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Relationships Between Rapid Urbanization Indicators and Flood Disaster Occurrence in Klang Valley, Malaysia: A Quantitative Correlation- Regression Study

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Abstract

Rapid urbanization has transformed the Klang Valley, Malaysia, but has also intensified urban flood risk through interconnected land-use and infrastructure pressures. This study examines the relationships between key urbanization indicators and perceived flood disaster occurrence using a single-method quantitative design. Primary data were obtained through a structured questionnaire survey of stakeholders involved in urban development and flood management (n = 122). Historical flood event records (2000–2023) were used to contextualize flood patterns and support the interpretation of survey findings. Data were analysed using descriptive statistics, reliability testing (Cronbach's alpha), Pearson correlation, and multiple regression analysis. All urbanization indicators exhibited significant positive relationships with flood disaster occurrence ($p < 0.01$). Regression results indicate that drainage inadequacy is the strongest predictor ($\beta = 0.42$, $p < 0.001$), followed by land-use change ($\beta = 0.31$, $p < 0.001$) and population density ($\beta = 0.21$, $p = 0.004$), demonstrating that flood vulnerability is driven by both development intensity and infrastructure capacity deficits. The study contributes empirical evidence from the Malaysian context by quantifying how urbanization-related pressures jointly explain flood disaster occurrence and by highlighting infrastructural and governance implications for integrated urban planning. Practical recommendations include upgrading drainage systems, implementing stricter land-use controls, and adopting climate-adaptive zoning to enhance urban flood resilience.

Keywords: Rapid urbanization; Urban flooding; Klang Valley; Drainage infrastructure; Land-use change; Flood vulnerability; Regression analysis; Urban resilience

1. Introduction

Urbanization has become one of the most dominant global development trends, particularly in rapidly developing economies, where expanding urban footprints increasingly interact with natural hydrological systems. While urban growth supports economic development and population concentration, it also alters land surfaces, drainage patterns, and river systems, often intensifying flood hazards in metropolitan regions. Globally, numerous studies have demonstrated that rapid urban expansion, when not accompanied by adequate planning and infrastructure provision, significantly increases flood frequency and severity (Bahrawi et al., 2020; Heidari et al., 2020; Yao et al., 2023).

In Malaysia, urbanization has accelerated significantly over the past few decades, with the national urban population projected to exceed 80% by 2020 (Kuppusamy & Salih, 2022). The Klang Valley represents the most pronounced manifestation of this trend, serving as the country's primary economic and administrative hub. The region has experienced extensive land-use conversion, population densification, and infrastructure development, often encroaching upon floodplains and natural waterways. Despite ongoing structural mitigation measures since the major 1971 Kuala Lumpur flood, floods continue to recur across the Klang Valley, raising concerns about the effectiveness of existing urban planning practices and flood management strategies.

Previous studies in the Klang Valley and Kuala Lumpur have primarily examined urban flooding through hydrological modelling, land-use and land-cover (LULC) analysis, and remote sensing techniques (Teh &

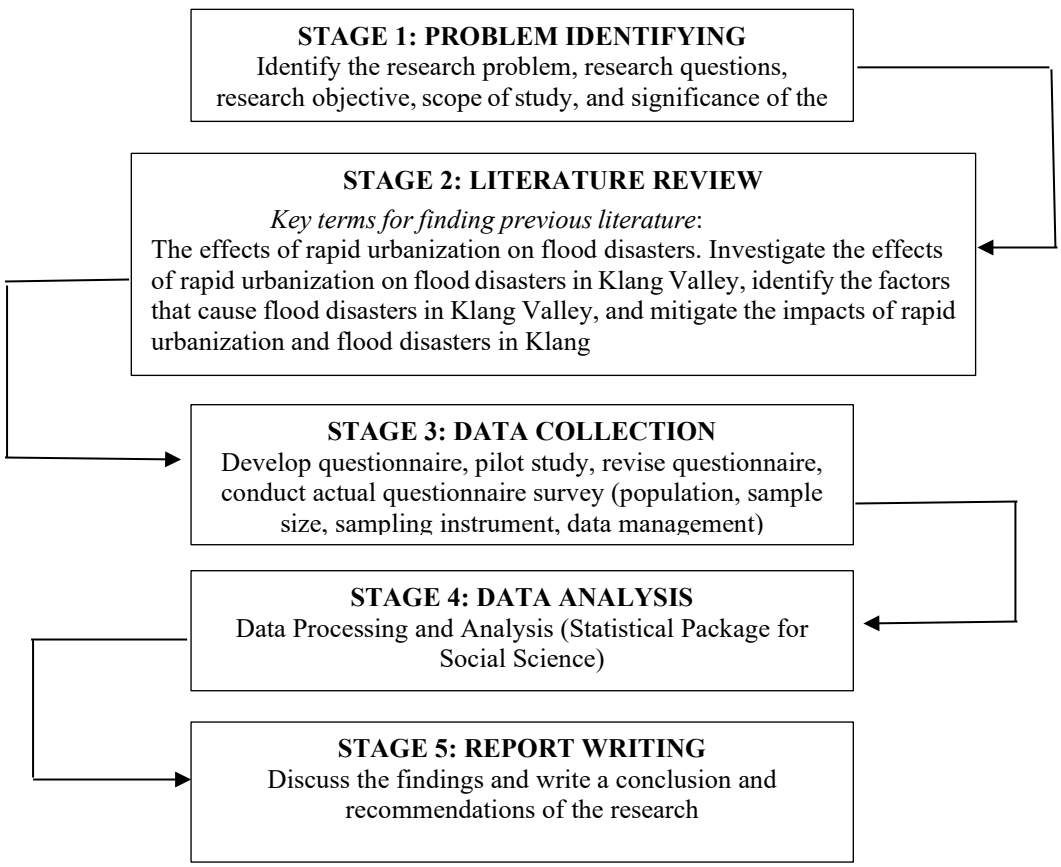
Liong, 2018; Khatib et al., 2021; Yusop et al., 2017). These studies have provided valuable insights into the physical drivers of flooding, such as increased impervious surfaces, river channelization, and reduced floodplain storage. However, much of the existing literature treats urbanization indicators in isolation or focuses predominantly on physical processes, with limited empirical examination of how multiple urbanization-related factors jointly influence flood disaster occurrence from a stakeholder-informed perspective.

Moreover, studies that explicitly quantify the relative influence of urbanization indicators such as land-use change, population density, and drainage system adequacy on flood disaster occurrence in the Malaysian context remain limited. Flood resilience research in Malaysia has also tended to emphasize structural solutions, often overlooking the combined roles of infrastructure capacity, planning enforcement, and institutional coordination that mediate the urbanization–flood relationship (Chan & Mustafa, 2018; Yabe et al., 2022). As a result, there is a need for integrative empirical evidence that goes beyond descriptive assessment to statistically examine how urban development pressures translate into flood vulnerability.

Against this backdrop, this study investigates the relationships between rapid urbanization indicators and flood disaster occurrence in the Klang Valley using a quantitative correlation and regression approach. By integrating stakeholder survey data with contextual historical flood records, the study provides empirical evidence on the relative significance of key urbanization drivers and their combined effects on flood vulnerability. The findings contribute to the urban flood management literature by offering a statistically grounded explanation of urbanization–flood dynamics in the Malaysian context and providing practical insights for planners and policymakers seeking to enhance flood resilience through integrated urban planning and infrastructure management.

2. Research Method

This study employed a single-method approach to examine the relationship between rapid urbanization and flood disaster occurrences in the Klang Valley. Quantitative data were collected to gain a comprehensive understanding of the contributing factors and stakeholder perspectives.



2.1 Research Design

This study adopted a single-method quantitative research design to investigate the relationships between rapid urbanization indicators and flood disaster occurrences in the Klang Valley. A quantitative approach is appropriate where the objective is to statistically assess the strength and direction of relationships between variables rather than to generate exploratory theory (Creswell, 2018). The design enables hypothesis testing through correlation and regression analysis, a method widely applied in urban risk and disaster management studies.

The study focuses on key urbanization indicators, including land-use change, population density, drainage system adequacy, river channelization, and loss of green areas, and examines how these variables collectively influence the occurrence of flood disasters.

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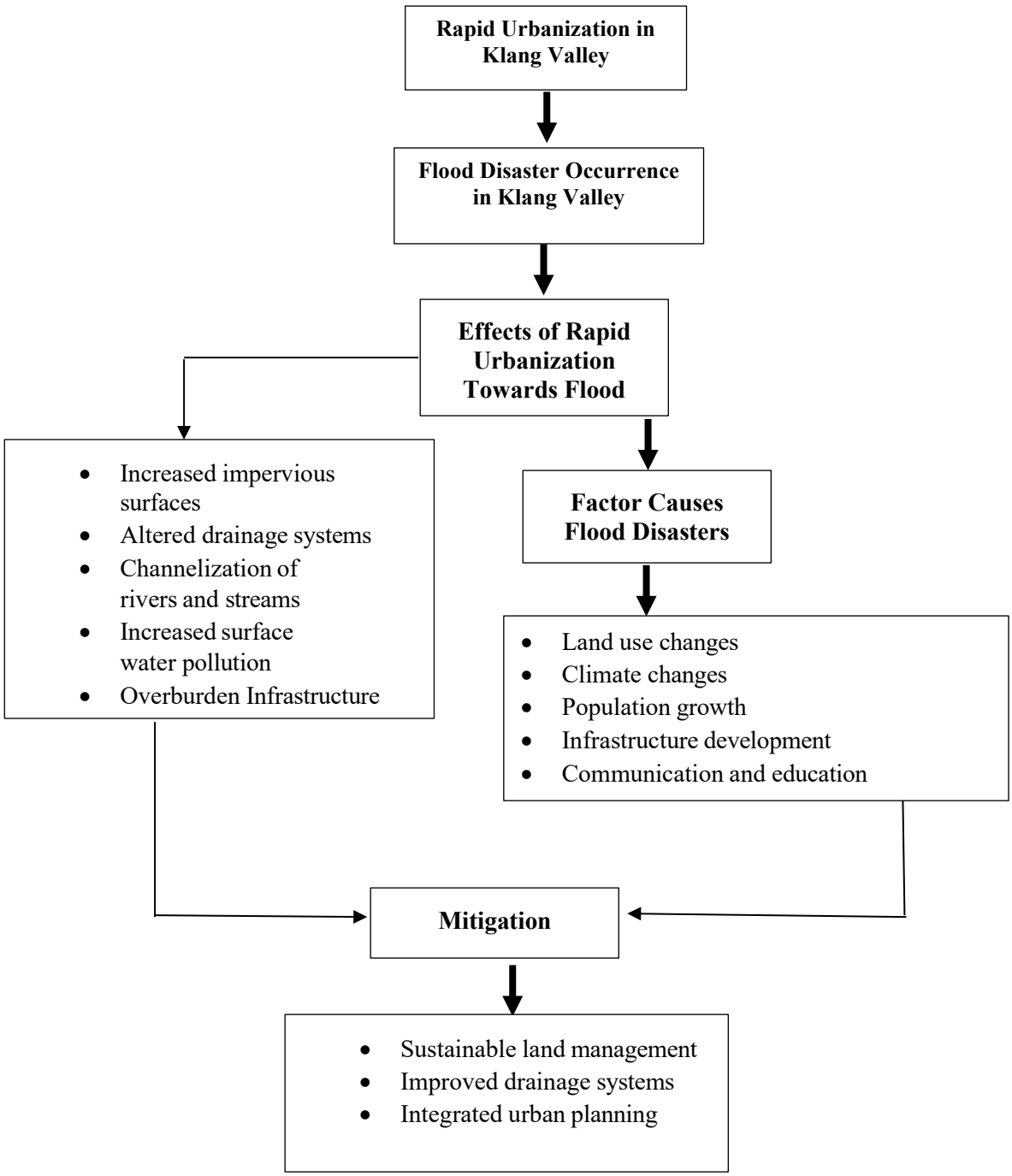

2.2 Data Collection

Secondary data on flood events in the Klang Valley from 2000 to 2023 were obtained from the Department of Irrigation and Drainage (DID) Malaysia, local authorities, and verified media reports. These data included information on flood frequency, affected locations, and severity levels.

Historical flood data were used contextually rather than as an independent inferential dataset, serving to support the interpretation of survey findings and to illustrate temporal and spatial flood patterns within the study area. This contextual analysis strengthens the empirical discussion by linking stakeholder perceptions with observed flood trends, consistent with prior urban flood research approaches (Ramli & Masbah, 2023).

2.3 Historical Flood Data Analysis

Secondary data on Klang Valley flood events (2000-2023) were obtained from DID Malaysia, local authorities, and news archives. Flood frequency, intensity, and affected locations were analyzed using trend analysis and GIS mapping to identify spatial-temporal patterns and correlate flood-prone zones with urban expansion, providing essential context for interpreting the quantitative survey results (Ramli & Masbah, 2023).

2.4 Data Analysis

Quantitative data were analysed using the Statistical Package for the Social Sciences (SPSS). Reliability analysis was conducted using Cronbach's alpha, with values exceeding the recommended threshold of 0.70 indicating acceptable internal consistency (Ursachi et al., 2015).

Descriptive statistics (mean and standard deviation) were used to summarise respondent perceptions of urbanization-related flood factors. Pearson correlation analysis was employed to examine the strength and direction of relationships between urbanization indicators and flood disaster occurrence. Subsequently, multiple regression analysis was conducted to identify the relative contribution of each urbanization factor in predicting flood disaster occurrence while controlling for other variables. This combination of analyses enables both relational assessment and explanatory modelling, which is appropriate for urban risk studies involving interrelated predictors.

2.4 Ethical Considerations

Participation in the survey was voluntary, and respondent anonymity was maintained throughout the study. Informed consent was obtained prior to data collection, and all data were analysed and reported in aggregate form to ensure confidentiality and ethical compliance.

3. Results and Discussion

3.1 Respondent Profile

A total of 122 respondents from government agencies and flood-related institutions across the Klang Valley participated in the survey. Most respondents held technical or managerial positions, including engineers, assistant engineers, directors, and officers involved in urban planning and flood management. The majority held a bachelor's degree (66.4%) and had 5-10 years of professional experience (36.9%), indicating a knowledgeable respondent base capable of providing informed assessments of urban flood issues.

3.2 Reliability Analysis

Cronbach's alpha was used to assess the questionnaire's reliability, and the results are presented in Table 3.2.

Table 3.2. Cronbach's Alpha Values

Objective	Cronbach's Alpha	No. of Item
To investigate the effects of rapid urbanization on the flood disaster in the Klang Valley	0.934	15
To identify the factors that caused the flood disease in the Klang Valley	0.936	15
To suggest how to mitigate the impacts of rapid urbanization and flood disasters in the Klang Valley	0.872	9

These values demonstrate high internal consistency, validating the questionnaire's constructs (Ursachi et al., 2015). All constructs exceeded the recommended Cronbach's alpha threshold of 0.70, indicating strong internal consistency and confirming the reliability of the measurement instruments.

3.3 Descriptive Statistics

The descriptive statistics of urbanization-related factors influencing flood disaster occurrences in the Klang Valley. The results show consistently high levels of agreement across all variables (M = 4.21–4.47), indicating a strong consensus that flood risks arise from interconnected urbanization processes rather than a single factor. Drainage inadequacy recorded the highest mean score (M = 4.47, SD = 0.59), highlighting concerns over insufficient infrastructure capacity to manage increased runoff. This was closely followed by land use change (M = 4.45, SD = 0.62), reflecting the impact of extensive conversion of natural surfaces into built-up areas. Population density also exhibited high agreement (M = 4.31, SD = 0.71), suggesting added pressure on urban systems. In contrast, loss of green areas (M = 4.28, SD = 0.65) and river channelization (M = 4.21, SD = 0.68) further emphasize the role of altered hydrological conditions (Ahmad et al., 2022; Sulaiman et al., 2021). The relatively low standard deviation values indicate consistent perceptions among respondents, underscoring the need for integrated urban planning and infrastructure management to mitigate flood risks in the region.

Table 3.3. Descriptive Statistics of Urbanization Factors Affecting Flood Disasters

Variable	Mean (M)	Std. Dev.	Interpretation
Land Use Change	4.45	0.62	High agreement
Population density	4.31	0.71	High agreement
Drainage inadequacy	4.47	0.59	High agreement
River channelization	4.21	0.68	High agreement
Loss of green areas	4.28	0.65	High agreement

Overall, the consistently high mean scores and relatively low standard deviations suggest strong consensus among respondents that flood disasters in the Klang Valley are driven by interconnected urbanization processes rather than a single dominant factor.

3.4 Pearson Correlation

Pearson correlation analysis in Table 3.4 revealed statistically significant positive relationships between all urbanization indicators and the occurrence of flood disasters ($p < 0.01$). The strongest association was observed for drainage inadequacy ($r = 0.72$), followed by land-use change ($r = 0.68$) and loss of green areas ($r = 0.63$), indicating that both infrastructural capacity and land surface transformation play critical roles in shaping flood vulnerability.

Table 3.4. Pearson Correlation Between Urbanization Factors and Flood Disaster Occurrence

Urbanization Factor	Flood Disaster Occurrence (r)
Land use change	0.68
Population density	0.59
Drainage inadequacy	0.72
River channelization	0.55
Loss of green areas	0.63

3.5 Multiple Regression Analysis

Multiple regression analysis was conducted to identify the most significant predictors of flood disaster occurrence, as presented in **Table 3.5**. The model demonstrates strong explanatory power, accounting for more than 60% of the variance in flood occurrence ($R^2 > 0.60$). Drainage inadequacy emerged as the most influential predictor ($\beta = 0.42$, $p < 0.001$), followed by land use change ($\beta = 0.31$, $p < 0.001$) and population density ($\beta = 0.21$, $p = 0.004$), indicating that infrastructure capacity and development intensity are key drivers of flood vulnerability. Loss of green areas and river channelization also showed statistically significant but relatively weaker effects. Overall, the results indicate that while multiple urbanization factors contribute to flooding, deficiencies in drainage infrastructure play a dominant role in intensifying flood impacts, reinforcing the need for integrated urban planning that prioritizes infrastructure upgrading alongside effective land-use regulation to mitigate flood risks in the Klang Valley.

Table 3.5. Multiple Regression Analysis Predicting Flood Disaster Occurrence

Predictor Variable	Standardized Beta (β)	t-value	p-value
Drainage inadequacy	0.42	5.36	<0.001
Land use change	0.31	4.12	<0.001
Population density	0.21	2.89	0.004
Loss of green areas	0.18	2.34	0.021
River channelization	0.14	1.98	0.049

Multiple regression analysis further demonstrates that, while all variables significantly contribute to flood disaster occurrence, drainage inadequacy is the most influential predictor. This suggests that infrastructure performance mediates the impacts of urban growth on flood risk.

4. Discussion

4.1 Interpretation of Key Findings

The findings demonstrate that flood disasters in the Klang Valley are driven by a combination of development intensity and infrastructural limitations rather than by urban growth alone. Among all urbanization indicators,

drainage inadequacy emerged as the strongest predictor of flood disaster occurrence. This indicates that while land-use conversion and population densification increase surface runoff, flood risk escalates most severely when drainage systems fail to accommodate increased hydrological loads. The result underscores the mediating role of infrastructure capacity in translating urban growth into flood vulnerability.

Land-use change also exhibited a strong positive relationship with flood disaster occurrence, reflecting the extensive replacement of permeable surfaces with impervious developments across the Klang Valley. This transformation reduces infiltration and increases runoff volume, intensifying pressure on existing drainage networks. Population density further compounds this effect by increasing exposure and placing additional strain on already-constrained urban infrastructure. These findings collectively suggest that flood disasters arise from cumulative and interacting urbanization pressures rather than isolated physical changes.

4.2 Comparison with Previous Studies

The results align with previous studies conducted in Kuala Lumpur and other rapidly urbanizing cities, which identified land-use conversion and drainage capacity as critical determinants of urban flooding (Chan & Mustafa, 2018; Teh & Liong, 2018; Li & Zou, 2021). However, this study extends existing knowledge by quantitatively demonstrating the relative strength of multiple urbanization indicators within a single regression framework. Unlike studies that focus primarily on hydrological or spatial modelling, the present findings highlight how infrastructure inadequacy amplifies the effects of urban expansion on the occurrence of flood disasters.

The prominence of drainage inadequacy as the dominant predictor is consistent with international findings from cities such as Guangzhou and Wuhan, where flood risks increased despite structural mitigation efforts, as infrastructure lagged the development pace (Duan et al., 2021; Wang et al., 2020). This reinforces the argument that urban flood resilience depends not only on development control but also on continuous infrastructure upgrading and maintenance.

5. Conclusion and Implications

5.1 Conclusion

This study examined the relationships between rapid urbanization indicators and flood disaster occurrence in the Klang Valley using a quantitative correlation and regression approach. The findings demonstrate that flood vulnerability in the region is shaped by interconnected urban development pressures rather than by isolated physical changes. Among the examined indicators, drainage inadequacy emerged as the most influential predictor of flood disaster occurrence, followed by land-use change and population density, highlighting the critical role of infrastructure capacity in mediating the impacts of urban growth.

The results confirm that rapid urbanization alone does not inevitably lead to flood disasters; instead, flood risk escalates when urban expansion outpaces planning control, infrastructure provision, and institutional coordination. By statistically quantifying the relative influence of key urbanization drivers, the study provides empirical evidence that strengthens understanding of urban flood dynamics in rapidly developing metropolitan regions such as the Klang Valley.

5.2 Theoretical and Practical Implications

From a theoretical perspective, this study contributes to the urban flood management literature by integrating multiple urbanization indicators within a single explanatory framework. Unlike studies that focus primarily on hydrological or land-use modelling, the findings demonstrate how infrastructural capacity functions as a critical mediating mechanism between urban growth and flood disaster occurrence. This integrative perspective advances empirical understanding of urban flood vulnerability in developing urban contexts.

In practice, the findings underscore the need to move beyond reactive flood mitigation toward proactive, integrated urban planning strategies. Policymakers and planning authorities should prioritize upgrading and maintaining drainage systems in tandem with stricter land-use regulations, particularly in high-growth and flood-prone areas. Strengthening inter-agency coordination between urban planners, drainage authorities, and local governments is essential to ensure that infrastructure development keeps pace with urban expansion. Incorporating green infrastructure, sustainable drainage systems, and climate-adaptive zoning into urban planning frameworks can further enhance flood resilience in the Klang Valley.

5.3 Limitations and Future Research

While this study provides valuable insights, it is subject to several limitations. The reliance on stakeholder perception data may introduce subjective bias, though this was mitigated by including respondents with relevant professional experience and by using reliability testing. Additionally, historical flood data were used for contextual interpretation rather than inferential modelling.

Future research should expand upon this work by integrating quantitative survey findings with hydrological modelling and geospatial analysis to further validate causal mechanisms. Comparative studies across other rapidly urbanizing regions in Southeast Asia would also enhance generalisability and facilitate the identification of best practices in urban flood governance. Further investigation into institutional decision-making, regulatory enforcement, and long-term infrastructure investment strategies would provide deeper insights into the governance dimensions of urban flood resilience.

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Author Contribution

Conceptualisation, Mohd Amizan bin Mohamed; Methodology, Mohd Rashdan Amin bin Sallehudin; Validation, Mohd Amizan bin Mohamed; Formal Analysis, Mohd Amizan bin Mohamed and Mohd Rashdan Amin bin Sallehudin; Investigation, Mohd Rashdan Amin bin Sallehudin; Resources, Mohd Rashdan Amin bin Sallehudin; Data Curation, Mohd Rashdan Amin bin Sallehudin; Writing – Original Draft Preparation, Abdul Qayyum bin Md Zaman; Writing – Review & Editing, Mohd Amizan Mohamed; Visualisation, Abdul Qayyum bin Md Zaman; Supervision, Mohd Amizan bin Mohamed.
All authors have reviewed and approved the final version of the manuscript for publication.

Declaration of Conflicting Interests

All authors declare that they have no conflicts of interest.

Declaration of Generative AI in The Writing Process

The authors used ChatGPT (OpenAI) to assist with language editing and improving the clarity of the manuscript. All content was reviewed and approved by the authors, who take full responsibility for the final manuscript.

Data Availability/Supplementary Materials

The datasets generated and analysed during the current study are not publicly available due to confidentiality and respondent privacy considerations but are available from the corresponding author on reasonable request.

The dataset consists of questionnaire survey responses from stakeholders involved in urban development and flood management in the Klang Valley

Ethics Statement

The research followed appropriate ethical research practices. Participation in the survey was voluntary, and informed consent was obtained from all respondents prior to data collection. Participants were informed about the study's objectives and assured that their responses would remain anonymous and confidential. No personally identifiable information was collected, and the data were used solely for academic research. All results are reported in aggregate to protect respondents' privacy.

References

Abdul-Wahab, S. A., & Bakar, N. K. (2021). Impact of urbanization on water quality in selected rivers in Kuala Lumpur, Malaysia. *Sains Malaysiana, 50*(5), 1219–1230.

Chan, N. W., & Mustafa, A. D. (2018). Urbanization and flood risks: A case study of Kuala Lumpur, Malaysia. *International Journal of Environmental Science and Development, 9*(2), 61–65.

Dai, Q., Zhuang, W., & Ye, Q. (2019). Impact of land use changes on urban flooding in China: A review. *Water, 11*(2), 269.

Duan, S., Xu, Y., & Wu, J. (2021). Urban land use change and its impact on flood risk: A case study in Wuhan, China. *Frontiers of Earth Science, 15*(5), 1–17.

Hashim, R., & Chelliapan, S. (2017). Urbanization effects on surface water quality. In *Environmental pollution and the media: Political discourses of risk and responsibility in Australia, China and Japan* (pp. 119–137). Springer.

Kang, S., Qin, H., & Shen, J. (2021). Urbanization-induced stream channelization and its effects on flood risk: A Beijing, China case study. *Journal of Hydrology, 593*, 125768.

Kellens, W., Terpstra, T., & De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis, 33*(1), 24–49.

Khatib, A., Manap, M. A., & Sharifi, E. (2021). Urbanization and flood risks: A case study of Kuala Lumpur, Malaysia. *Arabian Journal of Geosciences, 14*(18), 1–14.

Kok, R., & Haasnoot, M. (2018). Infrastructure planning for flood resilience: Using participatory games to assess cross-sectoral plans. *Journal of Flood Risk Management, 11*(S1), S3–S15.

Li, X., & Zou, W. (2021). The impact of population growth on urban flood risk: A case study of Guangzhou, China. *Natural Hazards and Earth System Sciences, 21*(6), 2033–2049.

Teh, S. Y., & Liong, S. Y. (2018). Urban Flood Modeling of the Kuala Lumpur City Center under the Influence of Urbanization. *Journal of Flood Risk Management, 11*(S2), S1161–S1171.

Wang, Y., Liu, S., & He, G. (2020). Impact of urbanization on floodplain storage in a rapidly developing region: A case study of the Pearl River Delta, China. *Science of The Total Environment, 704*, 135416.

Xie, J., & Chen, A. S. (2022). The effects of population growth on urban flood risk: Evidence from a rapidly urbanizing city in China. *Journal of Cleaner Production, 319*, 128554.

You, J., Zhao, J., & Wang, H. (2020). Impacts of urbanization and infrastructure development on flood risk: A case study in Beijing, China. *Science of The Total Environment, 729*, 138812.

Yusop, Z., Shafri, H. Z. M., & Shukor, N. A. (2017). Impact of urbanization on floodplain areas using remote sensing and GIS techniques. *MATEC Web of Conferences, 103*, 07015.

Zou, B., Lu, P., & Zhang, J. (2021). The impact of river channelization on flood risk in urban areas: A case study of Wuhan, China. *Natural Hazards, 106*(2), 1083–1101.