

Developing spatial information database for the targeted areas

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Jericho and Al-'Auja (Palestine)

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Jericho and AL-'Auja (Palestine)

1 BACKGROUND

In order to develop a spatial information database for the targeted areas, the GIS and Remote Sensing specialists from both ARIJ and RSS purchased high resolution satellite images that covered the period (2004 – 2013). The main purpose of analyzing the high resolution satellite images was to study the change in land use/ land cover and vegetation cover (crops) for the study period. Many satellites were employed for monitoring both the vegetation (NDVI) and land use/land cover at regional scale, but the SPOT satellites have been supplying high-resolution, wide-area optical imagery since 1986 (SPOT 1-5) . While SPOT 6 and SPOT 7 will assure data continuity through to 2024 (ASTRIUM EADS, 2014). For this project, it was necessary to compare different agriculture seasons in different periods of time, so the following images were purchased:

Table 1: Spot images data and satellite

Date	Satellite
August 7, 2004	Spot 5
March 25, 2005	
August 4, 2013	
March 13, 2013	
	Spot 6

Table 1 showed that the purchased images covered two different agriculture season; high vegetation density (March) and low vegetation density (fallow lands) in August. While table 2 shows the main difference between Spot 5 and 6 images.

Table 2 main difference between SPOT 5 and 6 images

Indicator	SPOT 5	SPOT 6
Date of Launched	May 2002	September 2012
Resolution	5 meters color	1.5 meters color
Bands	3 Bands <i>Green</i> (0.50 - 0.59 μm) <i>Red</i> (0.61-0.68 μm) <i>Near Infrared</i> (0.78 – 0.89 μm)	4 bands Blue (0.455 – 0.525 μm) Green (0.530 – 0.590 μm) Red (0.625 – 0.695 μm) Near Infrared (0.760 – 0.890 μm)

After purchasing and preparing the satellite images, the project team from ARIJ and RSS, extract the study areas from the original image using the available layers. After that each team conducted two main analyses on the images according to his knowledge and the available data for the study area. The main two analyses in Palestine can be described in the following:

2 MONITORING THE PLANT BIOMASS USING NDVI IN JERICHO AND AL AUJA

2.1 Introduction

Jericho and Al Auja have special environment significance as they contain various types of vegetables crops and fruit trees. Therefore these areas should receive much care and protection. One of the primary interests of the Remote Sensing is to study the distribution of vegetation types as well as spatial/temporal variation of plant biomass (Gross, 2005). The following study is designed to monitor the plant biomass in Jericho and Al Auja during the period (2004 – 2013). Satellite images of Normalized Difference Vegetation Index (NDVI) for the Spot 5 and 6 (1.5 and 5 meter) resolution were used. NDVI is related to vegetation representative of plant photosynthetic efficiency, and fluctuation due to changes in meteorological and environment parameters (Kawabata, *et al.*, 2001). NDVI images allow the researchers to analyze vegetation condition during different years and periods.

2.2 Calculating NDVI

NDVI images are obtained by calculating the ratio between the visible and near-infrared bands of the satellite images. NDVI values between -1 and 1, where higher values represent more vigorous and healthy vegetation. Very low values (0.1 and lower) correspond to barren areas of rock and sand, moderate values (0.2 – 0.3) indicate shrub and grassland, while temperate and tropical rainforests are represented by high NDVI values (0.6 to 0.8) (Gross, 2005).

2.3 Methods

Numerous techniques have been developed to analyze NDVI data and this study will use NDVI difference images and Land Use Land Cover changes to assess the growing conditions in Jericho and Al Auja during the period (2004-2013). NDVI difference images show the spatial distribution of plant growth anomalies (Gross, 2005), while the Land Use Land Cover changes help to understand the variation of each vegetation type (Di Gregorio & Jansen 2000). The basic concepts of both techniques are introduced in the following:

2.3.1 Calculating the NDVI difference images:

NDVI difference images easily track changes in the amount of plant biomass for a particular month to the same base month. The technique used here highlight areas in Jericho and Al Auja with comparatively reduced or increased in plant growth (crops). The NDVI difference images ($NDVI_{diff}$) between two same months are calculated by subtracting the NDVI image of a targeted month from the NDVI of the base month:

$$NDVI_{diff} = NDVI_{target\ month} - NDVI_{base\ month}$$

The comparison between the two months allows for the identification of actual anomalies rather than erratic changes between two single years.

2.3.2 Calculating the Land use /Land cover changes

The NDVI difference images monitor the spatial distribution of vegetation anomalies for a selected month while Land use Land Cover changes are an efficient means to monitor types of vegetation and land cover variation (area) during targeted years. This approach classifies the NDVI values (table 3) from each Spot image to five main types of land use/ land cover, and then it calculates the area (km²) for each type and visualizes it as Land Use Land Cover maps:

Table 3 main difference between SPOT 5 and 6 images

NDVI values	Class
-1 – 0.1	Rocks, water, sands and urban areas.
0.1 – 0.2	Soil and fallow lands
0.2 – 0.3	Shrubs and Grass land
0.3 - 1	Different types of crops (vegetables and fruit trees)

2.4 Dataset

To monitor the change in NDVI for Jericho and Al Auja, it was necessary to use satellite images derived from the same satellite, according to this Spot satellite as Several Earth Observation missions have or have had sensors that record Red and Near-infrared (NIR) reflectance (Kawabata *et al.*, 2001); the NDVI is calculated from the red waveband (Band 2 in Spot 5 and Band 3 in Spot 6), and the near-infrared (Band 3 in Spot 5 and Band 4 in Spot 6). The comparison between the same two months (August 2004 and 2013) and (March 2005 and 2013) allows for the identification of actual changes in NDVI values.

2.5 Results

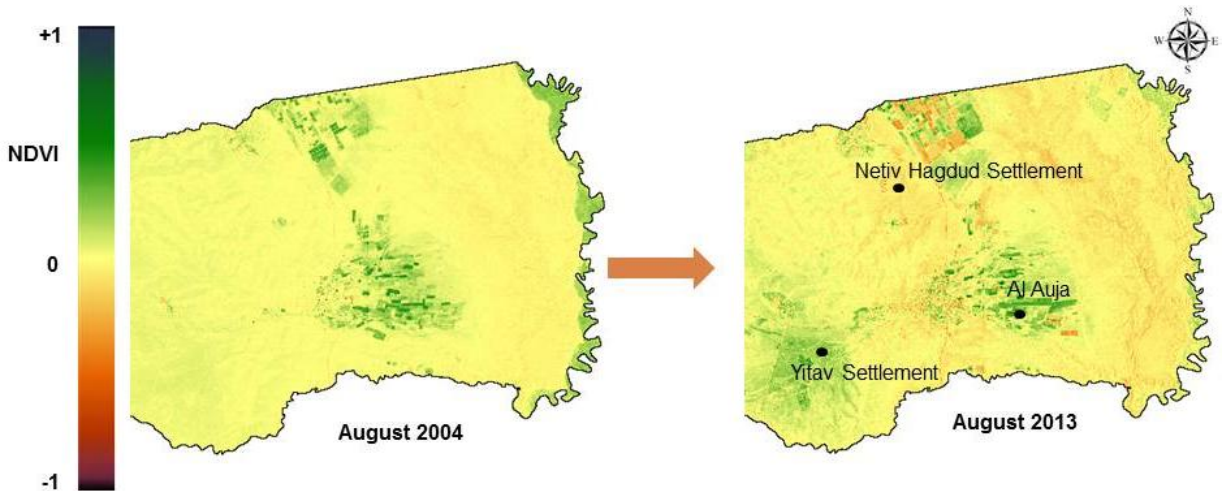
2.5.1 NDVI difference images

2.5.1.1 Al Auja

- **August 2004/2013**

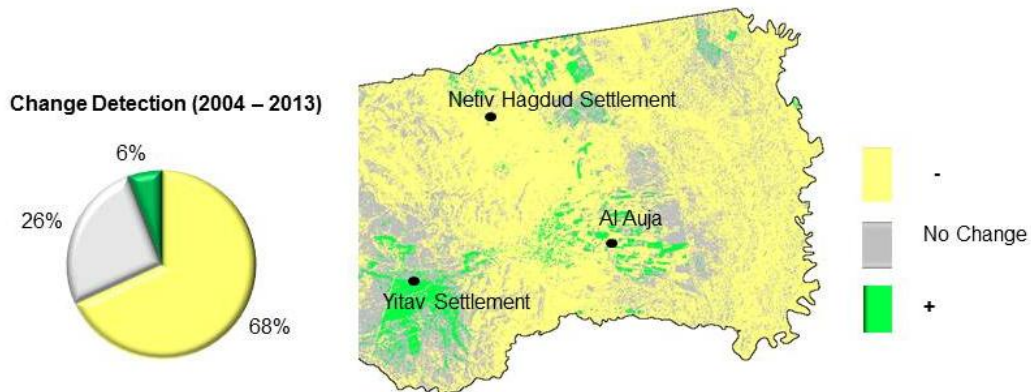
The visual comparison between August 2004 and 2013 (map 1) shows a big different in vegetation vigor; the comparison shows increase in vegetation cover in the occupied areas by Israeli settlements, and a decrease in vegetation cover in Al Auja area.

Map 1: visual comparison between NDVI values (August 2004/2013) in Al Auja



The NDVI difference image showed decrease of vegetation cover (map 2) for large parts of Al Auja area (68% of the polygon area), and only 6% of Al Auja area showed increase of vegetation cover (crops) especially in the occupied areas.

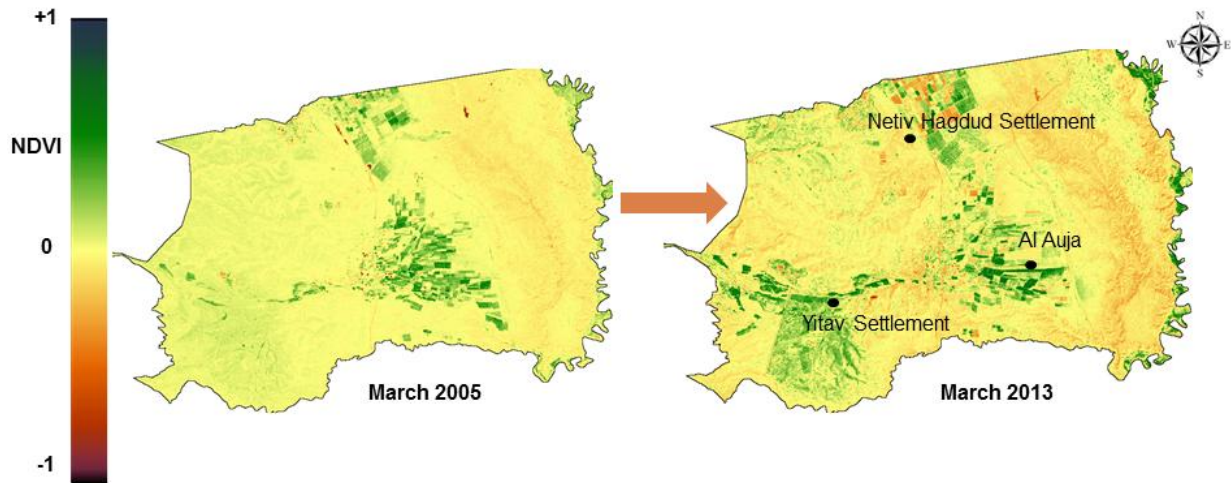
Map 2: NDVI difference images for Al Auja (August 2004/2013)



- **March 2005/2013**

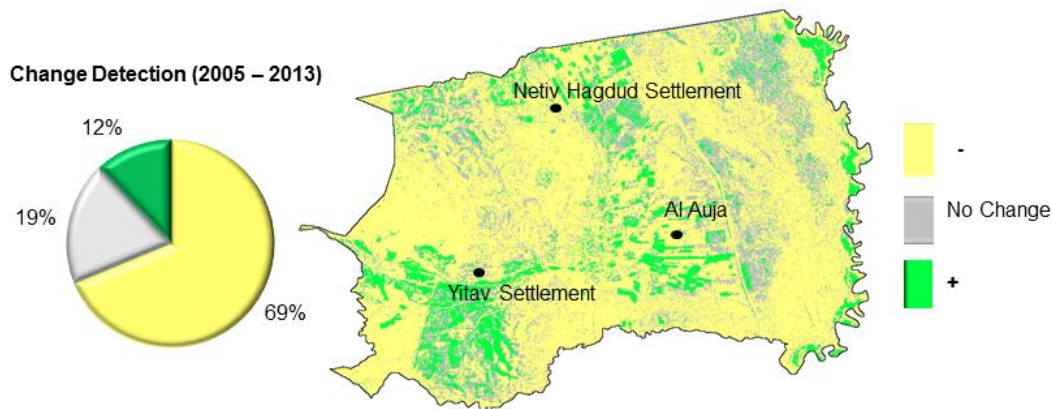
The same as August the visual comparison between March 2005 and 2013 (map 3) shows a big different in vegetation vigor; the comparison shows increase in vegetation cover in the occupied areas by Israeli settlements, and a decrease in vegetation cover in Al Auja area.

Map 3: visual comparison between NDVI values (March 2005/2013) in Al Auja



Also the same as August the NDVI difference image showed decrease of vegetation cover (map 4) for large parts of Al Auja area (69%), and only 12% of Al Auja area showed increase of vegetation cover (crops) especially in the occupied areas and some areas near the boundary with Jordan.

Map 4: NDVI difference images for Al Auja (March 2005/2013)

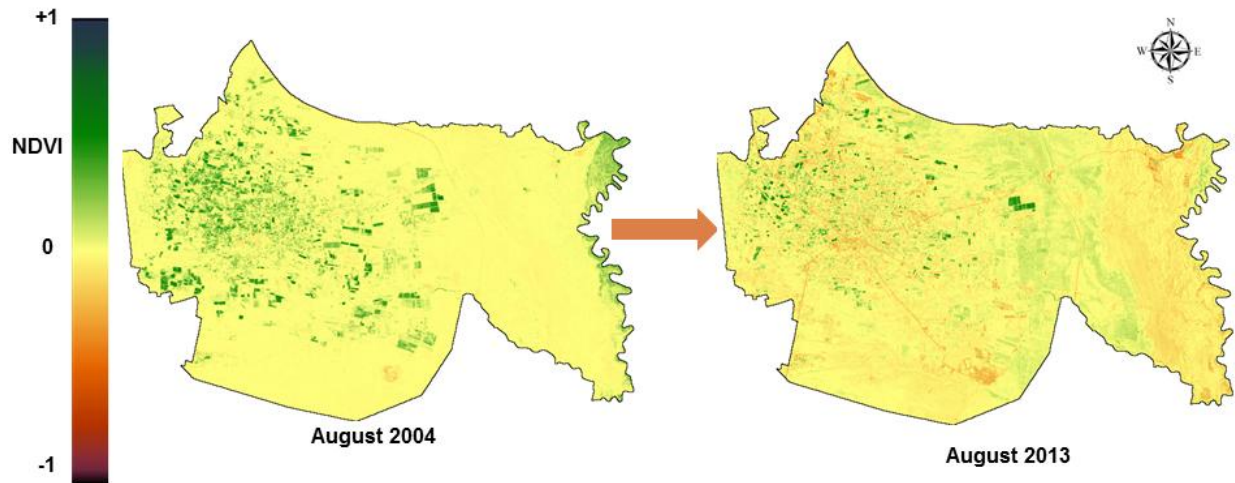


2.5.1.2 Jericho

- **August 2004/2013**

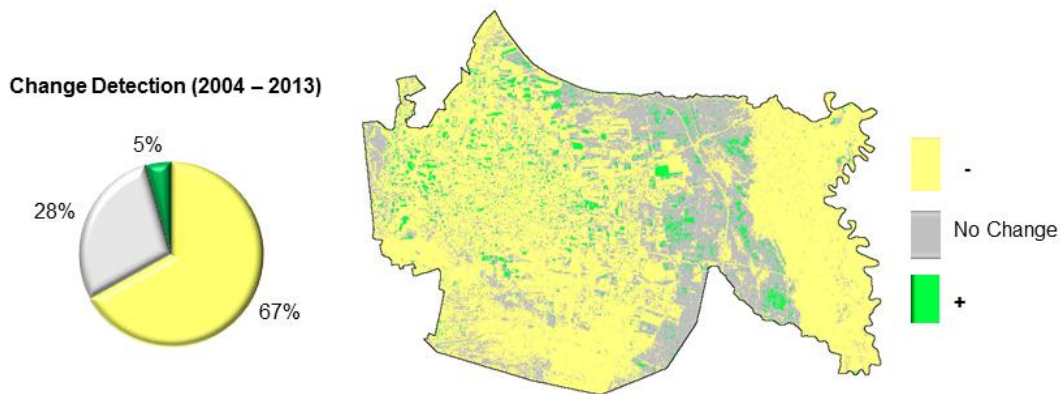
The visual comparison between August 2004 and 2013 in Jericho (map 5) shows a big different in vegetation vigor; the comparison shows an increase in vegetation cover in many parts of Jericho, and the intensity of green tones.

Map 5: visual comparison between NDVI values (August 2004/2013) in Jericho



NDVI difference image showed a decrease of vegetation cover (map 6) for many parts of Jericho area (67%), and only 5% of Jericho area showed increase of vegetation covers especially in the areas that considered as shrubs grasslands and date palm trees.

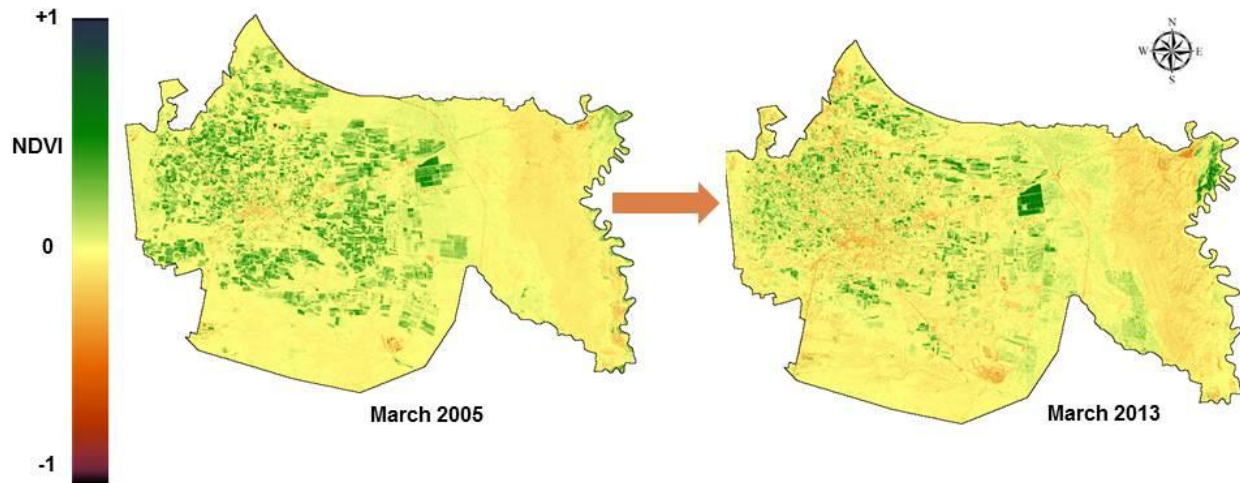
Map 6: NDVI difference images for Jericho (August 2004/2013)



- **March 2005/2013**

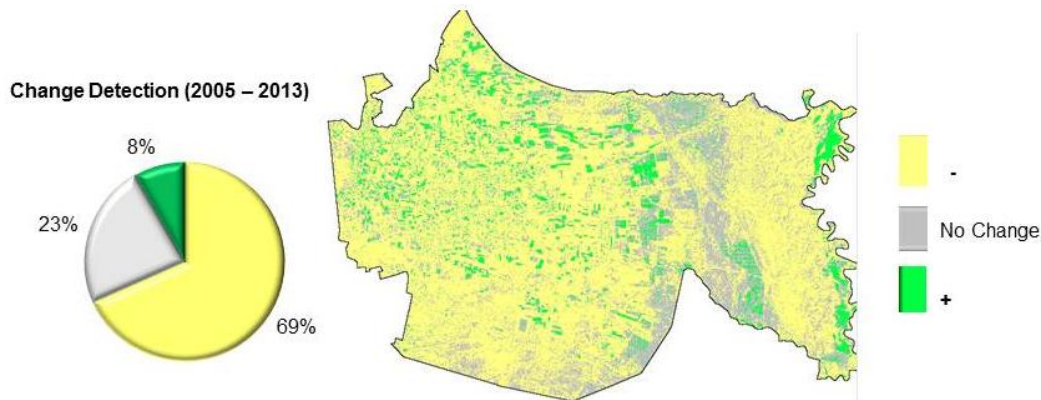
The same as August the visual comparison between March 2005 and 2013 (map 7) shows a big different in vegetation vigor; the comparison shows increase in vegetation cover in almost Jericho area especially in the city center.

Map 7: visual comparison between NDVI values (March 2005/2013) in Jericho



NDVI difference image showed a decrease of vegetation cover (map 8) for many parts of Jericho area (69%), and only 8% of Jericho area showed increase of vegetation covers especially in the areas that considered as shrubs grasslands, date palm trees and near Jordan border.

Map 8: NDVI difference images for Jericho (March 2005/2013)

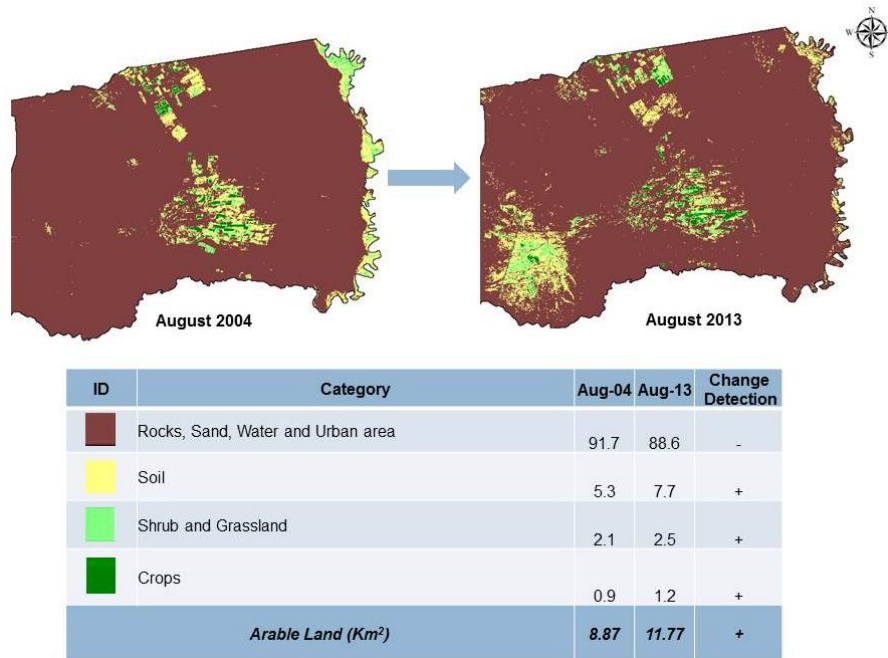


2.5.2 Land Use Land Cover changes maps

2.5.2.1 Al Auja

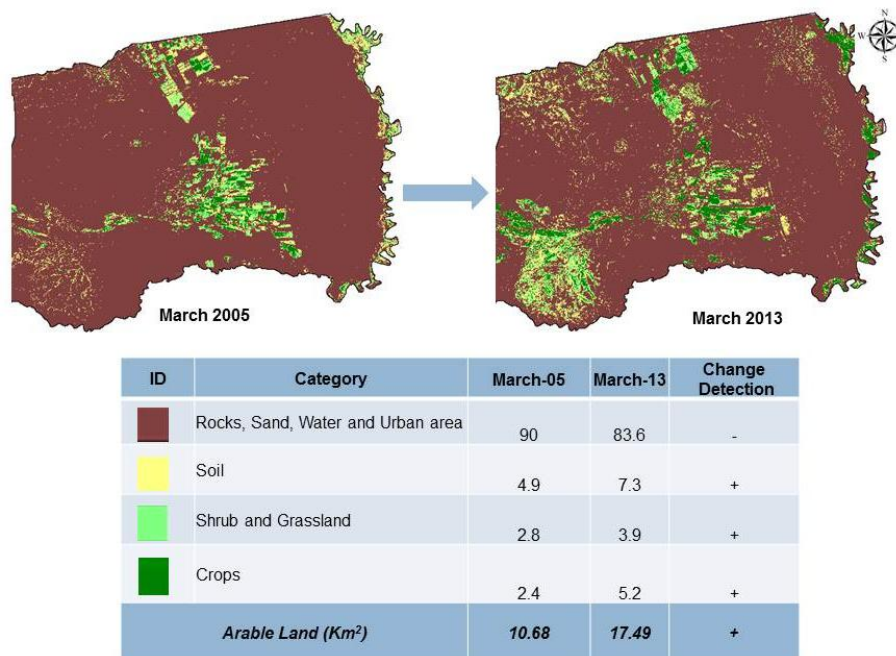
Map 9 shows that there was a decrease on bare soils cover (rocks, sand, water and urban areas) in Al Auja between August 2004 and August 2013, and an increase in Soil (Fallow lands), shrub and grass lands and crops. Also, the arable land increased from about 8.87 km² in August 2004 to 11.77 in August 2013, especially in the occupied areas by Israel settlements.

Map 9: Land Use Land Cover Changes in Al Auja (August 2004/2013)



The same results were for March 2005 and March 2013 in Al Auja, map 10 shows that the arable land increased from about 10.68 km² in March 2004 to 17.49 km² in March 2013.

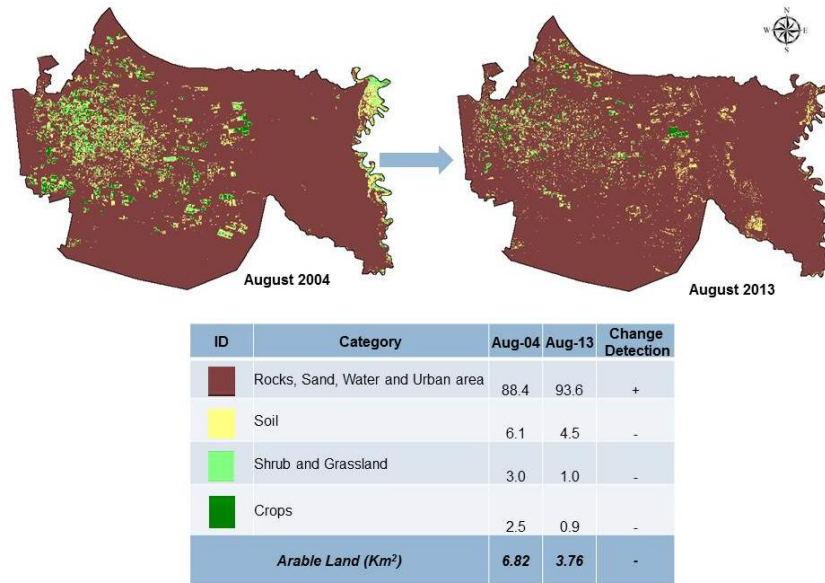
Map 10: Land Use Land Cover Changes in Al Auja (March 2005/2013)



2.5.2.2 Jericho

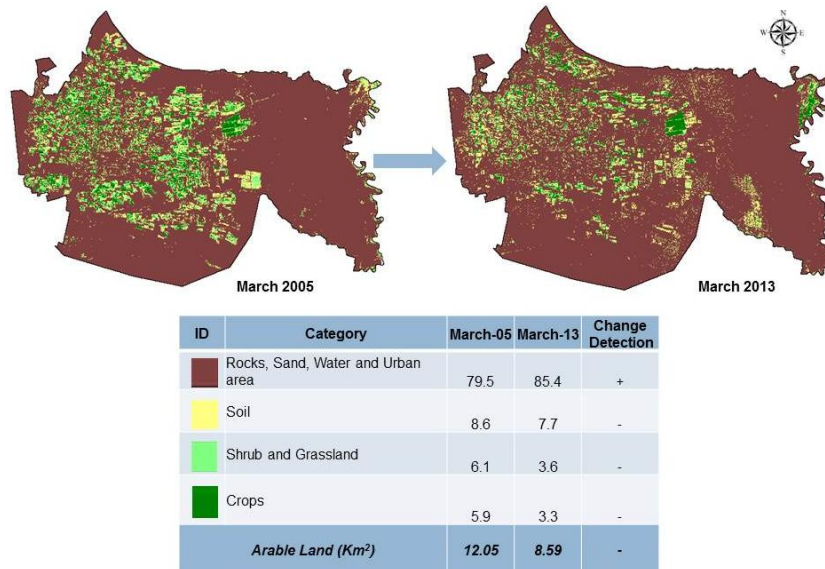
Map 11 shows that there was an increase on bare soils cover (rocks, sand, water and urban areas) in Jericho between August 2004 and August 2013, and a decrease in Soil (Fallow lands), shrub and grass lands and crops. Also, the arable land decreased from about 6.82 km² in August 2004 to 3.76 km².

Map 11: Land Use Land Cover Changes in Jericho (August 2004/2013)



The same results were for March 2005 and March 2013 in Al Auja, map 12 shows that the arable land decreased from about 12.05 km² in March 2004 to 8.59 km² in March 2013.

Map 12: Land Use Land Cover Changes in Jericho (August 2004/2013)



2.6 Discussion

The NDVI analysis results for Al Auja show an increase on the vegetation cover and arable land areas during the study period August 2004/2013 and March 2005/2013 especially in the occupied parts of Al Auja, and here it is necessary to mention that the results showed that about 22% of the Palestinian arable land in March 2013 was under Israeli full occupation; about 28.3% of Al Auja area considered as Israeli agriculture holdings (GIS & RS Department, 2013). Al Auja suffers from the lack of water for adequate agriculture cultivations, and it is worthy mention here that Al Auja spring is one of the main springs in Palestine that used for agriculture purposes, but it dried up as a result of Merkot Israeli Company withdrawing the water from the aquifer once the spring water started flowing. The spring's dryness is a direct result of Israel's control over the groundwater and the groundwater wells. Israeli occupation forces have constructed huge sized wells over Al Auja's hot water basins which has caused serious and direct harm to the quantity of water flowing from the spring, therefore resulting in its dryness, and also leading to the destruction of thousands of dunums of agricultural areas which were being fed by the water spring (ARIJ, 2012a) . In Jericho the NDVI results show a decrease on the vegetation cover and arable land areas during the study period, this due to the urban area expansion on the agriculture areas in Jericho. According to the Oslo II agreement between the Palestinian Liberation Organization and Israel, Jericho was divided into areas A and C. Approximately 55% were assigned as area A, where the Palestinian National Authority (PNA) has a complete control over administrative and security matters (ARIJ, 2012b). According to this the analysis showed that about 33.8% of the Palestinian arable lands in March 2013 were under Israeli control (Area C). While in Al Auja about 84.5% of the total area was classified as area C where Israel retains full control over security and administration related to the territory (ARIJ, 2012a); the analysis results showed that 75.2% of Al Auja arable land in March 2013 was under Israeli full control (area C).

However the agriculture sector in Jericho and Al Auja suffers some problems and obstacles that led to the increase of the agriculture (crops) area, mainly (ARIJ, 2012a, ARIJ, 2012b):

- Lack of water for adequate agricultural cultivations and the drought suffered by of Al Auja spring, and lack of water resource in Jericho.
- The lack of lands suitable for grazing.
- The confiscation of agricultural lands by Israeli occupying powers.
- Israeli settlers' attacks on agricultural lands (Al Auja).

2.7 Conclusions:

The results show an increase on the agriculture lands in Jericho and Al Auja during the study period (2004-2013), due to many reasons, mainly the Israeli occupation for water resources and agriculture lands, drought condition, and population growth and urban area expansion on agriculture areas. The fragmentation of agriculture areas can potentially have adverse impacts on food security in Jericho and Al Auja. This will have negative effects on agriculture production and food trade/market supplies.

3 LAND USE LAND COVER IN JERICHO, MARCH 2013

3.1 Introduction

Land cover can be defined as the observed (bio) physical cover on the earth surface, while land use is characterized by the arrangements and, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Di Gregorio & Jansen 2000). The land use land cover was studied in Jericho using the Supervised Classification of the purchased spot images for March 2013.

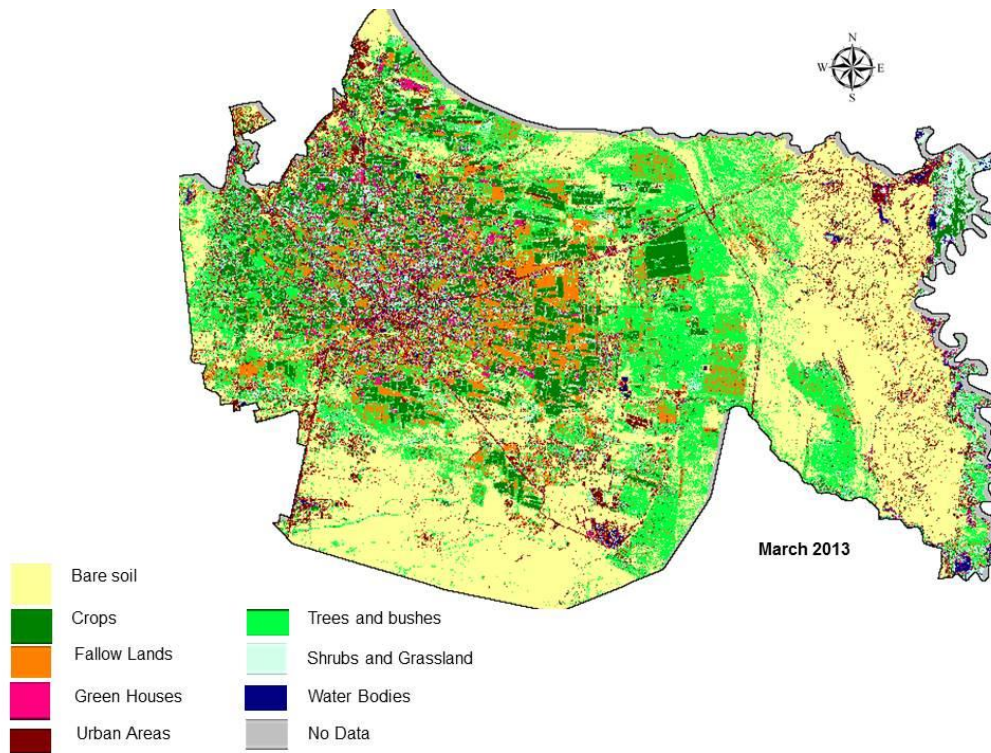
3.2 Methods

All the processes of supervised classification used the IDRISI selva software, the first step in supervised classification was to identify examples of the information classes (land cover and land use types) of the spot images, these called training sites. The software was used to develop characterization of reflectance for each site as simple as the mean or the range of reflectance on the Spot 6 four bands. This stage called signature analysis. The next step was classified the image by examining the reflectance for each pixel and making a decision about which of the signature it resembles most. This called classifiers which have a wide range of options the Hard and Soft classifiers. The one used here was hard classifiers using the Maximum Likelihood (MAXLIKE). Maximum Likelihood classifier is evaluated to determine the Likelihood that any pixel belongs to a given class.

3.3 Results

Map 13 shows the land use land cover for Jericho, March 2013, the maps include 9 different types of land use land cover. It is necessary to mention here that trees represent date palm, banana and citrus trees.

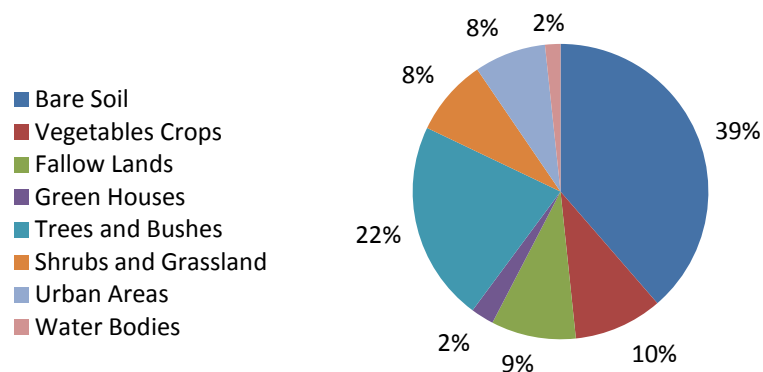
Map 13: Land Use Land Cover in Jericho, March 2013



3.4 Discussion and Conclusions

Figure 1 show that 39% of Jericho area considered as bare soil (uncultivated area) while 22% of the area considered as Fruit trees (Date palm, banana and citrus trees).

Figure 1: Land Use Land Cover main classes in Jericho, March 2013



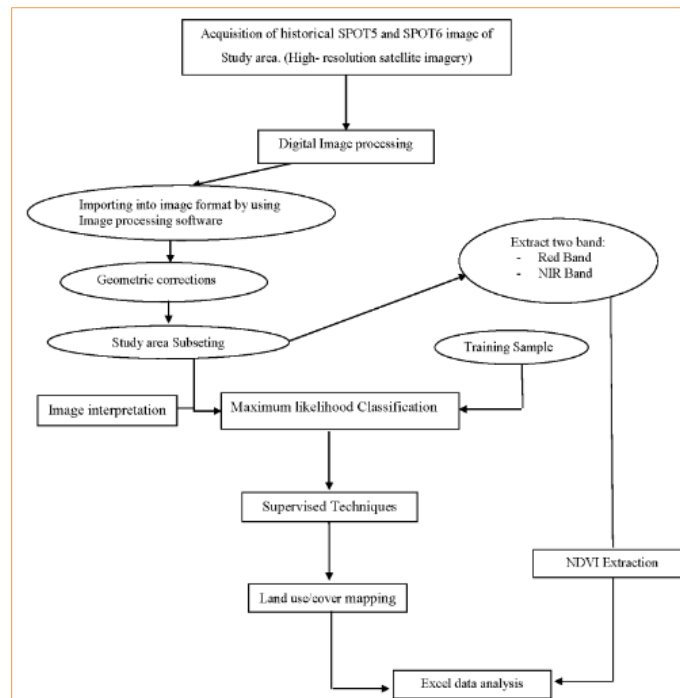
3.5 References

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4 METHODOLOGY

The methodology of the study included a sequence of steps and procedures of data collection and analysis. A summary is shown in (Figure 1). The following subsections include detailed description of these steps and procedures.

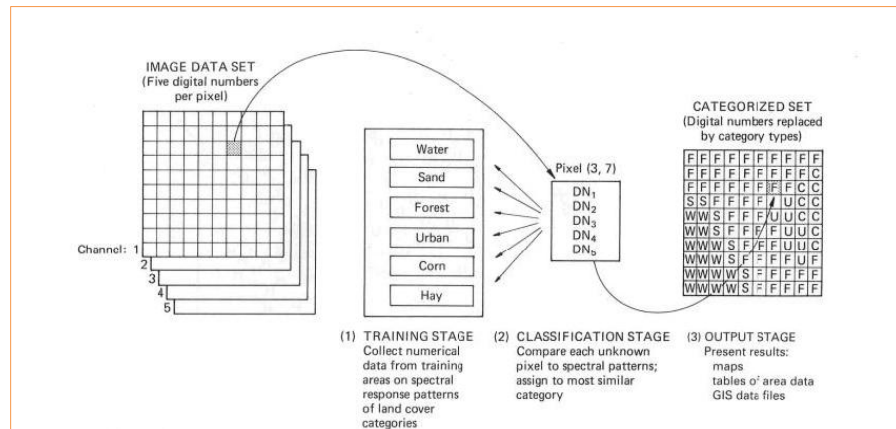
Figure 1: Schematic diagram of the study methodology.



4.1 Supervised Classification Techniques

A visual interpretation of high resolution satellite images was followed to map land use/cover for the South Jordan Valley (SJV). The available images included Spot5 (5 m) and Spot6 (1.5 m). The images were geometrically corrected, enhanced and clipped to the borders of the basin. An on-screen procedure was followed to delineate land use/cover parcels from the satellite imagery using a false color composite of visible and NIR bands (Supervised Technique). This form of classification involves some form of supervision by the operator. Steps and stages of this method are shown in the (Figure 2) below:

Figure 2: Basic steps in supervised classification



The main stages involved in Supervised Classification are: The Training Stage, Classification Stage, and Output Stage. All results should be assessed for accuracy during and after classification.

THE TRAINING STAGE: The analyst locates *training sites* representing the different land cover types to train the classification algorithm for eventual land-cover mapping of the remainder of the image. The selection can be performed using Area of Interest (AOI) or using seed files. The number of pixels for training the classifier = $10n-100n$, where n is the number of bands used in classification.

CLASSIFICATION STAGE: Every pixel both within and outside the training sites is evaluated and assigned to the class of which it has the highest likelihood of being a member. All results should be assessed for accuracy during and after classification.

The statistical method used to evaluate class separately was **Divergence and Transformed Divergence (TD)** for SPOT images.

In ERDAS Imagine 2013, the range for TD is from 0 (Identical classes) to 2000 (Completely separable classes). The following ranges of TD should be considered:

- TD > 1900 the two classes are separated.
- TD (1700 – 1900) Separation is fairly good.
- TD < 1700 Separation is poor.

The classification scheme is adopted for this project, was used with eight main classes. The interpretation was improved by using the available and free images of Google earth pro. The output map (Figure 6) was stored as a layer map representing the existing land use/cover of the SJV. The area of each land use/cover class was calculated using “calculate area” function in the ArcGIS software.

4.1.1 Results

Figure 3.a: Applied supervised technique for the SJV from August 2004 to August 2013.

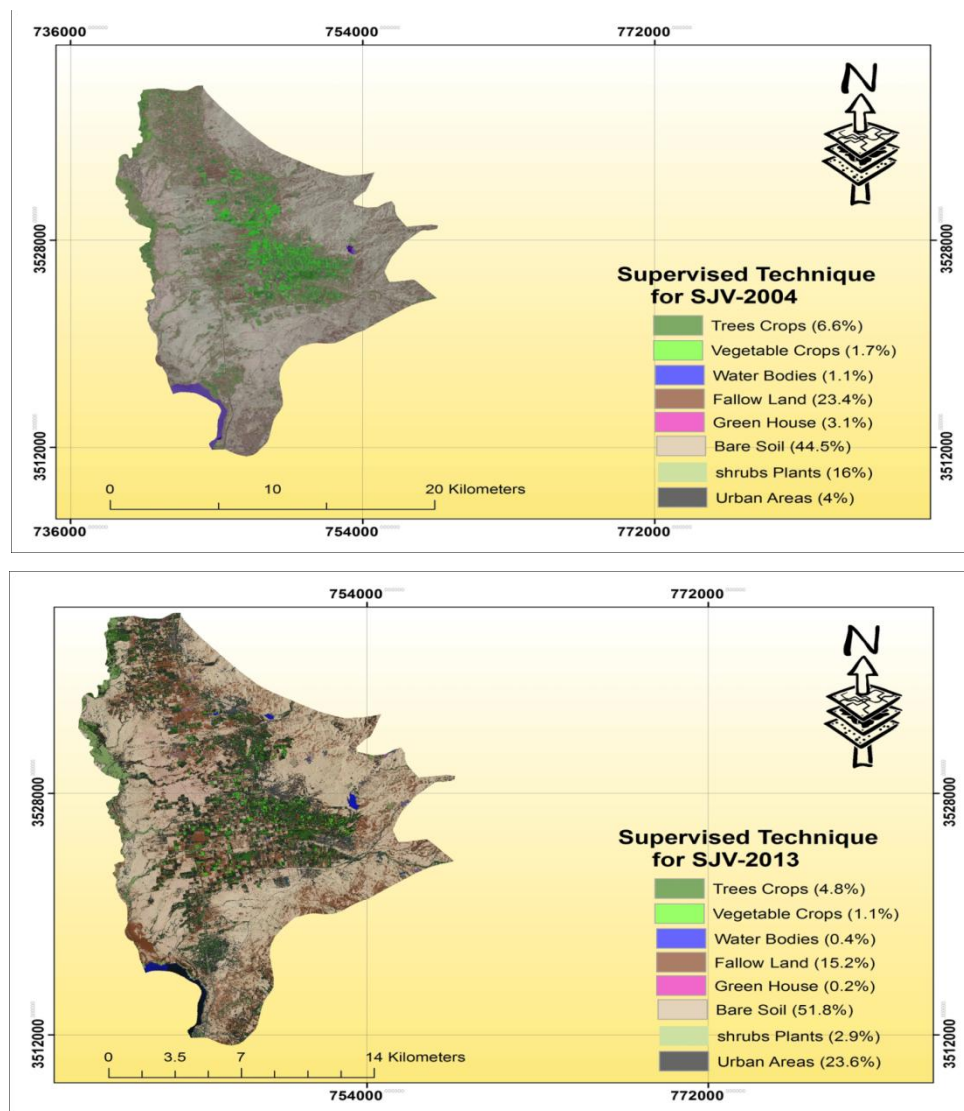


Figure 4.b: Applied supervised technique for the SJV from March 2005 to March 2013.

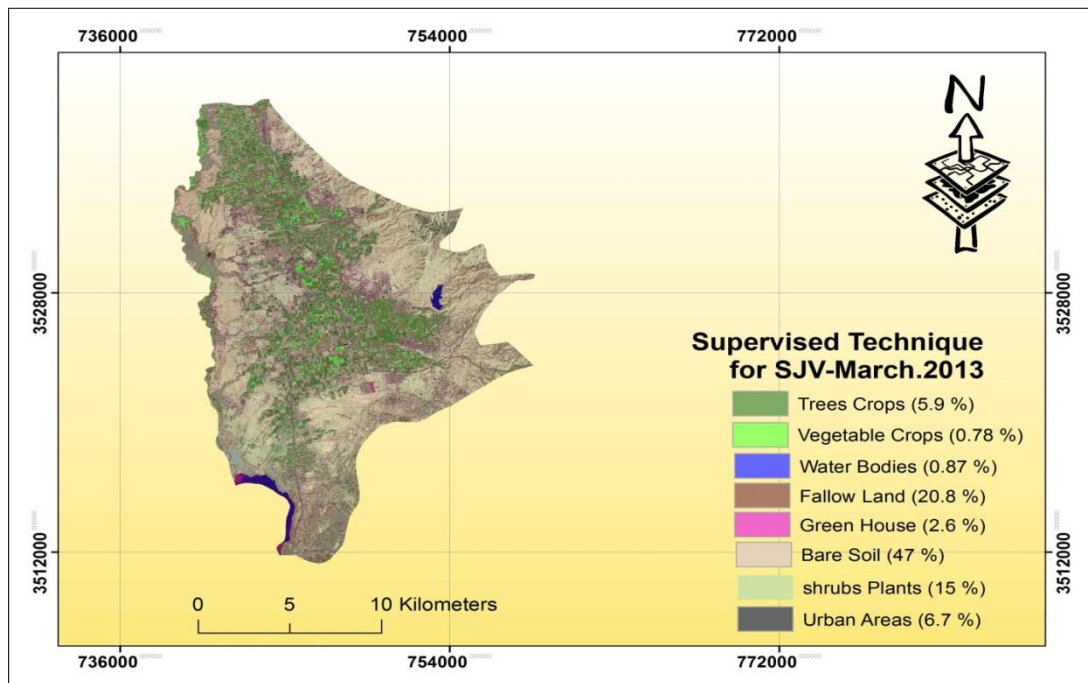
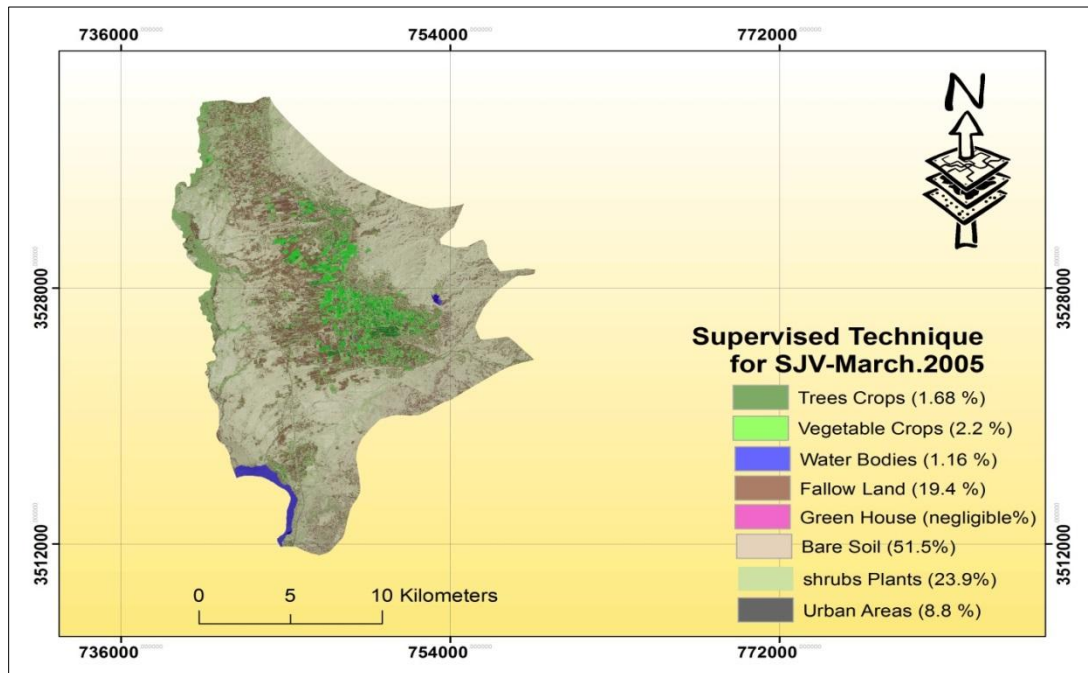


Table 1: A summary of land use/cover percentage

Land use/ cover Classes	SPOT 08-2004 (Area %)	SPOT 08-2013 (Area %)	Changing (+/-)
1- Trees Crops (Palm, Banana ,Citrus)	6.6	4.8	-
2- Vegetables and Field Crops	1.7	1.1	-
3- Water Bodies	1.1	0.4	-
4- Fallow Land	23.4	15.2	-
5- Green House	3.1	0.2	-
6- Shrubs Plant	16	2.9	-
7- Urban Areas	4	23.6	+
8- Bare Soil	44.5	51.8	+

Landuse/ cover Classes	SPOT 03-2005 (Area %)	SPOT 03-2013 (Area %)	Changing (+/-)
1- Trees Crops (Palm, Banana ,Citrus)	1.68	5.9	+
2- Vegetables and Field Crops	2.2	0.78	-
3- Water Bodies	1.16	0.87	-
4- Fallow Land	19.4	20.8	+
5- Green House	0	2.6	+
6- Shrubs Plant	16	2.9	-
7- Urban Areas	8.8	6.7	-
8- Bare Soil	51.5	47	-

4.2 Normalized Difference Vegetation Index (NDVI) Extraction

The most common approach in classifying composited time series of the Normalized Difference Vegetation Index (NDVI) is unsupervised classification, where pixels are assigned to a user defined number of classes based on a cluster analysis, the clustering may be the expression of different vegetation types but also of differences in background reflectance (particularly important in sparsely vegetated areas), of variations in vegetation coverage, or of climate induced phenological shifts. Accordingly, class descriptions tend to have little meaning, and especially important for the rangelands, typical intra-class coverage variations are not reflected. Due to these shortcomings unsupervised classification does not fully exploit the biophysical information contained in NDVI time series.

The NDVI is calculated from these individual measurements as follows:

$$NDVI = \frac{(NIR - VIS)}{(NIR + VIS)}$$

Where VIS and NIR stand for the spectral reflectance measurements that acquired in the visible (red) and near-infrared regions respectively. These spectral reflectance measurements are themselves ratios of the reflected over the incoming radiation in each spectral band individually, hence they take on values between 0.0 and 1.0. By design, the NDVI itself thus varies between -1.0 and +1.0. It should be noted that NDVI is functionally, but not linearly, equivalent to the simple infrared/red ratio (NIR/VIS). The advantage of NDVI over a simple infrared/red ratio is therefore generally limited to any possible linearity of its functional relationship with vegetation properties (e.g. biomass) as shown in below (Figure 5).

Figure 5.a: NDVI for South Jordan Valley Comparison between 08-2004 and 08-2013.

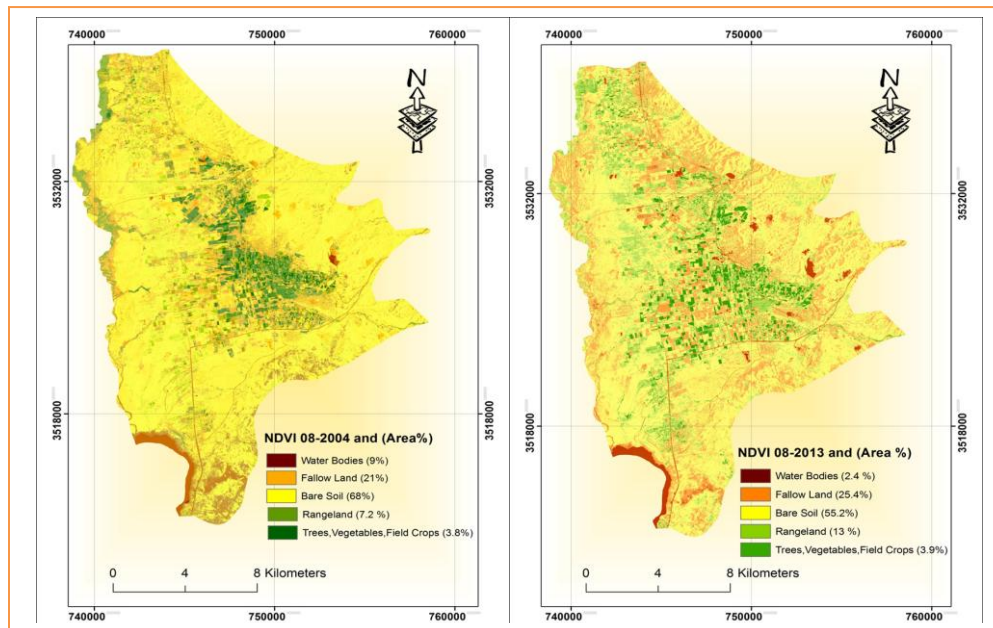


Figure 5.b: NDVI for South Jordan Valley Comparison between 03-2005 and 03-2013.

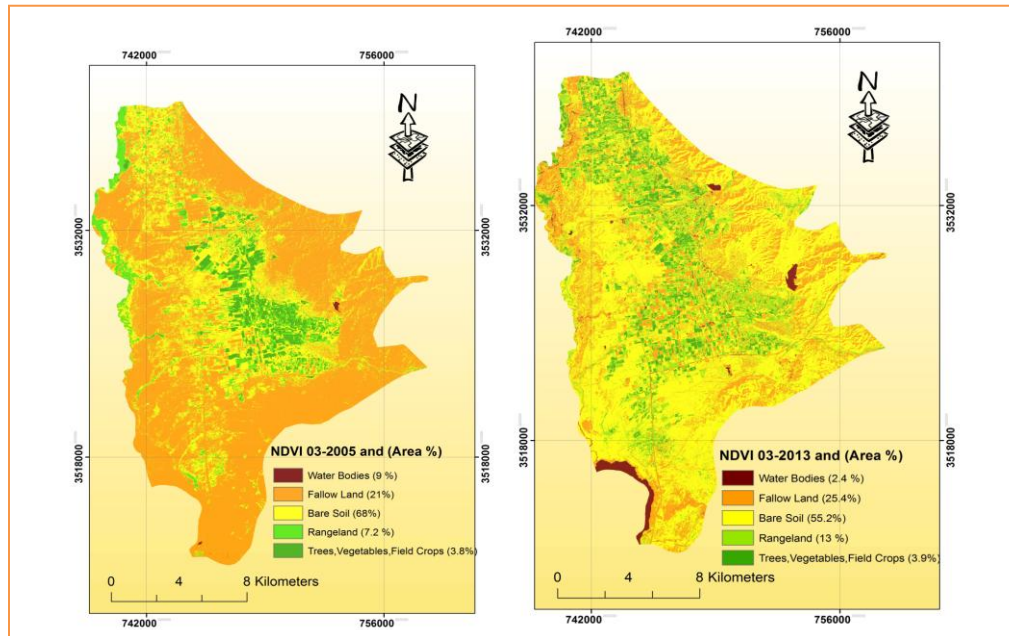


Table 2 A summary of NDVI analysis as percentage for SJV

NDVI Classes	NDVI 08-2004 and 03-2005 (Area %)	NDVI 08-2013 and 03-2013 (Area %)	Changing (+/-)
1- Water Bodies	9	2.4	-
2- Fallow Land	21	25.4	+
3- Bare Soil	68	55.2	-
4- Rangeland	7.2	13	+
5- Trees, Vegetable & Field crops	3.8	3.9	+

4.2.1 RESULTS & DISCUSSION

4.2.1.1 NDVI maps derived from images

Calculating indices allows for an efficient monitoring of vegetation over large areas. Due to their simplicity derived ratios from reflectance data are traditionally inferred from a wide range of optical sensors under varying environmental conditions and comparisons in time and space. The images of the study area revealed that the remotely sensed normalized difference vegetation index (NDVI) was suitable to describe crop ground cover and crop growing status. By comparing study NDVI maps which have been taken in 2004, 2005 and 2013, the following was concluded:

- A. The total agricultural areas (the fallow land and vegetation areas) has increased from 24.8 % to 29.8 % and the increase can be as a result of:
- Increase in demand for agricultural produce directly linked to increase in the population (a yearly growth of 8.5 %).
 - Jordan has been a host country for the refugees coming from the surrounding countries due to political unrest in neighboring countries in Syria and Iraq.
 - Increase in investments due to higher produce prices and profitability.
- B. The total bare soil area has been decreased from 68 % to 55.2 % for the following reasons:
- The increase in the demand of agricultural area.
 - The increase in demand for residential area.
 - Conversion of areas to range land areas due to the increase demand of animal stock.
- C. Number of water bodies have been reduced from 9.0 % to 2.4 % due to the following factors:
- Increase in water demand to provide for both population growth and the expansion of farming areas.
 - Severe decrease in Dead Sea levels of around 0.90 meters throughout the years.
 - Decrease in precipitation amounts between the two years compared.

4.2.2 Conclusions:

The utilized spot images have provided the project researchers with a broader vision about the study area, especially in monitoring the changes in the agricultural area. This helps in projection the possible areas for increasing arable lands area, through utilizing the available resources in the South Jordan Valley. Spot analysis will be utilized for scheming the future agricultural change.

4.3 References

1- MOEnv. (Ministry Of Environment, Jordan), (2006), National Action Plan and Strategy to Combat Desertification. Amman, Jordan.