Application of the Sponge City Concept in Malaysia through International Case Studies

*Aiman Al Fahmi Abdul Kashaf[1], Yusfida Ayu Abdullah[2], Nurulhusna Qamaruz Zaman[1] and Hamizah Yakob[2]

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Abstract: Flash floods are a significant and recurring issue in Malaysia, particularly during monsoon seasons. Rapid-onset floods, in particular, can cause substantial damage to infrastructure and property while posing risks to human safety. Understanding the causes, impacts and strategies to mitigate flash floods is crucial to developing effective responses and enhancing resilience. For example, proactive measures and comprehensive strategies such as the "sponge city" concept can mitigate the impacts of floods. This study aimed to assess the practice of the sponge city concept in Malaysia based on global best practices and its implementation. To understand the effectiveness and applicability of the sponge city strategy, a comparative study of various international case studies was conducted. This study delved into the strategies and unique approaches implemented in China, Australia, Thailand, Indonesia and Singapore. It is believed that significant progress can be achieved by learning from the experiences of other countries, specifically in addressing these challenges. This helps develop policy frameworks, secure adequate funding, foster public and private sector collaboration, build technical capacity and engage communities. By learning from the experiences of the case studies, Malaysia can enhance its sponge city initiatives to effectively manage stormwater, reduce flooding and improve urban resilience. Moreover, the implementation of a combination of green infrastructure, smart water management technologies, community engagement and supportive policies is the key to the successful transformation of Malaysian cities into resilient and sustainable sponge cities.

Keywords: Urban flood, Resilience, Sponge city, Nature-based solutions, Stormwater management

INTRODUCTION

In December 2021, Malaysia experienced one of its worst flood disasters in decades, primarily affecting the central and eastern regions of Peninsular Malaysia. The flooding was caused by continuous heavy rainfall over several days and was exacerbated by the northeast monsoon. Besides the unique tropical climate of Malaysia, factors such as urbanisation and fluvial floods contribute significantly to the occurrence of flooding. For example, the

[1]School of Architecture and Interior Architecture, Faculty of Built Environment, Universiti Teknologi MARA, 42300 Bandar Puncak Alam, Selangor, MALAYSIA
[2]School of Town Planning and Landscape Architecture, Faculty of Built Environment, Universiti Teknologi MARA, 42300 Bandar Puncak Alam, Selangor, MALAYSIA
*Corresponding author: aimanalfahmi96@gmail.com

increase in paved surfaces due to urban development hinders water infiltration and movement to nearby rivers, exacerbating urban flood risks (Saliluddin, 2019). Accordingly, urban flooding in Malaysia can be primarily caused by a combination of factors such as rapid urbanisation, intense rainfall, blocked drainage systems and inadequate flood control infrastructure (Hasan et al., 2019; Yusmah et al., 2020; Tella et al., 2023). This calls for the critical need for improved urban planning, enhanced drainage infrastructure and effective flood mitigation strategies.

A "sponge city" is defined as an innovative urban design concept aimed at enhancing stormwater management by mimicking natural water absorption and filtration processes (Ahmed et al., 2024). This concept involves constructing cities as large sponges to absorb and treat water. It addresses issues such as urban flooding and water pollution by creating water-absorbing areas, increasing permeable surfaces and integrating stormwater and drainage systems (Nguyen et al., 2020; Yin et al., 2022). Key principles include urban water resourcing and the transformation of traditional infrastructures into green spaces, which collectively contribute to a self-regenerating ecosystem that addresses excess precipitation and flooding.

Pilot projects in cities in China found significant reductions in runoff, peak flow and pollutant concentrations, contributing to improved urban water environments and sustainable development (Yin et al., 2022). The successful implementation of sponge cities relies on environmentally friendly materials and multidisciplinary strategies, necessitating robust policy support and public engagement. Moreover, the integration of urban greening within sponge cities not only controls floods but also improves urban landscapes and climate conditions. This paper aimed to analyse the best practices and implementation of the sponge city concept via assessments of current initiatives and relevant policies. Through the understanding of the initiatives and understanding of policies, planning frameworks, key challenges and barriers can be highlighted. Therefore, this work offers practical recommendations for the implementation of the sponge city in Malaysia.

Flooding in Malaysia

Malaysia is vulnerable to frequent flood disasters, especially during monsoon seasons (Rosmadi et al., 2023). The increase in extreme weather events and intense precipitation exacerbates the country's flood vulnerability as they lead to devastating effects on communities and infrastructure (Chan, 2018). In 2023, Malaysia encountered severe flood disasters that impacted multiple states. On 25 January 2023, Johor, Pahang and Sabah were hit by intense rainfall, which led to extensive flooding that displaced thousands

and caused substantial damage to homes, infrastructure and farmlands in the states. This was followed by another series of floods on 1st March 2023, affecting Johor, Pahang, Melaka, Negeri Sembilan, Sarawak and Sabah. The successive flood events disrupted the lives of approximately 35,000 people (Rosmadi et al., 2023).

Floods, often triggered by intense and prolonged rainfall, affect tens of thousands of people annually, causing widespread displacement, substantial damage to homes, infrastructure and agricultural lands, as well as considerable economic losses (Yusmah et al., 2020). There were also fatalities each year, particularly in Kelantan, Johor and Pahang. For instance, in 2021, 69 lives were lost due to floods. The repeated flood incidents, which affected up to 160,000 people in a single year, underscore the urgent need for Malaysia to enhance its flood mitigation strategies by improving infrastructure resilience and developing comprehensive emergency response systems (Rosmadi et al., 2023). Hence, it is vital to protect vulnerable communities and reduce the devastating impacts of future floods (Yusoff et al., 2018).

Definition and Historical Background of Sponge City

A sponge city is a city with a water system that is highly adaptable to environmental changes and natural disasters. The city acts like a sponge, absorbing, storing, infiltrating, cleaning and purifying rainwater before releasing it for reuse (Li et al., 2017; Qi et al., 2021; Yin et al., 2021). Figure 1 shows the concept of the sponge city water system. In the process of rainfall, the city can permeate, reduce emissions and collect, store and utilise rainwater. Introduced in China in 2014, this approach integrates green infrastructure, permeable pavements and ecological water management to mitigate urban flooding, improve groundwater recharge and enhance water quality.

Figure 1. Schematic diagram of the sponge city concept

Source: Chan et al. (2018)

Global Practices and Approaches

The sponge city planning has been thoroughly studied abroad from as early as the middle of the 20th century. For example, Australia advocated a water-sensitive urban design (WSUD) to scientifically improve the country's water recycling system, whereas the United States applied low-impact development (LID) in urban design to create a rainwater management system (Li et al., 2017) while Singapore produced a water guideline, Active, Beautiful, Clean Waters (ABC Waters) Programme.

Characteristics of Sponge Cities

Sponge cities are innovative urban designs aimed at enhancing flood management through the integration of green infrastructure and sustainable water management practices. Key characteristics include urban water resourcing, ecological water management and the use of permeable materials that mimic natural water cycles, allowing for effective rainwater infiltration, retention and purification (Ahmed et al., 2024). These cities mitigate urban flooding risks by utilising features such as green roofs, rain gardens and permeable pavements to reduce surface runoff and improve groundwater recharge (Balado and Solla, 2024). Additionally, sponge cities promote the restoration of natural water bodies, which enhances the urban ecosystem

and addresses water scarcity issues, particularly in rapidly urbanising areas (Khadra, Pál-Schreiner and Gyergyák, 2024). Overall, the sponge city approach not only addresses immediate flood management challenges but also contributes to long-term urban sustainability and resilience against climate change impacts (Ahmed et al., 2024).

Theoretical Framework of Sponge Cities

According to Kongjian Yu (2012), a prominent landscape architect and urban planner, the concept of a sponge city refers to an urban environment designed to manage water in a sustainable and resilient manner. It focuses on using natural and ecological methods to retain rainwater, alleviate flooding issues, reduce water environment damage and restore hydrological balance in urban areas. The idea is to create cities that absorb, store, infiltrate and purify rainwater through natural processes, much like a sponge. It is a crucial part of China's green and sustainable development goals, aligning with the country's vision for ecological civilisation (Chen et al., 2021).

The construction of sponge cities involves combining various technologies to address urban water challenges like flooding, water pollution and water resource scarcity (Griffiths et al., 2020). By integrating low-impact development techniques, sponge city initiatives aim to merge ecosystem conservation with urban development to mitigate urban flooding, pollution and enhance water supply (Ahmad and Ayob, 2023). The concept also emphasises the importance of sustainable urban development that can contribute to future urban resilience and sustainability (Ma, Liu and Wang, 2023; Yin et al., 2021).

Challenges and Limitations

A sponge city is an urban construction model designed to manage water resources in a way that mimics the natural water cycle. Figure 2 illustrates the framework of a sponge city, which integrates various approaches and technologies to enhance the absorption, storage and drainage of rainwater.

Urban water problems in Malaysia, such as water shortages, waterlogging, water pollution and ecological degradation, are interrelated challenges. Rapid urbanisation and population growth have increased water demand, while inefficient infrastructure and climate change exacerbate shortages. Poor drainage systems and extensive urban development result in frequent waterlogging, damaging infrastructure and disrupting daily life. Industrial discharge, untreated domestic waste and agricultural runoff lead to severe water pollution, posing health risks and harming aquatic ecosystems. Additionally, deforestation and wetland destruction for urban expansion contribute to ecological degradation, reducing biodiversity and compromising natural systems that provide essential services. Addressing these issues

requires integrated water resource management, such as the sponge city concept. The sponge city infrastructure encompasses comprehensive projects aimed at enhancing urban water management and resilience (Nethmika and Mahanama, 2023).

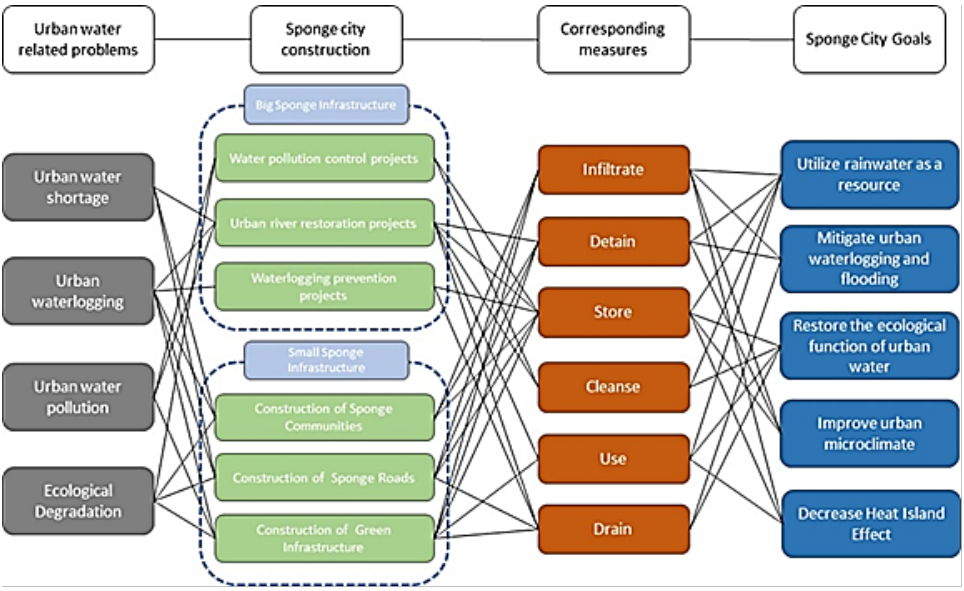

Figure 2. Framework of the sponge city concept

Source: NAHRIM (2019)

Future Directions and Applications

The key components for sponge cities include water pollution control projects, which involve the installation of advanced filtration systems, green roofs and constructed wetlands to treat and reduce contaminants in runoff before they reach natural water bodies (Song, 2022). Urban restoration projects focus on revitalising ecosystems within cities, such as restoring rivers, lakes and wetlands, and incorporating permeable pavements and green spaces to increase water infiltration and biodiversity. Waterlogging prevention projects are designed to mitigate flooding through the construction of extensive drainage networks, rainwater harvesting systems and retention basins that absorb and slowly release stormwater (Song, 2022). Together, these infrastructures create a multi-layered approach that improves water quality, reduces flood risks and restores natural hydrological cycles, making cities more sustainable and resilient to climate change impacts (Nguyen et al., 2020).

RESEARCH METHOD

The research utilised a qualitative method, mainly a comparative analysis of case studies. Case studies should represent a diverse range of geographical, climatic and socio-economic contexts to ensure a comprehensive analysis, as shown in Figure 3. The method provided a structured approach to examine the strategies, outcomes and challenges of different countries in implementing a sponge city. The process involved identifying and selecting relevant case studies from countries that had established sponge city initiatives, namely China, Australia, Thailand, Indonesia and Singapore.

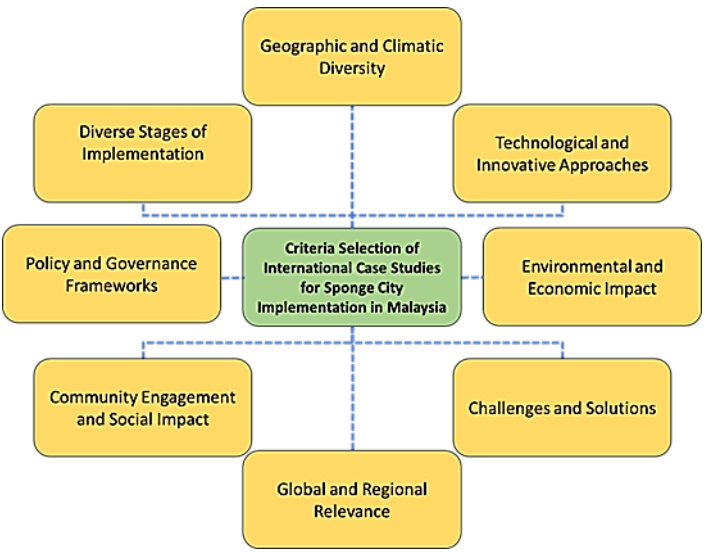

Figure 3. Criteria selection of international case studies for sponge city implementation in Malaysia

Data collection is crucial to gather relevant information on each case study. The current study documented sponge city strategies and interventions implemented in each location. The next step was to examine the sponge city strategies and outcomes within each case study, as well as across multiple case studies, using the matrix analysis method. The findings from the comparative analysis were synthesised to identify the key lessons learned, best practices and recommendations for policymakers, urban planners and practitioners interested in implementing sponge city strategies. This will reflect on the implications of the findings for theory, practice and future research in the field of urban resilience and sustainable water management related to sponge city.

RESULTS AND DISCUSSION

Future Directions and Applications

International case studies on sponge cities provide valuable insights into the strategies, key projects and policy, as well as the regulations for implementing the sponge city as a sustainable urban water management approach. Case studies from countries that had adopted the sponge city strategies in their respective flood mitigation and management were selected for analysis.

Across China, Australia, Thailand, Indonesia and Singapore, the sponge city strategies demonstrated significant benefits in terms of flood mitigation, water quality improvement and urban resilience. While each country faced unique challenges related to financial, technical and spatial constraints, the overall positive outcomes highlighted the importance of integrating green and blue infrastructure, smart water management and community engagement in urban planning. Therefore, continued investment, policy support and public participation are essential for the successful implementation and sustainability of sponge city initiatives globally.

Action for Malaysia to Implement Sponge City

Malaysia can learn from the experiences and strategies of other countries, such as China, Australia, Singapore, Thailand and Indonesia, to enhance its sponge city initiatives. Figure 4 outlines some key lessons that Malaysia can use to act and improvise in their implementation of the sponge city concept for flood mitigation in the future. Furthermore, Malaysia can enhance its implementation of the sponge city concept by adopting a comprehensive and integrated approach to urban water management from the lessons drawn from China, Australia, Thailand, Indonesia and Singapore case studies. This includes developing strong national policies and securing sufficient funding for large-scale projects, similar to China's approach. Malaysia should incorporate water-sensitive urban design principles and robust community engagement programmes, such as those adopted in Australia, to ensure sustainable and inclusive planning. Leveraging low-cost, low-tech solutions and integrating traditional practices can make the strategies more accessible and culturally relevant, as inspired by the case studies done in Thailand and Indonesia. Finally, Malaysia can adopt Singapore's model of integrated urban water management and technological innovations, supported by strong governance and clear policy frameworks, to build resilient and adaptive urban environments.

Table 1. International case studies of sponge cities

Country	Strategies	Key Projects	Policy and Regulatory	Review
Malaysia	1. Green infrastructure: Use of green roofs, permeable pavements and rain gardens. 2. Wetland restoration: Restoring natural wetlands and creation of retention and detention ponds to manage stormwater.	1. Kuala Lumpur: The implementation of the SMART tunnel and various green infrastructure projects to manage urban flooding. 2. Pulau Pinang: Initiatives to enhance urban drainage systems and incorporate green infrastructure in urban planning. 3. Iskandar Puteri: A significant focus on green infrastructure, including rain gardens, permeable pavements and green roofs as part of the Iskandar Malaysia Urban Observatory.	1. National Water Resources Policy: i. Provide guidelines and frameworks for integrated water resource management. ii. Enforced through national and regional regulations. 2. Financial incentives: i. Encourage private sector participation and investment in green infrastructure and sustainable urban development. ii. Tax incentives, grants and subsidies for green projects.	Malaysia flood mitigation focuses more on structural measures such as the SMART tunnel and several green infrastructure projects. Thus, Malaysia has introduced the Nature Based Solution in recent projects. Some of the projects were initiated by the developers. However, Malaysia is still inadequate in terms of using nature in combating floods.

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Table 1. *Continued*

Country	Strategies	Key Projects	Policy and Regulatory	Review
China	1. Green infrastructure: Extensive use of green roofs, permeable pavements and rain gardens. 2. Wetland restoration: Restoring natural wetlands. Creation of retention and detention ponds to manage stormwater.	1. Wuhan: Integrated Water Management Hydrological Park Systems 2. Shenzhen: Urban Green Spaces with Smart Water Systems – Implementation of advanced monitoring and management systems. 3. Shanghai: i. Sponge city districts: Development of specific districts with comprehensive sponge city features. ii. Restoration projects: Restoration of natural waterways.	1. National guidelines: The Chinese government has issued guidelines and standards for the design and implementation of sponge cities, providing a framework for local governments. 2. Funding and incentives: Providing substantial funding and incentives for pilot projects in selected cities to implement sponge city strategies effectively.	Sponge city in China has shown positive outcomes in handling flood issues. Ranging from small-scale to city-scale projects, this national guideline has provided benefits to their community.
Australia	1. Integrated Water Management WSUD: This approach integrates the urban water cycle, including stormwater, groundwater and wastewater management, into urban planning and design.	1. Melbourne WSUD: i. Melbourne is a leader in WSUD, incorporating it into urban planning and development. ii. Urban forest strategy: Increasing tree canopy cover to improve rainwater absorption and reduce urban heat islands.	WSUD guidelines and standards: Developing guidelines and standards for Water Sensitive Urban Design to ensure new developments incorporate sustainable water management practices.	The government initiative on water control throughout the country has produced a resilient and natural-based solution for urban areas. Water-sensitive urban design guidelines can be a reference for other countries to manage water and flood disasters effectively.

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Table 1. *Continued*

Country	Strategies	Key Projects	Policy and Regulatory	Review
	2. Green infrastructure: i. Green roofs and walls. ii. Urban forests and tree canopy. 3. Blue-green corridors: i. Creek and river restoration. ii. Creating artificial wetlands. 4. Permeable surfaces: i. Permeable pavements. ii. Bioswales and rain gardens.	2. Sydney: i. Green square urban renewal – Integrating WSUD principles, including rainwater harvesting, green roofs and permeable pavements, into the redevelopment of Green Square. ii. Parramatta River restoration: Restoring the Parramatta River to improve water quality, enhance biodiversity and provide recreational opportunities. 3. Brisbane: i. Flood Resilient Homes Programme: Providing guidelines and support for building flood-resilient homes in flood-prone areas. ii. WaterSmart cities: Implementing WSUD principles and creating blue-green corridors to manage stormwater and enhance urban resilience.	Greenbuilding certifications: Promoting green building certifications such as Green Star and NABERS, which include water management criteria.	

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Table 1. *Continued*

Country	Strategies	Key Projects	Policy and Regulatory	Review
Thailand	1. Green infrastructure: i. Urban parks and green spaces ii. Chulalongkorn University Centenary Park). iii. Green roofs and walls. 2. Water management systems: i. Retention and detention ponds (Thammasat University rooftop farm). ii. Artificial lakes and wetlands. 3. Blue-green integration: i. Canal restoration (Saen Saeb Canal). ii. Naturalised waterways.	1. Chulalongkorn University Centenary Park: Design features – The park includes a multilayered retention pond, green rooftops and a rain garden. It is designed to capture and retain up to one million gallons of water. 2. Benjakitti Park expansion: Green and blue integration – The expansion project includes a large retention pond, wetland areas and extensive green space that serves as flood control and recreational areas. 3. Thammasat University rooftop farm: Innovative design – This project features an urban farm on the rooftop, designed to capture rainwater and use it for irrigation, reducing runoff and promoting sustainable agriculture within the city.	1. Supportive policies: Implementation of policies and regulations that promote the adoption of green infrastructure and sustainable water management practices. 2. Incentives and funding: Providing financial incentives, grants and subsidies to encourage the implementation of sponge city initiatives by private developers and property owners.	Thailand has used parks as the sponge infrastructure to deal with floods in city areas. Even though they only have minimal guidelines from the government on flood management, they manage to deliver flood-resilient projects based on local expertise.

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Table 1. *Continued*

Country	Strategies	Key Projects	Policy and Regulatory	Review
Indonesia	Green infrastructure urban parks and green spaces (Waduk Pluit [Pluit Reservoir] Park).	1. Waduk Pluit (Pluit Reservoir) Park: Design features – This project combines flood control with recreational and green spaces. The reservoir helps manage stormwater and mitigate flooding while providing a park for residents. 2. Waduk Melati (Melati Reservoir) and Waduk Setiabudi: Flood control – These reservoirs are crucial for stormwater management in Jakarta, capturing and storing excess rainwater during heavy rain events.	1. Supportive policies: Implementing policies and regulations that promote the adoption of green infrastructure and sustainable water management practices. 2. Incentives and funding: Providing financial incentives, grants and subsidies to encourage developers and property owners to implement sponge city features.	Indonesia has invested in big-scale projects such as reservoirs to minimise flood impact in the country. The government initiative on disaster solutions has set a good benchmark for other countries.
Singapore	1. Integrated water management: i. ABC Waters Programme. ii. Water catchment areas. 2. Blue-green integration: Naturalised waterways, retention ponds and wetlands. 3. Permeable surfaces: Permeable pavements – Porous concrete and asphalt.	Kallang River at Bishan-Ang Mo Kio Park: 1. Integrates flood management with ecological and recreational functions. 2. Transforming concrete canals into naturalised rivers with vegetated banks.	1. Supportive policies: Implementing policies and regulations that promote the adoption of green infrastructure and sustainable water management practices. 2. Incentives and grants: Providing financial incentives, subsidies and grants to encourage developers and property owners to implement ABC Waters design features.	Singapore government has established a water guideline in terms of management of flood resilience and water quality. At this point, this country has shown a proactive approach to avoid disaster in the country.

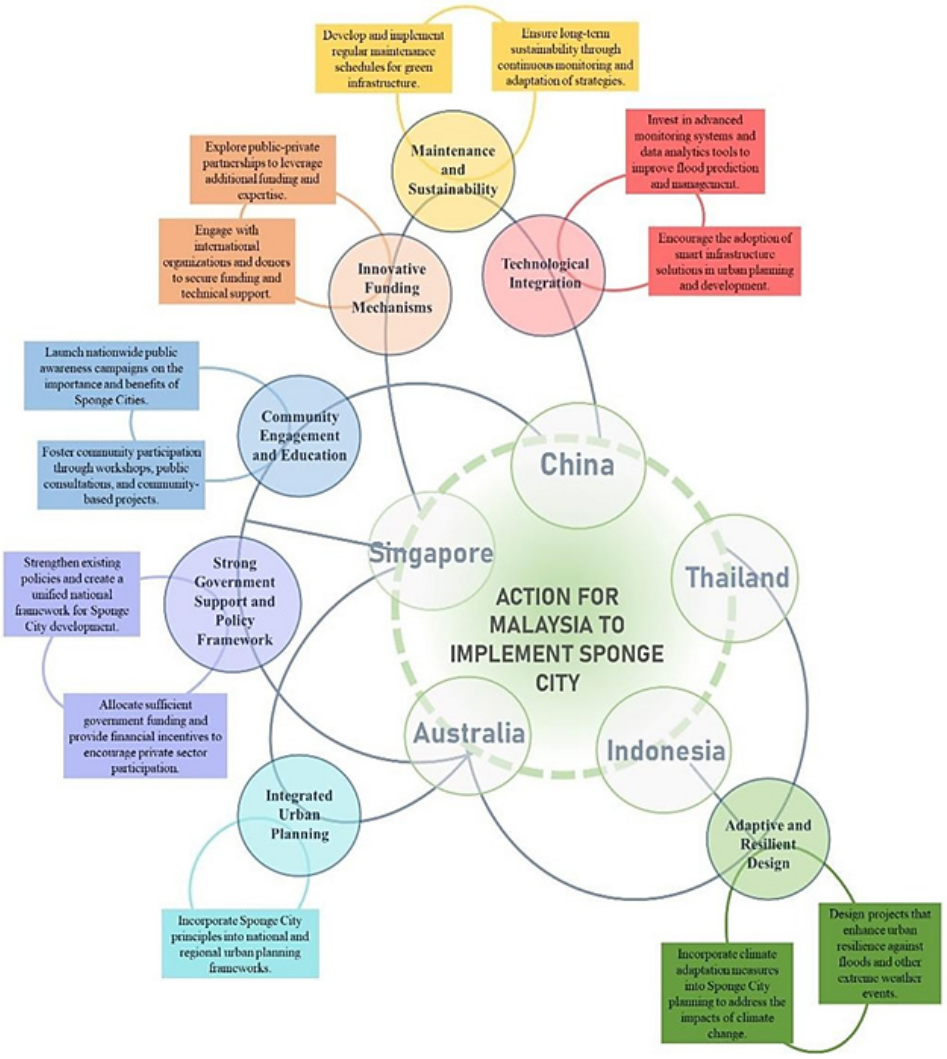

Figure 4. Action for Malaysia to implement the sponge city concept

Challenges of Implementing the Sponge City Concept in Malaysia

Implementing sponge city strategies in Malaysia involves navigating several challenges, including financial constraints, regulatory complexities, technical hurdles and social issues. Significant upfront investment and ongoing maintenance costs for green infrastructure like green roofs, permeable pavements and stormwater systems pose financial difficulties (Ahmad and Ayob, 2023). Malaysia lacks a cohesive policy framework and effective regulatory enforcement, requiring better coordination among government

agencies. Adapting successful strategies from other countries to Malaysia's unique climatic and urban conditions and integrating new infrastructure with existing systems presents technical challenges. Densely populated cities, such as Kuala Lumpur, have a scarcity of space for large-scale green projects to balance green spaces with urban development priorities (D'Ayala et al., 2020). This makes it vital to ensure cultural acceptance and social equity in sponge city initiatives for inclusiveness purposes. Thus, raising public awareness and encouraging behavioural changes are essential for community support. Reliable monitoring and evaluation systems are also crucial in the assessment of project effectiveness. Moreover, scaling successful pilot projects and encouraging private sector participation requires careful planning and attractive incentives.

CONCLUSION

The sponge city concepts have significant potential for addressing urban water management challenges in Malaysia. By utilising nature-based approaches and innovative urban planning, sponge cities can effectively mitigate issues such as flooding, water shortage and water pollution. Implementing sponge city strategies can optimise urban land use structures, enhance water ecological restoration and promote the utilisation of rainwater resources. Collaborative management frameworks based on the regional and interregional analyses can further enhance the effectiveness of sponge city initiatives in Malaysia. Embracing sponge city principles can lead to sustainable urban development, improved water management and enhanced resilience to climate change impacts in Malaysian cities.

By learning from the experiences of China, Australia, Thailand, Indonesia and Singapore, Malaysia can enhance its sponge city initiatives to effectively manage stormwater and flooding, and improve urban resilience. The implementation of a combination of green infrastructure, smart water management technologies, community engagement and supportive policies will be the key to the successful transformation of Malaysian cities into resilient and sustainable sponge cities.

REFERENCES

Ahmad, A.J. and Ayob, M.F. (2023). Flood mitigation management practice: A comparison between stormwater management road tunnel (SMART) and sponge city methods. *Journal of Project Management Practice*, 3(2): 1–17. https://doi.org/10.22452/jpmp.vol3no2.1

Ahmed, H.G., Aziz, S.Q., Wu, B., Ahmed, M.S., Jha, K.K., Wang, Z., Nie, Y. and Huang, T. (2024). Application of sponge city for controlling surface runoff pollution. *Asian Journal of Environment and Ecology*, 23(9): 1–23. https://doi.org/10.9734/ajee/2024/v23i9593

Balado, J. and Solla, M. (2024). Multi-criteria GIS for sponge city planning with open data sources in Vigo (Spain). *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, X-4/W5-2024: 41–48. https://doi.org/10.5194/isprs-annals-x-4-w5-2024-41-2024

Chan, N.W. (2014). Impacts of disasters and disaster risk management in Malaysia: The case of floods. In D.P. Aldrich, S. Oum and, Y. Sawada (eds.), *Resilience and Recovery in Asian Disasters: Community Ties, Market Mechanisms and Governance*. Tokyo: Springer Tokyo, 239–265. https://doi.org/10.1007/978-4-431-55022-8_12

Chan, F.K.S., Griffiths, J.A., Higgitt, D., Xu, S., Zhu, F., Tang, Y.T., Xu, Y. and Thorne, C.R. (2018). "Sponge city" in China: A breakthrough of planning and flood risk management in the urban context. *Land Use Policy*, 76: 772–778. https://doi.org/10.1016/j.landusepol.2018.03.005

Chen, S., Van de Ven, F.H.M., Zevenbergen, C., Verbeeck, S., Ye, Q., Zhang, W. and Wei, L. (2021). Revisiting China's sponge city planning approach: Lessons from a case study on Qinhuai District, Nanjing. *Frontiers in Environmental Science*, 9: 748231. https://doi.org/10.3389/fenvs.2021.748231

D'Ayala, Di., Wang, K., Yan, Y., Smith, H., Massam, A., Filipova, V. and Jacqueline Pereira, J. (2020). Flood vulnerability and risk assessment of urban traditional buildings in a heritage district of Kuala Lumpur, Malaysia. *Natural Hazards and Earth System Sciences*, 20(8): 2221–2241. https://doi.org/10.5194/nhess-20-2221-2020

Griffiths, J., Shun Chan, F.K., Shao, M., Zhu, F. and Higgitt, D.L. (2020). Interpretation and application of sponge city guidelines in China. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Science*s, 378(2168): 20190222. https://doi.org/10.1098/rsta.2019.0222

Hasan, H.H., Fatin, S., Razali, M., Zafuan, A., Ahmad, I. and Hamzah, F.M. (2019). Integrated hydrological-hydraulic model for flood simulation in tropical urban catchment. *Sustainability*, 11(23): 6700. https://doi.org/10.3390/su11236700

Khadra, L.B., Pál-Schreiner, J. and Gyergyák, J. (2024). Integrating sponge city elements in Pécs' green gate project. *Pollack Periodica*, 20(2): 147–152. https://doi.org/10.1556/606.2024.01056

Li, H., Ding, L., Ren, M., Li, C. and Wang, H. (2017). Sponge city construction in China: A survey of the challenges and opportunities. *Water*, 9(9): 594. https://doi.org/10.3390/w9090594

Ma, J., Liu, D. and Wang, Z. (2023). Sponge city construction and urban economic sustainable development: An ecological philosophical perspective. *International Journal of Environmental Research and Public Health*, 20(3): 1694. https://doi.org/10.3390/ijerph20031694

NAHRIM (National Water Research Institute of Malaysia) (2019). Framework for sponge city: Integrated action mechanism. Slides presented at the Regional Workshop on Climate Change and Urban Flooding Management. Daegu, South Korea.

Nethmika, T.A.T. and Mahanama, P.K.S. (2023). Study on the applicability of sponge city concept to flood resilient in Sri Lankan cities: Boralesgamuwa and sub urban areas. *FARU Journal*, 10(1): 59–72. https://doi.org/10.4038/faruj.v10i1.192

Nguyen, T.T., Ngo, H.H., Guo, W. and Wang, X.C. (2020). A new model framework for sponge city implementation: Emerging challenges and future developments. *Journal of Environmental Management*, 253: 109689. https://doi.org/10.1016/j.jenvman.2019.109689

Qi, Y., Chan, F.K.S., Griffiths, J., Feng, M., Sang, Y., O'donnell, E., Hutchins, M., Thadani, D.R., Li, G., Shao, M., Xie, L., Liu, S., Zhang, C., Li, X., Liu, L. and Zhong, M. (2021). Sponge city program (SCP) and urban flood management (UFM): The case of Guiyang, SW China. *Water*, 13(19): 2784. https://doi.org/10.3390/w13192784

Rosmadi, H.S., Ahmed, M.F., Mokhtar, M.B. and Lim, C.K. (2023). Reviewing challenges of flood risk management in Malaysia. *Water*, 15(13): 2390. https://doi.org/10.3390/w15132390

Saliluddin, S.M. (2019). Tows matrix of environmental health management for flood disaster in Malaysia. *International Journal of Public Health and Clinical Sciences*, 6(1): 1–21. https://doi.org/10.32827/ijphcs.6.1.1

Song, C. (2022). Application of nature-based measures in China's sponge city initiative: Current trends and perspectives. *Nature-Based Solutions*, 2: 100010. https://doi.org/10.1016/j.nbsj.2022.100010

Tella, A., Raza, M., Mustafa, U., Balogun, A.O., Okolie, C.J. and Bello, I. (2023). Spatial prediction of flood in Kuala Lumpur City of Malaysia using logistic regression. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLVIII-4/W6-2022: 363–369. https://doi.org/10.5194/isprs-archives-xlviii-4-w6-2022-363-2023

Yin, D., Chen, Y., Jia, H., Wang, Q., Chen, Z., Xu, C., Li, Q., Wang, W., Yang, Y., Fu, G. and Chen, A.S. (2021). Sponge city practice in China: A review of construction, assessment, operational and maintenance. *Journal of Cleaner Production*, 280: 124963. https://doi.org/10.1016/j.jclepro.2020.124963

Yin, D., Xu, C., Jia, H., Yang, Y., Sun, C., Wang, Q. and Liu, S. (2022). Sponge city practices in China: From pilot exploration to systemic demonstration. *Water*, 14(10): 1531. https://doi.org/10.3390/w14101531

Yu, K. (2012). Ecological security patterns for sustainable urban development. *Cities*, 29(6): 481–491.

Yusmah, M.Y.S., Bracken, L.J., Sahdan, Z., Norhaslina, H., Melasutra, M.D., Ghaffarianhoseini, A., Sumiliana, S. and Farisha, A.S.S. (2020). Understanding urban flood vulnerability and resilience: A case study of Kuantan, Pahang, Malaysia. *Natural Hazards*, 101(2): 551–571. https://doi.org/10.1007/s11069-020-03885-1

Yusoff, I.M., Ramli, A., Alkasirah, N.A.M. and Nasir, N.M. (2018). Exploring the managing of flood disaster: A Malaysian perspective. *Malaysian Journal of Society and Space*, 14(3): 24–36. https://doi.org/10.17576/geo-2018-1403-03