

## Estimation Area and Density of Date Palm Trees in Semawa City by Remote Sensing Data and Geographic Information System (GIS)

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### Abstract

This study was carried out to estimate area, trees number, and density in addition to productivity of date palm trees in Semawa-Iraq city using Remote Sensing data and Geographic Information System. Study area was (3446) Km<sup>2</sup>. Normalized Difference Vegetation Index (NDVI) was used to create a map and extract the plant cover in the study area. A process of digital classification has been performed for NDVI and Landsat 8 image for extract date palm trees from it, depend on ground truth and Quick bird image, in addition to Google earth images of 2014 for inferred of date palm trees through these images and extract spectral reflectance values for date palm trees of it. The results of analysis illustrated that total area of date palm trees in the city was about (57) Km<sup>2</sup>, the total number of date palm trees was about 1198425 trees, with density equal to (21025) tree per square Kilometer. The total productivity of the dates in the study area was (53,244) Ton.

**Keywords:** Google Earth, Landsat, Date Palm, Quick Bird, and Semawa.

### تقدير مساحة وكثافة اشجار النخيل في مدينة السماوة باستخدام بيانات التحسس النائي ونظم المعلومات الجغرافية

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بغداد - العراق

### الخلاصة

أجريت هذه الدراسة لغرض تخمين مساحة وعدد اشجار النخيل وكثافتها بالإضافة الى الانتاجية الكلية للتمر في مدينة السماوة - العراق باستخدام بيانات التحسس النائي ونظم المعلومات الجغرافية. وكانت مساحة منطقة الدراسة (3446) كيلومتر مربع. حيث تم استخدام الدليل النباتي لاستخراج الغطاء النباتي في المنطقة. استخدمت عملية التصنيف الرقمي للدليل النباتي وصورة القمر الصناعي لاندسات 8 لاستخلاص اشجار النخيل منها اعتمادا على البيانات الارضية من خلال العمل الحقلية وصورة القمر الصناعي كوك بيرد وصور الكوكل ايرث لعام 2014 لغرض المطابقة واستخراج قيم الانعكاسية الطيفية لاشجار النخيل منها. بينت النتائج بان المساحة الكلية لاشجار نخيل التمر في المدينة هي حوالي (57) كيلومتر مربع والعدد الكلي لاشجار النخيل حوالي (1198425) نخلة وكثافة 21025 نخلة في الكيلومتر المربع الواحد. بلغت الإنتاجية الكلية لمحصول التمر في منطقة الدراسة (53,244) طن.

**الكلمات المفتاحية:** كوكل ايرث، لاندسات، نخيل التمر، كوك بيرد والسماوة.

## Introduction

Date palm is one of the main fruit crops of arid climate areas. It is considered of major Socio-economic significance in the Arabian area. Iraq is famous as the greatest producer of dates in the world. Wars on Iraq have negatively influenced both the production and natural genetic variety of the crop in country (Kareem, *et al*, 2016). Iraq is considered as the date palm native land. It was the cultivation center of this type of crops. It is thought that the origin of this tree is Mesopotamia (Khierallah, *et al*, 2014). Iraq was one of the most important producers of date in the world. Many factors negatively have influenced both the production and natural variety of the crop. But efforts are being made by the Iraqi researchers and authorities to recompense for the serious damages on the date palm over the past thirty years (Al-Khayri, *et al.*, 2015). The date is an old crop which has been grown in many countries such as North Africa and countries of the Middle East for 5000 years. The number of date palm trees is to be around twenty-two million, covering more than 120000 hectares. The date is considered important source of food for the local population in the Middle East countries. Date palm trees supply preservation against land desertification and degradation (Shareef and Hasan, 2020). In the last years, plantations of date palm in Iraq were suffered from degradation because of an overall exploitation resulting from the increase in the human and animals' population. Also, thirty percent of the production can be lost due to diseases and pests. Socio-economic and technical factors have been engaged to the decrease of date production (Zabar and Borowy, 2012). Palm trees take up a significant place especially in deserts and oases areas due to their distinct shape that enabled them to acclimate to these severe climatic regions (Murad and Al-Dulaimy, 2021). Because of development in satellite

images and remote sensing techniques, so this study was made for show the ability of these techniques in determination and calculate the area and number of date palm trees in one of the most important Iraqi cities, a Semawa city, which is famous for the cultivation of palm. Where, number of date palm trees in Semawa city has been reached to about 612 389 Palm occupies an area of 17 384 acres in year 2010 (Tomas, 2012) and 1195101 in year 2013 (A.S.D, 2013).

This study aimed to estimate area, trees number, and density in addition to productivity of date palm trees in Semawa city using Remote Sensing data and Geographic Information System.

## Materials and Methods

In this study, which is carried out based on the visual interpretation and digital processing procedures. The date palm trees during season 2014 in Semawa city was detected and identified by using the digital images of Landsat 8 and quick bird, and Google earth 2014.

## Boundaries of Study Area

The area of study is the Semawa city in the south of Iraq, 280 Kilometers southeast of Baghdad. It is the modern center of the Al-Muthanna Governorate. It is located midway between Baghdad and Basra, at the northern edge of the governorate. It is bounded by the coordinate from (493459.257 to 576306.472) Easting and from (3413051.769 to 3512101.384) northing within UTM coordinate system. It covers an area of 4955 Km<sup>2</sup> as shown in Figure (1).

## Software Package

ArcGIS 10.4 and Erdas Imagine 2014 have been used to manage and analysis the thematic and raster data in this study.

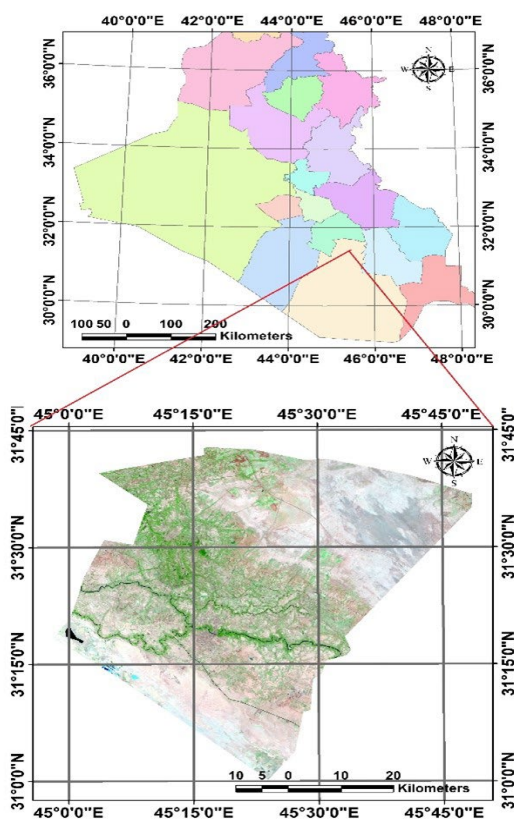


Figure (1) Boundaries of Study Area.

**Satellite Data**

Landsat 8, quick bird, and Google earth images were used in this research. These images acquired in December 2014. Three scenes of Landsat 8 images were covered the study area as shown in Figure (2) (<https://earthexplorer.usgs.gov>).

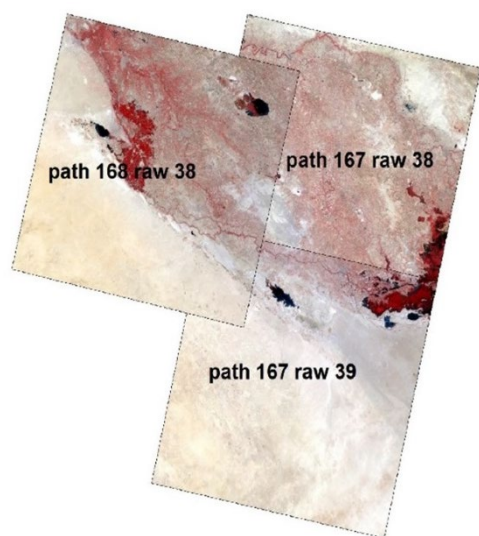


Figure (2) Scenes of Landsat 8 Images of Study Area 2014.

**Preprocessing**

**Radiometric Correction**

The aim of this procedure is to convert the measured values of brightness into Atmospheric reflectance (TOA). It is significant when making multispectral mosaic because it decreases differences between images, due to differ of solar zenith angle, sensors, and Earth-sun distance. This procedure can be done by the following equations (<https://www.Landsat.org>):

$$R_o = M * \bar{Q}_{cal} + \bar{A} \dots\dots\dots (1)$$

Where:

$R_o$ : TOA planetary reflectance ( $R_o$  Does Not Contain a Correction for the Angle of Sun).

$M$  = Multiplicative rescaling factor for specific band

$\bar{A}$  = Additive rescaling factor for specific band

$\bar{Q}_{cal}$  = Pixel values for standard product

Reflectance value after sun angle correction can be computed by:

$$\mathcal{R} = R_o / \sin(\theta) \dots\dots\dots (2)$$

Where:

$\mathcal{R}$  = TOA planetary reflectance

$\theta$  = Local sun elevation angle

**Registration**

Registration of Landsat 8 image was based on fifteen control points selected from intersections of rivers and roads in the region. Satellite images were geometrically corrected in the projection U.T.M zone 38N with datum WGS84. Image to image registration was made for registration the Landsat 8 image 2014 with Quick Bird image 2014 (Reference Image). RMS error was 0.41 meter for Landsat 8 image.

### Extraction of Study Area

The area of study consists or covered by three Landsat images, so the merging process by mosaicking method was made to create one image from these images, and then the selected area for this study was extracted from the result of mosaicking method. The results shown in Figure (3).

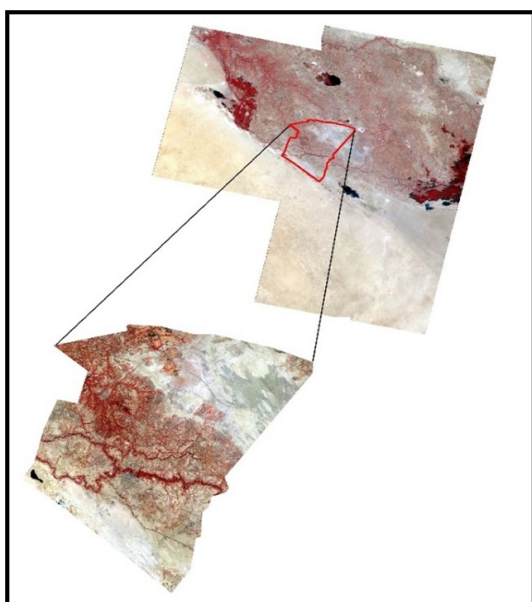


Figure (3) Extraction of Study Area.

### Normalized Difference Vegetation Index (NDVI)

This index is used to extract planet or vegetation values from satellite images. It is calculated by (AL-Hmedawy, 2008).

$$NDVI = \frac{N_{IR} - R_{ED}}{N_{IR} + R_{ED}} \dots\dots\dots (3)$$

Where  $N_{IR}$  and  $R_{ED}$  are near infrared and red bands of Landsat images respectively. The NDVI result is ranged between (1 to -1). In this study, the NDVI was applied for extract vegetation cover in the study area within the year 2014. For Palm trees, locate, extent, and detect NDVI in the study area was used. The resultant NDVI Images in Figure (4). It has grey scale interval from minus one to plus one. The brighter values indicate green vegetation, while the darker values have little or no vegetation. The raster map was divided

into two classes depending on its histogram using the 0.09 as a threshold number.

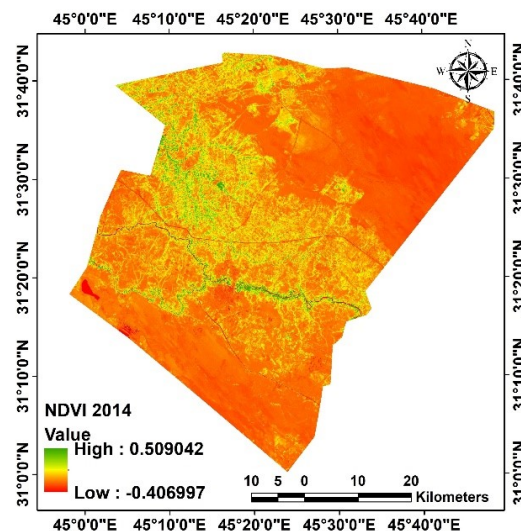


Figure (4) NDVI of Study Area 2014.

### Principal Components Analysis (PCA)

This technique is used to compression image data. It allows to compact excessive data into fewer bands or reduce the dimension of data. The image bands in PCA are independent (None Correlated) and more interpretable than the source data (Jensen, 1996). This study used this technique to compact redundant data into fewer bands and then the result was used in classify Landsat image within the year 2014 as shown in Figures (5 and 6).

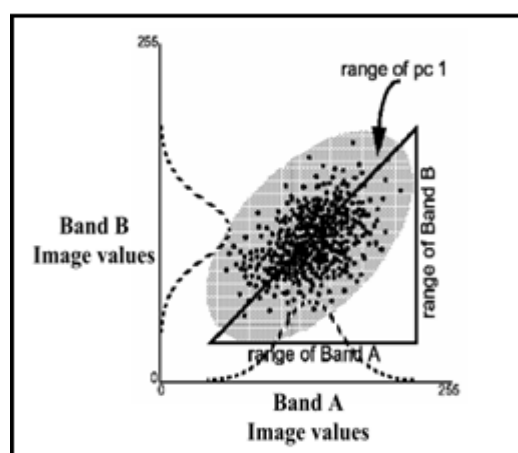


Figure (5) Range of First Principal Component.

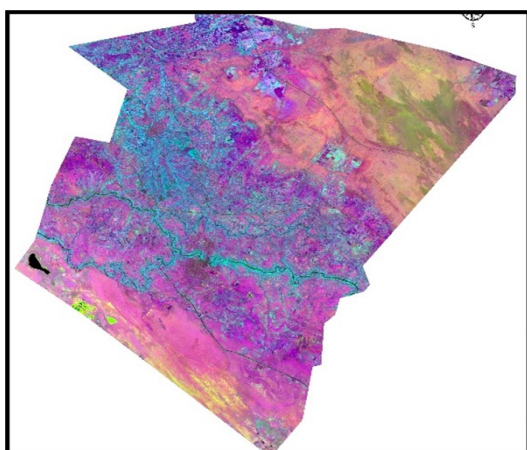


Figure (6) PCA of Study Area 2014.

### Classification Process

To get on accurate classes for land cover to represent study area, supervised classification technique was used to classify Landsat image 2014. This technique has been performed based on ground truth and Google earth images, as well as quick bird image 2014 and PCA1. Overall accuracy of classification was 89%.

### Results and Discussion

A process of digital classification has been performed for NDVI and Landsat 8 image for extract date palm trees from them, depend on ground truth and quick bird image 2014 with spatial resolution 60 cm, in addition to Google earth image 2014 for inferred of date palm trees through these images and extract reflectance values of date palm trees of it as shown in the Figures (7, 8 and 9).

The NDVI was classified by ArcGIS program to used remotely sensed data as the primary data source. Vegetation and non-vegetation areas were separated based on threshold values to classify the NDVI for the Landsat 8 image 2014. If the  $NDVI < 0$ ; the pixel represented non vegetation, and if  $> 0$ , then it belonged to vegetation. The classification system developed for vegetation in the study area based on five categories and all the values ranging from 0 to 1.

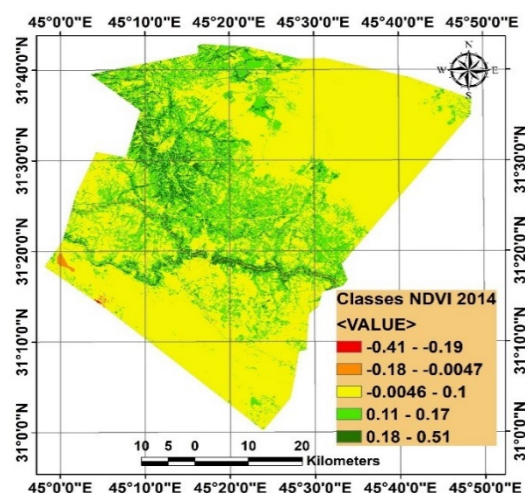


Figure (7) NDVI Classes of Study Area 2014.

To separate date palm trees areas, shrub, and grasslands, where area with vegetative cover have values greater than zero, these values are ranging from (0.09 - 0.5), which indicate the poor and high vegetation cover respectively.

The classified images are illustrated in Figure (9). The vegetated area which separated based on threshold values: the value of NDVI was less than 0.09. It can be observed from the figure 9 that large areas of the study site are bare land. The values of NDVI larger than 0.5, which were indicated to a high vegetation irrigated area, especially near the Euphrates River and its branch.

The results showed that the values of date palm trees ranging from (0.18 - 0.5), a highest value of NDVI. And then palm trees have been extracted from NDVI according to these values and converted into a linear form (Vector) and stacked out on quick bird and Google earth images for checking, as shown in Figure (8). The results of analysis illustrated that the total area of date palm trees in the Semawa city was about 57 Km<sup>2</sup>, total number of date palms trees was about 1198425, with density equal to 21025 trees per Km<sup>2</sup>. These results were near to results of Agricultural Statistical Directorate in 2013.

According to the report of (A.S.D, 2019), the productivity of one date palm

trees was 44.428 kg. Thus, the total productivity of the date crop in the study area, the productivity of one tree

multiplied by the number of trees in the study area was 53.244 Ton.

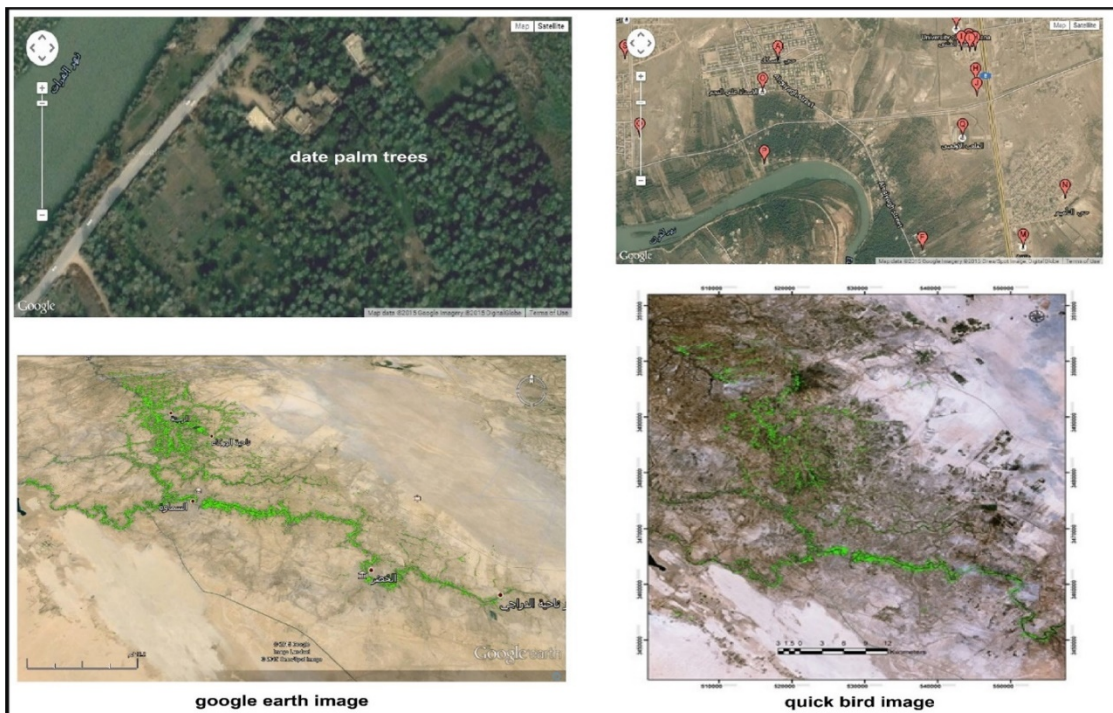


Figure (8) Date Palm Trees as Vector Form on Quick Bird and Google Earth Images 2014.

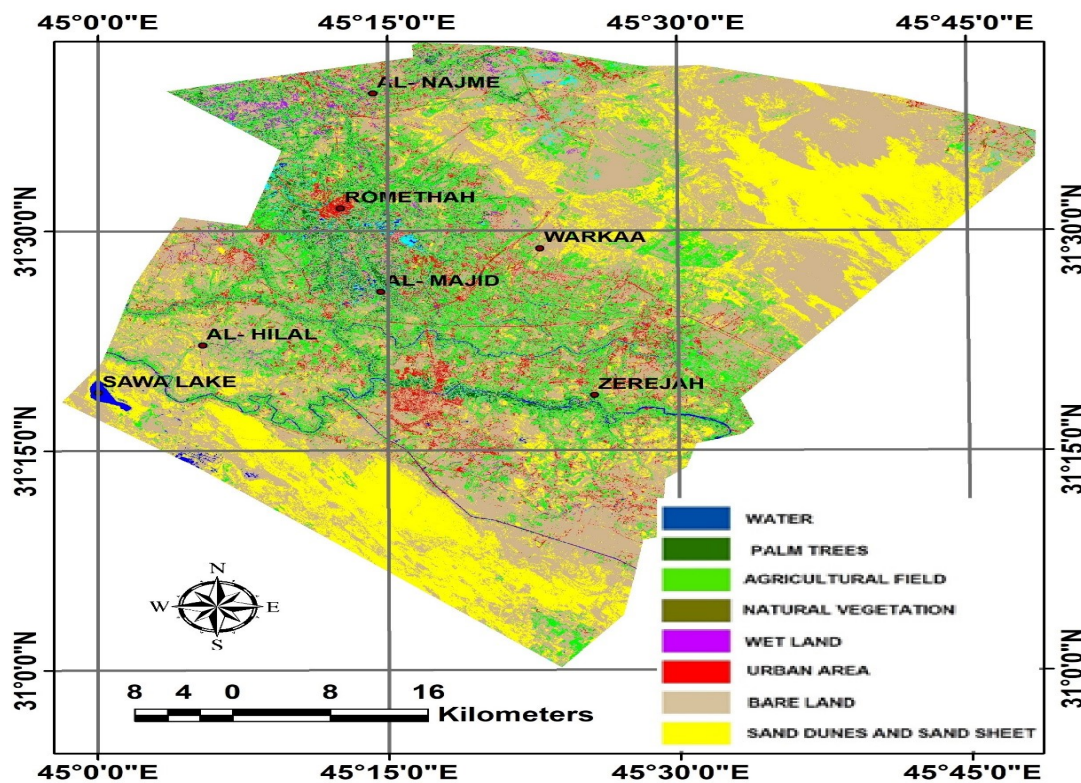


Figure (9) The Land Cover Map of Study Area 2014.

### Conclusions and Recommendations

This study employed the Landsat 8, quick Bird, and Google earth images to estimate area and density of date palm trees in Semawa city based on values of NDVI index and classification process. The results illustrated that NDVI is a powerful technique in extract and mapping of plants and date palm trees in the study area by providing direct measurements. In general view, the results of analysis illustrated that total area of date palm trees in the study area was about 57 Km<sup>2</sup>, the total number of date palms trees was about 1198425, with density 21025 tree per Km<sup>2</sup>. The total productivity of the date crop in the study area was 53,244 Ton.

Further research is required to study all governorates of Iraq to extract comprehensive statistical values for the number of trees, cultivated areas, and plant density for each governorate, as well as their total productivity of them.

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