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Flood Monitoring System

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Abstract—The proposed system employs a network of strategically placed sensors, including water level sensors, rainfall gauges, and temperature sensors, to collect critical environmental data. These sensors continuously monitor hydrological parameters and transmit the data to a centralized cloud-based platform via wireless communication technologies such as IoT (Internet of Things). The collected data is then processed using advanced machine learning algorithms and hydrological models to predict flood occurrences and assess potential risks in vulnerable areas.

Millions of people worldwide are impacted by floods each year, which are the most common and destructive of all natural catastrophes. In light of this, it is anticipated that increased climate variability and climate change would lead to an increase in the frequency and severity of floods [1]. The transboundary nature of water further complicates matters, making cross-border collaboration on integrated flood risk management not only essential but also very advantageous. Flood vulnerability is increased as a result of the many obstacles that impede effective transboundary collaboration in general and cooperation on transboundary flood control in particular [2].

The goal of flood risk management strategies, or FRMSs Their institutional embedding probably needs to change for this [3]. However, there are currently just a few, dispersed insights available regarding this institutional embedding of FRMSs. In this study, we contend that merging and utilizing legal and public administration expertise can produce such insights. We provide the Transboundary Flood Risks Governance Arrangements (TFRGAs) strategy to begin with the latter. We will apply this strategy to conduct comparative research in order to further develop the technique in the EU-funded STARFLOOD project.

Keywords: water governance, transboundary water management, floods, flood risk governance systems.

I. INTRODUCTION

One of the most frequent and damaging natural disasters, floods affect millions of people annually throughout the world. Due to climate-related factors exacerbated by urbanization and social, economic, and political activity, human exposure and vulnerability to floods have increased dramatically over time and with population growth [4].

The governance of transboundary floods, or floods that start in one nation or jurisdiction and then move downstream to another, is still not well understood, and there are few, scattered, and limited social scientific, institutional, and legal studies on transboundary flood risk management. Relevant conceptual work has been done, such as the adaptive capacity wheel developed by Gupta et al. and the social capacity building model developed by Kuhlicke et al.

Although these and other tactics are still in their infancy, they are being used in flood risk governance (see Van Den Brink et al., 2011). Prior studies on flood vulnerability have either looked at worldwide statistics of different natural disasters (Haque, 2003; GuhaSapir et al., 2004; Mutter, 2005) or all countries or continents' flood type data (Hoyois & GuhaSapir, 2003).

Others have focused on a single country, a single river, a single historical flood, or a mix of these topics. Few studies have examined the phenomenon of shared or transboundary floods occurring in international river basins (IRBs), let alone the governance of such events, despite the fact that rivers transcend political boundaries and have formed 279 IRBs (TFDD, 2006, unpublished data) (Bakker, 2006; Bakker, 2009; Marsalek et al., 2006). Global flood data analysis is a relatively new field of study (Bakker, 2006; Hossain & Katiyar, 2006).

The EU-funded project STAR-FLOOD will fill this information vacuum by focusing on transboundary river flood events and linking them to institutional, legal, and social-scientific studies on the topic. This will provide information on the tools needed to develop appropriate and strong so-called Transboundary Flood Risk Governance Arrangements (TFRGAs) [6]. The final goals of the project are to develop policy design guidelines for TFRGAs and to derive implications for laws and policies at the transboundary level of regional authorities.

II. LITERATURE REVIEW

Floods are often ignored in transboundary water management. Nonetheless, floods pose a significant risk to downstream riparian nations, and climate change is expected to increase their frequency and intensity in some regions. The consequences could be catastrophic if these risks are not managed. A recent study by Bakker (2006) examined the occurrence of flooding across international borders. She found that while just 10% of all floods are shared, 75% of countries that experience river floods do so with other countries. Bakker (2009) found in a follow-up study that flood losses were higher in shared basins with no institutional capability, such as international water management agencies and freshwater treaties. Ol. [1]

43 international river basins experienced frequent transboundary floods between 1985 and 2005, yet these basins lacked the institutional capacity to deal with these events. However, with integrated flood control, the probability of these events can be considerably reduced. It is crucial to coordinate flood-management activities throughout the basin, and including flood management protocols into all transboundary agreements could be a helpful risk-reduction tactic. [1]

Recent years have seen a sharp rise in extreme flood events, their negative effects on the economy, society, and environment, as well as the number of fatalities they inflict. [3] In light of this already dire situation, increased climate variability and climate change are predicted to make floods more frequent and intense. However, floods are also a natural occurrence that can have positive effects. For example, the inundation of seasonal floodplains is necessary to keep rivers healthy, create new habitats, deposit silts and fertile organic matter, and preserve wetlands. Human activity is the primary cause of flood susceptibility, including the placement of infrastructure and structures, the availability of early warning systems and emergency preparation, the presence of suitable institutional and legal frameworks, etc.

However, managing floods is already difficult in river basins under one administration; managing floods across borders is far more difficult. Because institutional capacity in an international river basin (IRB) should be able to absorb changes in the basin to reduce the chances of conflict and increase the chances of productive cooperation, the demands on international cooperation and management in all aspects of flood management are especially important under such circumstances (Wolf et al., 2003). [4] [5]

The boundaries of the river basin, not the national or administrative borders, should serve as the basis for flood management, which should ideally have a strong national foundation with strict within-country laws. The total efficacy of flood management services can be increased by transboundary cooperation between local and regional flood management authorities. This would ultimately lead to a reduction in risks and damages as well as improved protection of the environment and population. Indeed, transboundary collaboration is the only method to genuinely address basin-wide disasters like floods in an integrated fashion.

Thinagaran Perumal, C. Y. Leong, and Md. Nasir Suleiman. IEEE Explore: IoT-Powered Water Monitoring System An Internet of Things-based water monitoring system that measures water level in real time was proposed in this study. The prototype is predicated on the notion that water level can be a crucial factor in flood events, particularly in areas that are vulnerable to natural disasters. [1]

III. PROPOSED METHODOLOGY

As everyone is aware, one of the most significant and well-known natural disasters is flooding. There is a lot of destruction in the surrounding areas when the water level in dams, riverbeds, etc. abruptly rises. Both our environment and living things suffer greatly as a result of it. [2] Therefore, receiving emergency notifications about the water level status in various river bed conditions is crucial in these situations. This project's goal is to measure the water level in riverbeds and determine whether they are in a normal state. It notifies users by buzzer sound and LED signals if they go above the limit. Additionally, it notifies users via email and SMS when the water level rises above the limit.

System Components and Architecture: Three main parts make up the system's architecture: sensors, a microprocessor, and the SMS alert system. Temperature, humidity, and flood data are gathered by the sensors and sent to the microcontroller. Users can examine real-time data, establish thresholds, and receive warnings when specific parameters surpass the predetermined limits thanks to the microcontroller, which is usually a bolt-iot wifi module.

1) **The sensor layer consists of:**

   a) **The LM35 temperature sensor**: It is a sensor which is a precession an integrated circuit temperature sensor that changes its output voltage in response to ambient temperature. It is a compact, inexpensive integrated circuit that measures temperatures ranging from -55°C to 150°C.

   b) **HC-SR04 Ultrasonic Sensor** :- The HC-SR04 is a type of ultrasonic sensor which uses sonar to find out the distance of the object from the sensor. It provides an outstanding range of non-contact detection with high accuracy & stable readings. It includes two modules like ultrasonic transmitter & receiver

2) **Microcontroller Layer: -**

   a) **Bolt-IoT wifi module:** Getting started with IoT is quick and simple with the Bolt WiFi module and its surrounding environment. The ESP8266, which separates off pins to basic headers, is essentially carried by the bolt board. The software and interface they have developed are where the true magic lies.

   b) **Arduino Uno**: Developed by Arduino.cc and first published in 2010, the Arduino Uno is an open-source microcontroller board built on the Microchip ATmega328p microprocessor (MCU). Sets of digital and analog input/output (I/O) pins on the microcontroller board can be interfaced to different expansion boards (shields) and other circuits.

   c) **16x2 LCD display module:** An LCD screen, also known as a liquid crystal display, is an electronic display module that is utilized in a variety of circuits and devices. With the characters spread across two rows (i.e., lines), a 16x2 LCD may display 16 characters per line.

   d) **Battery 9 V :-** A 9 V battery, typically lithium-ion or lithium-polymer, provides stable power for electronics and portable devices. Known for its lightweight and rechargeable nature, it’s often used in drones, RC cars, and robotics for reliable, long-lasting energy.

   e) **5mm LED (Green, Red, Orange) with Buzzer:** A buzzer is an audio signaling device that can be mechanical, electromchanical, or piezeoelctric (pezieo for short). A 5mm LED is made up of a chip installed on a base that is covered by a protective epoxy dome. Buzzers are frequently used in alarm devices, timers, training, and to confirm keystrokes or mouse clicks.

1) **Application Layer : -**

   a) **Arduino IDE:** To develop and upload code to Arduino boards, utilize the open-source Arduino IDE software. The IDE program works with a variety of operating systems, including Linux, Mac OS X, and Windows. The programming languages C and C++ are supported. The term "Integrated Development Environment" (IDE) is used here.

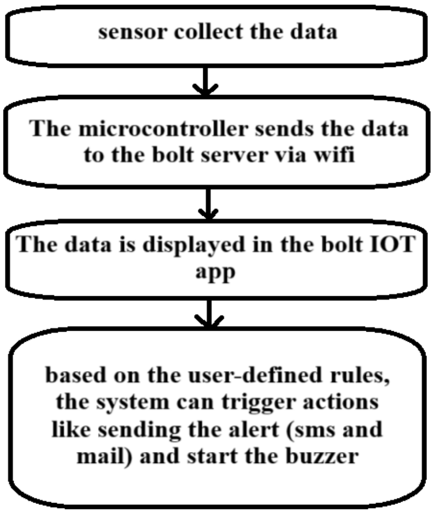
   b) **Bolt IoT Cloud:** Bolt's Cloud platform enables you to send text messages, monitor device health, create customized dashboards to visualize data, and operate and monitor your items online.

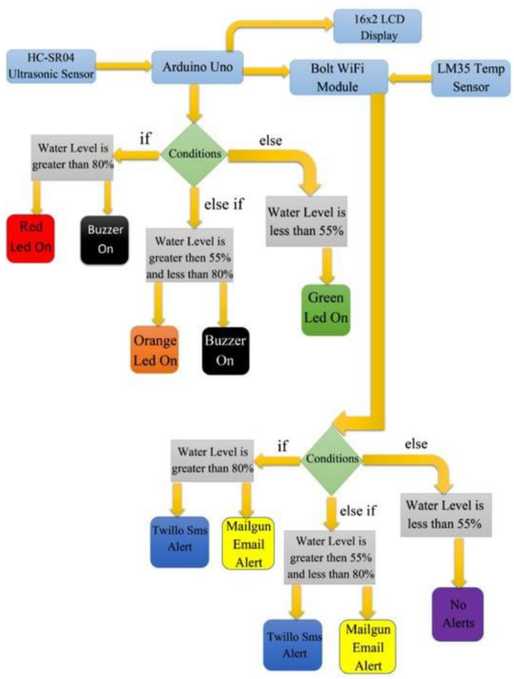
   c) **Bolt IoT Android App:** Bolt IoT is an integrated Internet of Things platform that provides a WiFi chip for Internet connectivity of your actuators and sensors. Such a system can be set up via the Bolt Cloud to collect, store, and display data in graph form.

   d) **Twillo SMS Messaging API:** Send and receive SMS, MMS, and WhatsApp messages, manage message media, and view delivery statuses with the Programmable Messaging REST API.

   e) **Components of the Mailgun Email Messaging API software:** HTTP is the foundation of the Mailgun API. Our RESTful API does the following:
   i) Makes use of resource-oriented, predictable URLs.
   ii) Makes use of HTTP's built-in features for authentication and parameter passing.

iii) Indicates failures by responding with normal HTTP response codes.
iv) Gives back JSON.





IV. EXPERIMENTAL RESULTS AND DISCUSSION

a) Results of the Experiment

Field data collecting, physical prototypes, and hydrological modeling were all used in the flood management project. Three main sections—structural performance, environmental effect evaluation, and water flow simulation—present the findings.

b) Discussion

The efficacy of flood mitigation strategies - The combination of non-structural and structural methods proved to be quite successful in lessening the intensity of floods. The model's dependability is confirmed by the peak flow reduction, which is consistent with the body of research on nature-based solutions.

Obstacles and Restrictions - Despite encouraging outcomes, certain difficulties were noted. Because to clogging, the permeable pavements demonstrated decreased efficiency during extended periods of intense rainfall. Self-cleaning materials or improved maintenance plans are examples of potential future advancements.

V. CONCLUSION

Given how common the Internet of Things (IoT) is nowadays, this system will use an LCD display to show the water level data. This project can be used by the Meteorological Department to continuously monitor the water level in the riverbeds and dams. This technology might potentially save many lives by sending out alerts when the water level climbs above a particular point. In areas that experience flooding often, this project is highly flexible, economical, and effective.

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5. Numerous literatures related to IoT-based sensors and Computer Vision for flood monitoring and mapping were outlined [1] by Arshad B.; Ogie R.; Barthelemy J.; Pradhan B.; Verstaevel N. and Perez P. This attempt reviewed different applications aided with IoT and Computer Vision for better monitoring and mapping of floods.
6. Wahidah Md. Shah, F. Arif, A. A. Shahrin and Aslinda Hassan presented a flood warning system [2] based on IoT that was able to detect water level and calculate the speed of water level increased and alert nearby residents. The experiments were conducted in a controlled environment for testing the implemented system.