

## PLANNING FOR DRAINAGE DEVELOPMENT IN JAKARTA'S URBAN SETTLEMENTS WITH THE CONCEPT OF A HEALTHY CITY

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### ABSTRACT

The need for land use in Jakarta can be a factor causing 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 channels or drainage system. For this reason, it is necessary to plan a drainage system (drainage network) so that it can function optimally in accordance with Minimum Service Standards (SPM) to accommodate water flow discharge, which is normal, especially during the rainy season and there are high tides so that you don't experience inundation or flooding. This research aims to plan the construction of drainage that is optimal according to standards in Jakarta in order to raise public awareness of the importance of keeping the environment clean, not throwing garbage in the drainage canals and always keeping the drainage canals clean so that they can drain wastewater from settlements, rainwater and puddles smoothly.

*Keywords : Drainage; Rainwater; Community*

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### INTRODUCTION

Water is an important resource and plays a major role in life. Water is needed to fulfill most of life's needs. Water needs to be absorbed and flowed so that it does not collect at one point. Water flow can be assisted 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). 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 (Xu et al., 2021). Environmental problems can be minimized at three basic levels: through primary prevention of acid-generating processes; secondary control, which includes implementing measures to prevent migration of acid drainage; and tertiary control, or waste collection and processing (Akcil & Koldas, 2006; Favas et al., 2016). Acid mine drainage (AMD) causes environmental pollution that affects many countries having historic or current mining industries (Johnson & Hallberg, 2005; Simate & Ndlovu, 2014). Handling environmental pollution problems can be done by conducting evaluations downstream of the mine to stabilize contaminated soil (Kefeni et al., 2017).

Urban areas that have high population growth, there are many changes in land use that switch functions to facilities and infrastructure such as housing, buildings, infrastructure, buildings, and others. So 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 many activities are centered in the area and population growth is high. Based on the Central Bureau of Statistics of DKI Jakarta Province (2020), DKI Jakarta's population growth rate in 2019 was 1.19%. To meet the needs of Jakarta's growing population, of course, land use by changing land functions from green open space to settlements has great potential. Yang and Gakenheimer (2007) examined land use uncertainty and accessibility and mobility related to current urban development themes. Anna et al. (2016) stated the need for a long-term perspective in city planning to meet various important parameters of a quality city.

The need for land use in Jakarta can be a factor in reducing the function of water infiltration and flow, resulting in changes and problems in the drainage system. It is suspected that downstream areas such as Jakarta are not able to accommodate excess water, because there may be problems in the channel or drainage system. To identify problems in drainage, an assessment of the level of service of urban drainage is required. The level of service of urban drainage is the level of ability of urban drainage channels and buildings to accommodate and

drain surface water so that it does not cause puddles. (Andayani & Yuwono, 2012). Muthusamy et al. (2018) stated that among urban water pollutants, the most common is sediment which also acts as a transportation medium for many contaminants. Therefore, there is increasing interest in being able to better predict sediments.

In general, a drainage system can be defined as a series of water structures that function to reduce and/or dispose of excess water from an area or land, so that the land can be used optimally. However, practically we can say that drainage handles excess water before it enters large channels or rivers (Suripin, 2004). Drainage network system in an area should be designed to accommodate normal flow rates, especially during the rainy season. This means that the capacity of the drainage channel has been calculated to accommodate the water discharge that occurs so that the area concerned does not experience inundation or flooding. If the capacity of the drainage system decreases due to various reasons, the discharge will be normal even though this cannot be accommodated by the existing system. The cause system capacity decreases, including a lot of sediment, damage occurs physical network system, the existence of other buildings above the network system. At certain times during the rainy season, the flow rate often increases or increases. If the flow rate is caused by various reasons, then the existing system capacity will not occur can accommodate flow discharge, resulting in flooding in an area. The causes of increased discharge include very high rainfall, changes in land use in urban Jakarta. Climate change results in changes in rainfall. Pervin et. al (2020) stated that the frequency of short-duration and high-intensity rainfall is expected to increase in the future due to climate change. Given the limited capacity of drainage systems in cities in South Asia.

An overview of drainage system problems in the city of Jakarta, so planning for the drainage system can be re-evaluated, namely how to plan optimal drainage development according to standards so that flooding and standing water do not occur. This research aims to re-evaluate drainage development in DKI Jakarta so that it can function to control flooding, especially when rainfall is high.

## **RESEARCH METHOD**

This research uses a qualitative method with a descriptive approach. Qualitative descriptives are used by presenting information obtained from previous literature studies. A qualitative approach is used to obtain a more in-depth explanation. Data collection was carried out by means of literature studies and distributing questionnaires. The literature study reviews several journals and books that discuss drainage and flooding. Questionnaires were distributed by asking questions to several respondents at the research location. The questionnaire data collection method in this research is Cluster Sampling (Area Sampling), where the questionnaire is distributed to several people in the Jabodetabek area, then the research sample is taken by taking data from respondents who live in Jakarta.

The location of this research 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 106° 58' 18" East Longitude and 5° 19' 12" South Longitude to 6° 23' 54" South Longitude. It borders Depok Regency and City to the south, Bekasi City and Bekasi Regency to the east, and Tangerang City and Tangerang Regency to the west. Based on this geographical area, it can be seen that the topography of the Jakarta area is low. During high rainfall, drainage channels do not function and result in flooding. Jakarta is an area that is likely to have low topography, because of its height and high sea level very short.

Agustin et. al (2021) explains about drainage in Jakarta. Drainage is a direct water removal system nature or with human assistance from a particular area to that area ground or in the ground. Jakarta is a lowland area and including in downstream areas when compared with surrounding areas such as Bogor are also included upstream area. Thus, to maintain optimal and smooth flow of water through the drainage system in Jakarta, there needs to be optimization and good and adequate management drainage system. Agustin et. al (2021) further explained that Jakarta is the area that is most likely the lowest, because the height and sea level are very short.

The following map depicts DKI Jakarta and its surroundings:



Figure 1 Map of DKI Jakarta Province

Data source: DKI Jakarta Province in Figures 2022

## RESULT AND DISCUSSION

Examining the results of the literature review theory to be poured into the planning process, theories are obtained that can support the planning of a good drainage network system in accordance with the standards in order to be able to function optimally to drain water that occurs due to the discharge of residential channels and puddles while answering the problems of drainage networks that exist in settlements in the Jakarta area. The theories used in the process of planning the drainage network system in settlements in Jakarta, namely:

### a. Type of Drainage

For a planning process the type of drainage is artificial drainage. This drainage is made with the intent and purpose of drainage planning. so that it requires a special building, namely stone/concrete masonry, besides being suitable for settlements, the planning budget is cheaper and more efficient. For example, Lyngsie et. al (2014) stated that eutrophication of phosphorus (P) in lakes and rivers, which originates from drained agricultural land, is a serious problem in areas with intensive agriculture. Installing a P-absorbing filter in the drain can be an efficient solution.

### b. Building Location

For the location of the building drainage channels built in the form of Surface Drainage (Surface Drainage) is a drainage channel that is above ground level that functions

to drain surface runoff water. Mahmoodian et. al (2018) stated that urban drainage modeling usually requires the development of very detailed simulators due to the nature of the various underlying surface and drainage processes, making it computationally too expensive.

### **c. Function**

For its function, the type of drainage used is Multipurpose drainage, where this channel functions to drain several types of waste water both mixed and alternating, very suitable with its function of draining household waste water and rainwater simultaneously. For example, Gupta (2002) stated that the usefulness of subsurface drainage as an intervention to reclaim land inundated with salt water and ensure the sustainability of irrigated agriculture in India has been established through experiments and pilot research conducted over more than a century.

### **Construction**

For its construction, 2 types of channel construction are used, namely:

#### **a. Open Channel**

For open channels, the top is open and in contact with outside air. This channel is more suitable for rain drainage that is located below which has sufficient area, or non-rain drainage that does not endanger health/disturb the environment. Open channels are best used in settlements that are not densely populated. Velasco et. al (2003) stated that hydraulic engineers and scientists working on river restoration realize the need for a deeper understanding of natural flows as complex and dynamic systems, involving not only abiotic elements (flow, sediment) but also biotic or biological components. From this point of view, the role of river vegetation in river dynamics and flow conditions becomes important.

#### **b. Closed channels.**

Closed channels are used in densely populated settlements. population. Closed channels are good for use in densely populated settlements (Yulianto et al., 2020). Because the shape of the drainage channel is closed to anticipate that it will not be clogged with garbage, then at several points near the settlement, trash cans are provided so that people do not litter and to filter the residents' Wastewater Disposal Channels (SPAL) so that they do not flow directly into the sea at several points of the drainage channel, infiltration wells are provided.

### **Drainage Network Pattern**

Efforts have been made to study drainage morphometry and its influence on landform processes, soil physical characteristics and soil erosion in the Vena basaltic river basin in the Central region (Reddy et al., 2004). The results of the analysis show that the influence of drainage morphometry is very significant on understanding landform processes, soil physical properties and erosion characteristics. The river basin is downstream of the surrounding drainage area. This condition is not much different from the drainage conditions in Jakarta (Costa et al., 2016; Remondi et al., 2016).

Actual projections provided by climate models show that the probability of heavy rainfall will increase in the future due to increasing greenhouse gas concentrations (Van Uytven & Willems, 2018). Given that the design of urban drainage systems is based on statistical analysis of past events, an increase in the intensity and frequency of extreme rainfall will likely result in more frequent flooding (Nguyen & Nguyen, 2020). Therefore, design criteria must be revised to take into account possible changes caused by climate change. A procedure was proposed to revise the design criteria for urban drainage infrastructure (Mailhot & Duchesne, 2010).

Because the research location is in Jakarta, which is a dense area of residential buildings, there are 3 suitable drainage network patterns used, namely:

1. Elbow pattern because it is adapted to the area in Jakarta, which is an area that has a

- topography slightly higher than the river so that the river is used as the final drain.
2. Parallel pattern, Because the main channel is located parallel to the branch channel. With quite a lot of branch channels (secondary) and short, in the event of settlement development in Kelurahan Lapulu, the channels can adjust.
  3. Jaring-net pattern, because the sewers follow the direction of the highway, and is suitable for use in Kelurahan Lapulu because there are also areas with flat topography.

Sadr, Fu and Butler (2018) explain that reliability, resilience and sustainability are the main goals of any urban drainage system. However, few studies have focused on measuring, operationalizing, and comparing these concepts amidst profound uncertainty. In this study, these key concepts are defined and quantified for a number of grey, green and hybrid strategies, aimed at improving the capacity problems of existing integrated urban wastewater systems. These interventions are investigated through a regret-based approach, which evaluates the robustness (i.e., ability to perform well under conditions of deep uncertainty) of each strategy in terms of three qualities through the integration of multiple objectives (i.e., sewer flooding, river water quality, combined sewer overflows, river flooding, greenhouse gas emissions, costs and revenues) in four different future scenarios. The results show that strategies that are considered strong in terms of sustainability are usually also strong in terms of resilience and reliability across future scenarios. However, strategies that are considered robust in terms of their robustness and, in particular, their reliability do not guarantee their durability. Conventional gray infrastructure strategies were found to be less robust in terms of sustainability due to imbalanced economic, environmental and social performance (Wang et al., 2022). However, these limitations can be overcome by implementing a hybrid solution that combines environmentally friendly retrofit and gray rehabilitation solutions (Bakhshipour et al., 2019).

### **Types of channels**

The types of channels used are trapezium and rectangular. These channels use smooth cement plastered masonry construction to reduce displacement and smooth the flow of water. Both forms of channel construction are in accordance with the standard and in addition to being suitable for residential use, the planning budget is more settlement, the planning budget is also cheaper and more efficient (Bredenoord & van Lindert, 2010).

### **CONCLUSION**

The impact of drainage problems, especially in the city of Jakarta, is that the risk of flooding will continue to increase and get worse and can disrupt the activities of affected communities. Poor drainage conditions will not be able to cope with overflowing water when it rains, which will cause stagnant water. How to solve drainage problems can be done by optimizing drainage functions, mapping drainage areas, making reservoirs and filters, restoring and reorganizing problematic drainage systems, doing good drainage planning.

Flood frequency analysis in urban watersheds is complicated by non stationary of annual peak records associated with land use change and evolving urban stormwater infrastructure (Villarini et al., 2009). Referring to the opinions of Mailhot and Duchesne (2010), it is further submitted that this procedure integrates information about (1) climate projections for extreme rainfall in the region under consideration; (2) expected level of performance (or acceptable level of risk); and (3) estimated age of infrastructure/system. The resulting design criteria ensure that the service level remains above the selected "acceptable" level for the life of the specified infrastructure. It is argued that the definition of new design criteria should be part of a global adaptation strategy that combines various measures to maintain acceptable service levels in a long-term perspective. However, defining this level of service is a challenge in a context where uncertainty regarding predicted changes in rainfall is high and remains important.



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