

## Flooding in Sungai Maka catchment in the town of Tanah Merah, Kelantan

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### ABSTRACT

Flooding has been a global issue since time immemorial. Though some of its occurrences are beneficial such that it produces a natural resource, viz., a fertile land, most flooding that has direct impact upon human beings cause destructions of properties and loss of lives. Malaysia is one such country that experiences this phenomenon. Although Malaysia is situated in a geologically stable belt with no earthquake and volcanic activities, large scale flooding as the combination of geographical, climatic, topographical, hydrological and human systems has routinely affected many parts of the country to varying degrees. Heavy rainfall brought about by the monsoon climate primarily causes several accounts of flooding in this country. Moreover, inundation in the floodplains is worsened by poor urban drainage practices. The Sungai Maka catchment in the town of Tanah Merah, in the state of Kelantan is particularly experiencing this setback. The town as a whole has several water issues. Foremost of which is the flooding due to the regular bank overflowing (monsoon effect) of the Sungai Kelantan where the town is situated. Sungai Maka has a direct link to Sungai Kelantan thereby making the flood occurrences in the catchment very crucial. A review of the causes and extent of flooding conditions in the catchment as well as some flood mitigation measures are presented in this paper.

*Keywords:* Flooding; monsoon climate; urban drainage practices; Sungai Maka catchment.

### 1 Introduction

Flood, which is defined as body of water which rises to overflow land which is not usually submerged, had taken place in many parts of the globe and its impact upon human lives and activities had been severe especially in the recent decade (Smith & Ward, 1999).

In Malaysia, the states of Kelantan, Johor and Penang, among others, experiences flooding in varying scales as these are flood prone areas in the Peninsular Malaysia as shown in Figure 1.

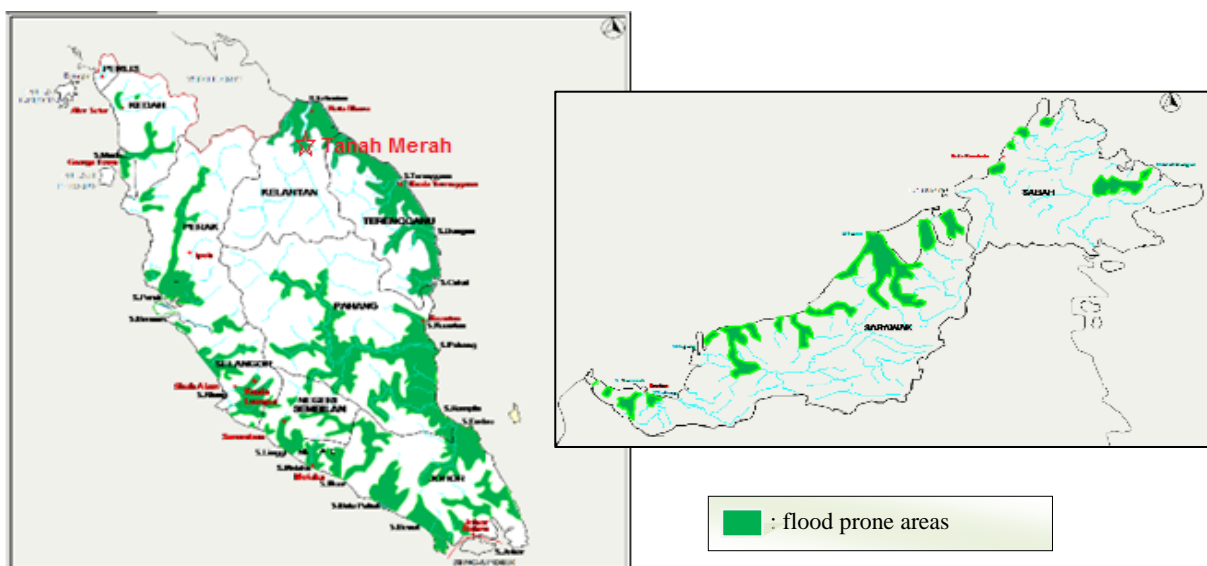


Figure 1 Flood Prone Areas in Malaysia (DID, 2011)

The town of Tanah Merah in the state of Kelantan is particularly distressed with annual flooding due to Sungai Kelantan (Kelantan River) bank overflowing which occurs at least once a year. This is an effect of a northeast monsoon climate experienced in the country that occurs between Novembers and February and brings about heavy rainfall, as much as 600 mm during intensive precipitation (DID, 2010).

The Department of Irrigation and Drainage (DID) Kelantan reported the flooding occurrences in Tanah Merah town in years 2003, 2004 and 2005 which were all caused by backflow of floodwater from Sungai Kelantan to the town areas. The highest number of flood victims recorded was in 2003 where it reached to as many as 2,599 individuals. This flood incidence also claimed two lives that got drowned in the flooding during the rigorous flash flooding. Number of flood victims and lives lost as well as worth of damages in properties/livelihood of the flood victims for 2003-2005 are shown in Table 1.

Table 1 Tanah Merah Direct Loss of Floods in 2003, 2004 and 2005 (DID, 2010)

| Year | Flood Victim | Life Lost (No) | Flood Damage (RM) |
|------|--------------|----------------|-------------------|
| 2003 | 681          | -              | 26,300.00         |
| 2004 | 2599         | 2              | 462,000.00        |
| 2005 | 1613         | 1              | 346,000.00        |

Sungai Maka is one of the six catchments in Tanah Merah and the most affected part of the flooding occurrences in the town due to its proximity to Sungai Kelantan. This catchment commands an area of 940 hectares and covers the entire town center. Its boundaries are delimited in Figure 2.

Sungai Maka (Maka River) is the main waterway running in the catchment. It is 10 km in length and flows through the southern part of Tanah Merah and drains to Sungai Kelantan downstream. Snapshots of this river in its different locations (natural condition), viz. two upstreams, midspan, downstream and confluence with Sungai Kelantan are given in Figure 3. Flooding condition in the catchment, on the other hand is documented in 2007 as shown in Figure 4.

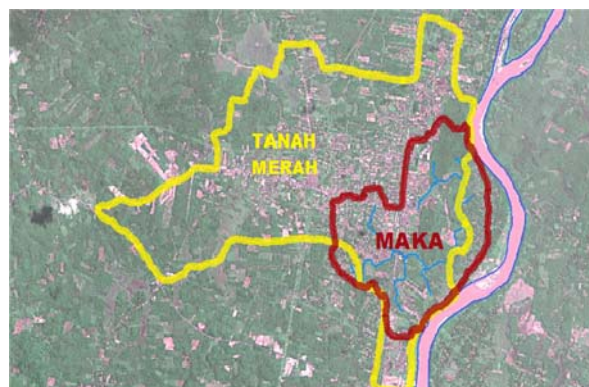


Figure 2 Boundaries of Sungai Maka Catchment in Tanah Merah, Kelantan (DID, 2010)

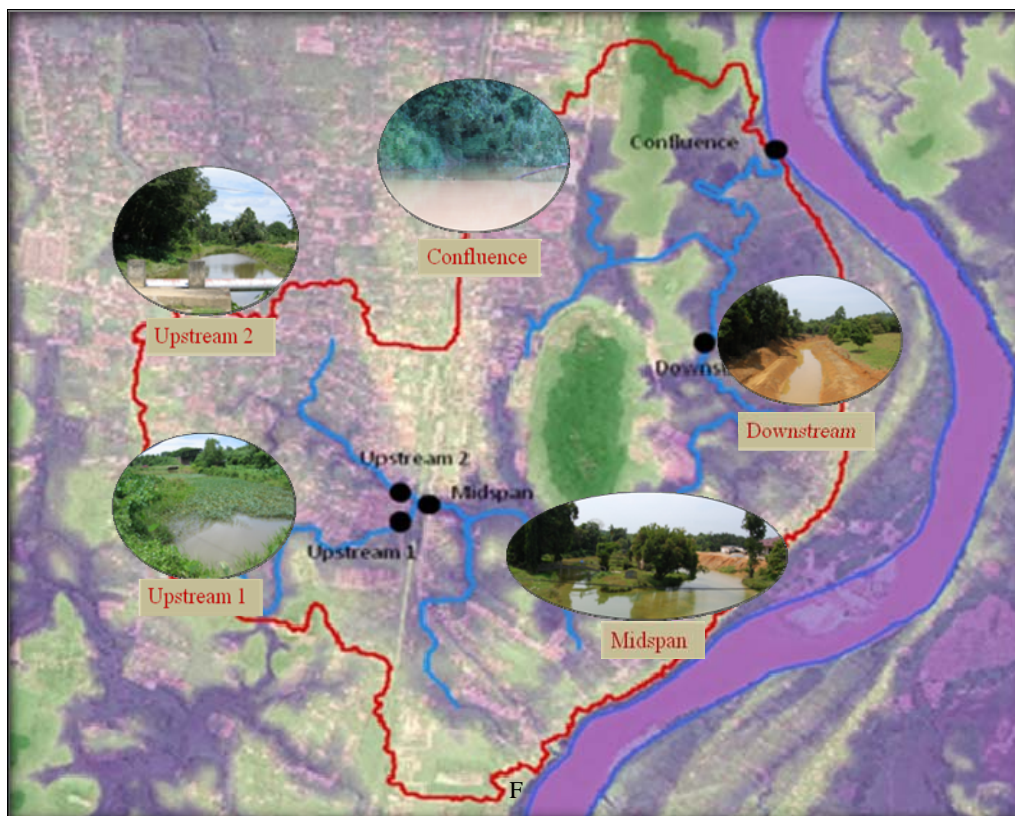


Figure 3 Conditions of Sungai Maka (DID, 2010)





Figure 4 Flooding in Sungai Maka catchment in 2007 (DID, 2010)

Several stormwater-related issues are experienced by the Sungai Maka catchment in particular and the Tanah Merah town in general. These issues are chiefly comprised of the following: water quantity issues, effects of urbanization and management issues (DID, 2010).

## 2 Water quantity issues

Flooding is the main issue pertaining to stormwater problems in the catchment. Primarily, the monsoon flood due to Sungai Kelantan bank overflowing is the main cause of the flooding that takes place within the catchment due to its proximity to the Sungai Kelantan. The whole of the town itself has a natural low and flat terrain which compounds the flood problem. Flood mitigation of the Sungai Kelantan is rendered ineffective as well so much so that the inhabitants in this region are already used to experience flooding on a regular mode.

Poor design and management of the urban stormwater system also contribute to the flooding in the catchment. In an overall assessment in the Masterplan study (DID, 2010), the existing stormwater system in the whole town is ineffective to contain and convey stormwater due to insufficient drainage facilities and fragmented urban drainage practices in the area. Inadequacy of these drainage practices in the town is exemplified in Figure 4. Lacking of maintenance in the main drains while some other main roads do not have drains, illicit discharges in the drains and presence of stagnant water and debris in them are the factors that worsen the flooding situation in the area.

The town is currently undergoing a rapid rate of development which inevitably heightens the effects of urbanization. In transforming formerly vegetated areas into impervious roads/structures, runoff volume and peak discharges are increased which subsequently exacerbates the flooding condition.



(a) No maintenance on main drains



(b) Effluent discharges into main drains



(c) Main roads without main drains



(d) Stagnant water and debris on main drains

Figure 5 Inadequate urban drainage practices in Tanah Merah (DID, 2010)

### 3 Effects of urbanization

Effects of urbanization have been serving its toll in the quality of waters in the area. Aftermath of urbanization such as pollution generation is one of these effects. The growing population in the town is one factor causing the increase in pollutant yields. As human beings generate most waste and pollution, population increase would entail increase in quantity of pollution yielded.

Construction activities in the area also cause excessive erosion which is another factor for the increased pollutant yields. This is further worsened by rubbish dumped in waterways indiscriminately. Apparently, proper waste disposals are not practiced in this side of the town.

Down the line, this pollution generated is gradually concentrating in the natural water bodies and gravely affect the aquatic life in them. It also decreases the volume of dissolvent in these bodies of water which cause the potential of the water body for self cleansing to be lost. Natural waterways create useful structures such as pool, riffles and drops that are very useful in doing the unique self-cleansing ability of river/stream (DID, 2010). However, all of these will be lost when the natural flow of such rivers/streams are altered, much worse when they are polluted.

### 4 Management Issues

Regulations on maintaining and operating stormwater system in the town are rendered poor and ineffective if there is any. This is exemplified by illegal discharges and heavy pollutant loads in the waterways and the poor drainage design that was constructed in the town. Cleanliness and good condition of the drains are not observed at all and vegetation grows excessively on main drains and gross pollutants are being trapped in these drains.

Consequently, the aesthetic function of the natural waterway is lost due to this inappropriate management and lacking of enforcement of regulations in the maintenance of these waterways. It is also attributable to the lacking of public knowledge of these functions and amenities of these natural rivers/streams that urban dwellers have such abusive attitudes toward urban rivers/streams.

### 5 Flood mitigation measures

Demands for flood mitigation have been increasingly sought due to destructive after effects of flooding. Existing flood mitigation measures being applied by various countries may be generally categorized into two, viz. structural and non-structural measures. Structural measures are hard engineering solutions basically aimed at controlling the flood which may involve river channel upgrading, construction of dams, reservoirs, embankments, levees, retention ponds, diversion channels and the likes.

In Japan's Comprehensive Flood Control Measures, basin-wide management is taken into consideration in preservation of retention areas such as installation of permeable pavement, seepage pit, among others; preservation of retarding areas to conserve urbanizing areas; and preservation of low land areas such as construction of water-resisting architectures (Fukami et al., 2005).

While structural measures involve engineering based solutions, non-structural measures on the other hand involve a broader range of disciplines, particularly from the social sciences (Chan, 1997). It comprises of land use planning and control, flood forecasting and warning systems, social resettlement, disaster management, emergency evacuation, relief and rehabilitation, public awareness and education programmes and effective flood control legislation to name a few. The non-structural activities implemented by various groups in Dhaka City, Bangladesh, after the devastating flood hit the city in 1988 and 1998 include emergency services, flood proofing of buildings, flood fighting, flood shelter and recovery and reconstruction (Faisal et al., 1999).

In the pursuit of the country's vision for a developed nation in 2020, Malaysia is striving to keep up with the trend of developed countries especially with regard to implementation of sustainable urban drainage system. Sustainability in terms of not only alleviating the menaces brought about by the floods but also preserving what is left of the natural environment in the process. This system also upgrades previous drainage practices such as a rapid conveyance system into a storage-at-source drainage system. It will have to integrate structural and non-structural measures in flood mitigation as well.

In the Stormwater Management and Drainage Masterplan Study for the town of Tanah Merah, Kelantan (DID, 2010), both measures have been extensively discussed.

The structural drainage master plan particular to the Sungai Maka catchment includes construction of control structures, waterway upgrades, drainage upgrades, construction of detention facilities and water quality structures.

Since the primary issue pertaining to flooding in the catchment is due to the Sungai Kelantan bank overflowing which occurs on a regular mode, water control structures are extremely needed in the catchment for the town's protection from flood. Sluice gates and multiple pumps comprise these structures as a means of obstructing flood water from entering the town and thereby reducing its susceptibility to flash floods.

Next to the monsoon flood, the poor condition of the existing waterways and drains in the catchment is a factor for the flooding as well. As such, necessary improvement to these channels shall be effected. It will involve full construction of waterways which require reprofiling, enhancement of other channels with slight improvement and maintenance and preservation of

existing waterways where drainage capacity is already sufficient. These improvements are necessary to facilitate proper conveyance of stormwater from existing drains to the waterways.

Absence of detention facilities in the catchment is another factor of the flood heightening. Floodwater is directly routed to the waterways which causes overflow during heavy precipitation and water backflow from Sungai Kelantan. For that, nine units of detention ponds are proposed in the catchment to alleviate excessive runoff. Further exploration of the configuration/size of these ponds for optimum usage is recommended.

For water quality enhancement, regional BMPs and gross pollutant traps (GPTs) are proposed in the catchment to help eliminate harmful source of pollutants brought about by the flood water.

However, these structures alone are not sufficient to mitigate the flooding if appropriate management and operation and maintenance are not in place. An emphasis on the apposite management of the stormwater system is a highlight of the non-structural measures in the flood mitigation since it will determine the sustainability of the urban drainage system in the catchment.

One such measure is public outreach and education. This endeavour is usually given less attention by authorities since it is considered to be an undertaking "on the sidelines". However, for urbanizing areas, public education regarding the citizen's responsibilities towards a sustainable environment is of paramount importance. The increase in the quantity of pollution generated will aggravate the already deplorable condition of the waterways which further leads to catastrophic problems, not only flooding, but also health problems among the urban dwellers.

Hence, there is a need to strengthen advocacies/education regarding the role of the citizens in the over-all operation of the urban drainage system in the catchment as well as their involvement in flood management process. Massive information on proper waste disposals which include segregation of wastes before dumping, appropriate maintenance of waterways/drainages, preservation and appreciation of the natural rivers/streams in the community are few examples of these endeavours.

Further, the involvement of the general public in the flood management processes will bring about enhanced viability to flood mitigation measures, aside from fostering better informed members of the society.

Non-structural methods of flood mitigation are less expensive compared to structural measures. Nevertheless, its impact on flood mitigation endeavours can not be understated as they serve to augment and reinforce the structural measures in alleviating the hazards brought about by the flood. An example of combining these measures in flood management is evident in Bangladesh, where combination of both structural and non-structural measures was promoted as they experienced firsthand that focus on the structural

components alone was not enough to mitigate the flood (Farouque et al., 2007).

## 6 Conclusion

Flooding issues in Sungai Maka catchment in the Tanah Merah town have various factors, foremost of which is the regular bank overflowing of the nearby Sungai Kelantan due to a monsoon climate. This is further exacerbated by several stormwater-related issues in the catchment such as poor management of urban drainage system, effects of urbanization and management issues.

Mitigation measures for flood occurrences in this part of the town are proposed which consisted of structural and non-structural components. Structural components proposed particularly in the catchment include waterway upgrades, drainage upgrades, construction of detention facilities, control structures and water quality structures. The highlighted non-structural measure for the catchment was on massive information dissemination on the citizen's responsibilities in the sustainability of the urban drainage system in particular and the natural environment in general.

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