CLASSIFICATION OF THE SURFACE SOIL OF DURBNDIKAN BASIN BY USING REMOTE SENSING & GIS TECHNIQUE[+]

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Abstract

This research aims to employ the ability of Remote Sensing & GIS (Geographical Information system) techniques to classify Durbndikan soil basin in the northern of Iraq (Kurdistan region), The importance of this research is the ability of using the digital geotechnical map in the hydrological work such as find surface run-off ,The research done through many stages the first stage is a maps collection (topographic map, satellite image) for study area , second stage is a site visit for collect soil sample and using radiometer device in field to record the spectral reflectance to recognize different soil type by their reflectance, The third stage is a laboratory test stage (liquid limit ,plastic limit, moisture content ,sieve analysis and hydrometer test) are used for unified soil classification , final stage is input data stage through ERDAS 8.4 program to obtain geotechnical map for the all basin, The map shows there are (five)main types of soil in Durbundikan basin (Inorganic silts, clayey sands, silty sands ,silty soil, inorganic clay) and that each type is a heavily represented in the region.

المستخلص

يهدف البحث الحالي الى توظيف أستخدام تقنية التحسس النائي ومنظومة المعلومات الجغرافية لتصنيف التربة السطحية لحوض دربنديخان في شمال العراق (اقليم كردستان)، تبرز أهمية البحث الحالي في أمكانية الاستفادة من الخارطة الرقمية, للأغراض الهيدرولوجية مثالها أيجاد السيح، لقد تم استعمال عدة وسائط من اجل الوصول لهذه الغاية ،المرحلة الاولى تمثلت بجمع الخرائط والحصول على صورة فضائية للمنطقة لدراسة المنطقة ثم اجراء زيارة موقعية وأخذ النماذج واجراء فحوصات حقلية بجهاز الراديوميتر لتسجيل الانعكاس الطيفي من اجل تمييز الترب على اساس انعكاسها الطيفي، المرحلة الثالثة تمثلت بالفحوصات المختبرية(حد السيولة ،حد اللدونة،المحتوى الرطوبي ،التحليل المنخلي،فحص الهيدروميتر) والتي استخدمت لتصنيف التربة على اساس التصنيف الموحد، اخر مرحلة تمثلت بمرحلة ادخال البيانات من خلال برنامج خاص بنظام المعلومات الجغرافية من اجل الحصول على خريطة التربة لعموم الحوض،لقد اظهرت الخريطة ان هناك خمسة انواع رئيسية من الترب في تلك المنطقة (تربة غرينية وتربة رملية طينية،تربة رملية غرينية،تربة غرينية،تربة طينية) .

Introduction

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Soil classification has an important relationship with many scientific fields, The object is to divide soils into groups such that all soils in a particular group have similar characteristics[1].

There are many systems for classifying soils available for general engineering use, they are:1.Unified soil classification system (USCS).

2.American Association of State Highway and Transportation Officials (AASHTO).

3.The British Soil classification system (B.S.)

4.Triangular soil classification chart (Mississippi River Commission).

5.Massachusetts Institute of Technology (MIT) classification system.

Most classification systems use a No. 200 sieve as a separation limit between fine and coarse soil. All soil classification systems of civil engineering interest use Atterberg limits (at least liquid and plastic limits) and grain size distribution, either partially or entirely. USCS and AASHTO are the general systems for soil classification in civil engineering;

The **USCS(**unified soil classification system)is used in this research to classify the soil of the study area. American Society for Testing and material(ASTM) adopted the USCS in 1969,and it is considered the standard method to classify soil for engineering purposes.

Spectral reflectance characteristics of features on the Earth's surface can be quantified by the proportion of energy reflected by the feature at different wavelengths, This done by using radiometer instrument[2].

Materials and methods

The study area (Durbndikan basin) lies about 80km from a AL-SULIMANIA city and its lie in the north east of Iraq between (45°.58´-45°.30´ E longitude) and (35°.20´-34.48´ N latitude) ,the watershed area is about (3813km2), Fig.(1) shows the area has been studied , The lake area is about (2300 ha), the topographic map shows a wide deference in elevation in the study area.

This study included four stages , The first including the use of various data sets such as Landsat-7 satellite image 14.25m resolution and topographic map(1-1000000) and from this maps we recognized eight sub basins ,the second stage included site visits to collect soil samples from specified locations found by using GPS device A radiometer device (was also used in this stage)with four filters (blue-green-yellow-red), A radiometer is a sensor that measures the intensity of EMR (electromagnetic radiation) emanating from all objects within its field of view and wavelength range[2]. The radiometer is one of the non-imaging instruments that measure electromagnetic radiation using optical techniques. The instruments are non-imaging in the sense that they do not produce a picture but rather integrate over time, space, and wavelength to produce a spectral curve. to recognize different soil type by their reflectance , Fig(2) shows the location of soil samples that were collected there locations are signed by using GPS device. The third stage included laboratory work to find soil properties and soil type. The different soil samples are tested in the soil laboratory in the university of technology to find their properties[3].

Fig.(1) Study Area

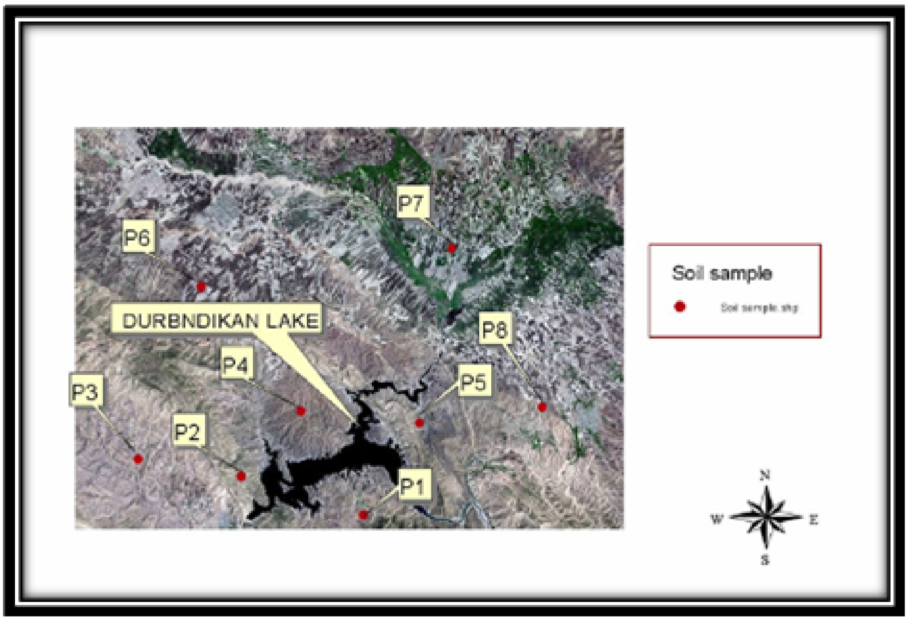

Fig.2 Soil Sample Position (Landsat-7 ETM)

i. Moisture content:

The moisture content is the ratio, expressed as a percentage of the weight of water in a given soil mass to the weight of soil particles

ii. Liquid limit and plastic limit determination:

The liquid limit and plastic limit are generally referred to as Atterberg limits, these limits are related indices which have become very useful characteristics for soil identification and classification. The limits are based on the concept that a fine-grained soil exists in various states; (liquid state, plastic state, semisolid state and solid state) depending on its water content.

The liquid limit (LL) is defined as the water content, in percent, of a soil at the arbitrarily defined boundary between the liquid and plastic states. The LL is generally determined by standard Casagrande device.

Plastic limit (PL) is defined as the moisture content, in percent, at which the soil changes from a plastic to a semisolid state.

iii. sieve analyses and hydrometer test

The particle size analysis of a soil sample involves determining percentage by weight of particles within different size ranges. The particle size distribution of coarse-grained soil can be determined by the method of sieving (sieve analysis). The soil sample is passed through a sieve of standard test sieves having successively smaller mesh sizes, weight of soil retained in each sieve is determined and the cumulative percentage by weight passing each sieve must be calculated, this is generally referred to as percentage finer.

The particle size distribution of a soil is presented as a curve on a semi-logarithm plot, the x-axis represent grain size in mm, whereas the y-axis represents the percentage of passing.

The flatter distribution curve refers to larger range of particle sizes in the soil; the steeper curve refers to smaller size range.

When 12% or less of the soil sample passes through No. 200 (75µm) sieve, coefficient of uniformity (Cu) and coefficient of curvature (Cc) are calculated, using the following equations (1) and (2).

$$Cu = D_{60}/D_{10} \quad (1)$$

$$Cc = (D_{30})^2/(D_{10})(D_{60}) \quad (2)$$

where: D_{60}, D_{30} and D_{10} are the particle diameters corresponding to 60, 30 and 10 percent finer on the cumulative particle-size distribution curve respectively.

The particle size distribution of a fine-grained soil can be determined by the method of sedimentation (hydrometer analysis) of soil grains. When soil particles are dispersed in water, they will settle at different velocities depending on their weight, shapes and sizes. Hydrometer readings are taken at various elapsed times to determine the finer percentage and a diameter of grain size.

The final stage uses GIS techniques by ERDAS8.4 software and use supervised classification, in this classification quantitative information of remote sensing image data are rests upon using suitable algorithms to label the pixels in an image representing particular cover type, or classes.

In classification stage each pixel in the image data is categorized into the land cover class, it most closely resembles if the pixel is insufficiently similar to any training data set, it is usually label "unknown".

The result of image classification can be introduced in several forms depending on the desired type of information. The three general forms of products that are commonly used are:

1. Tabular data: Statistics of whole image classes or any desired part can be tabulated.
2. Graphical product: Display of classified image (the classes) in different colors, tones or characters, each cell represents its related ground cover classes.
3. Digital information files: Output results may be recorded on some types of computer storage medium for further analysis and processing.

The results obtained from the multispectral classification are often displayed in the form of thematic map. A thematic map is produced by color-coding each individual pixel, to represent the class into which it has been assigned by classification algorithm. The thematic map is a useful way to present the information extracted by the classification process [4].

In our research we choose graphical product to produce a geotechnical map for Durbndikan basin, Fig.(3) shows the flow chart of work.

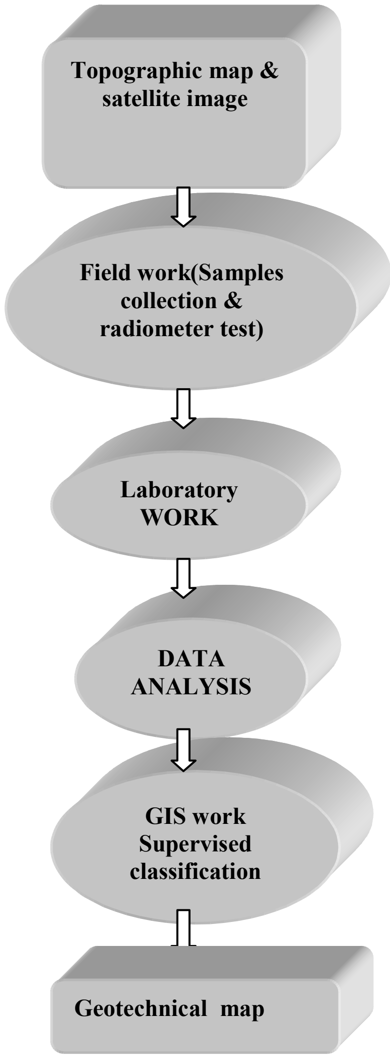

Fig.(3) Methodology of Research

RESULTS

From **field work** by using radiometer we recognized eight different types of soil from there spectral reflectance ,Fig(4) shows the reflectance of eight soil types by using four filters (red, blue, yellow & green) which represent the visible ray .

From laboratory work we do a number of experiments to classify soil according to USCS system Table (1) shows the result from these experiments for each borehole.

The **GIS work** include using supervised classification by ERDAS 8.4 to get the final geotechnical map for the all basin by separate different spectral reflectance of soil [5],[6], Fig.(5) shows the final result from this research represented by the geotechnical map for the all Durbndikan basin.

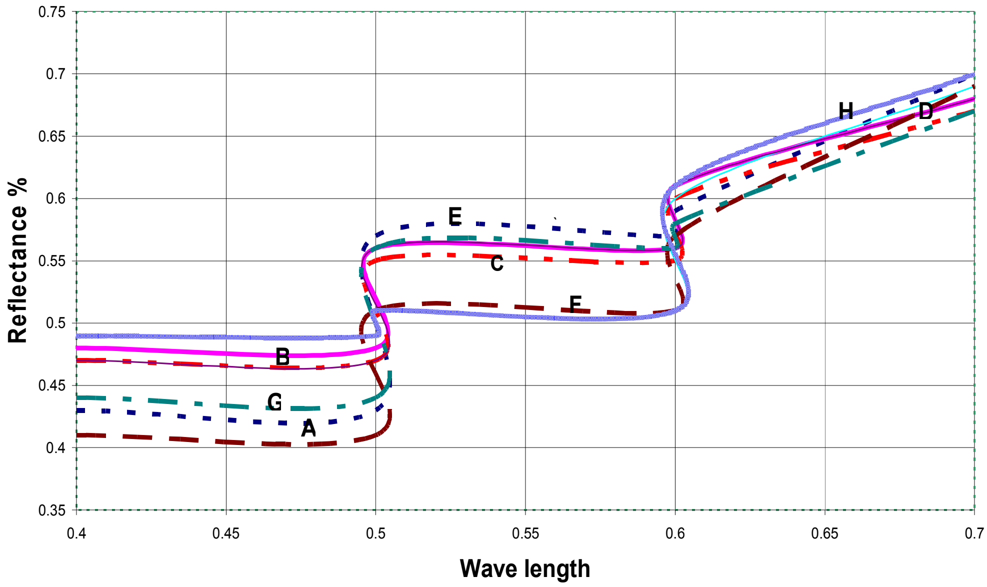

Fig.(٤) Spectral Reflectance

Table(1) laboratory result

Borehole NO.	Symbol	Moisture content%	Liquid limit%	Plastic limit%	Pass sieve NO. 200 %	Pass sieve NO. 4 %	Soil type (USCS)	
1	A	15.5	45.8	32.7	58.75	85.25	ML	Inorganic Silts
2	B	7.65	33	22	10.2	75.45	SC	Clayey sands
3	C	5	19	14	23.9	91.55	SC	Clayey sands
4	D	5.6	44	45	39.3	71.15	SM	Silty sands
5	E	5.56	33.2	18	34.25	54.25	SC	Clayey sands
6	F	10.2	40	25	57.2	80.3	CL	Inorganic clay
7	G	11.3	56	35	80.8	99.6	MH	Silty soil
8	H	10	37.5	37	32.75	57.6	SM	Silty sands

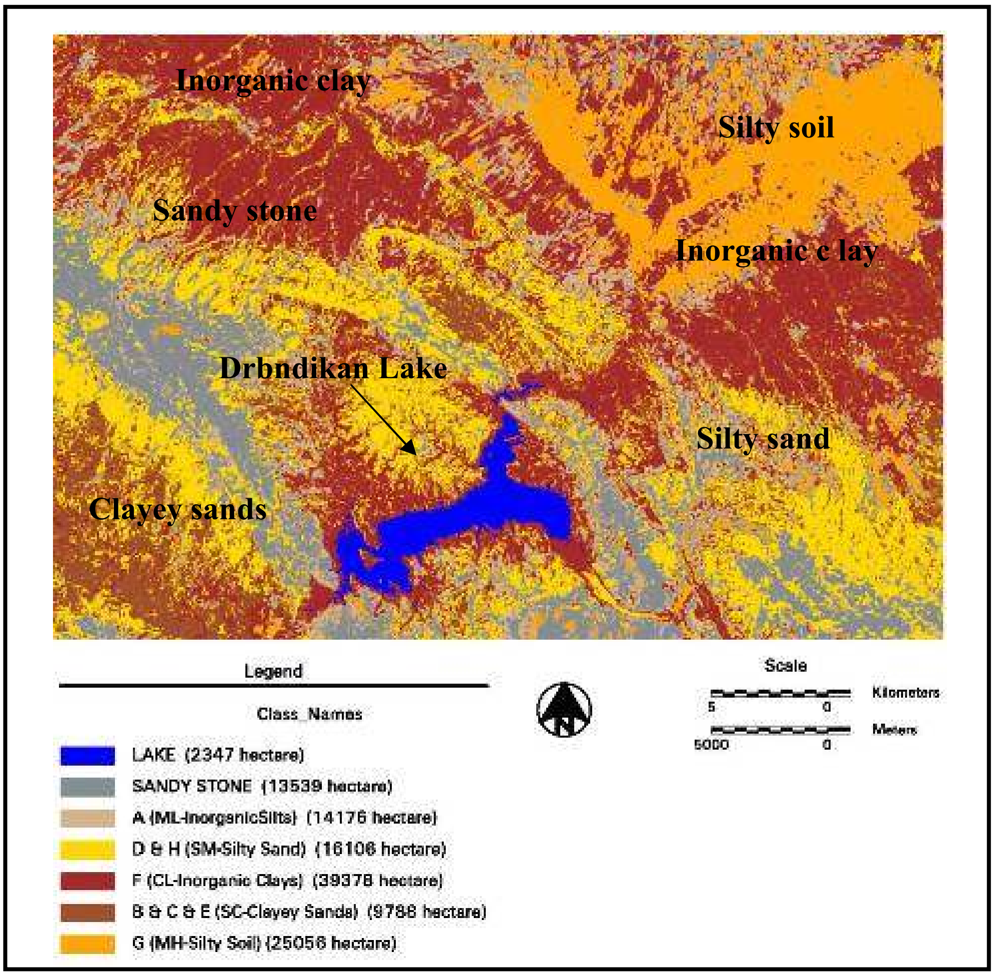

Fig.(5) Geotechnical map , Soil Type and Area of Each Type According to Unified Soil Classification System

DISSCUSION & RECOMENDUTION

In this research showed that remote sensing and GIS technique are very useful tools to determine a geotechnical map for Dubndikan basin with 14.25m resolution, the field work by using radio- meter could recognize eight types of soil by the deferent of there spectral reflectance , while the laboratory work recognize only five types of soil this deferent in the number of soil types result from the intensity of water content in soil ,in other word field work used here to make a first indication about number of soil types.

Know to generalize these results in all basin we used ERDAS 8.4 program (supervised classification) Fig.(5) shows the geotechnical map that result from GIS technique the map showed the location of each soil type and the area in hectare .

Finally in this research we recommended use supervised classification and not depending only on unsupervised classification because the first one depend on laboratory work in additional to spectral reflectance of soil in classification process.

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