

DRAINAGE HANDLING SYSTEM IN TAMBOLAKA CITY

^{1,2,3)} Civil Engineering
Department. Politeknik
Negeri Bali

I Gst. Lanang Made Parwita¹⁾, Gede Yasada²⁾, Made Mudhina³⁾

Corresponding email 1):
lanangkepakistan@yahoo.com

Abstract. A City which is lovable by the society is a livable city, productive and has good spirit Tambolaka City is the capital city of southwest Sumba, like other cities which focuses also on the city itself towards the desirable community. Tambolaka city is a small city with an area of 9,605 acre has population about 19,241 people with an average population growth is 4% (Central Bureau of Statistics in Southwest Sumba, 2010). One of the basic urban infrastructure which is considered quite important in Tambolaka City is the sewerage of the drainage system of the city. A good city needs to consider the condition of the culverts because if the water is stagnant, it will greatly affect the life of the city i. e buildings become easily damaged, unhealthy environments, and dirty houses. The drainage systems in Tambolaka City include the trade area, offices, housing, and other areas. The rapid growth of the city is trying to be balanced by make urban infrastructure, one of which very important related to infrastructure is in relation to drainage problems. The drainage conditions in the region are already organized to mitigate the effects of flooding and stagnant water, in some locations there are problems such as unavailability of drainage, inadequate of drainage, stagnant water, and so on.

Keywords: tambolaka city, drainage, flood

1. INTRODUCTION

Tambolaka city with an area of 9,605 hectare, has a population of around 19,241 people with an average population growth of 4 percent. Rapid population growth should be followed by the provision of adequate urban basic infrastructure and facilities [1]. Limited funds and development programs can hamper the provision of basic infrastructure and facilities of the city, so that the needs generally go beyond the provision that can be provided. That's when there is an imbalance, between the large needs while the limited supply. The planned infrastructure and facilities can no longer meet the needs. As a result, traffic jams, floods, municipal waste are not well managed, waste water disposal is not in place, the community is difficult to get clean water services and others [2].

So far, city development in order to answer the challenges and needs of basic urban facilities is aimed at the community to increase economic development. One of the basic infrastructure and facilities of the city which is considered quite important is drainage.

A good city really needs to pay attention to the condition of its drainage channels because if a settlement is inundated it will greatly affect the life of the city buildings become easily damaged, the environment becomes unhealthy and settlements become slums. Drainage channel is a channel that functions to dry surface water, both sourced from rain water, tide water, flood submissions, water puddles, etc.

The area to be handled in Tambolaka City is the trade, office and settlement area in Tambolaka City and its surroundings.

The speed of growth of this region has been offset by the provision of urban infrastructure and facilities [3]. One very important infrastructure and facility is drainage. The condition of drainage channels in this area

has generally been managed well.

In some locations there are drainage problems such as unavailability of drains, inadequate canals, standing water and so on. To improve the drainage system in this area it is deemed necessary to conduct a technical study for the Tambolaka City area and prepare a technical plan for priority areas / areas.

2. METHODS

2.1 Research Design

The outline of research is carried out in the form of information gathering (secondary and primary data collection), field surveys, problem analysis, and formulation of development.

2.2. Surveys, field observations and data collection

Conduct a field survey to determine the condition of existing drainage facilities, including among others: to identify and inventory data and information on the development of infrastructure and drainage facilities that already exist (built / existing) in the Study Area, to identify and inventory areas that have the potential for flooding and areas waterlogging, identifying environmental components (bio-geophysical and social communities around waterlogging and flooding areas), which are predicted to be affected by a large and important impact due to the development of drainage systems, make a mapping to get an overview of the drainage / river channel area.

2.3. Inventory of existing drainage systems and identification of locations of flood prone points

This inventory and identification of flood-prone points is an analysis relating to the cross-section capacity of existing channels, the current utilization / function of channels, and the function of complementary buildings. Inventory and identification activities include the collection of drainage channels, flow patterns and existing drainage network systems.

2.4. Analysis

The analytical work carried out includes analysis as the basis for preparing this study as a whole. The analysis included: hydrological analysis, hydraulics, drainage systems and plan handling patterns.

2.5 Determination of Service Level

Determination of the appropriate level of service for a drainage system, also plays a role in preventing the failure of the function of the drainage system. The optimal level of service will reduce the investment costs invested, in addition to ensuring the functioning of the drainage system for the planned service life. For micro drainage systems it is recommended that the re-design period be taken between 1 to 5 years. The 1-2 year return period can be used for drainage system planning is for settlements, while the above two year return period is used for commercial and industrial areas, as well as transportation facilities. For the primary development system, the annual flood is taken again.

2.6. Compilation of drainage handling patterns

The study must produce a basic pattern of the exhaust system as outlined in a plan that shows the basic pattern and the disposal systems and subsystems and is an integrated whole.

3. RESULTS AND DISCUSSION

3.1 Drainage in Urban Areas

Urban drainage such as those in the City area like Tambolaka has its own characteristics compared to other regions.

The beginning of the problem of drainage systems in urban areas is the development of a population with a relatively high rate [4].

The increase factor is not only due to birth factors but also due to migration factors from other regions.

Population growth affects many things such as residential land, cultivated land and land for production. Further impacts that occur next are an increase in the amount of waste, changes in land use, reduced absorption areas, increased erosion, reduced channel capacity, irregular flow systems, coupled with excessive land acquisition will cause subsidence and lead to floods and inundation. which occurs in the rainy season [5].

3.2 Hydrological Analysis

Hydrological analysis is an analysis that aims to calculate the potential of water that exists in certain regions, to be able to be used, developed and control the potential of water for the benefit of the community around the

area. This hydrological analysis is very important in the study stage especially for irrigation buildings. The purpose of the hydrological analysis in this study is to obtain the design rain value, and the design flood which will later be used as a reference in calculating channel or river capacity [6].

3.2.1 Design Rainfall

Design rainfall is the largest annual rainfall with a certain likelihood of occurrence [6]. To analyze the frequency of rainfall in order to get the design rainfall, there are several methods that can be done. The choice of the design rain analysis method depends on the suitability of the relevant statistical basic parameter data from the distribution selection test conducted or can also be chosen based on other technical considerations. The rainfall design in this study was analyzed using the Gumbel and Log Pearson methods, according to the characteristics of the rainfall that is owned.

1. Gumbel Method

The Gumbel method of getting a rainfall plan is as follows [7]

$$R_t = R + S.K \dots\dots\dots (1)$$

Where :

R_t = design rainfall for the "t" period of the year

R = average maximum daily rainfall

S = standard deviation

K = The frequency factor is a function of the "t" year return period

2. Log Pearson Method

To calculate the design rainfall using the Log Pearson type III method, the data must first be converted into a logarithmic form, then calculate the statistical parameters [7]

$$\text{Log } \overline{R_t} = \text{Log } R + K.S \dots\dots\dots (2)$$

3.2.2. Design Flooding

Design flood is the maximum discharge in a river or channel with a predetermined return period [3]. If the design flood is used as the basis for planning, the flood can occur without jeopardizing the stability of the building. Based on the analysis of planned rainfall from the maximum daily rainfall data, the magnitude of the planned flood discharge can be calculated with a 1, 2, 5, 10, 25, 50, 100, 200 and 1000 year return period [8]. Determination of the magnitude of the flood recurrence plan depends on several things such as risks that must be accepted, socioeconomic conditions of the affected community, budgeted costs and other factors [9].

Design flood analysis distinguishes between flooding in a river and flooding in a drainage channel. Floods in drainage channels are analyzed using rational formulas while floods in rivers use the unit hydrograph analysis of the Nakayasu method [7].

1. Flood Analysis with Rational Methods Surface runoff calculated in urban drainage channels is in the form of rainwater runoff that falls in the drainage area, which is the part of rain water that becomes surface flow, calculated by the rational formula [7].

$$Q_p = 0,00278 . C . I . A \dots\dots\dots (3)$$

Where :

Q_p = flood surface runoff discharge (m³ / sec)

C = surface runoff coefficient

I = rainfall intensity during concentration time (mm / hour)

A = drainage area (ha)

2. Synthetic Unit Hydrograph Method Nakayasu Method

Because there is no AWLR (Automatic Water Level Recorder) installed, then to determine the hydrograph of a watershed unit at the study site, a Nakayasu synthetic hydrograph is used [4].

The Nakayasu synthetic unit hydrograph formula is [10]:

$$Q_p = \frac{C \times A \times R_o}{3,6 (0,3 T_p + T_{0,3})}$$

Where :

Q_p = flood peak discharge (m³ / sec)

R_o = unit rain (mm)

T_p = grace period from the beginning of the rain to the peak of the flood (hour)

$T_{0,3}$ = The time required by the reduction in peak flow to 30% of the peak flow

3.3 Hydrological Analysis

Hydrological analysis is an important analysis in conducting studies in the field of irrigation. This analysis will produce a design rain value which will then be the basis for determining the design flood [10].

3.3.1 Design Rain Analysis

In the rain analysis the design uses the Labuhan Bajo rain station data, the position of the rain post is in Labuhan Bajo Regency. Rainfall data used is maximum daily rainfall data with a long range of rainfall observations for 13 years from 2007 to 2019. The initial analysis method used in the design rain analysis is the Log Pearson Type III method. The results of the design rainfall analysis are shown in Table 1.

Table 1. Rainfall Data from Labuhan Bajo Station

Year	Labuhan Bajo Station	Date of incident
2007	110	November 25th
2008	199	April 17
2009	184	December 25th
2010	82	January 31st
2011	92	January 5
2012	192	January 25th
2013	147	5 May
2014	126	December 27th
2015	231	April 10th
2016	139	March 19th
2017	99	March 2
2018	78	February 20th
2019	120	January 3

Data source : BMKG, Labuhan Bajo

Table 2. Rainfall Area Log Method Pearson Type III

Reset Period (T) (Year)	G	Price Extrapolation (Xt) (mm)
2	0,0010	130,64
5	0,8420	175,99
10	1,2850	205,90
20	1,5990	230,12
25	1,7560	243,29
50	2,0550	270,47
100	2,3280	297,94
200	2,5770	325,42
1000	3,1000	391,66

3.3.2 Design Flood Analysis

Design flood analysis was carried out to determine the magnitude of flooding that occurred in the main drainage system in Tambolaka City especially the Loko Paredawa River and the Loko Tuba River.

3.4 Existing Drainage Systems and Flood Handling Solutions

The main drainage systems in Tambolaka City are two rivers, Loko Paredawa and Loko Tuba.

a. Loko Paredawa

Loko Paredawa is a large channel in Tambolaka City with some of its tributaries such as Loko Mata, Loko Kaki and Loko Mara. Loko Paredawa has a watershed area of 55.03 Km² with a river length of 19.3 Km. From the analysis of the slope of the river bed (sloope) which is owned by the river is classified as a river with a small slope of 0.0064. With the slope of a small river like this, what is normal for natural river occurrences is meandering in some parts of the river. With a channel that is not too steep in the upstream will form tributaries that are fused in the downstream. In the upper reaches of Loko Paredawa, three tributaries are formed, namely Loko Mata, Loko Kaki and Loko Mara. Loko Mata is located in the hilly area of Weebou at an altitude of about 150 m above sea level. Leg Loko is located in the hilly area of Rakotera at an altitude of about 100 m above sea level. Whereas Loko Mara is the longest tributary of Loka Paredawa, which is located in the hilly area of Kalemburawo at an altitude of about 100 m above sea level. These watersheds are mostly dry land, little forest and a small part of settlements. The downstream Loko Paredawa empties into the Waikelo Bay region in the northern part of Sumba Island.

b. Loko Tuba

Loko Tuba is located east of Tambolaka City and also east of Loko Paredawa. This river also consists of several tributaries which are located in the mountainous area, namely in the Ponorongo area. Likewise with the hills in the mountains, there are some small grooves which then become a channel or tributary in Loko Tuba. LokoTuba has a Watershed Area of 55.31 Km² with a river length of 19.6 Km. From the analysis of the slope of the river bed (sloope) which is owned by the river is classified as a river with a small slope of 0.0076. Similar to the condition of Loko Paredawa with the slope of a small river like this, what is common in natural rivers is the meandering in some parts of the river. With a channel that is not too steep in the upstream will form tributaries that are fused in the downstream. These watersheds are mostly dry land, little forest and a small part of settlements. The downstream Loko Tuba empties into the Waikelo Bay region in the northern part of Sumba Island.

3.4.1 Causes of Floods and Puddles

Tambolaka City with the current conditions has the potential for flooding and standing water in several places. The main causes of flooding and inundation are irregular drainage systems and very limited and slow absorption by soil because soil types are soils with low absorption and are quickly saturated. Specifically the causes of flooding and standing water in this region are the causes:

- a. The system is not organized
Good flow is not yet organized from the upstream drainage to the primary (river) drainage.
- b. Soil type with a small typical absorption.
The type of soil in Tambolaka City is soil with a small absorption capacity so that it does not significantly reduce the potential for inundation and flooding that might occur.
- c. Limited channel / culverts capacity
The capacity of the existing channel / culvert is very limited compared to the flood discharge and standing water
- d. Sedimentation in the channel channel / culvert
This condition triggers a reduction in channel capacity / culvert

3.4.2. Solution to Handling Floods and Puddles

Based on the area of potential floods and inundations that occur it is necessary to do an effort to deal with inundation and flooding by looking at the characteristics of the drainage area in the City of Tambolaka. The complete flood management solutions carried out in the Tambolaka Region are as follows:

- a. Create or enlarge a new path to Loko Mata which is a tributary of Loko Paredawa
- b. Make a new path to the Loka Tuba

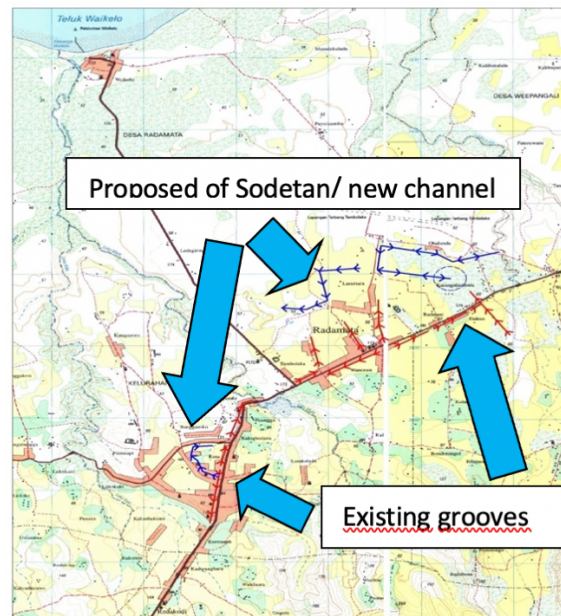


Figure 1. Solution to the handling of floods in the city of Tambolaka

4. CONCLUSION

4.1. Conclusions

From what has been said, it can be concluded as follows:

- The drainage system in Tambolaka City has not been well organized because it does not yet have a clear system
- Siltation that occurs in river bodies as a result of the sedimentation process
- The existing river capacity (Loko Paredawa River and Loko Tuba River) is very inadequate

5.2. Suggestions

- Need to make a new channel / sodetan in an effort to reduce water faster
- Maintenance of the function of the channel as a carrier of water discharge during the rainy season needs to be improved

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