STUDY ON BEACH MOR[illegible]NG DRY AND WET SEASONS A[illegible]HOR

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ABSTRACT

The Peninsular Malaysia experienced two seasonal changes which known as Northeast monsoon (wet season) which normally occur from November to March and Southwest monsoon (dry season) starting from May to August. This seasonal variations has been believed as the main factors for the changes in the beach profile which significantly caused erosion to occur during wet season while accretion is tend to happen during dry season. The aim of this study is to investigate the relationship between the seasonal variations to beach profile changes This study was conducted at Desaru beach, Johor. Desaru beach can be classified as a sandy beach because it consist of fine sand range from 0.4 to 0.8 mm. The rainfall data during this two seasons was collected together with the sample of sand and the beach profile of the study area in order to determine the relationship between the rainfall depth during the seasonal variations, the moisture content in the sand and the beach profile changes. The data was collected from May 2014 until February 2015. One rain gauge was installed at the study area to collect the rainfall data. For the beach profiles, the total station was used to do the survey works. The results indicates that during the wet season from November to March, the rainfall depth was higher compared to the dry season from May to August. The seasonal variations is the factor that affect the changes in beach profile. It is clearly shown by the total amount of the rainfall depth according to the monthly data from May 2014 until March 2015 which significantly increased and decreased in the wet and dry period, respectively. From this study also, it is found that the higher rainfall depth caused the temperature to decrease and when the rainfall depth is lower or when there were no rainfall receive, the temperature increased. High and low rainfall depth during dry and wet seasons also lead to increase and decrease in groundwater which caused the beach profile to change. This explains why erosion tend to occur during wet season and accretion tend to occur during dry season.

ABSTRAK

Semenanjung Malaysia mengalami dua perubahan bermusim yang dikenali sebagai monsun Timur Laut (musim hujan) yang biasanya berlaku dari bulan November hingga Mac dan monsun Barat Daya (musim kering) bermula dari bulan Mei hingga Ogos. Perubahan bermusim ini telah dipercayai sebagai faktor utama perubahan profil pantai yang menyebabkan hakisan berlaku semasa musim hujan manakala penambakan cenderung untuk berlaku semasa musim kering. Tujuan kajian ini adalah untuk mengkaji hubungan antara perubahan bermusim terhadap perubahan profil pantai. Kajian ini telah dijalankan di pantai Desaru, Johor. Pantai Desaru boleh diklasifikasikan sebagai pantai berpasir kerana ia terdiri daripada pelbagai pasir halus 0.4-08 mm. Data hujan dua musim ini telah dikumpulkan bersama-sama dengan sampel pasir dan profil pantai kawasan kajian untuk menentukan hubungan antara kedalaman hujan semasa variasi bermusim, kandungan kelembapan di dalam pasir dan perubahan profil pantai. Data telah dikumpulkan dari Mei 2014 sehingga Februari 2015. Satu tolok hujan telah dipasang di kawasan kajian untuk mengumpul data hujan. Bagi profil pantai, stesen jumlah telah diletakkan bagi kerja- kerja lapangan Keputusan menunjukkan bahawa semasa musim hujan dari bulan November hingga Mac, kedalaman hujan adalah lebih tinggi berbanding dengan musim kering dari Mei hingga Ogos. Variasi bermusim adalah faktor yang memberi kesan kepada perubahan profil pantai. Di sini jelas menunjukkan bahawa disebabkan oleh jumlah kedalaman hujan mengikut data bulanan dari Mei 2014 sehingga Mac 2015 yang meningkat dengan ketara dan turun dalam tempoh yang musim hujan dan musim kering. Kedalaman hujan yang lebih tinggi menyebabkan suhu menurun dan apabila kedalaman hujan yang lebih rendah atau apabila tidak ada hujan yang diterima, suhu meningkat. Berdasarkan kajian ini, tinggi dan rendah kedalaman hujan semasa musim kering dan musim hujan juga membawa kepada bertambah dan berkurang air bawah tanah yang menyebabkan profil pantai untuk berubah. Ini menjelaskan mengapa hakisan biasanya berlaku semasa musim hujan dan penambakan biasanya berlaku semasa musim kering.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

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 May to August.

In Malaysia, the seasonal wind flow patterns basically conjugated with the local topographic features which determine the rainfall distribution patterns over the country. The Peninsular of Malaysia experienced two seasonal changes which are Northeast monsoon known as wet season from November to March and Southwest monsoon known as dry season starting from May to August.

During Northeast monsoon, the east coast region of Peninsular Malaysia will experience heavy rainfall and storms together with strong wave condition caused by strong onshore wind which can contribute to a higher possibility of erosion rate at the beach area (Wong, 1981; Husain et al., 1997). This condition usually is correlated with the increasing in the groundwater table level. During this season, which occurs annually from November to February, the waves are larger than normal due to the strong onshore winds and thus can cause comparatively more damage (Hill, 1996; Wong, et al., 1979).

However, during the dry season which occurs from May to August, it experienced lesser rainfall which contributes to a significant drop in groundwater table level and will enhanced the beach accretion process. Significantly, it is believed that the seasonal variations factor in Malaysia influenced the erosion during wet season and accretion during dry season.

1.2 PROBLEM STATEMENT

Johor is one of the coastal states in Malaysia with the longest coastline facing the South China Sea in the east, the Strait of Malacca in the west and the Strait of Johor in the south. Coastal resources are the main source of income towards industrialization and economic development in Johor especially along the coastal area. Tourism plays an important role in the state's economy. Desaru is situated on the southeast coast of the district. It is located approximately 88 km east of Johor Bahru, on the South China Sea. Desaru is very close to the developing country, Singapore.

The seasonal variation experienced by Peninsular Malaysia has caused erosion and accretion to the beach morphology in Malaysia and Desaru beach is one of the highly affected coastal area along the shoreline. Among the significant factors that are suggested by many researchers are infiltration and exfiltration that occurs due to high or low condition of the beach groundwater .

During wet season which brings heavy rainfall it contributes to higher groundwater elevation and in this condition, the exfiltration occurs. This explains why the beach tends to erode when groundwater is high during the wet season. While during the dry season, the groundwater condition is low and infiltration occurs. This may lead to the beach accretion process. These two factors explain why the groundwater table with high or low level affect the erosion and accrete. This situation can be concluded that beaches in Malaysia are likely to erode during the wet season and accrete during the dry season.

1.3 OBJECTIVES

The main purpose of this study is to determine the beach morphological changes during dry and wet season which was conducted at Desaru beach, Johor. The objectives of this study are:

i. To collect and analyse rainfall and temperature data at Desaru beach during wet and dry seasons.
ii. To identify the size and moisture content level of sandy beach at study area.
iii. To study the relationship between hydrological data and beach morphological changes.

1.4 SCOPE OF STUDY

The scope of study is mainly focused on the beach morphological changes during seasonal variations which are wet and dry seasons. The study was conducted at Desaru Beach, Johor. From the study area, the data was collected by field works which involves collecting rainfall and temperature data, sand samples from the site and the beach profile data during these two seasons. The collection of data was conducted from May 2014 until March 2015. Basically, from May 2014 to March 2015 the wet and dry seasons was occurred.

Then, after all the data and sample was obtained, the laboratory works was conducted to determine the moisture content of the samples taken from the site and the grain size classification of the sample of sand.

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.

Table 1.1: Beach Erosion in Malaysia

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	

Source: DID, (2012)

1.5 SIGNIFICANCE OF STUDY

The significance of this study is to understand the process of the beach morphological changes during seasonal variations in Malaysia and to develop better understanding on the causes and impact of the erosion and accretion that occurs along the coastal area. The aim of this study is to investigate the relationship of the seasonal variations which affect the beach profile change. Processes and morphology are predominantly influenced by waves and tide on all natural beaches. Therefore, quantitative understanding of the relevant processes in this zone is very important for estimating coastal erosion and accretion.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Understanding the relationship of the beach morphological changes with the hydrological data obtained from the study area which includes rainfall data and temperature data, the moisture content and size distribution of sand samples during the seasonal variations which is dry and wet seasons. Cross-shore beach profile changes 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.

In Malaysia, basically the seasonal win flow patterns coupled with the local topographic features determine the rainfall distribution patterns over the country.

During the Northeast monsoon, the east coast region of Peninsular Malaysia will experience heavy rainfall and storms plus energetic wave condition due to strong onshore wind which can contribute to a higher possibility of erosion rate at the beach area (Wong, 1981; Husain et al., 1995).

2.2 BEACH CLASSIFICATION

According to Wright and Short (1984), beaches can be classified into three states which are reflective beach, dissipative beach and intermediate beach. Commonly, Malaysia's beaches can be classified as reflective and dissipative beaches. The reflective beach is relatively steep beach that present a narrow surf and swash zone. The waves present at reflective beach are of plunging to collapsing breaker type or do not break at all and surging. The sediment present at the beach is relatively coarse and there are no breaker bars. Due to the low wave energy dissipation, these beach are often referred to as low-energy beach.

Dissipative beach is relatively flat beaches with a wide surf and swash zone and multiple breaker bars present in the cross-shore profile. The waves present at dissipative beach are of the spilling breaker type and the sediment is relatively fine. The main swash motion consists of collapsed wave bores running up and down the beach. Because of the dissipation of a large part of the wave energy these beach are often referred to as high-energy beach. As reported by Short (1984), the topography of dissipative beach includes a few bars, and the slope is less than five degrees as well as lack of berm development.

Lastly, intermediate beach is a beach with a combination of the characteristics of the two other beach states (spilling to plunging/ collapsing breaker type) and can be seen as semi-dissipative (or semi-reflective) beach.

2.3 BEACH PROFILE

The vertical changes in beach elevation along a line running from the dry part of the beach through the low water mark and out into shallow water is known as the beach profile (Pilkey et al., 2011). The profile records the irregularities in the beach surface and its elevation at each point and reveals different features in the form of the beach. The profile is one of the most commonly measured attributes of a beach.

The beach profile extends from the point offshore where waves first begin to move sediment on a frequent basis, through the intertidal zone, through the shallow water where waves break, to the landward limit of the sand deposit reached by the largest waves. The final boundary includes the dunes at the rear of the beach, since these wind deposits sometimes contribute sand to the beach during storm.

2.4 COASTAL ZONE

The term coastal zone is used extensively in recent literature with some variations as to its exact meaning. Some definitions refer to the zone as a narrow area of land and wetland immediately adjacent to the shoreline, the line where the sea and the land meet. Some refer to it as the area extending inland approximately 1 km from the mean low tide level and seaward to the outermost limit of the state boundaries.

The coastal zone can also be known as a location where human population and human activities insists development within the area that has significant impact on resources and coastal processes. Human activities within this area are including agriculture, navigation, fisheries, aquaculture, transportation, communication, and recreation. These activities promote economic growth thus it is important to sustain this coastal zone to ensure these activities can be conducted safely.

According to Hail (1980), it can be defined as an area of variable width which extends seaward to the edge of the continental shelf, but which has no distinct landward demarcation. It is within this zone that man's activities can interrupt or destroy ecosystems and natural processes whether they are biological, chemical or physical.

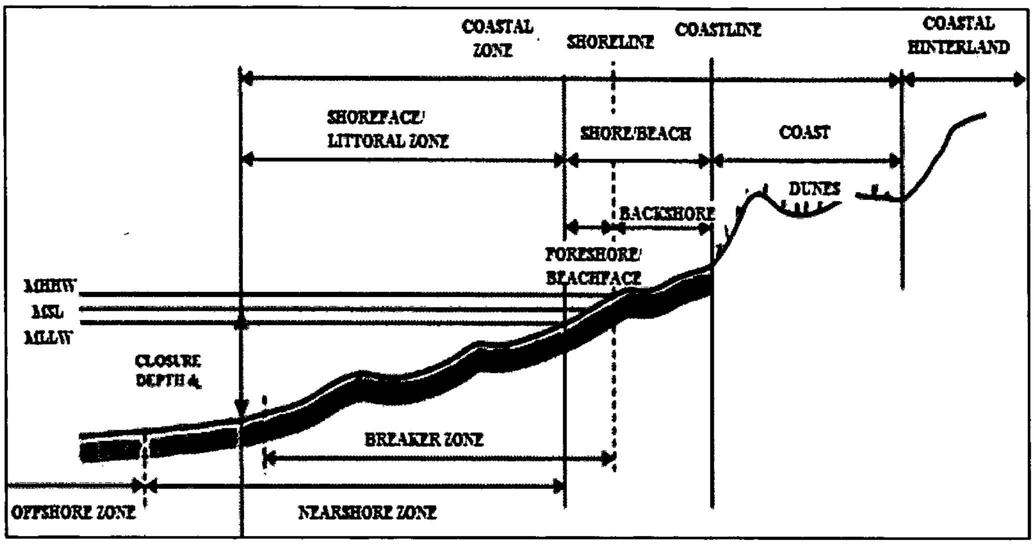

Figure 2.1: Coastal Zone

Source: U.S. Army Corps of Engineers (1984)

This coastal zone is technically being classified into many parts as shows in Figure 2.1. It shows the coastal zone condition which explains the location of near shore zone, offshore zone and backshore zone. Near shore zone is an area of the sea and the seabed adjacent to the shoreline. Offshore zone is the zone that is out of the coastal zone. Backshore is the boundary which is above the limit of wave up rush during high tides and the backshore may be reached by seawater during storms or wet season.

Previous study indicated that the most sediment transport occurs within the littoral zone on the sandy shoreline (Davidson-Arnott and Greenwood, 2011). Thus, the coastal processes within this littoral zone that may affect the beach profile changes are the main interest in this study.

Coastal zones are important because a majority of the world's population inhabit such zones. Coastal zones are continually changing because of the dynamic interaction between the oceans and the land. Waves and winds along the coast are both eroding rock and depositing sediment on a continuous basis, and rates of erosion and deposition vary considerably from day to day along such zones. The energy reaching the coast can become high during storms, and such high energies make coastal zones areas of high vulnerability to natural hazards. Thus, an understanding of the interactions of the oceans and the land is essential in understanding the hazards associated with coastal zones. Tides, currents, and waves bring energy to the coast, and thus we start with these three factors.

2.4.1 Coastal Erosion

Coastal zones are subjected to rapid erosion by natural processes and to a little extent by anthropogenic activities over a long period of time. The continuous decline in the size of the zone might also be influenced by steady rise in sea levels accompanied by subsistence of the lower delta plain. This is expected to create a serious ecological imbalance in the otherwise fragile ecosystem unless some effective coastal management measures are taken up (Lakshmi and Edward, 2010).

2.5 SWASH ZONE AREAS

Swash zone area is the upper part of the back beach and surf zone, where intense erosion occurs during storms. It is alternately experienced wet and dry condition. Swash zone is also known as a turbulent layer of water that washes up on the beach causes by broken incoming wave. According to Masselink and Hughes (1998), a swash zone is where the uprush of water up the beach slope and then formed the backwash which flowing downs the beach until the next breaker arrives.

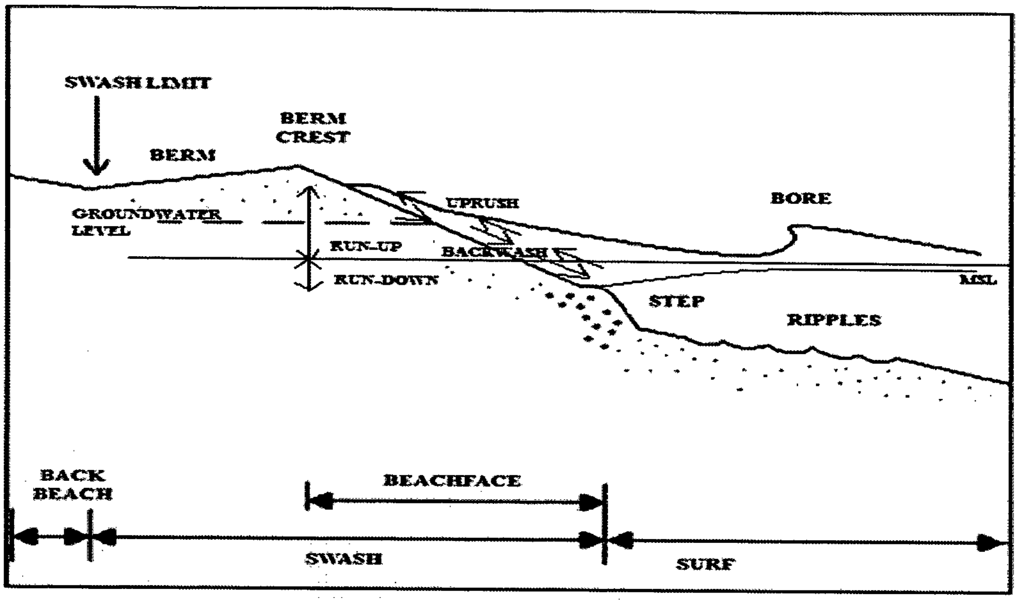

Figure 2.2: Definition of Swash Zone

Source: Masselink and Hughes (2003)

Figure 2.2 shows the formation of uprush occurs when the remaining energy is dissipated impact on the beach while the formation of backwash occurs when the water velocities reduce to zero and then flowing down the beach. Wave run-up and wave run-down are maximum extend of wave uprush and backwash vertically on a beach. The high wave uprush may cause erosion by directly impact the beach bluff and transport sands towards the shoreline. As such; if the uprush carries sands up to the bluff toe, thereby it will stabilise the bluff. However, if another strong wave uprush removes away the sands, then the bluff will be less stable and become more flat to direct wave attack to the beach.

During the swash action that will cause the beach materials to move up and down, a cross shore sediment exchange will occur. Generally, greater swash will occur on the flatter beaches. The swash motion plays the primary role in the formation of morphological features and their changes in the swash zone (Komar,1998). Morphological processes such as storm- induced erosion, post- storm recovery, seasonal variation in foreshore shape, and evolution of rhythmic shoreline features are all driven by the inter- relationship between swash zone hydro and sediment dynamics.

The sediment dynamics and sediment transport in the swash zone are predominantly driven by the swash hydrodynamics. There are four key aspects of the swash are considered which are, boundary conditions, swash zone characteristics, forcing mechanism and shoreline oscillations, internal flow kinematics and turbulence and bed boundary layer, percolation and groundwater.

2.5.1 Uprush and Backwash

Uprush and backwash is two phases under the swash action. The uprush is an onshore flow while backwash is an offshore flow. Generally, the uprush velocities are greater but the duration is shorter compared to the backwash.

During the uprush flow, the seawater will spread quickly into the upper layer of the beach surface. At the end of the uprush process, the flow will return to backwash and successive reduction in swash depth, there will be a rapid decrease of pore-pressure, producing forces acting vertically upwards just below the beach surface. This condition may lead to rapid outflow exfiltration in groundwater.

2.5.2 Coastal Sediment Transport

Sediment transport is the movement of solid particles (sediment), usually due to a combination of gravity acting on the sediment, and/ or the movement of the fluid in which the sediment is entrained. It only occurs only if there is an interface between a moving fluid and an erodible boundary (Reeve et al., 2012).

Sediment transport in the swash zone usually occurs under sheet flow conditions and with a flat bed, although temporary anti- dune bed forms sometimes develop during supercritical flow conditions at the end of the backwash (Osborne and Rooker, 1999). Coastal sediment transport results in the formation of characteristic coastal landforms such as beaches and barrier islands. Usually, the processes that lead to the net transport of sediment onshore or offshore and those tending to move sediment alongshore need to be distinguished although both processes occur simultaneously.

Knowledge of sediment transport is often used to determine whether the erosion or accretion will occur, the magnitude of this erosion and accretion, and the time and distance over which it will occur. According to Davidson-Arnott (2010), the direction of net sediment transport depends on the balance of all the forces acting on the sediment including those due to incident and long waves, wave-generated on-offshore and alongshore flows, wind-driven currents and tidal flows.

Sediment transport can be divided into long shore and onshore or offshore sediment transport. Generally, the long shore sediment transport is responsible for the long-term changes is defined as the movement of waterborne sediment along the coast. This process occurred in the surf zone which is landward of the offshore bar. Wave and current will influence the long shore transport to be transported parallel to the shoreline.

The offshore transport is responsible for the short-term variations in the coastline. Waves that occur during the storm events will erode the sand from beach berm or dune and then will transport it offshore to build a storm bar. This storm bar will widen the surf zone and flatten the beach profile gradient in the surf and swash zones. Impact from that, the waves will break further offshore, which requires a self regulating limit of the beach erosion.

2.5.3 Impacts of Sediment Transport on Beach Profile

Waves that travel from deep water to a sandy shore, then break, and run-up on a shoreline will continually reshape the beach. This continuous reshaping occurs due to the incident wave characteristics itself such as height, periods, and also direction. There are four seasons experienced by the Northern and Southern Hemisphere around the world which are winter, spring, summer, and autumn seasons as shown in Table 2.1. Normally beaches in Northern Hemisphere will experience a seasonal variation from the winter beach to the autumn while in Southern Hemisphere from summer to the spring seasons. These seasons more or less will affect the beach profile in the term of sediment transport.

Table 2.1: Seasons Classification over a Year

Northern Hemisphere	Month	Southern Hemisphere
Winter	December	Summer
	January	
	February	
Spring	March	Autumn
	April	
	May	
Summer	June	Winter
	July	
	August	
Autumn	September	Spring
	October	
	November	

Source: Pierce (2012)

Hayashi et al., (2012) found that the sediment transport was dominated majorly during the winter and summer season, whereby the other two seasons have quite similar volume changes. Hayashi had found that the energy flux during the summer season was lower than others.

2.6 BEACH GROUNDWATER

The groundwater level can be assumed as a continuation of the mean surface water into the beach, and therefore to have same elevation as the tide (Horn, 2006). The groundwater elevation within the beach is affected by the tidal, waves, and to an extent the rainfall and also sediment properties such as size, shape, sorting, porosity and permeability (Foote et al., 2002).

Water seepage will develop below the exit point at the beach face and can be identified by visual observation of a glassy surface (Foote et al., 2002). Water is infiltrates/exfiltrates the beach surface during up-rush or backwash, depending on the beach material, permeability and the degree of soil saturation (Elfrink and Baldock, 2002).

The uprush and the backwash on the swash will affect the groundwater table by altering the degree of saturation on the beach face (Butt and Russell, 2001). However, according to Hoque and Asano (2007), the beach groundwater table cannot response with the rapid swash up rush and backwash.

The system of the beach groundwater is highly dynamic, shallow, unconfined aquifer in which flows are driven through saturated and unsaturated sediments by tides, waves and swash and to a lesser extent by atmospheric exchanges (evaporation and rainfall) and exchanges with a deeper aquifer.

Since 1940s, several studies have described the shape and elevation of the beach water table as a function of beach morphology and tidal state. The elevation of the beach water table depends on prevailing hydrodynamic conditions such as tidal elevation, wave run- up and rainfall, and characteristics of the beach sediment that determine hydraulic conductivity such as sediment size, sediment shape, sediment size sorting and porosity (Gourlay, 1992). Observations on the beach water table behaviour show that the water table surface is generally not flat.

The interaction between the surface water and groundwater flow has been widely acknowledged as a key factor in controlling gravel beach morphology (Mason and Coates, 2001) but the exact nature of the relationship between surface flow, groundwater flow and cross- shore sediment transport is still not fully understood.

Infiltration and exfiltration are among significant factors which are suggested by many researchers in order to clarify about why beaches with a high water table are likely to erode and low water table tend to accrete. The type of beach property material that mainly controls the level of infiltration is the permeability or hydraulic conductivity of the beach material (Masselink and Li, 2001).

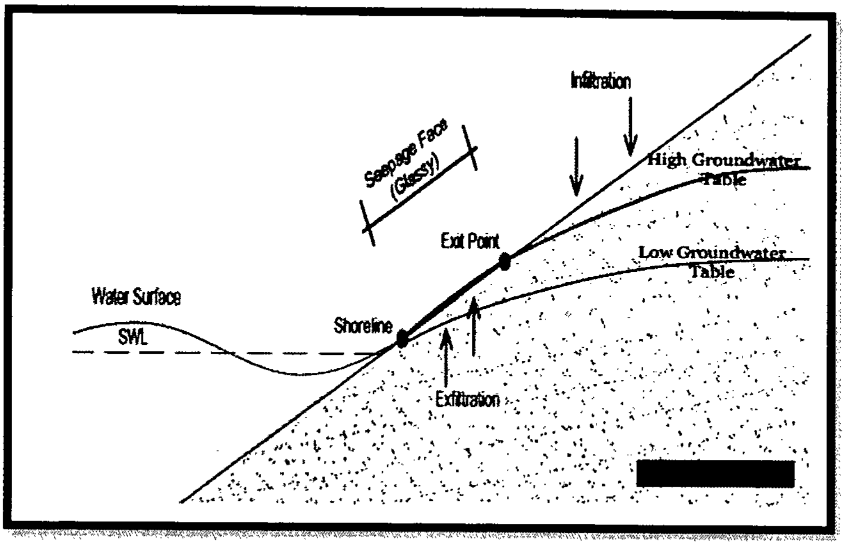

Figure 2.3: Infiltration and exfiltration during low and high groundwater

Source: Jamal (2011)

Figure 2.3 shows that the beach groundwater table position will affect the infiltration and exfiltration processes during the uprush an exfiltration. When the uprush reaches the beach face above the watertable's exit point, the uprush volume, depth and velocity will consequently decrease when the water infiltrate into the bed. However, during the lower exit point (saturated condition) it is totally different because the backwash flow will increase due to the groundwater seepage (Horn, 2006). The higher the groundwater level in the backshore, the higher the offshore sediment transport caused by reduction of the infiltration rate (Quick, 1991).

2.7 TIDES

Tides are movements of the oceans set up by the gravitational effects of the moon and the sun in relation to the earth. Approximately twice a month, the sun, moon and earth will more or less align to form either a full moon or a new moon. (Figure 2.4). They are very long waves that travel across the oceans and transmitted into bays, inlets, estuaries or lagoons around the world's coastline (Bird, 2011). Oceanic tides are indeed tidal waves, but this term has been widely misused as a synonym for tsunamis, which are large wave generated by tectonic events. During each phase of a new moon or a full