Stability of the Northern coast of Egypt under the effect of urbanization and climate change

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**ABSTRACT**
The effect of the human activities on the coastal area are enormous. They include impacts on natural resources, coastal stability, environmental quality, and the cultural environment. The instability condition is the predominant feature of the Egyptian coastal zone due to natural and anthropogenic effect. This paper discusses the stability conditions of the sediment within the Egyptian Mediterranean coastal zone. It includes the sediment sources, degradation of resources, reasons and side effects, climate change effects, and recommendations to control the degradation. The research methodology depends on collecting and discussing the results of the previous related studies, collecting field data and observation along the Egyptian Mediterranean coastal zone as well as satellite images within the last ten years. Sediment origin from territorial or sea resources, sediment transport, and interaction within the coastal zone are investigated to understand the sediment behavior and how to control erosion and silting problems. The study shows that urbanization, coastal structures, removing sand dunes, controlling the floodwater and sediment, as well as climate change cause severe shoreline changes within the coastal zone. Dramatically erosion along the Northern coast of Egypt, and migration of the sand spit inland along the Rosetta Nile branch document these unbalance conditions. The study recommends that the coastal sand dune, as well as other nature resources of sediment, should be protected to eliminate the coastal erosion.

**Introduction**
The World Cities Report (UN-Habitat, 2016) indicated that between 1950 and 2005 the level of urbanization increased from 29% to 49%. In addition, the urban areas population increased from 43% to 54% between years 1990 and 2015. That is leads to the intense and increasingly ongoing development especially in the coastal zone. The human activities within the coastal zone may be interrupt the supply of sand to the coast by constructing cities and harbors, dams and flood control works, navigation structures, as well as gas/oil/water extraction, (Magoon, Edge, & Stone, 2000).

Currently, many coastal communities around the world face serious problems related to coastal erosion, (Williams, Rangel-Buitrago, Pranzini, & Anfuso, 2018). The sea-level rise, saltwater intrusion, and increase of storms under the effect of climate change increase the sediment instability condition within the coastal zone and cause extra coastal erosion.

Coastal erosion under the effect of natural factors (waves, currents, tide, climate changes and sea level rise) is easy to identify, but the human effect on the coastal zone is not easy to report, (Magoon et al., 2000). It is because the short-term impact of human activities within the coastal zone may be difficult to quantify. The interaction of human activities and physical processes are significant contributors to that erosion, (Nguyen, Kevin, & Alison, 2017).

Human impact on coastal erosion can be identified in many places worldwide. Human activities in Taiwan coastal area, (damming rivers, mining from the riverbed, and coastal protections) modify the coastal processes and environments, which lead to the beach erosion, (HSU, LIN, & TSENG, 2007). The Nile Delta coast of Egypt suffers from severe erosion due to the construction of the control structures along the Nile River, which cut off the supply of sediment reaching the coast, Komar (2000).

The Egyptian coastline extends 1000 km along the Mediterranean Sea in the north, and 2000 km along the Red Sea in the east. The Northern Egyptian coastal zone has the low-lying Delta of the River Nile, Northeastern and Northwestern coast, with its large cities, agriculture activities, industry, and tourism. The coastal areas of the Nile Delta have about 40% of Egypt’s agricultural production, half of Egypt’s industrial production, and large urban population centers. Egypt’s population has reached ~95 million in 2017, with a growth rate of 2.0%/year, CAPMAS (2017). Of this number, more than 10 million people inhabit the northern coastal region. Population densities are extremely high (to 1000 or more/km²), especially in the Nile Delta and Valley. Due to the human activities, the Nile Delta natural resources have been deteriorated and the Nile Delta is no longer...
functions as a natural marine zone, (Stanley & Warne, 1993). The deterioration within the coastal zone is documented in the form of coastal erosion, siltation within lakes entrances, saltwater intrusion, increase soil salinity, and increase pollution in coastal water and soil. As well as due to the climate change, a reasonable area from the Nile Delta is expected to inundate under the seawater.

The main objective of this paper is to identify and evaluate the effect of urbanization and climate change on the shoreline stability within the northern coastal zone of Egypt.

Data and methodology

Where, most of the coastal physical changes have a strong correlation with the sediment transport. Also, the natural and human effects on the nearshore sediment can be easily identified by monitoring the shoreline. So, the shoreline changes are used as an indicator for the change in sediment stability within the coastal zone. Egyptian Northern coast from El Saloum to Rafah (about 1000 km) is used to study the effect of human activities on the shoreline stability within the coastal zone. Data for this study have been collected from, Table 1:

Collected, reviewed, and analyzed of the previous related work published in the field of coastal engineering, oceanography, sedimentology, and sand dunes to obtain secondary data using secondary data analysis.

Google Earth satellite images from 2003 to 2016 are used to identify the erosion and siltation zones within part of the Egyptian Northern coast. The shoreline is digitized manually by the author to fill gab in available data. Before digitizing, the images were corrected for the scale and distortion by using field control points. Then the shoreline from different images was digitized and compared to each other’s.

Field observation related to the shoreline stability of the Nile Delta, Northwestern coast, and Sinai coasts of Egypt.

Semi-structured interviews were executed during the field visits to discuss and share with the local communities the local knowledge and lessons learned on coastal erosion and the effect of human activities.

Table 1. Data sources for the research paper.

| Type of the data | Source of the data (Modified from) |
|------------------|-----------------------------------|
| **Sediment sources in coastal zone** | |
| (1) Nile Delta coastal zone | Inman & Jenkins, 1984; Sharaf El Din (1977); Stanley (1989) |
| (2) Northwestern coast of Egypt | Shata (1957); Batanouny (1999); DRC (2005); Coastal Group (2007) |
| Shoreline stability: | El Banna, 2004; El-Bady, 2016 |
| (1) Northwestern coast of Egypt | Iskander & El Kut, 2014; Coastal Group (2007); CoRI (2017) |
| 1.1 El Obayed 1977–2005 | Coastal Group (2007) |
| 1.2 El Obayed 2005–2015 | The author. |
| (1) Nile Delta coast | Darwish et al., 2017; Ali & El-Magd, 2016; El-Gamal (2017) |
| 2.1 Rosetta Promontory 2003–2016 | The author. |
| (1) Northeastern coast of Egypt | Frihy and Lotfy (1997); Nassar et al. (2018); CoRI (2015); El Banna & Hereher, 2009 |
| Field observation along the Egyptian coastal zone | The author. |
| Semi-structured interviews: | The author. |
| (1) Marsa Matrouh coastal zone | |
| (2) Rosetta promontory | |

Sediment sources in the coastal zone

The Egyptian Mediterranean coastal zone has two significant and distinct sediment types. A calcareous suite of sediments that consists of shell fragments and other organic detrital material, usually found near its origin, or of carbonate oolites. The second sediment type consists of sand, silt, and clay brought to the sea by the Nile River before the High Aswan Dam, (Inman & Jenkins, 1984).

The Nile River has been the primary source of sediment for the Delta and the entire Nile littoral cell that extends 700 km east then north to Haifa bay until the year 1964. These sediments have discharged to the Mediterranean Sea through the Nile branches. The control structures along the Nile River eliminated the sediment sources. The sediment load was reduced from a range of 54x10^6 to 163x10^6 t/year to less than 14x10^6 t/year after built the High Aswan Dam, Figure 1, Sharaf El Din (1977). Recently, the sediment load discharge to the sea can be neglected due to the control structures along the Nile River. The sediment thickness along the continental shelf of the present Nile Delta reach 3.5 km, and a sediment volume estimated to be 350 to 387 x 10^3 km^3. The eastward sediment transport is the predominant movement of seabed sediment. The longshore sand transport rates by waves and current are the greatest in the vicinity of the Nile Delta (~lxl0^6 m^3/year). It decreases to about one-half off Bardawil Lake (~0.5x10^6 m^3/year). The rates of erosion measured from the shoreline to 6 m depth along the Nile Delta is about (~20x10^6 m^3/ year), Figure 1, (Inman & Jenkins, 1984).

The composition of the beach sand within the Nile littoral cell reveals local contributions from other sources. These include inland sediments coming from the south and discharged to the sea during ancient times with periods of rainfall as well as erosion of coastal cliffs and exposures on the inner shelf.
Furthermore, the wind-blown coastal sand dune is an additional source contributed to the beach during stormy seasons. The non-Nilotic sediment contributions account for minor to small proportions of the total coastal sand budget, Stanley (1989).

The sediment source of the Northwestern coast of Egypt from Alexandria to El Saluim are of marine origin and consist of limestone which appear to have been formed near the shoreline in the shallow water. The sediment is washed into the shore and then transported by the wind to build the present dunes, Shata (1957). The sand dunes are developed in the backshore. These dunes may rise 5 to 15 m in height and extend about 0.5 to 1.5 km inland from the shore, Batanouny (1999). The sediment transport between the sea and the sand dunes in this area is not exactly quantified. On the other hand, the rarely occurred heavy rainfall within the area causes floods, which carry large amounts of soil to the sea from the southern plain. Part of this soil may reach the coastal sand dunes, and mixes with the white calcareous sand of the dunes. The estimated sediment deposit to the sea from the flood area in the northwestern coast of Egypt ranges between 80 and 530 ton/Km²/year, Figure 1, DRC (2005). Coastal cliffs erosion may contribute to the beach sediments locally in Northwestern coast of Egypt. The sediment transport rate within the coastal area range between 50000 and 200000 m³/year, Coastal Group (2007). The net littoral drift within this area is very small compared to the Nile Delta coast. The net littoral drift within Matrouh coastal area is about 5,000 to 10,000 m³/year. Part of this sediment develops the dune systems of the coast zone.

**Shoreline stability**

The sediment movement mechanism in the coastal zone shows that the offshore sandbars are created from the movement of the beach dune and berm sand under the effect of the storm waves. During periods of calm weather, the swell waves may move part of sand from offshore sources and store it back on the beach to form the beach berms as shown in Figure 2. These berms grow due to the advancing of shoreline to build dunes parallel to the coastline. While the small dunes are formed on the backshore, then massive dunes are formed after backshore, (El-Bady, 2016; El Banna, 2004). The prevailing winds produce sand transport along with the coastal littoral cell. Some windblown sand is lost to the sea, but mostly is

**Figure 1.** Sediment types and sediment sources along the Northern Egyptian Coast.

**Figure 2.** Schematic diagram showing the sediment movement between land and sea as well as the formation of coastal sand dunes under the effect of wave, current, tide, wind and flash flood.
deposited in coastal sand dunes. Finally, rivers, drains, and flood drains carry a significant amount of sediment to the coastal area.

The Mediterranean coast in Egypt extends over about 1000 km and can be divided into three sectors: Northwestern coast, Nile Delta Coast, and Northeastern coast. Now due to hydrodynamic forces, urbanization, industrial and agricultural activities the coastal sediment reaches severe unstable condition. Control structures along the Nile River as well as along the flood drains stopped the sediment from discharge to the coastal area. The sand berms and dunes are removed directly in short time due to the unplanned activities. The classes of coastal sand dunes and barren soil decreased by about 45% along the Nile Delta coast from 1990 to 2014, (Ali & El-Magd, 2016). Also, dense concrete structures along the beaches change the wind pattern locally. These human-made destructions of the sediment balance cause the hazardous impacts on the shoreline and bed morphology in the Northern coast of Egypt as following.

The North western coast

The North western coast of Egypt extends for 500 km west of Alexandria city, along the Mediterranean Sea, Figure 3. It can be divided into two parts according to the urbanization; the undeveloped areas (70% of the total coastline extend) and the developed area (30% of the total coastline extend). The undeveloped areas can be divided into two parts; flood drainage-affected areas (27% of the total coastline extend) where most of the watershed discharge their water to the Mediterranean Sea, and flood drainage-unaffected areas (43% of the total coastline extend). Monitoring of the undeveloped areas shows that it has dynamically stable shorelines with seasonally shoreline fluctuation, (Iskander & El Kut, 2014). The second part is the developed areas, which have an enormous change in natural conditions. In addition to the four main cities, more than two hundred resorts, as well as many coastal structures, have been constructed in this area within the last five decades.

Figure (3) shows the most affected coastal areas due to human activities. Field investigation and the interview with the stakeholder within the Northwestern coast show that coastal structures, removing of the sand dunes, controlling the floodwater and sediment as well as urbanization cause severe erosion in front of the main cities. The shoreline retreats in front of El Obaid beach, Marsa Matruh city reach 3.5 m/year during the period from 2005 to 2015 due to hydrodynamic forces and urbanization. On the other hand, the coastal structures in front of Marina El Alamein, Marabella, Sidi kerair and 6th of October resorts cause dramatic changes in the coastal zone, fluctuated from shoreline advanced upstream of the structure and shoreline retreated in the downstream as shown in Figure 3. Observing Marina El Alamein coastal areas reveal that the coastal structures along this area have a significant impact on the shorelines with shoreline advanced upstream the structures reach 18.0 m/year and shoreline retreats rate reach 10 m/year downstream of the structures during the period from 2007 to 2012, (Iskander & El Kut, 2014).

Urbanization effect can be clarified at El Obayed beach. El Obayed beach extends more than 6.0 km west of Marsa Matroh city, Figure 4. It is one of the fast-developed coastal areas within the Northwestern coast of Egypt. El Obayed beach is partially protected by submerged ridges, which eliminate the sediment transport within the western part of the beach. In spite of that, El Obayed beaches suffer from shoreline retreat ranges from 0.8 to 3.5 m/years according to the Shore Protection Authority surveys during the period from 2005 to 2015, Figure 4. 

The erosion rate decreases eastward with the decrease of the developed area where the sand dunes react naturally. From 2011, Tourist village owners start to use protection measures to stabilize the coastal zone and control the reiteration of the shoreline. Two headlands and four groins were constructed in front of Carlos hotel and El Obayed army hotel during the period from 2011 to 2013. These structures success to eliminate the shoreline erosion within the project site but the erosion rate increases eastward of the structures as discussed in the following part.

The average shoreline reiterates ranges from 0.2 to 0.4 m/year during the period from 1977 to 2005,
Coastal Group (2007). Then, the rate increases to 0.8–2.0 m/year during the period from 2005 to 2015. Site investigation during 2017 shows that this erosion trend is mainly due to the human activities within the coastal zone, which control the flash flood with its two components fresh water and sediment. It also removes or controls the movement of the sand dunes, which consider one of the leading components in sediment stability within the coastal zone. The hydrodynamic forces and climate changes have low rate effect in that erosion while, the interview with local communities and stockholders show that they did not know that human activities have significant contributors to coastal erosion. A detailed study was executed by Coastal Research Institute to control the beach erosion and secure sustainable development for Marsa Matroh beaches. A beach nourishment project with control structures (groins) is proposed to solve this problem, CoRI (2017).

The Nile Delta coast

The Nile Delta coast extends from Alexandria to Port Said. It suffers from dramatically erosion due to the construction of control structures along the Nile River, (Stanley & Warne, 1993). Between 1945 and 2015, 50% of the Nile Delta coastline was eroded and 50% was accreted. Shoreline changes along the Nile Delta coast can be classified into five types, (Darwish, Smith, Torab, Monsef, & Hussein, 2017): (1) Relatively stable (51% of the coast), (2) Shoreline change from 3.0 to 7.0 m/year (33% of the coast), (3) Shoreline change from 7.0 to 29.0 m/year (12% of the coast), (4) Shoreline change from 29.0 to 57.0 m/year (3% of the coast), and (5) Shoreline change greater than 57.0 m/year, which happened only on Rosetta Promontory. Most of the coastal areas with high reiterate rate are under control now by coastal protection measure. The shoreline changes on the Nile Delta
The side effect of human activities within the Nile Delta can be investigated at Rosetta Promontory not only as shoreline erosion but also as a siltation problem within the Rosetta Nile branch, Figure 6. A considerable decrease of freshwater discharge from Rosetta promontory and the resulting remarkable increase of salinity from less than 27 ppt in 1964 to more than 39 ppt in 2015 bring a change in water density in the coastal area; affect the coastal stability, the mixing processes and the current system in the area, (Ali & El-Magd, 2016). Siltation problem within Rosetta promontory started 50 years ago after the construction of the control structures along the Nile River. Nile River average discharge to the Mediterranean Sea changes dramatically with the time from 62 billion m3/year during 1912–1942 to 46.93 billion m3/year during 1956–1965 through Rosetta and Damietta branches. After the construction of Aswan High Dam, the discharge to the sea remarkably decreased to be 3.92 billion m3/year through Rosetta estuary during 1966–2007 and demolish gradually after 2007 under the impact of domestic, agriculture, and industrial activities (Said & Radwan, 2009).

The satellite images data during the period from 2003 to 2016 show that before 2007, the sedimentation problem concentrated directly on the entrance. This siltation has been washed naturally by river flood as happened during the high flood in 1998 or artificially by dredging project as executed during 2007–2008 when the sedimentation blocked 90% of the entrance and threaten the navigation of the fishing boat, Figure 6. After this dredging project, the spit has been migrated landward along the Rosetta branch with rate 250 m/year during the period from 2008 to 2013, Figure 6. The investigation of the sediment type and characteristics revealed that the sand detected in the Rosetta estuary is transported mainly from the coastal area, El-Gamal (2017). The sea-level fluctuation and salinity changes within the Rosetta estuary can enhance the flow of the seawater toward the Riverside. After 2013, the main spit localized 2000 m landward from the entrance starts developed laterally and blocks the Rosetta branch with rate 40 m/year (blocked more than 50% of the branch width from 2013 to 2016). This spit threatens the navigation, especially during low tide. The secondary spit formed during 2009 at a distance 2700 m landward from the entrance and started developed laterally by about 30 m/year with small shift landward during the period from 2009 to 2016 (blocked 40% of the branch width). The main spit localized in front of the mouth of emergency brackish water drain, which works only in emergency case to decrease the water level in agriculture lands, Figure 6. Where the secondary spit localized just north of the small creek, which controls the movement of the sediment.

The landward movement of the spits gives an emergency alarm for the unbalance of the fresh and saltwater within the coastal area, which leads to salt-water intrusion, deterioration of the cultivated land, degradation of the fresh groundwater, and coastal erosion. This change in sedimentation behavior is related to the irrigation development project, which stopped the fresh water and sediment from reach the promontory most of the year.

The Northeastern coast

The Northeastern coast of Egypt is extending from Port Said to Rafah along the Mediterranean Sea with
length about 200 km, Figure 7. This zone consists of a western low sandy/silty section, El-Bardawil Lake, and an eastern sand dune coast. The western part looks like the Nile Delta coast. El-Bardawil Lake is one of the best quality lakes in Egypt with two inlets. The eastern part characteristics with enormous sandy beaches with sand dune.

Frihy and Lotfy (1997) studied the shoreline change along the Northeastern coast of Egypt during the period from 1922 to 1992 and divided it into two parts, Figure 7. The Port Said sub cell extends about 70 km (35% erosion and 65% accretion) where sand eroded from a headland is transported to the east and is deposited in the next embayment. The Bardawil sub cell reaches about 130 km (70% erosion and 30% accretion), Figure 7.

Nassar et al. (2018) detected the shoreline changes along the Sinai coast by using the available satellite images during the period from 1989 to 2016. The erosion/accretion cells as well as the shoreline change average rate for each cell are shown in Figure 7. The results reveal that more than 63% of the study area

Figure 6. Rosetta promontory and the migration of the sand spit along the Rosetta Nile River branch according to the satellite image data during the period from 2003 to 2016.

Figure 7. The north-eastern coast of Egypt from Port Said to Rafah shows shoreline reiterate zone, modified from Frihy and Lotfy (1997) and Nassar et al. (2018).
suffer from erosion while the stable area less than 10%. The maximum erosion rate of −18.65 m/year occurs in front of Port-Fouad lake while the maximum accretion rate of 22.48 m/year is detected at the eastern border of the same lake. The erosion shorelines increased from 58% of the coastal area during the period from 1922 to 1992 to 63% during the period from 1989 to 2016 due to the human activities.

CoRI (2015) monitored the effect of coastal structures along the Sinai coast during the period from 2004 to 2013. The results showed that the coastal problems along this zone are mainly due to anthropogenic influences and the existing combined action of waves and currents. Beach erosion and accretion are some of the coastal structures side effects within these areas, Figure 8. The main vulnerable areas are the coastal barrier of the Port-Fouad Lake, El-Bardawil Lake outlets and El Arish coastal area. The shoreline changes range from few centimeters to 32 m per year during the period from 2004 to 2013. On the other hand, the straight coast of Rafah exhibited a nearly stable shoreline, (El Banna & Hereher, 2009).

The shoreline changes along the Northern coast of Egypt show that the maximum shoreline fluctuation found within the Nile Delta coast followed by the Sinai coast and the least changes found in the Northwestern coast of Egypt. On the other hand, the retreat rate accelerates with the time along the Northern coast of Egypt under the effect of human activities and the nature factors.

**Climate change effect**

The climate change is going to complicate the problem of shoreline stability under the effect of sea level rise, saltwater intrusion, increase storms, and extreme events within the coastal zone. Worldwide tide measurements during the period from 1901 to 2010 show that the sea level increased and accelerated with time from 1.7 to 3.2 mm/year, (IPCC AR5, 2013). On the other hand, the expected increase in the sea level to year 2100 ranges between 18 and 59 cm depending on the different IPCC 2007 scenarios from A1 to A1F1 then increased to the range between 52 to 98 cm according to the modified IPCC (2013) scenarios from RCP 2.6 to RCP8.5. Tide data along the Northern Egyptian coast from 1943 to 2000 show that the annual rate of sea-level rise ranges between 1.6 and 5.3 mm/year included the land subsidence which corresponding to the global sea-level rise, (Elshinnawy, Abo Zed, Ali, Deabes, & Abdel- Gawad, 2010). While the expected increase to year 2100 ranges between 4 and 22 cm according to the different IPCC scenarios which is less than the global rate, (Shaltout, Tonbol, & Omstedt, 2015). This will cause inundation of the lowland areas along the Nile Delta coast.

The subsidence of the Egyptian coastal area is happened under the effect of neotectonic lowering, compaction of Holocene sequences, and lack of the sediment from the Nile River, (Stanley & Clemente, 2017). The land subsidence is estimated at 1–5 mm/year to 3.7–8.4 mm/year along the Nile Delta coast, (Stanley, 1990; Stanley & Clemente, 2017). It will affect 11.75% of the low land Delta regions by 2100.

Saltwater/freshwater interface is predicted to advance 1065.8 m landward by the year 2100 within the Nile Delta coast as a result of projected climate change and sea-level rise, (Elshinnawy & Abayazid, 2011).

Also, analyze of the measured wave data from 1977 to 2010 in front of the Nile Delta shows that wave energy within the high storms will increase by about 20% in front of the coastal structures while within the normal weather, the wave energy will decrease by about 1% within the next 50 years, Iskander (2013).

Saltwater intrusion may be an additional risk of the climate change into the coastal zone, freshwater rivers and aquifers. It will affect the quality of the farming soil and coastal fresh water resources, (Ali & El-Magd, 2016).

The present sea-level rise of the climate change can cause addition shoreline erosion with rate of 0.1 to 0.15 m/year, (Inman & Jenkins, 1984). The Nile Delta coast will be accelerated losted under the effect of the sea-level rise, subsidence, and construction of the Aswan High Dam, Darwish et al. (2017).

**Conclusions and recommendations**

The water and sediment are the two main components controlled the sustainable development in the coastal zone. Urbanization and climate change have a considera
ble side effect on these components. Some elements of this balance such as the role of the sand dunes in stable condition were neglected scientifically for many years because of the difficulty in assessment. While, they may be volumetrically, and ecologically important.

This work discusses the shoreline stability within the Northern Egyptian coastal zone. The study reviews the sediment sources, shoreline stability components, the effect of urbanization, and climate change in this stability. The methodology depends on collecting the available related studies in coastal engineering, sedimentology, oceanography, and sand dunes. Field observation, as well as Google Earth images, are also used to identify the stability condition of sediment within the coastal zone and its side effect on coastal zone sustainable development.

The study shows that there are dramatically changed in the shoreline stability within the Egyptian Northern coast. This unstable condition can be investigated in the landward migration of the sand spit at the Rosetta Nile River Branch, and the predominant shoreline erosion condition along many of the Northern Egyptian beaches. It may be due to the construction of buildings and infrastructure, and other human activities, which cause deterioration of the sand dune, fresh water, and sediment sources in the coastal zone. Climate change, which causes sea-level rise and increased storm density has a vital role in coastal ecosystem stability.

To avoid more deterioration in sediment sources in the coastal zone, it is recommended to establish protected areas on the dune belt (don’t allow to modify the environmental condition or built any structures within this zone) and save the other sediment resources in the coastal zone, for example protection of the unique combined sand dune and Oolitic cliff landscape found around the Headlands of Ras Um Rakham, west of Matrouh city, Figure 4, by increasing the width of the Set-back zone around the headlands to about 700 to 1000 m to allow the nature sediment transport between the sea and the land for the shoreline stability. These protected areas can be used for ecotourism.

Multi-discipline measurement strategies should be designed to identify the load of human activities and climate change on the sediment stability within the coastal zone. The new measurement strategy should cover long time to identify the climate effect and wide area within the coastal zone to identify the human effect. In addition, improving local awareness about the effect of human activities in the coastal zone is very important to save the environment. Egyptian Environmental Affairs Agency (EEAA) and Shore Protection Authority (SPA) have the authorization to execute such awareness for the stockholders start from high to low according to the activities level on the coastal zone. Indeed, EEAA and SPA require more capacity building and support from the universities and coastal research centers within these issues.

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