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# Geospatial approach in Land Classification Analysis for Hunasuru Taluk of Karnataka State, India

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**Abstract:** Land identification and classification on a remotely sensed data play a major role in planning and designing of megastructures and proper land utilization in the present scenario. Rapid decrease in natural resources were recorded all over the world due to gradual increase in population, human forces, rapid industrialization, urban sprawl, illegal mining, global warming (?) etc. These causing greatest impact on surface & groundwater, forest, natural vegetation and also deterioration of bare land with more built-up and dumping of garbage. Fast increase in population demands for larger volume of food, fodder and fuel wood have compelled to massive scale environment degradation and ecological imbalance. Observing each land category is important, so as to know the dynamics of population and quality of life. Accurate land mapping can be an effective tool for better land developmental strategies to meet the needs of human demands. Land categories have been digitized from FCC data of IRS-1D PAN+LISS-III in GIS environment. Level-1, Level-2 and Level-3 land classifications were analyzed using NRSC guidelines (1995) in which the classification accuracy in terms of area statistics is found to be more precise in case of digital technique as compared to that of visual technique. The present study highlights the land classification mapping for natural resource management and monitoring to balance the future needs.

**Keywords:** Geospatial technology; Land Classification; LISS-III Image; Hunasuru taluk**.**

## I. INTRODUCTION

Land pattern of a region is the outcome of natural & socio-economic factors and their utilization by man in time and space (Basavarajappa et al., 2014b). Land pattern provides a plan of relative infiltration capacity of various land types and intercepts the surface flow of runoff water (Basavarajappa and Dinakar, 2005; Basavarajappa et al, 2016b). Land classification provides vital inputs required for socio-ecological concerns and optimal use of land resources for the developing countries like India (Sharma et al, 2018). Land classifications must undergo essential practices to keep up food security, to reduce deforestation, conservation of biological diversity, protection of natural land resources, enhancing the human occupation to the dynamic social, economic and natural environmental conditions (Basavarajappa et al., 2014b; Manjunatha et al, 2015). Multidisciplinary approach and research in identifying the specific land is very much needed for better utilization, maintenance of soil fertility and rehabilitation of degraded lands (Pushpavathi, 2010). Jacks (1946) reviewed land classification as it relates to the grouping of land keeping with their quality for manufacturing plants of economic importance (Basavarajappa et al, 2014b). In order to use land optimally, it is necessary to have firsthand information about the existing land patterns.

Indian Remote Sensing (IRS) has been extensively utilized for Satellite data acquisition to monitor the land resources and to evaluate land classification & its impact on natural resources (NRSA, 1995). Without a customary classification framework, it's troublesome to spot changes occurring over time, compare between places, and to avoid duplication of efforts (Manjunatha and Basavarajappa, 2020). Anderson classification system is the most widely used classification scheme today, consists of multiple levels of classification designed to be compatible with different levels of details as Level-I, Level-II and Level-III (Tammy and James, 2015). It is comprised of a graded grouping of 3 levels, allowing pertinence at multiple resolutions (Manjunatha and Basavarajappa, 2020). Land provides a better understanding on the cropping pattern and spatial distribution of fallow lands, forests, grazing lands, wastelands and surface water bodies, which is vital for developmental planning (Philip and Gupta, 1990). In modern times, satellite based remote sensing technology has been developed, which are of immense value for preparing land classification and their monitoring at regular periodic intervals of time (Kumar et al., 2004; Dinakar, 2005).

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## II. METHODOLOGY

**A. Study Area:** Hunasuru taluk is a part of southern transitional zone in Mysuru district covering an area of 895.17 km$^2$ with the elevation ranges from 680mts to 774mts above MSL. Hunsur is cool and moist during winter and rainy season and these taluks are located in the semi-malnad areas. Geologically, the area comprises of granites, gneisses and charnockite rock stratum. A fairly wide area of the district consists of charnokite series of rocks, particularly along the western border near Hangod in Hunasuru Taluk whereas dolerites are confined in large numbers towards western parts of Hunasuru. The catchment is primarily dominated by agricultural land and major part of the land is cropland, distributed vegetation and poor soil cover. The soil types are red sandy soil, red loamy soil and deep black soil of varying thickness upto 6 ft (Basavarajappa et al., 2014). Variation in rainfall leads to recurring drought and over usage of groundwater which characterizes the study area. Lakshman Theertha River which is a sub-basin of Cauvery river flows in the study area from south-westerly to north-easterly direction supplying the water for agricultural and irrigational activities.

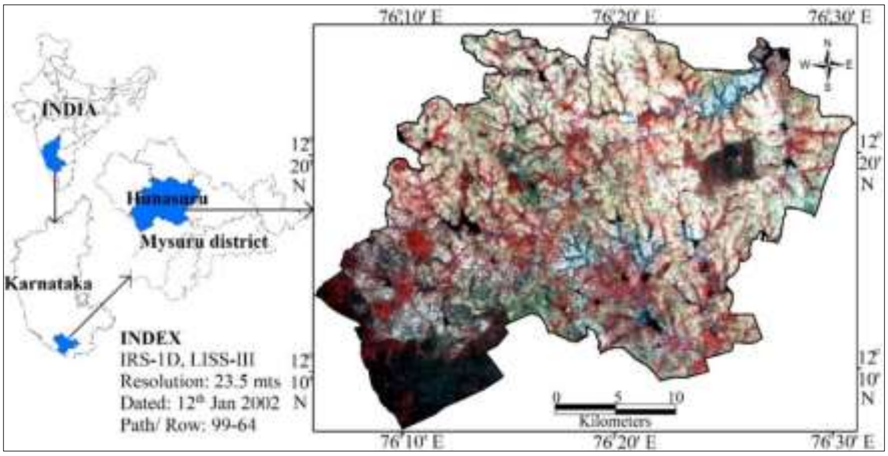


**Fig.1. Location and IRS-1D, LISS-III satellite image of Hunasuru taluk**

### *A.* Materials

**a. Topomaps:** SoI toposheets of 57D/3, 4, 7, 8, 11 in 1:50,000 scale, Survey of India office, Govt. of India, Bengaluru.
**b. Satellite Data:** IRS-1D LISS-III of 23.5m Resolution (Nov-2001 & Jan-2002) and PAN of 5.8m, Date of pass (Mar-2003), National Remote Sensing Agency (NRSA), Hyderabad.
**c. GIS software's:** Erdas Imagine v2011 and Arc GIS v10.
**d. GPS:** Garmin eTrex-10 of 3m accuracy is used during Ground Truth Check (GTC).

***B.* Methods:** Information on any land pattern is of utmost importance in hydrogeological investigation as the groundwater regime of a region is influenced by the type of land. Hence the satellite primarily based information extremely used in preparing the precise land category maps in an exceedingly very short period as compared to the conventional methods (Basavarajappa et al, 2014b). Digital interpretation and post classification comparison techniques are adopted to seek out the changes among numerous land uses over a period (Rubee and Thie, 1978; Likens and Maw, 1982; Priyakant et al., 2001; Basavarajappa et al, 2015). Land categories are described based on the image characteristics like tone, texture, shape, association, background, etc (Basavarajappa et al, 2016a). This helps in analyzing, mapping and grouping the specific data in generating thematic maps for development and management of natural resources (NRSA, 1995; Basavarajappa et al, 2016b). The level-1 classification consists of 5 major classes such as agricultural land, built-up land, forest, water bodies, wastelands and others (Basavarajappa et al, 2014b). These 5 major classes of level-1 are further divided into sub-categories of level-2; keeping the area under investigation (Basavarajappa et al, 2015). Level-3 classification has been done in detail on agricultural to study the cropping pattern.

## III. RESULTS AND ANALYSIS

### A. Level-I Classification

***i.* Agricultural land:** These are the land primarily used for farming, production of food, fiber, other commercial and horticultural crops. It includes land under crops (irrigated and unirrigated), fallow, plantations, etc covering an area of 736.36 km$^2$ (82.25%) (Fig.2; Table.1).

***ii.* Built-up land:** These are the land surfaces of man-made constructions due to non-agricultural use including buildings, transportation network, communication, industrial, commercial complexes, utilities and services in

 

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association with water, vegetation and vacant lands. Collectively, cities, towns and habitations are included under this category showing an area of 11.75 km$^2$ (1.31%) (Fig.2; Table.1).

***iii.*** **Forest:** It is an area bearing an association predominantly of trees, other vegetation types capable of producing timber and other forest products. Satellite data has become great tool in mapping the various forest varities and density categories with reliable accuracy through visual further as digital techniques (Madhavanunni, 1992; Roy et al., 1990; Sudhakar et al., 1992). Forest cover with 40% or more vegetation density (crown cover) is called dense or closed forest; while between 10-40% of vegetation density is called as scrub; whereas <10% is called as degraded forest. Forests exert influence on climate, water regime and provide shelter for wildlife and livestock (FAO, 1963). The area under this category is 87.4 km$^2$ (9.76%) (Fig.2; Table.1).

***iv.*** **Water bodies:** This class comprises areas of surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as streams, rivers, canal, etc. These are clearly observed on standard FCC in different shades of blackish blue to light blue color depending on the depth of water bodies. The area occupied by this category is 34.23 km$^2$ (3.82%) (Fig.2; Table.1).

***v.*** **Wastelands:** These are degraded lands which can be brought under vegetative cover with reasonable effort. These are currently underutilized and deteriorating due to lack of appropriate water & soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as locations, environment, chemical and physical properties of the soil/ financial/ management constraints (NWDB, 1987). The wasteland mapping is done using the Survey of India (SoI) toposheet on 1:50,000 scale and Satellite Remote Sensing data (NRSA, 1995). The total aerial extent of wasteland covers about 7.85 km$^2$ (0.87%) (Fig.2; Table.1).

***vi.*** **Others:** This can be treated as miscellaneous due to their nature of occurrence, physical appearance and other characteristics (Basavarajappa et al., 2017) in the integrated thematic layer noticed in western and central parts covering an area of 17.12 km$^2$ (1.91%) (Fig.2; Table.1).

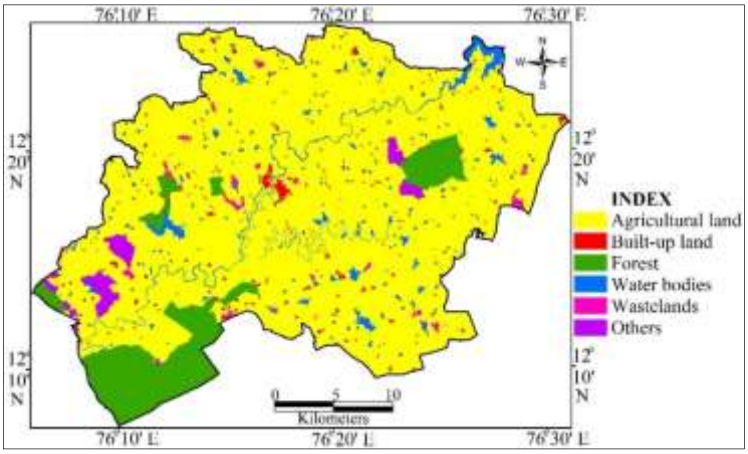


**Figure.2. Level-I Land Classified map of Hunasuru taluk**

**Table.1 Level-I Land Classification analysis of Hunasuru taluk**

| Sl No | Land patterns | Area (km$^2$) | *Percentage (%)* |
|---|---|---|---|
| 1. | Agricultural land | 736.36 | *82.25* |
| 2. | Built-up land | 11.75 | *1.31* |
| 3. | Forest land | 87.40 | *9.76* |
| 4. | Water bodies | 34.23 | *3.82* |
| 5. | Wastelands | 7.85 | *0.87* |
| 6. | Others | 17.12 | *1.91* |
| | **Total** | **894.75** | ***99.92*** |
| | **Total Geographical Area** | **895.17** | |

 

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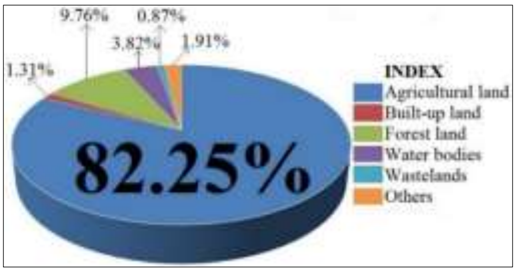


**Fig.3. Pie-chart depicting Percentage of Level-I LU/LC categories of Hunasuru taluk**

**B. Level-II Classification**

***i.*** **Agricultural plantations:** These are agricultural lands with tree plantation or fruit orchards other horticultural nurseries; planned by adopting certain agricultural management techniques. These plantations are undoubtedly considered to be lucrative as compared to agriculture crops; further no tedious maintenance is required for the plantation. Differentiation of plantation from cropland is possible by multi-temporal data of period matched harvesting time of inter-row crop/ flowering of the plantation crops. The total area under this category is 37.11 km$^2$ (4.14%) (Fig.4; Table.2).

***ii.*** **Barren rocky/Stony Waste:** These are the lands characterized by exposed massive rocks, sheet rocks, stony pavements or land with excessive surface, accumulation of stones that render them unsuitable for production of any green biomass. Such lands are easily discriminated from other categories of wastelands due to their characteristic spectral response. On FCC, they appears as greenish blue to yellow to brownish in tone with varying size associated with steep isolated hillocks, hill slopes and eroded plains. They occurs as a linear form within the plain land mainly due to varying lithology found in the villages of Boochahalli, Manuganahalli and Doddahunasuru villages. The area occupied by this category is 0.23 km$^2$ (0.02%) (Fig.4; Table.2).

***iii.*** **Crop land:** It includes those lands with standing crops as on the date of the satellite data acquisition. The crops may be either Kharif/ Rabi or double cropped. It includes land under crops (irrigated and unirrigated), fallow, plantation, etc (NRSA, 1989). The area under crops have been identified in both during Kharif (June to September) & Rabi seasons (October to February) and mapped. The land under double crop (land cultivated both during Kharif and Rabi seasons) have also been mapped and digitized. This category covers an area of 698.72 km$^2$ (78.05%) (Fig.4; Table.2).

***iv.*** **Degraded forest:** These are the lands of less than 10% cover which are notified as degraded forest. The degradation led to maltreatment meted out by continual felling, grazing and forest fires (Manjunatha et al., 2015). On the contrary, if further ravaged it, ultimately degrades into thorny type and ultimately dry grass prevails and naked boulders are exposed (Manjunatha et al., 2015a). These are notified near the villages of Kuppekolagatta, Jeenahalli, Gagenahalli, Penjahallikaval, Kurubarahosahalli, Haralahalli, Madahalli, Hyrige, Muthurayana Hosahalli, etc with an aerial extent of 14.53 km$^2$ (1.62%) (Fig.4; Table.2).

***v.*** **Fallow land:** The agricultural land which is taken up for cultivation but is temporarily allowed to rest, uncropped for one more season, but less than one year. These are particularly devoid of crops at the time; when the imagery is taken from both seasons. On FCC, fallow land shows yellow to greenish blue tone, irregular shape with varying size associated with amidst crop land as harvested agriculture field. Fallow lands are noticed near the villages of Kallaboochahalli, Kanagal, Doddakadanahalli etc. The total area under this category is 0.63 km$^2$ (0.07%) (Fig.4; Table.2).

***vi.*** **Forest plantation:** It is described as an area of trees with species of forestry and its importance raised on notified forest lands. These units are artificially planted areas with tree cover, either in the open spaces or by clearing the prevailing forests for economically inferior species (Manjunatha et al, 2015). The common indigenous and exotic trees of forest plantations are Teak, Sal etc. This category is observed in the eastern central parts and occupied by this class is about 12.02 km$^2$ (1.34%) (Fig.4; Table.2).

***vii.*** **Lakes/ Tanks:** Rivers and tanks are the major water sources in the taluk. 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 (Basavarajappa et al., 2017; 2019). These tanks have been extracted effectively from LISS-III image based on the

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color/ tonal variation from dark to light blue (Satish et al., 2008) covering an area of 20.43 km$^2$ (2.28%) (Fig.4; Table.2).

***viii.*** **Land with scrub:** Scrub lands are observed along the ridges, valley complex, linear ridges and steep slope areas. Most of these areas are characterized by the presence of thorny scrub, herb species, several hillocks of steep and domal formed area related to poor vegetal cover (Manjunatha et al, 2015). As a consequence, severe soil erosion frequently happens throughout rainy seasons and later most of the hill tops become barren/rocky (Basavarajappa et al, 2014b). Large patches are noticed in C.B Halli, Handanahalli, Hirikyathanahalli, Yamagumbha, Kothegala, Kallahalli, Adiganahalli, Ramenahalli, Hanagood, Haralahalli, Kurubarahosahalli, Varanchi, Kadavaddaragudi, Chowdikatte, Yalachanahalli, Kuppekolagatta, Jeenahalli with an aerial extent of 7.41 km$^2$ (0.82%) (Fig.4; Table.2).

***ix.*** **Mining/ Industrial wastelands:** These are the lands with large-scale mining operations, mine dumps and discharge of large scale industrial effluents causing land degradation. The features exhibit dark gray (coal mining areas) to light bluish to black (iron ore waste) tone on standard FCC based on the color of the mine dump, small to medium in size, irregular in shape with mottled texture, located at or near active mining areas and industrial complexes. Conspicuously around urban areas and alternative areas wherever industrial activity is outstanding (Manjunatha et al, 2015). This type of lands are observed in Chikkadanahalli and Tammadahalli villages in the study area. This category covers an area of 0.09 km$^2$ (0.03%) (Fig.4; Table.2).

***x.*** **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 (NCERT, 2019). Dry deciduous forest cover vast areas of the country, where rainfall ranges between 70 -100 cms and interspersed with patches of grass. As the dry season begins, the trees shed their leaves completely and the forest appears like vast grassland with naked trees all around (NCERT, 2019). Multi-temporal images, significantly throughout October and March/April seasons fecilitate in their discrimination from alternative forest varities (Manjunatha et al, 2015). On FCC, it seems redness to red tone mainly due to rich in timber trees (Basavarajappa et al, 2014b). These are confined to south-western regions and parts of central region (Karigala & Kalbetta forest) in the study area through LISS-III satellite image. This category covers an area of 60.83 km$^2$ (6.79%) (Fig.4; Table.2).

***xi.*** **River/ stream:** It is the natural course of water flowing openly on the land surface along a definite channel. The major parts of the study area are drained by river Cauvery and its tributary Lakshman Theertha flowing from south-westerly to north-easterly direction. The area occupied by river Cauvery is 13.80 km$^2$ (1.54%) (Fig.4; Table.2).

***xii.*** **Salt-affected land:** The areas are delineated based on white to light blue tone and its situation. These are found in river plains and in association with irrigated lands. These soils generally showing high intensity of erosion. These areas are adversely affecting the growth of most of the plants due to the action or presence of excess soluble or high exchangeable sodium. These are well observed near the villages of Sulekerekaval and Maranahalli. The area occupied by this category is 0.10 km$^2$ (0.01%) (Fig.4; Table.2).

***xiii.*** **Towns and Cities:** Land used for human settlement of population more than 5000 of which more than 80% of the work forces are involved in non-agricultural activities is termed as urban land use. Most of the land covered by building structures is parks, institutions, playgrounds and alternate open space within built up areas (Manjunatha et al, 2015). The major urban settlements are noticed in central part of the study area. Urban land occupies an area of 2.38 km$^2$ (0.26%) (Fig.4; Table.2).

***xiv.*** **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. A group of trees that grow close together are noticed extensively towards western and eastern parts of the study area, generally without many bushes or other plants underneath covering an area of 17 km$^2$ (1.89%) (Fig.4; Table.2). These are identified near the villages of Veeranahosahalli, Kallaboochahalli, Uthenahalli, Neralakuppe, Settahalli, H.Boreroppadakaval, Gowdikere, Hemmige, Muthurayana Hosahalli Kaval, Halepura and Arabbithittu vanyadhama.

***xv.*** **Villages (Rural):** Land used for human settlement of size comparatively less than the urban settlement of which more than 80% of people are involved in agricultural activities. These villages are interspread with trees and agriculture fields especially in southern and northern parts of study area occupied by thick lush green vegetation cover. The area occupied by this class is about 9.13 km$^2$ (1.01%) (Fig.4; Table.2).

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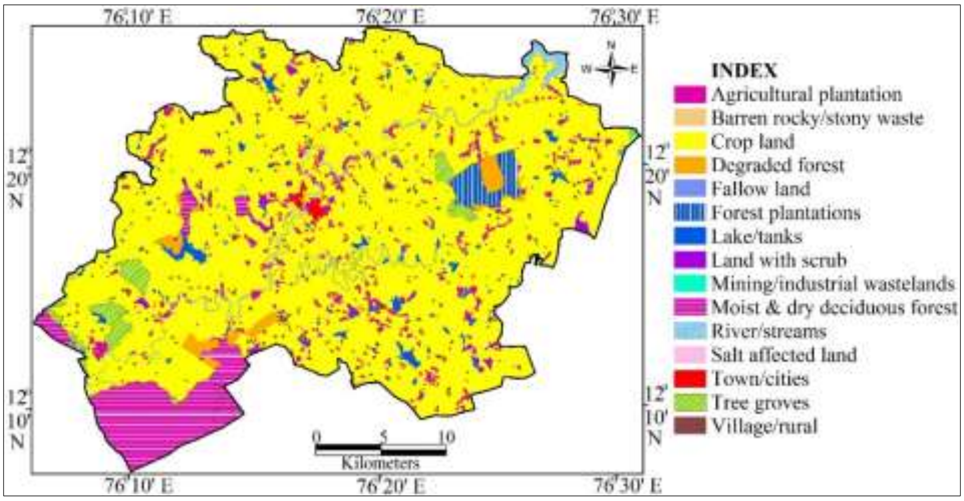


**Fig.4. Level-II Land Classified map of Hunasuru taluk**

**Table.2. Level-II Land Classification analysis of Hunasuru taluk**

| **Sl. No** | **Level-II Land patterns** | **Area (km²)** | ***Percentage (%)*** |
|---|---|---|---|
| 1. | Agricultural Plantation | 37.11 | *4.14* |
| 2. | Barren rocky / Sheet rock area | 0.23 | *0.02* |
| 3. | Crop land | 698.72 | *78.05* |
| 4. | Degraded forest | 14.53 | *1.62* |
| 5. | Fallow land | 0.63 | *0.07* |
| 6. | Forest plantations | 12.02 | *1.34* |
| 7. | Lake/ Tanks | 20.43 | *2.28* |
| 8. | Land with scrub | 7.41 | *0.82* |
| 9. | Mining/ industrial wastelands | 0.33 | *0.03* |
| 10. | Moist Dry deciduous forest | 60.83 | *6.79* |
| 11. | River/ Stream | 13.80 | *1.54* |
| 12. | Salt affected land | 0.10 | *0.01* |
| 13. | Town | 2.38 | *0.26* |
| 14. | Tree groves | 17.00 | *1.89* |
| 15. | Villages | 9.13 | *1.01* |
| | **Total** | **894.65** | ***99.87*** |
| | **Total Geographical Area** | **895.17** | |

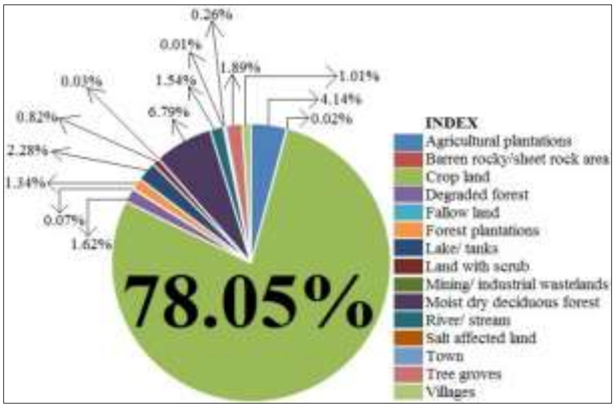


**Fig.5. Pie-chart depicting Percentage of Level-II LU/LC categories of Hunasuru taluk**

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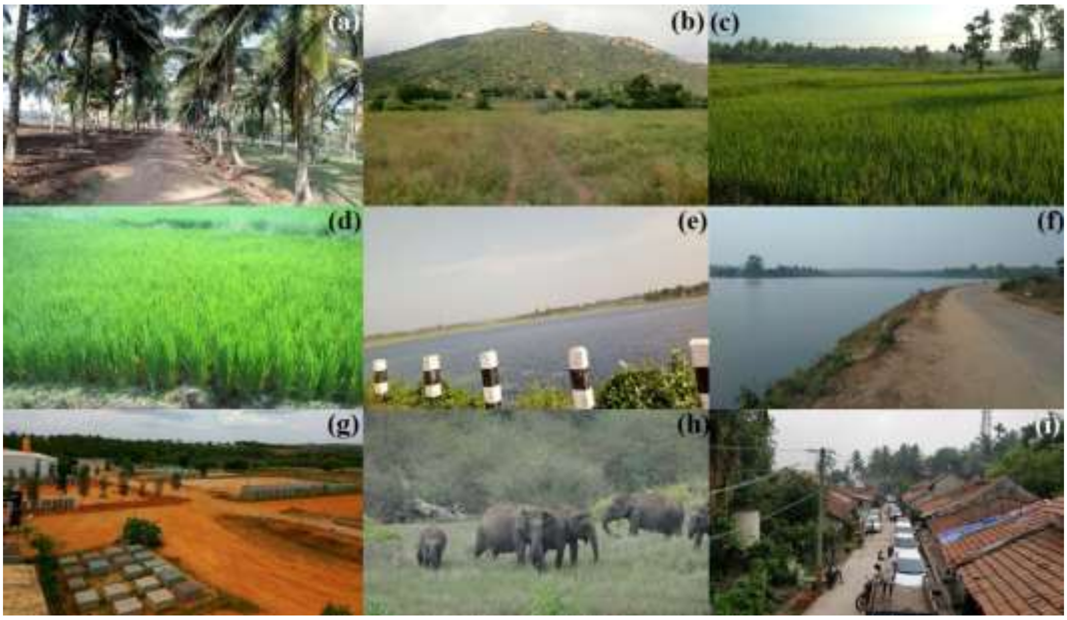


**Fig.6 (a) Agricultural plantations and (b) Scrub land in outskirts of Hunasuru (c) Crop land near Hundimala village and (d) Bhorae village (e) Devagalli village lake (f) Bilikere village lake (g) Industrial (Concrete) land in outskirts of Hunasuru (h) Forest land near Bharathavadi village (i) Aerial view of Katte Malalawadi village**

### C. Level-III Classification

***i.*** **Double Cropped (Kharif + Rabi):** This category has been identified and mapped using the two season satellite images. Most of the double crop areas are concentrated adjacent to the river Cauvery and Lakshman Theertha in the study area. The cropping intensity is incredibly high due to physical factors like flat terrain of land, fertile soil and irrigated from canal system (Manjunatha et al, 2015). On FCC, the double crop show red tone with square pattern representing soil covers with higher quantity of wetness on either sides of the streams (Basavarajappa et al, 2014b). The water table is found to be at shallow level, indicating the good groundwater prospects. Higher the growth of natural vegetation; higher will be the groundwater availability. The cultivated land at elevated zones show bright red tone generally representing the less amount of moisture and deeper levels of groundwater prospect indicates the moderate groundwater prospect zones. Intensive agriculture is seen in north, central and southern regions growing multiple crops in sequence on same land. The soils measures deep, provide good groundwater yield with maximum nutrient holding capacity (Basavarajappa et al, 2016b). This category covers an area of 269.12 km$^2$ (30.06%).

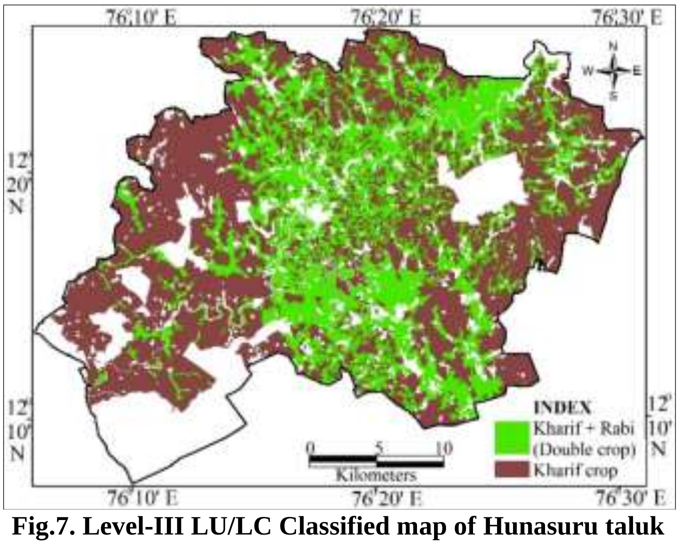


**Fig.7. Level-III LU/LC Classified map of Hunasuru taluk**

***ii.*** **Kharif:** Kharif includes standing crops from June to September in associated with rainfed crops under dry land farming and limited irrigation. Kharif crops include Jowar, Ragi, Horsegram and others in the study area. The prospect of Kharif crops primarily depends upon the regularity of monsoon to some extent on irrigation facilities (Basavarajappa et al, 2014b). The cultivated land of Kharif season on FCC shows bright red tone (Basavarajappa et al,

  

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2014b). The areas in single crop system with moderately deep to deep soil on nearly level to very gently sloping with good to moderate groundwater potential surface water resources or both can be put into intensive cropping system (Basavarajappa et al, 2014b). This land occupies an area of 429.59 km$^2$ (47.98%).

**Table.3. Level-III Land Classification of Hunasuru taluk**

| Sl. No | Level-III Land patterns | Area (km$^2$) | *Percentage (%)* |
|---|---|---|---|
| 1. | Kharif + Rabi (Double crops) | 269.12 | *30.06* |
| 2. | Kharif crops | 429.59 | *47.98* |
| | **Total** | **698.71** | ***78.04*** |
| | **Total Geographical Area** | **895.17** | |

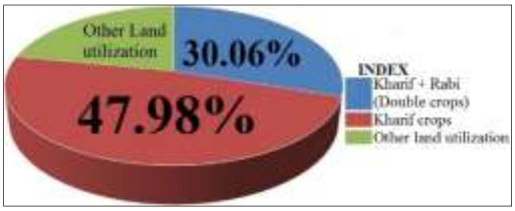


**Fig.8. Pie-chart depicting Percentage of Level-III LU/LC categories of Hunasuru taluk**

## IV. DISCUSSION

Land use systems need thorough systematic monitoring and management to keep up food security, to reduce deforestation, conservation of biological diversity and protection of natural resources (Basavarajappa et al, 2014b). Remotely sensed data has made it possible to study changes in land cover and its monitoring in less time, at low cost and better accuracy (Anji Reddy, 2001; Kachhwaha, 1985). The present study reveals that 5 major classes in Level-I (Fig.2; Table.1) 15 classes in Level-II (Fig.4; Table.2) and 2 classes in Level-III have been effectively generated by IRS-1D, PAN+LISS-III satellite images (Fig.7; Table.3). Rainfall dependent kharif crops occupy the maximum areal extent of 429.59 km$^2$ (47.98%), since the over-exploitation of groundwater is higher than 27% in the study area. Double crops are observed adjacent to the perennial rivers and in its drainage patterns which offer well developed canal system for irrigation purpose (Basavarajappa et al, 2014b). The area occupied by built-up land is 11.75 km$^2$ (1.31%) and further increase in population can negatively impacts on biodiversity, further groundwater exploitation and also disturbs natural land cover, increase in soil erosion into streams and lakes (Manjunatha et al, 2015a). Analysis shows the agricultural area mostly found in the entire taluk whereas forest covers with denudational hills are noticed in the central and western portions. Wastelands must be converted into cultivable land through massive programs of afforestation, plantation or pasture development to increase food security, fodder and fuel production. Land with and without scrub are often used for growing plants, which require fertile soil cover (Jay Krishna et al., 2011; Manjunatha and Basavarajappa, 2021). These plants are a source of fuel wood whereas some of them are of medicinal and economic importance. Currently, monitoring and mediating the adverse consequences of land modification whereas sustaining the production of essential resources has become a significant priority of researchers and policy makers around the world (Erle and Pontius, 2007).

## V. CONCLUSION

The study highlights the capability of geospatial technology in extracting meaningful and valuable information which is extremely important in monitoring and management of dynamic LULC features. Precise and timely interpretation of LULC classification data will be an effective tool in addressing the spatial changes, environmental & socio-economic concerns, growing demand in economic natural resources, risks related to public health, cropping patterns, vulnerability to certain management practices, future food security and decision making in land use planning & its policy. Satellite remote sensing integrated with GIS can play a useful role in effective land use planning and management. This would be useful to protect the fertile agricultural land in the region and further reduce environmental degradation in the form of soil erosion, water stress and pollution.

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