# ASSESSMENT OF BEACH MORPHOLOGICAL CHANGES AT PANTAI SEPAT

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# ASSESSMENT OF BEACH MORPHOLOGICAL CHANGES AT PANTAI SEPAT

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Thesis submitted in fulfillment of the requirements
for the award of the
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## ABSTRAK

Analisis morfologi pantai dapat menentukan profil atau sifat-sifat fizikal pantai dan dengan itu mendapatkan maklumat mengenai trend jangka pendek (pertambahan dan hakisan) kawasan pesisir. Proses hakisan dan pertambahan dipergiatkan dengan adanya kesan variasi bermusim. Kawasan kajian dijalankan di Pantai Sepat, yang terletak di daerah Pekan, menghadap ke Laut China Selatan. Kawasan kajian boleh dikategorikan sebagai kawasan pantai berpasir semula jadi. Tidak seperti pantai yang meluncur ke laut untuk beberapa meter dan tiba-tiba jatuh mendalam, pantai Pantai Sepat nampak lereng sangat perlahan ke arah laut. Beberapa profil pantai dipantau kira-kira setiap dua minggu bermula dari 20 November 2017 sehingga 28 Mac 2018 dengan menggunakan stesen total dengan mengumpul jarak mendatar dan jarak menegak dalam satu garis lurus tetap. Penanda aras sementara telah dikenalpasti dan dirujuk kepada pasang surut sebelum kerja-kerja mula mendapatkan jarak jauh semasa air surut. Tolok hujan dipasang di kawasan kajian di UMP Pekan. Kemudian, data hujan yang dicatatkan dianalisis untuk mengkaji kesan corak hujan ke perubahan morfologi pantai. Dari data hujan, jumlah kedalaman hujan untuk tempoh kajian (128 hari) adalah 1573.9 mm dengan data harian maksimum dicatatkan sebagai 256.2 mm pada 12 Januari 2018 dengan kedalaman hujan 256.2 mm dan kira-kira 60 hari dicatatkan tanpa hujan. Untuk taburan hujan bulanan, Januari 2018 direkodkan sebagai bulan paling basah dengan kedalaman hujan 771.2 mm. Sementara itu, pada bulan Februari 2018 dikenalpasti sebagai bulan kering dengan ketinggian hujan 19.7 mm. Analisis profil pantai berasaskan, proses hakisan berlaku di bahagian atas dan tengah sementara proses pertambahan terjadi di bahagian bawah pantai. Kadar hakisan tertinggi berlaku pada 19 Januari 2018 kerana kedalaman hujan tertinggi yang dikumpulkan dari 1 Januari 2018 hingga 18 Januari 2018 dan kedalaman 747 mm manakala kadar pertambahan tertinggi berlaku pada 28 Februari 2018 yang dipengaruhi oleh terendah kedalaman hujan dikumpulkan dari 15 Februari 2018 sehingga 28 Februari 2018 sebanyak 9.2 mm sahaja. Ujian analisis saringan juga dijalankan untuk menentukan saiz pengedaran D50 setiap dua minggu sepanjang tempoh kajian berdasarkan tiga bahagian yang berbeza iaitu bahagian atas, tengah dan bawah. Saiz zarah terbesar ialah 0.28 mm pada bahagian atas pada 28 Mac, 2018 manakala saiz zarah terbaik ialah 0.11 mm pada bahagian bawah yang dikutip pada 4 Disember 2017. Sebagai kesimpulan, profil pantai di kawasan kajian telah terjejas oleh corak taburan hujan yang banyak terhakis semasa tempoh basah (Disember 2017 hingga Januari 2018) dan meningkat dalam tempoh kering (Febuari 2018 hingga Mac 2018). Sementara itu, untuk saiz zarah pantai, D50 telah menunjukkan saiz terbesar di bahagian atas dan yang terbaik di bahagian bawah profil pantai sepanjang tempoh kajian.

## ABSTRACT

Analysis of beach morphology can determine the profile or physical attributes of a beach and thus obtain information about the short term trends (accretion and erosion) of coastal area. The processes of erosion and accretion are further intensified with the presence of seasonal variations effects. The study area was conducted at Pantai Sepat, which located in district of Pekan, facing the South China Sea view. The study area can be categorized as natural sandy beach area. Unlike beaches which slope to the sea for a few meters and then suddenly drop deep, Pantai Sepat beach seems to slope very gradually toward the sea. Several beach profiles were monitored approximately every two weeks start from November 20, 2017 until March 28, 2018 by using a total station by collecting horizontal distance and vertical distance in one fixed straight line. The temporary benchmark was identified and referred to sea tidal before the works started to get a long distance during a low tide. The rain gauge was installed at the study area in UMP Pekan. Then, the recorded rainfall data was analysed in order to investigate the effect of rainfall patterns to beach morphological changes. From rainfall data, the total rainfall depth for period of the study (128 days) is 1573.9 mm with the maximum daily data was recorded as 256.2 mm on 12 January 2018 with 256.2 mm rainfall depth and about 60 days were recorded as no rainfall. For monthly rainfall distribution, January 2018 was recorded as the wettest month with rainfall depth 771.2 mm. Meanwhile, February 2018 was identified as the driest month with 19.7 mm rainfall depth. Based beach profiles analysis, the erosion process was occurred at the upper and middle part while the accretion process was occur at the lower part of the beach. The highest rate of erosion occurred on January 19, 2018 because of the highest of rainfall depth collected from January 1, 2018 until January 18, 2018 as much as 747 mm depth while the highest rate of accretion occurred on February 28, 2018 affected by the lowest of rainfall depth collected from February 15, 2018 until February 28, 2018 as much as 9.2 mm only. Sieve analysis test also was conducted to determine the size of distribution $D_{50}$ every two weeks along the study period based on three different parts which is upper, middle and lower. The biggest size of particle is 0.28 mm at upper part on March 28, 2018 while the finest size of particle is 0.11 mm at lower part which is collected on December 4, 2017. As conclusion, beach profile at the study area was highly affected by the patterns of rainfall distribution which were significantly eroded during the wet period (December 2017 to January 2018) and accreted within dry period (February 2018 to March 2018). Meanwhile, for the particles size of the beach, $D_{50}$ were shown the biggest size at the upper part and the finest at the lower part of the beach profile along the study period.

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## LIST OF SYMBOLS

| | |
|---|---|
| % | Percentage |
| m | metre |
| mm | Millimetre |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| ASTM | American Standard Testing Manual |
| BSCS | British Soil Classification System |
| BS | British Standard |
| $D_{50}$ | Medium size of sand |
| HMC | High Magnesian Calcite |
| Ar | Aragonite |

## CHAPTER 1

## INTRODUCTION

### 1.1 Background of Study

Beach consists of a narrow backshore and foreshore. Based on Figure 1.1, there are many physical changes that always occur for the beach bed such as ripples, flat bed, dunes and ripples, chutes and pools. Beach morphology refers to the prevailing morphology of a beach, including the waves and currents, the extent of the near shore zone, the width and shape of the surf zone, including its bars and troughs, and the dry or sub aerial beach.

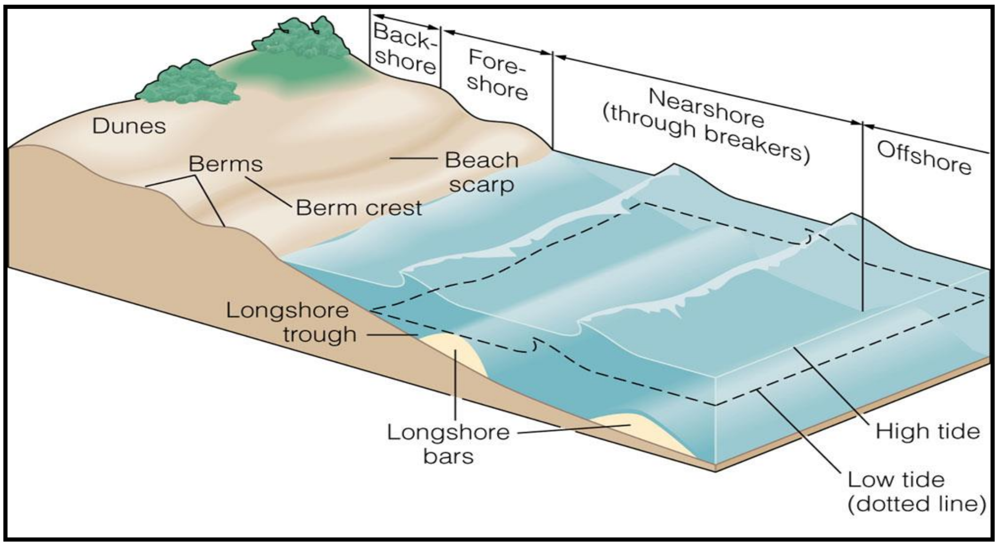


Figure 1.1 Beach Topography

Source: Arnott (2009).

The height and width of the beach are influenced by the tides of the sea, which lies between land and sea. It is the physical characteristics of a formal combine to form a physical division that operates. The morphology of the coastal system unit composed of coastal slopes, the distribution of the grain of sand, strength of waves, currents and tides that make up the coastal morphology. One element will change if other part is changing.

There are several factors that affect the coastal morphology such as types of soil, changes in the rise and fall of sea level, as well as sedimentary origin of the river, land erosion and wind. Beaches in Malaysia are very beautiful which are suitable for both leisure and family activities. There are many attractive beaches in Malaysia that can attract foreign tourists to Malaysia such as Port Dickson and Cherating. In addition, there are also clean beaches behind islands such as Langkawi, Pulau Kapas and Pulau Tioman. These beaches are called as sandy beach. Sandy beaches are composed of particles coming from eroded coral reefs in the ocean, sediment from the sea floor, and/or eroded rocks from nearby cliffs.

Climate is generally defined as average weather, and as such, climate change and weather are intertwined. Observations can show that there have been changes in weather, and it is the statistics of changes in weather over time that identify climate change. While weather and climate are closely related, there are important differences. In Malaysia there is almost no seasonal changes in climate, but there are existing of wet and dry periods. However, the climate of Malaysia is different and depending on which region you are. In the South of the Malacca and Kalimantan the climate is Equatorial, hot and humid, to the North – subequatorial monsoon. Monsoon winds blow towards the southwest from April to October and from October to February in the North-East of the country. During monsoon period in the North-Eastern coast of Malacca sometimes stops sea tourism. Strong, but brief rains throughout the year, so the rainy season as such in Malaysia.

On the West coast of Malaysia (Langkawi, Penang, Pangkor) the rainy season is not pronounced and almost falls from May to September; in April, May and October on the West coast of the Peninsula fall thunderstorms. On the East coast (Tioman Island, Redang) a more pronounced rainy season lasts from October to March. The rainy season is celebrated torrential rains continuing for two or three hours, they are usually in the afternoon. Because of the higher rainfall evergreen jungle on the East and the river network is very deep, though, and consists of short rivers. It also effects the changes of beach profile. In mountainous areas, the rains are often because the high peaks are constantly cloudy. In General, rainfall in Malaysia is about 2000 mm per year, in the mountains reaches 5000 mm (Mohtar et al., 2015).

## 1.2 Problem Statement

The aim of this study was to study the changes of beach profile and analyse the beach behaviour due to rainfall effect. Besides, this study also to investigate about beach erosion and accretion processes due to seasonal changes in Pantai Sepat. Beach erosion involves the breaking down and removal of material along a coastline by the movement of wind and water. It leads to the formation of many landforms, combined with deposition and plays an important role in shaping the coastline. Beach sand can be different colours depending on what type of rock formed the sand. When a wave impacts a cliff face, air is forced into cracks under high pressure, widening them. Over long periods of time, the growing cracks destabilise the cliff and fragments of rock break off of it.

Seasonal changes in beach profiles discusses the natural variability in beach shape throughout the year. One of the most obvious changes in the coastal environment is that of the beach morphology, often quantified as the beach profile, which represents the shape of the topographic surface of the beach created by slicing through the beach from the offshore region to beyond the dunes. Beaches profiles change their shape by adjusting to the forcing conditions of the ocean (i.e. waves, tides, wind, and the resulting near shore currents).

## 1.3 Objectives

The objectives of the study are:

i. To determines morphological changes at Pantai Sepat.

ii. To investigate the rainfall effect on the beach profile changes.

iii. To evaluate the coastal erosion and accretion processes due to seasonal changes.

## 1.4 Scope of Study

This study was focused on beach morphological monitoring as stated in the objective of the study. In order to achieve these objectives, several tools were used in the project such as total station, to determine the distance and level of the beach surface and rain gauge that was set up in UMP Pekan to collect rainfall data and total station is. The recorded rainfall data was used to determine the wet and dry period for beach profile analyses while morphological data from the survey works are for the beach profile assessment.

## 1.5 Significance of Study

This study is important to understand the relationship between rainfall events during wet and dry periods towards beach morphological changes. The study was focused on the pattern of rainfall events in the study area during dry and wet periods. These patterns were analysed with the beach morphology changes. It has aimed to improve the technical understanding of different parameters and processes that contribute to development in the future.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Introduction

Understanding beach morphology changes is important in regions where there is a large amount of recreation and development. Morphology is defined as the study of the physical form of landscape, including how structure operate, the adaptability of structural features, the dominant functions of a given structure change over time (Merriam-Webster, 2018). The purposes of this study are to determine the rate of erosion and accretion processes and to investigate the beach profile changes. This project was conducted during dry and wet season by collecting data in fieldwork. As a result, it is can be expected that the differences for beaches morphological changes vary between dry and wet season due to hydrological effects.

## 2.2 Beach Definition

A deposit of non-cohesive material (i.e. sand, gravel) which situated on the interface between dry land and the sea or other large expanse of water and actively worked by present day hydrodynamics processes (i.e. waves and tides) sometimes by winds (Merriam-Webster, 2018). The zone of unconsolidated material that extends landward from the low water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation.

The seaward limit of a beach unless otherwise specified is the mean low water line. A beach includes foreshore and backshore that waves abutting to sea cliff or structure. The zone of unconsolidated material that is moved by waves, wind and tidal currents, extending landward to the coastline.

### 2.2.1 Beach Geography

Beach geography is the study of the dynamic interface between the ocean and the land, incorporating both the physical geography (i.e. coastal geomorphology, geology and oceanography) and the human geography (sociology and history) of the coast (Merriam-Webster, 2018). It involves an understanding of coastal weathering processes, particularly wave actions and also the ways in which humans interact with the coast.

### 2.2.2 Shore

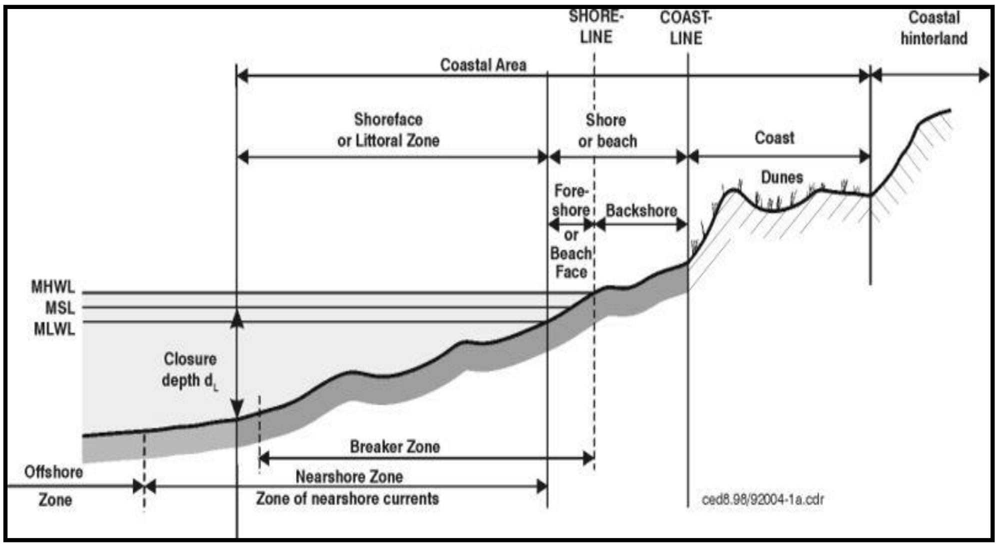


Figure 2.1 Coastal profile

Source: Mangor (2018).

The intersection of a specified plane of water with the shore. All of the water areas of the state, including reservoirs and their associated uplands, together with the lands underlying them. It also included the development of strategic, long-term and sustainable coastal defence and land-use policy within a sediment cell (US-IOTWS, 2007). A terrace made along a coast by the action of waves and shore currents, it may become land by the uplifting of the shore or the lowering of the water. That strip of ground bordering any body of water which is alternately exposed, or covered by tides and waves. The narrow zone seaward from the low tide shoreline permanently covered by water, over which the beach sands and gravels actively oscillate with changing wave conditions (Hazards, 2010).

Figure 2.1 shows the shoreline changes have been documented by many researchers around the globe and it is dominated with erosion especially at coastal areas where at least 70 % of the world's sandy beaches are affected (Marx, 2012). In Malaysia, almost 30 % of its coastline experienced critical coastal erosions (shore-based facilities or infrastructures are in danger of collapse/damage) especially in Sabah which experienced the longest coastal erosion compared to other states (Nakajima *et al.*, 2015).

Shoreline changes related to beach processes (accretion and erosion) happen along the shore. These can be classified into three parts which are long-term changes, short-term changes and episodic changes. These classifications provide a picture on how the shoreline has changed in a certain period of time and illustrate the most dynamic areas along the shoreline (Burningham & French, 2017). Long-term beach changes occur for between ten to thousands of years. It is caused by any activity that can significantly alter the sea level (rise or fall) and tectonic activities which lead to subsidence or emergence of coastal land (MIMURA, 2013). Short-term hanges occur within 5 to 10 years or several seasons. The beach responds to smaller scale events such as winds, coastal waves, currents and tides. Episodic changes only occur in response to a single storm and it usually causes more beach changes compared to long-term and short-term changes (Koiting et al., 2017). Based on Figure 1.3, it described all the beach parts.

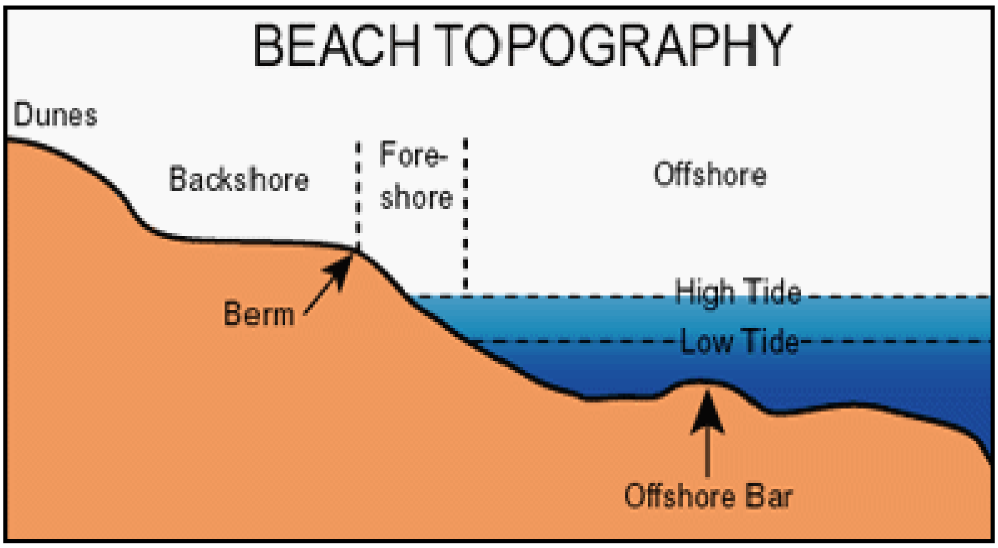


Figure 2.2 Beach topography

Source: MIMURA (2013).

### 2.2.3 Foreshore

The part of the shore, lying between the berm crest and the ordinary low water mark, which is ordinarily traversed by the uprush and backwash of the waves as the tides rise and fall ("Studies on beach morphological changes using numerical models," n.d.). The foreshore can be said to be the part of the beach, which is wet due to the varying tide and wave run-up under normal conditions, i.e., excluding the impact of extreme storm waves and storm surge (Brooks et al., 2017). The same as the beach face where unconsolidated material is present. In general terms, the beach between mean higher high water and mean lower low water.

### 2.2.4 Backshore

The upper part of the active beach above the normal reach of the tides (high water), but affected by large waves occurring during a high. The accretion or erosion zone, located landward of ordinary high tide, which is normally wetted only by storm tides (Xie et al., 2013). The area of a shore that lies between the average high tide mark and the vegetation. The backshore is affected by waves only during severe storms compare to foreshore (Brooks et al., 2017).

### 2.2.5 Wave

An oscillatory movement in a body of water manifested by an alternate rise and fall of the surface. A disturbance of the surface of a liquid body, as the ocean, in the form of a ridge, swell or hump. The term wave by itself usually refers to the term surface gravity wave that is progressive. Wave base is the plane or depth to which waves may erode the bottom in shallow water. Wave climate is the average condition of the waves at a place, over a period of years, as shown by height, period, direction, etc (Arnott, 2009).

Wave crest is the highest part of the wave. That part of the wave above still water level. It develop short crested wave which is of the same order of magnitude as the wave length. A system of short-crested waves has the appearance of hills being separated by troughs as shown in Figure 2.3.

Figure 2.3 Wave

Source: Arnott (2009).

## 2.3 Type of Beach

The beach is a subjective place. It is used as a tourist, resort and holiday destination. There are many types of beaches in this world such sandy beach, beach rock, pocket beach, raised beach and etc.

### 2.3.1 Sandy beach

A beach is a landform alongside a body of water which consists of loose particles. The particles composing a beach are typically made from rock, such as sand, gravel, shingle, pebbles, or cobblestones. The particles can also be biological in origin, such as mollusc shells or coralline algae.

Malaysia is home to many of the world's most pristine and sandy beaches. Its expansive coral beaches produce pure, snow-white sand which sits in dazzling contrast to the crystal blue waters of its shorelines. Many of these waters are teeming with exotic marine life, much of which cannot be found anywhere else on earth. The west coast has relatively few of the classic golden sand beaches. This is because much of the shore is lined with mangrove forests or muddy swamps and many of Malaysia's mighty rivers, flowing westwards into the Straits of Malacca, deposit their silt, sediment and vegetation onto the muddy shorelines.

Furthermore, being one of the world's busiest shipping lanes, there is a fair amount of rubbish and pollution which washes ashore. Next there is Penang, a booming economic powerhouse with a large population, a dynamic industrial and commercial hub, a UNESCO World Heritage site (Georgetown) and some beautiful beaches including the famous Batu Ferringhi.

Further south there is Pulau Pangkor, a scenic island with a more tranquil atmosphere. The island boasts some sparkling sand beaches such as Teluk Nipah, secluded coves and an active fishing community. Closer to Kuala Lumpur you can explore colourful islands such as Pulau Carey, Pulau Ketam (Crab Island) and Pulau Indah. There are no beautiful beaches here but they are all interesting in their own way.Port Dickson is the closest sandy beach to Kuala Lumpur and for that reason is very popular with local and foreign visitors alike. The east coast of Peninsular Malaysia is essentially one continuous sandy beach from Kota Bharu to Kuala Terengganu to Kuantan so you are spoilt for choice. Cherating is one of the more famous stretches of beach on this coast where you can ocean kayak, sail and windsurf.

Due to its climate, many of Malaysia's beaches sit right at the forest wall of Malaysia's majestic, lush rainforests, meaning that you can hike the jungles and go scuba diving all in the same adventurous afternoon. Other activities handily available at many of Malaysia's beaches include jet-skiing, snorkelling, deep sea fishing, or just relaxing on the beach and taking in the gorgeous panoramic view afforded at the ocean's edge (Nakajima et al., 2015).

Figure 2.4 Sandy beach

Source: Nakajima (2015).

### 2.3.2 Beach Ridge

A beach ridge is a wave-swept or wave-deposited ridge running parallel to a shoreline. Referred to Figure 2.5, it is commonly composed of sand as well as sediment worked from underlying beach material. The movement of sediment by wave action is called littoral transport. Movement of material parallel to the shoreline is called long shore transport (Otvos, 2000). Movement perpendicular to the shore is called on-offshore transport. A beach ridge may be capped by, or associated with, sand dunes. The height of a beach ridge is affected by wave size and energy.

A fall in water level (or an uplift of land) can isolate a beach ridge from the body of water that created it. Isolated beach ridges may be found along dry lakes in the western United States and inland of the Great Lakes of North America, where they formed at the end of the last ice age when lake levels were much higher due to glacial melting and obstructed outflow caused by glacial ice (Hesp et al., 2005).

Some isolated beach ridges are found in parts of Scandinavia, where glacial melting relieved pressure on land masses and resulted in subsequent crustal lifting or post-glacial rebound. A rise in water level can submerge beach ridges created at an earlier stage, causing them to erode and become less distinct. Beach ridges can become routes for roads and trails.

Beach ridges, frequent components of Quaternary coastal plains, and other coastal landforms, have been cited as indicators of the positions of ancient seashores and associated sea levels. Numerous authors utilized the term beach ridge for active and relict, usually wave-built supratidal andror intertidal forms. Wind-built ridges have been only occasionally included in the definition. The term was applied also to submerged, landward-shifting, eventually stranded bars. A consistent redefinition of the term is highly desirable. Beach ridges should include all relict strandplain ridges, whether dominated by waver swash-built or by eolian lithosomes. All active ridge-like shore features, regardless of dimensions, morphology, and origin are excluded (Pikelj et al., 2018).

Because of the resistance of coarse-clastic ridges to wave and wind erosion, swash-built gravel or coarse shell ‘‘storm’’ ridges may build several meters above the level of high tide. Swash-built high berms, even on pure sandy beaches, exceed the highest tides during episodes of wind-induced, record water levels. Frequently but not always burying underlying low-relief ‘‘berm ridges’’ of berm lithosomes, sequences of relatively steep multiple foredunes are commonly named beach ridge plains. The narrow, subparallel relict foredunes that form these strandplains presently are designated as eolian beach ridges. Beach ridges, thus, are defined as relict, semiparallel, multiple wave- and wind-built landforms that originated in the inter- and supratidal zones. Until separated from the shoreline by progradation, sandy, pebbly or shell-enriched backshore berm ridges behind an active foreshore should not be considered beach ridges (Otvos, 2000).

Figure 2.5 Beach ridge

Source: Otvos (2000).

### 2.3.3 Beach Rock

Beach rock is a friable to well-cemented sedimentary rock that consists of a variable mixture of gravel-, sand-, and silt-sized sediment that is cemented with carbonate minerals and has formed along a shoreline as shown in Figure 2.6. Depending on location, the sediment that is cemented to form beach rock can consist of a variable mixture of shells, coral fragments, rock fragments of different types, and other materials. Beach rock typically forms within the intertidal zone within tropical or semi tropical regions (Vousdoukas, 2012).

Beach rocks are hard coastal sedimentary formations consisting of various beach sediments through the precipitation of carbonate cements. The objectives of this contribution are to collate and review information on the reported occurrences, characteristics and formation mechanisms of beach rocks and consider their impacts on the coastal zone. The analysis of the available information has shown that beach rock formation is a global and diachronic phenomenon and the great majority of beach rocks are found in tropical or subtropical and low temperate coasts. The cementing agents of beach rocks are composed predominantly of the metastable carbonate phases High Magnesian Calcite (HMC) and Aragonite (Ar), appearing in a diverse crystalline morphology. It has been suggested that cement precipitation in the coastal environment is controlled by the physicochemical conditions the presence of organic compounds and microbes the magnitude and distribution of the wave energy along the coast; and the textural characteristics of the constituent sediments (Chandrasekaran et al., 2015). Various theories have been proposed to explain beach rock formation itself, linking the phenomenon to either physicochemical or biological processes. These theories, however, do not seem to be of universal validity and acceptance, as each is able to explain only some of the reported occurrences. The presence of beach rocks appears to affect beach by 'locking' the beach profile modifying the near shore hydrodynamics changing the porous character of the beach and, thus, its response to wave forcing; and differential bed erosion at the margins of the beach rock outcrops that can alter significantly the long- and, particularly, the cross-shore sediment transport. Therefore, although relict submerged beach rock outcrops may provide some coastal protection by reducing the wave energy impinging onto the coastline, modern beach rocks may promote offshore loss of unconsolidated beach sediments and buried beach rock outcropping. Finally, the presence of beach rocks may have also significant ecological impacts, as the indigenous (mobile substrate) fauna and flora of the beach is replaced by hard substrate benthic assemblages, which are commonly arranged in hydrodynamically-controlled zones (Vousdoukas, 2012).

They also seem to have a general inclination to the sea. There are several appearances of beach rock formations which are characterized by multiple cracks and gaps. The length of beach rocks varies from meters to kilo meters, its width can reach up to 300 meters and its height starts from 30 cm and reaches 3 meters. Following the process of coastal erosion, beach rock formation may be uncovered. Coastal erosion may be the result of sea level rise or deficit in sedimentary equilibrium. One way or another, unconsolidated sand that covers the beach rock draws away and the formation is revealed (Chu et al., 2015). If the process of cementation continues, new beach rock would be formed in a new position in the intertidal zone. Successive phases of sea level change may result in sequential zones of beach rock.

Beach rocks are located along the coastline in a parallel term and they are usually a few meters offshore. They are generally separated in several levels which may correspond to different generations of beach rock cementation. Thus, the older zones are located in the outer part of the formation when the younger ones are on the side of the beach, possibly under the unconsolidated sand.

Figure 2.6 Beach rock

Source: Vousdoukas (2012).

### 2.3.4 Pocket Beach

Pocket beach is usually a small beach, between two headlands. In an idealized setting, there is very little or no exchange of sediment between the pocket beach and the adjacent shorelines as shown in Figure 2.7. Pocket beach can be natural or artificial. Many natural pocket beaches exist throughout the world. Artificial pocket beaches are usually constructed in areas where natural beaches are fairly narrow or absent. Additionally, there have been many pocket beaches constructed in the Caribbean where resorts have been developed along rocky shorelines with minimal natural beaches (Turki et al., 2013).

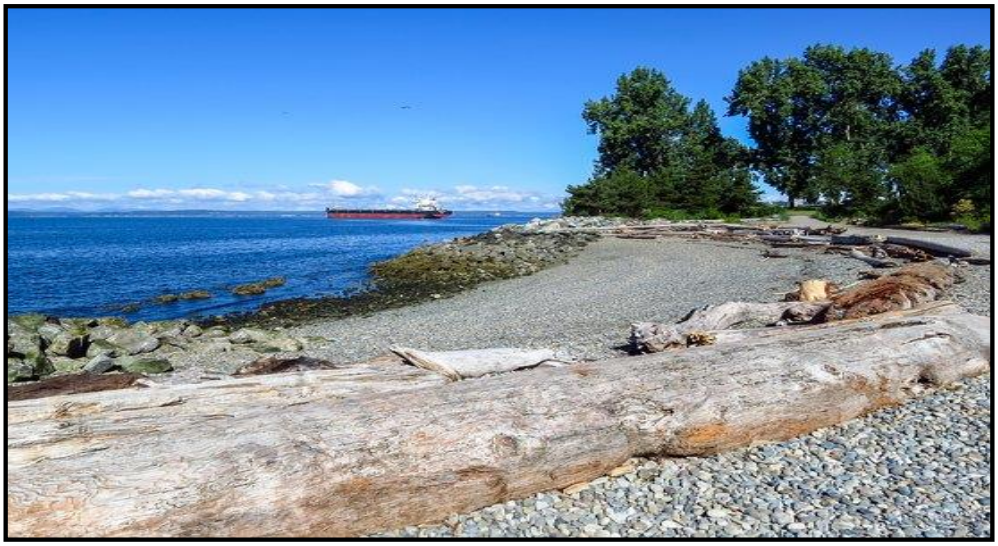

Figure 2.7 Pocket beach

Source: Turki (2013).

### 2.3.5 Shell Beach

A "shell beach" is a sea beach that routinely has an unusually large accumulation of seashells washed up on it as shown in Figure 2.8. Seashells are most often the dead empty shells of marine mollusks, but may also include tests or shells of other kinds of marine animals. The majority of beaches in the world are primarily composed of rock particles such as sand, grit, gravel and pebbles but in rare cases a beach can be composed entirely of seashells, both broken and whole valves.

Figure 2.8 Shell beach

Source: Turki (2013).

### 2.3.6 Shingle Beach

Shingle is coarse beach material that is on the whole more common in previously glaciated areas, where many of the stones are derived from glacial and fluvioglacial deposits as referred to Figure 2.9. Marine shingle becomes well rounded, and usually consists of resistant rocks, such as flint, quartzite, granite, and sandstone (Arnott, 2009). On a beach, shingle tends to be moved to the top of the beach, where it occurs mixed with sand, forming a steep bank near the high water level. A typical shingle beach has a ridge at the level of the level of the extreme storm wave action and minor ridges at lower elevations marking the levels of lesser storms or lower tides. A terrace commonly occurs at the low tide level. A shingle beach is a beach which is armoured with pebbles or small- to medium sized cobbles (as opposed to fine sand).

Typically, the stone composition may grade from characteristic sizes ranging from 2 to 200 mm (0.1 to 7.9 in) diameter. While this beach landform is most commonly found in Europe, examples are found in Bahrain, North America and in a number of other world regions, such as the shingle beach in Batanes, Philippine, where they are associated with the shingle fans of braided rivers. Though created at shorelines, post-glacial rebound can raise shingle beaches as high as 200 m (660 ft) above sea level, at the High Coast in

Sweden. The ecosystems formed by this unique association of rock and sand allow colonization by a variety of rare and endangered species.

Figure 2.9 Shingle beach

Source: Arnott (2009).

### 2.3.7 Storm Beach

These are associated with large spring tides, where, due to the time of greatest gravitational pull tides are highest. Some material is thrown up and beyond the usual high water mark because of the large waves. The material remains at the top of the beach if it is not pulled back down the beach by 'swash'. Storm beaches are more common on steep shingle beaches that are affected by destructive waves (Arnott, 2016). A storm beach is a beach affected by particularly fierce waves, usually with a very long fetch as refer to Figure 2.10. The resultant landform is often a very steep beach (up to 45°C) composed of rounded cobbles, shingle and occasionally sand. The stones usually have an obvious grading of pebbles, from large to small, with the larger diameter stones typically arrayed at the highest beach elevations. It may also contain many small parts of shipwrecked boats.

Figure 2.10 Storm beach

Source: Arnott (2009).

## 2.4 Beach Erosion

Coastal erosion is the wearing away of land and the removal of beach or dune sediments by wave action, tidal currents, wave currents, drainage or high winds (see also beach evolution) as shown to Figure 2.11. Waves, generated by storms, wind, or fast moving motor craft, cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments; erosion in one location may result in accretion nearby. The study of erosion and sediment redistribution is called 'beach morphodynamics' (Loureiro et al., 2013). It may be caused by hydraulic action, abrasion, impact and corrosion.

On non-rocky coasts, coastal erosion results in dramatic (or non-dramatic) rock formations in areas where the coastline contains rock layers or fracture zones with varying resistance to erosion (Dribek & Voltaire, 2017). Softer areas become eroded much faster than harder ones, which typically result in landforms such as tunnels, bridges, columns, and pillars. Also abrasion commonly happens in areas where there are strong winds, loose sand, and soft rocks. The blowing of millions of sharp sand grains creates a sandblasting effect. This effect helps to erode, smooth and polish rocks.

Figure 2.11 Beach erosion at Pantai Sepat

### 2.4.1 Factors of Beach Erosion

The ability of waves to cause erosion of the cliff face depends on many factors. The hardness (or inversely, the erodibility) of sea-facing rocks is controlled by the rock strength and the presence of fissures, fractures, and beds of non-cohesive materials such as silt and fine sand. The rate at which cliff fall debris is removed from the foreshore depends on the power of the waves crossing the beach (Özölçer, 2008). This energy must reach a critical level to remove material from the debris lobe. Debris lobes can be very persistent and can take many years to completely disappear.

Beaches dissipate wave energy on the foreshore and provide a measure of protection to the adjoining land. The stability of the foreshore is its resistance to lowering. Once stable, the foreshore should widen and become more effective at dissipating the wave energy, so that fewer and less powerful waves reach beyond it (Arnott, 2009). The provision of up drift material coming onto the foreshore beneath the cliff helps to ensure a stable beach.

The adjacent bathymetry, or configuration of the seafloor, controls the wave energy arriving at the coast, and can have an important influence on the rate of cliff erosion (Özölçer, 2008). Shoals and bars offer protection from wave erosion by causing storm waves to break and dissipate their energy before reaching the shore. Given the dynamic nature of the seafloor, changes in the location of shoals and bars may cause the locus of beach or cliff erosion to change position along the shore (Koiting et al., 2017).

Beach erosion has been greatly affected by the rising sea levels globally. There has been a great measure of increased coastal erosion on the Eastern seaboard of the Malaysia. Locations such as Pantai Cahaya Bulan, Kelantan have noticed increased coastal erosion. In reaction to these increases Pantai Cahaya Bulan and its individual counties have increased budgets to replenish the eroded sands that attract visitors to Kelantan and help support its multibillion-dollar tourism industries.

The secondary factors are:

i. Weathering and transport slope processes

ii. Slope hydrology

iii. Vegetation

iv. Cliff foot erosion

v. Human Activity

The tertiary factors are:

i. Resource extraction

ii. Coastal management

### 2.4.2 Flat Coast

At a flat coast or flat shoreline, the land descends gradually into the sea. Flat coasts can be formed either as a result of the sea advancing into gently-sloping terrain or through the abrasion of loose rock as shown to Figure 2.3. They may be basically divided into two parallel strips: the shore face and the beach (Yu et al., 2017). Flat coasts consist of loose material such as sand and gravel. Wind transports finer grains of sand inland over the dunes. The sea washes pebbles and sand away from the coast and dumps it at other locations.

Beaches are usually heavily eroded during storm surges and the beach profile steepened, whereas normal wave action on flat coasts tends to raise the beach (Pikelj et al., 2018). Not infrequently a whole series of parallel berms is formed, one behind the other. There is a consequent gradual increase in height with the result that, over time, the shoreline advances seawards.

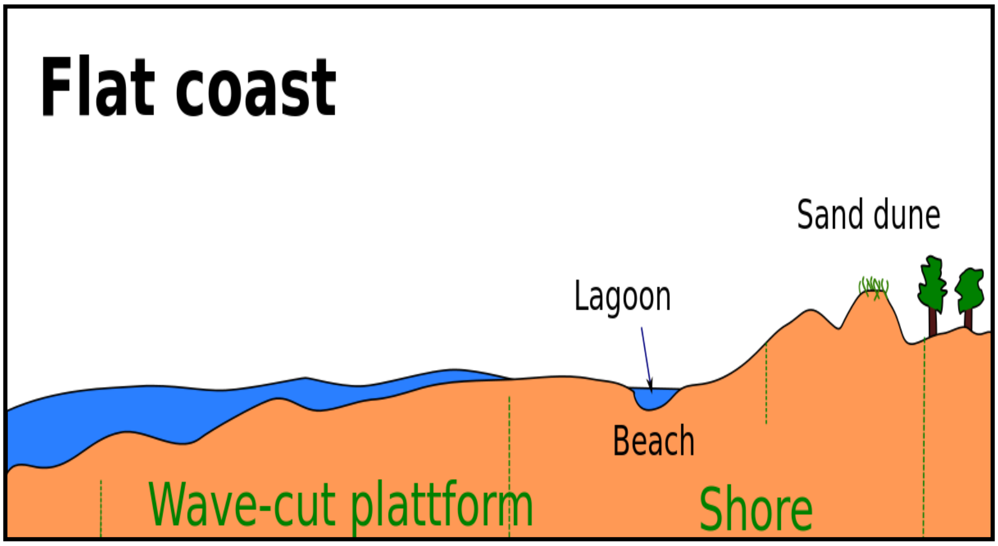


Figure 2.12 Flat coast

Source: Yu (2017).

### 2.4.3 Graded Shoreline

A graded shoreline is a stage in the cycle of coastal development characterised by a flat and straight coastline. It is formed under the influence of wind and water from the original bays, islands, peninsulas and promontories. Sand and gravel is carried away and dumped at other locations depending on the direction and strength of sea currents (Pagán et al., 2018). Typical of graded shorelines are the formation of dunes, wide sandy beaches and sometimes a lagoon or a spit. Where two graded shorelines meet, a headland may form with a sandy reef in the sea beyond it. Parallel to the graded shoreline sandbanks may form as a result of sediments transported away from the shore (Burningham & French, 2017).

### 2.4.4 Large Scale Behaviour

Large-scale coastal behaviour is an attempt to model the morphodynamics of beach change at time and space scales appropriate to management and prediction (Loureiro et al., 2013). Temporally this is at the decade to century scale, spatially at the scale of tens of kilo meters. Modelling large-scale coastal behaviour involves some level of parameterisation rather than simply up scaling from process or downscaling from the geological scale. It attempts to recognise patterns occurring at these scales.

### 2.4.5 Long shore Drift

Long shore drift is a geographical process that consists of the transportation of sediments (clay, silt, sand and shingle) along a coast at an angle to the shoreline, which is dependent on prevailing wind direction, swash and backwash (Turki et al., 2013). This process occurs in the littoral zone, and in or close to the surf zone. The process is also known as littoral drift, long shore current or long shore transport.

Long shore drift is influenced by numerous aspects of the coastal system, with processes that occur within the surf zone largely influencing the deposition and erosion of sediments. Long shore currents can generate oblique breaking waves which result in long shore transport (Arnott, 2009). It affects numerous sediment sizes as it works in slightly different ways depending on the sediment such as the difference in long shore drift of sediments from a sandy beach to that of sediments from a shingle beach. Sand is largely affected by the oscillatory force of breaking waves, the motion of sediment due to the impact of breaking waves and bed shear from long shore current. Because shingle beaches are much steeper than sandy ones, plunging breakers are more likely to form, causing the majority of long shore transport to occur in the swash zone, due to a lack of an extended surf zone.

### 2.4.6 Raised Shoreline

A raised shoreline is an ancient shoreline exposed above current water level. These landforms are formed by a relative change in sea level due to global sea level rise, isostatic rebound, and/or tectonic uplift (Burningham & French, 2017). These surfaces are usually exposed above modern sea level when a heavily glaciated area experiences a glacial retreat, causing water levels to rise. This area will then experience post-glacial rebound, effectively raising the shoreline surface.

### 2.4.7 Rip Current

A rip current, commonly referred to simply as a rip, or by the misnomer "rip tide", is one specific kind of water current that can be found near beaches. It is a strong, localized, and rather narrow current of water. It is strongest near the surface of the water, and it moves directly away from the shore, cutting through the lines of breaking waves. All situation of rip current was described in Figure 2.13.

Rip currents can occur at any beach where there are breaking waves on oceans, seas, and large lakes. The location of rip currents can be unpredictable: while some tend to recur always in the same place, others can appear and disappear suddenly at various locations near the beach. It was formed because breaking waves push water towards the land. Water that has been pushed up near the beach flows together (as feeder currents), and this water finds a place where it can flow back out to sea (Silva-Cavalcanti et al., 2018). The water then flows out at a right angle to the beach in a tight current called the "neck" of the rip, where the flow is most rapid. When the water in the rip current reaches outside of the lines of breaking waves, the flow loses power, and dissipates in what is known as the "head" of the rip. Sometimes tendrils of left-over current then actually curve back towards the shore.

It can be hazardous to people who are in the water. Swimmers or floaters who are caught in a rip and who do not understand what is going on, may not have the necessary water skills, may panic, or may exhaust themselves by trying to swim directly against the flow of water. It is not the same thing as undertow, although some people use the latter term when they mean a rip current. Contrary to popular belief, neither rip nor undertow can pull a person vertically down and hold them under the water surface a rip simply carries floating objects, including people, to an area outside the zone of the breaking waves.

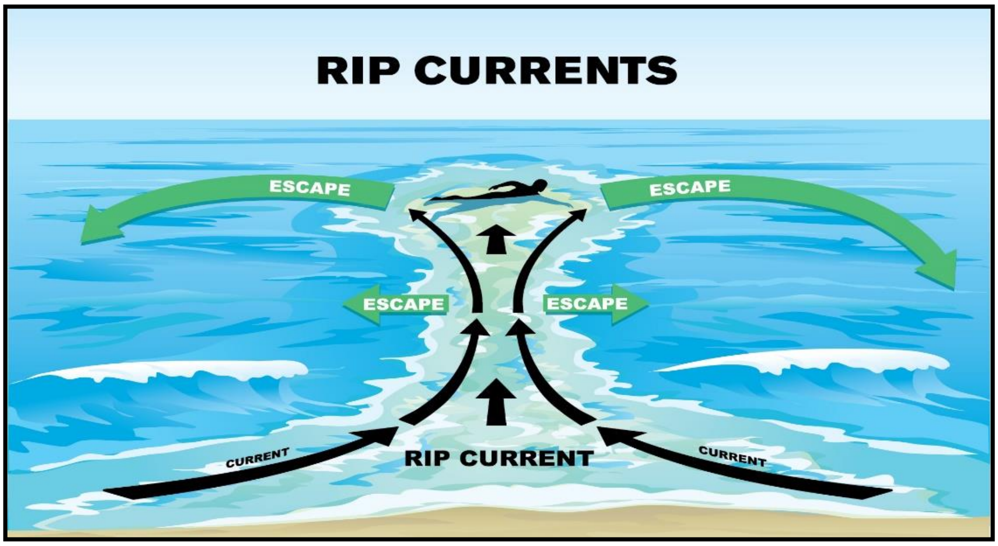


Figure 2.13 Rip currents

Source: Otvos (2000).

### 2.4.8 Rocky Shore

A rocky shore is an intertidal area of seacoasts where solid rock predominates. Rocky shores are biologically rich environments, and are a useful "natural laboratory" for studying intertidal ecology and other biological processes (Chandrasekaran et al., 2015). Due to their high accessibility, they have been well studied for a long time and their species are well known. There are a large number of factors that favour the survival of life on rocky shores. Temperate coastal waters are mixed by waves and convection, maintaining adequate availability of nutrients. Also, the sea brings plankton and broken organic matter in with each tide. The high availability of light (due to low depths) and nutrient levels means that primary productivity of seaweeds and algae can be very high. Human actions can also benefit rocky shores due to nutrient runoff.

Despite these favourable factors, there are also a number of challenges to marine organisms associated with the rocky shore ecosystem. Generally, the distribution of benthic species is limited by salinity, wave exposure, temperature, desiccation and general stress. The constant threat of desiccation during exposure at low tide can result in dehydration (Yu et al., 2017). Hence, many species have developed adaptations to prevent this drying out, such as the production of mucous layers and shells. Many species use shells and holdfasts to provide stability against strong wave actions. There are also a variety of other challenges such as temperature fluctuations due to tidal flow (resulting in exposure), changes in salinity and various ranges of illumination. Other threats include predation from birds and other marine organisms, as well as the effects of pollution.

### 2.5 Climate in Malaysia

Climatic characteristics of Malaysia are uniform temperature, humidity high and abundant rainfall. Winds are generally light. Malaysia, which is in the equatorial doldrums very rare to have a direct clear sky despite the severe drought. Malaysia is also rare to have a period of several days with no sunshine except during the northeast monsoon season. In general, climate Peninsular Malaysia is dominated by two cycles of the monsoon, the northeast monsoon (November to February) and the southwest monsoon (May-August). There are two between the monsoon season, in the month of March-April and September-October. Both seasons respect often lead to a high amount of rain and the seasons is often associated with convective rainfall activity. In general, monthly and annual rainfall received throughout Malaysia is heavily influenced by the monsoon so called monsoon rains. The influence of monsoon rain cycle-based forms the northeast monsoon, the southwest monsoon and two transition periods.

Based on information from Meteodology of Malaysia, it showed that at the beginning the northeast monsoon season usually Peninsular Malaysia remained sluggish, especially in the east coast. However, at the end of that season, many areas began to experience dry conditions. In addition, factors such as the topography of the area and distance from the coast should not be ignored because it can also lead to changes in rainfall patterns in the area.

#### 2.5.1 Rainfall Distribution

Seasonal wind patterns with the nature of the local topography determine the pattern rainfall in Malaysia. During the northeast monsoon season, the exposed area such as the east coasts of Peninsular Malaysia, Sarawak and West Sabah the coast northeast bouts of heavy rain. On the other hand, rural areas or areas covered mountain range is relatively free from this influence. Moreover, rainfall patterns are not thus forming a uniform regime of its own vital rain to understanding. The nature of such rainfall has mainly effect on resources and agricultural water supply. In fact, knowledge of the nature and intensity of rainfall is also important, especially for engineer in the design of irrigation structures, erosion, and landslides skidding (Vousdoukas, 2012). It is better rainfall in Malaysia according to seasons.

### 2.5.2 Seasonal Rainfall Variation on Peninsular Malaysia

Seasonal variation of rainfall in Peninsular Malaysia can be divided into three main types:

i. States on the east coast of Peninsular Malaysia, November, December and January are the months with maximum rainfall while June and July are the driest months in most states.

ii. Areas other than the west coast of Peninsular Malaysia, pattern rain show two periods of maximum rainfall separated by two periods of minimum rainfall. The primary maximum generally occurs in October-November, while the secondary maximum occurs in April-May. In the northwest, the primary minimum occurs in January-February while the secondary minimum occurs in Jun-July. In other places, the primary minimum occurs in June-July while the secondary minimum occurs in February.

iii. The rainfall pattern in the west coast of Peninsular Malaysia more characterized by the occurrence of “Sumatras” in May and August where double maxima and minima pattern does not exist. October and November are the months with maximum rainfall and February are the minimum rainfall. Maximum March, April, May and June-July minimum non-existent or poorly defined.

### 2.5.3 Rainfall Trend

Rain is a form of precipitation that fell to Earth as one of the processes complete the cycle of the earth. There is one of the precipitations that is in a liquid in which the details are beyond the diameter of 0.5mm.

Effectiveness or impact of rain on a system is dependent on the time intensity. rainfall intensity influenced by internal factors such as saturation of the water molecule, heat latent, the rate of evaporation, cloud formation processes, and the early coverage also external factors such as latitude position, move the monsoons and also the diversity of the landscape of the earth (Kristo et al., 2017).

In general, monthly and annual rainfall received throughout Malaysia is heavily influence by the monsoon so called rain monsoon. The influence of monsoon rain cycle-based forms east Monsoon Sea, south-west monsoon and two transition periods. Past studies show that early in the season northeast monsoon normally throughout Peninsular Malaysia remained sluggish especially in the east coast. However, at the end of the season many areas began to experience dry conditions (Jaafar et al., 2016). In addition, factors such as topography area and distance from the coast should not be ignored because it can also cause changes to rainfall patterns by region (Cruz et al., 2013). In fact, particularly rainfall patterns are induced by changes in the urban areas city climate caused by changes in the morphology of the city itself.

The latest IPCC report found that the intensity and the increasing frequency of extreme weather over the last 50 years. Between weather indicators that are considered has changed significantly, including frequency rain storms exceeding 30 mm / hour, daily rainfall intensity higher as well as the prolonged drought conditions. A recent study by (Kardooni et al., 2018) about climate change have proven the extreme Malaysia The city is also vulnerable to increased frequency and intensity of heavy rainfall amount rainy day.

### 2.5.4 Relative Humidity

As mentioned earlier, Malaysia has high humidity. Average monthly relative humidity is between 10% and 90%, that changed by places and months. It is noted that in Peninsular Malaysia, minimum relative humidity typically found in January and February except for the east coast states of Kelantan and Terengganu where relative humidity minimum in March. Moisture maximum is however generally is in November. The case of temperature, relative humidity is changed daily greater than the annual changes. That mean daily minimum can as low as 42% during the dry months and as high as 70% during humid months (Masseran & Razali, 2016). However, the maximum daily average was not much changing from place to place, which is over 94%. It may be as high as 100%. The states in the northwest of Kedah and Perlis have changed the daily relative humidity.

### 2.5.5 Evaporation

Among all the factors that affect evaporation rates, conditions cloudy and the temperature is the two most important factors are interrelated. Day a clear lack of sunlight in turn means less radiation the sun causes the temperature to low. Examination of the data evaporation shows that the months of cloudy or rainy evaporation rates low while the dry months are the months with the rate of evaporation.

### 2.5.6 Wind

Although the wind in the generally light and variable, There are changes in the wind flow patterns. Based on These changes, the four seasons can be distinguished, namely south-west monsoon, east Monsoon Sea and two inter-monsoon season is shorter (Cruz et al., 2013). Southwest monsoon usually in the latter half of May or early June and ends at the end of September. The prevailing wind is generally from the southwest at a speed poor, below 15 knots. Northeast monsoon usually begins in early November and ends in March. During this season, the prevailing winds are from the east or northeast at a speed of between 10 and 20 knots. Coastal states east of Peninsular Malaysia are more affected by the wind where its speed can reach 30 knots or more during periods of intense surges of cold air north (Jaafar et al., 2016).

During the monsoon season, winds are generally light and variable. It is worth mentioning here that in the period from April until November, when typhoons frequently develop in the western Pacific and moving westward across the Philippines, south westerly winds northwest coast of Sabah and the state becomes stronger and can reach 20 knots or more. As a country surrounded by the sea, the impact of land and sea breezes on flow patterns. The wind is not great, especially during the daytime air. In the afternoon's Bright sunshine, ocean breezes with a speed of between 10 and 15 knots the wind often occurs and can reach several tens of kilometres into the rural areas. On clear nights, the reverse process applies where weaker land breezes can also develop in the area beach (Masseran & Razali, 2016).

## 2.6 Classification of Soil

Soil classification is a means of grouping soils into categories according to a shared set of properties or characteristics that exhibit similar engineering behaviour under loading. Due to its natural formation, geological history, and particulate nature, amongst other features, soil behaves differently than other engineering materials such as steel or concrete.

The engineering characteristics of soil (stiffness, permeability, and strength) are dictated by particulate shape, size, microstructural composition, stress history, degree of saturation, and weathering (Sitton and Story, 2016).

Traditionally soils were classified into cohesive (fine grained) or non-cohesive (granular or coarse-grained) soils based on their particle size distributions. Granular soils were categorized exclusively on the relative percentage mass of the different constitutive particles, with increasing grain size determining the difference between sand, gravel, cobbles, and boulders.

The fines content of a soil is determined by the percentage of soil by mass which passes through a 0.075 mm sieve. If the fines content exceeds some predetermined percentage of the soil, typically 50% but maybe less depending on the soil classification system in use, the soil is deemed to be Cohesive or Fine grained. Fine grained soils are classified using relative percentage mass as above with additional hydrometer tests to determine the relative percentage of Clays and Silts in the soil.

Finally, they are sub classified based on their consistency. Soil consistency describes how a fine-grained soil holds together, describing its transition from a solid through to a liquid as its water content is varied.

Soils consist of grains (mineral grains, rock fragments, etc.) with water and air in the voids between grains. The water and air contents are readily changed by changes in conditions and location. Soils can be perfectly dry (have no water content) or be fully saturated (have no air content) or be partly saturated (with both air and water present).

Although the size and shape of the solid (granular) content rarely changes at a given point, they can vary considerably from point to point. Besides, consider soil as an engineering material, it is not a coherent solid material like steel and concrete, but is a particulate material. It is important to understand the significance of particle size, shape and composition, and of a soil's internal structure or fabric. Soils may be described in different ways by different people for their different purposes.

Soil Classification system is important in geotechnical engineering. Because it provide a systematic method of categorizing soil according to their probable engineering behaviour. From research and experience, engineering properties such as shear strength and compressibility characteristics of soil have been found to correlate quite well with the index properties (water content, density and void ratio) and classification properties (grain size and grain size distribution as well as plasticity) of a given soil deposit.

Engineers' descriptions give engineering terms that will convey some sense of a soil's current state and probable susceptibility to future changes (e.g. in loading, drainage, structure, surface level). Engineers are primarily interested in a soil's mechanical properties: strength, stiffness, permeability. These depend primarily on the nature of the soil grains, the current stress, the water content and unit weight. By knowing the classification of the soil, an engineer will have a good idea on how to proceed with detailed site investigation and laboratory testing and subsequently with the design of foundation as well as the engineering situations both during and after construction.

All laboratory test procedures are based on the manual of soil laboratory testing in accordance with the British Standard (BS) and American Standard Testing Methods (ASTM):

i. Coarse-grained soils with up to 50% passing No. 200 ASTM Sieve.

ii. Fine-grained soils with more than 50% pass No. passing No. 200 ASTM Sieve.

iii. Organic soils.

In the British Soil Classification System, soils are classified into named Basic Soil Type groups according to size, and the groups further divided into coarse, medium and fine sub-groups as shown in Table 2.1:

Table 2.1 British Soil Classification System

| | | | |
|---|---|---|---|
| **Very coarse soils** | BOULDERS | | > 200 mm |
| | COBBLES | | 60 - 200 mm |
| **Coarse soils** | **G** GRAVEL | coarse | 20 - 60 mm |
| | | medium | 6 - 20 mm |
| | | fine | 2 - 6 mm |
| | **S** SAND | coarse | 0.6 - 2.0 mm |
| | | medium | 0.2 - 0.6 mm |
| | | fine | 0.06 - 0.2 mm |
| **Fine soils** | **M** SILT | coarse | 0.02 - 0.06 mm |
| | | medium | 0.006 - 0.02 mm |
| | | fine | 0.002 - 0.006 mm |
| | **C** CLAY | | < 0.002 mm |

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

The study of seasonal rainfall patterns effects on sandy beach morphology at Pantai Sepat, Kuantan, Pahang is important to determine the current condition of morphology of the beach, and also to investigate the movement of beach profile in term of erosion and accretion processes. The adequate rainfall data that has been collected was used to analyse using rain gauge to determine the result. The rainfall data was determined during the wet and dry season along the study period.

Several surveying fieldworks were conducted at least 10 points to get the profile along the beach. Data can be used to draw profiles onto graph paper using distance from mean sea level as the horizontal axis and using to complete the profiles. The graphs were analysed and comparison was made across the width of the beach. It can be measured at different locations on the same stretch of coastline in different periods and compared. Different stretches of coastline which may have different natural characteristics. Beach profiles can be used in conjunction with other data collected to examine relationships between different variables.

## 3.2 Study Area

Based on Figure 3.1, the study area is located at Pantai Sepat, in district of Pekan, Pahang. This area can be categorized as rural area. Tanjung Sepat or better known as Pantai Sepat is a typical Malay fishing village located about 10 km from Kuantan and is located on the way south to the royal town of Pekan. Unlike beaches which slope to the sea for a few meters and then suddenly drop deep, the beach at Pantai Sepat seems to slope very gradually to the sea. The beach is famous among locals as the place is restful and tranquil. By referring to the Figure 3.1, it is not well-develop area. Pantai Sepat is one of the tourist's attraction and economic resources for villagers.


Figure 3.1 Location of the study area

Figure 3.2 View of Pantai Sepat

## 3.3 Equipment Installation

The equipment that is placed at the study area is Ranfall Logger ISCO 674 as shown in Figure 3.3. The data logger is well placed at UMP Pekan. The rainfall Logger is free from obstacle to ensure the accuracy of the data. This rain gauge was set up on to get the complete data. The data was taken every month at least for the analysis to determine the wet and dry period within 5 minutes interval. Rainfall data collected was linked to beach profile to get the conclusion of this study.


Figure 3.3 Rainfall Logger ISCO 674

## 3.4 Field Works

Field works is essential to get more information about the study area. More information about the study area was lead to more understanding, hence suitable and better analysis can be carried out. About 10 days of field works was conducted at Pantai Sepat which is from November 20, 2017 until March 28, 2018.

Table 3.1 Date of surveying works

| No. | Date |
|---|---|
| 1 | 20 November 2017 |
| 2 | 4 December 2017 |
| 3 | 19 December 2017 |
| 4 | 1 January 2018 |
| 5 | 19 January 2018 |
| 6 | 1 February 2018 |
| 7 | 18 February 2018 |
| 8 | 28 February 2018 |
| 9 | 14 March 2018 |
| 10 | 28 March 2018 |

Figure 3.4 Surveying work at Pantai Sepat

Figure 3.5 Front view of Pantai Sepat

Beach profile data is taken by using total station Topcon GTS-250 (referred Figure 3.6) and prism (referred Figure 3.7) by collecting horizontal distance, vertical distances of the beach as shown in Figure 3.5. Benchmark was placed before the surveying started to reduce the error during the study as shown in Figure 3.4. Beach profile data was taken during the low tide by refers to sea tidal near site area.


Figure 3.6 Total station Topcon GTS-250

Figure 3.7 Prism

## 3.4 Sieve Analysis

A sieve analysis or gradation test is a practice or procedure used commonly used in civil engineering to assess the particle size distribution also called gradation of a granular material by using the sieve shaker as shown in Figure 3.8. The samples were collected at Pantai Sepat as shown in Figure 3.9. After that, sieve analysis was conducted at Geotechnical Laboratory (UMP Gambang) to classify the particle distribution size of the samples as shown in Figure 3.10. Besides, the sieve analysis test procedures are based on the manual of soil laboratory testing in accordance with the British Standard (BS) and American Standard Testing Methods (ASTM). The size distribution is often of critical importance to the way the material performs in use such as 1.18 mm, 0.6 mm, 0.425 mm, 0.3 mm, 0.212 mm, 0.15 mm and 0.063 mm. It can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, soil a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common.


Figure 3.8 Sieve shaker

Figure 3.9 Collecting samples at Pantai Sepat

Figure 3.10 Sieve analysis test

# CHAPTER 4

# RESULT AND ANALYSIS

## 4.1 Introduction

For this chapter, all the beach profiles data were linked to the recorded rainfall data for section part of analysis. This analysis is important for better understanding about the relationship between rainfall distribution and beach morphological changes.

The beach profile were analysed based on survey works along the area every two weeks started from November 20, 2017 until March 28, 2018. Then it was analysed with time to identify the dry period and wet period on certain area. The result of analysis were compared to show the effect of wet and dry period on the beach profile.

## 4.2 Rainfall Analysis

Typically, the climate in Malaysia is divided into the southwest monsoon and the northeast monsoon. Annual and monthly rainfall are received throughout Malaysia is heavily influenced by the monsoon so called monsoon rains that can effect sea level, wave speed, erosion and accretion in certain area. An increased level of coastal erosion is causing coastal sizes smaller and threatens coastal population.

In this study, one rainfall gauge (Rainfall Logger ISCO 674) was setup at UMP Pekan to get the rainfall distribution. This data was taken from September 14, 2017 until April 20, 2018.

Based on the Figure 4.1, the total rainfall depth for period of the study is 1573.9 mm for 128 days and 60 days were recorded as no rainfall started from November 20, 2018 until the end of the study. For monthly rainfall distribution, January 2018 was recorded as the wettest month with rainfall depth 771.2 mm. Meanwhile, February 2018 was identified as the driest month with 19.7 mm rainfall depth with 20 days no rainfall which is 71.43% of 28 days.

In between November 20, 2017 and January 31, 2018, the rainfall distribution was higher than the other two months later which is February 2018 and March 2018. So that it was classified as wet period.  Starting from December 2017 to January 2018, the distribution was increased by 29.84%. The highest rainfall depth during the study was occurred on January 12, 2018. It was recorded as 256.2 mm. It was increased by 15.26% from the previous day, January 11, 2018. Besides, the dry period was classified started from February 1, 2018. The total rainfall depth was decreased by 93.60% if combined (December 2017 and January 2018) compared to combination of rainfall depth between (February 2018 and March 2018). In between February and March, 2018 the highest rainfall was only occur in March 8, 2018 about 15.4 mm depth.

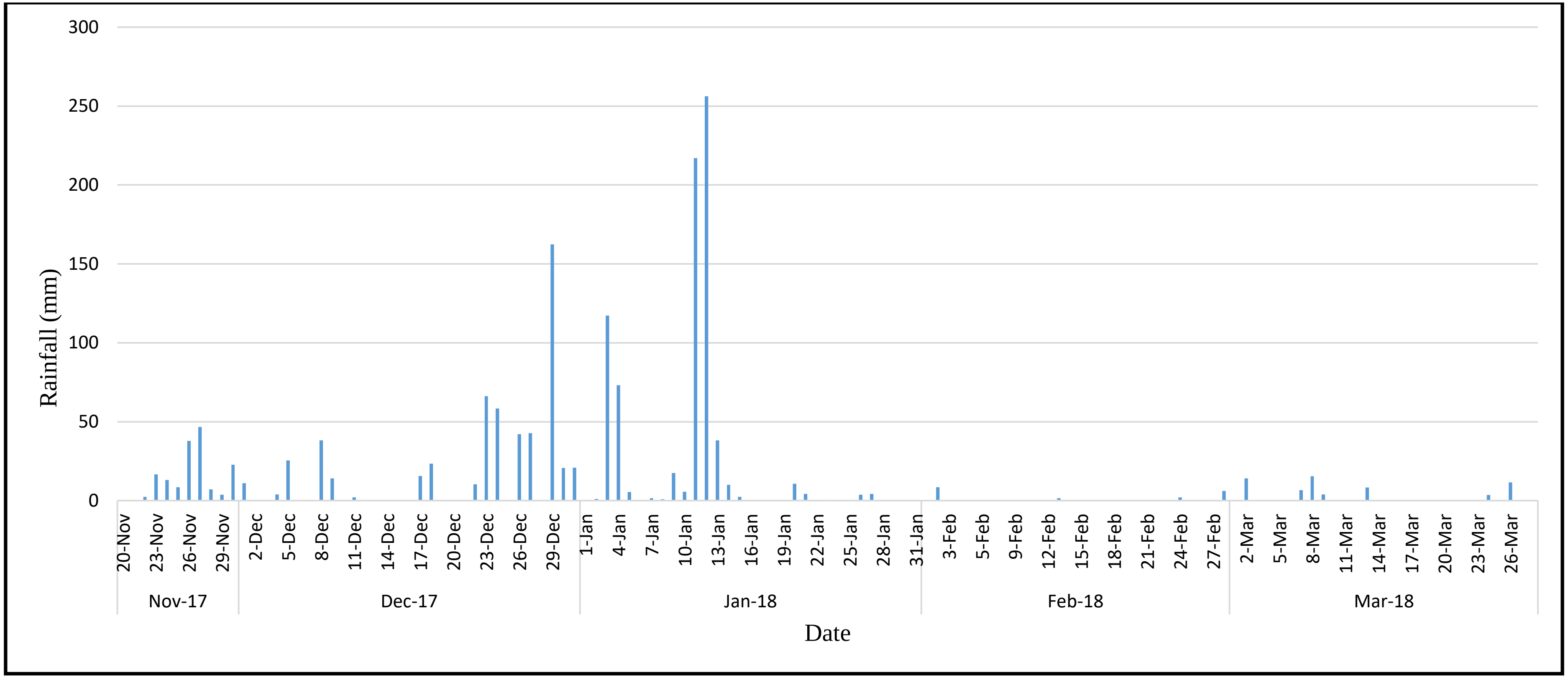


Figure 4.1 Daily rainfall data at UMP Pekan

## 4.3 Beach Profiles

Many factors that affect the changes of beach profile in a period of time. Rising of sea level are one of the factor that influence the erosion of the beach. The rate of erosion was calculated between the profiles taken and analysed with the rainfall. Table 4.1 to 4.10 show the vertical and horizontal distances at Pantai Sepat. This data was interpreted through the graph to form the beach profiles.

Table 4.1 Vertical and horizontal distances on 20 November 2017

| **Vertical Distance (m)** | **Horizontal Distance (m)** |
|---|---|
| | **20-Nov-17** |
| 0 | 0 |
| -0.364 | 8.081 |
| -0.221 | 16.473 |
| -0.448 | 20.237 |
| -1.1 | 27.467 |
| -1.704 | 44.985 |
| -2.171 | 59.1 |
| -2.753 | 83.115 |
| -3.046 | 105.513 |
| -3.481 | 120.856 |
| -3.667 | 128.209 |

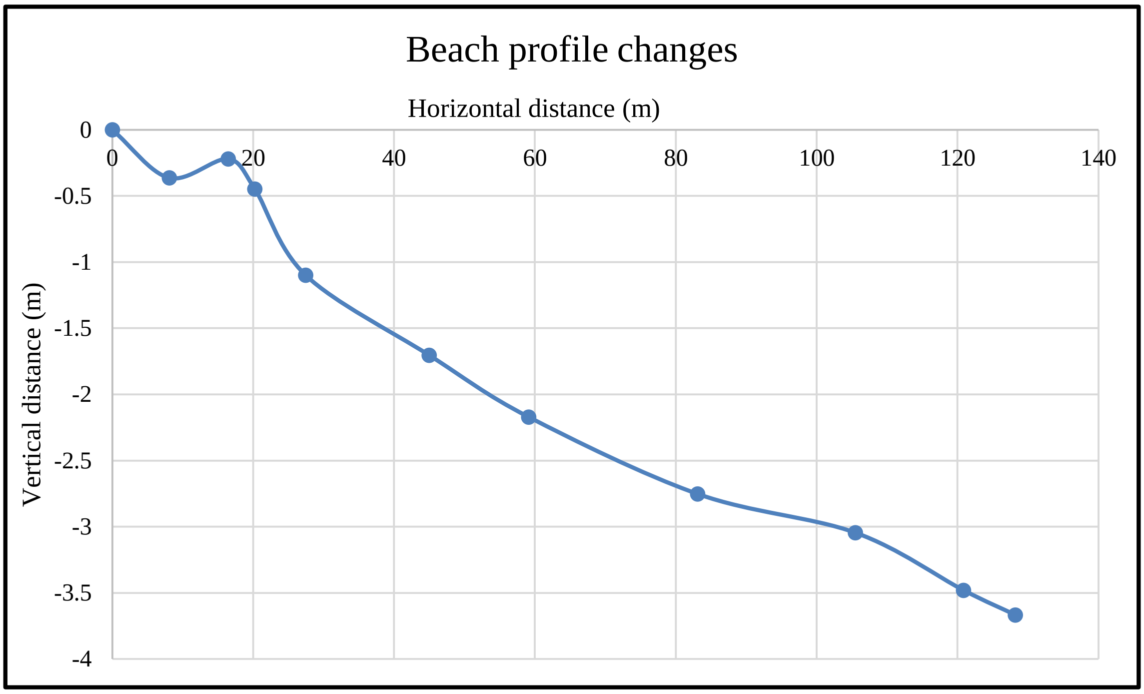


Figure 4.2 Beach profile on 20 November 2017

Referred to Figure 4.2, it look like the surface of the beach at the beginning of the study as erosion occurred at the middle part and accreted at the lower part started at 100 m of horizontal distance from total station. There was no rainfall on this day. The sand bar was appeared on this day because of the wave movement.

Table 4.2 Vertical and horizontal distances on 4 December 2017

| **Vertical Distance (m)** | **Horizontal distance** |
|---|---|
| | **4-Dec-18** |
| 0 | 0 |
| -0.312 | 8.503 |
| -0.224 | 16.473 |
| -0.997 | 23.485 |
| -1.496 | 32.757 |
| -1.867 | 43.907 |
| -2.197 | 54.894 |
| -2.433 | 67.268 |
| -2.629 | 78.661 |
| -3.027 | 102.694 |
| -3.474 | 124.943 |

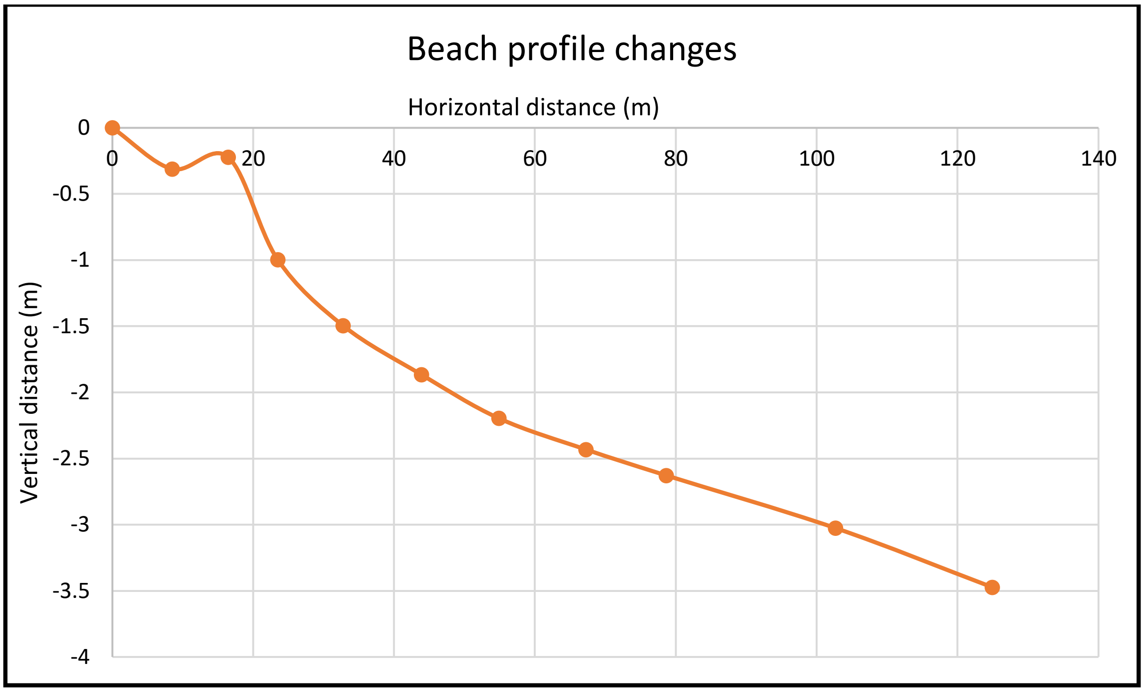


Figure 4.3 Beach profile on 4 December 2017

Figure 4.3 shows the erosion continued to occur as early as 20 m by 50% increase compared to the previous two weeks, November 20, 2017 and no accretion occurs on this day. This situation occurred affected by the increased of rainfall depth as maximum as 46.7 mm on November 27, 2017. The sand bar was still appeared on this day because of the movement of wave.

Table 4.3 Vertical and horizontal distances on 19 December 2017

| Vertical Distance (m) | Horizontal Distance (m) |
|---|---|
| | 19-Dec-17 |
| 0 | 0 |
| -0.178 | 8.618 |
| -0.494 | 17.468 |
| -1.53 | 26.154 |
| -1.987 | 37.363 |
| -2.315 | 48.248 |
| -2.394 | 67.783 |
| -2.632 | 78.543 |
| -3.024 | 97.118 |
| -3.412 | 106.08 |
| -3.594 | 112.987 |

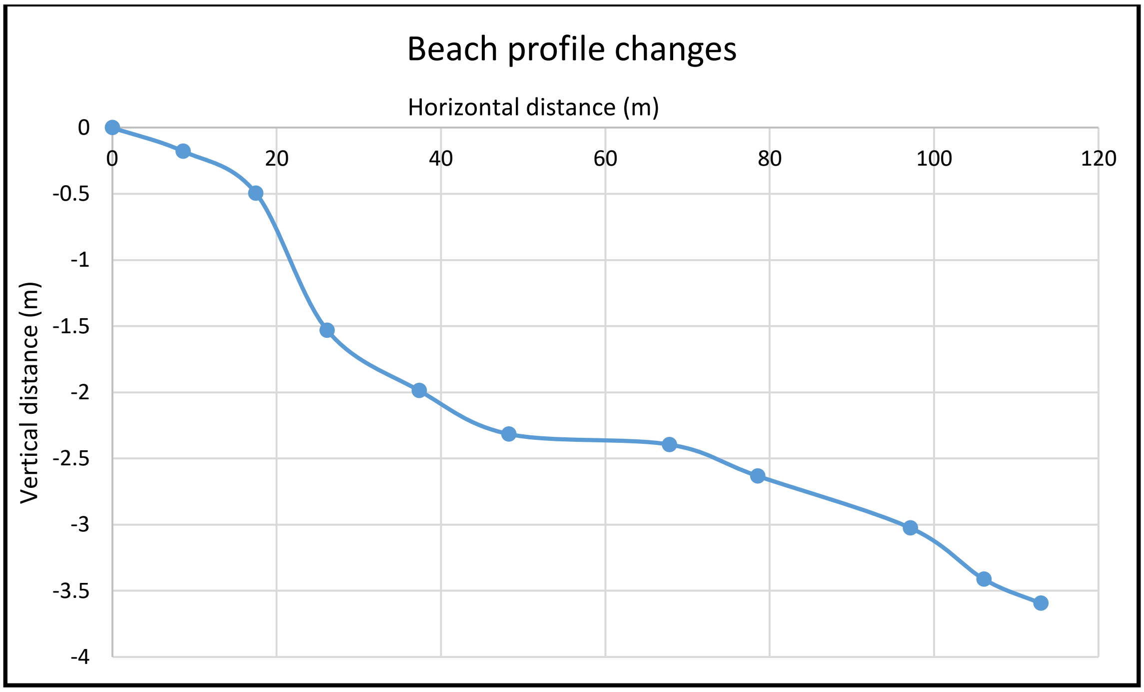


Figure 4.4 Beach profile on 19 December 2017

On December 19, 2017 the rate of erosion was increased at the middle part but it appeared that there was also an accretion process after 60 m distance from the total station, referred to Figure 4.4. It was erode by 20% compared to December 4, 2017 as the rainfall depth increased as much as 38.3mm on December 8, 2017. Furthermore, the sand bar become slop at the upper part.

Table 4.4 Vertical and horizontal distances on 1 January 2018

| **Vertical Distance (m)** | **Horizontal Distance (m)** |
|---|---|
| | **1-Jan-18** |
| 0 | 0 |
| -0.413 | 8.328 |
| -0.866 | 13.691 |
| -1.528 | 26.958 |
| -1.881 | 37.034 |
| -2.101 | 45.581 |
| -2.265 | 53.374 |
| -2.404 | 61.039 |
| -2.556 | 69.612 |
| -2.718 | 77.32 |
| -2.891 | 84.847 |

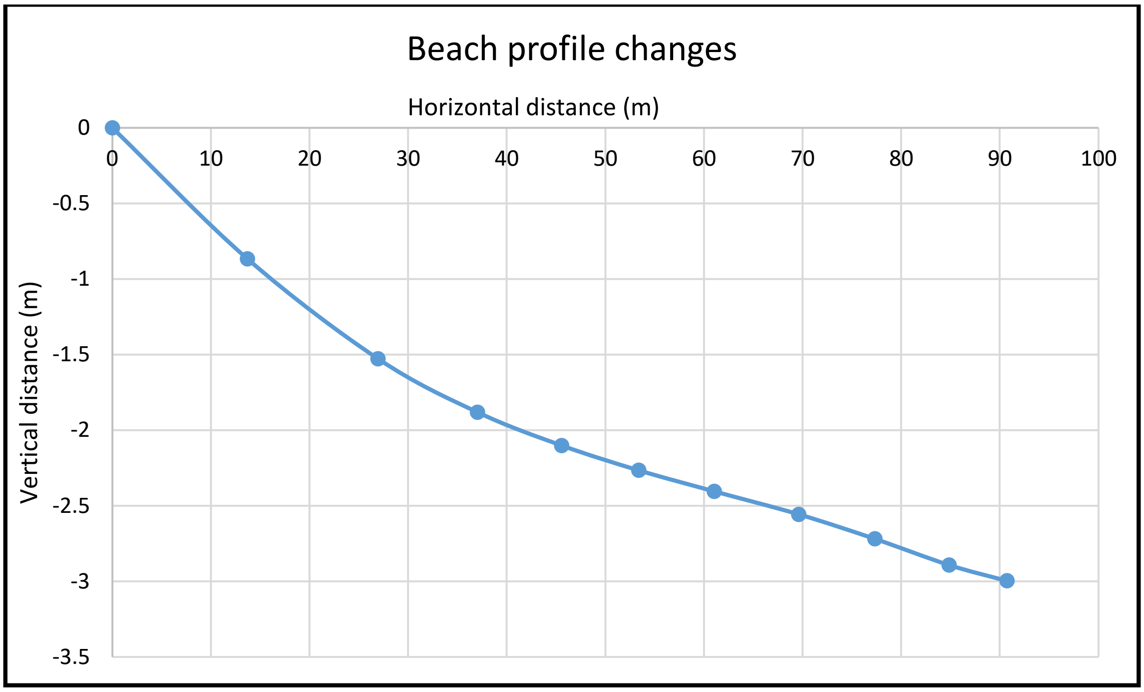


Figure 4.5 Beach profile on 1 January 2018

Based on Figure 4.5, there was no sand bar appeared at the upper part. This situation occurred because of the increased of sea level. It erode by 33.33% compared to the last two weeks, December 19, 2018. This was affected by the increased of rainfall distribution between 16 and 31 December 2017 as the total of rainfall depth was 464 mm. It was increased by 17% compared to previous month, November 2017.

Table 4.5 Vertical and horizontal distances on 19 January 2018

| Vertical Distance (m) | Horizontal Distance |
|---|---|
| | 19-Jan-2018 |
| 0 | 0 |
| -0.697 | 8.687 |
| -1.451 | 19.828 |
| -1.764 | 30.721 |
| -1.973 | 41.784 |
| -2.228 | 55.512 |
| -2.486 | 68.312 |
| -2.659 | 78.691 |
| -2.788 | 89.837 |
| -2.937 | 100.528 |
| -3.377 | 122.688 |

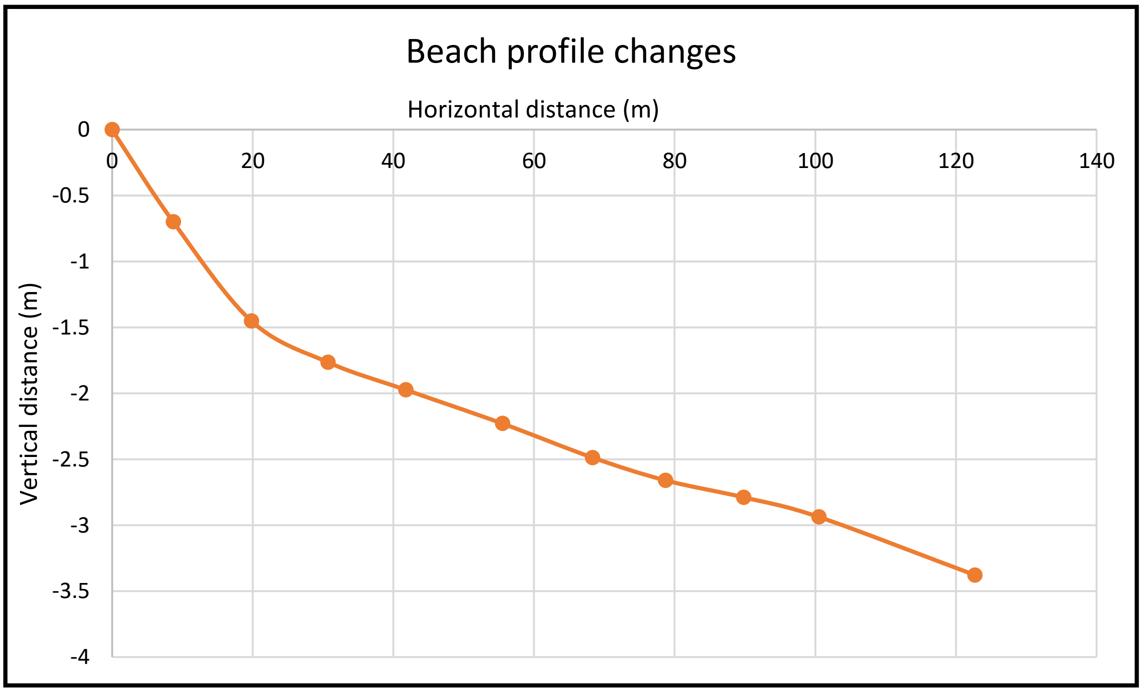


Figure 4.6 Beach profile on 19 January 2018

Figure 4.6 shows that the rate of erosion increased compared to the previous two weeks. There was high slop started at the upper part of the beach which is 20 m from total station. It was erode by 11.42% because of the highest of rainfall depth collected in

January 1, 2018 until January 18, 2018 as much as 747 mm depth. Referred to Figure 4.1, the maximum rainfall depth was occurred in January 12, 2018 as 256.2 mm.

Table 4.6 Vertical and horizontal distances on 1 February 2018

| **Vertical Distance (m)** | **Horizontal Distance** |
|---|---|
| | **1-Feb-18** |
| 0 | 0 |
| -0.359 | 8.012 |
| -1.002 | 10.744 |
| -1.585 | 24.267 |
| -1.831 | 32.86 |
| -2.092 | 44.959 |
| -2.336 | 57.338 |
| -2.644 | 72.751 |
| -2.911 | 86.038 |
| -3.232 | 102.561 |
| -3.429 | 114.617 |

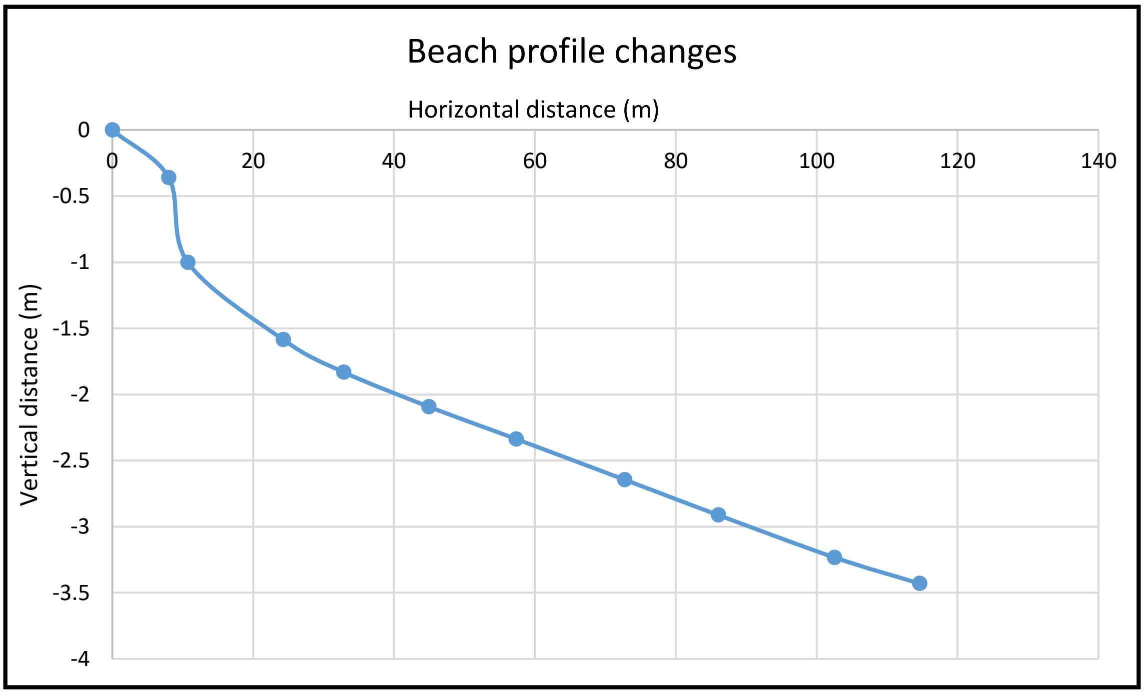


Figure 4.7 Beach profile on 1 February 2018

There was accretion occur along first 20 m distance from the total station, it was accreted by 42.86% but the beach was still erode at the middle and lower parts of the beach as shown in Figure 4.7. During this week, the value of rainfall distribution was decreased. There was no rainfall as 6 days between January 22, 2018 and February 1, 2018. Besides, there was only 24.2 mm rainfall depth started from January 20, 2018 until February 1, 2018. So that, it was classified as started of dry period. The decrease rate was as much as 90.17% compared to the maximum rainfall depth occurred in January, 2018.

Table 4.7 Vertical and horizontal distances on 18 February 2018

| **Vertical Distance (m)** | **Horizontal Distance** |
|---|---|
| | **18-Feb-18** |
| 0 | 0 |
| -0.447 | 8.474 |
| -0.821 | 11.818 |
| -1.424 | 20.816 |
| -1.861 | 35.414 |
| -2.091 | 48.489 |
| -2.37 | 62.769 |
| -2.592 | 75.074 |
| -2.742 | 84.232 |
| -3.097 | 104.592 |
| -3.31 | 117.046 |

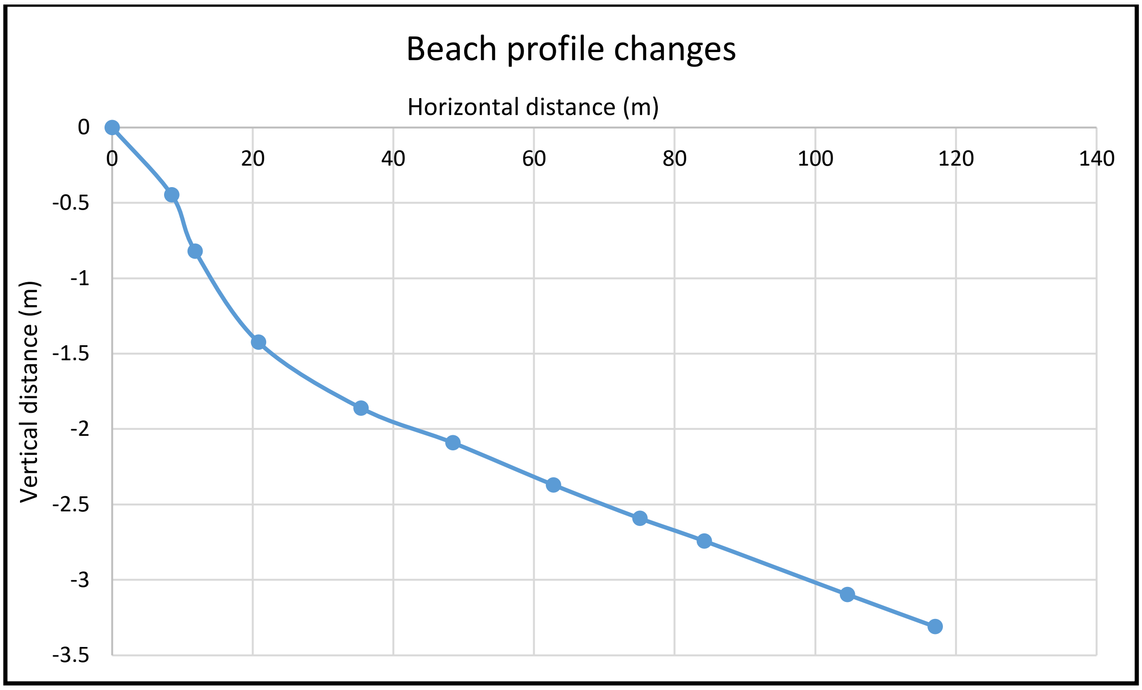


Figure 4.8 Beach profile on 18 February 2018

Based on Figure 4.8, steep beach surfaces indicate that accretion rates increased at upper and middle parts. It was increased by 19.86% compared to the previous two weeks. There was no rainfall during this weeks started from February 15, 2018 until February 22, 2018. Furthermore, there was only 4 days rainfall between February 2, 2018 and February 18, 2018 as total rainfall depth as much as 10.5 mm. It was influenced the erosion and accretion rate process at the beach.

Table 4.8 Vertical and horizontal distances on 28 February 2018

| **Vertical Distance** | **Horizontal Distance** |
|---|---|
| | **28-Feb-18** |
| 0 | 0 |
| -0.404 | 8.209 |
| -1.068 | 13.752 |
| -1.608 | 26.408 |
| -2.001 | 40.402 |
| -2.212 | 52.602 |
| -2.472 | 65.644 |
| -2.686 | 76.984 |
| -3.03 | 88.492 |
| -3.411 | 111.352 |
| -3.51 | 122.496 |

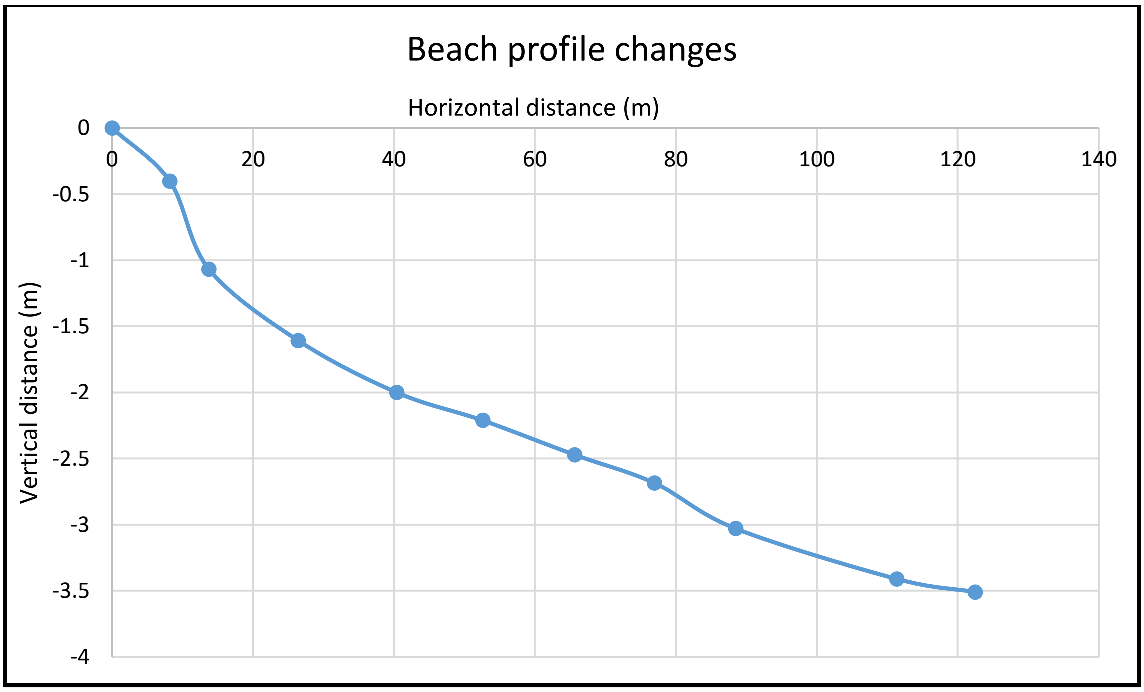


Figure 4.9 Beach profile on 28 February 2018

The beach surface becomes uneven as before, it seems that erosion occurred at the lower part but the accretion occurred at 40 m to 80 m as shown in Figure 4.9. There were rainfall distribution among this week started from February 23, 2018 until February

28, 2018. The total of the rainfall depth was 9.2 mm. But as stated in Figure 4.9, less rainfall could not give high impact to the changes of the beach profile.

Table 4.9 Vertical and horizontal distances on 14 March 2018

| **Vertical Distance** | **Horizontal Distance** |
|---|---|
| | **14-Mar-18** |
| 0 | 0 |
| -0.354 | 8.114 |
| -0.975 | 12.329 |
| -1.458 | 23.626 |
| -1.771 | 34.067 |
| -2.01 | 47.073 |
| -2.251 | 57.549 |
| -2.39 | 68.117 |
| -2.709 | 79.84 |
| -2.869 | 87.638 |
| -3.174 | 95.432 |

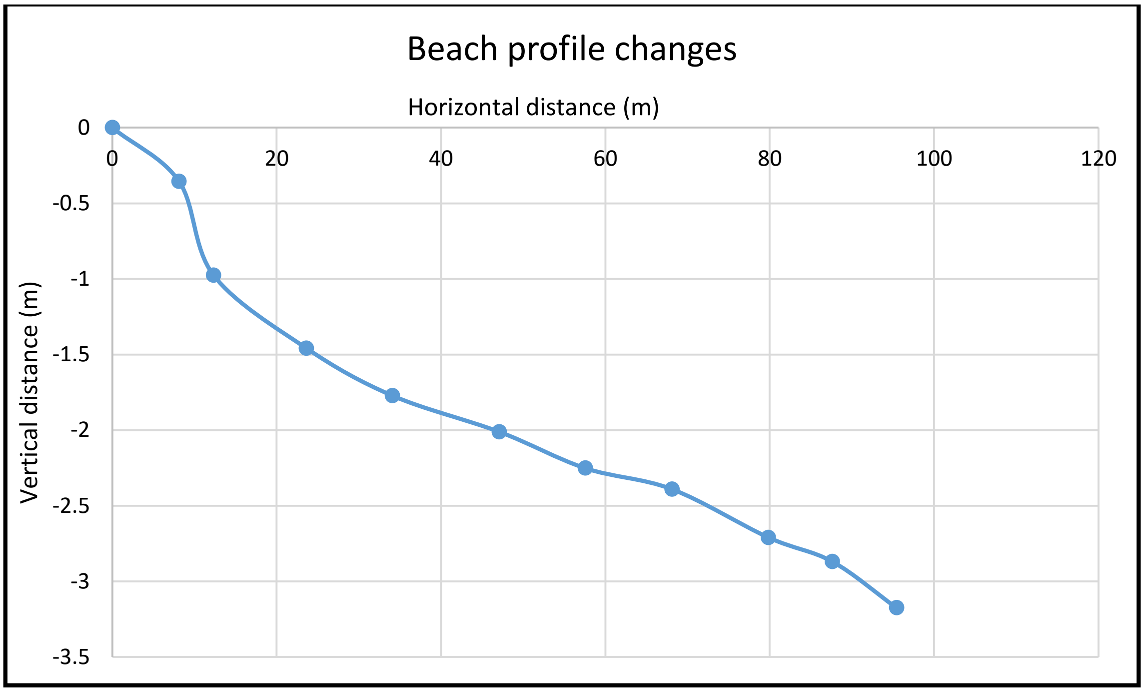


Figure 4.10 Beach profile on 14 March 2018

Figure 4.10 shows the accretion occurred at the upper, middle and lower parts of the beach which is 20 meter, 50 meter and 100 meter distances from the total station. It was increased as 8.5% to 15% compared to the beach profile on February 28, 2018. There was still rainfall in this week started from March 7, 2018 until March 13, 2018 but the total value of rainfall depth was small which is 34.8 mm. The rough surface of the beach was affected by the wave movement.

Table 4.10 Vertical and horizontal distances on 28 March 2018

| **Vertical Distance** | **Horizontal Distance** |
|---|---|
| | **28-Mar-18** |
| 0 | 0 |
| -0.294 | 7.728 |
| -0.962 | 9.865 |
| -1.501 | 21.12 |
| -2.042 | 43.131 |
| -2.178 | 53.871 |
| -2.359 | 64.175 |
| -2.562 | 75.123 |
| -2.92 | 86.302 |
| -3.323 | 109.16 |
| -3.631 | 118.384 |

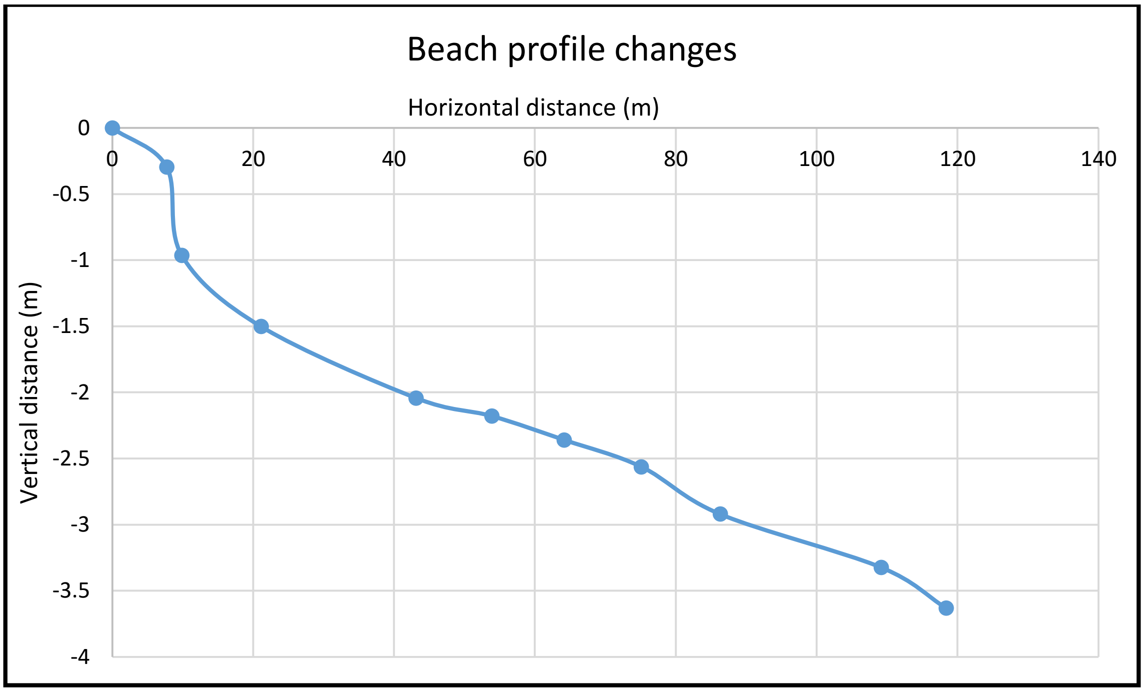


Figure 4.11 Beach profile on 28 March 2018

At the end of the study, the erosion process occurred at the upper and lower parts of the beach as shown in Figure 4.11. The total rainfall depth in March 2018 was higher than February 2018 which was 64.3 mm and 17.7 mm. The rate of erosion was increased as much as 2% to 5%. But it not really affected the changes of the beach profile because of the small value of rainfall depth occurred in these two months. Besides, the accretion process was occurred at the middle part due to the no rainfall started from March 14, 2018 to March 23, 2018. There was only 4 days rainfall started from March 24, 2018 until March 28, 2018 and the total rainfall depth was 15.4 mm.

### 4.3.1 Discussion

Based on Figure 4.12, it shown that the erosion started on November 2017 due to high rainfall average monthly recorded data. It shows the sand bar shaped at upper part during the 4 weeks. The erosion process was occurred at the upper and middle parts while the accretion process was occur at the lower part of the beach. The highest rate of erosion occurred on January 19, 2018 because of the highest of rainfall depth collected from January 1, 2018 until January 18, 2018 as much as 747 mm depth while the highest rate of accretion occurred on February 28, 2018 affected by the lowest of rainfall depth collected from February 15, 2018 until February 28, 2018 as much as 9.2 mm only. Figure 4.12 shows the erosion at upper part occurred until the end of the study, March 28, 2018. But the beach still accreted at the middle and lower parts were slowly increased.

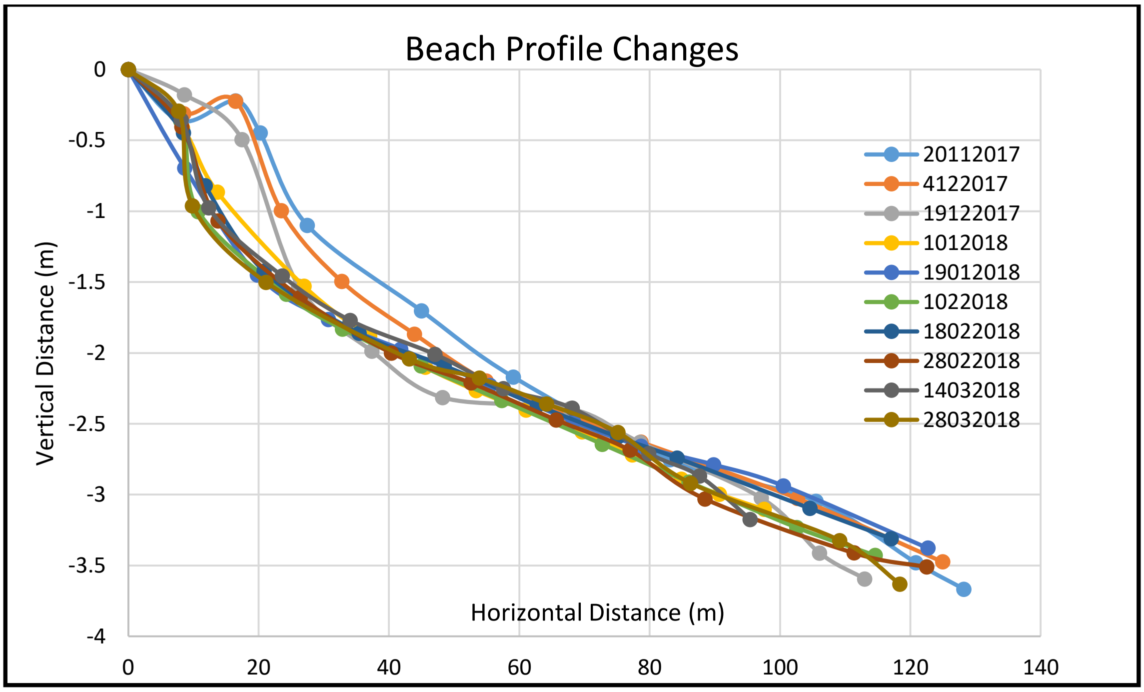


Figure 4.12 Combination of beach profile at Pantai Sepat

### 4.3.2 Sieve Analysis of Pantai Sepat

Sieve analysis test was conducted at UMP Geotechnical Laboratory to determine the medium size of the sand at Pantai Sepat, $D_{50}$ every two weeks along the study based on three different parts to collect the sand beach which is upper, middle and lower parts. In Figure 4.13 to Figure 4.22, there are the sieve analysis result from November 20, 2017 until March 28, 2018.

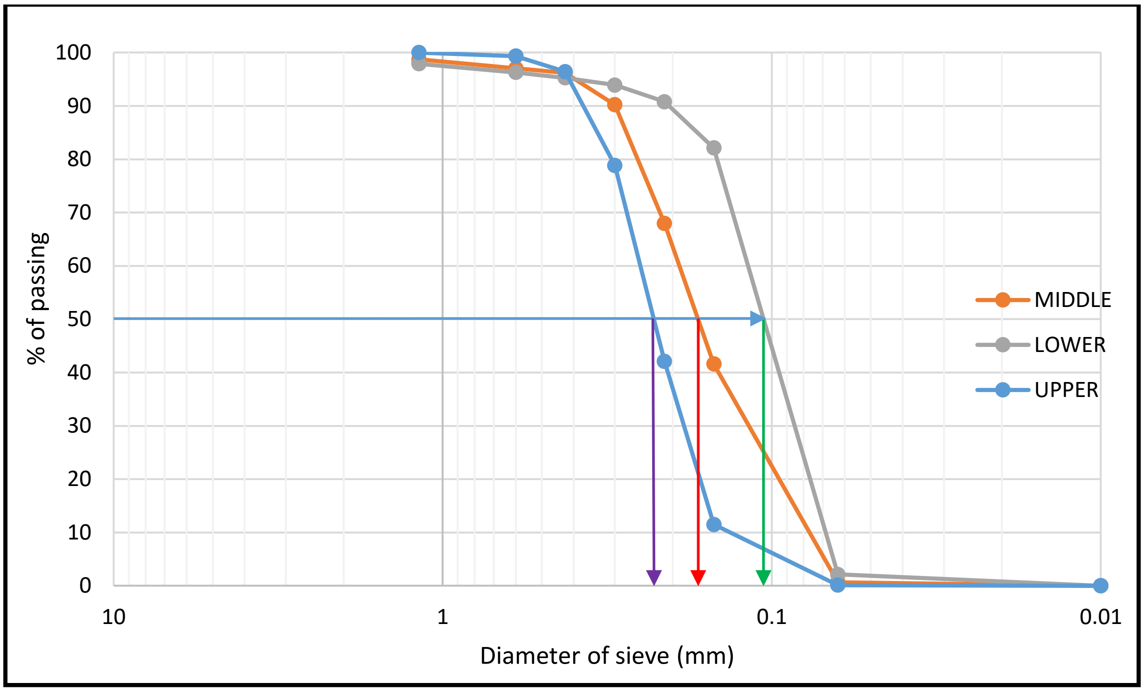


Figure 4.13 Sieve analysis of 20 November 2017

Based on Figure 4.13, the medium sizes of sand, D50 on November 20, 2017 for upper, middle and lower parts were 0.23 mm, 0.17 mm and 0.12 mm. As stated, the size of D50 at lower part was the finest compare to another. In this part, it was always in wet and watery condition because it was included in the sea water area. The wave moved along this part so that it affected the size on this area. There was no rainfall on this day, so that the sand at upper and middle part were in dry condition.

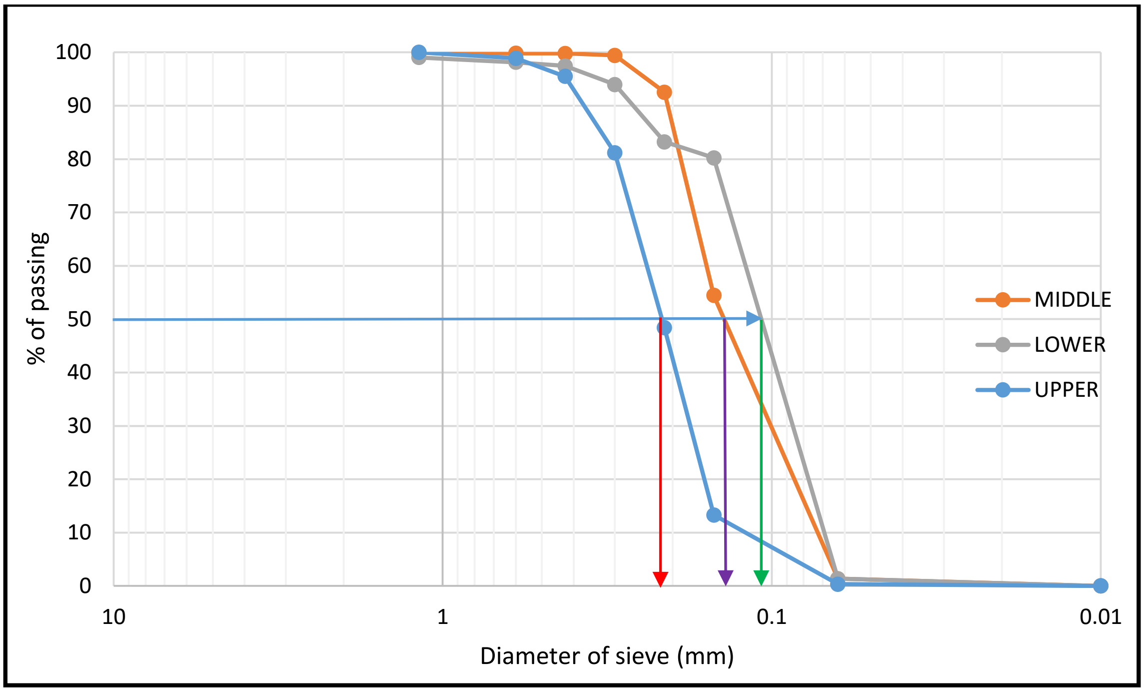


Figure 4.14 Sieve analysis of 4 December 2017

Based on Figure 4.14, the medium sizes of sand, D50 on December 4, 2017 for upper, middle and lower parts were 0.22 mm, 0.14 mm and 0.11 mm. It was found that the medium sizes of all parts were slightly decreased compared to the previous two weeks. This situation occurred affected by the increased of rainfall depth as maximum as 46.7 mm on November 27, 2017 although there was no rainfall in 2 days before, December 2, 2017 and December 3, 2017 but the days before that were raining all days started from November 20, 2017 until December 1, 2017 with 169.8 mm rainfall depth.

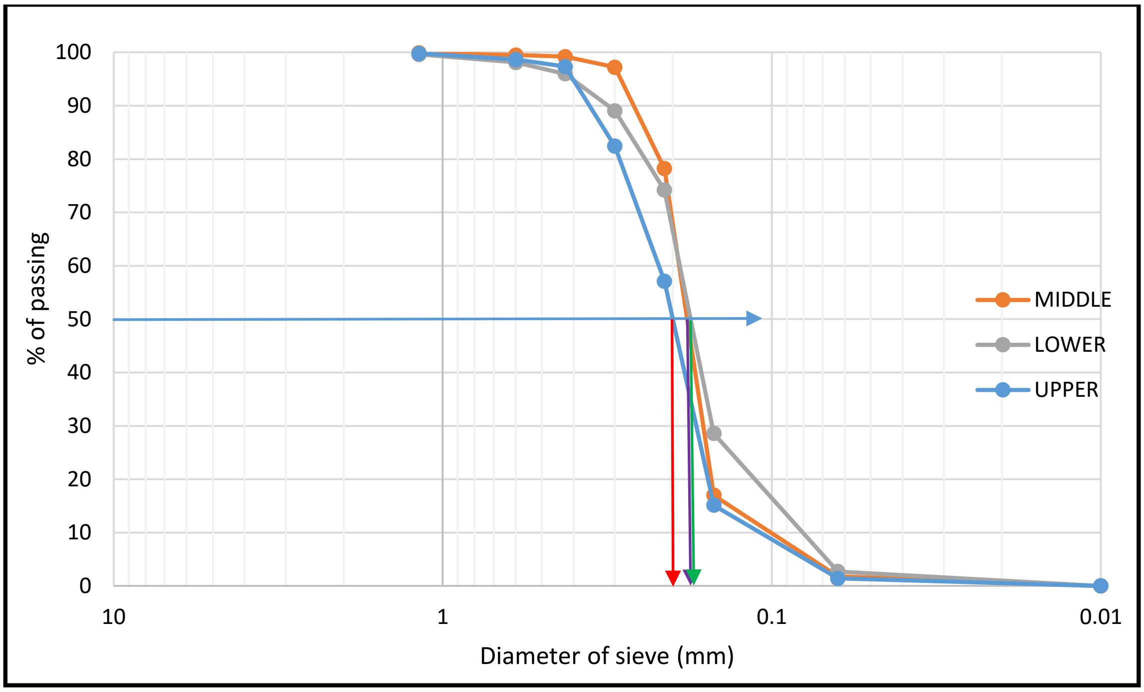


Figure 4.15 Sieve analysis of 19 December 2017

Based on Figure 4.15, the medium sizes of sand, D50 on December 19, 2017 for upper, middle and lower parts were 0.18 mm, 0.20 mm and 0.13 mm. It clearly stated that the medium size at middle part was bigger compared to the upper part. Furthermore, the medium sizes at middle and lower part were higher compared to the previous two weeks, December 4, 2017. This situation occurred maybe because of the time of sample taken was just on after sea high tidal. So that, the sand at the middle part was just in wet condition and not enough time to dry before the sample was collected. But, the medium size at upper part was finer than two previous weeks. This was affected by the less of rainfall distribution before this week as the rainfall depth was 120.5 mm. There was no rainfall for 4 days between December 5, 2017 and December 18, 2017. During this day, there was also no rainfall stated.

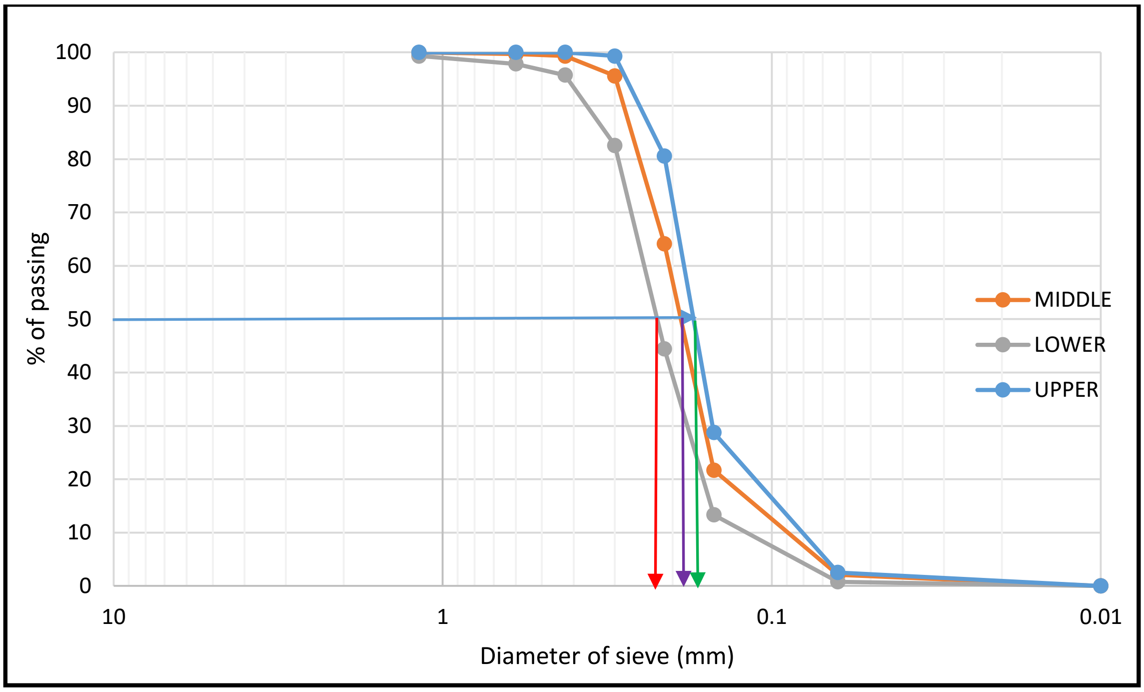


Figure 4.16 Sieve analysis of 1 January 2018

Based on Figure 4.16, the medium sizes of sand, $D_{50}$ on January 1, 2018 for upper, middle and lower parts were 0.17 mm, 0.20 mm and 0.13 mm. It clearly stated that the medium size at middle part was bigger compared to the upper part. There was no rainfall for 4 days between December 20, 2017 and December 31, 2017. Besides, the medium sizes at middle and lower part were maintain as the previous two weeks, December 19, 2017 although the value of rainfall depth was quite high as 424.8 mm, it was not really affected the changes of the medium size of sand at Pantai Sepat.

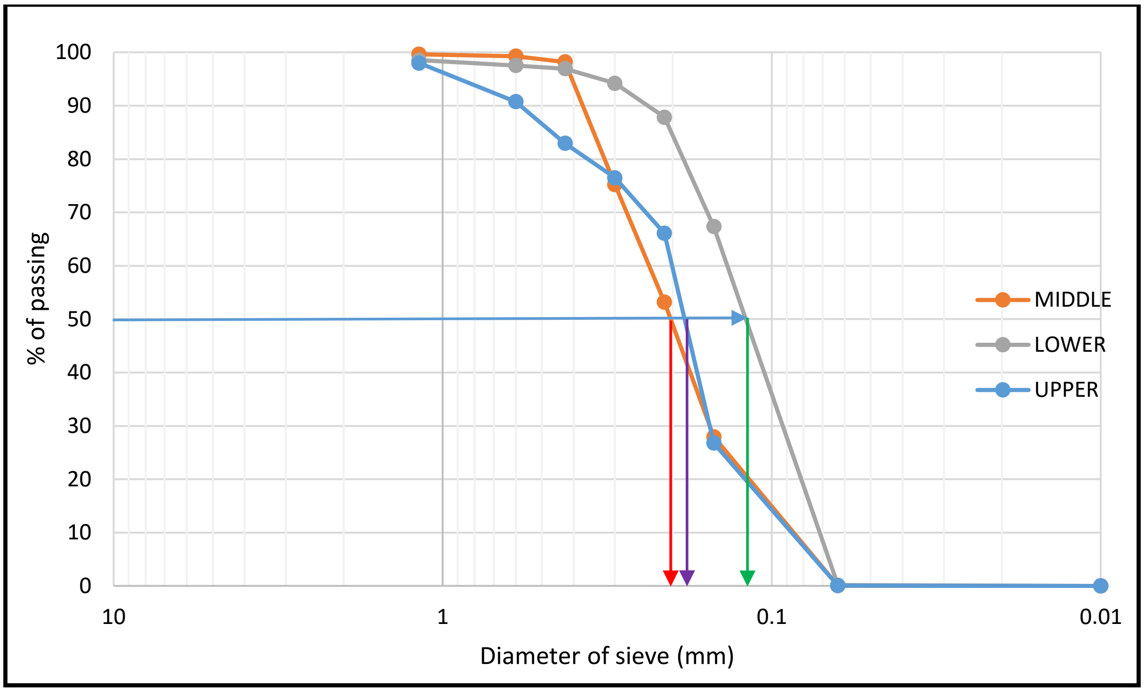


Figure 4.17 Sieve analysis of 19 January 2018

Based on Figure 4.17, the medium sizes of sand, D50 on January 19, 2018 for upper, middle and lower parts were 0.19 mm, 0.20 mm and 0.13 mm. It clearly stated that the medium size at middle part was bigger compared to the upper part. There was no rainfall for 3 days from January 16, 2018 to January 19, 2018. So that, the sand was in dry condition and the infiltration process has been occurred. The water from the sand has been removed by the dry condition among 3 days. Moreover, the medium sizes at middle and lower part were maintain as the previous two weeks, January 1, 2018 although the value of rainfall depth was quite high as 746.7 mm. It look like not really affected the changes of the medium size of sand on this weeks.

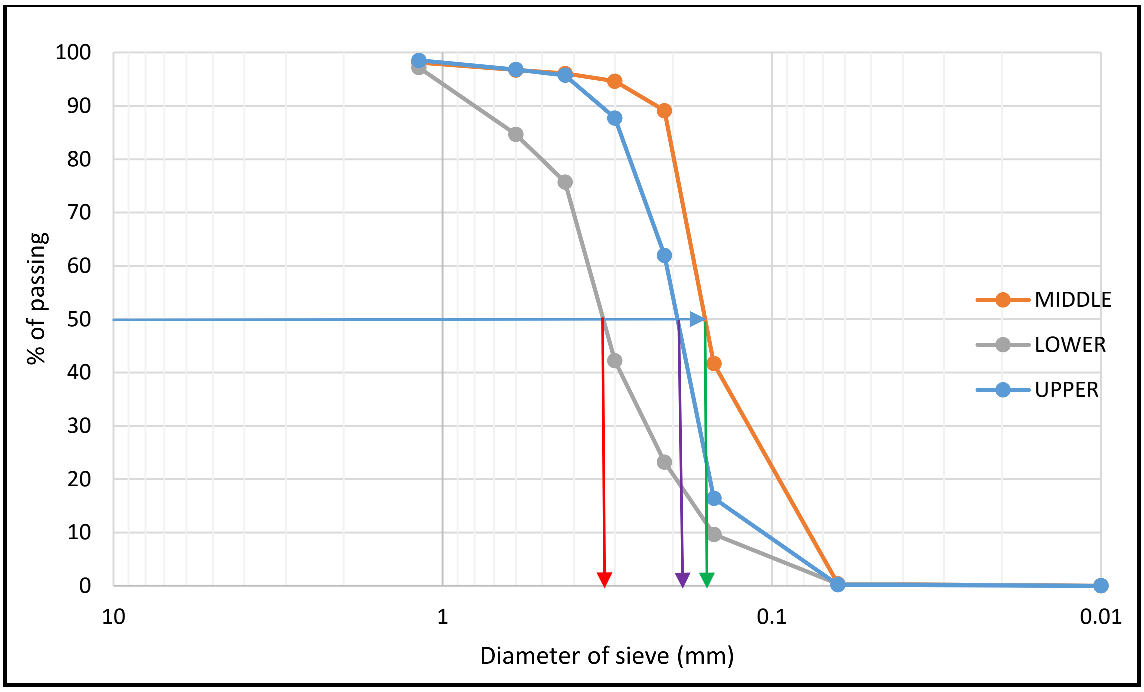


Figure 4.18 Sieve analysis of 1 February 2018

Based on Figure 4.18, the medium sizes of sand, $D_{50}$ on February 1, 2018 for upper, middle and lower parts were 0.20 mm, 0.17 mm and 0.13 mm. The size of $D_{50}$ at lower part was the finest compare to another. The size was maintained, same as the previous two weeks. At this part, it was always in wet and watery condition because it was included in the sea water area. The wave moved along this part so that it affected the size on this area. Compared to the previous two weeks, January 19, 2018, the medium size at upper part was bigger while the medium size at middle part was finer. These situations occurred because of the less of rainfall along two weeks started from January 20, 2018 until January 31, 2018. There was no rainfall for 4 days along these two weeks. The value of rainfall depth was decreased as 24.2 mm. It was consider that the dry period was started.

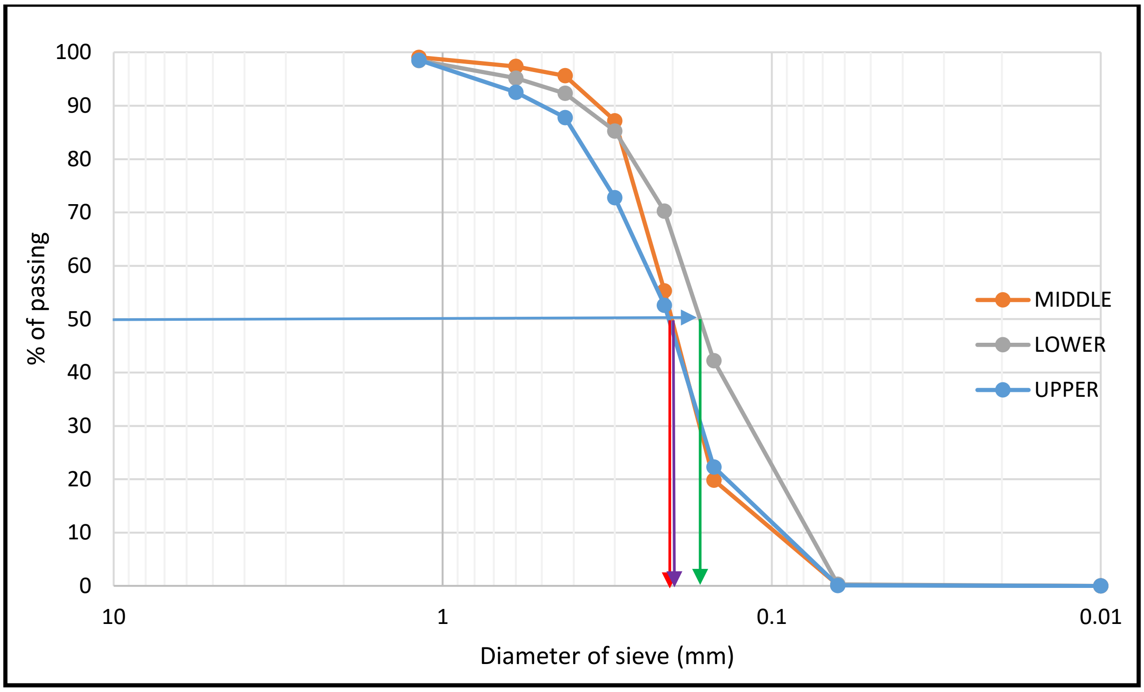


Figure 4.19 Sieve analysis of 18 February 2018

Based on Figure 4.19, the medium sizes of sand, D50 on February 18, 2018 for upper, middle and lower parts were 0.21 mm, 0.18 mm and 0.15 mm. It was clearly stated that the medium sizes were decreased among the parts. It was found that the medium sizes of all parts were slightly increased compared to the previous two weeks. February 1, 2018. This situation occurred affected by the decreased of rainfall depth as only total 10.5 mm during this two weeks started from February 2, 2018 until February 17, 2018. There was no rainfall for 12 days. The less of rainfall really effected the changes of the sand size.

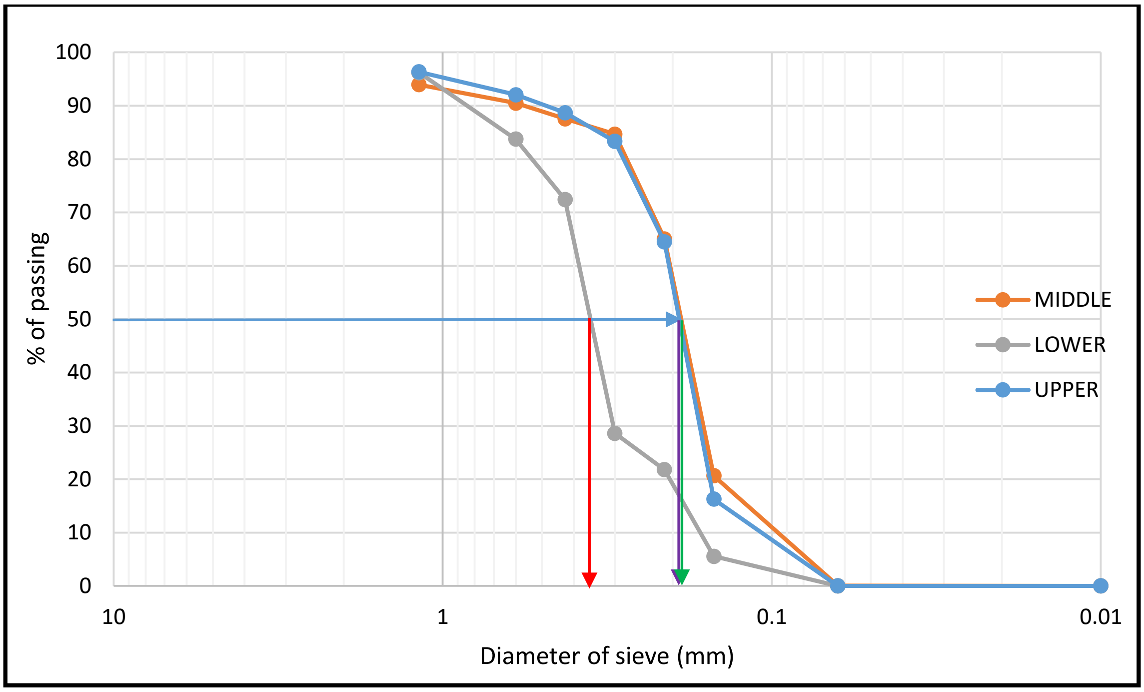


Figure 4.20 Sieve analysis of 28 February 2018

Based on Figure 4.20, the medium sizes of sand, $D_{50}$ on February 28, 2018 for upper, middle and lower parts were 0.22 mm, 0.19 mm and 0.16 mm. It was clearly stated that the medium sizes were decreased among the parts. It was found that the medium sizes of all parts were slightly increased compared to the previous two weeks, February 18, 2018. This situation occurred affected by the decreased of rainfall depth as only total 9.2 mm during this two weeks started from February 19, 2018 until February 28, 2018. There was no rainfall for 6 days. The less of rainfall really effected the changes of the sand size.

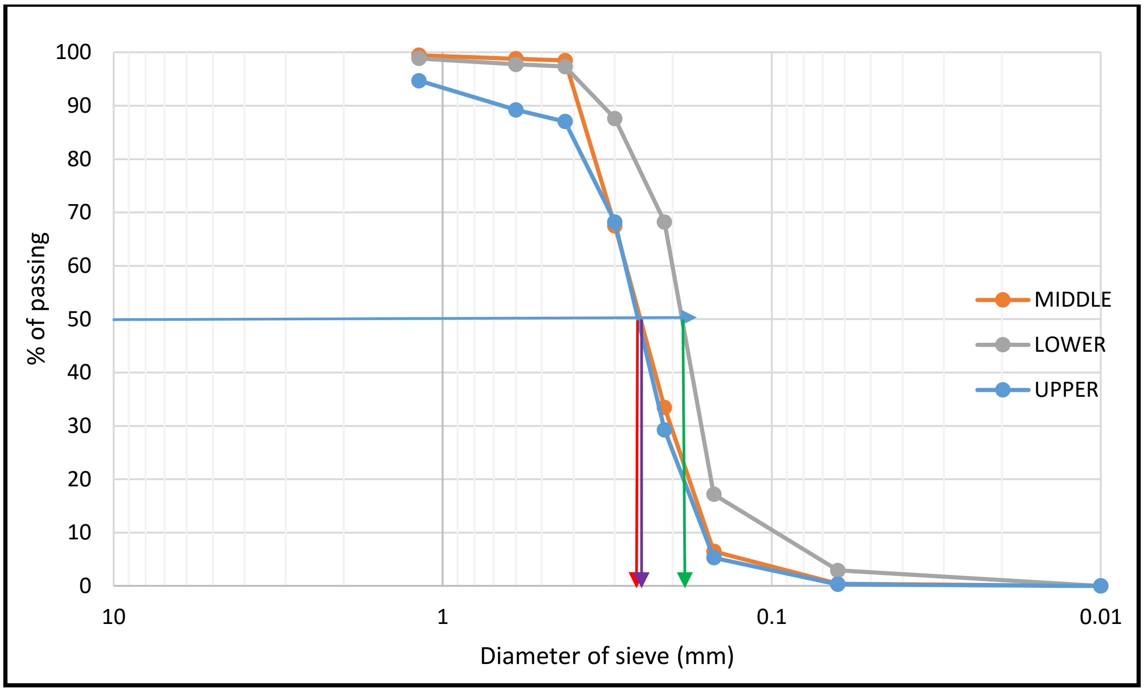


Figure 4.21 Sieve analysis of 14 March 2018

Based on Figure 4.21, the medium sizes of sand, D50 on March 14, 2018 for upper, middle and lower parts were 0.27 mm, 0.26 mm and 0.18 mm. It was clearly stated that the medium sizes were decreased among the parts. It was found that the medium sizes of all parts were highly increased compared to the previous two weeks, February 28, 2018. This situation occurred affected by the increased of rainfall depth as total 48.9 mm during this two weeks started from March 1, 2018 until March 13, 2018. The value of rainfall depth was not high because of no rainfall for 6 days. The less of rainfall really effected the changes of the sand size.

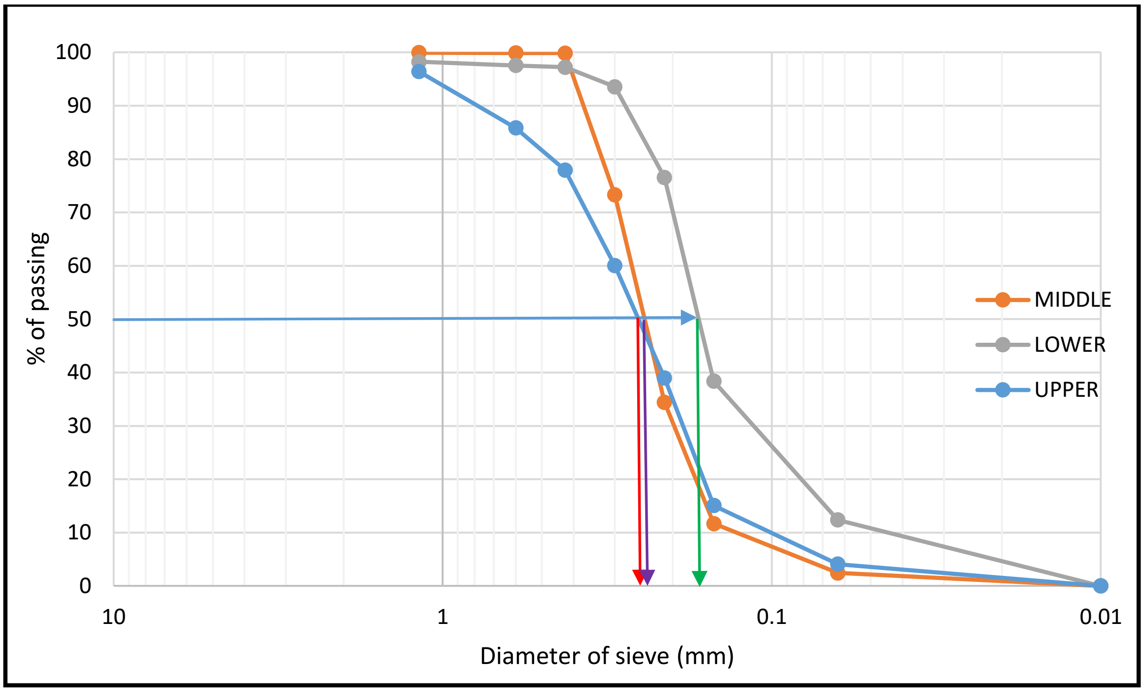


Figure 4.22 Sieve analysis of 28 March 2018

Based on Figure 4.22, the medium sizes of sand, $D_{50}$ on March 28, 2018 for upper, middle and lower parts were 0.28 mm, 0.26 mm and 0.19 mm. It was clearly stated that the medium sizes were decreased among the parts. It was found that the medium sizes of upper and lower parts were increased compared to the previous two weeks, February 28, 2018 while the medium size of middle part was maintained. This situation occurred affected by the decreased of rainfall depth as total 15.4 mm during this two weeks started from March 15, 2018 until March 27, 2018. The value of rain fall depth was small because of no rainfall for 10 days until the end of the study. The less of rainfall really effected the changes of the sand size.

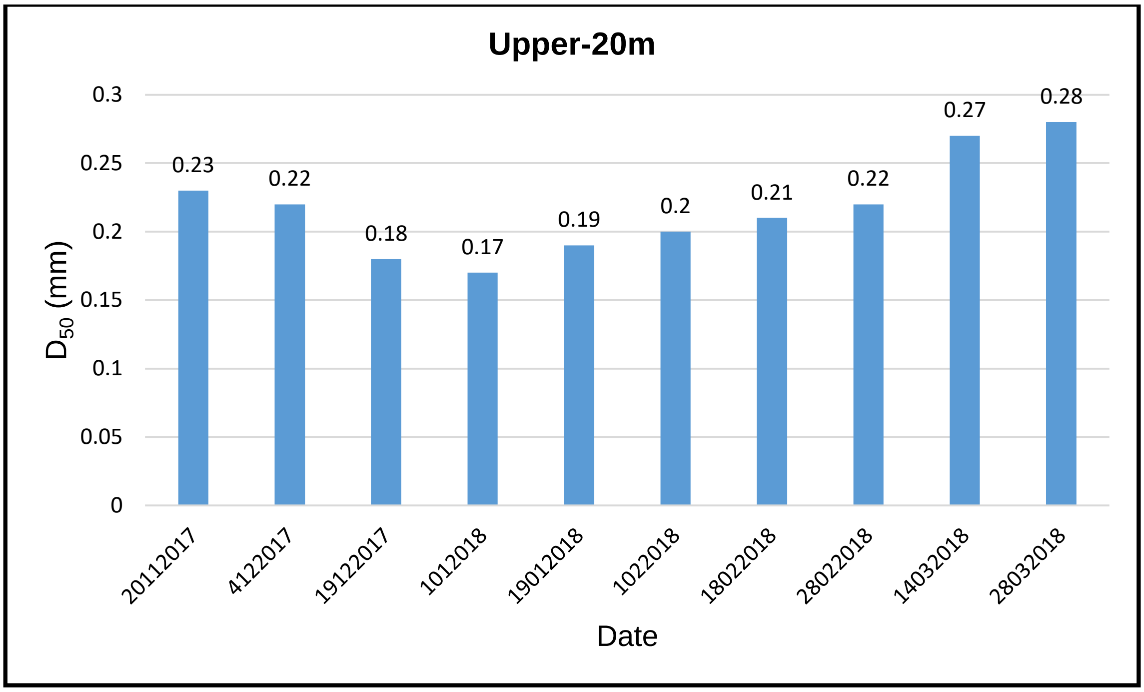


Figure 4.23 $D_{50}$ for upper part (20m)

All the values of D50 were stated in Figure 4.23 to Figure 4.25 by the following description. In additional, medium size of sand. D50 within 20 m distance from total station towards the beach decreased from November 20, 2017 which is 0.23 mm to 0.17 mm on January 1, 2018. It decreased by 0.06 mm among 43 days. This was affected by the rainfall distribution that occurred through the months. There was only 13 days no rainfall which is 30.23% from the total days. The value of total rainfall depth during this period was 719 mm which is quite high. Then, it increased slowly until February 28, 2018 by 0.05 mm within 8 weeks to 0.22 mm. It was influenced by highly rainfall that occurred in January, 2018 which is the total rainfall depth was increased compared to the previous to be 790.6 mm. Next, it increased rapidly within two weeks of 0.05 mm to 0.27 mm. Generally, the largest particle size value was at the end of the study on March 28, 2018 because of the sea water was not achieved to this level. Although it increased by only 0.01 mm within two weeks, it recorded the highest value of 0.28 mm.

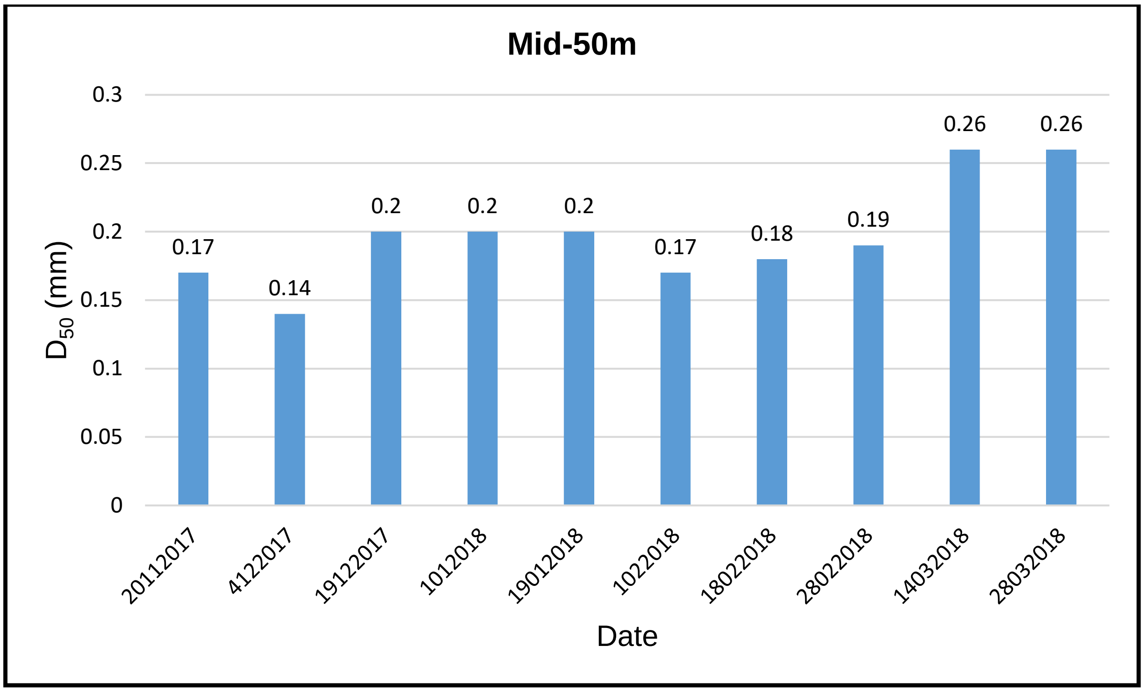


Figure 4.24 $D_{50}$ for middle part (50m)

In the first 50 m, the medium size of sand, D50 was decreased by 0.03 mm for two weeks from November 20, 2017 to December 4, 2017. This was affected by the rainfall distribution that occurred through these two weeks. There was only 4 days no rainfall which is 26.67% from the 15 days. The value of total rainfall depth during this period was 173.7 mm. It did not persist, it increased again by 0.06 mm in the next two weeks on December 19, 2017 and continues to be constant from 0.20 mm until January 19, 2018. There was 14 days no rainfall which is 30.43% from the 46 days. The value of total rainfall depth during this period was high, 1292 mm. After two weeks, the size decreased by 0.03 mm on February 1, 2018, making the size 0.17 mm. There was 6 days no rainfall which is 46.15% of this two weeks. The value of total rainfall depth during this period was small, 24.2 mm. Then, it has steadily increased by 0.09 mm within 6 weeks until March 14, 2018. There was 24 days no rainfall which is 58.53% from 41 days. The value of rainfall depth during this period was small, 68.6 mm. The particle size value of this week is the highest of 0.26 mm and it continues to constant until the end of the study, March 28, 2018.

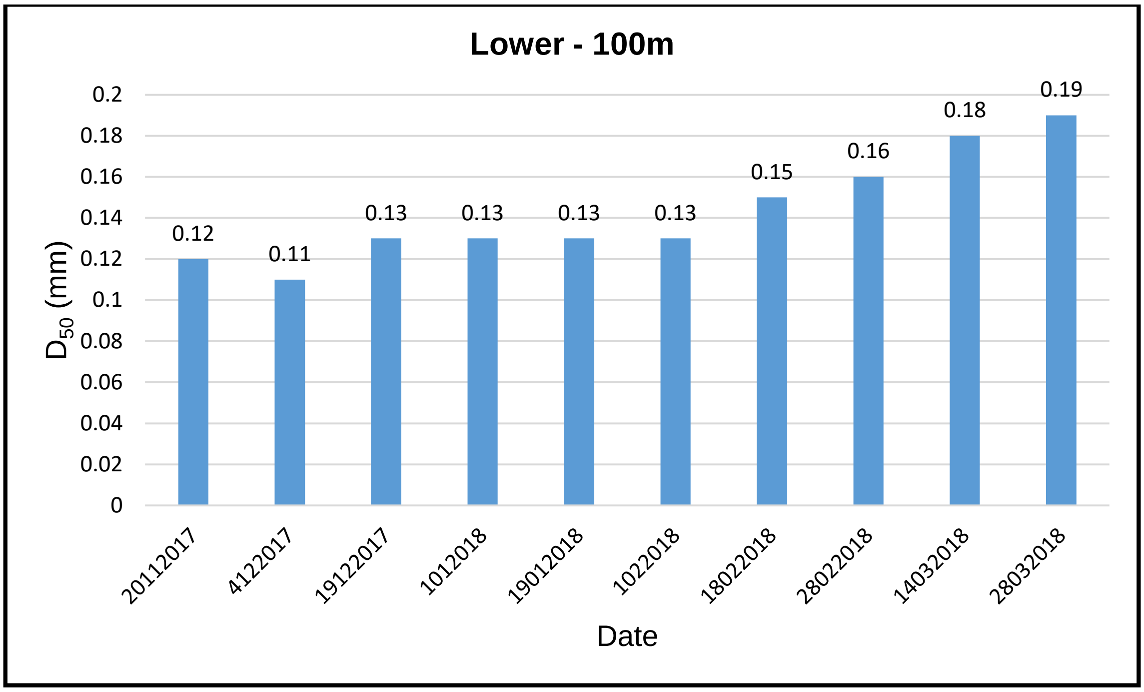


Figure 4.25 $D_{50}$ for lower part (100m)

For a distance of 100 m, the particle size is smoother than the other. The decrease process occurred by 0.01 mm from November 20, 2017 to be 0.11 mm on December 4, 2017. There was only 4 days no rainfall which is 26.67% from the 15 days. The value of total rainfall depth during this period was 173.7 mm. On the next two weeks, December 19, 2018, it increased by 0.02 mm to be 0.13 mm. There was only 6 days no rainfall which is 40% from the 15 days. The value of total rainfall depth during this period was 120.5 mm. Its medium size was kept constant for 8 weeks until February 18, 2018. There was 44 days no rainfall during this period which is 40% from the 15 days. The value of total rainfall depth during this period was 120.5 mm. There was no change in size during this period but it was increased after that until the end of the study. It increases by 0.01mm to 0.02 mm every two weeks.

# CHAPTER 5

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

Coastline is the boundary between land and sea. The shape and position are continuously changing due to ever-changing dynamic environmental conditions (waves, tides, winds and storms) which respond to the shoreline morphology and loose granular sediments. Analysis of beach morphology can determine the profile or physical attributes of a beach and thus obtain information about the short term trends (accretion and erosion) of coastal area. The processes of erosion and accretion are further intensified with the presence of monsoons.

Effect of monsoon on beach erosion or accretion are vary locally but usually affected mostly in the coastline that bordering South China Sea. In Malaysia, there are two major monsoon regimes every year, northeast monsoon (NEM) which occurs during November to March and southwest monsoon (SWM) that occurs from late May to September. During NEM, the coastal current flow was southward with heavy rain and rough at sea while the currents on SWM flows was northwards with calmer weather.

## 5.2 Conclusion

Beach profile was highly affected by the patterns of rainfall distribution which were significantly increased and decreased in the wet period and dry period, respectively. During the dry season, the beach was accreted while during wet season, the beach was erode. However, certain beach are erodes during dry season because the beach slope is small and the grain size of the particle. It was also influenced by the wave. So, the wave action easily can move the sand along the shore.

From the analysis, the maximum rainfall depth is 256.2 mm which is on January 12, 2018. The total rainfall depth for this event is 1573.9 mm within 128 days. The rainfall intensity for this event is 12.296 mm/day. In the analysis for beach profile of Pantai Sepat, the highest erosion rate occurred in between December 19, 2017 and February 1, 2018 at the upper part which is 20m from total station. But, the erosion process also occurred during the period at the lower part of the beach. The sandbars that form offshore help to protect the beach by causing waves to break farther offshore.

In this study, the morphology of beach at Pantai Sepat was determined by beach profiles changes during dry and wet period. Beach profile was highly affected by the patterns of rainfall distribution which were significantly increased and decreased in the wet period and dry period, respectively. Beach at Pantai Sepat have shown the slope becoming flatter or decrease. During the dry season, the beach was accreted while erode during wet season. This is because of the rainfall also has water behaviour which is erosive.

Field study in the beach profile related seasonal rainfall effect have been relatively few in numbers and there is a clear need to improve current available field equipment in order to get high quality data for better understanding of this complex process. Current work will continue the field observation for a long term monitoring in order to get a clear view of rate of erosion due to the seasonal rainfall effect under Malaysia's seasonal variation. Also the important of other parameters such as wind speed, wave height, wave period and wave direction need to be observed and analysed in order to enhance the understanding of this complex seasonal sedimentation process.

Based on the size of particle that collected at the beach during the study, the particle was known as sand because its sizes included in range 0.075mm to 4.75mm according to the Unified Soil Classification System, referred Table 2.1. Based on Figure 3.51, Figure 3.52 and Figure 3.53, the smallest size of particle was 0.11mm while the biggest size was 0.28mm. So that, the sand was included in very fine, fine and medium grain size. It can be referred at Table 2.2. Furthermore, the fraction passing the No.10

(2mm) U.S. sieve and retained on the the No. 200 (0.075mm) U.S. sieve as stated in AASHTO Classification System.

In additional, the median grain size, $D_{50}$ during wet season was finer than dry season. The erosion rate was increase during high tide due to high sea level and smallest average weekly rainfall is not so much affects the beach.

## 5.3 Recommendation

Options for handle coastal erosion are namely hard structural options and soft structural options. These solutions have at least two hydraulic functions to control waves and beach sediment transport in applying the solutions, their underlying principles should be well-understood, otherwise they will fail. A combination of hard and soft options has become more popular recently for optimum results because they have weaknesses when used singly. Many projects have failed and resulted in environmental and socio-economic problems because of improper design, construction and maintenance, and were often only implemented locally in specific places or at regional or jurisdictional boundaries, rather than at system boundaries that reflect natural processes.

Coastal erosion and accretion are natural processes, however, they may become a problem when worsen by human activities or natural disasters. They are universal in the coastal zone of Asia and owing to a combination of various natural forces, population growth and unmanaged economic development along the coast, within river catchments and offshore. This has led to major efforts to manage the situation and to restore the ability of the coast to accommodate short- and long-term changes induced by human activities, extreme events and sea-level rise. Understanding the key processes of coastal dynamics and how coasts are functioning both in spatial and temporal time scales (short and long term), in overlapping with human activities along the coast, within river watersheds and offshore is important for managing coastal erosion problems. Three main conclusions can be drawn on the roles that coastal forest and trees can play in handling coastal erosion.

Hard structural is options use structures constructed on the beach (seawalls, breakwaters or artificial headlands) or further offshore (offshore breakwaters). These options influence coastal processes to stop or reduce the rate of coastal erosion. Soft structural options is aim to dissipate wave energy by mirroring natural forces and maintaining the natural topography of the coast. They include beach nourishment, dune building, re vegetation and other non-structural management options.

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