



Urban Flood Challenges and Opportunities for Mitigation

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Abstract

Urban flood is one of the disasters that can happen at any time, which is quite concerning these days. Focus Group Discussion (FGD) was conducted qualitatively by a discussion from different organisations and backgrounds to identify the challenges and opportunities for mitigation in urban floods. Two main objectives discussed in this article are to assess the implication of climate change and future flood risks for health impacts, adaptation process, and emergency response; and to analyse the mitigation strategies for the flood related to the community's environment, health, and safety. This program was conducted to raise awareness and knowledge regarding urban floods and look for more profound views and perspectives of different organisations. FGD was held at the National Institute of Health (NIH), Setia Alam, Selangor. Six panellists were invited to participate, and all opinions from the panellists were recorded and taken during the FGD event and presented in the manuscript.

Keywords: extreme weather, climate change, infectious disease

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Introduction

The world has faced significant climate change over the past few decades, which causes some natural hazards and extreme weather in the environment, including floods. Monsoons and flash floods are the two varieties of flooding that typically affect specific regions. Asia and Southeast Asia have experienced a rise in hydro-meteorological disasters in the last two decades (Yusmah et

al., 2020). Notably, the climatic conditions in Peninsular *Malaysia* exhibit significant differences from those in East *Malaysia*. According to Vincent & Yusoff (2022), Malaysia has two types of monsoons that affect the weather: the Southwest Monsoon, which runs from late May to September, and the Northeast Monsoon, which runs from November to March. In Malaysia, the monsoon's annual flooding frequently causes significant losses. Floods are a major disaster in every nation, and these disasters have disrupted

daily community activities, caused financial losses, damaged infrastructure, such as railway tracks, bridges, roads, vehicles, and properties, and even claimed lives (Muzamil et al., 2022; Safiah Yusmah et al., 2020). Usually, flash floods occur in urban areas due to infrastructural and drainage problems. Urban flooding is defined as flooding in a densely populated area (Association of State Floodplain Managers, 2020). Urban flooding is known to cause damage to infrastructure and loss of life. Urban flooding inundates land or property in the built environment, particularly in densely populated areas (Yusmah et al., 2020). Extreme flood events are associated with the climate change caused by urbanisation, which resulted from a lack of effective flood risk management plans, especially in low and middle-income areas (Koje et al., 2022; Najibi & Devineni, 2018; Penning-Rowsell, 2014). One of the extreme flood events that had a detrimental impact on Malaysians was the flood that happened at Taman Sri Muda Shah Alam in 2021. When the rainfall exceeds 50mm, knee-deep floods will happen due to the low-lying Taman Sri Muda (Idris, 2022).

Flood risk, exposure, and damage potential increase, causing destitution and vulnerability to rise, which traumatised the communities, and the yearly flood hazard has compelled residents to plan to return to their everyday lives more quickly (Safiah Yusmah et al., 2020). Annual flooding is a predictable phenomenon, and the victim's experiences with this kind of emergency have led them to prepare in advance. Safiah Yusmah et al. (2020) indicate that the results suggest that the occurrence of the flood was due to several factors, including the demographic characteristics of the affected area, the positioning of the houses, inadequate and imprecise information and evacuation strategies, suboptimal management of the transit centre, and insufficient preparedness on the part of the community.

Urban flooding involves drowning land or property within a constructed setting, mainly in regions with high population densities. The impact of high population density, expanding infrastructure, and economic growth on the sustainability of urban areas is a subject of concern among researchers (Safiah Yusmah et al., 2020). Over time, it has presented an increasingly complex task for governmental bodies and developers to formulate a development strategy that effectively reconciles the need for urbanisation with the imperative to conserve natural resources.

Health impacts of increased waterborne and vector-borne diseases with poor healthcare access amidst urban floods

i. Increased waterborne diseases

Pathogens can quickly spread in floodwaters, making them a breeding ground for cholera, Hepatitis A, and diarrhoea. It can become established in floodwaters, increasing the likelihood of waterborne infections. During floods, bacteria, viruses, and parasites can spread in the water supply, making drinking unsafe. Sewage overflows, broken sanitation systems, and flooding combined with agricultural or industrial waste are all potential entry points for these bacteria. For example, diarrhoea during floods can spread *rotaviruses*, *noroviruses*, *E. coli*, *Salmonella*, and *Campylobacter*. Pathogens in contaminated water or food can cause gastrointestinal disorders. *Vibrio cholerae* causes acute diarrhoea and is spread by faeces-contaminated water or food in places with poor sanitation and insufficient water. It also contributes to hepatitis, which can spread *Hepatitis A* and *E* viruses mainly through feces, indirectly increasing hepatitis risk because of floods.

ii. Vector-borne diseases

During the focus group discussion, Mr Mohd Hairal Zainal mentioned that post-flood is one of the vital phases as the vector-borne disease is more prone to spread than during the flood. The vector-borne disease is easily spread as floods create unsanitary conditions that exacerbate the potential for malaria, instead of dengue fever, to spread more quickly in flooded areas because of the increase in mosquito populations. The unsanitary conditions happen due to the affected sanitation systems because the sewage and stagnant water that arise from the flood cause the mosquitoes breeding rates to increase (Kaur et al., 2020; Chan, 2017; Kouadio et al., 2012; Watson et al., 2007). Malaria spreads when the agent (*Anopheles* mosquito) infected by *Plasmodium* parasites bites the host (human) (Kaur et al., 2020).

iii. Healthcare access amidst urban floods while overcoming disruptions in service systems

Flood occurrence in urban and rural areas also disrupts healthcare services. Mr Mohd Hairal Zainal said that the vehicle can only access limited areas when floods happen for up to two days. Hence, distributing medical aid becomes a significant problem for flood victims at flood evacuation centres. Floods also

have a massive impact on healthcare services. People become very vulnerable to floods because there is little clean water and food; hence, when people stay at flood evacuation centres for more than two days, they have problems with cleanliness and healthcare services. Due to limited clean water, some infectious diseases that might occur during floods and at evacuation centres are leptospirosis and diarrhoea. There is also good evidence of outbreaks of leptospirosis but relatively weak evidence that flooding leads to an outbreak of other infectious diseases (e.g., *cholera*, *hepatitis*, vector-borne disease) (Few et al., 2004). Hence, disruption of healthcare services during floods could significantly impact the community's health. Medication and medical aid are crucial sources for the well-being of a community during a disaster. Dr Norfazillah Ab Manan highlighted that flood disrupts people's ability to get to the clinic for medical care, mainly when a flood takes a long time to subside, like the recent flood in Klang Valley.

Safeguarding lives through early warning systems, enhanced disaster preparedness, and effective coordination and communication in urban flood

i. Timely early warning system

One thing that needs to be emphasised when dealing with disasters is the effectiveness of early warning systems. The early warning system is crucial as it assures the affected communities receive information on potential hazards, such as floods (Global Disaster Preparedness Centre, 2023). It does not only help the communities but also helps the organisation or individual prepare and act appropriately when facing floods. However, the information must be disseminated promptly so communities, organisations, and individuals can prepare themselves, including taking precautionary measures like switching off the main power supply of the house or building to avoid any property damage. The effectiveness of early warning systems is determined by ensuring that the community receives the alerts, understands the signal or warning given, and acts toward it (International Labour Organization, 2022). Mr Herman Tawil said there is a public *Infobanjir* official website to be referred to, but more people need to know about this website. Dr Norfazillah Ab Manan mentioned that the warning does not alert the communities, and it is unclear to the community to prepare themselves during the flood, and Mr Mohd Firdaus Zainal concurred.

ii. Enhanced disaster preparedness

Mr Herman Tawil said there is a new National Flood Forecasting and Warning Center (PRABN) where the information received from meteorology map during rain will be simulated at an interval of time, and it will link to the system that can predict the situation in three days and seven days of preparation. Nevertheless, this prediction process is quite challenging because the climate is different nowadays, and it is hard to predict precisely, but it is still precautionary to proceed with the results.

Dr Ernieza Suhana Mokhtar agrees that a flood information system is an excellent way to inform people regarding flood occurrence. However, most people need assistance understanding the water level information, although adding a visual perspective for flood distribution is an innovative idea. She added that visual mapping is a better way to deliver understanding for communities, for example, a red alert on an affected area or location. In addition, the crowd-sourcing approach is an effective way of informing the flood status during real-time events on social media because, with the advanced technologies, people focus more on viral/current live events but be mindful of the validity of the information. Validity of information is essential even though the technology is vastly used, but still, meteorology maps and precise information is the essential.

It is challenging to implement to the people or engage with the community, as it all depends on the people themselves because they will only react according to the guideline if they regularly face the most extreme situation. The warning system should be like fire drills and more specific time instructions to face the disaster.

iii. Coordination and communication

Coordination and communication are crucial to an emergency response plan when a disaster happens. Lack of communication and loopholes in coordination could have a significant impact on emergency preparedness. Effective coordination and communication are essential in managing crises, public safety, and organisation relief support. The role of National Disaster Management Agency (NADMA) at local, state and federal levels needs to be reevaluated and reorganized. Mr Mohd Firdaus Zainal said that during the latest flood in Segamat, there was considerable support for food, clothes, and necessities in certain areas from any organisation, relief support, or NGO causing excessive aid support from agencies to distribute the aid. Segamat Municipal Council has developed comprehensive guidelines called Command Centre (CC) to guide the coordination of support relief. Establishing a clear

command structure and a chain of command could facilitate effective decision-making and coordination among agencies and response teams. Communication among communities is also essential to continually raise awareness to prepare for floods. Effective communication in delivering information is crucial to create early awareness among people about flood hazards.

The environmental impacts caused by urban floods

Major causes of urban flooding are rapid development, urbanisation, heavy rainfall, and drainage system problems. The drainage system will be challenged as the development happened rapidly, and the drainage system cannot withstand water overflow during heavy rains. Urban flooding also had detrimental effects on environmental pollution. Urban heat islands have also been identified as a cause for enhancing convective rainfall in and around cities and inducing flooding (Gupta, 2020). Post flood waste management remains an issue. Water supply and transportation are badly disrupted.

The detrimental effect on the environment due to flooding can be seen through changes in the topography of an area, land use changes, and climate change. Due to climate change, the factors exceeded 30% more than the estimated and overwhelmed the monsoon drainage. Based on flood occurrence records, the estimation of floods is crucial to providing broad information on the extent (the boundary or flood inundation region) of flood-prone locations. Numerous tasks were necessary for river basin planning and management, ranging from timely flood alarms to identifying areas in danger of flooding, stimulating, and occasionally even enforcing the necessity for such a modelling system (Adnan et al., 2014).

Low-lying areas and regions with steep slopes can be prone to flooding as, naturally, water will flow downhill, which has sometimes caused this area to become more sloping. Human activities due to urbanisation and rapid development have modified the landscapes, which can disrupt the drainage system (Cilia et al., 2021). According to the previous study by Mokhtar et al. (2020), the lowest elevation and near the riverbank has the highest percentage of flood inundation and supported by Wu et al. (2014) that said the downstream area was affected the most during flooding compared to the upstream area due to the speed of water for the high level to the lower elevation. Post flood waste management is critical for returning to normalcy. Environmental Impact Assessment (EIA)

studies should address such issues in the planning stages. All five panellists agreed that increasing or more uncontrolled development is one of the main reasons for the urban flood.

Addressing challenges in promoting community engagement, mitigating climate change, and enhancing land use planning in urban flood

i. Community engagement

Segamat's experience sees the management of disaster allocation needs to be better prepared, which helps to avoid any uncontrollable crisis. The victims' essential equipment and necessities are always available. However, there are no specific guidelines to distribute emergency aid accordingly, and there should be a decision-maker to centralise the situation. That makes collaboration between organisations important when facing a disaster. Head of the community plays a significant role in coordinating the people because the safety officer can only proceed with the guideline if only there is an engagement with the community.

Knowledge and awareness among people on handling solutions during floods are necessary to avoid consequences such as loss of life, property loss and others. However, people living in flood-prone locations must be informed and prepared early. Their mentality needs to be better prepared because flooding in an urban area only occurs occasionally, like on the east coast. For example, Taman Sri Muda flooding occurs unexpectedly, which makes the people unprepared for the situation, making the event more chaotic.

ii. Climate change

In the last few decades, Malaysia has increasingly experienced extreme weather events characterised by days of hot temperatures, high rainfall, dry spells, thunderstorms, and strong winds (Rosedil & Ishak, 2023). Moreover, the inter-monsoon seasons occur in March-April and September-October, which brings intense convective rainfall. It has also been said that during inter-monsoon, the rainfall is exceptionally intense, occurring at 3% more of the frequency of seasonal rainfall. Moreover, Peninsular Malaysia has an annual rainfall range of 1450 mm to 2575 mm. Thus, the amount of rainfall and its yearly variability and seasonal distribution have been drastically impacted due to climate change, where increasing monsoon rainfall intensities are a source of large

or flash floods. Besides, floods are also affected by various climatic system characteristics, most notably precipitation (intensity, duration, amount, timing, phase - rain or snow) and temperature patterns (Kundzewicz et al., 2014). Hence, the flash flood in Taman Sri Muda gradually increased the high intensities of rainfall by 1000 mm in a few hours for more than two days. Floods also can happen due to concurrent extreme tide events and storm surges.

iii. Land use planning

Adapting to future flood risks requires comprehensive land-use planning measures that steer development away from high-risk flood areas and protect natural floodplains. In the FGD session, flood mapping hazards from the Flood Management Division, Department of Irrigation and Drainage (DID) where the prediction of flood will take place in the future whole of Malaysia using the model of hydrodynamic on the land. This flood hazards mapping would predict the location in Malaysia prone to flood disasters, and the implication will be quite challenging since it involves the economy. The understanding and acceptance of the people on this issue is the most challenging aspect in accepting the bitter truth about the urban flood in the home area, and all five panelists agree upon this statement during FGD session.

Seizing opportunities for mitigation in integrated water, flood plain management and developing community response teams, and ensuring health and safety during urban floods

i. Integrated water and flood plan management

Mr Herman Tawil again highlighted that flood mapping hazards could be used as a tool in helping the government in preparing for mitigation action where the preparedness process can be prepared in advance for the flood-prone location. The concept from DID, "Living with the flood," because nothing can be done can be hard to accept because the development process cannot be pushed away. Dry ponds and wet ponds system should be enhanced. He also emphasised said the development should also have a resilient structure and waterproofing properties with a new guideline.

Dr Ernieza Suhana Mokhtar sees the plantation owners facing the consequences due to the lower land and highly exposed to flooded events. The uncontrolled water will release and affect their plantation. However, compensation for the loss should be taken seriously by the government after the flood event to recover the damaged crops during the flood. Flood Mitigation Project (*Projek*

Mitigasi Banjir) would include planning that refers flood mapping hazards and the risky location should be avoided for development and minimising the damages due to urban floods is necessary.

ii. Develop community response teams

Mr Mohd Zainoor Annuar Mohd Zain said the community could develop a CERT (community emergency response team) where the people can prepare themselves, and this shows a reasonable effort by the community to respond to a disaster before any help/aid comes to save the situation. Local authorities should always lead the way. Hence, improving the local community engagement to respond quickly to crises and react fast to save other people before too late. These efforts need collaboration between village heads and villagers in rural areas to respond to emergencies. Effective team organisation could effortlessly help other victims to evacuate to safe places and distribute any aid efficiently. Effective communication between CERT and external emergency responders would help deliver information through radios, phone systems, or messaging apps. Reliable resource management is also crucial in allocating resources during crises and emergencies, developing a sense of community among people around the affected area.

iii. Health and safety measures during urban floods

In terms of health and safety, comprehensive flood management strategies should be implemented. First, the responsible parties must establish protocols to address immediate health and safety risks during floods, including emergency medical services and evacuation procedures. Next, providing access to safe shelters and sanitation facilities for displaced individuals. Finally, promoting public health measures, such as disease surveillance, vector control, and access to clean water, to prevent post-flood health hazards. All points suggested were discussed and agreed upon by the panellists, and the most important factor in overcoming the situation is communication in all directions.

Conclusion

Urban flood challenges and opportunities for mitigation during FGD sessions from all five panellists have agreed on one statement: collaboration between departments and organisations during mitigation is essential during mitigation or flood disaster. Mentality, attitude, self-awareness, early education and knowledge, budget allocation, and human resources are vital in

preparing the organisation (NGOs), departments (local, state and federal), and every community during pre, during, and post-flood disaster response.

Contribution Statement

The MAEH Urban Health Forum was held at the National Institute of Health Setia Alam from 19-20 June 2023. NAH, NAFM, SFAR, ZA and FAS conceived the forum, applied for and obtained funding from the Malaysian Association of Environmental Health and Universiti Teknologi MARA, and drafted the article's first version. ESM, HT, MFZ, and MZAMZ analysed the issue. All participants at the forum contributed to the focus group discussion that produced the article, and all approved the final version.

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