TEMPORAL MAPPING OF FOREST RESOURCES IN HOSADURGA TALUK OF KARNATAKA STATE, INDIA USING GEO-INFORMATICS

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Abstract: Forest resources are the most diverse and widespread ecosystem that provides clean air, water, timber, food, fuel, fodder, medicinal plants, agricultural implements, construction materials and recreational opportunities on earth. Hosadurga taluk is classified as one of the Hot Spots of Indian Flora & Biogeographic zone of this study area falls under the Deccan Peninsula Zone. According to 1999 assessment of the Karnataka Forest Department, Hosadurga taluk holds 14% spread of forest cover which includes forest plantations; degraded forests; moist & dry deciduous forests and scrub types. 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 satellite images of IRS-1C/1D PAN+LISS-III of 5.8m resolution through GIS software's. The study area endowed with 5 State Reserved Forests which covers total area of 201.62 Km^2 (1975-78) which has been degraded due to human intrusions through agricultural patterns, depletion of rainfall, illegal mining etc. The final results highlight change detection in forest cover using multi-temporal satellite image using geo-informatics for its monitoring and sustainability.

Keywords **-** Temporal Mapping; Forest resources; CDA; Hosadurga taluk; Geoinformatics.

1. INTRODUCTION

Forests are the large area dominated by Medicinal plants, Timber yielding plants (hard & soft wood timber), Construction purposes, Agricultural implements, Carts & accessories, Firewood & charcoal, Aromatic plants, Oil yielding, Fodder plants, Dye yielding plants, Detergents & soap yielding plants, Resin & gum-yielding plants, Flavoring agents, vegetables, Cereals & millets, Pulses, Pickles, Fruits, Fibre-yielding plants, Green manure, Other commercial crops, Sacred trees, Basket making, Mat weaving, roof thatching (FAO, 1963). 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. The fertility in soil content particularly suited for rain-fed crops like short-staple cotton, groundnut, jowar and tur dhal attracts more farmers for agricultural activities within the boundaries of reserved forest covers (CGWB., 2013). Low rainfall conditions during extreme summers and increase in illegal mining activities on reserved forest cover leads to deforestation (Manjunatha et al., 2015a). Forest conservancy and its impact on environment has gained importance in national and international agenda (CFD., 2012). Degradation of forest is a matter of grave concern and the focus is now on its sustainable management for which systematic planning is very essential (CFD., 2012). Geoinformatics encompasses Survey of India (SoI) toposheet, Remote Sensing (RS) Satellite image, Geographic Information System (GIS) and Global Positioning System (GPS) for effective mapping of forest resources, its management and sustainability (Basavarajappa et al., 2014a; Tiwari et al., 1996).

2. STUDY AREA

It lies in between $13^0$34' to $14^0$00' N latitude and $76^0$06' to $76^0$34' E longitude covering an area of 1,433 Km^2 with ground elevation of 739m above MSL [Fig.1] (Basavarajappa et al., 2014b). The general trend of the study area shows the gentle slope from SW to East direction. Except in the region of the hilly belt, Western and Southern parts of taluk represents open and level plains with vast expanse of cultivation varying in certain seasons (CGWB, 2013). Palms, Palmyra, Conifer, Bamboo and other tress were noticed to be grown on mixed red, black & medium black soils observed in major portions of the study area.

2.1. CLIMATE & VEGETATION

As per the physio-agronomic classification of the areas within the Karnataka State, Chitradurga belongs to South-Eastern Cool and Equitable Maiden Zone. Temperature varies from 23^0 to 27^0C; may rise up to 38^0 C during extreme summers (CGWB, 2013). Rainfall ranges from 933.8 to 1185.1 mm during the year 2009-10 & agriculture is mainly dependent on the timely and adequate rainfall (CGWB., 2013; Table.1). Hosadurga taluk receives more rainfall when compared to other taluks of the Chitradurga district (CFD., 2012).

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

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Annual Rainfall (mm)	898.2	520.0	507.0	366.0	918.0	740.0	593.9	672.3	790.6	933.8	1185.1

Source: Zilla Panchayat, Chitradurga

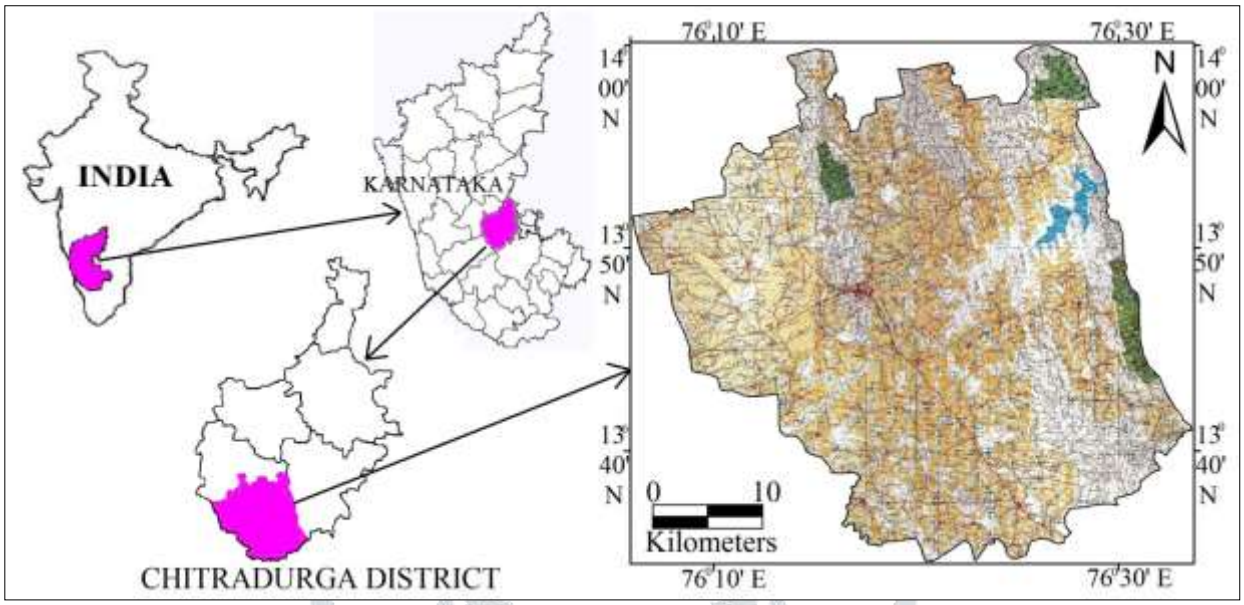

Fig.1. Location and Topomap of the Study area (2008-09)

3. METHODOLOGY

Satellite images are geo-rectified by considering permanent features such as major roads, power-lines, settlements, co-ordinates, forests and village boundaries derived from SoI topomaps on 1:50,000 scale. 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.4; 5; 6). The forest cover and its patterns were digitized based on the standard schemes developed by National Remote Sensing Agency (NRSA, 1995; 2007). The variation in the Association, Texture, Shape, Size, Shadow and Pattern are involved to identify and delineate types of forest cover using ArcGIS and Erdas Imagine software's (Manjunatha et al., 2015a). Supervised classification analyses were carried out on multispectral, multi-temporal IRS-1C & 1D, PAN+LISS-III FCC [Year of Pass: 2000-01 (Nov-Jan) & 2005-06 (Nov-Jan)] image through Erdas Imagine v10 (Manjunatha and Basavarajappa., 2015c) (Fig.2). 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).

3.1. Materials used:

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).

4. RIVERS AND TANKS

The River Vedavathi is a tributary of the Tungabhadra River, which ultimately drains into the Krishna River. Vedavati is formed by the confluence of two streams namely Veda and Avati, which originate in the Bababudan hills of neighboring Chikmagalur district (CFD., 2012). River Vedavati enters the study area in the SW parts and flows in the NE hills of Hosadurga taluk and harnessed into Vanivilasa Sagara Dam built among Marikanive Hills in Hiriyur taluk (Basavarajappa et al., 2016). Gundihalla River runs from North to South and ultimately drains into Vanivilas Sagar Dam. After flowing few miles beyond Hiriyur, it leaves the District near the Eastern base of the Molakalmuru taluk (CGWB., 2013). Most part of the study area is irrigated by this Rivers and tanks. Several anicuts have been constructed across these streams to impound water. Besides these rivers and rivulets, tanks, wells and tube-wells are the other water sources (CGWB., 2013). Vedavathi River, its streams and other major and minor tanks have been digitized using PAN+LISS-III satellite image and overlaid on SoI topomaps (Fig.3).

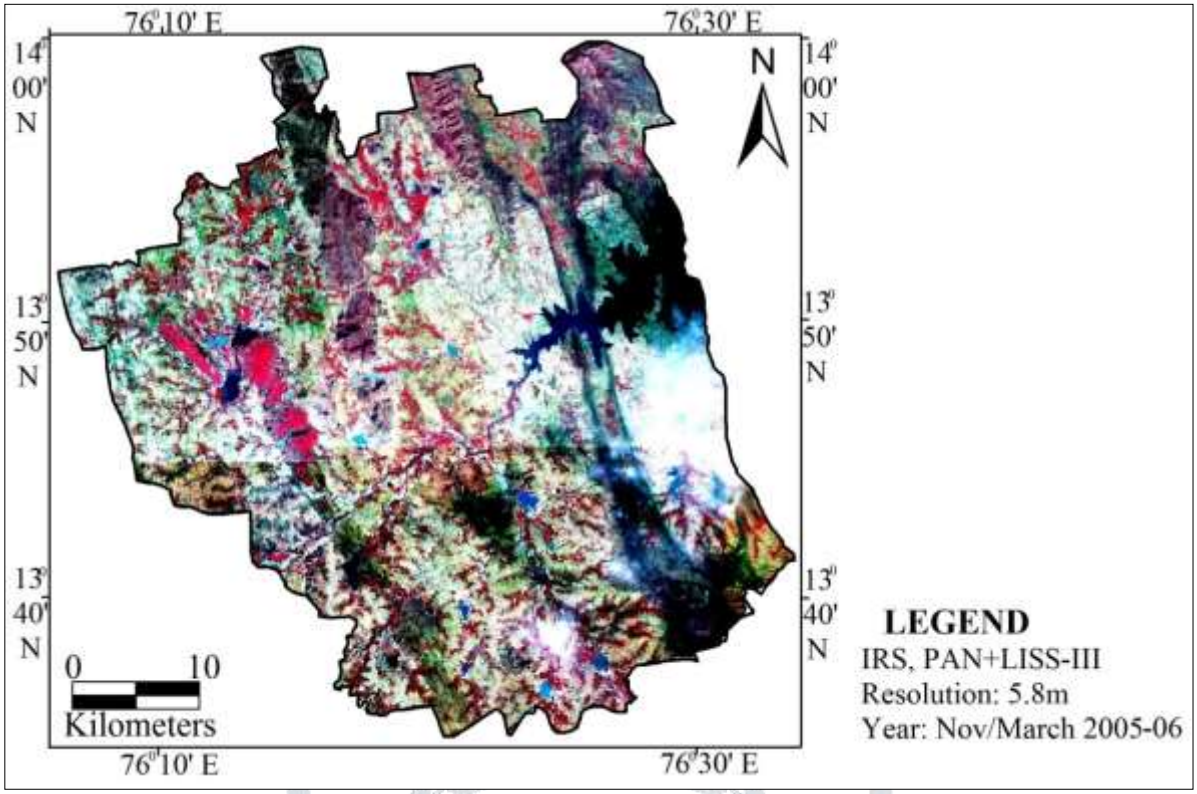

Fig.2. IRS-PAN+LISS-III Satellite image (B: 3,2,1) of the study area (2005-06)

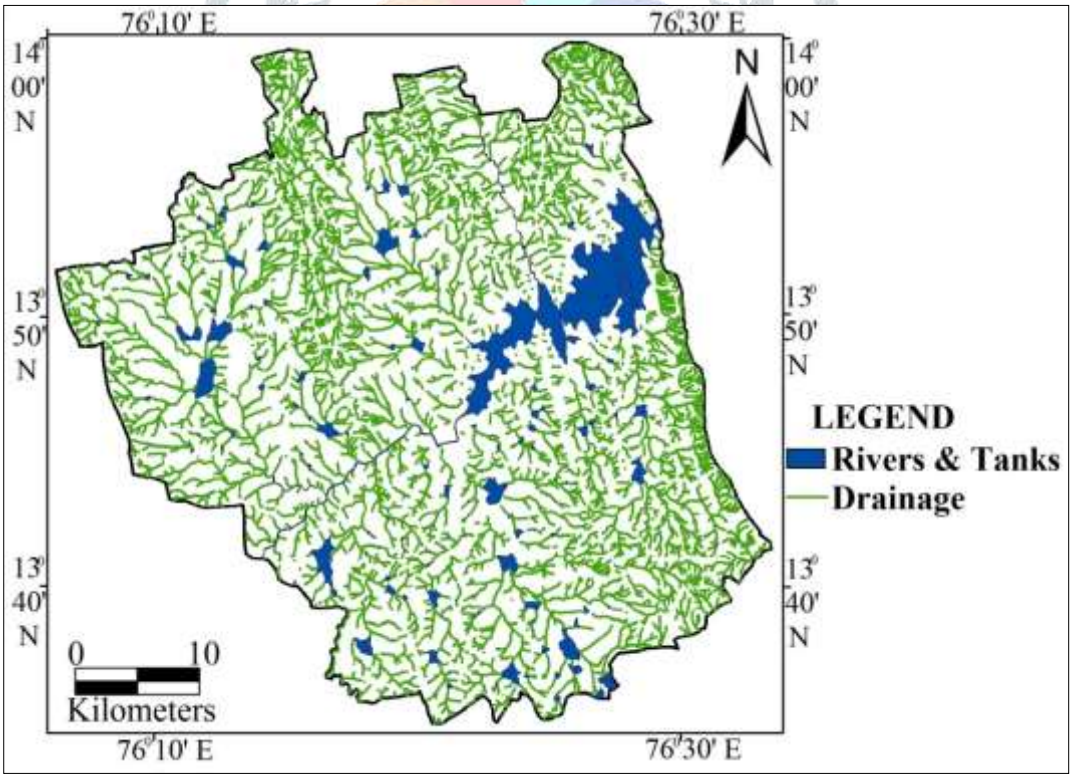

Fig.3. Rivers, Tanks and drainage map of the study area

5. FOREST COVER

It is an area predominantly consists of thick vegetation, medicinal plants & other large and huge number of vegetation types capable of producing timber and other forest products (Basavarajappa et al., 2014c; Saxena., 1993). The study area includes 5 State Reserved Forest namely, Devaragudda, Janakal, Lakkihalli, Marikanive and Kudrekanive with an approximately area of 201.62 Km^2 (1978) which were being degraded by several major and minor factors (Fig.4; 5; 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 southern and western parts (CGWB, 2013). These forest covers were crossed from SSE - NNW by a belt of intermittent parallel chains of high and low hills, through which several valleys were encountered.

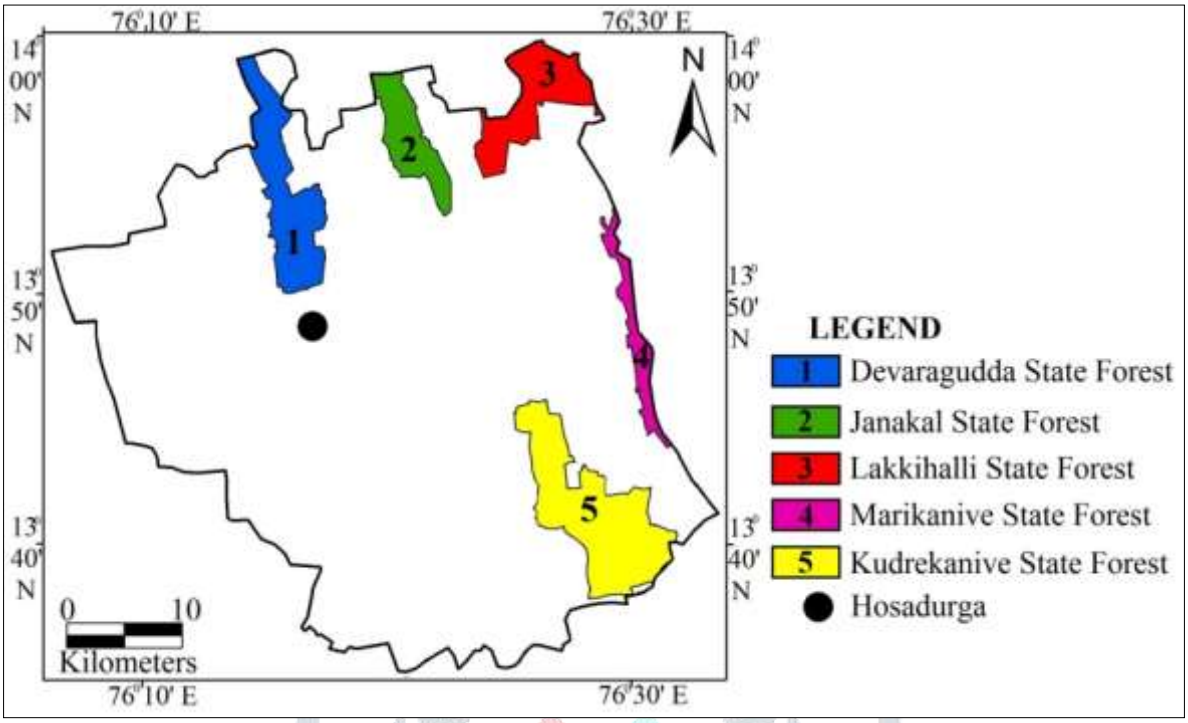

Fig.4. Reserved Forest map of the study area

5.1. FOREST PLANTATION

These are forest areas artificially planted with trees economic importance of forest resources. The common indigenous and exotic trees of forest plantations are teak, sal, deodar and others (Basavarajappa and Dinakar., 2005). Full grown plantations are normally difficult to differentiate from natural forests; however, new and young plantations can be readily separated from the contiguous forested areas. On Standard False Color Composite (FCC), it depicts light red to red tone (Dinakar., 2005). A huge mass of forest plantations were noticed on foot hills of almost all the major forest cover with elevations. These were noticed along the northern parts of Kanivesangenahalli, Galabenahalli, Mavinakatte; NE parts of Belaghatta; SE parts of Arenahalli and Bukkasagara villages.

5.2. DEGRADED FOREST

These are the lands located within notified reserved forest without scrub and may have less than 10% of crown density (NLULC, 2006). Forest degrades/ diminishes due to combination of several factors such as over extraction of timber; open mining; road building; encroachment of agricultural activities; expansion of urban areas; livestock grazing etc (CFD, 2013). These were well noticed along NE parts of Lingadevarahalli, Sannakittadahalli; SE parts of Kudrekanive fort, Gollarahalli, Doddabyladakere, Kanubenahalli and northern parts of Chinnapura and Janakal villages.

5.3. DECIDUOUS FOREST

It is described as a forest which predominantly comprises of deciduous species and where the trees shed their leaves once in a year. Type, crown density and composition of forest vegetation along with degradation stage help to analysis the deciduous forest vegetation under acceptable limits of accuracy (Pant et al., 1992). Multi-temporal data, particularly of October and March/April seasons help in their discrimination from other forest types (Basavarajappa et al., 2014c). On Standard False Color Composite (FCC), it represents dark red to red tone, mainly rich in timber trees like teak wood, rose wood, honne, bamboo, etc. These were noticed all along the medium relief of hill slopes occupy the NE parts of Kanubenahalli, Kasappanahally; SE parts of Kudrekanive fort and Grantapura villages. In moist and favorable localities, the lower canopy is well defined and tends to be patches of evergreen forests which were noticed in the valley of Marikanive and along water courses in Kudrekanive and Lakkihalli forests (CFD., 2012).

5.4. SCRUB FOREST

Scrub forest is associated with barren rocky/stony waste and scrub formed due to inadequate and erratic rainfall. The condition is drought and extreme heat in summer season precludes hardly any profitable forest (Manjunatha and Basavarajappa, 2017). These were encountered in northern parts of Galebenahalli, Devigere, Kallahalli, Mavinakatte, Doddaghatta, Sevanagara, Veeravvanaathiha; NE parts of Sannakittadahalli, Hanumanahalli; SE parts of Balenahalli, Hottugondanahalli, Bukkasagara, Mugilodu and Naganaikanakatte. On Standard False Color Composite (FCC), it represents light red to brown tone depending

upon the canopy cover (Dinakar., 2005).

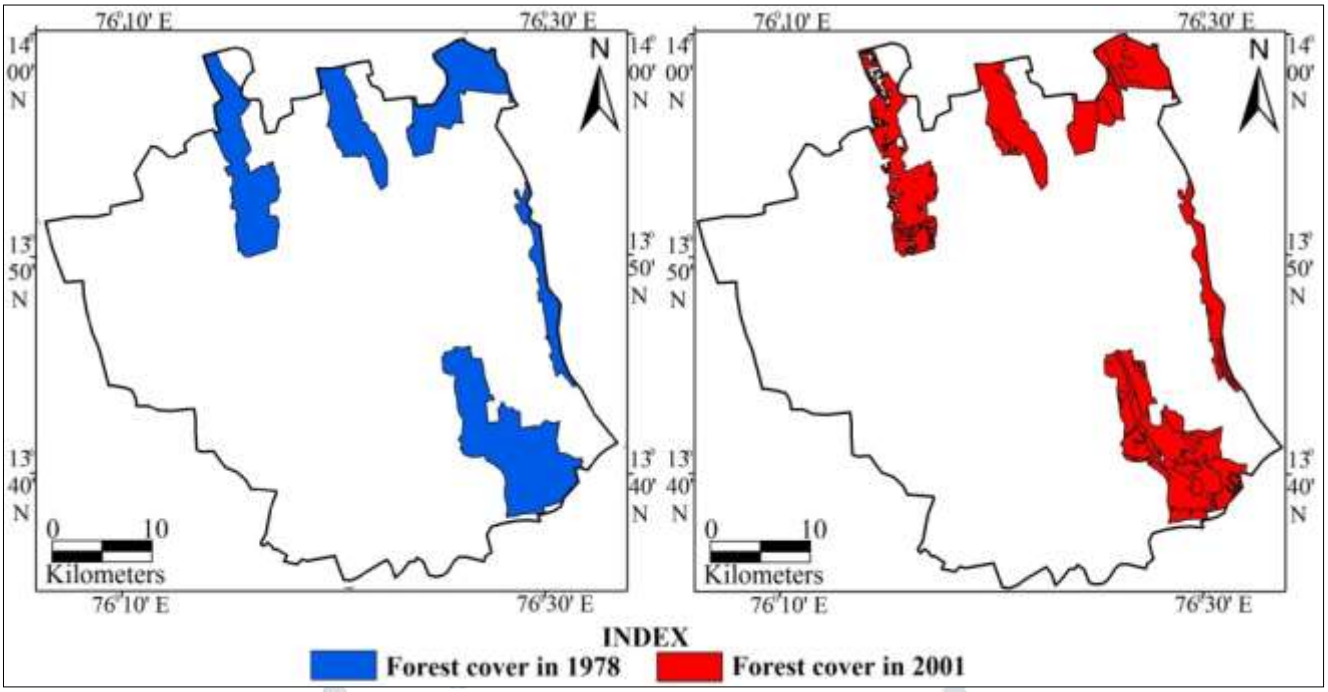

Fig.5. Temporal Mapping of Forest Covers during 1978 to 2001

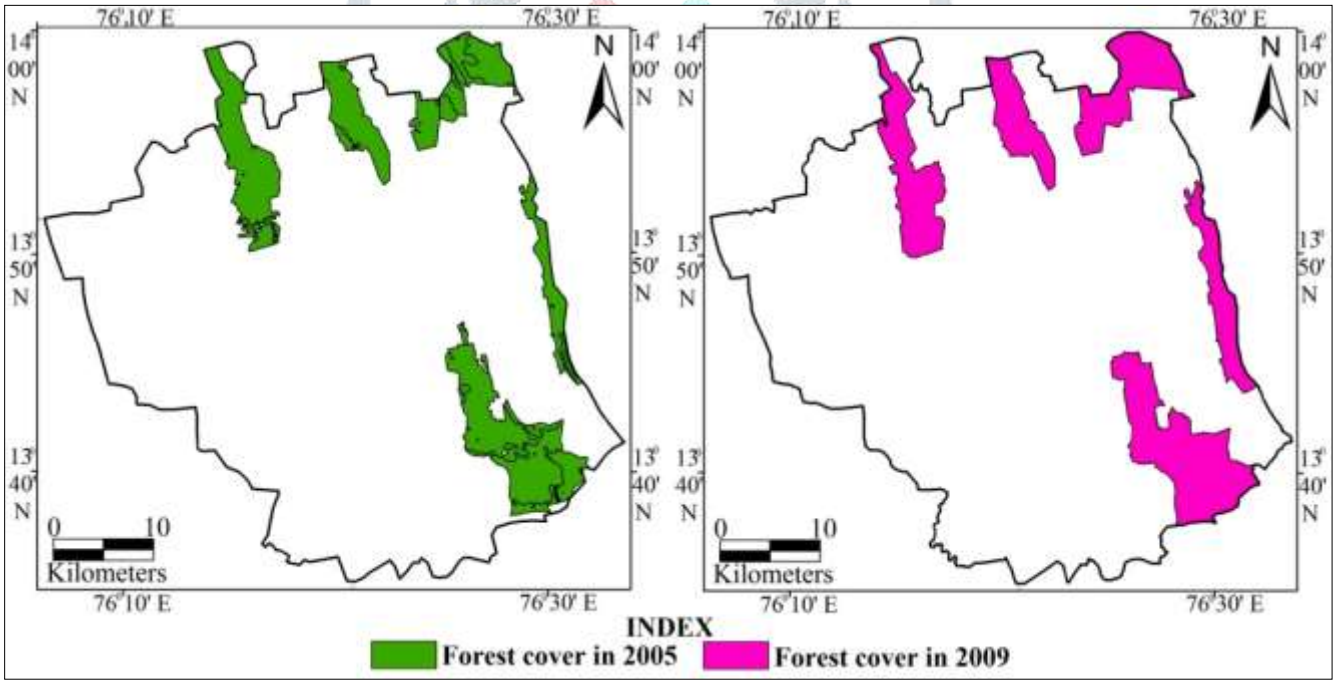

Fig.6. Temporal Mapping of Forest Covers during 2005 to 2009

Table.2. Temporal Mapping of Forest covers in Hosadurga taluk

Sl. No	Name of the Forest	Area -1978 (Km^2)	Area-2001 (Km^2)	Area-2005 (Km^2)	Area-2009 (Km^2)
1.	Devaragudda	47.8865	41.5481	45.5361	46.2669
2.	Janakal	26.1554	26.2623	25.3904	27.4310
3.	Lakkihalli	37.1078	36.8940	35.1282	42.6973
4.	Marikanive	16.4787	16.6803	17.9028	28.2581
5.	Kudrekanive	73.9954	72.2822	71.9224	74.4936
	Total	***201.6238***	***193.6669***	***195.8799***	***219.1469***

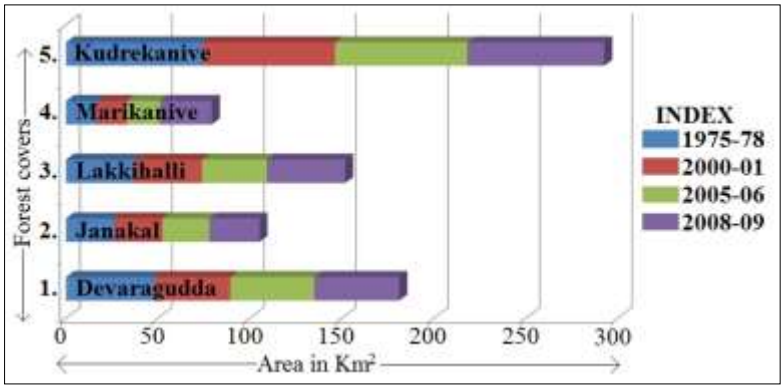

Fig.7. Bar chart representing the Temporal Mapping of Forest covers (Km^2)

6. ECONOMIC MINERAL DEPOSITS

Geologically, the study area confirms Archeans and Dharwars as basement complex (Radhakrishnan and Vaidyanadhan., 2011). Hosadurga taluk is well known for its metal ores such as ferruginous, manganiferous, limestone deposits and abound of many other metals & minerals (Fig.8). Discontinuous bands of ferruginous quartzites and magnetite rocks occur all along SSE-NNW directions on parallel chains of hills (CFD, 2012). Considerable float ore of manganese of low grade has been observed on taluk boundary of Kudrekanive Forest. Hematite quartzite and limonitic ore are found in association with manganiferous deposits in fairly large quantities (Ganesh Babu., 2013). Bands of limestone exist at various points in Chitradurga Schist Belt (CSB) in the vicinity of Marikanive. The study area is endowed with major proportions of iron, manganese and limestone which being illegally mined at the verge of forest vicinities (Manjunatha and Basavarajappa., 2017).

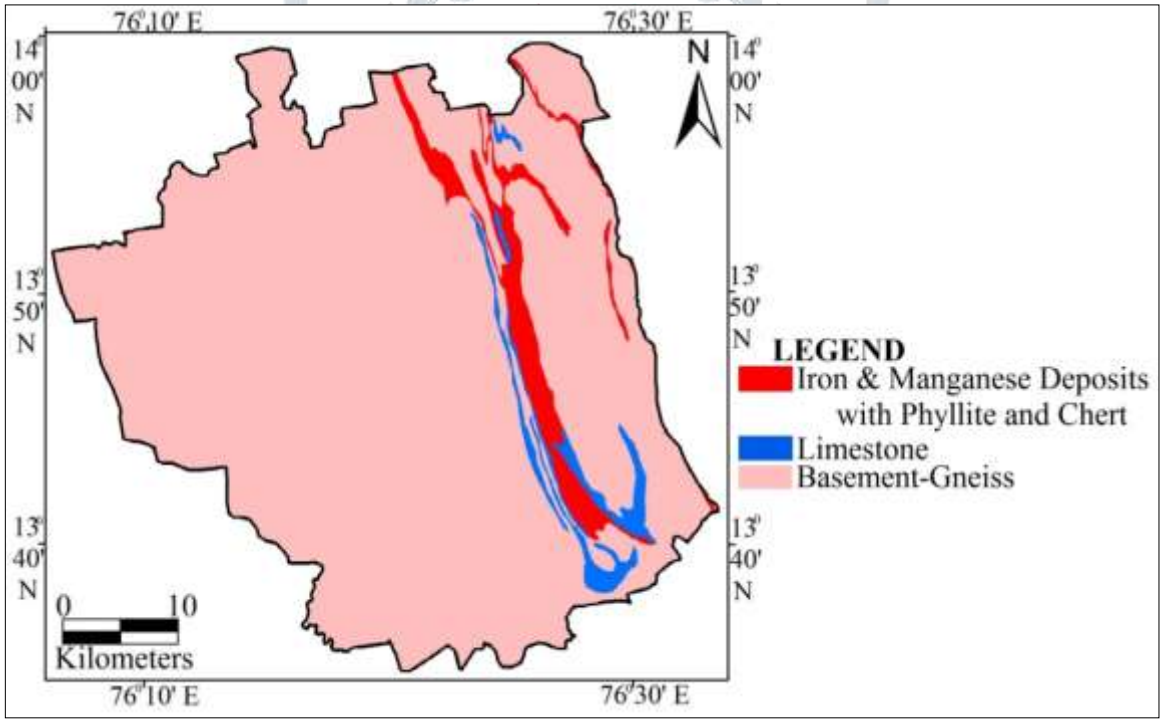

Fig.8. Mineral deposits map of the study area

7. CHANGE DETECTION ANALYSIS

Forest covers an area of 201.62 km^2 in 1975-78 has been degraded to 193.66 km^2 (2000-01) due to human intrusions at each forest boundaries by agricultural sprawl, installation of wind turbines and illegal mining activities (Fig.5 & 6). Major proportions of iron, manganese and limestone deposits were being mined rapidly and mine waste dump were noticed in eastern boundaries of Kudrekanive forest during 2001-06 (Basavarajappa and Manjunatha., 2015b; NRSA, 2007). Storage of mine waste materials, sliding of the dump outside the leased area, encroachment of forest area for dumping, mining pits, trenches, routes for wind turbine installation and other activities were gradually increasing the deforestation. Rapid increase in population increases the agricultural activities were identified near Kanivesangenahalli, Kallahalli villages of Devaragudda forest. Approximately 8 km^2 of the forest cover has been degraded 1975 to 2001 observed through Change Detection Analysis (CDA) (Fig.9; Table.3).

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

Sl. No	Forest covers	1978 to 2001	2001 to 2005	2005 to 2009
1.	Devaragudda	**-6.3384**	**+3.9880**	**+0.7308**
2.	Janakal	**+0.1069**	**-0.8719**	**+2.0406**
3.	Lakkihalli	**-0.2138**	**-1.7658**	**+7.5691**
4.	Marikanive	**+0.2016**	**+1.2225**	**+10.3553**
5.	Kudrekanive	**-1.7132**	**-0.3598**	**+2.5712**
	Total	***-7.9569***	***+2.2130***	***+23.2670***

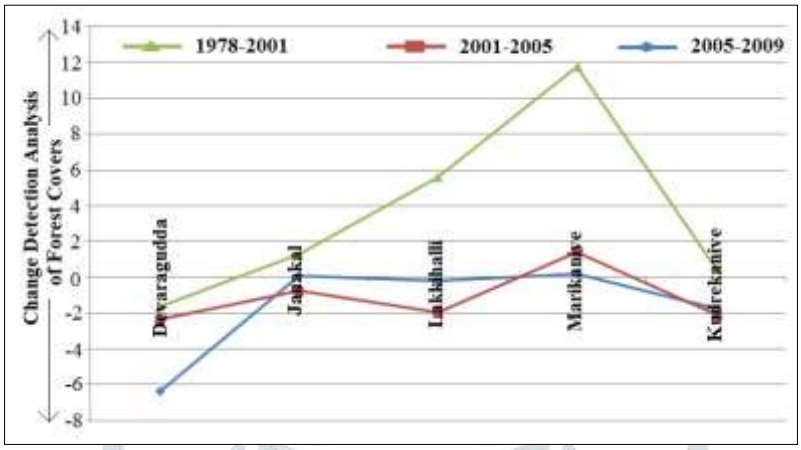

Fig.9. Line graph depicting the Change Detection Analysis (CDA) of Forest covers

8. RESULTS AND DISCUSSION

Reserved forest cover in the study area were distributed in fragmented blocks and include both natural forests and man-made forests (plantations) (Fig.4) (CFD., 2012). Degradation was recorded by the intensity of over-grazing, forest fires and other anthropogenic factors due to gradual increase in population (Manjunatha and Basavarajappa, 2017). Illicit cutting of trees were commonly observed by the vicinity of village peoples to fulfill their needs of fuel, small timbers for huts & houses and agricultural implementations (CFD., 2013). Over-grazing was observed by the large population of cattle, goat & sheep in the forest premises which affecting the natural regeneration status causing deterioration of wild life habitat (CFD., 2013). Number of gully plugs, check dams and percolation trenches are visible and seem to have far greater impact on moisture and soil conservation in the valleys of Kudrekanive and marikanive forests (CFD., 2013).

8.1. RECLAMATION STRATEGIES

Karnataka Forest Department Authority came up with many regeneration programs along with local village peoples to retain the forest resources during recent years (Manjunatha and Basavarajappa., 2017). In freshly leased forest and illegal mining lands were demarcated and maintained to enlarge the forest covers in the study area. A better natural growth of sandal has been observed in and around Devaragudda forest (CFD., 2013). Regeneration has been assisted through artificial mode by sowing of seeds of sandal in bushes and also by areal sowing (CFD, 2013). Large areal extent of encroachments of agricultural activities and mining lands has been evicted and plantations have been raised. Rotational grazing, controlling fire hazards combined with rigid protection avoiding soil erosion and enriching moisture regime were practiced periodically by the Forest Department Authorities (CFD, 2013).

9. CONCLUSION

SoI topomap & IRS Satellite images were effectively utilized to bring out temporal changes of Forest covers through GIS software's. The entire forest land in the study area measures about 201.62 km^2 in 1975-78 has been degraded to 193.66 km^2 (2000-01) due to human intrusions through agricultural sprawl, installation of wind turbines, over-grazing, illicit cutting of trees, illegal mining activities and its waste dumping. Approximately 8 km^2 area of forest cover has been degraded during the year 2001 noticed through CDA, when compared to 1975. More than 24 km^2 area of forest cover has been restored and reclaimed through periodic implementation programs by Forest Authorities (2008-09). It is necessary to take up periodic re-surveys and demarcations in order to protect the forest ecosystems to prevent further encroachments in other similar forest land.

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