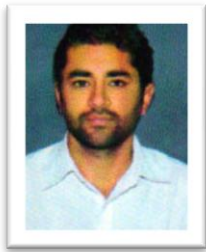# Periodic Research

Land use and land cover change in patiali rao watershed: a remote sensing and gis application

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Abstract

The term land use relates to human activity or economic function associated with a specific piece of land, while land cover is the physical material on the surface of the earth. Land cover includes grass, asphalt, trees, bare ground, water, etc. The change in spatial pattern of any material related to Land-use and land cover is called land-use and land cover change (LULCC). LULCC also known as land change is a general term for the human modification of Earth's terrestrial surface. Due to human activities it is changing at a very rapid rate. Changes in Land use and land cover are resulting in loss of biological productivity and biodiversity in aquatic and terrestrial ecosystems. To measure the changes in environmental conditions of a place, it is essential to detect the changes in land –use and land-cover of that place. The emergence of geospatial technology has provided an easy way to detect these changes. Remote sensing is an essential tool of land-change detection because it facilitates observations across larger extents of the Earth's surface at short time intervals which would not be possible by ground-based observations. Remote sensing satellites provide data at short and regular interval which is very beneficial to detect even minor changes in land use and land cover. GIS is further beneficial for analyzing land-use and land cover. The present study lays emphasis on the role of remote sensing and GIS in detection of land-use and land cover change. The area of study is the watershed of Patiali Rao. Satellite imageries for the years 1989 and 2005 are used for this purpose. Erdas Imagine 9.1 and Arc GIS 9.3 software are used for satellite data processing and reliable results are obtained from the study.

Keyword: Geospatial Technology, Environmental Conditions**.**

Introduction

"Land is the basic natural resources… it is perhaps regarded as a resource base rather than a resource itself" (Mather, 1986). Almost all the needs of human beings for food, clothing, shelter and energy are fulfilled the land. They always bring changes in the character of the land. "The term land use relates to the human activity or economic function associated with a specific piece of land." (Lillesand and Kiefer, 2008). In other words it has to do with series of operations on land, carried out by humans, with the intension to obtain products and/or benefits through land resources. The land use is simply regarded as the various ways by which man utilizes the land resource at a given time period. It has also been defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (FAO, 1997a; FAO/UNEP, 1999). Another term is used as interchangeably with land use i.e. land cover. The land cover reflects the biophysical state of the earth's surface and immediate subsurface, thus including the soil material, vegetation, and water (Prakasam, 2010). It is the physical and biological material found on the earth's surface weather it is natural or manmade, (Environmental Literacy Council, 2008). "The term land cover indicates the type of features present on the surface of the earth" (Lillesand & Kiefer, 2008). In other words it can be described as ground blanket of natural and cultural landscape. Campbell (1987) defines land cover as the vegetation (natural or planted) or man-made constructions that is found on the earth's surface. But these both terms are different from each other. Land use refers to how land is used by humans. In other words it refers to the economic use to which land is put. On the other hand, land cover refers to the vegetation, structures or other features that cover the land (CARA, 2006). At any

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one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension.

But when we talk about the changes on the earth's surface we use both terms jointly. Because human affects land use as well as land cover. Land-use and land-cover change (LULCC) is the change in the terrestrial surface of the Earth. It is the most ancient human phenomenon induced in the biosphere (Turner II, 2001). It is also known as land change is a general term by the human beings to the Earth's terrestrial surface (EOEARTH, 2010). Human beings are the agents which bring changes in the character of the land more than any other agents. Originally the nature is dominating factor for land use and land cover change. But now, humans are leading to nature and modifying the earth which is very difficult to bring under its original purpose. Centuries ago where we found large area under forests, now we find that area under agriculture, industries and large cities. The land resources are being damaged at an alarming rate in an unplanned manner.

Land change puts an impact of the environment of the area (Kostrowicki, 1983), (Li et al, 2009). Land carries ecosystems; land use is the application of human controls, in a relatively systematic manner, to the key elements within any ecosystem, in order to derive benefits from it. The conversion of agricultural lands to non agricultural uses is almost inevitable and irreversible. So, comprehensive information on the spatial distribution of agricultural land use and pattern of their change is prerequisite for planning, utilization and management of the land resources. Such information thus permits a better understanding of the land utilization aspects on cropping pattern, grazing lands, wastelands, surface water bodies, settlements and communication network, which are vital for overall development planning.

Land change is the primary modifier of the landscape, which leads to an impact on socioeconomic, biological, climatic, and hydrologic Systems (Sohl and Sohl, 2012). To identify the changes taking place at different times are known as change detection (Singh 1989). Remote sensing data is widely used to provide a cost-effective means to develop land change coverage over large geographic regions (Lunetta et al. 2006). The spatial and temporal distribution of land use and land cover is very important in understanding a wide variety of global change phenomenon. Geospatial technology is very much helpful to monitor such changes (Rajan and Shibasaki, 2000). Remote sensing techniques are applied by several scholars for land change detection (Campbell et al, 2003), (Deszo et al. 2004), (Fan et al. 2007), (Panahi et al. 2010) etc. (Singh et al. 2010) tried to investigate the land change of the adjoining area of the study region and established a link between land change and natural resources. Satellites provide a wide range of data of an area of different time periods. Essentially, it has the ability to quantify temporal effects using multi-temporal data sets (Singh 1989).

For better understanding the land use and land cover change we always need to develop a classification scheme for the whole area and divide all the objects into different classes according to our requirement (Anderson et al. 1976). The categorization of land use and land cover makes our work more useful and authentic.

This study also aims at to find the land change, responsible factors and to testify the relevance geospatial technology to carry out such type of studies.

Study area

The study of changes in land use and land cover is conducted in Patiali Rao Watershed which has its origin in Chandigarh Siwaliks (Singh, 2005). It covers an area of 21 sq km. The topography of the region is hilly. Most of the area is characterized by steep slopes; the remaining area comprises of undulating topography. Steep slopes pose serious limits to arable agriculture. This are was originally covered with extensive forests. But since the last century the area under forests is losing its extent. Now, this area is under bushes and stunted vegetation (Gosal, 2004). Human invaders are disturbing the ecology of this area. (Singh, 2005) found that since last five decades the area is experiencing environment and biodegradation. The areal extent of the area is from 30°46'39" N latitude to 30°50'13" N latitude and 76°48'07" E longitude to 76°52'20" E longitude. The location of the study area in India is shown on Map 1.

Methodology

Data Acquisition

To detect the land use and land cover change satellite imageries of atleast two different times are required. So, satellite imageries from Landsat TM (1989) and IRS P6 LISS-III (2005) imageries are used. Except this a toposheet (53 B/13) which cover the whole study area are used. Further ground verification is conducted with the help of GPS to verify the signatures and to verify the results.

Data Processing

For data processing visual image interpretation and digital image interpretation techniques are used. Signatures are identified from satellite imageries. Erdas Imagine 9.1 and ArcGIS 9.3 GIS software were used for data processing. Supervised classification was done for both images. Signatures of the classes are identified from satellite imageries and verified in the field. Eight classes of the land use and land cover are created in both time periods.

Data Analysis

The data which is processed with GIS software is also analyzed with these software. The changes in area under each category, mapping etc. all work is done with the help of GIS software. Mainly Erdas Imagine 9.1 is used for analysis the raster data.

Classes of the land use and land cover

For identifying the land use and land cover classes, classification scheme developed by National Remote Sensing Agency (NRSA) in 1995 is used. So on the basis of this scheme 8 land use and land cover

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classes are created. These land use and land cover classes are:

1. Closed Forest
2. Open Forest
3. Scrubs
4. Agricultural Land
5. Barren Land
6. Settlements
7. Water Bodies
8. Choes (Seasonal Streams)

Analysis and Discussion

For the detection of land use and land cover in 1989 and in 2005, Landsat TM and IRS P6 satellite imageries are used respectively. Supervised classification is done for land use and land cover detection. Significant areas are identified under these categories from the satellite imageries. Areas under these classes are further verified by field verification. The details of area under each category are given below in Map 2a and 2b. On the basis of analysis of the area for the years 1989 and 2005, several changes are found in land use and land cover of the study region. These changes are found in every land use and land cover class. Table No. 1 is showing the changes in land use and land cover:-

Table No. 3 - Changes in Land Use and Land Cover in Patiali Rao Watershed, 1989-2005

Category	1989 (area sq. km)	005 (area sq km)	Changes (area sq. km)
Closed Forest	3.78	0.45	-3.33
Open Forest	10.12	7.46	-2.66
Water	0.11	0.23	0.12
Barren Land	1.41	2.9	1.49
Agricultural Land	2.6	5.01	2.41
Settlements	0.02	0.48	0.46
Scrubs	2.08	3.47	1.39
Choes	0.91	0.65	-0.26

The results show that area under natural vegetation is decreasing. The trend of land change is shown with the help of Figure No. 1.

Figure No. 1 – Changes in Land Use and Land Cover in Patiali Rao Watershed, 1989-2005
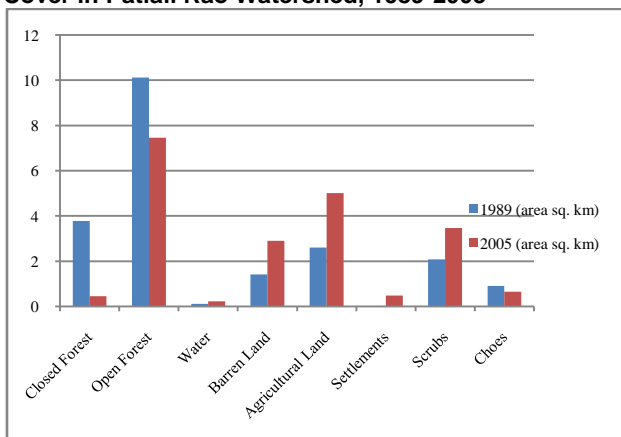
Determinants of Changes in Land Use and Land Cover

Changes in the land use and land cover do not occur itself. These are determinated by several factors. The determinants of changes in land use and land cover of an area are different from the other area. There is lot of determinants for the changes in land use and land cover in Patiali Rao watershed which are given below:-

1. The occupation of the people living in this area is agriculture. The agriculture in this area is intensive. So, people in this area are trying to cultivate more area. They are modifying valleys for agriculture and also capturing the choes area for cultivation. They are trying to sow their crops on every possible area in the region.
2. Area under natural vegetation is decreasing at a very fast rate in this area. The main cause of this is that people of this area are mainly dependent on fuel wood for cooking purposes. So, they cut natural vegetation for this purpose. They also use grasses and other small plants to feed their domestic animals like buffaloes, cows, camels etc.
3. The area under scrubs is also increasing because people are cutting trees in uncontrolled way. The scrubs are thorny in nature, so people rarely use them. So, in the several parts of dense vegetation only scrubs are left behind.
4. The area under water bodies has increased. Several reservoirs have taken place in recent years. These are introduced to proper utilize the water of the choes, which is available in monsoon season.
5. The barren land is also increasing at a very fast rate due to deforestation.
6. The area under choes is also decreasing, this is due to people are modifying land for agricultural purposes.
7. Settlements are also increasing in this area. This trend is found in the whole India due to high growth rate of population. So, it is natural that settlement will cover more space in the study region.

So, these above mentioned causes are the determinants of changes in the land use and land cover in study area.

Summary and Conclusion

On the basis of discussion it can be said that there are several changes are identified in the Patiali Rao Watershed. These changes are taking place at a rapid rate. The main change in this area is found that land under natural vegetation is decreasing at alarming rate. Most of the dense vegetation that is referred as closed forest is losing its extent. Most of the land which was under closed forest in 1989 is under open forest in 2005. So, this means that the density of natural vegetation is decreasing in this area. Similarly several other changes like increasing area under water bodies, agricultural area, settlements are also found in a noticeable way. Due to the loss of natural vegetation, the environment degradation is also taking place in this area. All the land changes are disturbing the ecology of the region.

Another objective of the study was that testing of the remote sensing and GIS for the purpose of detection of land use and land cover. This objective is successfully achieved in the study. When the results from remote sensing and GIS were compared with the ground reality they are found quite reliable. The results are found near to the reality. Remote Sensing is very useful for the view of the study area. Different time period satellite imageries are very useful for the detection of changes, which are taking place in short time period. This method saves efforts and time of the researcher who wants to investigate the changes taking place over large area. GIS is also very useful in such type of studies. GIS software are very useful for the processing of satellite imageries. The classifications which are done with these software for the detection of objects in the imageries are very reliable and time saving. We can detect a lot from satellite imageries in a single click just because of GIS.
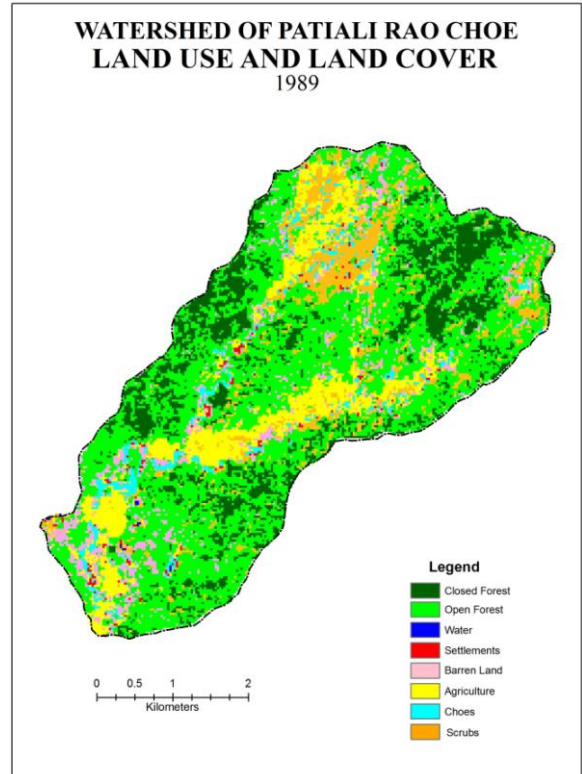
Finally, we can say that modern technology has made it very easy to identification the changes over the earth surface and made it very easy to handle a large area at a single time.

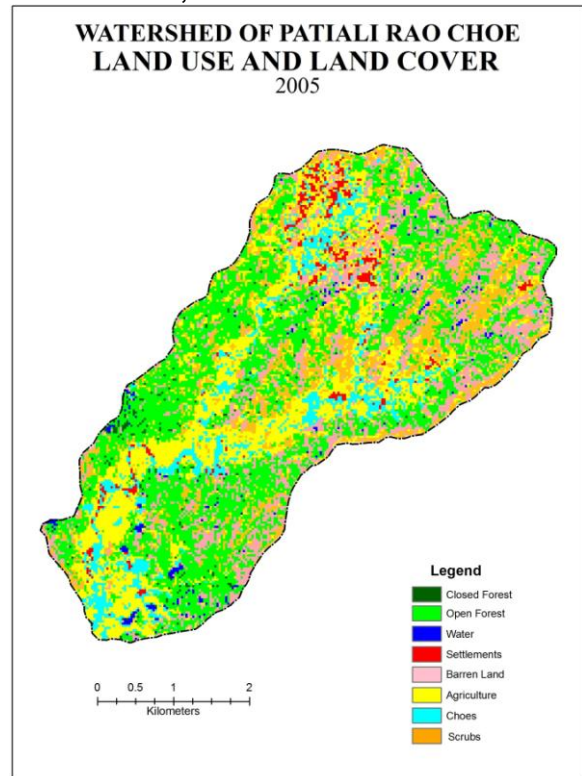**Map No. 1 Location of the Study Area in India**
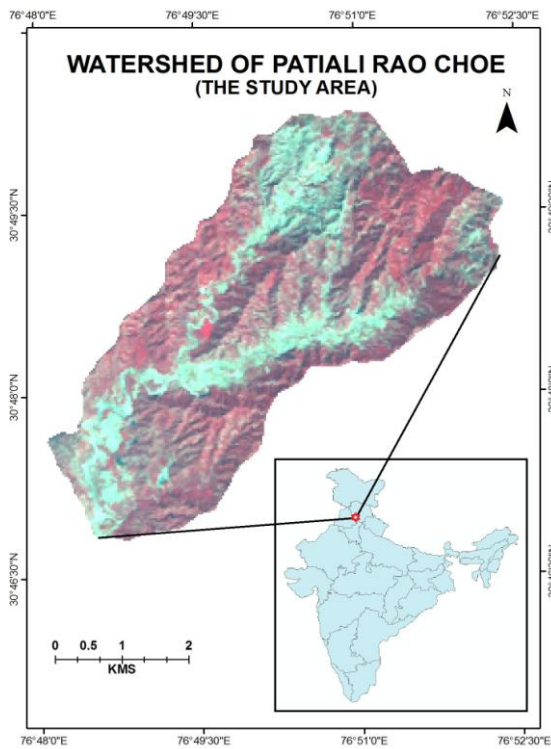
Source: LandsatTM16-10-1989

Map No. 2(a) - Land Use and Land Cover in Patiali Rao Watershed, 1989

Map 2(b) – Land Use and Land Cover in Patiali Rao Watershed, 2005

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References

1. Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. *A Land Use and Land Cover Classification System for Use with Remote Sensing Data.* Washington, US: United States Government Printing Office.
2. Campbell, J. B. 1987. *Introduction to Remote Sensing.* New York, US: The Guilford Press.
3. Campbell, D. J., D. P. Lusch, T. Smucker, and E. E. Wangui. 2003. *Root Causes of Land Change in the Loitokitok Area, Kajiado District, Kenya.* Land Use Change, Impacts and Dynamics Project. Working Paper Number: 19.
4. CARA (Consortium for Atlantic Regional Assessment). 2006. *Land Use Primer.* http://www.cara.psu.edu/land/lu-primer/luprimer01.asp (last accessed 12 July 2012).
5. Dezso, Z., J. Bartholy. R. Pongracz, and Z. Barcza. 2005. Analysis of land-use/land- cover change in the Carpathian region based on remote sensing techniques. *Physics and Chemistry of the Earth* 30: 109–115
6. Environmental Literacy Council. 2008. http://www.enviroliteracy.org/category.php/2.html (last accessed 15 June 2012).
7. EOEARTH. 2010. *Land-use and land-cover Change.* http://www.eoearth.org/view/article/154143/ (last accessed 17 August 2012).
8. Fan, F., Q. Weng, and Y. Wang. 2007. Land Use and Land Cover Change in Guangzhou, China, from 1998 to 2003, Based on Landsat TM /ETM+ Imagery. *Sensors* 7: 1323-1342.
9. Food and Agriculture Organization (FAO). 1997. United Nations Environment Programme (UNEP). 1999. *Land Use.* http://en.wikipedia.org/wiki/Land_use (last accessed 2 June 2012).
10. Gosal, G.S. 2004. Physical Geography of the Punjab, *Journal of Punjab Studies* 11(1): 19-37.
11. Kostrowicki, J. 1983. Impact on Environment, an Attempt at a Classification. *Adv. Space Res.* 2(8): 209-215.
12. Li, X.Y., Y.J. Ma, H. Y. Xu, J. H. Wang, and D. S. Zhang. 2009, Impact of Land Use and Land Cover Change on Environmental Degradation in Lake Qinghai Watershed, Northeast Qinghai-Tibet Plateau. *Land Degradation and Development* 20: 69-83.
13. Lillesand, T. M., and R. H. Kiefer. 2008. *Remote Sensing and Image Interpretation.* Remote Sensing and Image Interpretation. US: John Wiley & Sons.
14. Lunetta, R.L., F. K. Knight, J. Ediriwickrema, J. G. Lyon, and L. D. Worthy. 2006. Land cover Change Detection using Multi-Temporal MODIS NDVI Data. *Remote Sensing of Environment* 105: 142-154.
15. Mather, P. M. 2004, *Computer Processing of Remotely-Sensed Images: an Introduction.* 3rd Edition. UK: John Wiley & Sons Ltd.
16. Panahi, A., B. Alijani, and H. Mohammadi. 2010. The Effect of the Land Use/Cover Changes on the Floods of the Madarsu Basin of Northeastern Iran. *Journal of Water Resource and Protection* 2: 373-379.
17. Prakasam, C. 2010. Land Use and Land Cover Change Detection through Remote Sensing Approach: A case study of Kodaikanal taluk, Tamilnadu. *International Journal of Geomatics and Geosciences* 1(2): 150-158.
18. Rajan K. S., and R. Shibasaki. 2000. A GIS Based Integrated Land Use/Cover Change Model to Study Human-land Interactions, *International Archives of Photogrammetry and Remote Sensing* 33(B7): 1212-1219.
19. Singh, A. 1989. Digital Change Detection Techniques using Remotely-Sensed Data. *International Journal of Remote Sensing* 10(6): 989-1003.
20. Singh, Y. 2005. Operational Degradative Factors in Chandigarh Siwalik Hills, NW India. *Himalayan Ecology* 13(1): 50-66.
21. Sohl, T. L., and L. B. Sohl. 2012. Land-Use Change in the Atlantic Coastal Pine Barrens Ecoregion. *Geographical Review* 102(2):180-201.
22. Turner II, B. L. 2001. Land-Use and Land-Cover Change: Advances in 1.5 Decades of Sustained International Research. *GAIA* 10(4): 269-272.