PASCO
World's Leading Geospatial Group

PASCO's approach mitigating disasters from the spaceborne information in special reference to *The Great East Japan Earthquake 2011*

Tadashi Sasagawa, Ph.D.
Corporate Director

PASCO CORPORATION

PASCO OUTLINE

Founded: 1953 as an Aerial Survey Company **HQ:** Tokyo, Japan (55 nationwide offices) **President & CEO:** Mr. Yoichi Sugimoto **Capital:** JPY8,758 million (as of March 31, 2011)

Net Sales: 43 billion Yen (as of March 31, 2011) (600M$) **Employees:** 2,413 (as of March 31, 2011)

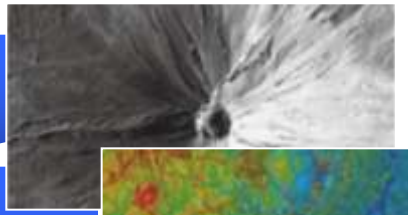
Group companies: 27 consolidated, 5 affiliated companies

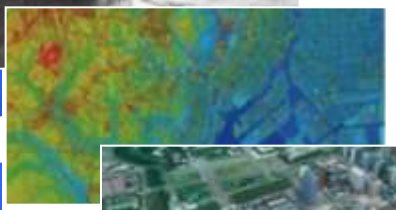
Global Network: USA, Finland, Belgium, Brazil, Indonesia, Thailand, Philippines, China

Geospatial Information Collection

Geospatial Data Processing

Service Provision





【Public】
- Administrative efficiency
- Improved residential service

-Environment and Disaster
-City planning・road
-Fixed Asset
-Health and welfare, etc

【Private】
- Managing analysis
- Improved customer service

-Marketing support
-Delivery Plan Management
-Crisis Management (BCP)
-Sales Support (SFA) etc.

【Overseas Sector 】
- NSDI
- Environmental & Disaster Monitoring

-Airborne /Spaceborne survey
-NSDI
-Land use infrastructure maintenance
-Environments & disaster prevention

【Others】
- R & D
- Education use
- For general consumer

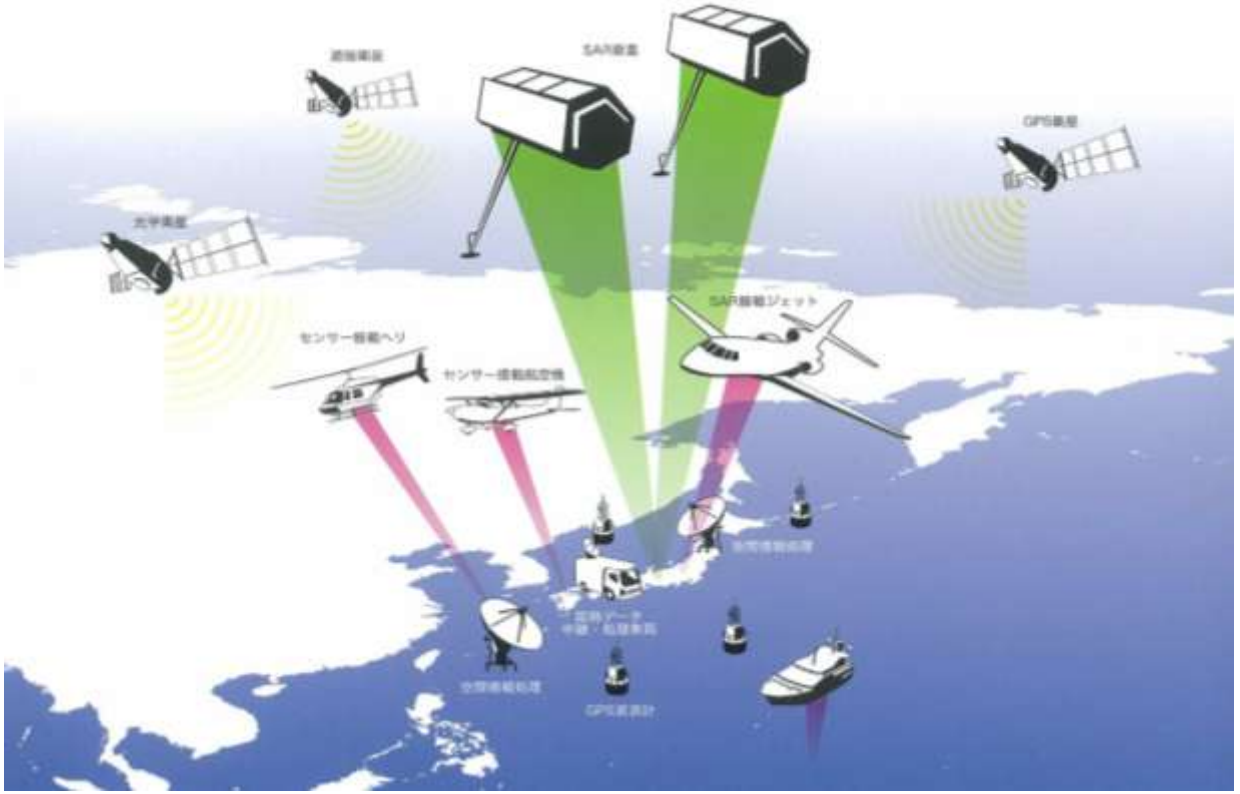
PASCO's concept for the Disaster Monitoring

- Observing wide area information and 3D data creation
- Speedy day/night observation and data creation
- Narrow area with higher accuracy
- Quick analysis of acquired data from various sensors, its visualization and provision
- Data relay and immediate processing in the areas of disaster

◆ Satellite data reception and processing
◆ Expansion of the Satellite Ground Station Network

Constructing the integrated social system and aiming to provide information within 3 hours

Global Disaster Management



Domestic & International Disaster Monitoring utilizing Satellites

Few examples of the major initiatives by PASCO

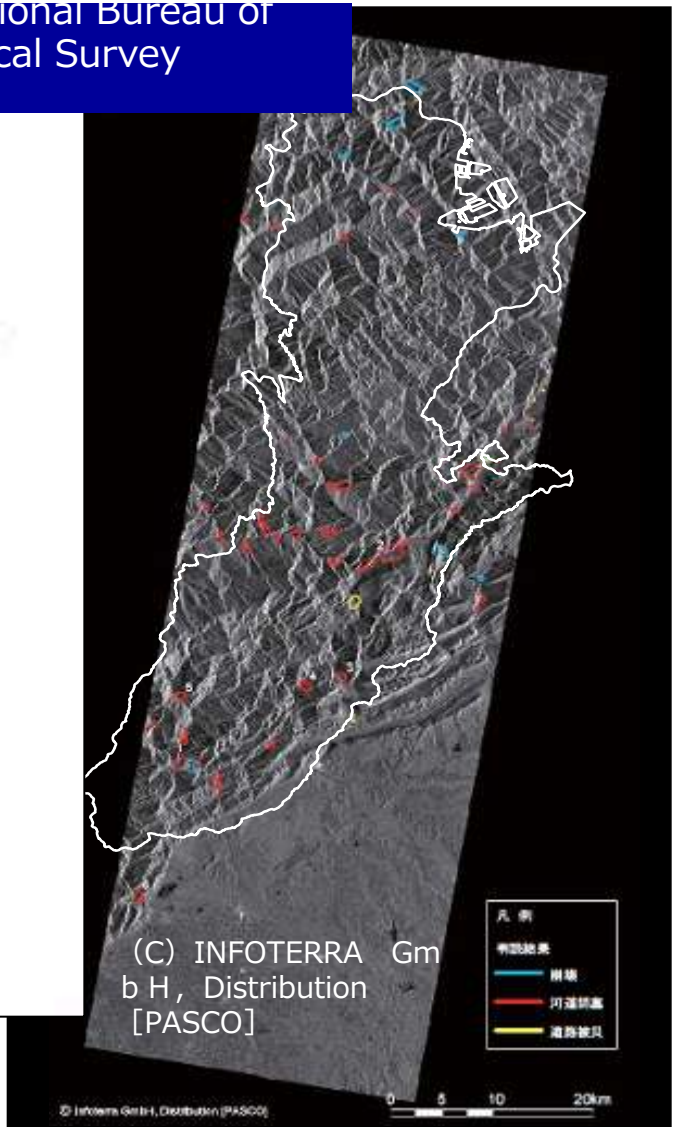
2008	Jan	Monitoring of GLOF (Glacial Lake Outburst Flood) in the **Himalayas**
	Feb	Eruption of **Sakurajima** volcano (Showa crater), Kagoshima Prefecture
	May	Damage interpretations around Kitagawa, the Great **Sichuan** Earthquake
	Jun	Changes in I**wate-Miyagi** inland earthquake slip
	Aug	Heavy rain flooded area estimation **Aichi** (town district Hishiike Kouda)
	Aug	Overflow of Kosi River in **Nepal**
2009	May	Disaster in Northern **Brazil** (near the Parnaíba River)
	May	Estimation of flood disasters due to cyclone “Aila” in **Bangladesh**
2010	Jan	Estimation of earthquake victims in **Haiti**
	Mar - Apr	**Iceland** volcano monitoring
2011	Jan	Monitoring eruptions of **Shinmoedake** volcano in Kirishima
	Feb	Earthquake monitoring in Christchurch, **New Zealand**
	Mar	Providing information about **the Great East Japan Earthquake**
	Oct ～	Flooding monitoring in **Thailand**

Sichuan Earthquake Damage Interpretation, May 2008

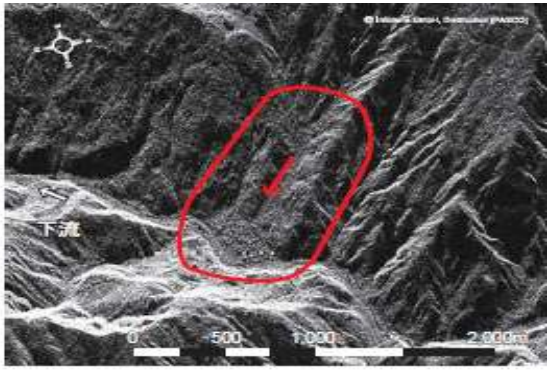
・Appreciation from the China's National Bureau of Surveying and Mapping(Geographical Survey Institute)

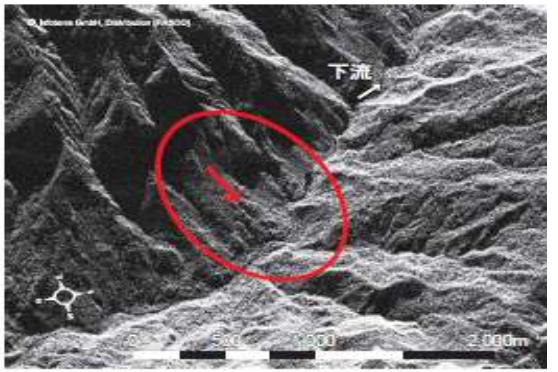

国 家 測 絵 局

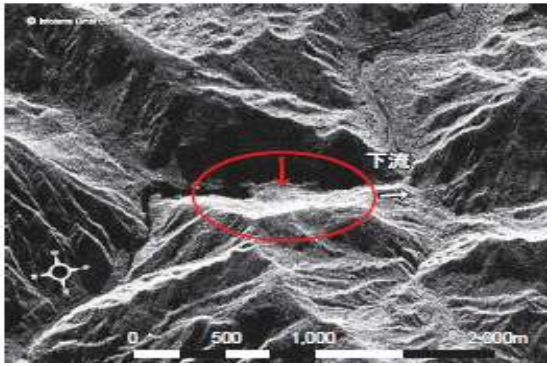
感 謝 信



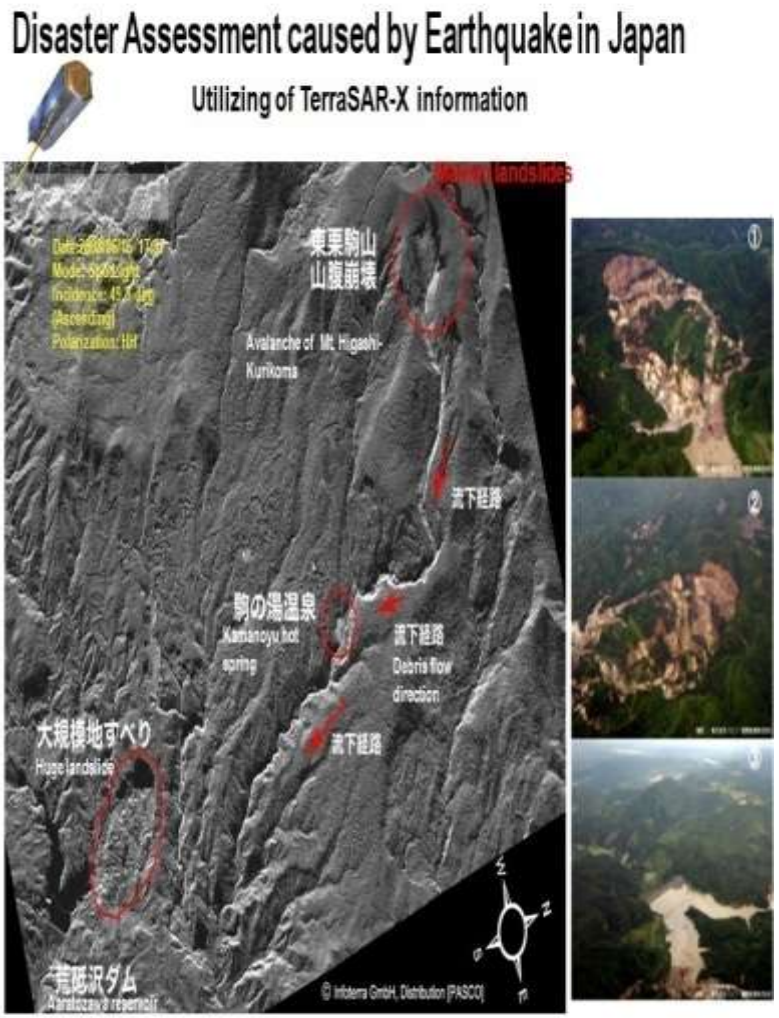
(C) INFOTERRA Gm b H, Distribution [PASCO]



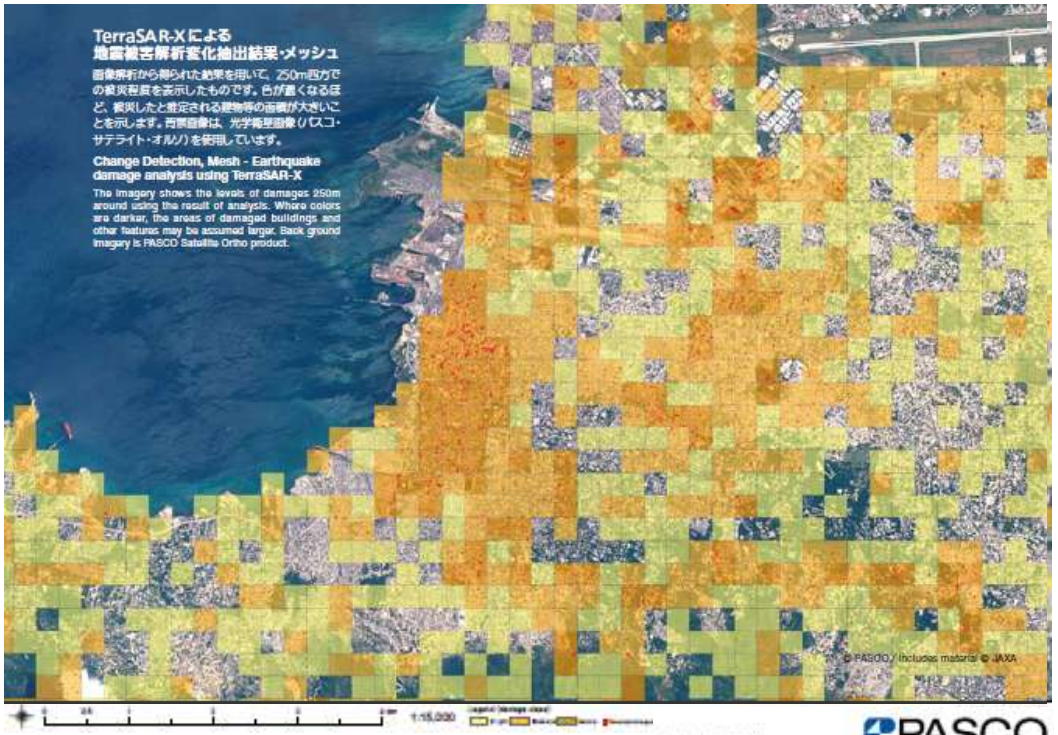




Earthquake Damage Monitoring



TerraSAR-X based damage analysis of Port-au-Prince, Haiti earthquake 2010

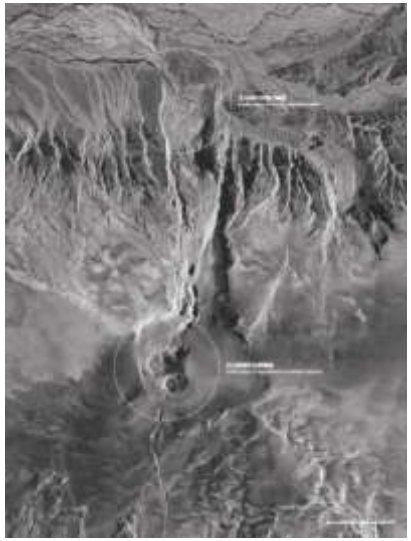


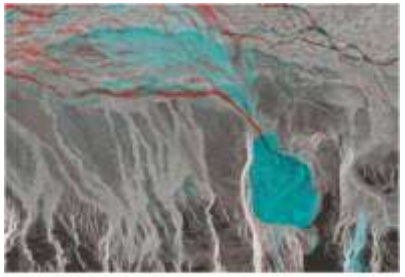
【Port-au-Prince, Haiti】

Acquisition date/time: 13 Oct 2009 10:44(UTC) and 20 Jan 2010 10:44(UTC)
Incidence angle: 39.1 deg.(Descending)
Acquisition mode: StripMap
Product type: EEC
Polarization: HH
Spatial resolution: 3.05 m (azimuth), 3.00 m (range)
Pixcel spacing: 1.25 m

Volcanic Eruption Monitoring

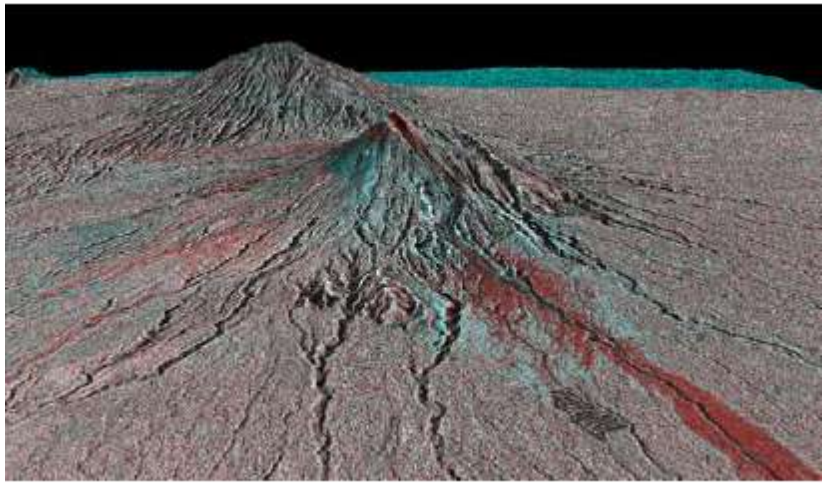
Eyjafjallajokull Glacier, March 2010





The imageries showed crater's change and glacier breakdown etc, due to volcanic eruption.

Merapi Volcanic Eruption, October 2010

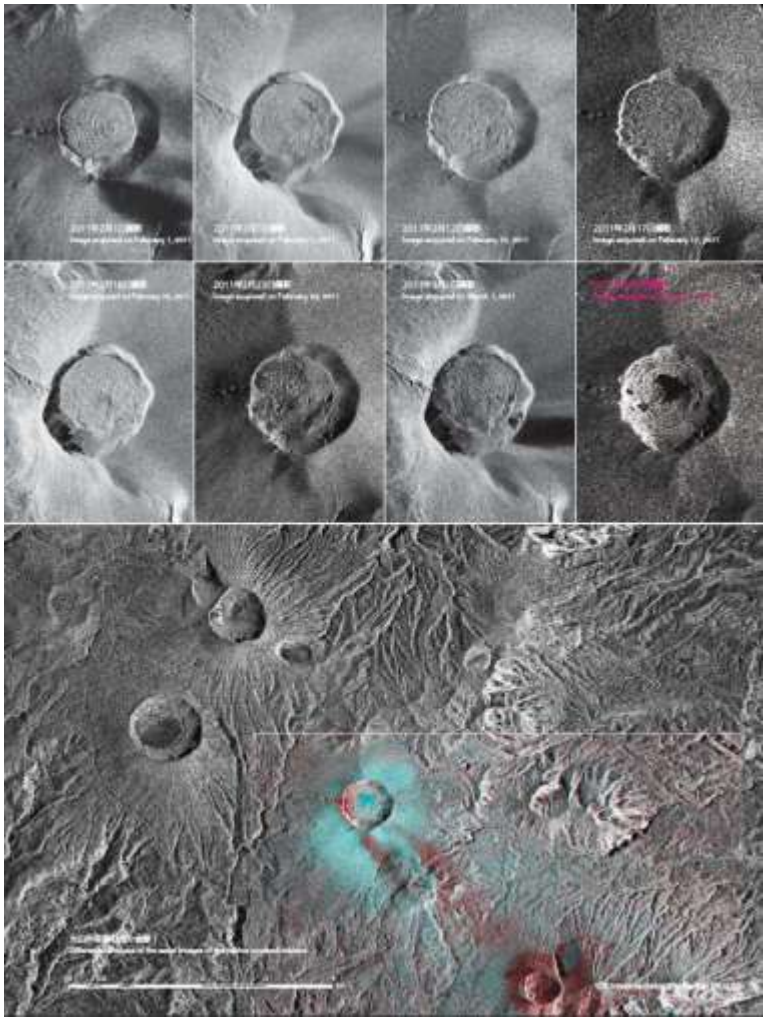


On October 27, 2010 & November 7, PASCO acquired TerraSAR-X images & extracted the topographical changes in a series of volcanic activities.

Shinmoedake Volcano, January 2011

Photographed on February 19, 2011. Aerial photo of the slope on the Shinmoedake volcano's eastside slope.

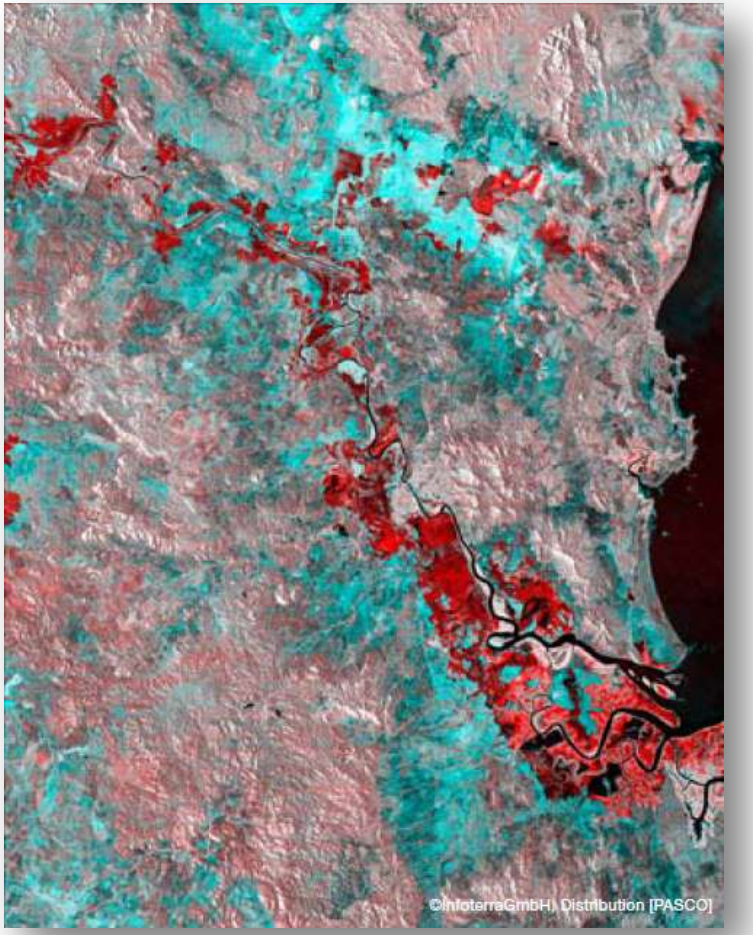
・Estimation of forest damage utilizing satellite（Forest Management Bureau, Forest Agency)
・Volcano Monitoring [National Research Institute for Earth Science and Disaster Prevention (NIED)]



PASCO continuously acquired images of the crater's vicinity. The images clearly showed the interior of the volcanic crater even during rising smoke & to record growth of the lava dome.

Flood Monitoring

Australia



On January 7, 2011 at 16:20 (local time), PASCO acquired TerraSAR-X imageries and extracted the wide flooded areas.

The image shows from West to South side of the Fitzroy River is low level ground and poor drainage, and there are many serpentine river channels with a very gentle slope.

Flood Monitoring

Interpretation of flooding in Bangkok, Thailand

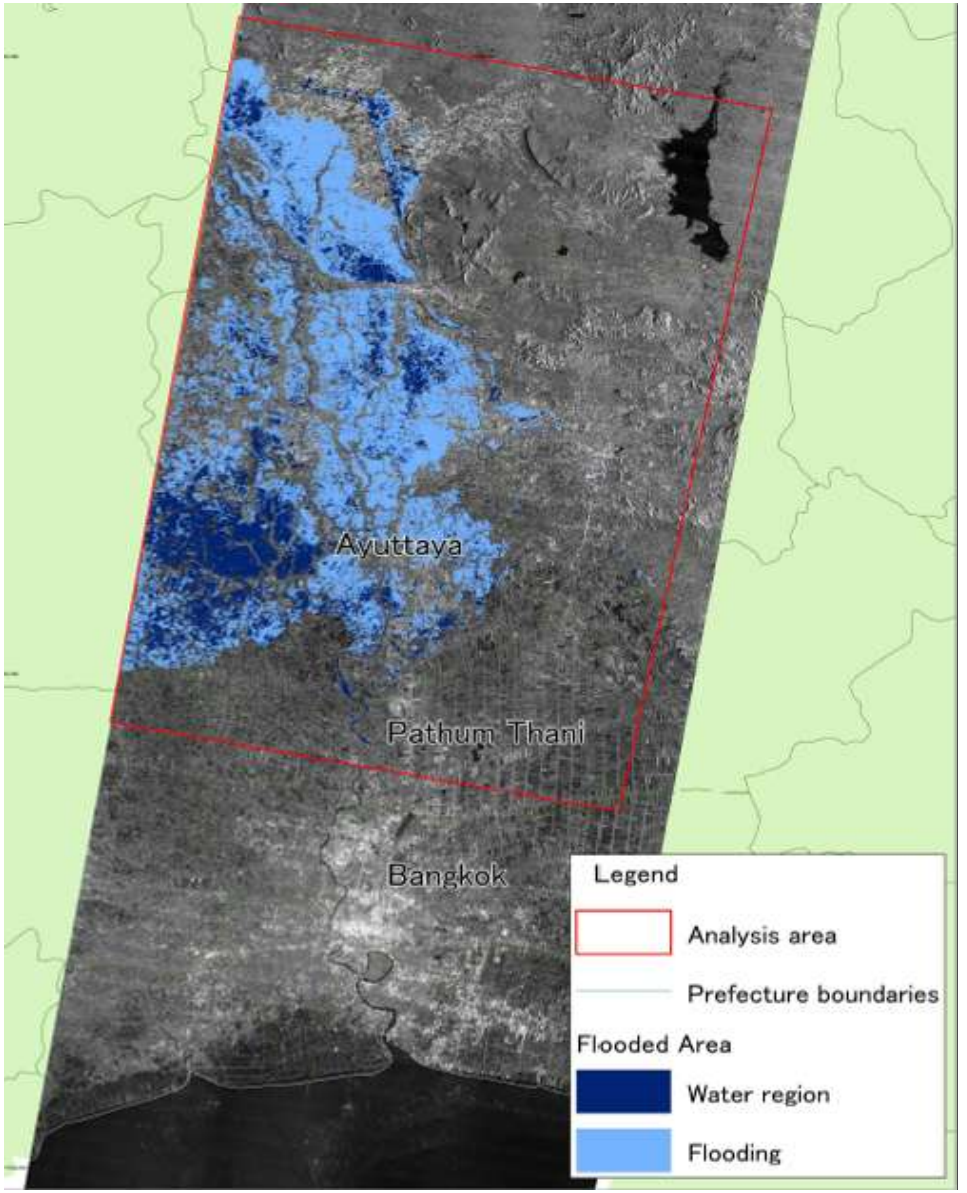
Extracted flooded area, by comparing pre- and post- flooding imageries of TerraSAR-X.

Dark blue: Water region
Light blue: Flooded zone

Acquisitions:

Pre-disaster: **7th** October, 2010

Post-disaster: **10th** October, 2011



Flood Monitoring

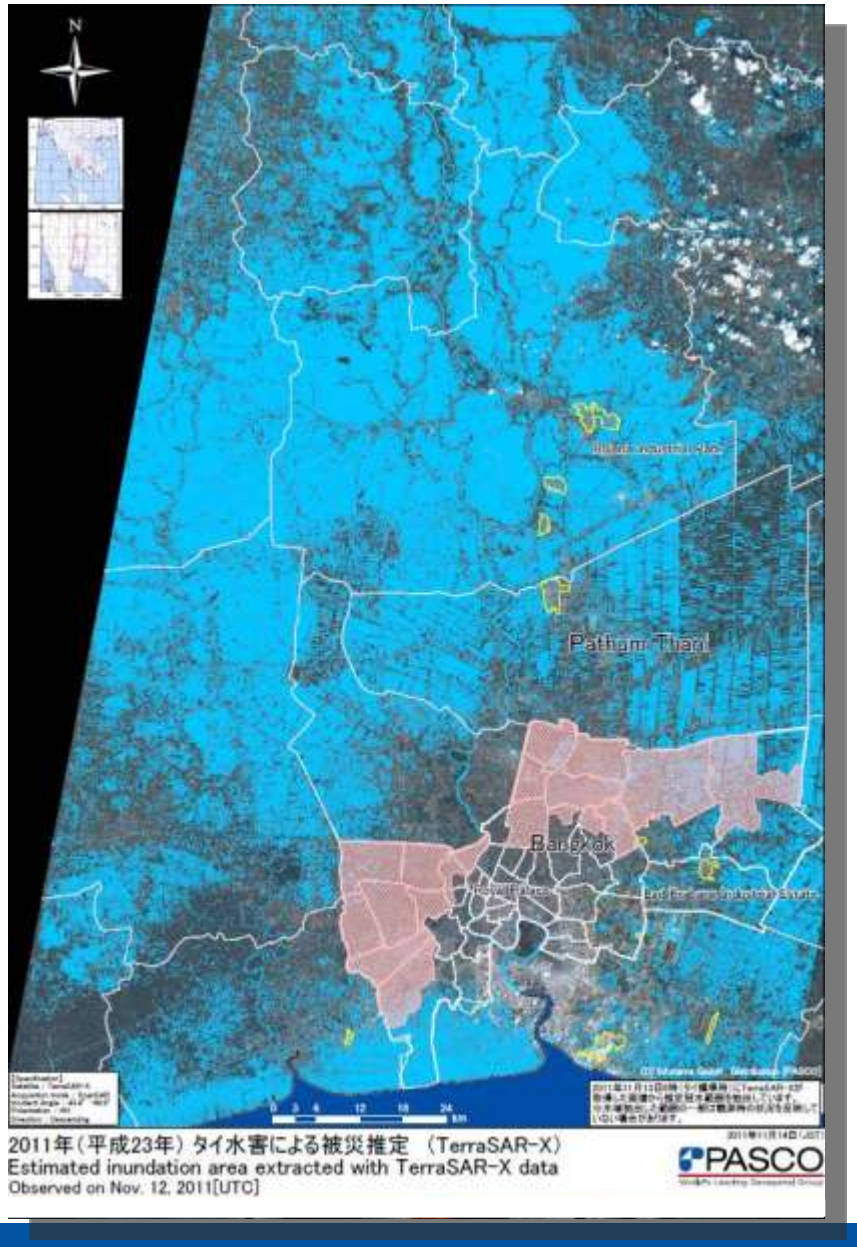
Interpretation of flooding and existing water in Bangkok, Thailand

Product contains: PSO* (ALOS Image)
- Flooded and existing water area
- Warning Area
- Industrial Park

Data acquisition:

12th November 2011

【Specification】
Satellite : TerraSAR-X
Acquisition mode : ScanSAR
Incident Angle : 43.4° -49.9°
Polarization : HH
Direction : Descending



*PSO: PASCO Satellite Ortho™

Flood Monitoring in Thailand from SAR Satellites

TerraSAR-X ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]

Flood Monitoring in Thailand from SAR Satellites

TerraSAR-X ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

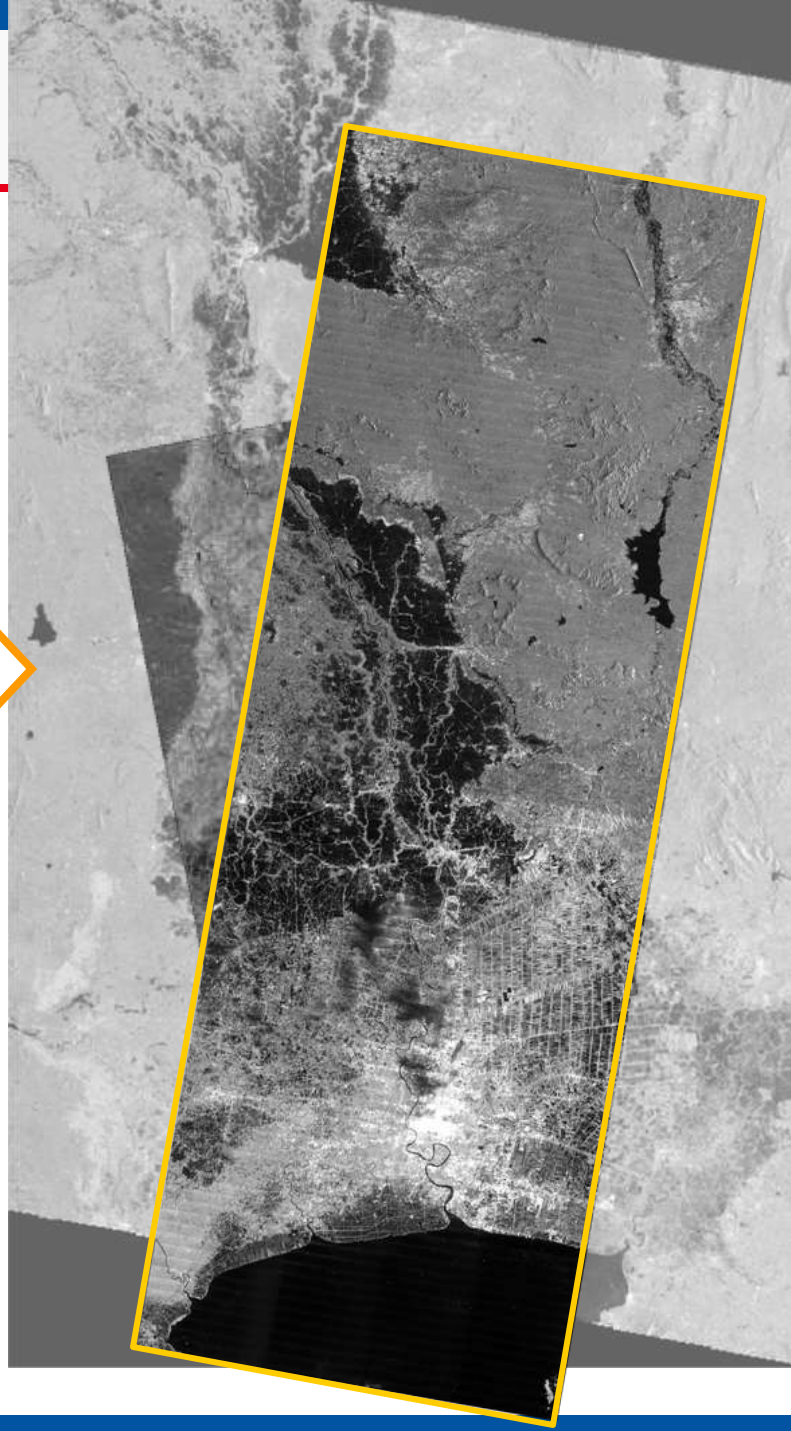
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]



Flood Monitoring in Thailand from SAR Satellites

RADARSAT-2 ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

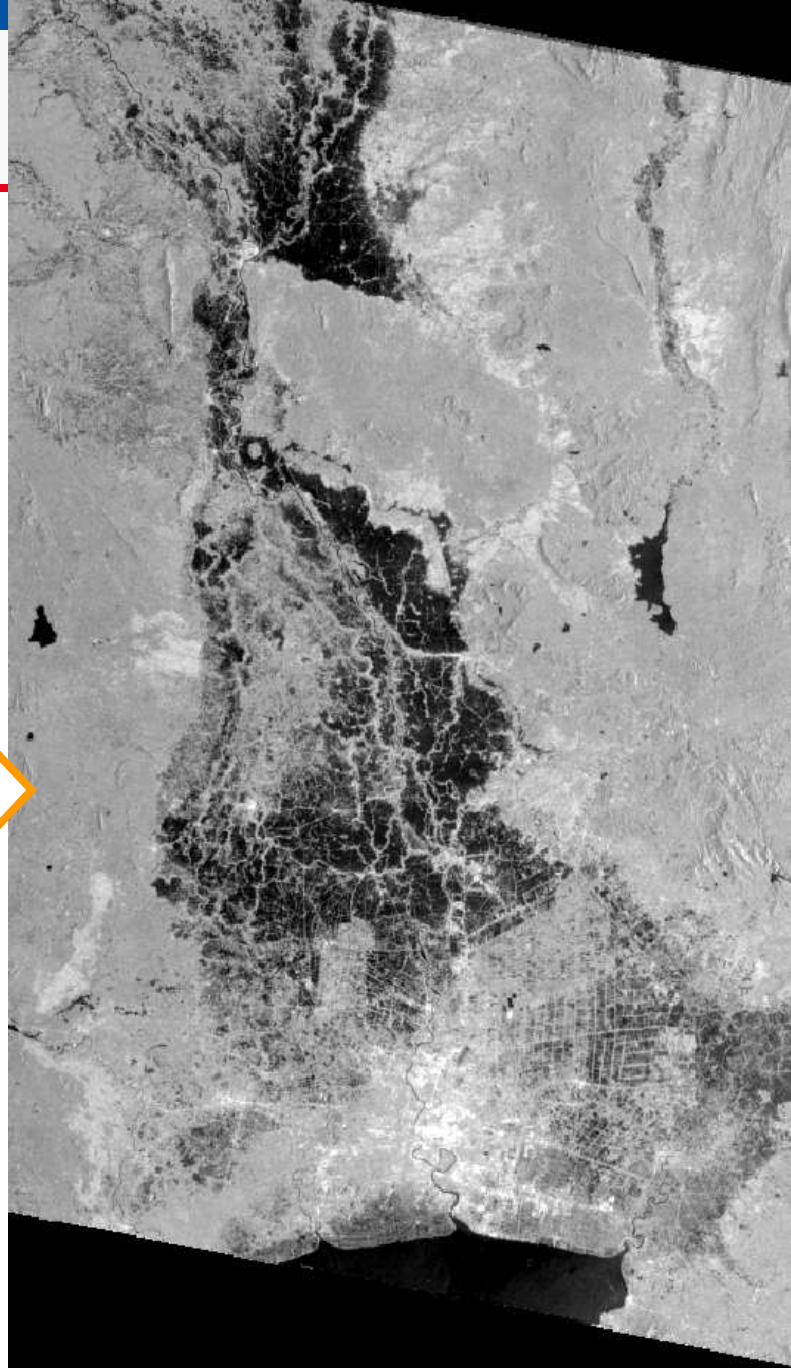
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]



RADARSAT-2 ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

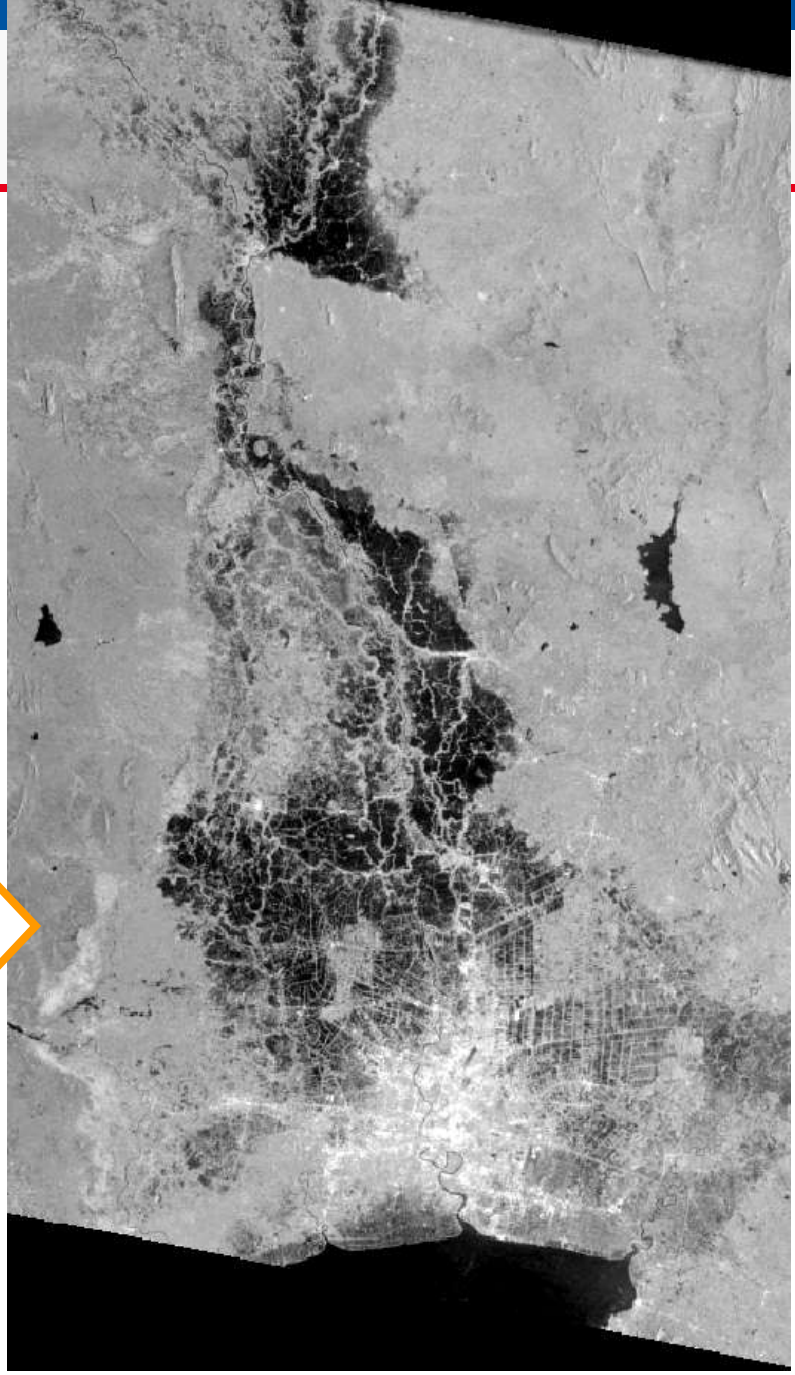
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]



Flood Monitoring in Thailand from SAR Satellites

TerraSAR-X ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

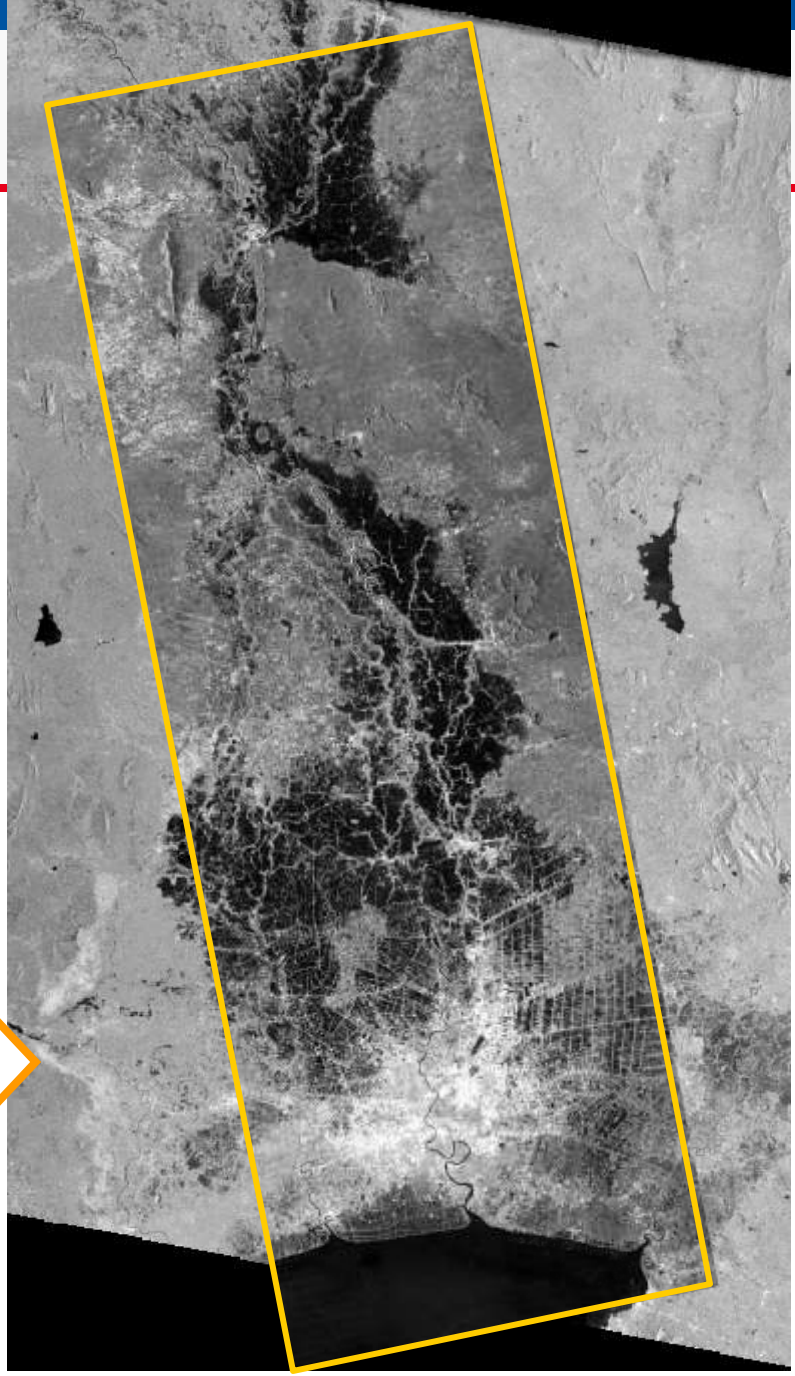
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]



Flood Monitoring in Thailand from SAR Satellites

TerraSAR-X ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

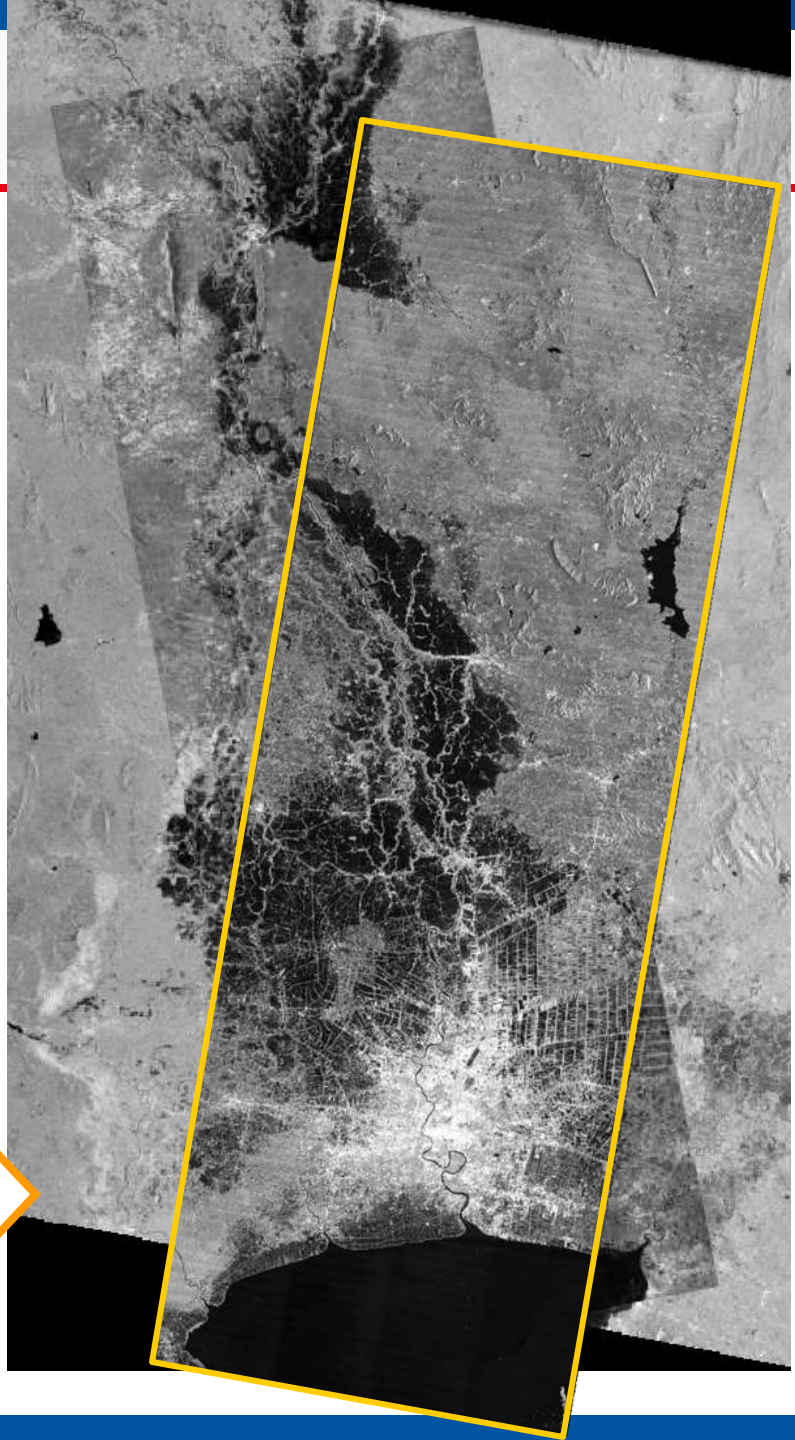
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

17th, Nov 2011-23:00 [UTC]



Flood Monitoring in Thailand from SAR Satellites

TerraSAR-X ScanSAR

10th, Feb 2011-11:00 [UTC]

10th, Oct 2011-23:00 [UTC]

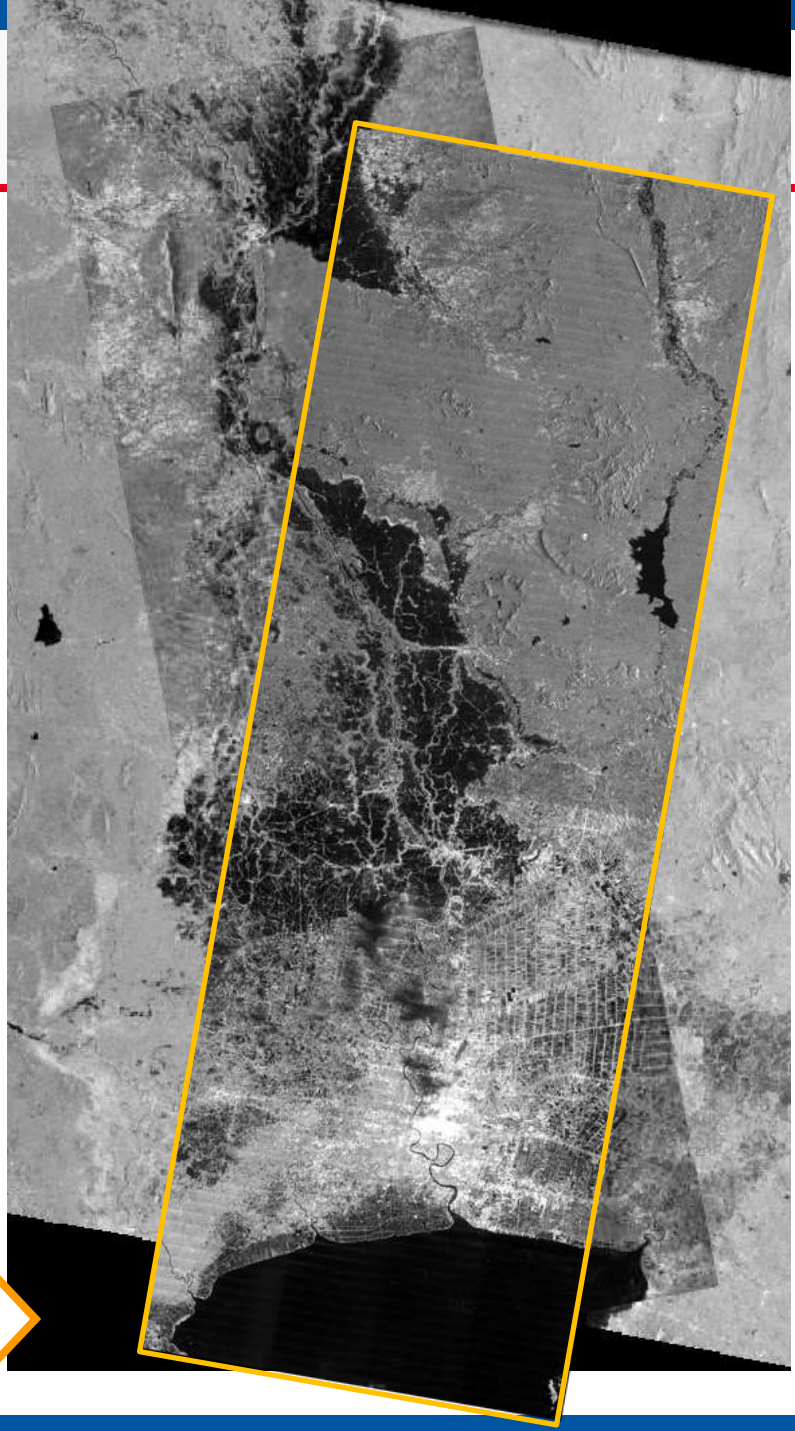
16th, Oct 2011-23:00 [UTC]

9th, Nov 2011-23:00 [UTC]

12th, Nov 2011-11:00 [UTC]

12th, Nov 2011-23:00 [UTC]

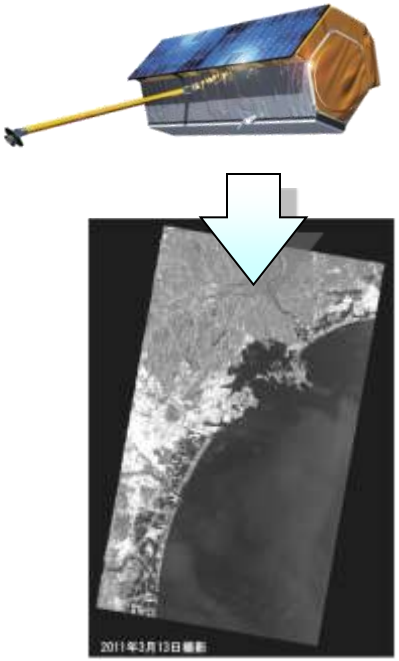
17th, Nov 2011-23:00 [UTC]



PASCO's actions for The Great East Japan Earthquake 2011.

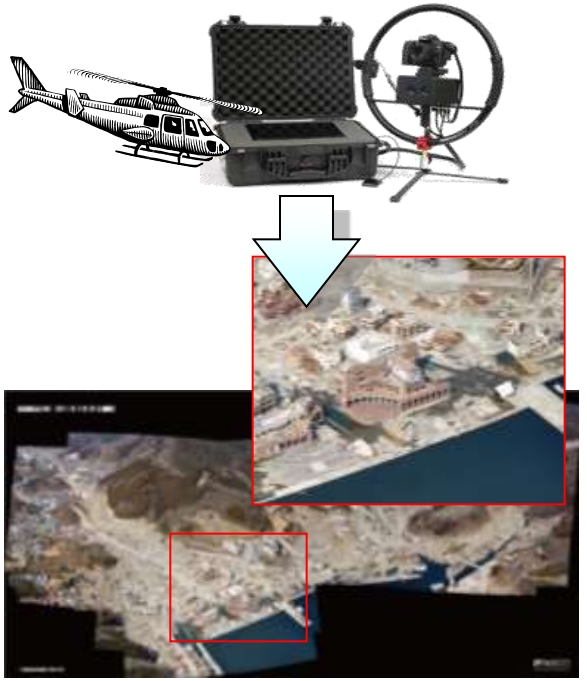
PASCO's actions for The Great East Japan Earthquake 2011

Immediately after the massive earthquake & tsunami, PASCO analyzed & delivered disaster information gathered by various sensors from the space, air & ground.



Spaceborne
TerraSAR-X
ALOS…

Aircraft and helicopter
Microsoft Digital Camera UltraCamX and
Original GPS Camera



Mobile Mapping System
MELCO

PASCO's Satellite Products

Satellites in red were utilized for the Great East Japan Earthquake

Sensor Type	Satellite	Appearance	Launch	Operated by	Resolution	Swath (Nadir for Optical Sensor)
Optical Sensor	IKONOS		Sep. 1999	Geoeye (USA)	Pan(0.82m) Multi(3.3m)	11.3km
	GeoEye-1		Sep. 2008	Geoeye (USA)	Pan(0.41m) Multi(1.64m)	15.2km
	WorldView-2		Oct. 2009	Digital Globe (USA)	Pan(0.46m) Multi(1.84m)	16.4km
	WorldView-1		Sep. 2007	Digital Globe (USA)	Pan(0.5m)	17.6km
	QuickBird		Oct. 2001	Digital Globe (USA)	Pan(0.61m) Multi(2.44m)	16.5km
	SPOT-5		May 2002	SPOT Image (USA)	Pan(5.0m) Multi(10m) SWIR(20m)	60km
	RapidEye		Aug 2008	RapidEye (Germany)	Multi(6.5m)	77km
	EROS-A		Dec 2000	Imagesat (Israel)	Pan(1.9m)	14km
	EROS-B		Apr. 2006	Imagesat (Israel)	Pan(0.7m)	7km
	Cartosat-1		May 2005	ISRO (India)	Pan(2.5m)	27.5km
	Cartosat-2		Jan. 2007	ISRO (India)	Pan(1.0m)	9.6km
Optical /SAR	ALOS		Jan. 2006	JAXA (Japan)	SAR(10m) Pan(2.5m) Multi(10m)	SAR 40-70km Optic 35-70km
SAR	TerraSAR-X		Jun. 2007	DLR/Infoterra	1m(highest)	10～100km (Range direction)
	TanDEM-X		Jun. 2010	DLR/Infoterra	1m(highest)	

Interpretation of Tunami damaged area

- Satellite images for interpretation of flooded areas （March 12-18）

WorldView-1,2 （Hitachi Solutions）

➢ 61 scenes 19,764km²

Obs. Date: Mar 12, 13 and 14

Area: Aomori, Iwate, Miyagi, Fukushima, Ibaraki, Chiba

ALOS [PRISM/AVNIR-2]（JAXA）

➢ **44 scenes 215,600km²**

Obs. Date: Mar 12, 13 and 14

Area: Aomori, Iwate, Miyagi, Fukushima, Ibaraki, Chiba

SPOT-5 （Spot Image）

➢ 9 scenes 32,400km²

Obs. Date: Mar 12, 18

Area: Aomori, Iwate, Miyagi, Fukushima, Ibaraki, Chiba

RapidEye （Panaxx）

➢ 40 scenes 237,160km²

Obs. Date: Mar 12, 13, 14, 15, 16

Area: Aomori, Iwate, Miyagi, Fukushima, Ibaraki

TerraSAR-X （PASCO）

➢ **40 scenes 60,000km²**

Obs. Date: Mar 13, 14, 15,16

Area: Hokkaido, Aomori, Iwate, Miyagi, Fukushima, Ibaraki, Chiba, Tokyo, Kanagawa, Niigata, Nagano, Gunma, Yamanashi

Total of 194 scenes (about 560,000 Km²)

A total of 50 technical experts were involved in this project.

< Interpretation Criteria >

1. Flood water is visible.
2. Boundary of farm lands disappears.
3. Properties like houses are broken.
4. Color changes due to debris deposits are visible.

(This procedure was developed to ensure accuracy and consistency of interpretation)

Identification of flooded areas → GIS data → Creating Maps / Calculation of flood area

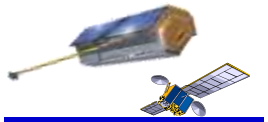
<Created products of est. flood map>

1. Overview Map
2. Detailed Map
3. Inundation area every local government
4. GIS polygon data (SHP, KML)

March 12 → 13 → 14 → 15 → 16 → 17 → 18

Actions within 72 hours

Disaster	24 hours	48 hours	72 hours
14:46JST Mar. 11	Mar. 12 (Sat)	Mar. 13 (Sun) First Observation	Mar. 14 (Mon) Second observation



15:30 Start Observation plan and order

20 : 00 Preparation for analysis and pre-Disaster images

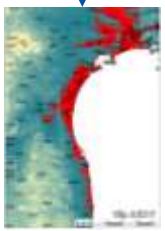
Geospatial Information

- Satellite images
- Aerial photos
- Census data
- Vetor Map
- DEM etc.

GIS:OVERLA

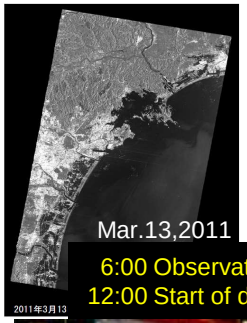
-20km radius from Fukushima Nuclear Power Plant

- Est. seismic intensity



- Areas less than 10m elevation above sea level

(Hokkaido – Kanagawa)



Mar.13,2011
6:00 Observation
12:00 Start of data provision

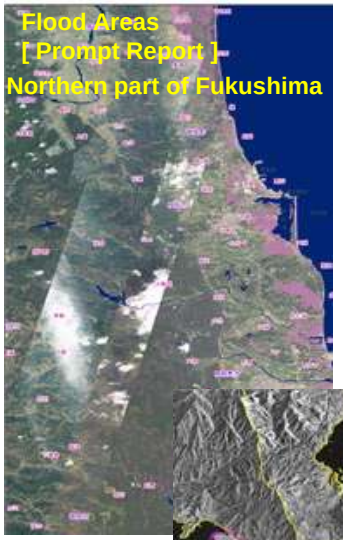
Change Detection

Est.Flood Areas (Coastline of SENDAI)

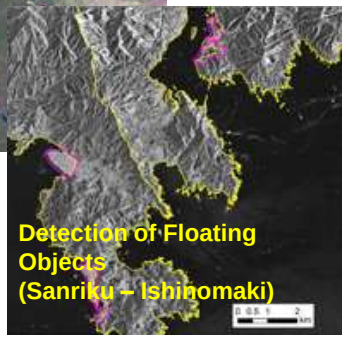
Est. flood area 18:00-

Pref. MIYAGI	Est. Flood Area	Area of City
Higasi-Matsushima city	17.7 km2	101.9 km2
Iwanuma City	14.6 km2	60.7 km2
Sendai City (Miyagino)	6.0 km2	58.1 km2
Sendai City (Wakabayashi)	15.1 km2	48.4 km2
Natori City	15.2 km2	100.7 km2
Total	68.6 km2	369.8 km2

(Hokkaido – Chiba)



Flood Areas
[Prompt Report]
Northern part of Fukushima

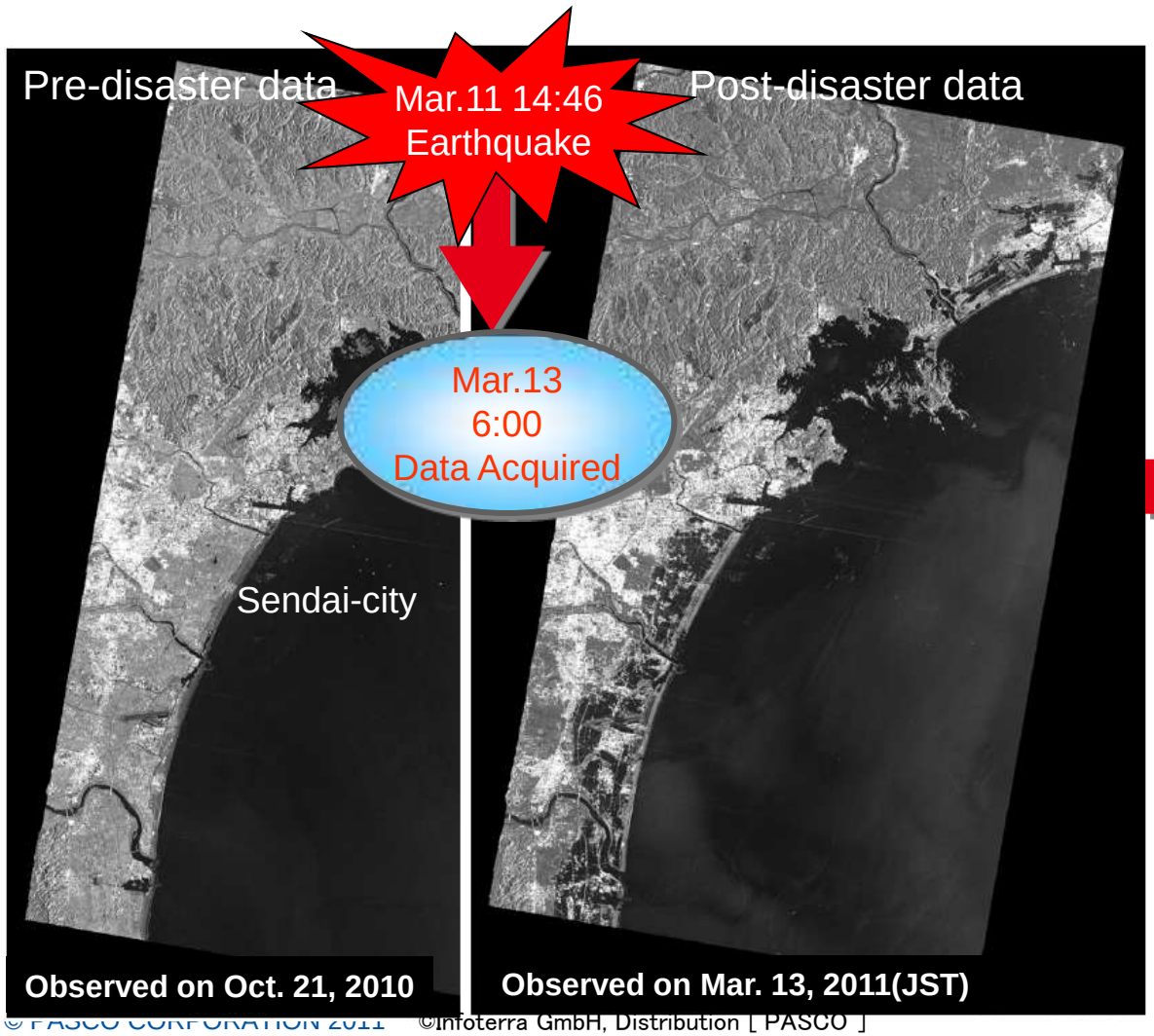


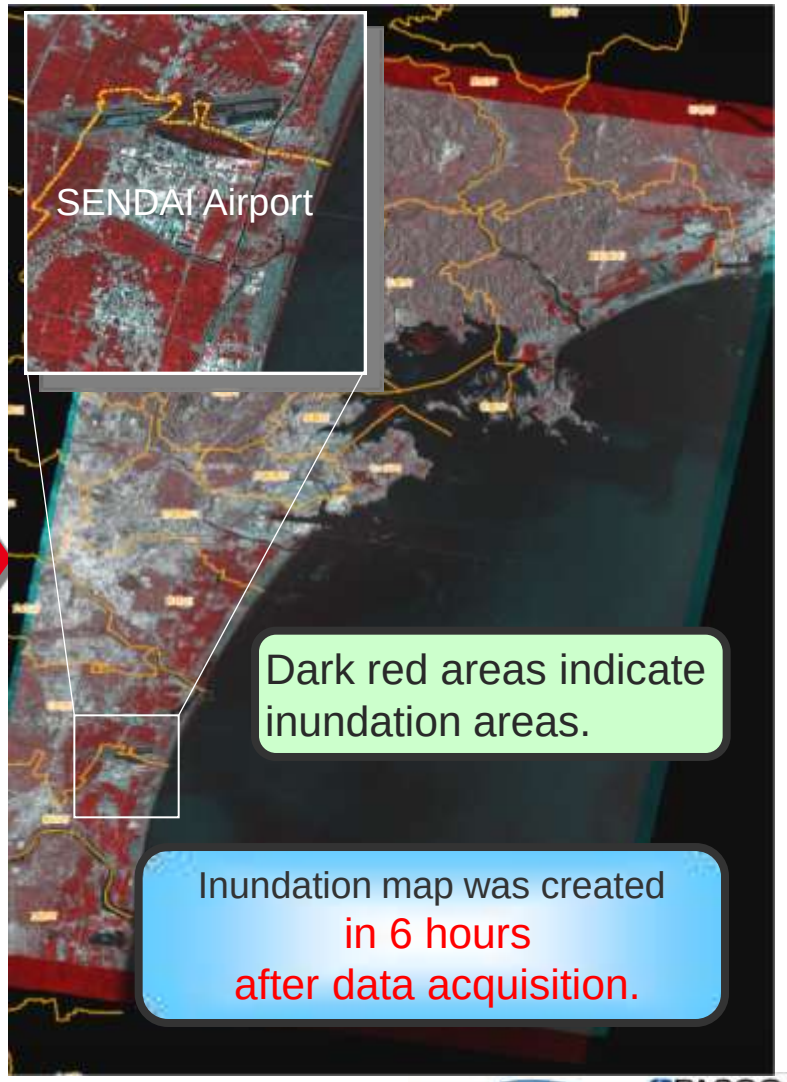
Detection of Floating Objects
(Sanriku – Ishinomaki)

Acquisition by EROS-B
(Fukushima Nuclear power plant)

Rapid Mapping for the Flooded Areas by Tsunami

-PASCO conducted automatic change detection between pre- & post-earthquake using TerraSAR-X images.
-This allowed us to quickly estimate the inundation areas around SENDAI on same day of data acquisition.



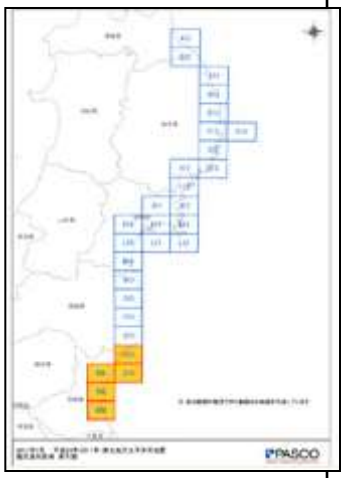


Actions after 3 Days ...*round-the-clock* remained active to acquire the data

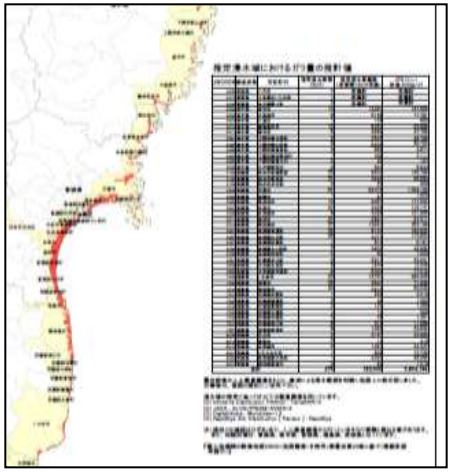
Mar. 15 (Tue)	Mar. 16 (Wed)	Mar. 17 (Thu)	Mar. 18 (Fri)	Mar. 19 (Sat)	Mar. 20 (Sun)	Mar. 21 (Mon)	Mar. 22 (Tue)	Mar. 23 (Wed)	Mar. 24 (Thu)	Mar. 25 (Fri) & later

Map of Flooded Areas

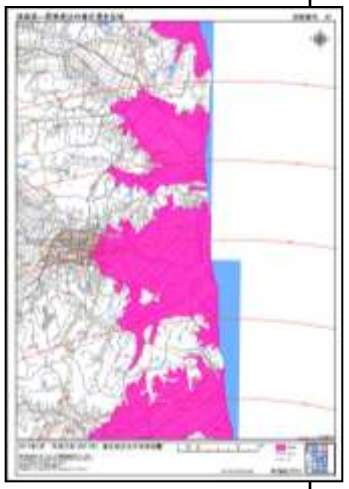
Coast line of Fukushima, provided on Mar. 15



Entire eastern coast of Japan Provided on Mar. 18

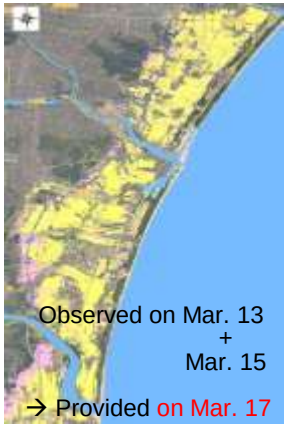


Amount of Debris Provided on Mar. 21



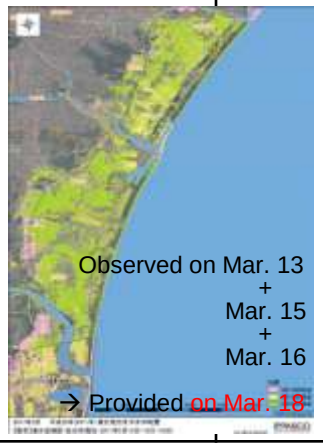
Map of Fukishima for entrance regulation

Map of estimated flodded areas in Sendai



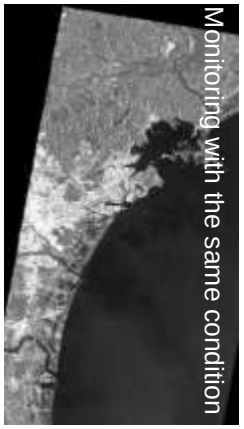
Observed on Mar. 13 + Mar. 15

→ Provided on Mar. 17



Observed on Mar. 13 + Mar. 15 + Mar. 16

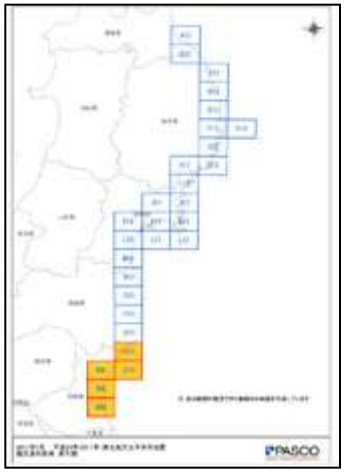
→ Provided on Mar. 18



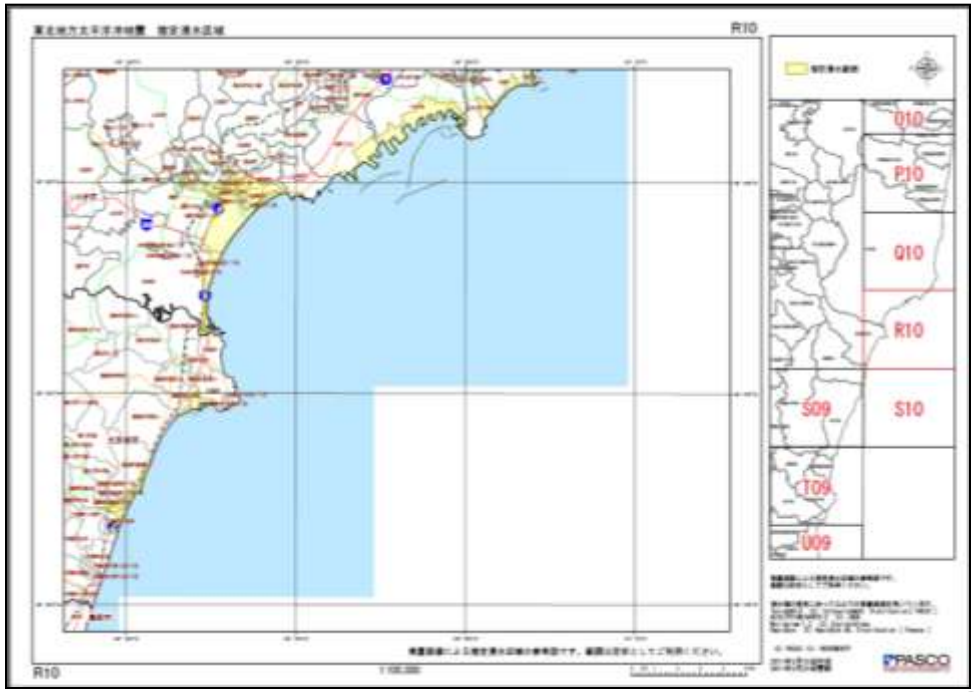
Monitoring with the same condition

Monitoring of Inundation Areas

Map of Flooded Areas for 500km



-Flood Maps for 500km along the entire eastern coast of Japan.



Feature of the Map:

- Area: Coastline from Aomori to Ibaraki pref.
- Satellites: TerraSAR-X, ALOS,RapidEye & Spot5
- Background data: 1:25,000 PASCO FreshMap with boundary, river, road
- Provided to: Disaster manegement agencies such as MLIT and affected local governments and News Media**.**
- Provided date: **Mar 18 and afterwards.**

Interpretation:

- Flooded areas by tsunami were extracted and mapped based on images of various satellites, including TerraSAR-X, ALOS , RapidEye GeoEye and WorldView.
- Detailed flooded areas were updated with aerial OrthoPhoto.

Change Detection of the inundated areas

TerraSAR-X images were acquired 5 times in SENDAI since March 13,
and inundated areas were automatically extracted from the images.

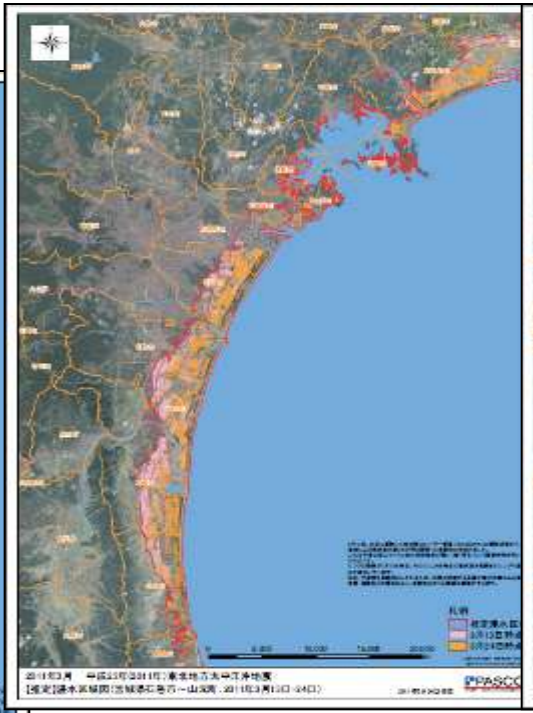
Daily change detection

between Mar. 13 and 15

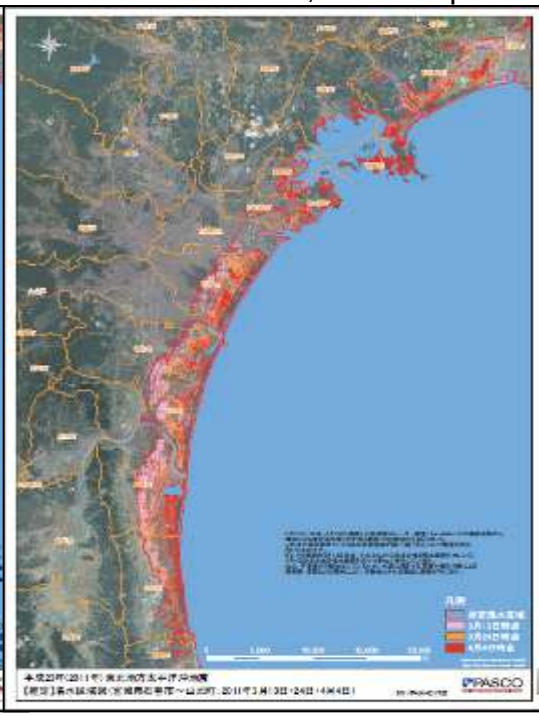
between Mar. 13, 15and 16

Summary of change detection

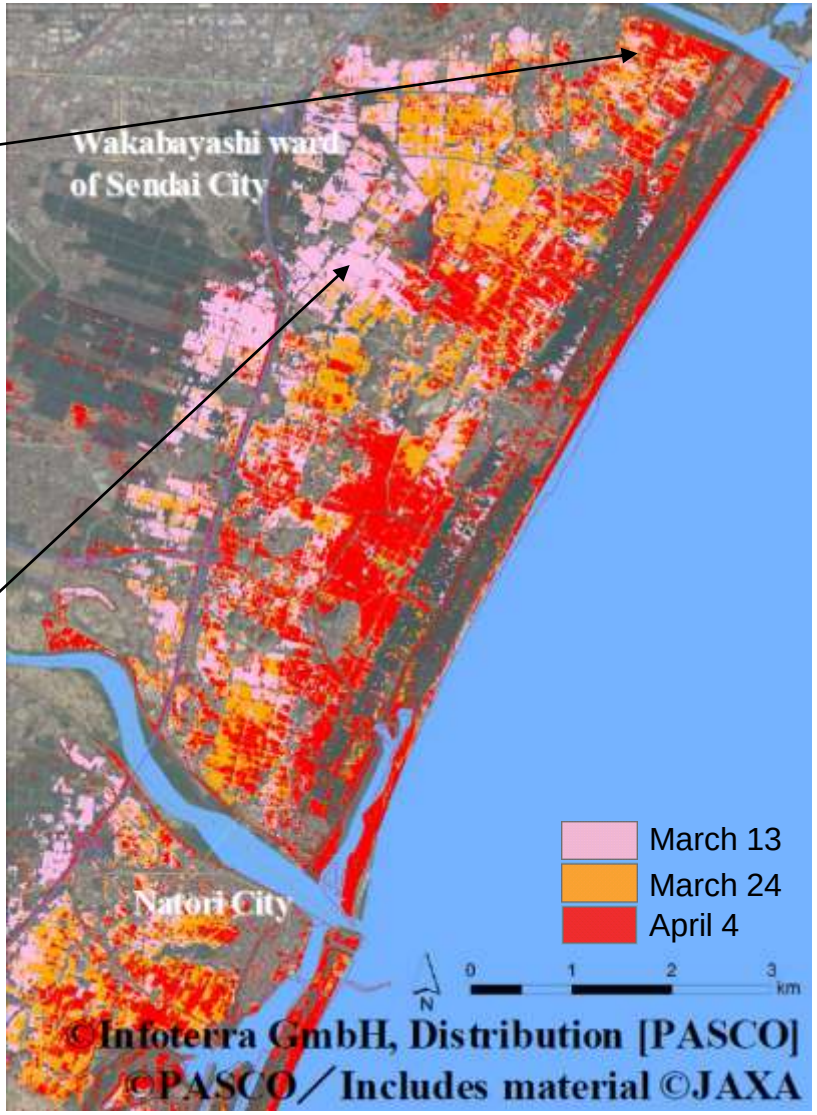
between Mar. 13 and 24



between Mar. 13, 24 and Apr. 4

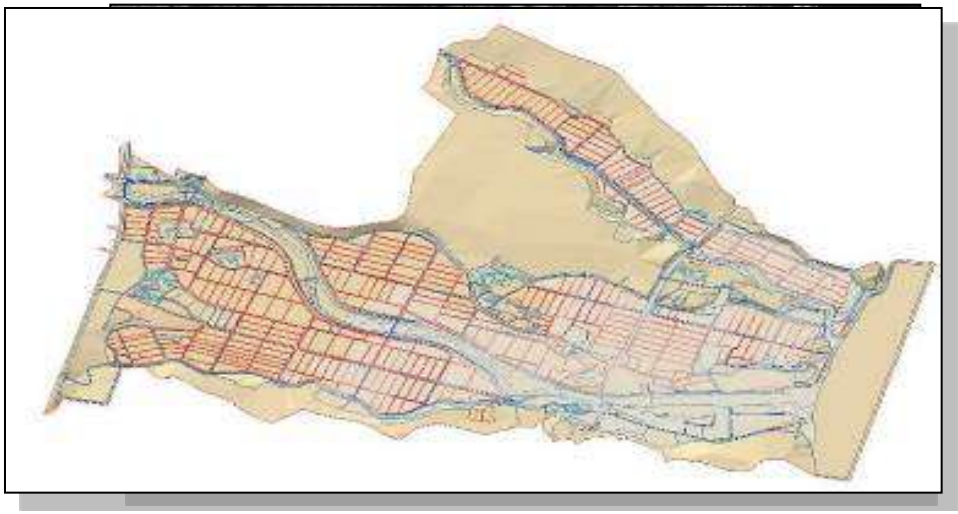


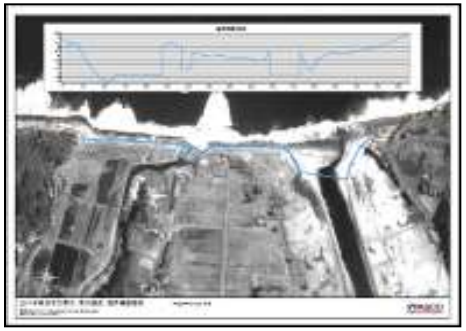
C h a n g i n g Inundation Areas

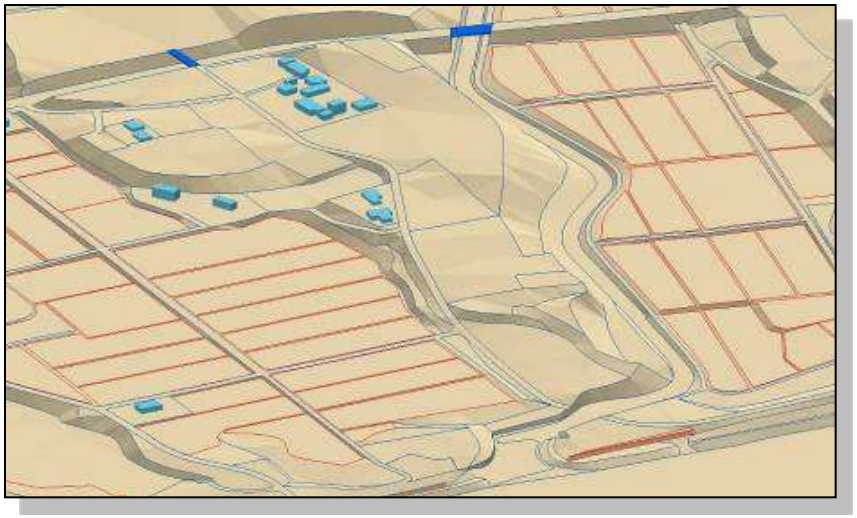


Satellite Stereo-Mapping by WorldView

Near the Fukushima first Nuclear Power Plant, Photogrametry or field survey was never allowed . PASCO applied satellite stereo-mapping by WorldView satellite.

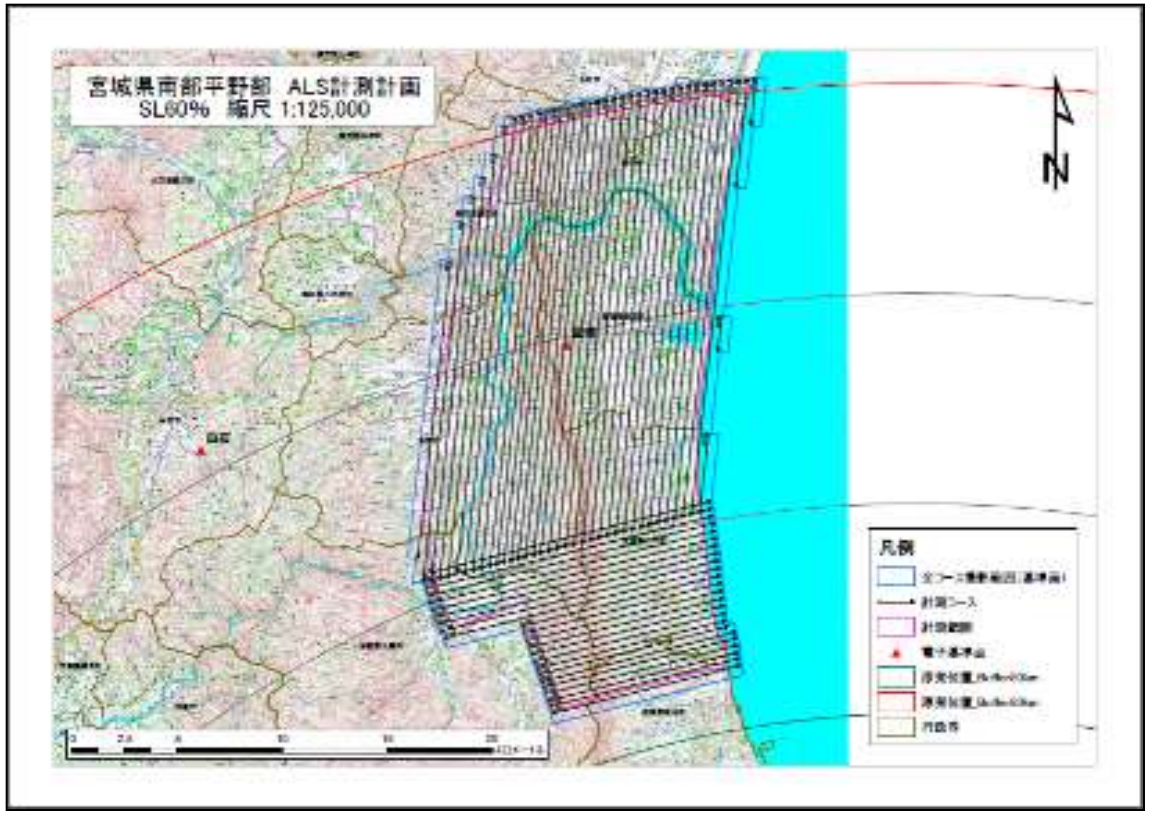


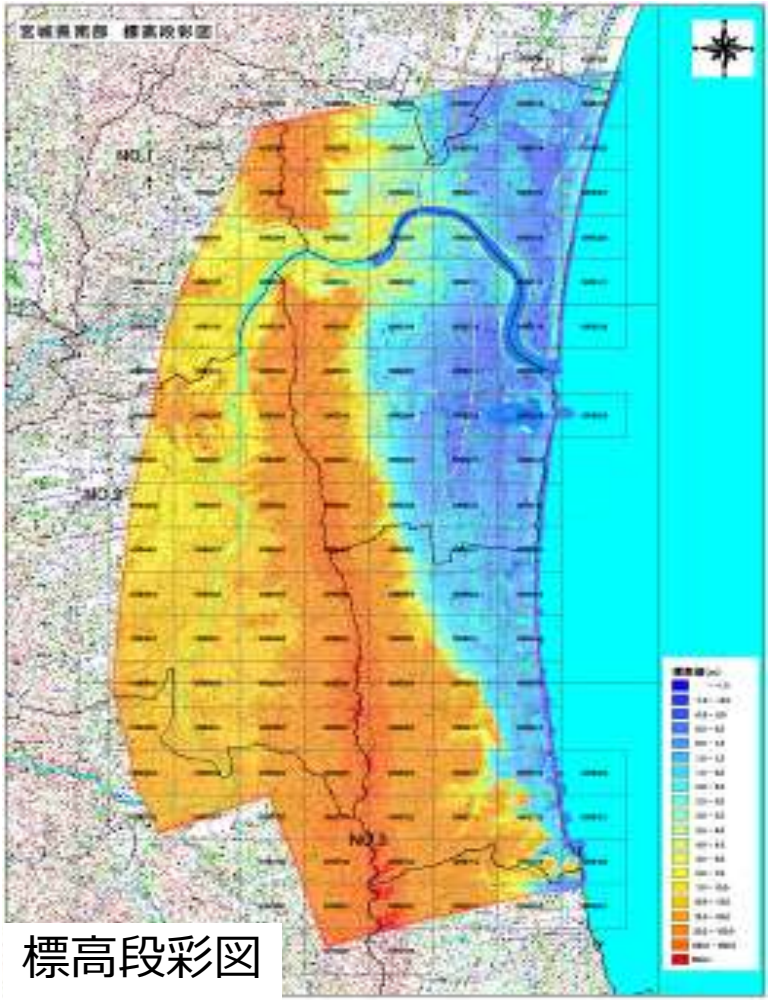




Detailed topographic mapping by LiDAR

Detail topographic survey could be done by airborne LiDAR.





標高段彩図

High resolution heliborne panoramic oblique photos

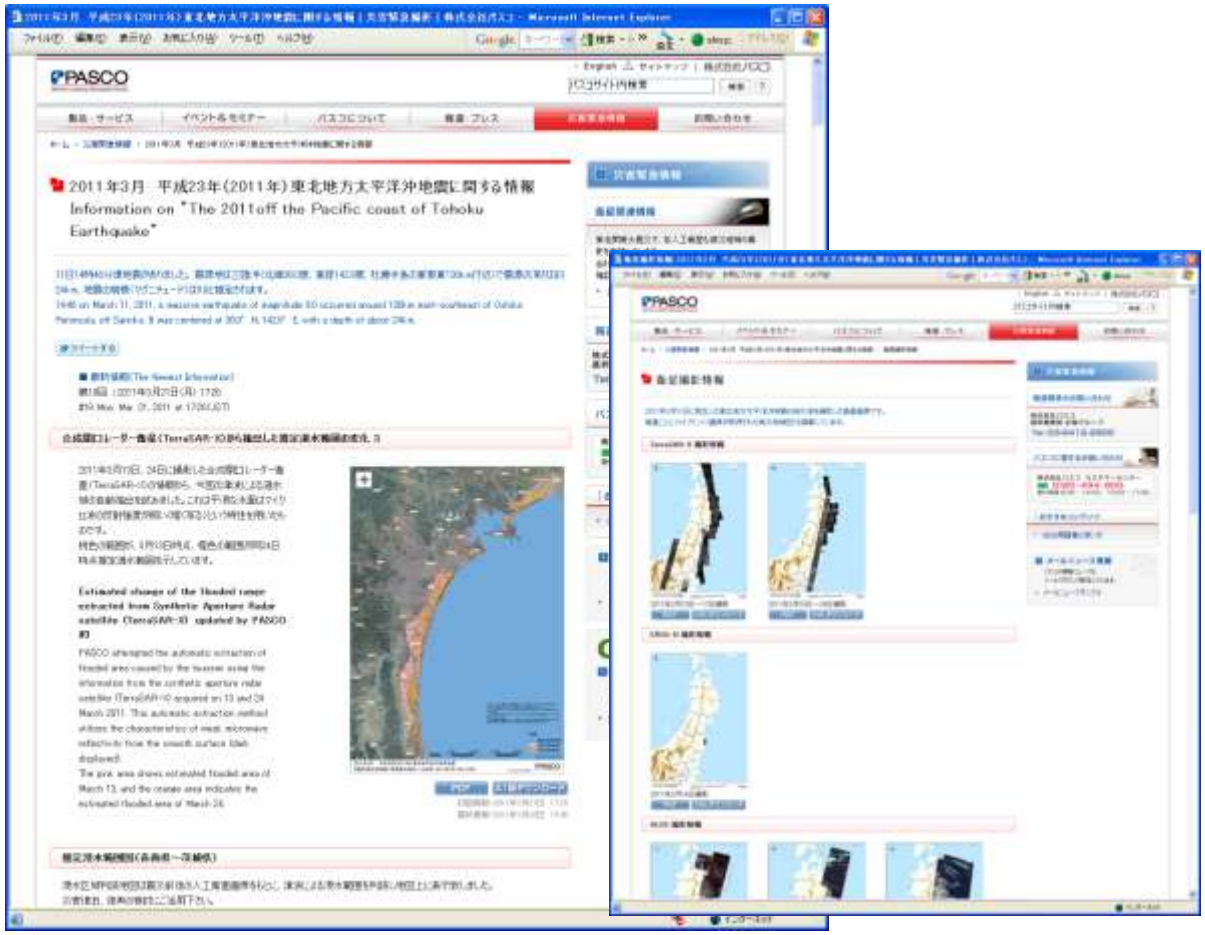
High resolution heliborne panoramic oblique photos are highly useful for damage estimation of houses and buildings and properties

Road damaged assessment by MMS

Detailed road information were collected and analyzed while driving vehicle with the mobile mapping system.

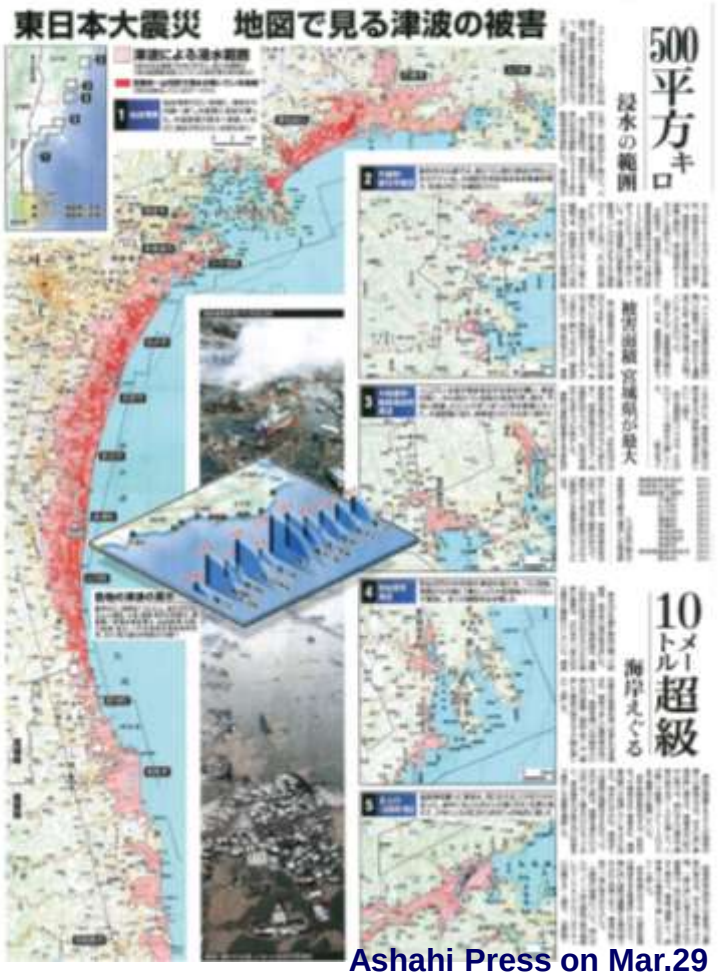
Quick delivery by any means…

- All maps and data were provided to the ministries & local governments by hand-carry in a shortest possible time.
- Maps were published on PASCO's web site as free access.



PASCO 株式会社パスコ

Published on major News Papers
Asahi ,Yomiuri, Mainichi…



Ashahi Press on Mar.29

Summary & conclusions

- Utilization of Multi-source data

  Data from satellites, airplanes, helicopters and vehicles were utilized to monitor the wide areas and in detail.

- Interpretation data were essential for GIS.

- Urgent processing of data

  Automatic change detection method was effective.

  Aerial photo, field survey and visual check ensured the accuracy.

- Quick delivery

  By any means; website, FTP and hand carry.

  Within a few hours, or within a day.

Summary & conclusions

- Analyzed information were immediately supplied to the Cabinet office & several organizations including the disaster affected municipalities, private corporations, media, etc.
- Spaceborne information has witnessed the increasing initiatives aimed to cover wide areas for timely assessments.
- PASCO will be committed to provide optimum services for mitigating disasters in Japan & globally cooperating with UN-SPIDAR in the near future

Thanks for your kind attention

World's Leading Geospatial Group

PASCO