Using remote sensing techniques to monitoring and evaluate the water cover in AL_Razzaza lake: Iraq at deferent periods

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Abstract

Multi-spectral satellite images of the Landsat satellite by the tow sensitive Thematic Mapper (TM) and Thematic Mapper Enhancement (ETM+), which covered the study area located south east of Iraq. In this research; used the sixth thermal spectral band (Thermal Band) for study the water cover in the Al-Razzaza Lake located within the province of Karbala. We intended to study the cover a case of the study area, used satellite images showing the status of region during the period from 1990 to 2001 and 2007. From this study we conclude that cover the water of the study area change in sequence case to decrease during these years.

Key words

Remote sensing, water cover, Al-Razzaza Lake, Thermal Band, TM and ETM.

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استخدام تقنيات الاستشعار عن بعد لمراقبة وتقييم الغطاء المائي في بحيرة الرزازة: العراق لفترات زمنية مختلفة.

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الخلاصة

استخدمت صور فضائية متعددة الأطياف للقمر الصناعي (Landdsat) وبالمتحسسين (Thematic Mapper) و(Enhancement Thematic Mapper) لتغطية منطقة الدراسة الواقعة جنوب شرق العراق. واستخدمت الحزمة الطيفية الحرارية السادسة لدراسة حالة الغطاء المائي في بحيرة الرزازة الواقعة ضمن محافظة كربلاء، وتبين الصور الفضائية المستخدمة حالة المنطقة خلال الفترة من 1990 و2001 و 2007. من هذه الدراسة نستنتج إن الغطاء المائي لمنطقة الدراسة قد تغيير وبصورة متوالية نحو النقصان خلال السنوات المذكورة أنفاً.

Introduction

In the recent years various remote sensing techniques as well as geographical information systems have been widely used [1]. Wide area coverage, timely delivery, digital storage, low cost, repeatedly information acquisition also in areas with limited accessibility is of the advantages of remote sensing. Land cover, the composition and characteristics of land surface elements is key information for many scientific and policy purposes and for sustainable management activities [2, 3, 4, and 5]. Although land cove mapping is one of the earliest applications of remote sensing but the effect of a thermal band on classification accuracy and differentiation of land cover types still is not fully explored. The thermal band Landsat-7, ETM+6 is measuring the reflected solar radiation of electromagnetic radiation from 10.40 to 12.50 µm. Thermal sensors essentially measure the surface temperature and emitted radiation of targets but reflective bands measures the spectral reflectance of the surface at different wavelengths. Thermal band data is potentially useful, highlighting reductions in temperature associated with recent irrigation, and earth's surface and land cover, with the possibility of its use for water control and the different stages of the crop growth[6].

A classic example of such integration would be a land cover/land use change study: the resolution of the Landsat-7 data doesn't allow for detailed discrimination between features in the way that aerial photography or field surveys do. However, the availability of multi-spectral data can help better identify certain features and their condition (vegetation health monitoring). The availability of repeat coverage over a certain area will then permit the production of land cover maps for different periods and thus aid change detection studies. Changes that might be of interest are able to range from short-term phenomena like flooding or snow cover to long-term phenomena like urban sprawl or deforestation. Vegetation health monitoring can also be performed using images from different seasons. This could be useful in urban vegetation studies or to relate air pollution and vegetation health. The ETM+ instrument is an eight-band multi-spectral scanning radiometer capable of providing high-resolution image information of the Earth's surface. It detects spectrally-filtered radiation at visible, near-infrared, short-wave, and thermal infrared frequency bands from the sun-lit Earth. Nominal ground sample distances or "pixel" sizes are 49 feet (15 meters) in the panchromatic band; 98 feet (30 meters) in the 6 visible, near-wave, and short-wave infrared bands; and 197 feet (60 meters) in the thermal infrared band [7].

1.2 The Landsat-7 ETM+ System and Remote Sensing of Surface Water Bodies

Landsat-7 was launched in April 1999 and is currently the latest platform of the Landsat program12 that started in 1972. It carries the "Enhanced Thematic Mapper Plus" (ETM+) sensor, a passive, optical across-track-scanner, which records the reflected portion of the electromagnetic radiation, and the earth's emitted radiation in the thermal band, respectively. With an inclination to the equator of 98.2° and an equatorial crossing time at 10:00am +/- 15 min (descending node), Landsat-7 belongs to the near-polar, sun-synchronous orbiters. Orbiting at an altitude of 705km, it has a period of revolution of 99 minutes and repeatedly covers an area every 16 days.

Table 1: Spectral and Spatial Resolution of the Landsat-7 ETM+ Sensor*

Band	Sensitivity (µm)	Normal Spectral Location	Spatial Resolution (m)
1	0.45-0.52	Blue	30
2	0.52-0.60	Green	30
3	0.63-0.69	Red	30
4	0.76-0.90	NIR	30
5	1.55-1.75	(SWIR) MIR	30
6	10.4-12.5	TIR	60
7	2.08-2.35	(SWIR) MIR	30
8	0.50-0.90	Visible+NIR	120

NIR=Near Infrared, SWIR= Short Wave Infrared, TIR= Thermal infrared. *Adapted by [8].

The spectral and spatial resolutions of Landsat-7 are denoted in Table 1. For the benefit of a continuous comparable dataset, the sensitivities or bandwidths of the bands one through seven abut on those of ETM+'s predecessor Thematic Mapper (TM), which was mounted on Landsat-4 and 5. While the resolution of the visible and infrared bands remained unchanged at 30 m, the resolution of the thermal band six was increased from 120 to 60 m. additionally; a panchromatic eighth band with a resolution of 15 m was introduced to the ETM+ sensor [9].

Thermal infrared images add another dimension to passive remote sensing techniques. They provide information about surface temperatures and the thermal properties of surface materials. Many applications of thermal infrared images are possible, including mapping rock types, soils, and soil moisture variations, and monitoring vegetation condition, sea ice, and ocean current patterns. Thermal images also can be used in more dramatic circumstances to monitor unusual heat sources such as wildfires, volcanic activity, or hot water plumes released into rivers or lakes by power plants. The Earth's surface emits EM radiation in the thermal infrared wavelength ranges determined by typical surface temperatures. Most thermal infrared images are acquired at wavelengths between 8 and 14 μm, a range that includes the peak emissions. Nearly all incoming solar radiation at these wavelengths is absorbed by the surface, so there is little interference from reflected radiation, and this range also is a good "atmospheric window". The natural sources that heat the Earth's surface are solar energy and geothermal energy (heat produced by decay of radioactive elements in rocks). Geothermal heating is much smaller in magnitude and is nearly uniform over large areas, so solar heating is the dominants source of temperature variation for most images. The daily solar heating of the surface is influenced by the physical and thermal properties of the surface materials, by topography (slopes facing the sun absorb more solar energy), and by clouds and wind.

The brightness values in a thermal image measure the amount of energy emitted by different parts of the surface, which depends not only on the material's temperature, but also on a property called emissive. Emissive describes how efficiently a material radiates energy compared to a hypothetical ideal emitter and absorber, called "a blackbody". Emissive is defined as the ratio of the amount of radiant energy emitted by a real material at a given temperature to the amount emitted by a blackbody at the same temperature. Emissive is wave-length dependent, so materials can be characterized by an emissive spectrum just as they are by a reflectance spectrum. Most natural materials are relatively strong emitters. Average emissive values for the wavelength range from 8 to 12μm vary from 0.815 for granite rock to 0.993 for pure water [10]. Detailed water consumption maps can be made quickly and easily with Landsat-7 because of its 30 m spatial resolution and thermal imaging capability. Landsat-7 has been proclaimed "the best and least expensive way to quantify and locate where water is used and in what quantity", by Anthony Morse and Richard Allen, two water management specialists from Idaho [11]. "Satellite imagery, especially in the thermal bands, can and will revolutionize the establishment of water rights in the many parts of the world where they are insecure", says Perry, who has worked on many water resources projects in developing countries [12].

Main Objectives

1- Monitoring the water cover in the study area.

2- Compare the distribution of water area in three deferent periods (1990, 2001 and 2007).

Material and Methods

1. Study area

The study area (Al-Razzaza lake) is located in the south-west of Iraq, as part of the provinces of Karbalaa and Anbar. Geographically within coordinates (Path 169 and Row 37). The area of the study area (approximately 0.6859) hectares, as to the climate, the annual average temperatures of up to (30.8˚C), the rain is few, annual average rainfall to (7.74mm). The attributes of this region as having a dry climate in summer, cold winter a little rainy, see Fig. (1).

2. Data source

Three scene of Landsat (TM and ETM+) image acquired on 1990, 2001 and 2007 (Path 169/Row 37) was applied in this study, were used to monitor the patterns of annual changes in water cover using ArcGIS program V.9.3. The geometric correction was doing with correct coordinate system (WGS_1984_UTM_Zone_38N) measure unit in meters, see Fig. (2).

3. History of lake

It's the natural low ground, draws its water from water surplus of the needs and energy storage Al-Habbaniyah lake across Al-Warrar adjuster. Its considering of the closed lakes also derived its waters in permanent case from the water taps Husseiniya. This is leading to increased salinity of the lake water and

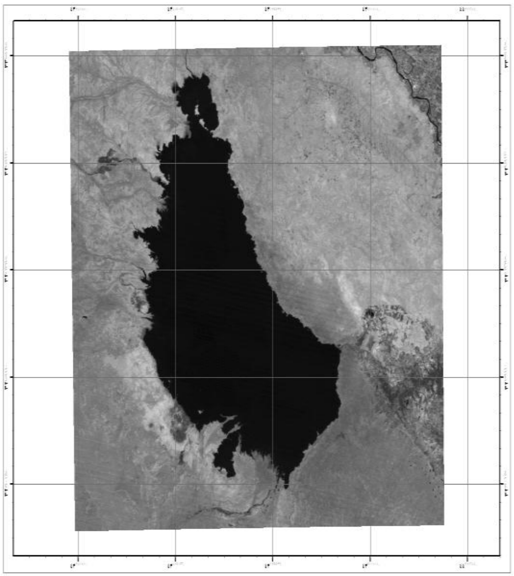

Figure (1): Map of study area [13].

classification of lakes Salt water, thus become a suitable environment for growth and reproduction of any marine fish. Al-Razzaza water in deteriorate continues as a result of being replenished by water from Al-Habbaniyah lake, without any discharge to another place to improve the reality of water. Al-Razzaza lake as pot enter the water and evaporates because it is flat water and increasing salt concentration which then is added the amount of water and evaporate also so that the salt lake is not tolerate salinity aquatic organisms even at the most after the other years will be salted.

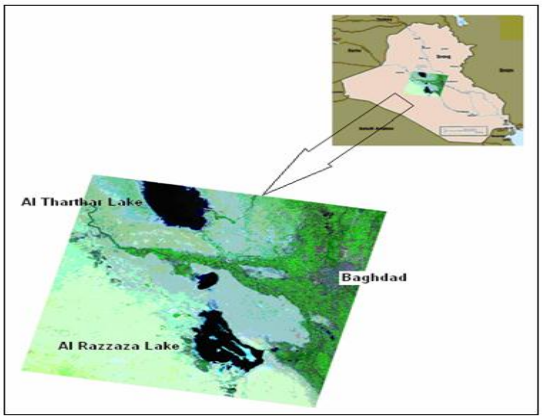

Figure (2): Satellite image (Landsat) show the study area in 1990 [13].

4. Classification process

Remote sensing classification is a complex process and requires consideration of many factors. The major steps of image classification may include determination of a suitable classification system, selection of training samples, image preprocessing, and feature extraction, selection of suitable classification approaches, post-classification processing, and accuracy assessment. Classified satellite image of the study area by using supervised method theory of Maximum Likelihood. The Maximum Likelihood classifier (MLC) takes the class variability in to account. The MLC classifier considers the cluster centre, its shape, size and orientation. This can be executed by computing a statistical distance recognized on the mean values of the classes and the covariance matrix of the clusters. The pixel is assigned to the class to which it has the highest probability. The user's need, scale of the study area, economic condition, and analyst's skills are important factors influencing the selection of remotely sensed data, the design of the classification procedure, and the quality of the classification results. This section focuses on the description of the major steps that may be involved in image classification, the chart(1) and Fig.(3) shows the steps of classification are show by the flowchart below.

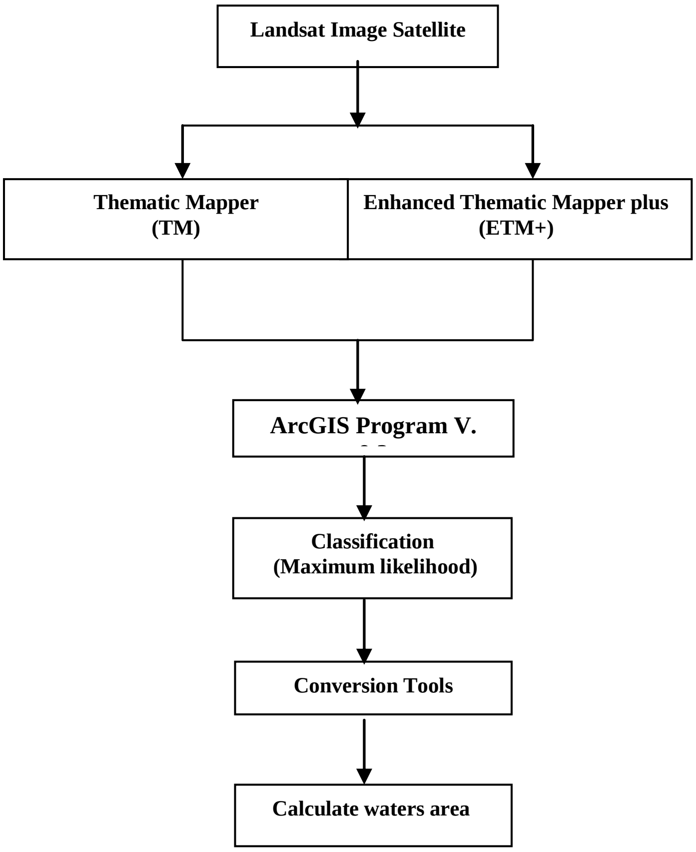

Chart (1): Explains of steps of analysis.

Results and Discussion

The classification process was applied on image satellite using a geographic information systems program, for the three periods to the spectral thermal bands. In order to isolate the areas of water and monitoring the area covered by water. Then compared the results of classification for each year in successively with the other year, the classification results indicated the presence of a sequential decline in the water area of the Al-Razzaza lake for the three years. The water area of the Al-Razzaza lake It is supplied in the year 1990 (0.154386299) hectare, Fig. (4). In the year 2001, the water area of the lake has decreased from 0.154386299 hectare

to (0.111895807936) hectare, Fig. (5). In year 2007 the lake water has continued to decline in the area (0.0725092871415) hectare, Note figure (6) and Table (2).

In relative terms, the percentage of water area to land area of the study area in 1990 (22.5%), and in 2001 (16.31%), either in the year 2007 (10.57%), figure(7). This decrease in water area of Al-Razzaza lake due to many reasons, most prominent of these reasons is the high temperatures in the summer season, which leads to high rates of evaporation of water surface. At the same time, lack of rainfall in this period sequence, leading to a reduction in the amount and area of the lake water. We therefore call upon approaching concerned (Ministry of Water Resources and the Ministry of Environment and the Ministry of Industry and Minerals/ Geological urvey) to develop solutions and address the phenomenon of drought, the lake water, which is reflected in the agricultural and economic activity and tourism.

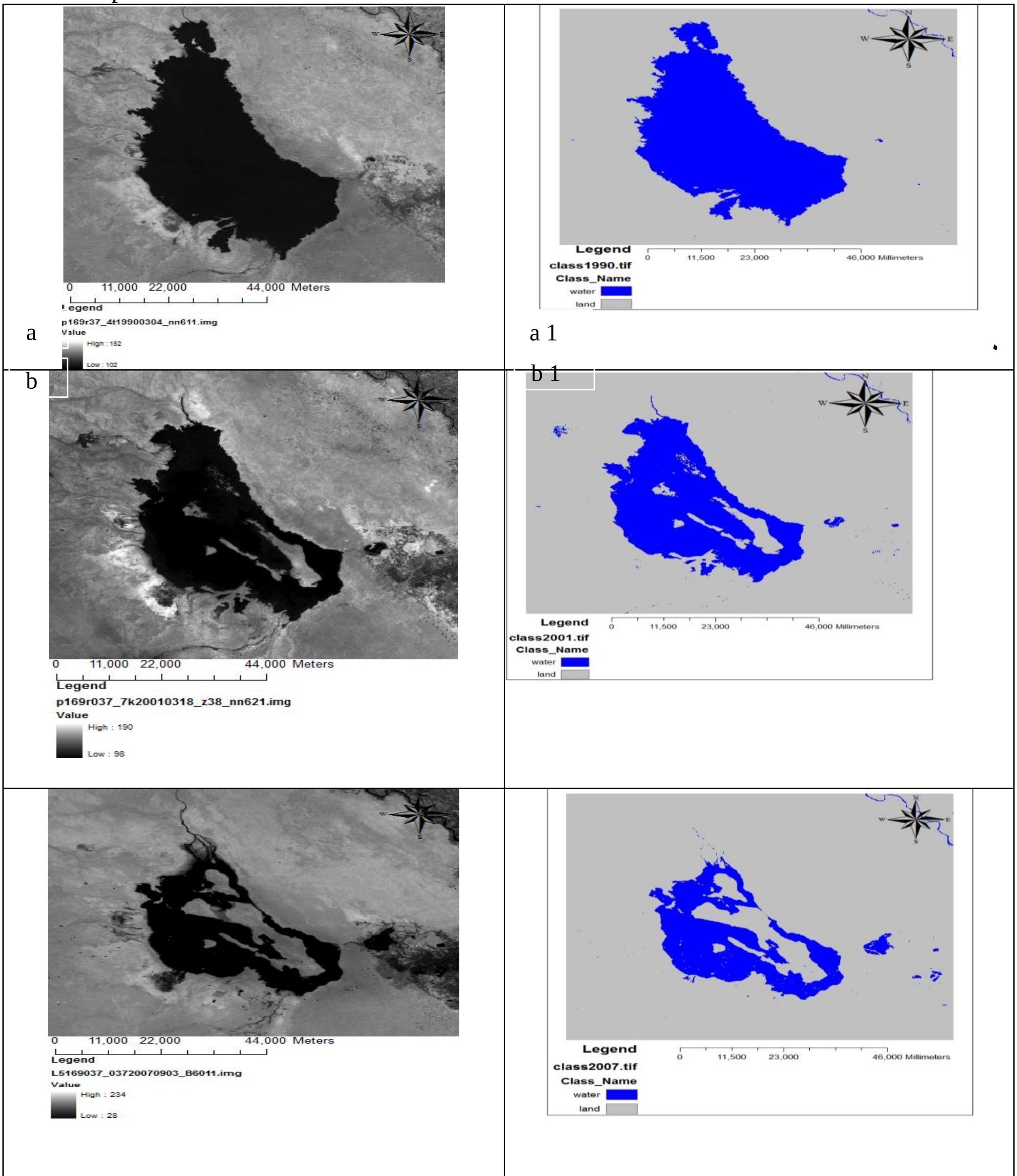

Figure (3): Original sat. Image (Landsat) and classified satellite image of the study area [13].
(a)/ (a1): Original/ classified sat. Image of the study area in period March 1990
(b)/ (b1): Original/ classified sat. Image of the study area in period March 2001
(c)/ (c1): Original/classified sat. Image of the study area in period March 2007

Table (2): The total/ water area and its percentage.

The period	Total area (Hectare)	Water area (Hectare)	The percentage of Water area from total area
1990	0.6859	0.154386299	22.5%
2001	0.6859	0.111895807	16.31%
2007	0.6859	0.072509287	10.57%

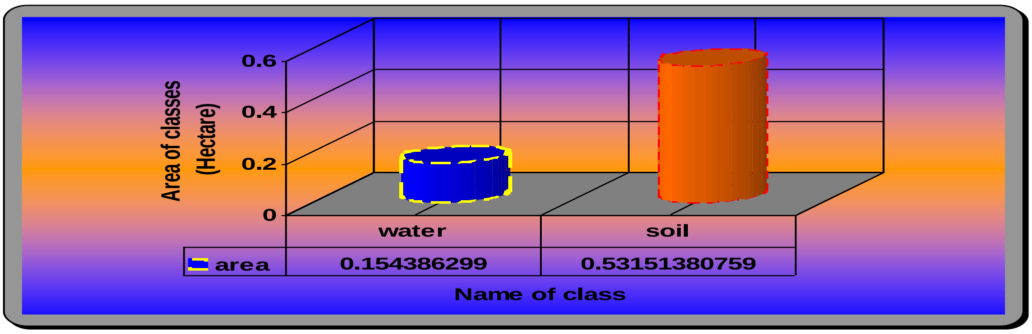

Figure (4): Study area in period 1990.

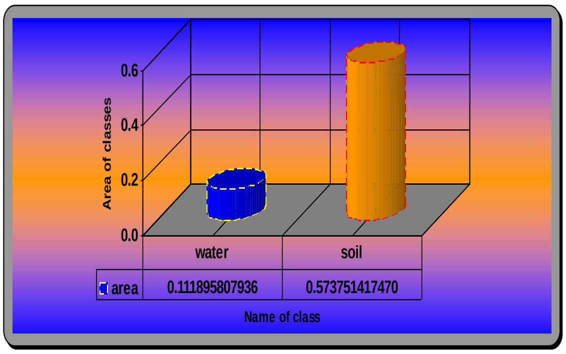

Figure (5): Study area in period 2001.

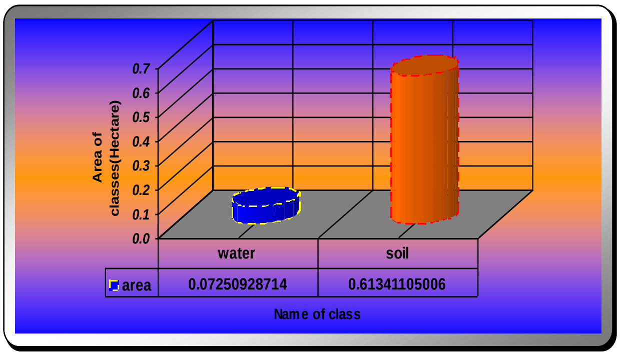

Figure (6): Study area in period 2007.

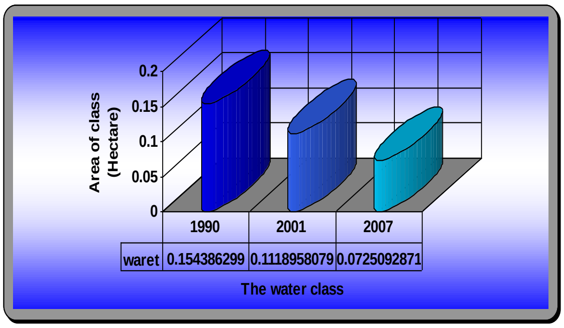

Figure (7): The water classes in study area at the three periods.

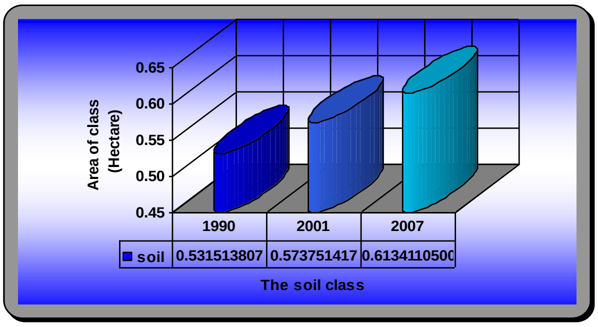

Figure (8): The soil (land) classes in study area at the three periods.

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