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Land Use Land Cover Classification and mapping for Al-Ula'a area: Saudi Arabia

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ABSTRACT:

Remote sensing software's, (PCI) provide a power full tool for land use land cover feature detection, its help to classify urban and agriculture coverage area. In particularly the classification of IKNOS satellite image (Al-Ula'a area) provide land cover information which need to divide, and calculate the classes area of land cover land use separately (class by class), to get more accurate accounted for each type of feature area. Thus temporal IKNOS image base on supervised classification approach were used to extraction of urban and agriculture over the study area (Al-Ula'a) area. Remotely sensed data were analyzed and processed using feature extraction based image processing techniques. The result of this study shown, the agriculture class has a largest class on the study area 118 KM, but the urbanization is increasing over the time about 20.76% compare to historical data, This extensive and expansion change of agriculture's due to fast development of urbanization.

Keywords: Remote Sensing, land use land cover, feature detection, classification.

I. INTRODUCTION

Spectral emit or reflect from features can be defined, in general terms as a technology cum technique used to extraction and monitoring information about the earth, from reflected or emitted electromagnetic radiations, and record by sensors, then into satellite image[10-13,14,19]. Recent advancements made in the development of satellite sensors, image processing techniques, environmental data collection techniques and remote sensing modelling have together provided a powerful tool for land cover land use [7-18, 20, 22]. Satellite remote sensing has been widely adopted for thematic map analysis, environmental classification, planning and decision making [5- 8, and 13].

The method of image classification and land use land cover were base in pixel classification technique (super-visor classification and unsupervised classification), these technique is useful for general land cover classification, but can't classify more one type of feature inside one class so the extraction feature class inside class become important, for detecting change on the land use land cover map with complicated land cover area classes. the related previous work reveals that satellite-derived information have been used in mapping land cover land use in urban planning and applications, many research have been investigate the geographical and environmental feature using object-oriented analysis with moderate-resolution satellite imageries [1- 2,6,9,14].

Many researchers have been study the agriculture classification and biodiversity mapping [3-4, 16, 17, and 21]. However, mostly did not eliminate the influence of species classification on land cover land use map and they included the whole species in one class, which lead to low accuracy land use mapping and difficult to investigate any class separately like vegetation or urbanization, in this project we have eliminated hierarchical classification derived from IKNOS satellite image, Which is a basic property is an important technical, To classify each feature separately and investigate species and classes of land cover in A'lua in 2016.

The related literature provided general land use land cover classification, of feature extraction variability in different area and different type of feature, these studies were, however, given general description and seems to be low accuracy land cover mapping, and mostly have no classification details for each class. In example vegetation with feature extraction class in side class cane defined the percentage of each type of vegetation classes.

This study improved significantly accuracy 92% and ability to detect class and features accurately which is useful to classify many classes inside one class, but the old method such as general classification of land use land over classification or mapping cant fiend class inside class, in example can't classify the agriculture separately and accurately from other class. In light of this the fractions spectral classification it's better for feature extraction which is allowed to investigating any element of land cover class. This study further explores and demonstrates the capability of IKNOS satellite image for feature extraction and class inside class for land cover classification from IKNOS imagery.

II. RESEARCH METHODOLOGY

A. *Study area location*

Al'Ula is one cities of Saudi Arabia, located in the west of the Arabian Peninsula. It is administratively located in the Medina area and is about 300 km north Medina. Al'-Ul, which lies between longitudes 37°55'27.58" E and latitudes 26°36'33.58" N. Figure 1 shows the study area location.

Figure 1–the location of the study area, Al' Ula

B. Research data

The Satellite data downloading from the Global Land Cover Facility, www.landcover.org. The IKONS datasets provide timely and reliable information for monitoring of natural resources. Obtaining the same information through field surveys would time consuming and use considerable human resources Composites. Table 1. Shows the details of IKONOS spectral band and spatial resolution [10-12].

Table 1. Shows the details of IKONOS spectral band and spatial resolution.

Satellite	Sensor	Band(s)	Spectral Range	Scene size	Pixel resolution
IKONOS-2	Multi-spectral	1 = Blue	455 - 520 µm	11× 11km	4 Meter
		2 = Green	510 - 600 µm		
		3 = Red	630 - 700 µm		
	panchromatic	4 = NIR	760 - 850 µm		

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The following data were collected for the study that includes the land use map obtains from the Al Al-Ula'a municipality, IKNOS image obtain from Almandinah development authority.

C. ATMOSPHERIC CORRECTION

The research data and IKNOS satellite images were process and corrected from atmospheric effects using the existing model of atmospheric correction. In this equation prosdguder, The DN value were converted to radiance value IKNOS (watts per square meter steroidal per micrometer), using the gains and offsets in the processing image Meta data and header files. For IKNOS ETM+sensors, l_{sat} was calculated as follows equation 1 [10, 12]:

$$L_{sat} = \left(\frac{l_{max} - l_{min}}{(DN_{MAX}) - (DN_{MIN})}\right)((DN) - (DN_{MIN})) + L_{MIN} \qquad (1)$$

Where, L_{MAX} and L_{MIN} are the calibration factors (watts per square meter steradian per micrometer), DN_{MAX} and DN_{MIN} represent the maximum and minimum digital number values as DN_{MIX}x0255,DN_{MIN} 00, respectively. TheL_{Sat} was calibrated to scale surface reflectance after atmospheric corrections using a dark feature subtraction approach, which is an efficient method for atmospheric correction and Land use classification [9,11].
The surface reflectance ρ was calculated using Equation2 and 3[23]:

$$\rho = \frac{\pi\left(L_{Sat-}\, L_P\right)}{T_S\,(E_0 \cos(\theta_0) T_Z E_{down})} \qquad (2)$$

$$L_p = G.\,(DN_{min}) + B - \frac{0.0[E_0 \cos(\theta_z) T_z + E_{down}] T_v}{\pi} \qquad (3)$$

Where: T_S and T_Z is the transmittance of the atmosphere in the View and illumination directions, respectively
E_{down}Edown is the down welling diffuse radiation E_0 is the exoatmospheric radiation entering to the atmosphere
^{z} is the sun zenith angle, L_p is the path radiance due to atmospheric effects, G is the sensor gain and B the bias used for converting the sensor signals (DN) to at satellite radiance.

The other variables as we mention before are already explained in Eq. (1). The header file of Asci value of the satellite image provided the G, B, and values. Whereas, the signature values of T_v, T_Z, and $E_{down}$are assumed as 1, 1, and 0, at the same time. One can obtain the value of E_0 from Data User's Handbook in Geographical Study [6, 12]. The main processing steps of the adopted methodology and analysis are as follows: (1) digital image enhancement and processing system, (2) ground trotting with field surveying, and (3) data analysis and interpretation using remote sensing and GIS [10].

D. GEOMETRIC CORRECTION

IKNOS images were acquired in 2016, were rectified using GPS, ground control point and a set of coordinates from the topographic maps using ENVI software (version 505). The geometric correction was established followed by an edge enhancement technique was applied to three images for the Al'Ula Satellite Image.

E. LAND USE LAND COVER CLASSIFICATION ANALYSIS OF AL-ULA'A AREA

The land use classification was done using IKNOS imageries acquired for 2016. The supervised classification algorithm was applied in this research. It is a part of the multi-scale object-oriented concept. Individual pixels are perceived as the initial regions. These pixels are then sequentially merged pair-wise into larger ones with the purpose of minimizing the heterogeneity of the resulting objects [5]. The segmentation is based on various scales determined by range of scale parameters, leading to the formation of a hierarchical network of objects.

The land use areas were classified into six categories: agriculture, industry, parks, residential area, and commercials area. In 2016, agriculture area was found to have the largest coverage - 65 %, while industry was the lowest – 4 %. Commercials and residential area still increasing over the time about 20.76% compare to historical data obtain from Alula municipality. Industry and green parks however retained its lowest position in coverage for all the three years obtain from historical data.

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I. RESULT AND DISCUSSION

The land use classification was done using IKNOS imageries acquired for 2016. The multispectral scaling supervisor classification algorithm was applied in this research. It is a part of the multi-scale concept. Individual pixels are perceived as the initial regions. These pixels are then sequentially merged pair-wise into larger ones with the purpose of minimizing the heterogeneity of the resulting features and land cover detection. The multispectral scaling is based on various scales determined by range of scale parameters, leading to the formation of hierarchical classes of features.

The membership limits of respective class inside classes determined for the study area were then analyses interactively using relevant bands of the IKNOS image. The class description of each child class was then used for classification with related class and subsequently classification based multispectral scaling. The final land use classification maps of the study area for the years 2016 are shown in Figure 2, 3, and 4. The classification accuracy was assessed using field reference data. Selected reference sites were imported by means of TTA mask. The corresponding classes were matched to form the confusion matrix. Several measurements such as Producer, User, and overall accuracies as well as Kappa index of agreement were computed for each class. Besides this, classification reliability (best classification result) and stability within multispectral scaling concept were also assessed. The overall accuracies achieved were 93.3 for the year of 2016.

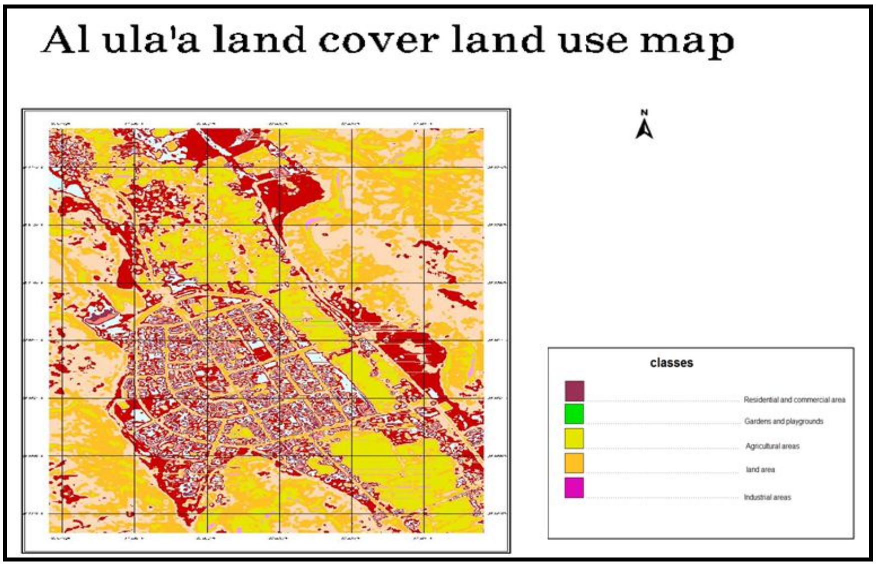

Figure 2. Land use classifications map of the north Alula'a area 2015.

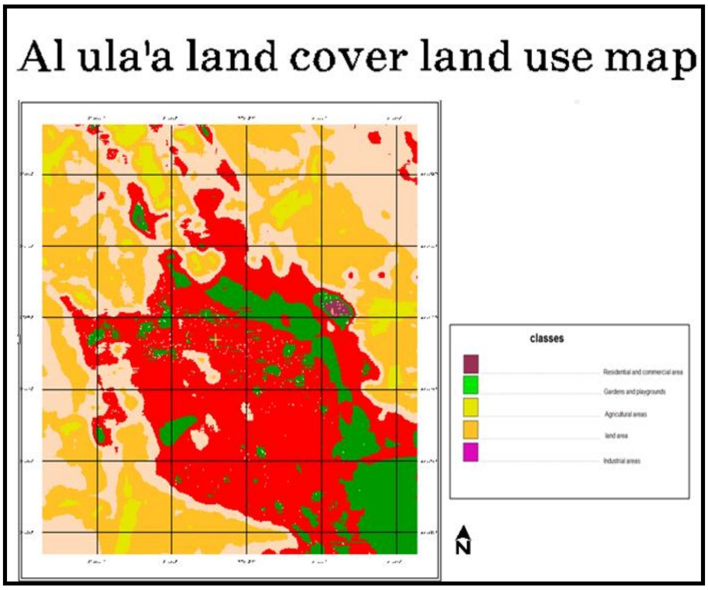

Figure 3. Land use classifications map of the south Alula'a area 2016.

The multispectral scaling limits for the two general classes of the study - vegetation and non vegetation were estimated in feature view through visualization of Gray scale imageries from bands relevant to the class of interest. In similar manner, the limits for their sub-classes were also estimated. These values were then used for class description and feature extraction multispectral expression. The membership limits of respective child classes determined for the study area were then analyses interactively using relevant bands of the IKNOS image. The class description of each child class was then used for classification with related class and subsequently classification based segmentation. The final land use classification maps of the study area for the years 2016 shown in Figure 4. The classification accuracy was assessed using field reference data. Selected reference sites were imported by means of TTA mask. The corresponding classes were matched to form the confusion matrix. Several measurements such as Producer, User, and overall accuracies as well as Kappa index of agreement were computed for each class. Besides this, classification reliability (best classification result) and stability within fuzzy concept were also assessed. The overall accuracies achieved were 92.3 for all images r respectively.

Alula'a land use areas were classified into five categories: residential and commercials area, agriculture, garden and playground, industry area. In 2016 a, agriculture area was found to have the largest coverage - 66.6 %, while industry was the lowest 4 %. Agriculture remained still the highest coverage in 1999 base in historical data but it's still overtaken by urbanization. Industry however retained its lowest position in coverage for all the years' base in historical data. Results of land use land cover statistics for the 2016 year in question are presented in Table 2. It was found that residential and commercials area has increased from 1991 to 2016 due to human activities and population growth but if we compare with historical data we can found agriculture reduced over the same period attributed to urban expansion and industrial area respectively.

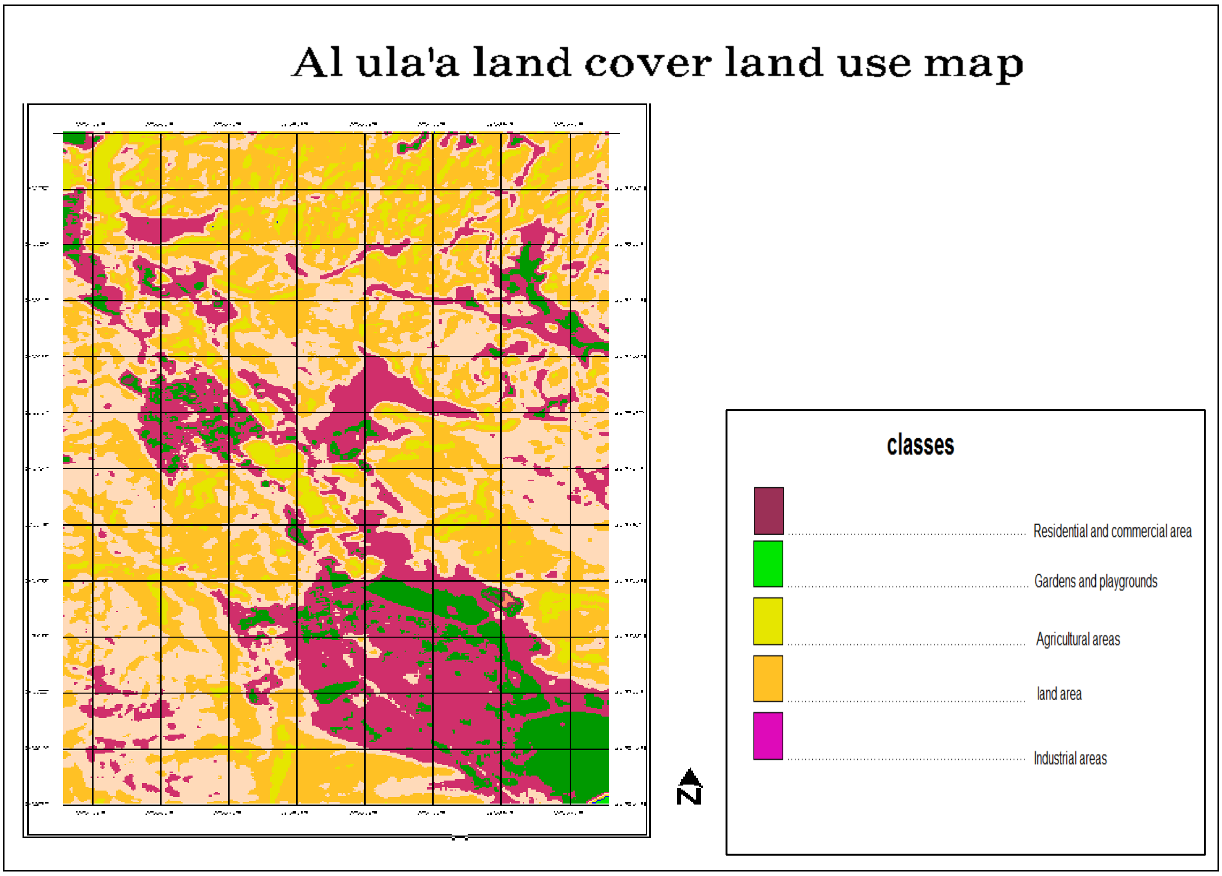

Figure 4. Land use classifications map of the oAlula'a area 2016.

G- Validation and Comparison OF Feature Extracted From Image- Result And Field Survey Data.

In order to checked the accuracy assessment of image classification analysis result, the comparison has been done between field data and result detected by supervised classification analysis from satellite image to check the validity of use the remote sensing analysis Table 2 show the result of classification result: percentage of coverage area for each class extracted from satellite image and Table 3 show the result of field survey data: percentage of coverage area for each class extracted from field work. The comparison has been done by applying linear regression coefficient and the ratio of validation in most classifications. The result of this comparison show high matching almost 92.5% between the two results in the central region.

Table 2. Shows the percentage of coverage area for each classes extracted from satellite image

CLASSES	Area km^2
Agriculture Area	118.3
Residential area and Business activities	23.5
garden and playground	3.21
Industrial Area	2.9

Table 3. Shows the percentage of coverage area for each classes extracted from Field Survey

CLASSES	Area km^2
Agriculture Area	118.5
Residential area and Business activities	23.00
garden and playground	3.00
Industrial Area	2.7

I. CONCLUSION

The present study has proven that the feature extraction multispectral scaling classification of land cover is significantly the accuracy assessment of supervisor classification analysis output was 93.3% for detection and identify of feature distribution coverage. IKNOS satellite image with high spatial resolution 1m significantly use and it's also enables the analysis to classifying the study area (Alula'a). There are other factors contributed to the accuracy of classification in the study area, including radiometric correction and geometric correction as preprocessing of satellite image before start the process of classification. The matching between satellite image result and field survey data was almost 92.5. both result field survey and classification analysis result show the agriculture have the largest coverage area in study area it's about 118.5km from the total coverage area, then the Residential and Business activities area with total area 23.00km, but the industry have the smallest coverage area 2.7% from the total area. The research result shows that the distribution of feature and activities within the urban regions in the study area is affected tremendously by agriculture activities, so the agriculture in the study area constitute more than 60% of all other activities .

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AUTHOR’S PROFILE

Omar M. Al-kouri received a B.S. in Geography from Damascus University in 1998 and M.S. in Geography information system & Remote Sensing from University Putra Malaysia in 2004 and Ph.D. in Geography information system & Geomatic engineering from University Putra Malaysia in 2009. He has been an Assistant Professor at the Geography information system & mapping Dept., Taibah University (Kingdom of Saudi Arabia) since Jan. 2011. His research interest is in the areas of Geo-hazard mapping using GIS Technology.