UN-India Workshop on use of EO for Disaster Management & Risk Reduction *"Asian Experience"*

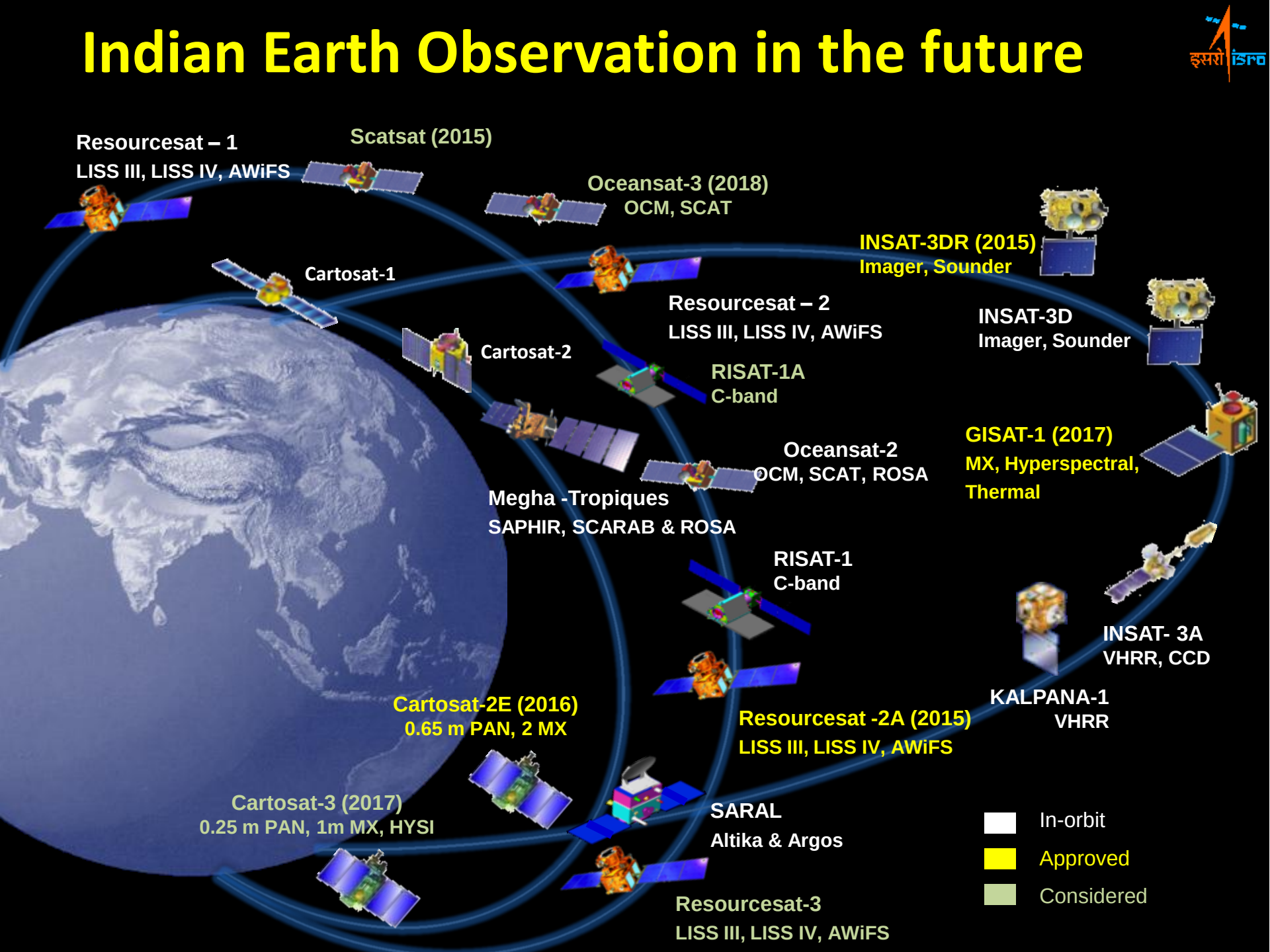
Space Technology in Disaster Response – Indian Scenario

PG Diwakar

March 08, 2016

National Remote Sensing Centre
Indian Space Research Organisation

Indian Earth Observation in the future



DISASTER RESPONSE

Floods

- Flood Inundation Maps
- Damage Assessment
- Hazard Zonation
- Bank Erosion Studies

Earthquake

- Damage Assessment

Cyclone

- Inundation Maps
- Recession Maps
- Damage Assessment

Landslide

- Damage Assessment
- Hazard zonation

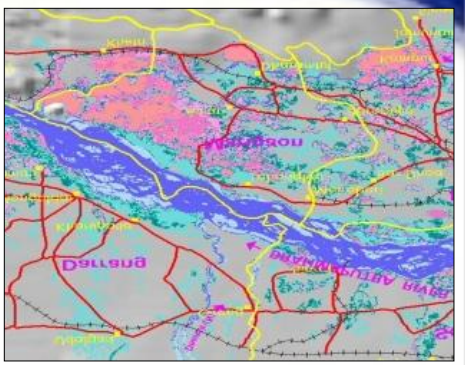
Early Warning & Assessments

Near Real-time monitoring of all major disasters

Forest Fire

- Active Fire Detection
- Damage Assessment

DMS – Decision support Centre



ALERTS
Adv. Info.
& near real time assessment

Data Acquisition, Analysis & Dissemination for all major disasters

Satellite Data Programming and Acquisition (NRSA Earth Station / NDC)

Data
- Satellite and Aerial
- All Resolutions
- Optical and Microwave

- ASAR /ALTM/ etc.
- Flight Planning
- Defense clearance
- Data acquisition, processing and transfer to DSC

Acquisition of data

Database, Knowledge Banks

Ground / Ancillary Information

Data Analysis

Hardware & software

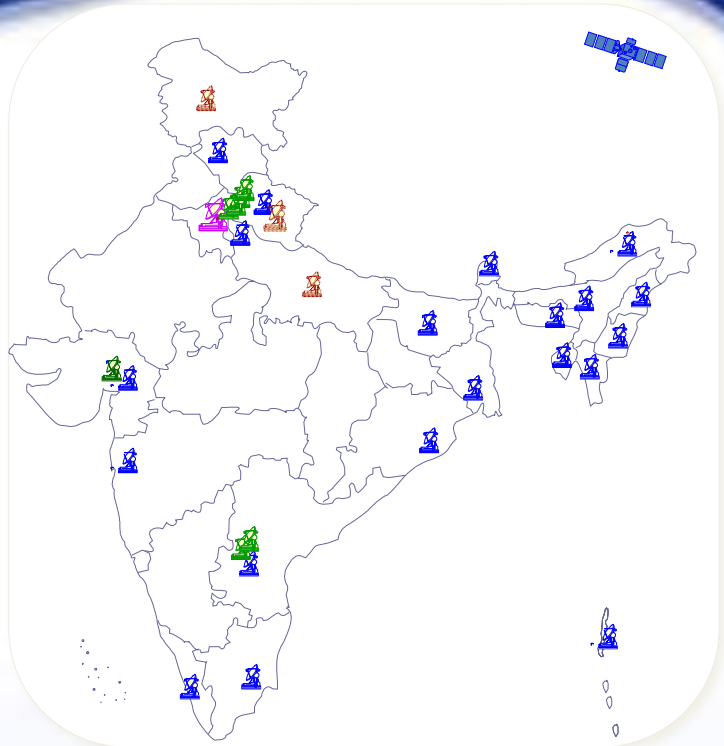
Customized Analysis Tools

Outputs

Dissemination to Users
VSAT, FTP, Bhuvan, E-mail etc.

Communication Network (VPN)

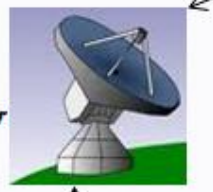
- SATCOM based Virtual Private Network (> 40 nodes) are operational (GSAT 12)
- Online GIS data analysis, data download, Video conf, …….
- 22 multihazard prone State Emergency Operation centres (10 Primary Nodes providing data CWC, IMD, INCOIS…) & 5 Monitoring nodes (CabSec, NEOC, PMO, PMR…)
- Expansion of the network to multi-hazard prone districts of the nation
- National Disaster Management Command Centre - in advanced stage of planning



National Database for Emergency Management

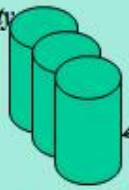
Physical Data security

NRSC, Shadnagar



*IP Packet encryption Planned***

Network Data security



Multi scale DB

Continues Disaster Monitoring

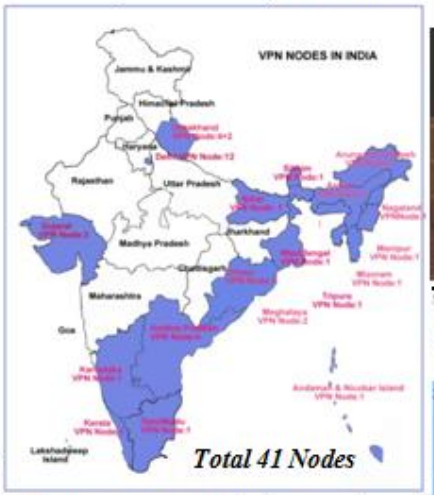
NDEM, Shadnagar

Real time field data collection

Database/Services from other Inline Departments

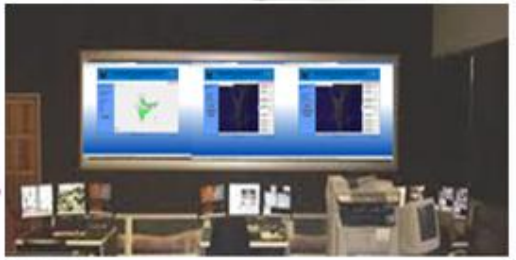
Ministry of Home Affairs

INDIAN RAILWAY



Centralized Control Room

*IP Packet decryptio Planned***



Mobile Control Room

Emergency Communication

Several Types of Emergency communication are in place use to meet critical requirements.

MSS TYPE-D Terminals – Satellite Phones

- Portable satellite phones for emergency communication – between terminals and terminals to PSTN

Distress Alert Terminals (DAT) for fishermen

- Floatable terminals which transmits messages while a boat is in danger.
- 1850 DATs provided to fishermen - India Coast Guard.

DTH based Disaster Warning Dissemination System

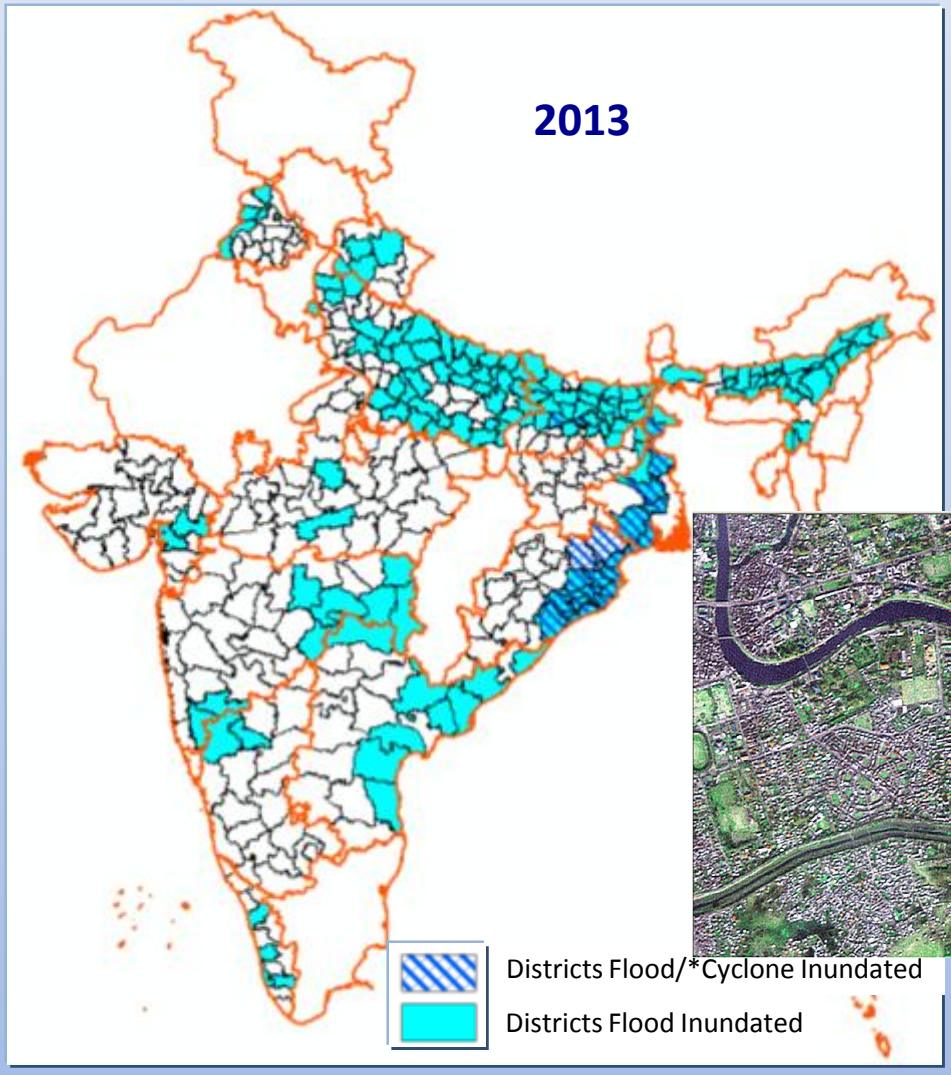
- Disaster alerts through Set-top-Boxes
- 500 DDWS systems - IMD and Doordarshan

Disaster Management Support
Floods

- **Response**
  - Inundated Area, Districts & Villages submerged.
  - Frequency – 5-day, 2-day, Daily, 12-hrly, thrice a day – depending on coverage & based on severity
  - Damage to structures – Uttarakhand Floods (2013), J&K floods (2014)
- **Early Warning**
  - Info. on discharge, likely submergence (fr rainfall), water levels / discharge parameters
- **Mitigation**
  - Villages frequently flooded - Historical satellite
  - Flood Prone Areas -Historic flood inundation (10-15 yrs)
- **Information Dissemination**
  - Central & State Disaster Management Authorities – Near real-time
  - Information on Public domain through Bhuvan Platform

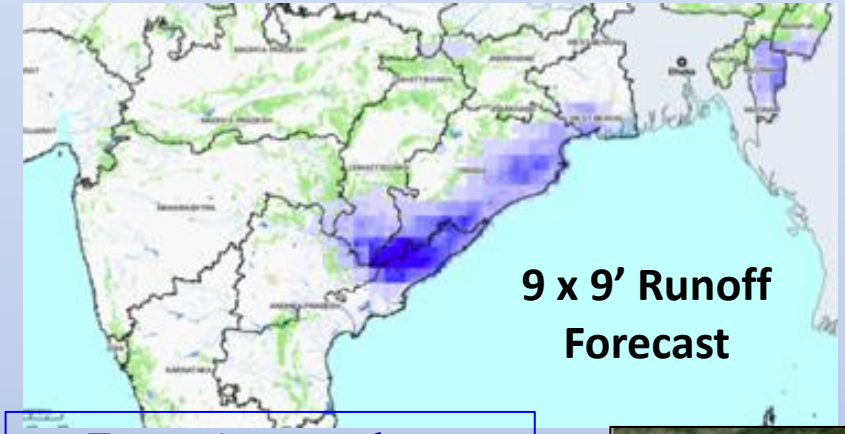
DISASTER RESPONSE

Major Floods & Cyclones

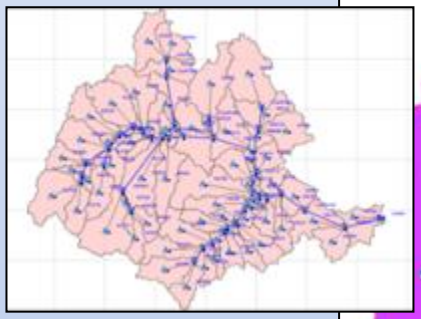


Flood Forecast & Stream-flow simulation

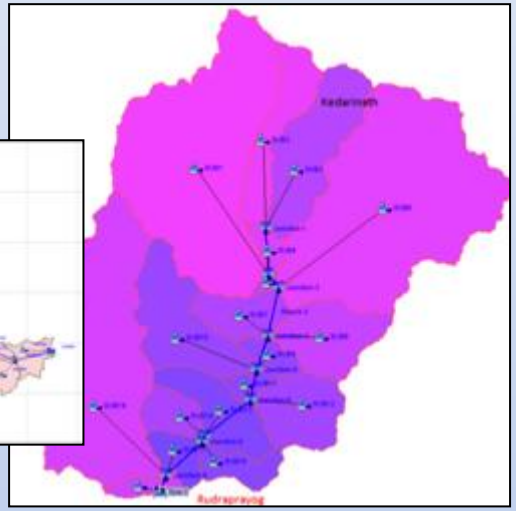
Flood forecast and simulations models are used in recent events – Preparatory phase



9 x 9' Runoff Forecast

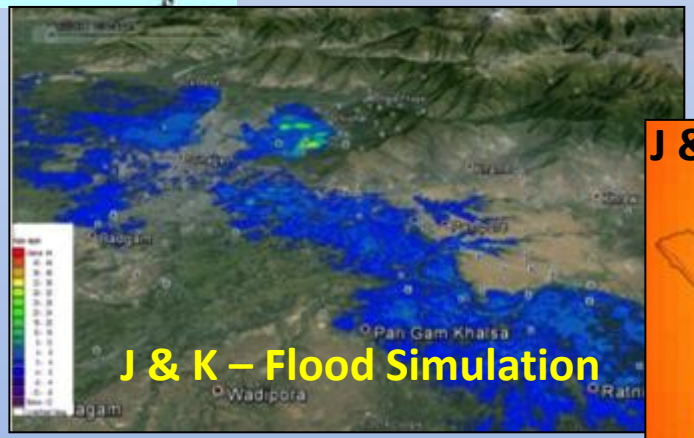


Mahanadhi

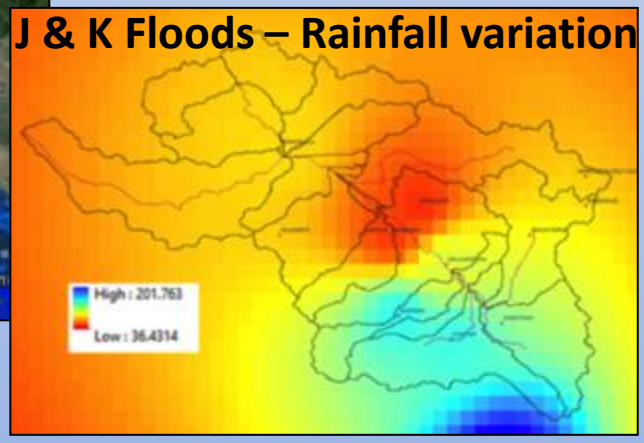


Mandakani, Uttarakhand

- Experimental Surface and River Runoff forecast for Nagavali & Vamsadhara rivers



J & K – Flood Simulation

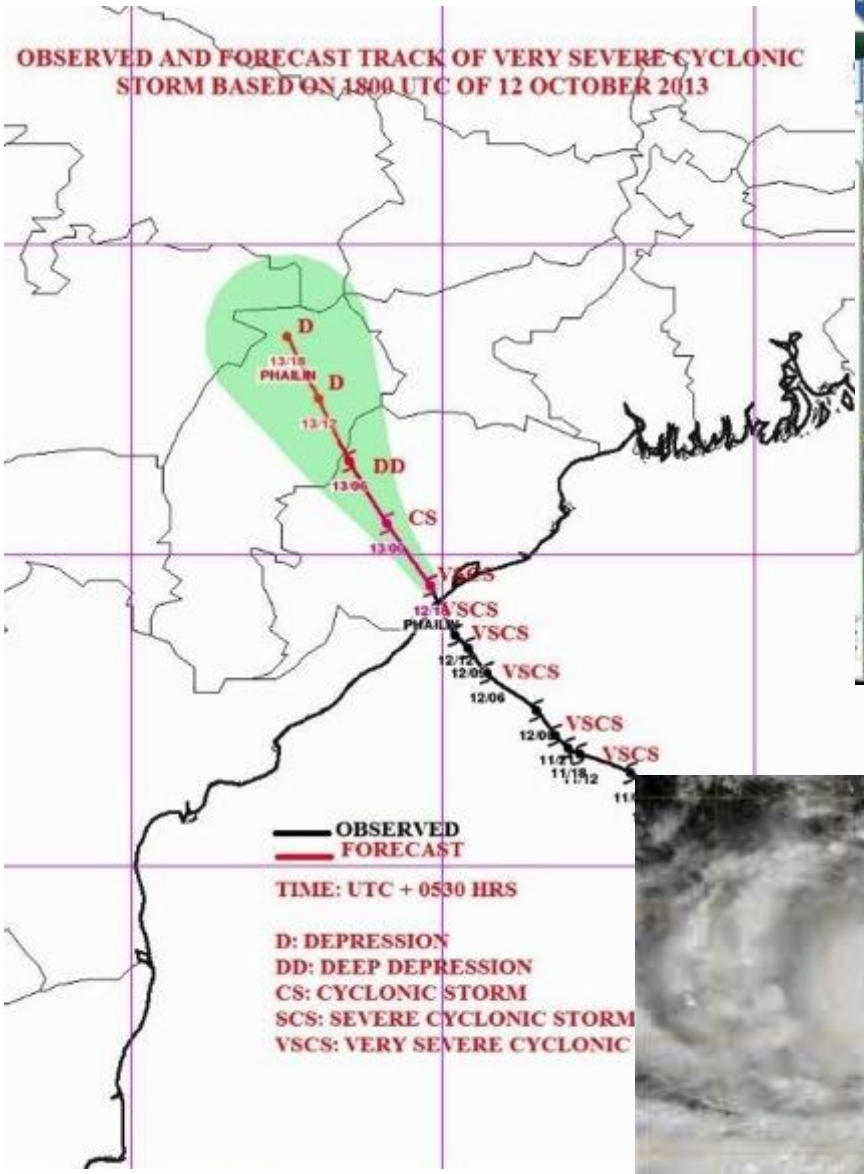


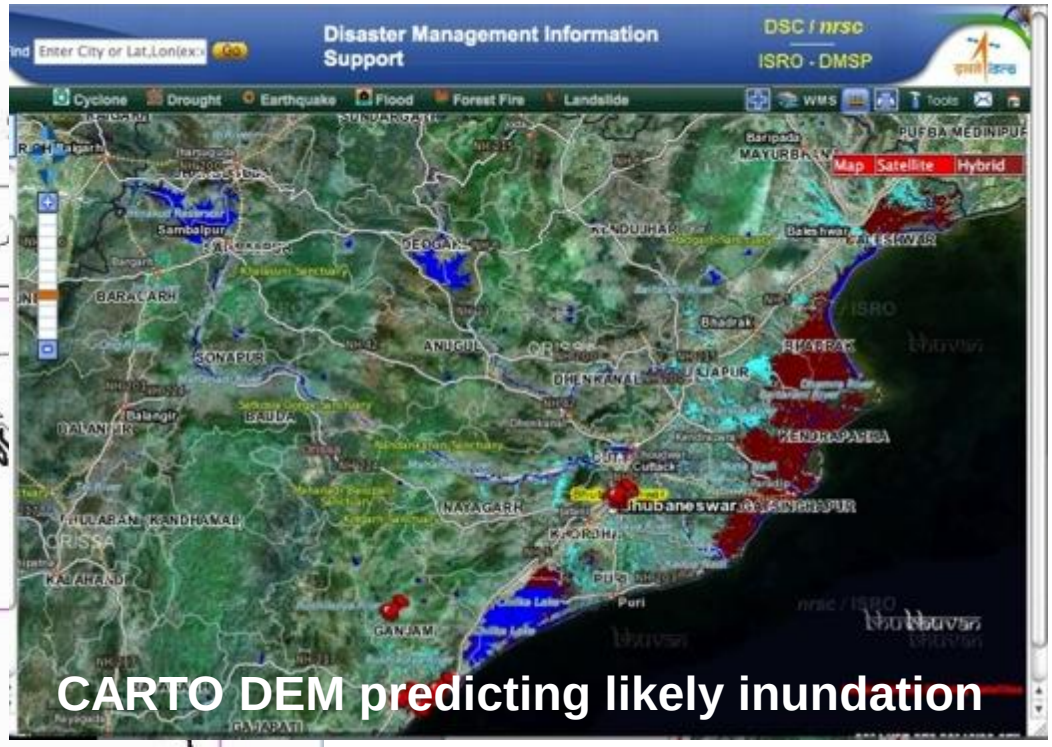
J & K Floods – Rainfall variation

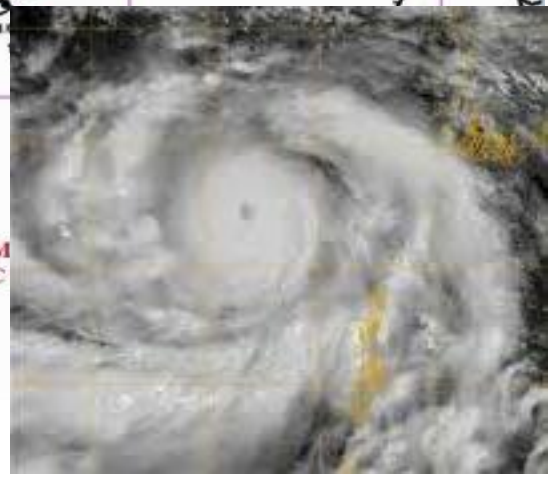
Disaster Management Support
Cyclones

- **Response**
  - Inundated Area - Blocks, Villages submerged
  - Frequency: Continuous Tracking; inundation: 5-day, 2-day, Daily, 12-hrly (thrice a day depending on satellite coverage)
- **Preparedness**
  - Probable inundations - historic satellite observations
    Cyclone Phailin (2013), Cyclone Hudhud (2014)
- **Mitigation**
  - Historic inundations DB due to cyclones in the country (last 10-15 years).
- **Information Dissemination**
  - MHA, NDMA, State Disaster Management Dept, CWC, IMD, and public domain

Cyclone Phailin – online Flood inundation maps

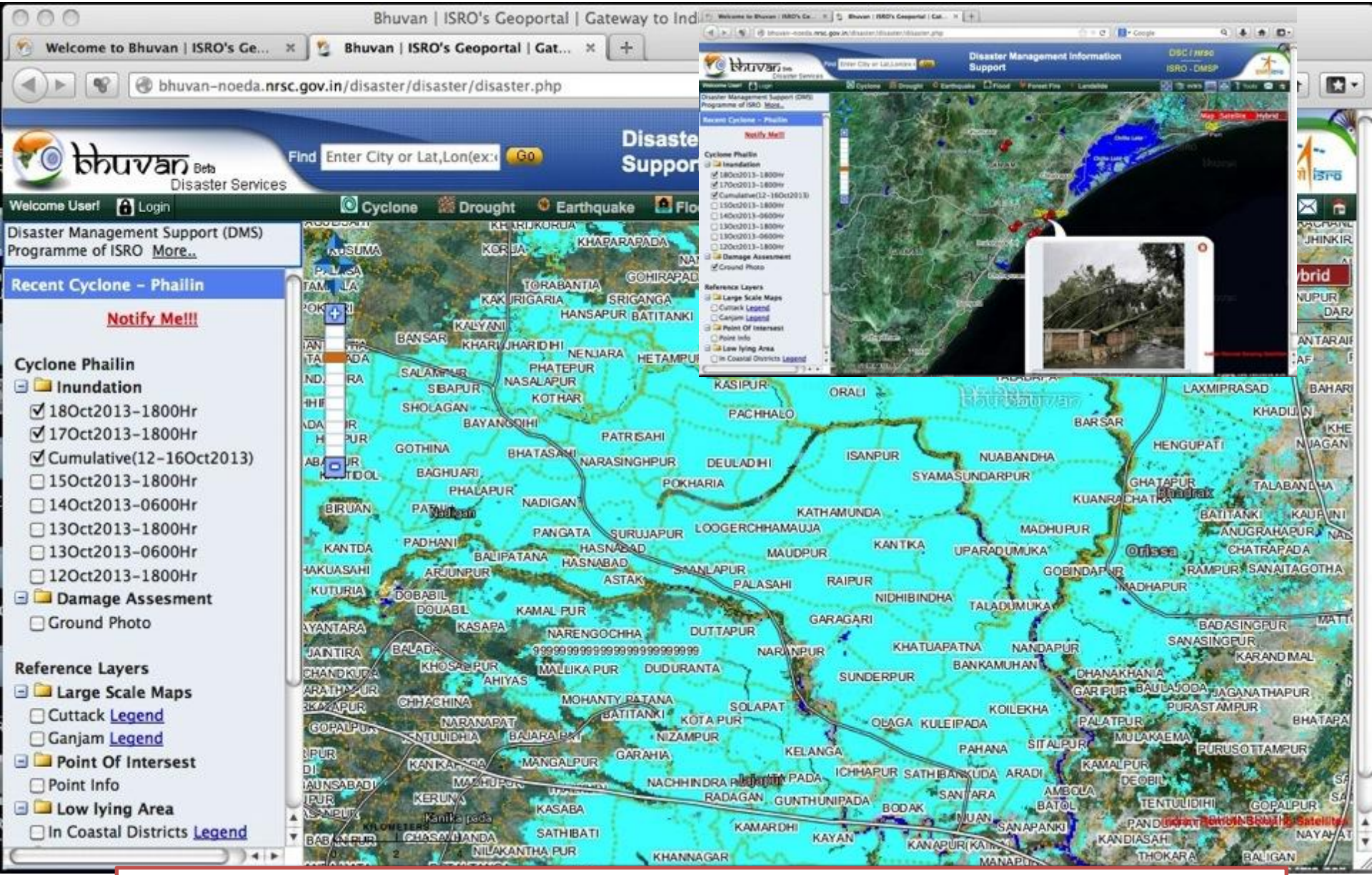






Near real time mapping from RISAT-1 and IRS Optical images for flood inundation

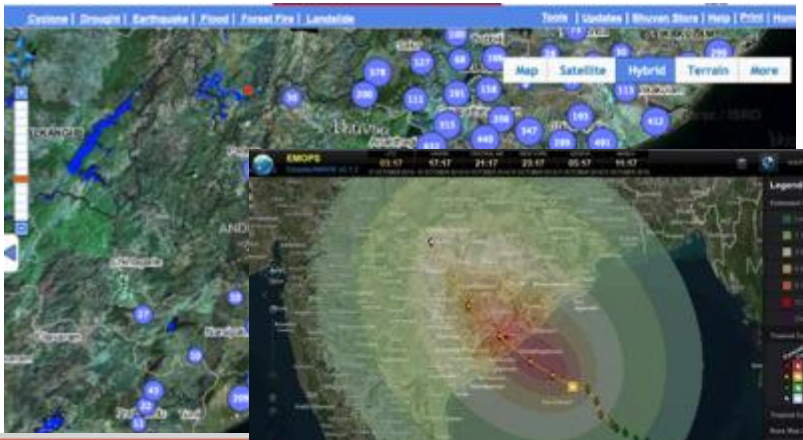
Phailin Cyclone – Info at Village level



Mobile smart phone based Crowd-sourcing data as field data

HudHud Cyclone

- **EO based monitoring, Geospatial, UAV, I T and Crowd-Sourcing tools**



bhuvan
Gateway to Indian Earth Observation

Disaster Services(NDEM Public)

Hudhud Cyclone Android App Download

Enter City or Lat,Lon(ex:chennai

Cyclone | Drought | Earthquake | Flood | Forest Fire | Landslide

Tools | Updates | Bhuvan Store | Help | Print | Home

Cyclone

Cyclone NILOFER

Cyclone HUDHUD

Track

Quick Mobile Survey

Damaged

Feature

All

Remove

Total No of Points Found:24792

- Crop Damage
- Drinking Water/RWS
- House Damage
- Livestock/Fisheries
- Other Building Damage
- People Marooned/Require Relief
- Power
- Tanks/Canal Breach
- Tree Fallen
- Telecom
- Road

Support for International Disasters

Map | Satellite | Hybrid | Terrain | More

Pusapatirega

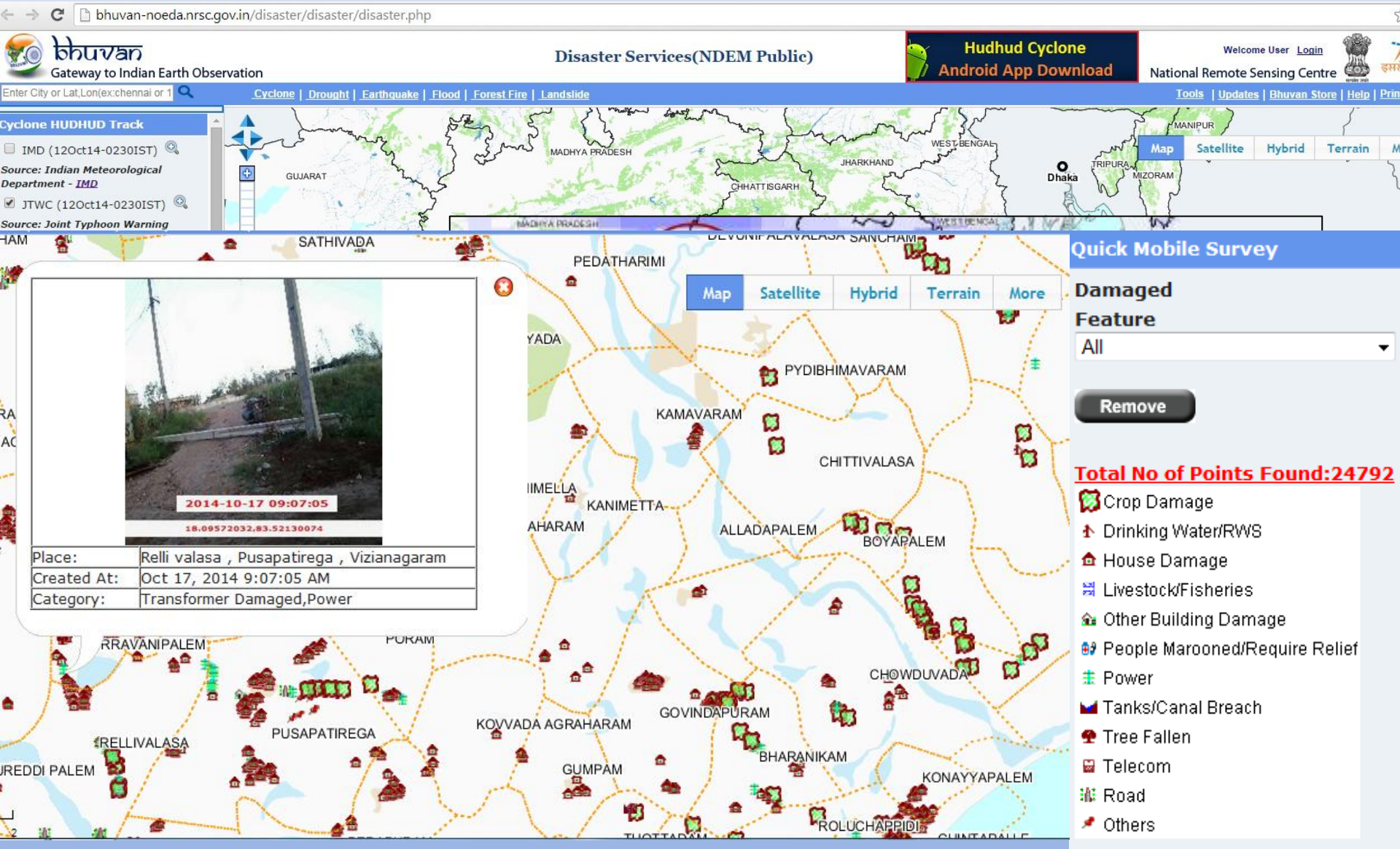
Bheemunipatnam

Place:	Ragumanda , Denkada , Vizianagaram
Created At:	Oct 20, 2014 8:32:19 PM
Category:	Kuccha_Parially Damaged,House Damage

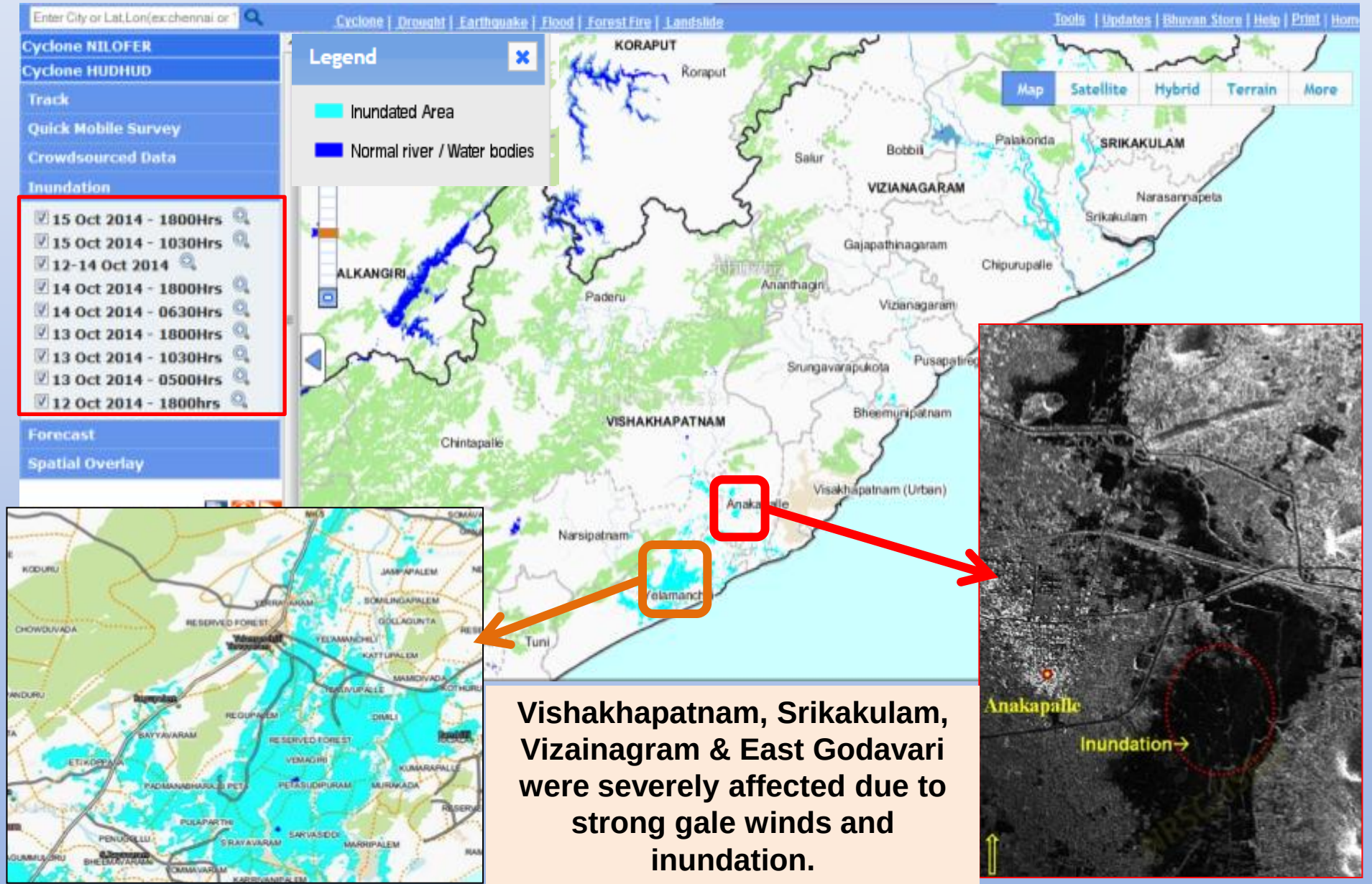
nrsc / ISRO

Indian Remote Sensing Satellites

Cyclone HUDHUD – Tracking and Online support



Cyclone HUDHUD – Inundation Monitoring



Vishakhapatnam, Srikakulam, Vizainagram & East Godavari were severely affected due to strong gale winds and inundation.

Cyclone HUDHUD- Crowd Sourcing

Public)

Android App Download

National Remote Sensing

Crowd sourcing enabled to collect information from ground.

Place:	Tattaband , Ravikamatham , Visakhapatnam
Created At:	Oct 16, 2014 1:14:50 PM
Category:	Pole Fallen,Power

Place:	Turakalapudi , Butchayyapeta , Visakhapatnam
Created At:	Oct 16, 2014 8:36:59 PM
Category:	Pole Fallen,Power

Place:	Peda madina , Butchayyapeta , Visakhapatnam
Created At:	Oct 16, 2014 8:33:08 PM
Category:	Transformer Damaged,Power

Total No of Points Found:25665

- Crop Damage
- Drinking Water/RWS
- House Damage
- Livestock/Fisheries
- Other Building Damage
- People Marooned/Require Rel
- Power
- Tanks/Canal Breach
- Tree Fallen
- Telecom
- Road
- Others

Crowdsourced Data

Inundation

Forecast

Map | Satellite | Hybri

KORAPUT

ANAGARAM

18339

3553

VISHAKHAPATNAM

3311

462

ST GODAVARI

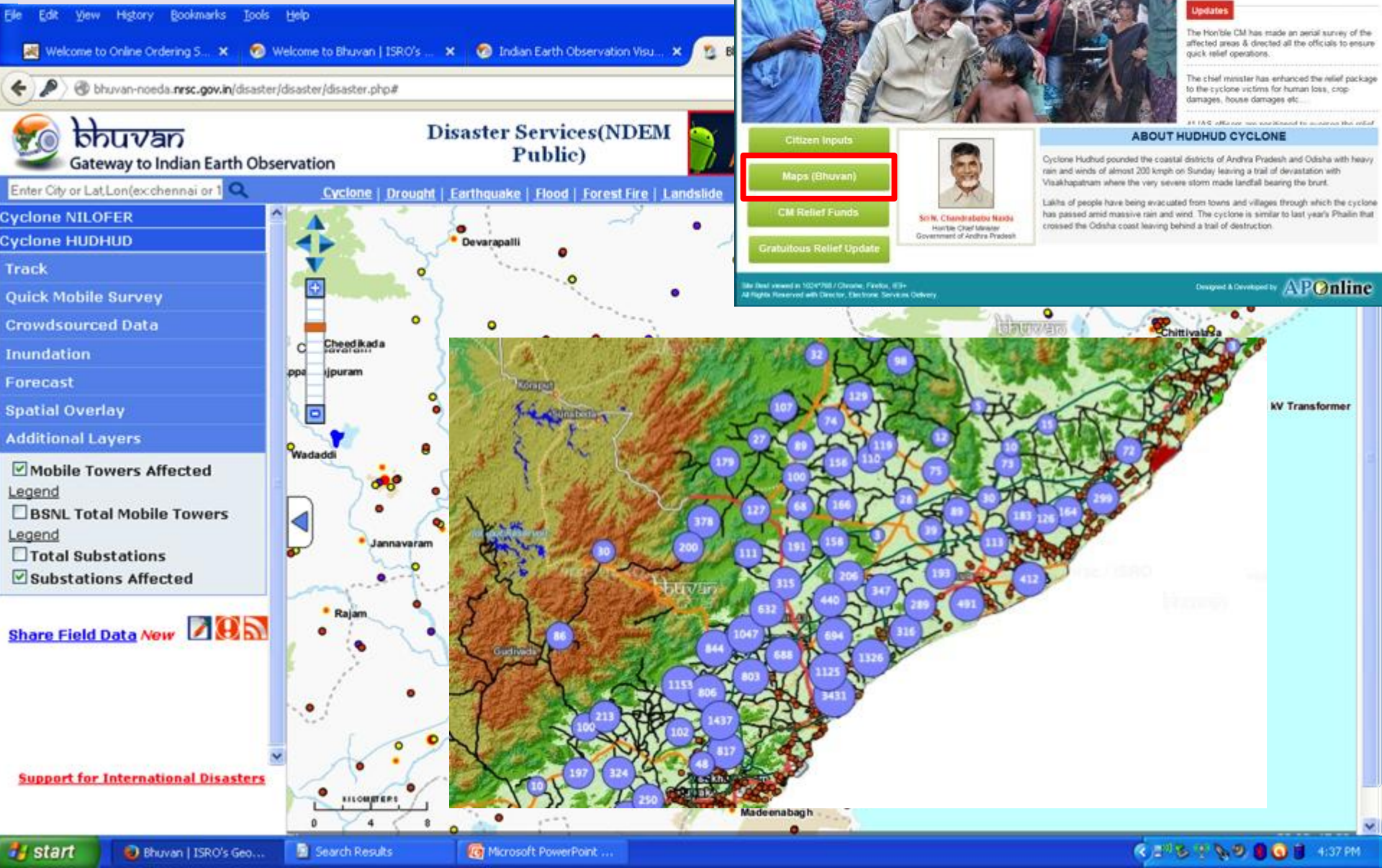
YANAM

More than 25,000 Field data + photos uploaded onto Bhuvan in just 3 days

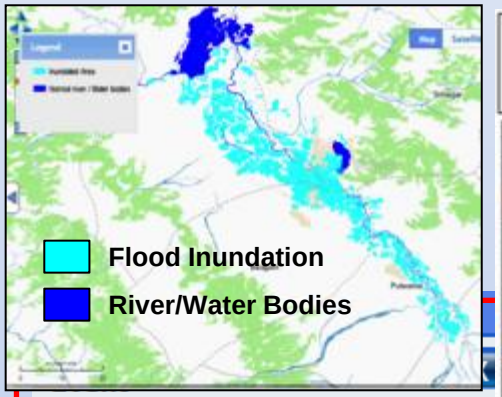
Support for International Disasters

House Damage-17192; Tree fallen-1031; Power-1636; ; Road-1078; Tank/Canal Breach-137

Disaster Management Supp



Himalayan Disasters: J&K – Sep, 2014



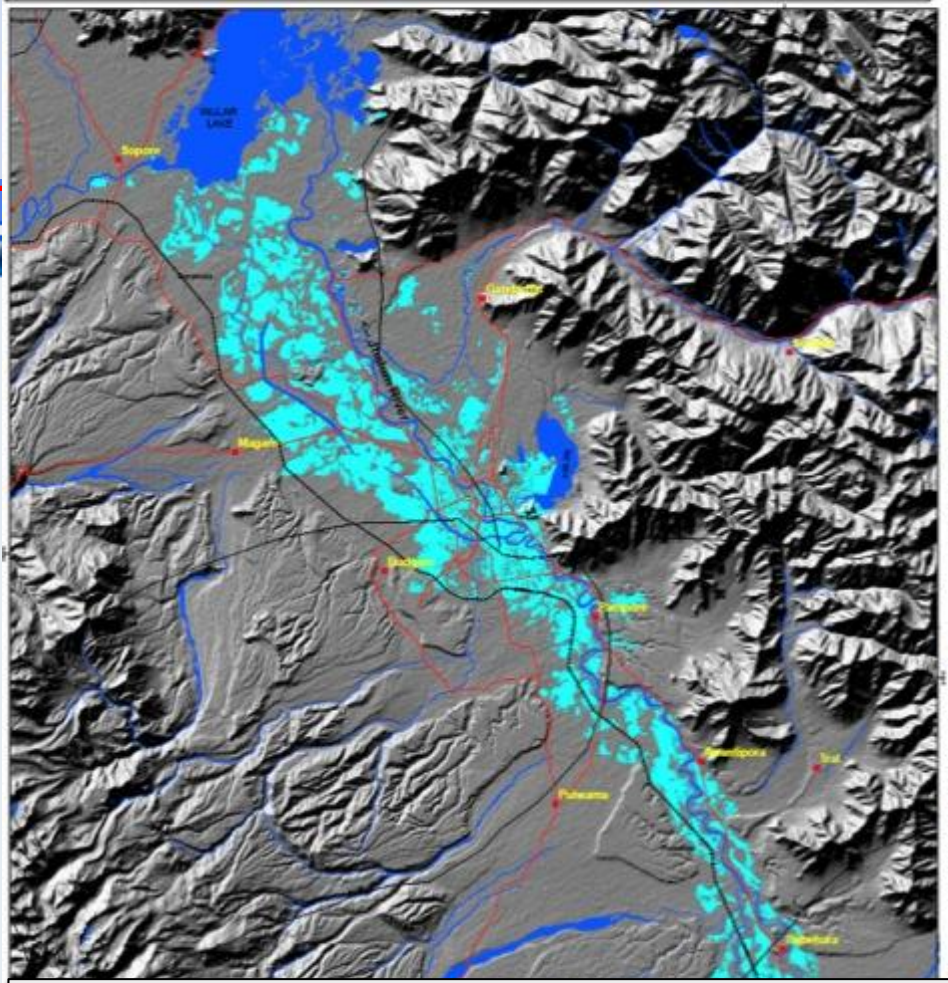
Jammu and Kashmir - 2014

Flood Layers New

- 23/09/2014
- 22/09/2014
- 08-21/09/2014
- 21/09/2014
- 20/09/2014
- 19/09/2014
- 17/09/2014-06Hr
- 08-15/09/2014
- 15/09/2014
- 08-12/09/2014
- 10-12/09/2014
- 12/09/2014
- Cumulative 8-10th Sept
- 10/09/2014
- 09/09/2014
- Progression 8-9th Sept
- 08/09/2014-06Hr

Cumulative Flood Inundated Area in part of Jammu & Kashmir State

Based on the analysis of RISAT, Cartosat, Resourcesat & RADARSAT data of 08, 09, 10, 12, 15, 17, 19 ,20 & 21 -September-2014

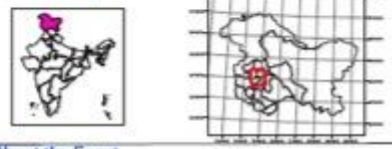


For official use

DISASTER EVENT ID: 11-FLD-2014-JK
MAP ID: 2014/46

Date of Issue : 21.9.2014

Location Map



About the Event

Severe floods were reported in Jammu & Kashmir during first week of September, 2014 Heavy rains coupled with rise in the water levels of Jhelum river had led to flooding in the districts of Anantnag, Pulwama, Badgam, Baramula & Srinagar.

(Source: New media).

Satellite Observations

This map highlights the cumulative flood inundation observed as on 08, 09,10, 12, 15, 17, 19,20 & 21 September-2014 in parts of Jammu & Kashmir.

Satellite data used

Pre Flood:
Satellite:RISAT-1
Sensor: SAR
Date of Pass:
14-Aug-2014

Post Flood:
RISAT-1 data of 08-September-2014
RISAT-1 data of 09-September-2014
Cartosat data of 09-September-2014
Radarsat-2 data of 10-September-2014
RISAT-1 data of 10-September-2014
RISAT-1 data of 12-September-2014
Radarsat-2 data of 15-September-2014
RISAT-1 data of 17-September-2014
Resourcesat data of 19-September-2014
RISAT-1 data of 20-September-2014
RISAT-1 data of 21-September-2014

Other data used

NRC Landuse/Landcover Data of 2008-09
Bckground data : Shaded Relief

Legend

0 2.25 4.5 9
Kilometers

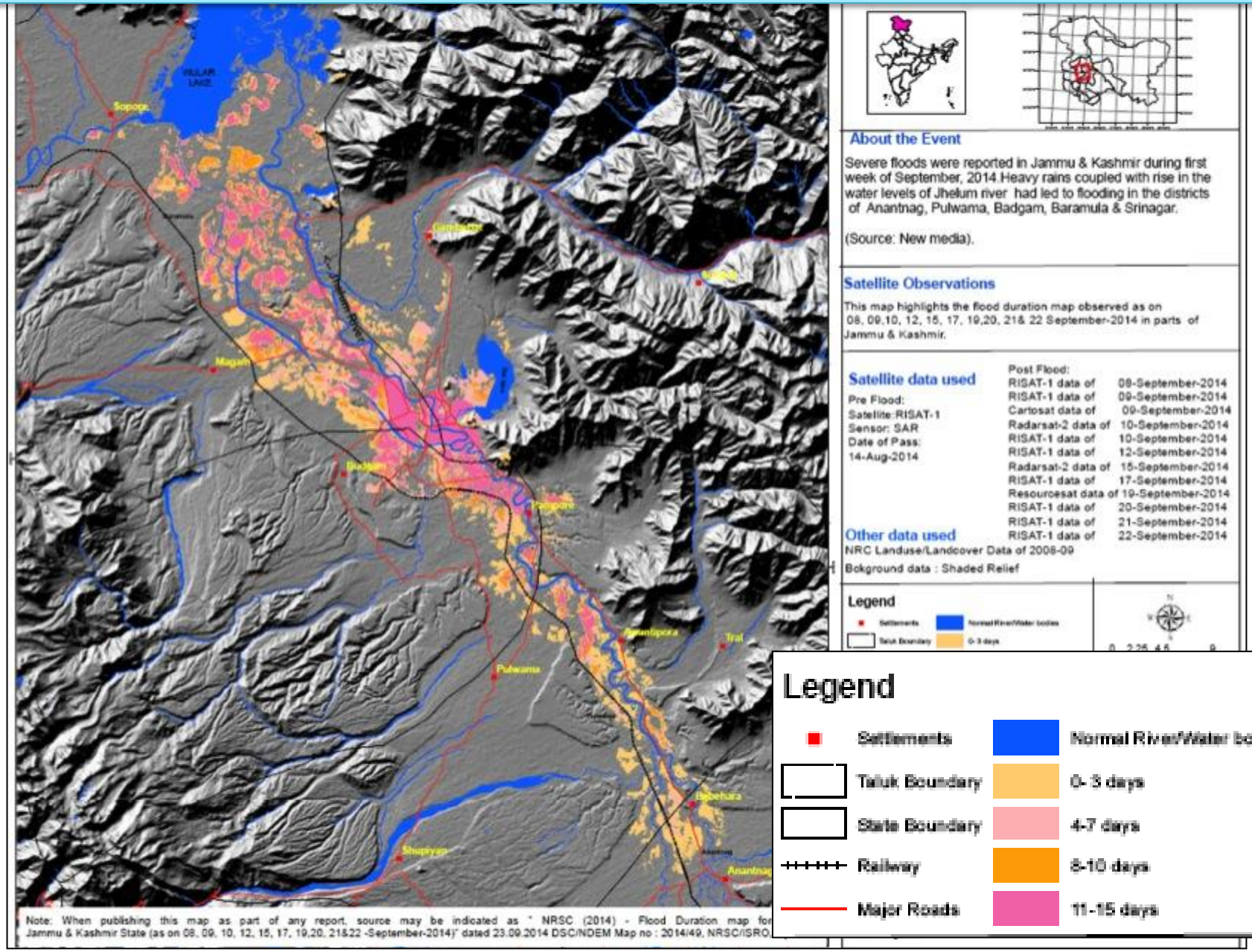
This product is prepared on rapid mapping mode for immediate use and sharing amongst official agencies. This provides preliminary results.

Flood inundation may include rain water accumulation / flood water in low lying areas.

All geographic information has limitations due to the scale, resolution, date

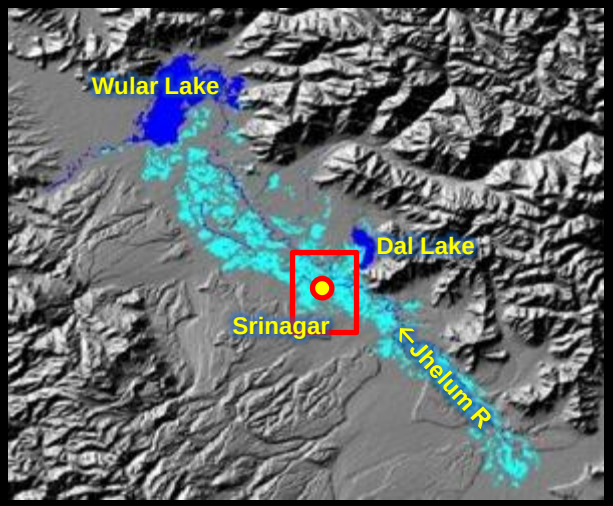
50 Flood inundation maps disseminated in near real time to MHA, NDMA, Govt. of J&K to help in relief and rescue operations.

Flood Duration Maps as a part of continuous monitoring



J&K Floods – Timeseries Analysis

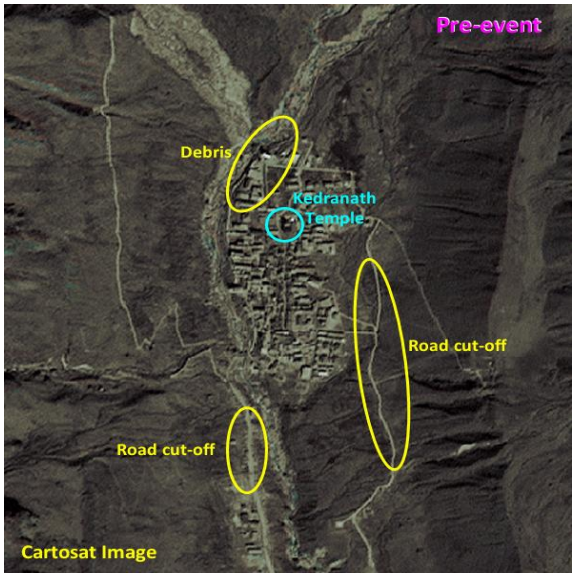
- Extreme Flooding event
- Severe flood in last 60 years
- Near real-time Info. On Bhuvan

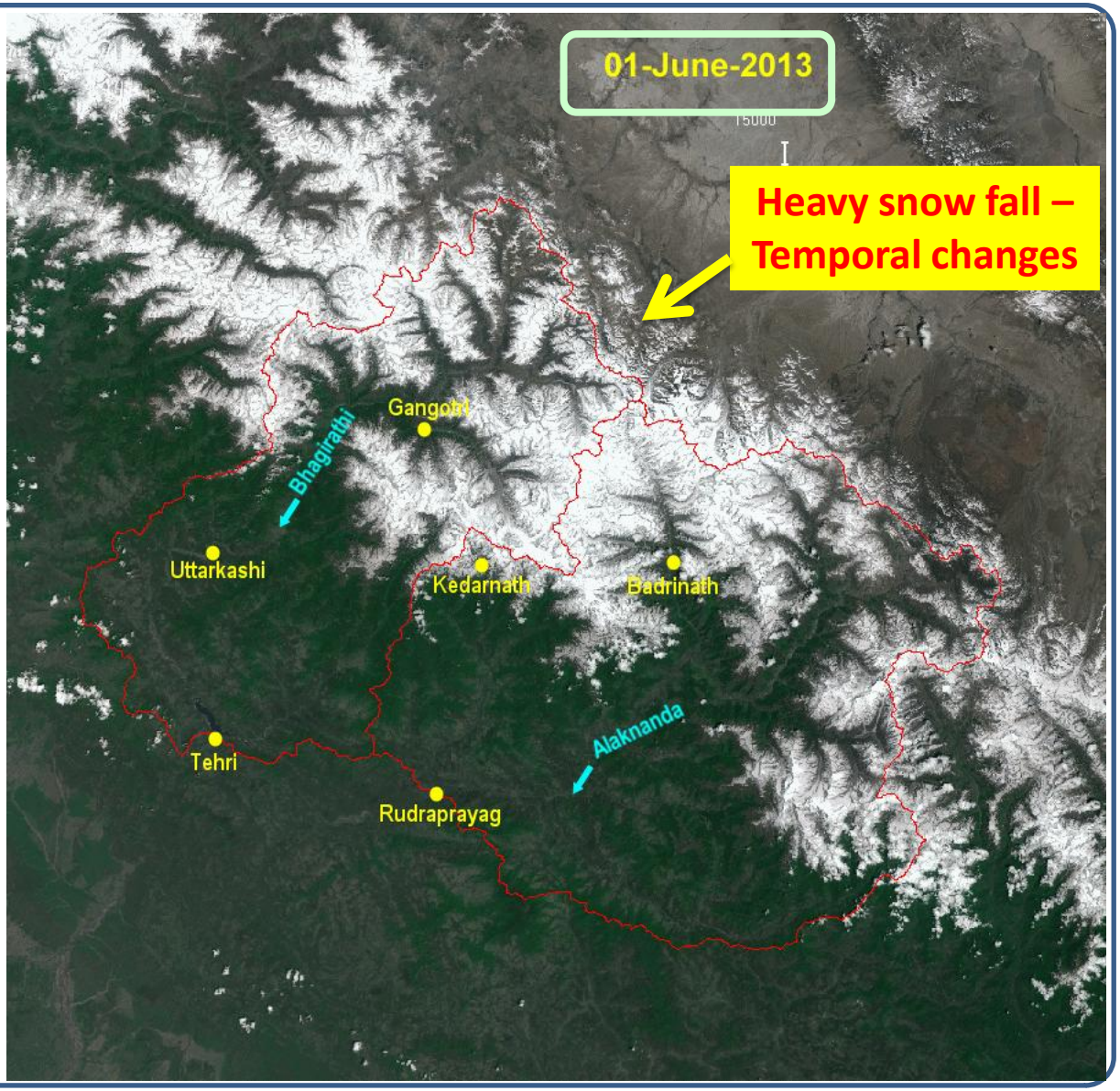


Uttarakhand Disaster – July 2013

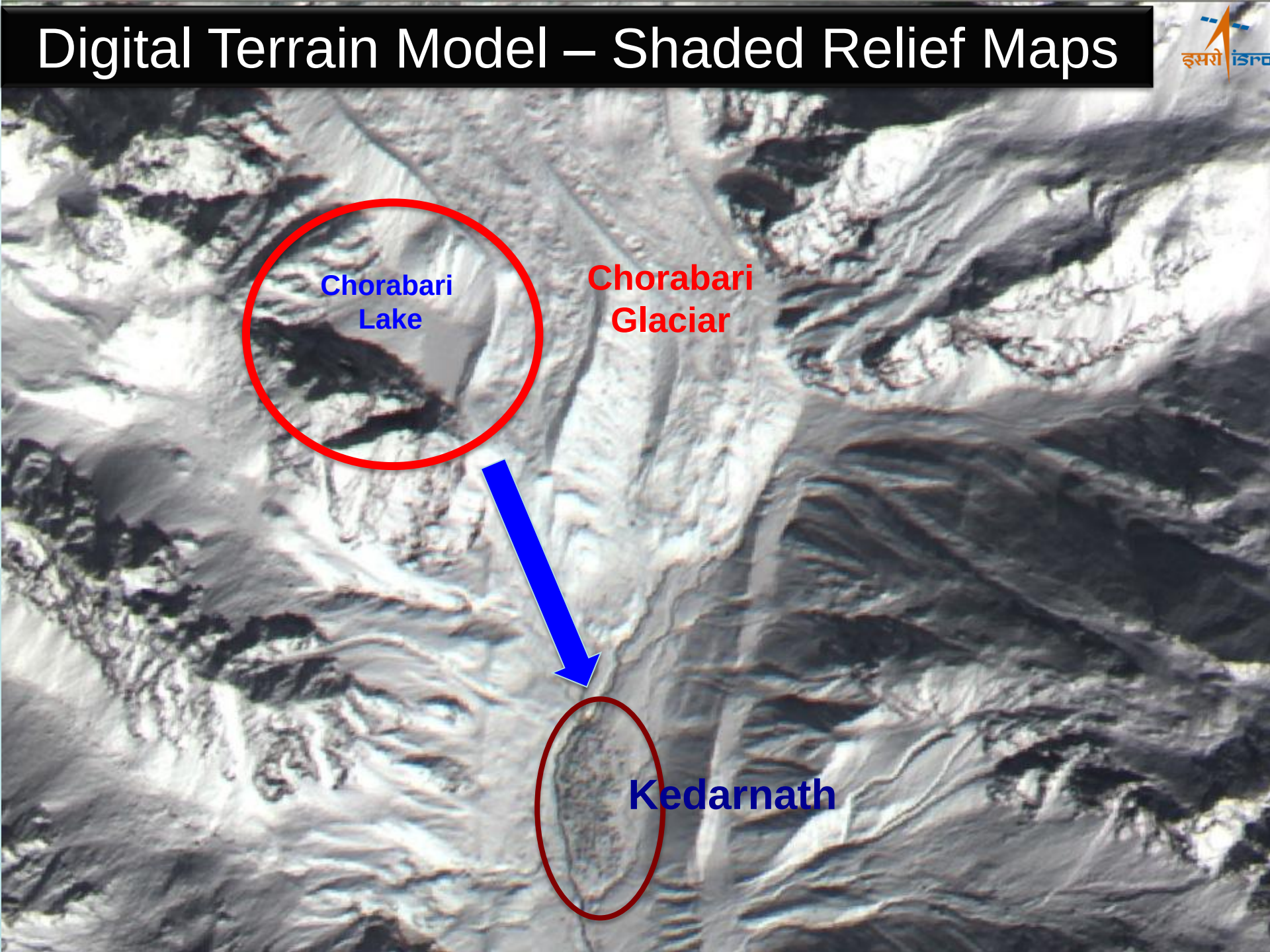
Heavy Snowfall in upper reaches

- Heavy railfall during 15 - 17th June, 2013 in the region, associated with heavy snowfall in upper reaches
- Sudden increase in snow cover area in Bhagirathi, Alaknanda & Yamuna basins - images of Resourcesat-2 AWiFS



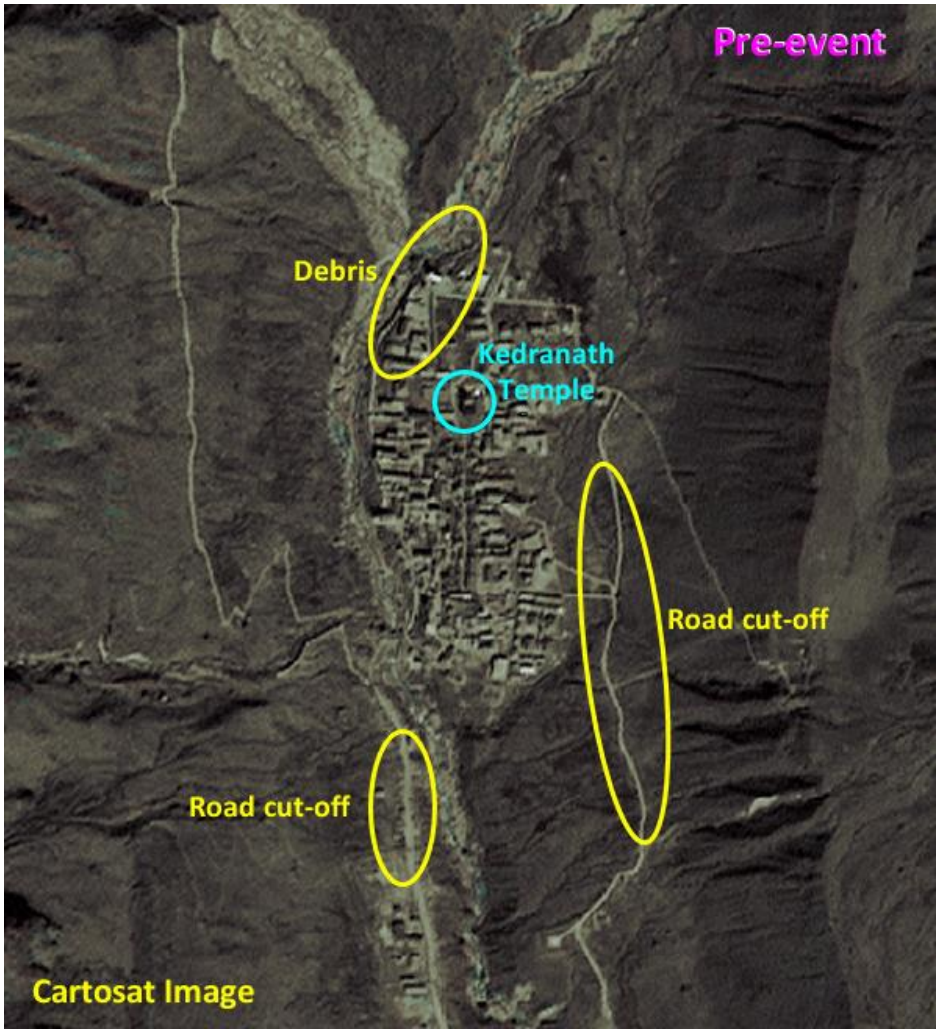


Digital Terrain Model – Shaded Relief Maps

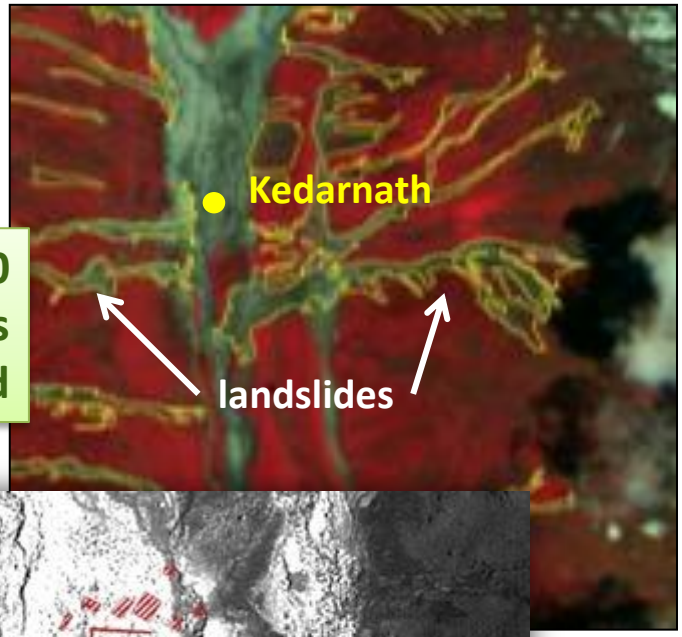


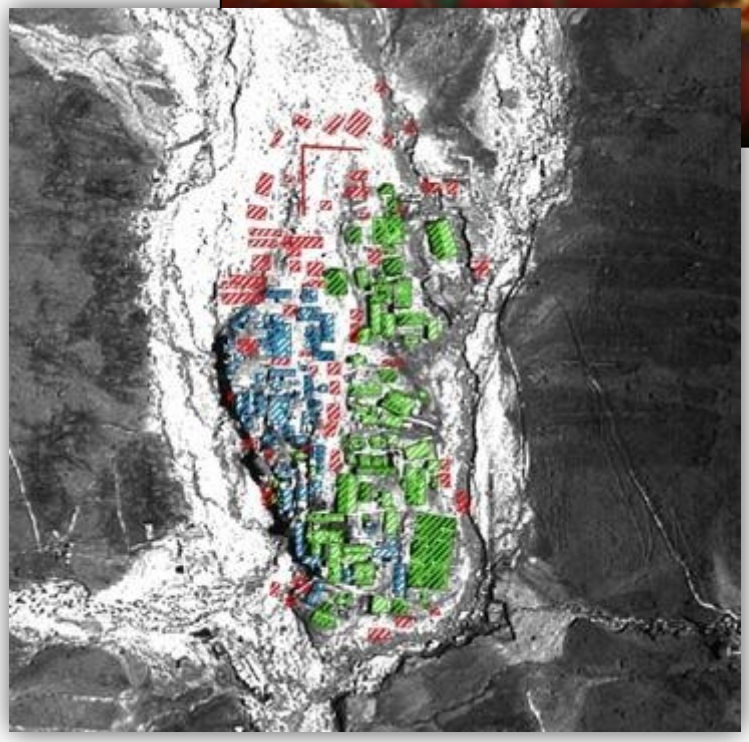
Damage Assessment – GIS analysis

- Inundation, Damage, Landslides
- *Near real-time* info on Bhuvan Portal



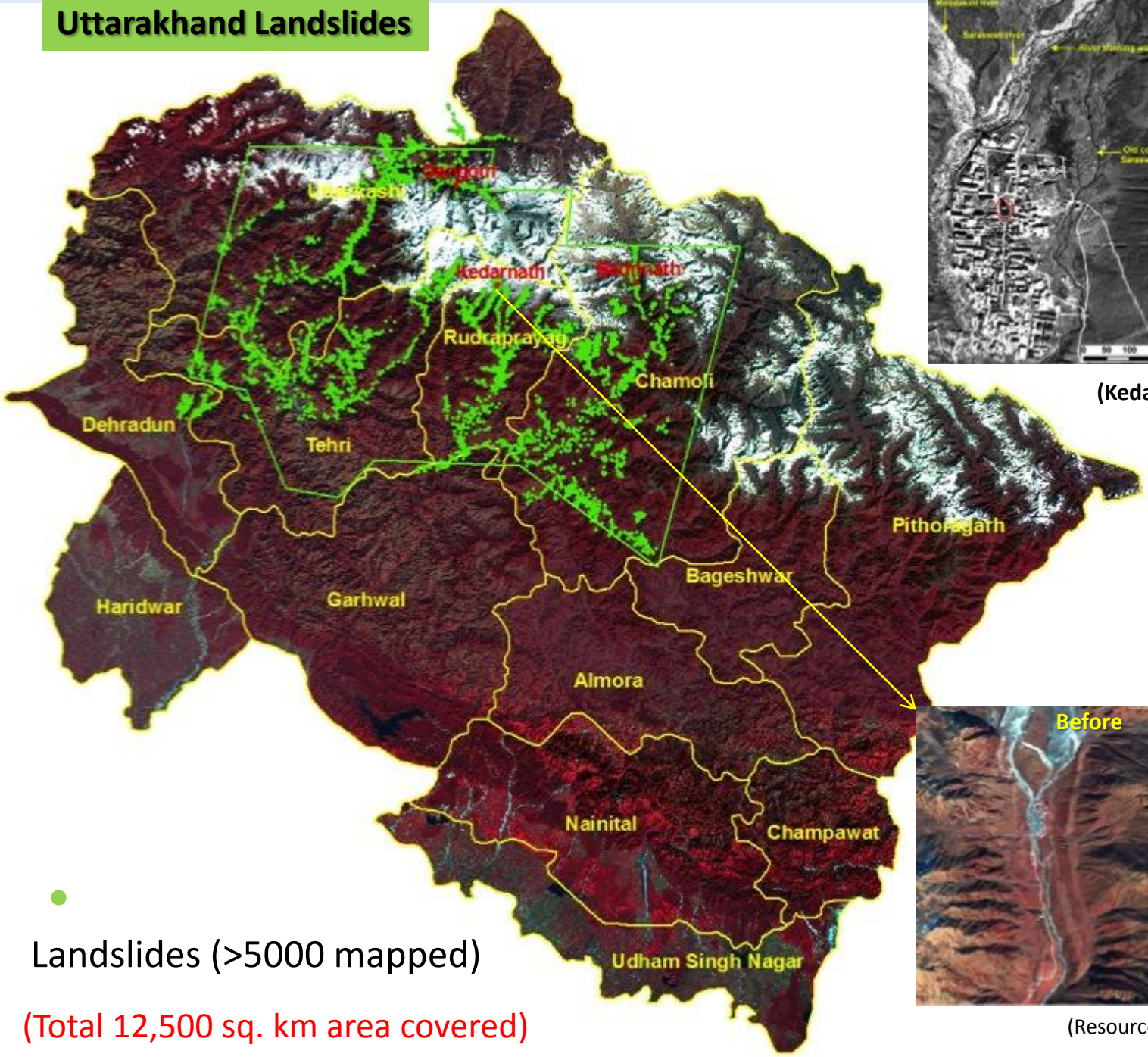
> 5000 landslides mapped

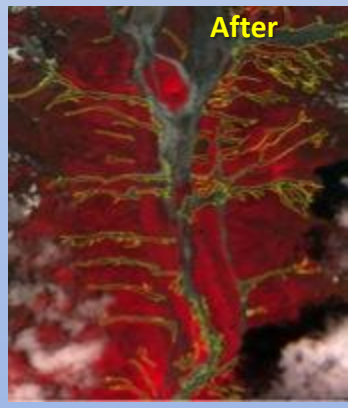




Uttarakhand Landslides

(Kedarnath town)





(Resourcesat-2 LISS IVMx)

- Landslides (>5000 mapped)

(Total 12,500 sq. km area covered)

Map the Neighbourhood in Uttarakhand (MANU)
Mobile SmartPhones for Crowd-Sourcing

- Damage Assessment through online field data uplink
- Active Participation of Student Community
- Simple Android Smart phone Utility + GAGAN usage
- Visualization on Bhuvan GeoPortal

Mapping the Neighbourhood in Uttarakhand (MANU)

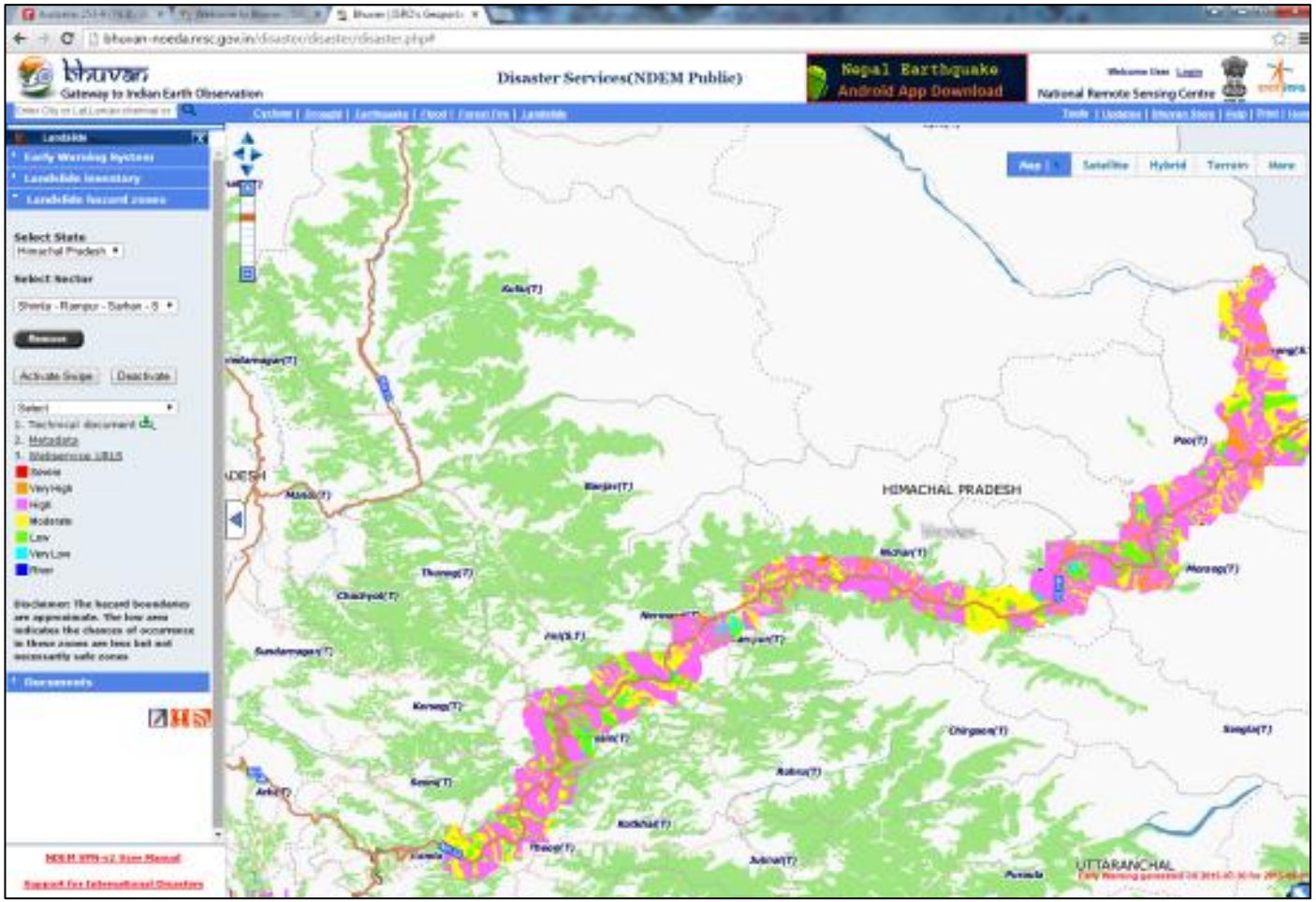
1 2

Sl.No	8400
themename:	MANU
profilename:	BhuvanPOI
observername:	ajay vipin shyam
org:	nrsc
creationtime:	2013-10-23 11:29:58
Ponit of Interest Category:	Guest House
About POI:	bharat seva asharam totaly diartroyed by flood

1 2

Sl.No	8406
themename:	MANU
profilename:	RiverBankErosion
observername:	ajay vipin shyam
org:	nrsc
creationtime:	2013-10-23 12:55:36
Longitude (GAGAN):	79.067920
Latitude (GAGAN):	30.735302
Village Name:	kedarnath
Tehsil Name:	ukhimath
River or Stream Name:	mandakini river
Affected Feature:	Settlement,
Type of Erosion:	Toe
Direction of Bank or River:	Left
Remarks:	distroyed after flooding flood makes tributary whch suppose to damaged this lodge

Landslide Hazard Zonation Maps



Uttarakhand

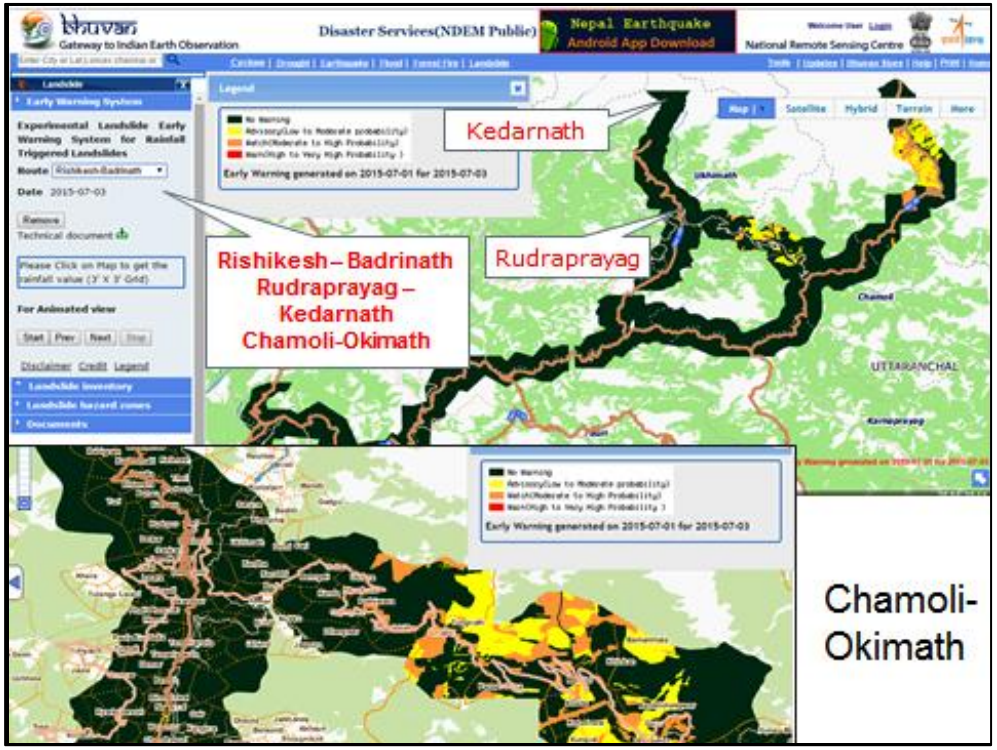
- Rishikesh-Uttarkashi-Gangotri-Gaumukh
- Rudraprayag-Okhimath-Kedarnath
- Rishikesh-Rudraprayag-Chamili-Badrinath
- Pithoragarh-Khela-Malpa

Himachal Pradesh

- Chamoli-Usara-Okhimath
- Dalhousie-Chamba-Brahmaur
- Shimla-Rampur-Sarhan-Sumdo
- Shimla-Bilaspur-Kulu-Manali

Landslides - Early warning system

- Spatial (geology, morphology & terrain), temporal triggering factors & controls of slope failure
- Rainfall (a trigger) for slope failure initiation
- Logistic Regression model using long term data on rainfall-landslide initiation



Rishikesh-Badrinath-Rudraprayag-Kedarnath-Chamoli-Okimath area.

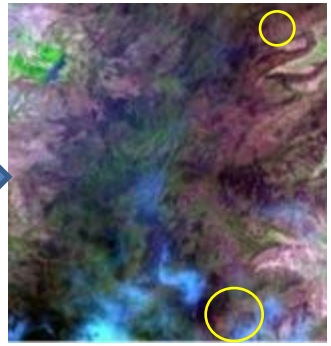
Forest Fire Alerts

Daily acquisition of TERRA/AQUA MODIS data

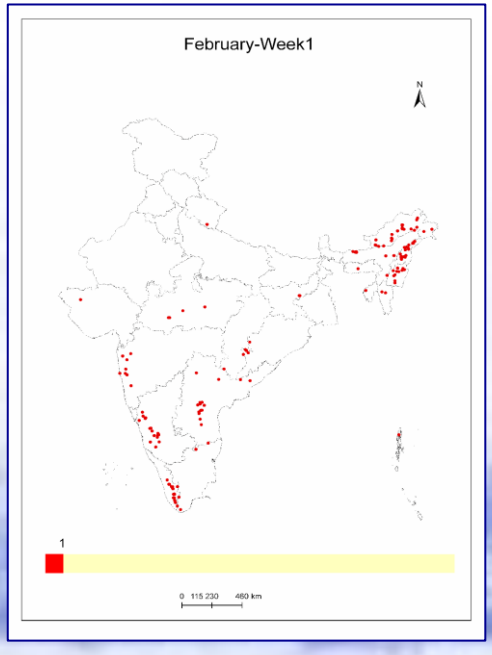
~4 daytime passes per day

Generation of 2 daily Active Fire Alerts

Special contextual Fire Algorithm- Deployed



Value additions
•Forest Mask
•Forest Admin. overlay



Fire map Visualization through BHUVAN

Disaster Management Support Programme

Decision Support Center

Indian Forest Fire Response and Assessment System (INFFRAS)

Feedback

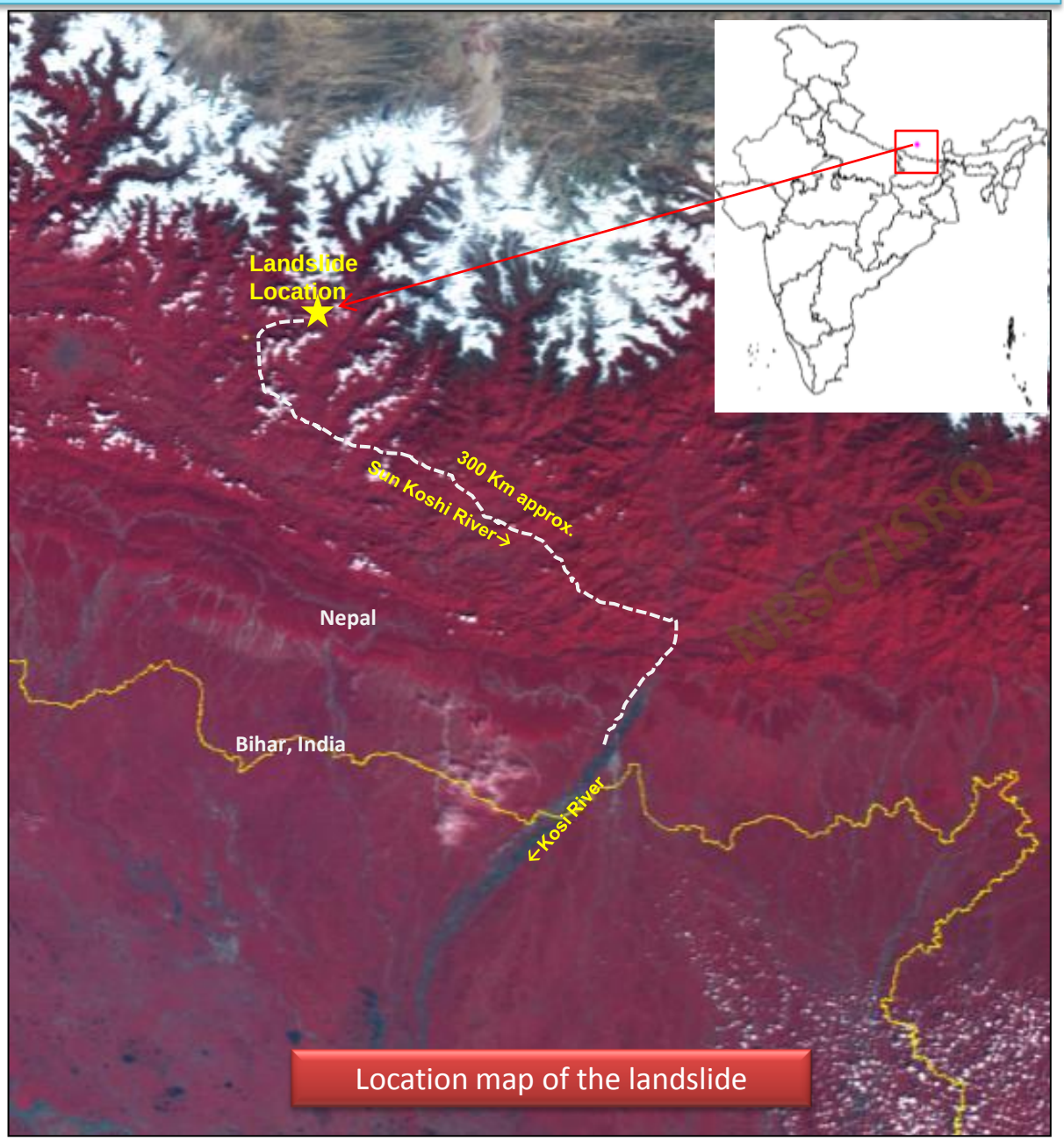
Information to ground personnel for fire mitigation

Email Dissemination to ~400 nodal officers

Turn-around time of less than 1 hr from satellite overpass

Nepal – Landslide on River Sun Koshi

- A massive landslide blocked Sun Koshi river in Northern Nepal on 02-Aug-2014
- Possible formation of a lake.
- Flood threat for several villages downstream in Bihar, India.



Location map of the landslide

Landslides on Transboundary Rivers

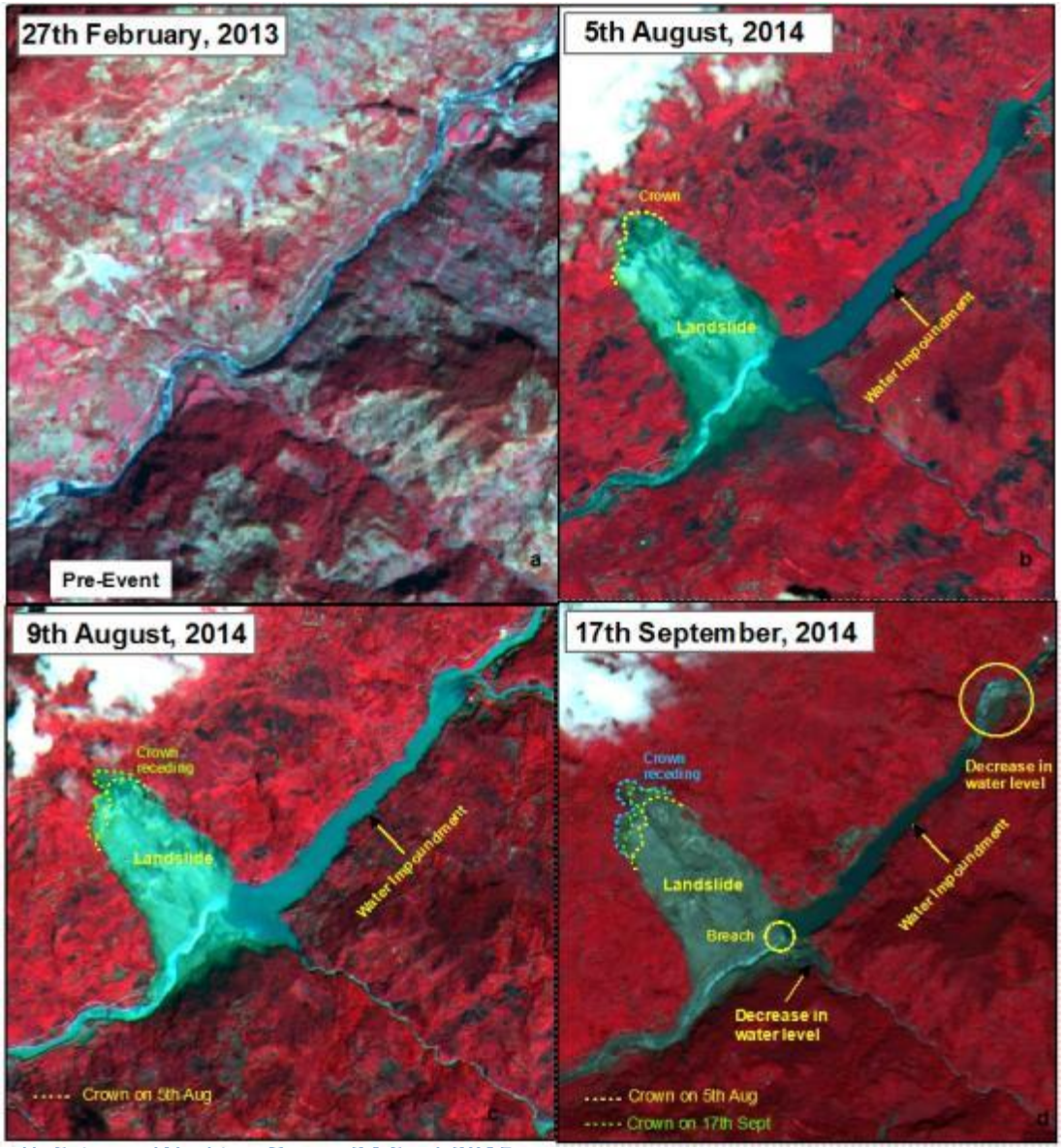
Sun Koshi River in Nepal

A landslide occurred on Sun Koshi river in Nepal on 2-Aug-14

Multi-temporal satellite data analysis shows the recession of the crown of the landslide

Water Impoundment was observed initially and in September, this impoundment was reduced due to human interventions through controlled blastings

Data helped Indian Govt. to work with Nepal Govt. in coordination/ avoiding major disaster in Bihar



Task No: NEPAL/LS/2014/01

Plate No: August/06

Landslide on Sunkoshi river, Nepal

(As seen from Resourcesat-2 LISS IV MX acquired on 5 Aug 2014)

- **The landslide that blocked the Sunkoshi river, is a deep seated rockslide (length 1.3 km and width 0.652 km) resulting in formation of a dammed lake**
- **The debris and boulders has blocked the river and moved onto the river terrace on the opposite bank.**
- **Analysis of historical imagery shows that it is an unstable zone with existence of small landslides.**

Landslide crown

Depletion zone

Depletion zone

Accumulation zone

Landslide dammed lake

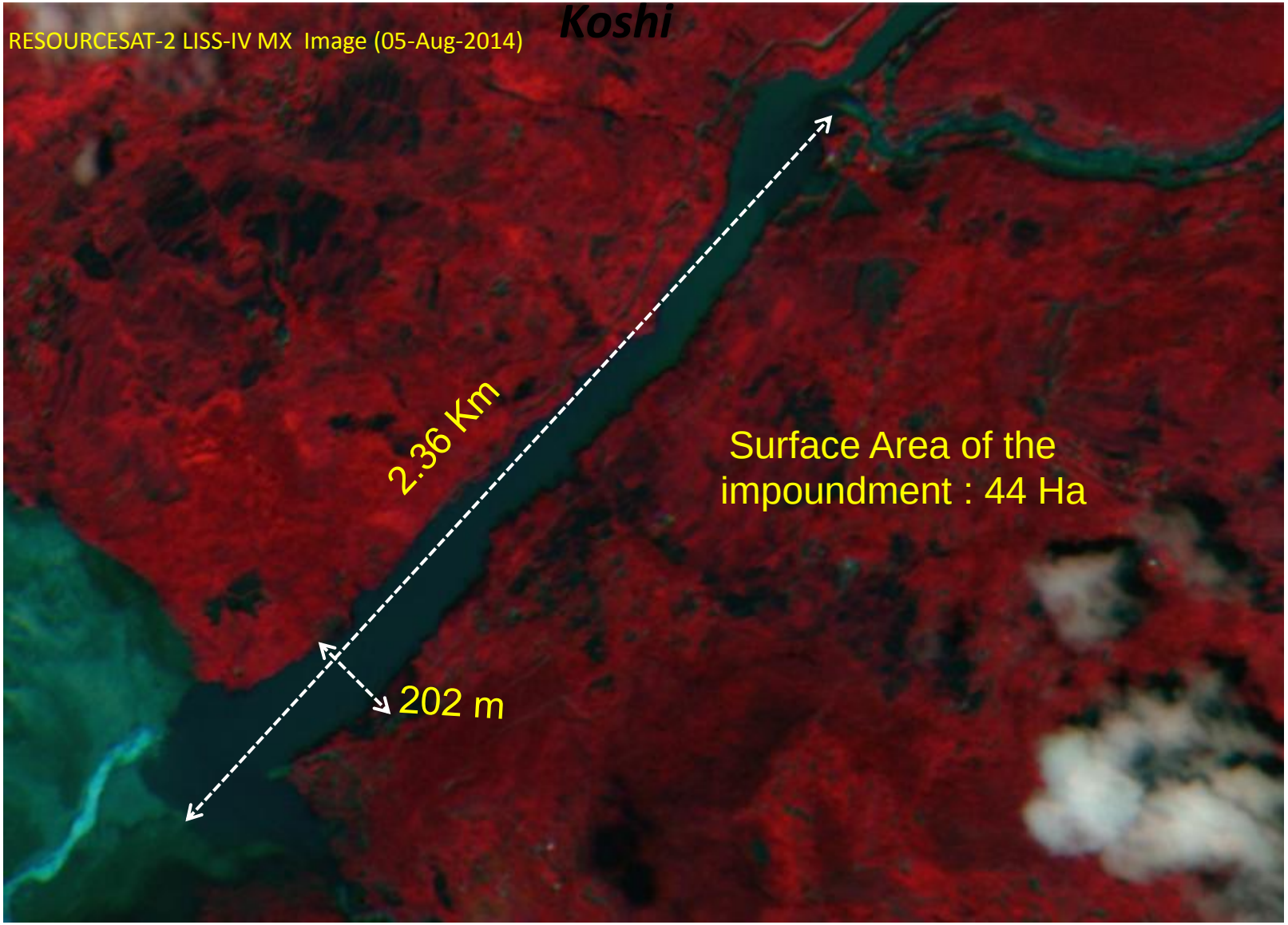
Accumulation zone

Landslide debris

HP site

Nepal – Landslide on River Sun Koshi

Details of the Impoundment on River Sun Koshi



RISAT-2 Image showing Landslide on River Sun Koshi

RISAT-2 SAR data

Post-Event Data – 05-Aug-2014

Ponding / Hill Shadow

Landslide

Sun Koshi River

Ponding

Image depicts a clear view of the landslide and water impounded due to blockade

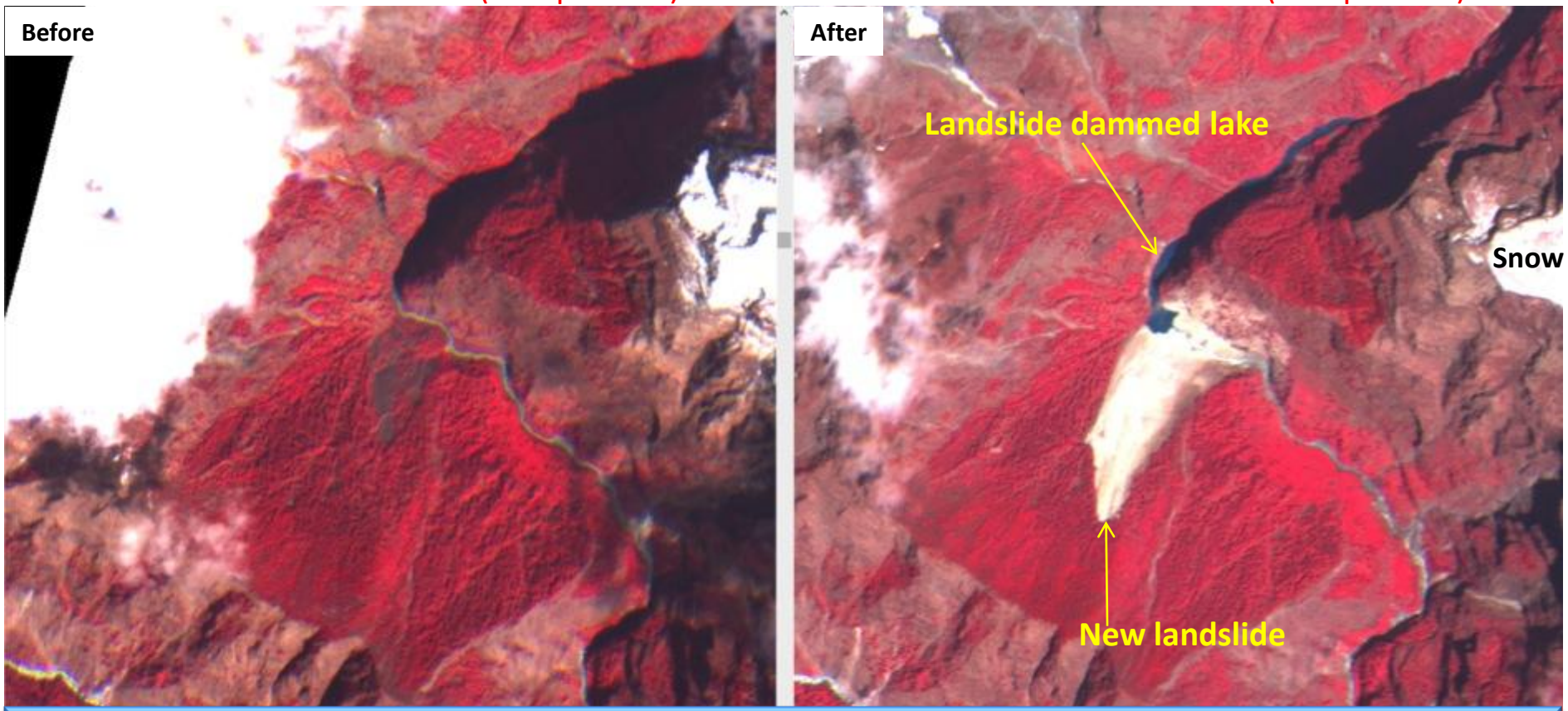
*** Due to undulations, the layover, fore-shortening and hill-shadows affects are observed**

Artificial Lake formation

Landslide Blocking the Valley

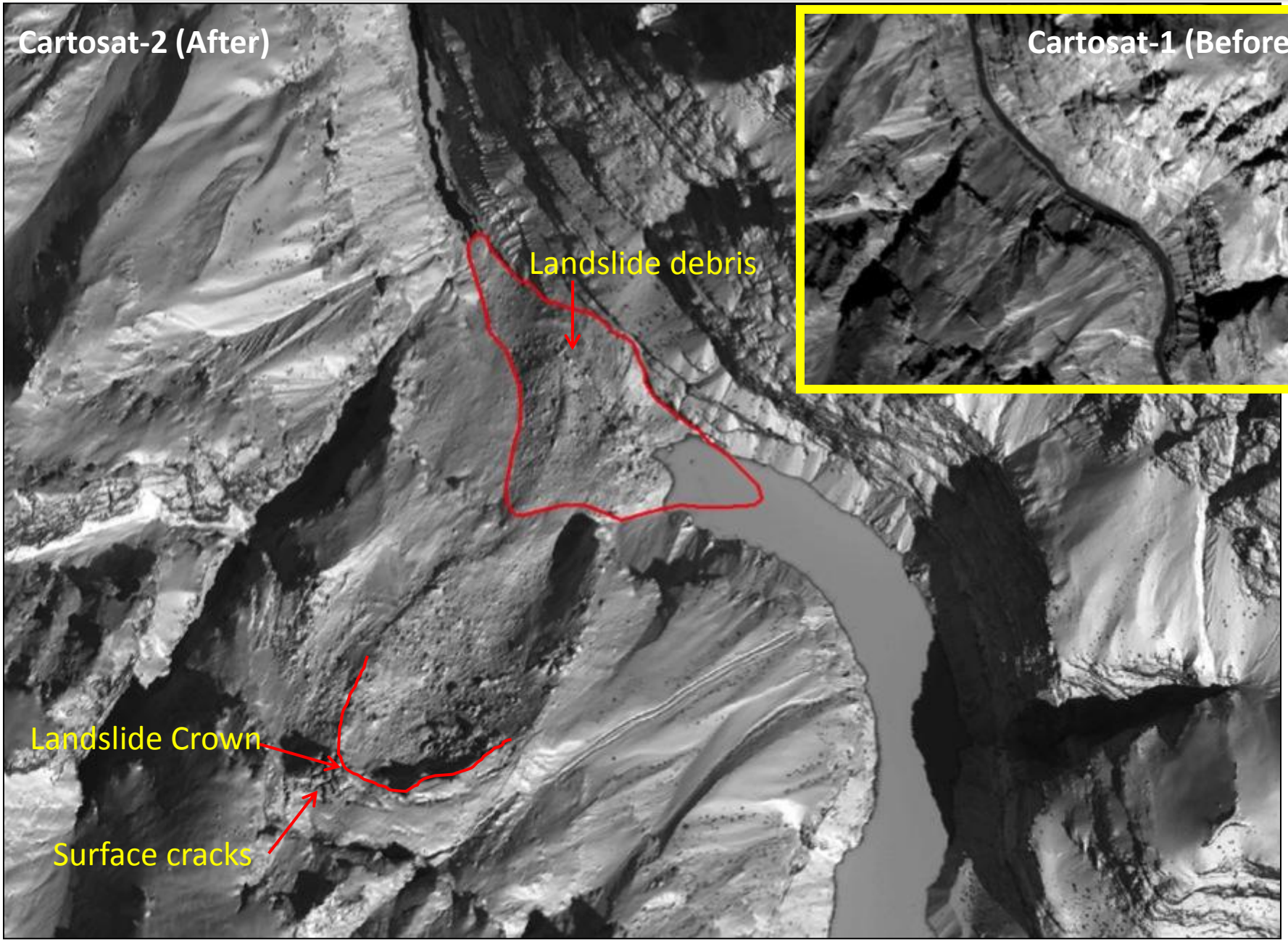
Resourcesat-2 LISS IV mx (01-Apr-2015)

Resourcesat-2 LISS IV Mx (30-Apr-2015)



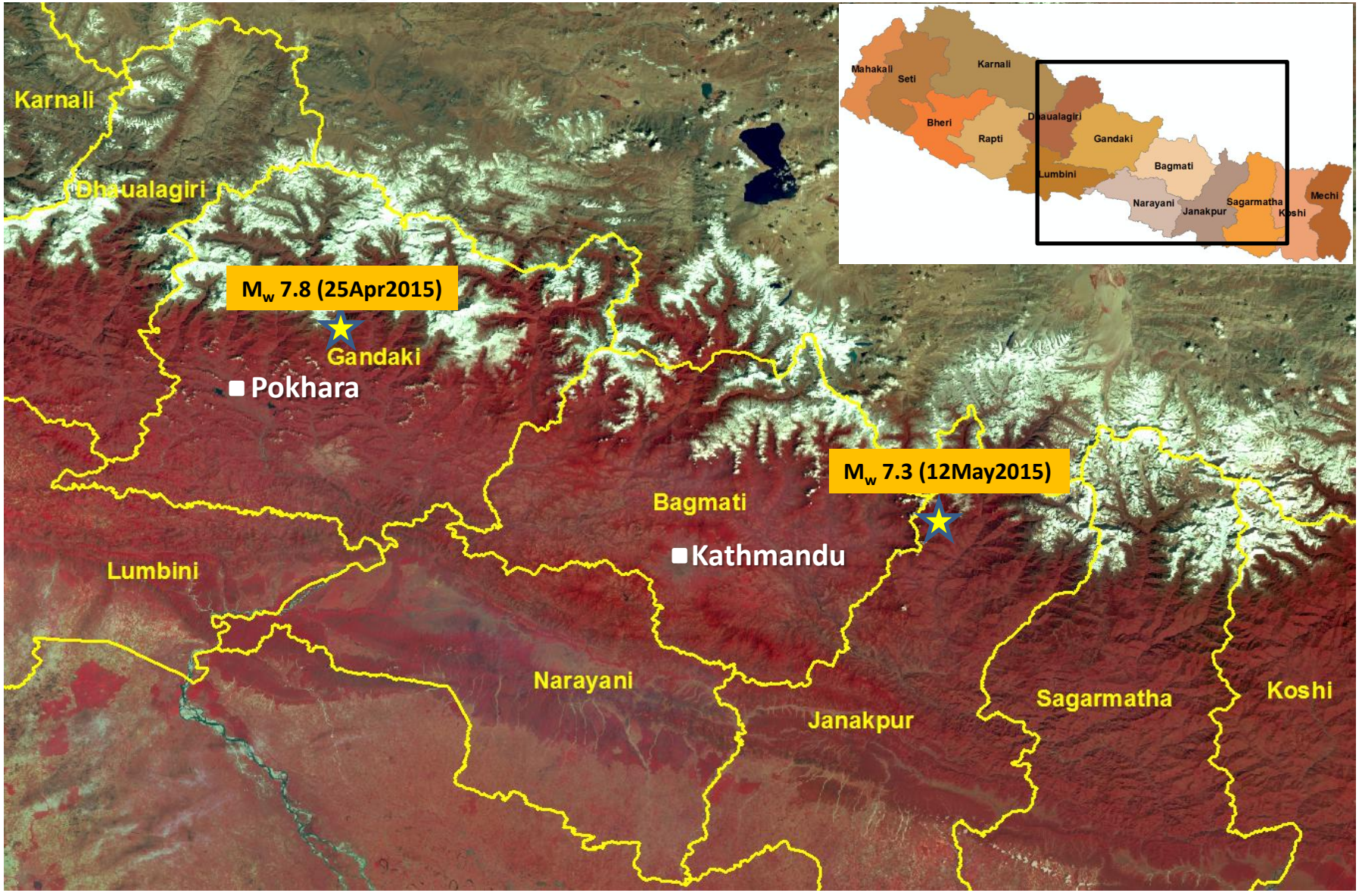
Observation: A new major landslide has blocked the valley resulting in development of a lake. Several other small new landslide are also seen.

Phuktal River Landslide, Lake formation..



Nepal Earthquake – April, 2015

Synoptic View of Earthquake affected area



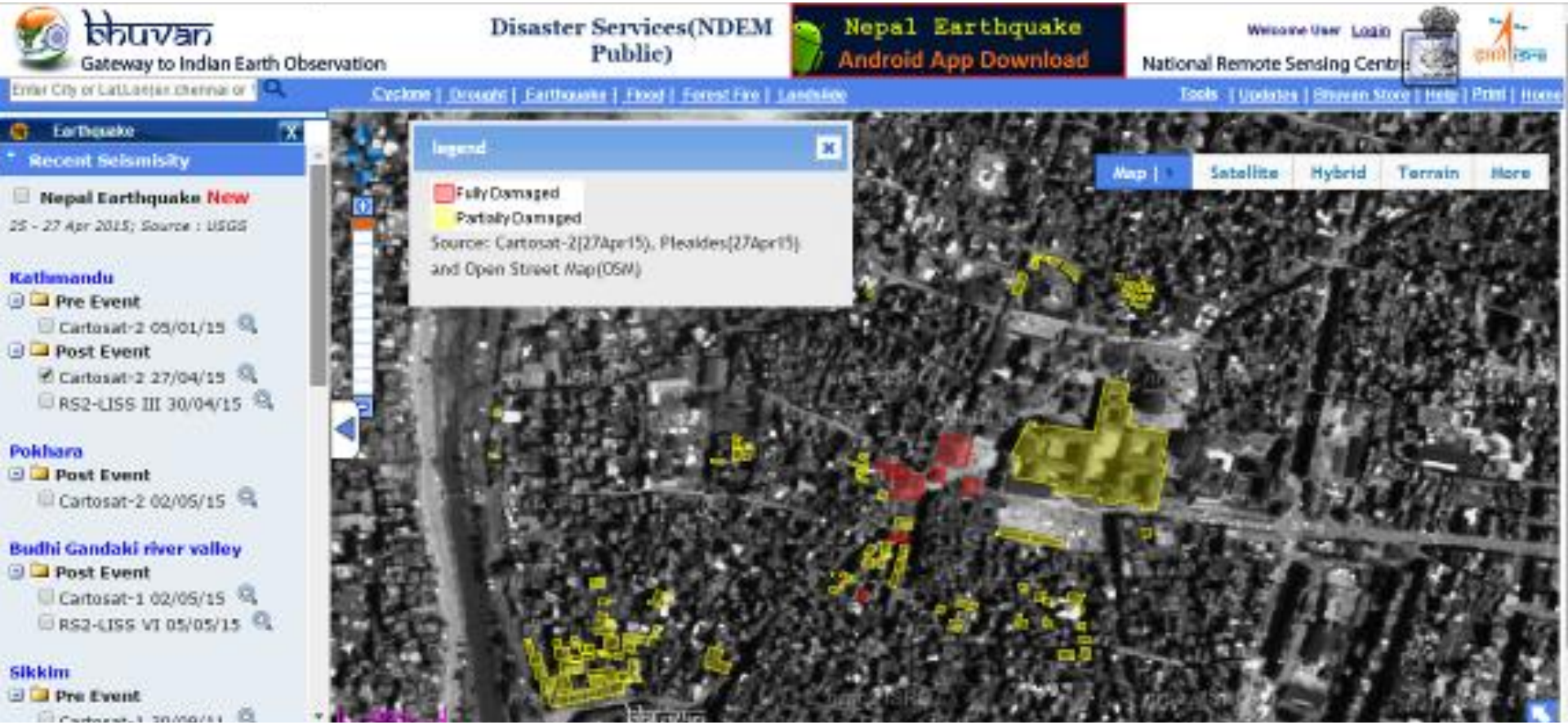
Nepal Earthquake – April, 2015

Dharahara Tower, Kathmandu

Cartosat-2 (05-Jan-2015)

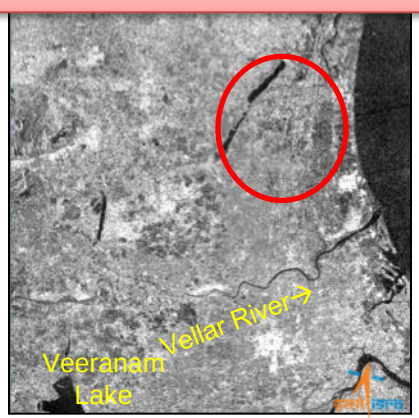
Cartosat-2 (27-Apr-2015)

Nepal Earthquake – Damage Assessment



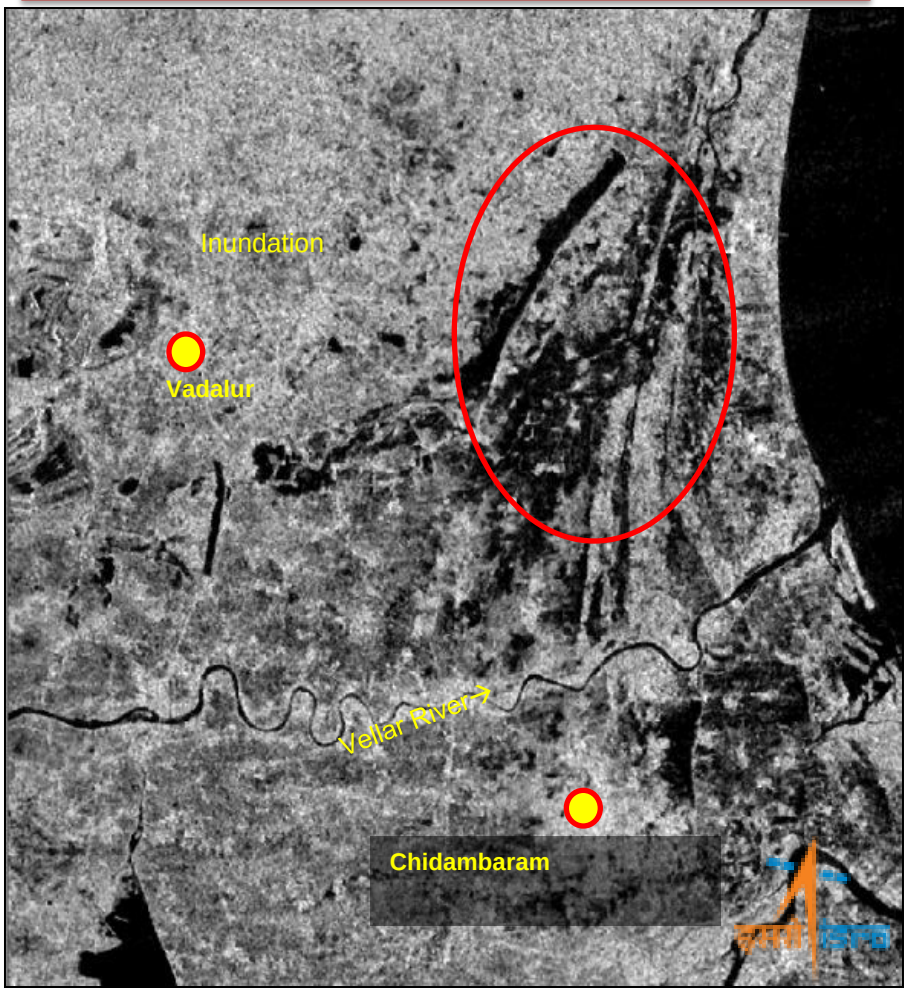
Chennai Flood Event

Before Event -RISAT-1 image



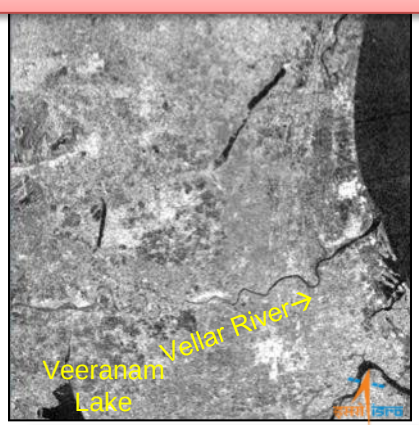
After Event- RADARSAT -2 image of 11-Nov-2015 (0600

After Event- RISAT-1 image of 14-Nov-2015 (1800 Hrs)

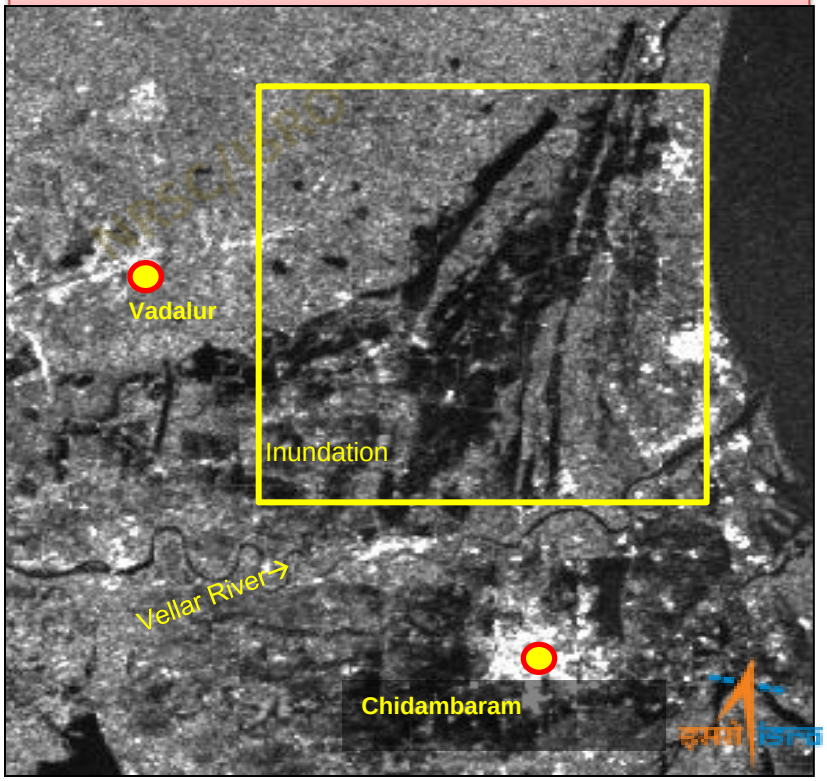


Flood maps Disseminated in near real-time

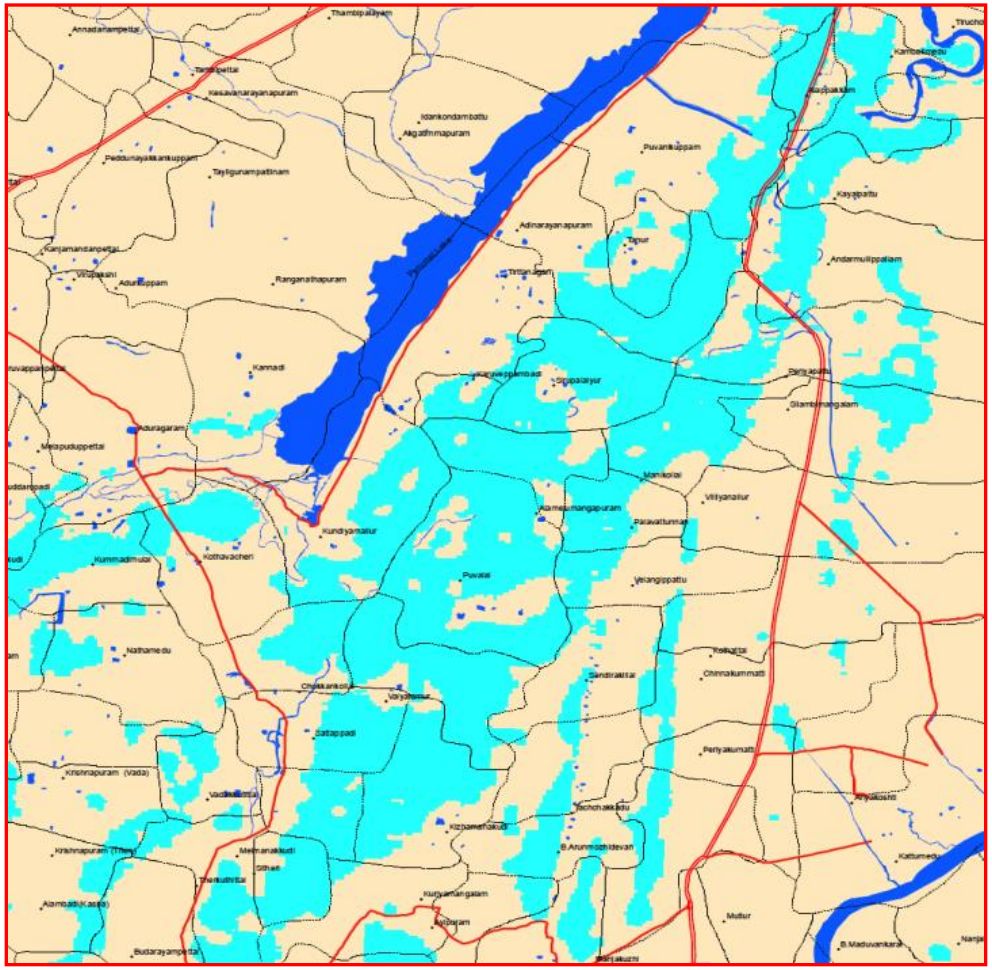
Before Event -RISAT-1 image



After Event- RADARSAT -2 image of 11-Nov-2015 (0600

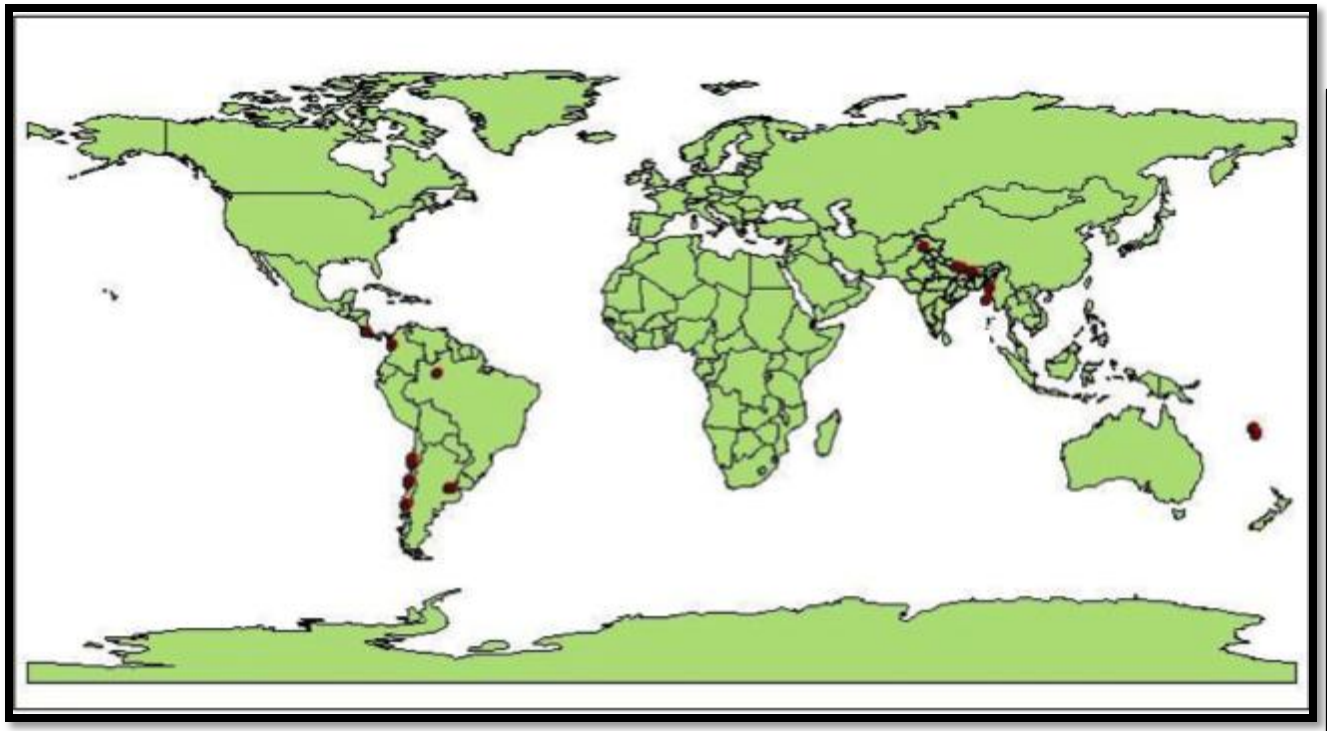


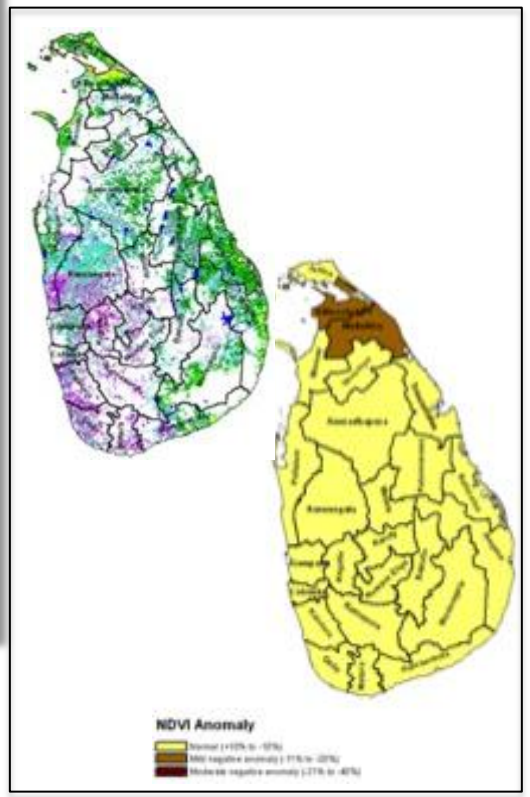
Flood map derived from Satellite data



ISRO Active in Global Disaster Management

International Charter – ISRO provided leadership during Apr – Oct 2015





ISRO's Support - 2015-16

- **Intl'l Charte** – > 142 Scenes
- **Sentinel Asia** – > 30+ Scenes
- **UNESCAP** – Drought: **Srilanka** all season support; **Nepal** feasibility study done
- **UN-SPIDER** – International Workshop on DRR in Mar 2016

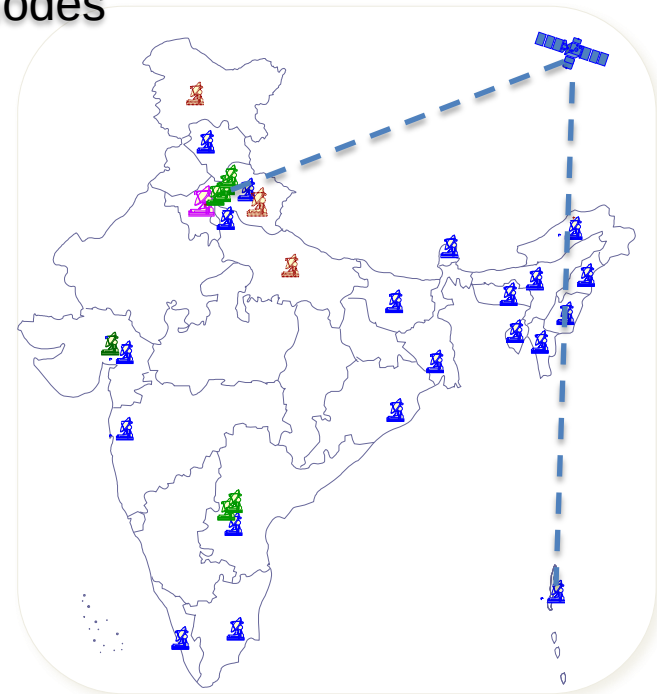
National Level Disaster Management – Way Ahead

NDEM: Serving Multi-scale Data on major disasters, DSS tools operationalised

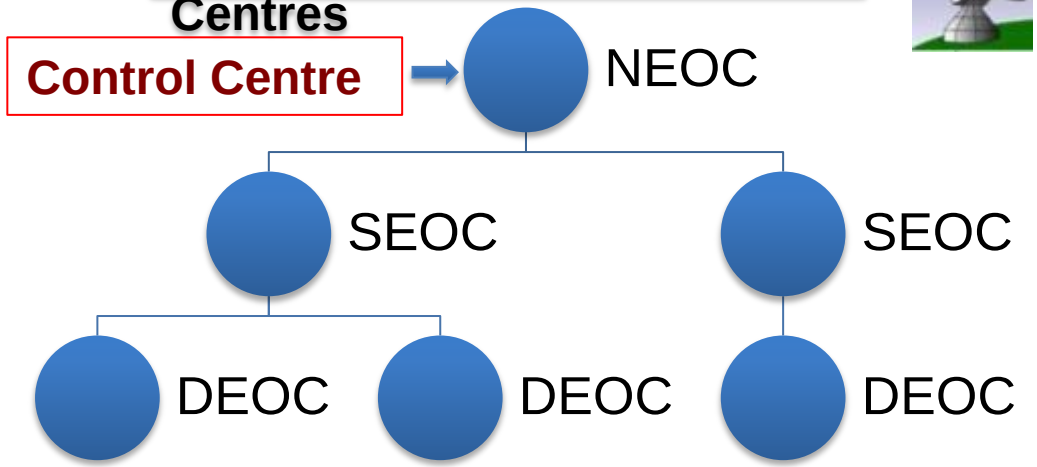
NDEM to serve all nodes at National level through Sat. communication and geospatial technologies to address all Major Disasters in the country

- **Fail-safe Connectivity (Terrestrial & SATCOM)**
- **Geospatial services for near real-time Images/Maps**
- **State of the art Control Room in Delhi with DSS**
- **State/ District level connectivity + Disaster Hotspot**

VPN Nodes with over 40 nodes – connecting 20 State nodes

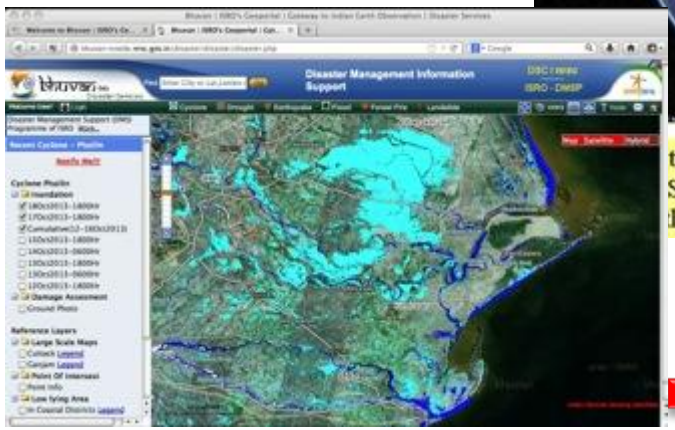


Emergency Operations Centres



Web Site: www.nrsc.gov.in

Geoportal: http://bhuvan.nrsc.gov.in



Thank You