New Adaptive Satellite Image Classification Technique for Al habbinya Region West of Iraq

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Abstrat

Developing a new adaptive satellite images classification technique, based on a new way of merging between regression line of best fit and new empirical conditions methods. They are supervised methods to recognize different land cover types on Al habbinya region. These methods should be stand on physical ground that represents the reflection of land surface features.

The first method has separated the arid lands and plants. Empirical thresholds of different TM combination bands; TM3, TM4, and TM5 were studied in the second method, to detect and separate water regions (shallow, bottomless, and very bottomless). The Optimum Index Factor (OIF) is computed for these combination bands, which realized the higher OIF value with low correlated from other TM combination bands. This study was performed using ArcGIS9.3, ENVI 4.5 softwares and MATLAB7.9b language.

Key Words :Image Processing and Analysis, Supervised Classification, Empirical Conditions, ArcGIS, Remote Sensing, Thematic Mapper (TM).

Introduction

Many remote sensing systems recorded brightness values at different wavelengths that commonly include not only portions of the visible light spectrum, but also infrared and, in some cases, middle infrared bands. The brightness values for each of these bands are typically stored in a separate grayscale image. Each ground-resolution cell in an image therefore has a set of brightness values which in effect represent the color of that patch of the ground surface, if we extend our concept of color to include bands beyond the visible light range. The relationship between spectral classes and different surface materials or land cover types may be known beforehand, or determined and discriminated after classification algorithms using spectral reflectance features, i.e. the color information is contained in each pixel [1].

The precision of water color remote sensing inversion limits its application to water environmental monitoring [2]. Various algorithms were implemented to extract water body in recent years, based on the spectral characteristics of this region. These algorithms are able to locate all of the major water pixels. However, they heavily depend on human experts to choose appropriate threshold values [3].

Two image classification methods were proposed for classifying the Al habbinya region with different band combinations. Both the introduced classification methods are based on utilizing the reflection of land surface features. In the first method, a separation of arid lands, moist lands, arid plants, moist plants, and mature plants was achieved via regression line to best fit method, whereas the second method is carried on via empirical conditions method to detect Al habbinya lake water regions (shallow, bottomless, and very bottomless).

Description of the Study Area and Data Used

Al habbinya region and around lies in Al-Anbar governorate in the middle of Iraq. It extends between latitudes (33° 25' 36.51") to (33° 10' 29.59") north between longitudes (43° 17' 5.34") to (43° 36' 40.62") east, and it covers (852.68) km^2. Tested scene in Al habbinya location, and main data source were the Thematic Mapper (TM) data which were taken on the 4th of March 1990 onboard Landsat-5. This image was geometrically corrected and previewed with three bands combination (R: 5, G: 4, and B: 3), which show clear geographical variance for the land cover classes as shown in fig. (1).

Al habbinya region covers considerable part of the area which is dissected by the Euphrates River. Structurally the area is built up of sedimentary stony soils and lies within the Tigris and Mesopotamian sub-zones of the unstable shelf, and Rutba- Jezira zone of the stable shelf. The most important structural feature is Abu -Jeer fault [4].

Geomorphologically, the area has six geomorphological units of different modes. The erosion by water is effective overall the area due to dense drainage system. Hydrogeologically the Al habbinya water depth ranges from > 1m, (11-9) m, and 17m [5].

Methodological Approach

Two different image classification methods will be described below:

1- First Classification Method

The distribution of MIR band (TM5) and Red band (TM3) values in the spectral class plane in the feature space can be represented as right angle triangle from the top, the base of triangle describes the arid lands, which is calculated using the regression line to best fit method as a linear method. The top of the triangle represents the mature plants, which are extracted by applying mathematical theorem (the length of the straight segment drawn from the top of the right in the right angle triangle to the mid-gut (the middle of triangle base) equals to half the length of the hypotenuse) [6]. The equation of regression line to best fit method should be calculated, and it is given by [7]:

$$y = mx + b \ldots\ldots (1)$$

Where:

y represents MIR band values.
x represents Red band values.
m represents its slope.
b represents MIR intersection.

The moist lands, moist plants, and arid plants can be determined in addition to some conditions for the eq. (1), as:

$$y = mx + b + T \ldots\ldots\ldots (2)$$

Where:

T represents specific threshold value.

2- Second Classification Method

The water body information is accurately extracted from the false color image composed from bands: TM3, TM4, and TM5 with band combination of 5, 4, and 3 as RGB.

To separate water body for Al habbinya lake as shown in fig. (1) with different regions, the empirical conditions for the shallow, bottomless, and very bottomless water regions were determined with the following equations, respectively:

$$13 \leq TM4 \leq 79 \ and \ TM5 \leq 36 \ldots\ldots\ldots\ldots (3)$$

$$22 \leq TM3 \leq 71 \ and \ TM4 < 14 \ldots\ldots\ldots\ldots (4)$$

$$TM3 < 22 \ and \ TM4 \leq 11 \ldots\ldots\ldots\ldots\ldots (5)$$

Statistical Approach

In this study OIF (Optimum Index Factor) technique was applied to TM3, TM4, and TM5 bands of TM data. These combination bands were produced and analyzed using OIF. The value of OIF is recorded for these combination bands 5-4-3 is (140.164). The aim of this study is to determine OIF in order to help for selecting the most favorable band color combination according to their information for different land cover studies of the region, to avoid the time consuming of visual analysis process. OIF simplifies statistical calculation based on the amount of total variance and correlation between various bands. The used algorithm to compute the OIF is [8]:

$$OIF = Stdi + Stdj + Stdk / |Corr\ i, j| + |Corr\ j, k| + |Corr\ i, k|$$

Where:

Stdi : standard deviation of bandi,
Stdj: standard deviation of band j,
Stdk: standard deviation of band k,
Corr ij: correlation coefficient of band i and band j,
Corr ik: correlation coefficient of band i and band k,
Corr jk: correlation coefficient of band j and band k.

Experimental Results & Discussion

The Landsat TM data will allow for discrimination between the arid lands, moist lands, arid plants, moist plants, and mature plants. It provides useful information on these land covers.

Spectral class plane in the feature space analysis was used to understand the relation between classes in two-dimensional spaces of TM bands between red (TM3) and middle infrared (TM5) bands. The data points for the arid land cover class generally lie on a straight

line, which represents the base of right angle triangle. Another land cover classes (moist lands, arid plants, moist plants, and mature plants) lie above the straight line due to the higher reflectance in the middle infrared region relative to the visible region. Whereas the Al habbinya lake body determine in the left-hand side of the right angle triangle base due to the smaller reflectance in the middle infrared region and the visible region. Some of sunlight that enters a water body is absorbed; the degree of absorption is highly dependent on wavelength.

Fig. (2) illustrates the classification of Al habbinya region with the proposed method implementing. As it is obvious in this figure, all land cover classes can be grouped into eight major categories. The plausible assignment of mean values to the each feature (class) for classified image of this scene are listed in table (1), which can be represented as the ratios centenary in fig. (3).

As it is seen from fig. (2), the empirical conditions technique was used, as illustrated in previous equations (3, 4, and 5) to detect the different regions of Al habbinya lake, by depending on the spectral characteristic of water absorption of these regions.

Conclusions and Suggestions

From the obtained result, the two image classification methods successes to cluster the region of Al habbinya image into eight major categories. This research presented an influential technique with fast performing and simple conditions to separate Al habbinya lake water into three regions (shallow, bottomless, and very bottomless)

The Optimum Index Factor (OIF) is computed for TM combination bands. These best bands (TM5, TM4, and TM3) for classification have the biggest OIF value from other TM combination bands which indicates, that these bands contain much information (e.g., high standard deviation) with little duplication (e.g., low correlation between these bands), and they provide a great amount of information and color contrast TM bands combination, which are useful for plants studies from where its conditions, circumstances, and monitoring. In addition to that, it is used to determine the extent of pollution in the water of lakes and rivers, the amount of the decline of coast, helps to know moisture content, the amount of organic matter lands, and to help us to find out whether the land was arable or not.

It is seen from fig. (3) and table (1) the arid land attained the highest ratio from other categories. According to Iraq Soil Map (1961), the demonstrated soil type for this arid land in the study area and surrounded by Al habbinya lake is stony soil. Rating term for depth of soil is shallow which represented less than 2 feets. Thus, it is very important to take in consideration the effect of erosion and sediment processes in Al habbinya lake coast inherent to dynamic coast changes which caused in long term a change in lake capacity.

The major obstacle for using remote sensing data for land cover classification is the similarity between some of the surface spectral characteristics. Endmember extraction algorithms can help to differentiate between similar classes.

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Table (1): Mean Pixel Values for Each Land Cover Class

Land cover Type	Mean of Each Land Cover
Arid Lands	39.49
Moist Lands	2.79
Arid Plants	20.49
Moist Plants	2.64
Mature Plants	7.49
Shallow Water	8.11
Bottomless Water	9.65
Very Bottomless Water	9.04

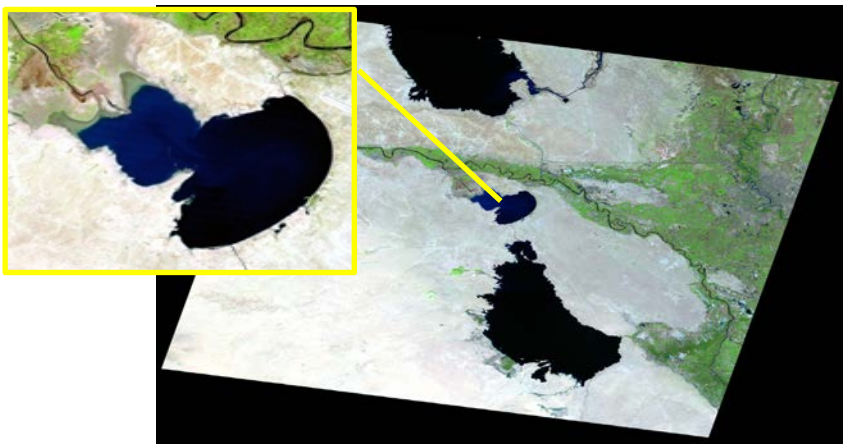

Fig. (1): RGB color composite of Landsat 5, TM bands 5, 4 and 3, in 1990 of West Iraq, and Tested Scene in Al habbinya Region [9]

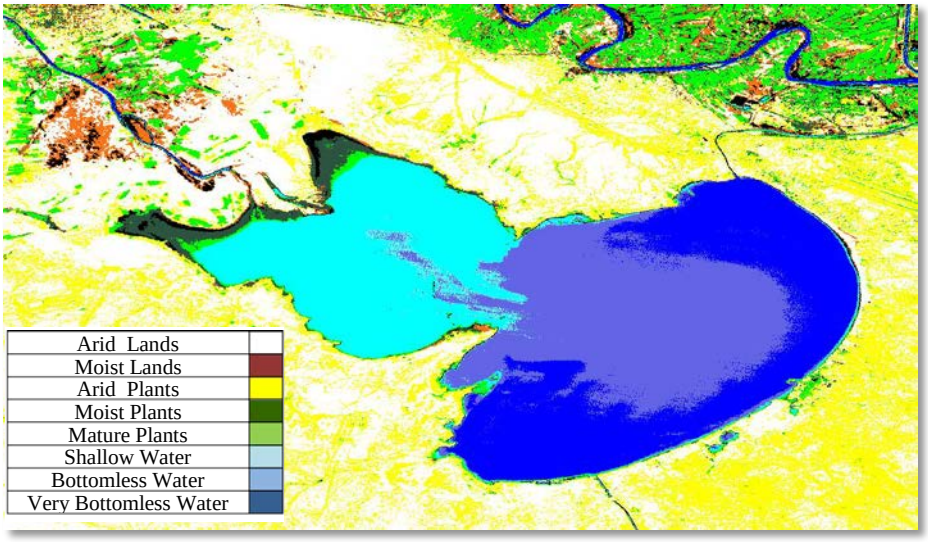

Fig. (2): Classified Image of Al habbinya Region with Two Image Classification Methods

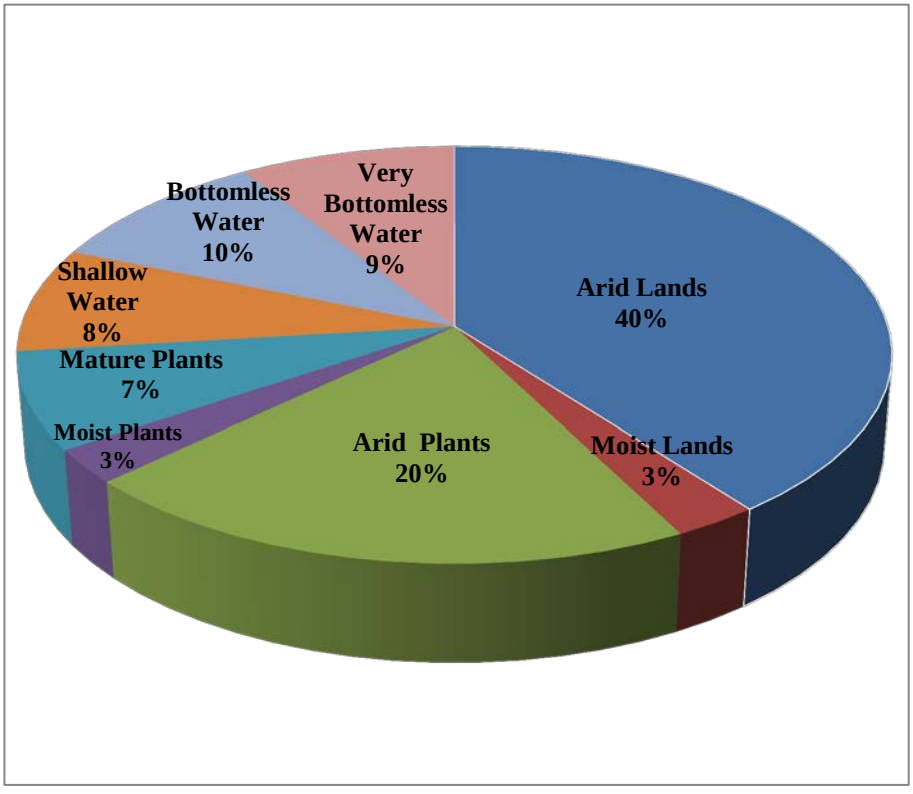

Fig. (3) : Centenary Ratios for Classified Image Features (Al habbinya Region)

تقانة مطورة جديدة لتصنيفِ صورة الأقمار الصناعيةِ لمنطقةِ الحبانية غرب العراق

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الخلاصة

قدم هذا البحث تقانة جديدة ومطورة لتصنيف الصور الفضائية، مستندة الى الدمج بين طريقة خط ارتداد افضل وطريقة الشروط التجريبية الجديدة لتمييزانواع أغطية الارض المختلفة لمنطقة الحبانية بوصفها طرائق تصنيف موجه. تعتمد هذه الطرائق على الخصائص الفيزيائية للارض التي تمثل انعكاسية معالم سطح الارض. تفصل الطريقة الاولى بين الاراضي القاحلة والنباتات. وتدرس الطريقة الثانية حد العتبات التجريبية لترابط حزم (TM) المختلفة (TM3، TM4 و TM5) لكشف وفصل مناطق المياه (الضحلة، العميقة، العميقة جداً). حسب معامل الدليل القصوي (OIF) لترابط الحزم المختلفة الآنفة الذكر التي حققت أعلى قيمة لل (OIF) وأقل ترابط من ترابط الحزم المختلفة الاخرى لل (TM). الدراسة تمت باستعمال برامج ArcGIS9.3 و ENVI 4.5 و لغة MATLAB7.9b.

الكلمات المفتاحية: معالجة وتحليل الصورة، التصنيف الموجه، الشروط التجريبيةِ، ArcGIS، الاستشعار عن بعد، متحسس الراسم ألغرضي TM.