FLOOD HAZARD EARLY WARNING COMMUNICATION SYSTEM AS A DISASTER MITIGATION EFFORT IN MANADO CITY

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Abstract : Flood Disasters are natural disasters that almost occur every rainy season in Manado City. Therefore, a Communication *System Of Early Warning Flood* is needed as an effort to mitigate disasters, involving warning information services through monitoring activities involving various parties; dissemination of warnings that are easily understood by people facing disasters; and the ability to respond and act quickly when disasters occur. With the existence of the Flood Hazard Early Warning Communication System, it is hoped that it can reduce casualties, property losses and psychological impacts can be avoided.

The results of the study show that the Early Warning Communication System for Flood Hazards as a Disaster Mitigation Effort in Manado City, starting from: *Detection*, which uses sensors that will predict the situation in a certain environment, as well as a remote dashboard to monitor the output of the sensor and display it in a clearer and easier to understand form. There is also a device with the ability to serve and routing, i.e. to detect specific conditions to take appropriate action. *Forecasting*, which is a forecast of rainfall, water level or flood discharge and the time of arrival of the flood, and is continued to give warnings. *Warning and Dissemination*, which is using information obtained from the *detection* or *forecasting* stages that disseminate the information to be able to minimize the risks it causes. *Response*, namely: responsiveness to the issue of flood warning, and this is very important for the achievement of the goal of implementing flood early warning.

As a recommendation, the government and the people of Manado City must maintain the equipment used in the *Communication System Of Early Warning Flood* in Manado City so that the equipment functions properly, and there must even be maintenance costs when there is a damaged device.

A quick response is also expected to be highly expected, so that when getting information that there will be a flood, the Manado City government changes the information into directions which are a follow-up to decisions taken in the form of a series of directions, both dynamic, namely SAR, Evaluation, Resource Mobilization, Warnings or Instructions for the community. It can also be in the form of static directives, namely waiting for further information, standing by, or not needing to take any action.

Keywords: Communication System, Early Warning of Flood Hazards, Disaster Mitigation

INTRODUCTION

Flood disasters include natural disasters that occur every time the rainy season comes. In Manado City. On January 27, 2023, extreme weather occurred, namely rainfall with a maximum intensity of 300 mm, which resulted in an increase in water discharge resulting in flooding. especially in the Watershed (DAS) in Manado City. As a result of the flood, 420 houses were severely damaged by the flood, while 103 others were moderately damaged and 448 were lightly damaged [1].

On January 21, 2024, due to high rainfall, flooding occurred in Ternate Tanjung Village, Singkil District, Manado City. According to the Singkil Police Chief, the locations affected by the flood include Kel. Ternate Tanjung 3 affected by the flood of 15 residents' houses, Kel. 1 about 25 residents' houses, Karame District, remembered about 20 residents' houses, Singkil Dua Ling District. V overflowed to the street and a tree fell and hit the resident's house. [2]

According to the Regional Disaster Management Agency (BPBD) of Manado City, extreme weather caused 164 hydrometeorological disasters in 10 sub-districts in Manado City. [3] The Manado City Government has urged and even prohibited people from building houses in riverbank areas, but a number of residents continue to rebuild their houses and businesses along the river. Even though it is very risky for the security and safety of the residents themselves. [4]

The lack of public knowledge about disaster preparedness and awareness is due to a lack of information. The flood caused property losses, environmental damage, and threatened and disrupted people's livelihoods. [5]

A Communication System Of Early Warning Flood *is needed* as a disaster mitigation effort through the following stages: *Detection, Forecasting, Warning and Dissemination, Response*. It is hoped that it can minimize the impact of flood disaster risk. The system is used to inform through communication media to the government and communities in downstream areas, as an effort to reduce disaster risk and preparedness in disaster management. [6]

The *Communication System Of Early Warning Flood* is a process of disseminating and exchanging information to influence the attitude, understanding, and behavior of the government and society. So, both the government and the community are part of the communication system using *channels* or media.

The development of science and technology brings new breakthroughs by utilizing *channels* or media in communication systems that detect or obtain information about floods that may occur,

how much rainfall and water level so that the information is forwarded to carry out warnings or warnings. It is necessary for the responsible party to disseminate warning information to minimize the risks caused. Response or response to flood warning information is very important in order to reduce material and non-material losses.

An Early Warning Communication System for Flood Hazards is needed as a disaster mitigation effort in Manado City by utilizing various data inputs in real time as well as forecast data for the next few days through the following stages: *Detection, Forecasting, Warning and Dissemination, Response*. This Flood Hazard Early Warning Communication System is expected to minimize the impact of flood disaster risks. The system is used to inform the government and communities in the downstream area, as an effort to reduce disaster risk and preparedness in disaster management.

LITERATURE REVIEW

Communication systems are how the interaction process creates the structure of the system, how people respond to each other determines the type of relationship they have. Communication systems begin with behaviors such as verbal comments and non-verbal actions as the smallest unit of analysis in a communication system. These observable behaviors are the only means of connecting individuals in a communication system. [11]

A communication system can be said to be a set of things about the process of delivering messages that are related to each other and form a whole worthy of a system. In addition, a communication system is a group of guided people and media who carry out an activity of processing, storing and pouring ideas, ideas, symbols, symbols into messages in making decisions to reach an agreement to process messages into sources of information. [11]

Types of Communication Systems, namely Diagonal Communication Systems, Vertical Communication Systems, Horizontal Communication Systems, and Communication are intertwined between a person or group of people who have the same or equivalent hierarchy. [12]

So the communication system is a group of guided people and media who carry out an activity of processing, storing ideas, symbols, symbols into messages in making decisions to reach an agreement to process messages into sources of information, and will experience developments that are in line with the times. So, adjustments or adaptations are needed to the development of communication systems.

The *Communication System of Early Warning Flood* is based on rainfall and water level level. This technology is placed in flood-prone locations with AWLR telemetry technology using SMS gateways. The sensor captures changes in water level and then digital data is sent to the receiving station online in real time. With a solar cell power supply, this tool can continuously monitor rainfall and river water level data. [13]

The Communication System Of Early Warning Flood is a communication system designed to detect, monitor and provide early warning about potential floods in an area. The communication system is used to inform the government and the community in the downstream area, as an effort to reduce disaster risk and preparedness in disaster management. Providing early warning to communities and authorities can help reduce losses caused by floods and improve disaster mitigation efforts. [13]

By conducting early detection, the government and the public get warning information before floods come, so they have more time to evacuate themselves and valuables.

Information from the *Communication System Of Early Warning Flood* can help the government plan and implement preventive measures, so that losses due to floods can be minimized. In the event of a flood, the government can arrange safe evacuation routes, and ensure that residents get better assistance during evacuation.

The Flood Hazard Early Warning Communication System also uses advanced and updated technology as a communication medium to provide accurate information about the potential for high and low floods. The system monitors water height, water discharge and water movement accurately on an *ongoing* basis to determine the flood situation possible impacts. [14]

In the *Communication System of Early Warning Flood* there are several stages to achieve effective results. These stages according to Werner and Kwadijk, 2005 are:

1. *Detection*, this stage, data in real *time* on the monitor and in the process to get information about possible flooding.
2. *Forecasting*, this stage is carried out to forecast rainfall, water level or flood discharge and the time of arrival of the flood, and is continued to give warnings.
3. *Warning and dissemination*, using information obtained from the *detection* or *forecasting* stage that disseminates the information to be able to minimize the risks it causes.
4. *Response*, responsiveness to flood warning issues, and this is very important for the achievement of the goal of implementing flood early warning. [13]

Education is also needed about warning signs and steps when floods occur, so that the community is more prepared and proactive in dealing with flood risks.

Disaster mitigation is a series of efforts to reduce disaster risk, both through physical development and awareness and improvement of the ability to deal with disaster threats (Article 1 paragraph 6 of Government Regulation No. 21 of 2008 concerning the Implementation of Disaster Management). Mitigation is defined as an effort aimed at reducing the impact of a disaster. Mitigation is measures to reduce danger so that losses can be minimized. According to the Decree of the Minister of Home Affairs of the Republic of Indonesia No. 131 of 2003 concerning Guidelines for Disaster Management and Handling of Refugees in the Regions, article 3 paragraph 5. Mitigation is an effort and activity carried out to reduce and minimize the consequences caused by disasters which include preparedness and vigilance, both through physical development and awareness and improvement of the ability to face disaster threats. [15]

Disaster mitigation is an important thing to do, in order to anticipate the impact caused when a disaster occurs, such as the impact of environmental damage, casualties, and so on. Without mitigation, the losses experienced by a city when a disaster occurs will be very large, because the disaster will damage all infrastructure and then must be overcome with a large budget, while this can be minimized with efforts made before the disaster occurs. The construction of this system is a form of government attention so that the public knows the situation more quickly when a disaster occurs and is more of a prevention and preparedness effort so that through this system it can accelerate the distribution of information to residents or the community and even the relevant government as an effort to detect disaster events early. [16]

RESEARCH METHODS

This study uses a qualitative method with a descriptive approach., is a research procedure that produces descriptive data in the form of written or spoken words from people and observable behaviors. [17]

A research informant is a person who is seen as able to provide information and is able to appoint others as informants who can provide more in-depth information, who are selected by *Purposive* and *Snowball Sampling*. [17]

The informants of this research are the Head of the Manado City Derah Disaster Management Agency (BPBD), the Head of Prevention and Preparedness, Sub-district Head,

Village Head, and the community who are selected *purposively*, as well as people living in flood-prone areas who are selected by *snowball.*

The focus of the research is an indicator of the Early Warning Communication System for Flood Hazards from Werner and I Kwadijk (2005), namely: How is the Early Warning Communication System for Flood Hazards as a Disaster Mitigation Effort in Manado City, starting from: *Detection, Forecasting, Warning and Dissemination, and Response*?

Data collection was carried out using a qualitative approach, namely observation (participation), in-depth interviews (*indept interviews*), and document studies. [18] This was done with the aim of capturing and understanding the Early Warning Communication System for Flood Hazards as a Disaster Mitigation Effort in Manado City.

In qualitative research, data analysis is carried out from the beginning and throughout the research process. In this study, qualitative data analysis with an interactive model developed by Miles and Huberman [18] will be used, namely: Data Reduction, Data Presentation, and Withdrawal of Results.

RESULTS AND DISCUSSION

Manado or Menado is the capital city of North Sulawesi Province. Manado City has 11 sub-districts and 87 sub-districts and villages. Manado is located in Manado Bay, and is surrounded by mountainous areas and its coastline is reclaimed land that is used as a shopping area. The city has 453,182 inhabitants as of the 2021 Census, making it the second largest city on the island of Sulawesi after Makassar City. The population in Manado is estimated (based on January 2014) to be 430,790 people and increased to 476,910 people as of June 30, 2022, based on data from the Ministry of Home Affairs in 2022, with a density of 2,934 people/km2.

Manado City is located at the northern tip of the peninsula of Sulawesi island, at a geographical position of 124°40' - 124°50' E and 1°30' - 1°40' N. The climate in this city is tropical with an average temperature of 24° - 27 °C. The average rainfall is 3,187 mm/year with the driest climate around August and the wettest in January. The average solar irradiation intensity is 53% and the relative humidity is ±84%.

The land area is 16,253 hectares. Manado is also a coastal city that has a coastline of 18.7 kilometers. The city is also surrounded by hills and mountain ranges. Its land area is dominated

by hilly areas with some lowlands in coastal areas. The altitude interval of the plains is between 0-40% with the highest peak on Mount Tumpa.

The waters of Manado City include Bunaken island, Siladen island and Manado Tua island. Bunaken and Siladen Islands have a bumpy topography with a peak as high as 200 meters. Meanwhile, the island of Manado Tua is a mountain island with an altitude of ± 750 meters.

Meanwhile, the waters of Manado Bay have a depth of 2-5 meters on the coast up to 2,000 meters at the boundary line of the meeting of the bottom coast of the continental slope. This depth is a kind of barrier so that until now the intensity of damage to Bunaken The distance from Manado to Tondano is 28 km, to Bitung 45 km and to Amurang 58 km. [19]

The distribution of flood-prone areas in Manado City consists of 4 levels of flood vulnerability that spread to 10 sub-districts, namely:

Bunaken, Malalayang, Mapanget, Sario, Singkil, Paal Dua,Tikala, Tuminting, Wanea, dan Wenang.

1. The level of not prone to flooding in Manado City with an area of 603.34 ha.
2. The level of vulnerability is moderate in Manado City covering an area of 5467.01 ha.
3. The flood vulnerability level in Manado City is 6492.39.
4. The level of flood vulnerability in Manado City is 2180.11 ha [20]

The Mayor is the highest leader in the Manado City Government. The mayor of Manado is responsible for the Manado region to the governor of North Sulawesi province. Currently, the mayor or regional head who serves in Manado City is Andrei Angouw, with deputy mayor Richard Sualang. They won the 2020 Manado Mayor General Election. Andrei Angouw became the 19th mayor and the first Confucian figure to serve as mayor of Manado. Andrei and Richard were inaugurated by the governor of North Sulawesi, Olly Dondokambey, on May 10, 2021 at the Mapalus hall of the North Sulawesi Governor's Office, for the 2021-2024 term.

Based on Regional Regulation (PERDA) number 4 dated September 27, 2000 concerning the change of the status of villages to sub-districts in the city of Manado and PERDA number 5 dated September 27, 2000 concerning the expansion of sub-districts and sub-districts, the area of Manado city originally consisted of 5 sub-districts with 68 sub-districts/village is expanded into 9 sub-districts with 87 sub-districts. Based on Manado City Regulation Number 2 of 2012, the city of Manado was redeveloped into 11 sub-districts with 87 sub-districts.

As an area located on the equator, Manado City only knows two seasons, namely the rainy season and the dry season. Rainfall in a place is determined by climatic conditions, orographic conditions and air current turnover/confluence, among others. Therefore, the amount of precipitation varies by month. Based on observations at the Manado City Meteorological Station, the average rainfall during 2022 ranges from 104.90 mm (July) to 373.30 mm (November). The highest number of rainy days is 22 days in November and the lowest is 18 days in May, August and September. Meanwhile, the highest percentage of solar irradiation is in June which is 5.58%, the lowest is in December which is 2.56%.

Manado City is an area with a topography and tropical climate with high rainfall that can reach >3000mm/year. In 2014 there was a flash flood disaster that hit Manado City, this flash flood was caused by the loss of forests and small rivers around Manado City and the destruction of catchment areas. The impact of the flood that occurred in Manado City was the damage to residents' houses, paralyzing community activities, and moral and material losses as well as damage to infrastructure and facilities. Determining flood-prone areas is essential for decision-makers for planning or managing activities. (Yalcin and Akyurek 2004).

Manado City with an area of 162.35 km2 is flowed by five large rivers, each of which has different characteristics and flow lengths.

The Bailang River is one of the large rivers that cross Manado City. With a length of 28,131 km in the main river, this river passes through two sub-districts, namely Mapanget, Tuminting and Bunaken Districts. The Bailang River is included in the Watershed (DAS) with an area of 104.5 km2. The flow starts at the foot of Mount Klabat and ends next to the Fish Auction Port (PPI) of Tumumpa village, Tuminting district.

The Tondano River is the third longest river in North Sulawesi, with a length of 39.9 km with a watershed area of 544.75 km2. The Tondano River is one of the potential flood waters whose water flows all the way to Manado City. The Tondano River empties into Manado Bay, with its original route located in Minahasa and through Paal Dua, Wenang, and Singkil Districts in Manado City. The downstream part of the Tondano River is approximately 7 km long passing through Manado City and its tributaries.

The Tikala River is also one of the main rivers in Manado City, has a number of tributaries that provide water discharge to the main river. One of the significant tributaries is the one that

crosses Banjer village, ward V with a length of 1,152 km and has a watershed area of 0.09432 km2. The Tikala River is located behind the Manado Pentecostal Church.

The Sario River is the main river in the Sario watershed with a flow length of 15 km and an area of 2,986 ha. The administrative area of the Sario watershed covers part of Manado City and Minahasa Regency where Manado City is downstream of the Sario watershed, covering the areas of Citraland, Wanea, Tanjung Batu and Sario.

The Malalayang River, which is also found in Manado City, is the result of the meeting between the river from Mount Mahawu and part of the Mount Lokon river. The Malalayang watershed has a catchment area of 46.33 km2 and a river length of 15.6 km. In the upper part of the river it reaches the highest elevation of 1172 m above sea level, with a river slope of 0.065.

Manado is also a coastal city that has a coastline of 18.7k ilometers. The Development and Development process of the Manado City area from the Tondano watershed, Sario watershed and Malalayang watershed has led to a reduction in water catchment areas.

Flood disasters often hit Manado City, especially in the rainy season. This makes North Sulawesi Province one of the flood-prone areas in Indonesia and judging from the area of inundation area, it is ranked 8th out of all regions in Indonesia so that it is one of the cities that is considered to be at high risk of flood danger.

In the last decade in Manado City, there have been 3 floods that resulted in great losses experienced by the community and the government, namely in 1996, 2000 and 2005. (Nanlohy, 2008). Manado has now become a flood-prone city because when it rains, several roads and houses in the lowlands will be flooded, this of course disrupts traffic, material losses, diseases and other impacts that also harm the city of Manado.

The distribution of flood-affected areas is in 5 sub-districts, namely Paal District 2 affected by floods with an area of 436.42 Ha, Tikala District affected by floods with an area of 230.76 Ha, Singkil District affected by floods with an area of 361.48 Ha, Tuminting District affected by floods with an area of 373.39 Ha, and Wenang District affected by floods with an area of 360.92 Ha.

Within 10 years, Manado City was often hit by widespread floods, such as in 2014 – 2020. The worst flood period was in 2014, which killed 25 residents and left 1 missing. Meanwhile, material losses, namely as many as 829 houses were damaged. In 2020, the district with the largest affected area is Paal Dua sub-district, because Paal Dua sub-district is squeezed by 2 large rivers in the city of Manado, namely the Tondano watershed and the Tikala watershed.

In early 2023, floods and landslides again hit Manado City, which caused one resident to die and dozens of families to be affected by the incident. Heavy rainfall that occurred in the city area caused the water discharge of the Tondano River to overflow. Flooding at several points was unavoidable so that dozens of houses were submerged with a water level of 80 to 300 cm. The flooded areas occurred in five sub-districts, namely Paal Dua, Tuminting, Sario, Wenang and Singkil Districts. Meanwhile, landslides hit six sub-districts. Landslide points were identified in Paal Dua, Singkil, Tikala, Bunaken, Wanea and Tuminting Districts. (BNPB Manado City, 2023)

Currently, there are around 2,250 families living in the watersheds in Manado City, namely in the Tondano, Tikala, Mahawu, Bailang, Sario and Malalayang watersheds. The floods in Manado were caused by the re-functioning of the Watershed (1) among others.

- **Regional Disaster Management Agency (BPBD) Manado City**

The government established the Central Natural Disaster Management Advisory Board (BP2BAP) through Presidential Decree Number 256 of 1966. The person in charge of this institution is the Minister of Social Affairs. BP2BAP activities play a role in emergency response and disaster victim assistance. The disaster management paradigm is developing not only focusing on disasters caused by humans but also natural disasters.

The frequency of natural disasters continues to increase. Serious and coordinated disaster management is urgently needed. Therefore, in 1967 the Cabinet Presidium issued Decree Number 14/U/KEP/I/1967 which aimed to form the National Coordination Team for Natural Disaster Management (TKP2BA).

In this period, the National Coordinating Team for Natural Disaster Management (TKP2BA) was upgraded to the National Coordinating Board for Natural Disaster Management (Bakornas PBA) chaired by the Minister of Natural Disaster Management and formed by Presidential Decree Number 28 of 1979. Disaster management activities include prevention, emergency handling, and rehabilitation. As an operational elaboration of the Presidential Decree, the Minister of Home Affairs with instruction Number 27 of 1979 established the Natural Disaster Management Implementation Coordination Unit (Satkorlak PBA) for each province and Regency/City Region. The vision of the National Disaster Management Agency (BNPB) is:

- The nation's resilience in facing disasters

The mission of the National Disaster Management Agency (BNPB) is:

1. Protecting the nation from disaster threats by building a culture of disaster risk reduction and preparedness in dealing with disasters to be an integrated part of national development;
2. Building a disaster emergency management system quickly, effectively and efficiently;
3. Organizing the recovery of post-disaster areas and communities through better coordinated rehabilitation and reconstruction with a disaster risk reduction dimension;
4. Providing support and governance of logistics and disaster management equipment;
5. Implementing disaster management in a transparent manner with the principles of good governance.

The duties of the National Disaster Management Agency (BNPB) are:

1. Provide guidelines and directions for disaster management efforts that include disaster prevention, disaster emergency handling, rehabilitation, and reconstruction in a fair and equitable manner;
2. Determining the standardization and needs of the implementation of disaster management based on laws and regulations;
3. Convey information on disaster management activities to the community;
4. Report the implementation of disaster management to the President once a month under normal conditions and at all times in disaster emergency conditions;
5. Use and account for national and international assistance;
6. Accounting for the use of the budget received from the State Budget;
7. Carry out other obligations in accordance with laws and regulations; and
8. Prepare guidelines for the establishment of Regional Disaster Management Agencies.

In Manado Mayor Regulation Number 64 of 2016 concerning the Position, Organizational Structure, Duties and Functions and Work Procedures of the Regional Disaster Management Agency (BPBD) of Manado City, it is explained that the BPBD is led by a head who is held concurrently (*ex-Officio*) by the Regional Secretary of Manado City.

BPBD has the following duties:

a. Provide guidelines and directions for disaster management efforts that include disaster prevention, emergency response handling, rehabilitation and reconstruction in a fair and equitable manner

b. Establishing standardization and the need and implementation of disaster management based on laws and regulations
c. Conveying information on disaster management activities to the community
d. Reporting the implementation of disaster management to the Mayor once a month under normal conditions and at any time in a disaster emergency condition
e. Using and accounting for national and international donations/assistance
f. Accounting for the use of the budget received from the APBD and other valid and non-binding budget sources
g. Carry out other obligations in accordance with laws and regulations

The functions of the Regional Disaster Management Agency (BPBD) of Manado City are:

1. Formulation and determination of disaster management policies and refugee management by acting quickly and appropriately as well as effectively and efficiently
2. Implementation and coordination of planned, integrated and comprehensive disaster management activities

Flooding is an event or situation where the water in a channel increases and exceeds its carrying capacity. Although sometimes it does not cause many casualties, this disaster still damages infrastructure and disrupts the stability of the community's economy.

Flood disasters include natural disasters that occur every time the rainy season comes. In Manado City. On January 27, 2023, extreme weather occurred, namely rainfall with a maximum intensity of 300 mm, which resulted in an increase in water discharge resulting in flooding. especially in the Watershed (DAS) in Manado City. As a result of the flood, 420 houses were severely damaged due to the flood, while 103 others were moderately damaged and 448 were lightly damaged.

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Manado City Government has urged and even prohibited people from building houses in riverbank areas, but a number of residents continue to rebuild their houses and businesses along the river. Even though it is very risky for the security and safety of the residents themselves.

The lack of public knowledge about disaster preparedness and awareness is due to a lack of information. The flood caused property losses, environmental damage, and threatened and disrupted people's livelihoods.

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The *Communication System Of Early Warning Flood* is a process of disseminating and exchanging information to influence the attitude, understanding, and behavior of the government and society. So, both the government and the community are part of the communication system using *channels* or media.

The development of science and technology brings new breakthroughs by utilizing *channels* or media in communication systems that detect or obtain information about floods that may occur, how much rainfall and water level so that the information is forwarded to carry out warnings or warnings. It is necessary for the responsible party to disseminate warning information to minimize the risks caused. Response or response to flood warning information is very important in order to reduce material and non-material losses.

Communication System is a process of conveying messages that contain the meaning of both parties who create the structure of the system, how people respond to each other determines the type of relationship they have. Communication systems begin with behaviors such as verbal comments and non-verbal actions as the smallest unit of analysis in a communication system. These observable behaviors are the only means of connecting individuals in a communication system.

A communication system is a set of things about the process of conveying messages that are related to each other and form a whole like a system. There is also a group of guided people and media who carry out an activity of processing, storing ideas, ideas, symbols, symbols into messages in making decisions to reach an agreement to process messages into sources of

information. This communication is established between a person or group of people who have the same or equal hierarchy.

So the communication system involves a group of guided people and media who carry out an activity of processing, storing and pouring ideas, ideas, symbols, symbols into messages in making decisions to reach an agreement to process messages into sources of information, and will experience developments that are in line with the times. So, adjustments or adaptations are needed to the development of communication systems.

The communication system involves several components that support the occurrence of the communication system, such as microwave systems, satellite communication systems, paging systems, cellular telephones, mobile data networks, personal communication services and personal digital assistants.

The *Communication System of Early Warning Flood* in Manado City uses *a Raspberry* PI, which is a small computer such as an AtM card that is connected to a TV or computer screen and *keyboard*. This small computer is used like *a desktop* PC. *The Raspberry* PI is used to control *devices* that use several programming languages but the most widely used is *python*.

The *Communication System Of Early Warning Flood* in Manado City through the following stages:

- ***Detection***

  The stage of *the Communication System Of Early Warning Flood* is timely data (*real time*) on the monitor and in the process to obtain information about floods that may occur. Information about possible flooding. The information is then forwarded so that warnings can be carried out without going through *forecasting*. At this stage, it is also necessary to filter the existing data because the data obtained from the field does not necessarily have good quality.

  Flood detection in Manado City uses *IoT (Internet of Things),* which is a network of connected devices, which allows devices to be controlled remotely from the internet, therefore it can create opportunities to directly connect and integrate what is happening in the field or the physical world to computer-based systems using sensors and the internet. With the connection of several embedded devices , it will produce automation in almost all fields and also allow for advanced applications. This results in increased accuracy, efficiency and economic benefits with reduced human intervention.

Sensors are also used to monitor the state of the environment in a specific environment, as well as a remote dashboard to monitor the output from the sensor and display it in a clearer and more understandable form. There is also a device with the ability to serve and routing, i.e. to detect specific conditions to take appropriate action."

The sensor used is the HC-SR04 or ultrasonic sensor, which is a sensor that measures ultrasonic wave-based distance that works by detecting a specific object in front. The ultrasonic sensor is divided into two parts, namely the transmitter and the ultrasonic wave receiver, which are then received back by the ultrasonic receiver. The distance between the transmit time and the receive time is a representation of the object's distance. This sensor is used in detecting floods because it is an electronic application that requires distance detection.

Ultrasonic sensors are used in detecting floods, because when ultrasonic sensors emit their rays by the transmitter, the transmitted signal will propagate as waves with a speed of around 340 m/s, then when the waves are reflected it will be directly received by the receiver.

The DHT-11 sensor is also used to detect floods, but focuses on temperature and brightness objects on a single module that has a calibrated digital signal output. This sonor module is classified as a reversive element such as a temperature measuring device. The advantage of the DHT-11 sensor is that it has excellent sensing data reading quality, is responsive or fast in reading room conditions, and is not easily intervened.

Based on the data of the Flood Threat Index in Manado City according to BPBD, the level of flood threat in Manado City is: High = 53 villages, Medium = 17 villages, and Low = 17 villages. The analysis of Flood Vulnerability in Manado City based on the Social aspect is divided into 3 classes, namely: High = 48 villages, medium = 32 villages, and low = 7 villages.

Economic vulnerability is divided into 3 classes, namely: High = 34 villages, Medium = 30 villages, and low = 23 villages. Physical Vulnerability is divided into 3 classes, namely: High = 19 villages, Medium = 67 villages, and low = 1 village. Environmental Vulnerability is divided into 1 vulnerability class, namely Low class = 87 villages.

- ***Forecasting***

At this stage, forecasts are carried out on rainfall, water level or flood discharge and the time of arrival of the flood, and is continued to give warnings.

The Meterology, Climatology and Geophysics Agency (BMKG) of Manado City is a Geophysics Station that has the main task of carrying out observation, data management, and

services in the field of geophysics that are fast, precise, accurate, broad, easy to understand, and accountable. In carrying out these main tasks, the geophysical station also carries out equipment maintenance, cooperation/coordination, administration, and additional tasks.

One of the tasks of the Manado City BMKG is to provide geophysical data and information related to the Tsunami. BMKG is tasked with reporting extreme weather events in the Manado City area based on weather forecast detection using AWS sensor tools that measure weather parameters such as temperature, humidity, air pressure, solar radiation, rainfall, water temperature and evaporation amount."

BMKG Manado City also has a vision to be responsive and able to capture and formulate stakeholder needs for data, information, and services in meteorology, climatology, air quality, and geophysics and be able to provide services in accordance with the needs of service users. BMKG will provide information for the Manado area and its surroundings that have the potential for moderate to heavy intensity rain accompanied by lightning/lightning.

The Manado City Government also has a Smart Command Center CCTV to monitor water levels.

- ***Warning dan Dissemination***

This stage uses information obtained from the *detection* or *forecasting stage* that disseminates the information to be able to minimize the risks it causes. One of the causes of the large number of victims in the 2014 flash flood in Manado City was the lack of information to the public about the condition of the Tondano watershed in Manado City at that time, so that the public in general did not know that the river water had overflowed, therefore the Manado City government produced a web-based application product equipped with *the SMS Gateway feature* as a monitoring of the condition of the Tondano watershed in Manado City to answer existing problems.

Short Message Service (SMS) is a wireless communication system that sends messages in the form of text. SMS supported by GSM or *Global System For Mobile Communication* and TDMA or *Time Division Multiple Access* which is currently widely used on cellular telephones".

At the Tondano Watershed Crossing Post in Manado City, there is a mobile phone number as a means of communication to inform via SMS *Gateway* regarding the condition of the Tondano watershed in Manado City. The informative SMS can be seen by all users who use

the web using an internet connection". For example, information through WA *Gateway* about the water conditions on the Wenang – Karame bridge as follows:

Dear : Admin Authority

Location : Jematan Wenang – Karame

Normal Water Limit : 1 cm

Height 1 cm

Status: The water rises.

This message is monitoring the Tondano watershed in Manado City through SMS *Gateway*. The Tondano watershed information system in Manado City functions as a repatriatory or storage place for Tondano watershed water level data, so that information can be monitored and shared with users, namely the Manado City Government and the general public.

By using SMS *Gateway* As a web-based and mobile web information system, information can be received in a short time directly to many related parties. *Communication System Of Early Warning Flood* is a communication system used to detect, monitor and provide early warning about potential floods in Manado City. The communication system is used to inform through communication media to the Manado City government and communities in downstream areas, as an effort to reduce disaster risk and preparedness in disaster management. Providing early warning to communities and authorities can help reduce losses caused by floods and improve disaster mitigation efforts.

- ***Response***

This stage is a stage of response to the issue of flood warning, and this is very important for the achievement of the goal of implementing flood early warning.

If the weather is bad followed by heavy rain, the Manado City Government through the CCTV Smart Command Center monitors the water level whether it is at a worrying level or not. Especially in flood-prone and landslide-prone areas. If it is at a worrying level, then residents are urged to be more vigilant and if the weather does not improve, they will be asked to evacuate to a safer location as soon as possible.

Education is also needed about warning signs and steps when floods occur, so that the community is more prepared and proactive in dealing with flood risks. By conducting early

detection, the government and the public get warning information before floods come, so they have more time to evacuate themselves and valuables.

Manado City Flood Hazard Early Warning Communication System uses advanced and updated technology as a communication medium to provide accurate information about the potential for high and low floods. The system monitors water height, water discharge and water movement accurately on an *ongoing* basis to determine the flood situation and estimate possible impacts.

Information from the *Communication System of Early Warning Flood* helps the Manado City government plan and implement preventive or mitigation measures, so that losses due to floods can be minimized. In the event of a flood, the government arranges safe evacuation routes, and ensures that residents get better assistance during evacuation.

When receiving information that there will be a flood, the Manado City government changes the information into directions which is a follow-up to the decision taken in the form of a series of directions, both dynamic, namely SAR, Evaluation, Resource Mobilization, Warning or Instruction for the community. It can also be in the form of static directives, namely waiting for further information, standing by, or not needing to take any action.

There are four levels of Early Warning Flood Information or *Communication System Of Early Warning Flood*, namely: Normal, Alert, Alert, and Alert.

Normal: Safe conditions, the average daily conditions of threats known from various scientific data, through experience or historical data on the behavior of the threat phenomenon.

Alert: There is an increase in threats and risks as evidenced by the results of data analysis and scientific information that show threat activity above normal conditions.

Ready : There is a significant increase in threats and risks but it can still be controlled so that at any time if the emergency status is raised to the highest level, then all resources can be immediately deployed to rescue from community evacuation or asset security. The actions taken are to bring resources closer to the nearest safe location from the threat location and ensure that all security and rescue equipment and systems are functioning properly.

Be careful : The level of threats and risks is so high that it endangers the community. The action taken was to carry out evacuation efforts.

Disaster warnings must come from official warnings from the government, for example from the BMKG Station and BPBD Manado City as well as from natural phenomena that have the potential to cause disasters, but also from the community at the scene.

The dissemination of information also uses traditional tools such as kentongan, bells, TOA, bedug and so on. Also communication equipment such as WA, telephone, sms, etc. TV, Radio, amateur broadcasting, etc. also perform the function of sending messages. Signs such as sirens that have been agreed upon are also an effective means of conveying messages by socializing the sound signs first.

The role of the community is very important in flood prevention and control, including by maintaining environmental cleanliness and not littering so that the environment remains clean and this is one of the efforts to avoid flooding.

Because if people throw garbage carelessly, the water channels will be clogged and obstruct the flow of water in the rainy season, so it can be a trigger for flooding. Public awareness is urgently needed to take part together with the government in preventing floods.

Similarly, people living on the banks of rivers are encouraged to move immediately, especially for those who have received houses in the guidance provided by the government during the 2014 floods. Because living on the banks of rivers is very dangerous, especially in the rainy season.

CONCLUSION

Early Warning Communication System for Flood Hazards as a Disaster Mitigation Effort in Manado City, starting from: *Detection,* which uses sensors that will predict the situation in a certain environment, as well as a remote dashboard to monitor the output of the sensor and display it in a clearer and easier to understand form. There is also a device with the ability to serve and routing, i.e. to detect specific conditions to take appropriate action. *Forecasting*, which is a forecast of rainfall, water level or flood discharge and the time of arrival of the flood, and is continued to give warnings. *Warning and Dissemination,* which is using information obtained from the *detection* or *forecasting* stages that disseminate the information to be able to minimize the risks it causes. *Response*, namely: responding to the issue of flood warning, and this is very important for the achievement of the goal of implementing flood early warning.

As a recommendation, the government and the people of Manado City must maintain the equipment used in the *Communication System Of Early Warning Flood* in Manado City so that the equipment functions properly, and there must even be maintenance costs when there is a damaged device.

A quick response is also expected to be highly expected, so that when getting information that there will be a flood, the Manado City government changes the information into directions which are a follow-up to decisions taken in the form of a series of directions, both dynamic, namely SAR, Evaluation, Resource Mobilization, Warnings or Instructions for the community. It can also be in the form of static directives, namely waiting for further information, standing by, or not needing to take any action.

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