GEOMORPHOLOGICAL STUDY USING GIS TECHNIQUE OF EL-BURULLUS COASTAL AREA, EGYPT

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Abstract

Nile Delta coastal area including El-Burullus headland has experienced to face significant erosion in some local parts. The temporal and spatial geomorphological variations due to coastal processing and establishment of shore protection structures along El-Burullus coastal area were investigated in two ways. The first way is to study the stretches surf, breaker and offshore zones as perpendicular to the shoreline and the second way is to focus on three regions of interest along the shoreline (El-Burullus lake outlet, Balteem beach, and Kitchener drain outlet). Geostatistical Analyst model was used as advanced GIS technique to interpolate the data gathered from field campaigns and laboratory work. The results of grain size analyses of the sediments indicated fine sand is the dominant size in surf (0.16 mm) and breaker (0.15 mm) zones, while very find sand is in offshore (0.11 mm) zone. The sediment sorting in the three zones is recognized as moderately well sorted. Certainly, the moderately sorted sites have a mixing between indigenous and allochthonous sands. Variation of depth during the two successive years 2015 and 2013 was used as indicator of coastal processing in this area to identify the sites of erosion and accretion. The depth indicator revealed that the majority of the coastal area of El-Burullus is in erosion status with little accretion sites. Texture characteristics of sediments were used to recognize the depositional environments in the three interested areas. The dominant finer sand can attributed to deposition at low energy condition. Sorting investigation revealed that indigenous sediments were detected.

Keywords: Nile Delta; El-Burullus coast; GIS; Mean grain size; Surf zone; Breaker zone; Kitchener drain
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1. Introduction

Coastal zones are the dynamic parts of the Earth's surface. The marine and atmospheric processes produce beaches, dunes, barriers, tidal inlets, rocky coast, and shape delta. The coastal zones are subjected to rapid erosion due to natural processes and anthropogenic activities. Inman and his group during 1976, reported that the Nile Delta in general is an erosion coast with intense erosion in some local parts and accretion in another parts (Inman et al, 1976; El-Gamal and Saleh, 2012). This erosion is mitigated by the construction of a series of coastal engineering structures such as jetties, groins, seawalls and breakwaters at the rapidly eroding promontories. These coastal structures, as one of the man-induced coastal changes are probably protect sites from erosion but it is the most remarkable cause of enhancing beach erosion at another sites (Frihy and Deabes, 2011).

Since the construction of Aswan Dam in 1902 and the High Aswan Dam in 1964, sediment discharge to the Nile River promontories has been significantly reduced. In the lack of sediment supply, coastal erosion was induced as consequences of the continued action of currents and waves. Furthermore, the coastal zone of the Nile Delta is anticipated that climate changes have been worsening the level of erosion at the coast (Ali and El-Magd, 2016). The prevailing NW-NNW wave direction results the dominant eastern long-shore current. It is the responsible for sediment transport from west to east along the Egyptian Mediterranean coast (Frihy and Deabes, 2011; Frihy et al, 1991).

Mechanical analysis is useful tool to distinguishing sedimentary environments and providing important evidences to the sediment origin, transport history and depositional conditions (Folk and Ward, 1957; Friedman, 1979). The pattern of coastal erosion and accretion is reflected in sand size and mineral composition of beach sand. These patterns reflect the natural processes of wave-induced longshore current and sediment transport (Frihy and Dewidar 1993).

The aim of the work is to assess the consequences of the updated coastal problems with its hard shore protection structures and give a clear picture of the temporal variations of the geomorphology of El-Burullus coastal area using advanced model of geographical information system (GIS). The variation of the mean grain size, and its sorting, skewness and kurtosis against the water depth in the near shore sediments is to understand the source of the change of the geomorphology of El-Burullus coastal area. Assessment was constructed on two bases. The first is depend on profiles along El-Burullus coastal area to study the surf, breaker and offshore zones during the years 2013 and 2015 and the second base is to characterize three regions of interest (El-Burullus Lake outlet, Balteem Beach and Kitchener Drain outlet). The updated water depths data are considered as a key element for degrading or transporting the sediments to identify the sites of erosion and accretion. The collected data of provide a basic information for proposing an integrated coastal zone management (ICZM) and to minimize risks of the coastal environment under investigation.

Importance of this work is considered mainly for the updating information of this highly dynamic coastal area. The coastal regime of this area is subject to change due to establishment of different types of shore protection structures. These hard structures play an important role to change the erosion-stable-accretion status of the sites under investigation. Therefore, the continuous updating of information about the coastal processing and the shoreline change with depth variation is important for short-term and long-term evaluation of this important area. This evaluation was done by the advanced technique of GIS to be more illustrative for decision maker.

2. Material and Methods

2.1. Study Area

The bulge-headland of El-Burullus is located in the central position along the Mediterranean Nile delta coast of Egypt, midway between the Rosetta and Damietta promontories as show in Figure (1). It extends between longitudes 30°30$^{/}$ and 31° 10$^{/}$ E and latitudes 31° 21$^{/}$ and 30° 35$^{/}$N (Donia and Farag, 2012). The coast forms a broad, actuate headland and is located on a very active littoral zone, which has experienced widespread erosion caused by natural coastal processes (Eladawy et al, 2013). The coastal area of El-Burullus – Balteem is characterized by a presence of coastal sand dunes, which have a plenty of sand accumulated along the beach. These backshore dunes act as a natural defense against coastal erosion (El-Asmar and Al-Olayan, 2013).

With regard to shore protection activities, three jetties were built successively to control the navigation activities in the outlet of El-Burullus lagoon as shown in Figure (1A). A concrete seawall and basalt revetment were built to protect the beach down drift of these jetties with length 400 m and extended more to 1900 m. Shoreline change rates along the coast of El-Burullus promontory show local accretion patterns (5 m/year) resulted in sand accumulation on the up drift side of the western inlet jetty. This is may be due to the predominant eastern littoral drift (Frihy et al, 2003). Conversely, due to this seawall the erosion transferred to the adjacent area called El Banayeen Village (El-Sayed, 2017). This erosion has risen from the diminishing of the budget of down coast beaches sand due to interruption of the dominant eastward sediment transport by the tombolo formation (Frihy et al, 2003). New protection structures were constructed as groins and breakwater to protect this area with

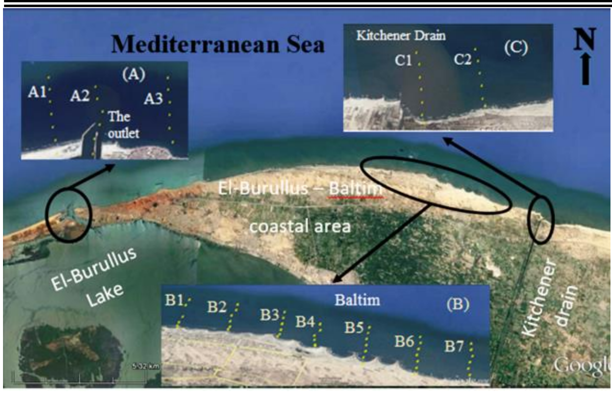

Figure 1. The study area of El-Burullus-Baltim bulge coastal area showing coastal profiles under investigation (A) El-Burullus Lake outlet (B) Baltim Beach (C) Kitchener drain outlet.

length 3100 m (El-Sayed, 2017). Further to the east, at about 11km from El-Burullus Lake outlet, fourteen emerged detached breakwaters were built in the active surf zone in a water depth between 3 and 4 m to mitigate coastal erosion at Balteem as show in Figure (1B). Each breakwater extended between 250 and 350 m parallel to the beach, and they are spaced 320–400 m apart. Sediment transport rate has increased systematically at this site. At Balteem beach, there is an accretion in the form of the tombolo occurred in the leeward side of the first-built detached breakwaters. In addition, nine groins at the west of the Kitchener drain were established to prevent the erosion in this site as show in Figure (1C) (Frihy et al, 2003). This system transfer the erosion to the adjacent area, so a nine groins were constructed to protect the shoreline till Kitchener drain with length of 2.1 km. Due to these protection works, erosion problem found in the eastern side of Kitchener Drain outlet (El-Sayed, 2017). Two jetties and a groin system (15 groins) with sand nourishment in the east had been proposed to stabilize the shoreline with length of 3.0 km east Kitchener Drain outlet (CoRI, 2016).

2.2. Methodology

The area of study were classified according to depth as surf zone (0-2 m), breaker zone (2-4 m) and offshore zone (>4 m). Beach profiles are extending perpendicular to the baseline and running across the beach on the coastal plain till 6.0 meters water depth or to a maximum distance of 1000 meters seaward. Coastal Research Institute (CoRI) team collected the sediment samples in 2015 every 200 meters distance from fixed benchmark along each profile using grab sampler as shown in Figure (1). Shoreline coordination and profile depth were determined using marine system with DGPS Model GPXPRO and ecosounder model Navi Sound connected with marine computer.

The data gathered through the analysis of the sediments collected during 2015 from specific depths were compared with the depth data during 2013 to check the exact situation at these sites. The comparison was carried out in order to distinguish between erosion and accretion sites within the area under investigation. Mechanical analysis was executed to characterize the sediment in the laboratory by series of sieves with mesh size from -1Φ (2 mm) to 4Φ (0.063 mm). Pipette analysis has been used to determine fine-grained and clay samples, according to methods described by Folk and Ward (1957). Statistical evaluation of the collected samples has been executed using GSSTAT computer program to determine the values of mean grain size of the sediments particles, their sorting, kurtosis and skewness.

The data were investigated and analyzed using Geostatistical Analyst model as an extension of Arc GIS. Geostatistical Analyst describes the spatial continuity (Isaaks and Srivastava, 1989) and provides a dynamic environment to solve spatial problems. The interpolation technique in this study was selected as the geostatistical technique (ESRI, 2001). This technique uses the nearby sample points at different locations in the landscape to create a continuous surface. The process of creating maps depends on models of spatial autocorrelation and includes different steps.

3. Results and Discussion

3.1 General description of El-Burullus coastal area

Mechanical analysis of the coastal sediments from El-Burullus coastal area has been carried out to indicate their sand-silt-clay percentages, mean grain size, sorting, kurtosis and skewness. The analysis results and its descriptions were listed in Tables 1, 2 and 3. Furthermore, according to Shepard's classification system modified by Schleec the percentages of sand, silt and clay of the sediment of the profiles under investigation is nominated as sand with percentages 95.97% and 96.75% for years 2015 and 2013, respectively. Minor exceptions were recognized as sandy silt, silt and silty sand as listed in Table 1. Water depths data are essential also for accomplishing sustainable management (Mohamed et al, 2016; Gao, 2009). It also considered as a key element hydrological modelling, and degrading or sediments removing (Finkl et al, 2005).

Table 1. Percentages of the sand-silt-clay in the profile sediments collected during 2013 and 2015.

	2015		2013	
	Counts	**Frequency**	**Counts**	**Frequency**
Sand	286	95.97%	268	96.75%
Sandy silt	3	1.01%	-	-
Silt	2	0.67%	2	0.72%
Silty Sand	7	2.35%	7	2.53%
Total	298	100%	277	100%

Table 2. Average, standard deviation, minimum and maximum mean grain size (mm) values in El-Burullus coastal area.

	Surf Zone	Breaker Zone	offshore	All Zones
Average	0.16	0.15	0.11	0.14
STD_DEV	0.11	0.12	0.02	0.08
Min	0.1٠	0.04	0.03	0.03
Max	0.51	0.62	0.17	0.62

Table 3. Sorting, kurtosis and skewness frequency percent (Fq%) in El-Burullus sediments.

Sorting	Fq%	Skewness	Fq%	Kurtosis	Fq%
Surf Zone					
poorly sorted	16.67	Fine skewed	16.67	Very leptokurtic	16.67
Moderately sorted	25	Near symmetrical	16.67	leptokurtic	33.33
Moderately well sorted	33.33	Coarse skewed	66.67	Mesokurtic	41.67
well sorted	25			platykurtic	8.33
Breaker Zone					
Poorly sorted	7.3	Strongly fine skewed	5.5	Very leptokurtic	5.4
Moderately sorted	14.5	Fine skewed	12.7	leptokurtic	47.3
Moderately well sorted	56.4	Near symmetrical	21.8	Mesokurtic	45.5
Well sorted	21.8	Coarse skewed	56.4	platykurtic	1.8
		Strongly coarse skewed	3.6		
Offshore Zone					
Very poorly sorted	0.5	Strongly fine skewed	1.6	Very leptokurtic	6.3
Poorly sorted	1.6	Fine skewed	9.4	leptokurtic	52.4
Moderately sorted	7.9	Near symmetrical	21	Mesokurtic	40.8
Moderately well sorted	45.5	Coarse skewed	65.4	platykurtic	0.5
Well sorted	38.7	Strongly coarse skewed	2.6		
Very well sorted	5.8				

The mean grain size is important tool for interpretations of sediment data in relation to bottom dynamics of coastal region (Vijayakumar et al, 2011). It is presented as an indicator of energy conditions. In coincidence with depth variation, it is useful indicator to monitor the beach processing to differentiate between erosion and accretion sites. Kumar with his group (2010) reported that the mean size of the sediments influenced by the source of supply, transporting medium, and the energy of the depositing environment.

Sorting is indication of purity (well sorted) or mixing the sand with anther transferred from other sites (poor sorted). The standard deviation is to measure the sorting of the sediments, representing the fluctuations in the kinetic energy or velocity conditions of the depositional agent (Vijayakumar et al, 2011). Sorting values varied between moderately sorted to very well sorted. As a result, it may indicate that there is no mixing of sediments (has indigenous originating) in the very well sorted parts. On the other hand, there are another sites have a mixing with indigenous sand and allochthonous sands that comes from outside (moderately sorted).

Skewness measures asymmetry of frequency distribution (Vijayakumar et al, 2011). The skewness values of the sediments showed that the sediment are falls in coarse (-ve) skewed to strongly fine (+ve) skewed nature. At El-Burullus Lake outlet and its eastern section in addition to Kitchener outlet and its spit are coarse skewed. Also, coarse skewed nature may provide indication of erosional and non-depositional places and the velocity of the deposition agent operated at a higher value that approved by Martins (2003) and Vijayakumar et al, (2011). At the western section, are varied between symmetrically, coarse skewed, and strongly fine skewed. Strongly fine skewed nature of sediments was observed and indicating of deposition and excessive inputs of finer material (Martins, 2003).

Kurtosis is a quantitative measure used to describe the departure from normality of distribution (Vijayakumar et al, 2011). Its values are falling in between platykurtic to leptokurtic nature. Platykurtic nature with finer size of sediments reflect maturity of the sand (agreed with Kumar et al, 2010). While, leptokurtic distribution is probably due to the incorporation of finer sediments (agreed with Vijayakumar et al, 2011and Coalala, 2013).

Figure (2) shows GIS maps representing elevation grid according to depths along El-Burullus area during the two years 2015 and 2013. The depth along El-Burullus coastal zone increase during 2015 than 2013 as shown in Figures (2A and 2B), especially the offshore area east of El-Burullus Lake outlet. This indicated of erosion was taken place at this area and the rate of erosion at the eastern side is higher than the western one. Figure (2C) illustrates the differences in depth between the two years to indicate the sites of erosion and accretion in the area under investigation.

The comparison in depths was primarily dependent on the percentage of error (%Error) and the mean absolute error (MAE) to assess the best and the worst cases. The MAE was small and the %Error was <20%. The investigation of depth variation in area extended from shoreline to 1km seaward revealed that the majority of the coastal area of El-Burullus is in erosion status with little accretion sites. In addition, the eastern sites from the lake outlet are recognized as more erosion area than the western sites. The coastal area in front of Baltim was observed as accretion site with the presence of the detached breakwaters. In addition, patches of accretion sites were observed in the western side of the area under investigation as shown in Figure (2C).

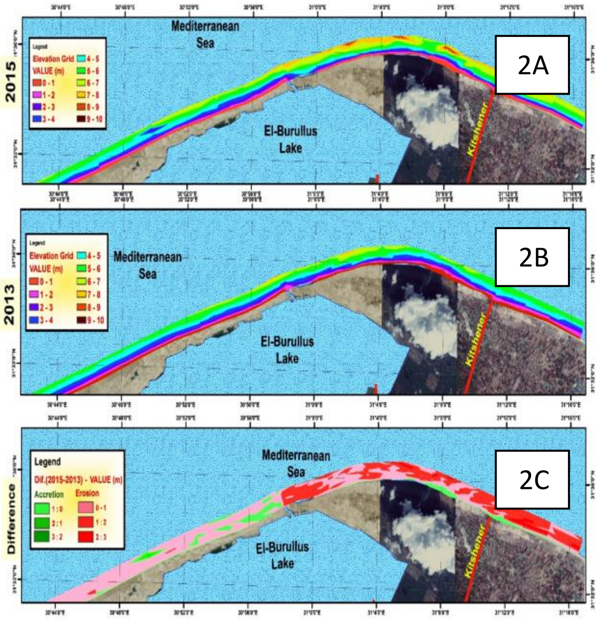

Figure 2. GIS elevation maps of El-Burullus coastal area during 2015 and 2013 with differences in depth between the two years.

3.2 Description of El-Burullus zones

Surface sediments of El-Burullus coastal area were investigated according to its depths into three zones: surf, breaker and offshore zones. As listed in Tables 2 and 3, mean grain size, sorting, skewness, and kurtosis were used as texture characteristics of sediments to recognize the depositional environments at the three zones of El-Burullus coastal area.

3.2.1 Surf zone

At surf zone, the average of mean grain size values of the sediments indicated fine sand. There is a variation between the maximum and minimum sorting value in the surf zone, which indicated the presence of the two opposite description as the well and poor sorting. The well sorting direction is the dominant with percentage 58.33%, while the poor sorting percentage is 16.67% as shown in Table 2. The skewness revealed that the two alternatives (fine and coarse skewed) are also present in this zone. The coarse skewed appear as the dominant with 66.67%, while the fine skewed appear as minimum with 16.67%. The kurtosis distribution of the sediment indicated of presence of the three main categories, which are leptokurtic (50%), mesokurtic (41.67%), and platykurtic (8.33%). These results indicated that the two status of the coastal processing were carried out, as erosion and accretion are present in the surf zone of El-Burullus area.

3.2.2 Breaker zone

At the breaker zone, the average mean grain size of the sediments are recognized as fine sand as the same with the surf zone with difference in percentages. The minimum and the maximum grain size were described as coarse silt and coarse sand, respectively. Variation in sorting was detected to cover the two alternatives but with little poor sorted (7.3%) condition than the surf zone. The well sorting categories were 78.2% as the majority in this zone. This indicated that the transport of the allochthonous sand is little to contribute to this coastal zone. The skewness analysis was indicated of the two alternatives and both extended to be strongly fine and coarse skewness. The dominant skewness was toward direction of coarse skewness with 60%, while 18.2% only for the fine skewness categories. The kurtosis distribution of the sediment indicated of presence of the three main categories, which are leptokurtic (52.7%), mesokurtic (45.5%), and the playkurtic decrease than the surf zone to be (1.8%) as shown in Table 2. These results indicated that the two status of the coast as erosion and accretion are present in the breaker zone of El-Burullus area with different percentages.

3.2.3 Offshore zone

At the offshore zone, the sediment are characterized as more finer, more well sorted more coarse skewed and more leptokurtic than the surf zone and the breaker zones. The average of offshore mean grain size values of the sediments was described as very fine sand, with minimum value of medium silt and maximum value of fine sand. Variation in sorting was recognized to cover the two alternatives but with very little poor sorted (2.1%) condition. The well sorting categories were 90% as the majority in this zone. This indicated that the transport of the almost no allochthonous sand is contributed to this coastal zone. The skewness analysis was indicated of the two alternatives and both extended to be strongly fine and coarse skewness. The dominant skewness was toward direction of coarse skewness with 68%, while 11% only for the fine skewness categories. The kurtosis distribution of the sediment indicated of presence of the three main categories, which are leptokurtic (58.7%), mesokurtic (40.8%), and the playkurtic decrease than the breaker zone to be (0.5%) as sown in Table 2. These results indicated that the erosion status is the dominant situation at this zone of El-Burullus coastal area.

3.3 Description of three regions of interest at El-Burullus coastal

El-Burullus coastal area was investigated according to three regions of interest. These are El-Burullus lake outlet, Balteem beach and Kitchener drain outlet. The status of the coastal area of these regions was changed after the establishment of hard structures as shore protection tools. The investigation was executed based on their depths during 2015 and its comparison with 2013 elevation using GIS technique in order to indicate the erosion and accretion sites as shown in Figure (3). The three regions appears as more deeper in 2015 than 2013, which mean more erosion in general. On the other hand, the description of grain size information is to indicate the sites of erosion and accretion with depth variation. The erosion site is characterized by fine sand and heavy minerals at beaches and the courser sand were present at the accretion beaches. The accreted beach sands are coarser and less sorted than the eroded ones (Anwar et al., 1979).

3.3.1 El-Burullus Lake outlet

The establishment of a series of groins as hard shore protection structures in the western side of the outlet and the seawall to protect the entrance of the outlet plays an important role to control the distribution of the beach sand. According to depth, as shown in Figure (3), this area turned to more deeper in 2015 than 2013. Also, in and in front of the entrance channel the depth turned to more deep. The western surf zone in this area observed as lower depth for the accretion condition compared with the relatively higher depth in the other side. The distribution of the sediment grains was illustrated by GIS technique in Figure (4). It shows medium sand was dominant in the surf area of the western side of accretion and the size turn to more fine toward the sea. The dominant grain size is the very fine sand in the area including the eastern part of the outlet. Therefore, accretion was observed in the western side of the outlet, which the sand were trapped.

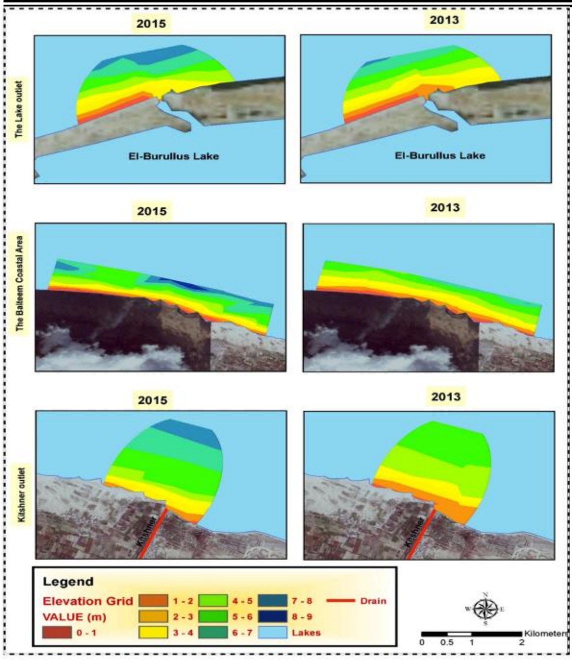

Figure 3. GIS maps for elevation grid of El-Burullus coastal sediments in three regions of interest.

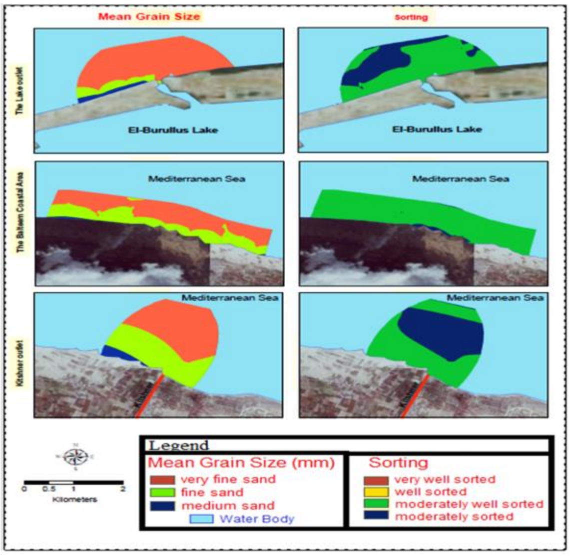

Figure 4. GIS maps for sediment mean grain size and sorting in three regions of interest of El-Burullus coastal area.

Figures (1A) and (5) show the coastal area El-Burullus outlet as three profiles (A1, A2 and A3). The outlet profile sector (A2) showed that the sediments sorting analysis considered as moderately well sorted. Moreover, the skewness was found as coarse skewed and its kurtosis distribution was found mesokurtic. On the other hand, the sediments of the western (A1) and eastern (A3) profiles of the outlet area was revealed that the sorting of eastern profile was varied between moderately well sorted and well sorted. While at the western one sorting was mixed between (moderately well sorted, well sorted, very well sorted) and moderately sorted as shown in Figure (4). Moreover, the eastern profile has coarse skewed and the one has varied between nearly as leptokurtic, very leptokurtic and mesokurtic. This confirm the difference between the surface sediment east and west of the outlet. This indicated that the western area of the outlet recognized as accretion site trapped the sand to transport to the east. The eastern side is still faced erosion more than the western one, recently, more east groins were constructed to stop the erosion. As usual, they stop the erosion at the groins sites but the more eastern sites faced the erosion as results of these groins.

Figure 5. El-Burullus Lake outlet with erosion and accretion

3.3.2 Balteem beach

Fourteen detached breakwaters were constructed parallel to the shoreline of Balteem. The series of hard structures were trapped the sand and make this zone as accretion area. Figures (1B) and (6) demonstrated that these breakwaters contacted to the beach by formation of tombolo. Figure (3) shows the depth was deeper specially at the offshore zone. Small stretch of medium sand at the western side with small area at the eastern end were recognized for the accretion at the surf zone.

Balteem coastal region is studied by seven profiles (B1 to B7). The mean grain size was ranged between fine and very fine sand as show in Figure (4). This is due to the accretion behavior of this area. The sorting of these profiles was observed moderately well sorted (except few samples was well sorted). The skewness was varied between coarse, fine, and near symmetrical skewed. The finely skewed nature is implies a low velocity, a removal of the coarser material and introduction and deposition of finer sediment in sheltered low energy environment that agreed with Vijayakumar et al, (2011), Coalala, (2013) and Kumar et al,(2010). Devi, (2014) suggested the fine skewness is more common at high kinetic energy of the depositional environment. Lastly, kurtosis distribution was found as mesokurtic (except few samples was leptokurtic).

3.3.3 Kitchener Drain outlet

The series of the groins west of this outlet trapped the sand west of Kitchener Drain. The trapping of the sand is play important role for spit formation at the outlet. In general, the depth was increased at this area in 2015 compared with 2013. Depth 5-6 m was observed as the maximum depth detected in 2013 while in 2015, 6-7 and 7-8 m were observed during 2015 as shown in Figure (3). This indicated to more erosion at this outlet area. Medium sand was the dominant size appear in the western side with groins of the Kitchener coastal area. This indicate to accretion of the surf zone at this area, which is different from the erosion area at the eastern part. Degradation of the size of the particles towards the sea was observed. At beach, the relatively coarser grains were detected at the accretion part of profile C1, while, the finer grains were detected at the erosion beach of profile C2 as shown in Figure (8). This is in agreement with the finding of Anwar and his group that the accreted beach sands are coarser and less sorted than the eroded ones (Anwar et al., 1979).

The sediment of the spit was medium to fine sand. The sorting ranged from moderately well sorted to well sort. Figures (1C) and (7) show Kitchener Drain coastal area, which represented by a profiles sector of C1 and C2. The mean grain size was observed as fine sand (from distances 0.0 to 600) and very fine sand (from distance 800 to 1200). Figure 8 shows the mean grain size of the two profiles C1 and C2. It show the beach sand size is indication to the erosion of the site of C1, which is presented as the relatively finer sediments and accretion in C2 site as the relatively coarse sediments due to the groins constructed at this site. The spatial distribution of mean grain size of beach and seabed sediment samples off the study area are falls between fine to very fine sand category, where it is characterized by a seaward fining trend. Except at Kitchener spit is ranged between medium to fine sand. This dominance of fine sand can attributed to deposition at low distribution and low energetic condition and that agreed with Kumar et al, (2010).

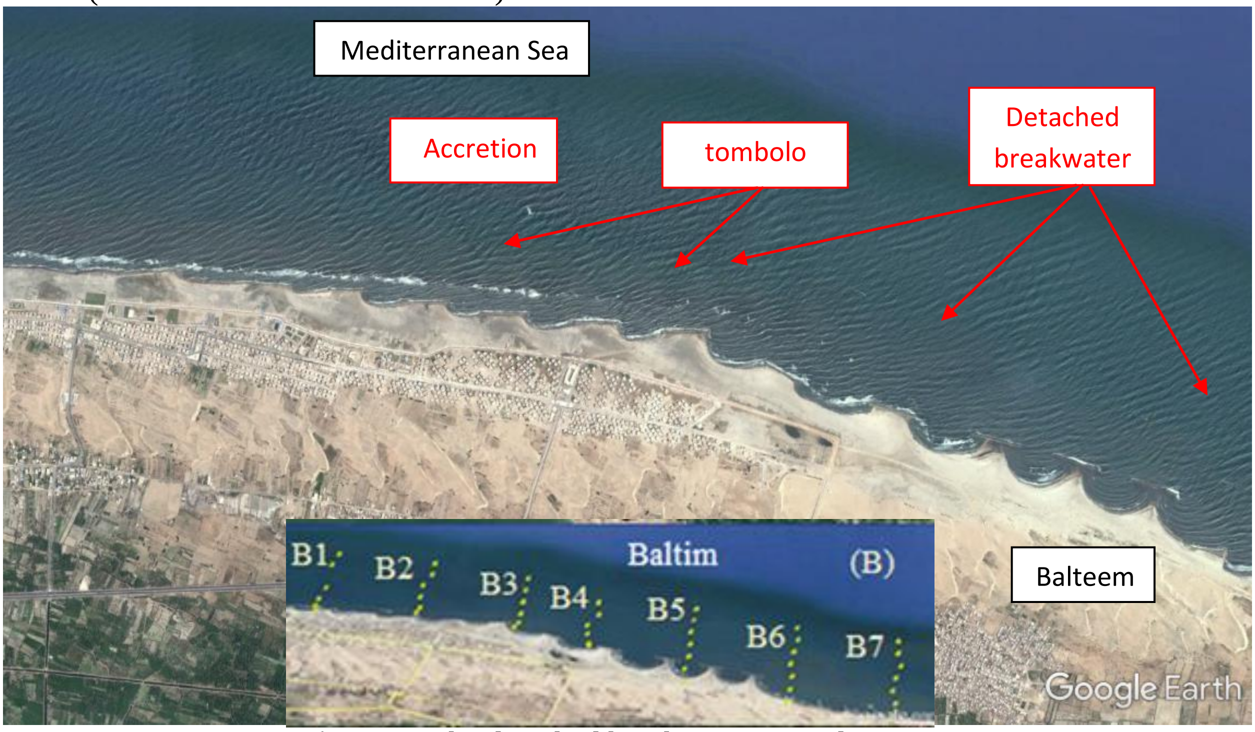

Figure 6. The detached breakwaters at Balteem.

Furthermore, it has a variation of sorting parameters from moderately sorted, moderately well sorted, well sorted, and very well sorted as show in Figure (4). Concerning the skewness, it was observed as coarse skewed (except at 600, 1000 m is near symmetrical). While kurtosis is leptokurtic (except at 200 m is very leptokurtic). The eastern side of Kitchener Drain still faces erosion. The coastal processing of this area with accretion in the west and erosion to the east make outlet of the drain shifted toward the east.

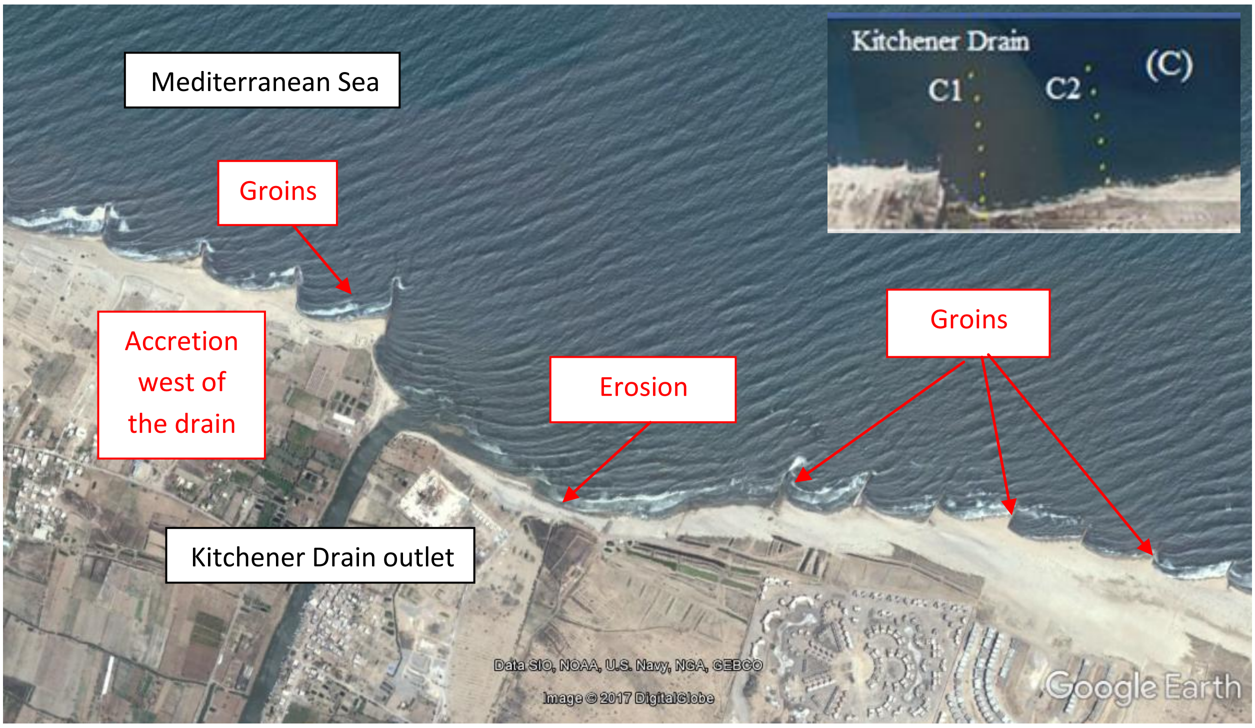

Figure 7. Kitchener Drain outlet.

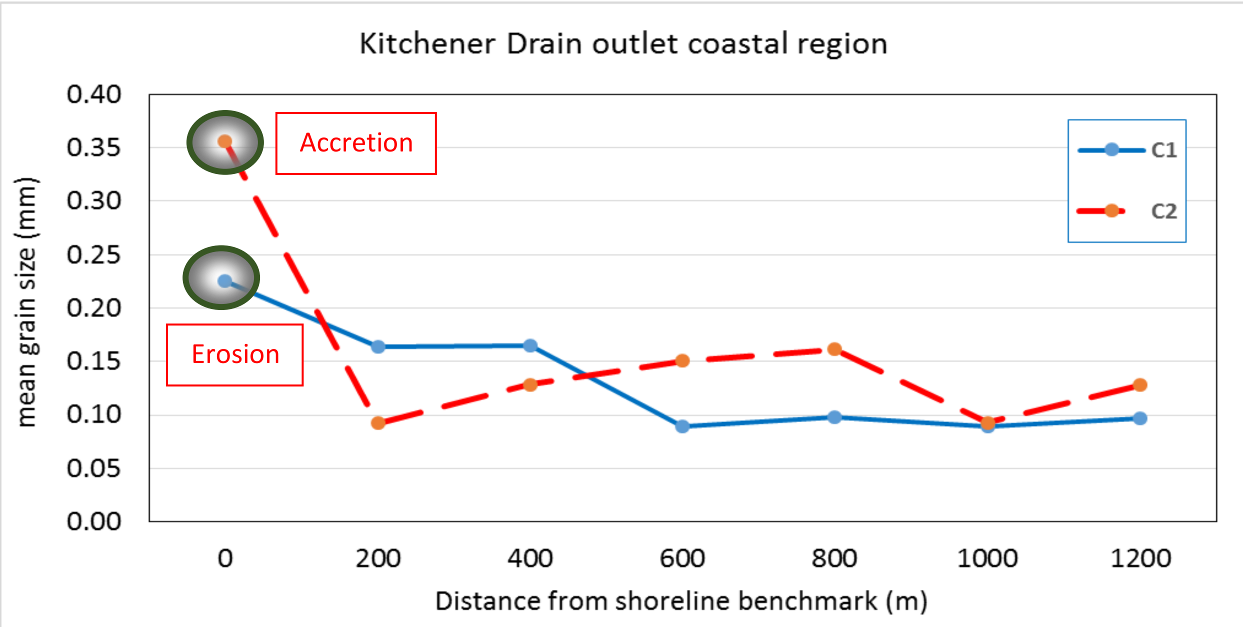

Figure 8. Mean grain size of the two profiles at Kitchener.

4. Conclusions

The present study is dealing with data from coastal sediment profiles described El-Burullus coastal area during the year 2015 in order to assess the vulnerability against the beach processing of this area with temporal variations. Advanced GIS technique was applied to illustrate the coastal problems and its temporal variations of its geomorphology. Grain size parameters and the depth variation are used as indicators and useful tools for recognizing sedimentary environments and providing important clues to the sediment provenance, transport and depositional conditions. Updated sediments texture has been studied in the surf, breaker and offshore zones of El-Burullus sector, and along three main interested regions within the study area; El-Burullus lake outlet, Balteem beach, and Kitchener drain.

The hydrodynamic of the water at this area is changed and modified due to anthropogenic activities after the establishment of the shore protection hard structure. The protected areas, which mainly in the western side and recognized as accretion are trapping the sand to reach the eastern neighbor area, which is subject to erosion. Different GIS maps of El-Burullus coastal area with its geomorphological properties were presented. The spatial distribution of mean grain size of beach and seabed sediment samples off the study area falls between fine to very fine sand category. This dominance of finer sand can attributed to deposition at low distribution and low energetic condition. Also, sorting values varied between moderately sorted to very well sorted.

The sediments of El-Burullus coastal area is nominated generally as sand with percentages 95.97% and 96.75% for years 2015 and 2013, respectively. Minor percentages of sandy silt, silt and silty sand were recognized. The study of surf, breaker and offshore zones revealed that the two status of the coastal processing were performed, as erosion and accretion with different proportions. The mean grain size of the sediments in surf and breaker zones are recognized as fine sand while it is very fine sand in the offshore zone. The offshore zone is differentiated from the other zones according to its sediments as finer, more well sorted, more coarse skewed and more leptokurtic than the surf zone and the breaker zones. No allochthonous sand is contributed to offshore coastal zone. These results indicated that the erosion status is the dominant situation at this zone of El-Burullus coastal area.

The establishment of a series of hard shore protection structures such as groins in the western side of El-Burullus outlet or as detached breakwaters as in Balteem or the western groins in Kitchener were trapped the sand and make this zone as accretion area. The eastern area of these structures are subject to erosion. In general, according to depth, El-burullus Lake outlet, Balteem and Kitchener coastal area turned to be deeper in 2015 than 2013.

Furthermore, the western surf zone in El-burullus Lake outlet area observed as lower depth for the accretion condition compared with the relatively higher depth in the other side. Medium sand was dominant in the surf area of the western side of accretion and the size turn to finer toward the sea. The dominant grain size is the very fine sand in the area including the eastern part of the outlet. The depth in Balteem was deeper especially at the offshore zone. Small stretch of medium sand at the western side with small area at the eastern end were recognized for the accretion at the surf zone. The mean grain size was ranged between fine and very fine sand. Medium sand was the dominant size appear in the western side with groins of the Kitchener coastal area. This indicate to accretion of the surf zone at this area, which is different from the erosion area at the eastern part. Degradation of the size of the particles towards the sea was observed.

Finally, it may indicate that there is no mixing of sediments. Recognition of the changes of the shoreline along the delta coast provides a basis for proposing a coastal management scheme as ICZM requirement for new activities related to coast and the beach. In addition, it should also consider development-taking place in the area, which caused major land use change. These results are useful for coastal area subjected to change by adding hard structure such as detached breakwaters, groins, jetties and others.

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