MANAGING THE FLOOD PROBLEM IN MALAYSIA

1. Background

Malaysia has an equatorial climate with constant high temperatures and a high relative humidity. The climate is influenced by the northeast and southwest monsoons. The former, prevailing between November and February, brings heavy rainfall (as much as 600 mm in 24 hours in extreme cases) predominantly to the east coast of Peninsular Malaysia and to Sabah and Sarawak. Rain bearing winds also come with the southwest monsoon from April to September though rainfalls during these periods are generally less than during the northeast monsoon. There are, in addition, two transitional periods between the monsoons (inter monsoon) when convectional thunderstorms are common.

The annual average rainfall is 2420 mm for Peninsular Malaysia, 2630 mm for Sabah and 3830 mm for Sarawak, with heavier precipitation recorded in the east coast of Peninsular Malaysia and the coastal regions of Sabah and Sarawak.

There are two basic types of rainfall causing flooding viz, (i) moderate intensity, long duration rainfall covering a wide area; and (ii) high intensity, short duration localised rainfall. In addition, flood records indicate that there is a seasonal pattern of flood occurrences. The east coast and the southern part of Peninsular Malaysia, Sabah and Sarawak are mainly affected by floods during December to January when the northeast monsoon is prevailing. Flooding occurs due to widespread prolonged heavy rainfall resulting in a large concentration of runoff which is very much in excess of the capacities of streams and rivers. Extensive areas are often inundated.

The west coast of Peninsular Malaysia on the other hand is mainly affected from September to November during the inter monsoon period when convectional thunderstorms become prevalent. Such storms bring short but very intense rainfall which severely overloads the drainage systems, causing localised “flash” floods.

2. Major Flood Events and Causes of Flooding

Several major floods have been experienced in the last few decades. As far back as 1886, a severe flood with gale-force winds caused extensive damages in Kelantan. The flood of 1926, supposedly the worst in living memory in Malaysia, affected most of Peninsular Malaysia, resulting in extensive damages to property, road systems and agricultural land and crops. In 1967 disastrous floods surged across the Kelantan, Terengganu and Perak river basins, taking 55 lives. A few years later, in 1971, a catastrophic flood swept across many parts of the country. Pahang was severely affected, suffering great economic losses to property and crops, as well as a death toll of 24. Kuala Lumpur, the Federal Capital, suffered equally the wrath of the flood, an incident that overshadowed all past memories of floods in Malaysia.

Flood occurrences seem to be getting more frequent in recent years especially in some cities like Kuala Lumpur, Penang and Kuching where rapid urbanisation is taking place.

The main causes of flooding in Malaysia are as follows:

i. increased runoff rates due to the urbanisation;

ii. loss of flood storage as a result of development extending into and taking over flood plains and drainage corridors;

iii. inadequate drainage systems or failure of localised drainage improvement works extended insufficiently downstream;

iv. constriction at bridges and culverts that are either undersized or partially blocked by debris buildup or from other causes;

v. siltation in waterway channels from indiscriminate land clearing operations;

vi. localised continuous heavy rainfall;

vii. tidal backwater effect;

viii. inadequate river capacity.

3. Flood Control Measures

Following the disastrous 1971 flood, the Government took several positive steps to deal with the flood problem. Among these were:

(a) establishment of the Permanent Flood Control Commission;

(b) establishment of flood disaster relief machinery;

(c) carrying out of river basin studies and preparation of drainage master plans for major towns;

(d) implementation of structural measures;

(e) implementation of non-structural measures;

(f) setting up of flood forecasting and warning systems;

(g) setting up of a nation-wide network of hydrological and flood data collection stations.

3.1 **Permanent Flood Control Commission**

The Permanent Flood Control Commission was established by a Cabinet decision on 21 December 1971 to study short-term measures to prevent the occurrence of floods and long-term measures for flood mitigation. The Commission, in its first sitting, drew up the following terms of reference:

(a) To take measures for flood control and to reduce the occurrence of floods;

(b) In the event of floods, to minimise damage and loss to life and property.

The main objective of the Flood Commission is prevention rather than cure. Since its inception, the Commission's recommendations of projects for flood control have been made with the overall view of meeting the objectives of the New Economic Policy of eradicating poverty and restructuring society. The Commission is presently chaired by the Honorary Minister of Agriculture with the Drainage and Irrigation Department (DID) acting as the Secretariat. (In 2004, due to the recent Cabinet decision of placing DID under the newly formed Ministry of Natural Resources and Environment; it is envisaged that the chairmanship of the Commission will be transferred to the new Minister of Natural Resources and Environment.)

3.2 **Flood Disaster Relief Machinery**

This machinery was established with the objective of co-ordinating relief operations at the federal, state and district levels so that assistance can be provided to flood victims in an orderly and effective manner. Overall, the coordination of relief operations is the responsibility of the Natural Disaster Relief Committee. This committee is headed by the Minister of Information with its secretariat at the National Security Council. The committee is empowered, among other things, to declare any district, state or even the whole nation to be in a state of disaster so as to be eligible for getting financial assistance from the Federal Government for remedial works in addition to the allocation of funds under the operation budget. Members of this Committee include government departments/agencies and social organisations which provide shelter, rescue and food supplies in case of disaster. At least once a year, normally before the northeast monsoon, this Committee will meet to ensure that its machinery will run smoothly.

3.3 **River Basin Studies**

The objective of river basin studies is to draw up appropriate flood maps and also feasible projects for the respective basin areas in order that their development is properly managed and also that water resources management including flood control measures is effective and well-controlled. These studies recommend the optional flood control planning and design criteria for the respective basins. Generally, socio-economic considerations for the basin will dominate the design criteria.

Since 1972, a number of river basin studies have been carried out for rivers where major flood problems exist. The objective of these studies is to draw up master plans for water resources development, and measures for flood mitigation form an important component. To date, more than 26 river basin studies have been completed, including Kuala Lumpur (1974 & 2002), Pahang River (1974), Kelantan River (1978 & 1989), Terengganu River (1978), Limbang River (1978), Kinabatangan River (1982), Samarahan River (1983), Batu Pahat River (1984), Johor River (1985), Golok River (1985), Besut River (1988), Klang River (1978,1989 & 1994), Menggatal, Sabah (1999), Miri Flood Diversion (2000), Linngi (2000), Selangor River (2000), and Bernam (2001).

Realising the need for a long-term water resources development strategy and master plan, the Government has carried out a National Water Resources Study (1982) to develop a comprehensive and coordinated water resources development programme for the country. The study has formulated a long-term plan for flood mitigation works in various flood-prone areas of the country. This includes improvement of 850 km of river channels, construction of 12 multi-purpose dams, 82 km of flood bypass, 12 ring bunds around urban centres, and resettlement of about 10,000 people in flood-prone areas. The whole plan was estimated to cost RM2.55 billion (1982 estimate) over a period of 20 years and will provide protection to some 1.8 million people. (However the cost for future flood mitigation works is now estimated to be in the region of RM17 billion for the next 15 years and the estimated number of people affected by flooding has now risen to 4.817 million.)

A number of studies have also been carried out with the aim of alleviating flooding problems in various locations in the country. These include the Cukai Flood Mitigation Study, Lower Perak Flood Mitigation Study and the Kangar Flood Mitigation Study as well as drainage master plan studies for the towns of Butterworth and Bukit Mertajam, Kuala Lumpur, Alor Setar, Sandakan/Tawau/Kota Kinabalu, Bintulu, Johor Bahru, Kelang and Port Kelang, Seremban, Melaka, Kuantan, Kota Bharu, Kuala Terengganu, Port Dickson, Raub, Kerteh, Teluk Intan, Penang, Langkawi, Batu Pahat, Sungai Petani, Kuching, Ipoh and the Multimedia Super Corridor (MSC).

3.4 **Flood Mitigation Measures**

From the studies that have been carried out, various structural (curative) as well as non-structural (preventive) measures have been proposed to alleviate the flooding problem. Under structural measures, engineering methods are used to solve the flooding problem. The river capacity can be increased to accommodate the surplus runoff through channel improvement, construction of levees and embankments, flood bypasses, river diversions, poldering, and construction of flood storage dams and flood attenuation ponds, either singly or in combination.

Non-structural measures on the other hand are proposed where engineering measures are not applicable or viable or where supplemental measures are required. They include restriction of development, land use zoning, resettlement of population, flood proofing, and flood forecasting and warning systems.

Numerous major flood mitigation projects for urban areas have been executed. Apart from urban areas, the aspects of flood mitigation and flood fighting have also been implemented in fast growing agricultural areas such as the Integrated Agricultural Development Project (IADP) areas namely Perlis IADP, Western Johor IADP, Ketara IADP, Kemasin Semarak IADP and Samarahan IADP.

Under the 2nd Malaysia Plan (1971-1975), a sum of only RM14 million was spent for flood mitigation projects. This was followed by the 3rd Malaysia Plan (1976-1980) with an expenditure of RM56 million, the 4th Malaysia Plan (1981-1985) with RM141 million, the 5th Malaysia Plan (1986-1990) with RM155 million, the 6th Malaysia Plan (1991-1995) with RM431 million, the 7th Malaysia Plan (1996-2000) with RM845 million, and the 8th Malaysia Plan (2001-2005) with an allocaton of RM2.7 billion. It is estimated that the cost for future river improvement and flood mitigation works for the next 15 years will amount to some RM17 billion.

Structural Measures (Engineering Solutions)

Structural measures are actually engineering methods which include the following:

3.5 **Flood Control Dams**

These dams are constructed to retain flood water in order to protect areas downstream of the dams. Construction of storage dams solely for flood control purposes is generally economically not viable and such dams are frequently utilised for other purposes such as water supply. In addition, dams constructed for hydro-electric purposes also have a portion of their capacity allocated for flood detention.

Among the dams specially constructed for flood mitigation are Batu Dam, Semberong Dam, Bekok Dam and Macap Dam while irrigation dams include Muda Dam, Pedu Dam, Timah Tasoh Dam, Bukit Merah Dam and Beris Dam. Hydro-electric dams built by Tenaga Nasional Berhad include Kenyir Dam, Bersia Dam, Kenering Dam, Temenggong Dam and Sultan Abu Bakar Dam.

The Klang Gates Dam is an example of a dam built for water supply but also serves as a flood mitigation dam.

3.6 **Canalisation and Related Works**

Canalisation works include the widening and deepening of channels as well as lining the banks and beds of the channels. They also include the replacement of undersized structures such as bridges. These works are necessary as the original channels have become undersized as a result of the increase in flood flows caused by development.

3.7 **Bunding of Rivers**

Bunding of rivers prevents overtopping and flooding of the low-lying adjacent areas. This option may give rise to problems of internal drainage as a result of the bunding. Bunding an urban area introduces a high flood damage potential as any occurrence of flooding as a result of flood water overtopping or breaching the bund would be very damaging.

3.8 **Storage Ponds of Flood Attenuation**

Ponds such as disused mining pools can be used for flood storage. The objective is to divert the flood water through such ponds and thus regulate the outflow so that the flood peaks are attenuated. This strategy has been used in the case of Batu/Jinjang Pond Project in Kuala Lumpur where excess flood water is diverted from Sg.

Gombak to Batu Pond for temporary storage and from Sg. Keroh to Jinjang Pond. Water in the pond will be released slowly back to the river after the flood flow has subsided. (See Figure 1)

3.9 **Poldering (Ring Bund)**

Poldering is the provision of a ring bund surrounding the area to be protected. This is normally carried out for an area which has high damage potential but for which the cost on overall basin-wide protection would be prohibitive. It includes the provision of internal drainage for the area to be protected and the evacuation of flood water by pumping during periods of high river flows.

The present strategy of using structural flood control measures such as the above has proven effective in controlling floods and is usually the only option available for built-up areas. However, structural measures usually incorporate “hard” engineering measures that result in bigger channels conveying high flows at high velocities. These measures incur high costs as well as require substantial land reserves for the channel.

3.10 **Flood Diversion Channel or Tunnel**

Certain river stretches especially in major city centres, due to intensive development along both river banks, can no longer be widened or deepened to accommodate the increasing flood discharges through the city. Under such circumstances, excess flood water has to be retained upstream in storage ponds or diverted downstream through a flood diversion channel or tunnel. This is being implemented in Kuala Lumpur where the Stormwater Management and Road Tunnel (SMART) Project has become a viable and innovative solution. The SMART system when completed will alleviate flooding in the Kuala Lumpur city centre by diverting large volumes of flood water from entering the city centre. The tunnel is designed to incorporate a stormwater channel and a motorway for dual purposes. The motorway section of the tunnel is expected to ease traffic congestion at the southern gateway to KL City near Sungai Besi. This concept is believed to be the first of its kind in the world.

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 comprise the following:

3.11 **Integrated River Basin Management (IRBM)**

Under the concept of Integrated River Basin Management, the whole river basin is planned in an integrated manner and all factors are taken into consideration when a certain development plan is proposed. Factors like zoning for river corridors, riparian areas, natural flood plain, conservation of wetlands, storage ponds etc will be taken into consideration when preparing flood management plans. The concept of IRBM has been incorporated into and will be implemented starting in the 8th Malaysia Plan.

3.12 **Preparation of Guidelines and Design Standards**

Suitable guidelines and design standards have been prepared, specifying clear requirements, 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 to minimise the occurrence of floods. The Department of Drainage and Irrigation has published more than 20 Hydrological Procedures as well as the Urban Drainage Planning and Design Procedure No. 1 for use as reference materials and guidelines by all planners, consultants and other Government agencies throughout the country.

Recently in the year 2000, a new Urban Stormwater Management Manual (MASMA) has been published by DID. The Manual has obtained Cabinet approval for implementation commencing 1 January 2001 and is to be complied with by all local authorities and the public and private sectors. The Manual provides control-at-source measures and recommendations on flood fighting by utilising detention/retention, infiltration and purification processes. This will result in a more harmonious urban environment thereby enhancing the aesthetic value of the surroundings as well as propertty values.

3.13 **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. Since 1971, 1672 families and 2715 families have been resettled in the States of Kelantan and Pahang respectively.

3.14 **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.

3.15 **Flood Forecasting and Warning System**

The provision of a 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. Following the 1971 flood, telemetric forecasting systems have been installed in the major river basins namely Kelantan, Pahang, Perak, Sadong, Kinabatangan, Klang, Terengganu, Besut, Dungun, and Johor which are susceptible to major floods from time to time. A similar system was recently installed in the Muar river basin in Johor and more are being planned for another 20 river systems. VHF flood forecasting systems have been established in smaller basins. In river basins which are subjected to flash floods, little lead time is available for effective warning. Therefore flood warning sirens, which automatically trigger once the flood level reaches a critical point have been installed at strategic locations along certain urban rivers to alert the local residents of impending floods with the aim of minimising flood damage.

Since 1980, flood warning boards have been erected in the major river systems. Levels marked on these warning boards are correlated to the levels at the observation point and they enable the residents of the villages to assess for themselves what the situation would be like in their areas, upon receiving information on the water level through radio broadcasts, village heads and/or police. In recent years, a web-based information system on flood warning and flood information can be readily obtained through http://infobanjir.moa.my.

4. Conclusion

Based on the experience accumulated over the years in implementing flood mitigation works, DID is today more conscious of the need to carry out such projects on a river basin basis rather than on a piecemeal approach. This kind of approach will involve a shift from the traditional thinking in terms of controlling flooding through expensive engineering structures to the more comprehensive approach of viewing the solution in terms of managing flooding by incorporating structural as well as non-structural measures.