

DESIGNING AN INFORMATION SYSTEM OF THE DIGITAL MAP MODELLED FOR THE OIL FIELDS IN IRAQ USING GIS

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ABSTRACT

Oil is considered as the most important mineral resources of Iraq. Iraq is ranked third in the Organization of Petroleum Exporting Countries (OPEC) in terms of oil reserves, where the reserve is estimated at (115 billion barrels) in 2013, and it ranks eighth among the countries of the Organization in terms of gas reserves. It exported more than 4.632 million barrels per day in 2016.

The oil sector suffers from negligence due to the absence of a digital electronic administration that manages and regulates its work according to a central control system that monitors the production and counts and organizes the exportation according to a programming and a central system structured with spatial information in points, maps and daily reports. Therefore, we will simulate the data in the map model through a huge database that gather the promising potentialities of oil wealth for the purposes of spatial development and building a database with GIS programs easy to update and add to them in future stages, utilizing the sensor data the satellite data, as well as constructing a model of geographic database and drawing the digital maps by the GIS programs.

LIMITS OF THE STUDY AREA

Iraq is located in the south-west of the Asia continent occupying the northeastern part of the Arab Homeland, thus Iraq occupies a spatial area of 435052 km², including the area of regional water of 924 km². The length of external borders is 3462 km. It is adjacent from the north by Turkey with an area of 377 km, from the east by Iran with an area of 1300 km, from the south and the south-west by Kuwait with an area of 195 km, Saudi Arabia with an area of 812 km, and Syria with an area of 600 km and from the West by Jordan with an area of 178 km⁽¹⁾.

Problem of Research: The oil sector in Iraq suffers from the lack of a spatial digital system to manage its production and export institutions, the absence of databases based on place and daily observation and the lack of a geographic digital database.

Research hypothesis: Through the integrated database built by remote sensing software and geographic information systems, we can organize the oil sector according to an integrated electronic software system and construct an integrated geographical data model.

Significance of Research: The significance of research comes through the unilateralism of the Iraqi economy which depends entirely on oil and that the spatial information concerning oil is conflicting, incomplete and slow information, resulting in wastes due to mismanagement and the exposure of this sector to waste and organized theft. Hence, the study significance came to lay proposals and systematic solutions for the decision maker to take appropriate decisions for future development.

Study Methodology: The study is based on the following methods to achieve the abovementioned aims, represented by the deductive method aiming at deducing things, i.e. moving from the special to the general, which helps us to uncover the interrelations between the variables of the oil sector in the study area, and the quantitative analysis method using the contemporary technical style to model the spatial analysis to manage and monitor the oil, and highlight the quantitative relationship by applying the variables to it, as well as the experimental method by conducting special measurements and projecting oil facilities, then modeling and scheduling those measurements that include the GIS.

RESEARCH MATERIALS AND IDENTIFICATION OF REQUIRED DATA

Modern and mechanical work techniques were used as well as digital data dealt with by computer as the following:

1. ArcMap 10.1 ARC Catalog 10.1 program produced by the American ESRI⁽²⁾ Company, one of the leading programs used in (spatial) Geographic Information Systems (GIS).
2. LANDSAT 7 ETM+ to make inserting and storing them easily in the database with a distinguished precision of (14)m and a drawing scale of (1: 10.000).
3. Vector Data⁽³⁾ represented by the database of database layers of the study area in the patterns of (dot, line and area) which represent the spatial analysis maps.

GEOGRAPHIC DATABASE

It is a collection of information and data of various sources, which represent different phenomena and topics as well as the relationship between them. The construction and design of the databases is one of the most expensive stages of building geographic information systems in that it requires a materialistic cost, time and effort, yet their construction is one of the most important stages that achieve the work objectives.

The most important benefits of building databases are the following:

- 1- It makes information accessible among individuals and institutions.
- 2- It reduces error in the transfer of data and limits the frequency of its registration in different institutions.
- 3- It standardize the methods of measurement and storage with the data which prevents the variation of recording the data and facilitates the comparison between them as well as the easiness of updating them.

4. It analyses the spatial and non-spatial data in a better way. It provides better services to users. The data from which the information is formed is obtained by digitalizing (conversion of traditional data to digital saved in the computer memory), field survey, tables, air photographs, satellites and archives, ...etc)⁽⁴⁾.

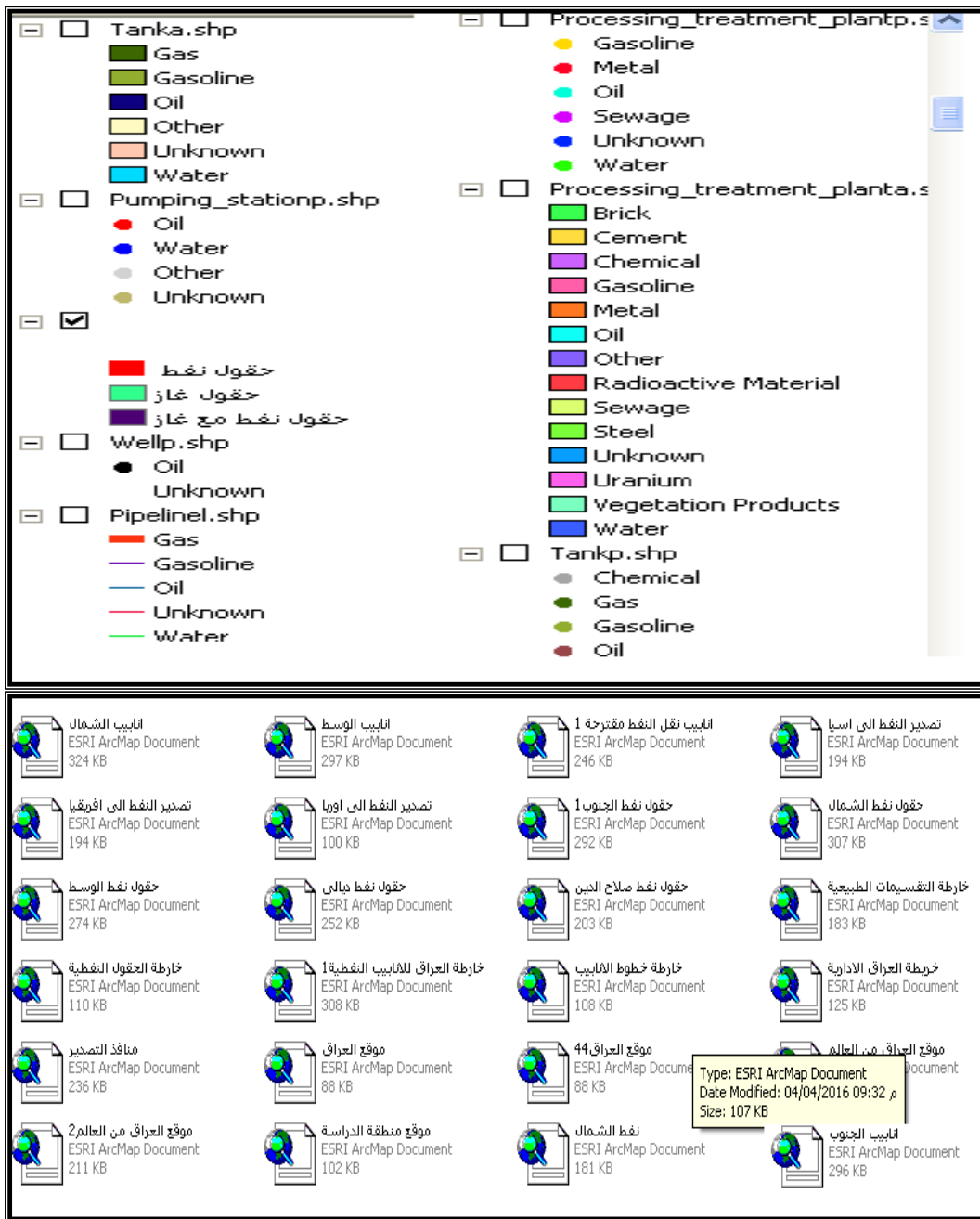
The GIS database is as if the heart for it. The base is a set of tables consisting of columns and rows that bear the information stored in the base which is called non-spatial information⁽⁵⁾.

BUILDING THE CONCEPTUAL MODEL OF DATA (GEOGRAPHIC DATABASE)

To complete the construction of the geographical database, a flowchart should be developed to illustrate the steps of the data of the study area database by classifying the data models and sources in the base and indicating the work stages of each type of those data. The purpose of establishing the layers in the geographic databases is to organize and classify the data by their types according to a definite geometric construction based on the data nature in a way that facilitates to the user displaying and using them in various analyses and applications and classifying the data in different layers in the database helps to access them easily and ease their analysis and then represent them to come out with multi outputs of those layers represented by (digital maps, charts, reports), as well as data scheduling and classifying in layers enable us to access the smallest geographical phenomenon and represent it by independent maps which will help us to track the development of various geographical phenomena in order to arrive at the results of that development and change⁽⁶⁾. Databases in the systems of geographical parameters can be divided into a number of types as the following:

Types of Databases according to Their Design(7)

- 1- Hierarchical design pattern: in which the information is graded according to the degree of its importance (such as the country - cities - wells - fields - pipes).
- 2- Network design pattern: that achieves together with the hierarchical pattern the network linking between the information. It is a pattern of a correlating design designed on a ranking basis of information. Finding a key for it indicates these information with their existence correlated in the information bases, facilitating the access to them easily and quickly through this key. It may require making several columns and maps to be kept in a special file. The GIS often corresponds with this pattern and the model is constructed, Fig. (1).



Source: Geographic database for the study area

Figure (1) A part of the layers prepared for the study in the geographical databases of the study area

The surface of the study area: Its general surface forms a large meander basin extending from the north-west starting from the Turkish mountains, heading towards the south-east till it ends at the Arab Gulf where it is bordered from the east by Zagros mountain series, from the north by Taurus Mountains, surrounded from the west by Syrian plains, Jordanian desert and Saudi Arabia, from the south by Kuwait desert and Saudia Arabia. The Tigris and Euphrates rivers are considered as the lifeblood of Iraq despite the origins of these two rivers are in the Anatolian plateau in southeastern Turkey. The two rivers supply a number of other small rives, before they meet at the Iraqi city of Germat Ali. Their courses cast in the course of Shatt El-Arab which casts in the Arab Gulf. Also,

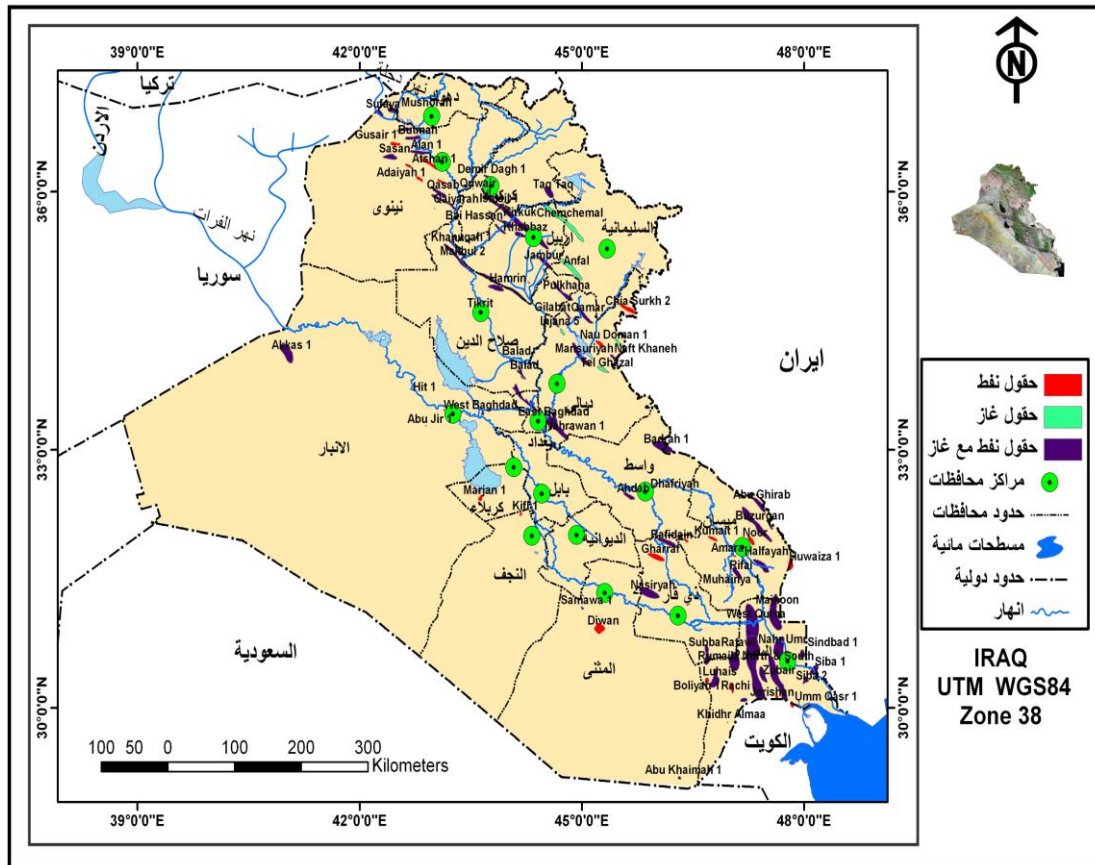
from the Zagros Mountains in the north-east of Iraq flows a number of permanent running river tributaries (Khabur, Upper Zab and Lower Zab, Idheim and Diyala) to recharge the Tigris with water⁽⁸⁾.

The nature of the region, its geological formations and the type of movements that it has been exposed to, whether they are meanders or refractions affect the stability of oil or its migration and even its kind, because the tectonic movements generate a tremendous pressure and a very high temperature, and these results affect the type of oil and the substances stuck in it such as salts, water, sulfur and other impurities, as well as the type of ground layer geologically in terms of their thickness, degree of their porosity, permeability, proximity and distance from the surface of the reservoir which is where the oil is reserved. It is rocky structures in which the oil gathers and forms the reservoir. The oil also exists in the so-called (Oil Traps) and these traps originate from the ground movements that occur during the earth movements that build the mountains and continents, such as the traps of convex folds, the traps of refractive fractures, the salt dome traps, layer traps, ...etc⁽⁹⁾. Oil basins are areas of lands that tend to unity and resemblance in their general appearance geologically and geographically despite the apparent diversity of some of their component parts, they include between their folds several oil fields that form the current production foci⁽¹⁰⁾.

MAP OF THE REALITY OF THE GEOGRAPHICAL DISTRIBUTION OF OIL WELLS IN IRAQ

The number of Iraqi wells are from 70 to 100 thousand wells. Despite these available oil potentials, the oil capacity in Iraq seems to be inactive and limited to two main fields: Rumaila field in the south where there are 663 productive wells, and Kirkuk field where there are about 337 wells, which was discovered in 1927⁽¹¹⁾. Since the discovery of these fields until now, they suffer from being exposed to depletion because of concentrating on them for a long time. They need modern studies and additional investments. The oil fields are distributed in most of the governorates of Iraq except for the governorates of Sulaymaniyah, Anbar, Babel and Qadisiyah. See map (1), which shows us three areas as follows:

Map (1) Geographical distribution of oil and gas fields in Iraq

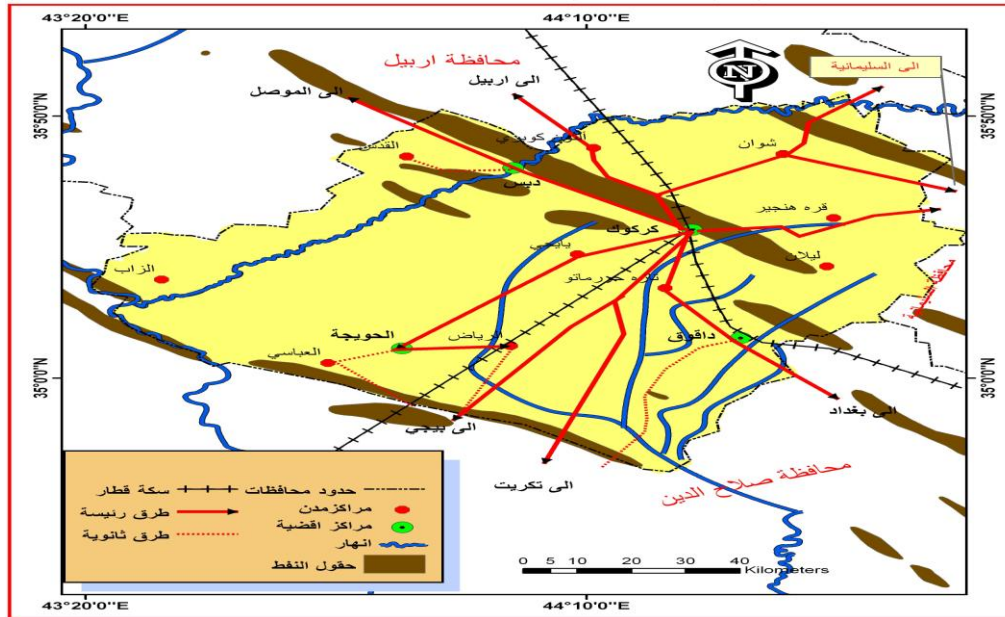


Source: Geographic database for the study area

a- The northern basin area: It is located in the northern part of Iraq. It covers all the lands of the waved region by about (15%) of the total area of the country. It also includes other areas of the western plateau and the northern and northeastern edges of the sedimentary plain, and it takes a general direction from the northwestern to the southeastern, which is determined by the nature of meander consisted of the area reliefs. The basin includes several large oil fields, including the giant Kirkuk fields, which oil reserves present in Kirkuk are estimated by about 13 billion barrels, i.e. it forms about 12% of the total Iraqi reserves of oil. The most prominent northern fields include⁽¹²⁾:

1- Kirkuk field: It is one of the very giant fields and is considered as the fifth largest field in the world in terms of capacity. It is a plateau cut by the Lower Zab by a region and its length of about 96.5 km and width of about 4 km. The depth of the wells of Kirkuk field ranges between (450-900)m and the production rate of each well is about (35) thousand barrels per day. Kirkuk contains more than (330) productive wells and their number is increasing, see map (2).

Map (2) Kirkuk oil fields of Iraq



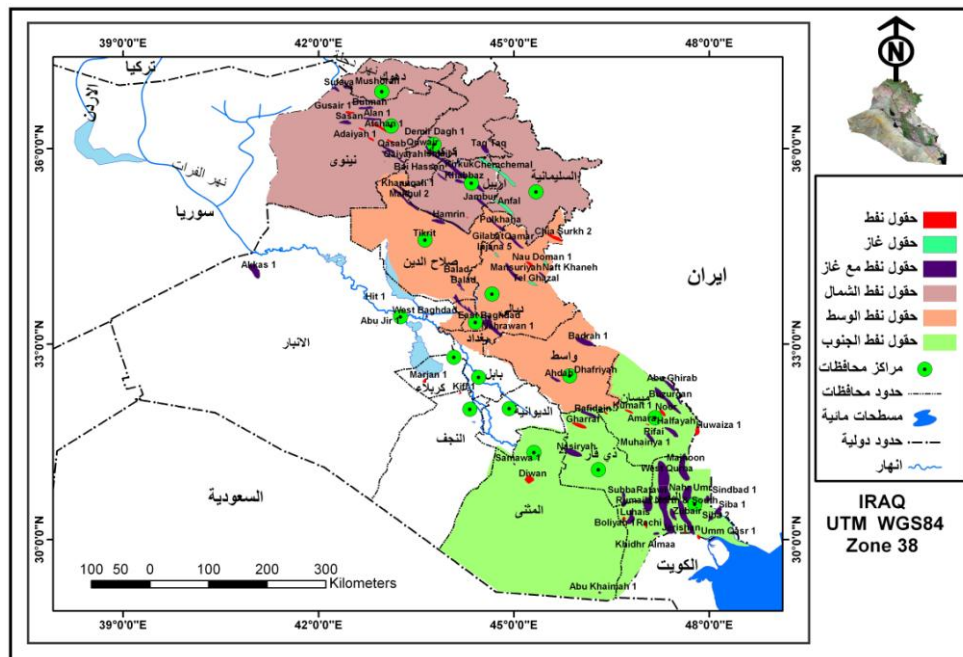
Source: Geographic database for the study area

2- Bai Hassan field: This field is located about 9 km to the southwest of Kirkuk field in parallel to it in the direction. the wells of Bai Hassan field are deeper than the wells of Kirkuk field and their depth is between (1500-3000)m, and the oil Bai Hassan field is closer in its chemical composition and physical properties to the oil found in Kirkuk field. It has the shape of a dome or a convex fold containing large amounts of oil⁽¹³⁾.

3- Jambour field: This field is located about 60 km southeast of Kirkuk field. It has the shape of a dome or a convex fold parallel to the installation of Kirkuk field and at the same direction. The oil was discovered in it in 1954 based on geological survey information and its production started in 1959. its reserve is proven to be (one billion barrels)⁽¹⁴⁾.

4- Other fields: Other fields that are located in the northern basin are the field of Ain Zalah and Batma and there is the field of al-Qayyara which is located in the governorate of Nineveh- al Qayyara district and includes four geological structures (reservoir or oil traps) in the shape of domes or convex fold: al-Qayyara, Najma, Joan, Qasab, as well as Safiya field adjacent to the Syrian borders, and Himreen field on the hills of Himreen to the south of Kirkuk field. There is also Khana oil field which oil is considered as light oil type, extending beyond the political borders of Iraq towards Iran at Khanaqin area and is called Naft Shah in Iran, as well as Khabbaz field in Kirkuk governorate, and Tikrit field, Ajeel, and Balad field, all of which is located in Salah al-Din governorate, see map (3)

Map (3) Geographical distribution of Iraq's oil producing fields



Source: Geographic database for the study area

b- The southern basin: The southern basin is complementing the Arab Gulf basin geologically and geographically. It represents the north of this basin and covers the southern sides of the region of the Sedimentary Plain in Iraq, in addition to some parts of the Western Plateau as well as the territorial waters of Iraq. It has an area smaller than the northern basin. The southern basin is also characterized by a plain topography that tends to be plane⁽¹⁵⁾. The basin includes a number of fields such as:

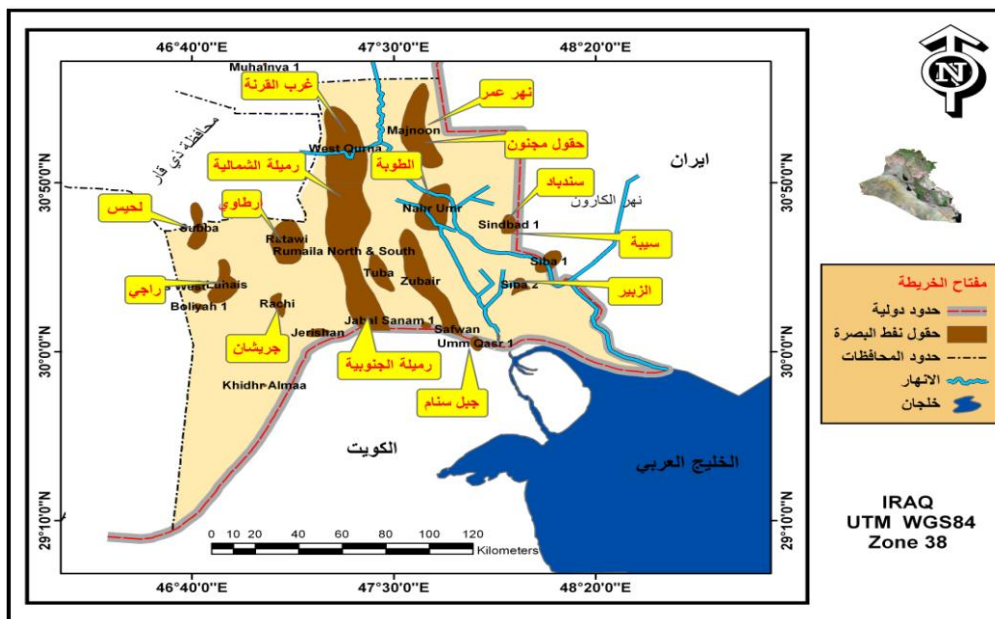
1- Al-Rumaila field: It is located in the southeast of Iraq and considered as one of the giant fields where its length is about (80 km) and its width (12.5 km), consisting of northern and southern domes. The southern dome was discovered in 1953 and its production began in 1955, while the oil was discovered in the northern dome (northern Rumaila) in 1958⁽¹⁶⁾. It extends from the west of Basra towards the south until its southern part enters Kuwait. Most of its wells are in Iraq. It is the ninth largest oil field in the world and the finest kind of oil. In 1970s, its wells were less than twenty, but they are now more than 663 productive wells⁽¹⁷⁾.

2- Al-Zubair field: It is located in the southeast of Iraq to the east of Al-Rumaila field. It was discovered in 1949 and its production began in 1951. It produces about (220 thousand barrels per day). It is 24 km long and 8 km wide with an average depth of (3300 m). Al-Zubair and Al-Rumaila fields form the main oil core for the southern basin⁽¹⁸⁾.

3- Majnoon field: It is a giant field in the governorate of Basra and produces temporarily about (100) thousand barrels per day. Its productive capacity may reach after development to about (600 thousand barrels per day).

4- West Qurna field: It is one of the Iraqi largest oil fields in Basra governorate. This field represents the northern extension of the northern Rumaila field, and its production started in 1973. It is believed that it contains a stockpile of at least (24 billion barrels), and produces (300 thousand barrels per day). Its production capacity may reach after development to about (700 thousand barrels per day)⁽¹⁹⁾, see map (4).

Map (4) Iraqi Basra oil fields



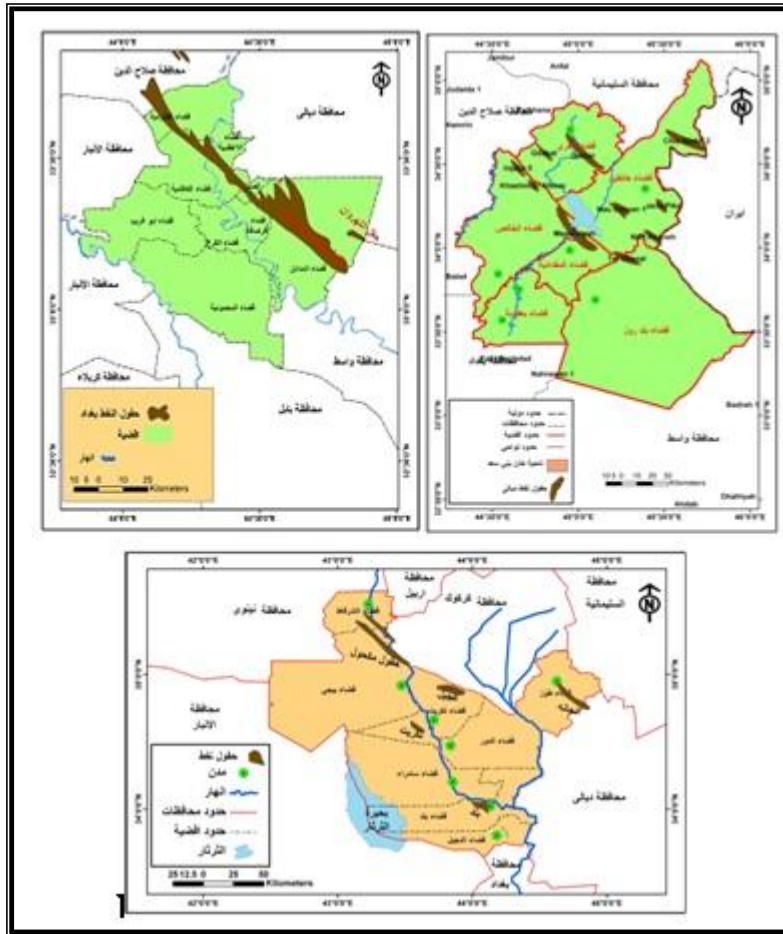
Source: Geographic database for the study area

c- The area of central fields: There is a group of central oil fields, see maps (5, 6, 7), the most important of which is:

* **East Baghdad field:** It is located to the east of Baghdad governorate. It is a longitudinal structure with northern extensions in Salah al-Din governorate and southern extensions in Wasit governorate. Its production is about (20.000 barrels per day, while its total production is estimated at (120.000 barrels per day). This field was discovered in 1976 and it is believed that its oil quantities are modest but the drilling has showed that its size exceeds the initial estimates⁽²⁰⁾:

- * Akkas field in Qaim/Al-Anbar.
- * Al-Ahdab field
- * Balad field
- * Badra Field
- * Al-Mansuriya gas field in Diyala (discovered and undeveloped)
- * Akkas Al-Ghaq field in Anbar (discovered and undeveloped)

Map (5), map (6) and map (7) some fields in the central region of Iraq



Map of the geographical distribution of oil reserves in Iraq

Iraq's reserves are fixed reserves that have already been discovered, but they are not the last ones in Iraq. Also, the undiscovered oil reserves are much more than the registered. Some expect that the reserves in Iraq may exceed their Gulf countries when completing the search and exploration in the lands that have not received a full geological survey for many sectors of Western Sahara have no drawn accurate geological maps. It is expected that they contain large quantities of oil. Estimates indicate the likelihood of the existence of other (100 billion barrels)⁽²¹⁾. The study of oil reserves is considered very important because it determines the strategic importance and impact of oil at present and in the future for the relationship is very strong between the amount of oil reserves, the larger the amount of proven reserves, the larger the likely reserves.

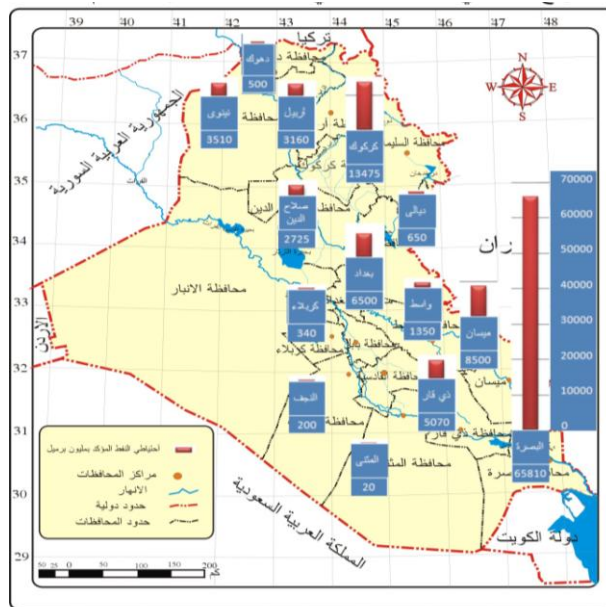
Oil Reserves: It is the quantity of the potential oil wealth stored in the underground and the fields scientifically discovered and their estimated quantities in the light of the information available from the search process in the identified area under exploitation or search with the possibility of its extraction economically, i.e. with costs and prices specified in a period of time and known technical and technological methods and technology when calculating the reserve.

a- Proven reserve: It is the reserve which existence is proven and quantity is known and can be obtained under the current circumstances and with known techniques under the current economic conditions of the market in the sense of proven oil existence with known quantity technically and known expenses economically.

b- Likely reserve: It is the quantities of crude oil that are likely to be found in the neighboring areas in which the oil existence is proven and in which the oil quantity and type of oil are not known, but the quantities are rated and estimated initially as well as approximated within the light of the geological characteristics of the ground layers in the areas adjacent to that area in which the oil was discovered.

After 1990, as a result of new discoveries of fields, the Iraqi remaining reserves amounted to more than (100 billion barrels) and the cumulative production rate was about (22.5 billion barrels). Despite the wars and blockade of the years followed 1990, the depletion was as low as possible mounting (billion barrels) for the period (1990-1995) and after the addition of other discoveries, the remaining reserves amounted about (112 billion barrels) until 2000, and it quickly increased to (115 billion barrels) in 2005. By observing table (1) which shows the productive and undeveloped fields in Iraq, it reached (13.475 billion barrels), and Kirkuk was in the second rank with its fields forming a percentage of (12.1%) of Iraqi reserves, as shown on map (8) which shows the proven reserves in most of Iraqi governorates by one million barrels.

Map (8) Distribution of proven oil reserves in the Iraqi governorates for 2015

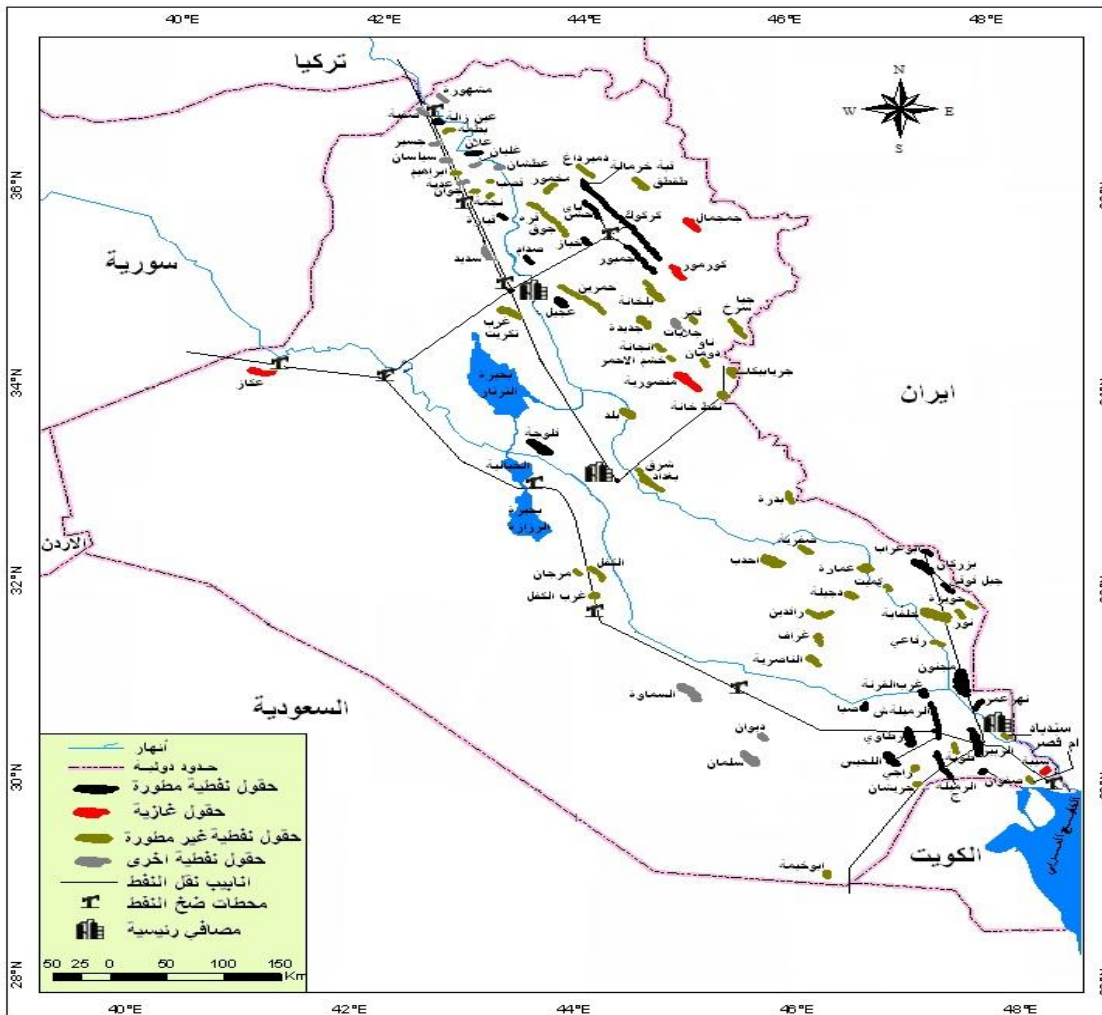


THE GEOGRAPHIC DISTRIBUTION MAPS OF THE IRAQI OIL FIELDS (DEVELOPED AND UNDEVELOPED)

The geological studies have shown that Iraq contains about 530 geological structures with good oil potentials. The bulk of the Iraqi oil reserves are concentrated in the south. The oil reserves of the governorates of Basra, Missan and Thi Qar combined form 71% of the total Iraqi reserves and 21%

of the northern fields, especially Kirkuk which oil reserve is estimated by 12%, while the middle fields form 8% of the total Iraqi oil reserves. Iraq owns 73 oil fields not fully operated except (24 fields), table (2), which shows the small size of Iraqi oil production compared to stocks, if we know that productive wells in Iraq range from 1500 to 1700 wells, while it is expected that the wells after the completion of search will reach at least (100 thousand wells). Despite these great oil potentials, the oil power in Iraq seems to be defective and limited to two main fields Al-Rumaila field in the south and Kirkuk field in the north⁽²²⁾, see map (9).

Map (9) Geographical distribution of oil fields developed and not developed in Iraq



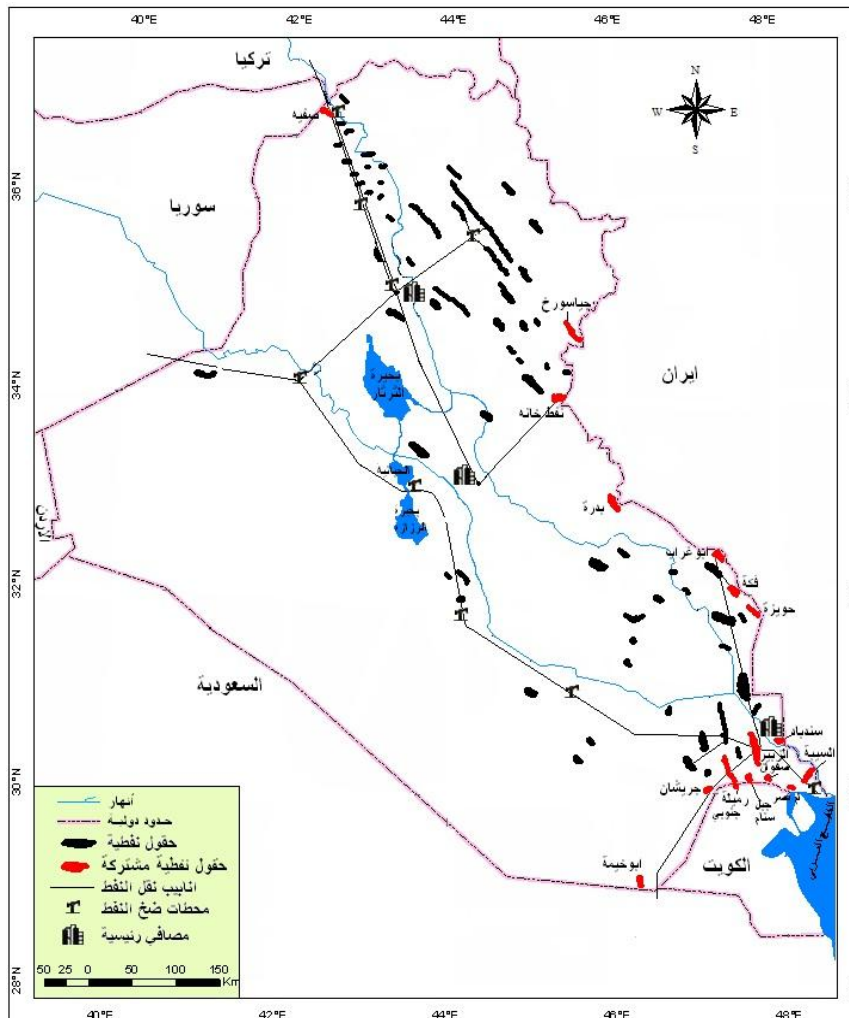
Source: Geographic database for the study area

The map of common oil fields of Iraq

The meaning of borders in geopolitics is the lines that define the geographical dimensions of countries and their spatial status as an independent and sovereign country, at which the sovereignty and laws of a country end with the beginning of the sovereignty and laws of another country. Within the frame of these borders, the water surfaces are included, that are overlooked by the state lands which are known as the territorial waters. It also includes the upper atmosphere layers that cover its lands and territorial waters in the so-called airspace, i.e. the border is a geographical location where

two states' powers meet, and at these borders the influence and laws of each one end. These borders are drawn on maps to show their paths between the two neighboring states in nature, defined by barbed wire or signs of stone pienes planted in the ground, see map (10).

Map (10) border oil fields shared between Iraq and neighboring countries



Source: Geographic database for the study area

First: The border fields with Kuwait:

(A) The productive border fields: They are the southern Rumaila field and Al-Zubair field (Safwan Dome).

(B) Border structures: There are four structures: the structure of Um Qasr, Jabal Sanam, Jreshan, and Khedher al-Maa.

Second: Border fields with Iran:

(A) Productive border fields: the fields of Fakka, Abu Ghurab, Naft Khana.

(B) Non-productive border fields: they are five fields, Badra, Hwayza, Sayba, Sinbad, Jyasourkh. As for the border structures, they are ten structures as the following: Kushk al-Basri, southern Hwayza,

al-Shihabi, southern Jyasourkh, southern nuhirat, zurbatya, Bizal, mandili, Bishkan, and Darbandikhan.

Third: The border fields with Syria:

(A) The productive border fields: Safiya field.

(B) The border structures: they are four structures: Aaus (TreFaoi), Turhaji (Qahtan), Abtakh, and Qaim.

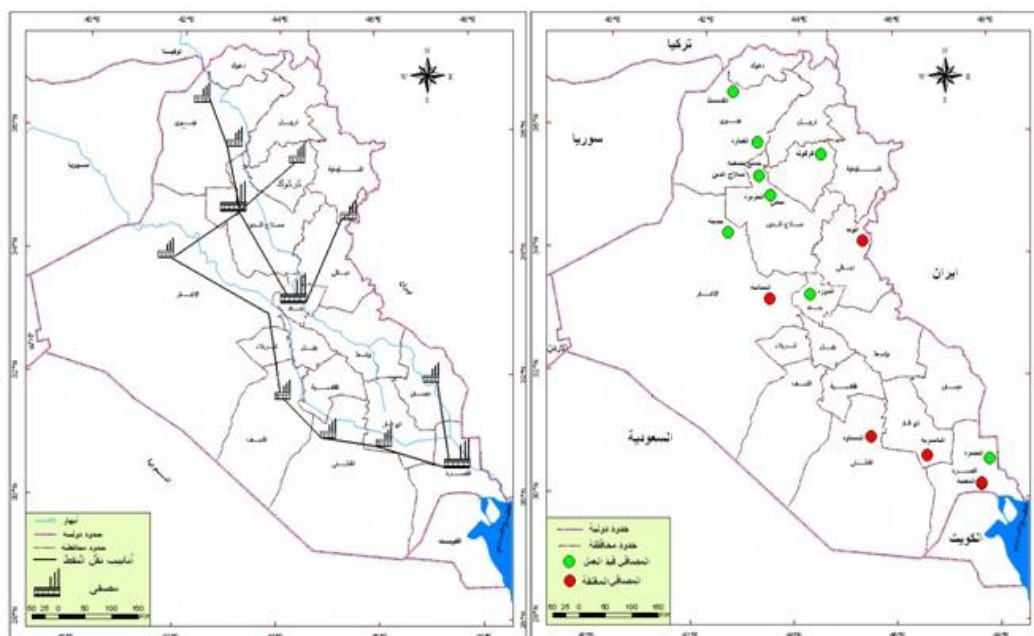
Fourth: The border fields with Saudi Arabia: No common fields have been identified with Saudi Arabia so far. This may be done during the fourth licensing cycle, if implemented. As for the border structures, there are seven joint structures with Saudi Arabia: southern Abu Khayma, Fursan, Ansab, Ar'ar, Hayjan, western Najd, and Haris.

Fifth: The border fields with Jordan: The most important fields are the gas field of Risha which is the only common field known so far⁽²³⁾.

IRAQI OIL REFINERY MAPS

Iraq currently owns (13) refinery distributed on the northern, central and southern regions of Iraq, three of which are large and central refineries concentrated in three governorates, Baghdad, Basra and Sala Al-Din, whereas the rest of the refineries are small ones also distributed in the other governorats of the country, maps (11) and (12) show the oil refineries operating in Iraq in 2014.

Map (11) and Map (12) operating and non-operating oil refineries in Iraq in 2014



Source: Geographic database for the study area

MAPS OF TRANSPORTING AND EXPORTING THE IRAQI OIL

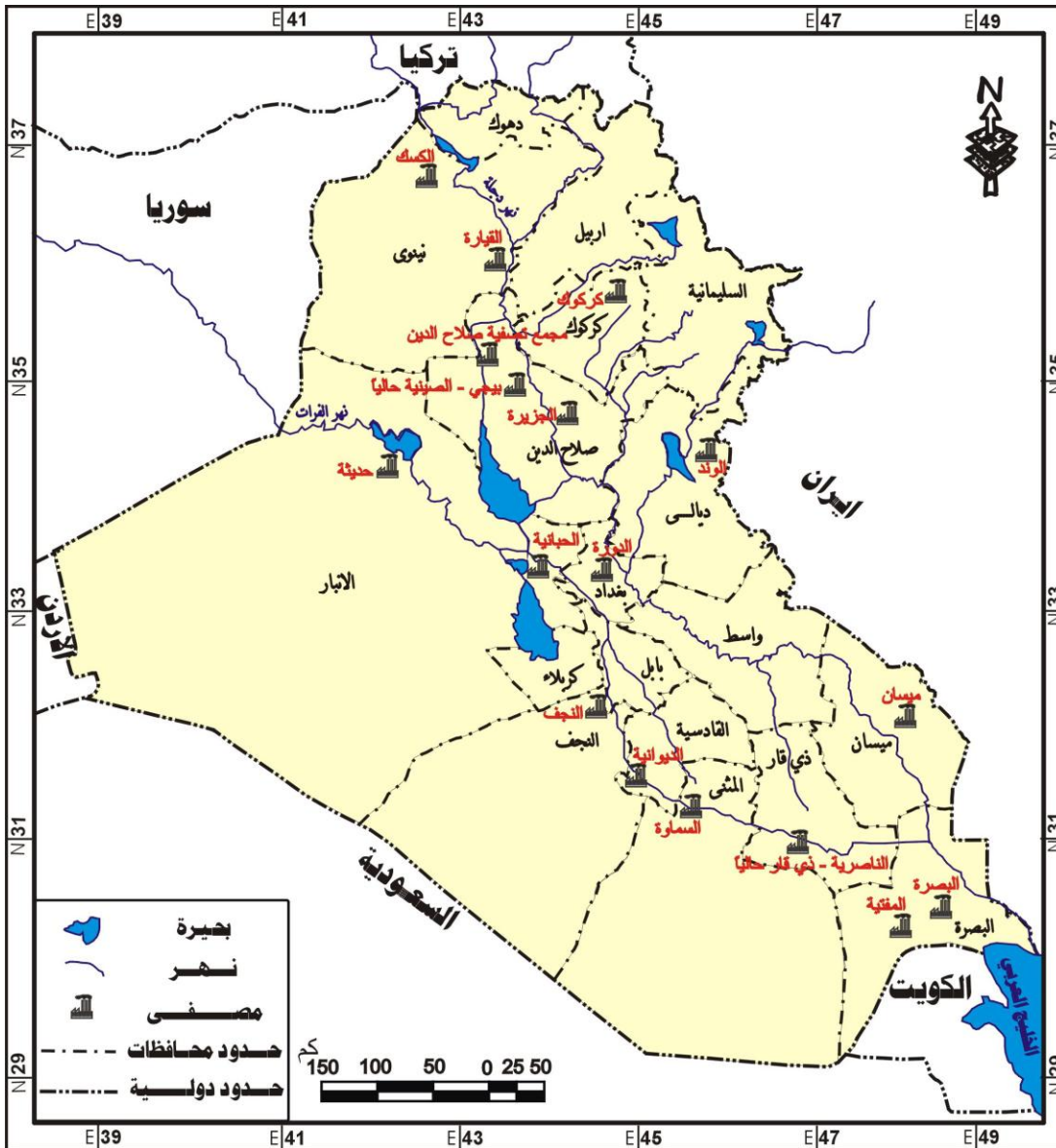
The pipeline is one of the cheapest means of transporting oil from its fields to the export ports, but the political borders between the countries may impede the establishment of pipelines between the countries. The pipelines lead to complex problems in that transporting lines require new transporting establishments in the country. Moreover, these establishments may not be of a direct value to the state through which it passes, as well as the oil pipeline needs oil pumping stations along its the length and warehouses at its end in addition to a port for shipment and unloading. It was necessary for the companies producing oil in Iraq to think about extending pipelines linking the fields of Kirkuk in the north and reach either the Mediterranean Sea or the Arab Gulf.

It has been found that extending the pipelines to the Mediterranean Sea is more economical⁽²⁴⁾.

THE MAP OF INTERNAL OIL TRANSPORTING PIPELINES

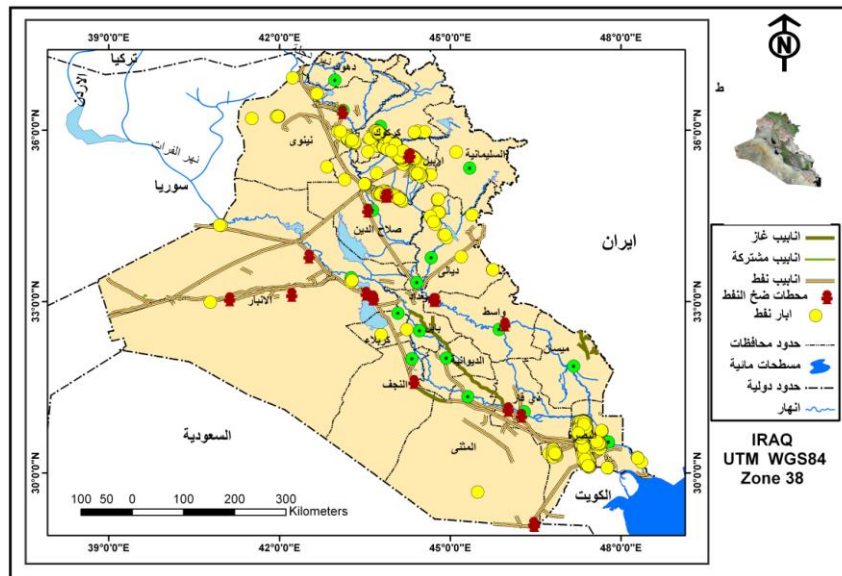
The oil pipelines inside Iraq are characterized by their short lengths, narrow diameter, and consequently their low productive capacity. Their total lengths are (1037 km) of which 42% for transporting crude oil from the productive fields and the exporting pipelines, 42% of which is used to convey crude oil to the refinement factories. As for the remaining percentage 16%, it is represented by the network of oil products transportation.

Map (13) Distribution of oil refineries in Iraq since 1927 – 2015



Source: Geographic database for the study area

Map (14) oil and gas pipelines and pumping stations in Iraq



Source: Geographic database for the study area

THE MAP OF IRAQ OIL EXPORTING SYSTEM

In the second half of 1980s, Iraq witnessed the integration of the main pipeline system and its final capacities and there was oil exporting flexibility which of oil became the following systems:

1- Western system: One of the first systems in Iraq which is known as the Iraqi-Syrian pipeline, consisting of two main pipelines with a diameter of (30-32 inches) and length of (893 km) to Baniyas harbor in Syria and (854 km) to Tripoli harbor in Lebanon. The capacity of this system at its peak is (1.4 million b/d) and can transfer crude oil to Kirkuk fields for export from the Mediterranean harbors through the Iraqi, Syrian and Lebanese territories. During the period between 2001-2003, Syria and Iraq used the pipeline to circumvent the sanctions imposed by the Security Council. The pipeline was transferring about (200.000 b/d) from the South Oil to the refineries in Homs and Baniyas. The pumping in the pipeline stopped in March 2003. After nearly a year, the pipeline state allowed to pump about (250.000 b/d). The Syrian side still uses the part located in its territories within the Syrian pipeline system for export⁽²⁵⁾.

2- The northern system: It is known as the Iraqi-Turkish pipeline. Working with this line started in 1977 with a diameter of (40 inches). The system was expanded twice in 1983 and 1987 and completed with a final capacity of (1.75 million b/d). The pipeline length is (1005 km) transporting crude oil from the fields of Kirkuk through Iraqi and Turkish territories, starting from the first pumping station (K1) west of Kirkuk to the Turkish port of Ceyhan on the Mediterranean Sea. A parallel line to this one was completed in 1988 which contributed in an increase in the export capacity of Iraqi oil, provided a large part of Turkey's oil needs and gave Iraq the possibility of marketing oil from the Turkish ports on the Mediterranean Sea to the European markets.

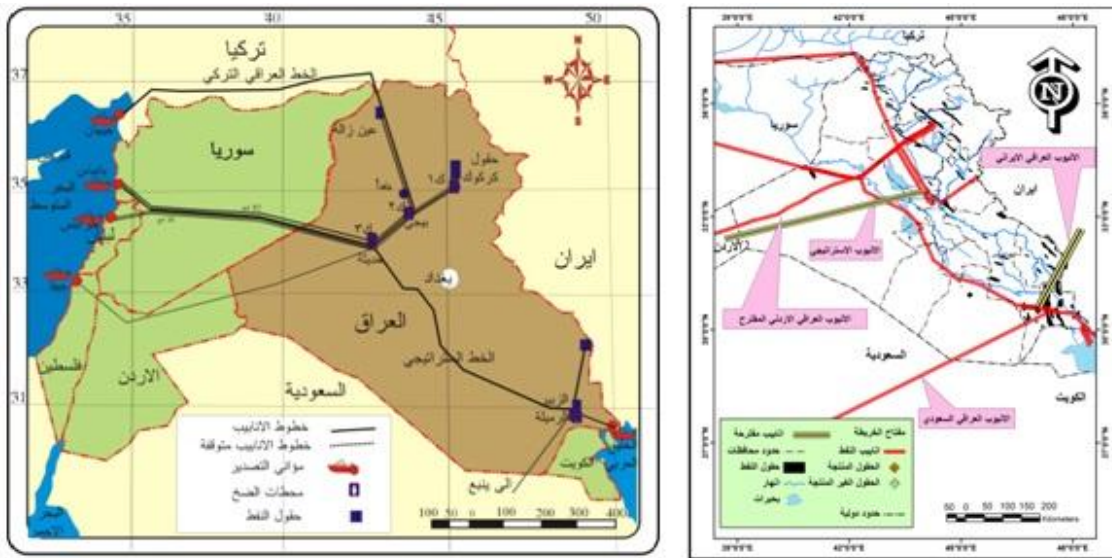
3- The strategic pipeline system: This internal line was established between the south and the north to provide flexibility in the export of oil produced from the southern fields (Basra) through the ports of the Mediterranean Sea and the export of oil from the northern fields (Kirkuk) through the ports of the Arab Gulf and vice versa. It was completed in 1975. The purpose of establishment is to arrive at maximum export potentials and to allow the transferring of oil shipments from the North to the South and vice versa. This pipeline consists of two main parallel lines, the first one with a diameter of (42 inches) to transfer crude oil, and the other one with a diameter of (18 inches) to supply gas to the three intermediate pumping stations (Habbaniya, Najaf and Samawah) and the protection and strengthening stations for the wireless networks. It also fueling some industrial projects near to the pumping stations through which it passes, and connects between Haditha and Fao passing through the west of Euphrates. The length of the strategic line is (810 km) and its capacity in the southern direction is about (million b/d) and its capacity in the northern direction is (900 thousand b/d). The decline of the land from north to south has affected this difference in capacity. During the Gulf War in 1990/91, the strategic line was damaged in Haditha after the destruction of the pumping station (K3) in addition to the destruction of four pumping stations in the south. The strategic line added a new dimension to the Iraqi oil export pipeline network to link the Northern and Western systems with the southern systems through the station of (K3) in Haditha and (Rumaila) in Basra, where Kirkuk oil can be exported through the Arab Gulf and the Red Sea as well as exporting Basra oil from the Mediterranean Sea.

THE MAP OF EXPORTING OIL THROUGH THE IRAQI PORTS

1- Port of Basra: This port is located to the south of the deep port in Khor al-Amya, which is in the shape of an industrial island with a length of one kilometer, based on (430) substrates. It was completed in 1975, and consists of four docks, three of which are capable of receiving carriers with loads ranging between (35-350) thousand tons. The port receives oil from the land part of Fao through two sea pipelines with a length of (42 km). It exports the oil of northern and southern Iraq via the strategic line which links it with Rumaila field at one hand and with Haditha station at the other hand. It is supplied with good equipments and the tankers can transport through it (million b/d). Crude oil can be pumped into the port four docks at one time according to marketing requirements⁽²⁶⁾.

2- The deep port (Khor al-Amya): This oil port was established in the late 1950s in 1959, and was completed in 1962 inside the waters of the Arab Gulf, 38 km from the port of Fao. The deep port is located in Khor al-Amya at a latitude of 30 15 north and a longitude 48 54 East in the Arab Gulf, map (11). The port consists of five docks or artificial islands linked to each other⁽²⁷⁾. As for the number of the docks exist in the port at present, they are four steel docks and the plunger in front of them (30 meters). The port receives the four oil tankers that can be loaded from the port at the same time. The load of tankers is between (30-350 thousand tons). The oil collected in Fao is pumped to the deep port by two land and sea pipelines. The port pumping capacity is about (1.6 million b/d).

Map (15) and a map (16) pipelines transporting and exporting Iraqi oil



Source: Geographic database for the study area

3- Port of Fao: This port is located, and can be located in the far south of Iraq on the bank of the West Shatt al-Arab, about 30 km from the entrance to the Shatt al-Arab, and about 100 km south of the center of the city of Basra. This port was completed at the beginning of the 1940s and began exporting oil from it in 1951. It consists of four docks for receiving oil tankers with a plunger (10.6 meters). Each dock has one pipeline to ship the crude oil with a diameter of (24 inches), where the process of loading the tankers by oil pipelines connected to oil reservoirs in Fao. The tankers load that can be received in these docks ranges between (30-350 thousand tonns). The port of Fao has two basic tasks: the first is the shipment of oil exported abroad in the tankers, and the second is the pumping of oil to the port of Khor al-Amya for shipment from there. The port is connected to al-Zubair and Rumaila oil fields by two pipelines, (32) and (24) inches in diameter, respectively. The work in this port was suspended after the operation of Basra port in Khor al-Amya in 1975, as well as the lack of depths in front of its docks greatly.

Map (17) Iraqi oil ports



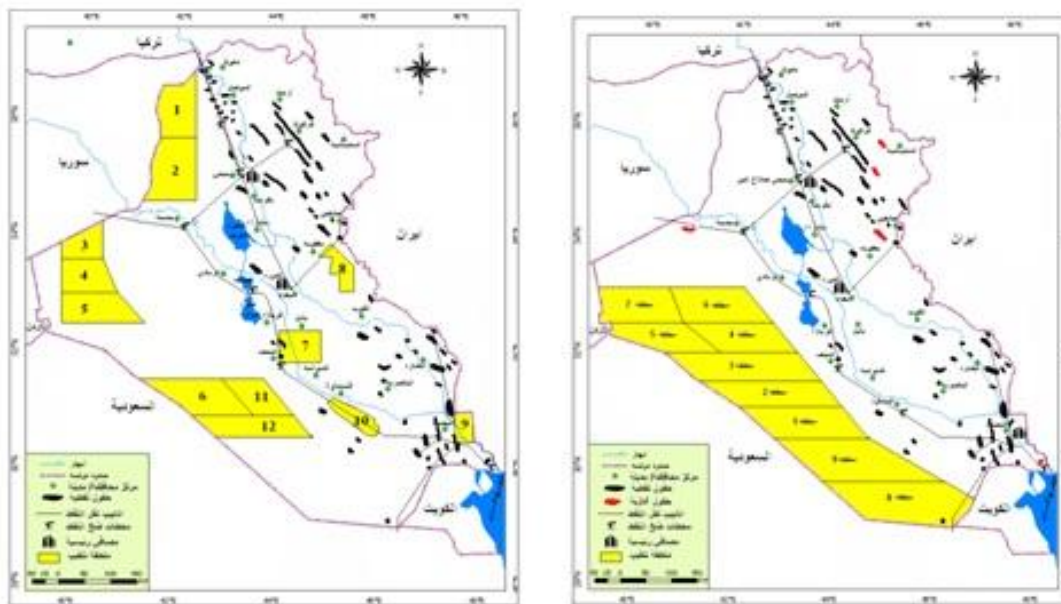
Source: Geographic database for the study area

1- Foreign investment in oil sector:

Investment* is considered as one of the most important economic activities, because it leads to the creation or increase of productive capacities in the national economy. In return, investment is considered as the most sensitive and influential type of expenditure for political, economic and social fluctuations and the positive or negative consequences they generate that affect the future prospects of businessmen⁽²⁸⁾.

* Investment: is the employment of funds to obtain profits in compensation of the present value of the invested funds.

Map (22) the specific exploration areas for investment in Iraq for the years 1999-2002 and the map of the 23 existing exploration areas according to the fourth licensing round for 2012



Source: Geographic database for the study area

THE BASIC REQUIREMENTS TO INITIATE THE PREPARATION OF A CENTER TO CONTROL AND MONITOR OIL PRODUCTION AND EXPORTATION

The requirements of building a structured and digital information project for the oil sector in Iraq requires the following:

First: The National Oil Information Center in Iraq

The organization and resolution of oil problems in Iraq require the establishment of the National Information Center (NIC) for the Ministry of Oil, which is the provider of information technology services to all various sectors of the ministry, such as extraction, transportation, individuals and others. The headquarters of the National Information Center is Baghdad City. The center must have ten (10) sub-centers, these branches are regional centers spread throughout the oil fields. These regional centers communicate with the main national information center at the Ministry of Oil in Baghdad via wide area networks (WAN).

Second: Operation and application phase:

The operation of the system and its application will be in full details of its functions and capabilities as a prototype experimental phase on a specific area. The applications will be expanded and detailed for each of the following sectors: command and control center, oil fields, transporting operations and all means of transportation, and management of oil transportation affairs, which includes supplying the operating rooms with a number of devices and systems, the most important of which are:

1. Dual-screen computers for crisis receivers, radio personnel and room officers.
2. Digital maps, high-resolution and direct radar satellites.
3. LCD screens with advanced server and crisis administration system (CAD).

connection to the central system via (NIC WAN).

5. Central control cameras for all oil systems and oil pump meters linked to the GPS device within this network and with various digital maps in order to control all sectors of extraction and export centrally

CONCLUSIONS

1. Despite the transformation of Iraq into a single economy and its dependence entirely on the export of oil, but its production and export processes are still subject to an old administrative system without modernization and contribution to reduce waste and loss of its production.
2. The information on the quantities of production from all wells is still inaccurate because it is not connected to sophisticated devices that digitally measure and read.
3. It is necessary to search for new more feasible export outlets.
4. Trying to develop ports so as to accommodate more ships.
5. Trying to extend a network of new pipelines across Saudi Arabia to the Red Sea.
6. Through the construction of a huge geographic database that can be used in the analysis of data and production as well as the issuance of digital Atlas and digital maps accompanied by reports and figures with maps and deductive maps of Iraqi oil can also be produced.

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