Egyptian J. Desert Res., 53, No.1, 1-17 (2003)

ASSESSING HABITAT FRAGMENTATION AND ITS EFFECT ON PLANT BIODIVERSITY USING MULTIDATE SATELLITE IMAGERY CASE STUDY: OMAYED BIOSPHERE RESERVE (OBR), WESTERN COASTAL DESERT OF EGYPT

Salem, Boshra B.
Department of Environmental Sciences, Faculty of Science, University of Alexandria, Alexandria, Egypt.
E-mail: boshra.salem@dr.com

The impact of man on biological communities, greater extent of land used, have resulted in rapid increase throughout the world of habitat modification, loss and fragmentation. This paper represents an attempt to monitor these phenomena in the Western Mediterranean coast of Egypt in a Biosphere Reserve "El Omayed" as a pilot site. It is divided into three zones that cover a total area of about 700 km^2 and constitutes 5 major habitats. There are many development projects in the OBR that have affected these habitats and consequently the associated biodiversity. Therefore, habitat loss and fragmentation have been observed in the last decade in these sites. The objectives of this paper are: to assess habitat fragmentation / loss and their effects on Biodiversity in OBR and to offer some highlights into tools that can be used in such a study. Multidate SPOT satellite imagery for the years 1987, 1993 and 1999 were used in this study for monitoring and assessing the changes in two of the five main habitats that are mostly affected by human impacts. The temporal changes measured in the selected habitats are habitat fragmentation, in terms of area, number of patches and transformation due to land use changes and loss (in terms of differences between areas of land cover). The results indicated that throughout the 12 years of study, about 83% of the total area of coastal sand dune habitat has been lost due to land transformation. While the non-saline depression habitat has been intensively fragmented and its total area has been reduced by about 35%. It is therefore concluded that rates of habitat fragmentation, transformation and loss as measured by satellite imagery are highly increasing in OBR with an associated plant biodiversity loss and consequently environmental degradation. As a conservation area it is recommended to revise the zonation in this Biosphere reserve

for possibilities of extension southwards to include less degraded and fragmented habitats to contribute to the national conservation efforts with the intention of including the petrified forests that lie about 20 Km^2 to the south.

Keywords: fragmentation, habitat, satellite imagery, biodiversity, biosphere reserves, conservation, western mediterranean coast, Egypt

Habitat fragmentation is the process whereby a large, continuous area of habitat is both reduced in area and divided into two or more fragments (Primack, 1998). When habitat is destroyed, a patchwork of habitat fragments may remain, and these may be isolated from one another by highly modified or degraded landscapes. The effect of fragmentation on populations is a major concern for resource managers and conservation biologists. Most scientific studies of fragmentation have focused on forest habitats and bird populations. Only very few studies relate to arid lands and desert habitats. When native vegetation in arid lands is cleared for agriculture and / or constructions for development projects, habitats, which were once continuous, become divided into separate fragments. These fragments tend to be very small islands isolated from each other. Small fragments of habitats can support only small populations and small populations are more vulnerable to extinction. Separated fragments of habitats are unlikely to be recolonised.

Habitat fragmentation may increase the risk of extinction in many surprising ways. It may limit a species potential for dispersal and colonization, and it also may cause population decline and extinction due to dividing an existing widespread population into two or more sub-populations in a restricted area (Primack, 1998). The effect of habitat destruction and loss on biodiversity is more profound than the effect of habitat fragmentation. The habitat being destroyed may contain the only site for a particular species. This is considered as the most important reason for population extinction. Habitat destruction involving clearance has a massive and often unpredictable impact on endemic fauna and flora. One popular solution to the problem of habitat fragmentation is to link the fragments by planting corridors of native vegetation. This has the potential to solve the problem of isolation.

The western coastal region of Egypt is floristically one of the richest parts of Egypt in flowering plants (nearly 50% of the Egyptian species). The flora of this region comprises a stock of genetical resources for quite a number of cultivars. In this coastal region of Egypt, the rapid growth of urban development, agricultural and other activities have resulted in habitat destruction, fragmentation and loss. These have made it difficult for natural wildlife to maintain a stable population. As urban growth increases, the realized niche of the different species of flora and fauna decreases. The aims

of the present study is to investigate the phenomenon of habitat fragmentation/loss in the western coastal desert of Egypt as represented by El Omayed Biosphere Reserve and monitor the associated plant biodiversity loss owing to this. This paper also offers some highlights into high technology tools that can be used to measure ecological temporal changes in landscape pattern and habitats. Much information about this area including the physiography, climate, land use and especially the plant cover are given by Zahran and Willis (1992)

THE STUDY AREA

According to UNESCO, Man and Biosphere (MAB) Program, El Omayed Biosphere Reserve (OBR) (about 722 km ^{2}; lies between latitudes 30° 38` and 30° 52` N and between longitudes 29° 00` and 29° 28`E. It lies in the El-Omayed region in the western coastal desert of Egypt and is about 80 km to the west of Alexandria and 200 km to the east of Matruh (Figure 1). This region represents a variety of habitats, biological communities, land use patterns and human settlements of the Mediterranean coastal desert of Egypt. OBR is distinguished into a variety of physiographic units characterized by successive undulations running more or less parallel to the coast. These undulations are in the form of calcareous rocky ridges (ancient dunes) alternating with depressions. Several ridges start near lake Mariut and become gradually less obvious towards the west. The main features of the various physiographic units lead to the distinction of three major physiographic systems: (1) a coastal system including the beach and the coastal sand dunes, (2) ridge-depression system including the ridges, their gentle slopes and the depressions in between and (3) the inland plateau system, close to the inland desert. The climate of OBR belongs to the "sub-desertic warm temperate climate", according to the UNESCO classification. Its rainfall is in winter. The rainy season begins in late October and extends to early May, but about three quarters of the total rain amount usually falls in December and January, or sometimes from November to February. Spring (March to May) is usually dry and receives only about 10% of the total rainfall. The average temperature of the warmest month (August) is 30.8° C, while the average temperature of the coldest month (January) is 7.9° C. The mean annual precipitation is 120 mm/year, recorded at an elevation of 10 m.

The life-form spectrum recorded in OBR expresses a typical desert flora. The majority of species are annuals (many ephemerals) and geophytes (perennial ephemeroid herbs), which are drought evaders or chamaephytes (subshrubs and shrubs). The area has high flora diversity that has been recorded and listed in this study. Five natural habitat types are recognized at OBR, from the sea inland: (1) coastal calcareous dunes (the first ridge), (2) inland ridges with skeletal shallow soils (the other three ridges), (3) saline

marshy depressions (between the second and third ridges, an extension of the Mariut Lake), (4) non-saline depressions (between the ridges, except the more seaward two) and (5) the inland plateau. The first type of habitat extends all along the Mediterranean coast and is therefore of regional distribution. Its characteristic species are: *Ammophila arenaria, Thymelaea hirsuta, Crucianella maritima, Ononis vaginalis, Pancratium maritimum,* and *Echinops spinosissimus*, among others. The important natural processes in this habitat are sand movement and wind erosion, as well as percolation of rain water into deeper layers. The main traditional uses are grazing, fig cultivation and catching of quail in autumn, but most of the strip has been transformed into lush resort villages for holiday makers from all over Egypt. The second habitat of inland ridges is of a rather local distribution, mostly restricted to the section between Alexandria and El-Alamein. They have shallow skeletal soils dominated by *Thymus capitatus Globularia arabica,* and *Dactylis glomerata* in rocky sites, *Thymelaea hirsuta* and *Gymnocarpos decandrum* in spots of accumulated soils in between rocks and *Plantago albicans* together with *Asphodelus microcarpus* in deeper soils. The important natural processes in this habitat are active wind and water erosion (gully formation). The main human impacts are settlement (they provide excellent observation opportunities), burials, quarrying for pure white limestone, completely removing the ridges to ground level, commerce, practised by the local population, as well as some poor grazing. The third type of habitat is the saline depression, which is of obvious regional distribution all along the Mediterranean coast (sabkhas). Its halophytic vegetation consists mainly of plant communities dominated by *Salicornia fruticosa, Cressa cretica, Atriplex halimus, Juncus rigidus, Arthrocnemum macrostachyou,* and *Limonium echioides* in sites of a shallow water table. *Suaeda monoica, Zygophyllum album, Limoniastrum monopetalum, Aeluropus lagopoides, Salsola tetrandra* and *Frankenia revoluta* dominate sites with a deep water table. The main natural process is sand deposition from the nearby ridges. Dry farming, irrigated farming and grazing are scarcely practised, while housing and wood cutting are more evident. The fourth habitat type, the non-saline depression, is also of regional distribution and has vegetation communities dominated by *Anabasis articulata* and *Zygophyllum album* on sandy soils with low calcium carbonate content and *Asphodelus microcarpus* and *Thymelaea hirsuta* on fine textured soils (from deposition of erosion particles). Sand deposition is the main natural process here. Dry farming, irrigated farming, grazing, settlements and wood cutting are the main activities here because of a relatively wide expanse and good deep soils, together with run-off from the neighbouring ridges. But grazing is of most importance here, and hence range management and improved dry farming should be the relevant management practice. Finally, the fifth habitat type is the inland plateau, which extends from about 10 km inland to the inwards frontal plain and is certainly of regional distribution. Its

vegetation includes communities dominated by *Artemisia monosperma* and *Hammada elegans* in less calcareous sites, by *Anabasis articulata* and *Hammada scoparia* in sites with shallow degraded soils and by *Suaeda pruinosa* and *Salsola tetrandra* in more saline soils. The important natural processes in this habitat are strong wind and water erosion, while the main human activities involve grazing, dry farming, limited housing and dispersed quarrying by large corporations. Because of the flatness of the ground, it is criss-crossed by roads going in all directions, including the new International Highway which links Egypt to Libya. Surveys have shown that all in all, more than 120 species of higher plants, some 20 species of nitrogen-fixing blue-green algae and a similar number of soil fungi, occur at the OBR.

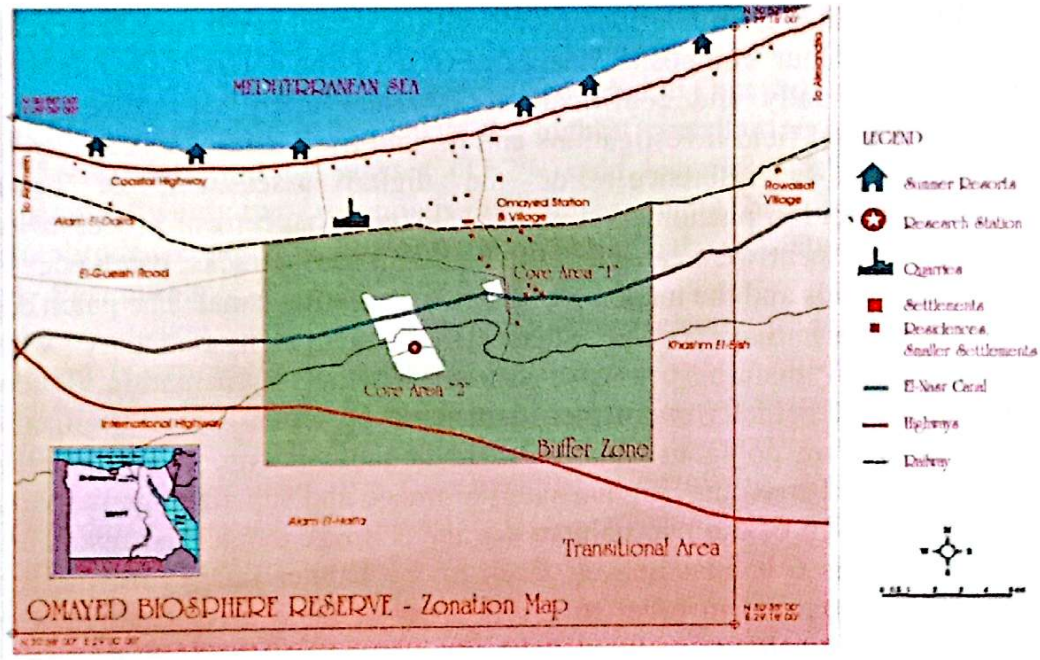

Figure (1). Location map of El Omayed biosphere reserve (OBR)

MATERIALS AND METHODS

Several field visits were conducted to assess the current plant biodiversity of each habitat in area under study. Five representative stands, one stands per habitat, were selected, where 10 random 2x1m quadrats were used to sample the vegetation types and community composition in each stand. In each quadrat, vegetation types were identified and recorded.

SPOT-HRV satellite imagery was the main source of data used in the present study to assess habitat fragmentation/loss. The SPOT frame that covers the study area has the path/raw number 107/188 and was already available through previous monitoring studies for the dates, September in the years 1987 and 1993. A new SPOT was purchased for the nearest date available - November 1999. The image processing work was carried out at the remote sensing and GIS unit of the Department of the Environmental

Sciences, Faculty of Science, University of Alexandria, using ERDAS/Imagine image processing software. Digital processed SPOT satellite image and digitized base maps of 1:50,000 were produced, integrated and used for establishing a digital geodatabase using the geographic information system (GIS). This geodatabase was built by digitizing base maps, overlaying satellite imagery and integrating field observations and attribute data using PC ArcInfo software and ArcView GIS.

The study area of 722 km^2 was extracted as a subscene from each of the three SPOT frames, then georeferenced and registered. The three subscenes (one for each date) when superimposed were typically fitting per pixel to the same Latitude/Longitude position, as indicated from base maps. The False colour composite images (FCC) of the three subscenes were examined visually and confirmation on visual interpretation was made through several field investigations and ground truth using the recent SPOT subscene as a reference. For the digital assessment of habitat loss/fragmentation phenomenon, several image enhancement processes e.g. edge enhancement were carried out to highlight roads, tracks, patch edges of cultivated fields and the mapping of the new irrigation canal. The patch edge is defined as that portion adjacent to the patch boundary where environmental disturbances have caused habitat fragmentation. Patches (fragments of habitats) were then delineated by an on-screen digitization process to form polygons. Satellite data of these polygons (pixel values) were extracted from the original satellite image and separated as individual images for each of the two habitats for the 3 image dates. The resultant of this process is 6 habitat images. Each of the habitat images for the three dates was classified in order to assess areas of land cover changes. Field visits were carried out to validate the image analysis and to observe the fragments of the two habitats and the vegetation cover in each fragment. Using a global positioning system (GPS) the actual location and boundaries of each fragment were assessed.

RESULTS AND ANALYSIS

The plant biodiversity monitoring process that started Autumn 1998 to Summer 2000 led to the record of 251 plant species (131 perennials and 120 annuals) belong to 169 genera and 44 families. Among these species, one is endemic, 40 are rare (23 perennials and 17 annuals) and 11 are threatened species. Fifty-eight species are woody plants (mainly shrubs) contributing about 23.1% of the total species (10 phanerophytes and 48 chamaephytes). One hundred and twenty nine species (51.4% of the total species) have at least one feature of potential or actual economic use. The grazing and medicinal uses are the most frequent. Forty-one plant communities were identified, of which 8 are in coastal sand dunes and 4 in

non-saline depressions. From ecological and vegetation viewpoints, it can be concluded that the site of Omayed Biosphere Reserve is ideal to represent the Mediterranean Desert ecosystems in Egypt. Its flora approximates 30% of the total flora of the Egyptian Mediterranean region (the richest phytogeographical region in Egypt). Eighteen species have a national distribution restricted only to the western Mediterranean region, where the Omayed Biosphere Reserve occurs: *Asparagus aphyllus, Fagonia cretica, Lotus polyphyllos, Centaurea alexandrina, Helianthemum sphaerocalyx, Prasium majus, Centaurea pumilio, Hyoseris radiata* subsp. *graeca, Rhodalsine geniculata, Ebenus armetagie, Leontodon tuberosus* and *Thymus capitatus* as perennials; and *Brachypodium distachyum, Daucus syrticus, Hyoseris scabra, Crucianella aegyptiaca, Hippocrepis cyclocarpa,* and *Matthiola longipetala* subsp. *hirta* as annuals.

Species richness: The species recorded in Omayed biosphere reserve included composites, that have the highest contribution to the total flora (15.9%), followed by grasses (13.2%) and legumes (12.8%). Thirty-two species (twenty-two perennials and ten annuals) have wide ecological amplitude (recorded in at least 6 out of 7 chief habitats). These species are:

A- Perennials

Allium roseum, Echinops spinosissimus, Plantago albicans, Anabasis articulata, Echiochilon fruticosum, Salsola tetrandra, Artemisia herba-alba, Gymnocarpos decander, Salvia lanigera, Asphodelus ramosus, Helianthemum lippii, Scorzonera undulata, Atractylis carduus, Lotus creticus, Suaeda pruinosa, Carduncellus eriocephalus, Noaea mucronata, Thymelaea hirsuta, Cynodon dactylon, Lygeum spartum, Zygophyllum album and *Deverra tortuosa.*

B- Annuals

Adonis dentata, Hippocrepis areolata, Rumex pictus, Astragalus annularis, Ifloga spicata, Schismus barbatus, Filago desertorum, Malva parviflora, Senecio glaucus subsp. *Coronopifolius* and *Matthiola longipetala* subsp. *livida*

The habitats of the highest species richness are the inland ridges (160 species) and non-saline depressions (156 species) and those of the lowest species richness are the rainfed farms (65 species) and salt marshes (23 species). On the other hand, the habitat of the highest number of unique species is the coastal dunes (35 species) (Table 1).

There is only one rare endemic species, *Helianthemum sphaerocalyx* (Cistaceae), that inhabits the coastal dunes in this region. Moreover, this and any other species with unique occurrence are considered as a threatened species because of the severe degradation process in the region.

Figure (2) shows the False Color Composite (FCC) SPOT satellite recent image, where water bodies appear in black color, desert background appears in yellow color and natural vegetation cover appears in grades of red color. Coastal summer resorts appear very obvious as dark blocks on the

coastal dunes. Figure (3) shows the geodatabase that was used to assess a digital evaluation of amount and extent of habitat fragmentation/loss in relation to its influence on habitat degradation. Examining the multidate satellite images indicated that OBR has been subjected to an intensive process of combined habitat fragmentation/loss due to human interventions.

TABLE (1). Species richness of the main habitats in Omayed Biosphere Reserve. The unique species (one of the criteria that used in assessing the nature reserves) of each habitat are indicated.

	Perennial		Annual		Total	
Habitat	All	Unique	All	Unique	All	Unique
Coastal dunes	74	19	53	16	127	35
Salt marshes	17	2	6	1	23	3
Saline depressions	52	3	43	1	95	4
Non-saline depressions	78	4	78	10	156	14
Inland ridges	79	7	81	9	160	16
Inland plateau	59	4	46	2	105	6
Rain-fed farms	35	1	30	3	65	4
Total	131	40	120	42	251	82

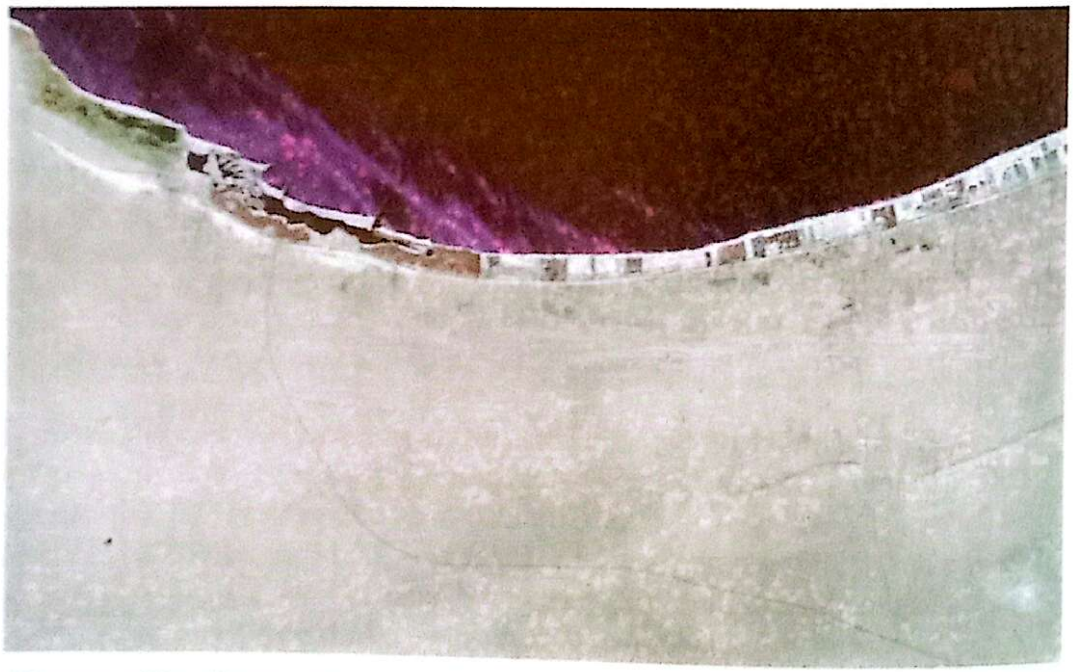

Figure (2). False color composite (FCC) image of OBR, SPOT-November, 1999

The results of image analysis are presented in figures (4 and 5). for coastal and non-saline habitats. These figures provide a clear visual assessment of the extent of fragmentation in the non-saline depression

habitat, in terms of area and time, as well as the extent of habitat loss in the coastal sand dunes habitat. Table (2) shows the number of patches arising from fragmentation and areas lost in each habitat during the period of study (about 12 years, 1987-1999). It is clear that the coastal dune habitat has lost about 83% of its area due to transformation to condensed summer resort projects. The coastal ridge has been completely leveled and all the natural vegetation, fig farms and even Bedouin settlements were removed and replaced by these touristic villages. Figure (6) shows the coastal sand dunes habitat before and after the establishment of the summer resorts. This land use transformation is associated with great loss of the biodiversity that existed since Roman times on the coastal ridges and dunes. It should be noted here that only the ridge summit is considered in this analysis and not the slopes. This is because the sand dunes on the ridge summit are very bright in color and are visually distinct on the satellite images from the background. This has increased the accuracy of the on-screen delineation on the FCC images of the three dates. The most striking observation was that no annuals were detected in any of the fragmented patches. The general trends of plant species richness and diversity in the distributed sites show a decrease in both richness and diversity coinciding with maximum dominance of these sites by *Ammophila arenaria*, which attains a relative density ranging from 70% on the stabilized dunes to 95% on the active (mobile) dunes. It is also notable that *Ammophila arenaria* and *Lotus polyphyllos* were the only species which could persist under different levels of disturbance. Seven species were completely absent from all the studied disturbed sites. Most of these species are herbaceous. This confirms the notion that habitat fragmentation and destruction and the extinction of species go hand in hand. It is of note that *Helianthemum sphaerocalyx*, which is an endemic species to Egypt and considered to be very rare and threatened, inhabits the coastal and dunes habitat. Due to habitat fragmentation and loss this species is currently under severe threat and is liable to become almost extinct.

With regard to the non-saline depression, fragmentation is the major cause of habitat degradation. The number of patches observed here increased from 2 in 1987 to 21 in 1999. According to observations, the non-saline depression habitat has been intensively fragmented and its total area reduced by about 35%. The fragmentation is mainly due to the construction of a new irrigation canal network (Nasr canal) in the area. The new canal is an extension (some 80 km) from the River Nile towards the Western Desert. This canal was designed for the supplementary irrigation of the annual cropping system after reclamation projects take place. Figure (7) shows the irrigation canal in two areas in the OBR. The direct environmental effect of the establishment of this irrigation canal is the fragmentation that occurred in the non-saline habitat due to the constructions and disturbances that affected

the homogeneity and caused spatial discontinuity, turning this habitat into separated and in some cases isolated fragments.

TABLE (2). Habitat fragmentation as indicated by the number and area of patches, and Habitat Loss in the Coastal Sand dunes and non-saline depression habitats according to the SPOT satellite imagery for the years 1987, 1993 and 1999

Satellite image date	Habitat fragmentation			
	Coastal Dunes		Non-Saline depression	
	No. of patches	Total area (km^2)	No. of patches	Total area (km^2)
1987	1	12.27	2	163
1993	10	6.343	8	140.7
1999	17	2.1	21	106.7
Habitat loss (1987-1999) Percent of loss		10.17 (82.9%)		56.3 (34.5%)

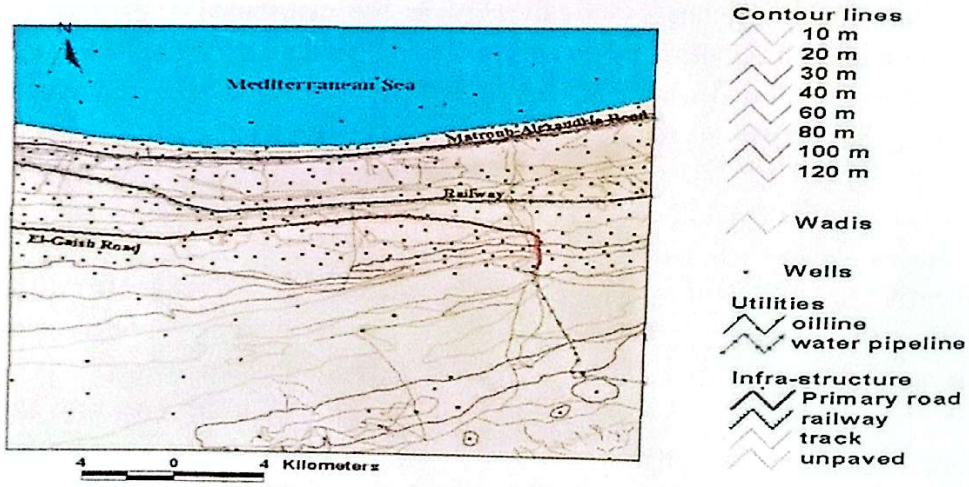

Figure (3). Geodatabase of El-Omayed biosphere reserve (OBR) showing the physiographic units.

DISCUSSION

Fragmentation almost always occurs associated with severe reduction in habitat area but it can also occur when an area is reduced to only a minor degree if the original habitat is divided by roads, railroads, canals, powerlines, fences, oil pipelines, firelanes, or other barriers to the free movement of species. The result is a reduced patchy habitat with a greater amount of edge(s) habitat. Habitat destruction is widely considered the most pervasive anthropogenic cause of the loss of biodiversity (Brown 1985; Wilson 1985; Myers 1988). McCloskey and Spalding (1989) produced a

quantitative analysis of the global distribution of 'undistributed ecosystems'. However, they defined " undistributed " simply in terms of roadless areas in areas of greater than 400,000 ha. Hannah *et al.* (1994) carried this effort further and reduced its mapping units to 100,000 ha. They concluded that 73% of the world's land surface other than rock, ice and barren land is either human-dominated (36.6%) or partially disturbed (36.7%), while 27% is "undisturbed". About half of the total area (49%) of Africa out (about 34 million km^2) is undisturbed, 36% is partially disturbed and about 15% is human dominated.

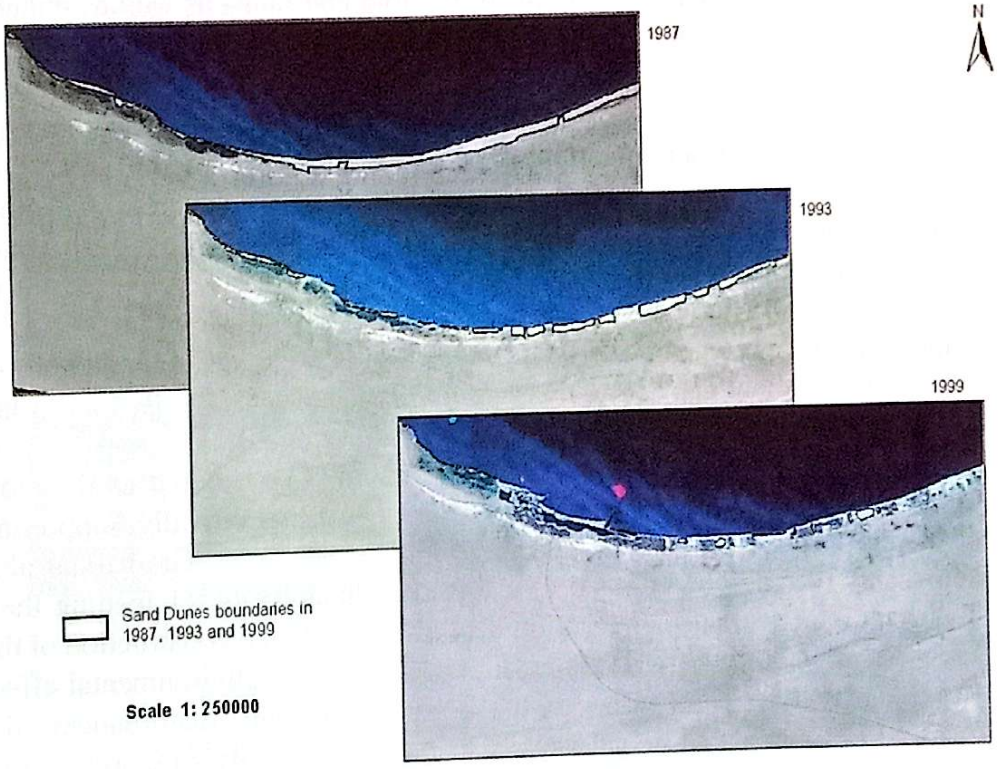

Figure (4). Habitat fragmentation/loss in the coastal dune habitat according to SPOT images of 1987, 1993 and 1999.

In the present study, the scale of fragmentation was considered in terms of the spatial and temporal scales. Spatial scales ranged between hundreds to a few square kilometers in the two habitats where the original plant communities existed in fragments (clumps or tussocks). In terms of time, the area under study has been subjected to tremendous fragmentation and loss, due to human impact particularly in the last decade. These effects have directly affected plant communities and caused changes in their microclimates. Fragmented habitats in the study area appeared to be "islands" in the landscape- in particular the patches of coastal sand dunes, where they appeared as "islands" in the "sea " of the surrounding buildings of summer resorts. The disturbance on coastal dune during establishment of

summer resorts has been pointed out by Ayyad and Fakhry.(1996). They have analyzed the plant communities that were affected by summer resorts and found that the mainly affected areas are those on the active (mobile) and stabilized dunes. The present study showed that throughout the 12-year period of study, the area of coastal sand dunes habitat has lost about 83% due to land transformation of the dunes ecosystem to an extended coastal strip of tourism resort. Almost all the natural resources of the sand dune habitat have been removed and replaced by the sprawl of urbanization: buildings, utilities, and others. The result is an associated loss of the biodiversity of this habitat, in terms of its flora and fauna as well as mineral non-renewable resources in OBR. It is assumed due to the above observations that this habitat loss would also affect the water table and the surface runoff system of this habitat, significant also because this habitat has been considered as an important fresh water reservoir in the area. This habitat also was supporting the best varieties of figs, palm trees and other rain-fed annual crops. It was as well found that the existing fresh water lenses beneath the sand dunes are currently heavily depleted as a result of pumping out for domestic use by the inhabitants of the resorts as a supplementary water source (water from the extended water pipelines is always insufficient especially during summer time). This calls for further study to assess the water balance and water quality in OBR.

The habitat of the non-saline depression is considered as the most fertile in the coastal desert in general and in the OBR specifically, supporting both rain fed and partially irrigated agricultural practices. The habitat also represents the main range-land used by local inhabitants for feeding their livestock. The habitat fragmentation here is caused by the construction of the new irrigation canal network as mentioned. The direct environmental effect is fragmentation mainly due to the constructions and disturbances that reduced the homogeneity and caused spatial discontinuity,with some cases isolated fragments. From the biodiversity point of view, this fragmentation increases the risk of extinction in many ways. It may limit the potential for species dispersal and colonization, it also may cause population decline and extinction by to dividing an existing widespread population into two or more sub-populations in a restricted area. The habitat of the non-saline depression suffers currently from break up of its continuous landscape containing large patches, into smaller usually more numerous and less-connected patches. Organisms, when faced with this type of stress, have three options: they can remain in the area and adapt to the changes, they can migrate to an area lacking the stress, or they can become extinct. This extinction may be local, state-wide, nation-wide, or world-wide depending on the organism and circumstances. However, there is one thing to realize about fragmentation. There are some important differences between distributions that are naturally patchy and those that become patchy because of habitat fragmentation. In the case of the non-saline depression habitat, the vegetation distribution is

patchy, sparse and contracted. With ongoing fragmentation, the vegetation distribution is becoming patchier, and this is more threatening the biodiversity. Whatever the effects of fragmentation are, even if they may be exhibited in a minority of species, but this may be the ones with the largest impact on the structure and function of the habitat. This result is inline with a study carried out by Leigh *et al.* (1993) who assessed changes in natural vegetation resulting from habitat fragmentation. They found that the pattern of tree diversity recorded in six small patches has been changed, associated with decline in tree diversity.

The introduction of fresh water to this arid environment is also important. This may introduce new water-borne invasive species that may replace existing plant communities, change the ecological balance and consequently the structure of the ecosystem. The changes in the structure of the plant communities would definitely affect animal communities and their distribution in OBR.

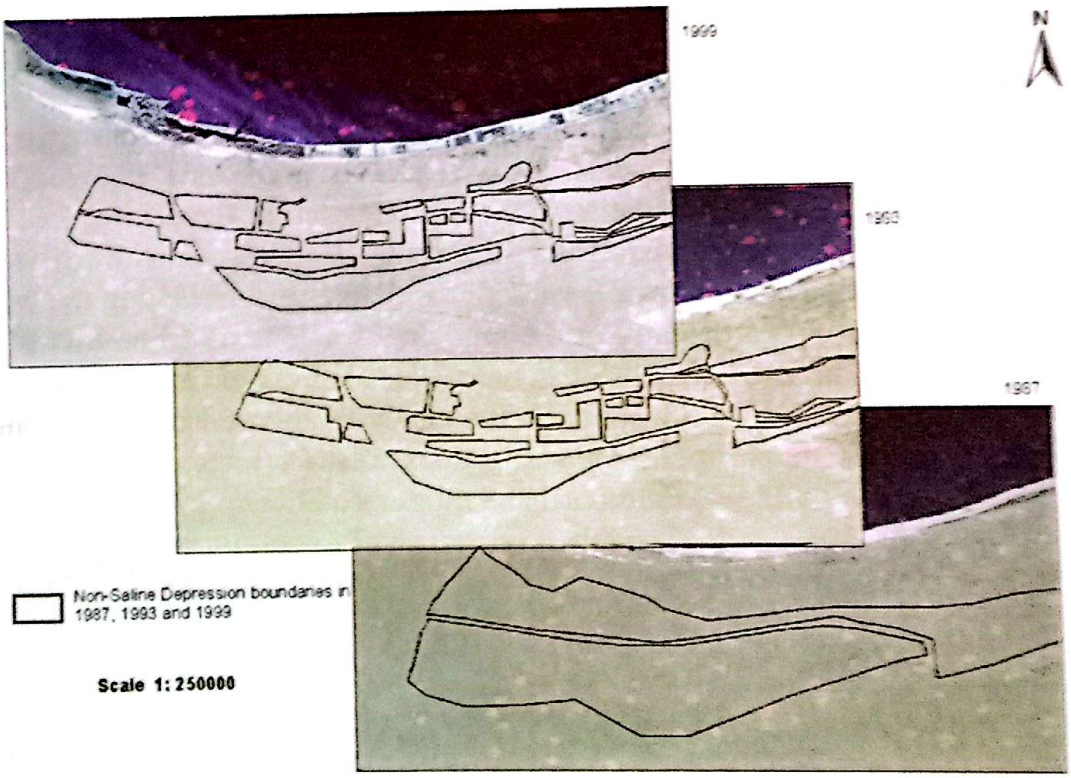

Figure (5). Habitat fragmentation/loss in the non-saline habitat according to SPOT images of 1987, 1993 and 1999

CONCLUSION AND RECOMMENDATIONS

The site of Omayed Biosphere Reserve is ideal to represent the Mediterranean Desert ecosystems in Egypt. Its flora approximates 30% of the total flora of the Egyptian Mediterranean region (the richest phytogeographical region in Egypt).

The present study has demonstrated, using high resolution satellite imagery, that the habitats of the coastal desert of Egypt, in the area of the OBR are subjected to environmental deterioration and degradation due to habitat loss and fragmentation. This is threatening the biodiversity of this area, which has an arid environment, with fragile ecosystems and native species sensitive to extinction. The habitats of coastal sand dunes and non-saline depression have been used to draw examples on habitat loss and habitat fragmentation. It was found that the fine scale habitat fragmentation in the non-saline depression habitat has disrupted the usual foraging and breeding behavior of species that have evolved to live in more continuous habitats and thereby affected the biodiversity of this habitat. It is therefore recommended that, for the Omayed biosphere to fulfill its objectives, efforts should be directed towards changing its zonation scheme and extend it to include less fragmented areas and also to include the petrified forests that exist about 20 km towards the south. It is clear from this study of the OBR that this site demonstrates the effect of habitat fragmentation on biodiversity. These results are important for decision-makers in the regional planning and sustainablility of the coastal desert.

It was also concluded through this study that remote sensing using high resolution imagery and GIS have proved to be effective tools in monitoring habitat fragmentation in the coastal desert of Egypt.

However, more studies are needed for the assessments of the effect of habitat fragmentation on vegetation growth and for elucidating the water balance in OBR, particularly in the sand dunes habitat after the loss of its fresh water resources, and in the non-saline depression habitat after the introduction of fresh water through the newly established irrigation canal. These studies should include investigations of the effects of climate, site geomorphology and vegetation on habitat fragmentation.

Figure (6). The coastal sand dunes habitat before and after the construction of summer resorts, 1987-1999.

Figure (7). The new network of irrigation in the non-saline depression

REFERENCES

Ayyad, M.A. and A.M. Fakhry (1996). Plant biodiversity in the western Mediterranean desert of Egypt. *Verhandlungen der Gesellschaft für Ökologie*, 25: 65-75.

Brown, L. (ed.) (1985). In "*State of the world 1985*". A Worldwatch Institute report on progress toward a sustainable society Norton W.W. & Co., New York.

Hannah, L.; D. Lohse; C. Hutchinson; J. L. Carr and A. Lankerani (1994). A preliminary inventory of human disturbance of world ecosystems. *Ambio*, 23: 246-250.

Leigh E.G. Jr.; S.J. Wright; E.A. Herre and F.E. Putz (1993). The decline of tree diversity on newly isolated tropical islands: a test of a null hypothesis and some implications. *Evolutionary Ecology*, 7: 76-102.

McCloskey J.M. and H. Spalding (1989). A reconnaissance-level inventory of the amount of wilderness remaining in the world. *Ambio*, 18: 221-227.

Myers, N. (1988). Threatened biotas: 'hot spots' in tropical forests. *The environmentalist*, 8: 187-207.

Primack, R.B. (1998). In "*Essentials of Conservation Biology*: *Habitat Destruction, Fragmentation and Degradation*". Sinauer Associates, Inc. 277pp.

Wilson, E. O. (1985). In *"The biological diversity crisis: A challenge to science"*. Issues in science and technology (fall): 20-29.

Zahran, M.A. and A.J. Willis (1992). In *"The Vegetation of Egypt"*. Chapman & Hall, London, U.K. 424pp.

Received: 16/04/2003
Accepted: 04/06/2003

تقييم تفتت الموائل وتاثير ذلك على التنوع البيولوجى باستخدام صور الأقمار الصناعية متعددة الأزمنة
دراسة حالة بمحمية العميد للمحيط الحيوي - بالساحل الشمالي الغربي بمصر

بشرى بكر سالم
قسم العلوم البيئية – كلية العلوم – جامعة الاسكندرية – الاسكندرية – مصر .

تزال المجتمعات الطبيعية والموائل وتتغير طبيعيا من حيث الشكل والمساحة والترتيب المكاني بالنسق البرية وقد نتج عن تأثير الإنسان وإستخدامه المتزايد للأراضي زيادة حادة على المستوى العالمي فى تحور الموائل وتفتتها وفقدها- وتمثل هذه الورقة محاولة لرصد هذه الظاهرة بالساحل الشمالي الغربي بمصر وذلك بمحمية العميد للمحيط الحيوي كمنطقة للدراسة. وطبقا لليونسكو وبرنامجه للإنسان والمحيط الحيوي فتنقسم محمية العميد للمحيط الحيوي إلى ثلاثة نطاقات لأنشطة الصون، تغطى جميعها مساحة قدرها ٧٠٠كيلو متر مربع تقريبا . وتحتوي هذه المساحة على خمسة موائل أساسية ويوجد بمحمية العميد للمحيط الحيوي عدة مشروعات تنموية كان لها التأثير البالغ فى تغير الموائل وما يصاحب ذلك من فقد فى التنوع البيولوجي. لذلك تمت ملاحظة فقد الموائل وتفتتها فى هذه المنطقة فى خلال العقد الماضي بأهم موئلين (من حيث الإنتاجية والتنوع البيولوجي) من الموائل الخمسة الأساسية لمحمية العميد للمحيط الحيوي- وبات الهدف الأساسي من هذه الورقة هو تقييم لتفتت الموائل وفقدها وتأثير ذلك على التنوع البيولوجي بمحمية العميد للمحيط الحيوي كما تساهم هذه الورقة فى إلقاء الضوء على التقنيات التى تستخدم لهذا التقييم.

وقد إستخدم فى هذه الدراسة صور القمر الصناعي الفرنسي أسبوت المتعدد سنوات التسجيل أما السنوات التى إختيرت لهذه الدراسة فهي ١٩٨٧، ١٩٩٣ ،١٩٩٩. وعن طريق تحليل هذه الصور رقميا فقد تم قياس التغير الزمني بالموائلين المختارين لتفتيت الموائل معبر عنه بالمساحة وعدد الرقع، والتحول نتيجة لتغير إستخدام الأرض، كما تم تعيين فقد الموائل وذلك بمقارنة صور الأقمار الصناعية ذات الأزمنة المختلفة.

وقد خلصت هذه الدراسة فى خلال هذه الفترة بتقييم التنير فى خلال أثنى عشرة عاما بأن حوالي ٨٣% من المساحة الكلية لموئل الكثبان الرملية الساحلية قد تم فقدها نتيجة تحول إستخدام الأرض بهذا الموئل أما بالنسبة لموئل المنخفضات غير الملحية فقد تم تفتتها بشدة مما نتج عنه فقد حوالي ٣٥% من أراضي هذا الموئل. ولذلك يمكن أن نستخلص من هذه الدراسة أن معدل تفتت هذه الموائل وتحولها وفقدها فى حالة متزايدة فى محمية العميد للمحيط الحيوي ويصاحب ذلك فقد فى التنوع البيولوجي النباتي وبالتالي تدهور بيئي.

وبما أن هذه المنطقة تعتبر منطقة صون طبقا لليونسكو فيوصي بمراجعة النطاقات بهذه المحمية وذلك بإمكانية إمتدادها جنوبا لإمكانية ضم بيئات أخري غير متدهورة مما يساهم فى جهود الصون الوطنية كما يمكن أيضا ضم مواقع الغابات المتحجرة والتي تقع على بعد حوالي ٢٠كم جنوب محمية العميد للمحيط الحيوي.