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Monitoring of environmental variations of marshes in Iraq using Adaptive classification method.

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Abstract

The object of the presented study was to monitor the changes that had happened in the main features (water, vegetation, and soil) of Al-Hammar Marsh region. To fulfill this goal, different satellite images had been used in different times, MSS 1973, TM 1990, ETM+ 2000 and MODIS 2010. K-Means which is unsupervised classification and Neural Net which is supervised classification was used to classify the satellite images and finally by use adaptive classification which is apply supervised classification on the unsupervised classification. ENVI soft where used in this study.

Keywords: Al-Hammar marsh , k-mean , Neural net ,ENVI

مراقبة التغيرات البيئية لاهوار العراق باستخدام طريقة تصنيف مطورة

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المستخلص

مراقبة وحماية هور الحمار ومكوناته (ماء ونبات وتربة) هي الشاغل الرئيس للعديد من المؤسسات الدولية والمحلية. اقمار التحسس النائي عالية الدقة هي الاداة المهمة المستخدمة لجمع المعلومات عن الاهوار لتقييم مكوناته من ماء وتربة ونبات.

المنطقة المدروسة هي هور الحمار احد الاهوار الكبيرة في جنوب العراق. والذي يعتبر احد المناطق المهمة طبيعيا لاحتوائه على الاسماك والنباتات النادرة. استخدمت طريقة التصنيف (K-mean) وطريقة التصنيف (Neural Net) لتصنيف صور الاقمار الصناعية واخيرا استخدمت طريقة مطورة والتي تتضمن تطبيق طريقة التصنيف المرشد على صورة طبق عليها التصنيف غير المرشد. استخدم برنامج ال ENVI في هذا العمل.

Introduction

Solar radiation hitting a target surface, may be transmitted, absorbed or reflected. Materials reflect and absorb differently at different wavelength. The reflectance spectrum of a material is a plot of the fraction of radiation reflected as a function of the incident wavelength serves as a spectral signature for the material. Remote sensing means collection an information about any object at a distance without any physical contact with it, the physical role for recording the information in remote sensing about the target is achieved by the Electromagnetic Radiation (EMR) which is the only communication link

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between the sensor and the target and also the most important dynamic radiant energy made evident by its interaction in force fields [1].

Remotely sensed imagery can be made use in a number of applications, encompassing reconnaissance, creation of mapping products for military and civil applications, evaluation of environmental damage, monitoring of land use, radiation monitoring, urban planning, growth regulation, soil assessment, and crop yield appraisal [2].

In the present work, remote sensing techniques have been applied for environmental monitoring using ENVI software. Has been applied to both types of classification unsupervised classification and supervised classification.

The main objectives of the present work consist of three stage; first, apply unsupervised classification on the images ,second apply supervised classification on the images and Finally, save the image of unsupervised classification and considered as original image and then apply the supervised classification and then comparison between the results.

To fulfill this study, LANDSAT (MSS 1973, TM 1990, ETM+ 2000) and MODIS 2010, for Al-Hammar marsh are used.

The area of Al-Hammar marsh objects (water, vegetation, and soil) can be distributed statistically and the value of these areas can be noticed in tables for every method.

Study area description

Al-Hammar marshes situated almost entirely south of the Euphrates, extending from near al-Nasiriyah in the west to the outskirts of al-Basrah on the Shatt al-Arab in the east,Roughly located in the triangle between Nasiriyah, Basrah, and Qurnah. To the south, along their broad mud shoreline, Al-Hammar marshes are bordered by a sand dune belt of the southern desert, Estimates of this marsh area range from (2,800) $km^2$of contiguous permanent marsh and lake, extending to a total area of over (4,500)km^2 during periods of seasonal and temporary inundation. Al-Hammar lake, which dominates the marshes, is the largest water body in the lower Euphrates.

In 1973, it is approximately (120) km long and (25)km at its widest point. Slightly brackish due to its proximity to the Arabian Gulf, the lake is atrophic and shallow. Maximum depth at low water levels is (1.8)m and about three meters at high water mark. During the summer,large parts of the littoral zone dry out, and banks and islands emerge in many places. Fed primarily by the Euphrates River, which constitutes the northern limit of these marshes, these waters drain at Qarmat Ali into the Shatt al-Arab. A considerable amount of water from the Tigris River, overflowing from the central marshes, nourishes the Al-Hammar marshes [3]

The coordinates of Al-Hammar marshe are (30° 35′ to 31° 00′ N), (46° 25′ to 47° 45′ E), and its altitude mostly ranges between (4.5 and 9m.) above sea level.

Al Hammar marsh complex boasts one of the most important waterfowl areas in the Middle East, both in terms of bird numbers and species diversity. The vast and dense reed beds provide ideal habitat for breeding populations, while the ecotonal mudflats support shorebirds.

Globally significant concentrations of migratory waterfowl have been recorded during winter, and although not properly surveyed, the area is likely to host similarly high numbers during the spring and autumn seasons [4].

Figure 1- the Historic Extent of the Southern Marshlands [5].

Major Components of Remote Sensing System

In much of remote sensing, the process involves an interaction between incident radiation and the targets of interest. This is exemplified by the use of imaging systems where the following seven elements are involved. Note, however that remote sensing also involves the sensing of emitted energy and the use of non-imaging sensors[6].

1. **Energy Source** – the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.
2. **The Atmosphere**– as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.
3. **Interaction with the Target -** once the energy makes its way to the target through the atmosphere, it interacts with the target depending on the properties of both the target and the radiation.
4. **Recording of Energy by the Sensor -** after the energy has been scattered by, or emitted from the target, we require a sensor (remote - not in contact with the target) to collect and record the electromagnetic radiation.
5. **Transmission, Reception, and Processing -** the energy recorded by the sensor has to be transmitted, often in electronic form, to a receiving and processing station where the data are processed into an image (hardcopy and/or digital).
6. **Interpretation and Analysis -** the processed image is interpreted, visually and/or digitally or electronically, to extract information about the target which was illuminated.
7. **Application -** the final element of the remote sensing process is achieved when we apply the information we have been able to extract from the imagery about the target in order to better understand it, reveal some new information, or assist in solving a particular problem [6].

Image classification

Remote sensing image classification can be viewed as a joint venture of both image processing and classification techniques. Generally, image classification, in the field of remote sensing is the process of assigning pixels or the basic units of an image to classes. It is likely to assemble groups of identical pixels found in remotely sensed data into classes that match the informational categories of user interest by comparing pixels to one another and to those of known identity [7].

The statistical classification methods of remote sensing images are divided into two types:

1. Unsupervised classification : is the process that for remote sensing images without prior knowledge, only depends to the statistical difference of combination of different spectroscopic

data,and then validates ground objects according to the properties of various classified objects, Common unsupervised classification methods include K-means method, ISODATA method.

2. Supervised classification : is the process that for remote sensing images with prior knowledge,that is, corresponding ground objects type is known, so can judge the types of non-sample data according to the type characters of samples, There are different supervised image classification procedures : Parallelepiped , Maximum likelihood , The Mahalanobis Distance , The minimum distance, Spectral Angle Mapper , Binary encoding , Artificial Neural Networks and Support Vector Machine[8].

Aim of the study

This research aims to prove the ability of a software program to obtain the spectral reflectance signatures which are used in the classification of satellite images for land cover/land use purposes.

Also this study goal to support the sustainable management of Al Hammar marsh by monitor and assess baseline characteristics of the marshland conditions to provide objective and up to date information and to disseminate tools needed for assessment and management.And monitoring the important change include (water , vegetation , soil) for the period between 1973 to 2010 and this led to find the most important tools to develop this marsh.

Practical work

The most important step of any research is the construction of the data base, it is necessary to obtain accurate information. The available sources are satellite images, different satellite images had been used in different times:

1. The landsat image MSS 1973 as shown in figure -2 .

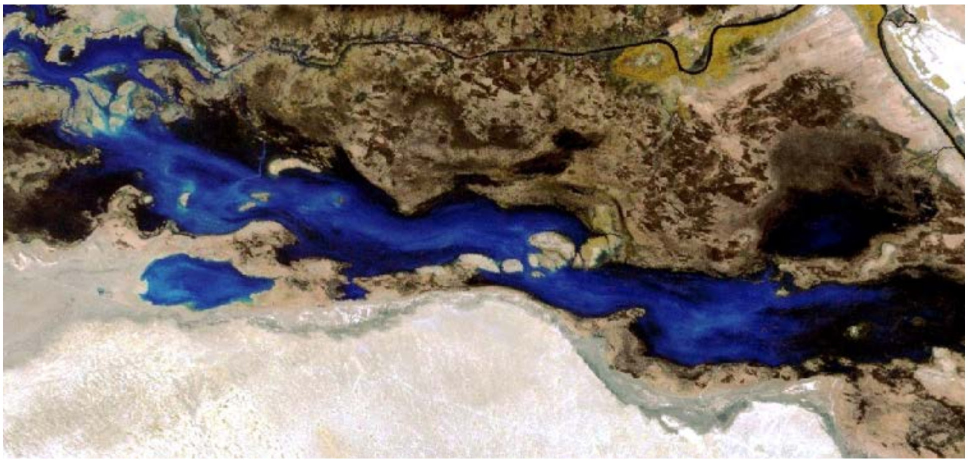

Figure 2- Represents the The landsat image MSS for 1973 year**.**

2. The landsat image TM 1990 as shown in figure -3.

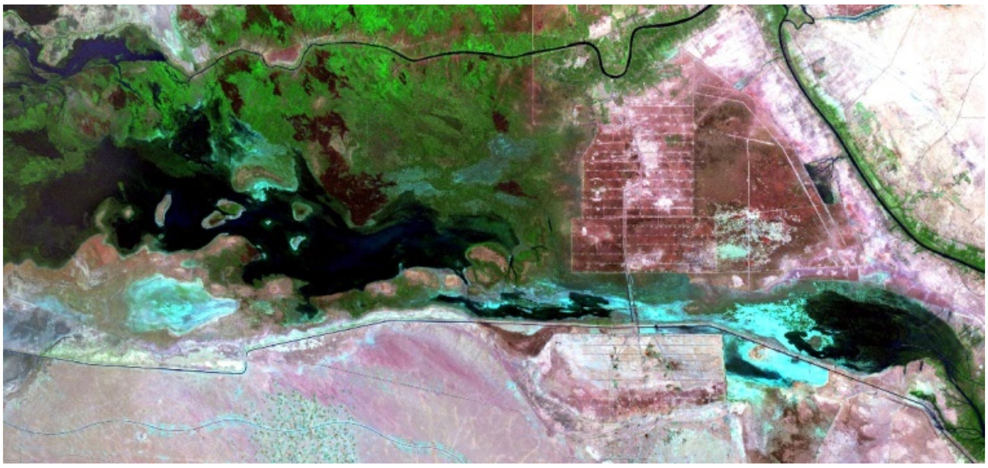

Figure 3- Represents the The landsat image TM in year 1990.

3. The landsat image ETM+ 2000 as shown in figure -4.

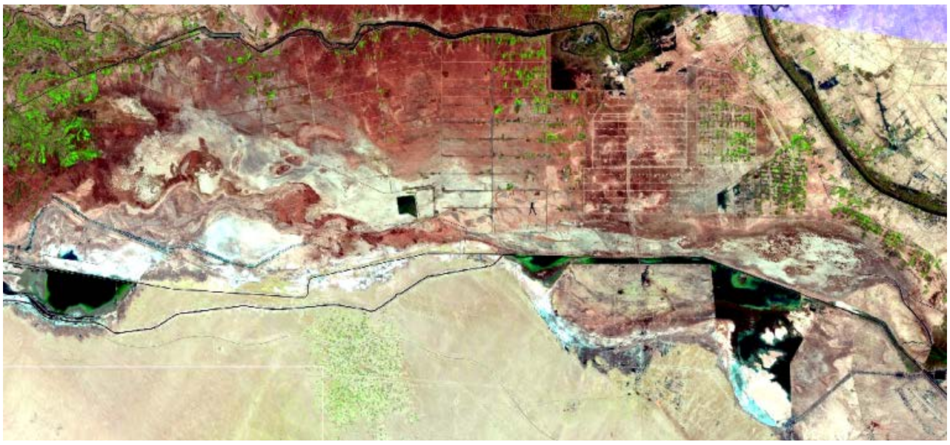

Figure 4- Represents the The landsat image ETM+ for 2000 year .

4. MODIS 2010 as shown in figure -5.

Figure 5- Represents the MODIS image for 2010 year .

K-Means method

K-Means unsupervised classification calculates initial class means evenly distributed in the data space,then iteratively clusters the pixels into the nearest class using a minimum-distance technique. Each iteration recalculates class means and reclassifies pixels with respect to the new means. All pixels are classified to the nearest class unless a standard deviation or distance threshold is specified, in which case some pixels may be unclassified if they do not meet the selected criteria. This process continues until the number of pixels in each class changes by less than the selected pixel change threshold or the maximum number of iterations is reached[9].

The results of this method for Al-Hammar marsh in years (1973 ,1990, 2000 , 2010) are shown in figures below:-

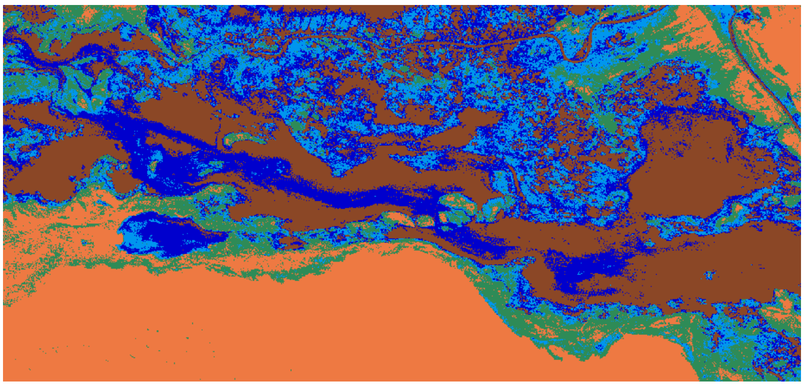

Figure 6- Represents the result of K-Means classification of 1973.

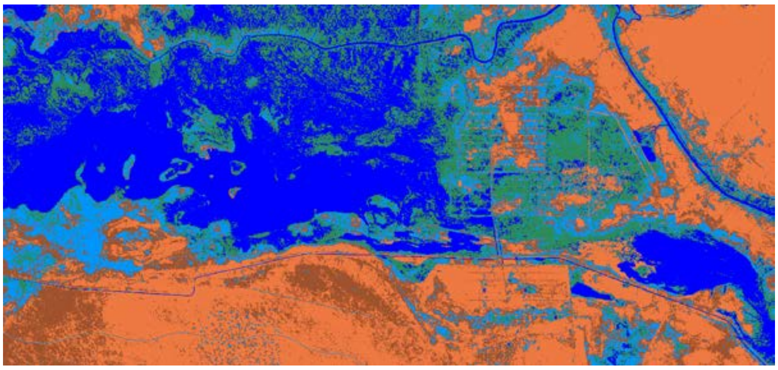

Figure 7- Represents the result of K-Means classification in 1990.

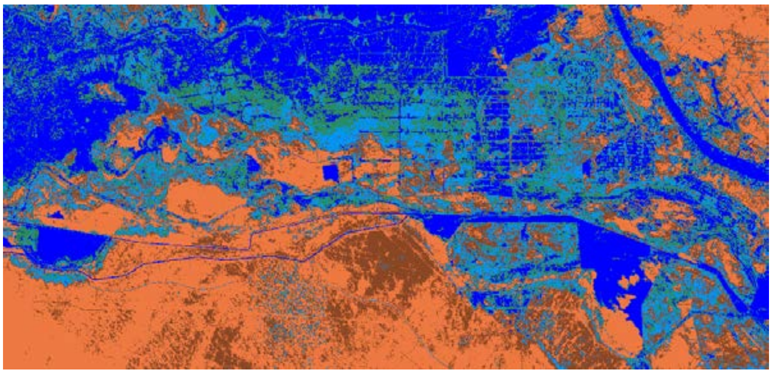

Figure 8- Represents the result of K-Means classification in 2000.

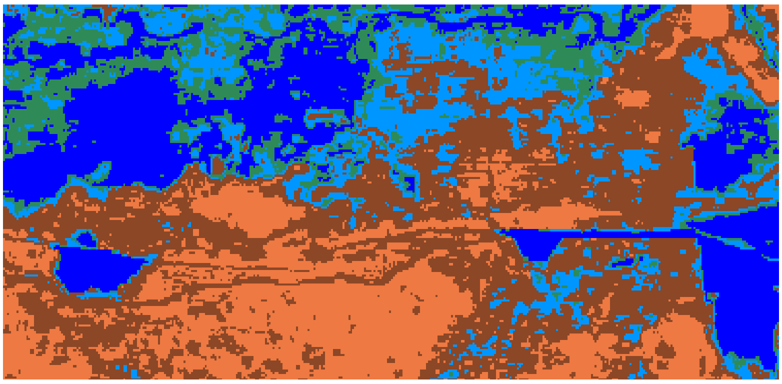

Figure 9- Represents the result of K-Means classification in 2010.

The area of Al-Hammar marsh objects (water, vegetation, and soil) for this method can be distributed statistically as shown in the figure -10 while the value of these areas can be noticed in the table -1.

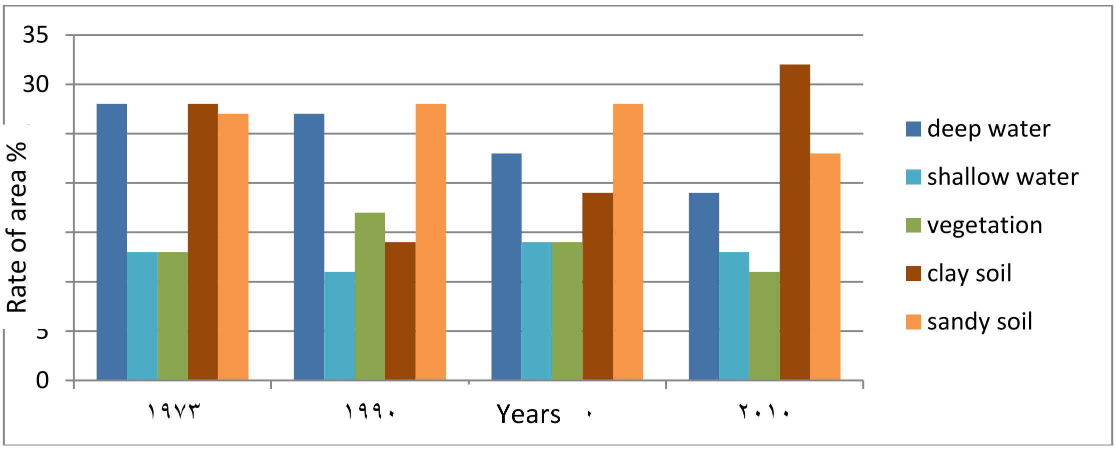

Figure. 10- Represents Al-Hammar marsh objects (vegetation, water, and soil) distribution for the results of K-Means classification.

Table 1- Shows the area distribution of Al-Hammar marsh objects (vegetation, water, and soil) for the results of K-Means classification.

year	deep water	shallow water	vegetation	clay soil	sandy soil
1973	28%	13%	13%	28%	27%
1990	27%	11%	17%	14%	28%
2000	23%	14%	14%	19%	28%
2010	19%	13%	11%	32%	23%

Neural Net method

Using the Neural Net to apply a layered feed-forward neural network classification technique. The Neural Net technique uses standard backpropagation for supervised learning. we can select the number of hidden layers and we can choose between a logistic or hyperbolic activation function. Learning occurs by adjusting the weights in the node to minimize the difference between the output node activation and the output. The error is backpropagation through the network and weight adjustment is made by using a recursive method. we can use Neural Net classification to perform non-linear classification.[10-11].

The results of this method for Al-Hammar marsh for years (1973 ,1990, 2000 , 2010) are shown in the figures below :

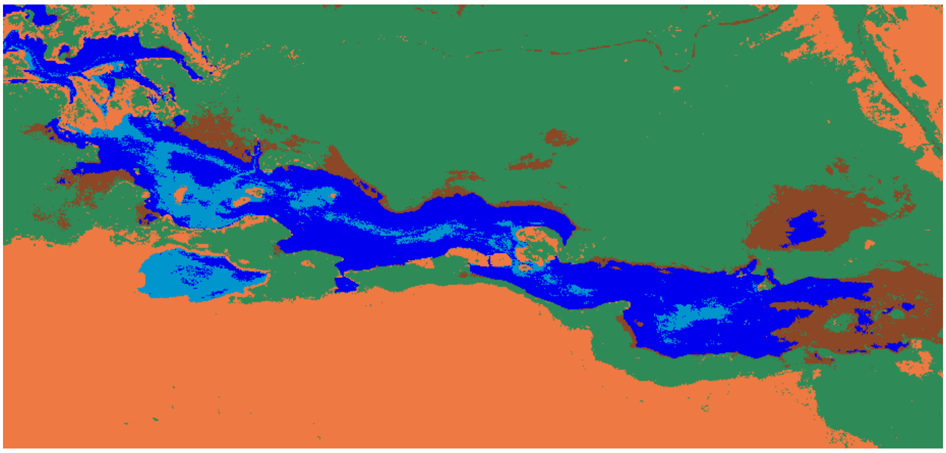

Figure 11- Represents the result of neural net classification in 1973.

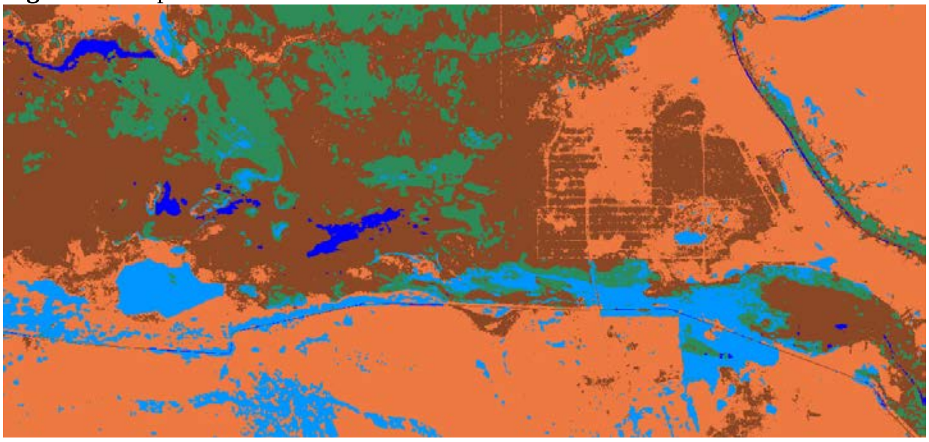

Figure 12- Represents the result of neural net classification in 1990.

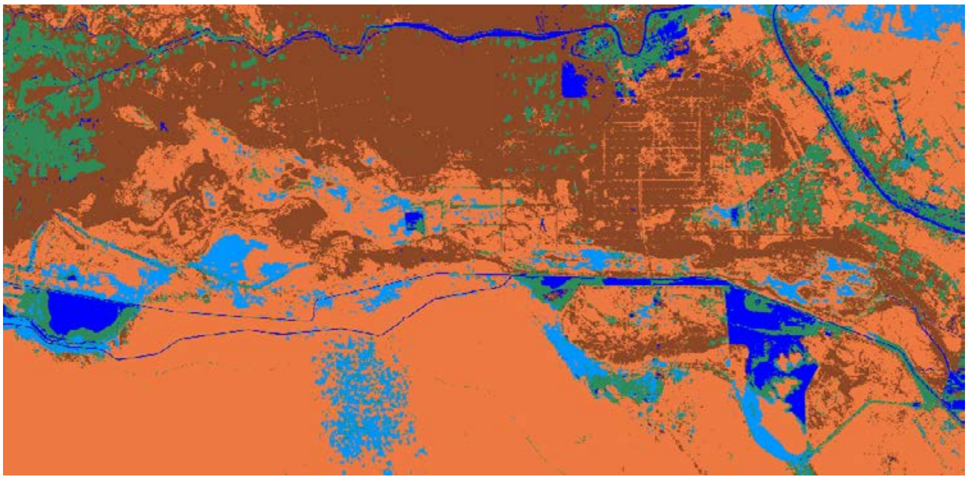

Figure 13- Represents the result of neural net classification in 2000.

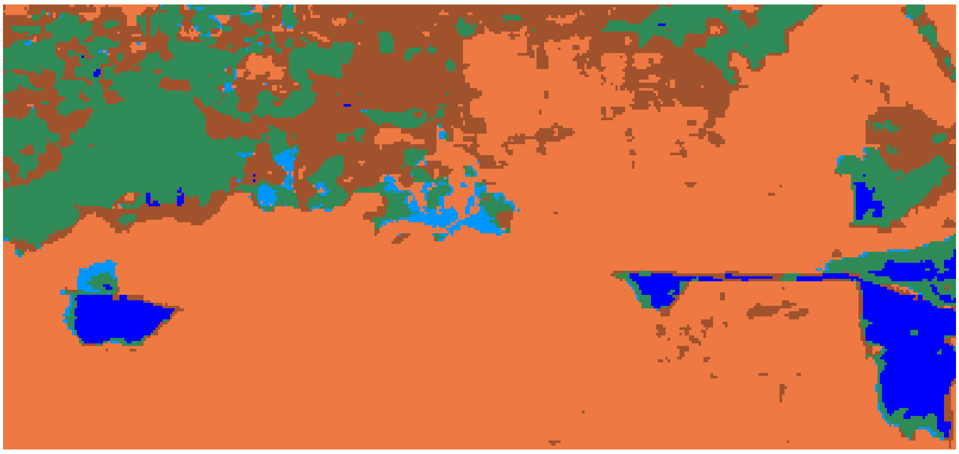

Figure 14- Represents the result of neural net classification in 2010**.**

The area of Al-Hammar marsh objects (water, vegetation, and soil) for this method can be distributed statistically as shown in the figure -15 while the value of these areas can be noticed in the table -2.

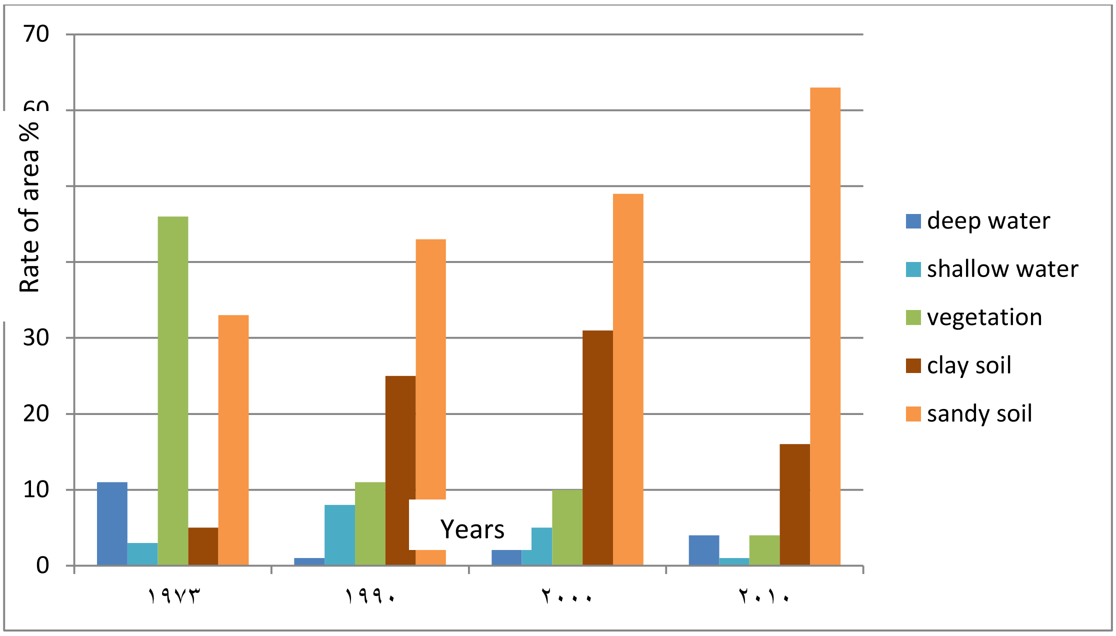

Figure. 15- Represents Al-Hammar marsh objects (vegetation, water, and soil) distribution for the results of neural net classification.

Table 2- Shows the area distribution of Al-Hammar marsh objects (vegetation, water, and soil) for the results of neural net classification.

year	deep water	shallow water	vegetation	clay soil	sandy soil
1973	11%	3%	46%	5%	33%
1990	1%	8%	11%	25%	43%
2000	3%	5%	10%	31%	49%
2010	4%	1%	4%	16%	63%

Adaptive classification

Adaptive classification technique has been adopted to achieve the classification process.This technique depend on both unsupervised and supervised classification, where the main lines of this technique can be summarized by saving the result image of unsupervised and depend it as orginal image then open it and apply supervised classification on it. Finally compare the result.
Consider the result of the K-Mean as an orginal image and apply on it each of the method of supervised classification.

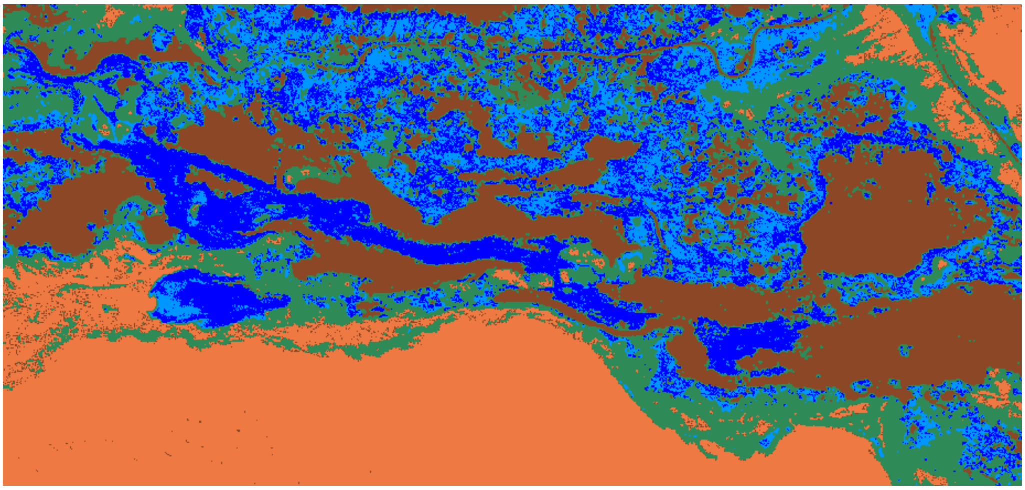

Figure 16-:Represents the result of K-Means neural net classification in 1973**.**

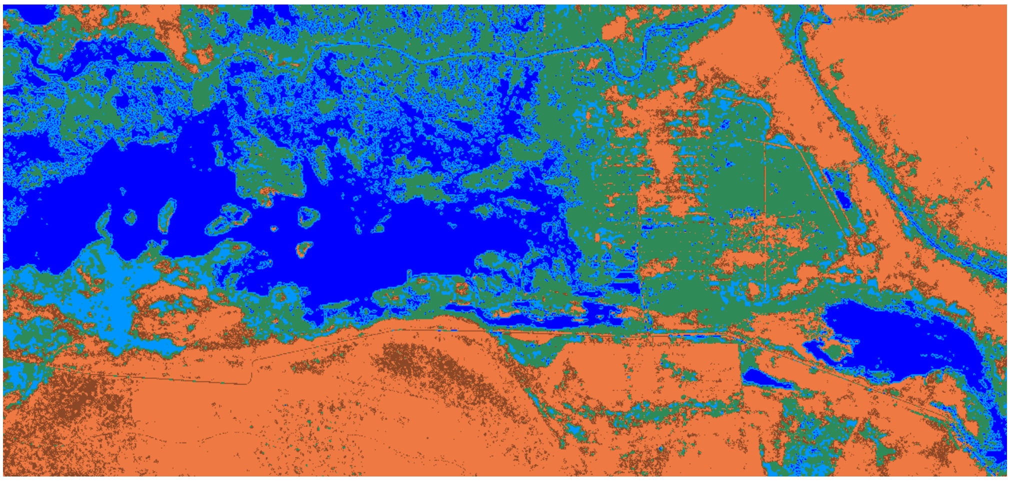

Figure 17-Represents the result of K-Means neural net classification in 1990.

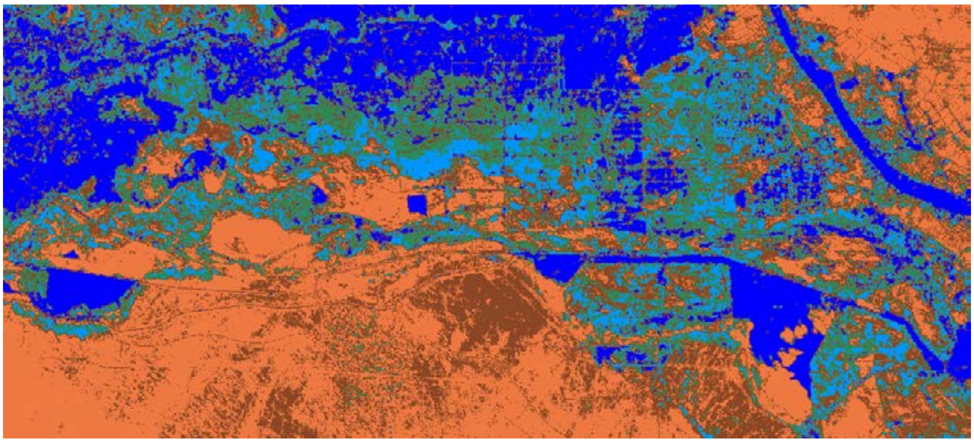

Figure 18- Represents the result of K-Means neural netclassification in 2000

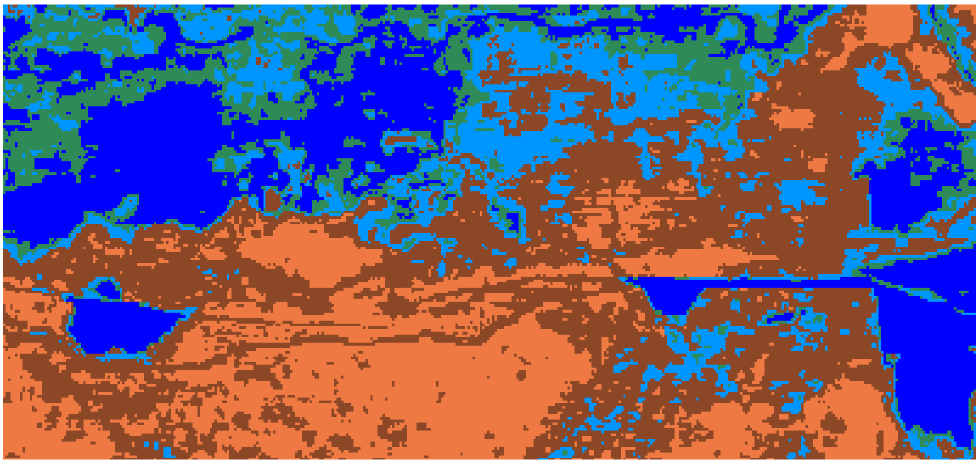

Figure 19-:Represent the result of K-Means neural net classification in 2010.

The area of Al-Hammar marsh objects (water, vegetation, and soil) for this method can be distributed statistically as shown in the figure (20) while the value of these areas can be noticed in the table -3.

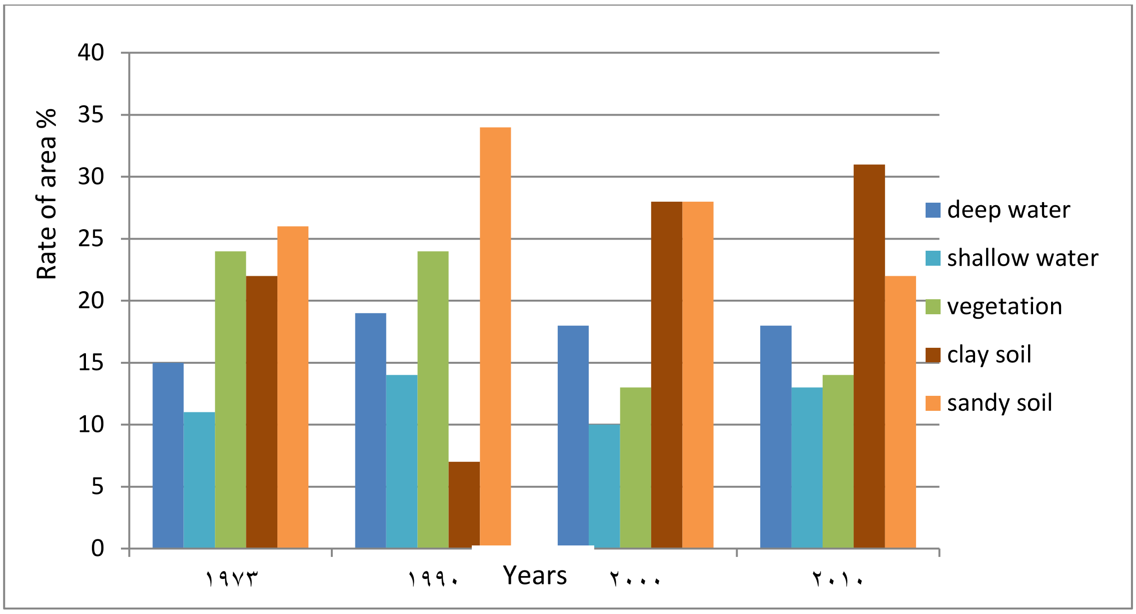

Figure. 20- Represent Al-Hammar marsh objects (vegetation, water, and soil) distribution for the results of K-Means neural net classification.

Table 3- Shows the area distribution of Al-Hammar marsh objects (vegetation, water, and soil) for the results of K-Means neural net classification.

year	deep water	shallow water	vegetation	clay soil	sandy soil
1973	15%	11%	24%	22%	26%
1990	19%	14%	24%	7%	34%
2000	18%	10%	13%	28%	28%
2010	18%	13%	14%	31%	22%

Discussion

Protecting and monitoring of AL-Hammar marsh objects (vegetation, water, and soil) is major concerns for many local and state agencies. High-resolution satellite remote sensing is an important tool that can potentially be applied to gather information needed for water, vegetation and soil area assessments in the marshes. The assessment has been achieved using classification methods and Adaptive classification technique has been adopted to achieve the classification process , When comparing the results with each other, find that the results of unsupervised classification methods did not give a good description of the studied area , as well as , Adaptive classification methods, Even when comparing the results of unsupervised with adaptive classification we find it close or identical despite the change in ROIs regions every time , In contrast the compartion the results of supervised classification we find it give a good and accurate description of the study area.

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