SUSPENDED SEDIMENT AND WATER FLUXES IN MENGGATAL RIVER MOUTH, KOTA KINABALU

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DISERTASI INI DIKEMUKAKAN UNTUK MEMENUHI SEBAHAGIAN DARIPADA SYARAT MEMPEROLEHI IJAZAH SARJANA MUDA SAINS DENGAN KEPUJIAN

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Ijazah: IJAZAH SARJANA MUDA DENGAN KEPUJIAN SAINS MARIN

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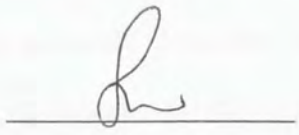

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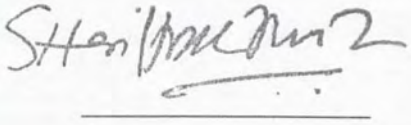

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ABSTRACT

Studies of suspended sediment and water flux have been conducted on 22-23 January and 26-27 February 2007. This study was conducted during one tidal cycle in Menggatal River mouth. Menggatal River mouth is situated at west bay of Kota Kinabalu and one of the main inlets into Sepanggar Bay. The objectives of this study are to identify the suspended concentration during tidal changes, to observed total water flux and sediment flux during flood tide and ebb tide in Menggatal River. Water samples were collected using water sampler and the samples were analyzed in the laboratory. The result of this study showed that the time average water velocities during flood tide were higher than ebb tide. Suspended sediment concentration in Menggatal River was higher during ebb tide than flood tide and water flux was higher during flood tide than ebb tide. Sediment fluxes were slightly different during flood tide and ebb tide.

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ABSTRAK

Kajian sedimen terampai dan fluk air di Muara Sungai Menggatal telah dijalankan pada 22-23 Januari dan 16-17 Februari 2007. Kajian dilakukan berdasarkan kitaran pasang surut air laut di muara Sungai Menggatal yang berada di sebelah pantai barat Kota Kinabalu, dan merupakan salah satu inlet ke Teluk Sepanggar serta terlindung dari Laut China Selatan oleh Pulau Sepanggar dan Pulau Gaya. Tujuan utama kajian ini ialah untuk menentukan kepekatan sedimen terampai ketika perubahan kitaran pasang surut dan seterusnya menentukan isipadu air yang merentasi keratan-rentas kajian dan menentukan jumlah isipadu sediment terampai di muara Sungai Menggatal. Kajian dibuat dengan menggambil sampel air dari kawasan keratan rentas kajian dan kemudian melakukan ujian makmal terhadap sampel yang diperolehi. Keputusan kajian menunjukkan halaju purata air ketika pasang lebih tinggi daripada ketika air surut. Kepekatan sedimen terampai di Sungai Menggatal lebih tinggi ketika air surut daripada air pasang. Isipadu air menunjukan bacaan yang lebih tinggi ketika air pasang berbanding ketika air surut. Walau bagaimanapun, isipadu sedimen terampai di muara Sungai Menggatal hanya menunjukan sedikit perbezaan ketika air pasang atau pun ketika air surut.

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LIST OF CONTENTS

UMS
UNIVERSITI MALAYSIA SABAH

UMS
UNIVERSITI MALAYSIA SABAH

UMS
UNIVERSITI MALAYSIA SABAH

LIST OF TABLE

UMS
UNIVERSITI MALAYSIA SABAH

LIST OF FIGURE

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UNIVERSITI MALAYSIA SABAH

LIST OF SYMBOLS

'	minute
^0C	Celsius degree
cm	centimeter
Ft	feet
g	gram
Km	Kilometer
L	Liter
M	meter
ml	milliliter
mm	millimeter
N	North
E	East

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Interest in studying suspended sediments has increased considerably during the last decade. At present, these sediments are considered as pollutants in many aquatic ecosystems. This non-point sources pollutant come from a number of sources and are washed into water ways mainly by surface runoff. When land disturbing activities occur, soil particles are transported by surface water movement. Soil particles transported by water are often deposited in streams, lakes and wetlands. This soil material is called sediment. Sediment is the largest single non-point sources pollutant and the primary factor in the deterioration of surface water quality. Land disturbing activities such as road construction and maintenance, timber harvesting, mining, agriculture, residential and commercial development all contribute to this problem.

The assessment of the volume of sediment transported by a river is very important in the design and management of water resources project. The sediment can aggregate channel beds with excess sand and gravel for ten to hundreds of kilometers downstream. Such aggradations promote lateral migration of channels and may cause serious flooding

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during rainstorm, due to loss of channels capacity necessary to convey floodwaters (Kisi, 2005).

Dissolved and particulate organic matter compounds in sea water are important modifiers to the biological and chemical reactions that take place in the sea. The sources of the organic compounds in sea water are from primary production in the euphotic zone. In coastal waters a significant proportion of the organic matter came from the land via rivers and coastal sediments.

Suspended sediment study is based on changes in water quality. One factor that can change water quality is rain. Rain water contains relatively few impurities but, as it flows through or over the ground, it pickup solutes and suspended matter. Once these enter the river channel, they normally remain there, becoming concentrated by further input and by evaporation. Therefore, proceeding from its source towards its mouth, the concentration of solutes and suspended particles in a river gradually increases, although rapid changes over a short distance can occur when a river channel passes through areas of contrasting catchment area geology, vegetation or land use. Major fluctuation in the concentration of the impurities result from high discharge which re-suspends sediment from the bed and, if it causes flooding, will input matter from the floodplain (Dobson and Frid, 1998).

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The estimate of the riverine inflow of fine sediment comes from Solomons and Egle (1990) and is probably the most reliable of all estimates being based on long-term river gauging and occasional measurements of suspended sediment concentration (Wolanski *et al.*, 1998).

Estimating net fluxes through a cross-section of an estuary is a difficult task (Wolanski *et al.*, 1998). This difficulty increases if the cross-section is far from flat bottom and includes a deep channel (a 'thalweg') and fringing shoals. Such large cross-section bathymetric variations can introduce a net inflow in the thalweg and a net outflow in shallower water (Kjerfve et al, 1981; Kjerfve, 1986; Turell and Simpson, 1988; Turell *et al.*, 1996). The time series of depth-integrated fluxes of fine suspended sediment were strongly dominated by tides. The largest fluxes occurred under a combination of spring tides and strong winds. Net fluxes during a given day were strongly dependent on maximum tidal range on that day. The estimates rely on averaging over tidal cycles with huge instantaneously fluxes of opposite sign at ebb and flood tides (Wolanski *et al.*, 1998).

While estuaries are region of high sedimentation when assessed on geology time scales, the rates are rarely high enough to cause smothering of the fauna. Nevertheless, the high quantities of mobile sediment in certain turbid estuaries can exert an ecological pressure on the fauna, a problem compounded by the temporal variability in the quantity of sediment in suspension, which varies with both the ebb-flood and the spring-neap tidal cycles (Dobson and Frid, 1998).

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This study is important in the design and management plan for Menggatal River area, such as in the design of catchment area, restoration of study area and other future plan. It is also important for conservation of natural ecosystem using suspended sediment as an indicator to determine human and natural activity. For marine organisms, it is important to determine suspended sediment fluxes in the river because it will affect marine phytoplankton by absorbing and scattering light available for photosynthesis. This will cause the depletion of oxygen gasses for respiration of other marine organism. Suspended sediment concentration will affect water quality and will disturb human activity (recreation, mariculture and fishery) at the surrounding area of Menggatal River.

1.2 Study area

Study of suspended sediment was conducted at Menggatal River estuary to identify suspended sediment and water fluxes in the river. Menggatal River is located north from Kota Kinabalu City, Sabah. It is facing Sepanggar Bay and situated in a semi enclosed bay (Figure 1.2) sheltered by the Gaya and Sepanggar islands. There is Kota Kinabalu Port (K.K Port) under construction at the upperside of Menggatal River. Menggatal River also located faces the navy base on the west side. However, Menggatal River that brings freshwater and suspended sediment to the sea also influences the sea water properties in the surrounding areas. This study can determine the effect of suspended sediment to human activity around Sepanggar Bay.

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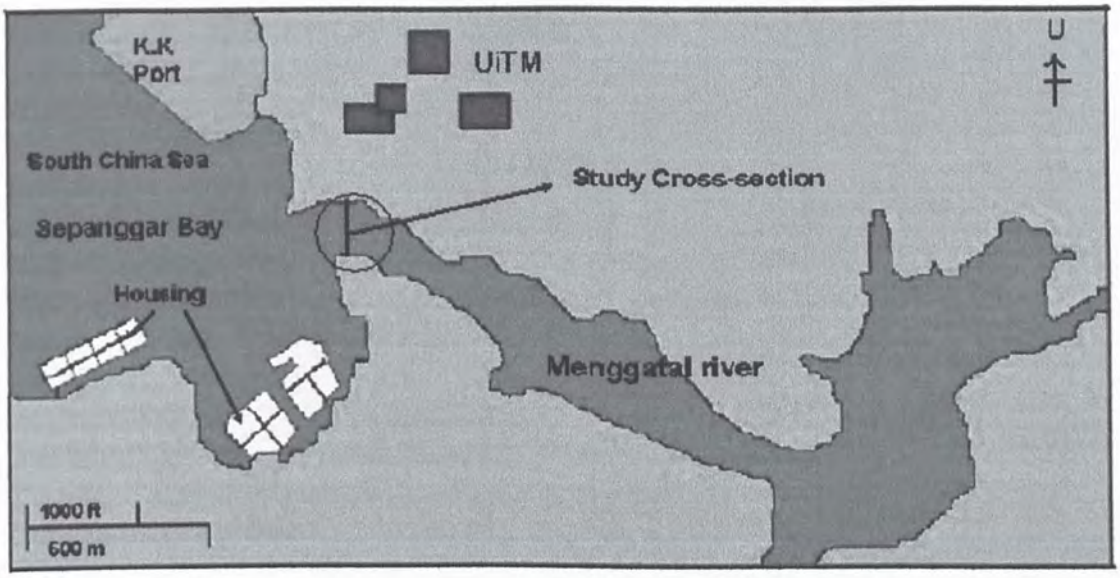

Figure 1.2: Menggatal River Mouth

1.3 Objectives

The main objectives of this study are:

i) To identify suspended sediment concentration during flood tide and ebb tide.

ii) To estimate total water fluxes during high tide and low tide.

iii) To determine total suspended sediment flux in the study area.

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CHAPTER 2

LITERATURE REVIEW

2.1 Suspended sediment

Sediment is the loose sand, clay, silt and other soil particles that settle at the bottom of the water body. Sediment can come from soil erosion or from the decomposition of plant and animals. Wind and water are some factors that help carry these particles to rivers, lakes and streams (Garisson, 2005).

Suspended sediment is very fine soil particles that remain in suspension in water for a considerable period of time without contact with the bottom. Such material remains in suspension due to the upward components of turbulence and currents or by suspension.

Suspended sediment concentration is the ratio of the mass of dry sediment in a water-sediment mixture to the mass of the water-sediment mixture. It is typically expressed in milligrams of dry sediment per liter of water-sediment mixture.

Suspended sediment discharge is the quantity of suspended sediment passing a point in a stream over a specified period of time. When expressed in tons per day, it is

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computed by multiplying water discharge (in cubic ft per second) by the suspended-sediment concentration (in mg per liter) and by the factor 0.0027 (Loseth, 1999)

Soil particles suspended in the water as a result of erosion in streams or on beaches, or from wave-induced re-suspension of particles from the bottom. Not only is the resulting muddy water unaesthetic, but also is a threat to living organisms. High total suspended sediment in the water greatly diminished sunlight reaching marine plant and blocked its growth by decreasing its photosynthesis (Mudroch, *et al.*, 1999).

Scientists have investigated feeding rates of suspension-feeding bivalves for many years. Most of the species studied are those that are commercially and recreationally important overseas. Suspended sediment concentrations have all been found to affect marine organisms (Mudroch, *et al.*, 1999).

The net transport of sediment within the water column when averaged over a tidal cycle is the product of the interaction of a range of mechanisms. Freshwater entering the estuary gives rise to a residual current which may transport seaward both sediment entering the estuary from riverine sources and sediment suspended within the estuarine water column, originating from local re-suspension or marine sources. If the water column is stratified, sediment derived from riverine sources is more likely to be transported within the upper layer while re-suspended bed sediment and sediment of marine origin is likely to be transported near the bed. The differing velocities associated with each layer in combination with the differing sediment concentrations result in vertically sheared sediment transport. The net transport in such a situation may be either seaward or landward (Lyons, 1997).

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2.2 Tides

Tides are very long-period waves that move through the oceans in response to the forces exerted by the moon and the sun. Tides originate in the oceans and progress toward the coastlines where they appear as the regular rise and fall of the sea surface. When the highest part or crest of the wave reaches a particular location, high tide occurs; low tide corresponds to the lowest part of the wave, or its trough. The difference in height between the high tide and the low tide is called the tidal range (Gordon and Lohrmann, 2001)

A horizontal movement of water often accompanies the rising and falling of the tide. This is called the tidal current (Yalin, 1977). The incoming tide along the coast and into the bays and estuaries is called a flood current; the outgoing tide is called ebb current. The strongest flood and ebb currents usually occur before or near the time of the high and low tides. The weakest currents occur between the flood and ebb currents and are called slack tides. In the open ocean tidal currents are relatively weak. Near estuary entrances, narrow straits and inlets, the speed of tidal currents can reach up to several kilometers per hour (Fulford, 1995).

Tides are the periodic movement of the sea, generated by the gravitational attraction of the sun and the moon on the hydrosphere. The effect of tidal activity is the periodic immersion and emersion of a strip of the coastal zone, as the sea level rises (flood tide) and falls (ebb tide) in sequence, normally twice per day. Additionally, over a period of about 14 days the tidal range follows a spring-neap tide cycle. Spring tides, with the largest tidal range, occur at approximately fortnight intervals, following which the

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tidal range decrease to the neap tide (approximately 7 days after the spring tides (Dobson and Frid, 1998).

2.3 Rain

Rain is a main transport of sediment into the river. It causes erosion inland from catchment areas. However, during heavy rain, excess water from the catchment passes rapidly into the river channel, bringing with it a pulse of sediment, detritus and solutes (Dobson and Frid, 1998). This particle is part of sediment transport and also suspended sediment. Calculating suspended sediment in the water ways give us a general idea of rain effect on water quality.

2.4 Catchment Area

Inputs of water to a river at any point are from four sources: direct precipitation, catchment runoff, groundwater and flow from upstream. Proceeding from source to mouth, the primary input changes from catchmnet runoff just about the only source of water in the headwater to flow from upstream, itself ultimately from the catchment, which dominates in the lower reach (Dobson and Frid, 1998).

Surrounding catchment area bring water contain sediment and also detritus into river. Catchment flow eroded sand, clay and slit from land and bring it to the river. All

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this particle will become sediment and some of them will remain suspend to be called suspended sediment. However, total catchment flow depends on its surrounding geography. Areas with open ground will cause more sediment transport into the river. Trees used as a filter that trap erosion before flowing into the river. At Menggatal river catchment area includes secondary forest and residential areas. Residential areas can cause a lot of sediment transport to the river cause by human activities such as road construction, house building and also agricultural industry beside river surrounding areas.

2.5 River runoff

River runoff may be an important source of fresh water. On a glance the most realistic and rigorous implementation could be an open boundary condition with prescribed values for the mass transport, the heat flux and the other tracer fluxes. However, such an implementation of rivers is overly complex and not necessary for the most purposes. Recall that for the momentum and tracer time tendency of a surface grid box, it is unimportant whether a flux enters the box vertically through the sea surface or horizontally through a vertical cell face. Thus, the fresh water flux into the surface boxes in a river mouth can be supplemented with the fresh water flux of the river. Similarly the corresponding tracer and momentum fluxes can be added to the surface boundary fluxes (Wolanski *et al.*, 1998).

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2.6 Marine life

Suspended sediment concentration in water body will effect marine life directly by blocking light into the water and unfortunately change water quality give stress to marine organism at that area. There is generally a high load of suspended sediments in estuarine and coastal waters. The particulates are both inorganic (e.g. clay particles) and organic (detritus). Suspended sediment load affects productivity of the waters by absorbing and scattering light available for photosynthesis. Suspended sediment modify the quantity and quality of light available to photobenthos and increases the abrasive action on algal cell (Blinn, *et al.*, 1976).

These sediment loads limit photosyntetically available reduction resulting in lower benthic algal (one of marine organisms) mass (Blinn and Cole, 1991). Suspended sediment also increases scouring and impede respiration of micro invertebrates, resulting in increased drift and reduced abundance and biodiversity (Newcombe and MacDonald, 1991).

Effects of elevated suspended sediment depend primarily on two factors: the size range of the sediment particles, and the food content of the suspended sediment. If the changes to sediment involve particles above the maximum size used by most suspension feeders (about 20 mm diameter) then effects will probably be minimal. Suspended sediment loads alter substrate size and degrade food quality available to benthic fauna (Culp, *et al.*1986; O'Conner and Lake, 1994). If the food content in sediment increases,

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