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Land Use / Land Cover Change Detection Studies over 25 years using Geoinformatics: A Case Study of Rambiara Catchment, Kashmir

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Abstract
Land use maps are useful tools for agricultural and natural resources studies as a base data. Due to dynamism of natural resources, updating these maps is essential. Employing traditional methods through aerial photos interpretation to produce such maps are costly and time consuming. Satellite data is suitable for such purpose, as a consequence of its fast repeatability, wide and unique view and availability of data from most part of electromagnetic spectrum. The present study was conducted to investigate the change detection in the land use / land cover over 25 years in Rambiara Catchment, erstwhile Pulwama District, J&K. LANDSAT MSS (1976) and LANDSAT ETM (2001) geometrically corrected satellite images were used to identify the land use/ cover information of the area Images were enhanced using contrast enhancement and a standard False Color Composite (FCC) was developed. On-screen visual interpretation and simultaneous digitization was performed to prepare landuse / landcover maps. Some of the most prominent changes include forests which have reduced from 13.15% to 7.1%, built up has increased from 1.24% to 3.32%, barren increased from 10.66% to 16.85% from 1976 to 2001 (25 year period).

Keywords: *Land use, FCC, Digitization, Change Detection*

Introduction

There are several urban applications where satellite based remotely sensed data are being applied, namely, urban sprawl/ urban growth trends, mapping and monitoring land use/ land cover, urban change detection and updation, urban utility and infrastructure planning, urban land use zoning, urban environment and impact assessment, urban hydrology, urban management and modeling (Raghavswamy, 1994). Remote sensing techniques offer benefits in the field of land use/ land cover mapping and their change analysis. One of the major advantages of remote sensing systems is their capability for repetitive coverage, which is necessary for change detection studies at global and regional scales (Miller et al. 1998).

Detection of changes in the land use/ land cover involves use of at least two period data sets (Jensen, 1986). The changes in land use/ land cover due to natural and human activities can be observed using current and archived remotely sensed data (Luong, 1993). Land use/ land cover change is critically linked to natural and human influences on environment. With the availability of multi-sensor satellite data at very high spatial, spectral and temporal resolutions, it is now possible to prepare up-to-date and accurate land use/ land cover map in less time, at lower cost and with better accuracy. Keeping the above in view, the present work was undertaken to prepare the multi-date land use/ land cover maps of Allahabad city from multi-sensor satellite data and to monitor the changes in various land use/ land cover classes using digital remote sensing techniques.

Remote sensing technology has emerged as an efficient and powerful tool in providing reliable information on various natural resources of a region in a spatial format so essential for planning (Roy et al. 1991). The use of Remote Sensing (RS) and Geographic Information System (GIS) technologies can greatly facilitate the process of collection, analysis and presentation of resource data. Repeated satellite images and/or aerial photographs (AP) are useful for both visual assessments of natural resources dynamics occurring at a particular time and space as well as quantitative evaluation of land use/land cover changes (Trapp and Mool, 1996). Land use data are needed in the analysis of environ- mental problems that must be understood if living condition and standards are to be improved or retained at current level (Anderson et al. 1976). Land use is a dynamic phenomenon and both its value and pattern change spatially and temporally with varying efficiencies, priorities and needs (Bisht and Tiwari, 1996). The information on landuse and landcover patterns, their spatial distribution and changes over a time scale are the prerequisite for making development plans (Dhinwa et al. 1992).

Geoinformatics has proven as a powerful tool for studying the natural resources and help in locational features, extent of coverage, monitoring the resources and in generating modeling for probable scenarios, which assists in optimizing resource utilization and can assist in preparing action plans (Yang and Lo, 2002). Further monitoring of various activities and impact assessments can be reliably administered for ensuring visible benefits to the community involved. Geoinformatics would be used extensively by all at all levels in the foreseeable future in a cost effective and time saving manner and would be customized and simplified with local language interface to be used by local communities with ease (Congalton, 1991).

Materials and Methods

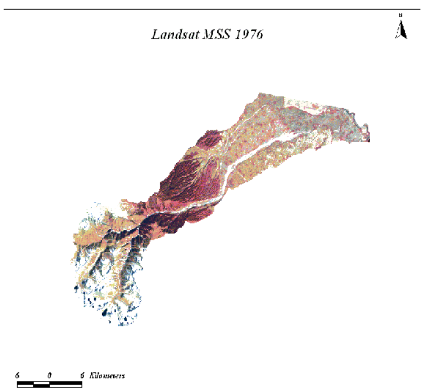
Study area

The Rambiara watershed situated in the erstwhile Pulwama district of J&K between long. 74°83, lat. 33°67′and long. 75°06′lat. 33°82′ was selected as the study area for the present research. The Rambiara River rises in the Rupri ridge of the Pir Panjal Range, its main feeders originating from Rupri peak and the Bug Sar Lake on one hand and the Pir Panjal and the Naba Pir Passes on the other. From its source of confluence the Rambiara registers a fall of 2466 mts. Rambiara catchment is having an area of about 75100 hac. The catchment comprises of two sub-catchments, six watersheds and 41 micro watersheds. Near Nayan lat. 33°49′, long 75°07′. Rambiara joins the river Vishu and then the both join the mighty Jehlum at Sangam lat. 33°83′, long. 75°07′which is the main source of irrigation for the valley.

The area supports a varied topography exhibiting altitudinal extremes of 1600m to 5000m above mean sea level. The high hill ranges are covered with forests and the dominant species are *Pinus wallichiana, Cedrus deodara, Abies pindrow and Picea smithiana.* A myriad of shrubs and herbs of medicinal value are found in the forests.

Satellite Data

LANDSAT MSS (1976) and LANDSAT ETM (2001) geometrically corrected satellite images were used to identify the land use/ cover information of the area.



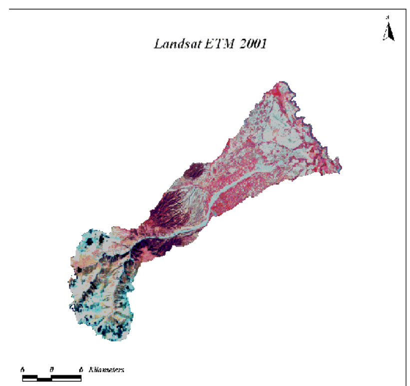


Figure 1. Landsat MSS 1976 and Landsat ETM 2001 images of the study area.

Classification

Data were classified through a Maximum likelihood classifier decision rule in ERDAS IMAGINE 8.4. After the classification, distance matrixes were examined to isolate all land cover features that did not classify within an acceptable distance to the mean of each class (i.e., stray pixels that were outside of any degree of confidence of classification).

Accuracy Assessment

By selecting random and field sampled ground truth data, 100 data points were collected and were utilized in the analyses. Overall Kappa statistics for our analyses of Landsat MSS 1976 is 0.84 and the overall classification accuracy is 86.00%. And Overall Kappa statistics for our analyses of Landsat ETM 2001 is 0.81 and the overall classification accuracy is 84.00%.

Change Detection

The change detection of Rambiara Catchment was done by using Post-classification change detection method. The land use/ land cover maps prepared from two data sets Landsat ETM (2001) and Landsat MSS (1976) were used for change detection.

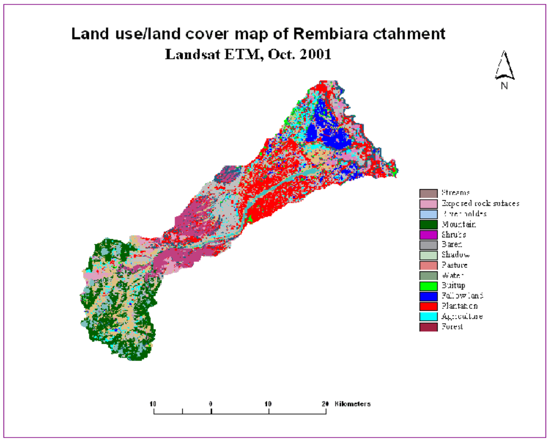
Results and Discussion

Land use / land cover data

The various land use and land cover classes delineated include agriculture, plantation, forest, built-up, pastures, river boulders, shadow, fallow, barren, streams, mountains, exposed rock surfaces, shrubs and water. The spatial coverage of each class may be visualized on both maps.

The classes dominating in Landsat ETM 2001 are mountains (10.78 % area), plantation (16.99 % area) and barren (16.85 % area). Water (8.71%) shrubs (8.56 %) agriculture (6.53%) and fallow 6.05%) areas respectively. In Landsat MSS 1976 the dominating classes are forest (13.15 % area), plantation (11.21 % area), barren (10.66 % area) and plantation (11.21 % area). Agriculture covers (12.79) % area and shrubs 10.47 % area.

The overall classification accuracy and the Kappa coefficient of Landsat ETM (2001) was found to be 84.00% and 0.8138 respectively. For Landsat MSS 1976, the parameters were 86.00% and 0.8454 respectively.



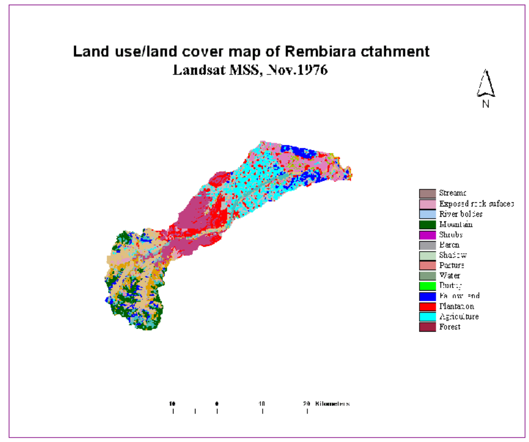


Figure 2. Land Use / Land cover Map of Rambiara Catchment, Landsat ETM 2001 and Landsat MSS 1976.

Table 1. Land use / Land cover area of 2001 image and 1976 image.

S. No.	Class Name	Area in sq. kms.	Area %	Area in sq. kms.	Area %
		2001		1976	
1	Streams	34.66	4.67	26.67	4.13
2	Mountains	80.08	10.78	47.44	7.34
3	Forests	52.66	7.1	87.18	13.15
4	Pastures	19.89	2.68	9.8	1.51
5	Shadows	17.86	2.4	9.07	1.4
6	River boulders	12.98	1.85	30.78	4.76
7	Built up	24.69	3.32	8.04	1.24
8	Plantation	126.08	16.99	72.43	11.21
9	Barren	125.01	16.85	68.86	10.66
10	Fallow	44.54	6.05	44.87	6.94
11	Agriculture	48.48	6.53	82.62	12.79
12	Water	64.62	8.71	33.86	5.24
13	Exposed Rock Surfaces	26.77	3.6	56.44	8.74
14	Shrubs	63.5	8.56	67.66	10.47

Change Detection

From Landsat ETM land use/ land cover map of year 2001, it may be seen that built-up area constitutes 3.32%, mountains 10.78%, forests 7.1%, pastures2.68% river boulders 1.85%, plantation 16.99%, barren 16.85%, agriculture 6.53% and water 8.71 respectively of total area. It was found that a change of +2.8% in built-up, mountains+3.44%, forests -6.05%,pastures +1.17%, river boulders -2.91%, plantation +5.78%, barren +6.19%, agriculture -6.26% and water +3.47% has taken place over 25 years since 1976.

Table 2. Percentage change in each class for Landsat MSS (1976) and Landsat ETM (2001

Percentage change in each class for Landsat MSS (1976) and Landsat ETM (2001)							
S. No.	Land Use/ Land Cover Classes	Area in 2001		Area in1976		Change(km^2)	Change(%)
		Area (Km^2)	% Area	Area (Km^2)	% Area		
1	Streams	34.66	4.67	26.67	4.13	7.99	0.34
2	Mountains	80.08	10.78	47.44	7.34	32.64	3.44
3	Forests	52.66	7.1	87.18	13.15	-34.52	-6.05
4	Pastures	19.89	2.68	9.8	1.51	10.09	1.17
5	Shadows	17.86	2.4	9.07	1.4	8.79	1
6	River boulders	12.98	1.85	30.78	4.76	-17.8	-2.91
7	Built up	24.69	3.32	8.04	1.24	16.65	2.8
8	Plantation	126.08	16.99	72.43	11.21	53.65	5.78
9	Barren	125.01	16.85	68.86	10.66	56.15	6.19
10	Fallow land	44.54	6.05	44.87	6.94	-0.33	-0.89
11	Agriculture	48.48	6.53	82.62	12.79	-34.14	-6.26
12	Water	64.62	8.71	33.86	5.24	30.76	3.47
13	Exposed Rock surfaces	26.77	3.6	56.44	8.74	-29.67	-5.14
14	Shrubs	63.5	8.56	67.66	10.47	-4.61	-1.91

Conclusion

Remote sensing, because of its capability of synoptic viewing, multi-spectral data and repetitive coverage provide useful information on land use land cover of an area, information on existing land use land cover, its spatial distribution are essential prerequisite for proper planning to many natural resource programmes. The present study demonstrated usefulness of satellite data for the preparation of land use/ land cover maps highlighting existing land classes for analyzing their change pattern from the last 25 years through digital image processing techniques. The land use/ land cover maps for two date satellite images ETM 2001 and MSS 1976 have been prepared and the various land use classes are delineated as agriculture, pasture, forest, water, streams, mountains, shrubs, built up etc. One of the main advantages of preparing land use/ land cover maps is to monitor changes among various land uses from last 25 years. Some of the most prominent changes include forests which have reduced from 13.15% to 7.1%, built up has increased from 1.24% to 3.32%, barren increased from 10.66% to 16.85% from 1976 to 2001 (25 year period).

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