Chapter 2:

Environmental Conditions of Red Sea

This chapter deals with Red Sea Morphology, Geological Setting, meteorological and oceanographic parameters. It summarizes the description of the physical parameters and behaviour of air, sea and land of the Red Sea environment. The Red Sea area was Longley been neglected and remained undeveloped until the 1973 war. Even in the beginning of the present century when the oil fields were discovered on both sides of the Gulf of Suez, the area left to the oil and mining companies. Therefore, these companies carried out some sorts of development according to their needs. A town like Ras Ghareb was established by the oil companies as a worker's town, and Safaga was developed as a port for Phosphate exportation etc. The lack of fresh water, roads and regular transportation between the Red Sea and the Nile Valley were the main reasons for the isolation of the area beside other reasons concerning the scarcity of population and the priorities of the Egyptian government at that time (Madkour, 2004). Since the establishment of the Marine Biological Station in the thirties of the present century, attention was directed to the Red Sea, mainly because of the scientific reputation of this station, and the staff working in it, and could create a truly attractive point in the Red Sea coast. However, it is also true, that the natural beauty of the Red Sea was quite attractive for the Egyptian elite. Who can go to practice sport fishing on their own yachts. It is worth to mention that all the coast area from Suez to the Southern Egyptian border on the Red Sea was completely neglected and remain undeveloped till the 1973 war. In about 1975, the Egyptian Government started to think about the best way to develop the area of The Red Sea and South Sinai. The purpose was creation of new work opportunities to attract the Egyptians out of the narrow and crowded valley and to magnify the national income from the natural and artificial resources existing in the area.

1 Red Sea Morphology

The main body of the Red Sea lies in a rift valley separating the African and Arabian plates. It is the Red Sea, a product of deep-ocean rifting, extends for 2000 km from Suez to the Strait of Bab el-Mandab, which connects it with the Gulf of Aden and the Indian Ocean. Plateaus and mountains rise steeply to more than 1,000 m above sea level north of Jeddah and 3,660 m in Yemen. The coastal plain is from 2-50 km wide and slopes up gently to the east until it meets the mountains. The mountains are deeply cut by valleys but streams flowing in the uplands fail to cross the coastal plain to reach the sea. The Red Sea is 180 km wide in the North and widens to 350 km in the south, before narrowing to 28 km in the strait of Bab el Mandeb where it joins the Indian Ocean (Behairy, 1992).

ISBN: 978-81-936820-1-2

Thesis DOI: 10.21467/thesis.1

The bathymetric map of the Red Sea reflects its bottom topography. It indicates that the maximum depth is 2850 m opposite to Jeddah and Port-Sudan and being very shallow in the south on its continental shelf. From the continental shelf, sometimes called the coral reef zone, the sea bottom drops rather rapidly away in a series of steep cliffs at about 500 m to the main trough. The trough deepens to about 1000 m near the northern central axis of the sea; where further changes in the bottom topography may occur as the bottom slopes deeply down to reach 1500 m deep along much of its axial trough. (Edwards and Head, 1987) reported that the axial trough may contain pits of depth reaching more than 2500 m (Fig, 2.1).

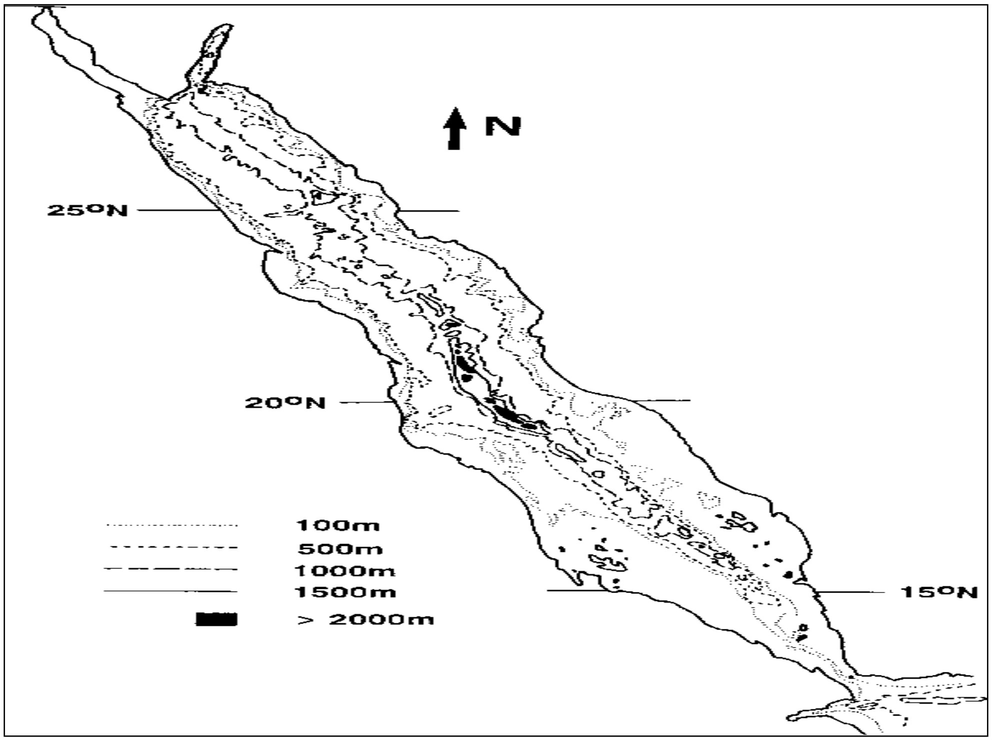


Fig 2.1: Major bathymetric profile of Red Sea (Head, 1987)

The Gulf of Aqaba is 170 km long, 14-26 km wide, and forms part of the Afro-Syrian Rift System with steep walls dropping to great depths (2,000 m in places). The Gulf of Aqaba is a continuation of this rift and extends along the Dead Sea rift. The Gulf of Suez extends for about 250 km south–southeast from the Suez port in the north (Lat. 29º 56') to Shadwan Island in the south (Lat. 27º 36'). The width of the gulf varies between 20 and 40 km, and its depth throughout its axis is fairly constant with a mean of 45 m (El-Sabh and Beltagy, 1983). Depth increases abruptly to about 250 m at its mouth (Shukri, 1945). The northern part of the Gulf of Suez (Suez Bay) is characterized by anticlockwise water circulation (Meshal, 1970 & Soliman, 1996), and it is an eutrophic region (Hamed, 1992).

The Red Sea shelf is rather narrow in the north and central regions; it is a few Kilometers wide. Much of the shelf length is covered with actively growing reefs. The reefs, patches, wall reefs, pillar reefs and atolls. The fringing reefs may be interrupted by bays or penetrated by narrow channels known locally as Sharm. Sometimes the fringing reefs are separated from the foreshore by backshore lagoons. Moreover, the living coral reefs provide food and shelter for many organisms with which they co-exist e.g. sponges, bivalves, urchins, Fishes etc…, therefore their damage represents serious economic and scientific loss.

2 Geological Setting

The oldest known formation in the Red Sea region is of Late Precambrian age, igneous and metamorphic rocks forming the northern edge of the African Shield. The basement complex outcrops in southern Sinai and in the Eastern Desert (Red Sea mountain range). (Said, 1962) and (El-Gezeery and Marsouk, 1974) showed that the depth of the basement increases northwards towards the Mediterranean Sea. Rifting in the Red Sea and Gulf of Aden continues an episodic process that began in the Permian: the peeling away of strips of the Gondwana part of Pangaea along Paleo- and Neotethyan continental margins (Stampfli et al., 2001). It is in reality more complex than this, because collision of Arabia with Eurasia and the emergence of the Afar plume also played important roles in the kinematics and dynamics of the region (William et al., 2005) (Fig, 2.2).

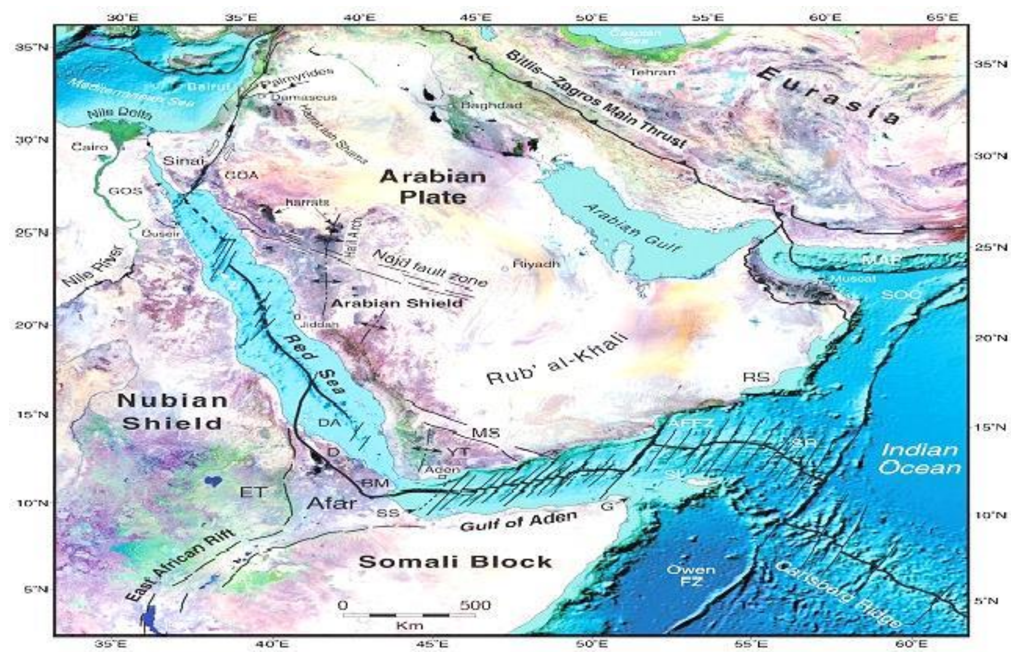


Fig 2.2: Landsat imagery (onshore) and Seasat-derived bathymetry (offshore) of the Red Sea–Gulf of Aden rift system and environs. Individual Landsat 5 scenes were color-matched

and mosaiced by the Stennis Space Center of NASA. Seasat bathymetric interpretation is from Smith and Sandwell, 1997.

The Basement complex of Egypt represents the northwestern part of the Arabo-Nubian shield, which is separated from the eastern portion in Saudi Arabia by the Red Sea (Gass, 1977). Reefal sediments and Sea-marginal lagoon sediments are the most characteristic sedimentary deposits in the near shore area of the Red Sea (El-Sayed, 1984 & Friedman and Krumbein, 1985). All along the present the shorelines are coral reef deposits. During the time of considerable alluvial activity in the last 140.000 years, reefs were developed along the coast. Their growth was irregular and discontinuous for two main reasons: First changing levels of sea relative to shoreline developing terraces, and second alluvial activity. Present fringing reef was developed on the contemporary shoreline, and patch reefs was developed on any older limestone (or other) platforms (Sheppard et al., 1992). Present reefs are a blanket of recent growth covering the Pleistocene highs. The high load of terrigenous deposits transported to the shore by wadis, and hence the high turbidity of sea water prevented the formation of the coral reefs and this gave rise to the formation of embayments (Sheppard et al., 1992).

Series of raised fossil coral reefs higher than current sea level are one of the most striking features of the Egyptian Red Sea coast line. Quaternary reef terraces are 2-6 terraces, three of them are distinguished in several areas. Each exhibits a short distance lateral facies development which begins at the shore with beach, mainly siliciclastics, and ends at the reef zone by carbonate sediments (Mansour *et al*., 2000). Strong similarity can be noticed between sedimentary facies (climatic conditions) of ancient Pleistocene sediments and those now present in modern fringing reefs. Reefs with their siliciclastics associations occur in the form of repeated cycles reflecting the tectonic effect and/or sea level changes (Mansour *et al*., 2000). Parallel lines of coral reefs between 50 and 100 m wide are found at the end of intertidal zone. The submerged reefs appear on the surface at low tides, in lines parallel to the coast a distance of one kilometer from it.

3 Meteorology

3.1 Climate

Temperature, rainfall and wind are of paramount significance in determining the nature of marine biological systems in all parts of the world including the Red Sea. The climate of Red Sea region is extremely arid. It is mainly regulated by the distribution of winds and change in atmospheric pressure over a very wide area. These pressures undergo variations during the course of the year causing a widespread seasonal change. Moreover, the Red Sea lies in the arid zone between two great deserts, the Sahara of North Africa and Arabian Peninsula in Asia. This may cause a little rainfall in association with low-pressure troughs moving from the north and accompanied by changes in wind, temperature, humidity and cloud. The Red Sea receives very small amount of water through precipitation and run off. Therefore, this relatively restricted marine body loses much more water through evaporation than it does drains by precipitation. (Madkour, 2004) During winter months (December-February) strong winds and occasional frontal rain occur where there is influx of cold air round Cyprus Lows. Desert depressions, occasionally invade the northern Red Sea in the spring (March-May), and are most characterized by dusty atmospheres (Khamasin) and poor visibility. Central Red Sea, pressure is usually relatively low, with prevailing calm and light air. November storms are sometimes violent, associated with heavy squalls and torrential rain lasting as hour or two and reducing visibility to the order of 100 yards (Abd El Raoof, 2004).

3.2 Air Temperature

The average annual temperature over the lowlands of the Governorate steadily increases from the north (22 °C) southwards (25 °C at Marsa Alam and Aswan). The coolest months are December-January, when the average temperature drops to 14-16 °C (Abd El Raoof, 2004). The average air temperature at Hurghada, as obtained from the Egyptian Meteorological Authority reports fluctuated around 17 - 28oC in winter and varies between 27.5oC and 30.6oC in summer (Anon., 1980).

3.3 Winds

The whole area is characterized by the near permanency of winds blowing from a northerly or north-westerly direction (Abd El Raoof, 2004). The results obtained from the Meteorological station of National Institute of Oceanography and Fisheries (NIOF), Red Sea branch in the year (2001) show that the prevailing wind is NE, E in summer and N, NE, NW in winter and the wind direction speeds usually range between 6.39 to 9.2 km/h with an average of 8.3 km/h in summer and between 6.01 to 11.57 km/h with an average of 9.43 km/h in winter (Madkour, 2004).

3.4 Rain Fall

The rainfall over the Red Sea and its coasts is extremely small. The high mountains surrounding the basin influence its weather, particularly the rainfall. The rain is mostly in the form of showers of short duration, amounting to some 10 -15 mm per year, almost entirely in the winter months. It is often accompanied by thunderstorms and occasionally preceded by dust storms (Morcos, 1970). The field observation and local residents affirm the non-regular rainfall between long dry periods. However, the southern coastal area along the Egyptian Red Sea is more susceptible to the sporadic rainfall during winter months.

3.5 Humidity

The relative humidity varies from day to day. It is greatly dependent upon the activity of the wind regime over the area particularly in summer. Also, in summer ES wind over saturated with water occasionally blows over the Red Sea. This wind has the local name Azyab. Along the Red Sea coast, humidity is usually rather lower than over the sea and generally increases from north to south. At night landward winds tends to be dry but lower temperature raise the relative humidity. By the higher 35 temperature decreases the relative humidity but sea breeze bring in moister air and the opposite effect. Edwards and Head (1987) stated that on the Egyptian coast of the Red Sea the monthly mean values are around 50 % throughout the year for morning observations and some 5 - 10 % higher in the afternoons. The lowest mean relative humidity between Quseir and Hurghada are recorded in June with an average value of 43.5 %. The highest mean relative humidity in the same area is recorded in October and November months with an average value of 54.5 % (Meteorological Authority, Egypt, 1978 - 1979). Humidity ranges from 56.38 to 61.97 with an average of 61.97% in summer and varies between 54.46 to 69.15 with an average of 62.18% in winter as obtained from the Meteorological station of National Institute of Oceanography and Fisheries (NIOF), Red Sea branch (2001) (Madkour, 2004).

4 Oceanography

Doubtless oceanographic conditions prevailing along the shore have an exchangeable effluence on the coastal features. The oceanographic parameters affect the shore environment and simultaneously have the impression on the shore activities. During collection of samples many oceanographic parameters include depth, temperature, salinity, pH, specific conductivity (SPC) and total dissolved salts (TDS) were measured by Hydrolab Instrument (HANNA HI 9828) and the data was illustrated in table (2.1).

4.1 Water Temperature

Sea surface temperature broadly correlate with air temperature (Ross, 1983), increasing from north (winter 21 oC; summer 26 oC) to south (winter 28 oC; summer 32 oC) until cooled by the water inflowing from the Gulf of Aden (Morcos, 1970 & Mohammed, 1988) noted that during winter season from January to March in the northern Red Sea (27 - 28o N) the surface temperature averages 21.7 oC. (Piller and Pervesler, 1989) showed that water temperature in Safaga Bay clearly reflects seasonal changes, except the shallow areas where higher values were reached due to solar radiation. Therefore, in shallow waters of normal marine salinity (euhaline), temperature plays the most significant role in determining the distribution and diversity of marine invertebrates. The average water temperature at Qusier, Safaga, Hurghada and Rasghrb as I obtained by using Hydrolab were: 20.6 – 23.7oC, 14.5 – 22.9 oC , 21.5 – 22.2 oC and 17.1 – 18.1 oC in winter 2012 and varies between 24.9 – 28.2 oC ,24.6 – 30.6 oC , 25.9 – 26.9 oC and 22.9 – 24.1 oC in Autumn 2012 , respectively .we recorded the highest and lowest air temperatures as 30.9oC in Autumn at Safaga touristic harbour and 14oC in January at Mangrove area, respectively (Table 2.1).

4.2 Salinity

The Red Sea is the most saline water body in the world oceans. The surface salinity of the Red Sea is high. Density of seawater increases with salinity and decreases with temperature. The surface salinity in summer varies from 37% near Bab El-Mandab to more than 40% in the northern part of the Red Sea (Siedler, 1969 & Morcos, 1970) recorded that the horizontal distribution of surface salinity decreases from north to south, from 40% at the southern tip of Sinai Peninsula to about 36.5% near Perim. (Grasshof, 1969) attributes this decrease in surface salinity of the Red Sea from north to south to evaporation and mixing of water of the Red Sea with less salty oceanic waters to the south, near Bab El-Mandeb. The data mentioned in the report of Red Sea studies (Anon., 1981) show that the average salinity in the area of Hurghada reaches 40.31, 40.06, 40.58 and 40.24% in winter, spring, summer and autumn, respectively. No significant differences between surface and bottom salinity values were observed at Safaga Bay (Piller and Pervesler, 1989 & Khedr, 1989) found that salinity of surface water of some embayment along the Red Sea coast at Bernece, Abu-Ghusson and Sharm Loly averages 58, 54 and 58% respectively. At Hurghada it reaches 40.31% and in deep water it reaches about 40.2% (El-Mamoney, 1995). The salinity of the studied areas was measured using the Hydrolab Instrument. Consequently, there is a gradual increase in salinity from south to north (Table 2.1). Whereas, the salinity varies from 40.5% in winter at El-Sakala area south Ras Ghareb city to 43.6% in winter at Km 17 Mangrove area, south Safaga city (Table 2.1).

4.3 Hydrogen Ion Concentration (pH)

pH values determine the media nature, high pH means oxidizing conditions present and low pH deals to reducing environment in the locality. The general pattern of the surface horizontal water distribution of pH gave local variations mainly due to the climatic conditions, water temperature, dissolved oxygen and biological activities. The vertical distribution of pH shows irregular variations attributed to the vertical mixing process of water. The decrease in the pH values with depth is mainly due to decomposition of the organic matter and decrease in the dissolved oxygen (Hanna et al. 1988). pH plays an important role in the rate of release of metals into water. If the water is acidic with low pH, the metals release much more rapidly than when the water is more alkaline and the pH is comparatively high. The lower pH values increase the competition between metals and hydrogen ions. Also, a decrease in the pH dissolves metal complexes and releasing metal ions in the water column.

Chemical and biological activities in the aqueous environment create a related pH values. (Wattenberg, 1933 & Saad, 1978) show the horizontal distribution of the pH values for the surface water have higher trend in winter than in summer, while the irregular vertical variation of the pH shows a little decrease with depth as a general trend. The pH values of water at Hurghada neighborhood is 8.08 and 8.37 as minimum and maximum, respectively (El-Mamoney, 1995). In the present, work the measured pH values using Hydrolab Instrument

(HANNA HI 9828) range between 8.0 in winter at north Safier Hotel, south Hurghada city to 9.48 in winter at north Flamiko Village, north Quseir Harbour (Table 2.1).

4.4 Currents

The currents in the Red Sea are the result of four factors, winds, excessive evaporation, water temperature and tides. The currents in the Red Sea are predominantly weak and the average flow at any season tends to be in alignment with the sea itself NW or SE (Anon., 1980). The coastal current along the Egyptian side is generally south direction. In the investigated areas, the currents are much influenced by the local topography and sometimes by tidal streams which are themselves much affected by local conditions.

4.5 Tide

Tide is one of the important influencing forces on the coastal zone. Tides are oscillatory, semi-diurnal with an average spring range of 0.5 m; and with a mean sea level up to 1.0 m higher in winter. A 6-hour time difference exists between tide times in the southern and northern areas (Morcos, 1970). The spring range is about 0.6 m near Hurghada and 0.7 m at Quseir (Moussa, et al., 1986). The tide range increases towards the terminals. For example, it attains about 90 cm at the strait of Jubal at the northern end of the Red Sea, where the tide current exceeds sometimes 100 cm/sec (El-Mamoney, 1995).

4.6 The Mean Sea Level

It fluctuates consistently with the season because of water evaporation, the highest in winter and lowest in summer. At Hurghada the mean sea level varies between 48cm (January) and 22cm (September) (Abd El Raoof, 2004).

5 Description of the Studied Areas

Red Sea is a deep semi-enclosed and narrow basin, lies between 12 - 30°N and 32 - 44° E, it is about 1930 km long with an average width of 280 km (Morcos, 1970). It has a maximum depth of 2211 m in the central median trench and an average depth of 490 m. It is connected to the Indian Ocean through Bab El-Mandab strait and extends north word to Sinai Peninsula which divides it into the shallow Gulf of Suez and deep Aqaba Gulf (Murty and EL-Sabh, 1984). The Red Sea is the habitat of more than 1000 invertebrate species, 200 soft and hard corals (3.8% of the world's coral reefs) and over 1200 fish species (Ormond and Edwards, 1987). Hurghada City is located at the northern part of the Red Sea proper. Since 1980, it has been continually developed by Egyptian and foreign investors to become the leading seashore resort on the Red Sea. The geophysics is considering the Red Sea in three parts. The northern Red Sea (north of 25o N), the central Red Sea (17o to 25o N) and the southern Red Sea (south of 17o N), where structural differences from north to south are noted (Said, 1962, 1970). In the northern Red Sea, the main depression is about 200km wide, and at latitude 27o 45\ N, it bifurcates into the Gulf of Suez and Gulf of Aqaba with the Sinai peninsula in-between.

The Red Sea coastal land of Egypt extends from Suez (Lat. 30o N) to Marsa Halaib (Lat. 22o N) at the Sudan - Egyptian border. The Egyptian Red Sea coast, intertidal zone and supratidal zone consisting of elevated Pleistocene reef, which separates land from sea by cliff and sand zone. The high load of terrigenous deposits transported to the Red Sea shore by valleys, and hence the high turbidity of seawater prevented the formation of coral reefs off these valleys, and this gave rise to the formation of the embayment. The clastic sediments transported from the mainland through several valleys "wadis" are debauched into the Red Sea beaches. However, biogenic activity is regarded as the major source of sediments a few meters away from the valley mouths. Beaches and adjacent nearshore zones act as buffers to wave energy. The rocks on the coastal plain range in age from Miocene to Quaternary (Issawi et at., 1971). Generally, the shallow parts of the Red Sea are rich in coral reefs these reefs are very abundant to the south and tend to decrease in intensity northwards. The Red Sea Governorate is bordered on the north by the Suez Governorate, to the east by the Red Sea, and to the west by the governorates of Aswan, Qena, Sohag, Asyut, al-Minya and Beni Suef. In the south it is bordered by Sudan's Red Sea State. The area of Red Sea Governorate is 203,685 km2 , and it has a 1080 km- long beach. Red Sea Governorate is one of the governorates of Egypt. Located between the Nile and the Red Sea in the southeast of the country, its southern border forms part of Egypt 's border with Sudan. It consists of its capital the city of Hurghada in addition to 5 other cities (Ras Ghareb – Safaga – Qusier – Marsa Alam – Shalatin).

The population of Red Sea Governorate was 288,233 inhabitants (according to the latest census in 2014), of which more than 337,051 lived in a few towns along the coast. Historically, the population since 1937 was as follows: 1937: 9914 - 1947: 15 929 - 1966: 38,000 -1976: 56 191 - 1986: 90 491 -1996 155 695 -2006: 288 23. (Red Sea Governorate web site, 2015).

The areas under study have a gentle slope, and sometimes are represented by rocky tidal flat. The inland geomorphology is characterized by the high mountains extending along the Red Sea coast. Between the shoreline and high lands, extends a gently sloping plain, which varies in width from about 2 to 30km. The four investigated areas along the Red Sea coast were selected for studies (Fig, 2.3). The first area was chosen at Quseir city, when the second and the third areas represent Safaga and Hurghada Cities. Finally the forth area was chosen on the Gulf of Suez namely Ras Ghareb City. Each area divided into three stations. Therefore, in the present investigation, the study area included twelve stations along the northern part of the Red Sea and Gulf of Suez coastline from the El-Edua area south Quseir City to General Company of petroleum, north Ras Ghareb City. All that stations were photographed with (Samsung-SM- G7102 camera), as it appear in (Plates 1 – 12).

5.1 Quseir City:

Quseir City divided into three stations from south to north, namely, El-Edua area, Quseir Harbour and north Flaminko Village (Fig, 2.3).

Station I: El-Edua area is located south Quseir City at latitude 26° 05\ 31\\ N and longitude 34° 17\ 30\\ E (Table 2.1; Fig.2.4).The beach is 3 m wide, 30 cm high and sloping 8° toward the Sea while the tidal flat is covered with sand, shell fragments, coral rubbles and scattered stones covering the bedrock. After 4.5 cm seaward from the shoreline a number of the Sea urchins appear. The needle-spine urchin was found in scattered aggregations on the reef flat around and in between cracks at 12.5 m from the shoreline. The presence of the different of Sea urchins continued all along the reef flat (Madkour and Ahmed, 2006).

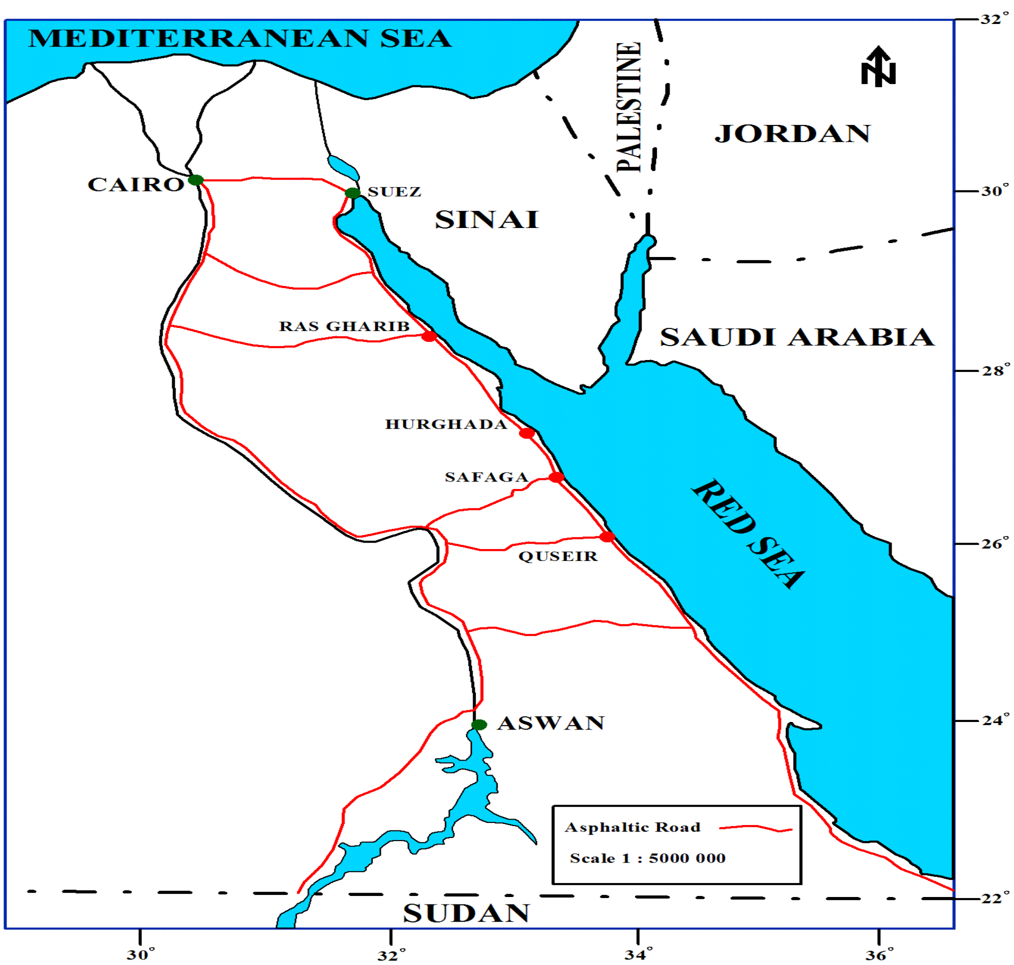


Fig 2.3: Location map of Red Sea Governorate

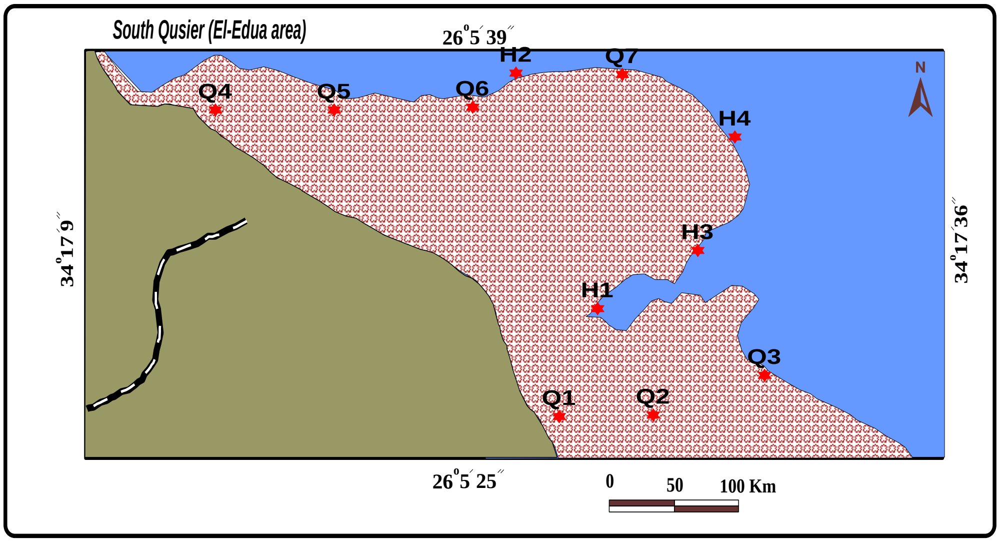


Fig 2.4: Sample locations in El-Edua area

Station II: Quseir Harbour is located in Quseir City, and is considered from old Harbour on the Egyptian Red Sea coast. It is lying at latitude 26 o 06\ 12\\N and longitude 34 o 17\ 12\\E (Table 2.1; Fig. 2.5).

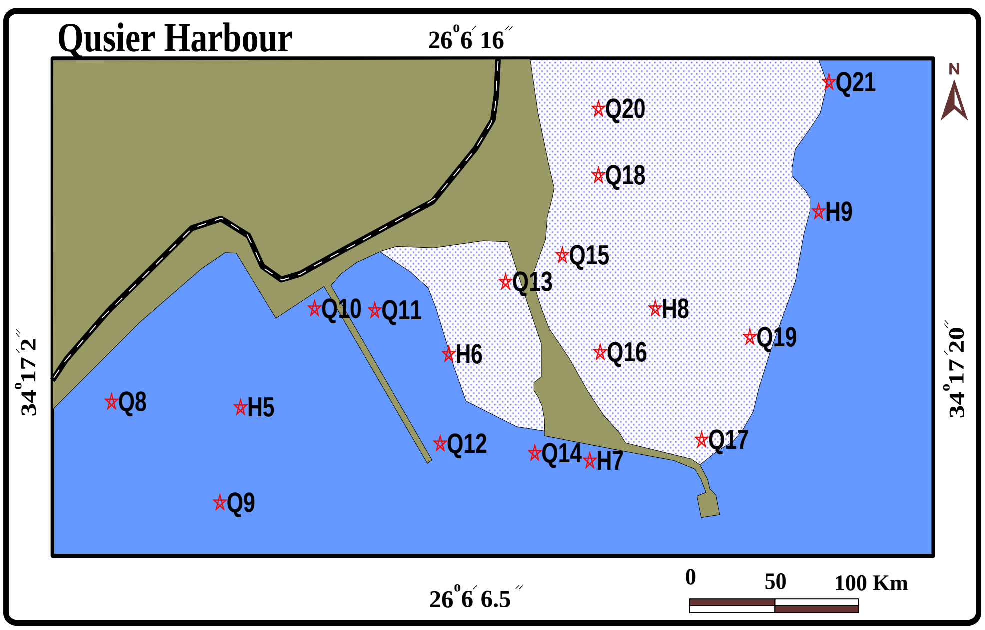


Fig 2.5: Sample locations in Qusier Harbour

This harbour lies in a small by the mouth of Wadi Ambaji. We collect our samples in winter season 2012; the salinity of the water in Quseir Harbour is relatively high. It varies between 42.24% and 43.08% in winter season. The water temperatures in this season were 21.7oC and 23.7 oCTerrigenous sediments have been transported to marine environment by Wadi Ambaji especially in the southern part of Quseir Harbour. It is observed that these sediments have a relatively large under cutting effect of the violent drive water during heavy torrents. The beach sediments are coarse sands. These sands are significant terrigenous fragments the tidal flat is very narrow and extends smoothly and slopes gently seaward. The sediments covering the bottom topography of this area are of fine sand to sandy mud. Most sediment samples have brown color. This is due to phosphate shipment operations. The system of the malaise of marine environment deterioration at Quseir area include the spread of algal blooms, dense sea grasses, coral bleaching and declining of productivity in addition to the poor biological activity of marine organisms especially coral reefs (Madkour 2004).

Station III: North Flaminko Village is located north Quseir City. It is lying at latitude 26o 09\ 20\\N to 26 o 09\ 36\\N and longitude 34 o 14\ 40\\E to 34 o 14\ 50\\E (Table 2.1; Fig. 2.6). The beach is 8 m wide, 50 cm high and sloping 12° toward the Sea. The sandy substrate extends to 9 m where some scattered stones found. The presence of living coral colonies were in the form of separated small-branched colonies of Acropora sp., Stylophora sp. at a depth of 45cm. The Sea urchin formed a dense population around the coral colonies and in between cracks on the reef flat at a depth of 60 cm, 23.7 m from the shoreline. The water depth increases as we go seaward to be 90 cm and at a distance of 59 m, where coral flourished, either branched or massive forms, making a number of communities where coral reef fishes were so abundant. The algal community began to dominate at a distance of 89.5 m and a depth of 45 cm. The dominant brown algal species forming dense long narrow mats of 2 m width covering the reef flat, 98 m from the shoreline at a depth of 60 cm. Also the water depth decreased as we approached the reef slope where water movement was so strong and the reef flat was relatively bare at a depth of 10 cm and a distance 250 m from the shoreline. Reef slope is dominated by (Millepora sp.) according to (Madkour and Ahmed, 2006).

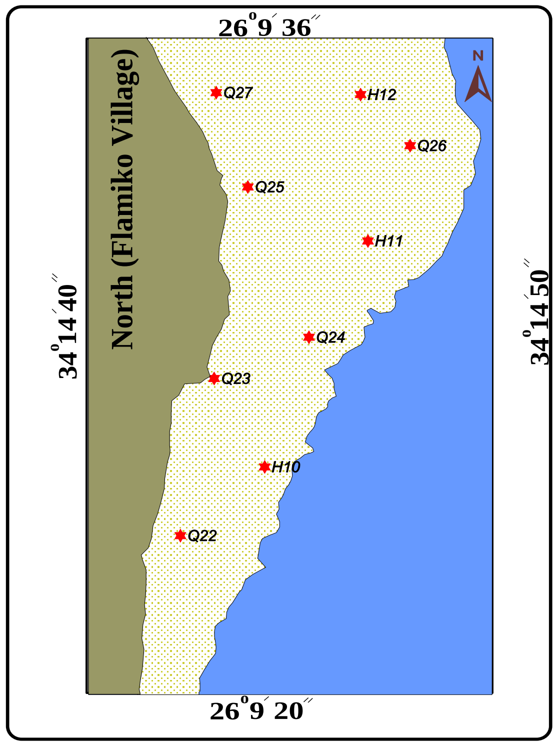


Fig 2.6: Sample locations in Flaminko Village

5.2 Safaga City:

Safaga City included three stations from south to north namely; Mangrove area (K17), Abu-Tartour Harbour and Touristic Harbour (Fig. 2.3).

Station VI: Mangrove area (k 17), it is located at latitude 26° 36\ 56\\ N and longitude 34° 00\ 43\\ E (Table 2.3; Fig. 2.7). It is distinguished by mangrove trees (*Avicennia marina*) and tidal zone reach to about 100 m occupied by sand mud and small rocks, the tidal zone followed by deep water which begins with 5 m.

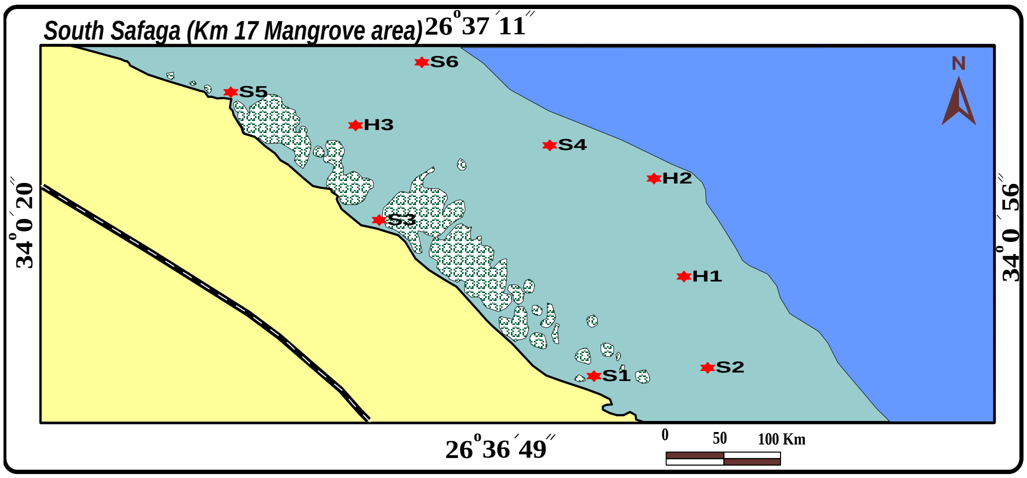


Fig 2.7: *Sample locations in Km 17 Mangrove area*

There is successful transplantation operation carried out in this area by Egyptian Environmental Affairs Agency (EEAA).

Station IV: Abu-Tartour harbour, it is located out of Safaga City. It is situated between latitude 26° 41\ 46\\ N and longitude 33° 55\ 47\\ E (Table 2.3; Fig. 2.8). Its activities are limited to exporting of the Egyptian phosphate, packed cement and crude alchortz. Shoreward, the area is skirted by high basement mountains. The beach sediments are generally coarse sands mixed with common rock-forming detritus from the surrounding formations. The sediments covering the intertidal zone are fine to very fine sands sizes and rich in terrigenous constituents. On the other hand, bottom topography of Abu-Tartour Harbour is mud to sandy mud. This is due to phosphate shipment; packing of cement and other activities enter this harbour.

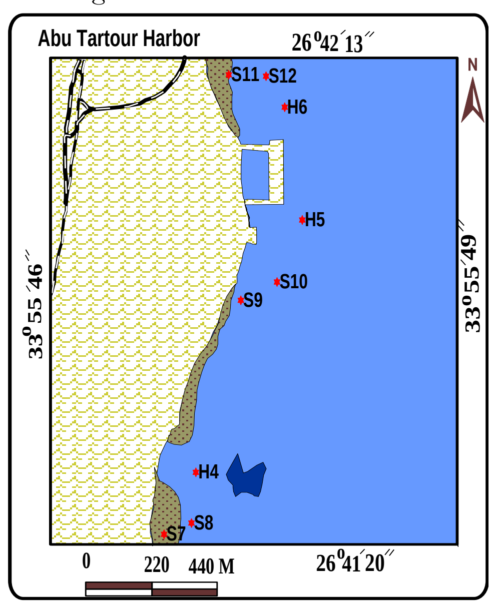


Fig 2.8: Sample locations in Abou Tartour Harbor

Station V. Touristic Harbour, it is located at north Safaga City. It is lying at latitude 26° 45\ 98\\ N and longitude 33° 56\ 42\\ E (Table 2.1; Fig. 2.9). Generally, the northern part of the Red Sea is characterized by the existence of a wide intertidal zone (~1000m wide). Also, Shoreward, the area is skirted by a raised reefal limestone (about 1.0m in height) that is considered to have been deposited during the marine transgression in the late Pleistocene or early Holocene (El-Sayed, 1984). The Egyptian experts of EEAA and Danish experts studied this area then, the EEAA allowed to use landfilling and dredging on beach and intertidal zone during construction this marina. A geotextile curtain has been used during the operation for preventing dust from spreading to the surrounding environment but in many times the wind was cut the geotextile. The fill operation has been used sediments transported from the natural land of this site, and mountain area, and as illustrated in the figure (plate1) there are many solid wastes and disposal of garbage from the boats in addition to, sunken boats at the area. Patch reefs and fringing reefs characterize the area in front of Tourist Harbour. The most common and widely distributed coral species in this area are *Acropora sp.*, and *Stylophora pistillata.* A long the intertidal zone, there are some patches of seagrass. Dense algal species and coralline algae are incorporated with the reefs.

5.3 Hurghada City:

Hurghada City divided into three stations from south to north namely; north Safier Hotel, Hurghada public Harbour and the third station namely, (NIOF) National Institute of Oceanography and Fisheries, Red Sea Branch (Fig. 2.3).

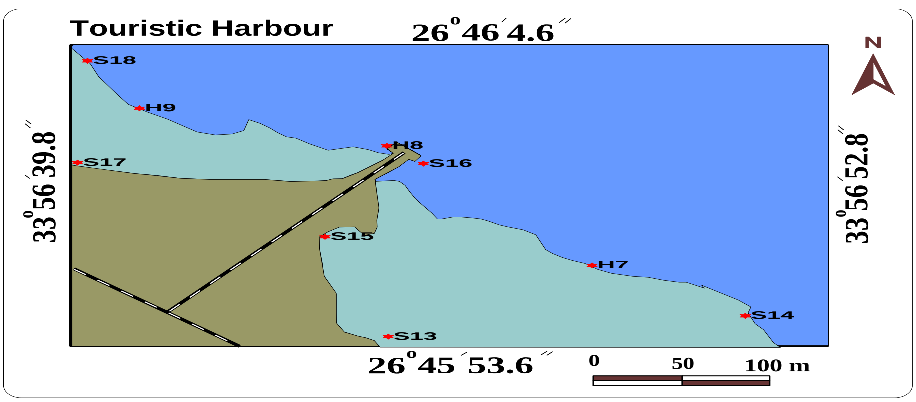


Fig 2.9: Sample locations in Touristic Harbour

Station VI: Safier Hotel area is one of Hurghada resorts which located 8 Km south of Hurghada at (27º 12' 10"N, and 33º 51' 04"E) (Table 2.1; Fig. 2.10). Most of the activities that took place in the area are, landfilling, dredging and reclamation of the intertidal zone. The filling operations has been carried out above the setback line area and around the dredged lagoon in the intertidal zone and violated two small channels have been dredged in the intertidal zone for water circulation inside lagoon. With nets mounted at the entrances of the channels so as to prevent the marine litters from entering the lagoon (Plate1). Currently, the original coastline of this area has been completely altered by dredging and landfilling operations. Landfilling results in burying and obliteration of any one of a number of biologically productive intertidal and subtidal habitats. The sea bed in the area is covered by patches of seagrasses and algae with coral fragments. The bottom facies is characterized by many patches of seagrasses, algae and coral reefs.

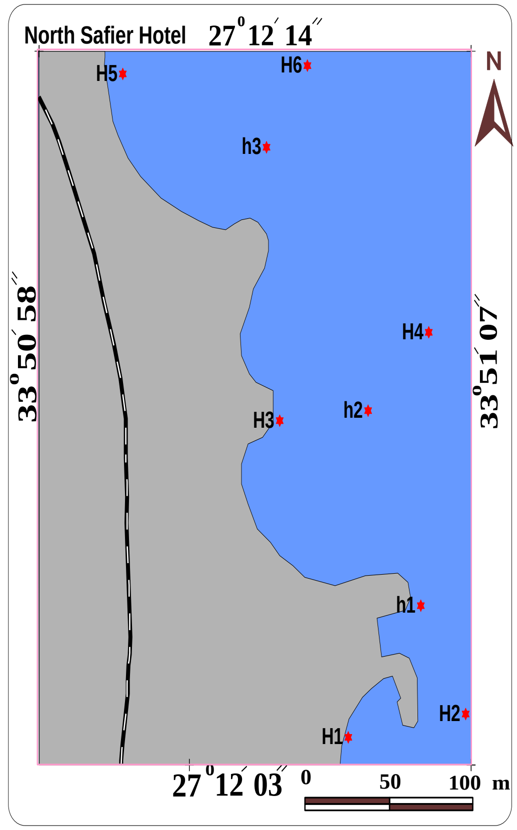


Fig 2.10: Sample locations in North Safier Hotel

Station VII: Hurghada Harbour, it is located at the center of Hurghada City (27° 13\ 47\\ N and 33° 50\ 36\\ E), which represents the main shipyard of Hurghada City (Table 2.1; Fig. 2.11). Longtime ago this site was used to repair, maintain and construct fishing ships. Recently, these activities were developed to repair, maintain and construct safari, diving ships and yachts. Ten years ago, the southern part of the shipyard beach was used to drain the brine water of the huge desalination plant of the city (Madkour and Dar, 2007).In the same manner in Touristic Harbour in Safaga City, Patch reefs and fringing reefs characterize the area in front of Tourist Harbour, the most common and widely distributed coral species in this area are *Acropora sp*., and *Stylophora pistillata.* A long the intertidal zone, there are some patches of seagrass. Dense algal species and coralline algae are incorporated with the reefs.

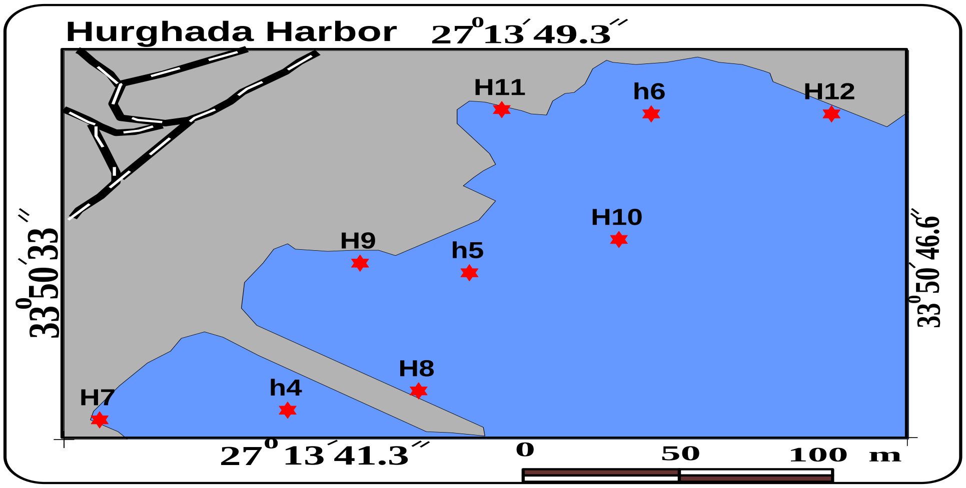


Fig 2.11: Sample locations in Hurghada Hurbor

Station VIII: NIOF, it is located in front of the National Institute of Oceanography and Fisheries (NIOF), 5 km north to Hurghada, (27° 17\ 04\\ N and 33° 46\ 20\\ E) (Table 2.1; Fig. 2.12). Although it isn't located under the direct affects of anthropogenic activities like other studied stations, it is distinguished by highly sedimentation rate. This site is characterized by a long patchy reef, representing the front edge of a wide and shallow reef flat with many depressions and lagoons. Seaward of the reef edge was a shallow mostly sandy bottom area extending a long distance with few coral patches. The depth ranged from about 3m at the reef front with gentle slope towards deep water.

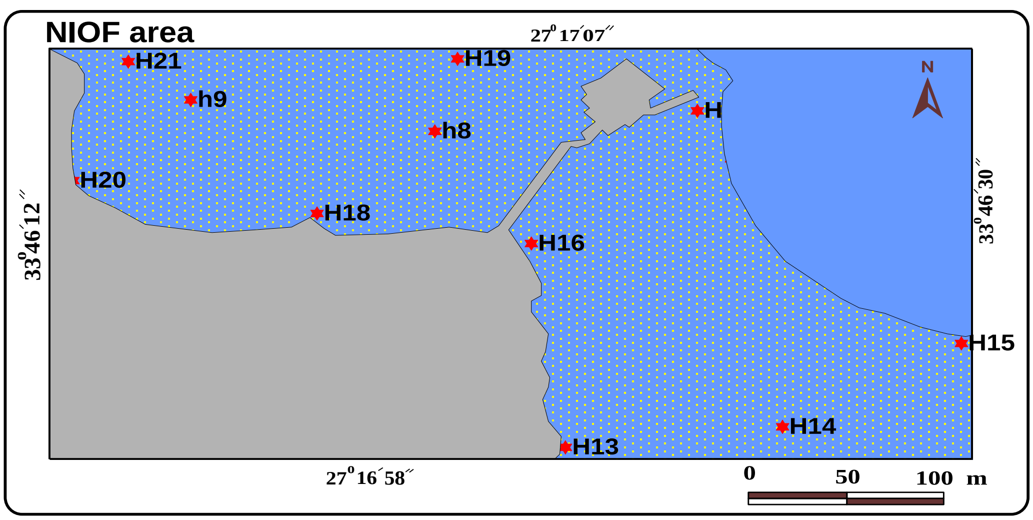


Fig 2.12: Sample locations in NIOF area

The area was generally exposed to strong waves, and the currents follow the prevailing current direction in the Red Sea from north to south. Fishing is considered the major impact in this area, mainly net fishing on the reef flat and the lagoons. A medium development does undergo along the coast of this area. The source rock at NIOF is composed of limestone and raised reefs (Plate1); the back shore area is occupied by buildings of El-Aheaa. The bottom topography of this area is characterized by seagrasses and algae in intertidal and subtidal area in addition to coral. An extended reef flat with seagrass and seaweed beds suitable for fish and shellfish breeding characterizes this site.

5.4 Ras Ghareb City:

Ras Ghareb City divided into three stations from south to north namly; El-Sakala area, General Beach area and the third station namely, General Company of Petroleum (Fig. 2.1).

Station IVV: El Sakala area is lying at latitudes 28°21\ 00\\ N and longitudes 33° 06\ 40\\ E (Table 2.1; Fig. 2.13). Station IVV is characterized by the existence of a narrow intertidal zone about (50 – 100m). In the beach area and intertidal zone, the sands are accumulated in the form of small dunes covered by some vegetation. These dunes separate between the shore zone and sabkha evaporates. The very gentle slope of this area creates a narrow sabkha basin and a narrow tidal flat and the intertidal zone of this area.

Station VVI: General Beach is located between latitudes 28°21\ 41\\ N and longitudes 33° 05\ 50\\ E (Table 2.1; Fig, 2.14).

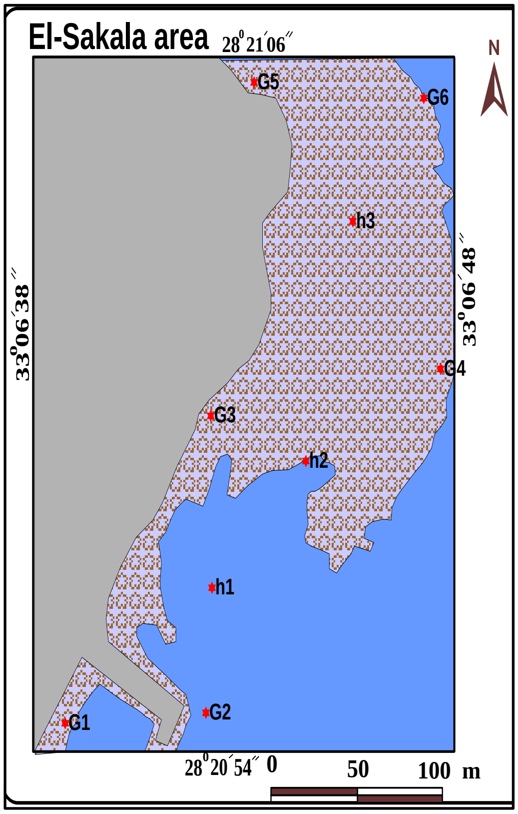


Fig 2.13: Sample locations in El-Sakala area

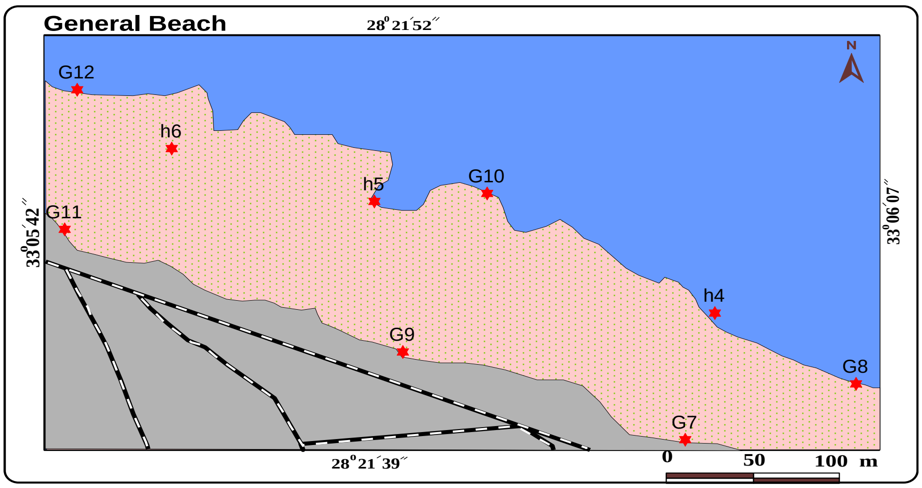


Fig 2.14: Sample locations in General Beach in Ras Ghareb City

Terrigenous sediments have been transported to marine environment by some wadis especially in the southern part of Ras Ghareb City. It is observed that these sediments have a relatively large under cutting effect of the violent drive water during heavy torrents. The beach sediments are coarse sands. These sands are significant terrigenous fragments. The tidal flat is very narrow and extents smoothly and slopes gently seaward. The sediments covering the bottom topography of this area are of fine sand to sandy mud.

Station VVII: General Company of petroleum is laying at latitude 28° 22\ 37\\ N and longitude 33° 04\ 02\\ E (Table 2.1; Fig. 2.15). This station is similar morphologically the general beach but the beach and the big part of the intertidal zone is covered by heavy oil spills as a result of exploration and extraction activities of crude oil and flooding of some oil wells. Generally, the beach area of Ras Ghareb is affected by oil spills.

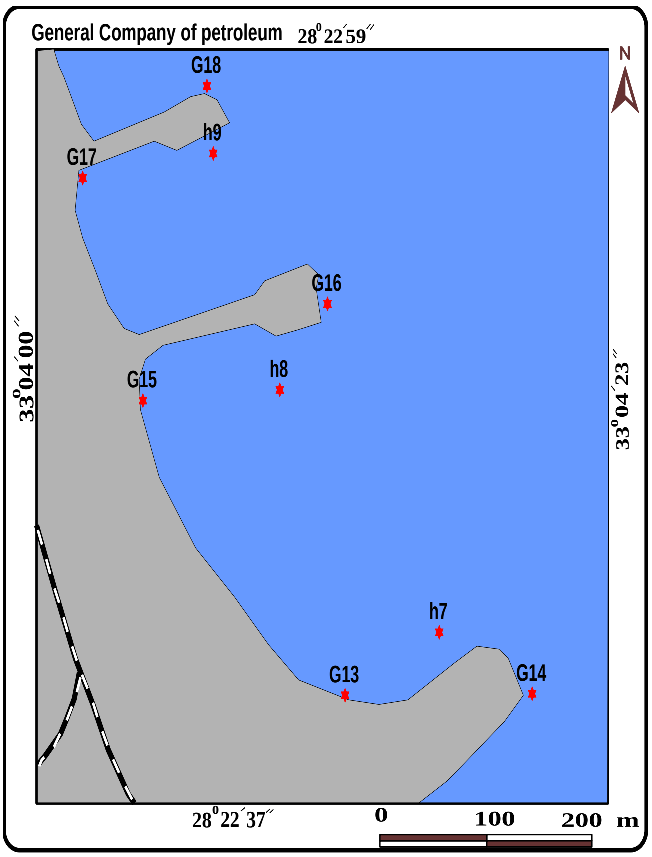


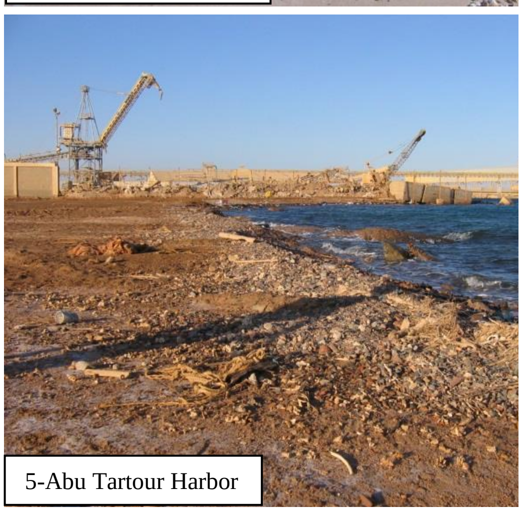
Fig 2.15: Sample locations in General Company of Petroleum


1-El Edua area


2-Quseir Harbor


3-N. Flaminko Village


4-Km 17 Mangrove area


5-Abu Tartour Harbor


6-Touristic Harbor

7-North Safier Hotel

8-Hurghada Harbor

9-NIOF area

10-Hurghada Harbor

11-Hurghada Harbor

12-General Company of petroleum

Plates 1 – 12: (Photograph of all study area with (Samsung-SM- G7102 camera)

Table 2.1: Sample location, depth, Temp, Sal, SPC and TDS from shoreline in the studied areas.

Sec. areas	Station	position		Depth (m)	Temp. (°C)	Sal. (%)	PH	SPC ms\cm	TDS (ppt)
		Lat. ° ' " N	Long. ° ' " E						
Quseir City	south (El-Edua area)	26°05'31"	34°17'30"	1.0	21.9	42.3	8.8	62.6	31.3
				1.5	22.1	42.3	8.6	62.5	31.3
				2.0	21.9	42.1	8.8	62.4	31.2
				8.0	20.6	42.6	8.7	62.9	31.5
	Middle (Quseir Harbor)	26°06'12"	34°17'12"	1.0	23.7	42.5	8.8	62.9	31.5
				1.0	21.7	42.5	8.6	62.8	31.4
				3.0	22.2	42.2	8.6	62.6	31.3
				0.3	23.3	43.1	9.1	63.7	31.9
				0.5	22	42.4	8.8	62.8	31.4
	north (north Flamink o Village)	26°09'26"	34°14'43"	0.5	22.	43.4	8.9	64	32
				0.5	23.2	42.6	8.9	63.1	31.6
				0.5	22.5	43.3	9.5	63.9	31.9
Safaga City	south (Km 17 Mangrove area)	26°36'56"	34°00'43"	0.5	14.6	43.6	8.8	64.5	32.2
				0.3	15.9	43.3	8.7	63.9	31.9
				0.5	15.2	43.3	8.6	64	32
	middle (Abu-Tartour Harbour)	26°41'46"	33°55'47"	2.5	20.7	42.4	8.6	62.8	31.4
				1.5	20.6	42.3	8.6	62.7	31.3
				4.0	21.2	42.4	8.8	62.7	31.4
	north (Touristic Harbour)	26°45'98"	33°56'42"	0.3	22.9	42.9	8.8	63.5	31.7
				0.3	21.8	42.4	8.6	62.8	31.4
				3.0	21.4	42.4	8.6	62.8	31.4
Hurghada City	south (north Safier Hotel)	27°12'10"	33°51'04"	0.3	22.1	42.3	8.6	62.7	31.3
				0.25	22.1	42.3	8	62.7	31.4
				0.35	21.8	42.3	8.6	62.7	31.3
	middle (Hurghada Harbor)	27°13'47"	33°50'36"	1.0	22.2	42.1	8.4	62.4	31.2
				0.75	22.2	42.2	8.5	62.6	31.3
				0.3	22	42.3	8.6	62.6	31.3
	North (NIOF Hurghada)	27°17'04"	33°46'20"	1.0	21.6	42.5	8.5	62.9	31.4
				0.5	21.5	42.3	8.5	62.8	31.4
				0.8	21.6	42.5	8.5	62.9	31.4
Ras GharebCity	south (El-Sakala area)	28°21'00"	33°06'40"	0.3	17.4	40.6	8.8	60.3	30.2
				1.0	17.4	43.3	8.61	63.9	31.9
				1.5	17.3	43.2	8.6	63.8	31.9
	middle (General Beach)	28°21'41"	33° 5'50"	0.3	17.4	43.3	8.6	63.9	32
				0.5	17.1	43.2	8.6	63.8	31.9
				0.3	18.2	43.2	8.7	63.8	31.9
	north (General Company of Petroleum	28°22'37"	33°04'02"	0.3	17.9	43.3	8.5	63.9	31.9
				0.5	17.5	43.2	8.5	63.7	31.9
				0.3	18.2	42.7	8.5	63.1	31.5

Egypt has about 700 km of coastline along the Red Sea proper, which is of great environmental, economic and recreational value. Commercial and subsistence fisheries provide a living for a large sector of the coastal population in Egypt. The eco-tourism infrastructure is continuously developing along the Egyptian Red Sea coast. The Red Sea recourses contribute substantially to Egypt's economy, particularly in the areas of oil production, tourism, and navigation by Suez Canal and fisheries. The purpose of this chapter to give a thorough explanation for the study selected localities; Quseir City, Safaga City, Hurghada City and Ras Ghareb City. Each area divided into three stations. Each station divided into number of transects nearly perpendicular to the shoreline where cover the areas under study also included a description sufficient for the grouped samples, This chapter deals with Red Sea Morphology, Geological Setting, meteorologic and oceanographic parameters. It summarizes the description of the physical parameters and behavior of air, sea and land of the Red Sea environment. In this chapter, Golden Software Surfer (V.8) was used to draw the bottom profile and facies for all studied transects. In addition to, the sediment samples of each transect were located on map, which was taken from Google Earth Pro as image and then georeferenced by ArcGIS (v.10) using WGS 1984 as Geographic Coordinate System. Also, the results of analysis for physical parameters (pH, Temp., salinity, TDS, and conductivity), of surface water samples are used as fingerprint to identify pollution sources, their amounts, and their effect on sediments and marine water in the areas under study to help managers to identify anthropogenic impacts, and better assessing the needs for remediation by detecting any changes, from the existing level expected with operation of future activity.