Change Detection of Vegetation Cover Using Remote Sensing Data as a Case Study: Ajloun Area

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Abstract
Remote sensing data in combination with the appropriate multispectral bands such as Landsat OLI/TIR and TM data were used to change detection of vegetation cover using vegetation indices for the periods of 1990 – 2015 in Ajloun area, where this study area has the highest forest cover in Jordan. The results indicate that overall increase in Unclassified area (urbanization, land degradation and agricultural activities) in the study area between 1990 and 2015 is approximately 146.84 km^2. Despite the fact that the cultivation and urbanization caused significant changes in the study area. and the percentages to removal of vegetation in the study area reached up to 5.84 of overall area annually which refer to the risk situation which mean that the study area reach to the high level degradation of the vegetation cover.
Keywords: NDVI, Satellite image, Landsat TM, Forest and Classification

Introduction

Developing countries have witnessed a growing in the agricultural production during recent decades (Aksoy and Beghin, 2005). where that the agriculture in the world faces limitation and challenges in agricultural production through determination of strategies that includes technologies development, policies and institutions which led to think seriously in studying impediments to effective production (Ibrahim, 2016. Ibrahim, 2014)

The agricultural production in most countries are considered one of the major components in sustainable development and increasing needs through sustainable agriculture, forestry, and other land-use to get more food and energy production trying to face increasing of population, especially in arid and semi-arid areas of the world. in additional the agriculture is considered one of the main natural resources in arid regions of the world especially for food security and it is considered one of the major sources of livelihood in many countries regardless of the acute environmental situation and characteristics in the arid and semi-arid. Arid and semi-arid ecosystems span over 40% of the earth’s total land surface, predominantly in Africa (nearly 13 million km2) and Asia (11 million km^2), with a continuous increase due to desertification processes, induced mainly by anthropogenic activities and/or climatic change (IPCC, 2008). (White *et al*. 2002). Three quarters of global food production occurs in dry land primarily rice, wheat, maize, sorghum, millets and potato (FAO 1999), Therefore increasing productivity in arid and semi-arid zones is vital to ensure global food security (MPRA, 2006).

Agriculture is considered a basic pillar of economic and social development in all countries. Agriculture has started to play a major role in the protection of the environment through the past three decades, as well as protection of bio-diversity and ensuring an environmental balance that helps in securing sustainable resource use and their preservation for future generation (UN, 2007). Accuracy farming is a successful agricultural management practice with the potential to mitigate difficulties and problems that face agriculture and contribute to the increase of production through utilizing of accurate information about agricultural resources.

Several technologies are used to in accuracy farming. These include: Remote sensing, Geographical Information Systems (GIS), Global Positioning System (GPS), Change detection and monitoring of yield and vegetation, crop growth models and variable rate application. The role of remote sensing is based on monitoring specific phenomena and assessment of land covers through perfect tools as well as monitoring of the crop situation the changes it undergoes(Al-Tamimi and Al-Bakri. 2005, Ibrahim. 2014, Meera *et al*. 2015)

The percentage of vegetation is estimated from vegetation indices such as NDVI, SAVI, MSAVI, and TSAVI and other indices, by using the spectral reflectance of various vegetation covers from satellite data. The vegetation cover has been measured by digitization and visiting sites, with satellite images also being used for extensive areas, in the same constant the percentage of vegetation cover is used as parameter to estimate the annual removable of vegetation which refers to the degradation condition in the regions spatially in the arid and semi-arid area.

Generally the main purpose using remotely sensed data in spatial change detection of vegetation cover and analysis of this study change detection of green vegetation between 1990 and 2015. Where the vegetation cover of green vegetation in study area refers to forest which play attention to sustainability of environment (Ibrahim, 2016).

Materials and Method

Study Area

The study area is located between 35°49′ E Longitude, 32°24' N Latitude and 35°51' E, 32°23' N. Ajloun covers a total area of 747 km^2 and the case study covers 39.266 km^2. It is located in the north of the country at a maximum altitude of 1250 m (Al-Bakri et al., 2008). The climate of Ajloun is a sub-humid Mediterranean, with the annual rainfall ranging from 300 to more than 600 mm. The area is characterized by cool temperature in winter and mild temperature in summer; the highest temperature occurs in August (mean maximum temperature is 34°C) and the lowest temperature in January is – 4 °C. The annual relative humidity ranges from 63% up to 77 % (JMD, 2000). The study area has the highest forest cover in Jordan (GEF, 2004). Indigenous forests of Pinus, Quercus, and Ceratonia are abundant at this site (GCEP 2000). Wild relatives and local cultivars of fruit trees, olives, and wheat are also grown in this area

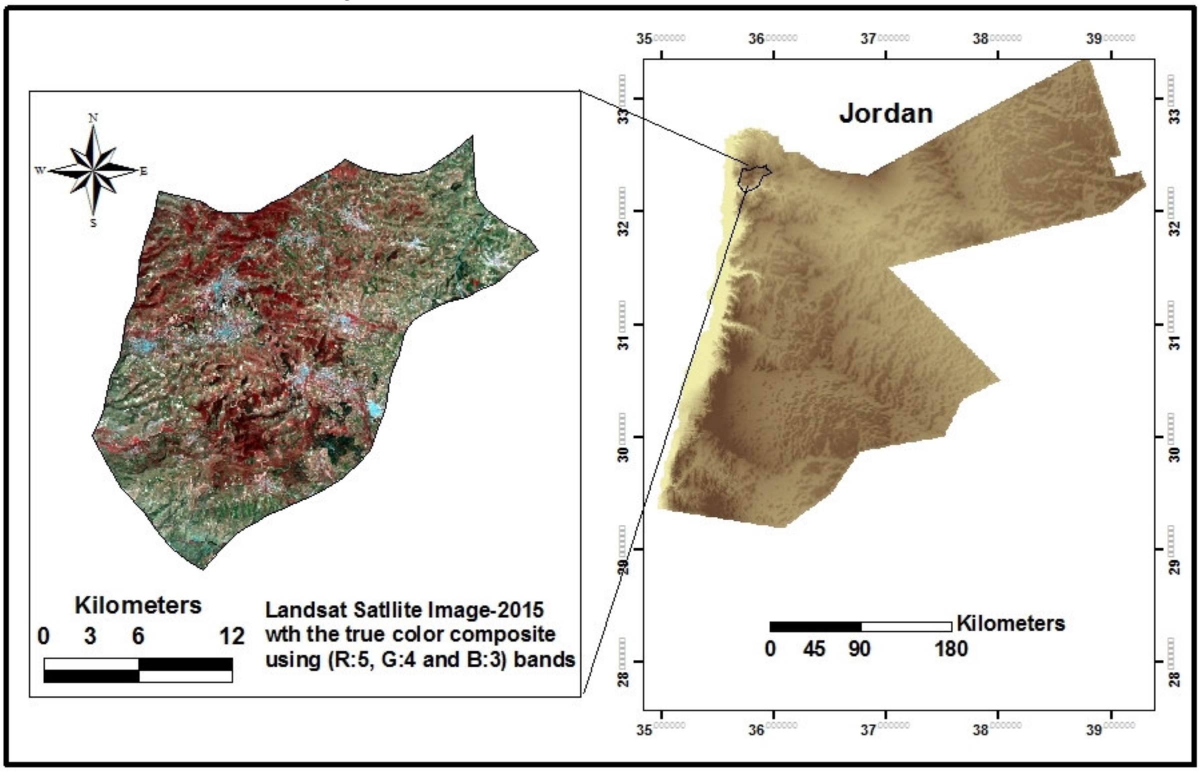

Figure 1: Location Map of study area

Data Used

Require preparation of data for the study area. The satellite archive used Landsat 4-5 TM (Thematic Mapper) and Landsat 8 OLI (Operational Land Imager) and TIRS (Thermal Infrared Sensor)used in this study in the same seasonal period, path 169 and row 45, the landsat 4-5 TM image of (May -1990)and landsat 8 OLI \TIRS in MAY 2015. For the All images were obtained from the United States Geological Survey (USGS) Global Visualization (GloVis) site and geometrically corrected and rectified to UTM zone 36.

In order to preparation data, management and analysis have to use software these software as follow are: ERDAS IMAGINE 2014 in this study ERDAS was applied in importing and enhancement, as well as Arc GIS 10.2 for Digitizing , Index and , image analysis, Geo-referencing , creation of database. For the composition and generation of maps were used Arc map.

Methodology

Image processing and geometric rectification techniques were undertaken for processing the digital data, a subset of each landsat digital images acquired inof (May -1990\2015)covering area. The digital images were geometrically and radio-metrically calibrated to each other to facilitate their comparison. Geometric rectification is critical for producting spatially corrected maps through time. Accurate per-pixel registration of multi-temporal remote sensing data is essential for change detection since the potential exists for registration errors to be interpreted as land-cover and land-use change, leading to an overestimation of actual change (Ibrahim, 2010).

Image processing

Visual interpretability is one of the image enhancement methods which aiming to increasing the apparent distinction between the features. On other hand False components color (FCC) was used to visually interpreted where the FCC in TM bands are 2, 3 and 4 color combination for landsate 4-5 images (1990), and 4, 5 and 6 color combination in landsate 8 OLI to support visual interpretation and analysis purpose of earth's surface in the study area.

Image Analysis

The Normalized Difference Vegetation Index (NDVI), which is a normalized ratio of red and near-infrared reflectance [11], has been used in many phonological studies, that has occurred between two different periods where it is the process of classifying the unknown-identity pixels by using samples of known identity. This process aims to calculate amount of vegetation and comparison of vegetation between to different years NDVI is defined as follows:

$$NDVI = [B_{nir} - B_{red}] / [B_{nir} + B_{red}]$$

Where B_{nir} and B_{red} are reflectance of visible red and near-infrared, respectively. Theoretically, NDVI values are represented as a ratio ranging in value from -1 to 1 but in practice extreme negative values represent water, values around zero represent bare soil and values over 6 represent dense green vegetation.

Image analysis stage in the study includes the percentage of vegetation removal with could estimated by measuring the ratio of annual losses of vegetation in the total surface area, method is measured by using a satellite dataset of earth observations. Table 1 shows three classes of vegetation cover that have been used for the purpose of this study (Ibrahim, 2014. DESIRE, 2007).

Table 1: Percentages to removal of vegetation

Parameter	**class**	**Description**
Removal of vegetation (%)	1	Low, < 1.5
	2	Moderate, 1.5–2.5
	3	High, > 2.5

Result and Discussion

Change Detection

The area was chosen to present study in the view if it's multispectral is useful to change detection of vegetation cover and to detect effect the commercialization and industrialization, the changes in study area is shown in Figure 2 for the 1990 and 2015 respectively, and different Green Vegetation using NDVI identified in the study area are displayed as following:

1. **Green Vegetation using NDVI**

A positive mean of 1990-2015 NDVI differencing is an indication of reduction in green vegetation within this period of study **Table 2 and Figure 2.** This implies a decline in vegetation. It thus confirms the change detected through post classification analysis.

Table 2: Results of land use/land cover classification for 1990 and 2015 for study area showing area, area change and percentage change.

Land Cover / Land Use Feature	Area in km^2		Percentage area %		Change (1990-2015) in Area km^2
	(1990)	(2015)	(1990)	(2015)	
Unclassfied	122.72	269.57	29.9	65.68	146.84
Green Vegetation	287.69	140.84	70.1	34.32	- 146.84
Total	410.41	410.41	100	100	0

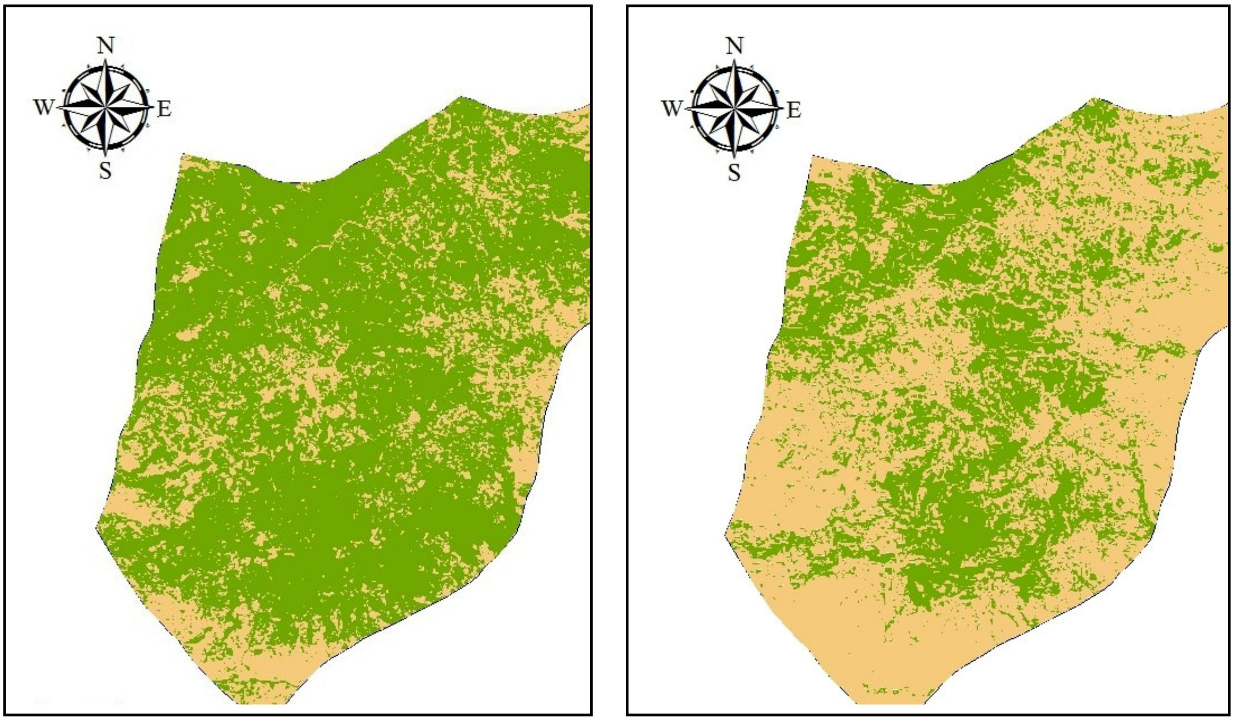

Figure 2: NDVI classes of study area in: (a) 1990 and (b) 2015.

Table 2 provides a summary of change detection of vegetation cover between 1990 and 2015. It shows that the overall increase in Unclassfied area (urbanization, land degradation and agricultural activities) in the study area between 1990 and 2015 is approximately 146.84 km^2. The classification categorized the area into two main classes of lands types as shown in Table (3)

Table 3: Description of the main land-use/cover types in the study area

Land-use/cover type	Description
Vegetation Cover	Indigenous forests of Pinus, Quercus, and Ceratonia, and olive trees and Fruits
Non Vegetation Cover	Areas with buildings, factories, soil and rock

2. Vegetation Cover

According the Table 1 the percentages to removal of vegetation in the study area reached up to 5.84 annually which refer to the risk situation (High level) where it is likely that the vegetation cover have been affected by several factors such as urbanization and land degradation**.**

Conclusion

The study confirms reports of destruction of the Ajloun area. The results of the study calls for the government, governmental organizations and the general public to respond fast and address the problem. The problem here is not only to do with the Ajloun forest area alone, but also all other forests in the country. Otherwise, the lives of present and future generations are at stake. By adopting the recommended measures, and others which may be appropriate the current situation on our forests is likely to improve.

In general, the project was successful since it achieved its objectives. The change in forest cover was successfully quantified using remote sensing data. However, with two epochs, monitoring of change was could not be effected. Efforts are still being made to acquire images for more epochs and keep refining the monitoring process. The study is thus still on and there is an intention to expand the scope to other threatened forests in the country.

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References

1. Al-Tamimi . S, Al-Bakri, J. 2005. Comparison Between Supervised and Unsupervised Classifications for Mapping Land Use/Cover in Ajloun Area. Jordan Journal of Agricultural Sciences, Volume 1, No. 1. Pp 73 – 83
2. Aksoy, M. Atam., and Beghin, John, C., 2005. Global Agriculture Tural Trade and Developing Countries. The International Bank for Reconstruction and Development. The World Bank.

3. DESIRE, 2007. Disseminating Educational Science Innovation & Research in Europe.http://www.desirehis.eu/wimba/WP2.1%20Indicators%20in%20the%20study%20sites%20(Report%2066%20D211%20Mar10)/index.htm
4. FAO. 1999. Drylands and the MFCAL approach in cultivating our futures – Background papers prepared for The FAO/Netherlands Conference on the Multifunctional Character of Agriculture and Land (MFCAL), 12-17 Sep 1999, Maastricht, The Netherlands. Rome, Italy: FAO.
5. GCEP [General Corporation for Environment Protection, Jordan]. 2000. Jordan Ecology, Ecosystems and Habitats. Amman, Jordan: UNEP [United Nations Environment Programme].
6. GEF (Global Environment Facility) 2004. Conservation and Sustainable Use of Dryland Agrobiodiversity: Jordan. Six Monthly Progress Report June- December 2004, Amman, Jordan.
7. Meera,.G, Parthiban. S, Thummalu. N. Christy. A. 2015. NDVI: Vegetation change detection using remote sensing and gis – A case study of Vellore District.
8. MPRA (Munich Personal RePEc Archive). 2006. MCS, Bantilan., P, Anand Babu., GV, Anupama., H, Deepthi., and R, Padmaja., Dryland Agriculture: Dynamics, Challenges and Priorities. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). MPRA Paper No. 16423.
9. Ibrahim, M. 2010. Environmental Assessment of Land Use Changes Using Remote Sensing and GIS Techniques in Irbid Area. Master Thesis unpublished, Al al-Bayt University, Al Mafraq.
10. Ibrahim, M. 2014. The Use of Geoinformatics in Investigating the Impact of Agricultural Activities between 1990 and 2010 Land Degradation in NE of Jordan. PhD Dissertation, Faculty of Environmental and Natural Sciences, Freiburg iversity, Freiburg im Breisgau.
11. Ibrahim, M. 2016. Temporal Interpretation for Land use/Land cover Changes Using Multispectral Images: Irbid as a Case Study. Journal of Natural Sciences Research, Vol.6, No.5, Pp 100 – 104.
12. IPCC. 2007. Climate Change 2007. Impacts, adaptions and vulnerability. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), Contribution of working group II to the fourth assessment, report of the intergovernmental panel on climate change. Cambridge, UK: Cambridge University Press.
13. Jawad Taleb Al-Bakri, Mohammad Ajlouni, and Mahfouz Abu-Zanat. 2008. Incorporating Land Use Mapping and Participation in Jordan. Mountain Research and Development, 28(1):49-57. DOI: http://dx.doi.org/10.1659/mrd.0863
14. JMD (Jordan Meteorological Department) 2000. Time Series of Monthly Means for Some Weather Elements in Jordan, Annual Report. Amman, Jordan.
15. UN Water. 2007. Coping with water scarcity: challenges of the twenty first century. Prepared for World Water Day, 2007.
16. White, R., Tunstall, D., and Henninger, N., 2002. An ecosystem approach to drylands: Building support for new development policies. Information Policy Brief no. 1. Washington DC, USA: World Resources Institute.