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Biological mapping for macro benthos in Abu Qir Bay, Mediterranean Sea, Egypt

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Received 22st November 2011, Accepted 15th December 2011

Abstract

Different biotopes and habitats studies in Abu Qir Bay reveal that 6 habitats and 6 bottoms were distinguished according to sediments structures. This indicates that the inshore western coast of the bay is heavily polluted with industrial wastes and sewage effluents through El Tabia Pumping Station. Certain bottom invertebrates appear to be tolerant to such pollution or even their growth may be promoted by the diluted effluents. This means that the composition of the substrate is greatly associated with their density and biomass values. The flowering plant sea grass *Zostera marina* was high and more sensitive to pollution on sandy biotope habitat. It is habited mainly from macro benthos showing a high number of 24 species of polychaetes, amphipods, gastropods and bivalves. On sludge biotope habitat 38 species are involved constituted mainly of bioindicator species from polychaetes, nematode, gastropods, amphipods, bivalves, and algal flora and *Zostera marina* appeared more frequent which are more tolerant to pollution. Sandy bottom habitat predominated mainly from faunal and floral structure involves polychaetes and bivalves that are relatively low in species composition and their numerical abundance. The offshore areas inside bay habitat are relatively high in algal cover which frequently inhabited by phanerogame *Zostera marina, c*hlorophytes *Ulva rigida, Caulerpa prolifera,* and *Cladophora prolifera,* Phaeophytes *Fucus virsoides, Sargassum vulgare, Cystoseira barbata,* and Rhodophytes *Gracilaria confevoides,* and *Pterocladia capillacea.* This is attributed to its sandy nature and consequently to its instability toward water currents. Structure of bottom sediments are greatly reflecting the nature habitat of benthic infauna and epifauna communities which can be dwelled the different habitats in Abu Qir Bay such as sludge, sandy, silty, muddy area depending on the nature of discharged pollutants into the sea in front El Tabia Pumping Station and Maadyia opening. A habitat consists of an area where a similar group of organisms cohabit. The term biotope refers to an environmentally uniform region in its conditions and in the animals and plants that populate it. This work will be used as a biological mapping for benthic macro benthic groups as a functional marine ecology and coastal zone management.

Keywords: Biological mapping, Habitats, Biotopes, epifauna, infauna, polychaetes, bivalves, Sea grasses, Algal cover.

1. Introduction

Abu Qir Bay is a shallow semi-circular estuary with a total area about 380 km^2 and a depth of about 16 m. It lies between longitude's 30° 05' and 30 °22` E and latitude's 31°16 'and 31°21` N . The bay located in the eastern part of Alexandria in between Abu Qir City and Rosetta mouth (Figure 1). Pollutants in Abu Qir Bay discharged in considerable amount from three main sources: 1- the brackish water of Lake Edku through Boughaz El Maadyia and the fresh water from Rossetta River Nile Branch; 2) Industrial wastes through El Tabia Pumping Station from Rakta Company, Kaha Canning Company, El Beida Dyers, Kafr El Dawar Company and directly to the bay from Ammonia Urea Plant, and 3) land drainage of Behera State agricultural sector. These huge amounts of waste materials were estimated by Abdel-Moati, (2001) reaching ca 0.95 x 10^6 m^3/ day causing a great change on the water quality of the bay that reflected on the ecosystem in particular the production of fishes, bottom fauna and flora.

The concept of biotope notion was examined and evaluated by Olenin and Ducrotoy (2006) referring that the term ‘‘biotope’’ was introduced by a German scientist, Dahl in 1908 as an addition to the concept of ‘‘biocenosis’’ earlier formulated by Mo¨bius (1877). Initially it determined the physical–chemical conditions of existence of a biocenosis (‘‘the biotope of a biocenosis’’). Further, both biotope and biocenosis were respectively considered as abiotic and biotic parts of an ecosystem. This notion (‘‘ecosystem = biotope + biocenosis’’) became accepted in German, French, Russian and other European ‘‘continental’’ ecological literature. The new interpretation of the term (‘‘biotope = habitat + community’’) appeared in the United Kingdom in the early 1990s while classifying ‘‘marine

habitats'' of the coastal zone. Since then, this meaning was also used in international European environmental documents.

This work will be used as a biological mapping for benthic macro benthic groups as a functional marine ecology and coastal zone management. Acoustic seabed classification by using QTC VIEW series V systems were used by various authors (Andertson *et al*. 2002, Collins and McConnaughey, 1998, Collins, and Rhynas 1998, Collins *et al*. 2002).

The purpose of the assessment mapping of habitats and biotopes may appear the impacts on the marine environment occurred as a result of the different human activities in study area such as: 1) Abu Qir Harbour; 2) effluent of industrial wastes and landing drains via El Tabia Pumping Station; 3) the construction of Liquefied Natural Gas field (LNGF) exploitation and transporting; 4) Edku Lake Water via Maadyia; 5) fish vessels anchor in Maadyia Harbour; 6) fresh water from Rosetta River Nile Branch and 7) deep offshore inside bay region. The objectives of the assessment are to: identify habitats or species on, or close to, source of manmade development which are likely to be of impacts on ecosystem or risk to components of species diversity, to investigate the presence of resistant species of flora or fauna; and to evaluate the ecological changes caused by different constructions in Abu Qir Bay.

2. Material and methods

Mapping of habitats and biotopes along the Abu Qir Bay (Figure 1) will undertake map of the distribution and extent of possible habitat changes and biotopes according to data analysis of fauna and flora occurrences in Abu Qir Bay (El Komi, 1997, 2000, 2001, Samaan and El Komi, 1994, El Komi and Beltagy, 1997).

3. Results

Habitat / biotope

Area of study is generally characterized by a wide continental shelf, low depth of water, dominant of soft bottom sediments mostly of sandy, muddy sands, sludge due to increase of land drainage (sewage, industrial wastes, and irrigation drain) and fresh water through Rosetta Nile Branch and Lake Edku.

3. 1. Head of Abu Qir-Sandy Biotope

The position of the harbor is shown in Figure 2 at latitude 31°19`30`` N and longitude 30°04`29`` E, in addition to photo of Nelson Island that located to the north of Abu Qir Head and sea sight photo inside the Harbor. This habitat is characterized by coarse sands biotope and the depth is ranged from 5 to 20m. Water quality and bottom sediments are slightly influenced by the impact of trade vessels enter the harbor in addition the entrance of fishing vessels into the bay due to water circulation and its location adjacent to the Mediterranean Sea connection.

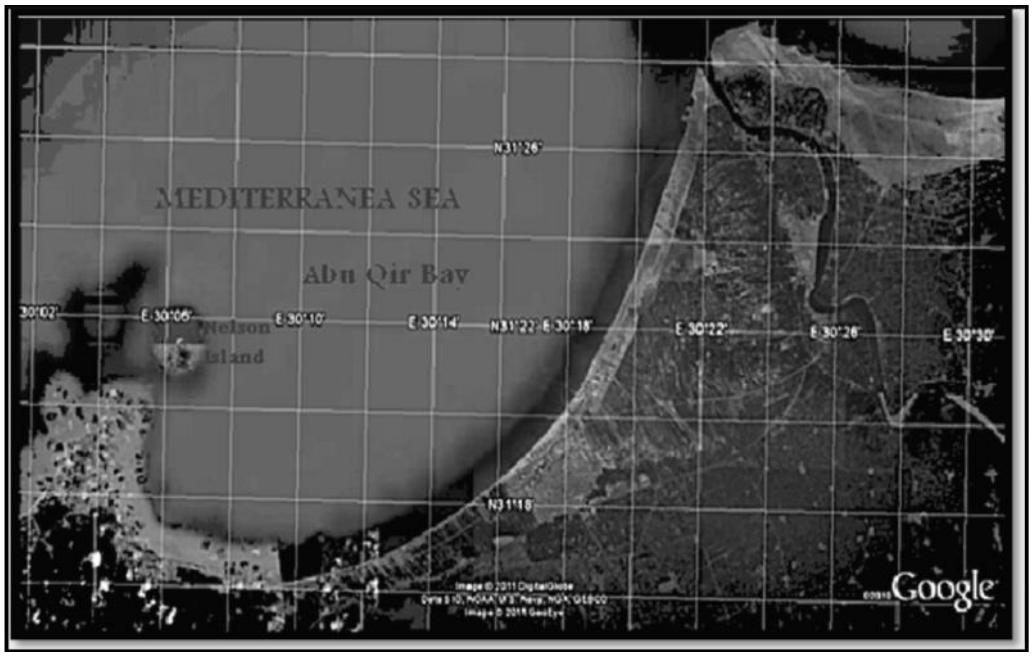

Figure 1. Area of study in Abu Qir Bay Egypt.

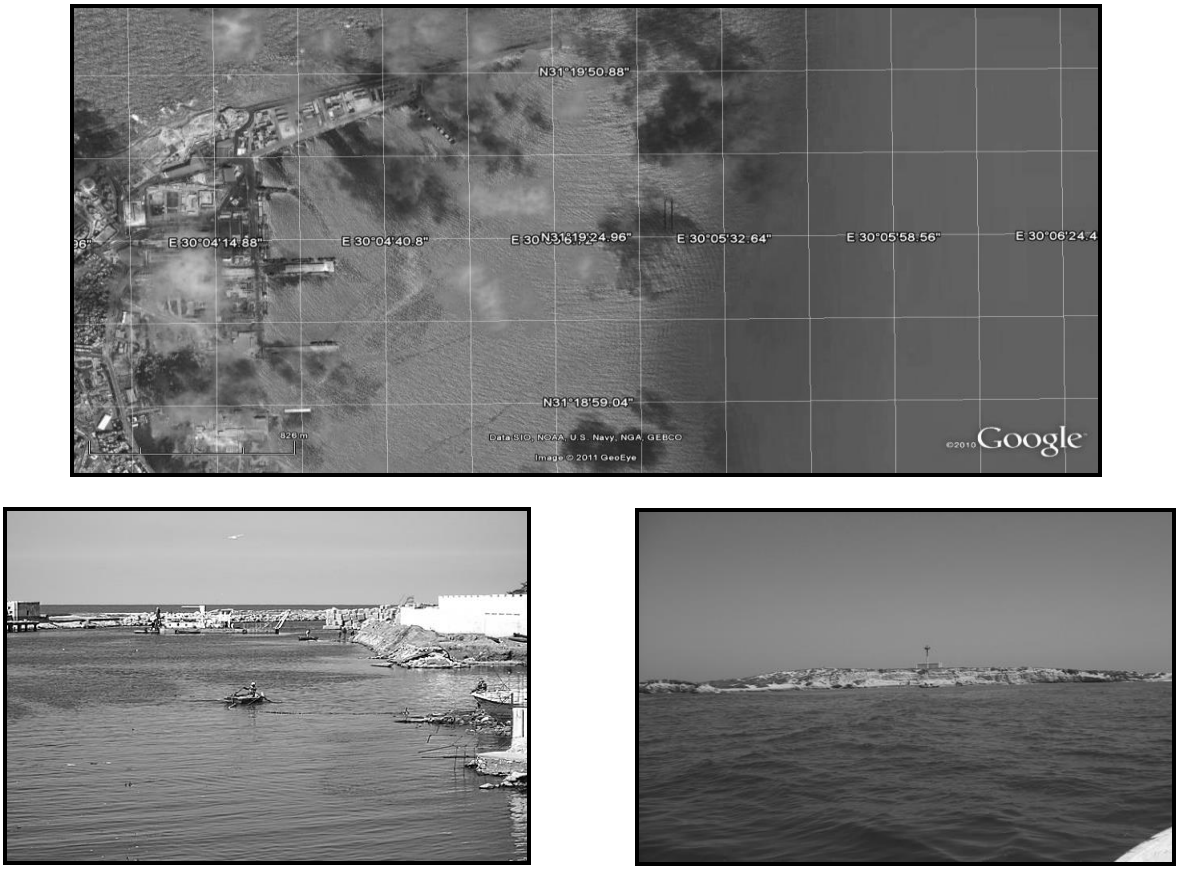

Figure 2. Abu Qir Bay harbor, Nelson Island.

The constituent macro benthos show high number of species 34 and composed mainly of polychaetes *Scolaricia typical, Cirratulus chrysoderema, Cirriformia filigera, Capitila capitata,* and *Sabella fabricii,* amphipods *Corophium sexton, Elasmopus pectinicrus,* and *Erichthonius barasiliensis,* gastropods *Neverita josephinia,* and *Hinia limata,* bivalves *Loripes lucinalis, Ruditapes decussates,* and *Ruditapes decussates,* ascidians *Ascidia nigra,* and *Polyclinium aurantium.* The total average abundance of macro benthos attained 6770 ind. /m^2. Most of them are infauna except the epifauna form *Sabella*, amphipods species, and ascidians species.

On this sandy biotope habitat the flowering plant sea grass *Zostera marina* was high and more sensitive to pollution.

3. 2 . El Tabia Pumping Station – Sludge Biotope

The locality of El Tabia Pumping Station is shown in Figure 3 at latitude 31 ^{o} 18`33`` N and longitude 30 $^{o}$ 04`03`` E. This habitat is greatly influenced by extensive load of pollutants without treatment directly into the bay. This habitat is characterized by sludge biotope and the depth is about 5m. Therefore the bottom sediments is completely composed of organic matter affecting on the species composition structure and type of benthic species which can tolerate the highly rates of nutrient and heavy metals coming from land drainage and the industrial wastes.

Macro faunal species involves 38 species composed mainly of polychaetes and bivalves. The predominated macro faunal species is mainly embarrassed of nematode *Enoplus sp.*, polychaetes *Aricia latreillii, Prionospio auklandica, Lumbriconereis latreilli, Nereis falsa, Nereis diversicolor, Eunice vittata, Nephtys hombergii, Fabricia* sp., and *Sabella fabricii,* amphipods *Elasmopus pectinicrus, Erichthonius barasiliensis, Hyale provesti,* and *Maera inaequipes,* Gastropods *Aplysia depilans,* bivalves *Lutaria angustior, Lutaria magnam Modiolus adriaticus,* and *Modiolus barbatus.* They mainly comprised infauna species and low numbers of epifuana species namely; amphipods, gastropod and bivalves *Lutria* and *Modiolus*. Due to the increased eutotrophication level in front El Tabia Pumping Station indicating increase in numerical density of benthos on this habitat which predominated by bioindicator polychetes, molluscs species and free living nematodes can tolerate the increase in pollution levels. The total average abundance of macro benthos was maximum in comparison to other sites in Abu Qir Bay yielding 10870 ind. /m^2.

Figure 3. El Tabia Pumping Station

On this habitat the algal flora was flourished on sludge biotope and composed mainly of chlorophyte *Caulerpa prolifera.* The brown alga *Cystoseira barbata* was very poor. Both *Caulerpa prolifera* and *Cladophora prolifera* ranged 3.3 to 26.1 gm fresh wt. /m^2. Other infrequent algae comprised *Codiurn tomentosum* and *Cystoseira barbata. Zostera marina* appeared more frequent.

3.3. Maadyia Harbour and Edku Lake Water outlet- Muddy Sands Biotope

The locality of Maadyia harbor and lake Edku is shown in Figure 4 at latitude 31 ^{o} 18`33`` N and longitude 30 $^{o}$ 04`03`` E. A wide fluctuation of water chlorosity and high level of eutrophication due to fresh water from lake Edku into Abu Qir Bay.

The bottom sediment structure is composed of sandy muds biotope. This habitat is characterized by low chlorosity and relatively increases in pollutant leading to predominant of polychaetes and molluscs euryhaline species.

Macrofaunal species involve 33 species composed mainly of polychaetes and bivalves species whereas the abundance density reached 2840 ind. /m^2. They embraced mainly of polychaetes *Prionospio auklandica, Lumbriconereis latreilli, Eunice vittata, Phyllodoce mucosa, Glycera convolute, Polydora ciliate,* and *Clymene collaris,* Cumacea *Pseudocuma lngicornis,* Anisopoda *Jphinoe serrata,* amphipod *Corophium sexton,* bivalves *Macoma Cumana, Tellina planata, Tellina pluchella Azorinus chamasolen, Loripes lucinalis, Donax venustus, Corbula gibba, Mactra coralline, Mactra glauca,* and *Tellina radiata.*

On the other hand, algal cover was very rare on this biotope due to the wide range in the water chlorosity.

3.4. Liquefied Natural Gas exploitation and transportation – Sandy Mud Biotope

The position of the LNGF is shown in Figure 5 which located at latitude 31^{o}21`07`` N and longitude 30$^{o}$18`40`` E, in addition to a photo of LNGF plate form in Figure 5. It was constructed in 2004 to export liquefied natural gas. This port is located at offshore basins (15m depth) including the turning and berthing areas which connected to the deep water by a 15-m depth dredged channel that extends 4 km offshore.

This habitat is characterized by sandy mud biotope with inshore shallow continental shelf of 5m depth. There are no continental discharges except the impact of gas tanker during loading processing on the jetty and effect of LNGF plate forms on the constituent of bottom invertebrates and algal cover in the bay.

The general faunal and floral structure was relatively low in species composition and their numerical abundance. The number of species encountered was 19 species belonging mainly to polychaetes and bivalves. The abundance reached 2010 ind./m^2.

This habitat was represented by Hydroids *Obelia geniculata,* polychaetes *Prionospio auklandica, Magelona papillonereis, Lumbriconereis latreilli, Glycera convolute,* and *Mediomastus cirripis,* Anisopoda *Jphinoe serrata,* gastropod *Neverita josephinia,* bivalves *Barbetia barbata, Loripes lucinalis, Corbula gibba,* and *Mactra coralline.* Phaeophyt *Padina pavonica* and Rhodophyt *Corallina* elongate were more frequent than chlorophyt *Cualerpa prolifera* and *Codium elongatum.*

Figure 4. Maadyia Harbour, Lake Edku and fish vessels anchor

3.5. Rosetta Nile River Branch – Sandy Muds Biotope

The position of Rosetta Nile River Branch is shown in Figure 6 which located at latitude 31°27`54`` N and longitude 30°22`00`` E.

Eastern inshore shallow continental shelf with 10m depth, this habitat is characterized by sandy mud biotope. Only freshwater from Rosetta Branch has been taken place in this area leading to decrease of chlorosity of sea water.

At this inshore habitat the sandy mud biotope fauna has low diversity with only 9 species contributed the least bottom density 930 ind. /m^2. The benthic community at this habitat mainly comprised of bivalves, amphipods and polychaetes. Polychaetes *Owenia fusiformis, Scolaricia typical,* and *Lumbriconereis latreilli,* amphipods *Elasmopus pectinicrus,* bivalves *Macoma cumana,* and *Mactra corallin* and echinoderm *Ophiura lyrifera.* Algal cover could not recorded at this habitat is being the sandy mud biotope is not stable for algal attachment and decreased in water chlorosity.

3.6. Inside Bay Offshore stations – Sandy Biotope

As shown in Figure 7 this habitat represented a wide area inside the bay is characterized by sandy biotope faunal and floral species. The species diversity is relatively moderated which the number of species reached 22 and density of benthos yielded 3220 org. /m^2.

At this sandy biotope the benthic community comprised mainly of bivalves, polychaetes, amphipods, gastropods and echinoderms. Polychaetes *Prionospio auklandica, Magelona papillonereis, Mediomastus cirripis, Onuphis eremite,* and *Prottula tubularia*, amphipods *Stenothoe gallensis Gammrus locusta* and *Elasmopus* spp. , Cumacea *Pseudocuma lngicornis,* gastropods *Hinia limata,*and *Neverita josephinia* and echinoderms *Ophiura lyrifera* and *Asteropecten* sp

The offshore inside bay habitat are relatively high in algal cover and were frequently inhabited by phanerogame *Zostera marina, c*hlorophytes *Ulva rigida, Caulerpa prolifera,* and *Cladophora prolifera,* Phaeophytes *Fucus virsoides, Sargassum vulgare,* and *Cystoseira barbata,* and Rhodophytes *Gracilaria confevoides,* and *Pterocladia capillacea.* This is attributed to its sandy nature and consequently to its instability toward water currents and increased in water chlorosity.

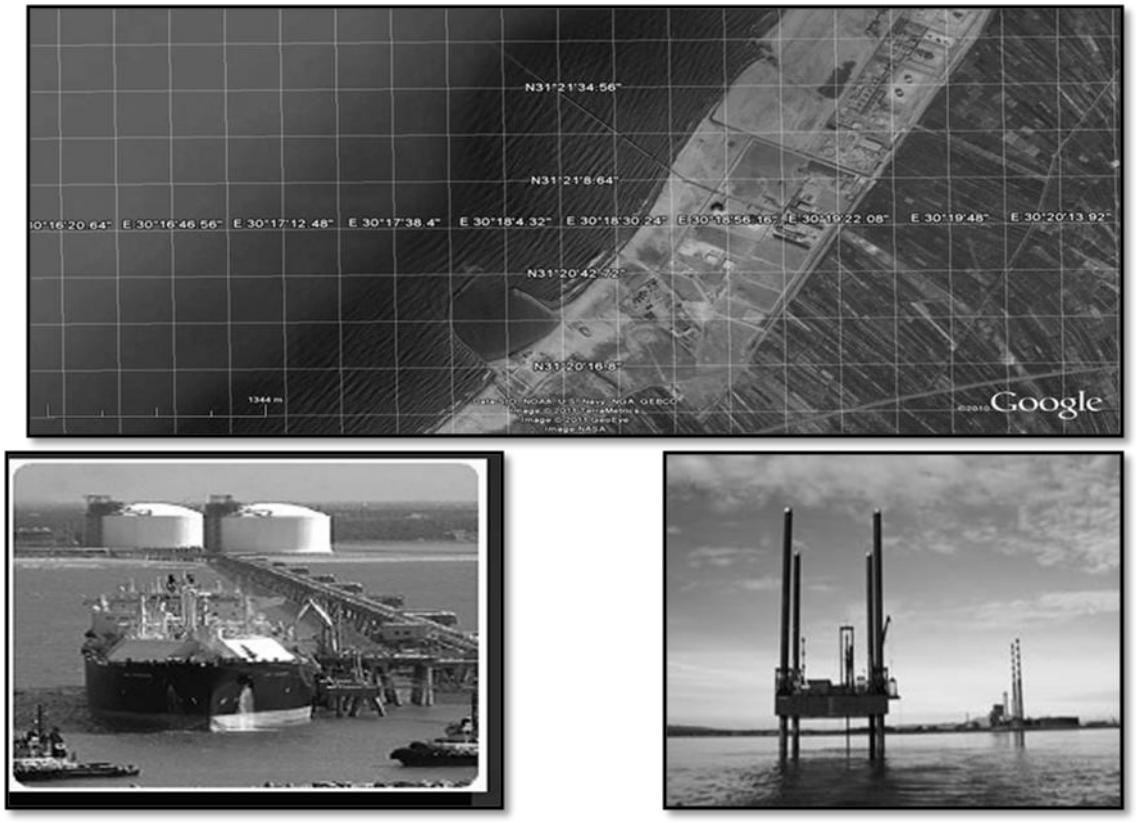

Figure 5. LNGF Tanker loading Natural Gas Field in Edku Port in front Edku Plate form.

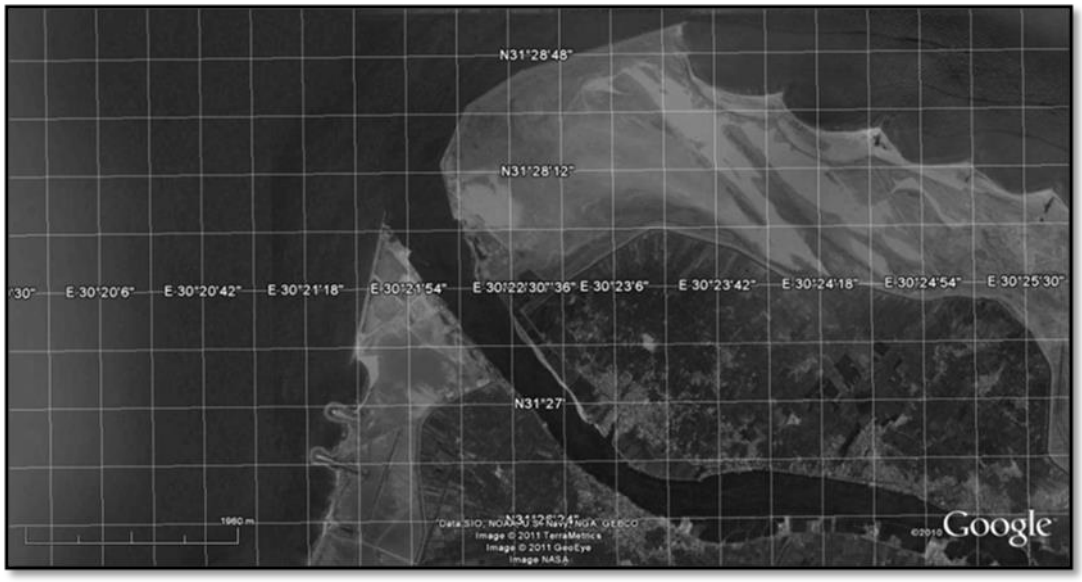

Figure 6. Rosetta Nile River Branch

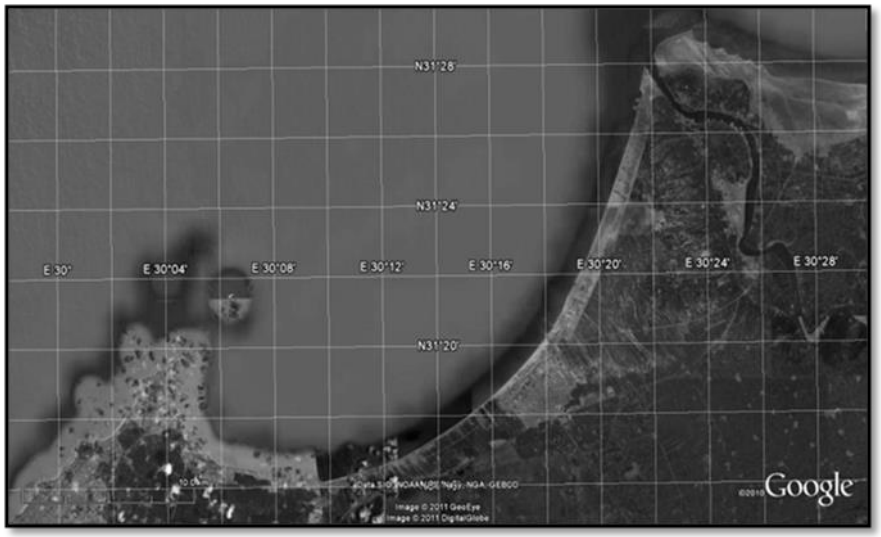

Figure 7. Offshore stations.

4. Discussion

Results of the present study summarized the different biotopes and habitats in Abu Qir Bay revealing that 6 habitats and 6 bottoms were distinguished according to sediments structures. This classification indicates that the inshore western coast of the bay is heavily polluted with industrial wastes and sewage effluents through El Tabia Pumping Station. Certain bottom invertebrates appear to be tolerant to such pollution or even their growth may be promoted by the diluted effluents. Also some nematodes, polychaetes, mollusces, amphipods, decapods, bryozoans and oligochaetes were found to resist such pollution. The species recorded mainly comprised of polychaetes *Enoplus* sp., *Aricia latreillii, Prionospio auklandica, Lumbriconereis latreilli, Nereis falsa, Nereis diversicolor, Eunice vittata, Nephtys hombergii, Fabricia* sp., *Sabella fabricii,* amphipods *Elasmopus pectinicrus, Erichthonius barasiliensis, Hyale provesti, and Maera inaequipes,* gastropds *Aplysia depilans, Lutaria angustior and Lutaria magnam, and* bivalves *Modiolus adriaticus,* and *Modiolus barbatus.*

The nature of seabed sediments is being hard, sandy, muddy, and silty and / or mainly of organic matters biotopes reflecting the nature habitat of floral and faunal species that can be dwelled where is naturally occurring area for living organisms. The obtained data on the regional distribution of macro organisms in different habitats in Abu Qir Bay that included some biotopes present such as sludge, sandy, silty, muddy area depending on the nature of discharged pollutants into the sea in front Tabia Pumping Station and Maadyia opening. In Abu Qir Bay the habitats within ecosystem is not a uniform region and has been distinguished to a number of habitats according to nature of the biotope. A habitat consists of an area where a similar group of organisms cohabit. The term biotope refers to an environmentally uniform region in its conditions and in the animals and plants that populate it.

While marine algae on bottom of inside offshore sites are relatively more frequent due to increasing in salinity and nature of bottom sediments. The species recorded comprised *Caulerpa prolifera, Codium tomentosum, Cystoseira sbarbata, Sargassum vulgare, Fucus virsoides, Gracilaria confervoides* and *Zostera marina.* The soft bottom sandy mud is favorable for occurrence of epifauna, meiofauna and infauna forms. Borg and Schemberi (1995) emphasized that the biotype is the main factor determines the fauna constituent and density of different benthic communities and the responses of biotic and abiotic factors are secondary effecting. Sarda (1990) found that polychaetes zonation associated to the substrate by algae rather than of the direct influence of physical factors. The effect of the environmental factors on the distribution of three edible bivalves' species on the coast of New Caledonia was studied by Baron and Clavier (1992). These show that the composition of the substrate is greatly associated with their density and biomass values. They mentioned that the temporal variation in the environmental limits has a marked in the intertidal zone.

Acoustic seabed classification of marine habitats data in Abu Qir Bay were analyzed by Hamouda and Abdel-Salam (2010) by using Quester Tangent Corporation (QTC) Impact Software which classified

into four classes. The study emphasized that the accumulation of the benthic-communities may be related to water depth, seafloor geomorphology, habitat complexity and current speed and influencing on the composition of the different communities. The 1st acoustic class corresponds to medium to fine sand and absence of shell debris and very poor habitats characteristics. The 2nd acoustic class is predominant in the survey area and corresponds to the region occupied by very fine sand and characterized intermediate density of Macro benthic invertebrate community where mainly characterized by Polychaeta. The 3rd acoustic indicates to very fine sand intercalated by silt. It is characterized by high density of Macro benthic invertebrate community mainly has Polychaeta with intermediate density Gastropoda and bivalve. The 4th acoustic indicates to silt clay and characterized by highly shell debris of gastropods, bivalve calcareous tube worms of polychaetes. They reported that the poor space biodiversity of benthos observed at the heavily polluted localities. Tie and Haijing (1993) reported that benthic communities are better indicators to the environmental changes. Barnes (1982) concluded that the stability of the marine environment is greatly due to wave action, tides and vertical and horizontal ocean currents producing a continual mixing of sea water where dissolved gases and salts fluctuate little. Azov (1991) considered the Levant basin is the most oligotrophic part of the Mediterranean Sea except too few coastal areas such having primary productivity ranged from 1 0 to 45 g C/m^2/day. He mentioned that the nutrient's reservoir is very limited and layer mixing in east of the Mediterranean is very slowly. Affected on the primary productivity and the fisheries near Egyptian coasts decreased after the construction of the Aswan High Dam in 1965.

On the other hand, Somerfield *et al*. (1994) found the overflow of waste water did not affect the benthic infauna in the estuary. Many epibenthic and tube-dwelling species may be responding differently to pollution events the endobenthic spices. The difference in the monthly distribution of macrofauna and copepod is more obvious than on nematodes of natural population than the effects of the waste discharge. However, Pearce (1970) reported several species around the sludge deposits occurring in greater abundance than in natural communities, e.g., deposit-feeder bivalve *Nucula* and polychaetes *Nephthys* and *Pronospis.*

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الخرائط البيولوجي للاحياء القاعية الكبيرة بخليج أبى قير بالبحر المتوسط – مصر

محمد محمد الكومى
– المعهد القومى لعلوم البحار والمصايد الإسكندرية

تشير الدراسة التى أجريت في خليج أبو قير على الموائل الحيوية المختلفة على تباين عدد ستة موائل بيئية لستة قيعان قاعية وفقا للهياكل الرواسب.هذه الدراسة تشير إلى أن المناطق الساحلية للساحل الغربي للخليج ملوثة بشكل كبيربالنفايات الصناعية ونفايات مياه الصرف الصحى والصناعى والزراعى عن طريق الصرف المباشر من الضخ من محطة الطابية. تشبر النتائج أن معظم كائنات اللافقاريات القاعية التى تم التعرف عليها والمسجلة بمناطق الدراسة تتحمل مثل هذا التلوث، أو يمكن أن تتحمل نموها النفايات السائلة المخفف .وهذا يعني أن يرتبط التكوين النوعى الى حد كبير على درجة الكثافة العددية وقيم الكتلة الحيوية .أشارت النتائج بأن النباتات المزهرة من الحشائش البحرية من نوع Zostera marina كانت عالية الكثافة والأكثر حساسية للتلوث في بئيات الرسوبيات الرملية . أوضحت النتائج على مكونات الأحياء القاعية الحية بتلك البيئة الرملية تسجيل عدد كبير وصل الى ٢٤ نوعاً معظمة من طائفة عديدة الأشواك وطائفة الرخويات، ومن رتبة مزدوجة الارجل من طائفة القشريات ومن طائفة ذوات الصدفتين . ويستوطن بيئة الرواسب المواد العضوية الملوثة نتيجة صرف الملوثات المختلفة نوعيات حيث تتعايش ٣٨ نوعاً تتكون أساسا من الأنواع التى تتحمل قدر من التلوث أى مدلولات التلوث (bioindicator) من طائفة عديدة الأشواك وطائفة الديدان الخيطية وطائفة الرخويات، ورتبة مزدوجة الارجل، وطائفة ذوات الصدفتين، و النباتات المائية من الطحالب و والحشائش البحرية من نوع Zostera marina حيث بدات أكثر تكرارا وأكثر تحملا للتلوث . تبين النتائج بأن تكوين الهيكل الحيوانية والنباتية بمناطق الموائل الرملية الساحلية بأنه يتكون أساساً وبشكل رئيسي من طائفة عديدة الأشواك وطائفة ذوات الصدفتين والتي تتواجد بنسبة منخفضة نسبيا في تكوين الأنواع والوفرة العددية . ومن الناحية الأخرى فقد لوحظ بأن التكوين الأحياء القاعية بمناطق الموائل البحرية الساحلية المقابلة للشواطئ داخل خليج أبى قير كانت مرتفعة نسبيا حيث سادت لطحالب *Zostera marina* ومن الطحالب *Ulva rigida* ، *Caulerpa prolifera* و *Fucus virsoides, Cladophora prolifera* ، *Cystoseira arbata* و *Gracilaria confevoides* و *Pterocladia capillacea* ويعزى هذا إلى طبيعتها الرملية، وبالتالي إلى عدم الاستقرار في اتجاه التيارات المائية .يتكون الهيكل التكوين الحيوانى والنباتى التى تتواجد ويتعايش على الرسوبيات القاعية التي تعكس إلى حد كبير من الموائل إلى طبيعة infauna القاعية والمجتمعات epifauna التي يمكن ان تسكن في بيئات مختلفة في خليج أبي قير مثل المواد العضوية الملوثة الموحلة من حيث طبيعة الملوثات التي تصرف في البحر من محطة صرف الطابية ومنطة بوغاز المعدية حيث تسود مجموعات مماثلة من الكائنات الحية للتعايش. يتكون الموطن من منطقة حيث تتعايش مجموعة مماثلة من الكائنات الحية . يشير المصطلح بأن الموائل الأحيائي فى منطقة موحدة للبيئة من شروطها بأن الحيوانات والنباتات يمكنها التعايش عليها .وسيتم استخدام هذا العمل بمثابة رسم الخرائط البيولوجية للمجموعات الأحياء القاعية باعتباره عامل بيئى بحري ووظيفي لإدارة المناطق الساحلية.