USE OF MODELS, REMOTE SENSING AND GIS TECHNOLOGIES FOR DISASTER MANAGEMENT – ANDHRA PRADESH A CASE STUDY

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ABSTRACT: The use of latest technologies in remote sensing, GIS, and improved communication systems coupled with Hydrodynamic modelling are very useful in managing the natural disasters especially in respect of Cyclones and floods. For the first time these technologies are used in an integrated manner in India by the Government of AP. This paper mainly illustrates the experiences of Government of AP in handling disasters in the recent past with the aid of Remote Sensing, GIS, Forecasting models and latest available instrumentation.

1. INTRODUCTION:

Andhra Pradesh (AP) covers 274,000 square km on the east coast of India, and it is the country's fifth largest state, accounting for 8.4 percent of its total area and also the fourth most populous state, with a predominantly rural population of over 66 million. Coastal Andhra spread with fertile lands along the state's 1,030 km of coastline. Two of India's largest rivers, the Godavari and the Krishna form Deltas covering 4 major districts of AP.

The factors which compound the vulnerability of AP due to natural disasters include: Cyclone threat to 9 coastal regions accompanied by storm surges leading to widespread flooding and deep inland sea water intrusion, wind damages extending up to several kilometers inside from coast and flooding of low laying areas along the major river systems. The high concentrations of population, infrastructure and economic activities along these areas warrants an integrated disaster mitigation system using the latest technological developments in the field of Remote sensing, GIS and satellite based communication system.

In view of the recurrence of frequent disasters like cyclones, floods etc., Government of Andhra Pradesh have implemented models based early warning frame work coupled with RS & GIS technologies and latest instrumentation.

- Enhancing the early warning mechanism by implementing hydrodynamic models run with real time data received from satellite based communication and remote sensing to forecast the events like Rainfall, runoff, wind speeds, storm surges and finally fore warning the likely vulnerable areas by transferring the outputs onto GIS.

- Long term planning of developmental activities in the vulnerable areas based on the Integrated Coastal Zone Management Plan prepared to optimize the resources such as land, water, air etc by taking the physical, social and economic vulnerabilities into consideration

- Improving the communication system for data dissemination by linking all district and mandal head quarters with state capital by means of dedicated network (APSWAN) and acquisition of real time data by installing telemetry stations through satellite based communication system.

2. REAL TIME SYSTEM (RTS) FOR CYCLONES:

All the models to forecast Cyclone tracks, wind, rainfall, storm surge will run in a sequential manner in an automated mode for real time operation as shown in the figure 1. The RTS check for the latest data received from different sources from the data server and identifies the model to be run and stores all the data in predefined directories for further analysis using Decision Support System (RTS). This model will be running continuously on an uninterrupted basis to trigger cyclone alerts and to run the required models to forecast the impact of the approaching cyclone.

3. REAL TIME SYSTEM (RTS) FOR FLOODS:

The flood forecasting data flow is shown in the figure 1. Forecasting model runs will use the latest data. The UP (Rainfall – Runoff) model will use the rainfall forecast given by the rainfall model. Mike 11 (Hydrodynamic model) / Mike GIS will use fluvial flow forecasts inputs from the UP model and the latest predictions of tide and storm surge sea boundary levels storm surge model. The results of the UP model run will be passed to the Mike 11/Mike GIS model. During calculation of the hydraulic results/forecasts the Mike programs will update the calculated real time values with the latest river flow/ water levels received from the field gauge stations.

Once a request for a forecast is made (either manually or via the task scheduler) the system will automatically extract the required data from the Flood Watch database to UP & MIKE 11/MIKEGIS models, execute a model simulation and transfer the MIKE 11 simulated forecasts & Inundation map to the Flood Watch database for display and further dissemination through DSS.

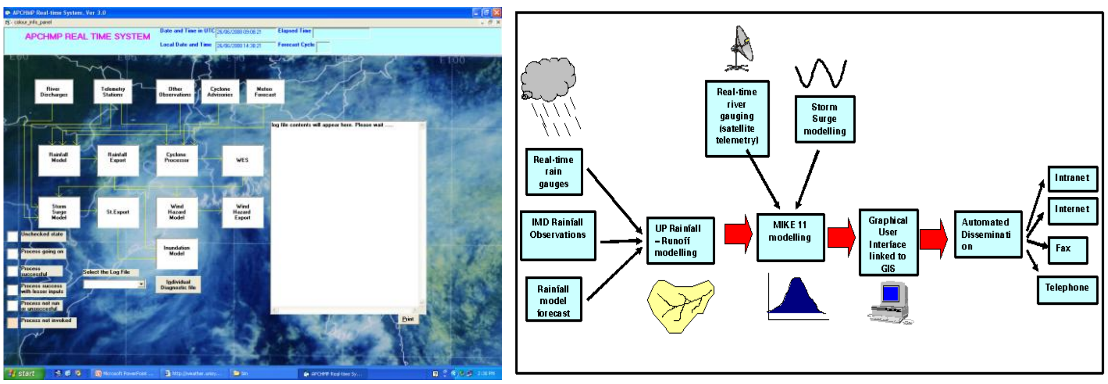

Figure 1. Flow Diagrams of RTS Cyclone and RTS Flood forecasting system

4. DECISION SUPPORT SYSTEM (DSS)

The DSS-RTS is a GIS based Support system for analysis of impact of the Cyclone and floods. This system analyses the output generated by all the models transferring the model out puts on to GIS platform at the required administrative boundary. The DSS is able to generate reports detailing the areas under inundation, population affected, other elements like infrastructure facilities at risk, buildings at risk, crops at risk etc., This also provides facility to over lay the high resolution image data for calculating damages. The maps generated by DSS depicting storm surge affected areas and likely wind damage to crops is shown in figure 2.

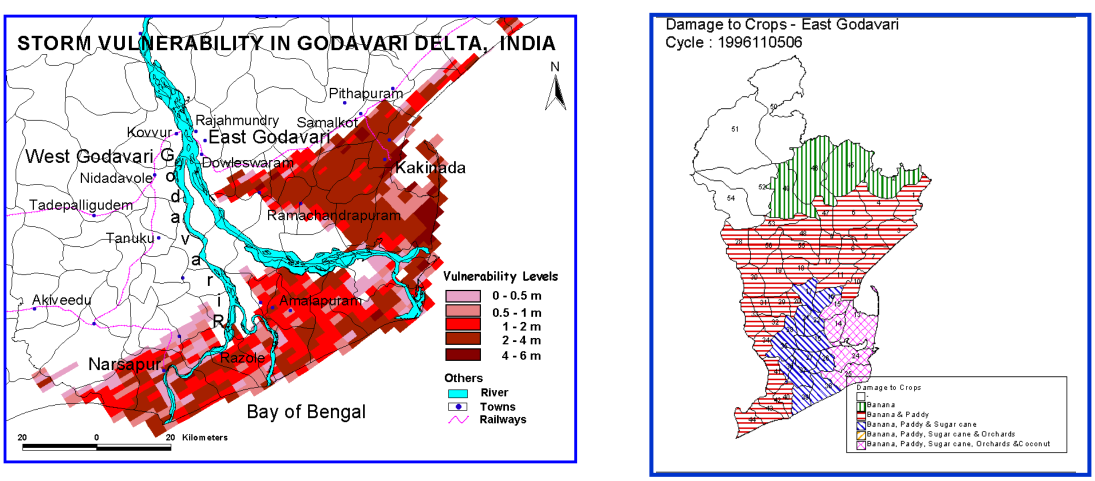

Figure 2. Impact maps as generated by Decision Support System

5. **RESULTS FROM RECENT EVENTS**

This frame work has been used in the recent disaster events in Andhra Pradesh and the results are enormous as the death toll is considerably reduced. The results from the implementation of this frame work in AP on real time during some of the recent disasters like Krishna floods in Oct 2009 which is a 1 in 10000 event, Laila and Jal Cyclones that crossed AP coast in the year 2010, where loss of life is minimised, are illustrated.

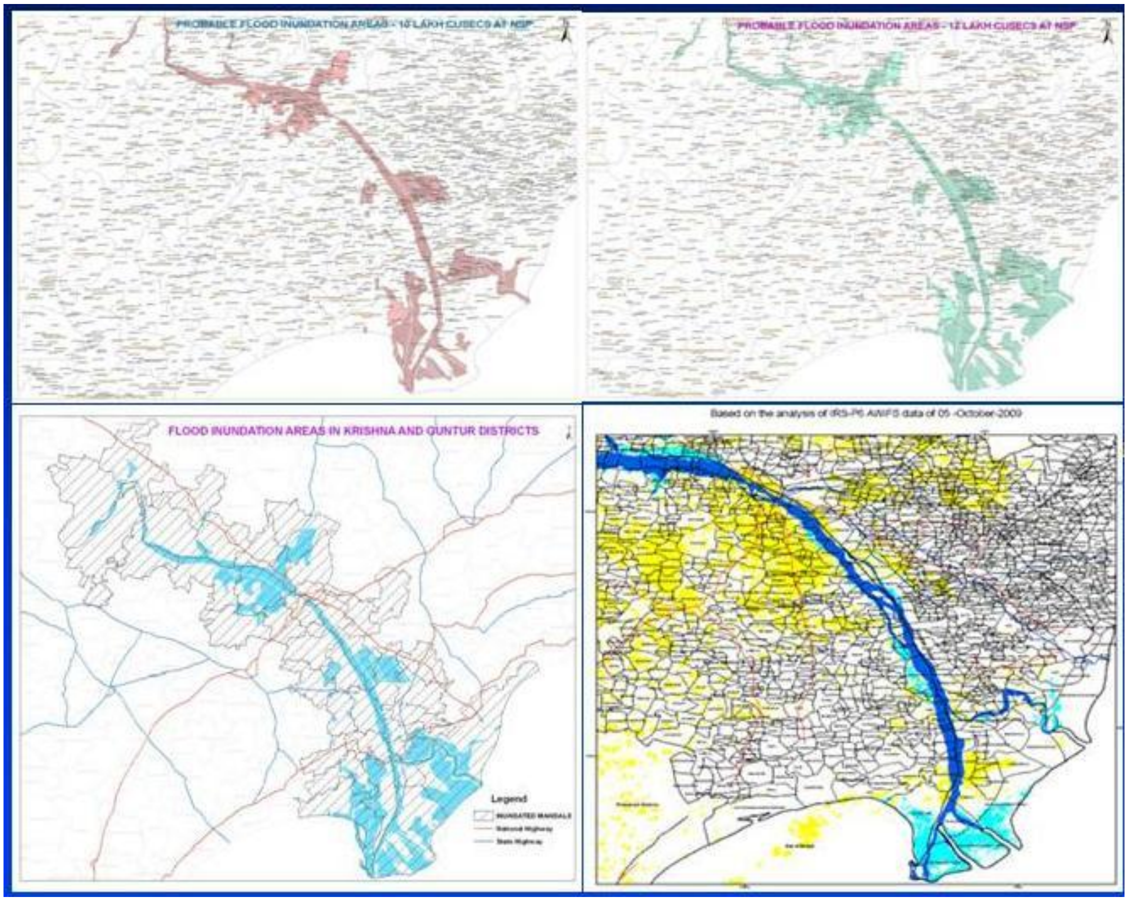

Figure 3. Scenario Based Maps Generated during October 2009 Krishna Flood

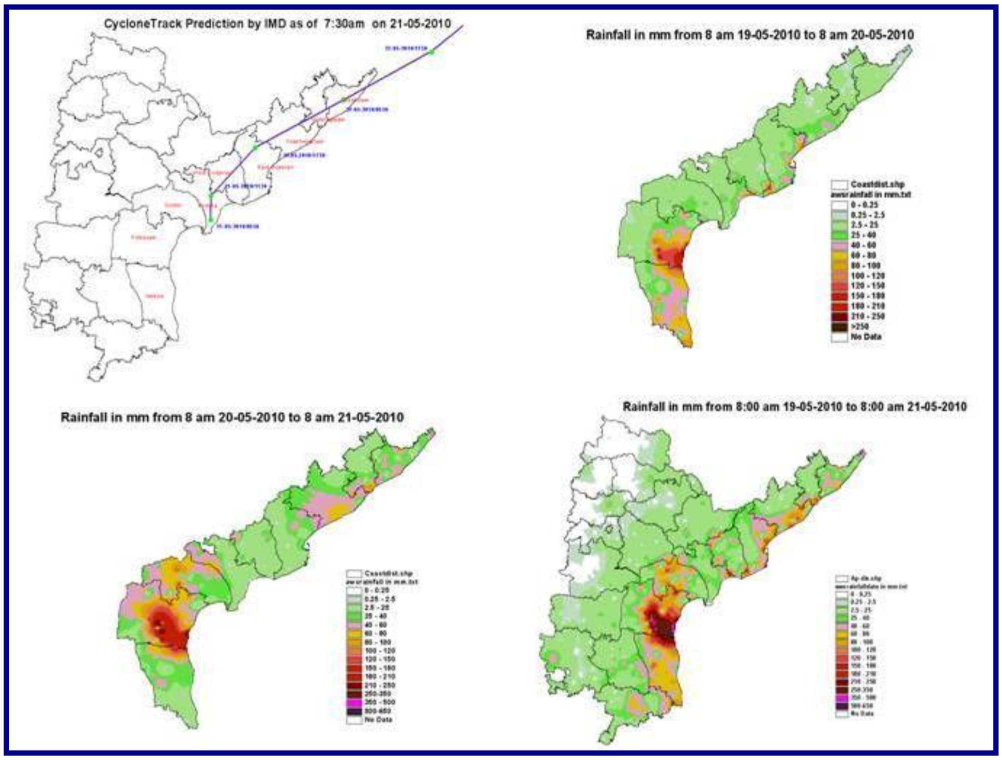

Figure 4. AWS data based Rainfall maps generated during May 2010 Laila Cyclone

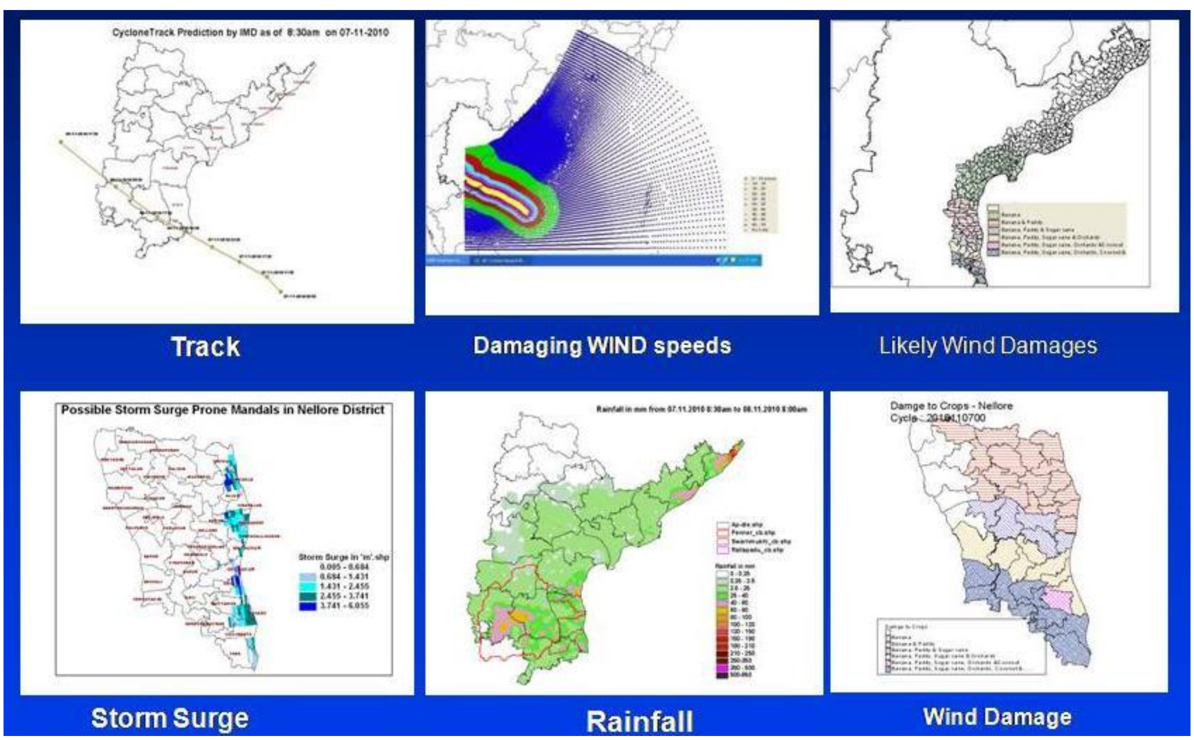

Figure 5. Event maps generated during November 2010 Jal Cyclone

6. CONCLUSION:

Thus the developments in the field of remote sensing, GIS and communications coupled with mathematical modeling can be better utilized for disaster management and also for planning better mitigation measures in the vulnerable areas to save lives and to minimise loss of property.

7. REFERENCES:

Kilsby, C.G., Ewen, J., Sloan, W.T. and Fallows, C.S., (1999) The UP modelling system for large scale hydrology: simulation of the Arkansas-Red River basin, Hydrol. Earth System Sci, 3, 137-149.

Das, P.K; Sinha, M.C; and Balasubramaniam,V. Storm surges in the Bay of Bengal. Quaternary journal of Royal Meteorological Society, vol. 100, 1974, 439-449.

Ghosh, S.K. Prediction of storm surges on east coast of India. Indian Journal of Meteorology, Hydrology, & geophysics. Vol 28/2, 1977, 157- 168.

Murty, T.S; Flather, R.H; and Henry, R.F. The Storm Surge problem in the Bay of Bengal. Prog. Oceonog. Vol 16, 1986, 195-233.

Rao, Y.R; Chittibabu, P; Dube, S.K; Rao, A.D; and Sinha, P.C. Storm surge prediction and frequency analysis for Andhra coast of India. Mausam, vol 48, no. 4, 1977, 555-566.

Vatvani,D.K; Gerritsen,H; Stelling,G.S; and Rao,A.V.R.K. Cyclone induced Storm Surge and Flood forecasting system for India. Solutions to Coastal Disasters Conference, Feb. 24-27,2002, San Diego, California. 473-487.