Application of Information Technology on Disaster Reduction and Emergency Preparedness

2012 International Training Workshop on Natural Disaster Reduction

3D GIS Taiwan on Cloud Service

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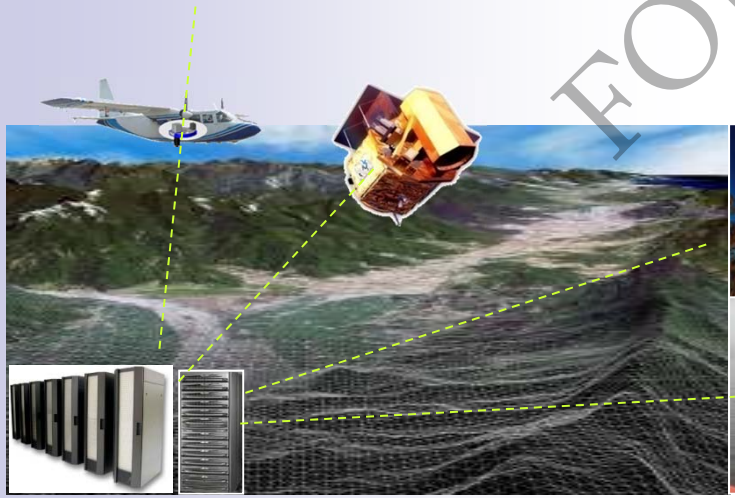
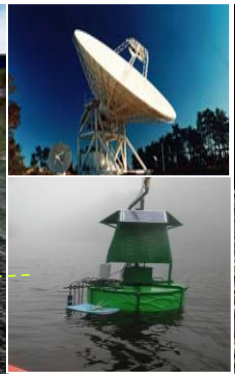
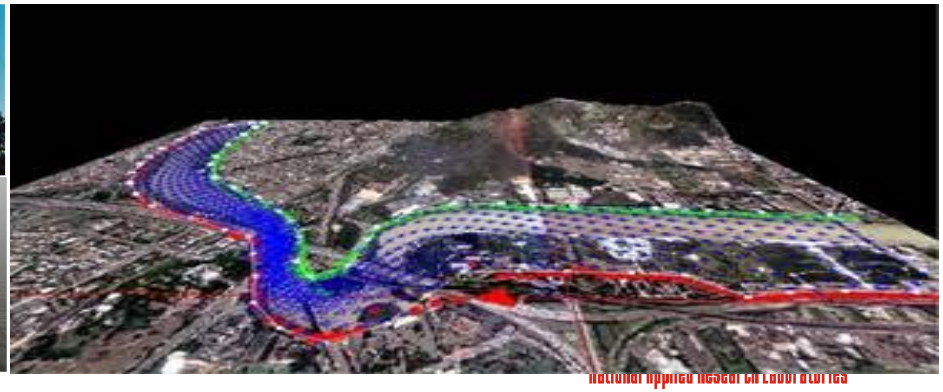
Outline

- Introduction to 3D GIS Taiwan
- Fast Capturing Disaster Scenario (Response Phase)
  - Technical development: near real-time image processing, web map service and image interpretation system
- Accurate Guarding Taiwan Environment (Recovery Phase)
  - Technical development: 3D GIS navigation cloud system
- Concluding Remarks



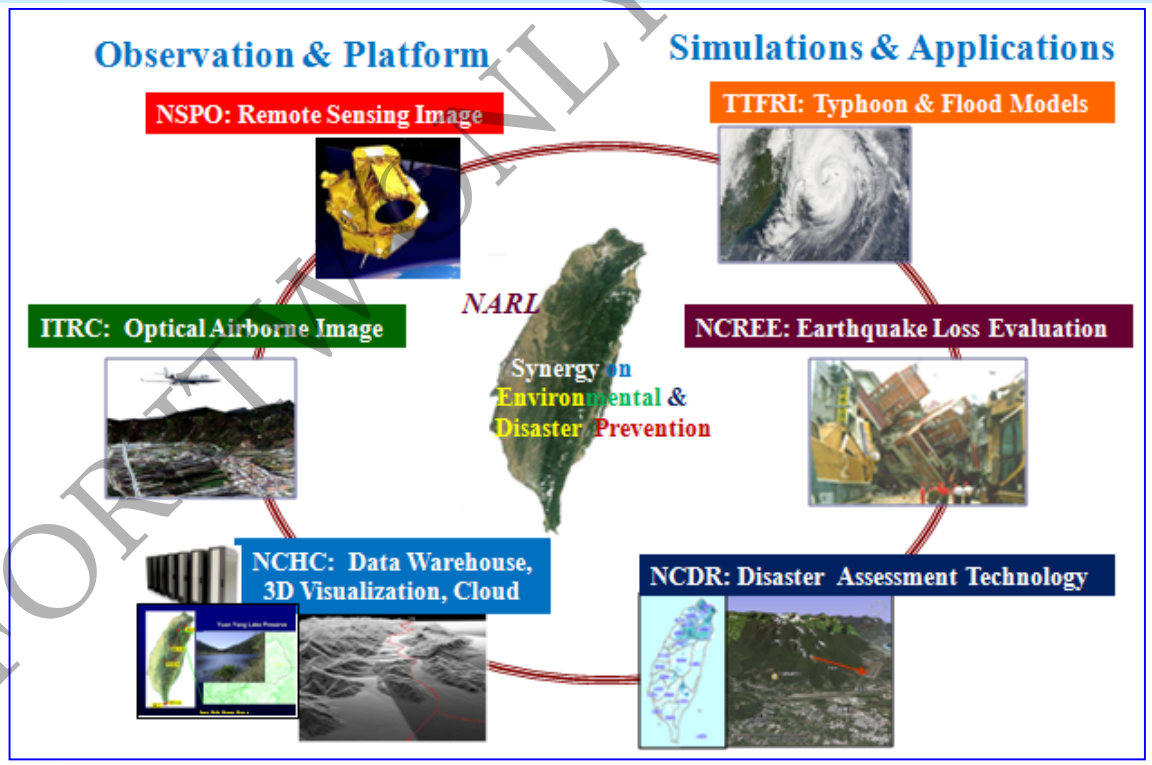




Introduction to 3D GIS Taiwan

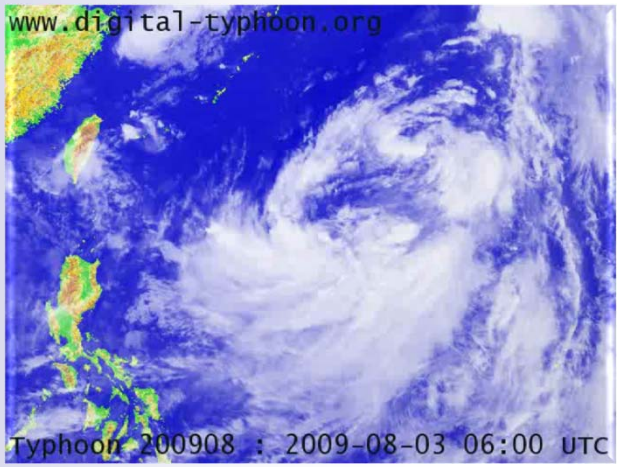
3D GIS Taiwan is a research project under National Applied Research Laboratories for development of near real-time, high-resolution, global earth observation 3D platform for disaster monitoring and assessment in Taiwan。

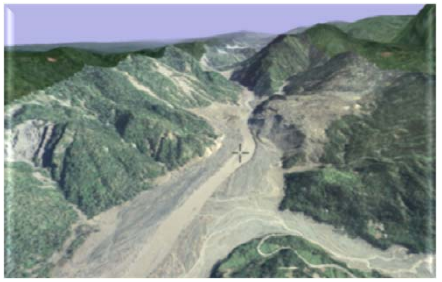
6 research institutes under NARL contribute on Observation, Platform, Simulation and Application technologies.



This developmental project integrates earth observation technologies, data warehousing, 3D visualization, cloud computing, and disaster prevention technology from contribution of six research institutes under NARL.

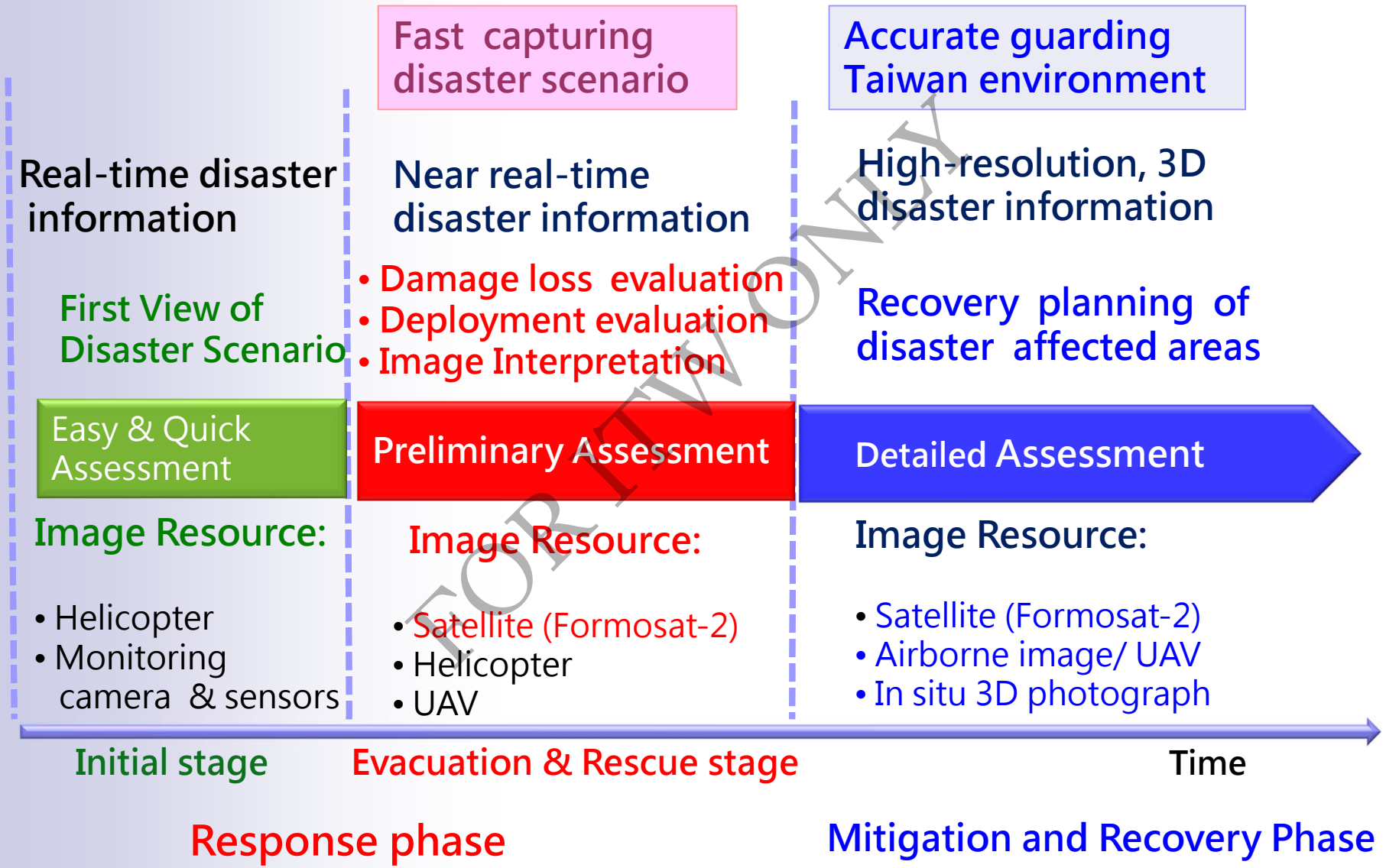
Natural Disaster in Taiwan





In Taiwan about 73% of the population over the same time exposed to the threat of natural disasters in three or more: such as typhoons, earthquakes, tsunami, flood , landslides and debris flows.

Watching Natural Disaster in Affected Areas



Objectives of Research

Immediately after disaster occurred: Fast capturing disaster scenario.

- In response phase, conducting near real-time image acquisition and processing, Web Map Service, and image interpretation, providing preliminary assessment of disaster loss and deployment, coupling with application models and disaster information database.
- Technical Development: near real-time image processing, web map service and image interpretation system

Post-disaster task: Accurate guarding Taiwan Environment.

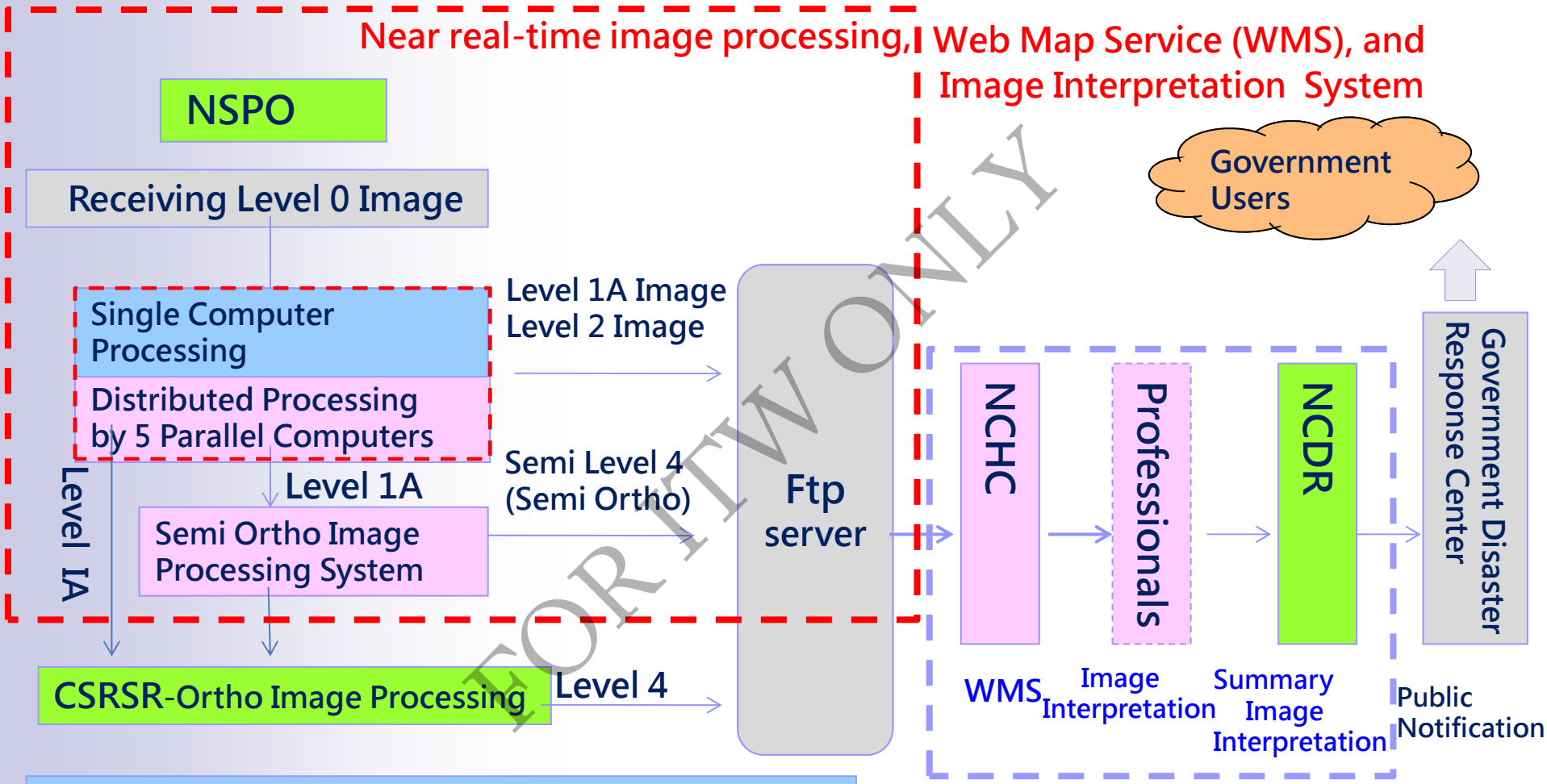
- In recovery, mitigation, and preparedness phase, utilizing high-definition, 3D GIS images for detailed assessment, providing the basis of reconstruction, review, research and education.
- Technical development: 3D GIS Navigation Cloud System

Near real-time Image Processing, Web Map Service and Image Interpretation System

Purpose: Fast Capturing Disaster Scenario

- Building pipeline processes
- Accelerating Formosat-2 image processing and providing semi-orthoretification image in shortest possible time
- Providing Web Map Service
- Conducting image Interpretation on Disaster Sites

Fast Capturing Disaster Scenario



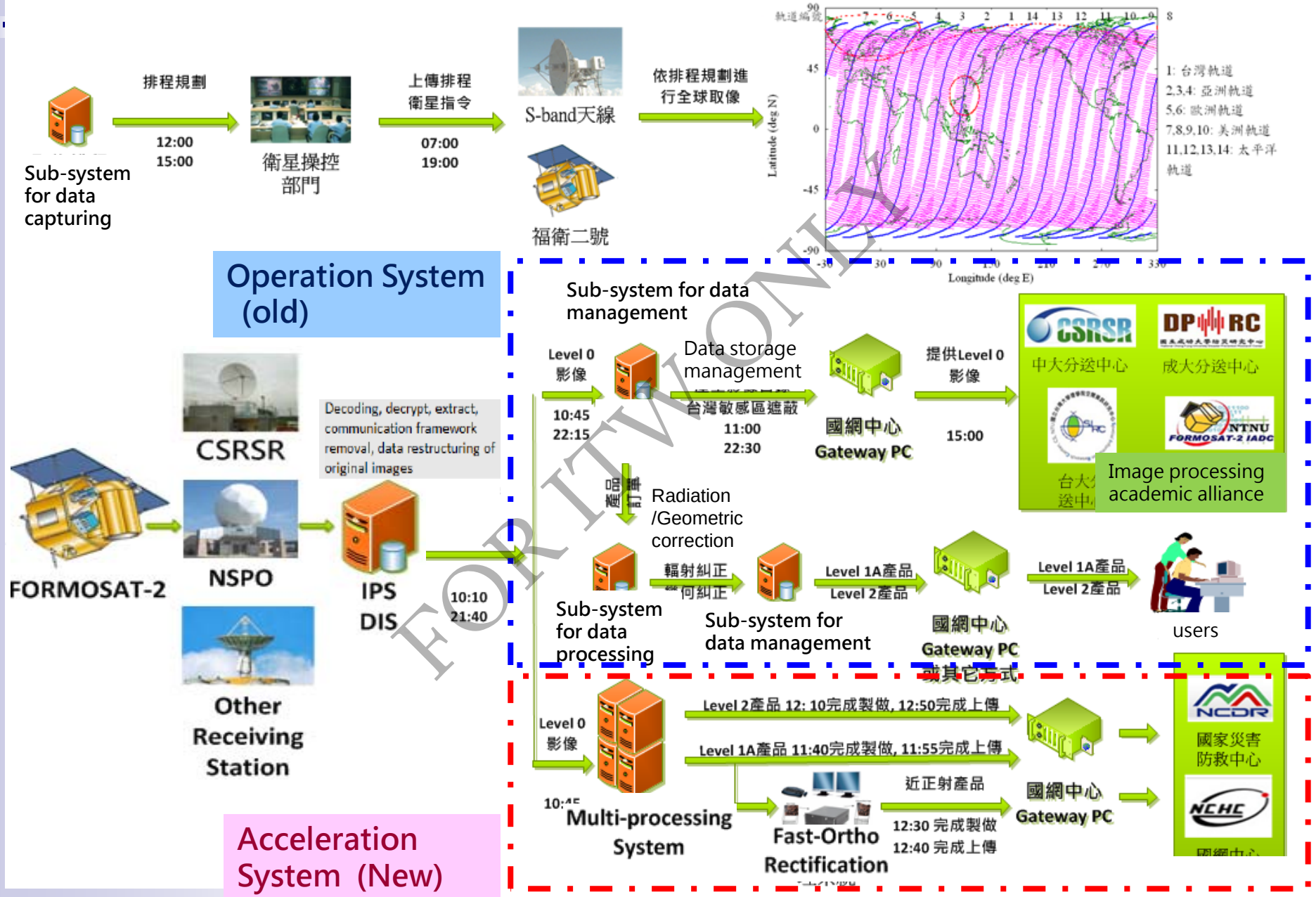
Operation System: about one day to deliver multi-band L1A and L2 image product

Acceleration System: within 4 hours to deliver multi-band L1A and L2 images and 2-band ortho images

NCDR using the semi-ortho image for interpretation of disaster scale

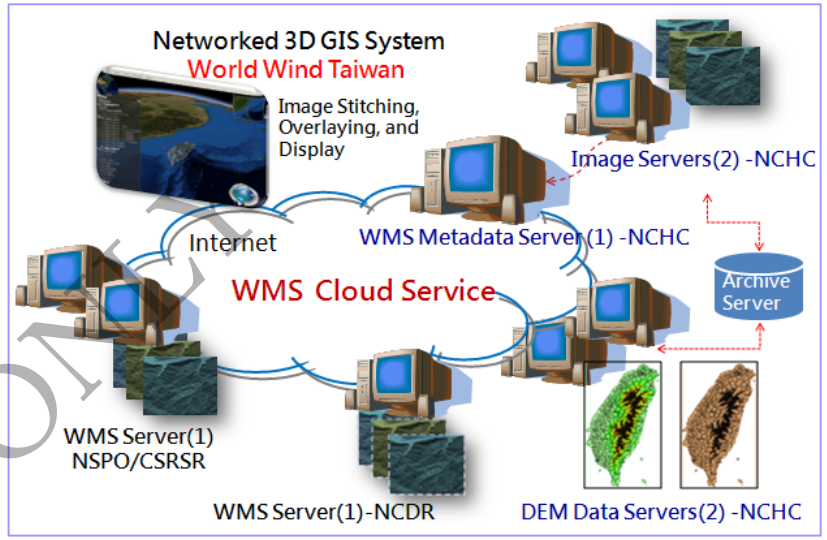
NCHC using WMS to provide professionals for initial image interpretation

Formosat-2 Acceleration & Operation Systems



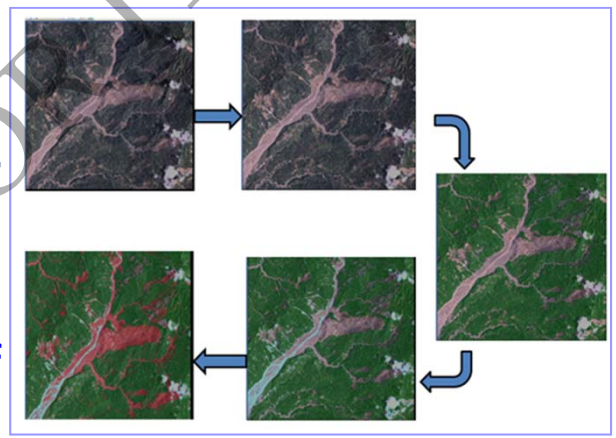
WMS and Image Interpretation

Web Map Service (WMS), a OGC standard, provides a simple HTTP interface for requesting geo-registered map images from distributed image data servers and terrain elevation data servers, that can be integrated with the frontend Networked 3D GIS system. Therefore, the disaster management users are able to have fast acquisition of image data for subsequent disaster and scale interpretation.



Using image spectral values, gray scale, texture, tone and geometric characteristics, and relationship between shape and position classification for disaster scale interpretation. FORMOSAT-2 image containing a four-band spectrum, the features and the degree of difference in ground surface are analyzed for disaster & scale interpretation.

Image Interpretation



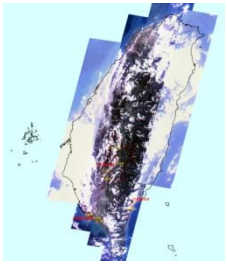
Using Formosat-2 image for disaster scale interpretation

Professional Agencies help image interpretation uploaded to web

Operation System & Acceleration System

NSPO NCHC NCDR

Typhoon Morakot
August 8, 2009

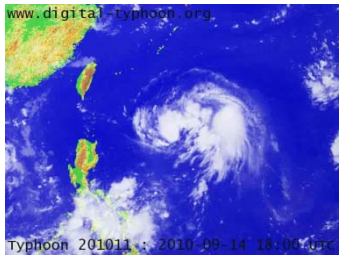


5 bands of Formosat-2 image capturing a day

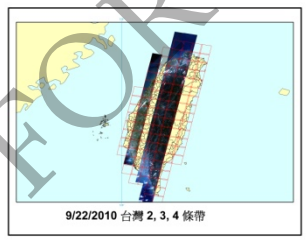
Identifying slope collapse at Shiaolin Village

Operation System

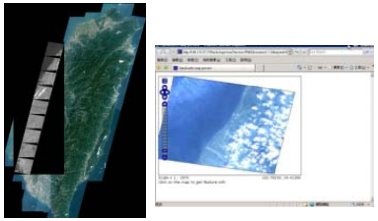
After receiving raw image, taking 6 hours to provide 4 bands of Level 1A image and taking 24 hours to provide 4 bands of Level 2 image, but being unable to provide in-time ortho image.



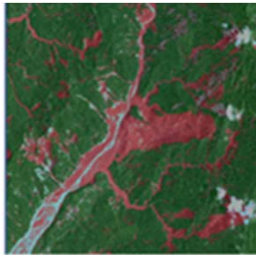
Typhoon Fanapi
Sept. 19. 2010



3 bands of Formosat-2 image capturing a day



Reviewing & WMS

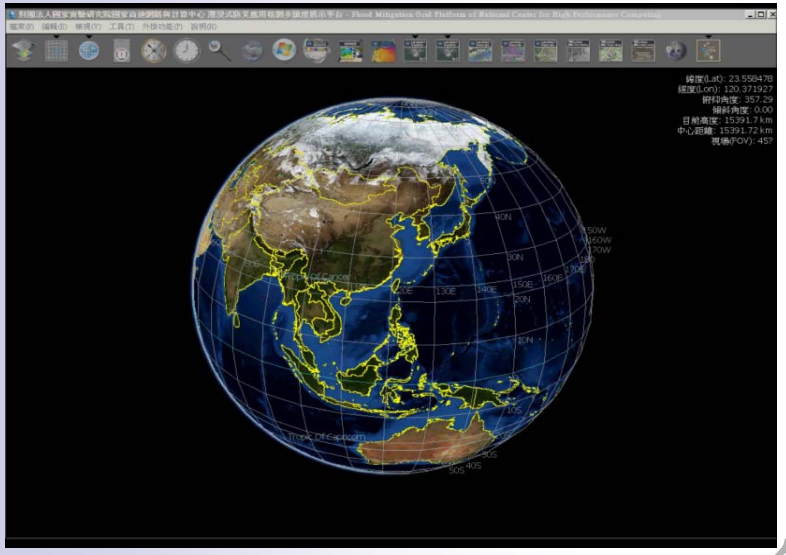


Slope collapse interpretation at Kaohsiung areas

Acceleration System

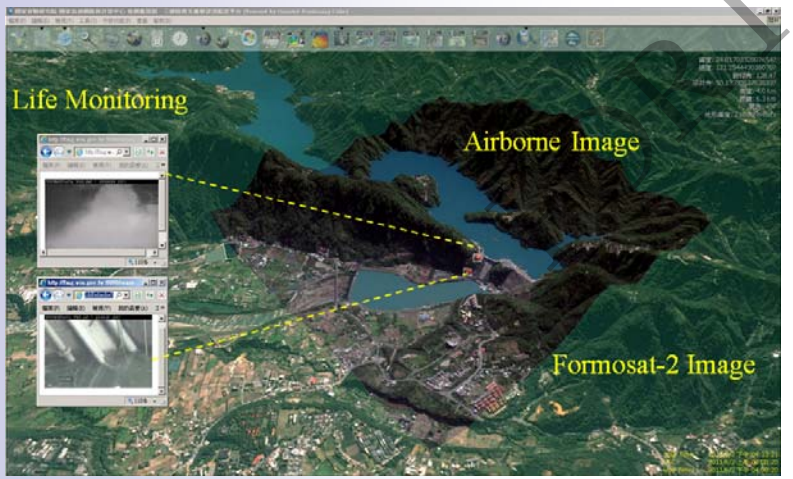
After receiving raw image data, taking 4 hours to provide 3 bands of Level 1A, Level 2 and semi ortho images.

Networked 3D GIS System: World Wind Taiwan



World Wind Taiwan is developed by modification of NASA World Wind system for image stitching, overlaying, display, and assessment for disaster management in Taiwan. To use the disaster images, World Wind Taiwan can be linked with WMS data servers.

World Wind Taiwan application GUI



The Shihmen Reservoir spillway area is displayed by overlaying the aerial image and Formosat-2 satellite image. Meantime, the real-time watching cameras, located in downstream of the spillway, are linked for life monitoring.

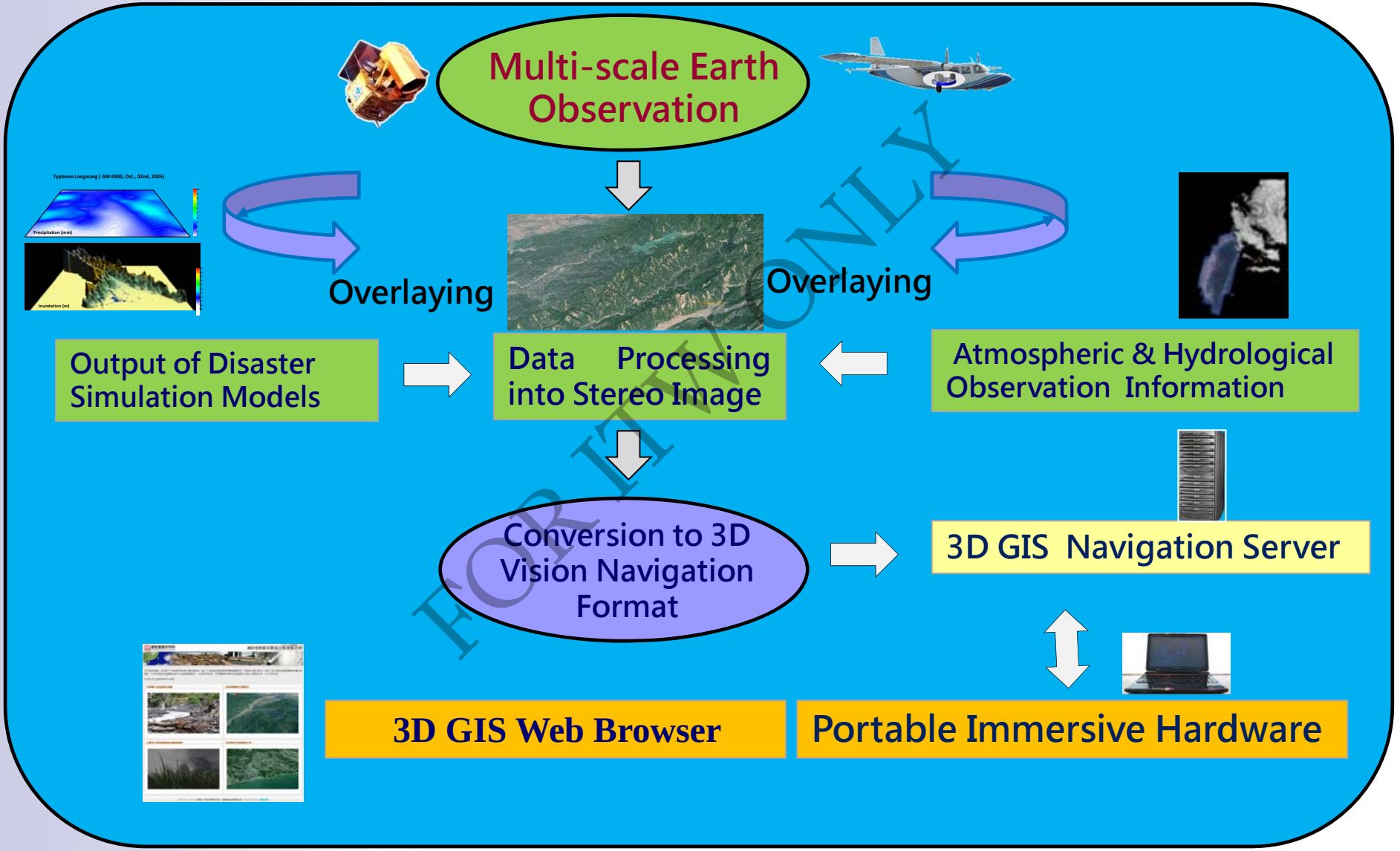
World Wind Taiwan integrate multi disaster information

3D GIS Navigation Cloud System

Purpose: Accurate Guarding Taiwan Environment

- The system uses satellite & aerial based 3D GIS and in-situ stereo photo shooting, integrated with virtual reality and web browsing cloud technologies, allowing disaster taskforce to navigate the disaster scenario in stereo from any location and time and therefore to review whole process in details.
- In order to facilitate disaster recovery, mitigation, and preparedness phases of post-disaster reconstruction planning and assessment, post-disaster review and research, people experience and science education, to master of disaster prevention information and sharing, and decision support.

3D GIS Navigation Cloud System



Multi-scale Earth Observation Technologies

Satellite Image

Formosat-2 is an application telemetry satellite focused on earth that passes over Taiwan twice a day; and it can perform stereo photography. Currently, the maximum resolution of Formosat-2 is about 2 m.

The advanced optomechanical system design and assembly of airborne imager, **VCDi-lite** (Vegetation and Change Detection imager) is developed for high-resolution 25-50 cm airborne shooting at disaster sites.

Airborne Image

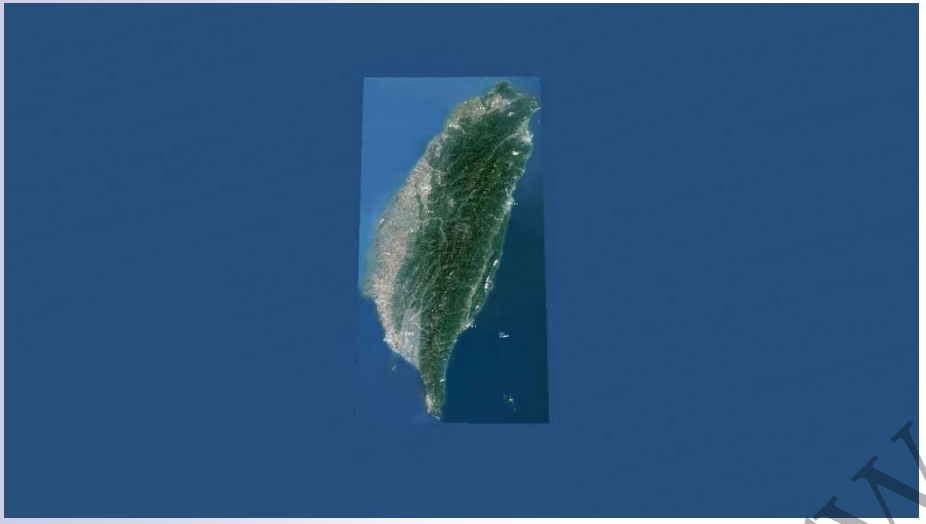
In-situ 3D Photo Shooting

Right/Left-eye Images

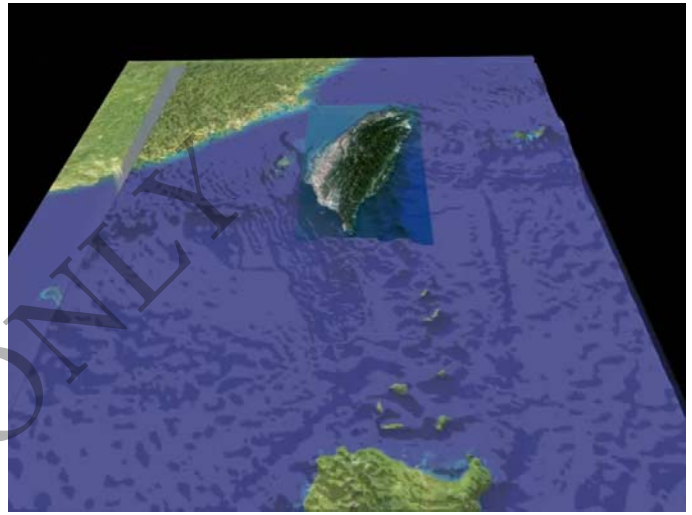
The Remote multiple simultaneous shooting system is a decentralized automated image capturing and post-production process technology. Users can control multiple remote digital cameras and proceed the synchronization of image capturing and can produce stereo and panoramic images. The resolution can achieve 1920 x 1080 pixels.

Multi-scale Earth Observation

Uniqueness of Diversity of Images



3D GIS Taiwan Terrain



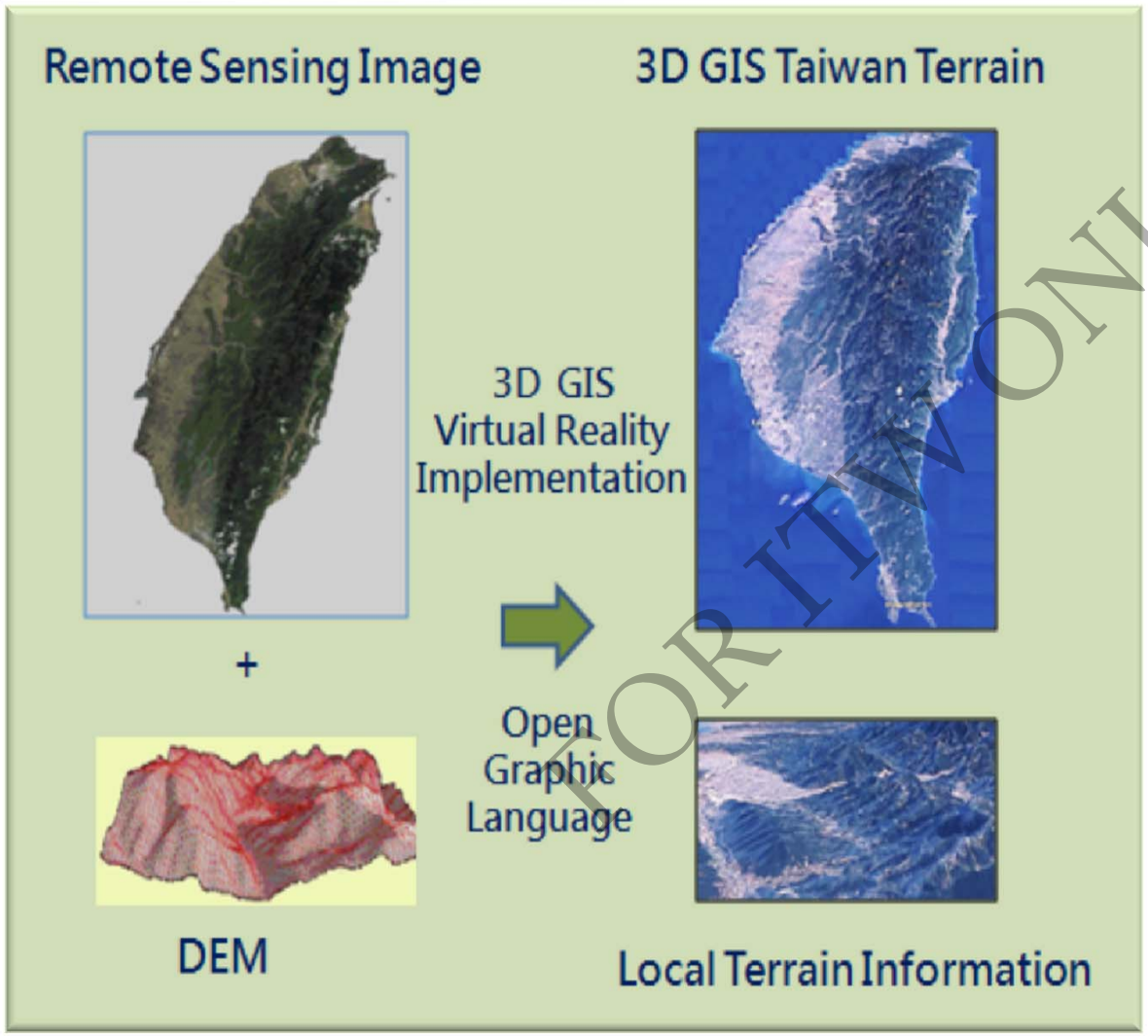
Marian Environment Surrounding Taiwan

Aerial Photo Shooting

UAV Photo Shooting

In-situ 3D Photo Shooting

3D GIS VR Display Technology



The software of 3D display technology adopted 3D VR Engine developed by NCHC Visualization team, including:

- Open GL
- 3D & Stereo image effect
- Discrete level of details
- Volume rendering
- Large scale & high-resolution 3D GIS navigation system
- Auto navigation system
- Using GPU to accelerate image processing

Portable 3D GIS Stereo Display Systems

The available portable 3D display systems in Taiwan

Viewsonic **glasses-required** 3D projector

Active projection system, can project on regular white wall, allowing 5-10 persons to watch at same time

Dell XPS 17 **glasses-required** 3D laptop

Active projection system, allowing 2-5 persons to watch at same time

Toshiba Qosmio F750 **glasses-free** 3D laptop

Stereo head tracking system, allowing one person to watch one time

3D Vision compatible

3D GIS Web Browser

http://3dgiscloud.colife.org.tw

Disaster survey, construction and reconstruction recording for review

Disaster scenario forecast & damage loss assessment

Review on thematic disaster scenario and processes

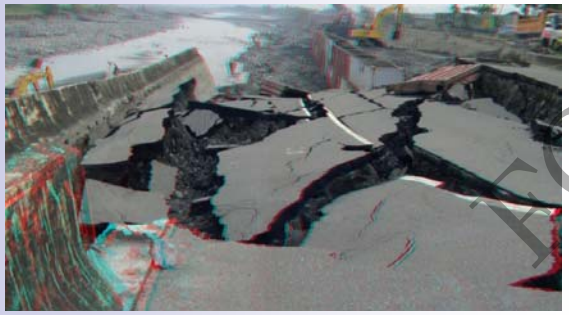
Disaster scenario comparison before & after disaster occurred

Disaster Survey, Construction & Reconstruction Recording

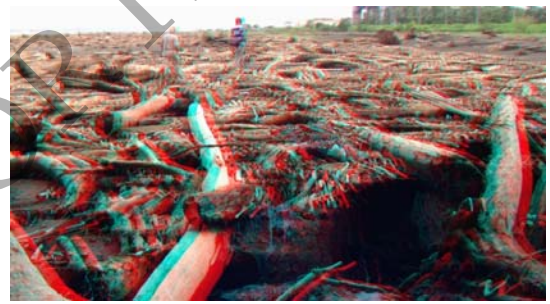
Remote monitoring multiple cameras for synchronized photo shooting

Produce stereo image
Back-end automation process

- Disaster Education
- Historic Record
- Disaster Survey



Damage in high way



Driftwood accumulated in riverbank

Reconstruction of bridge

Panoramic scene of driftwood near the Kaoping river bridge

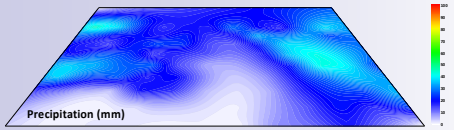
Disaster Scenario Forecast

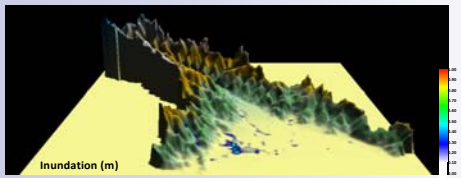
Flood & Inundation Forecast & Display in 3D GIS Watershed

World Wind Watershed system is dedicated for accessing flood & inundation simulation results and displayed with 3D GIS watershed, to forecast potential inundation area. The results can be ported to 3D GIS Navigation Cloud System for detailed review. Applicable for any watershed and model with same I/O format.

WRF Model

Typhoon Longwang (AM:0900, Oct., 02nd, 2005)

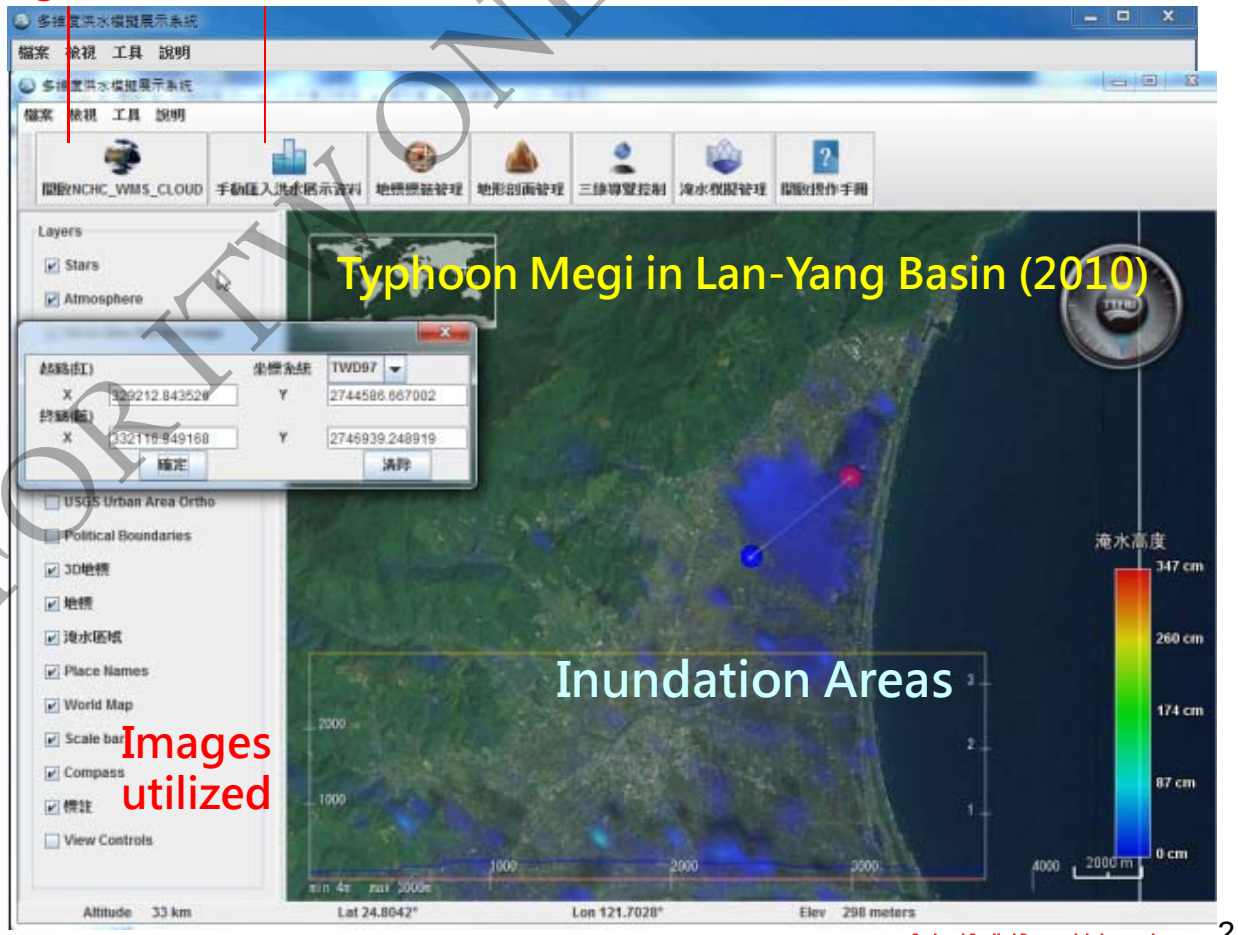




WASH 123D Model

Inundation forecast displayed with 3D Lan-Yang Basin

Image source Flood & Inundation data

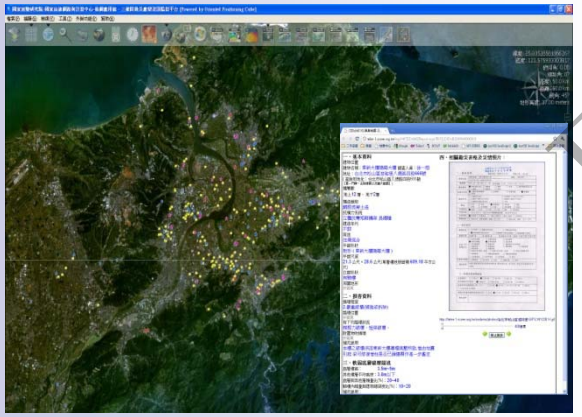


Disaster Damage Loss Estimation

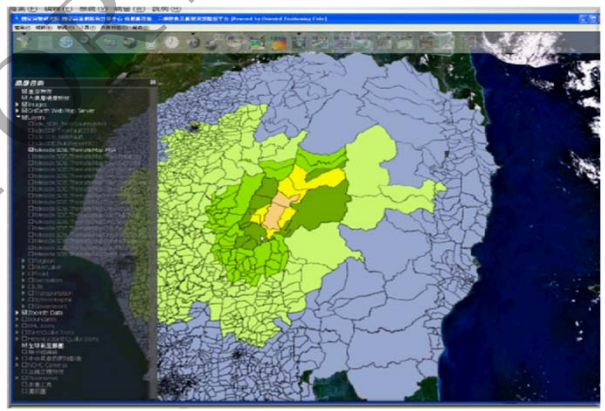
Taiwan Earthquake Loss Estimation System estimates loss & display

The Taiwan Earthquake Loss Estimation System (TELES) estimates disaster loss in early after-earthquake stage and overlays on 3D terrain, in order to facilitate rapid monitoring of the earthquake may cause damage to buildings, bridge damage, casualties, economic losses, and land cover change assessment information. The results can be displayed in both World Wind Taiwan and 3D GIS Navigation Cloud System.

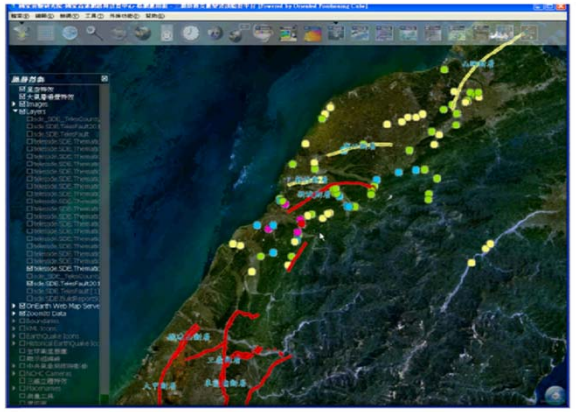
Application of 3D GIS spatial display features, combined with various types of geographic information map data, such as active fault map, the historical earthquake catalog, to assist disaster prevention and rescue personnel in interpreting disaster situation.



921 earthquake survey report

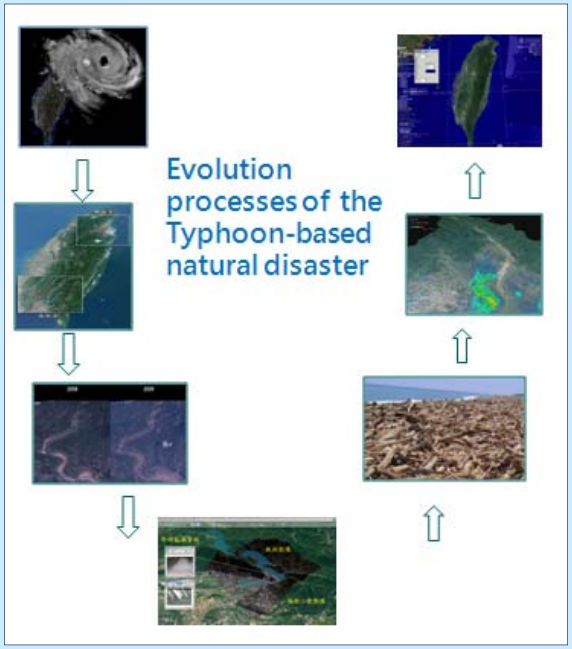


TELES estimated potential loss in early stage



Estimation of bridge damage in early after earthquake stage and display with 3D terrain

Review on Thematic Disaster Scenario and Processes



The theme is based on Typhoon Morakot induced disaster evolution processes, beginning with atmospheric and hydrological information and spatial information in disaster sites, that supporting for overall process review and countermeasures reference in the disaster event. Critical processes may include:

- Radar observations on dynamic vapor;
- 3D overview of Typhoon affected areas;
- Image comparison before and after disaster occurred;
- Interpretation of scale and situation at disaster sites; and
- Reconstruction of damaged facilities recorded by in-situ 3D shooting.

Targeting the theme on the natural disaster associated with flood and landslides caused by Typhoon Morakot induced extreme rainstorm, and producing "2884 mm" & "Natural disaster in Taiwan" animation.

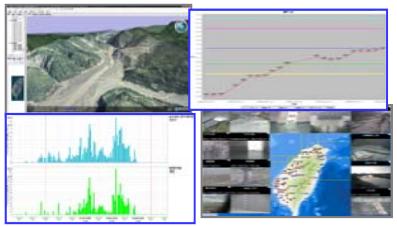
Concluding Remarks

- This study integrated cross-field innovation technologies, such as multi-scale earth observation, 3D GIS visualization, data warehousing and cloud services, and disaster prevention technologies. It has successfully built 3D GIS platform for application to disaster response and monitoring in Taiwan.
- This study facilitates near real-time acquisition of satellite image and conducts fast ortho rectification process, and delivers ortho image in less than 4 hours (was about one day). Complete pipeline processes from image capturing, processing, WMS service and image interpretation, integration and announcement have been built. The 3D GIS Taiwan allows integration of diversity of images, can link with disaster models, such as flood & inundation model and TELES assessment model, and has been successfully applied to decision support in natural disaster such as Typhoon Morakot.
- In this study, the observation data, simulation models, platform and service have been closely tied for fast application needs. The disaster prevention tasks have been firstly combined with the 3D GIS navigation cloud system, and in collaboration with the Water Resources Agency to achieve the sole real 3D photo set in 88 flood event.

Future Missions

Collaboration through multiple Communication

Distributed data connection & Cloud service



Integration of diversity information


3D GIS Taiwan
Thank you
FOR ITW ONLY