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Quantitative Assessment Of Land Use Land Cover Dynamics And Its Significance In Micro Watershed Management Studies

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Abstract: ***Land use land cover (LULC) change detection is fundamental requirement for better understanding of landscape dynamics during a known period of time for sustainable development. Since last few decades mapping of land use land cover and change detection analysis for micro watershed level studies using remotes sensing and GIS technology has became an area of interest of researchers and planners. This research paper attempts to highlights the importance of land use and land cover data and basic landscape information for micro watershed management studies. For the present research work, Mugaon micro watershed from western part of Pune district (Maharashtra) has been selected and land use land cover data is generated from IRS LISS 1C (1997) and IRS P6 LISS III (2012) on 23.5 m spatial resolution . Present study revealed that natural resources in the watershed are decreasing rapidly. It is anticipated that continued degradation of these resources over prolonged periods of time may lead to further damage the ecology of the watershed.***

Keywords: watershed, sustainable development, remote sensing, GIS, spatial resolution

I. INTRODUCTION

Rapid growth of population has led tremendous pressure on various natural resources including water, soil and forest which have affected the ecology of the watersheds in western parts of Maharashtra. Watershed development programs in India are largely confined to rain fed and dry agricultural land. Judicious use of water resources, especially in semi-arid and rural areas of India calls for good watershed management practices and implementing it in a watershed and micro watersheds (Johnson, N.J, Govindaradjane S, Sundararajan T, 2013). Watershed is typically a catchment area from where water flows to particular drainage system, mainly river. The area of watershed may range from few hectors to several thousand square kilometers. Watershed development programmes are mainly intended to conservation, regeneration and the judicious use of human and natural resources within a particular watershed (NABARAD 2006). Development of micro-watershed has been instrumental in raising agricultural productivity and employment opportunities in rain fed and dry regions of the country where resource degradation is a serious problem (Dutta N,).

Effective watershed management requires accurate present and past land use land cover (LULC) data to come up and meet with certain measures for resource conservation. The term, land use and land cover are inseparable. Land use is the term that is used to describe human uses of land, or immediate actions modifying or converting land cover (Sherbinin A.D. 2002). On the other hand, land cover refers to the natural vegetative cover types that characterize a particular area. Land cover is the layer of soil and biomass, including natural vegetation, crops and manmade infrastructures that cover the land surface. Changes in Land-use proximately cause change in land-cover pattern. Land use is obliviously constrained by environmental factors such as soil characteristics, climate, topography and vegetation. But it also reflects the land as key and finite resources for most human activities comprising agriculture, industry, forestry, energy, production, settlement, water catchments and storage (Bhat, Sulemeiman, Abdul, 2009).

The knowledge of land use and land cover is of immense importance and useful to understand the natural resources, their proper utilization, conservation and management. The driving forces to this activity could be economic,

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technological, demographic, scenic and or other. Hence, land use and land cover dynamics is a result of complex interactions between several biophysical and socio-economic conditions which may occur at various temporal and spatial scales (Reid R.S. *et al., 2000).*

II. STUDY AREA

For the present research work micro watershed namely 'Mugaon' has been selected which covers around 1016.64 ha geographical area of Mulshi tahsil of Pune district in Maharashtra state (Fig 1). Entire Mugaon watershed is truly endowed by scenic beauty. The watershed is a small part of Warasgaon reservoir and situated on eastern flank of Sahyadri. The geographical coordinates of the Mugaon watershed are 18°23′36″ to 18°25′58″ N latitudes and 73°26′55″ E to 73°29′6″ E of longitudes. The normal annual rainfall over the region varies from about 2000 to 3500 mm. Geologically the entire tract is covered by basaltic flows commonly known as 'Deccan trap' of Cretaceous Eocene age. Soils vary according to the elevation towards the northern part in watershed. Mugaon watershed comprises around 321 of population according to 2011 census.

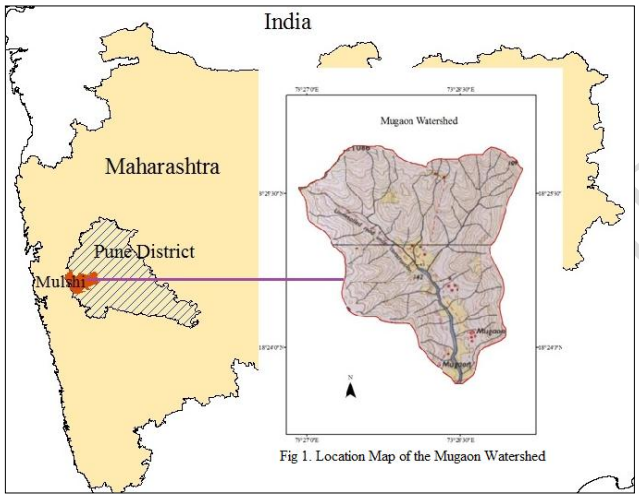


Figure 1

III. OBJECTIVES OF THE STUDY

- ✓ To investigate spatio-temporal land use land cover (LULC) dynamics in Mugaon watershed
- ✓ To suggest conservative measures for natural resources in the watershed

IV. MATERIALS AND METHODS

For the present research work, IRS LISS 1C (1997) and IRS P6 LISS III (2012) of 23.5 m spatial resolution along with Survey of India Toposheet No 47/F/7 on 1:50000 have been used. The digital data were geometrically corrected using toposheet with the help of Erdas imagine 9.2 image processing software. Using the toposheet, drainage pattern in the watershed is obtained in Global Mapper software 11.03. Satellite data is processed in Erdas Imagine 9.2 in unsupervised manner. Area under major land use land cover category has been categorized into five major classes (Level I) and ten subclasses (Level II). These different land use land cover classes like water body, agriculture, forest, wastelands and built up etc which are identified using unsupervised classification method (Fig 2) are also verified during the field work.

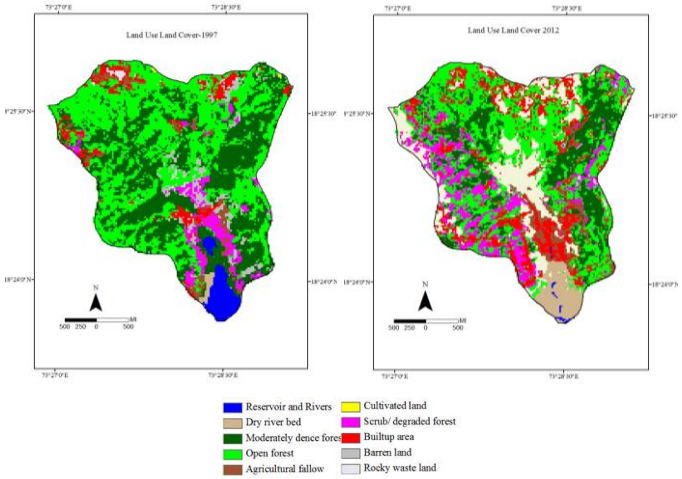


Figure 2: Un-supervised classified images of Mugaon watershed

V. CHANGE DETECTION ANALYSIS

Mapping of land use land cover and change detection analysis for micro watershed level studies using remotes sensing and GIS technology has became an area of interest of researchers and planners. Land use land cover change detection is very fundamental requirement for better understanding of landscape dynamics during a known period of time for sustainable management. The process of change detection is most frequently associated with environmental monitoring, natural resource management and measuring urban development. Understanding landscape patterns, changes and interactions between human activities and natural phenomena are essential for proper resource management and decision making (Prakasam C. 2010). Land use land cover change all over the world has been recognized as one of the major of environmental change on spatial as well as on temporal scales. It is observed that, the land use land cover pattern of the western part of Pune district has been changed dramatically during the last three decades. Observations of fifteen years have been noted as following table no 1.

Land Use Land Cover Classes			LULC- 1997		LULC-2012		Change between 1997 & 2012	
			Area	Area	Area	Area		
No	Level I	Level II	(Ha)	(%)	(Ha)	(%)	(Ha)	(%)
1	Water body	Reservoir & Rivers	34.56	3.40	2.42	0.24	-32.14	-97.58
		Dry River Bed	6.74	0.66	46.54	4.58	39.80	-53.46
2	Agriculture	Cultivated Land	0.98	0.10	0.00	0.00	-0.98	-100.00
		Agricultural Fallow	32.95	3.24	71.08	6.99	38.13	-28.92
3	Forest	Moderately Dense	376.24	37.01	184.38	18.14	-191.87	84.38
		Open	419.33	41.25	326.07	32.07	-93.25	226.07
		Scrub/Degraded	50.46	4.96	112.44	11.06	61.98	12.44
4	Wastelands	Barren Land	43.89	4.32	1.96	0.19	-41.93	-98.04
		Rocky Waste Land	5.64	0.56	145.56	14.32	139.91	45.56
5	Built-up	Built up area	45.85	4.51	126.20	12.41	80.35	26.20
TOATL			1016.64	100.00	1016.64	100.00		

Table 1: LULC data of Mugaon watershed

A. CHANGE IN WATER BODIES

Mugaon micro watershed is a part of Warasgaon catchment. The changing rate of water bodies is showing decreasing trend as it totally depends on and the annual rainfall in the study area and fluctuating water level of Warasgaon catchment. Increase in the dry river bed area in 2012 shows (46.54 ha) the low water level in the Warasgaon catchment.

B. CHANGE IN AGRICULTURAL LANDS

Area under the cultivated land is very less and shows negligible change as the watershed is characterized by hilly terrain and undulating topography. Cultivation is mostly confined to the banks of reservoir. During the monsoon, paddy cultivation is performed on gentle hill slopes. It shows that in the year 1997 area under cultivation was 0.98 ha and in 2012 there is no cultivated land recorded. Agricultural fallow lands are those lands which are available for cultivation but not used for one or the other reason. The agriculture activities in fallow land are totally dependent on monsoon. Most of the surface area under agricultural fallow is utilized in rainy season only. This area under fallow was 3.24 % in the year 1997 and increased by 6.99% in 2012. *Nachani*, lentils like *pawata* (Dolichos lablab), *masoor* (Lens esclenta), *gram* (Cicer arietinum) were grown.

C. CHANGE IN FORESTS

Land cover class under the forest is decreased and shows negative change. It was found that area under the moderately dense forests, particularly in western part of the watershed, which was 37.01% in the year 1997, comes down to 18.14% in the year 2012. It has been decreased by 84.34% within the fifteen years of span. Open forests over 93.25 ha area also decreased by from 1997 to 2012. Forests patches are mostly found at high altitudinal zone. Scrub or degraded forests however shows continuous increase by 12.44% from 1997 to 2012. The negative change in the forest is only because of increasing human interference, as well as need of forest product to satisfy daily livelihoods.

D. CHANGE IN WASTELANDS

Significant changes in wastelands are observed. In the year 1997 area under barren land was 4.32%, which decreased up to 0.19% in the year 2012. The total 98.04% decrease during this period has been observed. Area under rocky waste land in central and upper parts of the watershed has also been increased by 0.56% in 1997 to 14.32% in 2012 (45.56 %). During the field survey it was observed that the intensive encroachment of anthropogenic activities are increasing ecological stress and leading to soil erosion on hill slopes and land degradation. In period of heavy monsoon due the lack of vegetative cover along the slopes, most of the valuable soils washed out leaving behind the open bare land surfaces.

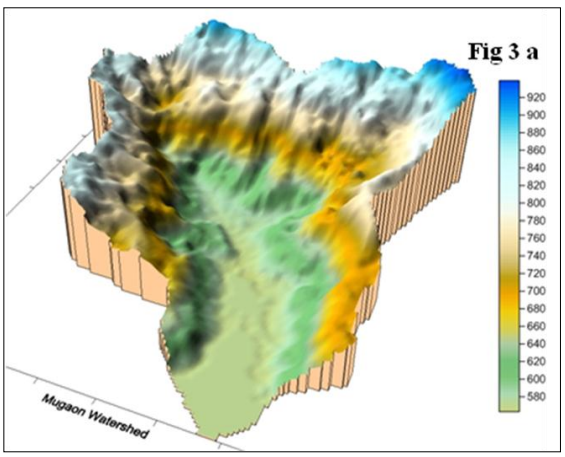
E. CHANGE IN BUILT UP LAND

The observation also indicated that built up area has increased from 4.51% in 1997 to 12.41% in 2012 and this growth is about 26.20%. One noticeable change behind this is not actually the increase in human population but the increasing trend of construction activities like farm house, bungalows and resorts in watershed. These construction activities in the watershed are also found to be the major reason in changing natural stream flow.

Above discussion clearly indicates that quantitative assessment of land use land cover data in spatio-temporal manner is important for watershed planning, management activities and modeling the future trends. Land use land cover of any watershed has a great influence on water, forest and land resources. Watershed's land cover directly impacts stream hydrology by influencing the amount of rainwater runoff. Forest and land in the watershed absorb rainwater, which allows rainwater to percolate back into the ground. Hence ground water, wells and streams gets recharge. However impervious surfaces particularly concretization reduces the percolation of water in the ground. Impervious cover has a major influence on streams. More the impervious surfaces in the watershed, lesser the groundwater recharge. In the present micro watershed loss of protective layer of forest, increase in exposed rocky wastelands and built-up area may affect the ground water recharge in future.

VI. WATERSHED MANAGEMENT

It can be observed that land and forest resources in the watershed are adversely affected. In the watershed, severely degraded forests sites are easy to identify and recognize (Fig 2). Over exploitation of forest in the study area has removed much of the original vegetation cover. Removal of forest cover on steeper slopes results in formation of gullies and erosion of soils. These changes cause significant loss of biodiversity which ultimately turns into reduction of human wellbeing. Further this loss of biodiversity and ecological services affects the sustainability of many agricultural practices. Accurate land use land cover data provides the base and helps for improvement in delineation of severely affected parts in micro watershed for proper implementation of soil and forest conservation measures in watershed.



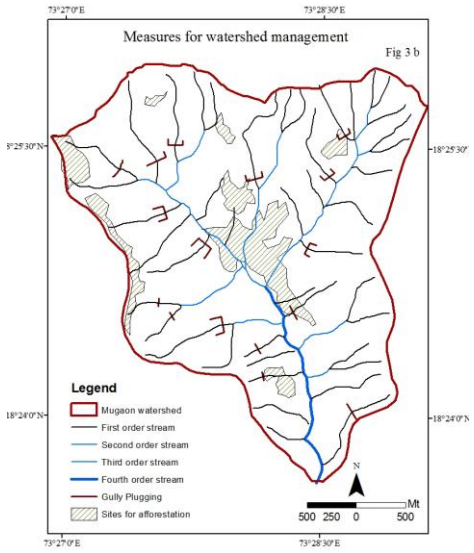


Figure 3a & 3b: Mugaon micro watershed management

In order to rejuvenate natural vegetation cover, to arrest soil erosion and siltation of the reservoir some strict measures should be undertaken and implemented accordingly for which verity of biological and engineering measures can be applied at appropriate sites. Considering the soil and climatic condition of the watershed indigenous plant species should be introduced at degraded sites (Fig 3b). Ample vegetation cover protects the underlying soil layer from direct impact of raindrops, high winds and also reduces the flow of running water (Shelar A- 2014). Small gullies can be protected by bunds and gully plugging by taking into consideration the high altitude and the steep slope (Fig 3a) of the watershed. It will help to prevent soil erosion on slopes, allow the water to flow at non-erosive velocity and to percolate into the ground.

VII. CONCLUSION

From the LULC statistics, derived from the digital data it can be concluded that land use land cover data at micro watershed is crucial as far as watershed management is concern and in this context remote sensing and GIS technology play an important role as it has ability to produce this data in spatio-temporal manner. For the present case study 23.5 m spatial resolution data has been used. Now a day's high resolution satellite data gives more precise numerical data about watersheds and monitoring or evaluation of measures taken for water, soil and forest conservation in watershed can be done in certain temporal manner.

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