Faculty of Resource Science and Technology

Coastal Vulnerability Assessment Along Pantai Cahaya Bulan

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DECLARATION OF AUTHORSHIP

I, SITI NUR NABILLA BT MOHAMAD SAYOTHI, declare that the final year project report entitled:

COASTAL VULNERABILITY ASSESSMENT ALONG PANTAI CAHAYA BULAN

.....

and the work presented in the report are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where I have made corrections based on suggestion by supervisor and examiners, this has been clearly stated;
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Signed:

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Date: 17 June 2016

Hereby I listed comments and corrections based on the supervisor and examiners suggestions:

No.	Comments from supervisor/ examiners	Correction done	Page
1	Redo the abstract	The abstract was corrected as per required	viii
2	Grammar correction	Some grammatical error was corrected	1,2,4,7,8,9,10, 11
3	Rearrange the description of the figure and graph	The description was changed before the figure.	14-30
4	Describe the results with its details	Some details was pointed out to make the result understandable by the reader	22 & 23
5	Modify the conclusions, include the recommendations	The conclusion answer the objectives requirement. Recommendation was separated from conclusion part.	40
6	Corrections on few references	Standard guideline of references was used.	41

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List of Abbreviation

AC	Adaptive Capacity
CIVAT	Coastal Integrity Vulnerability Assessment Toolkit
GPS	Global Positioning System
VA	Vulnerability Assessment
CCA	Climate Change Adaptation
PI	Potential Impact
NE monsoon	Northeast Monsoon

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Coastal Vulnerability Assessment Along Pantai Cahaya Bulan

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ABSTRACT

Coastal vulnerability assessment is very important in order to determine the current state of the climate. Sea level rise may cause huge damage for the coastal area such as coastal erosion. The erosion factor usually links to the natural disaster such as flood, exposure of the beach to the storm and the influence from the heavy rainfall. This study was conducted to identify and observe the current state of the beach condition along the coastline of Pantai Cahaya Bulan and Pantai Kundur Therefore, the vulnerability assessment was described the possible relationship of the sea level rise and coastal erosion. The Coastal Vulnerability Assessment Tools (CIVAT), beach profiling, shoreline tracing and questionnaires distribution was used to assess the coastal condition. The seasonal changes in both Pantai Cahaya Bulan and Pantai Kundur was caused due to Northeast monsoon exposure. The shoreline trend of both beach was stable from year 2006 until 2015 after viewed by Google Earth software. The perception from the visitors and local people was taken into account.

Key words: coastal vulnerability, CIVAT, beach profiling, shoreline tracing

ABSTRAK

Penilaian kelemahan pantai sangat penting bagi menentukan keadaan iklim semasa. Peningkatan air laut akan mengakibatkan kesan buruk yang teruk terutamanya kepada hakisan pantai. Hakisan pantai mempunyai hubung kait dengan fenomena bencana alam seperti banjir, kawasan pantai terdedah kepada ribut serta pengaruh hujan lebat. Kajian ini akan dijalankan bagi mengenalpasti dan memerhati keadaan semasa bagi kawasan pesisir Pantai Cahaya Bulan dan Pantai Kundur. Kelantan mengalami masalah banjir terutamanya ketika musim monsun. Hal ini disebabkan oleh dinamik kenaikan paras air laut kurang difahami sepenuhnya. Oleh itu, Kit Coastal Integrity Vulnerability Assessment Tools (CIVAT), profil pantai, pengesanan pesisir akan digunakan untuk melakukan penilaian. Keadaan perubahan musim di kedua-dua Pantai Cahaya Bulan dan Pantai Kundur adalah disebabkan oleh pendedahan terhadap Monsun Timur Laut. Trend pesisir bagi kedua-dua pantai adalah stabil sejak tahun 2006 sehingga 2015 setelah digambarkan melalui perisian Google Earth. Persepsi masyarakat setempat serta pengunjung juga telah diambil kira.

***Kata kunci**: coastal vulnerability, CIVAT, profil pantai, pengesanan pesisir*

1.0 INTRODUCTION

Climate change will bring threat to the surrounding environments either in the biological, geological or physical factors of system. In South-East Asia, the people faced several problems related to the climate change effects such as flooding and drought, coastal erosion, physical damage caused by strong wind, sea level rise, increased in the surrounding temperature including the changes of rainfall index. According to Asian Development Bank (2009), the climate change already affected Southeast Asia region due to increasing of mean surface air temperature and increase of sea level about 1-3 mm per year.

Vulnerability can be defined when the system unable to tolerate toward the climate change and may cause adverse effect (IPCC, 2007). The vulnerability will include exposure, sensitivity and adaptive capacity. The vulnerability assessment is important in order to determine the potential loss of surrounding due to climate change in periods of time. Coastal vulnerability assessment can be used by the coastal planner to identify coastal related problems and design the possible solutions.

This study was conducted in order to observe the coastal erosion due to sea level rise and monsoon effects. Kelantan has the shortest coastline in Peninsular Malaysia with 71 km long. The beach erosion occur in Peninsular of Malaysia reached almost 30% (Husain et al., 1995). In Kelantan, most of the beach experienced erosion because direct exposure to the wave from South China Sea. The erosion happened severely especially during monsoon time due to strong wave action.

Kelantan used to face the Northeast monsoon which brings heavy rainfall from the end of November until March. During this period, strong wave from the South China Sea hit the coastal area.

There are very little research conducted in Kelantan in assessing the coastal vulnerability. Instead of that, there are only few data obtained regarding this field of study in previous years. Moreover, the latest data is needed to support the development plan for the better coastal management.

In this study, the Coastal Integrity Vulnerability Assessment Tools (CIVAT) tool kit which is one of the Coral Triangle Initiative Climate Change Adaptation (CTI CCA) was used in order to investigate the potential vulnerability and its adaptation of coastal in Kota Bharu, Kelantan. Coastal area is very important in term of geological form, biological relations and economic sectors. In order to assess the condition of the coastal area, several measures must be well prepared. Therefore, designing the project and its aim is very important. The purposes of this study was to;

1. Identify the vulnerability of the coast by using the exposure factor such as sea level rise
2. Carry out vulnerability assessment including beach profiling and shoreline tracing
3. Identify the level of awareness of the local people about the importance of coastal area

2. LITERATURE REVIEW

2.1 Geomorphology of Kelantan's coastal area

Kelantan's coastal area faced toward South China Sea. As stated by Teh and Yap (2011) erosion occur in Pengkalan Datu resulted in the formation of delta and lagoons. The sea level rose up to 40 m during the northeast monsoon (Teh & Yap, 2011). Pantai Cahaya Bulan and Pantai Sabak was threatened with erosion especially during Northeast monsoon (Raj et al., 2007). In Kelantan most of the beaches were narrow and limited.

Severe erosion caused the deposition of the sediments to the north part of Kelantan's coastal area. Therefore, the formation of delta at the Kelantan river mouth is supported with the erosion that occur in the south of the Kelantan coastal area. The longshore transported to delta from Pantai Cahaya Bulan coast estimated about 778000 cubic meters every year. The sediment were transported away from the beach was because of the effect of break water built in Pantai Sabak. The breakwater was one of the initiators used to protect the beach from erosion, but for the long term effect, the sediments were carried away from the beach to another place due to alteration of wave pattern.

Based on the data obtained from the Department of Irrigation and Drainage (2009), the erosion of Kelantan's shoreline which critically eroded was about 5 km, significant erosion was 9.5 km and acceptable erosion was 37.6 km. The total erosion occurs in 2007 was 52.1 km. Based on the data provided, the erosion occurs severely along Kelantan's beach area.

2.2 Tidal Flooding

According to Pradhan (2009), floods are one of the reason of properties and life loss which frequently happen. The combination of natural and human factors lead to a flood phenomenon in Malaysia (Ngai, 1995). Kelantan is one of the state in Malaysia which faced the flood problem almost every year. According to Malaysian Institute of Architect (2015), Malaysia's National Security Council recorded that the worst flood scenario happens in Kelantan was in the year 2014. All the residential area was flooded and danger to the people. Most of the victims were placed at the new location for temporary.

According to Low (2006), severe flood affected at the east coast of Peninsular Malaysia was due to the monsoon. The movement of the wind was set to south after it passed through the eastern Malaysian. The flood was caused by heavy rainfall brought by monsoon (Khan et al., 2014). Therefore, after the flooding phenomenon occurs in Kelantan, the following event takes place in Johor.

During monsoon, the tidal flooding may occur and reach beyond the king tide of the coastal area. Strong wave, tides, storm and influence from the high precipitation may cause the tidal flooding. According to Sweet and Marra (2015), tidal flooding occurs due to sea level rise in that particular area. In Kelantan, due to the diurnal phenomenon where the earth at the closest point to the moon, there were gravitational attraction which cause the tidal level high. Sea level rise which causes the area of the beach became reduce, so the tidal flooding exceeding the king tides level and affected the nearby village. The tidal also affect the erosion of the beach for long term effect.

2.3 The Process of Coastal Erosion

Coastal erosion can be defined as the process where shoreline undergoes some changes, especially the breakdown of the sediments and rocks in land and below water surfaces. The erosion happens as the result of wave effect and sea level rise. Coastal erosion caused the structure of the beach loose and the landward movement of the shoreline. Coastal erosion happens during the strong wind, strong wave and tidal effect. The process of coastal erosion occurs in a long time. The coastal erosion and coastal deposition may occur at the same time depending on the inputs from the river, sea level and the tectonic activities. The coastal erosion drive by hydraulic action. Water from the sea hit the rock and the surface of the sand. The wave will transport the sand away from the beach.

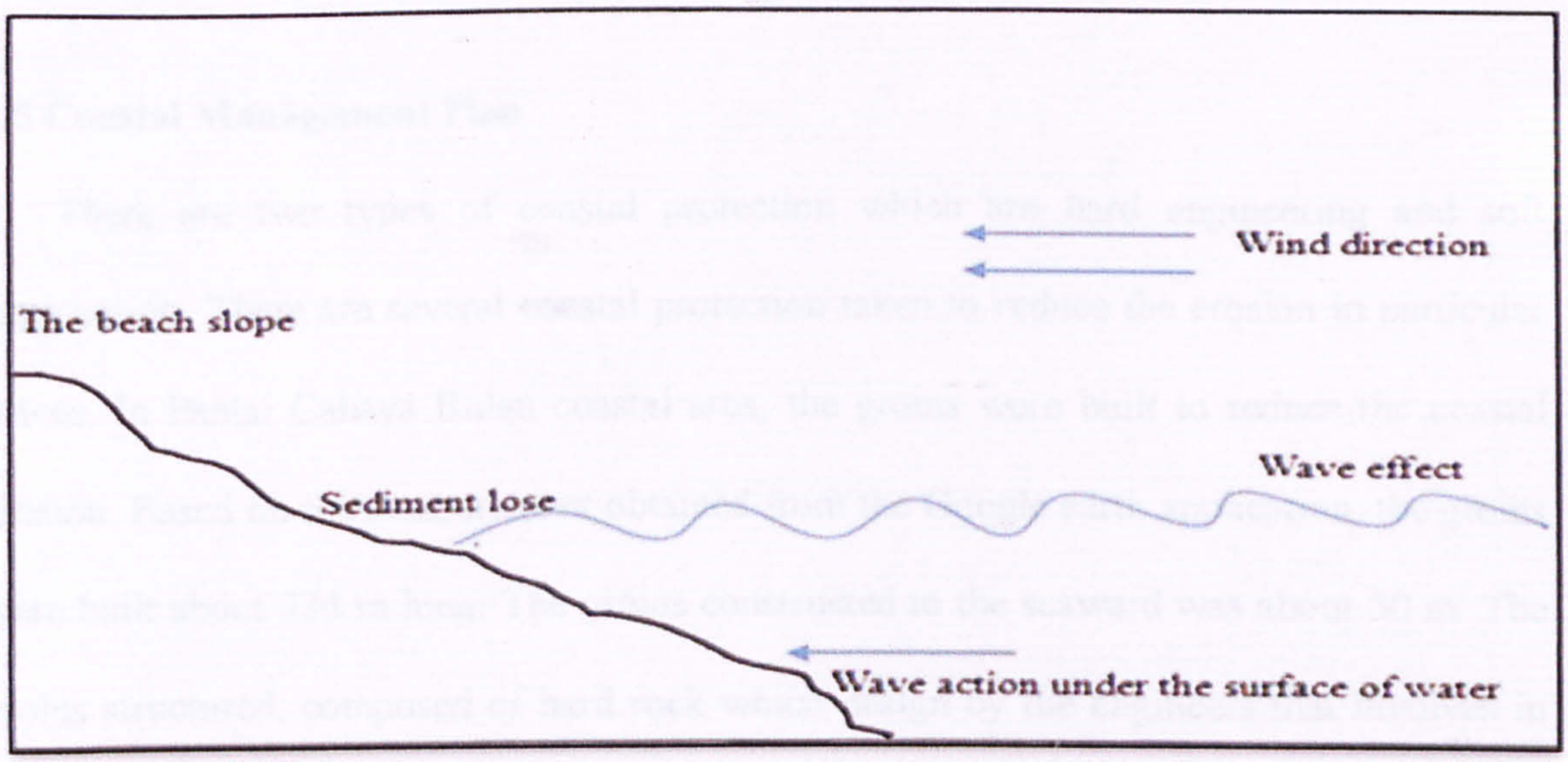

Figure 1: The illustration of wave and wind force which affect the sediments under the surface of water and the beach.

2.4 Relationship of Climate Change and Sea Level Rise

The climate change alters the surrounding environmental condition. The sea level rise is hardly estimated and difficult physical problem (Rahmstorf, 2006). This is because some factor such as thermal expansion and the penetration of heat into the ocean water will affect the melting of ice. The global warming causes the change of climate and expected as the reason for the acceleration of sea level rise Galbraith *et al.* (2002).According to Rahmstorf (2006) the model exists in monitoring the sea level rise is not yet mature. Instead of using the satellite data, the manual approach should be done in the selected area. The result of the monitored area can be used to support the data obtained from the satellite. Sea level rise is natural process which human must be adapted to it. It may accepted as the hazard to the local community, therefore good coastal planning is required in order to reduce the effect of coastal erosion.

2.5 Coastal Management Plan

There are two types of coastal protection which are hard engineering and soft engineering. There are several coastal protection taken to reduce the erosion in particular places. In Pantai Cahaya Bulan coastal area, the groins were built to reduce the coastal erosion. Based on the measurement obtained from the Google earth application, the groins were built about 734 m long. The groins constructed to the seaward was about 50 m. The groins structured, composed of hard rock which design by the engineers that involves in coastal management planning. Groins construction depends on the direction of maximum wave and the configuration of the shoreline. The groins performances must be able to withstand the wave force, stable, wave reflection and the designed model will be checking in a wave flume (Palmer, 1998).

3. METHODOLOGY

3.1 Study Area

This study was conducted at the Kota Bharu beach in Kelantan. Three stations were set along the shoreline of Pantai Cahaya Bulan and Pantai Kundur. Pantai Cahaya Bulan was also known as a famous recreational area in Kota Bharu. Pantai Kundur located at Kampung Pulau Kundur. Badang River acts as a border between Pantai Cahaya Bulan and Pantai Kundur. The study was conducted during the early of NE monsoon (November 2015) and at the end of the NE monsoon (February 2016). The expected months for the heavy rainfall and high wave impact at Kelantan usually within November to end of March. Each beach has three stations labelled as Station 1, Station 2 and Station 3.

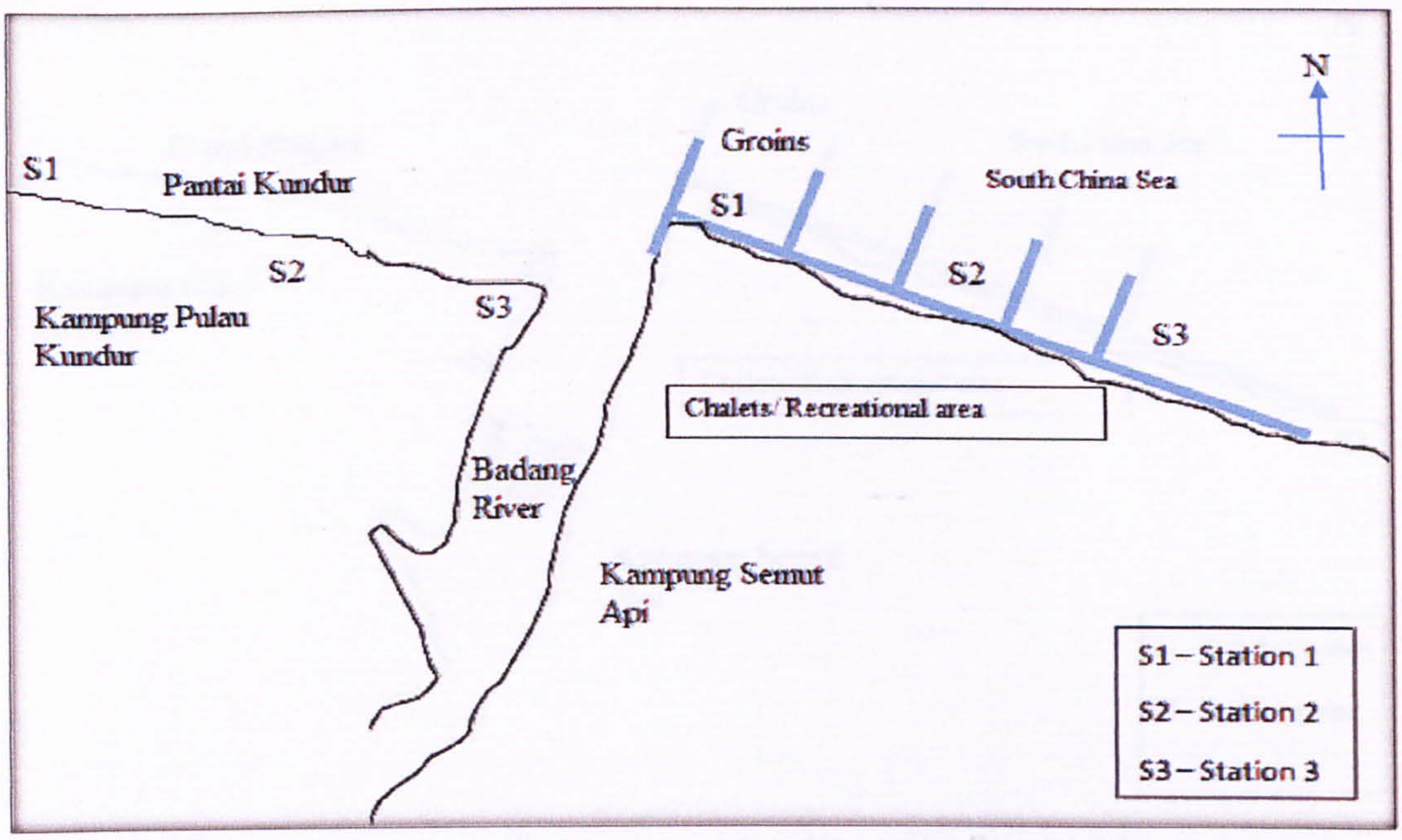

Figure 2: The study area of coastal assessment in Kota Bharu coastal area.

3.2 Shoreline Tracing

Rate of change in the shoreline position used by the researchers for coastal planning and management (Kraus and Rosati, 1997). Shoreline tracing was used to detect the sea level rise. The shoreline tracing is important to identify the position of the current shoreline and the data can be compared with previous years by using Google earth application. The shoreline tracing technique requires Global Positioning System (GPS). At the starting point, the coordinates were recorded. For each 20 steps, the coordinates was recorded. The same steps were repeated until the last point. The total distance for shoreline tracing in each beach was about 1 km long.

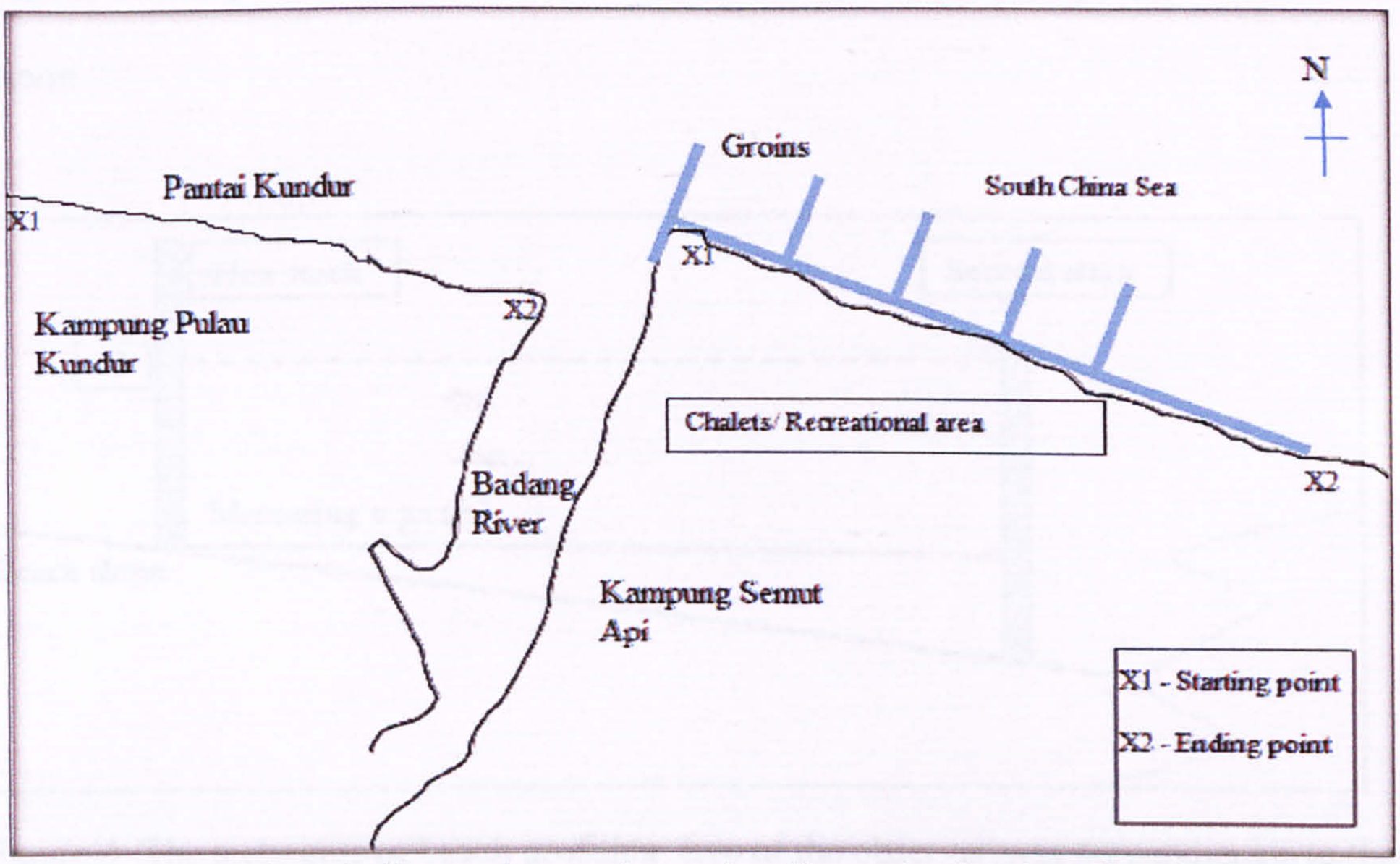

Figure 3: X1 and X2 indicates the starting and ending point for shoreline tracing in each beach.

3.3 Beach profiling

Beach profiling is a method introduced by Emery to determine the difference in level along the beach profile (Andrade & Ferreira, 2006). The height or the changes of elevation of the beach was determined by beach profiling data. Beach profiling at Pantai Cahaya Bulan and Pantai Kundur was done by selecting the king tide point. By using 2 sticks with 1 meter long and measuring tape, the measurement take placed from the king tide point until the shoreline. The first stick was placed at the first point. The distance were measured about 50 meters and the second stick were placed. The reading was recorded with respect to the horizon of the sea. There were three stations of beach profiling in each beach. The data collected from the pre-NE monsoon was compared to the data obtained from the end of NE monsoon.

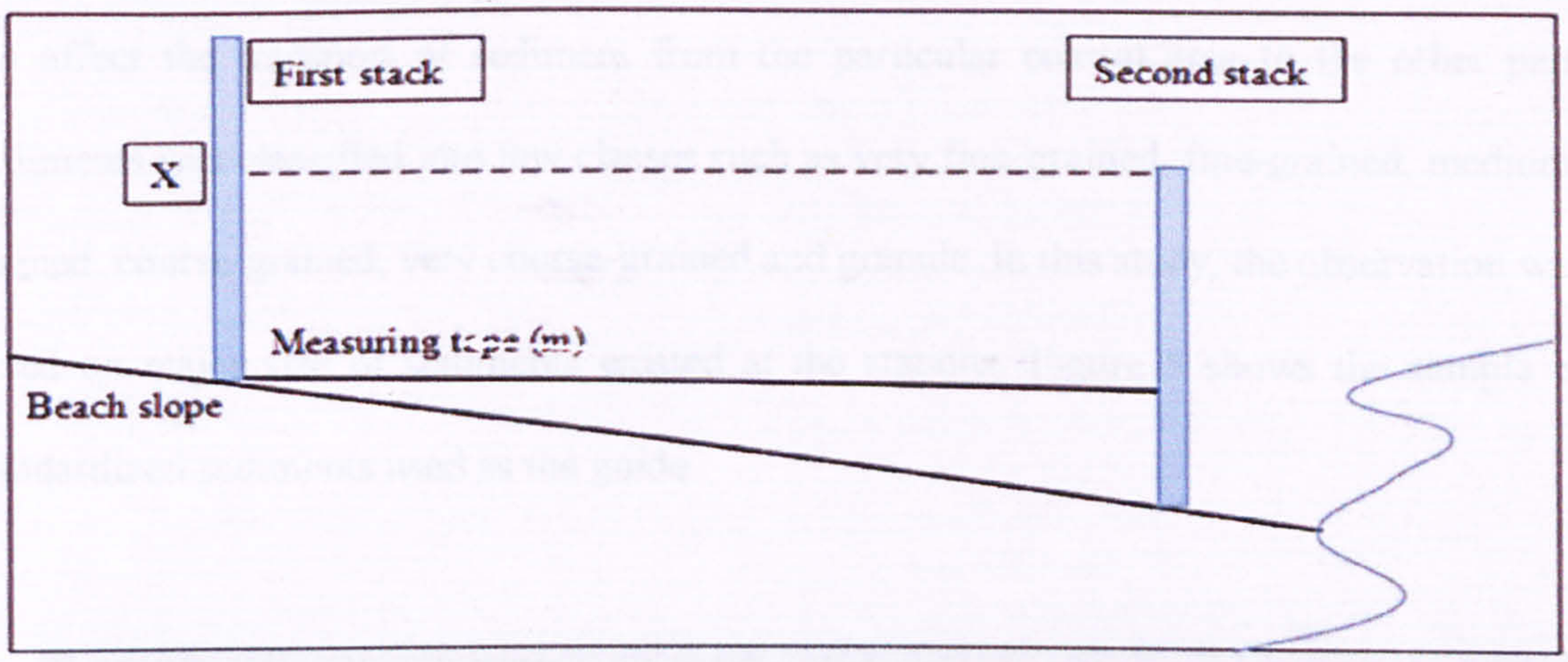

Figure 4: The technique of beach profiling. Eye of the observer was perpendicular to the horizon. Two person hold the stick and another person record the readings. The method was introduced by Emery.

3.4 Satellite Data and Image Overlay

There are few methods can be used to detect the changes of shoreline in particular beach such as ground surveying, modern altimetry technology and image measurement (Chen & Rau, 1998). In this study, the data obtained from the sampling was analyzed and compared by using the data from the satellites through Google earth software. The data of shoreline of historical image from years 2006 and 2015 were compared. The map of Pantai Cahaya Bulan coastal area was constructed by using overlay method by Google Earth software. From the image overlay, the changes of the shoreline trend was detected.

3.5 Sediments

The dominant sediments was observed in each station of both Pantai Cahaya Bulan and Pantai Kundur. Sediments size is very important because the size of the sediment one of the factor that lead to accretion and erosion of the coastal area. In addition, size of sediments can affect the transport of sediment from the particular coastal area to the other part. Sediments was classified into few classes such as very fine-grained, fine-grained, medium-grained, course-grained, very course-grained and granule. In this study, the observation was based on major size of sediments existed at the stations. Figure 5 shows the sample of standardized sediments used as the guide.

Figure 5: Siliciclastic-Carbonate Mixed used as size parameter to observed the size of the grains.

3.6 Coastal Vulnerability Assessment Tools (CIVAT)

The Coastal Integrity Vulnerability Assessment Tools (CIVAT) is a type of monitoring method used to assess the biological, physical and geological features of the beach toward risk and the adaptability. The CIVAT has been created to assess the ecosystem based management of the particular coast (Siringan et al., 2013). This assessment was conducted by previous researchers in order to assess the adaptation of the surrounding environment towards the climate change. There were several parameters was analyzed to get the data. This method was focused on coastal integrity. The hazard present especially in Pantai Cahaya Bulan was sea level changes and wave. The data obtained from this assessment used to analyze the current condition of the site, therefore early risk of the related can be detected.

Siringan *et al.* (2013) introduced this method in order to detect the potential hazard and how its affect the coastal area. CIVAT is the method where the rubric for assessing the coastal condition has been prepared. The score was given and the vulnerability of the coastal area was identified by using the CIVAT rubrics and guidelines. There were three steps of vulnerability assessments. The Pre-Vulnerability Assessment (Pre-VA) involves in identifying the suitable scale and the scope. The initial data was collected. The next steps followed by VA itself where the exposure factors analyzed. The Post-VA includes the adaptation of the local to survive with the potential hazard, the action that must be taken and the feedback of monitoring method (Siringan et al., 2013). The guide of assessment scoring can be refer in Table 1.

Table 1: Assessment on the impact of alteration of sea level rise and wave (adapted from VA Tools for Coastal Ecosystem: A Guide Book)

Adaptive capacity criteria	**Low (1-2)**	**Medium (3-4)**	**High (5)**
The shoreline trend in long term (m/year)	<< -1 (eroding)	-1 and 0	> 0 (accreting)
Continuity of sediment supply	If interruption of in sediments supply is regional	If interruption of sediment supply is localized	If sediment supply is uninterrupted
Guideline regarding easement (setback zone)	No provision for easement for (setback zone) in the CLUP and zoning guideline	Setback policy is clearly stated in the CLUP and zoning guideline	Implementation of setback policy is at least 50%
Guideline on coastal structure	Zoning guideline that promote the development of permanent and solid based structure along the coast	Semi-permanent structure that build along the coastal	The structure that caused damage to the coastal area will be removed
Type of coastal development	Industrial, commercial	Residential	Agriculture, open space, greenbelt

3.7 The Questionnaire

A standard questionnaire was prepared to survey the awareness of importance of coastal area to the local community. The questionnaire was prepared both in Malay and English language. The target person for this study was 40 persons which age ranged from 15 years old to 60 years old with various social back ground. The questionnaire helped this study to identify the suitable method to approach the local community for coastal educational purposes and the effective awareness program. The questionnaire was attached in Appendices 6.

4. RESULT

4.1 Beach Profiling

Figure 6 represent the graph of the differences in elevation dz (cm) during the pre-NE monsoon and at the end of NE monsoon of Station 1 in Pantai Cahaya Bulan. Based on Figure 6(i), the red line represent pre-NE beach profile while blue line represent end of NE beach profile. The gradient of pre-NE was -3.6085 while the gradient of end NE monsoon was -2.9147. The high value of gradient show that the accretion occur at that station. The starting point of both data collection was slightly differ due to beach condition at that particular period.

Figure 6(ii) shows the difference of elevation dz (cm) at Station 2 of Pantai Cahaya Bulan. The gradient of elevation during pre-NE was -2.4617 while the value of gradient at the end of monsoon was -1.645. Based on the graph, the beach undergo accretion at Station 2.

In Station 3 of Pantai Cahaya Bulan, the seasonal erosion was occur. It was proved where the value of the gradient during pre-NE monsoon was higher compared to end of NE monsoon. The graph of elevation can be referred in Figure 6(iii).

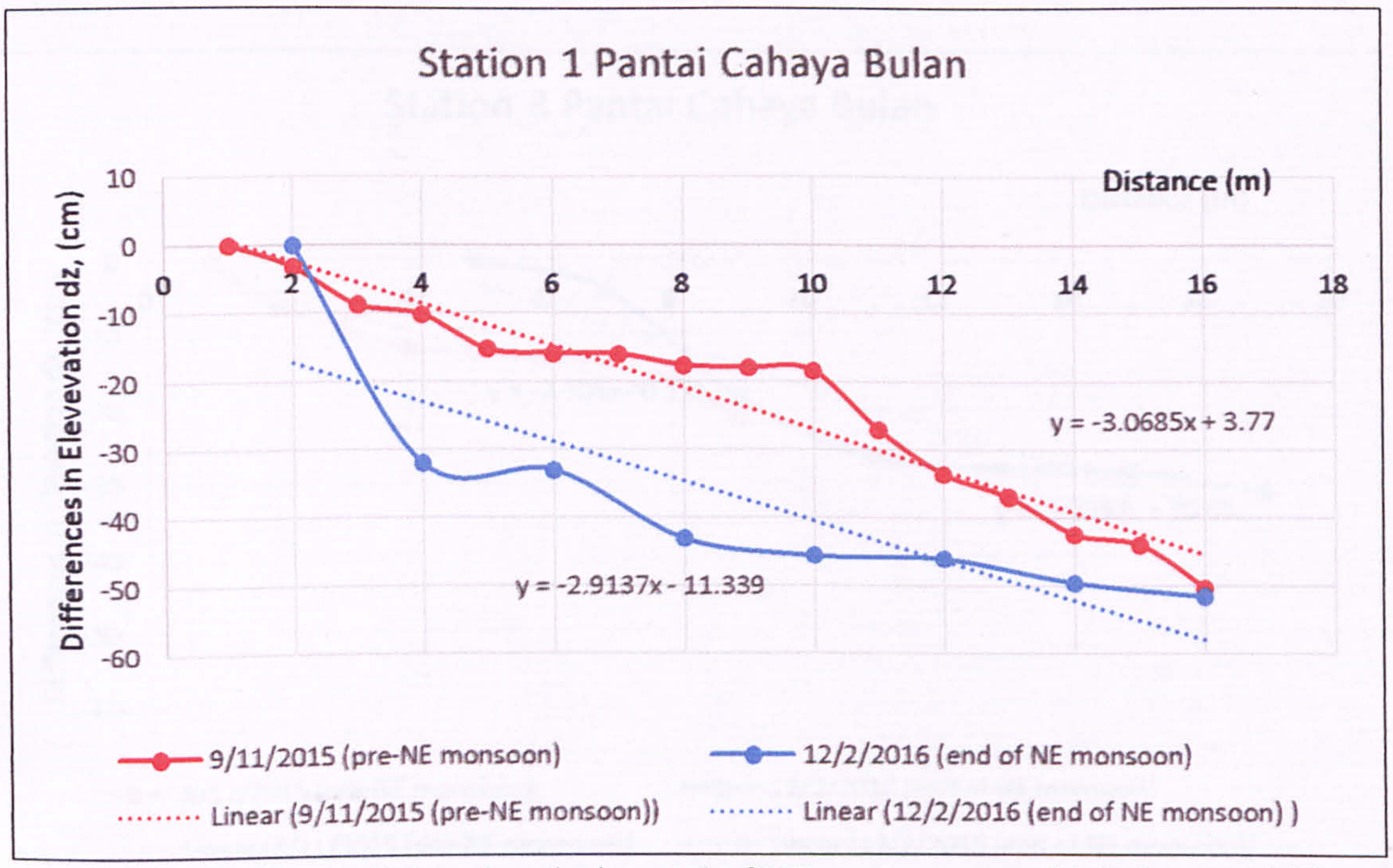

Figure 6(i): Gradient of elevation during end of NE monsoon was high than pre-NE Monsoon. The difference of gradient was about 0.1548.

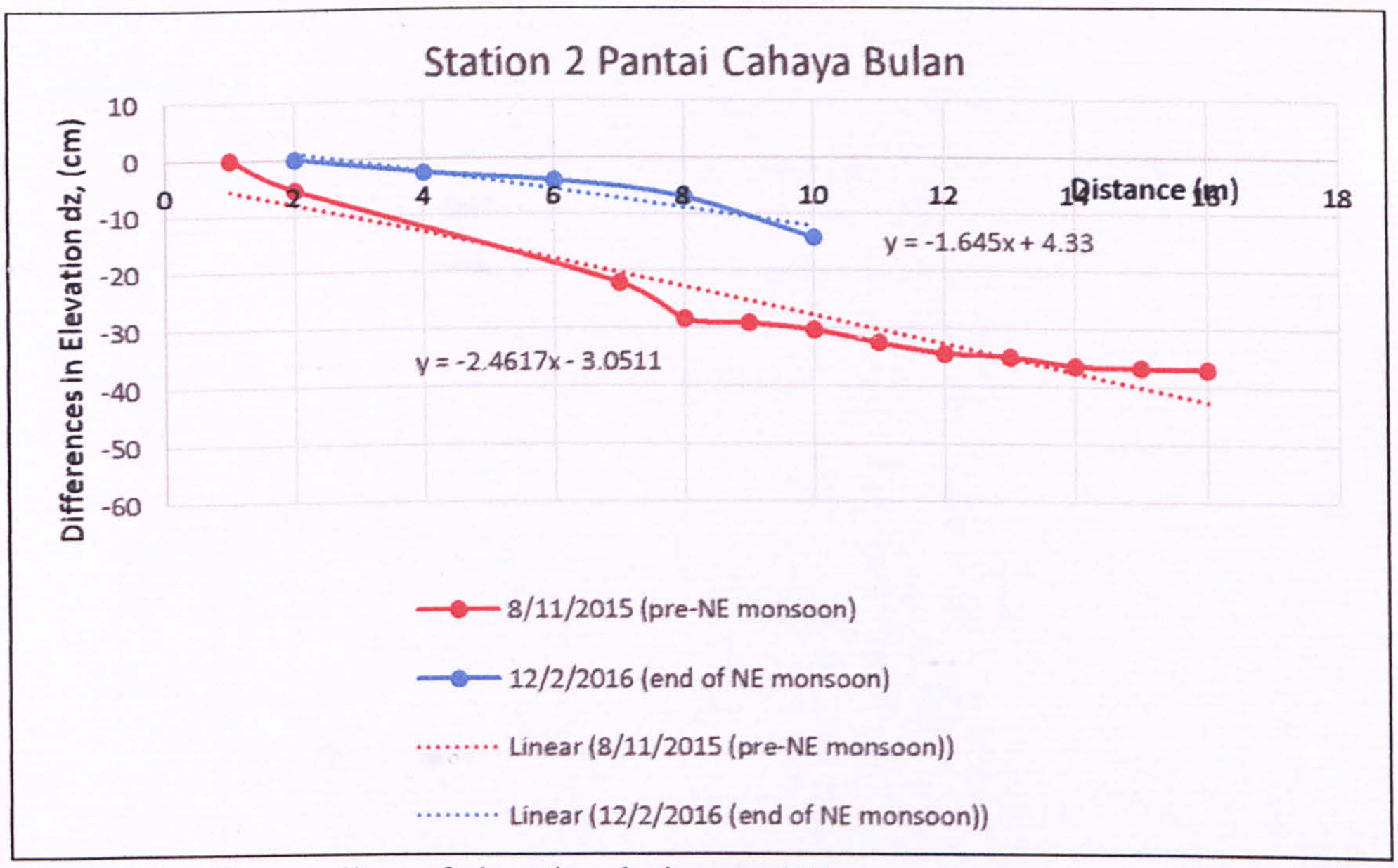

Figure 6(ii): The gradient of elevation during pre-NE monsoon was lower than end of NE monsoon. The difference of gradient was 0.8167.

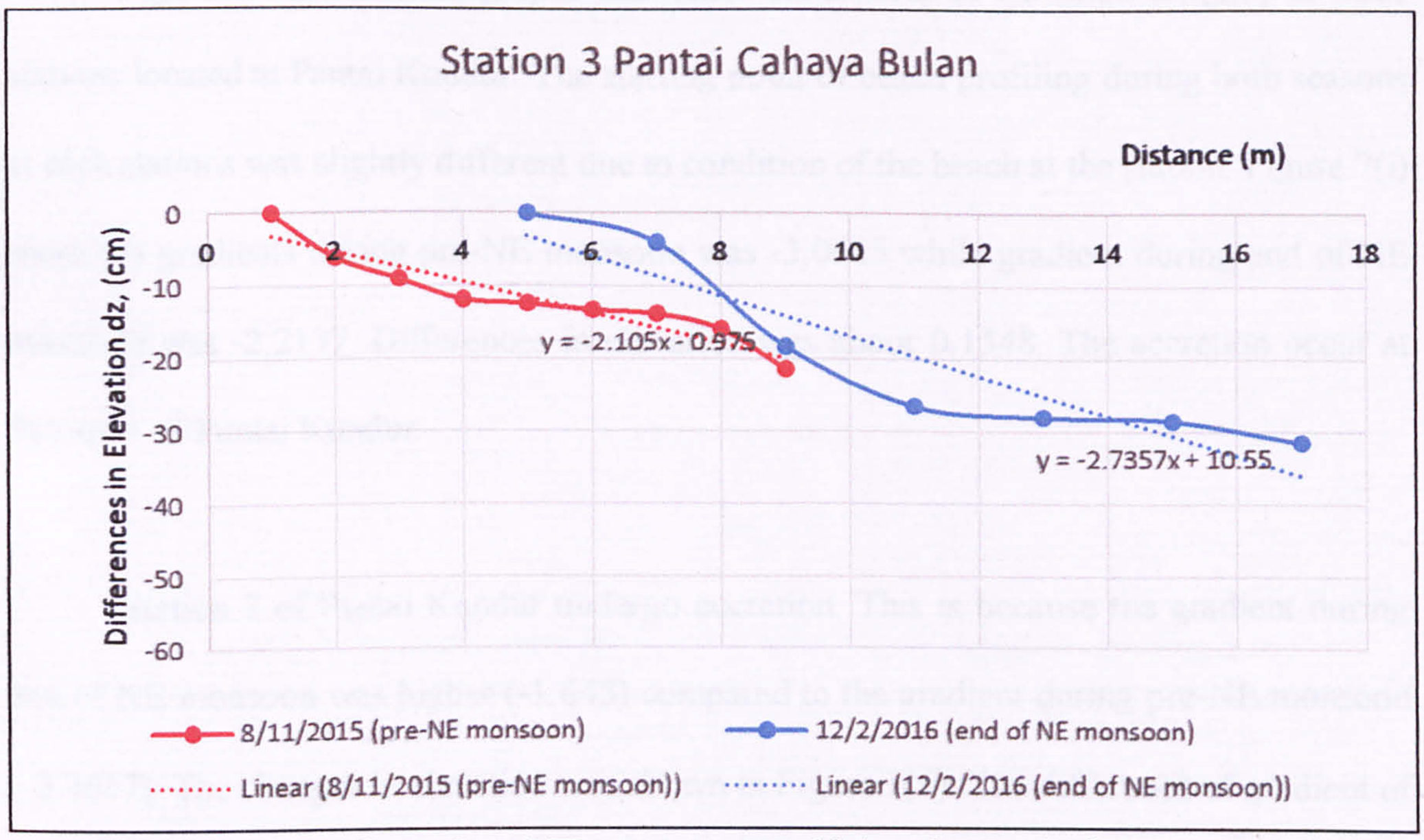

Figure 6 (iii): The gradient of pre-NE monsoon was higher than end of NE monsoon The difference of gradient was 0.6307.