**More information on the Physical features of the Site:**

Hammar Marsh is the part of the larger Mesopotamian marshlands in southern Iraq which are, in turn, part of the major river systems in the region encompassing a number of riparian countries namely, Turkey, Syria, Iraq and Iran.

Geology and Geomorphology of the Mesopotamian Plain
The Mesopotamian Plain is characterized by a complex system of river channels, levees, flood plain, marshes, and river mouths bordered on both sides by alluvial fans. In fact, Iraq structurally is a large northwest-southeast oriented syncline with a steeper north-eastern flank. This forms a broad depression filled with eolian, lacustrine, fluviatile, and marine sediments. Along the northeast flank, gentle folds gradually increase in magnitude and form the complex folded and faulted area of the upper fold and nappe zone. The southwest flank extends into Saudi Arabia and consists of gently tilted strata. These structures are the result of compressive forces exerted from the northeast, opposed to the southwest by the relatively stable Arabian Plateau. Superimposed on this, are local subsidence due to isostatic adjustments and sedimentary compaction, particular in the Mesopotamian Plain. The region is tectonically active today, as the Arabian tectonic plate is forced under the Iranian Plate.

The area of Hammar Marsh and neighboring areas are generally underline by the recent younger alluvium consisting of alluvial fan, alluvial depression filling and marsh deposits, eolian sand, channel and levee sand and silt, part of salt covered alluvial plain, deposits of estuarine sabkha, alluvial fan and Pleistocene-Tigris gravel fan.

The Quaternary deposits in these areas were made by the interacting Tigris, Euphrates, Diyala and Adhaim Rivers, on the alluvial fans emanating from the surrounding elevated areas, and following marine incursions from the Persian (Arabian) Gulf.

The ﬂood plain and the delta consist mainly of silty clay, silts and muddy sands.

In general, the Mesopotamian Plain was, from the Plio-Pleistocene to the present, a vast subsiding sedimentary basin in which relatively thick Quaternary sediments accumulated. This area of Southern Mesopotamia was a wide lagoon or embayment 3000 years ago. Low energy depositional conditions are indicated by laminated mud units in the basal parts of most pit-sections and of cores in the surface marshes.

The area of this Marshland is characterized by poor rock exposures, due to low relief and considerable Quaternary deposits cover. Instead outcrops may be present in the extreme south-west of this marsh, where there is the presence of Dibdibba Formation *(Upper Pliocene).* This formation comprises sand and gravel containing pebbles of igneous rocks (including pink granite) and white quartz, often cemented into a hard grit, and it was deposited in a fresh water environment becoming deltaic to E – NE. From data assumed by the boreholes stratigraphy, the age of the rock units in this area ranges from Miocene to Recent.

Soil types
Marsh soils: these are hydromorphic soils, developed on fluviatile sediments, mostly clay or silty clay, highly calcareous and containing some gypsum, that underlie both temporary and permanent marshlands. Their salinity varies. The upper layers seem to form an “organic” cover of about 30 cm thick, formed by the decaying reed vegetation.

Hydrogeology
The Mesopotamian Plain and the Hammar Marsh zone are the general groundwater discharge zone of the whole extended Mesopotamian Aquifer Megasystem. Geological factors determine the geometry (extent and thickness), porosity and permeability of aquifers and aquitards. Lithological variations and structural geological conditions control the hydrogeological environment affecting groundwater flow and accumulation.

Groundwater fluctuations are related to the quantity and distribution of rainfall. The annual water level fluctuations within the Mesopotamian Plain typically start in winter and spring with an abrupt rise of water levels due to recharge caused by precipitation, high water tables in streams, and irrigation activities.

During summer and autumn water levels fall because of lack of recharge; an increase in evapo-transpiration relative to groundwater runoff occurs under favorable geological and hydrogeological conditions. The largest annual amplitude of the water table may reach 2/3 m but it is usually lower and is locally < 1 m. Therefore in this marshland, the water table very often intersects the surface.

Groundwater quality
Dissolved solids are transported by both ground and surface water from different directions. After humid seasons, when groundwater level is high (especially in irrigated areas without adequate drainage) surface water is often present in depressions.

Evaporation subsequently increases the salinity in the remaining water and soils. As this process was repeated, large quantities of salts were accumulated in the Mesopotamian groundwater and soils. The chemical composition of ground water within the Mesopotamian Plain varies especially in the shallow zone.

In the Hammar Marsh area, the groundwater composition is also influenced by seepage from surface watercourses and reservoirs and is relatively fresh. Beneath this shallow fresh water lies highly mineralized salt water.

In particular, for the unconfined aquifers the salinity values in most part of this marshland is medium-high and the values are mostly within a range of 5000 to > 50,000 mg/l, which can be further divided into three categories: a) water seldom used for irrigation (5000-10,000 mg/l); b) unusable water (10,000-50,000 mg/l) and; c) brine (> 50,000 mg/l).

Fluctuations of the water level
The maximum flooded area of Hammar Marsh (calculated for the period 2000-2013) is 183071.3 ha; the minimum flooded area is 15164.5 ha. By using the storage curves of the marshes (area versus elevation) that correlate the extension of the marsh and the stored volume with the water elevation level, the higher and lower levels of water above sea level have been defined as follows:

Minimum water level = 0.1 m a.s.l.

Maximum water level > 1.4 m a.s.l.

**More information on the Physical features of the catchment area:**

Geologic and Geomorphologic features of Mesopotamian Lowland Basin
The complex of Central Marsh zone is contained within the Tigris-Euphrates river basin, in particular the Mesopotamian Lower Basin member. The geological and geomorphological features of this basin are largely those of Mesopotamian Zone, which is a relatively flat terrain with a gradient of less than 10 cm per kilometer, extending from Baiji in the NW to the Arabian Gulf in the SE.

The Mesopotamian Plain is considered a huge aggraditional (accumulation) geomorphologic unit, where the fluvial, lacustrine, and aeolian landforms prevail. Estuarine and marine forms also exist, but these are restricted to the extreme southeastern reaches of the plain. The main geomorphologic units of the aggraditional fluvial origin are: terraces, alluvial fans, flood plains of major rivers and their distributaries, shallow depressions, marshes and lakes, and sabkhas. From the geomorphologic viewpoint, the Euphrates zone is the shallowest unit of the Mesopotamian Zone. The basement is generally 7-9 km deep.

Three main stratigraphic subdivisions are recognized based on their relative ages; namely: Pleistocene, Late Pleistocene – Early Holocene, and Holocene. The main Pleistocene sediments are represented by river terraces, alluvial fans and fluvial sediments. The Pleistocene – Early Holocene Units include sheet run-off (sheet run-off is the broad, relatively unconfined down slope movement of water across sloping terrain), gypcrete and slope sediments. While the Holocene Units include sediments of different origins, such as fluvial, lacustrine, marine, estuarine, aeolian and anthropogenic. The Holocene sediments are also found in the modern sedimentary environments of the Mesopotamia Plain. The presence of Holocene marine sediments has been confirmed in the Southern Mesopotamia Plain, indicating the influence of marine inundation during early to mid Holocene. Such a marine transgression has reached as far as Amara City, on the eastern side and Nasiriyah City, on the western side, about 200 Km north of the present day northern shoreline of the Arabian Gulf.

During the Quaternary Period (and even earlier), the basin was continuously receiving sediments, originated from the erosion products of the Zagros Fold Thrust Belt and the Arabian Platform, through active deposition of fluvial systems. Thus, the infill sediments of the basin are essentially of fluvial, deltaic, and lacustrine origin. These sedimentary facies may replace each other, both horizontally and vertically at local scales.

The exposed Pre-Quaternary formations around the Mesopotamia Plain have variable lithology and range in age from Late Eocene to Late Pliocene.

Climate Type
The climate type of the catchment area is that of the larger Mesopotamian marshlands in southern Iraq which are, in turn, part of the major river systems in the region encompassing a number of riparian countries namely, Turkey, Syria, Iraq and Iran.

Annual rainfalls are in the order of 120 mm. Average annual air temperatures ranges from 13 to 36 °C. Humidity is about 43% during the year. Annual evapotranspiration is in the order of 3,000 mm/year.

**More information on the Hydrological values:**

The hydrology of the entire lower Mesopotamian river system, including the Hammar Marsh, is impacted by a number of factors including the annual flooding during spring which raises the water level in the marsh to its peak between March and May. Water levels then drop gradually toward their minimum in the dry summer season. The natural flood cycle has been severely changed starting in the 1970s until the present time. All countries in the Tigris-Euphrates basin have constructed huge hydraulic structures over various parts of the major rivers. These include dams, reservoirs, barrages and regulators which give the operators of these structures a high level of control over water. Despite this, the hydrological data still show similar behaviour, although less in magnitude and duration.

In addition to their direct economic benefits to marsh dwellers and surrounding communities, the marshes also provide natural functions such as flood control, prevention of saltwater intrusion, water temperature regulation, water purification and erosion control. They also act to moderate the local climate, with the influence being felt as far south as Kuwait. Coastal fisheries in the northern Gulf were dependent on the marshes as spawning and nursery grounds. These fisheries have declined significantly following the destruction of the marshes. Historically, these wetlands were a main source of freshwater for human consumption, supplying communities living in and surrounding the marshes. Destruction of the marshes has had severe human health consequences as a result of the loss of clean water and degradation of sanitation standards.

Hydrogeology and water characteristics
In the Hammar Marsh, the hydrogeological conditions are determined by geological, climatic, morphological and hydrographic factors. Geological factors determine the geometry (extent and thickness), porosity and permeability of aquifers and aquitards. Lithological variations and structural geological conditions control the hydrogeological environment affecting groundwater flow and accumulation.

In Iraq 22 aquifer subystems have been defined and have been grouped into 5 related systems that were delineated on the basis of the phisiography, geology, topography and tectonical/structural evidences. The Hammar Marsh has mainly the characteristics of aquifer number one.

The aquifer system 1 includes all the territories of the western and southern desert located in the right hydrographic bank of the Euphrates River. The ambits of the aquifer are represented by the national boundaries (to North West it borders with Syria and Jordan, to West with Saudi Arabia and to South with Kuwait) and by the natural ones highlighted by the springs line corresponding to the natural outflow of the aquifers.

In the investigated territory, different rock formations and sediments with different permeability - more or less permeable sediments alternate with low to watertight ones - are present

Subsystem 1D that includes most parts of the Hammar Marsh is characterized by a water divide in its western side between the aquifer Subsystem 1C and 1D, and the regional groundwater flow is uniformly directed to northeast and towards the Mesopotamian Plain.

There is the presence of Quaternary deposits aquifer, and these deposits are mainly made by sand, silt and clay in addition to salt characterized by lateral and vertical heterogeneities.

Subsystem 1C is characterized by a water divide in the western side between the aquifer Subsystem 1B and 1C. The regional groundwater flow is uniformly directed to northeast converging towards the springs belt at the right bank of the Euphrates River. A southern water divide is separating the Subsystem 1C from the 1D. Also for this subsystem there are no data outside the Iraqi border allowing an accurate reconstruction of the possible transboundary groundwater table, but the isophreatic lines are indicating a groundwater inflow from Saudi Arabia.

Hydrology
Hydrologically, Hammar Marsh receives water from the Euphrates. Actually, downstream of the city of Nasiryiah, the Euphrates River enters the Hammar marshland complex and ends up creating a complicated micro water system in itself, characterized by a dense network of canals crisscrossing the entire region. Some of the canals are man-made while others are natural. The canals within the marsh itself are manmade; reportedly constructed to provide irrigation waters to the “newly reclaimed” lands of the former marshes. Hammar Marsh is divided into two by a bridge/embankment at the southernmost part of the oil extraction area (between West Qurna I and South Rumaileh oil fields). Currently a set of culverts is placed under the bridge; a hydraulic structure to control marshland outflow is planned to be built here by the Ministry of Water Resources. As far as the outflow of the wetland, formerly the network of canals existing at the tail end of the marsh connected the marsh itself to the Shatt Al Arab and Shatt Al Basrah; those canals are no longer connected with Shatt Al Arab, but connection might be re-activated in case of extreme flood events. In addition to that, due to the substantial Euphrates water use and to the significant decrease in the amount of water available to Hammar Marsh, in the last couple of years the Ministry of Water Resources implemented a hydraulic connection between the MOD (Main Outfall Drain) and Hammar, in the western part of the lake; such intervention, considered provisional, is sustaining the marsh life. As of today water quality of the MOD is considered adequate for the wetland, but in the future, when the efficiency of the irrigation projects connected to the MOD is increased, water quality might become an issue. Ministry of Water Resources plans also include the re-utilization of Central Marsh water in Hammar Marsh, in order to cope with the shortage or water allocated to Hammar Marsh.

Surface water quality/water depth
Data obtained from a recent survey (January 2014) show that water temperature in West Hammar is, on average, 12.3°C; water depth at the site is about 2 m; salinity is around 3.5 ppt. Average pH value is 7.4; average DO value is 4.7 (slightly below the water quality standard limit (>5 for DO) as from Iraqi national legislation). For East Hammar, average water temperature is 12.6°C; average water depth is 4 m; salinity is around 5.5 ppt; average pH value is 8.5 (upper limit of the water quality standards – pH 6.5-8.5). DO average value is 9.01 mg/l.

**More information on the Ecological features:**

Historically, the Hammar Marsh comprised a wide area where the main features were large freshwater lakes that could extend to a total surface of up to 4,500 km2 during periods of seasonal inundation.

The lake tended to be oxygen-deprived and brackish. Sediments within the lake were generally gray calcareous silts. During the summer, large parts of the shoreline would dry out, and banks and islands emerged. The lake was surrounded on the north and northeast by freshwater marshes characterized by more terrigenous and organic-rich sediment and extensive reed beds.

Nowadays and as a result of the massive drainage operations started in the nineties the once continuous marshland complex of Hammar is cross-cut by a number of drainage canals and embankments; in addition the presence of the producing oil field of North Rumaila and West Qurna between the towns of Chibaish (Thi-Qar) and Qurna (Basrah), has created a physical barrier between the western and eastern Hammar Marsh. For this reason the Hammar marsh can be presently described as two separate units West Hammar and East Hammar.

West Hammar:
West Hammar extends along the south side of the Euphates River. The area is now very different when compared to the historical marshlands due to the presence of canals, ditches, embankments, and roads, especially around the edges of the site, as well as considerable agricultural activities. West Hammar is a continuous wetland extending for about 60 km from Suq Ash-Shuyukh in the west to the boundaries between Chibaish and Al Mdaina districts in the east, and from the Euphrates River in the north to the Main Outfall Drain Canal (MOD) in the south. Two sources of water feed the West Hammar Marsh: the Euphrates River (three openings in the river embankment allow water to enter from the north) and the MOD Canal (via a connecting canal that brings the water northward to the site). Presently water depth average ranges from 0.5 to 2 m (at the deepest point).

In the marshland area there are open water bodies like Rashid lake to the southern end of the marsh and Buhaira in the northeastern part; typical marsh vegetation (mainly Phragmites and Typha) like in Kermashia and Abu Ajaj (HA23); and terrestrial vegetation (shrub and desert shrubs). There are also rice farms, date palm plantations and agricultural crops (graminoids) especially in the northern edge of the marshland on the Euphrates side.

East Hammar:
East Hammar is located at the upper corner formed by the joining of the Euphrates and Shat Al-Arab Rivers and extends west to the oilfields of West Qurna and North Rumaila. The Shatt Al-Arab flows southwards along the eastern edge of the site.

This marshland area is characterized by zones subject to tidal influence such as Al- Nagarah (located 30 Km northwest of Basrah city), with dense reed (Phragmites), Typha, and Scirpus vegetation. The tidal influence present in this southern area of East Hammar, by creating periodically submerged mudflats provides an optimal habitat for waders. There is a high diversity of birds and also a high level of hunting and fishing throughout the whole area.

The northern part of East Hammar marsh is characterized by a network of drainage water canal and some swamps and pools having different water depths that range from 15 – 50 cm. The dominant vegetation is Phragmites as well as Scirpus and Typha. Some patches of open water with a low vegetation cover also exist in this zone.

**More information on the Ecosystem services provided by the Site:**

The current socio-economic values of the Hammar Marsh are reported in the Table below (source: Iraqi Marshlands - Integrated UNAMI UNCT White Paper, 2011). In addition to these general values there are also historical and cultural values of extraordinary importance because of the presence of the Marsh Arabs Tribes, as described below.

| Service | Sub-category | Examples |
| --- | --- | --- |
| Provisioning services – the goods of products obtained from Marshlands’ ecosystems |
| Food | Crops | Paddy rice, great millet, dates, vegetables and fruits |
| Livestock | Asian water buffalo, cattle, sheep, water-buffalo milk and yogurt |
| Capture fisheries | Shrimp, yellowfin seabream, khishni |
| Aquaculture | Cyprinids, grass carp, shellfish |
| Wild foods | Waterfowl (coot, teal), desert monitor |
| Freshwater |  | Freshwater for drinking, cleaning, cooling, and transportation (canoeing and boating) |
| Fiber and fuel | Fiber | Reeds for housing and mats; date palm wood |
| Fuels | Reeds, crude oil, cattle dung |
| Biochemical |  | Potential use of Marsh flora extracts, native herbs for pharmaceuticals and pest control |
| Genetic materials |  | Resistance and breeding of native plant and animal species |
| Regulating services – the benefits obtained from the Marshland ecosystems’ control of natural processes |
| Climate regulation |  | Moderation of the national rainfall patterns and control desertification and dust storms |
| Water regulation | Hydrological flows | Storage and retention of water flowing from Euphrates-Tigris system upstream and tidal flow downstream; Permeable clay and silt facilitates recharge of the Recent Alluvium aquifer |
| Water purification and waste treatment | Removal of harmful pollutants from water by trapping metals and organic materials; soil microbes degrade organic waste rendering it less harmful |
| Erosion regulation |  | Reeds, grasses and estuarine vegetation retain soils and sediments |
| Natural hazard regulation |  | Marsh areas naturally absorb seasonal floods and tidal surges; moderation of drought at a local scale |
| Pollination |  | Habitat for bees and birds, the key pollinators of economically important crops |
| Cultural services – the non material benefits that Iraqis obtain from Marshlands ecosystems |
| Ethical values |  | Customs, oral traditions, knowledge and rituals attached to the use of the land and rivers; Iraqi tangible and intangible cultural heritage; an area of global importance |
| Recreation and tourism |  | Canoeing, bird and wild-life watching, recreational fishing, archaeological site visitation, Marsh communities |
| Aesthetic |  | Globally significant natural beauty |
| Educational |  | Science, cultural awareness, specialized vocational training, public awareness of national, regional and global importance |
| Supporting services – the underlying processes that are necessary for the production of all other ecosystems services |
| Soil formation |  | Retention of sediment, recycling and supporting the health of the ecosystem |
| Nutrient cycling |  | Returning phosphorus, sulfur and nitrogen to Iraq’s atmosphere, water and soils |

All the southern Iraq marshes before the drainage were entirely populated by the Marsh Arab, who used to build their floating islands and slight reed houses inside the marsh, developing entire villages linked by a net of main and minor channels.

As described by W. Thesinger in its book “The Marsh Arabs”: “It is a large village in the heart of the Marshes where the reeds for mudhjf came from. At Qabáb you will see how the Madan live; nothing but buffaloes, reeds and water. You can only go about in a canoe. There is no dry ground anywhere.”

During the drainage program most of the Marsh Arabs living inside the marsh were forced to leave, after the re-flooding settlements (with reed and mud houses) were newly established on the numerous embankments. During 2008-2010, the Hammar Marsh lacked water again, that caused most of the people (M’adan) living on the embankments to leave the area. A large canal was dug near Al-Khamissiya to bring water from the Main Outfall Drain (MOD) northwards to flood the north-western parts of the site.

In the Hammar Marsh the villages are scattered mainly along the northern edge, where the Euphrates flows, numerous villages are found on the western side of the marsh (near Suq Ash Shuyukh) and in the south-eastern end of the marsh (on the Shatt Al Arab). On the contrary very few villages are present in the southern end of the marshland along the MOD canal.

In the villages on the northern side of the marsh, along the Euphrates River, the main economic activities of the villages’ inhabitants are related to fishing, buffalo rearing and agriculture; with a prevalence of fishing; on the western side the prevailing economic activity is agriculture but fishing and agriculture play an important economic role in the income of the villages’ inhabitants. On the other hand, the villages around the Shatt Al Arab River, to the eastern side of the Hammar Marsh, are characterized by a prevalence of economic activities which are not related to the marshland resources; this could indicate that on that side of the Hammar Marsh the influence of Basrah City and of the related economy and possibility of employment for locals decrease the dependence on the wetland environment by this part of the rural population.

**More information on Current land (including water) use:**

a) within the Ramsar site:

The land use inside the administrative boundaries of the Hammar Marsh is mainly linked to the wetland character of the area. In particular, the main land use categories that have been found inside the area are:

- marshland;

- water logged areas;

- water bodies and water courses

- sparsely vegetated areas and natural shrubland;

- irrigated crops;

- Rice fields and horticultures

- sandy areas and bare soil

The prevalence of the one or the other category is changing from one year to another and varies with current water availability, being this latter related with current climatic conditions and water management issues.

in the surroundings/catchment:

The area surrounding Hammar Marsh is characterized by approximately the same land use classes that are found inside the marshland area with some categories that might be present or absent and some differences in the surface/extension of certain categories.

In particular to the west of Hammar the agricultural land uses are more widespread, with graminoids crops, rice fields and palm orchards; to the south bare areas and sandy soil are the most common land cover features, to the north the Central Marsh wetland represents a ‘habitat continuum’ in terms of land cover and land use types. Finally, the eastern surrounding of the Hammar Marsh is characterized by scattered agricultural fields along the river courses (the Euphrates and the Shatt Al Basra), by marshland patches and bare soil.

**More information on the Factors (actual or likely) adversely affecting the Site’s ecological character:**

Past factors that have affected and modified the site’s ecological character are certainly the extensive drainage that the whole marshland complex of southern Iraq has experienced.

Historically, the marshlands constituted a chain of almost interconnected permanent and seasonal marsh, shallow and deep lake complexes that flowed into one another and mudflats that were regularly inundated during periods of elevated water levels. During periods of high floods, large areas of desert were seasonally under water. Consequently, some of the formerly separate marsh units would merge together, forming larger wetland complexes with a great variety of habitats and ecological features.

In the past centuries the marshlands area occupied about 16,000 km2. The deltas of Euphrates and Tigris dispersed their waters in these lands. After flowing out of the marshes, the Euphrates would take a unified course crossing the town of Al Zubayr and ending up in Khor Al Zubayr.

During the years and throughout the centuries, the area of the marshes shrank and increased according to the intensity of the seasonal floods of the two rivers and according to the ability of the rulers of Iraq to control the water of the rivers. The state and area of the marshes remained unchanged for centuries, until after the Ottoman Reign. The most important developments happening to the marshes of southern Iraq were the establishment of modern controls of the water of the Tigris and the Euphrates. This led to a decrease in the great floods that affected Iraq and consequently the area of the marshes in Iraq. In addition, the irrigation projects played an active role in determining the courses of the Tigris and Euphrates and their branches.

A program to dry out the marshlands was implemented in the early 1990s. Many hydraulic works were constructed to achieve this goal. As a result, by 2002, the marshes occupied only 14% of their original (1970s) size. The following image shows the marshes prior to the re-flooding initiated in the spring of 2003. Conditions in 2002 can be considered the lower limit of the marshlands’ extent. At that time, only 1,600 square km of marshes were still alive, mostly because some flow was still coming into Haweizah Marshes from Iran through the Hawr Al Azim.

Presently, Hammar Marsh still faces many threats even though re-flooding and restoration activities have played an important role in reviving these important ecosystems. The recently surveyed stations in Hammar Marsh has reported high levels of threats due to disturbance and over exploitation of resources (mainly illegal hunting and fishing) in the western part of Hammar; in the eastern part of the marsh, due also to the presence of oil fields and their developments, the main threats are related to lack of water.

Figure 1: Southern Iraqi marshland extent (including Hammar marsh) (in blue) in 2002 before the re-flooding as compared to the historical marshland extent (in red). 