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Evaluation of landuse / landcover dynamics of chilika catchment

Adikanda Ojha[1], Jajnaseni Rout[2], Samal. R.N[2], Rajesh. G[2], Pattnaik. A.K[2], Pritirekha Daspatnaik[3]
1- Research scholar, SPMU - ICZMP, Odisha, India
2- Chilika Development Authority, Bhubaneswar, India
3- Reader, Department of Geography, Ravenshaw University, India

ABSTRACT

Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Empirical observation revealed a change in land use land cover classification in Chilika Catchment. In this paper an attempt is made to study the changes in land use and land cover in this Catchment over 40 years period (1975 -2012). The study has been done through Remote sensing approach using SOI toposheet and LandSat imageries of 1975 and 2009, 2012. GIS software is used to prepare the thematic maps. Ground truth observations were also performed to check the accuracy of the classification. The present study has brought to light that

Landuse and landcover exerts considerable influence on the various hydrologic phenomenons such as interception, infiltration, evaporation and surface flow. Various aspects of hydrological problems (i.e. Rainfall-

Runoff modeling, Sedimentation studies, etc.) can be studied if information on landuse / landcover is available for a catchment. In the present study, a landuse / landcover maps of Chilika catchment for the years 1975, 99 and 2012 is prepared by Image processing and visual interpretation technique.

1. Introduction

Land use and land cover (LULC) change is a major issue of global environment change. Scientific research community called for substantive study of land use changes during the 1972 Stockholm Conference on the Human Environment, and again 20 years later, at the 1992 United Nations Conference on Environment and Development (UNCED). At the same time, International Geosphere and Biosphere Programme (IGBP) and International Human Dimension Programme (IHDP) co organized a working group to set up research agenda and promote research activity for LULC changes. Land use/ land cover mapping is essential component where in other parameters are integrated on the requirement basis to drive various developmental index for land and water resource. Land use refers to man's activities and the varied uses which are carried on over land and land cover refers to natural vegetation, water bodies, rock/soil, artificial cover and others noticed on the land (NRSA, 1989). Land Cover, defined as the assemblage of biotic and a biotic components on the earth's surface is one of the most crucial properties of the earth system. Land cover is that which covers the surface of the earth and land use describes how the land cover is modified. Land cover includes: water, snow, grassland, forest, and bare Soil. Land Use includes agricultural land, built up land, recreation area, wildlife management area etc. The Land cover reflects the biophysical state of the earth's surface and immediate subsurface, thus embracing the soil material, vegetation and water. Land use refers to

man's activities on land which are directly related to the land. Land use and land cover are dynamic. Changes may involve the nature or intensity of change but may also include spatial and time aspects. Land use/ Land cover changes also involve the modification, either direct or indirect, of natural habitats and their impact on the ecology of the area. Land degradation results mainly due to population pressure which leads to intense landuse without proper management practices. Over population makes people move towards sensitive areas like highlands. In such areas land use without considering the slope and erodibility leads to severe erosion and related problems.

It has taken as a serious problem in changing the environment. The change is due to human activities and natural processes (Meyer & Turnnor, 1994). Moreover, this change could be the result of complicated interactions of socio economic and biophysical situations like economic diversification, technological advancement, demographic pressure and many other related conditions (Reid *et al*., 2000).Such local-level dynamics is very important in determining the status of land and ecosystem health. Hence, information on land use, land cover, and possibilities for their optimal use is essential for the selection, planning, and implementation of land use schemes to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population (Moshen, 1999).

Application of remotely sensed data made possible to study the changes in land cover in less time, at low cost and with better accuracy (Kachhwaha, 1985) in association with Geographical Information System (GIS) that provide suitable platform for data analysis, update and retrieval (Star et al. 1997; Mc Cracker et al.1998; Chilar 2000). Space borne remotely sensed data may be particularly useful in developing countries where recent and reliable spatial information is lacking (Dong et al. 1997). Remote sensing technology and geographic information system (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. By understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, one is able to develop plans for multiple uses of natural resources and nature conservation. The change in any form of land use is largely related either with the external forces and the pressure built-up within the system (Bisht and Kothyari, 2001).

Land is the most important natural resources on which all activities are based. Land use unlike geology is seasonally dynamic and indeed is more changing. The increase in population and human activities are increasing the demand on the limited land and soil resources for agriculture, forest, pasture, urban and industrial land uses. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularize the use of such resources . Knowledge about existing land use and landcover and its trend of change is essential for various reasons. Landuse 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.

Changes in landuse can be due to urban expansion and the loss of agriculture land, changes in river regimes, the effects of shifting cultivation, the spread of erosion and desertification and so on. This, therefore, requires not only the identification of features but also the comparison of subsequent data in order to recognize when valid change has taken place. The land use change has a direct bearing on the hydrologic cycle. Various hydrologic processes such as interception, infiltration, evapotranspiration, soil moisture, runoff and ground water recharge are influenced by landuse / landcover characteristics of the catchment. Geographic Information Systems (GIS) and Remote Sensing (RS) techniques provide

effective tools for analyzing the landuse dynamics of the region as well as for monitoring, mapping and management of natural resources.

2. Study area

Chilika catchment which is located east coast of India and it extends from southwest corner of Puri and Khurda districts to the adjoining Ganjam district of Orissa state. It's catchment also covers 18 blocks of Puri , Khurda , Nayagarh & Ganjam with the area of 3987 sq. km. (Chilika Atlas, 2007). Hydrologically the catchment area is influenced by two sub systems; one is Mahanadi river system and another western catchment. There are four rivers named Bhargabi,Daya,Makara,Luna coming under the Mahanadi river system and Kusumi, Tarimi, Mangalajodi, Kantabaia, Badanai,Kansari,Janjira and Kalajhar rivers coming under western catchment.

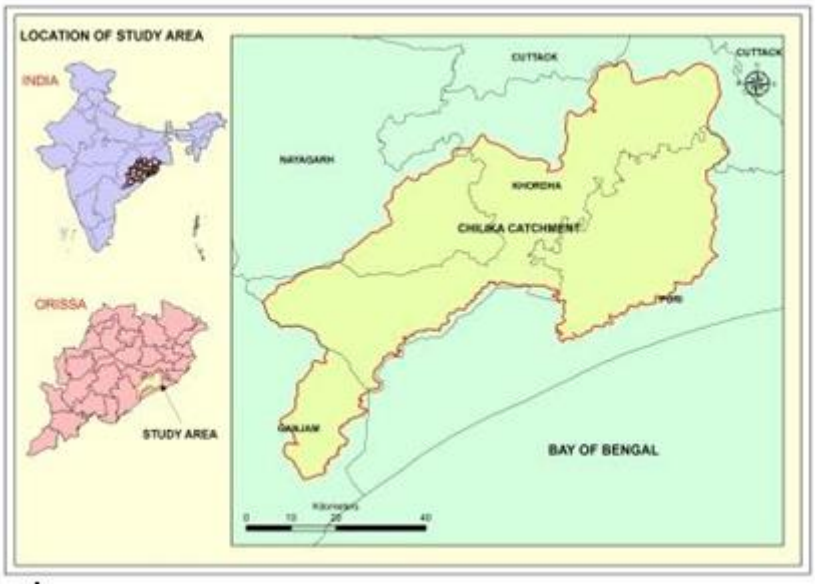


Figure 1: Location map

2.1 Data used –

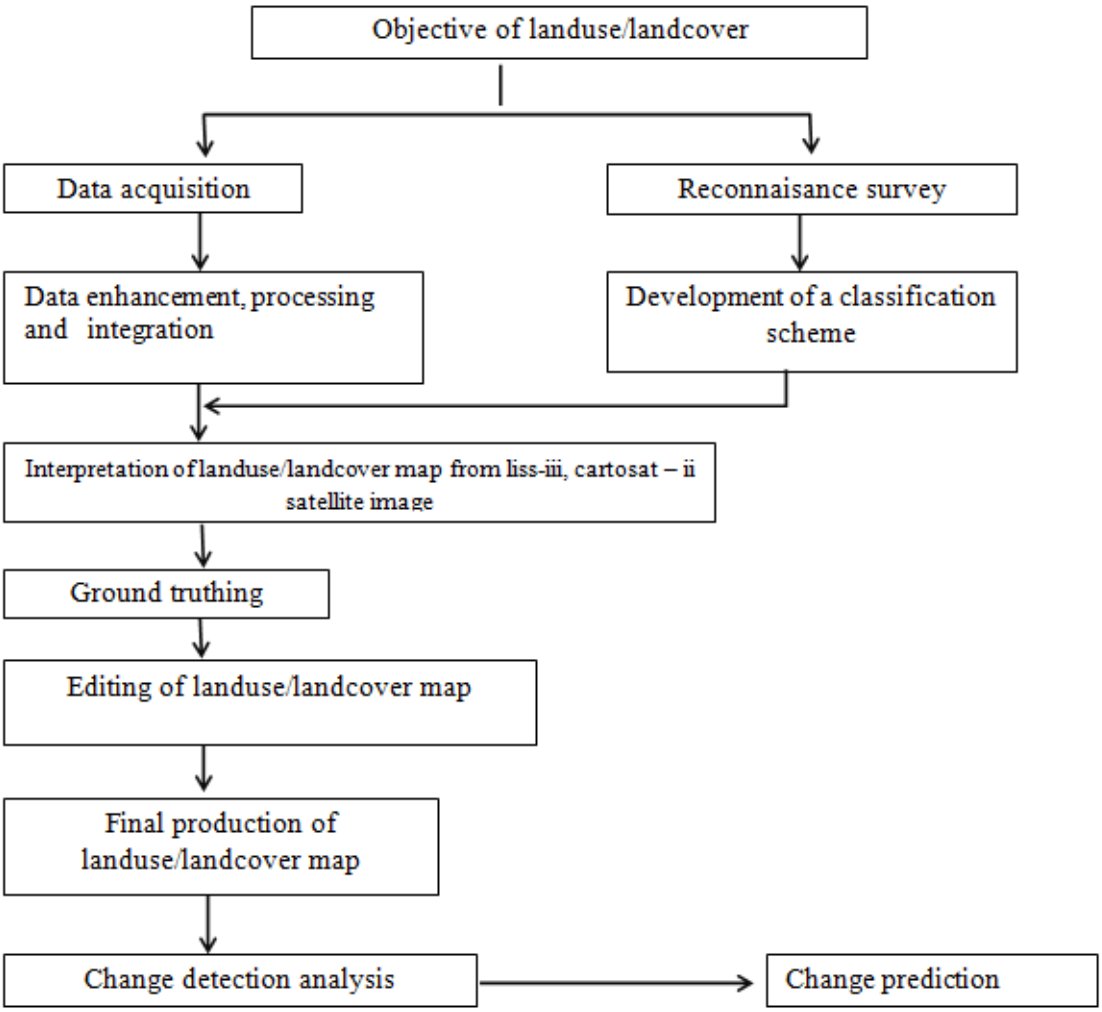
SOI Toposheet – 1:25,000 scale

Satellite imagery – LANDSAT, IRS P6 series

3. Methodology

In the present study Image processing and visual interpretation technique are employed to carry out Landuse / Landcover classification using digital data. The Level-IV classification is adopted to prepare landuse and landcover map. The base map consisting mainly of drainage map of the study area is prepared from the Survey of India (SOI) toposheet No. on 1: 50,000 scale.

3.1 Flow chart



4. Result & discussion

The major land use and land cover types shown by the maps of 1975, 1999, and 2012 include agricultural land , dense forest ,dense scrub, islands, land without scrub , open forest, open scrub, plantation , sand , scrub forest, rural settlement, urban settlement , swampy area & water body etc. . As indicated in Figures below that the greatest share of land use and land cover from all classes is agricultural land, which covers an area of 87953(ha), contributes 18% of the total area. Dense forest and double crop an aerial size of 75915 ha (15 %) and 67905 ha (14 %) respectively, whereas the rural settlement and urban settlement is 62289 ha (13%) & 3188 ha (0.66%) from the total area of the Chilika Catchment. This shows that 21% of the total area of the catchment covered by Chilika lake in 1975.

Table 1: (Landuse/ land cover area statistics of the year 1975)

NAME	Area (ha.)	Area in %
Agricultural Land	87952.6	18.18
Air Port	91.5	0.02
Chilika Lake	103410.7	21.38
Dense Forest	67904.6	14.04
Dense Scrub	3968.3	0.82
Double Crop	75915.1	15.70

Islands	1098.9	0.23
Land without Scrub	12856.3	2.66
Open Forest	13632.8	2.82
Open Scrub	31995.02	6.62
Plantation	2410.6	0.50
Sand	1578.8	0.33
Scrub Forest	1273.6	0.26
Rural Settlement	62288.8	12.88
Urban Settlement	3187.8	0.66
Water Body	1263.2	0.26
Swampy Area	12836.7	2.65

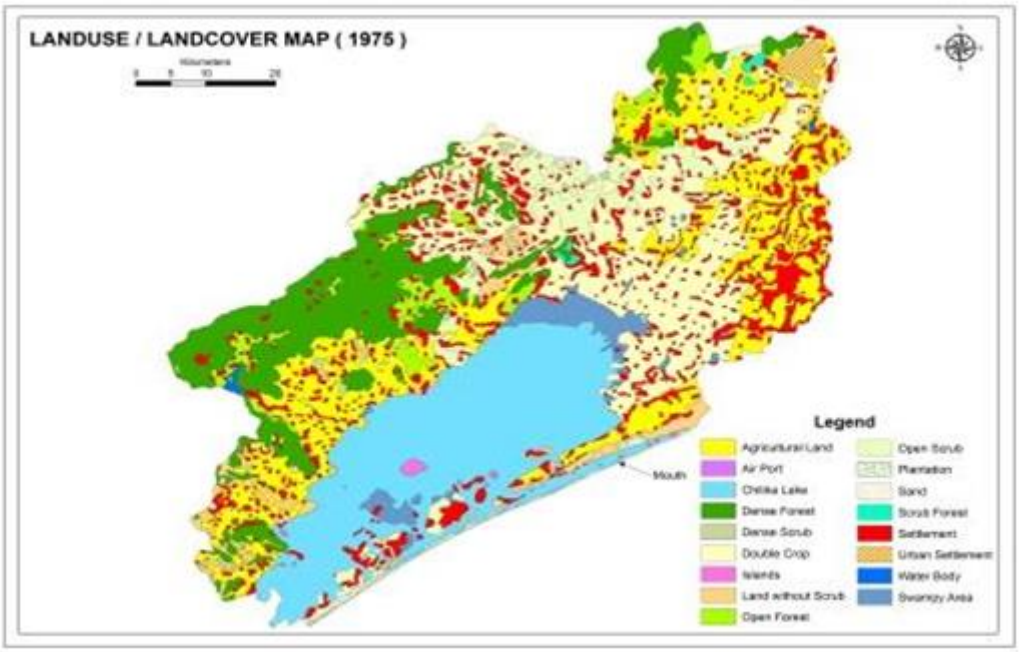


Figure 2: (Map showing landuse/landcover pattern of year 1975)

Table 2: Landuse land cover area statistics of the year 1999

NAME	Area (ha.)	Area in %
Agricultural Land	168608.4	34.84
Air Port	251.7	0.05
Aquaculture	1760.6	0.36
Chilika Lake	91048.3	18.81
Dense Forest	43666.6	9.02
Dense Scrub	1521.4	0.31
Islands	1332.04	0.28
Land without Scrub	21862.1	4.52
Open Forest	14674.7	3.03
Open Scrub	12793.6	2.64
Plantation	4830.5	1.00

Sand	719.1	0.15
Scrub Forest	11777.9	2.43
Rural Settlement	47967.07	9.91
Settlement with vegetation	46916.07	9.69
Swampy Area	1161.6	0.24
Urban Settlement	5548.4	1.15
Water Body	7484.6	1.55

As indicated in Figures below that the greatest share of land use and land cover from all classes is agricultural land, which covers an area of 168608(ha), contributes 35% of the total area. Dense forest is an aerial size of 43666 ha (9 %), whereas the rural settlement and urban settlement is 47967 ha (10%) & 5548 ha (1.15%) from the total area of the Chilika Catchment. This shows that 19% of the total area of the catchment covered by Chilika lake in 1999.In the year 1999 the double crop area converted to agricultural land and some new landuse / landcover category created like aquaculture area and some settlements are covered with vegetation, it means vegetation and agriculture area is increased but dense forest decreased because of population growth here urban population increased in **c**omparison with the year 1975.The Chilika lake also reduce its area because of sedimentation from it's catchment area . This is a big problem for Chilika Lake.

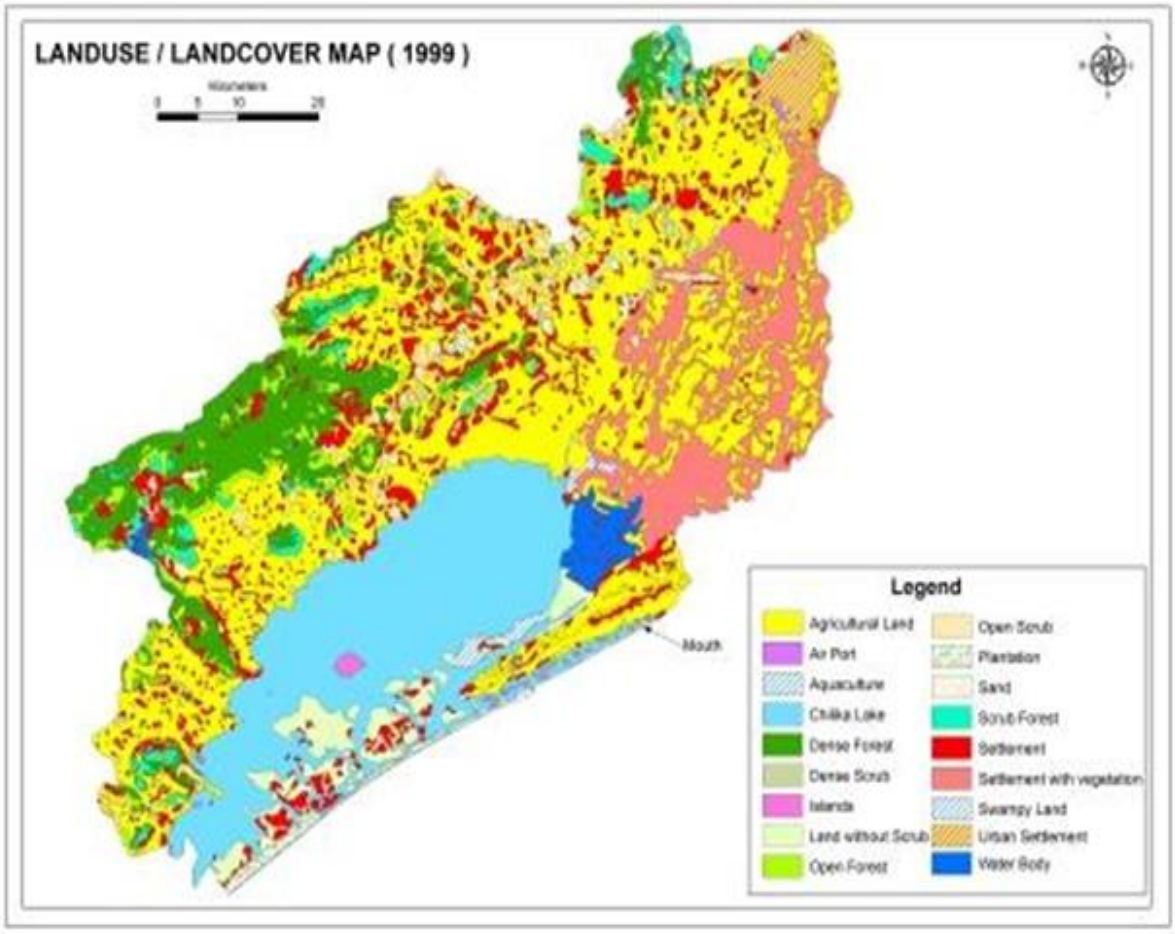


Figure 3: (Map showing landuse/landcover pattern of year 1999)

Table 3: Landuse land cover area statistics of the year 2012

Name	Area (ha.)	Area in %
Agricultural Land	125730.1	26.05
Air Port	296.3	0.06
Aquaculture	5158.6	1.07
Chilika Lake	88734.6	18.38
Creek	112.7	0.02
Dense Forest	61377.7	12.72
Dense Scrub	4589.6	0.95
Developed area	738.9	0.15
Islands	1258.5	0.26
Land without Scrub	21855.4	4.53
Open Forest	24252.3	5.02
Open Scrub	8838.7	1.83
Plantation	3471.01	0.72
Sand	312.06	0.06
Scrub Forest	10293.2	2.13
Rural Settlement	47078.3	9.75
Settlement with Vegetation	51652.3	10.70
Swampy Area	13602.1	2.82
Urban Settlement	11029.2	2.29
Waterbody	2273.8	0.47

As indicated in Figures no-4 below that the greatest share of land use and land cover from all classes is agricultural land, which covers an area of 125730(ha), contributes 26% of the total area. Dense forest is an aerial size of 61377 ha (13 %), whereas the rural settlement and urban settlement is 47078 ha (10%) & 11029 ha

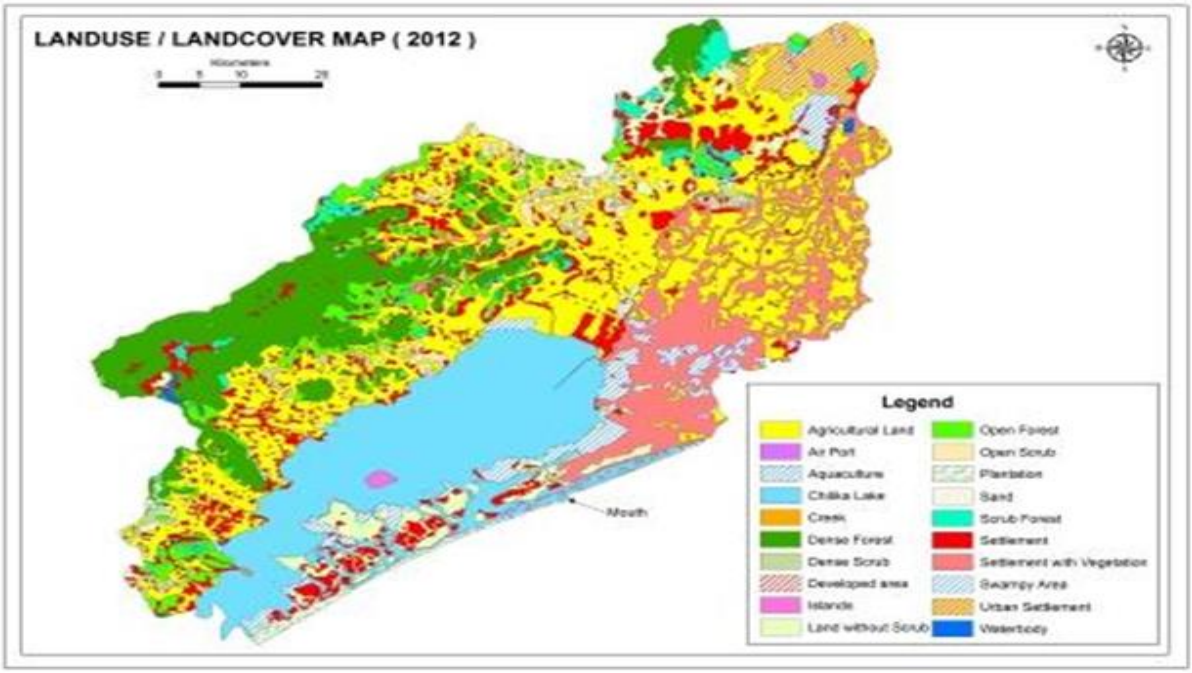


Figure 4: (Map showing landuse/landcover pattern of year 2012)

(2.29%) from the total area of the Chilika Catchment. This shows that 18% of the total area of the catchment covered by Chilika lake in 2012.In the year 2012 the agricultural land decreased and some new landuse / landcover category created like creek for boating purpose ,some areas are developed for industrial purpose and some forest area changed from open to dense because of plantation. Here also urban settlement increased more than last two years analysis. The some part of Bhubaneswar city is coming under the catchment area which is the capital of Odisha state.

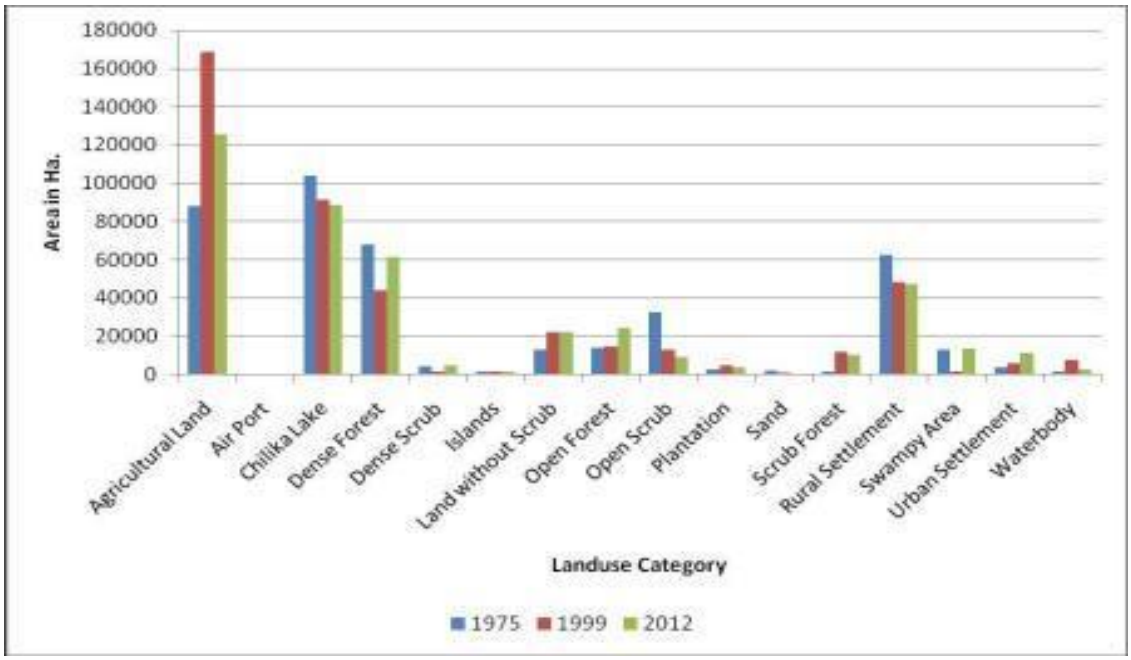


Figure 5: landuse/landcover area Comparison between 1975 to 2012

The fast growth of agriculture up has due to the conversion of forest, shrub, and grass land to agricultural land because of rapid population growth in the study area. Chilika Lake Conveted into aquaculture, agriculture, swampy area, so the area of lake is reduced. The water body area is reduced because of population growth, people fill up the drainage waterlogged area and ponds for using living purpose. Population growth is major factor for landuse/ landcover change.

5. Conclusion

This study shows land use and land cover changes that have occurred in Chilika catchment in the last 37 years and considers as well as relates different components responsible for the change with the implications on increase in biodiversity loss, soil erosion, and inappropriate land management. The methods developed as an outcome of this study have been employed for their capability to assess the spatial and temporal changes in land use and land cover at a landscape scale and to subsequently determine an effective means to measure landscape stability over large assessment areas such as Chilika Catchment. Specifically, Remote Sensing integrated into a GIS environment provides an ability to characterize large assessment areas and establish reference conditions. Generally the situations of land use and land cover dynamics have a depressing effect on the local scale as well as beyond that because its consequences do not have clear boundaries. There is, therefore, a need for local land use planning and design with conservation practices of the study area.

6. References

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