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Antropogenic Pressure on Forest Cover and Its Change Detection Analysis Using Geoinformatics in Holalkere Taluk of Chitradurga District, Karnataka, India

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ABSTRACT

There is a significant change in forest cover around the globe due to rapid rise in population, land use, forest fire, demand for economic mineral deposits, depletion of rainfall, climate change and global warming (?). The present aim is to focus mainly on planning and management of forest cover for environmental and socio-economic outcome to meet future needs. Mapping of forest cover and its Change Detection Analysis (CDA) is prepared using Survey of India (SoI) topomap of 1:50,000 scale; geo-rectified multi-spectral and multi-temporal image of IRS-1C/1D PAN+LISS-III of 5.8m resolution through GIS software's. The final results highlight change detection in forest cover using multi-temporal satellite image using geo-informatics for its monitoring and sustainability.

Keywords : Forest Cover, CDA, IRS Satellite Image, Holalkere, Geo-informatics

I. INTRODUCTION

Forests exert influence on climate, water regime and provide shelter for wildlife and livestock (FAO, 1963). The forest consists mostly of shrub growth which was exploited for fuel and agricultural implements due to increase in population (Basavarajappa and Dinakar., 2005). This results in substantial denudation and also affects the soil and vegetation conditions. But the forest authorities are concentrating on protection of existing forests and on afforestation. The black soils of the study area are fertile rich in bases having a high water-holding capacity (Basavarajappa et al., 2014a), high concentration of soluble salts and potash content particularly suited for rain-fed crops like short-staple cotton, groundnut, jowar and tur dhal (CGWB., 2013). This fertility in soil attracts more farmers for agricultural activities within the boundaries of reserved forest covers. Low rainfall conditions during extreme summers and increase in mining activities on reserved forest cover leads to deforestation (Manjunatha et al., 2015a).

Study area: It lies in between $13^0$51' to $14^0$15' N latitude and $76^0$01' to $76^0$28' E longitude covering an area of 1,099 Km^2 with ground elevation of 710 m above MSL in Chitradurga district [Fig.1] (Basavarajappa et al., 2014b). Temperature varies from 17^0 to 19^0 C; may rise up to 40^0 C during extreme summers. Rainfall ranges from 933.8 to 1111.6 mm during the year 2008-09 (CGWB., 2013; Table.1). No river flows in the study area, while Vedavati in Hiriyur taluk is the nearest river (Manjunatha and Basavarajappa., 2015b). Palms, Palmyra, Conifer, Bamboo and other tress are noticed in major parts of the study area.

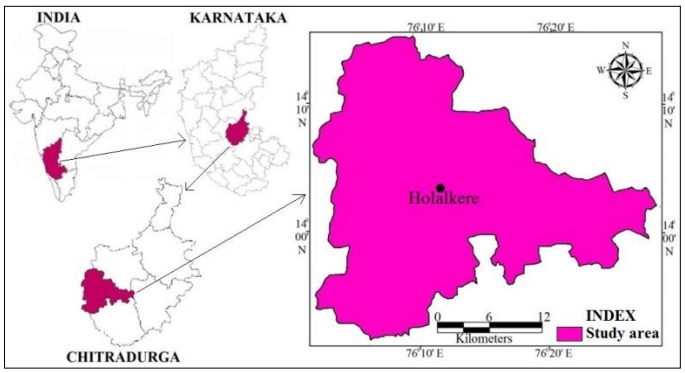

Figure 1. Location map of the study area

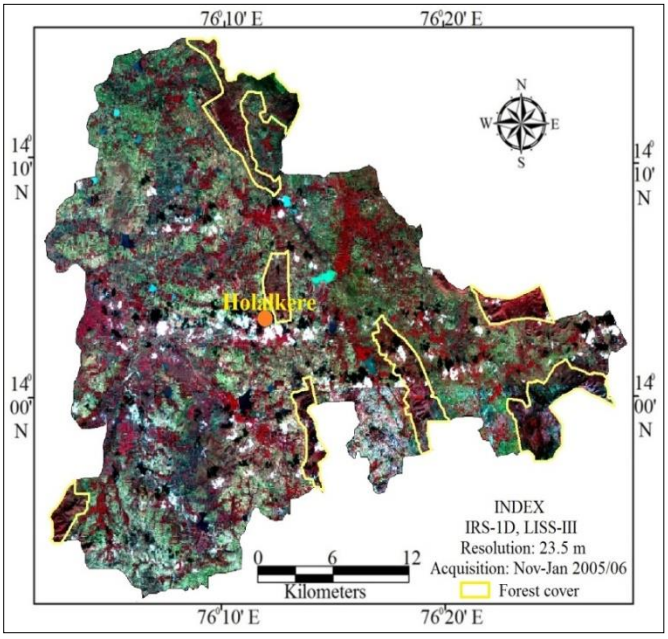

Figure 2. IRS-1C LISS-III Satellite image of the study area

II. METHODS AND MATERIAL

a. Topomaps: 57C/1, 2, 5, 6, 9, 10 of the year 1975-78 & 2008-09.
Source: Survey of India (SoI) of 1:50,000 scale, Bengaluru.

b. Satellite Data: IRS-1C & 1D; PAN+LISS-III of 5.8m Resolution (D43K03, 04, 08; D43Q01, 05) [Year of Pass: 2000-01 & 2005-06] (Fig.2).

Source: Bhuvan-portal, ISRO-NRSA, Hyderabad.
c. Software's: Arc GIS v10 and Erdas Imagine v2013.

d. GPS: Garmin-12 GPS is used to demark the exact boundaries of each forest cover during Ground Truth Check (GTC)

Table.1. Annual Rainfall of Holalkere taluk in mm from 2000-10

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual Rainfall (mm)	481.4	583.1	406.7	627.3	952.2	593.9	672.3	642.5	933.8	1111.6	518.6

Source: Zilla Panchayat, Chitradurga

Forest Cover: It is an area predominantly consists of thick vegetation, medicinal plants and other large and huge number of vegetation types capable of producing timber and other forest products (Basavarajappa et al., 2014c; Saxena., 1993). Satellite data has become useful tool in mapping the different forest types and density classes with reliable accuracy through Visual Image Interpretation Techniques (VIIT) as well as Digital Image Processing (DIP) (Madhavanunni, 1992; Roy et al., 1990; Sudhakar et al., 1992). Holalkere taluk includes 7 State Reserved Forest (Fig.3) namely, Devaragudda State Forest, Garaga Kaval State Forest, Janakal State Forest, Jogimatti State Forest, Lakkihalli Sate Forest, Niruthadi State Forest and Tuppadahalli State Forest with an area of 120 Km^2 approximately (SoI topomap – 2008-09) which were being degraded by several major and minor factors (Fig.7; Table.2). The major part of the taluk falls under semi malnad with Arecunut, coconut plantations and semi arid forest with bushy trees widely spread around Madakeripura, Mincheri, Bheemasamudra, Holalkere, Kavalu, Horakeredevarapura making it as trans-malnad region (CGWB., 2013) of Chitradurga district adjacent to the Shimoga and Davangere districts.

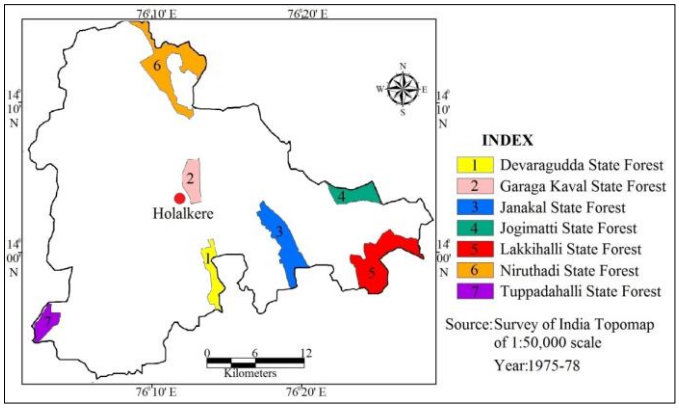

Figure 3. Forest map of the study area

Change Detection Analysis: Forest cover map was first derived from Survey of India (SoI) topomaps of

1:50,000 scale during 1975-78 and 2008-09 (Basavarajappa et al., 2016) (Fig.4a; 5b). SoI topomaps were utilized to geo-rectify the satellite images through the selection of GCP (Ground Control Points) and locating the training sets (Dinakar., 2005; Pushpavathi and Basavarajappa., 2009). Supervised classification analyses are carried out on multispectral, multi-temporal IRS-1C & 1D, PAN+LISS-III FCC [Year of Pass: 2000-01 (Nov-Jan); 2005-06 (Nov-Jan) & 2008-09 (SoI topomap)] image through Erdas Imagine v10 (Manjunatha and Basavarajappa., 2015c) (Fig.4b; 5a). The forest cover and its patterns were digitized based on the standard schemes developed by National Remote Sensing Agency (NRSA, 1995; 2007). Forest covers an area of 117.83 Km^2 in 1975-78 has been degraded to 111.21 Km^2 (2000-01); later degraded to 107.77 Km^2 (2005-06) due to human intrusions at each forest boundaries; agricultural sprawl and mining activities (Fig.7 & 8). The taluk is endowed with major economic mineral deposits such as iron which were being mined at Bedarabommahalli & Dindahalli (100.17 hectares), manganese at Sadarahalli; Keshavapura; Mahadevapura & Gilikevanahalli (43.3 hectares), barites at Ghattihosahalli (17 hectares), soapstone at Singanahalli (17 hectares), limestone and fuchsite quartzites at Ararnaghatta & Ghattihosahalli (70.41 hectares) (Basavarajappa et al., 2015a) (Fig.6). Such deposits were being mined rapidly and mine waste dumping were noticed in boundaries of major forest covers in northern and south-eastern parts of the taluk during 2001-06 (Basavarajappa and Manjunatha., 2015b; NRSA, 2007), which one of the major factors affecting the forest degradation. Storage of waste materials, sliding of the dump outside the leased area, encroachment of forest area for dumping, mining pit and other activities were gradually increasing the deforestation. Rapid increase in population increases the agricultural activities especially at the extreme interior parts of the forest cover. More than 6 Km^2 of the forest cover has been degraded 1975 to 2001 noticed through CDA; while 3.4 Km^2 of forest cover had degraded from 2001 to 2006 (Fig.9; Table.3).

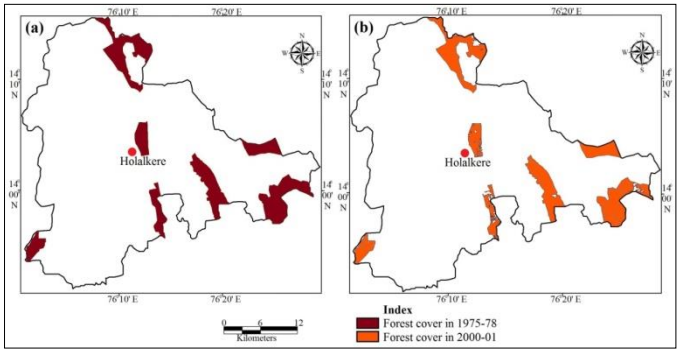

Figure 4. (a) Forest cover map in 1975-78 (SoI topomap) & (b) 2000-01 (LISS-III)

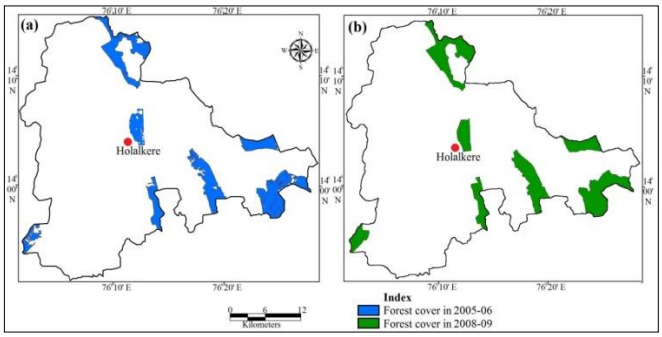

Figure 5. (a) Forest cover map in 2005-06 (LISS-III) and (b) 2008-09 (SoI topomap)

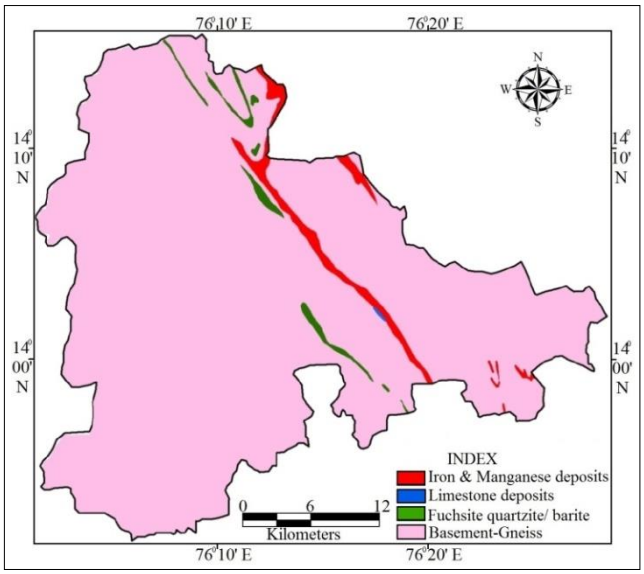

Figure 6. Economic mineral map of the study area

Table 2. Mapping of forest covers (Km^2) in different years

Sl. No	Forest covers	1975-78 (SoI)	*Percentage (%)*	2000-01	*Percentage (%)*	2005-06	*Percentage (%)*	2008-09 (SoI)	*Percentage (%)*
1.	Garaga Kaval	9.5460	*7.9550*	8.6598	*7.2165*	7.5698	*6.3081*	9.6290	*8.0241*

2.	Jogimatti	10.7899	*8.9915*	10.7542	*8.9618*	9.8267	*8.1889*	10.8778	*9.0648*
3.	Lakkihalli	28.4824	*23.7353*	26.9471	*22.4559*	28.4617	*23.7180*	29.1007	*24.2505*
4.	Janakal	21.3356	*17.7796*	20.9371	*17.4475*	20.1873	*16.8227*	22.0193	*18.3494*
5.	Devaragudda	10.0627	*8.3855*	7.7317	*6.4430*	10.0972	*8.4143*	10.8795	*9.0662*
6.	Niruthadi	30.0109	*25.0090*	28.4910	*23.7425*	26.2440	*21.8700*	29.2979	*24.4149*
7.	Tuppadahalli	7.6072	*6.3393*	7.6928	*6.4106*	5.3928	*4.4940*	7.5931	*6.3275*
		117.8347	***98.1952***	**111.2137**	***92.6778***	**107.7795**	***89.8178***	**119.3973**	***99.4974***
	TGA	**120.0000**		**120.0000**		**120.0000**		**120.0000**	

III. RESULTS

Note: TGA: Total Geographical Area of forest cover

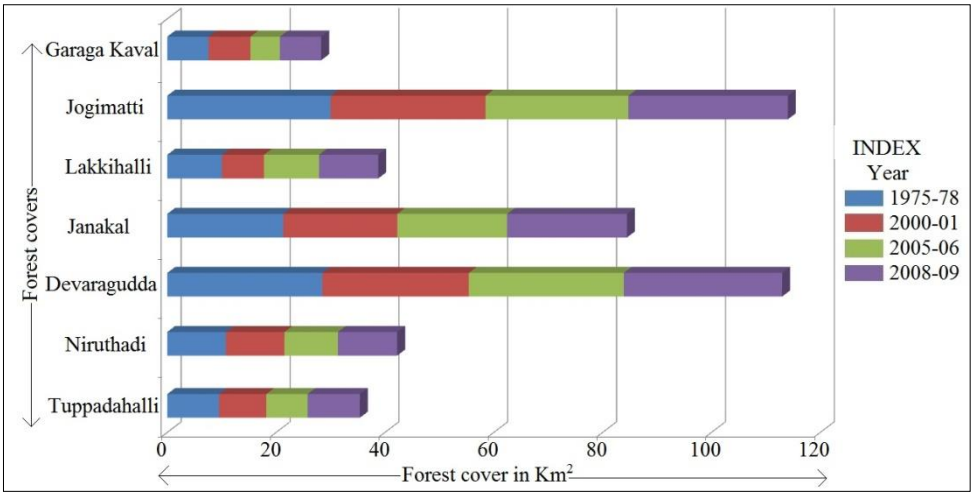

Figure 7. Bar chart representing the CDA of Forest covers (Km^2)

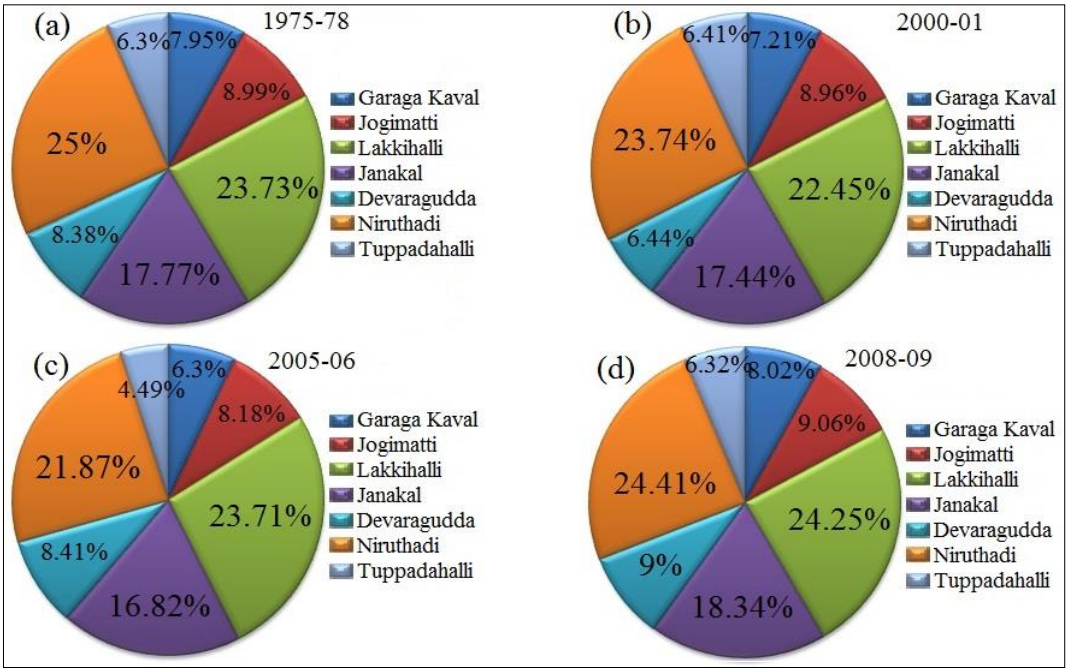

Figure 8. Pie-chart representing the CDA of Forest cover in percentage in (a) 1975-78 (b) 2000-01 (c) 2005-06 (d) 2008-09

Table 3. Change Detection Analysis (CDA) of Forest covers

Sl. No	Mapping of forest cover	1975 - 2001		2001-2006		2006-2009	
		Area in Km^2	*Percentage (%)*	Area in Km^2	*Percentage (%)*	Area in Km^2	*Percentage (%)*
1.	Forest cover	-6.6210	*-5.5174*	-3.4342	*-2.8600*	+11.6178	*+9.6796*

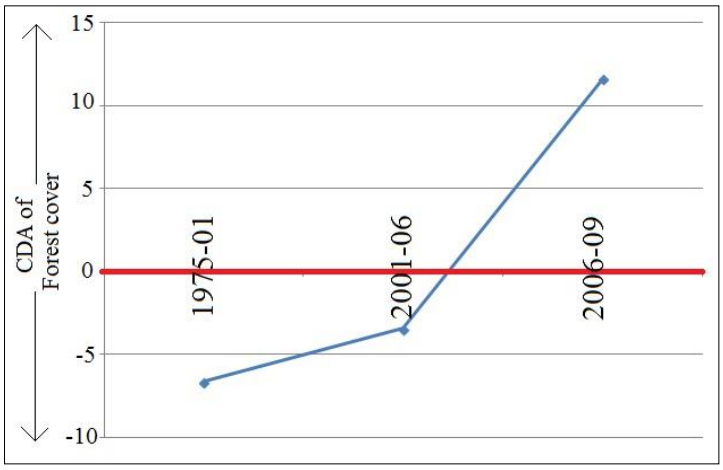

Figure 9. Line graph depicting the Change Detection Analysis (CDA) of Forest covers

IV. CONCLUSION

Mapping of Forest cover & its CDA were derived using SoI topomap & IRS-1C; 1D, PAN+ LISS-III Satellite image through ArcGIS v10 & Erdas Imagine v2013 software's; is a cost-effective and time consuming technology. Forest covers an area of 117.83 Km^2 in 1975-78 has been degraded to 111.21 Km^2 (2000-01); later degraded to 107.77 Km^2 (2005-06) due to human intrusions at each forest boundaries; agricultural sprawl and mining activities. More than 6 Km^2 of the forest cover has been degraded during the year 2001 noticed through CDA, when compared to 1975; while 3 Km^2 of forest cover had degraded in 2006. Gradual increase in human population raised the agricultural activities, mining of economic minerals and waste dumping were major factors caused the forest degradation. More than 11.61 Km^2 of forest cover has been increased due to heavy rainfall received by the taluk (2008-09) that increased the vegetation cover. Forest Department Authority had recovered the forest area of waste material storage, dumping yard, mining pit and other areas outside the mined leased boundary. Forest cover is associated with other land surface features which need immediate monitoring for its sustainability.

V. ACKNOWLEDGMENT

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