Disaster Monitoring using remote sensing for the Great East Japan Earthauake

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Key words: Disaster Monitoring, TerraSAR-X, Change Detection, Earthquake, Tsunami

SUMMARY

A massive earthquake of 9.0 magnitude hit off the coast of Tohoku, Japan on March 11, and following tsunami caused devastating damages over wide areas of the East Japan, particularly along with the coastline of the Pacific Ocean. PASCO has contributed to the disaster monitoring for mitigating by remote-sensing technologies.
Varieties of image data include satellites, airborne, helicopters, vehicles and ships.
Satellite images were utilized to obtain the information of the wide areas. Specifically, TerraSAR-X captured a series of images from March 13 through April 4 over the affected tsunami areas. Automatic extraction of inundation areas from the satellite images was effective. Oblique images of our sensor plat formed on the helicopter were also collected to observe the specific areas of the severely damaged regions. Mobile Mapping Systems were also used to comprehend the conditions of damaged sites.
This paper presents an example of our disaster monitoring and mitigation activities as a private company.
New disaster mitigation system should be proposed by the experience that we have gotten by this disaster.

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1. CONCEPT FOR THE MONITORING

Concept for the disaster monitoring and mitigation is as follows:

–Observing wide area information and creating three dimension data
–Speedy day and night observation
–Narrow area with higher accuracy
–Quick analysis of acquired data from various sensors, its visualization and supply.
–Data relay and immediate processing in the areas of disaster.

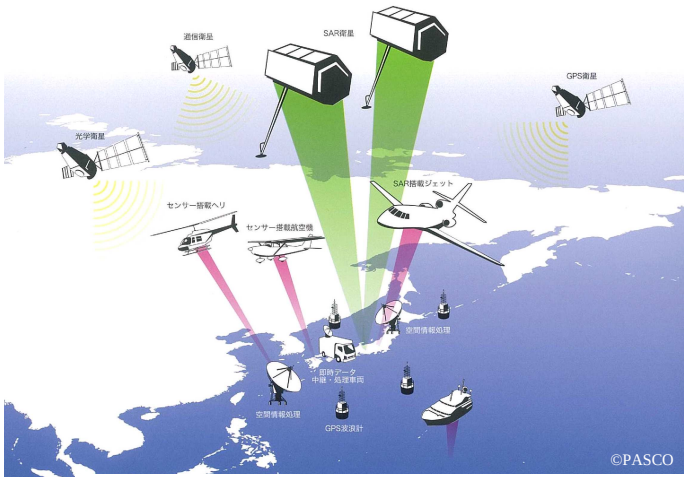


Fig.1 Concept for the Disaster Monitorig

Fig.1 shows PASCO's concept for the disater monitoring.
PASCO in approximately 4 years, after the launch of TerraSAR-X (TSX), has successfully carried out a total about 30 studies of disaster response for the worldwide and domestic cases.
Our goal is to develop integrated social system and providing information within three hours. To realize this concept, global disaster monitoring has been put into practice since 2008 (PASCO, 2011).

2. ACTION FOR THE GREAT EAST JAPAN EARTHQUAKE

2.1 Data acquisition using a variety of platforms and sensors.

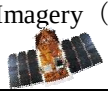
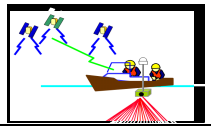
One of the characteristics of damage caused by this earthquake is due to its wide area. Immediately after the disaster,We were to gather wide area information using Satellites and Airbones. Thereafter, added helicopters, vehicles and vessels, we were to gather more detailed ifformation(Fig.2).
TerraSAR-X is the most suitable option as an emergency mean to grasp the disaster situation since its SAR sensor is independent of weather conditions and daylight. TerraSAR-X is also useful for monitoring activity, considering its revisit cycle is 11 days. Airborne photogrammetric digital camera images were acquired over severely affected and important areas such as harbors and cities and coast lines. High resolution panoramic aerial images from helicopter covered the areas, where damage was serious, for reconstruction plans. All of optical sensors depend on weather and it is best-effort basis.

Mobile Mapping System (MMS) was utilized in affected areas for road management. The system consists of laser scanners and digital video scanners

2.2 First Actions(within 72hours)

At 14:46pm on Mar.11(JST), we were evacuated temporarily due to strong shaking in tokyo, whichi despite the fact that more than 500km away from the epicenter. After a temporary confusion subsided, we started planning for the Disater Monitoring.
Fig.2 shows our first action within 72hours.
The day of the earthquake, we created distribution maps of seismic intensity, lowland, and range effects from Fukushima nuclear power plant.
On Mar.13(48hours), the topographic change map was created after tsunami around the Sendai city utilizing superimposed TerraSAR-X images acquired on October 21, 2010 (before the disaster) and March 13, 2011 (after the disaster). This map indicates the change of the ground surface roughness utilizing the characteristic of TerraSAR-X images.

Table1 Data acquisition

Platform and Sensor Appearance	Data Acquisition
SAR Imagery（TerraSAR-X） 	Mar. 13～
Optical Imagery（EROS-B） 	Mar. 14～
Vertical Photo （Airborn） 	Mar. 12～
Oblique Photo（Helicopter） 	Mar. 29～
Mobile Mapping System(MMS)（Vehicle） 	Apr.5～
Laser Svanner（Vessel） 	Mar. 17～

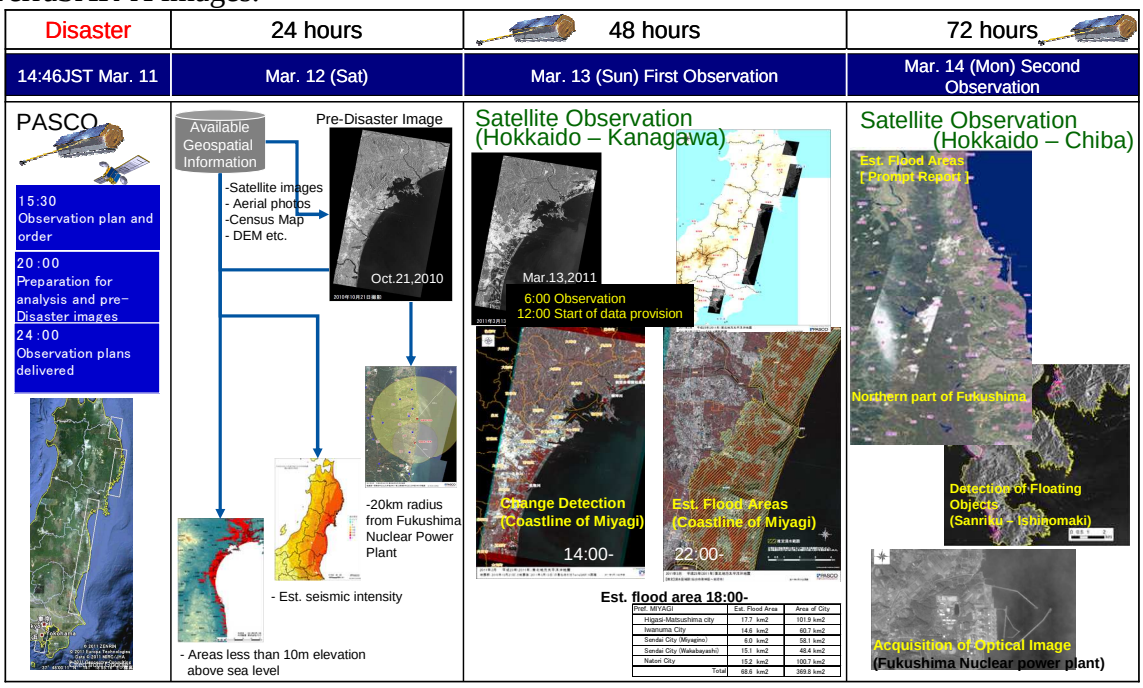


Fig.2 First Actions within 72hours

The yellow area of the map is estimated flooded areas using photogrammetric method. The analyzed data was showing that the tsunami reached approximately 6 km inland.
On Mar.14(72hours),detection of floating objects were shown.

2.3 Maps of Flooded Areas for 500 km Coastline(Within 1week)

The estimated flooded areas along the East Japan coast were visually interpreted from pre- and post-disaster satellite images with topographic maps (PFM*） overplayed. Target area was 500 kilometers long from Aomori Pref. to Ibaraki Pref. A total of 50 technical experts went into this project from March 12 to March 18(Fig.3).
Images from AVNIR-2(ALOS), RapidEye, WorldView-1,2, SPOT and Aerial photo were contributed and useful. The 2.5m pan-sharpened color image from ALOS （PSO**） acquired before the earthquake was utilized as reference. On March 23, the maps were updated with finer photogrammetric orthoimages.

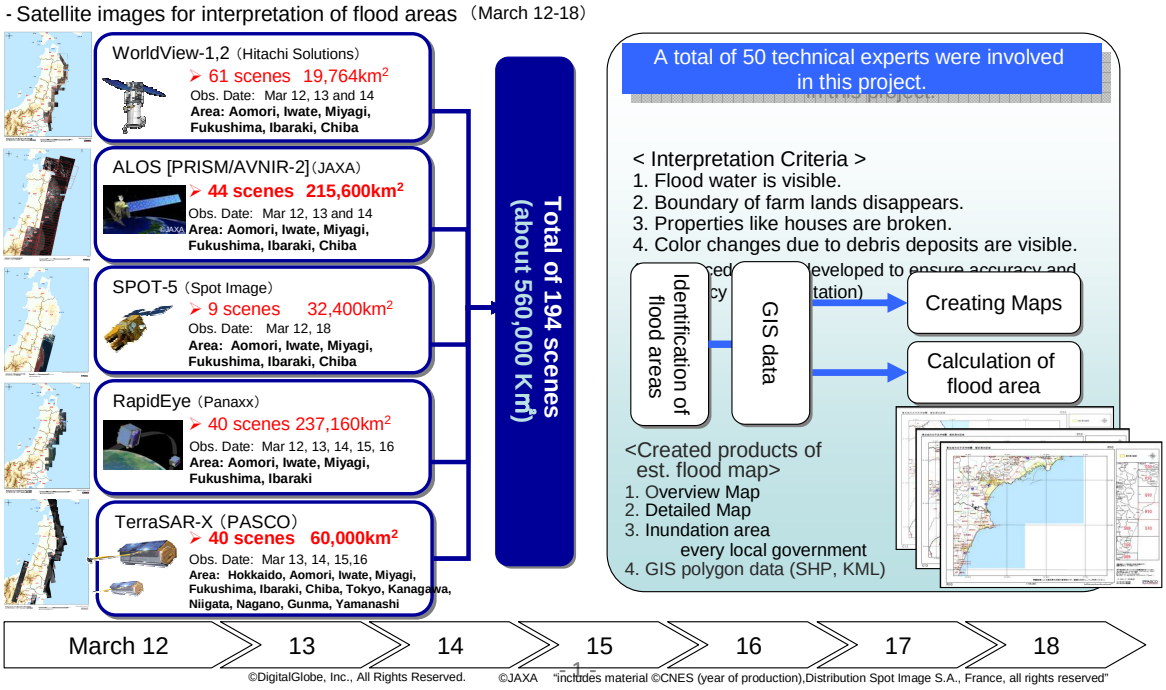


Fig.3 Production Flow Chart(Interpretation of flood areas)

*PFM (Pasco Fresh Map) is 25,000 scale vector map including river, road, boundary etc.
**PSO (PASCO Satellite Ortho) is 25,000 scale cloud free satellite color image

2.4 Change Detection of Inundated Areas(Within 1mounth)

Daily reporting of inundated areas was requested by Ministry of Land, Infrastructure, Transport and Tourism for their drainage efforts.

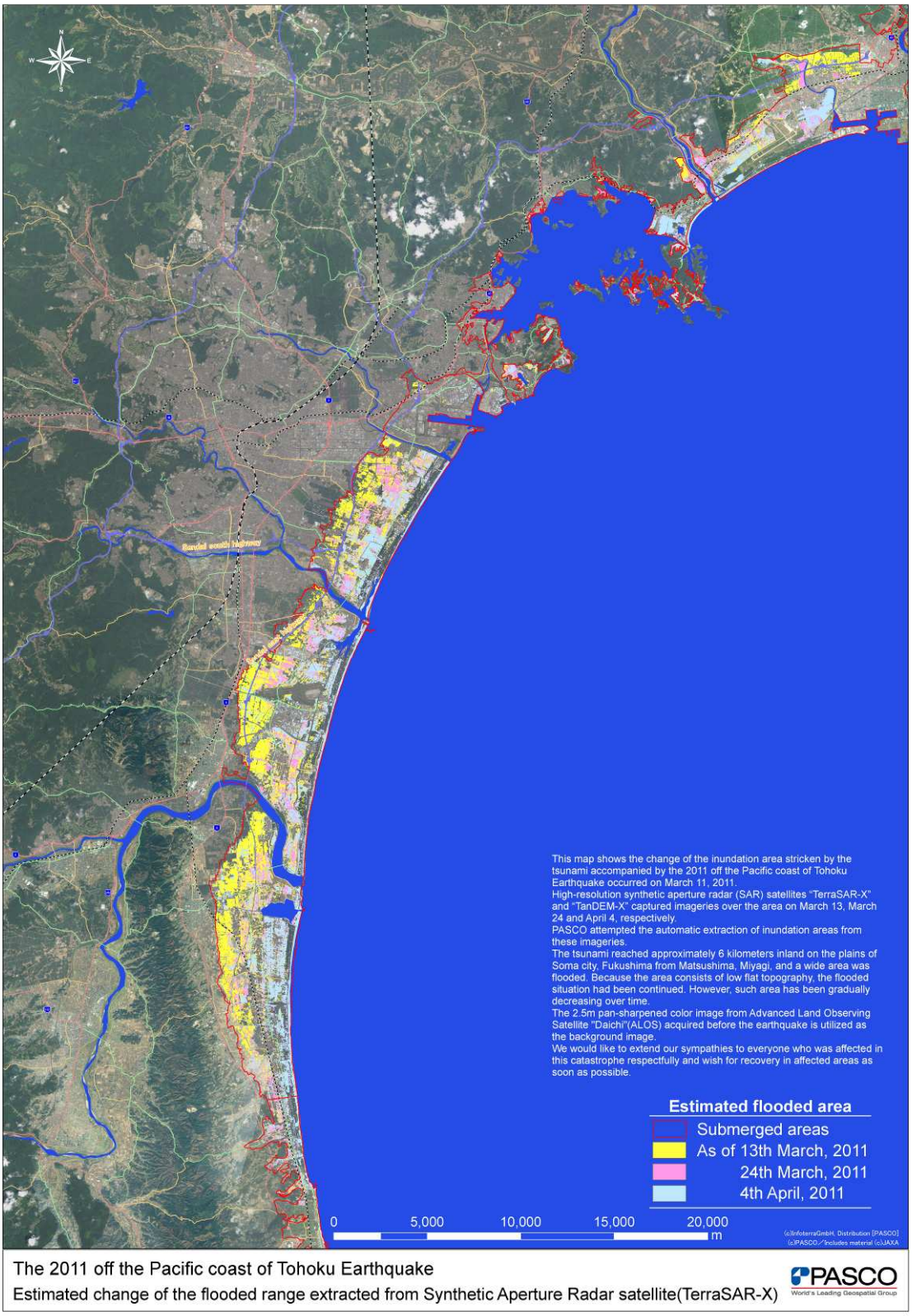


Fig.4 nundation monitoring using TerraSAR-X

To this end, TerraSAR-X images acquired on March 13, March 24 and April 4 were utilized. This automatic change detection method utilizes the characteristics of weak microwave reflection at the smooth surface (Fig.4). In Fig.4, yellow, pink and light blue areas indicate estimated flooded areas on March 13, 24 and April 4 respectively. The 2.5m pan-sharpened color image from ALOS (PSO), acquired before the earthquake was utilized as the background reference.

2.5 High Resolution Panoramic Oblique Photo(after about 1month)

Using a special device handy digital camera on the helicopter, over 20,000 oblique photos were taken within several days and combined to make the panoramic images by each districts. Its resolution is sub centimeter, so these panoramic images are useful for damage estimation of houses, buildings, roads and any other properties. These oblique image archives would be valuable as well as orthoimages for reconstruction planning by local governments, ministries and academics.

Fig.5 Panoramic oblique photo (Onagawa city, Miyagi Pref.)

3. QUICK DELIVERY

The maps have been delivered to the ministries and local governments directly hand-carry within a few hours or within a day. Publishing the information on the PASCO website as free access has been ongoing. These contents and analyses data were feature in major papers, magazines and other media.

4. CONCLUSION

Disaster Monitoring were provided within the shortest period of time, which could help to supply better disaster mitigation and restoration during the early stage of the huge disaster. Multi-source and multi-temporal data were essential to monitor the wide areas. To urgent processing of data, automatic change detection method was effective. Also, photogrammetry, field survey and visual check ensure the accuracy. Quick delivery to disaster management organization was important by any means through website, FTP and hand-carry within a few hours or within a day. The analysis results were provided in the form of user-friendly.
We believe that , those maps and analyses would be useful for planning the reconstruction of damaged areas and recovery from the disaster even more.

5. ACKNOWLEDGEMENTS

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