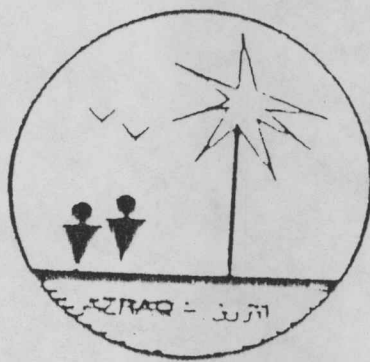


THE AZRAQ OASIS
CONSERVATION PROJECT

THE AZRAQ WETLAND
RESERVE
MANAGEMENT PLAN



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A UNDP/GEF funded, Nationally Executed Project

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Table of Contents

I. Summary of the Management Plan	1
1.1 Location	2
1.2 Habitat	2
1.3 Climate	2
1.4 Water support system. Hydrology	2
1.4.1 The Azraq Water Basin	3
1.4.2 Hydrology:	3
1.4.3 Surface water:	3
1.4.4 Change in flow of springs in the Wetland :	4
1.5 Pastoralism	4
1.6 Agriculture	4
1.7 History	5
1.8 The International Commitment. The RAMSAR Convention	5
1.9 Biodiversity :	5
1.10 The Azraq Village :	6
1.11 Ecotourism, public awareness, and Interpretation:	7
1.11.1 Ecotourism:	7
1.11.2 Public Awareness and Interpretation:	7
1.11 MANAGEMENT OBJECTIVES	7
II : INTRODUCTION	9
2.1 General Outlook	9
2.2 Location :	9
2.3 General History and Archeology	10
2.3.1 General History:	10
2.3.2 Archaeological Significance :	10
2.3.3 The modern scientific involvement	10
2.4 Evolution of legislation and regulations	11
2.5 Topography of The Reserve	11
Central Marsh	11
The Mud flat and its Surroundings	13
2.6 General Hydrology	13
Hydrology:	13
Recharge :	14
Pumping rates :	14
Surface water:	14
Water quality :	15
Change in water table during Azraq Project :	16
Change in flow of springs :	16
Water Quality :	16
Degradation of the Underground Aquifer :	17
2.7 Threats to Ramsar Site :	17
2.8 Biodiversity :	18
And the Regionally threatened or declining species are	18
And the species restricted wholly or largely to Middle East	19
And one percent or more of the population are	19

And the Globally threatned species	20
III. ENVIRONMENTAL INFORMATION	21
3.1 Physical Factors :	21
3.1.1 Topography :	21
3.1.2 Climate :	21
3.1.3 Hydrology :	22
3.1.4 Soil :	22
3.1.5 Nutrients	23
3.2 Biological.....	24
3.2.1 Primary Productivity:	25
3.2.2 Planktons:	25
3.2.3 Aquatic invertebrates:	26
3.2.4 Terrestrial invertebrates:	27
3.2.5 Fish:	28
3.2.6 Amphibian:	29
3.2.7 Reptiles:	30
3.2.8 Mammals:	31
3.2.9 Birds:	32
3.2.10 Vegetation:	35
3.3 The Mud flat and its Surroundings	37
3.4 Cultural	38
3.4.1 Population:	38
3.4.2 Cultural Background	39
3.4.3 Age Structure	40
3.4.4 Birth Places and Residency Dates of Azraq Heads of the Households	41
IV. EVALUATION	44
4.1 Size	44
4.2 Diversity	44
4.3 Naturalness	45
4.4 Rarity	45
4.5 Fragility	46
4.6 Typicalness	46
4.7 Recorded History	47
4.8 Ecological position	47
4.9 Potential	47
4.10 Intrinsic appeal.....	48
4.11 Summary of important features	48
V. Potential threats (activities) that could affect the special features of the Wetland Reserve	49
In the Wetlands	49
In The Vicinity of the Wetlands	49
5.1 Main Factors Influencing the Management of The Wetlands.	50
VI. Tourist management	51
6.1 Visitor Center staff and management:	51
6.2 Trails and Safari:	51
6.3 Picnic area:	52
6.4 Tower blinds:	52

6.5 Roman Wall:.....	53
VII. IMPLEMENTATION OF OBJECTIVES	54
Objective # 1.....	54
Objective # 2.....	54
Objective # 3.....	55
Objective # 4.....	55
Objective # 5.....	56
Objective # 6.....	56
Objective #7.....	57
Objective # 8.....	57
Objective # 9.....	57
Objective #10.....	58
VIII. Main Achievements in Management Objectives	59
IX. Transformation of Objectives to Actions	61
9.1. Water Monitoring:.....	61
Water Resources and its control:.....	61
9.2. Biodiversity and habitat protection.....	62
Vegetation:.....	62
Aquatic community:.....	62
Bird community:.....	63
Mud flat:.....	64
Tree planting:.....	64
Fencing and Gates:.....	64
Regarding Phytoplanktons	65
Regarding Aquatic Invertebrates :.....	65
Regarding Terrestrial Invertebrates	65
Regarding Fish.....	66
Regarding Amphibians :.....	66
Regarding Reptiles :.....	66
Regarding Mammals :.....	66
Regarding Birds:.....	67
Regarding vegetation.....	67
9.3 The local, national and international supporting network	68
9.4. Research and surveys.....	68
9.5. Ecotourism, educational tourism, and financial sustainability	69
X. Staffing and training:.....	70
Staff duties:.....	70
Warden:.....	70
Assistant warden:.....	70
Receptionist:.....	71
Gate keeper and night guard:.....	71
XI. Long term Management Guide.....	72

I. Summary of the Management Plan

Site: Azraq Wetland Reserve
Map Sheet: General Location maps # and #
Detailed map scale 1:5000 prepared by the Azraq Oasis
Conservation Project
Locality : Azraq Basin 90 Km east of Amman , Zarqa Governorate Eastern
Jordanian Plateau.
Area: 12 Km²
Managed by: The Royal Society For Conservation of Nature
Manager: Mahmoud Yassein

Till the end of 1993, the Azraq Oasis represented a clear example of an environmental disaster caused by human abuse of nature. Azraq today is a vivid example of the potential for success of environmental rehabilitation efforts. The Wetlands of Azraq are coming back to life. National and international support, the availability of adequate financial resources, and above all, the willingness to act to preserve our natural environment were the major determinants behind this success...

Located in the heart of the Jordanian Badia, the Azraq Oasis with its permanent fresh waters and springs has always been a rich habitat providing sources of livelihood for man and beast. In addition to providing the natural habitat for numerous indigenous unique aquatic and terrestrial species, the Oasis is nationally and internationally acclaimed as a major station for migratory birds. In spite of its apparent significance, the area was almost brought to a complete environmental disaster by environmentally damaging activities. In the last decade, and due to abuse and overuse of available environmental opportunities of water and soil, the Azraq area has been suffering immense environmental degradation at alarming rates. The most outstanding form of this degradation was the drying out of most of the Azraq Oasis and the deterioration of water and soil qualities in the area.

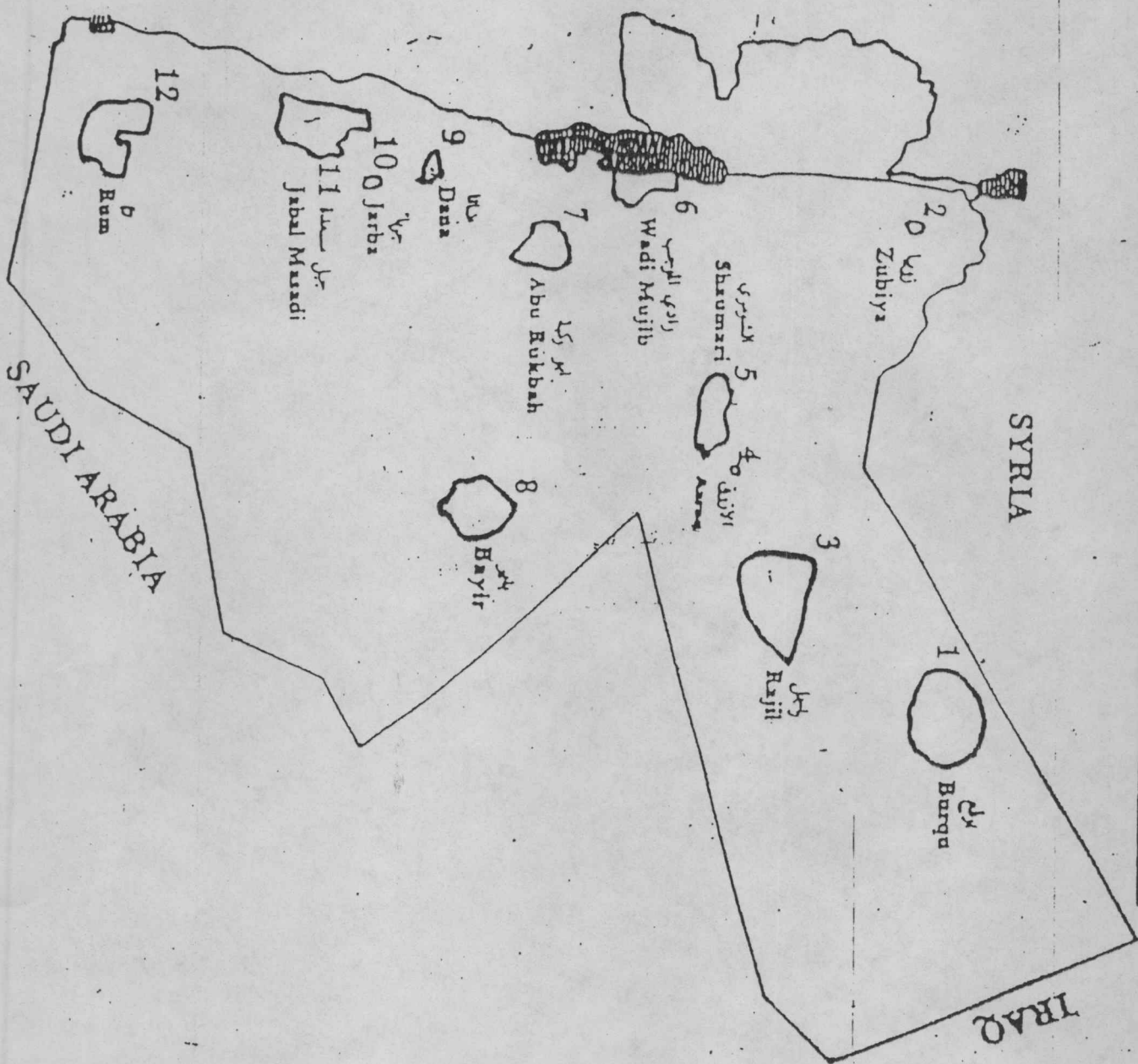
With this general background, and through joint funding by the Global Environmental Facility (GEF), United Nations Development Program (UNDP) and the Government of the Hashemite Kingdom of Jordan, the Azraq Oasis Conservation Project was initiated and started its work at the beginning of 1994. A main goal of the Project has always been restoring the environmental equilibrium in the Azraq area as a whole. The environmental rehabilitation of Azraq's unique wetlands is central to the Project's objectives and hence activities.

Ecological restoration, rehabilitation, and preservation of the unique ecosystems of Azraq Wetlands is the main objective of this management plan.

This is to be done taking into consideration the need for maintaining the equilibrium between the socio-economic needs of the people on one hand, and the available environmental opportunities of land and water on the other.

This is the philosophy that guides the plans and consequently management approaches and activities suggested in this management plan

Locations of Wildlife Reserves



1.1 Location

The reserve is located at the lowest point of the Azraq Basin almost in the middle of the flat terrain of the Azraq Depression at an altitude of 500m above sea level. The Wetland Reserve is approximately located at 36' 50" E and 13' 50" N. It is about 90 Km east of Amman, the capital city of Jordan. It is accessible from Amman through two major highways that meet just a few kilometers to the west of the reserve. The first highway passes through the Zarqa City and is about 100 km long. The second, and more important, passes through the industrial city of Sahab, and by the famous desert castles of Amara and Kharanah, before reaching Azraq.

1.2 Habitat

The Azraq Wetland Reserve contains one of the world's most unique habitats. Located in the middle of a dry desert in the Sahro - Arabian biographic region, yet it contains a variety of habitats and micro habitats that are only found in wetland environments. The diversity of habitats attracted a multiplicity of organisms that are extremely tolerant to the desert conditions and form the most unique ecological interaction in the whole region and in the world at large.

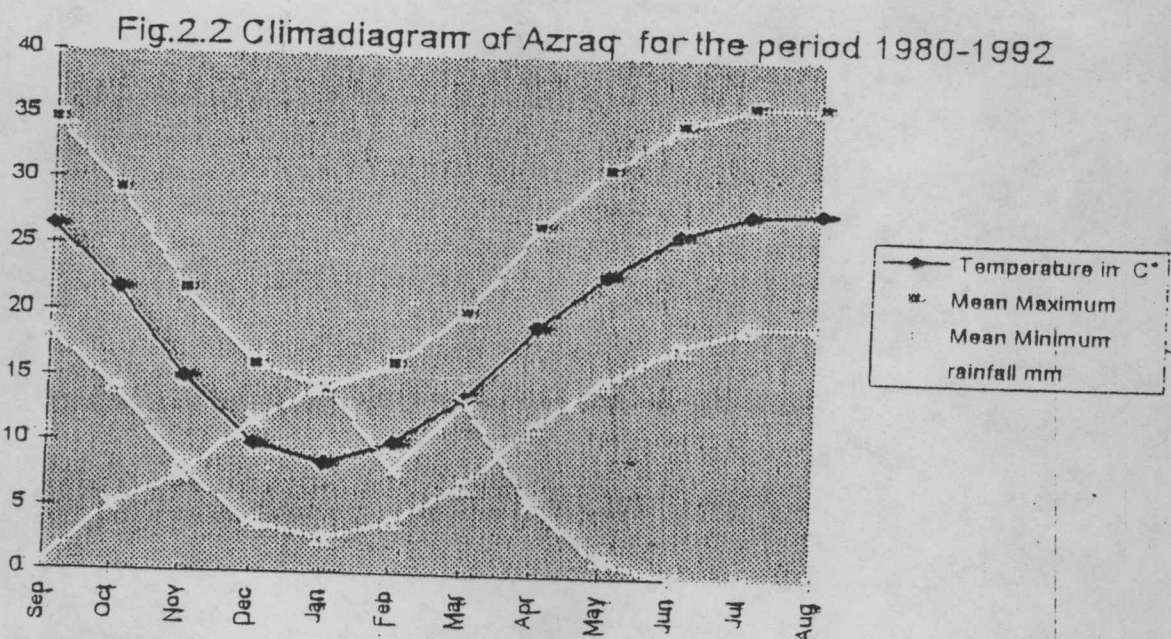
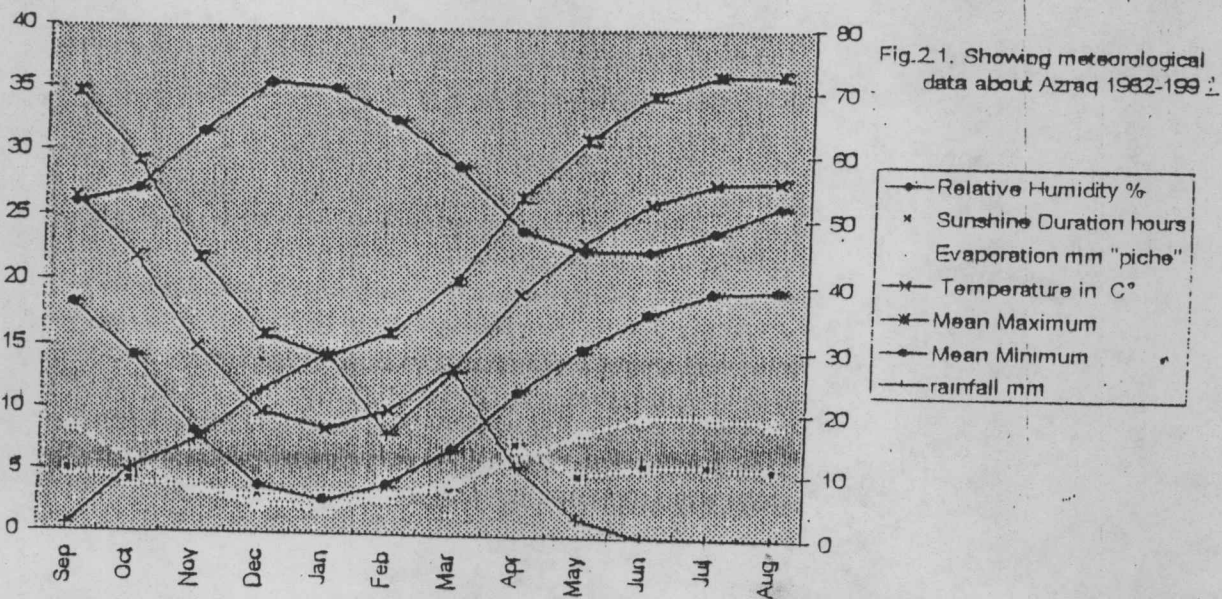
Three major sub-ecosystems exist in the Wetland Reserve; the Lake sub-ecosystem with its fresh waters, the Marsh (Dasha) sub ecosystem with its moderately saline waters and soils, and the mud flat (Qa) sub ecosystem with its highly saline waters and soils. Distribution of flora, fauna, and aquatic species varies according to habitat. The freshwater ecosystem is an outstanding unique habitat , containing a variety of both animal and plant species. The Dasheih is the sub habitat that surrounds the pools, again containing diversified life forms that came to existence due to restoration efforts. The Qa, is barren and unproductive. The fact that in such a relatively small area three sub systems meet and interact adds to the importance of this site. The lack of ecological barriers among the different sub habitats makes it feasible for the species to occupy their respective niches without restrictions.

1.3 Climate

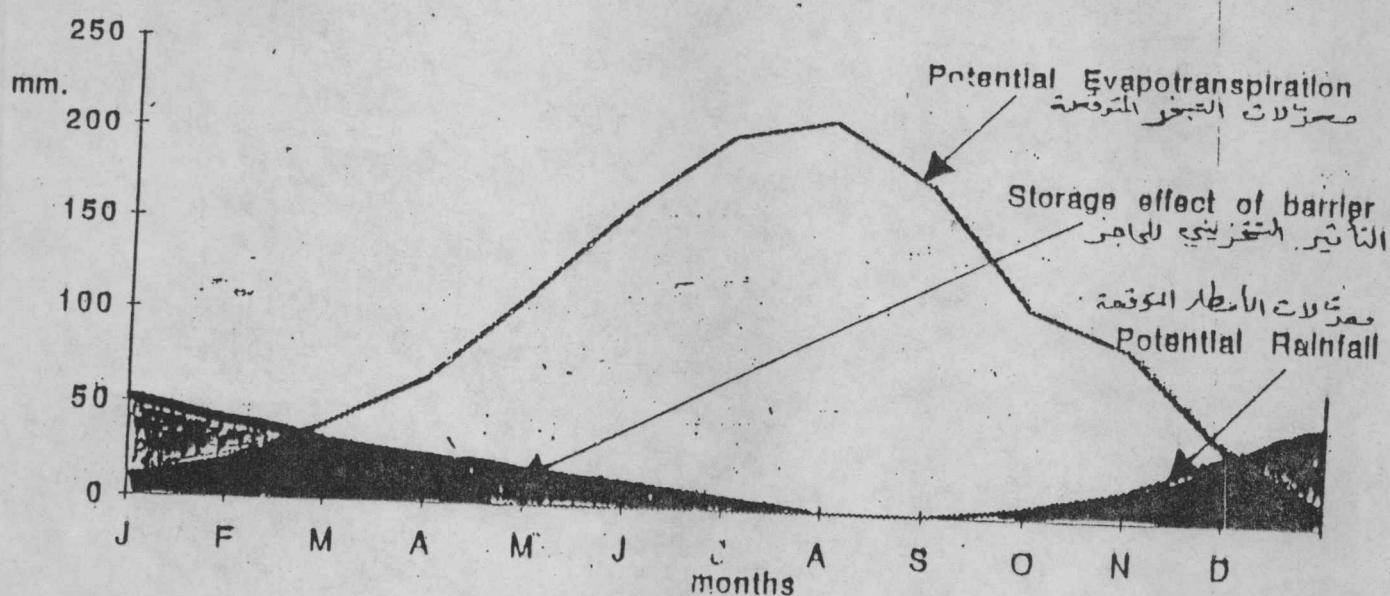
Azraq pools lie in the heart of the Azraq Depression in the Eastern Badia in the Sahara - Arabian Biogeographic Region. This Region is characterized by desert conditions, low rain fall (not exceeding 50 mm per annum) high evaporation rate (around 3000 m annually). Seasonal Khamasine winds blow into the area . The highest recorded temperature is 47 °C and the lowest is -5.7 °C.

1.4 Water support system. Hydrology

Seven Major wadies and several other minor ones pour into the Wetland area bringing water from the wide catchment area of the Azraq Basin (12710 Km²). The Azraq oasis is the focal point of a self-contained hydrological system (Basin) covering around 12,710 km.², with 94% in the Jordanian territory, 5% in the Syrian territory and 1% in the Saudi Arabian territory (Map1).

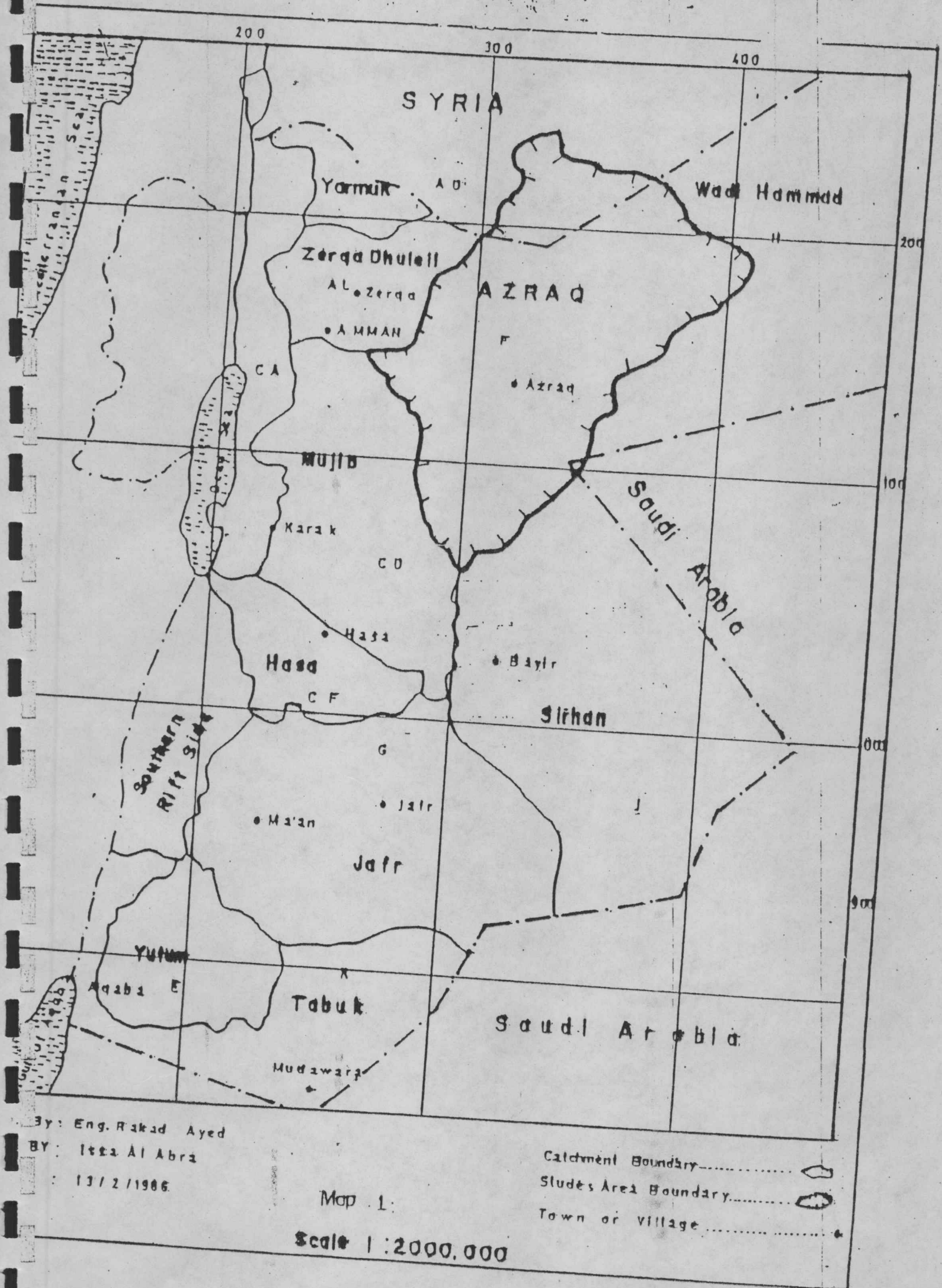


Potential Evapotranspiration & Rainfall



- Lost in runoff
- Normal soil recharge
- Storage effect of barrier

LOCATION MAP OF THE AZRAG BASIN



1.4.1 The Azraq Water Basin

The Azraq Basin is one of 13 ground water basins in Jordan. It is one of the most important desert basins in the country. Topographical, the basin has the shape of a depression and is described as the Azraq Depression. The area elevation ranges from 1350 m above sea level at Tillin in South Syria to 500 m above sea level which constitutes the lowest point at Azraq Jordan. the basin has an area of 12710 Km², 94% exist in Jordan, 5.4 % in Syria & 0.6 % in Saudi Arabia

1.4.2 Hydrology:

The basin is covered with basalt flows which are attributed to volcanic activities which go back to Quaternary ages and form the main aquifer in the basin and adjacent basins. Three main aquifers exist in the area; the shallow aquifer, the intermediate, and the deep. The shallow aquifer is the most important for the wetlands. The Wetlands of Azraq are formed by the intersection of topographical features with the underground water table.

The water in the shallow aquifer is generally fresh and has excellent quality, TDS (400 - 600 ppm). The shallow aquifer recharge area basically exists in the northern parts of the Basin and in South Syria where the annual precipitation averages about 350 mm. The shallow aquifer recharge volume is about 22- 24 MCM/Year. This aquifer is highly abused by much beyond its safe yield. Most of the drafted 50 MCM pumped from the basin come from this particular aquifer. Over pumping has caused the desiccation of the Oasis. Another threat is the existence of an advancing "saline front" in the form of pockets of saline waters that exist adjacent to the fresh water front. All related studies demonstrated that continuation of pumping at this rate will most probably lead to the salinization of the whole basin. This is one of the major threats to the basin as well as to the Wetland habitat.

The intermediate aquifer consist of limestone, chert, shale and marly limestone, it's separated from the shallow aquifer by thick aquiclude strata (B3). Recharge volume for the intermediate aquifer ranges from 7-10 MCM/Year. The deep aquifer consists of sandstone it has a thickness of about 300 m and it has poor quality water due to high salinity (about 20000 ppm) .

1.4.3 Surface water:

Seven main wadies entering Azraq Basin drain towards the center of Azraq depression to Azraq Mud Flat, the main wadies are: Wadi Rajil, Wadi Hassan, Wadi Asekhim, Wadi Buttum, Wadi Medeisisat, Wadi Shumari, Wadi Dabi, Wadi Jesha, and Wadi Ghadaf. Variations in the surface runoff are as high as the variation in the rainfall. The surface runoff ranges from 30.24 MCM for a relatively wet year; to 12.23 MCM for an average year; to 1.25 MCM for a dry year. Flood water remains several months or days before it evaporates depending primarily on its volume. Insignificant volumes of this water infiltrate into the ground and contributes to ground water replenishment.

1.4.4 Change in flow of springs in the Wetland :

Two main springs exit in the Wetland reserve; Ain Al Soda, and Qeisieh. In the 1970s the average flow of these springs was estimated to be about 10-12 MCM per annum. Over pumping that escalated during the 1980s and 90s, caused a continuous drop in the underground water table (2.5 to 6 meters). As a result of this, the springs flow dwindled gradually to reach almost zero by the end of 1993. Rehabilitation efforts performed by the Azraq Project, especially the cleaning and dredging works raised the flow of the springs again. Nevertheless the increase is very slight (less than 200,000 CM per annum)

1.5 Pastoralism

The Azraq Wetland is surrounded by rangelands. Being the most green area in the region, it attracts Bedouins from Jordan as well as neighboring countries, who use it as a grazing area for their flocks. As a result overgrazing is depicted in the area and constitutes a continuous threat to the Wetland. It has been recorded that the numerous tribes of the local Bedouins possess thousands of heads of sheep and goat that graze the area. The overall livestock population recorded reached an indicative alarming level (149,000 of goats and sheep and around 3600 heads of camels) postulating a major threat to the ecosystem of Azraq as a whole and to the Wetland in particular. These figures do not take into account the seasonal influx of animals that are brought to the area from as far as Jafar (180 km to the south of the Wetlands) in addition to numerous illegal entries by Bedouins and their animals from Syria and Saudi Arabia. *The recommendation and suggestion to fence the reserve is of urgent importance. The Management Plan stresses the need to ban grazing within the Reserve. Managing grazing outside the reserve is of equal urgency.*

1.6 Agriculture

Irrigated agriculture is one of the major consumers of waters in the Azraq Basin, consuming about 20 Million Cubic Meters of water per annum (almost equivalent to the safe yield of the basin which is 25 MCM). Agricultural activities constitute one of the major threats that has always to be monitored as the water status in the Wetlands is effected by any change in the hydrological system within the basin. Studies of the Azraq Project reveal that since the early seventies and up to 1995, the area of irrigated farms increased by about 1000 folds. Cultivation is extensive in and around the Azraq Oasis and by the end of 1991, there were approximately 1,400 hectares of olive groves and orchards, and 153 hectares of vegetable gardens, irrigated from private wells.

Urging and helping in rationalization of agricultural practice including transforming crop patterns to more sustainable and less water consuming crops within the overall management of the environmental opportunities of water and land is a major recommendation in the Management plan.

1.7 History

Evidence of human occupation in Azraq dates back to the Paleolithic period (Thomas, 1986). Historically this major Oasis was the most strategic point near the outlet of Wadi Sirhan. It has also been mentioned as the most important water source in the southern Syrian Desert.

1.8 The International Commitment. The RAMSAR Convention

The international importance of this wetland was recognized in 1977 when Azraq Oasis was designated for inclusion on the Ramsar list of wetlands of international importance. The Ramsar site covers some 7,372 hectares and includes the marshes and pools as well as the whole of Azraq Qa'. The spring-fed marshes in South Azraq and the adjacent parts of the Qa' were given reserve status in 1977, and have been managed since that time by the RSCN under an agreement with the ministry of Agriculture (Map 2).

The importance of Azraq as a Wetland stems from the fact that it lies on the major bird migration route between Europe and Africa. It has been deemed as one of the world's most important sanctuaries for migratory birds. " *When the pools are full and the Qa' is a quagmire after winter rain, thousands of waterfowl wing in.*" (Osborne, 1981).

1.9 Biodiversity :

The Azraq Wetland Reserve contains a wealthy diversity of life forms. The variety of species found during the field investigations comprised all classification hierarchical forms starting from the unicellular algae (phytoplanktons) such as *Bacillariophyta*, *Cyanophyta*, and *Chlophyta*. It is worth mentioning here that there were no previous studies regarding the Phytoplanktons of Azraq. The investigation carried out by the Azraq Project suggests that species of algae found under the main divisions of phytoplanktons as Epiphytic and Epiphylic are to be considered as new recorders to this area.

Zooplanktons have a high diversity where 13 species regarded as new recorders to the area were recorded during the field investigations namely: *Mesocyclops leuckarti*, *M. minutes*, *Eucyclops serrulatus*, *Monia rectirostris*, and *Brachionus caudatus*. Aquatic plants in the Wetlands exhibit high diversity, and most recent study conducted by the project revealed the presence of 12 species new to the flora of Azraq. The Management plant high lights the occurrence of *Phragmites australis*, *Typha australis*, *Typha domigensis*, *Juncus acutus*, *Juncus maritimus*, *Imperata cylindrica*, *Sonchus maritimus*, *Inula crithmoides*.

Aquatic insects are also found in abundance. Investigations logged 20 species 11 of which were considered new records to Azraq, such as : *Corix spp*, *Pachynomus lethierryi*, *Chironomus calipterus*. The Azraq Wetland also supports life forms of

aquatic insects like *Procladius choreus*, *Pachynomus*, *Chironomus calipterus*, *Dicortendipes pilosimanus*, *Lrytochirononus acutus*, *Leptochironomus stilifer*, *Polypodium n. subovatum*, *P. nubifer*, *Cladotantarsus pseudomancus*, *Orthetrum sabinae*, *Orthetrum chrysostigms* and *brachytemis leucosticta*.

A total of 209 species of birds were recorded during the field work undertaken by the project. Lists of rare and endangered species of birds found in Azraq are annexed in this management plan. Bird species of importance to this Management Plan include the following species: *Ciconia nigra*, *Circaetus gallicus*, *Circus aeroginosus*, *Chettusia leucura*, *Caprimulgus aegyptius*, *Rhamphocoris clotbey*, *Eremalauda dunni*, *Oenanthe moesta*, *Acrocephalus arundinaceus*, *Acrocephalus melanopogon*.

According to the flora survey conducted by the project, terrestrial plant communities, comprise of a total of 133 species of vascular plants belonging to 100 genera and 33 families. The Management Plan high lights the following halophytic succulent plants : *Suaeda sp.*, *Limonium sp.*, *Halopeplis amplexicaulis*, *Halocnemum strobilaceum* and *Tamarix passerinoides*.

The field survey recorded 7 new species to the flora of Jordan restricted to the Azraq Wetland Reserve. These species are : *Ruppia*, *Asparagus sp.*, *Cirsium alatum*, *Nitraria schoberi*, *Ruppia cirrhosa*, *Schingia sp.*, *Senniella spongiosa* and *Trigonella cylindrace*. *Senniella* and *Schingia* are believed to be new genera to the flora of Jordan.

Two species of **Amphibians** were identified in the area. *Rana ridibunda* is a main species in the Wetlands. As for **Reptiles**, species such as *Agama stelloo*, *A. pallida*, *Eremias brevirostris*, *E. guttulatata*, *Acathodactylus boskianus*, *A. paradalis* *A. gradis* are found in the area. The full list of species is annexed in this management plan.

Carnivores are believed to be represented by 9 families depending on sporadic spotting incidents. Currently extensive investigations are being carried out to upgrade the list of mammals. During and after the floods the various populations have been scattered and dispersed and more work is being implemented in this verified the impact the flood had on the population. The intention of this Management Plan is to produce the ecological status, dynamics importance of the species of Mammals of the Azraq Wetlands.

1.10 The Azraq Village :

An important social and economic structure that has a big effect on the on-going activities in the Wetland. The Azraq Village is devided according to social structure into the North and South Azraq, inhabited by the Druz and Shishan social minorities, respectively. The Azraq Project is aimed not only to rehabilitate the Wetlands, but also to encourage the social grass roots to participate in the conservation strategies and benefit from the restoration efforts in terms of improving the awareness of the locals as well as to upgrade the small income generating activities that are carried out

in relation to conservation strategies. The restoration mechanism would also include ecotourism as an activity that would definitely improve the economic status of the population.

1.11 Ecotourism, public awareness; and Interpretation:

1.11.1 Ecotourism:

Ecotourism is one of the most potential environmentally sound and socioeconomically feasible suggested activities in this management plan. It requires the attention and obligation of the management procedures. Educational tourism is another main potential for development. Proper management of the existing installations and infrastructure should bring to financial (or near to...) sustainability.

1.11.2 Public Awareness and Interpretation:

Proper interpretation is a vital component for raising support for the Azraq Wetlands'. It is also of importance to spread public awareness and help people develop a better appreciation for the biodiversity wealth existing in Azraq. Support facilities include the visitors center and trails are regarded as an asset. Continuous preparation and upgrading of illustrative material and tools such as slide shows, films, and exhibition materials booklets are most important. On the other hand, it is imperative to train interpreters in a continuous fashion by implementing periodical refreshment courses.

1.11 MANAGEMENT OBJECTIVES

1. To continue on the restoration, rehabilitation, and protection of Wetlands' unique and diversified ecosystem and biodiversity within the available environmental opportunities especially those related to the major environmental media of water.
2. To maintain an adequate ecological status of the Wetlands, in special and ecological terms, so as to ensure the continuation of the Wetlands' role in the global ecosystem with special emphasis on the role of being a major station for migratory birds.
3. To maintain efforts aimed at the conservation of biodiversity (faunal, and floral elements) in the Wetlands and their vicinity, and to keep accurate records on the population dynamics and their status.
4. To undertake various ecological and biological research and surveys in a systematic interactive manner; and to monitor the effects of interventions and subsequent changes and biological evolution.
5. To encourage, in cooperation with the related governmental and non governmental agencies, the adoption of recommendations of the Azraq Project in relation to water

management practices aiming at sustainable management of available waters in the Basin at large.

6. To encourage, in cooperation with the related governmental and non governmental agencies, the adoption of recommendations of the Azraq Project in relation to agricultural practices aiming at sustainable management of water and soil to prevent the depletion in the Wetlands' vicinity and the Basin at large.

7. To cooperate, encourage, and advocate for the conduction of Environmental Impact Assessment as a criteria for any developmental scheme or activity within the boundary of the Wetlands' reserve, the RAMSAR site, and the Azraq Water Basin as a whole.

8. To facilitate and encourage the educational use of the Wetlands.

9. To undertake and encourage ecotourism to the reserve and to manage the influx of visitors and researchers in order to minimize the negative effects of irresponsible practices .

10. To seek economic sustainability of the reserve.

11. To strengthen the social support network in the context of sound socio-economic and developmental texture. Develop cooperation and build positive relationships with the local communities and grass-roots activities in harmony and synchronization with the conservation policies and strategies that the Azraq Conservation Document stated.

II : INTRODUCTION

2.1 General Outlook

Wildlife reserves in Jordan cover approximately 1.3% (1200 Km²) of the country's total area. Five reserves have already been established in the country. An addition of seven reserves are planned to be established in a manner to represent the main ecosystems in Jordan. The establishment of these proposed reserves would bring the coverage of Jordan's reserve network up to 4.2 % of the total land area. The success of the establishment and the management of the protected areas in Jordan represent a major achievement and constitute a vital step towards insuring the sustainability and conservation of the ecosystem and biological diversity in the country.

A quick look at the status of the environment suggests a noticeable deterioration in the quantity and quality of natural resources in the past decade. This degradation was coupled with high population growth, urban expansion and severe destruction of the fragile natural components of the ecosystem. These factors led the Government of Jordan to concentrate efforts to produce the National Environmental Strategy which was published in 1992. The strategy aimed primarily at improving the management of the country's natural resources. This important document was later authorized as an official government reference regarding the environmental issues in Jordan.

The Azraq Wetlands Reserve has been identified nationally and internationally as one of the most important ecological sites in Jordan. Its protection and rehabilitation is a national and international commitment. Jordan's signature of RAMSAR Convention in 1977, and the National Environmental Strategy of Jordan both insured the urgent need and hence commitment to protect Azraq.

The UNDP project document that was prepared to assist the conservation of the biological diversity of Dana and the restoration of the Azraq Oasis represents one of the main priorities which was emphasized by the National Strategy. The rehabilitation of the Wetlands of Azraq was a main objective and challenge for the Project personnel and supporting team.

2.2 Location :

The Azraq Oasis is located 90 Km ESE from Amman, the capital, at approximately 31° 49' North, 36° 48' East. It lies at the heart of a large drainage basin, covering around 12,710 Km², 94% of which is in the Jordan territory, 5% in the Syrian territory and 1% in the Saudi Arabian territory. The highest relief point in the basin is at the Tillin town in Syria with an elevation of 1,550 meters. The lowest point is in the Azraq depression (Qa Azraq) reaching 500 meters. This depression constitutes the natural water flow for both surface and ground waters, forming the Azraq Oasis. The catchment area is drained by a number of wadis such as Wadi Rajil, Wadi Hassan, Wadi Asekhim, Wadi Al-Shaumari Wadi Jesha and Wadi Ghadaf. (Map).

The Azraq Wetland is a freshwater ecosystem of 12 Km², with several marshes, pools, water meadows and springs. The Wetlands formerly comprised a large area of permanent spring fed marshes and pools and a seasonally flooded playa wetland (Qa Azraq). Until recently, there were two groups of freshwater springs fed by the upper of the three aquifer systems underlying the Oasis. Streams carried water from the spring pools eastwards in the direction of the playa, creating extensive shallow wetlands which supported a variety of plant and various biotic communities.

2.3 General History and Archeology

2.3.1 General History:

The history of Azraq Oasis goes back to 30-40 million years. During this century, Azraq Oasis attracted the attention of various historians and naturalists. The Wetlands of Azraq were the most strategic point near the outlet of Wadi Sirhan. It was also the most important water source in the southern Syrian Desert. "Evidence of occupation dating back to the Paleolithic period has been found in Azraq" (Thomas, 1986).

Historically the Oasis and its vicinity represented a major attraction not only for migratory birds but for humans as well. The existence of the Roman wall within the reserve boundary goes back to 300 A.D. The area was known all through registered history as a hunting and resting place for caravans crossing the Syrian Desert (Badia) in all directions. The Ummayyad Arabs also contributed to the history of the area and the 8th century desert castles still stand as evidence of that contribution. The Azraq Castle, first built by the Romans and remodeled by the Muslim Arabs, and then by the Turks to be used latter by Lawrence of Arabia during the Great Arab Revolt at the turn of the Century and then by the revolting Druz in the 1920s during the Syrian revolution against the French testifies to the change of cultures and human activities that have passed in the area.

2.3.2 Archaeological Significance :

The various discoveries of the archaeological remains in the Azraq area is of great importance. These discoveries indicate that the area was inhabited many centuries back by a succession of civilizations. As indicated in the previous section the Roman Castle and the Roman wall are indications of the successive civilizations that are registered in the area.

2.3.3 The modern scientific involvement

Azraq Oasis is one of the main sites in Jordan that demonstrates uniqueness and rich heritage in its natural resources. This fact is due to the rarity of similar freshwater ecosystems in the country. The Azraq Oasis received attention since the beginning of this century. Meinertzhagen (1922), Hemming (1932), Mountford (1965), Hamsley and George (1966), Boyd (1966), Scates (1968), Attallah (1973), Nelson (1973), Condor (1982), Wallace (1982), Clark (1990), Andrews (1991) and Evans (1995).

Of the local scientists , Saliba (1977), Hatough- Bouran, Al-Eisawi and Disi (1986), Al-Eisawi, Hatough-Bouran (1987,1989), and Bouran, Disi (1990), Bouran (1991), Al-Eisawi (1995), Bouran (1995) , Amr (1995) and Al-

Humaïem (1995) contributed and added to the previous knowledge on the ecology, biology and hydrology of this important area.

2.4 Evolution of legislation and regulations

In 1965 the Azraq Oasis was declared a reserve by a Royal Proclamation. A draft management plan entitled " Azraq Desert National Park " was produced by Hamsely and George in 1966 and published by the International Biological Program. As development in the area proceeded and agricultural activities expanded uncontrollably, illegal digging of wells took place. The government responded by imposing more restricted licensing procedures and in 1971, digging of wells for irrigation was prohibited , a step that was taken at that time in the right direction . In 1977, the Azraq Oasis was included in the list of Ramsar as a site of ecological importance that should be preserved and maintained. At that time the responsibility for the management of the reserve was delegated to the Royal Society for the Conservation of Nature (RSCN). In 1979, Cander prepared a management plan for the Azraq Wetland Reserve , a joint IUCN WWF project.

In 1985, hunting was declared illegal , which was considered an enormous positive step. In 1990, a team from the Ramsar Convention Bureau visited Azraq Oasis for the purposes of monitoring the site, and submitted a report with specific recommendations to the Government of Jordan . In 1992, a project to conserve and restore the degraded habitats of the Oasis was submitted by the UNDP , and positively accepted by the Government of Jordan.

2.5 Topography of The Reserve

Central Marsh

From the Shishan pools most of the water flows out through well-marked channels about 2 meters in depth and after about 150 meters disappears into the beds to *Typha* of the central marsh. Only the Burgus South stream, which is rather thickly choked with vegetation, pursues an independent course through the silt dunes to the Burgus mud flat pools.

The central marsh which is roughly deltoid in shape occupies about 7 Km². This figure includes 80 to 70 silt islands some of which 6 to 7 hectares but others only a few square meters. The marsh is almost totally covered with a dense mass of aquatic plants. Only in a few creeks in the silt dunes are there small pools- one or 2 hectares at the most- virtually free of emergent weeds. Nelson says the *Typha angustata* and *Arundo donat* are the commonest plants often occurring in pure stands. He estimated that in 1968 *Typha* occupied 3.8 Km² and a further 0.8 Km² in association with the sedges *Scirpus littoralis* and *Cyperus laevitigatus*. Pure *Arundo* covered almost 1

Km² and another 0.3 Km² in association with *Scirpus* at the edge of pure stands. The reeds bed margins merge into *Typha*, *Scirpus* and *Cyperus* complexes. It is of course possible that in the eleven years since Nelson's visit the distribution of these plants has changed but the heavy over winter grazing made exact assessment of such changes impossible in 1979.

The general appearance of the marsh in winter is of a dense stands virtually impenetrable mass of brown *Typha*, some paler patches of *Arundo* and some smaller patches of semi open water often close to the edges of the silt dunes from which cows horses and to a lesser extent buffalo can most easily reach their food. There are numerous patches and strips of *Tamarix jordanensis* usually on the edges of the silt islands or where the water is shallower.

The aerial photographs also show the number of dry stream beds which have probably dried up since the water has been pumped from Ain Qasiyah to Irbid,. It is clear from the areal photographs that the 'fingers' or peninsulas of silt jutting westwards into the eastern marsh were at one time islands but which, because of the drying out of the marsh and silting action of *Juncus* and *Tamarix*, have gradually increased in size and joined with others. The process continues today and it is easy to find examples of two closely adjacent islands in the process of joining or of islands close to the silt dunes and where the gap is gradually silting up. There is danger that the Burgess South stream which is already choked with vegetation will eventually cease to flow.

The dunes are now penetrated by only 3 streams which carry the water from the springs eastwards. The most northerly streams flow, about 2000 metres apart, on parallel courses through the silt dunes until they reach the flatter areas near the mud flats there they meander, divide and join together again around grassy, but heavily grazed islands before running into the pools and mud flats which make up Ingilesi.

The third stream cuts through the silt dunes at the eastern end of the *Typha* and after about 66m spreads into water meadows and then on the mud flats and the Mon Filif pools.

From the south eastern part of the central marsh the fourth stream cuts through the silt dunes to join the fifth and most southerly stream- the Burgess South Stream- in a large pool. There are 2 outflows from this pool about 100m apart which pass through the Roman wall, and out on the wet grasslands and the mud flat of Burgess.

Finally the outflow from the mud flat pools follows ditches further out on the mud flats entering shallow areas which are regularly used by waterfowl and waders when the main pools are being hunted.

The edge of the silt dunes drops to the mud flat remarkable steeply and at this point there is a comparatively narrow belt of halophytic plants chiefly *Halopeplis amplexicaulis* and *Halocnemum strobilaceum* which again accumulated there own 30cm high silt dunes.

The Mud flat and its Surroundings

In addition to the 14 Km² of the marsh the government of Jordan also designated , under the Ramsar convention a further 86 Km² of mud flat and mud flat edge as part of the wetland of special importance as a water fowl habitat.

Approximately 60 Km² of this area is mud flat, the remaining comprising silt dunes, wadi spread, limestone hammaa basalt as well as some vegetated mud flat.

Salt is an important industry and there are at present about 7 groups of salt pans situated in the northern , eastern and central portions of the mud flats. Most of the workers come from Azraq North. The amount of salt extracted is strictly controlled by the Government with a limited working season from May until late July. Provided it makes no demands for water from the marsh and there is no future extension of the salt industry over other parts of the mud flats it should not present a problem to the management of the reserve. since the industry does not operate during the winter months when some of the salt pans are flooded the pans can be of some benefit to waders and waterfowl.

A growing problem is the increasing number of lorries crossing the mud flats from wadi Rajil, where sand is excavated, to Azraq south. There is no hard road and consequently the mud flat is criss-crossed by a very extensive web of heavy tracks which are very unsightly and cause considerable damage to the surface and the mud flat. In wet winters the mud flats are flooded and are impossible to cross lorries have to take another track to route 50 from there to Azraq.

2.6 General Hydrology

Azraq Basin is one of 13 ground water basins and one of the most important desert basins in Jordan. The topography ranges from 1350 m above sea level at Tillin in South Syria and 500 m above sea level which is the lowest point at Azraq Jordan , the basin has an area of 12710 Km² , 94% exist in Jordan , 5.4 % in Syria & 0.6 % in Saudi Arabia .

Hydrology:

The basin is covered by basalt flows which are attributed to volcanic activities which have occurred during Quaternary ages and these have formed the main aquifer in the basin and adjacent basins. The basalt aquifer overlies other permeable geological strata which consist of sand , gravel , chert , and chalky limestone. Recent deposits , Shallala Formation (B5) and Rijam Formation (B4) form one hydraulic unit defined as Shallow Aquifer which has a thickness of about 200 m occasionally it has a smaller thickness due to the absence of some formations .

The second aquifer in the basin is designated as an intermediate aquifer consists of limestone , chert , shale and marly limestone , it's separated from the shallow aquifer by thick aquiclude strata (B3) which has a thickness ranging from 50- 300 m , the aquifer thickness ranges from 200 to 300 m .

The third aquifer is known as the deep aquifer and consists of sandstone with a thickness of about 300 m and it contains water of poor quality, salinity (about 20000 ppm) .

Recharge :

The shallow aquifer recharge area exists in South Syria where the annual precipitation is about 350 mm infiltrates into 'highly permeable basalt. The water moves with the hydraulic gradient towards north Jordan and continues to Azraq pools where it approaches ground surface and finally intersects with topographical features of Azraq forming the Azraq pools . The shallow aquifer recharge volume is about 22- 24 MCM/Year.

The second aquifer is recharged from the south- east Amman . Ground water movement for this aquifer is from south west to north east , recharge volume ranges from 7-10 MCM/Year .

The third aquifer receives limited amount of water coming from adjacent basins . It has a high salinity and is thermal and has low productivity .

Pumping rates :

Water abstraction started in the forties and water was pumped from the pools in North Azraq to H5- station 45 Km north east Azraq at a total pumping rate that didn't exceed 0.3 MCM/Year .

In the sixties abstraction rate raised to 3 MCM/year as water pumping to Irbid and Mafraq started.

The water pumping increased in the seventies as pumping started to Amman from the Azraq pools and the rate was accelerated to about 15 MCM/year.

The pumping rate was accelerated to 50 MCM/Year from AWSA well field 10 km north -west Azraq pools , to meet growing water demands in the Amman district.

Surface water:

Seven main wadies entering Azraq Basin drain towards the center of Azraq depression to Azraq Mud Flat , the main wadies are (see map) :

- 1- Wadi Rajil entering from the east having a watershed extending to the east and north parts of the basin .
- 2- Wadi Hassan entering from the north .
- 3- Wadi Asekhim entering from the northeast.
- 4- Wadi Buttom and Wadi Medeisisat entering from the west.
- 5- Wadi Shomari and Wadi Dabi entering from the south west.
- 6- Wadi Jesha entering from the south .
- 7- Wadi Ghadaf entering from the south .

The average runoff volumes were calculated in accordance to Smith's Basin climate index empirical formula

- 30.24 MCM , for wet year .
- 12.23 MCM , for average .
- 1.25 MCM , for dry year .

Distribution of water Runoff during the rainy season:

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Wet Year	0.2	0.59	21.95	3.51	0.02	3.13	0.0	0.84
Average Year	0.00	0.05	0.18	1.02	0.25	10.59	0.14	0.00
Driest Year	0.00	0.00	1.08	0.04	0.01	0.12	0.00	0.00

Flood water remains from few to several months before it evaporates rendering as insignificant portion of this water that infiltrates into the ground and contributes to ground water replenishment .

A previous study has been held by hydrosult Company (Canadian) for the two locations of proposed dams in Azraq Basin ; Wadi Rajil and Wadi Er-Rattam . Wadi Rajil dam has been constructed in 1992 , the dam is located in eastern part of Azraq Basin , it occupies most of the area to the east and north east of the Azraq wetland . The total catchment area of Wadi Rajill is about 3200 Km² and mean runoff is 9.4 MCM .

The dam has been constructed on the lower part of Rijam Formation which has low permeability , this formation is underlain by Mowaqer formation which consists mainly of chert , shale and marly limestone .

The dam has been established for artificial recharge and local water supply ground water infiltration from the dam into ground is negligible due to the existence of acquiclude Mowaqer Formation and low permeable silt deposits in the bottom of the dam . The dam capacity is 3.5 MCM height 9 m most of surface water captured by the dam is lost by evaporation

Water quality :

Ground water draining from the north through basalt is characterized by a relatively low total dissolved solids ranging from 200 mg/l to 500 mg/l . The basalt waters are of sodium-chloride type and of good quality for most purposes. Water from the Rijam formation is characterized by a medium total dissolved solid content ranging from 350 mg/l and is also of sodium chloride type .

Ground water from other aquifers (B5/B4) has more salinity it ranges from 1500-5000 mg/l , Q'a Azraq where salt extraction occurs the salinity may reach 275000 mg/l , in general shallow aquifer is sodium chloride type .

Intermediate aquifer has a salinity ranging from 400 - 1000 mg/l .

The deep aquifer (Kurnab aquifer) has a very high salinity reaching more than 2000 mg/l and even more in oil exploration wells .

Many water samples have been collected from major springs before and after pumping to Amman , the results indicated that the Druze springs have a good quality

and the total dissolved solids ranges between 364 to 435 ppm , in the site of the Mustadema spring and between 326 to 672 ppm in the site of Aura spring , these results coincide with the intermediate and the local standard of the drinking water .

As a result of over drafting and water table lowering in the pools, as they exist in an evaporites area , the pools in Azraq Druze dried out while the salinity has increased to more than 2000 mg/l in Azraq Shishan , cleaning and developing the springs led to the increase of low salinity ground water flow towards the pools where the salinity became less, water quality in the pools is monitored on daily basis , taking into consideration low salinity water pumped to the pools from the water supply network which contributes to the pool water salinity dilution , estimated pump water volumes to the pools in South Azraq and Wetland range from 1.5 - 2 MCM / Year , tables show water quality results

Change in water table during Azraq Project :

Water table observation is carried out by means of automatic mechanical water level recorders type Stevens 71 for the shallow aquifer and 5 electronic loggers type Ciba which measure depth to water level temperature and electrical conductivity (EC) for the intermediate aquifer

As a result of over drafting , continuous water table decline has been noticed the table below shows the depth water table in the two observation wells in the shallow aquifer which is the exhausted aquifer in the basin AZ2 , AZ12 observation wells and annual draw down for the same period January in three successive years .

Years	Average SWL (m) AZ2	Average SWL (m) AZ12	3 years Average draw down (cm)AZ2	3 years Average draw down (cm)AZ12
1994	7.42	13.77	51.5	54
1995	7.92	14.27		
1996	8.55	15.35		

During the last 10 years water table draw down ranges from 2-5 m in the shallow aquifer observation wells , the hydrograph below shows water level fluctuation in AZ10 well from 1985 to 1993 .

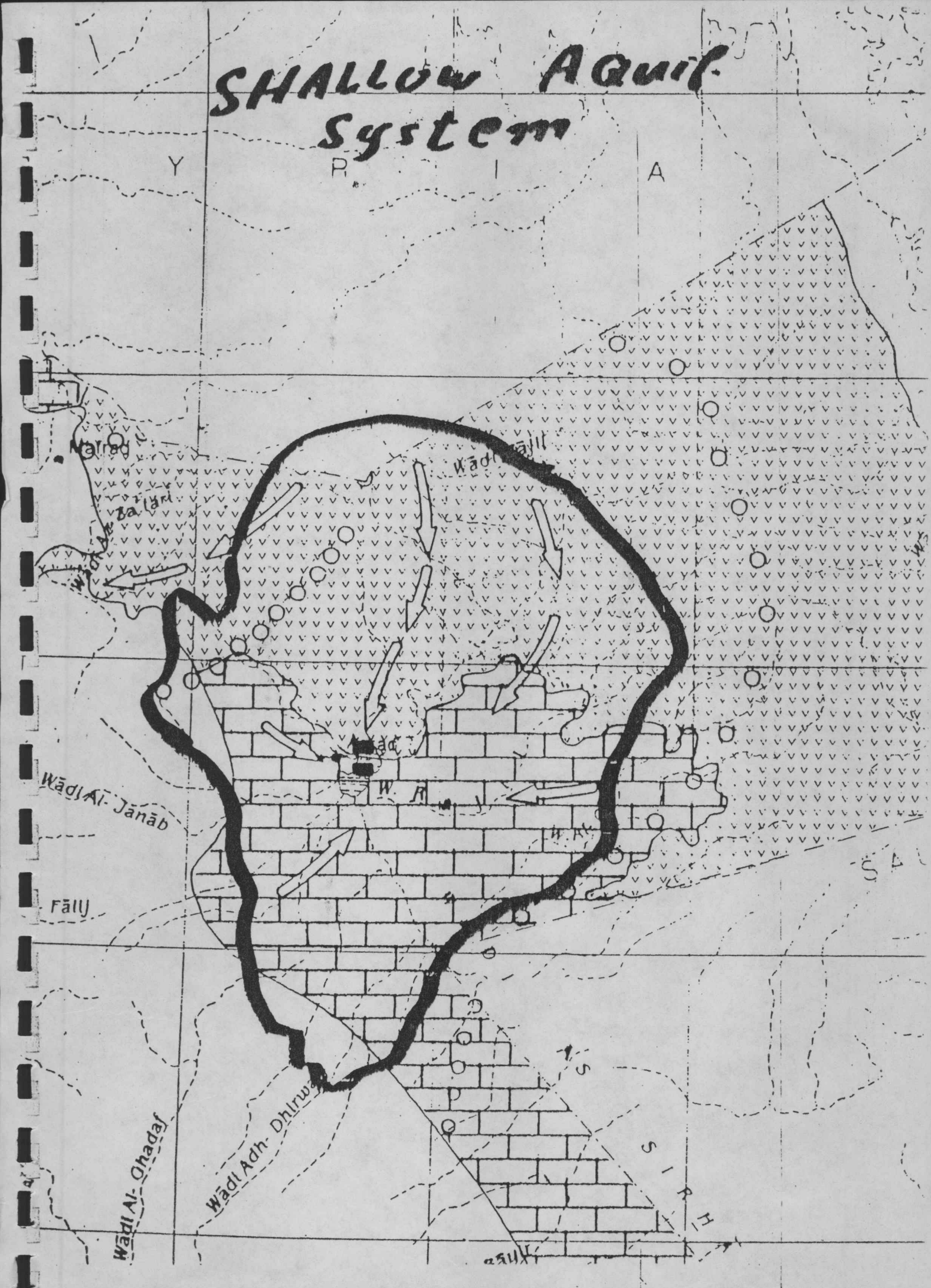
Change in flow of springs :

The ground water abstraction has been accelerated since 1970 when well drilling activities and pumping rate outside the basin has been started on large scale , the graph below shows the change in the springs flow since 1962 till 1992 where the springs dried out .

Water Quality :

Water quality in the basin ranges from 250 ppm in the northern part of the basin where basalt aquifer exists to about 1200 ppm where limestone aquifer exists . Agricultural activities contributed to the water quality deterioration occurring in the basin especially where the water table is shallow , the over drafting also contributed to this phenomenon

A



Topog MAP

Y R I A

1500

900

1200

Malraq

Wadi Az-Za'tari

900

600

Azraq

W. R. a.

Wadi Al-Jarab

Al-Falluj

Wadi Al-Qadaf

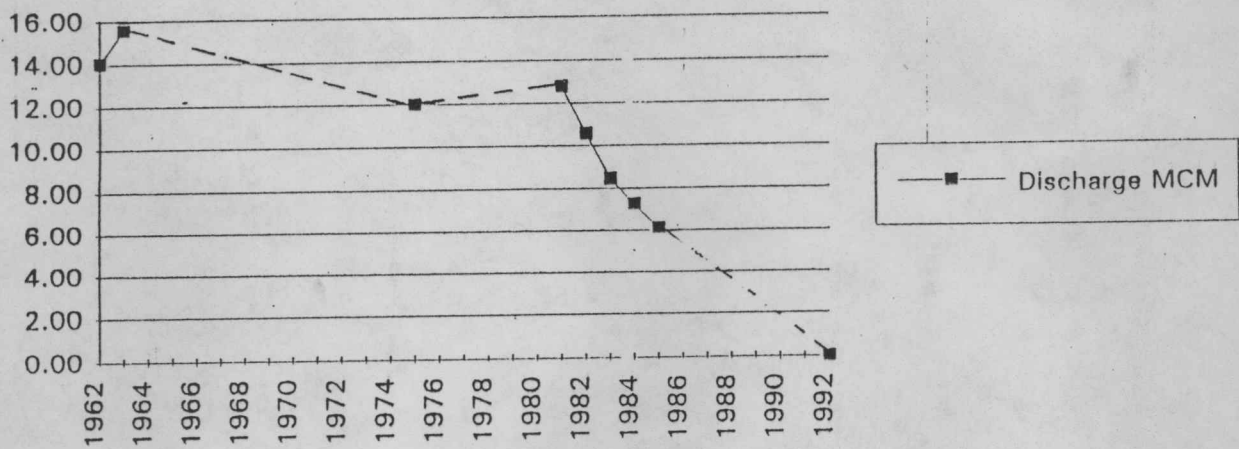
Wadi Adh-Dhirwad

Wadi Babil

S A

S I P H

Discharge MCM



Azraq Springs

Azraq Wetland Reserve

Readings of Meteorological Station At Azraq

Readings Time 8:00 am.

Month & Year	Wind Speed km./h.			Evaporation cum./d.			R. H. %		
	max.	min.	mean	max.	min.	mean	max.	min.	mean
11/94	15	2	6.7	8.2	1.8	4.4	94	57	79.2
12/94	20	3	7.2	5.2	1.0	3.1	95	67	81.4
1/95	25	2	6.9	9.0	1.8	4.6	92	55	77.3
2/95	14	2	6.6	10.2	1.2	4.2	94	62	77.5
3/95	30	8	12.9	9.8	4.5	6.9	79	32	65.5
4/95	30	1	10.7	18.3	3.8	10.0	77	33	55.2
5/95	30	2	9.4	23.5	8.8	14.3	75	17	46.1
6/95	27	4	11.9	27.0	11.6	18.2	77	23	49.7
7/95	12	5	8.2	26.0	12.8	16.8	84	44	69.8
8/95	30	3	14.9	23.0	12.2	16.8	77	45	65.2
9/95	20	2	6.3	21.0	8.5	13.3	75	30	55.6
10/95	20	2	9.7	14.7	6.0	9.9	85	35	63.0
11/95	25	2	6.8	11.0	3.2	6.4	88	30	56.2
12/95	15	2	5.8	7.0	1.0	2.9	87	40	74.6
1/96	20	2	6.6	5.0	2.2	3.3	90	60	76.9
2/96	20	3	7.7	8.8	1.8	5.1	88	35	69.7
3/96	35	2	12.9	12.7	2.5	7.5	88	40	72.2
4/96	40	4	12.4	16.0	7.8	10.3	85	17	56.6

highest
lowest
mean

14.9

5.8

9.1

18.2

2.9

8.8

81.4

46.1

66.2

Azraq WetLand Reserve

PH Monitoring (ppm)

Month & Year	Q*			S*			D*			W*		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
10/94	8.8	7.9	8.1	8.7	8.1	8.4	-	-	-	8.8	8.3	8.4
11/94	9	6.6	7.5	9.1	5.6	8.1	8.5	3.1	7.1	9	4.7	8.3
12/94	9.6	7.7	8.3	8.8	6.4	7.4	9.5	4.1	7.3	9.5	7.1	7.8
1/95	7.2	6.7	7.7	8.2	6.9	7.5	8.4	7.1	7.7	8.5	7.6	7.9
2/95	6.8	6.7	6.7	7.3	6.5	6.8	7.5	6.8	7.2	7.9	7.2	7.6
3/95	7.8	6.4	7.1	8.1	7.5	7.6	7.9	7.2	7.5	8.5	7.8	8.1
4/95	8.2	7.3	7.8	8.5	7.5	8.2	7.9	6.5	7.4	9.1	8.5	8.8
5/95	8.4	7.5	7.8	8.4	8	8.2	7.8	7.5	7.7	8.7	8.1	8.4
6/95	8.2	7.5	7.9	9.2	8	8.2	7.8	7.5	7.7	8.7	8.1	8.4
7/95	9	8.5	8.8	9.6	8.7	9.2	8.8	7.8	8.3	9.3	8.1	8.6
8/95	9.4	6.8	8.4	10.9	7.9	9.7	9.4	6.8	7.9	8.8	7.5	8.3
9/95	9.1	7.5	8.4	9.9	8.8	9.5	9.3	6.8	6	8.6	8.2	8.4
10/95	8.3	8.3	8.3	9.1	9.1	9.1	9.2	9.2	9.2	-	-	-
11/95	9.1	8.2	8.6	8.7	8	8.4	8.4	7.7	8.1	-	-	-
12/95	9.1	8.3	8.8	9.2	8.3	8.8	8.6	7.6	8.2	-	-	-
1/96	8.9	8.2	8.5	9.2	8.3	8.7	8.6	7.6	8.5	-	-	-
2/96	8.7	8.5	8.6	8.6	8.2	8.3	8	7.8	7.9	-	-	-
3/96	8.5	8	8.2	8.5	8.2	8.3	7.8	7.6	7.7	-	-	-
4/96	8.4	7.6	7.9	8.8	7.5	8.3	8	7.5	7.7	8.3	7.7	8

highest mean 8.8 9.7 9.2 8.8
 lowest 6.7 6.8 6.0 7.6
 Average 8.1 8.4 7.7 8.2

Q* : Ain - Qasiyah.

S* : Ain - Soda.

D* : The Dashsha.

WJA* : Water Jordan Authority (Pumping Water).

Azraq WetLand Reserve

OXI - Monitoring (ppm)

Month & Year	Q*			S*			D*			W*		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
10/94	11.8	4.5	5.7	8.7	7.1	8.4	-	-	-	7.3	3.3	4.9
11/94	10.9	7	8.2	9	7.1	7.8	12.7	7.7	9.2	8.2	5.5	6.7
12/94	12.1	6.6	9.5	10.2	8.1	9.2	11.2	8.2	10	10.1	6.8	8.1
1/95	10.8	5.5	7.8	9.3	6.9	7.8	9.6	7.1	8.3	9	5.6	7.2
2/95	9.6	5.7	7.5	9.3	7.2	8.2	8.3	4	6.2	9.3	5.6	7.4
3/95	7.5	4.8	6.3	8	5.3	6.8	8.1	5.9	6.7	7.5	6	6.8
4/95	7.8	7.8	7.8	11.3	11.3	11.3	8	8	8	6.5	6.5	6.5
5/95	11.4	8.4	9.1	10.4	7.8	8.8	11.1	6	9.1	7	6.5	6.6
6/95	17	8.6	10.7	15.7	9	12.2	21	12	14.9	6.5	5.5	6.2
7/95	17	7.5	13	15.7	8.5	11.3	21	8.3	12.9	6.5	5.9	6.2
8/95	19.2	6.6	10.4	18	9.8	12.3	13.4	6.8	9.5	6.5	6	6.2
9/95	8	5.1	7.2	16.5	5	10.6	8	4.9	6	6	5.5	5.9
10/95	9.9	7.1	8.4	9	6.3	7.6	6.2	5.5	6	-	-	-
11/95	12.5	8.7	10.1	12.7	7.4	9.4	7.6	6.1	6.8	-	-	-
12/95	13.2	9.2	10.6	17.7	8.8	11.2	9.3	6.1	7.8	-	-	-
1/96	13.2	7.4	10.7	18.5	8.7	13.8	12	6.2	8.5	-	-	-
2/96	12.6	10	11.5	12.4	11	11.4	11.3	8.4	10.1	-	-	-
3/96	14.8	8.6	11.5	17.4	9.8	12.5	24.9	8.2	16.7	-	-	-
4/96	13.9	6.7	9.3	13	5.2	9.3	14	4.6	10.4	8.5	5.	6.6

highest 13.0
 lowest 5.7
 Average 9.2

13.8
 6.8
 10.0

16.7
 6.0
 9.3

8.1
 4.9
 6.6

Q* : Ain - Qaslyah.

S* : Ain - Soda.

D* : The Dashsha.

WJA* : Water Jordan Authority (Pumping Water).

Azraq WetLand Reserve

CL₂ - Monitoring (ppm)

Month & Year	Q*			S*			D*			W*		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
10/94	.25	.25	.25	.25	.25	.25	-	-	-	.75	.50	.30
11/94	.25	.25	.25	.25	.25	.25	-	-	-	.25	.25	.25
12/94	.25	.25	.25	.25	.25	.25	.25	.25	.25	.50	.50	.50
1/95	-	-	-	-	-	-	-	-	-	-	-	-
2/95	-	-	-	-	-	-	-	-	-	-	-	-
3/95	-	-	-	-	-	-	-	-	-	-	-	-
4/95	-	-	-	-	-	-	-	-	-	-	-	-
5/95	-	-	-	-	-	-	-	-	-	-	-	-
6/95	-	-	-	-	-	-	-	-	-	-	-	-
7/95	-	-	-	-	-	-	-	-	-	-	-	-
8/95	-	-	-	-	-	-	-	-	-	-	-	-
9/95	-	-	-	-	-	-	-	-	-	-	-	-
10/95	-	-	-	-	-	-	-	-	-	-	-	-
11/95	-	-	-	-	-	-	-	-	-	-	-	-
12/95	-	-	-	-	-	-	-	-	-	-	-	-
1/96	-	-	-	-	-	-	-	-	-	-	-	-
2/96	-	-	-	-	-	-	-	-	-	-	-	-
3/96	-	-	-	-	-	-	-	-	-	-	-	-
4/96	.07	.01	.05	.20	.01	.08	.25	.03	.09	2.1	.52	1.2

highest
lowest
Average

0.25
0.05
0.20

0.25
0.08
0.21

0.25
0.09
0.17

1.2
0.25
0.56

Q* : Ain - Qasiyah.

S* : Ain - Soda.

D* : The Dashsha.

WJA* : Water Jordan Authority (Pumping Water).

water

W. Temp - Monitoring (ppm)

Month & Year	Q*			S*			D*			W*		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
10/94	25	17	20	23	19	21	-	-	-	-	-	-
11/94	19	10	13.4	20*	12	15	-	-	-	-	-	-
12/94	20	2	9.8	17	5	13.5	-	-	-	-	-	-
1/95	12	10	10.9	13	11	12.2	-	-	-	-	-	-
2/95	14	9	11.5	16	11	13.5	-	-	-	-	-	-
3/95	17	15	16.2	18	17	17.5	17	15	15.5	-	-	-
4/95	20	17	18.4	19	18	18.2	18	15	16.6	-	-	-
5/95	24	22	22.8	24	20	22.4	23	20	21.6	-	-	-
6/95	24	21	23	25	23	24.2	23	20	21.6	-	-	-
7/95	26	25	25.4	25	21	23.2	27	26	26.6	-	-	-
8/95	25	22	23.2	24	20	22.4	24	21	23.2	-	-	-
9/95	26.2	23.5	24.9	27	23	25.2	25	22	23.7	-	-	-
10/95	26.5	18.8	22.1	26.7	21.2	23.5	24.7	17.1	20.2	-	-	-
11/95	23.7	15.7	18.5	22.7	17.4	19.5	16.4	10.6	13.1	-	-	-
12/95	16.5	13.7	15.2	18.2	14.9	16.2	14.5	13.9	14.2	-	-	-
1/96	18.8	16.1	17	16.8	13.7	13.9	16.2	12.2	14.5	-	-	-
2/96	18.1	12.3	14.2	15.2	13.5	14.3	13.3	7.7	10	-	-	-
3/96	21.2	12	16.9	18.8	13.5	15.7	19.3	7.5	13.4	-	-	-
4/96	22.5	18.2	20.2	22.9	18.4	19.9	19.4	17.3	18	27.2	25.1	26.5

highest
lowest
mean

25.4
9.8
18.1

25.2
12.2
18.5

26.6
10.0
18.0

26.5
26.5
26.5

Q* : Ain - Qasiyah.

S* : Ain - Soda.

D* : The Dashsha.

WJA* : Water Jordan Authority (Pumping Water).

Degradation of the Underground Aquifer :

Major changes have occurred regarding the ecological status , and the overall features of the Wetlands as a result of the massive extraction's of the ground water from the Azraq aquifers . The main purpose for this extraction was to supply Amman for drinking water as well as for irrigation purposes . The natural rate for discharge of the four main springs fell rapidly from 10.5 MCM per year in 1981 to less than 1 MCM in 1991. The two northern springs dried up completely in 1987 and the southern springs finally ceased to flow in August 1992. By December 1992, the Azraq Wetland were completely dry.

All marsh vegetation was dead. Slow burning fires were moving through the ground in areas which were formally deep swamps. In 1993 and 1994 , the spring pools were almost dried up and the biodiversity of the area was in a complete loss.

Another factor that added up to the degradation of the wetland ecosystem was the increase in the salinity of some wells. The salinity varied between 1200-3000 ppm . In addition the existing of a deep saline underground aquifer in the area could cause some irreversible changes in the ecological features of the area as a whole.

The extraction of ground water in and around the Oasis for agricultural practices has increased rapidly in recent years and has been largely uncoordinated and uncontrolled. Concern is now expressed that the wide spread use of the saline brackish water for irrigation will soon lead to severe problems of increased salinity. The Azraq basin water resources study of 1989 recognized this potential threat and concluded that emergency policies and strategies should be implemented in this direction. No action however was taken prior to the beginning of the Azraq Project and extraction continued and even increased from about 12 MCM in 1988 to 23 MCM in 1990.

2.7 Threats to Ramsar Site :

The Azraq Qa comprises the major part of the Azraq Ramsar Site, while the Wetland constitutes only a small part of the overall area 16 %. The Qa receives most of its water from surface run off during the winter and spring seasons. The proliferation of salt pans around the Qa has reduced the expansion of the natural Qa Wetland. The construction of Wadi Rajil Dam , 45 Km north of Azraq in 1992 , along with two other dams on the upper reaches of Wadi Rajil in Syria , contributed to the reduction of water flow to the Qa. and thus adversely affected the ecological , hydrological features of the Ramsar Site.

Concern over the degradation of the Ramsar Site has been expressed in several international events, most notably in the Third Conference of the Ramsar Convention in Regina, Canadian 1987. The issues raised at the conference voiced the deep concern that urgent action measures should be taken to maintain the natural properties of the Wetland. A follow up mission was undertaken in 1990 by the Ramsar Convention Bureau , culminated by a report on the situation of the Azraq Oasis, supported by recommendations for immediate actions . These recommendations were subsequently identified by the National Environmental Strategy for Jordan.

2.8 Biodiversity :

The Azraq Oasis is famous for its rich faunal and floral elements. The biological and ecological components constitute an important life support system, with high tolerance and elasticity to the various environmental fluctuations. The conservation of these important genetic resources stems from the fact that they are fundamental components in the process of the formation of the ecological pyramids. Of the most important ecological features of the Azraq Oasis is reflected in the abundant diversity of the bird community. It was recorded that the following globally threatened species are found in Azraq : *Marrnaronetta angustirostris* , *Aquila helica* , *Chlamydotis undulata*.

The *Nationally threatened species* acknowledged in this Management Plan includes the followings :

Family Ciconiidae	<i>Ciconia nigra</i>
Family Accipitridae	<i>Circaetus gallicus</i> <i>Circus aeroginosus</i>
Family Charadriidae	
Subfamily Vanellinae	<i>Chettusia leucura</i>
Family Caprimulgidae	
Subfamily Caprimulginae	<i>Caprimulgus aegyptius</i>
Family Alaudidae	<i>Rhamphocoris clotbey</i> <i>Eremalanda dunni</i>
Family Turdidae	<i>Oenanthe moesta</i>
Family Sylviidae	<i>Acropcephalus arundinaceus</i> <i>Acrocephalus melanopogon</i>

And the Regionally threatened or declining species are

Family Ardeidae	<i>Botaurus stellaris</i>
Family Accipitridae	<i>Pernis apivorus</i> <i>Neophron percnopterus</i> <i>Gyps fulvus</i> <i>Torgos tracheliotus</i> <i>Accipiter brevips</i> <i>Aquila pomarina</i>
Family Scolopacidae	
Subfamily Gallinagininae	<i>Gallinago media</i>
Family Fringillidae	<i>Carpodacus synoicus</i>

And the species restricted wholly or largely to Middle East

Family Glareolidae	
Subfamily Glareolinae	<i>Glareola nordmanni</i>
Family Turdidae	<i>Oenanthe finschii</i> <i>Oenanthe cypriarca</i>
Family Sylviidae	<i>Hippolais languida</i> <i>Sylvia melanothorax</i>
Family Fringillidae	<i>Serinus syriacus</i>

And one percent or more of the population are

Family Ardeidae	
Subfamily Ardeinae	<i>Bubulcus ibis</i>
Family Ciconiidae	<i>Ciconia ciconia</i>
Family Anatidae	
Subfamily Anatidae	<i>Tadorna tadorna</i>
Family Gruidae	<i>Grus grus</i>
Family Recurvirostridae	<i>Himantopus himantopus</i> <i>recurvirostra avosetta</i>
Family Glareolidae	
Subfamily Glareolinae	<i>Glareola pratincola</i>
Family Charadriidae	
Subfamily Charadrinae	<i>Charadrius alexandrinus</i>
Family Scolopacidae	
Subfamily Calidrinidae	<i>Calidris minuta</i>
Subfamily Tringinae	<i>Philomachus pugnax</i>
Family Sternidae	<i>Chlidonias leucopterus</i>

And the Globally threatned species

Family Anatidae	
Subfamily Anatidae	<i>Marmaronetta angustirostris</i>
Family Accipitridae	<i>Aquila heliaca</i>
Family Rallidae	<i>Crex crex</i>
Family Otidadae	<i>Chlamydotis undulata</i>

In addition, 14 rare plant species , nine of which are restricted to the Azraq Wetlands are found in the reserve. An abundance of fish species and one specific endemic species *Aphanius sarhani*, were recorded and logged during the survey implemented in Azraq by the Project.

Recent scientific reports evaluated the effect of the rehabilitation process in the Wetlands, especially in the context of richness and biodiversity. Investigations showed that there are 100 species of different varieties of fresh water planktons, 20 species of aquatic insects , 15 species of mollusk, 13 species of fish, 14 species of aquatic plants , 66 species of terrestrial invertebrates , 136 species of terrestrial plants. The existence of animals as the Asian Jackel, Red Fox, Stripped Hyaena is still under investigation.

The available figures on the ground water recharge recorded during the implementation of the Azraq Project demonstrates the fact that the water supply is curtail to the existence of the Wetlands and its biodiversity. Estimates of a **safe yield** have ranged from 16 MCM annually (based on the natural discharge of the springs) to 28 MCM based on estimated annual recharge of 34 MCM per year. Since extraction rates have augmented every year since 1983 up to the start of the Azraq project, it was estimated that the rate of extraction's reached 50 MCM per year, with 25 MCM being pumped to Amman and the remainder spent for irrigation purposes. The importance of Azraq should be appreciated not only in the context of the Middle East as an ecological situation , but rather as a global issues that is related to freshwater ecosystem that are subjected to destruction and over exploitation.

III. ENVIRONMENTAL INFORMATION

3.1 *Physical Factors :*

3.1.1 Topography :

Azraq basin geologically belongs to the East Jordanian limestone Plateau , covered partially by basalt flows. The basin is surrounded by a series of hills that consist mainly of limestone deposits and basalt craters. The sedimentary rocks overlay the basement complex , found at a depth of 2550 meters in the eastern part of the basin .

The Azraq Wetland Reserve lies on a bed of bluish gray clay in a depression situated in the limestone hammada of the Syrian Desert. This spot is located at about 500 meters above sea level, where its connections with Wadis and various slopes, empty their silt - filled water into the mud flat. In many cases 50-70 Km of mud flats might be covered with waters poured from the Syrian side. The building of dams on the main Wadis, especially Wadi Rajil is considered a threat to the sustainability of the Wetland at large .

Azraq Basin is located between 055 to 230 north and 250 to 400 E Palestine coordinates . the highest topographical point is at Tillin Town in Syria with the elevation of 1550 m above sea level, while the lowest elevation is at Azraq village recording 500 m above sea level .

3.1.2 Climate :

The basic climatic feature of the Azraq basin is hot and dry in the Summer , cold and wet in winter low precipitation occurs during the winter . Recent recorders obtained from the Department of Meteorology for the period from 1981-1992 show that the mean maximum temperature obtained ranged around 26.4 C, while the mean minimum temperature recorded at the same period was 11.8 C. The maximum temperature recorded according to the sources was in August reaching 45 C. As for the minimum temperature recorded was in December and January , reaching -5.4C . The Azraq Oasis is characterized by a dry climate especially during the Summer season due to the little amount of humidity. The maximum humidity is usually correlated to the rainy months , and it becomes considerably less during the dry months . Winds are a climatic feature of the Wetland and the Azraq area as a whole. The velocity of wind varies according to the season , the basic climate feature of the Azraq Basin is hot and dry in Summer cold and wet in winter, precipitation occurs in winter ranging from 300 mms in the north to about 150 mms in west and even less than 50 mms in the east , average rainfall is about 91 mms . The area is classified as arid area , mean yearly temperature is 19 C° which ranges from 21-28 in summer and from 0-15 C° in winter maximum temperature is 46.4 C° and minimum recorded is -75 C° .

3.1.3 Hydrology :

Azraq pools have been formed as a result of topography and ground water table intersection, where the water table is higher than the ground water surface. Pools are situated in the depression where the topographic elevation is 506 m above sea level. Surface water flows as well as ground water through the center of the depression. Seven main Wadis flow towards the center of the depression where an average of 22 MCM surface flood water come through these Wadis every year. Some of the water flows back towards the pools.

Ground water is formed in the northern part of the Azraq basin in South Syria resulting from intensive rain where the annual precipitation is around 350 mm. The area is covered with basalt flows which attributes to the volcanic activities that have occurred during the quaternary period. These flows have high permeability which in turn help the ground water to move through.

As a result of the hydraulic gradient, ground water flows through the basalt from the south of Syria to the North of Jordan, towards the center of the Azraq depression, where the pools are located and in turn recharge the pools. Basalt flows and underlying permeable strata form a high potential aquifer defined as the shallow aquifer. 95 % the Azraq wells are penetrating this aquifer. The annual abstractions exceeds double the shallow aquifer annual recharge.

51 MCM per year are pumped from the aquifer while the annual recharge is around 22-24 MCM. The over drafting led to the ground water depletion. The water level observation wells show a ground water level decline in the order of 20 m during the past 30 years.

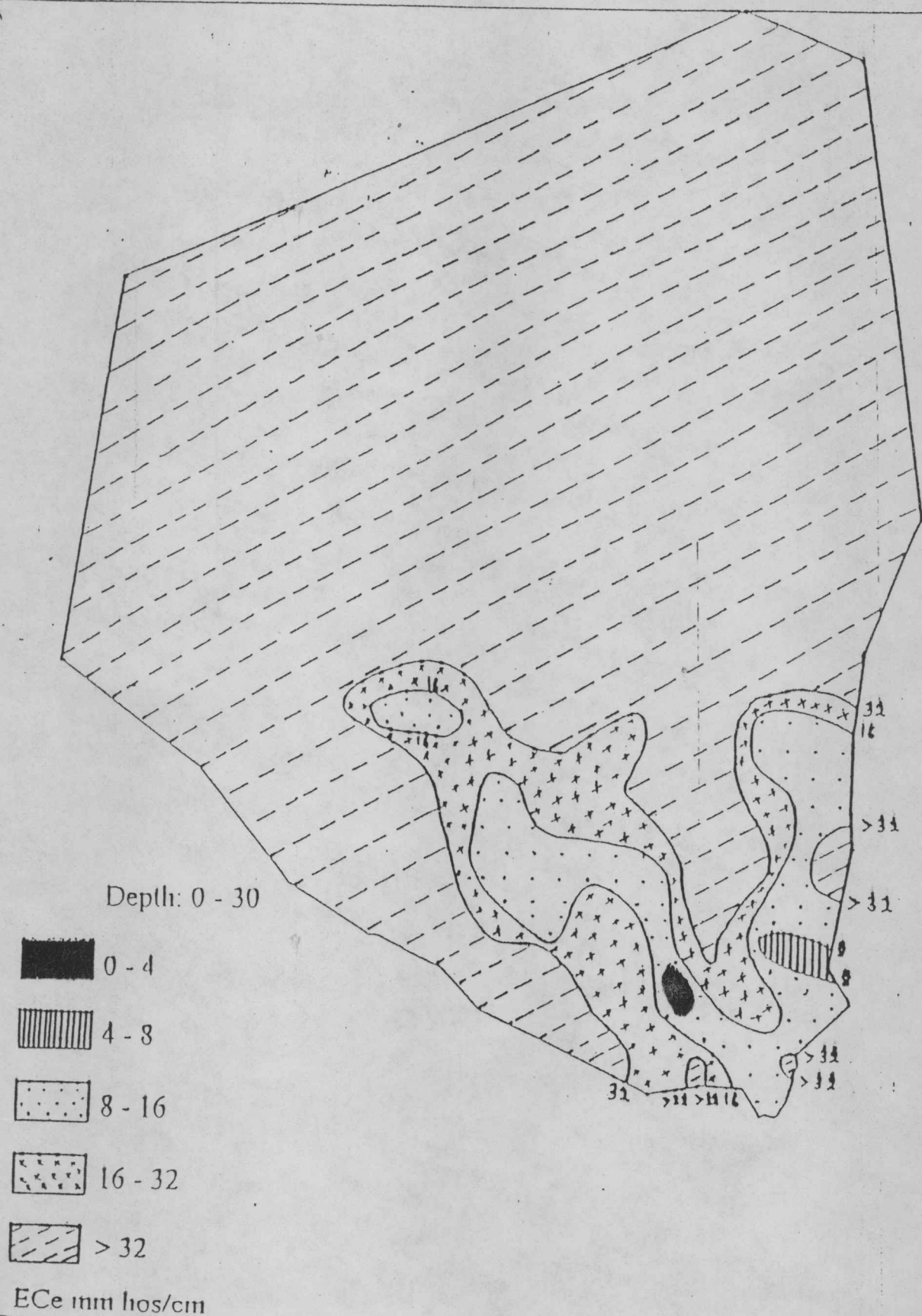
Intensive abstraction occurring in the AWSA field and the private agricultural wells accelerated the ground water level decline and deteriorated the water quality.

The pools have been affected by intensive ground water abstraction occurring in the AWSA well field and other private agricultural wells resulted in the upstraeming of the pools. The recharge to the pools became less, water levels in the pools drew down. In 1992, the pools dried out. The springs surplus flow to the swamps decreased from 12 MCM \ year in 1972 to zero in 1992.

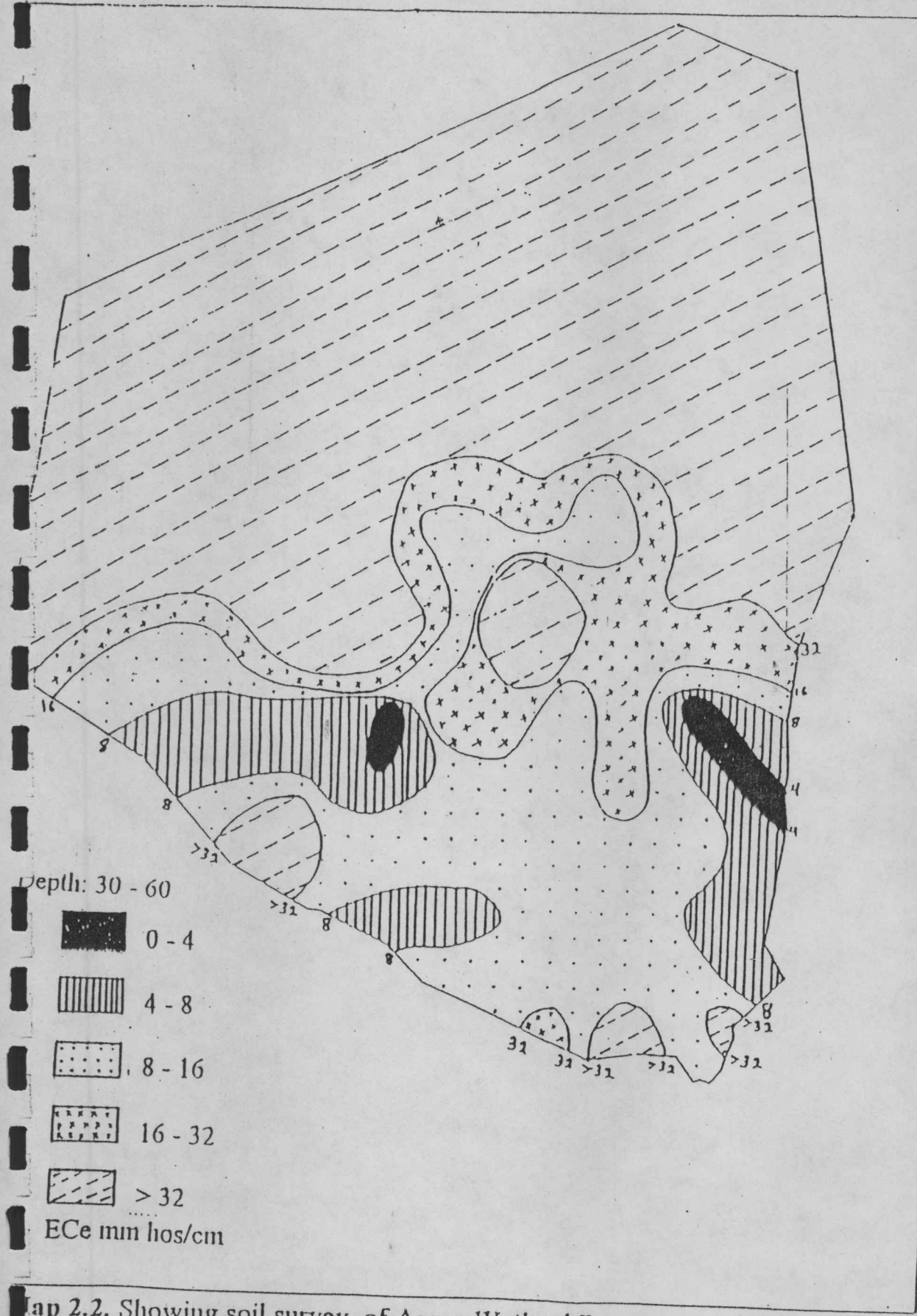
In 1994, The Azraq Conservation Project developed the springs, through the cleaning operations that it maintained, and managed to pump water from the AWSA network to the pools. The water level in the pools is monitored daily. Data collected showed that the annual released water from the network is about 1.5 MCM.

3.1.4 Soil :

In the past, the soil of the south - west par to the Azraq Oasis were saturated with water for prolonged periods and a permanent layer of bonded water presented at the surface. The physical and chemical characteristics of the soil was affected by these conditions. Nowadays, the bonded water layer vanished and the soil profile become dry. Pedecological studies along with the physical and chemical soil investigations were carried out recently. These studied reflected the following soil features: (detailed descriptions of the soils of the Wetlands are available in the documents of the Agricultural sub project):

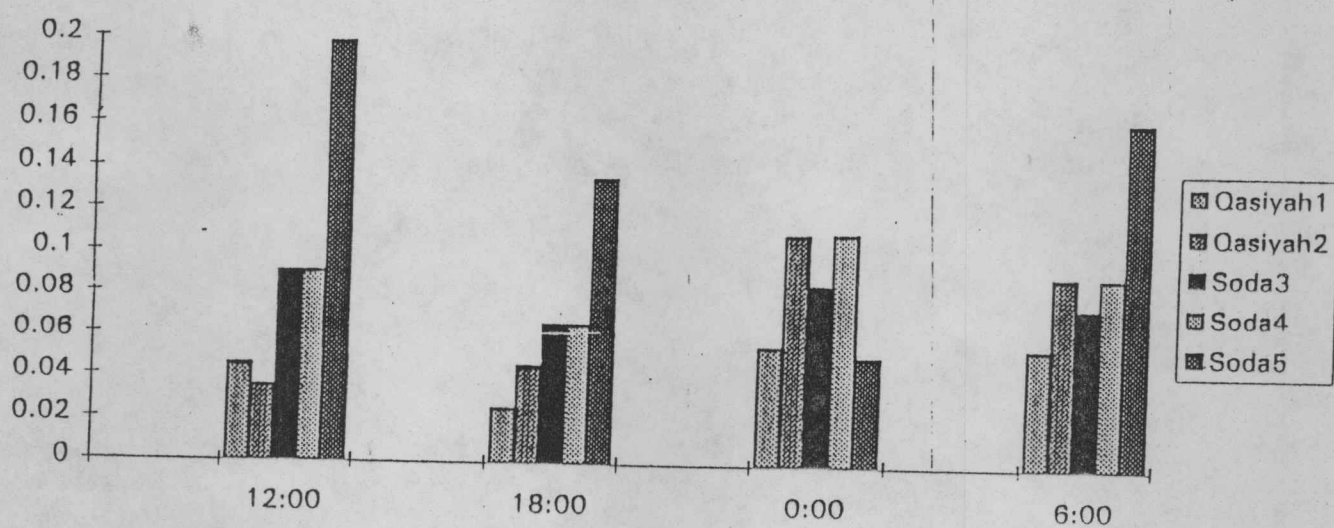


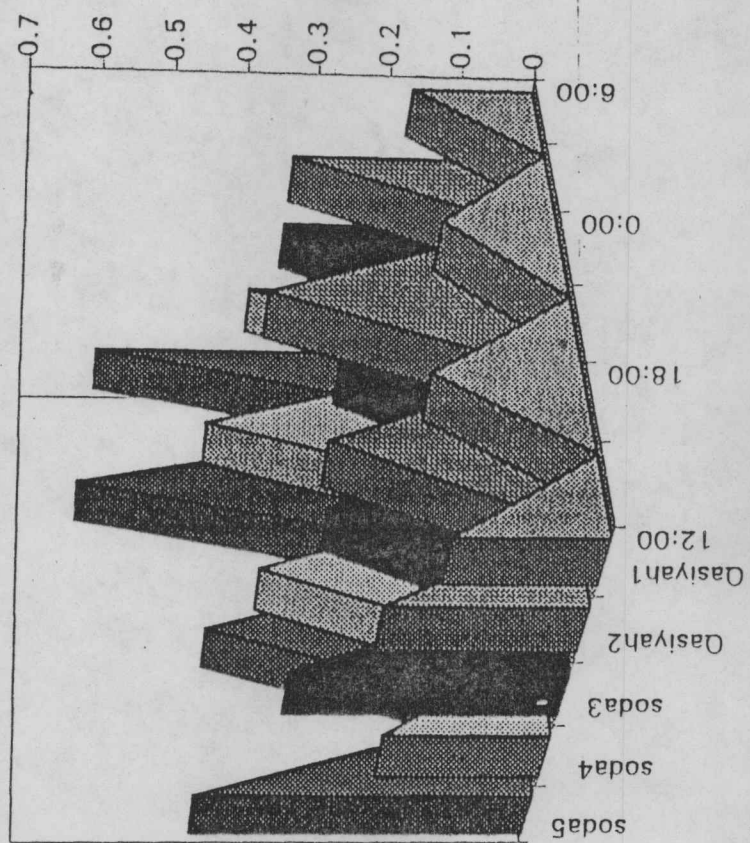
Map 2.1. Showing soil survey of Azraq Wetland Reserve at a depth of 0-30.



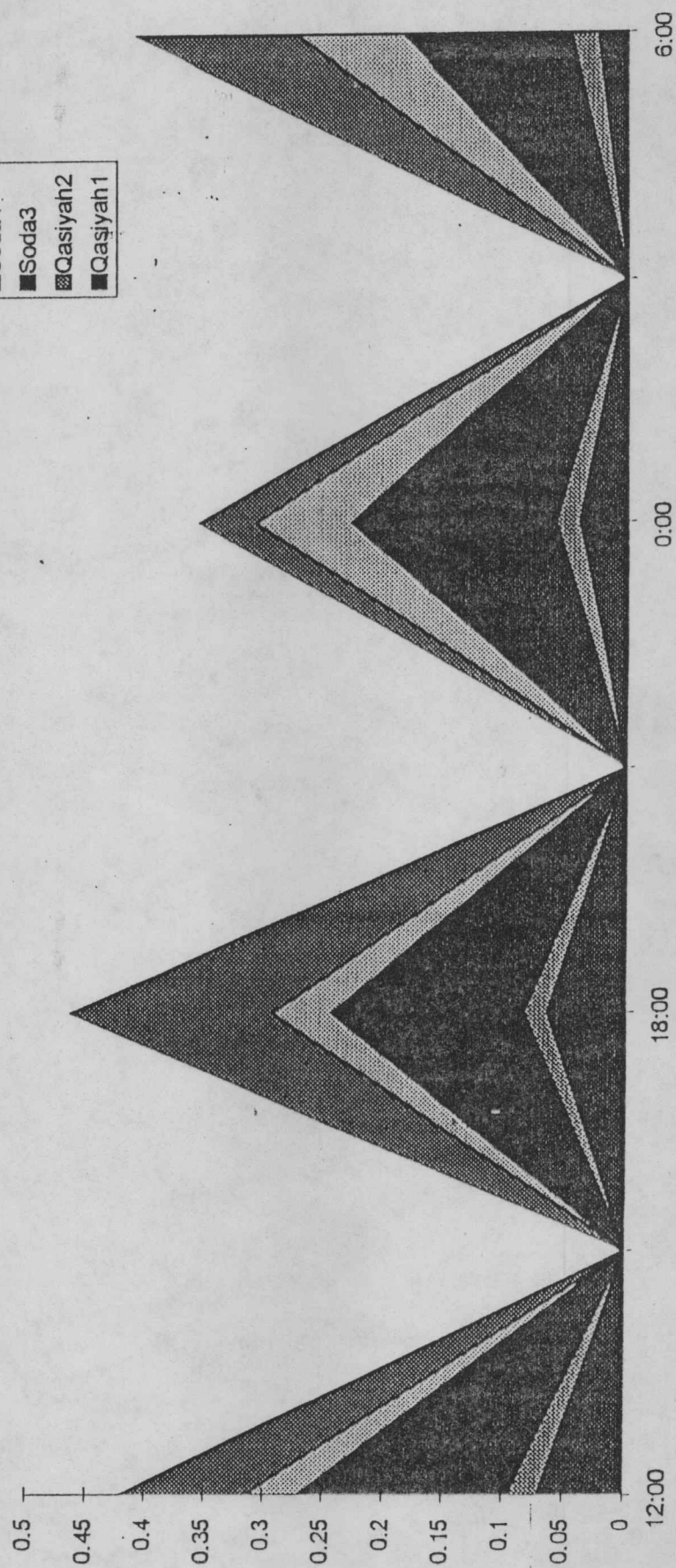
Map 2.2. Showing soil survey of Azraq Wetland Reserve at a depth of 30-60.

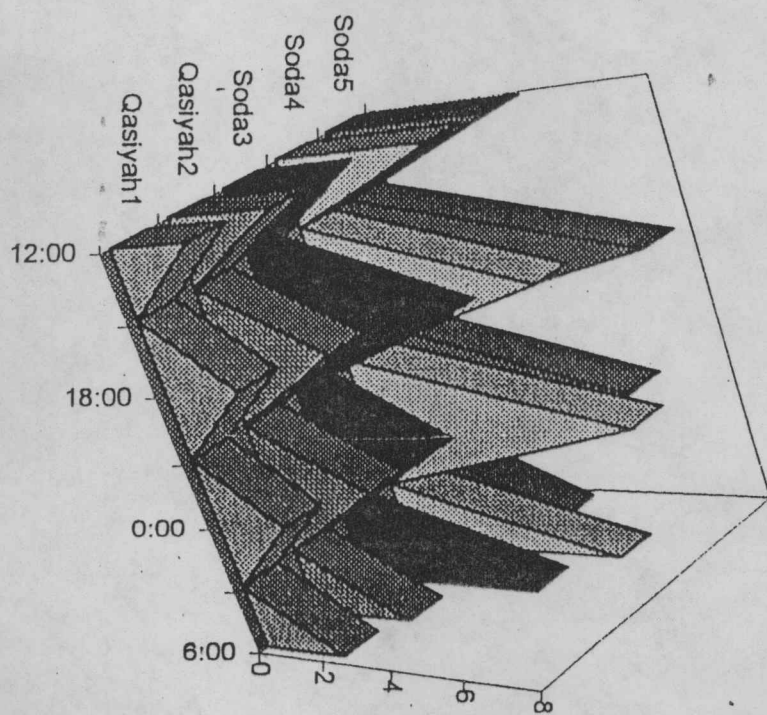
(Figure 8)
Concentration of nitrate in mg liter⁻¹



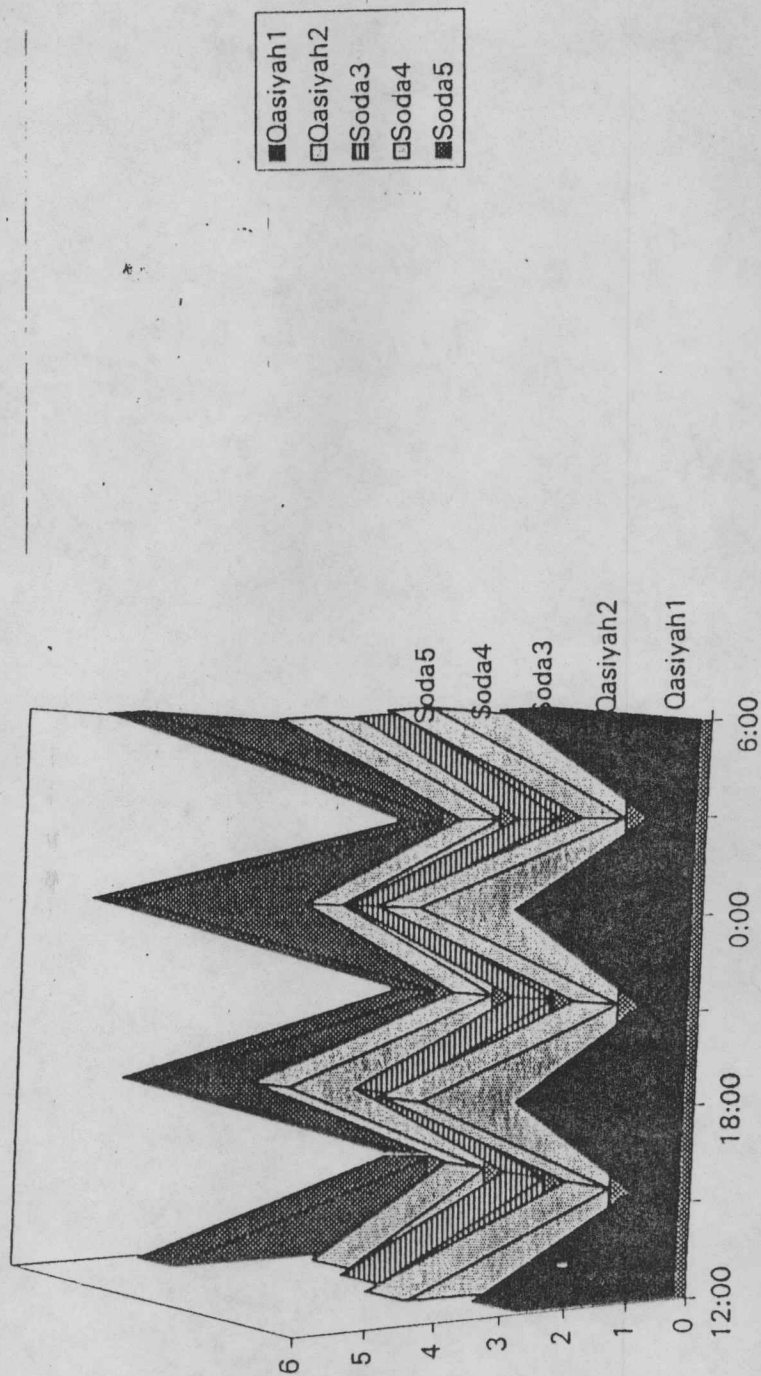


(Figure 9)
Concentration of nitrite in $\mu\text{g liter}^{-1}$





(Figure 13)
Concentration of Calcium in meq liter⁻¹



- * Presence of high organic matter, where the percentage of the O.M. is varied with soil depth, and the high percentage of O.M. reflect a positive picture of the soil fertility.
- * Deep soil, where the soil depth exceed 1.0 m and no impediment to root elongation was observed
- * Soil texture of the upper part and lower part of the rootzone is sandy to silt clay
- * The water holdday capacity of these soils is good and the available amount of moisture is estimated as 15-20 mm per 10 cm of soil depth.
- * soil salinity, small silted areas are presented and classified as non - saline soil (ECE is less than 4 ds/m). but the majority is classified as saline to high saline soils (ECE is > 16 ds/m).
- * Phreatic level is at depth of 1-3 m, therefore supply by capillary rise from the ground water is presented.

Mottled pattern with gray, yellow and red colors were observed. In general, such soils (that have the above mentioned chemical and physical characteristics cover and estimated area of about (2000-3000) dunums, around 15-20% of the wetland and it is suitable for agricultural development especially date cultivation. Soil of the eastern part of the wetland were subjected to periodic floods, these soils are characterized by deep soil profile, heavy texture and the ground water level is more than 2 m deep.

The soil of the nearest part, that is very close to the marshes, is classified as saline soils. Different species of shrubs and weeds that has a tolerant character to salinity can be successfully cultivated. This part of the land has an approximate area of 5000-6000 dunums. The rest of the area of the wetland is known as Al-Q'a where the soil has a very heavy texture, strong saline ground water, very poor in filtration rate almost equal to zero mm/hr. This soil is classified as a non- suitable land for any agricultural development.

The following elements were detected in relation to soil parameters; Sodium, Magnesium, Calcium, Chlorides, and Sulfates. (see maps on the distribution of salinity and relevant chemical elements)

3.1.5 Nutrients

Nitrate is the most common form of combined organic nitrogen in freshwater ecosystems. The concentration and rate of supply is connected to land use practices of the surrounding terrain. In addition, Nitrate moves freely through soils along with subsurface waters.

In Qaysyah 1, the mean amount of nitrate recorded was 0.046 mg Liter, in Qaysyah 2 0.073, in Soda 3, 4 and 5 0.078, 0.088 and 0.136 respectively. It is indicative that the Nitrate is not toxic to living biota if it does not exceed 1-mg Liter. The records at hand does not indicate an intolerable ecological status.

Again, in this draft of the Management Plan there are no correlation between the existing biological components of the Wetlands and the prevailing chemical conditions. However, the overall status of the reserve does not show extreme conditions that the existing species could not tolerate. An indication as it is presented further in this draft, that the diversity of species was well maintained so far. The

consultants feel that further monitoring of the data with the needed correlation is the utmost urgent task to be carried out.

Nitrite is generally present in trace quantities in water exposed to oxygen where it is transformed to Nitrate. Nitrate is converted to Ammonia in anoxic waters. In the pools of soda, the highest concentration of Nitrite recorded was 0.27 in Ug liter, the lowest concentration was 0.01 in Ug liter while the mean recorded was 0.114 Ug liters. In Queseyieh, the highest concentration recorded was 0.07, the lowest concentration was 0.01 and the mean reached to 0.036 Ug liters.

Phosphorus is one of the most common elements for phytoplanktonic growth. It also acts as a limiting factor for the formation of zoo plankton in the ecological food chains. Due to the geo chemical shortage in the Azraq basin, the amount of phosphorus was found to be less than the anticipated concentrations. Investigation showed that in Quesiyeh pools, the highest concentration of PO_4 was 0.29 mg/liter, the lowest was 0.01 mg/liter, while the mean recorded was 0.1006 mg/liter. In Soda pools, the highest concentration recorded was 0.63, the lowest 0.01 mg/liter and the mean recorded was 0.118mg/liter. The increased level in Phosphate in Queseyieh is thought to be related to rock break down and other factors that should be investigated at a later stage.

Calcium is an essential element for metabolic processes in all living organisms and as a structural or skeletal material in many. All invertebrates, mollusks and others require large quantities of $CaCO_3$ as a major strengthening skeletal material. In addition, there are some marine and algae which use $CaCO_3$ in their cell wall. Investigations recorded that in Quseih highest recorded value for Ca was 3.7 ppm, the lowest, 1.8 ppm and the mean value was 2.769 ppm. In Soda pools the recorded concentrations of Ca showed that the highest amount reached to 5.4 ppm, the lowest, 1.8 ppm and the mean value was 3.417 ppm.

3.2 Biological

The biological support systems and their components in the Azraq Wetlands were studied and investigated during the field work by the consultants.

It is important to focus the attention of the reader that the major groups that were investigated in the course of the study focused on the following prevailing groups:
Aquatic Habitat : In which the phytoplanktons, zooplanktons, aquatic invertebrates and fish were studied according to their occurrence and abundance, in addition to the aquatic forms of plants.

Terrestrial Habitat : In which the groups of terrestrial invertebrates, vertebrates including amphibians, reptiles, mammals and birds were investigated in terms of their status, abundance, and ecological importance. In addition this section includes the floral component, in relation to status and distribution according to the suggested habitats and micro habitats.

The Management Plan would like to draw attention that the species recorded and listed in the following sections do not represent the final findings of the species nor their final ecological status. It is also important to emphasize the fact that due to the floods that occurred in the Azraq area and the Wetlands some of the species could not re-inhabit the area into their appropriate niches. The researchers realize this natural phenomenon - although not a frequent happening and expect that during the updating, monitoring and implementation of the guidelines of the Management Plan the species list, status, dynamics and fluctuation will be observed and logged accordingly.

3.2.1 Primary Productivity:

Primary productivity is defined as the rate at which radiant energy is converted by photosynthetic and chemosynthetic activity of producers to organic substances. High rates of production occur when both physical and biological factors are favorable, and especially when energy subsidies from outside the system reduce the costs of maintenance.

In evaluating the productivity of the Azraq Wetlands, one must consider the energy drains resulting from human actions, pollution and any stress coming inside or outside the system.

The primary productivity of the pools varied between 67.6 ppm in Al-Qayseih to 101.9 in Al-Soda. It is clear that the productivity of Al-Soda is higher than Al-Qayseih. The above figures were obtained before the cleaning-up operation started. Studies should be continued to investigate the effect of the recent construction and activities on the primary productivity on the rehabilitated wetland.

Potential threats to primary productivity are summarized in the context of light, depth, and the availability of nutrients as well as the intensity of grazing. The most commonly limiting factors to the Azraq pools are nitrogen (usually as nitrate) and phosphorous (Phosphate).

This Management Plan recommends the upgrading of the studies that were previously undertaken in order to investigate in depth the policies and operational steps to sustain the optimum level of the primary productivity in order to sustain life-support systems in the pools.

3.2.2 Planktons:

The major groups of phytoplanktons found in the pools and the surrounding water bodies are comprised of the following: Bacillariophyta, 50%, Cynophyta 24%, Chlorophyta 15%, Dinophyta 4%, Euglenophyta 4% and Prasiophyta 1%. The quantitative study of the Euglenophyta and Cryptophyta 1%. As there is no previous study on the phytoplanktons of Azraq Area, all the above groups are considered as new records to this sensitive area.

Records of Zooplankton in the pools could be divided into two main groups: Crustacea (which was represented by 90% of the population) and Rotifera which

was represented as 10% of the total zooplanktonic community in the pools. Crustacea on the other hand showed 3 groups: Cladocera 55%, Copepoda 35% and Amphipoda 2%.

13 species of zooplanktons were recorded from Azraq Shishan Pools, all of which are believed to be new records to the area:

Mesocyclops leuckarti, *M. minutus*, *Eucyclops serrulatus*, *Bosmina longirostris*, *Monia rectirostris*, *Brachionus angularis*, *B. calyciflorus*, *B. caudatus*, *Keratella vulgata*, *K. quadrata*, *Synchaeta oblonga* and *Filinia longiseta*.

The policies and objectives that should operate under the guidance of this Management Plan should consider the followings:

1. To monitor and closely upgrade the data on planktons since Primary productivity is irreversibly depended on the occurrence of the planktonic community (reefer to paragraph primary productivity).
2. To record any fluctuations in the water quality of the pools of the Wetland, due to the high sensitivity of planktons to any shift along the existing water gradient of the different factors namely (pH, salinity, nutrients, contaminants).
3. To monitor and record monthly as well as seasonally the population dynamics of each group of planktons and to add any new species, filling in the gaps of scientific information at hand.
4. It is of extreme importance to sustain this trophic level in the water bodies of the pools. Phytoplanktons occupy the producers level in the Azraq freshwater reserve. They fix the sun energy convert it to chemical energy and produce needed energy to be transferred along the food web.
5. To introduce basic and applied knowledge on the sensitivity of this group of living organism to the staff of the reserve and to demonstrate the life-dependency of other biotic components on planktons.

3.2.3 Aquatic invertebrates:

The present study recorded 20 species of aquatic invertebrates and insects, classified under 3 groups: Diptera, Odonata and Hemiptera. 11 species are considered as new records to the Azraq Area; these are:

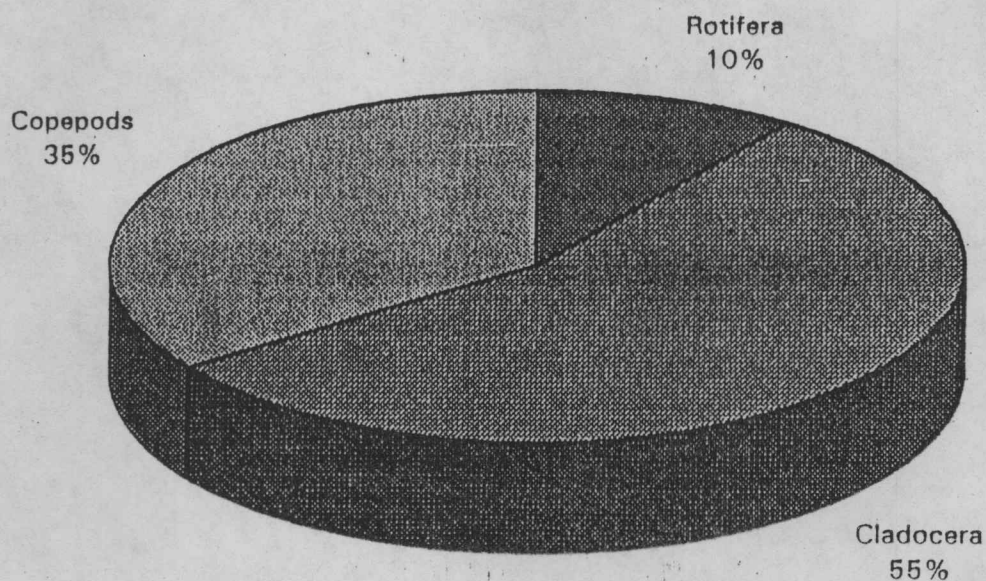
Procladius choreus, *Corixa spp.*, *Pachynomus lethierryi*, *Chironomus calipterus*, *Dicrotendipes pilosimanus*, *Lryptochironomus acutus*, *Leptochironomus stilifer*, *Polypodium n. subovatum*, *P. nubifer*, *Cladotantarsus pseudomancus*, *Orthetrum sabinae*.

Another two species were recorded that could be classified as a new record to Azraq. These are:

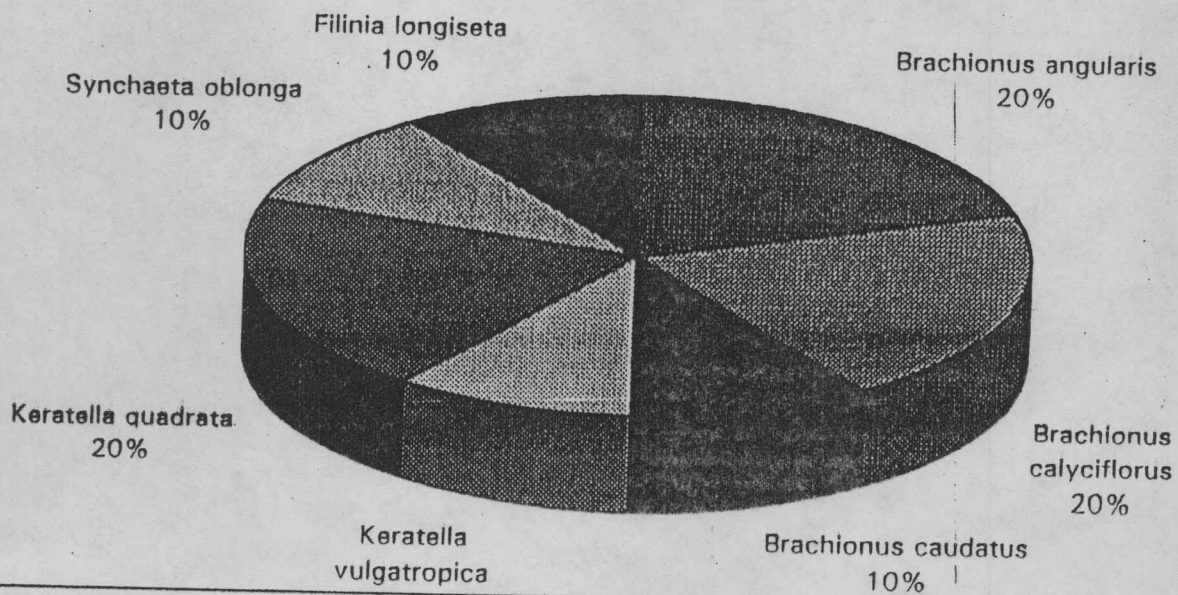
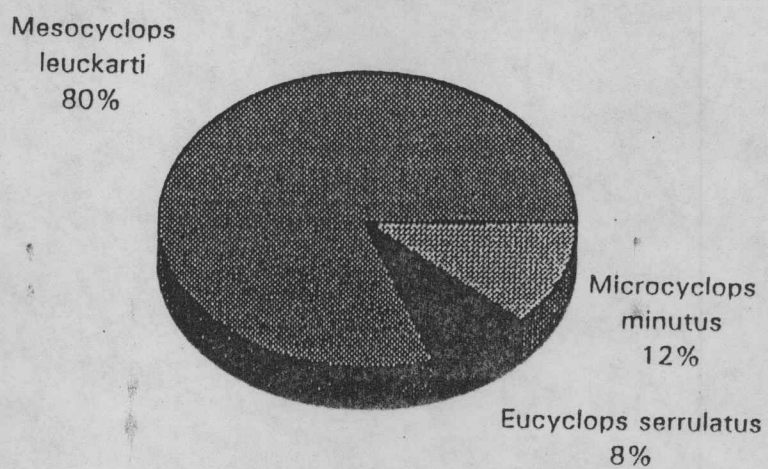
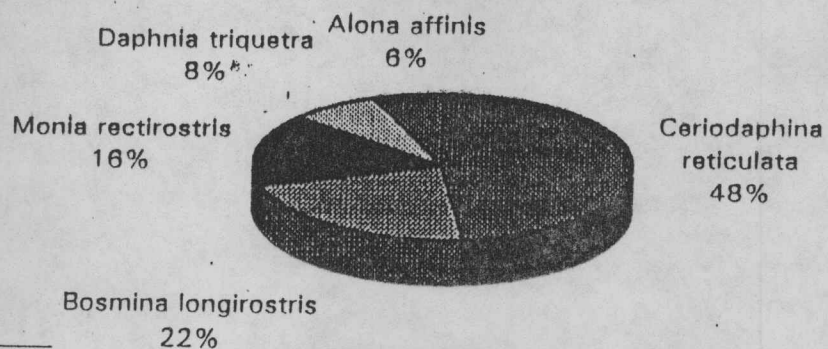
Orthetrum chrysostigma and *Brachytemis leucosticta*.

(Table 28)							
Rotifera		10%					
Cladocera		55%					
Copepods		35%					
(Table 29)							
Cladocera	<i>Ceriodaphnia reticulata</i>	26.40%	55%				
	<i>Bosmina longirostris</i>	12.10%					
	<i>Monia rectirostris</i>	8.80%					
	<i>Daphnia triquetra</i>	4.40%					
	<i>Alona affinis</i>	3.30%					
Copepods	<i>Mesocyclops leuckarti</i>	28%	35%				
	<i>Microcyclops minutus</i>	4.20%					
	<i>Eucyclops serrulatus</i>	2.80%					
Rotifera	<i>Brachionus angularis</i>	2%	10%				
	<i>Brachionus calyciflorus</i>	2%					
	<i>Brachionus caudatus</i>	1%					
	<i>Keratella vulgata</i>	1%					
	<i>Keratella quadrata</i>	2.00%					
	<i>Synchaeta oblonga</i>	1.00%					
	<i>Filinia longiseta</i>	1.00%					

(Figure 28)
Zooplankton community in Azraq area



(figure 29)
Zooplankton divisions



In addition, the survey recorded the occurrence of Nematodes, Oligochaete worms, leeches, flatworms, Lamellibranch (bivalve) mollusks as well as the Gastropod snail.

It is of extreme importance to note here that the mollusks of the Shishan Pools showed new records to Azraq. The list shows four new records:

Unio (limnium) terminalis, *Corbicula (corbicula) fluminalis*, *Theodoxus (Neritaea) jordani* and *Melanopsis (Melanopsis) praemorsum*.

This diversified fauna of aquatic invertebrates is attributed to the conservation and rehabilitation efforts that the Azraq Project is implementing. It is noteworthy to mention here, that those species have re-invaded the water ecosystem after the restoration efforts started. This bio-indicator is a positive sign on the successional tendencies the pools have obtained. Moreover, as much as those signs are positive, any external factor would oscillate the present conditions the survival of those species will act as a disturbing factor, leading for their removal from the just started food chain. Therefore, constant monitoring on the quality and level of water should be maintained, as much as those species are ecologically resilient, they are still unable to adapt fast enough to changes and potential threats to their surrounding media.

The Management Plan of the Azraq Project focuses on the following operational criteria:

1. To constantly monitor the fluctuations and changes in the relevant light availability, nutrients ... ect.
2. To constantly monitor and record any new species to the pool. The re-invasion of new species gives a positive indicator on the evolutionary tendencies of the wetlands.
3. To monitor and investigate seasonally population dynamics of the aquatic invertebrate community, thus upgrading the scientific data at hand.
4. To identify the feeding linkages with other populations (birds, other aquatic organism) to keep up in check the sustain ability of the ecological pyramid.
5. To identify and upgrade the fluctuations of rare and endangered species and to implement the necessary mitigating measure.

3.2.4 Terrestrial invertebrates:

Research and survey prescriptions clearly identified the need to monitor, maintain and upgrade the list of species composition of the terrestrial invertebrates prepared.

Classes of Arachnida, Chilopoda and Insecta are among the studied classes in the surrounding habitats of the Wetlands. Only one species was recorded belonging to class Arachnida, and species to class Chilopoda. Class Insecta was the major class in the vicinity of the Wetland in terms of its diversity and species composition. This Class was represented by 64 species belonging to 10 orders.

It is noteworthy to mention here that 8 rare species and 17 species of "Fragile" status were recorded in and/or in the vicinity of the reserve these are *Blepharopsis mendica*, *Ermiaphila braueri* (found in habitats of dense vegetation), *Brachythemis leucosticata*, *Orthetrum taeniolatum* (found in open water bodies),

Habitat, rarity, fragility and abundance for the terrestrial arthropods of Azraq

Species	Habitat	Rare	Fragile	Abundance
<i>Orthochirus scrobiculosus</i>	Under stones			C
<i>Scolopondra candis</i>	Under stones			C
<i>Blepharopsis mendica</i>	Dense vegetation	+		R
<i>Eremiaphila braueri</i>	Dense vegetation	+		R
<i>Empusa</i>	Burrows			C
<i>Platypleura arabica</i>	Dense vegetation		+	C
<i>Ischnura evansi</i>	Dense vegetation		+	VC
<i>Ischnur elegans</i>	Dense vegetation		+	VC
<i>Platynemesis dealbata</i>	Dense vegetation		+	VC
<i>Anax emperator</i>	Open water bodies		+	C
<i>Anax parthenope</i>	Open water bodies		+	
<i>Hemianax ephippiger</i>	Open water boddies		+	
<i>Sympetrum fonscolombei</i>	Open water boddies		+	
<i>Orthetrum sabina</i>	Open water boddies		+	
<i>Crocothemis erythraea</i>	Open water boddies		+	
<i>Crocothemis servilia</i>	Open water boddies		+	
<i>Brachythemis leucosticata</i>	Open water boddies	+	+	
<i>Orthetrum taeniolatum</i>	Open water boddies	+	+	
<i>Trithemis annulata</i>	Open water boddies		+	
<i>Anacanthoterma</i>	undertones			
<i>Chrysopa carnea</i>	Dense vegetation			C
<i>Myrmecaelurus laetus</i>	Dense vegetation			C
<i>Hyles linornica</i>	low vegetation			C
<i>Agrotis epsilon</i>	low vegetation			C
<i>Heliothis armigera</i>	low vegetation			C
<i>Utetheisa pulchella</i>	Dense vegetation			C
<i>Artogeria rapae</i>	Open areas			C
<i>Pontia daplidice daplidice</i>	Low vegetation			C
<i>Pontia glauconome</i>	Low vegetation			C
<i>Elphinstonia charltonia</i>	Open areas	+		
<i>Colias croceus</i>	Dense vegetation			C
<i>Vanessa cardui</i>	Open areas			C
<i>Ypthima asterope</i>	Low vegetation	+		
<i>Danaus chrysippus</i>	Open areas	+	+	
<i>Chilades galba</i>	Low vegetation			C
<i>Polyommatus icarus</i>	Low vegetation			C
<i>Lampides boeticus</i>	Low vegetation			C
<i>Tipula</i>	Dense vegetation			C
<i>Culex pipiens</i>	Waterbodies			C
<i>Chironomus dorsalis</i>	Tamarix trees			C
<i>Chironomus pulmosus</i>	Tamarix trees			C
<i>Tabanus</i>	Open areas			C
<i>Apoclea femoralis</i>	Dense vegetation	+		
<i>Anastoechus trisignatus</i>	Dense vegetation			C
<i>Metasyrphus luniger</i>	Dense vegetation			C
<i>Lucilia sericata</i>	Dead animals			C

<i>Stizus marnonis</i>	Dense vegetation	2	F	C
<i>Bembex dahlpomi</i>	Dense vegetation			C
<i>Camponotus xerxes</i>				C
<i>Cataglyphis niger</i>				VC
<i>Scarites</i> sp.	understones		+	
<i>Coccinella septempunctata</i>	all types of vegetation			VC
<i>Adesmia cancellata</i>	Dry habitats			VC
<i>Ocnosoma hispidum</i>	Burrows			C
<i>Tenebrio molitor</i>	Burrows			C
<i>Tribolium castaneum</i>	Burrows			C
<i>Oxyca laevigatum</i>	understones		+	
<i>Zophosis complanata</i>	understones			C
<i>Aphodius wallastoni</i>	understones			C
<i>Truxalis grandis</i>	Dense vegetation			VC
<i>Pseudocoelus ebneri</i>	Open areas and dense vegetation			C
<i>Acrotylus insubricus</i>	Open areas and dense vegetation			C
<i>Chorthippus peneri</i>	Open areas and dense vegetation			C
<i>Tropidopoda longicornis syriaca</i>	Open areas and dense vegetation			C
<i>Anacridium aegyptium</i>	Open areas and dense vegetation			C
<i>Duroniella lucasi</i>	Open areas and dense vegetation			C

C: Common

VC: very common

Danaus chrysippus, *Elphinstonia charltonia* (found in open areas and habitats), *Ypthima asterope* (found in habitats of low vegetation) and *Apoclea femoralis* inhabits dense vegetation.

Ecologically fragile species were also recorded. The survey conducted shows the presence of 17 species annexed as "fragile species", these are:

Platypleura arabic, *Ischnura evansi*, *I. elegans*, *Platycnemis dealbata* (found in dense vegetation habitats). *Anax emperor*, *A. parthenope*, *Hemianax ephippiger*, *Sympetrum fonscolombei*, *Orithetrum sabina*, *Crocothemis erythraea*, *C. servilia*, *Brachythemis leucosticata*, *Orghetrum taeniolum* and *Trithemis annulata* - all of which were recorded from areas of open water bodies. While *Danaus chrysippus* was located in habitats of open areas.

The work conducted will be undertaken in association with the changes in the surrounding microenvironment, in terms of the program of water supply water quality and vegetation distribution.

This Management plan considers the following programs to be implemented for the invertebrate fauna:

1. To monitor seasonally the different species recorded initially during this study
2. To monitor the seasonal fluctuations of species in terms of their density, abundance, frequency and diversity.
3. To determine the biological associations between the above parameters and the feeding linkages (other invertebrate species, plant species, planktonic representatives)
4. To and determine knowledge and understanding among the working staff of the importance of the rare and fragile species
5. To carry out the needed mitigating measures to preserve the ecological integrity of the invertebrate fauna.
6. To ensure the complete rejection of the use of insecticides in the Wetlands and recommend biological control techniques.
7. To introduce the basis for environmental education and public awareness on the need to preserve the existing invertebrate species at the Azraq Wetlands.

3.2.5 Fish:

The related species of fishes of the Azraq Wetlands were studied by several specialists: Nelson (1973) recorded 5 species of fish in Azraq, while Mire (1990) recorded 4 species. Al-Humaeium (1995) prepared a list of 13 species, 8 species of which are regarded as new records to freshwater fishes. These are:

Hypophthalmichthys molitrix, *Acanthobrama lissueri*, *Cyprinus carpio*, *Barbus longiceps*, *Tor canis*, *Clarias lazera*, *Clarias gariepinus*, *Sarotherodon galilaeus*, *Haplochromis flavijosephi* and *Tristramella Sacra*.

The list of recorded fish in the Azraq Wetlands is recorded in the Limnology of Azraq, 1995. The only species recorded as endemic is the *Aphanius sirhani*, lastly recorded in 18\988 and again recorded in this study.

Further detailed studies should be carried out to identify scientific gaps and to upgrade the data at hand. Fishes are bioindicators of the well-being of the reserve. The water quality should be monitored on daily bases and records of any fluctuations should be instantly recorded.

Fish as *Clarias lazera* are sensitive to food availability in the context of water invertebrates and water plants. The disappearance of which will cause an ecological gap in the existing food chain. The water quality and characteristics is of immense importance for the sustain ability of the existing life patterns in the Wetland.

Potential threats are to be taken into consideration mainly: Change of water status, outside forces that could contribute negatively to the existing water quality. Threats are also envisioned in terms of species deterioration. Since the interdependency and inter-relationships among species is a vital, integral aspect of the ecological pyramid. The gaps that would occur if a species should disappears due to an outside / inside factor would no doubt shift the ecological tolerance of species along the optimum gradient.

Policies and Management prescriptions should identify the following criteria:

1. To monitor daily the water quality of the pools and to record any fluctuation in the various physical and biological parameters.
2. To establish a scientific record on the direct relationship of the existing fish population and separate water parameters to identify the limiting factor to fish population dynamics.
3. Since fish species are vital bioindicator on the integrity of the water ecosystem, it is important to record, investigate the reproduction vitality (viability of the different species).
4. To determine and study the carrying capacity of the pools, so as to avoid overcrowding and competition among species.
5. To establish a record on the feeding relationship of fish on other organisms, thus monitoring the availability of food to the existing population.
6. To record and seasonally analyze the scientific data of fish population, mainly regarding their productivity.
7. To establish a working relationship with the private sector to promote fish farming in a sustainable manner.

3.2.6 Amphibian:

This group of vertebrates was also studied by several authors. Nelson in his book "Azraq Desert Oasis" (1973) gives the indication of the presence of one species *Rana ridibunda* while Hatough-Bouran and Disi in (1995) suggest the occurrence of two species. Lists of amphibian species are given in the records on the Biodiversity and Ecology of Azraq.

The main species of this class that should require the attention of the Azraq Management Plan due to their sensitivity and fragility are: *Rana ridibunda* and *Bufo varidis*.

Again, amphibians are excellent bioindicators against various perturbations and oscillations. Their importance is due to the fact that they are exposed both to the aquatic and terrestrial habitats.

This Management Plan should focus its attention on the following operational criteria to ensure the sustainability of this class of vertebrates:

1. Seasonal monitoring on the population dynamics of this very sensitive biotic component.
2. Monitoring of the specific niches of occurrence, specially what concerns the egg laying micro habitats.
3. Periodic surveys and species composition identification to record new species to the area.
4. Specific monitoring of water pH, since water properties acts as the most deterring limiting factor to the occurrence and survival of amphibians.
5. Specific scientific investigations of the liver and tissue status in selected species of amphibians for any sign of contamination penetration (specifically heavy metals).
6. Monitoring and investigations aimed at food selectivity, and food availability of amphibians, thus establishing the positive or negative relationship of the species to the surroundings.

3.2.7 Reptiles:

This class of terrestrial vertebrates was also investigated by Nelson in 1973. An upgrading of information was conducted by Disi, (1991) and Hatough-Bouran, Disi in 1995. The species composition contained the following species: *Agama stellio*, *A. pallida*, *Eremias brevisrostris*, *E. guttulatata*, *Acanthodactylus boskianus*, *A. opheodurus*, *A. paradalis*, *A. grandis*, *A. persica*, *A. pallida*, *Chamaeleo chamaeleon*, *Eumeces schneideri* and *Mabliya vittata*.

It is important to underline here the fact that the actual status of the above mentioned species needs to be closely investigated. The fluctuation of species status is not uncommon in areas of specific structure and activity as the Azraq Wetland. Due to the recent floods and construction activities, it is anticipated that the status of species would oscillate between "present to rare". The final judgment on this issue would be during the follow-up studies and the ecological surveys and monitoring that should be conducted constantly.

Snakes were also investigated in the Azraq vicinity, the species recorded consisted of: *Eryx jaculus*, *Coluber rogersi*, *Eirenic coronella*, *Malpolon moilensis*, *M. monspessulanus*, *Psammophis schokari*, *Natrix tessellata*, *Pseudocerastes persicum*, *Walterinnesia aegyptia*.

The specific obligation of the Management plan in this regard is:

1. To monitor species composition, abundance, frequency of occurrence and biological diversity for Class Reptilia inhabiting the Azraq Wetlands.
2. To preserve the microhabitats and narrow niches of Reptiles by measurements of strict conservation policies to ensure the ecological home range for reptiles.
3. To investigate the existing gaps in scientific data and to identify the population dynamics of different species within the existing population.
4. To continue surveys (both quantitative) to keep the flow of information and data regarding this class.
5. To identify the interdependencies and inter-specific relationships of Reptiles species with food availability, food selectivity. Thus, establishing the linkages with the diversified trophic levels within the ecological pyramid of the Azraq Wetland Reserve.

3.2.8 Mammals:

This vertebrate class was studied thoroughly by Nelson (1973), Disi (1985) and Hatough-Bouran (1995). A gap of data existed for at least 2-3 years, due to many reasons, one of which the dryness of the pools and the extensive scientific work done on Shaumari Wildlife Reserve. The scientific assumption was that many species dispersed and locally migrated from the vicinity of the pools to the Shaumari Reserve. The data available by Bouran, Al-Eisawi (1992) confirmed this assumption.

The mammalian species spotted in the recent survey (1993-1995) represented the followings Carnivores: *Felis silvestris*, *Caracal caracal* and *Acinonyx jubatus* as very rare to the area. These species could be found in the vicinity of Azraq pools.

Of the family Canidae the *Vulpes rupelli* is considered very rare. This species was spotted only once.

Of the family Hyaena, the *Hyaena hyaena* was spotted several times, foot prints were also observed. This species is also considered rare.

Rodentia was recorded abundantly in the Azraq area through the past extensive studies. Nevertheless, in the vicinity of the Wetlands, the following species were recorded: *Gerbillus dasyurus*, *Mus musculus*, *Jaculus jaculus* and *Allactaga euphratica*. It is believed that the yet fragile ecosystem is not in a position to sustain a dense population of rodents. Fortunately the vegetation cover is showing a rapid recovery which would act as a fundamental criteria for the re-invasion of mammals and specifically rodents to the vicinity of the Wetlands. The follow-up studies and monitoring which is to be carried out this year should show a higher population density of rodents.

The potential threats to this class of vertebrates originate from the fact that the various feeding requirements for these species are not adequate. Moreover, the

burrowing species requires special soil characteristics that enables them to dig their burrows. With the change that occurred-in the form of total dryness-many features of the micro habitat and physical properties changed, allowing for dispersal and local migration of species.

This Management plan should consider the following objectives:

1. To monitor seasonally, the population dynamics of the various species.
2. To monitor and any fluctuations with the respected pollution and record their frequency of occurrence, abundance and diversity.
3. To monitor and preserve the specific niches and micro habitats of the various species. The availability of ecologically suitable habitats for feeding, mating and nursing the young is of extreme importance to mammals.
4. To establish, record and monitor the feeding relationship among species. This would contribute to the understanding of the ecological pyramid existing in the reserve.
5. To upgrade the existing scientific data by recording any new findings. In doing so the existing gaps of information would be covered, enhancing the knowledge on the existing interactive mammalian population.

3.2.9 Birds:

The Azraq Oasis is the main attraction to class Aves. Through history, scientists, authors, writers documented each in its own style the majestic flow of migratory birds in Azraq. Nelson (1973) recorded 281 species of birds in Azraq Oasis, In 1987,1992 Disi and Hatough-Bouran published the occurrence of species. In 1994, Buder, Al-Hasseni, Bouran under the Azraq Project documented the occurrence of 209. species of birds.

The *Nationally threatened species* acknowledged in this Management Plan includes the followings :

Family Ciconiidae	<i>Ciconia nigra</i>
Family Accipitridae	<i>Circaetus gallicus</i> <i>Circus aeroginosus</i>
Family Charadriidae	
Subfamily Vanellinae	<i>Chettusia leucura</i>
Family Caprimulgidae	
Subfamily Caprimulginae	<i>Caprimulgus aegyptius</i>
Family Alaudidae	<i>Rhamphocoris clotbey</i> <i>Eremalauda dunni</i>
Family Turdidae	<i>Oenanthe moesta</i>
Family Sylviidae	<i>Acrocephalus arundinaceus</i> <i>Acrocephalus melanopogon</i>

And the Regionally threatened or declining species are

Family Ardeidae *Botaurus stellaris*

Family Accipitridae *Pernis apivorus*
 Neophron percnopterus
 Gyps fulvus
 Torgos tracheliotus
 Accipiter brevips
 Aquila pomarina

Family Scolopacidae

Subfamily Gallinaginae *Gallinago media*

Family Fringillidae *Carpodacus synoicus*

And the species restricted wholly or largely to Middle East are

Family Glareolidae

Subfamily Glareolinae *Glareola nordmanni*

Family Turdidae *Oenanthe finschii*
 Oenanthe cypriarca

Family Sylviidae *Hippolais languida*
 Sylvi melanothorax

Family Fringillidae *Serinus syriacus*

And one percent or more of the population are

Family Ardeidae

Subfamily Ardinae *Bubulcus ibis*

Family Ciconiidae *Ciconia ciconia*

Family Anatidae

Subfamily Anatidae *Tadorna tadorna*

Family Gruidae *Grus grus*

Family Recurvirostridae *Himantopus himantopus*
 recurvirostra avosetta

Family Glareolidae
Subfamily Glareolinae *Glareola pratincola*

Family Charadriidae
Subfamily Charadrinae *Charadrius alexandrinus*

Family Scolopacidae
Subfamily Calidrinidae *Calidris minuta*
Subfamily Tringinae *Philomachus pugnax*

Family Sternidae *Chlidonias leucopterus*

And the Globally threatned species

Family Anatidae
Subfamily Anatidae *Marmaronetta angustirostris*

Family Accipitridae *Aquila heliaca*

Family Rallidae *Crex crex*

Family Otidadae *Chlamydotis undulata*

The threats to class Avis is clearly demonstrated in the dryness of pools. In the years that preceeded the rehabilitation efforts of the Azraq Project, most of the migratory birds have changed route in Jordan to stop in areas elsewhere than the Azraq Oasis. Several species of birds were seen and documented mainly near King Talal Dam (in the north of Jordan). Few species were seen near Shuae'b Dam (near the Dead Sea), they were also recorded in Al-Kafreen Dam in the Ghor area. In 1994, and after the restortation efforts in Azraq Wetland started, the frequency of birds stopping in the Wetlands has increased.

3- Order Ansiformes

3-1- family Anatidae

3-1-1- subfamily Anserinae

1-*Anser albifrons* White-fronted Goose

اوز أبيض

3-1-2- subfamily Anatidae

1-*Tadorna ferruginea* Ruddy Shelduck

بط صيني، بط أحمر

2-*Tadorna tadorna* Shelduck

شهرمان، حبرجل

3-*Anas penelope* Wigeon

صواوي

4-*Anas strepera* Gadwall

جوشمة

5-*Anas crecca* Teal

شرشير شتوي

6-*Anas platyrhynchos* Mallard

خضاري، "أبو حشيش"

7-*Anas acuta* Pintail

بنبول

8-*Anas querquedula* Garganey

شرشير صيني

9-*Anas clypeata* Shoveler

كيش "أبو مجرف"

10-*Marmaronetta angustirostris* Marbelled Teal

شرشير مخطط

12-*Aythya ferina* Pochard

حمر اوي

13-*Aythya fuligula* Tufted Duck

بطة أبو خصلة

4- Order Accipitriformes

4-1- family Accipitridae

1-*Pernis ptilorhynchus* Honey Buzzard

صقر العسل

2-*Milvus migrans* Black Kite

حداة سوداء

3-*Neophron percnopterus* Egyptian Vulture

نسر مصري، رخمة

4-*Gyps fulvus* Griffon Vulture

نسر بني

5-*Torgos tracheliotus* Lappet-faced Vulture

نسر ذو أذن

6-*Circaetus gallicus* Short-toed Eagle

عقاب الحيات

7-*Circus aeruginosus* Marsh Harrier

مرزة البطائح

8-*Circus cyaneus* Hen Harrier

مرزة الدجاج

9-*Circus macrourus* Pallid Harrier

مرزة باهتة

10-*Circus pygargus* Montagu's Harrier

مرزة مونتاكو

11-*Accipiter nisus* Sparrowhawk

باشق

12-*Accipiter brevipes* Levant Sparrowhawk

باشق شرقي، بيدق

13-*Buteo buteo* Buzzard

صقر حوام

14-*Buteo rufinus* Long-legged Buzzard

صقر جراح

15-*Aquila pomarina* Lesser Spotted Eagle

عقاب أسفع صغير

1- Order Podicipediformes

1-1- family Podicipidae

1-*Podiceps ruficollis*

Little Grebe

غطاس صغير

2-*Podiceps nigricollis*

Black-necked Grebe

غطاس أسود الرقبة

2- Order Ciconiiformes

2-1- family Ardeidae

2-1-1- subfamily Botaurinae

1-*Botaurus stellaris*

Bittern

واق

2-*Ixobrychus minutus*

Little Bittern

سواق صغير

2-1-2- subfamily Ardynae

1-*Nycticorax nycticorax*

Night Heron

غراب الليل

2-*Ardeola ralloides*

Squacco Heron

واق أبيض

3-*Bubulcus ibis*

Cattle Egret

بلشون الماشية "أبو قردان"

4-*Egretta alba*

Great White Egret

بيوضي كبير

5-*Ardea cinerea*

Grey Heron

مالك الحزين الرمادي

6-*Ardea purpurea*

Purple Heron

مالك الحزين الأرجواني

2-2- family Ciconiidae

1-*Ciconia ciconia*

White Stork

لقلق أبيض "أبو سعد"

2-*Ciconia nigra*

Black Stork

لقلق أسود

2-3- family Threskiornithidae

1-*Plagadis falcinellus*

Glossy ibis

أبو منجل الأسود

2-*Platelea leucordia*

Spoonbill

الملاعقي "أبو ملعقة"

2-4- family Phoenicopteridae

1-*Phoenicopus ruber roseus* Greater Flamingo

بشروش بنحام

12-Accipiter brevipes

13-Buteo buteo

14-Buteo rufinus

15-Aquila pomarina

16-Aquila nipalensis

17-Aquila heliaca

18-Hieraaetus pennatus

Levant Sparrowhawk

Buzzard

Long-legged Buzzard

Lesser Spotted Eagle

Steppe Eagle

Imperial Eagle

Booted Eagle

باشق شرقي، بيدق

صقر حوام

صقر جراح

عقاب أسفع صغير

عقاب السهول

ملك العقاب

عقاب مسير

4-2- family Pandionidae

1-Pandion haliaetus

Osprey

عقاب نساري

5- Order Falconiformes

5-1- family Falconidae

1-Falco naumanni

2-Falco tinnunculus

3-Falco columbarius

4-Falco subbuteo

5-Falco eleonora

Lesser Kestrel

Kestrel

Merlin

Hobby

Eleonara's Falcon

عويسق

عوسق

يؤيز

شويهين

6- Order Galliformes

6-1- family Phasiandae

1-Alectoris chukar

2-Coturnix coturnix

Chukar

Quail

حجل شنار

فر، مريعي

7- Order Gruiformes

7-1- family Rallidae

1-Rallus aquaticus

2-Porzana parva

3-Porzana pusilla

4-Crex crex

5-Gallinula chloropus

6-Fulica atra

Water Rail

Little Crake

Baillon's Crake

Corncrake

Moorhen

Coot

مرعة الماء

مرعة صغيرة

مرعة بليون

مرعة الغلة

نجاغة الماء، مصفرد

غرة

7-2- family Gruidae

1-Grus grus

Crane

كركي

7-3- family Otidae

1-Chlamydotis undulata

Houbara

حباري،

8- Order Charadriiformes

8-1- family Haematopodidae

- 1- *Haematopus ostragalus* Oystercatcher

صبياد النحار

8-2- Recurvirostridae

- 1- *Himantopus himantopus* Black-winged Stilt
2- *Recurvirostra avosetta* Avocet

كرسبرع ابر مغازل

نكات

8-3- family Glareolidae

8-3-1- subfamily Cursoriinae

- 1- *Cursorius cursor* Cream-coloured Courser

درج صحراوي

8-3-2- subfamily Glareolinae

- 1- *Glareola pratincola* Collared Pratincole
2- *Glareola nordmanni* Black-winged Pratincole

أبو النيسر المطوق

أبو النيسر أسود الجناح

8-4- family Charadriidae

8-4-1- subfamily Charadrinae

- 1- *Charadrius dubius* Little Ringed Plover
2- *Charadrius hiaticula* Ringed Plover
3- *Charadrius alexandrinus* Kentish Plover
4- *Charadrius leschenaulti* Greater Sand Plover
5- *Charadrius morinellus* Dotterel

زقزاق مطوق صغير

زقزاق مطوق كبير

زقزاق اسكندراني

زقزاق الرمل الكبير

زقزاق أغبر

8-4-2- subfamily Vanellinae

- 1- *Haplopterus spinosus* Spur-Winged Plover
2- *Pluvialis squatarola* Grey Plover
3- *Chettusia leucura* White-tailed Plover
4- *Vanellus vanellus* Lapwing

أبو ظفر

زقزاق أبيض الذنب

زقزاق شامي

8-5- family Scolopacidae

8-5-1- subfamily Calidrinidae

- 1- *Calidris minuta* Little Stint
2- *Calidris temminckii* Temminck's Stint
3- *Calidris ferruginea* Curlew Sandpiper
4- *Calidris alpina* Dunlin
5- *Limicola falcinellus* Broad-billed Sandpiper

فطيرة صغيرة

فطيرة تمناك

طييطوي كروانية

درجة

طييطوي عريضة المنقار

8-5-2- subfamily Gallinaginae

- 1- *Lymnocyrtus minimus* Jack Snipe

شنقب صغير

2- <i>Gallinago gallinago</i>	Snipe	شنقب شائع
3- <i>Gallinago media</i>	Great Snipe	
4- <i>Gallinago stenura</i>	Pintail Snipe	شنقب كبير
8-5-3- subfamily <i>Tringinae</i>		
1- <i>Limosa limosa</i>	Black-tailed Godwit	بقويقة سوداء الذنب
2- <i>Numenius arquata</i>	Curlew	كروان الماء
3- <i>Tringa erythropus</i>	Spotted Redshank	طيوطي منقط أحمر الساق
4- <i>Tringa totanus</i>	Redshank	طيوطي أحمر الساق
5- <i>Tringa stagnatilis</i>	Marsh Sandpiper	طيوطي البطائح
6- <i>Tringa nebularia</i>	Greenshank	طيوطي أخضر الساق
7- <i>Tringa ochropus</i>	Green Sandpiper	طيوطي أخضر
3- <i>Tringa glareola</i>	Wood Sandpiper	طيوطي الفياض، طيوطي الغابة
9- <i>Xenus cinereus</i>	Terek Sandpiper	طيوطي معنوف المنقار
10- <i>Actitis hypoleucos</i>	Common Sandpiper	طيوطي شائع
11- <i>Philomachus pugnax</i>	Ruff	حجولة، شني
8-5-4- subfamily <i>Phalaropodinae</i>		
1- <i>Phalaropus lobatus</i>	Red-necked Phalarope	فالاروب أحمر الرقبة

8-6- family *Laridae*

1- <i>Larus minutus</i>	Little Gull	نورس صغير
2- <i>Larus ridibundus</i>	Black-headed Gull	نورس أسود الرأس
3- <i>Larus genei</i>	Slender-billed Gull	نورس دقيق المنقار
4- <i>Larus canus</i>	Common Gull	
5- <i>Larus fuscus</i>	Lesser Black-backed Gull	نورس أسود الظهر
6- <i>Larus argentatus</i>	Herring Gull	نورس فضي

8-7- family *Sternidae*

1- <i>Gelochelidon nilotica</i>	Gull-billed Tern	خطاف نورسي المنقار
2- <i>Sterna caspia</i>	Caspian Tern	
3- <i>Sterna hirundo</i>	Common Tern	خطاف شائع
4- <i>Sterna albifrons</i>	Little Tern	خطاف صغير
5- <i>Chlidonias hybridus</i>	Whiskered Tern	خطاف أبيض الخد
6- <i>Chlidonias niger</i>	Black Tern	خطاف المستنقعات
7- <i>Chlidonias leucopterus</i>	White-winged Black Tern	خطاف أسود أبيض الجناح

9- Order *Pteroclidiformes*

9-1- family *Pteroclididae*

1- <i>Pterocles orientalis</i>	Black-bellied Sandgrouse
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2-*Pterocles senegallus*

Spotted Sandgrouse

قطا منقط

3-*Pterocles alchata*

Pin-tailed Sandgrouse

قطا عراقي

10- Order Columbiformes

10-1- family Columbidae

1-*Columba oenas*

Stock dove

حمام اعتيادي

2-*Streptopelia decaocto*

Collared dove

حمام مطوق

3-*Streptopelia turtur*

Turtle dove

حمام رقطي

4-*Streptopelia senegalensis*

Laughing Dove

حمام حمري

5-*Columba livia*

Rock Dove

11- Order Strigiformes

11-1- family Tytonidae

1-*Tyto alba*

Barn Owl

بومة بيضاء/هامة

11-2- family Strigidae

11-2-1- subfamily buboninae

1-*Athene noctua*

Little Owl

بومة صغيرة

12- Order Caprimulgiformes

12-1- family Caprimulgidae

12-1-1- subfamily Caprimulginae

1-*Caprimulgus europaeus*

Nightjar

سبد شائع

2-*Caprimulgus aegyptius*

Egyptian Nightjar

سبد مصري

13- Order Apodiformes

13-1- family Apodidae

13-1-1- subfamily Apodinae

1-*Apus apus*

Swift

سمامة شائعة

14- Order Coraciiformes

14-1- family Alcedinidae

14-1-1- subfamily Alcedininae

1-*Alcedo atthis*

Kingfisher

سماك أخضر

14-1-2- subfamily Cerylinae

1-*Ceryle rudis*

Pied Kingfisher

سماك أبقع

14-2- family Meropidae

1-*Merops superciliosus*

Blue-cheeked Bee-eater

وروار أزرق الخد

2-	<i>Merops apiaster</i>	Bee-eater	وروار شائع
14-3-	family <i>Upupidae</i>		
1-	<i>Upupa epops</i>	Hoopoe	هدد

15- Order Piciformes

15-1-	family <i>Picidae</i>		
15-1-1-	subfamily <i>Jynginae</i>		
1-	<i>Jynx torquilla</i>	Wryneck	لواء

16- Order Passeriformes

16-1- family *Alaudidae*

1-	<i>Ammomanes deserti</i>	Desert Lark	قبرة انصحراء
2-	<i>Ammomanes cincturus</i>	Bar-tailed Desert Lark	
3-	<i>Alaemon alaudipes</i>	Hoopoe Lark	قبرة منحية المنقار
4-	<i>Rhamphocoris clotbey</i>	Thick-billed Lark	قبرة هدهدية
5-	<i>Melanocorypha calendra</i>	Calandra Lark	قبرة الشرق الكبير
6-	<i>Melanocorypha himaculata</i>	Bimaculated Lark	قبرة الشرق الصغيرة
7-	<i>Calandrella brachydactyla</i>	Short-toed Lark	قبرة قصيرة الأصابع
8-	<i>Calandrella rufescens</i>	Lesser Short-toed Lark	قبرة قصيرة الأصابع الصغيرة
9-	<i>Galerida cristata</i>	Crested lark	قبرة متوجة
10-	<i>Alauda arvensis</i>	Skylark	قبرة الحقن
11-	<i>Eremophila bilopha</i>	Temminck's Horned Lark	قبرة مقرنة
12-	<i>Eremalauda dunni</i>	Dunn's Lark	

16-2- family *Hirundidae*

1-	<i>Riparia riparia</i>	Sand Martin	خطاف الشاطئ
2-	<i>Hirundo rustica</i>	Swallow	سنونو شائع
3-	<i>Hirundo daurica</i>	Red-rumped Swallow	سنونو أحمر العجز
4-	<i>Delichon urbica</i>	House Martin	خطاف الليبوت

16-3- family *Motacillidae*

1-	<i>Anthus novaeseelandiae</i>	Richard's Pipit	أبو تمرة ريتشارد
2-	<i>Anthus trivialis</i>	Tree Pipit	أبو تمرة الأشجار
3-	<i>Anthus cervinus</i>	Red-throated Pipit	أبو تمرة أحمر الزور
4-	<i>Anthus spinoletta</i>	Water Pipet	أبو تمرة للماء

5-Motacilla flava

Yellow Wagtail

ذعرة صفراء

6-Motacilla citreola

Citrine Wagtail

ذعرة صفراء الرأس

7-Motacilla alba

Pied / White Wagtail

ذعرة بيضاء

ذعرة مبقعة

16-4 family Pycnonotidae

1-Pycnonotus xanthopygos

Yellow-vented Bulbul

بلبل أصفر المخرج

16-5 family Turdidae

1-Cercotrichas galactotes

Rufous Bush Robin

هازجة محمرة الذنب

2-Erithacus rubecula

Robin

أبو الحن أحمر الصدر

3-Luscinia luscinia

Thrush nightingale

عندليب

4-Luscinia megarhynchos

Nightingale

هزار

5-Luscinia svecica

Bluethroat

6-Irania gutturalis

White-throat

أبو الحن أبيض الزور

7-Phoenicurus ochruros

Black Redstart

حميراء سوداء

3-Phoenicurus phoenicurus

Redstart

حميراء

9-Saxicola rubetra

Whinchat

قنبيعي أحمر

10-Saxicola torquata

Stonechat

قنبيعي مطوق

11-Oenanthe isabellina

Isabelline Wheatear

أبلق أشهب

12-Oenanthe oenanthe

Wheatear

أبلق اعتيادي

13-Oenanthe pleschanka

Pied Wheatear

أبلق أبقع

14-Oenanthe hispanica

Black-eared Wheatear

أبلق أسود الأذن

15-Oenanthe deserti

Desert Wheatear

أبلق انبادية

16-Oenanthe finschii

Finsch Wheatear

أبلق عربي

17-Oenanthe moesta

Red-rumped Wheatear

18-Oenanthe cypriarica

Cyprus Pied Wheatear

19-Turdus merula

Blackbird

شحرور

20-Turdus pilaris

Fieldfare

دج

21-Turdus philomelos

Song Thrush

سمنة مغردة

22-Turdus iliacus

Redwing

16-6 family Laniidae

1-Lanius excubiter

Great Grey Shrike

صرد رمادي أبقع

2-Lanius isabellinus

Isabelline Shrike

3-Lanius nubicus

Masked Shrike

صرد مقنع

4-Lanius senator

Woodchat Shrike

صرد أحمر القنة

5-Lanius collurio

Red-backed Shrike

صرد أحمر الظهر

16-7- family Sylviidae

1-Acrocephalus scirpaceus	Reed Warbler	هازجة القصب
2-Acrocephalus arundinaceus	Great Reed Warbler	هازجة القصب الكبير
3-Acrocephalus melanopogon	Moustached Warbler	هازجة أم الشارب
4-Acrocephalus schoenobaenus	Sedge Warbler	هازجة أم السعد
5-Cettia cetti	Cetti's Warbler	هازجة شيتي
6-Prinia gracilis	Graceful Warbler	
7-Scotocerca inquieta	Scrub Warbler	هازجة الشجيرات
8-Hippolais languida	Upcher's Warbler	
9-Hippolais pallida	Olivaceous Warbler	خنشع زيتوني باهت
10-Sylvia communis	Whitethroat	زريقة فيرانية
11-Sylvia curruca	Lesser Whitethroat	زريقة فيرانية صغرى
12-Sylvia borin	Garden Warbler	هازجة الحديقة
13-Sylvia nisoria	Barred Warbler	هازجة موشمة
14-Sylvia atricapilla	Blackcap	أبو قلنسوة
15-Sylvia mysticae	Menetries' Warbler	هازجة منيتري
16-Sylvia melanocephala	Sardinian Warbler	هازجة سردينيا
17-Sylvia melanothorax	Cyprus Warbler	
18-Phylloscopus trochilus	Willow Warbler	نقشارة الصفصاف
19-Phylloscopus collybita	Chiffchaff	سكسكة

16-8- family Muscicapidae

1-Muscicapa striata	Spotted Flycatcher	خاطف الذباب المنقط
2-Ficedula hypoleuca	Pied Flycatcher	خاطف الذباب الأبقع

family Remizidae

1-Remiz pendulinus	Penduline Tit	
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16-9- family Emberizidae

1-Miliaria calandra	Corn Bunting	درسة مانوفة
2-Emberiza melanocephala	Blackheaded Bunting	درسة سوداء الرأس
3-Emberiza schoeniculus	Reed Bunting	درسة القصب

16-10- family Fringillidae

1-Fringilla coelebs	Chaffinch	عصفور ظالم
2-Fringilla montifringilla	Brambling	
3-Rhodopechys obsoleta	Desert Finch	عصفور وردي صحراوي
4-Rhodopechys githaginea	Trumpeter Finch	زمير وردي
5-Carduelis cannabina	Linnet	عصفور تقاحي
6-Serinus syriacus	Syrian serin	كناري سوري

1-Carpodacus synoicus

Sinai Rosefinch

عصفور وردى سينائي

16-11- family Ploceidae

1-Passer hispaniolensis

Spanish Sparrow

دوري اسباني

2-Passer domesticus

House Sparrow

عصفور دوري

16-12- family Sturnidae

1-Sturnus vulgaris

Starling

زرزور أوروبي

16-13- family Oriolidae

1-Oriolus oriolus

Golden Oriole

صغير، عصفور التوت

16-14- family Corvidae

1-Garrulus glandarius

Jay

قيق، أبو زريق

2-Corvus monedula

Jackdaw

غراب النزع

Policies undertaken by the Management Plan should:

1. To clearly demonstrate the direct dependent relationship of birds to the water bodies of the Wetlands.
2. To periodically analyze and record any fluctuation that might occur in the water body in regard to water quality (pH, salinity, contaminants ...).
3. To periodically analyze and record any fluctuation in the planktonic community due to the dependency of some bird species () on phyto-and zooplanktons as a source of food.
4. To ensure the sustainability of the water plants namely (.....) since many species seek refuge, and lay their eggs in reeds and other plant species.
5. To ensure, enforce environmental legislation that safeguards the ecological existence of birds, by preventing hunting and egg collecting.
6. To record any violation and guard the surrounding micro and macrohabitats, due to the dependency of several species.
On the vicinity of the reserve, in terms of nest building, mating and territorial significance.
7. To encourage positive attitude towards the environment in terms of bird watching, photography and identification of species.
8. To record any new species or arrivals to the Azraq Wetlands. New arrivals is significant to the overall status of the Wetlands.
9. To monitor seasonally the birds population dynamics, fluctuations, number of arrivals and establish linkages to water quality, surrounding habitats and feeding interactions.

3.2.10 Vegetation:

A list of the plant species occurring at the Azraq Wetlands is given in annex (). Al-Eisawi conducted a taxonomical survey in which he recorded the presence of 34 families, 100 genera and 133 species of plants. The majority of the species recorded are terrestrial including salt tolerant species, silt dune species, water boarder, submerged and floating plant species.

136 species of plants were recorded in the Wetland Reserve 7 of which were recorded as new to the flora at Jordan. An overall assessment of the vegetation survey suggested that the dominant species were: *Phragmites australis*, *Polypogon Aeluropus littoralis*, *Juncus maritimus*, *Nitraria retus*, *Spergularia salina*, *Alhagi maurorum*, *Tamerix passerinoides* and *Tamarix tetragyna*.

The most frequent species was *Aeluropus littoralis*, *Juncus maritimus*, *Nitraria retusa*, *Phragmites australis*, *Spergularia Salina*, *Tamarix passerinoides* and *Tamarix tetragyna*.

The most abundant was *Phragmites australis* and the most dense species was also *Phragmites australis* followed by *Polypogon monspeliensis*.

As for the dryland vegetation, the dominant species was *Nitraria retusa*, although the total number of individuals recorded was largest in *Aeluropus littoralis* followed by *Juncus maritimus*, *Nitraria retusa*, *Alhagi maurorum*, *Tamarix passerinoides* and *Limonium meyeri*.

It was clear from the vegetation analysis in the drylands habitat that the most frequent species was *Aeluropus littoralis*, followed by *Nitraria retusa*, *Juncus maritimus* and *Tamarix passerinoides*.

In the silt dune habitat, the dominant vegetation was recorded as *Nitraria retusa* and *Tamarix passerinoides*. It was obvious that *Nitraria retusa* becomes more dominant in dry habitats, while *Tamarix passerinoides* is the dominant species in more humid habitats. Both species are saline tolerant. *Tamarix passerinoides* tends to grow towards the Qa' habitat an area which is subjected to floods under natural conditions. As for the species recorded in the Rocky Limestone habitat (which is a subdivision of the dryland) it was recorded that an area of about 100-200 m² is occupied by different vegetation species. This habitat is dominated by two main species: *Limonium meryeri* and *Inula crithmoides*. In some other places those species were associated with *Halocnemum strobilaceum*.

The vegetation of the Qa border indicated that this habitat is dominated by *Halopeplis amplexicaulis*, *Suaeda asphaltica* and others, while if one moves to closer to the Qa, the leading species becomes *Tamarix passerinoides* and *Halocnemum strobilaceum*.

The freshwater vegetation occurs in the main place of the permanent water pools near Al-Qayseih and Ain-Soda, where the water is usually potable due to low amounts of salinity. The dominant species were recorded as *Typha domingensis*, *Phragmites australis*, *Juncus acutus*, *J. maritimus*, *Imperata cylindrica*, *Sonchus maritimus* and *Inula crithmoides*.

The vegetation species of the Brackish water consisted of *Chara sp.*, *Ruppia chirrosa*, *R. maritima*, *Zannichellia palustris* and *Scirpus maritimus*. It is important to mention here that the water is very rich in salts, where TDS exceeded 5000 ppm. In the shallow parts of some water bodies, the bryophyte *Riella cf. cossoniana* was covering the ground totally. In the Inglesi water canal, the aquatic flowering plant *Ranunculus aquatilis* was floating in massive batches.

The margins of the water bodies was always dominated by *Tamarix tetragyna* or *T. amplexicaulis* in association with *Phragmites australis*, *Juncus maritimus*.

Based on the survey carried out during the period between February and June, a total number of one hundred thirty three (133) species of vascular plants belonging to one hundred (100) genera and thirty three (33) families (Fig 3.1). The total list of flora is shown in (table 3.1)

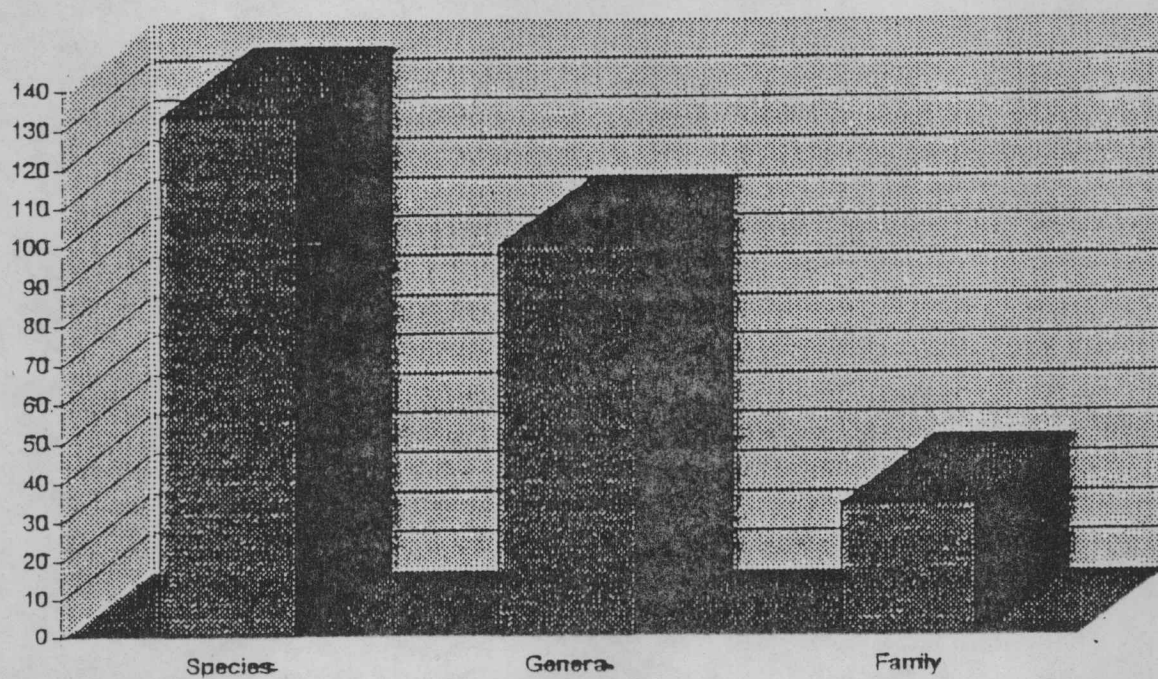
Table 3.1 Showing the Total List of Azraq Wetland Reserve Flora

Aizoaceae	Aizoon	hispanicum	L.
Aizoaceae	Mesembryanthemum	nodiflorum	L.
Arecaceae	Phoenix	dactylifera	L.
Boraginaceae	Gastrocotyle	hispida	(Forskal) C.B. Clarke
Boraginaceae	Lappula	spinocarpos	(Forskal) O. Kuntze
Caryophyllaceae	Hemiaria	hirsuta	L.
Caryophyllaceae	Spergularia	dlandra	(Guss.) Heldr. & Sart.
Caryophyllaceae	Spergularia	marina	(L.) Griseb.
Chenopodiaceae	Atriplex	hallmus	(Pallas) M.Beib
Chenopodiaceae	Atriplex	leucoclada	L.
Chenopodiaceae	Atriplex	semibaccata	Boiss.
Chenopodiaceae	Bassia	muricata	R. Br.
Chenopodiaceae	Chenopodium	album	L.
Chenopodiaceae	Chenopodium	murale	L.
Chenopodiaceae	Chenopodium	vulvaria	L.
Chenopodiaceae	Halocnemum	strobilaceum	L.
Chenopodiaceae	Halopeplis	amplexicaulis	(Forskal) Bge ex Schweinf
Chenopodiaceae	Salsola	jordanicola	Eig
Chenopodiaceae	Schlingia	sp.	
Chenopodiaceae	Saidlitzia	rosmarinus	Boiss.
Chenopodiaceae	Senniella	spongiosa	(F.V. Muell.) Allen
Chenopodiaceae	Suaeda	asphaltica	(Boiss.) Boiss.
Chenopodiaceae	Suaeda	fruticosa	Forskal ex J.E. Guel
Compositae	Aaronsohnia	factorovskyi	Wartb. & Eig
Compositae	Achillea	fragrantissima	(Forskal) Schultz Bip.
Compositae	Anthemis	bommullert	Stoj & Acht
Compositae	Anthemis	cf. hyalina	DC.
Compositae	Anthemis	hausknechtii	Boiss. & Reut.

Compositae	<i>Anthemis</i>	<i>melampodina</i>	Delile
Compositae	<i>Artemisia</i>	<i>herba-alba</i>	Asso
Compositae	<i>Aster</i>	<i>subulatus</i>	Michx.
Compositae	<i>Calendula</i>	<i>tripterocarpa</i>	Rupr.
Compositae	<i>Centaurea</i>	<i>cf. lanulata</i>	Eig
Compositae	<i>Cirsium</i>	<i>alatum</i>	(S. G. Guel.) Bobrov
Compositae	<i>Crepis</i>	<i>senecioides</i>	Delile
Compositae	<i>Filago</i>	<i>contracta</i>	(Boiss.) Chrtk & Holub
Compositae	<i>Filago</i>	<i>desertorum</i>	Pomel
Compositae	<i>Filago</i>	<i>inexpectata</i>	Wagenitz
Compositae	<i>Gymnanthemum</i>	<i>micrantha</i>	Desf.
Compositae	<i>Inula</i>	<i>crithmoides</i>	L
Compositae	<i>Koeleria</i>	<i>linearis</i>	Pallas
Compositae	<i>Lactuca</i>	<i>seriola</i>	L
Compositae	<i>Lasiopogon</i>	<i>muscoides</i>	(Desf.) DC.
Compositae	<i>Launaea</i>	<i>nudicaulis</i>	(L.) Hooker fil.
Compositae	<i>Leontodon</i>	<i>laciniatus</i>	(Bertol.) Widder ex Bomm
Compositae	<i>Matricaria</i>	<i>aurea</i>	(Loefl.) Schultz Bip.
Compositae	<i>Picris</i>	<i>cyanocarpa</i>	Boiss.
Compositae	<i>Reichardia</i>	<i>intermedia</i>	(Sch. Bip.) Coutinho
Compositae	<i>Reichardia</i>	<i>tingitana</i>	(L.) Roth.
Compositae	<i>Senecio</i>	<i>glaucus</i>	L
Compositae	<i>Sonchus</i>	<i>maritimus</i>	L
Compositae	<i>Sonchus</i>	<i>oleraceus</i>	L
Convolvulaceae	<i>Cressa</i>	<i>cretica</i>	L
Cruciferae	<i>Diplotaxis</i>	<i>hansa</i>	(Forsk.) Boiss.
Cruciferae	<i>Erucaria</i>	<i>boveana</i>	Cosson
Cruciferae	<i>Lepidium</i>	<i>aucheri</i>	Boiss.
Cruciferae	<i>Lepidium</i>	<i>sativum</i>	L
Cruciferae	<i>Matthiola</i>	<i>livida</i>	(Delile) DC.
Cruciferae	<i>Torularia</i>	<i>torulosa</i>	(Desf.) O. Schultz
Cruciferae	<i>Notoceras</i>	<i>bicorne</i>	(Solander) Caruel
Cruciferae	<i>Sisymbrium</i>	<i>runcinatum</i>	Lag.
Cruciferae	<i>Sisymbrium</i>	<i>speculum</i>	DC.
Cruciferae	<i>Zilla</i>	<i>spinosa</i>	(L.) Prantl
Cyperaceae	<i>Carex</i>	<i>divisa</i>	Hudson
Cyperaceae	<i>Cyperus</i>	<i>laevigatus</i>	L
Cyperaceae	<i>Scirpus</i>	<i>maritimus</i>	L
Frankeniaceae	<i>Frankenia</i>	<i>hirsuta</i>	L
Frankeniaceae	<i>Frankenia</i>	<i>laevis</i>	L
Frankeniaceae	<i>Frankenia</i>	<i>pulverulenta</i>	L
Geraniaceae	<i>Erodium</i>	<i>glaucophyllum</i>	(L.) L'Her.
Gramineae	<i>Aeluropus</i>	<i>littoralis</i>	(Gouan) Parl.
Gramineae	<i>Bromus</i>	<i>madritensis</i>	L
Gramineae	<i>Corynephorus</i>	<i>divaricatus</i>	(Poir.) Breistr.
Gramineae	<i>Cynodon</i>	<i>dactylon</i>	(L.) Pers.
Gramineae	<i>Eremopyrum</i>	<i>bonaepartis</i>	(Sprengel) Nevski
Gramineae	<i>Eremopyrum</i>	<i>distans</i>	(C. Koch) Nevski

Tamaricaceae	<i>Tamarix</i>	<i>passerinoides</i>	Delile ex Desv.
Tamaricaceae	<i>Tamarix</i>	<i>tetragyna</i>	Ehrenb.
Typhaceae	<i>Typha</i>	<i>domingensis</i>	(Pers.) Steudel
Umbelliferae	<i>Pterosolinum</i>	<i>crispum cult.</i>	(Mill.) Mausf.
Valerianaceae	<i>Valerianella</i>	<i>oxyrhyncha</i>	Fischer & C.A. Meyer
Zannichelliaceae	<i>Zannichellia</i>	<i>palustris</i>	L.
Zygophyllaceae	<i>Nitraria</i>	<i>retusa</i>	(Forsk.) Ascherson
Zygophyllaceae	<i>Nitraria</i>	<i>schoberi</i>	L.
Zygophyllaceae	<i>Peganum</i>	<i>harmala</i>	L.
Zygophyllaceae	<i>Zygophyllum</i>	<i>fabago</i>	L.

Fig. 3.1 Showing Total Number of Families, Genera and Species



Total number of	Family	Genera	Species
	34	100	133

Table 3.2 Showing the Number and Percentage of Species Belonging to Each Family

Family	Number of Species	The Percentage of Each Family
Aizoaceae	2	1.50
Arecaceae	1	0.75
Boraginaceae	2	1.50
Caryophyllaceae	3	2.26
Chenopodiaceae	15	11.28
Compositae	29	21.80
Convolvulaceae	1	0.75
Cruciferae	10	7.52
Cyperaceae	3	2.26
Frankeniaceae	3	2.26
Geraniaceae	1	0.75
Gramineae	20	15.04
Juncaceae	4	3.01
Labiatae	1	0.75
Leguminosae	8	6.02
Liliaceae	1	0.75
Lythraceae	1	0.75
Malvaceae	2	1.50
Papaveraceae	1	0.75
Plantaginaceae	2	1.50
Plumbaginaceae	3	2.26
Polygonaceae	1	0.75
Primulaceae	1	0.75
Ranunculaceae	2	1.50
Resedaceae	1	0.75
Ruppiaceae	3	2.26
Scrophulariaceae	1	0.75
Solanaceae	1	0.75
Tamaricaceae	4	3.01
Typhaceae	1	0.75
Umbelliferae	1	0.75
Valerianaceae	1	0.75
Zannichelliaceae	1	0.75
Zygophyllaceae	4	3.01

Fig. 1.2 Showing the Distribution of Taxa in Relation to Their Families, Genera and Species

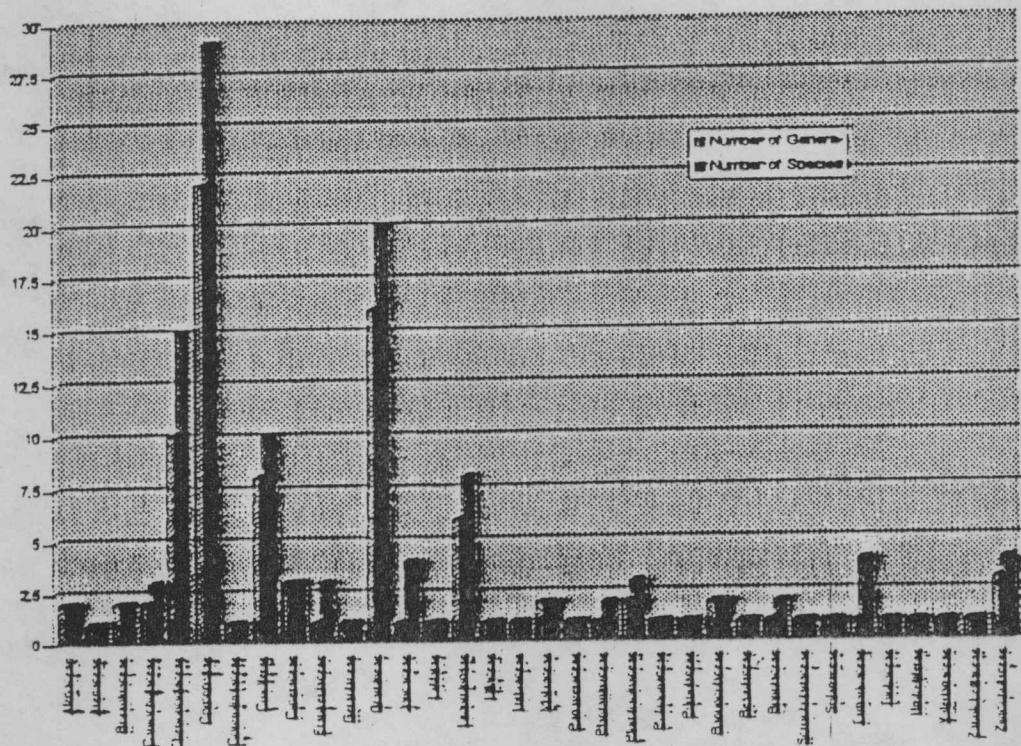


Table 3.3. Showing all species in relation to their phenology and vegetation structure

Number	Species Composition	Family	A	B	C	D	E	F	G	H	I
1	<i>Aizoon hispanicum</i>	Aizoaceae	3	6	1	3	2	6	4	2	2
2	<i>Mesembryanthemum nodiflorum</i>	Aizoaceae	3	6	2	2	2	4	4	2	2
3	<i>Gastrocotyle hispida</i>	Boraginaceae	3	6	1	3	1	6	4	2	2
4	<i>Lappula spinocarpos</i>	Boraginaceae	3	6	1	4	1	6	4	2	2
5	<i>Hemiana hirsuta</i>	Caryophyllaceae	3	6	1	3	1	4	4	2	2
6	<i>Spergularia diandra</i>	Caryophyllaceae	3	6	1	3	1	6	4	2	2
7	<i>Spergularia salina</i>	Caryophyllaceae	3	6	1	1	1	4	2	5	3
8	<i>Halocnemum strobilaceum</i>	Chenopodiaceae	4	4	2	1	1	6	2	2	2
9	<i>Atriplex Halimus</i>	Chenopodiaceae	2	5	1	1	1	5	4	3	2
10	<i>Atriplex leucoclada</i>	Chenopodiaceae	4	2	1	1	1	6	4	3	2
11	<i>Atriplex semibaccata</i>	Chenopodiaceae	3	3	3	3	1	6	8	5	3
12	<i>Bassia muricata</i>	Chenopodiaceae	3	6	1	1	1	6	4	2	2
13	<i>Chenopodium album</i>	Chenopodiaceae	3	6	1	2	2	4	4	5	5
14	<i>Chenopodium murale</i>	Chenopodiaceae	3	6	1	2	2	4	4	5	5
15	<i>Chenopodium vulvaria</i>	Chenopodiaceae	3	6	1	2	2	4	4	5	5
16	<i>Halopeltis amplexicaulis</i>	Chenopodiaceae	3	6	2	1	2	7	8	2	2
17	<i>Salsola jordanicola</i>	Chenopodiaceae	3	6	1	1	1	6	3	2	2
18	<i>Schimgia sp.</i>	Chenopodiaceae	3	6	1	3	2	7	1	2	2
19	<i>Sedlitzia rosmarinus</i>	Chenopodiaceae	4	4	1	1	1	6	4	4	1
20	<i>Senniella spongiosa</i>	Chenopodiaceae	3	3	3	3	1	6	1	2	2
22	<i>Suaeda aspratifica</i>	Chenopodiaceae	4	1	1	2	2	7	4	2	2
23	<i>Suaeda fruticosa</i>	Chenopodiaceae	4	4	1	2	1	6	4	2	2
25	<i>Aaronsonnia factorovskii</i>	Compositae	3	6	1	2	1	6	4	2	2
26	<i>Achillea fragrantissima</i>	Compositae	4	1	2	1	1	4	4	2	2
27	<i>Anthemis bommulleri</i>	Compositae	3	6	1	2	2	2	4	2	2
28	<i>Anthemis haussknechtii</i>	Compositae	3	6	1	2	2	2	4	2	2
29	<i>Anthemis cf. hyalina</i>	Compositae	3	6	1	2	2	2	4	2	2
30	<i>Anthemis melampodina</i>	Compositae	3	6	1	2	2	2	4	2	2
31	<i>Artemisia herba-alba</i>	Compositae	4	2	2	1	1	4	4	3	1
32	<i>Aster subulatus</i>	Compositae	3	6	1	1	1	6	2	2	2
33	<i>Calendula tripterocarpa</i>	Compositae	3	6	1	3	1	4	4	5	3
34	<i>Centaurea cf. lanulata</i>	Compositae	4	1	1	1	1	6	5	2	2
35	<i>Cirsium alatum</i>	Compositae	3	6	1	2	1	6	1	5	3
36	<i>Crepis senecioides</i>	Compositae	3	6	1	3	1	4	4	2	2
37	<i>Elago contracta</i>	Compositae	3	6	1	3	1	6	4	2	2
38	<i>Elago desertorum</i>	Compositae	3	6	1	2	1	6	4	2	2
39	<i>Elago inexpectata</i>	Compositae	3	6	1	2	1	6	4	2	2
40	<i>Gymnanthemum micrantha</i>	Compositae	3	6	1	3	1	6	4	2	2
41	<i>Inula crithmoides</i>	Compositae	4	4	2	2	1	4	2	2	2
42	<i>Koeleria linearis</i>	Compositae	3	6	1	2	1	6	4	2	2
43	<i>Lactuca serotia</i>	Compositae	3	6	1	1	1	6	4	2	2
44	<i>Lasiopogon muscoides</i>	Compositae	3	6	1	2	1	7	5	2	2

45	<i>Launaea nudicaulis</i>	Compositae	3	6	1	1	1	6	4	3	5
46	<i>Leontodon laciniatus</i>	Compositae	3	6	1	2	1	6	4	2	2
47	<i>Matricaria aurea</i>	Compositae	3	6	2	3	1	4	4	2	2
48	<i>Picris cyanocarpa</i>	Compositae	3	6	1	2	1	6	4	2	2
49	<i>Reichardia intermedia</i>	Compositae	3	6	1	2	1	6	5	2	2
50	<i>Reichardia tingitana</i>	Compositae	3	6	1	2	1	6	4	2	2
51	<i>Senecio glaucus</i>	Compositae	3	6	1	3	1	4	4	2	2
52	<i>Sonchus maritimus</i>	Compositae	3	4	3	2	1	6	2	2	2
53	<i>Sonchus oleraceus</i>	Compositae	3	6	1	3	1	4	4	2	2
54	<i>Cressa cretica</i>	Convolvulaceae	3	3	1	2	2	4	8	2	2
55	<i>Diplotaxis harra</i>	Cruciferae	3	6	1	2	1	5	4	2	2
56	<i>Erucana boveana</i>	Cruciferae	3	6	1	3	1	5	4	2	2
57	<i>Lepidium aucheri</i>	Cruciferae	3	6	1	2	1	5	4	3	3
58	<i>Lepidium sativum</i>	Cruciferae	3	6	1	3	1	5	5	2	2
59	<i>Matthiola livida</i>	Cruciferae	3	6	1	2	1	2	4	2	2
60	<i>Notoceras bicomme</i>	Cruciferae	3	6	1	2	1	6	4	2	2
61	<i>Sisymbrium runcinatum</i>	Cruciferae	3	6	1	3	1	6	4	2	2
62	<i>Sisymbrium speculum</i>	Cruciferae	3	6	1	2	1	6	5	2	2
63	<i>Torularia torulosa</i>	Cruciferae	3	6	1	3	1	6	4	2	2
64	<i>Zilla spinosa</i>	Cruciferae	3	3	1	1	1	6	4	2	2
65	<i>Carex divisia</i>	Cyperaceae	5	4	2	2	1	6	2	5	3
66	<i>Cyperus laevigatus</i>	Cyperaceae	5	4	2	2	1	6	2	5	3
67	<i>Scirpus maritimus</i>	Cyperaceae	9	4	4	2	1	6	8	5	3
68	<i>Frankenia hirsuta</i>	Frankeniaceae	3	4	1	2	1	6	8	2	2
69	<i>Frankenia laevis</i>	Frankeniaceae	4	4	1	2	1	6	8	2	2
70	<i>Frankenia pulverulenta</i>	Frankeniaceae	3	6	1	2	1	6	8	2	2
71	<i>Erodium glaucophyllum</i>	Geraniaceae	3	6	1	3	1	6	4	2	2
72	<i>Aeluropus littoralis</i>	Gramineae	4	6	4	1	1	6	4	2	2
73	<i>Bromus madritensis</i>	Gramineae	6	6	1	2	1	6	4	2	2
74	<i>Corynephorus divaricatus</i>	Gramineae	6	6	2	2	1	6	5	2	2
75	<i>Cynodon dactylon</i>	Gramineae	4	5	3	1	1	6	3	3	3
76	<i>Eremopyrum bonaepartis</i>	Gramineae	6	6	1	2	1	6	4	2	2
77	<i>Eremopyrum distans</i>	Gramineae	6	6	2	2	1	6	4	2	2
78	<i>Hordeum glaucum</i>	Gramineae	6	6	1	2	1	6	4	2	2
79	<i>Hordeum spontaneum</i>	Gramineae	6	6	1	2	1	6	4	2	2
80	<i>Imperata cylindrica</i>	Gramineae	4	6	1	1	1	6	2	2	2
81	<i>Lolium rigidum</i>	Gramineae	6	6	2	2	1	6	4	2	2
82	<i>Parapholis incurvata</i>	Gramineae	6	6	2	2	1	6	8	2	2
83	<i>Phalaris minor</i>	Gramineae	6	6	2	3	1	6	4	2	2
84	<i>Phragmites australis</i>	Gramineae	4	6	3	1	1	6	2	2	3
85	<i>Poa bulbosa</i>	Gramineae	6	4	2	2	1	6	4	2	2
86	<i>Polypogon monspeliensis</i>	Gramineae	6	6	3	2	1	6	4	2	2
88	<i>Polypogon viridis</i>	Gramineae	6	6	2	2	1	6	5	2	2
89	<i>Rostraria berythraea</i>	Gramineae	6	6	1	2	1	6	4	2	2
90	<i>Rostraria cristata</i>	Gramineae	6	6	1	2	1	6	4	2	2
91	<i>Schismus arabicus</i>	Gramineae	4	6	2	2	1	6	4	3	3
92	<i>Stipa capensis</i>	Gramineae	6	6	2	2	1	6	4	2	2

93	<i>Juncus acutus</i>	Juncaceae	5	2	2	3	1	6	2	2	2
94	<i>Juncus bufonius</i>	Juncaceae	6	6	2	2	1	6	2	2	2
95	<i>Juncus maritimus</i>	Juncaceae	5	2	2	3	1	6	2	2	3
96	<i>Juncus subulatus</i>	Juncaceae	5	2	2	3	1	6	2	2	3
97	<i>Salvia lanigera</i>	Labiatae	3	4	1	2	1	4	4	2	2
98	<i>Alhagi maurorum</i>	Laguminosae	3	6	2	1	1	4	4	2	2
99	<i>Astragalus tribuloides</i>	Laguminosae	3	6	1	4	1	6	4	4	1
100	<i>Astragalus cf. trimestris</i>	Laguminosae	3	6	1	2	1	6	5	2	2
101	<i>Lotus halophilus</i>	Laguminosae	3	6	1	1	1	6	2	2	2
102	<i>Meililotus indicus</i>	Laguminosae	3	6	1	3	1	6	4	2	2
103	<i>Prosopis farcta</i>	Laguminosae	4	3	3	1	1	4	4	2	2
104	<i>Trigonella cylindracea</i>	Laguminosae	3	6	1	2	1	5	1	2	2
105	<i>Trigonella stellata</i>	Laguminosae	3	6	1	2	1	6	4	2	2
106	<i>Asparagus sp.</i>	Liliaceae	7	6	2	2	2	2	1	2	2
107	<i>Lythrum tribracteatum</i>	Lythraceae	3	6	1	1	1	6	2	5	3
108	<i>Althaea ludwigii</i>	Malvaceae	3	6	1	2	1	6	4	2	2
109	<i>Malva parviflora</i>	Malvaceae	3	6	1	3	1	5	4	2	2
110	<i>Phoenix dactylifera</i>	Palmae	1	2	1	1	1	5	2	2	2
111	<i>Roemeria hybrida</i>	Papaveraceae	3	6	1	2	1	4	4	2	2
112	<i>Plantago amplexicaulis</i>	Plantaginaceae	3	6	1	2	1	4	5	2	2
113	<i>Plantago coronopus</i>	Plantaginaceae	3	6	1	2	1	6	4	5	3
114	<i>Limonium mayeri</i>	Plumbaginaceae	4	4	3	2	2	7	2	2	2
115	<i>Limonium pruinosum</i>	Plumbaginaceae	4	4	3	1	1	6	2	1	2
116	<i>Psylliostachys spicata</i>	Plumbaginaceae	3	6	1	2	1	6	5	2	2
117	<i>Polygonum patulum</i>	Polygonaceae	3	6	1	2	1	6	4	2	2
119	<i>Caratocapitula falcata</i>	Ranunculaceae	3	6	1	3	1	6	4	2	2
120	<i>Ranunculus aquatilis</i>	Ranunculaceae	9	6	2	2	2	7	5	5	3
121	<i>Oligomeres linifolia</i>	Resedaceae	3	6	1	2	1	6	4	2	2
122	<i>Ruppia cinctosa</i>	Ruppiaaceae	9	6	4	3	2	7	1	5	3
123	<i>Ruppia maritima</i>	Ruppiaaceae	9	6	4	3	2	7	2	5	3
124	<i>Chaenorthium sp.</i>	Scrophulariaceae	3	6	1	2	1	6	5	2	2
125	<i>Hyoscyamus desertorum</i>	Solanaceae	3	6	1	2	2	1	4	2	2
126	<i>Tamarix amplexicaulis</i>	Tamaricaceae	2	2	1	2	1	3	2	5	3
127	<i>Tamarix arborea</i>	Tamaricaceae	1	2	1	1	1	3	2	5	3
128	<i>Tamarix passerinoides</i>	Tamaricaceae	2	1	1	3	1	3	2	5	2
129	<i>Tamarix tetragyna</i>	Tamaricaceae	2	1	2	2	1	3	2	2	3
130	<i>Typha domingensis</i>	Typhaceae	9	2	4	1	1	3	2	5	3
131	<i>Valerianella oxyrhyncha</i>	Valerianaceae	3	6	1	3	1	6	5	2	2
132	<i>Pteroselinum crispum</i>	Umbelliferae	6	6	3	1	2	5	4	2	2
132	<i>Zannichellia palustris</i>	Zannichelliaceae	9	6	3	3	2	6	2	5	3
133	<i>Nitraria retusa</i>	Zygophyllaceae	2	5	3	1	1	6	4	2	2
134	<i>Nitraria schroberi</i>	Zygophyllaceae	2	5	4	2	1	5	1	2	2
135	<i>Peganum harmala</i>	Zygophyllaceae	3	4	1	1	2	1	4	2	2
136	<i>Zygophyllum fabago</i>	Zygophyllaceae	3	3	1	2	1	2	8	2	2

Fig. 3.2 Showing the Status of the Recorded Species in Azraq Wetland Reserve

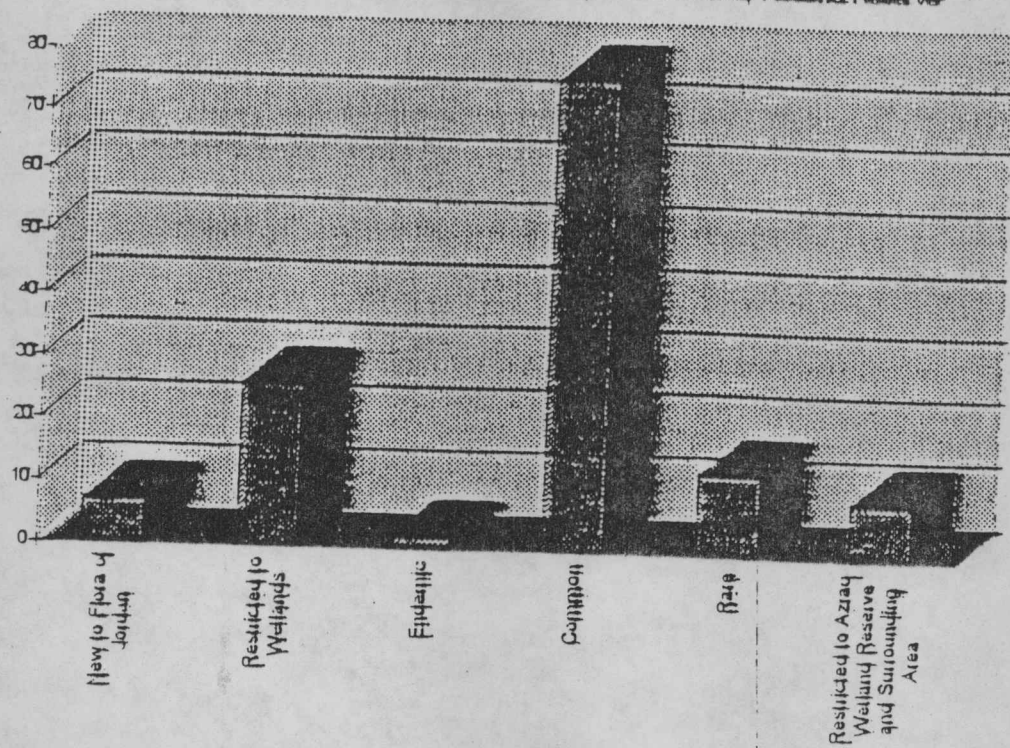
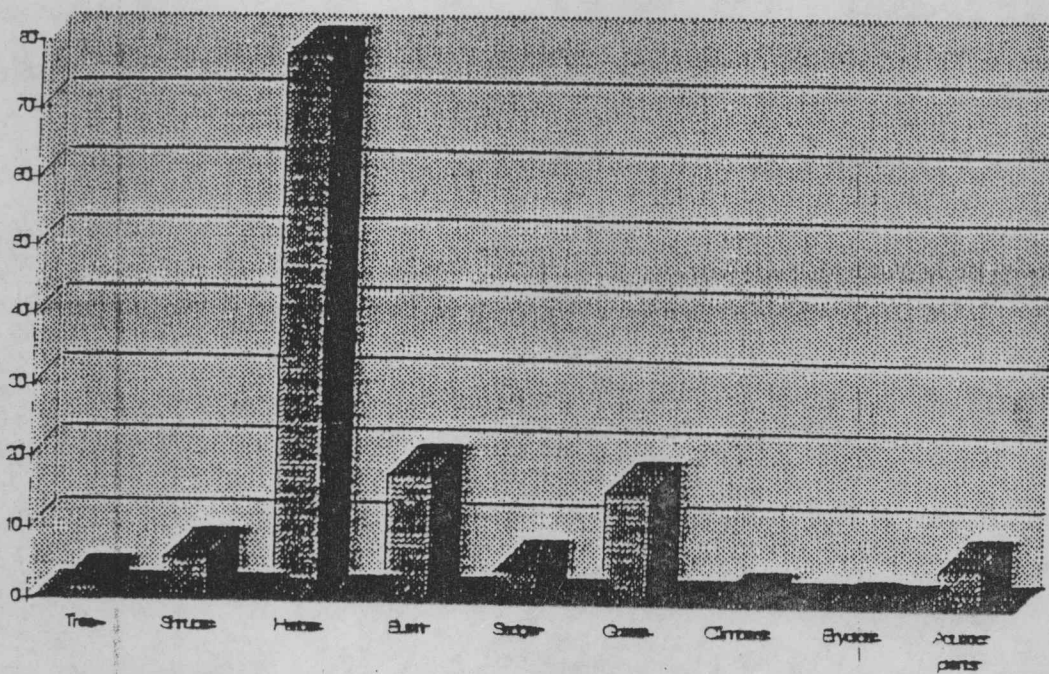


Table 3.4 Showing the Classification of Taxa According to Their Status of Distribution

New to Flora of Jordan	Restricted to Wetlands	Endemic	Common
<i>Asparagus</i> sp.	<i>Aster subulatus</i>	<i>Salsola jordanicola</i>	<i>Aaronsohnia factorovskii</i>
<i>Cirsium alatum</i>	<i>Carex divisa</i>		<i>Achillea fragrantissima</i>
<i>Nitraria schoberi</i>	<i>Cyperus laevigatus</i>		<i>Aeluropus litoralis</i>
<i>Ruppia cinnosa</i>	<i>Halocnemum strobilaceum</i>		<i>Aizoon hispanicum</i>
<i>Schimgia</i> sp.	<i>Imperata cylindrica</i>		<i>Alhagi maurorum</i>
<i>Senniella spongiosa</i>	<i>Inula crithmoides</i>		<i>Althaea ludwigii</i>
<i>Trigonella cylindracea</i>	<i>Juncus acutus</i>		<i>Anthemis bommulleri</i>
	<i>Juncus bufonius</i>		<i>Anthemis haussknechtii</i>
	<i>Juncus maritimus</i>		<i>Anthemis</i> cf. <i>hyalina</i>
	<i>Juncus subulatus</i>		<i>Anthemis melampodina</i>
	<i>Limonium meyeri</i>		<i>Artemisia herba-alba</i>
	<i>Limonium pruinatum</i>		<i>Astragalus tribuloides</i>
	<i>Lotus halophilus</i>		<i>Atriplex Halimus</i>
	<i>Lythrum tribracteatum</i>		<i>Atriplex leucocarpa</i>
	<i>Phoenix dactylifera</i>		<i>Bassia muricata</i>
	<i>Phragmites australis</i>		<i>Bromus madritensis</i>
	<i>Ruppia maritima</i>		<i>Calendula tripterocarpa</i>
	<i>Sonchus maritimus</i>		<i>Ceratocephala falcata</i>
	<i>Spergularia salina</i>		<i>Chenopodium album</i>
	<i>Tamarix amplexicaulis</i>		<i>Chenopodium murale</i>
	<i>Tamarix arborea</i>		<i>Chenopodium vulvaria</i>
	<i>Tamarix passerinoides</i>		<i>Crepis senecioides</i>
	<i>Tamarix tetragyna</i>		<i>Cynodon dactylon</i>
	<i>Typha domingensis</i>		<i>Diploaxis harra</i>
	<i>Zannichellia palustris</i>		<i>Eremopyrum bonaepartis</i>
			<i>Eremopyrum distans</i>
			<i>Erodium glaucophyllum</i>
			<i>Erucaria boveana</i>
			<i>Filago contracta</i>
			<i>Filago desertorum</i>
			<i>Filago inexpectata</i>
			<i>Gastrocotyle hispida</i>
			<i>Gymnanthemum micrantha</i>
			<i>Hemianthus hirsuta</i>
			<i>Hordeum glaucum</i>
			<i>Hordeum spontaneum</i>
			<i>Hyoscyamus desertorum</i>

Fig. 34 Showing The Total Count of Different Life Forms in Araq Wetland Reserve

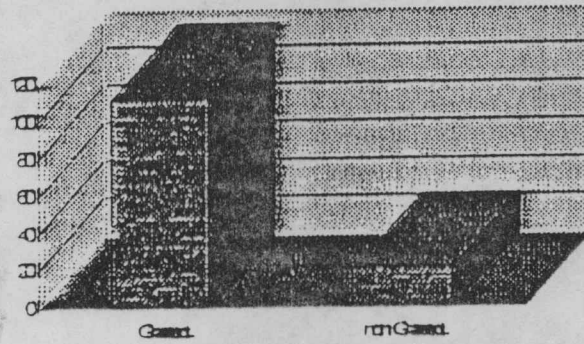


3.4). It is obvious that the most common life form is the herbaceous type and the least common type is the climbers.

Table 3.5 Showing Species List According to Their Life Form

Trees	Shrubs	Herbs	Herbs
<i>Phoenix dactylifera</i>	<i>Atriplex Halimus</i>	<i>Aaronschnia factorovskyi</i>	<i>Launaea nudicaulis</i>
<i>Tamarix arborea</i>	<i>Nitraria retusa</i>	<i>Aizoon hispanicum</i>	<i>Leontodon laciniatus</i>
	<i>Nitraria schoberi</i>	<i>Alhagi maurorum</i>	<i>Lepidium aucheri</i>
	<i>Tamarix amplexicaulis</i>	<i>Althaea ludwigii</i>	<i>Lepidium sativum</i>
	<i>Tamarix passerinoides</i>	<i>Anthemis bommulleri</i>	<i>Lotus halophilus</i>
	<i>Tamarix tetragyna</i>	<i>Anthemis haussknechtii</i>	<i>Lythrum tribracteatum</i>
		<i>Anthemis cf. hyalina</i>	<i>Malva parviflora</i>
		<i>Anthemis melampodina</i>	<i>Matricaria aurea</i>
		<i>Aster subulatus</i>	<i>Matthiola livida</i>
		<i>Astragalus tribuloides</i>	<i>Melilotus indicus</i>
		<i>Astragalus cf. trimestris</i>	<i>Mesembryanthemum nodiflorum</i>
		<i>Atriplex semibaccata</i>	<i>Notoceras bicombe</i>
		<i>Bassia muricata</i>	<i>Oligomeris linifolia</i>
		<i>Calendula tripterocarpa</i>	<i>Peganum harmala</i>
		<i>Ceratocaphala falcata</i>	<i>Picris cyanocarpa</i>
		<i>Chaenorthium sp.</i>	<i>Plantago amplexicaulis</i>
		<i>Chenopodium album</i>	<i>Plantago coronopus</i>
		<i>Chenopodium murale</i>	<i>Polygonum patulum</i>
		<i>Chenopodium vulvaria</i>	<i>Psylliostachys spicata</i>
		<i>Cirsium alatum</i>	<i>Reichardia intermedia</i>
		<i>Crepis senecioides</i>	<i>Reichardia tingitana</i>
		<i>Cressa cretica</i>	<i>Roemeria hybrida</i>
		<i>Diploaxis harra</i>	<i>Salsola jordanicola</i>
		<i>Erodium glaucophyllum</i>	<i>Salvia lanigera</i>
		<i>Erucaria boveana</i>	<i>Schimgia sp.</i>
		<i>Filago contracta</i>	<i>Senecio glaucus</i>
		<i>Filago desertorum</i>	<i>Senniella spongiosa</i>
		<i>Filago inexpectata</i>	<i>Sisymbrium runcinatum</i>
		<i>Frankenia hirsuta</i>	<i>Sisymbrium speculum</i>
		<i>Frankenia pulverulenta</i>	<i>Sonchus maritimus</i>
		<i>Gastrocotyle hispida</i>	<i>Sonchus oleraceus</i>
		<i>Gymnarchena micrantha</i>	<i>Spergularia diandra</i>
		<i>Halopeplis amplexicaulis</i>	<i>Spergularia salina</i>
		<i>Hemiladia hirsuta</i>	<i>Torularia tortuosa</i>
		<i>Hyoscyamus desertorum</i>	<i>Trigonella cylindracea</i>
		<i>Koelpinia linearis</i>	<i>Trigonella stellata</i>

Fig. 35 Showing number of gased and not gased spaces



<i>Sonchus oleraceus</i>	<i>Koelpinia linearis</i>	<i>Ranunculus aquatilis</i>
<i>Spergularia salina</i>	<i>Lactuca serriola</i>	<i>Ruppia cirrhosa</i>
	<i>Lappula spinocarpus</i>	<i>Ruppia maritima</i>
Edible	<i>Launaea nudicaulis</i>	
<i>Atriplex Halimus</i>	<i>Leontodon laciniatus</i>	
<i>Diploaxis harra</i>	<i>Limonium pruinosum</i>	
<i>Erucaria boveana</i>	<i>Lolium rigidum</i>	
<i>Lepidium aucheri</i>	<i>Lotus halophilus</i>	
<i>Lepidium sativum</i>	<i>Lythrum tribracteatum</i>	
<i>Malva parviflora</i>	<i>Mellilotus indicus</i>	
<i>Nitraria schoberi</i>	<i>Nitraria retusa</i>	
<i>Phoenix dactylifera</i>	<i>Notoceras bicombe</i>	
<i>Trigonella cylindracea</i>		

Fig. 3.6 Showing Plant Classification According To Their Uses

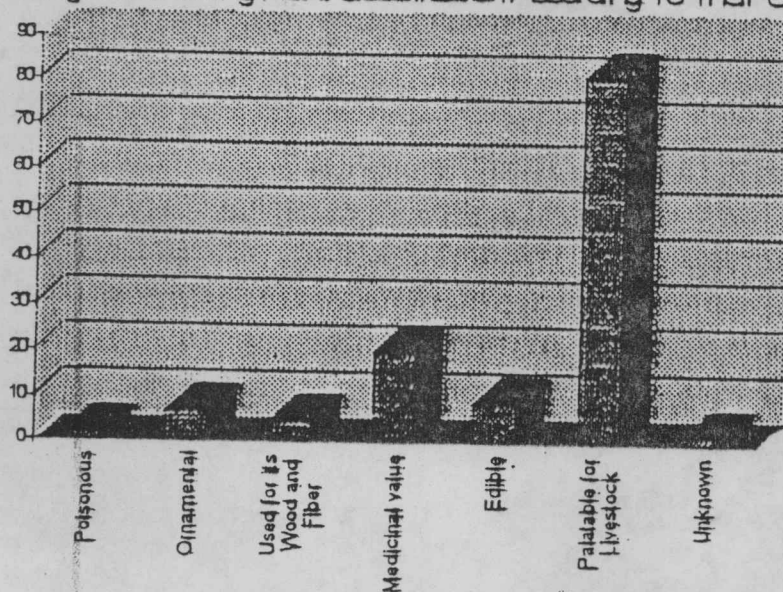
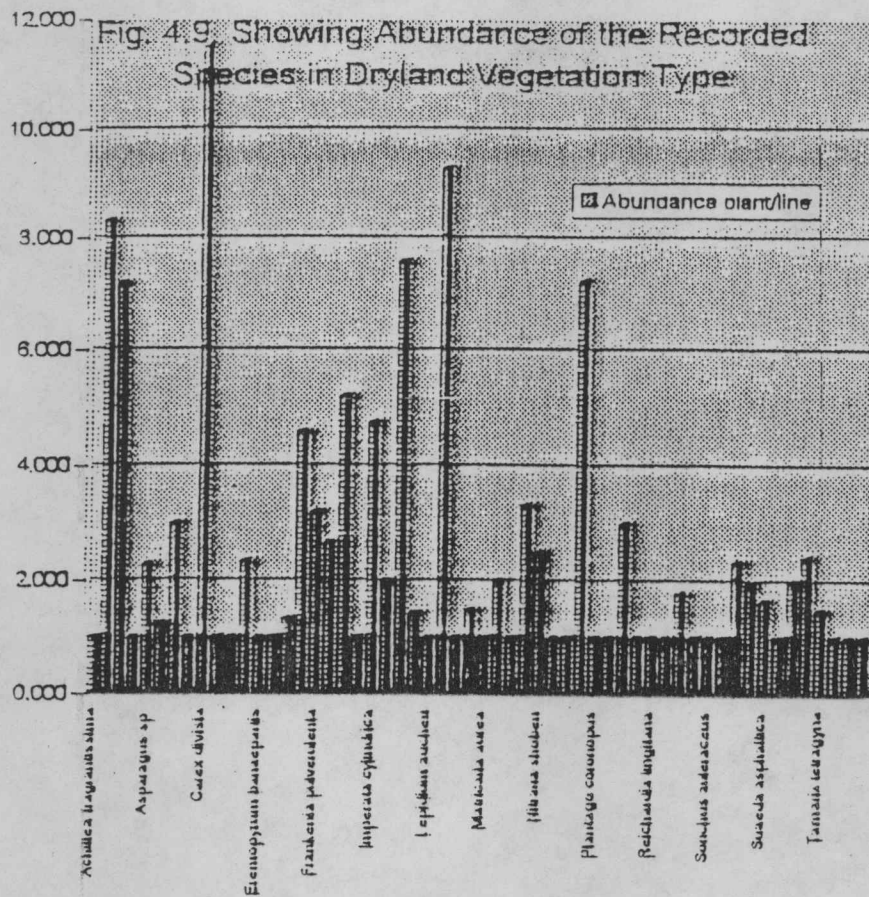


Table 3.6 Showing Grazed And Not
Grazed Species

Not Grazed Species	Family
<i>Aizoon hispanicum</i>	Aizoaceae
<i>Mesembryanthemum nodiflorum</i>	Aizoaceae
<i>Chenopodium album</i>	Chenopodiaceae
<i>Chenopodium murale</i>	Chenopodiaceae
<i>Chenopodium vulvaria</i>	Chenopodiaceae
<i>Halopeplis amplexicaulis</i>	Chenopodiaceae
<i>Sclingia</i> sp.	Chenopodiaceae
<i>Suaeda asphaltica</i>	Chenopodiaceae
<i>Anthemis bommulleri</i>	Compositae
<i>Anthemis haussknechti</i>	Compositae
<i>Anthemis hyalina</i> cf.	Compositae
<i>Anthemis melampodina</i>	Compositae
<i>Crassa cretica</i>	Convolvulaceae
<i>Asparagus</i> sp.	Liliaceae
<i>Limonium meyeri</i>	Plumbaginaceae
<i>Ranunculus aquatilis</i>	Ranunculaceae
<i>Ruppia cinnosa</i>	Ruppiaceae
<i>Ruppia maritima</i>	Ruppiaceae
<i>Hyoscyamus desertorum</i>	Solanaceae
<i>Zinnichellia palustris</i>	Zinnichelliaceae
<i>Peganum harmala</i>	Zygophyllaceae
Grazed Species	Family
<i>Gastrocotyle hispida</i>	Boraginaceae
<i>Lappula spinocarpus</i>	Boraginaceae
<i>Hemaria hirsuta</i>	Caryophyllaceae
<i>Spergularia diandra</i>	Caryophyllaceae
<i>Spergularia salina</i>	Caryophyllaceae
<i>Halocnemum strobilaceum</i>	Chenopodiaceae
<i>Atriplex halimus</i>	Chenopodiaceae
<i>Atriplex leucoclada</i>	Chenopodiaceae
<i>Atriplex semibaccata</i>	Chenopodiaceae
<i>Bassia muncata</i>	Chenopodiaceae
<i>Salsola jordani</i>	Chenopodiaceae
<i>Saidiitza rosarinus</i>	Chenopodiaceae
<i>Suaeda fruticosa</i>	Chenopodiaceae
<i>Aaronsohia factorovskii</i>	Compositae
<i>Achillea fragrantissima</i>	Compositae
<i>Artemisia herba-alba</i>	Compositae
<i>Aster subulatus</i>	Compositae
<i>Chenopodium leptocarpum</i>	Compositae

**Table 3.7 Showing classification of plants
according to their uses**

Poisonous	Palatable for Livestock	Palatable for Livestock
<i>Hyoscyamus desertorum</i>	<i>Aaronsohnia factorovskyi</i>	<i>Oligomeris linifolia</i>
<i>Peganum harmala</i>	<i>Aeluropus littoralis</i>	<i>Parapholis incurvata</i>
	<i>Aizoon hispanicum</i>	<i>Phalaris minor</i>
Ornamental	<i>Althaea ludwigii</i>	<i>Phragmites australis</i>
<i>Anthemis bommulleri</i>	<i>Aster subulatus</i>	<i>Picns cyanocarpa</i>
<i>Anthemis cf. hyalina</i>	<i>Astragulus tribuloides</i>	<i>Plantago coronopus</i>
<i>Anthemis haussknechtii</i>	<i>Astragulus cf. trimestris</i>	<i>Poa bulbosa</i>
<i>Anthemis melampodina</i>	<i>Atriplex leucoclada</i>	<i>Polygonum patulum</i>
<i>Asparagus sp.</i>	<i>Atriplex semibaccata</i>	<i>Polypogon monspeliensis</i>
<i>Matthiola livida</i>	<i>Bassia muncata</i>	<i>Polypogon viridis</i>
<i>Zygophyllum fabago</i>	<i>Bromus madritensis</i>	<i>Psylliostachys spicata</i>
	<i>Carex divisa</i>	<i>Reichardia intermedia</i>
Used for its Wood and Fiber	<i>Centaurea cf. lanulata</i>	<i>Reichardia tingitana</i>
<i>Tamarix amplexicaulis</i>	<i>Caratocaphala falcata</i>	<i>Rostrana berythaea</i>
<i>Tamarix arborea</i>	<i>Chaenonthium sp.</i>	<i>Rostrana cristata</i>
<i>Tamarix passerinoides</i>	<i>Cirsium alatum</i>	<i>Salsola jordanicola</i>
<i>Tamarix tetragyna</i>	<i>Corynephorus divaricatus</i>	<i>Schismus arabicus</i>
<i>Typha domingensis</i>	<i>Cynodon dactylon</i>	<i>Scirpus maritimus</i>
	<i>Cyperus laevigatus</i>	<i>Seidlitzia rosmannus</i>
Medicinal value	<i>Eremopyrum bonaepartis</i>	<i>Senniella spongiosa</i>
<i>Achillea fragrantissima</i>	<i>Eremopyrum distans</i>	<i>Sisymbrium runcinatum</i>
<i>Alhagi maurorum</i>	<i>Erodium glaucophyllum</i>	<i>Sisymbrium speculum</i>
<i>Artemisia herba-alba</i>	<i>Filago contracta</i>	<i>Sonchus maritimus</i>
<i>Calendula tripterocarpa</i>	<i>Filago desertorum</i>	<i>Spergularia diandra</i>
<i>Chenopodium album</i>	<i>Filago inexpectata</i>	<i>Stipa capensis</i>
<i>Chenopodium murale</i>	<i>Frankenia hirsuta</i>	<i>Suaeda fruticosa</i>
<i>Chenopodium vulvaria</i>	<i>Frankenia laevis</i>	<i>Torularia torulosa</i>
<i>Crepis senecioides</i>	<i>Frankenia pulverulenta</i>	<i>Trigonella stellata</i>
<i>Cressa cretica</i>	<i>Gastrocotyle hispida</i>	<i>Valerianella oxyrrhyncha</i>
<i>Hemaria hirsuta</i>	<i>Gymnanthera nictanthera</i>	<i>Zannichellia palustris</i>
<i>Inula crithmoides</i>	<i>Halocnemum strobilaceum</i>	<i>Zilla spinosa</i>
<i>Matricaria aurea</i>	<i>Hordeum glaucum</i>	
<i>Mesembryanthemum nodiflorum</i>	<i>Hordeum spontaneum</i>	Unknowit
<i>Plantago amplexicaulis</i>	<i>Imperata cylindrica</i>	<i>Halopepis amplexicaulis</i>
<i>Prosopis farcta</i>	<i>Juncus acutus</i>	<i>Schingia sp.</i>
<i>Rosmeria hybrida</i>	<i>Juncus bufonius</i>	<i>Suaeda asphaltica</i>
<i>Salvia lanigera</i>	<i>Juncus maritimus</i>	<i>Lasiopogon muscoides</i>
<i>Senecio glaucus</i>	<i>Juncus subulatus</i>	<i>Limonium meyeri</i>

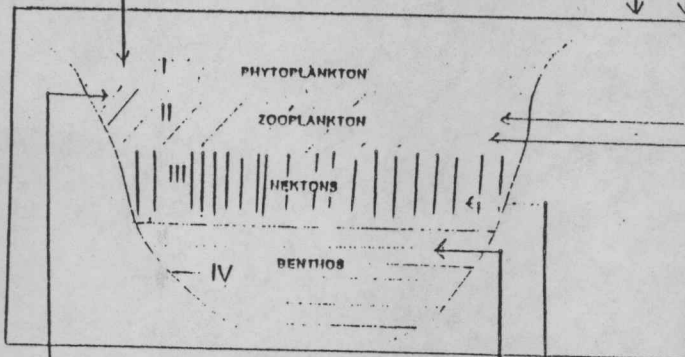


Acerosmopoda tenuissima
Atterocystis nerugiosa
Atterocystis boirys
Aphrocapsa delicatissima
Oscillatoria agardhii
Alphacitomenon gracile
Anabaina spiroides
Melosira granulata
Melosira granulata
Melosira varians
Melosira laticca
Cyclotella meneghiniana
Cyclotella stelligera
Stephanodiscus sp.
Diatoma vulgare
Synedra ulna
Synedra affinis
Synedra acus
Cocconeis placentula
Rhoicospaenia curvata
Gyrodinium acuminatum
Gyrodinium attenuatum
Navicula cryptocephala
Navicula sp.
Imphora sp.
Cymbella sp.
Bacillaria paradoxa
Nitzschia sigmaidea
Surirella robusta
Surirella elegans
Cryptomonas sp.
Gymnodinium sp.
Glenodinium sp.
Pyridinium sp.
Phacus caudatus
Phacus acuminatus
Trachelomonas valvulina
Chlamydomonas sp.
Chlorella sp.
Oocystis solitaria
Oocystis submarina
Kirchneriella lunata
Tetradon minimum
Tetradon regulare
Scenedesmus quadricauda
Crucigenia rectangulares
Ankistrodesmus falcatus
Ankistrodesmus falcatus
Closterium acerosum
Closterium moniliferum
Closterium gracile
Cosmonaut spp.
Staurastrum sp.
Platymonas cordiformis

Aquatic Vegetation

Typha Domigensis
Phragmites australis
Juncus acutus
Juncus maritimus
Imperata cylindrica
Sonchus maritimus
Inula crithmoides

Ischnura elegans
Platycnemis debitata
Anax imperator
Anax patenopis
Hemianax ephippiger
Sympetrum fonscolombet
Orthetrum sabina
Cratichneumon erythraea
Cratichneumon servilla
Brachymeria leucosticta
Orthetrum taeniolatum
Trithemis annulata
Anacanthotermis
Chrysopa carnea
Myrmecaelurus laevis
Hydrellia lineata
Agrotis epsilon
Heliothis armigera
Utheca pulchella
Pala dactylodes
Callas caceus
Vanessa cardui
Epithima asteria
Danaus chrysippus
Polymnia icarus
Lampides boeticus
Tipula
Chironomus dorsalis
Tahana
Apocles femoralis
Metasyrphus luniger
Lucilia sericata
Bemisia tabaci
Camponotus xerxes
Scutellus sp.
Oxyura laevis
Oxyura hispida
Truxalis grandis
Truphobola longicauda
Durania lucasi



PHYTOPLANKTON

ZOOPLANKTON

NEKTON

BENTHOS

Mesocyclops leuckarti
Atterocyclops minutus
Eucyclops serrulatus
Bosmina longirostris
Ceriodaphnia reticulata
Alona rectirostris
Daphnia triquetra
Alona affinis
Brachianus angulatus
Brachianus calceolatus
Brachianus caudatus
Keratella vulgatica
Keratella quadricauda
Synchaeta oblonga
Limnia longicauda

Mollusca

Unio terminalis
Corbicula stumbralis
Theodoxus jordanii
Melanoptyx praemorsum
Lymnaea auricularia
Hydrobia ventrosa
Theodoxus maculatus
Melanoptyx tuberculata
Planorbis planorbis

Acanthopneustes
Baculus longiceps
Tor carbo
Clarias lazera
Clarias gariepinus

Aquatic Insects

Procladius chareus
Chironomus callipterus
Microgaster Philanthus
Ephydra longicauda
Leptochironomus acutus
Polydora n. subvarium
Polydora nuhlsei
Cladotarsus pseudomancus
Hemianax ephippiger
Orthetrum taeniolata
Orthetrum sabinae
Orthetrum chrysipus
Trithemis annulata
Cratichneumon erythraea
Brachymeria leucosticta
Platycnemis debitata
Trithemis annulata
Brachymeria leucosticta
Corixa spp.
Pachynotus lethierryi

A Schematic Representation of the Biological Components of the Azraq Wetland.

The prescriptions, along with policies to maintain the existing vegetation cover that are described in this Management Plan should consider and implement the following points:

1. To update seasonally the flora survey in the Azraq Wetlands to identify the seasonal changes in species composition, frequency, abundance and diversity.
2. To monitor the existing taxa and species in relation to the changes in the surrounding habitats, due to the dependency of the floral elements on the well being of the macro and microhabitats of the reserve and its vicinity.
3. To monitor seasonally (preferably weekly) the water quality and its various attached parameters due to the dependency of certain life forms of vegetation on water quality.
4. To monitor seasonally, record and analyse the soil status, especially EC, due to the fact that salinity is a major limiting factor to distribution in the Azraq Wetlands.
5. Since the vegetation forms the first trophic level in the complex food chain, it is extremely essential to constantly monitor the vegetation status in the Wetland.
6. To monitor and record extreme environmental factors and oscillations (draughts, floods, frost ... etc) due to its defiant influence on the vegetation status in the Wetland.
7. To further study and monitor the rare and threatened species and work on changing their status.
8. To investigate the productivity of the producers level in the Wetland and to further study the herbivorous effect on the sustainability of the floral components in the Wetlands of Azraq.

3.3 The Mud flat and its Surroundings

In addition to the 12 Km² of the marsh the government of Jordan also designated, under the Ramsar convention a further 86 Km² of mud flat and mud flat edge as part of the wetland of special importance as a water fowl habitat.

Approximately 60 Km² of this area is mud flat, the remaining comprising silt dunes, wadi spread, limestone hammada basalt as well as some vegetated mud flat.

Salt is an important industry and there are at present about 7 groups of salt pans situated in the northern, eastern and central portions of the mud flats. Most of the workers come from Azraq North. The amount of salt extracted is strictly controlled by the Government with a limited working season from May until late July. Provided it makes no demands for water from the marsh and there is no future extension of the salt industry over other parts of the mud flats it should not present a problem to the management of the reserve. Since the industry doesn't operate during the winter months when some of the salt pans are flooded the pans can be of some benefit to waders and waterfowl.

3.4 Cultural

3.4.1 Population:

Table (2.1) shows the total number of Azraq villages up to the beginning of this decade. The socio economic survey which covered 95% of Azraq houses Figure (2.1), excluding the foreign workers and the bedouins who live in tents, reveals that the total population of Azraq is (4643) with (3463) in Azraq North and (1180) in Azraq South as shown in table (2.2). The December 10 of 1994 census of the Department of Statistics reveals higher numbers due to their including of all existing souls in the area at the moment of census, where a considerable number from abroad non-technical workers in the area mainly from Egypt, Syria and Sudan were present on the eve of the census. It is estimated from the results of both tables that the number of those from abroad workers exceeds 1300 in both villages and the number of Bedouins who use the Azraq area exceeds 1400.

Table (2.1) Azraq villages total population up to 1990

	1975	1990
Azraq North	1500	3500
Azraq South	Few hundreds	Over 1000
Total	Around 2000	Over 4500

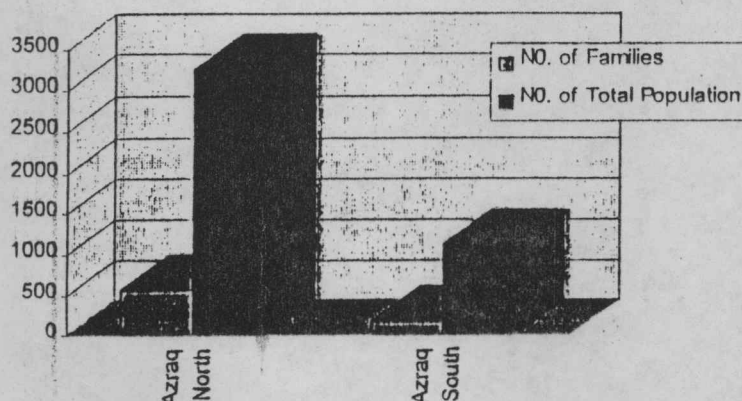
Table (2.2) Population distribution of Azraq surveyed residents

	Azraq	%	Azraq North %	Azraq South%
Males	2305	52.26 %	38.26 %	13.37 %
Females	2106	47.74 %	36.31 %	12.06 %
Total	4411	100 %	74.57 %	25.43 %

* Socio-economic survey results.

* Total population of all Azraq families after projection is 4643 with 3463 in Azraq North and 1180 in Azraq South.

Distribution of Surveyed Azraq Residents



3.4.2 Cultural Background

Figure (2.2) reveals that Azraq North consists of a closed community of Bani Maruff (Druze) who are the dominant segment. This community consists of people who settled in the area in the twenties of this century or who came from Syria recently to work and live among relatives.

Bani Maruff have their own culture, tradition and religious practices and strongly do not welcome marrying from other sects. In order to preserve intermarriage between members of the sect many marry Druze from Syria.

Families belonging to other backgrounds are few and most of them are not long term residents, but live in the area for working purposes such as technicians in governmental offices or in the military base.

Azraq South, as shown in Figure (2.3) is an open society with people of Shishani and Arab ethnic backgrounds. Inhabitants with Bedouin background formed about half the population who settled in the area due to the availability of services such as schools and health care. While the number of Shishani families who used to be around seventy in the eighties of this century does not exceed 35 families now. Those families left Azraq South to Zarqa and Sewelih where the largest Chechan community mainly concentrates, seeking better living conditions. Although the Shishani families are Sunni muslims they do not encourage marriage with people of other ethnic origins, but they are not as reserved as the Druze.

Figure (2.2)

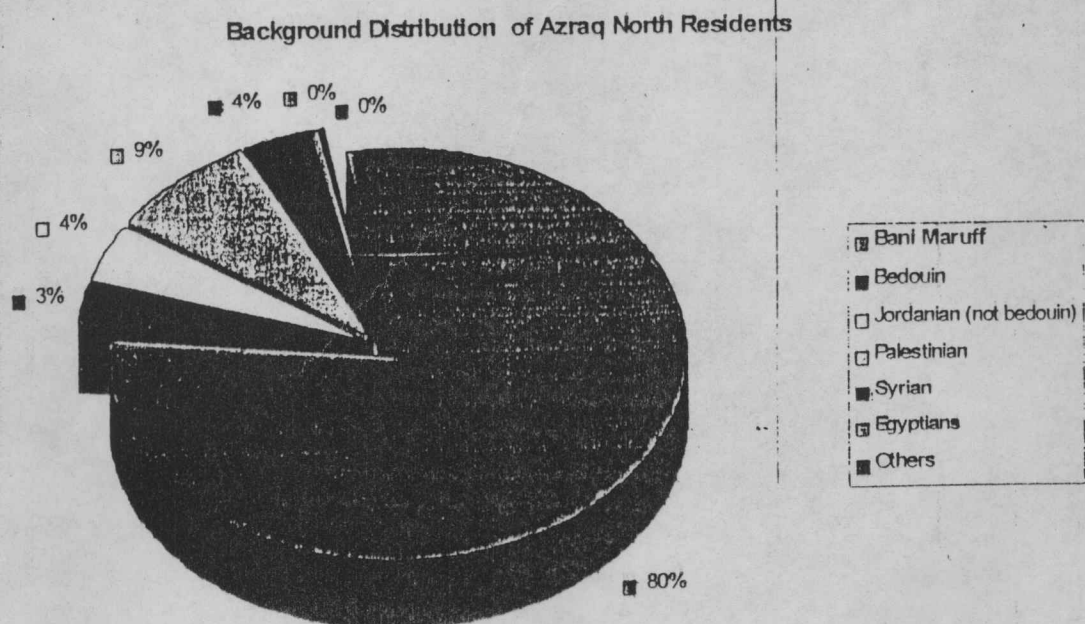
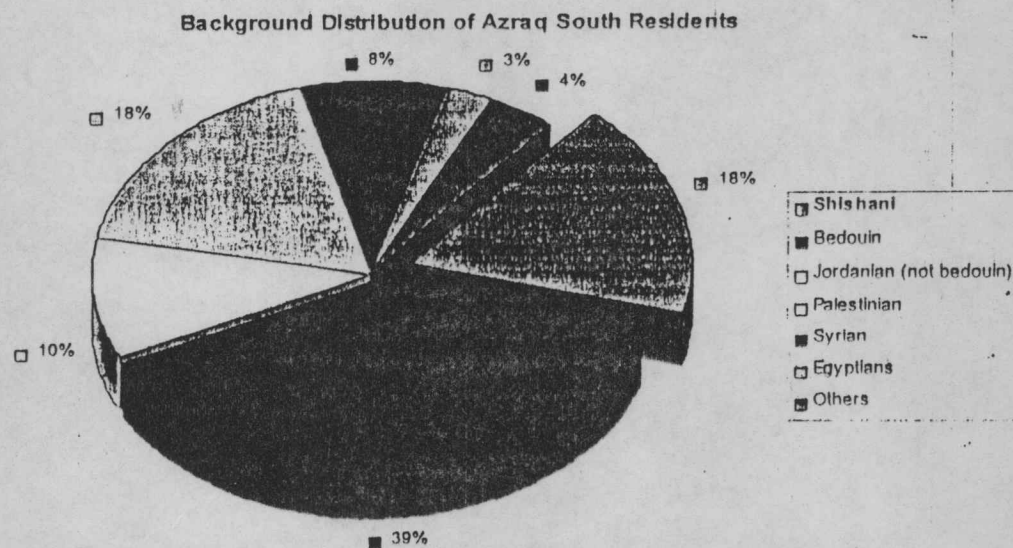


Figure (2.3)



3.4.3 Age Structure

Figure (2.4) shows the age distribution of Azraq residents. It was found as shown in table (2.3) that about 43% of the Azraq population was under the age of 15 indicating that Azraq community is young. This finding implies a high rate of support and decreased worker productivity, since, 43% of the population is not active economically bearing in mind that there are housewives, pensioners and others without work and high school and college or university students.

Also the findings indicate that the percentage of population at the compulsory education age (6-14) is 24.34 which emphasizes the need for educational facilities, and renders school children a potential target group for any future environmental awareness program. With such a young community it is essential to provide more working opportunities to decrease the rate of support. Potential fertility is very high which emphasizes the need for family planning programs to control the natural growth of this young community.

Figure (2.4))

Age Distribution of Azraq Population

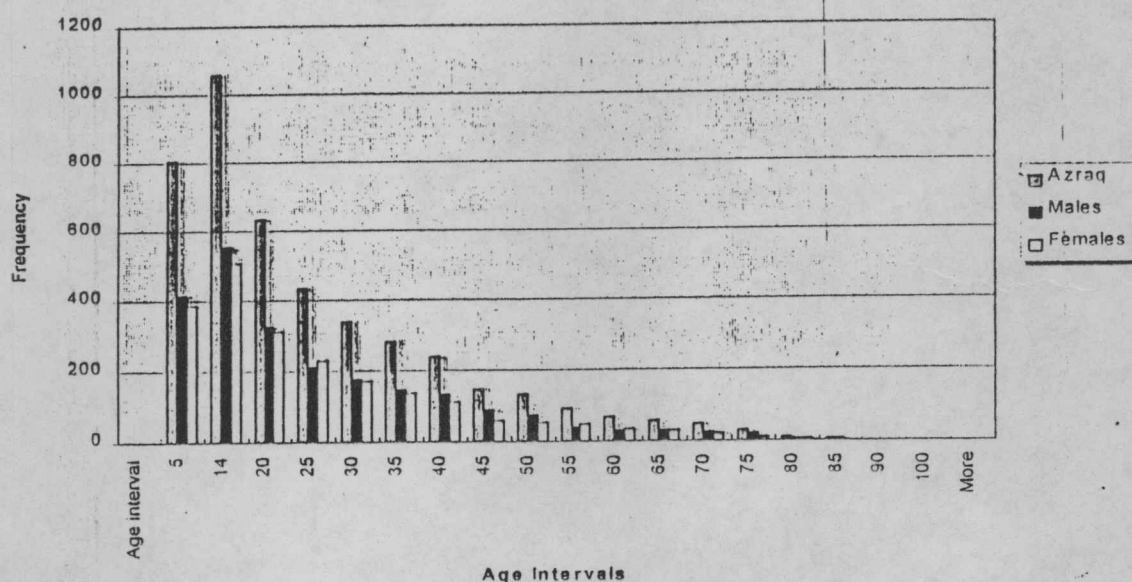


Table (2.3) Age Structure of Azraq Residents (1994)

Age period	Percentage
14 and below	42.65 %
15 - 64	55.30 %
65+	2.05 %
Total	100 %

3.4.4 Birth Places and Residency Dates of Azraq Heads of the Households

Figure (2.5) shows the distribution of birth places of Azraq heads of the households where 57.3% of Azraq heads of the households were born in Azraq North and in Azraq South while the rest came and settle later in Azraq permanently or to fulfill working commitment. Table (2.4) shows the distribution of birth dates of Azraq heads of the households. Figure (2.6) shows the distribution of residency dates of all Azraq heads of the households in Azraq villages, where figure (2.7) shows the distribution of residency dates of those who came to Azraq but where not born there. The later table shows that more people start coming to Azraq during and after the seventies of this century probably after the re-routing of the international highway. The main occupations that the heads of the households who came to Azraq during the seventies and after are holding are public services, building works, trade, military, government and salt production sectors respectively.

Figure (2.5)

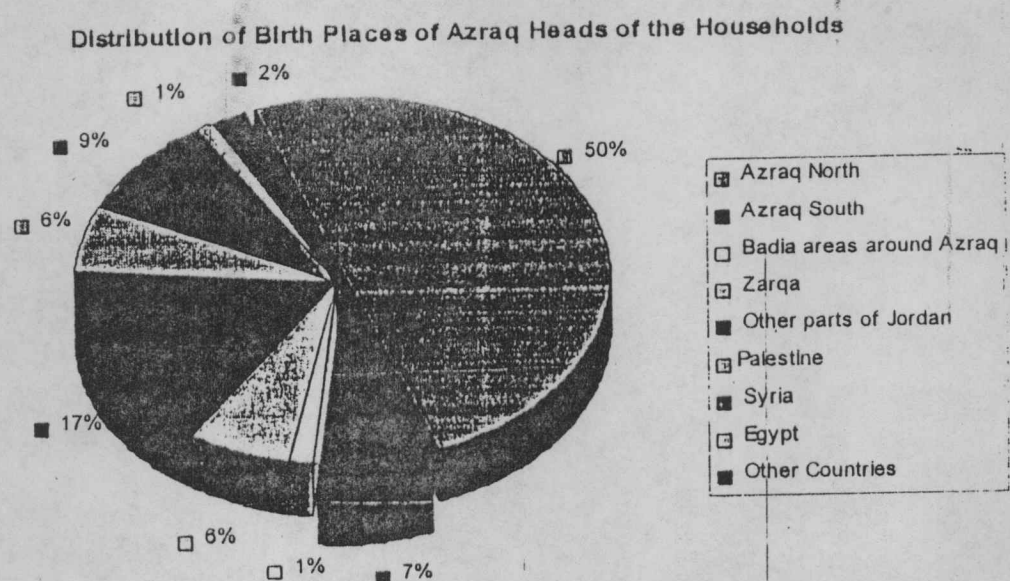


Table (2.4) Distribution of date births of Azraq heads of the households

Time period	Percentage
1930 and before	17.78 %
1931 - 1960	50.1 %
1961 - 1970	28.2 %
1971 - 1994	3.9 %

Figure(2.6)

Distribution of Azraq Heads of the Households According to Residency Dates

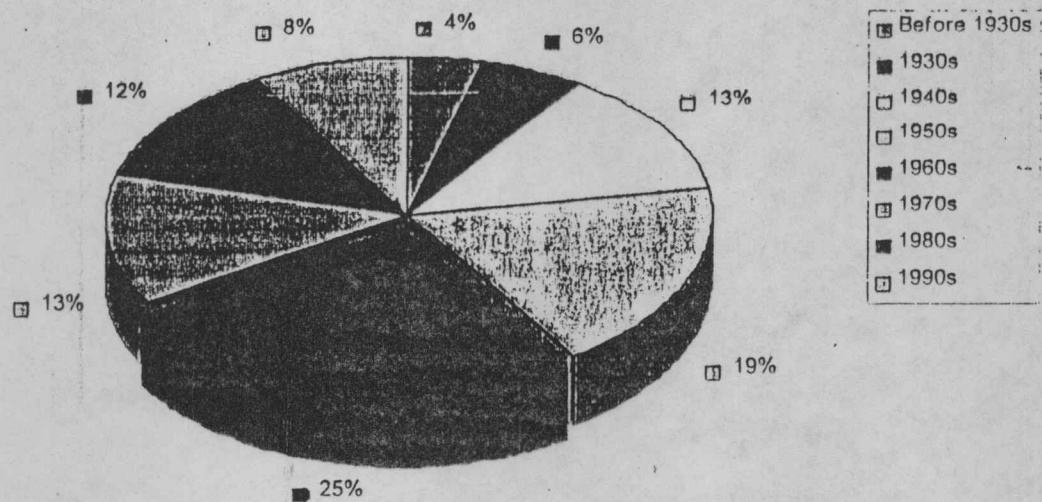
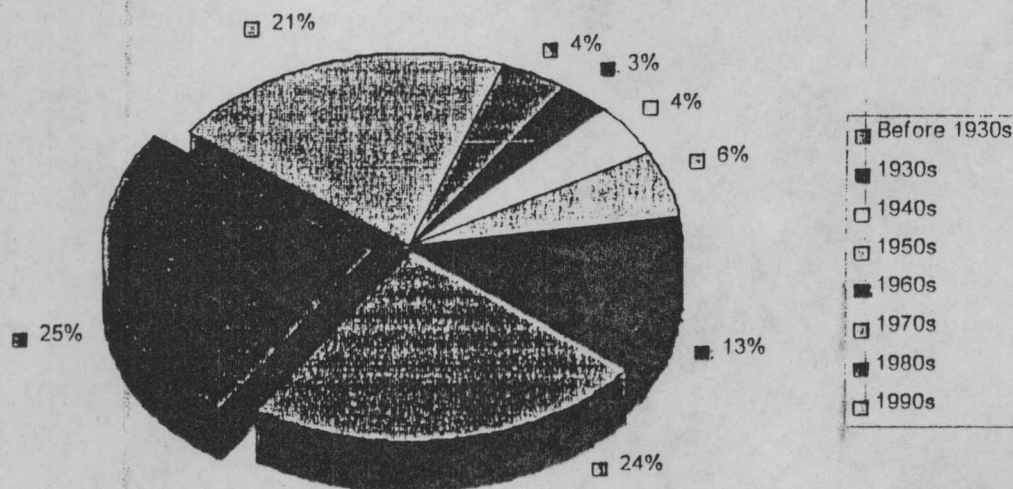


Figure (2.7)

Distribution of Azraq Heads of the Households who were not Born in Azraq According to Residency Dates



IV. EVALUATION

4.1 Size

The Azraq Wetland Reserve is the largest and only Wetland Reserve in Jordan lying in the heart of the Azraq Depression. Although the official size of the reserve is fixed (12 Km²) the actual size of waterspread varies according to seasons and timing during the year. This is due to the fact that the floods and springs which feed the Wetland increase their influx of water in winter due to elevation differences between the Wetland and the source of the floods. In the winter season of 1994-1995 the floods were enormous, covering an approximate area of 22 KM² holding over 12 MCM of water. The size of the reserve after the stabilization period reached to 12 Km, and it is considered as the natural size. Variation does not only occur during a season, but also vary from one year to the other primarily pending on the rain intensity in a particular year. During the season 1995-96, the rainy season was way below averages and the Wetlands did shrink accordingly to about 4 Km² during the winter of that season. In spite of this variation, investigations led by scientist and researchers confirmed the fact that the Azraq Reserve is ecologically able to support a multiplicity of life forms and biological support systems that sustain the diversity of the available species.

The reserve contains the pools of Quesieh and Soda as a natural freshwater ecosystem which was restored and rehabilitated by the Azraq Project. The pools cover an approximate area of 25 dunums and contain a diversity of unique freshwater species that re-invaded the habitat after the restoration efforts. Some of those species are new to Azraq and some of the plants recorded are considered as new taxa to Jordan. The Dasheih covers an approximate are of 85% of the total area of the reserve and is characterized by a variety of microhabitats that are also extremely important in the attraction of the original species and probably some introduced ones. The Qa is a barren habitat which covers and area and covers about 10% of the total area. It is to be noted that only a small portion of the Qa (Mudflat) is included in the reserve boundary.

4.2 Diversity

The Azraq Wetland Reserve contains the freshwater ecological system, the Dasheih and the Qa. Scientific records of the aquatic biotic components identified the occurrence of **phtoplanktons** (28 species), **Zooplanktons** (15 species), **aquatic plants** (14 species), **aquatic insects** (20 species), **mollusks** (15 species), **fish** (13 species), **terrestrial arthropodes** 66 species, **vascular plants** 133 species, **amphibians** 1 (?), **reptiles** 26 (?), **mammals** (?) and **birds** 209 species. Naturalness

4.3 Naturalness

The impact of man had a marked print on the natural ecosystem of the Azraq Area in general, and on the Wetlands in particular. The area was subjected to a variety of abuses by mankind up to the point of total exhaustion. Not only the Azraq pools were totally neglected but subjected to severe over pumping to the level of total dryness, causing an ecological disasters to the adjacent terrestrial biota. The decline in the number of different species and the disappearance of many was a clear signal on the deterioration of the Wetlands at large. The restoration efforts that the Azraq Project has in its objectives aims to re-invest in the ecological aspects of the Wetlands in terms of contributing and engaging efforts to restore the naturalness of the Reserve, and bring back the ecosystem from the point and depth of destruction to the level of stability. This task is regarded by the Management Plan as extremely urgent and it require the attention of the agency that is monitoring the ecosystem after the completion of the Azraq Project. The Wetlands in their present state are in the rehabilitation phase and the natural components of the Wetlands and its vicinity are starting to emerge. Evidence of natural rehabilitation could be seen in the re-appearance of species as *Bacillariophyta*, *Cyanophyta*, and *Chlophyta* of the phytoplanktonic groups, *Brachionus caudatum*, *Keratella vulgata*, *K. quadrata* and other species of zooplanktons listed in the Limnology publications. Evidence of natural rehabilitation is also evident in the reports of the terrestrial biota where some species as *Orchis laxiflora*, *Cladium mariscus* and *Elocharis palustris* re-appeared in the Wetlands Reserve

4.4 Rarity

The on-going investigations as well as the previous scientific records on the species of the Wetlands Reserve indicates that the area harbors a variety of habitats and micro habitats that are naturally attracting diversified plants and animals. The Wetland Reserve is the only site in Jordan that attracts the multiplicity of biological variability of the different categories of the ecological system. The occurrence of the endemic *Aphanius sirhani* is an outstanding example of the rarity of the site. Conservations strategies should focus on the diversity of the aquatic forms where a variety of species were recorded in Azraq for the first time. A total of 13 species of zooplanktons were recorded for the first time, 12 species belonging to aquatic plants, 11 new records of the aquatic insects that requires the attention of conservation strategies were logged.

In addition 66 species of arthropods were recorded in the vicinity of the reserve, of which 8 species are considered as rare : species as *Blepharopsis mendica*, *Eremiaphila*, *Brachythemis leucosticta*, *Orthetrum taeniolatum*, *Elphinstonia charltonia*, *Ypthima asterope*, *Danaus chrysippus* and *aoclea femoralis* are important species for the attention of this Management Plan. A total of 133 plant species were recorded in the Azraq Reserve of which 7 new species are recorded as new to the flora of Jordan. Plant species as *Astragalus cf. trimestris*, *Centaurea cf. lanulata*, *Chaenorrhinum sp.*, *Corynephorus divaricatus*, *Lasiopogon muscoides*, *lepidium sativum*, *Plantago amplexicaulis*, *Polypogon viridis*, *Psylliostachys spicata*,

Ranunculus aquatilis, *Reichardia intermedia*, *Sisymbrium speculum* and *Velerianella oxyrhyncha* are considered rare to the Wetlands and are in need of special attention and constant monitoring of this Management Plan. Of the 209 species of birds recorded in Azraq, 10 species are regarded as nationally threatened due to their rare status, 11 species are regarded as regionally threatened or declining species. The information at hand needs more elaboration and additions since the status of the various categories of species are highly dependable on the well being of the reserve. Moreover the status of the different species including "rarity" as an indicator might change and shift according to the overall situation of the ecosystem.

Additional investigations and constant monitoring is highly recommended, so as the Management Plan would identify in a more comprehensive way the final status of species.

4.5 Fragility

The highly dependent relationship of the safety of the Wetlands on one hand and the reversed pumping and the measures of sound use of water resources on the other hand that the Azraq Project is basing its main objectives and operations on categorizes the long term conservation process of the Wetland in a fragile status. The obligation of the sustainability of the Wetlands lies in the hands of the RSCN to ensure that the water status in terms of quantity and quality are in consistence of the present situation. In addition, the water that is used to irrigation purposes should be highly monitored and calls for the attention of the Management Plan. The risk could be accelerated if unsound practices and activities are carried out by farmers, illegal hunters or the Water Authority itself. Of the species that are highly at risk are naturally the water groups, including the planktons, the aquatic insects, the nektons and the benthos. The safety of the terrestrial biota is correlated to the water status. Previous experience taught researchers that life would actually vanish with the decline or disappearance of water. This kind of interdependency puts the whole of the ecosystem at risk. Not only the bigger frame of events, say the loss of water, but small events as oscillations in the quality of water, disappearance of nutrients, pollution (in its broad sense), would by all means affect the re-formation of life in the Wetlands. This management Plan focuses its attention on the potential threats and the needed mitigation that are highly needed for the continuity of this fragile ecosystem.

4.6 Typicalness

The Wetland Reserve includes different habitats and micro habitats that makes the site a combination of natural interacting biological system. The site includes the freshwater habitat, the Dasheih and the Qa. The varieties of plants and animal species recorded emphasizes the fact that the rehabilitation and restoration efforts in the site are attracting the re-invasion of the natural and typical species of the area.

4.7 Recorded History

The information available at hand as well as the archaeological evidence in the form of the Roman Wall and the Azraq Castle gives a vivid picture on the history of the area. Even at a larger scale, if one looks at the area as a whole, the 8th century Ummayed Castles on the way to Azraq demonstrates the historical and archaeological importance of this part of Jordan. The prints, drawings and artistic engravings on the walls of the Desert Castles tells not only the previous occurrence of wildlife, but the social, cultural and various traditions that prevailed at that time.

4.8 Ecological position

The Wetlands are situated in the Eastern Plateau of Jordan in the Saharo-Arabian biogeographic region. This region is characterized by being arid to semi arid but with a unique assemblage of interacting plants and animal species. The importance of Azraq Oasis was documented through history in the works of Mount fort, Nelson, Clark, Hatough-Bouran, Disi as a route for the passage of migratory birds. Jordan is characterized by having two major routes for migratory birds : Azraq in the east and Wadi Araba in the south of Jordan. This position gave Azraq a unique international importance in terms of the studies conducted on the species diversity, and status of the different bird species. Due to the total destruction of the freshwater ecosystem in the pools of Azraq by the year 1992, local researchers noted the obvious fact the migratory birds are less in number as well as in diversity. The route of the migratory birds shifted from the Azraq Wetlands to dams and other artificially made water bodies. The King Talal Dam (the largest dam in Jordan- capacity 90-100 MCM) became the attraction and stop site for a large number of the migratory birds, leaving the Wetlands almost vacant from signs of life. With the disturbance of this ecological level within the already destroyed food chain, the whole of the ecological pyramid started to disintegrate.

The Azraq Conservation Project stressed on this urgent matter and focused its attention on the importance of re-building the ecological position of the Wetlands through the rehabilitation process that it undertook as its objective. Recent studies showed that the level of attraction of the migratory birds to the Wetlands started to recover, but not to the level needed. The Management Plan is obliged to draw the attention of this important ecological issue, to keep the monitoring activities as well as the continuous scientific records of the different species and their status. Special attention should be focused on the rare, fragile and endemic species.

4.9 Potential

The Wetlands has got very high recreational, scientific, educational and socio-economic potential. Special emphasis is directed towards the eco-touristic and research potentials. The Azraq Visitor Center would provide the needed basis for the development of the social interactions with the environmental aspects.

4.10 Intrinsic appeal

A beautiful Oasis in the heart of the Jordanian desert is . The freshwater body of Azraq is a unique outstanding site that came back to life. Easy access to the Wetland is another advantage to the Azraq pools.

4.11 Summary of important features

Site Feature	Importance		
	International	National	Local
1. Scenic Beauty	H	H	M
2. Habitat Vegetation Types			
Flora of Wetland Reserve	H	H	H
Freshwater Vegetation	M	H	H
Brackish Water Vegetation	M	M	H
Dry land Vegetation	M	M	M
Silt Dunes	H	H	H
Rocky Limestone Vegetation	M	M	M
Qa Border Vegetation	H	H	H
Grassland Vegetation	M	H	H
3. Geology	M	H	M
4. Soils	M	H	H
5. Fauna			
Zooplankton	H	H	H
Aquatic Invertebrates	H	H	H
Terrestrial Invertebrates	H	H	H
Amphibians	H	H	H
Reptiles	H	H	H
Fish	H	H	H
Mammals	H	H	H
Birds	H	H	H

H= High, M= Medium, L= Low

V. Potential threats (activities) that could affect the special features of the Wetland Reserve

In the Wetlands

1. The deterioration of the water quantity and water quality at the Wetland Reserve.
2. Any unfavorable fluctuation in the water properties (light, temperature, nutrients) that could cause the shift of the tolerance abilities of the existing species .
3. Unplanned modifications of the water bodies.
4. Pollution - whether biological or chemical
5. Dumping, spreading or discharge of any material.
6. The killing or the removal of any aquatic plant or animal species.
7. The destruction, alteration of habitats or micro habitats.
8. Uncontrolled practices that includes the introduction of exotic species , unless subjected to intensive research.

In The Vicinity of the Wetlands

9. Overpumping of water from the Basin.
10. Unsound or negative agricultural practices in the vicinity of the Wetlands.
11. Unplanned infrastructural activities .
12. Uncontrolled recreational activities.
- 13 Use of vehicles outside the planned routes.
- 14 Extraction of minerals and disturbance of the top soil.
15. Unplanned re-introduction of species .
16. fuel collection for any purposes.
17. Hunting in all its forms and types.
18. Uncontrolled practices involving reintroduction of species.
19. Any potential (possible) threat to the trophic levels (removals, additions of species)

5.1 Main Factors Influencing the Management of The Wetlands.

1. Change in the quantity of water pumped to the Azraq pools, which would have its impact on the water level in the freshwater bodies.
2. Change in the quality of the water within the pools which could lead to major changes in the physical and chemical properties of the pools
3. Sharp changes in the properties in the Wetlands which could lead to fluctuation in the ecological populations , their dynamics and status. Such changes could also affect the tolerance capabilities of the floral and faunal populations.
4. The unplanned introducing of a plant or an animal species, which could alter dramatically the sensitive equilibrium of the interactive populations.. In such scenarios, certain undesired phenomena could appear in the form severe competition, predation or parasitism, thus interfering with the natural delicate ecological balance.
5. Illegal removal of a plant or an animal species through hunting or otherwise would have its negative impact on the ecological balance of the ecological pyramid yet in its fragile start. Such practices would create gaps in the food chains of the ecosystem.
6. Unplanned and uncontrolled practices that could lead to habitat alterations. Such practices could be damaging to the life support systems in the Wetlands.
7. Unplanned recreational activities could cause disturbance to the ecosystem and hence interfere with the management objectives and actions.
8. Development of uncontrolled or unauthorized agricultural practices and activities. These are curtail issues that could leave a negative impact on the ecosystem.
9. Activities related to the infrastructural framework. Any introductions of plan and schemes for buildings , trails or otherwise outside the established design would influence the management of the Wetlands.
10. Activities related to dumping, dispersal of any material in any form(solid, gaseous Or liquid)
11. activities related to spraying of pesticides , insecticides or otherwise
12. Pollution from any source from the near-by residing population . Such practices have a negative influence on the Management of the Wetlands.
13. Population over-booming due to infiltration of substances and material that could act as a activating agent for population increase on others.
14. Linkages and interactions with the local communities is an important aspect to the success of the Management objectives. Bulging positive ties and trust is a prerequisite to the implementation of the Management Plan.

VI. Tourist management

6.1 Visitor Center staff and management:

The visitor center should be managed by the reserve staff. Information room should provide information about the reserve to various visitors to maximize the reserve income from the admission fees and donations and to enhance the visitors experience. In addition, the working staff should be able to give information about local places of interests that the visitor would like see. Visitor care policy is require to maintain and enhance the visitor experience as much as its required. Annual program of themed events is require to provide additional information/enjoyment for visitor to attract visitors to the reserve during the off-peak visiting periods. It is important to note here that the main objective of the tourist management practice that the Azraq Project has adopted is to unify the various interest of visiting people into the theme of sustainable use of the resources. On the same line of interest is to increase the contact between visitors and the reserve staff and to maximize fund-raising and recruitment opportunities.

Education program of escorted visits and talks in schools must be practiced and developed. Enhancement of the education program by providing a targeted goal aiming education practices through the maximum benefit from the visitors center. Displays and support material in the form of guides, film demonstrations and various other educational techniques is a policy that the Azraq Project adopted.

The concentration of the support material and various aids should be focused on the sustainable use of resources, protection of the biological diversity, conservation of habitats, archaeology and water resources.

The reserve must be develop as a center of excellence for visiting conservationists, landowners, decision-makers and the like to show how the reserve policy is to be integrated with the targeted operations and practices.

6.2 Trails and Safari:

Trails will add another dimension to the visitor experience and assist in allowing the reserve to accommodate more visitors without detracting from their overall enjoyment. Trails should be constructed of any locally available material and in a way that should blend with the natural surrounding habitat. Trials should be used to take the visitors in groups of 10-15 people.

It is important to note here that through the restricted parts of Dashaha, visitors should not allow to use the trails and bridge without the supervision of the reserve staff. The use of the trails by visitors should be restricted in specific parts of the marsh which shouldn't cause any disturbance for the biota and especially migratory birds. Trails walks should be restricted to a specific time of the day and within a time tabulated schedule to avoid any possible disturbance. Safari routes will be used by the

warden in his routine patrol and inspection of the reserve. Safari routes also will allow specialists and visitors to use the pick up to visit and inspect the reserve. A detailed map of the routes is provided as annex This Management Plan stresses the important of abiding with the recommended rout plan.

6.3 Picnic area:

The proposed central part of the picnic area is near the palm date farm site which should be carefully prepared. The alternative site is the visitor center boundaries. The constructions of picnic site should include benches, shades and children's playing area. The site should be fenced and provided with a display board on which detailed information and restrictions might be given. The presence of the visitor in the site should be fully supervised by the reserve staff and clear signs must be used to indicate the numerous activity sites and facilities in the area. Barbiqueing , cooking should be completely banned from the area of the Wetland.

6.4 Tower blinds:

To assist the wardens in their various assignments and for those tourist interested in the study of birds, three tower blinds are necessary to be constructed. The floor of the blind should be a minimum of 4 meters above the ground.

Towers are essentially blinds with a roof and narrow observation slits; constructed of metals or any other suitable material. It is suggested that three towers should be constructed. The first proposed site is near the visitor center by adding extra floor with limited area that fits the required level of the tower. The second site would be among the *Tamarix* near the edge of the Inglesi pools, some where near the bridge (annex....). The third proposed blind is suggested to be on the south side of the marsh. All suggested sites for the tower should be reasonably accessible by earth track.

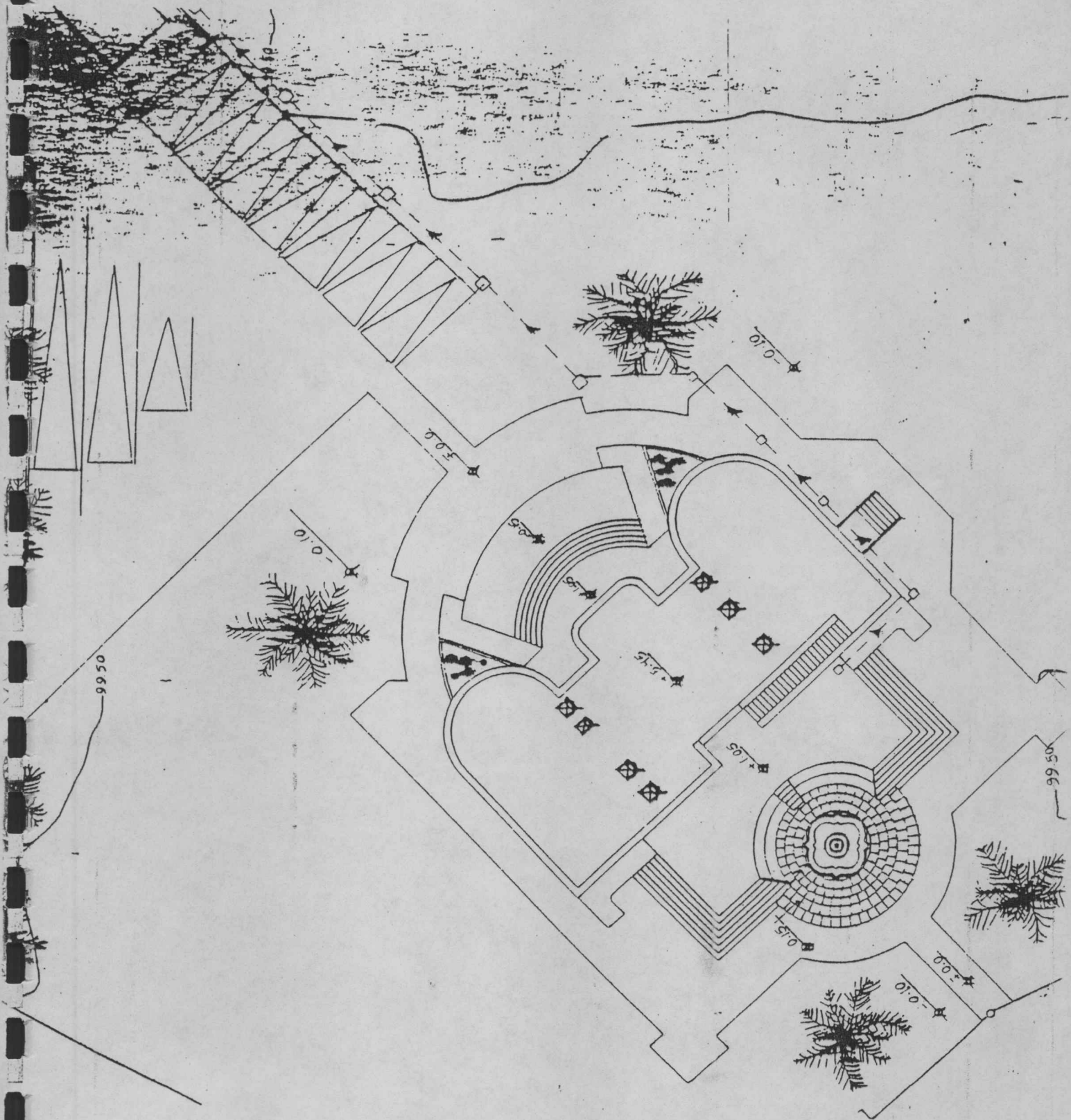
It would be essential to plant more *Tamarix* bushes along the path so that the bird watchers and others can approach the blinds unseen by the birds. Tower blinds would be of extreme value for the warden and his staff for checking on poachers or any other people engaged in unauthorized activities.

The North tower near the edge of the Ingilesi pool should be constructed in a away to allow the reserve staff for constant checking on the reserve. This tower is not for use of public and visitors.

6.5 Roman Wall:

The Roman wall around Al-Soda pool and the wall which separates the freshwater from the salty area are much neglected .A careful examination of this wall shows that it is roughly 5-side and Its longest wall is located on the west side approximately 500 meters in length, the southern side is about is 400 meters, and the eastern side is about 200 meters and northern is 300 meters. All these measurements are approximate and the northern, eastern and southern walls are linked to varying degrees. These parts must be maintain under the supervision of an archaeologist to attract and enhance tourists to the area.

The Wall surrounded Al-Soda pool is now silted up for three-quarters of its total length and at places up to the full height of the walls. It is proposed by this Management Plan that the Wall is restored in a manner to match its old style and that it should be protected by trees to avoid any disturbance from outside factors.



Visitors' Centre
site plan
1/200

ROAD

C.P. 2

Ain
Qasiyah

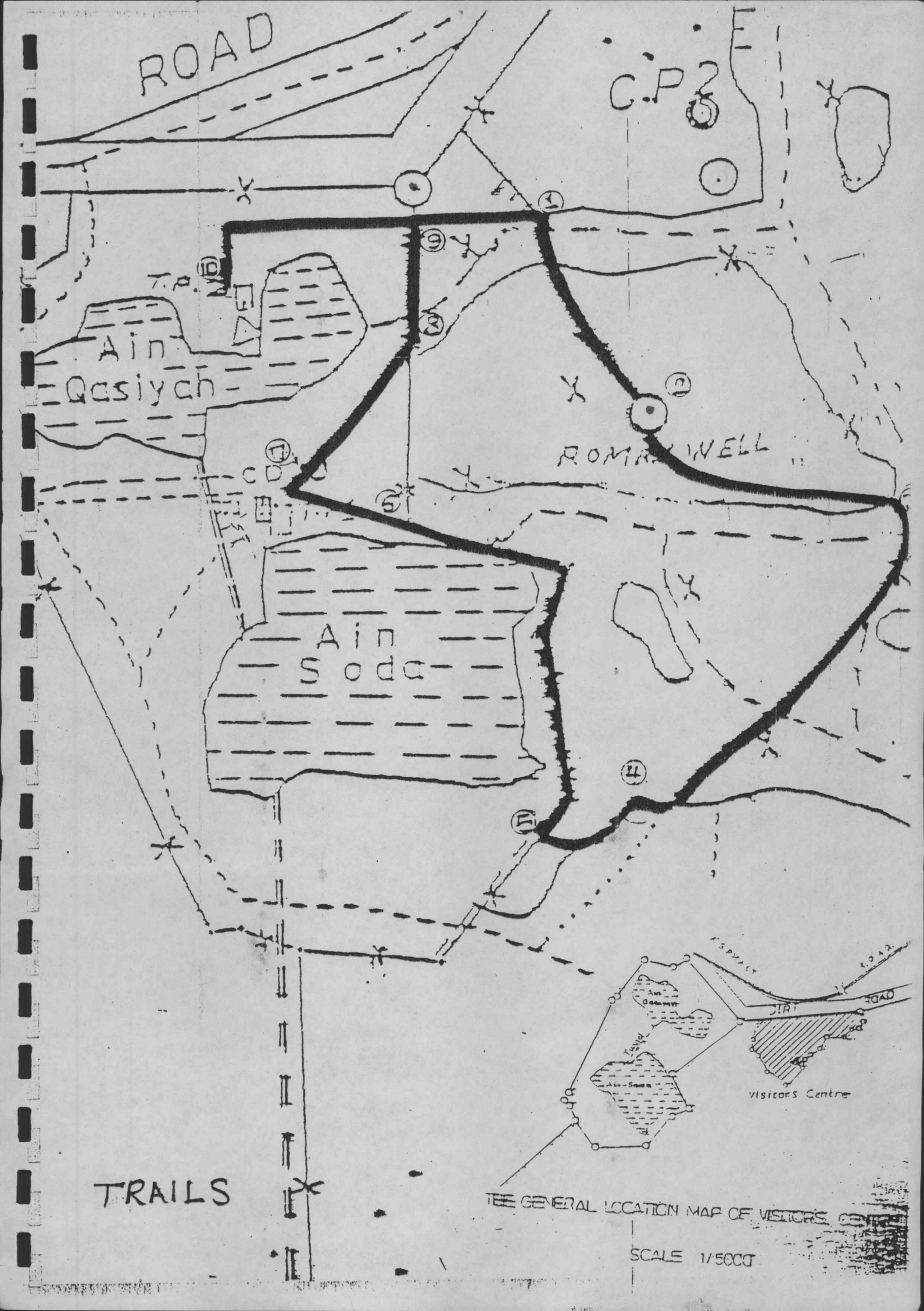
ROMAN WELL

Ain
Soda

TRAILS

THE GENERAL LOCATION MAP OF VISITORS CENTRE

SCALE 1/5000



VII. IMPLEMENTATION OF OBJECTIVES

Objective # 1

To continue on the restoration, rehabilitation, and protection of Wetlands' unique and diversified ecosystem and biodiversity within the available environmental opportunities especially those related to the major environmental media of water.

Relevant actions

1. Ensure the continuation of reverse pumping of water (1.5-2 MCM /year) from the Well Fields of the Ministry of Water and Irrigation through the existing network.
2. Monitor water quality received from the AWSA well fields to make sure that it is of appropriate chemical, physical, and biological properties.
3. Monitor water quantities in the reserve and in its various sections (the lakes, marshes (dasha), and the mud flat (Qa) .
4. Especially in the rainy seasons, monitor the quality and quantity of the water entering the Reserve from the wadies and springs.
5. Make sure that the water quantity in the various parts of the reserve is adequate for the faunal and floral biodiversity in the reserve.
6. Make sure that the water quality in the various parts of the reserve is adequate for the faunal and floral biodiversity in the reserve.
7. Design water models by which the standards of water supply and quality and fluctuations are periodically compared to the pre-designed model.
8. Involve and discuss with the local communities in cooperation with existing NGOs in the area in any violations regarding water-for- irrigation for example and seek assistance of the grass-roots (Friends of Azraq Society, ...etc.).
8. Make use of the importance of the site in its broad spectrum regarding its important archaeological, historical recreational and environmental properties.
9. Introduce the Azraq Reserve to the international arena through ecotouristic packages that attracts scientist, researchers and students.
10. Implement the prescriptions and policies regarding the sustainable development of the Wetland Reserve as described in the Wetland Management Plan.

Objective # 2

To maintain efforts aimed at the conservation of biodiversity (faunal, and floral elements) in the Wetlands and their vicinity, and to keep accurate records on the population dynamics and their status

Relevant actions

1. To continue on the protection of the reserve from any outside interventions
2. To systematically monitor and record any changes in the biodiversity status (flora, fauna)

3. To logg, record and compare the fluctuations of waters soils against the status and population dynamics of the different populations.
4. To introduce basic and applied knowledge on the sensitivity of diversified ecosystems to staff, visitors and locals
5. Monitor and investigate particular specificities of populations aimed at food selectivity, availability and record data regarding the re invasion of species into new niches.
6. Upgrade scientific information regarding competition, predation, parasitism, and other interspecific interactions among the various groups of organisms.
7. Make sure that no alteration of habitats is occurring since this factor is the strongest threat to biodiversity.
8. Monitor the transformation in the zoning within the reserve (Lakes, Marshes, and Mud flat)

Objective # 3

To protect land, habitat and microhabitats from degradation , loss of biodiversity and prevent misuse or alteration of land

Relevant actions

- 1 Create experimental areas (zones) for replanting species that are tolerant to the prevailing conditions of the Wetlands (species as).
2. Adopt measures to prevent change in land use, by planning zones for specific practices and activities.
3. Adopt mechanisms to prevent soil erosion .
4. Prevent the infiltration of pollutants from near-by residential areas namely organic pollution and agricultural pollution.
5. Prevent the use of vehicles inside the boundaries of the Reserve.
6. Maintain the public awareness campaigns on the importance of biodiversity , threats to biodiversity

Objective # 4

To encourage, in cooperation with the related governmental and non governmental agencies, the adoption of recommendations of the Azraq Project in relation to water management practices aiming at sustainable management of available waters in the Basin at large.

Relevant actions

1. Conduct public awareness campaigns on the local, national, regional, and international levels. Keep the "Azraq Cause" alive.
2. Maintain relations with the Ministry of Water and Irrigation.
3. Participate as possible in any water policy making for the Azraq Basin in particular, for Jordan and the region at large.
4. Encourage the implementation of the water policy for Azraq suggested by the Azraq Oasis Conservation Project.
5. Support as possible any efforts aiming at enhancement of artificial recharge

6. Support, and participate with the local community and NGOs in campaigns aiming at protection of the Azraq waters.

Objective # 5

To encourage, in cooperation with the related governmental and non governmental agencies, the adoption of recommendations of the Azraq Project in relation to agricultural practices aiming at sustainable management of water and soil to prevent the depletion in the Wetlands' vicinity and the Basin at large.

Relevant actions

1. Encourage the adoption and implementation of the recommended agricultural policies of the Agriculture Sub-Project.
2. Develop immediate strategies and actions to introduce biological controlled methods through the complete banning of chemicals.
3. Encourage and conduct research on the type of species that are best functional as soil fixatives to help in the prevention of soil erosion.
4. Prepare areas, habitats that are most suitable for planting (date, crops...) and give advice to locals on the sustainable use of land.
5. Erect the Palm tree forest inside the reserve to demonstrate its potential success as an alternative, environmentally sound crop.
6. Conduct public awareness campaigns.

Objective # 6

To cooperate, encourage, and advocate for the conduction of Environmental Impact Assessment as a criteria for any developmental scheme or activity within the boundary of the Wetlands' reserve, the RAMSAR site, and the Azraq Water Basin as a whole.

Relevant actions

1. Conduct public awareness campaigns. Check with the local community their understanding of the concept of EIA.
2. Promote the benefits of EIA to the local communities, local visitors, government agencies and investors.
3. Organize meetings with the owners of the small enterprises in Azraq and explain the concept of EIA.
4. Develop the appropriate mechanism with the Environmental Corporation along with the Legislation Department to prevent the establishment of activities that are not subjected to EIA studies.
5. Check with the local authorities the possibilities of establishing a waste management program to minimize the effects of waste (especially sewage water and plastic bags).
6. Work and discuss with the Housing and Municipality Authorities on their role in supervision activities with an EIA approach.

Objective #7

To encourage the educational use of the Reserve.

Relevant actions

1. Establish contacts with national and international academic and research facilities
2. Encourage and facilitate scientific research in and about the reserve and its biodiversity.
3. Conduct various kinds of relevant research.
4. Encourage and facilitate visits for the scientific community.
5. Encourage and facilitate visit for school children to the reserve.

Objective # 8

To undertake and encourage ecotourism and to manage the influx of visitors and researchers in a way to minimize the negative effects of irresponsible practices.

Relevant actions

1. Continue the upgrading of existing (and contemplated) facilities
2. Market the Wetland Reserve nationally and internationally
3. Establish linkages with the Ministry of Tourism and Antiquities
4. Establish linkages with the private sector agencies and personnel
5. Link the reserve with the other turistic attractions in the region such as the desert castles and the Shomari Reserve
6. Maintain the reserve in acceptable shape
7. Close highly protected areas
8. Monitor the influx of tourists within the carrying capacity of the reserve
9. Intensify the relationships with the locals through income generating projects with the concept and benefits of eco tourism.

Objective # 9

To seek economic sustainability of the Reserve

Relevant actions

1. Charge acceptable entrance fees.
2. Conduct public awareness campaigns
3. Conduct specialized fund raising campaigns
4. Encourage participatory and voluntary work in the Reserve and its vicinity
5. Rationalize expenditures

Objective #10

To strengthen the social support network in the context of sound socio-economic and developmental texture. Develop cooperation and build positive relationships with the local communities and grass-roots activities in harmony and synchronization with the conservation policies and strategies that the Azraq Conservation Document stated.

Relevant actions

1. Establish a working forum with the local communities.
2. Support and interact actively NGO's that have their aim targeted towards the conservation and preservation of the Azraq Wetlands (Friends of Azraq Society).
3. Conduct public awareness campaigns
4. Seek international support in financial, administrative, scientific, and political support

VIII. Main Achievements in Management Objectives

(Up to mid 1996)

The Azraq Oasis Conservation Project started its work at the beginning of 1994. Management objectives mentioned in this document have been in the core of its activities.

Up to mid-1996, the following main objectives have been met regarding the main arenas of action:

1. Water Securing and Monitoring

- * a permanent water supply of 1.5-2 MCM has been secured
- * a pumping plan has been empirically established and is being executed and monitored
- * a water monitoring system has been established and is functioning
- * related laboratories have been established and are functioning
- * a back stopping mechanism has been established and is functioning.

2. Biodiversity and habitat protection

- * habitat degradation has been halted
- * base line ecological surveys have been conducted (fauna, flora, limnology)
- * some of the threatened species have been saved and reintroduced
- * outside interventions and effects have been stopped
 - * the reserve has been fenced
 - * basic training accomplished
- * on the job training is continuous

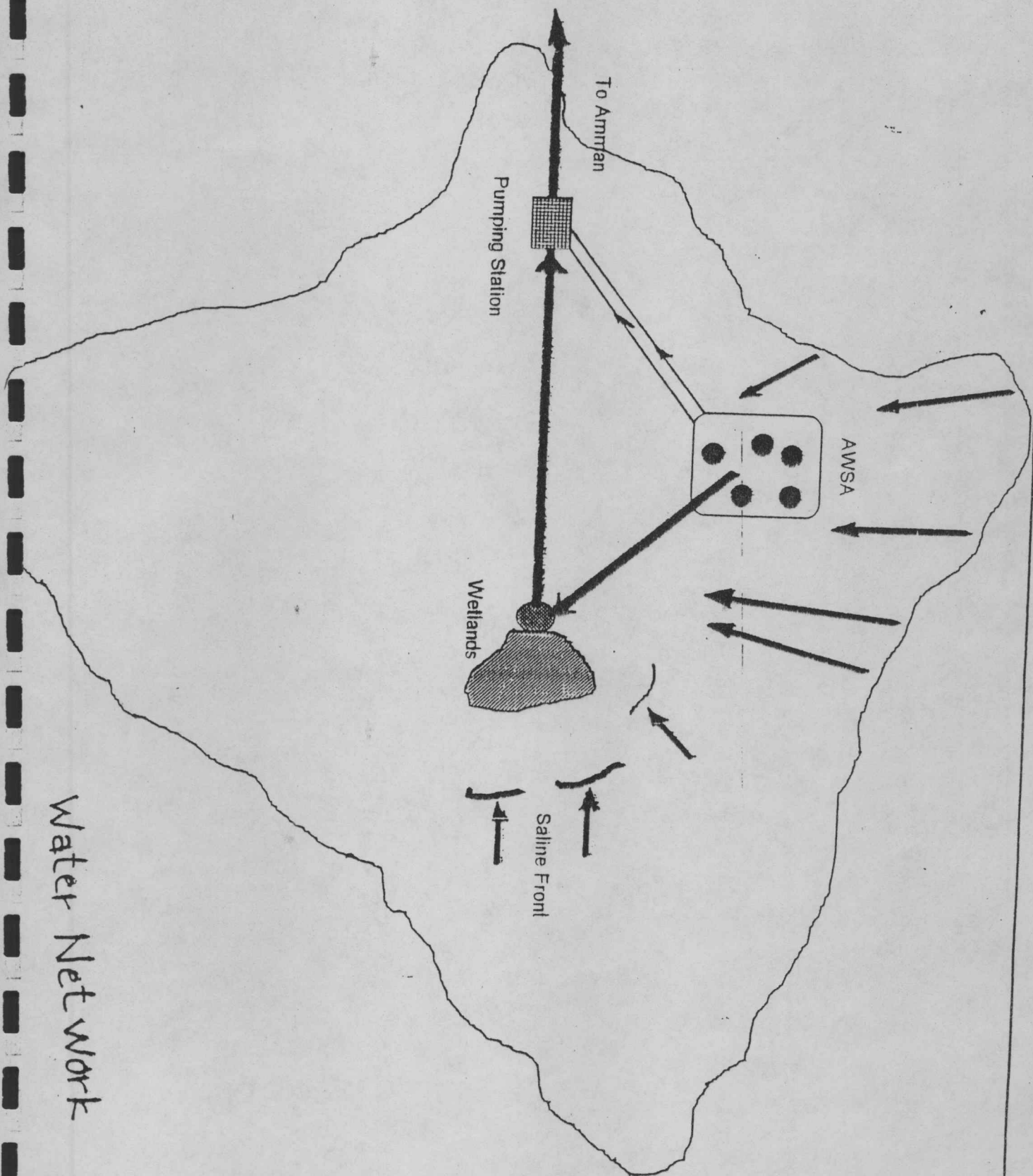
3. Local, national and international supporting network; and public awareness

- * The Friends of Azraq Society has been established. A grass roots local organization aiming primarily at encouragement of environmentally sound development including supporting the Azraq Project and preservation of the Wetlands Reserve
 - * socioeconomic surveys accomplished
- * public awareness campaign has been performed through the public media (TV, Radio
 - * systematic meetings with the locals are a practice.
- * public awareness materials are being distributed (posters, calendars..etc)
 - * a camp has been tested
 - * a permanent camping site is under design

4. Research and surveys

- * Base line biological surveys accomplished
- * base line chemical surveys accomplished
- * follow - up surveys planned and budgeted for

Water Network



- * detailed site maps (topography, water spread, cross sections...etc.)
- * linkages and backstopping mechanism have been established in coordination with academic institutions
- * environmental impact assessment studies accomplished (Wadi Rajil, salt extraction, socioeconomic surveys)

5. Ecotourism, educational tourism, and financial sustainability

- * fence installed
- * visitors center completely designed (contract is to be awarded very soon)
- * trails identified and designed (contract is to be awarded very soon)
 - * some basic exhibitor material prepared (insects, herbarium)
 - * interpretive material (under preparation)
 - * contacts with private sector established
- * plans for ecotourism to be linked with other facilities (Desert Castles and Shomeri) are under preparation.
- * basic staff training accomplished

IX. Transformation of Objectives to Actions

The following main arenas of actions are recognized based on the pre identified objectives

1. Water Securing and Monitoring
2. Biodiversity and habitat protection
3. The local, national and international supporting network
4. Research and surveys
5. Ecotourism, educational tourism, and financial sustainability

9.1. Water Monitoring:

Water Resources and its control:

Providing permanent monitored water supply to the wetland reserve is the main aspect of the management program. In the meantime 1.25-1.5 MCM per year is provided by the Jordanian water Authorities. Any decrease in the quality should be resisted strongly. Attempts to increase water supply should be a target for the Management Plan for future implementation. Permanent, safe and continuous water supply would safeguard and sustain the ecological and biological features of the Azraq Wetlands.

The implementation of a safe water strategy and strongly recommending attempt to decrease water extraction of the Azraq aquifer will help to avoid any water depletion in the reserve.

The winter flood in should be exploited to increase water resources in the reserve. The three sluices gates systems constructed on the main three streams in the reserve should be used efficiently to allow the water to flow from the Qa to the central march to prevent opposite direction flow.

The water quality monitory scheme should be developed and automatic water quality recorder should be install to measure the essential water quality parameters (temperature electrical conductivity,(EC),total dissolved solids (TDS), dissolve oxygen and pH) to ensure that the quality of the water entering the wetland from the JWA and floods remains within acceptable limits.

Towards that the following is highly recommended:

1. Implement the standard of water supply agreed upon and signed by the Government of Jordan and the Azraq Conservation Project, to sustain the keen effort aimed at the rehabilitation of the Wetlands.
2. Design water models by which the standards of water supply , fluctuations and quality is periodically compared to the pre designed model.
3. Monitor the standard and quality of waters, chemical, physical, and biological terms through periodic samplings, logging of data.
4. Upgrade data on water issues related to the pools through the establishment of a database for future studies and comparisons.

5. Discuss fluctuations and perturbations with the trained staff and researchers and introduce immediate actions when needed.
6. Check and discuss with the local communities any violations regarding water-for-irrigation for example and seek assistance of the grass-roots.
7. Make use of the importance of the site in its broad spectrum regarding its important archaeological, historical, recreational and environmental context.
8. Introduce the Azraq Reserve to the international arena through ecotouristic packages that attracts scientist, researchers and students.
9. Implement the prescriptions and policies regarding the sustainable development of the Wetland Reserve as described in the Wetland Management Plan.

9.2. Biodiversity and habitat protection

Vegetation:

Grazing should be banned completely from the wetland area. At a later stage, controlled grazing could be a useful management tool if carefully applied and controlled. The number of animals allowed to graze should be according to the carrying capacity of the reserve. Records should be kept about the change of the vegetation as a result of the occasional grazing. If any signs of overgrazing should occur, then this practice should immediately stop.

Some patches of open water need to be cleared in the middle of the extensive and dense mass of *Typha domingensis* and *Phragmites australis* in the central marsh. It is recommended that this task would have to be done by hand. The size of the area should not be exact and the edges of the cleared area should not be straight. Vegetation should be cut away and the debris cleared off the site during autumn or winter. A capable warden should be able to undertake this task with some assistance.

Vegetation survey should be carried out seasonally and for several years until the natural continuous vegetation cover is stabilized. Ranger vehicles should use the marked tracts only to make sure that no destruction of the new seedling, rare plants or vegetation will occur.

Aquatic community:

Information on all aquatic fauna occurring on the site must be collected continuously to understand more fully the aquatic ecology of the pools. Local expertise should be sought for further investigation, monitoring and training of the staff especially those which do not have adequate experience in the field work. Invertebrate sampling by means of sweep-netting and mud sampling should continue for further estimation of the existing populations and the changes associated with population dynamics. The new lagoon system should be monitored on seasonal bases to correlate the presence

or absence of species with their microhabitats. Results obtained should be logged and interpreted in a scientific manner to enrich the ecological information in the context of home range, selection of habitat, occurrence of niches and other related ecological information.

Fish populations must be monitored and results recorded. Studies of fish population, size, age class and their distribution is required to assess biomass and prey availability for birds. Adequate information on the population of fish is related to indicative parameters on the sustainability and quality of the waters of the Wetlands. The estimated populations on fish would give ecological indication on the availability of food within the food chain, efficiency of light penetration and optimum information on the content of dissolved oxygen.

Fish are excellent ecological link between the freshwater and terrestrial habitat, since birds are the main beneficiaries of the existing of fish in any given ecosystem. The ability to sustain the existing population of fish and to bring in new sound ideas on the ability to introduce species of commercial status is a challenge to be thought about.

Limnological studies must be carried out on a regular bases to assess the primary and secondary productivity of the pools. Phytoplankton and zooplankton assessment is essential for maintaining the food chain and population dynamics of different species. In addition to the water quality monitoring, other chemical and physical parameters such as light depth, nitrate, phosphate must be measured to monitor the water nutrient availability which is essential for the primary productivity and the overall condition of the Wetlands..

Bird community:

A daily log on the passing wintering and breeding birds is one of the important monitoring aspects to study bird communities. In addition, estimates on the population size, density, sex, age class and their fluctuations should be done regularly. Birds of the Wetlands have always been an attraction to locals as well as scientists. Adequate information on the ecological status of birds in terms of the rare, threatened, endangered, common and abundant species is considered as asset to the monitoring procedures and applications of the Management Plan of the Wetlands.

It is recommended that hunting should be banned completely from the boundaries of the Wetland reserve due to the scientific importance of the Azraq wetland bird species. In addition, the massive disturbance caused by hunters is beyond recognition and evaluation to the bird community, ecosystem and ecotourism.

The greatest variety of bird species are present in the central marsh and the pools. It is recommended that this area should be a highly restricted and protected with special trails and observation sites for photography and scientific observations.

Food selectivity and feeding habits of the resident bird community should be recorded regularly. These studies could be related to other ecological communities, especially fish community to evaluate the available food resources and to establish the interactions and inter dependencies of the various levels of the food chain.

Mud flat:

Destruction on the mud flat will reduce the natural quality of the area as a nature reserve. There should be an attempt to reduce the potential destruction imposed on the mud flats due to vehicle disturbance which damages the fragile micro flora and fauna of the area. Vehicle destruction should be prevented by the constructing a roads and trails. Surface water resources could be maintain by the construction of artificial lagoons to reduce the evaporation to the minimal possible level. New constructed lagoons would help maintain the number of birds that pass through the area. Regular studies of mud flat flora and fauna should be carried out to evaluate the effects of the new constructions on the biodiversity, microhabitates and newly introduced micro climates.

Tree planting:

During the course of field investigations it was recommended that the Wetland reserve should be planted with trees that could tolerate the existing environmental conditions. Sound planting is a practice implemented in many parts of the world in similar conditions as the Azraq Wetland. The recommended tree to be planted on the reserve is the date palm *Phoenix actylifera* as recommended firstly by Condor (1980) and confirmed by the project scientific records. The existing small group of palm on the silt dunes should expand whereas new groups should be planted in the marsh area. This suggestion was logged in the reports of the Azraq Project in order to provide the needed microclimate for various species. Other seedlings of palm trees could be planted on the mud flat areas of Inglesi, Monfilit and Burgess. It would highly appreciated if such seedlings are planted around observatories, to provide shelter and refuge for both the birds and the researchers.

Fencing and Gates:

The new alignment of fencing is shown on map .. and include these areas which are wet, (although not always) or those that are filled with standing water. Fencing is a part of the infrastructure that should provide the adequate protection which includes in its status that the biodiversity of the Wetlands is a reflection of natural conditions. The towers will make the ranger's duty easier by the daily use of the towers on location (map ...) and the routine tours. Localities of gates are marked on map (....). Through the south gate, vehicles could drive through to allow access to the Burgess bridge. The North side gate would allow access to the Inglesi bridge. The western boundary gate (Main gate) would allow access to the pools. The forth gate in the northwestern boundary would allow access to the visitor center. Gates should generally be kept locked by the warden.

The following actions are highly recommended:

Regarding Phytoplanktons

1. To monitor and closely upgrade the data on planktons since Primary productivity is irreversibly depended on the occurrence of the planktonic community (refere to paragraph primary productivity).
2. To record any fluctuations in the water quality of the pools of the Wetland, due to the high sensitivity of planktons to any shift along the existing water gradient of the different factors namely (pH, salinity, nutrients, contaminants).
3. To monitor and record monthly as well as seasonally the population dynamics of each group of planktons and to add any new species, filling in the gaps of scientific information at hand.
4. It is of extreme importance to sustain this trophic level in the water bodies of the pools. Phytoplanktons occupy the producers level in the Azraq freshwater reserve. They fix the sun energy convert it to chemical energy and produce needed energy to be transferred along the food web.
5. To introduce basic and applied knowledge on the sensitivity of this group of living organism to the staff of the reserve and to demonstrate the life-dependency of other biotic components on planktons.

Regarding Aquatic Invertebrates :

1. To constantly monitor the fluctuations and changes in the relevant light availability, nutrients ... ect.
2. To constantly monitor and record any new species to the pool. The re-invasion of new species gives a positive indicator on the evolutionary tendencies of the wetlands.
3. To monitor and investigate seasonally population dynamics of the aquatic invertebrate community, thus upgrading the scientific data at hand.
4. To identify the feeding linkages with other populations (birds, other aquatic organism) to keep up in check the sustainability of the ecological pyramid.
5. To identify and upgrade the fluctuations of rare and endangered species and to implement the necessary mitigating measure

Regarding Terrestrial Invertebrates

1. To monitor seasonally the different species recorded initially during this study
2. To monitor the seasonal fluctuations of species in terms of their density, abundance, frequency and diversity.
3. To determine the biological associations between the above parameters and the feeding linkages (other invertebrate species, plant species, planktonic representatives ...)
4. To and determine knowledge and understanding among the working staff of the importance of the rare and fragile species
5. To carry out the needed mitigating measures to preserve the ecological integrity of the invertebrate fauna.
6. To ensure the complete rejection of the use of insecticides in the Wetlands and recommend biological control techniques.
7. To introduce the basis for environmental education and public awareness on the need to preserve the existing invertebrate species at the Azraq Wetlands.

Regarding Fish

1. To monitor daily the water quality of the pools and to record any fluctuation in the various physical and biological parameters.
2. To establish a scientific record on the direct relationship of the existing fish population and separate water parameters to identify the limiting factor to fish population dynamics.
3. Since fish species are vital bioindicator on the integrity of the water ecosystem, it is important to record, investigate the reproduction vitality (viability of the different species).
4. To determine and study the carrying capacity of the pools, so as to avoid overcrowding and competition among species.
5. To establish a record on the feeding relationship of fish on other organisms, thus monitoring the availability of food to the existing population.
6. To record and seasonally analyze the scientific data of fish population, mainly regarding their productivity.
7. To establish a working relationship with the private sector to promote fish farming in a sustainable manner

Regarding Amphibians :

1. Seasonal monitoring on the population dynamics of this very sensitive biotic component.
2. Monitoring of the specific niches of occurrence, specially what concerns the egg laying micro habitats.
3. Periodic surveys and species composition identification to record new species to the area.
4. Specific monitoring of water pH, since water properties acts as the most determining limiting factor to the occurrence and survival of amphibians.
5. Specific scientific investigations of the liver and tissue status in selected species of amphibians for any sign of contamination penetration (specifically heavy metals).
6. Monitoring and investigations aimed at food selectivity, and food availability of amphibians, thus establishing the positive or negative relationship of the species to the surroundings

Regarding Reptiles :

1. To monitor species composition, abundance, frequency of occurrence and biological diversity for Class Reptilia inhabiting the Azarq Wetlands

Regarding Mammals :

1. To monitor seasonally, the population dynamics of the various species.
2. To monitor and any fluctuations with the respected pollution and record their frequency of occurrence, abundance and diversity.
3. To monitor and preserve the specific niches and microhabitats of the various species. The availability of ecologically suitable habitats for feeding, mating and nursing the young is of extreme importance to mammals.
4. To establish, record and monitor the feeding relationship among species. This would contribute to the understanding of the ecological pyramid existing in the

reserve.

5. To upgrade the existing scientific data by recording any new findings. In doing so the existing gaps of information would be covered, enhancing the knowledge on the existing interactive mammalian population.

Regarding Birds:

1. To clearly demonstrate the direct dependent relationship of birds to the water bodies of the Wetlands.
2. To periodically analyze and record any fluctuation that might occur in the water body in regard to water quality (pH, salinity, contaminants ...).
3. To periodically analyze and record any fluctuation in the planktonic community due to the dependency of some bird species on phyto-and zooplanktons as a source of food.
4. To ensure the sustainability of the water plants namely (.....) since many species seek refuge, and lay their eggs in reeds and other plant species.
5. To ensure, enforce environmental legislation that safeguards the ecological existence of birds, by preventing hunting and egg collecting.
6. To record any violation and guard the surrounding micro and macro habitats, due to the dependency of several species.
On the vicinity of the reserve, in terms of nest building, mating and territorial significance.
7. To encourage positive attitude towards the environment in terms of bird watching, photography and identification of species.
8. To record any new species or arrivals to the Azraq Wetlands. New arrivals is significant to the overall status of the Wetlands.
9. To monitor seasonally the birds population dynamics, fluctuations, number of arrivals and establish linkages to water quality, surrounding habitats and feeding interactions.

Regarding vegetation

- 1.. To update seasonally the flora survey in the Azraq Wetlands to identify the seasonal changes in species composition, frequency, abundance and diversity.
2. To monitor the existing taxa and species in relation to the changes in he surrounding habitats, due to the dependency of the floral elements on the well being of the macro and microhabitats of the reserve and its vicinity.
3. To monitor seasonally (preferably weekly) the water quality and its various attached parameters due to the dependency of certain life forms of vegetation on water quality.
4. To monitor seasonally, record and analyze the soil status, especially EC, due to the fact that salinity is a major limiting factor to distribution in the Azraq Wetlands.
5. Since the vegetation forms the first trophic level in the complex food chain, it is extremely essential to constantly monitor the vegetatus status in the Wetland.
6. To monitor and record extreme environmental factors and oscillations (draughts, floods, frost ... etc) due to its definite influence on the vegetation status in the Wetland.
7. To further study and monitor the rare and threatened species and work on changing their status.

8. To investigate the productivity of the producers level in the Wetland and to further study the herbivoral effect on the sustainability of the floral components in the Wetlands of Aqraq.

9.3 The local, national and international supporting network

1. Recruit locals to work as staff in the reserve to create the economic ties with the continuity of conservation.
2. Attract through media public support to preserve the Wetlands with special emphasis on the importance of the social and economic network.
3. Contact national and international agencies to provide financial support for the conservation and preservation of Azraq.
4. Incorporate the local grass-roots in the activities and linkages that are being carried on to create the feeling of support and togetherness.
5. Encourage and support (as a priority action) projects by local that are linked to conservation.
6. Make the best use of the Visitor Center and permit locals to demonstrate their handicrafts embroideries and creations.
7. Establish a fund raising mechanism to ensure the financial support needed to the sustainability of the Wetlands.

9.4. Research and surveys

Azraq reserve has a potential scientific value to various aspects of natural sciences. Many scientists who have visited Azraq over the years have suggested the need to establish a biological research station. With the re-establishment and restoration of the Azraq reserve and the presence of the adjacent Shaumari Reserve there is an urgent need for an RSCN scientific center that would be responsible for continuous scientific guidance of the reserves. The environmental management aspect should be domain of the activities of the suggested center. Capacity building and training would be the main activities of the center. In addition, the staff of both reserves would be in contact with the visiting researches, such contact would provide enrichment of experience and exposure to different methodologies in various issues ecological and environmental fields surveys. In addition, a network of relevant information in the form of a data bank is highly recommended in order to facilitate information flow at the national and regional levels.

9.5. Ecotourism, educational tourism, and financial sustainability

1. Recruit adequate staff
2. Develop and train staff on ecotourism
3. Implement the Wetland Reserve action Plan on ecotourism
4. Develop trails and observatories
5. Mark areas according to their sensitivity and carrying capacity and prevent access to ecologically sensitive areas
6. Maintain roads, trails and signboard system
7. Make the best use of the Visitor Center
8. Promote Azraq Wetlands on the national and international levels
9. Prepare, produce and distribute pamphlets and brochures on the Wetlands
10. Prepare and distribute lists on the endangered and rare species and encourage people not to destroy this natural wealth
11. Prepare and display within the boundary of the reserve photos on the key species and add a brief description on its status and reason for conservation
12. Monitor the visitors attitudes to the surroundings and instruct staff to interfere when needed
13. Develop a waste management system and clean up operations on daily basis
14. Intensify the relationships with the locals through income generating projects with the concept and benefits of eco-tourism
15. Charge an acceptable entrance fee

X. Staffing and training:

The staff should be comprised of a warden, an assistant warden, receptionist, and a gate keeper. The warden must have a degree in biological or environmental sciences and should possess a good background and knowledge of the needs of the reserve. In this case the warden should be able to assist in the scientific monitoring and up dates in information gathering that should take place in the reserve. *In addition the warden should be able to take decisions on the spot in case of emergency*. But nevertheless should report the RSCN HQ for further assistance.

The assistant reserve warden should have a primary degree in natural sciences, preferably a diploma that is related to biology, ecology or natural sciences. In this case he/she should be able to assist in the daily works of the warden, gather the needed information and assist in the tasks related to science and administration.

The receptionist should have the preliminary knowledge in the concept of conservation. In addition the receptionist should be able to give the needed information on the historical aspects of the area to visitors of all classes and various fields of interest.

The gate keeper and guards should be able to keep intruders off the reserves limit, and he should be able to perform manual works if needed.

Staff duties:

Warden:

- a. Directly responsible to the director of Royal Society for conservation of nature.
- b. Responsible for application of the management plan and its recommendations.
- c. Responsible for the daily supervision and management of the reserve
- d. Responsible for the daily supervision and work of his assistants.
- e. Prepare lectures on the work of the reserve for specialist and visitors.
- f. Control of events and activities within the reserve boundaries which may effect the reserve.
- g. prepare regular reports for the Royal Society for the conservation of nature.
- h. Carry out any other duties that may be given him.

Assistant warden:

- a. Responsible to the reserve wardens and should assist him in his duties.
- b. Responsible for keeping records of the numbers of wildlife on a regular basis.
- c. Counting migratory birds periodically.
- d. Daily patrolling of reserve boundaries and controlling any illegal activities and disturbances.
- e. control and help visitors to see and identify all forms of wildlife.
- f. Take care of buildings, equipment and ensure that they are properly maintained.

Receptionist:

- a. Responsible to the reserve wardens and should assist him in his duties.
- b. Responsible for keeping records of the numbers of visitors on a daily basis.
- c. Provide visitors with the basic information which help them to know the national and international importance of the reserve.
- d. Selling of cards , maps, brochures and local goods.

Gate keeper and night guard:

- a. Night patrolling of the reserve infrastructures
- b. Cleaning up of the reserve buildings.
- c. Assists any processional visitor during his visit.
- d. Insure that the local regulations are followed by the visitors.
- e. Daily monitoring of the main gate.

XI. Long term Management Guide

The following schedule represents the main activities that are to be carried out till the end of the year 2000

Action	1996	1997	1998	1999	2000
Water pumping	D	D	D	D	D
Water quality monitoring	W	W	W	W	W
Water quantity monitoring	D	D	W	W	W
Biological monitoring					
phytoplanktons monitoring	M	M	M	S	S
zooplanktons monitoring	M	M	M	S	S
aquatic invertebrates Mon.	S	S	S	S	S
terrestrial invertib, monitoring	S	S	S	S	S
fish	S	S	S	S	S
amphibians and reptiles Mon.	S	S	S	S	S
birds monitoring	S	S	S	S	S
Mammals monitoring	S	S	S	S	S
Conduct flora survey	Y	Y	Y	Y	Y
Conduct oth. fauna survey	Y	Y	Y	Y	Y
conduct limonogical survey	S	S	S	Y	Y
conduct pediological survey	Y	Y	Y	Y	Y
upgrade socioeconomic stud.		Y	Y		Y
conduct EIAs	Y	Y	Y	Y	Y
monitor turistic influx	M	M	M	M	M
evaluate ecotourism	S	S	S	Y	Y
conduct maintenance to buildings		Y	Y	Y	Y
conduct maintenance to fence		Y	Y	Y	Y
train personnel	SY	SY	SY	Y	Y
hold meetings with locals	M	M	M	M	M
contact NGOs and govern.	SY	SY	SY	SY	SY

Y= yearly, S= seasonally, M= Monthly, W=Weakly, D, Daily,