

Use of Space Inputs in Recent Major Disasters in India

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ISRO-DMSP (*Disaster Management Support Program*)

- **Comprehensive approach to use of space technology inputs for disaster management. Its components include**
 - **Communication Support**
 - **Weather Monitoring Satellites**
 - **Earth observation satellites & products from their data**
 - **Decision Support Centre (DSC) at National Remote Sensing Centre**
 - **Early Warning Research with space inputs**
 - **Aerial survey (Rapid surveys, High resolution terrain products)**
 - **Geospatial Support (WebGIS, mobile-geospatial, etc)**
 - **National Database for Emergency Management (NDEM)**
 - **BHUVAN Geo-portal (www.bhuvan.nrsc.gov.in)**
 - **Support disaster management at global level**
 - **International Charter, Sentinel Asia, UNESCAP, UN-SPIDER**

Satellites & Sensors

<u>INSAT-3D</u>	<u>SARAL</u>	<u>RISAT-1</u>	<u>Megha-Tropiques</u>	<u>Resourcesat-2</u>	<u>Oceansat-2</u>
26-7-2013	25-2-2013	26-4-2012	12-10-2011	20-4-2011	23-9-2009
Imager Sounder	ALTIKA	C-SAR	(MADRAS) SAPHIR SCARAB ROSA	AWiFS, LISS III, IV	Scatteromet er, OCM, ROSA
Geo	Polar	Polar; 6am- 6pm	Equatorial	Polar	Polar; Noon
					

+ Kalpana

Major Natural Disasters 2013

- Cyclone storm **Mahasen** (10-16 May, 2013) in Bay of Bengal
- Very Severe Cyclonic Storm **Phailin** (8-14 Oct, 2013) in Bay of Bengal

- Heavy rains & landslides in Uttarakhand (Kedarnath tragedy): 15-18 June, 2013

- Floods (*Multiple events*)

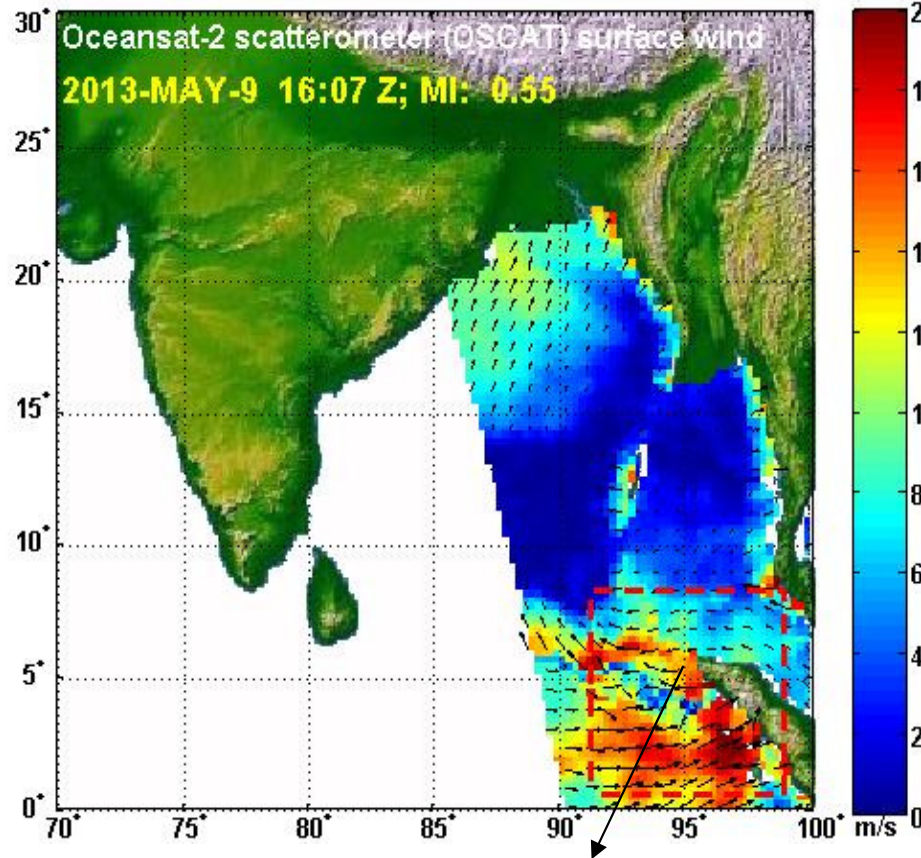
- Forest Fire (*Monitoring Jan-June*)

Cyclone Applications of EO data

- **Cyclo-genesis**
 - Aided by real-time OSCAT winds, future inputs from ROSA
- **Cyclone Parameter Retrieval**
 - Meghatropiques and INSAT-3D
- **Cyclone Tracking**
 - Geostationary Satellites (INSAT-3D, Kalpana, ...)
- **(Cyclone Prediction – Landfall (location & time), Intensity, ??)**
 - Modelling (Empirical/ physical) : Active Research to improve operational prediction models
- **Cyclone Impact : Flooding, High wind damage, ..**
 - Storm Surge Prediction
 - EO High resolution, terrain and models

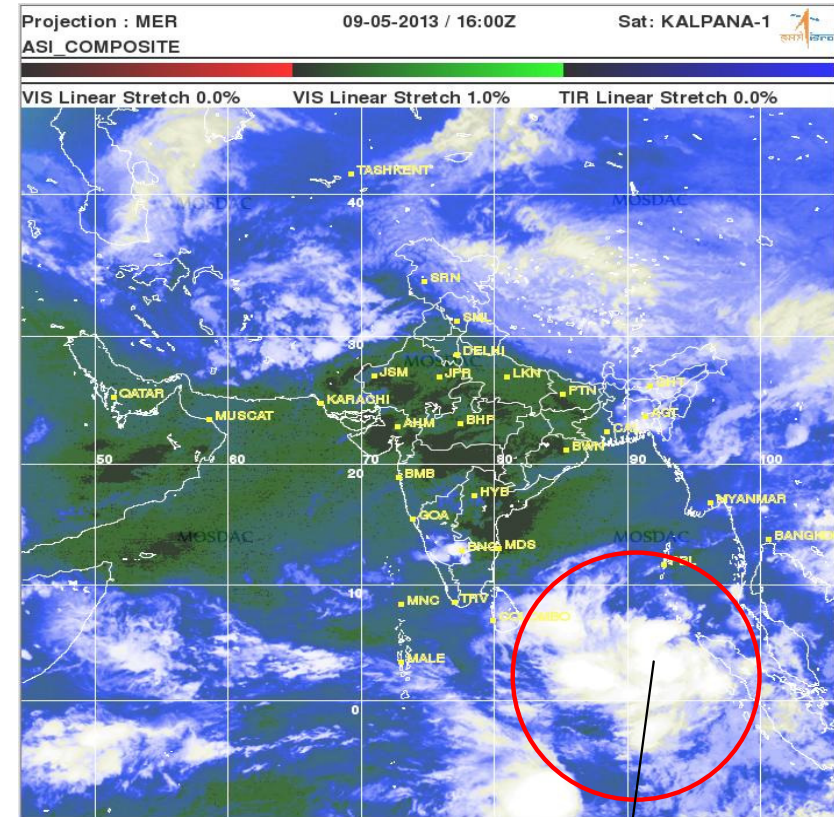
Cyclogenesis Using OSCAT Surface Winds

Cyclogenesis Prediction of TC MAHASEN (10-11 May, 2013)



Genesis Prediction time: 9 May 16 Z
Cyclone Formation time: 11 May 6Z
Genesis Prediction Lead time: ~40 hrs

**OSCAT derived winds (9 May, 2013;
16Z)**



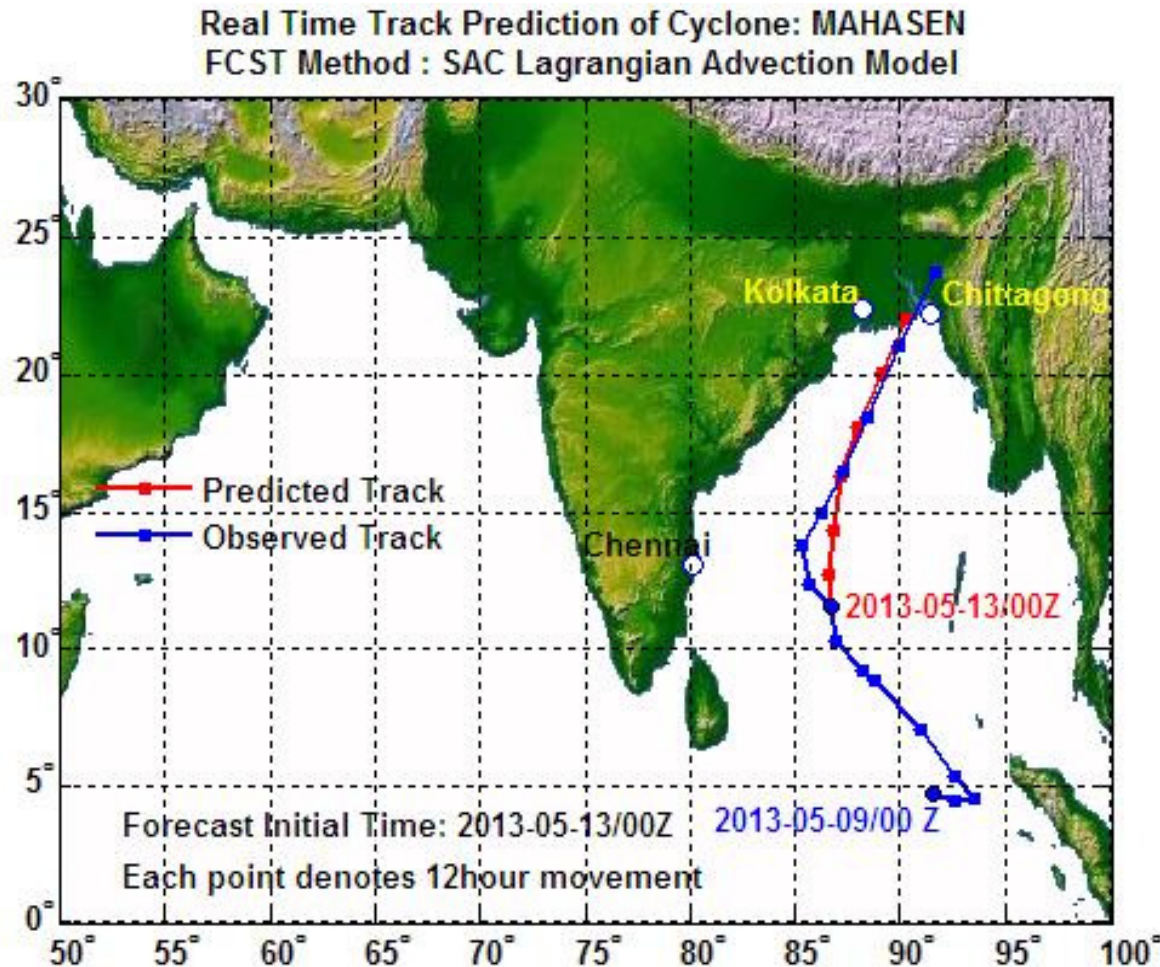
**Upper level cloud merging during
genesis of TC MAHASEN**

Kalpan-1 TIR image (9-May-2013, 16Z)

Source: MOSDAC/SAC

Cyclone Track Prediction : SAC-Developed Lagrangian Advection Model

Track Prediction of TC: MAHASEN (11-16 May, 2013)



24-h forecast land-fall position error: 28 km

24-h forecast land fall time error: 2 hr (delay)

Source:
www.mosdac.gov.in/cyclone

Phailin Cyclone, 2013

- Bay of Bengal prone to many cyclones
- Previous super cyclone 05B occurred in Orissa in 1999, causing 10,000 deaths
- Phailin caused 21 deaths, most intensively forecasted & managed cyclone with 1.2 million evacuation. (13 million affected)

Phailin : INSAT-3D & Oceansat

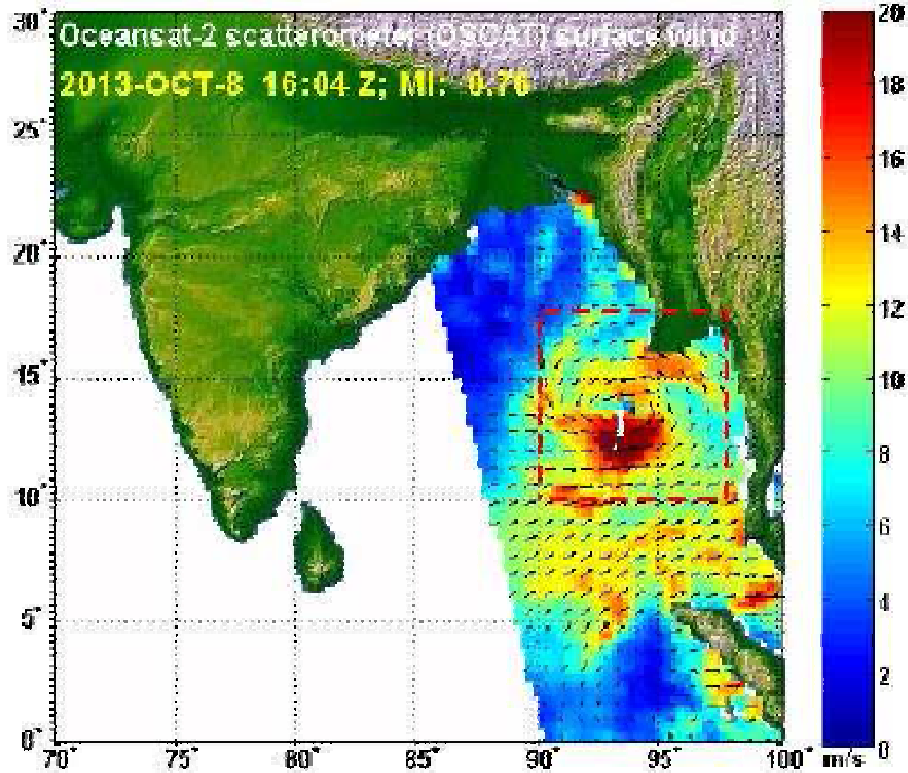
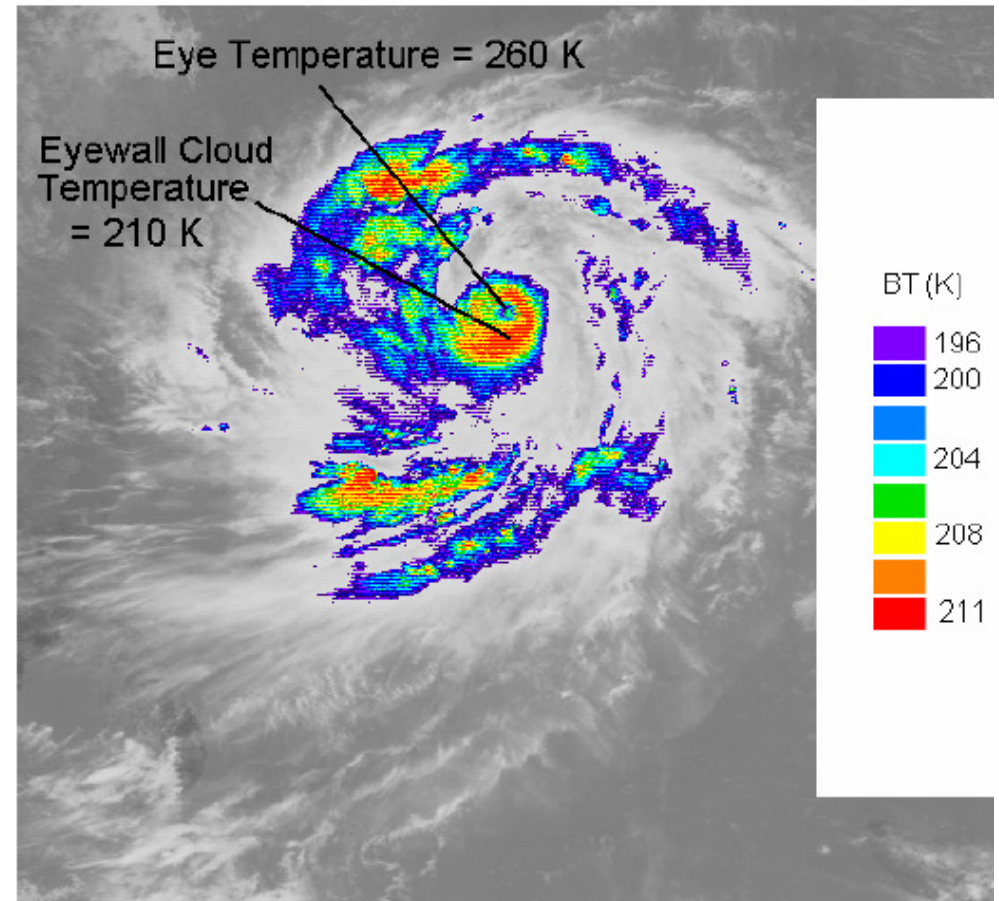


Fig. 2 : Patterns of OSCAT winds on 8th October 2013 indicating a strong possibility of cyclogenesis.

Early Cyclogenesis Detection

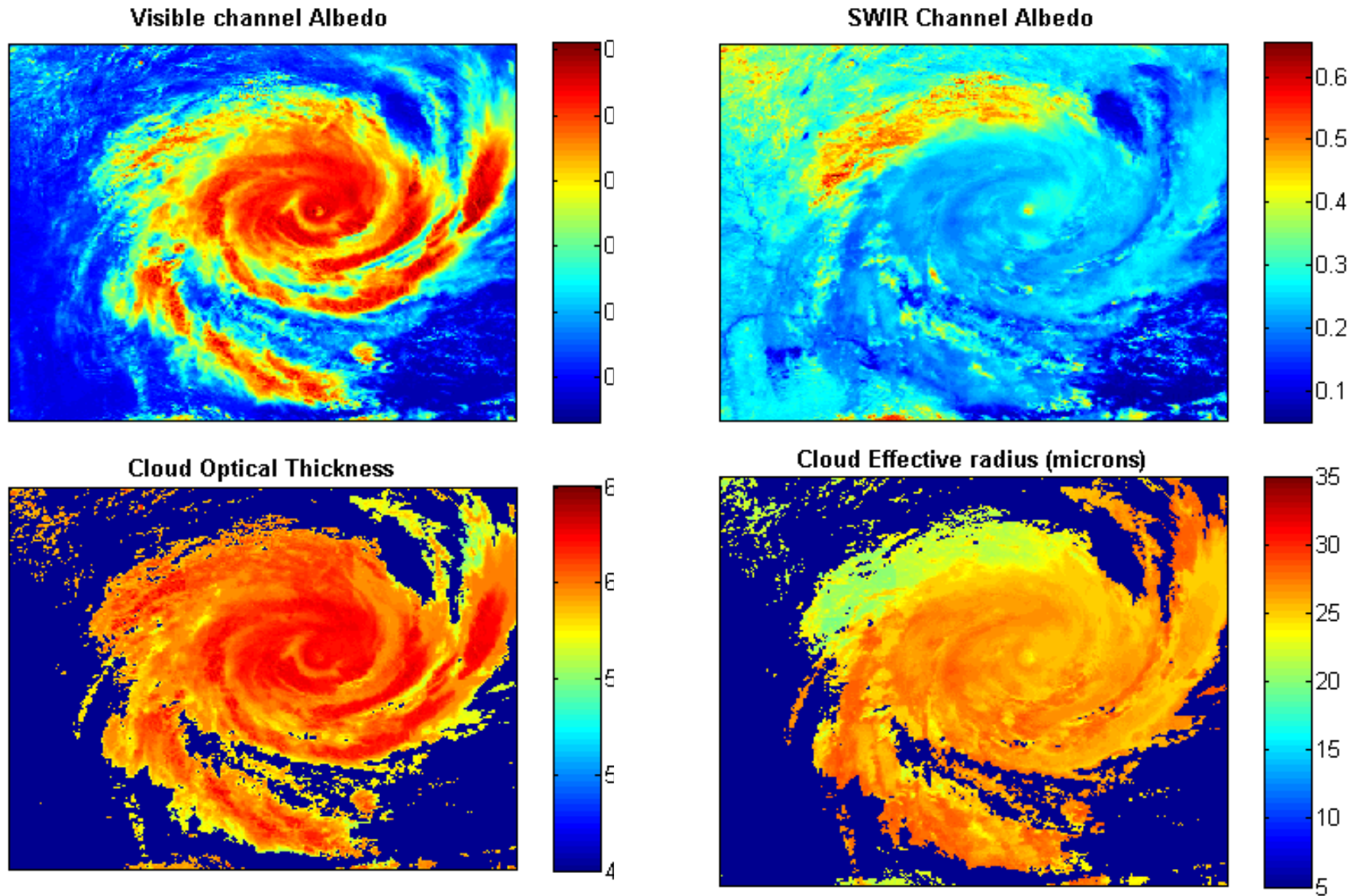
INSAT-3D TIR-1 Channel Image of Cyclone PHAILIN.

Brightness temperature gradients in the central dense overcast (CDO) region is useful for estimation of cyclone intensity.



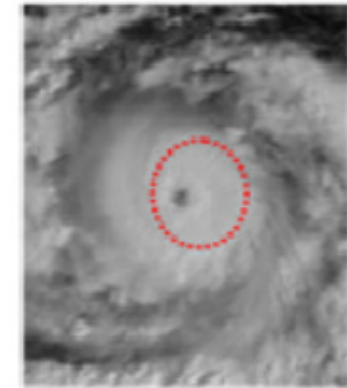
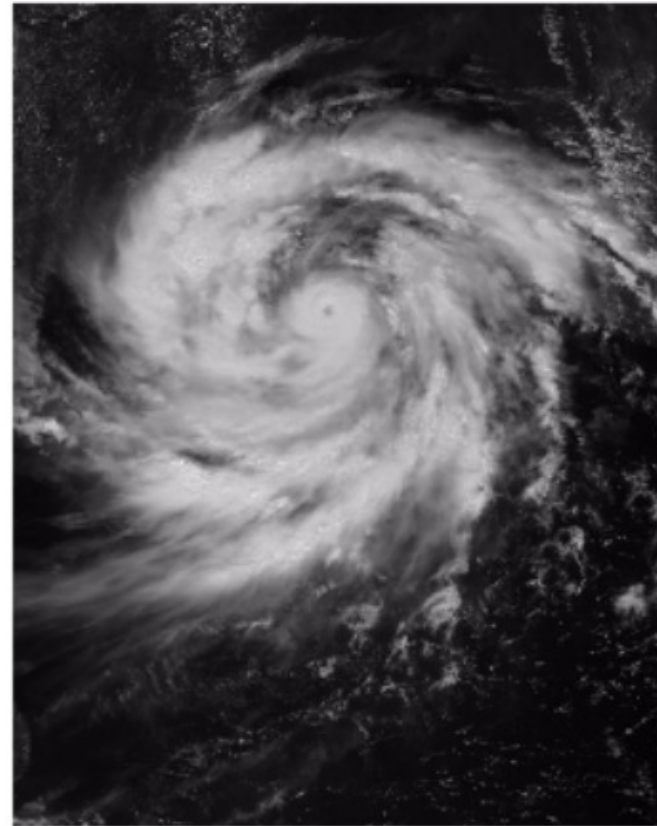
Improved Cyclone Characterization

INSAT-3D Use in Cyclone



The cloud optical thickness and Cloud Effective radius retrieved from INSAT 3D SWIR and visible channels for Cyclone Phailin (12 October 2013, 0800 GMT)

Phailin – INSAT-3D, Kalpana Comparison

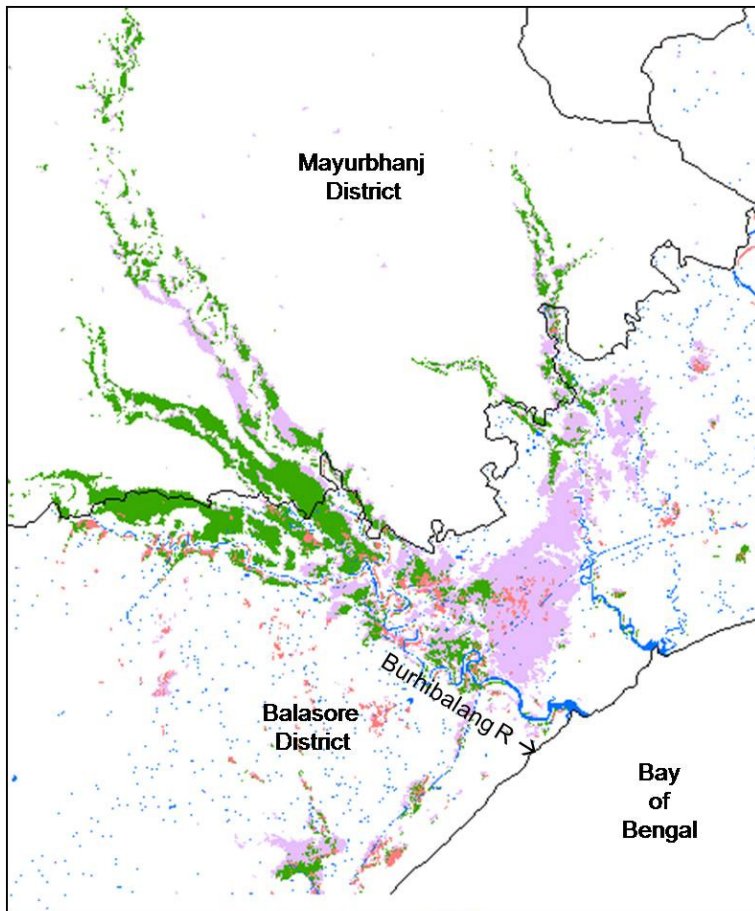


Coverage of cyclone Phailin by visible channels of (a) Kalpana and (b) INSAT-3D satellites on 11-Oct-0600Z. Higher resolution INSAT-3D images were useful in determination of key structural parameters such as radius of maximum wind (R_{max})

EO Data Applications post PHAILIN Landfall

- Monitoring of inundation
- Detection of damage to structures
- Crop damage
 - Inventory of inundated rice crop

1-Central Warehousing Corporation - Godowns



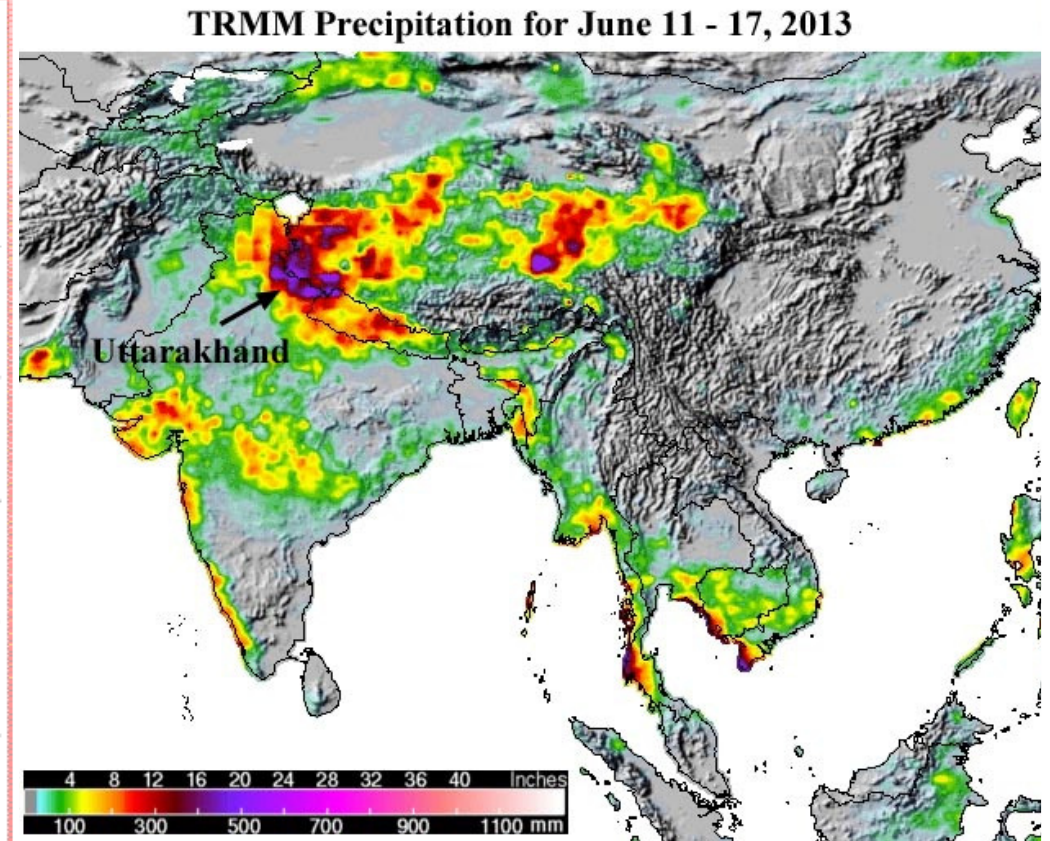
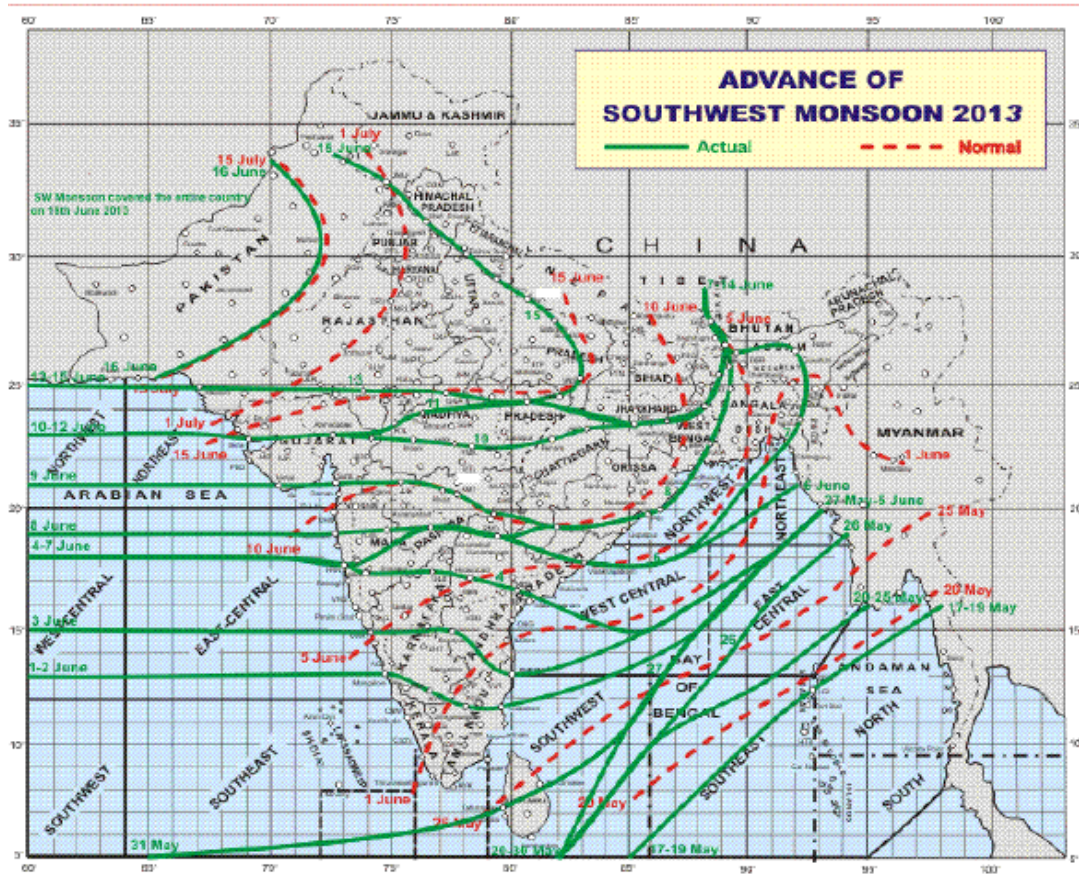
Arrow () indicates damaged roof tops



Kedarnath 2013 Disaster

Kedarnath : Multiple causes of disaster

- Early monsoon advance, special atmospheric conditions
- Heavy snowfall (9-11 June), heavy immediate rainfall (14-16 June)
- Flash floods (entire village washed away)
- Debris flow and landslides
- High-altitude lake formation & burst
- Massive road infrastructure & house damage affecting rescue



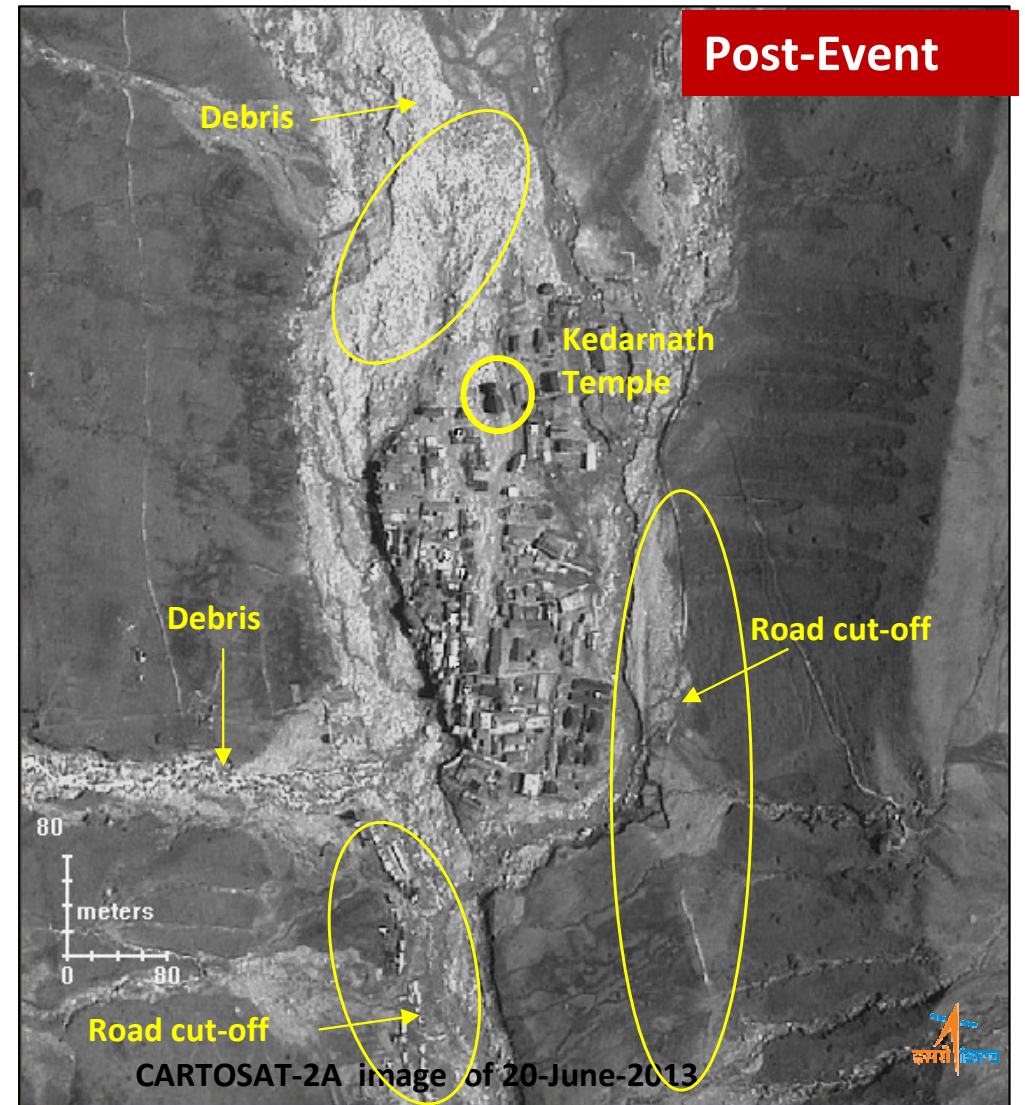
Kedarnath: Magnitude of disaster

- **Due to heavy rains (14-17 June, 2013) and associated phenomena, worst natural disaster since Dec 2004 tsunami in India**
- **4200 villages affected (580 dead, 5400 missing ‘presumed dead’), during event 170,000 people stranded in high mountains (70,000 tourists/ pilgrims)**
- **One of the largest emergency evacuation effort “Surya Hope”, airforce (23,775), army (38,750), ITBP (33,000), NDRF (9,000), civil helicopters (13,000) evacuated by air and land**
- **730 Mt of essential commodities air dropped**

Chaurabari Lake burst – Kedarnath tragedy (2013)



- Information Provided – Flood Inundation, Damaged Roads, Landslides
- Observation Period – June, 17 to till date
- Information Dissemination – NDEM – VPN, Bhuvan Portal



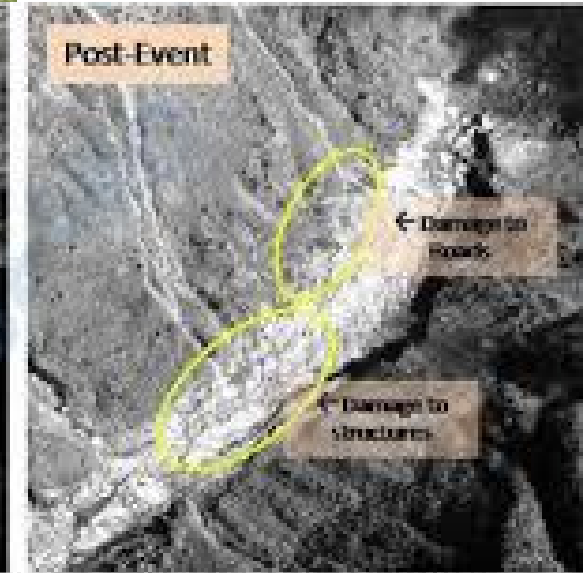
Kedarnath : View from Space and Ground



Downstream Impacts

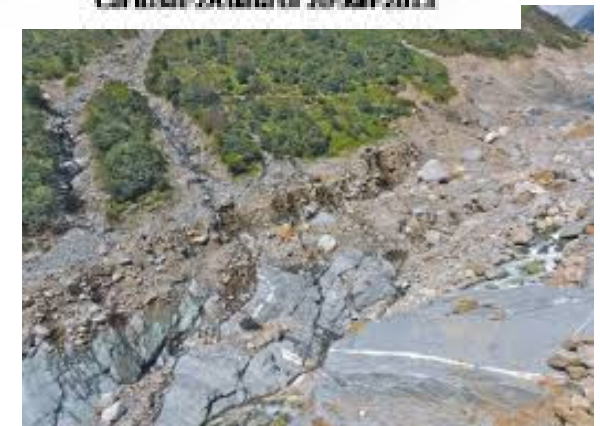


CartoSat-1 data of 2011



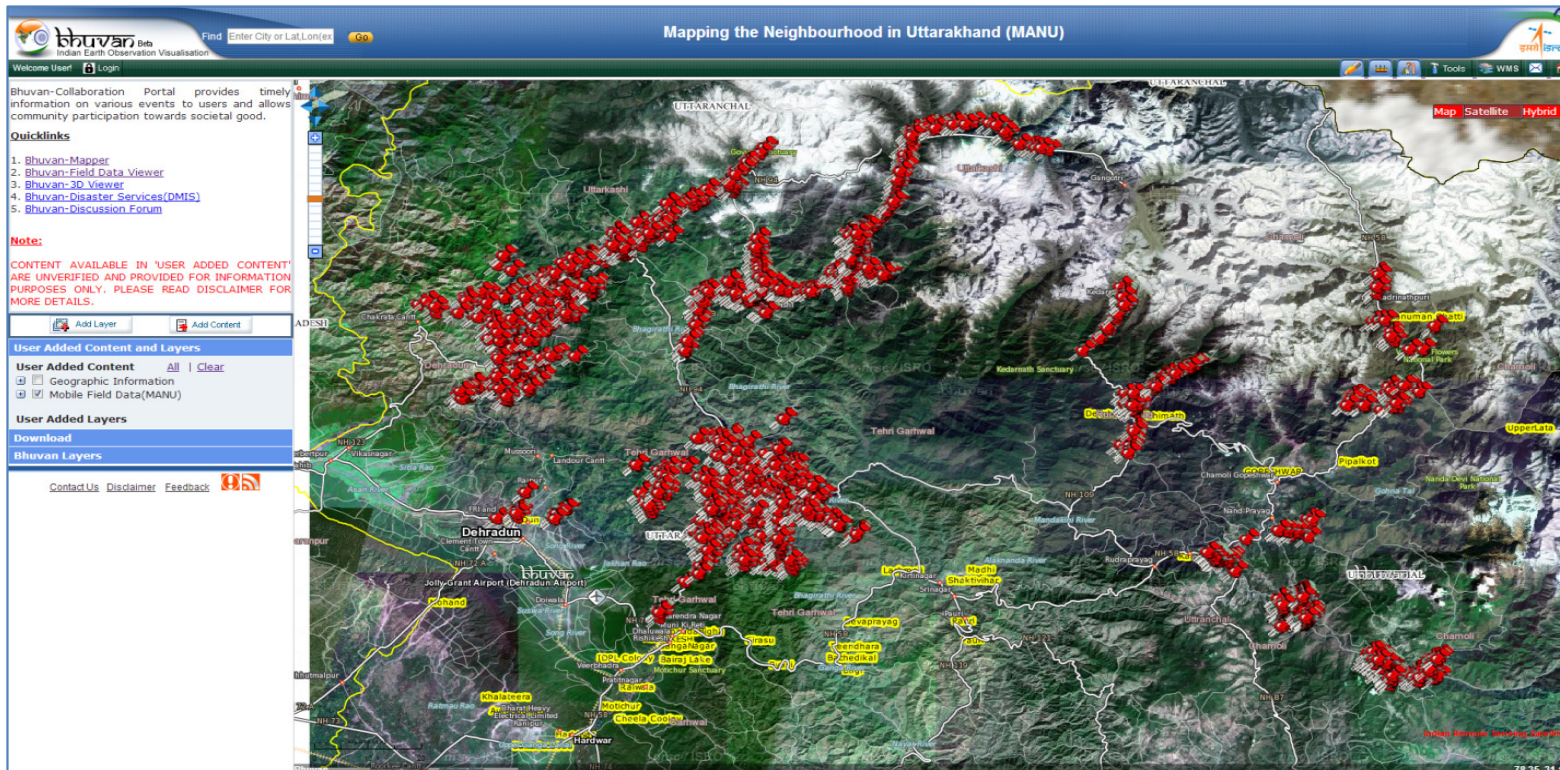
CartoSat-2A data of 20-Jun-2013

Rambara Village

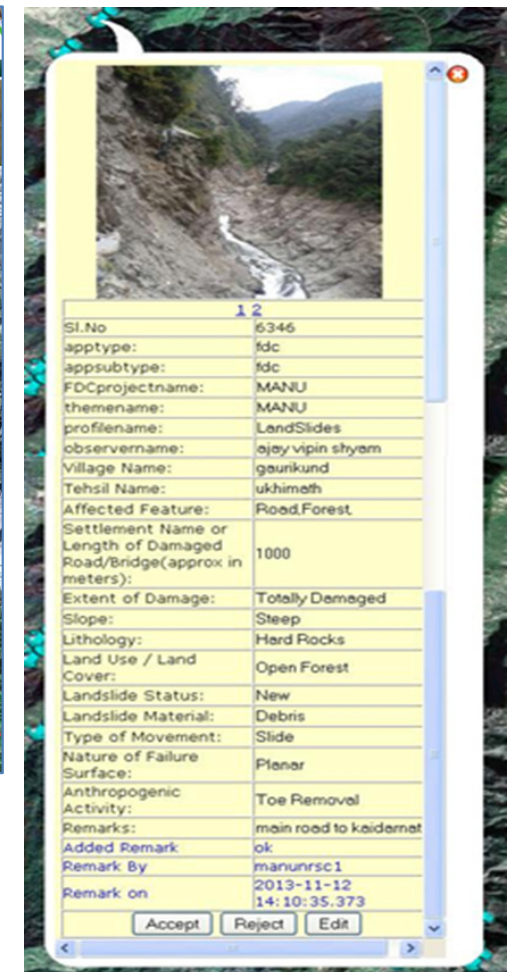


Crowdsourcing

- BHUVAN geo-portal adopted for crowd-sourcing for damage assessment and use in reconstruction planning
 - 150 Students were trained for mobile-based field data collection
- Being made accessible on BHUVAN for various uses



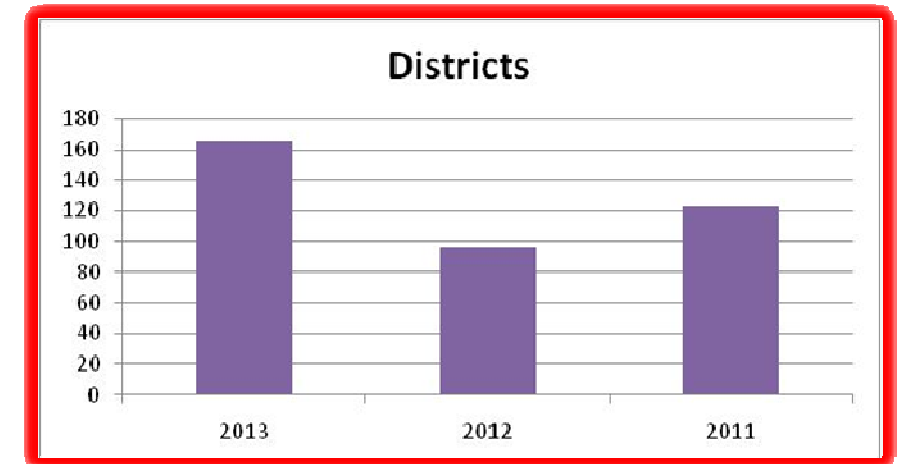
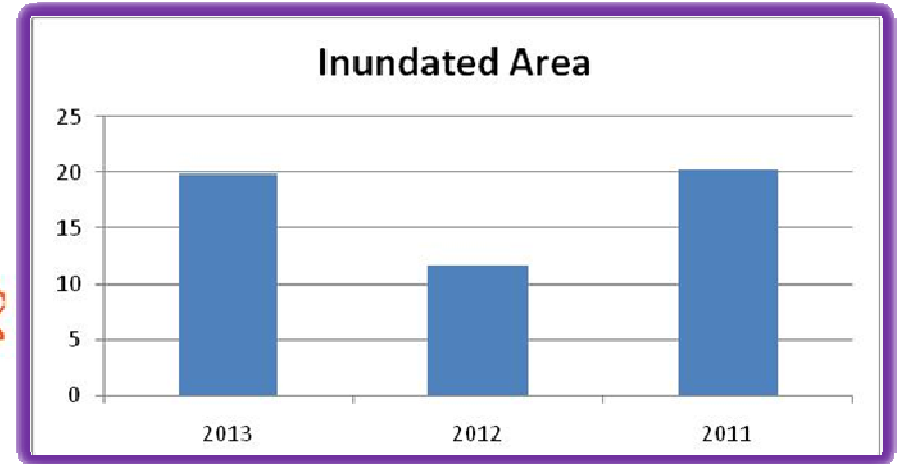
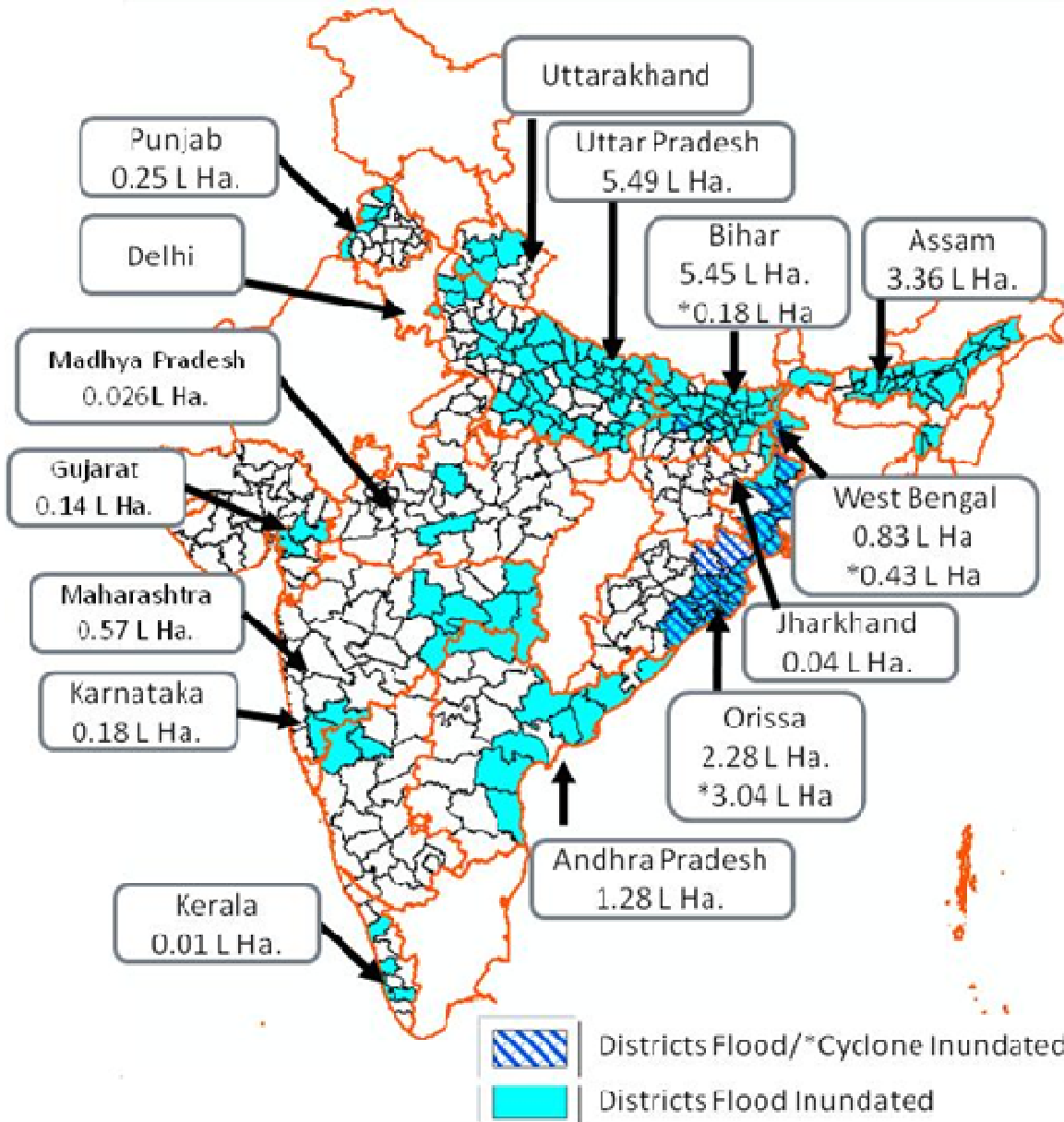
**19,799 geo-located information
Collected (11-Oct-13 to 18-Feb-14)**



Activities in Flood Management

- Produce duration of inundation maps and merge with terrain to provide Depth Class of Inundation
 - Experimental
- Use multiyear inundation to estimate Satellite-based cumulative flooded area
 - Only Flood in plains preliminary estimate ~ 10 Million ha (1998-2013)
- Use multi-year flood inundation to produce 'Flood Hazard Zonation'
 - Assam and Bihar released (available on www.bhuvan.nrsc.gov.in)
- Use models with inputs from current stage, forecast of rain to produce 'flood prediction'
 - Demonstrated in Godawari
- Use stage & flow of flood prediction for spatial prediction of flood.

15 States - 19.91 L ha. - 165 Districts - 144 Maps

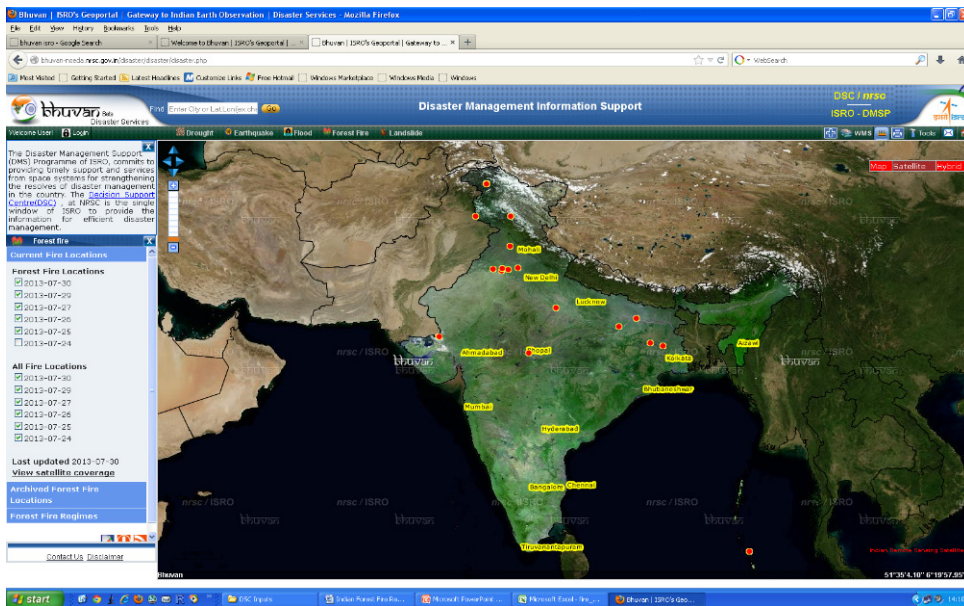
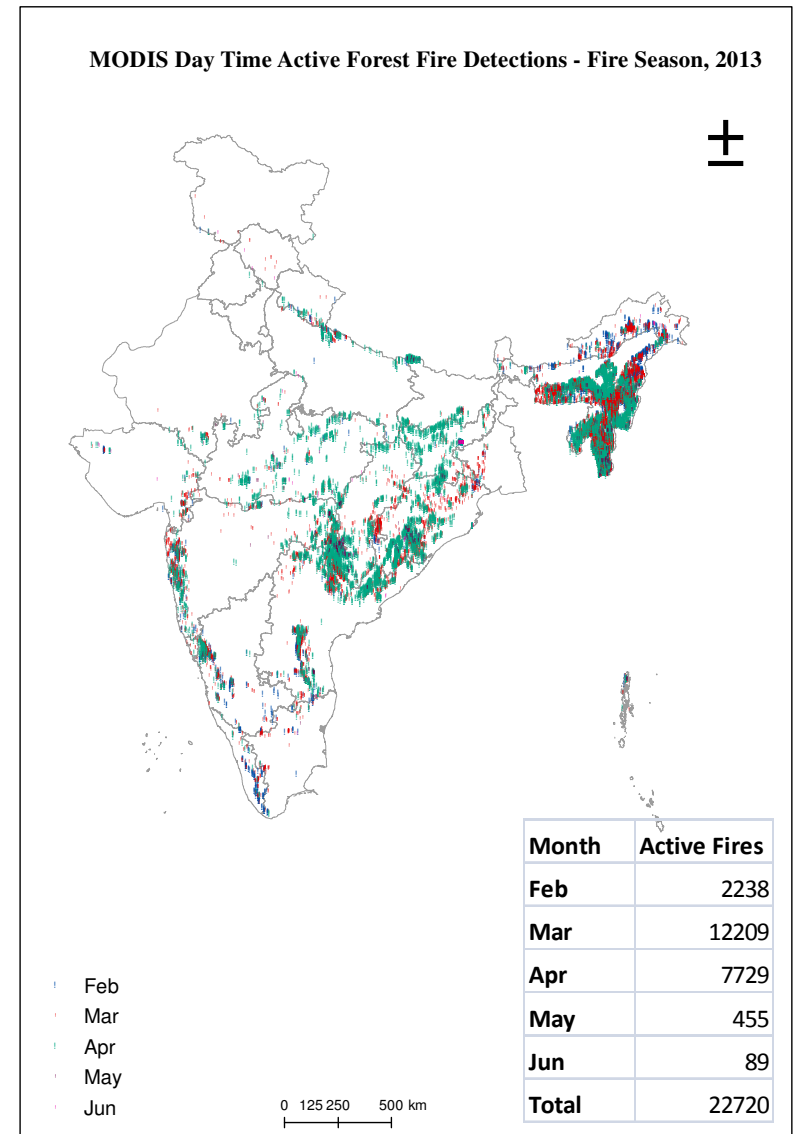


Users:

- Ministry of Home Affairs
- State Relief Commissioners
- IMD, CWC, NDMA

Forest Fire Monitoring

- Based on MODIS (Terra & Aqua), day & night near-real time (within 60 min) operational forest fire alerts to users since 2006
- Jointly with the Forest Survey of India from 2012





Thank You

<http://www.isro.gov.in>