

Land Use/Cover Change Detection in Arid and Semi-Arid Areas of Northeastern Jordan Using Landsat Images

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ABSTRACT

Digital change detection is the method that facilitates in determining the changes associated with land use and land cover properties using multi temporal remote sensing data. This paper is an attempt to assess the changes in land use/land cover in arid and semi-arid areas of northeastern part of Jordan. For this purpose a subset of each of the Landsat-TM and Landsat-8 digital images acquired in May, 2000, and May, 2014, respectively, were used. The two multi-temporal images were geometrically and radiometrically calibrated to each other, and then were classified using Maximum Likelihood classification algorithm. Change detection results showed that the decline of herbaceous areas is clearly the result of accelerated expansion of the bare land area class in the studied area. This paper highlights the importance of digital change detection in northeastern part of Jordan.

Keywords: Change Detection, Land use/Land Cover, Landsat, Northeastern Jordan.

1. INTRODUCTION

Land use/land cover (LU/LC) Change detection from remote sensing imagery is of great interest in environmental changes, urbanization, and other applications. Remote sensing tools and methods are becoming increasingly important for mapping LU/LC features; where images can be acquired with a spatial resolution that matches the degree of detailed required for the survey, and image interpretation is faster and less expensive than the ground survey, as well as images provide an objective, permanent data set that may be interpreted for a wide range of LU/LC aspects, such as urban growth, forestry, and agriculture (Al-Bilbisi et. al., 2004; Al-Bilbisi and Tateishi, 2003). Consequently remote sensing already proved useful in mapping LU/LC features and as data source for analysis and modeling of

LU/LC changes (Al-Bilbisi, 2012; Al-Bilbisi and Makhmreh, 2010, Xio et al., 2006; Grey et al., 2003; Herold et al., 2003; Wilson et al., 2003).

Land use/land cover change has been identified as an important indicator for land environmental changes that have taken place in the recent decades. In arid and semi-arid areas to have suitable planning and utilization of natural resources and their management; detection of environment changes in LU/LC is very important (Mallupattu and Sreenivasula Reddy, 2013). LU/LC change is widely documented as an important aspect of global environmental change, which plays a pivotal role in regional socio-economic development (Chen, 2002). Specific methodologies have also been developed to detect and model the land cover change in arid zones (e.g., Lambin and Ehrlich, 1997; Zhou and Robson, 2001; Maldonado et al. 2002; Li and Zhou, 2009).

Several researchers have been reported that deal with LU/LC change, accelerated environmental degradation, and significant human–environment conflicts (e.g., Al-Bilbisi, 2012; Al-Bilbisi 2003; Wang, 1996). According

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to many researchers the causes of LU/LC changes indicators in arid and semi-arid areas may take forms, depending on natural vegetation, soil type, salinization, soil erosion and the means of deploying grazing animals in rainfed areas (Thiam, 2003, Al-Dousari et al., 2000, Haboudaue et al., 2002, Hui et al., 2008; and Yanli et al., 2013).

Many marginal arid and semi-arid areas lands are at the risk of degradation, most of the changes are highly dependent on the biophysical constraints of the land units. Thus, the need to maintain sustainable use of these lands will require that they must be monitored for the onset of land degradation so that the problem may be addressed in its early phases. Monitoring of environmental changes will also be required to evaluate the effectiveness of measures to control land degradation (Al-Bilbisi, 2012).

Arid and semi-arid areas of northeastern Jordan, where the livestock production is the main job for the local population, are considered among the most important natural grazing lands rich in herbaceous rain-fed grazing plants in Jordan. These areas are coming under increasing of reduction or loss of their biological or economic productivity caused primarily by human activities and/or climatic variation, which in turn lead to land degradation (Al-Bilbisi et al., 2004; Al-Bilbisi and Tateishi, 2003). The objective of this study is assessing, monitoring and mapping environmental changes in northeastern part of Jordan using Landsat images.

2. Study Area

The studied area is Northeast Jordanian Limestone Plateau (Figure 1), which is a part of the Northeastern Desert of Jordan. It is a monotonous, flat plateau, stony desert that extends eastward from the Basalt Shield beyond the eastern borders of Jordan. Small scarps formed by more resistant beds of the Tertiary sedimentary sequence occasionally interrupt it. The land rises in all directions from the eastern margin of the Basalt Shield (Figure 1). The area contains many

flats, frequently more than 10 km long but rarely more than 1 km wide (Bender, 1974). Gradients are seldom steep and there are few sudden breaks of slope. Almost everywhere gentle concavo-convex slopes characterize the topography. The ground surface is largely covered by typical desert pavement.

Soil in the studied area is derived mainly from limestone rocks or basalt accompanying limestone rocks in some areas. According to the Soil Map of the World-Revised Legend (FAO/UNESCO, 1990) the area has mainly two dominant types, namely Calcisols and Gypsisols. The most prominent feature of Calcisols is the translocation of calcium carbonate from the surface layers to an accumulation layer at some depth in the soil. This layer may be soft and powdery, or consist of hard concretions and can eventually become indurated and cemented. Most Calcisols have a medium to fine texture and a good water holding capacity. They are generally well drained. These are potentially fertile soils but their high calcium carbonate content is not favorable for many crops and may result in iron and zinc deficiency in crops. These soils are mainly used for grazing (FAO, 2000).

Gypsisols in the studied area formed in the mudflats plains (Qaa), Qaa is the local designation for the fine sediment deposits, which are formed through dissolution from calcium sulphate contained in weathering materials. Much of the drainage appears to be radial, draining to, and terminating in, a large Qaa. Mudflats plains (Qaa) accumulate from ephemeral standing water through many wadis discharge in mudflats plains. They comprise fine, soft, various amounts of evaporates and silty clay.

The majority of the local populations in the studied area are involved in livestock production. Although, the studied area is considered poor in vegetation cover since there are no natural forests there; it is considered among the most important natural grazing lands in Jordan, where it is rich in herbaceous rain-fed grazing plants, such as, *Artimisia Alba* and *Rattamus*.

A generally arid to semi-arid desert climate exists in

the studied area, dominated by low precipitation, with average rainfall less than 100mm and high potential evaporation between 1500 mm/year and 2000 mm/year, resulting in scarce water resources (JMD, 2013).

There are noticeable seasonal temperature variations with summers tending to be hot and dry while winters

cool and wet. Mean annual maximum temperatures reach 35-41°C in July but absolute maximum values can exceed 46°C. Temperatures can decline reach 0°C in winter. Annual mean minimum temperatures decline to as low as 0-4°C in January (JMD, 2013).

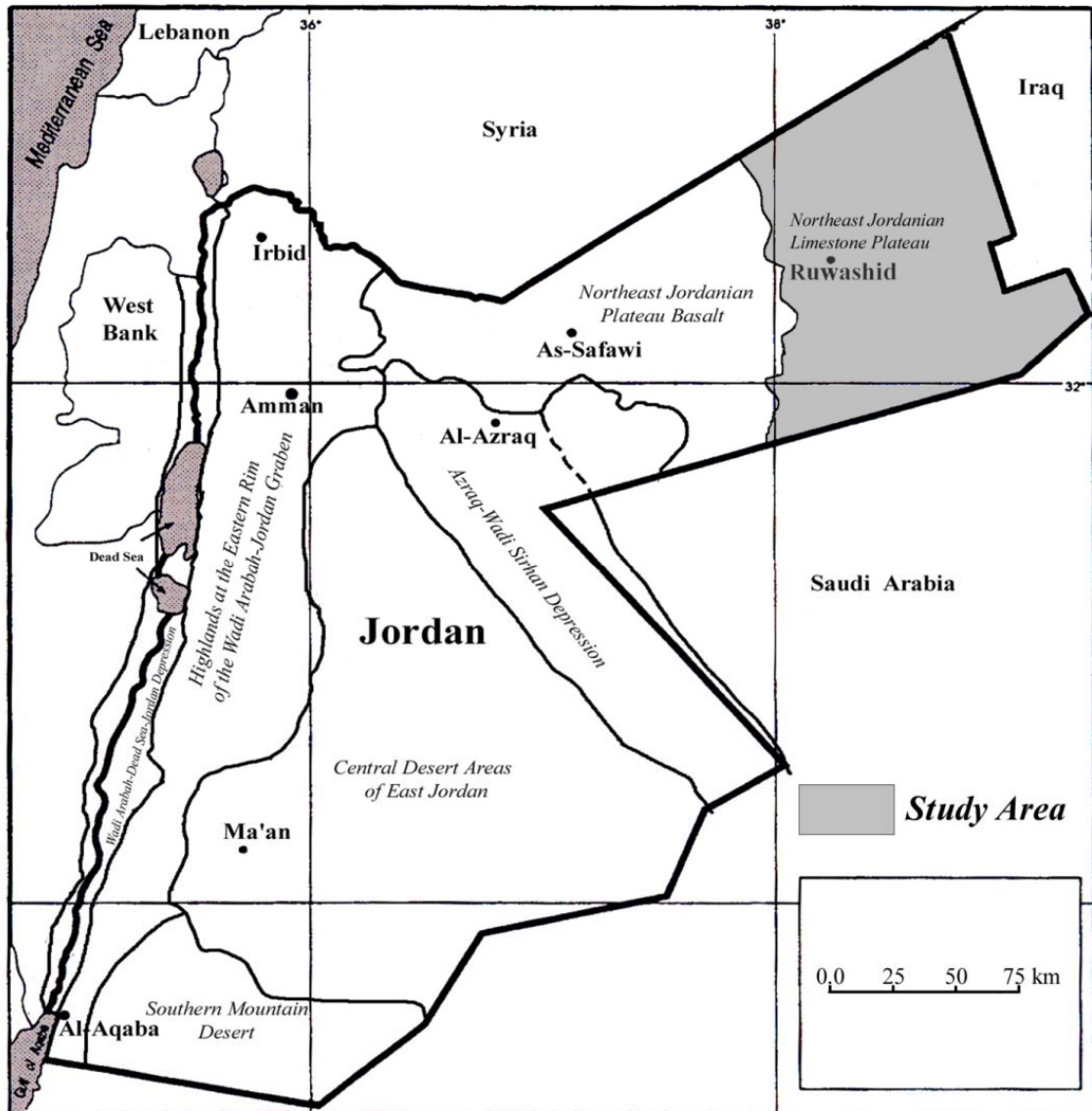


Figure 1. Location of the studied area, and the main geomorphological units of Jordan. (Modified After Bender, 1974)

3. Change detection techniques and methods

Spectral change detection techniques depend on the principle that land cover changes result in continual changes in the spectral signature of the effected land surface. These techniques involve the transformation of two original images a new single-band or multi-band image in which the areas of spectral change are highlighted. The spectral change data must be further processed by other analytic methods, such as a classifier, to produce a labeled LU/LC change results. Most of the spectral change detection techniques are based on some style of image differencing or image rationing. Since all spectral change detection methods are based on pixel-wise operations or scene-wise plus pixel-wise procedure. Accuracy in image registration and coregistration is more critical for these methods than for other methods. The greatest challenge to the successful application of the spectral change detection methods is the discrimination of “change” and “non-change” pixels from the continuous spread of data. The basic requirement for spectral land use/land cover change detection, using digital remote sensing, is the availability of two dates of imagery upon which the same area of land can be observed. Depending on the characteristics of the two data sets, change detection can be either an easy or difficult task (Al-Bilbisi, 2012; Al-Bilbisi and Tateishi, 2003; Yuan et al., 1998).

In arid and semi-arid zones, LU/LC change can be characterized as two kinds: categorical or quantitative changes, which can also be further classified as reversible or irreversible changes. Irreversible change means that LU/LC features have changed into other types and generally cannot change back (e.g., dam construction). Reversible change, on the other hand, means that the changes have not reached the “no return” stage so that the original status of the land cover can be restored (e.g., vegetative cover change due to weather conditions).

Several Researchers involved in change detection researches using satellite images data have considered a

large range of methodologies for identifying environmental changes. Change detection procedures can be grouped under three broad headings characterized by the data transformation procedures and the analysis techniques used to delimit areas of significant changes: (1) image enhancement, (2) multi-date data classification and (3) comparison of two independent land use/cover classifications (Mas, 1999). The enhancement approach involves the mathematical combination of imagery from different dates such as image regression, subtraction of bands or image rationing. Thresholds are applied to the enhanced image to separate the pixels that have changed. The direct multi-date classification is based on the single analysis of a combined dataset of two or more different dates, in order to identify areas of changes. The post-classification comparison is a comparative analysis of images obtained at different moments after previous independent classification. In the present study, post-classification analysis procedure was utilized.

4. Methodology

4.1. Geometric rectification and radiometric calibration

A subset of each of the Landsat TM and Landsat 8 digital images acquired in May 2000, and May 2014; respectively, covering the Northeast Jordanian Limestone Plateau (Figure 1) were used. The digital images were geometrically and radiometrically calibrated to each other to facilitate their comparison. Geometric rectification is critical for producing spatially corrected maps of LU/LC changes through time. The 2014 Landsat 8 image, which was supplied by USGS, had already been rectified and georeferenced to UTM map projection (Zone 36), and WGS84 ellipsoid. Then, this image was employed as the reference scene to which the second scene (TM of 2000) was registered. Using image-to-image registration the first-degree polynomial equation was used in image transformation. The resultant root mean square error (RMSE) was less than 0.5 pixels, indicating an excellent registration. The nearest neighbor resampling method was

used to avoid altering the original pixel values of the image data.

An important component to the change detection is radiometric calibration and corrections (Chavez and Mackinnon, 1994). Radiometric calibration and corrections can eliminate or reduce image differences introduced as a result of changing atmospheric conditions. Since both images are acquired in same season. A histogram matching provided by PCI software had been used in this study. After this correction, image statistics and histograms from the two periods were found to be similar and comparable.

4.2. Image Processing

4.2.1. Visual Interpretation

Different colors combinations had been carried out for visual interpretation and analysis of LU/LC classes, with the purpose of using the information of the three main spectral regions of Landsat imageries (i.e., visible, near-infrared and mid-infrared) regions. (i.e., TM-2000 bands 7, 4, 2 and their equivalents Landsat 8-2014 bands (7, 5, 3) color combinations were generated, bands 4, 3, 2 and bands 5, 4, 3 were also generated for TM and Landsat 8, respectively.

4.2.2. Image classification

To map changes that had occurred between the two dates, six spectral bands of both Landsat digital data (with the thermal bands being excluded) were individually used as an input for supervised classification purpose. Maximum likelihood algorithm provided by PCI software had been used for LU/LC mapping from Landsat images. For visual interpretation purpose and as a classification scheme design for this research; in total, five land use/cover categories were included in the scheme; these are:

- **Urban Class:** Construction materials, e.g. asphalt, concrete, etc.; typically commercial and industrial buildings, residential development including most of

single/multiple houses, transportation facilities, e.g. airports, parking lots, highways, and local roads.

- **Bare Land Class:** Particular soil layers or surfaces that have been indurated due to chemical or physical processes. Their hardness at the surface is irreversible. They form impenetrable layers for water and/or plant roots. The surface of the soil is cemented or indurated by calcium carbonate to the extent that dry fragments do not slake in water and plant roots cannot penetrate. The first 15-20cm is very hard, few gravels of limestone rock, chert and sometimes basalt fragments are exists on the surface.
- **Mudflats Plains (Qaa) Class:** Qaa is the local designation for the very hard, fine sediment deposits (mudflats plains), which are formed through dissolution from calcium sulphate contained in weathering materials. Much of the drainage appears to be radial, draining to, and terminating in, a large Qaa. Mudflats plains (Qaa) accumulate from ephemeral standing water through many wadis (valleys) discharge in mudflats. They comprise fine, soft, various amounts of evaporates and silty clay. The surface of the soil is cemented or indurated by gypsum to the extent that dry fragments do not slake in water and roots cannot penetrate.
- **Herbaceous (rain-fed grazing plants) Class:** Varies in thickness between 40cm and 80cm, in some areas it reaches 100cm. The first 20 cm is firm to hard, brown to pale brown, Clayey silty sand to Sandy silty clay, with fine roots and few gravels. Below 20cm firm to hard yellowish brown Silty clay. This class is a natural grazing land rich in herbaceous rain-fed grazing plants, such as, *Artimisia Alba* and *Rattamus*.
- **Wadi (Valley) Deposits Areas Class:** Consists of gravels, stones and boulders and other unconsolidated and loose materials.

Table (1) summaries the LU/LC classes including their definitions.

4.2.3. Spatial Reclassification

Basically, there are two types of misclassification errors: (i) the boundary error and (ii) the confusion in spectral classes representing two or more LU/LC types. These errors can be substantially reduced with the use of spatial reclassification procedures (Al-Bilbisi, 2012; Al-Bilbisi and Tateishi, 2003).

(i) **Reducing boundary errors:** because of the occurrence of spectral mixing within a pixel boundary error occur at class boundaries (Booth and Oldfield, 1989). These miss-classified pixels are often small relative to pixels of correct classification. There are also

some small areas of anomalous pixels (often in the forms of salt and pepper) representing the noise in the Landsat images within the same class. These small pixels should be removed and replaced with class values on their surroundings. An appropriate classification procedure could be used and it involves two stages (Yang and Lo, 2002; Booth and Oldfield, 1989): (1) identification of minimal pixels and their subsequent declassification, and (2) re-labeling of declassification pixels on basis of their surrounding pixels. To achieve a fast approximation of these two stages in a one-pass operation, the mode filter had been used.

Table 1. Land use/cover classes and definitions used in this research

No	Class	Definition
1	Urban	Construction materials, e.g. asphalt, concrete, etc.; typically commercial and industrial buildings, residential development including most of single/multiple houses, transportation facilities, e.g. airports, parking lots, highways, and local roads.
2	Bare Land	They form impenetrable layers for water and/or plant roots, few gravels of limestone rock, chert and sometimes basalt fragments are exist on the surface. The surface of the soil is cemented or indurated by calcium carbonate to the extent that dry fragments do not slake in water and roots cannot penetrate. Thickness of this class is usually between 50cm and more than 120cm. The first 15-20cm is very hard.
3	Mudflats Plain (Qaa)	They comprise fine, soft, various amounts of evaporates and silty clay. The surface of the soil is cemented or indurated by gypsum to the extent that dry fragments do not slake in water and roots cannot penetrate. Thickness of this class is usually exceeding 100cm. The first 5-15cm is very hard.
4	herbaceous (rain-fed grazing plants) area	This class is a natural grazing land rich in herbaceous rain-fed grazing plants, such as, <i>Artimisia Alba</i> and <i>Rattamus</i> . The first 20 cm is firm to hard, brown to pale brown, Clayey silty sand to Sandy silty clay, with fine roots and few gravels.
5	Wadi (valley) deposits	This class consists of gravels, stones and boulders and other unconsolidated and loose materials (mostly silty clay).

Mode filter is applied to $n \times n$ pixel patch, where n is an odd integer. A histogram of class values in the patch is generated and the value having the highest frequency is returned as the new central value. The center pixel's value

thus becomes that of the most commonly occurring class within the patch. In this way, the small (and erroneously classified) pixels are reclassified according to the dominant class within the patch.

The choice of filter size and the number of neighbors was based on the following considerations (Yang and Lo 2002; Booth and Oldfield 1989). First, the filter size should be large enough to allow some important or targeted components to be covered within the patch. Thus, a 3 x 3 mode filter was used here. Second, the mode filter could affect linear features. Most of the linear features found in the studied area are often urban uses and should be preserved. A 3 x 3 mode filter with the four corner cells disabled (i.e. with zero value) can preserve some linear features.

(ii) Resolving spectral confusion: since several LU/LC classes have similar spectral reaction, which is highly dependent upon imaging sensor characteristics (spatial, spectral, and radiometric resolutions) and scene contents, spectral confusion is expected. As image spatial resolution decreases (i.e. larger pixel size), the number of mixed pixels increases, and thus the spectral confusion have a tendency to be more serious. Spectral confusion is the major cause of classification accuracy of a spectrally based classification method (Al-Bilbisi, 2012; Al-Bilbisi and Tateishi, 2003; Yang and Lo, 2002; Campbell, 1996; Lillesand and Kiefer, 1994).

Defining spectral confusions needs the use of image spatial and contextural properties. For this purpose, visual interpretation was employed because it allows an integrated use of spectral and spatial contents as well as human wisdom and experience. At present, visual interpretation can be included effectively into a digital classification procedure with the use of multiple, zooming on-screen digitizing, and Area of Interest (AOI) functionality. In addition, several image processing platforms allow advanced tools for spatial modeling through which some “manual” operations can be implemented automatically. With the use of this method, three major types of spectral confusion can be identified in the current study: (1) herbaceous area class/bare land class; (2) herbaceous class/wadi deposit class; and (3) urban class/wadi deposit class. These spectrally confused

clusters were further spilt and recorded into their correct LU/LC classes.

5. Results and Discussion

Figures (2 and 3) show the color composites generated from the filtered TM-2000 bands 7, 4, 2 and Landsat 8-2014 bands 7, 5, 3, respectively. Urban area is pink color while vegetation is green because the near-infrared band, in which vegetation has a high spectral response, was exposed through the green filter. Color products using the TM-2000 bands 4, 3, 2 and Landsat 8-2014 bands 5, 4, 3 combinations were also generated for interpretation and analysis purposes; urban area in this combination is cyan color, while vegetation is red.

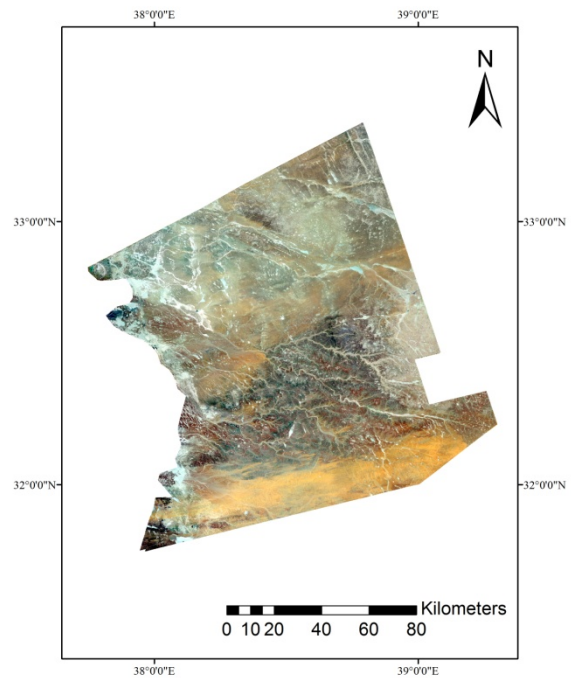


Figure 2. Color composite image of Landsat-TM (2000) bands 7, 4, 2 exposed through the red, green and blue filters, respectively

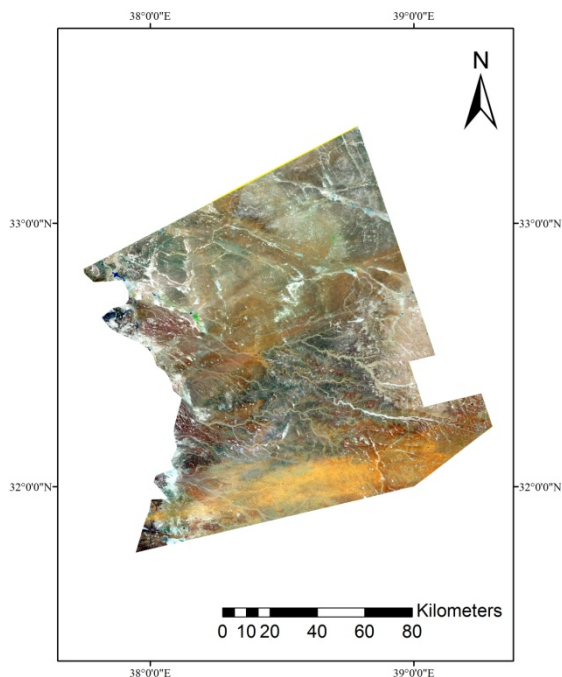


Figure 3. Color composite image of Landsat - 8 (2014) bands 7, 5, 3 exposed through the red, green and blue filters, respectively

5.1. Images Classification & Accuracy Assessment

Figures (4 and 5) show the results of the supervised classification of TM-2000 and Landsat 8-2014, respectively. Accuracy assessment is needed for testing the accuracy of the resultant classes of the classification process. There are several methods of quantifying accuracy, such as the overall accuracy and the Kappa coefficient (Congalton, 1991). The confusion (or error) matrix, which can be used as a starting point for a series of descriptive and analytical statistical analyses, is used to represent the accuracy assessment (Lillesand and Kiefer, 1994). In order to obtain the confusion matrix, a random sampling method was carried out. The columns of the matrix represent the reference data, while the rows indicate the classes generated from the classification process. According to previous studies, there are many ways to improve the interpretation of the confusion matrix. Among them, Kappa coefficient is one of the most popular measures for addressing the difference between

the actual agreement and the chance agreement (Congalton, 1991).

The Kappa coefficient of agreement was computed as:

$$\hat{k} = \frac{N \sum_{i=1}^r X_{ii} - \sum_{i=1}^r (X_{i+} \times X_{+i})}{N^2 - \sum_{i=1}^r (X_{i+} \times X_{+i})} \quad (1)$$

Where r is number of rows in the confusion matrix, X_{ii} is number of observations in row i and column i , X_{i+} is the total number of observation in row i , X_{+i} is the total number of observation in column i , and N is the total number of observations included in matrix.

Tables (2 and 3) show the error (confusion) matrices resulting from the classifying digital data. For TM-2000 LU/LC map, a total of 377 pixels were selected, which were then checked with reference to 1:50,000 topographic maps. The result shows an overall accuracy of 88.9%. In terms of producer's accuracy and user's accuracy, all classes were over 80% and a Kappa index of agreement of 0.84 (Table 2). This value indicates that the classification process was avoiding 84.0% of the error.

For Landsat 8- 2014 LU/LC map, a total of 422 pixels were selected. These were checked with reference to 1:50,000 topographic maps. The result indicated an overall classification accuracy of about 91.2%. In terms of producer's accuracy and user's accuracy, all classes were over 87% and a Kappa index of agreement of 0.87 (Table 3). This value indicates that the classification process was avoiding 87.0% of the error.

A comparison of Table (1) and (2) revealed that the 2014 LU/LC map based on Landsat-8 image yielded slightly better accuracy than that of the 2000 LU/LC map based on Landsat-TM. The 2000 land use/cover map is compatible in accuracy in every respect to the 2014 LU/LC map. Overall accuracy more than 85%, for both maps, indicate that this is good evidence that the image

processing approach adopted in this study has been effective in producing compatible LU/LC data over time.

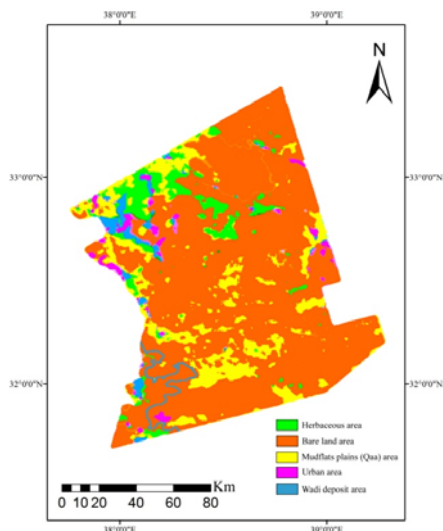


Figure 4. Land use/cover classification map of Northeastern Jordan based on the analysis of Landsat TM-2000

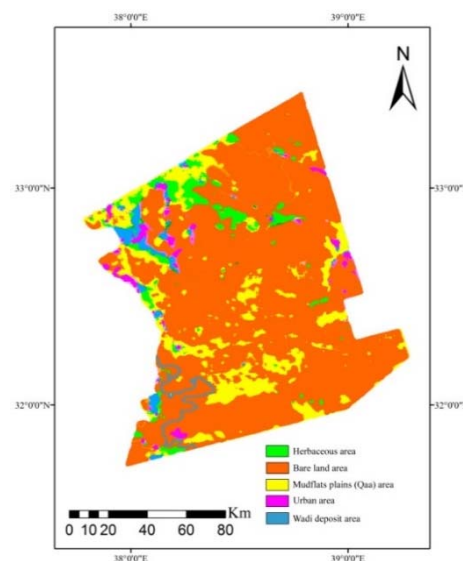


Figure 5. Land use/cover classification map of Northeastern Jordan based on the analysis of Landsat 8-2014

Table 2. Confusion matrix of the signatures derived from supervised training of TM-2000

Classified data	Reference data					Row User accuracy	
	1	2	3	4	5	total	(%)
1	25	2	1	0	1	29	86.2
2	0	165	7	2	7	181	91.2
3	1	2	62	2	2	69	89.9
4	2	1	2	33	3	41	80.5
5	1	1	3	2	50	57	87.7
Column total	29	171	75	39	63	377	overall Kappa index = 0.84
Producer's Accuracy (%)	86.2	96.4	82.7	84.6	79.4		

Note: Number of pixels correctly classified = 335; overall classification accuracy = **88.9%**; class 1 = Urban; class 2 = Bare Land; class 3 = Flat Plain (Qaa) ; class 4 = Herbaceous (rain-fed grazing plants); class 5 = Wadi (valley) deposits.

Table 3. Confusion matrix of the signatures derived from supervised training of Landsat 8- 2014

Reference data							
Classified data	1	2	3	4	5	Row\	User accuracy
						total	(%)
1	21	1	0	1	1	24	87.5
2	1	187	5	2	6	201	93.0
3	1	3	71	2	3	80	88.8
4	1	1	1	38	2	43	88.4
5	0	0	3	3	68	74	91.9
Column total	24	192	80	46	80	422	overall Kappa index = 0.87
Producer's Accuracy (%)	87.5	97.4	88.8	82.6	85.0		

Note: Number of pixels correctly classified = 385; overall classification accuracy = **91.2%**;
class 1 = Urban; class 2 = Bare Land; class 3 = Flat Plain (Qaa) ; class 4 = Herbaceous (rain-fed grazing plants); class 5 = Wadi (valley) deposits.

5.2. Change Detection

The post-classification comparison change detection approach was employed (Singh, 1989). This method involves comparing two independently produced classified LU/LC maps from images of two different dates. It was found to be an accurate procedure for LU/LC changes detection; provided that the two LU/LC maps had

been accurately produced, as they were in this study (Singh, 1989; Jensen et al., 1999). There are five major LU/LC classes of interest in northeastern Jordan: urban, bare land, Qaa, herbaceous, and Wadi deposit. The spatial distribution of these classes were extracted from each of the LU/LC maps of 2000, and 2014, , respectively, the results are shown in Table (4).

Table 4. Land use/cover change for the studied area as extracted from Landsat images

Class Name	Landsat TM-2000		Landsat 8-2014	
	Area (km ²)	(%)	Area (km ²)	(%)
Herbaceous	1961.72	14.09	1691.28	12.15
Bare Land	7697.37	55.30	7884.29	56.64
Qaa	3006.72	21.60	3045.70	21.88
Wadi deposit	1227.74	8.82	1255.58	9.02
Urban	26.45	0.19	43.15	0.31

The goal of this study was to recognize changes in the

spatial pattern of the LU/LC classes of interest in the

studied area. The spatial distributions of these classes were extracted from each of the LU/LC maps generated from Landsat-TM (2000) and from Landsat-8 (2014); the results are shown in Table (4). Based on Figures (2, 3, 4, and 5), and Table (4) the spatial expansion of bare land class is clearly visible. In quantitative terms, bare land area class has increased from 7697.37 km² (or 55.29%) in 2000 to 7884.29 km² (or 56.64%) in 2014 (Table 4), this represents an increment of 186.92 km² in land area. Another significant change is the decline in herbaceous area class in the studied area. In 2000, there were 1961.72 km² (or 14.10%) of herbaceous lands, which declined to 1691.28 km² (or 12.15%) by 2014, thus representing a decrement of 270.44 km² in land area. The results also revealed that the other three classes, namely; qaa, wadi deposits and urban class, had little changes been taken place between the two dates (Table 4). Notice the changes of LU/LC in the western and northeastern parts of the studied area (Figures 4 and 5).

6. Conclusion

Arid and semi-arid areas of northeastern Jordan are considered among the most important natural grazing lands rich in herbaceous rain-fed grazing plants in Jordan. Therefore LU/LC mapping of northeastern Jordan area is very important, where the livestock production is the main job for the local population.

Using post-classification comparison change

detection approach, the usefulness of the Landsat images were demonstrated for change detection study. The methodology used in this research was based on an adequate understanding of landscape features, and information extraction techniques employed. A digital LU/LC maps dealing with five LU/LC classes were produced using supervised classification scheme of two Landsat digital data. To minimize problems of boundary errors caused by spectral confusion in the image classification, a spatial reclassification method was used to break down spectrally clusters to smaller ones for re-labeling. Accuracy assessment confirmed that the image processing procedures were effective in extracting LU/LC maps and statistics of the studied area from Landsat images. Change detection results showed that the decline of herbaceous areas is clearly the result of accelerated expansion of the bare land area class in the studied area.

Results of the study were alarming and emphasized the need for land use/ land cover monitoring in the studied area. It is recommended to use remote sensing data to recognize the environmental changes in natural grazing lands in arid and semi-arid areas of Jordan.

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كشف التغيرات في استعمالات وأنماط الغطاء الأرضي في المناطق الجافة وشبه الجافة في شمال شرق الأردن باستخدام مرئيات اللاندسات الفضائية

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ملخص

تم استخدام طريقة كشف التغيرات في استعمالات الأراضي وأنماط الغطاء الأرضي في المناطق الجافة وشبه الجافة في شمال شرق المملكة الأردنية. ولتحقيق هدف الدراسة، تم استخدام بيانات فضائية مأخوذة بواسطة المستشعر لاندسات (TM) ملتقطة سنة (2000) ولاندسات (8) ملتقطة سنة (2014). وقد خضعت البيانات الفضائية للتصحيح الجيوميتري والراديوميترى وذلك من أجل تسهيل المقارنة بينهما. ولتحديد التغيرات في استعمالات وأنماط الغطاء الأرضي تم إنتاج خارطتين (2000 و 2014)، بعد إجراء عملية التصنيف الموجه لكلا المرئيتين كل على حدة، حيث تم حساب قيم التغيرات على هيئة مساحات خلال الفترة الزمنية للدراسة. أظهرت النتائج تدني مساحات المناطق ذات الغطاء النباتي مقابل زيادة في مساحات المناطق الجرداء مما يدل على تغيرات في استعمالات وأنماط الغطاء الأرضي وهذا يؤكد على أهمية مراقبة كشف التغيرات في منطقة الدراسة.

الكلمات الدالة: كشف التغيرات، استعمالات وأنماط الغطاء الأرضي، لاندسات، شمال شرق الأردن.

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