FIG WORKING WEEK 2012
May 6–10 2012
Rome, Italy

PASCO
World's Leading Geospatial Group

PSD-T1-AT1-1205-001

Disaster Monitoring Using Remote Sensing for the Great East Japan Earthquake

Kazuo Yoshikawa
Yuki Okajima
Susumu Takagishi
Satellite Business Division
PASCO CORPORATION

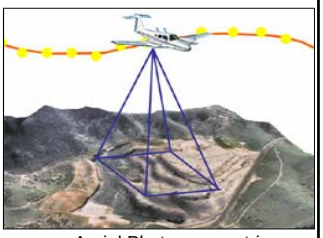
Contents

PASCO
World's Leading Geospatial Group

World's Leading Geospatial Group

1.Overview of PASCO

- Establishment : 1953
- Number of Employees : 2,478（as of Sep,2011）
- Head Office : Tokyo, Japan
- Global Network : Belgium, Finland, USA, Brazil, Indonesia, Thailand, Philippines, China
- TerraSAR-X operations since 2007 with grand station in OKINAWA, southern part of JAPAN .
- ALOS mission-operations since April 2011 sub-contract from JAXA.



Aerial Photogrammetric

＜PASCO MISSION＞

Establish spatial information system for protect people's life and safety.

Promptly grasp the situation of affected areas and support humanitarian and recovery effort.

PASCO

World's Leading Geospatial Group

2.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 platforms and sensors, its visualization and supply
■Data relay and immediate processing in the areas of disaster

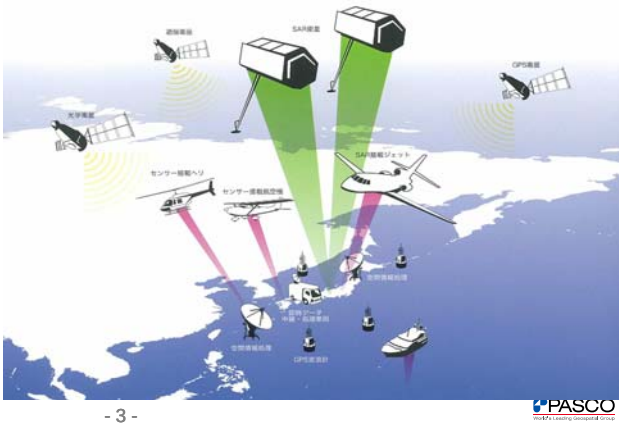
Satellite data reception and processing
Expansion of the Satellite Ground Station Network

▼

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

▼

Global Disaster Management



PASCO

World's Leading Geospatial Group

World's Leading Geospatial Group

PASCO's Domestic and International Disaster Monitoring

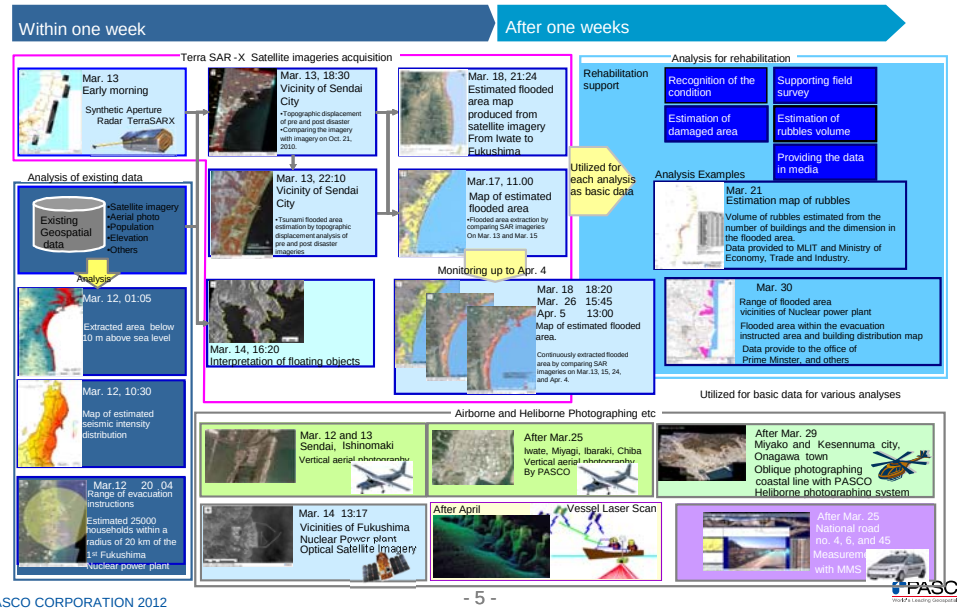
Major Initiatives

2008	Jan	Monitoring of GLOF (Glacial Lake Outburst Flood) in the Himalayas
	May	Damage interpretations around Kitagawa, the Great Sichuan Earthquake
	Jun	Changes in Iwate-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	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
	Sep	Landslide dam monitoring in kii Peninsula
	Oct	Flooding monitoring in Thailand
2012	Mar	Eruption of Sakurajima volcano(Showa crater), Kagoshima Prefecture

PASCO World's Leading Geospatial Group

World's Leading Geospatial Group

3.PASCO's Action for the Great East Japan Earthquake



PASCO World's Leading Geospatial Group

PASCO's Products of Satellites

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)	

World's Leading Geospatial Group

First Actions within golden 72 hours

World's Leading Geospatial Group

First Actions within golden 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

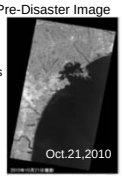
15:30 Start Observation plan and order

20:00 Preparation for analysis and pre-Disaster images

Geospatial Information

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

Pre-Disaster Image

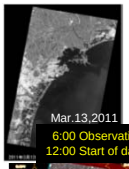


-20km radius from Fukushima Nuclear Power Plant

- Est. seismic intensity

- Areas less than 10m elevation above sea level

(Hokkaido – Kanagawa)

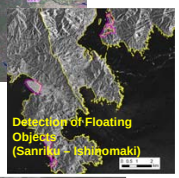


6:00 Observation
12:00 Start of data provision

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)	8.0 km2	58.1 km2
Sendai City (Wakabayashi)	15.1 km2	48.4 km2
Natori City	15.2 km2	169.7 km2
Total	68.6 km2	369.8 km2

(Hokkaido – Chiba)



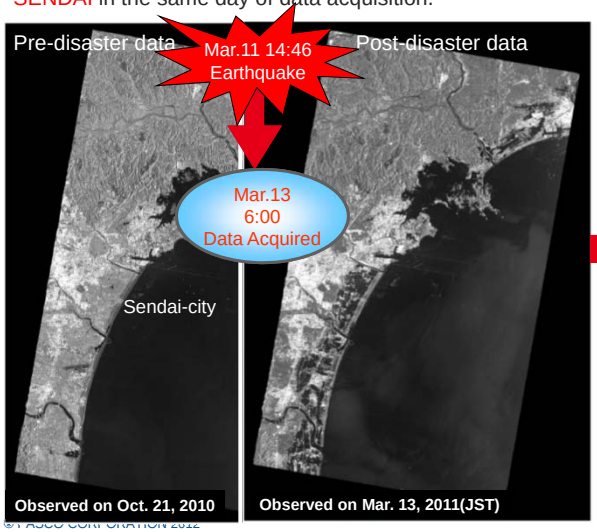
World's Leading Geospatial Group

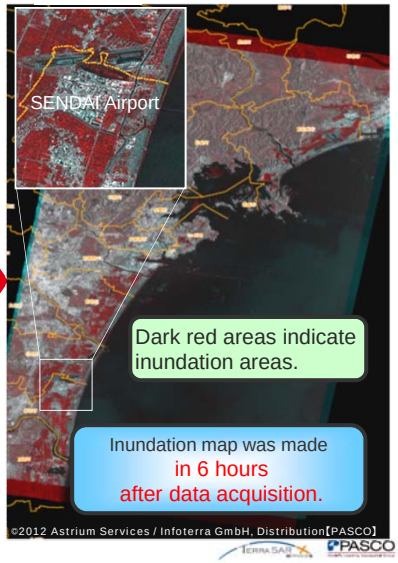
Rapid Mapping for the inundation areas around SENDAI

Within 48hrs

-PASCO carried out automatic change detection between pre- and post-disaster by using TerraSAR-X images.

-This allowed us to quickly estimate the inundation areas around SENDAI in the same day of data acquisition.



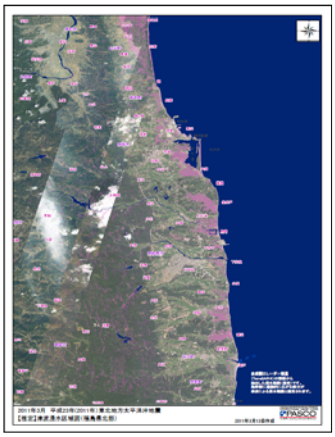


PASCO
World's Leading Geospatial Group

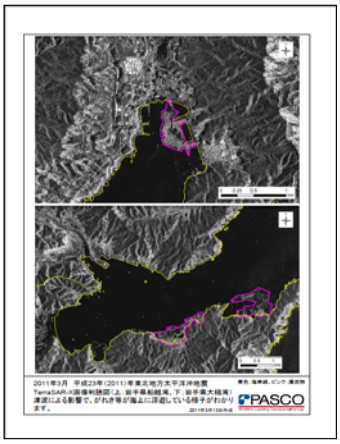
World's Leading Geospatial Group

Affected area, Detection of floating objects and etc.

Within 72hrs



Est. affected area by tsunami
Northern part of Fukushima
Around nuclear power plant
Using TerraSAR-X



Detection of floating objects
Iwate-Sanriku Pacific Ocean
Using TerraSAR-X

Optical Images（EROS-B）
Fukushima nuclear power plants
Above:first plant
Below:second plant

World's Leading Geospatial Group

Emergency responses within 1week

Map of Flooded Areas for 500km

Within 1week

· Satellite images for interpretation of flood 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 flood areas → GIS data → Creating Maps / Calculation of flood area

<Created products of est. flood map>
1. Overview Map
2. Detailed Map
3. Size of flooded areas by municipality
4. GIS polygon data (SHP, KML)

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

Continued Monitoring within 1month

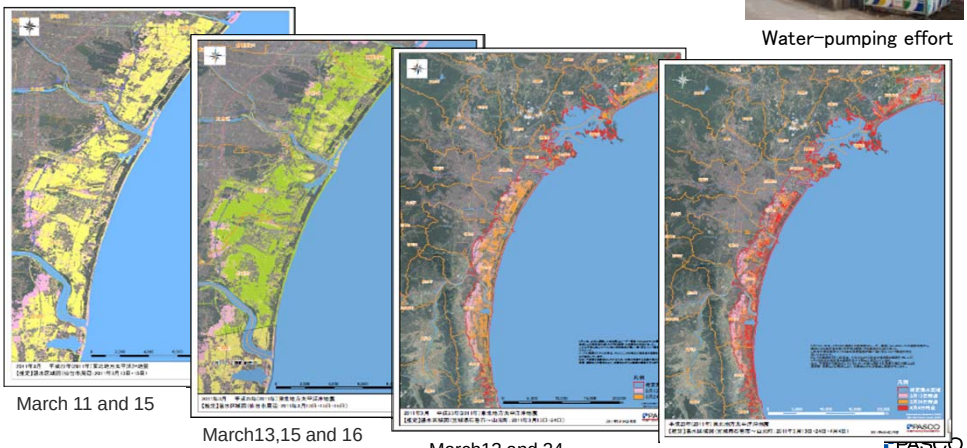
World's Leading Geospatial Group

Inundation Monitoring Using TerraSAR-X around SENDAI

Within 1month

Daily report update of inundated areas for Automatic change detection
Requested at Ministry of Land, Infrastructure, Transport and Tourism
Ten times Observation using TerraSAR-X between March 13 and April 4

Water-pumping effort



March 11 and 15

March13,15 and 16

March13 and 24

March13,24 and April 4

World's Leading Geospatial Group

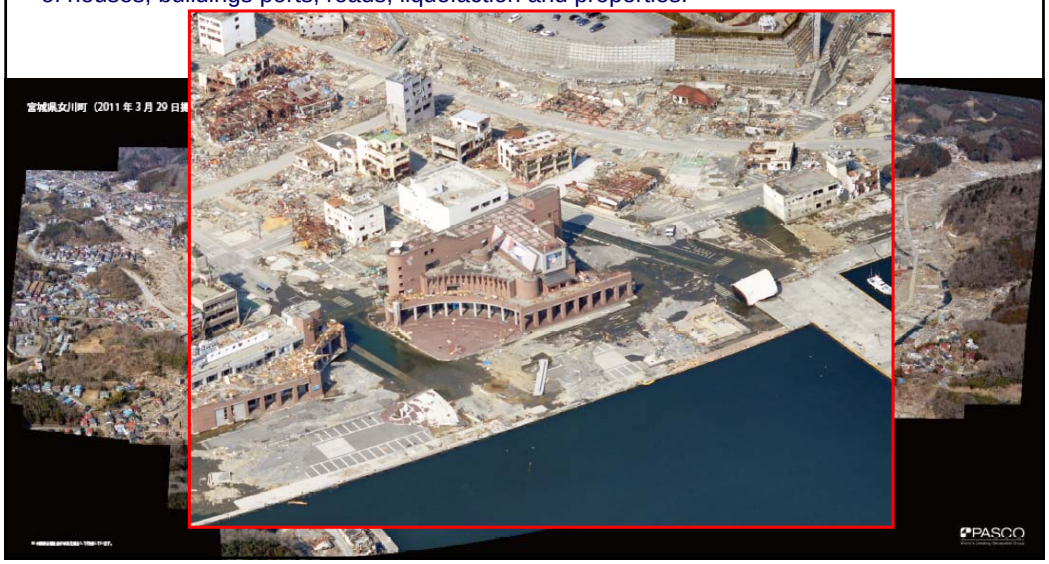
Recovery Support after about 1month

World's Leading Geospatial Group

High resolution Panoramic Oblique photos by helicopter

After 1month

High resolution Panoramic Oblique photos by helicopter were useful for damage estimation of houses, buildings ports, roads, liquefaction and properties.



World's Leading Geospatial Group

Road damage assessment by MMS

After 1month

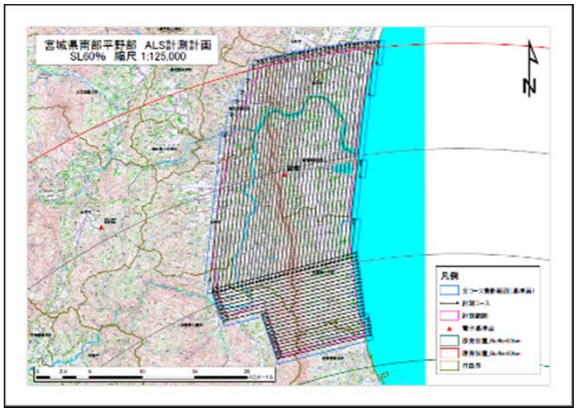
Detail road information was collected and analyzed while driving vehicle with mobile mapping system

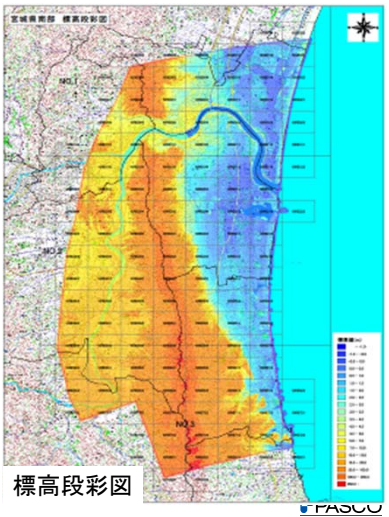
PASCO
World's Leading Geospatial Group

World's Leading Geospatial Group

Detail topographic mapping by LiDAR

Around over 20km from the Fukushima Nuclear Power Plant, Detail topographic survey could be done by airborne LiDAR.





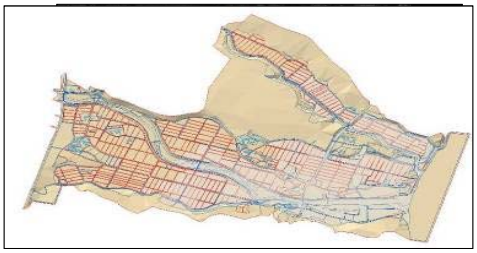
標高段彩図

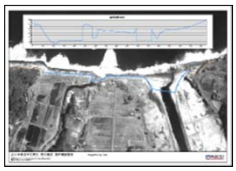
World's Leading Geospatial Group

Satellite Stereo-Mapping with WorldView images

After 1month

Near the Fukushima first Nuclear Power Plant, Photogrametry or field survey was never permitted. Therefore, satellite stereo-mapping with WorldView images were applied.





PASCO
World's Leading Geospatial Group

Quick delivery by any means…

-Maps were hand-carried to the ministries and local governments in a short time.
-Maps has been published on PASCO's web site as free access [www.pasco.co.jp].

Published on major News Papers
Asahi ,Yomiuri, Mainichi…

Ashahi Press on Mar.29

4. Conclusions

- **Utilization of Multi-source data**

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

- **GIS was essential for data interpretation.**
- **Urgent processing of data**

  Automatic change detection method was effective. Aerial photos, field survey ensured the accuracy.

- **Quick delivery**

  By any means; website, FTP and hand carry.Within a few hours, or within a day.

PASCO World's Leading Geospatial Group

PASCO is committed to provide
the dedicated services for the disaster monitoring

Thank you for your kind attention

World's Leading Geospatial Group

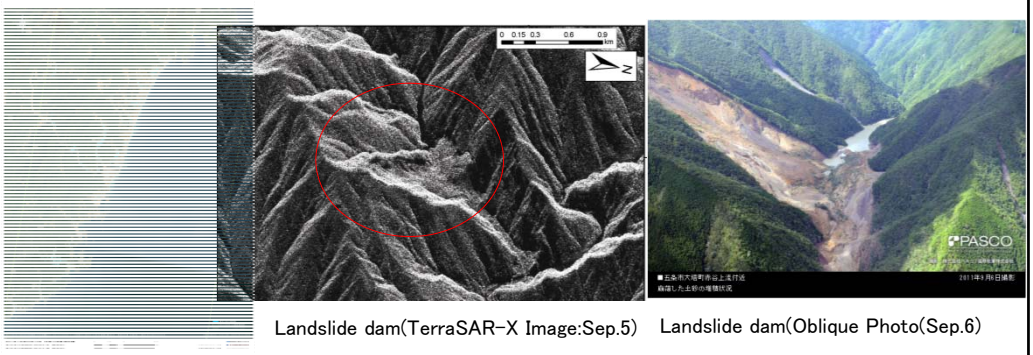
PASCO

- 22 -

World's Leading Geospatial Group

Recent Action:Interpretation of Landslide Dam

Typhoon No. 12 led to serious damage over Kii Peninsula on Sep 2011 in Japan.
We analyzed flooded area and landslide dams.
SAR Images had been utilizing effectively for continued bad weather conditions.
We interpreted 8 landslide dams.



Flooded Map
Utilizing TerraSAR-X

Landslide dam(TerraSAR-X Image:Sep.5)

Landslide dam(Oblique Photo(Sep.6)

- 23 -

PASCO