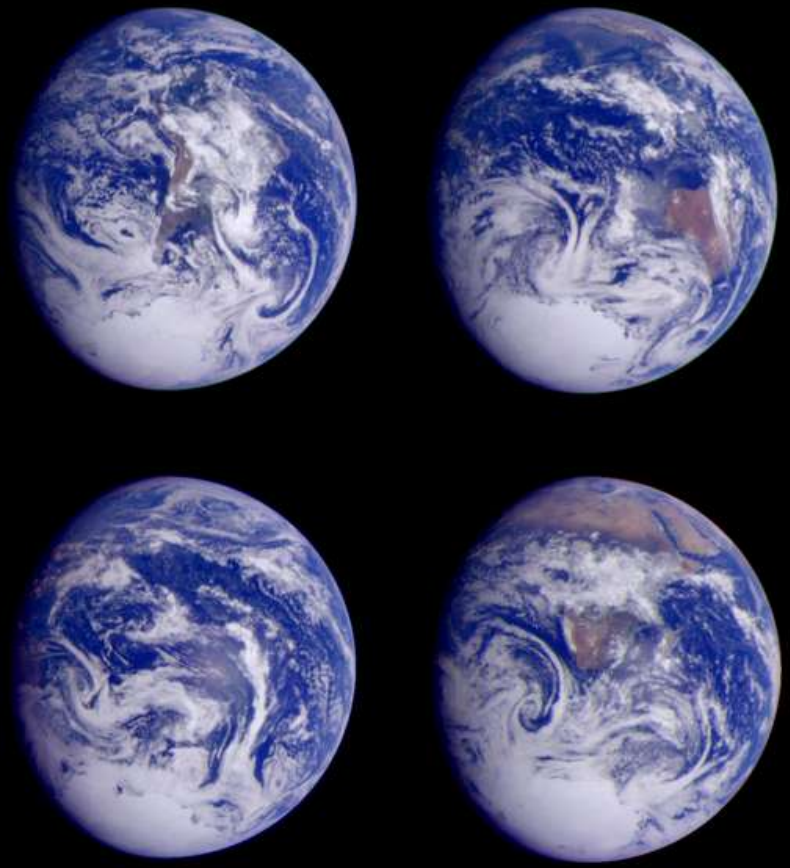


PERSPECTIVES OF BUILDING RESILIENT INDIA THROUGH EFFECTIVE CLIMATE AND DISASTER RISK REDUCTION

K J Ramesh
Ministry of Earth Sciences
kj.ramesh@nic.in

MoES Agencies dealing with various Hazards

HYDRO-METEOROLOGICAL HAZARDS – IMD, INCOIS

Floods, Tropical Cyclones
Local Severe Storms, Drought
Snow Avalanches, Winter Systems

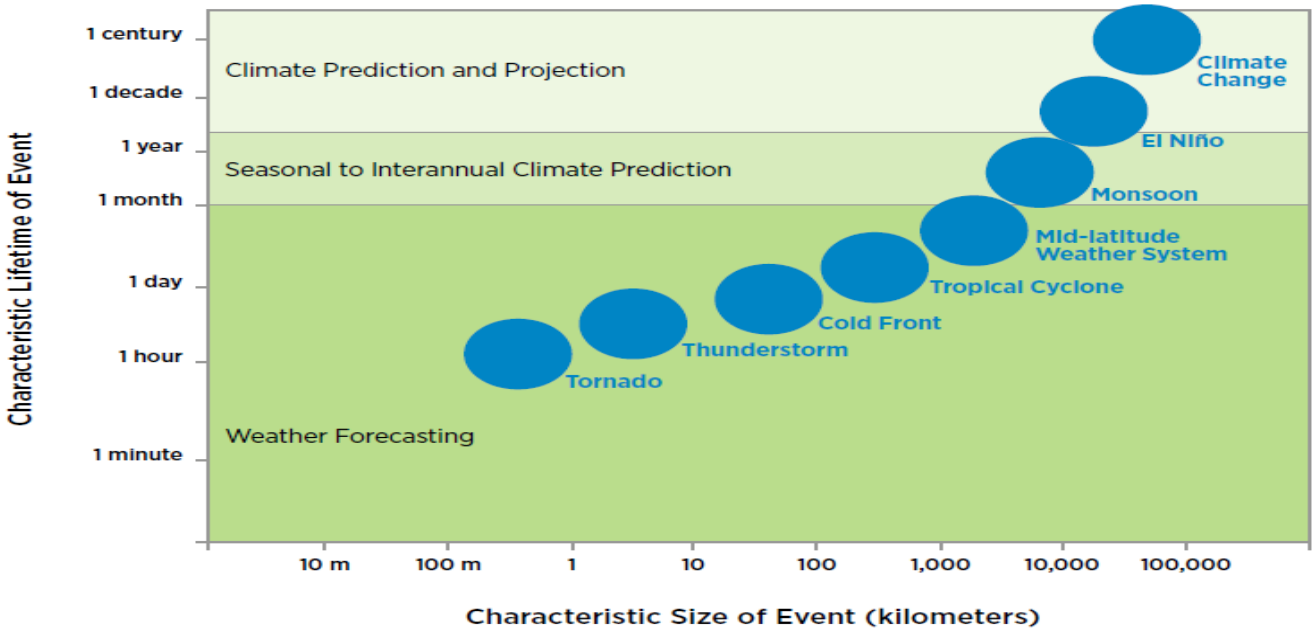
GEOLOGICAL HAZARDS

Earthquakes & Tsunamis (IMD and INCOIS)
Rain Induced Landslides/Mudslides (IMD)

ENVIRONMENTAL IMPACTS

-Air pollution & Haze, FOG, Smog (IMD)
-Coastal Zone Management (ICMAM)
-Coastal Erosion (ICMAM)
-Eco-system monitoring/ modeling (IITM and IMD)
-Climate change impacts on severe weather events (IITM)

Inputs of climate information services to various stages of the climate resilient framework



An operational framework for managing climate and disaster risk

PILLAR 2

Risk Reduction

Avoided creation of new risks and reduced risks in society through greater disaster and climate risk consideration in policy and investment

PILLAR 3

Preparedness

Improved capacity to manage crises through developing forecasting, early warning and contingency plans.

PILLAR 4

Financial Protection

Increased financial resilience of governments, private sector and households through financial protection strategies

PILLAR 5

Resilient Reconstruction

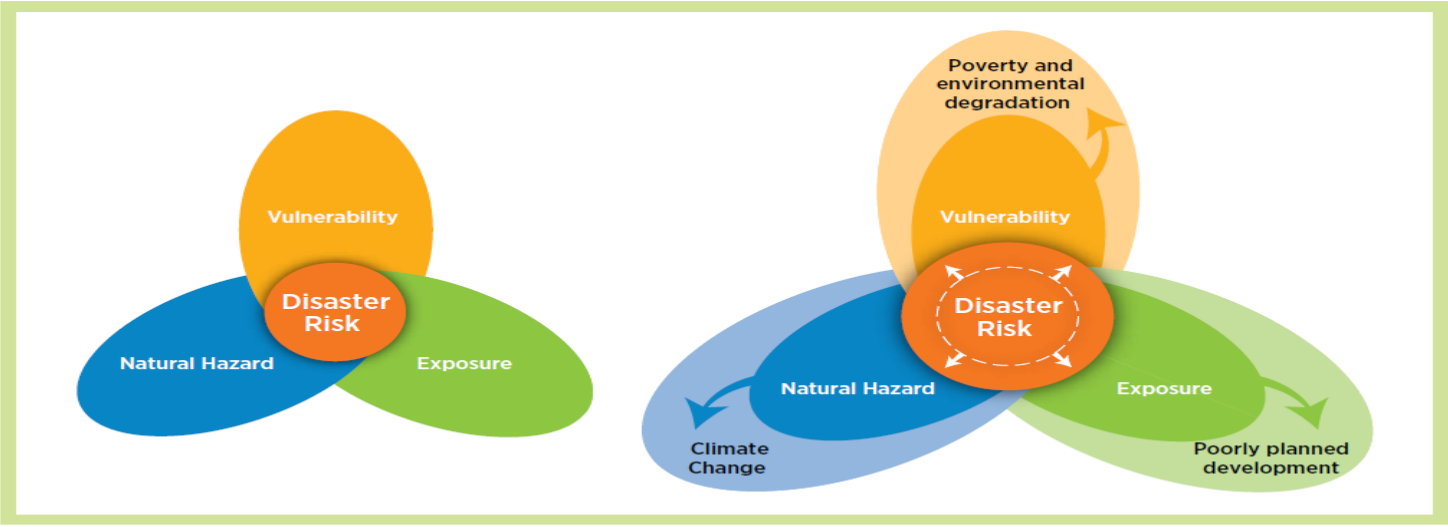
Quicker, more resilient recovery through support for reconstruction planning

PILLAR 1

Risk identification

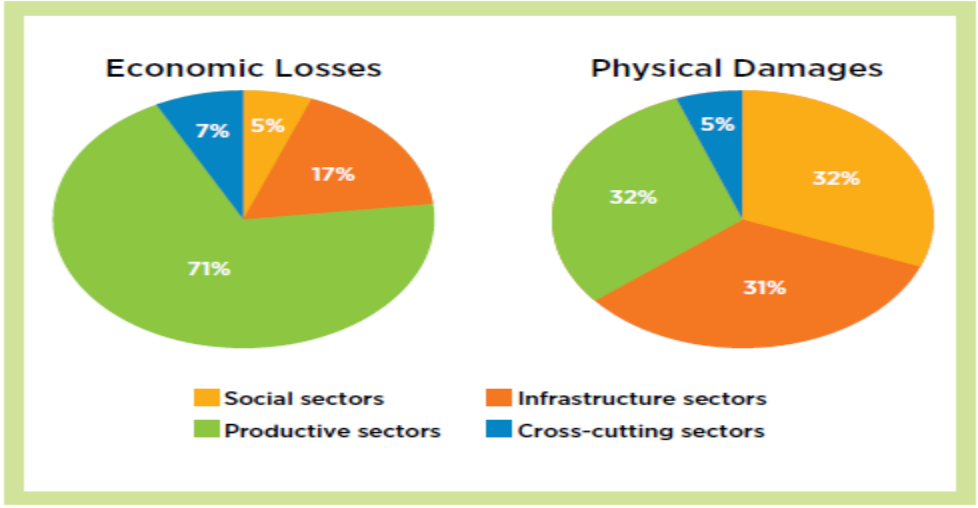
Improved identification and understanding of disaster and climate risks through building capacity for assessments and analysis

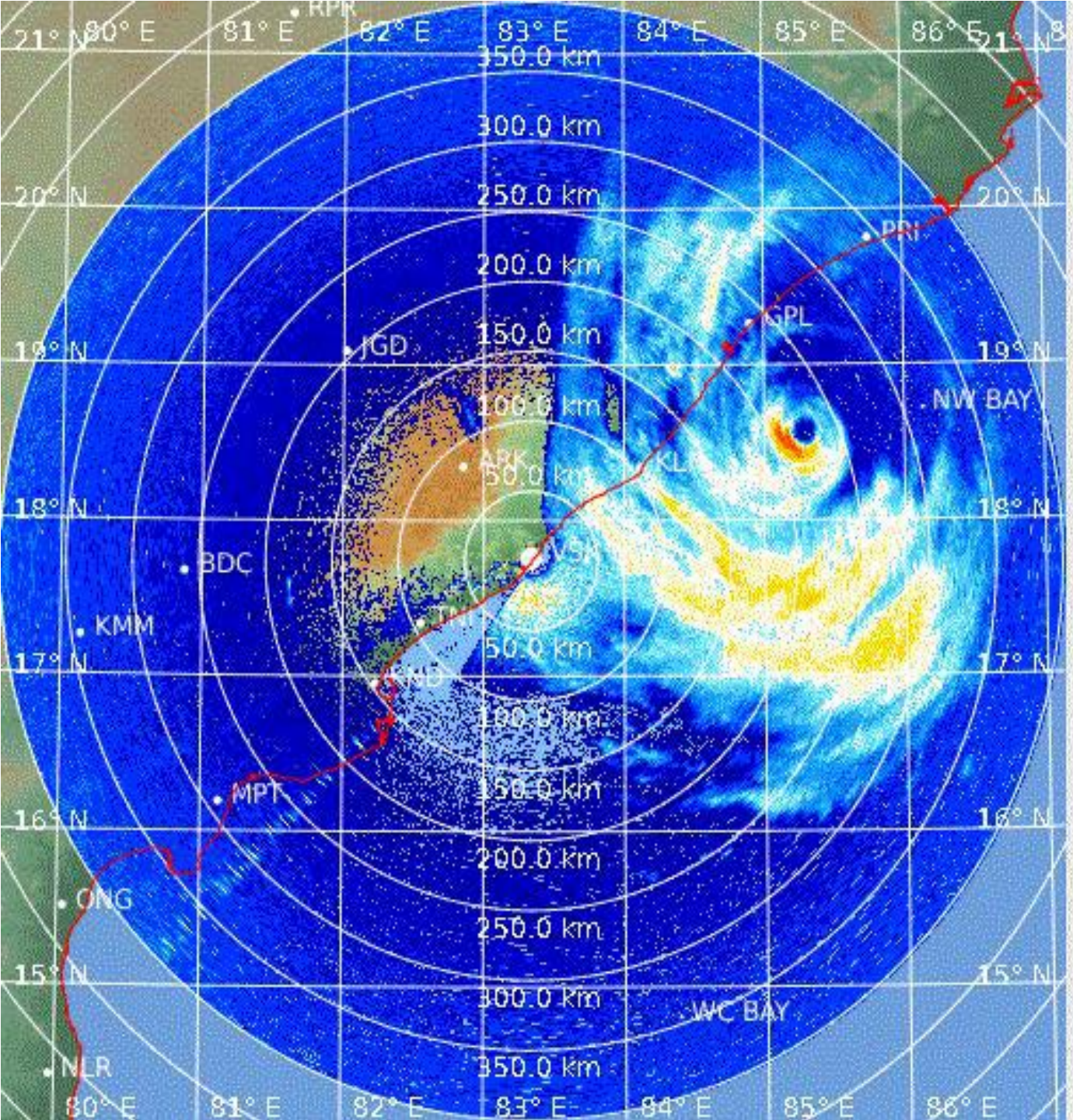
Disaster and Climate Risk



Disaster risk is determined by the occurrence of a natural hazard (e.g., a cyclone), which may impact exposed populations and assets (e.g., houses located in the cyclone path). Vulnerability is the characteristic of the population or asset making it particularly susceptible to damaging effects (e.g., fragility of housing construction). Poorly planned development, poverty, environmental degradation and climate change are all drivers that can increase the magnitude of this interaction, leading to larger disasters.

Total loss and damage from hydro-meteorological disasters, by affected sector (1972–2013)





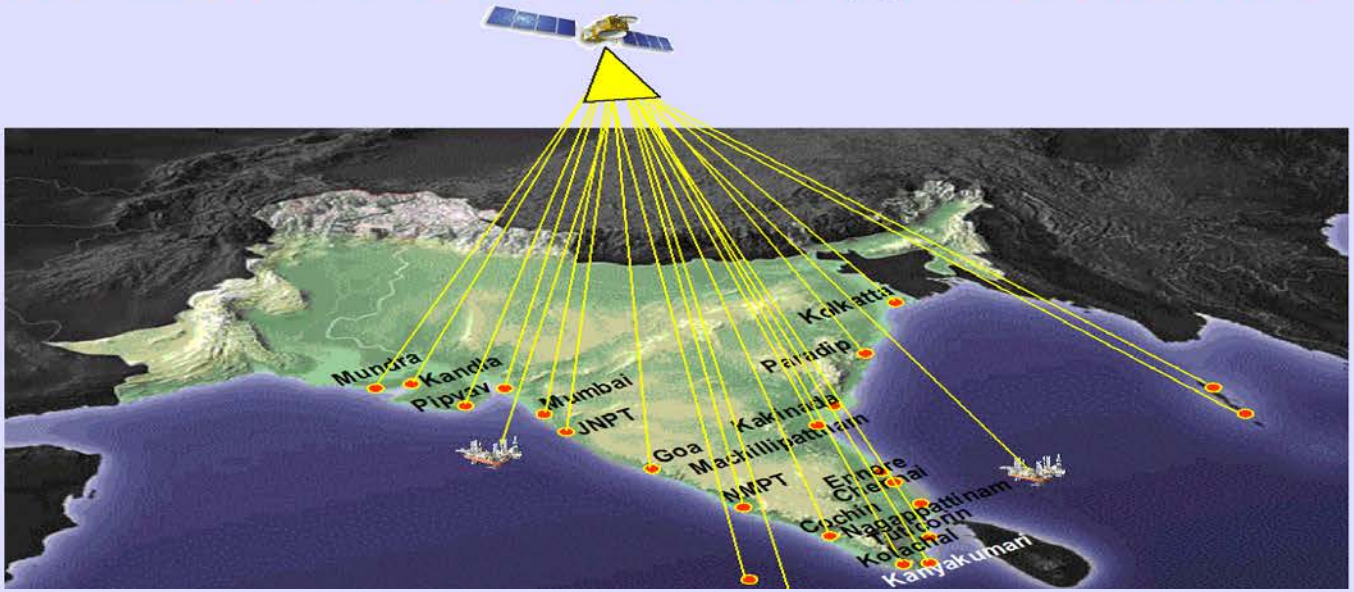
PPI (dBZ)
10:59 / 12-Oct-2013
Visakhapatnam

60.0 dBZ
48.0 dBZ
40.0 dBZ
32.0 dBZ
24.0 dBZ
16.0 dBZ
8.0 dBZ
0.0 dBZ

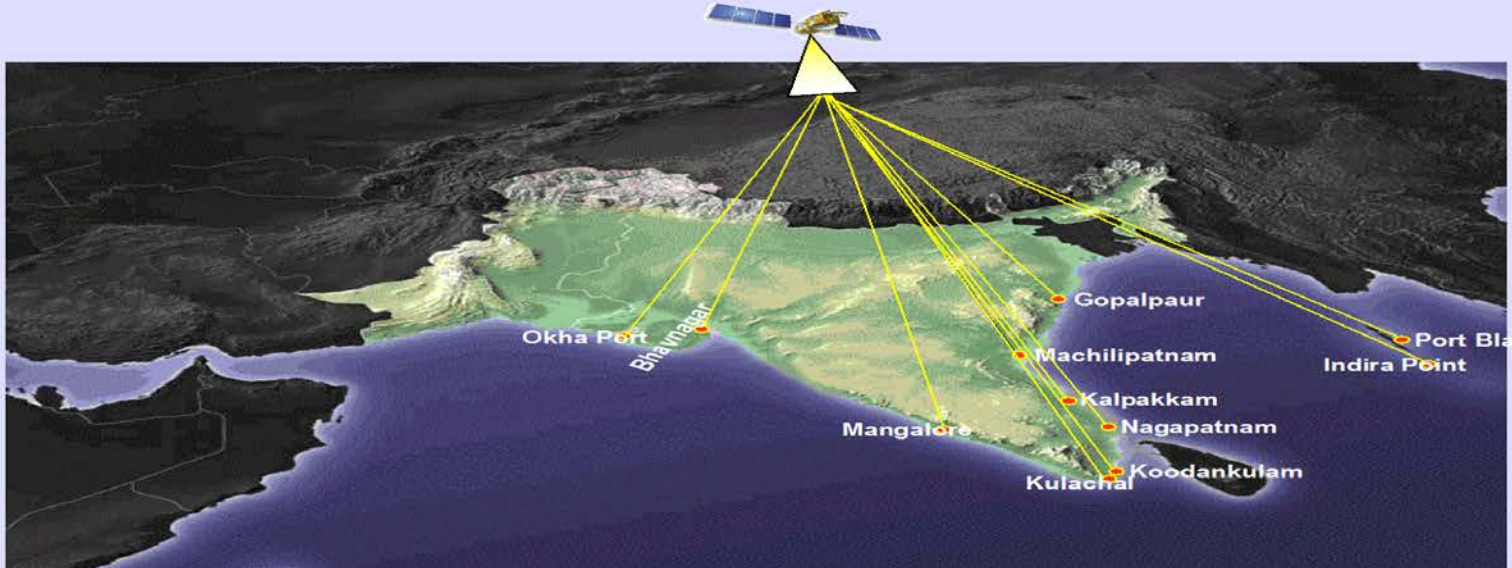
Pdf File:	400_ppz.ppi
Clutter Filter:	IIRDoppler 10
Time sampling:	16
PRF:	300 Hz
Range:	400 km
Resolution:	1.600 km/pixel
Elevation:	-0.2 deg
Data:	Radar Data

Rainbow® SELEX-SI

Sea Level Monitoring Stations

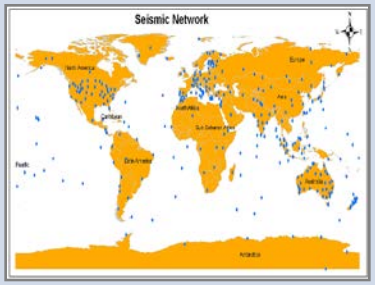


HF Radar-based Monitoring of Surface Current and Wave

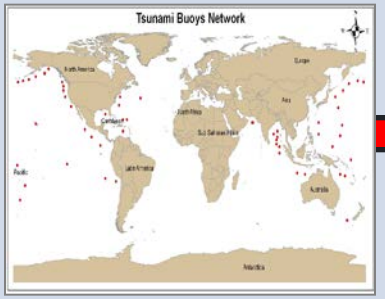


Tsunami Early Warning System

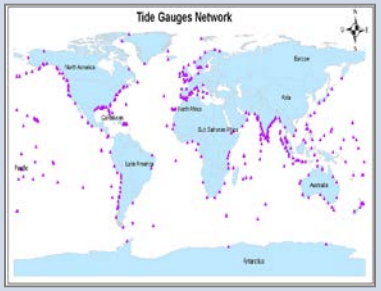
Detection → Warnings → Dissemination



Seismic Network



BPR Network



Tide gauge Network

Observation Networks

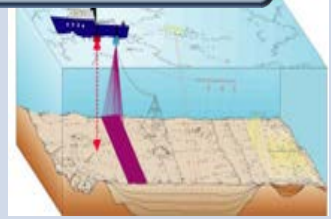
VSAT

INSAT

GPRS

INMARSAT

Communications



Bathymetry

Tsunami Modelling

Topography

Costal Vulnerability

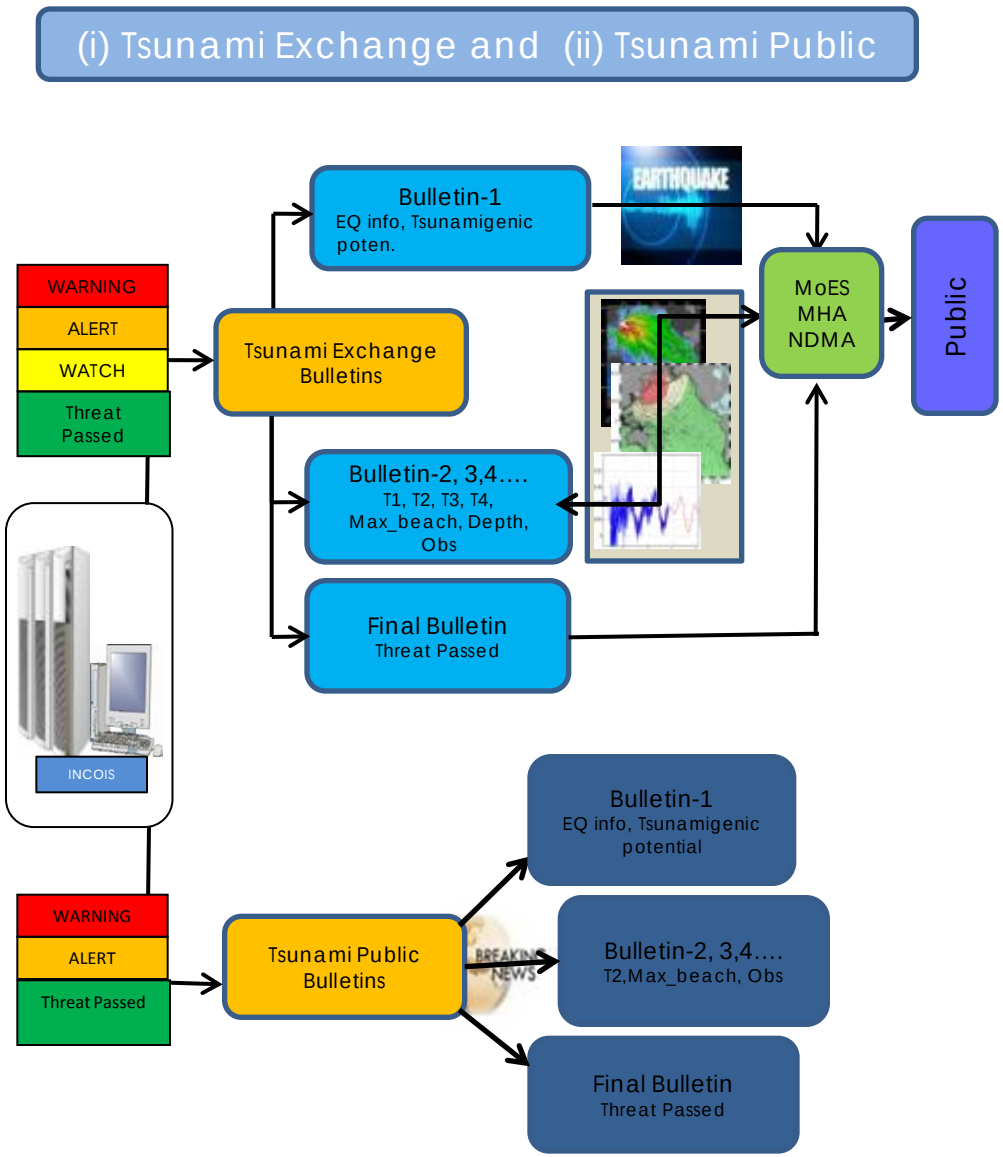
Simulations

Capacity Building

R & D

Last mile connectivity

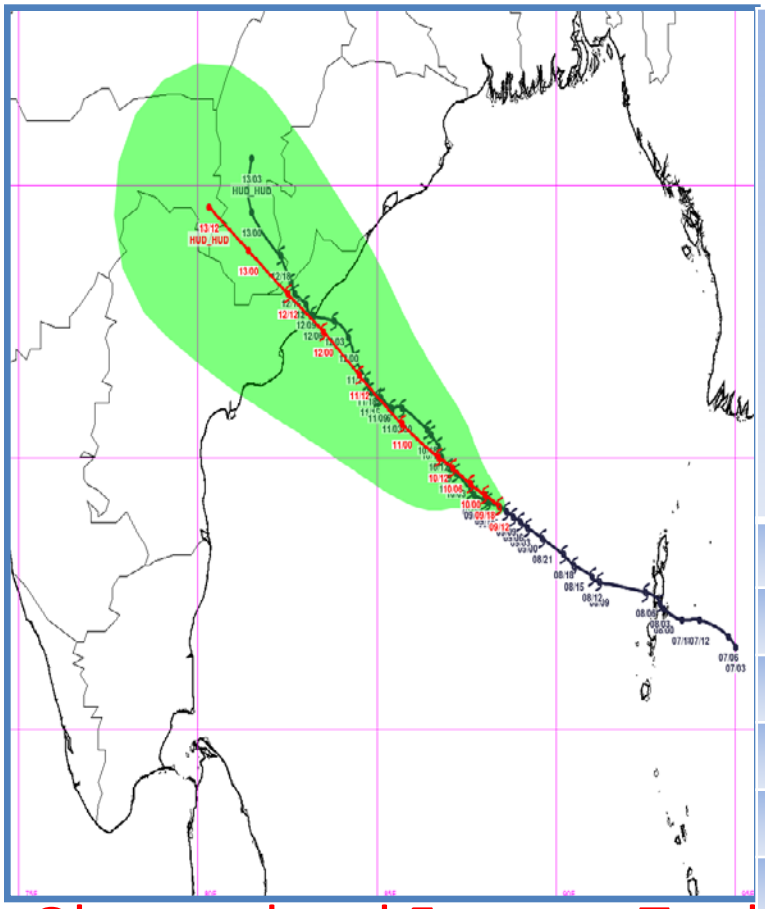
Bulletin Types and Content



Bulletin type	Information	Time of issue (Earthquake Origin time as T_0) mins
Type-1	Preliminary EQ Parameters	T_0 + 10
Type-2	No Threat Information from Model Scenarios	T_0 + 20
	Threat (WARNING / ALERT / WATCH) Information from Model Scenarios	
Type-2	Revised EQ Parameters and model results	as and when revised earthquake parameters are available
Type-3	Real-time water level observations indicating Tsunami Generation	as and when the first real-time water level observation is available
Type-3	Real-time water level observations indicating Tsunami Generation + THREAT PASSED information for individual Zones	Hourly update / as and when the subsequent real-time water level observations are available
Type-4 (Final)	No significant tsunami	
	Threat Passed	120 mins after the last exceedance of 0.5 M threat threshold at last Indian Ocean member state

All Bulletins are sequentially numbered regardless of the bulletin type

Cyclone Monitoring -HUDHUD

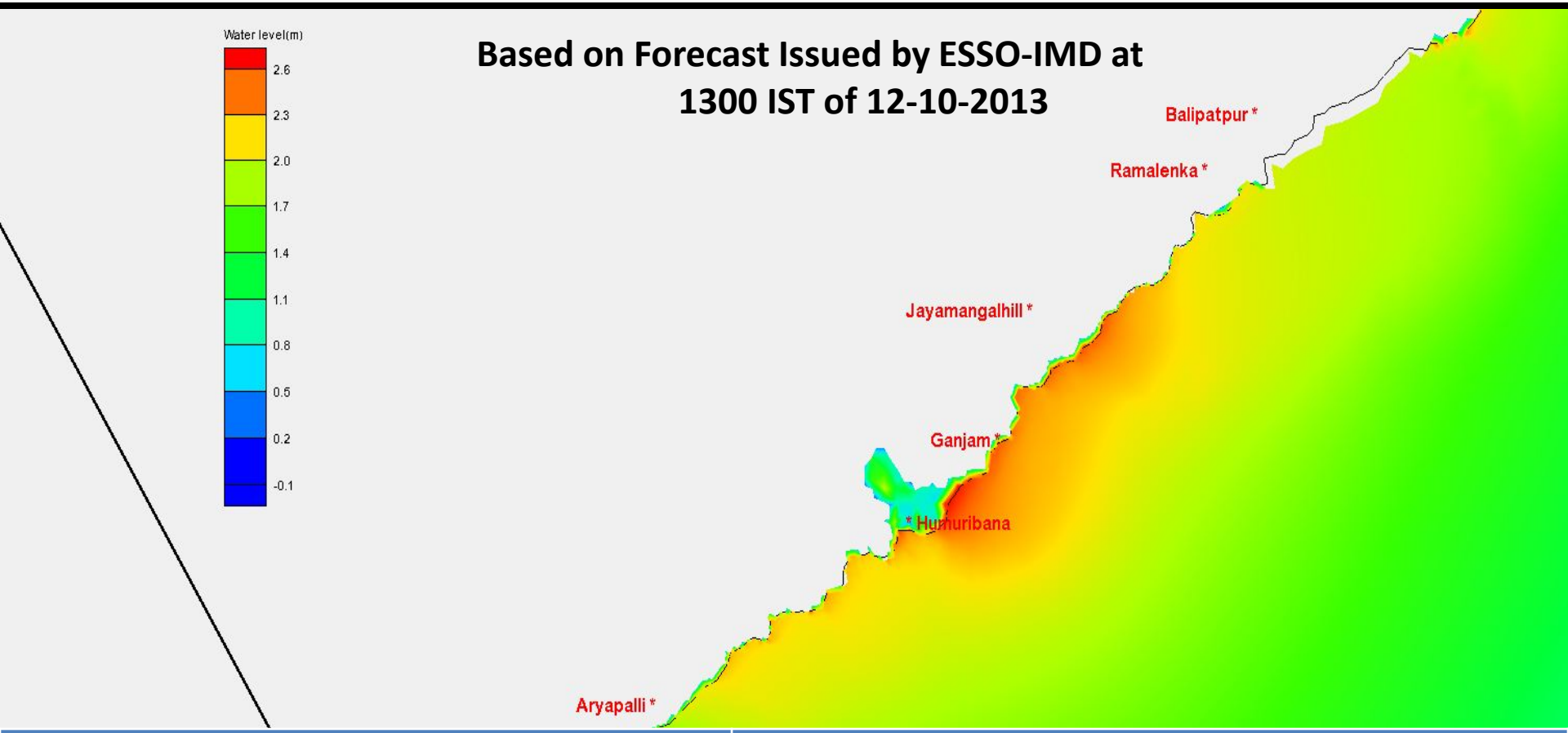


Lead Time (h)	Landfall Point Error (km)	Landfall Time Error (hours)
12	10	0
24	20	0
36	17	-4 h
48	04	-4 h
60	08	-3 h
72	02	-1 h

Observed and Forecast Track of Cyclone, HUDHUD based on 1200 UTC of 09 October 2014 (67 hours before landfall)
Landfall took place around 0700 UTC of 12 October 2014

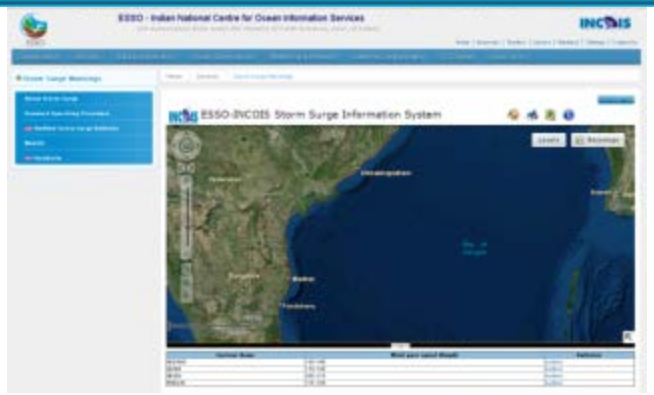
- Two Cyclones, *Hud Hud* and *Nilopher* were predicted well in advance and sufficient time was available to respond
- All aspects of genesis, intensity, track, landfall, associated rainfall, gale wind and storm surge were predicted

Storm Surge Modeling –Phailin Cyclone

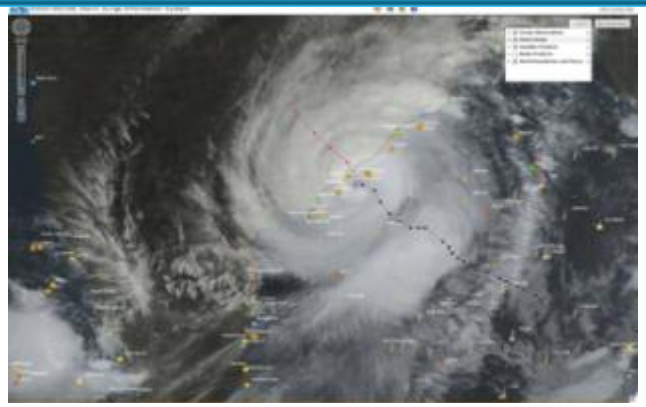


EXPECTED TIDE AT PARADEEP	-0.3M DURING LANDFALL
EXPECTED WIND SPEED	210 - 220 KMPH
MAX EXPECTED SURGE	2.6 M AT GANJAM, ORISSA
MAX EXPECTED INUNDATION EXTENT	3 KM THROUGH RIVER NEAR GANJAM, ORISSA

Storm Surge Website

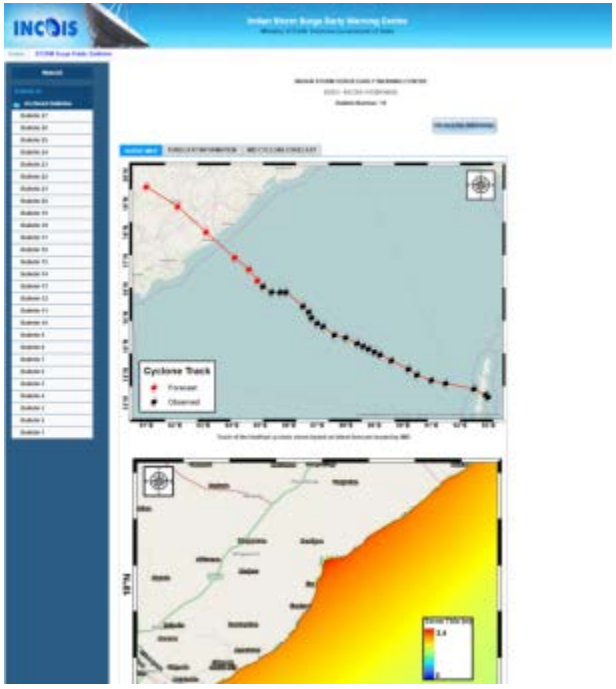


Website



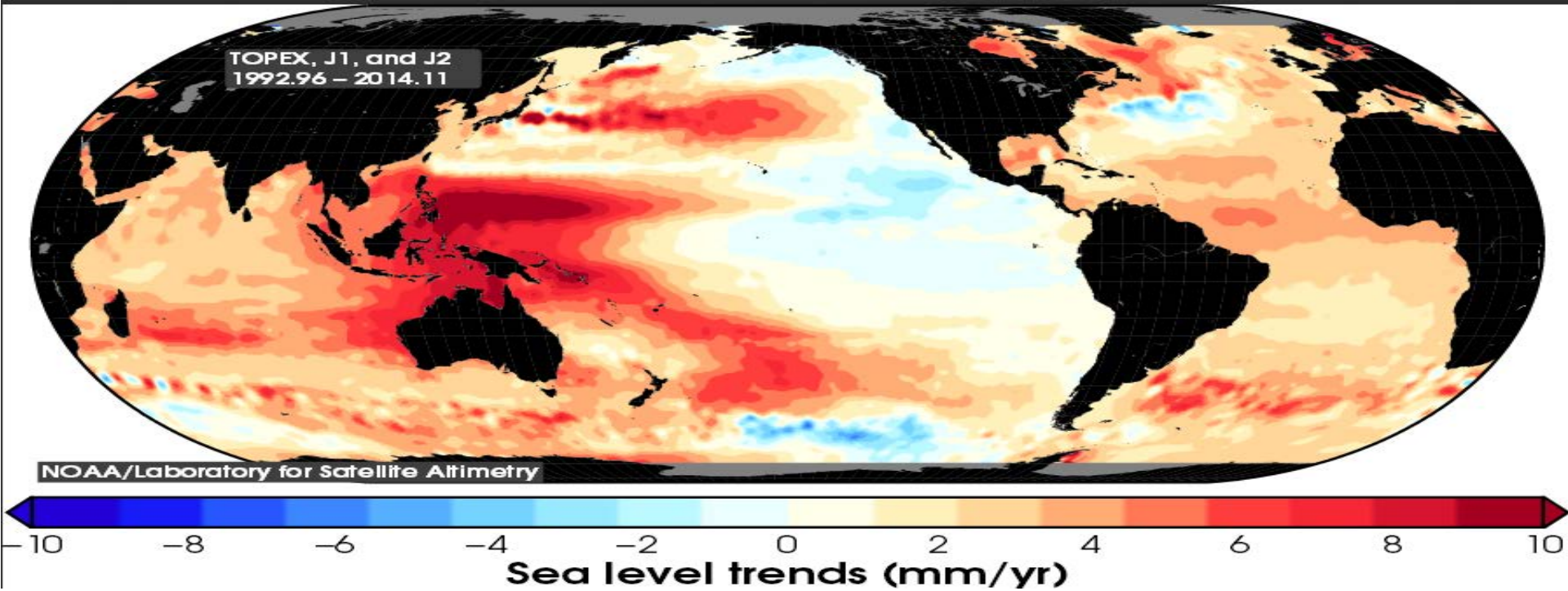
Web GIS Facility

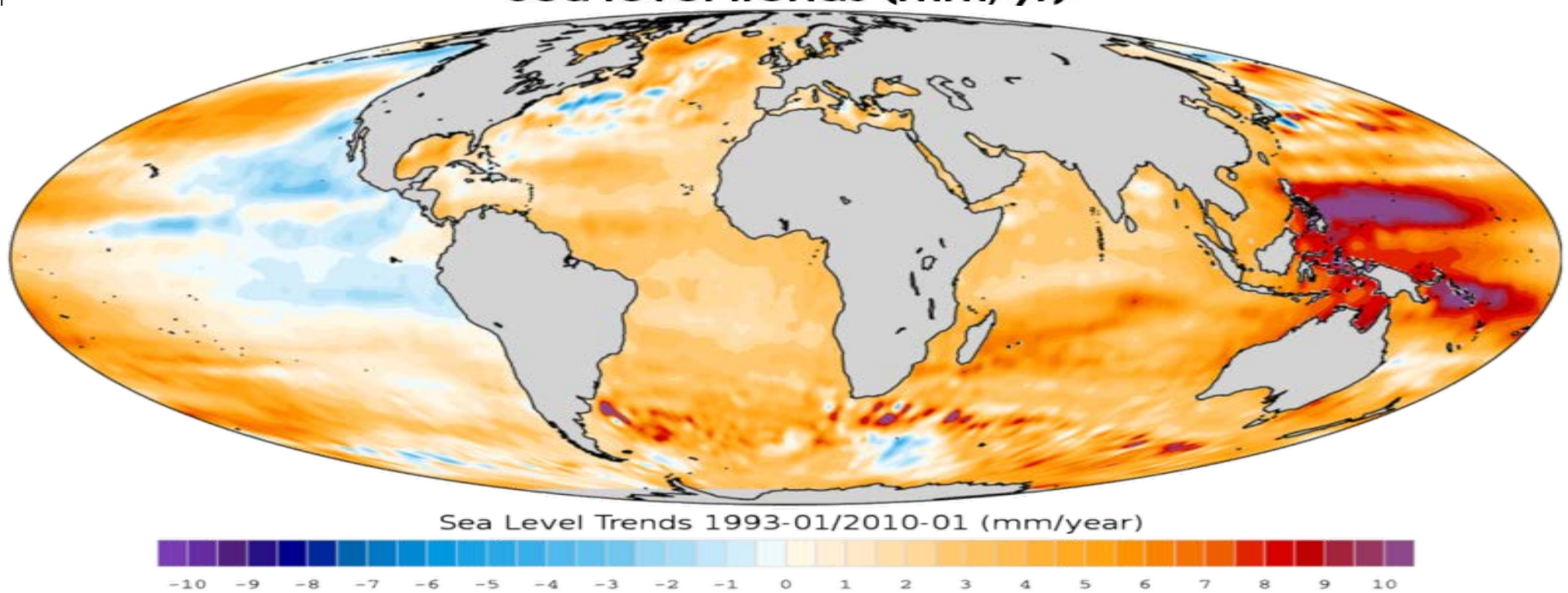
Bulletins of Hudhud



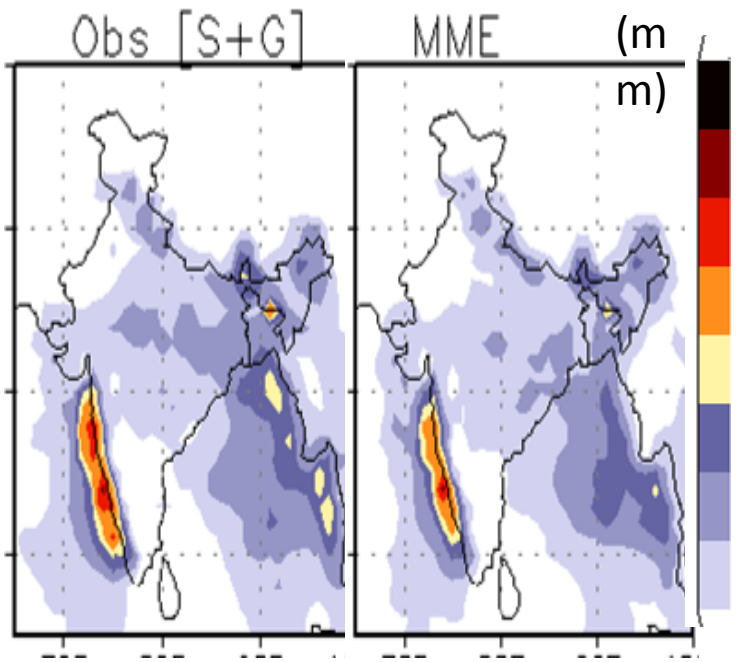
Graphical products of Hudhud advisory

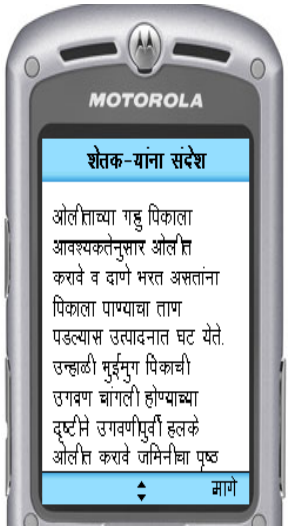
- Development of a website for storm surge warning system is completed
- Bulletins are published in real time and are tested during Phailin and made operational during Hudhud cyclone
- Website is functioning as expected and is user-friendly to access both information and graphical products.
- WebGIS facility is enabled where user can overlay satellite pictures, track and can asses the threat of the storm surge and inundation by panning and zooming facility.

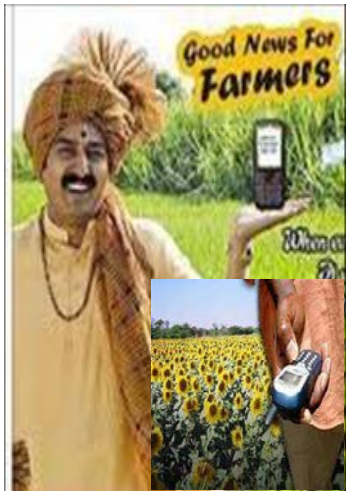

TOPEX, J1, and J2
1992.96 – 2014.11
NOAA/Laboratory for Satellite Altimetry
−10
−8
−6
−4
−2
0
2
4
6
8
10
Sea level trends (mm/yr)


Sea Level Trends 1993-01/2010-01 (mm/year)
−10
−9
−8
−7
−6
−5
−4
−3
−2
−1
0
1
2
3
4
5
6
7
8
9
10

District Level Forecast & Agro-Met Advisories







- Based on Multi-Model Ensemble (MME), forecast issued for 596 districts (Rainfall, Max and Min temp., Total cloud cover, Surface Relative humidity & Wind). Accuracy: 70-75 %.
- Bi-weekly Agromet Advisory Bulletins (608 districts). State and national level composite advisories also issued. Advisories at block level to be initiated.
- Dissemination: Print, Radio, TV, Web, Mobile. 7 Million farmers use mobiles. About 50 % farmers are using the advisories.
- Estimated Contribution GDP Rs. 50,000 crores.

Live Advisory

City Weather Forecast

Live Forecast

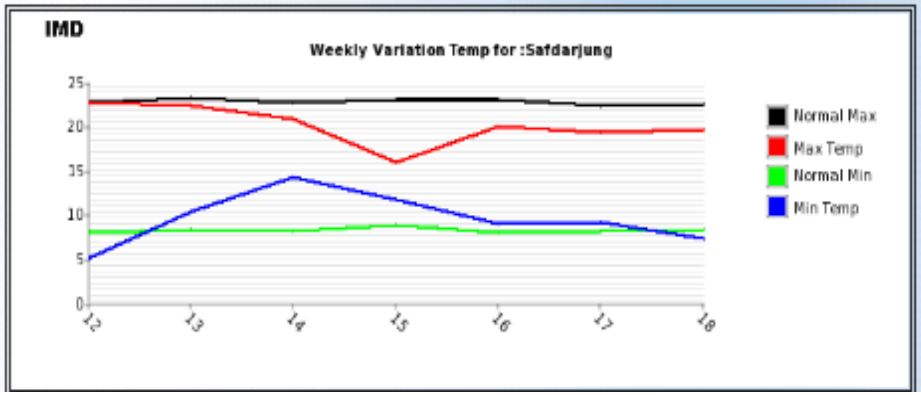
- Covers 324 major cities and tourist locations
- Updated 2 times a day and contains
  - ➢ Daily weather observations
  - ➢ Forecasts for Temperature (Min. & Max.), Weather outlook (rainfall, fog, clear sky etc.) for next 7 days
  - ➢ Last 7 days temperature trend
  - ➢ General monthly climatology
  - ➢ Climatology of extreme weather events
  - ➢ Available on SMS as well

Local Weather Report and Forecast For: Safdarjung Dated :Dec 18, 2014

Past 24 Hours Weather Data	
Maximum Temp(°C)	19.6
Departure from Normal(°C)	-3
Minimum Temp (°C)	7.4
Departure from Normal(°C)	-1
24 Hours Rainfall (mm)	NIL
Todays Sunset (IST)	17:29
Tommorows Sunrise (IST)	07:08
Moonset (IST)	14:37
Moonrise (IST)	04:05

Today's Forecast: MAINLY CLEAR SKY.FOG IN THE MORNING.THE MAXIMUM TEMPERATURE WOULD BE AROUND 19 DEGREE CELCIUS .

Date	Temperature (° C)		Weather Forecast	
	Minimum	Maximum		
19-Dec	8.0	20.0		Fog
20-Dec	8.0	20.0		Fog
21-Dec	8.0	20.0		Fog
22-Dec	10.0	20.0		Fog
23-Dec	8.0	20.0		Fog
24-Dec	8.0	20.0		Fog



DELHI AIR QUALITY STATUS (α Severity) (2011-2013)

SAFAR-Delhi @MoES

PM2.5: Number of Days (%) per year in Different Categories						
S.N.	PM2.5 (µg/m³) Range	Attributes	2011 (%)	2012 (%)	2013 (%)	Average (%) 2011-2013
1.	0-60	GOOD	30	32	21	27.7
2,	61-90	MODERATE	24	24	23	23.7
3.	91-210	POOR	27	34	50	37.0
4.	211-252	VERY POOR	8	4	4	5.3
5.	253 & Above	CRITICAL	11	7	3	7.0

DOMINANCE OF MIDDLE LEVEL-3 (POOR) POLLUTION EVENTS

PM10: Number of Days (%) per year in different categories						
S.N.	PM10 (µg/m³) Range	Attributes	2011 (%)	2012 (%)	2013 (%)	Average (%) 2011-2013
1.	0-100	GOOD	12	19	18	16.3
2.	101-150	MODERATE	19	13	24	18.7
3.	151-350	POOR	54	54	53	53.7
4.	351-420	VERY POOR	9	4	5	6.0
5.	421 & Above	CRITICAL	6	7	3	5.3

Pathway to Climate Risk Management

pasess through

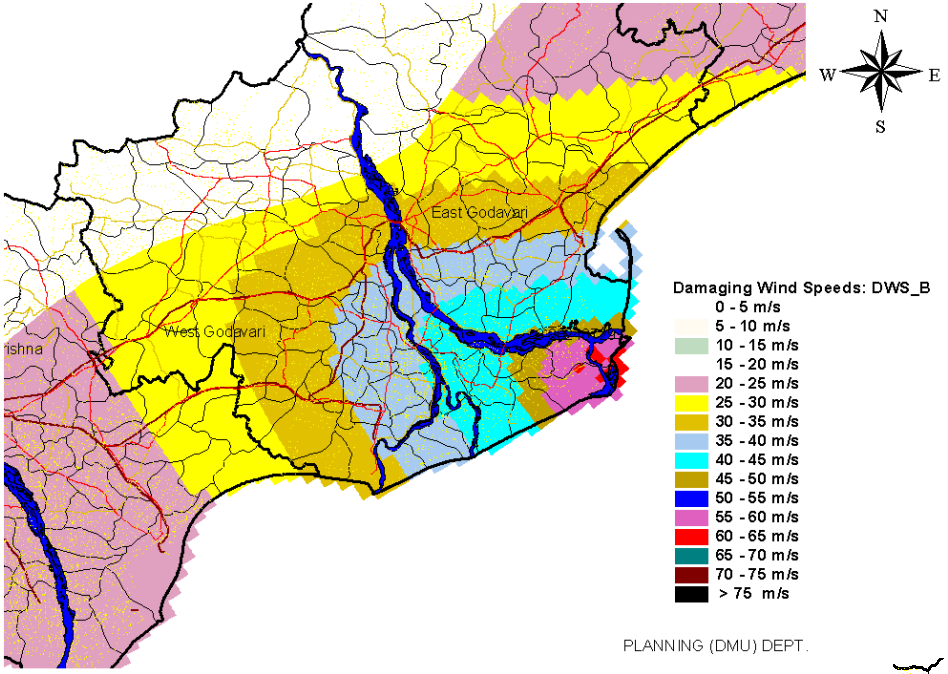
Disaster Risk Management

[as climate change brings additional degree of Vulnerability]

Information From DSS include …

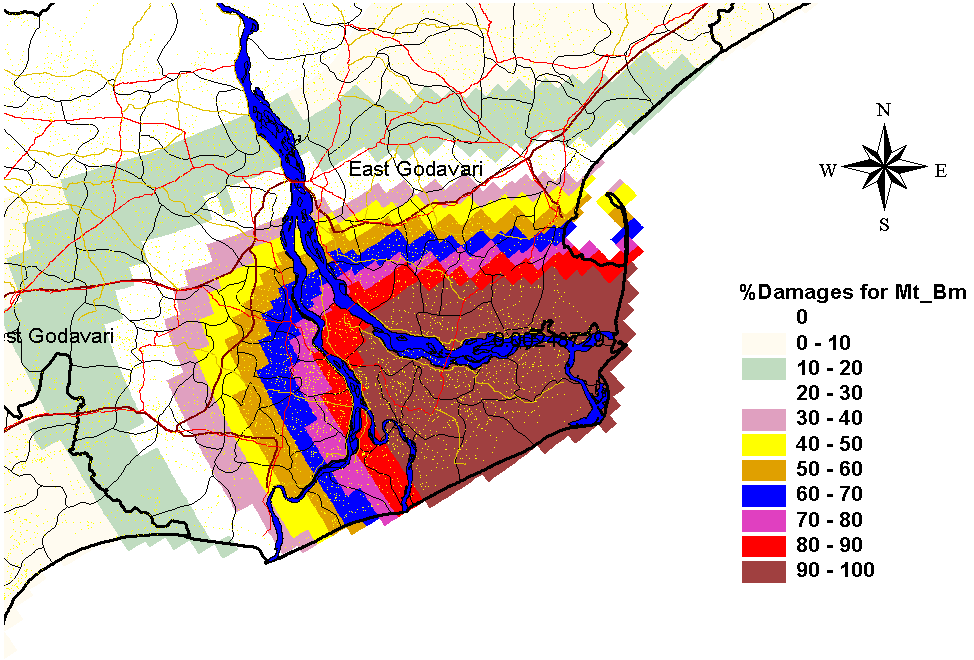
- Population to be affected
- Densely populated villages
- Areas under threat
- Threat to Crops
- Damage to Structures
- Rail and Road network in the affected areas
- Vulnerable points
- Cyclone shelters

DAMAGING WIND SPEEDS -NOV.1996 CYCLONE

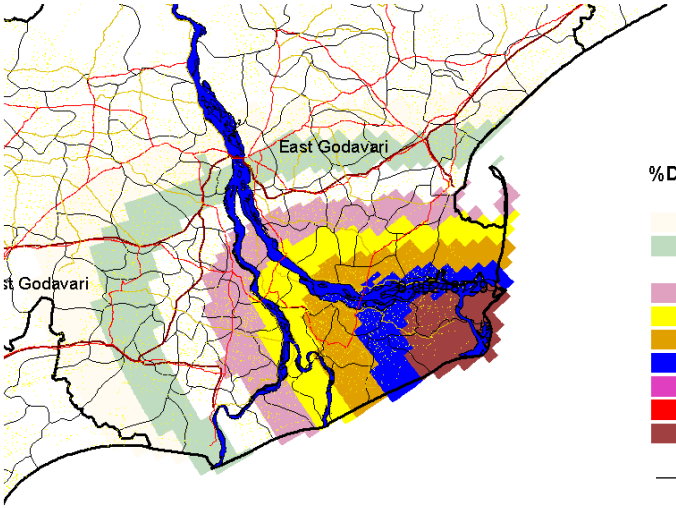


PLANNING (DMU) DEPT.

WIND HAZARD MAP- DAMAGE TO TILED HOUSES

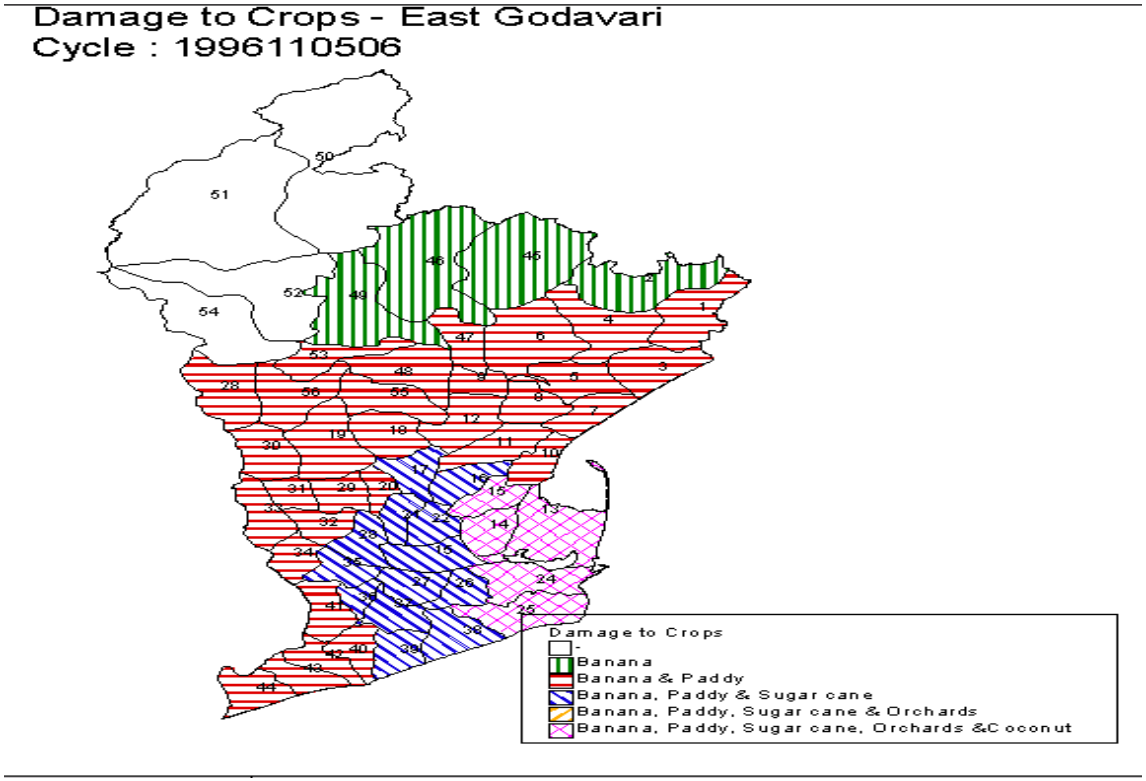


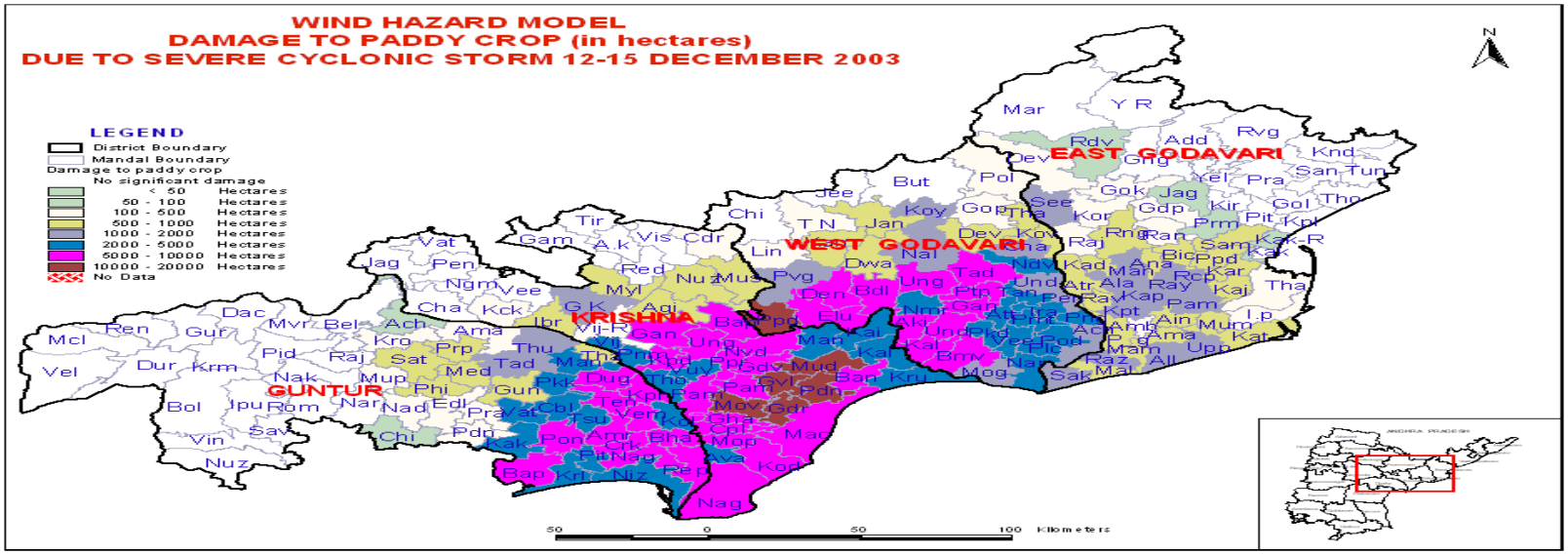
WIND HAZARD MAP - DAMAGES TO PADDY CROP

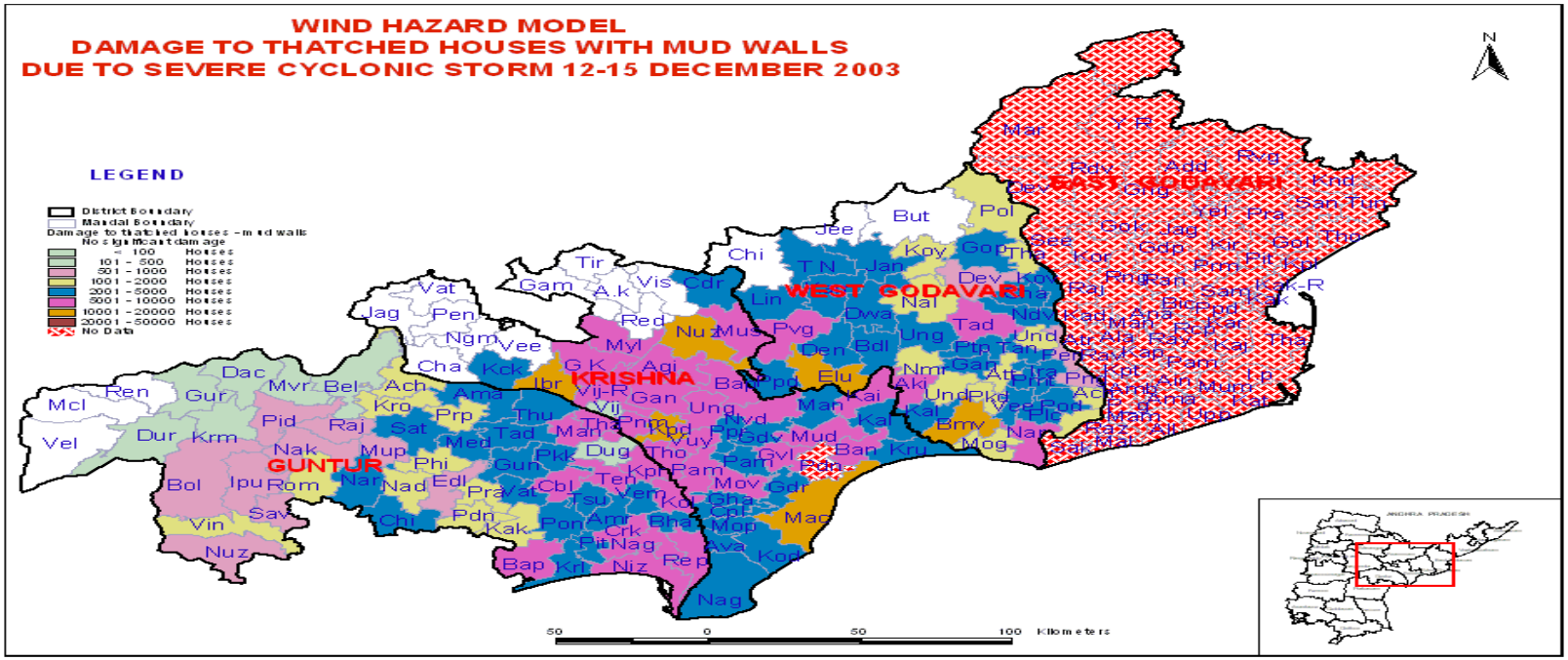


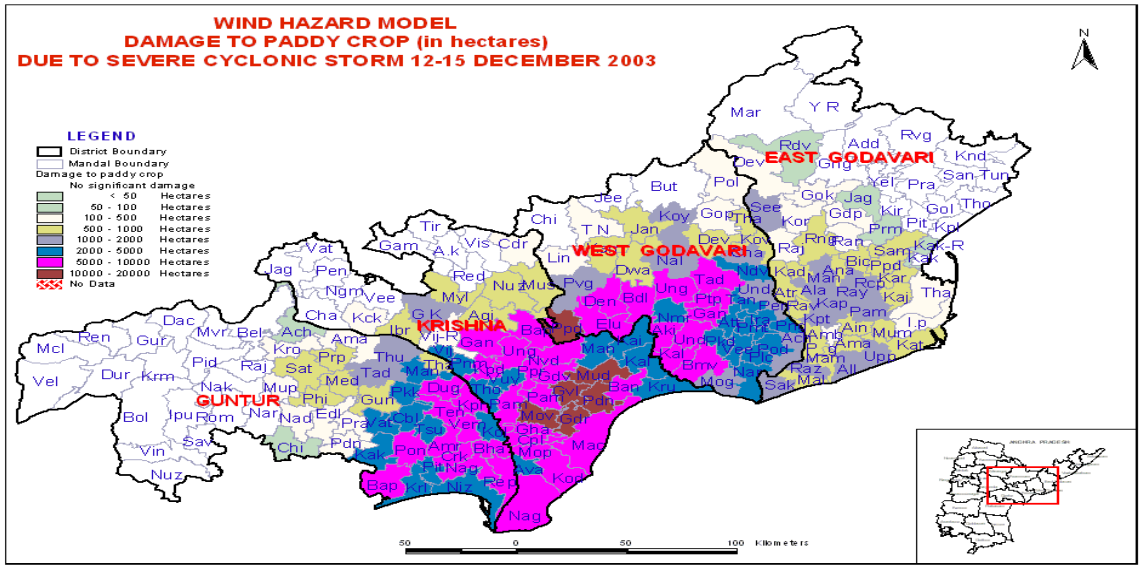
%Damages for Paddy

- 0
- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100




WIND HAZARD MODEL
DAMAGE TO PADDY CROP (in hectares)
DUE TO SEVERE CYCLONIC STORM 12-15 DECEMBER 2003
LEGEND
District Boundary
Mandal Boundary
Damage to paddy crop
No significant damage
< 50 Hectares
50 - 100 Hectares
100 - 500 Hectares
500 - 1000 Hectares
1000 - 2000 Hectares
2000 - 5000 Hectares
5000 - 10000 Hectares
10000 - 20000 Hectares
No Data
EAST GODAVARI
WEST GODAVARI
KRISHNA
GUNTUR
N
50 0 50 100 Kilometers


WIND HAZARD MODEL
DAMAGE TO THATCHED HOUSES WITH MUD WALLS
DUE TO SEVERE CYCLONIC STORM 12-15 DECEMBER 2003
LEGEND
District Boundary
Mandal Boundary
Damage to thatched houses - mud walls
No significant damage
< 100 Houses
101 - 500 Houses
501 - 1000 Houses
1001 - 2000 Houses
2001 - 5000 Houses
5001 - 10000 Houses
10001 - 20000 Houses
20001 - 50000 Houses
No Data
EAST GODAVARI
WEST GODAVARI
KRISHNA
GUNTUR
N
50 0 50 100 Kilometers


WIND HAZARD MODEL
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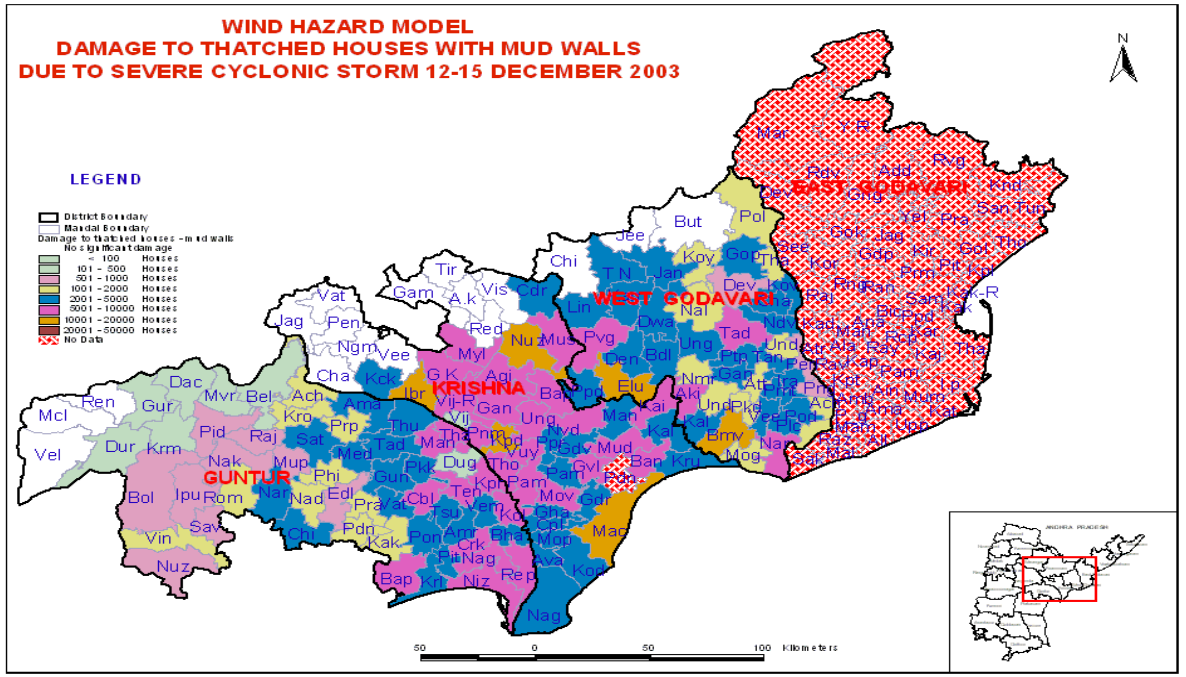
DUE TO SEVERE CYCLONIC STORM 12-15 DECEMBER 2003
LEGEND
District Boundary
Mandal Boundary
Damage to paddy crop
No significant damage
< 50 Hectares
50 - 100 Hectares
100 - 500 Hectares
500 - 1000 Hectares
1000 - 2000 Hectares
2000 - 5000 Hectares
5000 - 10000 Hectares
10000 - 20000 Hectares
No Data
EAST GODAVARI
WEST GODAVARI
KRISHNA
GUNTUR
N
50 0 50 100 Kilometers


WIND HAZARD MODEL
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DUE TO SEVERE CYCLONIC STORM 12-15 DECEMBER 2003
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101 - 500 Houses
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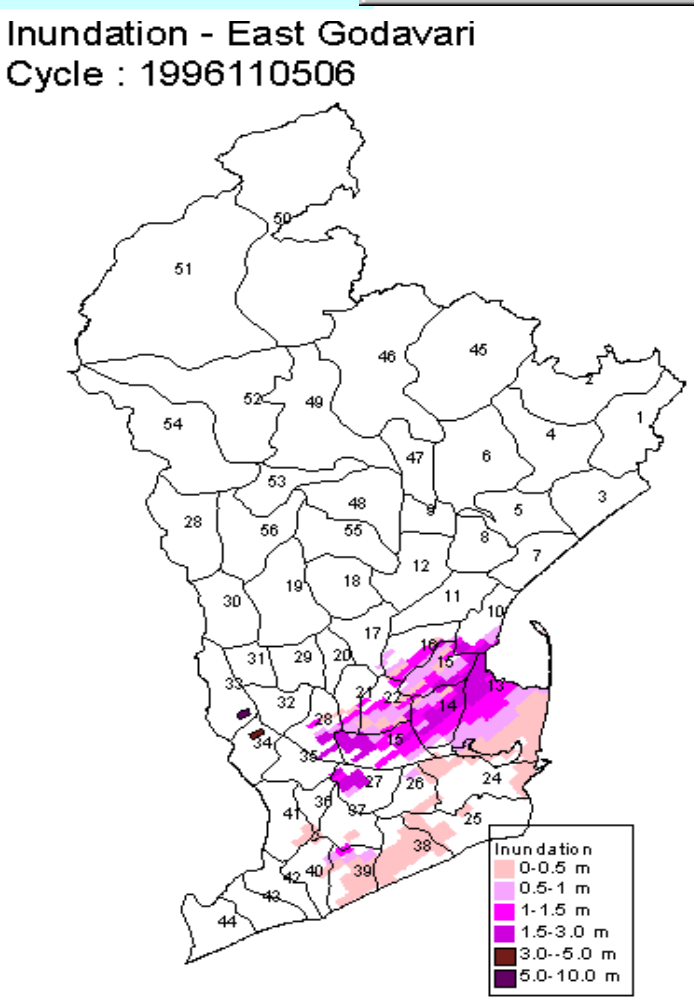
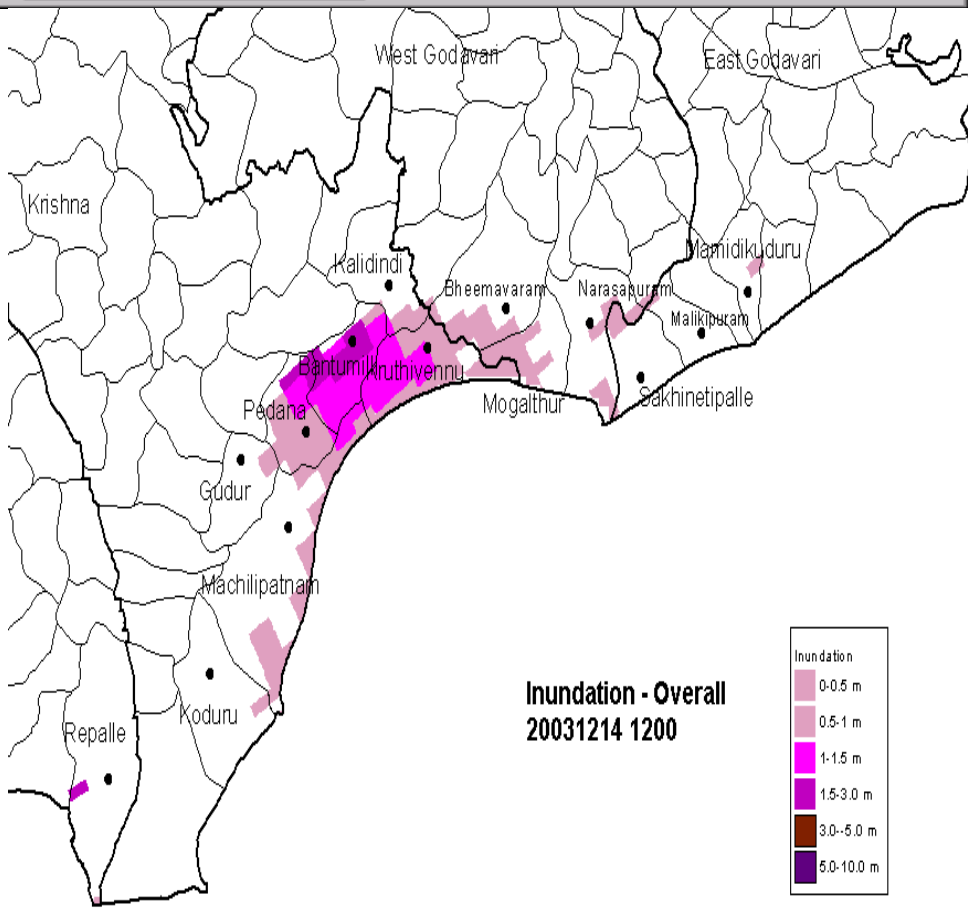
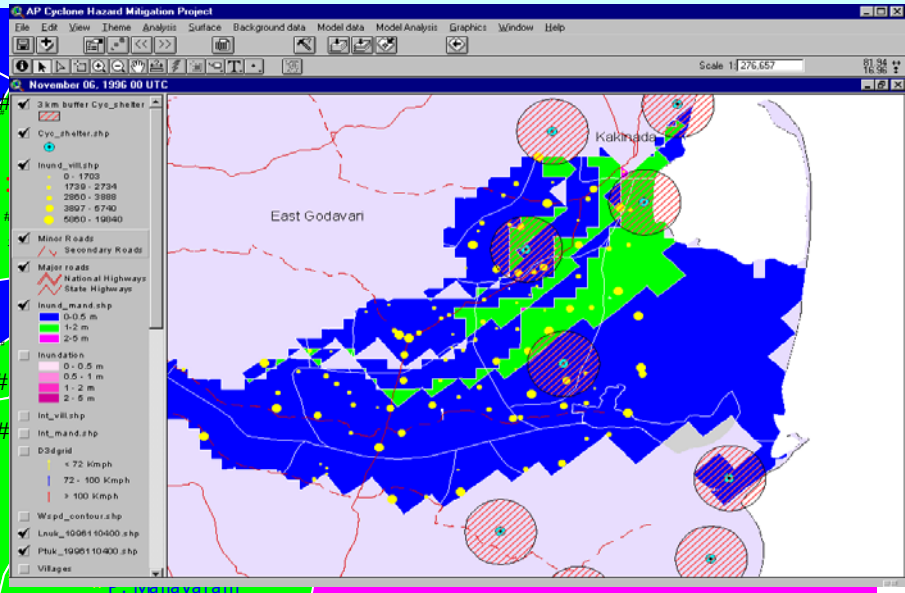
1001 - 2000 Houses
2001 - 5000 Houses
5001 - 10000 Houses
10001 - 20000 Houses
20001 - 50000 Houses
No Data
EAST GODAVARI
WEST GODAVARI
KRISHNA
GUNTUR
N
50 0 50 100 Kilometers

DSS Generating Sample Maps



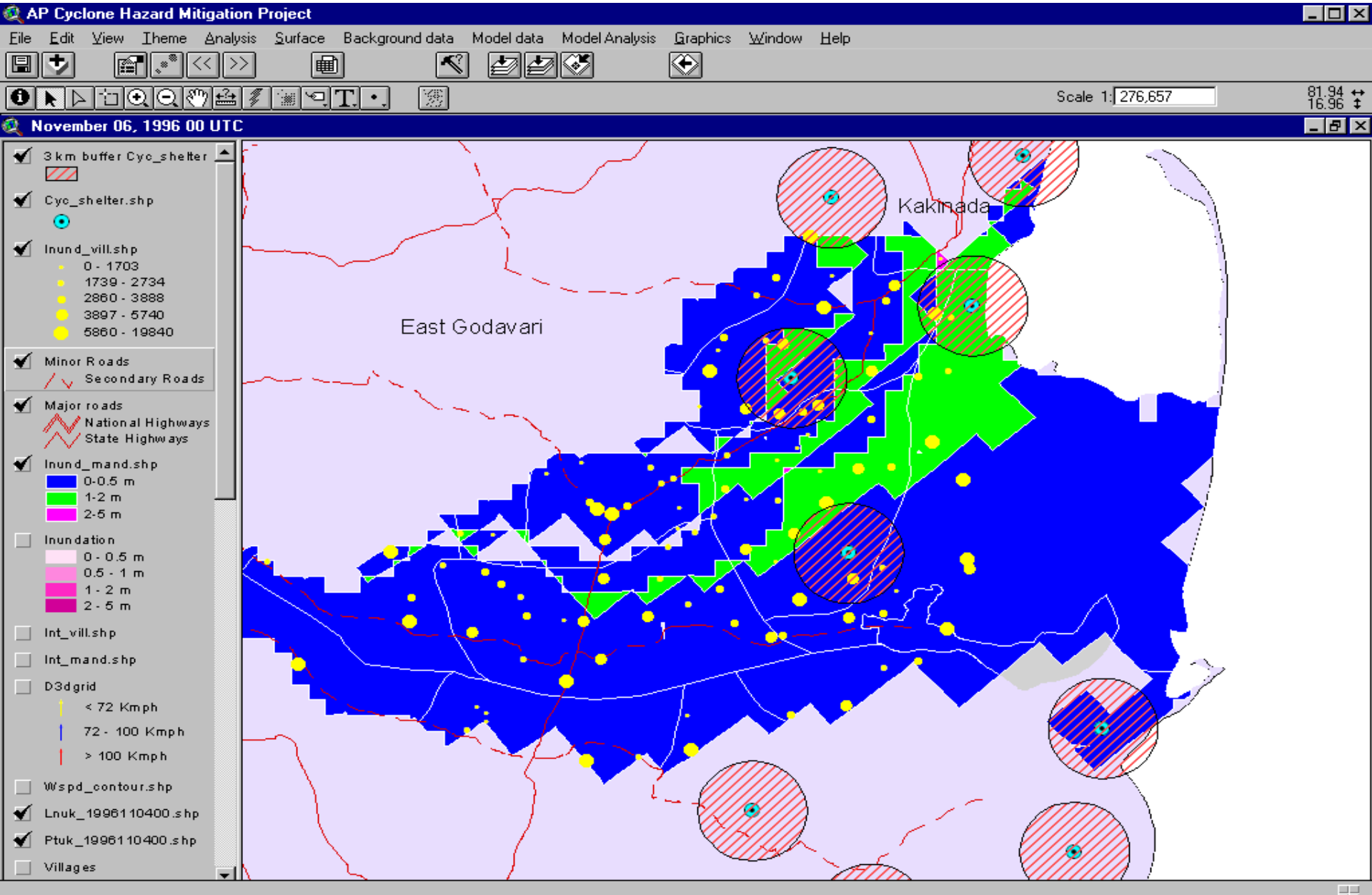


Report in Map and Table Forms



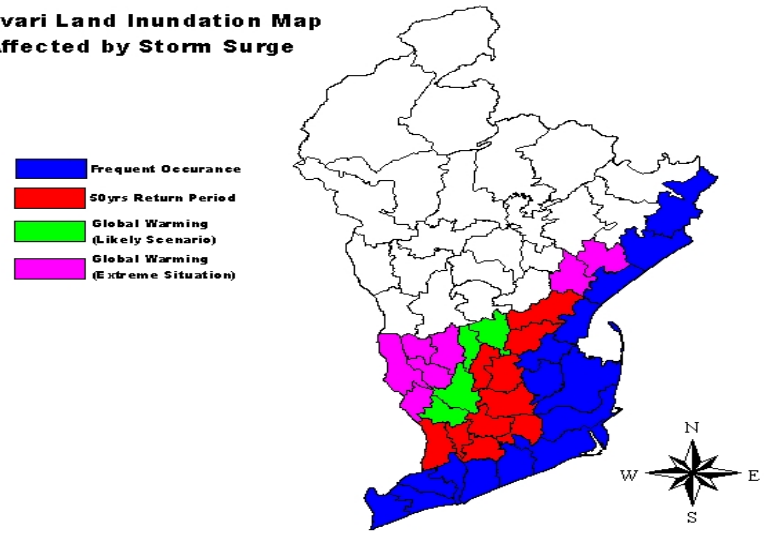
NAME	AREA1	HOUSEHOLDS	T_POPLN
Chollangi	750.28	499.00	2,363.00
Chollangi Peta	119.38	444.00	2,090.00
G. Vemavaram	889.90	773.00	3,708.00
Patavala	1,653.14	1,278.00	5,937.00
Koringa	1,148.09	2,416.00	10,875.00
Polekurru	2,422.85	4,333.00	19,840.00
P. Mallavaram	3,081.27	1,260.00	5,516.00

DSS identifying Cyclone Shelters

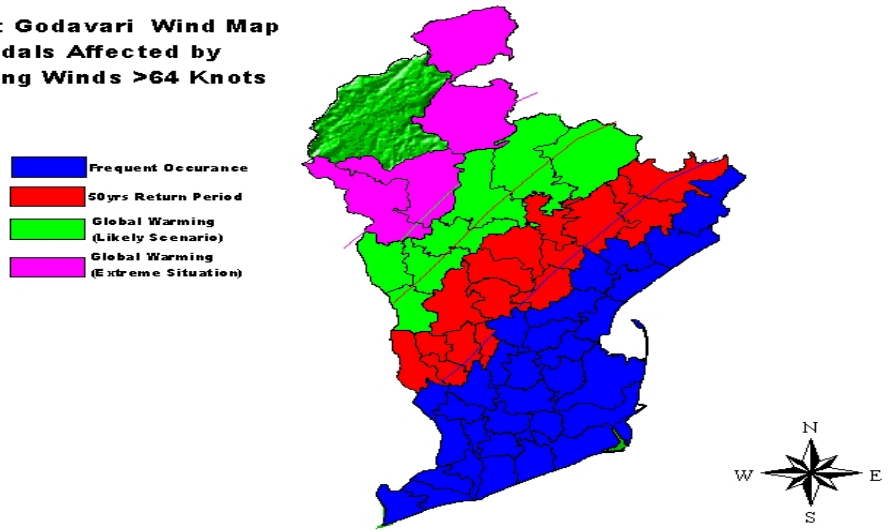


CYCLONE HAZARD MAPS

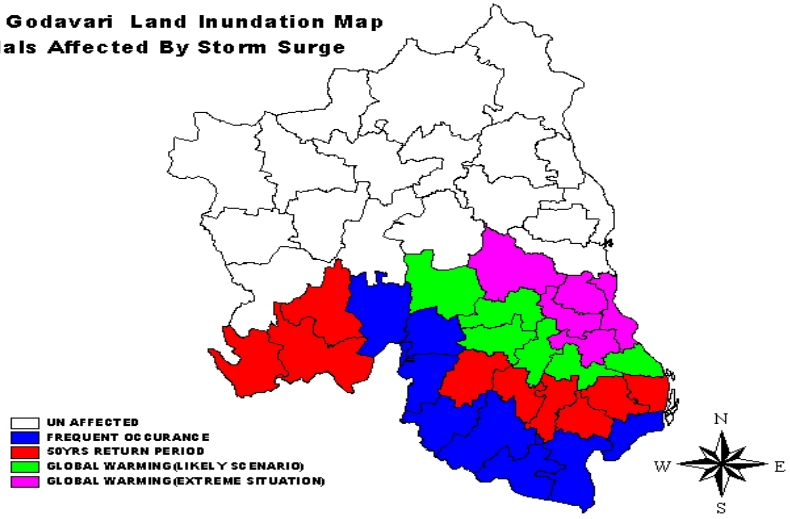
East Godavari Land Inundation Map
Mandals Affected by Storm Surge



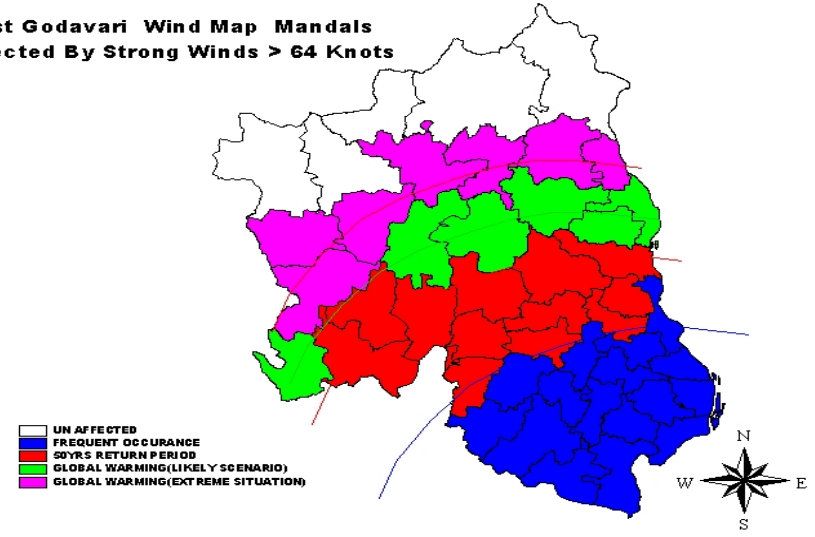
East Godavari Wind Map
Mandals Affected by
Strong Winds >64 Knots



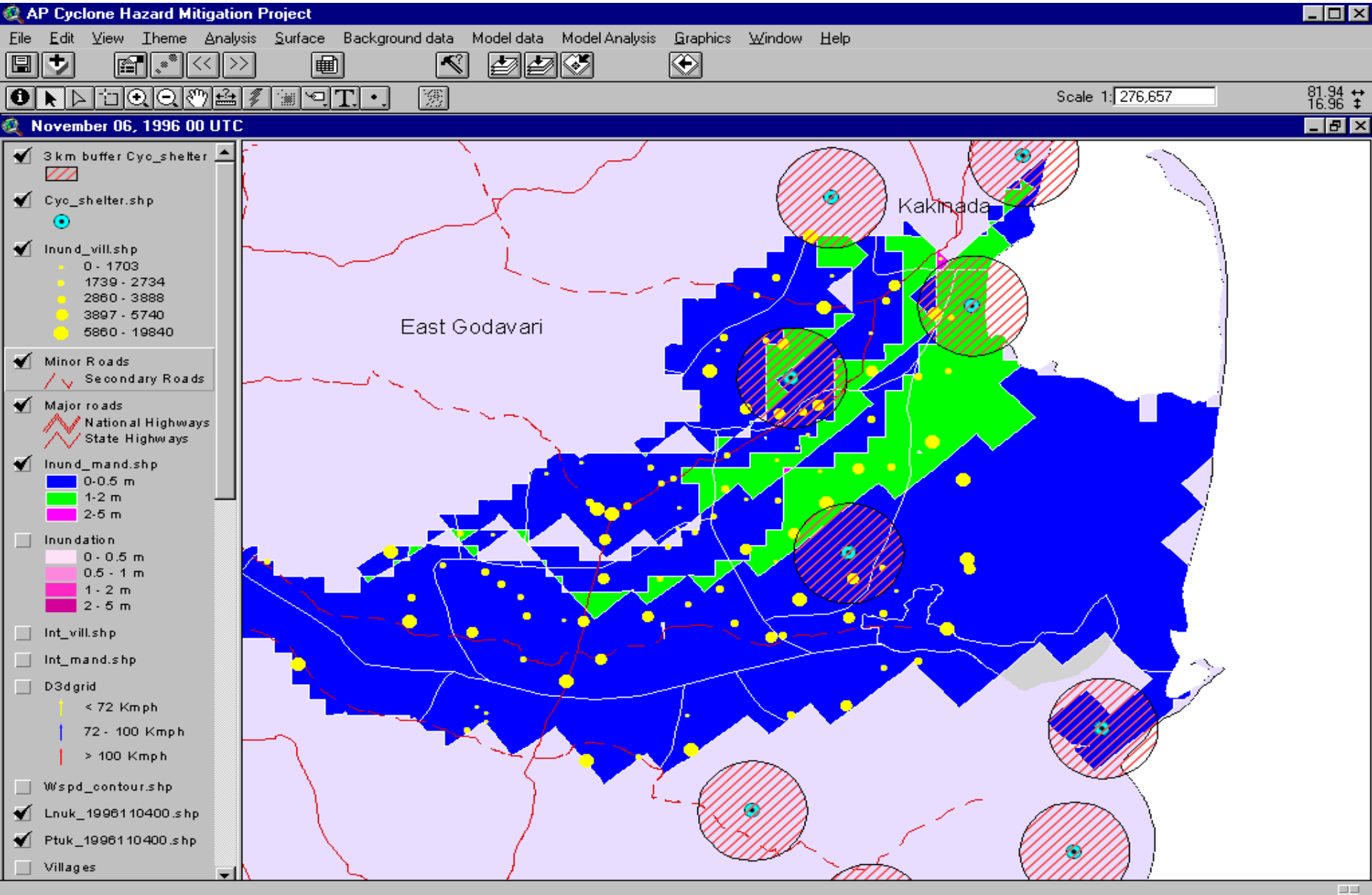
West Godavari Land Inundation Map
Mandals Affected By Storm Surge



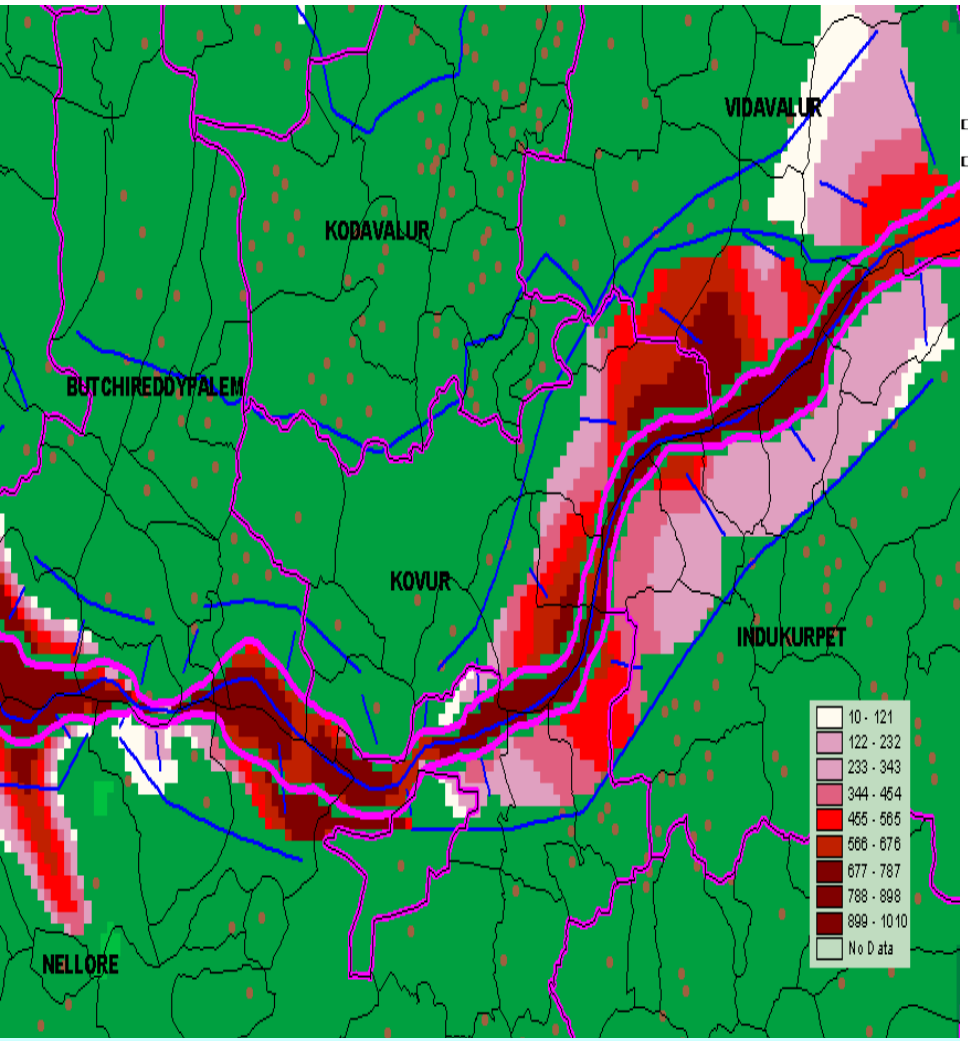
West Godavari Wind Map Mandals
Affected By Strong Winds > 64 Knots



DSS identifying Cyclone Shelters



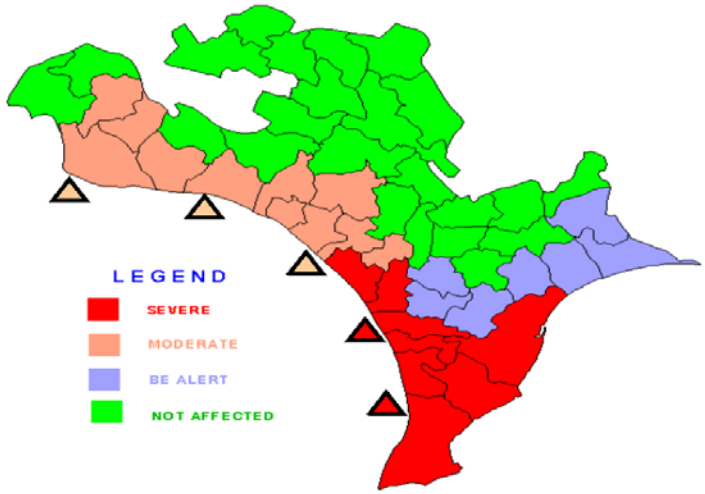
Flood Inundation Maps



Inundation map of Nellore District (Units:Cm)

DISTRICT INUNDATION WARNING REPORT
KRISHNA DISTRICT

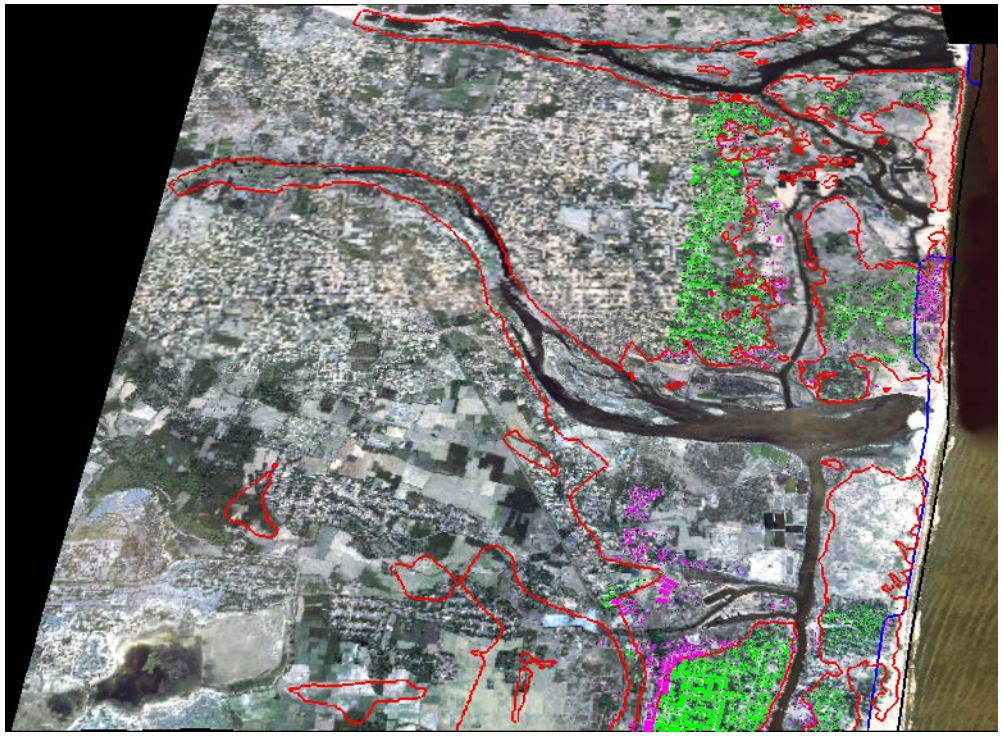
Date & Time of Information	:	23 April 2001 8:00 PM
Date & Time of Transmission	:	23 April 2001 8.15 PM



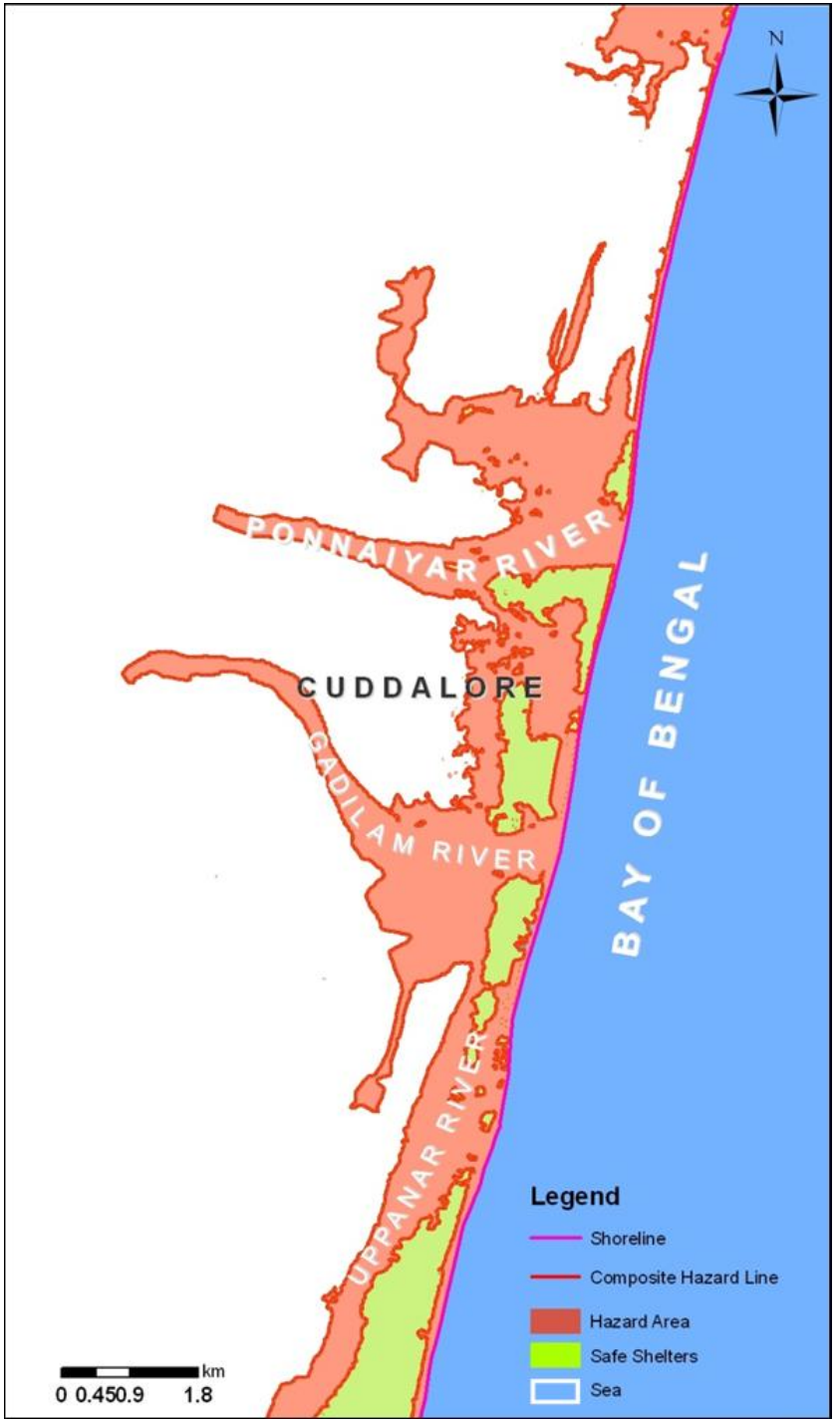
Severely affected Mandals	Max Flood Depth			
	+ 24 hours	+48 hours	+72 hours	Max Flood Depth and Time
Thotlavalluru	0 m	0.25 m	1.5 m	1.5 m 25/04/01 12.00pm
Pamidimukkala	0 m	0.6 m	1.5 m	1.6 m 25/04/01 6.00pm
Ghantasala	0 m	0.25 m	1 m	1.2 m 25/04/01 10.00am
Machilipatnam	0 m	0.2 m	1,2 m	1.3 m 25/04/01 12.00pm
Challapalle	0 m	0.6 m	1.6 m	1.9 m 25/04/01 9.00pm
Avanigadda	0.25 m	1 m	1.6 m	1.7 m 25/04/01 8.00pm
Koduru	0.25 m	1 m	1.5 m	1.5 m 25/04/01 7.00pm
Nagayalanka	0 m	1 m	1.4 m	1.5 m 25/04/01 8.00pm

Case Study

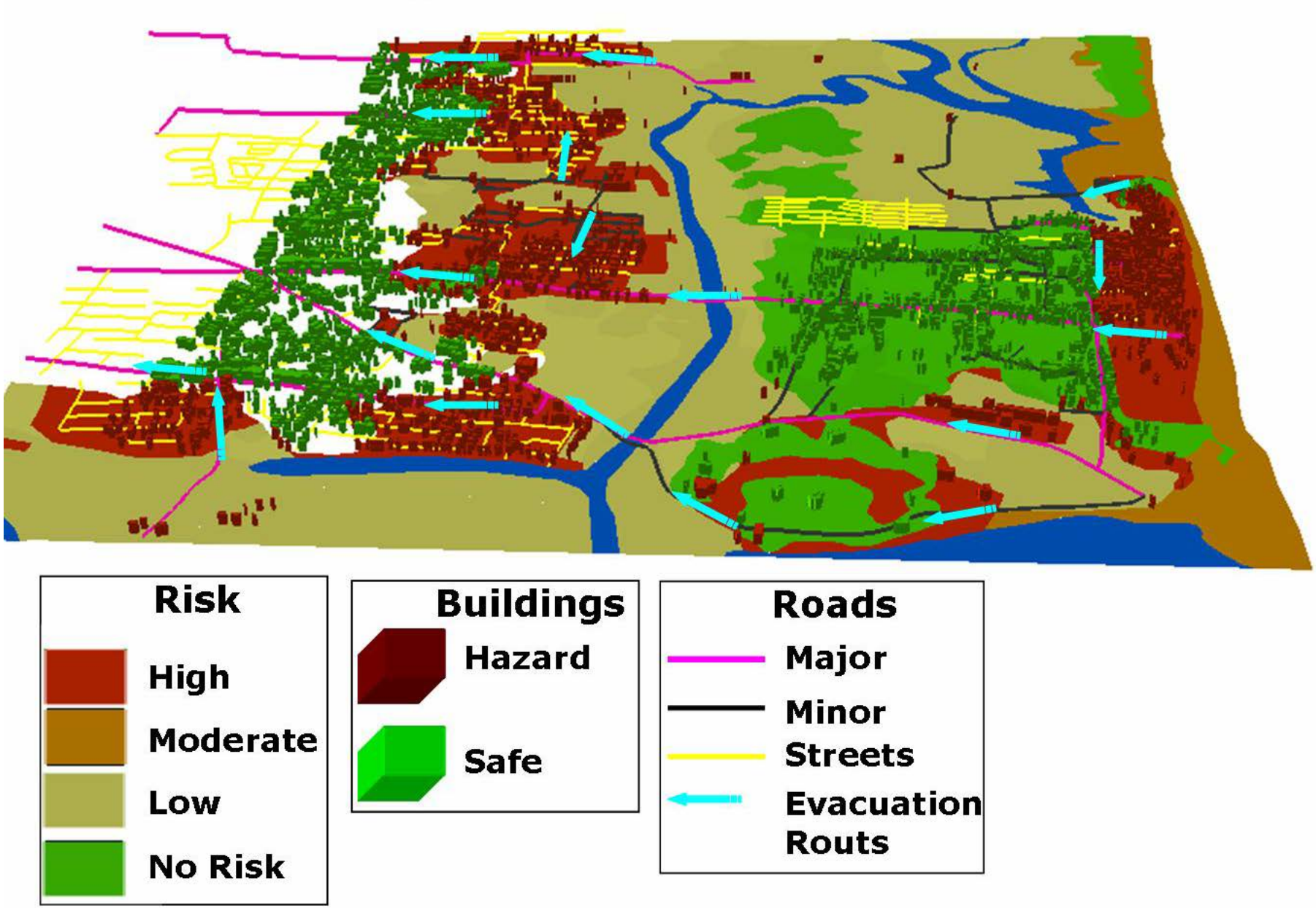
Composite Multi-hazard line and future shoreline overlaid on DEM



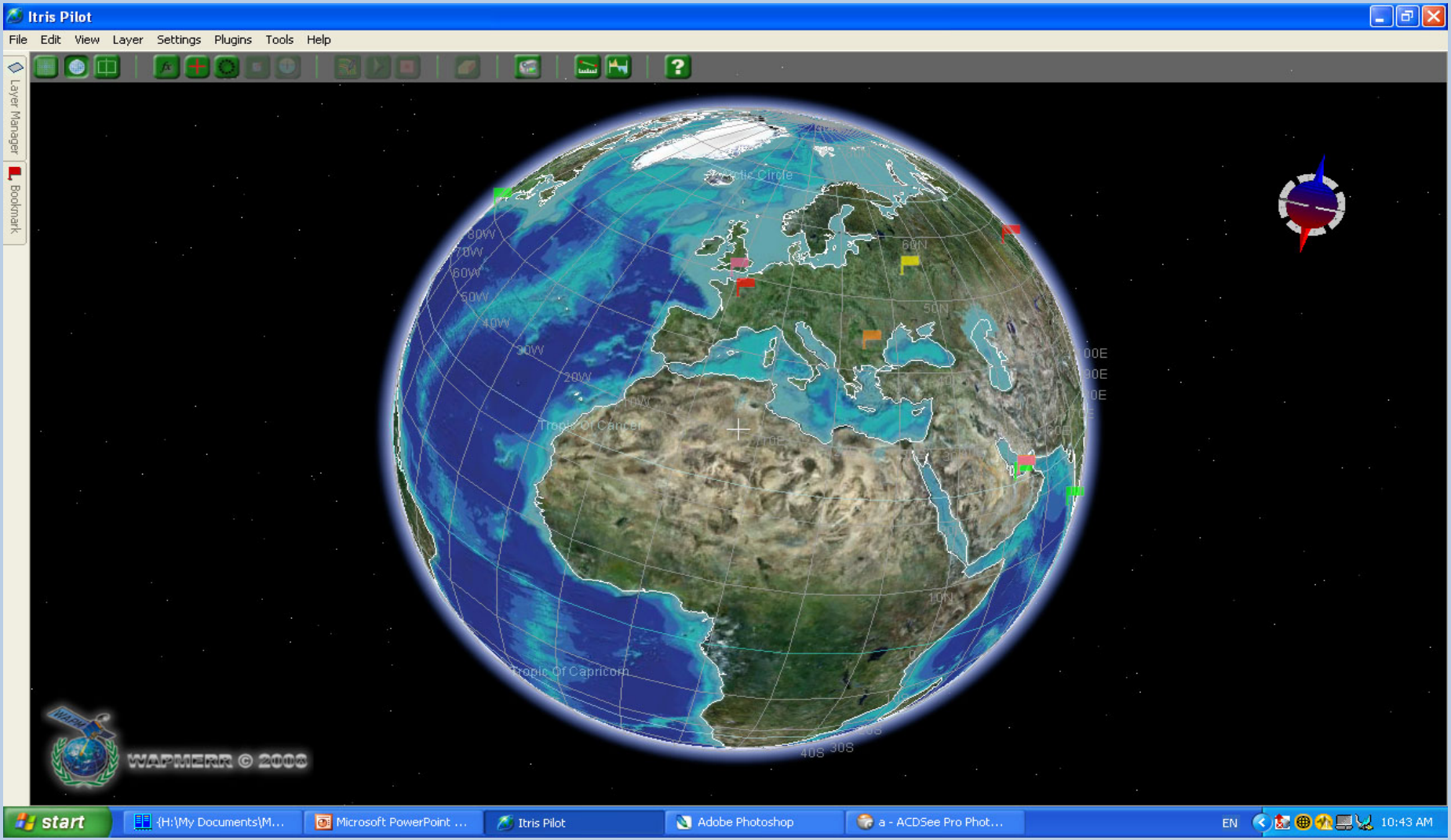
Building polygons are in hazard area (pink) and non-hazard area (green) are overlaid



Risk Mapping and Disaster Management



3D GIS



Main window shows 3D model of the Earth surface.
The cities having 3D building models are marked by colored flags.

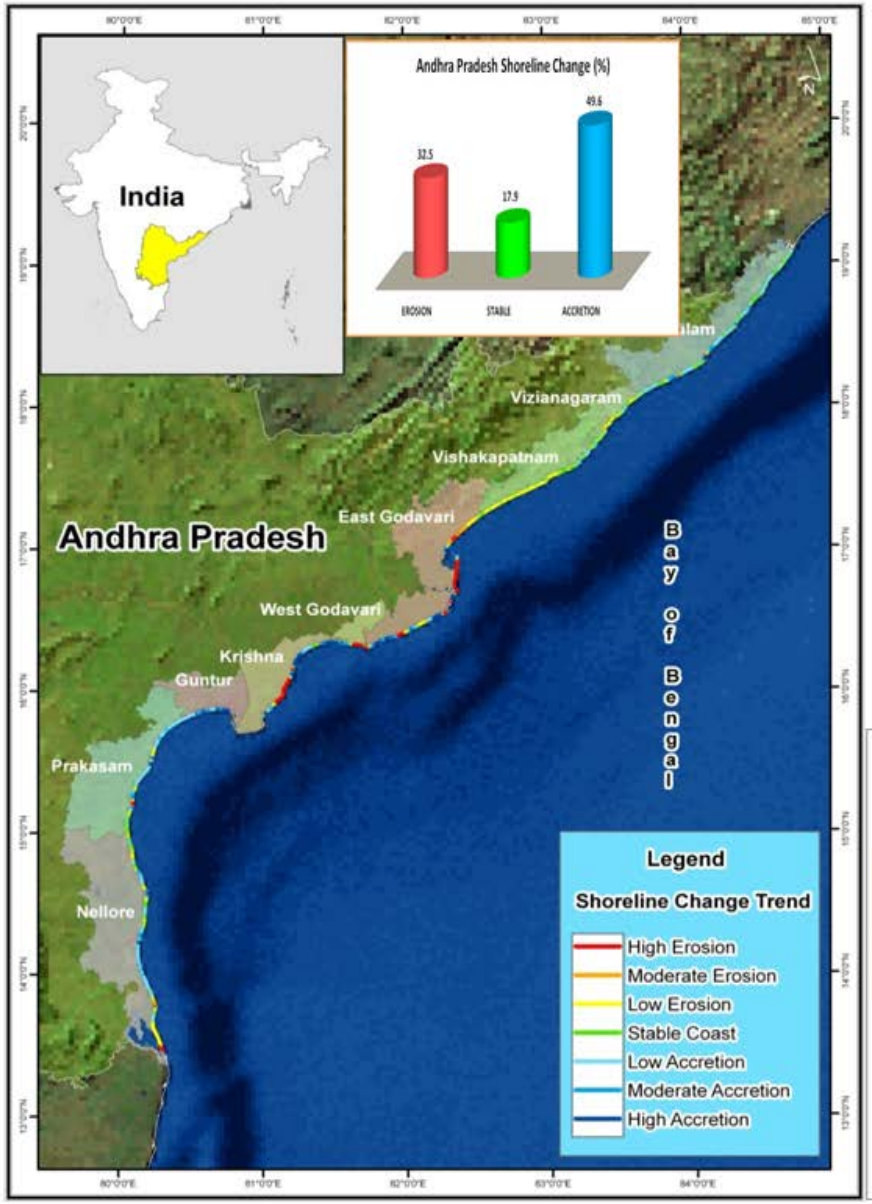
Allows to select any area of the Earth surface and zoom in on this area up to the highest resolution 60 cm (if a certain satellite imagery of the highest resolution is available)

Manipulation with realistic 3D models and textures of real buildings.
Inclusion of real object images (peoples, items, signs) in a 3D model.
The building brief (address, telephone, owner) appears in the pop-up information box.

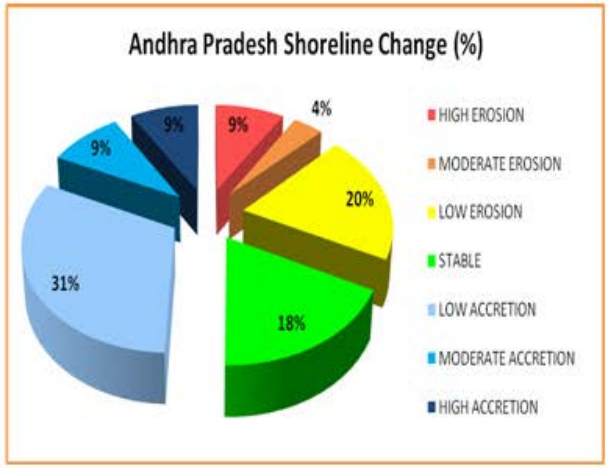
The example of design a photographically exact 3D model. These real buildings are the buildings for public worship in Nagapattinam (India).

INCOIS

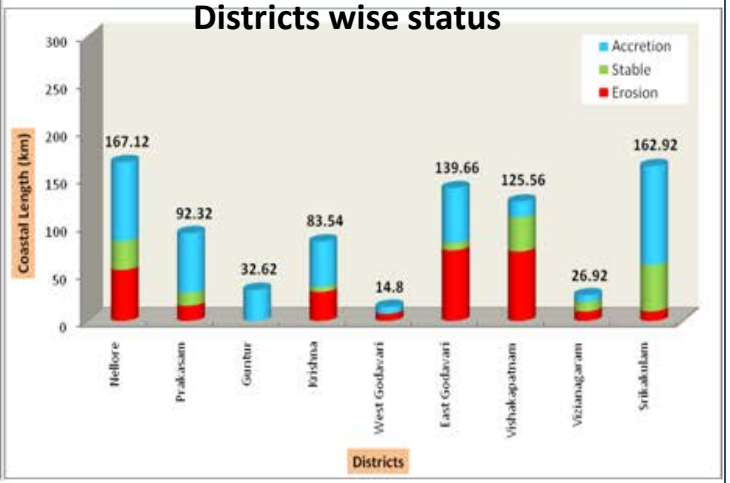
Long-term shoreline changes



Shoreline changes observed Andhra Pradesh coast (1990-2012)

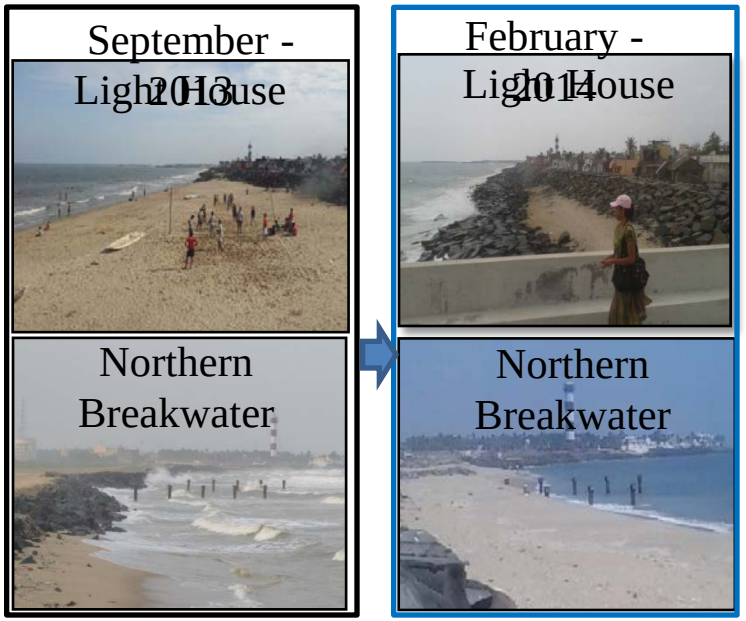


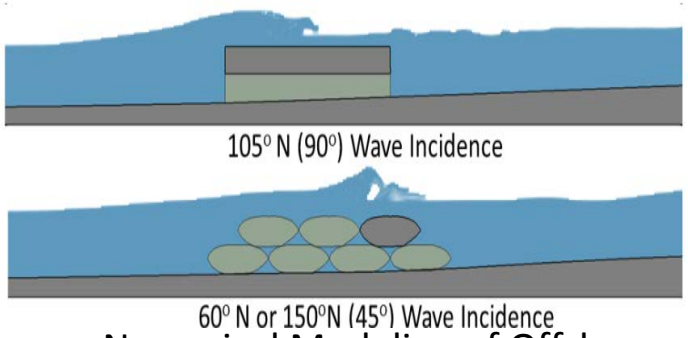
Districts wise status



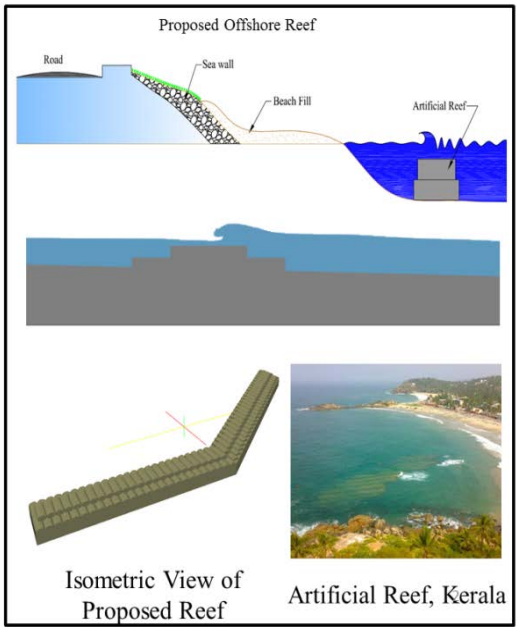
Design of Coastal Protection Structures

- Addressing the issue of continuous erosion along Puducherry coast
- Puducherry government implemented the Beach Nourishment prescribed by ESSO-NIOT which resulted in formation of 60m wide beach near New Pier.
- Now Puducherry government has requested for restoration of beach
- Preliminary Desk Studies are carried out for Hybrid Solution.
- An Offshore Submerged Reef in 4.5m depth along with





Numerical Modeling of Offshore



Lay out of proposed Hybrid Solution

Activities Critical for Coastal Areas

– multi-scale networks over Land (**Doppler Weather Radars; Automatic Weather Stations/Rain Gauges; High Wind Speed Recorders etc**.), Sea (**moored and drifting buoys, Argo Floats, ADCP and Current Moorings etc.**), in-situ airborne & ship borne platforms and Satellite Based systems (**INSAT, Kalpana, OCEANSAT, Megha Tropique, NOAA, EUMETSAT** etc.) for real time data transmission and reception

- 24X7 system of severe weather survellance and forecasting (continuously scaling up) - **Cyclones; Tsunami and Storm Surges; other severe weather systems**; River basin scale meteorological support for CWCs river flood warning system
- Continuously monitoring the pattern of sea level changes all along the Indian coastline with established 26 tide gauges.
- Vulnerability of the Coastal Zones – [3-Dimensional Geographical Information System (3D GIS) maps for the entire coastal stretch; mosaic with other available topographic and thematic high resolution maps at 1:100000; 1:25000; 1:5000 scale; shoreline change maps at 1:25000 scale] for effective emergency response, risk reduction, sustainable shoreline management and natural resource management
- Climate services information products viz. **spatial monthly scale anomalies of rainfall and temperature; minimum/maximum temperature; standardized Precipitation Index** (SPI) etc. along with severe weather events.

Thanks !