Journal of Mediterranean Ecology **vol. 17, 2019: 23-28**

Impacts of Anthropogenic activities on the Habitats and Flora at the Coastal Nile Delta Mediterranean Region, Egypt

Elsayed M. Ali Nafea

Aquatic Environment Department, Faculty of Fish Resources, Suez University, Suez, Egypt

Contact details
elsayed.nafea@suezuniv.edu.eg

Keywords: salt marshes, sand dunes, endangered species, habitat degradation, sustainable management, Nile Delta.

Abstract

This work aimed to assess the impacts of anthropogenic activities on the habitats and their flora at the coastal Delta region of Egypt. One hundred and thirty species of plants were found in four habitats: saltmarshes, small sand dunes, high dunes and new reclaimed sandy lands. The recorded species related to 92 genera and 37 families, classified in 71 annuals, 58 perennials and one biennial. Therophytes were the most represented life form (76 species = 58.46%), while phanerophytes were the lowest one (8 species = 6.15%). The study area is subjected to many threats and suffers from environmental degradation and fragmentation and may lose its diversity if the anthropic impact will persist. Accordingly more species became rare (f.i., *Pancratium maritimum* L., *Ammi visnaga* L. and *Asparagus stipularis* L.), while two species were endangered and disappeared from the study area (*Limoniastrum monopetalum* L. and *Ruppia maritima* L.). The restoration of wetlands seems dramatically urgent assuring a strategy of sustainable management.

1. Introduction

The Egyptian coasts that extend for 970 km along the Mediterranean Sea (the Nile Delta included) and about (1100 km) in the Red Sea, have a high diversity of habitats including sand dunes, salt marshes, wetlands, new reclaimed sandy lands, fresh and saline waters (Shaltout and Al-Sodany 2002). The anthropogenic disturbance (habitat degradation, fragmentation and loss of species distribution) has been observed in the Mediterranean coastal region (El-Sadek and Ayyad 2000). This region is bordered by salt marshes and sand dunes of different natures (Batanouny 1999). About 75 % of these habitats have been disturbed due touristic facilities (summer resorts and logistic infrastructures) (Shaltout and Ahmed 2012). Human activities (f.i., residential, commercial development and tourism, aquacultures and agriculture, transportation, urban pollution) are the most threats affecting plant diversity (Burgman *et al.* 2007; Shaltout *et* al. 2009) especially in the Delta area (Raven 1971), impacting on plant diversity and increasing the extinction risk of the rare ones.

The present study aims to assess the impacts of anthropogenic activities on the habitats and flora in the Delta region with special references to the threatened species and habitats.

2. Material and Methods

2.1. Study Area

The study area extends on 48 km from Gamasa in the east to Burg El-Burullus in the west (Fig. 1) along the Mediterranean Sea coast. Its width ranges between 300 m to 900 m at the sea side of the International Coastal Road. It is characterized by different habitats (salt marshes, low sand dunes, high dunes and new reclaimed sandy lands), which has its own vegetation type.

The region is characterized by a maritime climate with mild winters and hot summers. The annual rain ranges between 8.9 mm at Damietta and 14.6 mm at Baltim, while the annual mean temperature ranged between 20°C to 25 °C (Egyptian Meteorological Authority, 2017).

Fig. 1 - Location map for the study area after (EL-Bady 2016)

2.2. Soil analysis

Soil samples were collected from each stand as a profile (composite sample) at a depth 0-30 cm at the rhizosphere zone. The mechanical analysis for soil was by sieve method. Soil water extract of 1:5 was prepared for the determination of soil salinity (EC m mhos/second) as indication for salinity using conductivity meter and soil reaction pH using pH meter; chlorides were determined using direct titration. Bicarbonates and carbonates were also estimated by titration method. Calcium carbonate, organic carbon and sulfate were determined. All procedures were according to Piper (1945), Jackson (1962) and Allen *et* al. (1986).

2.3. Vegetation analysis

Ten study plots were selected to study the flora in each of the different habitats (salt marshes, small dunes, high dunes and new reclaimed sandy lands). The study plots area was 20×20 m in all habitats. The study extended from March 2017 to April 2018. During each field visit the study plots were surveyed and the following data were recorded: species list, dominant species, total cover and % cover of each species. Identification and nomenclature of species were according to Bolus (1999, 2000, 2002, 2005 and 2009).

Life forms were identified following the system of Raunchier (1937). The actual and relative number of species belonging to each life form (i.e. biological spectrum) was calculated. The anthropogenic influences were determined and the impact of habitats disturbances and loss of the species and total flora were recorded and evaluated. Comparison between the last record (2002) and the new (2017-2018) one is presented in Table 2.

3. Results and discussion

The results of mean soil analysis (Table 1) showed that soil is mainly fine sandy soil with low porosity (28.8%), low water holding capacity (35.9%) and low moisture contents (6%). The pH values ranged between 5.7 and 9.1, while soil salinity ranged between 0.2 to 8.6 g/l. soil samples characterized by high $CaCO_3$ % contents ranged between 0.2 to 32.2 %. The change of soil characteristics is mainly due the human induced changes.

Table 1 - The mean results of soil analyses of samples collected from four habitats at study area.

Parameters Physical characters	Minimum	Maximum	Mean
>2 mm	0.6	5	2.8
2-1 mm	2.2	8.3	5.25
1-0.5 mm	3.4	43.1	22.2
0.5-0.25 mm	30.2	52	41.1
0.25-0.125 mm	2.6	38.2	20.5
0.125-0.063 mm	0.38	12.22	6.49
< 0.063 mm	0.11	5.13	2.62
Porosity	8	42	28.78
Water holding capacity	20	60	35.87
Moisture contents	0.16	34	6
Chemical characters			
pH	5.7	9.1	7.4
Electrical conductivity m mhos/second	200	8600	1263
CaCO3 %	0.2	32.2	12.94
Organic carbon %	0.1	2.9	1.5
SO4 %	0.02	0.8	0.41
HCO3 %	0.006	0.05	0.028
CO3 %	0	0	0
Cl %	0.02	0.8	0.41
TSS %	0.1	1.9	1

Table 2 - The percent cover of the recorded species and the life form spectrum. Life forms: Th=Therophytes, Ch=Chamaephytes, Ph=Phanerophytes, H=Hemicryptophytes, Cr= Cryptophytes, Life span: Ann= Annual, Per =Perennial and Bie = Biennial

Year of records	2017-2018			2002
Species	Life span	Life form	% cover	% cover
Aegilopsbicornis (Forssk.) Jaub and Speh	Ann	Th	60	70
Aeluropus lagopoides (L.) Trin and Thwaites	Per	H	50	65
Alhagi graecorum Bioss.	Per	H	70	80
Amaranthus graezicans L.	Ann	Th	50	30
Amaranthus hybridus L.	Ann	Th	55	35
Amaranthus lividus L.	Ann	Th	45	20
Ammi visnaga (L.) Lam.	Ann	Th	10	55
Anchusa humilis (Desf.) I. M. Johnst	Ann	Th	20	65
Anethum graveolens L.	Ann	Th	20	35
Arthrocnemum macrostachyum (Moric.) Koch.	Per	Ch	70	85
Arundo donax L.	Per	Cr	20	10
Asparagus stipularis Forssk.	Per	Cr	10	50
Atriplex halimus L.	Per	Ph	40	75
Atriplex nummularia L. ndl.	Per	Ph	10	50
Atriplex portulacoides L.	Per	Ch	40	35
Atriplex semibaccata R. Br.	Per	H	20	45
Avena fatua L.	Ann	Th	20	30
Bassia indica (Weight) A. J. Scott.	Ann	Th	20	50
Brassica rapa L.	Ann	Th	10	-
Brassica tournifortii Gouam	Ann	Th	20	40
Bromus scoparius L.	Ann	Th	10	30
Cakile maritima Scop.	Ann	Th	20	35
Calligonum polygonoides L.	Per	Ph	10	30
Capsella bursa-pastoris (L.) Medik	Ann	Th	20	20
Carthamus glaucus M. Bieb.	Ann	Th	30	50
Chenopodium album L.	Ann	Th	30	35
Chenopodium murale L.	Ann	Th	40	35
Cistanche phelypeae (L) Cout..	Per	par	10	10
Convolvulus arvensis L.	Per	H	10	10
Conyza aegyptiaca (L.) Dyand	Ann	Ph	10	10
Cornulaca monacantha Delile.	Per	Ch	30	35
Cressa cretica L.	Per	H	30	45
Cronopus didymus (L.) Sm.	Ann	Th	30	20
Cutandia dichtoma Batt. Trab.	Ann	Th	30	20
Cutandia memphetica (Sperng.) Benth	Ann	Th	10	20
Cynanchum acutum L.	Per	H	10	20
Cynodon dactylon (L.) Pers	Per	Cr	20	15
Cyperus capitatus Vand.	Per	Cr	30	20
Cyperus congloneratus Rottb.	Per	Cr	30	40
Cyperus laevigatus L.	Per	Cr	20	20
Cyperus rotundus L.	Per	Cr	20	15
Daucus syrticus Murb.	Ann	Th	20	30
Denibera retroflexa (Vahl.) Panz..	Ann	Th	10	20
Deplotaxis harra (Forssk.) Boiss.	Per	H	10	10

Year of records	2017-2018			2002
Species	Life span	Life form	% cover	% cover
Echinocloa colona (L.) Link.	Ann	Th	10	20
Echinops spinosus Turra.	Per	H	60	70
Echium angustifolium Mill.sub spsericeum.	Per	H	10	65
Elymus farctus (Viv.) Runem. exMeld	Per	Cr	10	15
Erodium glaucophyllum (L.) L.Her.	Per	H	30	35
Erodium laciniatum (Cav) Wild.	Ann	Th	30	35
Euphorbia peplus L.	Ann	Th	20	15
Euphorbia prostrate Aiton.	Ann	Th	30	5
Halocnemum strobilaceum (Pall.) M. Bieb.	Per	Ch	60	70
Heliotropium curassavicum L.	Per	Ch	10	55
Hordeum marinum L.	Ann	Th	10	15
Hordeum vulgare L.	Ann	Th	10	10
Ifloga spicata (Forssk.) Sch. Bip.	Ann	Th	10	15
Imperata cylindrica L.	Per	Cr	20	15
Limbarda crithmoides (L.) Dumort.	Per	Cr	30	50
Juncus actus L.	Per	Cr	20	55
Juncus rigidus Desf.	Per.	Cr	20	60
Lactuca serriola L.	Ann	Th	30	40
Launaea capitata (Spreng.) Dandy	Ann	Th	20	45
Launaea mucronata (Forssk.) Muchl.	Per	H	20	15
Leptochloa fusca (L.) Kunth.	Per	Cr	10	10
Limoniastrum monopetalum L.	Per	Ch	-	20
Lobularia arabica (Bioss.) Muschl	Ann	Th	20	10
Lolium multiflorum Lam.	Ann.	Th	30	15
Lolium perenne L.	Per	H	10	35
Lotus arabicus L.	Ann	Th	20	25
Lotus glaber Mill.	Per	H	30	35
Lotus halophilus Bioss.	Ann	Th	10	25
Lycium schweinfurthii Dammer.	Per	Ph	20	35
Malva parviflora L.	Ann	Th	30	35
Medicago hispida L.	Ann	Th	10	25
Medicago laciniata (L.) Mill.	Ann	Th	20	15
Medicago polymorpha L.	Ann	Th	30	15
Medicago sativa L.	Per	H	10	10
Melilotus indicus L.	Ann	Th	20	25
Mesembryanthemum crystalinum L.	Ann	Th	30	65
Mesembryanthemum forsskaolii Hochst. and Bioss.	Ann	Th	50	70
Mesembryanthemum nodiflorum L.	Ann	Th	40	55
Moltkiopsis ciliata (Forssk) .I.M.Johnst	Per	Ch	20	55
Neurada procumbens L.	Ann	Th	10	15
Ononis serrata Forssk.	Ann	Th	10	15
Orobanche arabica L.	Per	Par	10	10
Orobanche cernua Loeflt	Per	Par	20	15
Pancratium maritimum L.	Per	Cr	10	65

Table 2 - The percent cover of the recorded species and the life form spectrum. Life forms: Th=Therophytes, Ch=Chamaephytes, Ph=Phanerophytes, H=Hemicryptophytes, Cr= Cryptophytes, Life span: Ann= Annual, Per =Perennial and Bie = Biennial

Year of records	2017-2018			2002
Species	**Life span**	**Life form**	**% cover**	**% cover**
Paronychia arabica (L.) Dc.	Ann	Th	20	15
Peganum harmala L.	Per	Cr	10	20
Phalaris minor Retz	Ann	Th	10	10
Phragmites australis (Cav.) Trin. Steud.	Per	Cr	30	65
Plantago lanceoata L.	Per	H	30	15
Plantago major L.	Per	H	30	10
Plantago notate Lag.	Ann	Th	30	10
Plantago ovate Forssk.	Ann	Th	30	15
Plantago squarrosa Murray	Ann	Th	30	15
Pluchea dioscoroides (L.) DC.	Per	Ph	30	15
Polygonum equisetiforme Sm.	Per	H	30	55
Portulaca oleraceae L.	Ann	Th	20	30
Reichardia tingitana (L) Roth.	Ann	Th	50	10
Retama raetam (Forssk.) Web and Berthel	Per	Th	10	10
Rumex dentatus L.	Ann	Th	20	0
Rumex pictus Forssk.	Ann	Th	60	65
Rumex vesicarius L.	Ann	Th	60	75
Ruppia maritima L.	Per.	H	-	20
Salsola kali L.	Ann	Th	30	45
Schismu sbarbatus (L.) Thell.	Ann	Th	10	10
Senecio gluaca L.	Ann	Th	30	15
Senecio vulgaris L.	Ann	Th	30	15

Year of records	2017-2018			2002
Species	**Life span**	**Life form**	**% cover**	**% cover**
Setaria verticillata (L) P.Beauv..	Ann	Th	40	15
Setaria viridis (L.) Beauv.	Ann	Th	10	10
Sida alba L.	Bie	Th	10	5
Silene arabica Bioss.	Per	H	20	15
Silene rubella L.	Ann	Th	50	15
Silene succulenta Forssk.	Per	H	10	10
Sisymbrium irio (L.) Gaertin	Ann	Th	20	15
Solanum nigrum L.	Ann	Th	60	20
Sonchus oleraceus L.	Ann	Th	60	65
Sphenopus divaricatus (Gouan) Rchb.	Ann	Th	30	15
Suaeda maritima (L.) Dumort.	Ann	Th	10	50
Suaeda pruinosaLang.	Per	Ch	30	65
Suaeda vera Forssk. J. F. Gmel	Per	Ch	30	65
Tamarix nilotica (Ehrenb.) Buge	Per	Ph	40	80
Thymelaea hirsute (L.) Endl.	Per	Ph	10	50
Trigonella maritima Poir	Ann	Th	10	15
Trigonella stellate Forssk.	Ann	Th	20	10
Typha domingenssis L.	Per	Cr	10	40
Urtica urens L.	Ann	Th	60	20
Urospermum picroides (L.) F. W. Schmidt	Ann	Th	30	35
Vicia sativa L.	Ann	Th	10	10
Zygophyllum aegyptium Hosny	Per	Ch	60	75

The floristic composition revealed that the relic flora of the coastal Nile Delta habitats is composed of 130 species related to 92 genera, belonging to 37 families. Among the recorded species 71 annuals, 58 perennials and one species biennial as shown in Table 2. The life form spectra indicated that the majority of the recorded species are therophytes (58.46%), cryptophytes (14.61%) and hemicryptophytes (12.3%) with lesser percentages of phanerophytes and chamaephytes (7.69 % and 6.15%, respectively).

The life form spectrum provides information which may help to assess the response of vegetation to variations in environmental factors (Ayyad and El-Ghareeb, 1982). Raven (1971) designated the Mediterranean climate type as a "therophytes climate" because of the high percentage (> 50% of the total species) of this life form in several Mediterranean floras. In the present study, the therophytes are the most frequent life form, followed by the cryptophytes and hemicryptophytes. The dominance of therophytes over the other life forms seems to be a response to the hot-dry climate, topographic variation and biotic influence (Heneidy & Bidak, 2001; Galal & Fawzy 2007).

Threats are the direct and indirect causes for habitat disturbance and loss. Based on field surveys, it has been found five types of threats due to the human activities and social development: (1) New buildings (Delta University), new Mansoura and the industrial city of Gamasa; (2) Clearance for agriculture and aquaculture development; (3) Construction of summer resorts of Baltim (industrial/urban growth, coastal development); (4) Disturbance by cars and trampling; (5) Gas station and development on both sides of the International Coastal Road.

Using the satellite images (1997 to 2016) it was observed a decrease of sand dunes and salt marshes surfaces during the last 20 years. The area of the coastal Delta habitats (sand dunes and salt marshes) between Baltim and Gamasa changed from 1897.4 Km^2 in 1990 to 846.5 Km^2 in 2014 with 30% decreases and by 1.9 % changes every year (EL-Bady 2016; Ali and EL-Magd 2016). The area was used for building of resorts, gas stations, fish farm construction and agriculture which in turn affect the species diversity, presence and distribution through habitat loss, degradation and fragmentation.

As consequence of the degradation, fragmentation and habitat loss many species became threatened, endangered and other became rare. Two species were disappeared from the study area: *Limoniastrum monopetalum* L. belonging to family Plumbaginaceae which is subshrub present in salt affected land and *Ruppia maritima* L. belonging to family Ruppiaceae which is a salt tolerant fresh water species present in the wet salt marshes and it is an important part of the diet of many species of resident and migratory waterfowls. A project of restoration of wetlands started with the recovery and protection of these species, where the last reporting by Nafea (2002) dated back the 2002. Furthermore, some species are represented by low percentages and others represented by high percentages when confronted with the last record in 2002 by Nafea (2002).

One of the major processes causing degradation in the ecosystems of the Nile Delta is represented by the destruction of plant cover (Shaltout and Ahmed 2012). Many species are exposed to habitat loss due to the construction of summer resorts at Baltim and Gamasa that have consumed large surfaces of natural habitats along the coast. A continuous row of new cities occupies the coastline between these two localities. This has not only led to the complete destruction of the habitats, but has also contributed to the degradation of vast areas of natural habitats around. In addition many species were threatened due to overgrazing by domestic animals (mainly sheep and goats) (Nafea 2005). Further threats are caused by the complete removal of natural vegetation for agriculture development and the settlement of fish farms (Heneidy & Bidak 1998; Ahmed *et* al. 2014).

Some important species became very rare (f.i., *Pancratium maritimum, Asparagus stipularis, Anchusa humilis* and *Ammi visnaga*). These species are very important as they used by local people and by pharmaceutical companies in treatment of many diseases (Nafea 2005). For instance, *Pancratium maritimum* L. which is used in treatment of skin diseases by local people and pharmaceutical company (Nafea 2005). The disturbance of sand dune by reclamation for agriculture and building new gas station and markets have a negative impact on these species and in turn affect the local economy and life for the local peoples.

The damage of the coastal salt marshes and sand dunes for constructing the summer resorts and any other land uses along the Nile Delta coast must be interrupted and a sustainable management and development program is requested to assure the conservation and restoration of the threatened habitats and species.

Conclusions

The Nile Delta Mediterranean habitats between Baltim and Gamasa are subjected to severe threats and more human intervention which leads to habitats disturbance, loss and habitat fragmentation leading to negative impacts on distribution and diversity of plants. Two important wetland plants were endangered and disappeared from this area and their presence were shifted away the study area (*Limoniastrum monopetalum L.* and *Ruppia maritima L.)* and other important medicinal plants became rare (f.i., *Pancratium maritimum L.* and *Asparagus stipularis L.*). So it is urgent to start with a sustainable management plan for the conservation and recovery of these habitats and vegetation to reduce the threats and disturbances caused by human activity, devoting, in particular, a special protection to the salt marshes and sand dunes habitats.

References

Ahmed, A. D., Shaltout, K. H. and Sania, A. K. 2014. Mediterranean Sand Dunes in Egypt: Threatened Habitat and Endangered Flora. Life Science Journal 11 (10): 946-956.

Allen,S.E., Grimshaw, H. M., Parkinson, I.A., Quamby, C. and Roberts, J.D. 1986 .Methods in plant ecology. 2^{nd} Edn. Moore, P.D.and Chapman, S. B. (Eds.) Blackwell Scientific Publications. Oxford pp: 411-466.

Ali, M. E., EL-Magd , E. 2016. Impact of Human intervention and coastal process along the Nile Delta Coast Egypt during the past twenty five years. Egyptian Journal of Aquatic Research, (42):1-10.

Ayyad, M., El-Ghareeb, R. 1982. Salt marsh vegetation of the western Mediterranean desert of Egypt. Vegetatio (49): 3-19.

Ayyad, M., Le Floch, E. 1983. An ecological assessment of renewable resources for rural agricultural development in the western Mediterranean Coastal Region of Egypt. CNRS/CEPE, Montpellier, France.

Batanouny, K. 1999. The Mediterranean coastal dunes in Egypt: An Endangered landscape. Estuarine, Coastal and Shelf Science (49):3-9.

Boulos, L. 1999. Flora of Egypt volume 1:419. Al-Hadara Publishing, Cairo.

Boulos, L. 2000. Flora of Egypt volume 2:352 Al-Hadara Publishing, Cairo.

Boulos, L. 2002. Flora of Egypt volume 3 :373. Al-Hadara Publishing, Cairo.

Boulos, L. 2005. Flora of Egypt volume 3:373. Al-Hadara Publishing, Cairo.

Boulos, L. 2009. Flora of Egypt Checklist Revised annotated edition. Al-Hadara Publishing, Cairo. 2009; 410 pp.

Burgman, M.A., Keith, D., Hopper, D, Wildyatmoko, S.D. and Drill, C. 2007. Threat syndromes and conservation of the Australian flora. Biological Conservation 134 (1): 73–82.

Egyptian Metrological Authority 2017. Climatic Atlas of Egypt.

El-Bady, M.S., M. 2016. New approach for the occurrence and characteristics of the coastal sand dunes, North of Nile Delta, Egypt. International Journal of Chem. Tech Research. 9: 61-72.

El-Sadek, L.M, and Ayyad, M. 2000. Genetic diversity as a basic component of biodiversity: Case studies in Egypt. In: Nordenstam B, El-Ghazaly G, Kassas N, Laurent T. (eds.), Plant Systematics for the 21st Century, Portland Press; 239-250 .

Galal , T. M., Fawzy, M. 2007. Sand Dune Vegetation in the Coast of the Nile Delta. World Applied Science Journal 2(5) : 427-438.

Heneidy, S.Z., Bidak, L. M. 2001. Multipurpose plant species in Bisha, Asir region, south western Saudi Arabia. Journal of King Saud University 13: 11-26.

Heneidy, S.Z., Bidak, L.M. 1998. Diversity of the wadi vegetation in Matrouh region, Egypt. Journal of Union of Arab Biologists; 6 (B): 13-28.

Jackson, M. L. 1962. Soil chemical analysis. Constable and Company, London. pp:498.

Nafea, E. M. A. 2002. Eco-Palynological studies on coastal habitats in the Nile Delta. M. Sc. Thesis Fac. Sci. Mans. Univ.137 p.

Nafea, E. M. A. 2005. On the ecology and sustainable development of the Northern Delta Lakes, Egypt. Ph.D. Thesis, Fac. Sci. Mans. Univ.

Piper, C.S. 1947. Soil and plant analysis. Inter. Sci. pub. Intc. New York : 416 p

Raunkiarer, C. 1937. Plant Life forms. Clarendon, Oxford, pp.104.

Raven, P. 1971. Relationships between Mediterranean floras. In: Davis PH, Harper PC, Hedge IC. (eds.) Plant life in south west Asia. Botanical Society of Edinburgh, Edinburgh; 119-134.

Shaltout K., Al–Sodany, Y. 2002. Phytoecology of Omayed site. Med Wet Coast Project, for Egyptian Environmental Affairs Agency, Cairo. 2002; 89 pp.

Shaltout, K., El-Hennawy, M., Nafea, E. M. A., Abo-Bakr, S, Ghazaly, O., Eid, E. , Fonda, M. 2009. National Progress towards Targets of the Global Strategy for Plant Conservation. Ministry of State for Environmental Affairs (MSEA), Cairo. 2009.

Shaltout, K., Ahmed, D. 2012. Ecosystem Services of the Flora of Southern Mediterranean Desert of Egypt. Ethnobotany Research and Applications 10: 403-422.