

INFLUENCES OF GROUNDWATER, RAINFALL, AND TIDES ON BEACH
PROFILES CHANGES AT DESARU BEACH

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Specially dedicated to my beloved mother and father, brothers, and sisters for their presence and encouragement.

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ABSTRACT

Relationships of hydrological parameters which are groundwater level, rainfall, and tides to the beach profile changes are examined in order to advance understanding on swash zone morphology. Heavy rainfall and drought affect the groundwater level in Malaysia during these two seasons. First, heavy rainfall and storms contribute to higher groundwater level in the wet season; thereby enhance erosion. Second, lesser rainfall or no rain in the dry season will drop the groundwater level and enhances accretion. According to this phenomenon, seasonal variation factor has significant impact to the sediment transport due to groundwater level fluctuations. A field investigation is conducted at Desaru beach by doing beach profile survey, tides, and groundwater monitoring. Based on the analysis, it is found that the highest rainfall for period of November 2013 to November 2014 was occurred on December 2013, while the driest month is on February 2014 with only one day of rainfall. Observations from both monitoring wells show that the groundwater surface is generally fluctuate during Northeast monsoon, and then started to flat with time from the first inter-monsoon to second inter-monsoon. The beach groundwater levels in the two monitoring wells were affected by rainfall but groundwater level in the well that located near to the shore is highly affected by tidal fluctuation. Finally, it is found that beach with high groundwater level and high precipitation tends to erode the beach.

ABSTRAK

Hubungan parameter hidrologi iaitu aras air bawah tanah, taburan hujan dan ketinggian aras pasang surut air laut dengan perubahan profil pantai perlu dikaji untuk memahami mengenai struktur zon condong morfologi. Taburan hujan lebat dan kemarau mempengaruhi paras air bawah tanah di Malaysia pada kedua-dua musim. Pertama, hujan lebat dan ribut menyumbang kepada peningkatan paras air bawah tanah yang lebih tinggi pada musim lembap; ini akan meningkatkan hakisan. Kedua, pengurangan hujan atau tiada hujan semasa musim kemarau akan menyebabkan pengurangan aras air bawah tanah dan akan meningkatkan kadar penambakan pantai. Menurut fenomena ini, faktor variasi musim mempunyai impak ke atas pergerakan sedimen pantai yang disebabkan oleh kesan perubahan aras air bawah tanah. Satu kajian lapangan dijalankan di pantai Desaru dengan melakukan kajian profil pantai, pemerhatian aras pasang surut air laut, dan pemantauan aras air bawah tanah. Berdasarkan analisis, didapati bahawa hujan yang paling tinggi dari tempoh November 2013 hingga November 2014 telah berlaku pada Disember 2013, manakala bulan yang paling kering adalah pada Februari 2014 iaitu dengan hanya satu hari hujan sahaja. Pemerhatian dari kedua-dua perigi menunjukkan bahawa permukaan air bawah tanah telah mengalami proses turun naik semasa monsun Timur Laut, kemudian mula sedikit mendatar di antara peralihan monsun pertama hingga peralihan monsoon kedua. Ketinggian aras air bawah tanah di dalam kedua-dua perigi tersebut telah dipengaruhi oleh taburan hujan namun ketinggian aras air bawah tanah di dalam perigi yang paling hampir dengan air laut telah banyak dipengaruhi oleh perubahan aras air laut. Akhir sekali, didapati bahawa pantai dengan paras air bawah tanah yang tinggi dan taburan hujan yang tinggi cenderung untuk mengakibatkan hakisan pantai.

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LIST OF ABBREVIATIONS

ACD	Admiralty Chart Datum
ADV	Acoustic Doppler Velocimeter
BH	Borehole
COEI	Coastal and Offshore Engineering Institute
DID	Department of Irrigation and Drainage
DOE	Department of Environment
EIA	Environmental Impact Assessment
ICSZ	Integrated Coastal Zone Management
ISMP	Integrated Shoreline Management Plan for Malaysia
KEJORA	South Johor Development Authority
LS	Lower Swash
LSD	Land Survey Datum
MET Malaysia	Malaysia Meteorology Department
MHHW	Mean Higher High Water
MHLW	Mean Higher Low Water
MLLW	Mean Lower Low Water
MLHW	Mean Lower High Water
MS	Middle Swash
MSL	Mean Sea Level
N	Neap
NHC	National Hydrographic Centre
PT	Pressure Transducer
RMN	Royal Malaysian Navy
S	Spring
US	Upper Swash

LIST OF SYMBOLS

β	Beach Profile Gradient
$^{\circ}\text{C}$	Degree Celsius
Cc	Coefficient of Gradation
Cu	Uniformity Coefficient
d ₅₀	Medium Grain Size
d ₁₀	Effective Size
g	Gram
hr	Hour
km	Kilometre
m	Meter
min	Minute
mm	Millimetre

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CHAPTER 1

INTRODUCTION

1.1 General

Malaysia is located near the equator that experience hot and humid climates throughout the year. Malaysia is mostly affected by the climate change that increased seawater levels, rainfall, flooding risks, and leading to extreme droughts. There are two dominant monsoons wind season in Malaysia which are the Northeast Monsoon and Southwest Monsoon. Thus, the Northeast Monsoon is normally known as wet season which starts from mid-November to March while the Southwest Monsoon is known as dry season which starts from June to September. There are also two interchange monsoons known as first inter-monsoon which starts from April to May, and second inter-monsoon which starts from October to early November.

Swash zone morphology with a complex interaction between beach profiles at different groundwater level; relationships of hydrological parameters which are rainfall, groundwater level, and tides to the morphological changes of a beach were examined. Cross-shore beach profile changes is commonly used as one of the main features in natural sea coasts that can be directly used to estimate the accretion or erosion process within the swash zone.

1.2 Problem Statement

Coastal erosion is a significant environmental issue especially erosion in Desaru beach, Johor since it involves development within coastal areas induced by human activities. As an extent to erosion damage, steep beach slope presents. On a steep slope, the waves do not interact with the bottom until they are almost right at the shore, so they do not have time to build up, and instead just surge far up the beach without breaking (Scherer et al., 2001).

Besides, heavy rainfall and drought may affect the groundwater level in the swash zone and it contributes to the changes of beach profiles, since Malaysia is located near the equator that experience hot and humid climates throughout the year. During the heavy rainfall and storms contribute to higher groundwater level during the wet season; thereby this will enhance the erosion rate in the swash zone.

Other than that, lesser rainfall or no rain during the dry season will drop the groundwater level. During this season, more or less, the drop in groundwater level will enhance the accretion rate in the swash zone. This situation can be concluded that beaches in Malaysia are likely to erode during the wet season and accrete during the dry season. According to this phenomenon, seasonal variation factor has significant impact to the sediment transport due to the groundwater level effect primarily in the swash zone.

1.3 Objectives of Study

The major objective of the present study is to analyse the influence of groundwater to the beach profile changes in swash zone. The specific objectives are:

- i. To analyse the relationship between groundwater, rainfall and tides at Desaru beach.
- ii. To analyse the beach profile changes at Desaru beach.

1.4 Scope of Study

The scopes of the study are:

- i. The study is based on field measurement conducted at Desaru beach, Johor, Malaysia.
- ii. The available data of groundwater level, rainfall depth, tidal level, and swash zone bed level were used for the study.
- iii. Swash zone elevation has been conducted by using Real Time Kinematic Global Positioning System (RTK-GPS).
- iv. The study used the available data of groundwater level and tidal level from the monitoring well at Desaru beach and tide gauge at Tanjung Balau.
- v. The study also used the available rainfall depth and wind speed data from Malaysia Meteorological Department.

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