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FLASH FLOOD PROBLEMS AND HUMAN RESPONSES TO THE FLASH FLOOD HAZARD IN KUALA LUMPUR AREA, PENINSULAR MALAYSIA

M.J. JAMALUDDIN

SINOPSIS

Kertas ini menghuraikan masalah banjir kilat, persepsi dan tindak-balas manusia terhadap bencana banjir kilat di kawasan Kuala Lumpur. Banjir kilat di Kuala Lumpur disebabkan oleh gabungan berbagai faktor, antara lainnya termasuk intensiti hujan yang tinggi, permukaan bandar yang tak telap air, saliran yang tidak mencukupi, sistem saliran yang tersekat dan mengalami pemendapan disebabkan oleh pembangunan pesat dan pembuangan sampah yang tidak teratur, terutamanya oleh setinggan. Kerajaan dan penghuni kawasan banjir berusaha mengatasi dan mengurangkan bencana banjir kilat melalui penyesuaian kestrukturan dan bukan kestrukturan berasaskan persepsi mereka terhadap bencana banjir kilat tersebut. Adalah dicadangkan, selain dari usaha-usaha yang berkaitan, kerajaan juga mengambilkira persepsi manusia dalam usaha mengurus kawasan yang dilanda banjir kilat. Mungkin sebahagian besar dari masalah berkaitan dengan bencana banjir kilat ini dapat diatasi sekiranya masalah setinggan di kawasan Kuala Lumpur dapat diselesaikan.

SYNOPSIS

This paper describes the problems of flash flood and human perception and responses to the flash flood hazard in Kuala Lumpur area. Flash floods in Kuala Lumpur are caused by the combination of various factors, among others including the high rainfall intensities, inadequate drainage, blocked and silted drainage system due to the rapid development and improper garbage disposal especially by the squatters. The government and the inhabitants of flood prone areas are trying to alleviate and overcome the flash flood hazard through structural and non-structural adjustments based on their perception of the hazard. It is suggested that other than the related actions, the government has also to consider human perception of the hazards in its efforts to manage flash flood areas. Probably a substantial part of the problems related to the flash flood hazard could be alleviated if the problems of squatters in the Kuala Lumpur area could be solved.

INTRODUCTION

Kuala Lumpur, Malaysia's capital, has experienced a very rapid urbanization process since the Second World War, especially after independence in 1957. The urbanization process has changed the landuse pattern and the urban structure. A larger portion of former forest and agricultural areas have been cleared and replaced by concrete buildings, roads, and drainage systems which are impermeable. The rivers and streams running through

the urban areas are choked up with sediment as a result of soil erosion from mining, housing, and other development areas. The problem of silting in the rivers and drains coupled with high rainfall intensity causes flash floods in low-lying areas and in areas with improper drainage facilities, especially those found close to development sites.

Such problem is not new or foreign to the people staying within and in the outskirt of Kuala Lumpur. Every time when copious rain falls for about two to three hours a few settlements and major trunk roads in the city will be flooded. Flash floods are not only causing problems to commuters who are usually caught in traffic jams for a few hours on ends, but at times the residents of some settlements have also to be evacuated to relief centres and safer grounds. Furthermore, whenever a flash flood occurs, daily socio-economic activities would be disrupted, and due to its frequency and the number of areas and people affected, it will certainly have an adverse effect on the nation's economy. The problem is much more acute as most of the people affected by the flash floods are the urban poor who are either renting the houses or squatting on either government or private lands.

Actually defining a flash flood is difficult, partly because flash floods are complex phenomena and patly because they are viewed differently by different people. However, to put it simply, a flash flood is a body of water which rises to overflow land which is not normally submerged and subsides after only a few hours. Flash floods are most frequently associated with violent, convectional storms which tend to be of short duration, often measured in minutes rather than hours (IASH, 1974). Convectional storms are also normally of small areal extent, and they generate floods only on small headwater streams, on minor tributaries or inadequately drained urban areas (Ward, 1978).

The phenomenon of flooding becomes a problem and is of great concern when places important to humans are affected, or in other words, the hazard is the risk encountered in occupying a place subject to flash floods. The flash flood hazard comprises many aspects including structural and erosional damage, loss of life and property, contamination of food, water and other materials, disruption of socio-economic acitivity including transport and communications, and in some cases the spoiling of agricultural land. There has been varios responses by the people affected by flash floods and the various authorities in the form of structural and non-structural adjustments and floodplain management (Smith & Tobin, 1979), aimed at either minimizing or putting and end to flood damage and flood loss. However, despite increasing flood control measures, the problems continue to increase as the areas subject to flooding expand.

Figure 1 shows schematically the main facets of man's response to the flood hazard. Human response is determined partly by the nature of the hazard which is the result of the joint interaction between physical and socio-economic processes, and partly by the characteristics of the decision-

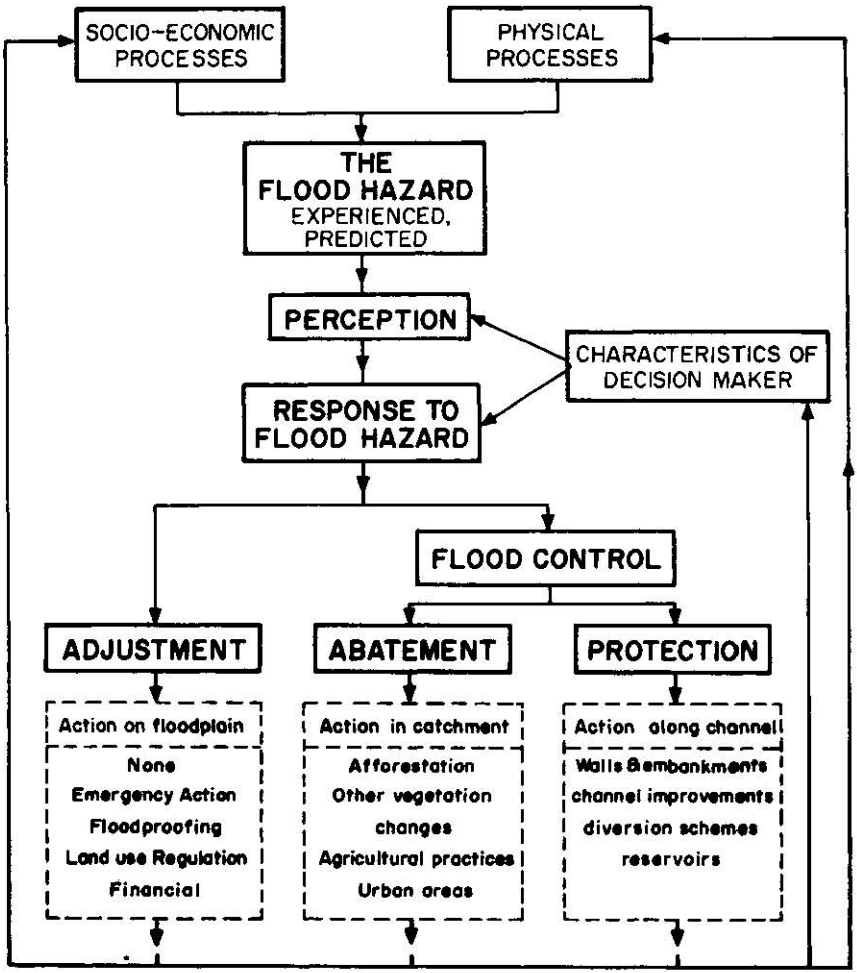

FIGURE 1. The Main Elements of Man's Response to the Flood Hazard (Modified from Ward, 1978, p. 115)

maker (Kates, 1971). According to Ward (1978), the characteristics of the individual decision-maker and the flood hazard itself combine to influence perception of the flood hazard, which may be sharp, blurred or non-existent. Actually, response to hazards is related both to perception of the phenomena themselves and to awareness of opportunities to make adjustments. It is very rare that individuals are unaware of the existence of possible hazards or opportunities for economic development within the flood-prone areas. In the real world an intermediate view normally prevails in which response is strongly related to perception of the hazard which, in turn, is very much

dependent upon experience. According to Kates (1962), past knowledge and experience of floods is related to the perceived probability distribution of floods, and thus whatever adjustments made by the individuals are based on their perception of the flood hazard.

This paper is aimed at looking into some of the physical problems related to flash flood such as its frequency, the areas affected, and its probable causes. The paper also aims at looking into human perception and adjustment to the flash flood hazards in Kuala Lumpur.

THE STUDY AREA DAN DATA

Kuala Lumpur[1], the Federal Capital of Malaysia (lat. 3° 08'N; long. 101° 44'E), covers an area of approximately 243 km^2 (94 square miles). It is situated within the Kelang Valley Urban Region (Shankland Cox Partnership et al., 1973) which is one of the most urbanized and industrially developed areas of Malaysia. It has a population of about 1.03 million in 1980 with an average annual growth rate of 4.3 percent (Dewan Bandaraya, 1982). The high population concentration and annual growth rate are not only due to natural growth, but also due to the inmigration of rural population to urban areas. The number of inmigration to the Kelang Valley Region in 1979 was estimated at about 429 000 (Shankland Cox Partnership et al., 1979), and a large proportion of them are to be found in the Kuala Lumpur Area. It is estimated that about 25 percent of the population of Kuala Lumpur resides in squatter areas (Dewan Bandaraya, 1982).

The topography of the study area is averaged at about 20 metres above sea level, with a few low hills. The area is drained by the Sungai Kelang and its tributaries. The river has its headwater at the Main Range to the east, and enters the Strait of Malacca to the west. Figure 2 shows the location, relief, and the general landuse of the study area.

The rapid growth in the population size, the industrialization and urbanization processes have led to increasingly more of the former forested and agricultural lands to be developed for housing and other projects (Jamaluddin & Sham, 1982). This leaves behind only about 25.2 percent of the total land area still available and not committed for any project (Table 1). The high percentage of land that has been cleared for development purposes, most of the time with total disregard for conservation of natural ecology, will certainly lead to soil erosion. The situation is rendered more serious as the cleared lands are exposed to the heavy rainfall that retains the same general pattern throughout the year (Dale, 1960; Sham, 1980). Morgan (1979), noted that the study area and its surroundings experience fainfall intensities of between 60 – 75 mm h^{-1} with a return period of 60 days, while it only requires a rainfall intensity of 25 mm h^{-1} to start sur-

[1]For the purpose of this paper, Kuala Lumpur area refers to those areas situated within the boundaries of both Kuala Lumpur City and the Federal Territory.

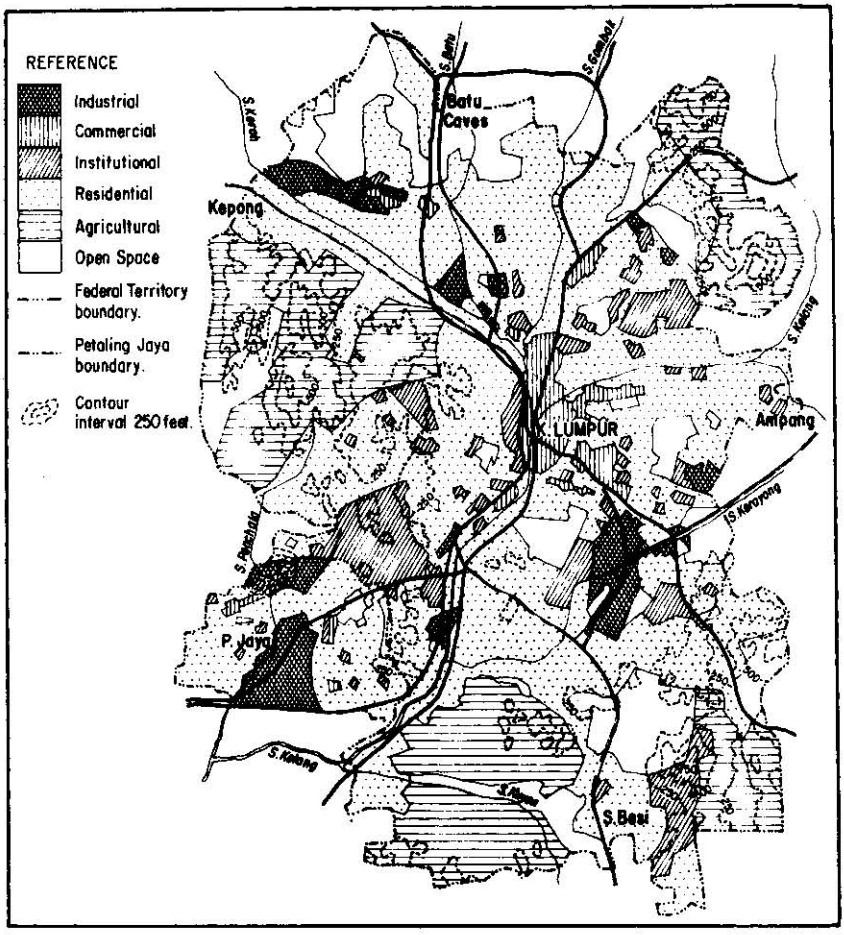

FIGURE 2. Location, Relief and General Landuse of Kuala Lumpur

face erosion. Some of the eroded material finds its way into the trunk drains and rivers and thus silting them up. Obviously, silting of river beds and trunk drains by sediment due to erosion in the areas cleared for development coupled with the occasional high rainfall intensities will lead to flash floods in low-lying areas and in areas with poor or improper drainage facilities.

Since flash floods stay for short durations and their occurrences are very unpredictable, direct measurements are difficult to be carried out, and as such the data on flash floods in Kuala Lumpur as to their occurrences, areas affected and some other minor details are gathered from local newspaper reports and records at the Drainage and Irrigation Department,

TABLE 1. The Land Situation of the Study Area

Landuse	%
Existing built-up areas	44.9
Areas approved for development	19.5
Areas approved for special projects	5.3
Active mining land	5.1
Ex-mining land	6.0
Land above 122 m (400') and slope of 1:3.1%	3.1
Land available	16.1
Total	100.0

(Source: Dewan Bandaraya, 1982: 46)

Federal Territory. These data are cross-checked with rainfall intensity data from Weld Reservoir station kept by the Department of Geography, Universiti Kebangsaan Malaysia. As for the information on human perception and responses these were obtained through questionnaires monitored at a number of settlements in the flood prone areas in Kuala Lumpur (Figure 3).

FLASH FLOOD IN KUALA LUMPUR AREA

Flash flood is not new or foreign to the people living in Kuala Lumpur or on the outskirt. They usually experience a few flash floods within a year. Table 2 shows flash flood frequency for some selected localities within the study area between 1979 to 1982 based on the Drainage and Irrigation Department's records at Sungai Tua, Sungai Gombak at 16th. kilometre, and Genting Kelang stations. Since flash floods are most frequently associated with violent, convectional storms which tend to be of short durration and are also normally of small areal extent (IASH, 1974), the Drainage and Irrigation Department's recording stations, which are located upstream of the study area, do not actually show the true picture of the frequency of flash flood in Kuala Lumpur area. Newpaper reports give a higher frequency of flash flood occurrences in Kuala Lumpur area and also a greater areal extent (Table 3), which even include a few of the major trunk roads such as the Federal Highway, Jalan Bangsar and Jalan Ceras. Infact, the findings of a recent study conducted in Kampung Kasipillay, Kampung Segambut Luar, Bamboo Garden, MBS Garden, Kampung Haji Abdullah Hukum, Kampung Pantai, Kampung Penghulu Mat, Kampung Puah Seberang, Kampung Baharu and Kampung Cendana

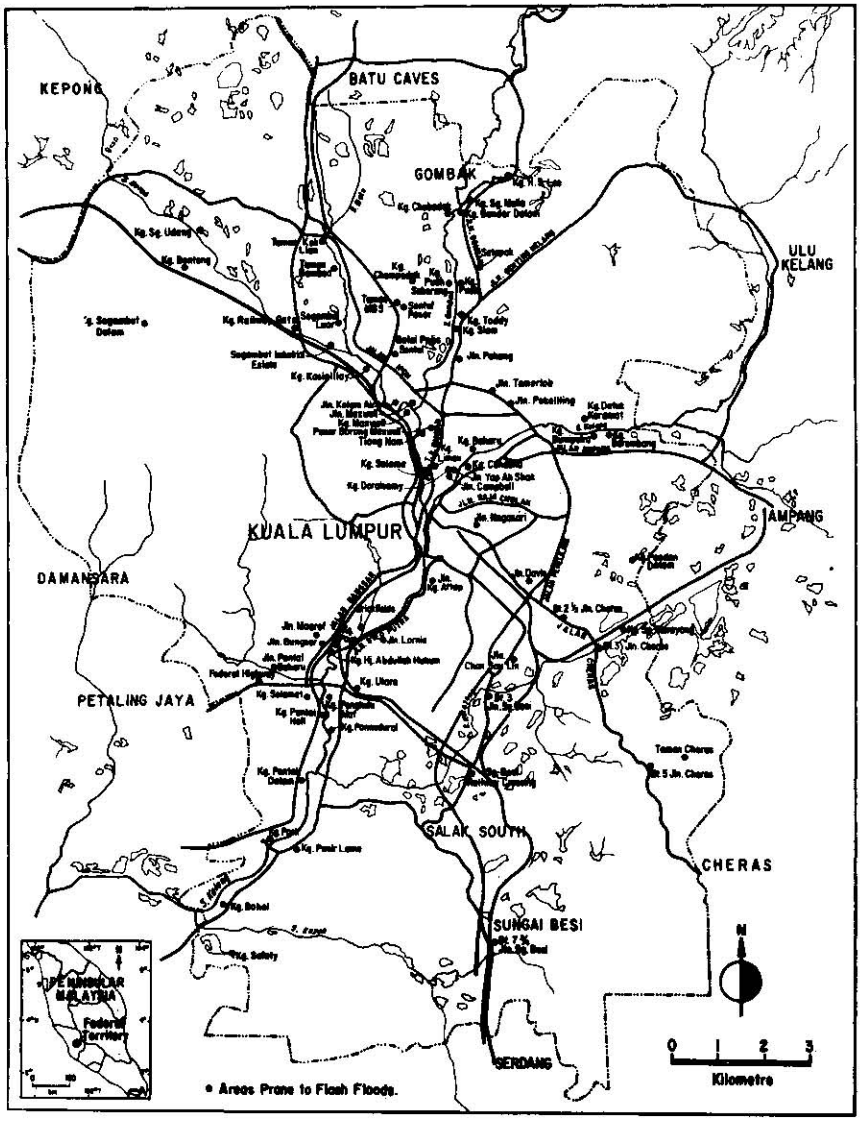

FIGURE 3. Areas Always Affected by Flash Floods

show that on average these areas experience from 8 to 10 flash floods within a year, although the frequency has slightly declined in 1982.

Since the data presented in Table 3 are obtained from newspaper reports, they are incomplete as not every flash flood that occurs in Kuala Lumpur area is reported. However, when they are cross-checked with rain-

TABLE 2. Flash Flood Frequency in Selected Localities from 1979 – 1982

Locality	Frequency per year			
	1979	1980	1981	1982
Kampung Kasipillay and surroundings	1	5	3	1
Kampung Segambut Luar and surroundings	NA	5	10	1
Kampung Puah Seberang and surroundings	2	3	1	4
Kampung Baharu, Kampung Cendana and surroundings	4	5	4	1

(Source: Drainage & Irrigation Department, Federal Territory)

TABLE 3. Flash Flood Frequency Based on Newspaper Reports in Selected Localities from 1977 – 1982

Locality	Frequency per year					
	1977	1978	1979	1980	1981	1982
Kampung Kasipillay and surroundings	10	6	3	5	4	4
Kampung Segambut Luar and surroundings	8	4	3	6	8	5
Kampung Puah Seberang and surroundings	8	7	4	6	5	7
Kampung Baharu, Kampung Cendana and surroundings	5	4	5	5	6	5
Jalan Bangsar, Kampung Pantai Dalam and surroundings	10	6	6	6	7	8
Jalan Ceras, Sungai Besi and surroundings	17	12	9	9	10	12
Total	58	39	30	37	40	41

fall intensity data, a lesser proportion of the flash floods occur on days when the ranfall intensity exceeds 60 mm h^{-1}, while the rest occur on days when the rainfall intensity is about 25 mm h^{-1}.

Flash floods in Kuala Lumpur area can be attributed to a number of reasons which are either directly or indirectly related to urbanization and development of the area. According to Jamaluddin and Sham (1982), the occurrence of flash floods may best be seen in the context of the water balance of an area, whereby in its simplest form the latter may be defined as,

$$r = E + g + \Delta f \quad \ldots\ldots(1)$$

where r is precipitation
E is evaporation
g is storage, and
Δ f is net runoff

From equation (1), the evaporation component, E, includes transpiration from grass, plants and trees and is sometimes referred to as evapotranspiration. The net runoff, Δ f, includes both surface and subsurface runoff.

The water balance components in equation (1) are greatly altered in an urban area where much of the vegetation has been cleared and replaced by concrete, bricks, asphalts and road surfaces whereby about 50 percent of it is waterproof (Sham, 1982:3). The evaporation component, E, is also reduced greatly in an urban area compared to that in the rural environment. Similarly, since about 50 percent of the urban setting is water-proofed, infiltration of water into the soil is also reduced causing a decrease in the storage component, g. Therefore, with the same amount of rain falling in an urban area, the net runoff, Δ f, is significantly increased causing flash floods in low lying areas and those where the drainage is poor or inadequate.

In Kuala Lumpur area, the occurrence of flash flood is further aggravated by the action of housing developers, miners and squatters. In this context the housing developers and miners are responsible for the increased load of sediment brought down by the rivers passing through the study area. This has been demonstrated by Douglas (1974), who found that except for smaller upland rivers, all other rivers flowing through the developed areas of Kuala Lumpur indicated a suspended sediment concentration discharge relationship of more than 1.0 which clearly indicates that the suspended sediment concentration increases more rapidly than the discharge. He also noted that during a heavy rainfall a sediment concentration of 81 230 mg l^{-1} was observed in one small river that flowed through an area that has been cleared and laid bare for housing development. Since the rate of soil erosion is dependent on the balance between soil, vegetation cover and the erosive power of the various geological agents, the clearing up of lands of their vegetation cover for housing development and mining purposes will certainly lead to a tremendous amount of accelerated erosion. An increase in soil erosion leads to increasing sedimen-

tation in the rivers and thus raising the river beds, and this in turn will lead to flash floods in the nearby low lying areas whenever there is a heavy downpour. However, some areas get flooded not by virtue of their being located in low lying areas or by the sides of rivers, but because of inadequate drainage facilities and drains that have been silted up. Another reason for the frequent occurrence of flash floods in Kuala Lumpur area is because of the presence of squatters (The New Straits Times, 12.5.1982). The squatters who are normally located in the low lying areas by the sides of rivers do not have proper facilities for dumping their domestic waste, and thus they conveniently dump rubbish into the drains, streams and rivers nearby. This will result in the blockage of streams and rivers and leads to flash floods.

HUMAN PERCEPTION OF THE FLASH FLOOD HAZARD

Human perception of the hazard is an important aspect of any study of the behaviour patterns of those people affected by flash floods, since it is likely that the individual will respond according to his beliefs rather than to the real situation as viewed by a more objective outsider, It is also well established (see e.g. Kates, 1962) that the perception of the environmental problems and hazards is closely related to the frequency of such events. In the Kuala Lumpur area, although all the 1202 respondents interviewed had experienced flash flood at one time or another, there is still about 2 percent of the respondents who are positive that flash flood would not occur in the near future and a further 19 percent are undecided. It is interesting to note from Table 4 that about 92 percent of the respondents who do not perceive future flash floods are those people who had experienced at least two or more flash floods. This is contradictory to the general beliefs that the more experienced a person of a certain hazard, the clearer is the resultant perception. There could be a number of reasons for this peculiar perception, and two of the most likely are their anticipation of the various flood alleviation and mitigation schemes undertaken by the authority and the degree of fear of the flash flood hazards. Presently there are a number of flood alleviation and mitigation projects being carried out by the government within and in the surrounding areas of Kuala Lumpur. The respondents who do not expect future flash floods to occur are probably those who harbour the idea that the various government schemes could put a stop to flooding. Insofar as the degree of fear fo the flash flood hazards is concerned, some of the respondents who had experienced flash floods would probably want to forget the recurring problem by saying that there would not be any more flash floods in the future.

Another important factor affecting human perception of future flash flood occurrences is the extent of losses and damages experienced during flash floods. About 96 percent of the respondents who perceived future flash floods experienced losses and damages during flash floods (Table 5). It is interesting to note that about 81 percent of the respondents who perceive

future flash floods experienced losses and damages of less than 100 ringgit. Their losses and damages could have been higher if not for the fact that about 68 percent of them are earning less than 500 ringgit per month.

TABLE 4. Residents: Perception of Future Flash Floods As a Function of Number of Flash Floods Experienced

Flood Experienced	Perceive Flooding		Do Not Perceive Flooding		Do Not Know	
One	61	5.1%	2	0.2%	18	1.5%
2 to 4	209	17.4	6	0.5	65	5.4
5 to 7	418	34.8	8	0.7	131	10.9
More than 7	263	21.9	7	0.6	14	1.2
Total	951	79.2%	23	2.0%	228	19.0%

With such a meagre earning the respondents cannot afford to stay in expensive houses and possess expensive furniture and other household goods, and thus when it floods the damages are also small.

TABLE 5. Perception of Future Flash Floods As a Function of Losses During Flash Floods

Losses in Ringgit	Perceive Flooding		Do Not Perceive Flooding		Do Not Know	
Less than 20	198	16.5%	9	0.8%	5	0.4%
21 to 50	259	21.6	3	0.3	19	1.6
51 to 100	315	26.2	8	0.7	43	3.6
101 to 500	123	10.2	1	0.1	51	4.2
More than 500	18	1.5	1	0.1	45	3.7
No loss	38	3.2	1	0.1	65	5.4
Total	951	79.0%	23	2.0%	228	19.0%

As has been mentioned earlier that all the respondents had experienced flash flood at one time or antoher and about 95 percent of them are aware of the danger of flash floods. However, awareness of the danger of flash flood hazard need not necessarily deter the respondents from staying in the hazard zone. This phenomenon is clearly reflected in their preference for not leaving the area. A high percentage of the respondents do not relocate in safer areas because they do not have other places to stay in Kuala Lum-

pur. Other reasons given by those respondents who are aware of the danger of flash flood hazard and not relocating in safer areas are given in Table 6. It is apparent from the multiple answers given by the respondents that most of them are either squatters who come from outside Kuala Lumpur or are in the poor income brackets. However, a great majority of the respondents who are affected by the flash flood would move to other places if they are paid compensation and provided with either a house or a piece of land for building a house within Kuala Lumpur area. There are also a few of the respondents (about 7 percent) who are willing to relocate in safer areas if they are given compensation only without the provision of a house or a piece of land for building a house.

TABLE 6. Residents: Reasons for Not Relocating in Safer Areas

Reasons for Not Relocating	Number of Respondents	%
No other places to stay in Kuala Lumpur	631	55.4
Nearness to places of work	418	36.7
Available facilities	402	35.3
Cannot afford other houses	135	11.8
Place of origin/family ties	131	11.5
Cheap house rents	128	11.2
No government directives for relocation	83	7.3
Temporary residence	62	5.4
Total respondents aware of hazard	1140	94.8

HUMAN ADJUSTMENT TO THE FLASH FLOOD HAZARD

Human response to the flash flood hazard takes a number of forms either through structural or non-structural adjustments which are aimed at either alleviating or controlling the problems. Both structural and non-structural adjustments are either carried out by the authority or the residents affected by the flash floods. An attempt is made here to describe the measures taken by the individual residents and also the government in making adjustments to the flash flood harzard in the Kuala Lumpur area.

INDIVIDUAL RESPONSE TO THE FLASH FLOOD HAZARD

Responses by the individual residents to the flash flood hazards are of two types, that is either on a short term or a long term basis. Actually, short term adjustments are emergency actions adopted following the receipt of

flash flood warning or when a flash flood occurs. Emergency actions constitute a more or less unpremediatated responses to a flash flood warning, which in this case is not very practical due to the nature of the flash flood itself, or flash flood occurrence. Individual response usually encompasses the removal of persons and property from the flash flood hazard area, and also the protection of immovable property. Table 7 shows the type of short term adjustments by individual residents in Kuala Lumpur area during a flash flood. One interesting feature of the individual response to the flash flood hazard as depicted in Table 7 is that only about 57 percent of the respondents moved out of their houses during flash floods although about 95 percent of the respondents are aware of the danger of flash floods. This could probably be due to the fact that the danger posed by flash floods in the study area is not great as there has been very few cases of deaths during flash floods.

TABLE 7. Residents: Short Term Human Adjustment to Flash Flood Hazard

Emergency Action	Number of Respondents	%
Move to safer places	683	56.8
Keep belongings at high places in the house	610	50.8
Move valuable belongings to safer grounds	518	43.1
Guard properties	113	9.4

The high frequency of flash floods experienced by the respondents does not guarantee them to make long term adjustment to the flash flood hazard since there is only about 56 percent of the respondents who take any action at all such as building and clearing outlet drains from their houses; building bunds and raising their houses; and preparing special places, such as attics, for keeping their belongings and household goods when there is flood. When checked against house ownership there seems to be no significant difference between house owners and those renting the house they lived in as far as the long term adjustment is concerned. About 78 percent of those who make long term adjustment are the respondents who perceive future flash flood occurrences, and a high percentage of those who experienced losses of more than 100 ringgit also make long term adjustment probably trying to minimize their losses during future flash floods.

Actually non-structural measures are essentially behavioural adjustments whereby some of these measures amount to little more than a negative attitude to the flood hazard, while others require sophisticated responses in order to reduce flood losses. One of the non-structural measures

which involves about 37 percent of the respondents in the Kuala Lumpur area is loss bearing, or in simpler words accepting the losses accruing from flash floods. This is probably the most negative of all responses to flooding, but considering among other things, the low monthly income of the respondents small losses incurred during flash floods, and their being flooded so often to the point that they are immune to it, perhaps their attitude is in some ways justified.

GOVERNMENT RESPONSE TO THE FLASH FLOOD HAZARD

There are many ways in which the authorities concerned respond to the flash flood hazard either through long term or short term measures which involves either structural or non-structural adjustments. Short term measures are actually emergency and relief measures undertaken during the occurrence of flash floods. Emergency actions usually involves the evacuation of flood victims to flood relief centres which are situated at safer places not very far away from flood prone areas. These evacuation or flood relief centres are usually school buildings, youth centres, police stations, or even the National Stadium and community halls. The evacuees at the evacuation or relief centres are usually attended to by government and non-government organisations such as the Social and Welfare Department, the Red Crescent Society, mosques, churches and some other voluntary organisations who provide blankets, clothings and foods.

TABLE 8. Kuala Lumpur Flood Mitigation Project Under the Fourth Malaysia Plan — ($'000)

Type of Work	Expenditure 1981	Allocation 1982	Allocation 1983 – 1985
1/ Dam works			
a/ Kelang Gate enlargement	84	—	—
b/ Batu dam	10 099	5 619	5 000
c/ Gombak dam	—	—	—
2/ River works			
a/ Sungai Batu	158	—	—
b/ Sungai Gombak	1 024	5 000	11 139
c/ Sungai Kelang	127	—	—
d/ Others	1 850	1 180	92
3/ Trunk Drainage works	127	400	2 000
4/ Operational expenditure	1 701	1 800	3 600

(Source: Drainage and Irrigation Department, Federal Territory)

Other short term measures taken by the relevant authorities include the desilting of drainage systems and rivers; widening of rivers; enforcing the Earthwork By-laws; freezing private housing shemes located on hills and elevated grounds; and revoking development approvals if developers are found to be flouting Drainage and Irrigation Department's flood alleviation regulations.

The long term measures can be divided into structural and non-structural adjustments. Insofar as the structural adjustment is concerned it includes dam works, river works, and trunk drainage works. Under the Fourth Malaysia Plan, works planned and carried out for Kuala Lumpur Flood Mitigation Project includes the raising of the Kelang Gate dam; the construction of a new dam at Sungai Batu; various river works at Sungai Batu, Sungai Gombak, Sungai Kelang and other rivers such as the Sungai Kerayong; and also some trunk drainage works (see Table 8 and Figure 4). According to the Drainage and Irrigation Department, the flood mitigation project in Kuala Lumpur area this far has been successful in alleviating flash flood problems at Tiong Nam area, Kampung Simpang Batu, Kampung Siam, Maxwell area, and parts of Kampung Kasipillay area.

The non-structural adjustment which forms a part of the long term measures undertaken is the setting up of a flood forecasting and warning system. Apart from the weather information fed by the Meteorological Service at Petaling Jaya, the Drainage and Irrigation Department also set up rainfall and water level recording stations at a number of points along the Sungai Kelang, Sungai Gombak, and Sungai Batu. Some of these automatic recording stations are also linked to automatic flood warning sirens stationed at Kampung Segambut, Kampung Kasipillay, Jalan Ipoh, Kampung Datuk Keramat, Kampung Baharu, and Tiong Nam area.

CONCLUSION

With the rapid urbanization process, flash flood is becoming more frequent in Kuala Lumpur area. Due to its frequency, areas affected, and in some localities, its magnitude, flash flood is fast becoming an environmental hazard especially in the low lying areas and in the vicinity of development sites. The government has been and is still taking a number of measures in order to alleviate or putting a stop to flooding. Some of these measures, such as the building of multipurpose dams and river improvement are beginning to show some results in some areas, but new flooded areas are multiplying especially in localities where drainage facilities are inadequate or lacking.

Flash flood occurrences in Kuala Lumpur area are in fact the result of the combination of various factors either natural or man-made. Viewed from the causes of flash floods, the measures taken by the government are certainly inadequate to stop the flooding. Perhaps what Kuala Lumpur area needs is a proper set-up and implementation of landuse regulations; stricter laws as regards socio-economic development of catchment areas;

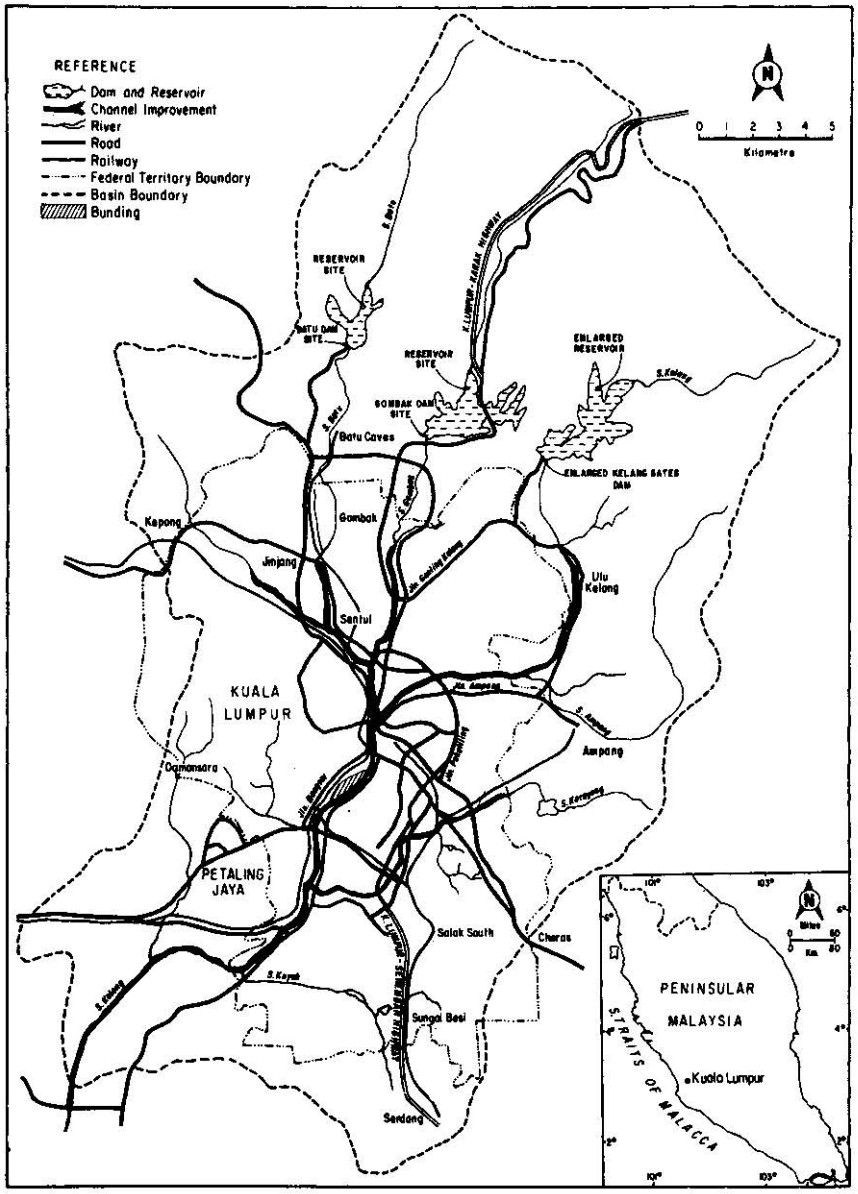

FIGURE 4. Proposed Works for Kuala Lumpur Flood Mitigation Project. (Source: Drainage & Irrigation Department, Federal Territory)

and a comprehensive and careful tree and grass planting programme in the City area.

The landuse regulations which could be introduced by the City Hall should include restriction on development of areas which are flood prone, and development through zoning ordinances, sub-division regulations, building codes, and urban renewal. Through the zoning ordinances the City Hall can determine the type of landuse and building in the flood prone areas, and this if handled carefully could probably tackle the problem of squatters. The sub-division regulations, on the other hand, will determine that no hazard lands are sold to the public. All these conditions could be enforced through urban renewal programmes where a proper urban planning can take place.

However, since flash flood is not only caused by conditions and activities found in the City area alone, but also due to socio-economic activities such as logging and the clearing of lands in the catchment areas for agricultural and other purposes, there should be stricter laws governing these activities, and more important they should be followed by effective enforcement. Alongside these preventive measures, there should also be tree and grass planting programmes in areas which have been left bare due to development projects. Comprehensive and careful tree and grass planting programmes will ensure the restoration of the water balance in the City area.

Last, but not least, other than the physical aspects of the flash floods, the planners and managers of the floodplain should also consider the behaviour pattern of the floodplain residents. The problem is more pressing in Kuala Lumpur area because a large proportion of the people affected by flash floods are squatters, and if the problems with squatters could be solved by resettling them at safer places within the City area, a substantial part of the flash flood problems could be solved.

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