

ASSESSMENT OF THREATS TO VEGETATION COVER IN WADI EL RAYAN PROTECTED AREA, WESTERN DESERT, EGYPT

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Abstract

Wadi El Rayan is located in the African Sahara ecoregion of the Palearctic eco-zone, the world's largest hot desert. The total area of Wadi El Rayan is 1759km². The objective of the present study is to enrich the knowledge on the vegetation cover along the shores of Wadi El Rayan lakes and to identify the different threats, underlying causes and recommended solutions for the conservation of natural vegetation cover in Wadi El Rayan Protected Area (WRPA). Based on field surveys, we found that current pressures of human activities on natural vegetation include overgrazing, irresponsible tourism, land encroachment, water pollution, water over-use, fire, and habitat change and destruction. The reduction of water levels due to decreased water incoming is considered the main threat facing ecosystems and biodiversity in the lakes area. We found that the perimeter of the lower lake has decreased from 48.6km² in 2007 to 34.09km² in 2013 (a loss of 29.8 % of the total lake area), due to lake decreased water level. The most underlying causes of vegetation loss in the study area were found to be the lack of awareness, weak law enforcement, lack of suitable strategies, weak financial support and lack of stakeholders' cooperation. Survey results show that vegetation cover in the area of the connecting channel and northeastern of the lower lake represents the highest impacted area by human pressures compared to other locations. Moreover, the role of WRPA is important in achieving good cooperation between governmental authorities, local community, and owners of different economic activities and in finding new ways to improve potential future cooperation with other stakeholders. We also provide some suggested activities for conserving vegetation cover in WRPA.

Keywords: Vegetation; Protected area; Wadi El Rayan; Threats; Conservation

Introduction

Wadi El Rayan is a desert area situated in the Fayoum Governorate of the Western Desert of Egypt. The total area of Wadi El Rayan is 1759Km². The flora of Egypt including Western Desert has been a subject of study by numerous authors [1-5]. The current flora in the Western Desert is poor both in diversity and plant cover [6]. Wadi El Rayan Protected Area (WRPA) is classified by the Egyptian Environmental Affairs Agency (EEAA) as a national park and managed resources protected area, in which nature protection and economic activities should run in harmony to avoid the extinction of wild species and the continuation of economic activity and resources sustainability [7]. Wadi El Rayan depression has been used as a water reservoir for storing excess agricultural drainage water above the capacity of Lake Qarun. Two man-made lakes (i.e. the first and second lakes), joined by a connecting channel, were

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constructed at two different levels. The first lake covers an area of around 53km² at 10m below the sea level, while the second is twice as deep and large as the first one (110km² at 18m below the sea level). The surplus water from the first lake floods into the second lake via a shallow connecting channel [8]. Throughout time, Wadi El Rayan lakes have created a variety of habitats surrounding it, although the adverse consequences of their creation on the ecology of the area cannot be ignored [9-11]. Wadi El Rayan was identified by the International Union for Conservation of Nature (IUCN) in 2011 as one of 20 important plant areas (IPAs) in Egypt [12] and nominated by Egypt in 2012 as a Wetland area of Ramsar Convention [13]. The area became increasingly inhabited by people from adjacent villages and consequently a rapid economic development was established, and so it has been listed by EEAA as Managed Resource-Protected Area, category VI [14]. By February 2000, around 242 reclaimed field systems were established, each of about 20 feddans (a total area of about 4840 feddans). Irrigation water is pumped on these fields from the upper lake through pipeline running toward west and entering the project area from the northwest, draining afterwards into the lower lake from southwest following the natural landscape gradient [15]. In Wadi El Rayan includes about 4575 feddans of reclamation areas and 1300 feddans of intensive and extensive fish farms [16]. The main threat to the effective long-term protection in Wadi El-Rayan is the development of un-controlled economic activities such as large-scale land reclamation schemes, rapidly expanding aquaculture, commercial fishing, oil extraction, and tourism [14 - 17]. The natural resources of the protected area are under threat from the economic and human activities within WRPA but, sound management practices, law enforcement (in collaboration with stakeholders) and monitoring can ensure the sustainable use of the natural resources [18]. The greatest threats to the surrounding area comes from a land-claim project which aims to cultivate 15,000 feddan of desert, right in the centre of Wadi El Rayan Protected Area. Fish-farming, taking place in and around the lakes is a potential source of water-pollution. Increasing reduction in water discharge caused (in some near shore waters, especially around the second Lake) lead to a dramatic increase in rooted aquatic plants. It also decreased the size of the lakes [19]. In the last 5000 years, Human impacts have been the most important influence on the vegetation and plant composition in the arid environments of the world, particularly in the Middle East [20]. The landscapes at global level are now occupied by human altered floras. Humans have been the primary agent in the creation of new plant species communities [21]. The environmental deterioration in arid ecosystems due to un-controlled human activities is evident in a decrease of vegetation cover and soil degradation [22]. The approach level of species population/community can help in exploring the responses of the whole ecological system to various kinds of disturbance [23 - 24]. The loss of biodiversity has large economic and social costs. The biodiversity, ecosystems and human knowledge that are being lost represent a source of options available for adapting to local and global change [25]. The Conservancy developed standardized approaches for analyzing conservation threats at the site level [26], and generalized guidelines for assessing threats at an ecoregional level [27]. Similar methodologies have been widely developed and used by other conservation organizations and institutions [28-30]. The last two decades have witnessed a substantial change in the land use system in and around the oases of the Western Desert of Egypt [31].

Successful management of wetland sites therefore requires maintenance of these sources of water. A key requirement for conservation and wise use of wetland is to ensure that adequate water of the right quality is allocated to the wetlands at the right time [32]. The principal objective of the present study is to enrich the knowledge about the vegetation cover along the shores of Wadi El Rayan lakes and identify the different threats, underlying causes and recommended solutions for the conservation of the natural vegetation cover in Wadi El Rayan Protected area.

Methods

Vegetation analysis

Quantitative surveys of the vegetation in the study area were carried out during the period from March 2013 to September 2013. We identified 10 stands in the surrounding area of the lakes (including the upper and lower lakes and the connecting channel) to represent vegetation cover variation of WRPA (Fig. 1). At each stand, we conducted 5 quadrat surveys, each of $10\text{m} \times 10\text{m}$ (50 quadrates in total) and identified the potential threats and challenges facing the local natural vegetation.

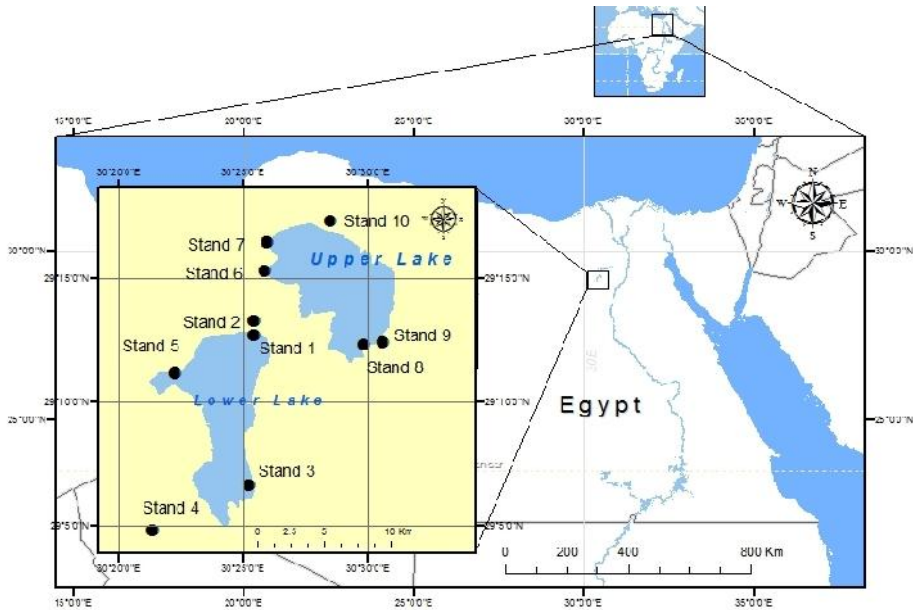


Fig. 1. The map of Egypt, with focus on Wadi El-Rayan and study locations (stands)

Identifying threats and solutions

We analyzed the threats and pressures facing the vegetation cover protection in the area and suggested the activities and measurements that can be used to protect, preserve, and enhance the vegetation cover according to IUCN and Ramsar convention guidelines. At each stand, we assigned the threats, underlying causes, barriers and solutions. The above terms are defined as follows: **Threat:** any human activity or process that has caused or may cause the destruction, degradation and/or impairment of biodiversity and natural processes [33]. **Underlying causes:** conditions or environments, usually social, economic, political, institutional, or cultural in nature, that enable or contribute to the occurrence and/or persistence of a direct threat [33]. Several tools were used to evaluate the threats, underlying causes, barriers and to help in providing/suggesting solutions, these tools include:

Threats matrix: The evaluation of vegetation conservation status was adapted from the Nature Conservancy's Enhanced 5-S process for measuring conservation effectiveness (outcomes) and analyzing threats [34]. We identified threats (severity rating) according to TNC in 2007 [26] as follows: very high; high; medium; low. **Severity:** level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation). Scored as: very high: the threat is likely to destroy or eliminate the conservation target over some portion of the target's occurrence at the

site; high: the threat is likely to seriously degrade the conservation target over some portion of the target's occurrence at the site; medium: the threat is likely to moderately degrade the conservation target over some portion of the target's occurrence at the site; and low: the threat is likely to only slightly impair the conservation target over some portion of the target's occurrence at the site.

SWOT analysis: strategies an organization adopts should match the environmental threats and opportunities and the organization's weaknesses and especially its strengths. SWOT analysis tries to establish a strategic fit between an organization's internal strengths and weaknesses and opportunities and threats posed by its external environment [35]. The method has its origins in the 1960s [36]. This thinking has widely been accepted as a fundamental principle underlying modern strategic management [35].

Venn diagram of stakeholders: a tool that helps to understand who will be affected by proposed development activities [37]. It is used in this study to analyze links between most important stakeholders in Wadi El Rayan related to and impacting natural vegetation cover.

Results

Vegetation distribution

In total, 17 plant species representing 13 families were identified in the surveys. Table 1 shows the present composition of the flora of the study area. Figure 2 shows a distribution map of the plant groups, while Figure 3 shows a satellite map of the vegetation cover over the study area.

The results in the present study showed the recorded species as follows:

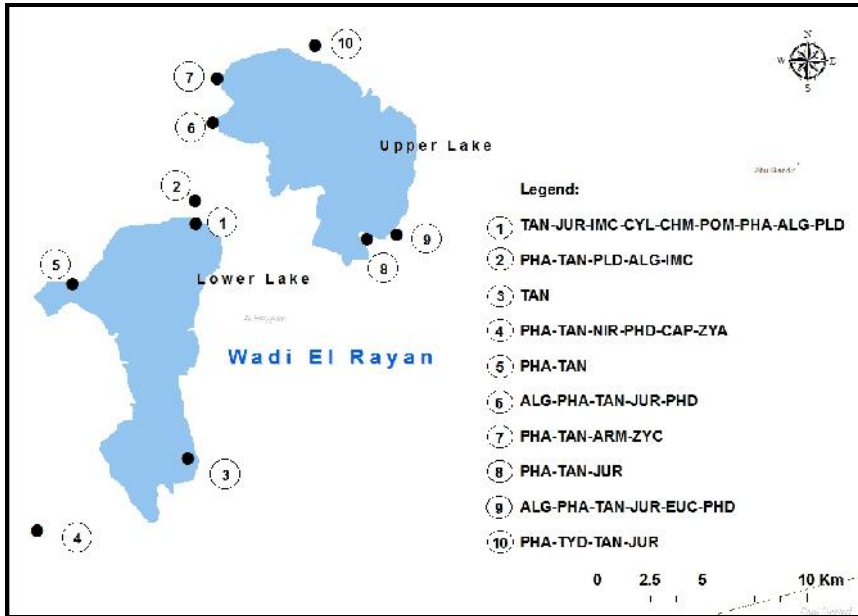
The lower lake (stands 1, 3, 4, and 5) is dominated by *Phragmites australis*, *Tamarix nilotica* and *Zygophyllum album*, with co-domination of *Juncus rigidus*, *Nitraria retusa*, *Alhagi graecorum*, *Chenopodium murale*, *Cyperus laevigatus*, *Imperata cylindrical*, *Polypogon monspeliensis*, *Pluchea dioscoridis*, *Calligonum polygonoides sub.comosum* and, *Phoenix dactylifera*.

Table 1. Present composition of flora (+ = recorded; - = not recorded)

Species	Lower Lake	Connecting Channel	Upper Lake
<i>Phragmites australis</i>	+	+	+
<i>Tamarix nilotica</i>	+	+	+
<i>Juncus rigidus</i>	+	-	+
<i>Alhagi graecorum</i>	+	+	+
<i>Imperata cylindrical</i>	+	+	-
<i>Polypogon monspeliensis</i>	+	-	-
<i>Cyperus laevigatus</i>	+	-	-
<i>Chenopodium murale</i>	+	-	-
<i>Pluchea dioscoridis</i>	+	+	-
<i>Calligonum polygonoides</i>	+	-	-
<i>Arthrocnemum macrostachyum</i>	-	-	+
<i>Nitraria retusa</i>	+	-	-
<i>Phoenix dactylifera</i>	+	-	+
<i>Zygophyllum album</i>	+	-	-
<i>Zygophyllum coccineum</i>	-	-	+
<i>Typha domingensis</i>	-	-	+
<i>Eucalyptus camaldulensis</i>	-	-	+

The connecting channel (stand 2) is dominated by *Phragmites australis*, with co-domination of *Alhagi graecorum*, *Tamarix nilotica*, *Imperata cylindrical*, and *Pluchea dioscoridis*.

The upper lake (stands 6, 7, 8, 9, and 10) is dominated by *Phragmites australis*, with co-domination of *Tamarix nilotica*, *Juncus rigidus*, *Alhagi graecorum*, *Zygophyllum coccineum*, *Typha domingensis*, *Eucalyptus camaldulensis*, *Phoenix dactylifera*, and *Arthrocnemum macrostachyum*.



Legend	
PHA <i>Phragmites australis</i>	CAP <i>Calligonum polygonoides sub.comosum</i>
TAN <i>Tamarix nilotica</i>	ARM <i>Arthrocnemum macrostachyum</i>
JUR <i>Juncus rigidus</i>	NIR <i>Nitraria retusa</i>
ALG <i>Alhagi graecorum</i>	PHD <i>Phoenix dactylifera</i>
IMC <i>Imperata cylindrica</i>	ZYA <i>Zygophyllum album</i>
POM <i>Polypogon monspeliensis</i>	ZYC <i>Zygophyllum coccineum</i>
CYL <i>Cyperus laevigatus</i>	TYD <i>Typha domingensis</i>
CHM <i>Chenopodium murale</i>	EUC <i>Eucalyptus camaldulensis</i>
PLD <i>Pluchea dioscoridis</i>	

Fig. 2. The distribution map of plant groups at the different study stands.

Threats and underlying causes

During the field work, we recorded pressures and threats facing the natural vegetation along the shores of the two lakes and the connecting channel. The decreasing water levels of the lakes due to the decline of water coming to them are considered a main threat to the health of ecosystems and biodiversity in the area. We found that major pressures of human at natural vegetation include: overgrazing, irresponsible tourism, land encroachment, water pollution, water over-use, fire, habitats change & destruction. Table 2 show current threats at different locations in the study area, while Figure 4 shows the map of current economic activities in Wadi El Rayan.

Tourism in WRPA provides employment and income for local people. Current estimates, based on WRPA monitoring data, indicate that the protectorate receives over 250,000 tourists annually [19]. Irresponsible tourism is determined by human damage and visitor behavior, while habitats change and destruction include over-exploitation of the natural resources for economic purposes at irrelevant areas (such as land reclamation, oil extraction, building of cafeterias, fish farming, and the construction of irrigation canals, roads & human settlement). Moreover, a land encroachment throughout replacing natural vegetation by commercial crop cultivation, without any permission.

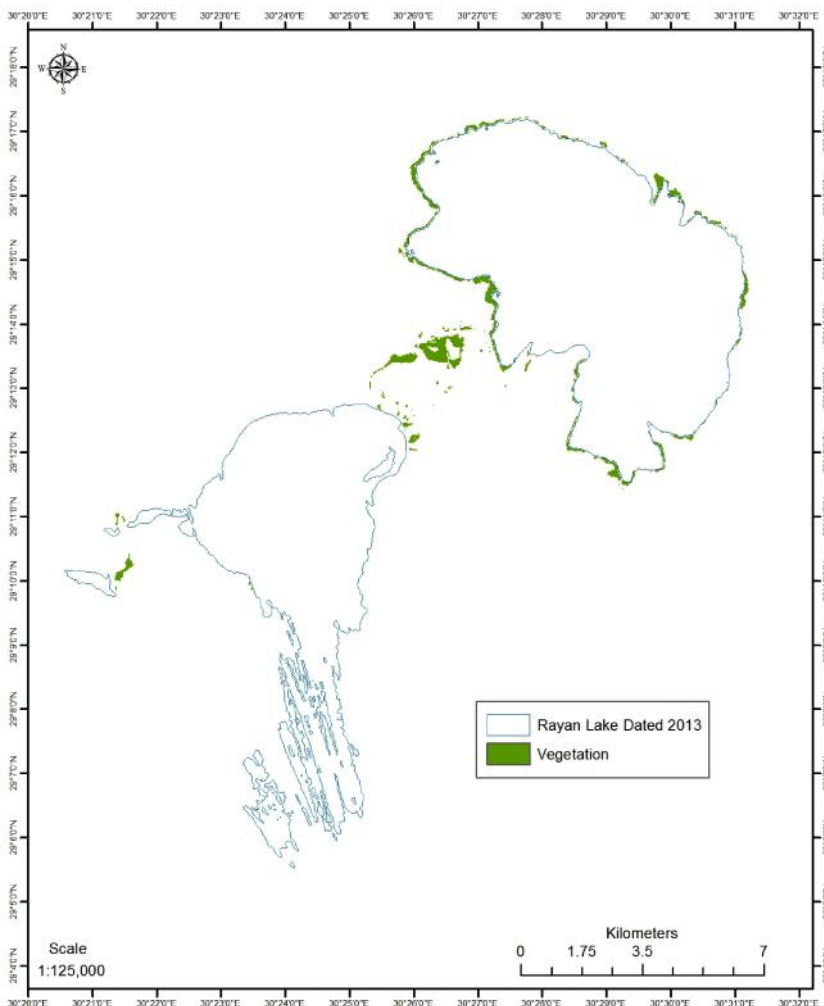


Fig. 3. Satellite map obtained from Landsat 8 satellite describing the vegetation cover over the study area during a summer season of 2013.

Table 2. The threats to vegetation cover along shores of lakes and connecting channel

Stand No.	Location	Type of Threats
1	North East of Lower Lake	GR – UT – WP – WO – HC
2	The connecting channel	GR – WP – FR – WO – HC
3	Southeast of Lower Lake	UT – LE
4	Southwest of Lower Lake	LE
5	El Modwara (Northwest of Lower Lake)	UT – HC
6	Southwest of Upper Lake	GR – WO
7	Northwest of Upper Lake	GR
8	Southeast of Upper Lake	GR – WP – WO – LE – HC
9	Northeast of Upper Lake	GR – WP – WO – LE – HC
10	North of Upper Lake	GR – WP – WO – LE – HC

Abbreviations:

GR: Overgrazing; UT: Irresponsible tourism; LE: Land encroachment; WP: Water pollution
 FR: Fire; WO: Water over-use; HC: Habitats change / destruction.

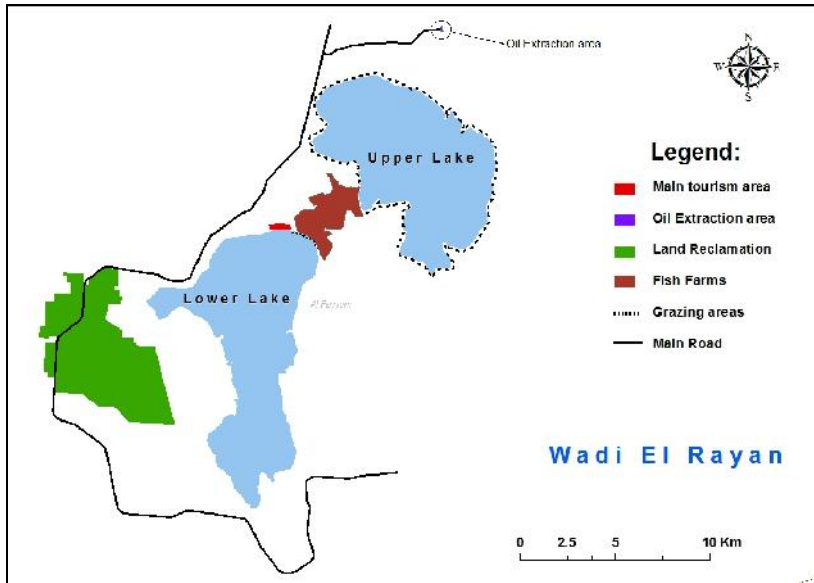


Fig. 4. Map of main human activities in Wadi El Rayan

The results of the current study are in accordance with the results of Abdou in 2006 [15] in regards to the effect of the agricultural activities and with Shahd *et al.* in 2007 [38] when referring to the impacts of oil extraction and land encroachment (by removing of the natural vegetation). Human pressures facing the vegetation cover in the study area can be explained as follows:

The Lower Lake

Land reclamation in western of the lower lake:

There are over 4,500 feddans of reclamation areas in WRPA [16]. Such large agricultural area consumes a large amount of water for irrigation, mostly pumped from the upper lake through pipelines. High uncontrolled consumption of water in the future will affect the quantity and quality of available water, and so highly affecting the vegetation cover populations at the boundaries of the upper lake.

During the land reclamation projects, native wild plants are uprooted and the landscape is modified in order to level the surface for cultivation. It is expected that land reclamation activities will excessively continue in the future in this area which will highly affect the vegetation cover and diversity in this area.

Domestic livestock introduced by farmers in the reclamation areas are feeding on the natural vegetation growing around the lakes, which destroys the vegetation cover and highly affects the survivability of the wild species.

Farmers have introduced non-native plant species into the area, which compete with (/prey on) native species. Such introductions may change the plant communities' composition of the area and so affecting the complex processes in the desert ecosystem.

Irresponsible tourism: The negative impacts of irresponsible tourism in WRPA caused by human damage and visitor behavior (such as: the growing number of tourists visiting sensitive natural areas, compaction and sealing of soils by cars leading to loss of vegetation, destruction of the landscape for the construction of cafeterias, buildings and facilities, and human-made fires of common reed (*Phragmites australis*) in waterfalls and connecting channel).

Land encroachment (by removing the natural vegetation) in the southwest sector of the lower lake is ongoing at one of the most sensitive and fragile areas of WRPA.

The current rate of water inflow: Wadi El Rayan lakes receive a high amount of agricultural and drainage water from El Wadi Drain [39]. The rate of water inflow is currently less than the total rate of water use and lost by evaporation, making the future of the lake system in WRPA in jeopardy. Accordingly, the salinity increases leads to problems for the ecosystem, particularly for the second lake. The salinity of the second lake increased progressively from 2.41% in 1984-1985 to 14.3 % in 2010 [19] (more than 17570 g/L [40]). The reason for such increase is the dramatic decrease of the water level throughout time.

In terms of lower lake perimeter, the lake was filled up in the early 2000 at stable levels, and then the water discharge into the lake started to decrease throughout time, resulting in a decreased perimeter of the lake. Abdou in 2002 [41] reported that the total area of lower lake is 57.5km². We found that the lower lake perimeter has decreased in 2013 to 34.09Km² due to decrease of water level in the lake. The comparison between the total area of the lower lake in 2007 (48.6km²) and 2013 (34.09km²) indicates a clear loss of 29.8% of the lake area. However, between 2010 and 2013, we noticed a decrease in the perimeter of the lake from 40.77km² in 2010 to 34.09km² in 2013 with a clear loss of 26 % of the lake area in 3 years only (Fig. 5).

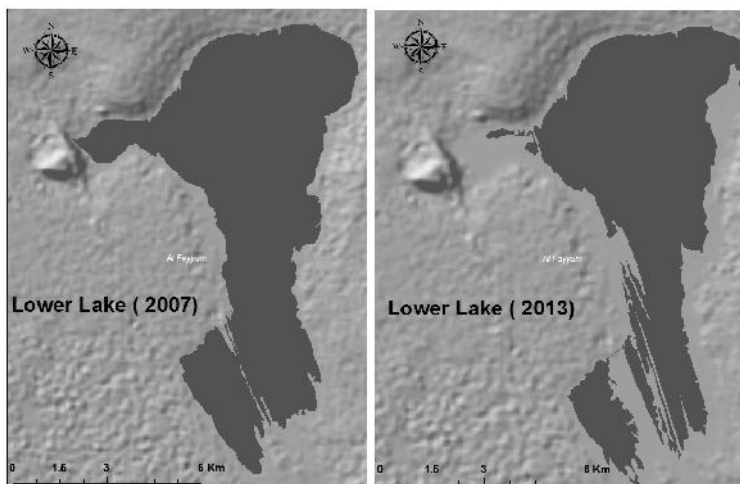


Fig. 5. The difference size a lower lake between year 2007 and 2013.

However, current natural vegetation around the lower lake are now under severe retraction due to the decrease of water levels in both of the lakes and it will reach a dangerous level if the same rate of high water consumption remains in the future.

The southwest of the lower lake (includes the area adjacent to Quaron-Benisuif Road) is covered by *Nitraria retusa*, *Calligonum polygonoides*, *Zygophyllum album*, *Tamarix nilotica*, and *Phoenix dactylifera*, with few individuals of *Phragmites australis*. In the southeast of the lower lake, most of remaining individuals of *Phragmites australis* were found died, however the woody species *Tamarix nilotica* was found to spread well in large areas in a good condition. Many young individual plants of *Tamarix nilotica* were recorded in the area and was found to spread well at many locations at the shoreline of the southern part of the lower lake.

The Upper Lake

Over-grazing: The local community living in the villages of WRPA has exploited the natural vegetation of the area throughout grazing. Local community bred a large number of cows and donkeys on the natural vegetation (e.g. common reed "*Phragmites australis*"). The effect of grazing is easily observable with different intensities at different localities around lakes.

Agricultural activities at the eastern part of the upper lake: Throughout the last three years, land encroachment in WRPA has become a serious problem (without permission). It has altered the landscape of the natural areas around the lakes via removing the natural vegetation and increasing the land clearance for crop cultivation.

Oil Extraction: Wadi El Rayan’s Protected Area Management Office (PAMO) has discovered exploration activities by the Quarun Oil Extraction Company inside the protectorate, without having any permissions or environmental consultancy of the PAMO office. PAMO office, yet, has a limited authority to control mining activities inside WRPA.

The connecting channel

Over-grazing: The effects of grazing are easily observable at different intensities along the connecting channel extending towards the upper lake

Fish farms: The major impact of fish farms on the vegetation cover in WRPA is related with the heavy water consumption and water pollution [15 - 40]. Along the connecting channel and the lower lake, fish farms, beside agricultural activities, contribute in a significant manner in reducing the quality of water and the destruction of habitats.

Threats Matrix

The severity rating allows an estimate of the threat magnitude. Table 3 provides an overview of the threats affecting each of the 10 key locations at the study area (read down the columns) and the importance of the individual threats across the area (read across the rows). It shows a very high degree of threat for 5/10 key locations; 4 have high degree of threat and 1 has a medium degree of threat. The principle threats in Wadi El Rayan are: water declining levels; water over-use; over-grazing; habitats change or destruction, and land encroachment. Often, the longer term threats are difficult to identify and address, especially when their impacts are small, variable or incremental; e.g. irresponsible tourism and land encroachment. There is a need to enhance the patrolling, monitoring and public awareness activities in WRPA to cope with those threats.

Table 3. TNC’s 5-S Framework describes four variables used to measure threats including low, medium, high and very high ranks.

Threats	Locations										Overall Threat Rank
	North East of L Lake (Stand 1)	The canal (Stand 2)	Southeast of L Lake (Stand 3)	Southwest of L Lake (Stand 4)	El Modwara (Northwest of L Lake) (Stand 5)	Southwest of U Lake (Stand 6)	Northwest of U Lake (Stand 7)	Southeast of U Lake (Stand 8)	Northeast of U Lake (Stand 9)	North of U Lake (Stand 10)	
Overgrazing	Medium	Very high	-	-	-	High	High	Very high	Very high	Very high	Very high
Irresponsible Tourism	Very high	-	Low	-	High	-	-	-	-	-	High
Water Pollution	High	Very high	-	-	-	-	-	Medium	Medium	Medium	High
Fire	-	High	-	-	-	-	-	-	-	-	Medium
Water Over Use	Medium	Very high	-	-	-	Very high	-	High	Medium	Medium	Very high
Water Declining Levels	Very high	-	Very high	Very high	Very high	-	-	-	-	-	Very high
Habitats Change or Destruction	Very high	Very high	Low	Low	Low	-	-	Very high	Very high	Very high	Very high
Land encroachment	-	-	Medium	Medium	-	-	-	Very high	Very high	Very high	Very high
Threat Status for Targets	Very high	Very high	High	High	High	High	Medium	Very high	Very high	Very high	Very high

The overall threat rank in area= Very High

Note: The following method was used for summing low, medium, high and very high ranks (TNC, 2007) for the areas (columns) and threats (rows): Multiple threats to individual targets and multiple target threat scores are summed together using the 3-5-7 rule: 3 High ranked threats are equivalent to 1 Very High-ranked threat; 5 Medium ranked threats are equivalent to 1 High-ranked threat; 7 Low ranked threats are equivalent to 1 Medium-ranked threat.

Barriers and solutions

SWOT analysis: This method aims to identify the key internal and external factors facing the conservation of vegetation at an area. Table 4 summarizes those factors (strengths, weaknesses, opportunities and threats) in WRPA.

Table 4. SWOT analysis for vegetation conservation in WRPA.

Element	Positive	Negative
Internal	<p>Strengths</p> <ul style="list-style-type: none"> - Possibility of enforce the rules of the protected area. - The relations with main stakeholders. - Availability of a preliminary “master plan” in order to protect of vegetation cover. 	<p>Weaknesses</p> <ul style="list-style-type: none"> - A lack of funding for the upkeep and maintenance of vehicles and equipment. They also need funding to maintain an appropriate amount of staff within the protectorate - Shortage of botanist researchers in WRPA - Shortage of awareness & education programs to local community and economic activities owners.
	<p>Opportunities</p> <ul style="list-style-type: none"> - Law 102/1983 for protected areas and 9/2009 for Environment. - Designated the area by Ramsar as Wetland of International Importance. - Identified the area as one of twenty important plant areas (IPAs) in Egypt. - Implement community awareness / education programs to promote the unique environmental qualities and characteristics of the area. - Possibility of establish a zontion system to protect the vegetation cover. 	<p>Threats</p> <ul style="list-style-type: none"> - Decreasing of water level due to Lack of water coming to the lakes. - Overusing of lakes water. - Infringements at natural areas & habitat destruction. - The negative human impacts such as overgrazing, unsustainable tourism, pollution, fires of common reed.
External		

Venn diagram: This tool aims to analysis the degree of linkages between different stakeholders in WRPA. Most stakeholders in WRPA have a direct/indirect role and are affecting/affected by the conservation actions of the natural vegetation (Fig. 6).

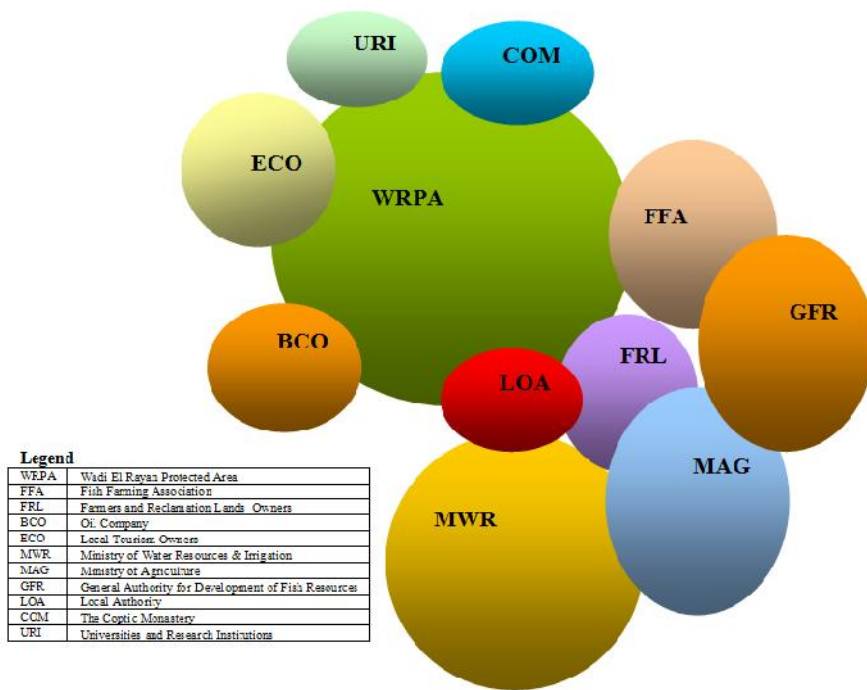


Fig. 6. Venn diagram of stakeholders in WRPA that impact on vegetation cover.

Note: The circles placed as follows: separate circles = no contact; touching circles = information passes between institutions; small overlap = some co-operation in decision making and large overlap = a lot of co-operation in decision making.

The results highlight the lack of stakeholders' active cooperation in WRPA and the need for cooperation between different stakeholders and WRPA administration to find measurements/ways to activate/improve future cooperation. However, the role of WRPA is important in achieving good cooperation with different governmental authorities, local community and owners of different economic activities. WRPA, Ministry of Water Resources, and Ministry of Agriculture are the three most important actors affecting the natural vegetation in Wadi El Rayan area.

The most underlying causes of the vegetation loss in the study area come from the lack of awareness, weak law enforcement, lack of suitable strategies, weak financial support and lack of stakeholders' cooperation.

The needed conservation tools

During the study, we found that vegetation conservation can be achieved through the use and effective implementation of the following tools:

- Environmental regulations and law enforcement: Law No. 102/1983, Law 4/1994 for the Protection of the Environment, Amended by Law 9/2009 and Prime minister's decree No. 943 /1989 for the declaration of WRPA.
- Monitoring programs, research encouragement and GIS tools availability.
- Environmental Impact Assessment (EIA): any economic activities at any protected areas in Egypt, including WRPA, should be agreed upon by the EEAA after the submission of an accepted EIA study following the guidelines of EIA system.
- Communication: such as meetings, lectures, publications, posters, pamphlets and the visitor center.

The solutions: The conservation of the vegetation cover in Wadi El Rayan requires seven major activities and programs (Fig. 7).

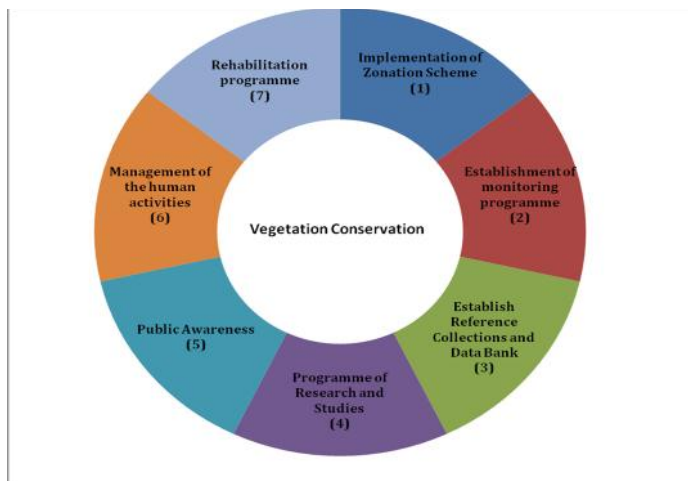


Fig. 7. Major activities to conservation of vegetation cover in study area.

The activities and programs are described as follow:

Implementation of Zonation Scheme: Three zones are suggested with different degrees of protection as shown in Figure 8 and are described as follows:

Zone A: "Strict Natural Zone" at the southern sector of the lower lake: A variation in species diversity at different locations across WRPA was detected in this study. The southwestern area of the lower lake is considered as one of highest species richness areas.

However, this area is located only few kilometers from the spring area (off the main road, west of the lower lake). EEAA in 2012 [19] reported that some wild plant species in the spring area support the existence of important mammal communities; e.g. Gazelles (*Gazella dorcas*). This area should be closed and scientific regular monitoring programs should be organized in this zone, dealing mainly with the different elements of biodiversity such as monitoring the vegetation cover which deals with different plant species in area. Also the economic activities are not allowed in this area.

Zone B: “Reserve Protection Zone” in the northeast area of the upper lake: Scientific regular monitoring programs in this zone are dealing mainly with the elements of biodiversity through organize a scientific regular monitoring program beside the other monitoring program in Zone A.

Zone C: “Development zone”: Human and economic activities (including tourism and recreation activities) in this area should be monitored by EEAA and any further activities in this area should be in accordance with EEAA regulations and the Environmental Impact Assessment (EIA) system.

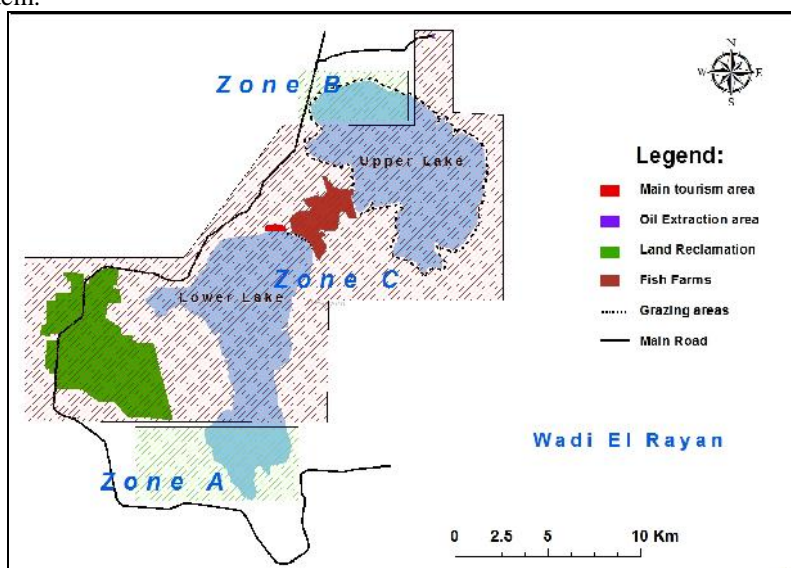


Fig. 8. The location of human activities and the zonation areas.

Establishment of monitoring program: throughout time, natural areas are susceptible to changes that may have drastic effects on their overall health. Establishing monitoring programs is important in order to assess the current condition and any changes that may affect the vegetation resources. The usefulness of this network is to feed a local data bank with an up-to-date information on the status of the vegetation cover and any other elements that may affect the natural vegetation (e.g. water level fluctuations in both lakes). The program includes two activities:

- Establishment of a set of locations, various ecological zones of the Protected Area, for periodical sampling of water and soil for analysis.
- Establishment of a monitoring program: the purpose is to monitor species and their populations and to use this information to indicate the up-to-date health of habitats. This activity requires a team of trained personnel.

Establishment of Reference Collections and Data Bank: This activity can be presented at the Protected Area’s visitor center and can be regarded as a start for establishing a

local natural history museum (for education and research purposes). The data bank will be linked with the monitoring network (activity 2) and with other ongoing research activities. Reference collections will include flora (herbarium). A documented reference collection of soil types can be built, kept and updated through the scientific surveys. A data bank is a computerized depot for data on biodiversity (with its various elements), ecological monitoring and research results. It will also contain a geographical information system (GIS) database for the lakes of Wadi El Rayan. This will be, eventually, a part of the national database of protected areas and biodiversity at the Nature Conservation Sector (NCS) of the EEAA. Also the data bank will store periodical reports (activity 4) on the status of conservation and sustainable use of natural resources.

Program of Research and Studies: There is a need for research work on population- and ecosystem dynamics, assessment of ecological changes, impact of current grazing rate etc. Environmental impact studies related to new development schemes (e.g. the new fish farms, land reclamation projects, tourism activities, etc.) need to be carried out and submitted to EEAA.

Management of economic activities in WRPA

Land Reclamation: Agriculture Activities should be under full supervision of EEAA, they should be accepted only after the submission of an exhaustive Environmental Impact Assessment (EIA) report, following the “Guidelines for Egyptian EIA”. EEAA has the right to monitor existing establishments following the Egyptian legislations: law No. 9/2009 and law 102/1983. No increase in the area of the reclamation land should be permitted until the problem of the over-use of the water resources in the lake system has been solved. Encouraging the farmers to use organic farming, environmental weeds control and natural chemicals in their cultivation of crops may help to protect the lakes and vegetation cover, as should encouraging the farmers to use of modern irrigation through the public awareness.

Oil Company: All oil mining activities should be monitored by EEAA after the submission of an accepted EIA report.

Fish Farms: We recommend that no further licenses for fish farming be issued until the critical problem of over-use of the available water in the lake system has been resolved. Again, all fish-farming-related activities should be monitored by EEAA after the submission of an accepted EIA report. The awareness activity should deal with the introduction of the required base-information about environmental low-cost technologies (such as artificial wetland) to mitigate the pollution of the fish farm effluent and giving in the same time a satisfied investment result.

Tourism activities: The vast majority of WRPA visitors are Egyptians (probably over 95%) and the demand for the WRPA as a recreational destination is likely to continue to rise, given the over-crowdedness and highly polluted conditions prevailing in many urban areas of Egypt. The main visitor area in the WRPA, widely known as the Waterfall Area and covers a stretch of beach of about one km along the northern shore of the Lower Lake. Overall, EEAA has to re-design the area in an attempt to transform it into a recreational area with a strong eco-tourist and educational vocation. The public awareness and community outreach is considered as a primary target of the management of this area.

Over-grazing: Protected Area staff is responsible for general and specific status surveys of common reed (*Phragmites australis*) and wetland ecosystem. This involves the establishment and monitoring of the grazing activity, developing a rotational grazing system which assesses the carrying capacity of the wetland ecosystem for grazing by local inhabitants of the villages around WRPA. Results of these studies are the only basis for designing a scientifically-sound program, aiming to control the over-grazing.

Rehabilitation program: Vegetation conservation urgently needs the evaluation of the success of rehabilitation trials implemented in other Egyptian protected areas network. This may help to establish a rehabilitation program in WRPA (such as: rehabilitation of *Calligonum polygonoides* in south of lower lake) to contribute to the success of future conservation activities.

Public Awareness: The purpose of this activity is to raise the awareness of people (of all ages) to ensure their support and participation to the operations that take place in the Protected Area and, in particular, the conservation of natural vegetation.

Discussion

The lakes that have been created in Wadi El Rayan within the extreme arid Western Desert have tremendous ecological effects on all biodiversity of the depression itself and near areas [5] (Zahran and Willis, 2009). Currently, the natural wetland vegetation communities around the lower lake are now under severe retraction due to the decrease of water levels in both of the lakes to a dangerous level. Therefore, the Water supply is of great importance as it determines the Wadi El Rayan vegetation cover and wild life.

Moreover, the area is rich in biodiversity and desert wildlife [9-10, 42]. In addition, the area harbors the world's only known surviving population of the endangered slender-horned gazelle, *Gazella leptoceros leptoceros* [9- 10]. The area is also inhabited by the declining *Gazella dorcas*, and some of the little known desert forms such as the fennec fox, *Vulpes (Fennecus) zerda*; the sand fox, *Vulpes rueppelli*; the sooty falcon, *Falco concolor*; and a very rare bat, *Eptesicus innesi* [10]. However, according to the present study, the status of current threats that affect the vegetation cover in southwest of lower lake may also have negative impacts on the wild animals in area.

Considerations regarding the exploitation and conservation of wild plant resources according to ecological principles must be taken into account. Sustainable management of the floral biodiversity in Wadi El Rayan requires some activities such as stopping the severe human impacts that lead to the disappearance of certain plant populations and hence the modification of the complex plant communities into simple fragile ones.

Conservation of vegetation cover in protected area is not easy, especially in our protected area case. The presence of economic investment stressed the ecosystem from different aspects and at different levels. The human impacts in this region takes the form of many activities: such as continuous land reclamation and expanse of natural habitats particularly the salt marshes and sand formations, also severe change of the water characteristics of the lake due to discharge of fish-farming, agricultural, petrol extraction, and fragmentation or even removal of the natural habitats, particularly the sand formations and salt marshes that occur currently at the two lakes.

There are many assumptions that may affect the future conservation of vegetation cover in Wadi El Rayan, such as: government policy not being supportive with the conservation of vegetation cover and lakes ecosystems; delays in strengthening the law enforcement regime may lead to over exploitation of vegetation cover; continuous decrease of water level due to lack of water coming outside WRPA; difficulty of applying some of the technologies at a local level; the limited number of protected area staff for education program and the lack of financial assistance. Additionally, carrying out many educational and training programs for raising the public awareness about the importance of lakes Wadi El Rayan as a natural reserve for hundreds of biota and sustainable use of their resources is highly important. We suggest for effectiveness of protected area management mechanism, the management planning must identify and quantify the resources required to manage a site, and this information can then be used to support and justify bids for resources. It's essential to find mechanisms to generate

income on the site, for example, through governmental income, or other long-term funding mechanism such as the establishment of a trust fund for the site. Moreover, the Public Awareness activities should deal with the introduction of the required base-information about environmental low-cost technologies to mitigate and reduce the negative impacts of economic activities and giving in the same time a satisfied investment result to activities owners; and encourage the environmental impact studies related to new development schemes (e.g. the new fish farms, land reclamation projects, tourism activities, etc.) that need to be carried out and submitted to EEAA. According to Ramsar Handbooks in 2010 [43], in order to safeguard sites and their features, including the vegetation cover, we must adopt a flexible approach that will allow to respond to the legitimate interests of stakeholder, accommodate uncertain and variable resources, and survive the vagaries of the natural. The importance of incorporating a more participatory approach into protected area decision-making processes in order to foster the implementation of conservation strategies has been widely recognized in the literature [44-48]. However, S. Aswani and P. Weiant in 2004 [49] assert that, when local communities are excluded from protected area management and their needs and aspirations are ignored, it becomes extremely difficult to enforce conservation policies.

The recommendations to preserve the vegetation cover and enhance the ecosystems in the study area are:

- Water supply is of great importance as it determines the WRPA future and its vegetation cover.
- On the level of decision-makers, stopping the decreasing of the water level of Wadi El Rayan lakes is a must. Decreasing the water level now affects adversely the occupied area with wetlands which supports the vegetation and wild life of the area.
- Implement the national wetland action plan for sustainable management and protection of the important wetland sites in Egypt
- The vegetation cover preservation requires policy resolutions that support the preservation of the vegetation resource with control and limiting all sorts of habitat destruction that can come through economic activities, visitors and different sorts of human settlements as land reclamation.
- The WRPA management should develop a strategy to deal with major violations which threaten the very existence of WRPA such as land reclamation, oil extraction and fish farming activities.
- Promote and encourage the funds and projects working on the plant species and habitat conservation such as Ramsar projects.
- Working for the financial and technical sustainability of the Protected Area (PA). Ignoring this issue would result in deleterious effects on the conservation and protection of the PA from different types of threats and ensure that the PA has access to a certain percent of the income generated by different economic activities in the PA.
- Links with national and international organization and universities should be strengthened to facilitate management-oriented research activities and further open the protected area as a study site for students and research institutes.
- A revision and development of adequate and clear set of indicators to monitor and evaluate the progress in conservation of biodiversity in WRPA and ensure that these indicators contribute to the fulfillment of the objectives of vegetation conservation.
- Working in partnership with other leaders at national and international levels to implement the Global Strategy for Plant Conservation (2011-2020), to secure a positive, sustainable future where human activities support the diversity of plant life.
- Activities of the public awareness and community outreach should be better identified and have clear outcomes with clear indicators of achievement to allow monitoring and progress evaluation.

- A Library should be established in the Protected Area to keep reference on the large inventory of research and documents and made accessible to community stakeholders in WRPA, and to the public.

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References

- [1] V. Täckholm, M. Drar, *Flora of Egypt*, **Bulletin Faculty of Science**, (1-4), Cairo University, 1941, 1950, 1954, 1969.
- [2] V. Täckholm, **Students' Flora of Egypt**, 2nd. Edition, Public Cairo University, Beirut, 1974.
- [3] L. Boulos, **Flora of Egypt Checklist**, Al Hadara Publishing Cairo, Egypt, 1995.
- [4] L. Boulos, **Flora of Egypt Checklist**, Al Hadara Publishing Cairo, Egypt, 1999, 2000, 2002, 2005.
- [5] M.A. Zahran, A.J. Willis, **The vegetation of Egypt**, Springer, 2nd edition, 2009.
- [6] L. Boulos, *The Mediterranean element in the flora of Egypt and Libya*, **Colloques Internationaux Du Centre National De La Recherche Scientifique, CNRS 235, La flore du Bassin Méditerranéen: essai de systématique synthétique**, Montpellier, France, June 4-8, 1974.
- [7] C.J. Nels, **Biodiversity in the balance Approaches to setting Geographic Conservation Priorities**, Corporate Press. Inc., Landover, Mary land, 1995.
- [8] M.A. Zahran, Wadi El-Raiyan, *A natural water reservoir, Western Desert*, **Egyptian Bulletin of the Society Geographic Egypt**, XLIII–XLIV, 1970, pp. 83–98.
- [9] M.A. Saleh, *The decline of gazelles in Egypt*, **Biological Conservation**, 39(2), 1987, pp. 83-95.
- [10] M.A. Saleh, M. Fouda, M.A. Saleh, M. Abdel-Latif, B. Wilson, *Inorganic pollution of the Wadi El Raiyan lakes in Egypt and its impact on their fish and wildlife*, **Archives of Environmental Contamination and Toxicology**, 17, 1988, pp.391-403.
- [11] M.A. Saleh, S.A. Saber, M. Saleh, *The structure of the sand dune ecosystem of Wadi El Raiyan, Egypt*, **Journal of Arid Environments**, 15, 1988, pp.283-296.
- [12] E.A. Radford, G. Catullo, B.de. Montmollin, *Important Plant Areas of the south and east Mediterranean region: priority sites for conservation*, **IUCN VIII**, Gland, Switzerland and Malaga, Spain, 2011.
- [13] *Ramsar, Egypt's two new Ramsar Sites*, **Convention on Wetlands of International Importance**, 2012, available online at <http://ramsar.rgis.ch/cda/en/ramsar-news-archives-2012-egypt-two/main/ramsar/1-26-45-520%5E2580940000> [accessed July 21, 2015].
- [14] G.H. Mattravers Messana, *Wadi el Rayan Protected Area Project. Guidelines for overall Work Plan (1998 – 2001)*, **Report 1**, IUCN, 1998.
- [15] W.A. Abdou, **Biodiversity study in Wadi El-Rayan**, Nature Conservation Sector, Egyptian Environmental Affairs Agency, Egypt, 2006.

- [16] M. Talaat, A. Salama, K. Allam, B. Abd El-Kader, D. Paleczny, **Wadi El-Rayan protected area Business plan, Nature Conservation Sector**, Egyptian Environmental Affairs Agency, 2007.
- [17] G. H. Mattravers Messana, *Wadi El Rayan Natural Protectorate Project. Guidelines for First Annual Work Plan (1998)*, **Report 2, IUCN**, 1998.
- [18] Wadi El Rayan Protected Area Management Plan, Natural Conservation Sector, **Egyptian Environmental Affairs Agency**, 2003.
- [19] EEAA (Egyptian Environmental Affairs Agency), *Information Sheet on Ramsar Wetlands to designate of Wadi El Rayan and Qaroun lakes as new Ramsar sites, Convention on Wetlands of International Importance (Ramsar Convention)*, 2012.
- [20] M. Zohary, *Man and vegetation in the Middle East.*, **Man's Impact on Vegetation** (Eds. W. Holzner, M.J.A. Werger and I. Ikusima.), Junk, The Hague, 1983.
- [21] E. Anderson, *Man as a maker of new plants and new plant communities*, **Man's Role in Changing the Face of the Earth** (Ed. W.L. Thomas.), University of Chicago Press, Chicago, 1956.
- [22] K.H. *Batanouny, Human impact on desert vegetation, Man's Impact on Vegetation*, **Dr. W. Junk Publishers, London**, (Eds. Holzner W, Werger M J A and Ikusima I.), 1983.
- [23] I. Hanski, M. Giplin, *Metapopulation dynamics: brief history and conceptual domain*, **Biological Journal Linnean Society**, **42**(1-2), 1991, pp. 3-16.
- [24] R. Barbault, M.E. Hochberg, Population and community level approaches to studying biodiversity in international research programs, **Acta Oecologica**, **13**(1), 1992, pp. 137-146.
- [25] UNEP (United Nations Environment Programme), **Global Biodiversity Assessment**, **Cambridge University Press, New York, NY**, 1995.
- [26] The Nature Conservancy, **Conservation Action Planning: Developing Strategies, Taking Action, and Measuring Success at Any Scale. Overview of Basic Practices**, The Nature Conservancy, Arlington, 2007, available online at https://www.conservationgateway.org/Documents/CAP_Handbook_intro_062007.pdf, [05.02.2014]
- [27] C. Groves, L. L. Valutis, D. Vosick, B. Neely, K. Wheaton, J. Touval, B. Runnels, **Designing a geography of hope: A practitioner handbook for ecoregional conservation**, The Nature Conservancy, Arlington, VA, 2000.
- [28] N. Salafsky, R. Margoluis, *Threat reduction assessment: A practical and cost-effective approach to evaluating conservation and development projects*, **Conservation Biology**, **13**(4), 1999, pp. 830-841.
- [29] CMP (Conservation Measures Partnership), **Open standards for the practice of conservation (version 1.0) CMP: Washington DC**, available online at www.ConservationMeasures.org, 2004, [05.02.2016].
- [30] R. Margoluis, N. Salafsky, **Is Our Project Succeeding: A Guide to the Threat Reduction Assessment for Conservation**, Biodiversity Support Program, Washington DC, 2001.
- [31] M.M. Abd el-ghani, H.A. *Marei, Vegetation associates of the endangered Randonia africana Coss. and its soil characteristics in an arid desert ecosystem of western Egypt*, **Acta Botanica Croatica**, **65**(1), 2006, pp. 83–99.
- [32] Ramsar, Resolution VIII.14, **New Guidelines for management planning for Ramsar sites and other wetlands** (Ramsar Convention), 2014, available online at <http://www.ramsar.org>, [accessed 30 April 2015].
- [33] N. Salafsky, D. Salzer, J. Ervin, T. Boucher, W. Ostlie, *Conventions for Defining, Naming, Measuring, Combining, and Mapping Threats in Conservation. An Initial Proposal for a Standard System*, Foundations for Success, Washington, 2003, available online at <http://www.fosonline.org/resource/conventions-for-threats>, [05.02.2014].

- [34] The Nature Conservancy, **The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success**, Volume I, Second Edition, The Nature Conservancy, Arlington, Virginia, 2000.
- [35] M. Beer, S.C. Voelpel, M. Leibold, E.B. Tekie, *Strategic management as organizational learning: developing fit and alignment through a disciplined process*, **Long Range Planning**, **38**(5), 2005, pp. 445-465.
- [36] E.P. Learned, C.R. Christensen, K.E. Andrews, W.D. Guth, **Business Policy: Text and Cases**, Irwin, Homewood, III, 1965.
- [37] FAO, *Socio-Economic and Gender Analysis (SEAGA) Programme, Field Level Handbook. Gender and Development Service*, FAO, Rome, 2001.
- [38] L. Shahd, G. Soncini, M. Saleh, Wadi El-Rayan Protected Area, Project Evaluation Reports, **The Egyptian Italian Environmental Cooperation Program**, 2007.
- [39] M.H. Ali, A.A. Abdel-Tawab, A.M. Ali, G.G. Soliman, *Monitoring of Water Quality and Some Pollutants of Man-Made Lake (Wadi El-Rayan First Lake, Egypt)*, **Egyptian Journal of Aquatic Biology and Fisheries**, **11**(3), 2007, pp.1235-1251.
- [40] * * *, *Wadi El Rayan water lakes analysis (May, 2013)*, **Egyptian Lakes Monitoring Programme**, EEAA (Egyptian Environmental Affairs Agency), 2013.
- [41] W.A. Abdou, *Environmental study on Wadi El Rayan, El Fayoum Governorate*, **PhD Thesis**, Mansoura University, Mansoura, 2002.
- [42] D.J. Osborn, I. Helmy, **The Contemporary Land Mammals of Egypt Including Sinai. Fieliana Zoology (New Series) 5**, 1980.
- [43] * * *, *Managing wetlands: Frameworks for managing Wetlands of International Importance and other wetland sites*, **Ramsar Handbooks for the Wise Use of Wetlands, 4th edition, 18**, Ramsar Convention Secretariat, Gland, Switzerland, 2010.
- [44] K. Brown, *Integrating conservation and development: a case of institutional misfit*, **Frontiers in Ecology and the Environment**, **1**(9), 2003, pp.749–487
- [45] J. Grainger, *People are living in the park. Linking biodiversity conservation to community development in the Middle East region: a case study from the Saint Katherine Protectorate, Southern Sinai*, **Journal of Arid Environment**, **54**(1), 2003, pp. 29–38.
- [46] J. Pretty, D. Smith, *Social capital in biodiversity conservation and management*, **Conservation Biology**, **18**(3), 2004, 631–638.
- [47] B. Anthony, *The dual nature of parks: Attitudes of neighbouring communities towards Kruger National Park, South Africa*, **Environmental Conservation**, **34**(3), 2007, pp. 236–245.
- [48] M.S. Reed, *Stakeholder participation for environmental management: A literature review*, **Biological Conservation**, **141**, 2008, pp. 2417–2431.
- [49] S. Aswani, P. Weiant, *Scientific evaluation in women's participatory management: monitoring marine invertebrate refugia in the Solomon Islands*, **Human Organization**, **63**(3), 2004, pp. 301–319.

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