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Research Paper

ASSESSING SPATIO-TEMPORAL OF LAND USE LAND COVER CHANGES AND ITS DYNAMICS USING REMOTE SENSING AND GIS APPROACH—A CASE STUDY OF MIDGHAT HALIYAL-SUPA, KARNATAKA

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The large-scale shift in Land Use and Land Cover (LULC) is being attempted to meet immediate needs by ignoring long-term complementarities among different components of natural resources in the tropical Western Ghats, Karnataka Hence, quantifying accurate LULC change within a region is an important component of monitoring watershed services. Thus curret effrots were made o quantiuy LULCC, rate of change and land use dynamics through application of Remote Sensing (RS) and Geographical Information Systems (GIS) in Haliyal-Supa Taluka of Uttara Kannada District, Karnataka. LULCC results shows that tropical evergreen/semi-evergreen forest located along the river valley and middle altitude found net reduce by 0.71%. However, moist and dry deciduous forest increased by 0.57% from 2001 to 2012. The degraded forest and scrub forest area remain under pressure and we can observe a slight increase in the area from the period of 2001 to 2012 (by 0.3% and 0.29% respectively). Similarly, the area covered by forest plantations shows an increment during 2012 as compared to 2001 with respect to water bodies especially Rivers/reservoir/streams and river island steady decline in trend. Similarly agricultural land use also showed a steady decline, especially agriculture plantation consisting of Arecanut, Coconut, and horticulture. However, cropland such as paddy, sugarcane, cereals, and pulses steadily increased from 2001 to 2012. The area under towns and city class marginally increased by 0.2% during the study period. Results of the maximum rate of fluctuation was observed in evergreen forest followed by moist and dry deciduous forest and Rivers/streams/ reservoir. However among all the land use changes, Barren rocky/stony wasteland, the minimum rate of change is 0.5%/year. With respect to dynamic degree of town/cities, scrub forest, tree plantation, Barrn rocky/ stony wasteland, degraded forest land/ tree groves, moist/dry deciduous forest and cropland has increased. We can see that landscape deviation degree has increased from 14.9% in 2001 to 15.02% in 2012 that shows the intensity of human activity has increased.

Keywords: Land use land cover change, RS and GIS, Land use deviation, Dynamic degrees

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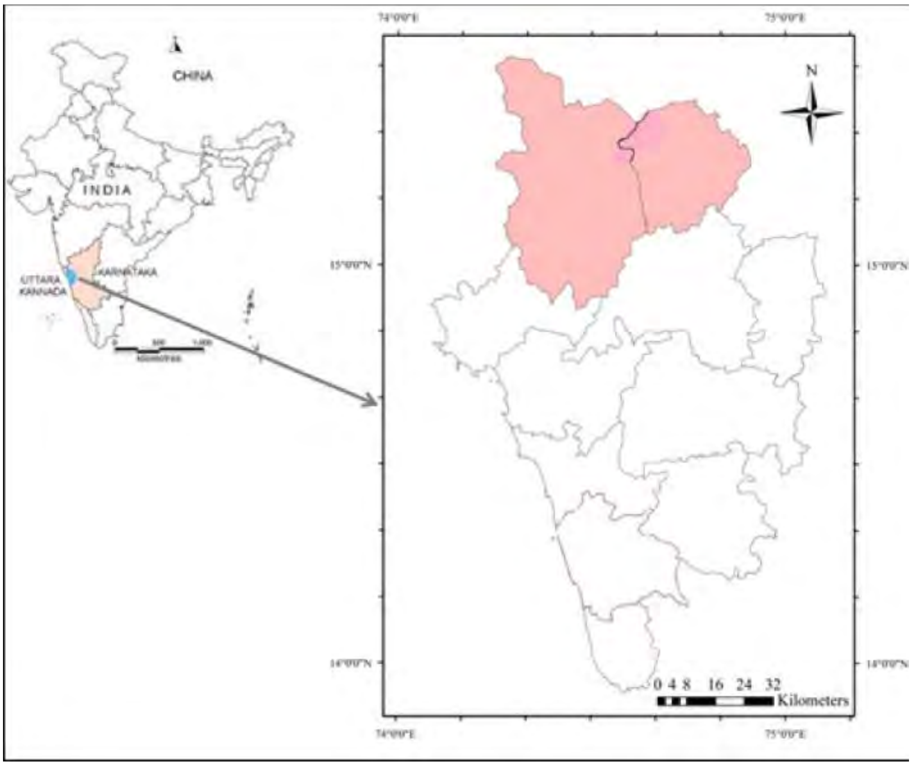
INTRODUCTION

The large-scale shift in Land Use and Land Cover (LULC) is being attempted to meet immediate needs by ignoring long-term complementarities among different components of natural resources (GEF, 2011). This is very true with tropical Western Ghats of Uttara Kannada district, Karnataka and the region in recent time has witnessed changes in LULC, ecological and environmental problem leading to change in ecosystem services, predominantly hydrological services. The forests in the Western Ghats were cleared in the past for agricultural expansion, plantation development and for various other developmental activities (Menon and Bawa, 1997; and Jha *et al.*, 2000). The impacts of these changes become regionally significant through their cumulative effects and assessment of Land Use/Land Cover Change (LULCC), and its dynamic degree through Remotes Sensing (RS) and Geographic Information System (GIS) approach at a different time interval is in a fancy stage. This can be accomplished more efficiently through change detection analysis of multi-temporal remotely sensed data sets. Hence, quantifying accurate LULC change within a region is an important component of monitoring watershed services.

STUDY AREA

The Haliyal and Supa taluka of Uttarakannada district, Karnataka are situated between 14°58’34" and 15°31’16" N latitude and 74°4’52" and 74°29’52" E longitude and encompass 2737.33 sq km area (Figure 1). The climate is mostly humid round the year in the Ghat regions of

Figure 1: Location Map of in the Western Ghats Region of Uttara Kannada District, Karnataka, India



Haliyal-Supa. In the eastern side, it is dry except during south-west monsoon. The hottest months are March to May. The minimum temperature is 15 ºC during winter and maximum goes up to 35 ºC. The tract receives rainfall mainly from southwest monsoon from June to September. The rainfall is more, in the western part and decreases towards east. The highest rainfall is about 3000 mm at Supa and lowest being 1000 mm in parts of Haliyal.

The topography taluka divided into three different zones namely the narrow coast, rising hills, and the relatively flat and elevation eastern zone, which merge with Deccan Plateau. Geologically, the tract underlined by Archaen complex and these are divisible into Dharwar system and peninsular gneisses. A capping of laterite frequently overlies both Dharwar and peninsular gneisses. The rocks commonly observed are granites, gneisses, greywackes, magnetites, magniferous shales, phyllites, schists and limestones. Red loamy soils are derived from laterite and traps are seen in Supa and Haliyal taluks (Davithuraj and Manjunath, 2014).

MATERIALS AND METHODS

Satellite data of Indian remote-sensing satellite IRS-1 LISS IV 5.8 resolution merged data of PAN and FCC of Kharif seasons of June 2001, and 2012 was acquired from National Remote Sensing (NRSC), Hyderabad, India. The study area lies in one swap (LISS IV). The study area is covered by fifteen different topographic maps/ sheets (48 I/8; at 1:50,000 scale) which were collected from Survey of India (SoI). All these SoI maps were scanned to ArcGIS for land use classification. The classification of the image was performed using unsupervised classification method. Before interpretation of satellite data, a reconnaissance survey of the study area is done to develop a classification scheme. Using ERDAS IMAGINE 8.6 software, onscreen interpretation of satellite data is done with the help of interpretation key. Ground truth data collected during field visits are used to compare with the imagery. After verification, these areas were reconciled on the maps and corrections are incorporated before a finalizing the map. From the classified outputs, statistics are obtained with the help of Arc GIS 10.1. The methodology followed for interpretation of satellite image is shown in Flow Chart 1.

The spatial analyses are carried out at the block level to describe LULC changes that have occurred and calculated percentage of change, trend, rate, and the pattern. The LULC area in 2001 is denoted as A and the LULC area for 2012 as B. By subtracting A from B, the change is either positive (increase) or negative (decrease).

The expression is as follows:

$$\text{Change (\%)} = \frac{\text{Observed change} * 100}{\text{Sum of Change}} \qquad ...(1)$$

Finally, assessment of landscape deviation induced by human activity and land use type dynamic change is calculated by analysing the land use dynamic degree, which reflects the intensity of the changes of the regional LULC types in a certain period (Wang Xiulan and Bao Yuhai, 1999; and Zhan Chunxiao *et al.*, 2008).

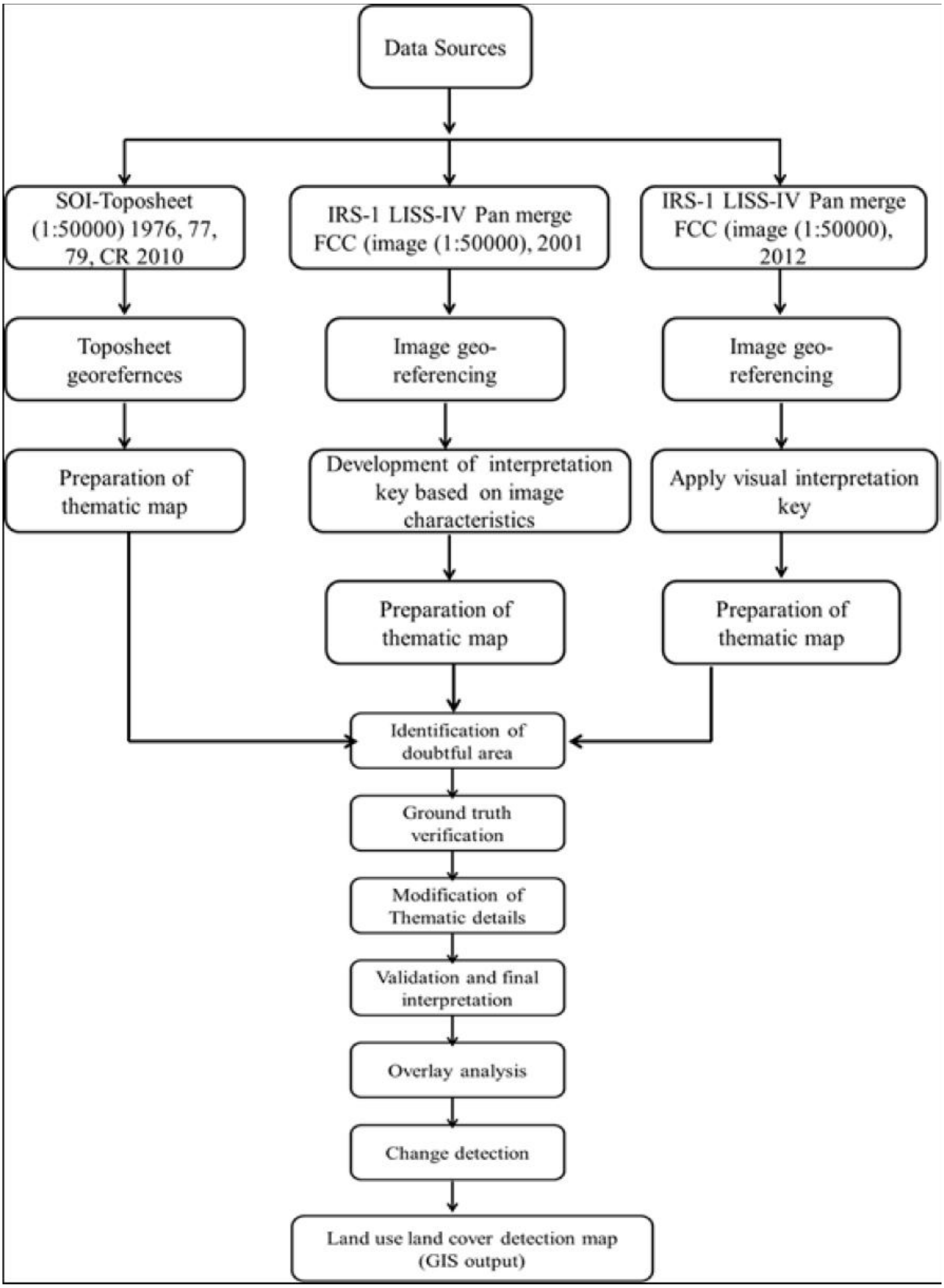
The expression is:

$$\text{LD} = \frac{\sum \text{MLC}}{\text{A}} \qquad ...(2)$$

where,

LD: Landscape deviation, "MLC: is Sum of Manmade Landscape A is Total geographical area.

Flow Chart 1: Methodology of Land Use Land Cover Mapping



$$LCD = (U_b - U_a) \times (U_a^{-1}) \times (T^{-1}) \times 100\% \quad ...(3)$$

where,

LCD: represents the dynamic degree of a certain type of land use within the study time; Ua and U_b represent the number of the certain land use type at the beginning and at the end of the study period; T represents the time that the study covered.

RESULTS AND DISCUSSION

Land use land cover classification analysis results Haliyal-Supa Taluka for 2001 and 2012 are summarized in Table 1 and the results diagrammatically illustrated in Figures 2 and 3. The study area covers 273784.08 ha and total 12-land use/land cover identified and mapped in the study area.

Forest and Forest Types

Overall, the result showed that the major land use reduction in 11 years period is tropical evergreen/ semi-evergreen forest located along the river valley and middle altitude of Haliyal-Supa block. Evergreen/semi evergreen forest cover of this region changes from 111768.86 ha to 109822 ha in 2011 or net 0.71% of forests cover the loss. The decrease in evergreen and the semi-evergreen forest was mainly due to the increase of agriculture along the river/stream and litter collected by local residents for arecanut plantation. Tripathi and Manish Kumar (2012) observed that forest area decreased from 20119.55 ha in 1990 to 18488.68 ha in 2005 in Takula Block of District Almora, Uttarakhand,

Table 1: Land Use/Land Cover Statistics of Haliyal-Supa Area During 2000 and 2012

LULC Category	Year 2001 (A)		Year 2012 (B)		Relative Change (B-A)		Rate of Change (%)	Dynamic Degree (%)
	Area (ha)	% Cover	Area (ha)	% Cover	Area (ha)	% Cover		
Agricultural Plantation	2286.12	0.84%	2019.18	0.74%	-266.94	-0.10%	3.02%	-0.973
Barren Rocky/Stony Waste	1063.05	0.39%	1107.18	0.40%	44.13	0.02%	0.50%	0.346
Cropland	32136.98	11.74%	32392.9	11.83%	255.91	0.09%	2.90%	0.066
Degraded Forest/Tree Groves	26645.33	9.73%	27459	10.03%	813.68	0.30%	9.21%	0.254
Evergreen/Semi-evergreen Forest	111768.86	40.82%	109822.37	40.11%	-1946.49	-0.71%	22.03%	-0.145
Lake/Tanks	525.27	0.19%	406.03	0.15%	-119.24	-0.04%	1.35%	-1.892
Moist/Dry Deciduous Forest	71668.59	26.18%	73215.57	26.74%	1546.98	0.57%	17.51%	0.18
Reservoir/River/Stream/ River Island	18792.57	6.86%	17255.07	6.30%	-1537.5	-0.56%	17.40%	-0.682
Scrub Forest	2612.6	0.95%	3409.86	1.25%	797.27	0.29%	9.02%	2.543
Town/Cities	679.34	0.25%	1213.53	0.44%	534.19	0.20%	6.05%	6.553
Forest Plantations	3584.39	1.31%	4010.18	1.46%	425.79	0.16%	4.82%	0.99
Village	2020.98	0.74%	1473.22	0.54%	-547.76	-0.20%	6.20%	-2.259
Grand Total	273784.08				8835.87			

Figure 2: Land Use and Land Cover Change for the Year 2001 and 2012, Haliyal-Supa, Block, Uttara Kannada District, Karnataka

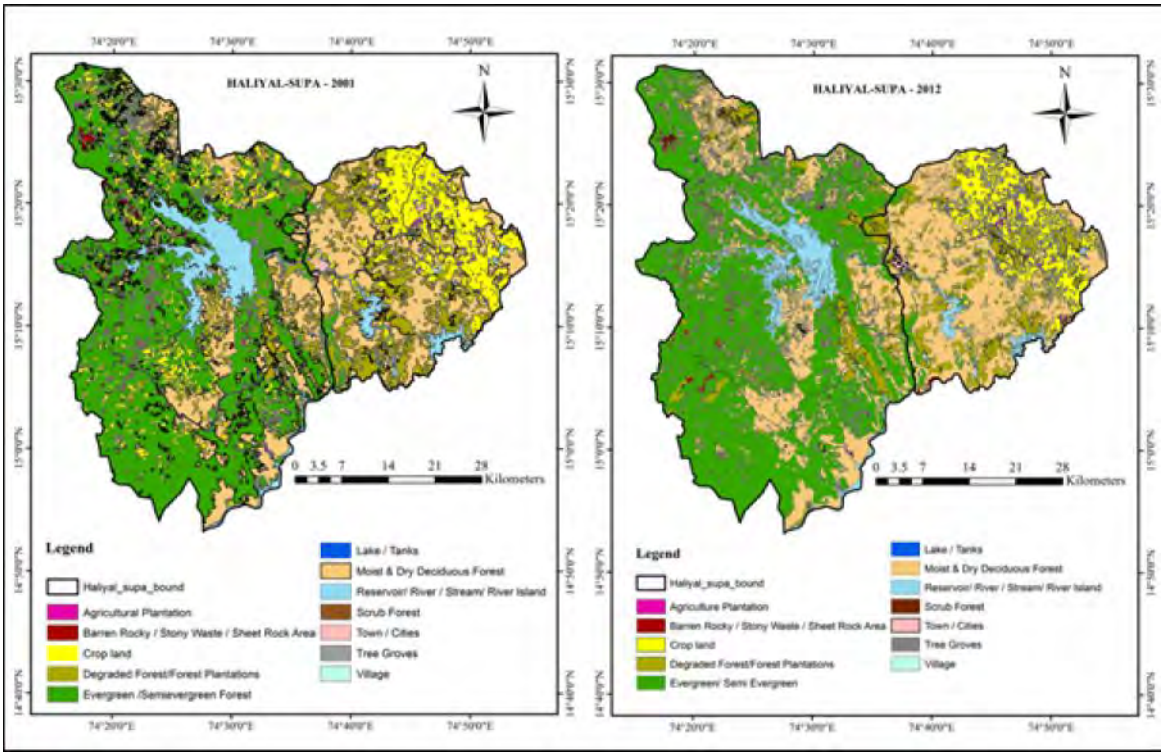
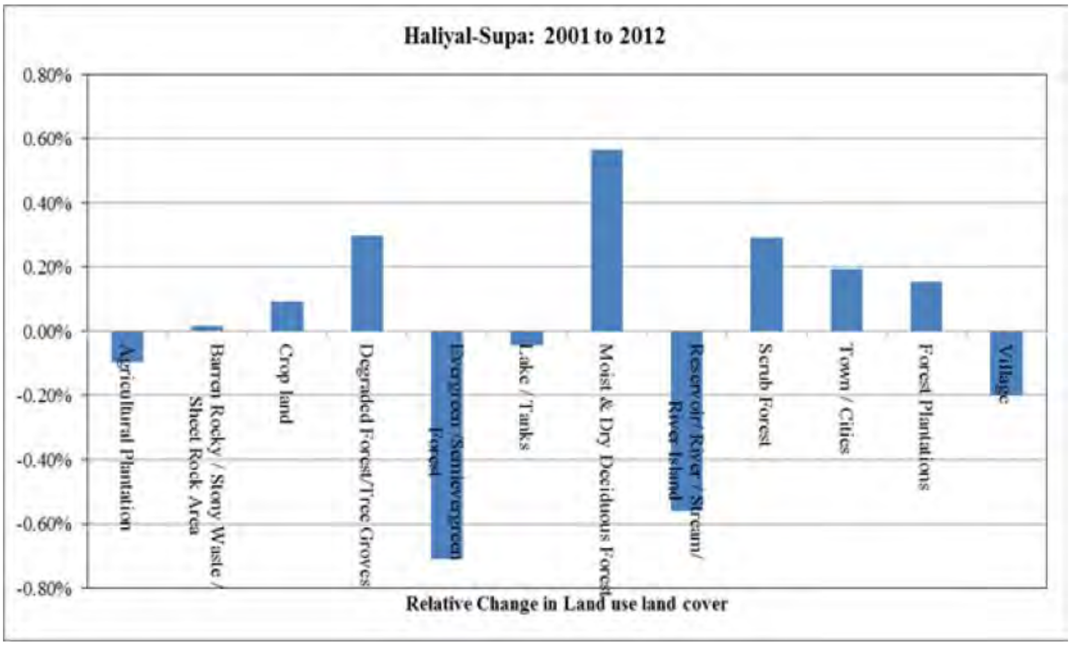


Figure 3: Percentage of Relative Land Use / Land Cover Changes from Haliyal-Supa 2001 to 2012



India. According to them, about 1630.87 ha of forest land was converted into the cropland, built-up, and fallow land during this period.

The moist and dry deciduous forest cover in 2001 occupied 71668.6 ha. However, the area increased to 73215.6 ha in 2012, increased by 0.57% from 2001 to 2012. The degraded forest and scrub forest area remain under pressure and we can observe a slight increase in the area from the period of 2001 to 2012 (by 0.3%, and 0.29% respectively). Similarly, the area covered by forest plantations shows an increment during 2012 as compared to 2001. During 2001, this was about 3584.39 ha, increase by 0.16%, and in 2012 it occupies 4010.18 ha. The increase in moist and dry deciduous, plantation in the region is due to a rehabilitation program by the forest department. However, simultaneously increase of degraded forest may be due to higher pressure of from livestock grazing in adjacent Natural forest.

Water Bodies

Water bodies showed a steady decline in trend, especially Rivers/reservoir/streams and river island that covered 18792.6 ha in 2001 with an area percentage of 6.86% of the total area. In 2012, it decreases to around 17255.1 ha, likewise, the percentage falls to around 6.30% of the entire area and net reduction from 2001 to 2012 is nearly 0.56%. Similarly, during same period lake/tanks declined slightly from 525.27 ha to 406.03 ha (reduced to 0.04%). This shrinking of water bodies mainly because most of the feeder channels/ distributaries have dried up due to changes in upstream land use system, which affects watershed services. The water spread area decrease occurred due to the gradual conversion of the water spread area in the built-up area or human developmental area as the population increased significantly during the past decades. Another reason for the reduction in water bodies is due to the expansion of agriculture cropland area. Abbas (2010), stated that the area covered by water body decreased by 1.91 km^2 because most of the distributaries have dried up, with the percentage change of about 24.68%. Adikanda Ojha *et al.* (2013) found that there is a rapid increase in agricultural activities attributed to conversion of forest, shrub, and grassland areas in to cultivation of agriculture.

Agriculture

Agricultural land use showed a steady decline, especially agriculture plantation consisting of Arecanut, Coconut, and horticulture. The total decline in agriculture plantation is 0.1% during 2001-2012. However, cropland such as paddy, sugarcane, cereals, and pulses steadily increased from 2001 to 2012. In 2001, the total cropland area was 32136.98 ha and this increased to 32392.9 ha in 2012, and the net increase within 11 years was about 0.09%.

This decline in areca nut plantation may be due to change in climatic factors, catchment hydrology, fluctuation in market price and non-availability of labour. Some researchers find similar observation and coated that agriculture expansion taken place from periferial of forest to wood lands (thick forest) due to loss of top soil fertility, fluctuation in market economy of agriculture goods (Xia Li *et al.*, 2004; and Hagler Bailly, 2007). In another study Vemu Sreenivasulu,(2010) found agricultural activities are more along the watercourse of the river and its tributaries. The agriculture with sparse habitation increased from 7.09% in 1958 to 13.92% in 1998 in Devak catchment in Jammu District (J&K).

Habitats/Settlement

The area under towns and city class marginally increased by 0.2% during the study period. The major cities in the region are Haliyal, Joida/Supa, and Dandeli, which comprised about 0.25% of the total land area in 2001. In 2012, the area found to cover 1213.53 ha, which is close to 0.44% of the total town/city area. With respect tocommon wasteland identified in this part is barren, rocky/ stony area found to occupy 1063.05 ha in 2001 and it increased to 1107.18 in 2012 (net increase of 0.02%). This variation is due to increase in urban infrastructure and rehabilitation of the village community of Supa and Dandeli wildlife forest in nearby urban areas. Mary Tahiret *et al.* (2013) observed the spatial trend in the expansion of the Mekelle city between 1984 and 1994, the total area of the city increased from 1,600 hectares to 2,304 hectares. The spatial growth trend of the city becomes rapidly after 2005 and covers 13,000 hectares. Muthusamy (2010) has observed an increase in population and industrialization along the coastal areas is added pressure on the coastal ecosystems of Tamil Nadu. Anil *et al.* (2011) found the area under settlements have increased considerably in Juvalapalem, West Godavari.

Results of the rate of rate of changes, land use deviation and dynamic degrees in Haliyal-Supa block are given in Table 1. The maximum rate of fluctuation was observed in evergreen forest followed by moist and dry deciduous forest and Rivers/streams/reservoir. The rate of decrease in evergreen forest/semi-evergreen is 22.03%/year and the rate of decrease in River/streams/ reservoir is 17.40%/year and the total decrease was recorded 0.56%. But, moist and dry deciduous forest, degraded forest plantation and scrub forest show increasing rate of 17.51%, 9.21%, 9.02% and 4.81%/year and net increase was found to be is 0.57%, 0.30%, 0.29% and 0.16% respectively during 2012.However among all the land use changes, Barren rocky/stony wasteland, the minimum rate of change is 0.5%/year.

With respect to dynamic degree of town/cities, scrub forest, tree plantation, Barrn rocky/stony wasteland, degraded forest land/tree groves, moist/dry deciduous forest and cropland has increased. However, the areas of other types such as village, lakes/tanks, and agriculture plantation have reduced drastically with the rate of 2.25, 1.89 and 0.97% respectively. Based on the results of landscape deviation degree in 2001 and 2012, we can see that landscape deviation degree has increased from 14.9% in 2001 to 15.02% in 2012 that shows the intensity of human activity has increased.

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