Analysis of land use and land cover changes in the area between Suleikhat and Yarmouk River Plain, Jordan

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Abstract: *This study has been conducted to assess the land use and land cover changes in the area between Suleikhat area and Yarmouk River in Jordan. The satellite images for the years 1972 and 2015 downloaded from GLCF web site have been used as a source data. The supervised classification has been followed to find out the different land use and land covers in the study area. To confirm the accuracy of classification the well-known error matrix has been used, from which the accuracy of classification found as 95 per cent. The result of analysis depicts that, vast area of plantation have been decreased followed by barren land while settlement, tree and water bodies have increased.*

Keywords: *land use and land cover, image classification, transit, error matrix.*

I. Introduction

The study of land use and land cover is one of the important scientific researches, from which the changes on the environment can be assessed. Land cover assessment and monitoring of its dynamics are essential for the sustainable management of natural resources, environmental protection, and food security (Foley et al., 2005; Gilani et al., 2015). Land cover change detection has been a focus of great interest and research for decades. Many applications require the present day information to identify the magnitude, direction and rate of land cover change (Lu et al., 2005). After the invention of satellite remote sensing technique, the study of land use and land cover has emerged rapidly as it provides current information on a periodic basis at low cost (Puissant et al., 2005).Through the use of remote sensing imagery many global land cover maps at different scales have been produced (Klein et al., 2012). In the recent years, the spatial resolution of the airborne and satellite image sensors has drastically been improved, providing more accurate and detailed information for the remote sensing image databases (Benedek et al., 2009).The surface of the earth has witnessed changes in its configuration more rapidly and extensively in the past 50 years than ever before in response to natural dynamics and human activity (Langroodi et al., 2015). The present study aims at detecting changes in the land use and land cover between the years 1972 and 2015 in the area between Suleikhat area and Yarmouk River area of NW Jordan.

II. Study Area

The study area is located on the north-western part of the Jordan (northern part of lower Jordan Valley), which lies from32^0 41' 00"to 32^018' 00"N latitude and from 35^0 42' 00" to 35^0 33' 00"E longitude "Fig. 1". It is covered by Syria in the north and West bank in the west while other parts of Jordan are covered in the east and south. Spatial extension of the study area is 504.3 Km^2. The elevation of the land features ranges from 328 m below mean sea level to 860 m above mean sea level "Fig. 2". It is bordered on both sides; east and west by high steep escarpments with differences in elevations between the valley floor and the surrounding mountains from 1200 m going up to 1700 m. The slope in the area varies from 0^0 to 30^0 "Fig. 3". Many wadies such as Wadi Al Arab, Wadi Abu Al Ghoul, Wadi Al Tayyiba, Wadi Ziglab, Wadi Al Jurm, Wadi Al Hamam and Wadi al Yabis run through the area. The distribution of rainfall varies from 200 mm/yr to 500 mm/yr. The higher elevated places get higher rainfall while lower elevation gets least rainfall.

The lithostratigraphic sequence of the study area (Bandel and Salameh, 2013) consists from bottom upwards (1) limestone, bedded massive dolomitic limestone and Dolomitic with chert beds, chalk limestone and marl of Cretaceous (Turonian-Maestrichtian) age, (2) chalk marls, marly limestone and chalky limestone of Paleocene-Miocene, (3) conglomerates, sands, silts and clayey marls of Pleistocene and (4) Holocene and Recent Sediments including soil, calcrete, gravel, fluvial sediments and alluvial fan deposits. Recent sediment in the highland part of the study area is the lime crust (Calcrete). This develops as surface cementation of carbonaceous material in areas of high seasonal rainfall. In the northern central part Upper Tertiary and Quaternary basalts cover the area

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III.   Methods and Materials

To detect the land use and land cover changes in the study area, the satellite images of the years 1972 (December 14th) and 2015 (January 15th) were downloaded from GLCF website. After the collection of the spatial data, the geometric, radiometric and atmospheric corrections have been performed by using ENVI software program to normalize the temporal changes of the two different time satellite images (Jepson, 2005). Based on the WGS-1984 geographical co-ordinate system and UTM Zone 36 projection co-ordinate system, the images have been analyzed. The suggestion given by Anderson et al., (1976) for the mapping of land use and land cover using satellite imagery has been followed in the study for the level of classification. Further the satellite images have been classified through supervised classified method in ERDAS. Totally five major units of land use and land cover have been identified and classified for both the years, such as, barren land, plantation, settlement, tree and water bodies "Table 1".

Once the classification of imageries were over, the accuracy assessment of classified images have been analyzed using error matrix, which is one of the popular method for the assessment of classification accuracy (Lu et al., 2005;Abd El-Kawy et al., 2011; Elkotb et al., 2014 and Huth et al., 2012). Field checks were carried out in 214 locations covering 60 locations in barren land, 71 in plantation area, 33 were tree and 15 were water bodies. The results of error matrix shown in "Table 1" represent the user and producer accuracy for each classified classes as well as the overall accuracy of classification. Barren land user accuracy is 97 and producer is 95, plantation user accuracy is 93 and producer is 97, settlement user accuracy is 94 and producer is 100, tree user accuracy is 94 and producer accuracy is 85, water bodies user accuracy is 100 and producer accuracy is 100 and the overall accuracy is 95 per cent. The minimum level of interpretation accuracy in the identification of land use and land cover categories from remote sensing data should be at least 85 percent and the accuracy of interpretation for the several categories should be about equal (Anderson et al., 1976). Therefore the results of error matrix depicts that 95 per cent of accuracy of present study is suitable for the land use and land cover mapping and change detection.

IV.   Results and Discussion

4.1 Land Use and Land Cover

The spatial distribution land use and land cover shown in "Fig. 4" and the results of existing and changes between selected years shown in "Table 2". From the obtained data it is clear that, of the total geographical area of 504.33 Km^2 the spatial extent of barren land (0.77 Km^2) and plantation (15.32 Km^2) have been decreased while settlement (12.06 Km^2), tree (3.56 Km^2) and water bodies (0.47 Km^2) have been increased.After the assessment of specific class overall changes in two time periods were over, the land use and land cover transition has been analyzed using overlay analysis in ArcGIS. Overlay analysis is one of the GIS fundamental operations, which Operate on spatial entities from two or more maps to determine. In ArcGIS several overlay tool sets are available such as, Erase, Identity, Intersect, Spatial Join, Symmetrical Difference, Union and Update, among these intersect is the best tool set to find out the changes between the selected two land use and land cover of study. Therefore using intersect the changes between the selected years have been found.

4.2 land use and land cover transition

The analysis of land use and land cover transits shown in "Table 3" and "Fig. 5" represents the changes happened from one class to another. From the data, it is clear that, transit of plantation to settlement covering about (10.59 Km^2) is higher than any other transit while least is tree to settlement (0.09 Km^2).The result also clearly states that, 168.92 km^2 of barren land, 227km^2 of plantation, 22.95 km^2 of settlement, 65.33 km^2 of tree and 0.11 km^2 water bodies have not changed and sustained as the same land use and lad cover classes from the year 1972 to 2015. Whereas1.26 km^2 and 3.62 km^2 of barren land have been changed into settlement and tree respectively. 3.95 km^2, 10.59 km^2 and 0.47 km^2 plantation area have been changed into barren land, settlement and water bodies respectively; the reason for increased water bodies is due to the construction of new dam at Wadi Al Arab. 0.09 km^2 spatial area of tree has been changed as settlement. The results represents that the conversion of other land use and land cover into settlement is higher than any others. Therefore it is clear that, the influence of human on the land use and land cover system on the study area.
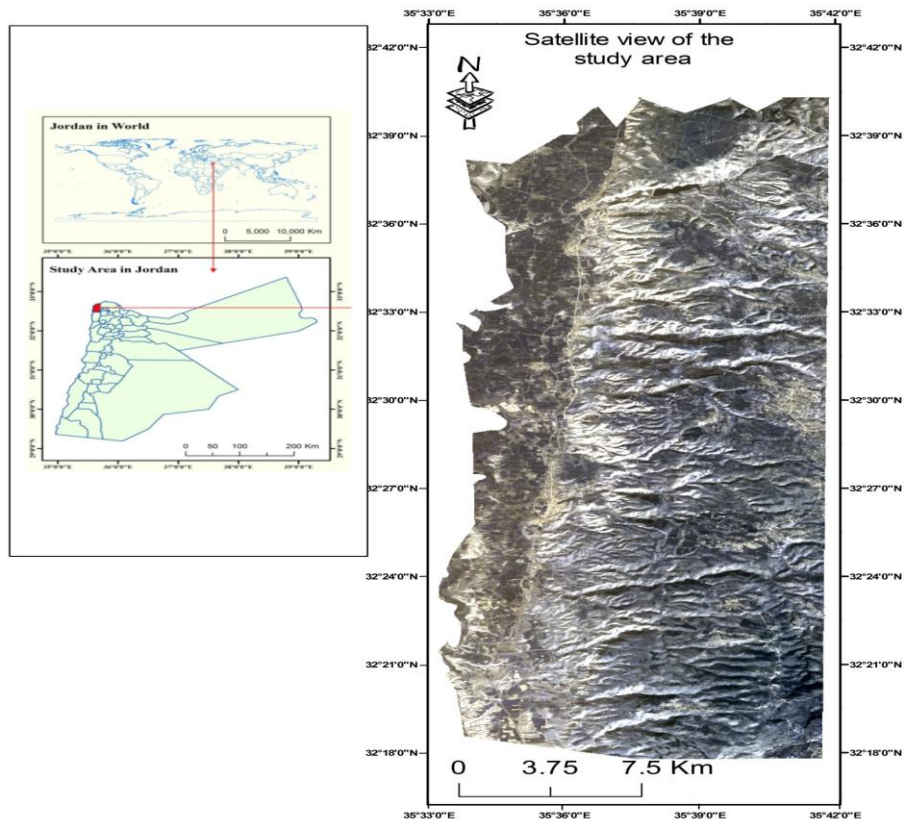
V.   Figures and Tables
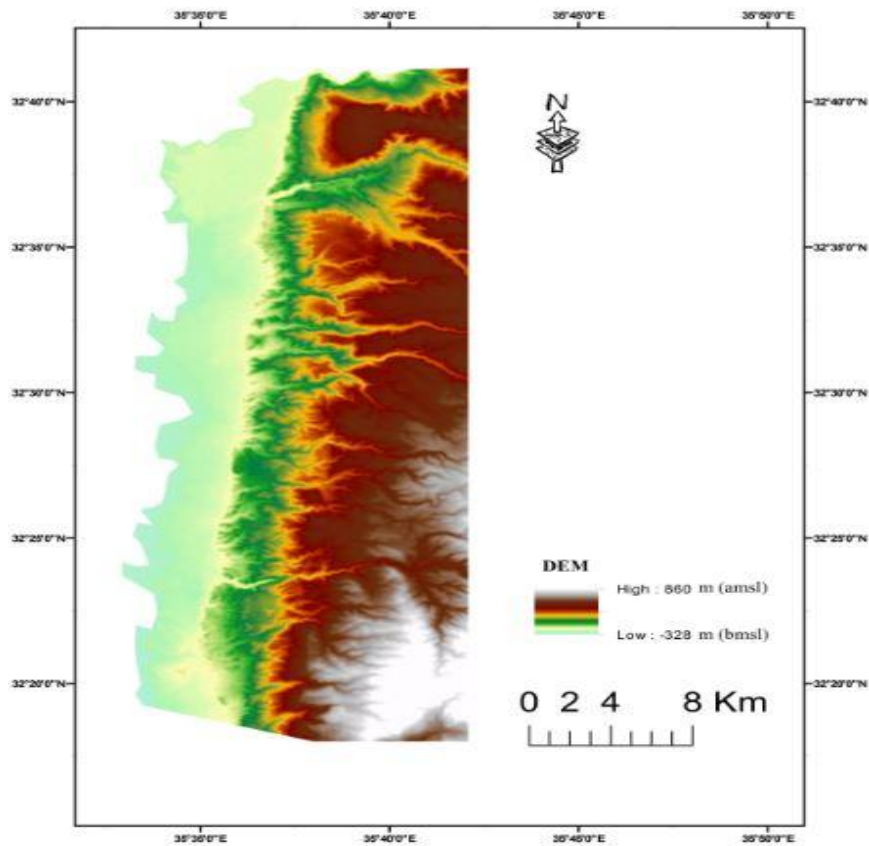

Fig. 1: Location map of the study area.

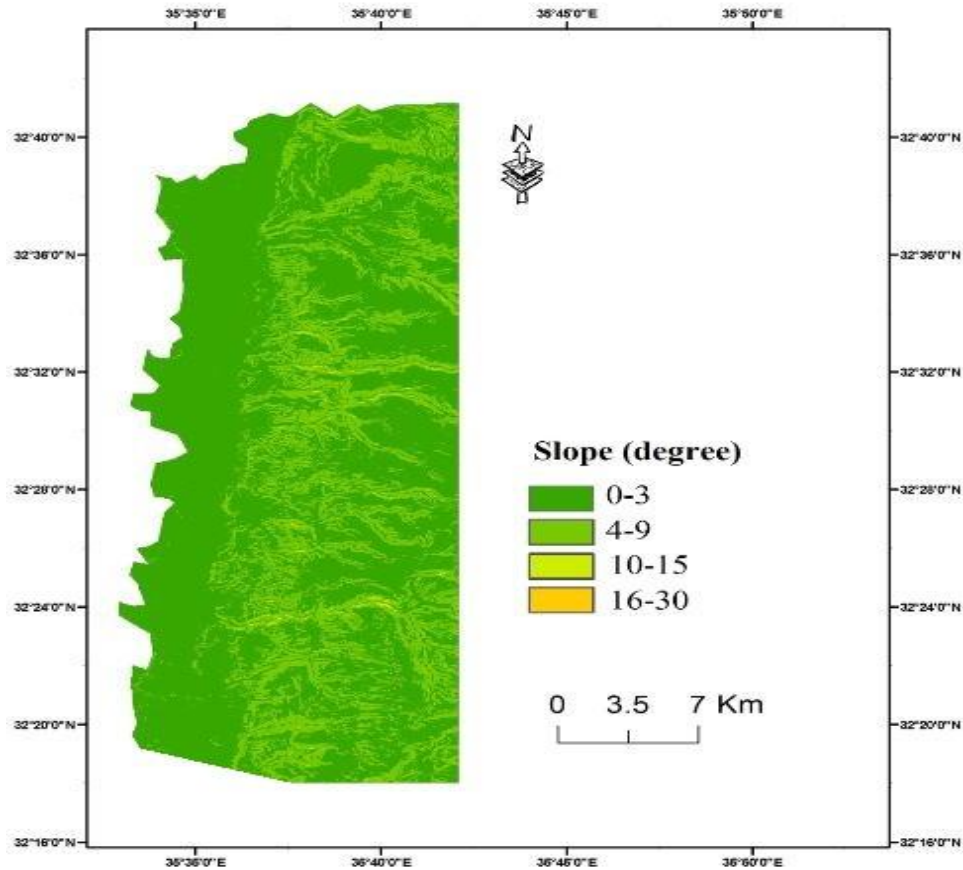**Fig. 2:** Topography map of the study area.
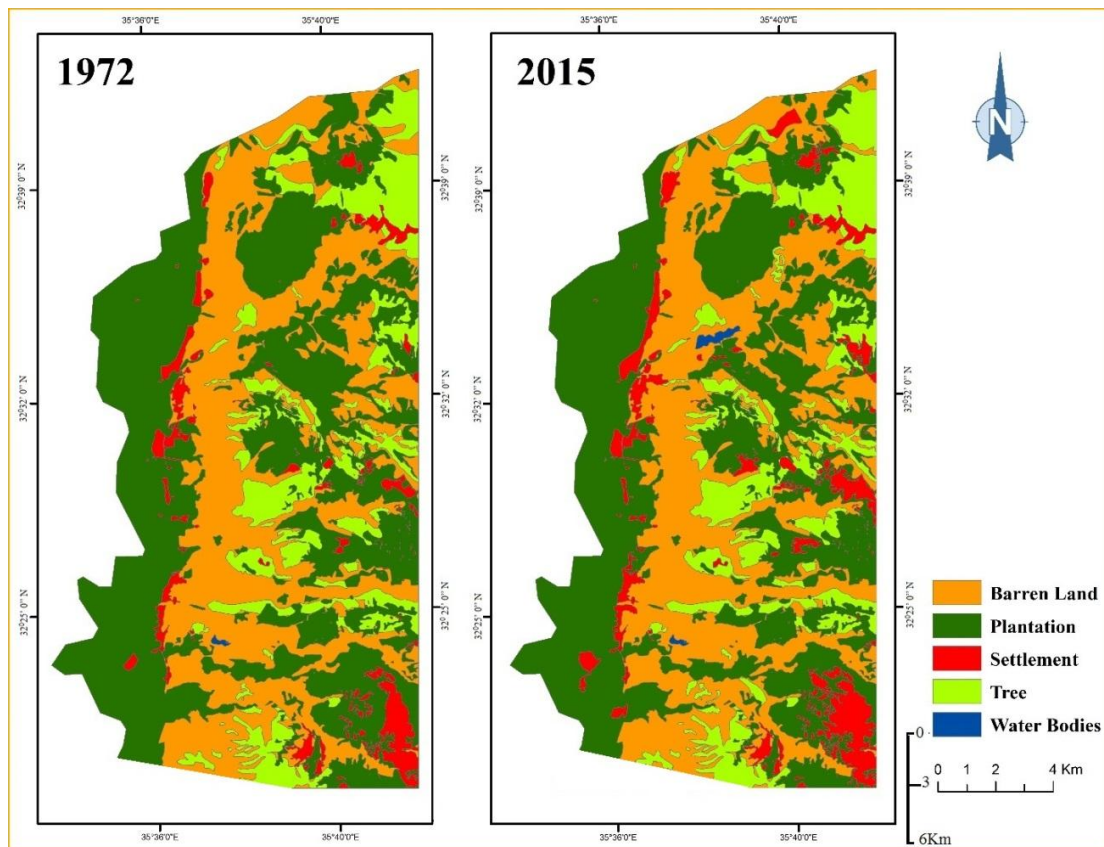
Fig. 3: Slope map in the study area.

Fig. 4: Spatial distribution land use and land cover in the study area.
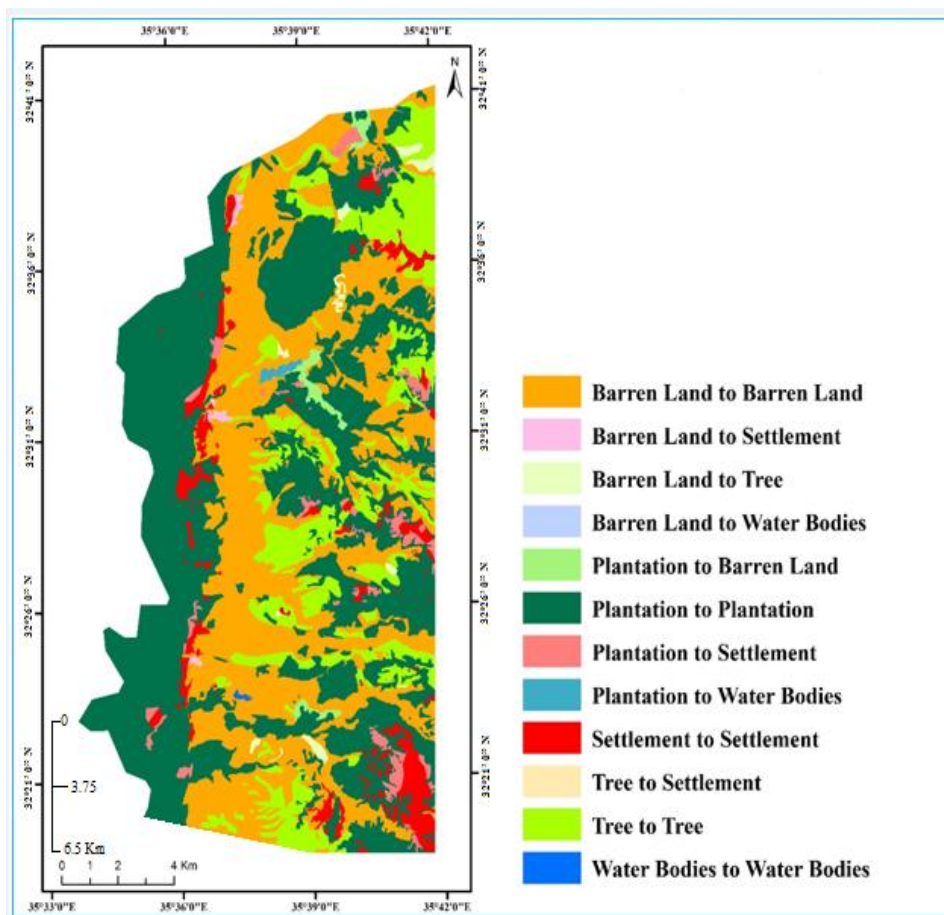
Fig. 5: Land use and land cover transition analysis between 1972 to 2015.

Table 1: Accuracy Assessment of Classified Image

No.	Classes	Barren Land	Plantation	Settlement	Tree	Water Bodies	Row Total	User Accuracy (%)	Producer Accuracy (%)
1	Barren Land	58	0	0	2	0	60	97	95
2	Plantation	1	66	0	4	0	71	93	97
3	Settlement	2	0	31	0	0	33	94	100
4	Tree	0	2	0	33	0	35	94	85
5	Water Bodies	0	0	0	0	15	15	100	100
	Column Total	61	68	31	39	15	214	Overall Accuracy = 95 %	

Table 2: Land Use and Land Cover

No	Classes	Year - 1972 (Area in Km^2)	Year - 2015 (Area in Km^2)	Changes (Area in Km^2)
1	Barren Land	173.67	172.9	-0.77
2	Plantation	242.32	227	-15.32
3	Settlement	22.83	34.89	12.06
4	Tree	65.39	68.95	3.56
5	Water Bodies	0.11	0.58	0.47
Total		504.32	504.32	

No	Transition classes	Area (Km²)
1	Barren Land to Barren Land	168.92
2	Barren Land to Settlement	1.26
3	Barren Land to Tree	3.62
4	Plantation to Barren Land	3.98
5	Plantation to Plantation	227
6	Plantation to Settlement	10.59
7	Plantation to Water Bodies	0.47
8	Settlement to Settlement	22.95
9	Tree to Settlement	0.09
10	Tree to Tree	65.33
11	Water Bodies to Water Bodies	0.11
	Total	504.32

VI.   Conclusion

The study conducted to analyze the changes if any in the land use and land cover in the area between Suleikhat and Yarmouk River plain area shows, the marginal decrease in the plantation and barren land while an increment in the settlement, tree and water bodies land units have been noticed. The result of land use and land cover transit represents that, large area of plantation have been converted into settlement, caused by the human activities in the study area. The result of present study clearly states the influence of anthropogenic activities on the land use and land cover. The study also suggests based on the results that, satellite images and the GIS are much suitable for the analysis of land use and land cover mapping and change detection.

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