Flood Prevention Strategies for Major Rivers in Afghanistan, China, India, Pakistan, Philippines, Thailand, Vietnam using Traditional Methods and Digital Technologies

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Abstract. Floods pose recurring and severe threats in South Asia and China, resulting in substantial damage to infrastructure, agriculture, and human lives. This research paper proposes a comprehensive flood prevention system for major rivers in India, Pakistan, Afghanistan, Thailand, Bangladesh, and China. The proposed system integrates floodplain calculation using the Exner Equation, levee design based on evaluated formulas, sensor data analysis employing machine learning algorithms, and an early warning system facilitated by real-time monitoring and predictive analytics. Additionally, the paper analyzes historical data on floods in the specified countries, encompassing river characteristics and economic significance, to identify patterns and inform flood prevention strategies. The article didn't concentrate more on the rivers or countries, but discussed more on the traditional and digital technologies to be used for the Asian terrain river beds.

Keywords: Flood Prevention, Asian Rivers, IOT based Warning Systems, Levee Design, Tree plantation, Rain Water Harvesting, Digital Technologies.

1 Introduction

One of the biggest climatic hazards to people's livelihoods, flooding has an impact on global development prospects and has the power to undo years of progress in development and the fight against poverty. Flood dangers are already high, but they will probably get worse due to climate change and increased urbanization in flood zones. The most recent report from the Intergovernmental Panel on Climate Change reiterates how urgent it is to address the growing effects of climate change and make sure that those who are most susceptible are resilient and able to adapt. In a one-in-100-year flood event, 1.81 billion people, or 23% of the world's population, are directly exposed to flood depths larger than 0.15 meters, posing a serious risk to lives and livelihoods. 89% of them reside in nations with low and moderate incomes. In addition, 170 million flood-exposed individuals live in extreme poverty (earning less than $1.90 per day),

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and 780 million people who have been affected by flooding live on less than $5.50 per day. To put it briefly, 4 out of 10 individuals who are at risk of flooding worldwide are impoverished [1].

Floods are devastating natural disasters that recurrently afflict numerous nations, posing a formidable challenge to South Asia and China due to the extensive presence of major rivers within their territories. These rivers, while being fundamental to the economic fabric of these nations, simultaneously act as potential conduits for cataclysmic flooding events. The resulting damage encompasses loss of life, disruption of critical infrastructure, severe agricultural setbacks, and economic downturns. The greatest annual average proportion of the total GDP is impacted by river floods, with the top 20 countries all being categorized as underdeveloped or least developed. India, with its $14.3 billion GDP, is by far the most exposed. Bangladesh, with $5.4 million, lags far behind [2].

This research paper addresses the pressing need for a robust and holistic flood prevention system tailored to the unique geography and hydrology of major rivers coursing through India, Pakistan, Afghanistan, Thailand, Bangladesh, and China. The strategic development of such a system encompasses multifaceted approaches, including floodplain calculation, levee design, sensor-based data analysis, and the establishment of an early warning system.

The foundation of this flood prevention strategy lies in the amalgamation of precise scientific methodologies, engineering expertise, data analytics, and cutting-edge technology. By synergizing these elements, we aim to significantly enhance our ability to predict, prevent, and mitigate the impact of floods in these regions.

This research endeavours to present not only the proposed flood prevention system but also delve into a comprehensive analysis of historical flood data across the specified countries. By examining patterns, river characteristics, and the socioeconomic importance of these rivers, we strive to inform future flood prevention strategies and fortify the resilience of these nations against the recurrent menace of floods. The ultimate goal is to foster sustainable development, protect lives, and secure the socioeconomic well-being of the communities dwelling along these major river basins.

Liu et al. [3] research proposed an evaluation approach for the rainy flood disaster risk index in Asia based on the fundamental principles of natural disaster risk assessment. Each indicator's data was standardized and put into a raster format. Using an analytical hierarchy technique, a hierarchy model was created to assess rainfall floods in Asia, and the weights assigned to the various theme factors were established. The risk potential of rainfall floods, the stability of the disaster-prone environment, and the environmental sensitivity of seven chosen Asian countries were mapped with the use of spatial computation and analytic capabilities in GIS. Ultimately, a thorough assessment of the risk of rainfall flooding was conducted, and the research area was separated into various zones based on varying risk stages.

In South Asian cities, floods that destroy entire neighbourhoods are happening more frequently and harming more people. Climate change and unchecked urbanization are the main factors contributing to the region's elevated flood danger [4]. By precisely predicting probable flood zones through hazard mapping, the impact of flooding can be minimized. However, it is important to choose the right model for a certain task.

Urban population and social infrastructure have suffered particularly serious damage as a result of the quick water inundation. In addition, metropolitan Southeast Asia frequently has complex land use patterns, insufficient drainage capacity, and a sizable susceptible population in constrained urban areas. The development of real-time urban flood forecasting systems for flood disaster prevention authorities and the urban population has been crucial in mitigating the risk of urban flooding and bolstering the resilience of susceptible urban areas. Rainfall forecasting, drainage system modelling, and inundation area mapping are the components of real-time forecasting systems for urban flash floods. The use of radar data for rainfall forecasting, physical-process-based hydraulic models for predicting flood inundations, and data-driven artificial intelligence (AI) models for real-time forecasting systems were all summarised in [5].

While most natural disasters are unanticipated, floods are the most common disastrous event worldwide. Due to the frequent occurrence of floods, developing nations are badly impacted. Compared to developed countries, developing countries lack an effective forecasting mechanism. The metro areas are also concentrated around riverbanks or the coast, which are the area’s most susceptible to flooding. Patel et al. [6] suggests a strategy for Surat, India's street-level flood monitoring and warning system. Strong storms and large releases from the Ukai dam cause waterlogging in Surat's low-lying areas. Flooding occurred in Surat's low-lying areas as a result of high discharges from the Ukai Dam upstream and heavy rainfall. For the purpose of monitoring street water levels and floods, this study suggested a wireless water level sensor network system. The system is designed to use CCTV cameras to take real-time pictures and wireless water level sensors to monitor the water levels in various parts of the city. This will assist authorities in planning flood mitigation strategies and the evacuation of residents in addition to issuing flood warnings.

Using the GIS technique, nine sub-watersheds of the Rampur watershed in the Mahanadi basin were subjected to quantitative morphometric analysis. GIS and RS approaches were used for drainage system study and delineation. Following the morphometric study, the drainage networks for each of the nine sub-watersheds revealed a dendritic to sub-dendritic drainage pattern; the variation in the stream length ratio was caused by changes in slope and terrain.

The morphometry is analysed in [7] using multiple drainage metrics, classifying the watershed as a six-order basin. Natural disasters are happening more often because of global warming, pollution, ozone depletion, deforestation, etc. Floods are among the many calamities that may be anticipated and warned about in advance. Despite the fact that there are many different kinds of natural disasters, flooding is one of the most dangerous and will have a significant impact on both persons and communities. When flooding occurs, those who live downstream and along riverbanks are more negatively impacted than others. In order to give them enough time to flee right away, they must be informed far in advance. Brindha et al. [8] proposed to create an early warning system that can identify floods and notify authorities, allowing them to evacuate people earlier and prevent damage and human casualties.

A set of sensors used in flash flood prediction is presented in a different publication [9]. This system provides vital real-time information needed to deliver early warnings that can give people the extra minutes to flee before impending events. Flooding is one of the deadliest natural catastrophes that people have to deal with because it has long-term effects that frequently have very negative social repercussions. However, because there is sometimes little to no notice of the approaching calamity, flash floods have the potential to be more destructive to human life.

The Malaysian government planned to create a public information website about floods and invest billions of amounts in the project [10]. The user needed an internet connection in order to access the website. In order to address this, the researcher created a Flood Detection and Prevention System that allows users to get flood alerts by SMS without requiring an internet connection. The FDAP hardware is comprised of a single microprocessor for input and output processing, three sensors for temperature, rain, and water level detection, and a GSM module for SMS delivery to the user's phone. Rapid prototyping, which focuses on making numerous prototypes before a finished product is developed, will be used in the system's development.

Irrigated agriculture provides a living for over 138 million people in the Indus River Basin of Pakistan [11]. the cultivated lands cover around 14 million hectares in the floodplains of the Indus River and its five major tributaries. However, issues including increased population pressure, climate change, and ongoing ecosystem service degradation have raised the risk of flooding, which is made worse by insufficient flood control and planning.

In March 2023, UNICEF [12] reported that 33 million people of Pakistan were impacted by floods, resulting in 1,739 fatalities and more than 2.2 million damaged or destroyed homes. Eight million people were displaced, and in 2023, aid will still be needed for the 1.8 million individuals who remain in flooded areas or are exposed to flooding. In order to meet the needs of the most vulnerable communities, UNICEF Pakistan collaborates with the government, other UN agencies, and non-governmental organizations. The organization is physically present in each of the four provinces impacted by the flooding.

2 Methodology

A. Floodplain Calculation

To estimate floodplain areas for major rivers, we employ the Exner Equation, a mathematical model that incorporates sediment transport and deposition processes. Understanding the potential flood extent is crucial for effective flood prevention and management.

B. Levee Design

The Eurocode formula to determine the optimal Levee design to set the sensors on the Levee for the Asian based rivers beds. Levees are essential structures to hold the sensors and share flood information and safeguarding population near the rivers.

C. Sensor Data Analysis

A strategically deployed network of sensors monitors critical parameters such as soil moisture, river water levels, rainfall intensity, pressure changes, and weather conditions. Collected data is analysed using machine learning algorithms to detect anomalies and predict potential floods. This real-time analysis enhances preparedness and response capabilities.

D. Early Warning System

Based on the sensor data and machine learning models, we design an early warning system to generate timely alerts in the event of potential flood events. Predictive analytics help in assessing flood risks and setting appropriate thresholds, allowing for effective communication and evacuation planning.

3 River Characteristics & Possible Policies

Table 1. Major Rivers and flood related data

River	***Country***	***Km***	***Year***	***Human Loss***	***Animal Loss [cost USD]***
Ganges	IN, BD	2525	1987	1500	1 million
Indus	IN, PK, CH	3180	2010	1700	2 million
Brahmaputra	IN, CH, BD, BH	2948	2013	100	100000
Mekong	CH, LA, MM, TH, CM, VT	4350	2000	200	1 million
Salween	CH, MM, TH	2857	2009	100	500000
Irrawaddy	MM	2170	2015	100	500000
Yangtze	CH	6300	1998	3000	1 million
Yellow	CH	5464	1887	2 million	10 million
Amu Darya	AF, TK, UZ, TS	2400	1972	2000	20000
Hari Rud	AF, IR	1150	2018	30	50000
Cagayan	PH	505	2020	240	2 million

Table 1 showcases the Rivers in Afghanistan, Tajikistan, Uzbekistan, Turkmenistan, Iran, Bangladesh, Bhutan, China, India, Myanmar, Laos, Pakistan, Thailand, Vietnam and Philippines related losses at the time of floods. The length of the rivers and major floods are shared in here.

The article is trying show the evidence the above Asian rivers are shared between the countries and the concern countries shall decide the implementation of caring the river beds and functions discussed below sections. Population of every country is significant meaning to run the government systems. Asians Era is upon us and Leaders and people have to accept the reality of saving the rivers, population and culture near the rivers are highly influencing the economy and lifestyle of the people. River beds are the first floodplain areas and people are vulnerable in the recent years because of flash floods occurring every year in Asia.

Education, Policies, practices, Applications, Business related to the rivers shall be given priority for next Era and shall be verified and monitored by the government authorities. Authors hope that Asian countries shall share their budgets from the defense and share to the reduce the floods in their region, which directly benefits in their future.

4 Flood Plan Calculation

Floodplain calculation is a critical component of our proposed flood prevention system, aiming to accurately estimate and visualize the potential extent of floods within major river basins. This process employs the Exner Equation, a mathematical model founded on sediment transport and deposition dynamics. Understanding the potential floodplain area is vital for effective flood prevention and management strategies.

Keep The Exner Equation considers various factors, including sediment loads and river discharge, to simulate flood events and calculate the resulting floodplain area. It takes into account the return period of a flood event, which indicates the average time between floods of a particular magnitude (e.g., a 100-year flood event). The calculation involves precise estimations of sediment transport, discharge, and other hydrological parameters.

To compute the floodplain for specific rivers such as the Indus, we undertake the following steps using the Exner Equation:

Define the Flood Event: Determine the return period of the flood event, establishing the average time between floods of that magnitude (e.g., 100-year flood event).

Gather Data: Acquire historical data on river discharge and sediment load from reliable sources, including monitoring stations and historical records.

Mathematical Simulation: Utilize the Exner Equation and other relevant mathematical models to simulate the flood event. Models like HEC-RAS, Delft3D, or others may be employed based on the specifics of the river and the region.

Calculate Floodplain: Utilize the model output to determine the elevation of the water surface during the flood event, thus enabling the calculation of the floodplain area.

The floodplain of the Indus River is calculated using the Exner equation, which incorporates sediment transport and deposition processes. Here is an example of how to calculate the flood plain of the Indus River using the Exner equation:

Depth = discharge * sediment_load / (return_period * 86400)

Area = depth * width

Discharge: The discharge of the river during the flood event.

Sediment load: The sediment load of the river during the flood event.

Return period: The return period of the flood event.

In essence, floodplain calculation employing the Exner Equation facilitates a data-driven approach to predict and visualize the potential reach of floods, assisting in the formulation of effective flood prevention and management strategies. This quantitative estimation is invaluable for preparedness, infrastructure planning, and risk assessment in flood-prone areas.

5 IoT in the Levee Design

Levee design constitutes a pivotal aspect of our proposed flood prevention system, focusing on creating effective barriers to mitigate the impacts of potential flood events. Levees are critical infrastructure components that help safeguard communities, agricultural land, and critical facilities from floodwaters. In this research, we evaluate three prominent levee design formulas—the Mississippi River Commission formula, the US Army Corps of Engineers formula, and the Eurocode formula—to tailor the optimal design for levees, particularly focusing on the river.

Levee Height Calculation Formula:

The formula to calculate the height of the levee (Levee_height) involves two primary components: the design flood height (Design_flood_height) and the freeboard (Freeboard). It can be represented as follows:

Levee_height = Design_flood_height + Freeboard

Design Flood Height: This signifies the height of the flood event that the levee is designed to protect against. It is determined based on thorough hydrological analysis, considering the severity and likelihood of floods in the area.

Freeboard: The freeboard is an additional height added to the levee to account for uncertainties in the design flood height, wave actions, wind effects, and to provide a safety margin. It acts as a buffer to accommodate variations and unexpected factors during a flood event.

Factors Affecting Levee Size and Design:

Several factors influence the design and size of levees, including:

Levee Material: The type and strength of the levee material significantly influence the levee's design. Different materials have different erosion resistances and structural properties.

Soil Type: The type of soil the levee is built on affects its stability and erodibility, necessitating adjustments in levee design accordingly.

River Characteristics: The width of the river channel, its slope, and the velocity of the river are crucial factors in determining the levee's design to withstand potential flood pressures.

Climate and Weather Conditions: The climate of the area, including wind patterns, rainfall intensity, and potential storms, play a role in determining the required levee height and width.

Vegetation: The presence and type of vegetation on the levee can stabilize the structure and reduce erosion, influencing levee design parameters.

Levee Design for IOT and digital Connectivity:

There are many Levee designs available, but the author suggests European standard formula integrates various factors, including the height of the levee, width of the river channel, strength of the levee material, and climate considerations, to determine the optimal levee size and characters. Fig.3 shows the River Levee Channel, Flood plain Levee design aligned with the sensors and communications network possibilities.

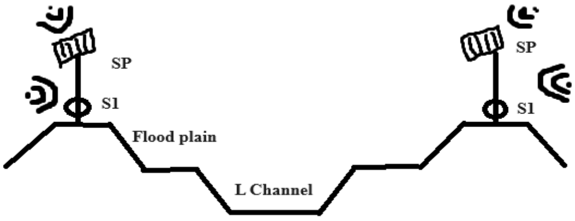

Fig.1 Flood plain Levee design

The Sensors on the levee shall be connected to the near Communication Bases. The sensors shall be connected and communicated in different channels and methods. Arduino shall be used to send information through GSM (Global System for Mobile Communication) based contact-interface chips shall pass the GPS information. Every government is using multiple service providers. The service providers providing services to the people can also share the services to these Levee IOT based communication nodes. These IOT connected to levee can be sharing the electricity through Solar panels and formulas and platforms were integrated and serve as fundamental tools along the flood risk zones through the major rivers. Every government shall calculate the levee size and ensure their effectiveness in preventing flood damage and providing safety to communities residing in flood-prone areas. The appropriate formula is selected based on the previous flood time, effects, break on the levee and direction of the water flow as well. Every river will have specific characteristics and flow based on the contour available in that region.

6 Sensor Data Analysis for Enhanced Flood Prevention

The implementation of the flood prevention system involves utilizing various sensors strategically placed along the rivers to monitor crucial parameters such as soil moisture, river water levels, rainfall intensity, pressure changes, and weather conditions. These sensors aid in real-time monitoring and data collection, which is crucial for effective flood prevention. Key sensors and their functions are as follows:

Soil Moisture Sensors: Measure the moisture content of the soil in the floodplain and levee. This data is essential for predicting potential flooding and understanding water movement.

River Gauges: Monitor water levels in the river, providing critical information to track the progress of a flood and assess levee integrity.

Rainfall Sensors: Measure rainfall in the surrounding area, aiding in predicting potential flooding and assessing the risk of levee breaches.

Pressure Sensors: Measure water pressure on the levee, helping to evaluate levee stability and assess the risk of breaches.

River Level Sensors: Monitor the water level within the levee, assisting in assessing levee stability and potential breaches.

Weather Stations: Measure various weather conditions in the area surrounding the river, providing data to predict potential flooding and assess the risk of levee breaches

7 Machine Learning Models for Flood Prevention

To enhance flood prevention, machine learning models can be applied to the collected sensor data. These models aid in early flood detection, levee health monitoring, and floodplain analysis.

Early Flood Detection: Machine learning algorithms such as Long Short-Term Memory (LSTM) networks or Gradient Boosting Regression models can be used to predict future flood levels or detect anomalies indicating potential flood events.

Levee Health Monitoring: Anomaly detection algorithms like Isolation Forest, One-Class Support Vector Machines (SVM), or Autoencoders can be used to monitor the health of levees and detect potential breaches.

Floodplain Analysis: Hydrodynamic models like HEC-RAS or MIKE Flood can be employed to analyze floodplain characteristics and predict flood extent based on inputs such as rainfall, river levels, and topographic data.

8 Real-Time Data Processing

To facilitate real-time data processing and analysis, a cloud-based approach is essential. Here's a high-level outline of the real-time data processing workflow using cloud services:

Sensor Data Streaming Configuration: Configure cloud-based data streaming using services such as Google Cloud Pub/Sub on GCP to handle the real-time sensor data.

Real-Time Data Preprocessing: Employ services like Google Cloud Dataflow on GCP for real-time data preprocessing to clean, transform, and structure the incoming sensor data.

Machine Learning Model Prediction: Utilize machine learning models hosted on cloud platforms like Google Cloud AI Platform on GCP or AWS SageMaker on AWS to make predictions on the preprocessed data.

Monitoring and Alerting: Implement a monitoring system that tracks model outputs and triggers alerts based on predefined thresholds, facilitating timely responses to potential flood events.

9 Flood Prevention Approaches (Solutions)

Conventional Approaches

Any ecosystem's lifeline is its rivers. For drinking, irrigation, and several other human needs, they supply freshwater. However, a number of issues, including pollution, deforestation, and climate change, are posing a threat to the world's rivers. Planting trees is one method of preserving river habitats. Planting trees is essential to preserving the ecosystem balance of river systems. Because they increase groundwater recharge, decrease soil erosion, and reduce sedimentation, trees can control the flow of water in rivers.

Furthermore, before water enters rivers, pollution and other contaminants are naturally removed from it by trees. This contributes to maintaining the purity and health of the river water.

The Amazon rainforest is among the most remarkable illustrations of the significance of tree plantations in maintaining river ecosystems. The Amazon River, which traverses South America for more than 6,400 km, is the world's largest river. The Amazon River's water flow is largely controlled by the Amazon rainforest. throughout the rainy season, the rainforest stores and absorbs water, releasing it gradually throughout the dry season. This process is similar to that of a sponge. This aids in preventing the region's frequent floods and droughts. However, deforestation—which is mostly caused by mining, logging, and agriculture—threatens to destroy the Amazon rainforest. In addition to destroying the wildlife's natural habitat, deforestation has an impact on the ecosystems of the rivers. The Amazon River is vulnerable to flooding and droughts in the absence of trees to control water flow, which might have disastrous effects on the animals and people who depend on it.

River ecosystem preservation in India also depends on tree plantations. India is home to numerous significant rivers, including the Godavari, Yamuna, Brahmaputra, and Ganges. The nation's businesses, human settlements, and agriculture all depend heavily on these rivers. However, as a result of urbanization and human activity, many of these rivers are extremely polluted. The Indian government has started a number of programs to encourage planting trees alongside rivers. One such programme to maintain and improve the nation's river health is the National River Conservation Plan (NRCP). In accordance with the NRCP, trees are being planted alongside riverbanks to stop soil erosion, lessen pollution, and preserve the natural equilibrium of river ecosystems [13].

Rainwater Harvesting System and Benefits

Around the third century BC, the farming communities in Balochistan (now located in Pakistan, Afghanistan and Iran), and Kutch, India used rainwater harvesting for irrigation. In ancient Tamil Nadu, rainwater harvesting was done in Chola kingdom [14]. The simplest rainwater harvesting systems consist of a roof or other similar surface for collecting rainwater, a gutter or downspout for directing the water, and a barrel for storing the collected water. Water gathered from a system this rudimentary would only be suited for basic uses like watering a garden, fighting fires, or as grey water—like toilet bowl water—because it lacks filtering and adequate storage.

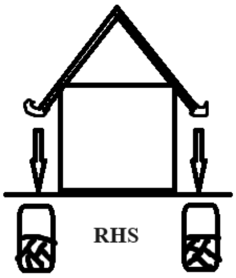

Fig 2: Rain Harvesting System

Fig 2. Rain harvesting System for every housing plan to reduce the flow of water and increase the ground water level.

The collection system and many tiers of filtration to keep particles and filth out of the water supply would be part of a more intricate system that would offer more possible applications for the water. A suitable storage tank should be constructed of materials that won't leach into the water and will prevent the growth of bacteria, and it should have a mechanism to securely handle overflow water. Then, that container ought to be connected to a water level monitor or, if necessary, a control system that may further filter the water to drinking-level purity. Lastly, the system would need to be powered by a flow metre, a backflow prevention system, and a pump for the purpose of directing water.

Reforestation & Restoring Wetlands

Planting new trees and afforestation

Afforestation and reforestation are two useful natural approaches to reducing the risk of flooding. Restoring forest cover and planting trees can help control water flow, lessen runoff, and enhance soil structure. Additional advantages of reforestation include improved livelihoods, biodiversity preservation, and carbon sequestration.

Restoring wetlands

Restoring wetlands can lessen the likelihood of flooding. Because they filter pollutants, absorb and store water, and lower peak flows, wetlands serve as natural flood barriers. Among the many advantages of restoring degraded wetlands are increased biodiversity, better water quality, and increased recreational opportunities [15].

Digital Technologies

Information technology in space

Flood catastrophe management using spatial information technologies is becoming more and more regarded as the most successful strategy. These include low-cost global positioning systems (GPS), a space-based satellite navigation system that delivers location and time information in all weather conditions, and remote sensing image analysis software. Geographic information systems (GIS) are systems that collect, store, and analyze data.

Early warning systems centered in the community

Community-based early warning systems are a "people-centered" approach that enables communities and individuals at risk to take prompt, appropriate action to lessen the likelihood of harm to themselves or others, loss of life, destruction of property or the environment, and loss of livelihoods. They offer advanced information about disasters like floods, landslides, and debris flows to the public and disaster risk management professionals. This information can be easily converted into disaster prevention and preparation response activities against loss of life and injury. Local government entities, such as counties and towns, will be able to better defend themselves against flooding thanks to this early warning system. It is also simple to maintain since it encourages a sense of community ownership. The warning's message content is often easy for end users to understand and sent promptly to encourage the right course of action [16].

SMS communications notify the public

In Madagascar, communities presently depend on low-tech methods to alert people to impending calamities due to restricted access to real-time meteorological forecasts. The primary system in place for warning rural populations ahead of cyclones is currently the "town crier" system, which is managed by the National Bureau for Risk and Disaster Management (BNGRC). A village leader carries a bell and announces directions and cautions while strolling throughout the community as part of the system [17].

Using AI and big data to warn of flooding in small and medium-sized rivers

China's efforts to avoid and control flooding this year have been greatly aided by these technology. For example, the Anhui Province in East China's Anqing has implemented real-time water-level monitoring using VR and 5G technologies. Monitoring staff can receive the water condition footage from panoramic cameras via low-latency 5G signals. Furthermore, workers equipped with virtual reality glasses can monitor water levels to gain a comprehensive understanding of the river's conditions and the advancement of disaster relief efforts. Consequently, there has been a notable enhancement in work efficiency [18].

10 Conclusion

Flood prevention and mitigation strategies are fundamental to the resilience and sustainable development of nations affected by the recurring threat of floods from major rivers. The proposed flood preventing Guyon system, incorporating floodplain calculation, levee design, sensor data analysis, and an early warning system, represents a comprehensive approach. It integrates scientific modelling, engineering solutions, and advanced technologies to effectively mitigate flood risks. By leveraging machine learning models and real-time data processing, the system provides timely alerts and actionable insights, contributing to enhanced flood resilience and safeguarding lives and infrastructure. The engagement of students from eminent academic institutions further enriches this endeavour, fostering knowledge transfer and innovation in flood prevention. Continuous research and refinement of this proposed system are crucial to optimize its effectiveness and adaptability to evolving environmental conditions and flood risk scenarios. Authors believe developing countries shall convert their river beds into safer area for livelihoods and generate economical zones using the existing natural methods and discussed digital technologies.

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