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Flash Flood Impact in Kuala Lumpur – Approach Review and Way Forward

Impak Banjir Kilat di Kuala Lumpur – Ulasan Pendekatan dan Langkah Kehadapan

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ABSTRACT

The understanding of the impact of flash floods is carried out by identifying the main causes of flooding. Measures have been undertaken to reduce the impact of flooding however, several recommendations are identified to address the problem more effectively. This paper is based on the analysis of the factors that has contributed to the occurrence of flash floods in urban areas particularly Malaysia's capital, Kuala Lumpur. Rapid development occurs here, leads to the compromise of green and forested areas that serve as the absorption of water run-off, causing drainage associated problem, moreover, when not managed effectively and obsolete drainage design that requires costly maintenance. Steps taken to reduce this problem are mainly structured approach which involves the construction of smart tunnel to diverted large quantities of water from the road surface to existing natural pond, widening and deepening of the drainage system, building reservoirs and dams for storm water at the upstream area. Meanwhile, the non-structured approached currently involves cleaning of the main waterway of Sungai Klang and Sungai Gombak of debris. Recommendation for future works is more active non structured approach that have been prove to be cost effective with greater impact to the livelihood of the people.

Keywords: Rapid urban development; flash flood; human migration; natural factor; non-structure

ABSTRAK

Pemahaman mengenai impak banjir kilat di kawasan Kuala Lumpur dilakukan dengan mengenal pasti punca utama banjir, mengenal pasti langkah-langkah yang telah dilakukan untuk mengurangkan impak tersebut dan memberikan cadangan menangani banjir tersebut dengan lebih berkesan. Berdasarkan analisis antara faktor yang telah menyumbang kepada kejadian banjir kilat di kawasan bandar membangun seperti Kuala Lumpur adalah lokasi pembangunan pesat yang menyebabkan kompromi terhadap kawasan hijau dan hutan yang berperanan sebagai penyerapan air larian, saliran yang tidak diurus dengan berkesan dan reka bentuk yang saliran yang lama dan memerlukan penyelenggaraan. Antara langkah yang telah diambil untuk mengurangkan masalah ini adalah daripada aspek struktur melibatkan pembinaan smart tunnel dengan menyalurkan jumlah air yang banyak di permukaan jalan dan kekurangan upaya saliran semasa menampung jumlah air, mendalamkan sistem perparitan khususnya yang berada di dalam bandar dan menyediakan takungan atau empangan banjir kilat di bahagian hulu sungai. Pendekatan bukan berstruktur pada masa ini lebih kepada pembersihan sungai utama iaitu sungai Kelang dan Gombak daripada sampah sarap. Cadangan pada masa akan datang lebih kepada pendekatan bukan berstruktur yang menggunakan kos yang lebih rendah dan mempunyai kesan yang lebih besar.

Kata kunci: Pembangunan pesat; banjir kilat; manusia; faktor semula jadi; tanpa struktur

INTRODUCTION

Flash flood characterized by high velocity flows and short warning time (Jonkman & Kelman 2005; Ashley & Ashley 2008; Sharesta 2010). Although, some confined the occurrence of flash flood to a specific geographical region such as mountain (Yong Tu et al. 2013), as the impact are more devastating due to the cascading hazard, it also rampant and disastrous to a low land area as well. It is known fact that flash flood is the most dangerous kind of flood, because they combine the destructive power of a flood with incredible speed and unpredictability (Doocy et al. 2013). As it happen without warning this type of flood often cause a lots of damage to infrastructures, the environment and the loss of lives that further degraded the livelihood and economic of local people. According to Jonkman (2005), flood events caused half million in mortality, and impacted over 3million people from 1980 until 2009. Emergency Event Database (EM-DAT) or Center for Research on the Epidemiology of Disasters

(CRED 2009), reported there was a 66 percent global increase of intense hydro-meteorological disasters of 1210 during 1991–2000 to 2004 during 2001–2010 and Asia region is the most affected area by flooding and has the highest casualties per year (Figure 1).

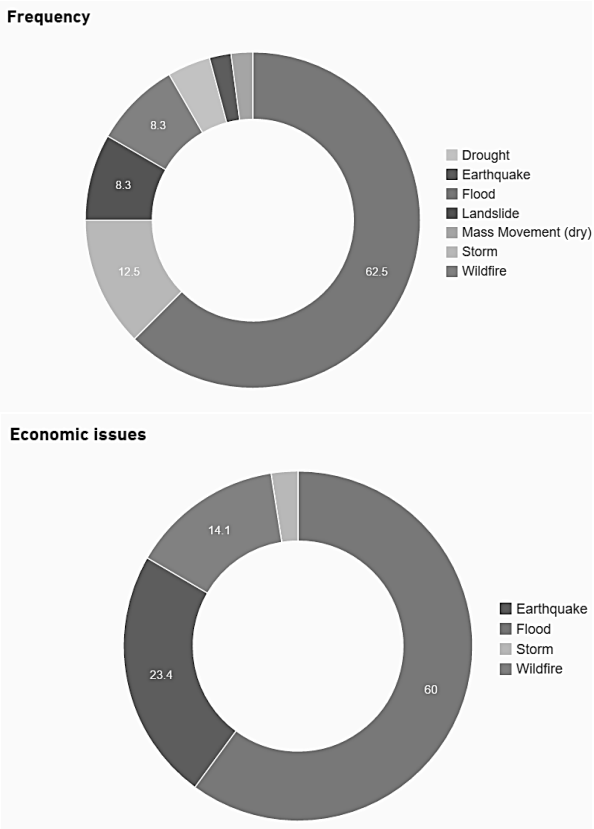

FIGURE 1. The frequency of disaster occurrence according to categories in the world and the economic implication cause by the most severe disaster as of CRED 2009.

This paper discusses flash floods in Kuala Lumpur, urban area and the understanding of its occurrences. Flash flood hazard is expected to increase in frequency and severity, through the impacts of global change on climate, severe weather in the form of heavy rains and river discharge conditions (Kleinen & Petschel-Held 2007). In Kuala Lumpur flash floods is a common phenomenon and occurs due to several factors. Two of the main factors highlighted here are the human induced factors for instance rapid urbanization with extreme increase in migration thus rapid spatial change in the land use and land cover (LULC) of Kuala Lumpur. Secondly, are the natural factors that consist of lithology, terrain, torrential rainfall, and natural drainage (river) system (Figure 2).

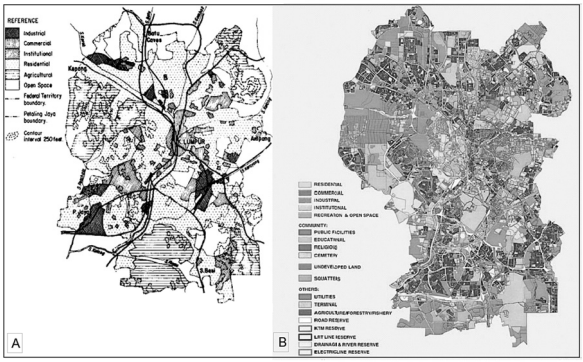

FIGURE 2. Land use and land cover of Kuala Lumpur

Source: A is taken from Jamaluddin (1985) shows the land cover back in 1985 whereas B taken from DBKL (2017) KL20 report showing Kuala Lumpur Land Use and Land Cover (LULC) in the year 2000.

The flash floods hazard in Kuala Lumpur are associated closely with rapid development as can be seen from figure 1 above the changes that has seen the reduction of green and forested areas and replacement of natural surfaces with roofing and concrete that has limited the rate of water absorption. Poorly maintained buildings with clogged drains and unsuitable design and construction of drainage and waterways have also contributed to flash flooding (Sinar harian 2017). The municipality of the city covers an area of 243 km^2 and referring to figure above it can be seen clearly on the southern edge of KL where there use to be open spaces has been developed into institutional and education areas and the amenities are much denser towards the center of KL.

The earlier recorded flood phenomenon in Kuala Lumpur in 1926 known as "Bah Besar 1926" or great flood. The other recorded incident of massive flooding was in 1971, which lasted for five days and caused extensive damage (Keizrul Abdullah 2004). Since then, there have been records of other incidences, including the great flood of 30 April 2000, 26 April 2001, October 29, 2001, June 11, 2002, June 10, 2003 and June 10, 2007. The occurrences have caused great damage to properties, loss of life, traffic disruption that in turn affects the socio-economic activities and the image of Kuala Lumpur as the capital of Malaysia (Ilah Hafiz Aziz 2013).

Following the disastrous 1971 flood, the Government took several positive steps to deal with the flood problem. among these were establishment of the permanent flood control commission; establishment of flood disaster relief machinery; implementation of structural measures; implementation of non-structural measures; setting up of flood forecasting

and warning systems; carrying out of river basin studies and preparation of drainage master plans for major towns; setting up of a nationwide network of hydrological and flood data collection stations (Chia Chong Wing 2004).

Flooding has a long lasting psychological effect on its victims. It has a profound impact and for those who remain to live by their homes it recurs. For example, during the monsoon season every year, residents living in the flood plain, they often feel quite anxious, worried and scared (Tuah Pah et al. 2011).

Kuala Lumpur is the capital city of Malaysia, which over the years has gone through rapid development rendering a constant change to the face of the urban area. Rapid development reduces green surface area replacing it with roofing and concrete. Mohamad Abdul Rahman et al. (2012) noted that flood phenomenon that is also known as flash flood can also called as *pensive flood*, where the water level rises instantaneously but is slow to recede. Flash floods is often characterized by a rapid rise of the river and waterways resulting in the height reading well above the riverbanks carry over flow of sewage and drainage. NDMO (2011) states that flooding is the most significant natural hazard in Malaysia as reported in the statistics by UNISDR, 2014 (refer to Figure 3).

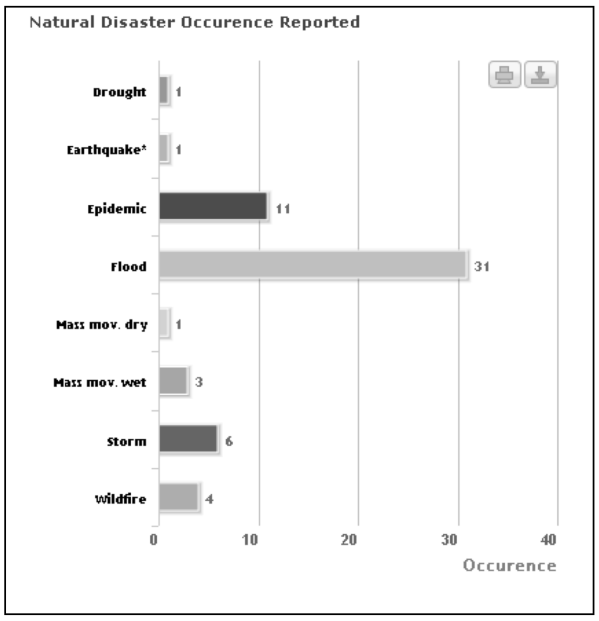

FIGURE 3. Disaster Occurrence Malaysia (UNISDR 2014)

Flash floods are short-term events that occur within less than a period of 6 hours of a causative event; i.e. heavy rain, dam breakage, levee failure, rapid snowmelt and volcanic eruption and often within two hours of the start of intense rainfall. The occurrences of flash flood are due to many factors. Flash flood tends to destroy properties and causes fatalities when it occurs in areas immediately adjacent or along a stream or rivers. Extreme rainfall on steep terrain can extensively weaken soil and cause mudslides, damaging homes, roads and property and poses an even higher threat to life. Flash floods can be happen with slow moving or multiple thunderstorms occurring over the same area. With fast moving, flash flooding is less likely since the rain distributed over a broader area. According to Baharuddin et al. (2012), there are two types of precipitation that can cause flooding; continued heavy rains covering a wide area and very heavy localised rainfall over a short period (Baharuddin et al. 2012).

FACTORS THAT LEAD TO FLASH FLOOD

Based on literature reviewed there are two main factors that cause flooding. Both are discuss briefly below.

FLOODING DUE TO CITY MIGRATION

The population densities in 2000 for the city centre of Kuala Lumpur city, Kuala Lumpur City (KL) and Kuala Lumpur Metropolitan Region (KLMR) are 6085, 7100 and 1052 (persons/sq km) respectively. While by 2004 these population densities become 6710 for the city center and 6429 for the city of Kuala Lumpur. Furthermore, the expected population densities for 2020 are 1750 for KLMR, 9402 and 13547 for Kuala Lumpur city and the city centre of the city respectively. Thus, the highest population density is located in the city center of the city, then Kuala Lumpur city, while the less population density is in KLMR. The population density of the city of KL has been increasing from 670 in 1980 to 6085 in 2000 to 6429 in 2004 due to the increasing levels of urbanization of the city compare to its periphery. It rose because of the increasing number of migrants searching for better working opportunities, services, and facilities.

In recent years, flooding have become a huge concern for the government agencies and the public. The network of drainage and waterways that intended to drain wastewater and rainwater runoff to avoid flooding sometimes rendered ineffective

because of mismatched development and problems of drainage water excess during construction periods. Ineffectiveness of irrigation and drainage systems are the main cause contributing to flooding problems (Azliana 2010). In Kuala Lumpur, the drainage system that existed along with the city already old and no longer efficient in accommodating and running water from heavier rain. Therefore, most of the existing drainage are seem to insufficient as the water overflow to the road. Beside, the old drainage constructed system and poor maintenance also contributes to flooding. Drainage system needs to be maintain properly at the right frequency (Baharuddin et al. 2012).

Social attitudes and environmental consciousness among the communities also play a role to help reduce flash floods. The 'little' rubbish throw by irresponsible public along the road accumulate at the drainage and often cause clogging to already stress drainage system. Lack of continuous monitoring on this simple responsible attitude and clogging lead to greater impact during heavy rain flooding of main road.

FLOODING DUE TO NATURAL SYSTEM

Floods can also occur naturally. The main cause of flooding is increased rainfall. According to Baharuddin et al. (2012) found that, with rainfall exceeding the annual rainfall and in exceptional condition with heavy rain in a short period of time which affects the drainage system cannot contain too much water and flooding occurs. In the past years the amount of rain in Kuala Lumpur exceed the highest predicted and accommodate by the drainage system at 50mm per hour (Sinar Harian 2017).

In urban areas, the lack of impervious area affects water quantity and capacity of the river channel. Stream typically receives a number of water due to surface runoff, through flow, intermediate flow and base flow. All these symptoms produce drainage outflow hydrograph, which varies over time. The runoff is produce by a reaction involving the development of city natural landscape change to manmade landscape (Sulong et al. 2005). The above briefly sets out some of the factors, and more needs to be determined and give full attention so that this problem can be overcome through more effective planning.

FLOOD FACTORS

The floods in Kuala Lumpur commonly occur in a short period due to high rainfall, and in conditions where the landscape is not able to accommodate runoff urban areas that have been developed where surfaces are covered impervious materials such as concrete and bitumen, coupled with improper drainage system and sediment barriers are more likely to be impacted.

Siti Badriah (2006) notes that flooding incidences have increased due to the rising number of impervious areas, made worse by the construction of paved roads and buildings (Zaiful 2013). What is clear is that the link between development and natural environment are not emphasized enough. Increased built up areas have also made it difficult to upgrade of streams, ditches and ponds to accommodate runoff.

Other factors include old sewage system not being well irrigated. Insufficient retention ponds built to control runoff from flowing into the drainage system. It was also noted that sewers and drains constructed are not large enough to accommodate the runoff that causing overflows and with more land use changes and development of new projects will probably increase the flow rate of runoff, necessitating drainage design that takes into account environmental changes (Zaiful 2013).

CURRENT EFFORTS TO MANAGE FLASH FLOOD INCIDENCES IN KUALA LUMPUR

The impact from floods in Kuala Lumpur has led to the construction of the Stormwater Management and Road Tunnel (SMART - Stormwater Management and Road Tunnel). SMART tunnel is not a total solution to the problem of flash floods in Kuala Lumpur as a whole but should focused on overcoming the problem of flash floods in Kuala Lumpur city centre. Since the SMART Tunnel became operational from July 2007, the target area is the heart of Kuala Lumpur city , around Masjid Jamek, Jalan Tun Perak, Dataran Merdeka, Kampung Baru, Jalan Munshi Abdullah, Old Court Complex, Jalan Melaka, Jalan Tunku Abdul Rahman and the low area around it had not faced any flash flood due to overflow of the Klang River.

Data has shown that the SMART Tunnel successfully diverted 280m^3 of floodwater from the upper river into the Berembang Klang village

holding pond of more than 70 times (until 27 April 2009) having a capacity of 600,000m^3 (Keizrul Abdullah 2004). During this period, at least 5 heavy rain events (May 21, 2008, May 30, 2008, September 4, 2008 , March 3, 2009 and March 13, 2009) that occurred. SMART has managed to save the Kuala Lumpur City Centre from the flood and avoid the loss of billions of dollars of damage and destruction of public property as it often happens when flash floods hit Kuala Lumpur City Centre (state.water.gov.my). Nevertheless, efforts to tackle floods in Kuala Lumpur is still ongoing as flooding still occurs.

Chia Chong Wing (2004) in their writing said that non-structural measures are employed more for preventing floods from occurring and with the aim of minimising losses due to flooding. These measures are broadly aimed at reducing the flood magnitude through the management of catchment conditions as well as reducing the flood damage. These measures including:

1. Integrated River Basin Management (IRBM) - Under the concept of IRBM, the whole river basin is planned in an integrated manner and all factors are taken into consideration when a certain development plan is proposed.
2. Preparation Of Guidelines And Design Standards - Suitable guidelines and design standards have been prepared, specifying clear quirements, both physical as well as technical, for rivers and their reserves, as well as flood mitigation and urban drainage projects. These guidelines and design standards, if followed strictly by the public and private sectors, will help minimise the occurrence of floods.

In year 2000, a new *Urban Storm Water Management Manual* (MASMA) published by DID has obtained Cabinet approval for implementation commencing January 1, 2001 and is to be complied with by all local authorities and the public and private sectors. The Urban Storm Water Management Manual (MASMA) is still used until this day. Chia Chong Wing (2004), also mention non-structural measure includes;

1. Resettlement Of Population - One positive measure to reduce damage potential as well as loss of life in flood-prone areas where floods would not be significantly reduced by structural measures is to resettle the population.
2. Flood Proofing - This measure consists of implementation of protective works to prevent the entry of flood water into individual houses and specific places, for example, by bunding a building with a wall so that the floor is not submerged during a flood, thereby reducing flood damage. In flood-prone cities like Kuala Lumpur and Penang, entrances to basement car parks should incorporate some flood proofing measures.
3. Flood Forecasting And Warning System - The provision of flood forecasting and warning system is an important, practical and low-cost measure to minimise flood losses. Flood forecasts given early will enable people living in flood-prone areas to be warned so that they can evacuate themselves and their belongings before the arrival of the flood. This can considerably reduce flood loss and damage and above all, the loss of human lives.

In 2012, River of life project have been carried out along Sungai Klang which include three main component river cleaning, river master-planning and beautification. This project which covers the confluences of three city rivers, with a total area of 781 hectares and 63 hectares of water bodies is a hope to bring the community 'back' to the river through a 100 per cent transformation into a vibrant waterfront with high economic and commercial value, rejuvenating the city's river and re-connecting it to the surrounding urban fabric (AECOM 2017). Nonetheless, this project contributes to the conservation of flood plain area as recreational area that plays a role as water absorbent area.

RECOMMENDATION

This recommendation is mainly of structural and non-structure approached that subjected to the town planning and pro-active measure by the local government.

Automated and real-time debris/waste seclusion system Water storage system for access rainwater containment for reuse and recirculation back to use in homes. There are two main basins of Kuala Lumpur River Basin, the Klang River Basin and the Gombak River Basin, all flowing to the Kuala Lumpur City Centre. The 9.7km long SMART Tunnel only represent as catchment or holding pond, acts as a bypass tunnel and storage preventing spillover during heavy downpour which is located in the eastern part of Klang Kuala Lumpur. Accordingly,

the SMART Tunnel is only part of the Department of Drainage and Irrigation (DID) measures to overcome the problem of flash floods in Kuala Lumpur City Centre and it is an important component of the entire Kuala Lumpur Flood Mitigation System. DID also plans to complete another stormwater retention pond under the *Flood Mitigation Project - Rock Pool Reservoir Jinjang*; as diversion ponds in Jinjang for Sg. Kroh and Sg. Notches.

There is also a need for the construction of more reservoir tanks, as well as increase the depth and cross section of drainage system. Retention ponds should be built to control runoff from flowing into the drainage system, which can be used as an alternative water source or released slowly into the nearby river (Siti Badriah 2006). Another alternative includes improves the capacity of existing reservoir tank and retention pond as initiated by the Kuala Lumpur City Hall (Sinar Harian 2017)

In regard to the old drainage system in Kuala Lumpur, Kuala Lumpur City Hall has taken measure to put aside fund to upgrade the system as part of monitoring and minimizing the flash flood impact (Sinar harian 2017). Previous researcher such as Siti Badriah (2006) recommended the existing drainage system will have to be reconstruct as is not able to accommodate a lot of water during heavy rains and Zaiful Nizam (2013) added that the drainage design must take into consideration the changes that may occur in the environment, taking into account the ability to avoid overflow. As the reconstruction of the drainage definitely will bring great impact to the city safety from flood, the action also includes financial burden. Another friendlier alternative to the drainage problem are considering the material used for the drainage construction. Material with ability to absorb water or permeable water material to maximize absorption yet still maintain the structure that has been practices in the ancient building recommended.

The non-structure approach as recommended includes intensify awareness programs, to engage the public to address indiscriminate disposal of rubbish that clogs water channels. The attitude of the city community in minimize or preventing rubbish dumping into the drainage system will definitely great impact on the flash flood mitigation. Inserting responsibility to all the city dweller and communities in preventing flash flood as well preparing them for flash flood emergencies also part of the awareness programme. Brochure, leaflet as well as awareness advertisement in the existing digital board about flash flood also a good reminder to the city community.

Regulations and guidelines penalising city dwellers who litter openly, shop and food traders who dump their garbage into drainage and river channels and developers who dump construction waste are already in place and enforcement will need to be intensify. Planning is also important to take into account urban design to avoid obstruction to drainage systems. A review of executing criteria in the design of irrigation and drainage systems should be consider. Government in using power should be made rules as new guideline that developer should be follow in maintain natural environment, it would include in deep and width of the natural drainage. Provide under the built with green environment which the floor of building not indirect on land.

Another non-structure approach includes utilizing the natural area for retention pond, such as series of abandon mining sites and natural drainage system which mean drainage design and built zero use any concrete structure. An identification of such area are crucial and in future how to diverted water to such area without much construction material will be needed. Often this approach are more viable to a new developing city as we be able to recognize the potential area and designate it for such purposes.

CONCLUDING REMARKS

The flash flood approach for a rapid develop city of Kuala Lumpur, is often costly as measures taken is more toward maintaining the existing structural. Although the advancement of technologies will brought more new idea of better managing the flash flood, we must not forget the non-structural approach that will give a long term impact to the people not just the building or structure. The non-structural approach which ranging from policies driven to the people awareness and respond play greater role in managing, minimize and improve live. The people altitude not just public but the policy maker and implementer in looking at the measures to minimize the impact through their daily live will leave more impact toward the livelihood in the city.

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