PREDICTION OF WAVE PROPAGATION, WIND WAVE EFFECTS AND ENERGY DISSIPATION NEARSHORE OF SUNGAI SARAWAK ESTUARY

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ABSTRAK

SWAN (Simulation WAves Near shore) ialah model simulasi ombak generasi ketiga yang digunakan untuk menganalisis parameter fizikal untuk muara Sungai Sarawak. Penyelidikan ini meliputi penyebaran ombak, kesan angin ombak dan pelesapan tenaga di kawasan pantai iaitu muara sungai Sarawak. Muara sungai Sarawak menghadapi masalah iaitu peningkatan dalam kadar pemendakan di kawasan kajian. Terdapat hasil ujian pemendakan pasir yang menunjukkan hasil di mana selepas pembinaan kunci air di hulu Sungai Sarawak, ini menyebabkan paras air yang masuk menurun dan menyebabkan kesan pemendakan di kedua bahagian hulu dan hilir sungai dengan anggaran kadar pemendakan pasir sebanyak 0.3 meter dalam setahun. Projek ini dijalankan dalam tiga (3) senario untuk model ombak iaitu Tahunan, Monsun Timur Laut dan Monsun Barat Daya. Selain itu, model ombak ini juga merangkumi analisis jangka masa panjang dan juga jangka masa pendek. Analisis jangka masa panjang menggunakan taburan ekstrim 30 tahun Gumbel dan Weibull. Hasil kajian yang penting dari kajian ini ialah Hs, Tm01, Dir dan pelesapan tenaga dari sebelas (11) lokasi yang dipilih sepanjang kawasan muara sungai Sarawak.

ABSTRACT

SWAN (Simulation WAves Near shore) is a third generation wave model that is use to investigate the physical parameters of Sungai Sarawak estuary. The investigation includes the prediction of wave propagation, wind wave effects and energy dissipation near shore of Sungai Sarawak estuary. Estuary of Sungai Sarawak faced with the problems of the increments in the sedimentation rate. There have been siltation test result shows that after a sluice construction at the upstream of Sungai Sarawak, it causes the tidal influx decreases and leading to some siltation at both upstream and downstream sides with an average siltation thickness of about 0.3m in a year. For this project, the wave modeling was developed for three (3) scenarios of Annual, Northeast and Southwest monsoon. Other than that, for each of the wave modeling scenarios, both short and long term analysis of waves also have been consider and carried out. The long term wave analysis are using Gumbel and Weibull statistical distribution functions for 30-year of return period. The main results for this project are Hs, Tm01, Dir. and energy dissipation. The results are from the eleven (11) selected area stretches along the Sungai Sarawak estuary.

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LIST OF ABBREVIATION

ANN	-	Annual
DID	-	Drainage Irrigation Department
GUI	-	Graphical User Interface
HAT	-	Highest Astronomical Tide
Hs	-	Significant wave height
MMS	-	Malaysian Meteorological Services
SSMO	-	Summary of synoptic Meteorological observations
SWAN	-	Simulating Waves Nearshore
NEM	-	Northeast monsoon
SWM	-	Southwest monsoon

LIST OF SYMBOLS

T_r	-	Return period
σ	-	Standard deviation
$P(x)$	-	Extreme value distribution
x	-	Wave height parameter
K_s	-	Shoaling coefficient
H_s	-	Significant wave height
$H_{1/3}$	-	Average one third of maximum wave height
T_s	-	Significant wave period
d	-	Depth
L	-	Wave length
K_r	-	Wave refraction coefficient
C	-	Celerity
T	-	Wave period

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Ocean engineering is the branch of engineering concerned with the design, analysis and operation planning of systems that operate in an oceanic environment. Examples of systems range from oil platforms to submarines, from breakwaters to sailboats. Nowadays, there is growing awareness of coastal problems since the past decade over the world for future research and development needs. Coastal engineering discussed and presented in this research has been limited to only the near shore zone, ranging from water depths that are just within the wave shoaling zone to the shoreline. Nearshore is indefinite zone extending seaward from the shoreline well beyond the breaker zone. The design waves for estuary Sungai Sarawak are generally based on the waves generated by wind. Estuaries are zones where fresh water debouches from river mouths into the sea causing stratification due to the density difference.

The principal coastal elements of the coastal zone of Sarawak are tides, winds and monsoon influences, wave action, sediment transport, littoral drift and mangroves. In ocean engineering, this inner coastal zone such as estuaries must given priority to make sure people are to live there in harmony with the environment. Wind generated waves are by far the largest contribution of energy from sea to the beach and near shore physical system. Air currents that caused by differences in air temperature above the oceans blow across the water and returning some energy to the water by generating wind waves. Winds that blow over the surface of oceans will generate waves.

This project stressed on physical and mathematical modeling of coastal processes for the study area, Sungai Sarawak. Simulation Waves Nearshore, SWAN will be used to modeling the design waves near shore of Sungai Sarawak from various return period. In the analysis of the coastal environment, spectral models are useful for determine the spectra in the region of interest, i.e. the region where wave data are needed for a design of a coastal structure or for other purposes. SWAN is a phase averaging wave model designed to obtain realistic estimates of wave parameters in coastal areas, lakes or estuaries from given wind, bottom, and current conditions (Holthuijsen et al., 2004). SWAN represents a water wave

models that significantly improved accuracy in design. SWAN (Booij et al.1999, Ris et al.1999) is one of the most widely applied spectral wave models at present in coastal engineering studies. SWAN is currently being used in about 50 countries, 700 institutes are registered. It is a public domain to the user's worldwide. In Russia, SWAN had been applied for hind casting waves for Barents, Caspian, Baltic, North, Okhotsk, Black, Azov, Mediterranean, Japan seas and Ladoga Lake.

1.2 Problem statement

According to Department of Irrigation and Drainage, Sarawak, 2000, Sungai Sarawak is important for Southwestern Sarawak as source of water, transportation and the inhabitants. The majority of the population lives in coastal areas in Malaysia. There is more than 80% population live along the 800 km coastline in Sarawak. The principal Uses of the Coastal Zone of Sarawak are human settlement, urbanisation, recreation, agriculture, industrial estates, amenity, timber processing and fishery. Sungai Sarawak near shore environments is facing problems with coastal landforms that exist because hydrodynamic of waves, currents, tides and wind processes erode, transport and deposit particles of sediment. Sedimentation is a major problem to Sungai Sarawak near shore. Sedimentary processes are among the most important but least understood aspects of the coastal environment. Sedimentary processes are the result of fluid/sediment interactions, or more

specifically, the response of sediment particles to the forces produced by shoaling waves, tides, coastal currents and winds.

According to Xiaodong Zhao et al., 2003, the Sarawak River regulation project has just been built in the year 1997/1998. The project includes a water retaining dam to the constructed upstream of oil terminal and a sluice to be built 1.8km downstream of Ironwoods. The main function of the project is to adjust the upstream water level of Sarawak River, especially to keep a high water level near Kuching City to beautify environment. As the runoff of Sarawak River is rather small, the sluice gates are normally closed. The automatic opening and closing gates are only used to adjust the upstream water level. But when the floodwater comes, the sluice gates must be opened. This river regulation project gives impact to Sungai Sarawak estuary as there are increments in the sedimentation rate. The siltation test result show that after the sluice construction, tidal influx decreases, leading to some siltation at both upstream and downstream sides with an average siltation thickness of about 0.3m in a year.

1.3 Description of study area

Sarawak is Malaysia's largest state located on the island of Borneo. It is located between longitude 109^{o}36'E and 115^{o}40' E and latitude 0^{o}50'N and 5^{o}N. The study area is within Sungai Sarawak near shore. Sungai Sarawak is a major river in the Sarawak state in Malaysia with its upper reaches and middle reaches running through a hilly area. Sungai Sarawak has two main tributaries; Sungai Sarawak Kiri and Sungai Sarawak Kanan. Sungai Sarawak (Muara Tebas) length is 38Km or 21miles. The river bed of Sungai Sarawak is almost in the natural state of an alluvial plane river without any man-made embankment.

The cross section of river is mainly in U-shape. The width, depth and area of the estuary are relatively stable during 1978 to 1996 (Xiaodong Zhao et al., 2003). The approach channel of Kuching port is the natural waterway of Sungai Sarawak containing two shoals, namely the Inner Bar and the Outer Bar, with the shallowest depth of 5.1m. The study areas boundaries are within the near shore of Sungai