pulo Gadung, with the highest water level at standby 1 which is approximately equal to 771.

Table 3. Water Level Status

Monitoring Location	Water Level (cm)	Status
Katulampa	50	Normal/Standby4
Depok	125	Normal/Standby4
Manggarai	715	Normal/Standby4
Karet	400	Normal/Standby4
Krutuk Hulu	110	Normal/Standby4
Pesanggrahan	150	Normal/Standby4
Angke Hulu	190	Alert/Standby 3
Waduk Pluit	-190	Normal/Standby4
Pasar Ikan	172	Alert/Standby 3
Cipinang Hulu	135	Normal/Standby4
Sunter Hulu	200	Alert/Standby 3
Pulo Gadung	340	Normal/Standby4

Source: Jakarta Department of Water Resources (2020)

As shown in table 3 obtained from the Jakarta SDP Office (2020), where it can be seen water level in the DKI Jakarta area as of October 11, 2020. Based on these data, it is known that the water level conditions in the upstream angke, fish market, and upstream sunter are already on standby 3 or in a warning alert condition. Alert here means that the water level will exceed the limit if it is followed by heavy rain and receiving water from the upstream area. This condition can allow flooding, if the drainage and storage systems are not sufficient or the water exceeds the storage limit or water level.

Based on these three data, it shows that if the water discharge increases when the rain intensity is high, it can trigger changes in the water level and can even exceed the water level limit. In problematic and suboptimal drainage, this will cause the drainage channel to have a large dependent water mass and unable to accommodate the overflow of water, so that this will cause water inundation which can cause flooding.

2) Catchment area

Catchment area is a coverage area in case of rain (Nurhamidin dkk., 2015). The bigger the catchment area, the greater the discharge. The determination of the catchment area is based on the principle of high difference. The division of the catchment area to the downstream or lower area of the catchment area is divided evenly on each side to the drainage channel. The division of the catchment area to the upstream or high area is based on the highest point, then it will flow to the low area based on the topographic flow.

3) Population growth in urban areas

Currently population growth is increasing and even though there are many communities, most people lack awareness of the importance of water drainage. The high rate of population growth greatly affects the availability of land. The narrowing of the green open space causes a large surface water drainage, so that the drainage system becomes heavier, more obstructed, and not smooth. Uncontrolled growth can result in stagnant water, due to a decrease in the function of the area as a catchment area.

4) Environmental factors

Environmental factors around the drainage canal can disrupt water drainage, such as disposal of waste into drains, dumping garbage into drains, and the existence of wrong construction resulting in damage and not optimal drainage of water in the drainage system so that it can have negative impacts.

3.5 How to Solve Drainage System Problems

There are several ways to solve the drainage system problem that can be pursued by optimizing the proper drainage system. In the research of Harsoyo dkk. (2016), there are several programs to address poor drainage quality by mapping drainage areas and managing infiltration and biopore wells. Infiltration wells, more precisely vertical infiltration, which holds water vertically downwards and horizontally, is suitable to be applied in areas that have a deep enough groundwater level and land area that is not too large (Wahyuningtyas dkk., 2011). Drainage system planning or management must be carried out appropriately by paying attention to the design and dimensions of the drainage channel in order to be successful and maximize drainage performance. Drainage planning must also consider land use, carried out in areas that become points of runoff and flood inundation. So that a well-integrated flood prevention system can be produced.

In the study of Pania dkk. (2013), in an effort to repair a bad drainage system, rearrangement of the drainage system can be carried out by changing the channel system, increasing the number of channel systems and channel capacity that have previously been analyzed so that a new drainage system is produced. In addition, in areas that tend to be sunken, drainage can be carried out using a reservoir and a pump. The reservoir is made from an existing drainage channel which overflows from the puddle, the waste water from the storage tank is then pumped into a secondary channel which will drain into the primary channel (Dewanti dkk., 2016).

The quality of drainage can be improved by making and adding several building support facilities to the drainage system, such as water holes in the channel walls that function to drain infiltration water from the ground, water holes on the sidewalk, coarse and fine trash filters, cover over ditches, control holes, bags, sand/mud, and landscapes (Harahap et al., 2020). The quality of natural drainage also needs attention. This can be done by maintaining and managing drainage that is environmentally friendly, such as the concept of eco hydraulic. The concept of eco hydraulic is a concept that restores the condition of a natural river basin. According to Syarifudin (2017), there are several environmentally friendly drainage methods, including conservation pond methods, infiltration wells, river side polders, and groundwater protection areas.

In order to maintain the quality of drainage performance, maintenance is required so that the drainage system can continue to work optimally. This maintenance can be carried out by normalizing the river, normalizing drainage channels and cleaning the channels from garbage and sedimentation. Cleaning can be carried out by regular cleaning and installation of garbage holding grilles. Handling and maintenance of drainage, apart from what the government does, also requires community involvement in it.

4. Conclusion

The impact of drainage problems, especially in the city of Jakarta, is the risk of floods that will continue to increase and get worse and can disrupt the activities of the affected community. Poor drainage conditions will not be able to cope with the overflow of water when it rains, which will cause stagnant water. How to solve drainage problems can be done by optimizing the drainage function, mapping the drainage area, making storage tanks and filters, restoring and rearranging problematic drainage systems, carrying out proper drainage planning, and providing supporting facilities for drainage buildings, and applying the eco drainage concept to support artificial drainage system performance. Drainage treatment also needs to be done to avoid drainage problems.

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