 © 2018 IJCRT | Volume 6, Issue 1 January 2018 | ISSN: 2320-2882
DOI: http://doi.one/10.1729/IJCRT.17193

Dynamics of Land Form Features in Coastal Tract of Odisha from Mahanadi to Dhamra River Estuary Using Remote Sensing and Geospatial Technology

[1]R.R. Thakur, [2]P.Kumarand [1]S.Palria
[1]Ph.D Research Scholar, [2]Scientist, [3]Professor
[1]Department of Remote Sensing & Geo-informatics
[1]Maharshi Dayanand Saraswati University, Ajmer, India

Abstract:The Coastal land use and land cover features are dynamically regulated due to marine and terrestrial processes and controlling by natural and anthropogenic activities. The detail knowledge of extent and impact of past changes and their implications for future management is needed to understand the challenges in coastal tract. Worldwide the coastal zone occupy about 8% of earth's terrestrial surface But contribute 37% and 44% of world's population (as of 1994) within 100k.m and 150k.m of a coast line respectively(Cohen et.al, 1997). Thus, coastal zone ecosystem (Estuaries, Wetlands, Coral reefs etc), which are rich in natural resources are in extreme pressure. There has been a tremendous pressure on the resources and habitats of Odisha coast in the last few decades. Rapid industrialization in Paradeep and Dhamra port, increase of aquaculture activities, denudation of coastal sands, rapid degradation of coastal vegetation, salinity ingress in the agricultural land, natural and artificial disturbance on the habitats of sea turtles etc. Mangroves, which act as a barrier for the coast from any natural disasters is now degrading in a rapid rate which threatens the ecosystem and coastal environment.Multidate Satellite images were used to delineate changes in Land use features. Arc Map and ERDAS Imagine softwares were used in the interpretation and analysis land use features. The main objectives of the current study changes in Land features and other thematic layers such as infractures, drainage etc to understand the impact of Land use changes in the coastal region and their socio-economic impact on the Coastal region. The coastal resources and their apparent changes and threats suggest that the existing conservation measures and protection plans are inadequate to reclaim the Coastal natural resources. The community participation is essential for the protection of the brittle coastal environment. But more rigid laws must be effectively enforced. In developing countries like India, public participation, education programme, awareness initiatives are the foundation of success of any Coastal Management Programme. Thus, in order to achieve a sustainable development in the delicate coastal ecosystem, involvement of local community at all levels is essential to protect the environmentally sensitive Coastal tract of Odisha. The findings of the study can be useful for the Coastal managers and decision making authority for proper implementation of Coastal Sustainable goals.

***Index Terms* -LULC, GIS, Geo-Spatial technology, MNP**

I. INTRODUCTION

Land cover refers to different features covering the earth's surface including vegetation cover, water bodies, open scrub etc. With the development of Geographic Information System (GIS) and Remote Sensing technologies and its applications, adoption of new methodologies prove to be highly efficient in mapping and visualizing land use/land covers. The coastal zones are the areas having the influence of both marine and terrestrial processes. It is a unique environment where land, sea and atmosphere interact and interplay continuously influencing a strip of spatial zone defined as "Coastal Zone". It includes the near shore marine waters, islands, beaches, intertidal areas, wetlands and island area to the limit of coastal watershed and flood-prone areas in which natural and anthropogenic activities can affect the coastal water. The term "Coastal Zone" means the coastal waters, wetlands and adjacent shore lands strongly influenced by marine watersor vice-versa" (Nayak et.al(1989).According to Hinrichsen (1998:2) "That part of land most effected by its proximity to the sea and that part of the ocean most effected by its proximity to the land". The LULC is regarded as one of the most important components and driving factors of global environmental change (Shi, P.J, 2000).Land cover refers to the physical characteristics of earth surface, captured in the distribution of vegetation, water, soil and physical features of the land.

Changes in land use can be categorized by their complex interaction of structural and behavioral factors associated with technological capacity, demand and social relations that effect both environmental capacity and demand. Analysis of detected change is the measure of the distinct date framework and thematic change information that can lead to more tangible of land cover and land use changes. The change analysis of features of earth's surface is essential for better understanding of interaction and relationship between human activities and natural phenomenon and it is necessary to improve resource management. (Lu et.al, 2004).And LULC change detection is essential to understand the landscape dynamics during a known period of time having

DOI: http://doi.one/10.1729/IJCRT.17193

sustainable management. In recent years, earth resource satellite data are very applicable and useful for land use/land cover change detection studies (Brondizio, E.S, 1994). Due to natural calamities and artificial processes, alteration of land cover take place dramatically and for sustainable management of natural resources, quantitative and qualitative information about these changes are useful for decision making process. Change detection is a process of identifying differences in the state of an object or phenomenon by observing it at different times. It is very useful in the study of land use/land cover analysis, erosion/accretion, and related works. Especially, coastal zones are prone to land cover changes. The important objective of change detection process is to recognize LULC on digital images that change features of interest between two or more dates. (Muttitanan, W & Tripathi, N.K, 2005).

The coastal zone refers to a broad geographic area in which terrestrial and marine features are mixed to produce unique landforms and ecological systems. They are known for their rich socio-cultural heritage, ecological diversity, living resources and environmental contamination. Thus, coastal zones are important biologically, ecologically and economically point if view. The coastal zone includes various important ecosystems which undergo rapid change due to development and population explosion. These pressures have raised concern for degradation of coastal environment globally. (Sevoski et. al.2012).

Coastal regions are the most fragile, dynamic and productive ecosystem and quite often under tremendous pressure due to man-made activities and natural processes. It is covered with very wide range of habitats such as coral reefs, mangroves, sea-grasses, sand dunes, vegetated stungle, mudflats, salt-marshes, estuaries; lagoons etc.The coastal landforms have an important role in protecting the coast line from erosion and flooding. Although coastal zone constitute just about 10% of the land yet it sustains about 60% of world population. India is having 7517 k.m long coastal line where about 35% of population lives within 100 k.m from the coast. They are continuously changing due to the dynamic interaction between the ocean and land. Erosion and accretion, inundation due to sea level rise and storm surge, shifting of shore line due to natural or anthropogenic forces like construction of artificial structure, port and harbor leads to alter in the coastal environment.

Remote Sensing and geo-spatial technology have been widely used in monitoring and management of the natural resources in the coastal areas. Due to its repetitive, multi-spectral and synoptic nature, Satellite Remote Sensing(RS) has been proved to be extremely useful in acquiring information on various aspects of coastal environment such as: Coastal wetlands, Coastal landforms, Shore line changes, High tide and Low tide boundary, Coastal inundation, brackish water areas, Coastal hazard, Sea level rise, Coastal saltpans, Suspended sediment dynamic various coastal habitats etc.Remote Sensing is proved to be an important tool towards generating a sustainable development plan of the coastal areas. Remote sensing technology is considered as a fundamental and cost effective tool to establish coastal environmental baselines and monitoring purpose.(Shetty et al.,2015).

The LULC change plays a major role in the study of global change of surface features and LULC and human/natural modification have results in deforestation, biodiversity loss, global warming and increase of natural disaster i.e. flooding and cyclones. (Mas, J.F et al.2004).Remote Sensing and GIS are powerful tool to derive accurate and timely information on the spatial distribution of land use/land cover over large areas (Zsuzsanna, D et al.2005). Landsat Multispectral Scanner(MSS), Thematic Mapper(TM) and Enhanced Thematic Mapper Plus(ETMT) data have been broadly used in studies towards the determination of land cover since 1972(Chambell,J.B 2007). Coast exhibit geomorphic change over seasonal, annual and multi decadal time scale(Cowell and Thom,1994).The long term coastal observational data, that span multiple years and decades are required to characterize the dynamics of these environment(Short and Trembanis,2004).

II. STUDY AREA

The coastal tract from Mahanadi to Dharma river is lying on the east coast of Odisha, India. The area is situated in the administrative unit of the state called Kendrapara district. It is also a part of the deltaic plain of Mahanadi river. It is visited by natural disasters mainly flood and cyclone frequently. It is an ecologically sensitive area as the tract is covered by Bhitarkanika mangrove forest-a RAMSAR site and a sensitive mangrove patch near the Mahanadi estuarine area on the south. In the north there is a developing port structure named Dhamra port and a developed port named Paradeep port on the south. It is treated as one of the most vulnerable coastal district of India. It lies in most severe flood zone and is referred to as a very high damage risk zone.

The area is situated in the administrative unit of the state called Kendrapara district of Odisha, India. It is a part of the lower deltaic plain of Mahanadi river. It is visited by natural disasters mainly floods and cyclones frequently. It is an ecologically sensitive area as the tract is covered by Bhitarkanika mangrove forest-a RAMSAR site and a sensitive mangrove patch near the Mahanadi estuarine area on the south. Rapid industrialization in Paradeep (southern sector) and Dhamra port (northern sector) areas, increase of aquaculture activities, denudation of coastal sands, rapid degradation of coastal vegetation, salinity ingress in the agricultural land, natural and artificial disturbance on the habitats of sea turtles etc.are major concern of the area. Mangroves, which act as a barrier for the coast from any natural disasters is now degrading in a rapid rate which threatens the ecosystem and coastal environment (Kumar,2004).The area is also treated as one of the most vulnerable area of India.

The study area lies within 20°17'58.556" to 20°45'55.574"North latitude and 86°42'43.82" to 86°50'32.541"East longitudes and covers geographical area of 1025 km2.The geographic unit constitute basically combined deltas and flood plains of the Mahanadi

 © 2018 IJCRT | Volume 6, Issue 1 January 2018 | ISSN: 2320-2882
DOI: http://doi.one/10.1729/IJCRT.17193

river system which is dominated by fluvial action of meandering stream and littoral action of tides, waves and currents. Unconsolidated sediment is the most dominant geological feature of the study area. The soil present in the study area is clayey loam and highly slushy due to the regular inundation through tidal action. Mostly tidal and littoral swamp forest occurs in the study area.

It enjoys a tropical wet-dry type of climate which is generally hot with high humidity. The maximum temperature recorded is 45°C and the minimum is 10°C during May and January respectively. The average annual rainfall is about 1300 mm, bulk of which is received during June to mid October. Mean relative humidity ranges from 70 to 85% throughout the year. The river system of the area consists of mainly Gobari, Nuna, Patsala and Hansua river.Bhitarakanika is covered with dense mangrove forests and saline creeks. It was declared as a Sanctuary on 21-04-1975 under the wild life protection act 1972. The sanctuary is bounded by the Dhamra river in the north, the Hansua in the west and the Bay of Bengal in the east and south. It is also declared as a Marine National Park of India and subsequently declared as a Ramsar site. The Bhitarkanika mangroves are home to 55 of India's 58 known mangrove species. Animals like deer, wild boar, monkeys, monitor, python, and king cobra also found here. The mangroves harbor one of the largest population of saltwater crocodiles in India. The role of Mangroves is vital in the coastal ecosystem because of their contribution to coastal fisheries and their role in mitigation of the coastal erosion. The mangroves vegetation along the Odisha coast is especially important as it supports largest numbers of mangroves species in India (Banerjee, 1987) and highly vulnerable to cyclone and subjected to stronglittoral drift. The beach on the Bay of Bengal is named as Gahirmatha beach. It separates the mangroves from the Bay of Bengal. It is also famous for the world's largest nesting ground for olive ridley sea turtles.

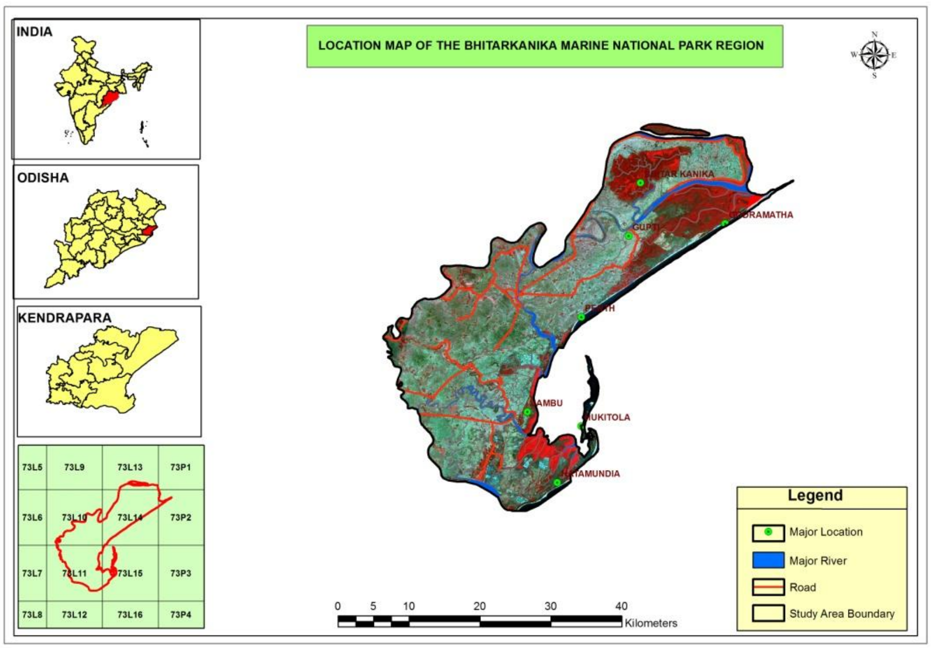


Figure 1. Location Map of the Study area

III. MATERIALS AND METHODS

In this investigation Landsat series of Satellite images and LISS-III, LISS-IV data were used for the period of 1973 to 2017. Landsat images are collected from United States Geological Survey (USGS) website, Earth Explorer (http://earthexplorer.usgs.gov/). Landsat images have been registered and geo-corrected from the source. And LISS-III data were downloaded from BHUVAN website of ISRO (Table-1).

Table-1: Satellite Data used

	Date of acquisition	Path	Row	Sensor
1973	17-Jan-73	149	53	Landsat-1
1985	17-Jan-85	149	46	Landsat-3
1995	14-Nov-95	139	46	LISS-III
2005	19-Feb-05	107	58	LISS-IV
2017	04-Mar-17	139	46	LISS-IV

DOI: http://doi.one/10.1729/IJCRT.17193

IV. DATA BASE PREPARATION

Landsat Thematic Mapper at a resolution of 30 m of 1973 and 1985 and LISS-III of 1995 and LISS-Iv of 2005 and 2017 were used for land use/cover classification. The satellite data (LANDSAT) covering study area were obtained from global earth explorer site (http://earthexplorer.usgs.gov/) and LISS-Iv data have been obtained from NRSC, ISRO. These datasets were imported in ERDAS Imagine version 14 (LeicaGeosystems, Atlanta, U.S.A.), satellite image processing software to create a false colour composite (FCC). The layer stack option in image interpreter tool box was used to generate FCCs for the study areas. The sub-setting of satellite images were performed for extracting study area from both images by taking geo-referenced out line boundary of the study area. All satellite images have been registered and geo-corrected from the source. Re-sampling of satellite images carried out using ERDAS-Imagine 2014 and the resolution is kept at 40meter after the resampling process. The visual image interpretation technique was adopted to classify the land use/land cover. A change detection matrix was generated by comparing the different years of thematic layers.

V. LAND USE/LAND COVER STATUS

The visual image interpretation technique was applied for the extraction of land use/land cover classes. Visual image interpretation keys such as tone, texture, color, association, shadow, size, shape etc. came into consideration while the interpretation of the image. Arc-Map (Ver-10.2) was used for this purpose. The land use classes' i.e. agricultural land, barren land, mangroves, land with-scrub, settlement, water bodies and plantation were classified for decadal changes analysis. A detailed Land use/land cover interpretation was carried out for different years such as 1973, 1985, 1995, 2005 and 2017.

The spatial distribution of different years are depicts in Fig.1-5.These data reveals that in 1973, about 61.19 %(671.90 km2) area of Bhitarkanika Marine National Park was under agricultural land, 3.97%(43.09 km^2) under barren land, 1.07%(11.64 km^2) under land with-scrub, 19.48%(211.54 km^2) under mangroves, 0.25%(2.67 km^2) under plantation, 4.07%(44.15 km^2) under settlement and 9.28%(100.73 km^2) under waterbodies. In 2017, areas under these categories was found about 49.78 %(540.44 km^2) under agricultural land, 9.65%(104.77 km^2) under barren land, 3.90%(42.34 km^2) under land with-scrub, 17.78%(193.07 km^2) under mangroves, 2.42%(26.24 km^2) under plantation, 7.22%(78.35 km^2)under settlement and 9.26%(100.51 km^2) under waterbodies.And land use spatial distribution for other years of interpretation are presented (Table-2). A pie-chart distribution of land use/land cover also prepared for graphical analysis of different classes of land use from 1973-2017.

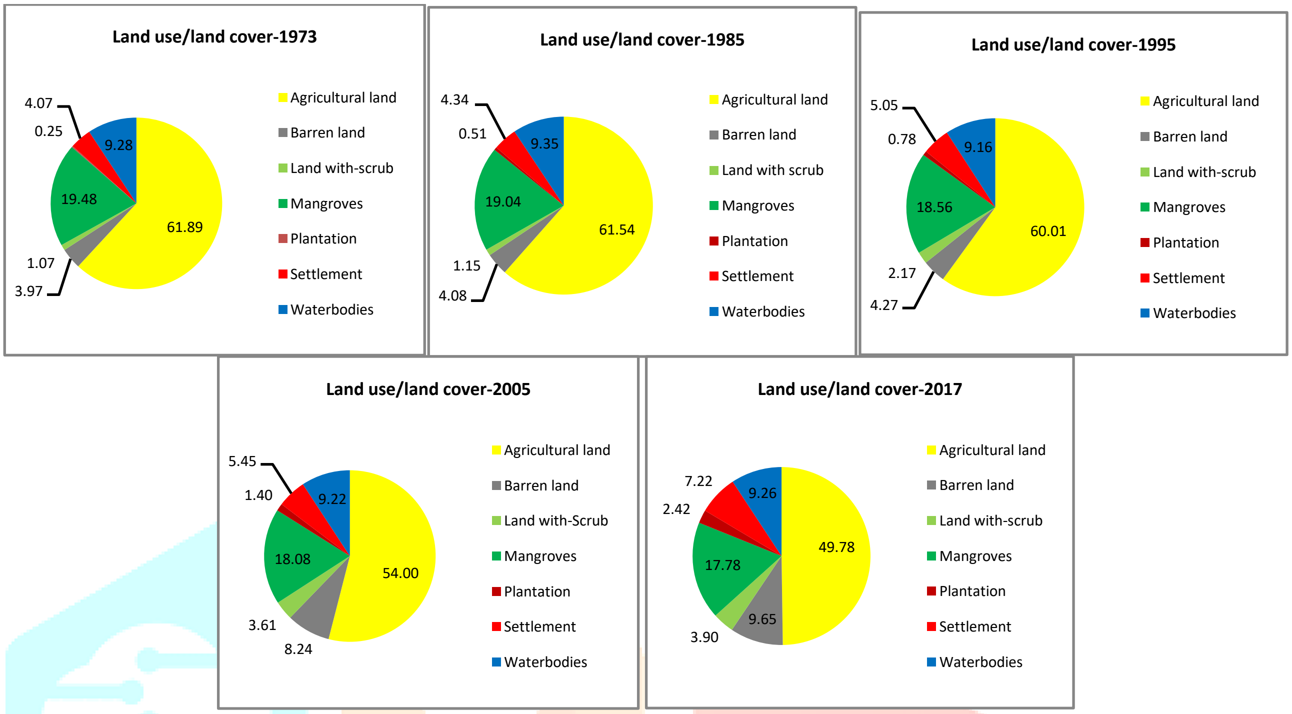
Table-2 Area and amount of change in different land use/land cover categories in the BNP area during 1973 to 2017

YEAR WISE LULC AREA IN SQ.K.M					
1973			1985		
CLASS	AREA(in Sq.k.m)	%	CLASS	AREA(in Sq.k.m)	%
Agricultural land	671.90	61.89	Agricultural land	668.15	61.54
Barren land	43.09	3.97	Barren land	44.30	4.08
Land with-scrub	11.64	1.07	Land with scrub	12.44	1.15
Mangroves	211.54	19.48	Mangroves	206.69	19.04
Plantation	2.67	0.25	Plantation	5.57	0.51
Settlement	44.15	4.07	Settlement	47.11	4.34
Waterbodies	100.73	9.28	Waterbodies	101.46	9.35
Total	1085.72	100.00	Total	1085.72	100.00
1995			2005		
CLASS	AREA(in Sq.k.m)	%	CLASS	AREA(in Sq.k.m)	%
Agricultural land	651.55	60.01	Agricultural land	586.32	54.00
Barren land	46.32	4.27	Barren land	89.45	8.24
Land with-scrub	23.54	2.17	Land with-Scrub	39.21	3.61
Mangroves	201.54	18.56	Mangroves	196.29	18.08
Plantation	8.43	0.78	Plantation	15.16	1.40
Settlement	54.87	5.05	Settlement	59.18	5.45
Waterbodies	99.47	9.16	Waterbodies	100.10	9.22
Total	1085.72	100.00	Total	1085.72	100.00
2017					
CLASS	AREA(in Sq.k.m)	%			
Agricultural land	540.44	49.78			
Barren land	104.77	9.65			
Land with-scrub	42.34	3.90			
Mangroves	193.07	17.78			
Plantation	26.24	2.42			
Settlement	78.35	7.22			
Waterbodies	100.51	9.26			
Total	1085.72	100.00			

***Note**:

Barren land includes Coastal sands, mudflats, Swampy area, Wetlands, Aquaculture ponds land without scrub) and Water bodies (River/Creeks, Tanks/Ponds). In each individual year of interpretation all land use classes have been identified using NRSC, Land use/Land cover standard.

Distribution of Land use/land cover from 1973 to 2017



VI. LAND USE/LAND COVER CHANGE DETECTION

For performing land use/cover change detection, a post-classification detection method was employed. Interpreted thematic layers of two different decade data were compared using cross-tabulation in order to determine qualitative and quantitative aspects of the changes for the periods from 1973 to 2017.Each year land use was compared to other year to analyse the change taken place in decade wise. Again each land use class were compared to other to know the percentage of degradation and other important aspect of changes which will help in knowing the Land use vulnerability of the study area. Quantitative areal data of the overall land use/cover changes as well as gains and losses in each category between 1973 and 2017 were then compiled.

Table 3 Land use/land cover change matrix in different years in BNP area

Land use/Land Cover Change Detection Matrix							
	Agricultural land	Barren land	Land with-scrub	Mangroves	Plantation	Settlement	Waterbodies
Changes	1973-1985						
Change in Sq. km	-3.75	1.21	0.80	-4.85	2.90	2.96	0.73
Change(%)	-0.35	0.11	0.07	-0.45	0.27	0.27	0.07
Avg. change(%)	-0.03	0.01	0.01	-0.04	0.02	0.02	0.01
	1973-1995						
Change in Sq. km	-20.35	3.23	11.90	-10.00	5.76	10.72	-1.26
Change(%)	-1.87	0.30	1.10	-0.92	0.53	0.99	-0.12
Avg. change(%)	-0.09	0.01	0.05	-0.04	0.02	0.04	-0.01
	1973-2005						
Change in Sq. km	-85.58	46.36	27.58	-15.25	12.49	15.03	-0.63
Change(%)	-7.88	4.27	2.54	-1.40	1.15	1.38	-0.06
Avg. change(%)	-0.25	0.13	0.08	-0.04	0.04	0.04	-0.0018
	1973-2017						
Change in Sq. km	-131.46	61.68	30.70	-18.47	23.57	34.20	-0.22
Change(%)	-12.11	5.68	2.83	-1.70	2.17	3.15	-0.02
Avg. change(%)	-0.28	0.13	0.06	-0.04	0.05	0.07	-0.00046
	1985-1995						
Change in Sq. km	-16.60	2.02	11.10	-5.15	2.86	7.76	-1.99
Change(%)	-1.53	0.19	1.02	-0.47	0.26	0.71	-0.18
Avg. change(%)	-0.15	0.02	0.10	-0.05	0.03	0.07	-0.02
	1995-2005						
Change in Sq. km	-65.23	43.13	15.67	-5.25	6.73	4.31	0.63
Change(%)	-6.01	3.97	1.44	-0.48	0.62	0.40	0.06
Avg. change(%)	-0.60	0.40	0.14	-0.05	0.06	0.04	0.01
	2005-2017						
Change in Sq. km	-45.88	15.32	3.13	-3.22	11.08	19.17	0.41
Change(%)	-4.23	1.41	0.29	-0.30	1.02	1.77	0.04
Avg. change(%)	-0.35	0.12	0.02	-0.02	0.09	0.15	0.0031

VII. RESULTS & DISCUSSION

The land use/land cover map was processed from LANDSAT –TM and IRS- LISS-II images. LULC maps from multi-temporal dataset such as 1973, 1985, 1995, 2005 and 2017 have been prepared by using the Arc-Map (ver.10.2). The study area has been classified as Agricultural land, Barren land, Land with-scrub, Mangroves, Plantation, Settlement and Water bodies. For each year, individual LULC map has been generated using visual image interpretation technique. The results obtained through the analysis of multi-temporal satellite imageries were diagrammatically illustrated in Figs. 2–6 and data are registered in Tables 2 and 3. A brief account of these results is discussed in the following paragraphs.

Data registered in Table 3 reveal that both positive and negative changes occurred in the land use/cover pattern of the study area. A change detection matrix has been prepared for different time periods. Changes between 1973-1985, 1973-1995, 1973-2005, 1973-2017,1985-1995, 1995-2005, 2005-2017 have been studied (Table-3). It is observed that areal extent of agricultural land has been decreased continuously as (671.90 Sq. km^2-1973, 668.15 km^2-1985, 651.55 km^2-1995, 586.32 km^2-2005 and 540.44 km^2-2017. The frequent variation in the agricultural land extent in the study area may be due to conversion of forest land in to agricultural land and other activities. The barren land as computed are as follows: 43.09 Sq.km2 (1973), 44.30 Sq.km2 (1985), 46.32 Sq.km2 (1995), 89.45 Sq.km^2 (2005) and 104.77 Sq.km^2 (2017). There is a drastic increase in barren land due to the development activities and degradation of vegetation in the study area. The spatial distribution of land with scrub class shows that there is a little increase in decade wise study.

The percentage of areal extent of Mangroves is reduced from 211.54 Sq.km^2 in 1973 to 193.07 Sq.km^2 in 2017. It is studied the areal extent of plantation is increasing continuously as follows: 2.67 Sq.km^2 -1973, 5.57 Sq.km^2 -1985, 8.43 Sq.km^2 -1995, 15.16 Sq.km^2 -2005 and 26.24 Sq.km2 -2017.It is observed that, Government has taken some initiatives for the sustainable development in the study area. Some degraded areas are now under plantation. The settlement distribution is rapidly increased which is adding tremendous pressure in the dynamic coastal environment. The study as computed for settlement categories is as follows: 44.15 Sq.km^2 -1973, 47.11 Sq.km^2 -1985, 54.87 Sq.km^2 -1995, 59.18 Sq.km^2 -2005 and 78.35 Sq.km^2 -2017.The extent of water bodies extent varies in different year of study due to imaging time.

It is observed that there are drastic changes in vegetation cover between different years. Severe cyclones have been experienced along the coast in the years 1967, 1971, 1980, 1981, 1984, 1999, 2013 and 2014.Due to this the vegetation cover has been also denuded. The study area not only affected by Tropical Cyclone but also it is also victim of severe flood from time to time. Some destructive floods were also witnessed in the years 1971, 1977, 1980, 1982, 1991, 1992, 1994, 1995, 1992, 1999, 2001, 2003, 2005, 2006, 2007, 2008, 2009, 2011and 2013. Conversion of agricultural land into industrial purpose, aquaculture and other developmental activities as well as vegetation clearance for settlement activities resulted in the deterioration in the natural vegetation cover.

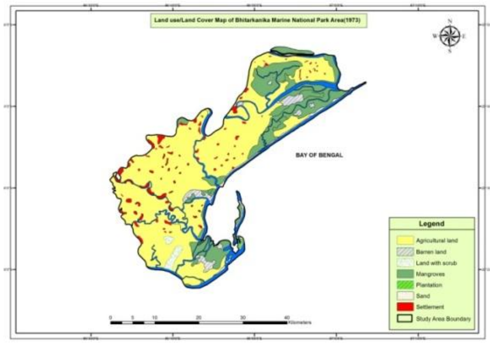
VIII. LULC VULNERABILITY ANALYSIS

In the present study, it is observed that there is a continuous degradation in the land use/land cover from the period 1973 to 2017.The land use vulnerability can be well discussed with some specific vulnerability classes such as Degradation in vegetation classes, increase in Barren land and sprawl in Settlement in the study area. The following data gives a clear observation of the vulnerability status presented in Sq.km^2: The areal extent of Mangroves has been decreasing (211.54-1973, 206.69-1985, 201.54-1995, 196.29-2005 and 193.07-2017).Some specific reason behind this drastic degradation are such as Encroachment of forest land and conversion in to other purpose and Dependence on Mangroves is rapidly increased. Spatial distribution of Barren land also rapidly increased such as 43.09-1973, 44.30-1985, 46.32-1995, 89.45-2005 and 104.77.Conversion of Agriculture land and forest land to Aquaculture activity poses tremendous biotic pressure on Mangroves, aquatic fauna and wildlife.In between 1995 to 2017, barren land has been marked more than twice in area as compared to 1973.There is a sprawl of settlement from 1973-2017 and the data shows the clear picture of this tremendous growth of population and settlement (44.15-1973, 47.11-1985, 54.87-1995, 59.18-2005 and 78.35-2017).Population growth leads to pressure on the Mangrove, Olive Ridley Sea turtle and other flora and fauna found in the study area.

IX. CONCLUSION

The study conducted in the Bhitarkanika marine National Park (BNP) region of Kendrapara district in Odisha state (India) advocates that multi temporal satellite imagery plays a vital role in quantifying spatial and temporal phenomena which is otherwise not possible to attempt through conventional mapping. Thus, the present study illustrates that remote sensing and GIS are important technologies for temporal analysis and quantification of spatial phenomena which is otherwise not possible to attempt through conventional mapping techniques. Change detection is made possible by these technologies in less time with low cost and better accuracy.The coastal land use/land cover and their apparent changes are studied. The observations clearly indicate degradation of vegetation occurred due to natural and anthropogenic factors. The study supports adoption of conservation measures andprotection plans. Thus, in order to achieve a sustainable development in the delicate coastal ecosystem, involvement of local community at all levels is essential to protect the Eco-sensitive Bhitarkanika Marine National Park region.

© 2018 IJCRT | Volume 6, Issue 1 January 2018 | ISSN: 2320-2882
DOI: http://doi.one/10.1729/IJCRT.17193



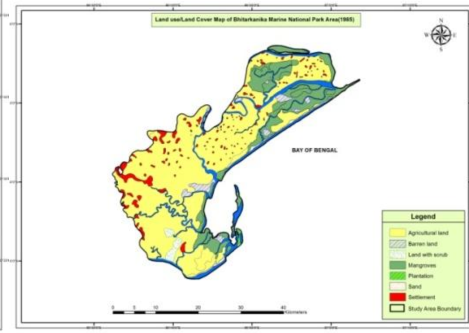
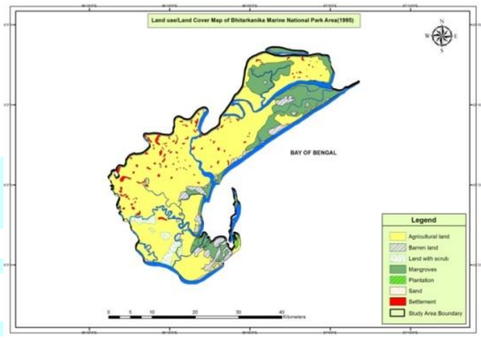


Figure 2. LULC Map-1973Figure 3. LULC Map-1985



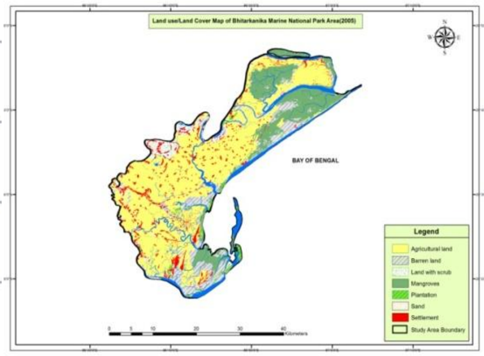


Figure 4. LULC Map-1995Figure 5. LULC Map-2005

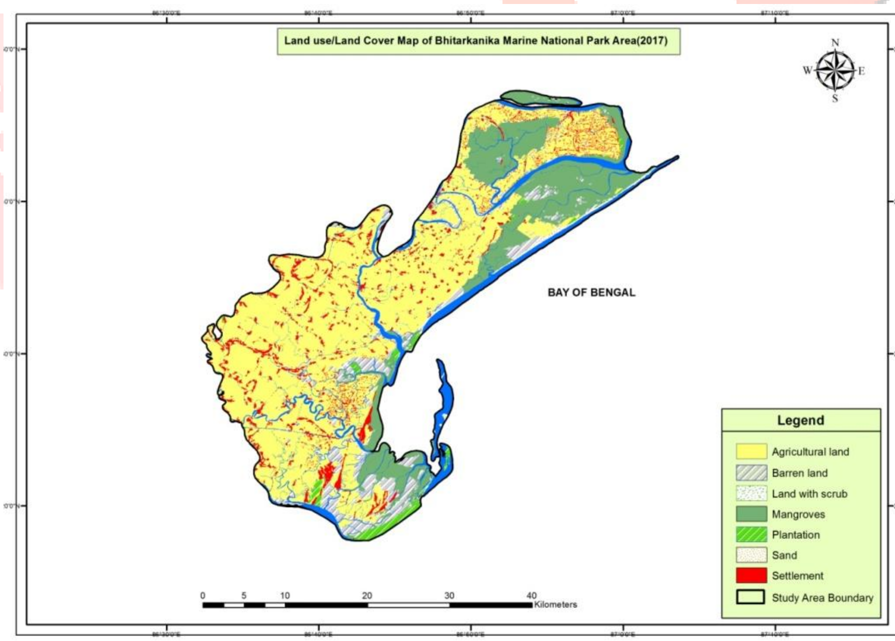


Figure 6. LULC Map-2017

DOI: http://doi.one/10.1729/IJCRT.17193

REFRENCES

[1] Banerjee, L.K., Ecological studies on the mangals in the Mahanadi estuarine delta, Orissa. Tropical Ecology. 28 .1987:117-125.

[2] Brandzio, E.S., Moran, E., Wu, Y.1994.Land use change in the Amazon estuary. Patterns of Caboclo settlements and landscape management. Human Ecology.Vol.22 (3):249-278.

[3] Butt, A., Shabbir, R., Ahmad, S.S and Aziz, N Land Use Change Mapping and Analysis Using Remote Sensing and GIS: A case study of Simly watershed, Islamabad, Pakistan. The Egyptian J. of Remote Sensing and Space Sciences. Vol. 18.2015:251-259.

[4] Chambell, J.B.Introduction to Remote Sensing, 4th edition, The Guilford Press, New York, USA.

[5] Cowell,P.J.,Thom,P.G.1994.Morphodynamics of coastal evolution.In:Carter.R.W.G.,Woodrotte,C.D(eds),Coastal evolution: lateQuaternary Shoreline dynamics. Cambridge University Press, Cambridge: 33-86.

[6] Cohen, J.E.; Small, C.; Mellinger, A.; Gallup, J.,Saches, J.; Vi-Tousek, P.M., and Mooney, H.B.,Estimates of coastal populations, Science, 14 November, 278.1997:1209-1213.

[7] Das, S. The role of natural ecosystems and socio-economic factors in the vulnerability of coastal villages to cyclone and storm surge. Nat. Hazards, 64.2012:531-546.

[8] Kumar, P. Integrated Coastal Zone Management of Orissa, Management of Coastal Ecosystem, Utkal University, Bhubaneswar.2004:31-37.

[9] Lu, D., Mausel, P., Brondizio, E., Moran, E.2004.Change Detection Techniques.Int.J.of Remote Sensing.Vol25:2365-2407.

[10] Muttitanan,W & Tripathi,N.K.2005.Land use/land cover change in the coastal zone of ban Dan Bay, Thailand using Landsat 5 TM data, Int. J.of Remote Sensing, 26(11):2311-2323.

[11] Mas,J.F.,Velazqucz,A.,Gallegos,J.R.D.,Saucodo,R.M.,Alcantax,C.,Bocco,G.,Castro,R.,Fernandez,T.,Vega,A.P.2004.Assessing land use/land cover change nationwide Multi-date spatial database for Mexico.Int.J.of Applied earth observation and Geoinformation.vol(5):249-261.

[12] Nayak, S., Gupta, Gupta, M.C., Paneya, A., Shaikh, M.G., Chauhan, H.B., and Rao, R.S.1989.Application of Remote Sensing For Monitoring of Coastal Environment, Proc. Appreciation seminar on Remote Sensing of Environment, Ahmedabad, India, Feb 3,1989:105-132.

[13] Palria, S. (Remote Sensing for Keoladeo National Park Wetland, Project Report, MDSU/KNP/PR/2001, Department of Environmental Studies, M.D.S. University, Ajmer.2001.

[14] Pattnaik, C., Reddy, C.S., Murthy, M.S.R., and Swam, S.Assessment and monitoring the coastal wetland and ecology using Remote Sensing and GIS with reference to Bhitarkanika mangroves of Orissa, India. Lakes and Coastal Wetland Conservation, Restoration and Management. Capital Publishing Company, New Delhi.2007:275-285.

[15] Reddy, A.S and Readdy, J.M NDVI based Assessment of Land Use Land Cover Dynamics in A Rain fed Watershed Using Remote Sensing and GIS: Int. Jn. Of Scientific & Engineering Research, Vol 4(12), (2013):pp.87-93.

[16] Short, A.D., Trembanis, A.C.2004.Decadal Scale patterns in beach oscillation and rotation Narrabeen beach, US-Time series, PCA and Wavelet Analysis.J.of Coast Res.vol (20):523-532.

[17] Shi, P.J., LI, P., Z.B.2000.Methods and Practice of land use changes in research. Science Press.Bejing, China.

[18] SAC, Manual for mapping of coastal wetlands/landforms and shoreline changes using satellite data. Space Applications Centre (ISRO), Project Report: IRS-UP/SAC/MCE/TN/32/91,March.1991:43-47.

[19] Sevoski, I., Newton, A., Demison, W.C.2012.Megacities in the Coastal Zone: Using a driver-pressure-state-important-response framework to address complex environmental problems.Estuar Coast. Shelf Sci.96:48-59.

[20] Shetty, A., Jayappa, K.S., Mitra, D.2015.Shoreline change analysis of Mangalore coast and morphometric analysis of Netravathi-Gurupur and mulky-Pavanje Spits, In: Aquat: Procedia, Int. Conference on water resources, Coastal and Ocean engineering, vol (4):182-189.

[21] Zsuzsanna, D., Bartholy, J., Z.2005.Analysis of land use/land cover change in the Carpathian region based on remote sensing techniques. Physics and Chemistry of Earth.Vol (30):109-155.