Optimal Use of Natural Resources in Al-Muthanna Desert (Soil as A model)

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Abstract

Soil is one of the important natural resources in Al-Muthanna desert, and the climate has played an important role in its formation. The soil in the study area is classified into several types that vary in their quality for agriculture. I concluded that the soil of the depressions and the plains alluvial soils are among the best types of those soils, followed by the sandy desert soil, which is characterized by its large area and can be exploited when providing water for it. As for the gypsum desert soils, they are of medium quality for cultivation, due to the presence of gypsum in them in high quantities and the lack of water retention. While the sandy and rocky dune soils are unsuitable for agriculture due to their high permeability. Wind and water erosion works to expose rocky soil rocks and transfer sand dune soil particles, but they constitute an important resource in the manufacture of building materials and glass if they are used properly.

Keywords: model, Desert, Human.

1.Introduction

The natural resources created by God Almighty to serve humans, so their good use reflects an ethical picture of human behavior towards those blessings that benefit the general population. The United Nations defines resource management (as the rational use of resources across the globe for the sake of a better life for humankind) [1]. Soil is an important natural resource that can be exploited in several investments, including the agricultural aspect, if it is used correctly. Al-Muthanna desert includes vast areas and has a variety of soils that can be used in the agricultural field, in order to supplement the economic aspect in terms of food and provide opportunities for labor on the other hand. It has elements that qualify it for this through the planned investment without causing much harm to wildlife and the depletion of groundwater.

2.Research problem

What are the types of soil available for investment in the desert of Muthanna Governorate? And how can it be invested?.

3.Hypothesis

The desert of Muthanna Governorate has many types of soil and there are several methods that can be invested with multiple uses.

4.Research goal

It aims to study the types of soil in Al-Muthanna desert and study its types to know the productive capacity of those types of soils for the purpose of agriculture and the possibility of improving them in possible ways.

5.The site

The astronomical location of the Al-Muthanna desert within the latitude (29 3 45 -31 03 30 north) and longitudes (44 52 30 -46 59 33). As for the administrative aspect, it is located within the borders of Al-Muthanna Governorate. It is bordered on the north by the Samawah district and from the north The eastern province of Dhi Qar is bordered by the province of Basra from the east and southeast, from the south, it is bordered by the international borders of the Kingdom of Saudi Arabia, and
from the west, it is bordered by the province of Najaf. The area of the desert of Al-Muthanna Governorate is (46254.5 k.m²)*, which constitutes (89.38%) of the area. The college of Al-Muthanna Governorate (51750 km²) Figure (1).

Figure 1. The location of desert Al-Muthanna in Iraq.

Source: From the researcher’s work based on the Figure of the Republic of Iraq, the Ministry of Water Resources and the General Authority for Surveying, Figure Production Department, Muthanna Administrative Map, at a scale of 1: 50000, Baghdad 2018.

6. The surface of Al-Muthanna desert

The surface of Al-Muthanna desert is an extension of the surface of the western plateau of Iraq, which is characterized by its varying surface due to the different geological formations and the multiplicity of types of rock structures and their impact on climatic factors (weathering and erosion), as its surface is dominated by gradients from the southwest side towards the southeast (Figure 2). Therefore, it slopes towards the sedimentary plain and reaches its maximum height in the southwestern parts (435 m) above sea level and its lowest height (15 m) above sea level in the Al-Mamlha area [2]. depressions, hills, sand dunes and stony areas. The area crossed by many valleys is called the valleys area, such as Wadi Al-Kasir, Al-Ashaali, Wadi Al-Dabaa, Al-Batin and Wadi Al-Kharaz Spring. There are also some wide depressions, such as the Salman Depression and the Sulaitate Depression, which is located in the southeastern part of the study area, as it is linked to the flood plain of the alluvial plain. Smaller desert depressions, such as the depression of Hadaniah, Al-Sa’a, Al-Lahab, Shawiah, and Al-Shaflahiyyah as for the alluvial fans, they are the product of rain torrents that come from the valleys from the higher areas to be deposited in the form of a morphological fan-like in the lower lands before ending in the depressions. The stony lands occupy the center and northwest of the Desert as it is located between the ridges and sand dunes from the north, as it is characterized by the abundance of stone pieces in it, which consist of rocks, boulders, rough limestone and dolomite, which were affected by ancient climatic factors [3] and factors of weathering and modern erosion, while it is bordered to the southwest by the Hammad area, which was taken Its name is due to its morphological shape, as it is characterized by the flatness of its surface despite its height in the southwest. The Hammad region is located between the borders of the Kingdom of Saudi Arabia in the south, the Al-Hajjar region in the north, the Najaf desert from the west, and the Al-Dabdaba region in the east. As for the Al-Dabdaba area, it is located in the eastern parts of the study area, as it extends between the desert of Muthanna Governorate and Basra Governorate.
Figure 2. Surface topography in the desert of Al-Muthanna Governorate.

Source: Digital dem altitude coil with a precision of 90, 2000 meters

7. The Climate

Climate elements (solar radiation, temperature, humidity, wind, rain, and evaporation) are major and influential factors in soil formation and its transfer operations since ancient times, directly with the daily changes in temperature, as well as rainfall and wind movement that have an impact on the transfer, sedimentation and disintegration of soil. The climate affects the weathering processes, as chemical weathering activates during the availability of moisture and rain works to transfer mineral and organic materials from the surface layer of the soil to the lower layers [4]. Therefore, the aim of the research is to know the elements of the climate in detail in the Muthanna desert, depending on the station closest to the desert, which is the Samawa station for the year 1990-2020.

7.1 Solar Radiation

The hours of solar brightness affect the rise in temperatures, which leads to an increase in evaporation and dryness of the soil, as it becomes dry and disintegrated and weak in front of wind erosion during the wind blows, as the hours of brightness gradually increase from the month of May, when it was recorded (13:04) hours. As for June and July, it recorded (13:05, 13:04, 13:01) hours in a row, then the hours of brightness begin to decrease until they reach the lowest hours of brightness (10:03, 10:02 and 10:03) hours in (October 2, December and January) respectively.

7.2 Temperatures

Temperatures are affected by the astronomical location, which in turn determines the amount of solar radiation reaching any region, and since the study area is located within the western desert plateau of southern Iraq, as it is located within the dry desert region, it acquires the characteristics of this region, which is characterized by high temperatures in summer and gradually decreases in winter, when observing Table (1), we find that the rise in average temperatures is at its highest levels in (June, July, and August, respectively), as it reached at Samawa station (35, 36.5, 36.5 °C), while the maximum temperatures reached for the same months (43.1, 44.8, 45.1 °C) and the lowest average decrease in temperatures during winter (December, January, February) was recorded (13.6, 11.5, 14.3 °C) respectively, while the lowest temperatures were recorded for the same months (7.6, 6.1, 8.1 °C) and this variation in temperatures during the day and the different seasons...
has a role in the disintegration of rocks and soil formation. Likewise, the rise in temperature leads to an increase in evaporation - transpiration from the soil. Therefore, the soil in Al-Muthanna desert is characterized by its loss of moisture during the hot months, which coincide with the complete interruption of rainfall.

7.3 The rain

Rain has a major role in the formation of the general appearance of the surface of the region and the formation of its soil through the processes of weathering, transport and sedimentation that occur during periods of rain, and since the region is located within a dry climate, it is of little rain. When noticing Table (1), the precipitation begins during the month of October and ends in June, as the highest amounts of precipitation (17.1 mm) are recorded in January and the lowest in October (2.9 mm), so the months (June, July, August) are a dry period of interruption Rain in it is final. As for the rainy period, it is volatile, and the highest amount was recorded in winter and spring in January, February, March and April, reaching (17.1, 11.9, 11.6 and 12.6 mm, respectively). Most of the rain in the region flows in the valleys that cut it and works to drench and transfer the soil from the upper regions to the lower regions, and it may sometimes reach the Euphrates River without benefiting from the groundwater as storage, or it remains in the valleys to be used for irrigation of crops.

7.4 Relative humidity

Relative humidity is affected by the fluctuation of precipitation and temperature variation during the different seasons in the study area, as the humidity begins to increase in the month of October and reaches its maximum rates in the winter months (December, January, February), as in Table (1), it was recorded (60%, 63.8%, 55.2%) respectively, and then the humidity begins to decrease when the spring comes, as the rainfall decreases and the temperatures begin to rise gradually until the beginning of the summer, when the relative humidity records a noticeable decrease in the months (June, July, August) (22.2, 22.1 and 23.4%) respectively, as the rainfall is completely cut off during the summer months, so the soil becomes dry and vulnerable to transport and sedimentation processes by other climate elements.

7.5 Evaporation

Evaporation is an important factor for soil, as it affects its moisture content, which controls the movement of its components during winds, and although water vapor constitutes about 2% of the mass of the atmosphere and 4% of its volume, it is one of the most important elements in weather and climate [5]. Evaporation is affected by the physical properties of the soil, such as the color and texture of its grains. Dark soils evaporate more than light soils, and evaporation is activated in soft soils more than coarse soils. The plant also works to protect the soil from evaporation [6], and when we observe Table (1), we note that evaporation increases in the summer months. Its quantities were recorded (464.1, 506.3, 469.9 ml) in June, July and August, respectively, while the lowest amount of evaporation was recorded in the desert (87.2, 86.6 ml) in (December and January), respectively.

7.6 The wind

Wind is one of the elements of the climate that has a direct impact on the soil, as it leads to its rapid drying after the rain in the study area. As for the summer season, which is characterized by dryness, the permanent interruption of rain and the lack of vegetation cover at a time when the wind speed is increasing as it reaches its highest levels in the months (June, July) reached (4 m/s), which leads to an increase in erosion, transport and sedimentation of soil components, and this is evident through sand accumulations. As for its directions, the prevailing winds are northwest and southeast winds on most days of the year. Dust storms that move soil particles to remote areas may reach hundreds of kilometers. These phenomena increase at the beginning of March and continue until May, as this period witnesses unstable climatic fluctuations.

Those months were recorded (1.07, 1.4 and 1.6) days, While suspended dust particles recorded their highest levels in the months (March, April, May, and June) (8.7, 9.5, 11.6 and 9.3) days, respectively. These suspended atoms do not remain suspended in the air, but will surely fall over the course of the days and add to the soil a new texture carried from other areas. As for the precipitation, the aforementioned months recorded (6.4, 6.1, 6.2 and 6.2) days, and the month of July also recorded (6.2) days. In sum, the wind is an important mechanical factor for the soil particles. It is possible to benefit from the transported soils, especially the (Lewis) soil, which adds to the study area a new texture of the soil.
Table 1. Climatic elements in Al-Muthanna desert for the period (1990-2020).

| Months | Theoretical solar brightness hours | Max temperature | Minimum temperature | General average temperature | Rain | Relative humidity | Evaporation | Wind | Dusty phenomena | Stuck dust | Falling dust |
|--------|-----------------------------------|-----------------|--------------------|----------------------------|------|-------------------|-------------|------|-----------------|-------------|--------------|
| 1      | 10:03                             | 16.9            | 6.1                | 11.5                       | 17.1 | 63.8              | 9.1         | 2.7  | 0.1             | 3.3         | 2            |
| 2      | 11:04                             | 20.5            | 8.1                | 14.3                       | 11.9 | 55.2              | 9.5         | 3.1  | 0.7             | 5.7         | 3.5          |
| 3      | 11:04                             | 25.9            | 12.3               | 19.1                       | 11.6 | 45.1              | 10.3        | 3.5  | 1.07            | 8.7         | 6.4          |
| 4      | 12:03                             | 32.0            | 17.9               | 25                         | 12.6 | 36.7              | 12.8        | 3.6  | 1.4             | 9.5         | 6.1          |
| 5      | 13:04                             | 38.9            | 23.8               | 31.3                       | 5.5  | 27.2              | 14.1        | 3.7  | 1.6             | 11.6        | 6.2          |
| 6      | 13:05                             | 43.1            | 26.8               | 35                         | 35   | 22.2              | 13.4        | 4.0  | 0.5             | 9.3         | 6.2          |
| 7      | 13:04                             | 44.8            | 28.3               | 36.5                       | 0    | 22.1              | 14.4        | 4.0  | 0.4             | 7.5         | 6.2          |
| 8      | 13:01                             | 45.1            | 27.9               | 36.5                       | 0    | 23.4              | 14.7        | 3.5  | 0.5             | 4.4         | 3.8          |
| 9      | 12:02                             | 41.4            | 24.0               | 32.7                       | 0    | 27                | 13.8        | 3.1  | 0.1             | 4.8         | 3.2          |
| 10     | 11:03                             | 35.0            | 19.4               | 27.2                       | 2.9  | 36.4              | 13.7        | 2.8  | 0.2             | 6.8         | 3.5          |
| 11     | 10:03                             | 25.8            | 12.6               | 19.2                       | 10.3 | 51.7              | 11.3        | 2.5  | 0.0             | 3.1         | 1.8          |
| 12     | 10:02                             | 19.5            | 7.7                | 13.6                       | 10.9 | 60                | 9.8         | 2.6  | 0.0             | 2.1         | 0.8          |
| Mean   | 11:08                             | 32.4            | 17.9               | 25.1                       | 39.2 | 3.3               | 0.5         | 6.4  | 4.1             |             |              |

Total 82.8 147.4

Source: Republic of Iraq, Ministry of Transport and Communications and the General Authority for Meteorology, Climate Department, Baghdad, unpublished data for the year 2020.

Table 2. Winds, dust phenomena and suspended and falling dust in the Muthanna desert for the period (1990-2020).

| Months | Wind | Dusty phenomena | Stuck dust | Falling dust |
|--------|------|-----------------|------------|--------------|
| 1      | 2.7  | 0.1             | 3.3        | 2.0          |
| 2      | 3.1  | 0.7             | 5.7        | 3.5          |
| 3      | 3.5  | 1.07            | 8.7        | 6.4          |
| 4      | 3.6  | 1.4             | 9.5        | 6.1          |
| 5      | 3.7  | 1.6             | 11.6       | 6.2          |
| 6      | 4.0  | 0.5             | 9.3        | 6.2          |
| 7      | 4.0  | 0.4             | 7.5        | 6.2          |
| 8      | 3.5  | 0              | 4.4        | 3.8          |
| 9      | 3.1  | 0.1             | 4.8        | 3.2          |
| 10     | 2.8  | 0.2             | 6.8        | 3.5          |
| 11     | 2.5  | 0.0             | 3.1        | 1.8          |
| 12     | 2.6  | 0.0             | 2.1        | 0.8          |
| Mean   | 3.3  | 0.5             | 6.4        | 4.1          |

Source: Republic of Iraq, Ministry of Transport and Communications and the General Authority for Meteorology, Climate Department, Baghdad, unpublished data for the year 2020.

8. Natural plant and its effect on soil

The natural plant is one of the important factors and has a direct impact on the soil in terms of maintaining its stability and fertility. As plants work to stabilize the soil and resist its erosion against wind and water erosion, as for its fertility, the natural plant has a major role in increasing the organic matter in the soil through the decomposition of plants after their death. Since the climatic factor, especially temperature and rain, are the most important natural factors in the natural plant growth and its distribution on the surface of the earth[7], the dry climate and the diversity of soils that characterize Al-Muthanna desert have
affected the vegetation cover that covers its surface. The desert was characterized by the diversity of its natural vegetation, and the plants were distributed between perennials and annuals, including shrubs and seasonal herbs.

Perennial shrubs such as Sidr, which are found in depressions and valleys such as Wadi Al-Kharaz and the Hadaniah depression, as they are characterized by their needle leaves to resist drought, as well as rams, wormwood, kisum, Alramram, bitter melon and others, as these species are distributed in most of the Desert depressions such as Sheikhiya and Salhoubih. It is used by sheep and camels when seasonal weeds die, and some of them are used in the manufacture of plant medicines. As for the annual and seasonal herbs that grow during the rains, they are many and varied. Their growth begins during the rains in the month of October and ends at the beginning of the summer when temperatures rise and rains interrupt. The desert blooms with many species, such as Al-Bakhtari, Al-Nawaar, Al-Daddaa’, Al-Aneej, Al-Rabla, Al-Hanita, Sansilah, Al-Kart, and other species, such as Al-Sam’a, which have two seasons for animal food at the beginning of spring, where their leaves are soft in the summer when they wither and the thorns fall from them.

Desert Al-Muthanna is characterized by the multiplicity of natural plants that grow in depressions, plain lands, bellies and valleys. As the Ghada plant maintains soil cohesion and prevents it from erosion, as well as it is of economic importance as it is used in the charcoal industry.

9. The optimal investment of the soil in the study area agriculturally

9.1 Types and specifications of the soil in the study area

Soil is defined as the surface layer of the earth's crust formed as a result of the disintegration of rocks and its fragmentation or as a result of the decomposition of organic matter [8], and everything on the surface of the earth and everything below this surface to a small depth participate in it, whether it is inanimate or whether it is a plant or an animal, and whether it is solid, liquid or gaseous [9]. Soil is one of the most important natural resources for agricultural production on which man depends in providing his food and clothing, including the plants and animals that grow in it. The study area is part of the southern plateau of Iraq, which means that its soil was formed from the type of soil. Stone, rocky and silt, as well as formed from sediments transported by the waters of the valleys that penetrate the study area and bring large quantities of soil with the running water in those valleys to the study area during the different geological ages. The soils of the study area are characterized by the presence of stratigraphy and the almost flatness of their surface with the presence of some the terrain is deep and reaches a depth of several meters. It is characterized by the high level of the underground water, especially during the wet seasons in some years. It is also characterized by being soils with high fertility in some parts. The optimal investment for the uses of agricultural land requires studying the soil and evaluating the lands for those uses, and then classifying them to know the productive capacity and knowing the determining factors for each type of these lands. Through the field study, (20) soil samples were collected from different regions and at a depth of (0-30 cm) in order to know their physical and chemical properties through laboratory analysis [10], and based on the results of soil samples analysis, we find a difference in soil properties depending on the variation in height and the spread of natural vegetation. Therefore, the soils were divided into six types based on Buday & Jasssim’s classification of soils, Table (3), Figure (3), and as shown below:

9.1.1 Soil Depressions

This type of soil is spread in depressions, which are formed due to natural factors and are found in separate parts of the study area, showing the soil of the depressions and the valleys’ stomachs with internal drainage, which consisted of sedimentary materials that were transferred by flowing water to those depressions in separate areas within the area of the lower valleys in the study area, which is characterized by being composed of clay, alluvial and sandy sediments as well as some formations limestone and gravel [11], occupies some central and northwestern parts of the study area. This type of soil is suitable for most agricultural crops and suitable for cultivation (11.6%) of the total area, spread in the lower parts of the valleys scattered in the study area.

Its texture is sandy to sandy mixture, and its properties vary according to the samples taken from it. The values of (pH) range between (7.5-8.1), as it is an alkaline soil, while the value of (T.D.S) ranges between (1.3-15.6 g/ kg), which means that it does not suffer from major saline problems, and thus it is a good soil for irrigated agriculture and if other agricultural ingredients are available, either (E.C) its value ranges (2-24ms/mic) It is of low conductivity, which indicates its low salinity. This type of soil is suitable for most agricultural crops and can be improved after mixing with sand, making it a good mixture soil for agriculture.
Figure 3. The soil types in Al-Muthanna desert.

Source: From the work of the two researchers based on
-Iraqi Ministry of Water Resources, General Authority for Surveying, Topographic Figure Production Department, Baghdad, 1:100,000 scale.
- Ministry of Agriculture, Department of Soils and Agricultural Chemistry, Iraq Exploratory Figure at a scale of 1:1000000, Baghdad, 1996.

9.1.2 Sand Desert Soil

This soil occupies an area estimated at (14362.49 km²), or (31%) of the total area of the study area. It comes after gypsum soil in area. It is located in most parts of the Al-Dibdbah area. It occupies the eastern and southeastern sides. With the gypsum desert soil, notes the Figure (3), the properties of this soil are characterized by being shallow, with a thickness ranging between (10 cm - 2 m) and the upper limit of its permeability velocity to (10 mm / hour) or the equivalent of (24 cm / day) [12]. Sandy to a silty mixture texture, and there is a discrepancy in its properties according to the samples taken from the soil, as well as the pH values range between the lowest value (8) and the highest value (8.2), so it is a soil that tends to be alkaline, while the electrical conductivity values are (0.66 - 4ms/cm), as for the organic and inorganic materials, it ranged between (0.3 - 2.8 g/kg), and the volume distribution of the main soil separations with regard to sand was (~90% 72%), while the silt amounted to (~5%-15%) and with regard to clay it amounted to (~5%-13%). One of the most important features of the sandy desert soil is the possibility of investing it (in the event that adequate water resources are available) for a large number of agricultural crops, especially cereals and vegetables, especially potatoes, it can be invested by improving the properties of the sandy soil by using charcoal resulting from the charring of organic waste, as the charcoal is mixed with petroleum bitumen at a rate ranging between 3-12%, and then the mixture is added to the soil in a special way that varies according to the nature of the soil, as its potential to exceed Retaining water and increasing the cohesion of its granules, and it can keep the added fertilizer for as long as possible.
9.1.3 Soil Gypsum

This soil is spread in the northern part of the study area within the lower valleys area with a wide spread and overlaps with the soil of the sand dunes and the floodplain soil in the western range of the study area and it has a large gypsum content and thus this content affects its productivity due to its direct impact on soil properties, including reducing the ability of soil to Water retention, in addition to preserving the soil content of colloidal particles, as this soil consists of various components of lime, clay and sand, so its particles are loose, which led to its exposure over time to erosion processes, and its composition is dominated by sand and stones and its rate of permeability (10 mm / hour) [13]. It is characterized by the presence of a layer of secondary gypsum in its upper part, which increases with depth, as the percentage of gypsum in it is about (70%) at a depth of two meters, while it forms a layer of up to (20%-30%) in other layers of the soil surface, and it is a hardened gypsum that prevents The penetration of the roots of plants and the exercise of their natural role in growth, and that they contain a large percentage of lime ranging (25-50%), and are highly porous and of little fertility compared to the soil of the alluvial plain [14].

This soil is characterized as loose and shallow in its depth and its original rocks are close to the surface and have a coarse to medium coarse texture, in addition to the presence of solid gypsum layers, which form the basic material of these soils with sandstone. As for the color, it is gray or light red, as the red color refers to The laterite process occurs due to the high temperature, while the gray color in some parts is a result of the different mineral compositions of the rocks [15].

This soil occupies an estimated area (17148.83 km2) and a percentage of (37.5%) of the total area and the most widespread soil in the study area, the Figure (2) notes, table (3). There is a discrepancy in the properties of gypsum soil according to the samples taken from it, as it is described as a sandy-sandy mixture, and the degree of interaction (pH) ranges between the lowest value (7.6-8.7). Its basicity is high, and the organic matter is very little due to the lack of natural plants, which leads to a decrease in biological activity in it, so its color tends to gray, while the (EC) values reached (4.27-47.7g/kg), and the percentage of (TDS) ranges between (0.26), milligrams/kg-24 milligrams/kg). As for the volume distribution of the main soil separations with respect to sand, it amounted to (6.7%-70.7%), while for silt it amounted to (17%-26.3%) and for clay it amounted to (9.6%-13%), which indicates that it is a porous soil, either the soil content Of the positive ions in relation to calcium amounted to (Ca +) (0.15-4.7g/kg), while the sodium ion (Na+) amounted to (0.28-18.1g/kg), while the magnesium ion (Mg+) amounted to (0.18-3.1g/kg), As for the potassium ion (K+) (0.6-4 g/kg), while the negative ions for sulfate amounted to (So4 ==) (0.94-3.5 g/kg) and the reason for this is due to the lack of sufficient amounts of rain to wash it from the surface of the soil and remove it. As for the chloride ion (-Cl) It reached (0.8-1.5 g/kg). For the purpose of investing these lands, it is necessary to get rid of the excess gypsum and this is done by adding improvers that add calcium to the land or dissolve the calcium element in the lands that contain calcium carbonate. To achieve this, the following must be followed [16]:

- Construction or improvement of the soil drainage network (covered or exposed).
- Analyzing soil samples to find out the amount of gypsum in the soil and thus the amount of agricultural gypsum to be added as a source of calcium.
- In the event that the earth contains a source of calcium, such as calcium carbonate, sulfuric acid or elemental sulfur is added, which is oxidized by bacteria and reacts with water to turn into sulfuric acid that interacts with calcium carbonate to separate the calcium required to replace sodium on the soil complex.
- After adding gypsum, the soil is plowed with a plow under the soil to mix the improver well with the soil.
- A good leveling of the soil, after which it is divided into basins and bellies are made for them to retain water on them.
- Adding the necessary irrigation water to the basins to the required depth and following up its replacement to give the opportunity to complete the interaction.
characterized as a total area and is found at the ends of the valleys. It appears in the far northwestern and northern sides within the study area. Its area is estimated (706,735 km²) (1.5%) having medium permeability. It is found in some depressions scattered in the region and spreads within the lower valleys. It is ch

It is found in areas adjacent to the Euphrates River and intertwined with marshes, swamps and sandy soils, characterized as a soil transported by torrential water and rain that flows through the network of the main valley basins. It is characterized by having medium permeability. It is found in some depressions scattered in the region and spreads within the lower valleys. It appears in the far northwestern and northern sides within the study area. Its area is estimated (706,735 km²) (1.5%) of the total area and is found at the ends of the valleys.

| Type soil          | Depth (cm) | Physical properties | E.C (mmh cm) | pH | T.D.S (g. cm) | Chemical properties |
|--------------------|------------|---------------------|--------------|----|--------------|---------------------|
| Flood plain        | 30         | 74 4 22             | 19.2 8.1     | 11.1 | 2.1 9.0 0.1 0.9 0.9 | Ca²⁺ Na⁺ Mg²⁺ K⁺ So₄²⁻ Cl⁻ |
| Mixed gypsum       | 30         | 61 6 33             | 13 7.2 6.7   | 1.3 | 3.1 11.9 0.2 0.1 0.7 | |
| Desert soil        | 30         | 84 5 11             | 2.65 8       | 1.3 | 1.3 7.0 0.5 0.6 0.5 | |
| Sand dune soil     | 30         | 80 7 13             | 9.94 7.9     | 2.7 | 1.2 5.0 0.6 0.5 0.5 | |
| Depression soil    | 30         | 70 17 13            | 4.27 8       | 2.7 | 0.3 0.2 0.9 0.8 0.9 | |
| Rocky soil         | 30         | 60 25.5 14.5        | 6.2 7.8 3.2  | 5.9 | 2.4 0.9 0.7 0.9 1.5 | |
|                    | 30         | 70 13 17            | 10.05 7.9 2.5 | 0.6 | 0.0 0.0 0.0 0.0 1.4 | |
|                    | 30         | 53 26 21            | 2 8.1 1.3    | 0.2 | 0.0 0.0 0.0 0.0 0.4 | |
|                    | 30         | 88 3 9              | 2.2 7.9 1.4  | 0.3 | 0.0 0.0 0.0 0.0 0.7 | |
|                    | 30         | 90 4 6              | 24 7.5 15.6  | 2.4 | 1.4 1.4 1.4 1.4 5.3 | |
|                    | 30         | 76 4 19             | 2.61 8 1.24  | 1.8 | 1.5 1.8 1.8 0.7 0.8 | |
|                    | 30         | 72 15 13            | 0.66 8 0.3   | 0.2 | 0.8 2.7 1.6 1.0 1.0 | |
| Sandy desert soil  | 30         | 79 11 10            | 1.21 8.1 0.7 | 2  | 0.8 0.5 1.2 1.2 2.6 | |
|                    | 30         | 72 15 11            | 2.39 8.2 1.8 | 0.7 | 2.0 0.8 0.9 0.8 1.2 | |
|                    | 30         | 90 5 5              | 4.1 8 2.8    | 2  | 4.2 1.8 1.8 1.8 2.4 | |
|                    | 30         | 63 12 25            | 3.8 8 2.5    | 3.2 | 2.1 0.2 1.2 4.2 0.7 | |

Source: 1- Results of laboratory analyzes conducted in U-Science laboratories, Al-Diwaniyah, Umm Al-Khail, Main Street 2021.
- Results of laboratory analyzes conducted in the laboratories of the College of Agriculture, University of Al-Muthanna 2020.
- Ministry of Water Resources, General Authority for Ground Water / Al-Muthanna, Geology Department, unpublished data, 2020.

9.1.4 Soil Flood Plains

It is found in areas adjacent to the Euphrates River and intertwined with marshes, swamps and sandy soils, characterized as a soil transported by torrential water and rain that flows through the network of the main valley basins. It is characterized by having medium permeability. It is found in some depressions scattered in the region and spreads within the lower valleys. It appears in the far northwestern and northern sides within the study area. Its area is estimated (706,735 km²) (1.5%) of the total area and is found at the ends of the valleys.
It is evident from the data in Table (3) that there is a discrepancy in the physical and chemical properties of the flooded soil, and its texture is sandy mixture, and the pH values range between (7.2-8.1) it is alkaline soil, while the value of (TDS) ranges between (1.3-11.1 g/kg), and this means that it does not suffer from major saline problems, and the (EC) ranges between (2.65-19.2 g/kg) and it is of poor conductivity. As for the volume distribution of soil separations with regard to sand, it amounted to (61%-84%), while the silt recorded (4%-7%), and with regard to clay it amounted to (11%-33%), either the soil content of (Ca +) ranged between (1.2-3.1 g/kg), while the (Na+) ion amounted to (5.7-11.9 g/kg), while the (Mg+) ion recorded its value between (0.5-0.23 g/kg), and the (K+) ion amounted to (0.1-0.96), g/kg, with regard to the negative ions, the value of (SO4=) was (5.4-1’2.5 g/kg), while the (-Cl) ion reached (0.01-0.93 g/kg). It is clear from this that the flooded soil is suitable for agriculture, as it is famous for the cultivation of wheat and vegetables.

9.1.5. Desert Soil Rock

These soils are found in the western and southwestern parts of the study area, and most of their formations consist of different rocks and stones such as flint, limestone and dolomite [17], these soils are spread in different areas of the region, as the rocks are exposed directly to the surface and sometimes they are covered with a thin layer Its thickness does not exceed (10) cm, and its surface is covered with stones with sharp edges and free of soil. The shallowness of the soil in these areas is due to water erosion during the rains in the winter season and wind erosion in the dry season as a result of the lack of vegetation cover, as the wind erosion works to transfer the rocky fragments. Small particles whose size is less than (2 mm) and leave rocks and stones visible, notes the Figure (3), so this is soil with a coarse scale, sandy gravel texture and high permeability, as its minimum permeability reaches 10 mm/ hour, and quickly filters.

The water through it goes to the depths, and therefore it is not suitable for agriculture because its soil is very shallow, so it cannot be exploited due to the difficulty of fixing it in its places. This type of soil can be used to build quarries for building materials, especially gravel sand, sand, space and building stone, its area is (1110,919 km2) and constitutes (2.4%) of the total area, and it is clear from the data of Table (3) some of its physical and chemical properties, as it is described as a sandy-mixed texture mixed with gravel and it reaches a PH degree) 8) The EC value was (3.8 ms/mc), while the TDS value was (2.5 g/kg) and it was from soils poor in organic matter and the soil separated from sand, silt and clay (25, 12, 63%) respectively, and the value was The (Ca+) ion (3.20 g/kg), the (Na+) ion (2.15 g/kg), the (Mg+) ion (0.29), the (K+) ion (1.2 g/kg), and the negative ions (0.79-4.21 g/kg) ions (sulfate, chloride) respectively.

9.1.6. Soil Sand Dunes

The sand dune soil is spread in the study area in separate locations and in different areas, as it is distributed in the lower valleys, Al-Hajar and Al-Dibbah areas in its affiliated areas. The sandy soil is light and loose, and the organic matter is little in it, in addition to the lack of clay material and its particles, which made it highly permeable, which made it unable to retain water and the speed of leaching in it, and the process of erosion and transportation abounded in it, making it poor in vegetation and unsuitable for agriculture. The sandy soil is located within an area The study is in the southwestern and central parts, and it appears in the northwest and in small scattered areas from the northeastern part of the study area. It is located in a longitudinal way extending in a direction called longitudinal dunes northwest to southeast with the direction of the prevailing winds in the region and most of the components of this type of sand and the percentage of sand in it rises Silica (Si03) because it is of the quartzite type, as the percentage of quartz in its dunes reaches (80%) [18], estimated survey area It is (7429.4 km2), 16% of the total area, as shown in Figure (2).

The physical and chemical properties of sandy soils vary, and its texture is sandy-sand mixture with a high percentage of sand, and the (pH) values range between (7.8-7.0) it is alkaline soil, while the value of (TDS) ranges between (2.5-6.5 g/kg), and this means that it does not suffer from major saline problems, either (EC) ranges between (3.92-10.05) and is of low conductivity, which indicates its low salinity and basicity. As for the volume distribution of the main soil separations with regard to sand, it reached (60-76.5%). As for the silt, it amounted to (17-26.2%) and for the clay it amounted to (7-17%), either the content of the soil of positive ions was (Ca+) (0.6-5.9 g/kg), while the (Na+) ion amounted to (0.04-2.3 g/kg), the (Mg+) ion amounted to (0.07-9.7 g/kg), the (K+) ion amounted to (0.04-2.3 g/kg), while the negative ion amounted to (SO4=) (1.4-1.4). 4.6 g/kg), while the (Cl-) ion amounted to (1.5-0.8).
Conclusions

- Desert Al-Muthanna occupies a large area whose resources can be invested in several areas.
- The climate of the study area is generally dry and its elements have an important role in soil formation and mixing of its particles.
- There are several types of soil in the Muthanna desert that can be used in agriculture.
- The research showed, through laboratory analyzes, that the soil of the depressions is one of the best soils in the Desert and can be invested in for agriculture.
- There are vast areas of desert sandy soil that comes after the soil of depressions in fertility that can be invested if water is available to grow wheat, potatoes and other vegetables.
- The rocky soil is not suitable for agriculture, because its surface is covered with stones due to wind and rain erosion, as well as its high permeability and can be invested in construction industries such as stones, sand, space and cement industry.
- The soil of sand dunes is not suitable for agriculture due to the high permeability that characterizes these soils and their exposure to erosion, transport and ease of movement and can be used in the glass industry due to the availability of quartz in it in a high percentage (80%) of its components.
- There are types of soils, such as gypsum desert soil, whose validity is low for cultivation, and they can be improved if appropriate methods were used.

Recommendations

- Going to the Badia for agricultural investment is planned, studied and in a balanced manner so that it does not affect the biological diversity in it and does not lead to waste in investing soil and water.
- Exploiting the areas of arable soil and improving it by modern methods and cultivating drought-resistant varieties.
- Intensifying studies and research on the Badia to invest the soil properly and using modern methods, and seek to use materials that reduce water depletion in irrigating crops.
- Using the distillation technique in planting trees and spraying while growing crops and vegetables.

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