INFLUENCE OF GROUNDWATER ON THE BEACH PROFILE CHANGE

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil – Hydraulics & Hydrology)

Faculty of Civil Engineering
Universiti Teknologi Malaysia

JANUARY 2014

Specially dedicated to my beloved father and mother,

Rahim Bin Isa & Noraini Binti Salleh

And my siblings members

Thanks for your pray, attention, and spiritual support..........

ACKNOWLEDGEMENTS

Assalamualaikum w.b.t.

It is a great pleasure to address those people who helped me throughout this project to enhance my knowledge and practical skills especially in research area. My deepest and most heartfelt gratitude goes to my supervisor, Dr Mohamad Hidayat for his guidance and help. Thanks for all the kindness and shared experiences to help me preparing this thesis. My deepest appreciation also goes to Mr Norasman for his guidance and sharing experiences towards my master project. Further thanks go to all staffs in NHC especially Lt Kdr Musa, RMN, DID, KEJORA, and METMalaysia for assistance and cooperation towards this study. To all staffs in COEI, Department of Hydraulics & Hydrology especially Mr Md Ridzuan, and my fellow friends; Izyan, Mariahti, Mardhiah, Hana, Nabila, Thanwa, and Farahiyah; thanks a lot for your criticisms and kindness.

Last but not least, thanks to my beloved family, who never give up in giving me encouragement and enthusiasm to finish my master project. May Allah swt rewards all of them for their kindness and sincerity.

Finally, I would also like to thank everyone who has contributed whether directly or indirectly to this project. This project would have been impossible without your guidance, advice and support. I hope this project will be useful for future use.

Thank you.

ABSTRACT

Relationships of hydrological parameters which are groundwater level, rainfall, and tides to the beach profile change of a beach are examined in order to advance understanding on swash zone morphology. Heavy rainfall and drought affect the groundwater level in Malaysia during two seasons. First, heavy rainfall and storms contribute to higher groundwater level during the wet season; thereby enhance the erosion rate. Second, lesser rainfall or no rain during the dry season will drop the groundwater level and enhances the accretion rate. According to this phenomenon, seasonal variation factor has significant impact to the sediment transport due to the groundwater level effects. A field investigation is conducted at Desaru beach with three monitoring wells are installed cross shore to the beach along with a rain gauge at the upslope. A tide gauge is installed at jetty Tanjung Balau in order to record the water level. Two field works are done for one week during spring and neap tides for both seasons. From the analysis obtained, Desaru is categorised as medium-sandy beach with the mean of medium grain size, d_{50} = 0.37 mm. It is found that the highest rainfall occurred on July while the driest month occurred on April with no rainfall at all. Observations from both monitoring wells show that the groundwater surface is generally not flat but fluctuated with time from the Southwest to the Northeast monsoon. The beach groundwater levels in the two monitoring wells were affected by rainfall however 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 tends to erode and producing flatter gradient.

ABSTRAK

Hubungan antara parameter hydrologi iaitu aras air bawah tanah, taburan hujan, dan ketinggian aras air laut dengan perubahan profil pantai dikaji untuk memahami struktur zon swash. Taburan hujan lebat dan kemarau mempengaruhi ketinggian aras air bawah tanah di Malaysia pada dua musim. Pertama, hujan lebat dan ribut semasa musim hujan akan menyumbang kepada peningkatan aras air bawah tanah, seterusnya akan meningkatkan kadar hakisan pantai. Kedua, pengurangan hujan atau tiada hujan semasa musim kemarau akan menyebabkan pengurangan aras air bawah tanah dan akan meningkatkan kadar penambakan pantai. Mengikut fenomena ini, faktor variasi musim mempunyai impak ke atas pergerakan sedimen pantai yang disebabkan oleh kesan perubahan aras air bawah tanah. Satu kajian dijalankan di pantai Desaru dengan memasang tiga telaga secara berserenjang bersama-sama dengan satu tolok air hujan di bahagian atas cerun pantai. Sementara itu, satu tolok pasang surut telah dipasang di jeti Tanjung Balau untuk merekod ketinggian aras air laut. Kerja mengukur telah dijalankan selama satu minggu semasa pasang surut anak dan pasang surut perbani untuk kedua-dua musim. Berdasarkan analisis yang diperolehi, Desaru dikategorikan sebagai pantai berpasir sederhana dengan min medium saiz butiran, d_{50} iaitu 0.37 mm. Kajian mendapati taburan hujan paling tinggi berlaku pada bulan Julai sementara bulan yang paling kering adalah bulan April dengan tiada hujan. Penilaian dijalankan mendapati bahawa permukaan air bawah tanah adalah tidak searas dan berubah dengan masa daripada monsun Barat Daya ke Timur Laut. Ketinggian aras air bawah tanah di dalam kedua-dua telaga tersebut telah dipengaruhi oleh taburan hujan namun ketinggian aras air bawah tanah di dalam telaga yang paling hampir dengan air laut telah banyak dipengaruhi oleh perubahan aras air laut. Akhir sekali, pantai yang mempunyai aras air bawah tanah yang tinggi lebih cenderung untuk menyebabkan hakisan pada profil pantai dan menghasilkan kecerunan yang curam.

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LIST OF ABREVATIONS

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
METMalaysia	Malaysia Meteorology Department
MHHW	Mean Higher High Water
MHLW	Mean Higher Low Water
MLHW	Mean Lower High Water
MLLW	Mean Lower Low 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
°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
%	Percent

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CHAPTER 1

INTRODUCTION

1.1 General

To advance understanding on 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 change is commonly used by many researchers as it is 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.

Malaysia is known as one of Asian country which 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. The Northeast Monsoon is generally carried in more rainfall compared to the Southwest Monsoon. Thus, the Northeast Monsoon is normally addressed as wet season which starts from November to March while the Southwest Monsoon is addressed as dry season which starts from June to September.

1.2 Problem Statement

Heavy rainfall and drought affect the groundwater level in the swash zone mostly during the two seasons as mentioned earlier. Firstly, heavy rainfall and storms contribute to higher groundwater level during the wet season; thereby enhance the erosion rate in the swash zone. Secondly, lesser rainfall or no rain during the dry season will drop the groundwater level. During this season, more or less, the drop in the 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 sediment transport due to the groundwater level effect primarily in the swash zone.

Table 1.1: Beach Erosion in Malaysia (Source: DID, 2012)

States	Length of Beach (km)	Number of Beach Erosion	Percentage of Erosion (%)
Perlis	20	8	72.50
Kedah	148	20	29.40
Pulau Pinang	152	15	41.60
Perak	230	10	61.00
Selangor	213	20	71.30
N. Sembilan	58	7	42.20
Melaka	73	9	50.30
Johor	**492**	**29**	**47.70**
Pahang	271	22	46.30
Terengganu	244	22	62.50
Kelantan	71	11	73.40
W.P. Labuan	59	6	51.90
Sarawak	1035	25	4.80
Sabah	1743	19	17.00
Total	4,809	223	

Table 1.1 shows the percentage, number, and length of eroded beaches experienced in Malaysia. Malaysia has 4,809 km long with 223 numbers of disturbed or undisturbed eroded beaches. According to DID (2012), Johor experience the highest amount of eroded beaches in Peninsular Malaysia which is 29 beaches with 234.8 km beach length. Figure 1.1 shows the beach erosion at different states in Peninsular Malaysia. It is shown that the beaches in the Northeast of Johor experienced greatest erosion rate. Hence, Desaru beach which located at the Northeast of Johor is chosen as the study site in order to estimate the beach morphological change within the swash zone.

Figure 1.1: Beach Erosion in Peninsular Malaysia (Source: DID, 2012)

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