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A Review of Major Flood Events in Malaysia Between 1970-2024
(Tinjauan Peristiwa Banjir Besar di Malaysia Antara 1970-2024)

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ABSTRACT

This study compiles comprehensive data on significant flooding incidents throughout the history of Malaysia and presents the official estimates of flood-related losses for the chosen major flood occurrences spanning from 1970 to 2024. Additionally, it offers details regarding the underlying factors and consequences of floods, as well as an explanation of the flood prevention strategies implemented in this area. In addition, it provides information on the allocation of funds for flood mitigation measures by the Malaysian government as part of the Malaysia Plan (1971 to 2020. Past flood experiences have shown that a significant danger leading to potential loss of life or severe harm to individuals arises from the scale and strength of the floods, encompassing factors such as water levels, flow rates, and the speed at which the flood occurs. Intense floods characterised by elevated water levels and sudden occurrence, such as flash floods, have the potential to overwhelm flood defences and escape routes, hence increasing the risk of drowning and injuries. Nevertheless, it is recommended that an Integrated Smart Alarm System to be implemented in flood-prone areas to reduce fatalities.

Keywords: Flood, Disaster, Malaysia, Rainfall, Monsoon

ABSTRAK

Kajian ini mengumpulkan data komprehensif mengenai kejadian banjir yang ketara sepanjang sejarah Malaysia dan membentangkan anggaran rasmi kerugian berkaitan banjir bagi kejadian banjir besar yang dipilih antara 1970 hingga 2024. Selain itu, ia menawarkan butiran mengenai faktor asas dan akibat banjir, serta penerangan tentang strategi pencegahan banjir yang dilaksanakan di kawasan ini. Selain itu, ia menyediakan maklumat mengenai peruntukan dana untuk langkah tebatan banjir oleh kerajaan Malaysia sebagai sebahagian daripada Rancangan Malaysia (1971 hingga 2020). Ia juga menekankan peranan agensi kerajaan dalam melaksanakan langkah-langkah ini semasa keadaan banjir. Pengalaman banjir yang lalu telah menunjukkan bahawa bahaya besar yang membawa kepada potensi kehilangan nyawa atau kemudaratan teruk kepada individu timbul daripada skala dan kekuatan banjir, merangkumi faktor-faktor seperti paras air, kadar aliran, dan kelajuan banjir berlaku. Banjir kuat yang dicirikan oleh paras air yang tinggi dan kejadian secara tiba-tiba, seperti banjir kilat, berpotensi menenggelamkan pertahanan banjir dan laluan melarikan diri, seterusnya meningkatkan risiko lemas dan kecederaan. Namun begitu, Sistem Penggera Pintar Bersepadu dicadangkan dilaksanakan di kawasan mudah banjir bagi mengurangkan jumlah kematian.

Kata Kunci: Banjir, Bencana, Malaysia, hujan, Monsoon

INTRODUCTION

Malaysia is often affected by disasters such as floods, landslides, haze and other man-made disasters, as well as some rare cases of earthquake and tsunami. Malaysia has an INFORM 2019 Natural Hazard and Exposure risk of 3.4/10. Globally, floods remain the most frequent and damaging disaster. Each year, floods cause the highest frequency of damage and are accountable for a substantial number of human fatalities, disease outbreaks, property and agriculture destruction, and other negative impacts. Figure 1 shows the occurrence by disaster type around the world from EM-DAT (2024). In 2023, a total of 399 catastrophic events were recorded, which is considerably higher than the average of 369 annual catastrophic events for 2003-2022. Floods dominated these events, with 164 occurrences, up from an average of 170 annual flood occurrences recorded across the 2003-2022 period. Malaysia has encountered 51 notable natural disaster occurrences between 1998 and 2018 had the

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highest flood exposure rate among ASEAN Member States from 2012 to 2019. During that era, 281 fatalities occurred, with over 3 million individuals impacted, and disasters resulted in nearly US $2 billion (MYR8 billion) in damages. Over the course of the last century, more than a dozen of major flood events have occurred in Malaysia, each displacing tens of thousands of people and costing millions of Ringgits in damage. Examples include the flood of 1971, 1973, 1988, 2001, 2005, 2007, 2010, and 2014. In total, there were 31 major flood events considered as disasters between year 1980 to 2010, resulting on average of 41 deaths, 20,000 victims being displaced, and costing up to RM100 million each year in damages. For example, the flood that hit Kuala Lumpur and many other states in January 1971 resulted in the death of 61 people and losses of nearly RM35 million (based on Malaysian Ringgit value in 1971). A report of the flood was published in an international newspaper as shown in Figure 2. In 2000, floods resulting from heavy rainfall claimed the lives of 15 individuals in Kelantan and Terengganu, prompting over 10,000 residents to evacuate their residences in northern Peninsular Malaysia. The floods in Johor in December 2006 and January 2007 resulted in 18 fatalities and required around RM1.1 billion for disaster assistance and relief.

Recent media emphasise the severity of flash floods in Malaysia. They cause property damage, interfere with daily life, and endanger public safety. The economic consequences are significant; however, it is frustration and anxiety they bring in communities that have the most profound impact. Rapid urbanisation plays a significant role. As urban areas grow, the disappearance of green spaces results in the absence of adequate space for rainfall drainage. Climate change worsens the problem, resulting in heavier rainfall. However, the issue extends beyond nature and include obsolete flood management systems. The government has undertaken initiatives to improve drainage infrastructure and enhance flash flood management. Nevertheless, the issue continues to exist due to the requirement of a comprehensive solution. Efficient flood prevention necessitates meticulous strategizing and active involvement from all parties involved. This study used secondary data from the Department Irrigation and Drainage (DID), National Disaster Management Agency (NADMA), the press, and a research paper on the flood disaster in Malaysia.

Thus, this study focused on flood tragedies due flood events from 1970 to 2024 occurred in the year 1970 to 2024. The year selected in this study is

Monsoon rains flood Malaysia, toll heavy

KUALA LUMPUR (UPI) – Authorities evacuated flooded villages today in the populous Kuala Lumpur area in the wake of one of the worst monsoon rains to hit Malaysia.

Prime Minister Tun Abdul Razak said "this year's flood might come up to the 1931 flood" which left hundreds dead.

Official reports said at least 24 persons had been killed as a result of heavy rains since Dec. 26. Four more persons, including three youths, were reported to have drowned in rising flood waters.

At least 28 persons have been killed since the monsoons lashed west Malaysia with 27 inches of rain beginning Dec. 26. Police said 18 of the fatalities were victims of drownings. The rest were passengers of a Thai motor boat that capsized in the northeastern seas.

Razak was briefed on the latest flood situation throughout this nation of 10.5 million people at the Royal Malaysian police headquarters in Kuala Lumpur.

The premier warned residents of flood-prone villages "to evacuate to higher grounds immediately before they are caught by the sudden rise of water."

Authorities told Razak the situation, particularly in Pahang state, has deteriorated during the past 24 hours.

More than 35,000 persons in the flooded areas in the states of Pahang, Trengganu, Kelantan, Johore and Selangor, which includes Kuala Lumpur, have been evacuated.

Food supplies, gasoline and fuel oil were flown today to Pahang, worst affected area. River boats and patrol craft were sent to help evacuate flooded villages, most of them built around rivers.

Floods and landslides cut off road and railway links to key cities of the east coast and to the island republic of Singapore, about 200 miles south of Kuala Lumpur.

Hijackers force jetliner to Cuba

FIGURE 2. The 1971 flood reported in The Bulletin, an Oregon-based newspaper on January 4, 1971

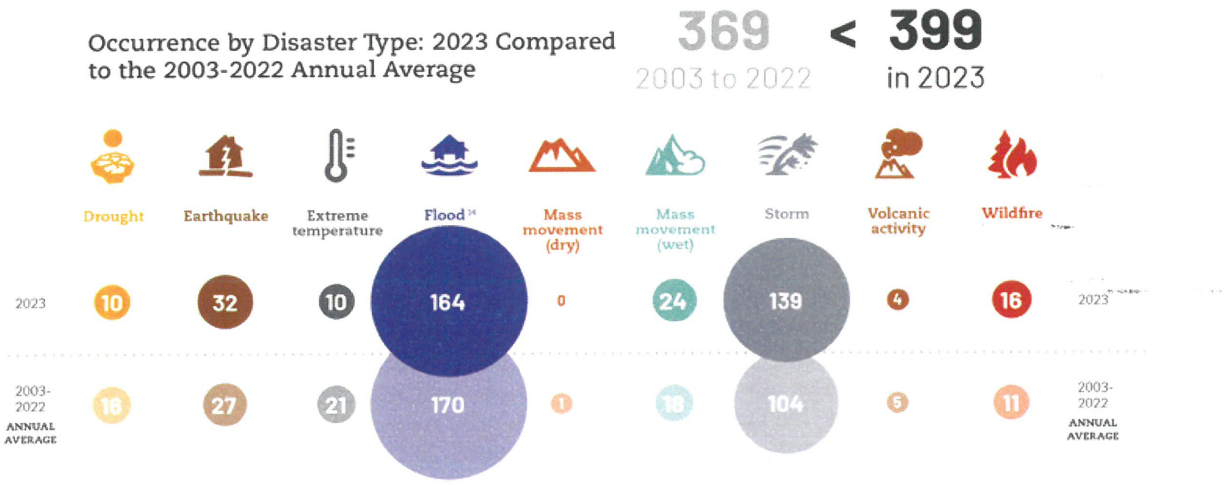

FIGURE 1. Occurrence by disaster type: 2023 compared to 2003-2022 annual average (EM-DAT, 2024)

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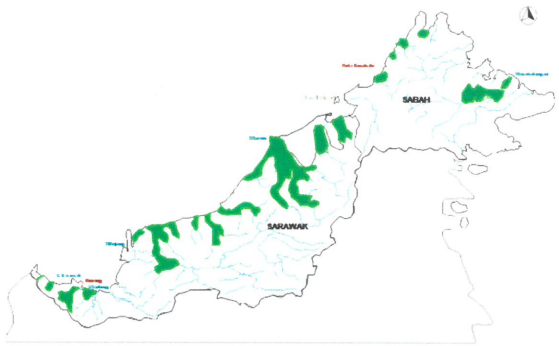
due to the terrible flood within these half-century especially in year 2014, 2017 and 2021 in Klang Valley that caused 54 deaths, and it caused the concurrent displacement of more than 71,000 residents and have affected over 125,000 people overall. The purpose of this article is to provide information for a preliminary review of the flood tragedy in the year 1970-2024.

FLOOD HISTORY IN MALAYSIA

Malaysia, a Southeast Asian nation known for its diverse landscapes and vibrant culture, has experienced its fair share of natural disasters over the past five decades. Flooding, in particular, has been a recurring challenge, with the country facing a significant number of devastating flood events during the period of 1970 to 2024. Malaysia located at latitude 2° N to 7° N and longitude 99.5° E to 120° E in Southeast Asia. This country is divided into two major parts, namely Peninsula Malaysia and Borneo Island, covering a total area of 330,200 km^2. Figure 3 shows the location of flood prone area in Malaysia.

Floods are one of the major disasters occurring all over the world, including Malaysia. These events can lead to the destruction of facilities, infrastructures, and properties, causing significant damage and disruption to the lives of the affected communities. Flooding in Malaysia is recurrent, covering a large, inhabited areas compared with other natural disasters. According to the World Meteorological Organisation, flooding is one of the three worst natural disasters in the world, claiming thousands of lives and causing the destruction of property worth hundreds of thousands of millions. A record number of floods have been reported in Malaysia, with events occurred in 1926, 1931, 1947, 1954, 1957, 1963, 1965, 1967, 1969, 1971, 1973,

a) Peninsular Malaysia



b) East Malaysia

FIGURE 3. Flood Prone Area in Malaysia (DID, 2023)

1983, 1988, 1993, 1998, 2001, 2006, 2007, and 2010.

In 2010, floods disrupted transport in Kedah and Perlis, leading to the closure of rail services, roads including the North-South Motorway, and the airport in Alor Setar, the capital of Kedah. Helicopters were the only available aerial transport into Kedah and Perlis during that time. Water in Kedah and Perlis was polluted, leading them to request water from Perak. The Department of Irrigation and Drainage has stated that about 29,000 square kilometres, or 9% of the total area, and more than 4.82 million people, or 22% of the total population, are affected by flood every year.

In December 2014, five states in Peninsular Malaysia experienced severe flooding, with Kelantan being the worst affected. The rainfall in Kelantan over 10 days was double the usual amount for the month of December. 232,913 evacuees were recorded in many evacuation facilities throughout Peninsular Malaysia, setting a new record. Figure 3 shows the Northeast Monsoon flood statistics where the numbers of evacuees, families, evacuation centres, death, missing, houses destroyed, houses damaged, losses and number of states affected had been reported between 2014-2020.

Another worst flooding event that hit Malaysia were on 4 & 5 November 2017. Meanwhile, extensive bridge damage due to scouring also was reported at Sungai Sembrong in 2006, Sungai Jeniang in 2009, Sungai Nenggiri (destroyed by floating debris during Dec 2014 flood), Sungai Tanum Kuala Lipis (Abutment scour during Dec 2014 flood). The worst scour effect due to the terrifying flood was on 4 January 2021 at Raub, Pahang where the bridge was collapse and leaving a huge gap between the land and the bridge pier and thus making it impossible for any vehicle to pass through.

According to the Malaysian Government, the disruption due to flood caused the total economic damage was estimated at more than RM 420 million. Faizah et al., (2019) has pointed out that to mitigate

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measures of flood disaster i.e. structural and non-structural, the Government of Malaysia has spent more than RM 3 billion on structural measures to mitigate flooding since 1970's until now. However, this figure is still insufficient, and this amount will keep on accumulating due to the increasing project cost at flooded areas. Figure 3 shows the selected photos of flood events in Malaysia and Table 2 shows the official flood loss estimates together with the number of deaths and people evacuated for the selected flood events in Malaysia from 1967 to 2024.

a) Flood in Kelantan, 2014

b) Flood in Terengganu, November 2023

c) The worst flood in Klang Valley on 19 Disember 2021

FIGURE 3. Selected photos of flood events in Malaysia.

CAUSES AND EFFECTS OF FLOOD IN MALAYSIA

Kong et al. (2010) presented seven causes of flooding in Figure 4. The results showed that 28% of people believe that flooding is due to improper drainage systems, 20% think the cause is pollution, 18% say it is the management of urbanisation, 16% say it is an environmental factor, and 11% believe weather is the causative agent, while 7% choose dam break.

Ooi et al., 2004 concluded that the primary causes of floods in Malaysia is the country's susceptibility to heavy monsoonal rains, particularly during the northeast monsoon season from November to February. The analysis shows that intense and prolonged rainfall, especially during the monsoon seasons, significantly contributes to flooding. The northeastern states of Pahang, Terengganu, and Kelantan are especially prone to these flooding incidents, with records dating back to the 1920s. Moreover, the effects of climate change, such as rising sea levels and increased rainfall intensity, have exacerbated the problem, leading to more frequent and severe flooding occurrences (Siti et al., 2020). Meanwhile, the tropical storms and typhoons in the South China Sea and adjacent regions also impact flood frequencies in Malaysia, contributing to extreme rainfall events (Kato and Kuroiwa, 2005).

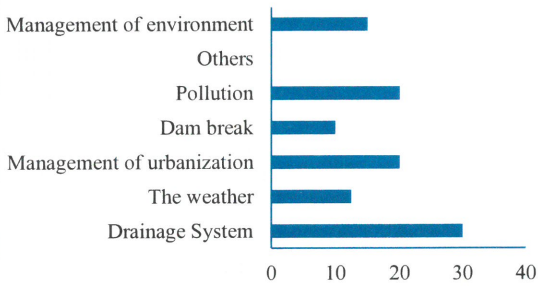

FIGURE 4. Seven Causes of flooding (Kong et al., 2010)

In addition to natural factors, human activities have also played a significant role in the increasing prevalence of floods in Malaysia. The rapid urbanization and development of infrastructure alongside rivers, coupled with the poor maintenance of drainage systems, have contributed to the worsening of flood events. Rapid urban development in Malaysia has led to increased impervious surfaces and inadequate drainage systems, contributing to higher flood risks (Abidin and Nordin, 2018).

Deforestation is another significant element that contributes to flooding in Malaysia. Deforestation for agricultural and development reasons diminishes the land's capacity to absorb and retain water. Vegetation and trees have a crucial role in stabilising soil and aiding in the absorption of water. Deforestation increases the risk of soil erosion and reduces the land's ability to manage rainfall. This can lead to increased runoff and higher chances of flooding, particularly in areas previously covered by dense forest (Sharma and Sreejith,

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2017). The effectiveness of drainage infrastructure is crucial in managing flood risks. In many parts of Malaysia, particularly in urban areas, existing drainage systems are often outdated or insufficient to handle the volume of water during heavy rains. Wong and Mak (2019) pointed out that blocked or poorly maintained drains can lead to localized flooding, which can quickly escalate into more severe flooding if not addressed promptly. Inadequate flood management practices and insufficient investment in infrastructure exacerbate these problems. Meanwhile, climate change is an

Table 2. Official flood loss estimates for selected flood events in Malaysia from the year 1970 to 2024 (Public InfoBanjir, 2024; Diya et al., 2014; Sulaiman, 2009)

Year	Place	Damage (RM Million)	Number of Deaths	People Evacuated
1971	Pahang R. Basin	93.1	24	153,000
1971	Kuala Lumpur	84.7	24	NA
1979	Peninsular Malaysia	NA	7	23,898
1982	Peninsular Malaysia	NA	8	9,893
1983	Peninsular Malaysia	NA	14	60,807
1984	Batu Pahat R. Basin	20.3	0	8,400
1986	Peninsular Malaysia	NA	0	40,698
1988	Peninsular Malaysia	NA	37	100,755
1988	Kelantan R. Basin	33.0	19	36,800
1988	Sabah	NA	1	NA
1991	Peninsular Malaysia	NA	11	NA
1992	Peninsular Malaysia	NA	12	NA
1993	Peninsular Malaysia	NA	22	17,000
1995	Peninsular Malaysia	NA	0	14,900
1996	Sabah (June)	NA	1	9,000
1996	Sabah (December)	130.0	200	15,000
1997	Kedah, Terengganu	NA	5	5,321
1999	Kedah, Pulau Pinang, Perak Utara	NA	1	15,500
2000	Terengganu, Kelantan	7.1	NA	NA
2001	Pahang, Johor	NA	15	13,195
2002	Kuala Lumpur	NA	NA	NA
2003	Kuala Lumpur, Pulau Pinang, Kedah	NA	5	31,046
2004	Kelantan, Terengganu, Pahang	NA	17	17,080
2005	Kedah, Perlis, Kelantan, Terengganu	240.1	14	99,405
2006	Johor, Negeri Sembilan, Melaka	NA	15	107,000
December 2006 & January 2007	Floods in Johor State	489 million	18	NA
2008	Floods in Johor State	21.19 million	28	NA
2010	Floods in Kedah and Perlis	8.48 million	4	NA
2011 & 2012	La Nina in 2011 and 2012 (which brought floods)	NA	NA	NA
2014	Kelantan	300 million	10	91,441
2015	Sabah, Sarawak	2.4 billion	1	13, 878
2016	Sarawak, Johor, Negeri Sembilan	4.5 billion	3	61,107
2017	Kelantan Terengganu	284 million 1.25 billion	NA NA	12, 615 12, 910
Dec 2021-Jan 2022	Shah Alam, Hulu Langat, Kuala Lumpur, Pahang, Perak, Melaka, Kelantan, Terengganu, Sabah	6.5 billion	54	125,000

increasing issue that impacts flood patterns worldwide, and Malaysia is not exempt from this. Increasing global temperatures contribute to the occurrence of extreme weather events, such as heightened precipitation and intensified storms. In addition, the rise in sea level caused by the melting of polar ice and the expansion of seawater due to thermal effects could increase the risk of coastal flooding. The convergence of heavy precipitation with increasing sea levels in Malaysia presents a dual danger, rendering both inland and coastal regions increasingly susceptible to flooding.

The issue of flooding in Malaysia has become chronic and severe, with wide-ranging implications for individuals, communities, and the environment. These effects have many aspects, impacting various parts of society and natural systems. Gaining comprehensive knowledge about the various implications of floods is crucial for developing efficient flood control measures and minimising the effects of future incidents. Rahman and Hanif (2020) provide a quantitative assessment of the economic damage caused by floods, including infrastructure and property damage. They have presented that floods can affect both personal finances and national economic stability. For personal level, flooding can cause significant damage to residences, commercial establishments, and personal belongings, resulting in considerable financial difficulties for those impacted. The expenses related to repairing and reconstructing, along with the loss of income for individual's dependent on farming or other enterprises, can be quite burdensome. For the national economy, floods have negative effects by disrupting economic operations and damaging infrastructure. Infrastructure damage, such as that to roads, bridges, and public buildings, can impede mobility and diminish productivity, resulting in increased expenses for repair and maintenance. Furthermore, floods can have a significant influence on vital industries, such as agriculture, which plays a crucial role in Malaysia's economy. Reduced production of food and increased food prices can result from crop losses and damage to agricultural land, impacting both consumers and producers.

Kong et al. (2010) have classified the effects of flooding by four categories. Figure 5 shows the four elements that have been taken in the study. It was found that, over 33% of individuals agree that flooding leads to water damage to houses, structures, and appliances. Closing of businesses resulting from flooding also leads to a loss of income. Approximately 25% of individuals agree with these effects, while 17% belief that transportation disruption is an additional consequence of floods (Kong et al., 2010). Research by Tan and Lai (2017) stated that floods have significant effects on the environment, such as causing soil erosion, vegetation loss and disturbance to ecosystems. Flood-induced erosion can result in the depletion of nutrient-rich topsoil, adversely affecting agricultural yield and causing lasting damage to the land. In addition, floodwaters have the ability to disseminate contaminants and debris, so polluting water sources and causing harm to aquatic life. Furthermore, floods have the potential to cause the destruction of ecological habitats. Forests, wetlands, and mangroves are highly susceptible to damage, and their destruction can lead to a series of negative consequences for biodiversity and ecological equilibrium. Wetlands, such as those mentioned, have a crucial function in filtering water and regulating floods, and their destruction can worsen flooding problems.

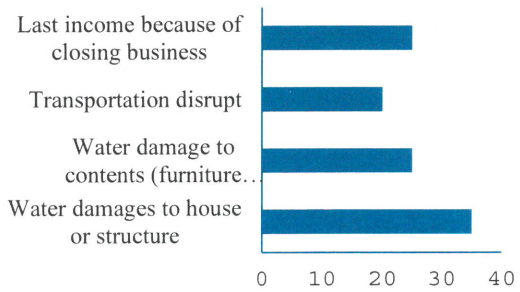

FIGURE 5. Effects of flooding (Kong et al., 2010)

The damage to infrastructure during floods is extensive and can have long-lasting effects. Transportation infrastructure, including roads and bridges, as well as essential public utilities like electricity and water systems, are frequently subject to significant damage, resulting in service disruptions and higher expenses for repairs. Infrastructure destruction not only disrupts daily living but also hinders the progress of rehabilitation operations and adversely affects economic activities. The most recent major flood on 16 December 2021 was hit seven states in Peninsular Malaysia where it gives significant impacts on transport infrastructures. A total of 98 federal roads and 126 state roads are affected due to flooding that struck Selangor, Negeri Sembilan, Terengganu, Kelantan, Melaka, Pahang and Kedah. The National Disaster Management Agency (Nadma) said there were flash floods, floods, landslips, road collapse, sunken roads as well as damaged bridges at 224 locations in the seven states after torrential downpours throughout the peninsular for three days. The resulting floods have left at least 54 dead and 2 missing and it caused the concurrent displacement of more than 71,000 residents and have affected over 125,000 people on the overall. According to the Malaysian government, it is declared as a "once in a century" disaster and it is the worst flood in the country in terms of displaced residents since the 2014–2015 Malaysia floods. It has also been historically compared with the 1971

Kuala Lumpur floods. Many bridges were destroyed or damaged during this hazard. The causes that resulted to the largest percentage of reported bridge failures is of hydraulic nature and in particular flood and scour effects, which may be exacerbated due to climate change (Tang, 2019). Record-high precipitations were measured at weather stations at Selangor and Kuala Lumpur. Widespread damages were reported at the states of Selangor and Pahang, especially the district of Hulu Langat and the city of Shah Alam. Figure 6 shows one of the locations of the collapsed bridge in Raub due to high discharge of river and extensive scour around pier and abutment in January 2021.

FIGURE 6. Bridge collapse in Raub, Pahang in January 2021 due to high discharge of river and extensive scour around pier and abutment.

FLOOD MITIGATION MEASURES IN MALAYSIA

To address this issue, Malaysia has been actively exploring a range of flood mitigation strategies, with a focus on integrating these measures into local development plans. The integration of flood risk reduction measures into local development plans is very important. To address this issue, Malaysia has been actively exploring a range of flood mitigation strategies, with a focus on integrating these measures into local development plans. The integration of flood risk reduction measures into local development plans is crucial, as it not only helps prevent risk but also reduces vulnerability and promotes preparedness in local communities (Wardah et al., 2021)

One of the key findings from the literature suggests that the rapid change in catchment land use, along with a lack of compliance with recommended practices, has contributed to the increased frequency of flooding in urban areas of Malaysia. To mitigate this, the study proposes that the removal of bridge constrictions, combined with other flood mitigation works, could significantly reduce flood levels (Shahrulnizam et al., 2020).

In addition to these centralised efforts, Malaysia has also implemented grassroots-level initiatives to address the issue of flooding. The development of a real-time flood monitoring system using Raspberry Pi technology, for instance, has proven to be a valuable tool in enhancing early warning capabilities and facilitating the timely dissemination of critical information to affected communities (Fairuz et al., 2020). This system not only allows for the rapid detection of flood events but also enables the enforcement of safety precautions, ultimately enhancing the resilience of local populations.

Moreover, the country has recognized the importance of proactive measures in mitigating the impact of flooding. Efforts to monitor rainfall rates, for example, have been undertaken to assist in early flood forecasting, even though these measures cannot fully prevent the occurrence of floods. (Parvin et al., 2018) By leveraging such data, communities can be better prepared to respond to impending flood events, minimizing the potential for loss and damage. In view of the prolonged rainfall and frequent flood incidents that pose a threat to the safety and property of citizens, the Malaysian government has made the decision to invest funds from the national budget towards flood mitigation measures in each of its Malaysia plans (five-year plans). Figure 7 displays the allocated funds by the Malaysian government for flood mitigation projects as part of the Malaysia plan from 1971 to 2020. The funding allotted for flood mitigation projects under the 2nd, 3rd, 4th, 5th, 6th, 7th, and 8th Malaysia Plan were 14 million MYR, 56 million MYR, 141 million MYR, 155 million MYR, 431 million MYR, 545 million MYR, and 2700 million MYR correspondingly. A total of 17 billion dollars have been allocated for flood prevention projects under this plan from 2005 to 2020.

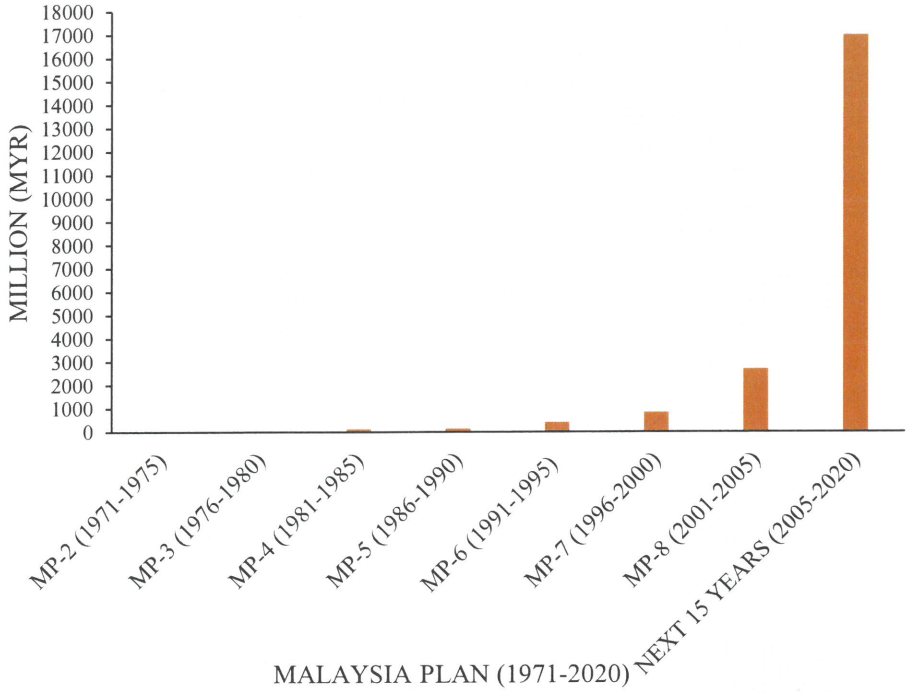

FIGURE 7. Budget allocation for flood mitigation projects under Malaysia Plan

Besides that, structural measures involve physical interventions designed to control or redirect floodwaters. These include flood barriers and levees (Rahman and Wong, 2020), retention basins and reservoirs (Abu Hasan and Ali, 2017) and river dredging and embankments (Yusof and Aziz, 2019). Non-structural measures focus on planning, policy, and community involvement to mitigate flood risks. These include urban planning and zoning (Tan and Lim, 2016), flood forecasting and early warning systems (Idris and Mohamad, 2018) and community education and preparedness (Haris and Hasan, 2021). Figure 8 shows some flood mitigation projects that have conducted in Malaysia.

RESEARCH GAPS

This study has compiled, categorised, organised, and archived all the scattered information related to the floods in Malaysia into one database. The study employed systematic approaches to examine various

a) Kg Melayu Subang flood mitigation project set for 2023

b) Kg Melayu Subang flood mitigation project set for 2023

c) Flood Mitigation Projects at Sungai Pahang

FIGURE 8. Flood Mitigation projects in Malaysia.

aspects related to disasters worldwide. These aspects included the most affected continent, the number of deaths caused by different types of disasters, the historical occurrence of floods in Malaysia, the causes and consequences of floods, the allocation of funds for flood mitigation under the Malaysia Plan, and the roles and responsibilities of government agencies during flood situations. Although most

flood-related deaths occur in developing nations, most of the studies on this topic focus on the United States, with a few being conducted in Europe and Australia. Past flood experiences have shown that a significant danger leading to potential loss of life, or severe injuries is the magnitude and intensity of the floods including water levels, flow rates, and the speed at which the flood develops. Severe floods with high water levels and rapid onset (such as flash floods) can overwhelm flood defenses and escape routes, increasing the risk of drowning and injuries. Besides that, the instability of cars while submerged in floodwaters also significantly affects the potential for loss of life and injury. Hence, the Environmental Agency in the United Kingdom and other flood management bodies worldwide have recently shown interest in the stability of automobiles during urban flood events.

Areas that have been flooded might provide challenges in terms of accessibility, which can complicate rescue efforts and cause delays in providing assistance to people who require it. This can increase the risk of fatalities and injuries. This is because floodwaters have the potential to block highways and cause harm to communication equipment, so hindering the effectiveness of emergency response operations.

Besides that, the design, construction, and maintenance of infrastructure, including buildings, roads, and levees, have an impact on the magnitude of damage and level of risk associated with a flood event. The reason for this is that infrastructure that is badly designed or not properly maintained might collapse or malfunction, resulting in injuries, deaths, and challenges in carrying out rescue efforts. Except for a few differences, particularly in the language used, the road signs in Malaysia are very similar to those seen another country. It continues to be believed that an Integrated Smart Alarm System is necessary in flood-prone locations to reduce the fatalities.

CONCLUSIONS

In Malaysia, the causes of floods are generally related to improper drainage caused by development activities. The recorded floods and casualties between 1970 and 2024 indicated an increase in the number of fatalities with an increase in the number of floods. Based on the research available, it shows that improper drainage system was the main cause of floods occurrences especially in Selangor and Kuala Lumpur. Inadequate or poorly maintained drainage systems in cities can lead to waterlogging. Blocked drains, insufficient drainage capacity, and lack of proper planning contribute to this issue. Rapid urbanization often leads to the construction of buildings, roads, and other infrastructure that reduces the amount of natural land available for water absorption. This increases surface runoff, which can overwhelm drainage systems. However, the effects of a flood will be different within a location and compared to those who have often experienced severe incidents in floods. The main effects of flood is the damage to houses and appliances and some stated that the evacuating people from flood-prone areas is the primary method of preventing flood damages.

In conclusion, Malaysia's flood history highlights the importance of sustainable development, effective flood management systems, and preparedness strategies. Efforts to mitigate the impact of floods include improving drainage systems, river management, early warning systems, and public awareness campaigns. As Malaysia continues to develop, balancing economic growth with environmental conservation will be crucial in reducing the long-term risks and impacts of flooding in the country.

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