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The Effective Control Strategy in Gunung Lingai Village due to Extreme Flood with SWOT Approach

Santi Yatnikasari[1 *], Sigiet Haryo Pranoto[2], & Pitoyo[1]
[1] Program Studi Teknik Sipil, Universitas Muhammadiyah Kalimantan Timur, Samarinda, Indonesia
[2] Program Studi Teknik Mesin, Universitas Muhammadiyah Kalimantan Timur, Samarinda, Indonesia
* Corresponding Email: sy998@umkt.ac.id

Abstract – Samarinda is the capital of the East Kalimantan, which remains troubled by flood risk. The flooding phenomenon happens not only during the rainy season. Some areas in the city of Samarinda are flooded in the rain with a period of 3 hours. This research aims to establish the causes of flooding in Gunung Lingai Village, as then flood control techniques can be implemented. Gunung Lingai Village has been chosen because it is a location with a history of extreme flooding in the town of Samarinda with an area of 432.93 Ha. There are 851 flood-affected households from 1390 households with a duration of further than 7 days. This research was carried out with the combination of qualitative and quantitative approaches. Data collection was carried out by combining literature study and secondary data with factual studies to obtain primary data and in-depth interviews with flood-affected communities *(mixed method)*. The status of the flood variables which became the baseline was that of 9 June 2019 and that of 22 May 2020. The results showed that there were two main factors causing flooding, namely natural factors and human factors. A vulnerability of social indicator was established to describe the actual condition, which was complex interaction among drainage system and public welfare. In addition, a SWOT analysis was performed on one of the selected representatives to verify the strategies on flood control system.

Keywords: Flood, Causes of Floods, Flood Control Strategies

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1. INTRODUCTION

Disaster is a series of events that threaten and disrupt people's lives, whether caused by natural or non-natural factors, or human factors, resulting in casualties, environmental damage, property loss and psychological impacts [1]. Indonesia is classified as one of the countries prone to disasters. Geographically, Indonesia is located at the intersection of three main plates, the Eurasian plate in the north, the East Pacific plate and the Indo-Australian plate in the south, making Indonesia prone to natural disasters such as earthquakes, volcanic eruptions and tsunamis. Flood is one of the occurrences that often occurs because Indonesia is a country with a larger water area than land area. Apart from natural disasters, Indonesia has the potential for man-made disasters from activities that can damage the environment, including logging and forest fires.

East Kalimantan is one of the provinces in Indonesia which has a wet tropical climate with quite high rainfall. This affects the occurrence of several natural disasters such as floods and landslides. Flood is a natural disaster that needs attention, because it threatens the lives and economy of the community and is the third largest natural disaster in the world that has claimed many lives and property losses [2]. Flooding is a form of natural phenomenon that occurs due to high rainfall intensity where there is excess water that cannot be accommodated. Samarinda as the developing capital of East Kalimantan is still plagued by flood problems. The phenomenon of flooding occurs not only during the rainy season but when it rains with a duration of only 3 hours, some areas in the city of Samarinda are inundated. This is referred to as sudden flooding, which is flooding that occurs in less than 5 hours after heavy rains have started. This is followed by the number of cumulus clouds clumping in the sky, lightning or thunder, tropic storms and cold weather [3]. This sudden flood was due to the overflowing of very heavy rainwater when the riverbanks were not able to hold enough water. It would be worse if there was heavy rain in the northern area of Samarinda city because the Benanga reservoir was unable to hold millions of cubic meters of rainwater so that the Karang Mumus river, which is a tributary of the Mahakam river, would overflow and cause flooding evenly in the city of Samarinda. The occurrence of flooding from river overflows proves that protective measures are unreliable due to the variety of sources of flooding, which are not

only from the main river but also from the tributaries [4]. Another cause is the failure of the dam / embankment to hold the increased volume of water (discharge), changes in temperature causing changes in sea water level, and / or various other major changes upstream of rivers including changes in land use [5]. Currently, the public issue is land conversion, density of settlements, which causes land cover, erosion and sediment that occurs in various urban and regional areas. The susceptibility to sudden flooding will increase if the area is steep slopes, rivers are shallow and the increase in water volume is much greater than that which is collected [6].

Previous research has discussed the problem of flooding, entitled the study of disasters in flood management in the city of Samarinda, to find out and analyze the description of the implementation of disaster programs in flood management [7]. Then in another scientific journal entitled Government Efforts in Flood Control in the city of Samarinda with the aim of wanting to know the efforts made by the government and the obstacles faced [8]. In this study, the researcher wanted to dig deeper, because the flood disasters greatly disrupted the activities of the residents of Samarinda city. Various attempts have been made, but these efforts have not been optimal in overcoming the flood problem in Samarinda city. The problem of flooding originates from population growth and urban development that is not matched by the provision of adequate regional facilities and infrastructure, causing land use to be disorderly and not properly controlled. In addition, it is caused by the low level of awareness of human resources in the community regarding the flood problems that often occur in the city of Samarinda. Based on this phenomenon, the researchers will analyze the flood problem in Gunung Lingai Village, Sungai Pinang District in Samarinda City. The problem of flooding is not merely a technical issue, but also non-technical, namely the social and economic conditions of the community. The aim of this research is to analyze the factors that cause flooding and its control, so that it is hoped that the research results can contribute to the scientific development of Urban and Regional Planning and the development of environmental infrastructure, especially the study of flood problems.

2. RESEARCH METHODS

This research is a form of case study research, by taking samples of residents of the Griya Mukti housing complex, Gunung Lingai Village, Sungai Pinang District, Samarinda City. A case study is a study of the status of a research subject who is pleased with a specific phase of the whole personality, with the research subject being individual, group, institution, or community [9].

The residents of Griya Mukti housing were chosen as the sample because based on the results of the initial assessment conducted by BPBD Samarinda City, the Sungai Pinang District Office and the Gunung Lingai Village Office, information was obtained that this location is a place that has a historical case of severe flooding in the city of Samarinda. The worst flood occurred on June 9, 2019 and again on May 22, 2020.

Figure 1. The flood occurred on June 9, 2019 in Gunung Lingai Village, Sungai Pinang District, Samarinda City.

Figure 2. The flood occurred on May 22, 2020 in Gunung Lingai Village, Sungai Pinang District, Samarinda City.

This research was conducted using a mixed method (Mixed Method) combining qualitative and quantitative approaches. *Mixed Method* is a methodology that provides philosophical assumptions in showing directions or providing guidance on how to collect data, as well as a combination of qualitative and quantitative approaches through several phases of the research process [10]. Data collection was carried out by means of library research and secondary data, field studies to obtain primary data and in-depth interviews with related communities. Furthermore, a phenomenological approach is presented, which describes various phenomena as an approach to determine the causes and countermeasures of flooding. The Phenological approach seeks to see as deeply as possible the events that occur in society. Phenological studies describe the meaning of a life experience for some people about a concept or phenomenon [11].

The timing of the research and the sampling technique of respondents greatly influenced the results obtained in the study. The research was conducted from 15 June 2020 - 8 August 2020. The sampling technique for respondents was carried out using *purposive sampling*, which was then followed by *snowball*

sampling that had met the criteria. Purposive sampling can be interpreted as a sampling technique for data sources with the consideration of the sampling technique initially being small in number, then the sample is directed to select its friends to be sampled and so on, so that the number of samples is increasing [12]. The number of samples of respondents in this study were 60 people.

In dealing with flood problems, it is necessary to have a strategy for controlling the targets to be achieved. Strategy can be defined as the placement of long-term goals and objectives of an organization and the use of a series of actions and allocation of resources needed to achieve these goals [13]. In this study using a SWOT analysis.

3. RESULTS AND DISCUSSION

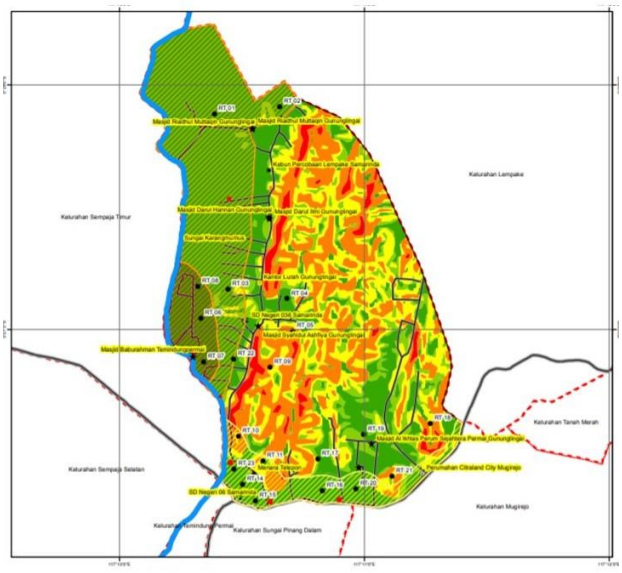

Figure 3. Flood Map of Gunung Lingai Village, Sungai Pinang District, Samarinda City.

III.1 Regional Demographic Characteristics Overview

Administratively, Gunung Lingai Village is located in Sungai Pinang District, Samarinda City. Based on the data obtained, Gunung Lingai Village consists of 21 RT. The number of family heads (KK) from each RT can be seen in Table 1 below.

Based on information from the Gunung Lingai sub-district through in-depth interviews with the Gunung Lingai village head, information was obtained that the areas that often experience the worst flooding are the Griya Mukti housing complex, namely RT 6, 7 and 8. This becomes a consideration in selecting respondents, because these residents have more experience in dealing with floods. Furthermore, by using the *snowball sampling method*, 60 respondents from the three RTs were obtained, which could represent the existing population.

Table 1. Number of Households / RTs in Kelurahan Gunung Lingai

RT	KK	Duration of the Flood
1	55	< 7 days
2	75	< 7 days
3	68	< 7 days
4	55	a few hours
5	90	a few hours
6	120	> 7 days
7	85	> 7 days
8	99	> 7 days
9	45	a few hours
10	65	< 7 days
11	47	< 7 days
14	51	< 7 days
15	66	< 7 days
16	55	< 3 days
17	53	a few hours
18	74	a few hours
19	55	a few hours
20	65	< 3 days
21	47	< 3 days
22	75	< 7 days
23	45	< 7 days
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III.2 Social Vulnerability

Vulnerability is a condition in society that leads to or causes inability to face the threat of danger [14]. According to the IPCC, the components of vulnerability comprise three factors, namely the level of exposure, the level of sensitivity and the adaptive capacity [15].

The variables used to assess the level of vulnerability are grouped based on physical, social and economic aspects in each of its constituent components. The variables in the exposure level component consist of road conditions, drainage network conditions, the presence of open spaces, the presence of social institutions, and the number of poor families. The level of sensitivity has variables consisting of the basic building coefficient (KDB), waste management facilities, availability of clean water sources, number of family members, employment status. Meanwhile, the variable on adoption capacity consists of the presence of local technology, community knowledge of disasters and the welfare of the population. The result of the multiplication of scores and weights on the variable levels of exposure and sensitivity is the Exposure and Sensitivity Index (IKS), while the result of the multiplication between the scores and weights on the adaptation capacity variable is (Adaptive Capacity Index (IKA), in Figure 2. Next will be grouped using a matrix. typology of vulnerability.

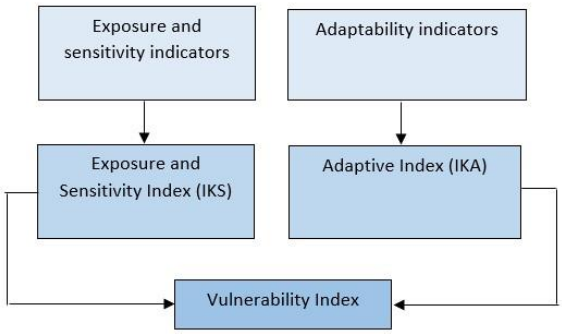

Figure 4. Concept of vulnerability index

The typology matrix of community vulnerability in Griya Mukti housing (figure 3) shows that the number of people in quadrants 2, 3 and 4 is more than those in quadrant 5. The people in these three quadrants are people who are somewhat vulnerable or people who are still living at the tolerance interval of their ability to withstand the flooding that occurred. If intervention is not carried out by making the right form of adaptation, then this community can turn into a very vulnerable community.

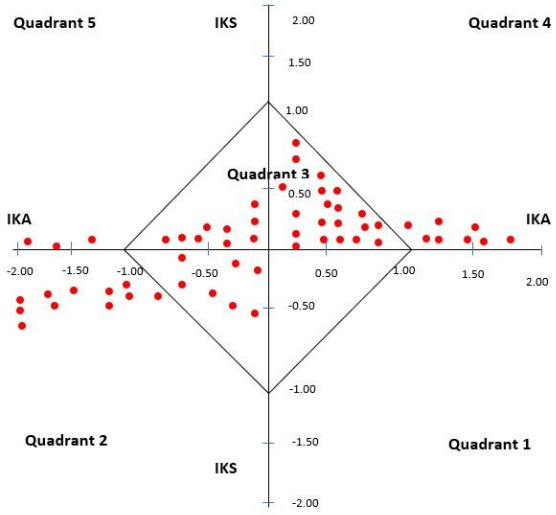

Figure 5. Typology of community vulnerability in Griya Mukti housing, Gunung Lingai Village.

Each component of vulnerability is influenced by several variables that have the multiplication of the score with the highest weight, including the condition of the drainage network, the number of family members, the basic coefficient of the building and the welfare of the population. In the exposure component, the variable that has the highest scoring results is the condition of the drainage network. Given that the floods that occur are local floods caused by the quality and quantity of drainage, both primary drainage and poor environmental drainage.

In the sensitivity component, the large number of people who violate the provisions of KDB makes the level of sensitivity in facing floods higher because the rainwater that falls will be charged to the drainage channel, and nothing is infused into the ground.

In the adaptation capacity component, the variable of community welfare can be seen from the ability of the community to save the generated income. The results of the questionnaire show that the community has not been able to spare their income, so that their adaptation capacity is still low in facing unexpected conditions due to the flood disaster that occurs.

III.3 Causes of Floods

In general, the problem of flooding occurs due to excess surface runoff and cannot be accommodated in river bodies so that water overflows. There are two main factors causing flooding, namely natural factors and human factors. Natural factors such as high rainfall, regional topography, tides, and others. The second factor is human origin, which comes from the population growth element, followed by an increase in the need for infrastructure such as housing, clean water facilities, education, and community services. In addition, the increase in land supply will reduce the potential for water uptake into the soil. The more land is opened, the easier the soil layer will be eroded by rainwater, the sedimentation will occur in the river which results in a decrease in river flow capacity. Population growth will also increase waste production, which if not managed properly will cause problems such as blockages in drainage channels and rivers.

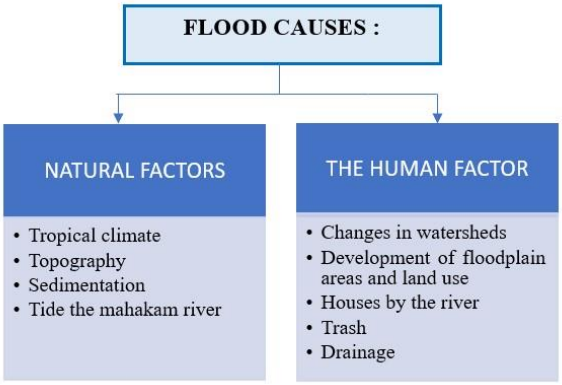

Figure 6. Causes of Floods in Gunung Lingai Village, Sungai Pinang District, Samarinda City.

Based on the description above, the flood problem in Gunung Lingai village, Sungai Pinang District, Samarinda city can be estimated as follows:

1)Natural Factors

Floods can occur due to the influence of climate, topography, sedimentation and the tide of the Mahakam River.

a. Tropical climate, the city of Samarinda is characterized by two seasons, namely the rainy season and the dry season. The rainy season occurs from November to April and the dry season usually occurs from May to October. This situation continues every year which is interspersed with transitional / transition seasons in certain months. However, in recent years, the seasonal conditions in Samarinda city have been uncertain. In the months that should have rained, in reality there was no rain at all, or vice versa in the months that should have been dry, there was rain with a much longer season, even very heavy. Heavy rains in the rainy season are the cause of flooding and are exacerbated by the high population density in the floodwaters. Based on the Geostatistical Krigging analysis used in forming the parameter map of the average annual rainfall distribution in the city of Samarinda, it shows that most areas in the city of Samarinda are areas with an average annual rainfall between 2,200 - 2,300 mm / year with an area of 37,828.05 Ha namely 54.77% [16].

b. Topography. Samarinda City is at an altitude between 0 - 200 masl (above sea level). Based on the altitude line, the city of Samarinda is located in a lowland area and tends to have a flat topography, this is evidenced by the area at an altitude of 0 - 12.5 masl of 35.29% of the area of Samarinda city or 24,445.99 hectares. Areas with an altitude> 100 masl are only 1,328.88 hectares which is 1.92% of the area of Samarinda city. With its location in the lowlands, the city of Samarinda has a fairly gentle or flat slope. It can be seen that the land slope class of 0 - 8% has an area of almost half having an area of almost half of the area of Samarinda, namely 41.76% (28,844.76 Ha). For areas that have a steep slope (mountainous areas) with a slope of> 40% of the area, it reaches 2,526.06 hectares or 3.66% of the total area of Samarinda city [17]. Areas with a low slope of land are more likely to experience flooding than areas with a high slope.

c. Sedimentation. Reduced flow capacity in rivers can be caused by erosion due to the absence of vegetation cover and tillage. This erosion causes sedimentation in rivers, where the products of erosion are deposited in the downstream part of the river, causing the elevation (aggradation) of the riverbed. In the river that flows in the city of Samarinda, due to rain in the upstream part of the river, soil erosion occurs by water and rain (erosion). The fine grains of soil will be carried away by the water so that the water is very cloudy or has a blackish brown colour, which indicates that there is a high enough sediment concentration. The flow to the downstream part of the Samarinda city river causes the Mahakam river, Mahakam tributaries, rivers, ditches, lakes, and dams to experience sedimentation or accumulation of mud on the riverbed. This causes the water capacity to decrease. As a result, during the rainy season, the Mahakam River and the Mahakam tributary will overflow into the mainland, causing flooding. In addition, the high level of erosion in the watershed can be seen in the drainage channels that enter natural rivers. Many drainage channels are narrowed, and some are no longer functioning due to sedimentation in the drainage channels.

d. The tide of the Mahakam river has an impact on the problem of flooding, especially if the peak height of the flood coincides with the high tide. The Mahakam River greatly influences the smooth flow of its tributaries, including the Karangmumus river, the Karang Asam Besar and Karang Asam Kecil rivers, the Loa Bakung river, the Sambutan river, and other rivers.

2)Human Factors

Population growth is followed by growth in human needs and behaviour. Floods caused by human actions can occur due to changes in the watershed area, development of floodplain areas and land use, houses on stilts on the banks of rivers, garbage, and drainage.

a. Changes in watersheds. Among other things, deforestation, land clearing for agricultural land, plantations and mining, provision of land for settlements. This can lead to a loss of land absorption power due to the absence of land cover vegetation, a momentary runoff which is quite high when it rains and sedimentation.

b. Development of floodplain areas and land use. Increasing population in urban areas so that flood plains which are actually prone to inundation and flooding have to be used as urban settlements, centralization and distribution of government services, social services and economic activities. The area of Gunung Lingai village is one of the locations in the city of Samarida, which at the beginning of its development was a temporary water storage area, currently a residential area.

c. The houses on stilts on the riverbank will block the flow of water and narrow the river flow.

d. Garbage. With increasing population growth, waste also increases. The amount of reduction in channel capacity in the Samarinda area is due to sedimentation of waste material. Locations that have the potential to produce waste, such as market areas, which are located close to rivers, are a source of disasters in the downstream area because the waste that is disposed of into the river will clog the downstream areas.

e. Drainage, inadequate drainage of floodplain areas can obstruct the flow of rivers and ultimately increase the flood elevation so that the area will become a flood-prone area during the rainy season. The drainage service area of Samarinda City is currently quite extensive, however, the problem is that the capacity of the drainage channels has decreased. Besides the capacity is too small, the sediment is also high. So that if there is heavy rain for a long time, there will be flooding.

The source of inundation or flooding in Gunung Lingai Village, Sungai Pinang District, Samarinda City can be divided into 3 types, namely:

1. Dispatched flood, flood flow that comes from the upstream area. This happens when rain occurs in the upstream area causing flood flow that exceeds the capacity of the river, causing runoff.
2. Local flooding, due to rain falling in the area itself will cause standing water. This can happen if the rain that occurs exceeds the capacity of the existing drainage system. The height of the inundation is between 0.25 - 1.00 m and will be even greater if it coincides with the Mahakam river tide.
3. Floods due to tides of the Mahakam river, floods that occur due to tidal flow or return water from the drainage channel because it is obstructed by tide, namely in areas that have a height below the tide level of about + 1.58 m. The inundation height is between 0.2 - 0.5 m with inundation time between 2 - 4 hours. In the last 5 years, flood disasters have increased both in frequency and in magnitude.

III.4 Flood Control

Control can be defined as the process of determining what must be achieved, namely the standards of what is being carried out, namely the implementer, assessing the implementation and if necessary making improvements, so that implementation is in accordance with the plan, namely in accordance with the standard [18]. Flood control is a complex activity. The success of the flood control program depends on social, economic, environmental, institutional, institutional, legal and other aspects. Political support from various agencies including the executive (Government), legislative (DPR / DPRD) and the judiciary will greatly influence the solution to the flood problem.

Based on the analysis of the causes and sources of flooding in Gunung Lingai Village, Sungai Pinang District, Samarinda City, flood control can be carried out:

1. Management of the upstream part, with the consideration that the area is still underdeveloped so that it is easier to organize. Among other things, building flood control dams that can slow down the arrival time of floods and reduce the amount of flood discharge, making field reservoirs that can change the flood hydrograph pattern and greening in the watershed.
2. The control of the downstream part, in addition to functioning mostly as a residential development area, is also a center of government, education and trade center. By repairing river channels, constructing flood control channels and utilizing inundation areas for retarding basins.

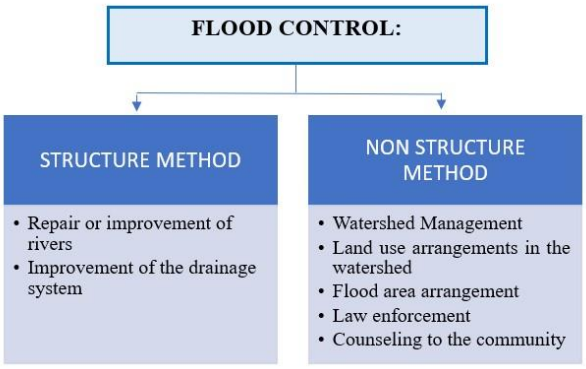

Figure 7. Flood Control in Gunung Lingai Village, Sungai Pinang District, Samarinda City.

Technically, flood control can be done with technical flood control (structural method) and non-technical flood control (non-structural method). The method of flood control structures for river network systems is 1) Repair or enhancement of rivers, with the aim of increasing the flow capacity of the river. This can be done to accommodate the flood discharge that occurs to flow downstream, resulting in runoff. The work that can be carried out includes activities such as repairing cross-sectional shapes, reconstructing buildings along the Mahakam river that are unsuitable and disturbing flood drainage. The channel dredging system also needs to be carried out with the aim of increasing the river holding capacity and smoothing the river flow. Dredging the Mahakam river is expected to widen the river, direct the river flow and deepen the Mahakam river. 2)

Improvement of the drainage system with a special gravity type system consisting of natural channels. The alternative is by pumping in areas where the water level downstream is too high. Another thing is because drainage in urban areas where natural drainage is inadequate. Non-Structural Method, namely by 1) Watershed management with the aim of holding water and soil conservation. Activities undertaken by planting and maintaining vegetation in the upstream watershed to control overflow or soil erosion. So that it can reduce the flood discharge in the downstream area and improve the environment in the watershed and river boundaries. 2) Arrangement of land use in the watershed to regulate land use in accordance with the existing spatial plan. This can prevent uncontrolled land use, resulting in damage to the watershed. Land use regulation is intended to improve the hydrological conditions of the watershed, so as not to cause flooding in the rainy season and drought in the dry season. In addition to reducing the rate of erosion in excessive river flow, by means of land management, because the presence of high land erosion will determine the amount of sediment transport in the Mahakam river and accelerate the sedimentation rate, especially in the downstream. This sedimentation will change the cross-section of the river and reduce the drainage capacity of the river. 3) Setting the flood area. Problems arise because people live in inundated areas, thereby reducing the capacity of river channels and inundation areas. The smooth running of water will be reduced because houses, buildings and other facilities will obstruct the flow. So it must prohibit the use of floodplain areas such as building houses, as well as regulating land use control to reduce damage caused by flooding. 4) Law enforcement, needs to be done as an effort so that legal norms can be enforced. Among other things, not littering anywhere (in the river), and not clearing the forest. 5) Outreach to the community. Communities who are in flood-prone areas must care about preventing floods. With counselling, it will increase public awareness with all its activities that can cause flood problems. In addition, the authorities including related agencies can carry out guidance, supervision, control and prevention of floods in an intensive and coordinated manner.

In dealing with the problem of flooding, it is necessary to have a strategy, which is useful for controlling the goals that the organization wants to achieve, without a strategy an organization will experience difficult problems both within the organization itself and from the external environment, especially the organization's competitors that strategy is one way to help. organizations cope with the ever-changing environment and help organizations to help and solve the most important problems they face [19]. With a strategy, organizations can build strengths and take advantage of opportunities, while addressing and minimizing external weaknesses and threats.

In this study, a SWOT analysis is used, namely a strategic planning method by evaluating the four factors that make up the SWOT acronym (strengths, weaknesses, opportunities, and threats) for flood control in the city of Samarinda, in Table 1. SWOT analysis.

Based on the concept of flood control and the SWOT approach, namely the strengths and opportunities faced by weaknesses and threats, the strategies for flood control in the city of Samarinda are as follows:

a. Building a commitment between the government, private sector and the community towards flood-free Samarinda.
b. Revitalization and relocation of settlements along the Karamg Mumus river.
c. Construction of drainage channel normalization in Samarinda city.
d. Sustainable flood control program implementation.

Table 2. SWOT Analysis

INTERNAL FACTORS / EXTERNAL FACTORS	Strenght (S)	Weakness (W)
	1. The available natural resources are mainly coal companies to make financial contributions to local governments. 2. Human resources capable of making flood management policies. 3. The local income of Samarinda is quite large. 4. Regional autonomy which allows local governments to plan flood prevention.	1. The topography of Samarinda is located in the lowlands. 2. The increasing number of newcomers added to the buildings along the river flow. 3. Lack of public awareness to protect the environment. 4. Samarinda government policy on mining permits. 5. Weak oversight in the mining sector, after replenishment or reclamation. 6. There is no strict control over buildings along the river. 7. There are no strict sanctions for people who do not comply with local regulations on waste.
Opportunity (O) 1. There is funding from the Provincial Government to the City Government for flood problems and community relocation along the Karang Mumus river. 2. Private companies that care about flood problems in Samarinda through the Corporate Social Responsibility (CSR). 3. Implementing biopore technology in every home, as an alternative to flood prevention efforts in Samarinda. 4. Community support in flood management.	**Strategi S-O** Make a commitment between the government, the private sector and the community, for Samarinda to be safe from flooding.	**Strategi W-O** Revitalization and relocation of housing along the Karang Mumus river.
Threat (T) 1. Disruption of the people's economy. 2. Damage to infrastructure and public facilities caused by flooding. 3. Diseases such as diarrhea and scarlet fever. 4. Investors move to another city.	**Strategi S-T** Construction of drainage channel normalization in Samarinda city.	**Strategi W-T** Sustainable flood control program implementation.

As a follow-up to the flood control strategy, it is more focused on the technical concept of flood control in the city of Samarinda, adjusting to the availability of funds and developing social conditions in the community. This control concept was developed based on the causes of flooding in Samarinda city, namely:

a. Short-term countermeasures, namely activities to control flooding due to local rain in priority locations and to increase community awareness and involvement on flood control issues.
b. Medium-term measures, namely controlling floods from the upstream area and arranging watersheds from rivers that cross the city of Samarinda.
c. Long-term measures, namely controlling the tides of the Mahakam river.

4. CONCLUSION

Samarinda City is an area prone to banirs. The causes of flooding are 1) natural factors due to the influence of climate, topography, sedimentation, and tides of the Mahakam river, and 2) Human factors, namely due to changes in river basin areas, development of floodplain areas and land use, slum areas, garbage, drainage.

The source of inundation or flooding in the city of Samarinda, especially the downstream area, which impacts on community activities can be divided into 3 types, namely: 1) Dispatched flood, namely flood flow that comes from the upstream area. 2) Local flooding, due to rain falling in the area itself, causing puddles. 3) Floods due to tides of the Mahakam river, namely floods that occur due to tidal flow or return water from the drainage channel due to tide obstruction.

Based on the analysis of the causes and sources of flooding in Gunung Lingai Village, Sungai Pinang District, Samarinda City, flood control can be carried out: 1) Upstream management, with the consideration that the area is still underdeveloped so that it is easier to organize. Among other things, building flood control dams that can slow down the arrival time of floods and reduce the amount of flood discharge, making field reservoirs that can change the flood hydrograph pattern and greening in the watershed. 2) Control of the downstream part, in

addition to functioning mostly as a residential development area, it is also the centre of government, education and trade centre. By repairing river channels, constructing flood control channels and utilizing inundation areas for retarding basins.

Based on the concept of flood control and the SWOT approach, namely the strengths and opportunities faced by weaknesses and threats, the strategies for flood control in the city of Samarinda are as follows: 1) Building commitment between the government, private sector and the community towards flood-free Samarinda. 2) Revitalization and relocation of settlements along the Karang Mumus river. 3) Construction of drainage channel normalization in Samarinda city. 4) Sustainable implementation of the flood control program.

This technical control concept was developed based on the causes of flooding in the city of Samarinda, namely: 1) Short-term measures, namely activities to control flooding due to local rain in priority locations and to increase community awareness and involvement on flood control issues. 2) Medium-term measures, namely controlling floods from the upstream area and structuring the watershed of the rivers that cross the city of Samarinda. 3) Long-term measures, namely controlling the tides of the Mahakam river.

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