Jurnal Kejuruteraan 36(6) 2024: 2709–2715
https://doi.org/10.17576/jkukm-2024-36(6)-40

Enhancing Flood Disaster Management in Klang Valley

Mohd Amizan Mohamed[a]*, Abdul Qayyum Mohd Zaman[a], Stephen Kajewski[b] & Bambang Trigunarsyah[c]

[a]*School of Civil Engineering, College of Engineering,*
Universiti Teknologi MARA (UiTM) Shah Alam, Selangor, Malaysia,

[b]*Faculty of Engineering, School of Architecture & Built Environment,*
Queensland University of Technology, Brisbane, Australia

[c]*School of Property, Construction and Project Management,*
College of Design and Social Context, RMIT University, Melbourne, Australia.

[*]*Corresponding author: amizan8124@uitm.edu.my*

Received 29 February 2024, Received in revised form 5 August 2024
Accepted 6 September 2024, Available online 30 November 2024

ABSTRACT

The Klang Valley, encompassing Kuala Lumpur and Selangor, faces recurrent flooding due to rapid urbanisation and inadequate drainage systems, particularly during monsoon seasons. This research aims to develop a comprehensive framework for enhancing regional flood disaster management. Data were collected from 255 civil engineering professionals through an online survey, with descriptive statistics used to analyse the challenges, practical solutions, and stakeholder roles in managing floods. Key findings highlight that rapid urbanisation and insufficient drainage infrastructure significantly contribute to flood vulnerability. Respondents rated floods as one of Malaysia's most common natural disasters, with a mean score of 3.90, while lack of public awareness on flood preparedness scored lower at 3.77. Comprehensive urban planning was identified as the most effective solution (mean score of 3.88), followed by investing in drainage infrastructure (mean of 3.73). The study underscores the need for centralised coordination among stakeholders, receiving strong support with a mean score of 3.87. The proposed framework integrates three key phases: mitigation, focusing on urban planning and infrastructure improvements; preparedness, which involves enhancing public awareness and emergency response systems; and response/recovery, ensuring effective crisis management and long-term rehabilitation. The framework emphasises collaboration between government agencies, local authorities, and communities to enhance flood resilience. This research provides valuable insights for developing sustainable, long-term strategies for flood disaster management in the Klang Valley, addressing the challenges posed by urbanisation, climate change, and infrastructure limitations.

Keywords: Flood; flood disaster management; challenges in flood disaster management

INTRODUCTION

Malaysia's tropical climate is characterised by consistently high temperatures and high relative humidity and is impacted by the northeast and southwest monsoons (Craig et al. 2024). Two basic types of rainfall causing flooding are moderate intensity, long-duration rainfall covering a wide area and high intensity, short-duration localised rainfall. In addition, flood records indicate a seasonal pattern of flood occurrences (F.S. Buslima et al. 2018).

According to a study by N Rosedi, 2023, the Klang Valley comprises 9 million citizens, constituting 26% of Malaysia's population. This urban village consists of squatter homes surrounded by high-rises along major roads. The village is a flood-prone area with a frequency of 3 to 5 times yearly flood. It was severely affected by the 2020 flood disaster, which affected 80% of the settlements, making them most vulnerable to hazards, risks, and disasters. Flooding due to climate change could cause more drowning deaths and cause indirect effects. These impacts can affect food production, water provision, ecosystem

disruption, infectious disease outbreaks and vector-borne diseases (Berry et al. 2018).

This research aims to answer three critical questions: identifying the primary challenges in managing flood disasters in the Klang Valley, investigating the most effective practical solutions to address these challenges, and determining the critical stakeholders involved in developing and implementing flood disaster management strategies in the Klang Valley. The primary objective of this study is to comprehensively investigate the critical challenges associated with managing flood disasters in the Klang Valley, subsequently identifying practical solutions to address these challenges and ultimately developing a robust framework for effective flood disaster management in the region.

The social impact of flood disasters encompasses various dimensions, including psychosocial, socio-demographic, socio-economic, and socio-political aspects (Noraini et al. 2018). Flood disaster affects the economy for either a short or long time, and their impact is difficult to measure accurately because it not only involves the value of the currency but also includes the perceptions and emotions of those involved and also people who see it (Tasri ES et al. 2022). The impact of infrastructure that often happens when flooding, whether flash floods or monsoon floods, is the closure of several roads in lower areas. Vehicles passing through the area at risk of flooding may be vulnerable to the problem of vehicles being flooded or caught in the flooding (F.S. Buslima et al. 2018).

LITERATURE REVIEW

In March 2022, several parts of Klang and Shah Alam have been hit by flash floods following continuous downpours. Among the areas affected are Seksyen 13, Seksyen 22, Padang Jawa, I-City, Bukit Lanchong, and Taman Sri Muda in Shah Alam, while in Klang, flooding was reported in Taman Sentosa, Kota Raja, Taman Sri Andalas, Taman Chi Liung, and GM Klang. The sudden rise in water levels caught many residents off guard, resulting in water entering homes and vehicles. The floods caused traffic disruptions and damage to infrastructure (Norazam Khamis 2022)

Figure 1 shows the list of challenges in managing flood disasters in Klang Valley. The challenges include rapid urbanisation and development. A study by Kamarulzaman et al. (2019) found that the Klang Valley has the potential to become a sustainable city, but this will require a holistic approach that considers environmental, social, and economic considerations. Lee and Lye (2019) found that inadequate funding for drainage infrastructure projects is a significant challenge in the Klang Valley. Next, one of the major themes is the impact of climate change on the frequency and intensity of extreme weather events in the Klang Valley. It was found that climate change is likely to increase the frequency and severity of floods, landslides, and other extreme weather events in the region (Siti Jahara et al. 2021).

FIGURE 1. List of Challenges by Syed Ahmad Hakim et al. (2022).

In Figure 2, it shows three solutions for managing the flood. Effective floodplain management can reduce people's and property's exposure to flood hazards. Research has shown that implementing floodplain management measures can significantly reduce the impact of flood disasters (Islam et al. 2021). Azmi et al. (2019) found thatupgrading and expanding existing drainage systems was an effective cost solution to reduce floodrisk in Klang Valley. According to Rosli et al. (2020), the literature highlights the importance of capacity building and education in supporting adopting climate adaptation measures. It wasfound that building the capacity of government agencies, local communities, and other stakeholders is critical for the effective implementation of climate adaptation measures.

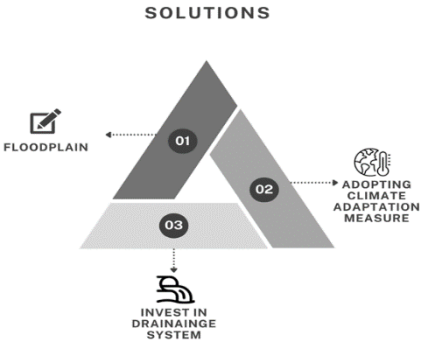

FIGURE 2. List of Solutions by Syed Ahmad Hakim et al. (2022).

The Association of Southeast Asian Nations (ASEAN) aims to ensure the safety of citizens and mitigate the impacts of disasters throughjoint and coordinated approaches to disaster risk management (Osti et al.2017). One aspect of preparedness that is not always prioritised adequately is individual or family preparedness. It is usually regarded as comprising measures that enable governments, organisations, communities,and individuals to respond rapidly and effectively to disaster situations (Abid et al.2020).Response measures are usually taken immediately before and after a disaster's impact. Such measures are mainly directed toward saving lives, protecting property, and dealing with the immediate disruption, damage, and other effects caused by the disaster (Noorhashirin et al. 2016). Recovery is the process by which communities and the nation are assisted in returning to their proper functioning following a disaster. The recovery processcan be very protracted, taking 5-10 years or even more (Kamarudin et al. 2018). Figure 3 illustrates the stages for developing a framework for flood management.

FIGURE 3. Stage for Framework by Mohammed, N et al. (2018)

The literature review highlights significant challenges in managing flood disasters in the Klang Valley, remarkably rapid urbanisation and climate change. Studies indicate that this region, frequently impacted by flash floods, faces infrastructure and preparedness issues. Kamarulzaman et al. (2019) suggested that a holistic approach, incorporating environmental, social, and economic considerations, is needed to make the Klang Valley a sustainable urban area. However, as pointed out by Lee and Lye (2019), funding limitations for drainage infrastructure projects and the intensifying impact of climate change, as discussed by Siti Jahara et al. (2021), are significant obstacles to effective flood management. These factors contribute to the increased frequency and intensity of extreme weather events, such as floods and landslides, further complicate disaster management efforts.

Several solutions have been identified in the literature to address these challenges. Effective floodplain management has proven beneficial in reducing exposure to flood hazards, as emphasised by Islam et al. (2021). Upgrading and expanding drainage systems are cost-effective solutions for mitigating flood risks in the Klang Valley (Azmi et al. 2019). Additionally, capacity building and education play a crucial role in supporting climate adaptation measures, with Rosli et al. (2020) stressing the importance of equipping government agencies, local communities, and stakeholders with the necessary tools for implementation. Despite this, the literature also points out a gap in individual and family preparedness, often overlooked but vital for reducing disaster impacts (Abid et al. 2020).

Based on the previous studies, the research gap table for this study was established as Table 1.

TABLE 1. The research gap in this study

Literature Findings	Research Gap
Rapid urbanisation and lack of adequate drainage infrastructure contribute to flood disasters (Kamarulzaman et al., 2019; Lee & Lye, 2019).	Lack of a holistic approach integrating urban planning with flood risk management to address both infrastructure and environmental challenges. |
Climate change increases the frequency and intensity of extreme weather events (Siti Jahara et al., 2021).	Limited studies on how local communities and stakeholders integrate climate adaptation measures to reduce future flood risks.
Floodplain management and drainage system upgrades are effective solutions (Islam et al., 2021; Azmi et al., 2019).	Insufficient focus on the long-term sustainability of these solutions and their scalability in urbanised settings like Klang Valley. |
Capacity building and education are critical for climate adaptation (Rosli et al., 2020).	There is a gap in exploring the role of individual and family preparedness in disaster management strategies, particularly for Klang Valley. |
ASEAN emphasises coordinated disaster risk management (Osti et al., 2017).	Limited research on local-level coordination between government agencies, communities, and other stakeholders in disaster response and recovery. |

METHODOLOGY

This study employed a quantitative research design through an online questionnaire survey targeting engineers, contractors, consultants, architects, and surveyors engaged in civil engineering work in the Klang Valley. The Klang Valley was selected as the research location due to its frequent exposure to flash floods and extended periods of inundation, making it highly relevant for flood-related studies. The region's rapid urbanisation, complex drainage systems, and diverse flood management challenges provide a valuable context for analysing the impact of human activity on flood dynamics.

The sample selection was guided by specific inclusion criteria, focusing on Grade G7 contractors registered with the Construction Industry Development Board (CIDB). 255 respondents responded to the online questionnaire survey conducted for this study. These respondents were considered for their expertise and experience in large-scale

civil engineering projects, making them critical stakeholders in flood disaster management.

The questionnaire aimed to identify challenges, explore practical solutions, and develop a framework for improving flood management. It was designed to achieve three specific research objectives, as outlined in Figure 4. Data was collected using structured questions to ensure consistent responses across all participants. The gathered data were initially processed using Microsoft Excel for essential data management and then further analysed using IBM SPSS software to conduct descriptive statistics, including means and rankings, to address the study's objectives.

To ensure the validity and reliability of the findings, the study employed Cronbach's alpha coefficient to test the internal consistency of the questionnaire items. The study design was carefully structured to provide robust and reliable results, adhering to rigorous research standards for achieving the objectives. This methodological approach ensures that the research is well-grounded, generating meaningful insights for enhancing flood disaster management in the Klang Valley.

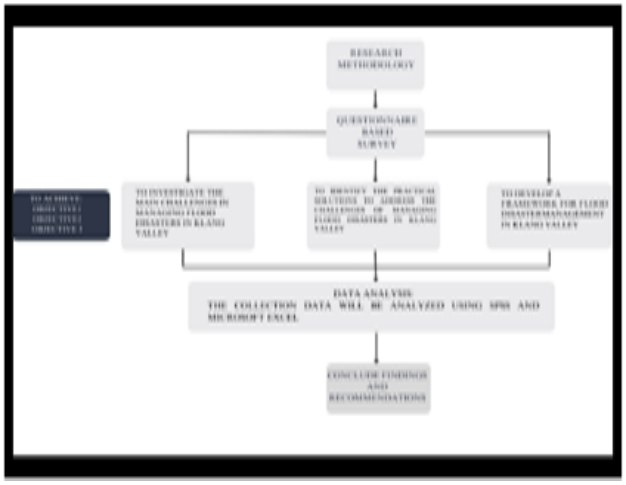

FIGURE 4. Research Design & Method

RESULTS AND DISCUSSION

The study utilised Cronbach's alpha coefficient (Table 2) to assess the consistency and validity of the questionnaire items. A Cronbach's alpha value above 0.6 is required for validity, with values between 0.70 and 0.90 being ideal. For Objective 1, the Cronbach's alpha was 0.962, indicating excellent internal consistency. This section included 8 items, confirming the validity of the questions. Objective 2 had a Cronbach's alpha of 0.757 with 9 items, indicating sufficient consistency for the study. Objective 3 had a Cronbach's alpha of 0.769 across 6 items, reflecting acceptable validity and consistency. These values suggest that the questions for all objectives are reliable and valid for this research.

TABLE 2. Cronbach's alpha coefficient

Objective(s)	Cronbach's Alpha	No of Item
To investigate the main challenges in managing flood disasters in Klang Valley	0.962	8
To identify the practical solutions to address the challenges of managing flood disasters in Klang Valley.	0.757	9
To develop a framework for flood disaster management in Klang Valley.	0.769	8

This study aimed to identify the main challenges and practical solutions and develop a comprehensive framework for flood disaster management in the Klang Valley. The analysis involved data collection through a survey distributed among civil engineering stakeholders, including engineers, contractors, consultants, architects, and surveyors, with responses analysed using descriptive statistics.

OBJECTIVE 1: CHALLENGES IN MANAGING FLOOD DISASTERS IN KLANG VALLEY

The results revealed that floods are one of Malaysia's most frequent and impactful natural disasters, particularly in the Klang Valley, with a mean agreement score of 3.90 among respondents. Rapid urbanisation and development were consistently identified as key contributors to increased flood risk, aligning with previous studies (Kamarulzaman et al. 2019; Lee & Lye, 2019). These challenges have overwhelmed the drainage infrastructure, as evidenced by the frequent flash floods in 2022. The respondents also highlighted the lack of public awareness and education on flood preparedness, which received a lower mean score of 3.77, indicating that while urbanisation is a prominent challenge, public engagement remains a critical area for improvement.

OBJECTIVE 2: PRACTICAL SOLUTIONS FOR ADDRESSING FLOOD MANAGEMENT CHALLENGES

Regarding practical solutions, comprehensive urban planning scored a mean of 3.88, indicating broad agreement

on its effectiveness in addressing flood risks. This result mirrors findings in the literature, such as the importance of floodplain management in reducing exposure to flood hazards (Islam et al. 2021). However, investing in drainage infrastructure was rated slightly lower at 3.73, despite being an essential solution. This result suggests that while upgrading infrastructure is recognised as necessary, its perceived effectiveness might be overshadowed by larger-scale planning initiatives. Floodplain management, identified as the best practical solution, supports prior literature, indicating that urban planning prevents new flood risks while floodplain management mitigates risks in vulnerable areas (Azmi et al. 2019).

OBJECTIVE 3: FRAMEWORK DEVELOPMENT FOR FLOOD DISASTER MANAGEMENT

The third objective focused on developing a robust framework for flood disaster management in Klang Valley. Respondents agreed significantly on the importance of centralised coordination, with a mean score of 3.87. This result aligns with the literature stressing the role of coordinated approaches between government agencies, local authorities, and stakeholders in managing disasters (Osti et al. 2017). In contrast, regular and comprehensive risk assessments, including vulnerability mapping, were rated lower at 3.70, suggesting that while assessments are critical, more emphasis is needed on integrating these findings into actionable strategies. The responses also highlight the need for capacity building and education as critical components for effective disaster management (Rosli et al. 2020). The proposed framework for developing flood disasters in Klang Valley is shown in Figure 5.

The results of the study align closely with the literature reviewed. Rapid urbanisation, inadequate drainage infrastructure, and the impact of climate change were identified as significant challenges, corroborating findings by Kamarulzaman et al. (2019) and Siti Jahara et al. (2021). As identified in this study, practical solutions, such as urban planning and floodplain management, also reflect those proposed by Islam et al. (2021) and Azmi et al. (2019). Additionally, the role of capacity building and education, as stressed by Rosli et al. (2020), was supported by the responses from stakeholders.

Despite these findings, gaps remain in individual and family preparedness, which requires further attention (Abid et al. 2020). Coordinating disaster management efforts at the local level also presents an opportunity for future research to explore how collaboration between communities, local authorities, and national agencies can be optimised.

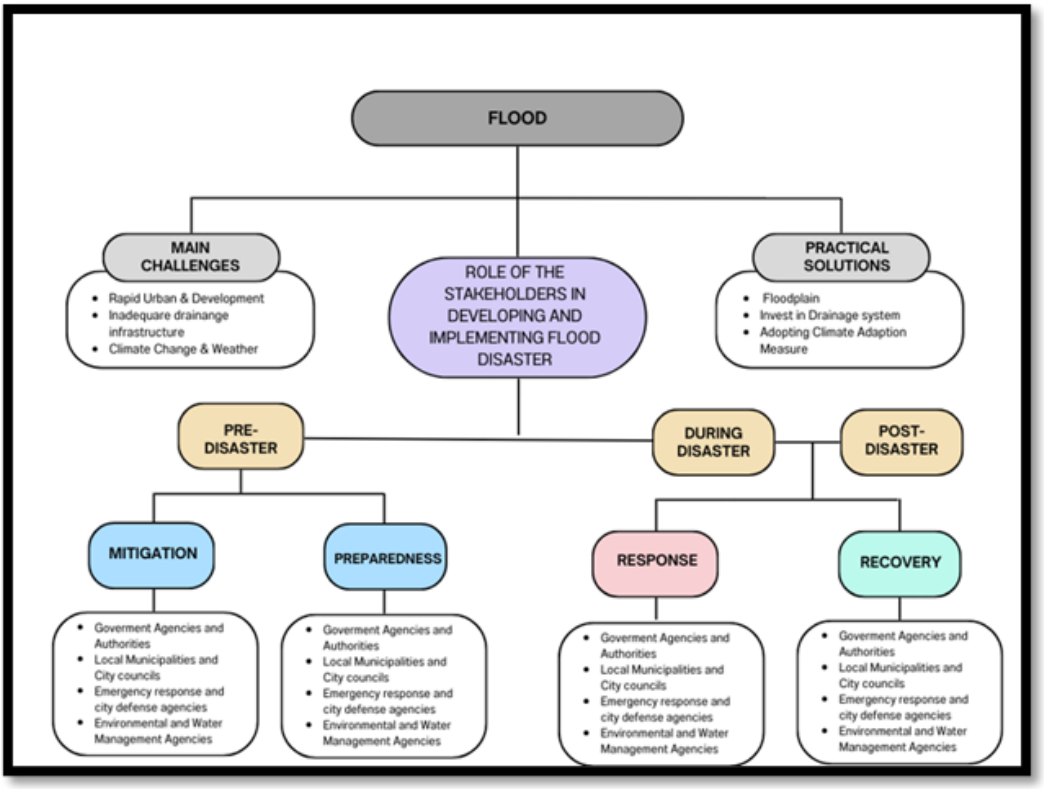

FIGURE 5. Framework for Flood Disaster Management in Klang Valley

CONCLUSION

This study has successfully presented clear and comprehensive results on the challenges and solutions for enhancing flood disaster management in the Klang Valley. Through appropriate analysis, supported by examples and discussions within the manuscript, the study identifies rapid urbanisation, inadequate drainage systems, and limited public awareness as the primary factors exacerbating flood vulnerability in the region. The findings align with the literature, and the proposed framework integrates mitigation, preparedness, and response/recovery strategies, providing a holistic approach to flood disaster management.

However, this study is not without limitations. The reliance on online surveys may have introduced response bias, as the perspectives gathered are limited to professionals in civil engineering. Broader stakeholder engagement, including residents and community leaders, may offer additional public awareness and preparedness insights. Moreover, while this study focuses on Klang Valley, future research could expand to other flood-prone regions to validate the proposed framework's applicability across different urban settings. Additionally, the study could further explore the long-term sustainability of infrastructure solutions and the scalability of floodplain management practices in diverse urban environments.

The implications of this research are significant. By developing a comprehensive framework for flood disaster management, the study provides actionable insights for policymakers, urban planners, and local authorities. On a societal level, implementing these strategies can enhance flood resilience, reduce infrastructure damage, and better prepare communities. Adopting centralised coordination and improved public education can mitigate future floods' social and economic impacts, ultimately contributing to safer and more sustainable urban living environments.

ACKNOWLEDGEMENT

I appreciate the School of Civil Engineering, College of Engineering, Universiti Teknologi MARA, Selangor, Malaysia, for funding the publication of this paper. I appreciate their assistance, which has enabled me to disseminate the results to a larger audience.

DECLARATION OF COMPETING INTEREST

None.

REFERENCES

Abid, S. K., Sulaiman, N., Mahmud, N. P. N., Nazir, U. & Adnan, N. A. 2020. A review on the application of remote sensing and geographic information system in flood crisis management. *Journal of Critical Reviews* 7(16): 491-496.

Azmi, E. S., How, V. & Rahman, H. A. 2021. Effect of health belief model on flood-risk educational approach among elementary school children in Malaysia. *Jàmbá: Journal of Disaster Risk Studies* 13(1): 1-6.

Buslima, F. S., Omar, R. C., Jamaluddin, T. A. & Taha, H. 2018. Flood and Flash Flood Geo-Hazards in Malaysia. *International Journal of Engineering & Technology* 7(4): 760-764.

Chong, N. O., Kamarudin, K. H. & Abd Wahid, S. N. 2018. Framework considerations for community resilient towards disaster in Malaysia. *Procedia Engineering* 212: 165-172.

Lee, L. 2021. Malaysian Manufacturers Fear Heavy Losses from Floods. *Reuters*. https://www.reuters.com/markets/commodities/malaysian-manufacturers-fear-heavy-losses-floods-2021-12-20/ (accessed on 15 January 2022).

Leinbach, T. R., Bee, O. J., Ahmad, Z. B. & Lockard, C. A. 2024. Malaysia | History, Flag, Map, Population, Language, Religion, & Facts. *Encyclopedia Britannica.* https://www.britannica.com/place/Malaysia/Religion

Mohammed, N., Edwards, R. & Gale, A. 2018. Optimisation of flooding recovery for Malaysian universities. *Procedia engineering* 212: 356-362.

Mustafa, M. 2021. Analysis of Impacts of Climate Change and Environmental Degradation on Children in Malaysia and assessment of child-sensitivity of current adaptation and mitigation policies: Legal perspective. Nota Pengajaran.

Muzamil, S. A. H. B. S., Zainun, N. Y., Ajman, N. N., Sulaiman, N., Khahro, S. H., Rohani, M. M., ... & Ahmad, H. 2022. Proposed framework for the flood disaster management cycle in Malaysia. *Sustainability* 14(7): 4088.

Noorhashirin, H. & Juni, M. H. 2016. Assessing Malaysian disaster preparedness for flood. *International Journal of Public Health and Clinical Sciences* 3(2): 1-15.

Osti, R. 2017. Strengthening Flood-Risk Management Policy and Practice in the People's Republic of China: Lessons Learned from the 2016 Yangtze River Floods. In *ADB East Asia Working Paper Series*. Philippines: Asian Development Bank.

Rosedi, N. & Ishak, M. Y. 2023. Evaluation of the vulnerability and resilience towards urban flash floods in Kuala Lumpur, Malaysia. *IOP Conference Series: Earth and Environmental Science* 1144(1): 012012.

Sahani, M., Othman, H., Kwan, S. C., Juneng, L., Ibrahim, M. F., Hod, R., ... & Rosli, Y. 2022. Impacts of climate change and environmental degradation on children in Malaysia. *Frontiers in Public Health* 10: 909779.

Ursachi, G., Horodnic, I. A. & Zait, A. 2015. How reliable are measurement scales? External factors with indirect influence on reliability estimators. *Procedia Economics and Finance* 20: 679-686.