

# HASHEMITE KINGDOM OF JORDAN

## INTRODUCTION

by Adnan Budieri

**Area:** 89,210 sq.km.

**Population:** 4,009,000 (1990).

The Hashemite Kingdom of Jordan is bordered by Syria in the north, Iraq in the northeast, Saudi Arabia in the east and south, and Israel and the West Bank in the west. The country is land-locked except for a 27 km stretch of coastline bordering the Gulf of Aqaba on the Red Sea in the extreme southwest. The majority of the population inhabits the western strip, either in the agriculturally rich Jordan Rift Valley, or in the highlands east of the Rift Valley. The desert supports only nomadic pastoralists and a few villages and settlements set widely apart.

The country consists of distinctive topographic units shaped by the Jordan Rift Valley which trends in a general south-north direction from the Gulf of Aqaba through the Dead Sea to Lake Tiberias. The elevation of the bottom of the valley ranges from sea level in Aqaba on the shores of the Red Sea to around 240 m above sea level at a distance of 80 km to the north; from there it drops gradually to about 400 m below sea level at the present shores of the Dead Sea, and to around 750 m below sea level at the bottom of the Dead Sea. To the north of the Dead Sea, the elevation of the valley rises gradually to around 210 m below sea level on the shores of Lake Tiberias. This rift valley, with a length of 375 km, is about 30 km wide in the area of Wadi Araba and narrows to around 4 km in the Lake Tiberias area.

The highlands to the east of the Jordan Rift Valley rise to elevations of over 1,000 m above sea level in the north at Ajlun and Belqa, and over 1,200 m in the Shoubak and Ras El Naqab areas. This zone ranges from 30 to 50 km in width and extends from the Yarmouk River in the north to Aqaba in the south. From the highest elevations along the edge of the rift, the land drops gradually away to the plateau in the east, but more sharply to the rift valley in the west. The mountains forming the highlands consist mainly of sedimentary rocks with deeply incised wadis draining in a westerly direction.

The steppe or plateau of Jordan developed at the eastern foot of the highlands. Maximum elevations around the edge of the plateau range from 1,000 m in the south to 700 m in the northeast; the lowest part of the plateau lies at an elevation of 500 m in Azraq Oasis. The plateau is a peneplain with hills and weakly incised wadis, but has a generally smooth topography. Surface water, if not captured by westerly wadis, discharges into desert playas or "qa", which form extensive shallow lakes in winter and dry mudflats in summer. The most southerly part of

the plateau, which lies to the south of the Ras El Naqab escarpment, is considered a different topographic unit, although it belongs to the same plateau. This is because it is separated from the plateau by the prominent topographic feature of the escarpment, because it drains to the Dead Sea, and because of its steep topography dictated by different geology consisting of sandstone and granitic basement complex. The elevation of the area is around 900 m above sea level, with a north-south width of around 300 km.

Climatically, much of Jordan can be classified as semi-desert, with only the western highlands enjoying a Mediterranean climate. Over 95% of the land area has an annual rainfall of less than 200 mm, while only 2 % has more than 350 mm. Temperatures in the Jordan Valley, Wadi Araba and Aqaba region can rise to 45°C in summer, and the mean annual temperature is 24°C. In winter, the temperature in these areas falls to a few degrees above zero, and frost is a rare event. Most precipitation falls in the form of rain. Snowfall occurs generally once or twice a year over the highlands. The rainy season extends from October to April, with the peak of precipitation taking place during January and February.

Jordan is situated at the junction of three phyto-geographical regions, the Irano-turanian, Afro-subtropical and Mediterranean, and acts as a faunal and floral bridge between the continents of Asia, Africa and Europe. The resulting rich fauna includes species such as *Canis lupus*, *Mellivora capensis*, *Meles meles*, *Lutra lutra*, *Felis chaus*, *Sus scrofa*, *Gazella spp.*, *Oryx leucoryx*, *Struthio camelus*, *Francolinus francolinus*, *Ketupa zeylonensis*, *Tilapia gallileae* and *Aphanius serhani*, while the flora includes *Juniperus phoenicia*, *Cupressus sempervi Tens*, *Pinus halepensis*, *Quercus calliprinos* and *Ziziphus spina-christi*.

### **Summary of Wetland Situation**

Much of Jordan is desert or semi-desert with an arid climate, and as a consequence there are rather few large natural wetlands, the best known being Azraq Oasis in the Eastern Desert. This large desert oasis formerly comprised a complex of spring-fed marshes and pools adjacent to a large seasonally flooded mudflat (Qa Al Azraq) covering some 12,000 ha. However, within the last 15 years, the spring-fed marshes have suffered drastically as a result of the extraction of groundwater for water supply and irrigation purposes and consequent depletion of the aquifer. Natural flow from the two main groups of springs ceased completely in August 1992, and the once extensive marshes and pools have now dried up. The mudflat, which receives its water from surface run-off, was not affected by the exploitation of groundwater, and continues to flood during periods of heavy winter rains. However, a dam was constructed on Wadi Rajil in 1991, cutting off the single most important supply of water to the qa, with the result that winter flooding is far less extensive than was formerly the case.

Elsewhere in the country, there are a number of smaller wetlands that support a distinctive aquatic flora and fauna, and are important for migrating or over-wintering waterfowl. They include permanent spring-fed ponds and marshes,

saline marshes, seasonally flooded playa wetlands, man-made water storage reservoirs and sewage treatment plants. The wetlands may be grouped into four main areas:

- (1) North Jordan Valley  
Wetlands of the Yarmouk River basin (including Birket Al Rais pool), Wadi El Arab and Wadi Ziglab.
- (2) Middle Jordan Valley  
Zarqa River and King Talal Dam, Kherbit As-Samra Sewage Treatment Plant, and wetlands in the lower Jordan River (Wadi Damia, Kibed Pool, Kafrein Dam, Shu'eib Dam and Swaimeh Pool).
- (3) South Jordan Valley  
Wadi Mujib.
- (4) Eastern Desert  
Ghadir Burqu, Qa Khana, Azraq Oasis, Qa Al Jafr and Qa Disi.

Coastal wetlands are confined to Jordan's short stretch of coastline at the head of the Gulf of Aqaba at the northern end of the Red Sea. They include sandy and rocky shorelines, coral reefs and seagrass beds.

Jordan lies on a major migration route for Palearctic waterfowl. The wetlands of Azraq Oasis formerly supported large numbers of migratory waterfowl during the migration seasons and in winter, but with the drying out of these wetlands in recent years, the majority of migratory waterfowl have shifted from the Azraq area to the Jordan Valley. Migrating waterfowl are now more widely dispersed than was formerly the case, and occur in substantial numbers at many different water bodies throughout the Jordan Valley.

The floral and faunal diversity of the wetlands has not as yet been thoroughly surveyed. Key species of wetland plants include *Phragmites communis*, *Juncus maritimus* and *Nerium oleander*, while the non-bird fauna includes 18-20 species of freshwater fishes (e.g. *Tilapia* spp., *Barbus* spp., *Aphanius* spp., *Gara rufa* and *Claris lazera*), the frogs *Rana ridibunda* and *Hyla arborea*, the Tessellated Water Snake *Natrix tessellata* and the Common Otter *Lutra lutra*.

In most parts of Jordan, water resources are scarce and insufficient to meet the growing demands of a rapidly increasing population. As a consequence, the water resources situation is now precarious and of great concern to the Government. All water bodies are looked upon as a source of exploitation for urban, agricultural and industrial uses. Many water bodies are affected by increasing salinity, pollution and eutrophication due to intensive agricultural practices. The once extensive wetlands of the Azraq Oasis have been completely destroyed by over-exploitation of groundwater and dam construction on the major wadis, while seasonal marshes in the Disi and Al Jafr areas are now deteriorating due to the

cultivation of barley and wheat. Many of the wadis which once contained small wetlands fed by permanent springs and streams have been dammed for water storage, and there are plans for a joint Syrian-Jordanian dam project on the Yarmouk River. Hunting occurs commonly around wetlands and poses an additional threat to wildlife. As a result of these various detrimental factors, many aquatic species are now on the verge of extinction in Jordan, if not already extinct.

A recent inventory of Important Bird Areas in the Middle East, sponsored by BirdLife International, identified 17 sites of special importance for bird conservation in Jordan (Evans, 1994). Eight of these sites include significant wetlands and are described in the present inventory.

### **Wetland Research**

Numerous studies have been made on the availability and quality of Jordan's water resources, and a variety of recommendations for water conservation and sound water management have been put forward, but the wetlands, with the exception of Azraq Oasis, have received relatively little attention. A considerable amount of research has been carried out at Azraq Oasis, especially in the 1960s when the wetlands were still almost intact, and the avifauna in particular has been well documented. An International Biological Research Station was established at the oasis in 1968, as part of the International Biological Programme, but this was closed down in the following year. A considerable amount of marine research has been conducted in the Gulf of Aqaba, especially on the coral reefs and seagrass beds. A small marine research station was set up near Aqaba by the University of Jordan in 1972, and a new Marine Science Station was established in 1982, to be managed jointly by the University of Jordan and Yarmouk University. Only a few studies have been made on wetlands elsewhere in Jordan. The University of Jordan conducted some studies on aquatic invertebrates and fish at certain man-made water bodies. Yarmouk University has also conducted a comprehensive study on the taxonomy and distribution of fish in Jordan. The Research and Survey Section at the Royal Society for the Conservation of Nature (RSCN) is currently conducting a survey of migratory waterfowl in Jordan.

### **Wetland Area Legislation**

To date, no legislation exists in Jordan which specifically protects wetlands. Protection of wildlife is the responsibility of the Forestry and Range Department in the Ministry of Agriculture. Agricultural Law No.20 of 1973 (Articles 89 to 95 and 144 to 155, as amended by Act No. 14 of 1974) provides the legal basis for the control of all hunting activities. The Ministry of Agriculture, lacking expertise, has delegated the control of hunting activities (as well as the establishment and management of protected areas) to a non-governmental organization, the Royal Society for the Conservation of Nature (RSCN), established in 1966 and financed by both government and private donations. In Articles 180 to 186 of the Agricultural Law No.20 (Part IV Aquatic Resources), there are declarations on

marine and freshwater fishing areas, and areas and seasons in which fishing may be prohibited or specific kinds of fishing permitted. Under the same law, coral collecting and spear-fishing are prohibited. Dynamiting by fishermen has been forbidden since 1967, and legislated under the 1973 law. The 1975 Ship Act No. 25 prohibits the disposal of chemicals and toxic products, including oil, into the Gulf of Aqaba (IUCN, 1992; UNEP/IUCN, 1988). Other legislation relevant to wetlands and their wildlife includes Agricultural Regulation No. 113 of 1973 (Articles 1 to 8), Water Authority Law No. 18 of 1988 (Articles 1 to 32), and Jordan Valley Development Law No. 19 of 1988 (Articles 1 to 50).

The Department of Environment, established in the Ministry of Municipal and Rural Affairs and Environment in 1988, has responsibility for regulating and enforcing environmental protection measures in Jordan, including those relating to wildlife, pollution and misuse of natural resources, and for conducting environmental impact assessments. The recent National Environmental Strategy Project (1988-91), coordinated by the Department of Environment, included a review of existing environmental legislation. The National Environmental Strategy was ratified by the Government in 1992, and the proposed Law of Environment, which covers *inter alia* the protection of wetlands and wetland fauna, awaits ratification by the Government.

### **Wetland Area Administration**

The Ministry of Water and Irrigation, created in 1987, has responsibility at national level for the study and development of water resources. The Ministry has two authorities, the Water Authority of Jordan and the Jordan Valley Authority. The Water Authority of Jordan is responsible for water resources studies, planning and allocation, as well as for the provision of water supply and sewerage services throughout Jordan. The Jordan Valley Authority is responsible for the social and economic development of the Jordan Valley, including irrigation activities.

Jordan's protected areas system was established in the early 1970s, and currently comprises three National Parks, six Wildlife Reserves and a Marine Nature Reserve, as well as a number of Grazing Reserves. National Parks are established by ministries and municipal authorities, mainly for recreation and tourism; none of those established to date contains significant wetland habitat. The Ministry of Agriculture has delegated the establishment and management of Wildlife Reserves to the Royal Society for the Conservation of Nature (RSCN). Only one of the Wildlife Reserves established to date was created specifically to protect wetland habitat, namely the Azraq Wetland Reserve (1,245 ha), first declared a reserve by Royal Proclamation in 1965 and upgraded to its present status of Wetland Reserve in 1977. Since the wetlands of Azraq Oasis have dried out, this reserve has to a large extent been abandoned. However, one other Wildlife Reserve, the Wadi Mujib Wildlife Reserve (21,200 ha, established in 1985), incorporates an interesting perennial wadi system and a section of the Dead Sea shoreline. A small Marine Nature Reserve was established by the Aqaba Region Authority near the

Marine Science Station in the Gulf of Aqaba in 1985, and other marine reserves are planned for this area. The Aqaba South Coast Master Plan, which was prepared under the auspices of the Aqaba Region Authority, involved the preparation of a coastal zone management plan for the entire Aqaba region.

At international level, the Government of Jordan ratified the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention) on 10th January 1977, and designated Azraq Oasis (7,372 ha) as a Ramsar Site at the time of ratification. The Department of Environment in the Ministry of Municipal and Rural Affairs and Environment is responsible for administration of the Ramsar Convention in Jordan. The Government of Jordan ratified the World Heritage Convention in May 1975, but has not as yet designated any natural World Heritage Sites. The Government has also ratified the Biodiversity Convention and the Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment, and is a contracting party to the Convention on International Trade in Endangered Species (CITES) and the Hague Convention for the Protection of the Environment QUCN, 1992). Jordan participates in the UNESCO Man and the Biosphere Programme through a National Committee. No Biosphere Reserves have as yet been established, but at least one is under consideration, and this (the Burqu area) includes important wetland habitat.

BirdLife International's regional office for the Middle East, established in 1994, is based at the Royal Society for the Conservation of Nature in Amman. This regional office will monitor the status of Important Bird Areas, many of which are wetlands, throughout the Middle East, and will promote the establishment of protected areas wherever possible.

### **Organizations involved with Wetlands**

#### **a) Government of Jordan**

Ministry of Municipal and Rural Affairs and the Environment Department  
of Environment

Ramsar Convention Division Ministry of Agriculture

Department of Forestry and Soil Preservation

Forestry Division Ministry of Water and Irrigation

Water Resources Administration

Water Authority of Jordan

Water Resources Studies Department Irrigation Division

Jordan Valley Authority Aqaba Region Authority

b) Universities

University of Jordan

Water and Environment Research and Study Centre

Yarmouk University

Biology Department

c) Non-governmental Organizations

Royal Society for the Conservation of Nature (RSCN)

Reserves Section, Research and Survey Section

BirdLife International Middle East Regional Office

## WETLANDS

**Wetland Name:** Yarmouk River

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°44'N, 35°44'E

**Location:** on the Syrian border, about 20 km north of Irbid, Irbid Governorate.

**Area:** c.3,000 ha.

**Altitude:** c.300 m above sea level to 210 m below sea level.

**Physical and ecological features:** The Yarmouk River, which is said to be the least polluted of Jordan's rivers, flows through a steep-sided valley running along the international border with Syria, and eventually enters the River Jordan a few km south of Lake Tiberias. The average annual flow in the river has been variously estimated at 393 million cubic metres (Ahmad, 1989) and 357 MCM (MMRAE, 1991). The river banks support lush stands of *Phragmites communis*, *Nerium oleander*, *Juncus maritimus* and other wetland plants typical of the region, while the hill slopes support remnants of native *Pinus halepensis* woodland. There is a small, spring-fed pool at Birket al Rais.

**Land tenure:** No information.

**Conservation measures taken:** None. Access to much of the area is restricted for security reasons, and this provides some indirect protection. The Yarmouk Valley has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** None known.

**Land use:** Situated along the Syrian border, the river valley is treated as a military zone. The river is used as a water supply to irrigate farmland in the Jordan Valley. Fishing and reed-cutting occur along the river, and the adjacent land is intensively cultivated for fruits and vegetables.

**Possible changes in land use:** There have long been plans for a large-scale, joint Jordanian-Syrian dam across the Yarmouk River (Wahda or Unity Dam), which would potentially be a critical threat to the riverine wetlands. In the 1970s, a major environmental impact study to assess the adverse effects on the human and natural environment of this dam was completed by US-AID.

**Disturbances and threats:** Diversion of water to supply irrigation to intensive agricultural projects in the Jordan Valley is a critical problem along the lower course of the river. Wet areas along the banks of the river have been drained for agricultural purposes, and dynamite fishing has been reported in the river. Soil erosion is said to be a problem locally, and occasional hunting occurs. Over-exploitation of groundwater in the basin has led to a general depletion in spring flows. The Coypu *Myocastor coypus* has been introduced; its effects on riverine vegetation are unknown but may be highly destructive. The Ramtha Wastewater Treatment Plant discharges treated effluent into the river, but this is currently considered to be at an acceptable level (Ahmad, 1989).

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** Many species of waterbirds have occurred in the area during the migration seasons and in winter, including *Bubulcus ibis*, *Ardea cinerea*, *A. purpurea*, *Anas crecca*, *Gallinula chloropus*, *Vanellus vanellus*, *Gallinagogallinago*, *Tringa totanus*, *T. nebularia*, *Actitis hypoleucos*, *Larus ridibundus* and *Alcedo atthis*. *Fulica atra* breeds, and the rare Brown Fish Owl *Ketupa zeylonensis* is known to have occurred in the area as recently as 1986 (Evans, 1994). Other fauna includes the Rock Hyrax *Procavia capensis*, Jungle Cat *Felis chaus*, the frog *Rana ridibunda* and species of tilapia *Tilapia* spp. including the endemic *Tilapia gallileae*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** The area lies under the jurisdiction of the Jordan Valley Authority.

**References:** Ahmad (1989); Evans (1994); MMRAE (1991); Pearce (1993).

**Reasons for inclusion:** 1a, 1c & 2b. A good example of a relatively intact riverine system along an international border, with habitat for the rare and local *Ketupa zeylonensis*.

**Source:** Adnan Budieri.

**Wetland Name:** Wadi El Arab

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°35'N, 35°40'E

**Location:** in the northern highlands and north Jordan Valley, 10-25 km west-northwest of Irbid, Irbid Governorate.

**Area:** 26,700 ha.

**Altitude:** c.300 m above sea level to 220 m below sea level.

**Physical and ecological features:** Wadi El Arab and its tributary wadis rise in the hills west of Irbid city and drain west into the Jordan Valley, entering the Jordan River about 10 km south of Lake Tiberias. The annual average flow in the wadi has been estimated at 28.8 million cubic metres (Ahmad, 1989) or 17 MCM (MMRAE, 1991). A dam was constructed on the main wadi in 1987, with a total capacity of 20 MCM, to collect flood water and base flows for use in irrigation in the Jordan Valley area. Since its completion, the dam has filled with water originating from within its catchment area only in the very wet year of 1991/92. In other years, water has been pumped from the King Abdallah Canal during floods to increase the stored amount of water in the dam for use during the dry season. Wetland vegetation includes *Phragmites communis*, *Nerium oleander* and *Tamarix aphylla*.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** None known.

**Land use:** The dam is used for irrigation, and has substantial potential for fish production (Ahmad, 1989). The catchment area is under agriculture.

**Possible changes in land use:** No information.

**Disturbances and threats:** Irbid City is expanding westwards into the catchment, and this may put increasing pressure on the quality of the water collected in the dam.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** Many species of waterbirds have occurred in the area during the migration seasons and in winter, including *Bubulcus ibis*, *Egretta garzetta*, *Casmerodius albus*, *Ardea cinerea*, *Anas crecca*, *Fulica atra*, *Tringa totanus*, *T. stagnatilis*, *T. nebularia*, *Larus ridibundus*, *Ceryle rudis*, *Halcyon smymensis* and *Alcedo atthis*. Other fauna includes the frog *Rana ridibunda* and the fish *Tilapia zilli* and *Claris lazera*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known .

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1989); MMRAE (1991).

**Reasons for inclusion:** Ia. A good example of a wadi system with perennial surface flow.

**Source:** Adnan Budieri.

**Wetland Name:** Wadi Ziglab

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°29'N, 35°40'E

**Location:** in the northern highlands and north Jordan Valley, 10-25 km west-southwest of Irbid, Irbid Governorate.

**Area:** 10,600 ha.

**Altitude:** c.300 m above sea level to c.250 m below sea level.

**Physical and ecological features:** Wadi Ziglab rises in the hills southwest of Irbid city and drains west into the Jordan Valley, entering the Jordan River about 20 km south of Lake Tiberias. The annual average surface flow in the wadi has been estimated at 9.5 million cubic metres (Ahmad, 1989). Various springs produce a total discharge of some five million cubic metres per year, and flood waters make up the remainder. A dam was constructed in the wadi in 1966 to provide water for irrigation in the Jordan Valley area. The capacity of the reservoir is 4.3 million cubic metres. The catchment area is agrarian with natural forests and a very low human population density. Hence, the water collected in the dam is of high quality. The wetland vegetation is dominated by plant species typical of semi-arid conditions such as *Nerium oleander*, *Phragmites communis*, *Retma raetum* and *Tamarix aphylla*.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** None known.

**Land use:** The dam is used for irrigation purposes, and has potential for substantial fish production (Ahmad, 1989),

**Possible changes in land use:** No information.

**Disturbances and threats:** None known.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** The wetland fauna includes the frogs *Rana ridibunda* and *Hyla arborea*, and reptiles such as *Agama spp.* and *Geko spp.* Species of waterfowl

recorded on migration include *ixobrychus minutus*, *Nycticorax nycticorax*, *Egretta garzetta* and *Ardea cinerea*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1989).

**Reasons for inclusion:** Ia. A good example of a wadi system with perennial surface flow.

**Source:** Adnan Budieri.

**Wetland Name:** Zarqa River and King Talal Dam

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°12'N, 35°35'-36°00'E

**Location:** in the northern highlands and north Jordan Valley, about 35 km north of Amman, Balqa and Irbid Governorates.

**Area:** Area of river basin 402,500 ha.

**Altitude:** c.600 m above sea level to c.300 m below sea level.

**Physical and ecological features:** The Zarqa River and its main tributaries rise in the highlands northeast of Amman and drain almost due west into the Jordan Valley, entering the Jordan River about 65 km south of Lake Tiberias. The annual average surface flow in the river has been variously estimated at 67.3 million cubic metres (Ahmad, 1989) and 92.0 MCM (MMRAE, 1991). A large dam, the King Talal Dam (32°12'N, 35°48'E; 300 m above sea level) has been constructed on the Zarqa River about 15 km south-southwest of Ajlun. The reservoir behind the dam is about 4 km long, and has a capacity of 85 million cubic metres. There are natural pine forests adjacent to the dam.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** None known.

**Land use:** Although originally constructed for water storage for human consumption, the dam is now used only for irrigation purposes because of the high levels of pollution in the lake. It has been estimated that the reservoir could produce 400 tonnes of tilapia per year, but the levels of pollution are such that the fish would be unfit for human or animal consumption (Ahmad, 1989).

**Possible changes in land use:** None known.

**Disturbances and threats:** Pollution is a very serious problem in the Zarqa River and hence also in King Talal Dam, the major sources of pollution being phosphate mines, oil refineries and heavy industry in the catchment. Rare elements and heavy metals occurring at unacceptably high levels include mercury, nickel, arsenic, lead, selenium and cadmium (Ahmad, 1989). Waste water from Kherbit As-Samra Sewage Treatment Plant is discharged into Wadi Dhulayl, a tributary of the Zarqa River, adding to the pollution in the dam, with the result that King Talal Dam is now one of the most contaminated water bodies in Jordan. Elsewhere in the basin, over-exploitation of groundwater has led to a reduction in spring flows.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** King Talal Dam is an important staging and wintering area for a wide variety of migratory waterfowl such as *Ixobrychus minutus*, *Bubulcus ibis*, *Egretta garzetta*, *Ardea cinerea*, *Ciconia ciconia*, *Anas crecca*, *A. platyrhynchos*, *Fulica atra* and various shorebirds. The dam sustains large stock of fish, including both indigenous species and introduced species, notably *Tilapia spp.*, *Claris lazera*, *Noemacheilus damascena* and *Aphanius spp.* A Common Otter *Lutra lutra* was observed in one of the streams near the Zarqa River in 1987, and it is reported that the Persian Squirrel *Sciurus anomalus* still survives in native pine forests on the adjacent hills.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1989); MMRAE (1991).

**Reasons for inclusion:** 1a & 3b. A major river system and reservoir important for migratory waterfowl.

**Source:** Adnan Budieri.

**Wetland Name:** Kherbit As-Samra

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32° 10'N, 36° 10'E

**Location:** in the northern highlands, about 35 km northeast of Amman, Zarqa Governorate.

**Area:** 300 ha.

**Altitude:** c.500 m.

**Physical and ecological features:** Kherbit A1-Samra Sewage Treatment Plant is the main sewage treatment plant for the city of Amman; it comprises a large area of open, manmade pools in a broad depression close to Wadi Dhulayl, a tributary of the Zarqa River. Pools range from sludge to "fresh" water, with rocky shores and very little natural vegetation. The pools are surrounded by rather bare limestone desert.

**Land tenure:** No information.

**Conservation measures taken:** None. The site has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** In the late 1980s, a consultant proposed various wildlife-friendly management regimes to the operators of the sewage treatment plant.

**Land use:** The sewage treatment plant utilizes stabilization ponds and is capable of achieving secondary treatment of up to 68,000 cubic metres of raw sewage per day (Ahmad, 1989). Some of the treated water is used to irrigate olive groves.

**Possible changes in land use:** No information.

**Disturbances and threats:** Levels of human disturbance are high, but hunting is considered to be insignificant at present.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** An important staging and wintering area for a wide variety of migratory waterfowl, and especially important as a staging area for White Storks *Ciconia ciconia* in autumn; as many as 6,000 have been recorded roosting at the site in August. Other peak counts of migrants in autumn have included 230 *Anas querquedula*, 500 *Calidris minuta*, 110 *Tringa ochropus* and 150 *Chlidonias leucopterus*. Breeding species include *Vanellus spinosus* (at least 14 pairs) and possibly *Himantopus himantopus*, *Charadrius dubius* and *C. alexandrinus*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1968); Evans (1994).

**Reasons for inclusion:** 3b & 3c. An important staging and wintering area for migratory waterfowl, notably *Ciconia ciconia*.

**Source:** Adnan Budieri.

**Wetland Name:** Wadi Damia, Kibed Pool, Kafrein Dam, Shu'eib Dam and Swaimeh Pool

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 31°50'N, 35°40'E

**Location:** in the north-central highlands and middle Jordan Valley, about 10-40 km west-southwest of Amman, Baiqa and Amman Governorates.

**Area:** Wadi Damia 18,600 ha; Kibed Pool 50 ha; Kafrein Dam 800 ha; Shu'eib Dam 600 ha; area of Swaimeh Pool unknown.

**Altitude:** c.600 m above sea level to the shores of the Dead Sea at 395 m below sea level.

**Physical and ecological features:** A group of small wetlands including natural brackish to saline pools, water storage reservoirs and riverine marshes in the Jordan Valley and tributary wadis near the north end of the Dead Sea. The Jordan River in the west flows in a deeply incised channel, and supports *Tamarix* woodland and beds of *Phragmites* along its banks. The river is now highly saline because of inflow of water from brackish and saline springs near Lake Tiberias in the north and return flow from irrigated land throughout the valley. Savage (1968) refers to a small marsh at the head of the Dead Sea near the outfall of the Jordan River (Em Feshka; 31°37'N, 35°38'E), but the present status of this area is unknown. Dams have been constructed on two of the principal tributary wadis: Kafrein Dam, with a capacity of 4.8 million cubic metres, in Wadi Kafrein, and Shu'eib Dam, with a capacity of 2.3 million cubic metres, in Wadi Shu'eib. Both wadis rise in the highlands to the southwest of Amman and join the Jordan River just north of the Dead Sea. Ahmad (1989) gives the average annual surface flows as 14.3 million cubic metres in Wadi Kafrein and 7.9 million cubic metres in Wadi Shu'eib. Kibed Pool is a highly saline pool. The dominant wetland vegetation is *Phragmites communis* and *Tamarix sp.*, but there are some patches of *Populus euphratica*. All the sites are surrounded by irrigated cultivation, with crop fields, market gardens and orchards.

**Land tenure:** No information.

Conservation measures taken: None. An area of about 80,000 ha of cultivated plains along the Jordan River has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** None known.

**Land use:** This is the main agricultural area in Jordan, and population density is relatively high. Other activities include livestock grazing, aquaculture, hunting, recreation and tourism. Kafrein Dam is used for irrigation purposes, while Shu'eib Dam is used for groundwater recharge. The Jordan River is now too saline to be used for irrigation purposes.

**Possible changes in land use:** No information.

**Disturbances and threats:** All of the wetlands are subjected to over-extraction of groundwater, intensification of agriculture, eutrophication, salinization, unplanned urban expansion, and toxic pollution from persistent pesticides, herbicides and heavy metals. Because of increasing salinity, the River Jordan is apparently no longer fit for human use. Other less serious threats include overgrazing, hunting, the dumping of rubbish, and excessive disturbance from human activities.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** The Jordan Valley lies on a major bird migration route, and the wetlands are of considerable importance as breeding, staging and wintering areas for waterbirds. Breeding species include *Ardea cinerea*, *Francolinusfrancolinus*, *Gallinula chioropus*, *Himantopus himantopus*, *Ceryle rudis*, *Halcyon smyrnensis*, *Alcedo atthis* and *Acrocephalus scirpaceus*. *Marmaronetta angustirostris* is a very scarce breeding bird (less than 10 pairs) in reed-beds along the Jordan River (e.g. in the Wadi Damia area). Waterbirds recorded on passage and in winter include *Pelecanus onocrotalus* (up to 350 in a day in autumn), *Nycticorax nycticorax*, *Bubulcus ibis* (up to 300 in winter), *Egretta garzetta*, *Ciconia ciconia* (up to 5,000 on passage), *C. nigra* (up to 11 on passage), *Tadorna ferruginea*, *T. tadorna*, *Anas penelope*, *A. crecca*, *A. querquedula*, *Rallus aquaticus*, *Porzana porzana*, *Fulica atra*, *Recurvirostra avosetta*, *Charadrius dubius*, *Pluvialis squatarola*, *Vanellus vanellus*, *V. spinosus*, *Eudromias morinellus* (up to 50 in winter), *Tringa nebularia*, *T. ochropus*, *Actitis hypoleucos*, *Calidris minuta*, *C. alpina*, *Larus ridibundus* and *Chlidonias leucopterus*. *Botaurus stellaris* has occurred as a rare winter visitor, and *Crex crex* and *Gallinago media* have been recorded in small numbers on passage. Em Feshka, at the north end of the Dead Sea, was reported to be of great ornithological interest and used by waterfowl on passage (Savage, 1968). The main water bodies are inhabited by many crustaceans, notably *Gammarus spp.* and crabs, and various fish such as *Barbus canis*, *B. longiceps*, *Gara rufa*, *Tilapia gallileae* and *Aphanius spp.*

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1989); Evans (1994); Savage (1968).

**Reasons for inclusion:** 1a, 2a, 2b, 2c & 3c. The site contains a variety of wetland habitats with a diverse fauna, including globally threatened species (e.g. *Mar,naronetta angustirostris*) and endemic species (e.g. *Tilapia gallileae*), and is an important staging and wintering area for migratory waterfowl.

**Source:** Adnan Budieri.

**Wetland Name:** Wadi Mujib

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 31°27'N, 35°35'-36°00'E

**Location:** in the central highlands and south Jordan Valley, about 30 km south of Madaba, Amman and Karak Governorates. Area: Area of wetlands unknown; area of catchment 659,600 ha. Altitude: 400 m below sea level to 1,100 m above sea level.

**Physical and ecological features:** A major wadi system extending from near the summit of the eastern escarpment of the Rift Valley west for about 70 km to the shores of the Dead Sea. In their upper reaches, the main wadi and its tributaries descend through steep gorges in rocky, mountainous terrain, with cliffs and crags; in their lower reaches, the wadis cut through a broad plateau which slopes gradually down to the Dead Sea. The principal tributary wadi, Wadi Hidan, enters Wadi Mujib from the north only a few km from the shores of the Dead Sea. Perennial, spring-fed streams flow down the wadis, and are lined with a narrow strip of *Nerium oleander* shrubs. The vegetation in the wadi floor also includes beds of *Phragmites communis* and *Juncus maritimus*, and scattered *Phoenix dactylifera*. The average annual surface flow in Wadi Mujib has been estimated at 34.7 million cubic metres (Ahmad, 1989). Away from the wadi floor, the slopes are very sparsely vegetated, with semi-desertic steppe vegetation on the plateau. Groundwater seepage occurs rarely on rocky ground near the Dead Sea shore, especially at the hot springs of Zara, which support a luxuriant thicket of *Acacia*, *Tamarix*, *Phoenix* and *Nerium*. The rocks forming the catchment area consist of fractured limestone, dolomites, shales, sandstone and shert beds. The average annual rainfall in the area is about 150mm.

**Land tenure:** No information.

**Conservation measures taken:** A Wildlife Reserve of 21,200 ha was established in Wadi Mujib in 1987, and extends to the shores of the Dead Sea. The Nubian Ibex *Capra ibex nubiana* is being bred in an enclosure for re-introduction. The Wildlife Reserve has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** None known.

**Land use:** Adjacent slopes at higher elevations are used for livestock grazing, mainly sheep and goats. There is a temporary military camp in the southern part of the reserve.

**Possible changes in land use:** No information.

**Disturbances and threats:** Wadi Mujib is vulnerable to the effect of over-pumping of groundwater and increasing salinity. Pumping projects were started in some of the main streams in 1993. A highway is currently being built linking the Middle Jordan Valley with Aqaba, and this will create additional pressure on the wildlife of the area. Much of the steppe vegetation on higher plateaux has been destroyed by ploughing and overgrazing. The flow of water in Wadi Hidan, within the Wildlife Reserve, is potentially threatened by the planned damming of the upper reaches of the wadi (known as Wadi Wala) east of and outside the reserve.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** The indigenous fauna of Wadi Mujib includes the fishes *Barbus* spp., *Capoeta damascena*, *Gara* spp., *Hemigrammacopoeta nana* and *Aphanius* spp., various crabs, the frogs *Rana ridibunda* and *Hyla arborea*, lizards of the genus *Agama*, Nubian Ibex *Capra ibex nubiana*, Mountain Gazelle *Gazella dorcas*, Rock Hyrax *Procapra capensis*, Caracal *Lynx caracal*, Wolf *Canis lupus*, Red Fox *Vulpes vulpes* and Indian Crested Porcupine *Hystrix indica*. The Leopard *Panthera pardus* may still occur in the area. The White Stork *Ciconia ciconia* occurs in very large numbers during the spring and autumn migration seasons, with flocks often resting on the shores of the Dead Sea. Other waterfowl recorded on passage include *Bubulcus ibis*, *Egretta garzetta*, *Ardea cinerea*, *Plegadis falcinellus*, *Platalea leucorodia*, *Ciconia nigra*, *Phoenicopterus ruber*, *Haematopus ostralegus*, *Himantopus himantopus* and *Charadrius hiaticula*. *Charadrius alexandrinus* and *Vanellus spinosus* breed along the shores of the Dead Sea. The region as a whole supports a rich breeding bird assemblage of unusually mixed biogeographical origins, including at least nine species of birds of prey (Evans, 1994).

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Ahmad (1989); Evans (1994); MMRAE (1991).

**Reasons for inclusion:** 1a, 2b & 3b. An outstanding example of a wadi system with rich and diverse indigenous fauna; also an important staging area for migratory waterfowl, notably *Ciconia ciconia*.

**Source:** Adnan Budieri.

**Wetland Name:** Ghadir Burqu

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°38'N, 37°57'E

**Location:** in the Eastern Desert, 12 km north-northwest of the village of Muqat on the main Amman to Baghdad road, about 200 km east-northeast of Amman, Mafraq Governorate.

**Area:** 200 ha.

**Altitude:** c.700 m.

**Physical and ecological features:** Ghadir Burqu is a natural freshwater lake covering about 200 ha in the Eastern Desert, some 40 km south of the Syrian border. The lake is fed by springs, and seldom if ever dries out completely. The surrounding desert landscape consists of flint/chert plains (hammada) in the east, and flattish to gently rolling country covered in black basalt boulders (harrat) in the west, interspersed with silt flats and many shallow wadis. Plant cover is generally sparse, mainly limited to the shallow wadis and dominated by woody perennial herbs such as *Artemisia*, *Anabasis* and *Achillea*.

**Land tenure:** No information.

**Conservation measures taken:** A Wildlife Reserve of 95,000 ha, including the wetland and a large area of the surrounding desert, is currently in the process of being established by the RSCN. The Wildlife Reserve has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** The RSCN is currently planning to carry out a survey of the area to assess its suitability as a Biosphere Reserve. Large fauna proposed for reintroduction include Ostrich *Struthio camelus*, Cheetah *Acinonyx jubatus*, gazelles *Gazella* spp. and Wild Ass *Equus hemionus*.

**Land use:** The lake is a major source of water for the livestock of bedouin living in a wide surrounding area. The main land use in the surrounding desert is nomadic pastoralism, and there is very little cultivation.

**Possible changes in land use:** No information.

**Disturbances and threats:** The area is subjected to very intense grazing by camels, sheep and goats. The trapping of birds of prey at the wetland is a major problem, and bird shooting is often excessive. Water extraction by pastoralists for their flocks could have a serious impact on the lake in the near future if current trends continue (Evans, 1994).

**Hydrological and biophysical values:** No information.

**Social and cultural values:** There is a Roman/Byzantine castle at Burqu, which gives the area its name.

**Noteworthy fauna:** A wide variety of waterbirds and passerines are attracted to the wetland during the migration seasons and in winter, including *Ciconia ciconia* and several species of ducks *Anas* spp. As many as 100 Common Cranes *Grus grus* spend the winter in the area, and the scarce and local southwest Asian race of the Greater Sand Plover *Charadrius leschenaultii columbinus* breeds on the silt flats. The wetland is an important source of water for large numbers of birds of prey during the autumn migration season (e.g. up to 85 *Circus pygargus* in one day in September). The surrounding desert supports a relatively rich and intact desert bird community including *Chiamydotis undulata*, which may breed (Evans, 1994). Mammals in the surrounding desert include Goitred Gazelle *Gazella subgutturosa*, Wolf *Canis lupus*, Red Fox *Vulpes vulpes* and possibly Caracal *Lynx caracal*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Evans (1994); MMRAE (1991).

**Reasons for inclusion:** id, 2c & 3b. A good example of a rare wetland type (permanent freshwater lake in a desert region), of considerable importance as a staging area for migratory birds.

**Source:** Adnan Budieri.

**Wetland Name:** Qa Khana

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 32°04'N, 36°35'E

**Location:** in the Eastern Desert, 7 km north of the main Zarqa to Azraq highway, about 40 km east of Zarqa and 60 km east-northeast of Amman, Zarqa Governorate.

**Area:** c.3,000 ha.

**Altitude:** c.600 m.

**Physical and ecological features:** Qa Khana (Qa Hanna) is a seasonal playa lake, about 15 km long and up to 3 km wide, with very sparse vegetation consisting mainly of halophytes. The mudflats and surrounding saline marshes flood in years of good rainfall, and can then remain wet for several months. In some wadis, there are scattered beds of *Phragmites communis* and patches of *Juncus maritimus*, *Tamarix jordanis* and *Retma raetum*.

**Land tenure:** No information.

**Conservation measures taken:** None. Qa Khana has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** None known.

**Land use:** A large farm has been established in the surrounding desertic steppe, and this takes irrigation water from the qa. The steppe is grazed by domestic livestock, and there is a military base near the site.

**Possible changes in land use:** No information.

**Disturbances and threats:** Threats include the expansion of agriculture and increasing use of the qa as a source of water for irrigation. Hunting is often excessive, and there is very heavy grazing pressure on the surrounding plains.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** When flooded, an important staging and wintering area for migratory waterfowl, including *Ardea purpurea*, *Ciconia ciconia*, *Tadorna tadorna*, *Anas crecca*, *A. acuta*, *A. clypeata*, *A. querquedula*, *Aythya fuligula*, *Grus grus* (up to 200 in spring), *Charadrius alexandrinus*, *Vanellus vanellus*, *V. spinosus*, *Tringa nebularia* and *Philomachus pugnax*. The scarce and local southwest Asian race of the Greater Sand Plover *Charadrius leschenaultii columbinus* breeds around the qa. Very soon after flooding, the shallow pools develop a rich fauna of halophytic crustaceans such as *Cyclops* spp., *Triops canseriformes* and *Daphnia* spp., most probably transferred to the site by waterfowl. The toad *Bufo viridis* also becomes common after rains.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**References:** Evans (1994).

**Reasons for inclusion:** 1a & 3b. A good example of a playa wetland, and an important staging and wintering area for migratory waterfowl in wet years.

**Source:** Adnan Budieri.

**Wetland Name:** Azraq Oasis

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 31°14'-31°53'N, 36°48'-36°55'E

**Location:** in the Eastern Desert, about 85 km east southeast of Amman, Zarqa Governorate.

**Area:** c.12,000 ha.

**Altitude:** 500 m.

**Overview:** The wetlands of Azraq Oasis formerly comprised a complex of fresh to brackish pools and marshes fed by two groups of springs (Druze and Shishan) and

a large seasonally flooded mudflat or playa (Qa Al Azraq) fed by surface run-off during winter and spring. Massive extraction of groundwater for water supply and irrigation, especially since 1982, has resulted in a cessation of all spring flow, and the former extensive spring-fed marshes have now almost disappeared. Some marsh vegetation survives around the main spring pools, at an artesian borehole and around a small group of fishponds, but elsewhere the marshes are now desiccated. With the construction of a dam in 1992 on Wadi Rajil, one of the main wadis emptying into the oasis, the extent of winter flooding in Qa Al Azraq has been reduced.

Until recently, Azraq Oasis was an outstanding example of an oasis wetland in an arid region, with few parallels anywhere else in the world. The oasis was especially important for migratory birds, with up to a million birds utilizing the area during the course of a single spring migration. At least 33 species of waterbirds are known to have bred in the wetlands, and as many as 347,000 waterfowl have been recorded in mid-winter. The oasis was first protected as a Reserve by Royal Proclamation in 1965. Some 7,372 ha of the wetlands were designated as a Ramsar Site in 1977, and 1,245 ha, including the main spring-fed marshes and a part of the adjacent qa, were declared a Wetland Reserve in the same year.

The RSCN and various international bodies have intervened on a number of occasions in an attempt to reduce the rate of groundwater extraction in Azraq Oasis, and a special Cabinet Committee, headed by the Prime Minister, was set up in the late 1980s to investigate the problem, but no lasting solutions were found and the condition of the spring-fed marshes continued to deteriorate. A recently initiated project funded through the Global Environment Facility will endeavour to halt further degradation of the aquatic ecosystems in the oasis and to restore as much of the wetlands as possible to a natural or near-natural condition with a view to maintaining the biological diversity of this unique wetland ecosystem.

**Physical features:** Azraq Oasis is located at the heart of a large internal drainage basin covering around 12,710 sq. km, most of which (94%) lies in Jordanian territory, with the remainder in Syria (5%) and Saudi Arabia (1 %). The highest relief in the basin is at Tillin Town in Syria with an elevation of 1,550 m; the lowest point is at Qa Al Azraq in the Azraq Depression, with an elevation of 500 m. The catchment area is drained by a number of wadis, the principal ones being Wadi Rajil, Wadi Hassan, Wadi Asekim, Wadi Shaumari, Wadi Jesha and Wadi Ghadaf.

Until recently, the wetlands of Azraq Oasis comprised a large complex of spring-fed marshes and seasonally flooded mudflats covering about 12,000 ha. The three principal systems were as follows: (1) a small area of freshwater marshes fed by two springs near the village of Druze or North Azraq in the northwest (31°51'N, 36°50'E); (2) a large area of fresh to brackish marshes and pools fed by two large springs near the village of Shishan or South Azraq in the west (31°49'N, 36°49'E); (3) a large seasonally or intermittently flooded mudflat

or playa wetland (Qa Al Azraq) in the east (31°50'N, 36°53'E). Streams carried water from the main spring pools at Shishan eastwards towards the playa, creating extensive shallow wetlands with a variety of habitats. The two main areas of spring-fed marshes have disappeared within the last ten years (see below), but the qa wetland remains, along with about 50 ha of pools and freshwater marshes fed by an artesian borehole, drilled in 1963, and about 100 ha of fishponds recently excavated in silt desert on the edge of the qa.

Qa Al Azraq covers some 6,127 ha, and is fed by surface run-off from an extensive network of wadis. The qa is partly or wholly flooded in most winters, creating a temporary fresh to brackish lake with a maximum depth of 1.25 m and broad muddy margins. Small islands are formed from the mounds of salt-workings left over from the dry season. Owing to the impervious nature of the soil and rapid evaporation, the lake usually dries up again by April or May, becoming increasingly saline in the process and finally exposing bare saline silt flats. Even during years of deep flooding, the playa is usually completely dry by the end of May.

Colonel R. Meinertzhagen visited the oasis in 1922 and described it as "a perfect paradise for birds with green meadows, pools and bushes" (Meinertzhagen, 1924). More recently, accounts of the oasis in its original condition have been given by Mountfort (1965), Dakhgan and Bandak (1970b) and Nelson (1973).

Major changes have occurred to the wetlands of Azraq Oasis in the last ten years. The two springs at Druze dried out completely in 1987; one of the large springs at Shishan ceased to overflow in 1990, and the other finally stopped discharging in August 1992. By December 1992, both main areas of spring-fed marshes were completely dry except for small stagnant pools at the two Shishan springs. The cessation of spring flow has occurred as a direct result of the massive extraction of groundwater from the Azraq aquifers for water supply to Amman and the irrigation of agricultural land around the oasis. As the water table has been lowered, the natural discharge of the springs has fallen from an estimated 14-16 million cubic metres (MCM) in the 1960s, before the extraction of groundwater commenced, to 10.5 MCM in 1981, 2.0 MCM in 1989, 0.3-0.4 MCM in 1991, and zero by the end of 1992. In March 1990, when water was still flowing from the southern springs at a rate of 1.5-2.0 MCM per year, much of the main marsh remained flooded, with some water reaching the Burgess, Monfilit and Ingilesi pools. By early June 1992, the total overflow from the southern springs had fallen to about 0.25 MCM per year, less than 2% of its original level. This overflow created a single stream which extended for about one km through the marsh and then dried up. Only the marsh vegetation around the spring pool and along the stream remained green. All other marsh vegetation was dead and brown; the Burgess, Monfihit and Ingilesi pools were completely dry, slow-burning fires were moving through the ground in **areas** which had formerly been deep swamp, and heavy grazing pressure from the feral water buffalo and horses in the reserve was

causing considerable damage to the surviving marsh vegetation. The problem in the marshes was further compounded by the diversion of water from the Shishan springs to a complex of fishponds to the south. In June 1992, these fishponds constituted the largest area of open water in the oasis.

The playa wetland has been largely unaffected by groundwater extraction. However, the construction in 1992 of a dam on Wadi Rajil, the most important single source of water for the qa, has reduced the frequency and extent of winter flooding in the qa.

Azraq Basin belongs geologically to the East Jordanian Limestone Plateau, which is partially covered by basalt flows. The basin is surrounded by a series of hills consisting mainly of limestone deposits **and basalt** craters. The sedimentary rocks overlay the basement complex, found at a depth of 2,550 m in the eastern part of the basin. Three partly connected aquifer systems have been identified in the sedimentary rocks overlaying the basement: the Upper Aquifer System (Basalt/B4), the Middle Aquifer System (B2/A7) and the Lower Aquifer System (Kurnub). Natural discharge from the upper aquifer occurs at the springs at Shishan and Druze. Little information is available on the deeper aquifers, but it appears that in general the salinity increases with depth.

The pattern of water-flow indicates that most of the recharge to the upper aquifer takes place in the north-northeast and northwest, with about 50 % of the recharge taking place in the Jebel El-Drouz in Syria. The velocity of groundwater flow from the recharge area in Jebel El-Drouz to the springs in Azraq Oasis is believed to be very slow. Recent studies have shown that the groundwater in the well field about three km north of the oasis is between 4,000 and 20,000 years old. Tritium has never been detected in the wells, indicating that no recent recharge to the groundwater has taken place.

The mean annual rainfall in the catchment ranges from 300 mm in the north (in Syria) to about 150 mm in the west, and less than 50 mm in the east and south. The average annual rainfall over the basin as a whole is 87 mm. The mean annual evapo-transpiration is approximately 2,000 mm. The summers are hot and dry, with temperatures occasionally reaching 44°C; the winters are relatively wet and cold, with occasional frosts.

**Ecological features:** The once extensive spring-fed marshes contained a variety of habitats including dense stands of *Juncus maritimus*, *Carex sp.*, *Typha angustifolia*, *Phragmites communis*, *Scirpus sp.*, *Cyperus sp.* and *Arundo donax*, and shallow pools with *Ruppia sp.* *Nitraria* and *Tamarix* communities occurred in the silty dunes between the streams and pools. The permanently wet areas around the artesian borehole support a small area of *Tamarix* bushes surrounded by wet marshes and meadows. The fishponds are fringed with *Phragmites* reeds. The playa is largely devoid of vegetation, except for a fringe of succulent halophytes such as *Halopeplis sp.* and *Halocnemum sp.* When the playa is flooded, there is abundant production of zooplankton, phytoplankton and some filamentous algae.

In the past, when the water level in the playa lake was high, large numbers of fish (mostly *Tilapia*) escaped from Shishan marshes into the qa.

**Land tenure:** Government ownership.

**Conservation measures taken:** Azraq Oasis was declared a Reserve by Royal Proclamation in 1965. In January 1977, the Government of Jordan acceded to the Ramsar Convention and designated the greater part of the oasis (7,372 ha) for inclusion in the List of Wetlands of International Importance. The Ramsar Site includes the whole of Qa Al Azraq and the marshes and pools fed by the southern group of springs. The southern area of spring-fed marshes and adjacent parts of the qa (an area of 1,245 ha) were declared a Wetland Reserve in 1977, and have been managed since that time by the Royal Society for the Conservation of Nature (RSCN) under an agreement with the Ministry of Agriculture. The Azraq Wetland Reserve is fenced, and there is a RSCN warden allocated to the reserve. A management plan for the reserve was prepared for RSCN under a joint IUCN/WWF project in 1979 (Conder, 1979), but only a few of the recommendations in this plan were ever implemented. The artesian pools and fishponds lie outside the Wetland Reserve and are unprotected. A three-year project for the conservation of Azraq Oasis, funded through the Global Environment Facility, was initiated in 1993 (see below). Azraq Oasis has been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** Plans were put forward in 1966 for the establishment of a large Azraq Desert National Park (525,000 ha) around Azraq Oasis, and a Draft Management Plan was produced by the International Biological Programme (Hemsley & George, 1966), but the plans were subsequently abandoned. In the early 1970s, a Committee appointed by the Prime Minister recommended to the Government that all forms of exploitation which might change the area's wetland nature be prevented or stopped. In particular, the Committee recommended that grazing by camels and cows be stopped and compensation paid to their owners.

Concern over the degradation of the Ramsar Site as a result of excessive pumping of groundwater was expressed at the Third Conference of the Contracting Parties to the Ramsar Convention, held in Regina, Canada, in May/June 1987. Recommendation 3.8 of this Conference called for a proper assessment of the environmental impact of the pumping; suggested that pumping be reduced by at least 50%, at least until the environmental impact study was completed; and urged that there be established a longterm water resources plan guaranteeing the maintenance of the natural properties of the wetland. A Special Cabinet Committee was formed by the Prime Minister in 1987 to study the situation and suggest a plan to save the wetland. The Cabinet Committee approved the concept of a "safe yield" of 20 MCM of water per year, and recommended that 14 MCM be allocated for Amman water supply, 3.5 MCM for irrigation and 2.5 MCM for natural discharge from the springs. Later in the same year, the Ministry of Agriculture issued an Agricultural Policy for the Azraq Area based on an allocation of 3.5 MCM of water per year for irrigation.

In March 1990, a Ramsar Monitoring Procedure Mission to Jordan visited the oasis and discussed the situation with Government Ministers and officials, NGO representatives and local people. The mission produced a detailed report, containing thirteen specific recommendations for action (Jones & Clarke, 1990). The mission concluded that Azraq Oasis "remains a wetland of great ecological, economic and social value", and considered that populations of aquatic plants and animals would recover rapidly if the wetlands could be restored. The National Environment Strategy for Jordan, published in 1991 and ratified by the Government in 1992, identified the rehabilitation of Azraq Oasis as one of the highest priorities in the conservation of wildlife and habitats in Jordan, and endorsed the earlier recommendations of the Ramsar Convention Bureau (MMRAE, 1991).

Between October and December 1991, missions from the World Bank and UNDP visited Jordan to assist the Government in identifying projects potentially suitable for funding through the Global Environment Facility (GEF). A project proposal was drawn up in 1992, and in 1993, the Government of Jordan approved a three-year project (Conservation of the Dana Wildlands, the Azraq Oasis and the Institutional Strengthening of the RSCN) to be funded under the Third Tranche of the GEF. Almost half of the project's budget of 6.3 million dollars has been allocated to the conservation of Azraq Oasis. The long-term goal is to establish a sustainable basis for the utilization of the water resources of the Azraq Basin for water supply and agriculture, while at the same time conserving the outstanding biodiversity values of the natural wetland ecosystems. The Azraq project has five main components: (1) rehabilitation and management of Azraq Wetland Reserve; (2) establishment of an environmental impact assessment unit within the Department of Environment and improved implementation of the Ramsar Convention in Jordan; (3) establishment of guidelines for agricultural development in the Azraq Basin; (4) investigation of groundwater resources in the Azraq Basin and development of a water management plan for the basin; and (5) support for long-term research on the conservation and management of water resources in arid and semi-arid regions. The primary objective is to conserve the biodiversity of Azraq Oasis through the restoration and rehabilitation of the aquatic ecosystems in the Azraq Wetland Reserve and adjacent qa. The immediate problem of water supply to the reserve will be resolved through the provision of up to 2.5 MCM of water per year from wells drilled into the underlying aquifers. Management procedures will be implemented to make the fullest possible use of the limited supply of water available to halt any further degradation of the wetland ecosystems, and to preserve a viable nucleus of the animal and plant communities from which rapid recolonization of wetland habitats can occur if more water should become available in the future. A comprehensive management plan for the Azraq Wetland Reserve will be prepared and implemented. This will address the issues of grazing by domestic livestock, disposal of rubbish and other pollutants in the reserve, and hunting. Existing reserve infrastructure will be repaired; a new reserve headquarters and two ranger stations will be constructed, and a Visitor

Centre will be established along with a variety of other facilities of an educational, recreational and scientific nature for both national and foreign visitors.

More generally, the Azraq project will provide substantial support for studies on the water resources of the Azraq Basin and their utilization for water supply and irrigation purposes with a view to developing a water management plan for the entire basin. It will also support long-term research on the conservation and management of water resources in arid regions, specifically through research on the use of infiltration techniques to accelerate groundwater recharge. The project is being coordinated by an inter-ministerial Steering Committee, and is being implemented by the Royal Society for the Conservation of Nature, Department of Environment, Ministry of Agriculture, Ministry of Water and Irrigation, and Water and Environment Research and Study Centre.

**Land use:** Major highways from Amman and Zarqa to Iraq and Saudi Arabia transect the basin, passing through the villages of South Azraq (formerly Shishan) and North Azraq (formerly Druze) on the northwestern edge of the oasis. Both villages were founded this century (Druze after World War I and Shishan in the 1920s) and remained small until the main highways from Amman to Iraq and Saudi Arabia were re-routed past the oasis. The population of Druze then grew from 1,500 in 1975 to over 3,500 in 1990, while that of Shishan grew from a few hundreds in 1975 to over 1,000 in 1990. This rapid expansion has been closely linked to the rapid increase in heavy traffic through the oasis, with most people now being involved in the service industry rather than any traditional pastoral activities. There is also a military base on the edge of the oasis.

Traditional activities in the wetlands formerly included livestock-rearing, reed-cutting, fishing and salt extraction. Cattle, water buffalo, horses, sheep and camels were allowed to graze in the marshes, and local villagers cut *Arundo donax* and *Typha angustifolia* for mat-making. There was also some fishing of introduced *Tilapia*, carp *Cyprinus* sp. and catfish *Silurus* sp. A pilot project for breeding freshwater fish in artificial ponds was initiated by the Ministry of Agriculture in the 1970s, with the help of FAO, and some fishponds were still in operation as recently as 1992. Salt extraction remains an important economic activity in the qa, and has been unaffected by pumping activities.

Starting in about 1980, there has been rapid expansion in agricultural activities in and around Azraq Oasis, based on the extraction of groundwater for irrigation. By the end of 1991, there were approximately 1,400 ha of olive groves and orchards and 153 ha of vegetable gardens in the Azraq area. New farms are continually being established and the area under cultivation is increasing rapidly.

Duck-hunting was formerly a popular activity in winter, and a hunting lodge was built on a hill overlooking the oasis. Hunting was effectively controlled, and only took place on the margins of lakes from blinds and on two designated days each week (Fridays and Sundays) between 30 September and 31 March (Savage, 1972).

Annual bag statistics reveal that in the 1968/69 and 1969/70 seasons, the total numbers of birds shot were 1, 105 and 979, respectively. These were mainly *Anas crecca* (63 %) and *A. acuta* (19%) (Dakhgan & Bandak, 1972). A total of 1,664 birds were shot during the 1973/74 season, mainly *Anas crecca*, *Fulica atra*, *Anas acuta*, *Tadorna tadorna* and *Anas penelope* (Qasem, 1976). However, legal hunting was finally abandoned throughout the oasis in 1985, largely because of the increasing scarcity of waterfowl.

**Possible changes in land use:** Restoration and rehabilitation of wetland habitats (see under "Conservation measures proposed" above).

**Disturbances and threats:** The ecological character of Azraq Oasis has been radically altered by man's activities in the basin during the past three decades. Some of these changes are relatively superficial and are linked to the routing of new highways through the area and rapid growth of Druze and Shishan villages. However, major changes to the wetland ecosystems have occurred as a result of the massive extraction of groundwater from the Azraq aquifers for water supply to Amman and the irrigation of agricultural land around the oasis.

Utilization of the springs as a water supply for towns and villages in northern Jordan began as long ago as 1963, but throughout the remainder of the 1960s and during the 1970s, only small quantities of water were extracted, mainly to supply the town of Irbid, some 125 km northwest of Azraq. However, in November 1980 the then Amman Water Authority (now part of the Water Authority of Jordan) began pumping water to Amman at the rate of about 1.5 MCM per year. In 1981, the Water Authority dug 15 wells some 3-10 km northwest of the Druze springs, and in 1982 pumping from the springs was replaced by extraction from the new well field. Pumping was stopped shortly afterwards, following protestations from the RSCN, but *was* resumed again later in the same year. Extraction rates then rose rapidly over the next six years to a peak of about 22 MCM in 1988, and have since stabilized at about 16 MCM per year. (No figures are available for the off-take for the Military Airbase at Azraq. However, it is thought that this is unlikely to exceed 60,000 cubic metres per year, and is therefore no cause for concern).

At the same time, the extraction of groundwater in and around Azraq Oasis for agricultural purposes has increased rapidly, and has been largely uncoordinated and uncontrolled. Already by 1970, 54 unlicensed wells had been dug near the qa, and these were being used to irrigate agricultural land to the north and east of the oasis (Dakhgan & Bandak, 1972). The digging of wells for irrigation purposes was prohibited in 1971, but was resumed again in 1984. By 1990, approximately 310 shallow wells and 140 deep bore holes had been dug to provide water for irrigation, and these were extracting groundwater at an estimated rate of 22-23 MCM per year. Over 95% of these well and bore holes were unlicensed and therefore illegal. Most produce water with a concentration of dissolved solids in the range 2,000-4,000 ppm, and concern is now being expressed that the widespread use of this slightly brackish water for irrigation will soon lead to severe problems of increased soil salinity.

Natural discharge of the Azraq springs in the 1960s, before the extraction of groundwater commenced, was estimated at about 14-16 MCM per year. Extraction rates have exceeded this every year since 1983, and in 1990, an estimated 40 MCM were extracted from the aquifer, with 16-17 MCM being pumped to Amman and the remainder used for irrigation purposes in the Azraq area. The natural rate of discharge of the four main springs fell rapidly from 10.49 MCM per year in 1981 to an estimated 1.96 MCM in 1989. The two northern (Druze) springs dried up completely in 1987, and by November 1991, only one of the two southern springs was overflowing from its pool, at an estimated rate of 0.3-0.4 MCM per year. The discharge from this spring had fallen to an estimated 0.2-0.25 MCM per year by early June 1992 and ceased completely in early August of that year. By early December 1992, the entire Wetland Reserve was dry, and underground fires were spreading throughout the former marsh area.

There is now general agreement that the upper aquifer is being heavily over-exploited and that this is causing a lowering of the water table and deterioration in water quality. A study of the water resources of the Azraq Basin in 1989 (Water Authority of Jordan, 1989) concluded that if the groundwater level in the well-field supplying Amman were to fall below an elevation of 504 m (the static water level in Qa Al Azraq saline aquifer), a movement of saline water from Qa Al Azraq towards the well-field might be expected to occur. Measurements taken in January and May 1991 revealed that the groundwater level had fallen by as much as six metres below this critical level at four of the seven wells tested. There were already signs of increasing salinity in some of the wells, and it was thought that saltwater intrusion could become a critical problem within as little as three to five years. In recognition of these problems, the Water Authority of Jordan initiated a study in 1991 to investigate the characteristics of the middle and upper aquifers in the Azraq Basin with a view to locating alternative sources of water supply for Amman.

Qa Al Azraq, which comprises the greater part of the Ramsar Site, has scarcely been affected by the extraction of groundwater, as it receives most of its water from surface run-off during winter and spring. However, the proliferation of salt pans around the qa has reduced the extent of natural mudflat. Furthermore, in 1992 a dam was constructed in Wadi Rajil about 45 km north of Azraq, in an effort to alleviate water shortages and to accelerate infiltration into the aquifer. Wadi Rajil is the single most important wadi feeding floodwaters into Azraq Oasis, providing approximately one third of the surface run-off from the catchment area. The new dam, along with two other dams on the upper reaches of Wadi Rajil in Syria, are undoubtedly reducing the frequency and extent of flooding in the qa. During the unusually wet winter of 1991/92, there was no recorded surface flow at the Wadi Rajil site in Jordan, and this was attributed to the presence of the two dams further upstream in Syria. The new Wadi Rajil Dam flooded in early December 1992, following heavy rains in the catchment, but no water reached Qa Al Azraq, which remained dry. Thus in the winter of 1992/93, for the first time ever, both the

spring-fed marshes and the qa were completely dry, despite good rains in the catchment.

Other threats to the wetlands of Azraq Oasis have included overgrazing, burning, the dumping of rubbish and hunting. The uncontrolled grazing by domestic livestock in the marshes caused considerable damage to the wetland vegetation, especially in the late 1980s and early 1990s, as the area of permanent marshes dwindled. The aquatic vegetation was regularly burnt to promote growth for grazing. However, all domestic livestock have recently been removed from the marshes. Large quantities of rubbish have been dumped in the Wetland Reserve, particularly in recent years since the perimeter fence has fallen into disrepair. Hunting pressure was heavy in the late 1960s and early 1970s, despite being limited to two days a week, and duck numbers had already fallen to low levels by the late 1970s, before any real deterioration had occurred in the spring-fed wetlands. Conder (1979) attributed this decline in duck numbers to excessive hunting pressure, rather than to any loss of wetland habitat. Hunting was prohibited in the Wetland Reserve in 1977, and legal hunting was finally abandoned throughout the oasis in 1985. Illegal hunting continued, often at a high level, until at least 1992, and a wide variety of species, including herons and egrets, were being shot.

**Hydrological and biophysical values:** The Azraq aquifer is one of the principal sources of drinking water for Amman, contributing approximately a quarter of the total consumption in the Amman District in recent years. Pumping to Amman began in 1980, and in recent years has provided about 16 MCM of fresh water per year to the city.

**Social and cultural values:** Azraq Oasis was formerly an important watering place for nomads and their livestock. There are several important archaeological sites in the area, including a well-preserved Roman wall around one of the Shishan springs (Am Soda), Azraq Fort near the Druze springs, and Qasr Al Amra castle by the Azraq to Amman road. There are plans to renovate the Roman wall around Am Soda as part of the recently initiated GEF Project at Azraq Oasis.

**Noteworthy fauna:** In their original state, the wetlands of Azraq Oasis were one of the most important wintering areas for migratory waterfowl in the Middle East. The highest counts of wintering waterfowl were obtained in the late 1960s and early 1970s. In February 1967, RSCN undertook an aerial survey of the wetlands and estimated the total number of waterfowl at 347,000, including 20,000 *Anas penelope*, 180,000 *A. crecca*, 2,000 *A. platyrhynchos*, 100,000 *A. acuta*, 5,000 *Aythya fuligula* and 40,000 *Fulica atra*. A series of ground counts in the winter of 1967/68 produced peak counts of 1,500 *Anas penelope*, 2,000 *A. strepera*, 4,000 *A. crecca*, 10,000 *A. acuta*, 800 *A. clypeata*, 1,500 *Aythya ferina*, 700 *A. fuligula*, 600 *A. nyroca* and 1,500 *Fulica atra*, along with up to 11 *Phoenicopterus ruber*, five *Cygnus cygnus* and 10 *Anser anser*. However, an aerial survey in February 1968 gave a rough estimate of 72,000 ducks and *Fulica atra* (Dakhgan & Bandak, 1970a). In the winter of 1973/74, following the heaviest rains for some 30-40 years, numbers of waterfowl were again very high; a ground count in February 1974 gave a total of 110,000 birds, including 400 herons (Ardeidae), 600 *Ciconia*

*ciconia*, 100 *Anser anser*, 14,000 *Tadorna tadorna*, 70,000 dabbling ducks *Anas* spp., 200 *Grus grus* and 25,000 *Fulica atra* (Qasem, 1976).

However, numbers of wintering Anatidae then fell rapidly during the 1970s (e.g. only 2,325 were present in January 1979). Numbers remained low throughout the 1980s, varying between 880 (in 1986) and 3,650 (in 1989), but showed no discernible trend and seemed to be more dependent on the state of flooding in the qa, than to the condition of the spring-fed marshes. The qa was extensively flooded in the winters of 1989/90, 1990/91 and 1991/92, and a count in January 1992 produced the highest total for many years, viz. 12,750 waterfowl of all species, including 3,490 *Tadorna tadorna*, 100 *Anas penelope*, 4,000 *A. crecca*, 500 *A. platyrhynchos*, 1,000 *A. clypeata* and 610 *Fulica atra* (Rose, 1992). Some 2,500 Common Cranes (*Grus grus*) appeared on the qa in February 1992. No censuses were carried out in the winters of 1992/93 and 1993/94, but it is doubtful if any birds were present in these years, when both the spring-fed marshes and qa were completely dry. However, heavy rainfall in 1994/95 caused extensive flooding in the wetlands, and large numbers of birds were again present in January 1995.

Azraq Oasis is also an extremely important staging area for migratory birds in spring and autumn. Of the 300 or so species of birds that have been recorded at the oasis, the great majority are migratory species belonging to the West Palearctic-Afrotropical flyway. Estimates made in the 1960s and 1970s indicated that between several hundred thousand and a million birds were utilizing the oasis during the course of a single spring migration, with up to 50,000 birds being present at any one time. Despite the loss of most of the permanent wetland habitat during the last decade, the oasis remains important for migratory birds, particularly species of shorebirds and passerines such as swallows, wagtails and warblers. Peak counts of waterfowl on passage have included 300 *Recurvirostra avosetta*, 2,000 *Charadrius alexandrinus*, 3,000 *Calidris minuta*, 3,500 *Philomachus pugnax* and 1,500 *Chlidonias leucopterus*. Large numbers of birds of prey are attracted to drink at the pools on autumn migration, including *Pernis apivorus* (up to 14) and *Circus pygargus* (up to 66).

The wetlands are also important for breeding waterbirds. Some 28 species of waterbirds were found breeding in the 1960s, several at the extreme edge of their ranges. With the destruction of the spring-fed marshes, many of these have disappeared. However, in years of prolonged flooding, such as 1991 and 1992, the qa still supports a variety of breeding species, notably shorebirds, while a few species continue to breed around the fishponds. Five species of waterfowl were found breeding for the first time at Azraq in 1991 and 1992, including a globally threatened species, the Marbled Teal *Marmaronetta angustirostris*. *M. angustirostris* has been recorded at Azraq on five occasions since 1983 as a scarce spring migrant (in April), and a pair bred at the fish ponds near Shishan in 1990 (Green, 1993). Other breeding species have included *Tadorna tadorna*, *Rallus aquaticus*, *Himantopus himantopus* (up to 465 pairs), *Recurvirostra avosetta* (up to 20 pairs), *Glareola pratincola* (up to 10 pairs), *Charadrius dubius*, *C. alexandrinus*

(up to 25 pairs), *C. leschenaultii*, *Vanellus spinosus*, *V. leucurus*, *Gelochelidon nilotica* and *Sterna albifrons*.

Other interesting fauna in the oasis include local subspecies of the Asian Jackal *Canis aureus syriacus*, Red Fox *Vulpes vulpes arabica* and Striped Hyena *Hyaena hyaena syriaca*, the Tessellated Water Snake *Natrix tessellata*, two amphibians *Rana ridibunda* and *Bufo viridis*, and a variety of aquatic invertebrates including the Tadpole Shrimp *Triops canseriformes* - a "living fossil" with a strangely disjunct distribution in the Middle East.

**Noteworthy flora:** The wetlands formerly supported a very diverse wetland plant community, of great interest in view of its isolation in a desert region. It seems likely that many species may not have survived the recent degradation of the marshes.

**Scientific research and facilities:** The wetlands of Azraq Oasis have been extremely well studied and well documented. The International Jordan Expedition of 1966, organized by the Conservation of Terrestrial Communities section of the International Biological Programme, compiled information on the climatology, hydrology, limnology, entomology, ornithology, mammalogy, human ecology, logistics and management of the oasis (Loffler & Bonomi, 1966; Morton Boyd, 1967). The oasis vegetation was studied in detail by Nelson (1973), and the hydrobiology by Scates (1968). The birds of Azraq Oasis have received a considerable amount of attention, especially in the 1960s and 1970s, when several international expeditions and consultants visited the site (Cameron & Cornwallis, 1966; Conder, 1981a; Mountfort, 1965; Wallace, 1982 & 1983). The importance of the oasis for wintering waterfowl has been summarized by Savage (1968), Dakhgan and Bandak (1970a & 1972), Qasem (1976) and RSCN (1982b). A list of 281 bird species recorded at the oasis is given in RSCN (1982b). In recent years, the basin has been the subject of several major hydrological and hydro-geological investigations by the Water Authority of Jordan (e.g. Anon, 1991; Water Authority of Jordan, 1989 & 1990). A major investigation of groundwater resources in the Azraq Basin was initiated by the Water Authority of Jordan in 1991, with funding from the EEC. The aim of this project was to investigate the characteristics of the middle and upper aquifers in the Azraq Basin with a view to locating alternative sources of water supply for Amman. The Water and Environment Research and Study Centre at the University of Jordan has conducted studies on artificial recharge of groundwater in the Azraq Basin with a view to developing new technologies to accelerate infiltration. An International Biological Research Station was established at the oasis in 1968, but was closed down in the following year.

**Conservation education:** Situated little over an hour's drive from Amman, Azraq Oasis has enormous potential for conservation education for school children, students and the general public. An important component of the recently initiated GEF project at Azraq Oasis is to develop this potential as fully as possible. The Visitor Centre at the nearby Shaumari Wildlife Reserve, managed by RSCN, has already become an important centre for conservation education, and includes an exhibit on the wetlands of Azraq Oasis.

**Recreation and tourism:** Azraq Oasis has long been popular for outdoor recreation and tourism. It is readily accessible from Amman by good asphalt highway, and is situated close to several other sites of major touristic or archaeological interest, e.g. Azraq Fort, Qasr Al Amra castle and the Arabian Oryx herd at Shaumari Wildlife Reserve. The GEF project at Azraq Oasis includes activities designed to promote tourism to the oasis and will provide facilities for nature-oriented outdoor recreation.

**Management authority and jurisdiction:** Legal ownership of the Ramsar Site rests with the Forest Department in the Ministry of Agriculture, while the Department of Environment in the Ministry of Municipal Affairs and Environment has responsibility for matters relating to the implementation of the Ramsar Convention. The RSCN has responsibility for management of Azraq Wetland Reserve under an agreement with the Ministry of Agriculture.

**References:** Al-Bakheet (1989); Andrews (1991); Anon (1991); Cameron & Cornwallis (1966); Carp (1980); Clarke (1979, 1990); Conder (1979, 1981a, 1981b, 1982, 1985); Dakhgan & Bandak (1970a, 1970b, 1972); Evans (1994); Green (1993); Hemsley & George (1966); Jones & Clarke (1990); Loffler & Bonomi (1966); Luther & Rzoska (1971); Meinertzhagen (1924); MMRAE (1991); Morton Boyd (1967); Mountfort (1965); Nelson (1973, 1985); Qasem (1976); Ramsar Convention Bureau (1993); Rose (1992); RSCN (1982b, 1986); Savage (1968, 1972); Scates (1968); Scott (1993); Wallace (1982 & 1983); Water Authority of Jordan (1989, 1990); WCMC (1990).

**Reasons for inclusion:** 1a, id, 2a, 2b, 2c, 3a & 3c. Until recently, Azraq Oasis was an outstanding example of an oasis wetland in an arid region, with few parallels anywhere else in the world. The wetland supported a rich and varied aquatic fauna and flora characteristic of freshwater habitats and, as one of the few significant natural wetlands in a large arid region, was of major strategic importance for migratory birds, especially waterfowl, raptors and passerines using the Palearctic/Afrotropical flyway. It was particularly important for wintering waterfowl, regularly holding concentrations of over 100,000 birds in mid-winter. Azraq Oasis belongs to an internationally shared aquifer, and has been recognized as a wetland of international importance under the Ramsar Convention. A Mission from the Ramsar Convention Bureau in March 1990 concluded that much of the natural values of Azraq Oasis remained, and that populations of aquatic plants and animals would recover rapidly if the wetlands could be restored.

**Source:** Derek A. Scott.

**Wetland Name:** Qa Al Jafr

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 30°20'N, 36G2OE

**Location:** in the Eastern Desert, about 45 km east of Ma'an, Ma'an Governorate.

**Area:** c.35,000 ha.

**Altitude:** c.850 m.

**Physical and ecological features:** Qa Al Jafr is a large, seasonal playa wetland in the Eastern Desert, consisting mainly of extensive bare saline mudflats (sabkha)

and seasonal saline marshes which flood in years of good rainfall, and can then remain wet for several months. The qa is about 40 km from east to west and up to 20 km from north to south; it receives run-off from numerous seasonal streams, mostly rising to the west in the southern highlands. There are many much smaller "satellite" mudflats in the desert to the south and east. Very little is known about the flora.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** None known.

**Land use:** The small village of Al Jafr is situated at the west end of the qa. The principal land use throughout the area is grazing, and there is very little cultivation.

**Possible changes in land use:** No information.

**Disturbances and threats:** Water salinity has increased in the basin as a result of the over-pumping of ground water.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** Very little is known about the fauna of this area. Waterfowl recorded on passage in recent years have included *Bubulcus ibis*, *Anas acuta*, *Himantopus himantopus*, *Charadrius dubius*, *C. leschenaultii*, *Tringa ochropus*, *Actitis hypoleucos*, *Calidris minuta* and *C. alpina*. *Charadrius alexandrinus* breeds in the marshes.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**Reasons for inclusion:** 1a (3b). An outstanding example of a playa wetland; probably an important staging and wintering area for migratory waterfowl in wet years.

**Source:** Adnan Budieri.

**Wetland Name:** Qa Disi

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 29°38'N, 35°32'E

**Location:** in the Eastern Desert about 10 km east of Wadi Rum and 50 km east-northeast of Aqaba, Ma'an Governorate.

**Area:** c.1,500 ha.

**Altitude:** c.800 m.

**Physical and ecological features:** Qa Disi is a typical playa wetland in the Eastern Desert, consisting of a large area of saline mudflats, about 8 km long by up to 2.5 km wide, and three or four seasonal pools which are flooded with rainwater during wet years. There is a rich underlying aquifer of fossil water.

**Land tenure:** No information.

**Conservation measures taken:** None.

**Conservation measures proposed:** None known.

**Land use:** The aquifer is exploited to provide water for irrigation purposes and urban consumption.

**Possible changes in land use:** No information.

**Disturbances and threats:** Over-exploitation of the aquifer.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** The qa attracts a variety of migratory waterfowl when wet; these have included *Bubulcus ibis*, *Himantopus himantopus*, *Vanellus spinosus*, *Tringa nebularia*, *T. ochropus* and *Actitis hypoleucos*.

**Noteworthy flora:** No information.

**Scientific research and facilities:** None known.

**Management authority and jurisdiction:** No information.

**Reasons for inclusion:** Ia (3b). A good example of a playa wetland and an important staging and wintering area for migratory waterfowl in wet years.

**Source:** Adnan Budieri.

**Wetland Name:** Gulf of Aqaba

**Country:** Hashemite Kingdom of Jordan

**Coordinates:** 29°22'-29°33'N, 34°58'-35°01'E

**Location:** the head of the Gulf of Aqaba, from the border with Israel in the northwest to the border with Saudi Arabia in the southeast, Ma'an Governorate.

**Area:** Unknown; 27 km of coastline.

**Altitude:** Sea level.

**Physical and ecological features:** The coastline of Jordan extends for 27 km along the northeastern section of the Gulf of Aqaba, a long, narrow and very deep arm of the Red Sea. The town of Aqaba is situated at the extreme northeast corner of the Gulf; on its landward side, the town is surrounded by granite mountains except to the north where Wadi Araba enters the Gulf through a canyon. The coastline consists of a series of embayments in each of which a comparatively similar and wide range of communities is present, including rocky shore, reef flat, reef face, fore-reef, sandy shore, sandy bottom and seagrass ecosystems. There is a discontinuous series of fringing coral reefs and reef flats, never more than 150 m wide, over a length of 13 km. These are found mainly around the headlands, and are separated by bays, usually with seagrass beds, which correspond to the mouths of dry wadis. The largest seagrass bed occurs in Al-Mamiah Bay. Fringing reefs are better developed on the more exposed lengths of shore, and are reduced to scattered patches in sheltered areas. The coastal plain is very limited, with alluvial fans spreading from the inland mountains to the shore. Most of the coastal zone has been extensively modified by man. Freshwater springs along the coast support irrigated vegetable gardens and native palm groves, and some natural scrub vegetation survives near the Israeli border in the northwest.

Rainfall is very low, averaging only 22 mm per year. This results in an elevated salinity of about 42 p.p.t. in the Gulf. Winds blow predominantly from the north-northwest, and seem to cause a counter-clockwise current in the surface waters. There is a small tidal range, but occasional unpredictable low tides expose the reef flat.

**Land tenure:** No information.

**Conservation measures taken:** In January 1985, a Marine Nature Reserve was declared to protect a 2 km stretch of coral reef south of the Marine Science Station. As far as is known, legislation has never been approved, although fishing and other activities have apparently been banned at the site. Two other areas have been identified as being suitable for nature reserve status, and according to the National Environment Strategy for Jordan (MMRAE, 1991), were to be publicly granted reserve status "in the next two years". The Aqaba South Coast Master Plan, which was prepared under the auspices of the Aqaba Region Authority, involved preparing a coastal zone management plan for the entire Aqaba region (IUCN, 1992). The Aqaba region and surrounding hills (an area of c. 130,000 ha) have been identified as an "Important Bird Area" by BirdLife International (Evans, 1994).

**Conservation measures proposed:** A Marine National Park has been proposed, to cover the central third of the Jordanian coast from the Marine Science Station south to the headland north of Al-Dirrah. This National Park would incorporate the existing Marine Nature Reserve and two proposed Marine Nature Reserves. A Marine Environmental Management Zone surrounding the whole National Park has also been recommended within which partial protection would be given to marine life. It was recommended that the proposed Marine Park and Environment Management Zone should extend 0.5 to 1.0 km out to sea (UNEP/IUCN, 1988). Detailed recommendations for the implementation and management of these schemes are given in Ormond (1978). Feasibility studies for the establishment of the proposed Marine National Park are apparently still under way. It has also been recommended that a few particular sites, e.g. in front of some of the major hotels and at the power station at El Bordj, should be established as "sites of recreational and scientific value". Wahbeh and Mahasneh (1982) give a general description of coastal management requirements.

**Land use:** The head of the Gulf of Aqaba is an area of very intense human activity, both on land and at sea. Aqaba is Jordan's only port and is thus a major centre of transportation. It is also a popular holiday resort both for Jordanians and international tourists. The city is growing rapidly; estimated at 55,000 in 1990, the population is expected to reach 119,000 by the year 2000 (MMRAE, 1991). The north coast, which is fronted by a long sandy beach, is occupied by the royal palace and a string of tourist hotels. Port facilities cover much of the area from El Bordj to just north of the Marine Science Station. The area to the south is proposed as a tourist area, and industrial and military developments are planned for the area beyond this. Several sites along the coast are used by SCUBA divers, and an international diving centre was opened in late 1986 by the Aqaba Region Authority. Despite efforts to promote the fishing industry in the Gulf of Aqaba, the estimated size of the catches has been decreasing since 1955 (Ahmad, 1989), and commercial fishing is now of only minor importance in the local economy. There were about 70 licensed fishing boats in the Gulf in 1990 (MMRAE, 1991).

**Possible changes in land use:** As much land as possible is needed for port expansion and industrial development, and further development of the coastal zone is therefore likely.

**Disturbances and threats:** Port expansion and coastal development for industrial, military and touristic uses are a critical problem around Aqaba due to the lack of space. Little natural coastline will remain unless some conservation action is taken soon. Extension of port facilities has resulted in land-fill in certain areas along the coast, and this has obliterated some reef systems. Fine sediments resulting from these land-fills have spread onto nearby reefs. Phosphate dust emitted during loading operations at the phosphate terminal has produced adverse impacts on the coral reefs. Other threats to the marine habitats include: anchor damage; chemical pollution from an industrial complex in the south, a fertilizer plant, a potash plant and a plywood factory; hot water effluent from the Aqaba Power Plant; contamination with sewage; and oil spills. Some damage may have been caused by explosives used in the course of geophysical research.

**Hydrological and biophysical values:** No information.

**Social and cultural values:** No information.

**Noteworthy fauna:** Many waterfowl and seabirds are attracted to the head of the Gulf, particularly during the summer months, because of the richness of the marine fauna caused by an upwelling in the area. Species known to occur regularly include *Calonectris diomedea* (up to 50), *Puffinus griseus*, *Sula leucogaster*, *Stercorarius pomarinus*, *S. parasiticus* (up to 75), *S. longicaudus*, *Larus leucophthalmus*, *L. ridibundus*, *L. genei*, *L. ichthyaetus*, *L. cachinnans*, *L. fuscus*, *Sterna caspia*, *S. hirundo*, *S. repressa*, *S. anaethetus* and *S. albifrons*. The Gulf of Aqaba lies on a major bird migration route, with many waterfowl passing through the region on their way to and from Africa. Species known to occur in good numbers include *Phalacrocorax carbo*, *Nycticorax nycticorax*, *Ardea cinerea*, *Charadrius alexandrinus*, *Calidris minuta*, *Tringa totanus* and *Chlidonias leucopterus*. The Osprey *Pandion haliaetus* is a regular winter visitor.

Although the coral reefs are near the northern limit of coral distribution and may experience water temperatures as low as 20°C, they have a relatively high diversity of corals, 98 species having been recorded (UNEP/IUCN, 1988). Similarly, they support a moderately diverse reef-fish community, including the Red Sea endemic *Paracheilinus octotaenia*, which occurs on the deep-water reefs. The garden eel *Gorgasia silineri* occurs in the reef "gardens", and a new species of callinassid shrimp *Callichirus laurae* was discovered in 1982. It is estimated that 5% of the 1,000 species of marine fish which inhabit the Gulf of Aqaba are endemic.

**Noteworthy flora:** There are extensive seagrass beds in many of the embayments along the coast.

**Scientific research and facilities:** A small marine research station was set up by the University of Jordan in 1972, and in 1982, a new Marine Science Station was established, to be managed jointly by the University of Jordan and Yarmouk University. A considerable amount of marine research has been carried out since then, especially on the coral reefs and seagrass beds. This has been summarized by UNEP/IUCN (1988). A monitoring programme on water quality was initiated in January 1985 in the zone in front of the Marine Science Station, and a study of metal pollution in sediments has been carried out (UNEP/IUCN, 1988).

**Management authority and jurisdiction:** Aqaba Region Authority .

**References:** Ahmad (1989); Evans (1994); ISPAN (1992); IUCN (1992); MMRAE (1991); Ormond (1978); RSCN (1982a); UNEP/IUCN (1988); Wahbeh & Mahasneh (1982).

**Reasons for inclusion:** 1a, 2b, 2d & 3b. The site contains good examples of coral reefs near the northern limit of coral distribution, and has a diverse marine fauna including several rare and endemic species. The area is of considerable importance as a staging area for migratory waterfowl and as a feeding area for non-breeding seabirds.

**Source:** Adnan Budieri.

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