



# National Applied Research Laboratories Taiwan



## Status of 3D GIS Taiwan Project and Its Cloud Service

**Whey-Fone Tsai  
& 3D GIS Team members**



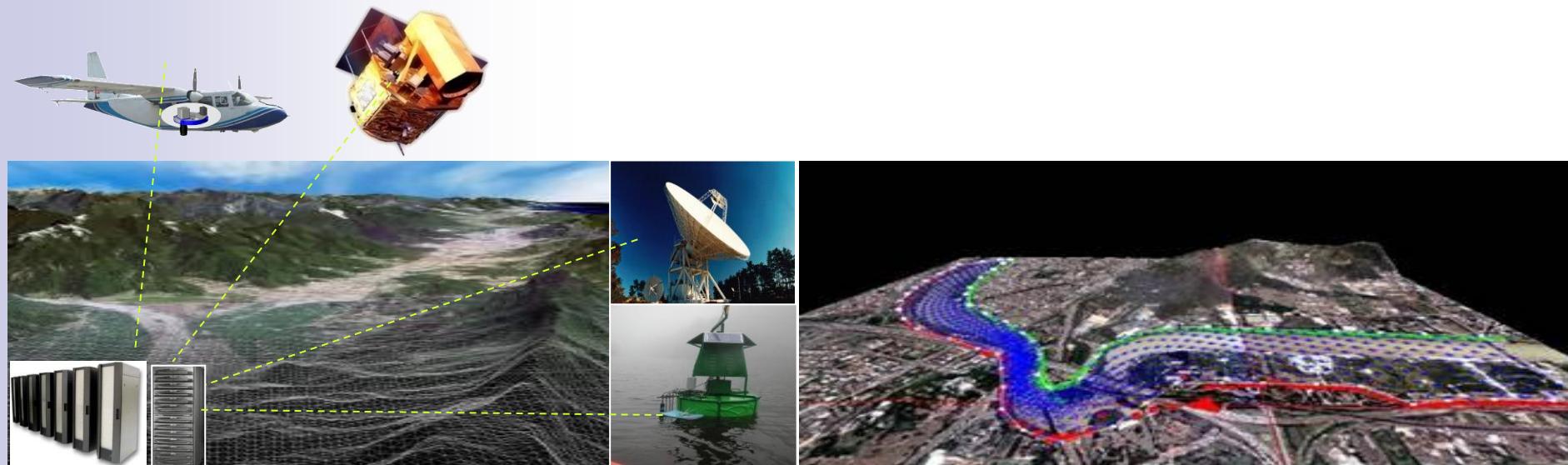
**National Center for High-performance Computing  
National Applied Research Laboratories  
Hsinchu, Taiwan**



**Oct. 17, 2011**

# Outline

- Introduction to NARL 3D GIS Taiwan Project
- Multi-scale Global Earth Observations
- Multi-scale 3D GIS Display System
- Web 3D GIS platform & Cloud Service
- Near real-time Image Processing for Decision Support
- Future Development



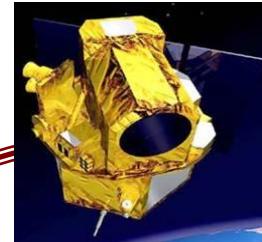
# **Introduction to NARL 3D GIS Taiwan Project**

# 3D GIS Taiwan Platform (2009-2011)

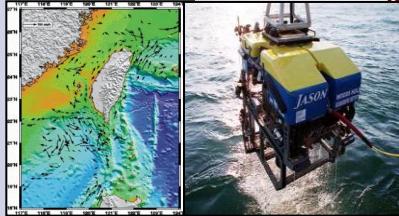
A Multidisciplinary Research Taskforce under NARL, Application-driven GEO Grid

## Observation & Platform

NSPO: Remote Sensing Image



TORI: Marine Observation



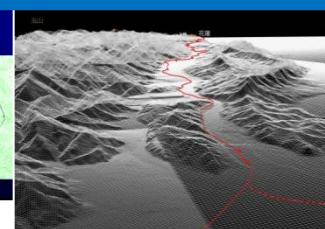
ITRC: Optical Airborne Image



NARL

Synergy on  
Environmental &  
Disaster Prevention

NCHC: Data Warehouse  
HPC & 3D Visualization



## Simulations & Applications

TTFRI: Typhoon & Flood Research



NCREE: Earthquake Engineering



NCDR: Disaster Reduction Technology



# Implementation of 3D GIS Taiwan Platform



Remote sensing satellite FORMOSAT-2



The images captured by FORMOSAT-2 during daytime is 2 meter resolution

DEM in Taiwan

High-Resolution  
3D GIS Taiwan Platform

Web 3D GIS Taiwan (on-line)



VR 3D GIS Taiwan (off-line)



Optical Multi-Spectrum Airborne Imaging is available on demand  
20cm Resolution Image

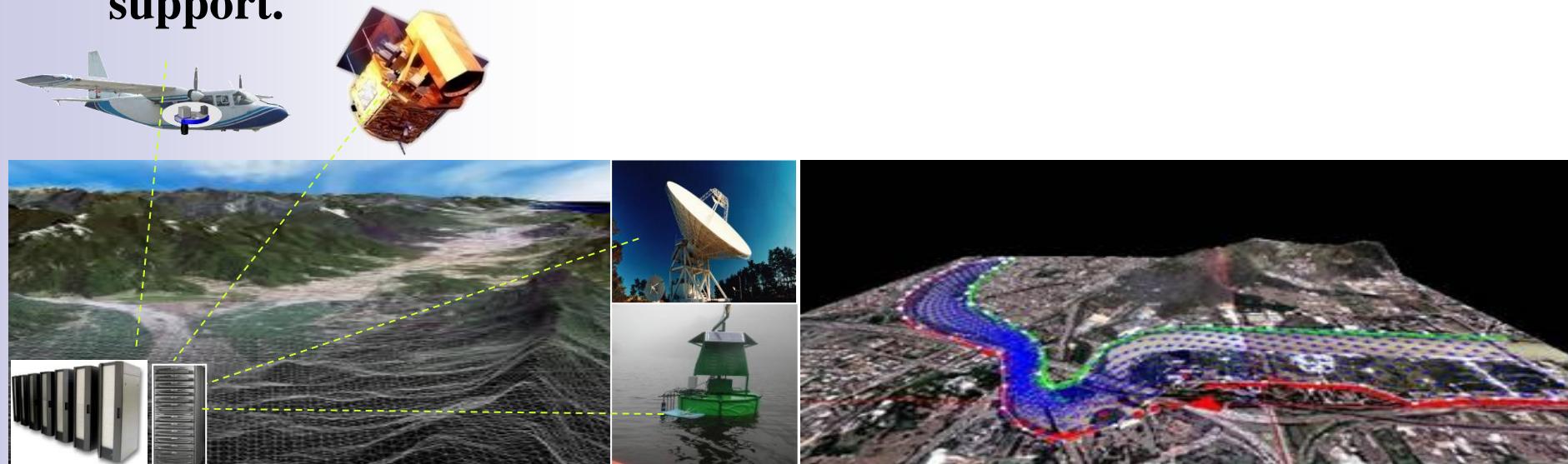


# Objective

**Development of Near Real-time, High-resolution, Global Earth Observation 3D Platform for Disaster Monitoring and Assessment**

## Technology Developments

- Integration Multi-scale global earth observations
- Development of advanced 3D GIS display systems
- Development of Web 3D GIS platform & cloud service
- Development of a near real-time image processing for disaster decision support.



# **Multi-scale Global Earth Observations**

# Multi-Scale Global Earth Observation

## ■ Large-scale (~100KM<sup>2</sup>); 2-8M resolution

- Formosat-2 satellite image, NSPO
- Other allied international satellites



## ■ Middle-scale airborne image (10KM<sup>2</sup>); 25-50 CM resolution

- VCDi-Lite

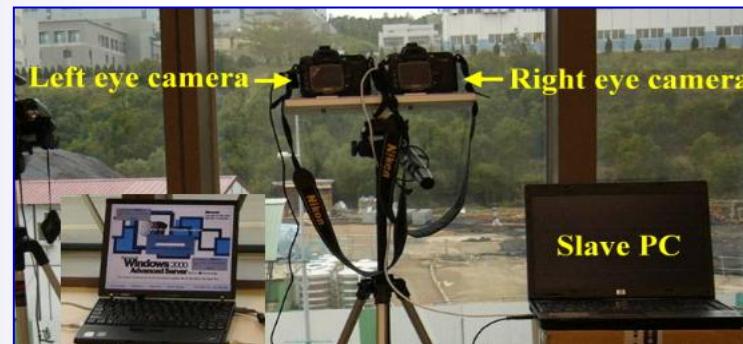
The advanced optical electronics and mechanical system design and assembly of airborne imager, VCDi-Lite (Vegetation and Change Detection imager) is developed by Instrument Technology Research Center.



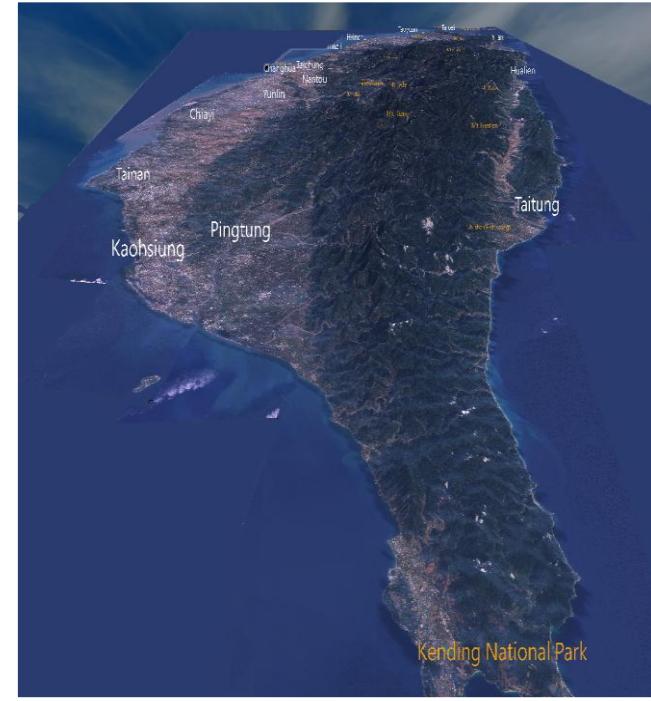
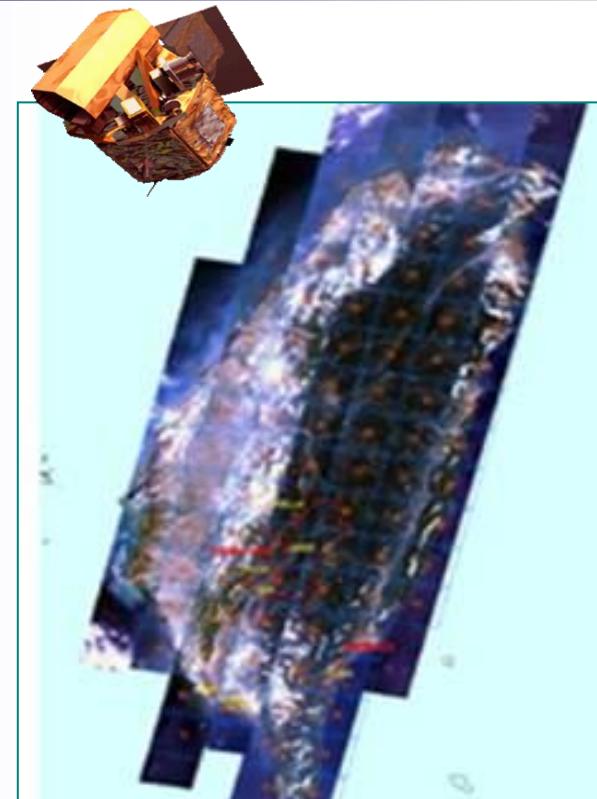
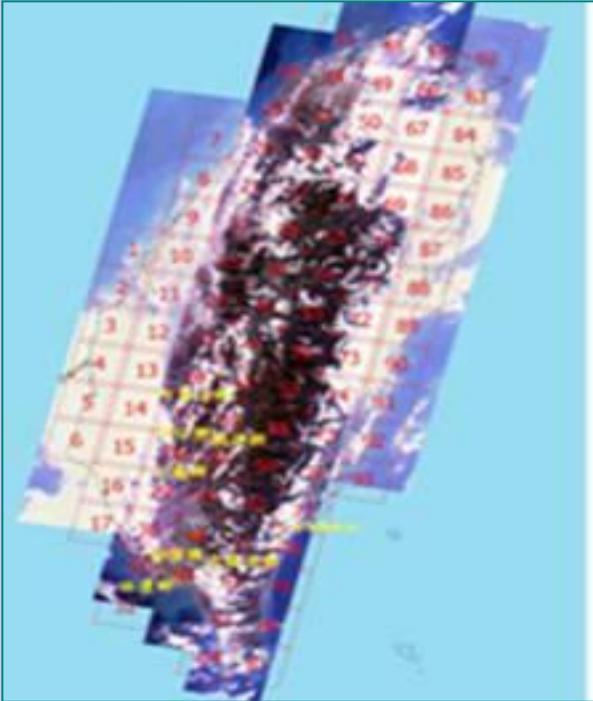
- UAV (National Center for Disaster Reduction)

## ■ Small-scale High-precision in-situ 3D photography (1 KM<sup>2</sup>)

- NCHC
- Others



# Large-scale Observation in Taiwan



Formosat-2's wide-area imaging

Formosat-2's Nadir-view ortho-photo imaging

3D GIS Taiwan

# Airborne Imagery by Using VCDi in Local Taiwan Areas



Kaohsiung County  
county area, 200 KM,  
500 photos

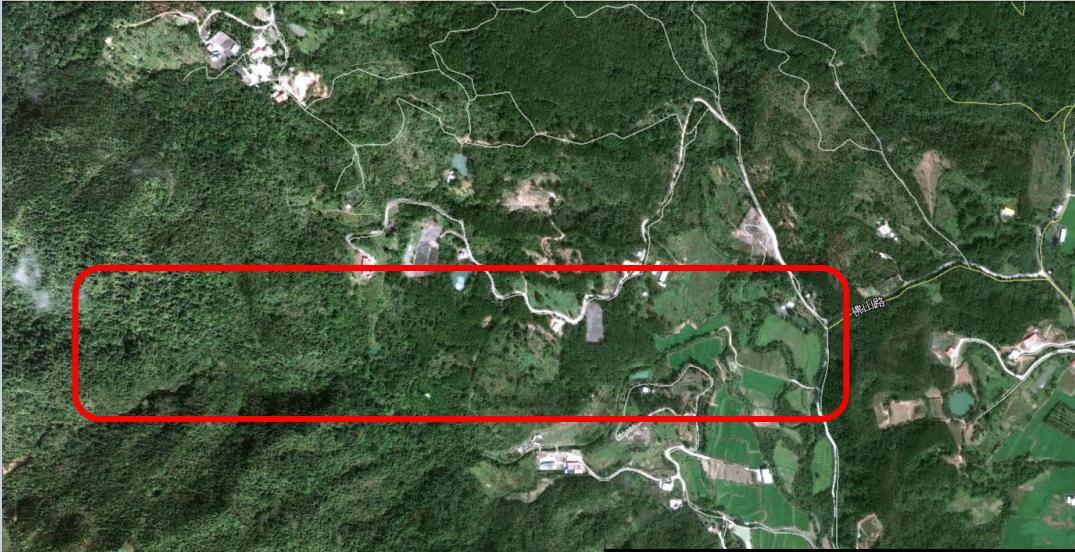


Nantou county area,  
234 KM, 585 photos

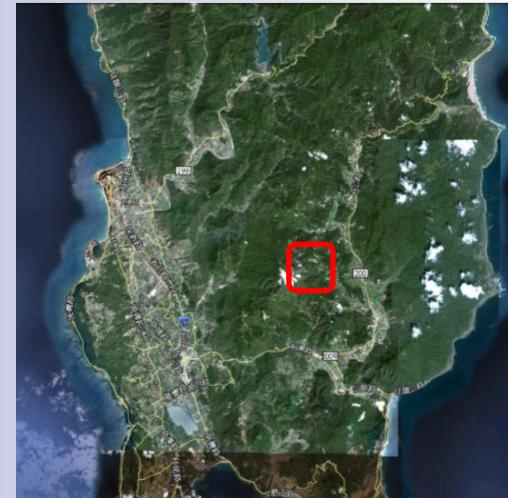


# Images Taken by UAV

## Example at Pington County



Before



After

**Before and after  
Typhoon Nanmatol in  
August 2011**

# Small-scale In-situ 3D Photos



Nantou county, 963 photos



Kaohsiung & Pingtung  
Counties, 344 photos



Tainan county, 56 photos



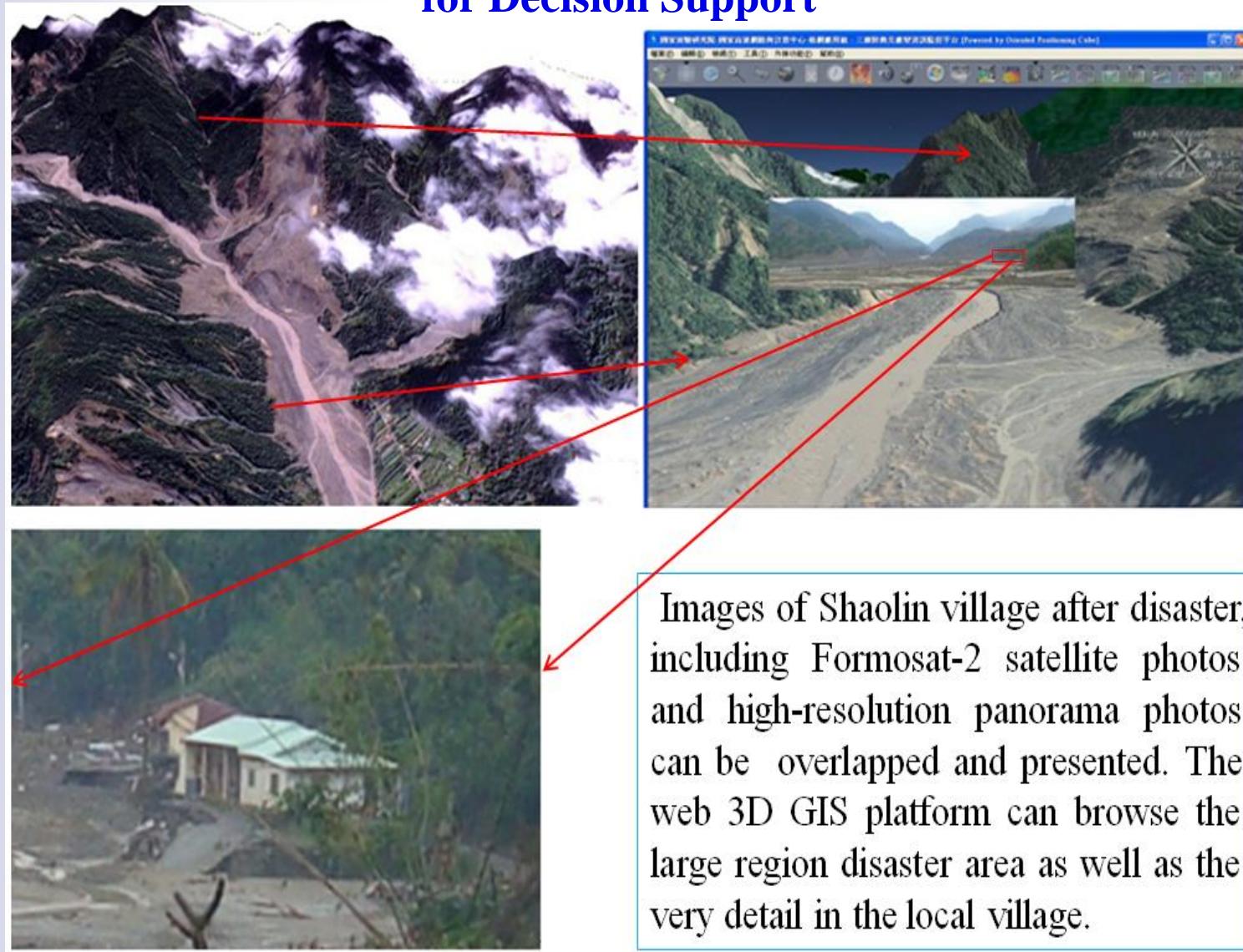
Panoramic scenes composed of consecutive photos



Taitung county, 234 photos

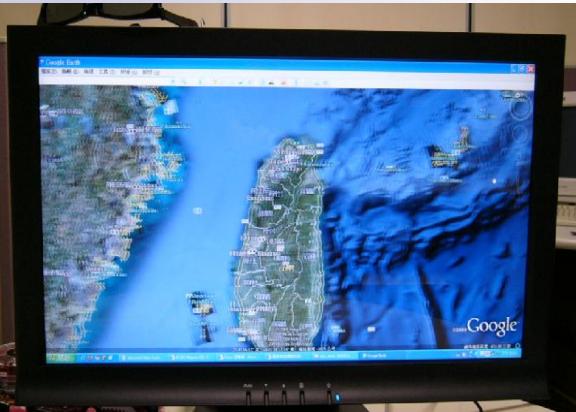
# Integration of Multi-scale Remote Sensing Images

## for Decision Support



# **Multi-scale 3D GIS Display System**

# Multi-Scale 3D Display Systems



3D PC or Notebook;  
Active; (1-5 persons)

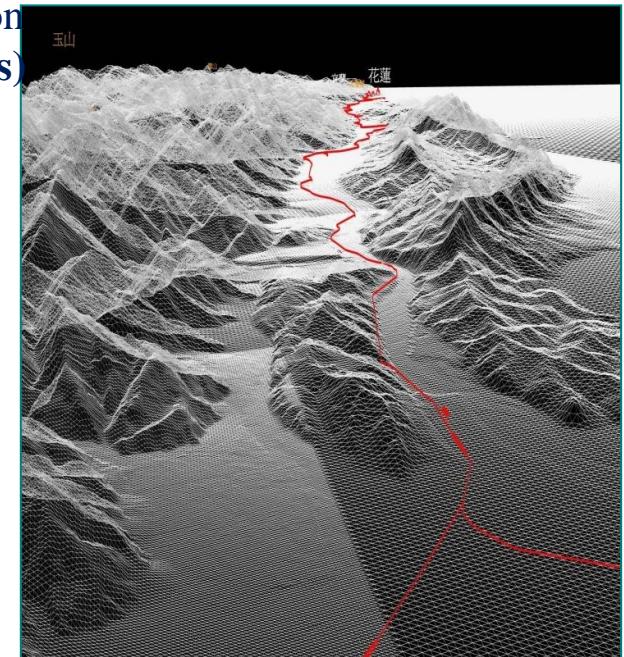


The 3D projector displays images on a white wall, Active; (5-10 persons)



Tile Display Wall

4K High-resolution VR  
**Passive; (50-200 persons)**



# VR 3D GIS Taiwan: Language/Software

FORMOSAT-2 Taiwan Image



## 3D GIS VR Technology

- Language: Open-GL
- Volume Rendering
- Discrete Level-of Detail

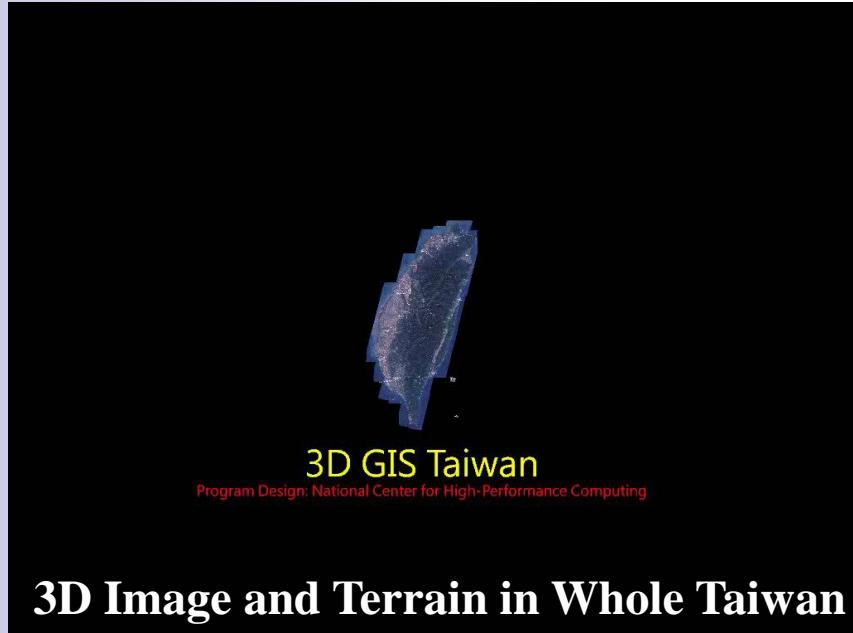
- 2M x 5M 3D GIS Taiwan: 33GB
- Mesh: 40,388 X 75,526
- Triangulation: 6 billion triangles



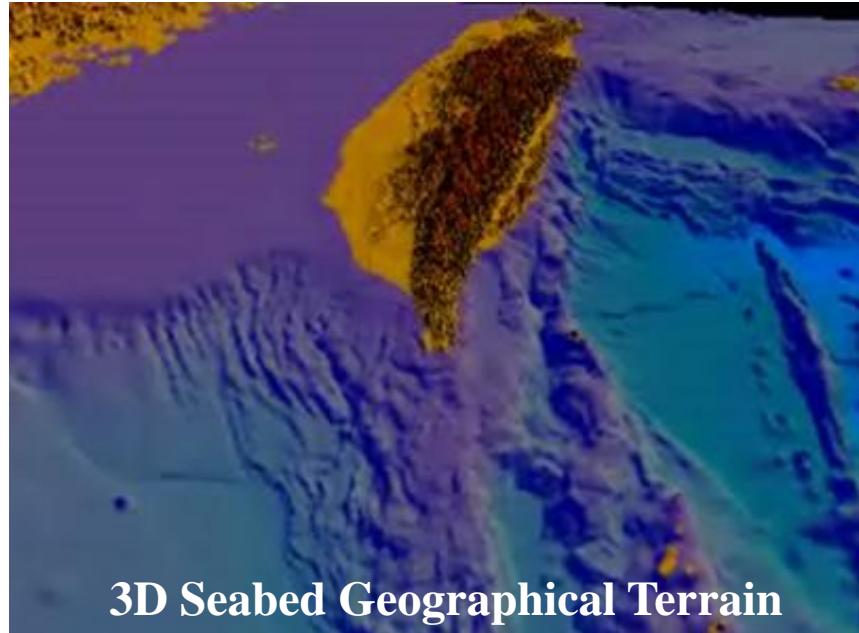
# 3D Large Display Systems at NCHC



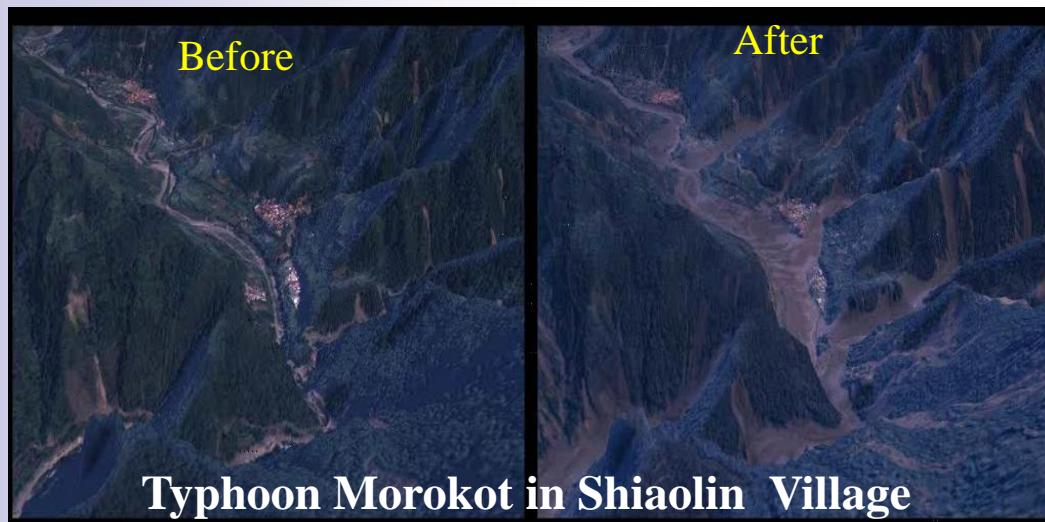
# Applications (displayed in stereo 3D) have been Achieved



3D Image and Terrain in Whole Taiwan



3D Seabed Geographical Terrain



Typhoon Morokot in Shiaolin Village

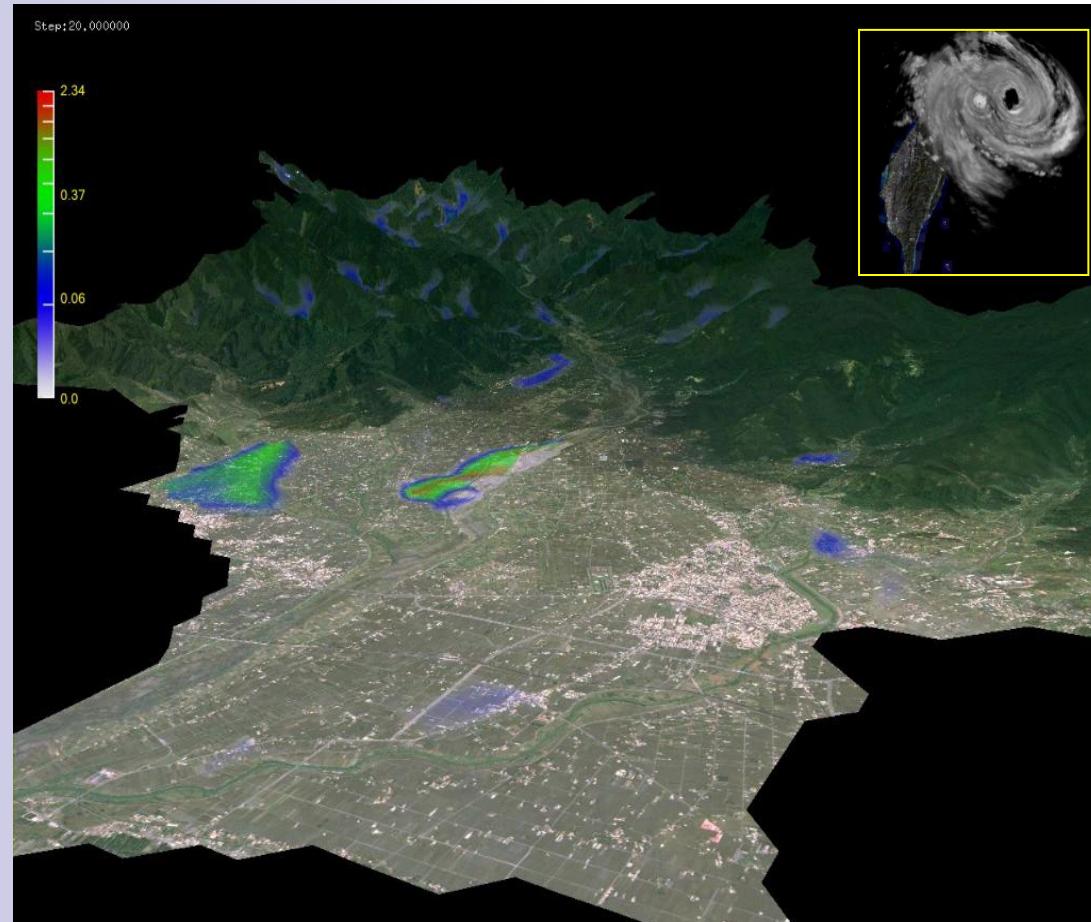


3D Cloud: Radar Return Wave

# 3D Display of Flow & Inundation in Lan-Yang Creek Basin

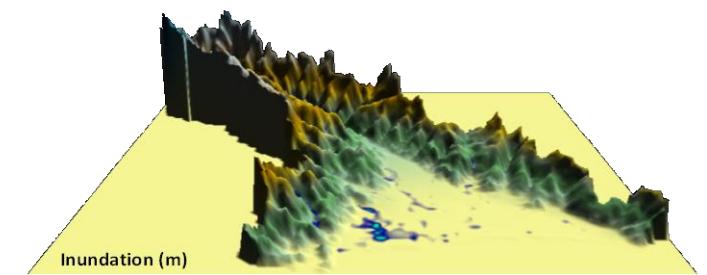
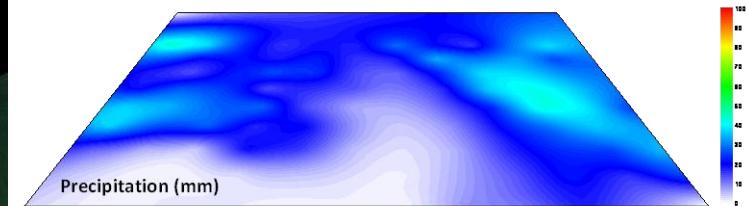
Based on WASH123D Surface & Subsurface Model  
Using WRF model for Typhoon/Storm Precipitation simulation

Typhoon Longwang 2005



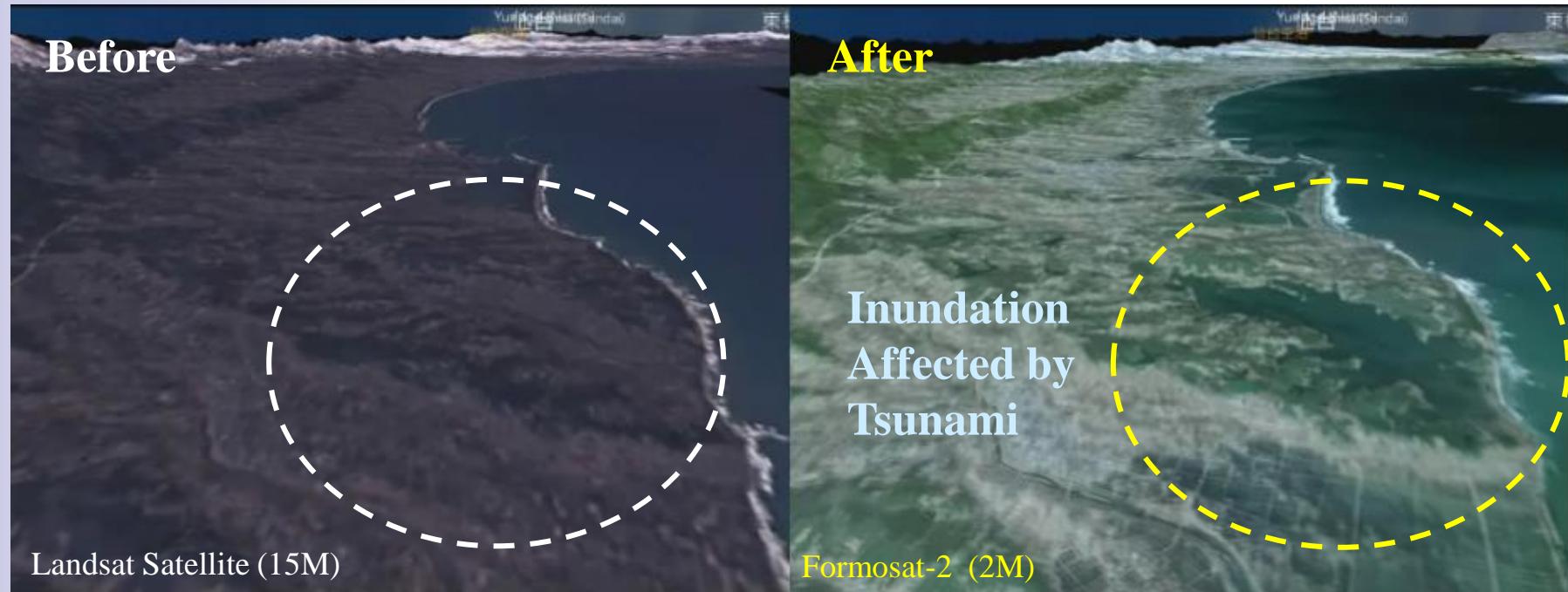
WRF Model

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



WASH 123D Model

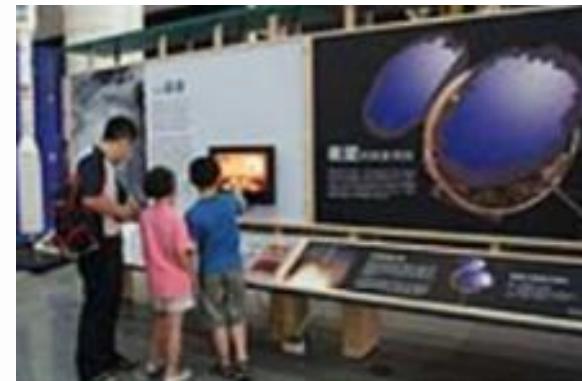
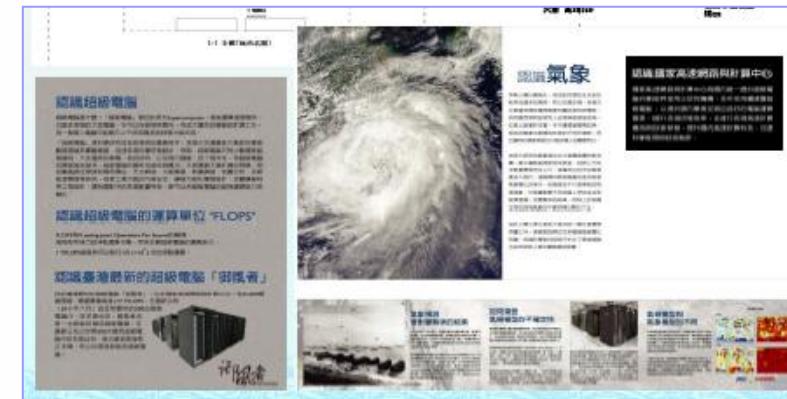
# Developing Fukushima 3D Animation after 311 Earthquake



3D Images in the Fukushima nuclear power plants No.1, 2, and 3

# Joint Exhibition at Taichung Science Museum

To support for producing a 3D education movie associated with Typhoon Morakot

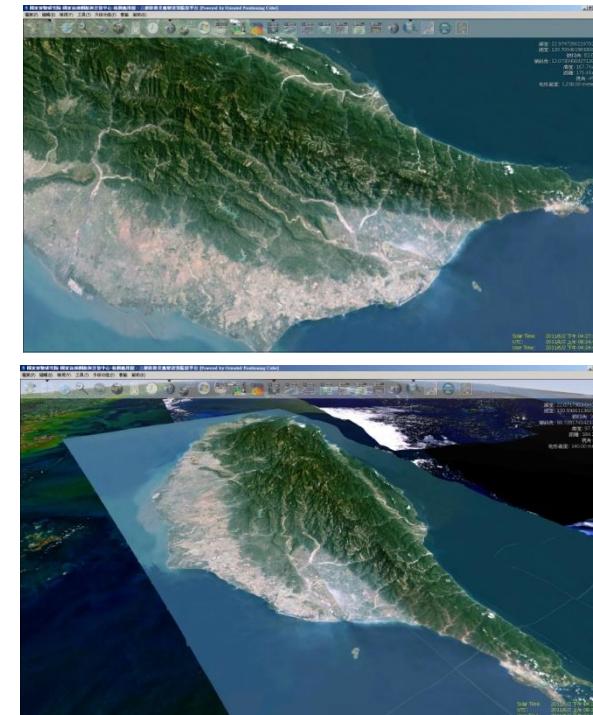
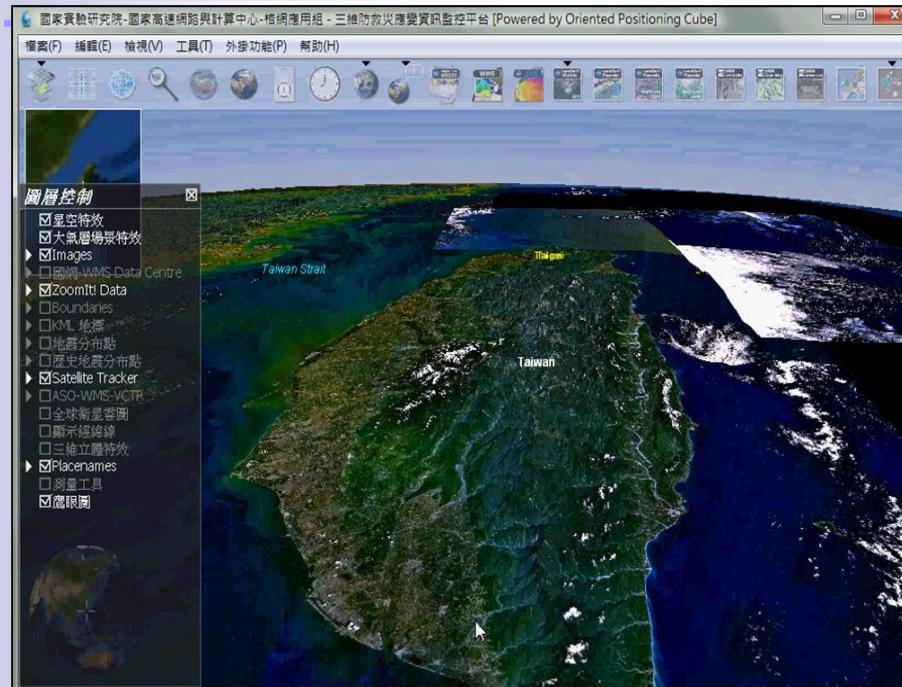


## **Web 3D GIS Platform & Cloud Service**

- World Wind Taiwan (no stereo)**
- WebM 3D (Stereo) GIS Animation**

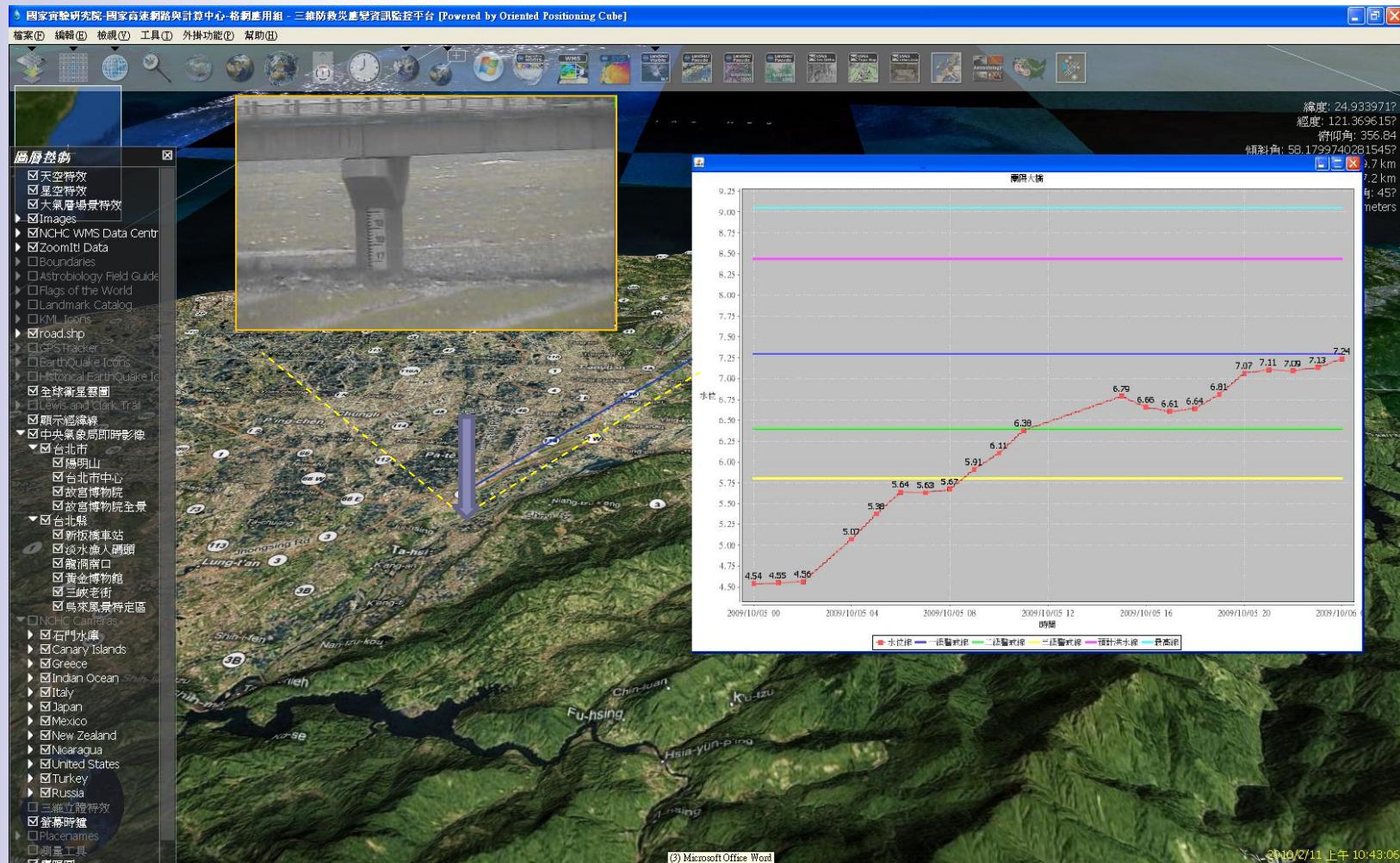
# The World Wind Taiwan Platform

- Developed by modification of NASA World Wind system (Open Source) for image integration (stitching, overlaying, display, and assessment).
- Support OGC standard, WMS、WFS、WCS, etc.; Coupled with Cloud service.
- Encompassing Formosat-2 space borne and airborne images incorporated with data warehouse/fusion and high-performance visualization technologies.
- Linking with end-user disaster prevention database, sensor network, and analyzed model for decision support.



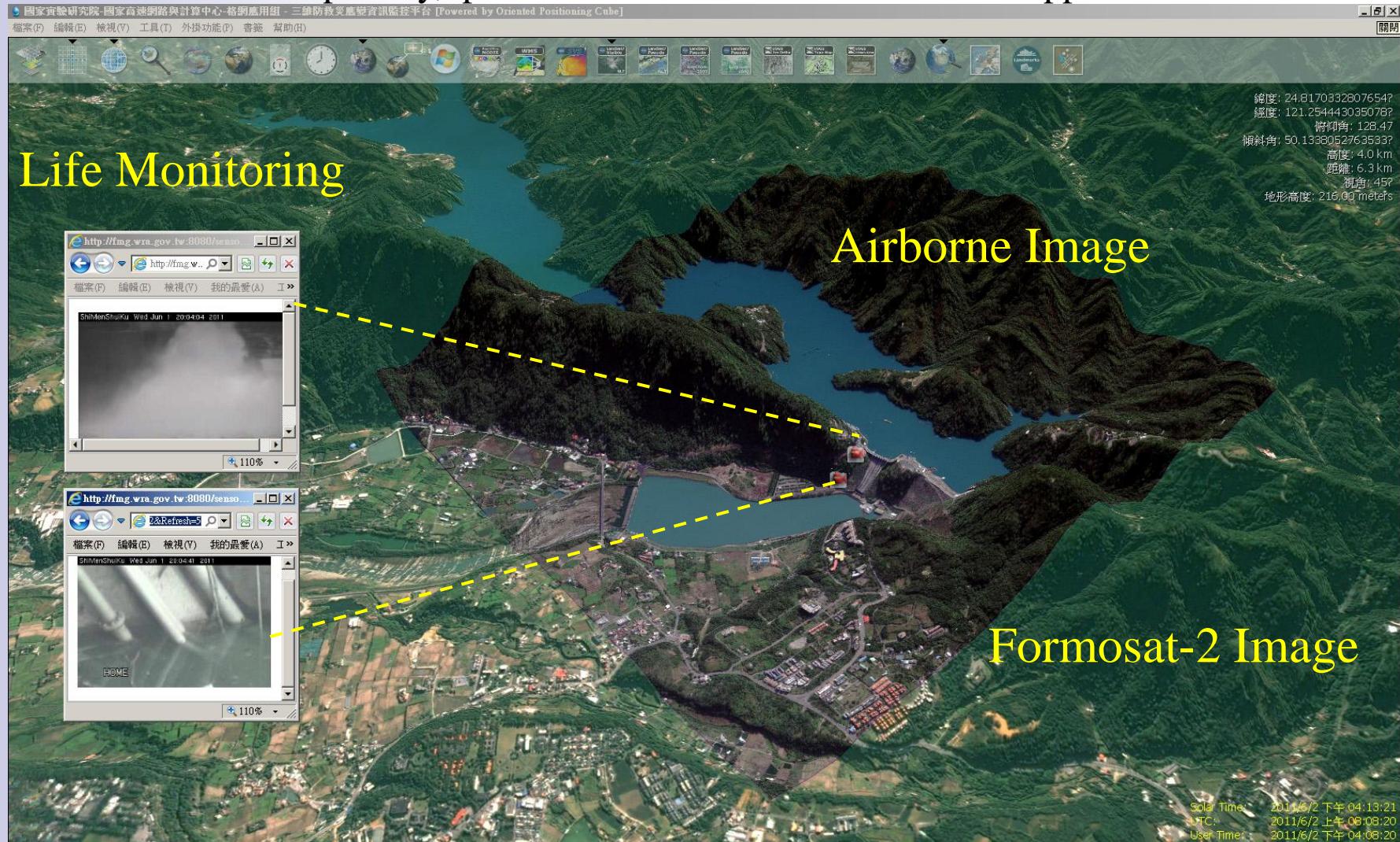
# World Wind Taiwan Platform Integrates Sensor and Data

Lan-Yang watershed is displayed in the 3D Platform linking with the real-time water level monitoring and associated data.

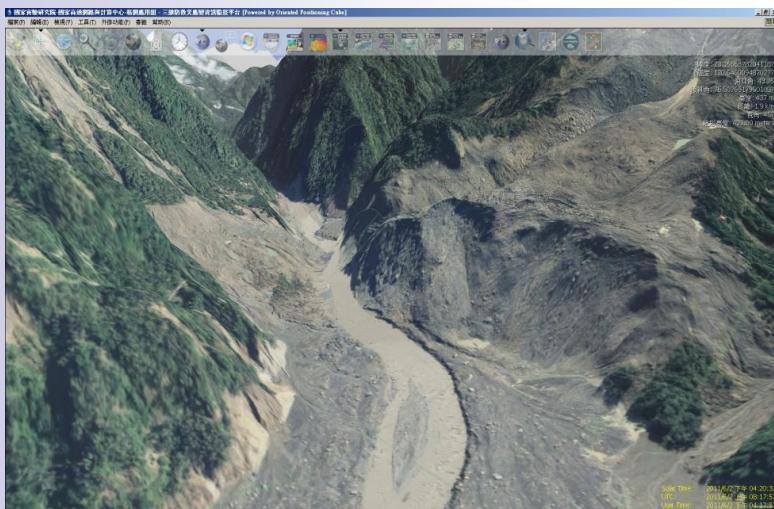


# World Wind Taiwan Platform Integrates Multiple Information

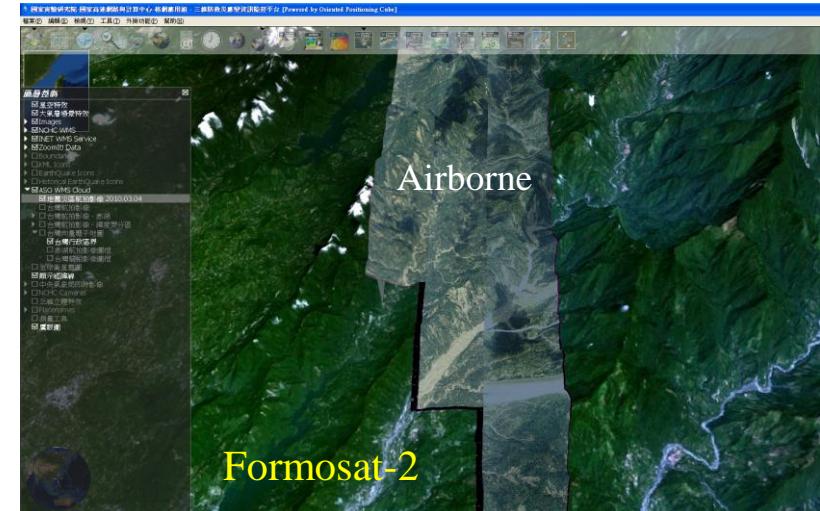
The Shihmen Reservoir spillway area displayed by overlaying the aerial image and Formosat-2 satellite image. Meantime, the real-time watching cameras, located in downstream of the spillway, provide two live videos for decision support.



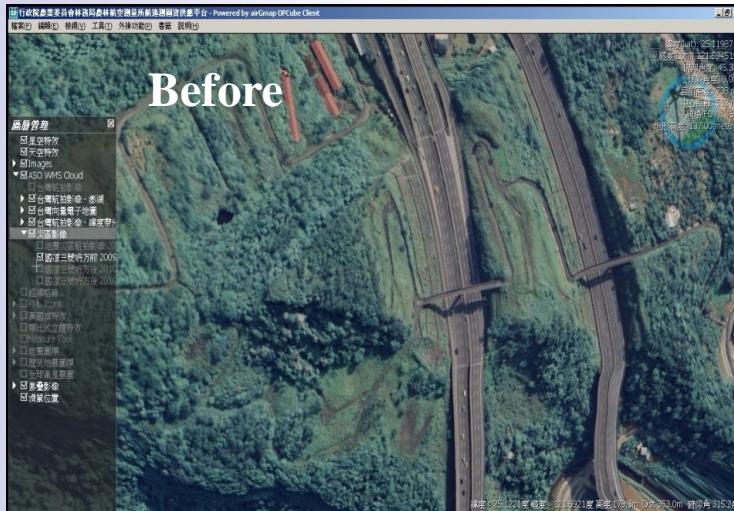
# World Wind Taiwan Platform: Application to Disaster Monitoring



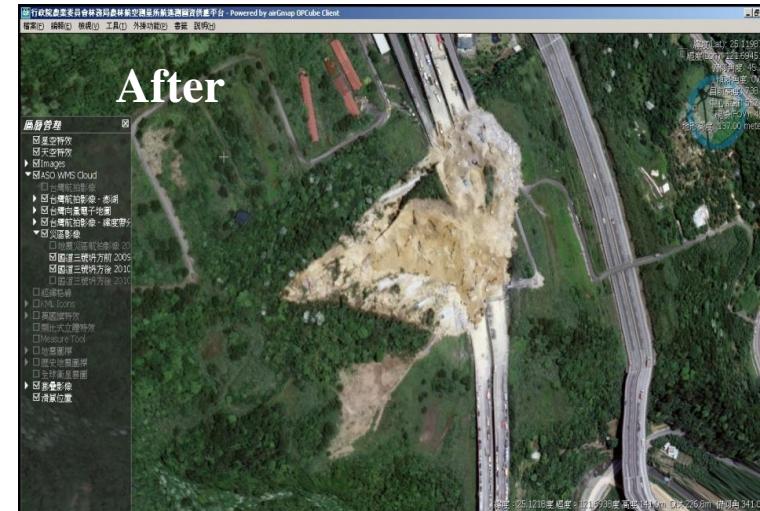
Typhoon Morakot induced landslide at Shiao-lin village



The 2010 Jia Sian Earthquake monitored in the platform

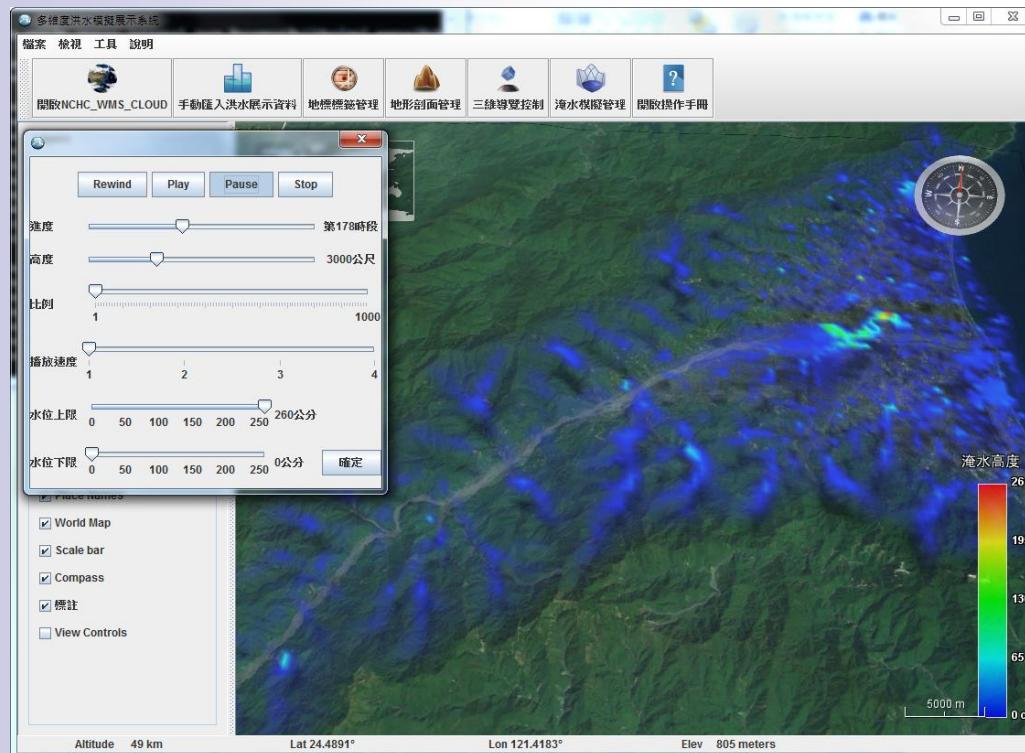


The landslide in the freeway No.3 near the Keelung area



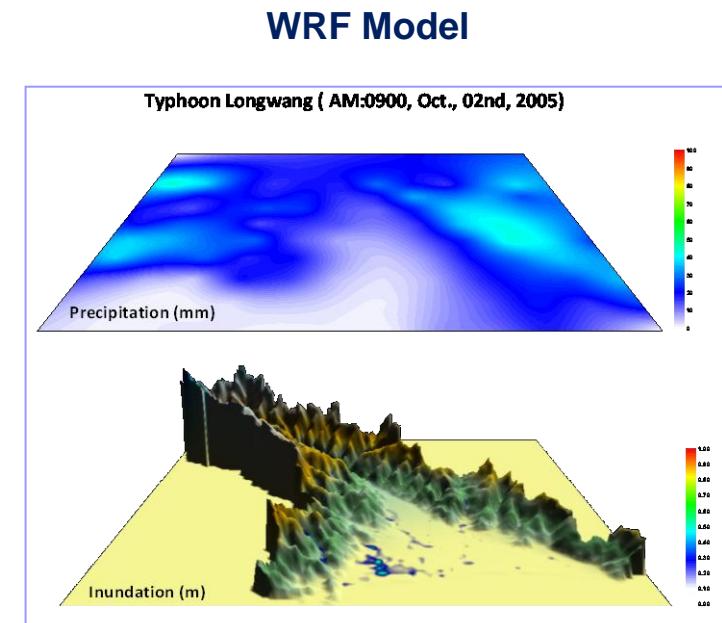
# World Wind Taiwan for Precipitation and Inundation Simulations

- Using WRF model for Typhoon/Storm Precipitation simulation
- Based on WASH123D Surface & Subsurface Model
- Can be applied for watershed and models with same I/O format



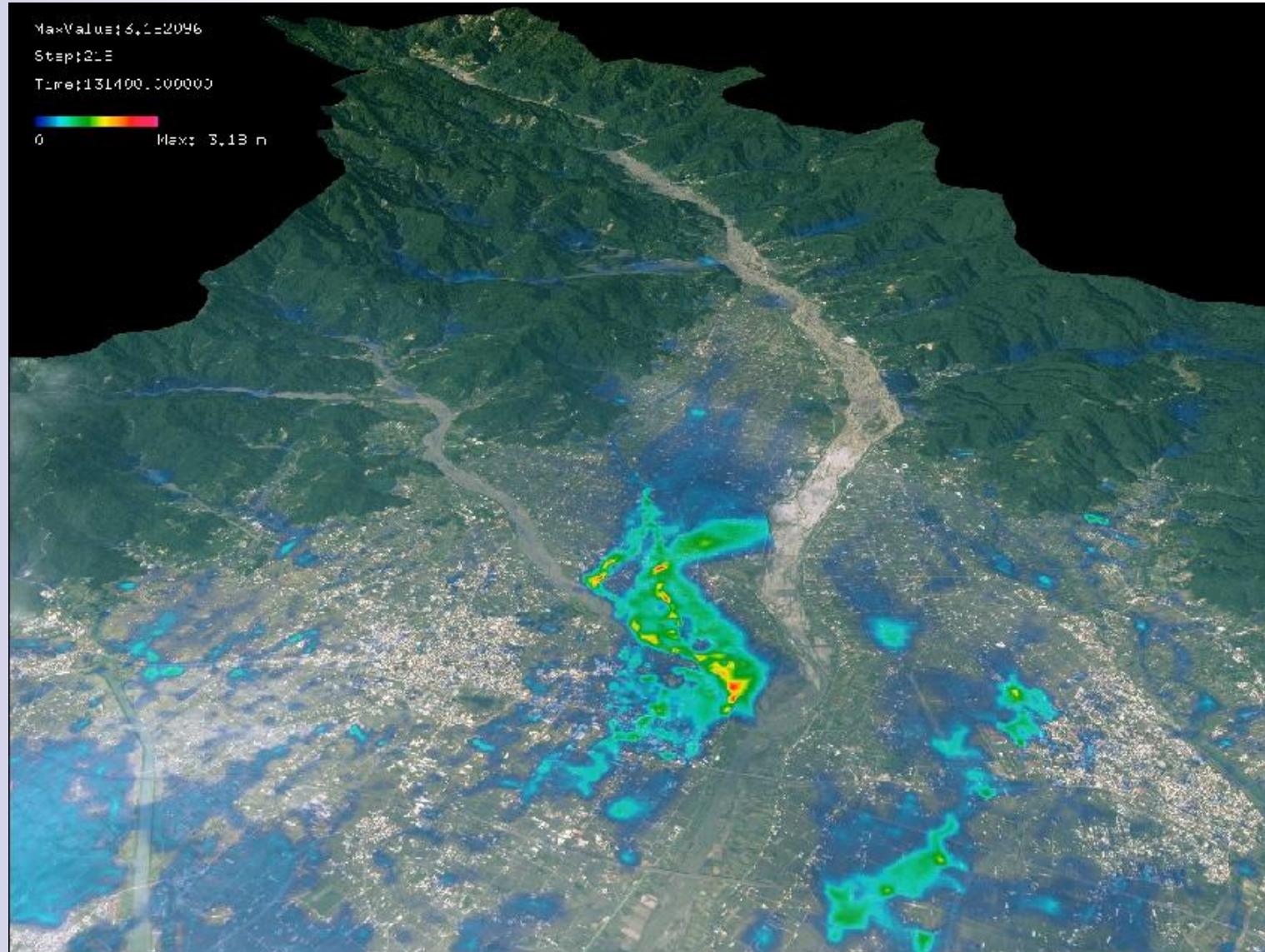
Dedicated World Wind Taiwan User Interface

NASA World Wind → World Wind Taiwan → World Wind Watershed



WASH 123D Model

# 3D Simulations and Display of Flood & Inundation



2010 Typhoon Megi in Lan-Yang Creek Basin

# WebM 3D (Stereo) GIS Animation

## 3D Vision System Requirements



+



+



+



NVIDIA 3D Vision Kit

3D Vision-Ready  
Display

Compatible NVIDIA  
GeForce Card

PC with Microsoft  
Windows Vista or Win7

### MINIMUM SYSTEM REQUIREMENTS

- › Microsoft® Windows® Vista 32/64-bit or Windows 7 32/64-bit
- › Intel® Core™2 Duo or AMD Athlon™ X2 CPU or higher
- › 1GB of system memory (2GB is recommended)
- › 100 MB free disk space



**WebM, HTML5 + Firefox version 4 and above**



DESKTOP/  
NOTEBOOK PC



SUPPORTED  
3D HDTVs



SUPPORTED  
3D PROJECTORS



GEFORCE GRAPHICS  
PROCESSORS



Web 3D GIS 應用

3D GIS 立體影片

首頁 | 計畫簡介 | 技術發展 | 研究發展 | 平台服務 | 相關活動 | 沉睡中的記憶 | 全球氣候變遷下的台灣自然災害

Home > 3D GIS 立體影片 > 颶風降雨淹水模擬應用

3D GIS 立體影片

## WebM 3D (Stereo) GIS Animation

### 颱風降雨淹水模擬應用

從3D GIS Taiwan平台結合計算模擬，與國研院的颱洪中心合作。從3D GIS Taiwan資料中，將宜蘭蘭陽溪流域的一部分地形模型抽取出來，提供颱洪中心利用數值模擬運算，在高速運算電腦主機上推測淹水潛勢狀況。目前使用顏色表示淹水深度，藍色是最淺、紅色是最深。



### 其它 3D 影片



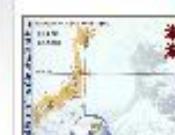
全台 3D GIS



颱風寒露的普達回波圖



莫拉克風災災區受損狀況分析

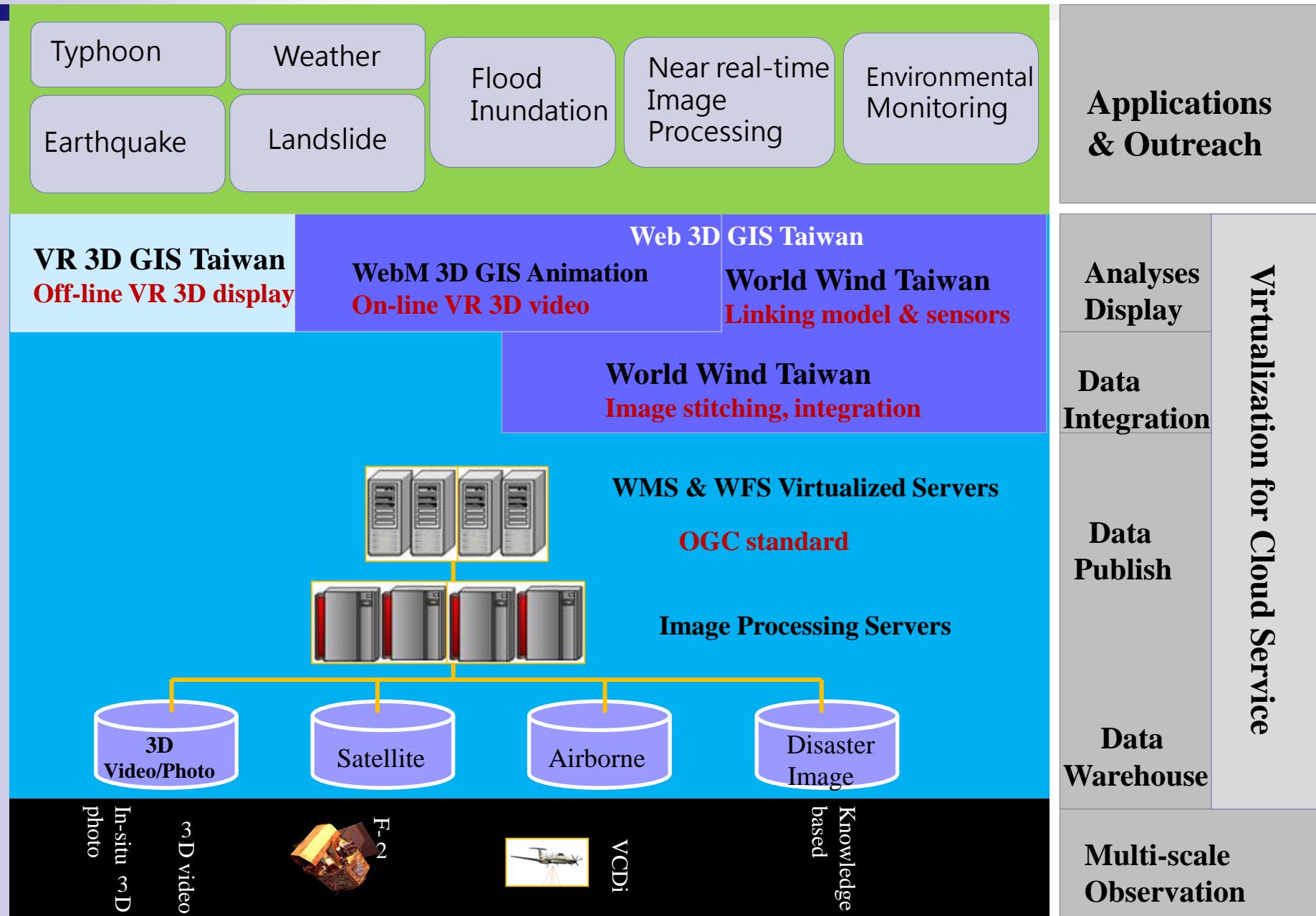


2011日本311大地震與海嘯

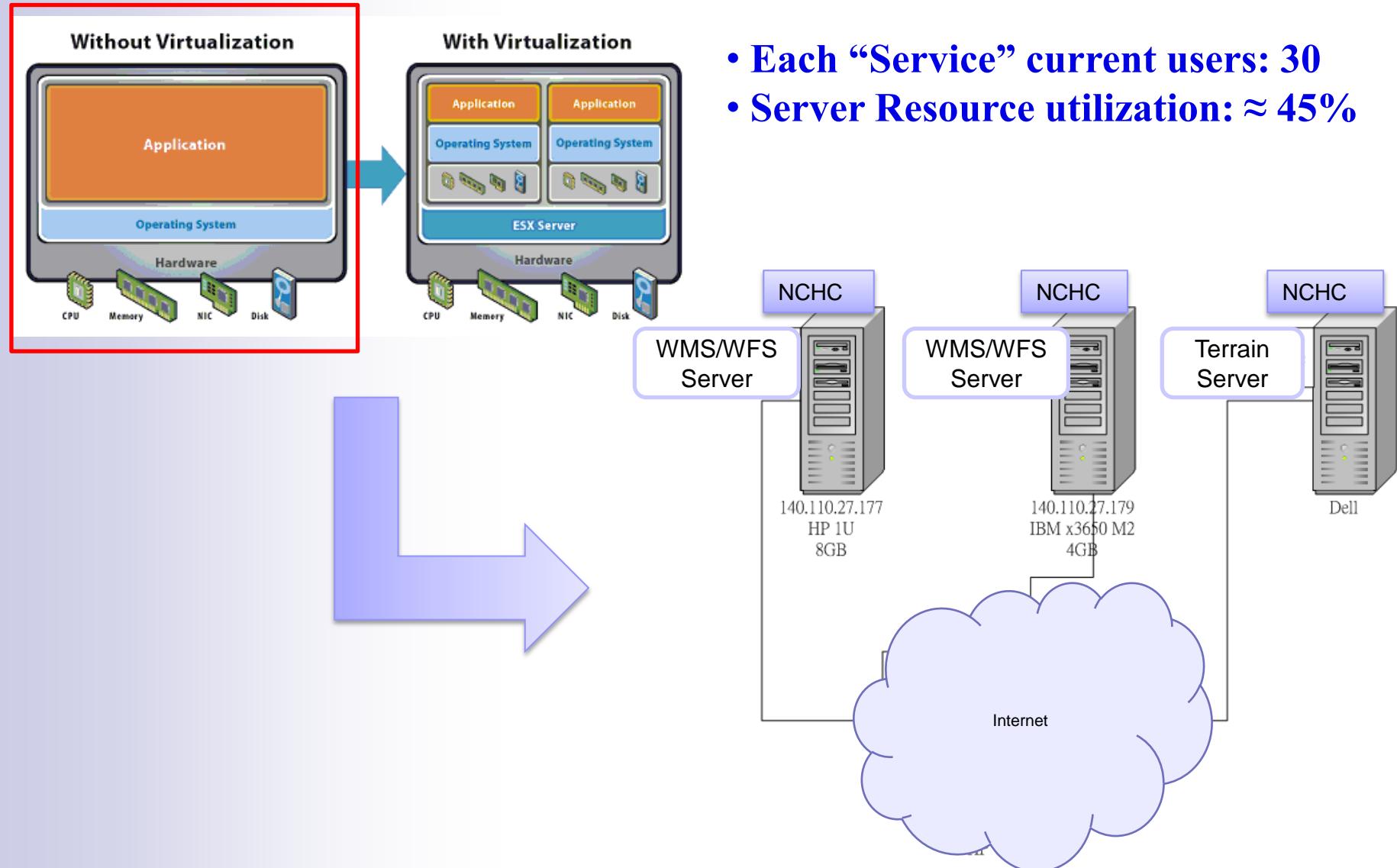


台灣四周的海底地形

# GEO Cloud Service Framework

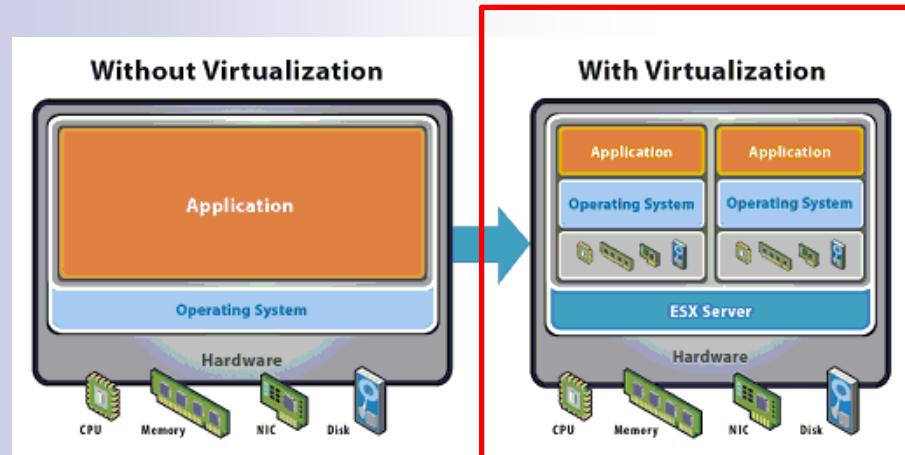


# Original WMS Cloud Prototype

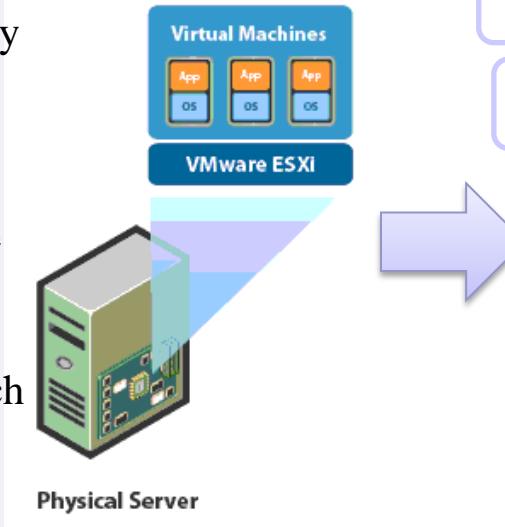


# WMS Cloud Prototype

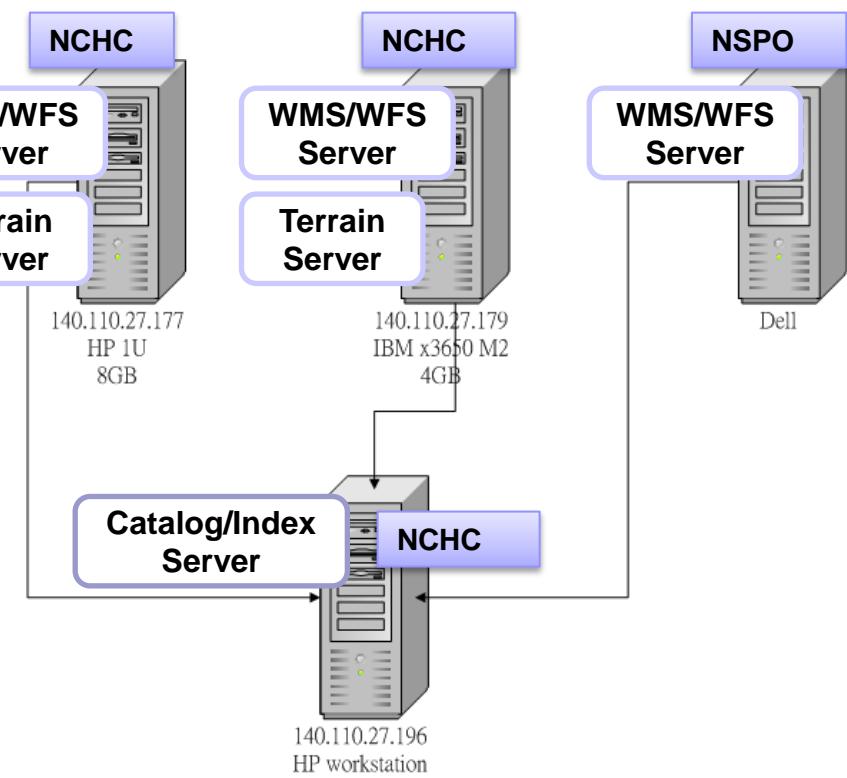
## Using Middleware VMWare vSphere & ESXi



Using “Virtualization” in improving the efficiency and availability of IT resources and applications, and to eliminate the old “one server, one application” model and run multiple virtual machines on each physical machine.

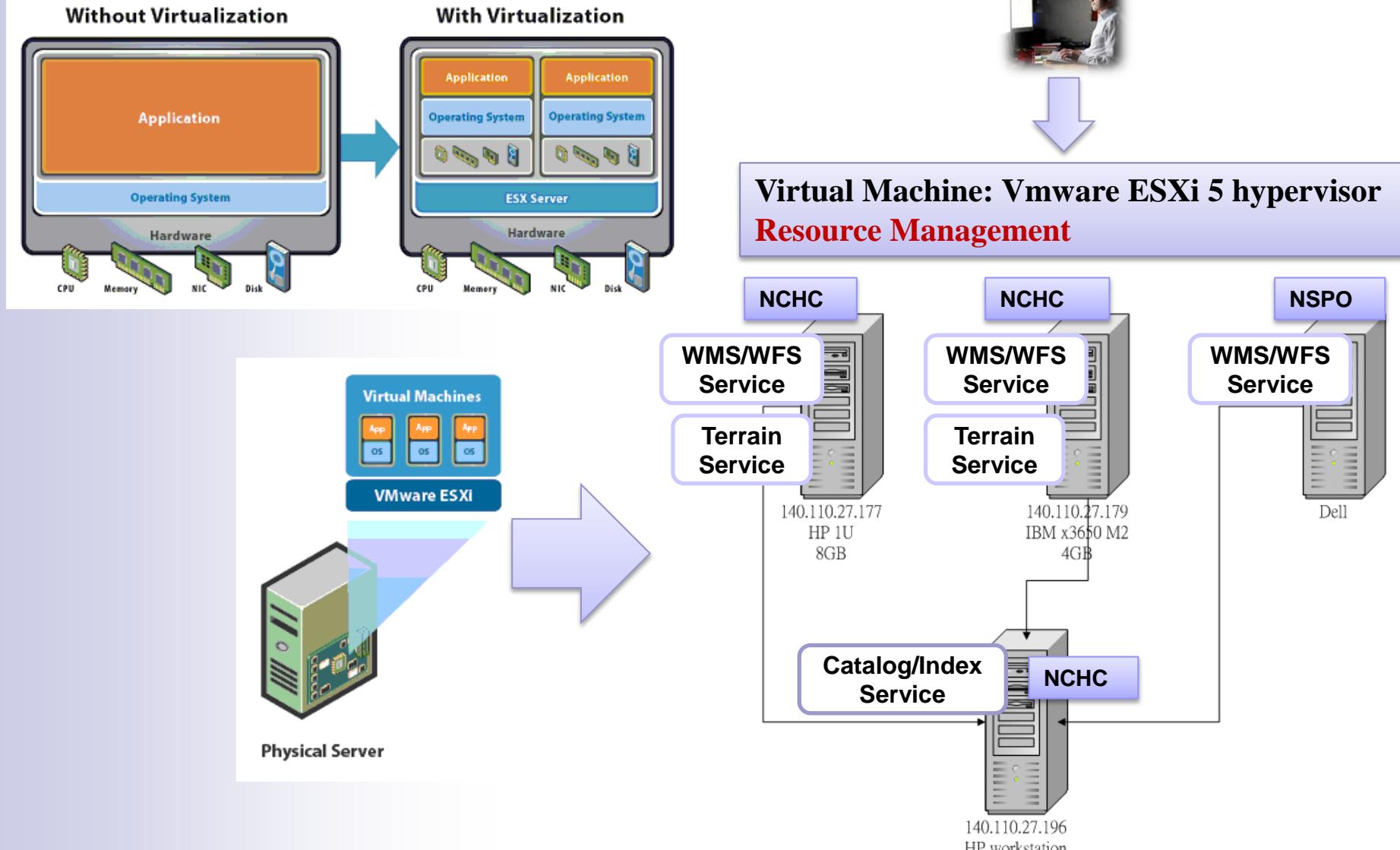


- Each “service” current users: 30
- Add VM service to each server
- Server Resource utilization: ≈90%
- Every server can support almost 2~3 VM in it, depending on server’s resource (CPU & memory).



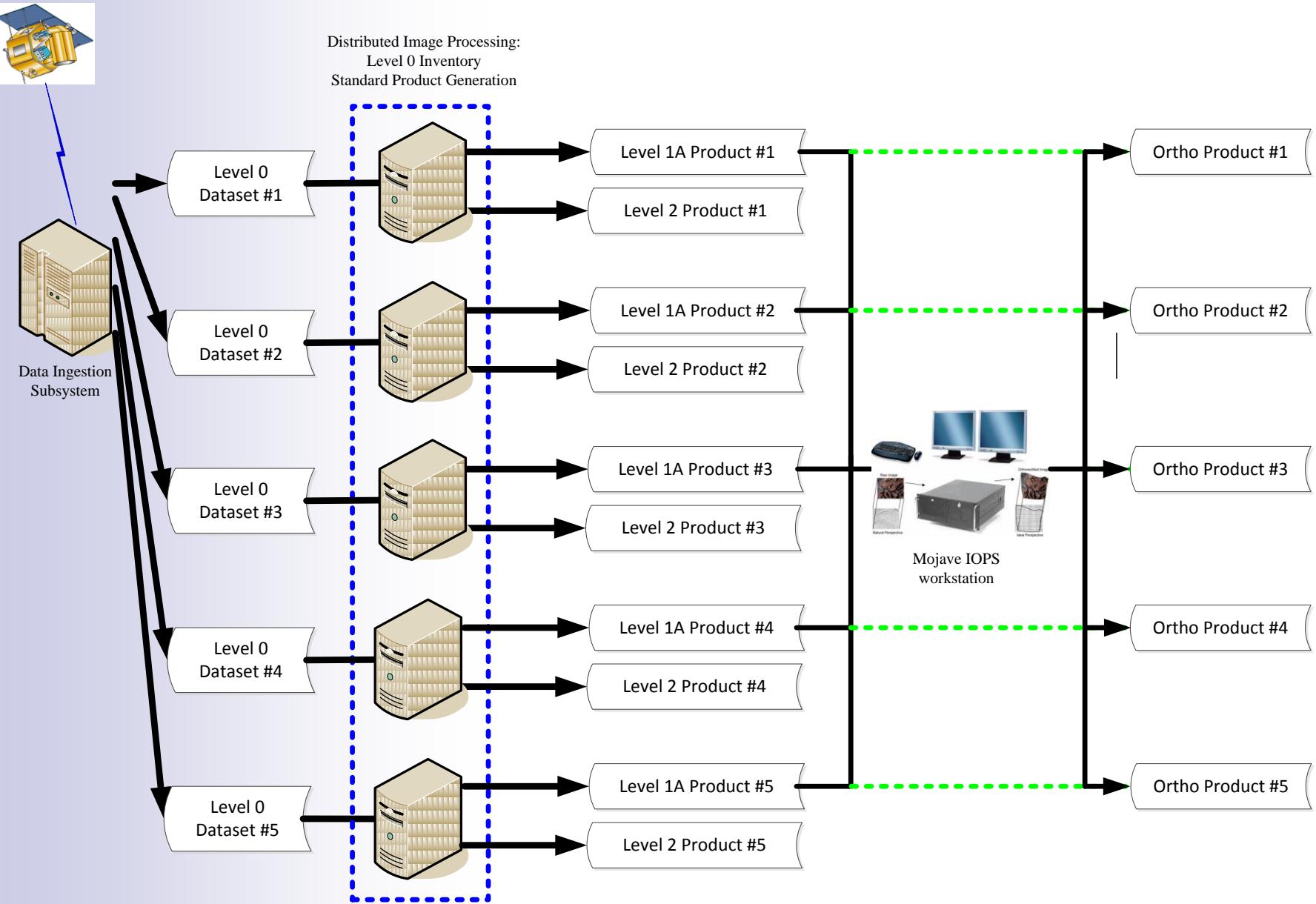
# WMS Cloud Infrastructure

VMWare vSphere5 admin. client

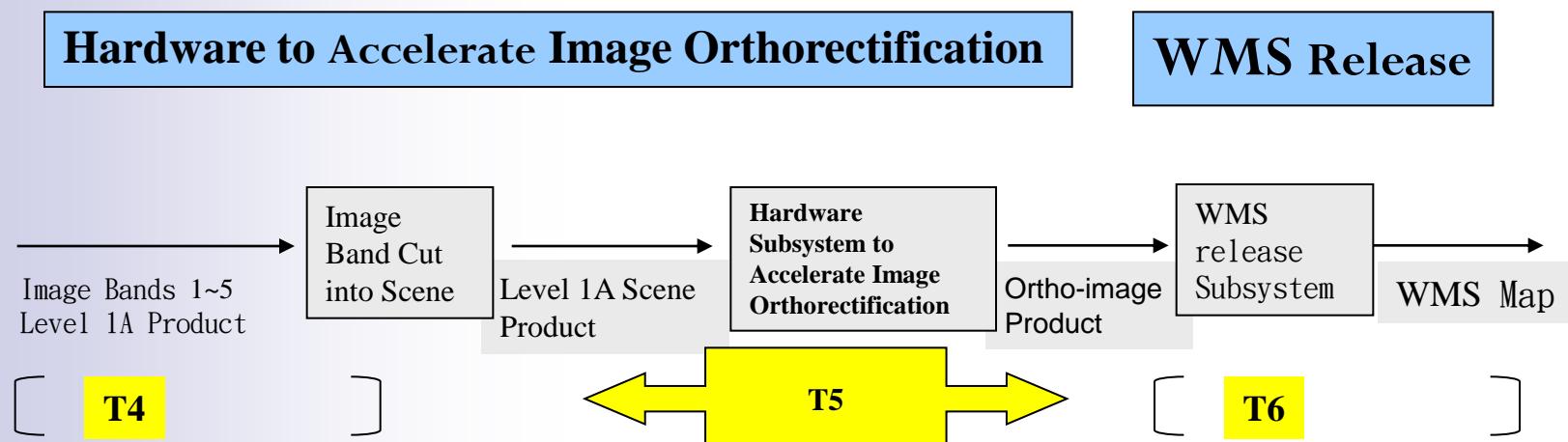
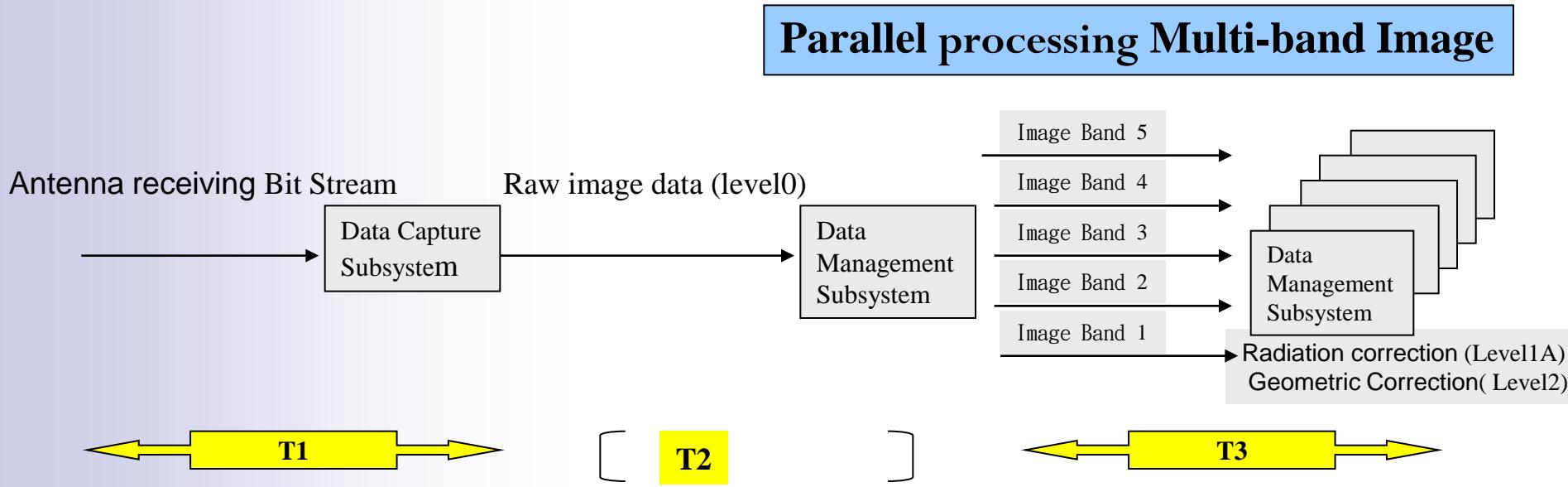


# Near real-time Image Processing for Decision Support

# Formosat-2 Image Processing Framework

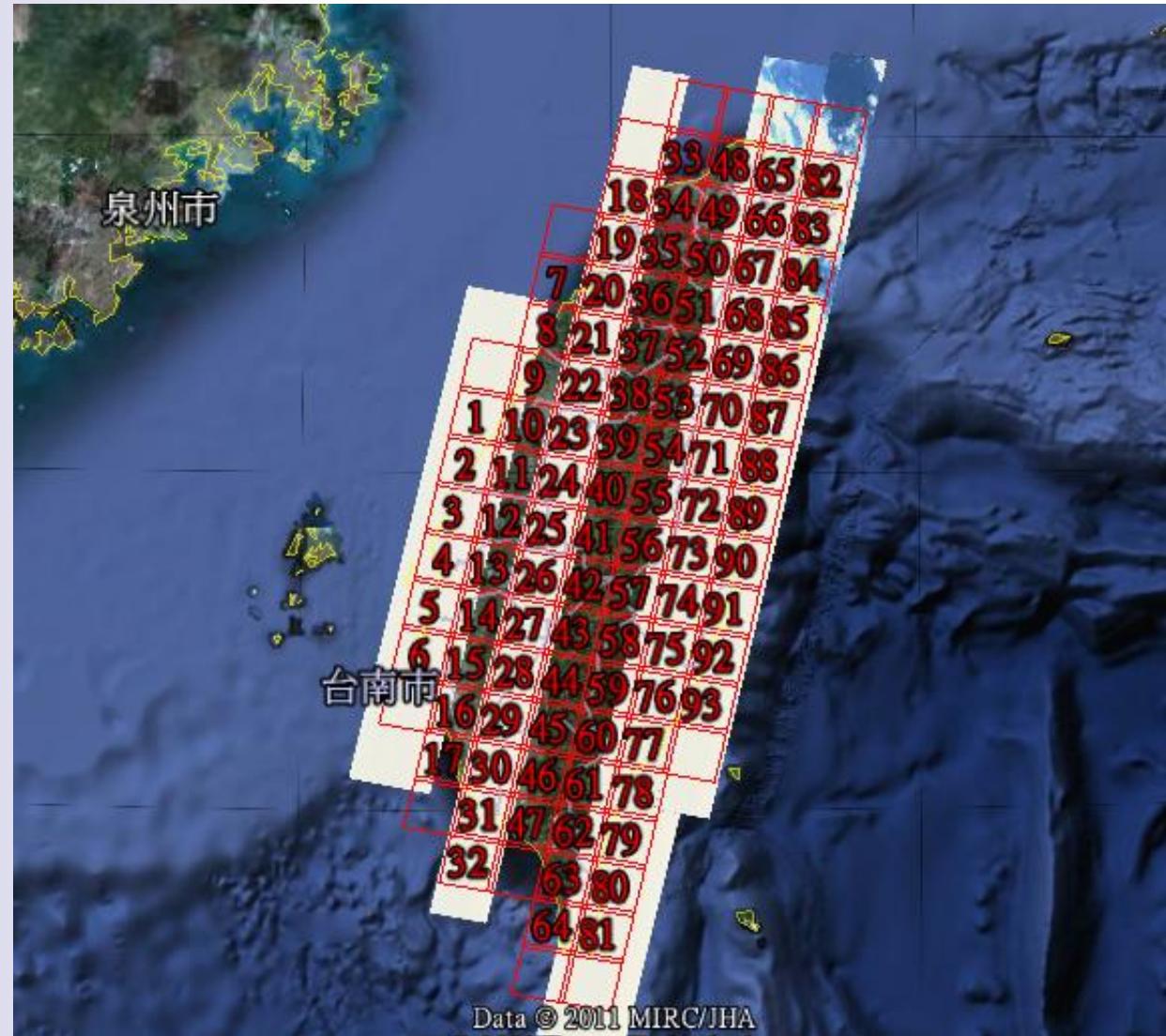


# Image Processing and WMS Notification



# Formosat-2 Satellite Image Capturing

after Typhoon Nanmadol, August 31, 2011



# Co-work Flow by Using Co-life System

Co-life: <http://www.colife.org.tw>

**Team member list**

**Chat room**

**Whiteboard**

**分工流程**

The central whiteboard displays a flowchart titled "分工流程" (Workshop Flow) with the following steps:

```

graph TD
    Start[啟動近即時影像處理流程] --> Step1[1. 接收衛星影像  
2. Level 0 影像處理  
3. Level 0 影像傳輸]
    Step1 --> Parallel1[分散平行處理影像 Level 1A]
    Step1 --> Parallel2[自行處理 Level 2 程序]
    Parallel1 --> SubStep1[擷取影像  
→ 分散平行處理影像 Level 2]
    Parallel1 --> SubStep2[擷取影像  
→ 參考]
    Parallel2 --> SubStep3[擷取影像  
→ 3rd上傳至FTP]
    SubStep1 --> SubStep4[擬正射影像處理]
    SubStep4 --> SubStep5[3rd上傳至FTP]
    SubStep5 --> SubStep6[擷取影像  
→ 做為備份]
    SubStep5 --> SubStep7[擷取影像  
→ WMS 發佈]
    SubStep6 --> SubStep8[擷取影像  
→ World Wind 3D 檢視]
    SubStep7 --> SubStep9[擷取影像  
→ 調整與套疊]
    SubStep8 --> SubStep9
    SubStep9 --> SubStep10[WMS 發佈]
    SubStep10 --> End[WMS 影像資料檢視]
  
```

**Video conference**

The video conference window shows four participants from different organizations: NCDR, NSPO, NCHC, and NCC. The video feeds are labeled with their names and frame rates: 頭伸運\_nspo(ketaryan) at 15.5 fps, 李正國\_國家高速網路與計算機中心 at 20.0 fps, 游輝宏\_nchc(mulderyu) at 15.0 fps, and 常若愚(stoca) at 7.5 fps.

At the bottom, the taskbar shows various application icons, and the system tray indicates the date and time as 上午 09:55, 2011/8/31.

# L1A Image Processing Flow

After Typhoon Nanmadol in August 31, 2011

This screenshot illustrates the L1A Image Processing Flow after Typhoon Nanmadol on August 31, 2011, using the Co-life system for multiple communication.

The interface shows several windows:

- Top Left:** A file explorer window showing users online, including 周冠州\_NCHC (qjg), 顏仲運\_nspo (keteryan), colife (colife), 游輝宏\_nchc (mulder), 施奕良\_NCDR (liang), 李正國\_國家高速網 (zhengguo), colife2 (colife2), and 常若愚 (stoca).
- Top Center:** A terminal window titled "taiwan02 (shared desktop)" showing processing logs for the 7th Band. The log includes commands like "End ADVPan", "GRPan", and "GainOffsetPan". It also shows coordinates and processing times.
- Middle Left:** A terminal window titled "IDIB:b bash" showing logs for the 1st Band. The log includes "GC\_out.Pos[0] = -3427794.667011" and other sensor data.
- Middle Center:** A terminal window titled "IDIB:b bash" showing logs for the 6th Band. The log includes "m\_rotl[0]: 0.985481 0.169788 0.000000" and other sensor data.
- Bottom Left:** A terminal window titled "IDIB:b bash" showing logs for the 3rd Band. The log includes "m\_rotl[0]: 0.985481 0.169788 0.000000" and other sensor data.
- Right Side:** A video conference window titled "視訊會議" showing four participants: 李正國\_國家高速網 (zhengguo), 顏仲運\_nspo (keteryan), 常若愚 (stoca), and 施奕良\_NCDR (liang). The video stream for 顏仲運\_nspo (keteryan) is highlighted.
- Bottom Right:** A clock showing the time as 11:01:43 AM on Tuesday, August 31, 2011.

Red callout boxes with labels "1st Band", "3rd Band", "6th Band", and "7th Band" point to the respective terminal windows.

**Using Co-life system for multiple communication for accelerating image processing**

2011年8月31日

# WMS Notification and Viewing Band Image

After Typhoon Nanmadol in August 31, 2011

0831南瑪都颱風即時影像處理--09:30開始

檔案 電子白板 視訊會議 桌面分享 視窗(W)

線上使用者

- 周冠州\_NCHC(jgj)
- 顏仲運\_nspo(ketaryan)
- colife(colife)
- 游輝宏\_nchc(mulderu)
- 施奕良\_NCDR(liang)
- 李正國\_國家高速網...
- colife2(colife2)
- 常若愚(stoca)

CoLife 電子白板 桌面分享 stoca-常若愚的桌面

0.27.177.4322 - 遠端桌面 Global Mapper v10.00 - REGISTERED

File Edit View Tools Search GPS Help

Atlas Shader

視訊會議 我的画面 施奕良\_NCDR(liang)

顏仲運\_nspo(ketaryan) 李正國\_國家高速網路與計算機

2.5 fps 160x120

20.0 fps 15.0 fps 游輝宏\_nchc(mulderu) 常若愚(stoca)

15.0 fps 8.0 fps

Using Co-life system for multiple communication

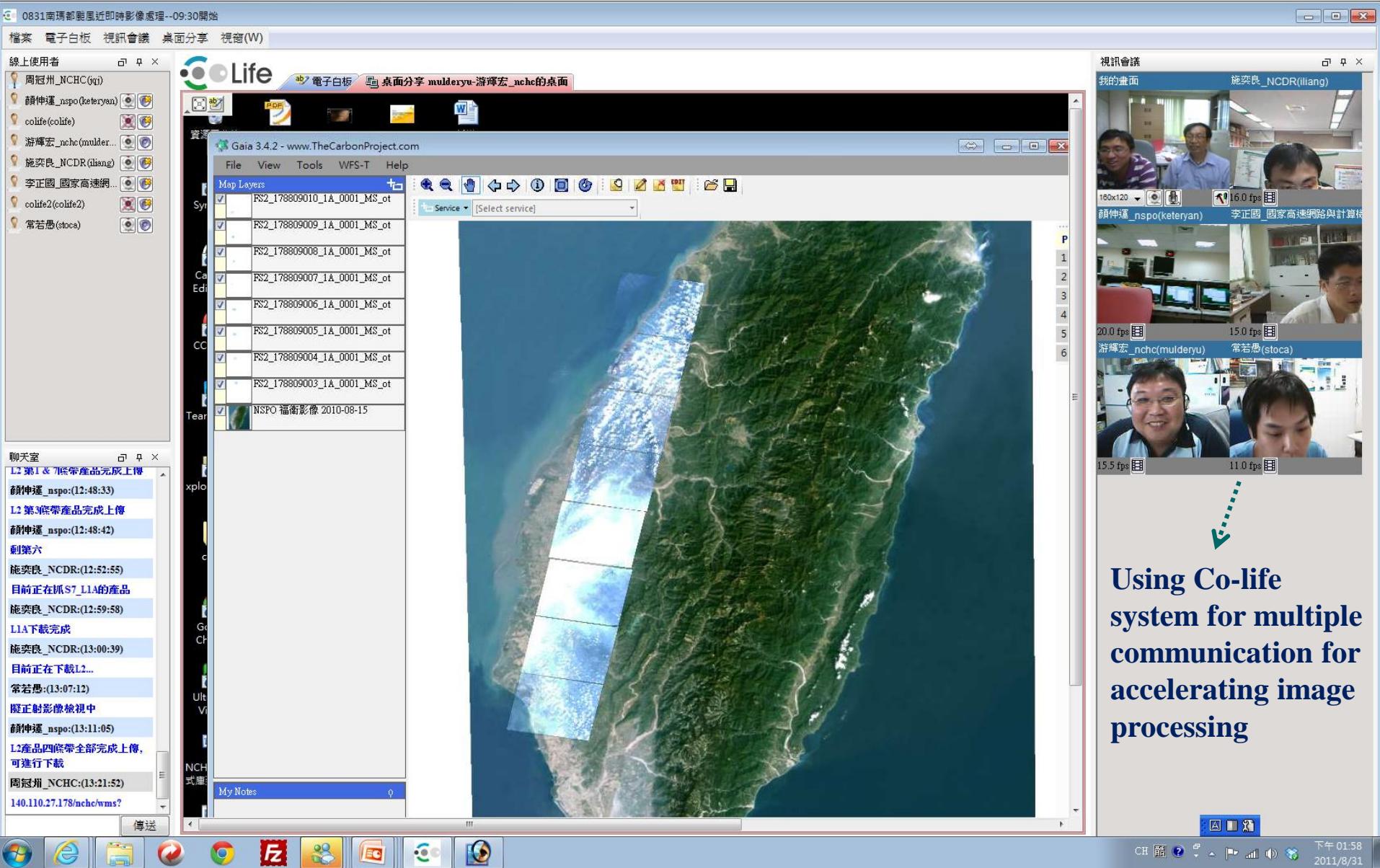
進行資料進入WMS Storage  
常若愚:(12:46:29)  
5.3GB  
顏仲運\_nspo:(12:47:05)  
L2第1&2底帶產品完成上傳  
顏仲運\_nspo:(12:48:33)  
L2第3底帶產品完成上傳  
顏仲運\_nspo:(12:48:42)  
利第六  
施奕良\_NCDR:(12:52:55)  
目前正在抓S7\_L1A的產品  
施奕良\_NCDR:(12:59:58)  
LIAT截完成  
施奕良\_NCDR:(13:00:39)  
目前正在下載L2...  
常若愚:(13:07:12)  
擬正射影像檢視中

傳送

CH 酷 ? 下午 01:08  
2011/8/31

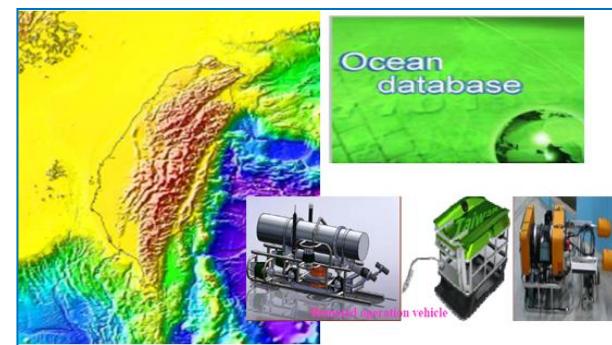
# WMS Released Image Overlaying with Taiwan Image

After Typhoon Nanmadol in August 31, 2011



# Future Development

- Following up with a 4-year NARL multidisciplinary project, **the Disaster Prevention Cloud Management**
- Multi-scale observation extended to cover both satellite and ocean remote sensing image
- Virtualization for Cloud Service
  - Improvement in Resource Utilization & Management WMS Notification
  - Customized 3D Video animation service
  - Future scale up and linking with government disaster reduction flow service



- Human-Centered hazard information integration for decision support





3D GIS Taiwan

*Thank you*