RESEARCH ARTICLE

Assessment of Land Use Land Cover at Mining Areas in Panadhro, Kachchh using Remote Sensing and GIS

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Abstract

Land use and land cover is a very important factor to understand the relation between the human and the environment. Land cover change is a major keynote of global environmental change. The development of any region is dependent on the urbanization and industrialization; however, the development sometimes shows an adverse impact on the environment resulting in loss of biological wealth of an ecosystem. Panadhro and the surrounding villages like Fulara and Khanot of Kachchh district are having abundant of coal minerals. There are lots of changes in Land Use Land Cover (LULC) because of the exploration of the minerals in this area. Remote Sensing (RS) and Geographic Information System (GIS) are very effective tools for analysis of land use and land cover changes at a regional level. This research explains the use of RS and GIS technology for the detection of LULC changes in the study area. Image classification has been done by ERDAS imagine. It is observed that LULC changes have been detected in last 13 yrs. mainly in the open land followed by the water bodies. The study has been pointed out the various effects of coal mining activities on the land use.

Introduction:

Human activities bring the change in land use which affects all the components of the environment, but the effects of these changes are very slow and not measurable quickly by a normal person (Nagarajan & Poongothai, 2011). Land use is generally noticeable by socio-economic and political convince on the land by the human while the land cover is identified as the biophysical surface of the Earth. It is essential to study the land use land cover (LULC) changes. Remote sensing (RS) and geographic information system (GIS) are extensively used for the LULC change detection studies (Diallo *et al.*, 2009, Boakye *et al.*, 2008, Sarma *et al.*, 2008). Land use refers to human activities and the varied uses which are carried on over land and land cover refer to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land classification (Yanli *et al.*, 2012). Information like maps and statistical data of land use land cover is essential for the planning, management and further utilization or conservation of land. According to Reis (2008), humans have misused the innate environment. Increasing population growth, industrialization, urbanization and

some other factors affect the LULC of a particular area. The information generated on landscape change and configuration help to analyze global ecological and environmental change.

Population growth and human activities like mining in Panadhro, Fulara and Khanot villages of Kachchh district, Gujarat- India are responsible for the LULC change and environmental degradation (Kaul & Sopan, 2012). Because of the population growth, there is a loss of agriculture land. Coal mining plays a fundamental role in the development and progress of this region, but it has some adverse impact on humans and environment. Panadhro of Kachchh district has ample amount of coal minerals (Singh *et al.*, 2011). There is a lot of changes in LULC because of the exploration of coal minerals and it adversely affects the environment of that region (Chitade & Katyar, 2010). Remote sensing (RS), integrated with the geographic information system (GIS), provides an effective tool for analysis of land use and land cover changes at a landscape level. Remote sensing as a direct adjunct to field, playing an important role to study and assess the natural resources (Abbas *et al.*, 2010). By

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understanding the dynamics of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, one is able to develop plans for multiple uses of natural resources and nature conservation (Prakasam, 2010). Anthropogenic changes in land use and land cover are often assumed to be identical; they are rather quite different (Sreenivasulu *et al.*, 2013). The main objective of this study is to evaluate and quantify land use land cover changes in Panadhro village and surrounding areas due to coal mining in last 13 years using the LISS III satellite image and its classification.

Methodology:

Study area: Panadhro and the surrounding villages Fulara and Khanot are belongs to Lakhpat Taluka of Kachchh district, on the northwestern part of Gujarat. The climatic condition in this region is considered to be of the semi-arid type. Extreme temperature both in summer and winter are felt. The minimum and maximum temperatures recorded are 15.4°C in winter and 50.16°C in summer respectively. The average temperature of this region is about 32°C. Rainfall is extremely scanty and is active from June to September with annual average rainfall of 29.2 cm. The Panadhro village has population of around 10,000 as per the population census 2011, out of which around 3000 people are working in coal mines (www.census2011.co.in). It is famous for its lignite mines, which were developed in early 1970s and are run by Gujarat Mineral Development Corporation (GMDC) Limited (Singh *et al.*, 2011). The town S. K. Varmanagar was developed very few kilometers away from Pandhro to fulfill the daily needs of mining community after the Pandhro mines were opened. The first unit of mines was commissioned in 1974 and operated by GMDC. The lease area of this lignite mine is about 1157 ha. The total exploration area is 11.33 km². Lignite and limestone are mined in this area by using hydraulic excavators and dumper combination with subsidiary equipments like dozer, water sprinkler motor grader etc. (Plate-1) The product lignite coal is directly used in Akrimota thermal power station and Kuchchh lignite thermal power station. According to an estimate made by the experts this mine has deposits of around one million tones of lignite which would be explored by the GMDC on commercial basis on the lines of the work done at Panadhro since last three decades. Panadhro lignite mines have in all 10 million tones of underground lignite reserves while 90 million tones have been so far dug and sold to the industries in and outside the Gujarat (www.deshgujarat.com).

In this study, LISS-III satellite images of the year 2000 and 2013 was used and explored through supervised classification in ERDAS® imagine (Alsaaidh *et al.*, 2011). A supervised classification is a significant tool for the process derives statistical relationships between the input and the ground truth habitats (Basana & Wodeyar, 2013).

The images are obtained from Bhaskaracharya Institute for Space Applications and Geo-Informatics (BISAG) and National Remote Sensing Centre (NRSC), Hyderabad. Ground-truthing was done by collecting GPS points for confirmation and georeferencing (Phukan *et al.*, 2013, Varadharajan *et al.*, 2012). Change detection for all the land use land cover classes was evaluated between both the satellite images. Among different classification algorithms, the maximum likelihood was used for supervised classification by taking 50 training areas for five major LULC class categories (10 training points for each LULC class) (Temesgen *et al.*, 2014). The LULC classes include Agricultural Land, Built Up area, Open/Waste Land, Water bodies and Mining area (Table 1). ERDAS Imagine® 2014 and Arc GIS® 10.2 were used for satellite image processing and LULC change analysis (Tiwari and Saxena 2011). Digital land use land cover classification through supervised classification method was performed for the LULC classification. Recoding method is also done for converting pixel value into a proper class. Area statistics of each land use category is calculated in hectares in attribute table in ERDAS Imagine® as suggested by Abate (2011) (Table 2). The rate of change was calculated for each LULC class using following formula given by Temesgen *et al.* (2014).

$$\text{Rate of change (ha/year)} = (A-B)/C$$

Where: A = Recent area of LULC in ha,

B = Previous area of LULC in ha,

C = Time interval between A and B in years

The classified images were edited on the basis of the ground truth data collected from the field and then final classified maps were prepared with assessing classification accuracy using accuracy assessment tool of ERDAS® where LULC maps were used in raster format. By applying random points in accuracy assessment window we received accuracy report containing overall classification accuracy (Dwivedi *et al.*, 2015). Image analysis operations have been carried out using GIS and finally, the changes in various LULC classes are obtained using post-classification comparison method. Error matrix and KAPPA analysis were done for accuracy assessment classification. The final map was prepared after the ground truth and changes were estimated in GIS (Tiwari & Khanduri, 2011). The output was analyzed for land cover degradation and interpreted with ancillary data collected from various government agencies. The results obtained were used in order to assess the stress of land use on the ecosystem for the better natural resource management.

Results and Discussion:

The study depicts that, Panadhro has undergone a huge change in various land use categories from 2000 to 2013. The land use assessment depicts that the total area of 11238.2 ha in the year 2000 was classified into agricultural

land (24.60 %), built-up area (2.56 %), open/wasteland (67.07 %) and water body (5.77 %). While in 2013, no change was detected in agriculture land and built up area; however open lands are reduced by 7.14%. Moreover, 7.19 % of the land was converted in mining area which was not detected in 2000. The land use difference has been shown in Figure 1. Table 2 illustrates the LULC change in Panadhro from 2000 to 2013.

Table-1: Description of Land Use Land Cover Classes

LULC	Description
Agricultural land	Areas allotted to rain fed and irrigated cultivation, including fallow plots, agricultural land mixed with some bushes, trees and the scattered rural settlements included the cultivated fields.
Built up area	Areas that have been populated with residential, commercial, transportation facilities, settlements, roads and tourist places
Open/Wastelands	Area of thin soil, sand or mountainous or hilly areas, almost has no vegetation cover or degraded agricultural lands.
Waterbodies	Areas covered by manmade small dams, seasonal and permanent water bodies (streams, rivers, lakes, reservoirs and sea).
Mining area	Areas that have been allotted for the open cast mining

After- Abate (2011), Temesgen *et al.* (2014), Diallo *et al.* (2009), Solaimani *et al.* (2010)

Table-2: Land Use Land Cover Changes in Panadhro (2000- 2013)

S. n.	Land Use & Land Cover Class	LULC Area Year 2000 Ha	LULC Area Year 2000 %	LULC Area Year 2013 Ha	LULC Area Year 2013 %	Change in ha 2000-2013	Rate of Change (ha/yr)
1	Agricul. land	2764.5	24.6	2764.5	24.6	0	0
2	Built Up area	287.4	2.56	287.4	2.56	0	0
3	Open/Waste lands	7537.2	67.07	6734.8	59.93	-802.4	-61.72
4	Water bodies	649.1	5.77	642.9	5.72	-6.2	-0.48
5	Mining area	0	0	808.6	7.19	808.6	62.20
	Total	11238.2	100	11238.2	100	0	0

The overall accuracy of classification methodology is 89.7% and 90.5% and KAPPA statistics is 0.87 and 0.88 respectively for the 2000 and 2013 images. The major land use in Panadhro and surrounding area of Kachchh is agricultural land, open land, water bodies, and settlements. But the land under the open category has experienced a declining trend in the past thirteen years. Here water bodies decrease and open land converted to the mining area. Table-2 depicts that almost all the mining areas are converted from the open land. There is a risk of decline in the extent of land under agriculture and built up in the near future. Changes in land use and land cover tend to affect greatly to the local biodiversity and the ecosystem. It is observed that because of changes in

Plate-1: Panadhro coal mining site

Figure-1: Satellite and classified images of year 2000 & 2013

vegetation and water bodies, pollution level has increased extremely in the surrounding area and during the recent years, it has attained the critical level (Beniwal *et al.*, 2015).

The results also reveal that there is a need to monitor the LULC changes at regular interval to prepare the land use plan for the sustainable development. The geological experts of GMDC have found a huge stock of lignite at Umarsar village near Panadhro spread in 2100 ha which has brightened new hope for industries in Kuchchh using lignite as fuel (Mengistu & Salami, 2007). This area will also undergo the same situations as the Panadhro, which can be regulated through regular monitoring of LULC change using the techniques described in this research so that a suitable land management plan can be proposed for such areas affected by mining activities.

Conclusion:

The changes measured using remote sensing and GIS technologies shows critical adverse and undesirable environmental impacts. Therefore an effective sustainable land management policies and practices are required in the mining sites to avoid the environmental stress and promote sustainable development. The increase in the area under the mining may lead to a lot of environmental and ecological issues. As a sum up it could be stated that Panadhro area is now under the threat of change in land use. As the area is close to the Kachchh biosphere reserve it requires immediate attention. There

is a need to take effective measures to protect the land especially open lands and water bodies in Kachchh region where the mining is now flourishing as an important industry.

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