Soil degradation assessment using FAO/UNEP, (1978) and (1979) for some agricultural areas west of Anbar Governorate

Ali Mohammed Raja, Burhan Al-deen Ghazi Enad, Hussein, Adnan Neama, Mnagd M.H. and Abdulkarem A.M. Alalwany

Abstract: *Three regions were selected, and one of the key variables influencing agricultural development is thought to be soil deterioration. region Zangora 7.10 km2 (16.08%), region Al-Qataniya 16.25km2 (36.80%), and Douar region 20.81km2 (47.12%), covering an area of approximately (44.16 km2) in Anbar Governorate are the regions that serve as a model for the remaining regions ,the majority of which are affected by various factors of deterioration. In order to prevent soil deterioration, recognize it, and take effective action to stop it, agricultural soil is being monitored in order to maintain its health. Through the use of spatial methodologies and field surveys, the vulnerability of the soils in a few agricultural regions in the Anbar Governorate to deterioration has been evaluated. Both chemical (salinization - sodicity) and physical (ground water rise - compaction) methods are used to evaluate soil degradation. With the use of satellite data and field survey methods, five primary categories of land degradation were discovered. Using geographic information systems techniques, the International Food and Agriculture Organization (FAO)/United Nations Environment Program (1978–1979) approach was used to evaluate land degradation. The results showed that the main types of degradation in the study area are caused by humans and pertain to salinity and alkalinity (sodicity). The state of waterlogging and compaction. Fieldwork conducted in the years 2022–2023 yielded soil data for the*

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research region. Through a free-flowing survey, eight primary soil sites representing the principal land forms that predominated in the research area were identified. Samples were gathered. The data show that salt and water logging are the most active soil deterioration mechanisms, alkalinity, and urban sprawl. The human factor had a clear impact on the land degradation processes. The actual danger is in terms of inappropriate soil management, intensive irrigation procedures, the use of heavy machinery and the absence of maintenance measures. It was noted that there isProductivity has a negative association with both salinity and alkalinity. As a result, it was necessary to take the precautions prevent the deterioration of those qualities by improving soil management, such as adding washing requirements or increasing the efficiency of drainage networks, in order to achieve the highest productivity and ensure long-term use of the soil. The current and future state of land degradation in the study area is characterized by a lack of adequate land use planning and management.

Keywords: salinity: agricultural provinces; land degradation; spatial dispersion and spatial information systems

Introduction

Land degradation is defined as a decline in the optimal function of soil in ecosystems.Understanding the changes and magnitude of degradation of cultivated soil may provide a model for sustainable management of the resource. There is increasing concern about the vulnerability of soil to degradation.[11]evaluated the Zakho region in northern Iraq's susceptibility to land degradation using a mix of GIS and a multi-criteria decision analysis approach. Three primary categories of factors pertaining to vulnerability to land degradation were found after a review of the literature was done. These categories included: Physical, chemical, sociological, and economic factors are examples of successful criteria. Land use/cover, slope, soil erosion rate, soil salinity, soil sodium, soil organic carbon, soil acidity, and population density were the selection criteria. The data was obtained from several sources, and it was Create attribute maps in ArcGIS 10.3. To display the spatial pattern of land degradation risk in the study area, the maps were standardized, altered into comparable units, and then combined using the weighted overlay approach[1]. According to the findings, just 7% of the research area was considered susceptible, although 50% and 43% were categorized as low and medium levels, respectively. Natural elements like soil erosion and slope are the primary causes of land degradation hazards. Organizations and national agencies for sustainable land use planning and land management may find value in the research's findings. Humanity's food security and the capacity of developing nations to boost their wealth through increased productivity will be in jeopardy unless the current rate of land degradation is halted and reversed. There is land degradation in every region on every continent, regardless of the agroclimate. Human activity is the primary cause of degradation, notwithstanding climate factors like droughts and floods. Although localized land degradation is an issue in many places, it has cumulative effects both locally and globally. The most impacted nations are those in emerging nations, particularly those in arid and semi-arid regions [15].

The severity of the process is reflected in the status of soil degradation. The extent and proportion of the deteriorated region within the designated physiographic unit, as well as the degree of soil degradation, define the severity of the processes [16].

One of the main issues with agricultural soils around the world is soil degradation in agricultural regions [13].Because soil quality has a major impact on ecosystems, it is crucial for both human health and the environment. Therefore, soil degradation is a disruption of the ecosystem's sustainability, economic growth, and natural ecological balance. In order to improve and safeguard the ecosystem, steps must be taken to preserve soil quality and repair degraded areas[9].

The rate at which urban expansion patterns occur, or urban sprawl, is the most important element contributing to the destruction of Earth's ecosystems. Human activities that accompany urban growth, such as building, road construction, and industrial expansions, are the primary sources of this effect. The quality of the soil, air, and water that comprise the ecosystem as a whole is affected by these activities [14]. The growth of an urban area at the expense of any land cover, particularly the replacement of vegetation and agricultural regions, is referred to as "urbanization" in land use.The majority of people on Earth reside in cities, and by 2050, that number is predicted to rise to 70%. (Ochoa and others

Changes in land use and cover can be effectively tracked because Geographic Information Systems (GIS) software and sensor pictures are useful instruments for locating and combining spatial data with other available data. The most detrimental effects on the environment and human health, according to[18] and [19], are the buildup of heavy metals in agricultural soil, which is directly tied to the rate of urbanization, urban sprawl, and [5] stated that urban sprawl is one of the main problems that limit fertile lands in the Nile Delta in Egypt and may lead to problems in food security, and that remote sensing and geographic information systems are effective tools for mapping and analyzing urban sprawl and using 3 Landsat satellite images. which provides the necessary data to measure the change in the urban area of the area that was studied. The aim of this study was to estimate the changes In the agricultural area of urban sprawl in Gharbia Governorate, Egypt, using multi-spectral Landsat remote sensing images for the period between 1986 and 2019, using programs (10.2 GIS Arc land 5ENVI) to process and analyze remote sensing data. Satellite visualizations have monitored changes in land use. Land cover in the area under study. Two categories were identified in the area that was studied in the years 1986 and 2019, for the agricultural area and urban sprawl, and the decrease in the area of agricultural land by 6,000 hectares and the increase in the urban area by 5,880 hectares. The change in human lifestyles and the increase in population growth in the area The study has accelerated the environmental deterioration of urban sprawl, which is one of the dominant processes of land degradation and agricultural activity in the study area, which represents the largest economic sectors in the study area. The study recommended the need for more attention from the government because these sectors are the most affected and damaged by urban sprawl.

[3] mentioned in their study of the impact of urban expansion on the components of agricultural development in Libya, with the aim of determining the extent of the impact of urban expansion on one of the components of agricultural development in the municipality of Zliten. Due to the difficulty of determining this impact, modern methods and technologies were used, represented by remote sensing and geographic information systems, and It has been shown through its use that the volume of urban expansion of arable land has developed from 665.01 hectares2 in the year 1984 to 22,669.69 hectares2 during the year 2018. Thus, the study area witnessed a huge, unbalanced and sustainable expansion that contributed to obstructing the process of agricultural development and future investment in the agricultural sector. The study recommended the need to develop future policies and plans to reduce this phenomenon that affects arable lands.

explained that fertile lands in the Nile Delta are limited in light of the constant threat of expansion in urban areas. The resulting impact of the increase in urban areas on agricultural lands in the northern Nile Delta was determined using satellite images of the LandSat TM type in the years 1984 and 2002 and of the LandSat +ETM type for the year 2016. (2.26% of the total area). Lands with medium productive capacity lost 32.7 square kilometers (0.3%) of the total area, while lands with low productive capacity lost 57.4 square kilometers (0.53% of the total area. Urban expansion on non-production lands was It was very limited during the period from 1984 to 2002, as it was estimated at only about 7.3 square kilometers. The shape and pattern of urban expansion changed during the period from 2002 to 2016, as a larger area of non-productive land, 50.6 square kilometers, was converted into urban areas. This can be summarized in: Urban sprawl is one of the main factors in soil loss and degradation in the Nile Delta. The current study aims to follow changes in land use in general, the deterioration and decline of agricultural soils, and urban encroachment on agricultural lands in some agricultural districts of Anbar Governorate.

Materials and working methods

Description of the study site

The most important characteristic of the general geographical location of the Study area (Al-Dawar) west of Anbar Governorate on the Euphrates River, which borders it to the north, and to the south it is bordered by a desert plateau, which sometimes approaches to narrow the capacity of the river’s floodplain. This approach is in some places in the form of long tongues, and sometimes the plateau moves away slightly to display This plain is also penetrated by a group of dry valleys that descend from the south towards the river and the alluvial plain. The study was conducted in three agricultural regions affiliated with the General Directorate of Agriculture in Anbar, western Iraq (Al-Dawar district). The ground perspective represents vast areas of agricultural land within the floodplain of the Euphrates River. On the right side of the river,The area is classified as flat, rising from 51-54 meters above sea level. The main land use of the area is characterized by crop cultivation, palm trees and fallow land that has been abandoned for decades. Natural factors influence the agricultural ecosystem of the area in terms of the distribution of geographical suitability for the growth of agricultural crops. Its impact also applies to economic and development activities, Figure 1, Location of the study area. With regard to surface appearances, the study area is characterized by a lack of diversity in surface appearances. It is part of the alluvial plain, and its surface appearances have few differences between one region and another, and this is due to the nature of the geological structure. Flood river deposits also contributed to leveling and moderating the earth’s surface. As for the second section, it is the plateau. The desert is characterized by being flat and only slightly rising above the surface level of the flood plain [12].

The plateau is spread over some small hills that are characterized by their low height. There is also in the study area a group of dry valleys that descend from the plateau towards the alluvial plain. The most important of these valleys are Wadi Madlus and Al-Sha’ir. The surface of the study area descends from west to east towards the course of the Euphrates River, Figure 2. Geomorphology and geology of the study area.

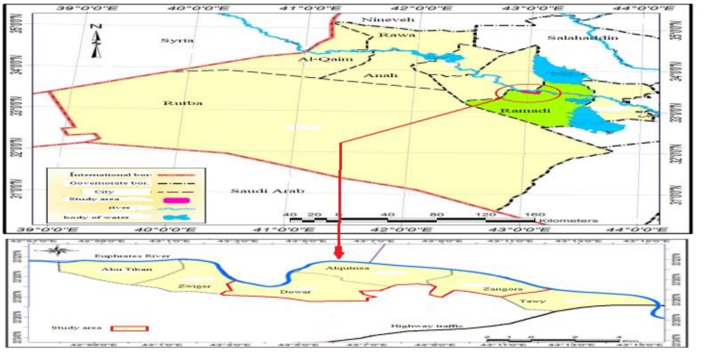


Figure 1. Location of the study area relative to Anbar Governorate (Source: Ministry of Water Resources, General Authority for Survey, Topographic Map of Anbar Governorate, scale 1:500000 - 2007)

Geomorphology of the study area:

The study area is located within the lower Euphrates Plain, which starts from the city of Hit in the northwest to the city of Fallujah in the southeast, with a slope of 0.01 m/km. The sediments of the region are the sediments of the floodplains that were deposited during the Halocene era, which included the fourth geological period (Quaternary), and in the Halocene era, which began at the end of the rainy period (8,000-10,000 years ago) and continued until the present time, the influence of the wind erosion factor increased and the deposition of layers of wind separations over the sediments. As a result of the ancient agricultural and irrigation applications and the flooding of rivers, layers of alluvial sediments were added on top of the ancient sediments. Patterns of river deposition often give many indications about the nature of the original material and the nature of the transporting agent. Therefore, coarse materials are deposited near the channels, while clay, silt, and materials dissolved in the water are carried to greater distances. It takes a longer time to be deposited from the ground perspective, which is why we notice that the coarse materials are deposited periodically, forming simple elevations as natural dams called river shoulders and along irrigation systems. Sedimentation processes are divided into natural sedimentation, which is characterized by textured soils with a clay content not exceeding 25%, and anthropic sedimentation, which results from irrigation operations in which the soil texture contains more than 25% clay.

Based on the nature of sedimentation, the sediments of the region include sediments from irrigation canals and sediments from ancient floods, which are of two types:

1- Vertical Accumulation, which occurs when the speed of the river current decreases sharply and suddenly, so the coarse materials settle out, forming low hills, while the fine particles move and settle away from the riverbed.

2- Fluvial deposits, which are areas that include secondary physiographic units, namely the river basin unit and the irrigation basin unit.

In general, the Euphrates Plain in the study area includes the geomorphological features of the natural levees, as they are located directly next to the river and are high areas in the alluvial plain, and these were more evident along the course of the river, as well as terraces, as they represent the oldest areas of the floodplain alluvial plain. In the study area are the terraces of Zangora.

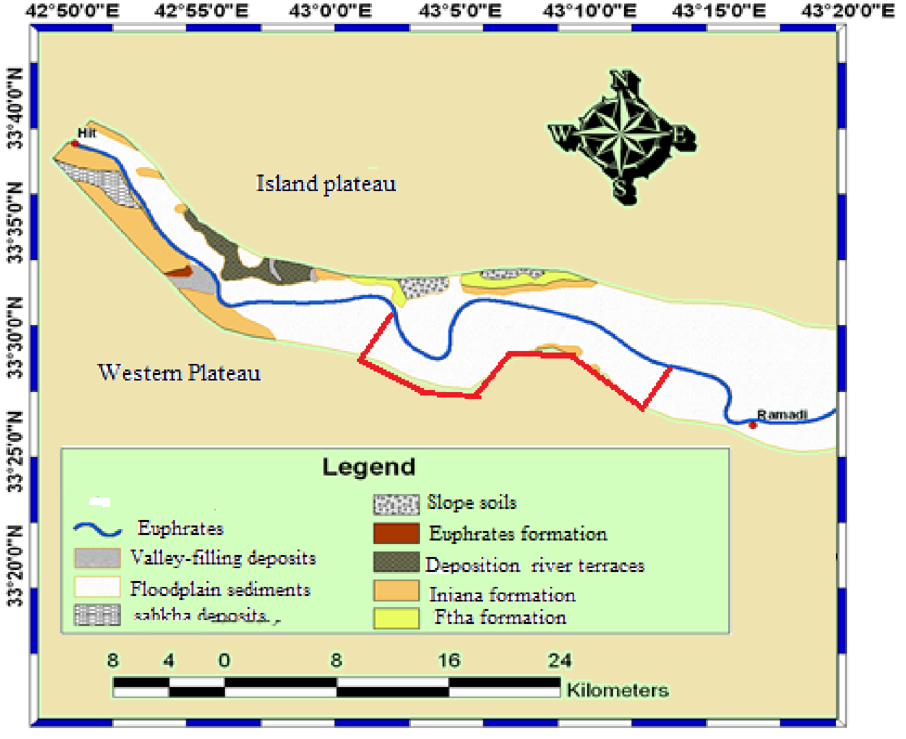


Figure 2. Geomorphology and geology of the study area (Source: Landsat satellite visualization using Arc GIS V.9.3)

Climate:

Climate is one of the most important natural factors that directly or indirectly affect the formation of the Earth's surface and its various aspects, whether those related to the topography and composition of the Earth's crust or those related to the formation of the soil and the life of plants and livestock. The climate of the study area is classified based on the Koppen-Geiger classification, 1936, which classifies the study area as a dry, hot desert (BWH) zone. Figure 3: Koppen-Geiger classification of the climate of the study area. Temperatures are one of the main controls that have a direct impact on the agricultural ecosystem, as the air acquires its heat through terrestrial radiation. Temperatures in the study area rise to their highest value in the month of July and decrease to their lowest value in the month of January. The temperature rates recorded at the station can be observed, Gray during the months of the year. The figure shows the monthly average temperatures.

The most important main characteristics of temperature in the study area are the high temperatures in the summer months (June, July, and August), as the monthly averages in the Ramadi station were 31.2 °C, 33 °C, and 32.9 °C, respectively, and the temperatures decrease in the winter months (December and January). (and February), the average reached 11.6°C, 9.9°C, and 11.5°C, respectively. It is also characterized by a large temperature range, The temperature range for the month of September reached 17.2°C, while in the month of February it reached (12.3°C). This indicates the presence of a large temperature range between night and day. The temperature range between summer and winter reached 14.2°C, Figure (2). High temperatures and long daylight hours during the summer affect the increase in evaporation rates, which is shown in the aforementioned table and figure, in which the evaporation rate for the months of July and August reached 416.3 and 372.8 mm, respectively, while it was lowest in the winter, at a rate of 55.6 and 53.2 mm for the month of December. In January, although these rates have positive effects represented by the length of the growing season and thus the diversification of agricultural crops, they have negative effects, especially in the summer, represented by the loss of a large portion of irrigation water through evaporation, and thus the high percentage of salinity in the soil as a result leads to its deterioration and decreased productivity. Figure 4, State climate diagram of the study area for maximum and minimum temperatures, average, and precipitation.

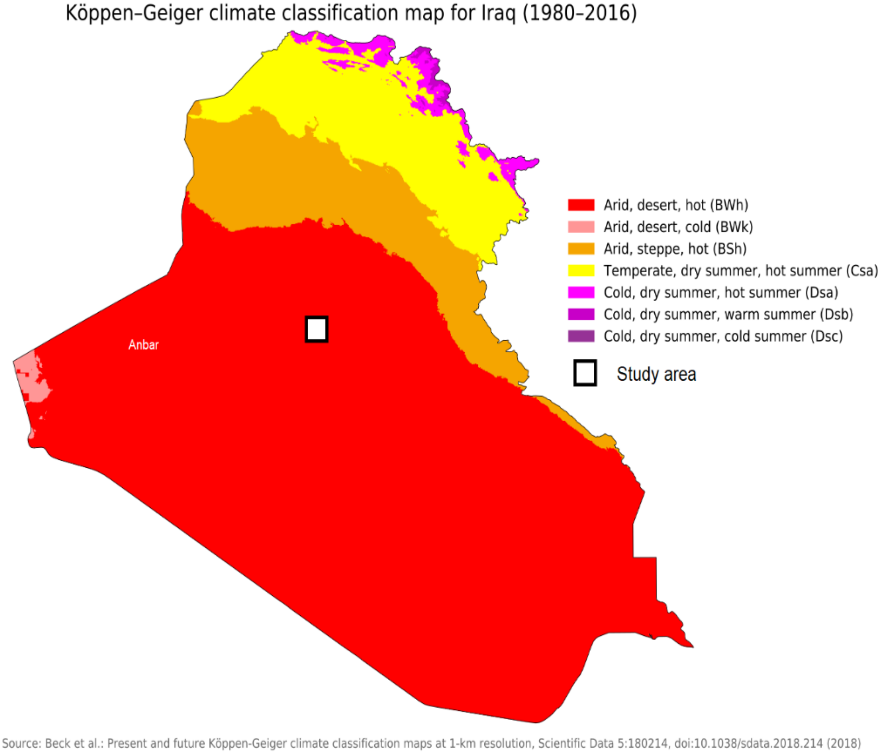


Figure 3. Koppen-Geiger classification of climate of the study area

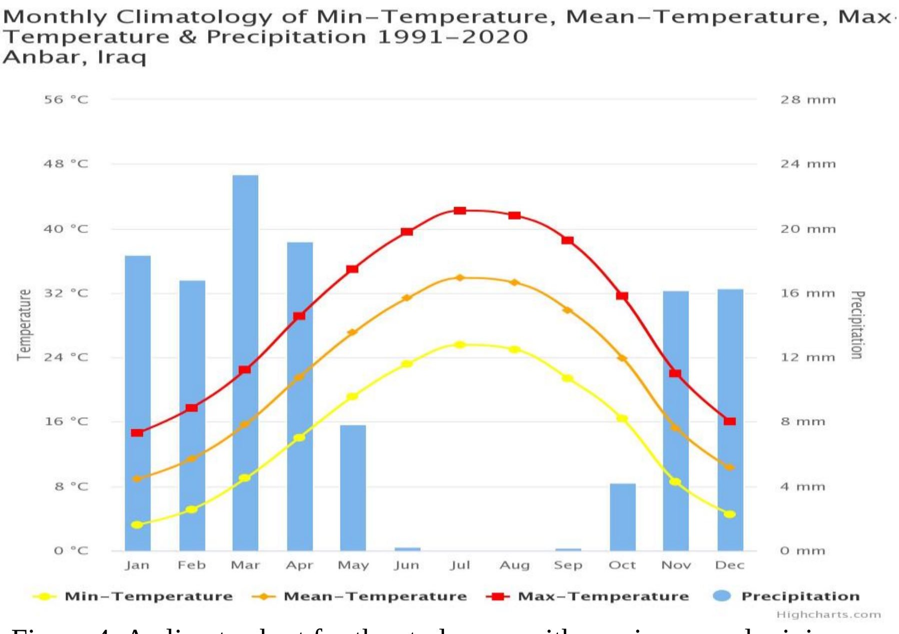


Figure 4. A climate chart for the study area with maximum and minimum temperatures, average, and rainfall

Wind speed rates reach their maximum in the summer and in July (3 m/s), and their lowest rates are in the winter months, as their speed does not exceed 1.6 m/s in December. Therefore, the study area, through its geographical location on the edge of the plateau, is a source of storms. As for the direction of the winds, they are not subject to a clear degree of stability and are constantly changing. It is clear that the northwesterly winds are dominant in the study area, with a blowing rate of (35.2%) of the total blowing winds. They are characterized by their relative dryness and coldness, because they blow from the Anatolian Plateau, followed by the westerly winds. With a blowing rate of (18.3%), it is characterized by its dryness and dustiness as it passes through the western plateau region, followed by the southeastern winds from the Arabian Gulf, which are loaded with moisture, the negative impact of which is reflected in summer on the population and agriculture. Its blowing rate reached 6.1%, while the southern winds had the lowest percentage, at 3.4% [2]. Because Iraq's climate is generally influenced by the Mediterranean climate, rainfall in the study area is concentrated in the winter and is irregular during one season, and its amounts vary from year to year. The study area is part of the area located between two rain lines (100-150) mm. Figure shows The annual average amount of rainfall amounted to 130.2 mm, and its rates vary between the months of the year, as the highest in January reached 22.2 mm and the lowest in September reached 0.8 mm. It does not fall in the summer months (June, July, August). It is clear that it is not possible to rely on Rainfall in the agricultural production process, so the water of the Euphrates River is completely relied upon to irrigate agricultural crops.

Land degradation assessment:

This procedure was carried out in accordance with the FAO/UNEP (1979) ("Human-induced land") degradation was assessed taking into account the type, degree, causative factors and rate using the criteria given in Tables 1 and 2. Rate of soil degradation over decades the past was described based on a comparison between the data extracted from the soil field survey report and the data obtained from relevant sources. The risks of deterioration were estimated according to the values and categories shown in Table 1.

Table 1 Criteria used to determine the degree of different types of deterioration

Specific/type of risk	Guide	unit	Classify the risk			
			Low	Moderate	High	Very high
Salinization	EC	$dS.m^{-1}$	4	4–8	8–16	>16
Alkalization	ESP	%	10	10–15	15–30	>30
Compaction	Bulk density	$g.cm^{-3}$	1.2	1.2–1.4	1.4–1.6	>1.6
Water logging	Water table	cm	150	150–100	100–50	<50

Data collection and analysis:

A Landsat 8 satellite image sourced from the US Geological Survey website (http://gov.usgs.earthexplorer://http://gov.usgs.earthexplorer) was used with a discriminatory power of 30 m, excluding the first bands for the coasts and the eighth, ninth, and eleventh bands for the thermal band from the 2022 Landsat 8 visualization by false color composition (G, NIR, R), the process of coordinate correction for space visuals was carried out by determining the astronomical coordinates and verifying them through the geomorphological map of Iraq at a scale of 1:1000000 Ramadi plate, and performing calibration to ensure that it is free from the influence of atmospheric conditions, then making a cut of the study area based on the cover units. On the ground in the study area, the data collection stage was represented by the tools used to obtain the data, represented by the direct field method through direct contact with the study community and field visits to discover the site and conduct interviews.

The stage of analyzing the collected data is represented by the use of modern geographical techniques - Geomatics techniques (and satellite images from the Land Sat satellite, and the Google Earth program, where the satellite images of the study area included a period of 2022 to determine the spatial situation, and then geographic information systems were used to complete the analysis and modeling processes. And also the final thematic maps.

Physical and chemical analysis:

Analysis of soil characteristics is an important step in evaluating soil degradation. 8 sites were selected distributed over the study area using a random sampling technique to collect soil samples using a free survey method. These soil samples were analyzed in the laboratory to understand the physical and chemical characteristics. In addition to these physical and chemical soil parameters, we used Disturbed samples to determine the following properties:-

- Soil texture size distribution: The particle size distribution of soil samples according to the pipette method was described by [16].
- Bulk density: Bulk density values were determined using an unstirred soil sample according to (Soil Survey Manual, 2014) (Core sampling method) using the equation:

$$Bd=Ms/Vt$$

Where: Bd = bulk density (Mg. m^{3-}), Ms = soil mass and Vt = total volume of soil (cm3).

- EC electrical conductivity: by (conductivity cell2510 Bstandard methods)
- pH: pH meter.

Sodium Na: Flame photometer method

- Ca: EDTA titrimetric method ppm.
- Mg: EDTA titrimetric method-
- Calcium carbonate $CaCO_3$: acid neutralization method.
- TDS: Multiply the EC value by 640.
- Soil alkalinity condition ESP: Exchangeable sodium percentage (ESP) is the relative amount of sodium ion present on the soil surface, expressed as a percentage of the total cation exchange capacity (ESP). ESP can be estimated with the following empirical formula:

$$\mathbf{ESP} = [100\ (-0.0126 + 0.01475 \times SAR)] / [1 + (-0.0126 + 0.01475 \times SAR)]$$

Field work:

Eight main sites were selected for a surface soil depth of 0-30 cm, representing all the soils of the study area, the prevailing geomorphological form of the soil, variables in soil characteristics, and the density of crops grown within the study area using a free survey method and drilling augers of up to fourteen to distinguish and identify the land map units, initially. Undisturbed soil samples were taken by pushing an iron cylinder 5 cm high and with an inner diameter of 5 cm into the soil using a hammer, This is taken to keep the sides of the cylinders vertical and avoid disturbance and drying of the soil columns inside the cylinders. As for other samples, disturbed soil samples are collected in polyethylene bags containing on numbered labels attached to the bags so that they are away from contact with the soil samples, the containers were used to transport the soil samples to the soil analysis laboratory. The soil samples were then prepared in the laboratory, where the samples were air-dried and the blocks were broken with a wooden pestle to crush the soil and sieved through a circular hole sieve. 2 mm for the size of the soil and get rid of large sizes of gravel, rock fragments, and plant parts so that the soil samples are ready for chemical and physical analyzes that are related to evidence of degradation of the studied soil. Figure 5, Locations of the studied soil samples. Figure 6 represents field work in the study areas. Figure 7 Field survey of the areas the study.

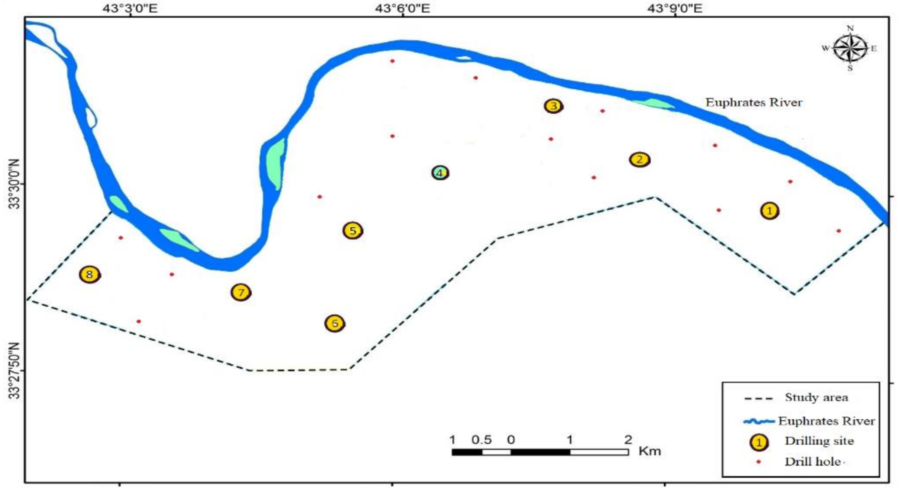


Figure 5. Locations of the studied soil samples

Degree of soil degradation

The criteria used to determine and describe the degree and type of salinization; sodicity, soil compaction and waterlogging state are in Table 6, according to[6,7].

Figure 6. It represents fieldwork in the study areas in the year 2023

Figure 7. Field survey of the study areas in 2023

Results and discussion

Soil condition of the study area:

Soil is a natural body that develops over time due to physical, chemical, and life processes. It is crucial for plants, animals, and humans for food, industries, housing, transportation, and economic activities. Soil consists of solid materials, solutions, air, and living organisms. It forms through disintegration of foundation rocks, physical processes, chemical reactions, and the impact of living organisms. The optimal balance between soil components is 50% solids, 45% minerals, 5% organic materials, 25% water, and 25% air.The study area's soils are primarily floodplain soils, formed by river sediments from the Euphrates River and dry desert valleys like Wadi Al-Sha'ir. The soil is soft and fragile, with a high percentage of limestone formations and increased salinity,Iraq known as the land of blackness, has varying soil characteristics due to its abundance and fertility. [4] classified the suitability of these lands for cultivation into good and medium quality, with soil texture being a significant factor. The desert provinces' edges are classified into arable suitability and good for grazing.. Table 2 shows some chemical and physical characteristics of the main sites in the study areas.

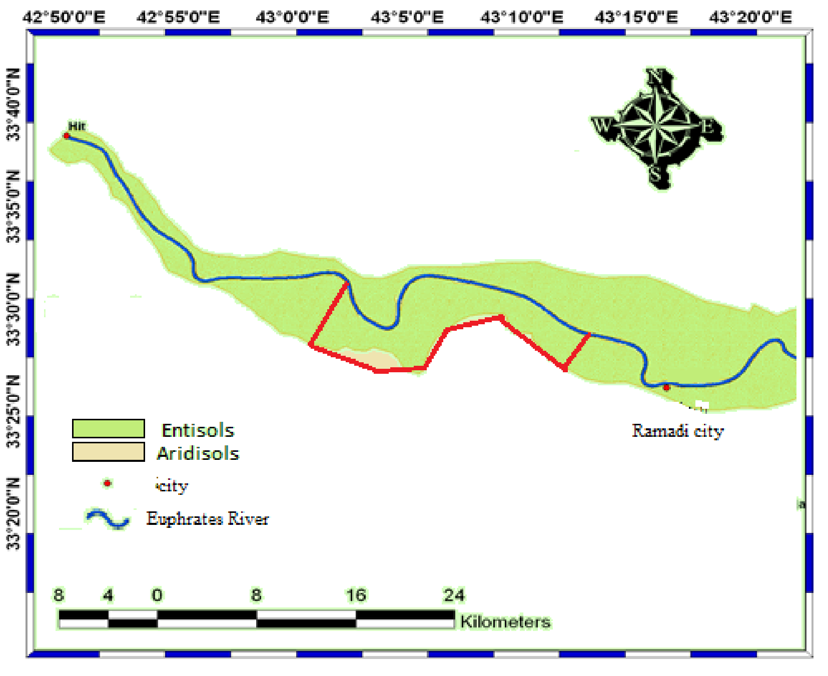


Figure 8. Floodplain deposits within the study areas

Table 2. Some chemical and physical characteristics of the main sites in the study areas

Sample no.	County name	EC* dSm^{-1}	PH	O.M $g.kg^{-1}$	BD* $g.cm^{-3}$	ESP %	الكلس %	Dw cm	Sand %	Clay %	Silt %	Text. class
1	Zangora	2.5	8	3.4	1.30	2.58	35	155	41.4	19.2	39.4	loam
2	Zangora	3.2	8.1	2.3	1.34	2.64	21.5	120	58.3	19.4	22.3	Sand loam
3	Zangora	3.6	7.6	2.4	1.29	7.3	23	140	68.7	24.3	7	Sandy clay loam
4	Katnea	55.0	8.5	0.7	1.31	32.3	25	75	61	19.2	19.8	Sand loam
5	Katnea	8.0	8.4	0.3	1.31	4.91	22.5	120	73.6	16.8	9.6	Sand loam
6	Dawar	6.9	8.3	4.4	1.35	4.91	27.5	140	63.6	16.7	19.7	Sand loam
7	Dawar	4.0	7.6	3.8	1.29	0.9	25	155	63.2	22.1	14.7	Sandy clay loam
8	Dawar	2.1	7.6	3.3	1.40	25.7	31	110	40.4	21.2	38.4	loam

* BD: bulk density; ESP: exchangeable sodium ratio: EC; Soil salinity Dw; :ground water depth; O.M: organic matter.

Soil degradation risk assessment:

In order to evaluate soil deterioration, this study compares data from fieldwork and laboratory work using the FAO/UNEP methodology [6,7]. The provinces' flood plain was used to evaluate the outcomes. examined and assembled data tables in the geographic information system's digital map units for the attributes of salinity, alkalinity, bulk density, and ground water depths. The combined attributes were then utilized to create objective layers for the spatial distribution of the previously mentioned attributes. Value distributions in Tables (3–6) (Figures 9–12) Additionally, the percentages of the primary deteriorating risk variables in the study area include salt, sodicity, compaction, and water depth. The percentage of the entire area that is impacted by the high hazards of salinity, sodicity, compaction, and waterlogging is 14.49%, 6.19%, 7.56%, and 10.17%, respectively.

Different land formations comprising 44.59%, 23.35%, 83.72%, and 89.45% of the total area, respectively, showed moderate hazards of soil salinity, sodicity, compaction, and waterlogging. Because of improper land use, soil management practices, and human activity, there was a serious risk of compaction. Both large machinery and human intervention can disrupt natural drainage systems. There are two possible causes of salinization and alkalization brought on by humans. The first is inadequate irrigation and drainage project management and upkeep.

Irrigated fields quickly become salinized due to the salt content of the irrigation water and poor drainage practices, which causes this pattern of salt accumulation. primarily in arid and semi-arid environments. The second kind happens in regions with a high concentration of salt when human activity causes more soil moisture to evaporate. The findings indicate that if the soil's EC falls to (EC < 4 dS m-1), it is considered salinity-free. As for the moderately hazardous soils (EC of 8–16 dS m-1), the less hazardous soils (ESP of less than 10) and the moderately hazardous soils (-15–30),

Materials additions could be used to address these changes. Both gypsum and organic compounds. The value of (Bd less than 1.2 mg m^{-3}) is the upper limit of safe compaction zones; greater values may have detrimental effects on plants. There are moderate hazards of Bd (1.6-1.4 mg m-3) in the soil. The primary cause of increased compaction hazards is the frequent usage of large machines. Waterlogging is a danger in soils where the water table is deeper than 150 meters.

As for soils located within the range of the groundwater level of 30-50 cm (the risks of saturation are high), attention to drainage contributes to mitigating the risks. Waterlogging, Table 7, final classification of land units in the study areas, and Figure 13. Final evaluation of the distributions of degrees of deterioration in the studied agricultural provinces.

Table 3. Salinity types and soil areas of the study area

Class	Area.km^{-2}	ratio%
5,04-2,50	24,05	54.46
9,96-5,05	13,71	31.05
20,9-9,97	5,98	13.54
43,0-21,0	0,42	0.95
total	44,16	100

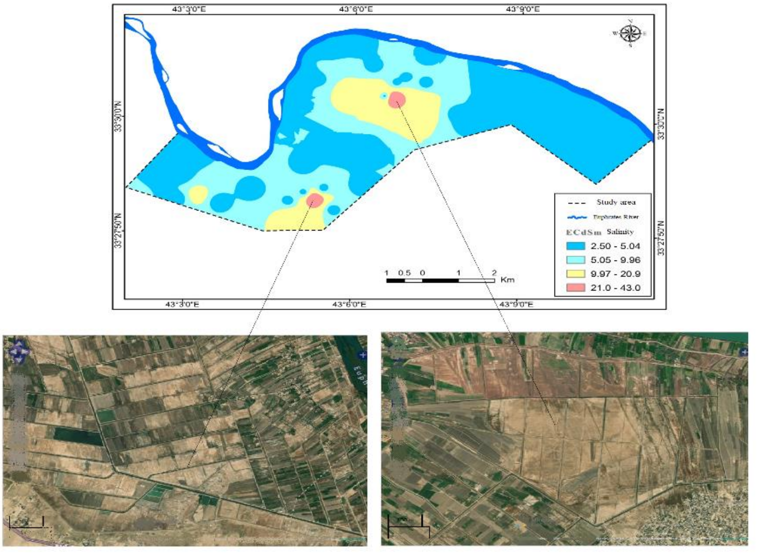


Figure 9. Spatial distribution of soil salinity types in the study area (Source: using Arc GIS 10.8.4 and Google Earth-2022)

Table 4. Areas of sodic ranges (ESP) for the soils of the study area

Class	Area/km^2	ratio%
5,21-0,09	20,57	46.58
10,90-5,22	13,287	
18,40-11,00		30.07
32,30-18,5	7,26	16.44
	3,05	6.91
Total	44,16	100

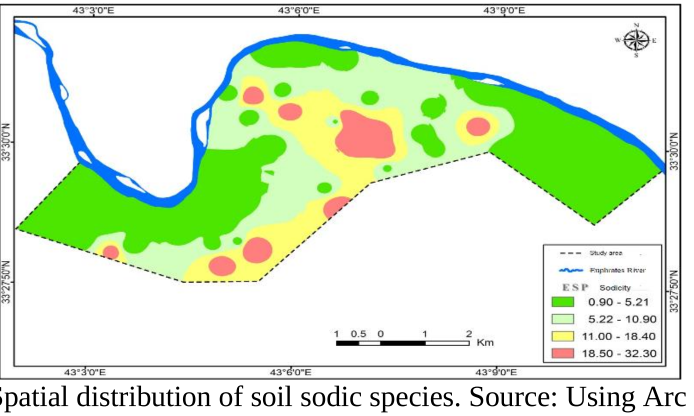
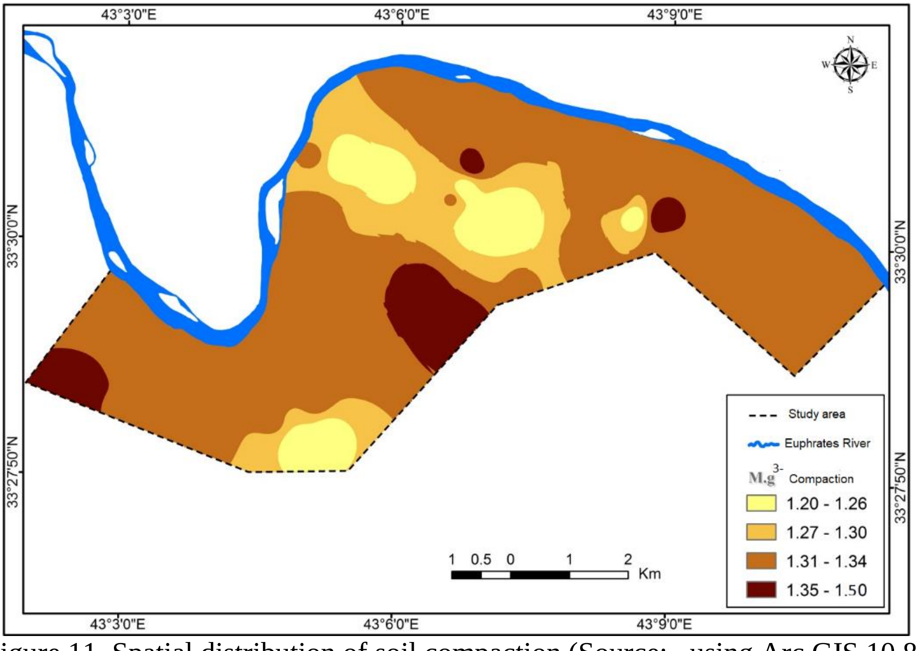


Figure 10. Spatial distribution of soil sodic species. Source: Using Arc GIS 10.8.4 .V.

Table 5. Areas of the bulk density ranges (BD) of soil compaction of the study area

Class	Area/km^2	ratio%
1,26-1,20	3,85	8.72
1,30-1,27	6,98	15.81
1,34-1,131	29,99	67.91
1,50-1,35	3,34	7.56
total	44,16	100



.Figure 11. Spatial distribution of soil compaction (Source: , using Arc GIS 10.8.4)

Table 6. Areas of soil logging (WT) (ground water) in the study areas

Class	Area/km^2	ratio%
118-75	4,49	10.17
136-119	11,82	26.77
160-137	27,68	62.68
200-161	0,17	0.38
total	44,16	100

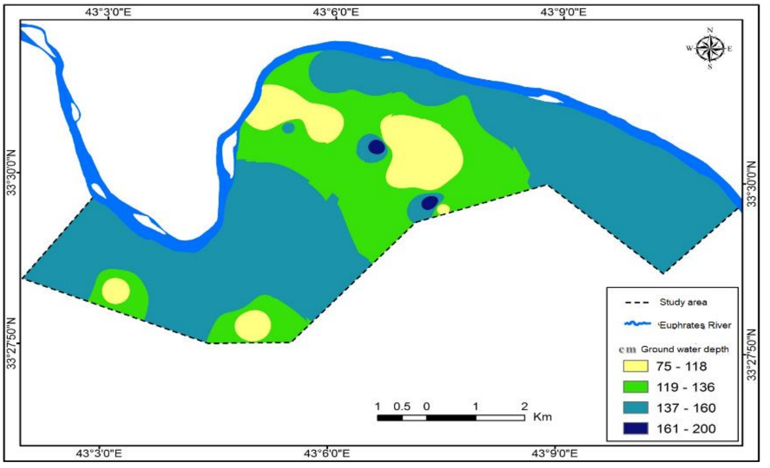


Figure 12. Spatial distribution of water level depth in the studied area (Source: .using Arc GIS 10.8.4 V.

Table 7. Final classification of land units in the study areas

Degree of soil degradation	Percentage %	Space km2	Land cover
very low	32.39	14,3	Intensive farming, medium density farming
few	39.49	17.44	Light-density agriculture, newly plowed lands
Moderate	14.26	6.3	Sandy desert lands, ancient plowed lands
high	11.21	4,95	Abandoned lands
very high	2.65	1,17	Salty lands

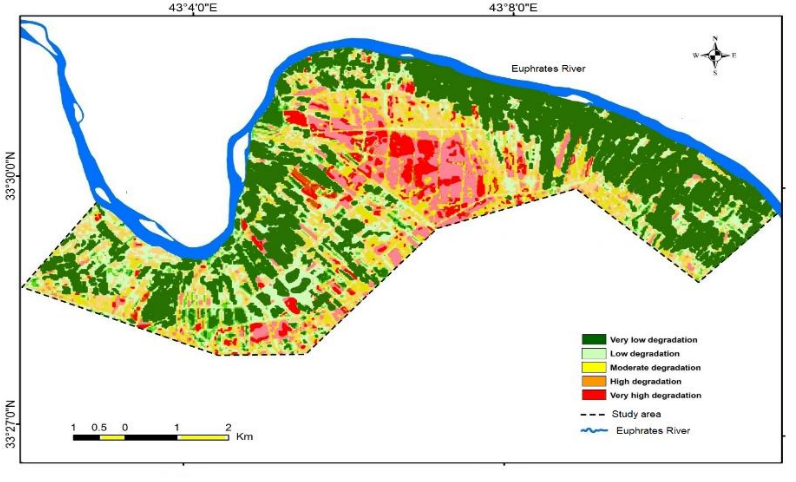


Figure 13. Final evaluation of the distributions of degrees of deterioration in the studied agricultural provinces

Urban sprawl on lands studied provinces:

During recent years, the study area has suffered from an increase in population numbers, which has led to urban encroachment on agricultural lands and their transformation into a residential area. The main reason behind the emergence of this problem is due to the increase in population numbers within the region, which has led to the noticeable disappearance of agricultural lands and the formation of population hotspots with the potential to expand. Expansion and erosion of the best agricultural areas, through a noticeable contraction of agricultural lands in several directions within the studied provinces, such that agricultural lands were previously surrounding all directions of the region, and also a decline in the area of agricultural lands. In this study, a set of satellite images were used that were obtained, From the Landsat satellite, in order to identify and follow the increase in areas and areas of urban sprawl, as well as to identify agricultural lands, and this is clearly shown as in Figure 14, where the area of the urban area reached 3.64, a percentage of 0.08 of the total area of the study area, which amounts to 44.16 km^2, as well as in digital processing operations, For satellite images, where direct classification operations were carried out in order to compare and identify urban expansion and agricultural areas, this shrinkage in the areas of agricultural land leads to a noticeable decline in the production of some agricultural crops in the provinces, their deterioration, the impact on irrigation and drainage networks, and also a decline in the numbers of palm and citrus trees, as well as the emergence The problem of desertification is of a slight type in the region, which was confirmed through personal interviews. Accordingly, from this standpoint, it was necessary to call for appropriate planning solutions to avoid the exacerbation of this problem and to take action by the competent bodies to prevent harm to agricultural lands and prevent the conversion of agricultural lands to residential lands, And work to reclaim it and prepare it for advanced agricultural work by establishing projects for livestock and poultry that reflect the value of this region and its importance in achieving food security for the residents of the governorate and provide economic returns compatible with[17] and[8].

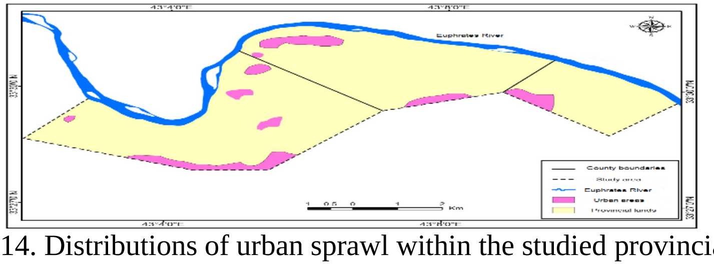


Figure 14. Distributions of urban sprawl within the studied provincial areas (Source: Satellite visualization of the Land Sat_9 satellite, using Arc GIS 10.8.4 V.)

Conclusions:

The moderate to severe hazards of salinity and alkalinity, the moderate risk of compaction, and the low risk of waterlogging pose threats to the soil in the studied area. According to the GIS spatial model, there are high and moderate degradation risks affecting 25.4% of the region, while extremely low and low degradation risks influence about 31.7% of the area. These hazards are mostly related to overwatering ,neglecting maintenance, operating heavy equipment incorrectly, and insufficient drainage. observing the spread of residences, businesses, and roads on primary and secondary streets while also noting that the area is experiencing a constant rate of man-made urban sprawl, which has contributed to the rise in soil degradation over the previous few decades.

Recommendations:

Based on the results of the current study, the study recommends the following:
It is recommended to issue laws regulating urbanization to ensure that the area of agricultural land is preserved from loss.

- Taking all measures to ensure the preservation and improvement of agricultural land fertility in order to maintain the natural balance of the ecosystem at a high level.
- Creating a digital database using geographic information systems, based on entering topographic maps of the provinces under study at a drawing scale of 1:10,000 into the computer using a scanner, then converting them to digital maps using the AutoCad program, then exporting these maps to the programs MapInfo, ArcGis, ArcView and linking them With descriptive spatial data, such as: data on total areas, built-up and unbuilt areas inside and outside the urban bloc, and road lengths, which were previously stored in the Excel program, and then it was possible to control and manage them, draw conclusions, draw maps, and obtain from the database any property or spatial variable of the characteristics of agricultural land using methods. Available in geographic information systems programs, and creating a number of aggregate tables, as well as analyzing the satellite visualizations that were available for the study area using the Imagine ERDAS program, as it facilitates the temporal tracking of changes in the characteristics of soil and urban areas by including directed and undirected classification of visualizations.
- Completing the maintenance of irrigation canals and lining irrigation canals to reduce water losses and seepage, as well as the main and field drains, and cleaning them of plants that obstruct the flow of water in them, such as reeds and sedges.
- Adopting the agricultural rotation system, in which the cultivation of crops is introduced that helps reduce salinity in the soil, such as barley, jet, and clover, in addition to providing the soil with the nutrients that the plant needs.

- Expanding the use of modern irrigation systems, such as drip and spraying, monitoring and maintaining irrigation and drainage systems, and maintaining their suitability for operation throughout the year.
- Educating farmers and peasants about the dangers of excessive use of water in excess of what the plant needs.
- Mitigation intensity of the solar radiation and the intensity of the wind speed by planting trees on farms.
- Washing the soil from time to time with sufficient drainage systems to reduce salinity levels.
- These results indicate the need for special policies regarding integrated land and water resources management strategies in the study area.
- When identifying areas with a high risk of deterioration, it is recommended to plan better to preserve the soil and maintain an organized sustainable agricultural system, and farmers must be aware of the type of soil that must be improved.
- The study recommended that the land should be allowed to foliate to form nutrients again, the use of natural fertilizers such as organic or animal materials should be encouraged, and grasses and leguminous plants should be grown to increase soil fertility in the area.

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