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ASSESSING THE PHYSICAL CHANGES AND THE STRESSES ON THE COASTAL AREAS USING GEOINFORMATICS FROM SIPASURUBILI TO MOHANIPUR, PURI, ODISHA

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ABSTRACT

Climate change occurs naturally besides it has increased after the involvement of human activities. Theimpacts are observed in agriculture, transport, forestry, maritime and coast etc. Majorly the impacts ofclimate change are observed on the agricultural sector and on the coastal sector. Most of the people residing near/on the coast are directly or indirectly relying on coast for their livelihoods, which in turnalso has direct along with indirect impacts on the marine life. Coastal areas are one of the important key systems for global sustainability. These are the transition areas between land and sea. The activitieshave put the Indian coastal areas under threat along with multiple stressors like global climatic changeand human interference. These stressors are driving vulnerabilities like sea-level rise, coastal erosion,frequent extreme events, and saltwater intrusion. In this scenario, the most important thing in the last two decades has been the coastal management. In the present research, the main focus is given on the coastal area of Puri beach which covers the coastline from Sipasurubili to Mohanipur. In recent years, there has been much focus on the coastal vulnerability assessments using various kinds of data. Keeping the applications of satellite based remote sensing and GIS in the study of the coastal area, thisresearch tries to assess the impacts of humans and what are the various physical changes that have occurred in decades.

Keywords: *Climate Change, Coast, impacts, Vulnerability, Remote Sensing, Stress, Ecosystem, GIS.*

INTRODUCTION

Coastal conservation is of utmost importance because one third of population is relying on coastal life for their livelihood. According to the Center for International Earth Science Information Network (CIESIN) of Columbia University, in India, one fourth of the population lives within 100km of the coast, one third within 200 km of the coast. Population densities in the coastal urbanareas were close to 100 people per km^2 compared with inland densities of 38 people per square kilometer in 2000. The extreme events have increased after the interference of anthropogenic activities such as the growth rate of emissions since the industrial era and urbanization has increased. The global climate has been changing since the earth was formed but then it was a natural process but as soon as the industries came into existence the emissions of different kinds of gases lead to the rise in greenhouse gases which are responsible for the current climate change(Kumar *et* al., 2018). Due to climate change the impacts on coasts have increased drastically as most of the population resides on or nearby the coast and there has been a rise in the number of extreme events like flood, cyclone, etc. In the year 1999, the Super cyclone, also known as ParadipCyclone hit Odisha with a speed of 250 km/h, resulting in a huge death toll of about 10,000 peopleand extreme

damage was caused in its path to the property as well. That cyclone flattened hundred thousand houses, uprooted trees and destroyed infrastructure, thousands of livestock were lost, paddy and other crop fields were submerged and a large number of people were severely affectedby the disaster. Those who were residing on the coast were fully dependent on the marine life fortheir food and earnings but after the devastation that was caused by the cyclone there was no source of income left, which directly affected the economy of the state (IndiaToday.in 1516419-2019-05-03, 2019).
Climate change impacts on coast have increased in the past decades due to rise in the population.

The impacts of climate change are directly or indirectly noticeable on the human health as well asmarine health. Most of the human population residing on the coast and a slight change in weatheror coastal conditions can affect their lives a lot. There are main two causes of climate change - natural and anthropogenic. The natural cause includes the volcanic eruptions, methane emissions from animals, etc whereas the human induced cause includes the rise in greenhouse gases which gives rise to global warming, the rise in built-up areas giving rise to urban heat island effect whichin-turn would directly or indirectly give rise to global warming creating a vicious cycle. The impacts of climate change can be observed on the people relying on coastal life for their livelihood.The slight change in precipitation pattern can directly affect the coastal agriculture, coastal life and the fisherman's earning would be at stake. Due to climate change there are several impacts that have been observed such as the change in precipitation leading to floods and droughts directlyaffecting the socio-economic situation of the study area Donev *et al.*, 2018). Even warming of theoceans alters the food chain and the breeding and mating patterns of the marine animals, hamperingthe growth of marine life. The pollution on the beaches also has stopped fauna such as migratory birds; Olive Ridley turtles etc., from coming and breeding along the coast.

STUDY AREA

Puri is a district in Odisha which is 3051 km^2 in area and is renowned for the religious sites especially the Jagannath Mandir, which is one of the four religiously pious sites also called the Char Dham. Thus attracting a large amount of tourists and visitors and the trend tends to show theincrement of the visitors in the coming years (Paul *et al.,* 2017).

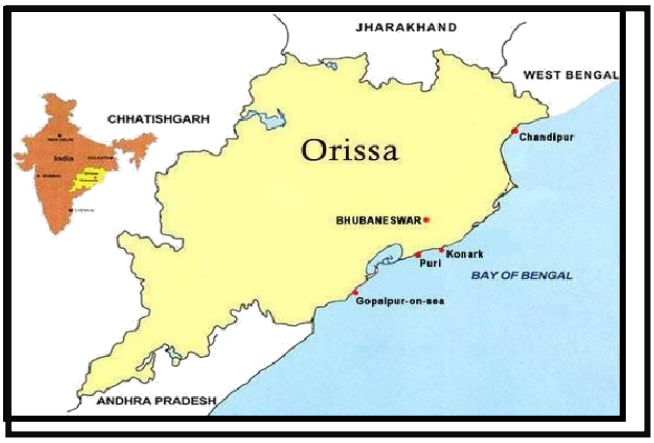
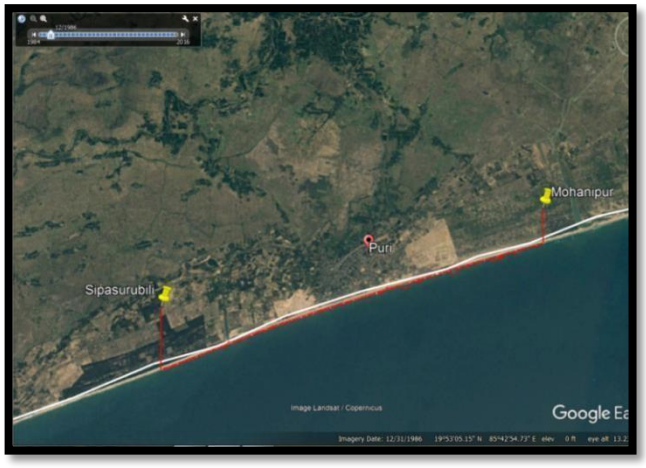


Figure 1: Map of Odisha State

Above map depicts the state of Odisha. Population growth is another reason because as the population increases the demand for food, water, amenities, and security also increases. The morethe population, the more will be the pollution which directly contributes to the climate change because as the population increases the carbon footprint also increases. Puri has the climate classification as "Aw" (Tropical Savanna Climate).The languages spoken in Puri are Odia, Bengali, Hindi, English, and Telegu (Mohanty *et* al., 2008). This research was carried out for the comparative study of the physical changes from the area Sipasurubili to Mohanipur which showednoticeable changes throughout the years under study.

Figure 2: the study area from Sipasurubili to Mohanipur

The study was done with the use of remote sensing and GIS. The years 1986 and 2016 were usedfor the study of land-use land-cover change. The coastal areas have been assuming more importance in recent years due to the increase in human population and accelerated



developmentalactivities which include industrial and maritime development. Rising sea levels coupled with change in wind patterns are causing high tidal waves and inundating coasts for a longer period oftime (Nicholls, 2002). Human triggered environmental impacts are one of the major issues faced by coast. Coastal zones in India assume importance because of high productivity of its ecosystems,concentration of population, exploitation of renewable and non-renewable natural resources, discharge of waste effluents and municipal sewage, industrialization. Coastal zones are continuously changing because of the dynamic interactions between the ocean and land. Erosion and accretion, inundation due to sea level rise and storm surge, Shifting shoreline caused by naturalor anthropogenic forces, such as construction of artificial structure, port and harbors leads to changes in the coastal zone and it's environment. Thus, regular monitoring of coastal zone is indispensable, Moreover, preparation of a suitable coastal zone management plan as well as implementation of regulations in the coastal zone require spatial information on the coastal land use and land forms along with high tide and low tide lines, the inventory and status of coastal habitat and information on ESAs (Ecologically Sensitive Areas).

MATERIALS AND METHODOLOGY

The land use/land cover changes were observed using Remote sensing data and GIS, Google EarthPro tools. The area and distance was measured using Google Earth Pro and the land use/ land coverclassification were done for the following two years 1986 and 2016 in ArcGIS 10.4.The satellites'data which were used for the study were LANDSAT and COPERNICUS used by Google Earth Pro engine.

APPLICATIONS OF REMOTE SENSING IN COASTAL REGION

Applying remote sensing in the study of coastal zone management gives idea about the coastal habitat, marine water quality, marine environment and climate change, the change in shoreline from time to time so that a proper knowledge is distributed amongst the researcher and students about the climate change and its impacts on coastal region so that the shoreline can be protected by making informed decisions and proper implementation of policy

instruments providing solutions and withstanding plans for decreasing the impacts of floods, cyclones or any other catastrophic climatic extreme events (Miller *et* al., 2005).

GIS APPLICATIONS IN LAND USE / LAND COVER STUDIES

According to Zhou, (2004), Geographical Information System (GIS) has two important applications for its characteristic. In land use / land cover change detection, land cover data and other GIS data can be used to make the detection. On the other hand, GIS provides many methodsin the land use / land cover research. In the land use / land cover change detection, driving factorsand impact analysis many GIS methods which are from simple spatial analysis are used (Feng andZhou, 2004). The analysis such as image differencing, vegetation index differencing, selective principal components analysis, and direct multi-date classification, post-classification analysis andso on can be carried out by the use of GIS based land use land cover data (Coppin *et* al 2004; Mas,1999).

IMAGE CLASSIFICATION FOR LAND USE AND LAND COVER CHANGE ASSESSMENT

Land use and land cover change can be detected from time to time of a region (Sekovski *et al.*, 2014). Here the study area is the coast line from Sipasurubili to Mohanipur of Puri Coast in whichyears taken for the observation and study has the decadal change detection for 30 years so that thechanges can be clearly observed. The land-use land-cover changes were classified after which thecalculation of the shifts in various LULUC classes was carried out to estimate the changes using ArcGIS 10.4.

RESULTS AND CONCLUSION

For analyzing the land use/ land cover of the above study area different tools were used throughwhich the following results were obtained

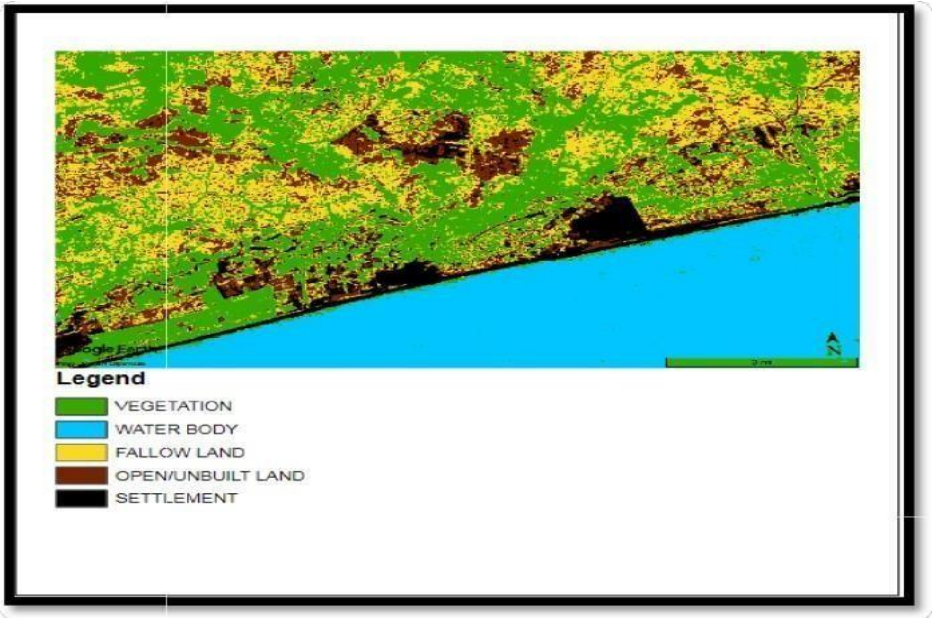
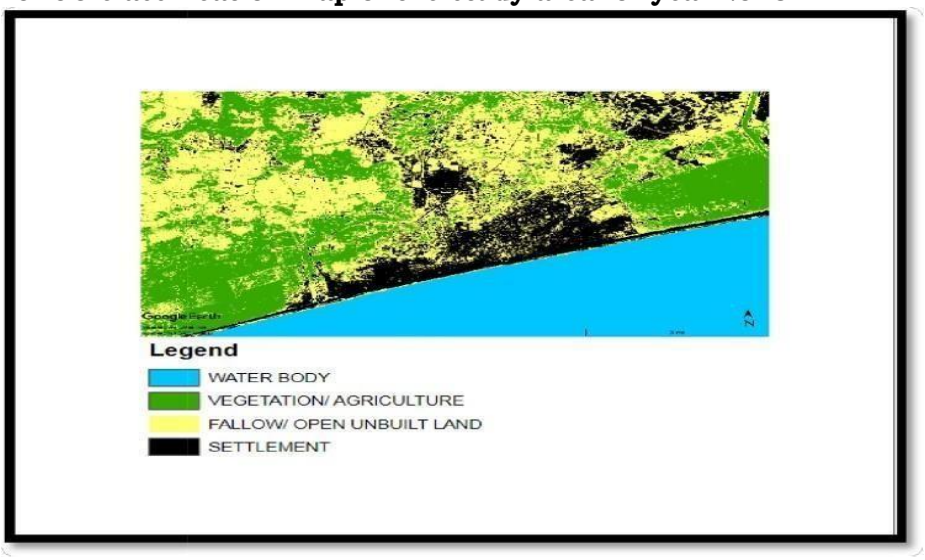


Figure 3: LULUC classification Map of study area for year 1986.

Figure 4: LULUC classification Map of the study area for year 2016



The difference of these two years can be clearly seen in the table given below in the three main LULUC classes:

SRNO.	CLASS/ CATEGORY	YEAR		DIFFERENCE (%)
		1986 (%)	2016 (%)	
1	Agriculture / Vegetation	43.77%	33.58%	-10.19 %
2	Fallow Land/ Open Land	48.6%	44.94%	-3.66%
3	Settlement	7.61%	21.46%	+13.85%

Table 1.1: Showing difference between the year 1986 and 2016

From the images and table shown above it can be clearly noticed that the increase of anthropogenicactivities on/ near the coast/ shoreline have a great impact on the coastal life and the people depending on the coastal life for livelihood. The land-use land-cover differences of the two years1986 - 2016 can be clearly seen which states the following:

- In 1986 the vegetation and agriculture was 43.77% which decreased to 33.56% in 2016.
- In 1986 the fallow land/ open land was 48.6% which decreases to 44.94% in 2016. This shows that most of these open lands were converted into built up areas as there was a decrease inthe vegetated or grown areas and almost a doubling of the built up land in 2016.
- In 1986 the settlement was only 7.61% which gradually increased over the years to 21.46%in 2016 which is almost thrice than the previous decade of study, exhibiting a rise of 13.85%.

CONCLUSION

From the above research work it can be concluded that the LULUC changes are clearly observableby using the tools and software like RS, GIS, GR, GEP, etc.

The construction near the beach has gradually increased in past decades due to which the climate and coastal area are affected. The population has played an important role in affecting the coast, the tourism has increased due to which the beach pollution has increased a lot. From the above study it can be concluded that from the year 1986 to 2016 the vegetation area has decreased due to increase of anthropogenic activities like clearing land for commercial activities as well as increment in settlements both leading to encroachment on the beaches. This encroachment is bothillustrated in the above LULUC classification and in the following figure:

Figure 5: The above image shows the pollution and human intervention in the beach area **a) The image shows degradation of the beach area b) The human interference and pollutionin the beach area c) The commercial activities and setups in the immediate proximity of the** coast d) Encroachment of the population for leisure activities

As clearly visible from the remote sensing data and GIS based analysis that the encroachment on the coastal land for both economic and residential purposes has not only led to exertion of more pressure on the coastal land and resources but also has made an increased amount of population more and more vulnerable towards future climate change and its impacts. The above mentioned changes in the LULUC is drastic considering the IPCC 2007 report stating the projections of sea level to rise from 8 to 20 inches globally by the end of the century. But a study from INCOIS (2018) suggested that the rise could be as severe as 34 inches (2.8 feet) which could be devastatingfor much of the Indian coast especially the low lying areas of Odisha, especially in southern Puri places like the Astaranga port which is a high erosion region (Mishra, *et al.*, 2019).

STRATEGIES TO CONSERVE COASTAL AREAS

As we know that the climate change and human interference in coastal areas have increased whichposes a threat to the coastal life so there are some policies or regulations to conserve shoreline (Notification, C. R. Z., 1991).

1) Prohibiting Some Activities On Coast And Sea/Ocean:

i. release of untreated wastes and effluents from industries, cities or towns and other humansettlements should be stopped
ii. dumping of garbage on the coast should be banned
iii. mining of sand, rocks and other materials should be stopped
iv. construction / built-up activities in ecologically sensitive area should be banned accordingto theCRZ norms
v. proper monitoring should be carried out timely so that rules can be followed

2) Management And Regulations On/ Near The Coast

i. timely inspections should be carried out to know about how beaches are maintained

ii. dykes or walls can be made to prevent soil erosion

iii. mangroves/ vegetation should be planted along the shoreline to prevent from disasters likecyclone, hurricane, storm

iv. regulations should be followed regarding the built-ups in the coastal area

v. timely beach cleanup should be done with the support of public participation

❖ Awareness of climate change among the people via different activities should be included in schools, colleges, offices, etc. More information should be provided through social media.

❖ Use of remote sensing, GIS etc. should be known to the different fields of people. Multi temporalsatellite data and multiyear data and information should be available for future so that climate models can be prepared.

❖ For protecting or restoring natural shoreline buffers like sand dunes and wetlands, improving stormdrainage systems, and building protective barriers where necessary can be done by the coastal cities to prevent the impacts of climate change.

❖ People should protect wetlands as much as possible by not disturbing the land, the flow of water, or vegetation in these areas.

❖ Plantation of mangroves and vegetation should be given more focus so that natural hazards can bestopped and destruction due to these hazards would be reduced.

❖ The public participation should be made compulsory through which more number of people would be conscious about the coastal hazards and proper planning such as pre-disaster, post-disaster activities can be carried out.

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IMAGE SOURCES:

1) http://brethrentimes.com/2013/09/event-orissaleaders/
2) Image downloaded from Google Earth Pro with path showing the study area (Sipasurubili to Mohanipur)
3) LULUC classification of the year 1986 was done by using software ARCGIS/QGIS
4) LULUC classification of the year 2016 was done by using software ARCGIS/QGIS5)
5) https://images.app.goo.gl/qZy3AysjJZHWNZ469
6) https://images.app.goo.gl/b67NE3S7zjkSD2sD6
7) & D. Images taken during field survey