Land Uses in the Oil Fields in Southern Iraq: The Case of the Zubair Oil Field

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Abstract

It is known that the emergence of oil fields and the subsequent changes of use of land in the vicinity of them affect the settlements and the communities. In Iraq, this has occurred significantly, and there is little understanding about the impact of the oil fields in the land uses of the surrounding areas. In this context, this study focuses on the Zubair oil field, a prominent oil exploration and production site in southern Iraq. The research aims to assess the different land uses within the Zubair oil field and understand their impact on the environment and local communities.

To achieve this, a thorough analysis of satellite imagery, field observations and interviews with key stakeholders were carried out. The study identifies and classifies different land uses in oil, including drilling sites, production facilities, infrastructure and associated support services.

The findings reveal that the predominant land use in the Zubair oil field is dedicated to oil exploration and extraction activities, resulting in the conversion of agricultural and pastoral land. This shift has led to many environmental consequences. In addition, the expansion of infrastructure and related services has also affected the local communities, changing their socio-economic dynamics.

Keywords: Land uses, oil field, spatial determinism, supervised classification, satellite imagery

Introduction

The rapid development and expansion of oil extraction activities in different regions have led to many challenges related to land use planning and management. The southern region of Iraq, known for its rich oil reserves has undergone significant shifts in land use as a result of extensive oil-field operations. Among the prominent oil fields in this region, the Zubair oil field stands as a prime example of the complex interactions between oil production and land prefecture. Understanding the dynamics of land prefectures within these oilfields are critical in addressing the complex spatial, environmental, economic and social impacts that arise.

The Zubair oil field located in the southern part of Iraq is known for its large oil reserves and plays a pivotal role in the country's oil industry. Extraction of oil from this field has led to the creation of many infrastructure facilities, including drilling rigs, pipelines, processing plants and supporting structures, transforming the local landscape. This research paper focuses on the analysis of land use in the Zubair oil field and aims to shed light on the absence of planning principles, the potential competition between different land occupations, and the implications of these factors for sustainable resource management.

The paper is based on the premise that assessing the interdependence between land use and implementing comprehensive planning principles in the Zubair oil field will lead to improved management of spatial, environmental, economic and social impacts, and a more

balanced and sustainable use of the land resources. The primary objective of this paper is to provide an analysis of land uses in the Zubair oil field, focusing on the interdependence between different sectors, the effects of each land use on the surrounding environment, the economy, local communities, and the potential competition arising from these uses. It thus examines the current land use practices and assess their impacts.

In summary, this research paper presents a case study of the Zubair oil field in southern Iraq, studying land employment within the field and associated challenges. It investigates the absence of planning principles, competition between different sectors, and the broader impacts of land uses.

Theoretical basis and general concepts

The oil industry is a significant part of the Iraqi economic sector, and it is very clear that this industry is spread over large areas. At the same time, it adjoins with the communities linked to it developmentally.

The rapid development and expansion of oil extraction activities in various regions have led to many challenges related to land-use planning and management. Here, the problem of research arises on the increase in waste of land-use in favor of oil projects, which leads to spatial, environmental, social and economic imbalances that threaten the sustainability of land resources.

An oil industry anywhere will have its impact which can be either negative or positive depending on if things are well planned. It is known that this industry would constitute a tangible impact on the spatial structure as well as affect the nearby communities in terms of the availability of job opportunities. Such a facility certainly provides opportunities for the construction of roads and buildings and the participation of local communities in them. However, there are other concepts that one must understand in order to understand these implications.

Land use& Land cover

Land use and land cover are related concepts that describe different aspects of the earth's surface. Land use refers to human activities that take place on land, such as agriculture, urban development, and mining. It describes how people use land and the resources it provides. Land cover, on the other hand, refers to the physical and biological features that cover the land, such as forests, grasslands, water bodies, and built-up areas. It describes the type of actual ground cover, regardless of how it is used by people (Naidu et al,2022).

While land use and land cover are related, they are not always the same. For example, a forest area can be used for timber production (land use) or protected for conservation purposes (land use). However, the land cover remains the same. Similarly, grasslands can be used to graze livestock (land use) or converted into agricultural land (land use), which could lead to a change in land cover.

Land cover can change over time due to natural and man-made factors, such as climate change, land-use change, and natural disasters. Understanding and monitoring land cover changes is important for the management of environmental and natural resources, as well as for assessing the impact of human activities on the planet. In fact. understanding land use and land cover is important for natural resource management, environmental impact assessment, sustainable land use policy development, and therefore successful urban or regional planning.

Main influences in changing uses

The process of changing the use of land begins with the idea of meeting a specific need within the space within which that need arises, such as housing, transportation roads, schools, hospitals, or any other use that meets the need (Amer et al,2021). The idea is to invest a specific aspect available within the space, such as investing Nature for tourism purposes. Thus, the projects are added that serve such directions, or investing arable land by implementing various agricultural projects, or investing lands in which there would be wealth by implementing

mining projects in them, or investing in oil fields by implementing oil industry projects (Jameel et al,2023).

Thus, the first change made by a user in a land is the implementation of a project on the ground. Therefore, it is necessary to know what a project is.

What is a project?

A project can be defined as an activity involving two or more parties working together in an organization involving a number of activities. We can also define a project as a set of interrelated tasks that will be accomplished over a specific period and at a limited cost. Projects are temporary, no matter how many years they take. This is because projects exist to solve certain problems and efficiently achieve specific goals. As it is often said: "The project is a problem to be solved".

Definition

Over the years, many professional bodies and individuals, in many different ways, have answered the question, "What is a project?" However, the definition in ISO 21500:2012 "Project Management Manual" is perhaps the most appropriate.

There, a project is defined as:

“A unique set of operations consisting of coordinated and controlled activities with start and end dates, carried out to achieve a goal. Achieving the project objective requires outputs that correspond to specific requirements, including multiple constraints such as time, cost and resources”.

It is clear from this definition that a project is essentially a vehicle for change and there is a fundamental difference between a project and a working organization. While the first process is essentially a process of change, the second is its ongoing operations in a continuous, repetitive and routine manner, often following a well-defined path. Any small improvement in the latter case is carried out as part of the daily work without affecting the main structure (Ghosh, 2022).

A definition that is considered the most reliable is the definition in BS 6079-2:2000 Project Management Vocabulary, which states that a project is:

“A unique process, consisting of a set of coordinated and controlled activities with start and end dates, undertaken to achieve objectives that correspond to specific requirements, including time, cost and resource constraints” (Lester,2017).

The Project Management Institute (PMI) is the professional association of project managers. In the latest edition of the Knowledge Project Management Authority, or PMBOK® Guide (2008), a project is defined as "a temporary endeavor to produce a unique incentive – done to produce a unique result or service". A product, service, or temporary result means that each project has a specific beginning and an end [PMBOK®WELL (2008).]. Unique means that this product, service, or result is different from other products that may have preceded it. In fact, the only part of the definition that fits all the projects is that they are all functions that produce something unique. It is probably better to say that they are intended to be temporary in nature (Lewis,2011). For the purpose of implementing any project, the basic and most important element must be available, which is the site.

The Site: Industrial location

Location is a concept that means where something exists in relation to other things. Thus, an industrial location means a statement not only of the spatial distribution of the industry, but also of the relationships between this distribution and other phenomena (Webber, 2020).

Site selection is a typical strategic decision for many industries dealing with determining the most suitable location for a facility. In the context of sustainable development, site selection decisions need to be improved by adopting environmental, economic and social requirements (Maryam et al,2015).

As it is known, site selection plays an important role in sustainable development (Falih and Hamel,2017). Efficient land use–and according to the suitability of the site for its intended purposes–is a fundamental principle of "smart" growth or sustainable development. Sustainable development requires fewer inputs than energy and materials and generates fewer negative outputs such as water and air pollutants.

The U.S. Green Building Council's LEED certification program considers site context and past land use history in evaluating developments for potential certification as Platinum, Gold, or Silver (www.usgbc.org/LEED) for the "green" projects. Choosing to build on an urban filling site, especially if it is previously developed land, helps to reduce urban sprawl and reduce the "ecological footprint" of development. Urban filler is development that occurs on vacant or residual land that has undergone previous development (Alwehab,2017). Indeed, urban redevelopment involves "replacement, remodeling, or reusing existing structures to accommodate new development" (La Gro Jr., 2008).

The spatial determinism of the oil industry

Oil and gas developments continue at a rapid pace throughout the countries that possess this wealth, as development has exploded in the past few years. Not surprisingly, in many regions of these countries, this form of industrial development is increasingly at odds with other land uses, such as agriculture, housing, recreational activities, and the enjoyment of private property. As it is known, land ownership can be public, i.e. owned by the state, and in this case its investment is somewhat easier because the oil works are carried out for the benefit of the state. However, if they are private property, then it requires negotiation with the owner, satisfying him and ensuring his rights related to the land (OGAP, 2005).

All energy productions require land. Reducing the "footprint" of land use in the energy industry is an important part of reducing environmental impacts while meeting our energy needs. Advanced exploration techniques such as 3D seismography, and drilling techniques such as horizontal and inclined wells, reduce the amount of land required for a certain amount of oil or gas produced (Allison and Mandler,2018).

All oil and gas projects are closely linked to land, which is the basic material of these projects, and therefore the distribution of projects spatially is also linked to the sites that ensure the success of these projects. This is what we express as the spatial inevitability of oil and gas projects.

Spatial determinism is a concept that refers to the physical location of places and the human activities that occur in them which are determined by the spatial environment where they can affect the development of their society and economy. The oil industry has been particularly affected by this concept, as many of its projects are determined by the physical location of oil reserves and the environmental conditions of the areas in which they are located. They are related to the location of those resources, the availability of infrastructure, and the local environmental conditions. These factors can determine the cost, risk, and potential profits of a project.

Understanding spatial determinism is essential for wealth-holders looking to maximize their profits. By studying the physical environment and its resources, companies can identify the most efficient and cost-effective ways to develop their projects (Naniek,2021). This can help them reduce costs and increase the profits.

Spatial determinism of oil industry projects is a complex process involving many factors, including geology, economics, and politics. These include resource availability, political climate and environmental conditions. By understanding these factors, companies can better plan and execute their operations. The political climate in a region can have a significant impact on the spatial determinism of the oil industry projects. For example, if the region is politically unstable, companies may not have access to resources or operate in the region. In addition to the local political environment, the global political environment must be considered. International trade agreements, sanctions, and other geopolitical factors can affect the profitability of an oil project. Companies must be aware of these global political trends in order to make informed decisions about their investments.

The spatial determinism of oil industry projects also plays a role in production. The physical environment can affect the cost and risks associated with the project. For example, a project located in a remote area may require more infrastructure, which may increase the cost of the project.

Literature Review

Remote sensing techniques (RS) and geographic information systems (GIS) and programs have been widely used globally and locally in geographical studies in general and spatial studies in particular. Urban planning studies have focused specifically on this aspect, but what concerns industrial planning in general and the oil industry in particular, are that the studies were few, because of the specificity of this sector and important economic priorities locally and globally, which make production a first priority.

James et al. (1983) have presented the uses in detail that meets all types of land uses throughout the globe such as the land use classification system and land cover, using remote sensing data in a timely manner using the land use classification system presented in the circular of the American Geological Survey 67. He has presented the historical development of the classification system and has explained the differences between land varieties, noting that there is no single ideal classification of land use and land cover. James et. al. (1983) says that it is unlikely that it is developed at all. There are different perspectives in the classification process and the process itself tends to be subjective, as remote sensing data have not reached what they have reached at the present time and the programs supporting the sensing process have not yet appeared as GIS programs.

Al-Ali (2007) examines surface changes that are the result of changes in land uses and land cover changes. He has stressed the importance of using remote sensing techniques (RS) and geographic information systems (GIS) in studying the features and surface changes of the southern part of Iraq. This study was a geographical study in which the researcher proved the effectiveness of the use of remote sensing systems in studying the changes that occur on the surface of the earth, but it also did not specialize in the effects of those changes to the surrounding environment or to uses to each other.

Umayyan (2008) has examined the assessment of the causes of environmental degradation and biodiversity depletion arising from the activities of the oil industry in the region. He argues that there are specific negative impacts on the region arising from the industry activities including: environmental pollution, biodiversity depletion, social instability, under-development of host communities, global warming and associated high flood risk. Moreover, host communities have lagged behind despite huge national profits from oil and gas since 1970. The author concluded by favoring all incubated stakeholders and genuine participation in environment and development.

Among the studies that were concerned with the subject of land cover classification and land uses, Al-Mawla (2014) has examined the available techniques such as the use of satellite data and sensors whose images provide adequate data for the Basra Governorate. He has conducted a classification and cartographic representation of land cover changes in the Basra Governorate in general using remote sensing techniques and GIS programs and has reached the proportions of uses according to common the classifications of the earth's surface during the study period, which extended from 1973 to 2013. This study seeks to find a classification of land cover and land uses and did not specialize in a specific matter related to the land uses and their effects during their change or even the relationship between one use and another.

Tarjan (2017) has specifically discussed development and urban planning strategies, as well as the challenges of the city of Balikpapan, in transforming its economic activities to anticipate the post-oil industry era. As evidenced by this study, the transformation of an oil-based urban economy does not always occur naturally towards more service-based activities to address problems related to resource depletion, price volatility, and environmental degradation. This study has also shown that policies appropriate for general guidelines are important for achieving a process of clear direction, not only in providing short-term and long-term benefits,

but also in managing institutional arrangements that enable a system of allocation between different levels of government.

The study also argued that large-scale infrastructure development in a city that is not accompanied by modernization of basic infrastructure and local services to improve the quality of life of its people will not lead to sustainable socio-economic activities.

Kryakov (2017) shows that resource zones cannot follow a single model of innovative development that targets the needs of the oil and gas industry. These models should take into account a wide range of regional features. The results show the need to strengthen the role of resource areas in regulating the oilfield and gas services sector. The research focused on developing a methodology for studying innovative processes within social, economic and regional systems and on providing practical recommendations for the development of the Services of oil and gas fields in Russian resource areas. As a general rule, research takes into account the spatial factors that affect the development of the oil and gas industry. However, the research did not focus on the mechanisms of influence of spatial factors, but rather took them as an element of development regardless of the relationship of uses with each other.

Al-Zaidi (2019) examines the spatial dimension and include it in the contents of oil investment contracts for its role in achieving spatial development. The inclusion of spatial dimensions within the investment policy in the oil sector is an important factor in achieving sustainable spatial development. However, in this research, he focused on the technical and contractual aspects while ignoring the spatial effects that result from the change of land use and the subsequent changes at the social, environmental and economic levels.

Peng et al. (2022) have studied how Karamai, a typical mining city in northwest China, expanded and developed using remote sensing (RS) imagery, geographic information system (GIS) and spatial analytics. The expansion rate, urbanization development index, spatial orientation and urban hoarding are used to discuss the features of expansion. Socio-economic factors and multi-level policies were the main factors influencing urbanization. This study is the first to combine the process of urbanization with the changing spatial characteristics of cities, which are of importance for the sustainable development of these types of cities and contribute to the diversity of case backgrounds to discuss the possibility of integrated urban growth.

Research Methodology

One of the most important techniques used in the study of changes that occur on the surface of the earth, especially when the study is for large and wide areas, is Remote Sensing techniques (RS) Remote sensing is the process of obtaining information about the environment or an object without direct physical contact with it.

This is done through the use of various technologies that capture and measure electromagnetic radiation emitted or reflected from the object or environment under study. Remote sensing can be used to study a wide range of phenomena, including weather patterns, land and land cover pre-occupations, sea currents, and natural disasters.

The remote sensing process involves the integration of sensors, platforms, data processing, GIS, and applications to collect and analyze information about the Earth's surface from a distance. Sensing techniques are employed for using satellite images covering the study area. They are analyzed using GIS. A guided classification has been used that allows the classification of satellite images and the mapping of different land cover and land use categories.

Analysis Tools

One of the most important tools used in remote sensing data analysis is Geographic Information Systems programs, especially the programs of the American company Esri, represented by the Arc GIS group, which was used in analyzing the data of this research. GIS is a powerful tool that can be used in industrial planning as well as in the study, organization and planning of oil fields and the balance of land employment. Remote sensing data is often

combined with other geographic information in the GIS. It integrates spatial data from different sources, making it possible to analyze and visualize data in a spatial context (Fleih et al, 2021).

Satellite imagery can be classified into different categories using different techniques in the GIS (Geographic Information System) software. The most common classification techniques used in GIS include:

1. Supervised classification
2. Unsupervised classification
3. Object-based classification
4. Hybrid classification

In general, the classification of satellite imagery in GIS software allows the identification and mapping of various categories of land cover and land use, which is useful for a variety of applications, including environmental monitoring, urban planning, and natural resource management.

Study area

The study area, the Zubair oil field is located within the Zubair district, southwest of the Basra Governorate, South of the Republic of Iraq, near the border with Kuwait, within the geographical coordinate longitudes "12 '29 º 47 and "51 '48 º 47 E and latitudes "56 '03 30º and " 00 '42 º30 N. It is one of the largest oil fields in the world, with reserves estimated at more than 4 billion barrels of oil. The oil field is currently operated by Italian oil and gas company Eni, in partnership with Iraq's state-owned Basra Oil Company and U.S.-based Occidental Petroleum.

The spatial organization of the Zubair field is characterized by a network of oil wells, pipelines and processing facilities. Oil wells are distributed throughout the oil field and are connected by pipelines that transport oil to the processing facilities.

The Zubair oil field covers an area of approximately 1100 square kilometers, and production began in the fifties of the last century. In 2010, Italy's Eni and its partners won a tender to develop the oil field, and since then they have been working to increase production and modernize the infrastructure.

The processing facilities are located in the northern part of the oil field near the city of Basra. The location was chosen for its proximity to the port of Basra which provides easy access to the global markets. The oil field also serves a network of roads and highways that connect it to the other parts of Iraq and the neighboring countries.

The area around the Zubair oil field is predominantly rural and agriculture is the primary occupation of the locals.

Temporal limits

The study was carried out during the period between 2013 (the beginning of activity for oil licensing round companies) and 2023, while oil operations are still continuing within the study site.

Data and information sources

Data was based on the analysis of space visualizations, which are images of the Earth's surface taken by satellites orbiting. These images are usually taken using specialized cameras mounted on satellites, which capture data at different wavelengths of light, including visible, infrared and ultraviolet radiation.

Satellite imagery can provide valuable information about the Earth's surface, such as land use, vegetation, water bodies, and changes in the environment over time. They are used in a wide range of applications, including urban planning, weather forecasting, natural resource management, and disaster response.

One of the main advantages of satellite imagery is their ability to quickly and efficiently cover large areas of the Earth's surface, without the need for surveys or ground measurements.

This makes them particularly useful for monitoring large-scale changes, such as deforestation, urbanization, or the effects of natural disasters.

Satellite imagery can be processed and analyzed using a range of technologies, including image classification, change detection and data integration. It can also be combined with other types of data, such as ground measurements or geospatial data, to provide a more comprehensive understanding of the Earth's surface and environment. Another source of data is field visits to the Zubair field.

Satellite image source

Many satellite image providers are available globally. Some of them offer their products for specific costs according to the accuracy of the image, the date it was taken, and the clarity of the landmarks. Usually, such images are used for specialized studies with high resolution, and some of them provide users with satellite images for free, as there are many websites that offer free high-resolution images via satellite. However, the availability and quality of the images may vary.

In this research, the source USGS Earth Explore, specifically Landsat 8 satellite images for the years from 2013 to 2023, as in Fig. 2 was used. The research chose the satellite images of the study area at the same time of the year, as the selected images were on the date of March of each year (approximately). Noting the crawl in time for appropriate coverage of the study area, the analysis periods will be from the third month of one year to the third month in the year after it.

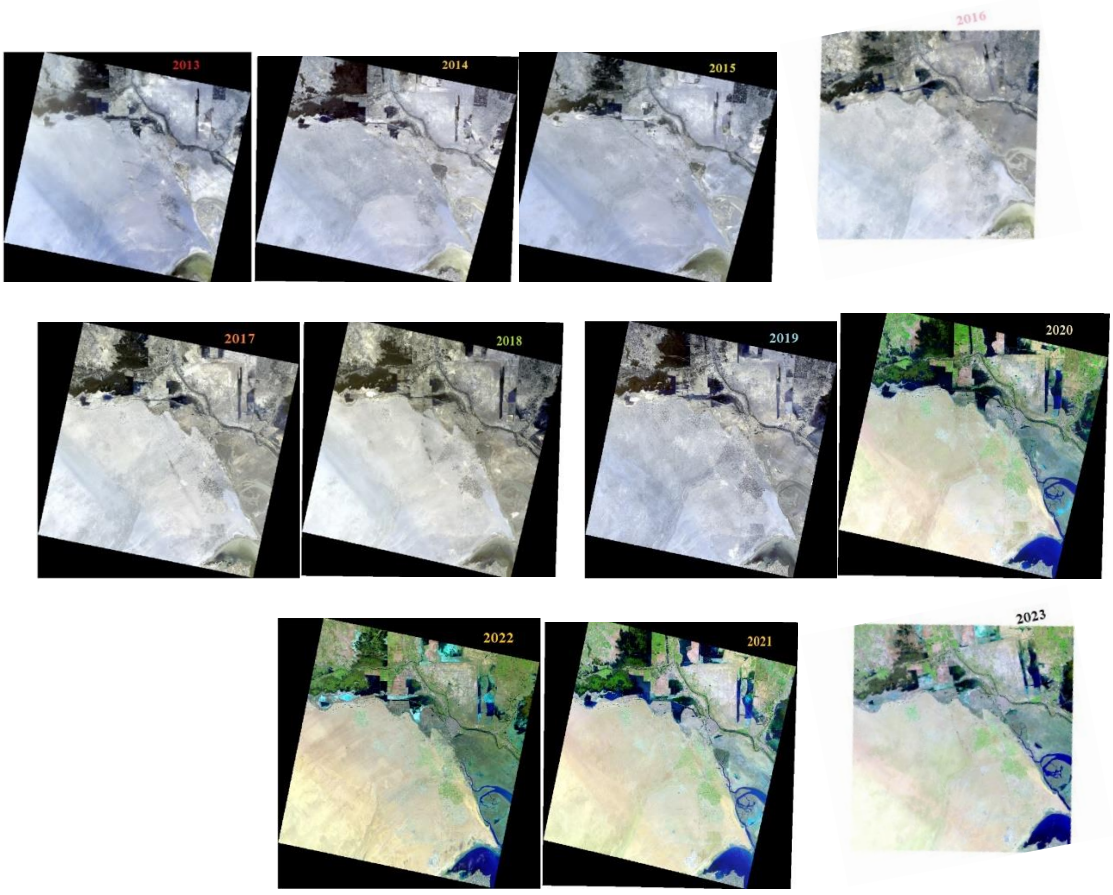

Fig. 2: Satellite image models for the study period
Source: Author

Supervised classification of the study area

This type of classification was chosen because of the accuracy it provides in sorting the categories of uses and according to the needs of the work in terms of the number of categories to be studied, as it depends on the decision of the user himself.

Since the studied topic is the relationship of industrial oil uses with other common uses within the study area, following categories were adopted for the classification: intensive agriculture, agricultural uses, urban uses, empty land, oil uses, barren lands, and water.

The training samples are selected according to the above categories, taking care of the need for accuracy in the selection and coverage to the extent possible in order to reach a better representation of the classified use. The findings are as follows, where the figures show a model for the work of the study period: three models were selected for the beginning of the period, the middle of the period and the end of the period.

Findings

Year 2013

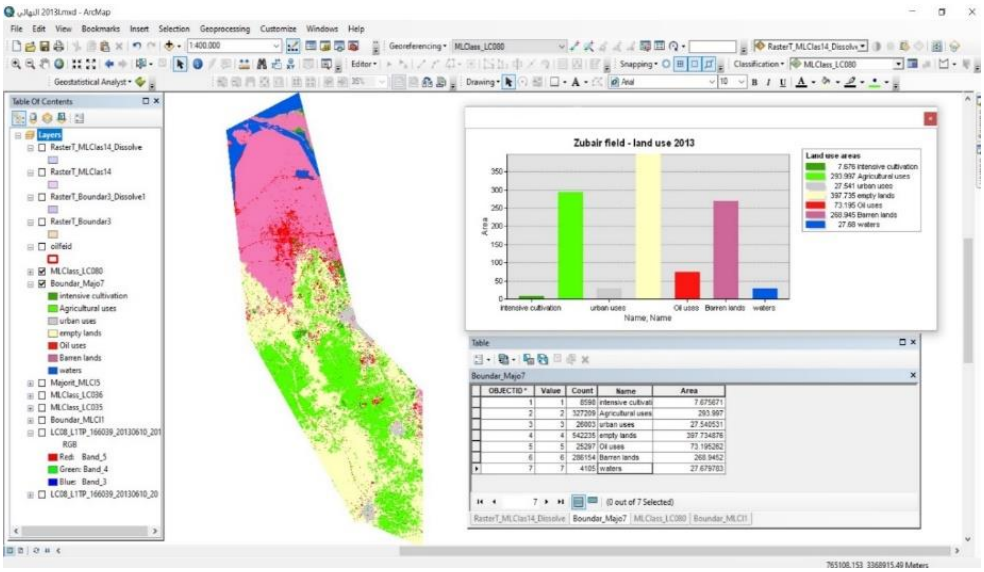

Fig. 3: Supervised classification of the study area for 2013
Source: Author

The classification shows the land uses of the study area for the year 2013 and the years preceding it, where the change in land uses was taking place regularly according to the actual need for each activity, especially the oil activity. It was dependent on the national effort because the contract with the Italian ENI company is still in the field study stage or at the beginnings of activity on the ground.

Year 2017

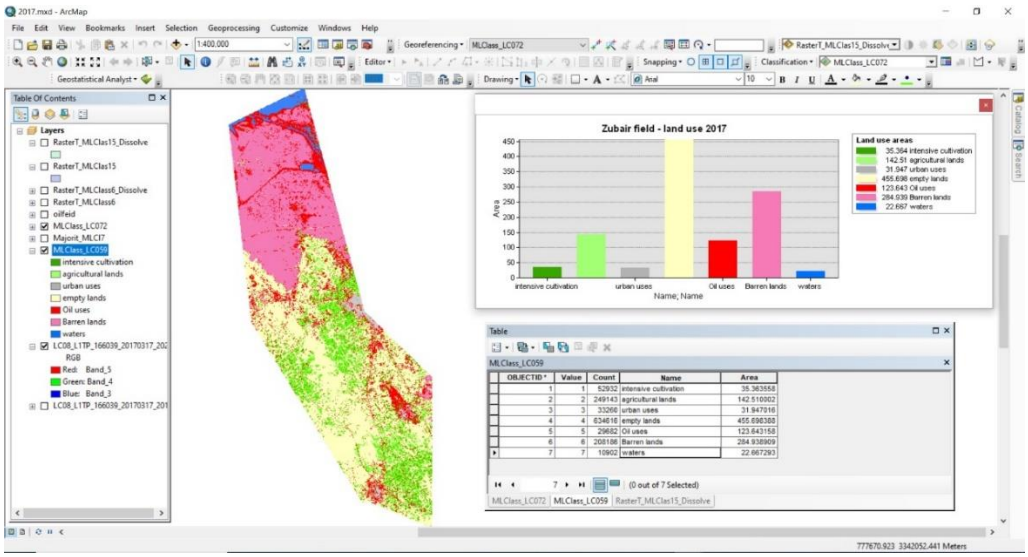

Fig. 4: Supervised classification of the study area for 2017
Source: Author

The results of the classification of land uses for the study area for the year 2017 show a decrease in agricultural land use, noting an increase in the use of intensive agriculture compared to the previous year. It also notes the increase in land uses in oil and urban use, where the increase in oil use amounted to 12.964 square kilometers. The increase in urban use reached 1.469 square kilometers from the previous year.

Year 2023

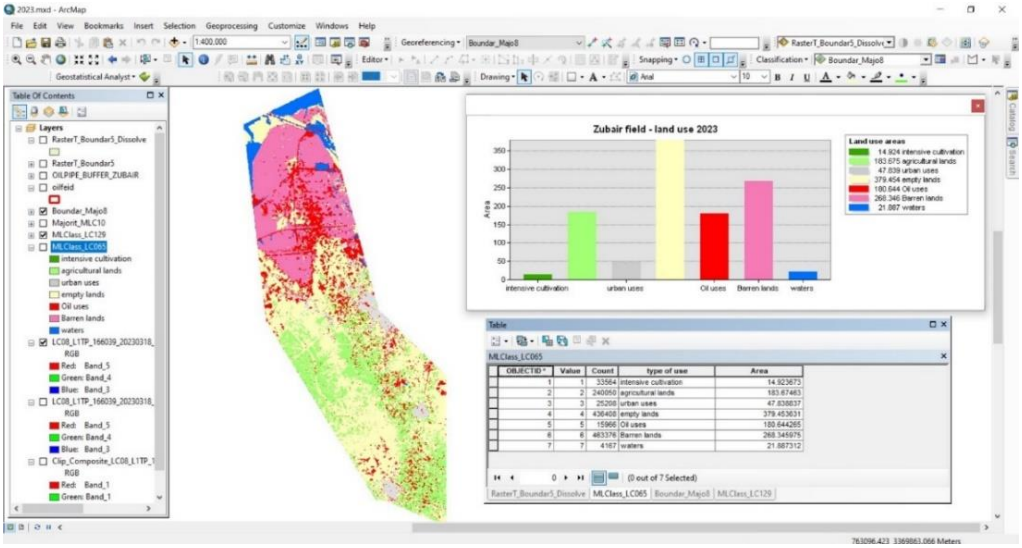

Fig. 5: Supervised classification of the study area for 2023
Source: Author

The results of the classification directed to the study area for the year 2023 did not differ from the previous years, as the decrease in agricultural land uses, intensive agriculture, and the increase in urban and oil uses, as the increase in oil uses reached 2.125 square kilometers. The urban uses were 1.798 square kilometers.

Analysis summary
Table 01: Data resulting from classification
Source: Author

All the classification results for the study area can be summarized for the period studied in the Table 1. The results of the classification directed to satellite images of the study area and period (previous images 1,2,3 models of the classification process), which appear in the Table 1 shows the data that have been obtained for them, which allows us to know the behavior of increase or decrease in the uses of each class of the study area.

It is clear that oil use is constantly increasing, and this is normal because of the oil field. However, it is necessary to pay attention to the fact that this increase in oil use may be at the expense of another use such as agricultural use, as well as the escalating increase in urban use which can be distinguished as the use of facilities for oil use within the field area for what is required by the need to build administrative, residential or health buildings.

To show the behavior of uses during the study period, it is possible to convert the data of Table 1 into a line chart that shows the increase or decrease in each use during the period studied, as in the scheme No. (1) below. It shows a regular increase in oil use, urban use, fluctuation in land occupancy for agricultural uses, empty lands and arid lands, and this confirms that any increase in oil uses or urban uses is necessarily going to occupy land of the other uses.

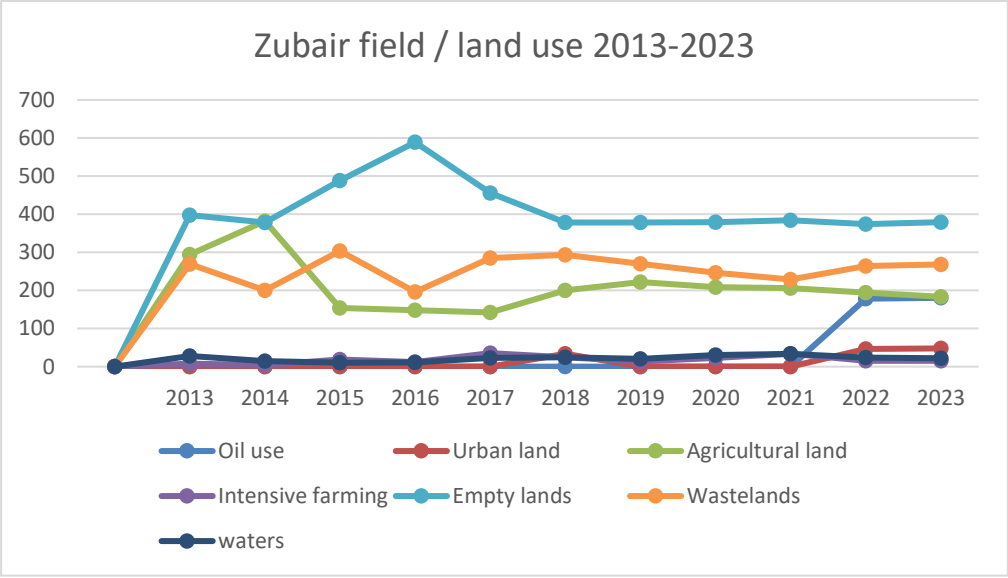

Diagram 1: Land use of different categories over the study period
Source: Author

Conclusions

This study therefore concludes the following**.**

1. Through the results of the classification, it is clear that the land uses in the study area were not subject to any plan in the distribution of uses, the theory of spatial signature or industrial planning. This means the absence of planning for a long time.
2. There is a continuous increase in land occupancy within the study area by active users within the area.
3. The increase in the area occupied for use in a particular activity is at the expense of another use within the area, which means a lack of coordination in land uses.
4. The steady expansion of oil uses may have environmental impacts that need to be studied as well as the spatial effects of the other uses.

5. The increase or expansion of oil uses is followed by an increase in supporting uses such as population and service uses.
6. It is necessary to not to separate the uses within certain limits throughout the period under study and to enter the uses on each other and according to the immediate need.
7. There is effectiveness of the use of remote analysis and sensing programs, especially the GIS program, in accessing important data on land uses.
8. It is very important to develop a plan that regulates the use of land within the study area to prevent the growth of one use at the expense of another use.

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