Beach Profile Changes using RTK GPS : A Case Study

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Abstract. Beach profile changes are subjected to various parameters such as tides, currents and wave effect. This study investigates the beach profile changes at Teluk Gorek Beach, Mersing and to evaluate the effect of soil density on beach sediment. A total of seven beach profile cross-sections with offset of 20 m apart were established to monitor the presence of erosion and accretion. The monitoring work was done on January and March 2016 during spring tide. The estimation of erosion and accretion were performed by comparing the profile obtained on January and March. The result shows that the beach profiles have experienced both erosion and accretion during the period of study. The soil density change varies to the erosion and accretion process. As a conclusion, the beach is slightly changes during the period of study. The density increase for erosion process while decrease when accretion takes place.

Introduction

Malaysia has a long coastline and associated coastal zone of about 4809 km and about 29% or approximately 1380 km is facing erosion problem as reported in [1]. The increasing incidence of coastal erosion threatens the coastal population and leads to the loss of properties along the coastlines. Beach shoreline changes are a complex process which involving oceanographic and coastal process including waves, tides, currents, and sediment transport. In order to measure and gain an understanding of these processes, a variety of techniques can be used including the use of mathematical models, aerial photography and topographic surveys can be employed.

Beach profiles are traditionally surveyed at right angles to the contours, from datum points backshore down to the low water mark and into shallow water as stated in [2]. Various survey methods can be employed to determine the magnitude of beach profile changes, whether it is short or long term. Changes in the beach profile are usually measured by repeating the topography profile surveys along and across the beach can be done using various tools such as levels, theodolites, total station, bar profiler and RTK GPS technology.

Most well survey techniques used vary from site to site are leveling and total station. However, the most frequently used data capture method is by using total station as stated in [3]. The time used to collect the data is less than leveling since the instrument generally has to be set up less frequently. The advantages using total station is the data is saved automatically and no manual recording of data is required.

In order to investigate the beach profile changes, the accurate baseline or cross section is required. The locations and the elevations must be known accurately. As described in [4], the elevation distance along the baseline must be determined for the volume of erosion and accretion estimation. The profile lines are used as reference for future study. In order to study the beach profile changes, each profile survey work must use same location in order to get the variation of beach profile changes between consecutive studies.

RTK GPS is particularly well suited to repetitive surveys since fairly long stretches of coastline can be surveyed from a single base station set up. The system is well suited to low light conditions and can be used in complete darkness as reported in [2]. It is also well suited to measurements of slope stability in areas of unstable terrain since no control is required within the zone of instability.

Beach morphology monitoring using RTK GPS surveying techniques was widely accepted as an accurate and efficient means to collect coastal morphology data. Survey done as in [5] stated that

RTK GPS is suited to repetitive surveys since long stretches of coastline can be surveyed from a single base station set up and can be conducted considerably more efficient.
Recently, RTK GPS have been used for surveying beach profile changes. Due to the advantages of RTK GPS highlighted by previous researchers, the RTK GPS was selected for this study in addition of the tools availability in faculty.

This study investigates the beach profile changes at Teluk Gorek Beach, Mersing and to evaluate the effect of soil density on beach sediment. A total of seven beach profile cross-sections with offset of 20 m apart were established to monitor the presence of erosion and accretion. The monitoring work was done on January and March 2016 during spring tide.

Methodology

The methodology flow of this study is as follows:

1. Identify the problem and do literatures review about the selected topic.
2. Collect data and soil samples from study area.
3. Conduct laboratory soil analysis to obtain soil data in order to relate and strengthen the beach profile changes produce from RTK GPS.
4. Analysed data and produce results.

Data Analysis

The beach profile changes study at Teluk Gorek Beach was undertaken on January 2016 and March 2016 using RTK GPS technique. Within this period, the beach profile changes for seven cross-section lines have been successfully obtained. In this chapter, discussion will focus on findings and analysis of the results obtained in order to estimate the presence of either erosion or accretion during the study period.

The beach profile changes study at Teluk Gorek Beach was undertaken on January 2016 and March 2016 using RTK GPS technique. Within this period, the beach profile changes for seven cross-section lines have been successfully obtained. The followings are the results obtained from the study that has been carried out (Figure 1).

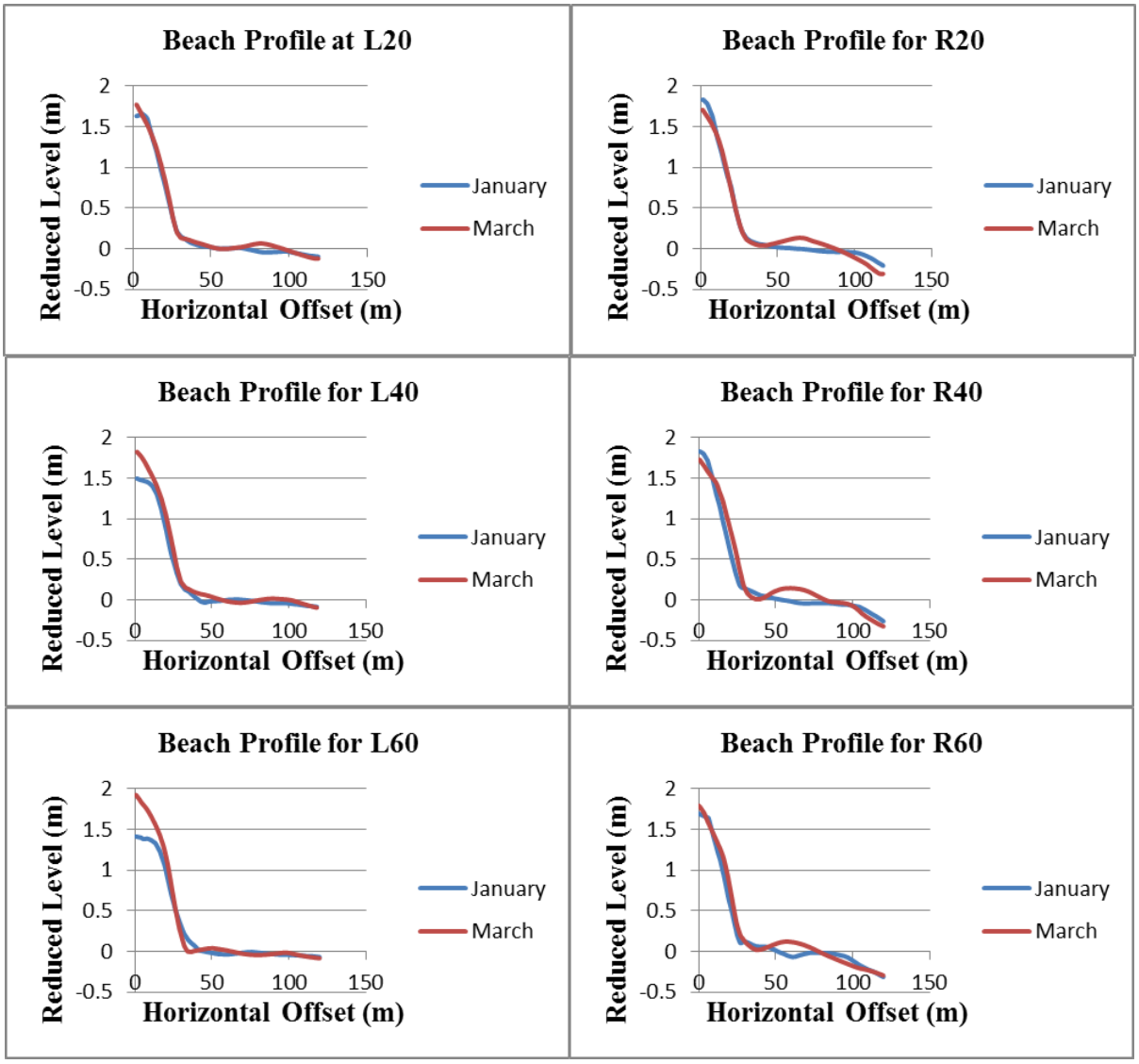
Profile line at CL is located at the middle of the other profile. It acts as a control profile to other cross-section. Profile line at L20 is located at 20 m offset to the left of the control profile and profile line R20 is located at 20 m offset to the right of the control profile.

According to the result of the study, variations of the profile have been recorded within the period of study on January and March 2016. There is a number of accretion processes occurred (Table 1) especially towards the intertidal zone where the area is most affected by waves and tides. As the beach goes down to the low water line into the intertidal zone, variations of accretion process along profile line can be observed before it turns to erosion process.

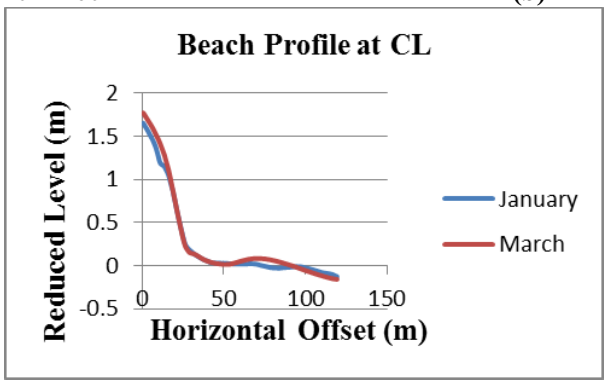
Table 1:Value of Erosion and Accretion (m)

Lines	L60	L40	L20	CL	R20	R40	R60
Maximum	-0.0003	-0.0008	-0.0004	-0.0004	-0.0030	-0.0001	-0.0035
Minimum	-0.1538	-0.0401	-0.0739	-0.0480	-0.1590	-0.1391	-0.0799
Average	-0.0399	-0.0196	-0.0151	-0.0226	-0.0678	-0.0647	-0.0418
TOTAL AVERAGE						-0.0388	

Lines	L60	L40	L20	CL	R20	R40	R60
Maximum	0.5107	0.3290	0.1398	0.2217	0.1363	0.2854	0.2290
Minimum	0.0015	0.0055	0.0002	0.0006	0.0020	0.0064	0.0032
Average	0.1135	0.0838	0.0417	0.0637	0.0699	0.1195	0.0942
TOTAL AVERAGE						0.0838	



(a) L20 – L60 **(b)** R20 – R60



(c) CL

Figure 1: Beach Profile Cross-Section

All profiles show that there are few erosion and accretion processes take place within the study period. As in Table 2, profile line R40 undergoes largest accretion process while profile line R20 undergoes largest erosion process. The average depth of erosion is 0.0388 m and accretion is 0.0838 m. It can be conclude that the beach faced accretion process during the period of study.

From the analysis, a graph was plotted for each of the soil samples. Figure 2 shows the bulk density for every sample taken from the site in January and March 2016 respectively and the value as in Table 2.

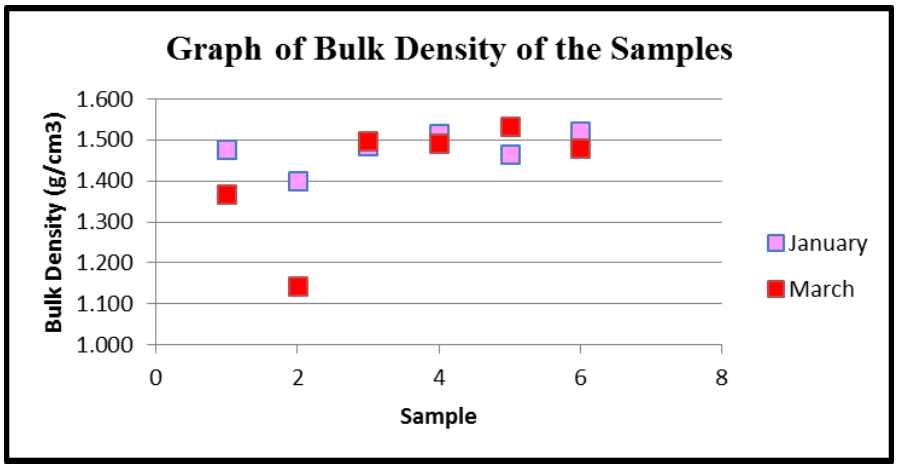


Figure 2**:** Graph of Bulk Density

Table 2: Value of Bulk Density (g/cm^3)

Sample Point	Bulk Density for January 2016 (g/cm³)	Bulk Density for March 2016 (g/cm³)	Difference (g/cm^3)
1	1.478	1.369	-0.109
2	1.400	1.143	-0.257
3	1.487	1.499	+0.012
4	1.516	1.493	-0.023
5	1.464	1.534	+0.070
6	1.522	1.481	-0.041

The analysis of the soil samples shows that there was no significant difference for sample 3, 4, 5 and 6. Sample 2 shows the largest difference between samples taken in January and March. The difference is 0.257 g/cm³.

Graph of beach profile with reduced level of sample is plotted as in Figure 3. The cross section lines are exactly on the sample points. The difference in reduced level for each sample is tabulated in Table 3. Positive value in the table shows that the beach undergoes accretion process while the negative value shows erosion process.

Table 3: Difference in Reduced Level of Samples

Sample Point	Reduced Level on January 2016 (m)	Reduced Level on March 2016 (m)	Difference (m)
1	1.044	1.262	+0.218
2	1.030	1.292	+0.262
3	0.003	-0.042	-0.045
4	0.008	0.176	+0.168
5	-0.078	-0.160	-0.082
6	-0.067	-0.060	+0.007

From Figure 2 and Figure 3, the graphs show that the bulk density of soil increased when accretion process occurred and decreased for erosion process. Since bulk density relates to the combined volume of the solids and pore spaces, soils with high proportion of pore space to solids have lower bulk densities than those that are more compact and have less pore space.

Bulk density typically increased with soil depth. The density is higher as the soil goes deeper. The maximum difference in reduced level of the sample is 0.262 m. This occurred at sample point 2 as it undergoes accretion process. The bulk density for sample 2 decreases 0.257 g/cm^3. Loose soil with low densities is transported by wave to the foreshore and settles.

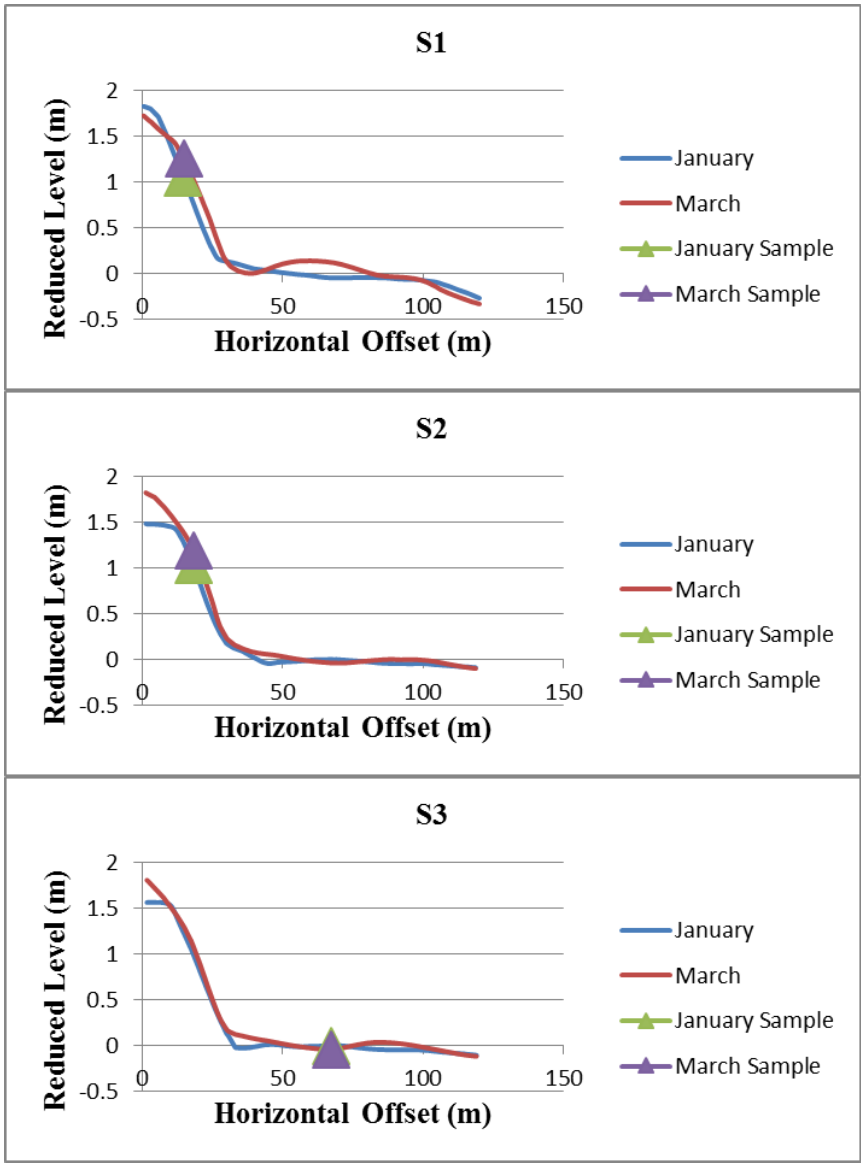


Figure 3:Beach Profile with Reduced Level of Samples

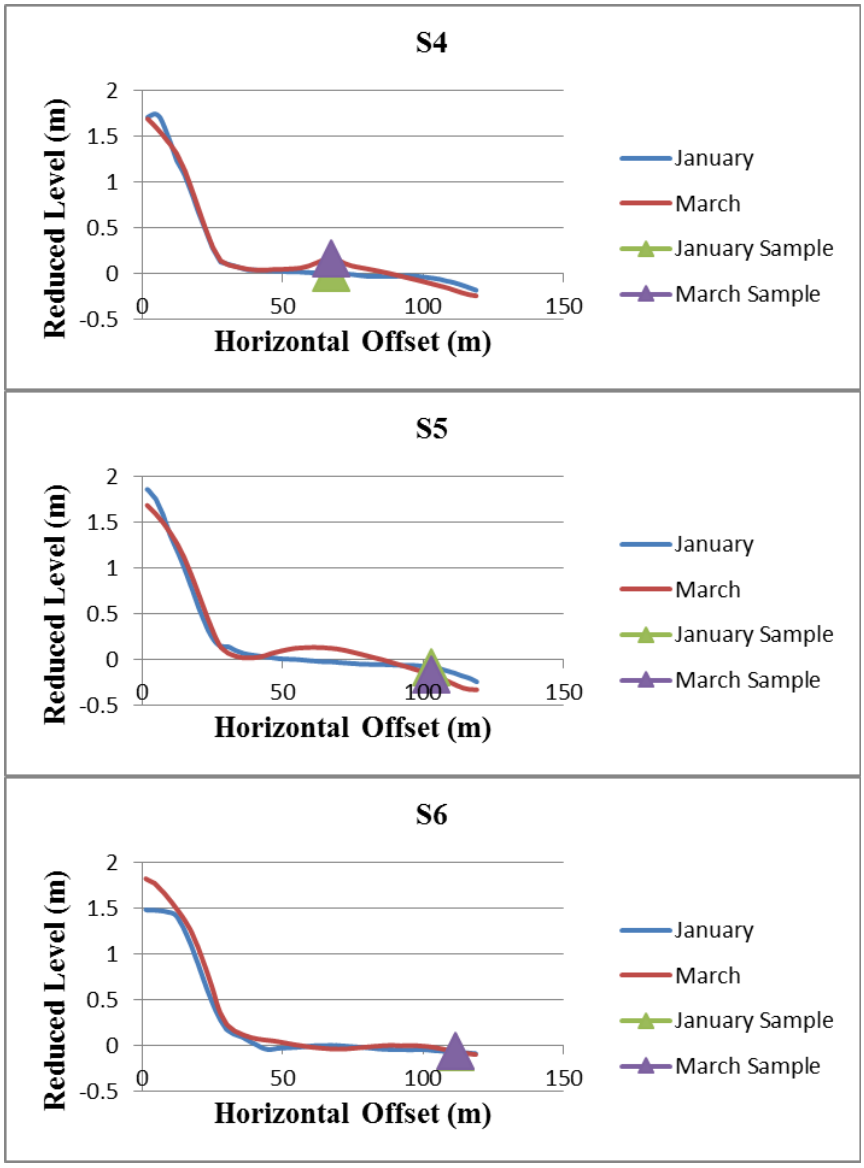


Figure 3:Beach Profile with Reduced Level of Samples (cont')

Conclusion

The beach profile lines have been successfully generated and the erosion and accretion process have been determined to have happened throughout the study period. Although the changes are not as significant, it still can be concluded that the coastline shows variations in the beach profiles each time the data is collected. Basically, it gives the idea that the beach is constantly changing with respect to time. The soil density change varies to the erosion and accretion process. The density increase for erosion process while decrease when accretion takes place. This study can be used as a reference by further researchers to get the general idea of the study. It is believed that more research will be done by time to time because coastal study is very important especially in order to maintain its natural ecosystem and the sustainability of the area.

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