Research Paper

Volume : 4 | Issue : 10 | October 2015 • ISSN No 2277 - 8179

Impact of Spatial Resolution on Coastal Zone Mapping

Science

KEYWORDS : Coastal Zone, Spatial Resolution, Mapping, Land use, Sustainable Development

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ABSTRACT

Coast is an area where air, land and ocean waters meet. India has a long coastline of 7516.6 km (Nayak S.R. et. al., 1992). The present paper reports the study of the impact of spatial resolution on the classification of various wetland and landuse classes in the coastal zone. Hazira area near Surat city was selected for the study area as many anthropogenic activities have taken place and many more developmental projects are coming up in this area. The landuse / landcover change is very rapid, thus making this area highly vulnerable. Data from LISS III, LISS IV and CARTOSAT have been used for landuse classification in the study. CARTOSAT PAN data was merged with LISS IV to classify various coastal wetland and landuse features. The classification system developed by SAC for wetland and landuse mapping in Coastal Regulation Zone (CRZ) has been used (Nayak et. al., 1991). Certain features, which are visible but not possible to map at the medium resolution data, can be identified and mapped using merge (CARTOSAT + LISS IV) data. Merging the CARTOSAT and LISS IV data allows to exploit full benefit of spatial and spectral resolution. Merged data allow differentiating various vegetation classes, which is not possible using CARTOSAT data alone. Improvement in spatial resolution enhances the interpretability and the accuracy of the mapping in the coastal zone. Thus satellite data like LISS III and LISS IV can be used to prepare wetland and landuse maps on 1: 25,000 scale, which can be used for regional planning; where as CARTOSAT merged data (CARTOSAT + LISS IV) can be used to map the coastal zone on 1:5,000 scale, which can be used for local level planning.

Introduction:

Coastal zone is an area where interaction of ocean water and landmasses occurrs. Atmosphere is also interacting with both together in the region. Unique ecosystems like mangrove, coral, tidal mudflats occur in this region only. Coastal zone assumes importance because of various developmental activities like industry, port development, population pressure, waste disposal and recreational activities. These activities put pressure on the fragile ecosystems and resultant impact of these activities make the coast vulnerable. Since coasts provide food and shelter to the humans, coastal development should take place in a sustainable manner. In the pursuit of progress, knowingly or unknowingly, unplanned growth can make man susceptible to natural hazards and calamity. Thus, sustainable, well-planned growth is prerequisite for the existence of human life and property in the coastal area. Taking the stock of resources available is the first step in any planned management process. Baseline information is a key to every sustainable development. To understand the system and various interactions of the system with other systems, constant monitoring is required. It should be for longer duration, enough to understand the total impact on the eco-system (e.g. Lunar cycle is of 18.6 years. So, we should have minimum more than 19 years of data to understand full impact of tidal activity on the other related activities.). Remote sensing, because of its repetitive, synoptic, multi-band, multi-sensor capabilities becomes an ideal choice for mapping and monitoring the natural resources. In the present study we are using the remote sensing sensors available in visible and IR bands for studying the coastal landuse changes.

Objective and Study Area:

Main objective of the present work is to study the impact of spatial resolution on the classification of various wetland and landuse classes in the coastal zone. The Surat district stretches from the Damanganga River in South to the river Kim in the north on the coastal fronts. The Surat district has 15 towns and 1938 villages. Total population of the Surat district is 49, 95,174 (Census, 2001). The Chorasi Taluka stands at Tapi River and Surat city was included in this Taluka (Fig. 1). Surat district has the highest investment in large projects in Gujarat (Industries in Gujarat, 2004). At Surat and Hazira large industrial units, petrochemical units, fertilizer units have come up or are developing. Hazira is also being developed as a port. These development activities require large number of people and this area has therefore attracted lot of housing construction also. These situations create problems like air / water pollution, shortage of drinking water, waste disposal, recreational needs, erosion and depositional changes and results in degradation and exploitation of coastal resources. The largest industrial development, which is mainly concentrated along the coast, needs special attention in order to protect the coastal ecosystems. Sustainable coastal zone development requires taking the stock of the natural resources, proper planning and constant monitoring of the developmental activities. Because of availability of natural resources like gas & oil onshore from Gandhar to Hazira, favorable economical, social, climatic and other parameters, South Gujarat has become the prime industrial hub in this region having very high economical growth rate. Varieties of industries like textile, dye and dye intermediates, chemicals, petrochemicals and on-shore and off- shore oil and gas explorations have developed in this region. Also, free economy boosts port development. All this rapid development and man made activities are making a great impact on the coastal ecosystem of this area and altering the coastline and coastal area.

Data used and methodology:

To evaluate the effect of spatial resolution on classification of the coastal wetland / landuse different data from sensors like LISS III, LISS IV acquired on 7 June 2004and CARTOSAT 1 PAN data acquired on 21 November 2005 were used (Appendix 1). Merge product of LISS IV and CARTOSAT1 PAN was also used for the present study. Radiometrically corrected data was procured from NRSA, Hyderabad.

Appendix 1: Characteristics of different Sensors used for mapping

Sr. No.	Sensor	Spatial resolution	Spectral bands	Radiometric resolution
1	LISS III	23.5	0.52 - 0.59 μm 0.62 – 0.68 μm 0.77 – 0.86 μm 1.55 – 1.70 μm	7
2	LISS IV	5.8	0.52 - 0.59 μm 0.62 – 0.68 μm 0.77 – 0.86 μm	7
3	CARTOSAT 1	2.5	0.50 – 0.80 μm	10

LISS III data was first geo-corrected with the help of topographical map of the study area. First-degree polynomial transformation was performed and overall error was kept less than 0.5 pixels. This corrected LISS III data was used to correct the LISS IV and CARTOSAT 1 data. Resolution merger was performed using LISS IV and CARTOSAT 1 data. First, LISS IV data was resampled and geo referenced to CARTOSAT 1 data for generating merge product. Resolution merge methods, namely, Principal Component Analysis (PCA), Multiplicative and Brovey are readily available in ERDAS image processing system. These methods are used for generating merged image (Chauhan, H. B. and Nayak Shailesh, 2000). HIS (Hue- Intensity-Saturation) method is found suitable for coastal landuse (Chauhan, 1990) and applied for the present exercise to generate merge product. Classification of the different coastal wetland features like, mudflat, beach, spit, mangrove, sea grass etc. and landuse categories like mining area, barren land, habitation, Agriculture land, was carried out using classification system developed by SAC (Nayak et al., 1992). Onscreen digitization method for visual interpretation was used for the classification. Independent analysis of different sensors LISS III, LISS IV, CARTOSAT1 and merged (LISS IV + PAN) data was carried out and information upto different levels of classification was drawn.

Results and Discussion:

Certain categories like mud flats, forest, Agriculture, which can be seen on all the images gives different level of information using the various sensors. Like when we use LISS III data Mudflat can be seen and mapped, but with the help of high resolution CARTOSAT data, the creeks and small patches of vegetation can be separated out within mudflats, which is not possible with LISS III data. Mangrove, which is mainly separable from agriculture or forest on the spectral behavior, can be accurately mapped using merge data (LISS IV + CARTO). Creeks, which are difficult to mark properly upto level 2, can be easily mapped for level 3 using LISS IV, whereas, in CARTOSAT 1 data creeks upto level 4 can be easily mapped. Water bodies, man-made or natural, can be easily identifiable with all sensors, but the mapping accuracy increases greatly with merge data. Habitation areas are easily separable using LISS IV data comparing to LISS III data, while habitation with vegetation category which occupies large areas in the coastal belt can be separable using merge data accurately. Even the roads within the habitation can be separated well using merge data. The separation between habitation and industrial area, which is difficult using LISS III data, can be separable using LISS IV data. It can be further separable as the building structure, ponds, vacant land and vegetation within industrial area using CARTOSAT data. Small Jetties, which can not be mapped using LISS III data can be mapped using LISS IV or CARTOSAT data. Agriculture and fallow land can be mapped using LISS III data, but using LISS IV data field boundaries can be separated. CARTOSAT and merge data gives the details of a tree available in the fields. Category wise impact of mapping coastal wetland and landuse categories using different sensors are given in Table 1.

Conclusions:

Improvement in spatial resolution enhances the interpretability and the accuracy of the mapping in the coastal zone e.g. minor creeks, which are not visible in the LISS III data can be mapped using LISS IV data. But using LISS IV It is not possible to map separately the creeks and mangroves along those creeks. It is only when we use merge (CARTOSAT + LISS IV) data, that the mangroves along these creeks, can also be distinguished and mapped further. Thus satellite data like LISS III and LISS IV can be used to prepare wetland and land use maps on 1: 25,000 scale, which can be used for regional planning where as CARTOSAT and merge (CARTOSAT + LISS IV) data can be used to map the coastal zone on the scale of 1:5000, which can be used for local level planning.

Acknowledgements:

We express our sincerest thankfulness to Dr.B.K.Jain – Principal, M.G. Sc. Institute and the Ahmedabad Education Society, for their help and support throughout the work and always.

Our profound sense of gratitude to Dr.Ajai, Group Director, MESG, Space Applications Centre, for his encouragement, valuable counsel and constructive criticism throughout our work.

We are also thankful to Shri R.M.Dwivedi, Head, MCED, SAC, Ahmedabad, for providing all the necessary help during the work.

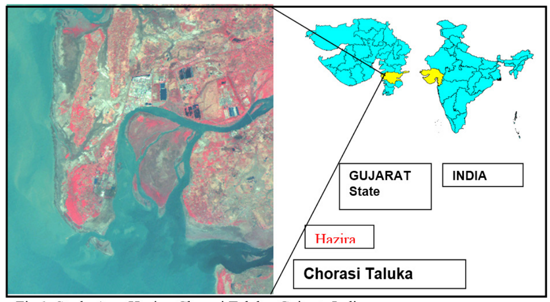

Fig 1. Study Area Hazira, Chorasi Taluka, Gujarat, India

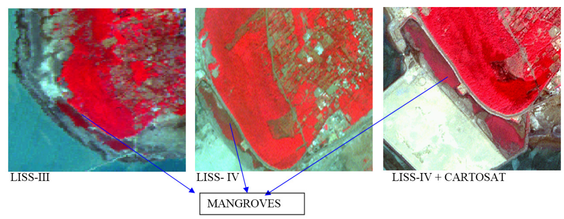

Fig. 2 Comparative example of LISS-III, LISS-IV and LISS-IV+ CARTOSAT data Spatial Resolution

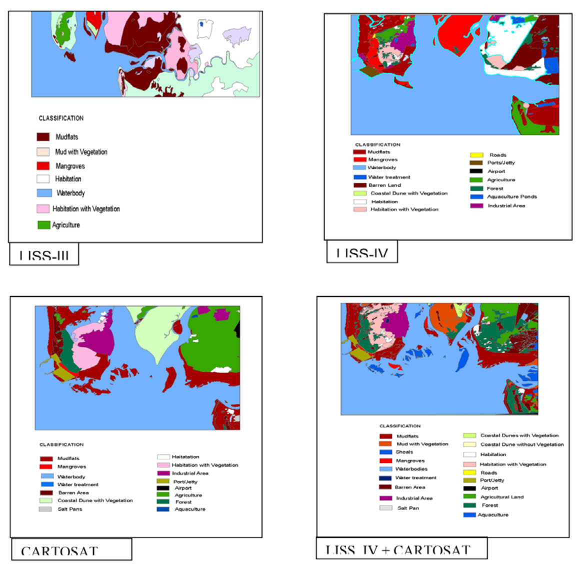

Fig. 3 Comparisons of LISS-III, LISS-IV, CARTOSAT, LISS-IV+ CARTOSAT data Classification on the basis of spatial resolution

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