RESEARCH ARTICLE OPEN ACCESS

A Review Paper on Coastal Hazard

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ABSTRACT
With the coastal population increasing, storms have been inflicting unprecedented losses on coastal communities. Coastal agencies require advance information on the predicted path, intensity and progress of a storm and associated waves and storm surges;
Near-real-time information during the peak of the storm to monitor flooding and control rescue operations; And post storm reports to assess the damage and plan the recovery. The same holds true for other disasters, such as oil spills and algal blooms. Coastal communities are also facing a rising sea level, caused mainly by global warming. Airborne and satellite remote sensors, such as multispectral imagers, LIDAR and RADAR, are now able to provide Most of the information required for emergency response and coastal management.
***Keywords* -** LIDAR, RADAR

I. INTRODUCTION

Coastal Hazards are physical phenomena that expose a coastal area to risk of property damage, loss of life and environmental degradation. Rapid-onset hazards last over periods of minutes to several days and examples include major cyclones accompanied by high winds, waves and surges or tsunamis created by submarine earthquakes and landslides. Slow-onset hazards develop incrementally over longer time periods and examples include erosion and gradual inundation.

Since early civilization, coastal areas have been attractive settling grounds for human population as they provided abundant marine resources, fertile agricultural land and possibilities for trade and transport. This has led to high population densities and high levels of development in many coastal areas and this trend is continuing into the 21st century. At present, about 1.2 billion people live in coastal areas globally, and this number is predicted to increase to 1.8-5.2 billion by the 2080s due to a combination of population growth and coastal migration. Along with this increase follows major investments in infrastructure and the build environment.

II. COASTAL ENVIRONMENTS

There are many different types of environments along the coasts with very diverse features that affect, influence, and mold the near-shore processes that are involved. Understanding these ecosystems and environments can further advance the mitigating techniques and policy-making efforts against natural and man-made coastal hazards in these vulnerable areas. The five most common types of **coastal zones** range from the northern ice-pushing, mountainous coastline of Alaska and Maine, the barrier island coasts facing the Atlantic, the steep, cliff-back headlands along the pacific coast, the marginal-sea type coastline of the Gulf region, and the coral reef coasts bordering.

a) Ice-pushing/mountainous coastline

These coastal regions along the northernmost part of the nation were affected predominantly by, along with the rest of the Pacific Coast, continuous tectonic activity, forming a very long, irregular, ridged, and steep mostly mountainous coastline.

b) Barrier island coastline

Barrier islands are a land form system that consists of fairly narrow strips of sand running parallel to the mainland and play a significant role in mitigating storm surges and oceans swells as natural storm events occur.

c) Steep, cliff-backing abrasion coastline

The coastline along the western part of the nation consists of very steep, cliffed rock formations generally with vegetative slopes descending down and a fringing beach below.

III. CAUSES OF COASTAL HAZARDS

a) Natural VS Human disasters

The population that lives along or near our coastlines are an extremely vulnerable population. There are numerous issues facing our coastlines and there are two main categories that these hazards can be placed under, Natural disasters and Human disasters. Both of these issues cause great damage to our coastlines and discussion is still ongoing regarding what standards or responses need to be met to help both the individuals who want to continue living along the coastline, while keeping them safe and not eroding more coastlines away.

b) Storms, Flooding, Erosion

Storms are one of the major hazards that are associated to coastal regions. Storms, flooding, and erosion are closely associated and can happen simultaneously. Tropical storms or Hurricanes especially can devastate coastal regions.

c) Pollution, Trawling, Human Development

Pollution, trawling, and human development are major human disasters that affect coastal regions. There are two main categories related to pollution, point source pollution, and nonpoint source pollution. Point source pollution is when there is an exact location such as a pipeline or a body of water that leads into the rivers and oceans. Known dumping into the ocean is also another point source of pollution.

d) Coastal hazards & climate change

The predicted climate change is adding an extra risk factor to human settlement in coastal areas. Whereas the natural dynamics that shape our coastlines have been relatively stable and predictable over the last centuries, much more rapid change is now expected in processes as sea level rise, ocean temperature and acidity, tropical storm intensity and precipitation/runoff patterns.

IV. SPACE TECHNOLOGY FOR NATIONAL DEVELOPMENT

Fig 1: Space Technology for National Development

- The study of basic space science in order to lay the foundation for deriving maximum benefits from the nation's participation in the space enterprise; For the attainment of space capabilities, Nigeria's efforts should focus on research and rigorous education, engineering development, design and manufacture, particularly in the areas of instrumentation, rocketry and small satellites as well as in satellite data acquisition, processing, analysis and management of related software.
- The establishment of a national earth observation station for remote sensing and satellite meteorology data acquisition. Such an infrastructure will enhance the indigenous ability to adopt, modify and create new techniques for national resources inventories, monitoring, evaluation and management.

V. WHY SATELLITE SURVEY

Only means of getting accurate, reliable and quick information due to synoptic view and multi-temporal coverage from various space-borne sensors with different capabilities.

The major components of application of satellite based data are:

¬ Detection, monitoring and forecasting (Preparedness)
¬ Monitor the event during time of occurrence (Disaster event)
¬ Damage assessment (Relief)
¬ Hazard zonation (Rehabilitation, reconstruction, mitigation and prevention)

The nation's coastal areas are all susceptible to coastal hazards. While these may be different depending on what part of the country one is in, the solution to mitigating the effects of these and creating more resilient communities all depend on the ability to have access to good, reliable information. U.S. IOOS plays an important role in collecting this data and developing products that help to plan for and respond to hazards within the coastal environment.

VI. DISASTER MANAGEMENT CYCLE

Fig 2: Disaster Management Cycle

- Disaster is a sudden adverse or unfortunate extreme event which causes great damage to human beings as well as plants and animals. Disasters occur rapidly, instantaneously and indiscriminately. These extreme events either natural or man-induced exceed the tolerable magnitude within or beyond certain time limits, make adjustment difficult, result in catastrophic losses of property and income and life is paralyzed.

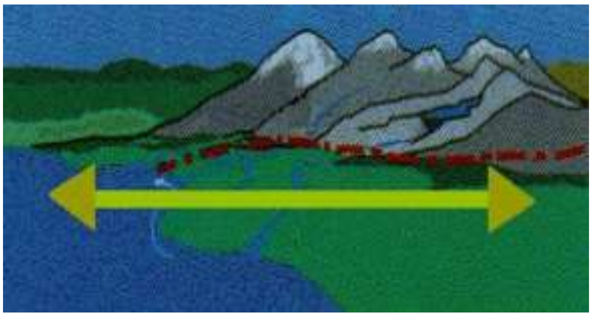
- These events which occur aggravate natural environmental processes to cause disasters to human society such as sudden tectonic movements leading to earthquake and volcanic eruptions, continued dry conditions leading to prolonged droughts, floods, atmospheric disturbances, collision of celestial bodies.
- Disasters have always co-existed with civilizations. With technological advancement, development initiatives resulted in the creation of a lot of infrastructure and permanent assets.

VII. THE MAJOR COASTAL PARAMETERS RETRIEVABLE FROM SATELLITES

Parameter(s)	**Present and future Sensor/Satellite**	**Country/ Agency**
Wave height	Altimeter (ERS-1/ERS-2) (OCEANSAT-2)	ESA India
Wave direction	SAR(ERS-1/ERS-2) SAR (RADARSAT)	ESA India
Wave length	SAR (ERS-1/ERS-2) SAR (RADARSAT)	ESA Canada
Surface Wind Speed	Scatterometer (ERS-1/ERS-2) MSMR (IRS-P4)	ESA India
Surface Wind direction	SAR (ERS-1/ERS-2) SAR (RADARSAT)	ESA Canada
Sea Surface topography	Altimeter (ERS-1/ERS-2) (GEOSAT) (TOPEX) (POSEIDON) (OCEANSAT-2)	ESA ESA USA USA USA INDIA
Chlorophyll	MOS (IRS-P3) SeaWiFs (Ornview-2) OCM (OCEANSAT-1) OCM (OCEANSAT-2)	Germany/India USA India India

Table 1: Coastal Parameters Retrievable From Satellites

VIII. COASTAL ZONES PLACE



The coastal zone is the transitional area between land and sea. It is a band rather than a line. The width of the band varies from place to place and is determined by the interaction of marine and terrestrial processes.

The zone occupies less than 15% of the Earth's land surface. Only 40% of the one million km of coast-line is accessible and temperate enough to be habitable. Yet it accommodates more than 60% of the world's population.

A. Coastal Zone and its Significance

a) 60 % of human population
b) 2/3 of the world's large cities
c) 8 % of ocean surface
d) 14 % of global ocean primary production
e) 90 % of world fish catch
f) 75-90 % of global sink of suspended river load

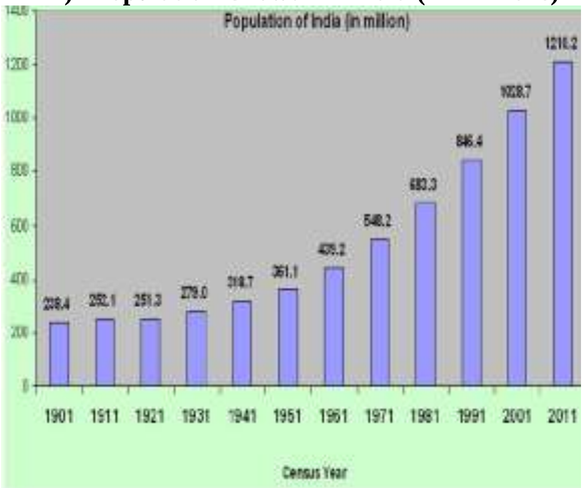
Integrated coastal zone (ICZ) or integrated coastal (IC) is a process for the management of the coast using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries, in an attempt to achieve sustainability.

B. The Coast

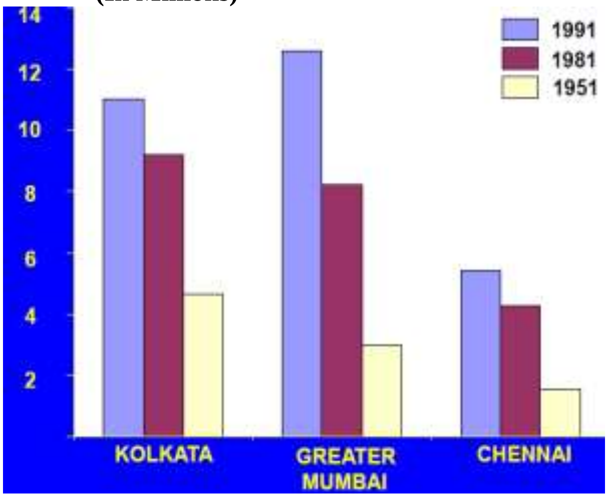
a) Of vital importance to humanity
b) Essential, fragile element of the global ecosystem
c) Zone of rapid transitions, gradients and variations
d) Very difficult to put boundaries around
e) Highly dynamic
f) Subject to multiple uses

IX. POPULATION GROWTH

A) Population Growth in India (In Millions)



B) Population of Metropolitan Coastal Cities (In Millions)



X. Application of space technology in coastal disaster management

Disaster	Preparedness	Relief	Mitigation/Prevention
Cyclone	Detection monitoring and communicating	Map extent of damage	Early warning strategies and their implementation
Flood	Flood forecasting and communicating	Mapping peak flood Inundation areas, Identifying areas for Dropping relief aid, Setting up communication links	Mapping sequential inundation phases, geomorphologic mapping of the flood prone areas, identification of the vulnerable areas,
Earthquake	Data base preparation within the known seismic active zones, detection of surface deformation	Identification of large associated features due to fault rupture, damage due ground shaking, liquefaction, landslides, fires and floods	Mapping of active faults, measurement of fault displacement, identification of risk zone
Landslide	Forecasting of rainfall, Monitoring the vulnerable zones communicating	Damage assessment	Inventory of past landslide hazard zonation using integrated approach
Volcanic eruption	Identification of the precursors such as fumarolic activity, detecting volcanic eruption	Monitoring volcanic activity, damage assessment and identifying safe areas	Volcanic hazard assessment and risk maps
Coastal erosion	Monitoring shoreline change and coastal environment	Monitoring implementation of coastal regulation zones	Understanding coastal processes, mapping zones of risks and predicting shoreline changes
Non-point and point pollution	Detection and communicating	Monitoring the extent and communicating	Risk maps and alternative strategies
Sea level rise	Developing models using DEM and shoreline change predictions to identify likely areas of inundations, monitoring glacial area and estimating run off	--- ---- ---- ----- -----	Global monitoring of environmental parameters and suggesting strategies for combating human induced activities
Mangrove/Coral reef decline	Monitoring mangrove and coral reef areas	Monitoring implementation of coastal regulation zone	Mangrove and coral reef extend maps and coastal regulation zone maps

Table 2: Application of space technology in coastal disaster management

XI. COASTAL HAZARDS

A. Short term

a) Cyclone - hurricane - typhoon
b) Tsunami
c) Flash flooding from river

B. Long term

d) Land subsidence
e) Sea level rise
f) Coastal Erosion

Definitions: Coastal Hazards

Coastal Hazards are physical phenomena that expose a coastal area to risk of property damage, loss of life and environmental degradation. Rapid-onset hazards last over periods of minutes to several days and examples include major cyclones accompanied by high winds, waves and surges or tsunamis created by submarine earthquakes and landslides. Slow-onset hazards develop incrementally over longer time periods and examples include erosion and gradual inundation Cyclone An atmospheric closed circulation rotating counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

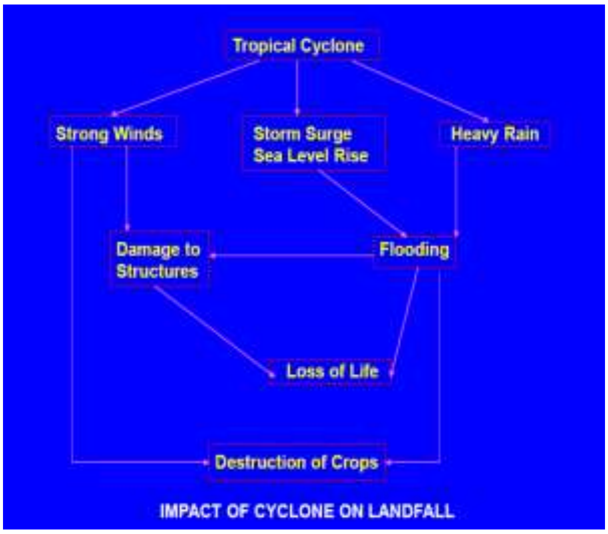
Storm Surge an abnormal rise in sea level accompanying a cyclone or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. Storm surge is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide.
Storm Tide The actual level of sea water resulting from the astronomic tide combined with the storm surge.

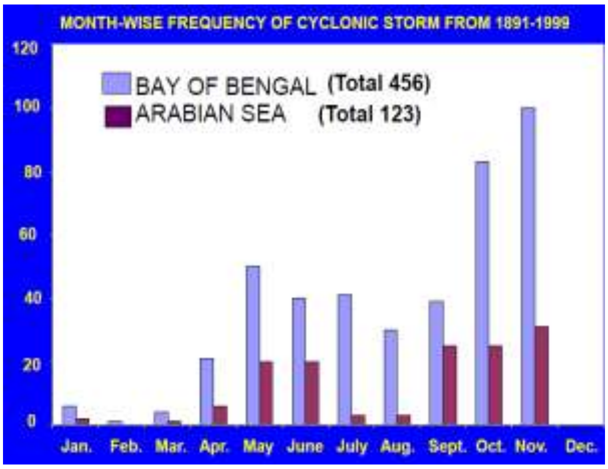
A) Hurricanes / Cyclones

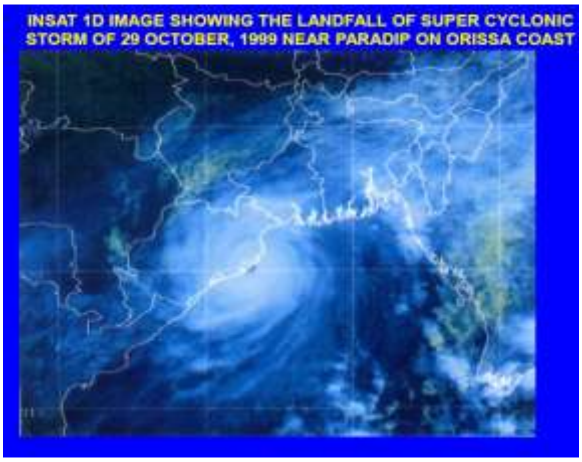
Typhoons or hurricanes are tropical revolving storms. There are called cyclones, when they occur in the Indian Ocean area.

It is low-pressure systems or depressions around which the air circulates in an anti-clockwise direction in the northern hemisphere, but in a clockwise direction in the southern hemisphere.

The speed of the circulating air may exceed 33 metres per second near the earth's surface.





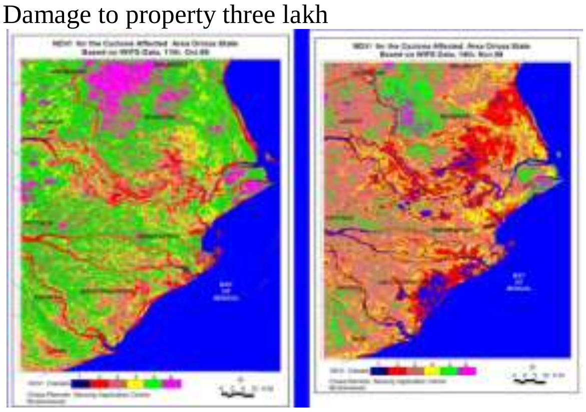


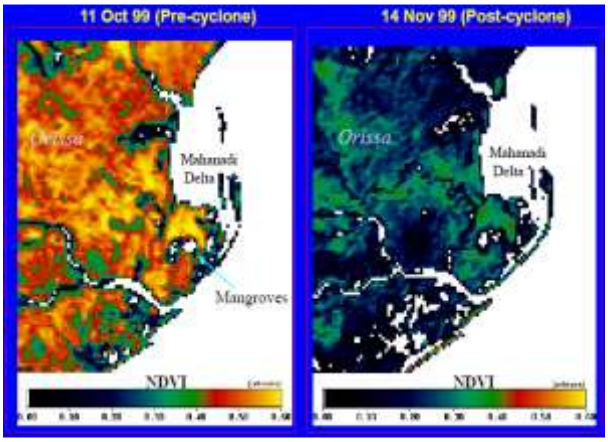
XII. DAMAGE DUE TO SUPER CYCLONE OF OCTOBER 29, 1999 (SOURCE ORISSA GOVERNMENT))

Districts affected	12
Blocks affected	97
Villages affected	14643
Population affected	129.22 Lakhs
Crop area affected	18.42 Lakh
Houses affected	16.49 Lakhs
Loss of life	9887
Persons missing	40
Persons injured	2507
Livestock perished	4.44 Lakhs
Fishing boats lost	9085
Fishing nets lost	22143

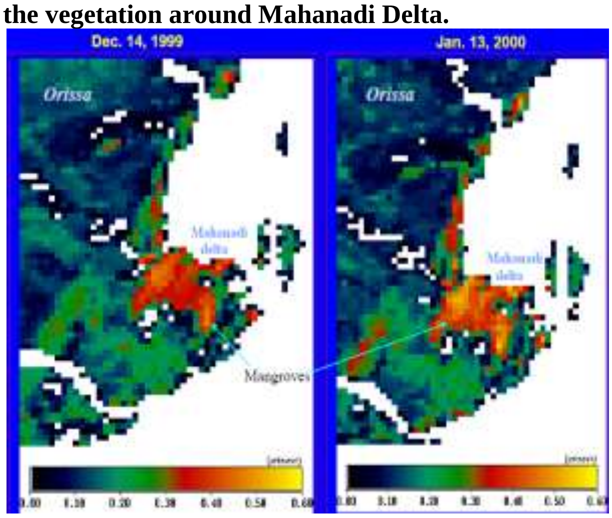
a) Damage due to severe cyclone of October 17, 1999 (Source Orissa and Andhra Pradesh Government)

Lives lost - 198
Persons injured -402
Loss of crops -thousands Hectare of land
Damage to property three lakh

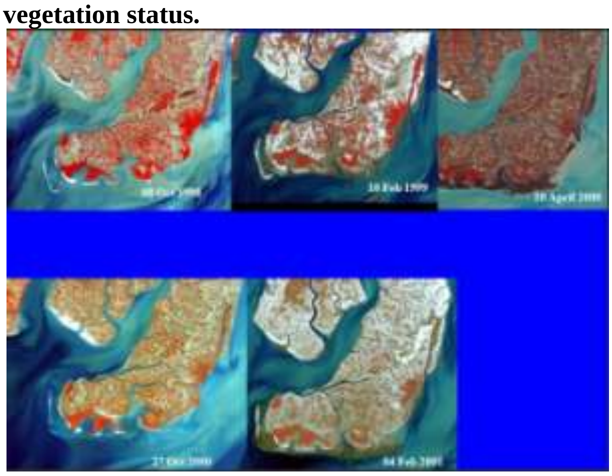




IRS-P4 OCM derived Normalized Difference Vegetation Index (NDVI) images for the pre and post-cyclone period dates, showing the status of the vegetation around Mahanadi Delta.



IRS-P4 OCM retrieved NDVI images for the cyclone affected coastal area, showing the vegetation status.



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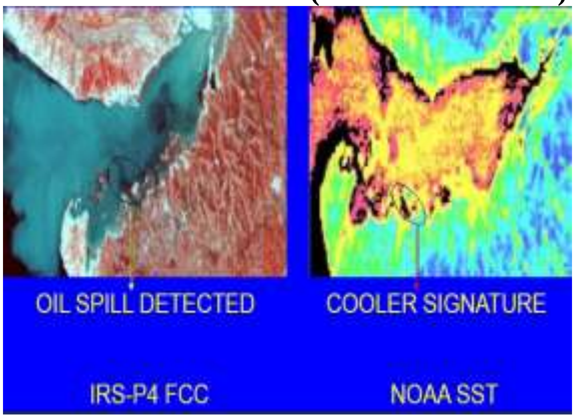
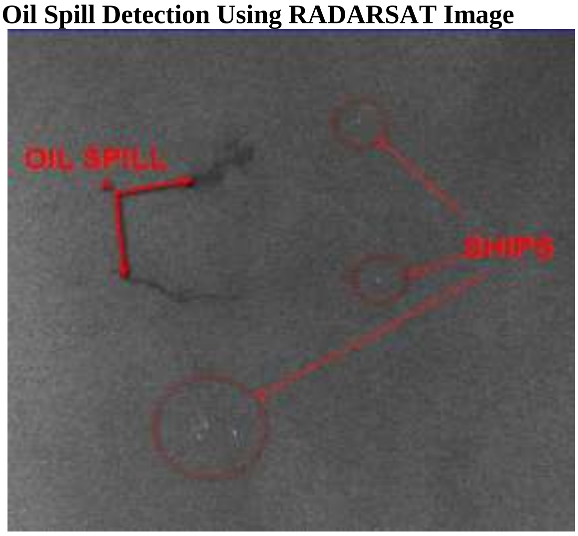
XIII. OIL SPILL DETECTION IN GULF OF KACHCHH (IRS-P4 OCM FCC)

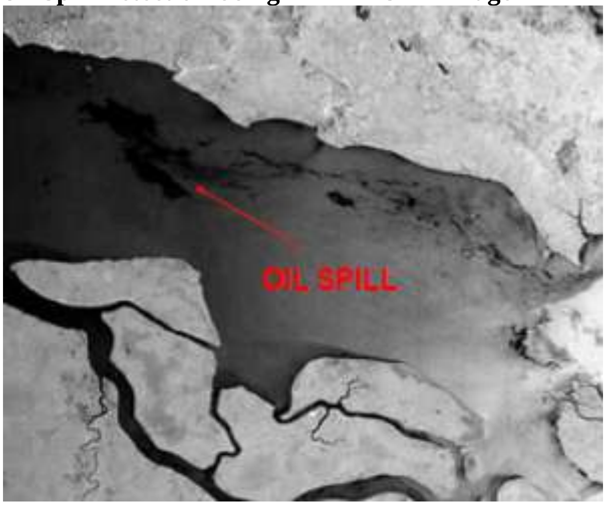


Oil Spill Detection Using RADARSAT Image



- The main objective of this work is to develop comparative automatic detection procedures for oil spill pixels in multimode (Standard beam S2, Wide beam W1 and fine beam F1) RADARSAT-1 SAR satellite data that were acquired in the Malacca Straits using two algorithms namely, post supervised classification, and neural network (NN) for oil spill detection. The results show that NN is the best indicator for oil spill detection as it can discriminate oil spill from its surrounding such as look-alikes, sea surface and land.

Oil Spill Detection Using RADARSAT Image

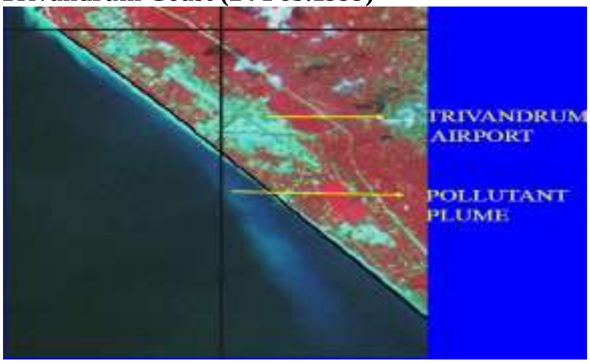


- The receiver operator characteristic (ROC) is used to determine the accuracy of oil spill detection from RADARSAT-1 SAR data. The results show that oil spills, look- alkies, and sea surface roughness are perfectly discriminated with an area difference of 20% for oil spill, 35% look–alikes, 15% land and 30% for the sea roughness.

XIV. HIGH RESOLUTION (2.8 M) MULTISPECTRAL

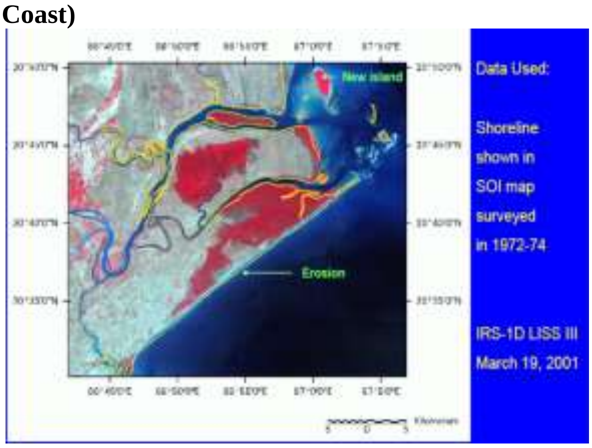
Imagery Showing Oil Spill

Pollution Dispersal Seen On Irs-1d Liss Iii Off Trivandrum Coast (24 Feb.1999)

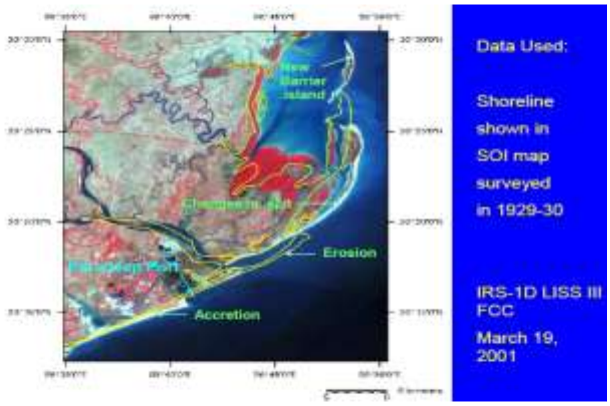


- The sequential Suspended Sediment Concentration (SSC) maps were generated using IRS-P4 OCM data for selected tide dominated, wave dominated and deltaic coasts around the Indian subcontinent. Patterns of SSC were studied to understand the sediment dynamics, circulation patterns, fronts and consequent impact on coastal processes. Hitherto unknown sediment plumes extending for large distance into deep offshore areas could be identified from the major deltaic regions

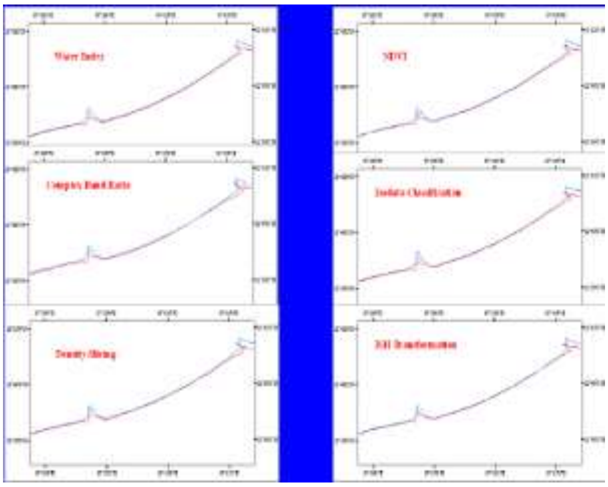
Shoreline Changes Arpund Dhamra Estuary and Environs (Parts of the Mahanadi Delta, Orissa Coast)



Shoreline Changes around the Mahanadi Estuary and Environs (Parts of the Mahanadi Delta, Orissa Coast



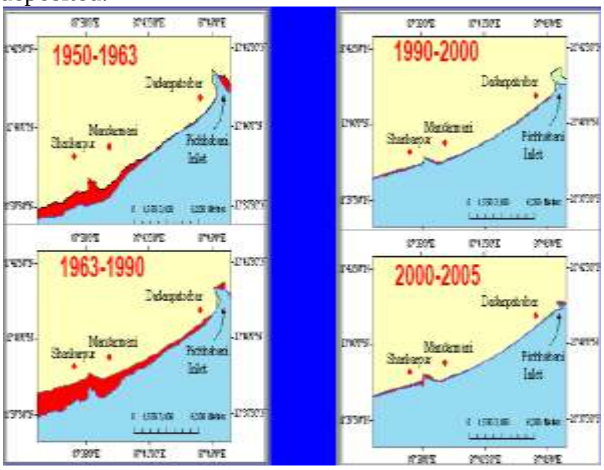
Shorelines Extracted Applying Selected Techniques on (Optical) LANDSAT ETM+ and IRS 1C LISS-III



- Morphological changes in coastal areas, especially in river estuaries, are of high interest in many parts of the world. Satellite data from both optical and radar sensors can help to monitor and investigate these changes. Data from both kinds of sensors being available for up to 30 years now, allow examinations over large timescales

b) Overall Change Detection Result at Temporal Scale Between 1950 to 2005

Total accretion considerably less with respect to erosion. Along Coast •85385.28 ha (3.25% to total surface area) eroded•77.16 ha (0.01% to total) deposited.



c) Integrate Coastal Hazard Risk and Sea Level Rise

- Local governments and decision makers often have only limited access to the critical information necessary to support choices for managing social and economic vulnerability and, specifically, to understanding the role natural habitat can play in reducing risk. As a consequence, they are unable to comprehensively integrate coastal hazard risk and sea level rise into their decision making in order to increase the resilience of human and natural communities.
- Until recently, the idea of mapping sea level rise based on emission scenarios from the Intergovernmental Panel on Climate Change was novel in the United States, and proposing to combine these with storm surge models was more novel still.
- Enter Coastal Resilience, an approach to assess risk and vulnerability while identifying restoration and adaptation choices, the backbone of which is an online mapping decision support tool.
- The approach and tool began in 2008 on the southern shores of Suffolk County, Long Island, in New York. The hypothesis at the time was that despite awareness of growing coastal hazards, local governments and decision makers do not have the capacity to map and plan for future climate projections, let alone identify coastal management scenarios to address these threats.
- Coastal Defense:
  At the core of Coastal Resilience is the ability to demonstrate the value of ecosystem services and the role nature plays in disaster risk reduction and adaptation. Through a collaboration between TNC, USGS, and the Natural Capital Project

XV. COASTAL DEVELOPMENT HAZARDS

- A coastal development hazard is something that affects the natural environment by man-made products.
- As coasts become more developed, the vulnerability component of the equation increases as there is more value at risk to the hazard. The likelihood component of the equation also increases in terms of there being more value on the coast so a higher chance of hazardous situation occurring. Fundamentally humans create hazards with their presence. In a coastal example, erosion is a process that happens naturally on the Canterbury Bight as a part of the coastal geomorphology of the area and strong long shore currents. This process becomes a hazard when humans interact with that coastal environment by developing it and creating value in that area.
- A natural hazard is defined as the release of energy or materials that threaten humans or what they value. In a coastal context these hazards vary temporally and spatially from a rare, sudden, massive release of energy and materials such as a major storm event or tsunami, to the continual chronic release of energy and materials such long-term coastal erosion or sea-level rise. It is this type coastal hazard, specifically around erosion and attributes surrounding erosion that this article will focus on.

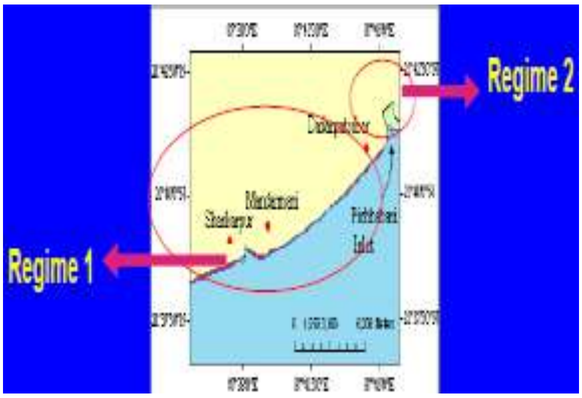
a) Erosional Regimes of the Study Area

In geomorphology and geology, erosion is the action of exogenic processes (such as water flow or wind) which remove soil and rock from one location on the Earth's crust, then transport it to another location where it is deposited. Eroded sediment may be transported just a few millimeters, or for thousands of kilometers.

Based on the spatio-temporal coastal change pattern –

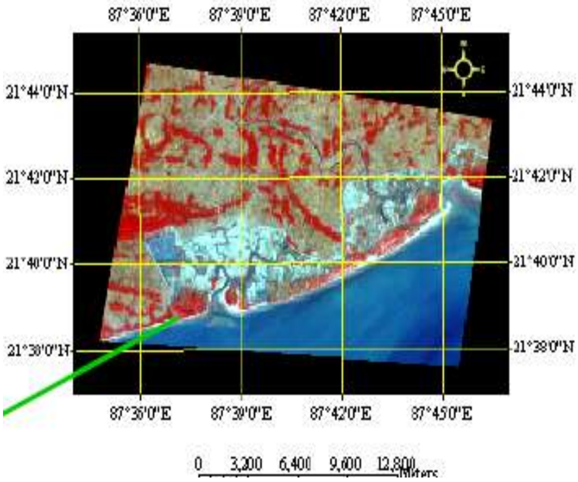
Regime 1: Shankarpur to western portion of the Dadanpatrabar sector chiefly under erosional regime and

Regime 2: Eastern portion of Dadanpatrabar to rest of the study are belonging chiefly to accretional regime.



a. Causes of Deposition and Erosion

- Tides, Waves, Rip Currents and Long shore Currents
- Sea Level Rise
- Cyclonic Storm Surge
- Anthropogenic Activities



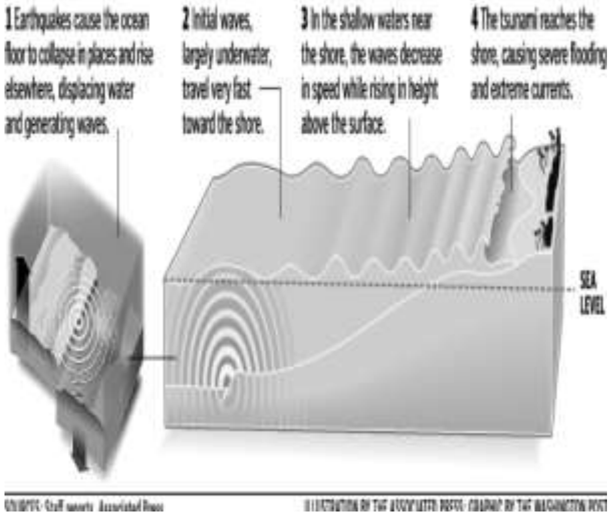
XVI. HUMAN ACTIVITIES ON

a) Coastal Zone

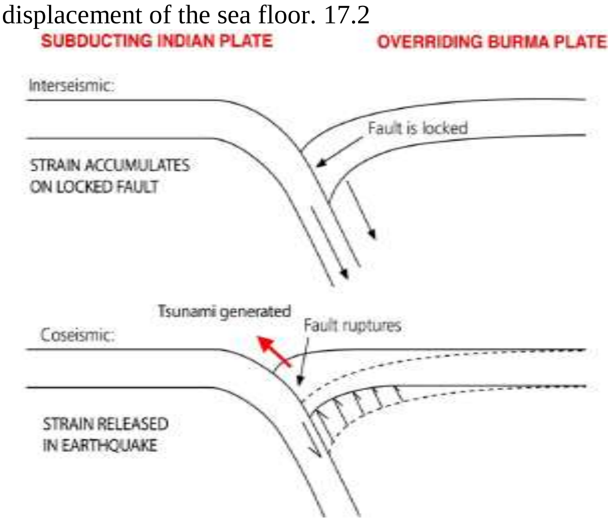
- Hotel on the intertidal mudflat
- Construction and transport on tidal mudflat
- Fishing activities on tidal mudflat

b) Tsunami waves

- Tsunami Japanese word for 'Harbor wave'
- A series of waves of extreme length and period triggered by a sudden displacement of the sea floor: seismic activity or volcanic eruption
- The wave travels outwards in all directions from the source area with speeds of over 500 km/hr
- Still it can have a velocity of over 50 km/hr and a height of 30 m at the coast
- Several waves may follow each other at intervals of 15 - 45 minutes



Waves are triggered by: Seismic activity / displacement of the sea floor. 17.2

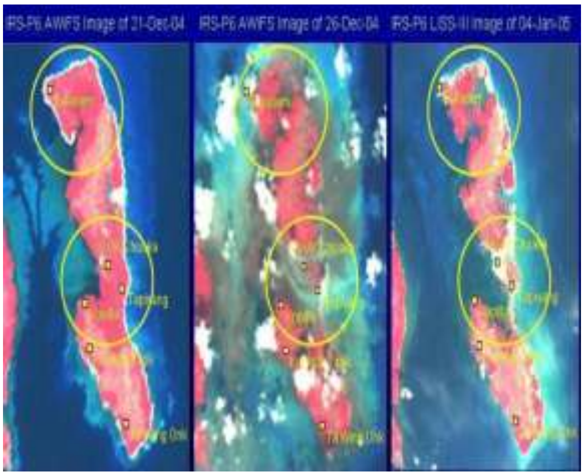


c) Describing Ocean Waves

- Tsunami Wave: V~ 1000km/s, l~800 km
- Since the long-wavelength waves lose less energy a tsunami can travel transoceanic distances with only limited energy loss.
- In the deep ocean the amplitude of a tsunami is a few cm to few dm on a very long wavelength: it is not felt aboard a ship or seen from air in open ocean (but can be measured by buoy or satellite altimeter).
- When a tsunami approaches the shoreline the velocity decreases (D diminish) and in order to conserve energy (proportional to v and H) the amplitude increases.
- Satellite remote sensing data is also very helpful for finding out inundations due to tsunami. Penetration of water body because of tsunami towards land can be easily traced from suitable remote sensing data.
- The inundation line derived from ground survey can be superimposed over the taluka or village

map using GIS to have an idea about the affected agricultural areas, human population and infrastructure.

Close view of Trikant Island



Groundwater vulnerability analysis (using model)

- Vulnerability may be defined as the degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude. It is expressed on a scale from 0 (no damage) to 1 (total loss).
- In case of groundwater, the most useful definition of vulnerability is one that refers to the intrinsic characteristics of the aquifer, which are relatively static and mostly beyond human control.
- The most important map able factors that control sea water intrusion are found to be the following:

¬ Ground water occurrence (aquifer type; unconfined, confined and leaky)
¬ Aquifer hydraulic conductivity
¬ Depth of groundwater level above the sea
¬ Distance from the shore (distance inland perpendicular from shoreline)
¬ Impact of existing status of seawater intrusion in the area
¬ Thickness of the aquifer which is being mapped

- A numerical ranking system to assess sea water intrusion potential in hydrological settings has been devised using GALDIT factors. The system contains three significant parts: weights, ranges and ratings. Each GALDIT factor has been evaluated with respect to the other to determine the relative importance of each factor.

XVII. CONCLUSIONS

As coastal populations continue to grow, so too does the need for better ways to increase the resilience of coastal areas to the effects of severe weather, coastal flooding and inundation, and erosion. Comprehensive, cohesive policies on coastal protection need to be based on the best possible information, from improved coastal mapping to enhanced weather and impact forecasting. Armed with knowledge gleaned from these tools, government officials, coastal managers, property owners, and everyone who enjoys the nation’s coastal areas should work toward developing a long-term plan for ensuring that coastal resources will be sustainable for future generations to enjoy.

REFERENCES

[1] Agbley SK, Basco DR (2008) an evaluation of storm surge frequency-of-occurrence estimators. Proceedings of the ASCE conference on Solutions to Coastal Disasters, April 13–16, 2008, Turtle Bay, Hawaii, pp 185–197.

[2] Inman, Douglas L. "ENVIRONMENTAL SCIENCE IN THE COASTAL ZONE." Environmental Science in the Coastal Zone: Issues for Further Research. The National Academic Press. Web. 09 Apr. 2012. <http://www.nap.edu/openbook.php?record_id=2249>.

[3] Jayappa KS, Vijaya Kumar GT, Subrahmanya (2003) Influence of coastal Structures on the beaches of Southern Karnataka, India. J Coast Res9:

[4] Theiler ER, Williams J, Hammer-Klose E (2000) National assessment of Coastal vulnerability to future sea-level rise. http://woodshole.er.usgs.gov/project-pages/cvi/. Accessed online the 28 Nov 2011.