EVALUATION ON THE EFFECTS OF SEA LEVEL DURING EL NIÑO AND LA NIÑA EVENTS IN MALAYSIAN WATER

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ABSTRACT

Phenomenon on sea level rise has received a great concern from the Malaysian government and the community. Due to its location, Malaysia is vulnerable to sea level rise threat. MINITAB13 software was used to investigate the sea level rise phenomena using the least square regression method. Mean Absolute Percentage Error (MAPE) method generated from MINITAB13 was used to measure the accuracy of fitted time series values, for example the future sea level data. This was followed by null hypothesis test, test statistics-*t*, *t*-distribution and statistical significant test. Meanwhile, forecasting the future sea level using exponential smoothing approach as part of time series analysis technique was carried out. These analyses were performed on sea level data sets ranging from 1984 – 2007 from four stations across Malaysia. The regression analyses showed that the sea level was influenced by the 1997 El Niño and 1999 La Niña events as well as the monsoon season. The impact from the warmth, coolness and the occurrence of monsoon season were significant with the increased or decreased of dissolved oxygen saturation in Kuala Sungai Johor. Thus, during the El Niño event in 1997 and 2004, saturated oxygen value in freshwater was low in Kuala Sungai Johor. However, the occurrences of pre-monsoon and northeast monsoon (in October and January) consequently had lowered the temperature, resulting in a higher value of saturated dissolved oxygen.

ABSTRAK

Fenomena peningkatan aras laut menerima perhatian yang besar daripada kerajaan Malaysia and rakyatnya. Disebabkan lokasinya, Malaysia terdedah kepada ancaman peningkatan aras laut. Perisian MINITAB13 telah digunakan untuk mengesan fenomena kenaikan aras laut menggunakan teknik regresi kuasadua terkecil. Peratusan kesilapan bagi purata tetap (MAPE) teknik yang dihasilkan daripada MINITAB13 telah digunakan untuk mengukur ketepatan nilai tetap siri masa, sebagai contoh, data aras laut pada masa hadapan. Ini diikuti dengan ujian hipotesis nol, ujian statistik-*t*, agihan-*t* and ujian kepentingan statistik. Sementara itu, pendekatan menggunakan pendataran eksponen yang mana sebahagian daripada teknik analisis siri masa telah digunakan untuk meramal aras laut pada masa depan. Analisis ini telah dijalankan ke atas set data daripada tahun 1984 hingga 2007 meliputi empat stesen dari seluruh Malaysia. Analisis regresi menunjukkan aras laut dipengaruhi oleh kejadian El Niño pada 1997 dan La Niña pada 1999 serta musim monsun. Kesan daripada kejadian panas, sejuk dan musim monsun memainkan peranan penting dengan peningkatan dan pengurangan penepuan oksigen terlarut di Kuala Sungai Johor. Justeru semasa kejadian El Niño pada 1997 dan 2004, nilai oksigen terlarut dalam air tawar adalah rendah di Kuala Sungai Johor. Walau bagaimana pun, kehadiran monsun timur laut dan pra-monsun (pada Oktober dan Januari) telah menyebabkan penurunan suhu, kesannnya nilai oksigen terlarut adalah tinggi.

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LIST OF ABBREVIATIONS

APHA	American Public Health Association
atm	Atmosphere
Chlro	Chloride concentration
DO	Dissolved oxygen
DOE	Department of Environment
DSMM	Department of Survey and Mapping Malaysia
ENSO	El Niño Southern Oscillation
IPCC	Intergovernmental Panel Climate Change
ITCZ	Inter-Tropical Convergence Zone
MAPE	Mean Absolute Percentage Error
MINC	Malaysia Initial National Communication
MMD	Malaysian Meteorological Department
MSL	Mean Sea Level
MSLP	Mean Sea Level Pressure
NE	Northeast monsoon
NOAA	National Ocean and Atmospheric Administration
ppt	Part per thousand or in percentage (%)
SCS	South China Sea
Sg	Sungai or River
SST	Sea surface temperature

SW	Southwest Monsoon

LIST OF SYMBOLS

α	-	smoothing constant
τ	-	a positive number
ρ	-	population correlation coefficient
a	-	intercept at y-axis
b	-	slope of the line
e_i	-	residual or error
H_0	-	null hypothesis
H_1	-	alternative hypothesis
n	-	number of observation or observation
o_{sf}	-	saturation concentration of dissolved oxygen in freshwater at 1 atm (mg/l)
O_{ss}	-	saturation concentration of dissolved oxygen in saltwater at 1 atm (mg/L)
r	-	correlation coefficient
S	-	salinity (g/L = part per thousand (ppt) or in percentage (%))
S_T	-	single smoothed estimate or single smoothed statistic
$S_T^{[2]}$	-	double smoothed statistic
T	-	time/Period
T	-	temperature in Celsius (^{0}C)
T_a	-	absolute temperature (K); $T_a = T + 273.15$
y	-	actual observed value
y_c	-	computed value
y_T	-	observation at t^{-th} time/period
$\hat{y}$	-	forecast value
$\hat{y}_t$	-	fitted value or y_c.

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Hadley models suggested a mean expected sea-level rise of approximately 45-51cm above current levels by the end of the century (Boesch et al, 2000). These scenarios are consistent with the Intergovernmental Panel on Climate Change's 1995 estimates that sea-levels would most likely to increase by approximately 37 cm by 2100 (Houghton et al 1996).

The rise of sea level brings a devastating impact especially to the coastal community. Human life, places of attractions, infrastructures such as electric power station and economies will be threatened by the rise of the sea level. According to Klein et al (1999), even though the sea on the Sunda Shelf is shallower compared to the open seas, the South China Sea's surface temperature is closely related to El Niño Southern Oscillation (ENSO). El Niño represents the warm phase while La Niña represents the cold phase. It has been observed since 1977 that the El Niño Southern Oscillation (ENSO) has occurred more frequently.

1.2 Problem Statement

An attempt was made to study the variations of Malaysian sea level during El Niño and La Niña events. Two meteorological parameters were used in this study to identify the correlation between the mean sea level and air temperature, mean sea level and air pressure; and to identify the variations of the sea level in the Straits of Malacca and the South China Sea during these events. This study is considered an extension of the studies by Wai (2004) and Camerlango (1999). The effect of El Niño and La Niña events, particularly the effect of temperature to water quality parameter (dissolved oxygen) will be also investigated in this study. Therefore, it is hope that this study will bring benefit to a wide range of professionals who are responsible for policy making, agriculture, environmental planning, decision making and economies.

CHAPTER I

INTRODUCTION

1.1 Introduction

The phenomenon on the rise of the sea-level is of great concern to the Malaysian government and the community. The 1997-98 El Niño event had made the public and the Malaysian authorities aware, for the first time, of the environmental problems caused by the ENSO events (Camerlengo, 1999). Peninsular Malaysia, Sabah and Sarawak are surrounded by the South China Sea (SCS), Celebes Sea, Straits of Malacca, Johor Straits and Karimata Straits which is located on Sunda Shelf, the shallowest sea compared to the open seas such as the Pacific Ocean. Strategic locations in the country, such as the coastal areas, are home to more than 60% of the total population (Malaysia Initial National Communication (MINC), 2000) and major cities like Pulau Pinang, Johor Bahru, Kota Bharu, Kuching are located less than 50 kilometres from the coastal region.

Coastal and marine environment are linked to the climate in many ways. The ocean's role as the distributor of the planet's heat could strongly influence the changes in global climate in the 21st century. The rise of the sea level, the increase of nitrogen and carbon dioxide in coastal waters are threatening the coral reef populations and these are among the examples of the impact of the climate change. Study by MINC (2000) showed that when the temperature increases, it will cause the ocean to expand and the sea level will rise between 13 to 94 cm or 0.9 cm/year (based on the High Rate of Sea Level Rise) in the next 100 years. The General Circulation Model, Canadian and

1.2.1 Description of Study Area

Malaysia lies between the latitude of 1^0N and 7^0N and longitude of 99^0E and 120^0E (Figure 1.1). It has an equatorial climate. The mean temperature of the lowland station is between 26^0C to 28^0C with little variation for different month or across different latitude (MINC, 2000). The ranges of rainfall variations in Malaysia are highly, regularly and fairly uniform. However, most parts of Malaysia received peak rainfall during the northeast monsoon season. During this period, the east coast of Peninsular Malaysia and northeast coast of Borneo island received up to 40% of their annual rainfall (Andrews and Freestone, 1973).

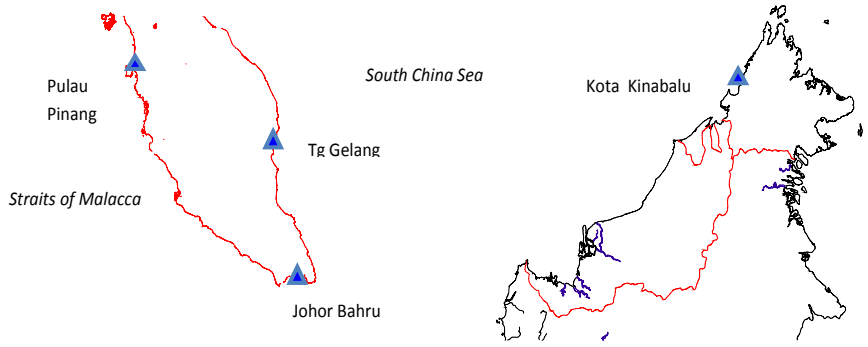

Figure 1.1: Selected tidal stations in Peninsular Malaysia and Sabah

The South China Sea divides Malaysia into separate sections West Malaysia or Peninsular Malaysia and East Malaysia, which is also known as Borneo Island. It is the largest marginal sea (semi-isolated bodies of water) situated in the Southeast Asia. The sea is surrounded by South China, the Philippines, Borneo Islands, and the Indo China Peninsula. This sea is shallower than the Pacific Ocean and has different salinity and temperature from those of typical open ocean seawater. The sea is fed from the north by the Pacific waters through the Luzon Straits and the Taiwan Straits, while the southern part of the sea is fed by the Java Sea. Thus, the South China Sea has the most variety of marine ecosystems which includes the soft-bottom and deep shelves oceanic waters, mangroves swamps, lagoons, seashores, sea grasses and coral reefs.

The sea has also one of the widest continental shelves and the edges of the sea are well fed by many rivers. The rivers have supported human activities in the region and consequently become one of the most populated regions in the world. Because of its geographical location, the South China Sea surface temperature is closely related to ENSO (Klein et al, 1999). The Mediterranean and the Caribbean Seas are other examples of marginal seas which are located in the Atlantic Ocean.

Peninsular Malaysia is hilly and mountainous with few large areas of plains (Andrews and Freestone, 1973). Human settlements are concentrated along the alluvial plains towards the coast. Most of the coastal regions are low-lying areas with less than 0.5m above the astronomical tide, or are within 100m inland of the high-water mark and are vulnerable to sea-level rise.

Southeast Asia is dominated by the monsoon wind system, which produces two major types of climate in Malaysia, Singapore and Indonesia. First is the monsoon climate occurs in northern Malaysia, northern Sumatra and eastern Indonesia. Second is the equatorial rainforest climate which occurs over the southern section of Peninsular Malaysia, Singapore, southern Indonesia, western Java, Kalimantan and Sulawesi (Andrews and Freestone, 1973).

1.3 Significant of the study

Basically, this study is considered as an extension or continuation from the study by Camerlengo (1999) as well as Wai (2004). The variation of sea level during El Niño and La Niña years is of significant interest in this study. Moreover, further investigation on the response of sea level during southeast monsoon and southwest monsoon seasons is investigated.

Additional information on the effect of temperature event to water quality parameter due to ENSO event is also included since there are few studies on this matter.

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