Primary Data Analysis Node (P-DAN) Report

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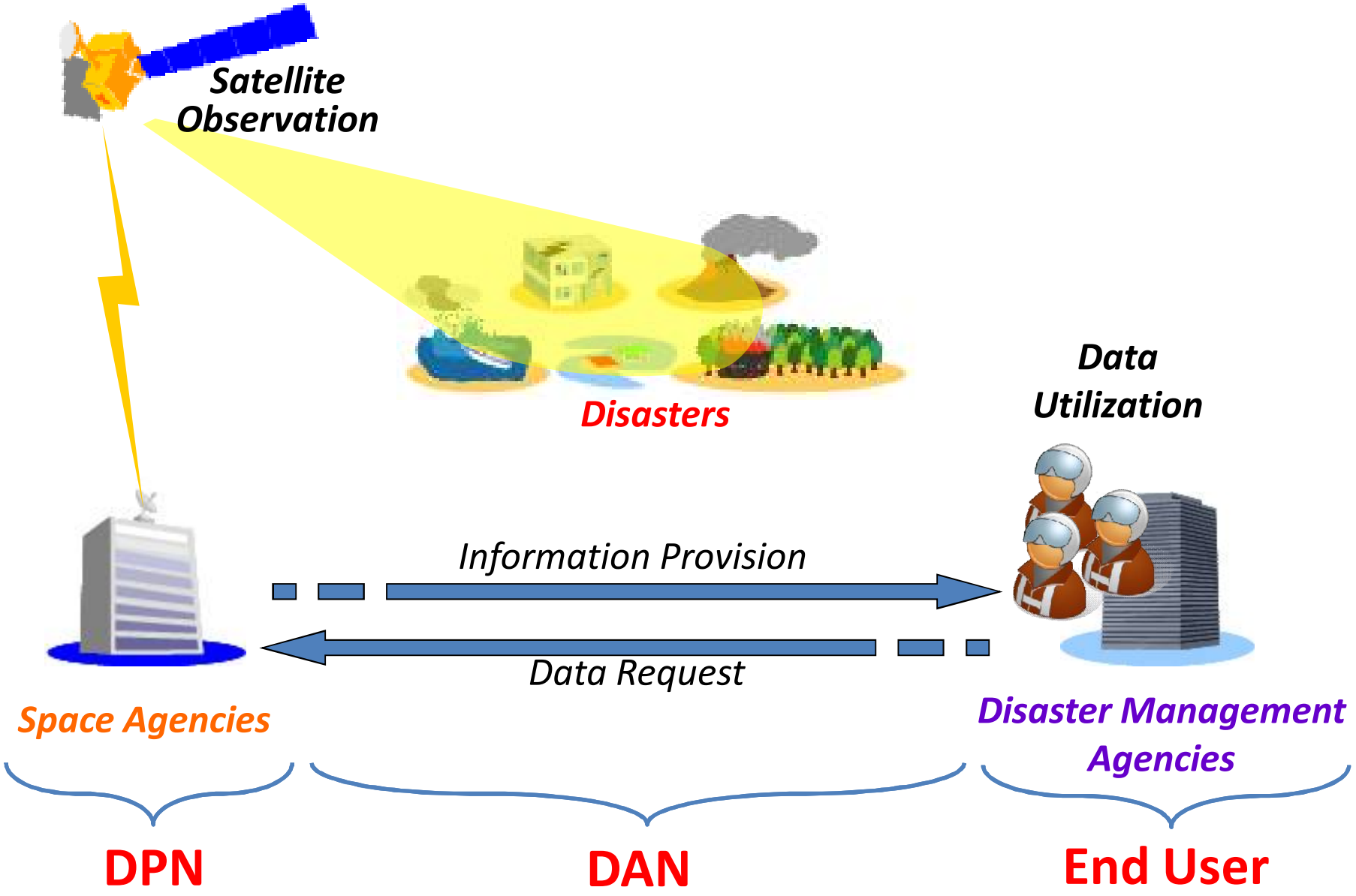
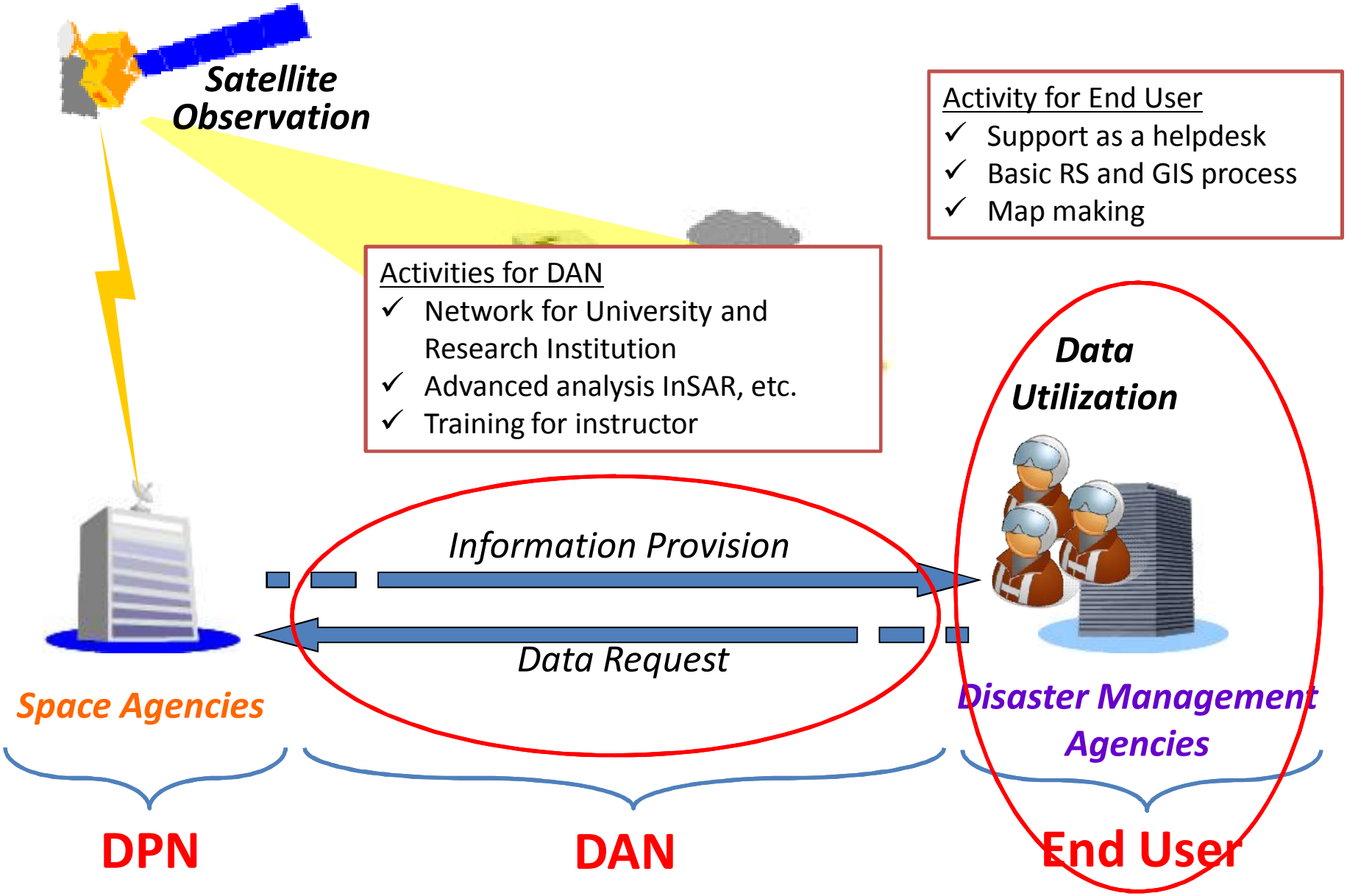
3rd Joint Project Team Meeting for Sentinel Asia STEP3 (JPTM2016)

Concept of Sentinel Asia



P-DAN Activity of Sentinel Asia



Strategy of Capacity Building

Disaster Management Agencies

Narrow network,
Low visibility

Network for Universities and Research Institutions

University of Tokyo

Keio University

Tokyo University of Marine Science and Technology

AIT

University of Philippines

Indonesia University

Chulalongkorn University

National University of Laos

etc.

Strategy of Capacity Building

Disaster Management Agencies

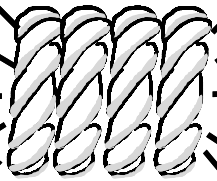




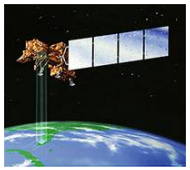




Cloud-based System for Archive, Integration and Analysis



Satellite data



Network for Universities and Research Institutions

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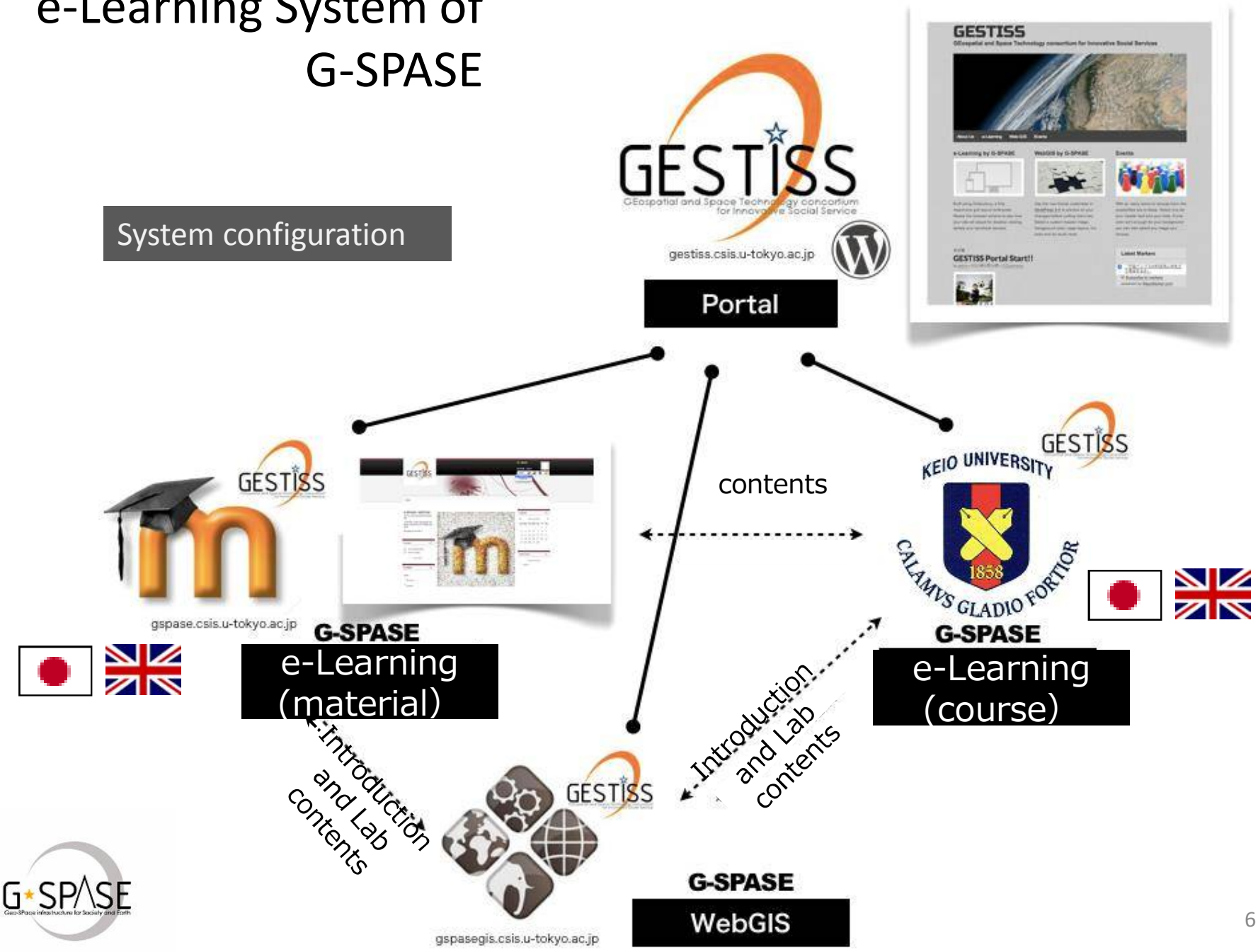
etc.

e-Learning System of G-SPASE

System configuration



SAR Interferometry

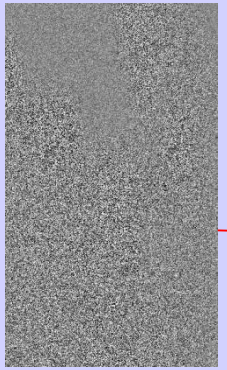
Preprocess

Registration

Interferogram Generation

Phase Unwrapping

Geocoding



SAR processing

RAW data

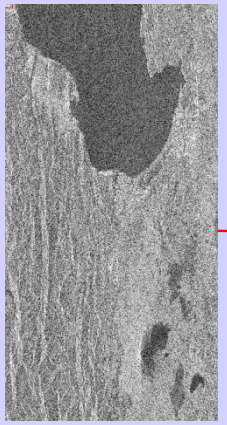
Sensor Parameter

Processing Parameter

Range Doppler processing

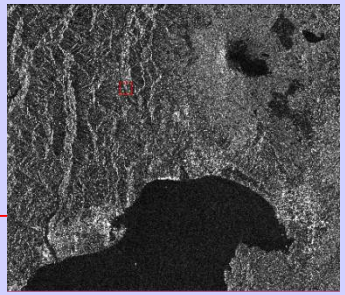
Range Compression

Azimuth Compression



Single look complex (SLC)

Multi look image



SAR Interferometry

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Co-registration of SLC Data: co-registration is the process of fitting one SAR image accurately upon another SAR image. Co-registration of complex images involves two steps.

1) the location of each pixel in the slave image is changed with respect to the master image.

2) the amplitudes and phases of the sensors are recalculated by interpolation.

GMTSAR is used for this research using cross correlation algorithm (*xcorr) for registration. "xcorr" uses w*indow size of 64 pixels and has never failed to provide accurate co-registration even in cases where the interferometric coherence is close to zero.

SAR Interferometry

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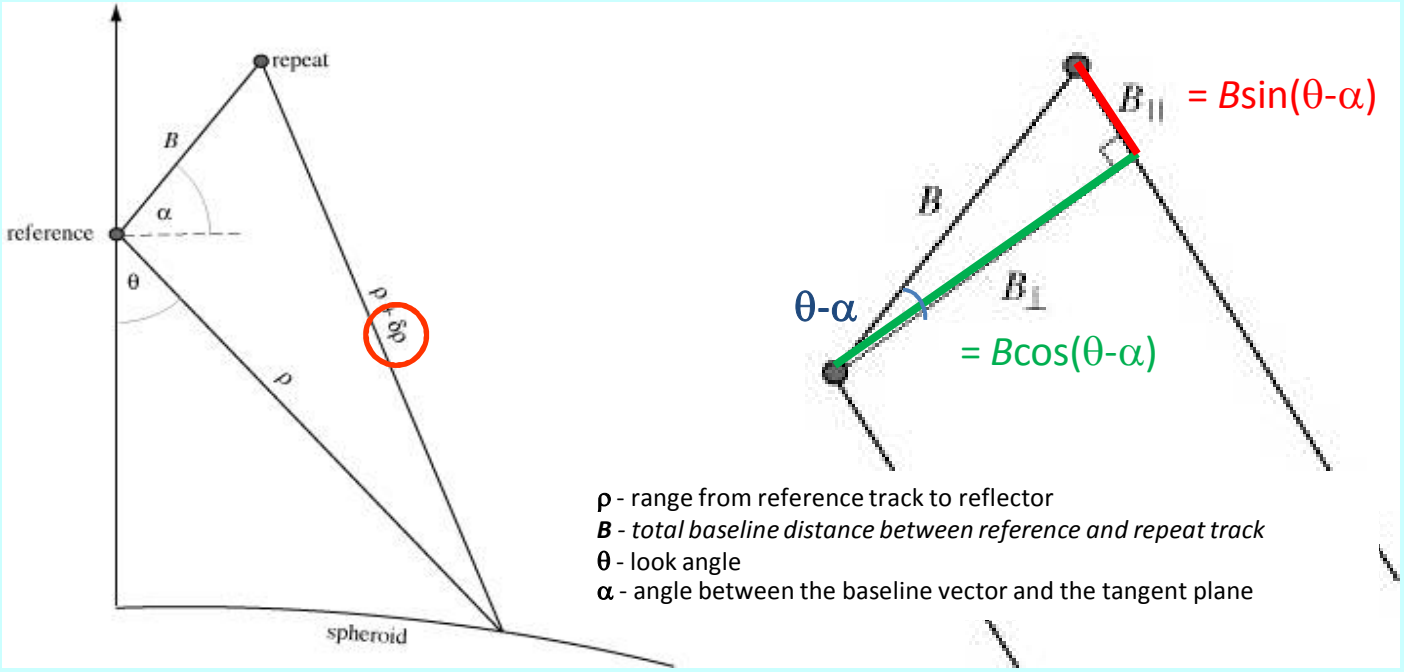
Concept of repeat orbit interferometry



ρ - range from reference track to reflector
B *- total baseline distance between reference and repeat track*
θ - look angle
α - angle between the baseline vector and the tangent plane

The phase difference ϕ to point on the ground is related to the range difference $\emptyset = \frac{4\pi}{\lambda}\delta\rho$;Therefore $\emptyset = \frac{4\pi}{\lambda}B\sin(\theta - \alpha)$

SAR Interferometry

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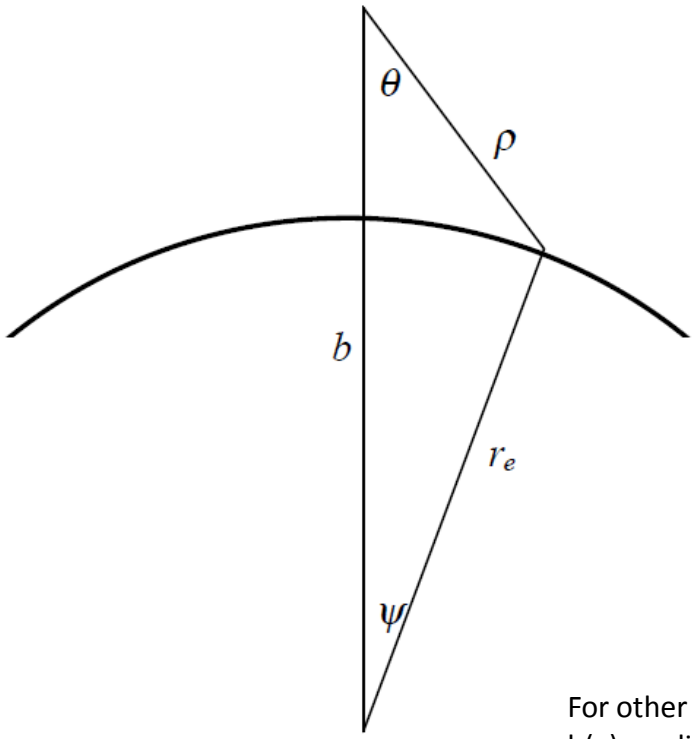
Correction of earth curvature and topographic phase



Using the Law of cosines one finds

$$\eta = \cos\theta = \frac{\left(b^2 + \rho^2 - r_e^2\right)}{2\rho b}$$

Interpolate the topography

$$\theta = \cos^{-1}\left\{\frac{\left(b^2 + \rho^2 - \left(r_e + t(\rho,a)\right)^2\right)}{2\rho b}\right\}$$

topography (range, azimuth)

For other information, it can be computed from SAR data
b(a) - radius of the spacecraft orbit for the reference image
B(a) - the length of the baseline
α(a) - the orientation of the baseline

SAR Interferometry

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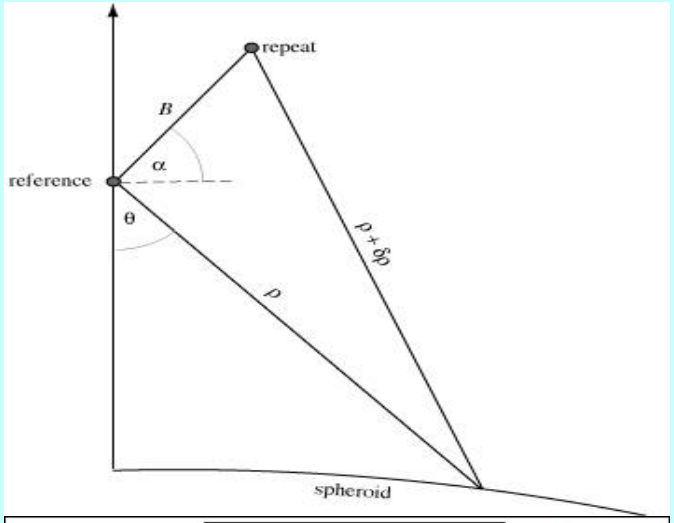
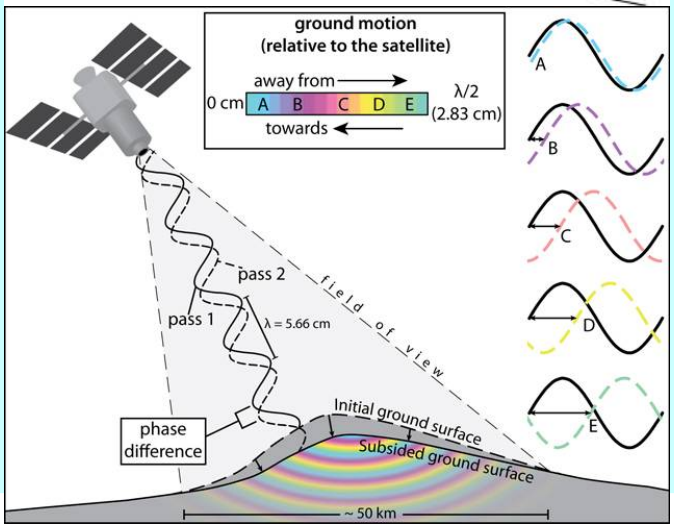
Phase due to earth curvature and topography





Law of cosine

$$(\rho+\delta\rho)^2 = \rho^2 + B^2 - 2\rho B\sin(\theta-\alpha)$$

$$2\rho\delta\rho + \delta\rho^2 = B^2 - 2\rho B\sin(\theta-\alpha)$$

It can be rewritten as

$$\delta\rho = -B\sin(\theta-\alpha) + \frac{1}{2\rho}\left(B^2 - \delta\rho^2\right)$$

$\delta\rho = -B\sin(\theta-\alpha)$

It can be rewritten as

$$\delta\rho = -B\sin(\theta-\alpha) + \frac{B^2}{2\rho}\left[1-\sin^2(\theta-\alpha)\right]$$

or

$$\delta\rho = -B\sin(\theta-\alpha) + \frac{B^2}{2\rho}\cos^2(\theta-\alpha)$$

Phase to range = $\phi = \frac{4\pi}{\lambda}\delta\rho$

$$\phi = -\frac{4\pi B}{\lambda}\sin(\theta-\alpha) + \frac{2\pi B^2}{\lambda\rho}\cos^2(\theta-\alpha)$$

Reference: GMTSAR (2011)

SAR Interferometry

Preprocess

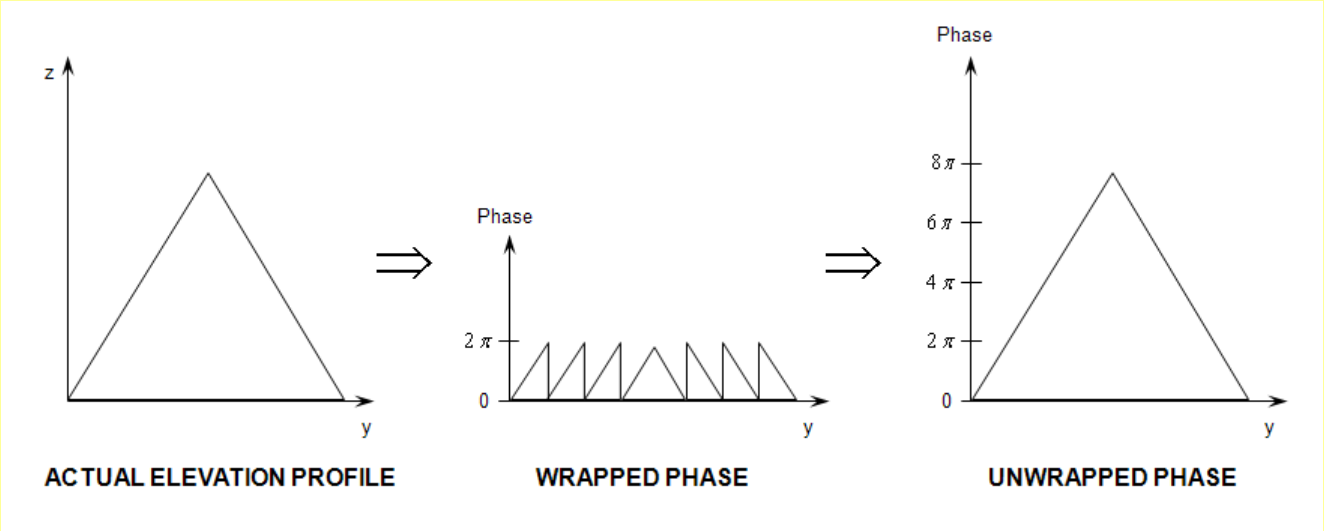
Registration

Interferogram Generation

Phase Unwrapping

Geocoding

Phase unwrapping: The interferometric phase shows many discontinuities, which originate the classical fringe pattern. The interferometric phase is almost linearly proportional to the topographic height. The difficulty is that the interferometric phase is only known to module 360 degrees. If the phase variation exceeds 360 degrees, it wraps around to 0 degrees. It is necessary to unwrap the phase in the interferogram by using several algorithms for converting the interferometric phase to topographic phase.



SAR Interferometry

Preprocess

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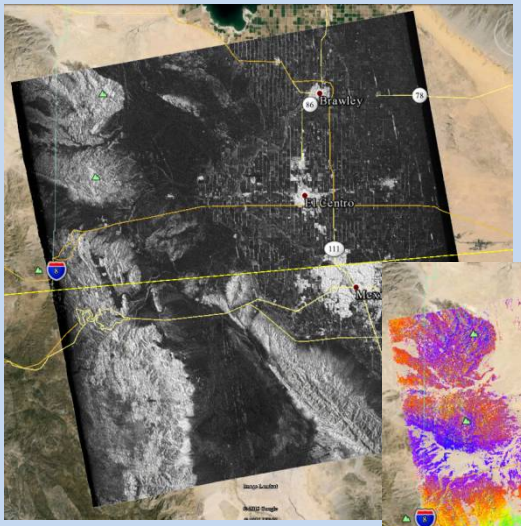
Interferogram Generation

Phase Unwrapping

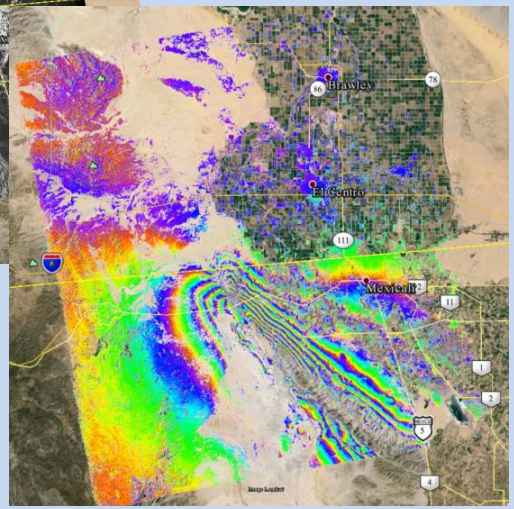
Geocoding

The final step is to *geocode all the products by transforming from the range/azimuth* coordinate system of the master image to longitude and latitude.

Geocode

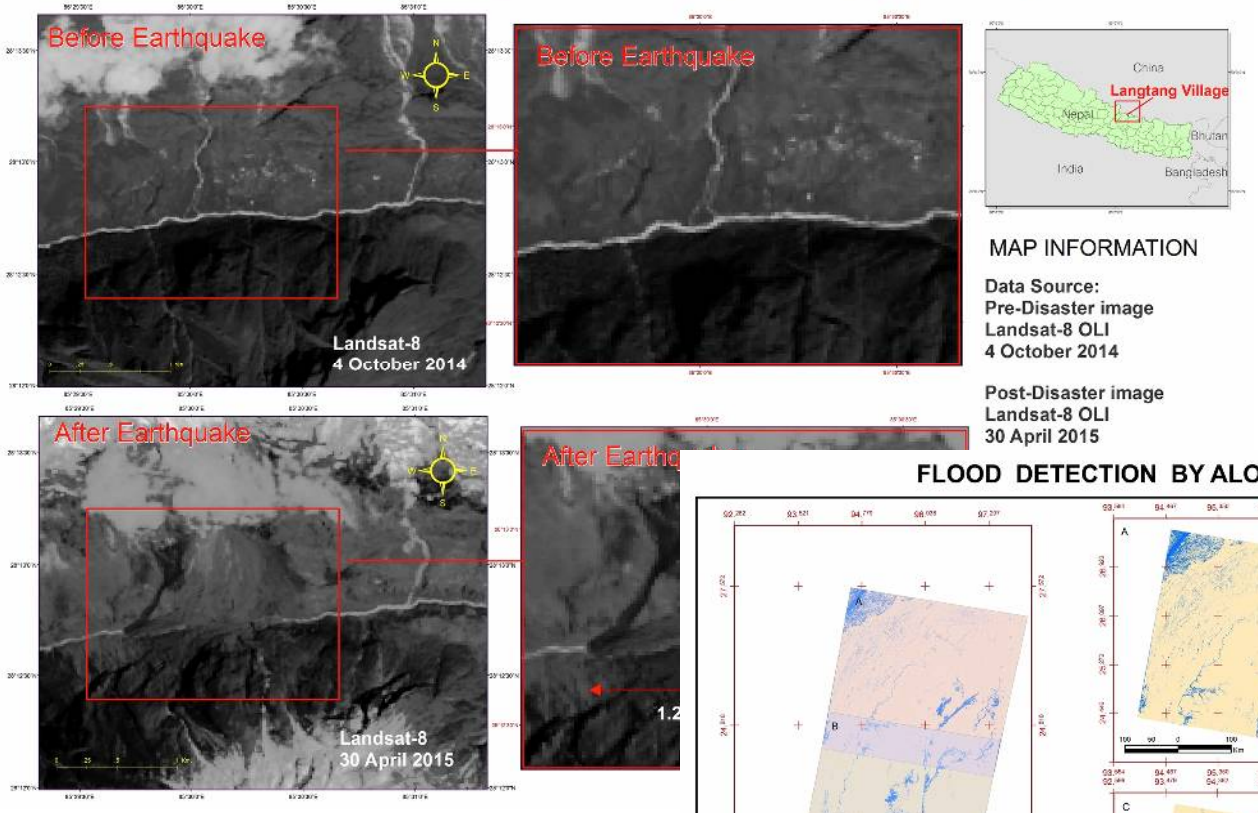


Amplitude image



Interferogram image

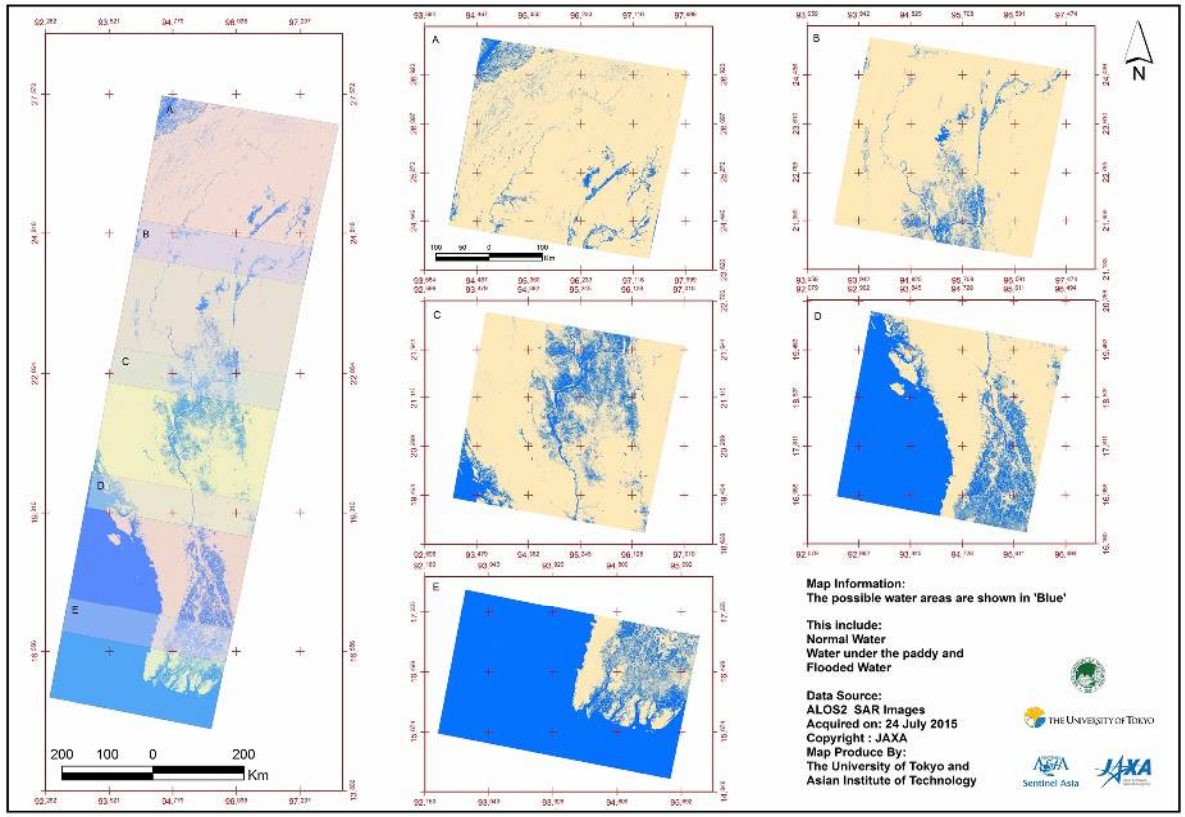
Landslide in Langtang Village,Rasuwa,Nepal in Apirl 2015 by Landsat-8



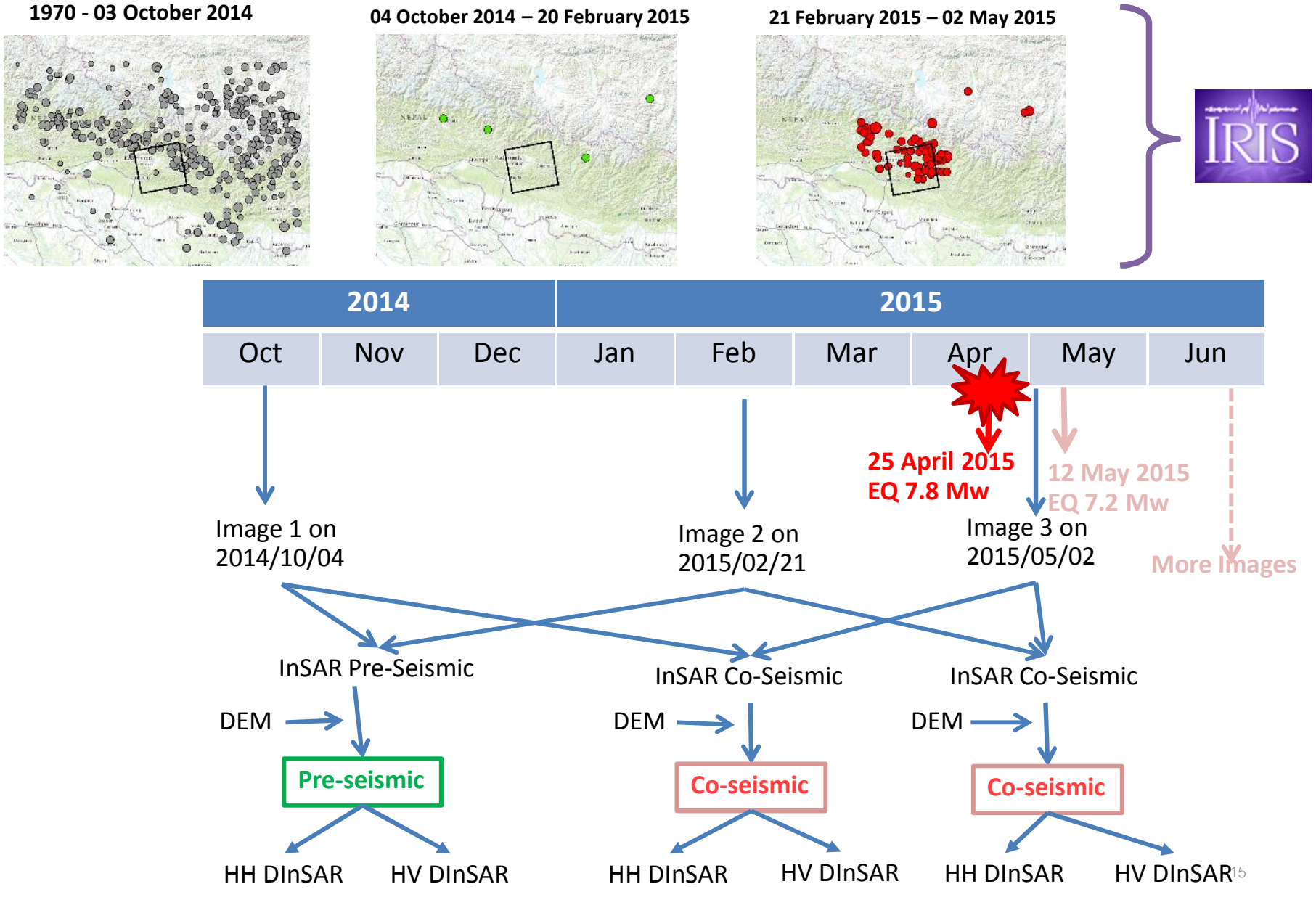
- Range Doppler Processing
- Single Look complex (SLC)
- Multi look image

- Color enhancement
- Classification
- Change detection
- Deep learning

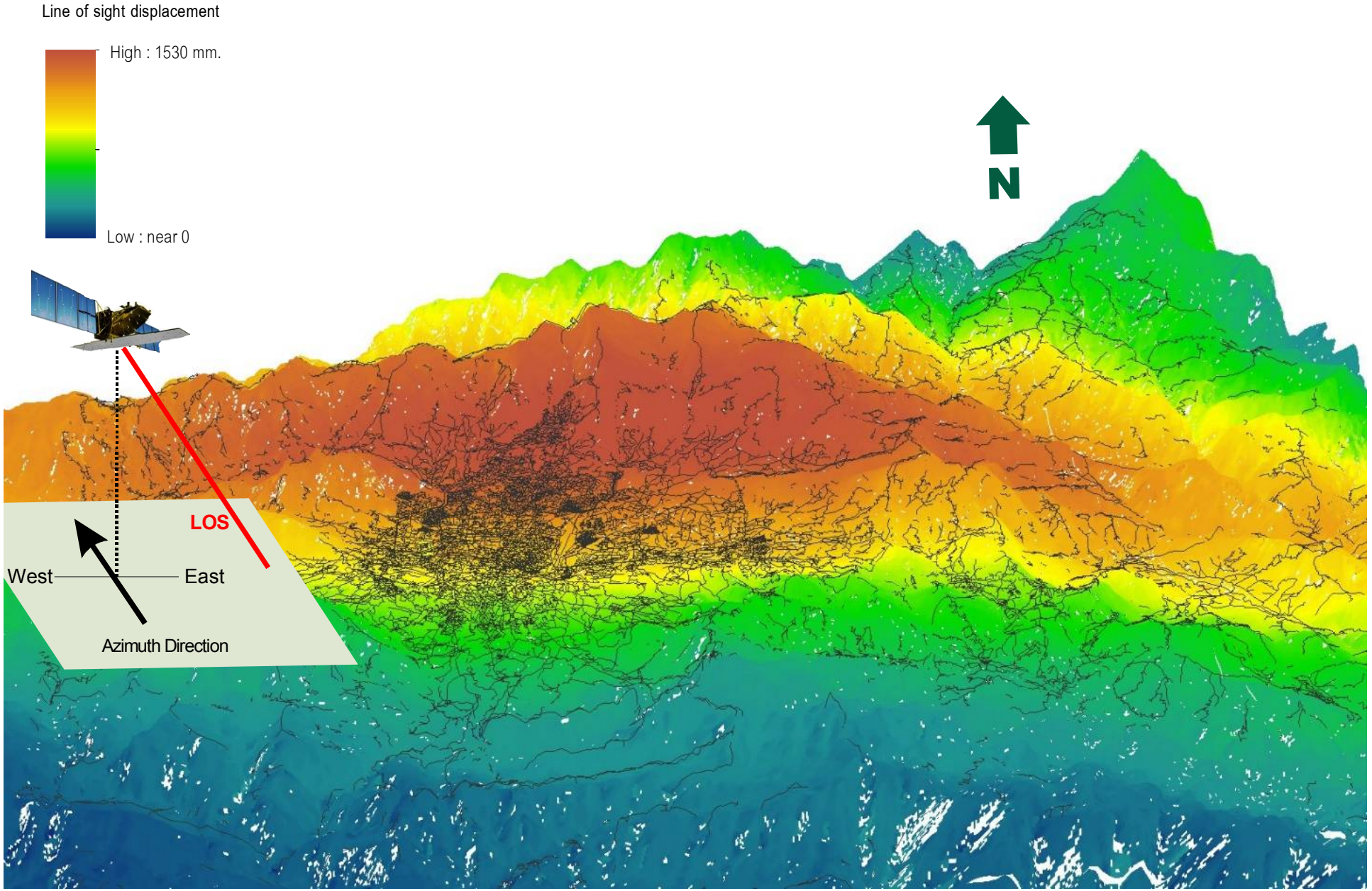
FLOOD DETECTION BY ALOS 2 , MYANMAR, JULY 24, 2015



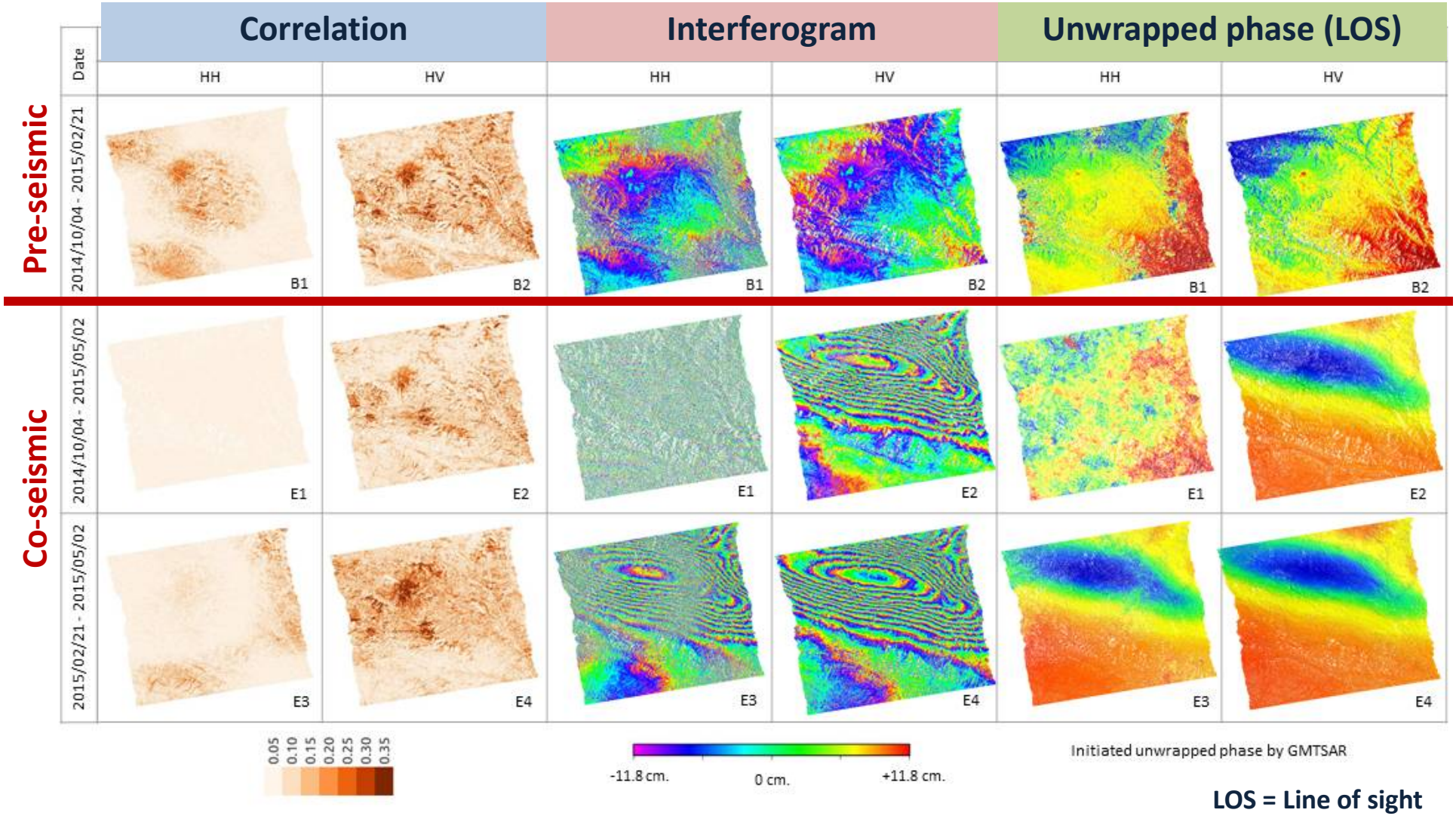
DInSAR and ALOS2 images



Line of sight displacement



Summary of DInSAR results



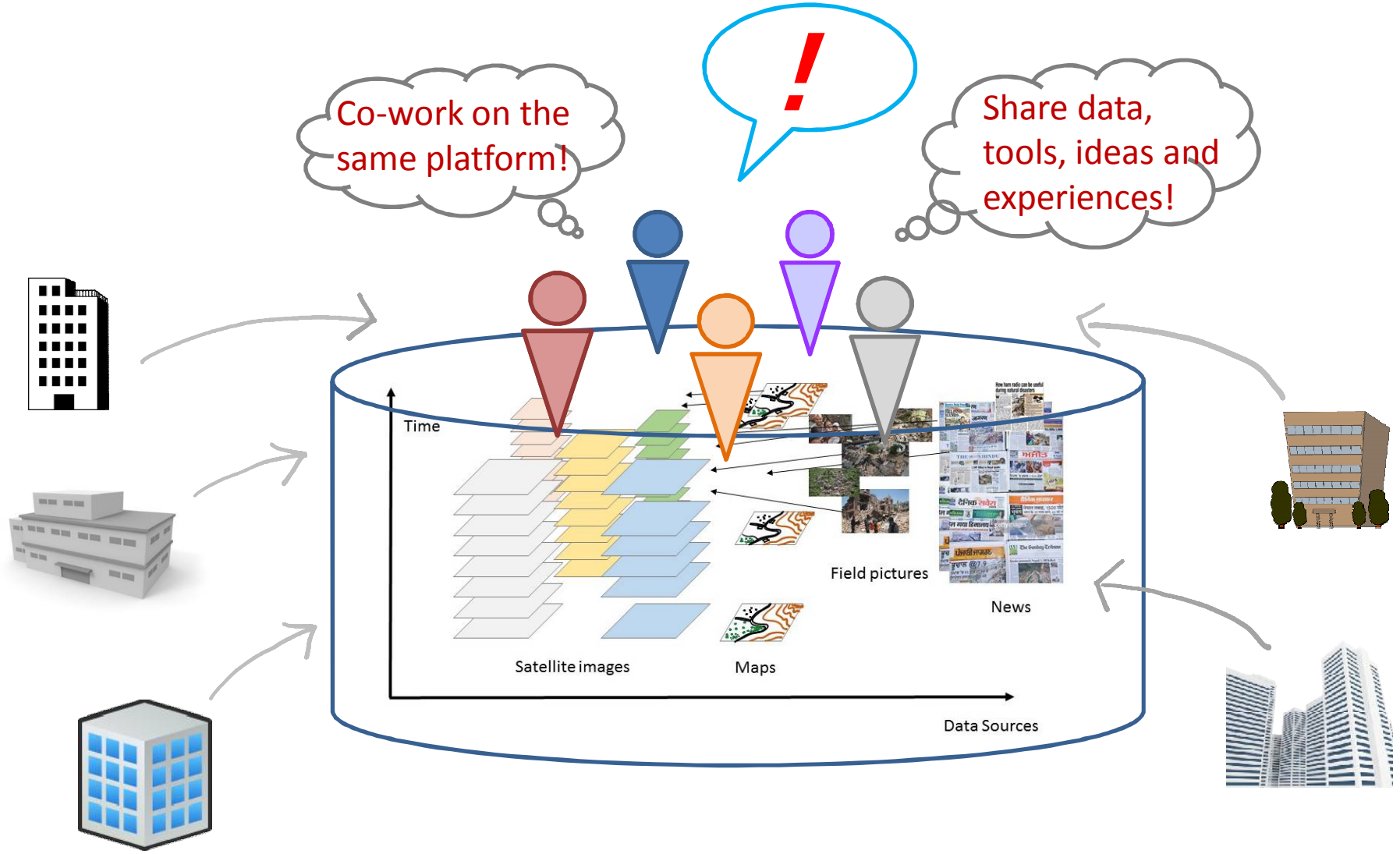
LOS = Line of sight

Earthquake in Japan 2011 (5500 Scenes), Flood in Thailand 2011 (1500 Scenes),

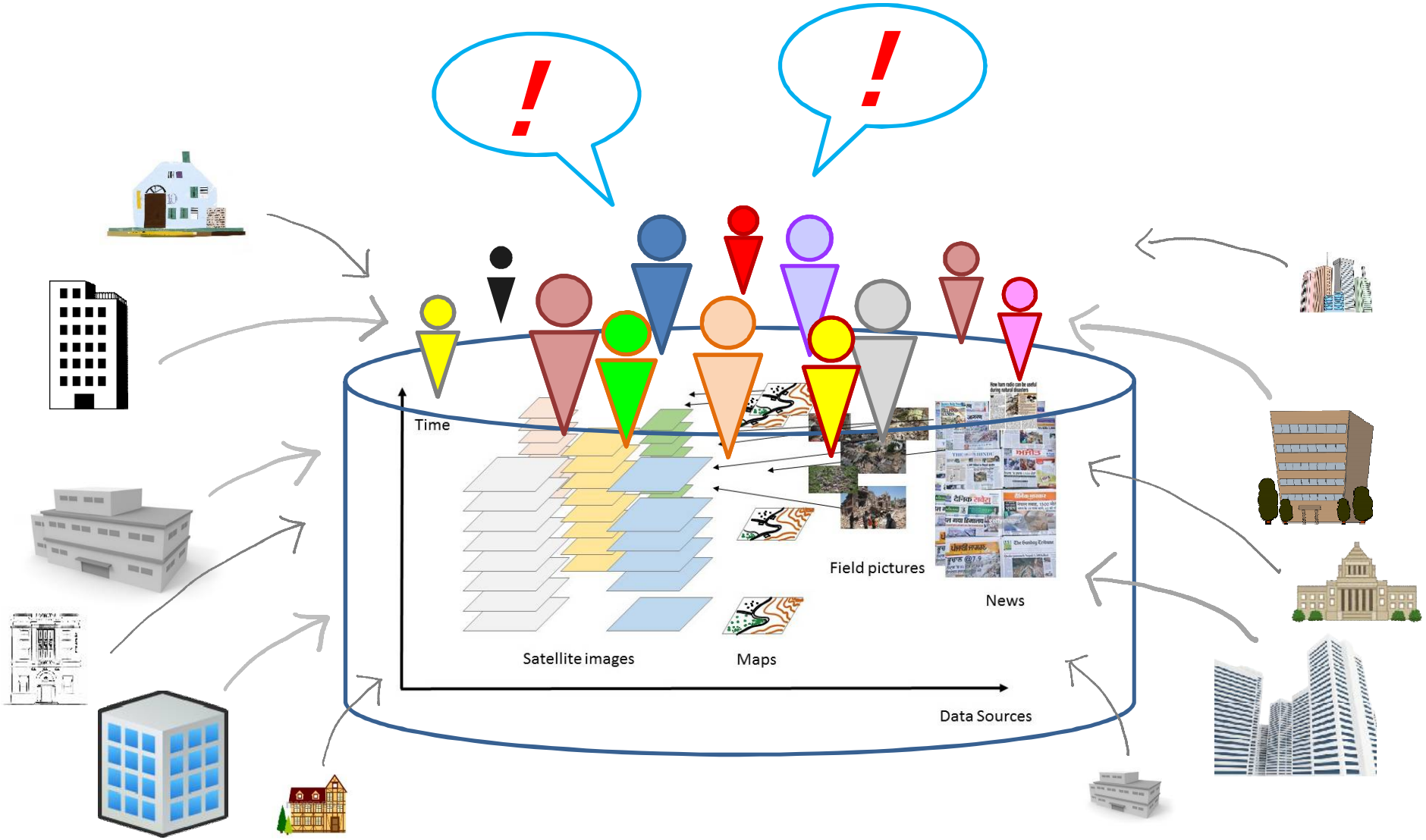
≀

Earthquake in Nepal 2015 (more than 8000 Scenes)

A Solution;
Cloud-based System for Archive, Integration and Analysis

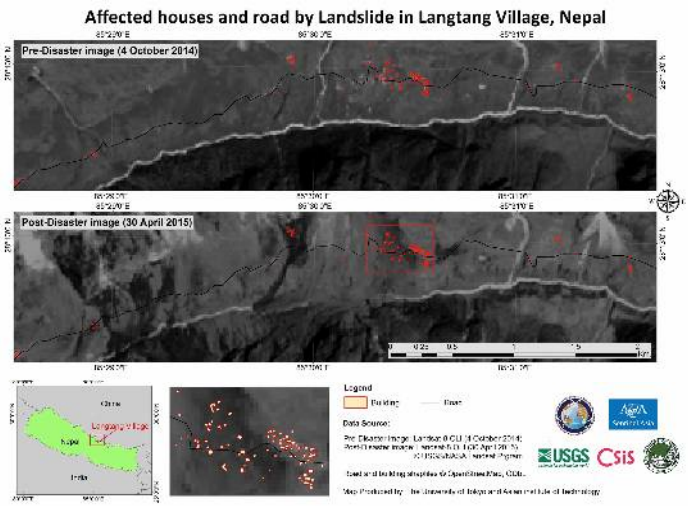


More Participations and Contributions



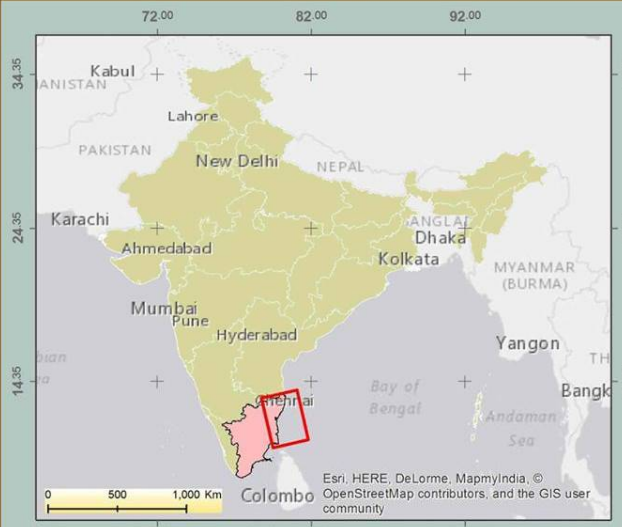
Information Sharing for Earthquake in Nepal, 2015

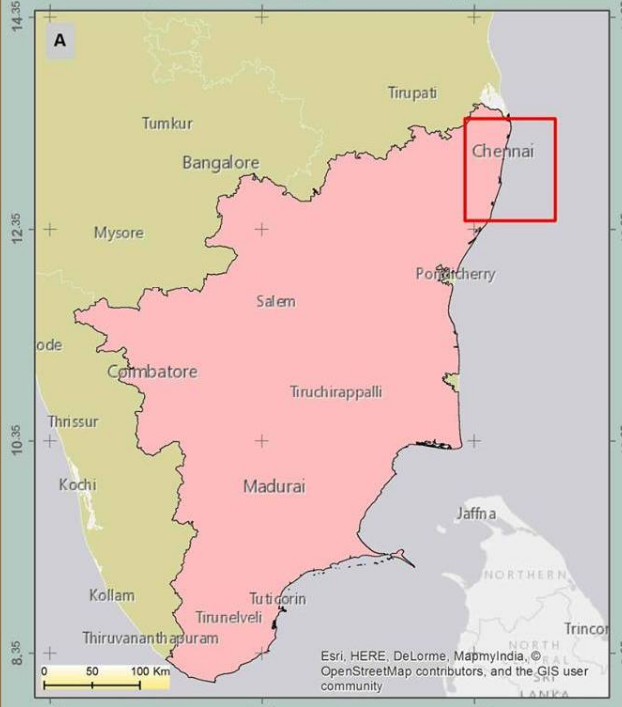
http://gestiss.org

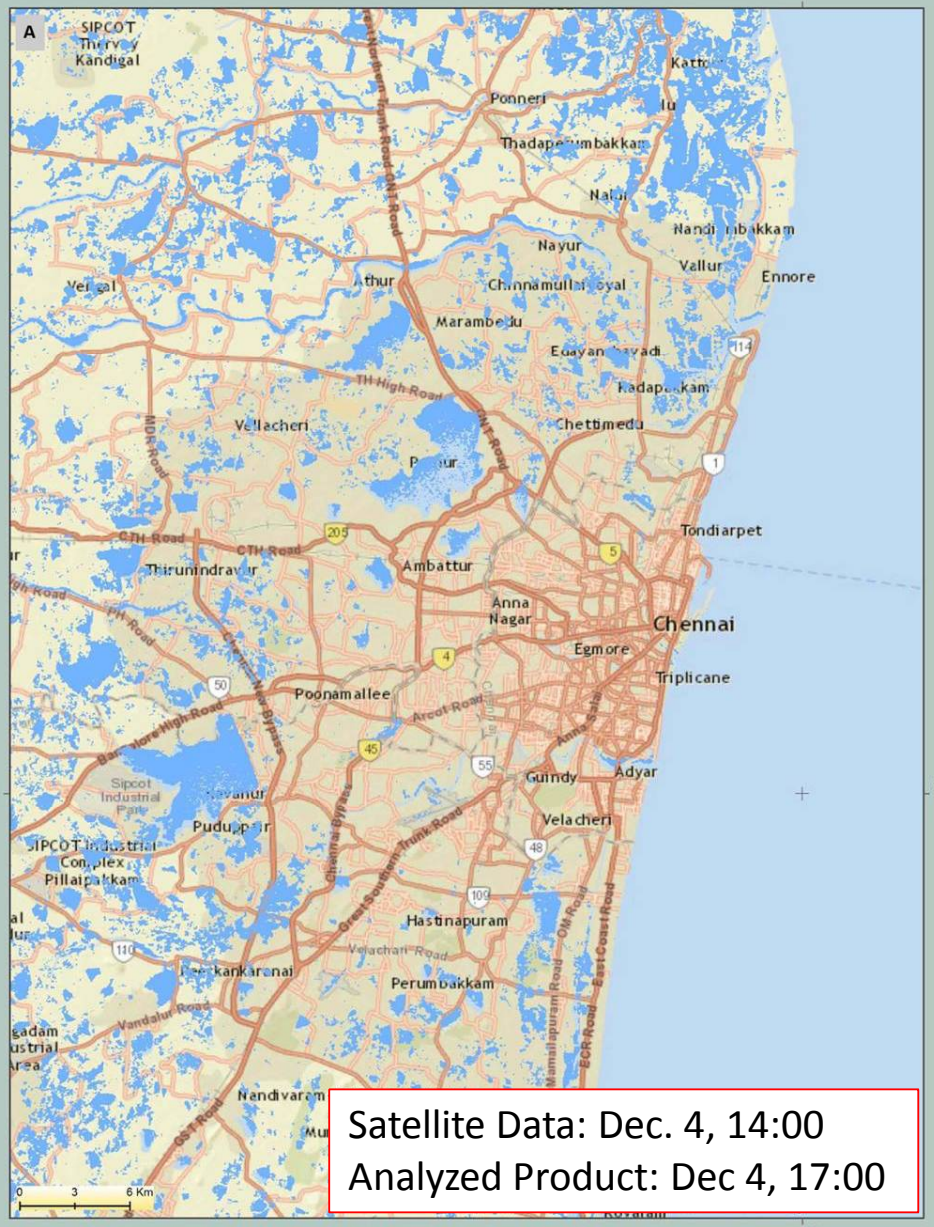


Faculty in RSGIS: 7
Faculty in DPMM: 2
Student in RSGIS: 15
Nepalese: many

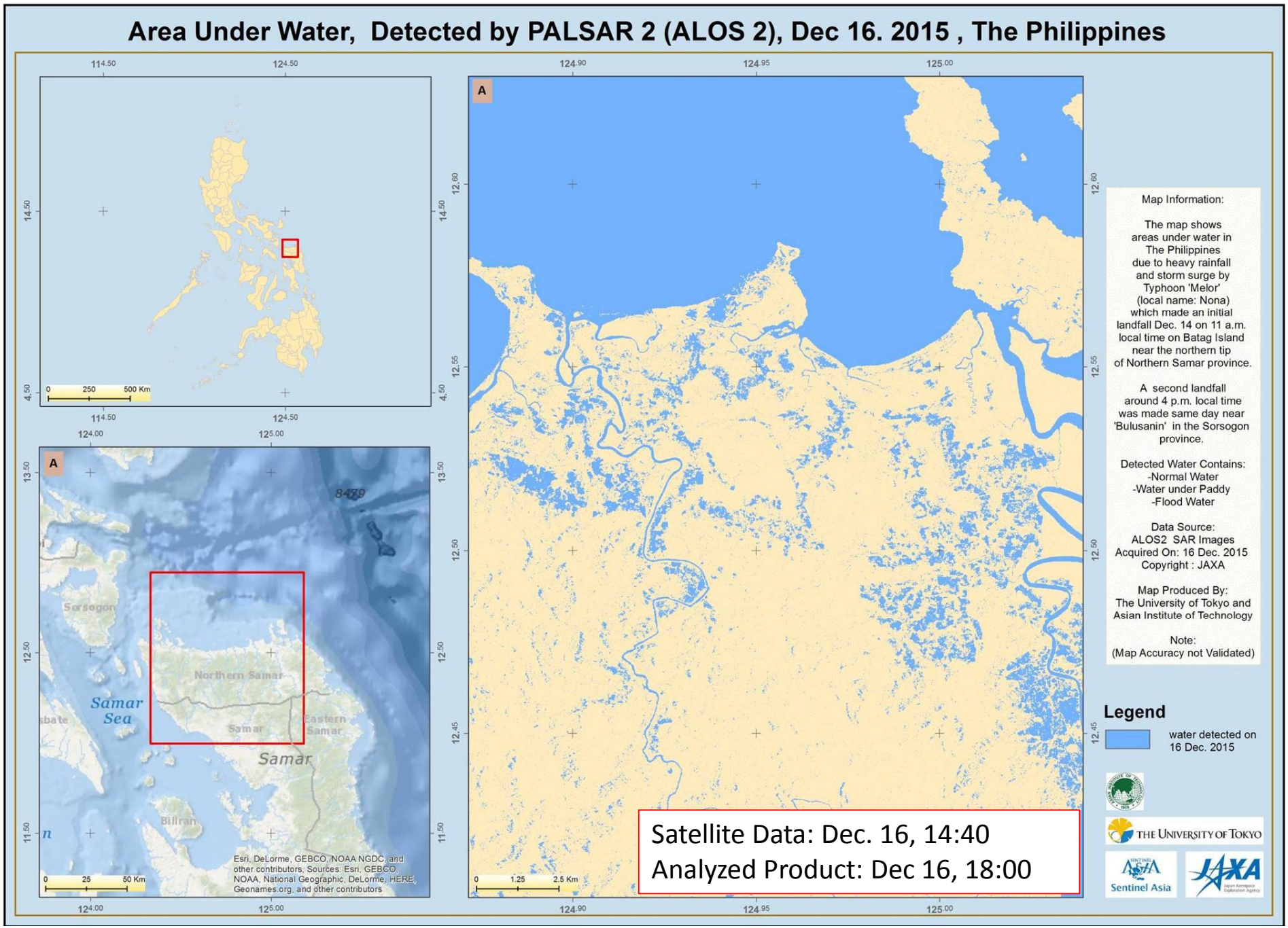
Area Under Water, Detected by PALSAR 2 (ALOS 2), Dec 03. 2015 , Chennai, India







Area Under Water, Detected by PALSAR 2 (ALOS 2), Dec 16. 2015 , The Philippines



Map Information:

The map shows areas under water in The Philippines due to heavy rainfall and storm surge by Typhoon 'Melor' (local name: Nona) which made an initial landfall Dec. 14 on 11 a.m. local time on Batag Island near the northern tip of Northern Samar province.

A second landfall around 4 p.m. local time was made same day near 'Bulusanin' in the Sorsogon province.

Detected Water Contains:
-Normal Water
-Water under Paddy
-Flood Water

Data Source:
ALOS2 SAR Images
Acquired On: 16 Dec. 2015
Copyright : JAXA

Map Produced By:
The University of Tokyo and Asian Institute of Technology

Note:
(Map Accuracy not Validated)

Legend

water detected on 16 Dec. 2015

Satellite Data: Dec. 16, 14:40
Analyzed Product: Dec 16, 18:00

THE UNIVERSITY OF TOKYO

Sentinel Asia

JAXA