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Classification of soil infiltration rate depending on the Hydrological soil group map South East Iraq

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Abstract

The study area is located in the East of Missan governorate, southeast of Iraq between (32°'29.52" – 32°37'30") latitude and (46°46'21.16" – 47°58'53.52")longitude. It encompasses an area of (1858km^2) with elevation ranges from 8 to 165m. Soil is a natural body that exists as part of the pedosphere and which performs four important functions. It is a medium for plant growth and a means of water storage, supply and purification. The spatial mapping of soil usually involves delineating soil types that have identifiable characteristics. The delineation is based on many factors such as geomorphologic origin and conditions under which the soil is formed. Hydrologic soil group (HSG) refers to the classification of soils based on their runoff , producing characteristics and their infiltration rate. Soils are assigned to 4 hydrologic groups namely Group A - high infiltration rate when wet, low runoff potential, Group B - moderate infiltration, low runoff potential, Group C - slow infiltration, higher runoff potential, and Group D - very slow infiltration rate, highest runoff potential. According to the USDA soil classification system, four hydrological soil groups are recognized: A, B, C, and D with 19%, 48%, 32%, and 1%, respectively, the high percentage extension of moderately infiltration group (B and C).

Keywords: Hydrologic soil group (HSG), U.S. Department of Agriculture (USDA), Soil, Missan Governorate, GIS.

تصنيف ارتشاح التربة اعتمادا على خريطة التربة الهايدرولوجية جنوب شرق العراق

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الخلاصة

تقع منطقة الدراسة في الشرق من محافظة ميسان جنوب شرق العراق بين خطي(32درجة 29دقيقة 52ثانية ، 32درجة 37دقيقة 30 ثانية) طول وخطي(46 درجة 46 دقيقة 21.16 ثانية ، 47 درجة 58 دقيقة 53.52 ثانية) عرض . تحتل منطقة الدراسة 1858كيلومتر مربع مع معدل ارتفاع من 8 الى 165 متر . التربة هي جسم طبيعي التي تظهر كجزء من غلاف الارض الترابي والتي تنفذ اربع وظائف مهمة. هي وسط لنمو النبات وتعتبر وسيلة لخزن وتجهيز وتنقية المياه . الخريطة المكانية للتربة عادة تتضمن تعيين انواع التربة التي تمتلك خصائص معروفة. عملية التعيين تعتمد على عدة عوامل مثل اصل اشكال سطح الارض و الظروف التي تكونت تحتها التربة . مجموعة التربة الهيدرولوجية تشير الى تصنيف الترب اعتمادا على الجريان ،الخصائص الناتجة ومعدل الترشيح . تعين الترب الى اربع مجاميع هايدرولوجية تسمى : المجموعة أ معدل ترشيح سريع عندما يكون هنالك جفاف ومعدل جريان قليل ، المجموعة ب معدل ترشيح متوسط ومعدل جريان قليل ، المجوعة ت معدل ترشيح بطيئ ومعدل جريان سريع والمجموعة ج معدل ترشيح بطيئ جدا

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ومعدل جريان عالي جدا . اعتمادا على تصنيف قسم الزراعة في الجامعة الامريكي صنفت المنطقة الى مجموعة أ ، ب ، ت ، ج واحتلت 19% ، 48% ، 32% ، 1% على التوالي ، ان النسبة المئوية الاكثر امتداد هي النسبة ذات معدل الترشيح المتوسط (مجموعة ب ، ت).

1. Introduction

Soil is defined in different ways for different processes. Generally, it is a complex biogeochemical material on which plants may live and grow. We must need Information about the type of soil as a basic input in hydrologic evaluation. Mapping soil usually involves delineating soil types that have identifiable characteristics. The delineation is based on many factors garment to soil science such as geomorphologic origin and the conditions that the soil formed under it [1]. The essentially hydrologic interest in soil maps is the modeling of infiltration and runoff as a function of soil properties. Convenient measurement of infiltration and runoff for ungauged watershed is complex task. Therefore, sturdy efforts have been carried out to relate soil properties with soil texture. Soil texture is a term that used to assign the proportionate distribution of the different sizes of mineral particles in a soil. According to their size, these mineral particles are classified into "separate"[2].

2. Location of the study area

The study area is located in the east of' Missan governorate, southeast Iraq between latitude 32°'29.52" – 32°37'30" and longitude 46°46'21.16" – 47°58'53.52" (Fig.1). It covers an area of 1858 km^2 with elevation ranges from 8 to 165m. The land surface is relatively flat in the central part of the area and is bounded by Hemrin hills in the northeast and Band hill in the north. In general, the elevation of the study area decreases from northeast to southwest. Most parts of the area is covered with different types of Quaternary deposits mainly sand and alluvium deposits of recent and Pleistocene age. The Quaternary sediments are unconsolidated and usually fine grained, where alluvial fans, flood plain, depression fill, and aeolian deposits are the major units of the Quaternary deposits in the area [3] and [4].

One of the common landforms in the area and very effective one is the existence of Wadies (valleys) , which are filled with water after heavy rain and significantly contribute in groundwater recharge. Wadies can be classified into two types depending on their occurrence; mountain or flat area. Wadies in mountain area are very rugged and dissected due to action of strongly water coming from Iran. Shallow wadies in flat area are simple depression with gentle slope and commonly terminate in marshes and they consist of a mixture of gravel, sand, and silt sediments.

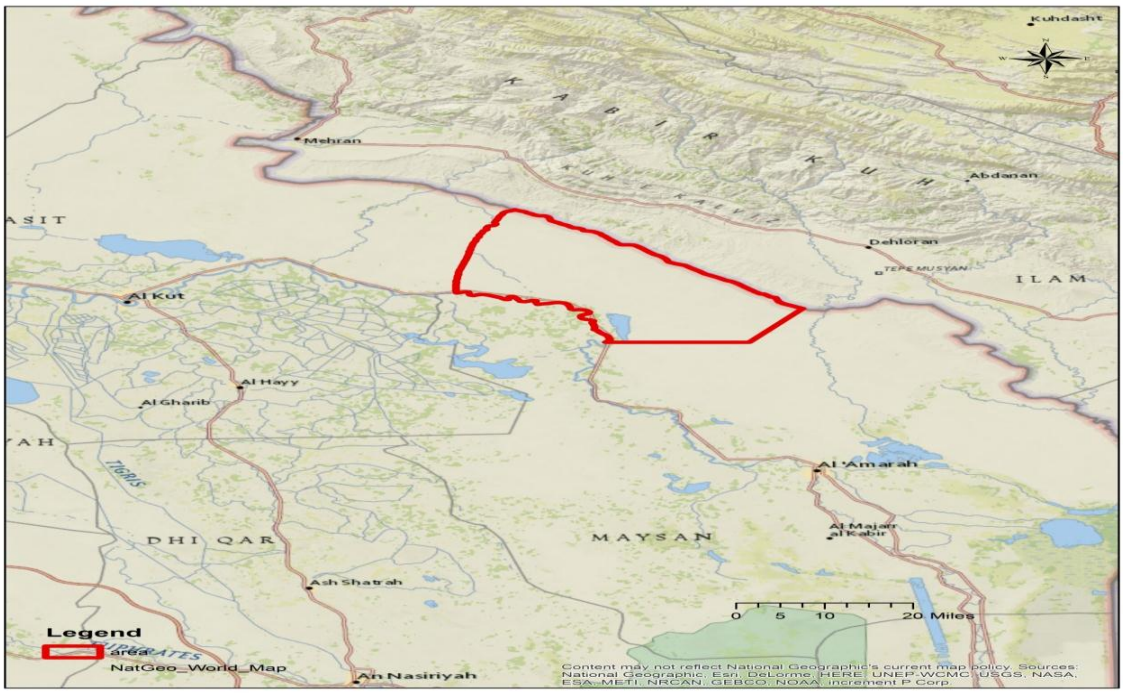

Figure 1- location map of the study area.

3. Hydrologic soil group map

A soil separate is a group of mineral particles that fit within known size limits expressed as diameter in (mm) table1. There are twelve major textural classes [2]. Their compositions are defined by USDA with other related factors, (Table- 2). The USDA soil texture triangle was prepared for any combination of particle sizes must be involved within a textural class, (Figure-2). The each sides of the triangle represent 100% of size fractions: sand, silt, and clay within the triangle are areas that represent the combinations of the three size particles.

Table 1-Size limits (diameter in millimeters) of soil separate in the USDA soil textural classification system [2].

Name of soil separate	Diameter (mm)
SAND	2.00 - 0.05
Very coarse	2.00 – 1.00
Coarse	1.00 – 0.50
Medium	0.50 – 0.25
Fine	0.25 – 0.10
Very fine	0.10 – 0.05
SILT	0.05 – 0.002
Coarse	0.05 – 0.02
Medium	0.02 – 0.005
Fine	0.005 – 0.002
CLAY	< 0.002
Coarse	0.002 – 0.0002
Fine	< 0.0002

Classes can be read from the textural triangle. For example a soil with 55% sand, 15% silt, and 30% clay classified as a sandy clay loam.

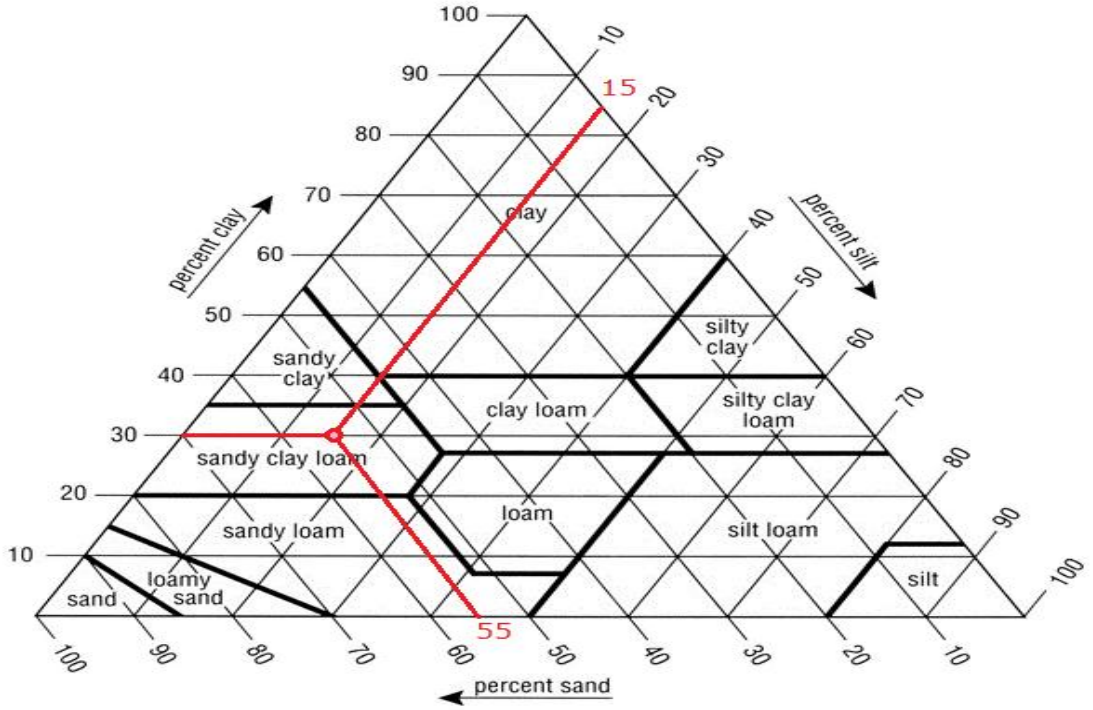

Figure 2- USDA triangle texture for soil sample example [2].

Table 2- Hydrologic soil properties classified by soil texture [5].

Texture class	SCS hydrological grouping
Sand	A
Loamy sand	A
Sandy loam	B
Loam	B
Silt loam	C
Silt	C
Sandy clay loam	C
Clay loam	D
Silty clay loam	D
Sandy clay	D
Silty clay	D
Clay	D

Using more than 3000 specifically named soil types, the Natural Resource Conservation Service (NRCS) separated each into one of four hydrologic soil groups, (Table 3) depending on infiltration, soil texture and other criteria [2]. Soil group is of great use in estimation the runoff for any given watershed as soil influence the process of generate runoff from rainfall. To create raster layer of HSG, a total of 17 soil samples were collected from a depth of about 50 cm below the ground surface after removing the top soil cover. The soil samples were collected in clean bags and transported to soil laboratory to carry out grain size analysis. The collected soil samples of the study area were assigned texture name based on the web-based USDA soil texture calculator (http://soils.usda.gov/technical/aids/investigations/texture/) (Table- 4 and Figure-3). The soil types map (Figure-4) in the study area are then converted to soil permeability values based on soil taxonomy, (Table- 3). According to this classification each soil hydrological group is assigned a range of values of infiltration rates in mm/hr. The average value of infiltration rates is then interpolated using kriging techniques in Geostatistical analyst extension of ArcGIS 10.2 to produce the soil hydrological group layer of the study area, (Figure- 5)

Table (- SCS Hydrologic soil group [6].

Soil group	Description	Final infiltration rate (mm)
A A	Lowest runoff potential. Includes deep sands with very little silt and clay, also deep, rapidly permeable loess.	8-12
B	Moderately low runoff potential. Mostly sandy soils less deep than A, and less deep or less aggregated than A, but the group as a whole has above-average infiltration after thorough wetting.	4-8
C	Moderately high runoff potential. Comprises shallow soils and soils containing considerable clay and colloids, though less than those of group D. The group has below – average infiltration after pre saturation.	1-4
D	Highest runoff potential: Includes mostly clays of high selling percent, but the group also includes some shallow soils with nearly impermeable sub horizons near the surface.	0-1

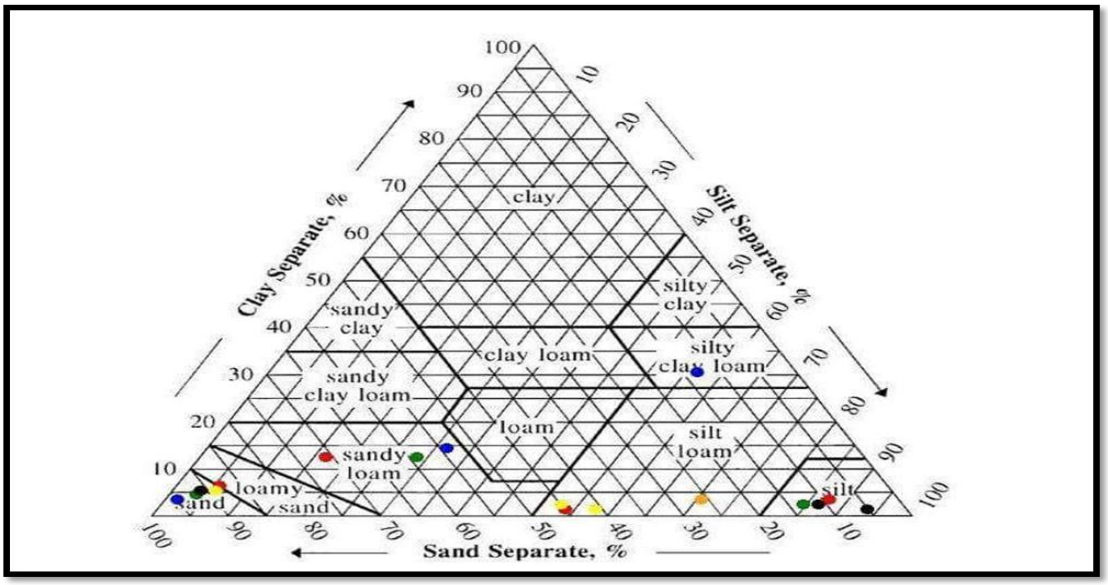

Figure 3- Soil texture types of the collected samples according to USDA calculator.

Table 4-The characteristics of the collecting soil samples.

Soil No.	Easting	Northing	Sand	Silt	Clay	Texture	SCS Hydrologic soil grouping
S1	667162.8	3596345	14	56	30	Silty Clay Loam	D
S2	672520.6	3597702	72	16	12	Sandy Loam	B
S3	674774.4	3601247	96	1	3	Fine Sand	A
S4	685883.3	3605678	93	3	4	Fine Sand	A
S5	678775.2	3609994	92	3	5	Fine Sand	A
S6	675332.3	3612120	89	5	6	Fine Sand	A
S7	678078.9	3605909	55	31	14	Sandy Loam	B
S8	676486.5	3604790	42	57	1	Silt Loam	C
S9	670095.6	3606583	46	54	1	Silt Loam	C
S10	657143.7	3614001	27	70	3	Silt Loam	C
S11	655083.3	3618112	6	93	1	Silt	C
S12	654362.3	3616065	46	42	2	Silt Loam	C
S13	658770.6	3614452	10	87	3	Silt	C
S14	658557.4	3612616	14	84	2	Silt	C
S15	658633.4	3613412	12	86	2	Silt	C
S16	664999.495	3620760.4	90	5	5	Fine Sand	A
S17	666290.37	3611665.6	60	28	12	Sandy Loam	B

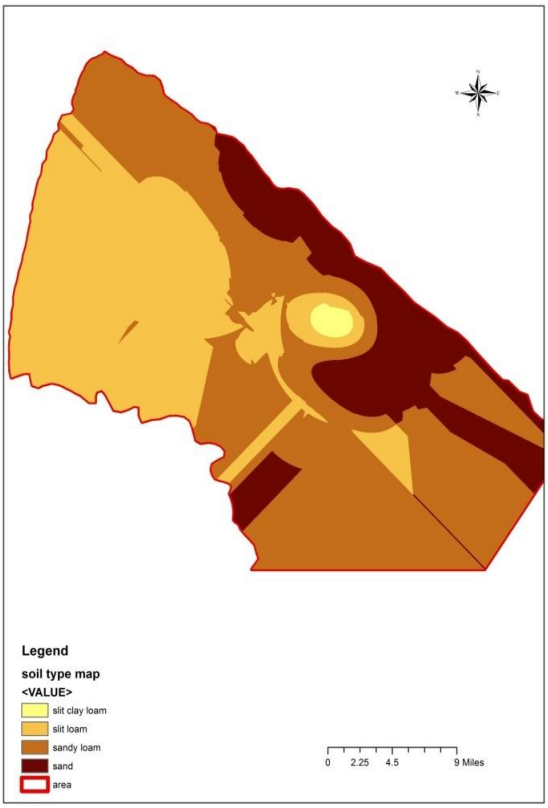

Figure 4- Soil type map of Ali Al-Ghurbi Watershed.

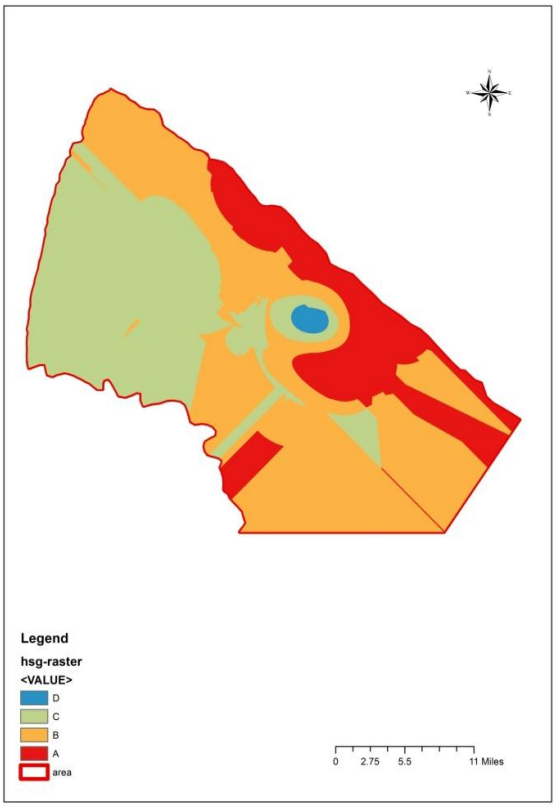

Figure 5- Hydrological soil group map of study area.

4. Conclusions

- According to the USDA Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration, four hydrological soil groups are recognized: A, B, C, and D
- *Group A* - Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission
- *Group B* - Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.
- *Group C* - Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.
- *Group D* - Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a clay pan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.
- The occupy space of these group are 19%, 48%, 32%, and 1%, respectively.
- The high percentage extension of infiltration rate in the study area is the moderately infiltration group: B and C.

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