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Research Paper

Land cover classification using landsat-8 optical data and supervised classifiers

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Abstract

Land use and land cover information of an area has got importance in various aspects mainly because of various development activities that are taking place in every part of the world. Various satellite sensors are providing the required data collected by remote sensing techniques in the form of images using which the land use land cover information can be analyzed. Constistency of Landsat satellite is illustrated with two time periods such as Operational Land Imager (OLI) of 2013 and consecutive 2014 procured by earth explorer with quantified changes for the same period in visakhapatnam of hudhud cyclone. Since this city is consisting of mainly urban, vegetation, few water bodies, some area of agriculture and barren,five classes have been chosen from the study area. The results indicate that due to the hudhud event some changes took place. vegetation and built-up land have been increased by An increase of 19.1% (6.3 km^2) and 11% (5.36 km^2) has been observed in the case of vegetation and built up area where as a decrease of 1.2% (4.06 km^2), 6.1% (1.70 km^2) and 1.2% (0.72 km^2) has been observed in the case of agriculture, barren land, and water body respectively. With the help of available satellite imagery belonging to the same area and of different time periods along with the change detection techniques landscape dynamics have been analyzed. Using various classification algorithms along with the data available from the satellite sensor the land use and land cover classification information of the study area has been obtained. The maximum likelihood algorithm provided better results compared to other classification techniques and the accuracy achieved with this algorithm is 99.930% (overall accuracy) and 0.999 (Kappa coefficient).

Keywords: *LANDSAT-8, Optical data, Land cover classification, Maximum Likelihood*

1. Introduction

In any area the available land can be utilized for various applications such as agriculture, industries, housing constructions, plantation and water resources etc [1]. Hence the land of any area may be covered with one of these features including some part of bare soil also. Since both land-use and land-cover are closely related to each other and are not mutually exclusive, they are interchangeable as the former is inferred based on the land cover and their contextual evidence. The ecological studies and planning departments of the municipalities require the information about land use and land cover of the concerned area (Stefanov, 2001). Though the urban encroachment information can be obtained with the help of traditional surveying methods, the advancement in the space technologies provides better results in all aspects [2]. In the present study, during the period of 2013-2014, certain changes in land utilization in Visakhapatnam were examined. Some changes have been observed in residential areas, waste land and water bodies [3]. This kind of information is useful for taking important decisions for future planning and developement of any area by the concerned departments.

2. Study Area

Visakhapatnam city of Andhra Pradesh state, India has been chosen as the study area in the present study. This city has been recently merged with the nearby municipalities and since recent past this city is named as Greater Visakhapatnam Municipal Corporation. Total area of 621.52 sq.km has been chosen as study area for investigation. The latitude and longitudes of this city are extended between 17^0 10' and 17^0 56' in the north direction and 83^0 08' and 83^0 40' in the east direction respectively.

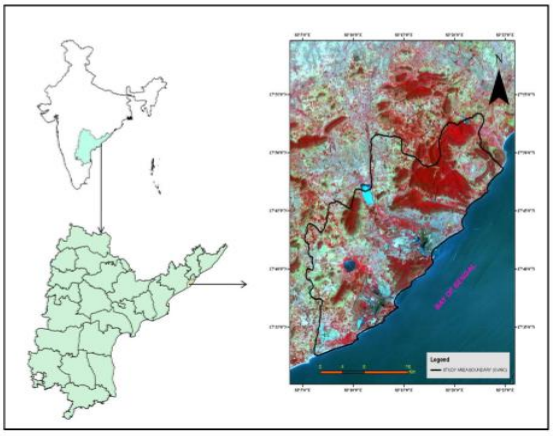


Fig.1: Location Map of the Study Area

3 Data Used

This case study used the images from Landsat-8 Operational Land Imager (OLI). The data sets of pre-hudhud and post-hudhud cyclone event that took place in the study area on October 12th, 2014 are used for mapping the land cover features and also for doing the change detection analysis. Satellite images used in this study are of 20th October 2014 and 26th March 2013. Cloud-free optical data was acquired from earth explorer.

3.1 Pre-Processing

Due to the inaccuracy of the sensing devices and errors in the measurement, the pre-processing of the raw data has to be done which is available from the satellite sensor [4-5]. In this study, the pre-processing included radiometric and geometric corrections of the satellite images. Radiometric correction comprises the process of histogram matching of the satellite images from two time periods, whereas geometric correction means co-registration of the satellite images so that the images could overlap in the best possible way [6]. This is important in the case of supervised classification as the two data sets of the satellite sensor belonging to two time periods of the same area are to be compared [5-8].

Table-1 Change detection information using multi-temporal optical data (2013 & 2014) of LANDSAT-8 sensor

	Water	Urban	Vegetation	Beach Sand	Bare Soil	Road	Row Total	Class Total
Urban	0.05	605.8	89.31	2.46	529.31	188.6	1415.52	1415.52
Vegetation	0	72.95	11.33	0.01	10.64	20.12	115.05	115.05
Water	0	0.76	0.23	0.12	0.25	0.03	140	1.4
Bare Soil	0	0.78	6.2	0	26.97	0.81	34.77	34.77
Beach Sand	74.27	86.3	2.46	282.9	6.4	3.55	455.87	455.87
Road	0	18.86	0.16	0.07	0.82	1.99	21.9	21.9
Class Total	74.32	785.44	109.69	285.56	574.39	215.11	-	-
Class Changes	74.32	179.65	98.36	2.66	547.42	213.12	-	-
Image Difference	-72.92	630.08	5.36	170.31	-539.62	-193.2	-	-

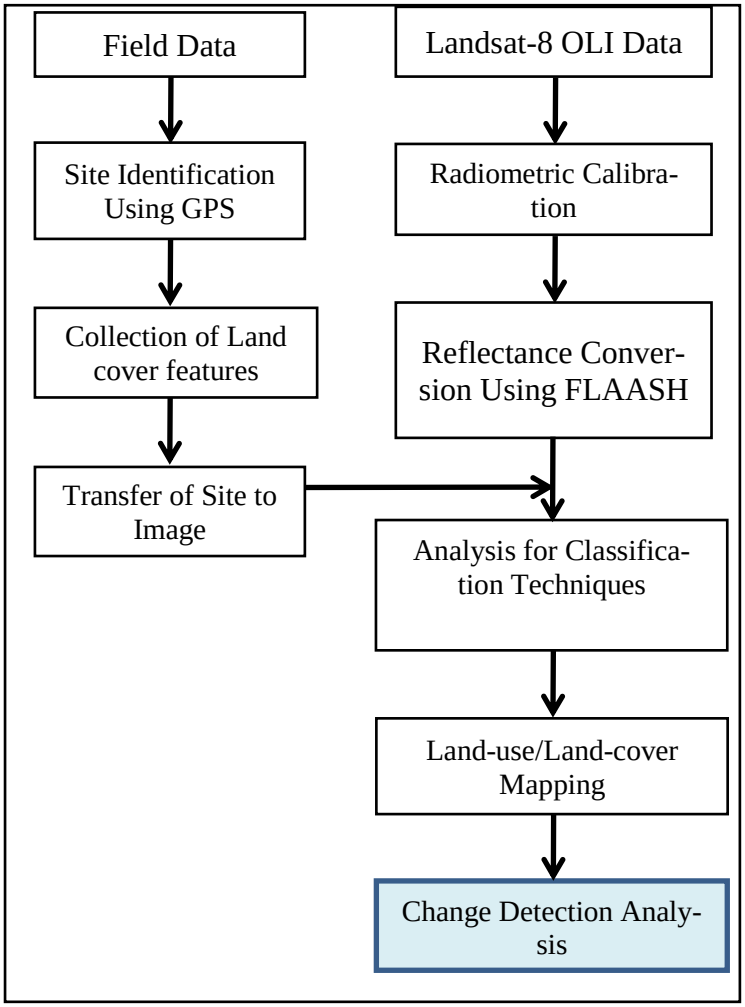
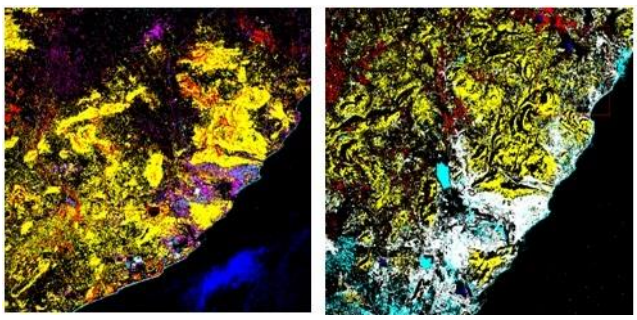


Fig.2. Methodology of Landsat-8 Optical Data

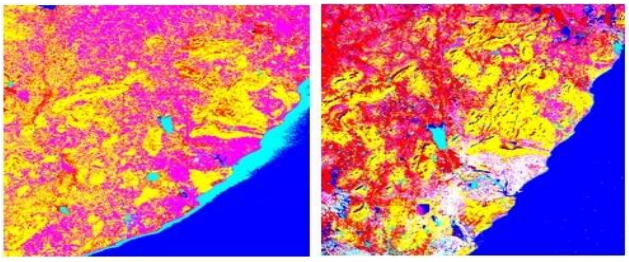
4 Results and Discussions

In this section, classification results obtained from various classification algorithms have been presented. Classified images of some of the supervised classification techniques that are employed in the present study including machine learning algorithms such as artificial neural net classification have been presented based on Landsat-8 OLI data. Using the ground truth information and with the help of confusion matrix the classification results of the respective classification methods are obtained. ENVI 5.2 processing tools are used in the present work to obtain the results.



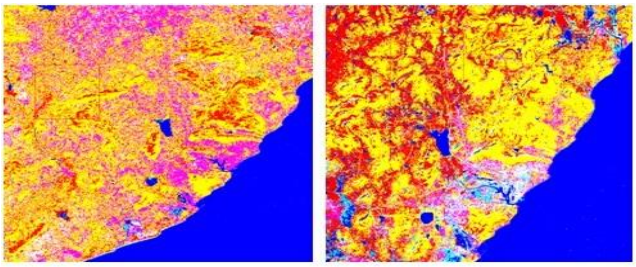
20th October 2014 26th March 2013

Fig.3: Parallelepiped classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8



26th March 2013 20th October 2014

Fig.4: Mahalanobis Distance classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8

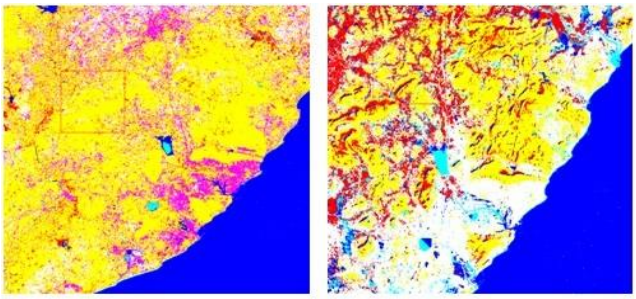


26th March 2013 20th October 2014

Fig.5: Minimum Distance classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8

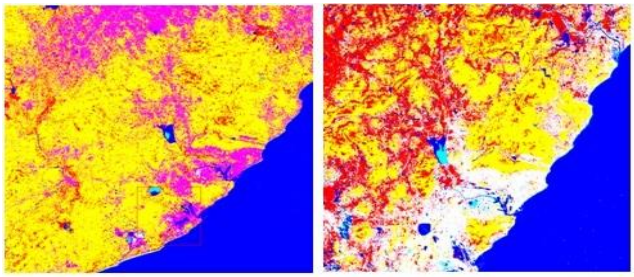
26th March 2013 20th October 2014

Fig.6: Maximum Likelihood classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8



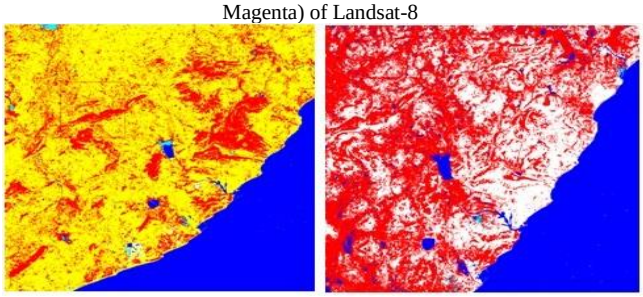
26th March 2013 20th October 2014

Fig.7: Artificial Neural Net classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8



26th March 2013 20th October 2014

Fig.8: Support Vector Machine classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8



26th March 2013 20th October 2014

Fig.9: Binary Coding classified Images (Urban-White, Vegetation-Red, Water-Blue, Beach sand-Cyan, Bare soil-Yellow and Road-Magenta) of Landsat-8

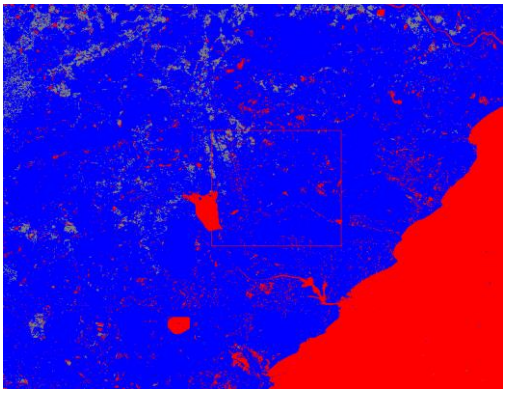


Fig.10: Change Detection Image (No change: Red, Decreased: Brown (Water, Vegetation and baresoil) and Increased: Blue (urban)) of Landsat-8

Table 2: Accuracy results such as overall accuracy (O.A) and Kappa coefficient (K.C) calculated by using confusion matrix method for various classification techniques

	26th March 2013		20th October 2014	
Supervised Classification	O.A	K.C	O.A	K.C
Parallelepiped	92.426	0.904	94.167	0.919
Minimum Distance	98.808	0.985	84.028	0.794
Mahalanobis	97.055	0.962	95.278	0.937
Maximum Likelihood	99.930	0.999	98.194	0.976
Artificial Neural Net	99.229	0.990	97.222	0.962
Support Vector Machine	99.719	0.996	97.5	0.966
Binary Coding	76.368	0.689	82.5	0.745

5. Conclusions

The utilization of Remote Sensing and GIS tools were helpful in analyzing the land-use and land-cover (LULC) classification and also detecting the amount of land use land cover changes that took place in Visakhapatnam city during the hudhud cyclone period. In the present study, the expansion of the study area, Visakhapatnam city has also been revealed. An increase in the area occupied by some of the classes during recent past has been observed. The increase in the built up area is about 19.1% from 2013 to 2014,

where as the amount of decrease in the farm land is about 1.2% over the period of 1 year [8-10]. It is observed that the increase in the total built up area is a result of the newly constructed projects and industries that attracted other construction activities also in and around the city. Among all the advanced land use land cover classification and change detection algorithms [11-14] used for the present study the supervised Maximum Likelihood classification algorithm is found to be very effective which resulted in an overall accuracy of 99.93% and a Kappa coefficient of 0.999% and an overall accuracy of 98.194% and Kappa coefficient of 0.976% for the data sets of two consecutive years 2013 and 2014 respectively compared to the other supervised classification algorithms that have been implemented for the present study. The comparison of all the pixels that are present in the two multi temporal data sets of the study area provided by the LANDSAT-8 sensor has been done with the help of change detection algorithm.

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