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Geoinformatics for Spatio-temporal analysis of Land use dynamics in Bobbili mandal, Vizianagaram district, Andhra Pradesh

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Abstract

Changes brought in Land use due to anthropogenic factors on the nature have posed serious threat to Environment. Land use / Land cover dynamics and its effects on ecological and hydrological process and on human livelihood has constituted major concerns today, evident from the consideration of Land use / Land cover change as an important driver for climate change. Land use change is a locally pervasive and globally significant ecological trend. An attempt has been made to study the changes in the land use pattern of Bobbili mandal. Comparative analysis of maps of two-time period can provide authentic data with respect to changes brought in the Land use pattern. For detection of temporal changes in the land use pattern two period data sets i.e., IRS LISS III 1999-2000 and 2009-2010 are used. The geospatial tools have been used to assess the changes in land use / land cover. The detailed analysis have revealed that the area under agriculture is decreased and built up land increased from 3.19 to 4.13%. The generated information for the land use pattern will aid in understanding the spatial distribution and extent which will ultimately help in further planning and taking in time appropriate decisions for sustainable development.

Keywords: Land use / Land cover, Land use Dynamics, Temporal change, Remote Sensing, Geoinformatics

Introduction

The increase in population and human activities are escalating the demand on the limited land and soil resources for agriculture, forest, pasture, urban and industrial land uses. The growing human population has triggered alteration of the earth surface at unprecedented pace, magnitude and spatial extent (Lunetta and Elvidge, 1999), thereby, making it difficult to find pristine land any more. Changes in habitat, water and air quality and the quality of life are some of the environmental, social and economic concerns associated with land use and land cover changes. Thus land use / land cover change is impact on quality of life and environment, which are impact on human wellbeing. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to standardize the use of such resources (Gautam and Narayanan, 1983). Knowledge about existing land use / land cover and its trend of change provides a better understanding of land utilisation aspects and plays a vital role in development planning. Spatially explicit temporal data helps in the inventorying, mapping and monitoring spatio-temporal processes and changes. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current level (Anderson et al., 1976). Geographic Information Systems (GIS) and Remote Sensing (RS) techniques provide effective tools for analyzing the land use dynamics of the region as well as for monitoring, mapping and management of natural resources (Sreenivasulu and Udaya Bhaskar, 2010).

Shah and Archana (2006) have analysed techniques of supervised classification in Land Cover/Land Use Mapping of Rishikesh, Uttarakhand. Land use/Land cover classes of Pilibhit District in Uttar Pradesh were studied by Nayak and Behera (2008). Alaguraja and Durairaju (2010) have analyzed Land use/ Land Cover categories of Madurai district in Tamilanadu using satellite data. Harikrishna et al., (2011) has analysed Land use/Land cover classes in Greater Visakha Municipal Corporation (GVMC). Harikrishna et al., (2013) studied systematically Land use/Land cover categories i.e. built up land,

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agricultural land, aquaculture, forest, waste land and water bodies around Kolleru Lake. Appala Raju et al., (2013) demonstrated the potential of remote sensing technology for mapping the land use/land cover status of an area and the study illustrates how to classify land use and land cover from satellite imagery.

Land use change is a dynamic process taking place on the bio-physical surfaces that have taken place over a period of time and space is of enormous importance in natural resource studies. Land use / Land cover change dynamics are important elements for monitoring, evaluating, protecting and planning for earth resources. Land use/ Land cover changes are the major issues and challenges for the eco-friendly and sustainable development for the economic growth of any area. Detection of changes in the land use / land cover involves use of at least two period data sets (Jenson, 1986).The changes in land use / land cover due to natural and human activities can be observed using current and archived remotely sensed data (Luong, 1993). Land use / land cover change is critically linked to natural and human influences on environment. With the availability of satellite data at very high spatial, spectral and temporal resolutions, it is now possible to prepare up-to-date and accurate land use / land cover map in less time, at lower cost and with better accuracy (Kachhwaha, 1985). Keeping the above in view, the present work has been undertaken to prepare the multi-date land use/ land cover maps of Bobbili mandal from Remote Sensing data and to monitor the changes in various land use/ land cover classes using GIS techniques. The present study aims at mapping of land use / land cover for the years 1999-2000 and 2009-2010 and quantifying the changes in land use.

Study Area

Bobbili mandal lies in the central part of Vizianagaram district between 18º 30' - 18º 40' N latitudes and 83º 15' - 83º 30' E longitudes. The mandal broadly divided into two physiographic divisions, namely, the hilly region and the plain region. The hilly region covers the west and north western parts of the Mandal (Figure-1). The rest of the area is an open flat plain broken with few hills. Bobbili Mandal extends over an area of 207.85 km^2 with a density of 543 persons per km^2 covering 38 revenue villages. The economy of Bobbili Mandal is predominantly agriculture and rain-fed. The study area exhibits typical semi arid climatic conditions and the source of water is the south-west monsoon rainfall, which starts in mid June and extends until the end of September. The average annual rainfall is about 1082 mm. This place is associated with the historic battle fought against the Rajahs of Vizianagaram and French on one side and Rajahs of Bobbili on the other.

Objective

The objective of the study is to prepare land use / land cover maps of two time periods and to assess the land use / land cover change in the landscape from 2000 to 2010 using remote sensing data.

Materials and methods

Data

The land use / land cover is prepared using LISS-III+PAN merged digital data of 24th November 1999, 17th January 2000 and LISS-III data of 27th November 2009, 7th February 2010 of IRS-P6 satellite data. The path / row number of IRS-P6 imagery is 104 / 59. The Survey of India (SOI) topographical map 65N/6 at the scale 1:50,000 has been used.

Methodology

The overall methodology adopted for the preparation of land use/ land cover map and change analysis is shown with the help of a flow chart (Figure-2). The IRS LISS III geometrically corrected data is the primary input for classification and mapping. Base map has been derived from the Survey of India topographic map No.65N/6 on 1: 50,000 scale. The multi dates of both (Kharif and Rabi) images were chosen to be as closely as possible in the same vegetation season and used to analyse the spatial and temporal variability in land cover classes. The multi dated imagery have been rectified and registered to correct the effect of relief with LCC projection and WGS84 datum. Land use / land cover mapping of the study area was carried out by using visual interpretation techniques as described in the manual of nationwide land use / land cover mapping using Satellite imagery (NRSA, 2006). Preliminary interpretation was made using standard classification system developed by the National Remote Sensing Centre, Hyderabad and land use / land cover polygons have been delineated. This classification has been proven effective to meet the user requirements and enhance the ability to understand and manage the natural resources.

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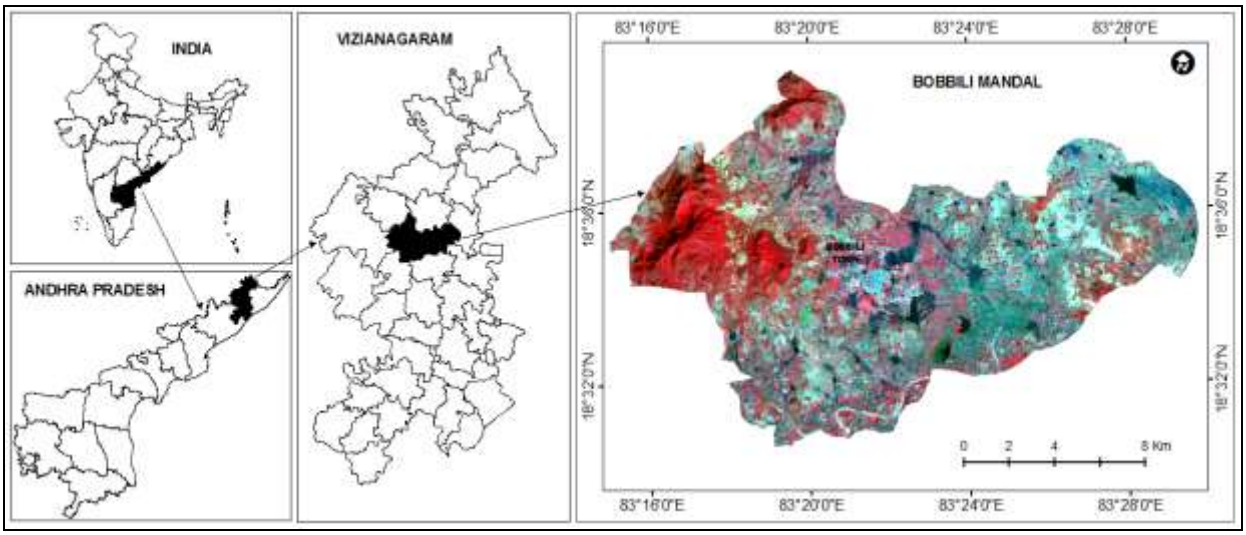

Figure 1: Location map of the study area

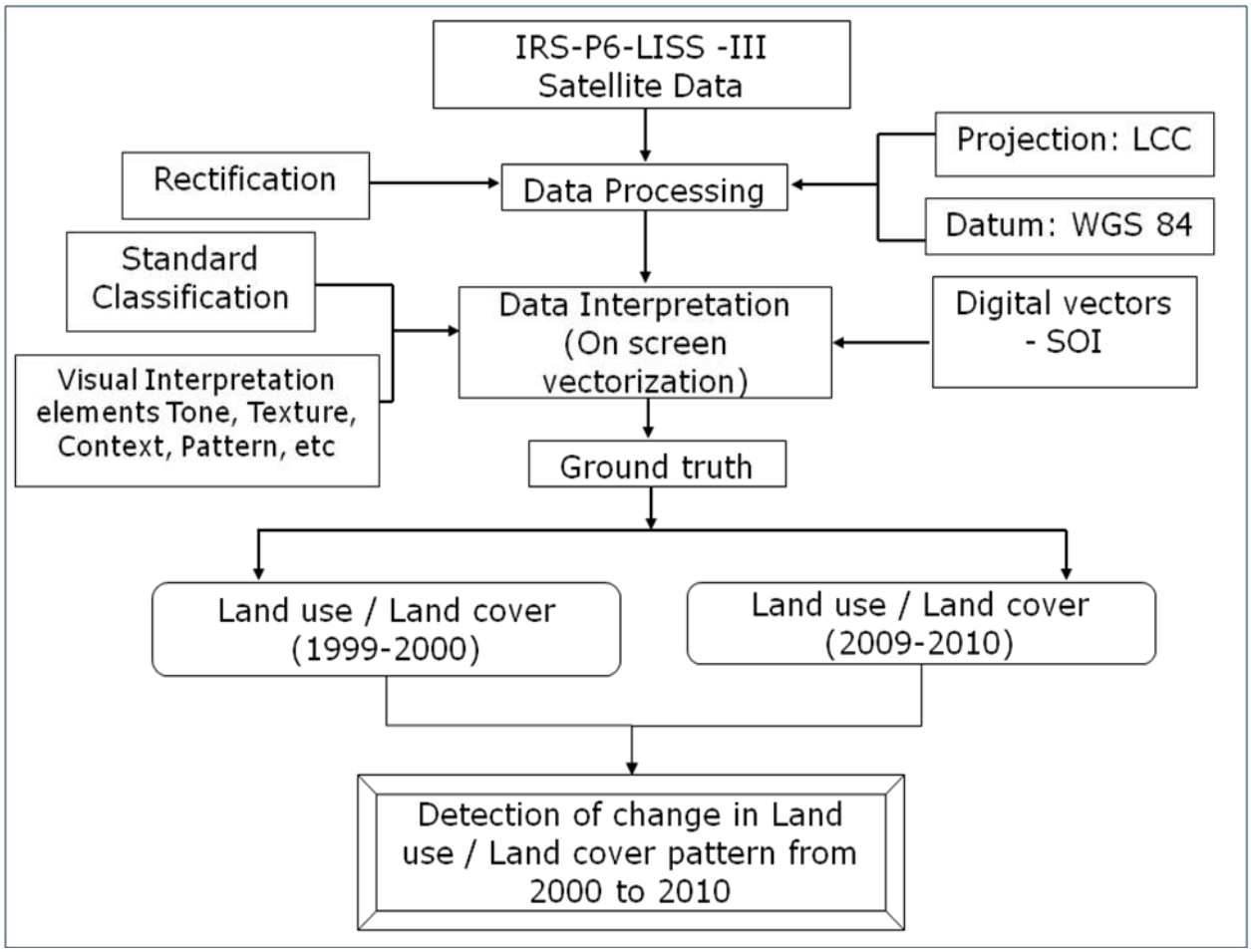

Figure 2: Schematic diagram of the methodology

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Results and discussions

Information on the existing land use / land cover pattern, its spatial distribution and changes in the land use pattern is pre-requisite for planning, utilization and formulation of policies and programmes for making any developmental plan (Dhinwa et al., 1992). This information not only provides a better understanding of land utilization aspects but also plays a vital role in developmental planning. Macloed and Congalton (1998) have listed four important aspects of change detection that are crucial for monitoring natural resources. They include detection of changes that have occurred, identifying the nature of change, measuring the areal extent of the change and assessing the spatial pattern of the change.

Land use / Land cover 1999-2000

Twenty three land use / land cover types have been delineated under Level-III classification (NRSA, 2006). The land use category of level-III constitutes built-up, agricultural, forest, wastelands and water bodies. In built up category urban and rural settlement occupied 0.82% and 1.51% of total geographical area respectively. Industrial area occupied 0.8% and mine quarry cover an area of about 0.05%, which is very less. The most predominant category of land use identified is agricultural land covering 73.25% of the mandal area. This includes five subclasses which are kharif crop, more than two crop, two crop, plantations and fallow lands covering 43.05%, 0.24%, 19.52%, 5.54% and 4.91% respectively of the mandal. The next dominant land use class is forest, which is mainly concentrated in western part of the mandal and is about 13.17% in which forest plantation is about 0.04% of the mandal area. The wastelands occupy 2.90% of mandal area; this includes three subclasses which are Barren rocky stony area, gullied land and scrub land which occupy 1.65% of the mandal area. The water bodies which include all the sub-categories are about 7.49%. Figure-4 Shows the spatial distribution, location and extent of land use / land cover categories in Bobbili mandal of the year 1999-2000. The actual area and percentage of total geographical area for each category is given in Table-1.

Land use / Land cover 2009-2010

The land use / land cover map prepared for the year 2009-2010 is shown in Figure-4 and it is seen that five land use categories of level-I and twenty three of Level-III were identified (Table-1). The urban and rural settlements occupied an area of about 1.19% and 1.85% of the total area of Bobbili mandal. The area occupied by industrial and mine quarry was 1.09%. Under the agricultural category, kharif crop, more than two crop, two crop area, plantation and current fallow contributes 36.01%, 0.24%, 24.45%, 6.21% and 5.39% respectively. The open forest and scrub forest occupied 8.83% and 4.21% respectively. In wastelands, mostly scrublands were contributed is about 1.57% and gullied/shallow ravinous is about 1.01% of the total area. Waterbodies constitutes 7.83% of total area of which tanks are major source of irrigation is about 17.4%. Table-1 shows the comprehensive land use / land cover statistics of the study area.

In order to have comprehensive information on land use, kharif crop, two crop area, more than two crop, agriculture plantation and fallow land have been grouped as agricultural land. Open forest, scrub forest and forest plantation have been grouped as forest. The dense and open scrub, barren rocky and gullied lands have been grouped as wastelands and all sub water body categories are grouped as water bodies. The relative area distribution of different land use categories and change are shown in the Table-2 and Figure-5.

Analysis

From the analysis, it is observed that there is a slight increase in built up from 662.22 ha in the year 2000 to 858.32 ha in 2010. With the growth of settlements, Industries and non-agricultural activities, built-up area has also increased particularly around Bobbili town. Obviously such growth in built-up land has been at the cost of agricultural land. The agricultural area is decreased from 73.25% to 72.30% during this period; the decrease in agricultural land is about 197.27 ha which equals to increased built up area. Under agricultural category, the kharif crop is decreased from 8946.97 ha in the year 2000 to 7484.28 ha in 2010 which is about 7.04%. Within that 6.08% kharif crop area converted to two crop area (4.93%), plantation (0.67%) and current fallow (0.48%) respectively. There is a significant change in cropland due to suitable irrigation systems. The open forest and scrub forest together are slightly decreased from 13.13% to 13.04%. Decrease in forest area indicates unhealthy trends of land use pattern. The reduction in forest cover may be due to the constant felling of trees for fuel and fodder. The wastelands also slightly decreased from 603.12 ha in the year 2000 to 553.46 ha in 2010. The area under water bodies has decreased from 7.49% to 7.83% during this period and this is because of the normal rainfall in the year 2010.

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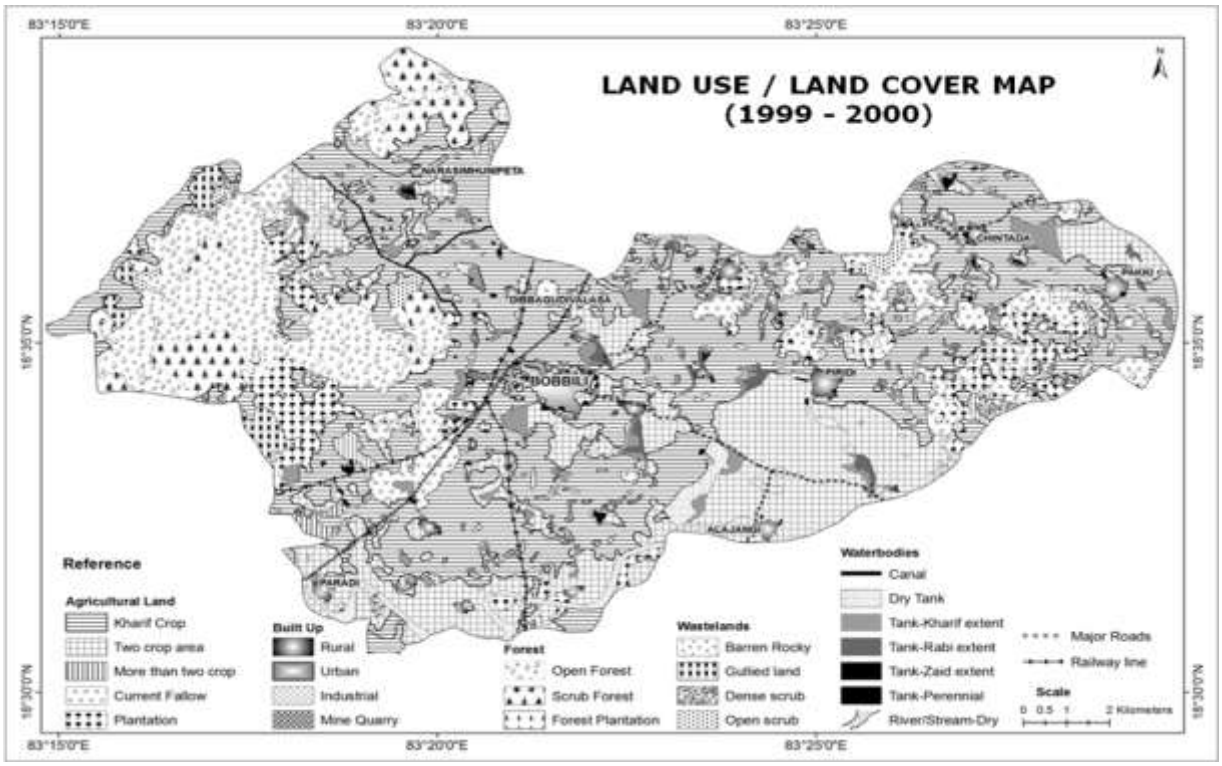

Figure 3: Land use / Land cover Map (1999 - 2000)

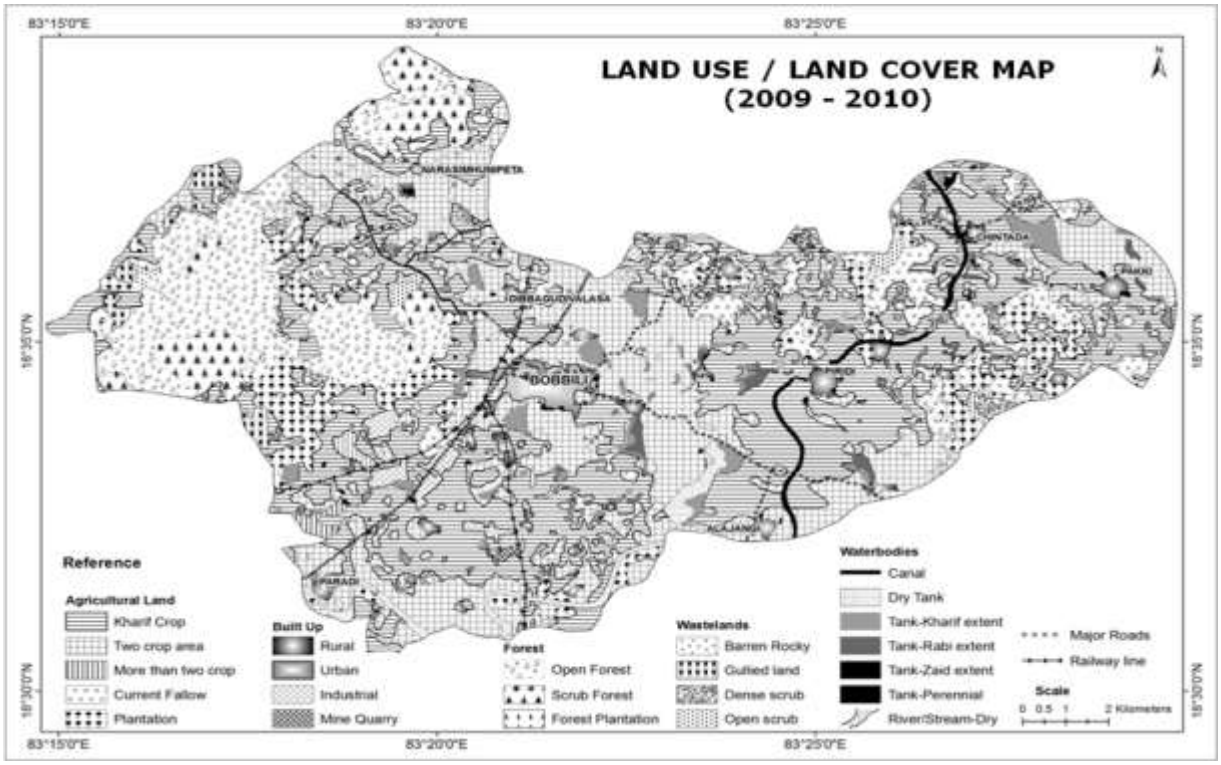

Figure 4: Land use / Land cover Map (2009 - 2010)

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Table 1. Actual area (hectares) and percent of total area under different land use categories in Bobbili mandal, Vizianagaram district, Andhra Pradesh for 1999-2000 and 2009-2010 (in Level-III classification)

Land use categories	Year 1999-2000		Year 2009-2010		Change ±	
	Area	%	Area	%	Area	%
Agricultural Land						
Kharif Crop	8946.97	43.05	7484.28	36.01	-1462.69	-7.04
More than two crop	49.73	0.24	49.73	0.24	0.00	0.00
Two crop area	4057.21	19.52	5082.69	24.45	1025.48	4.93
Current Fallow	1020.07	4.91	1120.76	5.39	100.69	0.48
Plantation	1151.42	5.54	1290.67	6.21	139.25	0.67
Built Up						
Rural	313.77	1.51	384.43	1.85	70.66	0.34
Urban	170.93	0.82	247.14	1.19	76.21	0.37
Industrial	166.31	0.80	209.24	1.01	42.92	0.21
Mine Quarry	11.21	0.05	17.52	0.08	6.31	0.03
Forest						
Open Forest	1848.75	8.89	1835.70	8.83	-13.06	-0.06
Forest Plantation	7.38	0.04	7.38	0.04	0.00	0.00
Scrub Forest	881.33	4.24	875.19	4.21	-6.14	-0.03
Wastelands						
Barren Rocky/Stony waste	25.67	0.12	18.95	0.09	-6.72	-0.03
Gullied/Shallow Ravinous	234.36	1.13	209.12	1.01	-25.25	-0.12
Dense scrub	138.09	0.66	141.02	0.68	2.93	0.01
Open scrub	205.01	0.99	184.38	0.89	-20.63	-0.10
Waterbodies						
Canal	29.12	0.14	127.56	0.61	98.44	0.47
Tanks-Dry	559.43	2.69	554.68	2.67	-4.74	-0.02
Tanks-Kharif extent	633.70	3.05	612.21	2.95	-21.48	-0.10
Tanks-Rabi extent	121.21	0.58	129.42	0.62	8.21	0.04
Tanks-Zaid extent	19.10	0.09	22.30	0.11	3.20	0.02
Tanks-Perennial	29.92	0.14	32.70	0.16	2.78	0.01
River	164.42	0.79	148.05	0.71	-16.38	-0.08
Total	**20785.10**	**100**	**20785.10**	**100**	**0.00**	**0.00**

Table 2. Summary of Land use / Land cover statistics (hectares) of Bobbili mandal, Vizianagaram district, Andhra Pradesh for 1999-2000 and 2009-2010 (in Level-I classification)

Land use categories	Year 1999-2000		Year 2009-2010		Change ±	
	Area	%	Area	%	Area	%
Agricultural Land	15225.39	73.25	15028.12	72.30	-197.27	-0.95
Built Up	662.22	3.19	858.32	4.13	196.10	0.94
Forest	2737.46	13.17	2718.27	13.08	-19.19	-0.09
Wastelands	603.12	2.90	553.46	2.66	-49.66	-0.24
Water bodies	1556.90	7.49	1626.93	7.83	70.03	0.34
Total	**20785.10**	**100**	**20785.10**	**100**	**0.00**	**0.00**

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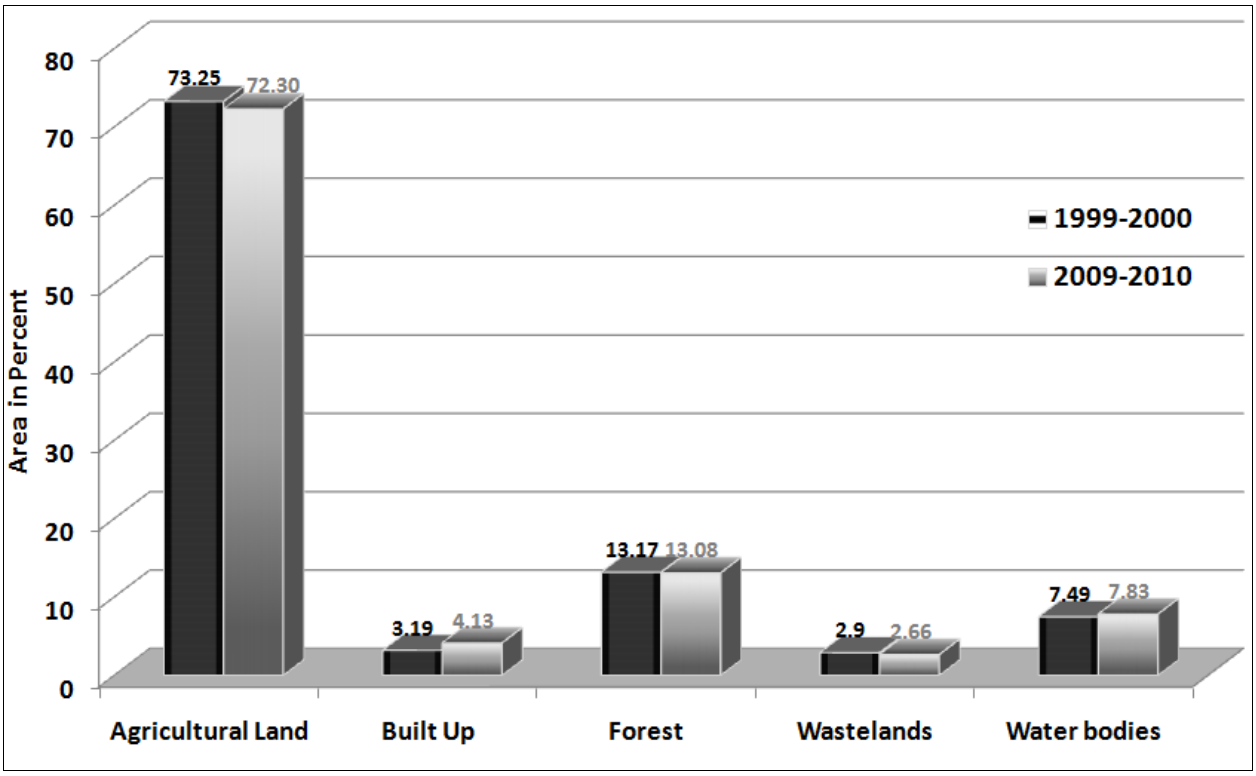

Figure 5. Major land use changes of Bobbili mandal during 1999-2000 and 2009-2010

Conclusions

Change detection techniques using temporal remote sensing data provide detailed information for detecting and assessing land use land cover dynamics. The land use / land cover system is highly dynamic which undergoes significant changes according to the changing socio-economic and natural environment. The change in any form of land use is largely related to bio-physical or socio-economic. The reduction in the area of agricultural land is attributed to the growth of settlements and industries. The detailed analysis have revealed that the area under agriculture is decreased and built up land increased from 3.19 to 4.13%, whereas the wastelands are slightly decreased from 2.90 to 2.66%. Expansion of industrial area has been found to be estimated from 116 to 209 hectares during the period from 2000 to 2010. The forest land which is sparse should be increased. This will help in maintaining ecological balance and improving environment of the region. The generated information for the land use pattern will aid in understanding the spatial distribution and extent which will help in further planning and taking in time appropriate decisions for sustainable development. Also the local people should be made aware of the importance of the land use / land cover pattern and land use change.

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References

*[1] Alaguraja, P. and Durairaju, S., "Land use Land Cover Mapping - Madurai District, Tamilnadu, India Using Remote Sensing and GIS Techniques" International Journal of Civil and Structural Engineering, Vol.1 (1), pp.91-100 (**2010**).*

[2] Anderson, J. R., Hardy, E., Roach, J. T., and Wiremer, R. E., "A Land use and Land cover classification system for use with

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

*Remote Sensing data" A USGS Professional paper No.964. Reston Verginia, pp.28.(**1976**).*

*[3] Appala Raju, N., K. Harikrishna, P. Suneetha and S. Sachi Devi, "Land Use/Land Cover Analysis Through Remote Sensing and GIS Techniques: A Case Study of Vizianagaram District, Andhra Pradesh, India" International Journal of Emerging Technology and Advanced Engineering, Vol. 3 (10), pp. 274-281 (**2013**).*

*[4] Dhinwa, P.S., Pathan, S.K., Sastry, S.V.C., Rao Mukund, Majumder, K.L., Chotani, M.L., Singh, P.J., and Sinha, R.L.P., "Land-use change analysis of Bharatpur district using GIS" Journal of the Indian Society of Remote Sensing, Vol. 20(4), pp.237-250 (**1992**).*

*[5] Gautam, N. C., and Narayanan E. R., "Satellite remote sensing techniques for natural resources survey" In Environmental Management, edited by L R Singh, Savindra Singh, R C Tiwari and R P Srivastava (Allahabad geophysical society), pp.177-181 (**1983**).*

*[6] Harikrishna, K., N.Appala Raju, V.Venkateswara Rao, G.Jaisankar and E.Amminedu, "Land Use/Land Cover patterns in and around Kolleru Lake, Andhra Pradesh, India using Remote Sensing and GIS techniques" International Journal of Remote sensing and Geoscience, Vol. 2(2), pp. 1-7 (**2013**).*

*[7] Harikrishna, K., N. Appala Raju, V.Venkateswara Rao, G.Jaisankar, E.Amminedu, "Land Use and Land Cover Mapping Analysis through Remote Sensing and GIS Techniques – A case study of GVMC" Journal of Applied Hydrology (JAH), XXIV– No.1&2, Jan. & Apr. 2011, PP. 1-8 (**2011**).*

*[8] Jenson, J.R., "Introductory Digital Image Processing" Prentice Hall, New Jersey. (**1986**).*

*[9] Kachhwala T. S., "Temporal monitoring of forest land for change detection and forest cover mapping through satellite remote sensing" In: Proceedings of the 6th Asian Conf. on Re mote Sensing, Hyderabad, pp 77–83 (**1985**).*

*[10] Lunetta. R.S. and Elvidge, C.D., "Remote sensing change detection: environmental monitoring methods and applications" Landon, Taylor & Francis Ltd. (**1999**).*

*[11] Luong, P.T., "The Detection of land use/ land cover changes using Remote Sensing and GIS in Vietnam" Asian Pacific Remote Sensing Journal, Vol. 5(2), pp.63-66 (**1993**).*

*[12] Macleod, R.D., and Congalton, R.G., "A quantitative comparison of change detection algorithms for monitoring eelgrass from remotely sensed data" Photogrammetric Engineering & Remote Sensing, 64, pp.207-216 (**1998**).*

*[13] Nayak, S and Behera MD., "Land Use/Land Cover Classification and mapping of Pilibhit District, Uttar Pradesh, India" The Indian Geographical Journal, Vol.83, No.1, Pp.15-24 (**2008**).*

*[14] Manual of "National Land Use / Land Cover Mapping using Multi Temporal Satellite Data" National Remote Sensing Agency, Hyderabad, Govt. of India. (**2006**).*

*[15] Shah G.L and Archana. K Roy, "Techniques of supervised classification in Land Cover/Land Use Mapping: A Case of Rishikesh, Uttarakhand" National Geographical Journal of India, Vol. 52, pp. 163-170 (**2006**).*

*[16] Sreenivasulu, Vemu., and Udaya Bhaskar, Pinnamaneni., "Change Detection in Land use and Land cover Using Remote Sensing and GIS Techniques" International Journal of Engineering Science and Technology, Vol. 2(12), pp.7758-7762 (**2010**).*