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Review

Reviewing Challenges of Flood Risk Management in Malaysia

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Abstract: This study reviewed some of the challenges faced by local authorities in disaster management, especially flood disasters that occurred in Malaysia. Flood disasters are the most frequent disasters in Malaysia, especially during the monsoon seasons. The hard structure developed by Malaysia's National Security Council (MKN) under 'Directive 20' is used to manage disasters in the country. Although Malaysia has become more skillful in managing flood disasters, the frequent climate changes along with weakness in implementing flood risk management plans resulted in much losses and damages throughout the country. Therefore, this study explored the gaps and weaknesses in flood risk management (FRM) in Malaysia by reviewing the available literature to recommend better flood management. This study revealed four main issues which are weaknesses in terms of (i) coordination and communication, (ii) manpower and assets, (iii) public awareness, and (iv) power and authority among local authorities to implement flood management plans. The capacity of local authorities and individuals in charge of disaster management is inadequate, especially for flood risk preparedness and management. Hence, responsible individuals are also in a vulnerable situation to implement management plans or rescue operations when flood disasters occur since they are also flood victims. Thus, the National Disaster Management Agency (NADMA) which acts as the main coordinator of disaster management in Malaysia should re-examine the flood management plan to ensure that it can be implemented efficiently and effectively, especially at the local level as they are the first respondents on the scene when the disaster occurs. The combination of both structural and non-structural measures might require in many cases the management of flood disasters; however, the disaster risk preparedness and management of individuals via customized training is a must to prevent flood disasters as well as minimize their impact. The flood management plan should also incorporate natural-based approaches at the whole-river-basin level for the long-term solution and sustainable development, not only focusing to manage the localized flood problem at the specific area.

Keywords: losses and damages; flood risk management; local government; Malaysia

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1. Introduction

The Department of Irrigation and Drainage (DID) in Malaysia in 2023 defined flood as a body of water, rising, swelling and overflowing land not usually thus covered [1–3]. Overflowing of the bank of a stream, lake or drainage system of water onto adjacent land as a result of the storm, ice melt, tidal action and channel obstruction is also categorized as a flood. Disasters caused by flooding are a social concern that exists today and has an impact on urban areas all over the world [4,5]. Flooding can affect the community that lives close to the water body such as seas and rivers by disrupting essential services and harming infrastructure. Some of these frequent repercussions include damage to homes and businesses, bodily health problems from contaminated flood water, mental health problems, including post-traumatic stress disorder, and even fatalities. It is also projected that climate change, land-use change and continued rapid urbanization in flood-prone

areas continue to increase the risk and the frequency of extreme disasters such as flood incidents [6,7].

Floods are the leading cause of natural disaster deaths worldwide. According to Our World in Data, floods have historically been the leading cause of natural disaster deaths worldwide with droughts being the second leading cause [8]. The Human Impact of Floods: a Historical Review of Events 1980–2009 also reports that floods are the leading cause of natural disaster deaths and have caused more than 500,000 deaths worldwide between 1980 and 2009 [9]. A total of 1.81 billion people, or 23% of the world population, are directly exposed to inundation depths of over 0.15 m during 1-in-100-year floods, which would pose significant risk to lives, especially of vulnerable population groups. The majority of the affected people (1.24 billion) are located in South and East Asia, where China (395 million) and India (390 million) account for over one-third of global exposure [10]. More than 2 million people nationwide have been impacted by floods, which are also Malaysia's most frequent natural calamities. Malaysia has suffered from some major flood disasters since 2015 [11]. Problems with deforestation and uncontrolled land use have been common reasons for flood incidents happening around the country [6,12]. Every year, thousands of people are reportedly evacuated to evacuation centres after the area was ravaged by flooding, and few lives are lost because of this disaster. The losses and damages caused by the floods have been immense, with thousands of homes destroyed and millions of ringgits worth of property lost [13].

Flood management is a complex and challenging task, especially in countries that are prone to floods. It is a global challenge that requires careful planning, resource allocation, and effective communication with the public. Several challenges come with flood management, including the increasing frequency and severity of floods. The five countries with the most risk of flooding are the Netherlands at 59%, Bangladesh at 58%, Vietnam at 46%, Egypt at 41%, and Myanmar at 40% [10]. Each of these countries faces different challenges in the effort to create effective disaster management in their respective region. It is very important to identify the challenges these countries face as they try to combat natural disasters. As per a report from the United Nations Environment Programme, 'Global Trends in Climate Change-Related Disasters-2020', climate change is leading to an increase in floods, and the effects are devastating. The report further suggests a rise in sea levels as a result of the changing climate. This is one of the main problems faced by the Netherlands, as more than 50% of the country is below sea level, encouraging the Dutch to look for innovative water management solutions [14]. Climate change that causes increasingly heavy rainfall continues to threaten, and that exposure is likely to increase through greater flooding depths in the country. There are also weaknesses and flaws in the current flood risk management policy, as it has been focusing on flood defence without considering the socio-economic growth aspect. The problem can be seen as socio-economic development causing the population's centre to grow and move towards the flood-prone parts of the country which can increase fatality risk [15].

In Bangladesh, floods have been one of the main natural disasters. Floods constitute about 50% of all natural disasters, and as a result, lives and livelihoods are regularly affected by flooding [16]. Currently, there is a weakness in existing flood management policies, as the planning policies offer mostly short-term disaster risk reduction (DRR) rather than reduction in vulnerabilities per se. Flood Forecasting and Early Warning (FFEW) in Bangladesh is not adequate due to limited communication and dissemination facilities [17]. The warning message does not carry other relevant information such as the expected flood water travel time in respective areas, the potential inundated area, or the water depth due to flooding. Zimmermann et al. [18] argue that there is no coordination between the Government of Bangladesh (GOB) and NGOs for risk reduction and preparedness. The policy is still focused on emergency response. Even local governments in flood-prone areas have no budgetary allocations for immediate emergency response.

In Vietnam, the floods are mainly focused on the Mekong River Delta. It is a typical large, economically dynamic, and highly vulnerable delta that receives about 475 km^3 of up-

stream inflow annually [19]. Climate change and accelerating socio-economic development have also become major issues that continue to increase the risk of flooding in the country. Research reveals that while managing flood risk in Vietnam faces a variety of challenges, the most pressing ones are primarily related to the country's current institutional and political structures, which include weak collaboration, conflicting management objectives, and low responsiveness to new issues. Many critical challenges arise from the current governance and institutional settings [19]. There is also the duplication and overlap of flood management roles and responsibilities in Vietnam, as both the Law on Dykes (2006) specifically deals with dykes from the viewpoint of a flood-protection structural measure and, at the same time, is also protected by the Ordinance on the Management of Irrigation and Drainage Structures (2001) as an irrigation and drainage structure. Other than that, there is repetition in the responsible agencies that are tasked with the implementation of legislation, as provincial and district authorities have the exact same responsibilities for natural disaster management [20].

Therefore, flood management poses significant challenges globally due to the increasing frequency and severity of floods, inadequate flood risk assessment processes, a lack of proper infrastructure and resources, and changing climate patterns. Addressing these challenges requires a comprehensive, collaborative, and integrated approach to flood management that involves better planning, risk assessment, and communication with the public. Implementing long-term strategies to reduce carbon emissions and address climate change is also critical to reducing the severity and frequency of floods. A holistic approach, taking social and environmental factors into account, is necessary to achieve sustainable flood management.

Floor risk management or FRM refers to a process of managing an existing flood risk situation which includes the planning of a system that reduces flood risk [21]. Each nation has its own policies and plans for reducing the flood problem in its region, as well as written plans and methods for exchanging information on risks, risk avoidance and mitigation, and preparedness. All of these details are crucial to researchers' ability to conduct adequate comparisons and develop better flood management strategy for the future. In Indonesia, Badan Nasional Penanggulangan Bencana (the National Disaster Management Agency, BNPB) manage the flood management policies that include rescue, mitigation, prevention, and reconstruction. An inter-agency disaster task force was also established at the provincial, district, and sub-district levels, same as we can see happening in Malaysia. In 2012, the Indonesian government implemented the National Disaster Management Plan (2010–2014). For a five-year period, the strategy placed more emphasis on flood policies, management techniques, and disaster risk reduction [22]. In Bangladesh, the Ministry of Disaster Management and Relief (MoDMR) was responsible for managing the FRM and had the authority to create policies, draught plans, and oversee all disaster-related operations. The MoDMR creates the National Plan for Disaster Management (NPDM) 2021–25 based on the Sendai Framework for Disaster Risk Reduction (SFDRR) and Standing Order on Disaster (SOD). This plan includes context, legal background, the current state of prior plan implementation, and Bangladesh's likely position in the context of shifting disaster risk [15]. Pakistan also highlighted a risk-based proactive strategy for effective flood management apart from current structural and non-structural measures [23].

FRM in Malaysia has been a top-down government responsibility, and Malaysians are heavily reliant on a top-down government-controlled techno-centric approach to flood management [4,24,25]. Every time a disaster occurs, the Malaysian government declares a state of emergency in several affected states and sends out teams of rescuers and aid workers to assist in the relief effort [26,27]. Integrated Flood Management (IFM) is an approach used by agencies such as by the Department of Irrigation and Drainage (DID) in Malaysia to mitigate the impact of flood disasters in order to reduce the damage to property and loss of life which is in line with the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework). The Sendai Framework is the roadmap used by the United Nations Office For Disaster Risk Reduction (UNDRR) to make our communities

safer and more resilient. However, there are still many challenges and problems that the local government are facing in managing flood disasters [28]. Therefore, this study aimed to identify the challenges in flood risk management in Malaysia. This aim is based on the hypothesis that the current capacity along with initiatives to mitigate the flood disaster's impact in Malaysia by the local government is inadequate [29–32]. Therefore, to carry out this review, suitable research articles were collected from journal portals such as Web of Science (WOS), SCOPUS, Google Scholar and MDPI. The articles that were extracted from the journal portals were published between 2000 and 2022, and the keywords used to search the articles were issues and challenges of flood management, flood risk management, and Malaysia. Hence, the challenges in flood risk management by the local government identified via this review would contribute to better and comprehensive flood risk management by tackling the problem at its sources.

2. Issues and Challenges in Flood Risk Management (FRM)

Floods are natural phenomena of geo-hazards that usually happen when prolonged heavy rainfalls occur. Floods in Malaysia can be categorized into monsoon floods and flash floods. Monsoon floods are caused by the Northeast Monsoon season, which commences in early November and ends in March; it brings heavy rainfall, particularly to the east coast states of Peninsular Malaysia and western Sarawak. Flash floods usually occur in areas with rapid development by a rapid rise in water level, high velocity, and large amounts of debris [33]. Malaysia has a tropical climate. Malaysia's mean annual temperature is 25.4 °C (Figure 1). There is relatively little seasonal variability in average monthly temperature, amounting to one degree Celsius between a minimum of 24.9 °C in January and maximum of 25.9 °C in May. April, May and June are the hottest months of the year. Rainfall also remains high all year round, with mean annual precipitation of 3085.5 millimetres (mm). Average monthly precipitation is also relatively constant throughout the year, ranging between approximately 200 mm during June and July and 350 mm in November and December. There are two monsoon seasons: the Southwest Monsoon (April–September) and the Northeast Monsoon (October–March). Malaysia receives about six hours of direct sunlight per day, with cloud cover most likely to occur during the afternoon/evening [34,35].

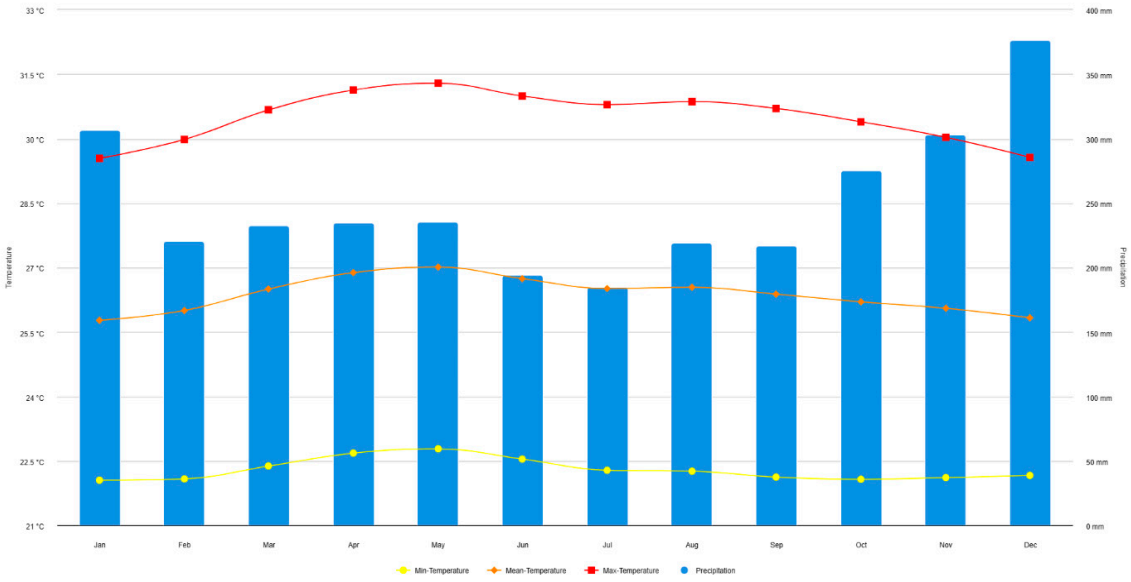

Figure 1. Monthly climatology of min temperature, mean temperature, max temperature and precipitation of Malaysia during 1991–2020 [34].

Flood is a very common phenomenon in Malaysia (Figure 2); however, the frequency and intensity of floods have increased significantly over the last few decades mainly due

to climate change. Small-scale flash food events are climate-related disasters which can put multiple aspects of the system at risk, especially in densely populated cities like Kuala Lumpur in Malaysia [36]. Losses and damages occurring from the flood incidents are also amplifying, although seldom are the non-economic losses incorporated properly while the flood risk assessment and management are performed [37]. For example, the recent flood incidents in Selangor, Malaysia during 18–22 December 2021 could amount to at least RM 20 billion [38]. Independent research into the financial outlook of the floods being carried out from December 2021 to February 2022 and official welfare department data, which stated that the highest number of families evacuated in six states was 19,711 families at 3.30 p.m. on December 21 [38], were collected. Flash floods in the Klang Valley have greater implications for the economy and the country's GDP [39], and this recent flood during 18–22 December 2021 severely affected the Shah Alam Local Authority within Klang Valley. This flood occurred due to the erratic rainfall pattern and short-term heavy downpour within a small geographical area. Continuous downpours since 10 a.m. on Friday (17 December 2021) in Selangor—the highest rainfall ever recorded—resulted in extensive flooding throughout the state. Selangor State government declared that the Selangor Department of Irrigation and Drainage informed the state government that the rainfall exceeded 380 mm. The rainfall in Selangor increased twofold to reach 380 millimetres (mm) compared to its highest record of 180 mm and its average rainfall of 60 mm. Moreover, the rapid urbanization and development activities in the floodplain of Klang Valley including the Shah Alam Area contributed to magnifying the damages from the floods due to blocking the natural drainage system in the floodplain. Similarly, rivers are above the danger mark in at least 16 locations in the state of Johor, Malaysia, where thousands of people have evacuated their homes in March 2023. Around 630 mm of rain fell in under 48 h in some locations of Johor, making the flood situation worse [40]. Malaysia is currently facing its sixth episode of continuous heavy rains from the monsoon runoff brought about by the North East Monsoon (NEM) in 2023. The Malaysian Meteorological Department (MetMalaysia) reported that although this sixth episode is probably the last to bring heavy rain, there is still a possibility that rain and flooding will continue in some areas right into March and April 2023 [41]. Malaysia will undergo a monsoon transition phase starting March until mid-May reported by the Malaysian Meteorological Department (MetMalaysia) and it could potentially cause flash floods as well as damage to unsound structures [42]. Hence, the recent frequent flood incidents are mainly the impact of climate change.

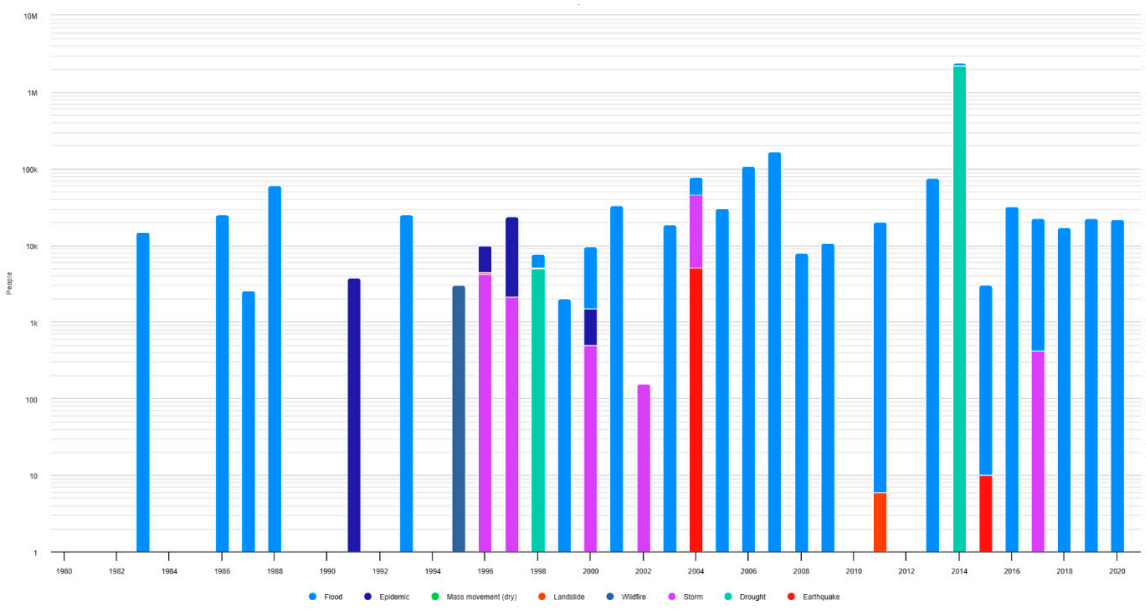

Figure 2. Key natural hazards and number of affected people in Malaysia during 1980–2020 [43].

Peninsular Malaysia is bordered by Thailand to the north, the South China Sea to the east, and the Andaman Sea and the Straits of Malacca to the west. Singapore is connected to the southern tip of the peninsula by a causeway [44]. Flood risk in urban areas is rising, and growing urban populations are particularly exposed to flash floods driven by high intensity rainfall. Malaysia's geographic location and low poverty rates mean that both its risk and vulnerability to natural hazards are lower than those of some of its Southeast Asian neighbours. Nonetheless, Malaysia suffers high average annual losses. Department of Irrigation and Drainage Malaysia (JPS) in 2012 found that 10.1% of the country's total area is a flood-prone area with nearly 5.67 million people affected by floods. Its impact leads to a loss of property exceeding RM 1.0 billion a year [45], and in 2014, UNISDR estimated these at around USD 1.3 billion. While Malaysia can experience drought, landslides, earthquakes and storm surges, the large majority of its losses are attributable to flooding [43]. Recent incidences of heavy downpour in Malaysia have wreaked havoc, destroying property and leaving countless residents homeless. Apart from the personal losses, floods leave a significant financial impact—in December 2021, it was estimated that up to RM20 billion in losses were incurred by flooding that damaged households, private property, shops, warehouses and factories [46]. The number of human deaths was also higher in 2021 than that in other years due to heavy rainfall within very short period of time in 18 December 2021 (Table 1).

Table 1. Some examples of flood disaster impact in Malaysia.

Year	Flood Incident	Impact	Number of Deaths
2015 [1]	496 total flood cases recorded in 2015 because of prolonged rainfall around Malaysia.	Affected 46,000 people and caused more than RM 30 million in losses and damages.	N/A
2016 [1]	404 total flood cases, also caused by prolonged rainfall of more than 100 mm.	Affected 95,000 people and caused more than RM 53 million in losses and damages.	N/A
2017 [1]	1239 total flood cases, also caused by prolonged rainfall of more than 100 mm.	Affected 68,000 people and cause more than RM 63 million in losses and damages.	5 at Kelantan
2018 [1]	844 total flood cases, prolonged rainfall is the main factor.	Affected 12,000 people and caused RM 44 million in losses and damages.	1 at Kelantan, 1 at Pahang
2019 [1]	535 total flood cases, prolonged rainfall is the main factor.	Affected 49,000 people and caused more than RM 26 million in losses and damages.	2 at Kelantan
2020 [1]	869 total flood cases, prolonged rainfall is the main factor.	Affected more than 14,000 people all around the country.	N/A
2021 [2]	1057 total flood cases, prolonged rainfall is the main factor.	Affected 160,000 people all around the country.	10 at Johor 6 at Kedah 3 at Sabah 25 at Selangor 21 at Pahang 4 at Kelantan
2022 [2]	- Flood in Kelantan and Terengganu on 25 December; - Flood in Kedah on 4 July; - 81 flood incidents reported during flood in Johor, Kelantan, Pahang, Perak and Terengganu on 19 December.	Affected 50,000 people all around the country.	3 at Kedah 1 at Terengganu
2023 [2]	- Flood in Johor, Pahang and Sabah on 25 January; - Flood in Johor, Pahang, Melaka, Negeri Sembilan, Sarawak and Sabah on 1 March.	As of May 2023, flood has affected more than 35,000 people around the country.	0 deaths reported

Note(s): Source: [1] [47]; [2] [48].

Selangor state, which has the highest population of Malaysians of about 6.6 million, suffered RM 3.1 billion in losses due to floods in 2021, making it the most vulnerable

state. Losses from house damage totalled RM 1 billion, while damage to manufacturing properties amounted to RM 0.89 billion, and vehicle damage amounted to RM 0.86 billion. The districts of Klang, Petaling and Hulu Langat were the most heavily affected, comprising RM 2.7 billion in total losses. Pahang is the second most vulnerable Malaysian state, logging a loss of RM 593 million in 2021. Housing losses came up to RM 426 million, while damage to business premises, vehicles and manufacturing amounted to RM 167 million. Specifically, housing losses were highest in Kuantan at RM 197.4 million, followed by Temerloh (RM 95.1 million), Bentong (RM5 9.9 million), Pekan (RM 32.5 million), and Maran (RM 10 million). Melaka state registered RM 85 million in flood losses last year, with housing exceeding other categories at RM 70 million, or 82% of total losses. By location, Melaka Tengah, which houses the capital city, suffered the highest housing losses at RM 60.8 million. This was followed by Alor Gajah (RM 6.9 million) and Jasin (RM 2 million). Negeri Sembilan lost RM 77 million to flooding in 2021. Housing topped the list with RM 46 million or 59% in total losses, followed by vehicles (RM 18 million) and business premises (RM 12 million). Jelebu had the highest housing losses at RM 12.9 million, followed by Port Dickson (RM 11.8 million), Seremban (RM 9.3 million) and Tampin (RM 6.6 million). Johor suffered RM 50 million in flood damage, with housing again leading the way at RM 19.9 million, followed by vehicles (RM 16.4 million) and business premises (RM 13.8 million). An interesting difference from other states is that flood losses in Johor were well distributed across categories, with housing encompassing 40%, followed by vehicles (33%) and business premises (28%). By location, Segamat was the most flood-prone area, registering a loss of RM 24.6 million. This was followed by Tangkak (RM 9.6 million), Muar (RM 6.9 million) and Mersing (RM 3.8 million). Kelantan rounds off the list with flood losses in the amount of RM 22 million last year. Housing loss is the highest at RM 16 million, followed by business premises (RM 4.5 million) and vehicles (RM 1.5 million). By location, housing losses were highest in Pasir Mas at RM 9.8 million, followed by Gua Musang (RM 2.7 million), Kuala Krai (RM 1.2 million) and Tumpat (RM 1.2 million). Kuala Lumpur registered RM 32 million in 2021 flood losses, housing losses topping the list at RM 22.4 million, followed by vehicles (RM 6.1 million) and business premises (RM 3.8 million) [46].

In every form of management, there must be challenges and problems that make implementation difficult in the management. Flood management by local government is also not exempt from the dilemma when various obstacles and challenges often make it difficult for local governments to implement flood management activities in Malaysia [13,49–51]. This study, based on the thorough analysis of full text, identified a total of 10 research articles that fully met the search criteria. Based on WOS, SCOPUS, MDPI and Google Scholar databases, papers with the following characteristics were extracted:

- Published between 2000 and 2022;
- Keywords contained in the title include flood issue, flood challenges and flood management;
- Focused on Malaysia.

This study is very important to ensure that the weaknesses that exist in disaster management in Malaysia can be identified and overcome immediately to ensure smooth management when disaster situations occur. Most of the identified weaknesses happened during the implementation stage, which usually occurs at the local management level. This is because during the implementation stage, all weaknesses are easier to identify in respect to whether the plans and strategies that have been implemented have a positive impact during disaster situation. The findings of this study are also important in the prospective of the Asia region as they provide an initial overview especially for neighboring countries that also have the same characteristics and types of weather and climate as in Malaysia for them to adapt based on the problems and issues that arise in disaster management in Malaysia. Based on the literature review, it was found that the local government usually faces four main problems in flood management, namely inadequate (i) coordination and communication, (ii) manpower and assets, (iii) public awareness and (iv) power and

authority. Table 2 summarizes the list of issues and challenges faced by the local government in Malaysia.

Table 2. Summary of the list of issues and challenges faced by local government in Malaysia.

NO	Title	Challenges	References
1.	Flood Risk Management In Malaysia: The Current Hindrances For Flood-Related Agencies	(1) Limited authorities and lack of enforcement power (2) Cooperation among agencies (3) Insufficient funding (4) Lack of manpower, assets for logistics (5) Communication issues	[52]
2.	Flood Risk Mitigation: Pressing Issues And Challenges	(1) Inadequate flood preparation (2) Inadequate staff and rescuers (3) Lack of public awareness (4) Communication problems (5) Lack of assets (6) Transportation issues (7) Lack of food supply	[53]
3.	Flood Disaster Management In Sungai Pahang Basin: Case Of Temerloh	(1) Transportation issues (2) Communication issues (3) Lack of capacity of flood evacuation centres	[54]
4.	Disaster Risk Management In Malaysia: Issues And Challenges From The Perspective Of Agencies	(1) Weakness in coordinating with different agencies (2) Poor planning for disaster risk management (3) Inadequate planning for a lengthy recovery	[24]
5.	Transformation towards Risk-Sensitive Urban Development: A Systematic Review of the Issues and Challenges	(1) Politics and leadership (2) Complex procedure for evaluating risks (3) Equity and equality (4) Inadequate consideration of resilience attributes (5) Temporal and spatial conflict	[55]
6.	Water Resource Management In Malaysia: Legal Issues And Challenges	(1) Slow flood preparation (2) Financial problem (3) Federaland state government's conflict (4) Lack of awareness	[56]
7.	Lessons on environmental health and disaster preparedness, response and recovery from the severe Kelantan flooding in 2014	(1) Lack of preparation for flood (2) Unsuitable relocation centres (3) Issues of communication and coordination (4) Transport issues (5) Disaster management and emergency response problem	[57]
8.	COBIT principles to govern flood management	(1) Unclear roles for each agency (2) Lack of information across different agencies (3) No clear improvement for previous disaster (4) Weak enforcement and documented policies	[58]
9.	Reducing Flooding Impacts to the Built Environment: A Literature Review	(1) Increasing efforts for greening the environmental (2) Raising knowledge and awareness	[59]
10.	Assessing Malaysian Disaster Preparedness For Flood	(1) Inadequate human resources (2) Inadequate coordination and communication (3) Inadequate standard operation procedure (4) Funding problem (5) Lack of knowledge and training (6) Redundancies of roles and responsibilities (7) Redundancies of the law and legislation	[60]

2.1. Inadequate Coordination and Communication

In Malaysia, managing floods is complicated due to inadequate coordination and communication among relevant stakeholders. This is a significant challenge faced by local authorities related to flood management in Malaysia as few research papers focus solely on this problem. In many areas of the nation, flooding is a persistent issue that

can result in substantial property, infrastructure, and crop damage, as well as the eviction of thousands of people. This is especially true during the monsoon season. Several government organizations, including the Department of Irrigation and Drainage (DID) in Malaysia, the Malaysian Meteorological Department (MMD), and local governments are in charge of managing floods, but there have been instances when the efforts of these organizations have not been effectively coordinated, resulting in ineffective and inefficient flood management [61,62]. Slow action from the Federal Government, especially the National Disaster Management Agency (NADMA), coupled with the chaotic coordination of the local government and local agencies has apparently complicated this crisis for the people and made it a governance disaster [31,63].

Inadequate cooperation among agencies has also been a real challenge in flood management (Table 2). The roles and responsibilities of some government entities and private property, historic preservation and environmental interests conflict and compete with each other, which can impede effective flood risk management. Insufficient coordination among the various agencies involved in flood management results in misunderstandings and disjointed responses to and relief from floods [64]. The divergent policies and regulations among the involved government agencies represent one of the major difficulties in Malaysian flood management. Ineffective and insufficient flood mitigation infrastructure may be built as a result, which may raise the risk of flooding. Conflicting rules, for instance, have occasionally made it difficult to build effective flood protection barriers, like dykes and embankments, in flood-prone areas.

Limited communication among the various agencies in charge of managing floods is another problem. This might result in misunderstandings and a lack of coordination when it comes to putting flood response and relief plans into action, which might make it difficult to manage the flood situation. One of the most obvious examples during a flood is communication difficulty between rescuers on the scene. When this happens, contact between many parties is lost and the situation becomes chaotic, causing flood management to become more difficult and tedious [65]. This also causes problems as the rescuer is having difficulty in communicating with other responsible agencies due to inadequate collaboration and cooperation in flood management. This problem has also been stated by Deputy Minister in the Prime Minister's Department (Special Duties), Datuk Mastura Mohd Yazid, namely that the number of National Disaster Management Agency (NADMA) staff is small and there is no staff at the state level, making it difficult to coordinate with and deliver bilateral information directly to the agencies in the field [65]. All in all, communication is very important in viewing the coordination of all agencies involved in the scene.

Similarly, Mabahwi [52] also found that in one year, the meeting held by bringing together representatives from each agency involved was only held once. This caused a negative response from the public because this was not enough to draw up a good and systematic flood planning and action plan, especially operations involving several different agencies. Each agency has a different way of working, and a form of coordination is essential to ensure that each agency can work together efficiently and effectively. In addition, it was also found that the platform medium used by the individuals involved in the rescue operation was not suitable. It was reported that social media, i.e., the WhatsApp communication platform was used as the main communication platform throughout the rescue operation. However, problems began to arise when the internet connection became unstable, especially during the disaster season, making it difficult to rescue flood victims and slowing down operations.

Hence, the major obstacle to effective flood management in Malaysia is indeed a lack of coordination. However, the government is taking action to address this problem through several initiatives, including the creation of a central coordinating body and the development of a comprehensive national flood management plan. The government aims to reduce the risk of flood damage and ensure the safety of communities living in flood-prone areas by enhancing coordination and cooperation between the various agencies involved in flood management and by investing in efficient flood mitigation infrastructure [66–73].

2.2. Inadequate Manpower and Assets for Logistics

Lack of manpower and assets also can present a significant challenge for flood management. Flood management requires a variety of skilled professionals, including engineers, hydrologists, meteorologists, emergency responders, and administrators to plan, build, and maintain flood defence infrastructure, as well as to conduct research, monitor and predict, and prepare for and respond to flood events. Without adequate manpower, government and other organizations may not have the human resources needed to effectively manage the risk of flood disasters. Mabahwi et al. [52,74] also reported the lack of manpower and assets during the disaster in Malaysia. This problem occurs a lot at the district level, where the local government in each district suffers from a lack of manpower and assets to carry out operations to rescue victims of flood disasters. This becomes a serious issue and makes it difficult to rescue victims where the officers who should be on duty are also among the victims of the disaster that happened in the nearby area. The shortage of personnel occurs also due to the weakness of the local authorities to obtain enough personnel to carry out search and rescue operations for disaster victims. The weakness in terms of lack of assets is also one of the main problems at the local government level. The existing assets are insufficient or do not reach the appropriate standards to be used when operations are carried out. This indirectly delays the rescue operation while presenting great risk to disaster victims who need immediate help. The bureaucracy that is practiced in government agencies also makes it difficult for the local agencies to obtain allocations and clearances to buy important assets that are much-needed during a disaster [75].

Similarly, in 2017, Yazid also reported the lack of staff and assets when the researcher focused on the flood in Kelantan in 2014 [53]. During the flood incidents, local agencies were short of rescuers as the flood was affecting too many people around. Officers and staff that were involved in the operation also could not help as they also were the victims of the flood. The scale of the disaster was so big that it was affecting almost everyone in the area. Without adequate personnel, governments and organizations may not have enough emergency responders, such as rescue and evacuation teams, or enough personnel to assist those affected by floods. Other than that, there was no assistance or rescue team from outside that could help in the area because they could not enter the area and they were not familiar enough with the surroundings. Assistance from local authorities is very important to make sure the whole rescue operation can run smoothly and can cover the whole area effectively and efficiently. The assets used by the rescuers were also very limited, and this made it difficult for the rescuers to carry out rescue operations. Although some of the agencies involved have sufficient manpower to help flood victims, rescue help remains difficult to execute in the event of a shortage in terms of available assets such as boats and heavy machinery. The fact that the government agencies themselves acknowledge the assets were not sufficient to move flood victims is very concerning. The available current assets were also not up to standard and lacked maintenance. This is very dangerous, as it also can put a rescuer's life at risk during the rescue operation [64].

Accordingly, in 2019, Nurul Ashikin Alisa [54,76] also highlighted the challenges faced by local governments in flood management and focused on the lack of manpower and appropriate assets to be used when a flood disaster occurs. There was a problem in terms of water transportation, where the local government lacked important assets such as boats and helicopters to be used throughout the flood rescue operation. Assets like these are very important, especially when a flood disaster occurs. This is because these assets can be used to provide emergency assistance, especially to flood victims who live in island areas that are difficult for rescuers to reach. According to the researcher, the lifeboats used by the rescuers should have a boat engine power of at least 60 hp to enable them to wade through the fast currents of the Pahang River [77]. Air transport such as helicopters is also very important to bring large quantities of food and medicine to flood victims.

Noorhashirin [60] also mentioned a lack of manpower and important assets as a challenge in flood management in Malaysia. In her research, she highlighted that a low number of committee members involved in flood management would not contribute

effectively to resolving the flood problem, even though the coordination involved various agencies in Malaysia. Additionally, a lack of manpower can also make it difficult to implement land-use policies and regulations that can help reduce the risks of flooding. For example, without adequate personnel, governments may not have enough staff to enforce zoning laws that restrict development in flood-prone areas or to provide incentives for property owners to take steps to reduce their flood risk. Flood management in Malaysia is too reliant on local authorities and agencies to relay real-time data to the NADMA as a main coordinator before the whole rescue operation is activated. As a result, there has been always a shortage of equipment and supplies for relief efforts in particular [74].

Inadequate manpower and important assets can be a significant challenge for flood management. Adequate personnel are essential for building and maintaining flood defence infrastructure, conducting research and monitoring, preparing for and responding to flood events, and implementing land-use policies and regulations that can help reduce the risks of flooding. Without adequate manpower, governments and organizations may not have the human resources needed to effectively manage the risk of flooding [78–82].

2.3. Inadequate Public Awareness

Inadequate public awareness among the communities is also one of the main challenges that the local authorities have to face in implementing flood disaster management in specific areas. Awareness among the community is very important to gain support and encouragement from the local community, especially when involving project efforts and initiatives to overcome and reduce the risk of flooding in the area. Although flood disasters are natural disasters that often occur in Malaysia, there are still communities and individuals who are less sensitive and less aware of flood disasters. This can be illustrated by the fact many people still do not take the flooding seriously, as can be seen from the attitude shown. For example, there are cases of deaths when children drown after playing in the water during the flooding season, and this is caused by the attitude of parents and local communities who underestimate the danger of flooding in their home area [83,84]. One major aspect of the lack of awareness is the public's level of education related to the potential risks and impacts of flooding. Many individuals may need to be made aware of the potential hazards of flooding, such as flash floods, riverine floods, and coastal floods, or may not understand the potential impacts of these hazards on their communities. This lack of understanding can lead to a lack of preparedness and a lack of willingness to take steps to protect themselves and their property from flood risks. This way of thinking is very dangerous as people might be unaware of the danger in their surrounding area that can cause losses. This also contributes to another aspect of lack of awareness which is the public's understanding of the steps they can take to prepare for and respond to a flood event. Many individuals may not be aware of the importance of having an emergency plan in place or may not know how to develop an emergency plan. They may also need to be made aware of the importance of having emergency supplies on hand or may not know what supplies they should have. With the right exposure and knowledge, they can cooperate with the rescuers and make the evacuation process smoother and easier [85–88].

In 2017, Yazid [53,89] also mentioned lack of public awareness as one of the issues and challenges in mitigating flood losses. In his findings, he noticed that people in the affected area lack awareness of the Standard Operating Procedure (SOP) during a flood disaster. Some people refused to move even though orders were given. Some people refused to move as they believe that the area they lived in would never be flooded as never happened before. To make things worse, some people ignored the warning and treated the flood as if it was a water festival. This kind of attitude is very dangerous as it can bring harm to people. Flood disasters can be very dangerous and can put people's lives at risk. All of this is happening because there is a lack of public awareness and education regarding the risk of flooding as well as flood preparedness and response. Communities may not cooperate as a result because they may not fully comprehend the dangers of flooding and may not take the necessary safety measures to protect themselves and their property. This

requires more attention from the local government to ensure that the local community is fully exposed to the dangers of flood disasters to further increase awareness among the local communities. This high level of awareness indirectly helps the local government to gain community support if they want to implement operations or projects to overcome the problem of flooding that continues to hit their area.

Another aspect of the lack of awareness has also been reported by Rahman and Khalid in 2009 [56]: the overall effectiveness of Integrated Water Resource Management (IWRM) heavily depends on the mindset of the politicians as well as the general public. To ensure a more sustainable future, the Malaysian public needs to be informed about the issues in the water sector. The public may help tackle it by simply using water sensibly as a community. Using rainwater could lessen reliance on piped water and, if implemented on a large scale, eliminate periodic flooding. Furthermore, the public can do their part in raising awareness about water conservation. The participation of stakeholders in the decision-making process must be ensured by the government. Creating a database for the water industry to facilitate knowledge sharing can aid in raising awareness among pertinent stakeholders and the general public. Without a doubt, the voice of the people can act as a catalyst to convert political capacity and will into awareness.

Additionally, lack of awareness can also be a challenge when it comes to understanding the importance of land use and development policies that can help reduce the risks of flooding. Many individuals may not be aware of the potential impacts of development on flood risk or may not understand the importance of zoning regulations that restrict development in flood-prone areas. Furthermore, lack of awareness can also be a challenge when it comes to understanding the importance of natural flood management measures, such as preserving and restoring wetlands and other natural areas that can help absorb and slow down water [90]. Many individuals may not be aware of the benefits of these measures or may not understand how they can be used to reduce flood risks.

To address these challenges, an increase in public awareness of the risks and impacts of flooding is important to achieve, as well as teaching the public about the steps that can be taken to prepare for and respond to a flood event. According to the Director General of the National Security Council (MKN) Datuk Rodzi Md Saad in 2021, empowering the public's awareness in the face of disasters needs to be a priority in improving national disaster management, including floods [85]. This can be achieved through education and outreach programs, public information campaigns, and community-based programs. It is also important to involve the community in the development of flood management plans and to provide them with the information and resources they need to reduce flood risk.

2.4. Inadequate Power and Authority

When discussing some of the challenges that the authorities involved in flood risk management have to face, limited authorities and a lack of enforcement power are one of the main issues that need to be addressed. Jurisdiction and power allow an agency to carry out tasks more efficiently and effectively to help reduce the risk of disasters due to floods. All initiatives and efforts can be carried out more efficiently by an agency if the agency is given appropriate jurisdiction and adequate resources suitable to the scope of its duties. However, problems start to arise when some organizations or agencies experience constraints in their jurisdiction to carry out the tasks and responsibilities assigned. This is because the limited jurisdiction hinders all forms of initiatives and efforts that need to be carried out to ensure that the problems that occur can be overcome efficiently. Malaysia lacks an effective legal mechanism on integration of policies and mechanisms in flood management [29]. At present, water legislation is contained within the laws that are enforced by the various water-related government agencies, and many of these laws are outdated, redundant or ambiguous [91].

Mabahwi [52] focused on limited authority and a lack of enforcement power. He reported that the Department of Irrigation and Drainage Malaysia (DID) is lacking in power although they are the main agency that works directly with water management

and is responsible for flood disasters. DID lacks authority, especially in terms of flood mitigation for every new development activity. This is because the agency can only provide technical advice, but has no authority to reject the new development plan even though it might possess potential harm that can cause flood disasters in the future. By the time the research was completed, DID already requested a law amendment to allow more power and authority so that they can stop any new development that can bring harm and possess a risk to the area; however, the application was never granted and passed in the parliament.

Noorhashirin in 2016 [60] also focused on the lack of enforcement power in flood management. In his study, he stated that there is a need to create a special institution to overcome the problem of flood disasters. The current flood management practice in Malaysia is very complex and complicated when there is a conflict of authority among various agencies in managing floods in an area. For example, the local government and the state government share the same jurisdiction over an area, which makes cooperation difficult between these two parties to ensure that flood management runs smoothly, whether in the form of flood prevention projects or the provision of aid to flood victims. According to him, the focus of numerous water-related government agencies is on various water management issues, such as flood and drought issues. Also, there are inconsistencies and overlaps in the jurisdiction of different agencies. This problem has also been stated by Deputy Minister in the Prime Minister's Department (Special Duties) Datuk Mastura Mohd Yazid, who asserted that NADMA's ability is also limited to coordinate disaster management actions at the local level involving various parties due to problems at the chain in command as NADMA does not have staff at the district and state levels. At the time of foundation of NADMA's establishment on 26 August 2015, it was a mere coordinator for flood management in Malaysia [65,92,93].

Limited authorities can present a challenge for flood management as it can impede coordination and cooperation among different government agencies and stakeholders. This can lead to inefficiencies in decision-making and resource allocation, and can also hinder the development and implementation of effective flood management plans. For example, if different government agencies have different responsibilities and jurisdictions for flood management, it can be difficult to ensure that all aspects of flood risk are being addressed and that resources are being used most efficiently. This can also lead to confusion and conflicting priorities among different agencies, making it difficult to achieve a cohesive and effective response to a flood event [94,95].

Additionally, limited authority can make it difficult for different levels of government to work together effectively. For example, if a state government has primary responsibility for flood management, but local governments are responsible for land-use planning, it can be difficult to ensure that development in flood-prone areas is being properly regulated and that the risks of flooding are being minimized. Limited authority can also make it difficult to involve other stakeholders such as private sector organizations and community groups in flood management efforts. This can lead to a lack of buy-in and support for flood management plans, and can also hinder efforts to build resilience and prepare for future flood events. Therefore, limited authority can be a significant challenge for flood management as it can impede coordination, cooperation, and communication among different government agencies and stakeholders. Effective coordination and cooperation among different levels of government and stakeholder groups are crucial for effective flood management and reducing the risks of flooding [96].

3. Recommendation for Flood Risk Management

Preparedness is one of the most important aspects of disaster management cycle [97]. The preparations implemented can offer a significant impact to reduce and overcome the problem of flooding that occurs in an area. Until today, there have been several initiatives and projects implemented by the authorities in Malaysia to overcome the problem of disasters. Floods are natural disasters that can have devastating effects on the environment, infrastructure and human life. Flood mitigation methods are implemented to reduce the

damage caused by floods either by preventing them from happening or minimizing their impact. Following the disastrous 1971 flood, the Government of Malaysia implemented several positive steps to deal with the flood problem [2,98]. Among these were (a) the establishment of the Permanent Flood Control Commission; (b) the establishment of flood disaster relief machinery; (c) carrying out of river basin studies and preparation of drainage master plans for major towns; (d) implementation of structural measures; (e) implementation of non-structural measures; (f) setting up of flood forecasting and warning systems; (g) setting up of a nation-wide network of hydrological and flood data collection stations. Although the Department of Irrigation and Drainage (DID) in Malaysia is in charge of implementing these plans to prevent and mitigate the impacts of flood disasters, the implementation is needed from the perspective of the river basin approach rather than focusing on a localized problem-solving of flood disaster.

Structural methods are physical methods implemented to reduce the effects of flooding. Under structural measures, engineering methods are used to solve the flooding problem. River capacity can be increased to accommodate the surplus runoff through channel improvement, construction of levees and embankments, flood bypasses, river diversions, poldering, and construction of flood storage dams and flood attenuation ponds, either singly or in combination. In Malaysia, some examples of development carried out in the form of structural methods are the development of the SMART (i.e., Stormwater Management And Road Tunnel) in Kuala Lumpur and the flood reservoir in Batu Jinjang [2]. Dam construction is one of the most effective structural methods for flood mitigation. Among the examples of dams is the Klang Gates Dam in Gombak, Selangor. Dams can control river flow, store water during periods of heavy rain, and release water slowly during dry periods. This helps maintain a stable water level in the river and prevents flooding downstream. Likewise, embankments are built along the banks of the river to prevent the water from overflowing. Flood walls are built in urban areas to protect buildings from flood water. An embankment is a sloping structure built along a river to prevent its water from flooding the area adjacent to the river. Among the examples of flood walls is the flood wall in Batu Jinjang. There is also river improvement that has been conducted along the Kelantan River basin that focuses on dredging, widening, straightening and deepening river channels to encourage swift flow and maintain drainage capacities [99].

Non-structural measures, on the other hand, are proposed, where engineering measures are not applicable or viable or where supplemental measures are required. They include restriction of development, land-use zoning, resettlement of population, flood proofing, flood forecasting and warning systems, flood hazard maps and public awareness campaigns for sustainability [100]. For instance, the Kuala Lumpur Multi-Hazard Platform in Malaysia is a revolutionary forecasting tool to create a hazard map that can be used by the authorities to prepare emergency responses [101]. However, the implementation of this multi-hazard platform to reduce the impact of floods is still inadequate, especially due to the uncertain impact of climate change [102]. Flood forecasting is the process of predicting the occurrence and scale of floods. This helps offer people time to prepare and respond to flooding before it happens. Warning systems warn people in flood-prone areas of impending flooding, providing them with enough time to evacuate the area. A flood hazard map is a method used to map areas that have a history of flooding and provide an early picture to the authorities to implement precautionary measures to reduce damage caused by floods. Public awareness campaigns aim to educate people about the risks and dangers of flooding and must be made aware of how the warning system works and how to respond to the disaster's early warnings. Flood awareness, flood education, flood preparedness, and flood warning and evacuation programs must be communicated to the people regularly [99].

Both structural and non-structural methods are important for flood mitigation. Although structural methods are effective in reducing the effects of flooding, the cost to build and maintain them is high. Non-structural methods can be implemented at a lower cost and can have a large impact on flood mitigation. In addition, non-structural methods can

be adapted to changing environmental conditions and can also address issues of social inequality and environmental sustainability. For example, a flood warning system sent over mobile phone networks can reach a larger audience and be more effective in alerting people to potential flood hazards. A combination of both methods can provide the best results in reducing the effects of flooding. The implementation of these methods requires a multi-disciplinary approach and the involvement of various stakeholders to ensure social, environmental and economic sustainability. Plans and policies should be developed with a long-term perspective, taking into account the potential impacts of climate change and other natural and man-made hazards [103]. Additionally, building community capacity to respond to floods through appropriate training and awareness programs is essential. The community is encouraged to participate in the decision-making process regarding flood mitigation methods in their area as the application of structural measures addresses only the technical aspects of floods and these measures can only be successful if the public has confidence and responds correctly to them [104,105].

Weaknesses at the local government level in managing flood disasters that occur very frequently due to climate change are indeed a very worrying issue. This is because the issue does exist and will become a huge problem if it is not dealt with quickly and appropriately. Figure 3 depicts the overall findings of this study including the expected outcome in mitigating the flood disaster impact that can happen if one of these problems still has not been addressed properly. The diagram also suggests solutions to fix the issues and challenges related to flood risk management.

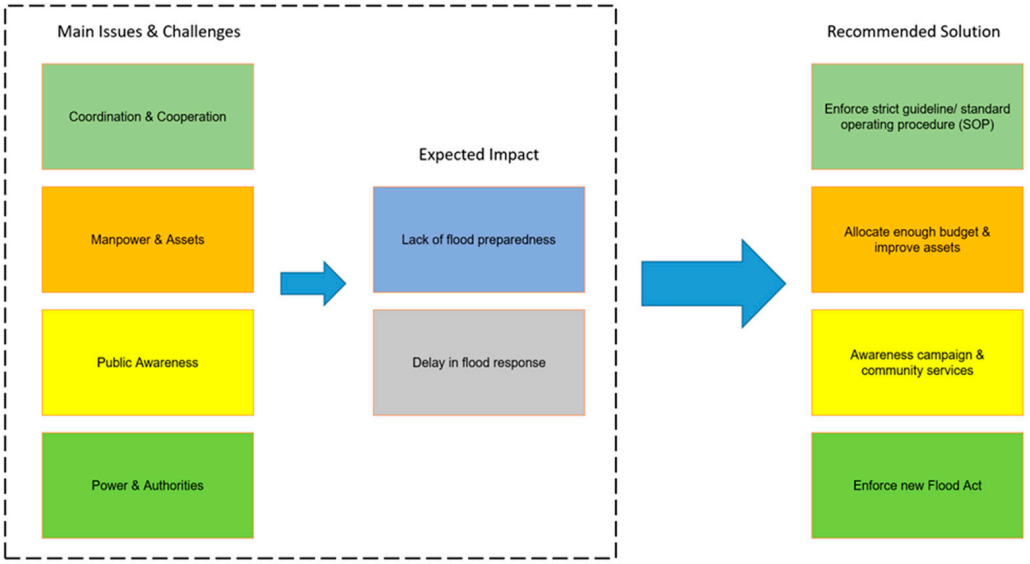

Figure 3. Mitigating the impact of flood disasters in Malaysia.

Overall, these four issues are the main challenges that need to be emphasized and noticed immediately. The issues that have been listed can contribute to bigger problems and challenges if not addressed at an early stage. Almost every research article analyzed in this study touches on problems that arise during flood management that are closely related to the four main issues highlighted in this study. This at once proves that all these issues are critical and should be prioritized by the local government to ensure disaster management can operate more efficiently.

Therefore, several suggestions can be considered to overcome the problems faced. Stricter enforcement of standard operating procedures (SOP) in disaster management helps in overcoming problems related to coordination and communication. If the work plans and guidelines that have been prepared are followed correctly by each agency or local government, coordination of all parties involved can be indirectly helped. This also facilitates coordination for each workforce involved in the operation and makes flood

management smoother and more systematic. Therefore, it is very appropriate for the main coordinating body such as NADMA to carry out periodic inspections of the guidelines and SOPs practiced in agencies and local governments to avoid confusion in flood management.

In addition, adequate budget allocation and periodic inspection of assets are also very important to ensure that the same problem does not occur again. A sufficient budget is quite important and critical in disaster management to ensure that every new initiative carried out can be implemented well. The amount of manpower can also be increased to ensure that there is no problem of manpower when a disaster occurs. Assets can also be improved by performing more frequent maintenance or adding important assets for use when the monsoon season arrives.

Moreover, the implementation of awareness campaigns and community activities are also among the suggestions that can be considered to ensure that community awareness related to disasters is at the highest level. High awareness is very important to develop full cooperation in the community, especially when hit by a disaster. Community involvement with local agencies is very important to provide a clear message to the public about the dangers of flooding and the guidelines that should be followed when a flood disaster occurs. Each of these actions is very important and contributes to keeping the community safe.

Thus, the enforcement of new laws and acts is also very important to overcome problems related to power and authority for some critical agencies. Therefore, the agencies that are actively involved in flood management such as DID should have greater influence and jurisdiction to enable them to take critical decisions in flood disaster management, especially to support the local government in flood disaster management. This is certainly appropriate to implement since DID is a special body responsible for flood management and has specific skills that are very critical for better flood disaster management.

4. Conclusions

The role of local government in flood risk preparedness and management is very crucial because they are the first responders on the scene when any disaster occurs. However, the capacity of local authorities in disaster, especially flood risk management, is inadequate mainly due to lack of coordination and communication among stakeholders, their manpower and assets, and power and authority as well as public awareness during implementing flood management plans. Therefore, customized training of local government officials is a must to prevent flood disasters as well as minimize its impact in the era of uncertain impacts of climate change. The government must create a cohesive vision and a supportive organizational structure for flood risk management. A thorough organizational structure will aid in improved agency coordination. Local government should be empowered via capacity-building programs to avoid duplication of authority and overturning of judgements that do not favor flood-resilient development. To address the absence of agencies cooperation, the position of NADMA as the main coordinator should be carefully regulated. The government should also develop specific flood laws to treat flood management seriously. A thorough allocation of power, responsibility, and funding for flood risk management under successful flood governance could directly result in the improvement of performance of flood-related agencies.

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