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Utilization of IoT Technology in Flood Disaster Mitigation, A Review

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ABSTRACT

In efforts to mitigate flood disasters, the use of Internet of Things (IoT) technology is the main focus. This article discusses the implementation of an IoT-based early warning system (EWS) to reduce the impact and risk of flood disasters in Indonesia. Mitigation steps, early warning systems, how tools work with ultrasonic sensors, and determining the installation point of the tool are important points in this study. Integration of IoT with various communication platforms, such as radio, WiFi, and messaging applications, increases the effectiveness of early warning. In conclusion, the development of EWS tools by utilizing IoT can accelerate evacuation responses and reduce losses due to flooding. IoT-based early warning systems (EWS) are described as an effective solution. The EWS tool is equipped with a water level sensor that is connected online, allowing continuous measurement and fast information through the IoT network. The article emphasizes the importance of communication facilities, with IoT as a more integrated and efficient solution than conventional methods. The research method is based on a literature review, exploring mitigation measures, early warning systems, how the equipment works, and determining the installation location. The results show that the use of ultrasonic sensors, microcontrollers, and integration with communication platforms through IoT can increase system effectiveness. In conclusion, the implementation of IoT technology in flood disaster mitigation provides a significant contribution in providing fast and measurable early warnings.

KEYWORDS: Mitigation, Flood Disaster, IoT, Technology

1 INTRODUCTION

Floods can be caused by static natural conditions such as geography, topography, and river channel geometry. Dynamic natural events such as high rainfall, damming from the sea/tides on the main river, land subsidence and shallowing due to sedimentation, and dynamic human activities such as inappropriate land use in flood plains, namely: by establishing settlements on riverbanks, lack of flood control infrastructure, land subsidence and sea level rise due to global warming (Sastrodihardjo, 2012). Flood disasters can threaten various areas from urban, rural, to forest areas. The impacts can be in the form of material losses and threaten lives (causing fatalities). According to BNPB data (2018-2023), each year the number of flood disasters that occur in Indonesia is 700 to 1700 incidents, the number of people affected is up to thousands of people. The impacts caused by flood disasters can be reduced by implementing flood disaster mitigation.

Mitigation is the steps taken to reduce the risk of disaster. These steps can be through physical development or awareness and increasing the ability to face disasters (BNPB, 2012). In Government

Regulation Number 37 of 2012 it is explained that a River Basin Area (DAS) is a land area that is a single unit with rivers and their tributaries, which functions to accommodate, store and channel water originating from rainfall to lakes or to the sea naturally, where the boundaries on land are topographical separators and the boundaries at sea up to the water areas that are still affected by land activities.

One of the steps that can be implemented in flood disaster mitigation is to install an early warning system (EWS) on river flows that are connected online via an IoT network (Saravanan et al., 2022). IoT-based EWS tools are equipped with sensors that can detect water levels continuously so that they can provide information via the IoT system (Irfan et al., 2022). There are various ways of communicating through the IoT system, namely radio devices, WiFi, Bluetooth, SMS, Telegram, email and other networks (Ali et al., 2015). The effectiveness of an early warning system depends on the means of communication used. So far, early warning still uses conventional communication such as sirens and community-based methods (local wisdom) (Lassa et al., 2014). The use of IoT is very effective and can reach wider because it is supported by an integrated communication network. IoT applications are one of the means of communication that quickly provides information.

However, on the other hand, the security factor of internet network connectivity is the main challenge in developing IoT-based early flood detection tools. This is due to the placement of early detection tools far from residential areas and in remote areas. Therefore, these challenges can be minimized by using a telemetry module that has wide coverage (Bhatter et al., 2020). In addition, it is necessary to provide education to the public about the importance of early detection tools and maintain the security of the tools for the common good (Akinsiku & Ubochi., 2024).

2 METHOD

This article was prepared based on the results of a review of the literature with a focus on discussion of early warning systems (EWS) for flood disasters. There are 4 important points that are reviewed to support writing this article. These points include: mitigation measures, early warning systems, how the equipment works, and determining the installation points for the equipment.

3 RESULT AND DISCUSSION

Disaster mitigation is a series of steps taken to reduce the impact of a disaster risk. Based on BNPB data, in the last 5 years Indonesia has faced 2000 to 5000 disasters each year. The geographical location of Indonesia is at the confluence of two oceans. For this reason, Indonesia causes frequent hydrometeorological disasters such as floods, extreme weather, landslides, and so on. One of the most frequently occurring disasters is floods, especially when entering the rainy season. Flood disasters are caused by various factors such as increased rainfall, dam breaks, blockage/shallowing of water channels/river areas.

3.1 Flood Disaster Mitigation

Flood disaster mitigation is a series of efforts to reduce the impact or risk caused by flood disasters on communities located and/or living in flood-prone areas. Flood disaster mitigation consists of mitigating before, during and after the flood disaster occurs (BNPB, 20019). Flood prevention and mitigation can be carried out through the following steps (KemenPUPR, 2014):

a. Prevention Stage: Identification, Control, Monitoring, Management, Strengthening.
b. Mitigation Stage: Physical Efforts and Non-Physical Efforts.
c. Preparedness Stage: Early Warning, Emergency Plan, Evacuation.

3.2 Early Warning Systems

There are 4 main elements in an early warning system, namely Risk Knowledge, Monitoring & Warning Services, Dissemination & Communication, Response Capabilities

(BNPB, 2012). In order to fulfill the four elements, the use of technology in disaster mitigation has an important role. One of them is the design of tools that are integrated with early warning systems. There are two main parameters for knowing whether a flood will occur, namely rainfall and river water levels (YPM & JICA, 2011). Another parameter is the characteristics of the river basin (DAS). A watershed is a land area that is connected to a river and functions to accommodate, store and channel water that comes from rainfall to a lake or the sea naturally. Watershed characteristics that influence streamflow include: watershed area, watershed slope, watershed shape, soil type and influence of vegetation (Chay, 2022). If the function of the watershed is disrupted, this can cause various problems such as flooding.

Therefore, it is very important to install early detection devices in every watershed that threatens settlements or people's livelihoods. The simple design of the EWS tool consists of a parameter detection system (sensor), controller & processor (microcontrol), and alarm (Wandi, 2023). Flood EWS tools basically use the principle of water level monitoring, usually using ultrasonic sensors as height detectors. The working principle of this sensor is to emit ultrasonic sound waves which are then reflected by the water surface. The reflection of the sound waves is received back by the receiving sensor. The most commonly used distance sensor is the HC-SR04 type, this sensor has a maximum detection of 4 meters with an accuracy of 0.1 cm (Hanan, 2013). In physics, it is very possible to determine depth using sound, namely by using the standard value of air speed in the air divided by the time interval between the sound of a falling object.

The use of the Internet of Things (IoT) in early warning systems has also been widely used with the increasing number of IoT platforms. Ease of access to platforms and components that are easy to obtain are important points in the development of IoT-based early warning systems. In addition to direct access via WiFi, data can also be sent to telegram, email, WhatsApp, and other platforms. There are many free platforms, one of which is Blynk Cloud with access services via website or mobile application. Cloud access is not only limited to one network, but can be accessed anywhere and anytime (Hadi, 2020). The effectiveness of an early warning system depends on the means of communication used. So far, early warning still uses conventional communication such as sirens and community-based methods (local wisdom). The use of IoT is very effective and can reach wider because it is supported by an integrated communication network. The IoT application is a means of communication that quickly provides information. In addition to the IoT platform that is already available, a special website can be created so that data can be accessed in one network or by purchasing a domain (Rahayu, 2022).

3.3 Determination of EWS Installation Points

Providing information to the community in the affected area is very important to reduce losses and casualties. In order to increase the effectiveness and level of validation of disaster parameter data, it is necessary to pay attention to matters related to the installation points of equipment and early warning sirens. This is regulated in the Guidelines for Planning the Installation of Sirens and Community-Based Early Warning Systems. These are as follows (BNPB, 2014).

a. Determine effective methods to reach the entire community (especially people with disabilities).
b. Determine the noise level so that it can be heard clearly.
c. Determine the best location such as a public area.
d. Avoid sensitive locations such as hospitals and communication stations.
e. Determine the height of the pole in the range of 35-100 feet depending on the height of the surrounding buildings.

Based on the 5 things above, the installation of flood warning system tools and sirens can be combined or separated depending on the geographical conditions of the watershed. Installations can be combined in one location if the watershed is close to a residential area and is useful for detecting sudden increases in water levels. However, the installation is separated if it is installed upstream so that it can

provide a warning before reaching a residential area. To be more effective, the installation of EWS flood water level detection tools is placed at each river confluence. This provides more time to carry out mitigation and evacuation actions.

However, on the other hand, the security factor and internet network connectivity are the main challenges in developing IoT-based flood early detection tools (Saini et al., 2020). This is because the placement of early detection tools is far from residential areas and remote. Therefore, these challenges can be minimized by using telemetry modules that have a wide range such as LoRA or LoRAWAN (Prakosa et al., 2021). In addition, it is necessary to provide education to the public to maintain and maintain these tools properly for the common good. The community also needs to be educated regarding the signs provided by early detection tools (Godawale et al., 2024).

4 CONCLUSION

Based on the results of the review and reference studies related to the early flood detection system (EWS), it can be concluded that in the development of EWS tools, the Internet of Things (IoT) system can be utilized as a means of distributing information. The rapid development of IoT is one way to reduce the risk of flooding. The use of ultrasonic sensors used in water level meters increases the effectiveness of monitoring in river basins, especially at points where the flow meets. Integration of early warning communication systems with IoT devices can reach wider and more effectively, providing more time during the evacuation process.

AUTHOR CONTRIBUTIONS

SM : Reviewing reference about applied IoT technology in disaster early warning systems and writing manuscript
SZ : Reviewing reference about community based flood disaster management
KB : Reviewing reference about community based especially local wisdom based early warning systems
BYI : Reviewing reference about flood and its causes
K : Directed and provided advice on writing this article

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