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Land Use Land Cover Change Detection on Kanchinegalur sub watershed using GIS and Remote Sensing Technique

Ajaybhaskar Reddy[1], Mohan Kumar[2], H. Hemanth Kumar[3], A. V. Shivapur[4]
[1]*Assistant Professor, REVA University, Bengaluru.*
[2] *Project Associate, KSCST, IISc campus, Bengaluru.*
[3] *Fellow & Principal Investigator - NRDMS & KSSDI, Karnataka State Council for Science & Technology (KSCST), Indian Institute of Science, Bangalore.*
[4]*Dean Faculty of Engineering, P.G. Coordinator, VTU, Belgavi.*

Abstract: ***Land use\Land cover is a vital component in understanding the interactions of the human activities with the environment and thus it is necessary to monitor and detect changes for the maintenance of sustainable environment. Land use Land cover change analysis is executed as part of current study on Kanchinegalur sub-watershed of Dharma Watershed, Hangal Taluk, Haveri District. Remote Sensing and GIS Technologies are incorporated in the study. Classification based on Land Use Land cover is performed over the temporal resolution from 2003 to 2015 using Survey of India (SOI) toposheets, LANDSAT-7 (2003 & 2015) and IRS-P6-LISS-III (2012) dataset. Maximum Likelihood method is used in supervised classification algorithm of image classification technique. Thematic maps are prepared using GIS software. Ground truth observations are used to validate the result of classification. Environmental impact assessment is essentially based on the efficient modelling and projection of land cover change. Exploitation of natural resources is increasing with the urban sprawl and has modified the pattern of land use and land cover. Rapid urbanization has led to reduction of natural resources such as forest land, water bodies and arable land. Government of India (GOI) collaborated with Government of Karnataka (GOK) to undertake the project Integrated Watershed Management, for improvising the agricultural land, arable land, forest land and to work on provision of better living condition for the people settled in the watershed. Current study is presenting the positive impact of work carried out as part of the project Integrated Watershed Management in Kanchinegalur sub-watershed of Dharma Watershed, Hangal Taluk, Haveri District, based on Land Use Land cover change detection study.***

Keywords: Land use Land cover, Change detection, GIS and Remote Sensing Technique, LULC study

I. INTRODUCTION

Watershed as a planning unit has been in practice since long. Watershed and Catchments have been recognized as important planning units for administrative purpose to preserve the precious worthwhile resources. Land use pattern has a robust effect on the hydrological characteristics and soil erosion parameters. The origination of watershed administration recognizes the connections between water, soil and Land use, and the linkage in the middle of uplands and downstream territories. The hypothesis of watershed has been in India for long; however, it gained importance since 1974 when the ministry of agriculture, Government of India (GOI) started the projects on soil and water preservation, draught alleviation, dry farming, flood control, hill area development, etc. This conception has gained impetus since then and hence, watersheds are being considered as the basis to prepare a characteristic assets database for successful arranging and practical advancement of area and water assets.

Micro-watershed advancement includes improvement of area and water assets, change in the financial status of individuals and ideal asset utilization, and sustainable development of resources. The principle centre of development strategy is to minimize the danger to the agriculture and to give them area-specific technological packages, inputs and administrations to the farmers. Hence the importance should be given to the small area improvement taking micro-watershed as a unit of advancement.

The advancement measures embraced in the micro-watersheds incorporating soil and dampness preservation, area forming, bunding, development of water collecting structures, ground water recharge structures and drainage line treatment structures.

Watershed development at micro-level helps in conservation of soil moisture. In rain-fed areas, development of water storage structures provides lifesaving irrigation during moisture stress. It helps in raising the water table to secure and to improve drinking water sources and to give defensive watering system.

Micro-watershed wise implementation provides good scope for quick post implementation assessments viz., ground water improvement, economic status, cropland, vegetation status, etc. and to plan or change the developmental strategies

Geographical information systems (GIS) and remote sensing are well-established information technologies, the value of which for applications in land and natural resources management are now widely recognized. Current technologies such as geographical information systems (GIS) and remote sensing provide a cost effective and accurate alternative to understand landscape dynamics. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated an enormous potential to understand landscape dynamics- detect, identify, map, and monitor differences in land use and land cover patterns over time.

Recent improvements in satellite image quality and availability have made it possible to perform image analysis at much larger scale than in the past.

A. Integrated Watershed Management Programme:

In view of the Common Guidelines, 2008, the Government of India (GOI) has authorized another plan - the Integrated Watershed Management Program (IWMP) that is operational in all the areas in Karnataka. Money related backing is given by the Ministry of Rural Development, GOI and Government of Karnataka (GOK). Amid 2009-10 the IWMP is being actualized in 119 tasks in 27 areas with a treatable region of 4.91 lakh ha. In 2010-11, 127 tasks were actualized in 29 areas with a treatable range of more or less 5.46 lakh ha. The tasks are executed more than a five-year period.

The major objectives of the IWMP are:

1) Increase the productive potential of degraded lands through various interventions
2) Improve the biomass through Agro-horticulture, Agro-forestry.
3) Income Generating Activities(IGA) support to the asset-less, small land holders and other vulnerable category
4) Support the livestock sector and demonstrations in agriculture related sectors
5) Improved production systems and micro enterprises

B. Land Cover Land Use change detection:

Land cover Land use change is impacted by a variety of activities working on a few spatial and temporal levels, and acting in mind boggling networks of place and time-particular connections, at the level of an individual area unit. In this study, a sub-watershed of Dharma watershed is selected in which the watersheds are treated according to the Integrated Watershed Management Planning (IWMP) project jointly undertook by Government of Karnataka (GOK) & Government of India (GOI) to improve the crop yield and land fertility of the study area. land cover Land use change detection is done to the kanchinegalur sub watershed of Dharma watershed for the year 2003, 2012 & 2015 to check the efficiency of work done on treated watershed, using LANDSAT-7 & LISS III satellite images with the use of Geographical Information System & Remote Sensing technology, and compare the results of treated and untreated watershed characteristics i.e., the results of the year 2003, results of 2012 and the results of the year 2015 of the sub watershed.

II. METHODOLOGY

A. Materials and Methodology:

Analysis of temporal changes in Land use Land cover is carried out by obtaining satellite imagery of three different time periods are that are represented in Table 1. Landsat 7 ETM+ imagery of 2003 and 2015 are downloaded from USGS site (NASA) of row-50, path-146 and having 30 m spatial resolution and 9 spectral bands. This dataset is pre-processed for removal of scan-line errors. Resource SAT-1 LISS III imagery of 2012 is downloaded from BHUVAN (ISRO)

TABLE 1 Data Source of Satellite Imagery

Space craft ID	Sensor ID	Row	Path	Resolution	Number of bands	Date of pass
Landsat-7	ETM+	50	146	30meters	9	02-2003
ResourceSAT-1 (IRS P6)	LISS - III	62	97	23.5 meters	4	02-2012
Landsat-7	ETM+	50	146	30meters	9	02-2015

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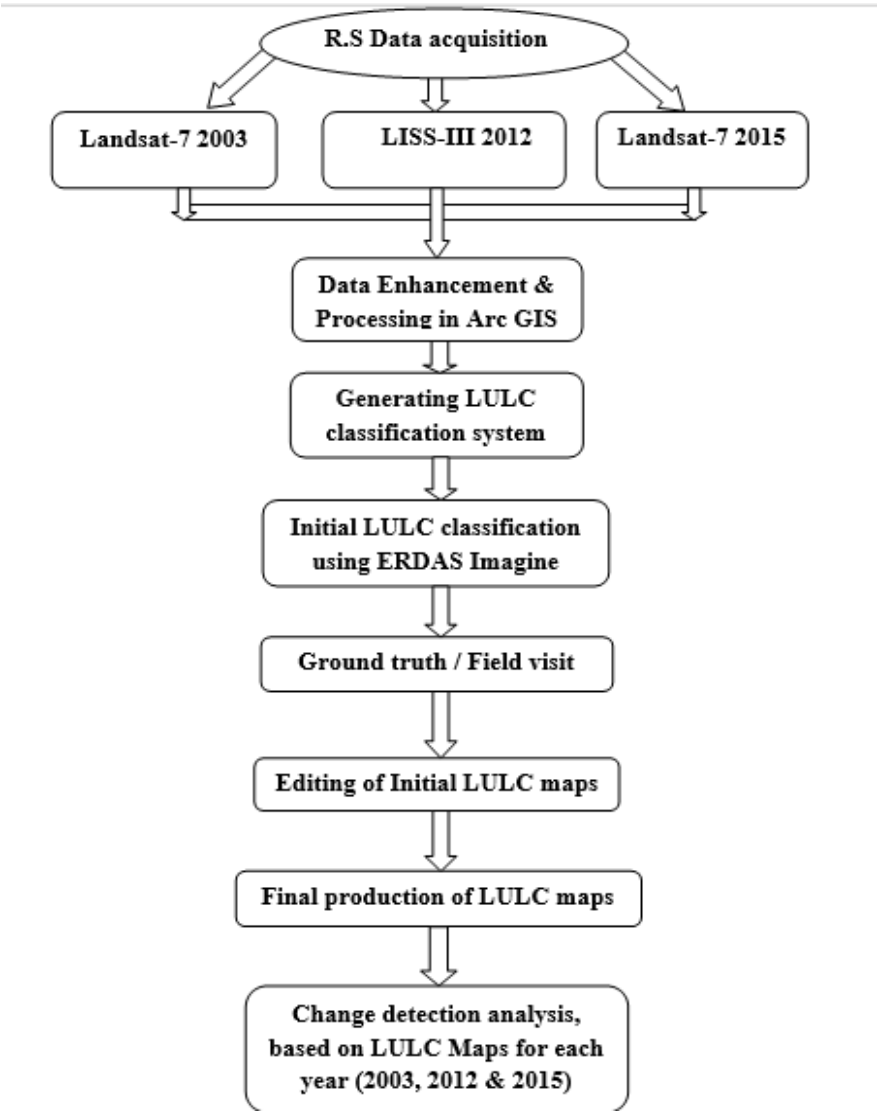

Fig. 1: Flow chart of Land Use Land Cover Change Detection

B. Software used:

ArcGIS V and ERDAS IMAGINE V are utilized for pre-processing of downloaded satellite imagery and for visualization of spatial and remote sensing analysis. Pixel-based classification is performed on satellite imagery, known as Supervised classification by defining training sites for each class. Each class is identified by unique spectral signature. Maximum Likelihood algorithm is considered for Supervised classification in ERDAS IMAGINE V.

Classes are identified based on the classification scheme approved by National Remote Sensing Center (NRSC). Supervised classification process is performed on 2003, 2012 and 2015 imagery and identified six land use land cover classes namely,

1) Irrigated, 2) Rainfed, 3) Water bodies, 4) Agro-Forestry/Horticulture, 5) Settlements, and 6) Cultivable wasteland.

Ground truth information is collected by field visit of 150 sites in Kanchinegalur sub-watershed region on April 2015, to validate the Supervised classification in the form of Accuracy assessment for 2012 and 2015 Land Use/Land Cover maps

C. Development of a Classification Scheme:

In view of the earlier learning of the study territory a brief surveillance review with extra data from past examination in the study zone, a characterization plan is produced for the study zone. An expansive characterization where the land use land cover is distinguished by a solitary digit.

The following classification scheme was used to check the change detection in the study area.

TABLE II Land use land cover classification scheme

Code	Land Use/Land Cover Categories
1	Irrigated
2	Rainfed
3	Water Bodies
4	Agro – Forestry/ Horticulture
5	Settlements
6	Cultivable Wasteland

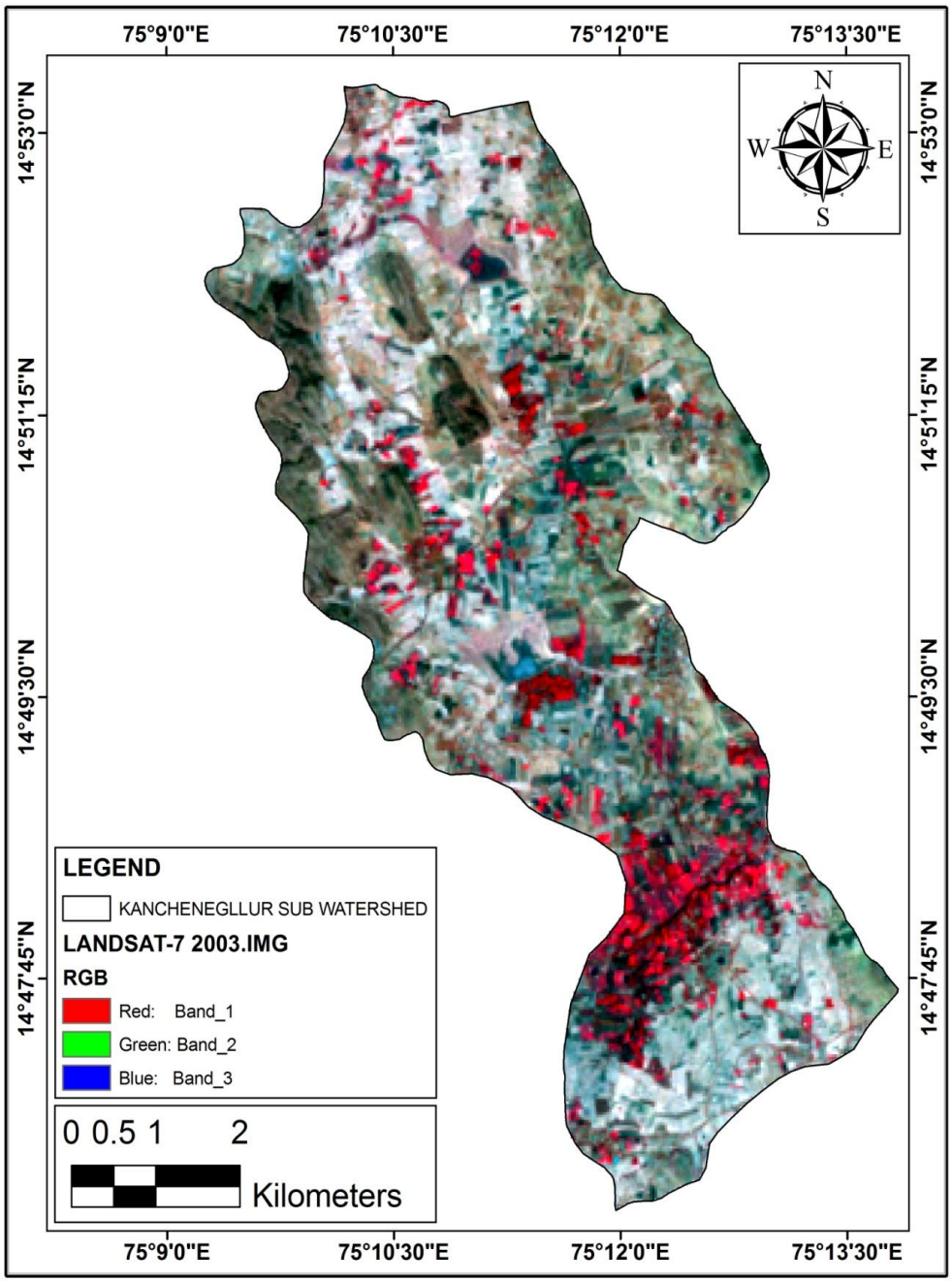

Fig. 2: Kanchinegalur sub watershed LANDSAT – 7 Imagery, year 2003

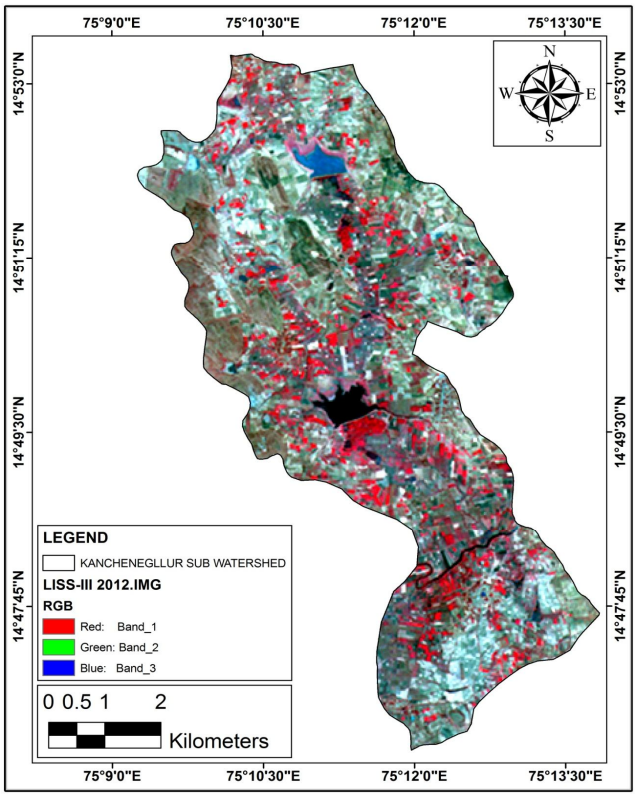

Fig. 3: Kanchinegalur sub watershed LISS – III Imagery, year 2012

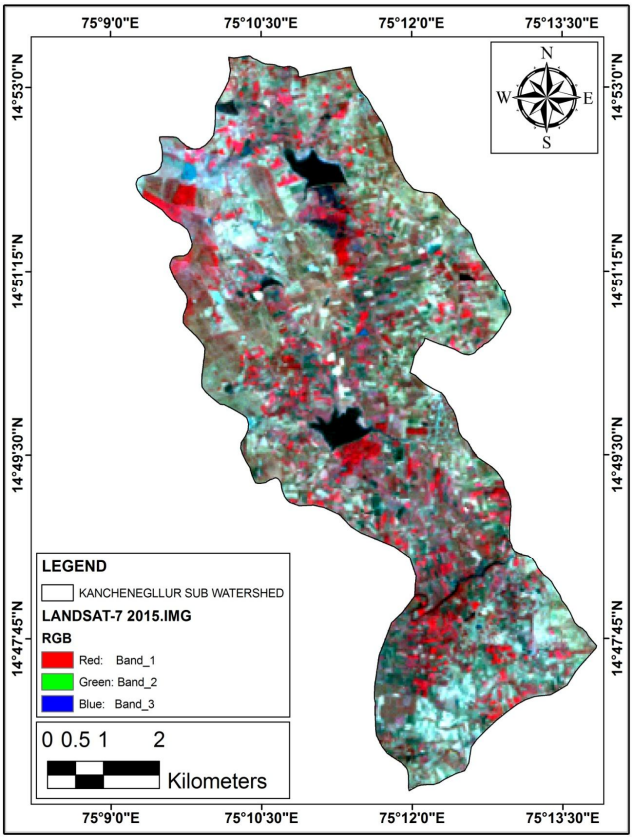

Fig. 4: Kanchinegalur sub watershed LANDSAT – 7 Imagery, year 2015

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III.RESULTS AND DISCUSSION

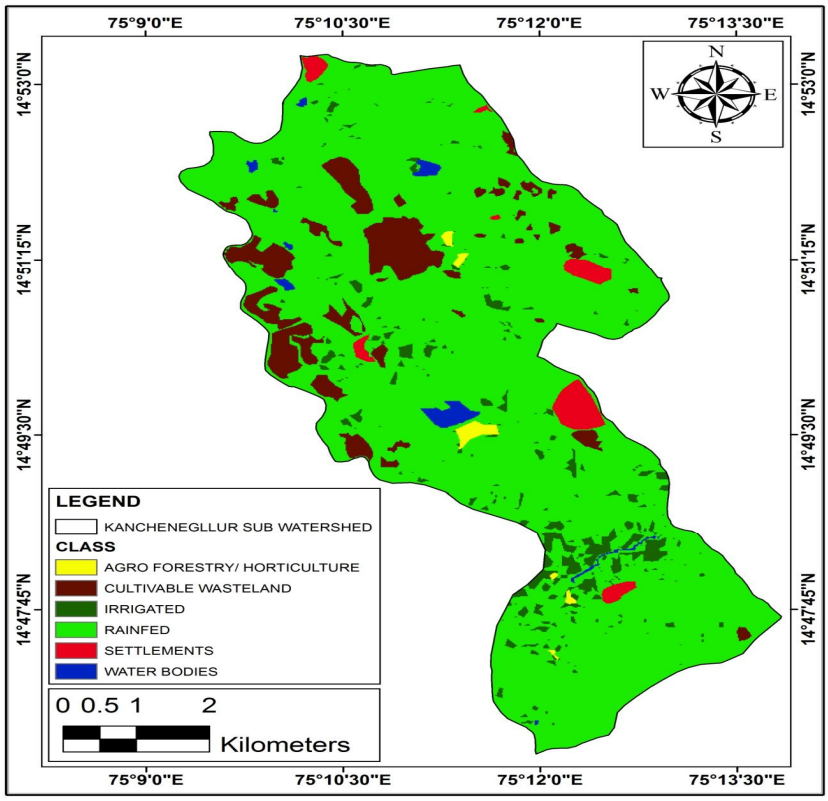

Fig. 5: Land use Land cover classified map of the year 2003.

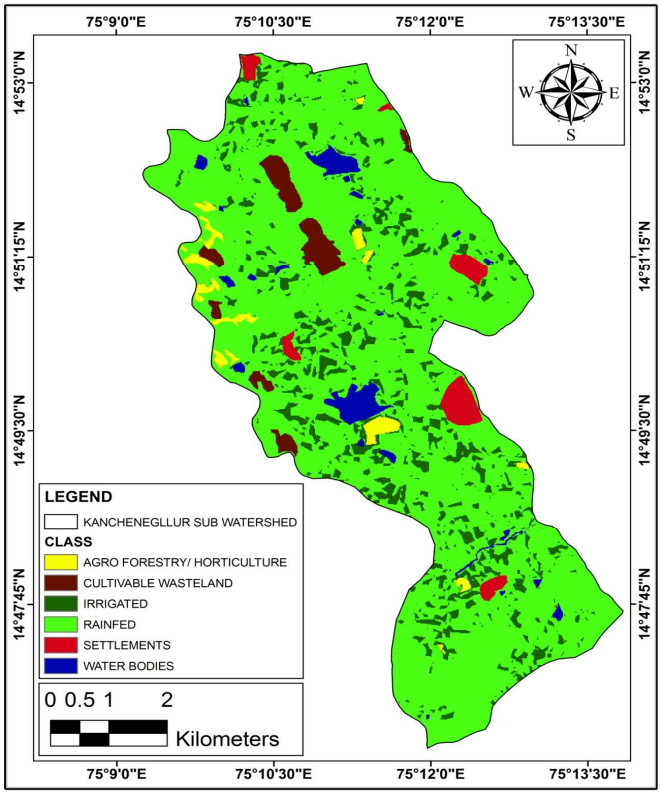

Fig. 6: Land use Land cover classified map of the year 2012.

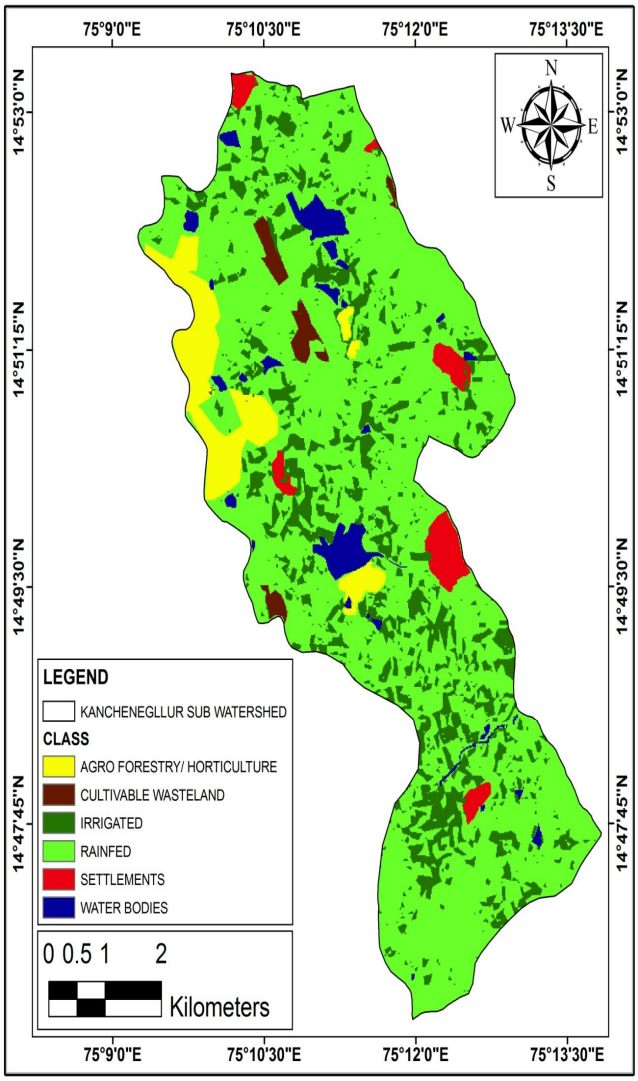

Fig. 7: Land use Land cover classified map of the year 2015.

Fig. 5, Fig. 6, Fig. 7 shows the Land Use Land Cover classified map for the year 2003, 2012 and 2015 respectively. The Land Use Land Cover area statistics for all three years viz., 2003, 2012 and 2015 and the change detection from year 2003 to 2012 and 2012 to 2015 are shown in the TABLE III, TABLE IV and TABLE V respectively.

TABLE III Land Use Land Cover area statistics for all three years

Class	2003 Ha.	2012 Ha.	2015 Ha.
Irrigated	194.22	533.49	812.97
Rainfed	3878.1	3632.70	3148.56
Waterbodies	44.73	113.01	145.8
Settlements	96.21	102.7	126.45
Agro-Forestry/ Horticulture	23.94	78.13	283.32
Cultivable Wasteland	344.52	121.69	64.62

TABLE IV Land Use Land Cover change from the year 2003 to 2012

Class	Area in Ha. (2003)	Area in Ha. (2012)	+Ve Change	-Ve Change
Irrigated	194.22	533.49	339.27	
Rainfed	3878.1	3632.70	-	245.39
Waterbodies	44.73	113.01	68.28	-
Settlements	96.21	102.7	6.49	-
Agro-Forestry/ Horticulture	23.94	78.13	54.19	-
Cultivable Wasteland	344.52	121.69	-	222.83

TABLE V Land Use Land Cover change from the year 2012 to 2015

Class	Area in Ha. (2012)	Area in Ha. (2015)	+Ve Change	-Ve Change
Irrigated	533.49	812.97	279.48	-
Rainfed	3632.70	3148.56	-	484.14
Waterbodies	113.01	145.8	32.79	-
Settlements	102.7	126.45	23.75	-
Agro-Forestry/ Horticulture	78.13	283.32	205.19	-
Cultivable Wasteland	121.69	64.62	-	57.07

Dynamic events are monitored and analysed by performing change detection analysis on Land Use Land Cover maps created from multi-temporal imagery of Kanchinegalur sub-watershed, Hangal Taluk, Haveri District. Comparative study of Land Use Land Cover statistics has assisted to identify the increment and decrement in area in different classes from 2003 to 2015. Irrigated land of Kanchinegalur sub-watershed has a positive change in area successively of about 194.22 ha in 2003, 533.49 ha in 2012 and 812.97 ha in 2015. Rain fed land experienced a nominal decrease in area showing a negative change from 2003 to 2015. Rain fed area extent in 2003, 2012 and 2015 are 3878.1 ha, 3632.71 ha and 3148.56 ha respectively.

Water spread area of water bodies is presenting a positive change in area of about 43.73 ha in 2003, 113.012 ha in 2012 and 145.8 ha in 2015. This incremental change in area of water bodies is mainly due to the contribution of previous year rainfall to successive year. Such a circumstance is well exemplified by the rainfall data, which states 708.3mm rainfall of year 2002 contributed to 2003, 1004.2 mm rainfall of year 2011 contributed to 2012 and 1118.4 mm of rainfall in the year 2014 contributed to 2015.

Urban sprawl is observed in the multi-temporal analysis performed. Area of human settlement is increasing every year. The extent of settlement in the year 2003 is about 96.21ha, 102.7 ha in 2012 and 126.45 ha in 2015, indicating a rise in human settlement in Kanchinegalur sub-watershed. Considerable growth is observed in Agro-forestry/horticulture sector from 2003 to 2015. In 2003, the spatial extent of Agro-forestry/horticulture was about 23.94 ha and it increased to 78.13 ha in 2012 and 283.32 ha in 2015, presenting an increase in the interest of people towards Agro-forestry/horticulture sector.

Extent of cultivable waste land has drastically reduced in area from 2003 to 2015. In 2003, cultivable waste land was about 344.52 ha, which reduced to about 121.69 ha and 64.62 ha in 2012 and 2015 respectively.

IV. CONCLUSIONS

From the above results, we can conclude that the Irrigated area has increased over a time and at the same time Rain fed area has decreased. The main aim of the Watershed program was to increase the arable land and decrease the waste land. From the analysis of results, we can conclude that though the rain fed area decreased from the year 2003 to 2015 the agricultural area has increased

excluding the Agro – forestry/ horticulture. If Agro – forestry/ horticulture is also added under agriculture than it shows a good increment in the agricultural area with decrease in cultivable waste land. Hence objective of watershed development has been achieved partially.

The agriculture land excluding Agro – forestry/ horticulture in the year 2003 is 4072Ha. And that in the year 2012 is 4166.193 Ha. & in 2015 it is 3961.53 Ha. it shows improvement from 2003 to 2012 and where as in 2015 It has decreased. If the Agro – forestry/ horticulture is also added in the agricultural land, then the final agricultural land in 2003 is 4096.26 Ha. and that in 2012 it is 4244.32 and in 2015 it is 4244.85 Ha.

Despite the limitations of different spatial resolution, the results obtained in the LULC change detection studies are close to truth which is confirmed by the GCP collected during Ground Truthing or Field visit.

Hence it can be confirmed that the considerable amount of work done under IWMP programme has changed the condition of the Kanchinegalur sub watershed. i.e., the considerable amount of agricultural land has increased & the cultivable waste land has decreased in the study area.

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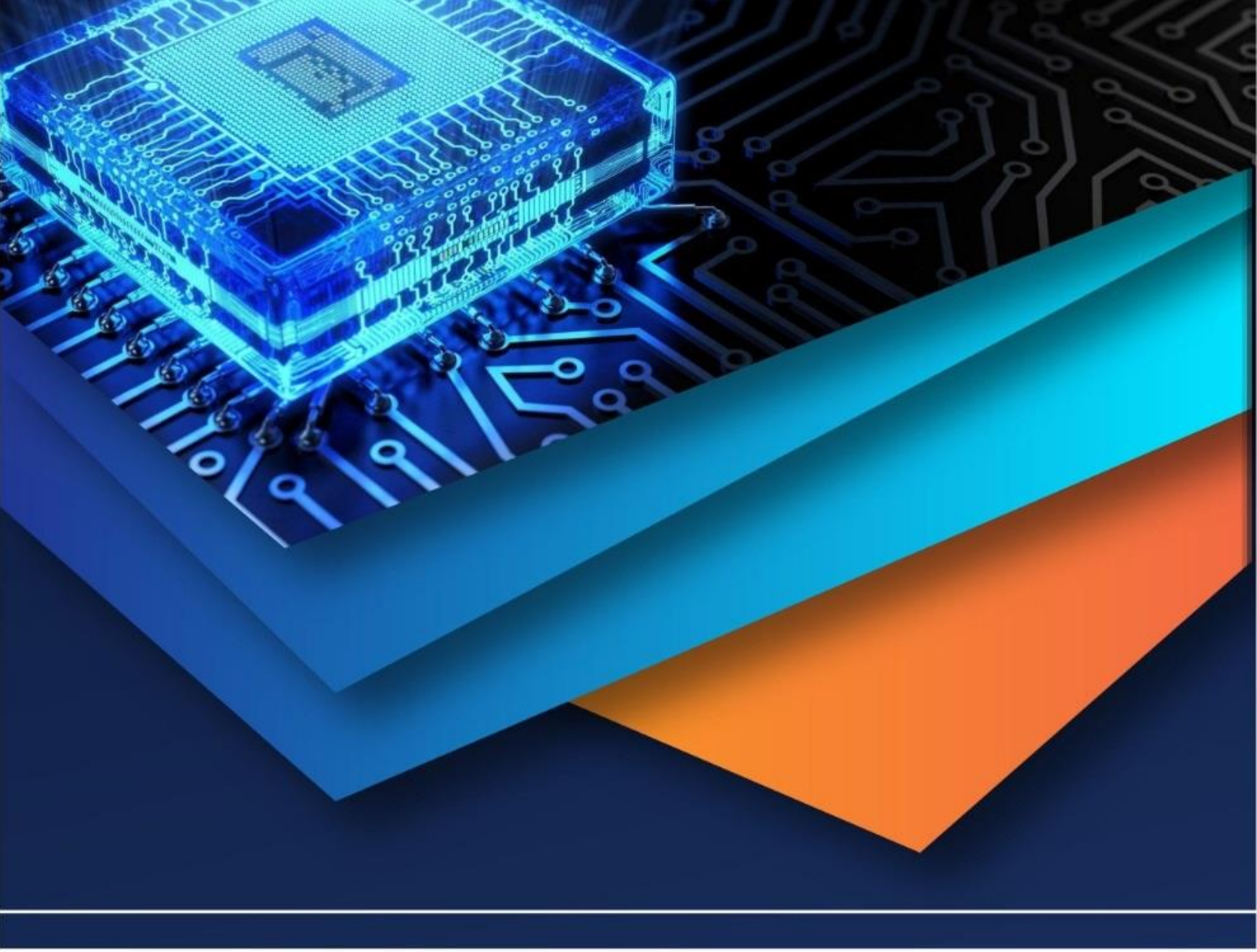

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