

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

Space Technology in Disaster Response – Indian Scenario



PG Diwakar

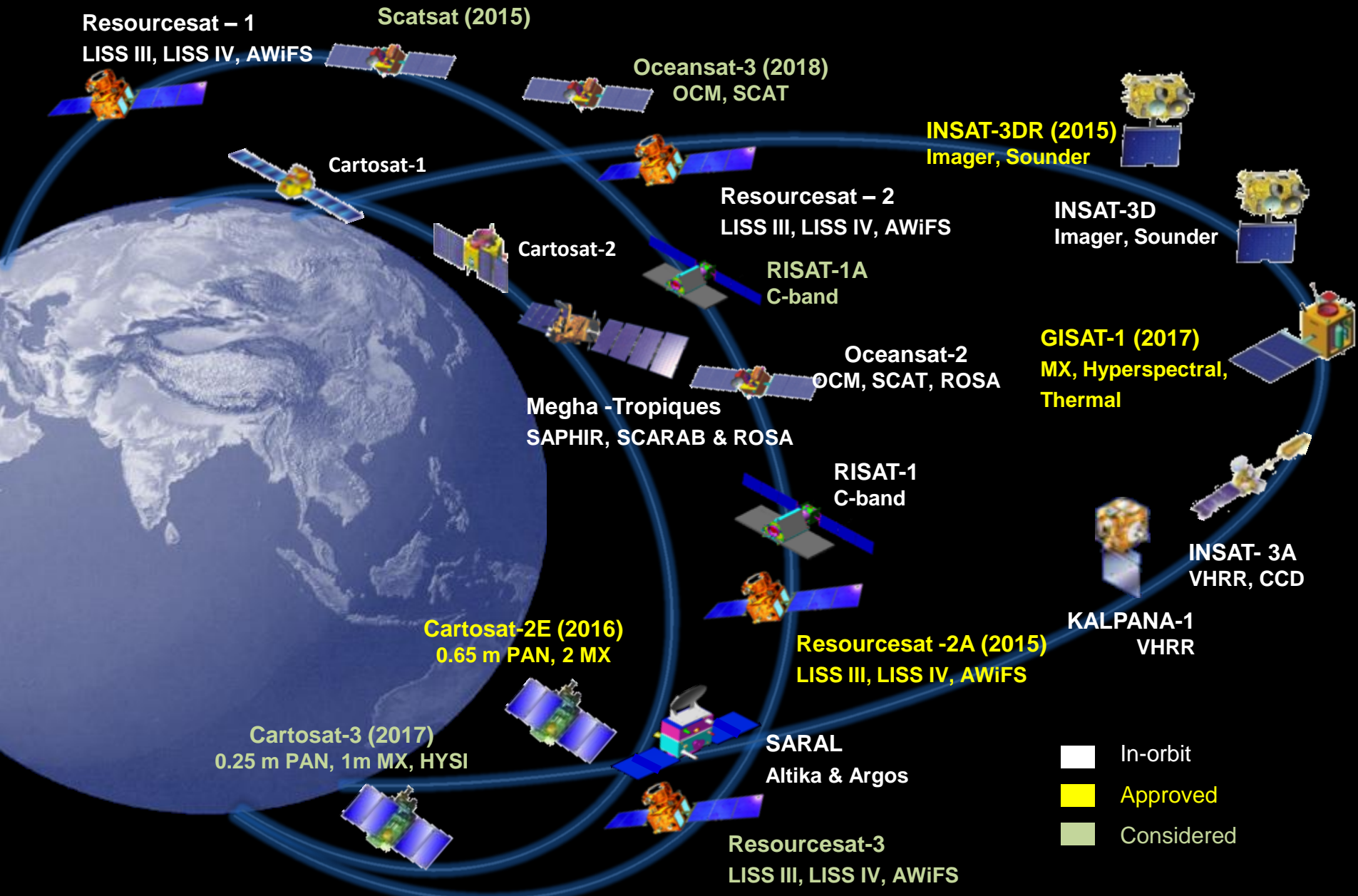
March 08, 2016



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

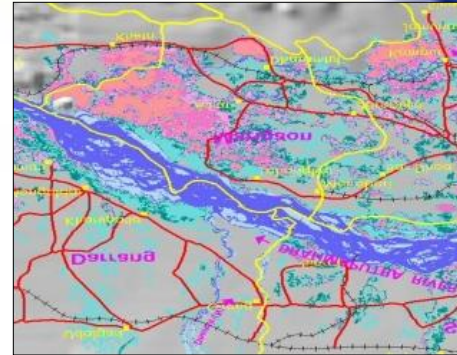


- Active Fire Detection
- Damage Assessment

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

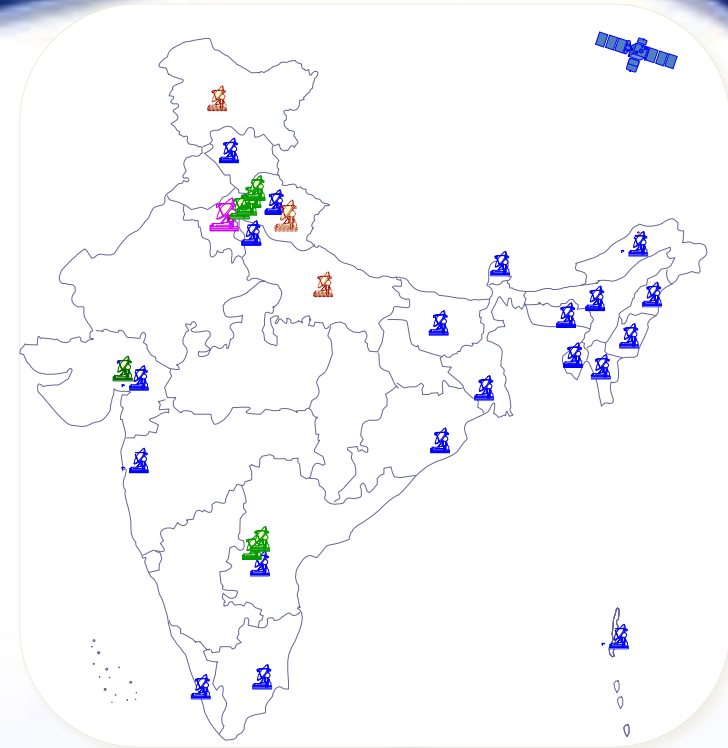


Outputs

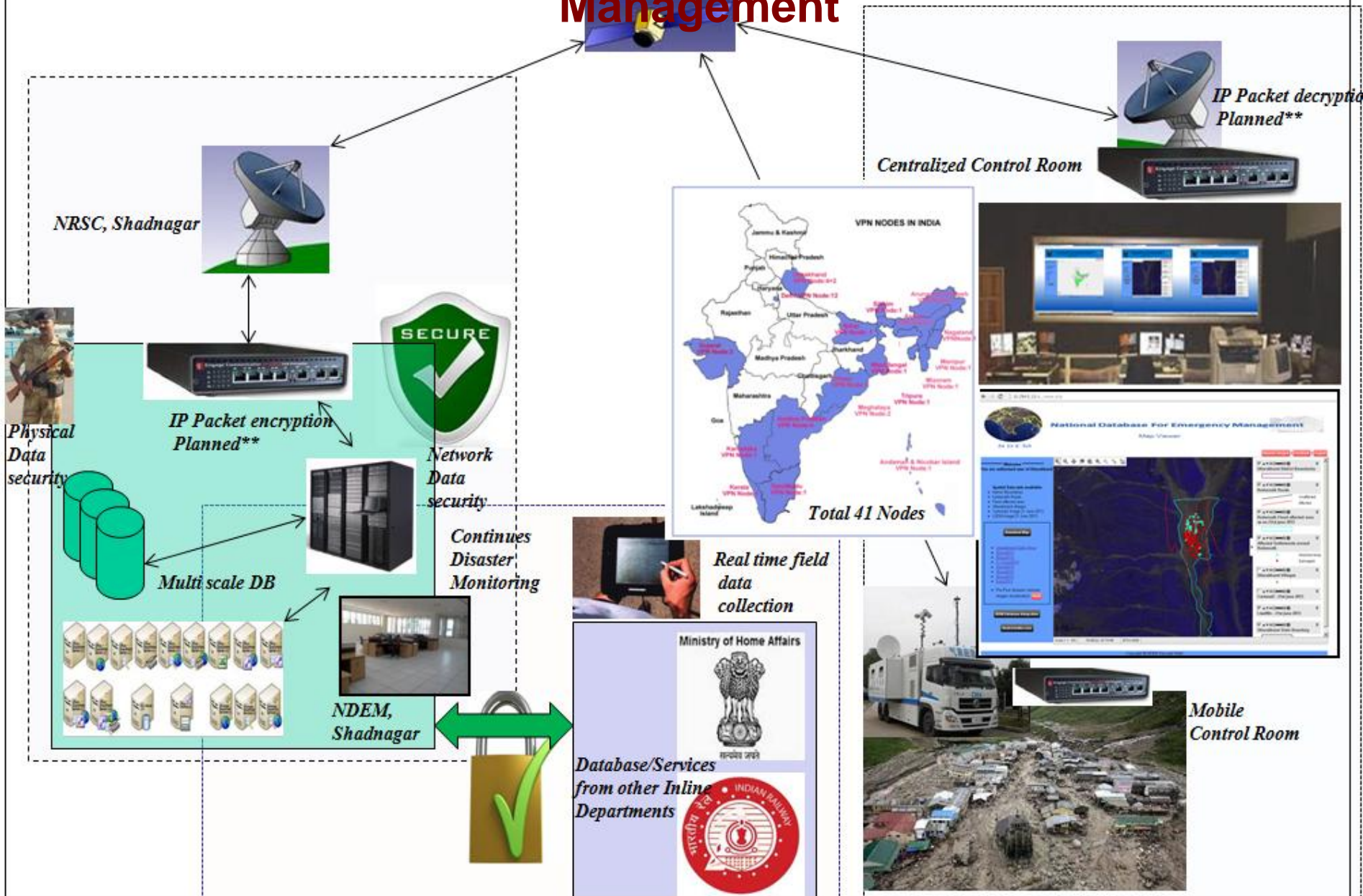
Dissemination to Users
VSAT, FTP, Bhuvan, E-mail etc.

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



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

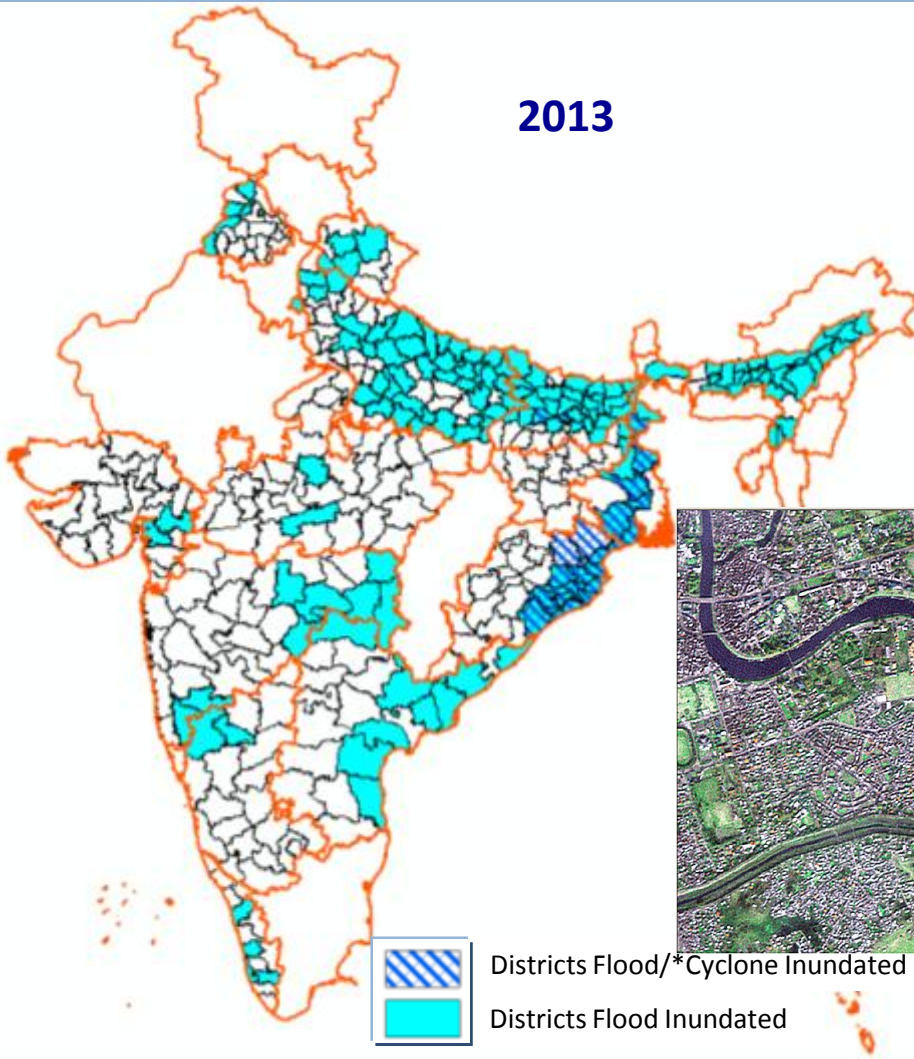
- **Response**
 - Inundated Area, Districts & Villages submerged.
 - Frequency – 5-day, 2-day, Daily, 12-hrly, thrice a day – depending on coverage & based on severity
 - Damage to structures – Uttarakhand Floods (2013), J&K floods (2014)
- **Early Warning**
 - Info. on discharge, likely submergence (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



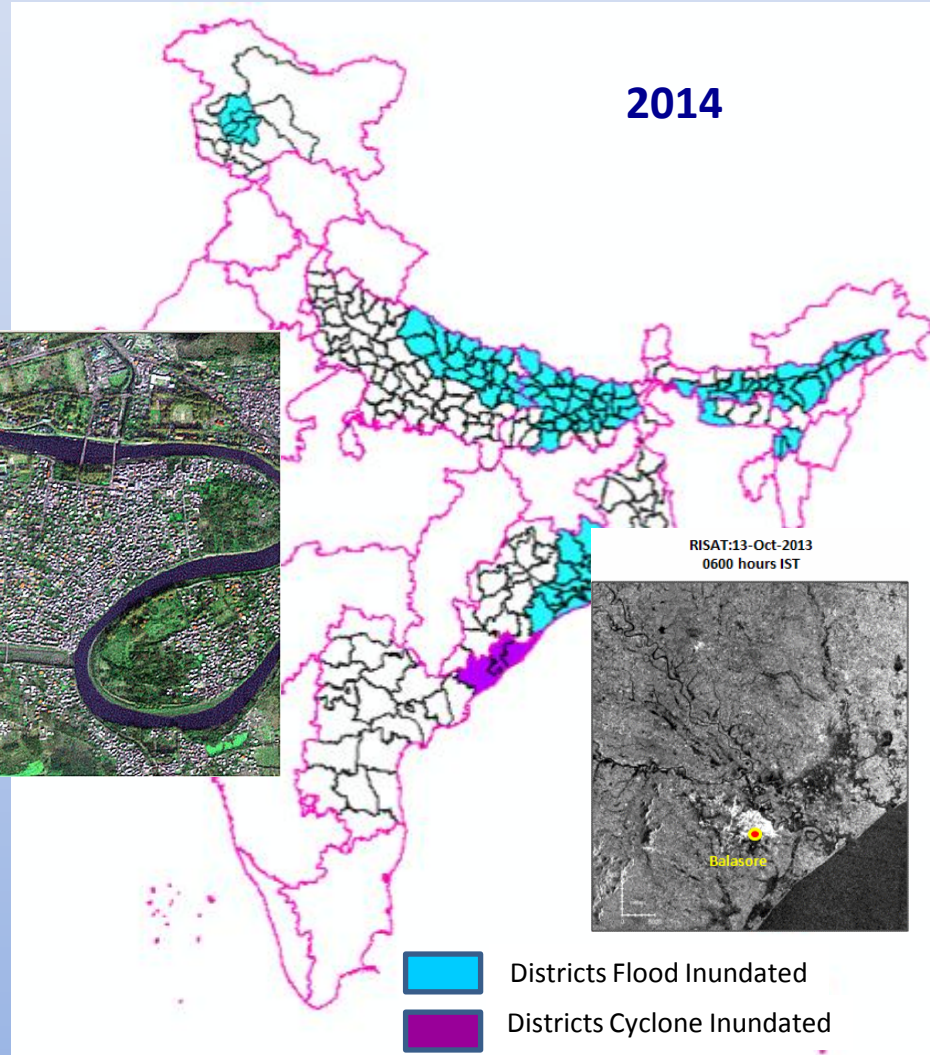
DISASTER RESPONSE

Major Floods & Cyclones

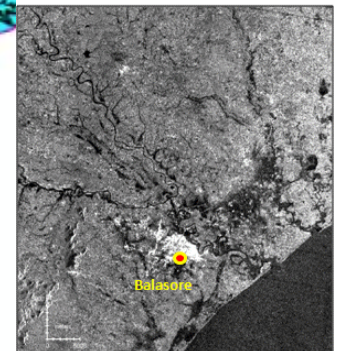
2013



2014

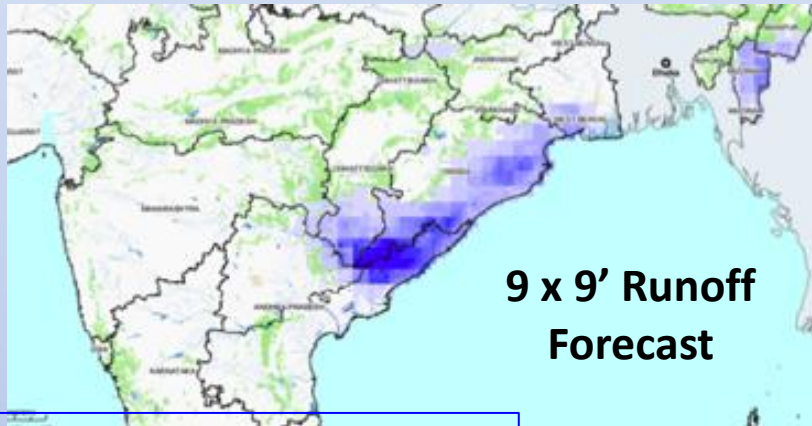


RISAT:13-Oct-2013
0600 hours IST

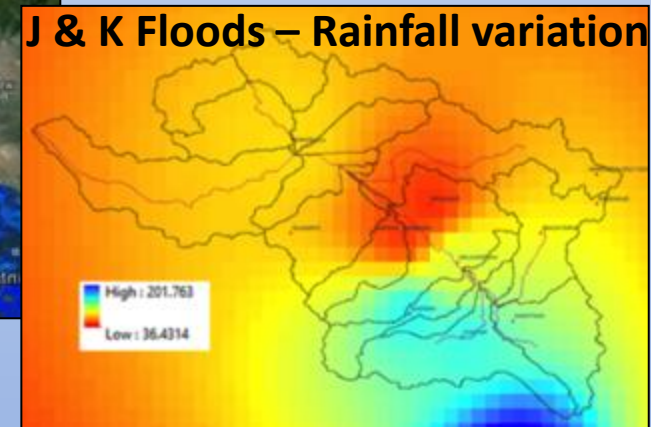
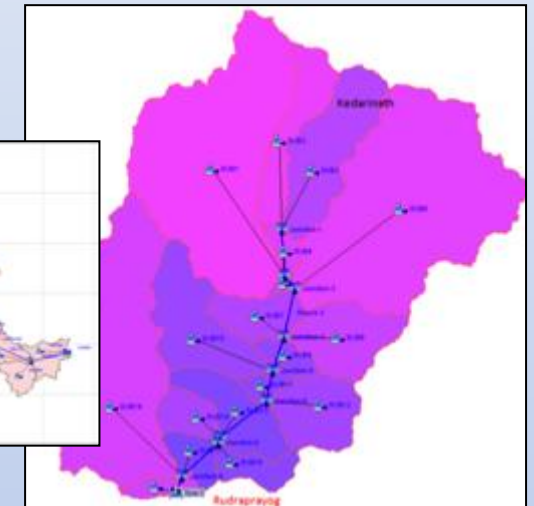


Flood Forecast & Stream-flow simulation

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



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



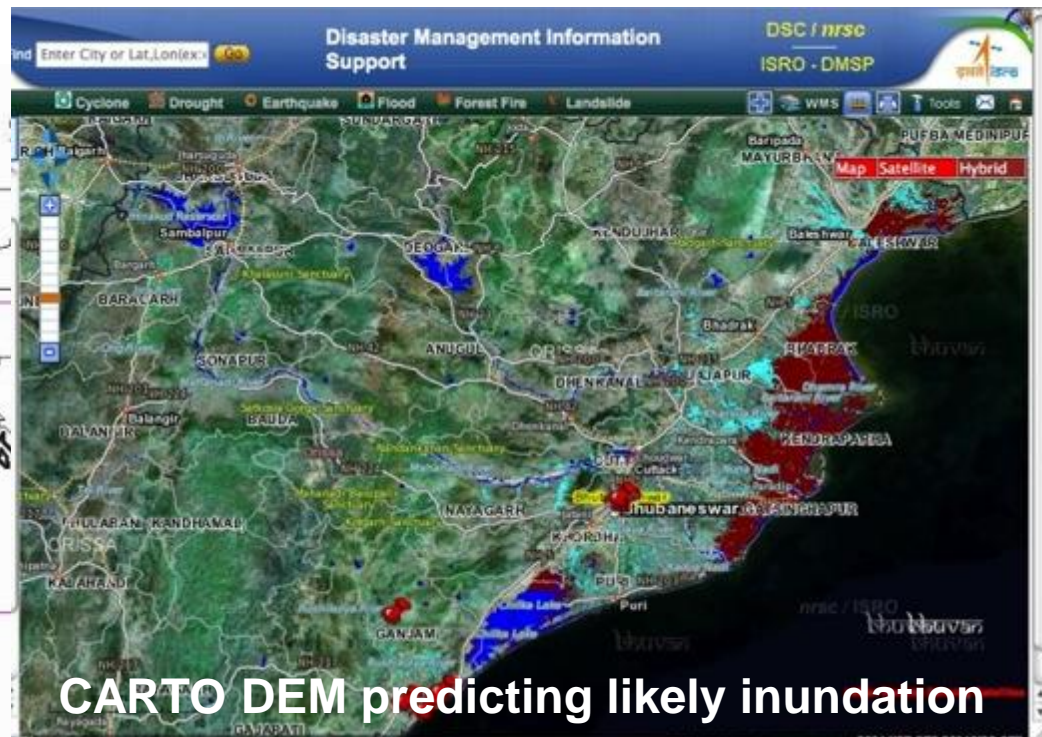


Disaster Management Support

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

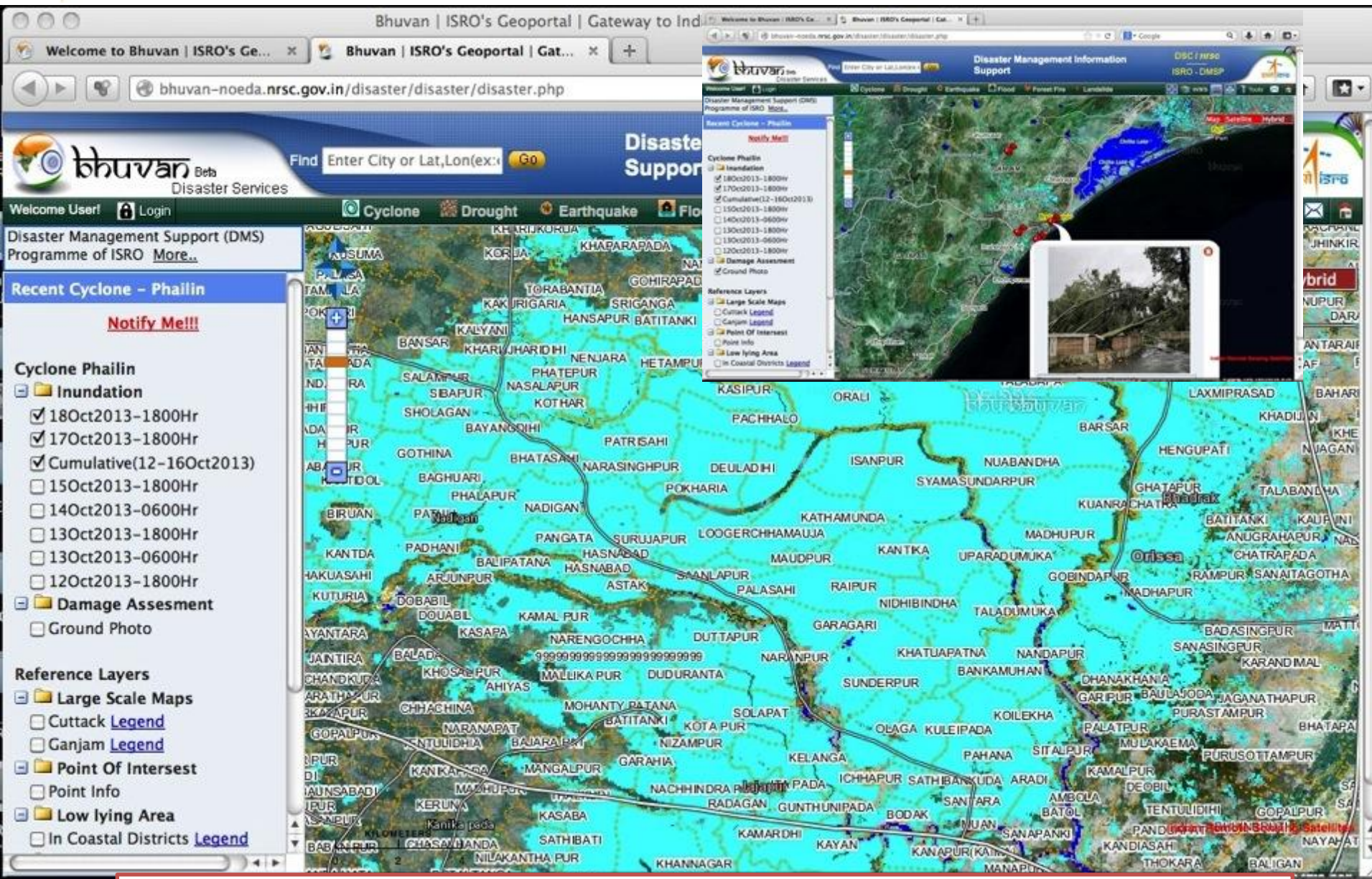
Cyclone Phailin – online Flood inundation maps



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



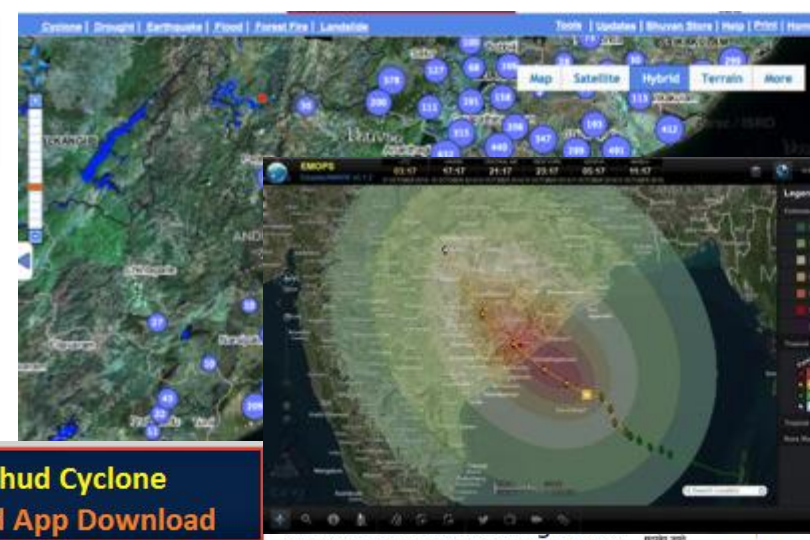
Phailin Cyclone – Info at Village level




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

Map | **Satellite** | **Hybrid** | **Terrain** | **More**

Rusapatirega

IRA PRADESH

Bhuvan

Bheemunipatan

2014-10-20 08:32:19

18.055691099073,83.43206827813701

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

nrsc / ISRO

Indian Remote Sensing Satellites

Cyclone HUDHUD – Tracking and Online support

bhuvan-noeda.nrsc.gov.in/disaster/disaster/disaster.php

bhuvan
Gateway to Indian Earth Observation

Disaster Services(NDEM Public)

Hudhud Cyclone
Android App Download

Welcome User [Login](#)

National Remote Sensing Centre

Enter City or Lat, Lon(ex:chennai or 13.7611, 79.1852)

[Cyclone](#) | [Drought](#) | [Earthquake](#) | [Flood](#) | [Forest Fire](#) | [Landslide](#)

[Tools](#) | [Updates](#) | [Bhuvan Store](#) | [Help](#) | [Print](#)

Cyclone HUDHUD Track

☐ IMD (12Oct14-0230IST)

Source: Indian Meteorological Department - **IMD**

☒ JTWC (12Oct14-0230IST)

Source: Joint Typhoon Warning Center - **JTWC**

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
- Others

Map | **Satellite** | **Hybrid** | **Terrain** | **More**

Place: Relli valasa , Pusapatirega , Vizianagaram

Created At: Oct 17, 2014 9:07:05 AM

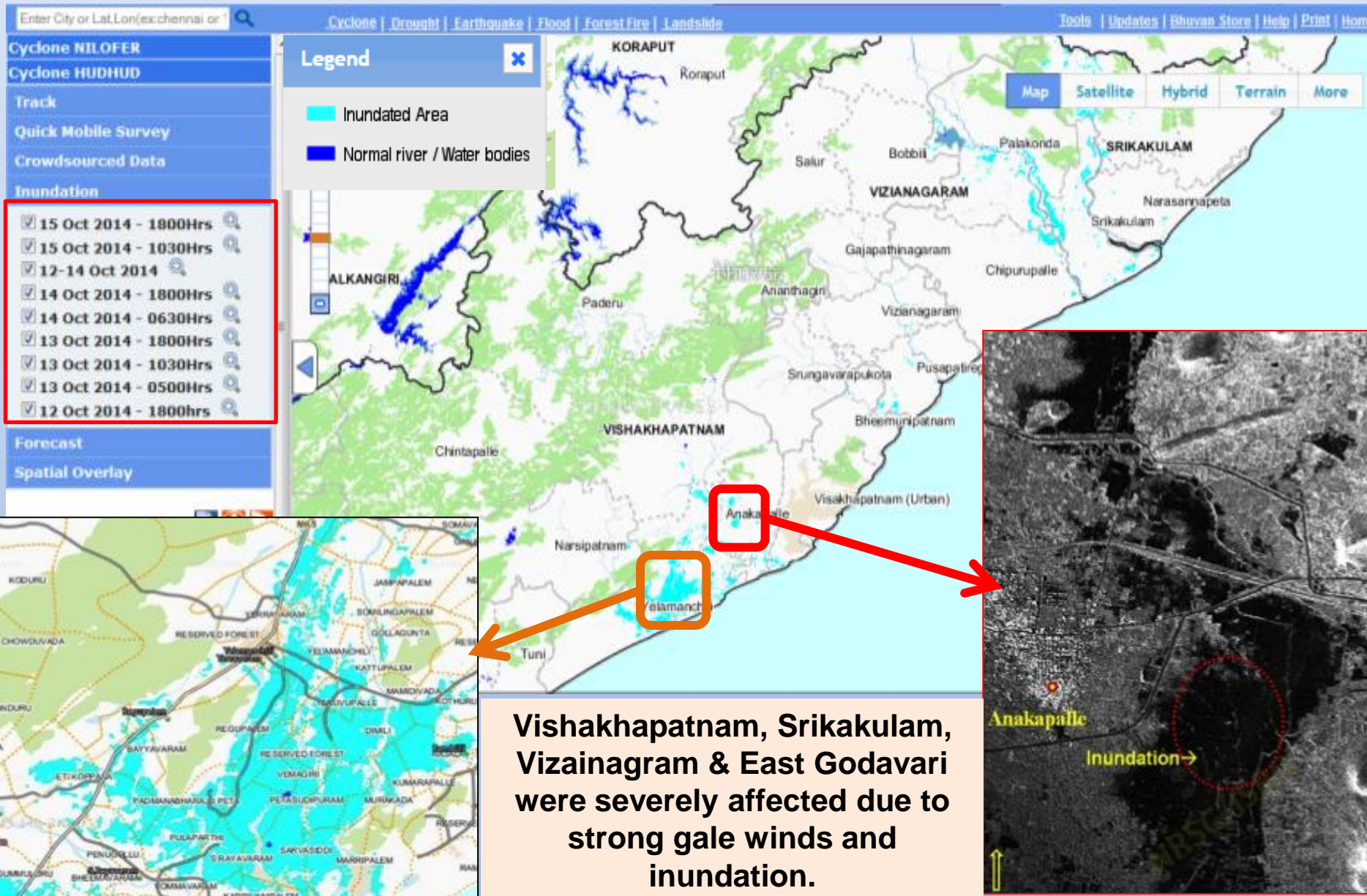
Category: Transformer Damaged,Power

2014-10-17 09:07:05

18.09572032,83.52130074

RAVANIPALEM **PORAM** **RELLIVALASA** **PUSAPATIREGA** **KOVVADA AGRAHARAM** **GOVINDAPURAM** **BHARANIKAM** **KONAYYPALEM** **ROLUCHAPPIDI** **CHOWDUVADA** **BOYAPALEM** **ALLADAPALEM** **KANIMETTA** **AHARAM** **IIMELLA** **KAMAVARAM** **PYDIBHIMAVARAM** **CHITTIVALASA** **PEDATHARIMI** **YADA** **SATHIVADA** **DEVONIPALVALASA SANCHAM** **WEST BENGAL** **JHARKHAND** **CHHATTISGARH** **MADHYA PRADESH** **GUJARAT** **MANIPUR** **TRIPURA** **MIZORAM** **Dhaka**

Cyclone HUDHUD – Inundation Monitoring



Cyclone HUDHUD- Crowd Sourcing

Public)



Android App Download

National Remote Sensing

Crowd sourcing enabled to collect information from ground.



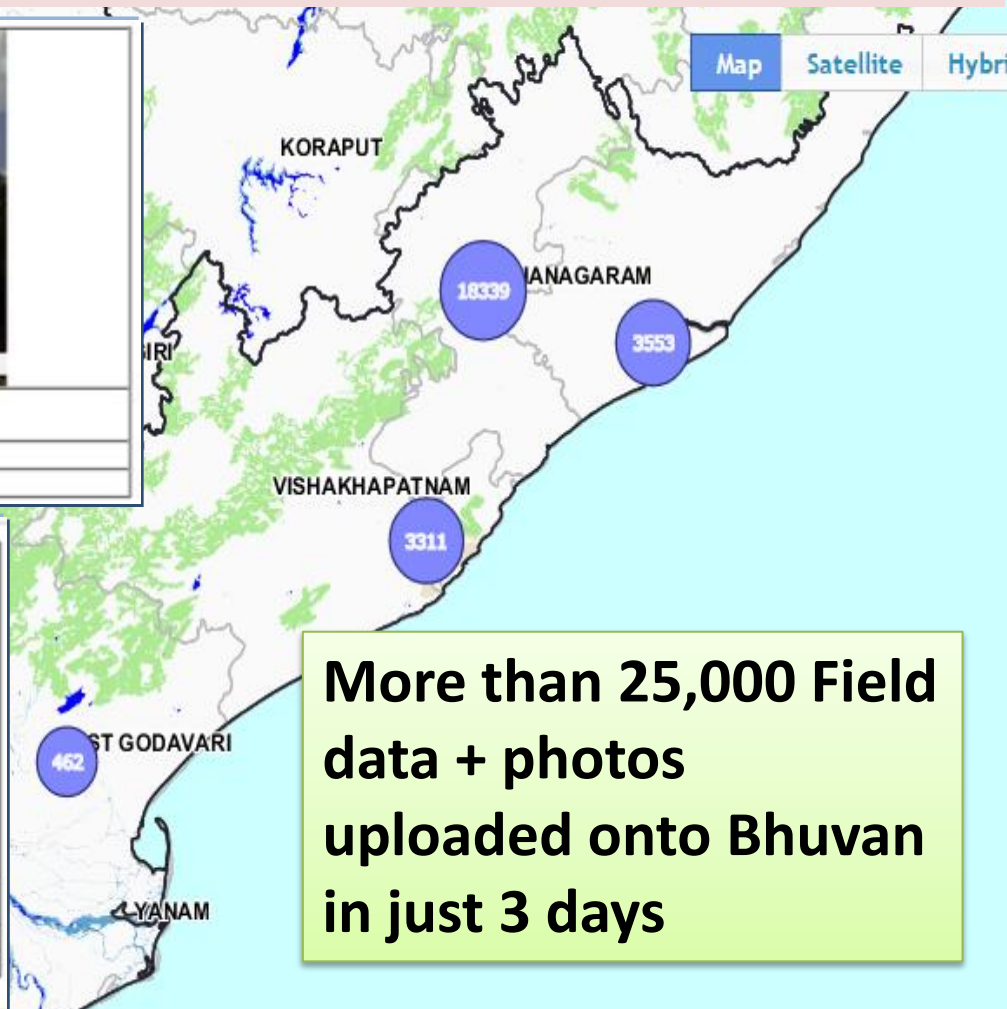
Place: Tattaband , Ravikamatham , Visakhapatnam
Created At: Oct 16, 2014 1:14:50 PM
Category: Pole Fallen,Power



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



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

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

Support for International Disasters

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

Disaster Management Supp

File Edit View History Bookmarks Tools Help

Welcome to Online Ordering S... Welcome to Bhuvan | ISRO's ... Indian Earth Observation Visu... bhuvan-noeda.nrsc.gov.in/disaster/disaster/disaster.php#

bhuvan
Gateway to Indian Earth Observation




Disaster Services(NDEM Public)

Enter City or Lat,Lon(ex:chennai or 13° 45' N, 77° 30' E)

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

Cyclone NILOFER
Cyclone HUDHUD
Track
Quick Mobile Survey
Crowdsourced Data
Inundation
Forecast
Spatial Overlay
Additional Layers

☒ Mobile Towers Affected
☐ BSNL Total Mobile Towers
☐ Total Substations
☒ Substations Affected

Share Field Data New   

Support for International Disasters

HUDHUD DAMAGE ASSESSMENT & RELIEF MONITORING SYSTEM
Government of Andhra Pradesh

Home Circulars & Go's Gallery Downloads Media Releases Skilled Worker Tracking Telecom Status Power Status Helpline Numbers

Department Login
Username Password

Updates
The Hon'ble CM has made an aerial survey of the affected areas & directed all the officials to ensure quick relief operations.
The chief minister has enhanced the relief package to the cyclone victims for human loss, crop damages, house damages etc...

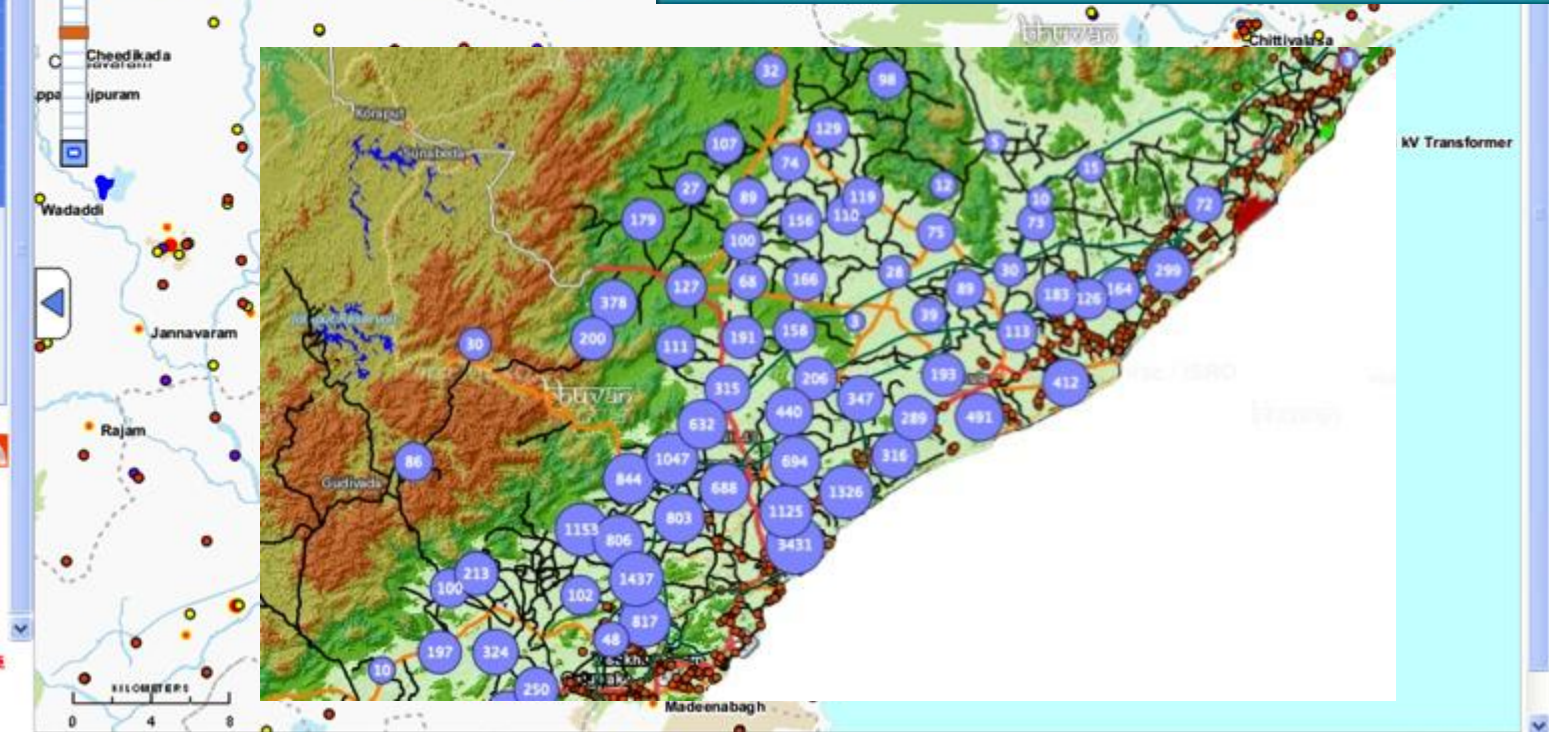
ABOUT HUDHUD CYCLONE
Cyclone Hudhud pounded the coastal districts of Andhra Pradesh and Odisha with heavy rain and winds of almost 200 kmph on Sunday leaving a trail of devastation with Visakhapatnam where the very severe storm made landfall bearing the brunt.
Lakhs of people have being evacuated from towns and villages through which the cyclone has passed amid massive rain and wind. The cyclone is similar to last year's Phailin that crossed the Odisha coast leaving behind a trail of destruction.

Citizen Inputs
Maps (Bhuvan)
CM Relief Funds
Gratuitous Relief Update

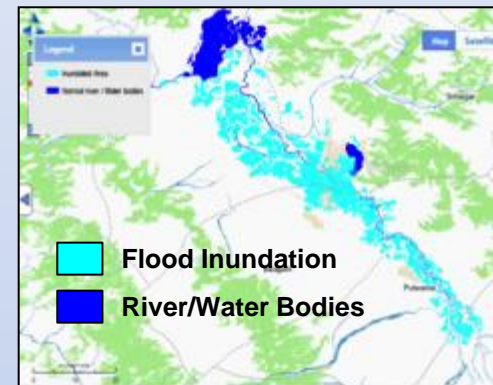
Shri N. Chandrababu Naidu
Hon'ble Chief Minister
Government of Andhra Pradesh

Site Best viewed at 1024*768 / Chrome, Firefox, IE+
All Rights Reserved with Director, Electronic Services Delivery

Designed & Developed by **APOnline**



Himalayan Disasters: J&K – Sep, 2014



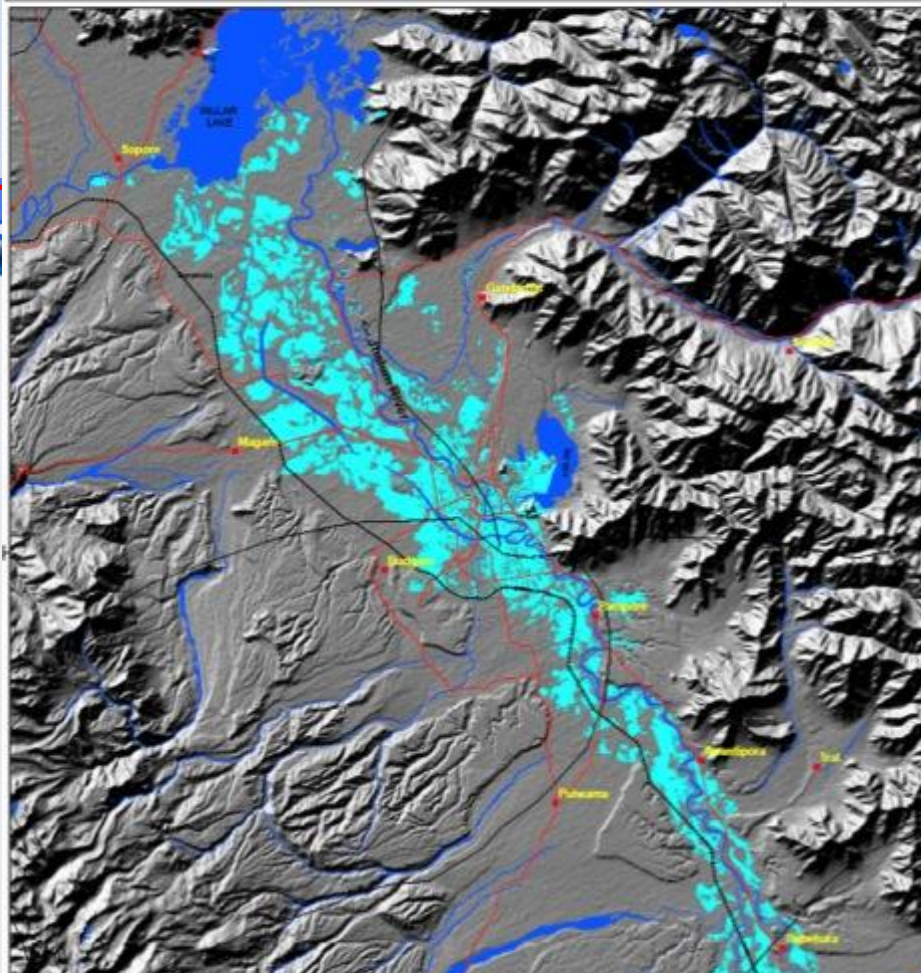
Jammu and Kashmir - 2014 ▾

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

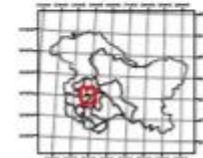


For official use

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, Baramulla & 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 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
Background data : Shaded Relief

Legend

- Substations
- Normal River/Water bodies
- Flood Inundation
- Total Boundary
- State Boundary
- Railway
- Major Roads



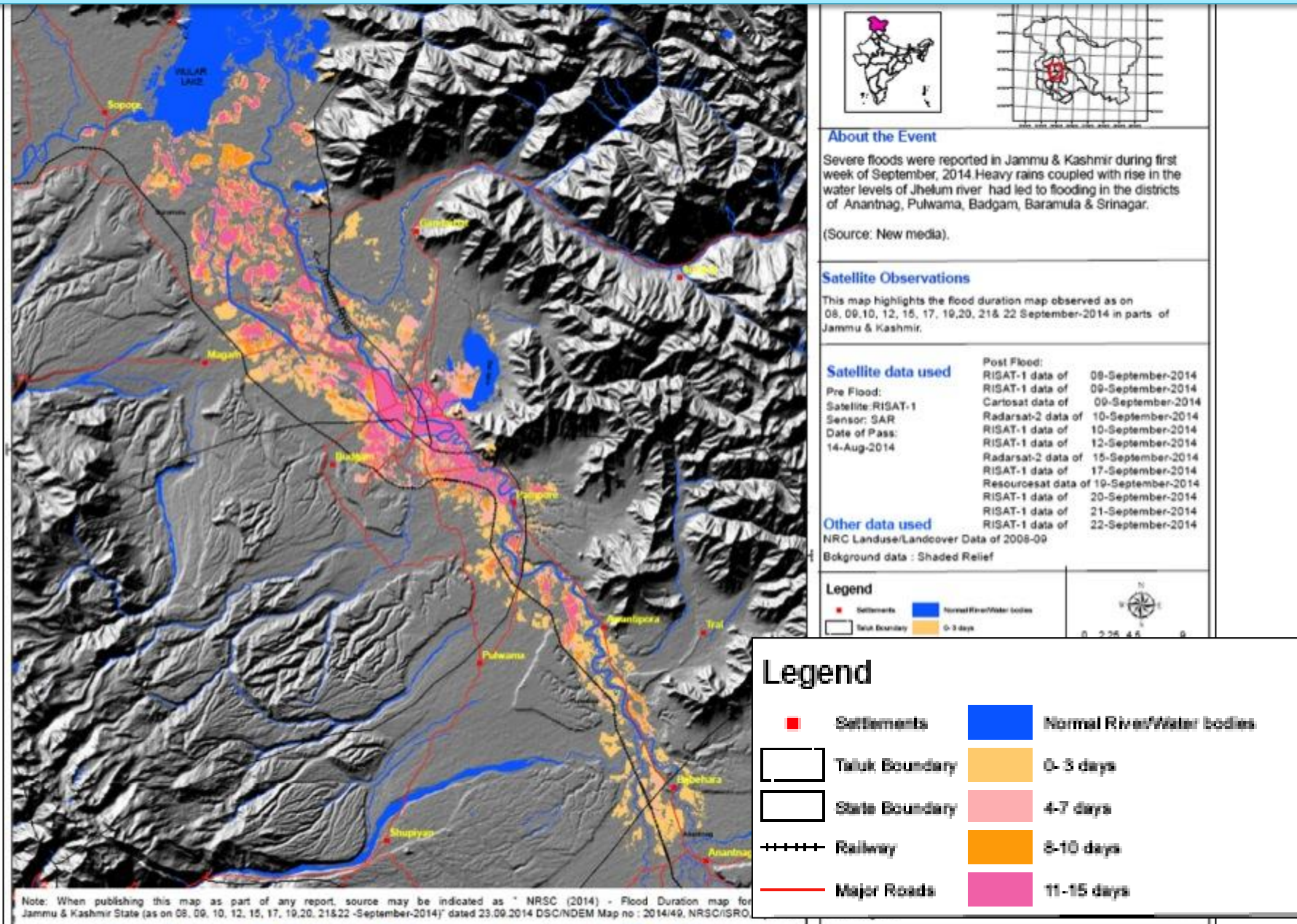
This product is prepared on rapid mapping mode for immediate use and sharing amongst official agencies. This provides preliminary results.

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

All geographic information has limitations due to the scale, resolution, date and presentation of the original source materials.

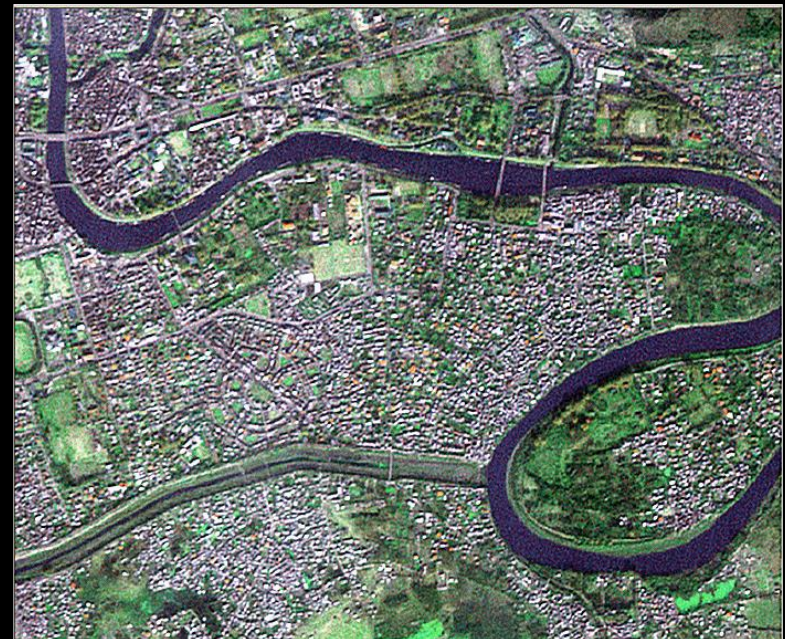
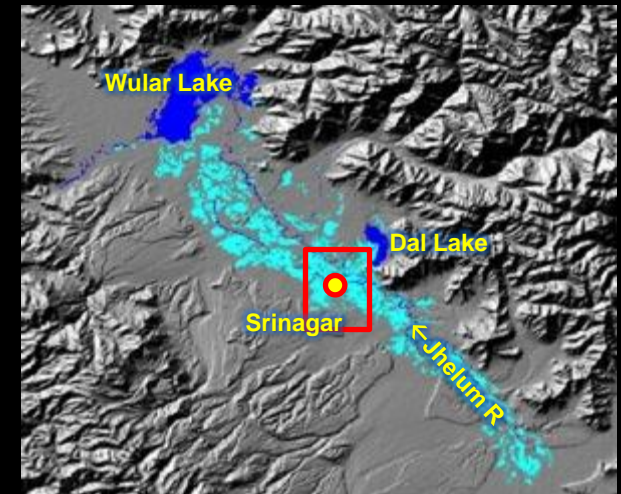
50 Flood inundation maps disseminated in near real time to MHA, NDMA, Govt. of J&K to help in relief and rescue operations.

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

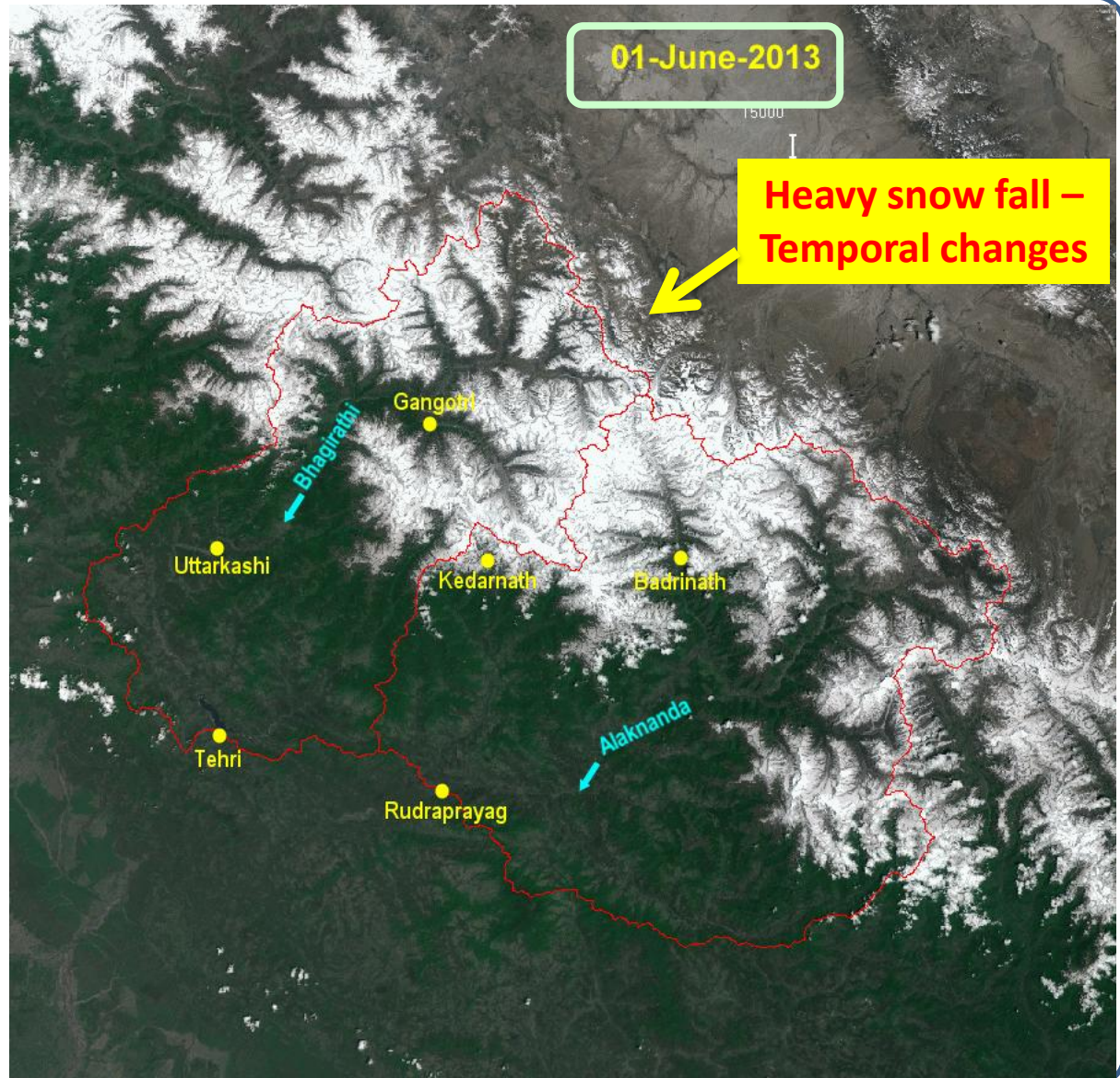
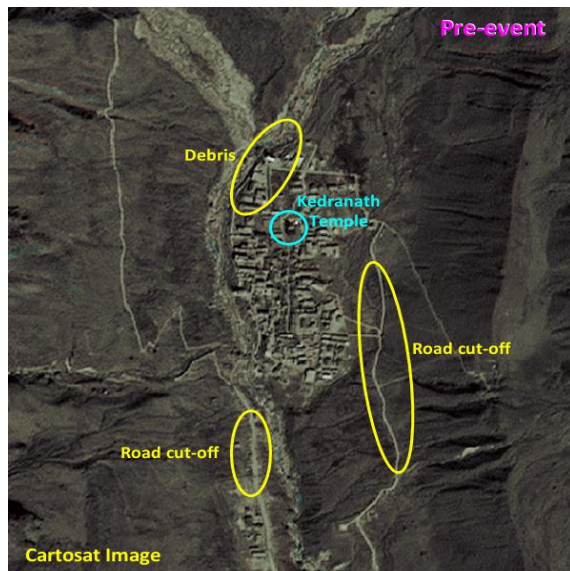


Uttarakhand Disaster – July 2013

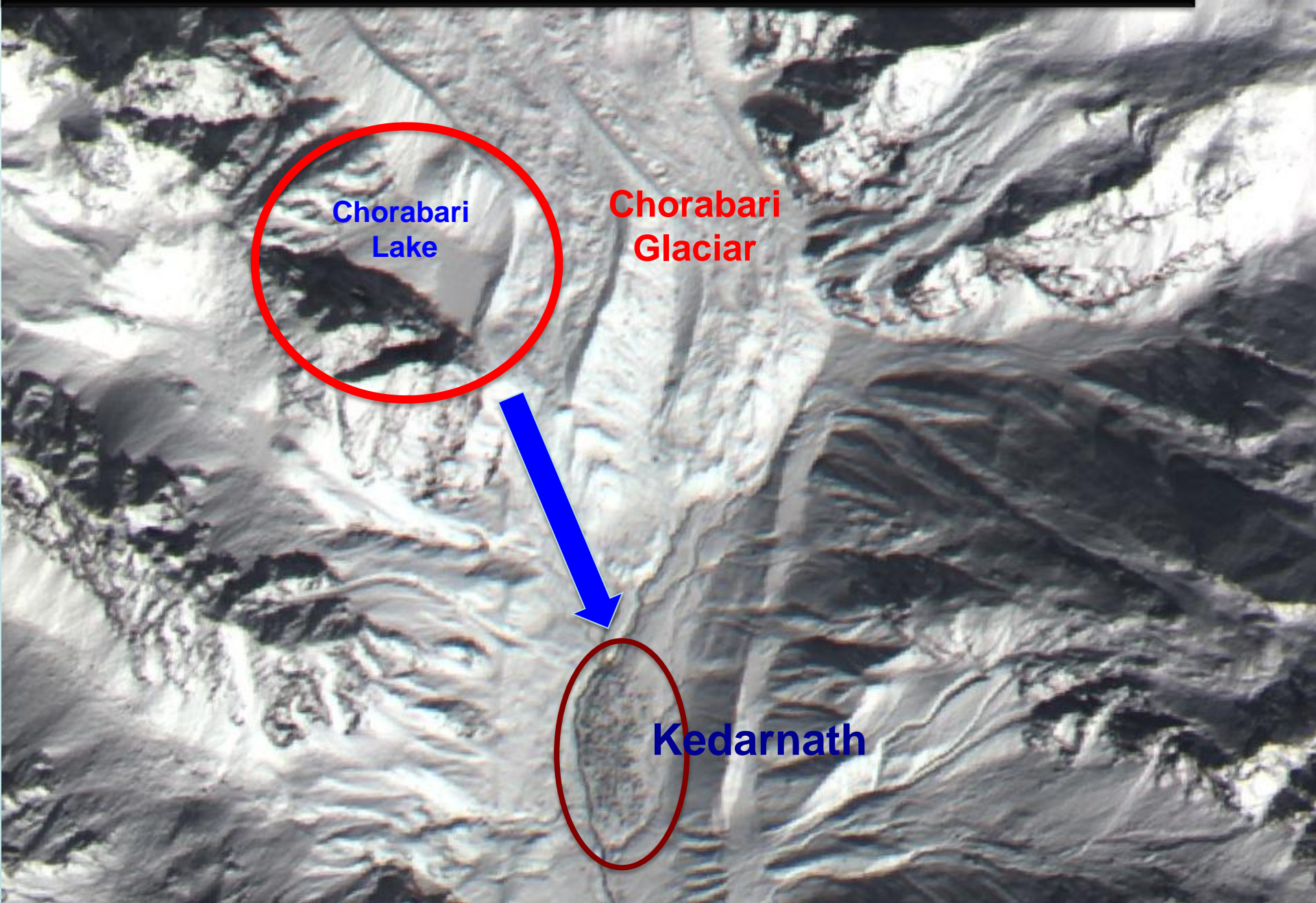


Heavy Snowfall in upper reaches

- Heavy rainfall 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

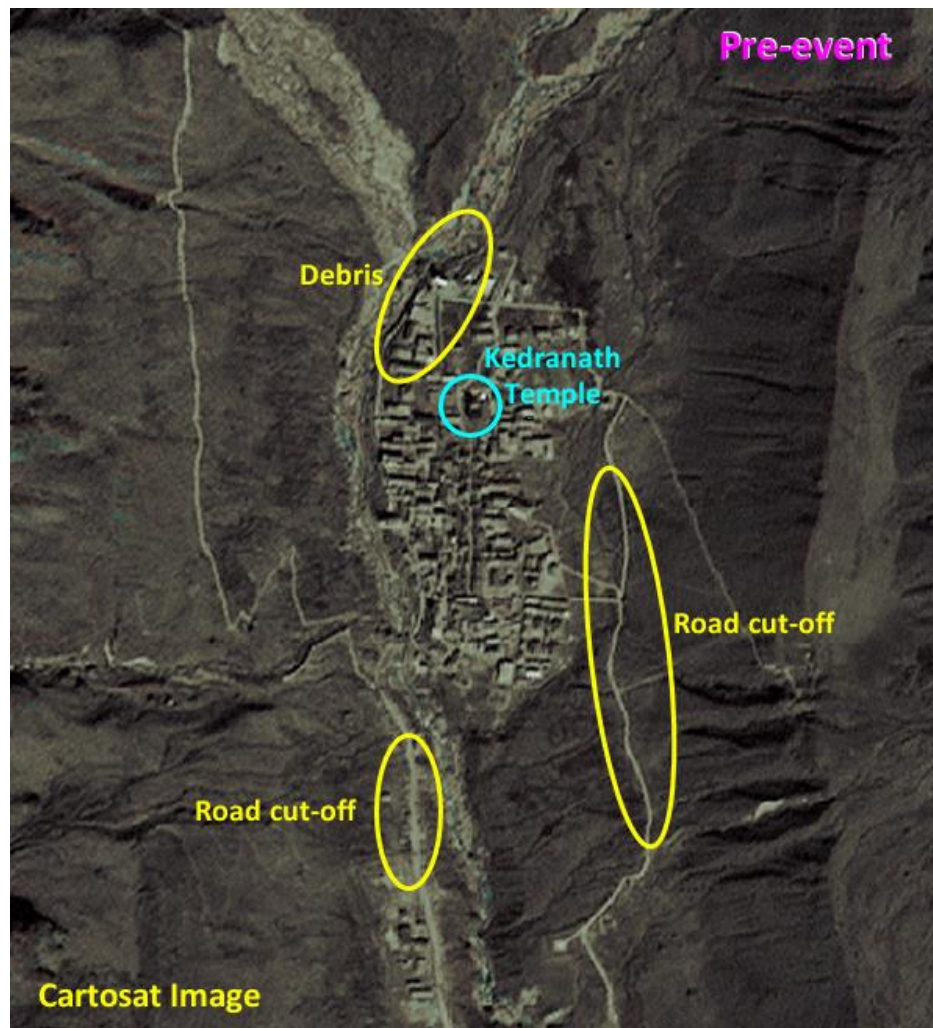


Digital Terrain Model – Shaded Relief Maps

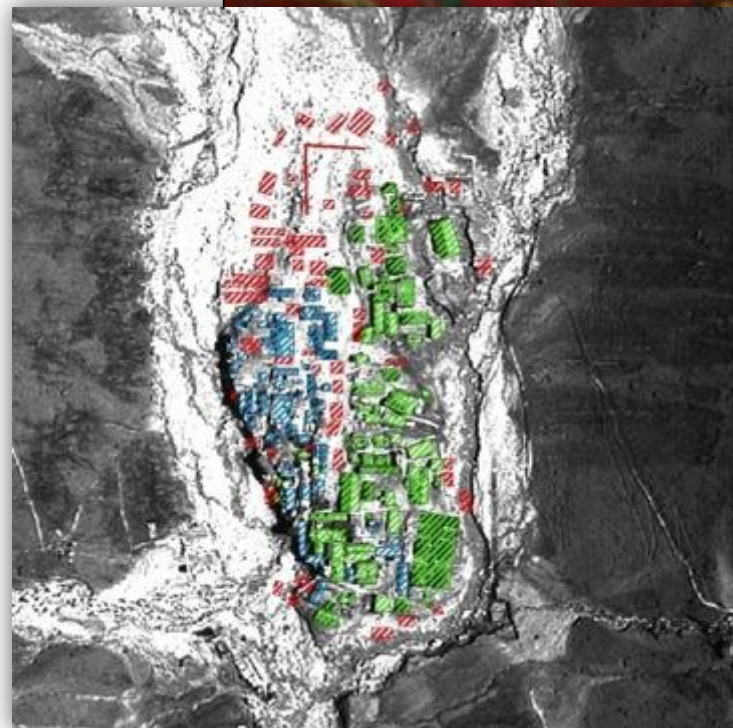
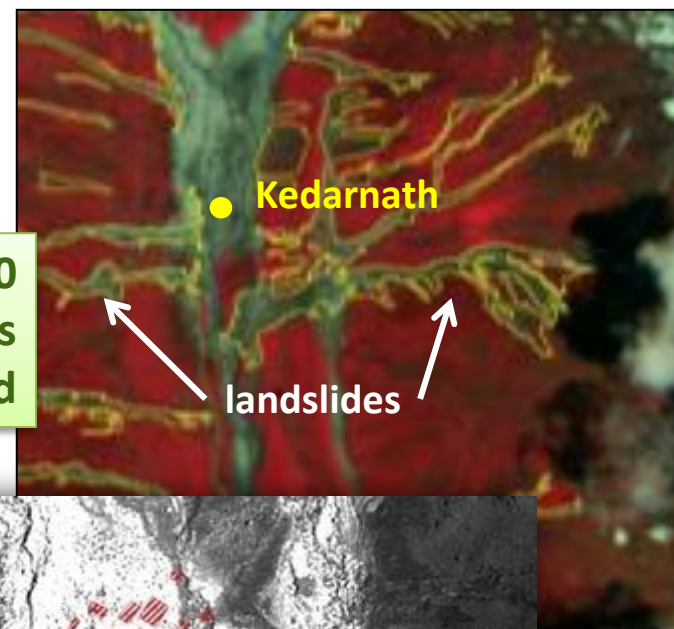


Damage Assessment – GIS analysis

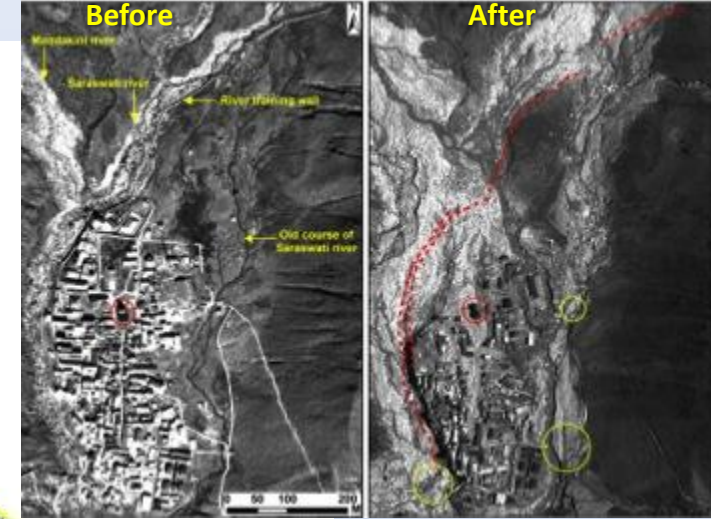
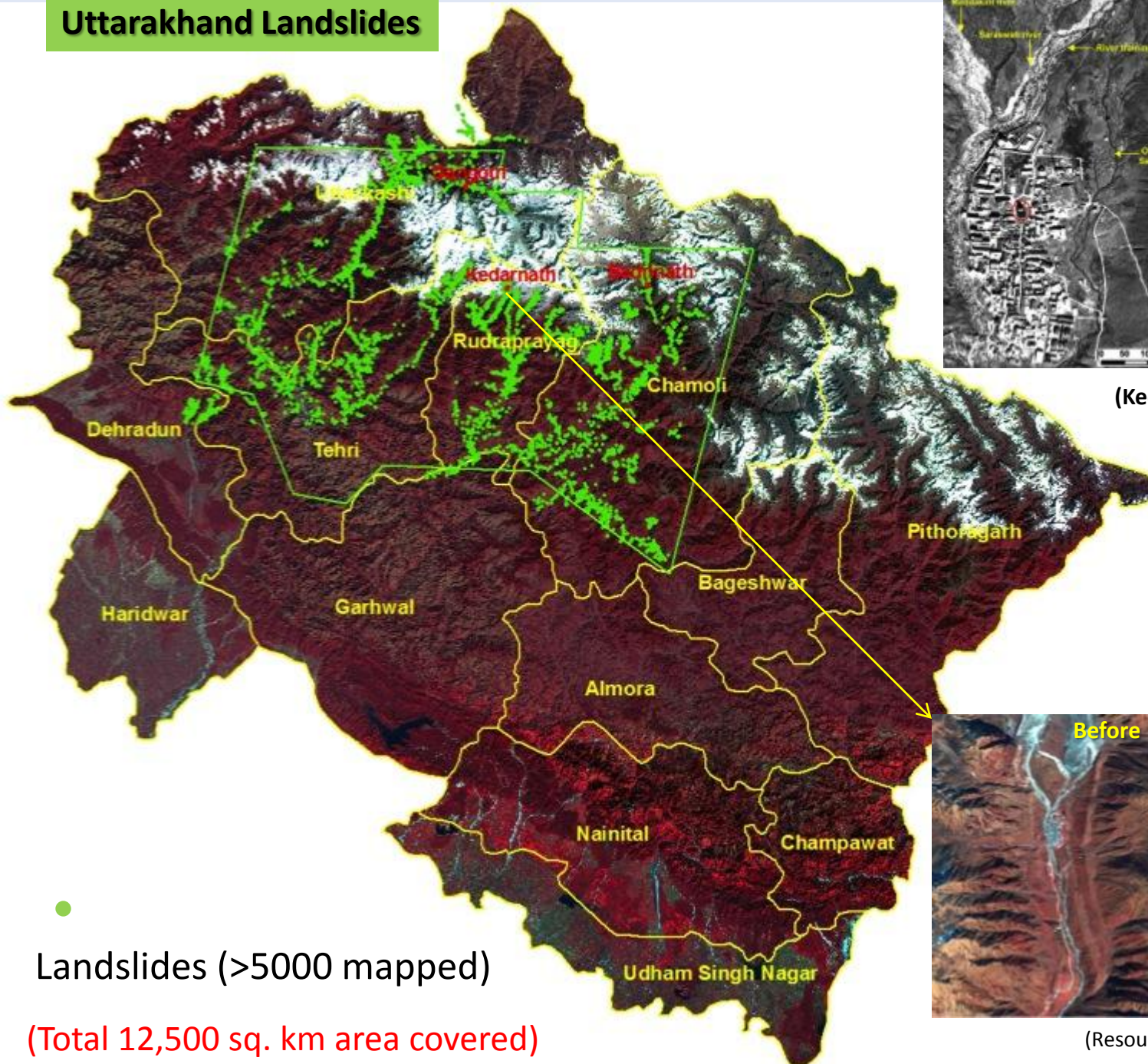
- Inundation, Damage, Landslides
- *Near real-time* info on Bhuvan Portal



> 5000
landslides
mapped



Uttarakhand Landslides



(Kedarnath town)



(Resourcesat-2 LISS IVNx)

●
Landslides (>5000 mapped)
(Total 12,500 sq. km area covered)

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

Collaboration Portal x + manu.php ☆ Google

Lat, Lon(ex: chei) Go

Mapping the Neighbourhood in Uttarakhand (MANU)

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

Uttarakhand

Delhi

Haryana

Punjab

Uttaranchal

Shimla

Dehradun

Haridwar

Roorkee

Kashipur

Moradabad

Rudrapur

Rampur

Bareilly

Shahjahanpur

Pali

Mathura

Bharatpur

Agra

Aligarh

Faridabad

Gurgaon

New Delhi

Meerut

Rohtak

Bhiwani

Hisar

Sirsa

Barnala

Patiala

Ambala

Khanna

Chandigarh

Phagwara

Hoshiarpur

Batala

Patankot

Udhampur

Jammu

0 100 200 KILOMETERS

SAMSUNG DUOS

Enter any City or Place

Map the Neighbourhood in Uttarakhand (MANU)

Feature Type:

Point Line Polygon

Capture Point:

Pick Point Unpick Point

Point:

Take Photo

Photo Photo

Note: (*) are mandatory fields

Longitude (GAGAN):
[Enter here]

Latitude (GAGAN):
[Enter here]

Village Name: (*)
[Enter here]

Tehsil Name: (*)
[Enter here]

Mapping the Neighbourhood in Uttarakhand (MANU)



1 2

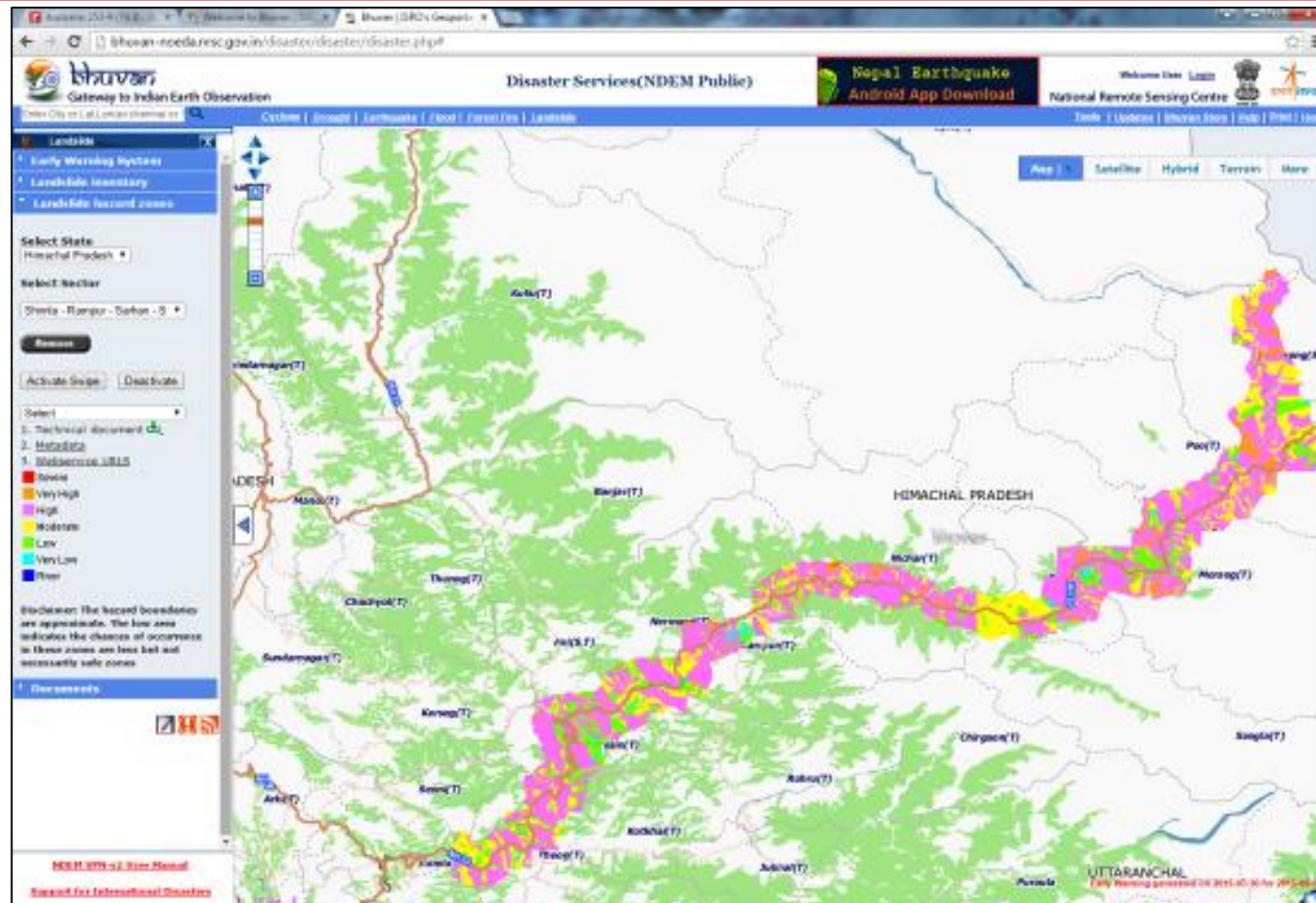
Sl.No	8400
thename:	MANU
profilename:	BhuvanPOI
observername:	ajay vipin shyam
org:	nrsc
creationtime:	2013-10-23 11:29:58
Ponit of Interest Category:	Guest House
About POI:	bharat seva asharam totally diartroyed by flood



1 2

Sl.No	8406
thename:	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:	destroyed after flooding flood makes tributary which suppose to damaged this lodge

Landslide Hazard Zonation Maps



Uttarakhand

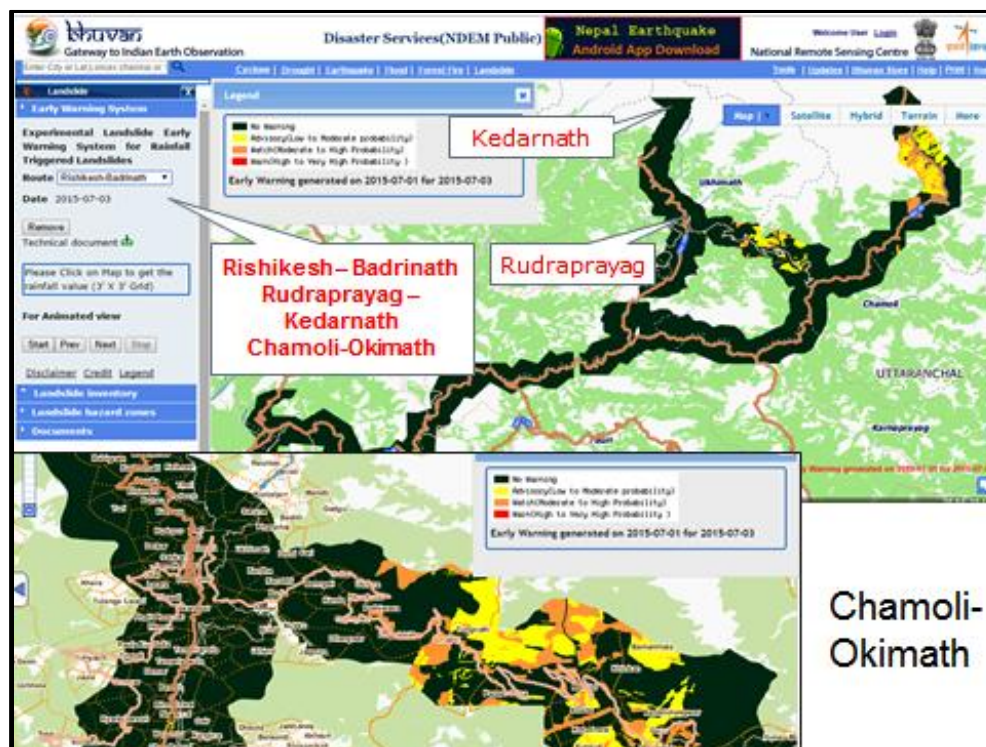
- Rishikesh-Uttarkashi-Gangotri-Gaumukh
- Rudraprayag-Okhimath-Kedarnath
- Rishikesh-Rudraprayag-Chamoli-Badrinath
- Pithoragarh-Khela-Malpa

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



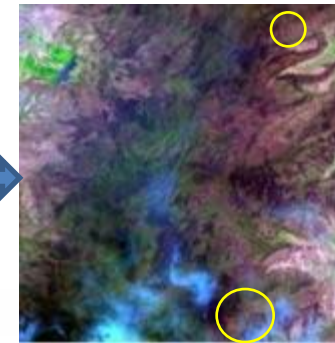
Daily acquisition of
TERRA/AQUA
MODIS data

~4 daytime
passes per day



Generation of 2
daily Active
Fire Alerts

Special
contextual Fire
Algorithm-
Deployed



Value additions
•Forest Mask
•Forest
Admin.
overlay

Disaster Management Support
Programme

Decision Support
Center

Indian Forest Fire Response
and Assessment System
(INFRRAS)

Feeda
ck

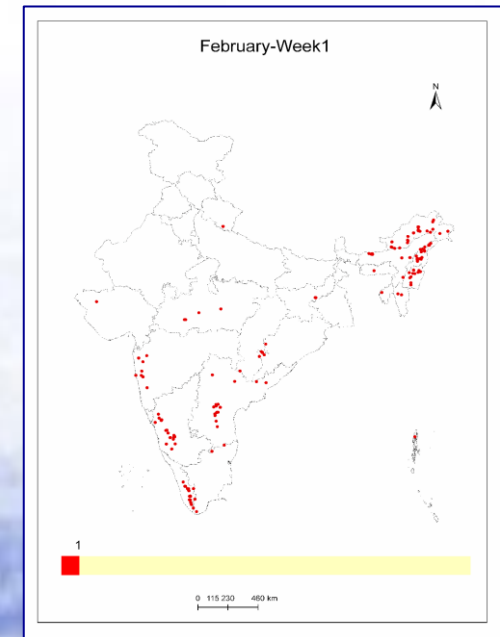


Fire map
Visualization
through
BHUVAN

Email
Dissemination
to ~400 nodal
officers

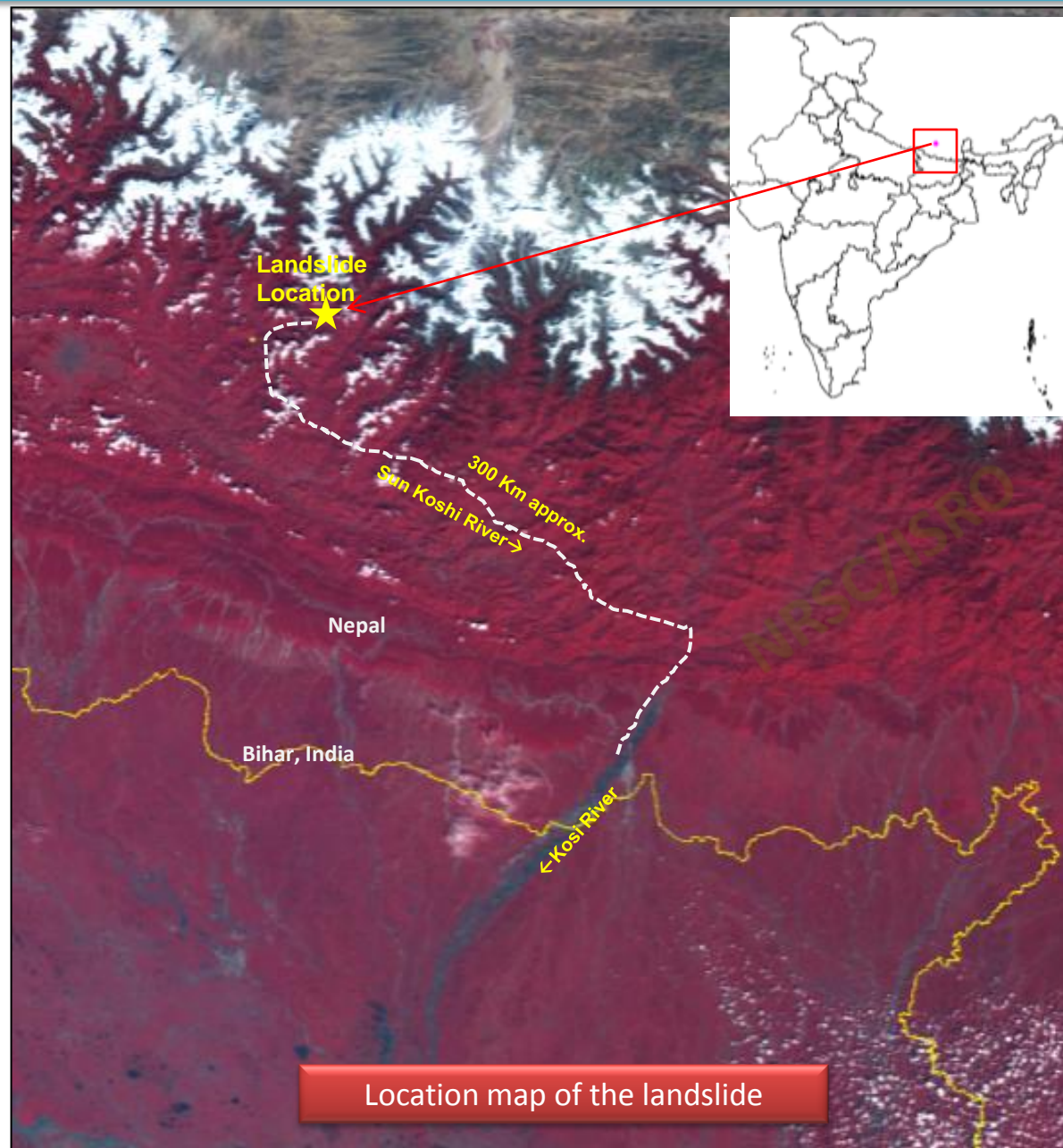
Turn-around time
of less than 1 hr
from satellite
overpass

Information to
ground
personnel for
fire mitigation



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.



Landslides on Transboundary Rivers

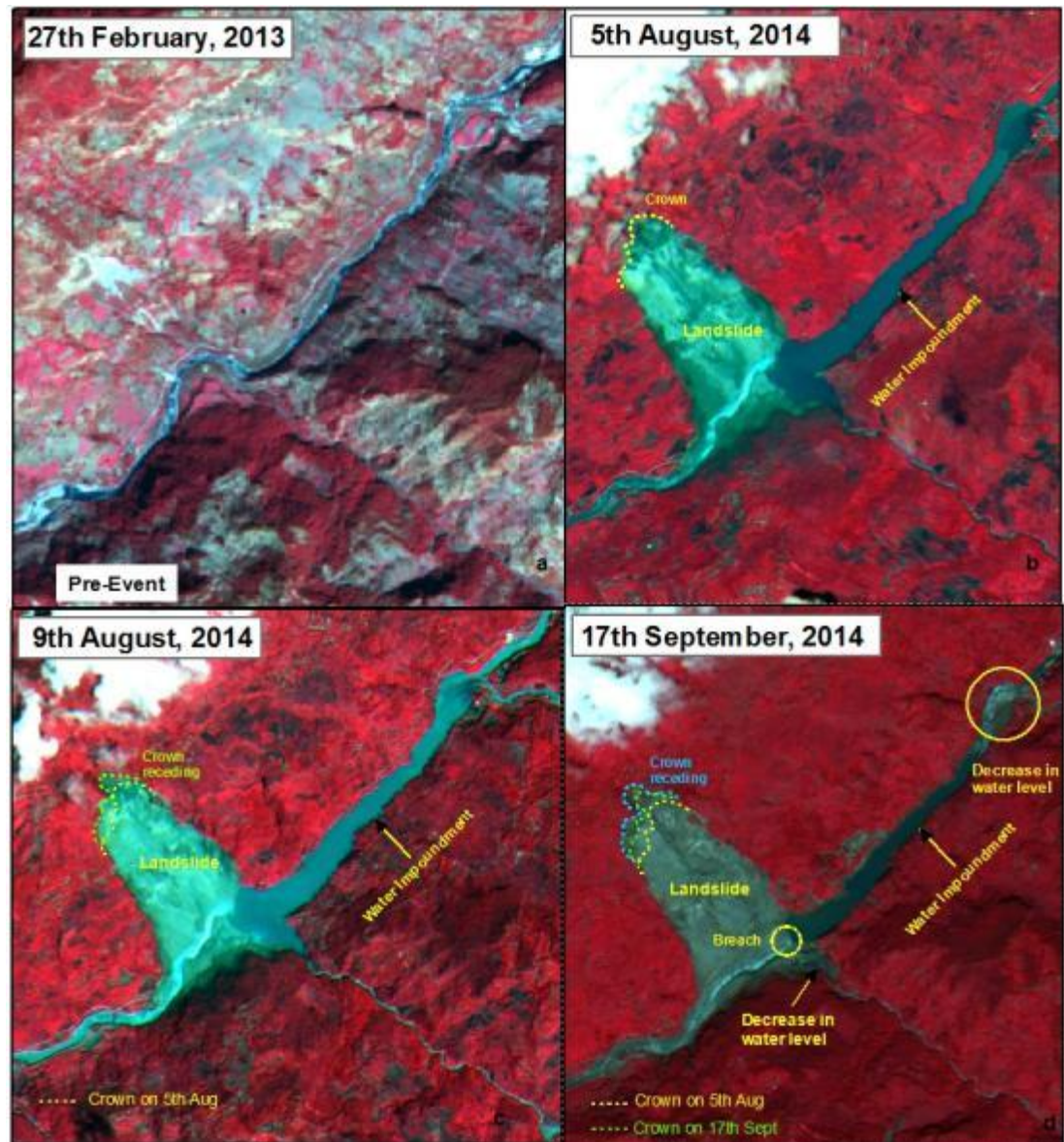
Sun Koshi River in Nepal

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

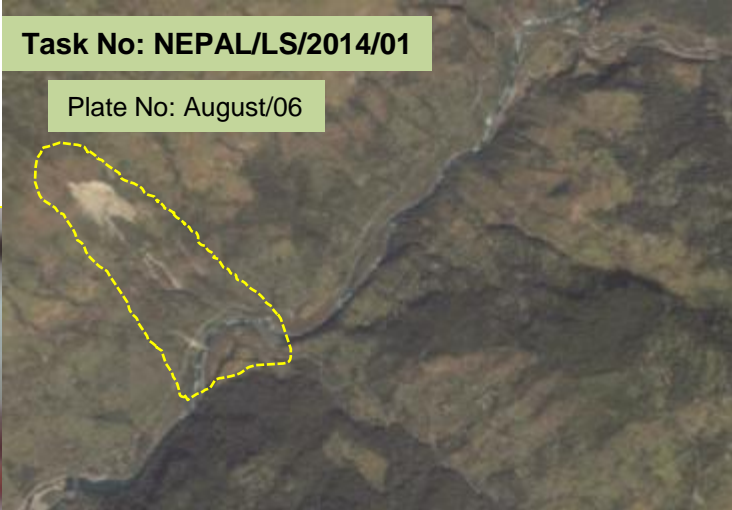
Water Impoundment was observed initially and in September, this impoundment was reduced due to human interventions through controlled blastings

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



Landslide on Sunkoshi river, Nepal

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

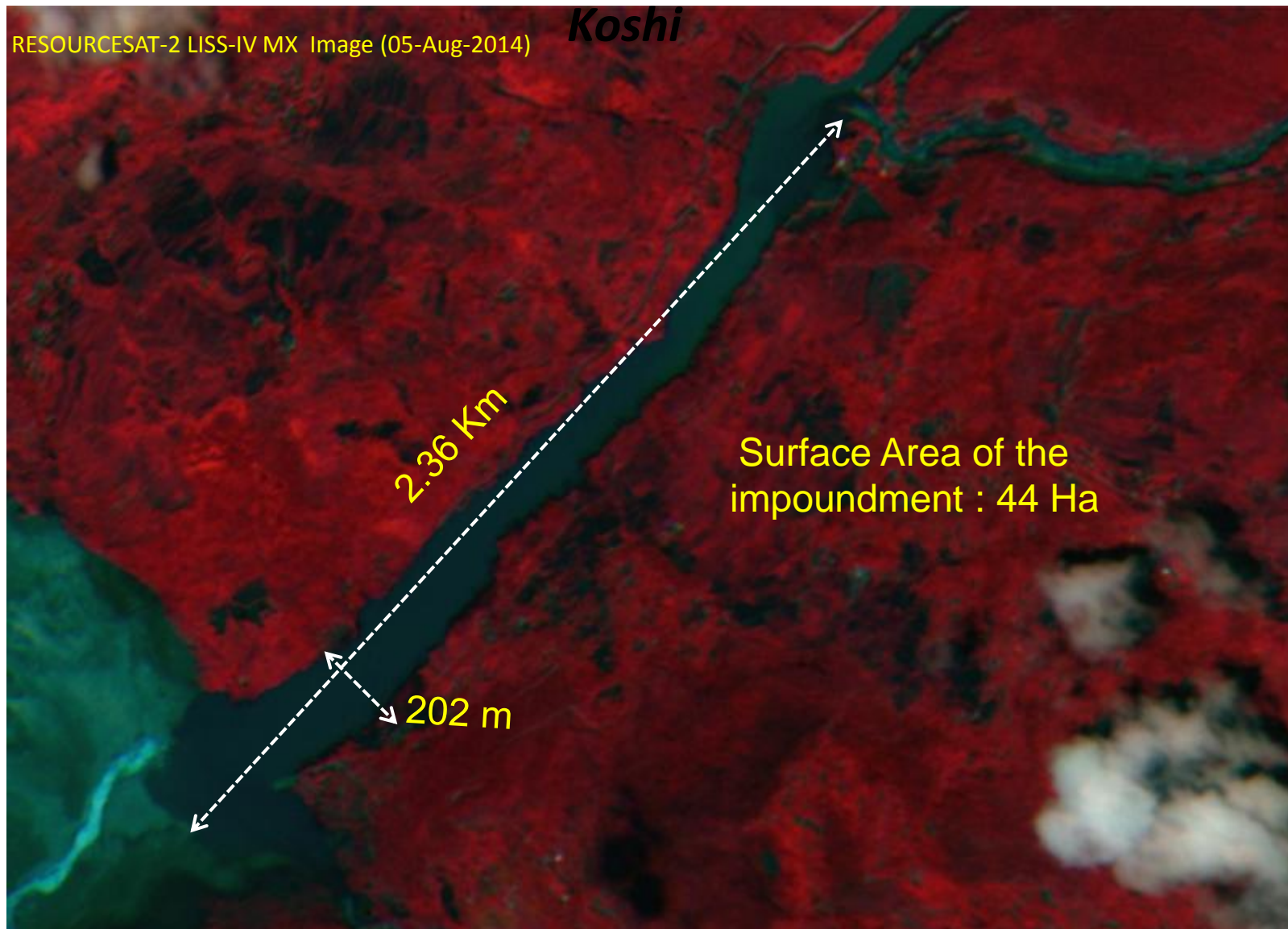


- The landslide that blocked the Sunkoshi river, is a deep seated rockslide (length 1.3 km and width 0.652 km) resulting in formation of a dammed lake
- The debris and boulders has blocked the river and moved onto the river terrace on the opposite bank.
- Analysis of historical imagery shows that it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

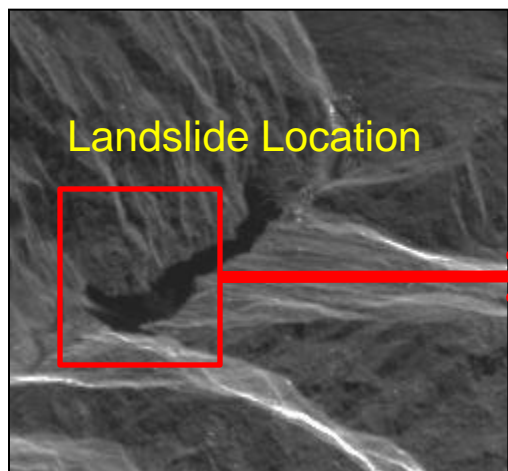


Nepal – Landslide on River Sun Koshi

Details of the Impoundment on River Sun



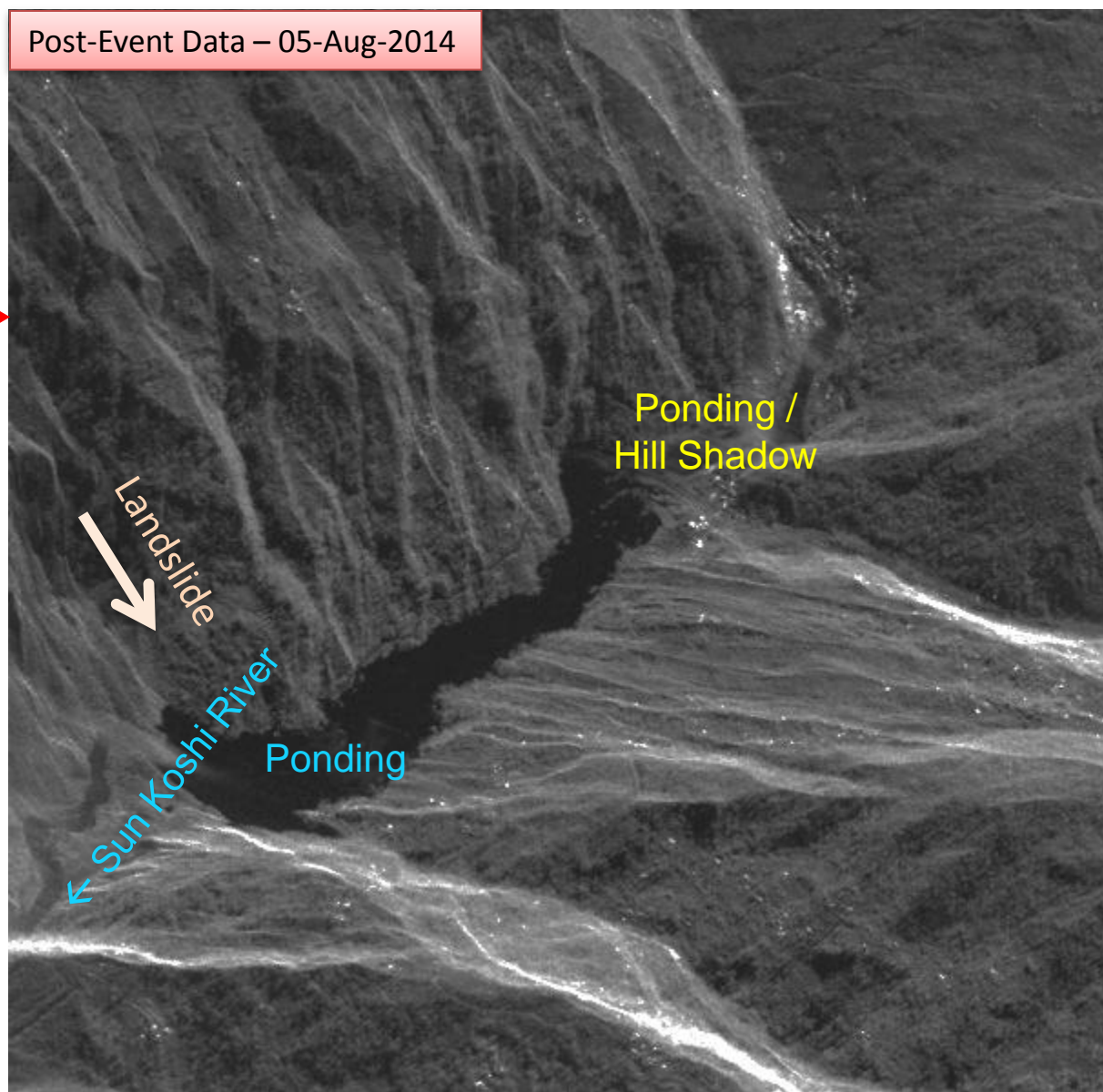
RISAT-2 Image showing Landslide on River Sun Koshi



RISAT-2 SAR data

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

Post-Event Data – 05-Aug-2014



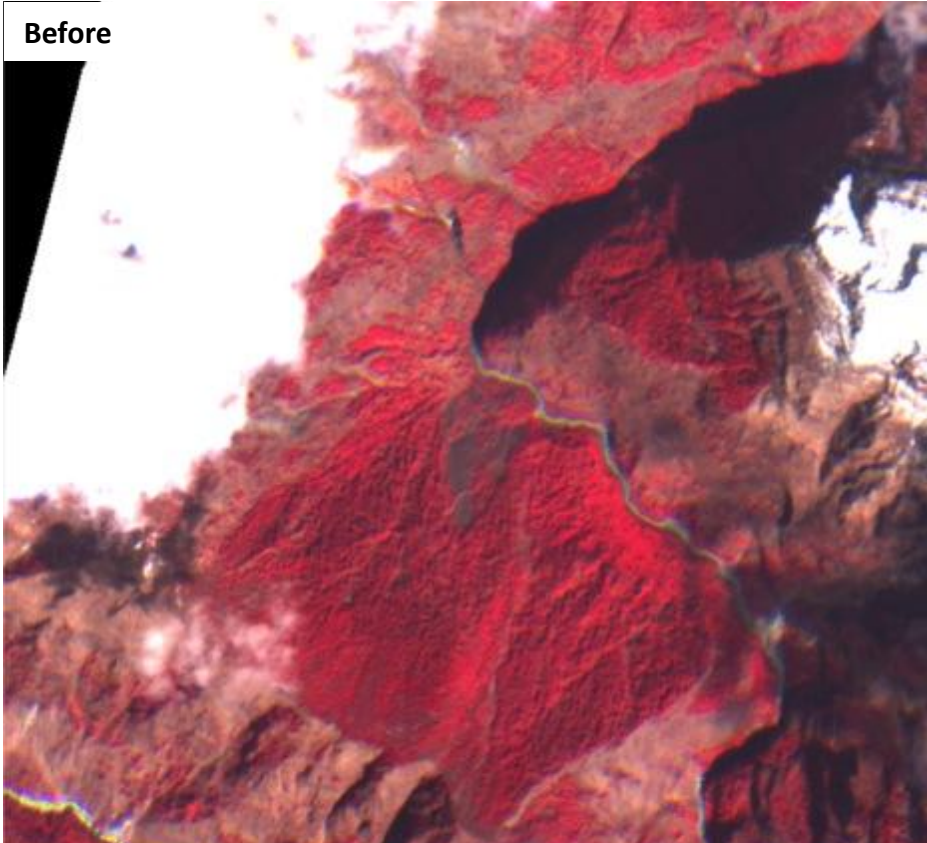
* Due to undulations, the layover, fore-shortening and hill-shadows affects are observed

Artificial Lake formation

Landslide Blocking the Valley

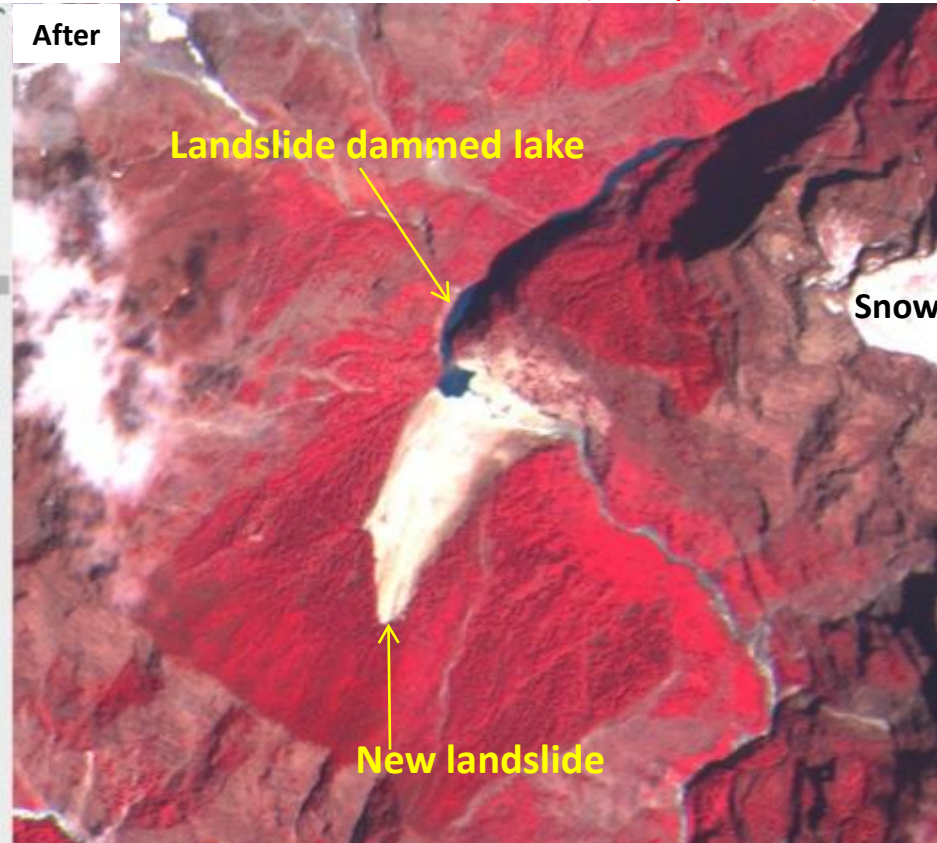
Resourcesat-2 LISS IV mx (01-Apr-2015)

Before



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

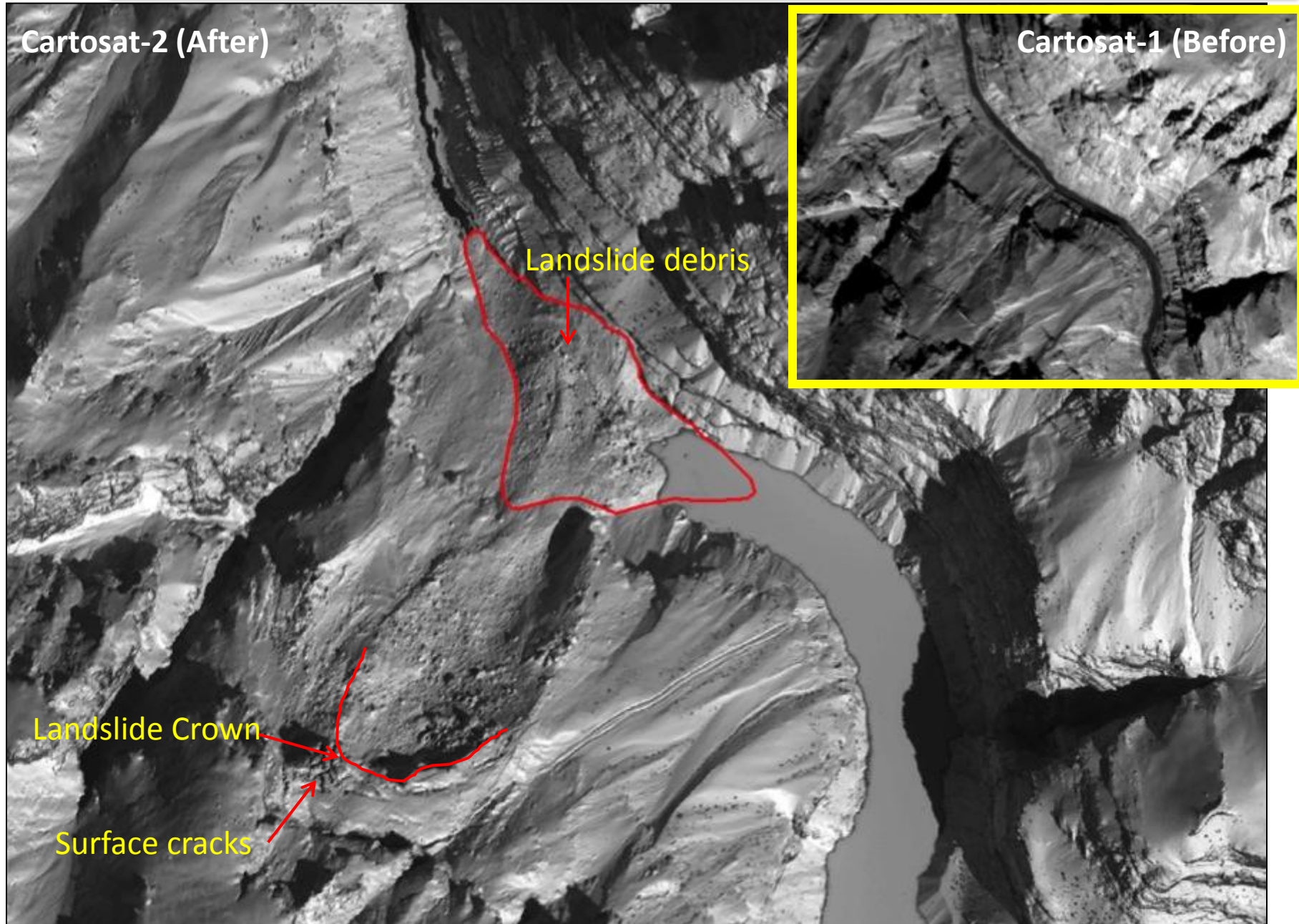
After



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..

Cartosat-2 (After)



Cartosat-1 (Before)

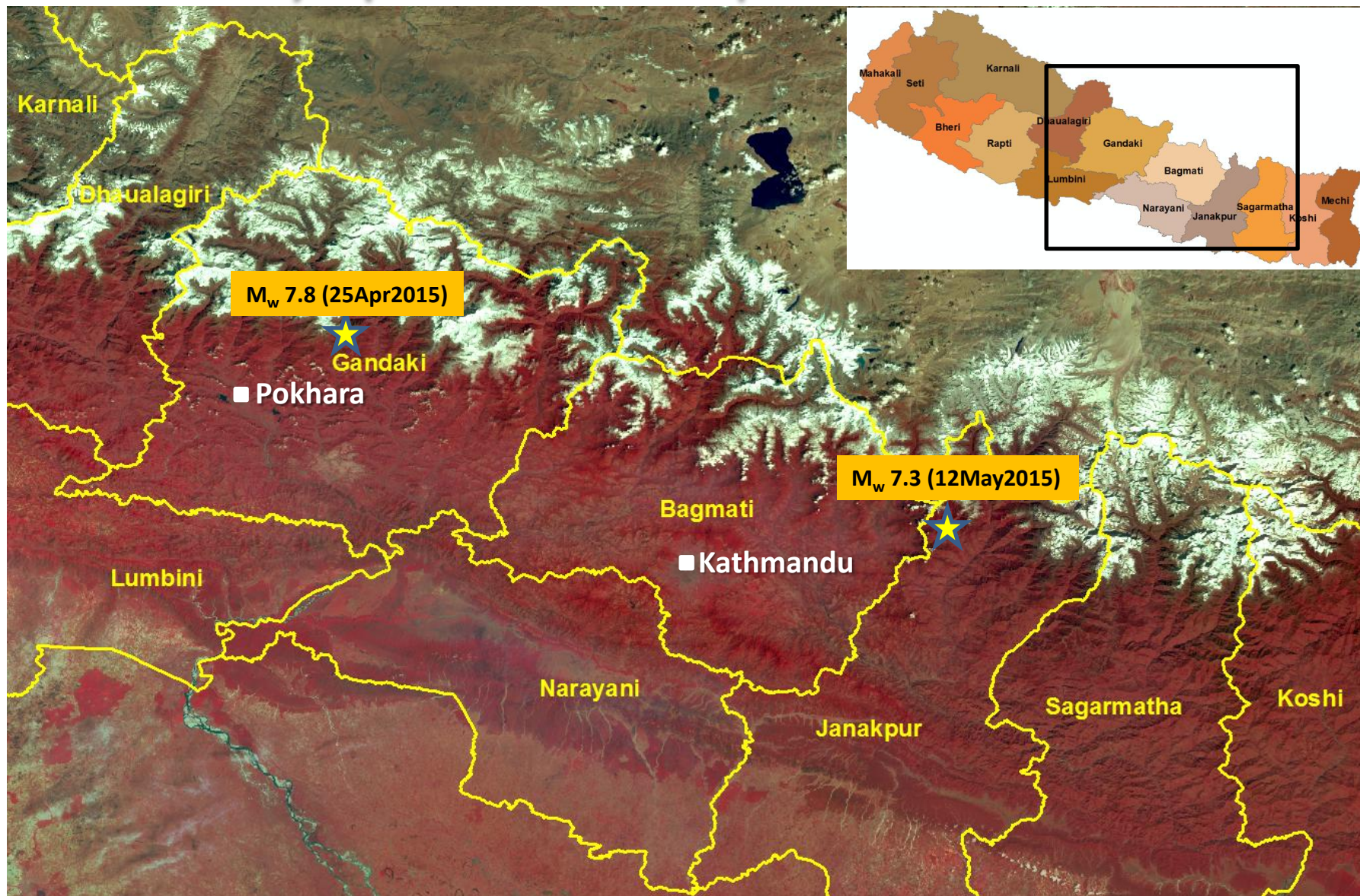
Landslide debris

Landslide Crown

Surface cracks

Nepal Earthquake – April, 2015

Synoptic View of Earthquake affected area



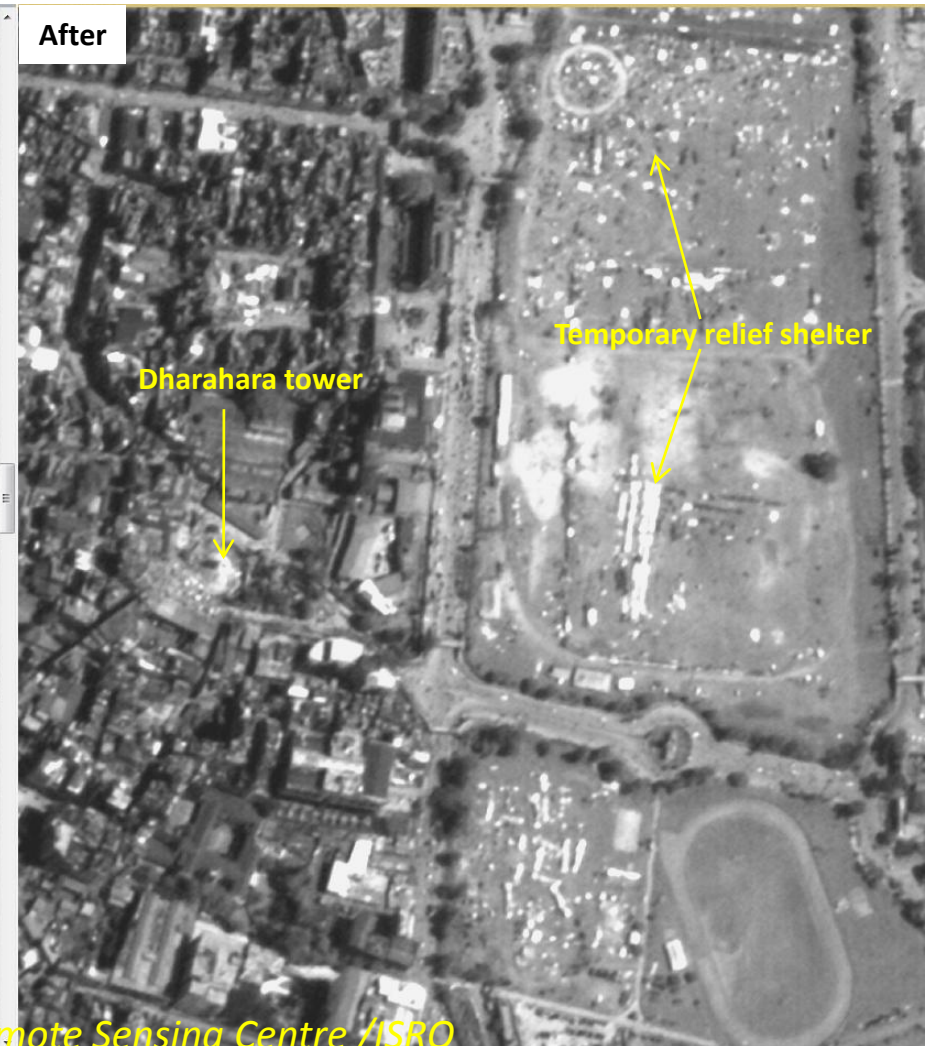
Nepal Earthquake – April, 2015

Dharahara Tower, Kathmandu

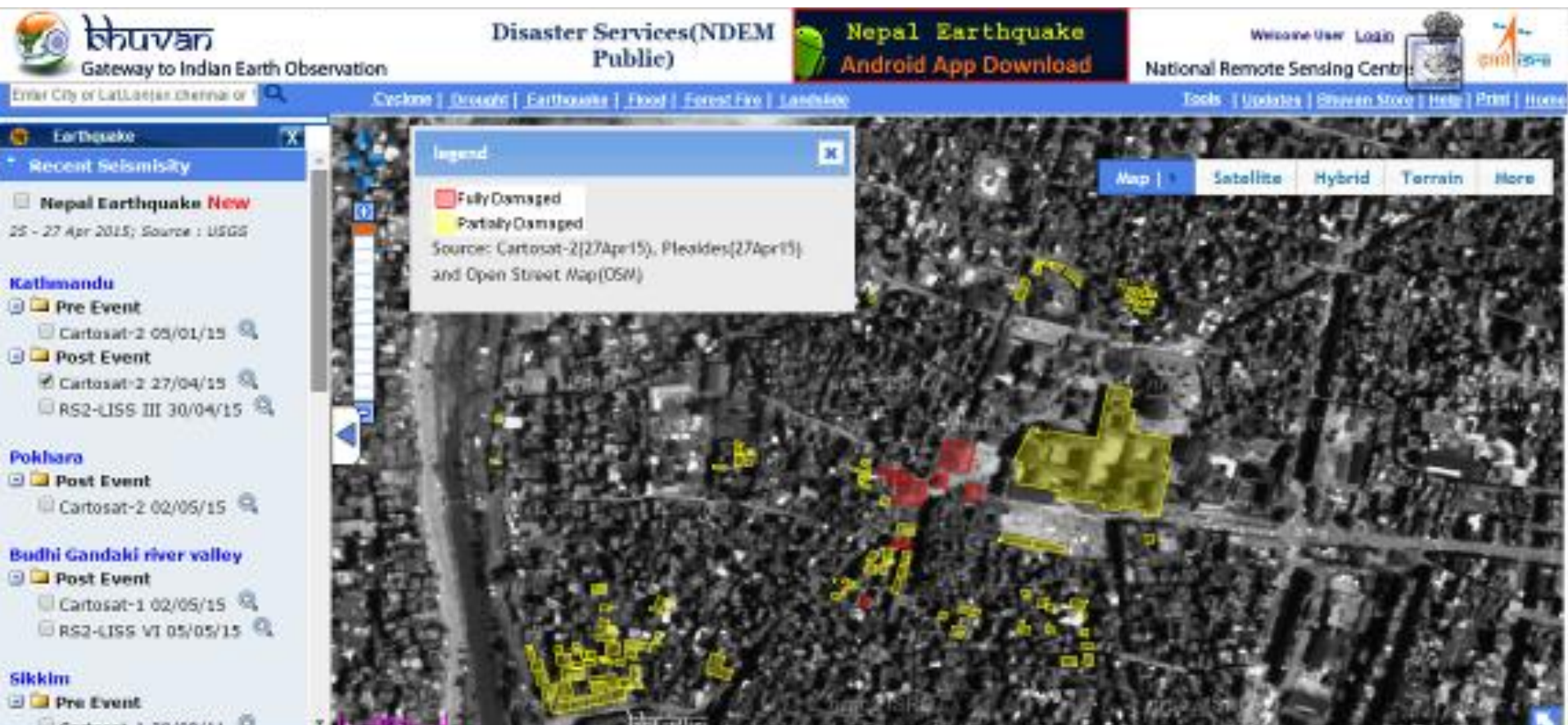
Cartosat-2 (05-Jan-2015)



Cartosat-2 (27-Apr-2015)



Nepal Earthquake – Damage Assessment

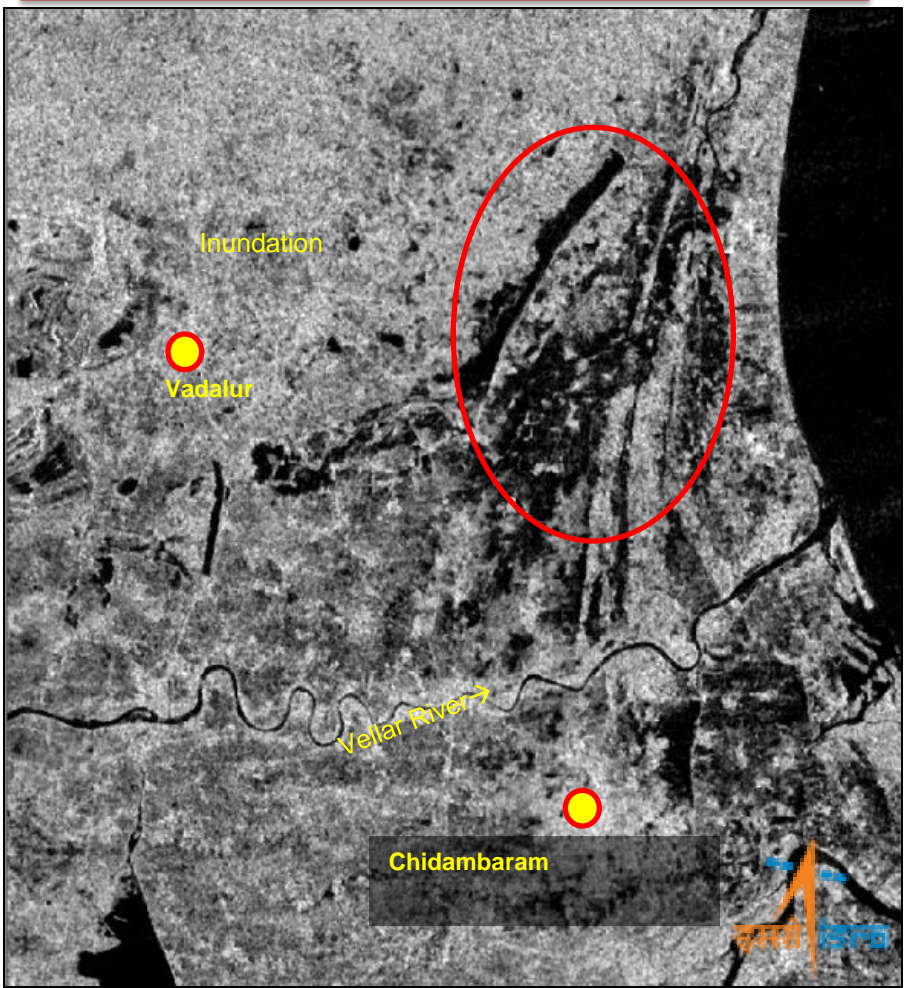


Chennai Flood Event

Before Event -RISAT-1 image



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



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

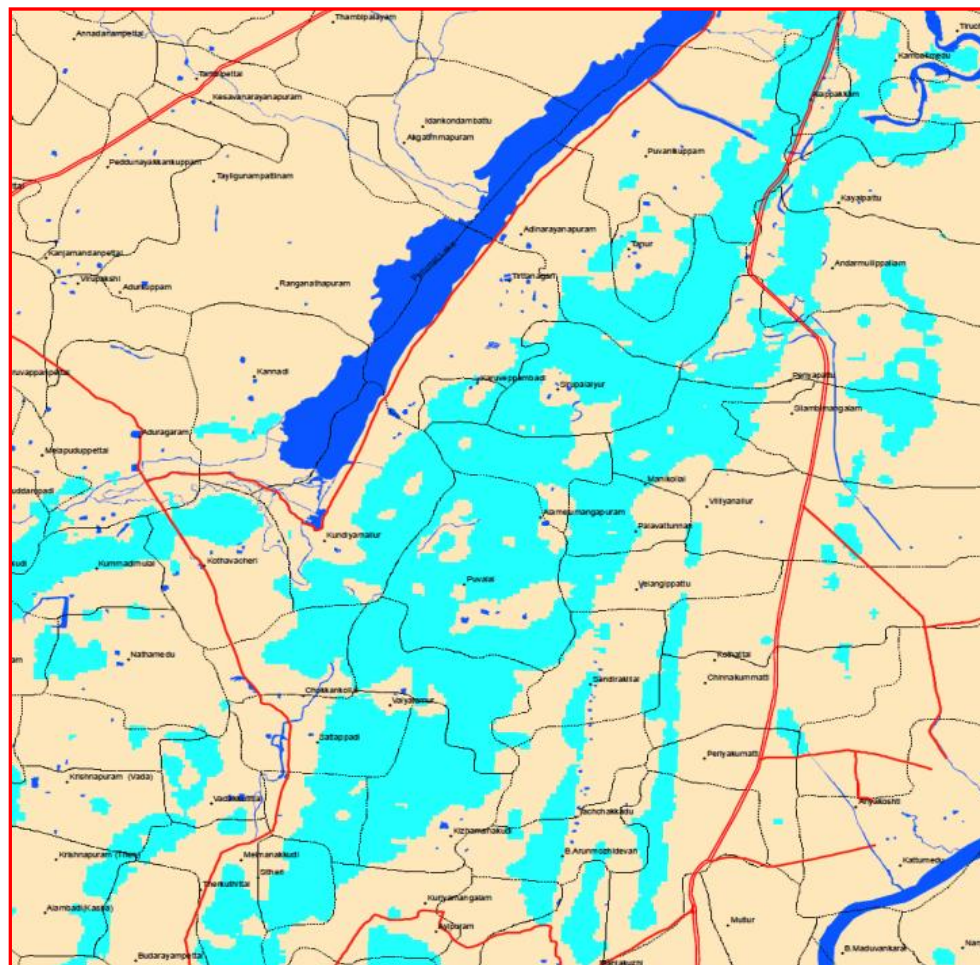


Flood maps Disseminated in near real-time

Before Event -RISAT-1 image



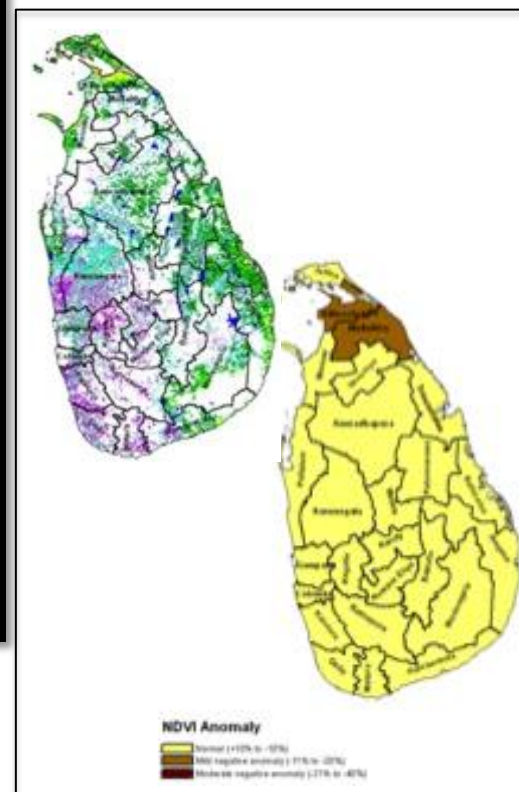
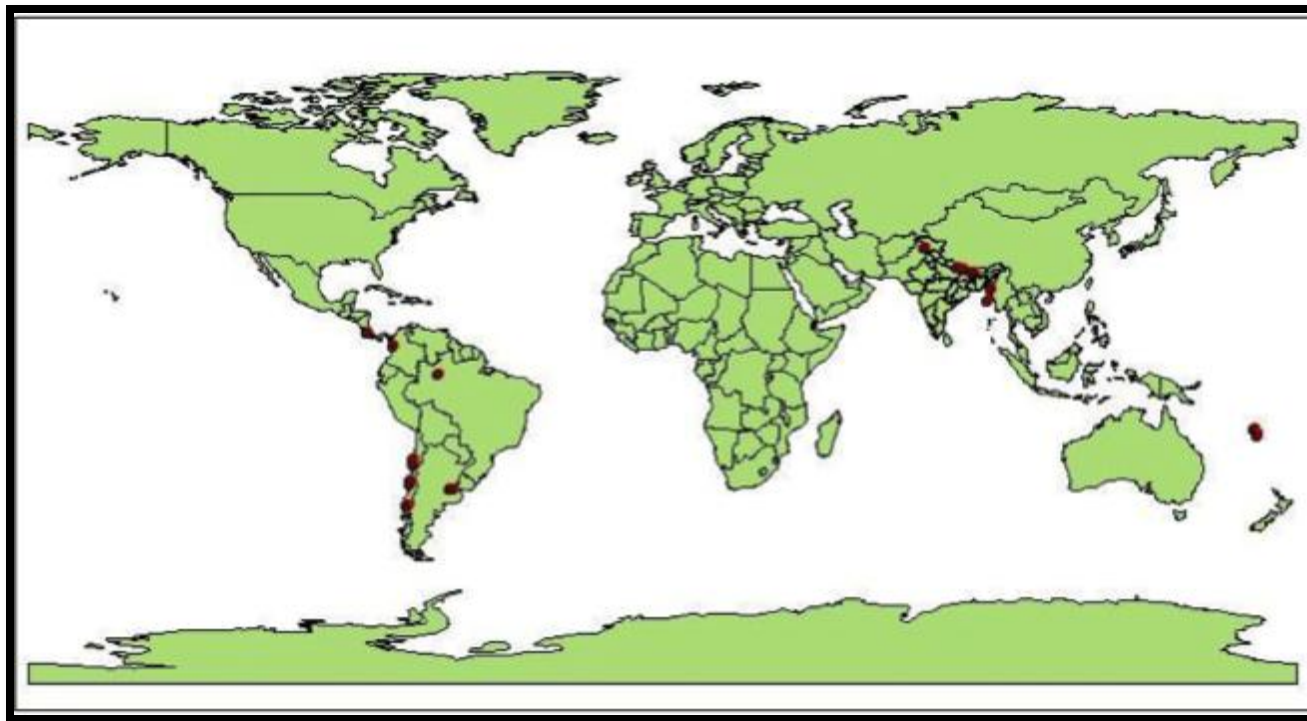
Flood map derived from Satellite data



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



International Charter – ISRO provided leadership during Apr – Oct 2015



ISRO's Support - 2015-16

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

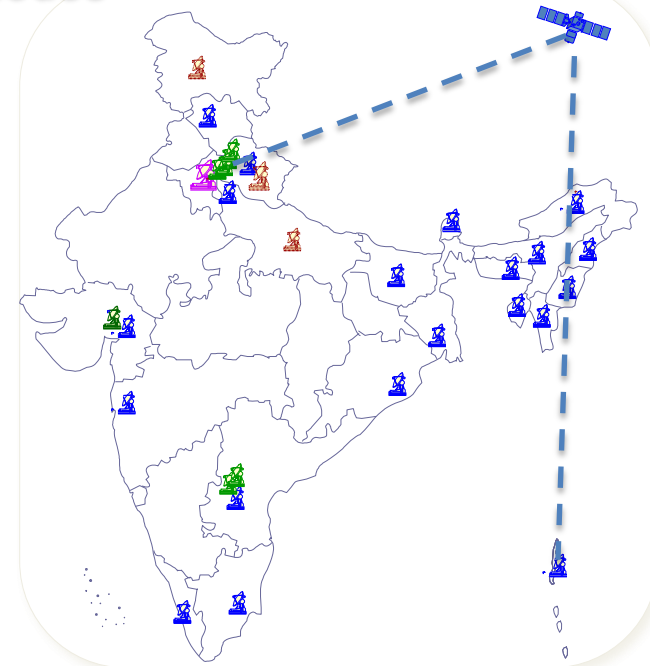
National Level Disaster Management – Way Ahead

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

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

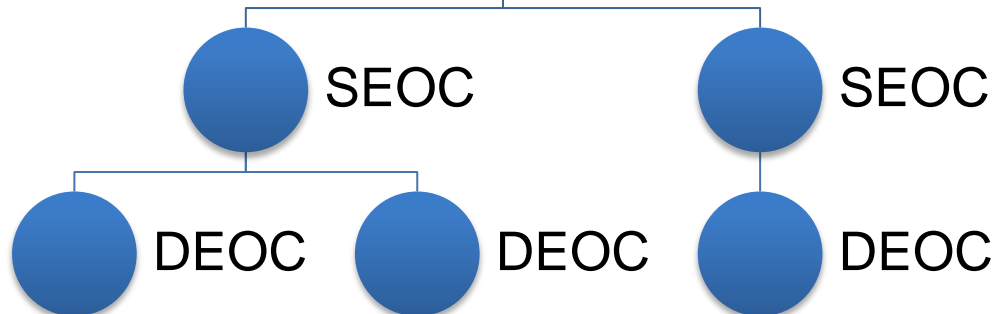
VPN Nodes with over 40 nodes – connecting 20 State nodes



Emergency Operations

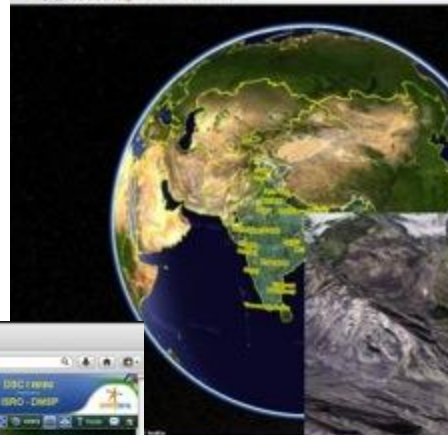
Centres

Control Centre

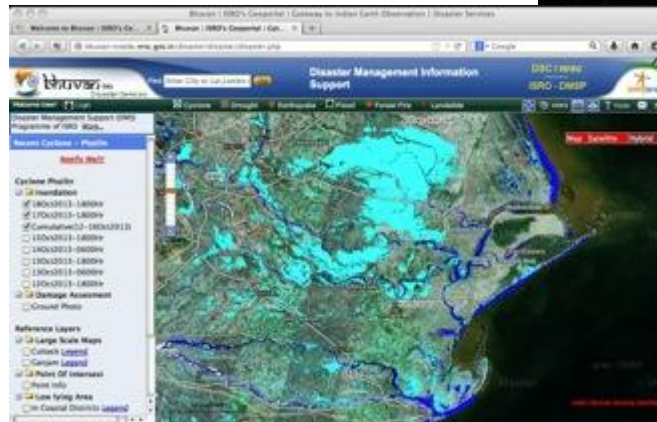


Web Site: www.nrsc.gov.in

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



terrain view with
S data and
element locations



Thank You

