

# THE WATER ECOSYSTEM OF THE MARSHES OF MAYSAN GOVERNORATE USING REMOTE SENSING AND GIS

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## ABSTRACT

*The study addressed the water ecosystems of the marshes of Maysan Governorate as one of the important areas in Iraq in terms of the environmental, economic and tourism aspects. This area was exposed to great environmental changes due to natural and human factors which greatly affected the water ecosystem and made the area susceptible to many problems that affected the biological life of living organisms. The marshes of Maysan Governorate was affected by vital factors and non-vital factors. The marshes of Maysan Governorate was characterized by the UN Organization as one of the most important centers of biodiversity in the world because of the abundance of different and rare living organisms such as birds, fish, and reptiles as well as the existence of oil wealth and environmental tourism.*

## INTRODUCTION

The water ecosystem is considered as one of the natural ecosystems that represents a model for asserting the idea of organic association between natural and human origin systems, as the system is characterized by a wide range of interactive relations with the rest of ecosystems in the marshes of Maysan Governorate as being a unique phenomenon resulted from the overlap of ecological processes. This wide area of fresh, volatile water derived from various sources and resource abundance have made it represent an ecological system of utmost importance to the natural and human life in the region. The water ecosystem of the study area marshes is considered as a kind of open ecosystem because it contains all the primary basic components (living and non-living), where the exchange of material and energy are done and there are arteries through which the transfer

process is represented in the collection of courses that carry water to various destinations.

## SIGNIFICANCE OF THE STUDY

The study of the natural ecosystems of the marshes of Maysan Governorate acquires a great amount of significance due to a group of considerations, the most important of which is the interest of the study in describing the water ecosystem within the study area marshes in a frame of communication and connection between the ecosystems altogether, confirming the principle of totality which represents one of the pillars of ecosystem studies.

## PROBLEM OF THE STUDY

What are the most important natural and human factors affecting the water ecosystem and their impact on sustainable development?

## HYPOTHESIS OF THE STUDY

The natural characteristics represented by (climate, relief) have an impact on the formation of water ecosystems and their environmental sustainability within the marshes of the area.

## JUSTIFICATIONS OF THE STUDY

The area suffers from a lack of surface water resources that feed it, leading to the drought of the marshes of Maysan Governorate as well as the fluctuations in the quantities and dates of rainfall and the impact of that on the area environment and the impacts left behind on the sustainable development in the area.

## AIMS OF THE STUDY

- 1- The study and analysis of the water ecosystem and the geographical distribution of marshes in Maysan Governorate.
- 2- Developing a future vision for sustainable development in the marshes area.

## LIMITS OF THE STUDY AREA

The spatial limits of the study include Maysan Governorate which is located in southeastern Iraq alongside Iran on the east side, Map (1). The Governorate area is (16072)km<sup>2</sup>, including (6) districts and (15) administrative units or townships, therefore; they represent (3.7%) of the area of Iraq which is (435052)km<sup>2</sup>(1), the marshes constitute an area of about (9.17%), while the temporal limits are

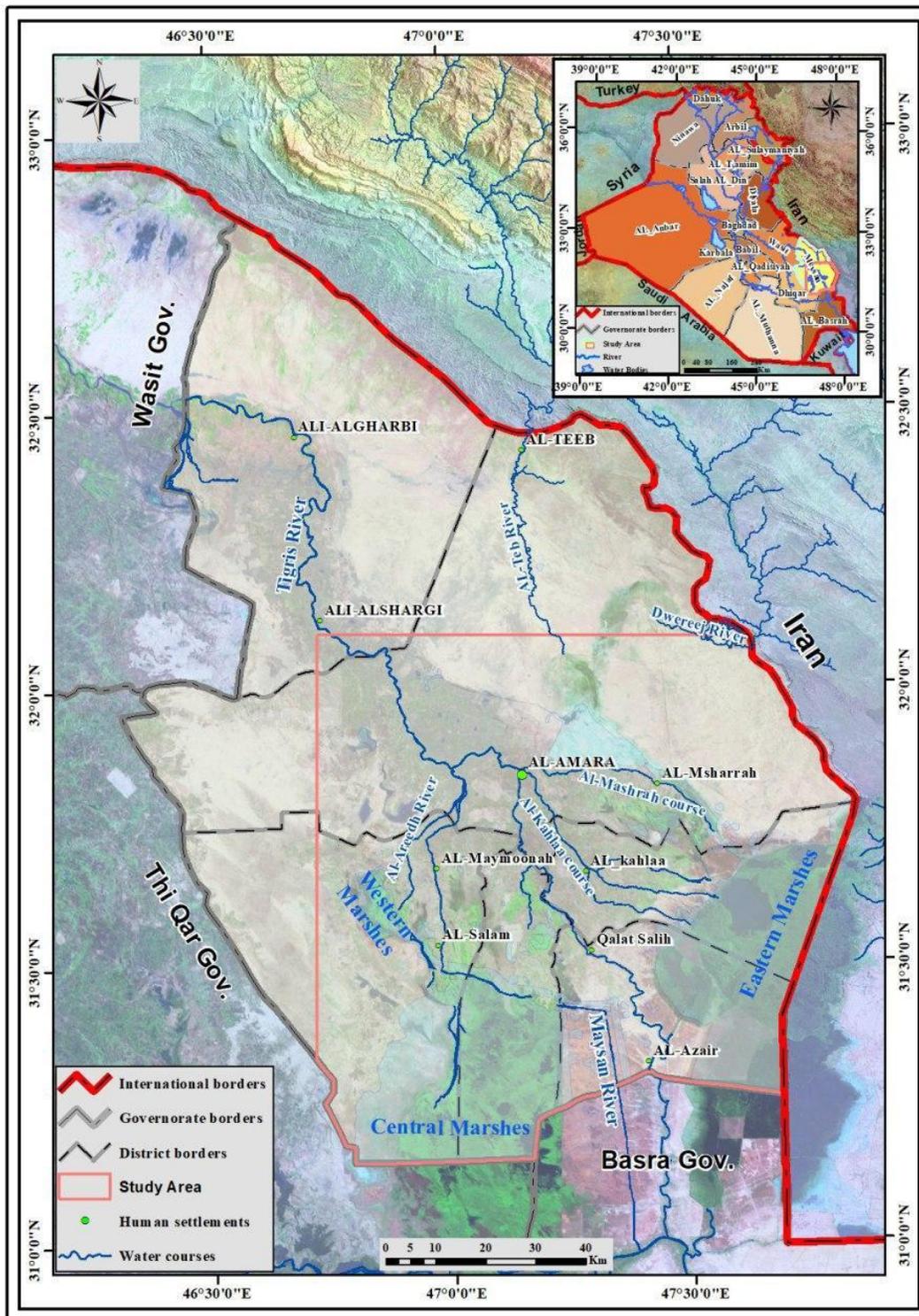
represented by the water reality of the study area of 2017.

## THE GEOGRAPHICAL DISTRIBUTION OF MARSHES IN MAYSAN GOVERNORATE

The water ecosystem is regarded as one of the natural ecosystems that exemplifies a model for asserting the idea of organic association between the natural and human origin systems, where this system is characterized by a wide range of interactive relations with the rest of the ecosystems in the marshes of Maysan Governorate as being a unique phenomenon resulted from the overlap of ecological processes. This vast area of fresh, volatile water derived from various sources and resource abundance have made it represent an ecological system of utmost importance to the natural and human life in the area.

**Marshes:** are water bodies covering the lowlands and are considered by the environment experts as one of the largest lakes in the Middle East and one of the oldest natural sanctuaries in the world, they are called Venice of the East. They provided a natural shelter for the population of Mesopotamia(1). The reason for the emergence of these marshes in the study area is due to the irregular phenomenon of the Tigris River sedimentation and (80%) discharge of the Tigris River ends into the marshes(2). The geographical reality of the marshes areas of Maysan Governorate is characterized in its difference from the rest of the marshes areas in other governorates, as these areas are divided according to the geographical distribution into three main areas:

Map (1) Location of the Study Area to Iraq



**Source: The work of the researcher based on Iraq's administrative map of scale (1: 10000000), Ministry of Water Resources, Directorate General of Survey, Department of Maps Production, Digital Unit, Baghdad, 2007.**

**First- The Eastern Marshes/Hor al-Huwayza:**

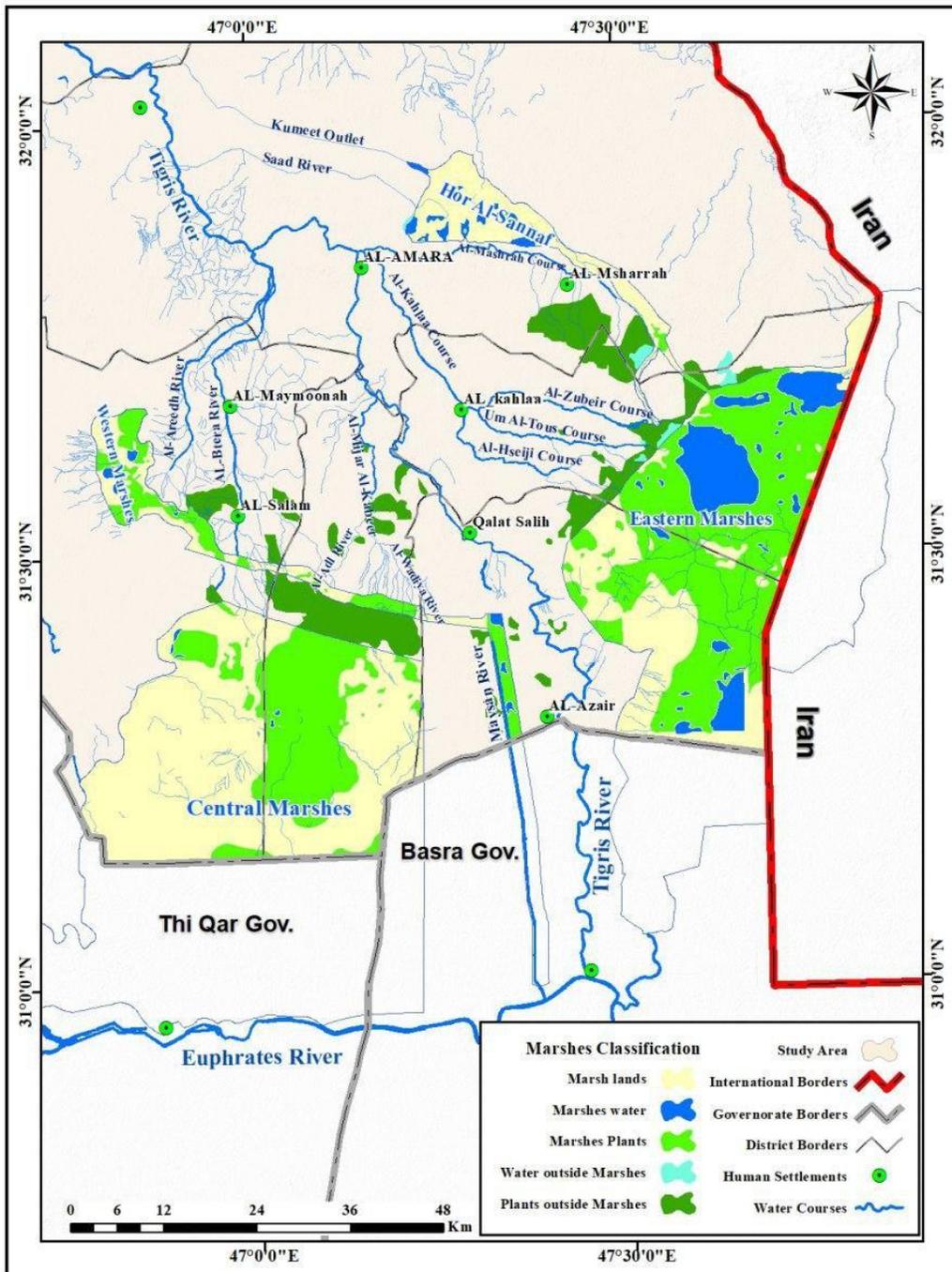
They represent the eastern region of Maysan Governorate, which include a group of marshes located east of the Tigris River extending within the common border between Iraq and Iran and starting from al-Mashrah district with Hor al-Idhem passing through Hor Um al-Ni'aj in Al-Kahla district and ending in al-Izeir district with Hor al-Tarraba within the limits of Maysan Governorate with Basra Governorate. Hor al-Huwayza represents a common water body with Iran in terms of location and sources of water feeding. It is located east of the Tigris River bordered from the eastern and south-eastern side by the administrative borders with Iran, from the south and south-west side by Basra Governorate, and from the north and west side by Maysan Governorate. It ranges between the two latitudes (31-31.50)<sup>o</sup> north, and between the two longitudes (48- 48.45)<sup>o</sup> east, as shown in Map (2).

The component is the first site to be declared within the Ramsar Wetlands of International Importance, as the site contains (5) criteria out of (9) criteria required for listing, focusing on biodiversity-related criteria, where the component supports (1%) bio-geographic numbers of a number of endangered types. It is also considered as a shelter for types of plants and animals, and an important food source for fish and laying eggs, as well as a unique environment and a rare and typical example of a natural wetland pattern(2). The total area approved for Hor al-Huwayza in the Ramsar Treaty is (1377)km<sup>2</sup>, and its area within Maysan Governorate is (1055)km<sup>2</sup> in the flood season, while during the dry season, it is

reduced to (650)km<sup>2</sup>. The average length of Hor al-Huwayza is about (80)km and its width is (20)km. The depths vary in Hor al-Huwayza and the deepest regions are located in the northern part of it specifically in al-Idhem, Um al-Ni'aj and al-Soda pools which are permanent pools with depths ranging between (4-6)m and less depth in the southern parts of it. This variation in depths has a great role in the provision of environmental diversity which is reflected on the biodiversity. Also, the regions of open water (free of reed) have a great importance because they represent large gathering regions for many migratory birds and fish. The water level is above the level sea surface (+5.5)m, and the area of Hor al-Huwayza shrank to about (66%) of its total area due to the drying operations until 2003. Hor al-Huwayza was able to maintain its position as a natural marsh because it was taking quantities of water from the Iranian side through the feeding riverbeds (al-Karkha, al-Tayeb and Dwerej)(4).

Hor al-Huwayza has several local names for it is known on the Iranian side as Hor al-Idhem, as on the Iraqi side it is known as (Hor al-Suwa'id or Hor al-Nawafil). It is characterized by its lands being immersed with water throughout the year unlike other marshes which turned into swamps because of weak feeding sources. It is one of the strategic reliant marshes in the development of the economic aspects of activities based on the water budget such as agriculture, livestock and fishing. Hor al-Huwayza includes a number of water bodies (pools):

Map (2) The geographical distribution of the study area



**Source: The work of the researcher based on the visual satellite (Land Sat) for the year 2007 using the program (Arc Gis).**

**1- Hor al-Idhem:** Hor al-Idhem represents the beginning of Hor al-Huwayza. It is located in al-Mashrah district and considered as the largest marsh in Maysan Governorate and it is regarded as one of the marshes exposed to the drying operations and then the water returned to it naturally. This marsh is fed and refreshed with water through internal outlets including al-Mashrah river and external outlets including (al-Tayeb, Dwereej, al-Karkha, Nissan and Khafajiya), and the amount of water feeding it is variant different, and is also considered being within the common borders between Iran and Iraq and is linked to Hor Um al-Ni'aj through Hor al-Soda(5).

**2- Hor al-Jekka:** Hor al-Huwayza is connected from the north-west side to a water body known as Hor al-Jekka. It is supplied with water through the courses of al-Mashrah and al-Kahlaa. The current area of the marsh is (83.31)km<sup>2</sup>, while its depth is between (20-175)cm and al-Jekka lake forms the deepest point inside Hor al-Jekka and this pool is characterized by most of its parts being free of reeds and papyrus(6).

**3- Hor Um al-Ni'aj:** It is located within the geographical segment of al-Kahlaa district and has two land entrances through al-Kahlaa district (Bani Hashim township of Hor Um al-Ni'aj and another entrance called al-Kahlaa al-Mu'eel Abu Khaasaf village Hor Um al-Ni'aj. The width of the marsh is around (25)km and its depth to the Iranian borders is around (30)km. It is considered among the marshes partially dried and then the water returned back to it naturally, and feeding sources come from the rivers of al-Mashrah and al-Kahlaa as well as from outside Iraq including the rivers of al-Tayeb, Dwereej and Karkha<sup>(7)</sup>.

**4- Hor al-Tarraba:** It is located within the geographical segment of Qal'at Salih district. It is one of the partially dried marshes and then the water

returned back to it naturally, and it is fed and refreshed with water from al-Tarraba river which is a branch of Tigris River and this marsh is an extension of Hor al-Huwayza (Um al-Ni'aj) .

**5- Hor al-Sannaf:** It represents the northern branch of Hor al-Huwayza and it is supplied with water from the rivers of al-Tayeb and Dwereej coming from the Iranian highlands. This marsh takes the shape of arm in its south end north-east of al-Mashrah township of (4)km and meet Hor al-Huwayza at the eastern end of the tails of al-Maleh course which is the eastern branch of al-Mashrah course with a length of (50)km and a width of (5)km.

**6- Hor al-Maleh (al-Maleh lake):** It is located within the geographical segment of al-Mashrah township. It was named by this name due to the salinity of its water and it is a seasonal little marsh. It is away from al-Imara city by (4)km and is located east of al-Imara city (Imara – al-Mashrah). Its length is (27)km and its width is (10)km. several rivers cast in it including (Dwereej, al-Tayeb and the project of Saad river), note that these rivers do not benefit from the waters of the marsh because they are seasonal and some of them are disabled agricultural projects. These rivers cast at the beginning of the marsh, while the end of Hor al-Maleh is linked to Hor al-Sannaf in al-Mashrah township (Ghzela bridge), where the water of Hor al-Maleh discharge through Hor al-Sannaf which is linked to Hor al-Soda.

Hor Al-Huwayza is linked to Tigris River with many courses from north to south as the following<sup>(8)</sup>:-

**1- Um al-Jurri drainage:** which ends in Tigris River at the village of al-Zechiya north of al-Izeir, and this drainage comes with the water of al-Kahlaa streams, especially the waters of al-Hseiji stream.

**2- Al-Kharas drainage:** It casts in Tigris River to the south of the first drainage at about (100)m in the village of al-Zechiyia also and its length before the estuary is about (110)m. It comes with the central and southern waters for the marsh.

**3- Al-Kassara drainage:** This is wider than those drainages, as its extension becomes before its cast into Tigris River (4)km between (50-60)m, and this drainage casts in Tigris River at al-Kassara north of al-Izeir by (5)km. It is a deep drainage in which the large sailing vessels and commercial vessels were entering to transport the mats.

4- To the south of al-Kassara drainage, there are other drainages come with the marsh water to Tigris River, including small al-Mneha, big al-Mneha, Khinitri and Ruta.

**5- Al-Swayib drainage:** It is the largest of these drainages which comes with the marsh waters from South al-Izeir to cast them in Tigris River south of al-Qurna about (10)km.

#### Second- The Middle or Central Marshes:

They are water bodies connecting between the southern governorates (Basra, Thi Qar and Maysan). They represent the largest lowland in the area extending between two latitudes (30.57-31.14)°

north, and between two longitudes (46.51-21.47)° east. It is located between Tigris and Euphrates Rivers from the north bounded by the road of Imara-Fajr, from the east by Tigris River, from the west by the ends of al-Gharraf projects, and from the south by the road of al-Chibayish city adjacent to Euphrates River. It is located within the geographical segment of al-Mijar district, al-Adl township and al-Khair township in Maysan. The area of the middle marshes in Maysan Governorate is about (1230)km<sup>2</sup>, as shown in Table (1). It is composed of a group of deep pools such as (al-S'hein, al-S'geil, Um al-Bunni, al-Jadi, al-Aker, Breida, al-Adla, al-Oda, Abu Shather al-Baghdadiya, Um al-Matabeej and Um al-Mashaheef) and others. These pools originally are feeders of Oda river. The depths of these marshes in Maysan Governorate reach (3.5)m, and this rate varies between the flood and drought seasons by (4.5) and (2)m, respectively. When these marshes were subjected to the drying operations, al-Izz river was established in which the rivers feeding the marsh areas cast including (al-Mijar al-Kabeer, al-Bteira and al-Areedh). At present, the waters have returned with low levels to some of the southern sides of these marsh regions due to the flow of water from the side of Thi Qar(9). The area of the central marshes reduced as a result of the drying operations by (97%) of its total area.

**Table (1) illustrates the immersion of Maysan Governorate marshes areas till 13/11/2015**

Marsh name	Area before drying 1973km <sup>2</sup>	Excluded from immersion km <sup>2</sup>	Non-immersed km <sup>2</sup>	Currently immersed km <sup>2</sup>	Total area eligible for immersion km <sup>2</sup>	Achievement rate%
Al-Huwayza	1800	745	396	659	1055	80
Central marshes (Hor Oda)	1450	222	1060	170	1230	46
<b>Total</b>	<b>3250</b>	<b>967</b>	<b>1456</b>	<b>829</b>	<b>2285</b>	

Source: The Central System of Statistics/Water Resources Estimates/Directorate of Agricultural Statistics.

**Third- The Western Marshes (Hor Oda):** This marsh is located within the district of al-Maymouna and it is one of the completely dried marshes to which the waters returned naturally in recent years where they covered a large area amounting (80%) of its total area (105km<sup>2</sup>) and the feeding and refreshing sources of water for this marsh are through the rivers of (Breida, Raffashiya, al-Adla and Um al-Mashaheef) and others. These rivers are fed by (al-Haddam river) currently and (al-Areedh river) previously. This river is a branch of al-Bteira river via al-Shitheriya bridge and this marsh previously cast or connects to the central marshes and is currently closed due to the drying operations.

It is considered as one of the most beautiful marshes exist in Maysan Governorate and is characterized by biodiversity and thus was one of the most densely populated marshes by fishermen because it is not bordered by any neighboring country. Many dams were built on sub rivers and streams, i.e. the feeders of those marshes. The course of those feeders were changed and they were excluded and connected to a network of rivers established to limit the refreshing process of the feeders of those areas and to limit these waters and divert them by means of huge water feeders called (al-Nahhalat), where those pumps convert and pull the waters of those marshes into the course of the river called al-Izz river which was established for the purpose of drying. At present, Hor Oda suffers from a fluctuation in the quantity and quality of the waters feeding it, as well as the exploitation of its water for agriculture purposes by the population.

### **THE FEEDING SOURCES OF THE STUDY AREA MARSHES**

The marshes of the study area are supplied with water from various sources including the surface water represented by rivers, rain and groundwater. The marshes of the study area are originally natural lowlands where water is collected from multiple sources. The quantities of these waters are affected by the high and low levels of Tigris River and the

streams and rivers of al-Tayeb, Dwereej and al-Karkha, which represent the area basic water resources. The climate of the study area is dry in terms of low rates of rains and high temperatures, and thus there is an increase in the amount of evaporation. The rates of discharge of these rivers change according to the change of the climate over the months and years, in addition to human activities represented by the establishment of dams and regulating systems as well as the construction of irrigation channels. The feeding sources of Hor al-Huwayza come from two sides:-

#### **10-1 The Iranian side - represented by:-**

**10-1-1 Al-Karkha River:** The river is constituted in Iran and is considered as the second source of importance because it feeds Hor al-Huwayza with water, follows Tigris River in the volume of discharges entering the marsh, is characterized by the capacity of its basin inside Iran, Map (2-3), and its area is estimated by (48500 km<sup>2</sup>) with a length of (850km). It springs from the mountains located within Hamadan, Kermanshah, Khurramabad and then it heads southwards until it reaches the city of al-Hamidiya which is (60)km far from its mouth, then it heads westward and its slope decreases until it reaches (16.0m/km) and before enters al-Karkha river to Hor al-Idhem it branches to (6) branches (al-Karkha, Ni'ma, Nissan, al-Syla, al-Kharaba and A'moud al-Saidiya). These branches dry up in summer except for A'moud al-Saidiya because Iran controls most of al-Karkha river waters(10). Its discharge rate in the area of al-Hamidiya (204m<sup>3</sup>/sec). The total annual supply of al-Karkha river is estimated at (6.43 billion m<sup>3</sup>) per year, (3.15 billion m<sup>3</sup>) of it is consumed in Iran and (303 billion m<sup>3</sup>) of it to irrigate the lands which are irrigated from the reservoir of al-Karkha dam/1. Most of the river's inflows are consumed by Iran(11). For inflows coming to Iraq (Hor al-Huwayza) estimated at (55.1 billion m<sup>3</sup>), most of them evaporate in the marshes, as well as they are of bad quality and have negative impacts on the marsh waters, Tigris River, agriculture, environment and other uses. Al-Huwayza

was affected by the inflows of the Iranian Karkha River in particular which are considered as unknown in the future because of the projects implemented by Iran, in addition to the impact of the inflows on the branches of the rivers (al-Kahlaa and al-Mashrah) related to the construction of Bekhma Dam and the waters coming to Tigris river after the development of Turkish projects on the basin(12).

**10-1-2 Al-Tayeb River:** It springs from the Iranian mountains located to the east of Badra and Jassan district. Its length is (159)km and its basin area (2690)km<sup>2</sup> on the Iranian side. The annual quantity of inflows are about (481 million m<sup>3</sup>)(13). The river enters the Iraqi territory at a point located to the east of the Iraqi police station al-Tayeb which is about (31) miles north of al-Imara city. It runs southwards in a deep valley until it ends in the areas near Hor al-Sannaf. The water contains a high percentage of salts and the river passes a saline area known as al-Mamaleh. The expansion rate of the river is between (40-80m)(13).

**10-1-3 Dwereej River:** Its springs are located in the Iranian territory. It is located between the two basins of al-Karkha and al-Tayeb rivers and it heads westwards to enter Iraq at al-Fakkah police station. It is divided into two branches: Menderes which heads southwards with a shallow depth of (1m) and its waters cast in Hor al-Huwayza during the high flood seasons, as for the second branch, it is known as Dwereej river which flows into Hor al-Sannaf with a length reaches (202km) in the Iranian side, its basin area (3270km<sup>2</sup>), and its drainage peak reaches (1000 m<sup>3</sup>). More than (85%) of this river waters are exploited by the Iranians to irrigate their plantations in the spring and autumn days, while in summer the water of this river dries up or runs in small quantities of water that are highly saline. It is noted that al-Tayeb and Dwereej rivers currently run outside the fans of al-Tayeb and Dwereej rivers because the fans are currently ineffective, they were effective in the Pleistocene era which was characterized by wet climate and rainy times where the coming discharges were large and thus carry with them large amounts of sediments.

**10-2 The Iraqi side:** It is represented by the rivers of al-Mashrah and al-Kahlaa and during the period of the Iraqi-Iranian war, the ends of their branches were closed towards the marshes, causing a decrease in the amount of flows from the top and this leads to an increase in the amount of sediments in their bottoms, which helped in the decrease of discharges passing through them, accompanied by the establishment of the flood dams on their both sides, in addition to the construction of Kumeet flood channel in 1993 which lies north of Kumeet township on the left of Tigris river. Hor al-Huwayza feeders are al-Mashrah, al-Zubayr, al-Hseiji and Um al-Tous. One of the main drainage outlets of Hor al-Huwayza waters is through al-Kassara drainage which flows into Tigris River at the village of al-Kassara, while the other outlet is al-Sweib outlet which flows in Shatt el-Arab south of Qurna city, which is located outside the borders of Hor al-Huwayza(14) at a rate of discharge (182m<sup>3</sup>/sec), Hor al-Huwayza is characterized from the rest of the south of Iraq marshes by the fact that it did not dry although the marshlands were subjected to drying operations at various stages and the largest immersed area of Hor al-Huwayza was in 2016. This fluctuation is reflected on the water levels in the region depending on the amount of water entering the marsh from Tigris River or from other feeding streams and rivers. It can be said that the greater the quantity of water entering Hor al-Huwayza with suitable quantities and good quality, it will affect the sustainability of biodiversity which indicates that the marshes environment can restore its value by itself and maintain its existence. It can be said that the drainages of marsh feeders vary according to the seasons, as they increase in winter and spring because of rainfalls and snow melting and decrease in summer and autumn due to natural and human conditions. The natural conditions are represented by the climate and its elements in terms of high temperatures and increased sunshine hours, as well as the existence of natural plants that their growth and existence depend on water, while the human conditions are caused by man and the consumption of large amounts of marsh water in his daily life for the purpose of drinking and other uses.

### THE CHANGE OF THE AREAS OF THE MARSHES OF MAYSAN GOVERNORATE:

The areas of the marshes of Maysan Governorate have undergone many changes in the area of open water and vegetation which in turn is reflected on the total area calculated from the use of satellite images (Raw Images) and classified using the program (ERDAS) to compute the changes in the area of marshes and prepare an information base using the GIS, Table (2), to prepare a map of changes in the areas of the marshes of Maysan Governorate, to produce maps for them and to make the time comparison based on the specifications of the satellite image to study the areas of the marshes of 1975 taken by the American satellite (Land sat MSS) with an image resolution of (79\*79m). The visual interpretation and classification used to determine the dominant types of vegetation and open water area

were used, Map (2-7), as well as the satellite image that covered the region in 1990 because it was of the type (Land sat 5 TM) with a distinguishing capacity of (30x30m) and the satellite image that covered the marshes of Maysan Governorate for the years 2000 and 2017 which was used in the study and analysis and taken from the satellite (Land sat 7 TM) with a distinctive resolution (30x30m). This difference in area varies from one season to another, as it increases in the rainy season, the quantity of water flow increases and decreases in the dry season because of the lack of the feeding water sources. By comparing table (2-1) with Table (2-6), it was shown that the area of marshes was (3250km<sup>2</sup>) in 1973 and (4313.345km<sup>2</sup>) in 1975, i.e. there was an increase of about (1063.345km<sup>2</sup>) due to the increase in water flows from the eastern floods or due to the increase of the amount of rains and this stage represents the natural growth stage of Maysan marshes.

**Table (2) shows the marshes areas of Maysan Governorate during the years of the study**

Year	Total Area km <sup>2</sup>
1975	4313.345
1990	2899.192
2000	892.130
2017	1618.281

**Source: The work of the researcher based on the satellite images of (Land Sat) of 1975, 1990, 2000, 2017 using the program (Arc Gis).**

As for 1990, the marshes area was (2899.192)km<sup>2</sup> which was lower than 1975 by (1414.153)km<sup>2</sup>, representing the changes that occurred on these marshes during the period of the Iraqi-Iranian war. These marshes were exposed to landfills and burning operations and became a war zone, in addition to the drying operations set up to extract oil from the northern and southern fields of Majnoon.

In 2000, it was clear that the marshes area of Maysan Governorate was (892.130)km<sup>2</sup>. The reason for this decrease was the construction of soil dams as

well as water withdrawal, the prevention of the feeding water resources from access and the intentional and unintentional drying operations. They are an extension to the changes of 1990 and the rate of dried lands has increased as a result of high temperatures and cutting the feeding sources from them and thus there is an increase the proportion of desertification. After 2000, the refreshing processes of these marshes began by breaking the soil dams randomly by the population and thus the amount of water increased and the areas of these marshes increased in 2017 by (1618.281)km<sup>2</sup> and although this phase is considered a transitional phase for Hor al-Huwayza because the marsh was exposed to the

drying operations and at the same time the soil dams were broken. It can be said that Hor al-Huwayza, despite the refreshing and immersion operations, did not return to its peak except after it was listed within the Ramsar Treaty, where the water increase is observed and the plant life represented by the reeds, papyrus and wild plants is restored, as well as the animals represented by migratory fish and birds from Eurasia, and the native marshes population to their lands with buffalo flocks which are abundant in the marshes as being the suitable environment for their growth. The refreshing process has increased to (65%) of the marshes areas of Maysan Governorate by breaking the soil dams regularly and increasing the amount of water coming inside the dried lands.

We note from the identification map of determining the marshes of Maysan Governorate of four stages at different time periods (1975, 1990, 2000 and 2017) a variation in the marshes areas and through map (3) which shows the changes of marshes during the years of the study as the following:-

**1- The first phase of 1975:** This phase is characterized by the expansion of the marshes areas because of the recurrence of floods resulting from high rates of discharges to the feeding rivers coming from the neighboring countries, the phase of natural drying. The marshes areas are expanding and

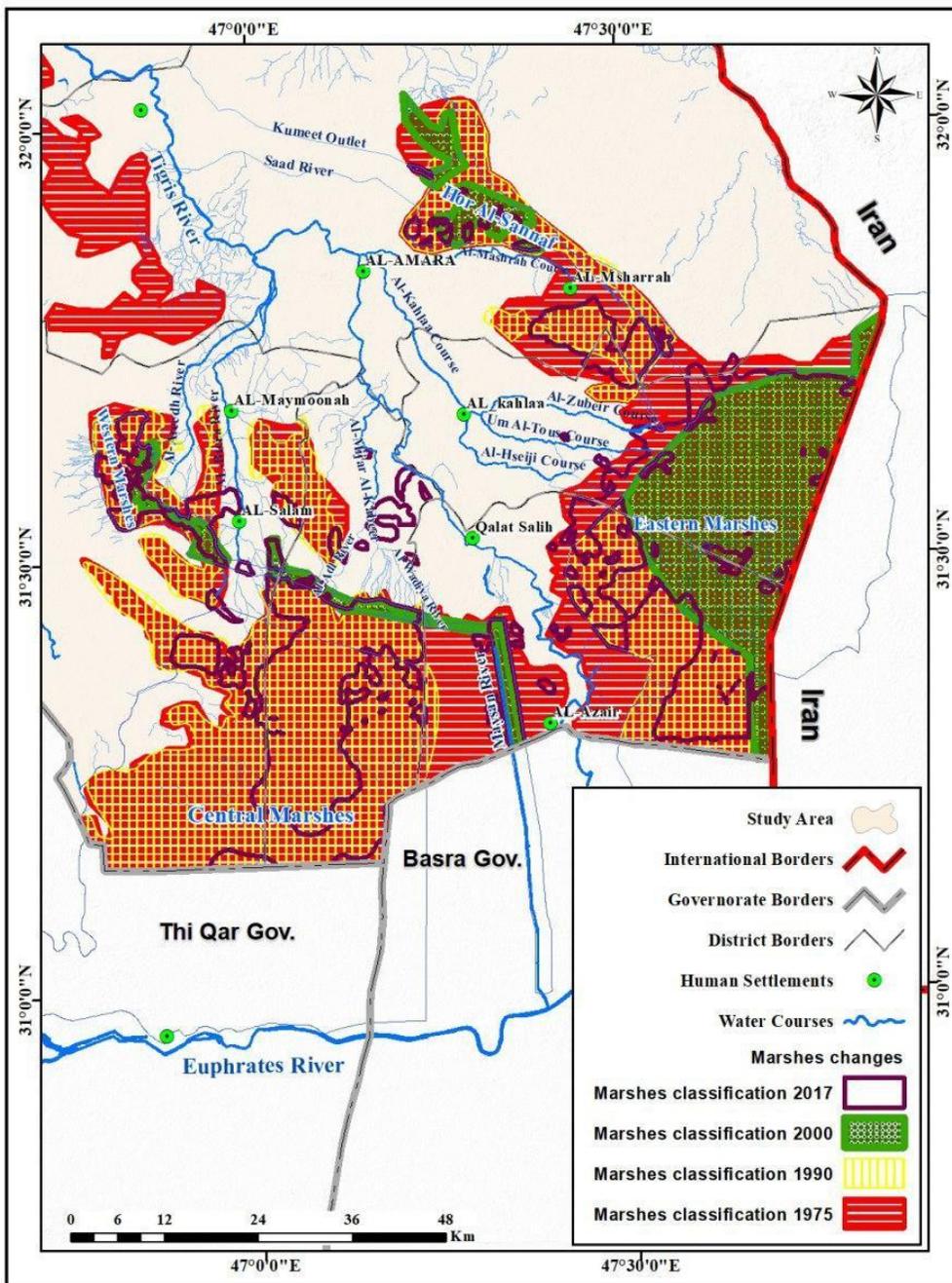
shrinking due to the effect of natural factors including the climate and its elements, where the water salinity increases due to evaporation, as waters dry in the seasonal marshes and leave a saline layer on the surface of land in addition to human factors.

**2- The second phase of 1990:** The marshes area of Maysan Governorate decreased because of the human factors represented by the control and storage through the construction of dams and reservoirs established on the feeding rivers, the most important of which was Tigris River and being a war zone during the Iraqi-Iranian war.

**3- The third phase of 2000:** It is the phase that witnessed extensive drying processes, limiting the borders of the marshes and preventing the feeding water resources from access to the marshes through the water policies, and that thing affected negatively the environment and because of drought the lands became of high salinity.

**4- The fourth stage of 2017:** It is the phase of refreshing and the return of life in these marshes as well as the return of natural flow of waters to the marshes because of the destruction of barriers and dams by the population and during this period the marshes recovered significantly and returned to life.

Map (3) Changes in the marshes areas of Maysan Governorate during the years of the study



Source: The work of the researcher based on the classification of satellite images (Land Sat) for 1975, 1990, 2000, 2017 using the program (Arc Gis).

**CONCLUSIONS**

- 1- The area eligible for the immersion of Hor al-Huwayza in 2015 was (1055)km<sup>2</sup>, while the area currently immersed is (659)km<sup>2</sup> with a completion rate of (80%). As for the central marshes and Hor Oda, the area eligible for immersion was (1230)km<sup>2</sup> and the area currently immersed is (170)km<sup>2</sup> with a completion rate of (46%).
- 2- The study proved the multiplicity of the feeding sources of the study area marshes, as they are fed from the waters of Tigris River inside Iraq and from the river waters coming from Iran.
- 3- The monthly and annual discharge levels of the study area marshes were characterized by their seasonal and annual fluctuation due to their being affected by climate variability and establishing control and storage projects.
- 4- The field study and the analysis of data taken from satellite images using the (ERDAS) program and the Geographic Information System (GIS) program demonstrated the significant impact of human factors and the change of marshes areas as a result.

**RECOMMENDATIONS**

- 1- The water ecosystem is considered as a national wealth for its being rich of many natural resources and economic potentials, thus it is necessary to have a studied scientific plan in dealing with its components so as not to lose their characteristics and avoid its natural hazards.
- 2- Conducting researches and studies on marshes, especially the natural and economic environmental studies that are lacked in the marshes environment, and there should be a joint cooperation between the national institutions and the interested experts and the specialists in the field of marshes in order to stand at the nature of the conditions from which the marshes suffer, as well as conducting periodic studies and surveys of water and soil, which adversely affect the

quality of water and soil and thus affect the nature of growth and the presence of living organisms.

- 3- Establishing the monitoring units in the regions of the marshes of Maysan Governorate for the purpose of programming, observing the quantities of water entering and exiting them, measuring the proportions of salts and the sources of discharge for the purpose of conducting the water budget and thus improving the environment of the marshes and immersing the largest possible area.

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