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A Concentrated Analysis of the Situation of Flood Control Management: A Review

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Abstract: Floods are happening more often and with greater severity due to socioeconomic development and climate change. Flood control is widely acknowledged as an effective means of reducing the negative effects, and recent research has aimed to develop a more robust and sustainable approach to flood management. A thorough bibliometric examination of terms, keywords, and dates in the flood research field was employed in this work.

It provides new insight into the flood research trends, by examining the research frontiers from 2000 to 2021. We conclude that there has been a shift in the focus of flood research from flood management to flood resilience. Flood resilience management offers a more resilient and sustainable plan to deal with flood disasters, while flood risk management offers an adaptation approach by adjusting mitigation measures. The review demonstrates how flood research has progressed from traditional flood management, which provides mitigation strategies, to flood resilience management. Along with reviewing the definition of risk, risk analysis techniques, flood resilience, flood management, and flood risk management, we also provide a thorough introduction of the field of flood research. We come to the conclusion that a preferable strategy for future flood control directions is to incorporate the idea of resilience into the risk management framework. Consequently, employing the theories of risk, resilience, and sustainability, sensible choices and actions made before, during, and after a disaster will successfully minimize the negative effects.

Devastating floods brought on by swift urbanization and severe weather patterns have claimed millions of lives and continue to inflict direct economic losses estimated at tens of billions of dollars annually. Furthermore, as extreme precipitation events intensify (Tabari, 2020) and the population at risk of water-related disasters rises (Jongman et al., 2012; Paudel et al., 2014; Tellman et al., 2021), these losses will only rise in the future due to global warming (Bloeschl et al., 2019; CRED and UNISDR, 2020; Hallegatte et al., 2013).

Even worse, severe compound flooding from excessive river flow, intense rainfall, and storm surges might arise from the simultaneous occurrence of flash floods, river flooding, urban flooding, and coastal flooding (Ming et al., 2022). Given that the causes of coastal, urban, and river flooding vary, determining the locations most vulnerable to these types of floods is a challenging. While flood risk is known to rise in response to population growth, climate change, and the accumulation of economic assets, it is also known that this risk is dynamic and ever-changing due to changes in underlying surface conditions (Hallegatte et al., 2013; Lai et al., 2020). Thus, it is critical to manage flooding in order to address the rising risk of flooding.

Prior studies have demonstrated the pressing need to address flood events (da Silva et al., 2020), and future flood mitigation measures must be developed in order to lessen the negative effects and handle increasingly complicated flood kinds.

Keywords: Flood control management, flood risk, flood disasters, flooding

I. INTRODUCTION

Numerous nations have put in place a number of procedures to deal with , storm water, etc. As an illustration, the United States has adopted green infrastructure (GI), low-impact development (LID), and best management practices (BMPs); the United Kingdom has adopted sustainable urban drainage systems (SUDS); Australia has adopted water-sensitive urban design (WSUD); and New Zealand has implemented low-impact urban design and development programs (LIUDD). The Delta Programme has been arguably the most expansive. The goal of this project was to provide some supplementary benefits in addition to making "room for rivers" (Rijke et al., 2012; Van, 2016).

It is a more sustainable approach than the Netherlands' conventional embankment measures, was designed to deal with more severe flood disasters, and has been successful in reducing the danger of flooding. The term "nature-based solutions" (NBS) was defined by the European Union (ECDRI, 2015). In their evaluation of the efficacy of NBS initiatives, Pagano et al. (2019) showed that NBS improves flood risk mitigation and climate change adaptation.

Nevertheless, it has been unable to fully corroborate the conclusions for any of these approaches due to the absence of long-term observation data. Therefore, we anticipate that the study's findings will give future decision-makers further adaptation strategies for dealing with the frequency of flooding.

The population at risk of water-related disasters is growing, and extreme precipitation events are becoming more intense due to global warming. Even worse, severe compound flooding from excessive river flow, intense rainfall, and storm surges can arise from the simultaneous occurrence of flash floods, river flooding, urban flooding, and coastal flooding. Given that the causes of coastal, urban, and river flooding vary, determining the locations most vulnerable to these types of floods is a challenging task. While it is well recognized that flood risk is dynamic, ever-changing due to underlying surface condition changes, it also grows with population growth, economic asset accumulation, and climate change. Thus, it is critical to manage flooding in order to address the rising risk of flooding.

II. PREVENTION AND RESILIENCE TO FLOODING

A. Flood Control

In order to lessen the risk of flooding, flood control refers to altering the natural condition of floods by technical techniques. When people learned that floods were unavoidable but manageable, they began to apply flood control. But as a result of climate change, there is a greater chance of flooding, which means that flood control project criteria need to adapt as well. Nevertheless, flood tragedies persisted even after a number of flood control measures were put into place, and people started to recognize the limitations of these initiatives. For instance, flood control projects must be updated and maintained constantly due to their aging, necessitating investments in both financial and human resources (Rezende et al., 2019). Even worse, the ongoing costs of maintaining flood prevention measures may be higher than the original. Furthermore, it is impossible to increase the bar for flood control projects without taking cost effectiveness into account (Abdi-Dehkordi et al., 2021). The phrase "flood management" was coined as a result of these realizations and refers to the process of coping with floods, reducing its damages, and sometimes even benefiting from it.

B. Flood Management

According to Sayers et al. (2013), traditional flood management techniques include both structural and non-structural ways to lessen the negative effects of a flood event. Table 3 details certain mitigation techniques.

Conventional flood control strategies often aim to mitigate, minimize, or completely remove effects and activities prior to an occurrence (Peacock and Husein, 2012). It costs more to install structural interventions than non-structural ones. The maintenance of structural measures is extremely expensive in the long run and can result in significant losses if improper or insufficient maintenance is done. In addition, the ecological effects of structural measures may be greater. Non-structural measures are more comprehensive, less costly, and have less adverse consequences than structural ones (Peacock and Husein., 2011). They are also more sustainable. Evidence from earlier research has shown that non-structural remedies are more affordable and easier to adopt than structural solutions. Humanity has thousands of years of water control experience under its belt, which it has used to try and lessen the impact of flood disasters on human life and property. Through non-engineering techniques to keep people away from floodwaters and engineering measures to keep floodwaters away from humans, societies have consistently improved flood control standards. The economic losses brought on by flood disasters have not, however, decreased despite all efforts, and as a result, determining the best mix of engineering and non-technical solutions has emerged as a prominent area of research to lessen the damage caused by flood disasters. However, from the standpoint of catastrophe reduction, the likelihood of natural disasters occurring is hardly impacted by human intervention. However, by lowering the vulnerability of disaster victims, reducing the amount of property exposed in flooded areas, and bolstering disaster prevention and mitigation capacities, humans can lessen the losses caused by natural catastrophes. As a result, risk-based flood control strategies have replaced flood management systems focused on both structural and non-structural measures.

Water control has been a part of human existence for thousands of years, with the goal of lessening the impact of flood disasters on property and lives. Through the use of both non-engineering and engineering measures to keep people and floodwaters apart, societies have steadily improved their flood control standards. The economic losses brought on by flood disasters haven't decreased, despite all efforts, therefore figuring out the best mix of engineering and non-technical solutions has become a hot topic in minimizing the damage caused by flood disasters. However, from the standpoint of catastrophe reduction, the likelihood of natural disasters occurring is hardly impacted by human intervention. However, by lowering the vulnerability of disaster victims, reducing the amount of property exposed in flooded areas, and bolstering disaster prevention and mitigation capacities, humans can lessen the losses caused by natural catastrophes. As a result, risk-based flood control strategies have replaced flood management systems focused on both structural and non-structural measures.

C. Risk Management for Flooding

Flood risk management encompasses risk analysis, risk assessment and risk reduction. Risk reduction is the process of offering flood risk management options. Risk analysis is the identification of risks; risk assessment is the categorization of risks. Effectively reducing disaster losses can be achieved through flood risk assessment and management prior to a disaster (Dhiman et al., 2019; Lai et al., 2020; Pham et al., 2021). Effective risk management requires a thorough grasp of flood risk and its contributing factors (Muis et al., 2015).

Therefore, before a disaster strikes, it is crucial to carry out a flood risk assessment and implement suitable flood management measures, involving both regular people and flood managers.

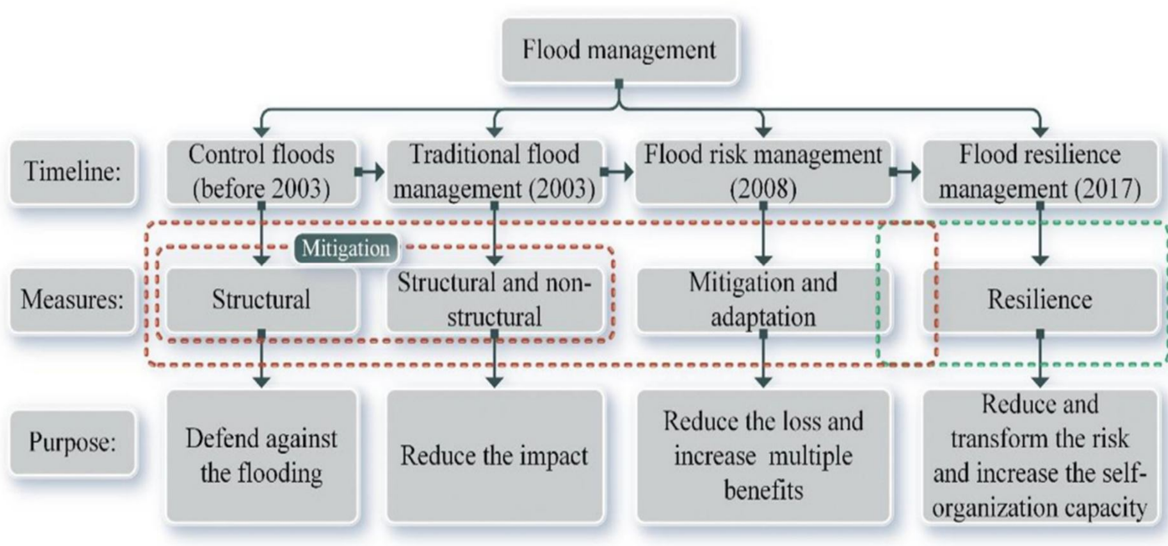
D. Flood Danger

There are differences in definitions of risk throughout disciplines, hence the idea is not widely understood. However, in general, risk is defined as

1) The probability of future occurrences and their potential repercussions;
2) The uncertainty of the occurrence of losses; and
3) The combination of these three factors As demonstrated in Table 4, risk is commonly expressed in the IPCC AR5 report as the probability of hazardous events or trends occurring multiplied by the impacts if these events or trends occur (IPCC, 2014). The IPCC AR3 report, for instance, characterizes risk as a function of probability and consequence (IPCC, 2001). To optimize the uniformity of IPCC group utilization,

Risk as outlined in the reports of the IPCC.

a) Risk Definitions The relationship between risk and probability and consequence Consequences ¼ Probability ¼
b) Risk (IPCC, 2001)
c) Risk is commonly expressed as the likelihood that dangerous trends or occurrences will occur multiplied by the consequences if these trends or events do occur. Consequences of Risk (Probability of Events or Trends) ¼ (IPCC, 2014)
d) The possibility of negative effects on ecological or human systems, taking into account the variety of goals and values connected to these systems (IPCC, 2019).



III. FLOOD CONTROL STRATEGIES

A. Structural

Retaining water away from populated areas to lessen the risk of flooding.

The measures consist of dikes, embankments, tidal gates, diversion channels, seawalls, levees, weirs, dykes, reservoirs, pump stations, and so on.

B. Non Structural

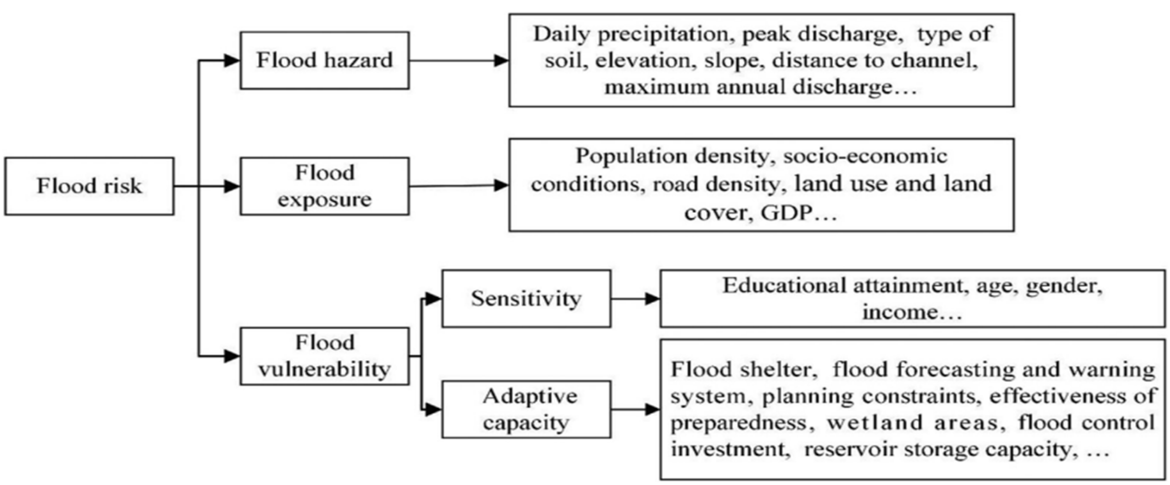
Keeping people away from bodies of water will lessen their vulnerability to flooding. Policies and legislation, public awareness campaigns, flood forecasts and warnings, evacuations, education and training programs, adjustments to land use, insurance and regulation, funding and subsidies, and strategies for managing land and flooding are some of the measures.

The assessment of flood risk based on hazard, exposure, and vulnerability addresses the interaction between floods and people. These three elements can be used to identify more potent countermeasures for catastrophe risk reduction. Koks et al. (2015) consider estimations of economic damage and loss of life to be part of the flood risk assessment process. Conventional techniques include the Source-Pathway Receptor conceptual model, a flood risk assessment that integrates remote sensing and a geographic information system (GIS), a complete flood risk assessment, and a probability evaluation method based on historical data

The risk assessment technique is becoming more and more focused on scenario-based methodologies in the age of big data and the synthesis of flood risk assessment approaches (Zhang et al., 2020). The assessment of flood risk is covered in detail in the section that follows. A comprehensive overview of flood risk assessment methods encompasses the three key indicators of vulnerability, exposure, and hazard. Both flood damage simulation and a hydrodynamic model are necessary for a scenario-based flood risk assessment. "Addition" and "multiplication" are the most commonly used terms in risk assessment models. The "plus"-based statement represents a linear risk evaluation model; Eq. (1) defines the formula for estimating the flood risk. The "multiplication"-based expression is an index model; Eq. (2) defines the formula for estimating the danger of flooding.

Risk ¼ w1 Hazard þ w2 Exposure þ w3 Sensitivity þ w4 Adaptive Capacity (1)

Risk ¼ Hazard w Exposure w Vulnerability w (2)



IV. CONCLUSIONS

Flood management is replacing risk-based flood management. Therefore, we investigated the connections among flood risk management plans, flood defense plans, flood management techniques, and flood resilience plans. This study demonstrates that current flood environments have not been met by flood management strategies.

Although it cannot be completely eliminated, flood risk can be reduced or redirected with the use of both engineering and non-technical strategies. In place of the strategy of putting flood control measures into place and keeping them up to date, flood risk management incorporates the idea of a continual adaptation process. Flood resilience is the incorporation of sustainability and the idea of an ongoing adaption process into flood risk management. In the future, flood control techniques will be reintegrated with resilience, sustainability, and adaptability.

By analyzing current research frontiers, this study offers fresh insight into flood research trends and presents a clear timeframe for flood research. It will assist interested parties in comprehending the benefits of the various approaches to flood resilience, flood risk reduction, and traditional flood control. Reducing human-caused disasters, adapting to changing climates, and creating more resilient cities, towns, and watersheds are the next steps for stakeholders. In order to effectively minimize flood risk, this study recommends flood adaptation and mitigation techniques as well as the integration of the twin strategies of flood resilience and flood risk management.

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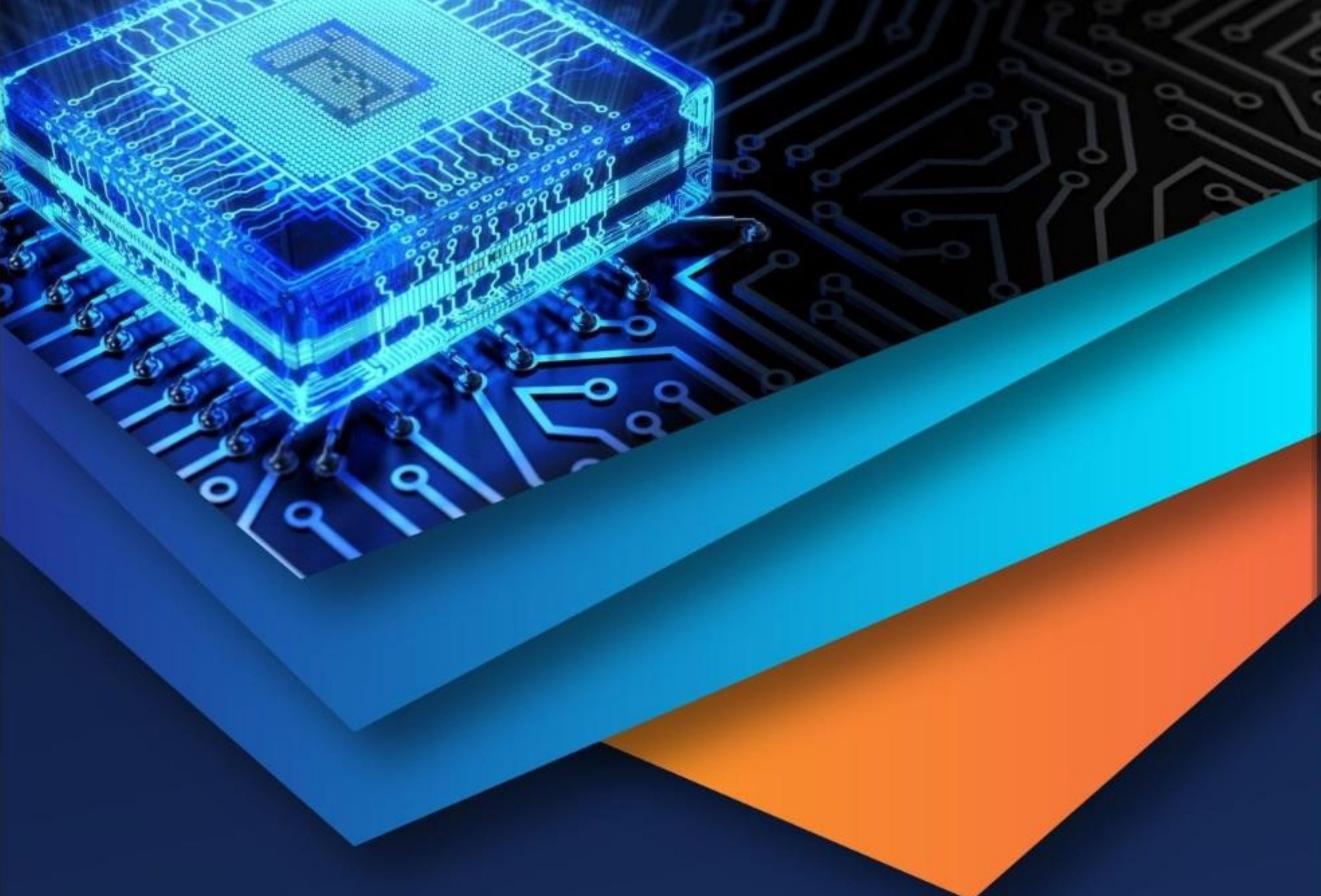

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