International Journal of Agriculture Innovations and Research
Volume 2, Issue 6, ISSN (Online) 2319-1473
Manuscript Processing Details (dd/mm/yyyy) :
Received : 17/05/2014 | Accepted on : 03/06/2014 | Published : 07/06/2014

Classification and Distribution of Iraqi Soils

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Abstract - **The work of soil survey and classification in Iraq was started before 1950. At this point in time, the number and type of soil units in Iraq are incomplete due to the lack of semi-detailed or detailed surveys covering all of Iraq. Non-systematic work of soil survey has been the dominant type of work to date. Only 35% of Iraq is considered covered by a semi-detail survey work with 1:50 000 to 1:25 000 soil maps. There is no general soil map covering the whole country up to now,using soil Taxonomy or other system. The exploration work of Buringh in1960 using 1938 system, is the common work done on Iraqi soils.He recognized 18 great groups. So the need for detail soil survey to developing soil map at large scale is very necessary. In order to develop general soil map for Iraq following USDA soil Taxonomy, 300 pedons representing all expected Iraqi soils were collected from the previous works. The collected data were reclassified using the key of soil classification, 2012. Digitized soil map at 1:500000scale was developed. The results indicated the presence of five soil orders each one shows some variations with the common properties reflecting the effect of the dominant soil formation factors.The soil orders are arranged according to their dominance as following : Aridisols (62.2%), Entisols(16.2%), Inceptisols (12.6) , Mollisols (3.8%) and Vertisols (1.2%),respectively. Twelve suborders belong to the dominant orders were recognized, with twenty five great groups.**

Keywords - **Soil Classification, Soil Survey, Iraq.**

I. Introduction

Since ancient days Iraq was known as the valley of the two rivers Mesopotamia.Its bountiful land, fresh water and varying climate contributed to the creation of agriculture since thousands of years. Iraq has soils which are markedly different from one another due to differences in soil forming factors. In general, the degree of soil development decreases from northern to southern Iraq as represented by the differences in morphological, physical, chemical and mineralogical properties. Most soils in Iraq are of secondary origin, consisting of materials transported from the place of weathering and accumulated somewhere else [1])The work of soil survey and classification in Iraq was started before 1950. Most of the works were done by foreigner person or companies for specific purposes. [2]Weist,1954, attempted to classify Iraqi soil according to soil texture and their suitability for crop production. The most common work done at that time by[1] .He proposed 18 great groups in Iraq using the old US soil classification system. Upon completion of the exploratory soil map for Iraq, as follow: Desert, Red Desert, Sierozem, Reddish Brown, Brown, Chestnut, Reddish Chestnut, Chernozem, Solonchack, Solonetz, Soloth, Terra Rosa, Rendinza, Hydromorphic soils, Lithosols, Regosols, Alluvial soils and Man-made soils. After 1965,the state board for soil survey and land reclamation was established in order to take care the responsibility for the works of soil survey and classification in Iraq. About more than 35% from the Iraqi area was covered by Semi-Detail soil survey How ever,there is no semi detail or general soil map covering the whole country using US Taxonomy, up to now.

[3]Altaie (1968) conducted a study of the regional soil surveys, selecting and describing 60 representative soil profiles from all physiographic regions of Iraq. These 60 pedons were classified to three soil orders [3, 4] as defined by [5] U.S. Soil Taxonomy as follows: Aridisols, Entisols, and Vertisols. Since then, soils classifying as Mollisols and Inceptisols[6] have also been found in Iraq [7] ; [8]; [9 و10, 11,12 and 13]. The main objectives of this study are :1-To collect soil data from previous works ; 2-To reclassify soils using US Taxonomy ; and, 3- To improve the knowledge regarding distribution of Iraqi soils units.

II. Materials and Methods

A. Site Description

Iraq can be divided into four main physiographic regions, each region has its specific geological, hydrological and climatologically conditions, and consequently specific soil conditions (Figure 1).

B. Mountains Region

Mountains cover an area of 92,000 km2, or about 21 percent, of the total area. The mountain region extends mainly in the northern and north-eastern parts of the country. The mountains consist mainly of parallel anticline ridges separated by elongated synclinal valleys. But they are united by narrow gorges, the outlets of the drainage of the interior basins. The mountains, for the greater part, are eroded and the detritus material has been deposited in the valleys and in the area in front of the mountains. The climate of this region is characterized by cool-moist winters and mild dry summers (Walter and Leith, 1960). Diurnal and seasonal temperature fluctuations are less compared to the rest of Iraq. Annual rainfall is between 700 and 1200 mm or greater, while the annual temperature ranges from 10 to < 20º C (Figures 2). According to Guest (1966), the mountains region includes the forest vegetation zone which merges gradually into a steppe zone dominated by Savannah, represented mainly by Pistacia and other small trees. Most have been eradicated by

continuous cultivation and harvesting for wood and fuel. The forest zone is characterized by Quercus Aegilops and Pistacia Bhingulz, Quercus Infectoria and pine Juniper oak forest.

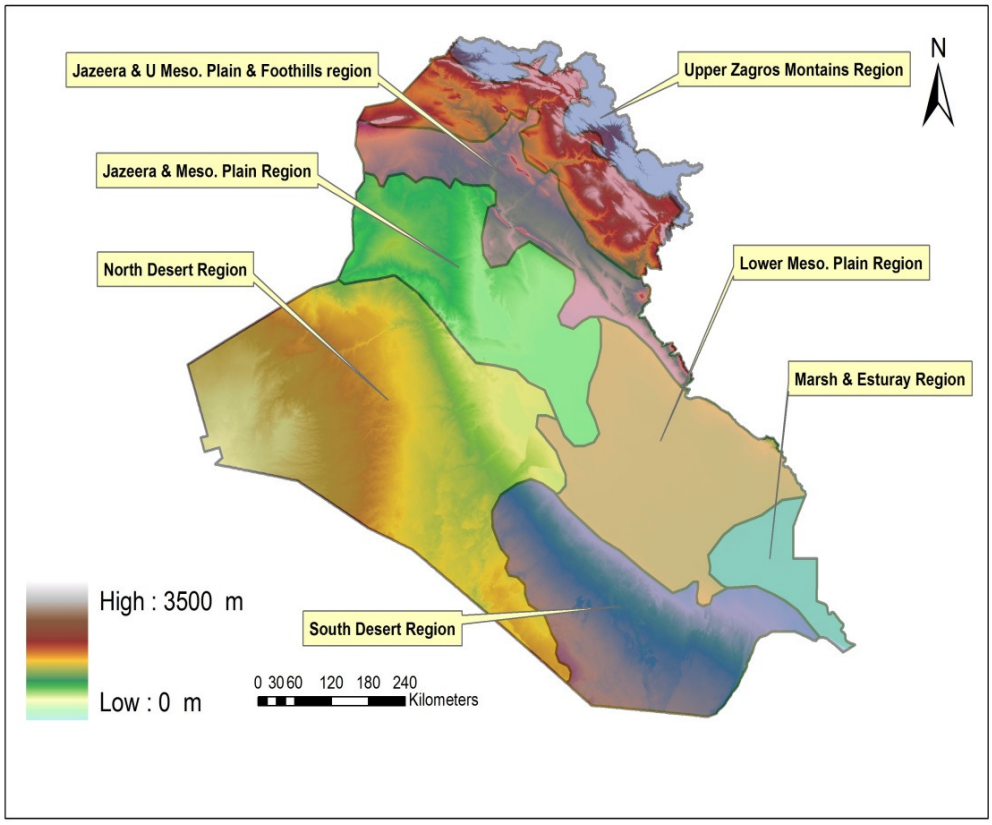

Fig.1. Physiographic regions of Iraq.

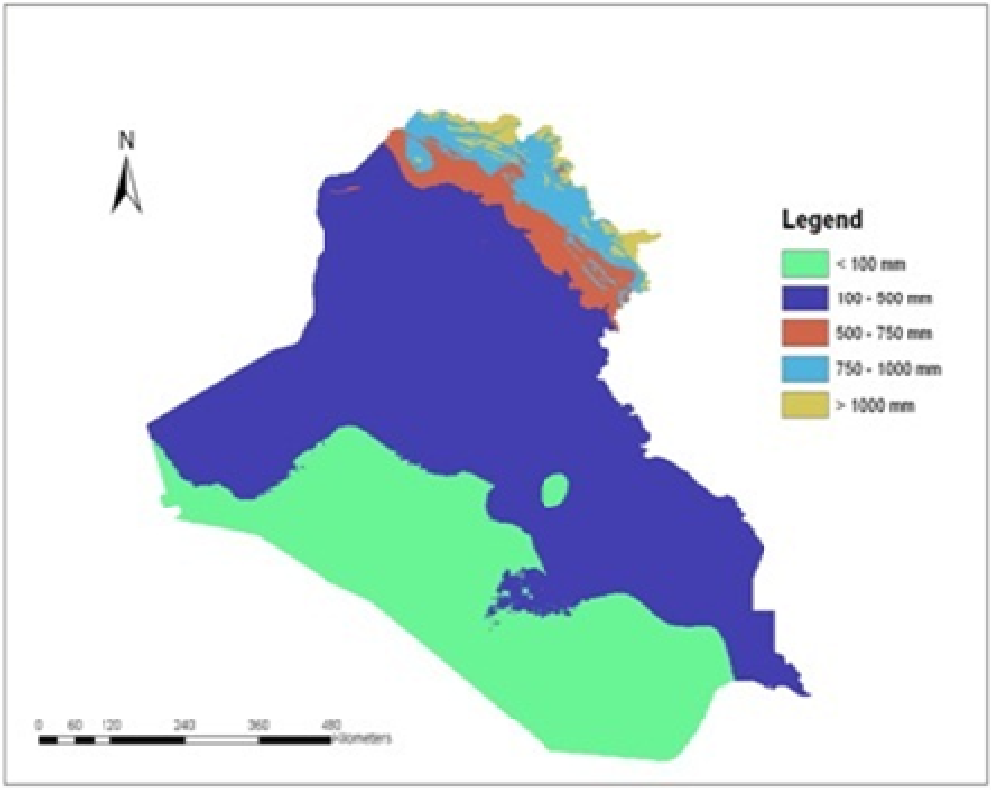

Fig.2. Mean annual precipitation in Iraq

C. Undulating Region

This area is comprised of a fairly hilly landscape, located south and west of the mountain region. It covers an area of about 42,000 km2, or nearly 9.6% of Iraq's total area. Although there are some similarities with the former region, general landscape differences stand sharp. The area is somewhat folded in the later phase of folding. It consists of low parallel hill ridges, wide shallow valleys and extensive plains, in which various streams have cut their valleys. In general, average altitude varies from 200 to 1,000 meters. Local relief ranges from a minimum of 200 to a maximum of 800 meters per square kilometer. Beds of gravel, conglomerate and sandstone make up the area. It can be divided, in terms of geomorphic landforms structure, surface rocks and degree of erosion process, into a number of plains, plateaus, mountains and hill ridges. The southern edge of the mountain range is a highly dissected part. Climatic conditions of this region are characterized by a Mediterranean climate with warm dry summers and cool moist winters, with mean annual precipitation ranging from 400 to 700 mm and mean annual temperature from 20 to 22.5º C. Dominant natural vegetation is an open Savannah, primarily Pistacia and other small trees, with most eradicated by continuous cultivation. Other areas support luxurious grasses dominated by Poa bulbosa and Hordeum bulbosum (Guest, 1966).

D. The Mesopotamian plain:

It is the plain of the twin rivers, the Tigris and the Euphrates, referred to in ancient times as Shinar and later on called Al-Sawad (i.e., black lands), because of its high agricultural productivity. The plain is located in central and southern Iraq with a number of distinct landscapes. The undulating lands are to the north, the western plateau to the west, Zagros mountains to the east and the Persian Gulf to the south. The plains (including marshland and lakes) cover an area of 132,500 km2, or 30.2% of the total area of Iraq. It has a northwest-southeast orientation, trending in the same direction of the Tigris, Euphrates and Shatt al-Arab. Geologically, the plain occupies the southern part of an extensive geosycline. It was filled up during the quaternary and recent geological periods. Besides sediments carried by the twin rivers, some material of aeolian origin, blown out of the desert, is accumulated and mixed with fluvial deposits. Most of the plain appears to be dead flat. The climate is worm and dry with mean annual precipitation less than 150mm and more than 22 C.

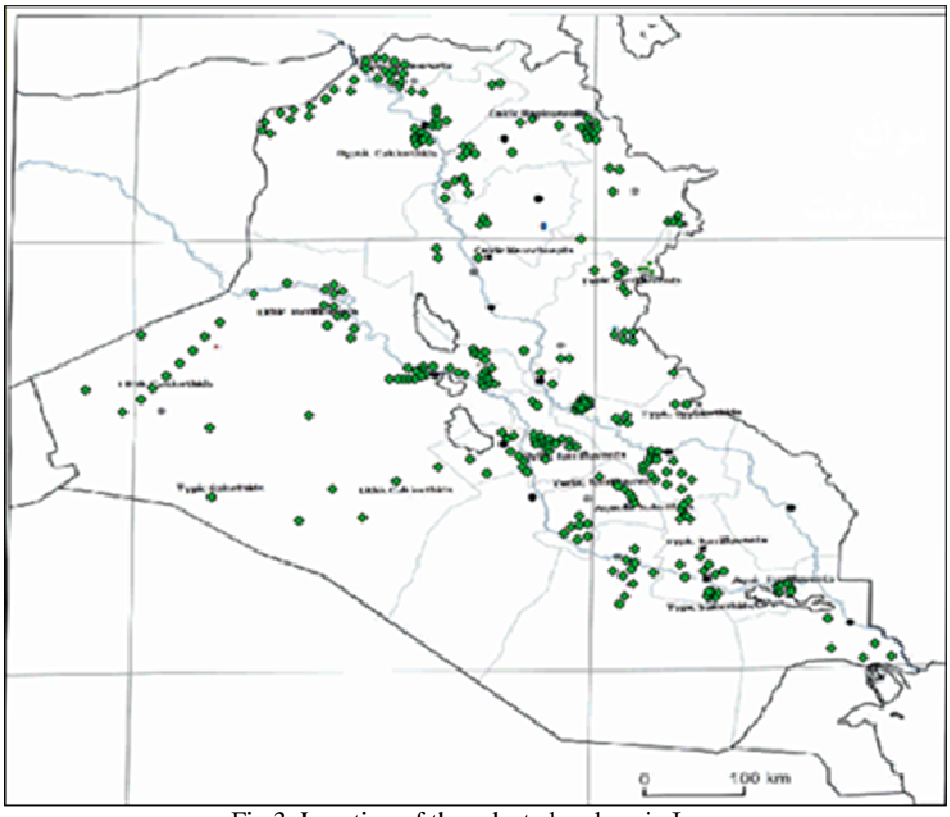

Fig.3. Location of the selected pedons in Iraq.

E. The Desert Region:

This is the largest physiographic region in the country. It occupies an area of 171,817 km2, or about 39.2% of Iraq's total area. The surface rises gradually from 120 m in the east to 700 m in the west. Surface drainage takes a general west-east direction, but streams bring large amounts of water from Sinjar mountain to be drained southward to the Wadi Tharthar, which has been used to store excess Tigris water diverted near the Samarra Barrage. It was lately connected with the Euphrates and the Tigris by two feeding canals to divert enough irrigation water back to both rivers. Within this very extensive region, there are a number of different plains; Al-Widian (valleys), Jezira (island), al-Hijara (rock), al- plains; Al-Widian (valleys),

Jezira (island), al-Hijara (rock), al- Hamad and Dibdibba. The differences are based on physical factors such as relief and rock formations. Al-Widian Plain developed in an area of limestone and gypsum rock ranging from level to undulating with shallow to rather deep valleys. In the northern Widian area is the large Ga'ara de are common. Plateaus are small in number, and the best known are those of Mosul and Kirkuk. The surface of Mosul plateau is dissected by shallow valleys with hills rising to 400 meters above the sea surrounding valleys Fertile soils together with an adequate amount of winter rain provide a good basis for agricultural land use. The Climate is very hot and dry with low rainfall generally < 75 or 100 mm which is not sufficient to maintain continuous plant cover.

Soil survey is considered the first step in any development project and the basis of land evaluation (present and potential agricultural value of the land).There are different types of soil data are available including :soil maps, salinity maps,land use,Geological, Metrological Land cover and topographic maps. The problems are most of the available data are in a hard –copy maps and tables, and there is no soil data base development.

F. Data Collection:

Soil data were collected from previous soil survey works done by the State board and other workers.250 pedons representing dominant climatic and physiographic regions across the Iraqi country (Figure 3). Common soil properties including morphological, physical and chemical soil properties were reorganized and reclassified using US Taxonomy.

III. Results and Discussion

The results for morphological, physical and chemical properties of the collected soil data indicated that there is some variations between all pedons.In general, Iraqi soils show a weak degree of development represented by the type of diagnostic horizons with in the selected pedons. This is may be due, mainly,to the effect of dry climatic conditions and young calcerous alluvium parent materials. However, the pedons of the mountain region with higher annual rain fall more than 650 mm and lower mean annual temperature 20 Cº show a greater degree of soil development in comparison to the pedons of other regions. This is reflected by a deeper soil profile, greater organic mater content in the surface horizon and low salinity level. The morphological, physical and chemical data for the pedons in the mountain region meet the criteria for the formation of some diagnostic horizons including Mollic, Calcic and to some extent the formation of Campic and Argillic horizons. While, soil properties of other regions indicated the presence of weak developed diagnostic horizons represent the common horizon for arid soils include Ochric, cambic, salic, Gypsic and Calcic horizons.

According to the morphological, physical and chemical properties for the selected pedons in Iraq, five soil orders were recognized.These orders arranged according to their percentage from the total Iraqi area as following:

Aridisols (62.2 %), Entisols (16.2%), Inceptisols (12.6%), Mollisols (3.8%) and Vertisols (1.2 %) respectively (Figure 4).The common soil properties for each soil order and their suborder as following

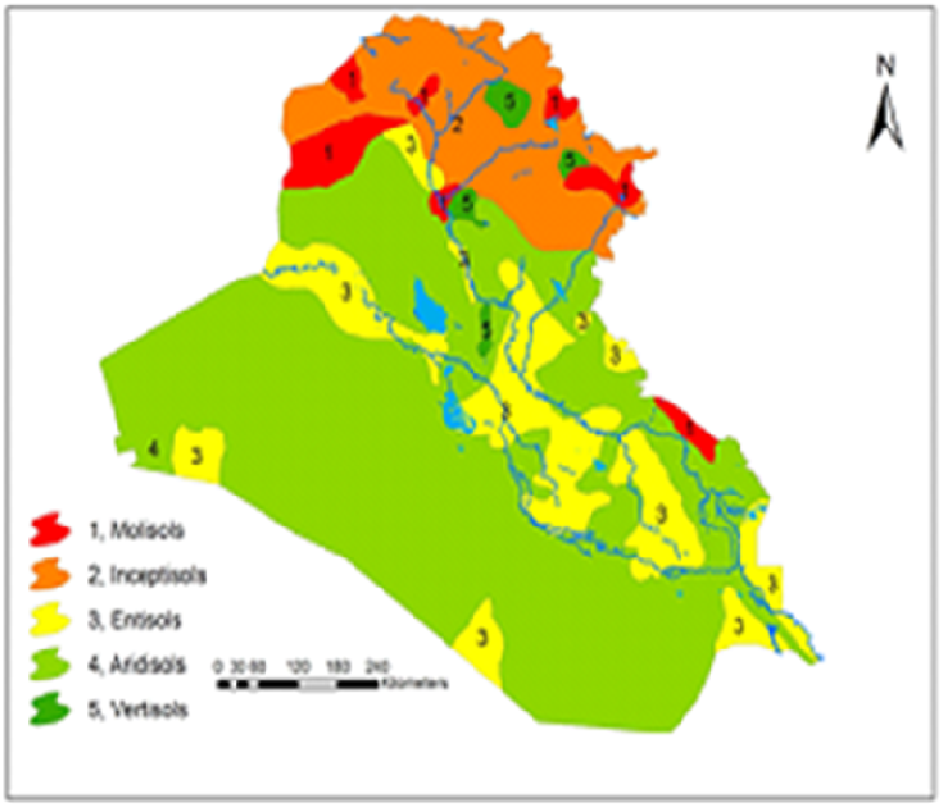

Fig.4. Distribution of soil orders in Iraq.

A. Aridisols:

Aridisols are the most common soil order found in Iraq. They occupy about 62.2 % from the total area of Iraq. The occur in different area in Iraq from southern Mousul to Basra governorates (Figure 4). The concept of Aridisols is based on limited soil moisture available for the growth of most plants. In areas bordering deserts, the absolute precipitation may be sufficient for the growth of some plants. Because of runoff or a very low storage capacity of the soils, or both, however, the actual soil moisture regime is aridic. Because of an extreme imbalance between evapotranspiration and precipitation, many Aridisols contain salts. Aridisols show variations with the common soil properties reflecting the effect of the dominant local conditions. These differences represented by the presence of different diagnostic horizons. The common subsurface horizons are associated with the accumulation of different types of salts. The accumulation of salts is the second most important constraint to land use. According to the amount and types of salt accumulation, the Aridisols order are subdivided to three suborders including Salids, Gypsids and Calcids. In Iraq, Aridisols occur in the dry regions. Some of these soils are found in the Western Desert, some of which are recognized over limestone and on the middle and high gypsiferous Tigris and Euphrates terraces. The calcids contain Calcic or petrocalcic within 50 cm of the surface soil, are the most dominant suborder in Iraq. Gypsids (gypsic or petrogypsic horizon within 100 cm of the soil surface without an overlying petrocalcic horizon). Salids (accumulations of salts more soluble than gypsum). Other suborders also,are recognized in Iraq including : Argids (have argillic or natric horizon with no gypsic, petrogypsic, petrocalcic, or salic horizon within 100 cm of soil surface); and Cambids (have cambic horizon within 100 cm of soil surface and no other diagnostic horizon, i.e., petrocalcic, gypsic, calcic, unless upper boundary ofsuch horizon is 100 cm or more below soil surface) (Soil Survey Staff, 1999).

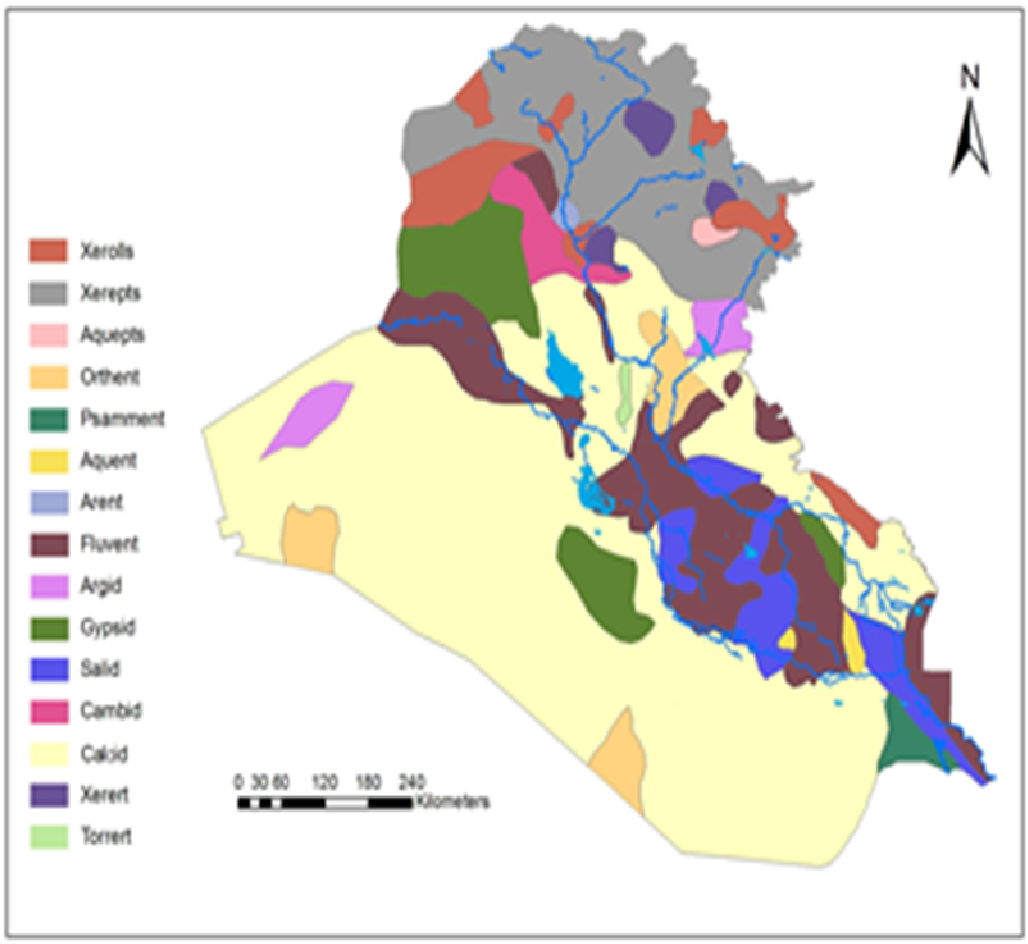

Fig.5. Distribution of soil suborders in Iraq.

B-Enitisols:

Entisols are the second dominnt order in Iraq occupy about 26.2 % from the total area of Iraq. They occur in different physiographic units starting from the mountain to the flood plain in the southern Iraq. Entisols are soils with little or no evidence of the development of pedogenic horizons. Most Entisols have no diagnostic horizons other than an ochric epipedon. A few that have a sandy or sandy-skeletal particle-size class have a horizon that would be a cambic horizon were it not for the particle-size class exclusion.Entisols may have any mineral parent material, vegetation, age, or moisture regime and any temperature regime, but they do not have permafrost. The only features common to all soils of the order are the

virtual absence of diagnostic horizons and the mineral nature of the soils. Three suborders were recognized in Iraq including : Fluvents, Arents and Aquents. The following great groups were recognized in Iraq:

Psammaquents, Xerarents, Xerofluvents, Fluvaquents, Torriarent, Torrifluvents, Torripsamments, Xeropsamments, Torriorthents and Xerorthents.

C. Inceptisols

Inceptisols include a wide variety of soils. In some areas these soils have minimal development, whereas in other areas these soils have diagnostic horizons that merely fail the criteria of other soil orders. They have many kinds of diagnostic horizons and epipedons.. The most common horizon sequence is ochric epipedon over a cambic horizon.Three great groups were found in Iraq : Haploaquepts , Calcixerepts and Haploxerepts.

D. Vertisols

Vertisols are clayey soils that have deep, wide cracks for some time during the year and have slickensides within 100 cm of the mineral soil surface. These soils have long been well known for their characteristic color, cracks they produce during the dry season, and the difficulty of their engineering properties. Vertisols occur in many areas in Iraq but are mostly located in low-lying depressions of central and northern areas, the intermountain alluvial valleys and terraces in the North and in the Mosul-Erbil-Kirkuk plains. Typically, these soils are deep and clayey, with shrink-swell processes resulting in cracking during the dry season. Vertisols in Iraq are associated with Mollisols in semiarid regions and with Aridisols in arid regions. Some suborders pertinent to Iraq are the Torrerts and Xererts, the former of arid climates and the latter of Mediterranean climate, typified by cool wet winters and warm dry summers and rice, provided excessive soluble salts are not present (Altaie, 1968). Vertisols have unique morphologies, with horizonation often so weakly expressed that the profile appears to be the same throughout because of self-mixing, resulting from the shrinking and swelling of the clay with drying and wetting. Textural differences in the profile may be minimal, with horizon differentiation primarily based upon color and structure. Some great groups pertinent to Iraq are the Calcitorrerts, Gypsitorrerts, Calcixerrerts and Haploxererts, the former of arid climates and the latter of Mediterranean climate, typified by cool wet winters and warm dry summers.

E. Mollisols

Mollisols commonly are dark-colored, base-rich mineral soils of the steppes. Nearly all of these have a mollic epipedon, and many have an argillic, and calcic horizon. Many of these soils developed under grass and many apparently were forested. Mollisols occur in the northeastern mountain area particularly on the foot slope plain of intermountain valleys.. In Iraq, the following suborders of Mollisols are the Xerolls and Aquolls, and some subgroups include Typic Calcixerolls and Pachic Argixerolls.

IV. CONCLUSIONS

Iraqi soils show different degrees of development according to the dominant local conditions mainly climatic and geological conditions. The results of the morphological, physical and chemical soil properties indicated the presence of five soil orders including : Aridisols, Entisols, Inceptisols, Mollisols and Vertisols. Each order show some variations with in the common properties refelecting the effect of the dominant local conditions mainly, climatic and type of parent materials.The results indicated the need for semi detail soil survey covering the total area of Iraq with soil map.

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