

Multi-Hazard Early Warning and Communication

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Vision

- Nurture Scientific Research for developing cutting edge Multi-Hazard Early Warning Support Systems in an integrated manner
- Implement state-of-the-art Early Warning Systems (Monitoring and Prediction) in respect of
 - i) Tsunamis over the Indian Ocean and Storm Surges along the Indian coast line
 - ii) Hydro-Meteorological Disasters (Cyclones; Floods; Drought)
 - iii) Monitoring of Earthquakes and Risk Evaluation
 - iv) Rain/Snowfall Induced Landslides and Avalanches
 - v) Oil Spill in the Coastal Ocean

Vision

- Establish fail-safe Communication Infrastructure in support of real-time observational data collection and multi-hazard warning dissemination
- Develop and Implement integrated programme initiatives for continuously upgrading operational services

MoES Agencies dealing with various Hazards

HYDRO-METEOROLOGICAL HAZARDS – IMD, INCOIS

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

GEOLOGICAL HAZARDS

Earthquakes (NCS)
Tsunamis (INCOIS, NIOT, ICMAM, DST, ISRO)
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)

Specific Issues of Priority

- Modernization and Upgradation of Land and Ocean based observational systems
- Cyclone track, intensity and landfall forecast Capability
- Expanding Earthquake Monitoring Networks over Indian Ocean and Indian landmass in support of Tsunami Early warning
- Identification of triggers on the occurrence of local scale extreme weather events based on global/regional scale model predictions

Specific Issues of Priority

- Development of Cyclone Impact Assessment modules linked to the global/regional scale model predictions (Torrential Rain over Coastal areas, Wind Damage, Storm Surges and Coastal Inundation)
- Expanding Basin scale high intensity rainfall monitoring integrated with hydrology frameworks (for rainfall-runoff estimates and inflows in to rivers)

Specific Issues of Priority

- Developing effective Drought Monitoring and Early Warning Systems by leveraging land and space based observational support systems and medium/long range model predictions
- Seismic Hazard Vulnerability and Micro-zonation
- Development of Multi-Hazard Decision Support Systems (DSS) and Warning Dissemination Protocols

Indian Ocean Tsunami Warning System

Challenging Requirement

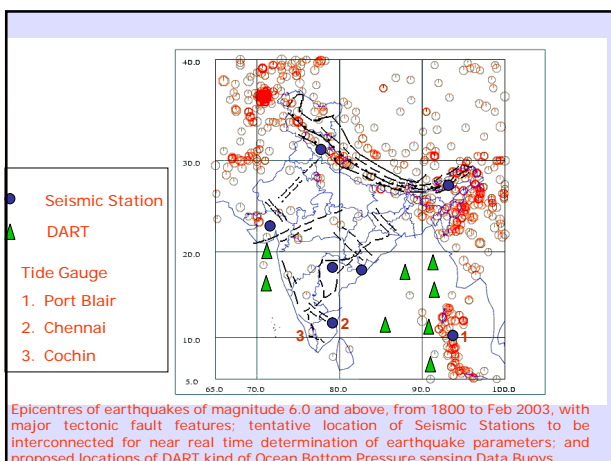
- Effective Early Warning System is imperative for the Indian Ocean to mitigate the loss of life and property due to Tsunamis and Storm Surges

Designed Solution

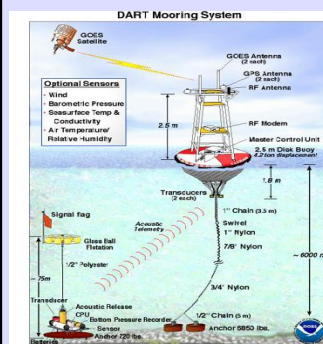
- The Indian Tsunami Early Warning System design is centered around end-to-end automation involving state of the art Science & Technology

- ❖ Implemented a system with near-real time determination of earthquake parameters in the two known Tsunamigenic zones of Indian Ocean region through - Land-based Seismic Stations

Real time network of ocean observational network comprising Bottom Pressure Recorders around the two Tsunamigenic zones, Tide Gauges, Radar - based Coastal Monitoring Stations etc.

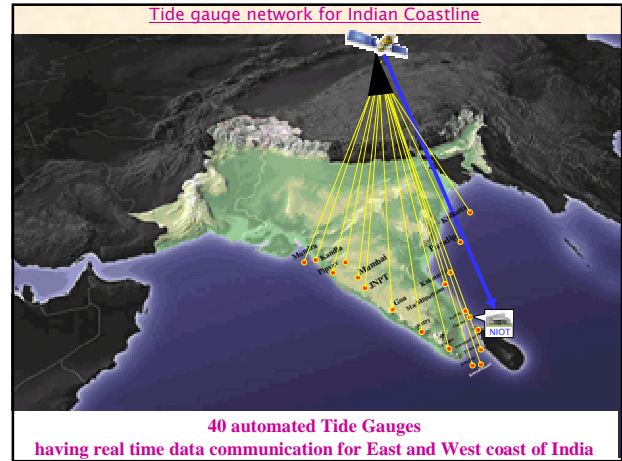
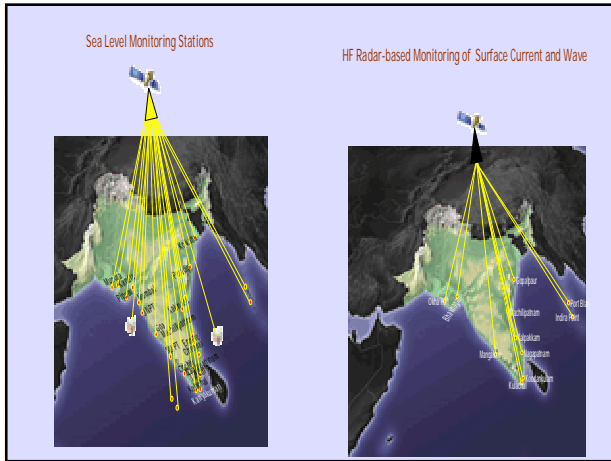


Deep Ocean Assessment and Reporting of Tsunamis Buoy (DART)



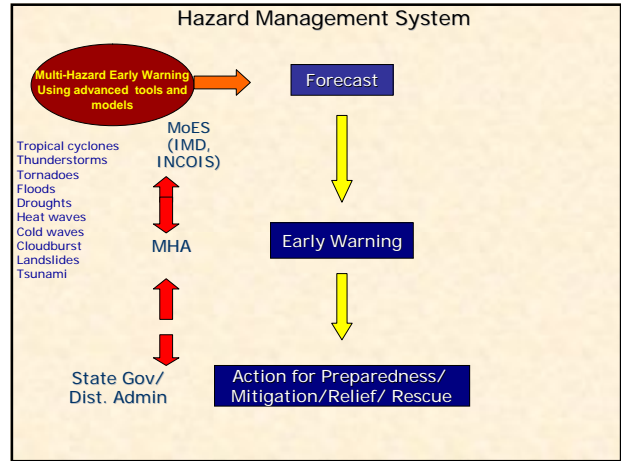
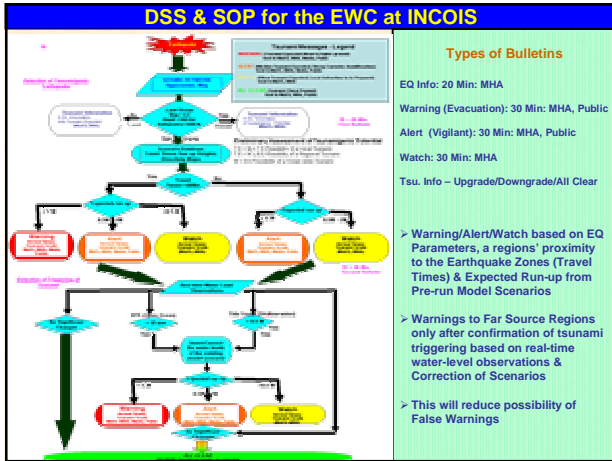
- Detection and measurement of change in water level of 1 cm in 6000 m of water

- Operational by the Pacific Tsunami warning System as well



- ### Accomplishments
- **Developed numerical models for Tsunami and Storm Surges with all associated data inputs**
 - Directivity Map Generation
 - Time of arrival at all Locations
 - **Generated a Hierarchical Library of Coastal inundation and Vulnerability maps based on Tsunami travel times over the Indian Ocean**

- ### Accomplishments
- **Established a dedicated Tsunami Warning Centre (include Storm Surge) at Hyderabad and operating it on 24x7 basis for generation of timely advisories (Interim Tsunami warning system was running from the October 2006)**
 - **Made fully operational, Inaugurated on 15th October, 2007**
 - **Capacity building, training, education of all stakeholders (Continuous Activity)**



Cyclone Forecasting, Tracking and Warning System

- Scientific Activity**
Meso-Scale Models (MM5, WRF, HWRF and others) with meso-scale data assimilation systems are being extensively tried out
- Technology Support**
Tracking of cyclone movement by Satellite, Doppler Weather Radars(DWR), Automatic Weather Stations(AWS), Data Buoys, tide gauges, Dropsonde etc.
- Outreach**
Support for updating existing preparedness and emergency response action plans by the disaster management authorities at national, state and district levels

Cyclone Forecasting, Tracking and Warning System

Immediate Future Plans

- > Improve meso-scale assimilation by injecting AWS, DWR data from coastal area observational networks
- > Enhance DWR, AWS Networks along the coastal areas vulnerable to cyclones on priority
- > Develop lead time cyclone impact assessment tools and coastal vulnerability atlas

Rainfall Forecasting and Flood Warning Systems

- **Scientific Activity**
Use of Meso-Scale Models (MM5, WRF, HWRF) for heavy rainfall forecasts over major river basins at very high resolution (10Km)
- **Technology Support**
Monitoring of river sub-catchment rainfall scenario involving rainfall data of IMD(satellite and ground based data), CWC and state governments
- **Outreach**
Support to the efforts of CWC, River and Reservoir Management Authorities, state governments for planning emergency response actions

Rainfall Forecasting and Flood Warning Systems

- **Immediate Future Plans**
 - Enhance sub-catchment scale rainfall and river gauge observation networks using satellite telemetry
 - Generate high-resolution (5-10Km grid scale) rainfall forecasts at river basin scale
 - Work towards development of basin-specific hydrological models for rainfall-runoff/inflow estimations

Drought Monitoring and Warning Systems

- **Scientific Activity and Technology Support**
District scale monitoring of Meteorological Drought (rainfall deficit scenarios), Moisture Stress on Crops in Rainfed Areas (Aridity Index, Vegetation Index, Productivity) on weekly basis during Kharif Season
Outlook for sub-divisional scale (cluster of districts) rainfall prospects and crop specific agro-advisories based on medium range rainfall and temperature forecasts
- **Outreach**
Enhanced support to Crop Weather Watch Groups in Central and State levels for various field level agricultural operations and crop contingency planning

Drought Monitoring and Warning Systems

- **Immediate Future Plans**
 - Develop Sub-District Scale Monitoring of Meteorological Drought using enhanced rainfall networks of IMD, CWC and State Governments
 - Develop district scale crop specific agro-advisory services
 - Work towards development of appropriate tools for assessment of Agricultural Drought and Hydrological Drought Scenarios on weekly basis
 - Evolve partnership initiatives with National Rainfed Area Development Authority in support of yield enhancements of rainfed agriculture

Immediate Prospects of Satellite Data over Indian Seas

- Launch of **OCEANSAT-II** would enable India to get **WIND VECTORS(25Kms grid)** over sea surface
- Launch of **INSAT-3D** would enable to get high resolution(10Km at the equator and goes up to 20Km away from the equator) **vertical soundings of the atmospheric temperature and moisture** (geo-stationary radiances) over the Indian seas
- Launch of **MEGHA-TROPIQUES** would enable to get high resolution(25Km) **rain rate, cloud liquid water, net column moisture and wind speed** over the Indian seas
- Enhanced imaging and remote sensing capabilities from **CARTOSAT- I & II** to **generate and update relevant topographic and thematic layers** for facilitating virtual reality vulnerability scenario decision support application systems

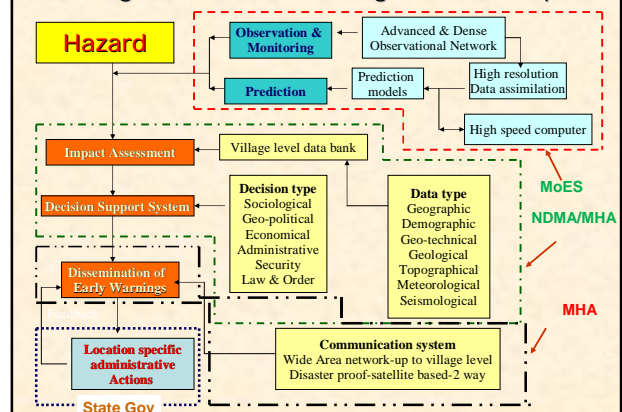
Integration of other Telemetry Networks in India with that of India Meteorological Department

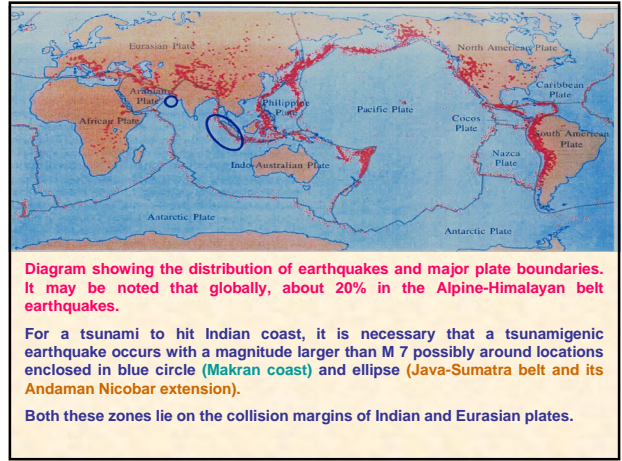
- Central Water Commission
- Narmada Control Authority
- Department of Space
- State Government Networks
- State Agricultural Universities
- Irrigation and Power Generation Agencies

Integration of Warning Dissemination Systems

- Potential Fishing Zone(PFZ) Information Boards
- Digital Cyclone Warning Dissemination Systems (DCWDS)
- Mass and Rapid Mobile Short Messaging System (SMS)
- Leveraging Locational Technology Services (GPS, GPRS)

Integrated Disaster Management Concept





Real time Data reception at TWC INCOIS

Seismic Network

- Data from 3 IMD stations, 10 WIHG. Early bird software is configured.
- Data from about 200 IRIS stations and 48 GEOFONE stations. SEISCOMP 2.0 configured.
- Autolocation in 10 – 15 Minutes

BPR Network

- Data From 5 NIOT Tsunami Buoys TB10, TB10A, TB07, TB11, TB12 being received

Tide Gauge Network

- Data from 11 SOI tide gauges and 12 NIOT tide gauges being received
- Data from about 50 International tide gauges being received

Data Centre Facilities

Hardware

- IBM Server P590 (2), IBM Server P570 (1), IBM Storage (6 TB Fiber; 1 TB Disk; Tape), IBM Intellistation Workstations (10), Display System (BARCO) Cisco Networking, etc.

Software

- ETL (DB2 Dastage), Staging & Central Database (DB2), Web Application Server (Websphere), GIS (Arc IMS, SDE), Firewall (Checkpoint), etc.
- Application Software for real time data reception, display, analysis and generation of bulletins based on the SOP.