UNIVERSITI PUTRA MALAYSIA

TIDAL EFFECTS ON THE FLOW AND CHANNEL GEOMETRY OF KLANG RIVER ESTUARY

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Thesis Submitted in Fulfilment of the Requirement for the Degree of Master of Science in the Faculty of Engineering Universiti Putra Malaysia

July 2000

DEDICATION

TO

MY WIFE AZLIN

MY DAUGHTER SUHA

AND ALL THE FAMILY MAMBERS

IN

IRAQ AND MALAYSIA

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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Faculty: Engineering

The aim of this study is to predict the long-term behaviour of the Klang River estuary in terms of changes in the river morphology due to tidal effect that will help plan the industrial and commercial activities within the estuaries. The main objectives were to simulate the tidal effect on channel geometry, and the flow (water level) by using a mathematical modelling of finite difference approach (MIKE 11) as well as analysis of available data. The input data for MIKE 11 was the tide water level at port Klang and the probable discharge at Kota Bridge for ARI100, 70,50,10 from previous report and the cross section for 1993 survey. Changes in river morphology were evaluated by dividing Klang River estuary into five sections based on the available data for the cross section throughout the year. Soil investigation was also carried out to determine the soil properties in order to study the behaviour of the estuary. The findings show that water level at the end of the study area (Kota Bridge) was subjected to high and low water level with the same sequence as in Port Klang, and the ARI 100 flood capacity could be achieved if the amount of sediment load entering the estuary from upstream due to river improvement work was controlled. The grain size diameter was obtained by using the hydrometer analysis from two locations in the estuary and d_{50} was found to be an average between 0.006mm-0.008mm. Simulated flows using MIKE11 software gave tidal discharge of 2000m^3/sec. The study also showed that there was a decrease in volume of flow by 40% below Kota Bridge between Section-1 to Chainage 15900 m and between Chainage 300 m to Chainage 3200 m from the river mouth, in the other hand there was a 20 %. Decrease in channel capacity between Chainage 3200m to Chainage 15900m. The estuary is considered a well- mixed estuary and the water depth are more than 3 m that made it suitable for navigation. The study recommended the use of hydraulic sluicing, agitation dredging and tidal flushing to reduce sedimentation. It is recommended to set up a permanent station at Kota Bridge that can measure hourly discharge, water level, velocity, and suspended solids that pass through the above section.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KESAN PASANG SURUT KE ATAS ALIRAN DAN GEOMETRI TERUSAN BAGI MUARA SUNGAI KELANG

Oleh

MUHANNAD A. MAHDI

Julai 2000

Pengerusi: **Dr. Suleyman Aremu Muyibi**

Fakulti: **Kejuruteraan**

Matlamat kajian ini adalah untuk meramalkan tabiat jangka panjang Muara Sungai Kelang dari segi perubahan dalam bentuk morfologi sungai berdasarkan kesan pasang surut air yang mana akan membantu dalam perancangan aktiviti perindustrian dan perdagangan di lingkungan muara. Objektif utama ialah untuk mengsimulasikan kesan pasang surut air ke atas geometri terusan, dan aliran (paras air) dengan menggunakan model matematik kaedah pendekatan pembezaan terhingga (MIKE 11) dan juga analisa ke atas data yang tersedia. Maklumat "input" bagi MIKE 11 ialah paras air pasang surut di Pelabuhan Kelang dan kebarangkalian kadar air keluar di Jambatan Kota bagi ARI 100, 70, 50, 10 daripada laporan terdahulu dan keratan rentas bagi kajian 1993. Perubahan dalam morfologi sungai telah di nilaikan dengan membahagikan Muara Sungai Kelang kepada lima bahagian berdasarkan maklumat yang tersedia untuk keratan rentas sepanjang tahun. Penyelidikan tanah juga telah dijalankan untuk menentukan kandungan tanah untuk mengkaji tabiat muara tersebut. Penemuan menunjukkan paras air di penghujung kawasan kajian (Jambatan Kota)

bergantung kepada tinggi rendah paras air dengan turutan yang sama seperti di Pelabuhan Kelang dan keupayaan banjir ARI 100 boleh diperolehi sekiranya jumlah berat sedimen yang memasuki muara daripada hulu sungai disebabkan oleh peningkatan kerja-kerja dikawal. Sais diameter butiran telah diperolehi dengan menggunakan analisa hidrometer daripada dua lokasi di muara sungai dan d50 didapati mempunyai purata di antara 0.006 mm – 0.008 mm. Simulasi aliran menggunakan perisian MIKE 11 menunjukkan pengeluaran pasang surut sebanyak 2000 m^3/saat. Kajian juga menunjukkan bahawa terdapat penurunan di dalam jumlah aliran sebanyak 40% di bawah Jambatan Kota di antara seksyen – 1 ke rantaian 15900m dan diantara rantaian 300 m ke rantaian 3200m, manakala terdapat 20% penurunan di kapasiti terusan di antara rantaian 3200m ke rantaian 15900m. Muara ini dianggap sebagai muara bercampur yang elok dan kedalaman air adalah lebih daripada 3m yang mana ia sesuai untuk navigasi. Kajian mencadangkan penggunaaan pintu mengawal aliran air hidrolik, "agitation dreging" dan pengepaman pasang surut untuk mengurangkan pemendapan. Adalah dicadangkan untuk membina stesen kekal di Jambatan Kota supaya dapat mengukur kadar air dekeluarkan setiap jam, paras air, kelajuan dan pepejal berampai yang melalui stesen di atas.

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LIST OF ABBREVIATIONS

KRBFMP	Klang River Basin Flood Mitigation Project
FTDP	Federal Territory Drainage Project
TYPCKR	The Ten Year Program on Cleaning up the Klang River
ARI	The Average Recurrent Interval
T R	Tidal Range
AEP	Annual Exceedence Probability
JICA	Japan International Cooperation Agency
LSD	Land Survey Datum
DSM	Department of Survey and Mapping
MSL	Mean Sea Level
NCST	Non-Cohesive Sediment Transport
DSM	Department of Survey and Mapping
DOE	Department of Environment
V	Velocity
R	Hydraulic Radius
S	Slope of the Energy Grade Line
n	Manning Roughness Coefficient

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The Klang River basin is located on the west coast of Peninsular Malaysia. The river flows through the national capital Kuala Lumpur, and it is mostly contained within Selangor. Other major urban areas in the Klang River basin are Petaling Jaya, the Selangor State Capital of Shah Alam, Ampang Jaya, Klang and Port Klang. The population of the Klang River basin was some 3 million or just under 20 per cent of the total national population at the 1991 census with population growth exceeding 4 per cent per annum. The rapid urbanisation and industrial growth has resulted in increased pressure on the Klang River and its tributaries both in terms of flooding and water quality. Therefore there have been many studies most of which are related to flood mitigation and focus only on the upstream of the river. This study has been carried out on the downstream of the Klang River basin to study the tidal effects on the flow and the change in river morphology.

1.2 Background

The Klang River basin with a catchment area of 1,288.4 square kilometres occupies the central part of Selangor on the west cost of peninsular Malaysia. The basin is bounded by latitudes of 2°55' N and 3°25'N and longitudes of

101°20'E and 101°50'E, roughly extending 55 km from east to west. The seaward edge of the basin faces the straits of Malacca to the west. The Klang River originates in the main range at an altitude of 1,330 m in the east of the basin.

The upper basin above the existing dams is mountainous with fairly steep slopes. The major part of the mountains is covered by tropical jungle. In the lower downstream stretch of Kuala Lumpur, the land is low and rolling. The hills in this area are mostly covered by rubber and oil palm plantation. The river may be divided into three stretches as described below

1.2.1 Upstream River Stretch

The upstream stretch of the Klang River comprises three major rivers of similar characteristics, namely the Klang River (main stream), the Gombak and Batu Rivers (tributaries). The upstream of Klang River drains a catchment of approximately 189 km^2.

1.2.2 Middle River Stretch

The middle stretch of Klang River lies between its confluence with the Gombak and Damansara Rivers, covering a distance of some 30 km . This stretch runs through relatively low rolling country, bounded on the west by hills of Damansara district and on the south by hills. The slope of the river in this stretch changes from the relatively steep value averaging 1/700 to a relatively gentle value of 1/2300. Within this stretch, the river changes course three times. In this stretch there are three major tributaries namely the Kerayong River, Kuyoh River and Rasau River .

1.2.3 Lower River Stretch (Study Area)

The lower river stretch commences downstream from the confluence of the Klang River and its last major tributary, the Damansara River. This stretch runs through flat low lying plains, initially in a general westerly direction. The river meanders substantially along its seaward approach, for about 12 km in a straight stretch before making a 45° turn towards the south at the point where it is joined by its last minor tributary, the Pulus River, before making its final approach to the sea. This stretch of the river increases in width before Klang-Damansara confluence which is about 39km from the river mouth, varying from 50 m just downstream of the confluence to the width of 300 m just upstream of the river mouth. The series of 3 largest meanders is just up stream of the river mouth, occupying almost half the rectilinear distance between the Klang–Pulus confluence and the river mouth.

The slope of this lower river stretch is very gentle varying from about 1/2300 at the Klang-Damansara confluence to 1/7000 when the river meets the sea. A small section of the river, which lies about 2 km downstream of the Klang-Damansara confluence, has been re-aligned to remove two of the sharpest meandering loops out of the river course. This was one of the reasons why the study area was selected below this confluence. There are three ongoing project, namely the Klang River Basin Flood Mitigation Project (KRBFMP), the Federal Territory Drainage Project (FTDP), and the Ten Year Program on Cleaning up the Klang River (TYPCKR). The first of these projects covers channel improvement works to a number of the main tributaries as well as the Klang River itself. The basic structure for this work under the current KRBFMP has been derived from a flood mitigation study completed in 1989, although an earlier study in 1979 had initiated the Kuala Lumpur Flood Mitigation Project which was a forerunner to the KRBFMP. The second project was initially based on a 1978 study but the rapid changes in the urban areas had resulted in the retention of only some of the criteria from the earlier study in the current FTDP programs. The FTDP works now need to be extended into the surrounding areas of Selangor where urbanisation requires improved local drainage. The last three programs(KRBFMP,FTDP,TYPCKR) aim to improve the quality of water in the Klang River system and the amenity of the river corridor through a comprehensive series of sub-programs.

The Klang River channels in the middle reaches of the river or within the federal territory and including the Klang River down to the Puchong drop area are presently in alluvial deposits altered during mining operations. The mining operations have generally straightened and steepened the river and subsequent channel improvement works have also further straightened the river alignment. Below the Puchong Drop, although the river has been straightened in some reaches, the bank materials are more cohesive. Batter slopes used on the upper and lower banks vary between 1 in 1.5 (1V:1.5H) and 1 in 2 generally with comparable slopes on both batters, but occasionally a flatter batter has been designed for the use on the lower slope. The assessment of the erosion occurring in the Klang River basin indicates overall soil losses of about 18 tonnes per hectare with individual catchments having average soil losses of between 3 tonne per hectare and 42 tonnes per hectare. An average loss of 3 to 4 tonnes per hectare is the maximum loss considered acceptable (Kinhill & Ranhill, 1993).

1.3 Topography

The Klang river with a main stream length of 120km, originates from the above mentioned hilly terrains and flows roughly towards the southern direction . It is fed by several tributaries before reaching the centre of Kuala Lumpur city, which is located at its confluence with the Gombak River, at an elevation of about 30m above the sea level. The river then meanders towards the western direction and flows through a low lying plain in its downstream reaches, from Kuala Lumpur city centre to Port Klang which is located at the river mouth. The river originates from hilly terrains and flow along steep valleys and then enters the lowland plains which is less than 50m in elevation. The bed slope of the river is steep in its upper reaches and mild in the rest of the reach. The riverbed slope changes remarkably in the border area between the hilly terrains and the plains. This peculiar topographic conditions cause a rapid change in the flow velocity between the steep slope of upper reaches where the flow velocity is very high, and the mild slope of lower reaches where the flow velocity is rather low. This results in the reduction in the river flow capacity in the plain especially during the rainy season. Some measures such as diversion channels, channel improvements and storage basins like storage reservoirs and retention ponds are deemed necessary to prevent inundation of the plains caused by floods. The vegetation surrounding the Kota Bridge to the river mouth is a mangrove, whilst the geological formation is considered as folded Palaeozoic and Triassic.

1.4 River Morphology

The morphological behaviour of a river is greatly influenced by the river discharge and sediment load. The river channel width, depth and bed slope, bank slopes and river meanders are all determined by the variation in the discharge, sediment load, bed materials and soil cohesion in the banks. The flow that is considered to have strong influence on river morphology is the dominant discharge. For a natural river, the bankful discharge is normally taken as the dominant discharge. Klang River, in the present state has been altered considerably and the cross-section cannot be used to estimate the dominant discharge. The next best estimate is the average annual discharge or the average recurrent interval ARI 2.33 year flood. The ARI of 2.33 year flood event is about 300 m^3/s in the Puchong drop with an average velocity downstream of 1.5 m/s (Kinhill & Ranhill, 1993). The bed shear stress variation downstream varies from about 12 N/m^2 to 18 N/m^2. These values are higher than the critical bed shear stress for bed materials finer than 10mm; therefore during the occurrence