A Geo-Spatial approach to the Land Use/Land Cover mapping of the centre part of Srikakulam district, Andhra Pradesh, India

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Abstract-In the present investigation, the land use/land cover mapping of the centre part of Srikakulamdistrict in the state of Andhra Pradesh has been carried out using Resourcesat-1, LISS IV satellite imagerybased on standard visual interpretation techniques. The identified land use / land cover features are Aquaculture, Coastal sand, Coastal wetland, Mud-flat, Coastal-wetland, Creek, Deciduous dense forest, Deciduous open forest, Forest-plantations, Industrial, Kharif (single crop), Kharif +Rabi(double-cropped), Plantation, Tank, Towns/cities(Urban), Villages(Rural), Wastelands, Barren-rock, Wastelands, Gullied land, Wastelands, hills with densevegetation, Wastelands-hills with scrub, Land without-scrub, Salt affected land and Stone-waste. Out of all these features, the maximum area is covered by Kharif +Rabi (double-cropped) (28.091%) followed by Kharif (single crop) (22.773%), Plantation (13.13 %) and Wastelands, hills with scrub (10.916%).

Keywords:Land Use, Land Cover, Resourcesat-1, LISS IV, satellite imagery, Visual Interpretation

1.INTRODUCTION

Land and water have been the basic elements of life supporting systems on our planet since the dawn of civilization (Redclift, M. 2002). All great civilizations flourished where these resources were available in plenty and they declined or perished with the depletion of these resources.In recent years, the land resource has been subjected to a variety of pressures, yet it is surviving and sustaining mankind. Theconcernedmatter is the way, land is being overexploited which is leading to threat to the environment.Out of all the species on the earth, man is the chief culprit to this degradation. He views land in terms of its utility to meet his perceived needs and wants. The most easily categorized varieties of land from the utility point of view are land fit for use, land with potential for use and land which appear useless in the foreseeable future.

Here probably lies the genesis of the problem of land degradation and erosion of ecosystems. Mahatma Gandhi said -"The Earth has enough for everybody's need but not for anybody's greed". Preserving, protecting and defending the land resources have been part of our age-old culture. The respect for the importance of land resources is best depicted in the conventional concept of Panchabhutas – land, water, fire, sky and air that

constitute a set of divine forces. There are innumerable examples of the traditional conservation practices and systems which arestill surviving and are effective. But with the advent of modern age and the newer forces, this tradition is quickly deteriorating mainly on account of – consumerism, materialistic value systems, short-term profit-driven motives and greed of the users. As a result, land is degraded, soil fertility depleted, the rivers polluted and the forests destroyed.

India constitutes 18% of the world's population,15% of the live stock population and only 2% of the geographic area; 1% of the forest area and 0.5% of pasture lands. The per capita availability of forests in India is only 0.08 per ha, as against the world average of 0.8%, thus leading to the pressure on land and forests which poses a major and urgent concern. Land cover change can affect the ability of the land to sustain human activities through the provision of multiple ecosystem services and because the resultant economic activities cause feedbacks affecting climate and other facets of global change. Land use/land cover mapping serves as a basic inventory of land resources for all level of government, environmental agencies and private industries throughout the country.

Land use and land cover have some fundamental differences. Land use refers to the purpose the land serves. E.g. recreation, wildlife habitat or agriculture- it does not describe the surface cover on the ground. E.g. a recreational land use could occur in a forest, shrub land, grass lands or on manicured lawns. Land cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other; it does not describe the use of land and the use of land may be different for lands with the same cover type. All land use planning processes in most of the countries are based on geomorphologic units (Dragut, Blaschke, 2006).Understanding both the land use and land cover of a track of land provides a comprehensive picture of a particular area. This data is a fundamental component of the planning and decision-making processes for many communities because it helps them to understand better where to plan for different types of growth and where to preserve it; also helps them to understand the connectivity or fragmentation of various features in their community.

Land use/Land cover information is the basic requisite for change of spatial pattern of different categories. Man's activities and various uses for daily activities which are covered on the land are known as land uses where as the land has been covered by naturally called land covers. This study revealed that regular monitoring with the help of remote sensing may serve as a very critical tool to assess the magnitude and rate of local

environmental changes and to quantify interactions among local land use and land cover changes with ground water potential and quality. The land use/land cover analyses have been delineated by standard visual interpretation technique as suggested by NRSA. In this analysis, IRS Resourcesat-1, LISS IV satellite imagery (Figure 1) is used to delineate land use/ land cover of the study area following standard visual interpretation techniques.

2.STUDY AREA

The area under investigation lies between the $84^0$7'to $84^0$24' East Longitude and $18^0$38' to $18^0$45' North Latitude. The area is located in and around the Nandigam and parts of surroundingmandals in Srikakulam District, Andhra Pradesh. The study area falls in the toposheet numbers 74B/1, 74 B/2, 74 B/3, 74 B/5, 74 B/6, 74 B/7 and 74 B/9. It is located 73 km towards East from the district headquarters of Srikakulam. The rural area of Nandigam surrounding mandals is divided into further six mandals including the Vajrapukotturu, Palasa, Meliaputti, Tekkali and Santhabommali along with the actual six mandals. The study consists of Nandigammandal and some portion of area of six mandals and other portion excluding the Palasa-Kasibugga Municipality. The study area is covering mandals area around 986 km^2. The study area of Nandigammandal is covering Vajrapukotturumandal towards East, Palasamandal towards North, Meliaputtimandal towards west, Tekkalimandal and Santhabommalimandal towards west. Total population of Nandigam and the surrounding mandals is around 4,24,497 (2011 Census).

The study area is well connected by NH16 and rail network. The Chennai to Kolkata railway line is passing through the study area. Physiographical, the area is mostly covered in Nandigam and surrounding areas. The area has long sea coast which is vulnerable to cyclones. Recently, the 'Titli' cyclone devastated the study area rendered homeless around 4, 24,497 (2011 Census) population with an ectypal property loss is at 2017.

The study area belongs to the North coastal Andhra Pradesh, mostly a backward state. It is covered by red soils, loamy soils and coastal aluminum. Palasa is famous for agro based Cashew industry. Tekkali is famous for white granite. About 90% people livelihood is agriculture. Food crops such as paddy and bajra, ragi millets are the major crops beside vegetables. Coastal areas support coconut and cashew plants.

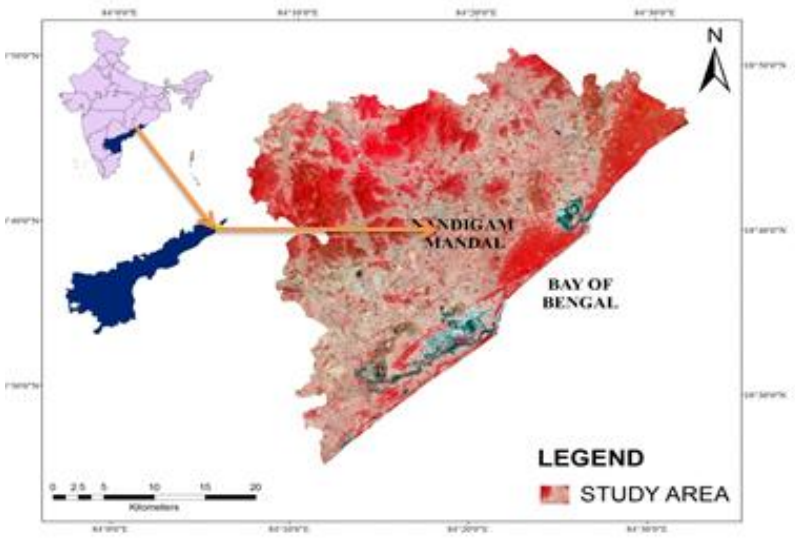

Figure1. Location map of the study area (Resourcesat-1, LISS IV satellite imagery, 2015)

3.MATERIALS AND METHODS

The investigation zone covers 2 numbers of Survey of India (SOI) toposheets, they are 74B/1, 74 B/2, 74 B/3, 74 B/5, 74 B/6, 74 B/7 and 74 B/9on 1: 50000 scale. These topographic maps are geo-rectified and projected to polyconic projection. The Srikakulamtoposheet map has been scanned and saved in .jpg format and then it is imported into image format (.img) using ERDAS IMAGINE 2014 software. The study area boundary is digitized and overlaid on Mosaic toposheet and demarked the study area boundary on 1:50000 toposheet and verified by ground truthing. Necessary corrections were made and checked in the field with the help of GPS. Image processing was carried out for Resourcsesat-1, LISS IV satellite imagery. In this analysis, level-1 and level-2 categories have been identified as per the guidelines given by the NRSC (1990). The land use/land cover classification of NRSC is given in Table 1. The land use/ land cover map of the area is shown in Figure 2.

4.UNSUPERVISED CLASSIFICATION

Unsupervised classification is to automatically segregate pixels of a remote sensing image into groups of similar spectral character (Figure 2).Many real-world domains are best described by relational models in which instances of multiple types are related to each other in complex ways(Dudaetal.,2001). In order to understand the land use/land cover of the study area, unsupervised classification was performed in ERDAS Imagine-2014 environment. Considering the tonal variations and different land use and land covers of the area, 10 major classes were assigned based on a mixture model. The output is compared with supervised and visually classified land use/land cover of the study area.

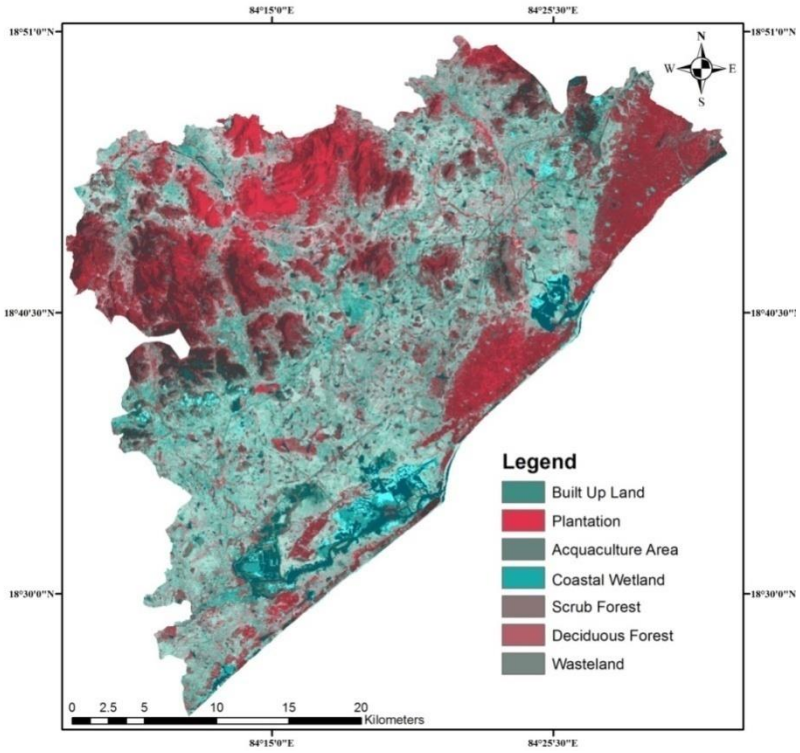

Figure 2:Landuse/Landcoverbasedon unsupervisedclassification

5.SUPERVISED CLASSIFICATION

In order to make use of the multitude of satellite imagery digital data available, the supervised classification guides the image processing software to help it decide how to classify certain features (Lillisand, 1994).This is done by the use of a vector layer containing training polygons. Supervised classification of land use/land cover with the homogeneous training sites selected in signature editor and extended in Erdas-2014 environment. The study area has 10 training areas. By using Erdas-2014 training areas have assigned in supervised classification to obtain the output as shown in (Figure 3).

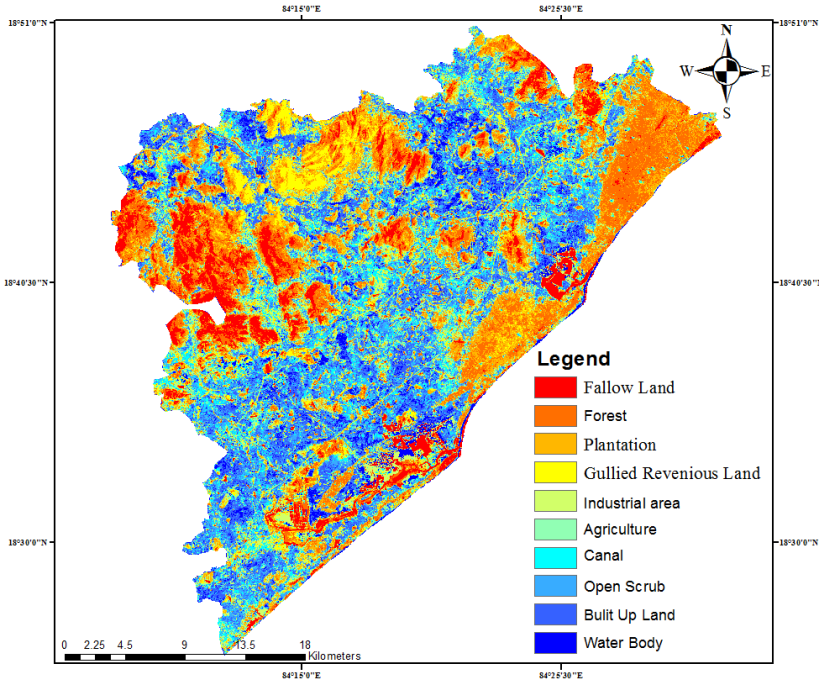

Figure 3:Landuse/Landcoverbased on supervised classification

6.RESULTS AND DISCUSSIONS

In this study, land use/land cover is a prerequisite for an effective conservation strategy is a continuous and consistentmonitoring program. Use of the remotely sensed datafor monitoring purposes requires periodic updates of two basic sources of information on LU/LC. Seven land use and six land cover categories have been observed. The image interpretation elements for observing the above classes are given the output as shown in (Figure 4) and Table 1.

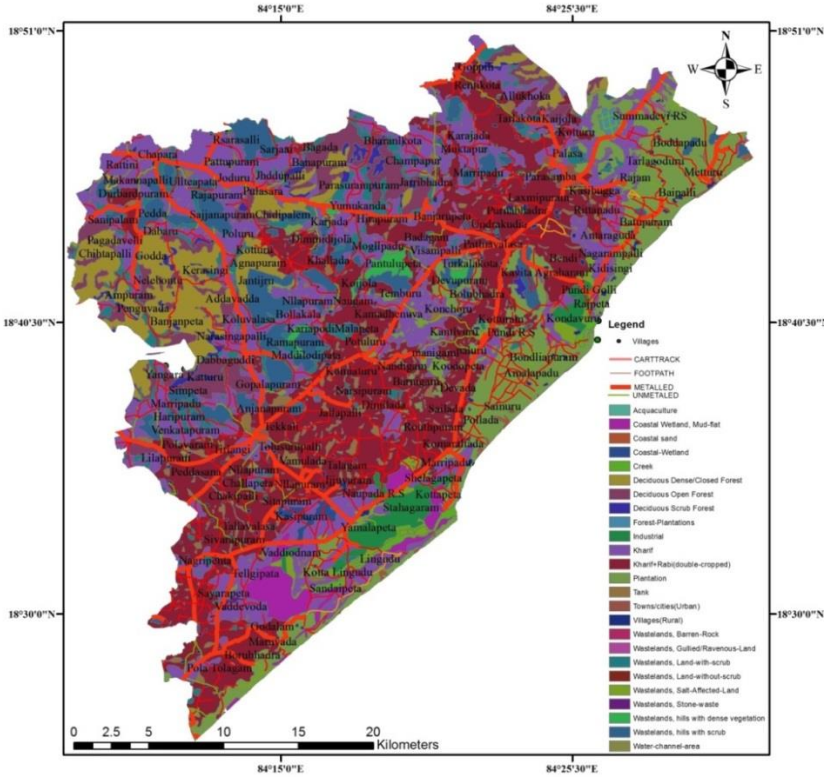

Figure 4: Land use/ Land cover classes based on Resourcesat-1, LISS IV

Table 1: Land use/ Land cover classes (area in km^2)

Land use/ Land cover type	Area in km^2	% of area
Aquaculture	0.020	0.002
Coastal sand	1.869	0.189
Coastal Wetland, Mud-flat	18.715	1.897
Coastal-Wetland	3.067	0.310
Creek	5.632	0.570
Deciduous Dense/Closed Forest	61.581	6.242
Deciduous Open Forest	57.239	5.802
Forest-Plantations	1.739	0.176
Industrial	18.495	1.874
Kharif	224.659	22.773
Kharif +Rabi(double-cropped)	277.122	28.091
Plantation	129.529	13.130
Tank	35.125	3.560
Towns/cities(Urban)	3.747	0.379

Villages(Rural)	18.092	1.833
Wastelands, Barren-Rock	0.119	0.012
Wastelands, Gullied/Ravenous-Land	1.629	0.161
Wastelands, hills with dense vegetation	11.159	1.131
Wastelands, hills with scrub	107.691	10.916
Wastelands, Land-without-scrub	0.269	0.0273
Wastelands, Salt-Affected-Land	7.527	0.763
Wastelands, Stone-waste	0.449	0.0455
Water-channel-area	1.011	0.102
Total Area	986.498	100

From the above table it is clear that Out of all these features, the maximum area is covered by Kharif +Rabi (double-cropped) (28.091%) followed by Kharif (single crop) (22.773%), Plantation (13.13 %) and Wastelands, hills with scrub (10.916%).

7.BUILT-UP LAND

It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands. In the study area, about 40.334 km^2 built-up has been extracted (including the Urban-3.747 km^2, Rural- 18.092 km^2, Industrial-18.495 km^2). In this analysis, urban built-up land use includes residential colonies, industries, institutions and commercial areas, temples etc. Chennai to Howrah and Naupadato Gunpur (Gunpur line) railway lines are passing through this area. National Highway (NH-16)Chennai to Howrah is also passing from the area and State Highway (SH-4) fromPalasa to Rayagada isalso passing from the study area.

8.AGRICULTURE LAND

These are the lands primarily used for farming and for production of food, fibre and other commercial and also horticultural crops. The outskirts of the study area is covered by agriculture. Paddy is observed near PattaTekkali, Mujjada, Haridesapuram, NandigamAgraharam, and Jallapalli etc. Vegetables are the major crop types near the villages-Vikrampuram, Boopaipuram etc. The crop appeared on the satellite image in light red tone with fine texture and the area is associated with canals/ tank, sand surface water bodies.

It reflects that the area has very good water facility and also covered with nutrient rich soils. The study area consists of Kharif (224.659 km^2) and Kharif+Rabi (277.122km^2) covering total of 501.781 km^2.

9.PLANTATION

Plantation is developed along the sea coast in recent years in the study area. Most of the plantation has been identified in the Bypalle, Kidisingi in Eastern Part, Lingudu, Godalamin South–West part and Golpalli, Marripadu and Rajam in North part of the study area. Scrub/ Plantation are identified in some of the areas in foot hills of the Banapuram hill range. The total area covered in plantation is nearly 129.529km^2.

10.FALLOW LAND

The fallow lands are identified in the villages of Marripadu, Yemalapeta, ChinnaNaupada, Gullapalem, Meghavaram and Akasalakkavaram. The total fallow land cover in the study area is about 110.48 km^2.

11.FOREST AND DEGRADED LAND

The forest land includes deciduous forest (61.581 km^2), open forest (57.239 $km^2$and forest plantation(1.739 km^2) areas were identified to cover a total area of 120.559km^2. Degraded forest land has been located in main hill ranges of Banapuram hill and Bandi hills.

12.WATER BODIES

The water bodies include both impounded and regular flowing waters. It is represented by light blue to very dark blue tone depending upon the depth and turbidity levels of the water bodies. Its texture is smooth and shape is irregular on the image. The water bodies in the study area contain tanks (35.125km^2) and water-channel area (1.011km^2) The Balancing reservoir and Tekkalireservoir covers total area of 1.85 km^2; comes under the jurisdiction of Tekkali area. These are the major water sources to Tekkali.

13. SAND AREA

Beach sand is along the sea coast of the sandy area. Beach topography seldom changes owing to wind and marine action. Beautiful parks are developed at Ramakrishna beach, Metturu beach, Amalapadu beach and Bhavanapadu beach covers an area of 1.87 km^2.

14. WASTE LANDS

The study area consists of a total area of 128.843 km^2 under the wastelands including the Barren rock (0.119 km^2), Gullied land (1.629 km^2), Hills with scrub (107.691 km^2) and dense vegetation (11.159 km^2), land without scrub (0.269 km^2), salt affected land (7.527 km^2), stone waste (0.449 km^2).

The below pie chart (Figure 5) shows various land use/ land cover classes and the percentage of area covered under each land use/land cover classes.

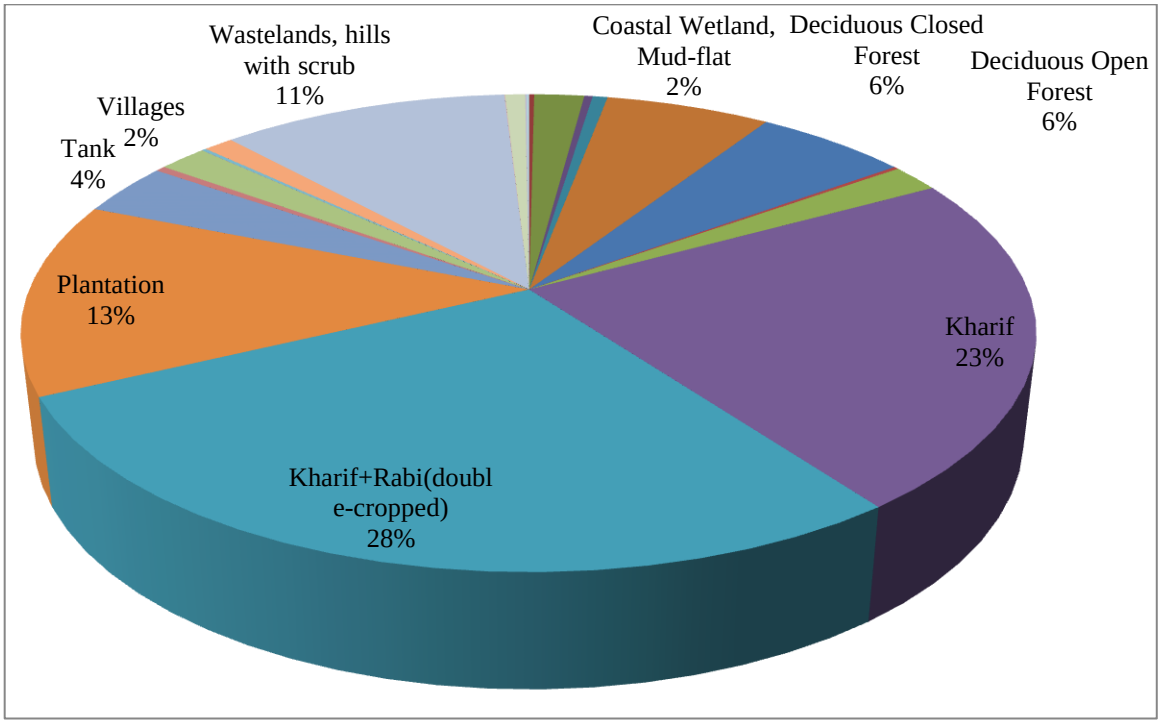

Figure 5.Percent area of land use/land cover classes

CONCLUSION

In this paper, the area of investigation has been divided into eleven Land use/Land cover categories in Classification. The major land use categories are double crop, single crop, un-irrigated, gullied land, etc. Out of all these features, the maximum area is covered by Kharif +Rabi (double-cropped) (28.091%) followed by Kharif (single crop) (22.773%), Plantation (13.13 %) and Wastelands, hills with scrub (10.916%).

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REFERENCES

[1] Redclift, M. (2002). Sustainable development: Exploring the contradictions., Routledge.

[2] Lillesand, T. M., Kiefer, R. W. (1994). Remote sensing and photo interpretation., John Wiley and Sons: New York, 750.

[3] Chauhan, H.B., ShaileshNayak (2005). Landuse/Landcover changes near Hazira region, Gujarat using Remote Sensing Satellite Data. [J]. Journal of the Indian Society of Remote Sensing, 33(3): 413-420.

[4] Drăguț, L., Blaschke, T. (2006). Automated classification of landform elements using object-based image analysis., Geomorphology, 81(3-4), 330-344.

[5]Rao, D.P., Gautam, N.C., Nagaraja, R. & Ram Mohan, P.(1996). IRS-IC application in land use mapping and planning. [J].Current Science, 72:165-190.

[6] RamprasadNaik, D., AppalaRaju, N., JagadeeswaraRao, P., Chandrasekhar Rao,T. (2015) Land Use/Cover Mapping of Paderu Mandal of Visakhapatnam District, Andhra Pradesh Using Geospatial Techniques, [J].International Journal of Remote Sensing & Geoscience (IJRSG), 4(6): 23-28.

[7]Balaselvakumar,S., Kumaraswamy,KSrileka,S., N. Jawahar Raj (2003), Application Of Remote Sensing Data For Land Use / Land Cover Mapping A Case Study Of Arjuna River Basin, Tamil Nadu, [J].Biosciences, Biotechnology Research Asia, 1(1): 43-48.

[8] Doucette, P., Agouris, P., Stefanidis, A., Musavi, M. (2001). Self-organised clustering for road extraction in classified imagery., ISPRS Journal of photogrammetry and Remote Sensing, 55(5-6), 347-358.

[9] WawaleSurindar, G., AherAankush B.(2005).Land Use / Land Cover Mapping using Remote Sensing Data in Pravara River Basin, Akole, Maharashtra, India, [J].International Research Journal of Environment Sciences, 4(9): 53-58.

[10] Skidmore, A.K.,WitskeBijker, Karin Schmidt, Lalit Kumar (1997). Use of remote sensing and GIS for sustainable land management, [J].ITC Journal, 3(4): 302-315

[11] Merolla, Sivia, Mesto, Griseda, Calvanese& Gustavo.(1994). A GIS application for assessing agricultural land.,[J]. ITC Journal, 3: 264-269.

[12] Patel, N.K.,Saxena R.K., & Ajay Shiwalkar (2007). Study of Fractional Vegetation Cover using High Spectral Resolution Data, [J].Journal of the Indian Society of Remote Sensing, 35(1): 73–79.

[13] Alaguraja, P., Durairaju, S.,Yuvaraj,D.,Sekar,M.,Muthuveeran,P.,Manivel.M., Thirunavukkarasu. A.(2010).,Land Use Land Cover Mapping-Madurai District, Tamil Nadu, India using Remote Sensing and GIS Techniques, [J] International Journal of civil and structural Engineering, 1(1): 91-100

[14] TulliChandrasekharaRao, Jaisankar, G., AdityaAllamraju, Amminedu, E. (2018)

Land Use/Cover Mapping for Janjhavathi river basin of Odisha and Andhra Pradesh using Geo-Spatial techniques. [J]. International Journal of Engineering, Science and Mathematics, 7(3): 171-177.