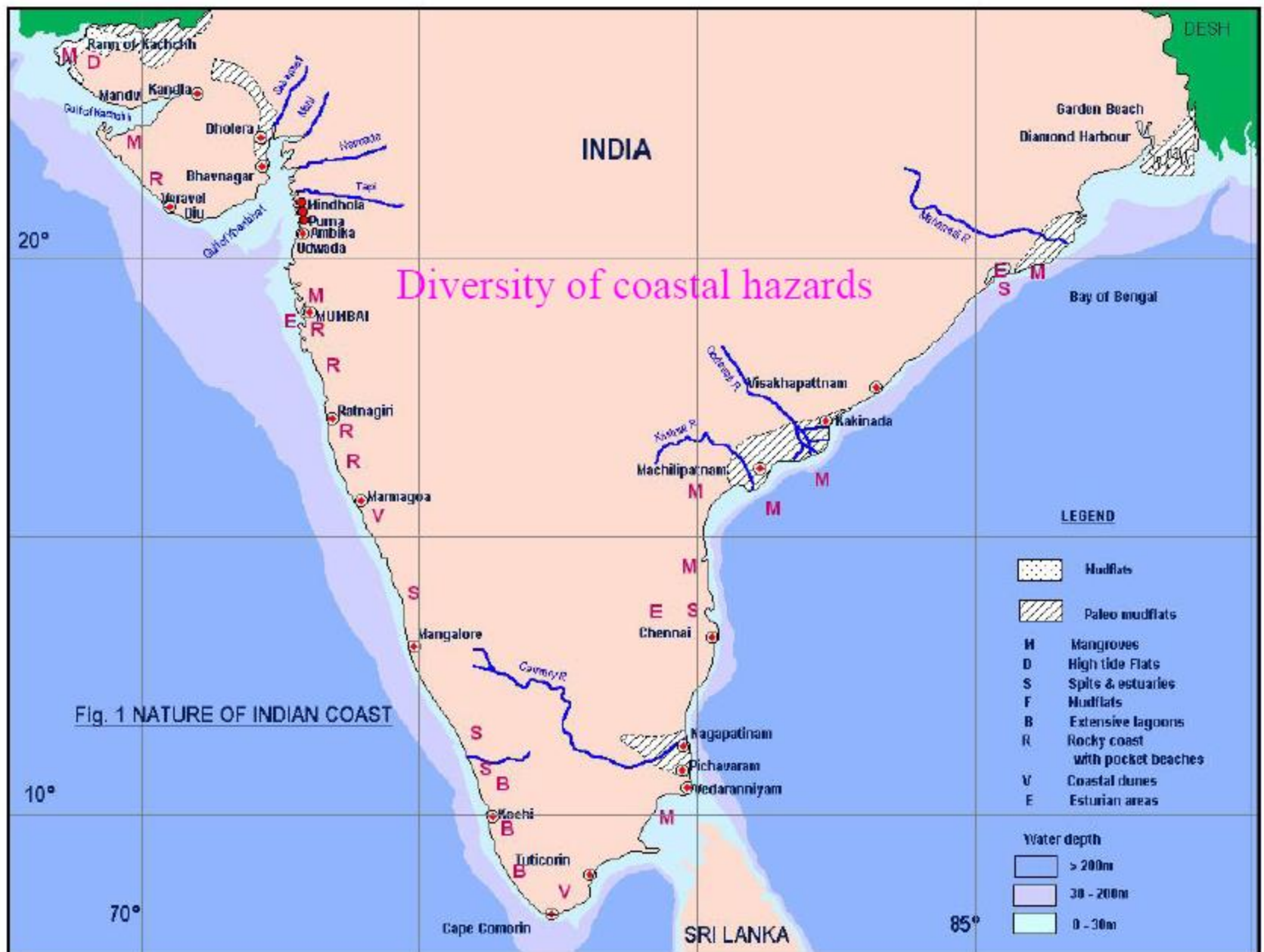


# ***Coastal Zone Regulations and Management***

## **Introduction to Coastal Zone Management**

Dr. Swarna Subba Rao

Former Surveyor General of India



Coastal zones are defined by the extent of territorial waters up to the high water mark. Generally, the world's coastal zones are long narrow features of mainland, islands and seas, generally forming the outer boundary of the coastal domain (from 200m above sea level to 200 m below sea level). Coastal zones include the entire continental shelf and occupy about 18% of the surface of the globe, supplying about 90% of global fish catch and accounts for some 25% of global primary productivity while at the same time being some of the most endangered regions on the planet.

## Importance of coastal zone?

- Protection from storms and hurricanes
- Climate stabilization
- Treasures unique ecosystems
- Harbors rich diversity
- Provides varied resources

# Coastal Zone

- Coast is the zone of interaction between land and sea where both land & oceanic processes work.
- It is most dynamic, resourceful and disaster prone zone of any country.
- Coastal zone always includes floodplains, mangroves, marshes, and fringing coral reefs.

# Coastal Zone Management

- Coastal zone management involves managing coastal areas to balance environmental, economic, human health, and human activities.
- Coastal Management integrates the biological, physical, and policy sciences to plan and execute sustainable solutions for environmental challenges where land meets water.

# Integrated Coastal Zone Management

- ICZM 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.
- It is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones.
- It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation.

“ICZM provides the opportunity to allow policy orientation and development of management strategies to address the issue of resource use conflicts and to control the impacts of human intervention on the environment. It provides institutional and legal framework, focuses on environmental planning and management, coordinates various concerned agencies to work together towards a common objective. Sectorial planning and management, is still essential but should operate within the general framework of ICZM. Maintaining species habitats, natural resource base and management of development processes are part of ICZM programme”

# Uniqueness of the Coastal Zone.

India's coast line is over 8100km.

- Supports a wide variety of coastal activities.
- Comprise various types of coastal habitats.
- Plays a major role in terms of economy and ecology
- Natural processes and human interventions cause Changes in status of coastal zone resulting in Degradation /loss of amenities and habitats
- An interface between land and sea with integrated Complex of marine, coastal and sub-systems and shoreline environments.
- Includes beaches, sand dunes, coastal plains, inter-tidal mudflats, mangrove forests, seagrass, coralreefs and lagoons.
- Is dynamic with frequent Changes in biological, chemical and geological parameters.



# IMPORTANCE OF COASTLINE

- Constitutes to 5% of the total landmass.
- Coastal regions sustain almost three-quarters of the world's population and yield more than half of global gross domestic product.
- India is one of the 27 countries which are most vulnerable to storm surges, tsunamis and the sea-level rise (SLR).
- India has a long coastline of over 8100 km (including the islands)
- India has a large exclusive economic zone (~2 million km<sup>2</sup>) that are susceptible to different coastal hazards.
- Huge investments being made in the coastal zones of India for oil and gas exploration, exploitation and industrial growth in the last few decades.

# Issues & problems

## NATURAL

Sea Level Rise

Sedimentation

Disasters

Tsunamis

Earthquakes

Flooding

Cyclones

## MAN MADE

Pollution

Biodiversity Threats

Urbanization

Soil Erosion

Salinity Ingress

Population Stress

Sewage Disposal

Resource Exploitation

Over Urbanization

# NECESSITY FOR COASTAL ZONE REGULATIONS

- Being an important economic asset/feature, it needs to be properly protected.
- Planned development.
- Balanced activities between development and protection.

# WORLD SCENARIO

# International Players

- International Maritime Organization (IMO)
- UN Environmental Program
- UN Conference on Trade and Development
- Organization of Economic Cooperation and Development (OECD)
- World Health Organization
- World Trade Organization
- World Bank
- International Treaties:
  - United Nations Convention of the Law of the Seas (UNCLOS)
  - Convention for the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Dumping Convention, 1972)
  - International Convention for the Prevention of Pollution from Ships, 1973

# Federal Players

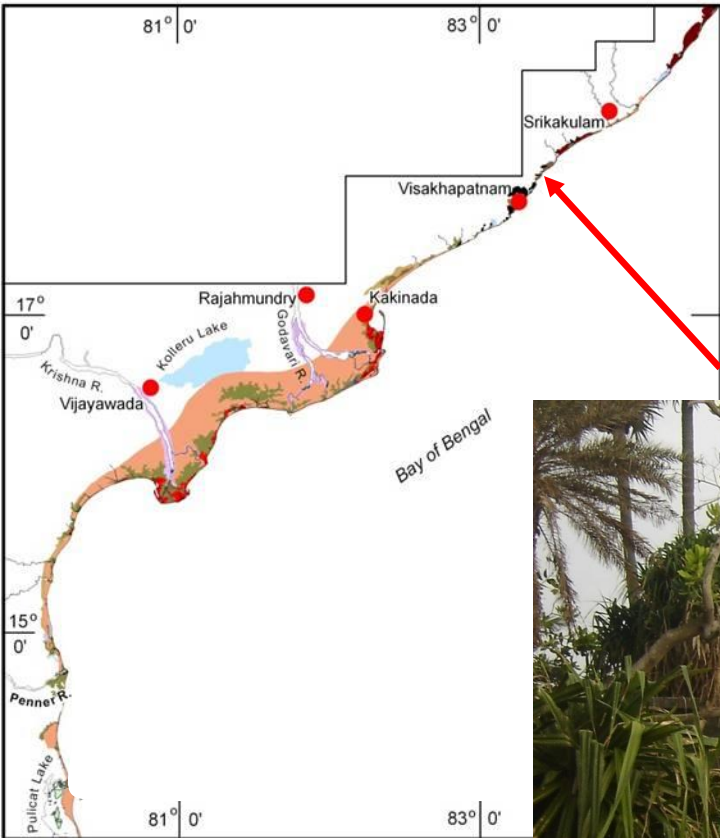
- National Oceanic and Atmospheric Administration (NOAA-US Department of Commerce)
- US Army Corps of Engineers (Department of Defense)
- Federal Emergency Management Agency (FEMA)
- National Park Service (Dept. of Interior)
- Fish and Wildlife Service (Dept. of Interior)
- National Marine Fisheries Service (Dept. of Interior)
- US Coast Guard
- Environmental Protection Agency
- US Geological Survey
- US Minerals Management Service
- US Natural Resources Conservation Service

# INDIAN SCENARIO

# EROSION AND DETERIORATION OF INDIAN COAST

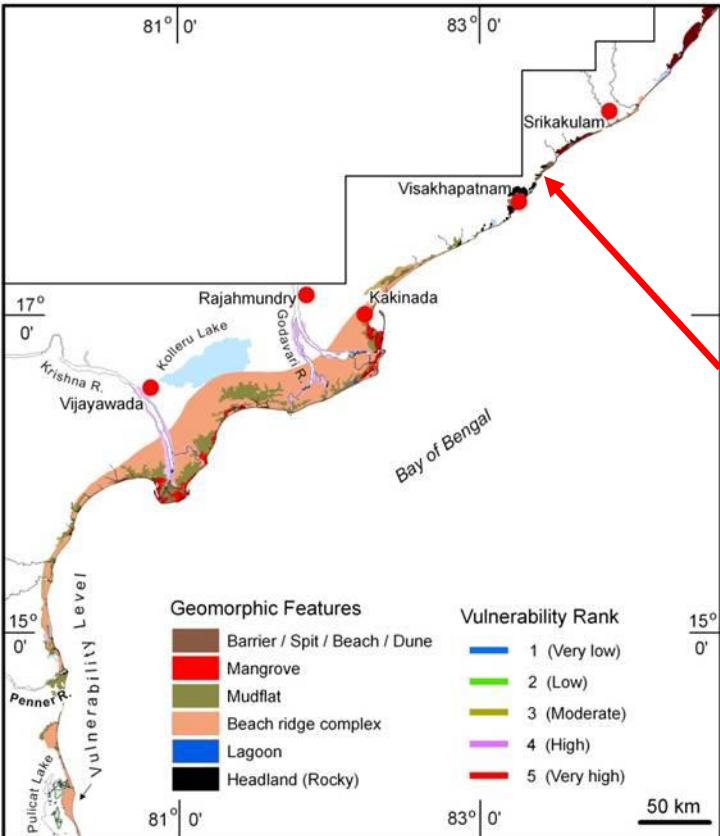
- Following slides depict some cases of Coastal degradation and erosion in the State of Andhra Pradesh.





**Bhimuniapatnam Coast**  
**20 km north of Visakhapatnam city**

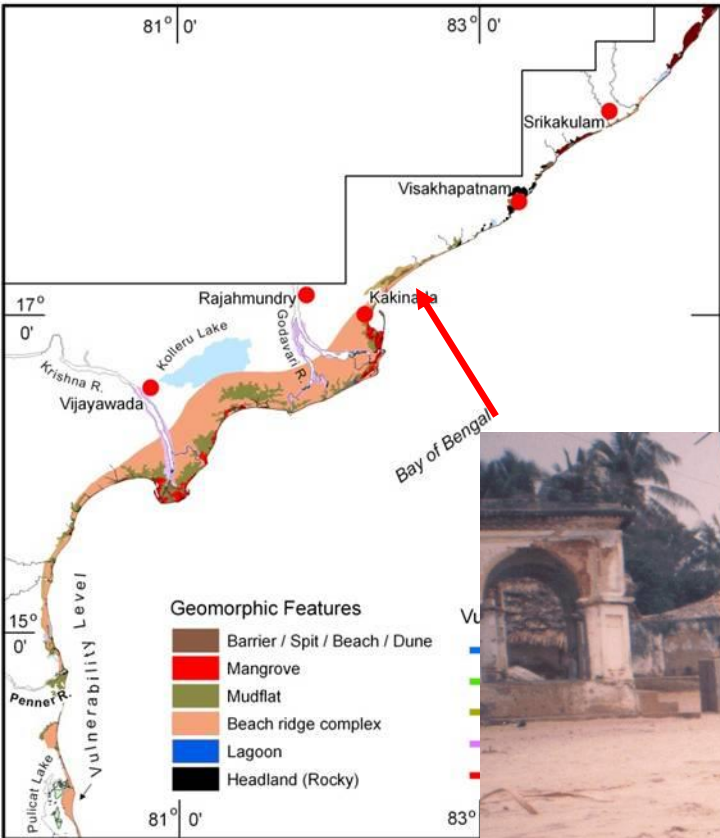




## Bhimuniapatnam Coast 20 km north of Visakhapatnam city

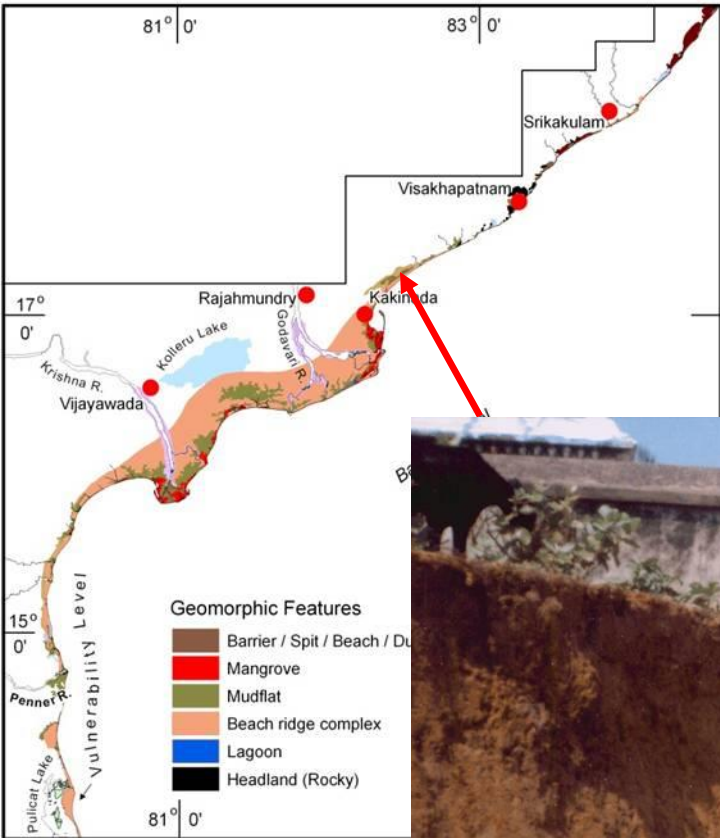




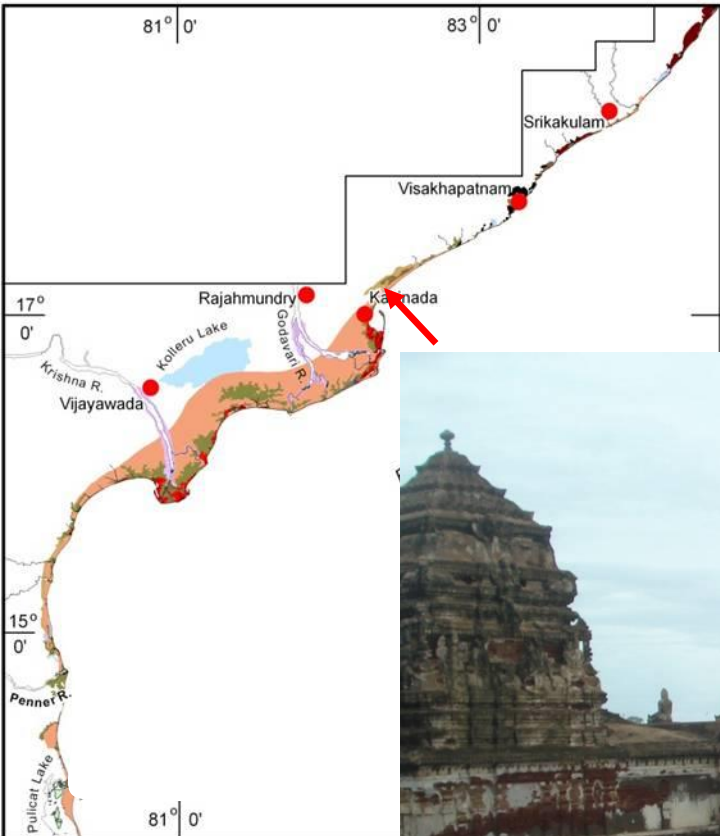


**Uppada village  
9 km north of Kakinada**









## GODAVARI DELTA COAST

### EROSION AT UPPADA VILLAGE



2007



2009



**Uppada 2011**





Uppada 2011

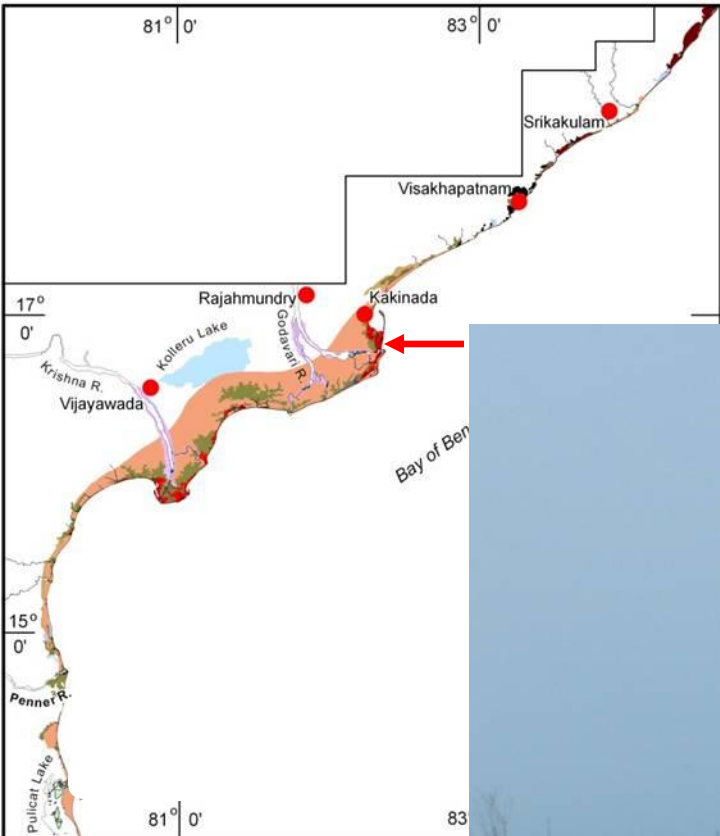




Uppada 2011



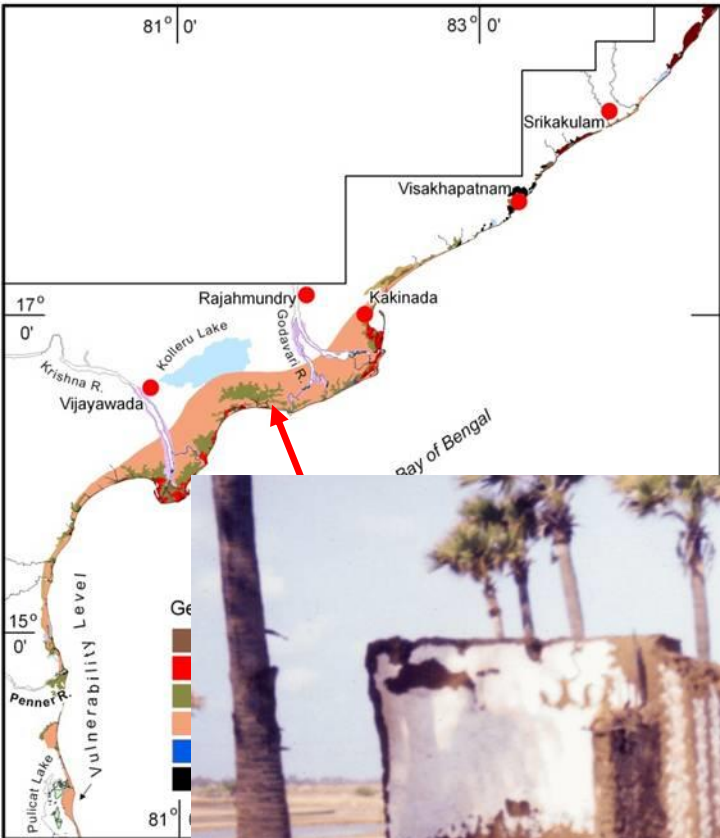




## GODAVARI DELTA COAST

### MANGROVE EROSION NILAREVU ESTUARY

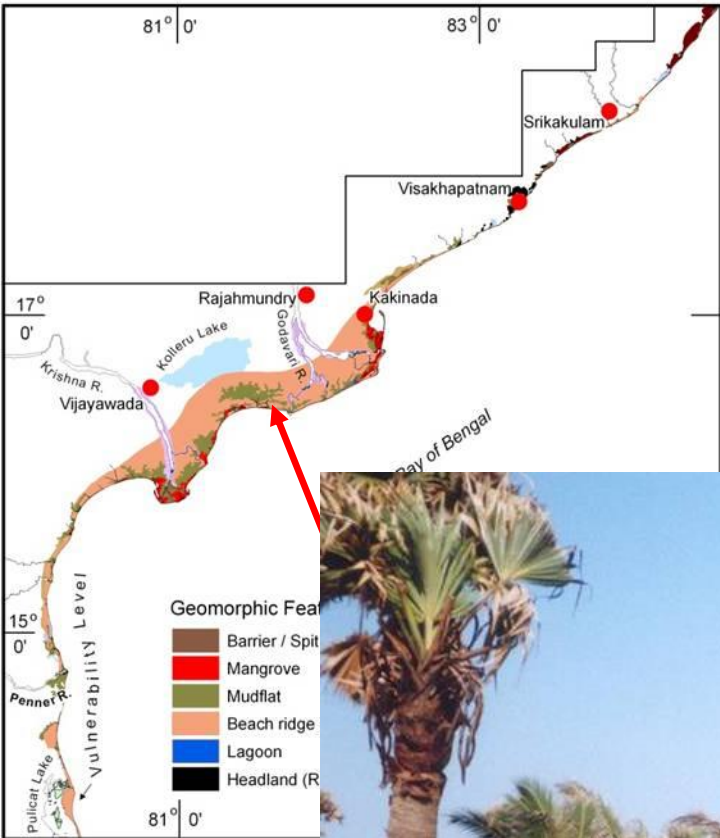




## Chinna Mailavanilanka in Godavari delta

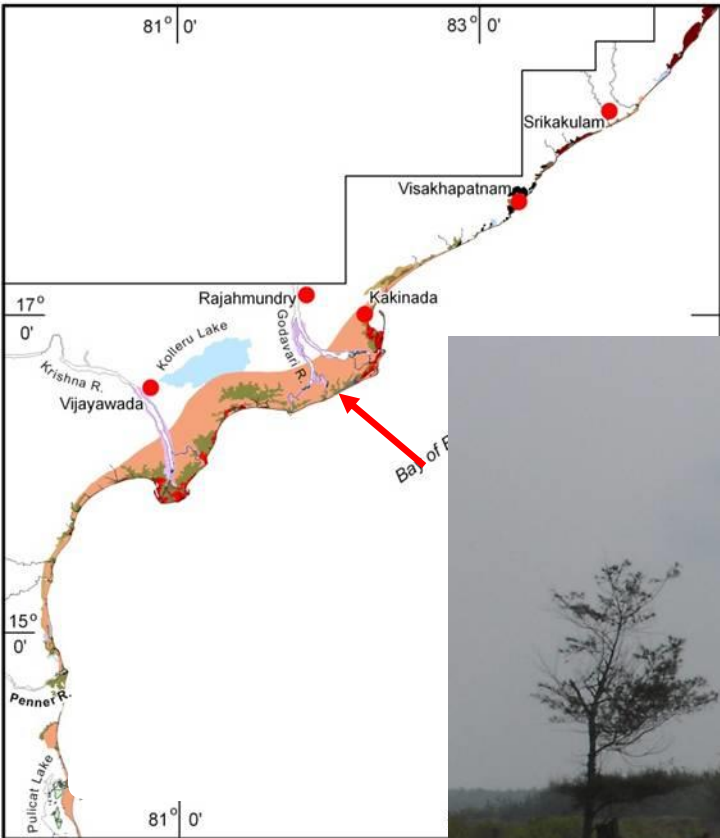






## Chinna Mailavanilanka in Godavari delta

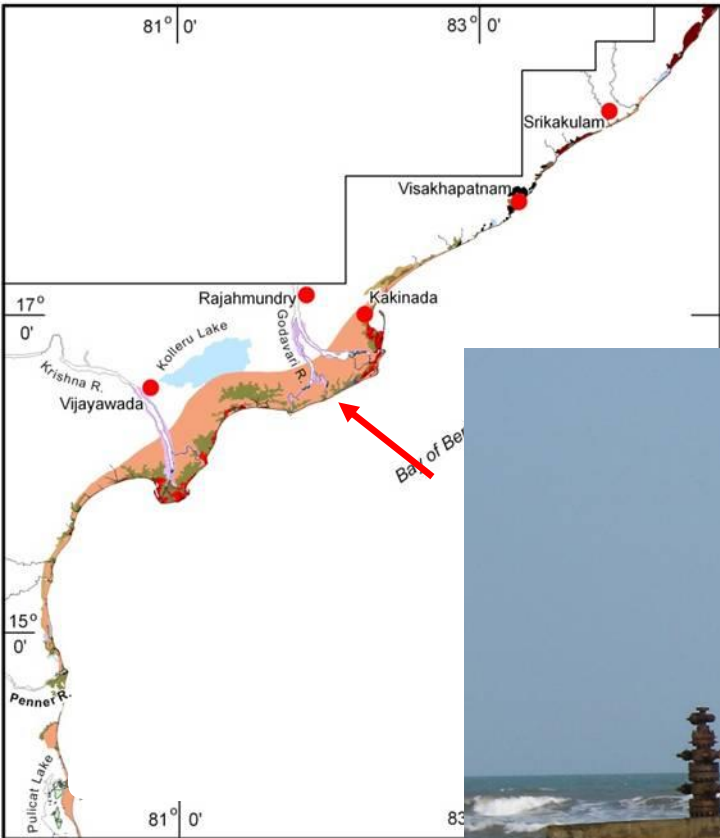




## GODAVARI DELTA COAST

### EROSION ALONG VAINATEYAM COAST



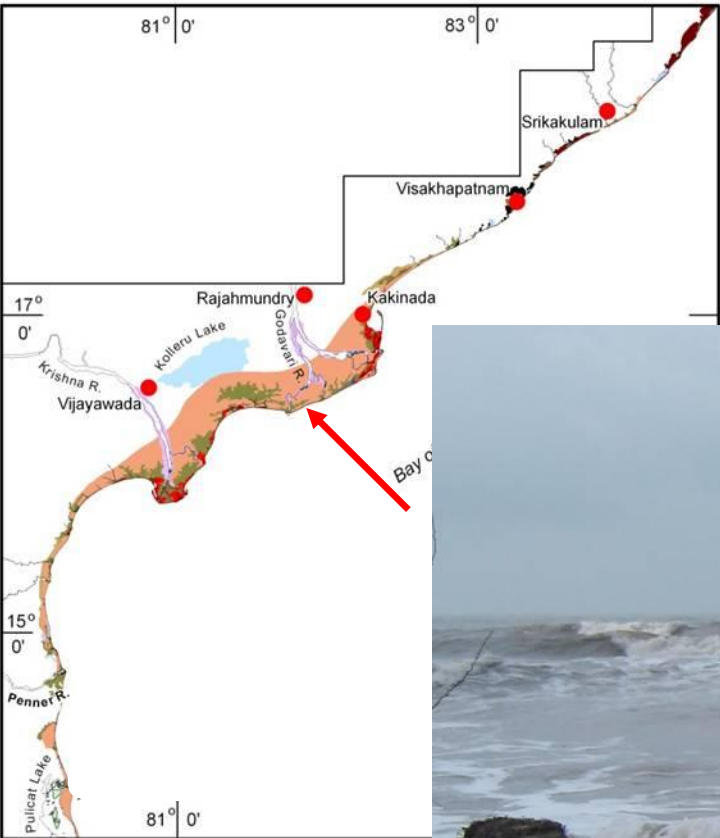


## GODAVARI DELTA COAST

### EROSION ALONG VAINATEYAM COAST



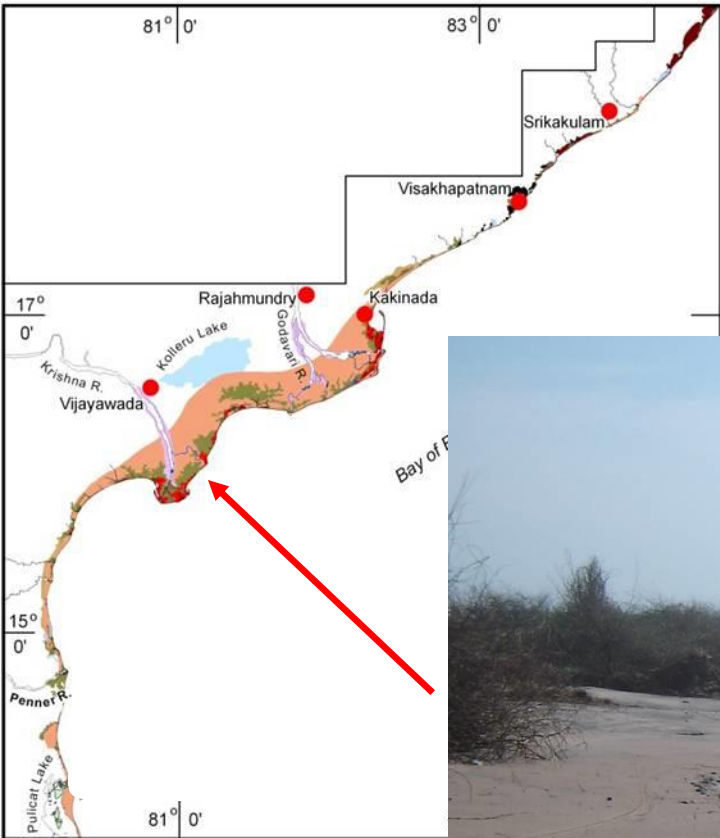




## GODAVARI DELTA COAST

### BREACHING OF BEACH RIDGES



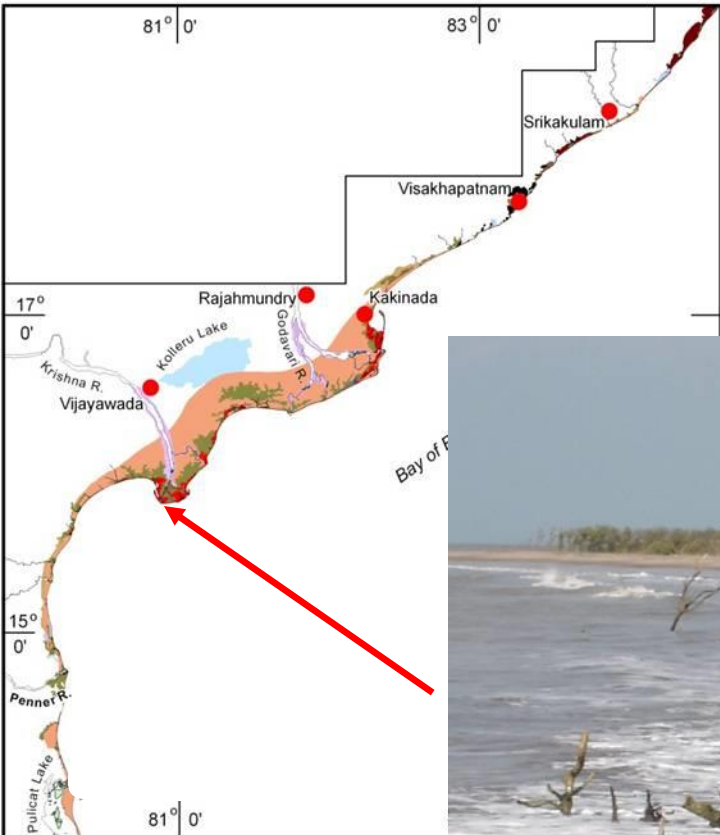


## KRISHNA DELTA FRONT COAST

### CLAY BEDS EXPOSED BY EROSION







## KRISHNA DELTA FRONT

### MANGROVE DESTRUCTION BY EROSION



**The entire 8100+km-long Indian coast is segmented at 1-km intervals and for each segment the shoreline change during the 18-year period is noted.**

**Based on the amount of shoreline erosion in 18 years, annual rate of shoreline retreat is calculated**

**Present annual erosion rate is linearly extrapolated to demarcate the hazard line for 2100 AD**



# SHORELINE CHANGES BETWEEN 1990-2008 ANDHRA PRADESH COAST



Bay of Bengal

50 KM



Area Eroded

Area Accreted



Shoreline retreat by erosion



Shoreline advance by accretion

## LENGTH

Total AP coast: 1030 km

Erosion was along: 650 km

Deposition was along: 310 km

No mappable change: 70 km

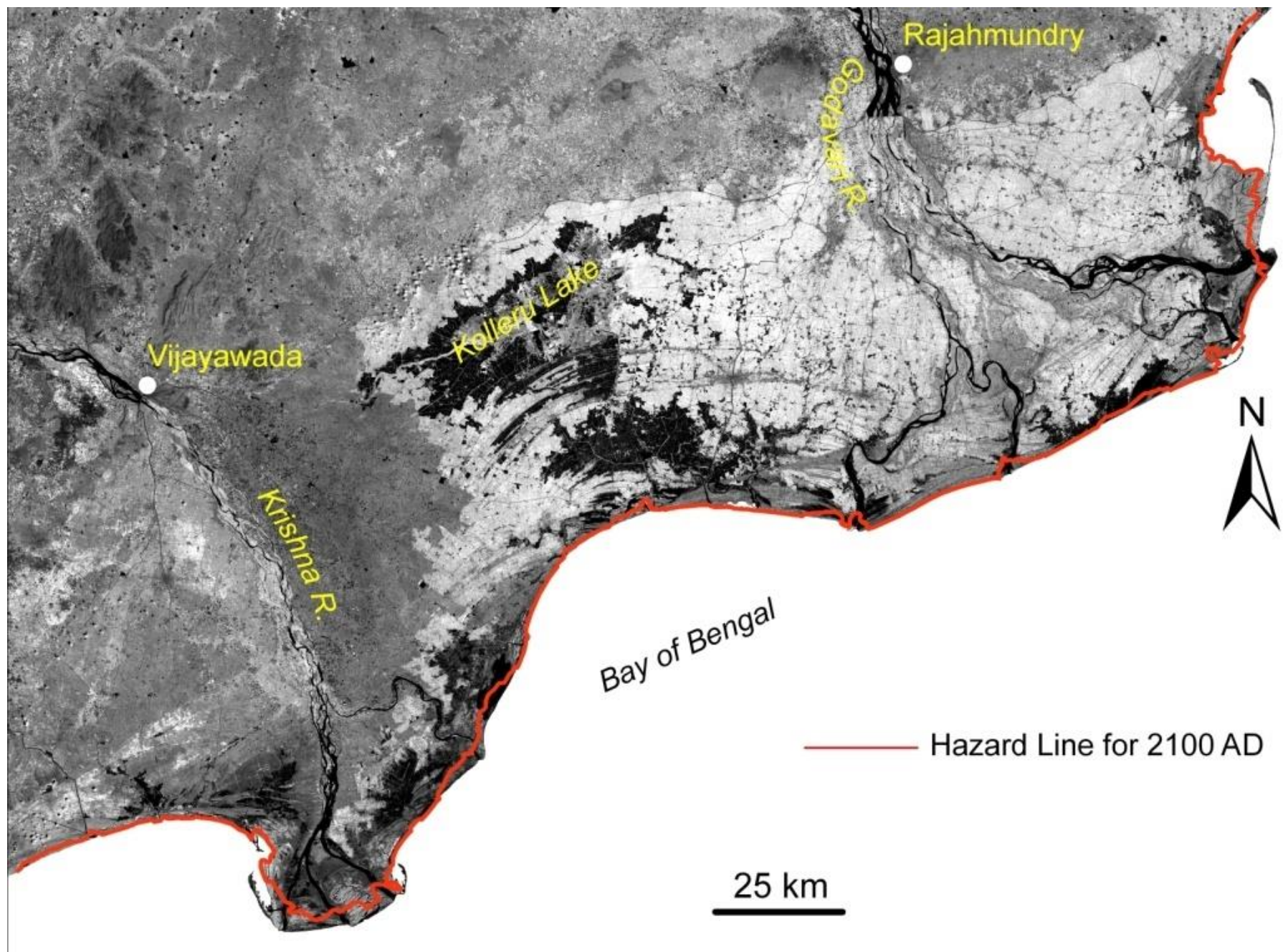
## AREA

Lost by erosion: 88 km<sup>2</sup>

Gained by accretion: 40 km<sup>2</sup>

Net area lost: 48 km<sup>2</sup>

Annual rate of loss: 2.67 km<sup>2</sup>



| Land use/land cover features | Area of the land use/land cover that would be eroded (ha)<br>in Andhra Pradesh coastal region |                |                 |                |
|------------------------------|-----------------------------------------------------------------------------------------------|----------------|-----------------|----------------|
|                              | Northern sector                                                                               | Central sector | Southern sector | Total AP coast |
| Beaches                      | 2400                                                                                          | 2500           | 2700            | 7600           |
| Mudflats                     | 500                                                                                           | 4700           | 700             | 5900           |
| Mangrove swamps              | 12                                                                                            | 15600          | 100             | 15712          |
| Backwater bodies             | 3200                                                                                          | 2300           | 900             | 6400           |
| Saltpans                     | 8                                                                                             | 1400           | 300             | 1708           |
| Aquaculture ponds            | 600                                                                                           | 6100           | 1900            | 8600           |
| Plantations                  | 15900                                                                                         | 5900           | 13200           | 35000          |
| Seasonal crops               | 500                                                                                           | 4300           | ---             | 4800           |
| Port facilities              | 16                                                                                            | 400            | ---             | 416            |
| Total                        | 23136                                                                                         | 43200          | 19800           | 86136          |

## STORMS AND STORM SURGES

Mean monthly data on storm occurrences in the four states along the east coast during 1891-2007 (Source: Cyclone e-Atlas published by IMD)

| <b>Months</b> | <b>Names of the states along the east coast of India</b> |               |                       |                   | <b>Total</b> |
|---------------|----------------------------------------------------------|---------------|-----------------------|-------------------|--------------|
|               | <b>West Bengal</b>                                       | <b>Orissa</b> | <b>Andhra Pradesh</b> | <b>Tamil Nadu</b> |              |
| January       | 0                                                        | 0             | 1                     | 3                 | <b>4</b>     |
| February      | 0                                                        | 0             | 0                     | 1                 | <b>1</b>     |
| March         | 0                                                        | 0             | 0                     | 1                 | <b>1</b>     |
| April         | 0                                                        | 0             | 2                     | 3                 | <b>5</b>     |
| May           | 8                                                        | 5             | 10                    | 5                 | <b>28</b>    |
| June          | 26                                                       | 52            | 10                    | 0                 | <b>88</b>    |
| July          | 31                                                       | 97            | 7                     | 0                 | <b>135</b>   |
| August        | 37                                                       | 119           | 11                    | 0                 | <b>167</b>   |
| September     | 27                                                       | 83            | 44                    | 0                 | <b>154</b>   |
| October       | 13                                                       | 25            | 64                    | 14                | <b>116</b>   |
| November      | 6                                                        | 6             | 25                    | 45                | <b>82</b>    |
| December      | 1                                                        | 0             | 3                     | 18                | <b>22</b>    |
| <b>Total</b>  | <b>149</b>                                               | <b>387</b>    | <b>177</b>            | <b>90</b>         | <b>803</b>   |



## Seasonal distribution of storms along the east coast of India during 1891-2007

| Seasons                 | Names of the states along the east coast of India |            |                |            | Total      |
|-------------------------|---------------------------------------------------|------------|----------------|------------|------------|
|                         | West Bengal                                       | Orissa     | Andhra Pradesh | Tamil Nadu |            |
| Winter (Dec.-Feb.)      | 1                                                 | 0          | 4              | 22         | 27         |
| Pre-monsoon (Mar.-May)  | 8                                                 | 5          | 12             | 9          | 34         |
| SW monsoon (June-Sept.) | 121                                               | 351        | 72             | 0          | 544        |
| NE monsoon (Oct.-Nov.)  | 19                                                | 31         | 89             | 59         | 198        |
| <b>Total</b>            | <b>149</b>                                        | <b>387</b> | <b>177</b>     | <b>90</b>  | <b>803</b> |

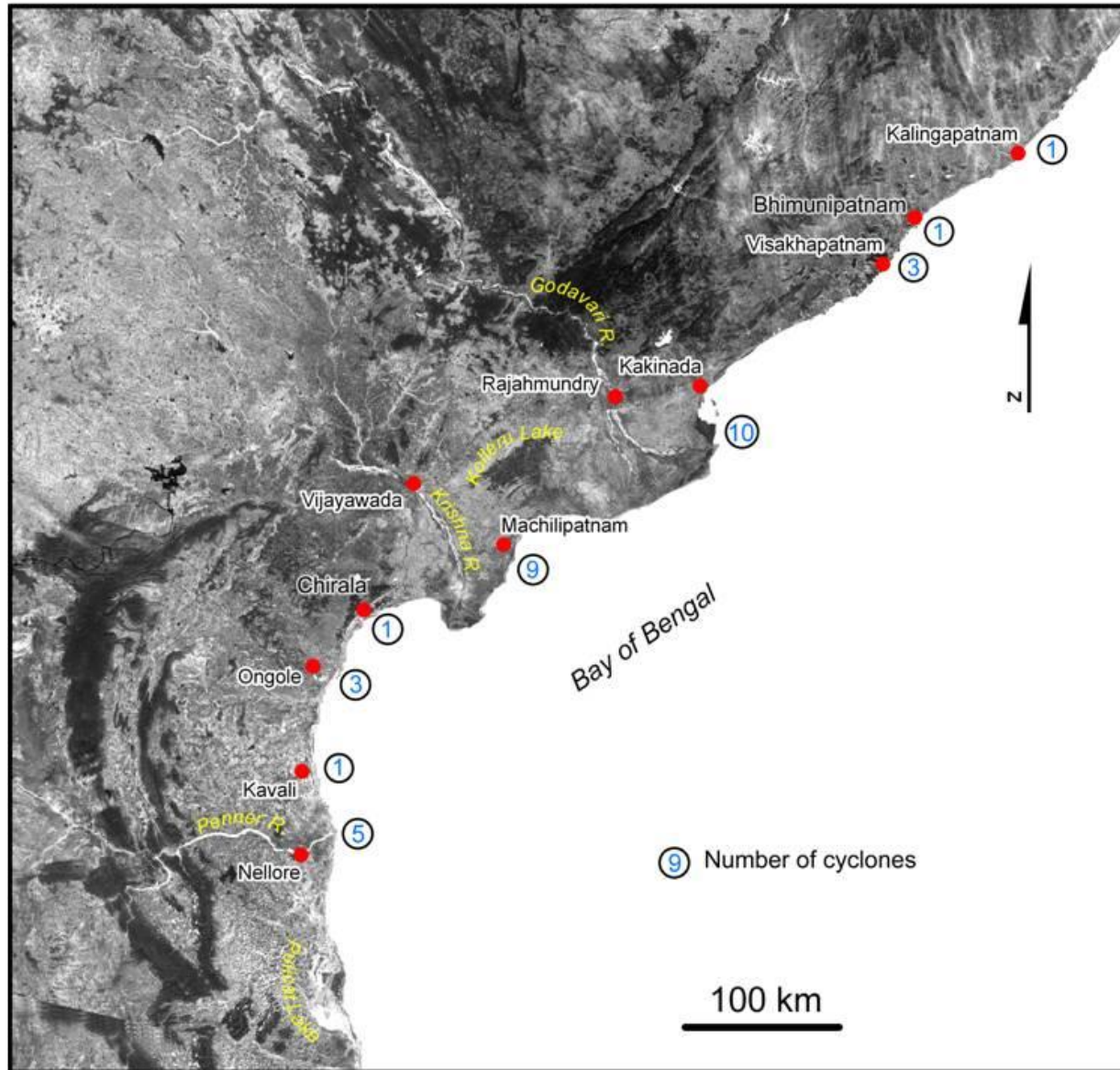
Data on storms of different intensities occurred along the east coastal states during 1891-2007

| States         | Storms of different intensities |                              |                                    | Total      |
|----------------|---------------------------------|------------------------------|------------------------------------|------------|
|                | Cyclonic storm (CS)             | Severe cyclonic storms (SCS) | Very severe cyclonic storms (VSCS) |            |
| West Bengal    | 95                              | 25                           | 29                                 | <b>149</b> |
| Orissa         | 281                             | 77                           | 29                                 | <b>387</b> |
| Andhra Pradesh | 91                              | 47                           | 39                                 | <b>177</b> |
| Tamil Nadu     | 38                              | 22                           | 30                                 | <b>90</b>  |
| <b>Total</b>   | <b>505</b>                      | <b>171</b>                   | <b>127</b>                         | <b>803</b> |

## Monthly distribution of storms of different intensities along AP coast during 1891-2007

| Months       | Storms of different intensities |                              |                                    | Total      |
|--------------|---------------------------------|------------------------------|------------------------------------|------------|
|              | Cyclonic storms (CS)            | Severe cyclonic storms (SCS) | Very severe cyclonic storms (VSCS) |            |
| January      | 0                               | 1                            | 0                                  | <b>1</b>   |
| February     | 0                               | 0                            | 0                                  | <b>0</b>   |
| March        | 0                               | 0                            | 0                                  | <b>0</b>   |
| April        | 1                               | 1                            | 0                                  | <b>2</b>   |
| May          | 2                               | 3                            | 5                                  | <b>10</b>  |
| June         | 6                               | 4                            | 0                                  | <b>10</b>  |
| July         | 5                               | 2                            | 0                                  | <b>7</b>   |
| August       | 10                              | 1                            | 0                                  | <b>11</b>  |
| September    | 34                              | 5                            | 5                                  | <b>44</b>  |
| October      | 31                              | 21                           | 12                                 | <b>64</b>  |
| November     | 2                               | 8                            | 15                                 | <b>25</b>  |
| December     | 0                               | 1                            | 2                                  | <b>3</b>   |
| <b>Total</b> | <b>91</b>                       | <b>47</b>                    | <b>39</b>                          | <b>177</b> |

## SPATIAL DISTRIBUTION OF VSCS ALONG AP COAST

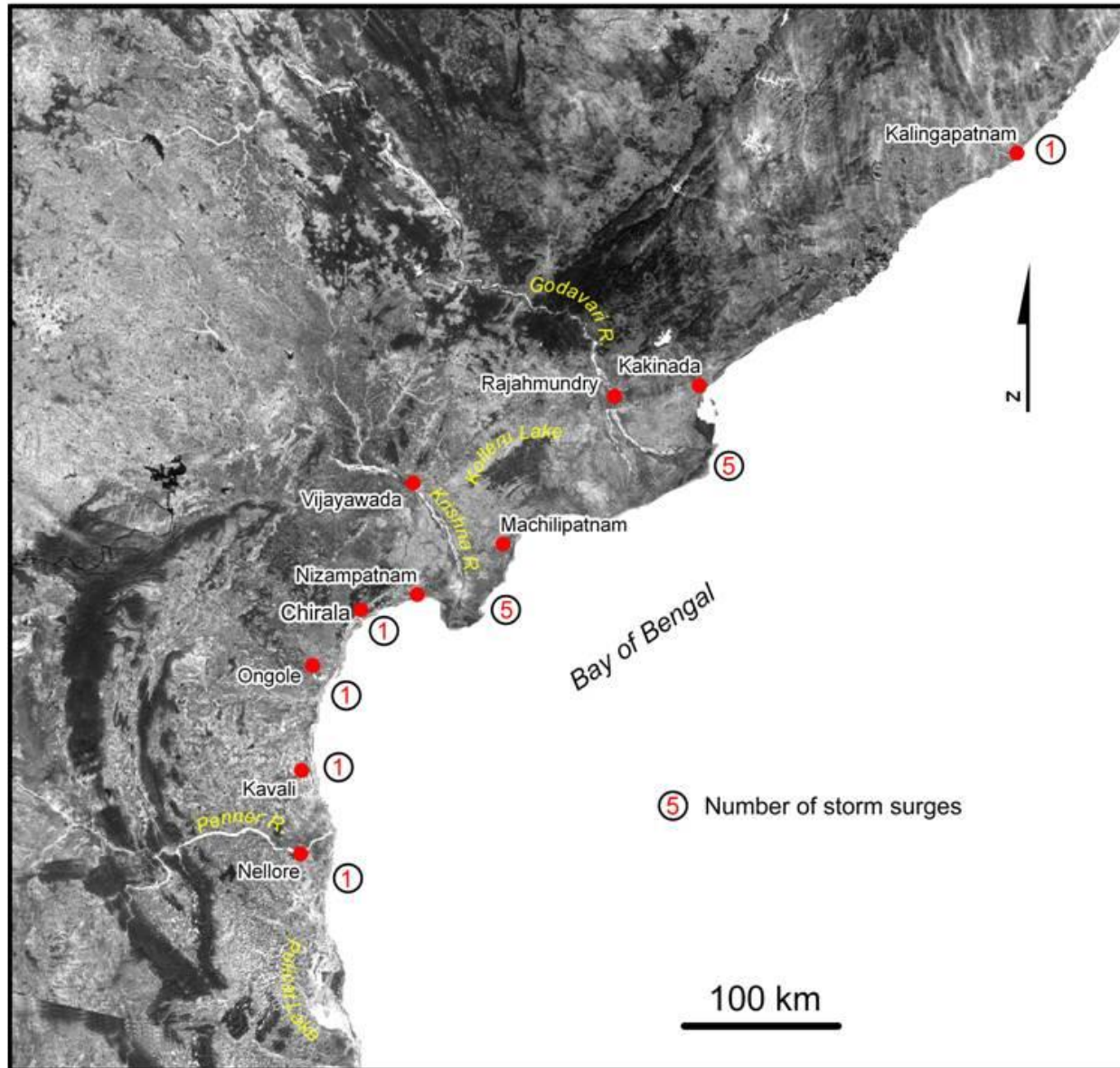


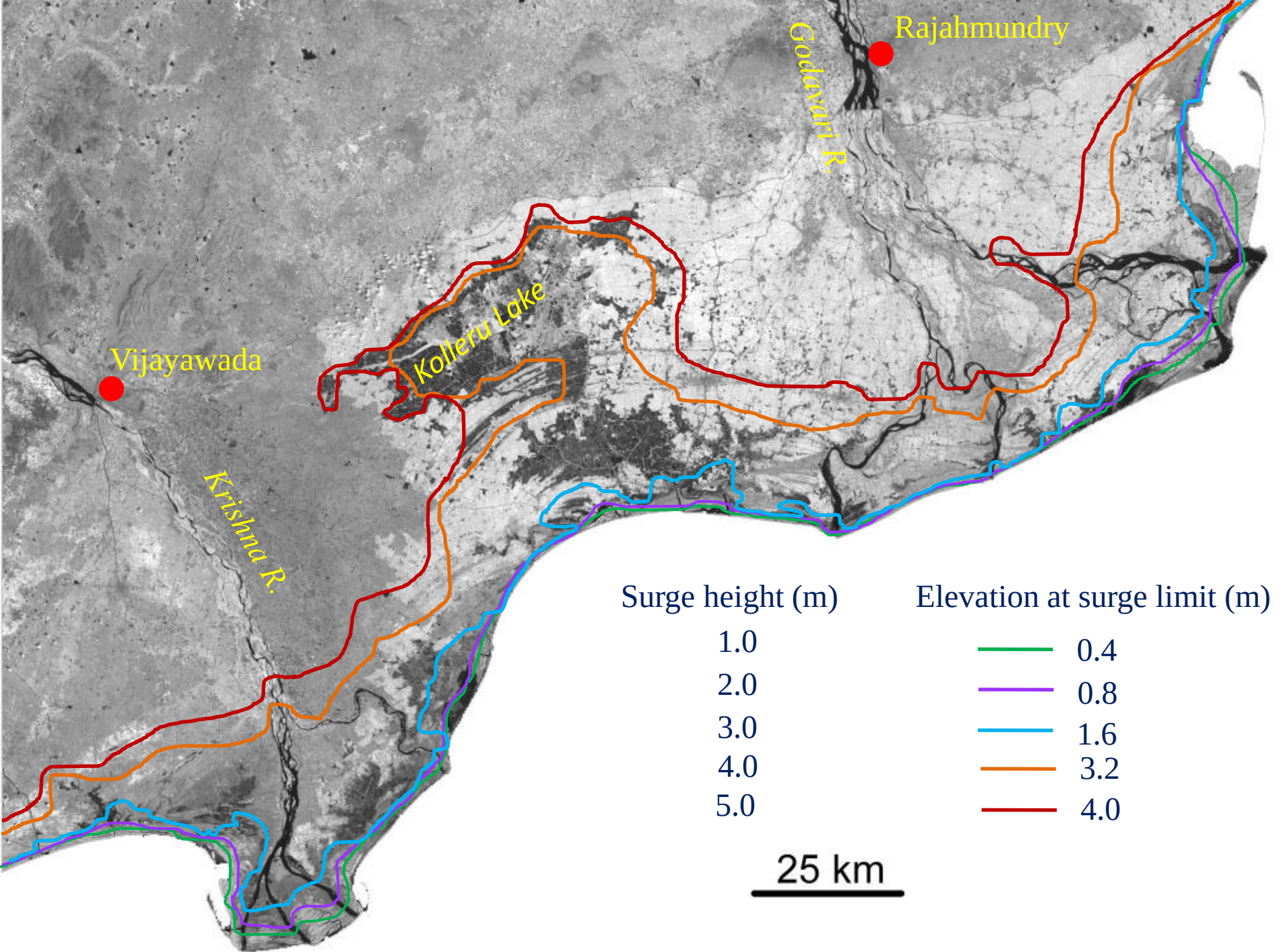


## List of storm surges along Andhra Pradesh Coast during 1779-1996

| Period       | Surge height (m) in different coastal sectors of AP |          |               |          |          |          |          | Total     |
|--------------|-----------------------------------------------------|----------|---------------|----------|----------|----------|----------|-----------|
|              | Kalingapatnam                                       | Kakinada | Machilipatnam | Chirala  | Ongole   | Kavali   | Nellore  |           |
| Oct.,1779    |                                                     |          | 4             |          |          |          |          | 1         |
| Dec.,1789    |                                                     | 2        |               |          |          |          |          | 1         |
| Nov.,1839    |                                                     | 6        |               |          |          |          |          | 1         |
| Nov.,1864    |                                                     |          | 4             |          |          |          |          | 1         |
| Nov.,1938    |                                                     | 2        |               |          |          |          |          | 1         |
| Oct.,1945    |                                                     |          | 5             |          |          |          |          | 1         |
| Oct.,1949    |                                                     |          | 5             |          |          |          |          | 1         |
| Oct.,1955    | 1.7                                                 |          |               |          |          |          |          | 1         |
| Nov.,1969    |                                                     | 3.1      |               |          |          |          |          | 1         |
| Nov.,1977    |                                                     |          |               | 5        |          |          |          | 1         |
| Nov.,1978    |                                                     |          | 5             |          |          |          |          | 1         |
| May,1979     |                                                     |          |               |          | 3.6      |          |          | 1         |
| Nov.,1989    |                                                     |          |               |          |          | 4        |          | 1         |
| May,1990     |                                                     |          |               |          |          |          | 5        | 1         |
| Nov.,1996    |                                                     | 4        |               |          |          |          |          | 1         |
| <b>Total</b> | <b>1</b>                                            | <b>5</b> | <b>5</b>      | <b>1</b> | <b>1</b> | <b>1</b> | <b>1</b> | <b>15</b> |

## SPATIAL DISTRIBUTION OF STORM SURGES ALONG AP COAST





| Land use/Land cover features | Area (in km <sup>2</sup> ) of inundation for various surge heights in <b>Krishna-Godavari delta region</b> |     |      |      |      |
|------------------------------|------------------------------------------------------------------------------------------------------------|-----|------|------|------|
|                              | 1m                                                                                                         | 2m  | 3m   | 4m   | 5m   |
| Mangroves                    | 108                                                                                                        | 247 | 400  | 400  | 400  |
| Beach                        | 30                                                                                                         | 31  | 61   | 61   | 61   |
| Mudflats                     | 26                                                                                                         | 43  | 106  | 106  | 106  |
| Barrier Bars                 | 1                                                                                                          | 2   | 2    | 2    | 2    |
| Saltpans                     | 1                                                                                                          | 2   | 23   | 23   | 23   |
| Aqua ponds                   | 11                                                                                                         | 45  | 278  | 936  | 1225 |
| Casuarina Plantation         | ---                                                                                                        | 55  | 104  | 230  | 251  |
| Plantation Crops             | ---                                                                                                        | 3   | 10   | 187  | 449  |
| Agriculture (Single crop)    | ---                                                                                                        |     |      | 408  | 630  |
| Agriculture (Double crop)    | ---                                                                                                        |     | 74   | 1244 | 2565 |
| Habitation                   |                                                                                                            |     | 2    | 40   | 107  |
| Port Facilities              |                                                                                                            | 1   | 2    | 2    | 2    |
| Total                        | 177                                                                                                        | 429 | 1062 | 3639 | 5821 |



# NATIONAL COASTAL ZONE MANAGEMENT POLICY

- Issues due to resource overuse,
- Degradation of ecosystems,
- Conflicts among stakeholders
- Coastal hazards
- Livelihood security
- Sustainable development



# Why regulated development of the coast?

- Protection of fishery
- Protection of coastal ecosystems
- Protection of life and property
- Maintain the scenic beauty of coast
- Encourage sustainable tourism
- Ensure public access to beach





# Coastal Regulation Zone

- Intertidal zone- area between HTL & LTL
- Defined regulation zone landward of the HTL on sea coast and on the banks of estuaries creeks and backwaters
- 500 m along sea & estuary coast
- 100 Or 150 m on banks of backwater, river



## CRZ Notification - Genesis

- 1981 – Prime Minister Indira Gandhi's letter: Keep 500 m from the HTL free from development activities
- 1982- Working Group on beach development guidelines
- 1983- Guidelines for the development of beaches  
(Tourism, Industrial development, Urban and rural development  
Special areas – mangroves, scenic areas, corals, oceanic islands)
- 1986 – Environmental Protection Act
- 1989 – Draft CRZ Notification
- 1991 – CRZ Notification
- 1994 – Supreme Court direction asking for strict implementation of CRZ
- 1996 – Approval to State CZMPs
- 1997 – Constitution of Aquaculture Authority
- 1998 – National and State Coastal Zone Management Authorities



# How it progressed.....

- Vohra Committee
- Saldhana Committee
- Balakrishnan Nair Committee
- Saldhana Committee
- Babu Paul Committee
- Swaminathan Committee



## **MSS Committee**

# **GUIDING PRINCIPLES OF CZM**

- **Ecological and cultural security, livelihood security and national security**
- **Territorial sea and the landward administrative biological limits**
- **Regulation, education and social mobilization**
- **conformity with international laws**
- **Regulation based on sound, scientific and ecological principles**
- **Precautionary approach where there are potential threats or irreversible damage to ecologically fragile systems**
- **Significant biological, cultural and natural assets should be considered incomparable**

# Benefits of CRZ

- Awareness on coast
- Traditional rights
- Industries controlled
- Natural hazard protection
- Livelihood security
- Fragile systems
- Aesthetics



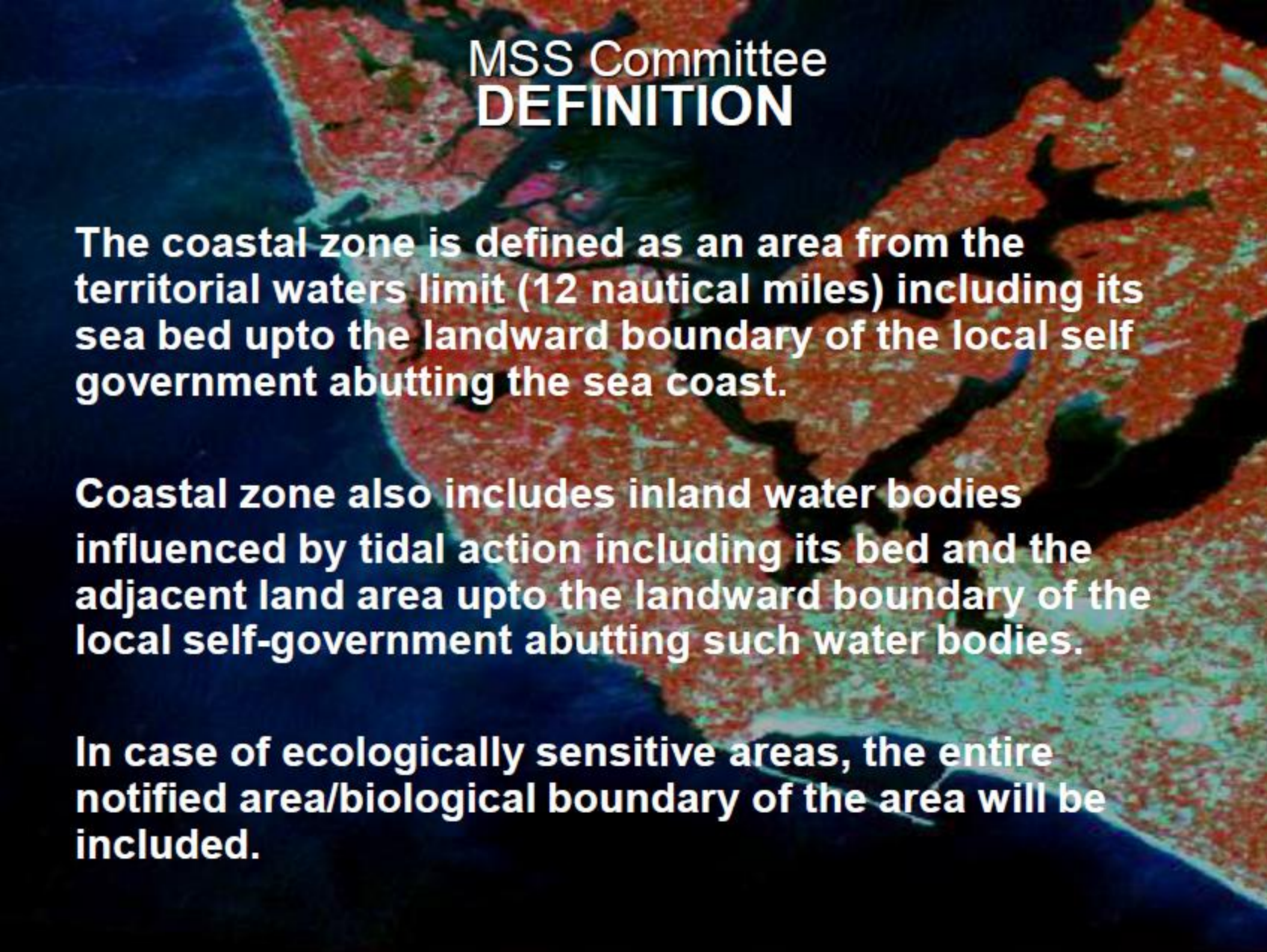


# Failures of CRZ

- Arbitrary zone
- Mainly violated
- No participation
- Too restrictive
- Goals undefined
- No incentives
- No enforcement





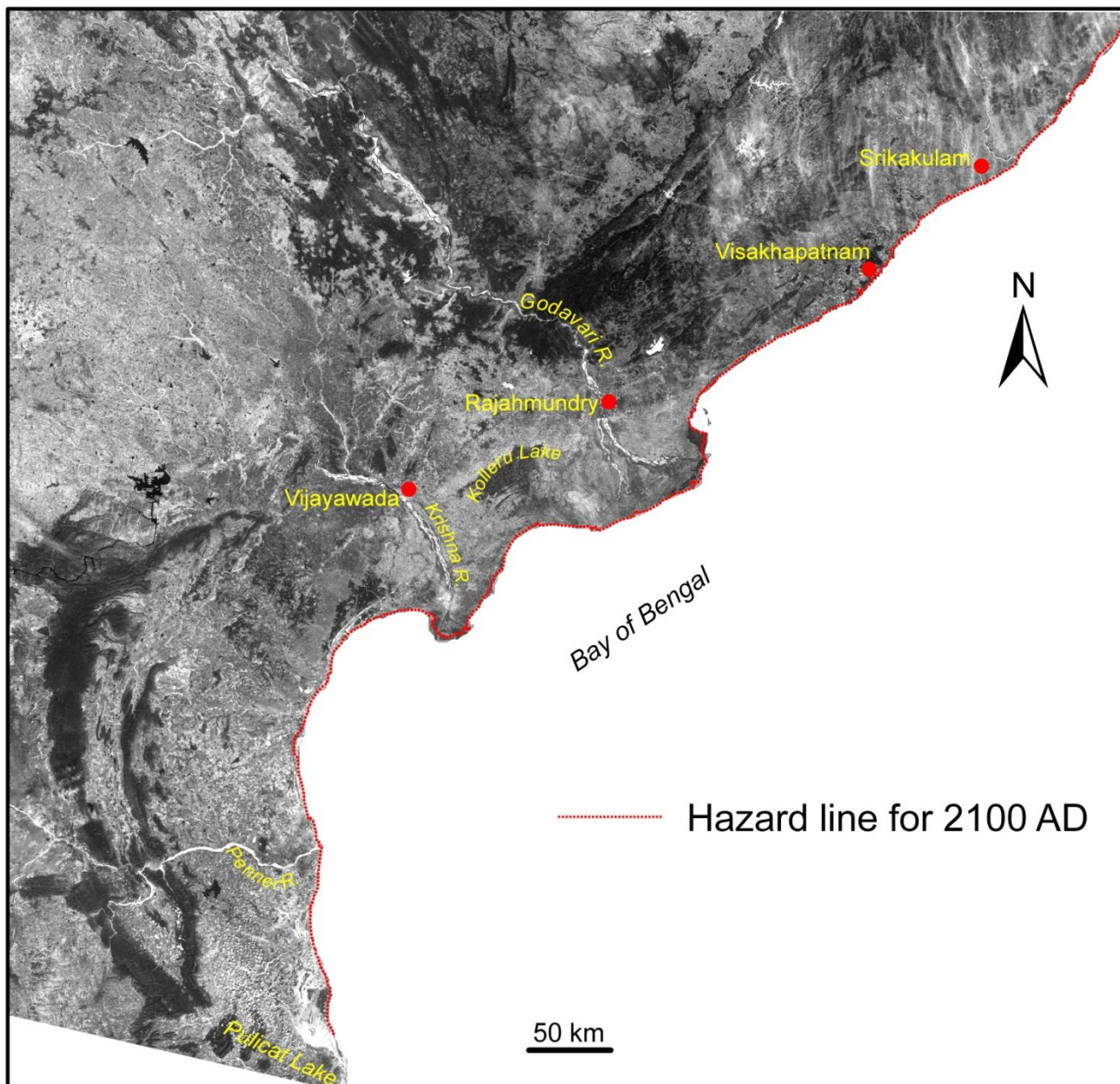
An aerial photograph of a coastal region. The land is shown in shades of red and orange, while the water is dark blue. A white line marks the territorial waters limit. A red-shaded area, representing the coastal zone, extends from the coast inland, following the landward boundary of the local self-government. The text is overlaid on the image.

## **MSS Committee DEFINITION**

**The coastal zone is defined as an area from the territorial waters limit (12 nautical miles) including its sea bed upto the landward boundary of the local self government abutting the sea coast.**

**Coastal zone also includes inland water bodies influenced by tidal action including its bed and the adjacent land area upto the landward boundary of the local self-government abutting such water bodies.**

**In case of ecologically sensitive areas, the entire notified area/biological boundary of the area will be included.**



**ICZM**

**Coastal Hazard Line  
Mapping By  
Survey of India**

**New Delhi, 27/09/2011**



# Survey of India( SOI ) & ICZM

- SOI & MoEF Signed an MoU in May 2010
- For Coastal Hazard Line Mapping, involving
  - **Mapping of Sea Level Rise Line**
  - **Mapping of Coastal Erosion Line**
  - **Mapping of Composite Hazard Line &**
  - **Demarcation of the Hazard Line on the Ground in all the 8 coastal states.**

Under the World Bank Assisted  
ICZM Project of MoEF.



# ROLE OF SOI

Demarcation of a Vulnerability

Setback / Hazard line.

- Setback line is the boundary line beyond which the effect of Natural Hazards such as erosion and sea-level-rise will not be felt.
- The parameters involved are: Elevation, sea-level-rise & Coastal Erosion.

- **Elevation:** DEM will be generated by Photogrammetry.
- **Sea-Level Rise:** Tidal data will be processed to compute the 100 year Return Period Extreme Tidal Height values at any Transect point using Weibull Distribution and Linear Interpolation.
- **Coastal Erosion:** Annual Rate of Coastal Erosion will be Computed by comparing the oldest Topo-Map and the Latest Aerial Photography Stereo / Ortho / satellite Image and extrapolated to next 100 years.

# Project Sub-Components

- **Aerial Photography**
- **Photogrammetry**
- **Tidal Data Analysis**
- **Creation of DEM**
- **Plotting Tidal Data for Mapping Flood Line**
- **Plotting Erosion Data for Erosion Line**
- **Mapping Composite Hazard Line**
- **Erecting Pillars and Markers along the Hazard Line on the Ground.**

THANK YOU