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Application of Resilience Model for Flood Management in Local Planning Context

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Abstract

Combination of rapid urbanisation and climate change likely results in significantly larger flood impact compared to the previous flood events. Complexity in urbanisation process and uncertain climate factor are the main challenges faced by urban planners in developing a safe and less vulnerable city. The existing traditional flood management depends on the flood-control measure cannot cope with the emergent flood. In this context, the concept of resilience gained much attention as a relatively new approach in urban areas. This paper therefore presents a study on the application of resilience model for flood management in urban areas. Kuala Lumpur which is located at the Southeast Asia region was chosen as the case study due to its compact urban area and densely populated. A case study method and qualitative approach were employed in conducting the study. Results obtained from the study revealed that Kuala Lumpur had not extensively practice a comprehensive urban flood management approach based on the resilience model. However, the intention to change from typical and conventional measures into resilience and holistic approach is evident and promising.

Keywords: Resilience model, Flood management, Urban area, Local planning

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INTRODUCTION

History shows that natural disasters occurred all over the place, and one of them are floods. The urban flood caused countless damage and loss particularly in the highly vulnerable areas, despite being protected by an extensive flood-control infrastructure, such as levees, dams, and drainage system. Over the past decades increasing numbers of developments related to human activities have certainly caused changes in the flood hazards for example occurrence frequency, duration and magnitude of high flows. Helm (1998) illustrated the relation between flood risk and vulnerability by either reducing the level of exposure of the region (through improving capacities) or

reducing the vulnerability (through resistance and resilience increasing measures). Hazard can be explained as a chance or probability of a certain flood event to happen at any time and place, commonly expressed as occurrences. While, vulnerability is defined as the degree to which a system or asset that make it susceptible to the damaging effects of a hazardous event (ISDR, 2007).

Over the past decades Malaysia has experienced numbers of disastrous natural events such as floods, landslides, tsunami and these have caused a significant impact in terms of economic growth and urbanization. Many areas in both rural and urban area have been affected by the flood and caused massive damage and losses (Chan, Zakaria, Ghani, and Lian, 1997). Furthermore, to fulfills the need for development and urbanization, floodplain and upstream areas have been exploited which will increase the vulnerability and exposure of this area and the local inhabitants to the future flood disaster. Nowadays, urban flood management is becoming multifaceted and more complex due to the endless factors such as uncontrolled developments and rapid urbanization that are related and interconnected. Various mitigation strategies have been introduced, in search for more holistic and comprehensive measures for flood management. Among these new approaches, the concept of resilience gained attention and considered as a promising framework that integrating both fields, environmental management and urban planning.

LITERATURE REVIEW

Resilience Model and Flood Management

The term resilience originates from most of physics and engineering literature, as characteristic of a spring to withstand an external shock and the ability to return to the stable state after such a disruption (Davoudi, 2012). However, its implementation in the fields of ecology and spatial planning practice embraces the possibility of a system to flip into a new or alternative domains (Folke, 2006) due to the complexity and uncertainty as they extend geologically, financially, socially and politically (Disse, M., et al., 2020).

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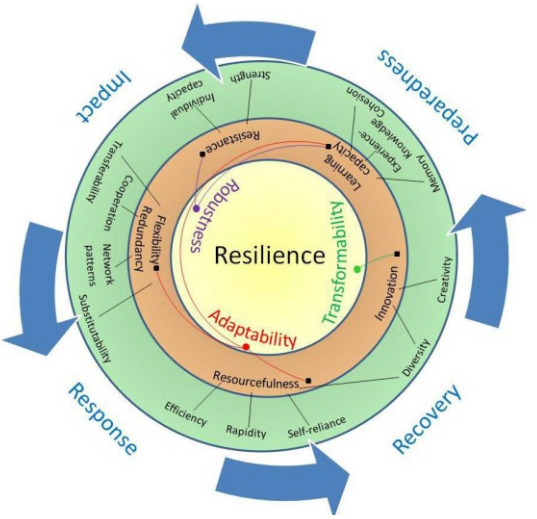

Figure 1: *The Ring Model of Resilience (Galderisi et al., 2010)*

Galderisi et al. (2010) in the "Ring Model of Resilience" addressed three main components includes robustness, adaptability and transformability that could overcome the interpretations and overlapping issues between resilience and vulnerability in the different phases of the disaster cycle. Robustness refers to the ability of city and its element (human and physical system) to withstand a given level of stress without suffering degradation or loss of function. While adaptability refers to the capacity to adapt in face of the consequences of a hazardous event and the last one, transformability reflects on the possibility to turn the disaster into an opportunity by creating different conditions, sometimes more desirable, with respect to the pre-impact configuration.

Flood management involves all activities that enable an area to maintain or improve the way it copes with flood waves, storm surges, peak discharges or excessive rainfall (de Bruijn and Klein, 2001). There are various measures in flood management as Meijerink and Dicke (2008) have illustrated in three main strategies that focus on; - i) hazards reduction; ii) exposure reduction and; iii) vulnerability reduction. The first strategy emphasises on the city's robustness to keep the flood away from people or urban area. This traditional engineering solution through the construction of dams, barrier or river dykes (Kendrick, 1988; McMinn, Yang and Scholz, 2010; and Tingsanchali, 2011) is highly effective in some circumstances and conditions such as for a long terms solution and required a strong financial support. While on the others

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hand, they tend to transfer flood risk from one location only to increase it in another (World Bank, 2012).

The second strategy is aim at reducing the impact of the flood. As more cities are already located and concentrated in deltas and flood prone area, this strategy focuses to reduce vulnerability within the city by preparing the urban area or people for floods. Early warning systems and evacuation systems are the examples of approach that will ensure urban areas are better prepare for flooding. Flood risk map and flood insurance also are logical instruments in this strategy.

Last but not least, current policy makers and water managers increasingly aimed at reducing the exposure and vulnerability to flooding by preventing any new development in flood-prone areas such as in river banks. In other word, this strategy imposes to keep people or urban areas away from floods (Meijerink and Dicke, 2008). This strategy is seen to be the most efficient in reducing flood risk and against a dynamic and wide range of hazards (Disse, M., et al., 2020). . However, it is the hardest strategy to implement. It is almost impossible to prevent or relocate any development in floodplain and river basin area because many cities, and urban area are already located in this area for so many years.

According to Restemeyer et al. (2015), flood resilience cities require an actively stakeholder participation and broadening collaboration between different disciplines in the different cycle of disaster (before, during and after flooding). Hence, a broad perspective of strategy-making is used to address the resilience framework. Based on the theoretical framework developed by (Restemeyer et al, 2015), the analysis section consisted of three components; (i) context; (ii) content; and (iii) process. The context dimension defines as the internal and external factors that influence the flood risk management and can be expressed in terms of legislative system and organizational structure. The content dimension refers to the aims and combination of measures as well as policy instruments applied to reduce flood risk. Moreover, this dimension also acknowledges the effectiveness and efficiency of strategic measures in flood management strategies. The process focuses on how strategies are formulated and how they can be implemented (Restemeyer et al., 2015).

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RESEARCH METHODOLOGY

In this study, the resilience model put forward by Galderisi et.al (2010) and Restemyer et al. (2015) were examined against the current urban flood management framework applied in Kuala Lumpur. This framework encompassed three main dimensions named, (1) Context; (2) Content; and (3) Process. This study explores the current flood management through qualitative content analysis on various government documents and policies both at the federal and local government particularly on water resources management and flood management. In addition, statutory documents on spatial and land use planning also been considered to determine the extent of environmental and flood management are deliberated in the development of policy and strategy at both local and national levels. The main planning document includes the Kuala Lumpur Structure Plan 2020 (KLSP2020) and Kuala Lumpur City Plan 2020 (KLCP2020). Semi-structured interview with the professionals and government officers also been conducted to help researcher in understanding the current practice. A total of 2 respondents were involved in the session one from Department of Irrigation and Drainage of Malaysia (DID) and one from Kuala Lumpur City Council (DBKL).

Kuala Lumpur which is located at the Southeast Asia region (3.1390° N,101.6869° E) chosen as the case study due to its compact urban area and densely populated. From geographical and hydrological perspective, Kuala Lumpur is situated in Klang River Basin from the upstream at Klang Gates Quartz Ridge in Gombak, towards the downstream in Port Klang. At present, Kuala Lumpur practices urban flood management based on structural and technological measures to "control" floods (Liu and Chan, 2003). Structural measure includes the application of high tech and engineering based solution. This costly infrastructure and measure require huge allocation of fund from the government to construct and manage the asset. However, schemes that depend on the flood-control measure likely will have a problem to cope with the emergent flood that is expected to increase due to the extreme and unpredictable climate.

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FINDING AND DISCUSSION

Context

The first dimension, Context is related closely on how to understand the strategic issue and factors (external and internal). In the context of this study, planning legislation and institutional structure have been identified and analysed in order to understand on how urban planning is related to flood risk management. Although flood is a frequent event in Malaysia, there is lack of specific legislation and law to address the issue (Department of Irrigation and Drainage, 2009). Currently, there is only one specific legislation that related to the environmental aspect applied in the country. Analysing the institutional and organizational structure on the local context, the institutional arrangement for flood risk management and urban planning still seem rather separate. Furthermore, lack of coordination and legislative power within agencies and stakeholders will influence and affect the implementation of flood management policy and strategy. As highlighted by Chan (2005), both DBKL and DID as the responsible agencies in urban planning and water management should work closely in any work related to development and flood risk management.

Content

This dimension comprises the set of strategies which include measures and policy instruments taken in flood risk management. Content analysis of the KLSP2020 revealed the need to address and mitigate the flood hazard issue through a combination of measures, although it was just a mere policy statement. The analysis also revealed that significant attentions have been given to the flood mitigation infrastructures projects such as flood retention facilities, flood dam and water gates. These structural measures would elevate the robustness and persistency towards flooding in Kuala Lumpur. However, on the long run the high dependency on structural infrastructure will burden the government with the rising cost of construction and maintenance.

Table 1: *Flood Mitigation Measure in KLSP2020*

Development Plan	Policy and Strategies
Kuala Lumpur Structure Plan 2020 (KLSP2020)	UT 3: DBKL shall, in coordination with Department of Irrigation and Drainage, take measures to mitigate flash floods UT 4: DBKL shall identify, gazette and utilise former mining ponds as flood retention and recreation facilities.

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The Kuala Lumpur City Plan 2020 (KLCP2020) on the other hand, provided more holistic and comprehensive measures and policy instruments which requires solutions beyond hard infrastructure. Furthermore, climate change is another factor perceived to have a significant impact on the flood management strategy and measure apart from the technical and engineering solutions. Hence, the demand for more adaptive and resilience measures is vital (Restemyer et al., 2015) in the face of uncertainty and extreme climate condition.

Table 2: *Flood Mitigation Measures in KLCP2020*

Development Plan	Strategic Directions	Key Initiatives
Kuala Lumpur City Plan 2020 (KLCP2020)	10.2 Mitigating Flood and Managing Stormwater	10.2a Implementing Kuala Lumpur's Drainage Master Plan 10.2b Managing Urban Stormwater in a Sustainable Manner
	10.3 Addressing Climate Change by Encouraging Low Carbon Cities Initiatives	10.3b Promoting Rain Water Harvesting, Recycling and Water Saving

The above policies and initiatives are examples of flood mitigation measures that integrate robustness and adaptive capacity attributes. The Kuala Lumpur' Drainage Master Plan has proposed various methods including retention ponds, pollution traps installation and improving culvert and drain size. In addition, KLCP2020 also included adaptation and sustainable infrastructure measure to reduce flood risk through water sensitive urban design. Urban sensitive urban design or sustainable urban drainage system aims to improve the management of Kuala Lumpur's urban stormwater and runoff through collaborative efforts in integration of urban planning and design with the management, protection and conservation of the whole water cycle.

The statement is also supported by both officers from Department of Irrigation and Drainage of Malaysia (DID) and Kuala Lumpur City Hall (DBKL) which highlighted the importance of Storm Water Management Manual (MSMA) in improving the quality of flood risk management through spatial and land use planning. The government through DID has introduced the Storm Water Management Manual for Malaysia (MSMA) as a proactive measure which emphasize on the peak discharge control at source and integration of flood risk management into physical and spatial

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planning as an attempt to reduce flood risk especially in urban areas. Every new development must comply with the guidelines and design standards in MSMA regarding the drainage system. Throughout local authority like Kuala Lumpur City Hall, the implementation of MSMA will be enforced as one of the prerequisite needs in any new planning application.

Process

As stated by (Restemeyer et al., 2015) in their theoretical framework, the process dimension implies an extensive understanding of who is involved and what are the responsibilities of the stakeholders to conduct the resilience strategy through three main capital; intellectual, social and political.However, this study only focuses on the social capital aspects where it will look at the collaboration and relationship between public and private actors in flood management as well as in spatial planning. In discussing the capacity of Kuala Lumpur to adapt and rebuild after a certain flood event, river and flood management is one of the challenging tasks to be carried out. It is caused by the physical and hydrological characteristics of the river basin itself where it flows from one jurisdiction area to another jurisdiction area and located under various local planning authority. The natural drainage system in Kuala Lumpur is made up of three (3) primary rivers (e.g., Gombak River, Klang River and Kerayong River) and joined by 12 major tributaries and is the fourth largest river basin in Malaysia with approximately 120 km in length and drains a basin of about 1,288 km2.

The Klang River Basin crosses six local authority areas, namely Ampang Jaya Municipal Council (MPAJ), Kuala Lumpur City Hall (DBKL), Shah Alam City Council (MBSA), Subang Jaya Municipal Council (MPSJ) and Petaling Jaya City Council (MBPJ) and Klang Municipal Council (MPK). However, only five Local Authorities are under the management of the Selangor state government and DBKL is under the Ministry of Federal Territories. River stream that cross different local authorities usually pose difficulties in river management coordination. As Chan (2005) highlighted, there always been the contention between the Federal, State and Local Governments in term of river management.

The collaboration between public-private sectors has been long practiced in Malaysia, particularly in Kuala Lumpur. The River of Life Project - is one of the latest projects in Kuala Lumpur City Centre that promote high collaboration between Kuala

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Lumpur City Council and private stakeholders. The River of Life project has three major component which aimed to transform the Klang River into a vibrant and livable waterfront with high economic value, namely; (i) River cleaning; (ii) River master planning and beautification; and (iii) River development. However, according to him, the project is still in its early stages, and the formation of a more detailed planning is required in the next few years.

In addition, the public engagement and involvement mostly perceived in physical/urban planning process compare to flood management. Community engagement and collaboration also highlighted in both planning documents at the local level, such as Kuala Lumpur Structure Plan 2020 and Kuala Lumpur City Plan 2020 as an input into city planning through the public participation process. In addition, under the provisions of Town and Country Planning Act (Act 172) (1976), the public is allowed to involve in the planning process especially in the preparation of spatial and development plan preparation.

CONCLUSION

This paper has presented the assessment of urban flood management in Kuala Lumpur. It has also examined the application of flood resilience model for flood management. The built up of flood resilient strategy can be summarized in this simple equation;

(Resilience = Resistance + capacity building + transformability)

Resistance refers to the ability to withstand or reduce the impact of a flood hazard through numbers of measures usually based on the technical and engineering measures. This equation shows that the resistance strategy is not contrary to a resilience strategy, but it is part of the strategy because a city still needs a certain degree of robustness to be resilient. Whilst, the capacity building often understood as an ongoing effort by individuals, groups, organizations and societies to enhance their ability to identify and meet development challenges as well as to create effective institutions. In order to ensure that a city would be more flexible to changing conditions and past mistakes are not repeated, it is important to incorporate all components of resilience, at all stages of the disaster cycle, which encompasses from pre-disaster preparations, ability to withstand at the time of hazard impact, capacity for

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recovery after an event, and ability to learn and transform into a new resilience system in the future.

According to the results and findings, Kuala Lumpur has taken various measures that are necessary to overcome the flood which embedded since past decades. Much effort has been devoted by the government, either at the Federal, State or Local level, for examples structural and non-structural measures. However, relying too much on these measures could result in limiting and narrowing the scope of the flood management itself. Although the measures perceived a positive impact in mitigating the flood, nonetheless for a long-term planning, a more practical and holistic approach is necessary. Though, the government has started to implement more adaptive and cross-disciplinary measures. For example, through the consideration of environmental and spatial planning aspect. Even though there is an effort being made to enforce it in the current flood management strategy, but the empirical study proved that engineering and structural solutions are favored instead of non-structural measures such as land use and spatial planning.

To conclude, cities are complex which made up of dynamic linkages of physical and social networks. Planning for resilience strategy in the face of urban disaster requires designing cities that combine seemingly opposite characteristics, including redundancy and efficiency, diversity and interdependence, strength and flexibility, autonomy and collaboration, and planning and adaptability.

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