Sentinel Asia Success Story in the Philippines

Summary: 2006-2017

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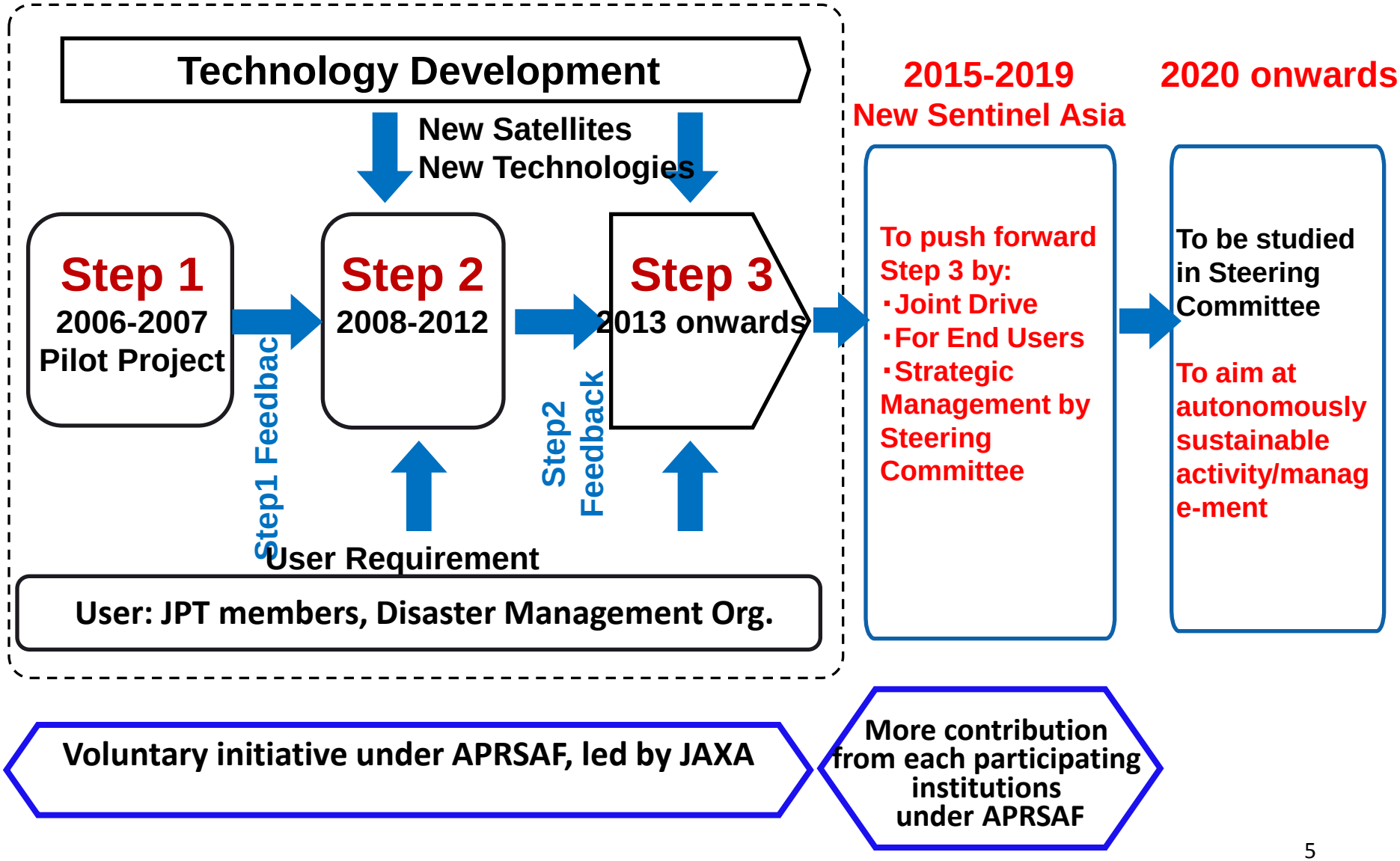
March 9, 2017
Hanoi, Vietnam

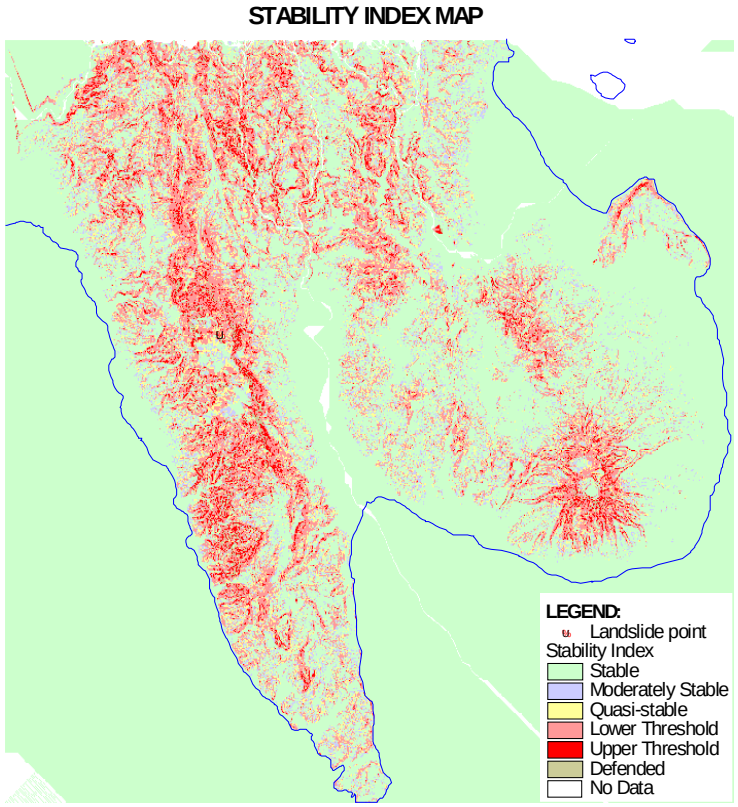
Sentinel Asia Evolution Image



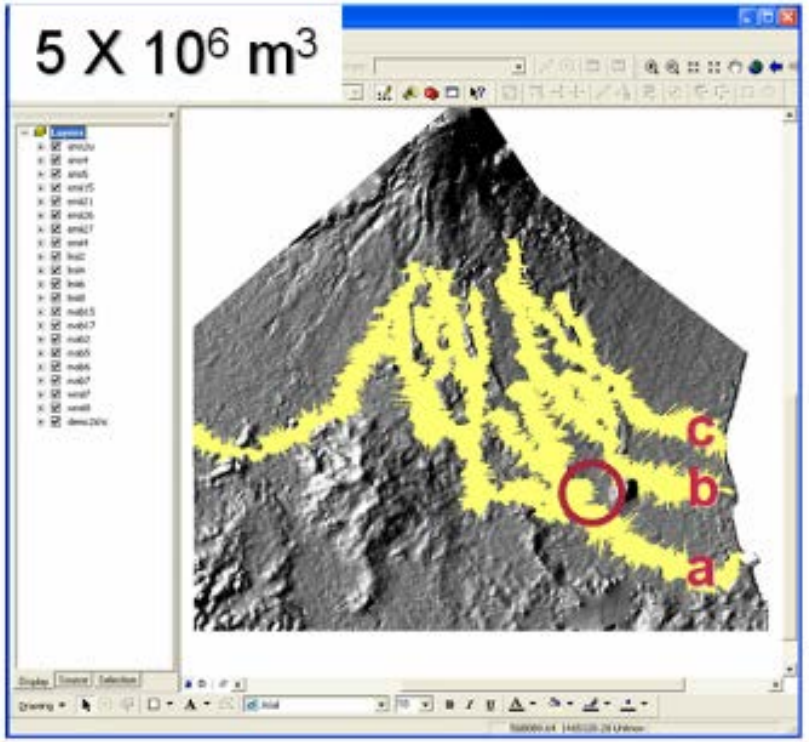
Space Technology Application-Related Program/Projects (2006)

JAXA-AIT Mini projects:

1. Landslide modelling



2. Lahar Modelling

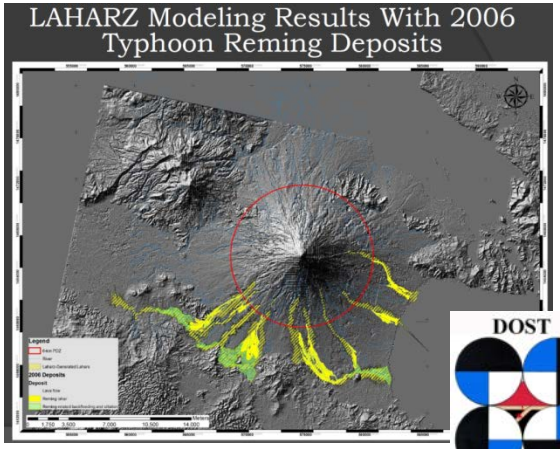


DOST PHIVOLCS

Step 1

Sentinel Asia Success Story

- Training of RADAR and optical image processing
- 1st Workshop – Introduction of Project; 20 March 2009, Makati City;
- 2nd Workshop – Sharing of preliminary results and information; Ilo-ilo City
- 3rd Workshop – Presentation of results, SA systems operation, open source tools for image overlaying to local maps; Manila City



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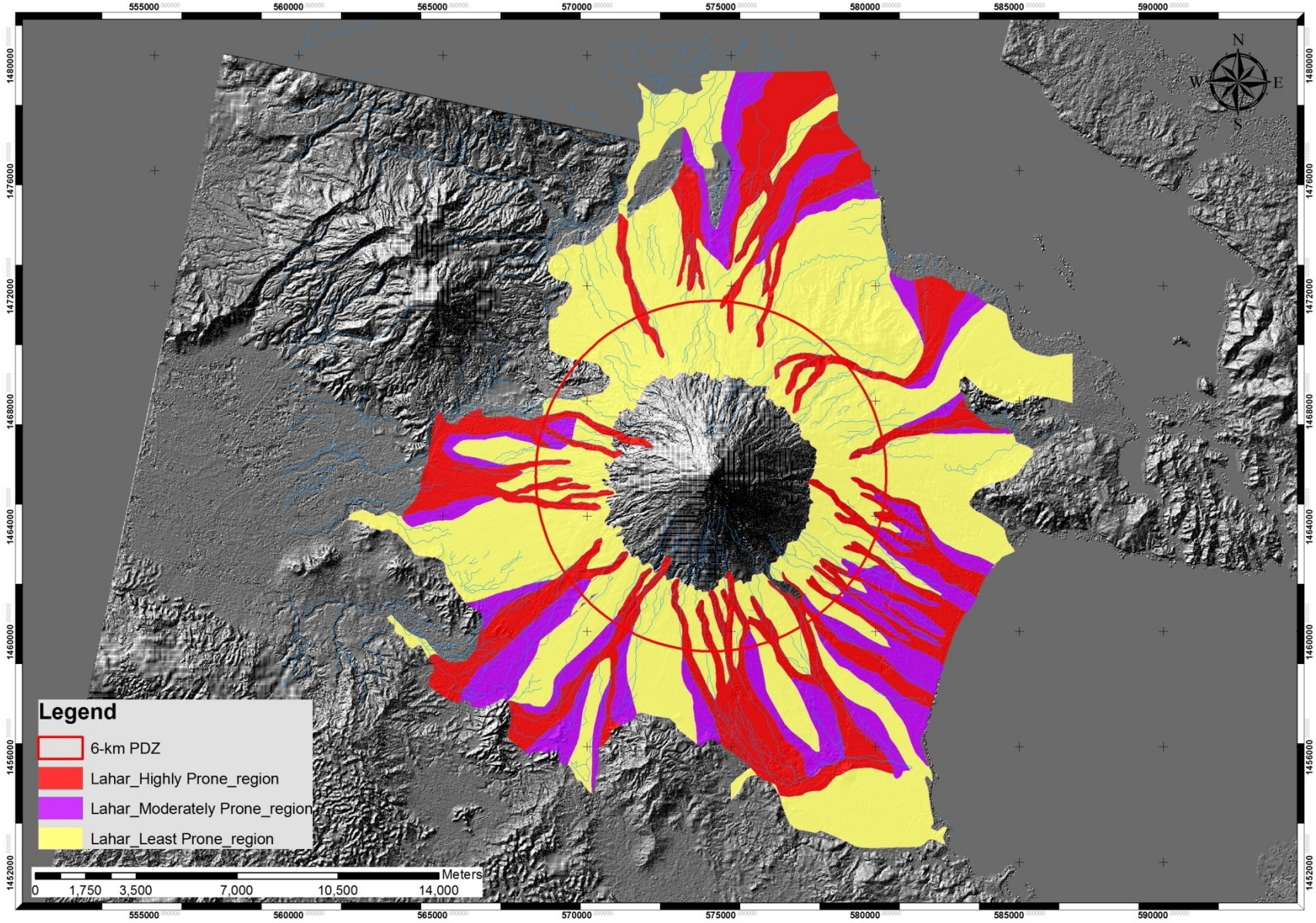
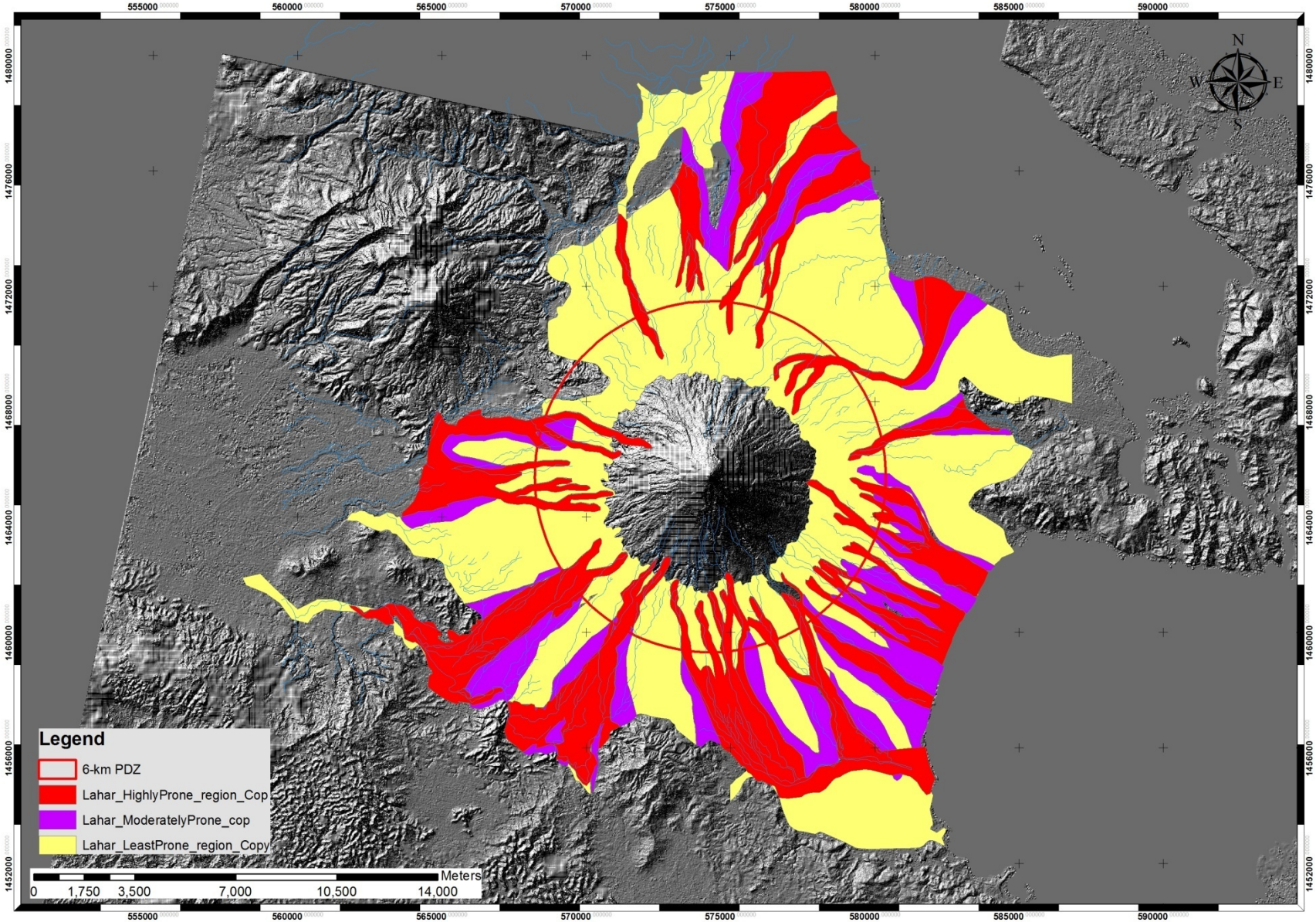
PHIVOLCS

2000 Mayon Volcano Lahar Hazard Map



Revised Mayon Volcano Lahar Hazard Map (2010)

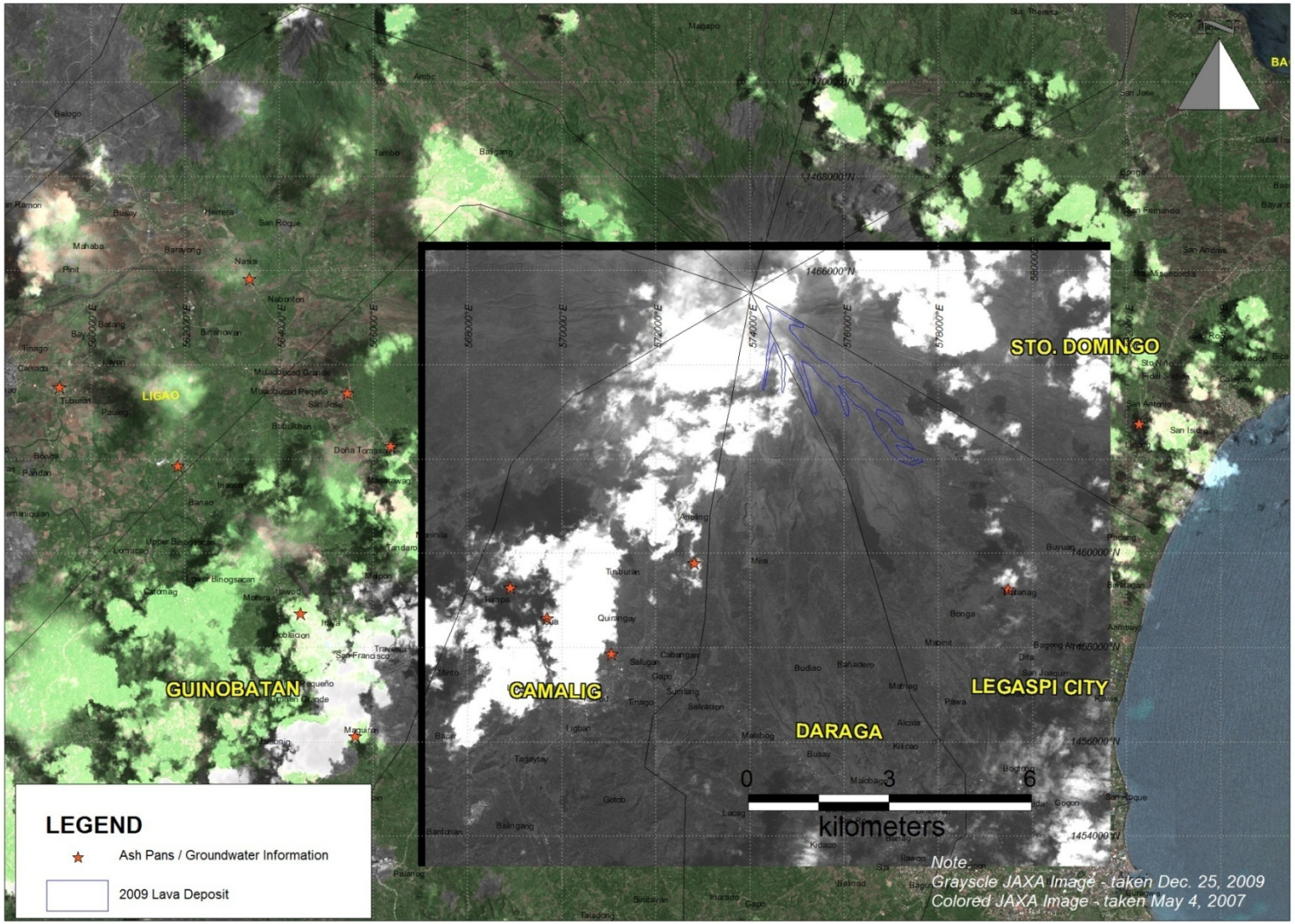


Space Technology Application-Related Program/Projects

Collection of Ground Control Points (GCP) to validate imageries around Mayon Volcano

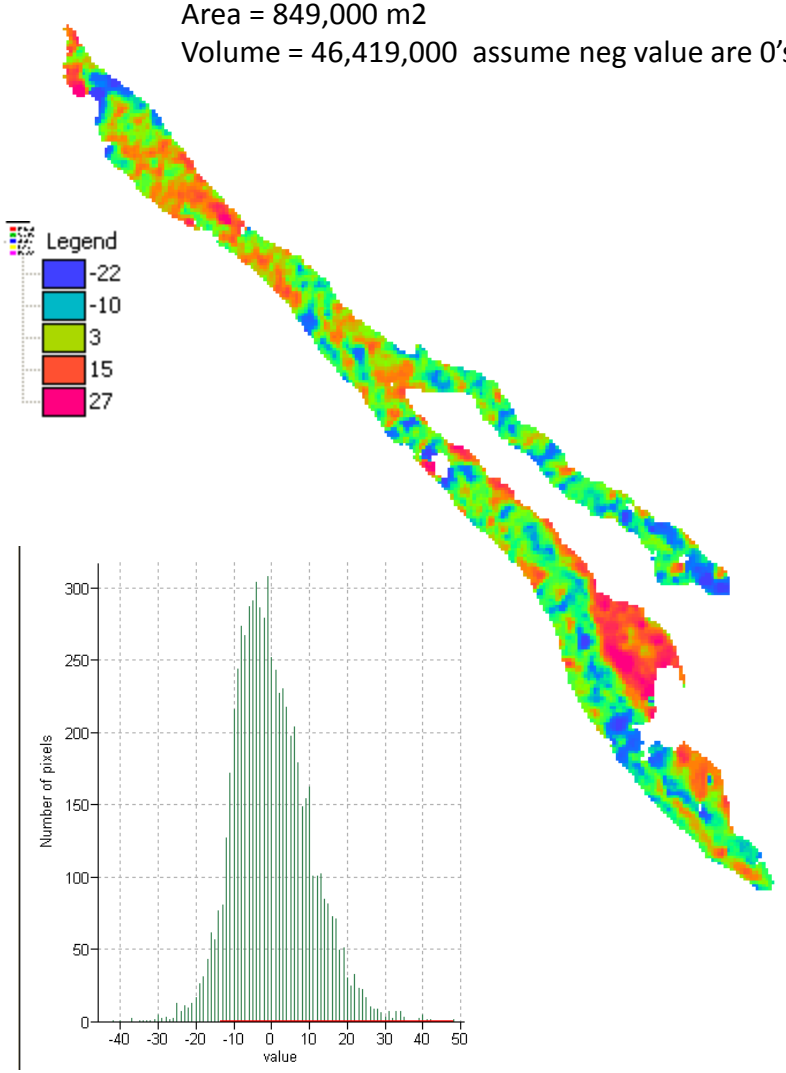
DOST
PHIVOLCS

Lava Estimation:
December 25, 2009 ALOS Image

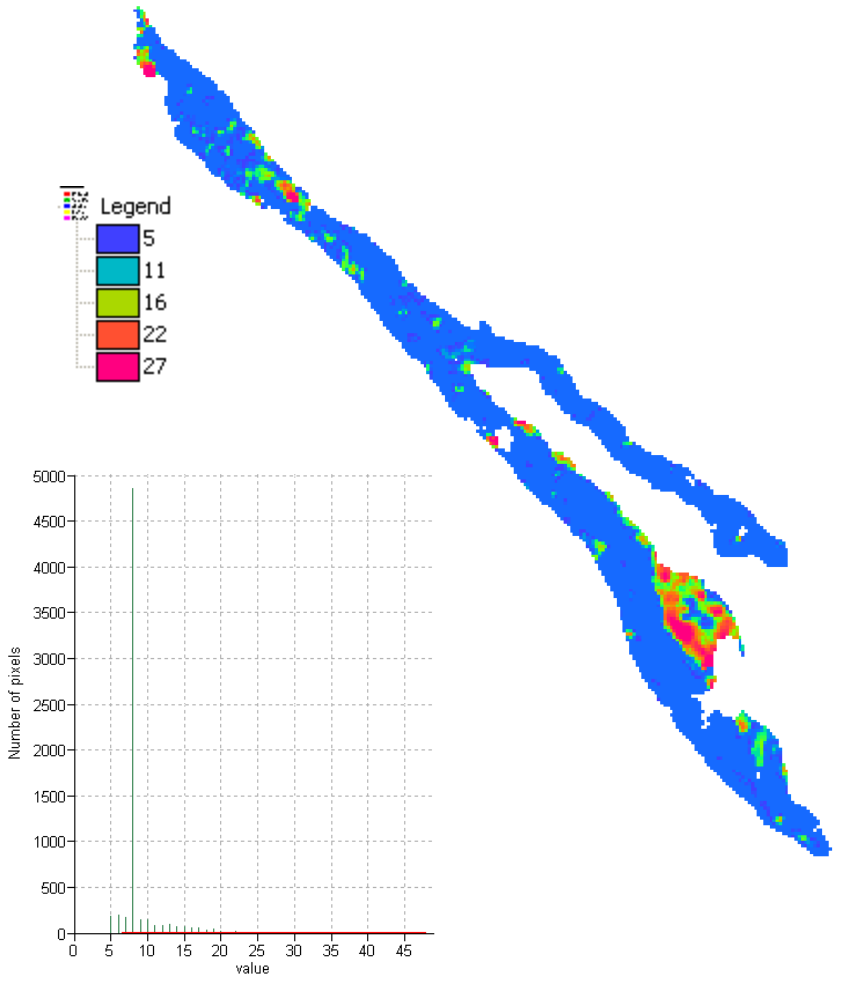


Lava Volume Estimation from October 2009 and Dec 25, 2009 ALOS DEMS

BASED ON RAW DEM
Lava flow (Dec 25, 2009)
Length = 4.3km from Summit
Area = 849,000 m2
Volume = 46,419,000 assume neg value are 0's



BASED ON adjusted DEM
Lava flow (Dec 25, 2009)
Length = 4.3km from Summit
Area = 849,000 m2
Volume = 6,209,200 assume neg value are 8m



Step 1

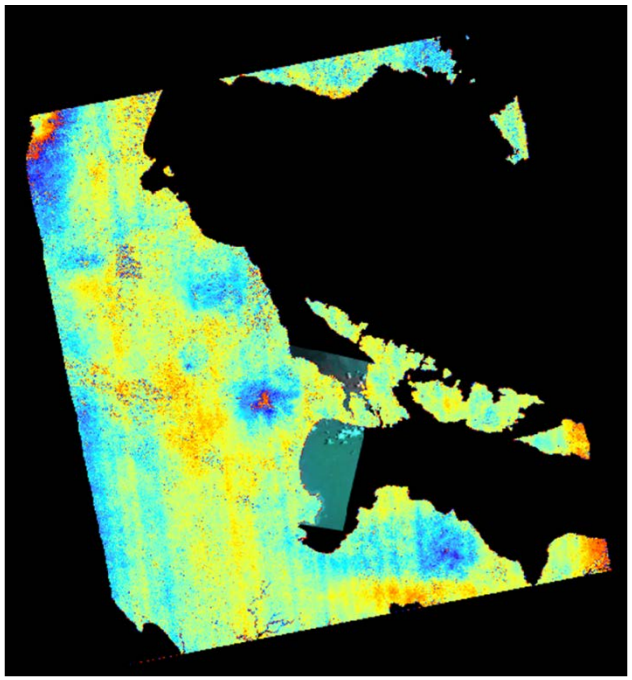
- Collaboration with Sentinel Asia had brought advantages to PHIVOLCS

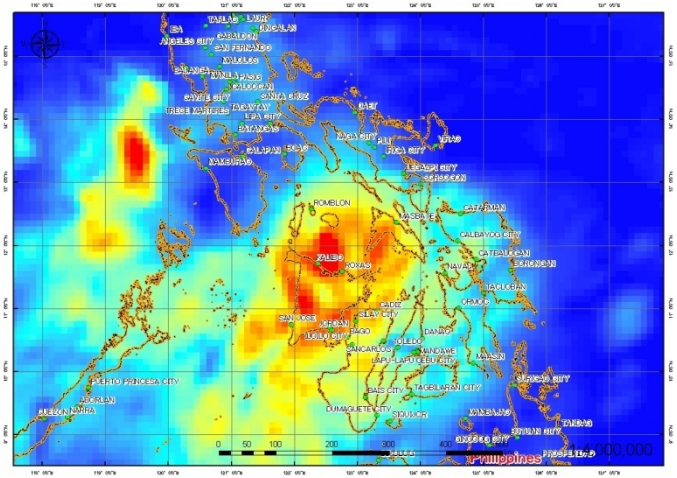
✓ Aided in the revision of Mayon Volcano Lahar Hazard Map

✓ Aided in decision formulation during volcanic eruption

Step 2

- **Interferometry**
- **Satellite Rainfall Precipitation applied to landslide and flood**





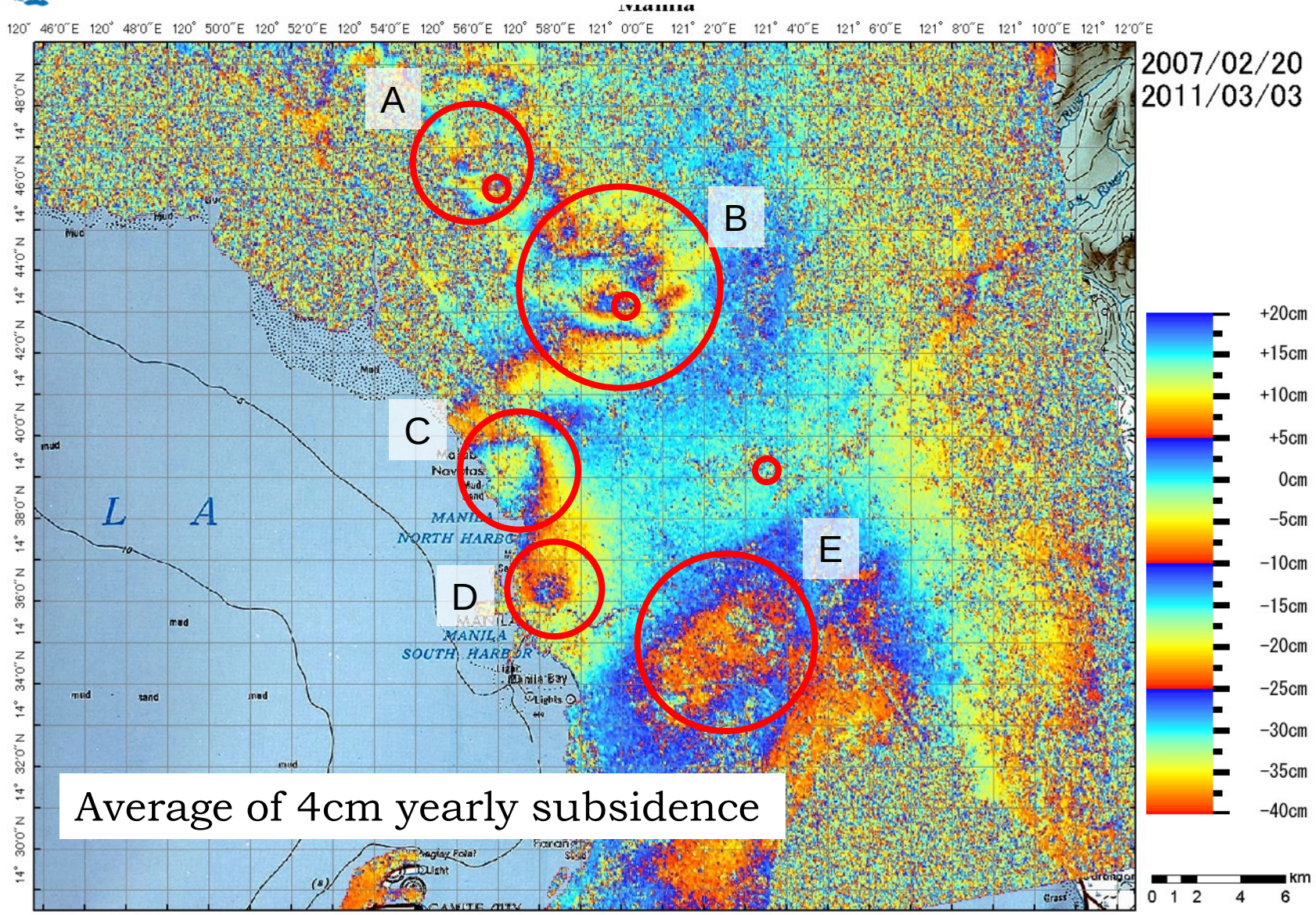
Ground Deformation using RADAR Interferometry

PARTICIPANTS

PAGASA, MGB, PHIVOLCS, OCD, NAMRIA, UPDGE, APSEMO

DOST PHIVOLCS

GROUND SUBSIDENCE MAPPING AND MONITORING USING ALOS PALSAR Mar.2011 –Feb.2007 (1472 Days)



STEP 2 Subsidence: Metro Manila Four years from 2007-2010

with Supplemental GPS Data

Original

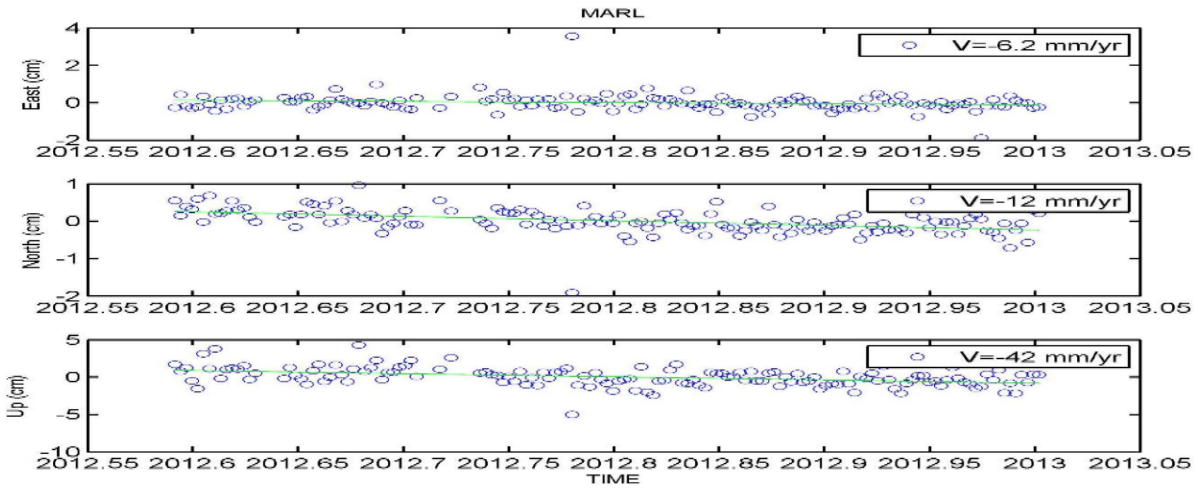
				A	B	C	D	E
1	2010/11/14	2007/2/3	1380	–	−30	–	–	12
13	2011/3/3	2007/2/20	1472	−40	−27	−20	−12	7.5

Conversion

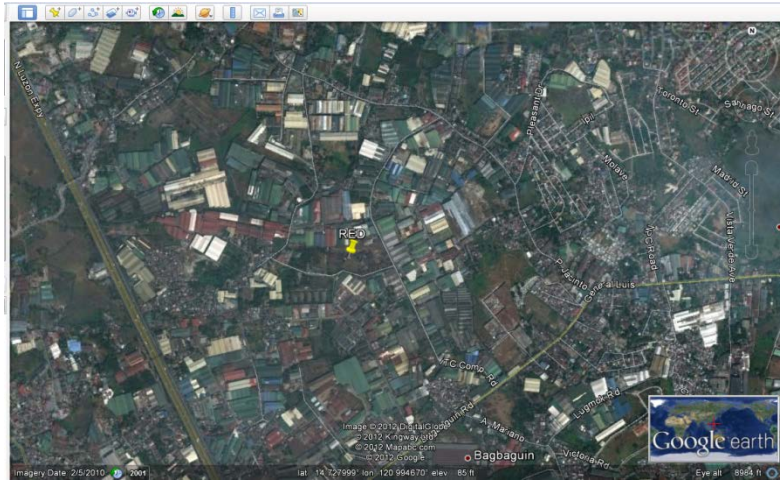
1	2010/11/14	2007/2/3	1460	-	−32	-	-	13
13	2011/3/3	2007/2/20	1460	−40	−27	−20	−12	7

Average

4 years	−39.7	−29.3	−19.8	−11.9	10.1
1 year	−9.9	−7.3	−5.0	−3.0	2.5

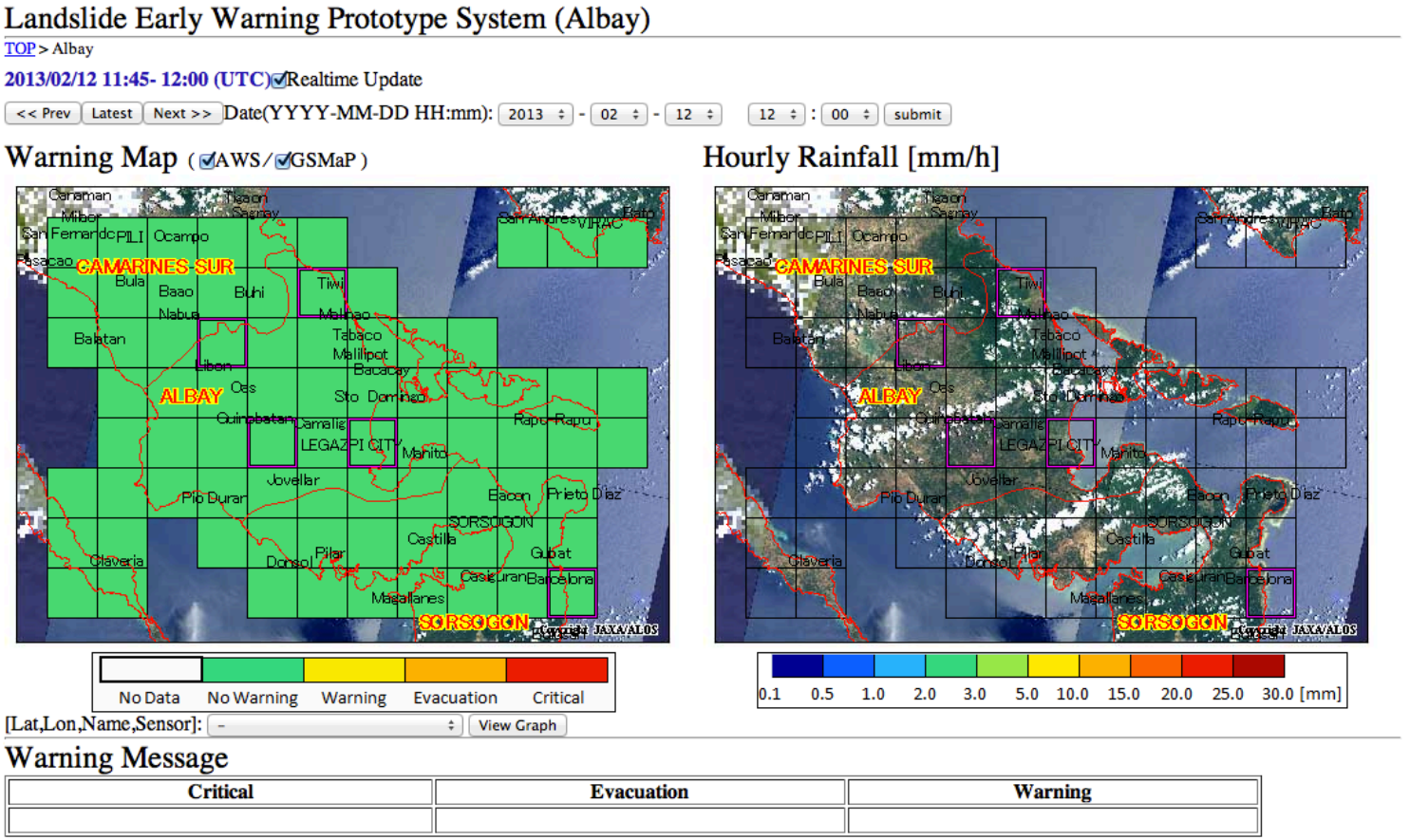


Visit at the Subsidence Site
Large industries dependent on ground water extraction

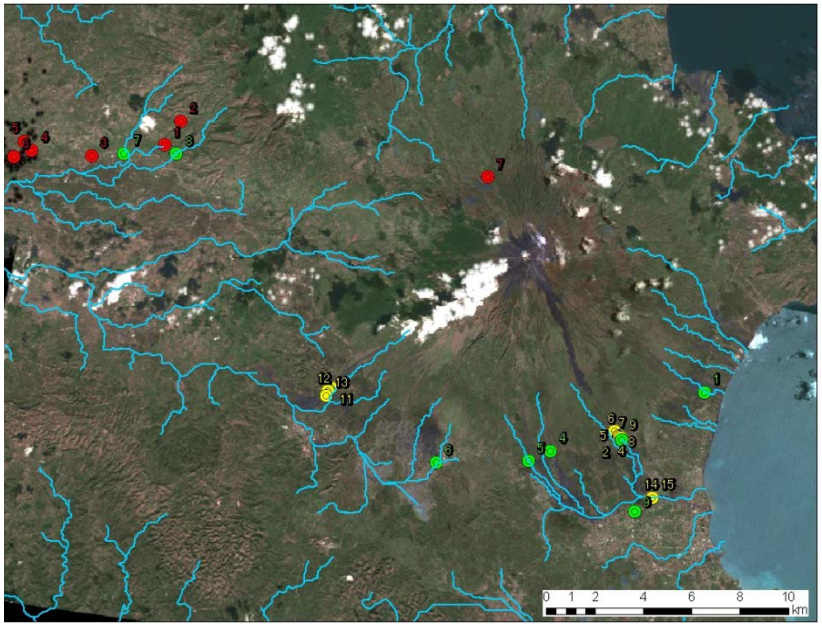


August 14, 2012

Established Landslide Warning server at NTT Data Tokyo Office Website http://60.36.183.126/lsWarning/



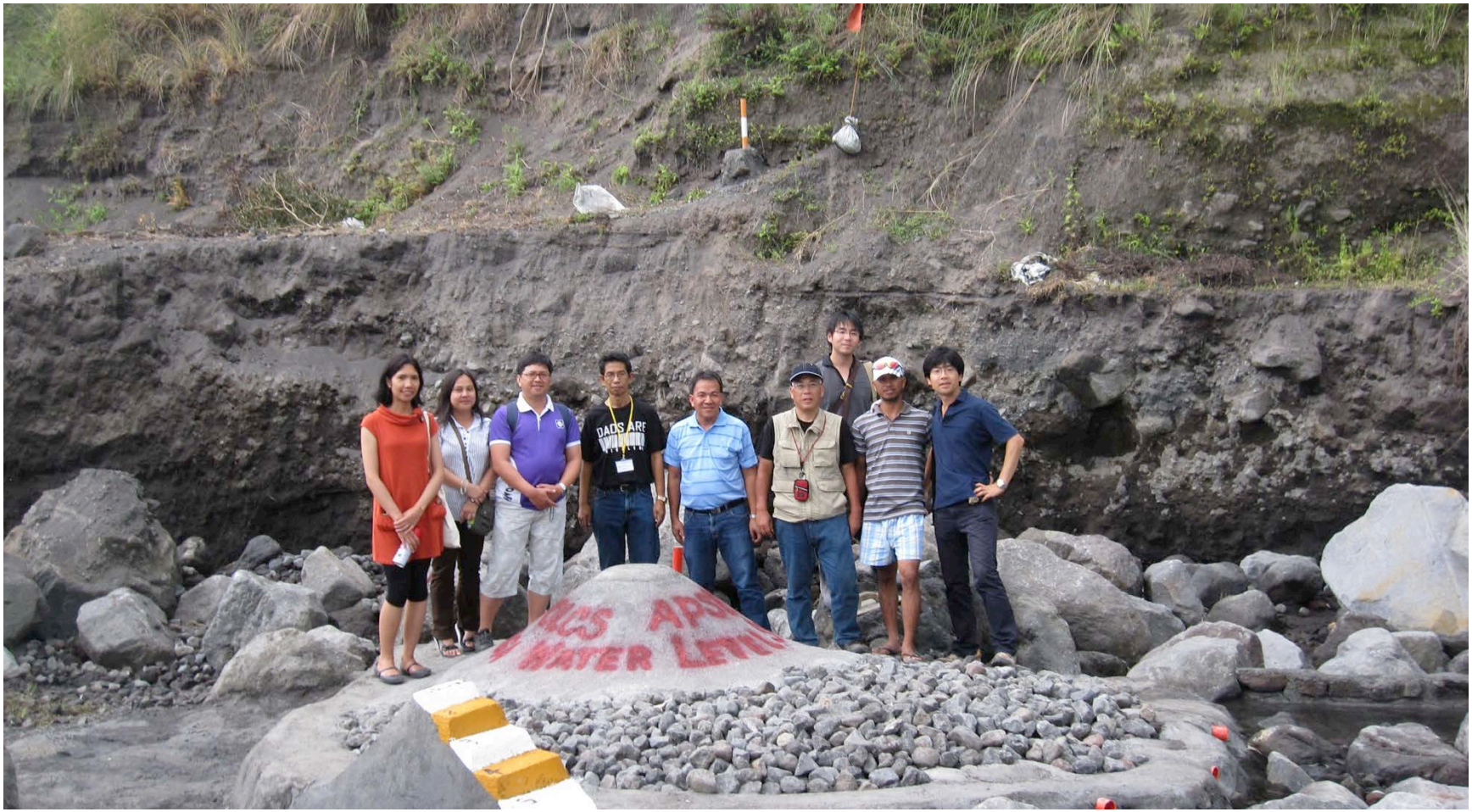
December 3-6, 2011:
Fieldwork in Mayon/Masaraga for coordination & site selection



December 8-9: GEOCON 2011
Paper presentations:
a.Subsidence Monitoring in Bulacan using PALSAR Interferometry
b.Landslide Monitoring using GSMap, RBFN and SWI

August 26-27, 2012

Establishment of river cross section, water flow sensors and observation station



August 28-31, 2012

Technical Training on Landslide Warning – La Piazza Hotel and Convention Center, Legazpi City

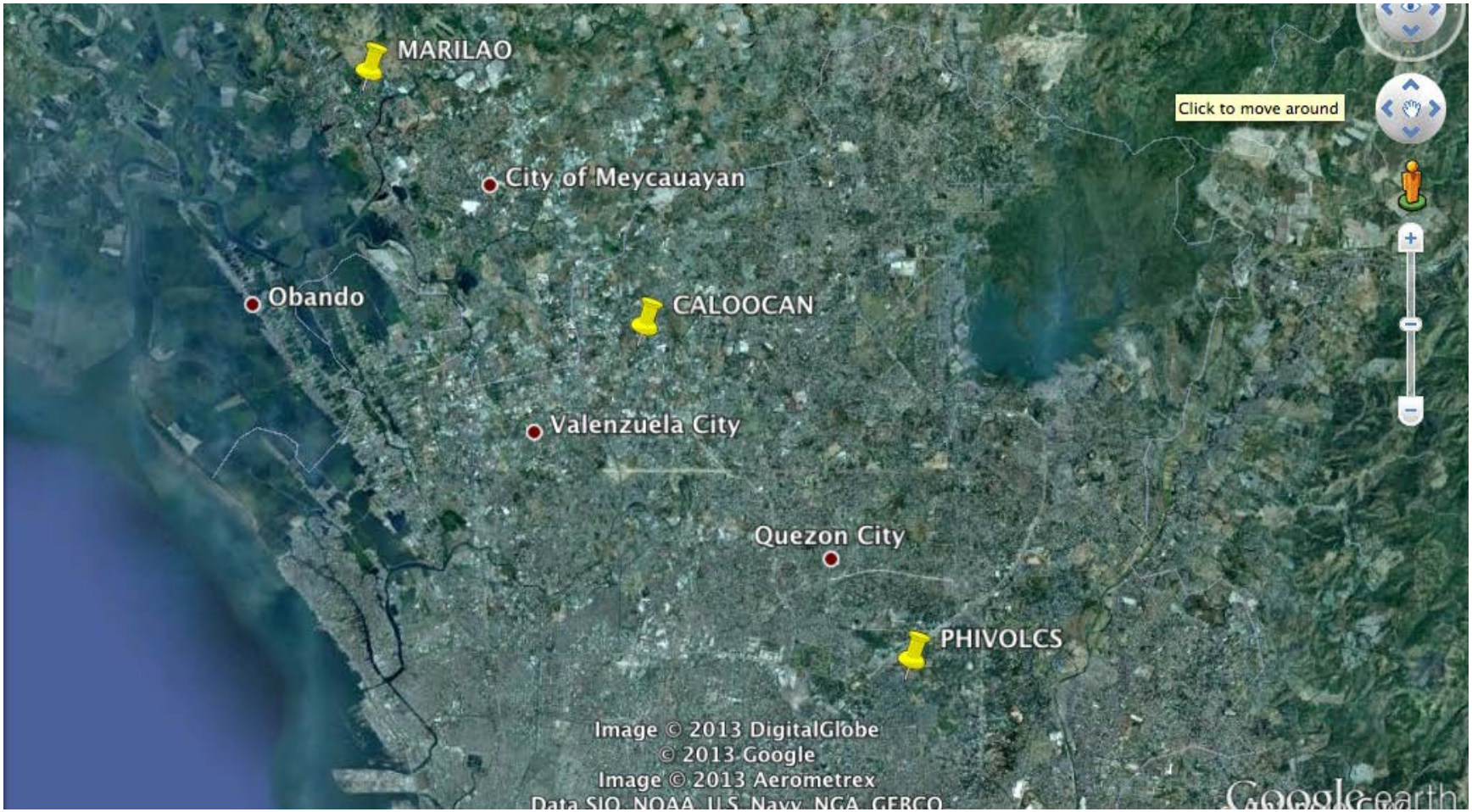
- Review landslide and debris flow warning technique
- How to operate the landslide warning prototype
- Making warning lines for the prototype
- Discussion on the prototype
- Demonstration (Flood / Debris flow simulation etc.)
- Map exercise for landslide evacuation

PARTICIPANTS:

- PAGASA, MGB, PHIVOLCS, APSEMO, ASTI

September 1st week, 2012

Installed GPS in Marilao and Caloocan



Step 2

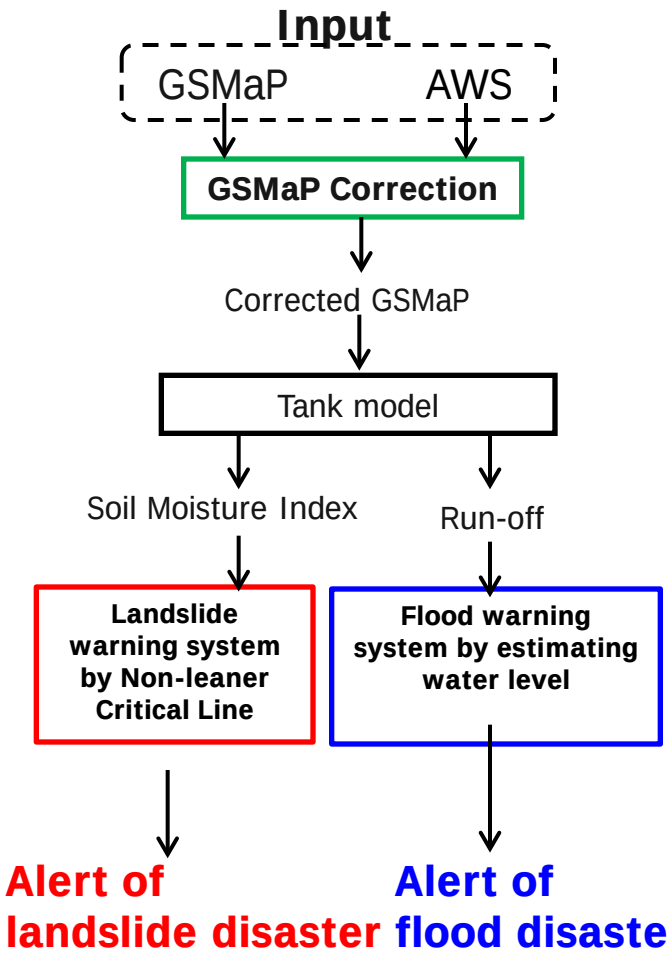
- Collaboration with Sentinel Asia had brought advantages:

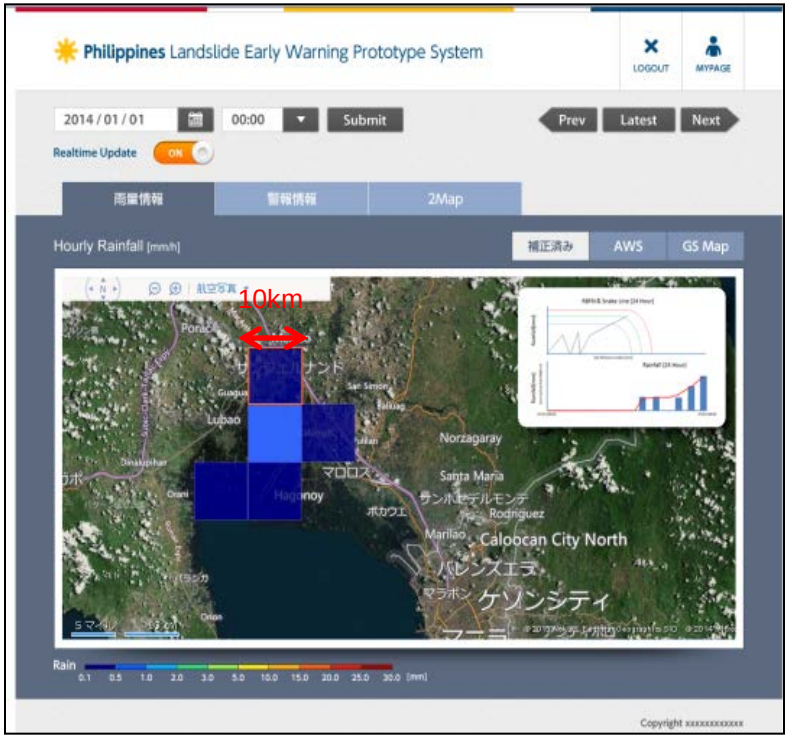
✓ Revealed that subsidence is occurring in areas north of Manila

✓ It also facilitated the creation of prototypes for landslides and flooding

Step 3: Overview of the prototype-system

The Landslide and Flood disaster Early Warning System with GSMaP





Web Browser

First user list is necessary (User's Name and Email address)

Login:

User ID

Password

GSMaP based Landslide Warning System (GLWS)

- Pilot Study in the Philippines -

GSMaP rainfall archives are analyzed by a machine learning method (RBFN), and critical lines (CLs) of hourly rainfall and soil moisture index (SMI) are selected.

The system monitors rainfall in real-time and determines the landslide warning level.

Rainfall monitoring

Sensor network

AWS

GSMaP-Now

Satellite

Automatic prediction

System

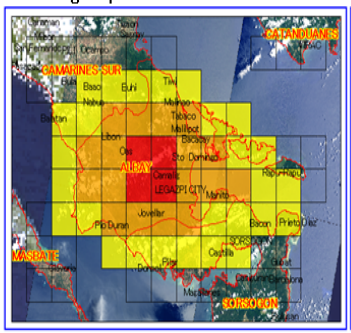
Landslide Early Warning Prototype System (Albay)

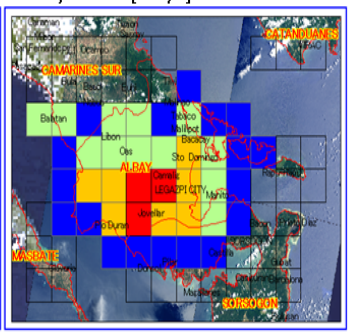
TOP > Albay

観測値 YYYY-MM-DD HH:MM - HH:MM (UTC) Lat: 123.55 Lon: 13.15 submit

Warning Map

Hourly Rainfall [mm/h]





<< Prev | Latest | Next >>

Date: 2012 06 15 00:00 – 23:45 submit

Realtime Update

No Warning
Warning
Evacuation
Critical

0 0 - 1 1 - 5 5 - 10 10 -

Warning Message [YYYY-MM-DD HH:MM – HH:MM (UTC)]

Critical
[Lat1, Lon1] : Rainfall: X mm, SMI: X mm, RBFN Value: X

Evacuation
[Lat2, Lon2] : Rainfall: X mm, SMI: X mm, RBFN Value: X

Warning
[Lat3, Lon3] : Rainfall: X mm, SMI: X mm, RBFN Value: X

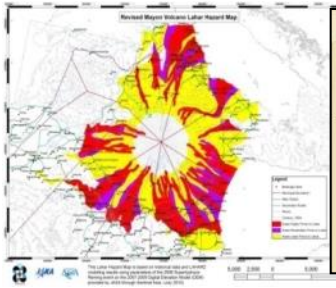
Application

Analysis / warning

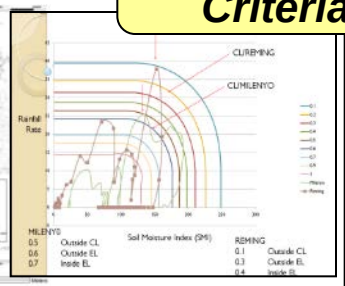
Agency / Local gov.

Model preparation

Hazard maps, Criteria



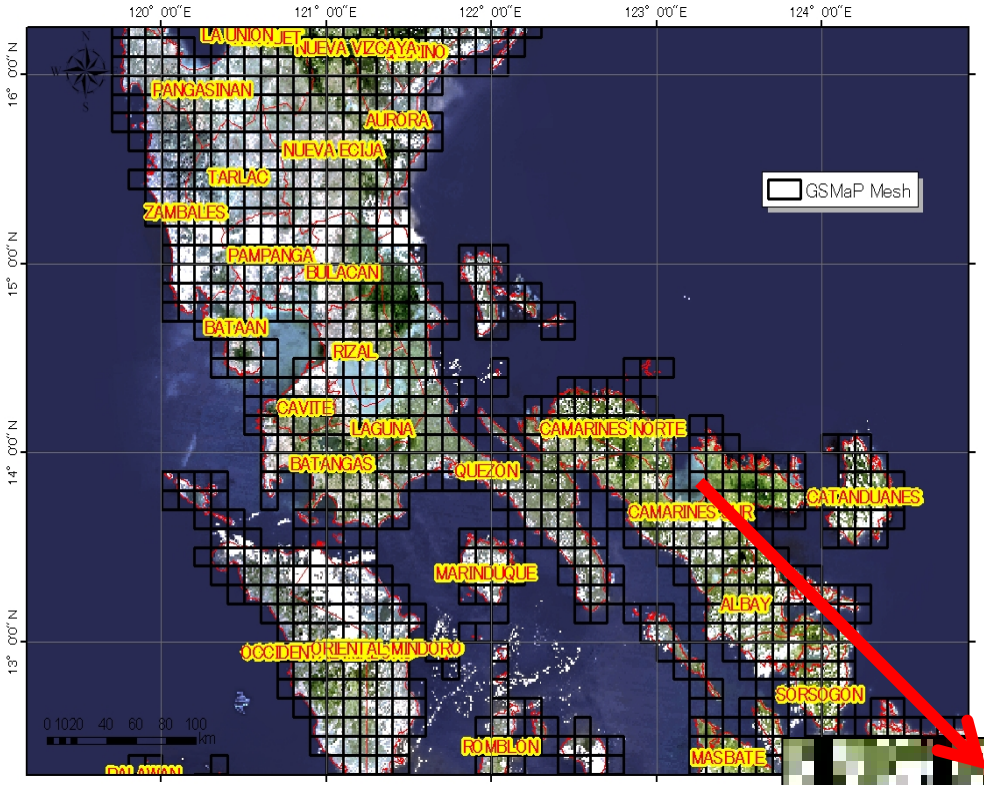
Maps



Warning criteria

Sentinel Asia Step 3

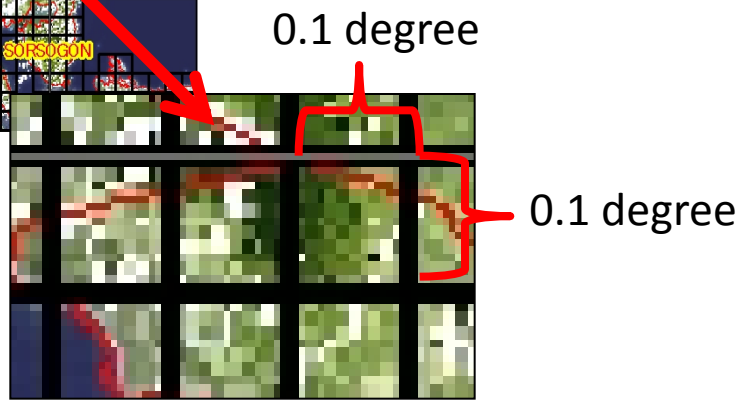
Addition more monitoring points for Landslides and Flood Alert System (PROTOTYPE)



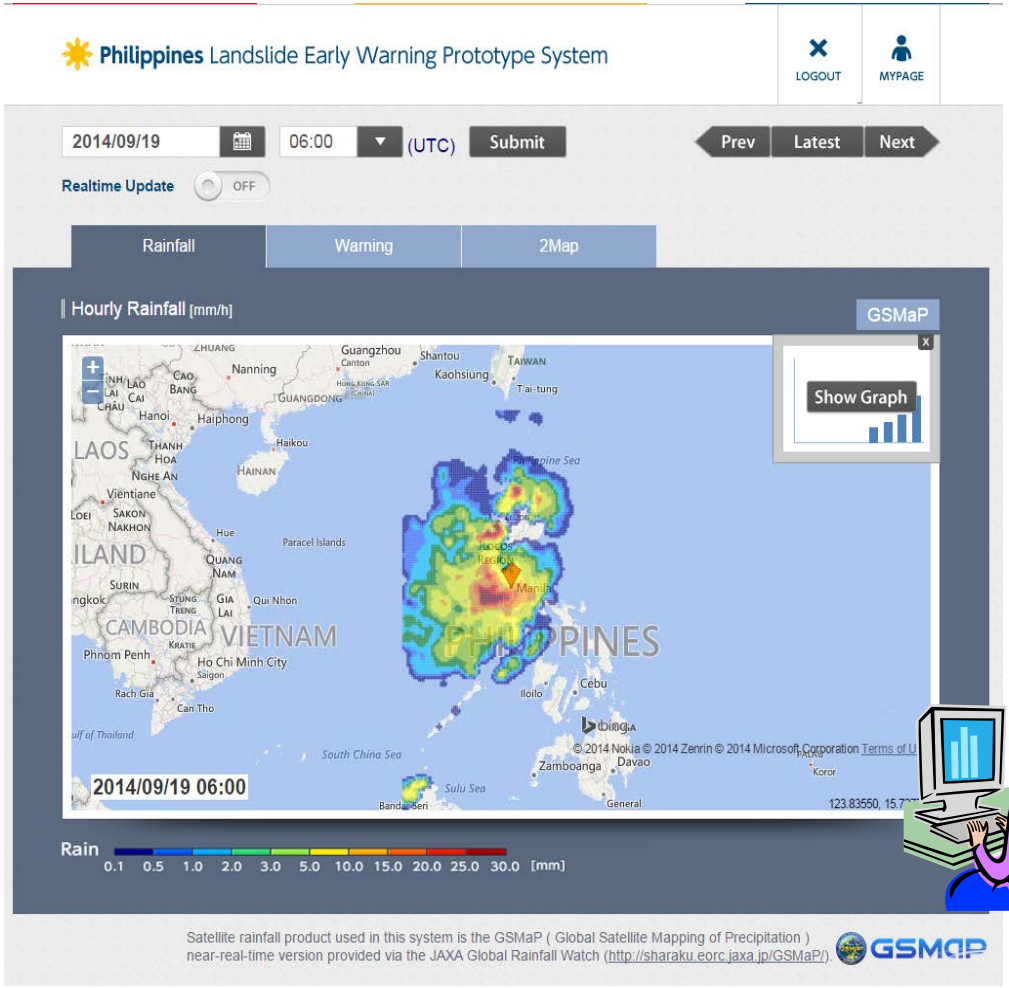
GSMap

We needs

- ◆Latitude/Longitude
  - ✓GSMaP mesh size is 0.1 degree * 0.1 degree.
  - ✓(ex) N13.55, E123.85
  - ✓(ex) N20.25, E122.15
- ◆RBFN Model
  - ✓RBFN Calculation from rainfall data in GSMaP.
  - ✓GSMaP (NRT) started observation since Oct. 2008 (4 years).



The Landslide and Flood disaster Early Warning System with GSMaP



Web application (Recommended: IE 11, Firefox 20.0, Chrome 10.0 or later)

- GSMaP input
- Display
  - Rainfall map (GSMaP)
  - Warning map
    - Landslide
    - Flood
    - Time-Rainfall graph
    - CL and snake line
- Cover all the Philippines
- Update every 1 hour.

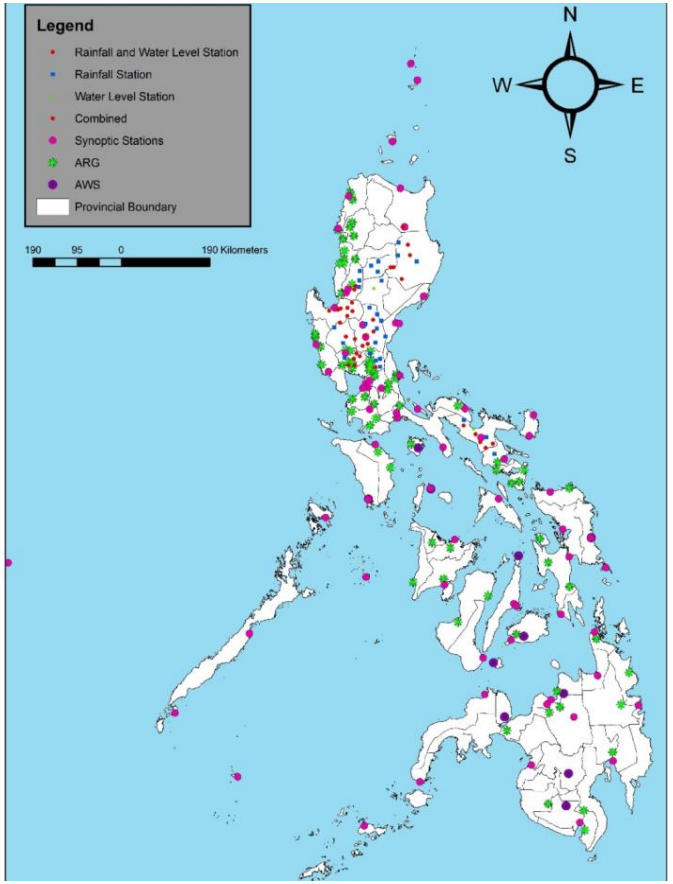
GSMaP based Landslide Warning System (GLWS) Prototype in the Philippines

- *2016 Sentinel Asia Success story Team*

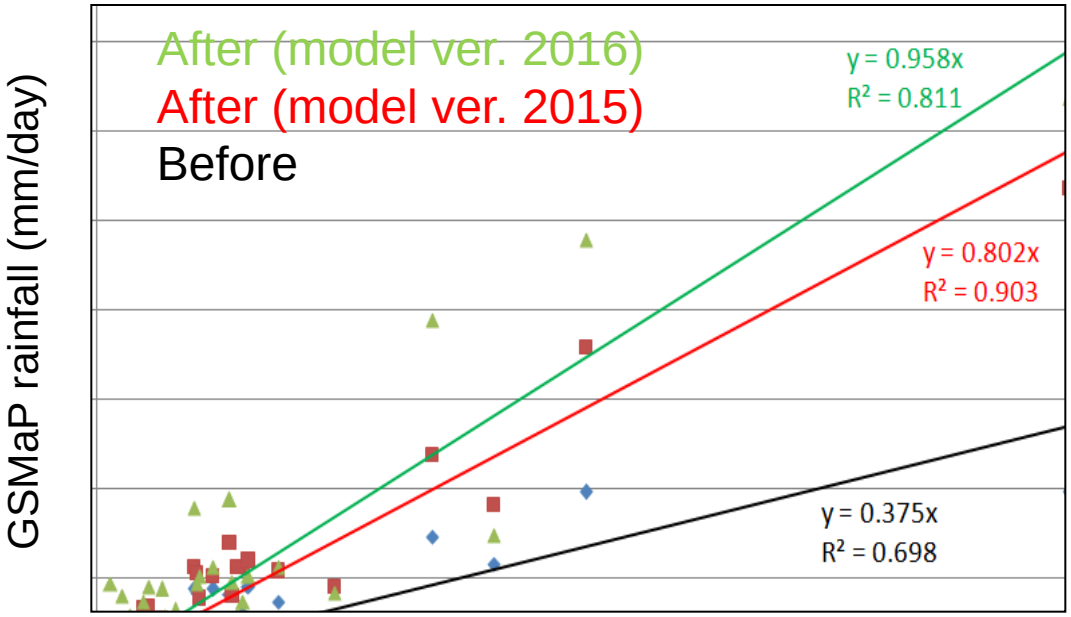
Local calibration of GSMaP

GLWS calibrates GSMaP rainfall rate real-time by comparison between GSMaP and "local observed rainfall data" from PAGASA etc by using GSMaP-IF.

AWS Rainfall station



Calibration check result



* Independent evaluation result in the event of Typhoon Neoguri (July, 2014) in Japan.

Rizal Province Pilot Study – training and calibration

A pilot study including system calibration was conducted in Rizal Province under the collaboration with local government and disaster prevention agencies.

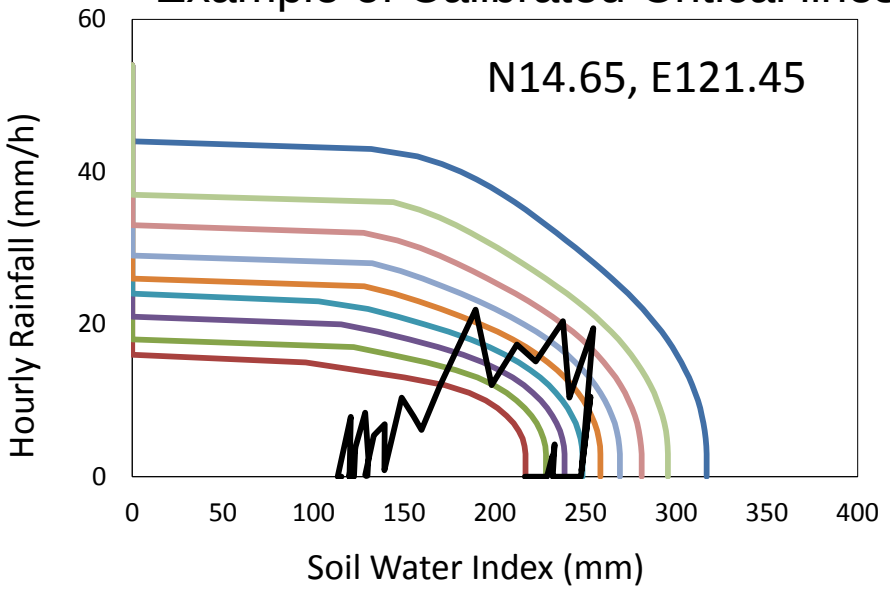
1. Tank model adjustment
2. Quality check of rainfall and SMI
3. RBFN surface generation
4. Collection of landslide occurrence data
5. Selection of appropriate Critical Lines

RBFN surface

Critical Lines

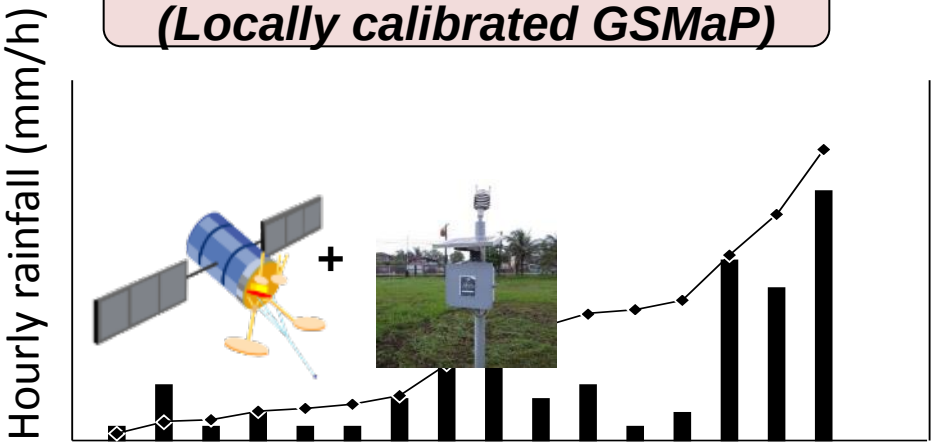
Calibrated system for Rizal

Example of Calibrated Critical lines

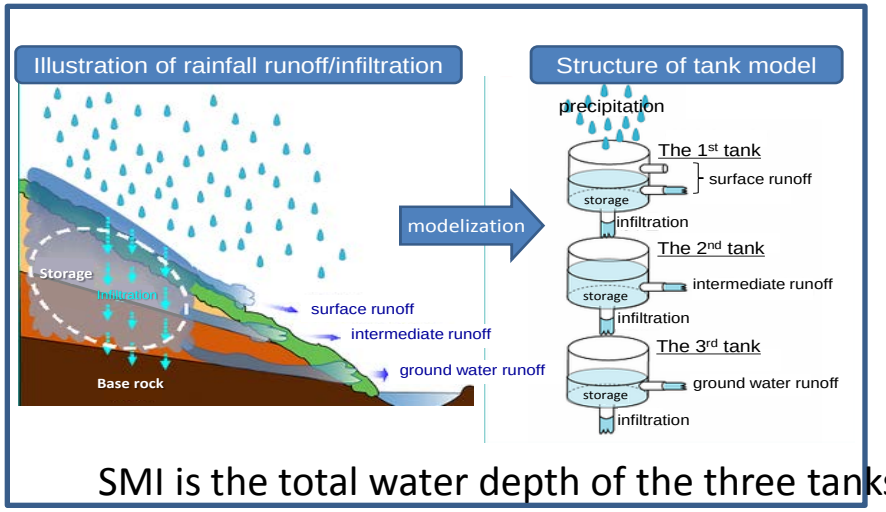


Methodology in the Philippines

Hourly Rainfall (Locally calibrated GSMaP)

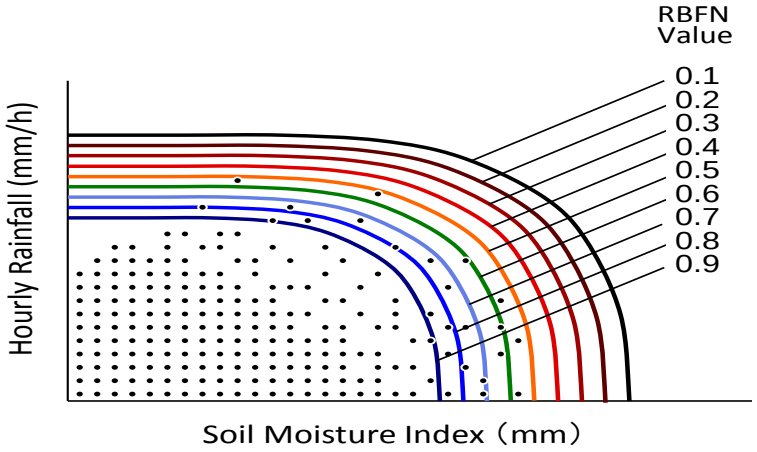


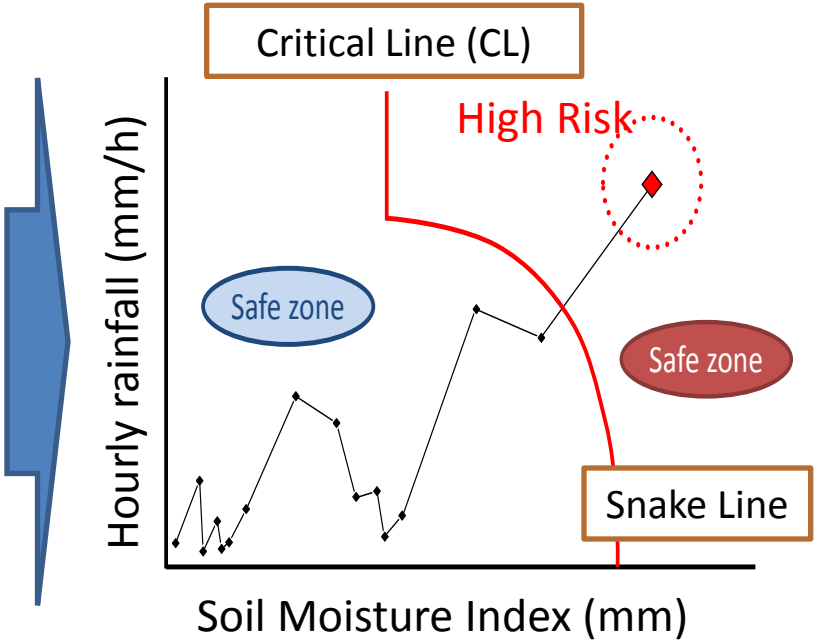
Soil Moisture Index (estimated from tank model)



SMI is the total water depth of the three tanks.

Risk Level based on Critical Lines





GSMaP Application to Landslide Warning System (GLAWS)

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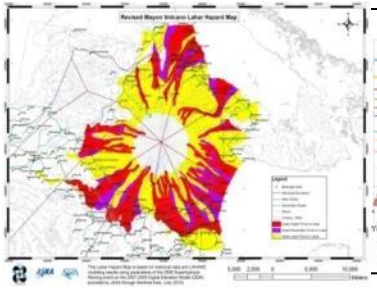
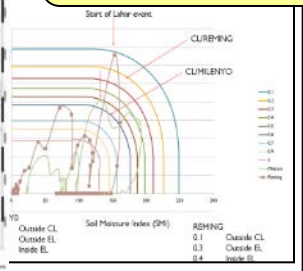


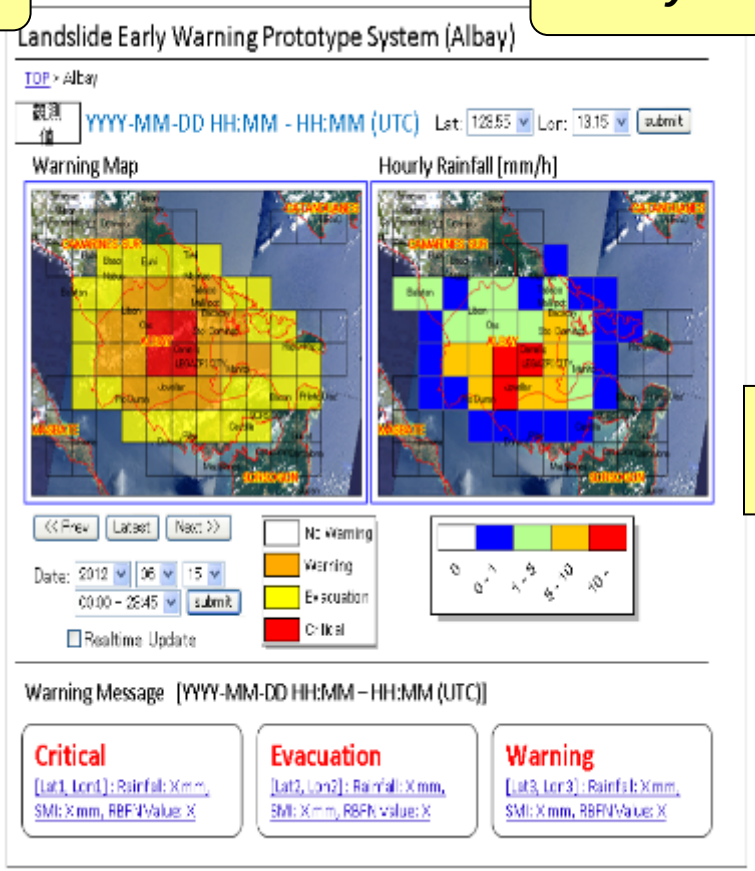
Maps



Warning criteria

System Prediction

System



Application

Analysis / Warning

DRR Agency / Local Government Unit (LGU)

Rizal Pilot Study – Training and Calibration

A local calibration and training on the use of WEB-based Landslide Warning System (GLAWS) was conducted in Antipolo City (Barrangay-Level) and Rizal Province (Municipal Level) together with National DRR agencies (MGB,PAGASA,PHIVOLCS).

WORKSHOP WITH LOCAL GOVERNMENT UNIT (LGUs)
Rizal Province, Philippines
March 2017

Two LGUs have undergone Sentinel Asia workshop

•This warning system is promising

STEP 3

- ✓ ***A prototype of GSMaP Application to Landslide Warning System (GLAWS) has been developed and tested in some pilot areas in the Philippines (Rizal). And the system can be replicated in other areas.***

- ✓ ***A technology transfer (landslide monitoring and warning) has been given to the pilot study sites (Antipolo City and Rizal Province) attended by Disaster Risk Reduction Officers. It is now used in their operation – in test mode.***

- ✓ ***Test results showed the effectiveness of bigger landslide triggered by heavy rainfall. Smaller landslides produced from smaller rainfall still remains a challenge.***

- ✓ ***On the sustainability aspect, SA-PHIVOLCS, DRR Agencies, and LGU will continue to test and eventually operationalized the system in a national scale.***

■ *Future plan*

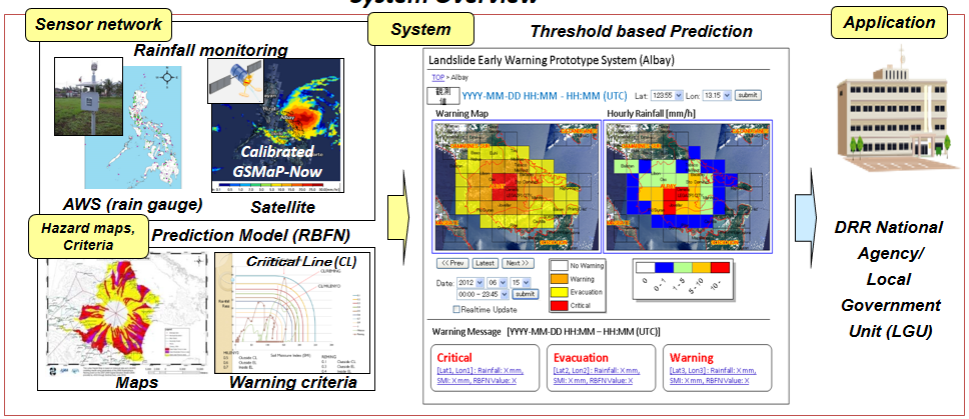
- ✓ ***The system function will be improved based on the comments from local government: localized information and rainfall forecast.***
- ✓ ***The GLWS will be upgraded to cloud based scalable system, and be easy to expand to other regions/countries (anywhere in the world!).***
- ✓ ***The team will compile the project results as a document for standardization of this methodology.***

GSMaP Application to Landslide Warning System (GLAWS)

Prototype in the Philippines

GLAWS is a new web-based landslide warning system that monitors rainfall in real-time and determines landslide risk level by using satellite based rainfall (GSMaP) and critical lines (CLs) based on RBFN (a machine learning method). The system has been piloted under the Sentinel Asia Success Story in the Philippines since 2015.

System Overview

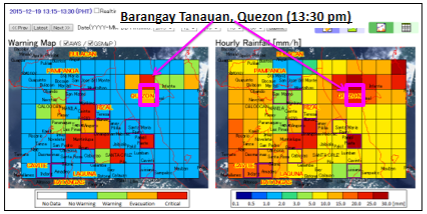


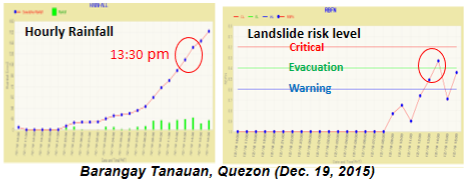
Pilot Study in Rizal Province, Philippines

Recent landslide event in Rizal and neighbor province

No.	Date	Warning	Damage	Cause
1	Dec.19, 2015	Yes	3 killed 1 missing	Tropical storm "Nona" (international name: Melor)
2	Oct. 15, 2016	Yes	3 killed 4 causalities	Tropical storm "Karen" (international name: Sarika)

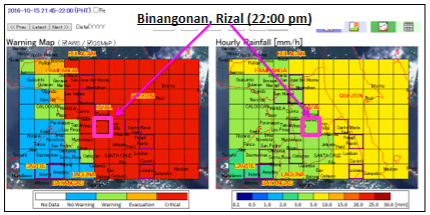
Example of landslides in Rizal
(Left: Marikina-Infanta Road, Antipolo city)

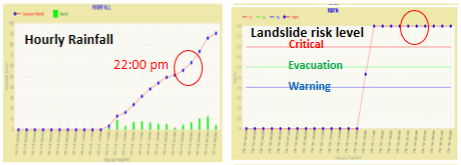




Barangay Tanauan, Quezon (Dec. 19, 2015)

Typhoon Nona, Dec. 19, 2015 (Landslide occurrence time 1:30 pm)





Binangonan, Rizal (Oct. 15, 2016)

Typhoon Karen, Oct. 15, 2016 (Landslide occurrence time 22:00 pm)

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Flooding in Cagayan de Oro due to Typhoon Sendong

Using Space to Save Lives

How satellites can provide much-needed warnings

By **DR. ART DAAG**

If disasters were like trains, their frequency of arrival to the Philippines would make it seem that we are the Grand Central Station of disasters. Being located in the Pacific Ring of Fire puts us in the intersection of both geological and hydro-meteorological disasters. The former brings volcanic eruptions and earthquakes (such as the recent one in Surigao del Norte), while the latter brings typhoons, storm surges, floods, and landslides. In some cases, the extent of damage is widespread, as we have seen in Typhoon Yolanda in 2013, the Mt. Pinatubo eruption in 1991, and the 1990 Luzon Earthquake, all of which claimed numerous lives and billions of pesos worth of property damage.

Assessing the extent of damage and mapping these disasters on the ground can be time consuming, given that the places are sometimes inaccessible and dangerous. Lack of information makes impact assessment, disaster response, and rehabilitation extremely difficult.

Nowadays, we no longer need to rely on purely ground-based disaster assessment. Imaging satellites from space has become an invaluable tool for rapid damage assessment, response, and rehabilitation planning. These are capable of taking high-resolution optical images down to objects smaller than one meter in size. One of the most commonly available set of optical images are those being displayed on Google Earth. Anyone with a computer and Internet connection can see every part of the Earth in the comfort of their living rooms, although these images are oftentimes

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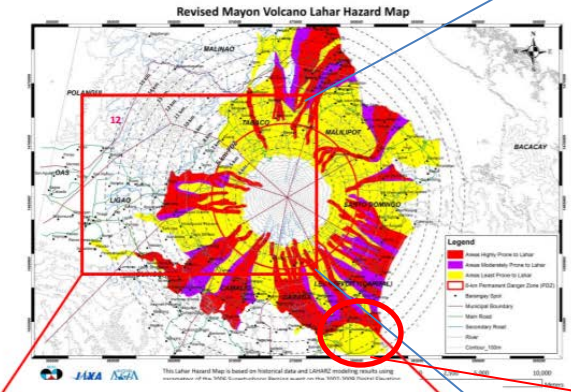
SENTINEL ASIA WORK IN THE PHILIPPINES IS USED AND BEING RECOGNIZED AS ESSENTIAL IN SAVING LIVES FROM NATURAL DISASTERS

http://newsbits.mb.com.ph/2017/02/26/using-space-to-save-lives/

Typhoon Nock-Ten 2016

The typhoon affected the whole Bicol Region particularly the areas north, northwest, west southwest of Mayon Volcano. A quick response team (QRT) was deployed to Mayon from 3-10 Ja 2017 in order to assess, record, and map the lahar deposits and damages brought by typhoon Nin 2).



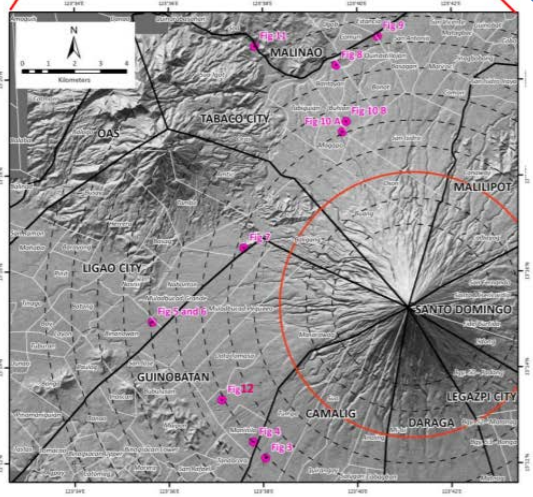


Fig.2 . Map of May coverage of the fi corresponding figu each survey statio

Based from the interview with the Brgy. Kagawad, heavy rain started around 4 PM that triggered strong lahar flows carrying boulder-sized debris, rooted trees, old pyroclastic flow deposits and remobilized old lahar/river deposits. The build-up of debris concentrated flows dammed the culvert bridge connecting Brgys. Oras and Sua-Igot which by 6 pm in the evening, resulted to flooding of houses adjacent to Oras river. Breaching of the dammed bridge around 9 pm prevented the risk of lahars flowing towards the adjacent houses (Fig. 11).

Fig. 11. Damaged culvert bridge connecting Brgy. Sua-Igot and Brgy. Oras

To check eastern portion

Lahar Impacts and Drainage Conditions in Other Mayon Channels:

There was no evidence of lahar generation observed along Yawa River and a channel of Bañadero in Legazpi City. Same was also observed along channels of Budiao and Miisi in Municipality of Daraga. Likewise, channels of Anoling, Quirangay, and Sua in Municipality of Camalig didn't show evidence of lahar generation.

*Typhoon Nina*generated hyperconcentrated lahars in Brgy. Masarawag reaching upto ~2-3 meters. Thehouses which are buried by dominantly sand-sized sediments (Fig. 12 B,C& D) is locatedalong an unnamed tributary that drains towards Ligao City (Fig. 12 A).This tributary is adjacent to the Masawarag channel.

The path of typhoon Nina concentrated on the NW, W, and SW portion of Mayon. Damages and lahars are mostly observed within these areas.

Fig. 8. Lahar overflow contains boulder-sized materials that buried several houses in Brgy. Bantayan.

Fig. 9. A residential house showing the estimated peak height to be 1 to 1.2 meters.

Fig. 10. A) View looking upstream of Colus Creek. Note the same boulder-sized rocks that were transported in Brgy. Bantayan. B) Active channel

THANK YOU