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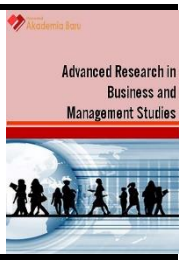

A Review of Flood Resilience Implementation in Malaysia

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ABSTRACT

Floods are Malaysia's severest catastrophe that can result in the loss of life and property. They also have devastating consequences and effects to the economy, people and environment. Malaysia records an average annual damage of around RM 36 billion as reported in the previous study and this is expected to increase in the near future. Investments in flood prevention and mitigation have been rising, from around RM14 million (1971) to RM5.774 billion (2020). This research aims to understand the current scenario of flood resilience implementation in Malaysia in strengthening governance. From the study, CMMI is identified as a suitable tool to assess flood resilience maturity in Malaysia. Flood resilience in Malaysia that can potentially lead to a reduction in flood risk is benchmarked against good standard practice led by the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030. Recognizing the complexity of hazards and their impacts, while Malaysia is using this SFDRR framework, there is still concern about the severity of loss and management of flood risk. Successful implementation of flood resilience is accomplished when the four stages of disaster risk reduction (DRR) consisting of flood prevention/mitigation, preparedness, response and recovery are effectively prioritised in the short, medium and long-term plans to prevent new risks, reduce existing risks, and strengthen societal and environmental resilience. Pursuant to the anticipated outcome and goal, there is a need for focused actions within and across sectors by states at local and national levels starting from understanding flood risk, strengthening flood risk governance, investing in disaster risk reduction for flood resilience and enhancing flood emergency preparedness for successful response and recovery. The findings will be of interest to policy and decision makers in enhancing their understanding of the current scenario of flood resilience in Malaysia, the improvements to be made and investments to be spent on approximately 10 percent of the total area of Malaysia, which have been identified as flood-affected areas.

Keywords:
Flood resilience; CMMI; disaster risk reduction; Malaysia; natural flood management

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1. Introduction

Floods are the severest catastrophe in Malaysia which occur mainly due to natural reasons. These are heavy rainfall and the rise of the sea level, in addition to the man-made causes such as inadequate development planning, rising deforestation and improper conversion of land uses. Floods bring about tremendous effects on human life, properties, the economy as well as towards the environment. In the past two decades, the country was hit by 13 major floods with economic losses reported at around RM2.9 billion, while RM800 million was allocated for the reconstruction of damaged infrastructure [1]. Since natural disasters tend to be unpredictable and uncontrollable, prevention needs to be done by managing the man-made causes. This research aims at understanding the current scenario of flood resilience implementation in Malaysia in strengthening governance.

Flood risk management in Malaysia is based on the National Security Council (NSC) Directive No. 20 and Fixed Operating Regulations (PTO) [2], which outlined the aims of Policy and Mechanism on Disaster and Relief Management. NSC is also responsible in post-disaster evaluation for remedial actions in the future [3]. In 2015, Malaysia along with 195 other countries have adopted the good standard practice led by the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030. The framework has seven targets with 38 indicators to achieve the targets. In the same year, the National Disaster Management Agency (NADMA) was founded and has adopted DRR framework's four stages of flood resilience consisting of flood prevention/mitigation, preparedness, response and recovery. It believes that the efficient implementation of flood resilience is achieved when the four stages are effectively prioritized [4]. In achieving the target, NADMA has performed collaborative governance with public, private (including NGO) and academic (PPA). Each agency in PPA is functioning on their own, and/or work together with other agencies to execute Disaster Risk Management (DRM) projects at various levels [5].

Malaysia, like most of the other countries, prefers to choose structural measures in flood control [6]. However, with the current trend of flooding, the costs of implementing these measures are increasingly prohibitive. A review of flood mitigation literature suggests that non-structural measures such as land use control, flood plain management, improvement of flood forecasting and warnings and resettlement of flood-prone communities are more economically efficient [6-7]. In addition, community awareness is also an important ingredient in successful flood preparedness measures. Studies have also shown that urban communities are more alert with flood issues compared to those in rural areas due to better access to information [8-9]. For rural communities, awareness programmes do help to increase the understanding and readiness of society in facing flood hazard. The use of appropriate technology has also led to more effectiveness and efficiency in reducing flood vulnerabilities. Ultimately, preparedness and non-structural adaptation measures can be more effective and sustainable solutions to flood problems by reducing the vulnerability of human beings and properties exposed to flood risk [7].

Capabilities Maturity Model Integration (CMMI) is an instrument to apprise the maturity of the system or organization. It has been used widely in the various practices such as software and system engineering, construction, workforce development and management as a benchmarking tool in tracking and improving the system [10]. CMMI also has been used in assessing the readiness of a country in flood resilience implementation [11]. A study done by Adeniyi [12] has established 19 key capabilities areas in assessing the flood resilience readiness. This paper will review the current flood resilience practices and competencies in Malaysia based on the developed maturity model by focusing on management and operation at national and sectoral scale.

2. Flood Conditions in Malaysia

The earliest recorded major flood in Malaysia was back in 1926. Other two significant floods occurred in 1949 and 1971. Throughout the years, flood events and frequency tend to increase due to riverbank overflow, high tides or flash floods. However, most of the economic centers are situated on low-lying terrain and along the coastline, being vulnerable to flooding [6]. The floods become more severe or it may take longer time to subside when heavy rain and high tides coincides. There are many natural and local factors that can lead to floods such as heavy monsoon rainfall, intense convection rain storms, lack of maintenance to the river system, and increasing number of urbanized areas with inadequate drainage [13-14]. The main reasons for increasing the potential flood risk are; 1) the increase of population development in the floodplain, 2) the increase of flooding extent due to climate change, and 3) changing environment conditions due to urbanization [15].

Beginning after the 1971 major flood experience, a flood mitigation plan prepared by the Department of Irrigation and Drainage, Malaysia (DID/JPS) was implemented. Malaysia's investments in flood prevention and mitigation have since been rising from around RM14 million in 1971 to RM5.774 billion by 2020 (Figure 1). Currently, several specific major flood reduction schemes are underway in priority areas. As of the present, a total of RM20.78 billion had been spent on such schemes since 1971 [16].

The Department of Irrigation and Drainage, Malaysia has also compiled annual flood records from all states and identified more than 10 percent of the land in Malaysia as being flood-affected areas (Figure 1). Floods in these areas can potentially have destructive impacts on the built environment and expose more than 20 percent of the Malaysian population, which is about 5.7 million people, to flood risk [17]. Data collected by an international emergency events database (EM-DAT) shows that, from 1965 to 2019, there were 772 fatalities caused by floods, storms, mudslides, and tsunami reported in 58 events.

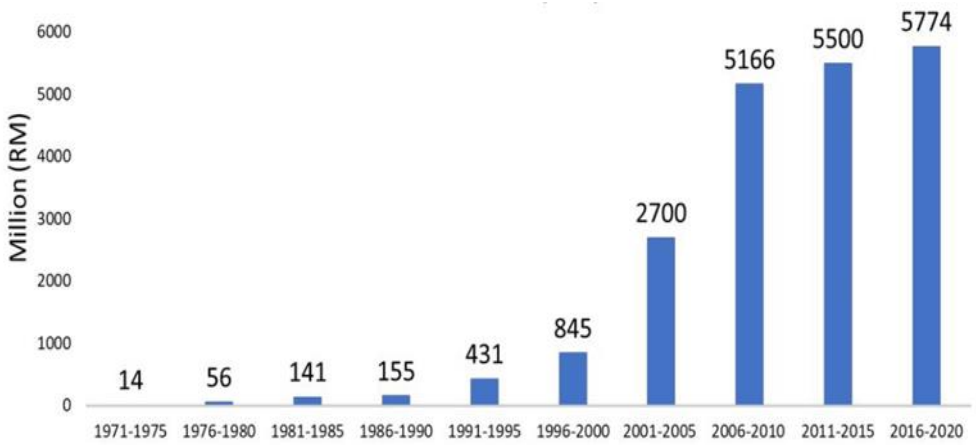

Fig. 1. Flood prevention and mitigation expenditure in Malaysia [16]

One of the severest flood events in a decade was the monsoon surge between December 2014 and January 2015 that brought flooding to the east coast states in Peninsular Malaysia. In Kelantan, more than 250,000 people were affected with 21 fatalities and severe property damages as a result of these floods, according to the Asia One study [18]. In this flood event, the estimated overall flood damage for the river basin of Sungai Kelantan is recorded at around RM13.2 billion, which include tangible and intangible damages [19].

Another impacting factor is that Malaysia is surrounded by the world's most active geological region, the Pacific Ring of Fire, and is not spared from its effects. Underwater earthquake floods such

as the 2004 Aceh event have impacted the west coast of Peninsular Malaysia, causing 80 fatalities and destroyed more than 1,500 properties [20].

3. Flood Resilience within Sendai Framework Paradigm

In 2015, a global legally binding agreement on Climate Change now known as the Paris Agreement was established. This is the first-ever universal agreement that, in some way, merges three international agreements: The Sendai Framework for Disaster Risk Reduction, the 2030 Agenda for Sustainable Development and in the Intergovernmental Panel on Climate Change (IPCC) Conference of the Parties (COP) 2015 [21]. This agreement recognizes the importance of flood resilience, under Article 8 on loss and damage. It had alarmed decision makers and planners with the prediction that, without drastic improvement to flood resilience strategies, annual global flood losses could reach $1 trillion by 2050 [22].

The Sendai Framework (SFDRR) was adopted by the United Nations in March 2015, as a successor instrument to the Hyogo Framework which ended in 2015. The objective of the SFDRR is to de-risk the disaster risk by implementing integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political, and institutional measures that prevent and reduce exposure to hazards and disaster vulnerability, increase preparedness for response and recovery, and thereby strengthening resilience. In achieving the goal globally, seven targets were accepted and 38 indicators developed to measure progress made by all countries on disaster risk reduction by the year 2030. The targets are; 1) to reduce global disaster mortality, 2) to reduce the number of affected people globally, 3) to reduce direct disaster economic loss in relation to global gross domestic product (GDP), 4) to reduce disaster damage to critical infrastructure and disruption of basic services, 5) to increase the number of countries with national and local disaster risk reduction strategies, 6) to enhance international cooperation to developing countries, and 7) to increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments for the people [23].

In line with the purpose of SFDRR, Malaysia agreed to implement the framework in its Disaster Risk Reduction (DRR) management in order to achieve the Sendai Framework's (SF) global targets and related Sustainable Development Goals (SDGs) in the 2030 Agenda [24]. As part of the process, NADMA had conducted a series of national workshops such as the National Workshop on Terminology and Indicators for Sendai Framework for Disaster Risk Reduction (SFDRR) on 15 June 2016 [25], National Workshop on Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR) Series No. 2 on 6 March 2017 [26] and Sendai Framework Monitor (SFM) Orientation and Training Workshop with UNISDR was held on 19-20 March 2018 [27].

However, the main challenge is the lack of data management [28]. In practice, each agency is responsible in collecting disaster data related to their respective roles. For example, NADMA records expenses for response and recovery processes while DID collects disaster risk-related data. However, the available data may not be applicable or useful for others and only suitable for internal usage. The process of data collection for different agencies varies according to their respective needs and policies. The fragmented state of existing data set may have led to poor inter-agency decision making. Establishing a solid evidence base through improvement of data collection, methodologies and analysis for all DRR stages is significant to enhance flood resilience strategies, international cooperation, and risk-informed availability.

4. Flood Resilience Capability Maturity Model

"Resilience" is a comprehensive concept that includes "involving the development of the ability or capacity to build back better after a disaster". Resilience can be divided into five spatial scales namely household/individual, local, national, regional, and global community [29].

Malaysia was rated as medium rank in the World Risk Index (89 out of 171 countries) in 2016 due to its vulnerability and lack of adaptive capabilities, and low rank for susceptibility in the event of a natural hazard [30]. This means that it has a low likelihood of suffering harm, but has a relatively high rank in terms of lacking in coping capabilities (including immediately available measures and capabilities to minimize harm and damage in the occurrence of an event) [9].

The capability areas presented in the CMMI model enable agencies and business sector representatives to prepare their properties and core businesses to cope with, withstand, prepare for, prevent, mitigate or quickly recover from flood hazard. Among the capabilities to be assessed are [12]

i. Awareness and understanding of flood risk to property.
ii. Review for a flood resilience scheme.
iii. Survey of property.
iv. Acquisition and installation of relevant products.
v. Maintenance and post-flood management scheme relationships.
vi. Operation of acquired flood facilities.
vii. Organisation of disaster scenario simulations.
viii. Turn-over, cash flow, and customer management.
ix. Insurance adequacy and management.
x. Utility/Communication system.
xi. Electronic data/record management.
xii. Management of disruption (to production/service/operations/processes).
xiii. Crisis response budget.
xiv. Paper records management.
xv. Decision making in emergency situations.
xvi. Definition of responsibilities and how it changes in disaster situations.
xvii. Post event review, analysis and management.
xviii. Network strength.
xix. Physical characteristic of property – fabric, design, construction, and waterproof compartment.

According to available literatures, the issues and challenges in achieving effective flood resilience in Malaysia include; 1) flood risk or disaster management planning imbalanced between top-down and bottom-up approaches, 2) the lack of coordination flood resilience in DRR cycle, with greater focus only on the disaster emergency response stage, and 3) the lack of planning of a long-term recovery (post-disaster) process, which resulted in low level community and stakeholders' resilience to disasters [5].

Some of the concerns related to resources, means, strengths and competencies compiled from the literatures and case studies are summarized as follows

i. Lack of cooperative funding and inefficient use of resources [31].
ii. The centralisation of the national disaster database and disaggregated data becomes a major challenge, as the conventional database is only found in agencies that are main data custodians [28].

iii. Weakness in tracking and monitoring of flood activities and systems, poor mitigation of flood risk, and non-optimal use of given (as well as investment) resources [32].
iv. High capital costs of control infrastructure and high competition by states in obtaining approval from government. This often links to the lack of voice in decision-making processes related to flood control planning and financing [7].
v. Lack of integration among various agencies that are responsible for flood management [13].
vi. Lack of awareness of the available flood early warning system and the dissemination medium [9].
vii. Lack of awareness and understanding of the needs, abilities and interests of the community, and their adaptation plan [9].
viii. Lack of abilities to adapt to climate change effects that are expected to increase the frequency and severity of potential flood losses [33].

The findings from this model will portray the current quantitative maturity levels of flood resilience on the key capability areas for sectoral and national levels. This will assist in identifying the gaps and future target of flood resilient capabilities of the built environment in terms of the following

i. Alignment (Strategy and risk governance).
ii. Data Management (Data-driven decision making, social network).
iii. Operating Environment (Adaptation process).
iv. Integration (Cross sectoral/Society roles).
v. Sustainability (Integrated flood management).

5. The Way Forward in Malaysia's Plans for Flood Resilience

The Eleventh Malaysia Plan focuses on strengthening flood resilience as outlined in Chapter 6 of the Disaster Risk Management (DRM) Strategy under Focus Area D: Strengthening Resilience against Climate Change and Natural Disasters. There are three strategies identified to achieve the goal [34]

i. Strategy D1: Strengthening disaster risk management by establishing DRM policy and institutional framework, improving disaster detection and response capacity, incorporating DRM into development plans and creating community awareness;
ii. Strategy D2: Improving flood mitigation by generating new investments from flood mitigation projects, enhancing long-term planning and strengthening flood forecasting and warning systems; and
iii. Strategy D3: Enhancing climate change adaptation by developing a national adaptation plan, and strengthening resilience of infrastructure, natural buffers including water and agriculture sector as well as creating awareness on health impact.

In these matters, DID is emphasizing the nature-based approach to flood management in Malaysia. The Natural Flood Management (NFM) is an approach that reduces flood risk by slowing down the flow of water through a catchment with higher holding capacity, thus minimizing run-off and the catchment's ability to retain water, and decreasing the peak flow of rivers. It involves taking steps to mitigate fluvial and coastal flood threats by maintaining, restoring and emulating the natural controlling role of catchments, rivers, floodplains and coasts [35].

Development planning and control for new development is another preventive measure to ensure that future development would not result in any increased floods. Flood losses are expected to increase in frequency and severity in the future due to a combination of socio-economic development and climate change [33]. It is essential to highlight the flood-affected areas in the national Physical Plan, development plans, structural plans and local plans to ensure they reflect the

current global policies such as the Sustainable Development Goals, New Urban Agenda and SFDRR that focus a lot on climate change issues and disaster risks. Further effort is also required to focus on the collaborative action among planners, such as the local authorities and PLANMalaysia, and developers, to optimize the alignment of development goals with flood resilience targets at all planning stages [36].

6. Conclusions

Malaysia's approach and efforts to flood management had begun in 1932 on an ad-hoc basis through river conservancy and river training work. This approach continued after the major flood of 1971, through the implementation of structural flood mitigation projects in order to cater for the continuous and rapid urbanisation. DID began introducing the control-at-source approach in 2000, which is significant for the management of urban stormwater. This is then followed by the Integrated Flood Management plan, where this approach is well-balanced with structural and non-structural measures as well as public participation.

The way forward to solve flooding is through the application of the Natural Flood Management (NFM) strategy. NFM is an approach that starts from source to the sea, with the combination of several strategies such as upland restoration, sediment management, the storage of run-off and river restoration, with the target of reducing the flood risk. The management of land use is therefore important because any parcel of land would play a part in absorbing and storing water, slowing the speed towards downstream and thereby reducing flood risk. This approach could reduce long-term costs in river infrastructure, as well as the adaptive capability of NFM techniques to mitigate the impacts of climate change.

Therefore, as best practice, it is suggested that all of the physical damage indicators be gathered and kept as essential information assets at all levels. This is to feed risk assessments with an evidence base, aid understanding disaster risk, and to provide accountability as a means of verifying the Sendai Framework indicators.

In pursuance of the anticipated NFM outcome and SF targets, coordinated efforts are required within and across sectors by states at local and national levels. This starts from understanding flood risk, strengthening flood risk governance, reducing risk to acceptable levels through structural and non-structural investments in NFM and DRR, as well as improving flood emergency preparedness for successful response and recovery such as early warning systems and financing arrangements for disaster relief and recovery.

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