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Geospatial approach for Mapping of Dynamic LU/LC Classification in Piriyapatna Taluk, Karnataka, India

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Abstract: Earth's surface data are analysed for various domains of policy, designing and management goals. Over the last 3 centuries, rapid growth in population and economic boom have initiated fast changes on land cover and there's impact will accelerate in the future. These fast changes are superposed on long-term dynamics associated with climate variability. The present study aims to map and monitor the existing Land Use/ Land Cover (LU/LC) classification scientifically using geospatial tools in database generation, analyses and information extraction. There are totally different views within the classification method, and therefore the method itself tends to be subjective, even once an objective numerical approach is employed. Land use Land cover of Level-I, Level-II and Level-III LU/LC classifications are delineated through NRSC standards (2011) using both Digital Image Processing (DIP) and Visual Image Interpretation Techniques (VIIT) with limited Ground Truth Check (GTC). The results portray the geospatial capability in best and sustainable land cover designing of natural resources and its management.

Keywords: Geospatial technology; IRS-1D, LISS-III Image; LU/LC Classification; Piriyapatna taluk.

I. INTRODUCTION

Land uses are remarked as man's activities and therefore varied uses that are carried on land [26]. Land cover, on the opposite side are the biophysical attributes of the land that have an effects on ecosystem process [9;31]. Land covers are named after natural vegetation, water bodies, rock/soil, sand/ snow cover, wastelands resulted by land transformation and each LU/LC are closely connected & interchangeable [14]. Land use is influenced by economic, cultural, political, historical and land-tenure factors at multiple scales [6]. In the past few decades there is change in land use due to expansion of mining areas, construction of dams, industrialization and urbanization [6]. Viewing the Earth from space is now crucial to understand the influence of man's activities on his natural resources over time due to mining, industrialization and urbanization [6].

The temporal satellite data was acquired to map the detailed information of crop lands in kharif and rabi seasons, the realm below double crops (kharif & rabi seasons), fallow lands, different types of forest, degradation status, wasteland, water bodies [6,26]. shifting cultivation areas, selective logging are the internal changes occurs due to anthropogenic pressure on forest resources and environment loss of wildlife due to reduction in the forest & vegetation land modifies at landscape level [17,26], as an instantaneous process of socio-economic impacts, land use patterns with bio-geophysical patterns to predict areas most vulnerable to future deforestation and biodiversity loss [6].

Geospatial tool is one of the advent high-tech tools in analysing the causes, rates, magnitude, patterns, and trends in landscape changes at local scales [6]. These inputs forms the primary basis for studies on regional climatic variations, accounting changes in deforestation/ degradation, forest encroachment, evapo-transpiration and regional ecosystem mapping and monitoring [6].

II. METHODS AND MATERIALS

A. Study area

It lies in between $12^0$12' to $12^0$34' N latitude and $75^0$55' to $76^0$15' E longitude with an aerial extent of 815 km^2 [15] (Fig.1). The general elevation is 1307mts above MSL. The taluk is moist during the winter and rainy season with the mean temperature ranges from 16^0C to 34^0C. The average annual rainfall ranges from 700 to 810mm [10,15]. The land

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is obvious to undulating region, part southern maiden region with major Cauvery watercourse flowing in northwestern border in the taluk [2,29].

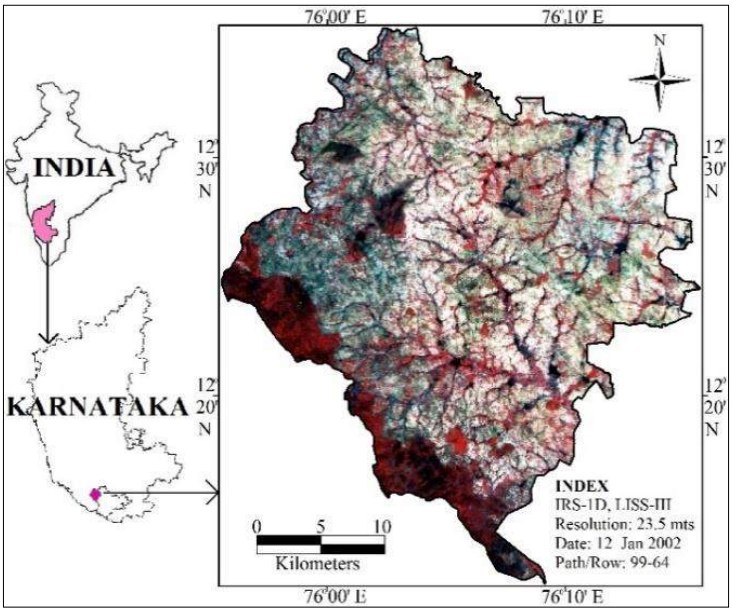

Fig.1. Location & LISS-III Satellite Image of Piriyapatna taluk

B. Methodology

LU/LC maps are processed through satellite data in conjunction with SoI topomaps on 1:50,000 scale by considering permanent features such as co-ordinates settlements, major roads, railways, drainages, power-lines and village boundaries [14]. On-screen manually extracted land features are overlaid on digitally extracted vector layers in portraying LULC level of classes [16]. Multi-temporal Resourcesat-1 of LISS III data of 2001-02 acquired during kharif (Aug –Nov), and rabi seasons (Jan- Mar) are acquired to estimate the spatial distribution variability of cropping pattern [20]. Preliminary analyzed LULC features from satellite data are updated by restricted field surveys & information and then final thematic details are overlaid on base maps [16].

C. Materials used

a. Base map: Survey of India toposheets of 48P/14; 48P/15; 57D/2; 57D/3, 57D/4 in 1:50,000 scale, Survey of India (SoI) Office, Govt. of India, Bengaluru.

b. Satellite Data: IRS-1D LISS-III of 23.5m Resolution and PAN of 5.8m (Nov-2001 & Jan-2002) (Fig.1), NRSA-ISRO, Hyderabad.

c. GIS software's: Erdas Imagine v2011 and Arc GIS v10 [16].

d. GPS: Garmin 12 is used to mark exact boundaries and to check the conditions of the land use/land cover patterns during field visits [16].

III. RESULTS AND DISCUSSION

A. Level-I LULC Classification Analysis

1. Agricultural land: These perform land productivity and land utilization practices over a period of time [20,24]. These covers farming, fallow, plantations, production of food, fiber and other commercial/ horticultural crops including land under crops (irrigated and un-irrigated) etc [16]. Major crops such as tobacco, ragi, paddy, maize, pulses, oilseeds & cereals, turmeric, vegetables & fruits, flowers, banana, coconut and areca nut plantation [12] grown in an area of 622.69 km^2 (76.68%) (Fig.2 & 3, Table.1).

2. Built-up land: These are the human habitation developed by non-agricultural use such as buildings, transport and communication, utilities in association with water, vegetation and vacant lands [20,24]. All human constructed structures without agricultural uses are enclosed within this category [7]. The total aerial extent of rural built-up land is 13.15 km^2 (1.61%) (Fig.2 & 3, Table.1).

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3. Forest: These are the land within the notified forest boundary bearing an association preponderantly of trees, different vegetation varieties, timber and various forest products [16]. Remote Sensing (RS) satellite data come in handy in mapping the various forest kinds and density categories with reliable accuracy through visual as well as digital analysis [13,14,30]. The taluk falls under semi-arid region of southern dry – agro-climatic zone (VI) which is a part of western ghats measuring an area of 107.42 km^2 (13.22%) (Fig.2 & 3, Table.1).

4. Water bodies: This class comprises areas of surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as streams, rivers, canals [11]. Collectively waterbodies are ascertained on standard FCC in various shades of blackish blue to light blue tone based on the water floor [8]. Cauvery is the main perennial watercourse flowing in the north-western regions of the taluk and fulfilling the canal irrigation system [12,15]. The area occupied by this category is 24.01 km^2 (2.95%) (Fig.2 & 3, Table.1).

5. Wastelands: Deteriorated area that may brought underneath vegetative cover with cheap effort. Presently, these are underutilized and deteriorating by lack of water and soil management or on account of natural effects [16,20]. Wastelands may end up from inherent/ obligatory disabilities like locations, atmosphere, chemical and physical properties of the soil/ financial/ management constraints [16,21,22]. The total aerial extent of wasteland covers about 15.76 km^2 noticed in central and northern parts of the taluk (1.94%) (Fig.2 & 3, Table.1).

6. Others: These are treated as miscellaneous by their nature of prevalence, physical look and different characteristics [7,16]. These are identified within the integrated thematic layer majorly noticed in southern and north-western parts covering an area of 28.16 km^2 (3.46%) (Fig.2 & 3, Table.1).

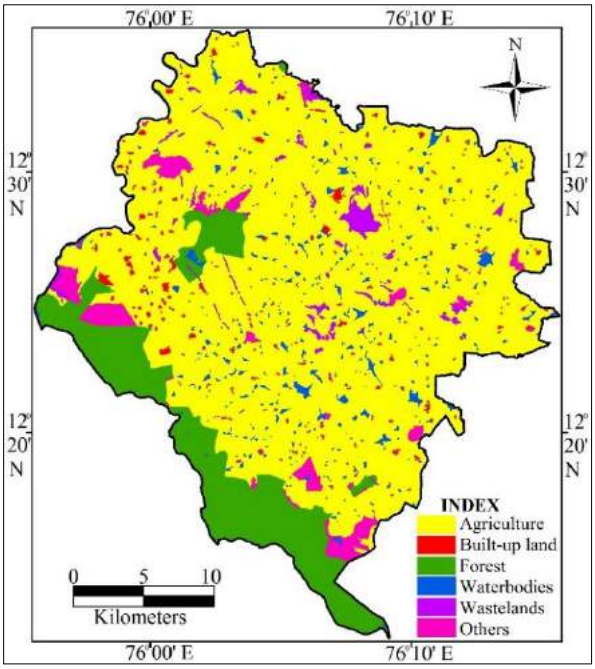

Fig.2. Level-I LU/LC Classified map of Piriyapatna taluk

Table.1. Level-I LU/LC Classification of Piriyapatna taluk

Sl No	Land patterns	Area (km^2)	Percentage (%)
1.	Agricultural land	622.69	*76.68*
2.	Built-up land	13.15	*1.61*
3.	Forest land	107.42	*13.22*
4.	Water bodies	24.01	*2.95*
5.	Wastelands	15.76	*1.94*
6.	Others	28.16	*3.46*
	Total	***811.19***	***99.86***
Total Geographical Area (TGA)		***812.06***	

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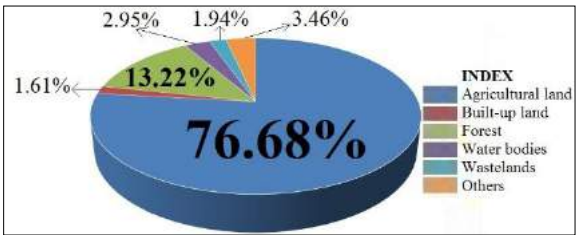

Fig.3. Pie-chart depicting Percentage of Level-I LU/LC categories of Piriyapatna taluk

B. Level-II LULC Classification Analysis

1. Agricultural plantations: These are the areas under agricultural tree crops exhibit a distributed or contiguous pattern planted adopting agricultural management techniques [20]. Use of temporal satellite data can change their separation in an exceedingly higher means which has agricultural plantations farming plantations and agro-horticultural plantations [16,20]. These croplands may kept aside from plantation is feasible by temporal information of harvesting time of inter-row crop/ flowering of the plantation crops [16]. The total area under this category is 22.41 km^2 (2.75%) (Fig.4 & 5, Table.2).

2. Barren rocky/Stony Waste: Rock exposures of varied lithology usually remain barren by direct action of sun and wind [8,11]. These lands are characterized by exposed huge rocks, sheet rocks, stony pavements or land with excessive surface, accumulation of stones that render them unsuitable for production of any inexperienced biomass [8]. Such lands may simply discriminated from various classes of degraded lands by their spectral responses [7,8]. These lands portray greenish blue to yellow tone to brownish and varied size related to steep isolated hillocks, hill slopes and worn plains [8]. Barren rocky land are observed as linear forms at intervals plain lands by varied lithology (gneiss) in northern and central regions of the taluk [16,20] measuring 3.37 km^2 (0.41%) (Fig.4 & 5, Table.2).

3. Crop lands: This category encompasses kharif, rabi and zaid croplands together with land underneath double or triple cropping activities [16,20] together with irrigated and un-irrigated, fallow, plantation [16,19]. The realm below crops are digitized supporting the standing crops as on the date of satellite data acquisition vectomization of each Kharif & Rabi seasons [14]. Cropped areas represented by bright red color with varied form and size in an exceedingly contiguous to non-contiguous category [16]. These may widely distributed in several terrains; conspicuously seem within the irrigated areas regardless of the supply of irrigation [16]. This category covers an area of 600.78 km^2 (73.98%) (Fig.4 & 5, Table.2).

4. Degraded forest: Forest cover with less than 10% are notified as degraded forest. The degradation is brought about by maltreatment meted out by repeated felling, grazing and forest fires [16]. On the other hand, these ultimately degrades into thorny, dry grass and naked boulders that expose on the surface [14]. These are notified in the south-western corner (part of Western ghats) of the taluk with an aerial extent of 9.02 km^2 (1.11%) (Fig.4 & 5, Table.2).

5. Fallow land: The lands that are preoccupied for cultivation however these are quickly allowed to rest, un-cropped for one or additional season, however not but one year [16,20]. These are notably devoid of crops at the time; when the imagery is taken from each seasons [14]. These are identified by yellow to blue color with irregular type with varied size associated with amidst crop land as harvested agriculture field [16]. The total area under this category is 0.03 km^2 identified in north eastern parts of Chikkamalali village (Fig.4 & 5, Table.2).

6. Forest plantations: Area of trees with species of forestry and its importance raised on notified forest lands [20]. These are unnaturally planted areas with tree lands, either within the open spaces or by clearing the present forests for economically inferior species [16]. New and young plantations can be readily separated from contiguous forested areas [16]. The area occupied by this class is about 1.69 km^2 (0.20%) near Muthakur village (Fig.4 & 5, Table.2).

7. Lakes/ Tanks: It is the natural course of water flowing openly on the land surface along a definite channel occupied either as seasonal or perennial river systems [7]. Rivers and tanks are the main water sources notified within the taluk [16]. 373 major and minor lakes/tanks have been extracted effectively from LISS-III image based on the color/ tonal variation from dark to light blue [28] covering an area of 21.34 km^2 (2.62%) (Fig.4 & 5, Table.2).

8. Land with scrub: Scrub lands are observed along the ridges, valley complex, linear ridges and steep slope areas [14]. Majority of these lands are Most of these units are distinguished by the existence of thorny scrub, herb species, many hillocks of steep and domal types that are linked to poor vegetation area [3]. This category covers an aerial extent of 11.97 km^2 (1.47%) noticed majorly in central, western and north-western parts of the taluk (Fig.4 & 5, Table.2).

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9. Mining/ Industrial wastelands: These are large-scale mining operations, mine dumps and discharge of enormous industrial wastes inflicting land degradation [14]. These are identified by dark grey to light bluish to black color on customary False Color Composite (FCC) image supported the color of the mine waste [5], irregular in form with dappled texture, placed at or close to active mining lands and industrial regions [16]. These are the dumps of industrial/ mining quarried raw wastes/ mixed trash exploited from earth's surface/ subsurface regions [5,20]. This category covers an area of 0.04 km^2 noticed near Gorahalli village (Fig.4 & 5, Table.2).

10. Moist & Dry Deciduous Forest: Moist deciduous forests are more pronounced in the regions which record rainfall between 100-200 cms with main species of Teak, sal, sandalwood and other [18]. Dry deciduous forest covers large areas wherever the precipitation measuring 70 -100 cms and interspersed with patches of grass [16]. Once the time of dry season begins, the trees shed their leaves utterly and therefore the forest looks like large piece of and with naked trees all around [16,18]. On FCC, it seems as thick red to red tone principally because of richness in timber trees like teak, eucalyptus plantations, bamboo etc [5,16]. Part of Doddaharve and Devamachi forests are the state reserved moist-dry deciduous forests identified in the southern-western part of the taluk through LISS-III satellite image. This category covers an area of 96.7 km^2 (11.9%) (Fig.4 & 5, Table.2).

11. River/ stream: Rivers/streams are natural course of water flowing on the land surface on an exact channel/slope often or intermittently towards an ocean in most cases or in to a lake [27]. Cauvery is the main perennial river flowing in the north-western parts of the taluk and later joins KRS reservoir in Mysuru taluk. These cover an area of 2.67 Km^2 (0.32%) (Fig.4 & 5, Table.2).

12. Salt-affected land: These are the lands that has excess salt in the soils with patchy growth of grasses [20]. These are found in river plains and in association with irrigated lands and adversely affecting the growth of most of the plants due to the action or presence of excess soluble or high exchangeable sodium. These are represented by white to light blue tone and its scenario [8]. Salt affected lands are observed near Manchedevana village with an extent of 0.23 km^2 (0.02%) (Fig.4 & 5, Table.2).

13. Sandy areas: Sandy areas are developed in situ or transported by Aeolian or fluvial processes [5]. These occur as a sandy plain in the form of sand dunes, beach sands and dune (windblown) sands. The area occupied by this category are observed as patches of sand bars along either sides of river Cauvery in western and northwestern boundary of the taluk. These are noticed along the villages of Sulekote, Chamarayanakote, Kanagal and Madapura measuring an area of 0.13 km^2 (0.01%) (Fig.4 & 5, Table.2).

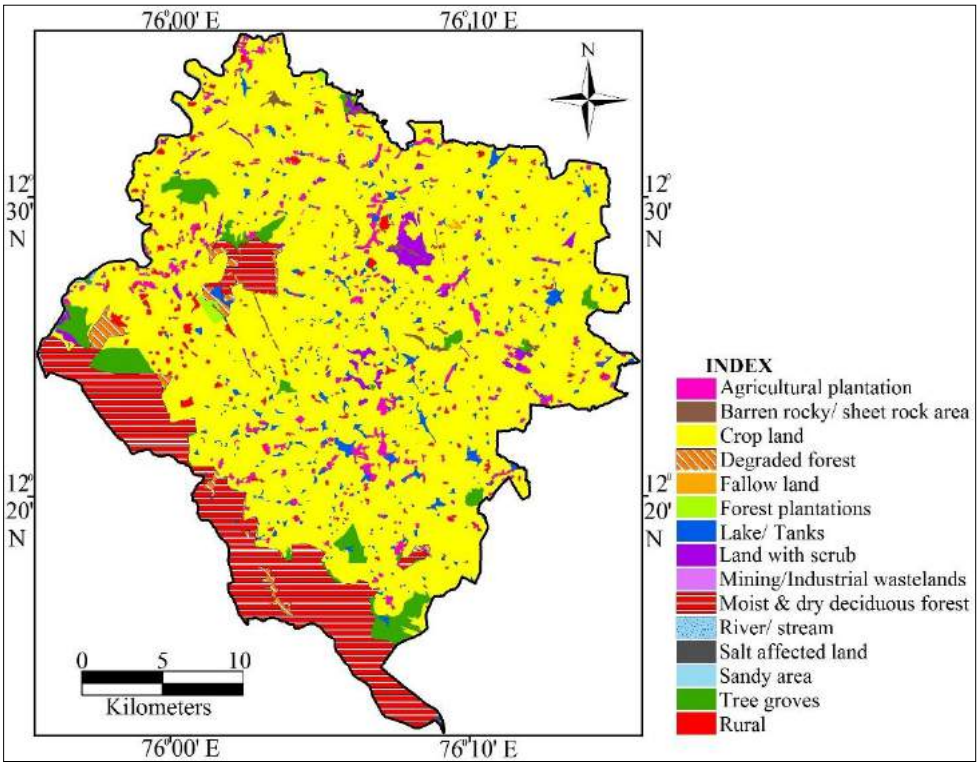

Fig.4. Level-II LU/LC Classified map of Piriyapatna taluk

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Table.2. Level-II LU/LC Classification of Piriyapatna taluk

Sl. No	Level-II Land patterns	Area (km^2)	Percentage (%)
1.	Agricultural Plantation	22.41	*2.75*
2.	Barren rocky / Sheet rock area	3.37	*0.41*
3.	Crop land	600.78	*73.98*
4.	Degraded forest	9.02	*1.11*
5.	Fallow land	0.03	*0.00*
6.	Forest Plantation	1.69	*0.20*
7.	Lake/ Tanks	21.34	*2.62*
8.	Land with scrub	11.97	*1.47*
9.	Mining/ Industrial wastelands	0.04	*0.00*
10.	Moist & Dry deciduous forest	96.70	*11.90*
11.	River/ Stream	2.67	*0.32*
12.	Salt affected land	0.23	*0.02*
13.	Sandy area	0.13	*0.01*
14.	Tree groves	27.35	*3.36*
15.	Rural	13.15	*1.61*
	Total	***810.88***	***99.76***
	TGA	***812.06***	

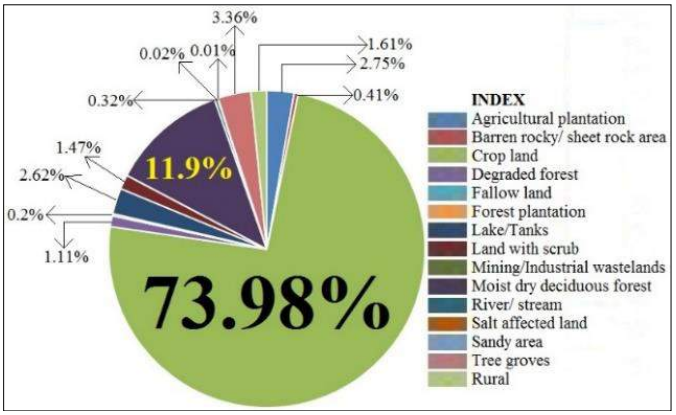

Fig.5. Pie-chart depicting Percentage of Level-II LU/LC categories of Piriyapatna taluk

14. Tree groves: These are clump of trees that doesn't have much undergrowth and occupies a contained area such as a small orchard planted for the cultivation of fruits or nuts [8]. A group of trees that grow close together are noticed extensively towards western, north-western and southern parts of the taluk, generally without many bushes or other plants underneath. This category covers an area of 27.35 km^2 (3.36%) (Fig.4 & 5, Table.2).

15. Rural (Villages): Land used for human settlement of size relatively but the urban settlement which covers 80% area units concerned in agricultural activities [16,23]. They can be seen in clusters non- contiguous or scattered [16,20]. Villages can be clearly noticed from satellite images with number of houses, inter spread with trees and agriculture fields especially in south western parts of the taluk [7]. The area occupied by this class is about 13.15 km^2 (1.61%) (Fig.4 & 5, Table.2).

C. Level-III LULC Classification Analysis

1. Double Cropped (Kharif + Rabi): Kharif is one of main cropping season in the country that starts from May and ends by September [8]. The intensity of kharif crops are incredibly high observed by their physical factors such as flatland, fertile soil and irrigated from canal system [8]. Most of the double crop areas are concentrated adjacent to the river Cauvery flowing in the study area [23]. These are represented by dark red color and square patterns depicting soil covers with higher quantity of wetness close to the streams on standard FCC image [7,16]. The cultivated lands at elevated zones represent bright red tone representing less quantity of wet and deeper levels of groundwater prospect zones [8]. This category has been identified and mapped using the two season satellite images which covers an area of 105.33 km^2 (12.97%) (Fig.6 & 7, Table.3).

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2. Kharif: These are the standing crops from June to September related with rainfed crops below dry land farming and restricted irrigation [1]. Kharif crops are identified and mapped by red tone on FCC data [8]. The major kharif crops grown are maize, jowar, bajra, cotton, sugarcane, pulses grown under rainfed condition, whereas paddy are grown under irrigated conditions [10]. Kharif land occupies an area of 495.45 km^2 (61.01%) (Fig.6 & 7, Table.3).

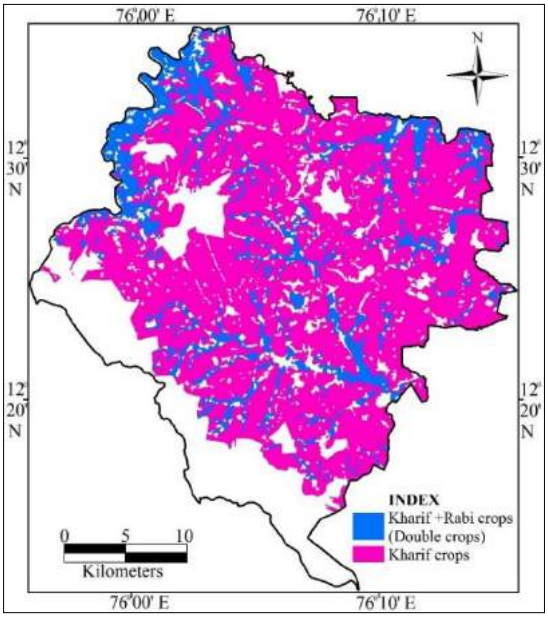

Fig.6. Level-III LU/LC Classified map of Piriyapatna taluk

Table.3. Level-III Land Use/Land Cover Classification of Piriyapatna taluk

Sl. No	Level-III Land patterns	Area (km^2)	Percentage (%)
1.	Kharif + Rabi (Double crops)	105.33	*12.97*
2.	Kharif crops	495.45	*61.01*
	Total	**600.78**	***73.98***
	TGA	***812.06***	

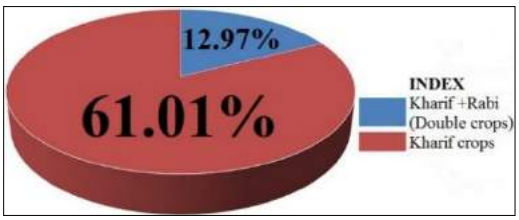

Fig.7. Pie-chart depicting Percentage of Level-III LU/LC categories of Piriyapatna taluk

IV. CONCLUSION

Accurate and appropriate analysis of LU/LC classes will be a successful tool in addressing earth's surface modifications, environmental & socio-economic considerations, increased demand for economic resources, risks connected to public health, cropping patterns, future food safety and law-making in land use designing & its policy. Geospatial tools yield big selection of digital databank info during a synoptic, spatial and temporal assessment in sustainable utilization of land use/land cover in cost-effective fashion. Thus this study highlights the capability of geospatial approach in extracting meaningful and valuable information which are extremely important in monitoring and management of dynamic LULC features.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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