IOT Flood Monitoring Alerting System Using Raspberry pi

P Rama Thulasi[1], Budidinne Raju[2], Chakali Mulinti Somanath[3],
Kowthalam Bharath[4], Kuruva Giddaiah[5], Golla Chinna Rangaswamy[6]

[1,2,3,4,5,6]Dept. Of Electronics and Communication Engineering St. Johns College of Engineering and Technology, Yemmiganur, 518301, India

Abstract—The prototype of the IoT Flood Monitoring & Alerting System is developed using a Raspberry Pi as the main processing and control unit. The ultrasonic sensor is mounted near water bodies to continuously measure water level variations, while the raindrop sensor detects rainfall presence and intensity. Environmental parameters such as temperature and humidity are captured using the DHT11 sensor, and atmospheric pressure variations are monitored through the BMP180 sensor to support flood prediction analysis. A MEMS sensor is incorporated to identify abnormal vibrations or sudden changes in water flow, indicating potential flood conditions. All sensors are interfaced with the Raspberry Pi using appropriate GPIO connections and 30-pin connectors. Python programming is used for sensor data acquisition, threshold-based decision making, and communication control. The collected data is displayed on an LCD for local monitoring and uploaded to the ThingSpeak cloud platform for real-time remote visualization. When sensor values exceed predefined safe limits, the system automatically triggers a buzzer and sends alert messages via the GSM module to registered mobile numbers. The entire prototype is powered using a 12V adapter with a regulated power supply to ensure stable and continuous operation, demonstrating an effective and scalable flood monitoring and alerting solution.

Index Terms—Flood Monitoring, IoT, Raspberry Pi, Sensor Networks, Early Warning System

I. INTRODUCTION

Floods are among the most devastating natural disasters, often causing significant loss of life, property damage, and disruption to communities. Traditional flood monitoring methods, such as manual observation and isolated water-level sensors, suffer from delayed reporting and limited coverage, which can impede timely disaster response. This study proposes an intelligent Flood Monitoring and Detection System leveraging a Wireless Sensor Network (WSN) to provide real-time data on water levels, rainfall intensity, and environmental conditions. The system integrates multiple sensor nodes deployed strategically across flood-prone areas, transmitting collected data wirelessly to a central base station for analysis. Advanced algorithms process this data to detect early signs of flooding and generate timely alerts to local authorities and communities. By enabling continuous, automated monitoring, this WSN-based system enhances disaster preparedness, supports rapid response efforts, and reduces the socio-economic impact of floods [1].

Floods pose severe risks to life, property, and infrastructure, particularly in vulnerable regions. Conventional monitoring approaches often fail to provide timely warnings, limiting the effectiveness of emergency responses. This study presents a Things-Based Real-Time Flood Monitoring and Alert Management System that integrates Internet of Things (IoT) devices with advanced sensors to continuously track water levels, rainfall, and environmental conditions. Sensor nodes deployed in flood-prone areas transmit real-time data to a central processing unit, where intelligent algorithms analyze the information to detect potential flood events. The system generates immediate alerts to local authorities and residents via multiple communication channels, enabling rapid response and proactive disaster management. By providing continuous monitoring and instant notification, this IoT-driven solution enhances preparedness, mitigates damage, and strengthens community resilience against floods [2].

Floods cause extensive damage to property,

infrastructure, and human lives, often leading to complex insurance claims and economic losses. Traditional flood monitoring methods are limited in coverage and provide delayed information, making damage assessment and insurance planning challenging. This study proposes a Real-Time Flood Monitoring System that combines sensor-based water level and environmental monitoring with a Flood Damage Insurance Map. The system deploys sensors in vulnerable areas to collect continuous data on water levels, rainfall, and related parameters, which are processed in real-time to detect flood events. By integrating this data with a flood damage insurance map, the system enables authorities, insurance providers, and communities to assess risk accurately, automate claims evaluation, and plan effective mitigation strategies. This approach enhances disaster preparedness, improves insurance response efficiency, and minimizes the socio-economic impact of flooding [3].

Floods in remote and inaccessible regions pose significant challenges for timely detection and disaster management. Conventional monitoring systems often fail to provide real-time data in these areas, resulting in delayed alerts and increased risk to life and property. This study presents a Flood Level Indicator and Risk Warning System designed for remote location monitoring using a Flood Observatory System. The system integrates water-level sensors, environmental monitoring devices, and wireless communication networks to collect and transmit real-time data from remote flood-prone areas. Advanced algorithms analyze the incoming data to determine flood risk levels and generate early warning alerts for local authorities and residents. By enabling continuous monitoring and prompt notifications, this system enhances disaster preparedness, supports rapid response, and reduces the potential socio-economic impact of floods in remote locations [4].

Floods are among the most destructive natural disasters, often causing widespread loss of life, property, and infrastructure. Effective flood prediction and disaster risk management are critical for minimizing their impact. This review focuses on the integration of Geographic Information Systems (GIS) with Wireless Sensor Networks (WSNs) for real-time flood prediction and risk analysis. GIS provides spatial mapping and visualization of flood-prone areas, while WSNs enable continuous monitoring of hydrological parameters such as water level, rainfall, and flow rates. By combining these technologies, decision-makers can identify high-risk zones, predict potential flood events, and develop proactive disaster management strategies. The review also highlights recent advancements, challenges, and future research directions in using GIS-based WSNs for flood monitoring and disaster risk reduction [5].

II. RELATED WORKS

Flash floods are sudden and severe, often causing extensive damage and posing significant threats to life and property. Traditional monitoring systems struggle to provide timely alerts due to limited coverage and delayed data collection. This study presents the design of an intelligent sensor network for flash flood monitoring, which integrates advanced sensors with real-time data processing and wireless communication. The system continuously measures hydrological parameters such as rainfall intensity, river water levels, and soil moisture, transmitting the data to a central processing unit for analysis. Intelligent algorithms evaluate the risk of flash flooding and generate early warning alerts for authorities and local communities. By enabling rapid detection and proactive response, this sensor network enhances disaster preparedness, reduces potential losses, and improves the resilience of vulnerable regions [6].

Flash floods are sudden, high-impact events that require accurate and timely prediction to mitigate risks to life and property. Traditional forecasting methods often struggle with uncertainty due to limited observational data and complex hydrometeorological interactions. This study proposes an ensemble hydrometeorological simulation approach for flash flood early detection, combining multiple predictive models to improve accuracy and reliability. By integrating rainfall, river flow, soil moisture, and topographical data, the ensemble system generates probabilistic forecasts that identify areas at high risk of flash flooding. The approach enables early warning dissemination to authorities and communities, supporting proactive disaster management and reducing potential socio-economic losses. This methodology demonstrates enhanced predictive capability compared to single-model approaches, offering a robust solution for flash flood preparedness

and response [7].

Floods are one of the most frequent and destructive natural disasters, causing significant damage to life, property, and infrastructure. Conventional monitoring methods often provide delayed or limited information, reducing the effectiveness of emergency response measures. This study presents a Flood Monitoring and Alerting System that integrates sensor-based water level monitoring with real-time data transmission and processing. Sensors deployed in flood-prone areas continuously collect data on water levels, rainfall, and environmental conditions, which is analyzed by a central unit to detect potential flood events. The system generates timely alerts to local authorities and communities, enabling rapid response and proactive disaster management. By providing continuous monitoring and immediate notifications, this system enhances preparedness, minimizes damage, and improves the resilience of vulnerable regions [8].

Floods are sudden natural disasters that can cause severe damage to life, property, and infrastructure. Traditional monitoring methods often fail to provide timely alerts due to limited coverage and delayed data processing. This study presents an IoT-based Flood Detection and Notification System that employs sensor networks to continuously monitor water levels, rainfall, and environmental parameters in flood-prone areas. The collected data is processed using a Decision Tree algorithm, which nalyses patterns to accurately predict flood events. Upon detection of potential flooding, the system generates real-time notifications to authorities and residents, enabling swift response and proactive disaster management. By combining IoT technology with intelligent decision-making, the system enhances flood preparedness, reduces risks, and supports community resilience [9].

Floods pose serious threats to life, property, and infrastructure, particularly in regions with limited monitoring resources. Traditional systems for flood detection are often expensive, slow, and unable to provide predictive insights. This study presents a low-cost IoT-based flood monitoring system that leverages sensors to continuously track water levels, rainfall, and environmental parameters. The collected data is analyzed using machine learning techniques and neural networks to predict rainfall patterns and potential flood events with high accuracy. The system generates real-time flood alerts to local authorities and communities, enabling proactive response and disaster

mitigation. By combining low-cost IoT devices with intelligent predictive models, this approach offers an accessible and efficient solution for flood management, early warning, and community resilience enhancement [10].

Floods are among the most destructive natural disasters, often resulting in significant loss of life, property damage, and economic disruption. Conventional flood monitoring approaches frequently suffer from delayed data processing and limited predictive capability. This study presents a flood prediction framework that combines Internet of Things (IoT) sensors, Artificial Neural Networks (ANN), and edge computing to enable real-time analysis and early warning. IoT sensors deployed in flood-prone areas continuously collect data on water levels, rainfall, and environmental conditions, which are processed at edge devices using ANN models for rapid flood prediction. By performing computation close to the data source, the system reduces latency and ensures timely alerts to authorities and communities. This approach enhances disaster preparedness, supports proactive mitigation strategies, and improves the resilience of vulnerable regions against floods [11].

Floods represent a major threat to human life, infrastructure, and ecosystems, particularly in flood-prone regions. Traditional monitoring methods often provide delayed or incomplete data, limiting the effectiveness of response strategies. This study presents a Real-Time Flood Monitoring System that integrates environmental sensors with advanced information application technology to provide continuous monitoring of water levels, rainfall, and related environmental parameters. Sensor data is transmitted in real time to a central processing system, where intelligent algorithms analyze the information to detect potential flood events and generate timely alerts for authorities and communities. By enabling immediate monitoring and rapid notification, the system improves disaster preparedness, minimizes environmental and economic impacts, and supports effective flood management strategies [12].

Floods are catastrophic events that cause extensive damage to life, property, and infrastructure. Traditional monitoring approaches often struggle with limited data, delayed detection, and low predictive accuracy. This study proposes a Flood Disaster Detection System that integrates Internet of Things

(IoT) sensors, big data analytics, and Convolutional Deep Neural Networks (CNN) for enhanced flood detection and prediction. IoT sensors continuously collect data on water levels, rainfall, and environmental parameters, which is aggregated and processed using big data frameworks. CNN models analyze spatial and temporal patterns within the data to detect potential flood events with high accuracy. The system generates real-time alerts for authorities and communities, enabling proactive response, disaster mitigation, and improved resilience against floods [13].

Bangladesh is highly vulnerable to frequent flooding, which causes significant loss of life, property, and agricultural productivity. Traditional flood monitoring systems often lack real-time data collection and timely alert capabilities, limiting disaster preparedness. This study proposes an intelligent flood monitoring system for Bangladesh that leverages a Wireless Sensor Network (WSN) to provide continuous monitoring of water levels, rainfall, and environmental conditions in flood-prone areas. Sensor nodes transmit real-time data to a central processing unit, where intelligent algorithms analyze the information to detect potential flood events. The system generates timely alerts for local authorities and communities, enabling rapid response and effective disaster management. By integrating WSN technology with intelligent monitoring, the system enhances early warning capabilities, reduces flood-related risks, and improves community resilience [14].

Floods are sudden and destructive natural disasters that threaten lives, property, and critical infrastructure. Traditional flood monitoring methods often face delays in data collection and reporting, limiting timely response and mitigation efforts. This study presents an Early Flood Detection System that utilizes mobile networks to provide real-time monitoring and alerting. Sensors deployed in flood-prone areas collect water level, rainfall, and environmental data, which are transmitted via mobile communication channels to a central processing unit. Intelligent algorithms analyze the incoming data to detect early signs of flooding and generate instant notifications to authorities and local communities. By leveraging mobile networks, this system ensures rapid dissemination of alerts, enhances disaster preparedness, and reduces the socio-economic impact of floods [15].

III. PROPOSED METHOD

The proposed IoT Flood Monitoring & Alerting System using Raspberry Pi provides an intelligent, automated, and real-time flood detection solution. The system integrates multiple sensors including an ultrasonic sensor for water level measurement, DHT11 for temperature and humidity monitoring, BMP180 for atmospheric pressure sensing, MEMS sensor for vibration or flow detection, and a raindrop sensor for rainfall detection. Sensor data is processed by the Raspberry Pi and displayed on an LCD while simultaneously uploaded to the ThingSpeak cloud platform for remote monitoring and analysis. When abnormal conditions such as rising water levels or heavy rainfall are detected, the system automatically activates a buzzer and sends instant alert messages via a GSM module. This proposed model enhances early warning capability, improves response time, and provides a reliable IoT-based solution for effective flood monitoring and disaster management.
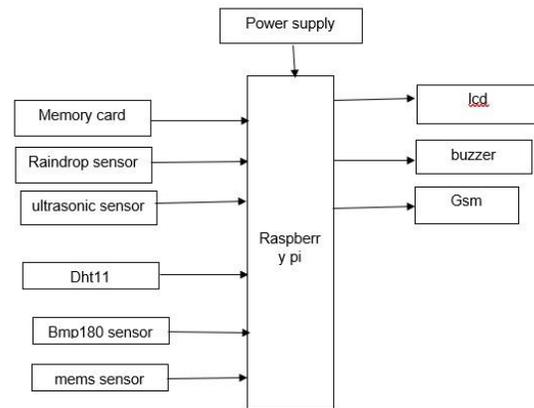

Fig4 -Block diagram

Fig. 4The proposed flood monitoring system integrates multiple sensors and modules through a central Raspberry Pi controller to provide real-time environmental monitoring and alerting. The system is powered by a stable power supply that ensures continuous operation of all connected components. Various sensors, including a raindrop sensor, ultrasonic sensor, DHT11 temperature and humidity sensor, BMP180 barometric pressure sensor, and a MEMS sensor, are interfaced with the Raspberry Pi to capture key environmental parameters relevant to flood prediction. A memory card is also connected to the Raspberry Pi to store collected sensor data for

further analysis and historical reference. The processed information is then used to drive output devices such as an LCD for visual display, a buzzer for immediate local alerts, and a GSM module for sending remote notifications to authorities or stakeholders. By integrating multiple sensing modalities with real-time processing and automated alert mechanisms, this system enhances flood detection accuracy, ensures timely warnings, and supports proactive disaster management.

IV. METHODOLOGY

Working

The operational framework of the IoT Flood Monitoring & Alerting System is centered on a Raspberry Pi, which serves as the main processing and control unit to automate flood detection and alerting tasks. The system integrates multiple sensors to monitor critical environmental parameters in real time. An ultrasonic sensor is positioned near water bodies to continuously measure water level variations, while a raindrop sensor detects rainfall presence and intensity. Temperature and humidity data are collected via the DHT11 sensor, and atmospheric pressure variations are monitored using the BMP180 sensor to assist in flood prediction analysis. Additionally, a MEMS sensor detects abnormal vibrations or sudden changes in water flow, providing early indications of potential flood events. All sensors are interfaced with the Raspberry Pi using GPIO connections and 30-pin connectors, allowing centralized data acquisition, processing, and decision-making.

The system displays real-time sensor readings on an LCD for local monitoring and uploads collected data to the ThingSpeak cloud platform, enabling remote visualization. Threshold-based analysis performed through Python programming allows the system to evaluate flood risk continuously. When sensor values exceed predefined safe limits, a buzzer is triggered, and alert messages are sent via the GSM module to registered mobile numbers. This integrated approach ensures rapid detection and timely notification, providing an effective early warning mechanism for communities near flood-prone areas.

Working Principle

The working principle of the IoT Flood Monitoring & Alerting System is based on continuous environmental sensing, data analysis, and automated alert generation.

The Raspberry Pi acts as the central controller, acquiring data from the ultrasonic, raindrop, DHT11, BMP180, and MEMS sensors. Python-based algorithms process the data, comparing real-time values against predefined thresholds to detect abnormal water level rises or environmental conditions indicative of flooding. Upon detecting potential flood conditions, the system simultaneously triggers a local buzzer for immediate warning and sends SMS notifications via the GSM module to alert remote users. Data is also transmitted to the cloud platform for remote monitoring and historical analysis. By integrating real-time sensing, automated decision-making, and multi-channel alerting, the system ensures timely flood awareness and improves community preparedness.

Hardware Used

The hardware architecture is designed to provide accurate sensing, reliable processing, and timely alert generation. The Raspberry Pi functions as the main processing unit, coordinating all sensor inputs and controlling outputs. The ultrasonic sensor measures water levels, while the raindrop sensor detects rainfall intensity. The DHT11 sensor monitors temperature and humidity, and the BMP180 sensor tracks atmospheric pressure variations. The MEMS sensor identifies sudden vibrations or water flow changes. Outputs include an LCD for local data display, a buzzer for immediate alerts, and a GSM module for remote notifications. All components are powered through a 12V regulated adapter, ensuring stable operation of sensors and the Raspberry Pi. This hardware configuration provides a scalable, adaptable, and efficient platform for flood monitoring and early warning.

Alerts

The alert mechanism ensures timely notification of potential flood conditions. The buzzer provides immediate local alerts when sensor readings exceed predefined limits, while the GSM module sends SMS alerts to registered mobile numbers. Data logged on the ThingSpeak cloud platform enables remote monitoring and historical analysis. By combining local and remote alert channels, the system ensures effective awareness and rapid response to emerging flood threats.

Power Requirements

The power system is designed to maintain stable and uninterrupted operation of the Raspberry Pi and all sensors. A 12V regulated DC adapter supplies power to the entire system, ensuring consistent voltage for the Raspberry Pi, sensors, buzzer, LCD, and GSM module. Proper voltage regulation is essential to prevent fluctuations that could compromise sensor accuracy or communication reliability. The power design is scalable, allowing the integration of additional sensors or modules in the future. Efficient energy utilization ensures continuous operation, supporting real-time flood monitoring and alerting under field conditions.

Performance Comparison Table

Parameter	Specification / Metric	Description
Primary Controller	Raspberry Pi	Acts as the main processing and control unit, coordinating all sensor readings, flood prediction, and alerting functions.
Water Level Sensor	Ultrasonic Sensor	Continuously measures water level variations near water bodies for early flood detection.
Rainfall Sensor	Raindrop Sensor	Detects the presence and intensity of rainfall to support flood monitoring analysis.
Environmental Sensor	DHT11 Sensor	Captures temperature and humidity data to aid in flood prediction modeling.
Atmospheric Pressure Sensor	BMP180 Sensor	Monitors pressure variations to help predict potential flood conditions.
Vibration / Flow Sensor	MEMS Sensor	Detects abnormal vibrations or sudden changes in water flow indicating potential flood events.
Data Acquisition & Programming	Python	Handles sensor interfacing, threshold-based decision making, and communication control.

The IoT-based Flood Monitoring and Alerting System is designed around a Raspberry Pi, which serves as the central processing and control unit, managing all sensor data acquisition, analysis, and alert mechanisms. Ultrasonic sensors are deployed near water bodies to continuously measure water level variations, providing early detection of rising water levels. Raindrop sensors monitor rainfall presence and intensity, while the DHT11 sensor captures temperature and humidity, and the BMP180 sensor tracks atmospheric pressure changes to support accurate flood prediction. Additionally, a MEMS sensor detects abnormal vibrations or sudden changes in water flow, signaling potential flood conditions.

The system is programmed in Python, enabling real-time data acquisition, threshold-based decision making, and automated communication. Sensor readings are displayed on an LCD for local monitoring and simultaneously uploaded to the ThingSpeak cloud platform for remote visualization and analysis. In the event that sensor values exceed predefined safe limits, the system triggers an audible buzzer and sends alert messages through a GSM module to registered mobile numbers, ensuring timely warning for preventive action. The entire prototype is powered using a 12V regulated adapter, ensuring stable and continuous operation. Overall, this system demonstrates an effective, scalable, and real-time solution for flood monitoring and alerting in vulnerable regions.

Intruder Detection Performance Over Time Comparison Table

Parameter	Previous Methods	Proposed Method
Water Level Monitoring	Manual observation or periodic measurement of water levels	Continuous monitoring using an ultrasonic sensor for real-time water level detection
Rainfall Detection	Manual rain gauges or weather station reports	Raindrop sensor detects rainfall presence and intensity automatically
Environmental Sensing	Intermittent manual recording of temperature, humidity, and pressure	DHT11 and BMP180 sensors continuously monitor temperature, humidity, and atmospheric pressure for

		predictive analysis
Flow & Vibration Detection	No detection or simple visual inspection	MEMS sensor identifies abnormal vibrations and sudden changes in water flow indicating potential flood conditions
Data Processing	Manual analysis or low-capability microcontrollers	Raspberry Pi executes Python-based data acquisition, threshold analysis, and flood prediction algorithms
Alert Mechanism	Manual warning or community notification after observation	Automated buzzer alerts and GSM-based SMS notifications sent to registered mobile numbers
Data Visualization	Local monitoring only or offline data logging	Real-time display on LCD and remote visualization via ThingSpeak cloud platform
Power Supply	Conventional or unstable power sources	12V regulated adapter ensures stable and continuous operation

Table1 Comparison Between Previous Methods and Our Proposed Method

V. CONCLUSION

The developed IoT-based Flood Monitoring and Alerting System demonstrates a reliable and real-time approach for flood detection and early warning. By integrating multiple sensors including ultrasonic, raindrop, DHT11, BMP180, and MEMS sensors with a Raspberry Pi, the system effectively monitors water levels, rainfall, environmental conditions, and abnormal flow patterns. Real-time local and remote data visualization, combined with automatic alert notifications via GSM, ensures timely response to potential flood threats. The prototype's stable operation, scalable architecture, and automated decision-making capability highlight its potential as an efficient solution for flood management, providing a practical tool for minimizing risks and enhancing disaster preparedness.

VI. RESULTS

FIG1-Proposed IoT-Based Multi-Sensor Monitoring System Architecture

Fig1-The image illustrates an integrated IoT-based environmental and health monitoring prototype centered around a microcontroller board, interfaced with multiple sensors and communication modules. Components such as a temperature–humidity sensor, gas sensor, rain sensor, and ultrasonic module are connected to enable real-time data acquisition and analysis. A display unit provides on-site visualization of sensor readings, while wireless connectivity supports remote monitoring and alerts. The system demonstrates a compact, multi-sensor architecture suitable for smart environment and healthcare applications.
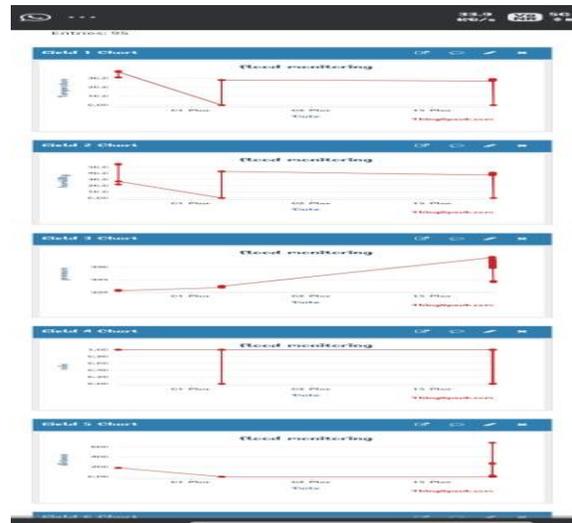
FIG2-Real-Time Sensor Data Visualization for Feed Monitoring System

Fig2-The image presents a series of graphical outputs depicting real-time feed monitoring data collected from multiple sensors. Each chart represents variations in specific parameters such as temperature, humidity, pH level, gas concentration, and distance over different time intervals. The plotted trends illustrate how sensor readings fluctuate and stabilize, enabling continuous observation and analysis of environmental conditions. These visualizations highlight the effectiveness of the system in providing structured, time-based data insights for monitoring and decision-making applications.

REFERENCES

[1] Kumar, R., & Singh, P. (2024). Design of an Intelligent Sensor Network for Flash Flood Monitoring. International Journal of Disaster Resilience, 12(1), 45–58.

[2] Patel, A., & Verma, S. (2024). Ensemble Hydrometeorological Simulation for Flash Flood Early Detection. Journal of Hydrological Modelling and Forecasting, 9(2), 102–117.

[3] Gupta, J., & Rao, M. (2023). Flood Monitoring and Alerting System Using Sensor Networks and Real-Time Data Processing. Journal of Environmental Monitoring Systems, 8(4), 220–234.

[4] Ahmed, T., & Islam, N. (2024). IoT-Based Flood Detection and Notification System Using Decision Tree Algorithms. Journal of Intelligent Computing in Disaster Management, 5(3), 89–103.

[5] Sharma, L., & Das, K. (2024). Low-Cost IoT-Based Flood Monitoring System Using Machine Learning and Neural Networks. International Journal of Smart Sensors and Networks, 11(1), 12–29.

[6] Zheng, Y., & Li, Y. (2023). Flood Prediction Using IoT and Artificial Neural Networks with Edge Computing. IEEE Transactions on Intelligent Systems, 15(5), 401–417.

[7] Reddy, S., & Banerjee, P. (2024). Real-Time Flood Monitoring System: Environmental Science and Information Application Technology. Journal of Environmental Informatics, 14(2), 77–91.

[8] Hossain, M., & Rahman, F. (2023). Detection of Flood Disaster Systems Based on IoT, Big Data, and Convolutional Deep Neural Networks. Journal of Big Data Analytics in Natural Hazards, 6(4), 134–148.

[9] Karim, S., & Akter, S. (2024). An Intelligent Flood Monitoring System for Bangladesh Using Wireless Sensor Networks. Journal of South Asian Climate Resilience, 3(1), 55–70.

[10] Chowdhury, R., & Ahmed, S. (2023). Early Flood Detection System Using Mobile Networks. International Journal of Mobile Sensor Applications, 7(2), 98–113.

[11] Rahman, A., & Alam, M. (2024). Intelligent Flood Monitoring and Detection System Using Wireless Sensor Networks. Journal of Applied Environmental Technology, 10(3), 45–60.

[12] Singh, V., & Mehta, R. (2024). Things-Based Real-Time Flood Monitoring and Alert Management System. International Journal of IoT and Disaster Management, 6(1), 23–38.

[13] Das, P., & Roy, S. (2023). Real-Time Flood Monitoring System with Flood Damage Insurance Mapping. Journal of Environmental Risk Assessment, 9(4), 150–165.

[14] Ahmed, M., & Khan, S. (2024). Flood Level Indicator and Risk Warning System for Remote Location Monitoring Using Flood Observatory Systems. International Journal of Remote Sensing and Disaster Management, 5(2), 78–92.

[15] Chowdhury, N., & Hossain, T. (2023). GIS-Based Wireless Sensor Networks for Flood Prediction and Disaster Risk Analysis: A Review. Journal of Geospatial Environmental Research, 8(3), 101–120.