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Environmental Change Detection using Geo - Spatial Techniques in Aravalli hills and Environs (Faridabad District, Haryana)

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Abstract

Environmental change detection is very mandatory to understand the relationship of human activities with the environment and its importance to manage the change that has been take place due to their activities. Due to the Human activities in the Aravalli hills of Faridabad district lots of ecological imbalances has been occurred from last 10 years. In the present paper an attempt has been made to understand the changes occurred due to Mining and urbanization activities in Aravalli hills of Faridabad district of Haryana through the Geo spatial techniques. The study area is classified into the land cover feature by using LISS III imagery of 2002 and World View (WV) imagery of 2012. Arc GIS software is used to prepare thematic maps based on land use/ land cover classes.

The 10-years' time gap from 2002 to 2012 shows the major type of land use/ land cover changes such as Agriculture land decreased by 3.21%, Urban land increased by 4.66%, some Mining pits filled with water increased by 7.96% whereas the surface water bodies such as ponds, lakes etc. are depleted by 32.69% from total water bodies area etc. The reason of this change have been discussed. Aravalli hills of Faridabad is very well known for Mining activities and the Mining had been carried out from 1960's to till 2002 after that supreme court banned Mining activities in this belt due to large destruction of environment so, it is necessary to closely detect the land use/land cover changes for maintaining the sustainable environment.

Keywords: Remote sensing, Arc GIS, Land use/Land cover, Aravalli Hills, Environmental change**.**

I. INTRODUCTION

Remote sensing and GIS have covered wide range of application in the field of agriculture, environments, and integrated eco-environment assessment (Yeh, *et al, 1998;*Fung, *et al, 1987* and Long, *et al, 2008).*Urban environment represents one of the most important areas for remote sensing analysis due to the high spatial and spectral diversity of surface features (Maktav *et al., 2003).*Remote sensing has become important tool applicable to promote and empathize the global, physical processes affecting the earth (Hudak *et al,1998).* Change detection is the process of analysing the characteristic in the state of an object or body by observing it at various times (Singh, *1989).* There are numbers of digital change analysing techniques has been produced such as mono-temporal change delineation, delta or post classification comparisons, multi-dimensional temporal features space analysis, composite analysis, image differencing, multi temporal linear data transformation, change vector analysis, image regression, multi temporal biomass index, background subtraction and image rationing (Nori *et al, 2005* and Lunetta *et al 2008*). Most of the researchers have concentrated on LU/LC studies by the reason of their unfriendly effect on ecology of the area and vegetation (El-Raey, *et al, 2000;* Martinuzzi, *et al, 2007;* Sudhira *et al, 2004*and Hathout *et al, 2002).*

Evaluation of watersheds and development of a management strategies requires accurate measurement of the past and present land cover/ land use parameters as changes observed in these parameters determined the hydrological and ecological processes taking place in a watershed (Harish *et al, 2016*). An understanding of the growth dynamic of urban agglomeration and land use change is essential for ecologically feasible developmental planning (Vanum, *et al 2012).*Remote sensing satellite and GIS are the most typical methods for quantification, mapping and analysing of pattern of LU/LC by the reason of their accurate geo-referencing methods, digital format convenient for computer processing and repetitive data procurement (Lu *et al. 2004*; Chen *et al.2005;* Nunez *et al. 2008*; Rahman *et al. 2011*). LU/LC mapping changes at regional scales is mandatory for a wide range of application, including landslide, erosion, land planning, global warming etc. (Reis *et al,2008).* Many problems generally related to environmental issues and great complication to handle the multidisciplinary data set to resolve this kind of problems we require new technologies like remote sensing satellite and GIS. These technologies in present data to analyse and monitor the dynamic of natural resources for environmental management (Hassan *et al, 2016).*

Present study area witnesses' rapid development during past decades in terms of Urbanization, industrialization, and also population increase substantially. The main objective of this paper is to detect and quantify the LU/LC changes after the closure of Mining activities in and around the Aravalli hills of Faridabad district, Haryana (Figure 1), from 2002 to 2011 using satellite imagery and topographic map.

II. MATERIAL AND METHODS

2.1 STUDY AREA

A study area (*fig.1*) is 273 km^2, situated in Aravalli hills of Faridabad district. It lies between the latitudes 27º 51' 15" and 28º 30' 52" north and the longitudes 77º 04' 39" and 77º 35' 50" east. There is the region where mining had been taking place from 1960's to 2002 after that Supreme court put banned blanket on it. The Aravalli hills located about 10-12 km from the Faridabad city. Open cast Mining of silica, Quartzite, Badarpur sand and other good quality construction material which is basic need for all construction activities were extracted from this region. The Climate of the area is moderate and May to July are the warmest months of the year, with average temperature ranging from 28ºC to 35ºC with extreme sometimes as high as 42ºC. While the coolest month November and December with the Average temperature 20ºC to 13ºC. It is most populous city of Haryana and River Yamuna forms the eastern boundary with Uttar Pradesh.

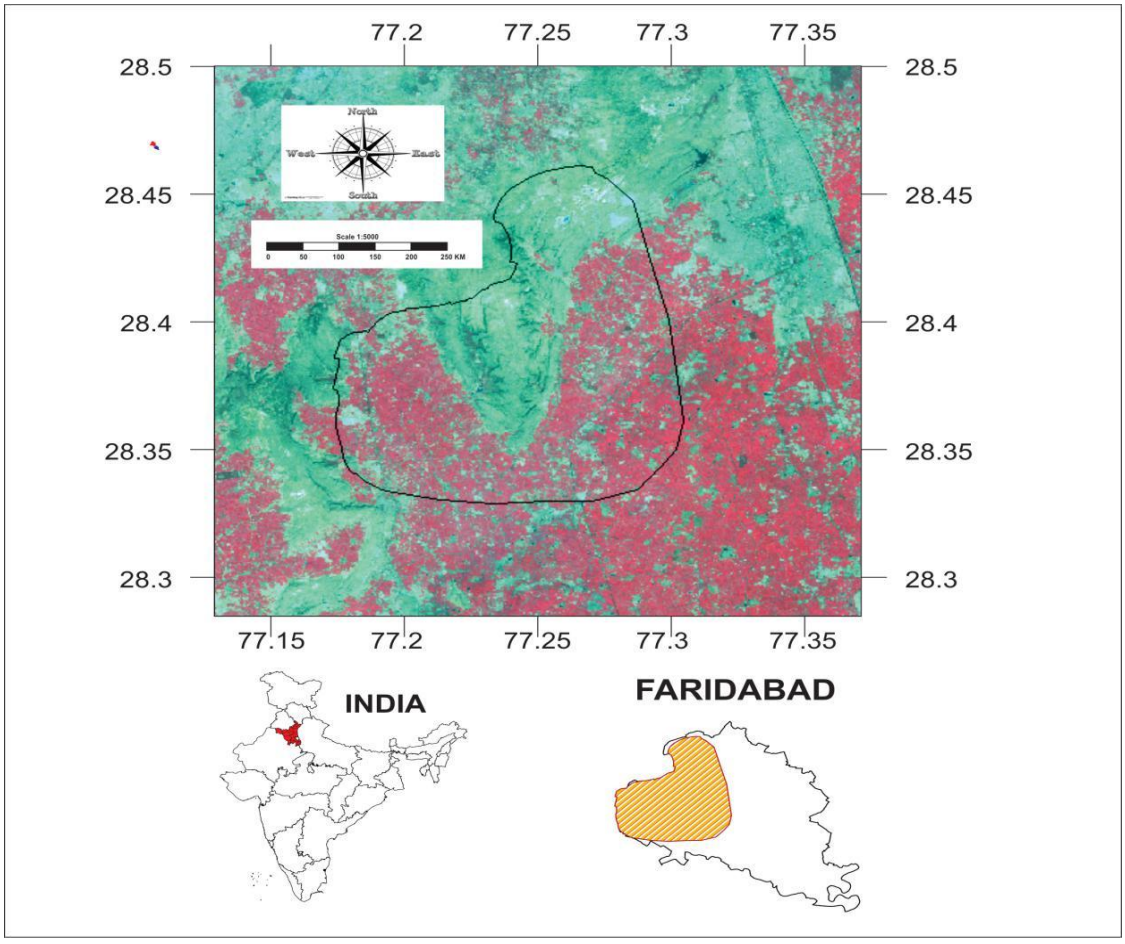


Figure 1. Location map of the study area.

2.2 DATA SOURCE

The data used in this research were divided into satellite data and ancillary data. Ancillary data include ground truth data for the land cover/ land use classes, aerial imagery of Aravalli hills and their surrounding area, topographic maps. The ground truth data were in the form of reference data, points collected using GPS system in Oct 2013 for data analysis, used for image classification and overall accuracy assessment of the classification results. The toposheet from survey of India bearing numbers 53H/3 and 53 H/5 were used to prepare the base map of the study area. The Landsat image of 2002 has a spatial resolution of 50m while 2011 of World View has 30m with the details given in (Table 1) was acquired to determine the changes in LU/LC. These data were collected from Haryana Space Application Centre Hisar, Haryana (HARSAC). The satellite image of the study area was classified using ERDAS Imagine. The existing analogue boundary map was converted into digital format through digitizing using ArcGIS *9.2* Version software.

Table 1: Satellite data specifications.

Data	Year of acquisition	Bands/color	Resolution	Source
Landsat LISS III	2002	Multi-spectral	50m	HARSAC
World View (WV)	2011	Black and White	20m	HARSAC
Toposheet number	53H/3 and 53H/5		1:50000	Geological Society of India

III. SPATIAL ANALYSIS AND INFORMATION PRESENTATION

3.1 Land Use Mapping and Distribution

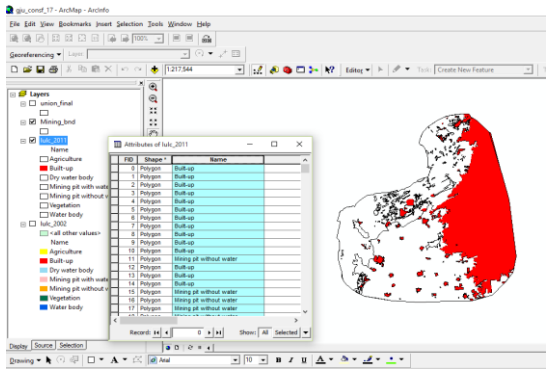
A supervise classification are implemented for the two images and the final classification products provide an overview of the major land use/ land cover feature of Aravalli Hills and their outskirts for the year of 2002-2011. Post processing change detection has been successfully used by various research in urban environment to detecting the rate of change (Hardin *et al, 2007).* Five categories of land use/land cover are identified.

Table 2: Classes delineated on the basis of supervised classification.

Sr.No	Class Name	Description
1	Agriculture Land	Crop land with cultivation and without cultivation
2	Number of Mining pits	No of Mining pits with water and without water
3	Built-up area	Residential, commercial, industrial, transportation, roads, mixed urban, rural.
4	Water Bodies	Ponds and Lakes with water and dry
6	Vegetation	Thick, moderate and sparse vegetation.

3.2 Database Query

Decision making requires for information generated from spatial search and necessary operation performance. The database and graphics are manipulated and processed to generate information about the entities for GIS analysis. Data are retrieved from the database i.e. graphics and tabular data by using ArcGIS *9.2 software*. GIS analysis helps to ascertain the fitness of the database.



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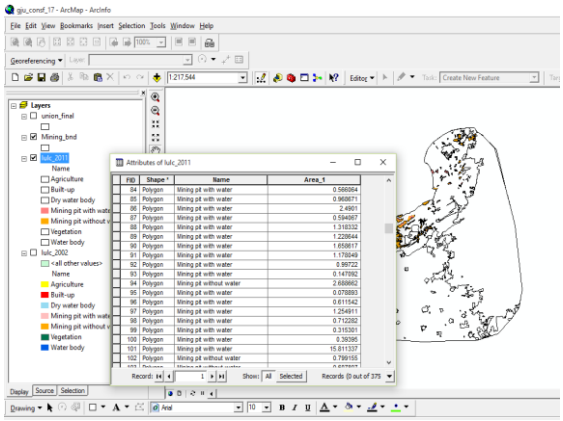

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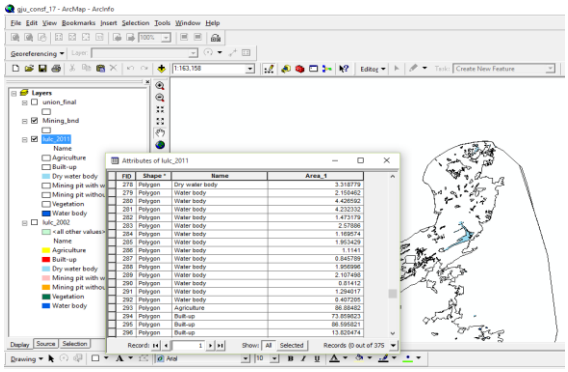


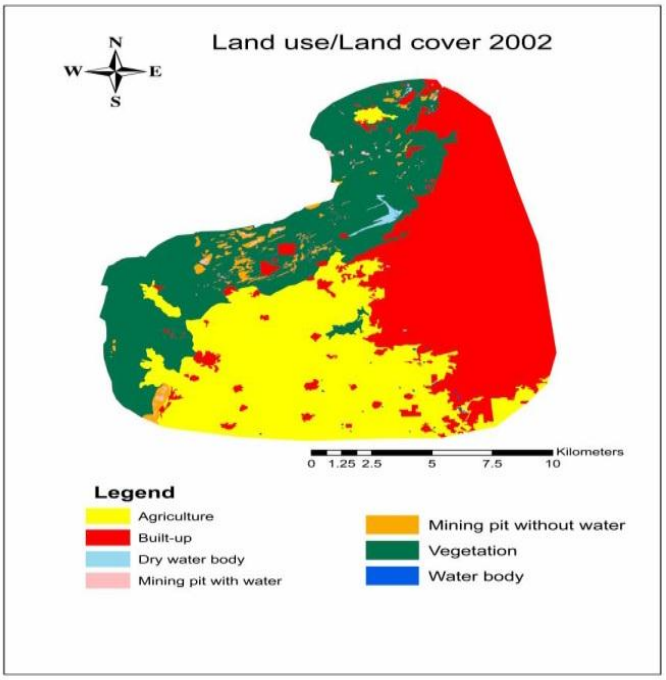
(c)

Fig. 2. Data base query of different parameters (a) Query for Built-up Area (b) Query for Mining pits with water and without water (c) Query for surface water bodies (ponds and lakes).

IV. RESULTS AND DISCUSSION

Figure 3 and 4 illustrate the land use/land cover maps of the Aravalli hills and their surroundings in the year of 2002 and 2011. (*fig.2*). The classification results for 2002 and 2011 are summarized (*Table 3).* Supervised classes percentage has been done on the basis on the results shows in LU/LC images. Observed number of pits including mining pits with water which is increased in 2002 to 2011 after the closure of mining activities. The comparison of 2011 LU/LC map with 2002 LU/LC map indicated a significant negative shift of water bodies to dry water bodies, increase of built-up area, decrease of agriculture land and vegetation area as 0.14%, 4.66 %, 3.21 %, and 1.43% respectively. The comparison of each classes of 2002 and 2011 showed that there has been a significant change occurred within a 10 years.

From the 2002-2011 the percentage covered by built-up class in agriculture area increased by 0.14%. this is due to the reason of increasing population. Surface water bodies with water decreased by 0.14% in the Vicinity of Aravalli hills, as this area received less rainfall apart of this facts water level in the mining pits have been increased. It is because of the reason that, during the mining activities, mining of silica sand had been extracted below water level by pumping of groundwater and water had been drained in near about Nala's but after the illegally banned this area the Mining activities were also being stopped here and hence, it gives positive impact on groundwater level and their vicinity areas. This results are good to maintain the environment sustainability. This study elucidates the significance of incorporating Remote sensing and GIS for change detection study of LU/LC of the study area as it offers important information about the spatial distribution as well as environment changes. The LU/LC cover figures indicates the integration of supervised classification of satellite imagery with visual interpretation in an effective method for the documentation of change in land use/land cover of an area.



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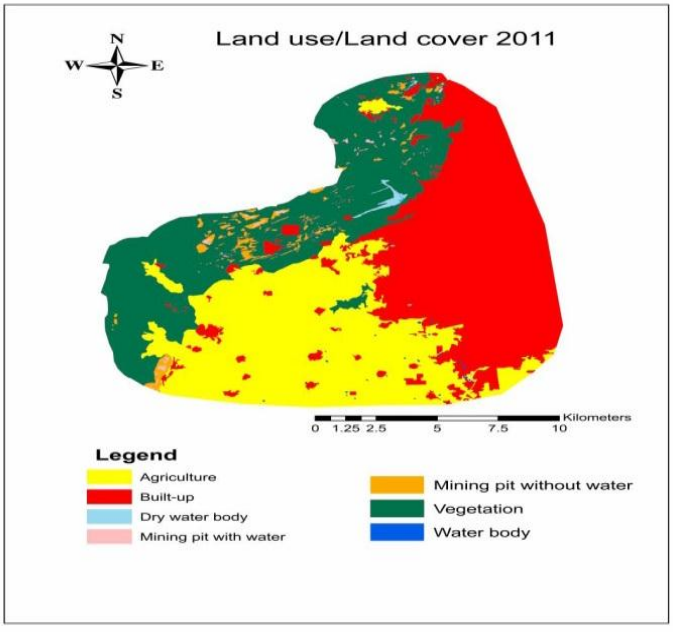

(b)

Fig. 3. (a) Land use/ Land cover changes in 2002 (b) Land use/Land cover change in 2011

Tables 3: Classification results for 2002 and 2011

Major-categories	2002 Area in (Hectares)	2002 Area in %	2011 Area in(Hectares)	2011 Area in %	%Change in Area
Built-up	8412.64	30.78	9685.86	35.44	+4.66
Water body	61.59	0.10	23.24	0.08	-0.14
Dry water body	55.71	0.00	94.07	0.03	+0.14
Mining pit with water	54.15	0.20	98.1	0.36	+0.16
Mining pit without water	542.72	1.99	498.77	1.82	-0.16
Vegetation	8407.78	1.46	8015.13	1.02	+1.43
Agriculture land	9791.29	35.83	8916.37	32.62	-3.21
	27331.52	100	27331.52	100	

Table 4: Surface Water body changes from 2002-2011

Class	2002 Area in (Hectares)	2002 Area in %	2011 Area in(Hectares)	2011 Area in %	%Change in Area
Water body	61.59	52.50	23.24	19.81	32.7
Dry water body	55.71	47.49	94.07	80.19	-32.7
Total	117.3		117.3		

Table 5: Mining pit with and without water changes from 2002-2011

Class	2002 Area in (Hectares)	2002 Area in %	2011 Area in(Hectares)	2011 Area in %	%Change in Area
Mining pit with water	54.15	9.07	98.1	16.43	7.36
Mining pit without water body	542.72	90.93	498.77	83.57	-7.36
Total	596.87		596.87		

V. CONCLUSION AND RECOMMENDATION

Conclusion

Based on the results and facts obtained from the analysis of ArcGIS and Remote sensing application to get the particular research objectives, it is concluded that the LU/LC practices in the study area have modified significantly from 2002 to 2011 periods. The LU/LC changes in the Mining areas are evident by the increase of Mining water pits from 54.15 Ha to 98.1 Ha from the total area 596.87 Ha, and the areas covered by the classes of built-up is increased 4.66%, Vegetation and Agriculture part decreased 8407.78 Ha to 8051.13 Ha, and 9791.29 Ha to 8916.37 Ha which is the matter of concern, vegetation part has been decreased due to increasing built-up area and population growth. Additionally, all these modifications in the LU/LC pattern if prolonged for future as such then it will adversely affect surface water bodies, vegetation, and agriculture land. LU/LC mapping and analysis using remote sensing indicating that both industrial and residential factors may also be responsible for further loss of already shrinking vegetation and agriculture areas. Hence, proper management of the surface water bodies is required because without proper management, this important resources will soon to be lost or will hard to recover and it affect the environment adversely.it plays important role in environment sustainability of the area.

Recommendation

With this concept there are several recommendations also based on the conclusion of the present study for the proper management and conservation of the vegetation and water resources.

- An effective management practice for water conservation is necessary to minimize the water problem in the foothills of Aravalli region such as Faridabad city where water level reached at 250 feet.
- Government should take appropriate steps to restore the vegetation areas specially forest region in Aravalli hills. Cutting down of forest part for residential plot and industries purposes which is adversely affected the forest part and plays important role in environment sustainability.

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