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Node-Red Flood Detector

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Abstract: *Floods and excessive rainfall can cause floods and this natural phenomenon often happens at the end of the year. This phenomenon can cause loss of life and destruction to infrastructure. As a surveillance measure, early notification messages should be sent to the local community to avoid loss of property and loss of life. The system in this project implements water level detectors, alarms, emergency lights and notification senders to identify the existence of water levels in current conditions that can be categorized as safe or dangerous. It is a cheaper flood monitoring alternative than systems used by Disaster Management Agencies. A prototype model used as a system simulation to describe the real state of the water level. If the water level is at a dangerous level, this prototype model will send a warning message to the community through the Node-red application, an alarm system and turn on a warning light with a light emitting diode (LED).*

Key Word: *Flood phenomenon; Water Detection; Monitoring using Internet of Thing (IoT)*

I.INTRODUCTION

Flooding is a persistent natural calamity in Malaysia, worsened by intense rainfall and seasonal monsoons. Over time, the occurrence and intensity of floods have escalated, primarily due to the inadequacy of current rivers and drainage systems to handle the increasing water levels. These floods result in catastrophic impacts on local communities, damaging infrastructure, residences, and agricultural lands, which leads to considerable economic losses and prolonged recovery expenses. Recently, it has become clear that conventional flood monitoring systems fall short in delivering real-time alerts to the public, thereby hindering timely response efforts.

This research introduces an innovative solution to tackle this escalating problem by creating a Node-RED Flood Detector system. This system is intended to monitor and alert residents about potential flood threats in real time by employing a blend of IoT sensors, alert systems, and web-based monitoring platforms. Specifically, the system features an ultrasonic sensor that measures water levels and determines if they have reached a perilous threshold. When the water level crosses into a designated

II. MATERIAL AND METHODS

The Flood Detection System utilizing Node-RED is composed of four essential elements: the sensor unit, alarm mechanism, notification service, and web interface. The sensor unit employs an ultrasonic sensor to gauge the distance to the water surface, continuously assessing the water level. This information is analyzed to classify the water level into three categories: safe (green), warning (yellow), and danger (red), based on established thresholds. When the water level enters critical zones, the alarm mechanism is triggered, activating both an audible buzzer and visual LED indicators to alert nearby residents. The notification service, which operates on the Node-RED platform, delivers real-time alerts to users through mobile notifications, emails, or SMS when water levels surpass the danger threshold. Lastly, the web interface enables residents to monitor water levels from a distance, offering real-time visualizations and alerts to keep users aware of potential flood hazards. Collectively, these components function harmoniously to provide an efficient and user-friendly approach to flood detection and early warning.

The methodology for data collection in the Node-RED Flood Detector system encompasses the acquisition of real-time sensor data, environmental parameters, user input, and historical information to guarantee precise flood detection and notifications. The ultrasonic sensor serves as the primary data source, continuously measuring water levels by emitting sound waves and determining the distance to the water surface. This data is subsequently classified into safe, warning, or danger zones according to established thresholds. Upon finalizing the system design and establishing the data collection methodologies, the system is incorporated into a holistic flood detection and alert framework. The data from the ultrasonic sensors is processed by a microcontroller, such as the ESP32 or Arduino, which interfaces with the Node-RED server to facilitate real-time monitoring and alerting. The Node-RED platform orchestrates the logic necessary for activating alarms and notifications based on the data collected and the thresholds set by users.

Following the deployment of the system, it undergoes continuous monitoring, and the process of data collection is sustained indefinitely. The data gathered will be scrutinized for identifying patterns and trends related to fluctuations in water levels, and modifications to the system's thresholds will be implemented based on input from the community and historical records. Furthermore, the system's efficacy will be evaluated periodically through rigorous stress tests and simulations to confirm its resilience under extreme conditions.

The Node-RED Flood Detector system offers a thorough solution for flood detection and alerting by integrating real-time sensor data, environmental assessments, and user feedback. This combination of precise data collection techniques with automated monitoring and alert systems ensures that the system can significantly mitigate the risk of flood-related damage, enhance community safety, and furnish residents with timely information necessary for responding to potential flood threats.

In summary, the ongoing monitoring and data analysis, coupled with community engagement and systematic performance evaluations, contribute to the overall effectiveness of the flood detection system. By leveraging advanced technology and community insights, the Node-RED Flood Detector not only addresses immediate flood risks but also fosters a proactive approach to flood management, ultimately safeguarding the well-being of the community.

The block diagram and flowchart of the system are shown as Figure 1 and Figure 2 below.

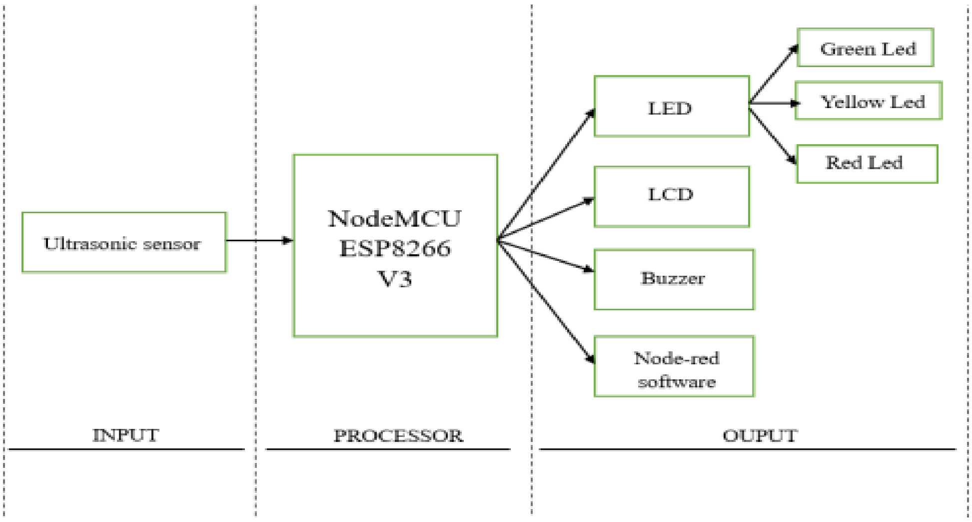

Figure 1: Block Diagram of the System

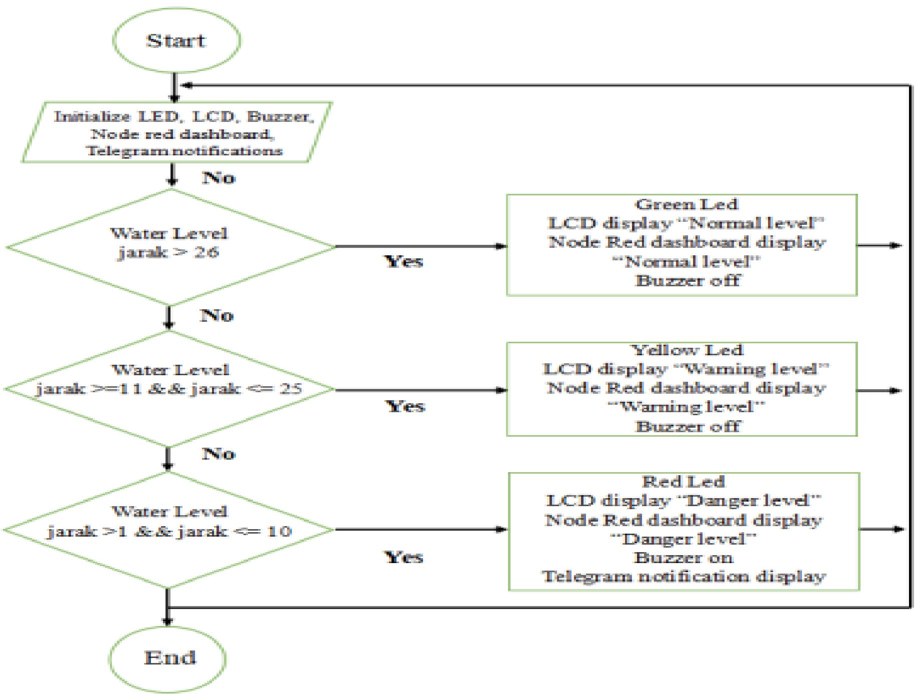

Figure 2: Flowchart of the System

The diagram of the circuit and its connections, as shown in the Figure 3 below, demonstrates the thorough integration of various components within the Node-RED Flood Detection system. This schematic delineates the relationships among the ultrasonic sensor, microcontroller, alarm system, notification module, and web interface. It emphasizes the process by which the microcontroller interprets the distance measurements from the sensor, subsequently activating the alarm system and transmitting data to the Node-RED platform for immediate monitoring and alert generation.

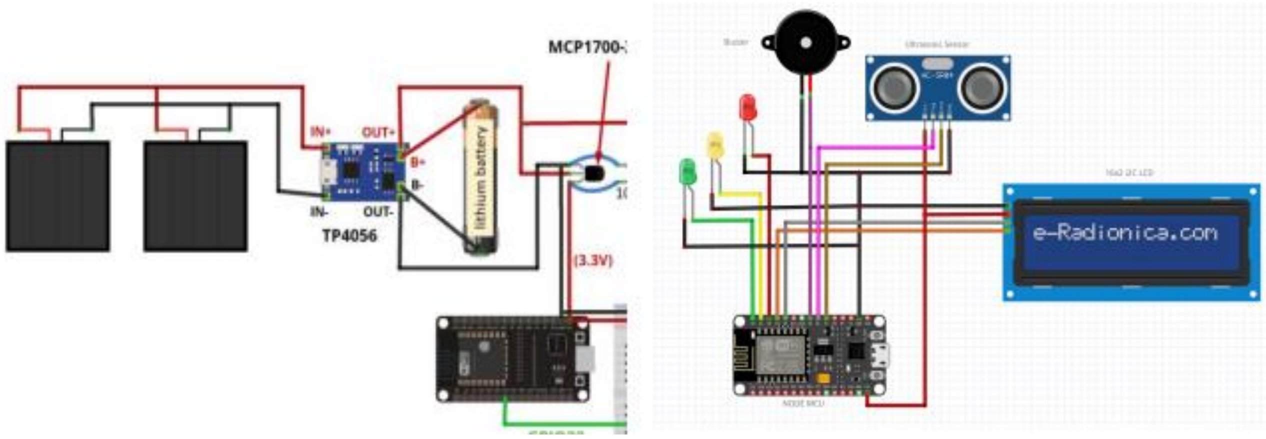

Figure 3: Circuit connection of the System

The detailed components involved in this system are as follows:

A. Node MCU (ESP8266)

Figure 4: Microcontroller

The Node MCU ESP8266 serves as a development platform that integrates the ESP8266 Wi-Fi module, specifically designed to support the creation of Internet of Things (IoT) applications. This board provides a straightforward interface with built-in Wi-Fi functionality, simplifying the prototyping process for developers. The ESP8266 module is recognized for its affordability, energy efficiency, and high level of integration, enabling devices to connect seamlessly to Wi-Fi networks and engage in online communication.

B. Ultrasonic Sensor

Figure 5: Ultrasonic Sensor

Ultrasonic sensors function by emitting high-frequency sound waves to measure the distance to the water level. They calculate the time it takes for these sound waves to return after bouncing off the water's surface. This time-of-flight technique allows for accurate distance measurement, which is then translated into a water level reading.

C. Buzzer

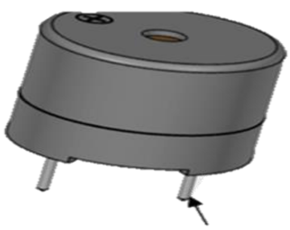

Figure 6: Buzzer

The buzzer functions as an auditory alert mechanism that is triggered when water levels or flow rates surpass designated thresholds. Governed by the ESP8266 microcontroller, it emits a loud and immediate signal to notify local residents of possible flood risks, ensuring that individuals remain aware even without smartphone notifications. Additionally, the buzzer's sound pattern can be adjusted to indicate different levels of urgency, thereby enhancing community safety by delivering a clear and understandable warning.

D. Light Emitting Diode (LED)

Figure 7: LED

In this framework, the implementation of LEDs serves to represent different safety levels through a variety of colors. A green LED indicates that the environment is safe, suggesting that no immediate action is required. In contrast, a yellow LED serves as a cautionary signal, advising users to be alert for potential changes in the situation. A red LED, on the other hand, denotes a hazardous condition, signaling a critical scenario that may require prompt action. This color-coded LED system provides users with a clear and immediate visual indication of the prevailing conditions, enabling swift understanding at a glance.

E. Liquid Crystal Display (LCD) I2C 20x4

Figure 8: Liquid Crystal Display (LCD) I2C 20x4

LCD technology is a prevalent choice for visual displays in electronic devices. It functions by utilizing liquid crystals that adjust light to showcase various types of information, such as text, numbers, and symbols. In microcontroller applications, LCDs play a crucial role in delivering information to users, including sensor readings and system statuses. Their widespread use can be attributed to their cost-effectiveness, straightforward integration with microcontrollers, and ability to display multiple characters or lines at once.

F. IOT (NODE-RED)

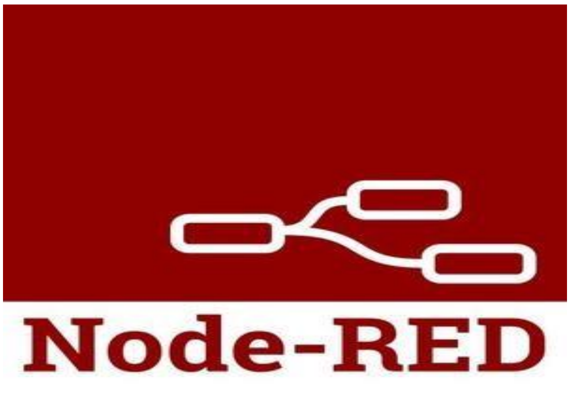

Figure 9: Node-red application

Node-RED is a flow-based development platform that is specifically designed for the integration and automation of hardware devices, APIs, and online services. It boasts a user-friendly visual interface that allows users to effortlessly drag and drop nodes, which represent various actions or processes, to create workflows referred to as flows. Each node acts as an individual block of code or a specific function, such as collecting data from a sensor, processing that data, or sending notifications. This platform is especially favored in Internet of Things (IoT) projects, as it simplifies the integration of various hardware and software services. Furthermore, Node-RED supports a wide range of protocols, making it an excellent choice for building complex IoT systems that require seamless communication among multiple components.

III. RESULT

The ultrasonic sensor functions as the key element for detecting water levels, relaying information to various components such as LEDs, LCDs, buzzers, Node-RED servers, and Telegram bots. This system employs a Node MCU to provide Wi-Fi connectivity, which allows for the effective integration of a server, a Telegram bot, and a Node-RED dashboard. Under standard conditions, when water levels are between 21 and 100 cm, the green LED is activated, and the LCD indicates that the water level is normal.

Table 1: Expected and Real result reading

Water Level Distance	Expected Result				Real Result			
	Led	**Buzzer**	**Lcd Display**	**Telegram Notification**	**Led**	**Buzzer**	**Lcd Display**	**Telegram Notification**
0-10	Red On	On	Danger Level!!!	Start Evacuation!!!	Red On	On	Danger Level!!!	Start Evacuation!!!
11-20	Yellow On	Off	Warning Level	-	Yellow On	Off	Warning Level	-
21-100	Green On	Off	Normal Level	-	Green On	Off	Normal Level	-

Figure 10: Display the conditions when water level detect the setting value

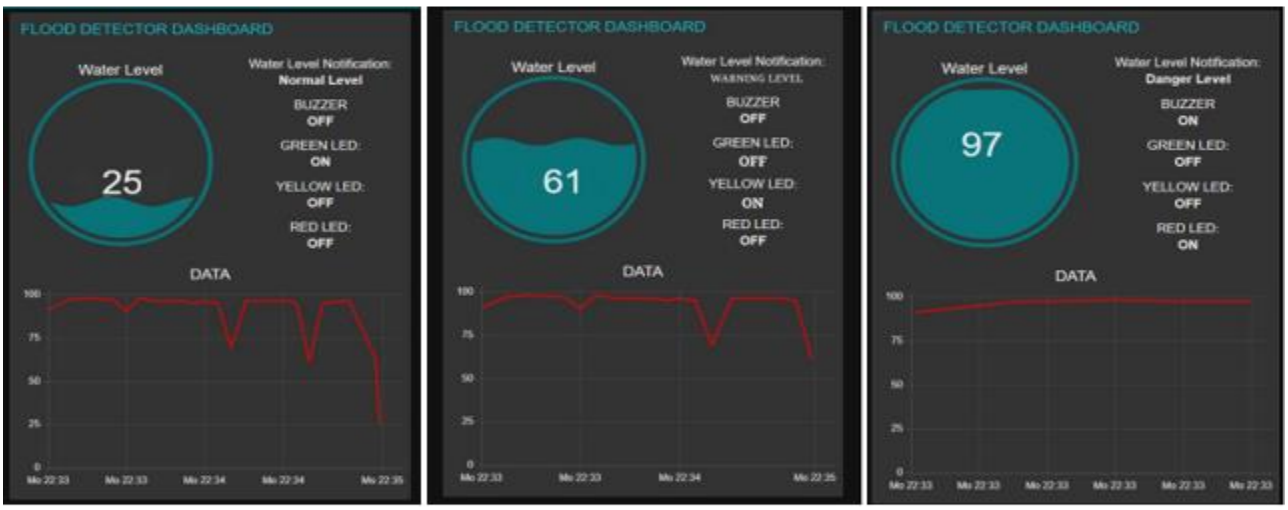

Figure 11: The dashboard webserver for monitoring the water level

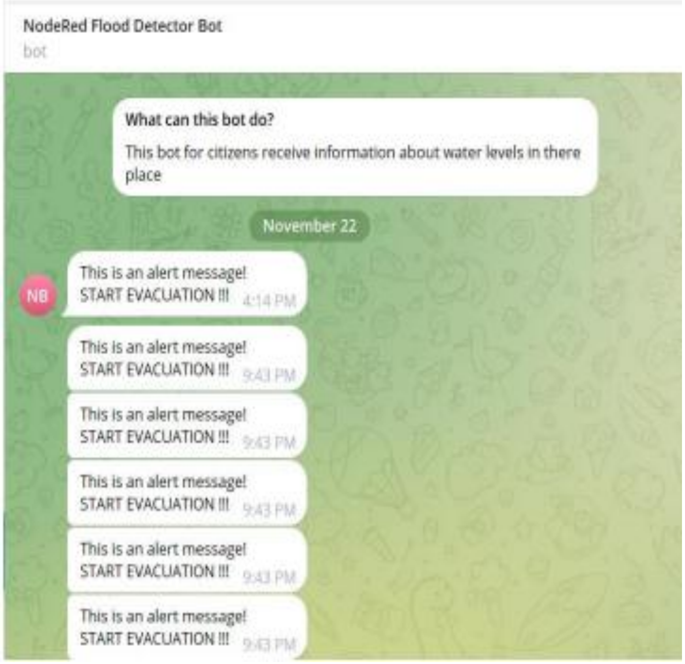

Figure 12: Telegram Notification when danger conditions

Figure 13: Monitoring in Mobile Phone

Users have the ability to effortlessly track the water level through their smartphones or a web browser by utilizing a registered address ID to access the system. This functionality allows for immediate access to flood monitoring information, irrespective of the user's geographical location. Furthermore, the system captures and presents a graphical representation of water level trends over time, offering essential insights into the dynamics and variations of water levels.

IV.DISCUSSION

The deployment of the Node-RED Flood Detector system exemplifies a dependable and effective method for real-time flood monitoring, especially in flood-prone regions of Malaysia. By integrating ultrasonic sensors with a NodeMCU microcontroller, the system achieves precise and ongoing water level detection. Its capability to categorize water levels into safe, warning, and dangerous thresholds allows for timely alerts. The incorporation of visual signals, such as LEDs and LCDs, along with automated notifications through Telegram bots and the Node-RED dashboard, greatly improves situational awareness and user engagement. These functionalities are vital for issuing prompt warnings that can reduce flood-related impacts and protect communities. The classification of water levels into green (safe), yellow (warning), and red (danger) has proven to be both practical and effective in real-world scenarios. The sensor data reliably activated appropriate responses, including LED lights and alert notifications, based on established distance parameters. The smooth interaction between hardware components and IoT platforms validated the system's reliability and minimal delay in relaying essential information. Additionally, the ability to access water level data via mobile devices or web browsers offers users convenient and continuous monitoring, enabling them to make timely and informed decisions.

The documented trends in water levels have been crucial for comprehending hydrological patterns over time. This visual data representation provides a straightforward depiction of fluctuations in water levels, which aids in analytical predictions and confirms system efficacy across various environmental scenarios. Furthermore, the insights derived from these visualizations can guide infrastructure development, enhance early warning mechanisms, and support the creation of predictive models for potential flooding incidents. In summary, the integration of real-time monitoring, user-friendly interfaces, and visual data analysis positions the Node-RED Flood Detector as a valuable asset for community-oriented flood management and disaster response strategies.

In contrast to conventional flood alert systems that typically depend on manual monitoring or delayed text alerts from centralized organizations, the Node-RED framework presents a more prompt, user-focused alternative with improved responsiveness. While traditional systems may necessitate specialized servers and intricate backend configurations, the implementation of NodeMCU along with cloud-based dashboards streamlines the setup process and lowers infrastructure expenses—making it particularly adaptable for rural or financially constrained areas.

Nonetheless, this system does have its drawbacks. The precision of the ultrasonic sensor can be compromised by environmental elements such as debris on the water's surface, wind, or rain splashes, potentially resulting in inaccurate readings. Moreover, the dependence on internet connectivity implies that regions with unreliable or weak Wi-Fi signals may face delays in data transmission and alert notifications. Future enhancements could incorporate redundancy measures like GSM-based backup alerts or solar-powered battery systems to guarantee operational reliability during critical events such as power failures or network interruptions.

Enhancements could involve the addition of extra sensors, such as rainfall gauges and flow rate sensors, to create a more comprehensive understanding of flood conditions. Integrating machine learning algorithms into the Node-RED flow would allow for the analysis of trends and the prediction of flooding by utilizing both historical and real-time data. Additionally, connecting with public APIs from hydrology departments or disaster management organizations would facilitate automatic updates and validation of data from multiple sources, leading to more precise risk assessments. Ultimately, the Node-RED Flood Detector offers a cost-effective, scalable, and responsive flood alert system with significant potential for practical application. By overcoming its existing challenges and improving its predictive capabilities, this system can transform into a thorough smart flood management solution that plays a vital role in enhancing disaster preparedness and climate resilience in areas susceptible to flooding.

V. CONCLUSION

In conclusion, the Node-RED Flood Detector system exemplifies an innovative strategy for intelligent flood monitoring, utilizing IoT technology to improve community safety, raise environmental awareness, and enhance disaster readiness. By incorporating ultrasonic sensors, the NodeMCU microcontroller, and cloud-based services like Node-RED and Telegram, the system provides real-time monitoring, visual and digital notifications, and user-friendly data access through mobile and web platforms. This capability ensures that users remain informed and can react promptly to fluctuations in water levels, thereby minimizing potential damage and preserving lives. The system's cost-effective design and low energy consumption not only make it scalable but also align with sustainable development objectives, particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 13 (Climate Action). It offers a robust, technology-based answer to the critical issue of early detection and communication in flood-prone areas. Although the current system operates effectively under testing conditions, future upgrades, including the addition of environmental sensors, AI-driven flood forecasting, and hybrid connectivity options (such as GSM and Wi-Fi), could significantly enhance its functionality and flexibility. With ongoing advancements, this solution could be implemented on a national level, contributing to a larger framework of smart cities or villages aimed at environmental safety and climate resilience. Ultimately, this initiative marks a significant advancement in the integration of accessible technology into disaster risk management strategies, benefiting not only local communities but also supporting global initiatives to foster a more prepared and sustainable future.

VI.RECOMMENDATION

For future improvements, it is recommended that the Node-RED Flood Detector system be enhanced with additional sensors such as rainfall gauges, flow rate meters, and temperature/humidity sensors to provide more comprehensive environmental data. This multi-sensor approach would improve the accuracy of flood prediction and enable the system to respond to more complex hydrological patterns. Furthermore, integrating AI or machine learning algorithms into the Node-RED platform could support predictive analytics, allowing the system to anticipate flooding based on historical trends and real-time inputs. To ensure continuous operation during connectivity issues or power outages, it is also advisable to incorporate backup communication modules such as GSM or LoRa, as well as a solar-powered energy supply. From a user experience standpoint, developing a dedicated mobile app with advanced features such as push notifications, location-based risk alerts, and community reporting tools could significantly enhance user engagement and system responsiveness. Lastly, collaboration with local authorities such as the Department of Irrigation and Drainage (DID) and disaster management agencies like NADMA would allow for wider deployment, improved data integration, and better alignment with national disaster risk reduction strategies.

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