

# Sustainable flood management strategies for resilient cities

Samuel Ariyo Okaiyeto<sup>1</sup>, Jun Wang<sup>2</sup>, Hongwei Xiao<sup>1\*</sup>

(1. College of Engineering, China Agricultural University, Beijing 100083, China;

2. College of Economics and Management, China Agricultural University, Beijing 100083, China)

The world is suffering more and more serious climate change events this summer<sup>[1]</sup>: temperature records broken constantly, ocean waters as warm as hot tubs, floods are raging around the world. It has been confirmed that the July 2023 was the hottest month in recorded history and the average global temperature was 1.54°C above the preindustrial average for July<sup>[2]</sup>. The world seems to be entering the tipping points of climate change beyond which climate change will occur more dramatic and quickly, become self-perpetuating and difficult or impossible to undo<sup>[3]</sup>.

The increasing occurrence of flood disasters poses a significant threat to the lives and properties of vulnerable populations, especially in the context of global climate warming. Recently, the record-breaking rainfall induced by tropical cyclones has caused devastation and casualties in the Chinese capital Beijing. Between 29th of July and 2nd of August, 2023 Beijing recorded its heaviest rainfall broken a 140-year record with the maximum amount of precipitation was recorded at a city reservoir in Changping district, which received approximately 744.8 mm of rain in 59 h. So far, the floods in Beijing have killed 33 people and left 18 missing, affected nearly 1.29 million people, destroyed 59 500 houses, severely damaged 147 000 houses and affected 14 063 hm<sup>2</sup> of crops<sup>[4]</sup>. Furthermore, as located in bordering Beijing's southern outskirts Zhuozhou city in Hebei Province was the worst-hit city in the flood disaster and 1.54 million people in Hebei Province had been relocated, among whom 961.2 thousand people were leaving for Flood Detention Basin<sup>[5]</sup>. In face of the tipping points of global climate change challenge, sustainable flood management strategies for resilient cities are urgently needed.

A society may not become sufficiently adaptive to reduce the risk from unprecedented subsequent events, which are becoming more frequent as a result of climate change, by just managing risk and reducing vulnerability in the wake of one severe event<sup>[6]</sup>. If people will continue to live in floodplains, risk management efforts alone, such as improving flood early-warning systems, will not significantly reduce flood fatalities and damage. Furthermore, 14 of the 20 flood events that occurred mainly in South America and Asia between 1951-2010 were said to have been enhanced by human-induced climate change<sup>[7]</sup>. It is therefore high time for cities to take proactive measures to manage floods effectively and reduce harm associated with floods. Here we will explore various strategies that cities can adopt to enhance flood management and build resilience against future disasters.

First, one of the most effective flood management strategies is to incorporate flood risk considerations into urban planning and development. This is necessitated by the recent catastrophic floods around the world, which have brought into sharp relief the urgent need to increase societies' resilience to flooding both now and in the future<sup>[8]</sup>. Effective flood risk adaptation strategies must be based on a thorough understanding of the physical risks that the hazard poses and the rising frequency of these occurrences. Cities should identify flood-prone areas and avoid constructing critical infrastructure and housing in such zones. Furthermore, adopting a comprehensive, multi-sectoral approach can help create resilient urban landscapes that incorporate green spaces, wetlands, and permeable surfaces. These elements can serve as natural buffers to absorb excess water during heavy rainfall, reducing the intensity of flooding.

Investing in flood-resilient infrastructure is crucial to minimize flood-induced damages. Modern infrastructure should consider elevating buildings and roads above flood levels, implementing storm water drainage systems, and constructing flood barriers. Sustainable and nature-based solutions, such as constructing green roofs and rain gardens, can mitigate the impact of floods by slowing down runoff and enhancing water absorption. Establishing robust early warning systems can also help to inform residents about impending floods and provide them with sufficient time to evacuate safely. The integration of technology, such as flood sensors, satellite imagery, and data analytics, can significantly improve the accuracy and timeliness of flood warnings. Additionally, community-based programs and education campaigns are essential to ensure that residents are aware of evacuation procedures and emergency contacts.

Second, cities should prioritize the restoration of natural floodplains, as these areas act as natural reservoirs that can absorb and store excess water during heavy rainfall. Through strategic land-use planning, floodplains can be designated for recreational purposes, agriculture, or as protected natural areas. By restoring wetlands and floodplains, cities can enhance biodiversity, improve water quality, and reduce the risk of flooding downstream. Traditional storm water management systems are often designed to transport water away from urban areas quickly, exacerbating flooding downstream. Sustainable storm water management techniques, such as rainwater harvesting and infiltration basins, can slow down and manage storm water runoff effectively. The resource utilization of flood can reduce the damage of flood and solve the problem of water shortage. By promoting the infiltration of rainwater into the ground, cities can replenish groundwater reserves and reduce the risk of surface flooding as well as water shortage.

Third, cities should promote the retrofitting of existing buildings and infrastructure to make them more flood-resilient. Measures such as elevating electrical systems, installing flood-resistant doors and windows, and relocating critical infrastructure away from flood-prone areas can significantly reduce damages and ensure that

Received date: 2023-08-15 Accepted date: 2023-08-25

**Biographies:** Samuel Ariyo Okaiyeto, PhD candidate, research interest: food drying technology and equipment, Email: samuelariyo496@gmail.com; Jun Wang, Lecturer, research interest: futures and agricultural market, Email: cauwangjun@cau.edu.cn.

\*Correspondence author: Hongwei Xiao, Professor, research interest: agricultural products processing technology and equipment, College of Engineering, China Agricultural University, No. 17, Qinghua East Road, Beijing 100083, China, Tel: +86-10-62736900, Email: xhwcaugxy@163.com.

essential services remain operational during and after a flood event. Effective flood management requires collaborative governance involving various stakeholders, including government agencies, NGOs, businesses, and community representatives. Engaging with local communities is crucial, as residents possess valuable knowledge about local flood risks and can contribute to designing effective flood management solutions. Participatory approaches and community-driven projects foster ownership and resilience within neighborhoods. Additionally, many floods extend beyond city boundaries, necessitating cooperation between neighboring cities and even countries. Shared river basins and interconnected waterways demand collaborative strategies to manage floods effectively. Encouraging international cooperation and information exchange can lead to comprehensive solutions that protect populations and resources across borders.

The increasing frequency and severity of flood disasters under the condition of global climate warming call for immediate and comprehensive action. Cities must adopt integrated flood management strategies that encompass urban planning, infrastructure design, early warning systems, floodplain restoration, storm water management, and community engagement. By combining nature-based solutions with innovative technology, cities can build resilience, protect vulnerable populations, and minimize the harm caused by floods. Furthermore, international collaboration will be essential in addressing shared flood risks and ensuring a sustainable and safe future for all. However, integrated urban flood risk management process must be considered for these laid down principles to be very effective and sustainable in real time<sup>[9]</sup>. This process covers every stage, from comprehending flood risk and choosing the best countermeasures to planning, carrying out, and ultimately evaluating the strategies and countermeasures. We hope the current work can provide valuable guidance to urban planners, policymakers, and researchers working towards building flood-resilient cities in face of the tipping points of global climate change.

**Keywords:** flood disasters, management, sustainable strategies, resilient cities, global climate change, Zhuozhou city

**DOI:** 10.25165/j.ijabe.20231604.8584

**Citation:** Okaiyeto S A, Wang J, Xiao H W. Sustainable flood management strategies for resilient cities. *Int J Agric & Biol Eng*, 2023; 16(4): 269–270.

### [References]

- [1] Weise E. The world inches closer to feared global warming ‘tipping points’: 5 disastrous scenarios. <https://www.usatoday.com/story/news/nation/2023/08/05/>. Accessed on [2023-08-13]
- [2] Tollefson J. Earth’s hottest month: these charts show what happened in July and what comes next. *Nature*, 2023; 620: 703-704.
- [3] Armstrong McKay D I, Staal A, Abrams J, Winkelmann R, Sakschewski B, Loriani S, Fetzer I, Cornell S, Rockström J, Lenton TM. Exceeding 1.5°C global warming could trigger multiple climate tipping points. *Science*, 2022; 377: eabn7950.
- [4] Ren S, Wang T Q. The Information Office of the Beijing Municipal People’s Government held a press conference on the flood control and relief work in Beijing. *Beijing Daily*, August 9th, 2023. <https://baijiahao.baidu.com/s?id=1773730331742424927&wfr=spider&for=pc>
- [5] More than 2.22 million people in Hebei were affected by the disaster and more than 1.54 million people were displaced. China News Network, August 5, 2023. <https://baijiahao.baidu.com/s?id=1773355048932666182&wfr=spider&for=pc>
- [6] Tellman B, Eakin H. Risk management alone fails to limit hazard impact. *Nature*, 2022; 608: 41-43.
- [7] Alifu H, Hirabayashi Y, Imada Y, et al. Enhancement of river flooding due to global warming. *Scientific Reports*, 2022; 12: 20687. <https://doi.org/10.1038/s41598-022-25182-6>
- [8] Davitt L, Neal J, Coxon G, Savage J, Wagener T. Flood hazard potential reveals global floodplain settlement patterns. *Nature Communications*, 2023; 14: 2801. <https://doi.org/10.1038/s41467-023-38297-9>
- [9] Jha AK, Bloch R, Jessica L. A guide to integrated urban flood risk management for the 21st century. The World Bank, 2012. <https://doi.org/10.1596/978-0-8213-8866-2>