Faculty of Engineering

CONCEPTUAL DRAINAGE IMPROVEMENT PLANS FOR THE MAONG RIVER CATCHMENT AREA

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CONCEPTUAL DRAINAGE IMPROVEMENT PLANS FOR THE MAONG RIVER CATCHMENT AREA

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This project is submitted in partial fulfillment of
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To my beloved mother, Madam Jenifer Nyim.

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ABSTRACT

The study is particularly evolves around the strategic ideas to tackle flood problem in the Maong river catchment area vis-à-vis the development cycles that of the study area. In other words, both of the variables are in 'direct relation' towards each other. It is based on the February 2003 flood event; refer to Appendix B. The February 2003 flood event flood is associated with a 20-years return period of rainfall. It is computed by using the recorded rainfall data from the Kuching Airport rainfall station. Plenty of areas in the upstream of the barrage were inundated during the event as well as some parts of the area in the Maong river catchment area. For that reason, the conceptual drainage improvement plans are generated. Among the proposed structures in this study are levees or flood walls, storage, tidal control device and pumping facilities. Several data collection and calculation processes will follow through in this project. Whereby, the computed value of Q_{peak} by using the modified rational method is $263.58m^3/s$ and estimated storm water volume to be stored is $2,851,200m^3$. The computed data will be used in the discussion section. This study is still in the identification stage of the stages in project planning. In addition, according to Carpenter (2002), "the protection of areas of floodplain reduces out of bank storage and changes the shape of the flood wave...potentially increasing flood risk downstream". In short, there is no total solution for flood problem.

ABSTRAK

Kajian ini berkisar terhadap idea-idea strategik untuk mengatasi masalah banjir di kawasan tadahan Sungai Maong di mana ia berkadar terus dengan kitaran pembangunan di kawasan kajian. Kajian adalah berdasarkan kepada kejadian banjir pada Februari 2003, rujuk Appendix B. Kejadian banjir pada Februari 2003 dikaitkan dengan 'return period' 20 tahun. Keputusan yang diperolehi adalah berdasarkan data yang direkodkan di stesen hujan Kuching Airport. Beberapa kawasan yang berada di hulu 'barrage' termasuk beberapa kawasan di kawasan tadahan Sungai Maong turut dibanjiri. Di atas sebab itu, pelan-pelan pembaikan perparitan secara teori telah disediakan. Antara struktur-struktur yang dicadangkan dalam kajian ini ialah tetambak penghalang ombak atau tembok banjir, 'storage', struktur penghalang ombak dan kemudahan mengepam. Proses pengumpulan maklumat dan pengiraan akan dilakukan sepanjang projek. Di mana, nilai Q_{peak} yang diperolehi melalui kaedah 'modified rational method' ialah 263.58m^3/s dan anggaran bagi isipadu air hujan yang perlu di takung ialah 2,851,200m^3. Data-data yang telah dikira akan digunakan dalam bahagian diskusi. Kajian ini berada pada peringkat identifikasi untuk peringkat-peringkat dalam 'project planning'. Tambahan pula, menurut Carpenter (2002), "the protection of areas of floodplain reduces out of bank storage and changes the shape of the flood wave...potentially increasing flood risk downstream". Secara ringkas, tiada penyelesaian yang menyeluruh untuk masalah banjir.

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Chapter 1

Introduction

1.1 Background

The nature of this study is basically based on the February 2003 flood event that hit Kuching town. Refer to Appendix B (flood indication map, dated 5th February 2003). The study area for this study is the Maong river catchment area. It is the largest sub-catchment of the Sarawak river catchment area, which covers an area of nearly "40 km^{2}" (KTA, 1997). The information pertain to the flood event will be obtain from the relevant authorities, for example, from the Department of Irrigation and Drainage (DID), Sarawak.

1.2 Statement of Problem

During the February 2003 flood event, considerable amount of areas in the upstream of the barrage was inundated.

The closure of the barrage gates due to king tide coincided with the heavy down pour that last for several days has prevented the storm water from flowing out of the system and was forced to accumulated in the upstream of the barrage, thus transforming the large areas in the upstream into a temporary retarding basin. Majority of those areas that acted as the temporary retarding basin further upstream are undeveloped land, so it is good in the sense that it help to contained and attenuated the flood wave instead of inundating the large developed areas in the downstream.

Moreover, the situation worsens when the barrage gates are open. This is due to the King tide coming into the river systems that prevented the discharge of storm water into the sea, thus allows for the accumulation of storm water in the river systems. Therefore, the water level in the river rise and the overflowing of storm water into the adjacent areas of the river happens.

Some part of the areas in Maong river catchment area which mainly areas adjacent to the Maong river are flooded or in other words operating as the temporary retarding basin during the February 2003 flood event due to the over-bank flow from the Maong river.

Maong river catchment area is more developed than the other flooded areas located in the upstream of the barrage, so there is a significant reason to protect and to improve the drainage system that of the catchment area. Besides, the author believes that Maong river catchment area have the potential to grow in the coming years.

1.2.1 Floods in Maong River Catchment Area

Maong river catchment area is situated in the upstream of the barrage system, by which the water level in the Sarawak river and its tributaries is controlled by the barrage operation with respect to the control of water level upstream of the barrage and the tidal affected Sarawak river downstream. During the February 2003 flood event, the existing discharge carrying capacity of the Maong river channel has failed to safely regulate the storm water, which caused overflowing of storm water to the areas adjacent to the river and inflicted inconveniences to the affected public. Data obtained from DID on Kuching City flood report

(2003) shows that few parts of the areas namely Desa Wira, MJC Bridge and Jalan Batu Kawa are practically inundated with storm water level ranges from 0.4m – 0.8m above road level. The over-bank flow had inundated quite a long stretch of Jalan Batu Kawa, which significantly disrupts the traffic flow along that flood-affected roadway.

The over-bank flow during the February 2003 flood event proved that the existing discharge carrying capacity of Maong river channel is insufficient to accommodate any large quantity of storm water from a heavy and consistent downpour event plus the influx of tidal water from the tidal affected Sarawak river.

In addition, the frequent occurrence of flood event in the Maong river catchment area is also due to the fact that it is located at low-lying areas.

1.2.2 The Current Drainage System

The current drainage system especially that of the observed system (Maong river catchment area drainage system) is depending on the barrage operation which significantly influences the water level at the confluence of Sarawak river and Maong river, through its opening and closing operation. The entire drainage systems in the areas upstream of the barrage link up very effectively with the barrage operation under the normal situation.

The problem arises when the gates are closed and the concurrent event of heavy downpour and King tide occurs, the water level in the Sarawak river channel particularly at the upstream of the barrage will rise due to the increased in the storm water volume and the backwater effect from the tidal affected Sarawak river when the gates are opened to allow free flow of water. Thus, the over-bank flow happens as the accumulated storm water in the river system exceeded the maximum discharge carrying capacity that of the tributaries river system, in this case, of the Maong river.

In addition, there are apparently no devices to control the back flooding at the confluence of Sarawak river and Maong river.

Apart from that, the current drainage systems existing in the catchment area is seen as inadequate to support the current pace of developments in the study area.

1.3 Objective

Based on the available data and information, several conceptual drainage improvement plans will be generated for the study area. In addition, the discussion regarding the phasing of the generated conceptual drainage improvement plans in relation to the degree of developments in the study area will be carried out.

The purpose of the conceptual drainage improvement plans is to cater for the current and future developments in the Maong river catchment area and to reduce the flood risk if the flood like the one in February 2003 or designed flood happens. The Sarawak river and Sarawak river barrage will be the boundary condition for the conceptual drainage system.

1.4 Scope of Work

Considering the data availability, this study is within the identification stage of the project planning process. Whereby, areas affected by the February 2003 flood event are recorded. Consequently, the study area is being identified and several conceptual drainage improvement plans will be generated.

Chapter 2

Literature Review

2.1 Planning

Planning can be defined as the orderly consideration of a project from the original statement of purpose through the evaluation of alternatives to the final decision on a course of action. It includes all the work associated with the design of a project except the detailed engineering of the structures (Linsley, Franzini, Freyberg et Tchobanglous, 1992). Dept. Pekerjaan Umum (1985), summarised the stages in planning as below:

- Inventories by province or river basin of potential for development, discernable on aerial photography at reconnaissance level, in terms of land and water availability and access.
- Identification of projects by name, during or after the inventories, and notification of interested parties.
- Reconnaissance to clarify aspects not resolved during the inventory, and classification to determine scope of further studies, if any.
- Pre-feasibility study and screening to compare outlines or types of scheme which may fulfil the objectives, to compare approximate costs and benefits, to select schemes for further study, and to determine the requirements for surveys and investigations.
- Feasibility study to establish the need, to define precisely the scheme to meet, recommend a program for implementation, draw attention to possible problems,

calculate capital and running costs and benefits, and indicate whether the project is technically and economically viable.

- Design is preliminary designs and/or detailed final designs, contract documents, and cost estimates.
- Construction is the implementation of agricultural and administrative aspects, including operation and maintenance.
- Monitoring of progress in construction and expenditure of area brought under irrigation and/or other objectives achieved and of benefits arising from the project.

2.2 Floods

Flooding is the inundation of normally dry land as a result of a rise in the level of surface waters or the rapid accumulation of storm-water runoff. It will become flood hazard when it has the potential to induce economic loss and threaten human life or health. Flooding is strictly a natural process, in which the event is bound to occur no matter what. The author believes that there is no drainage system that can prevent flood.

On the other hand, rapid development has in turn increase the amount of impervious surfaces and change the natural hydrological balance, in which it cause considerable effect on the frequency and severity of floods. Flooding can take many forms – river floods, storm-related flash floods and coastal floods and they can be caused by many reasons.

The major contributors to the flood event in our country are normally heavy rains and poor drainage systems.

2.3 River Flood Control

It is a counter-floods measure aim at reduces the adverse effects of flooding. The constant threat of flood especially to those living in the flood-prone areas has prompted the design and implementation of flood control schemes by civil engineers and relevant authorities in order to lower the risk of flood to those subjected to flood. According to Smart et Herbertson (1992), "In many cases flood control schemes which are of local benefit will have an adverse effect elsewhere, notably further downstream".

Flood control can be classified into two main categories. As Mays (2001) observes, "Construction of flood-control facilities, referred to as structural measures, are usually designed to consider the flood characteristics including reservoirs, diversions, levees or dikes, and channel modifications. Flood-control measures that modify the damage susceptibility of floodplains are usually referred to as non-structural measures and may require minor engineering works. Non-structural measures include flood proofing, flood warning, and land-use controls".

2.3.1 Structural Alternatives

According to Mays (2001);

2.3.1.1 Flood-Control Reservoir

Flood-control reservoirs are used to store flood waters for release after the flood event, reducing the magnitude of the peak discharges. Reservoirs modify the flood-flow frequency curve, which is lowered because of the decrease of the peak discharge of a specific event.

2.3.1.2 Diversion

Diversion structures are used to reroute or bypass flood flows from damage centers in order to reduce the peak flows at the damage centers. Diversion structures are designed to modify (lower) the frequency curve so that the flow magnitude for a specific event is lowered at the damage center.

2.3.1.3 Levees or Floodwalls

Levees or floodwalls are used to keep flood flows from floodplain areas where damage due to flood can occur. The effect of levee is to reduce the damage in protected areas from water surface stages within the stream or main channel by constricting the flow to flow within levee, thus reduces the amount of natural storage of a flood-wave, causing an increase in peak discharge downstream. Even though levee has the purpose of protecting property and lives, they also bring the potential for major disasters when design discharges are exceeded and areas are inundated that had been considered safe.

Besides, Petersen (1986) writes based on the U.S. Army, Corps of Engineers (1978) listed the following general steps levee design:

- Conduct geological studies based on a thorough review of available data, including aerial photographs, and initiate preliminary subsurface explorations.
- Analyse preliminary explorations data and establish preliminary soil profiles, borrow locations, and embankment sections.
- Initiate final explorations to obtain additional soil profile data, undisturbed strengths of foundation materials, and more detailed information on borrow areas and any other excavation.
- Using final explorations data determine embankment and foundation soil parameters and refine preliminary sections, compute rough quantities of suitable material, and refine borrow area locations.
- Divide the entire levee into reaches of similar foundation conditions, embankment height, and fill material, and design a typical trial section for each reach.
- Analyse each trial section for under seepage and through-embankment seepage, slope stability, and settlement, as required.
- Design special treatment for any problem areas identified.
- Establish final typical sections for each reach.
- Compute final quantities needed; determine final borrow area locations.
- Design embankment slope protection, if required.

Where there are limited spaces for levee construction thus flood wall is used instead.

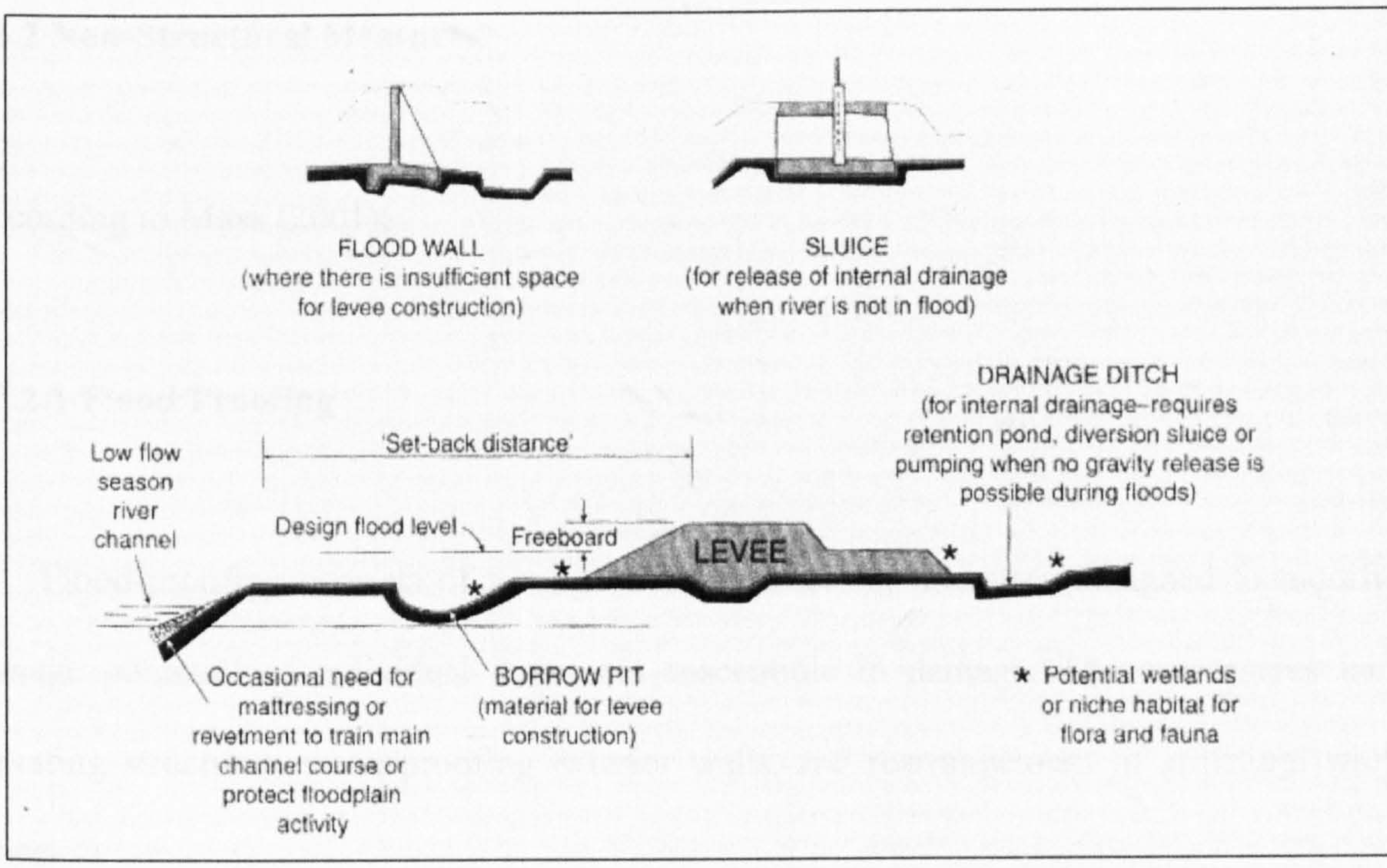

Figure 2.1 Flood protection levee constructions

(From Carpenter, T.G., 2001)

2.3.1.4 Channel Modifications

Channel Modifications (channel improvements) are performed to improve the conveyance characteristics of a stream…the peak discharges for flood events are passed at lower stages, decreasing the effect of natural valley storage during passage of a flood wave. This effect result in higher peak discharges downstream.