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Disasters Worldwide and Floods in the Malaysian Region: A Brief Review

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Abstract

Background/Objectives: To gather the information on the natural disasters occurred Worldwide from the year 2004 to 2013 Average and 2014 and emphasizes on the disaster type which has severely affected the continent Asia, particularly, Malaysia. **Methods:** This paper collects all the information about major overflows in the history of Malaysia and gathers the facts about the official flood loss estimates for the selected major flood events from the year 1967 to 2012. It further provides information on the general causes and effects of floods and explains about the flood mitigation measures being used in this region. Additionally, it explains about the allocation of funds for flood mitigation measures by the Malaysian government under the Malaysia plan (1971 to 2020) and enlightens the responsibility of the government agencies accountable to the mitigation measures during the flooding conditions. **Findings:** Experiences from past floods, demonstrate that a common hazard which causes risk of death or serious injury to the people is due to the instability of vehicles in floodwaters. Therefore, the stability of vehicles during urban flood events has aroused recent interest from the Environmental Agency in the United Kingdom and other flood management authorities around the World. However, it is still believed that there is a need of an Integrated Smart Alarm System that can be used in the flood prone regions to minimize the vehicle related fatalities. **Application:** To provide researchers, government agencies and decision makers etc., an overview on the most notable disaster type which has severely affected the Malaysian region.

Keywords: Disasters Worldwide, Major Overflows in Malaysian History, Vehicle Related Fatalities

1. Introduction

The definition of disasters defined by the Malaysian National Security Council (MNSC) directive 20 (2003) states that "an emergency situation that will cause the loss of lives, damage property and the environment, and hamper local, social, and economic activities". During the period of 1947 to 1981, the World witnessed a total of 554 hydrological disasters (floods and cyclones) and 208 geological disasters (earthquake, volcanic eruption and landslides). Within these two categories floods were the most frequent natural disasters followed by tropical cyclones and earthquakes[1]. In the 20th century, floods alone have been reported responsible for the death of 08 million people Worldwide[2,3].

Figure 1 shows the number of reported disasters and victims from the year 1990 to 2014. Particularly in the year 2014, a total of 324 disasters were reported which affected nearly 141 million people Worldwide. Table 1 shows the regional figures about the occurrence of natural disasters and its impact by each continent. Globally, among 324 natural disasters that occurred in the year 2014, the hydrological disasters (flood, landslide and wave action) took the largest share of 153 events (47.2%) out of which 65 events were reported to occur in the continent Asia. In the same year, the number of victims affected by the impact of hydrological disasters Worldwide were counted to be 42.28 million out of which 37.10 million victims were reported from the continent Asia which is indeed alarming. Similarly, the estimated economic loss (US $ billion) caused by the hydrological disasters altogether in the entire World in the year 2014, was estimated to be 37.39 US $ billion out of which 29.42 US $ billion were to be borne by the continent Asia. Moreover, the Average (2004 to 2013) result

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also shows that the continent Asia has remained constantly prone to hydrological disasters which had destructive impacts on it. Additionally, among the hydrological disasters, floods are said to be most lethal when compared to any other natural disaster type as shown in Figure 2[4].

Floods can effectively be described as natural disasters that affect, as well as is affected by human activities, particularly, physical development[5]. It is a progressive abnormal increase in the elevation of the surface level of a stream's flow until it reaches an extreme height from which the level gradually drops to what was its usual level[6].

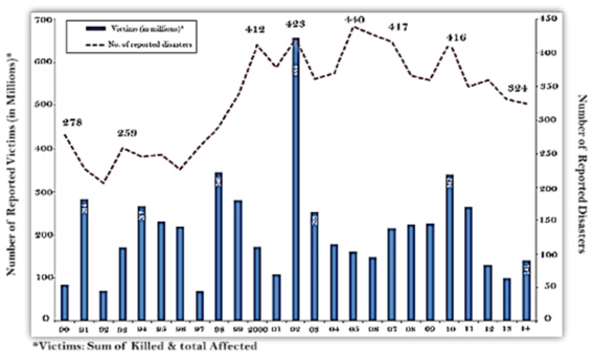

Figure 1. Number of reported victims and disasters from 1990 to 2014[4].

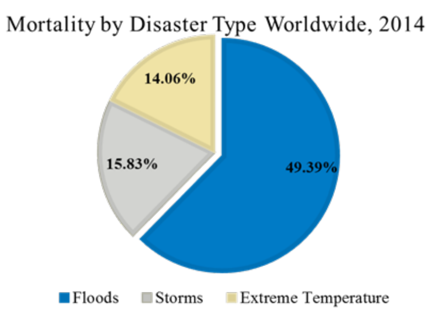

Figure 2. Mortality by disaster type[4].

2. Floods History in Malaysia

Malaysia is located in Southeast Asia with an area of nearly 330000 km^2. The average precipitation is between 2000 mm to 4000 mm with the temperature ranging between 26°C to 32°C all over the region[7]. The Malaysian climate has three attributes that is uniform temperature, high humidity and copious rainfall – round the year[8]. The country is blessed that it is not directly influenced by the calamities like hurricanes, tornados, typhoon, volcanic eruptions[9] and earthquakes[10] but there are two significant water related problems causing adverse impact to this country that is excess water in terms of floods and water shortage in terms of droughts. Among these two significant causes, floods are considered to be the most notable natural disasters in Malaysia in terms of duration, frequency, area extent, affecting population and damaging the socio economic structure of the country[11].

There are a total of 189 river basins throughout Malaysia out of which 89 are in peninsular Malaysia, 78 in Sabah, and 22 in Sarawak. The main channels of these river basins are flowing directly to the South China Sea. Approximately, 85 of the river basins (45%) are marked prone to the regular flooding[12, 13]. The approximate estimated area inclined to flood disaster is 28900 km^2 or 9% of the total area of Malaysia which is affecting almost 4.82 million people, that counts nearly 22% of the total population of the country[14, 15].

Historically, the Malaysian people are considered to be the riverine people as the early settlement grew on the river banks but still nearly 3.5 million people are reported to be residing on the flood plains which is undeniably frightening[16].

Table 1. Natural disaster occurrence and impacts: Regional figures[4]

The regional figures about the occurrence of natural disasters for the year 2014 and average 2004-2013						
No. of Natural Disasters	Africa	Americas	Asia	Europe	Oceania	Global
Climatological 2014 Average 2004-2013	5 13	9 9	5 5	1 4	1 1	21 32
Geophysical 2014 Average 2004-2013	4 2	8 6	17 21	2 2	1 2	32 33
Hydrological 2014 Average 2004-2013	24 45	31 38	65 83	29 20	4 5	153 192
Meteorological 2014 Average 2004-2013	6 9	28 38	57 47	22 28	5 6	118 127
Total 2014 Average 2004-2013	39 69	76 91	144 156	54 54	11 14	324 384

The regional figures about the people affected by natural disasters for the year 2014 and average 2004-2013						
No. of Victims (Millions)	**Africa**	**Americas**	**Asia**	**Europe**	**Oceania**	**Global**
Climatological 2014	6.61	29.73	31.73	0.00	0.00	68.06
Average 2004-2013	24.24	1.84	26.83	0.12	0.00	53.03
Geophysical 2014	0.01	0.62	2.65	0.08	0.00	3.36
Average 2004-2013	0.05	0.94	7.51	0.02	0.07	8.59
Hydrological 2014	0.98	1.44	37.10	2.68	0.08	42.28
Average 2004-2013	3.23	4.48	86.07	0.32	0.08	94.19
Meteorological 2014	0.13	0.37	26.33	0.11	0.09	27.03
Average 2004-2013	0.35	2.56	40.30	0.19	0.04	43.43
Total 2014	7.74	32.16	97.80	2.87	0.17	140.74
Average 2004-2013	27.86	9.82	160.71	0.64	0.19	199.23

The regional figures about the damages caused by natural disasters for the year 2014 and average 2004-2013						
Damages (2014 US $ Billions)	**Africa**	**Americas**	**Asia**	**Europe**	**Oceania**	**Global**
Climatological 2014	0.00	7.43	3.71	0.15	0.03	11.31
Average 2004-2013	0.05	4.40	1.12	1.74	0.29	7.60
Geophysical 2014	0.00	0.80	5.93	0.63	0.00	7.36
Average 2004-2013	0.08	4.48	40.93	2.00	2.62	50.12
Hydrological 2014	0.12	2.31	29.42	5.52	0.02	37.39
Average 2004-2013	0.35	5.11	19.32	5.19	1.32	31.32
Meteorological 2014	0.39	15.21	25.03	1.48	1.03	43.14
Average 2004-2013	0.09	53.98	13.87	4.52	1.03	73.48
Total 2014	0.51	25.76	64.08	7.77	1.08	99.20
Average 2004-2013	0.58	67.97	75.27	13.45	5.26	162.53

The Department of Irrigation and Drainage (DID), Malaysia has categorized floods into two categories that is flash floods and monsoon floods. Based on the hydrological perspective, the difference between the flash floods and monsoon floods rely on the time taken by the river flow to go back to its normal position[13]. Floods can be predicted to a reasonable extent, with the exception of flash floods, whose scale and nature are often less certain[17]. Flash floods are sudden and occur without any prior warning which surprise people during their daily routine and particularly hit people traveling[18]. Whereas, monsoon floods are caused by the Northeast monsoon winds between the months of November to March and the Southwest monsoon winds between the months of May to September[16].

The major overflows Malaysia has experienced since 1920 were in the years of 1926, 1963, 1965, 1967, 1969, 1971, 1973, 1979, 1983, 1988, 1993, 1998, 2005, 2006 and 2007[11]. The coastal plains and riverine areas of Malaysia are considered to be most extensive flood prone areas which are highly built up and densely populated[16]. The state of Pahang, Terengganu and Kelantan in the East Coast of Malaysia gets severely affected by floods almost every year[19, 20].

Since 1920, Malaysia has experienced a series of floods. The recent monsoon flood from December 2014 and January 2015 are regarded as one of the most shattering floods to strike Malaysia. Officially, more than 100,000 flood victims were evacuated from their houses during these disastrous events[20].

Similarly, the floods in December 2006 and January 2007 are also considered to be most damaging floods in the history of Malaysia. The flood strike as a result of two waves, the December 2006 (19th to 31st December) and January 2007 (12th to 17th January). The water level recorded during these floods reached 2.75 meters which is the highest level observed since 1950. The mortality rate was recorded to be 18 and the number of persons evacuated during that catastrophe were more than 100,000[13].

Another study reported that from the year 1968 to 2004, Malaysia faced a total of 39 disasters. The frequency of major natural disasters was 19 (49%), which led to 1460 fatalities and 821 injuries. The man-made disasters were counted to be 18 (46%) which caused 282 mortalities and 1892 injuries and the subsequent disasters (forest fire and haze) were reported to be 2 (5%) only which neither caused any death nor any injuries. Among the natural disasters, floods (06 events) were stated to occur most regularly followed by landslides (05 events), storms and epidemics (03 events each) and mudslides and tsunami (01 event each)[1].

Figure 3 shows the selected photos of the past flood events in Malaysia during the year 1926, 1967, 1971, 1995, 2004, 2006 and 2007[21]. 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 the year 1967 to 2012[13, 21] and Figure 4 shows the newspaper cuttings for the different flood events in Malaysia gathered from different sources[21, 22].

Table 3 shows the rate of increase in the population of major urban centres located on the banks of major rivers in Peninsular Malaysia between 1957 and 1990. Other than Kuala kangsar (-5% increase) located in Perak, there was observed an increase in the population almost in every centre with the highest increase of 513.3% in K. Terrenganu[23]. Therefore, there lies the responsibility on the Malaysian government to relocate these people to a safe place with all the basic facilities.

2.1 Causes and Effects of Floods in Malaysia

The majority of the Malaysians (those who are not affected by the floods) are not too concerned about floods. Despite the damage to the private and public properties, loss of

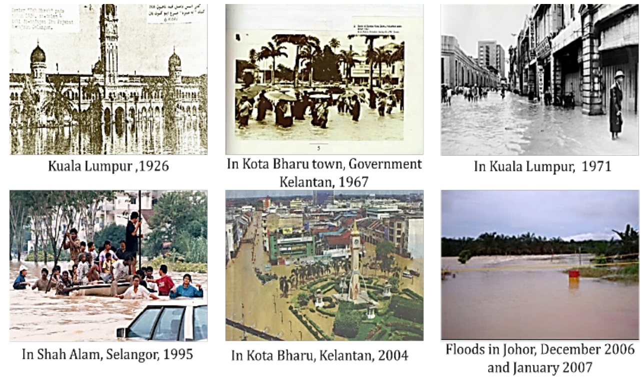

Figure 3. Selected photos of the flood events in Malaysia[21].

Figure 4. Newspaper cuttings for the selected flood events in Malaysia[21,22].

Table 2. Official flood loss estimates for selected flood events in Malaysia from the year 1967 to 2012[13,21]

Year	Place	Damage (RM Million, 1993 Prices)	Number of Deaths	People Evacuated
1967	Kelantan R. Basin	199.3	38	320,000
1967	Perak R. Basin	154.5	0	280,000
1967	Terengganu R. Basin	40.2	17	78,000
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

Year	Place	Damage (RM Million)	Number of Deaths	People Evacuated
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
2007	Pahang, Kelantan, Johor, Kedah (Dec.)	316.1	22	36,143
2007	Kuala Lumpur (June)	NA	NA	NA

Year	Place	Damage (USD)	Number of Deaths	People Evacuated
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

life, drop in business and the inconvenience caused. There have been stated three major reasons that are responsible for the flood risks in Malaysia which includes human activities that has caused changes to the physical characteristics of the hydrological system, continued development of the areas that are prone to flooding and destruction of forests and hill slope development[16, 24].

In general, the north-east monsoon (October to March)[13], the south-west monsoon (May to September)[16], landslide and mudflow, inadequate drainage[21], soil erosion from land development into the river and etc. are considered accountable for the occurrence of floods in Malaysia[14].

Floods being a natural phenomenon have both positive and negative impacts. Floods are necessary for sustaining certain sector of biodiversity in the flood plains. It further replenishes the lands with nutrient rich soil which is good for the agricultural production and also recharges the ground water storage. On the other side, the negative impacts of floods are more prominent in the developed urban areas as it threatens lives, disrupt the economic and social activities and destroy properties. Further, the post flood recoveries can be costly to both the individuals and the Government[21].

2.2 Flood Mitigation Measures being used in Malaysia

To reduce the losses caused by the natural catastrophe like flooding the structural and non-structural approaches are usually undertaken[25]. In flood management system, the structural measures refer to the choice of structural solutions that can mitigate the flood related issues. The instalment of these measures is beyond the capacity of individuals/public and can only be constructed by the government. The type of structural measure to be used to manage the flood flow is based on its specific function. The structural measures can only be the practical solution in some circumstances (e.g. land limitation) and if not regularly maintained then it can have disastrous consequences. Few examples of structural measures being used in Malaysia are shown in Figure 5[21].

The non-structural measures refer to programming, planning, setting policies, co-ordination, rising awareness,

Table 3. Rate of increase in the population of major urban centres located on the banks of major rivers in Peninsular Malaysia between 1957 and 1990[23]

Rate of increase in the population of major urban centres located on the banks of major rivers in Peninsular Malaysia between 1957 and 1990				
Centre	River	1957	1990	% Increase
Kuala Lumpur	Kelang	316,200	919,600	190.8
Ipoh	Kinta	125,800	293,849	133.6
Georgetown	Pinang	234,900	248,241	5.7
Johor Bahru	Johor	75,100	246,395	226.6
Kelang	Kelang	75,600	192,080	154.1
K. Terrenganu	Terrenganu	29,400	180,296	513.3
Kota Bharu	Kelantan	38,100	167,872	340.6
Kuantan	Kuantan	23,100	131,547	469.5
Melaka	Melaka	69,900	87,494	25.2
Alor Setar	Kedah	52,900	69,435	31.3
Muar	Muar	39,100	65,151	66.6
Batu Pahat	Batu Pahat	40,000	64,727	61.8
Keluang	Mengkibol	31,200	50,315	61.3
Teluk Intan	Perak	37,000	49,148	32.8
Sungai Petani	Merbok	22,900	45,343	98.0
Dungun	Dungun	12,500	28,903	131.2
Kulim	Kulim	17,600	26,817	52.4
Kemaman/ Cukai	Kemaman	NU	15,952	NA
Kuala Kangsar	Perak	15,300	14,539	-5.0
Mersing	Mersing	NU	13,888	NA
Pasir Mas	Kelantan	NU	13,402	NA
Tangkak	Tangkak	NU	13,251	NA
Kota Tinggi	Johor	NU	13,056	NA
Ampang	Kelang	NU	12,987	NA
Kuala Krai	Kelantan	NU	12,607	NA

strengthening the society to manage the impacts and threats of floods and warning and informing those at risk. These measures further aim at reducing physical and economical vulnerability and making the social structure of the community strong. These actions can be undertaken at individual, community and state level[21]. The non-structural measures are considered more sustainable and more efficient solutions in long terms to the water-related problems. However, these measures should be enhanced, to minimize the vulnerability of human beings and goods exposed to flood risk[26]. Few examples of non-structural measures being used in Malaysia are shown in Figure 6[27].

Figure 5. Few examples of structural measures[21].

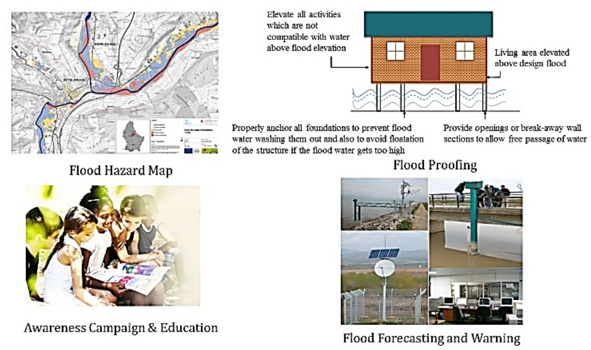

Figure 6. Few examples of non-structural measures[27].

2.3 Malaysia Plan for Flood Mitigation Projects

To cope with flooding mishap, bulk of annual budget is kept for the flood disaster preparedness, relief operations, rehabilitation of post flood victims and public utilities[16]. The economic development plan was first introduced by the government of Malaysia for the welfare of its citizens. Keeping in view the prolonged rainfall and the regular flood events endangering the property and life of the citizens, the government of Malaysia decided to allocate funds from the national budget for the flood mitigation measures in every of its Malaysia plan (five-year plan). Figure 7 shows the allocated amount by the Malaysian government for flood mitigation measures under the Malaysia plan from the year 1971 to 2020. The amount (MYR) allocated for the flood mitigation projects under the 2nd, 3rd, 4th, 5th, 6th, 7th and 8th Malaysia Plan were 14 million, 56 million, 141 million, 155 million, 431 million, 545 million and 2700 million respectively. From the year 2005 to 2020 a total of 17000 million have been allocated for the flood mitigation projects under this proposal[28]. Allocation of such an amount clearly shows that the Malaysian government is well familiar with the needs of the country to avoid the damages caused by floods.

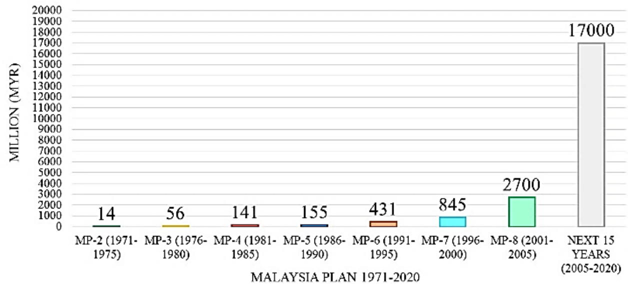

Figure 7. Budget allocation for flood mitigation projects under Malaysia Plan[28].

2.4 Flood Warning and Forecasting Services in Malaysia

Flooding is inevitable, but the hazards associated to it can be reduced through effective management and planning[29]. For successful mitigation of flood damage, proper flood forecasting and warning is mandatory. Its potency relies on the level of correct response and effective preparedness. Therefore, it is the responsibility of the concerned government authorities to provide reliable and timely flood warnings[26].

The previous records have shown that the first flood warning was provided during the flood events in the year 1925 when the floods occurred along the Klang river in Selangor, Kinta River in Perak and Bernam River in Selangor and Perak boundary, Malaysia[30, 31].

The National Disaster Relief Committee was established in 1972 after the disastrous flood of 1971, headed by the Deputy Prime Minister of Malaysia in the National Security Council of Prime Minister Department. The tasks given to this committee were to co-ordinate flood relief operations at National, State and District level; prevent loss of human lives and reduce flood damages.

The committee consists of various cabinet ministers, such as the Minister of National Resources and Environment, the Minister of Social Welfare, the Minister of Finance, the Minister of Science, Technology and Innovation, senior government officials such as Government's Chief Secretary, the Army General and the concerned government agencies such as Department of Irrigation and Drainage (DID), Malaysian Meteorological Department (MMD), Malaysia Centre of Remote Sensing (MACRES), Social Welfare Department, Fire and Rescue Department, and Police Department[11]. However, the additional responsibility of flood mitigation was assigned to DID from 1972 onwards[32] with the following tasks:

- To execute Flood Mitigation Projects,
- To carry out river basin studies and
- Implementation of flood warning and forecasting services[31].
- The DID follows the mentioned operating procedures under the flood relief mechanism as described below[30] and shown in Figure 8[31].
- The relevant flood control centres are advised by the DID to activate their flood relief mechanism when the river stage of flood warning station reaches the "alert level".
- The flood forecast operation is then carried out by the respective state DID office using real time telemetric data and river forecasting computer models.

If at any forecasting point, the river water level exceeds the "critical level", the forecast is then transferred to the flood operation centres and the concerned government agencies such as the National Security Division (BKN) and the national and state control centres for flood relief and operations.

During the flood event, the officers in charge of the government agencies like DID, MMD, BKN, Police and Army receives a Short Message System (SMS) to alert[30]. Further, the info banjir webpage provides the updated real time information of river water levels and rainfall which is published online at www.infobanjir.water.gov.my. The online webpage is accessible to the public and the government officials that enables effective early flood warning through internet at any time and any place[27, 30].

3. Research Gap

This paper has collected, classified, arranged and stored all the scattered information related to floods in Malaysia into one record. A systematic approach was followed to conclude the study following disasters Worldwide, the

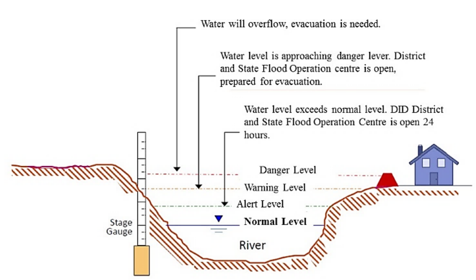

Figure 8. Water level classification and flood warning centre (DID)[31].

most affected continent, mortalities by disaster type, floods history in Malaysia, causes and effects of floods, the allocation of budget for floods mitigation under the Malaysia Plan and the responsibilities of government agencies during the flooding conditions.

Despite the fact that most of flood deaths have occurred in developing countries, majority of the studies are limited to the United States, with a few in Europe and Australia[2]. Experiences from past floods, demonstrate that a common hazard which causes risk of death or serious injury to the people is due to the instability of vehicles in floodwaters. Therefore, the stability of vehicles during urban flood events has aroused recent interest from the Environmental Agency in the United Kingdom and other flood management authorities around the World[33].

Drowning is considered to be the major cause of deaths during floods[2] and nearly 2/3 of the fatalities that occur during floods are due to drowning (majority of which are reported in vehicle)[3]. Further, it has been stated that one of the factor that contributes to the flood fatality occurrences is human behaviour as people tend to intentionally drive through the flooded areas by "neglecting risks such as underestimating warnings and ignoring traffic safety barriers"[34] and get swept away due to the buoyancy force or stuck in the flood water[35].

Except for certain distinctions, specifically the language used, the Malaysian road signs are nearly similar to those in the World[36]. Perhaps, it is still believed that there is a need of an Integrated Smart Alarm System that can be used in the flood prone regions to minimize the vehicle related fatalities.

4. Conclusions

In summary, the purpose of this paper was to highlight the disaster type which has severely affected the continent Asia, particularly Malaysia. While focusing the Malaysian region, the study further reviewed the history of major floods in different years by portraying it in the form of photographs and newspaper cuttings. The consequences and effects of floods were also discussed and the flood mitigation measures being used in Malaysia were briefly discussed. Further, the paper reviews the budget allocation for the flood mitigation projects by the Malaysian government under the Malaysia Plan. Lastly, it defines the responsibility of government agencies responsible for the flood mitigation projects and point out the research gap, observed while conducting the literature survey.

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