

# Geospatial Information Applications Based on Cloud Computing and Open Data

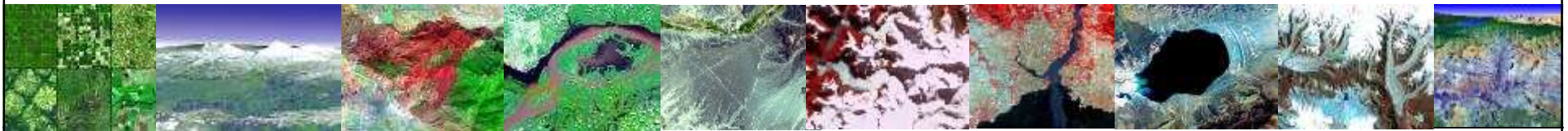
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Directorate for IT and Electronics, (情報&電子)

National Institute of Advanced Industrial Science and Technology (AIST)

独立行政法人 産業技術総合研究所



# 1. What AIST is?

- National Institute of **Advanced Industrial Science and Technology, JAPAN**
  - Supported by METI(Ministry of Economy, Trade and Industry)
    - Our Important Mission = Bridge between basic research and product development
- **Established at 2001**
  - By merging **15!** research institutes under METI
    - Electric, Machinery, Chemistry, Material, Bio, etc.
  - Many of them had 50~100 years history
    - Oldest= Geological Survey of Japan(est. 1882)

## 2. Where is AIST?

- **Tsukuba-(science)-City**
  - Planned (artificial) city created by the government
    - Started to construct 1962~> Now 50 years
  - Current Status
    - 1 university, 2 colleges
    - About 30 governmental research institutes
      - » including AIST, JAXA, KEK
    - About 30~40 company labs.
  - 60km Northeast from Central Tokyo
    - 45min with Tsukuba-Express
      - We call it “TX”:
      - 130km/h high speed commuter train



# Aerial Look of Tsukuba(in part)

Geographical  
Survey Institute

University of  
Tsukuba

Mt. Tsukuba  
876m

Aerial Tram  
or  
Funicular  
or  
Walk

Tsukuba  
Station

Geological Survey of Japan (GSJ)  
of AIST

JAXA

Japan Aerospace  
eXploration  
Agency

Information Technology Research  
(ITRI) of AIST

Our Guest  
House

AIST

## 3. What area does AIST cover?

Almost everything about science & technology 😊

– By merging 15 research labs under METI

### •6 Major research directorates



#### *Environment and Energy*

Aiming to realize a sustainable society



#### *Nanotechnology, Materials and Manufacturing*

Developing new manufacturing technologies that lead to the use of outstanding materials



#### *Information Technology and Electronics*

Toward a society where intellectual activities are accelerated with the safe use of information technology



#### *Metrology and Measurement Science*

Establishing common scales for industrial measurement and dissemination of advanced evaluation technology for administration measures



#### *Life Science and Biotechnology*

Contributing to healthy and active lives



#### *Geological Survey and Applied Geoscience*

Understanding and living with the Earth

Good for Cross-Domain  
Research



## AIST (traditional) aspects

- **Metrology:** = set/maintain the standards

kilogram calibration  
weight of japan



- **Geology:** = explore/maintain (physical) objects  
Geological museum



## Abe Administration Statement (安倍内閣宣言)

『世界最先端 I T 国家創造』宣言 - June, 2013

- ▶ Statement on “Forging the World-Leading IT Nation”

### Basic Philosophy (基本理念)

- ▶ Japan in Need of Revitalization (閉塞打破、再生日本)
- ▶ Toward the Achievement of the World-Class IT-Driven Society (世界最高水準IT利活用)

## Abe Administration Statement (安倍内閣宣言)

### Our Goals for the Future Society

1. A society that enhances the creation of innovative technologies and new services and the growth of their providers

- 增強革新的新產業・新服務的創作&全產業成長促進社会

2. The most natural disaster-proof society in the world, in order to ensure a safe and healthy lifestyle

- 健康/安心/快適生活 & 社会抗災能力/安全的世界

3. A society which guarantees that public services are available on a “one-stop” basis for anyone, anytime and any where

## Efforts to Make to Fulfill the Goals

1. Creation of innovative technologies...
  - a. Promotion to make the best use of bothe Open data and Big data
    - Open data for public, Big data for commercial usage
2. The most natural disaster-proof society in the world ...
  - a. Build resilient infrastructure of IT communication so that people are able to access related and latest information
  - b. GPS/Quasi-Zenith Satellites for positioning system
3. One-stop public services
  - a. Innovation of the government information system across both local and national government
    - “Cloud First” Concept for the system cost reduction

# G-space x ICT

# Make it all together – Need integration

## GPS/QZS

## GIS in local Gov.

### 高精度な測位環境の実現

2010年、準天頂衛星初号機打ち上げ。  
2010年代後半に、準天頂衛星の4機体制が整備

<準天頂衛星初号機「みちびき」>



### 行政におけるGISの高度利用の進展

地方自治体間で利用状況に差があるものの、一部の地方自治体において、GISを高度利用し、政策判断に積極的に活用

<富山市と浦安市のGISによる分析>



### センサーの普及等によるG空間情報の大量生成

データの収集等を可能とするセンサーの小型化・低価格化が進展し、G空間情報等の大量生成

<センサーの小型化・低価格化>



### 測位デバイスの普及によるG空間情報活用環境の向上

GPSを受信する機能を有するスマートフォン等モバイル端末の普及により、G空間情報を活用する環境が向上

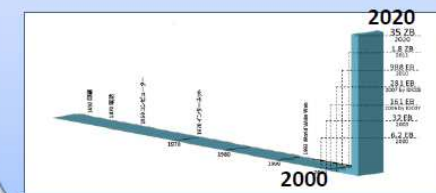
<多様な測位デバイスの普及>



### G空間情報の高度な利活用による付加価値の創出

G空間情報等のビックデータやオープンデータによる新産業・新サービスの創出

<国際的な10年間のデジタルデータの成長>



Sensors produce huge data

More handy devices

Add new value

出典：総務省 G空間XICT推進会議

# Geospatial Information Open Data Platform (idea)



出典: 総務省 G空間XICT推進会議

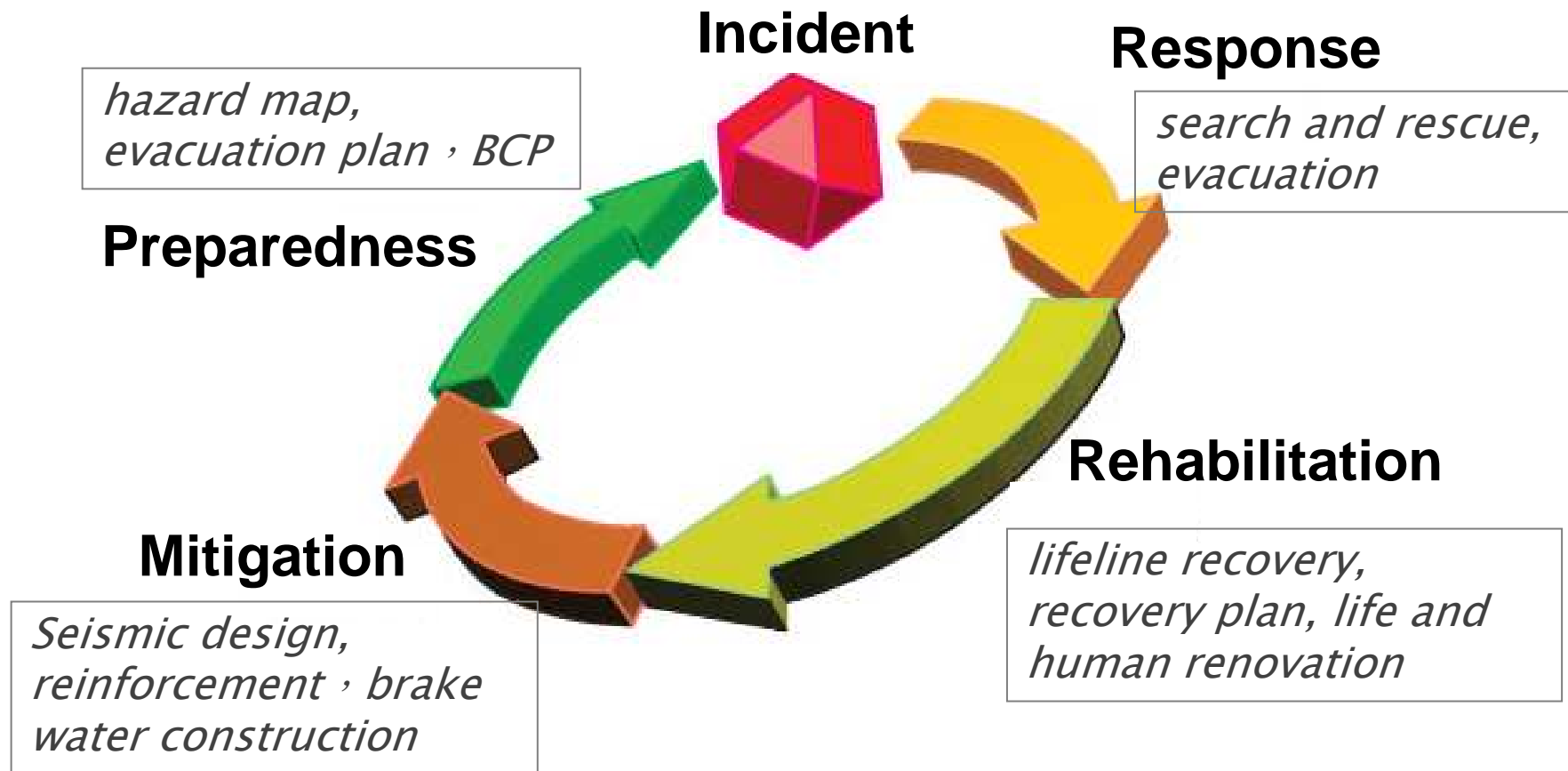
# Vision: Disaster management system by ICT



出典: 総務省 G空間XICT推進会議

# GEO Grid

# Disaster Management Cycle





## What is GEO Grid?

**GEO= Geospatial**

**Grid = Grid(cloud) Computing**

***e-Science infrastructure on heterogeneous data archives.***



<http://www.geogrid.org>

- Cross-Domain (joint) project from 2004(almost 10 years)



- **Core archive contents: Our Satellite Sensor Data**
  - ASTER satellite images >= 200TB(2000,000 scenes, y2000->)
  - Now extending to manage (Petabyte-Scale) PALSAR,PRISM,Landsat8 etc.
- **Core technologies: Grid Based => Parallel/Distributed R&D**
  - Distributed file system: Gfarm(started at AIST, Now at Tsukuba-U)
  - Database Integration: OGSA-DAI@Uk /Distributed SPARQL
  - Tsukuba-GAMA: Integrated Credential(Authentication) Management(some codes are included in MyProxy)



# GEO Grid Services for Disaster Management

## Satellite Imagery

- ▶ Optical , Radar , DEM, etc.
  - Ⓞ Preparedness: Vulnerability evaluation
  - Ⓞ Response: Damage detection

## Geoscientific Maps

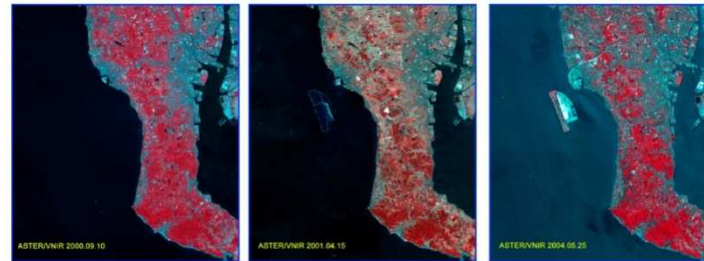
- ▶ Geology, Active Fault, Gravity, etc.
  - Ⓞ Rehabilitation: Reconstruction Planning
  - Ⓞ Mitigation: Soil condition for built environment

## Hazard Information

- ▶ Shake Map, pyroclastic flow simulation
  - Ⓞ Preparedness: Hazard mapping
  - Ⓞ Response: Damage estimation

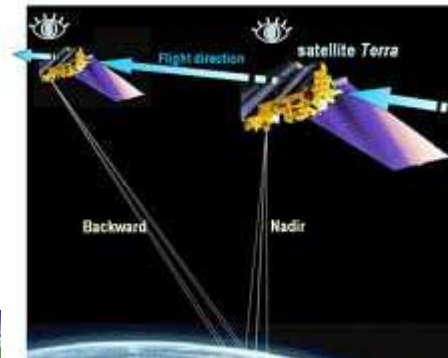
## What is ASTER?

- Japan-made sensor on NASA Terra satellite (2000~)
  - Resolution(Mid-range):15m(VNIR),30m(SWIR),90m(TIR)/px
  - 60km wide
    - 50~60GB daily Level 0 data transfer from NASA to JAPAN
  - Observe the same area for every 16 days.
    - Good for detecting long range change(= large computation)
      - Urban development. Desertification

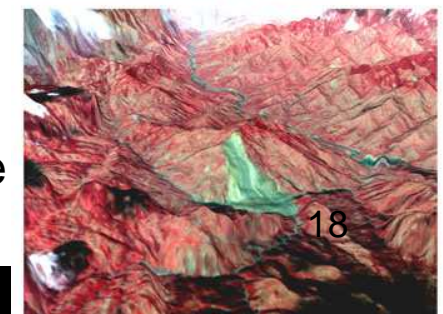
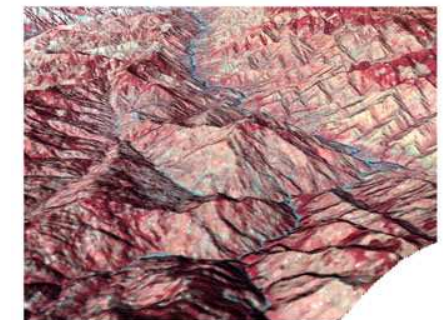


- 2 cameras with different angles

- Can create DEM(Digital Elevation Model) by stereo matching



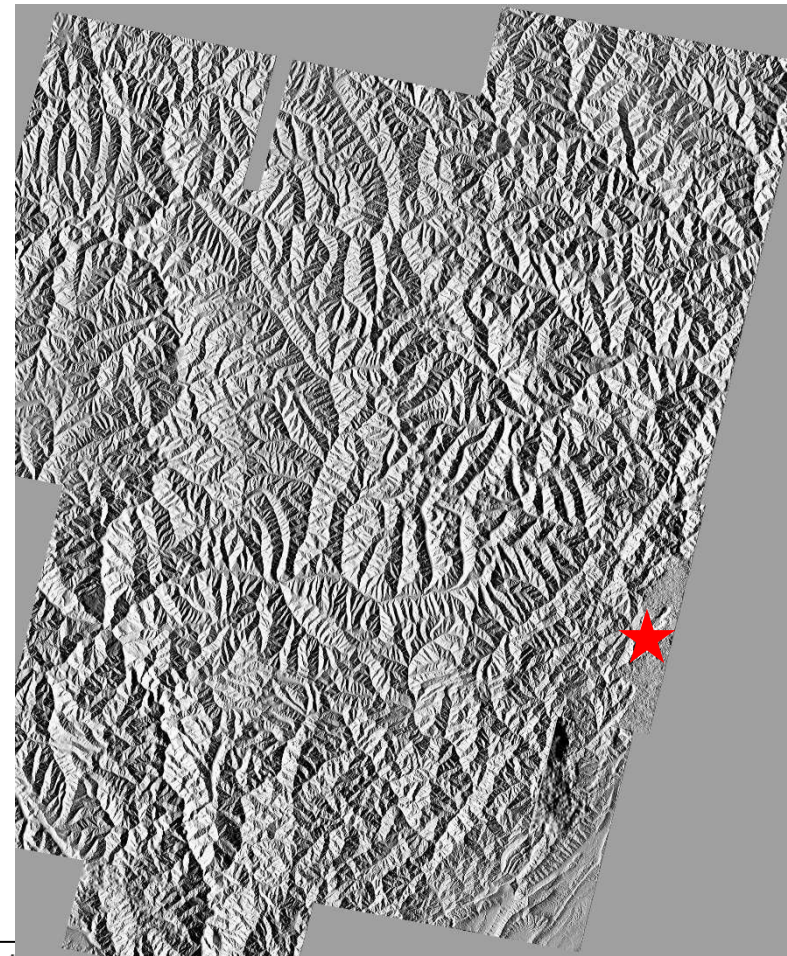
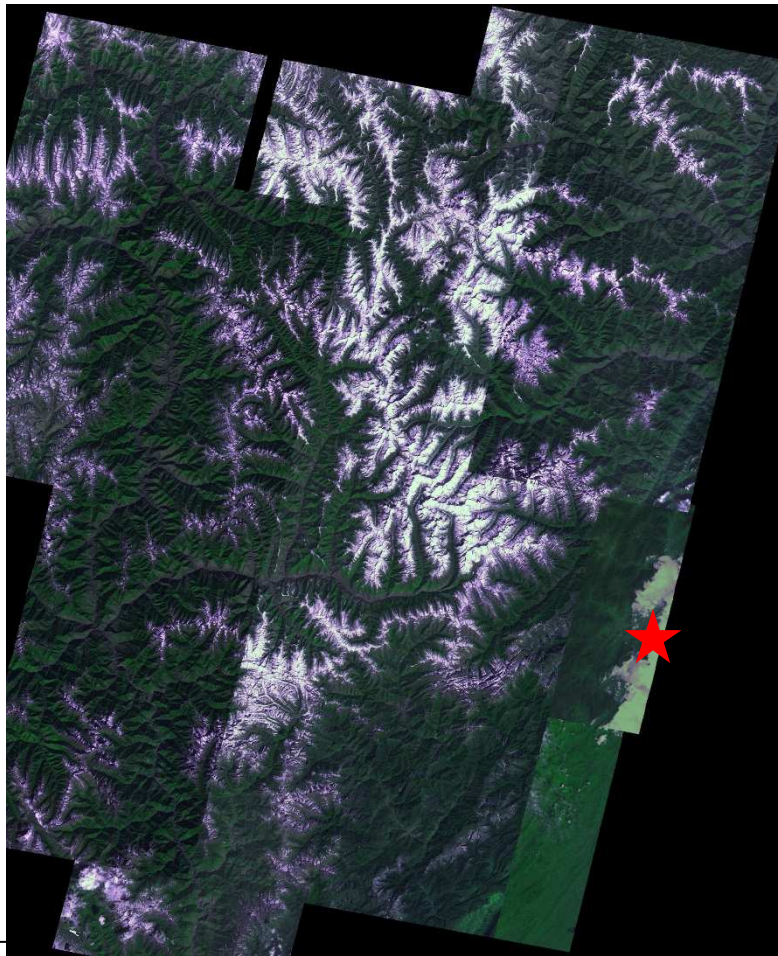
DEM of Pakistan Landslide  
2005



# Vulnerability Evaluation: ASTER Image and DEM

The 2008 Sichuan earthquake, China

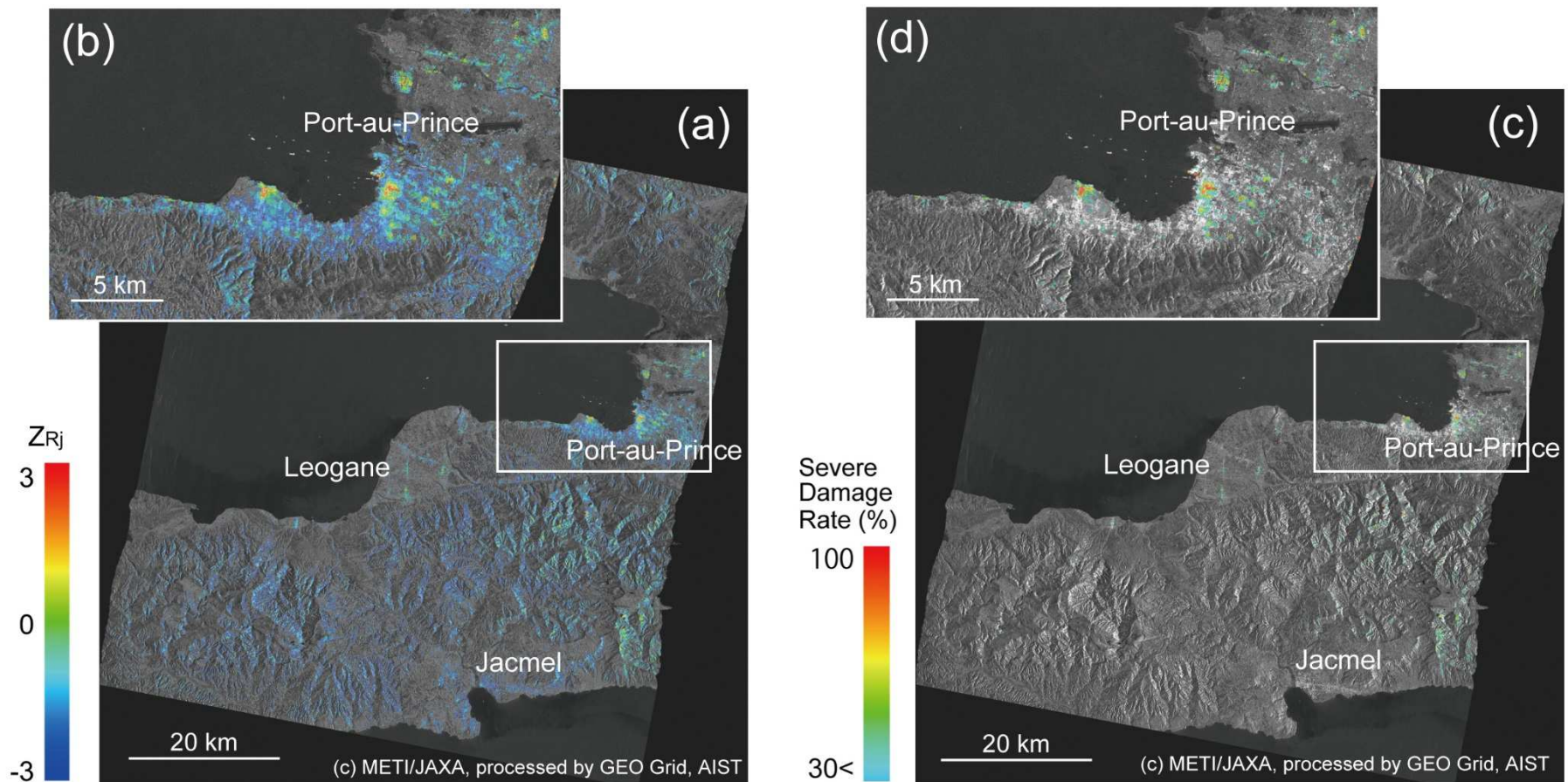
Pre-event ASTER data (15m resolution)



# Response: Damage Detection

The 2010 Haiti earthquake

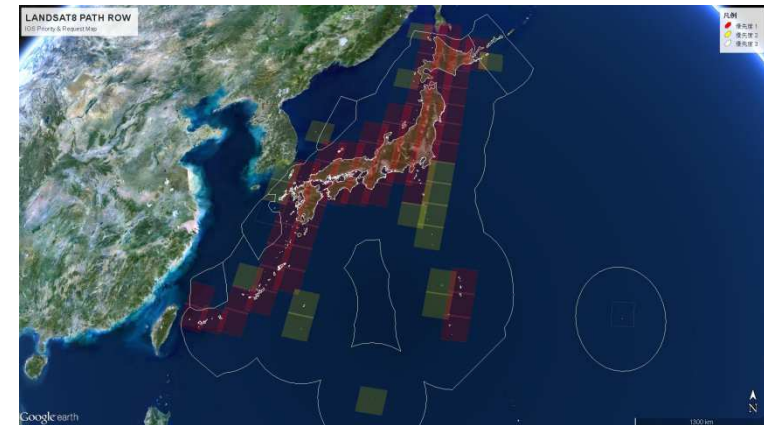
Change detection and building damage ratio estimated from pre- and post-event PALSAR images



## What we are doing/thinking now are

### 1. Plan to archive Landsat-8

- launched this Feb.
- Receive japan area directly from the satellite and send the data to USGS  
Daily  $\approx$  20GB data transfer from Antenna to AIST and AIST to USGS
- We will publish our own archive



We(and OSDC) are archiving many satellites

### 2. Multi-satellite data integration -> constellation

Example: ASTER and Landsat7 take a same orbit path with 25min time difference  
= You can find just 25min difference(15m~30m object)

More satellites, more interesting results.

Possible Collaboration with  
NARL/OSDC

21

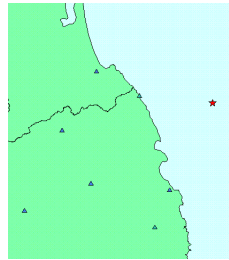


## Heterogeneous Data integration Example using GIS Data@GEO Grid

GEO Grid Application Example:  
Quick Estimation System for Earthquake Ground Motion Map

Seismic  
Sensor Data  
(NIED)

Real-Time  
Diverse

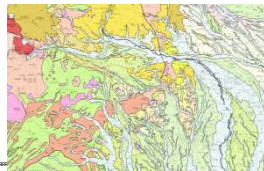


Distributed  
Data  
Integration

High  
Performance  
Computing

Geological  
Map (GSJ)

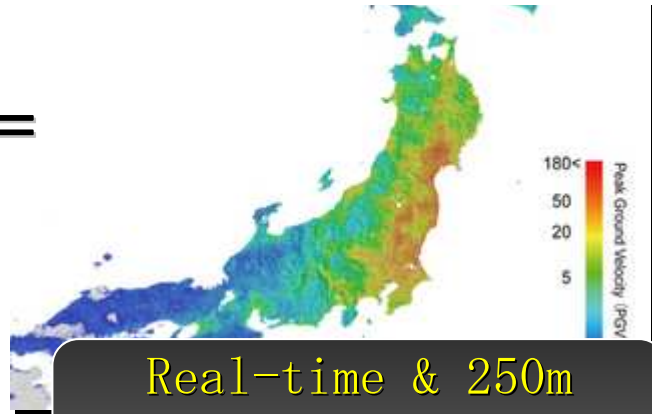
Static  
250m mesh



Internet Service  
QuiQuake

<http://qq.ghz.geogrid.org>

Propag.  
- Tohok



Real-time & 250m  
resolution  
Information

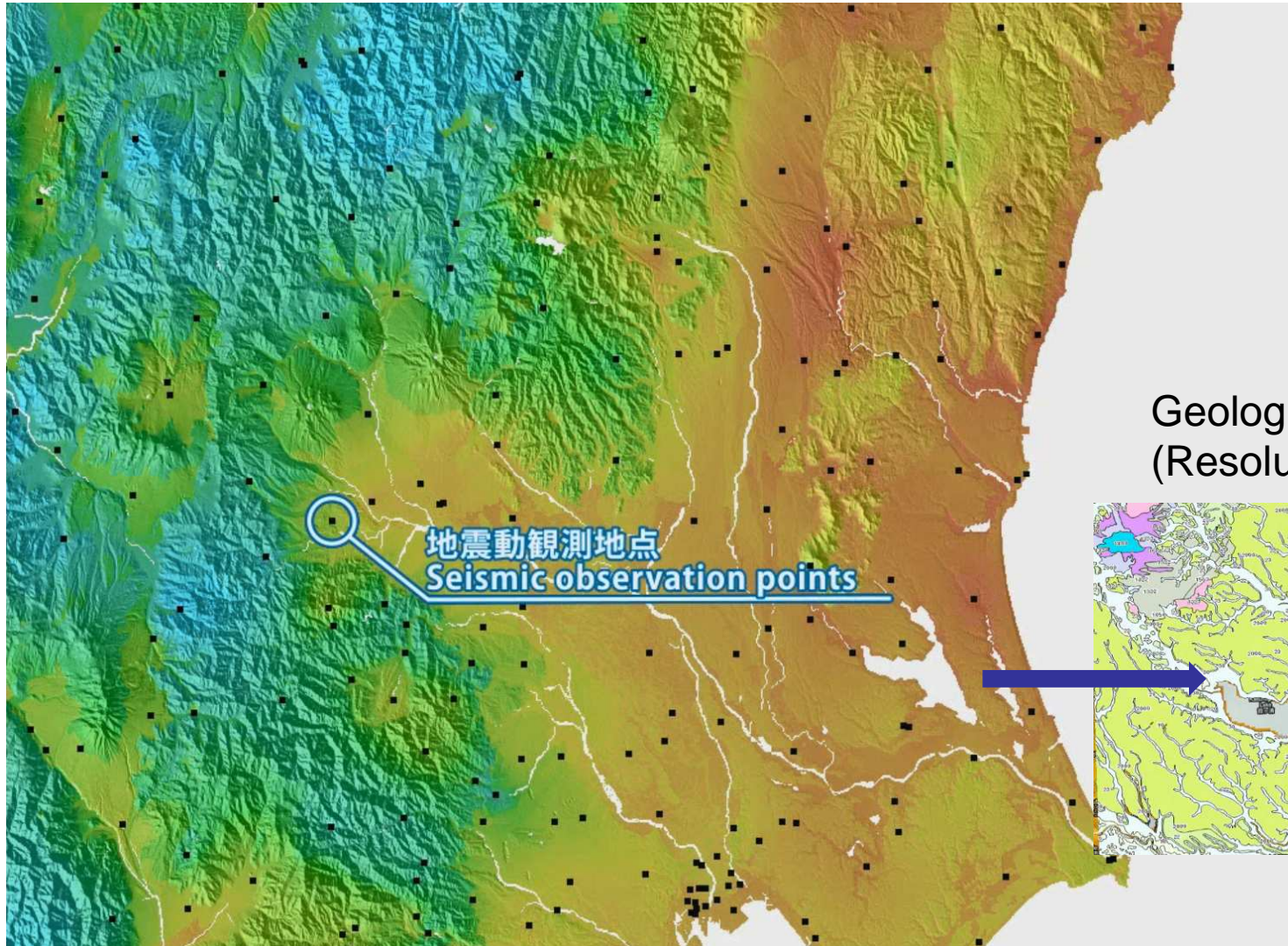




# GEO Grid

Grid-based e-infrastructure for geosciences

Close look at QuiQuake Map = large scale computation

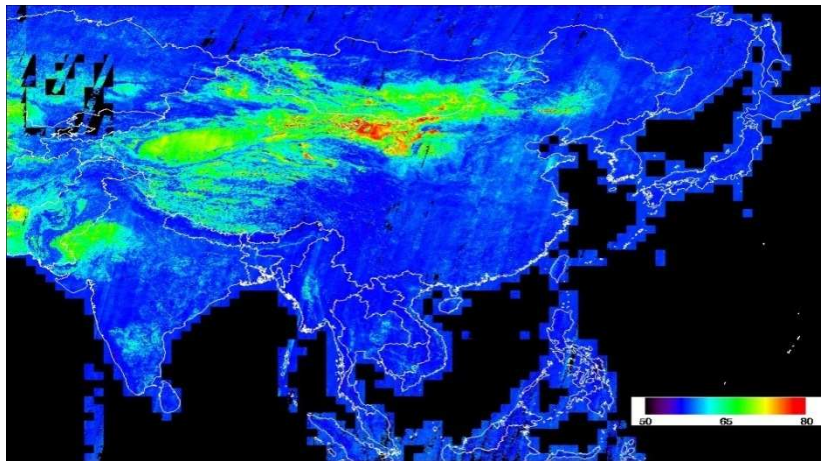


Geological Map  
(Resolution 250m/px)

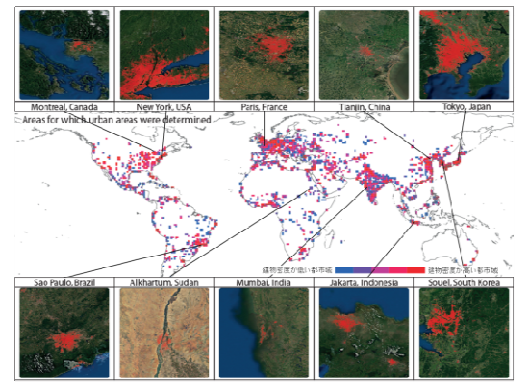


## Other GEO Grid Result Examples

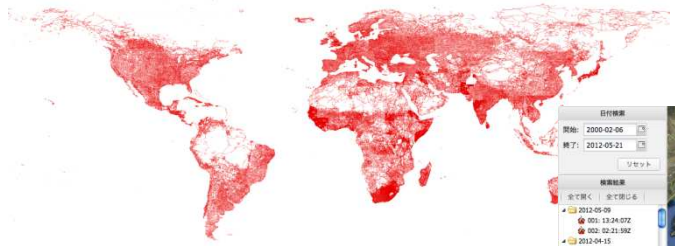
SiO<sub>2</sub> Detection from ASTER



Urban Area Detection from ASTER/PALSAR



Road Detection from ASTER



HotSpot Alert System from ASTER

**Scene information**

VNIR	TIR	Links
		<a href="#">KML</a> more detail

**Event information**

VNIR	TIR	LandCover	Other Links
			<a href="#">KML</a> <a href="#">Compare Images (V/T)</a> <a href="#">Time Series</a>

Radiation Monitoring after 3.11 (Sensor Fusion)

**WMS Time Series Control**

WMS Time Control

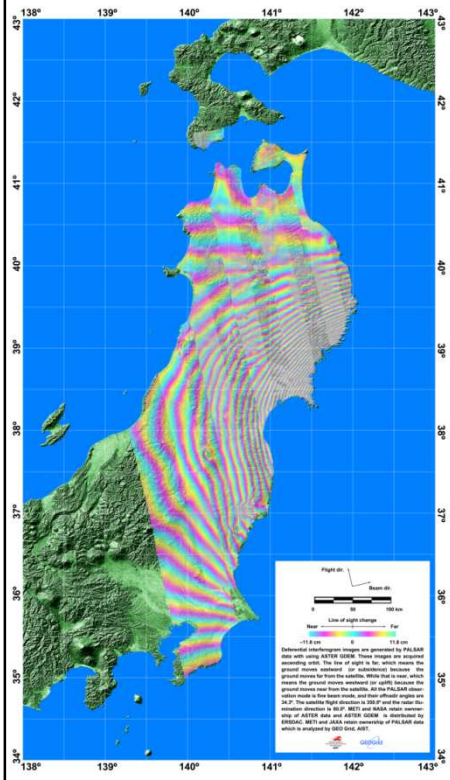
2011-03-20T23:30:00 to 10 mins

**Radiation WMS Layer Opacity Control**

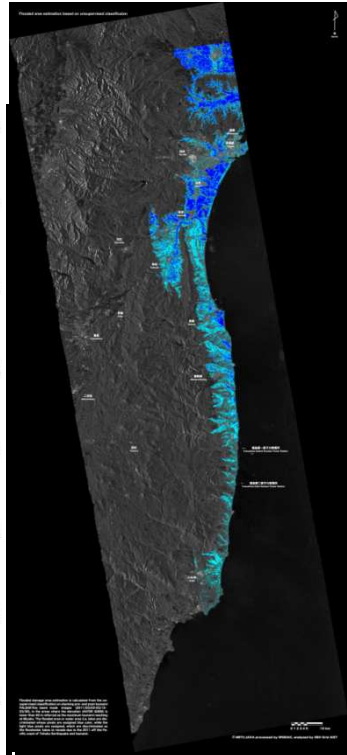
Make KML

# 3.11 data examples produced by the GEO Grid

Ground move with radar(SAR) satellite



Flood simulation

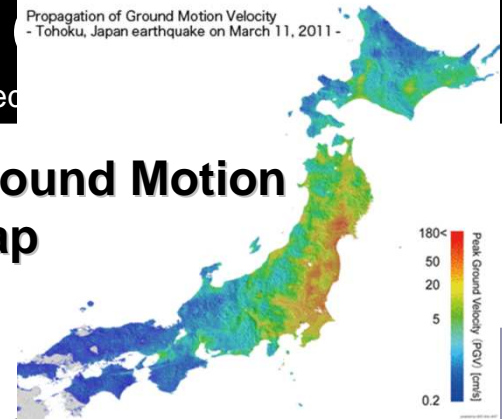


ASTER images with 3D DEM



Grid-based

Ground Motion Map

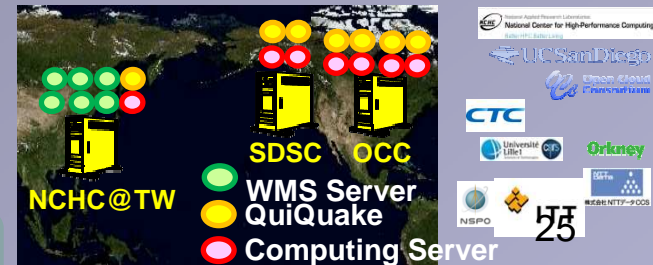


GEO Grid archive/cluster is also damaged by 3.11 earthquake



We evacuated our environment with the help of OCC/SDSC/NCHC etc. and created these data

International collaboration



# GEO Grid Disaster Response Task Force

## - Requirements and solutions-

- **Redundancy**: Migration of data processing and distribution functions of the GEO Grid to external servers and Cloud system seeking stabilized and redundant operations
- **Rapidity**: High speed automatic data processing using high-performance computers
- **Standardization**: Most of the geographic information is open to the public as Web Map Service (WMS) and KML (KMZ), which are international standards for geographic data.

# Time-line of Activity (1)

月日	内容	詳細
Mar 11	Occurrence of Earthq.	GEO Grid services stop
Mar 14	GEO Grid disaster TF Establishment	Support by private companies, research inst., universities worldwide
Mar 15	Start of data transport and migration of processing codes	ASTER and PALSAR from ERSDAC Computer and WMS in Orkney Portal site in Google group
Mar 19	HP open and WMS start	ASTER and PALSAR, damage interpretation, QuiQuake(manual)
Mar 21	Start of data transport	Formosat-2 by NSPO (via JAXA)
Mar 25	Geological maps in WMS	・ Seamless geological map, active fault, and geochemical map
Mar 31	Value-added-ASTER	Natural color, orthorectification, automation
Mar 31	CS-W deployment	WMS list

# Time-line of Activity (2)

date	内容	詳細
Apr 1	QuiQuake open	QuiQuake (automatic)
Apr 20	Value-added-PALSAR	Crustal deformation by InSAR
Apr 21	Services move abroad	NCHC (NARL-Taiwan), SDSC (UCSD), OCC (Univ.Chicago)
Apr 28	GEO Grid cluster resume	
May 24	ASTER/AIST service resume	Data publication to research users
May 27	QuiQuake/AIST resume	
June 30	PALSAR/AIST service resume	

1.3 million WMS access (Mar 20~Apr 20)

supported by NARL|NCHC|NSPO, UCSD|SDSC, OCC, Orkney, ERSDAC, NTT-data-CCS, CTC, Univ. Lille, and ITT

# Website <http://disaster-e.geogrid.org/>



The screenshot shows a web browser window with the URL <http://disaster-e.geogrid.org/>. The page title is "GEO Grid 災害対応タスクフォース". The main content area features a section titled "Tohoku Pacific Ocean Earthquake and Tsunami (2011.3.11)" with a search bar and a "Search this site" dropdown. Below this, there is a "contact:" section with the email [geogrid\\_query@m.aist.go.jp](mailto:geogrid_query@m.aist.go.jp) and a "WMS" section with a "Service List" and a "Viewer" button. A "Disaster Related Info:" section lists links to "QuiQuake", "Geological Survey of Japan", "Road Traffic Performance", "TokyoPowerHeart", and "more". A "Links:" section contains logos for GEOGrid, GSI, ITRI, and AIST. The main text describes the GEO Grid's role in providing satellite imagery and ground motion maps for disaster response and research. A "Propagation Animation of Ground Shaking" section includes a "Subscribe to posts" button and a "posted May 10, 2011 9:07 AM by Masashi Matsuoka [ updated Jul 16, 2011 12:07 AM ]" notice. A map of Japan shows the propagation of ground motion velocity from the Tohoku earthquake on March 11, 2011, with a color scale from 0.2 to 180 cm/s.

**GEO Grid 災害対応タスクフォース**

**Tohoku Pacific Ocean Earthquake and Tsunami (2011.3.11)**

The Global Earth Observation Grid (GEO Grid) under AIST offers satellite imagery which observed the stricken area, geological maps, and hazard information, including a strong ground motion map based on observation records of seismic networks and geomorphologic conditions in Japan.

The information will help those working on the emergency response, researching the tsunami and structural damage, and engaged in the restoration and rehabilitation of civilian life and economic activities.

Most of the geographic information is publicly accessible as Web Map Service (WMS) and KML (KMZ), which are international standards for geographic data. The latter file is also compatible for viewing on Google Earth and other GIS platforms.

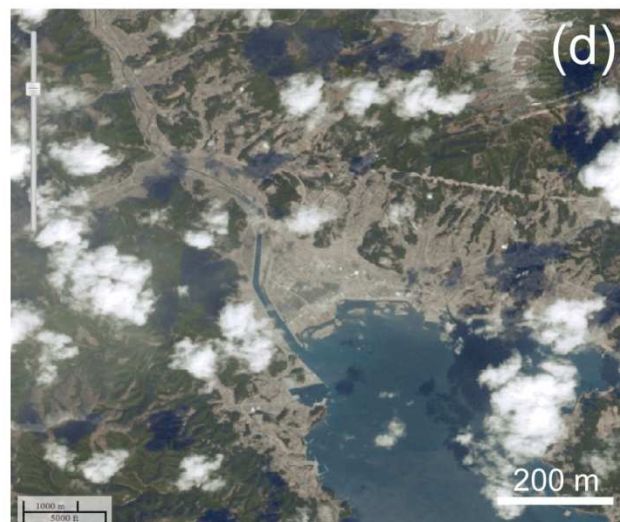
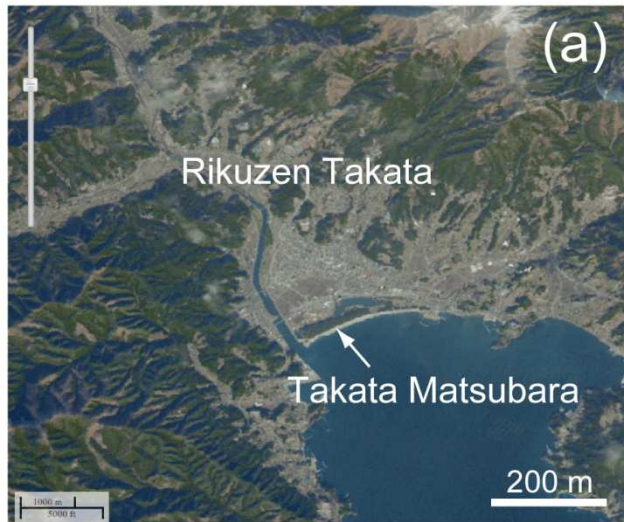
[Subscribe to posts](#)

**Propagation Animation of Ground Shaking**  
posted May 10, 2011 9:07 AM by Masashi Matsuoka [ updated Jul 16, 2011 12:07 AM ]

Propagation of Ground Motion Velocity - Tohoku, Japan earthquake on March 11, 2011 -

The animation of seismic intensity (ground velocity) featured a distribution of over 5 m/s

# ASTER Comparison Before and After Tsunami



(a) 2008/12/25

(b) 2011/3/14

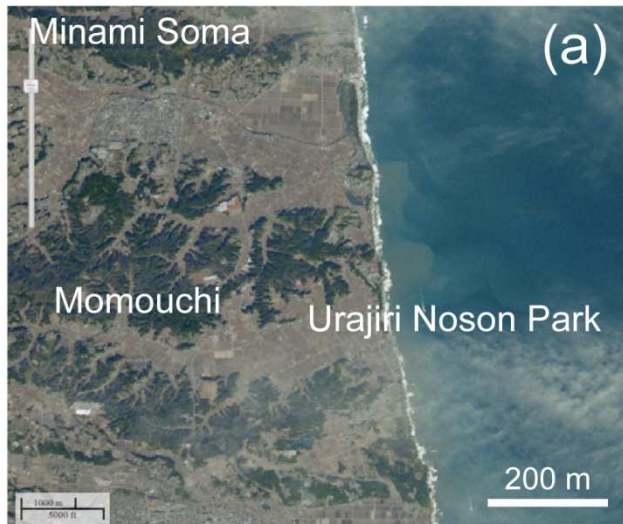
(c) 2011/3/19

(d) 2011/3/28

Rikuzen-takada

The tsunami reached a very deep part of the bay and changed the shape of the coastline.

# ASTER Comparison Before and After Tsunami



(a) 2008/12/25

(b) 2011/3/14

(c) 2011/3/19

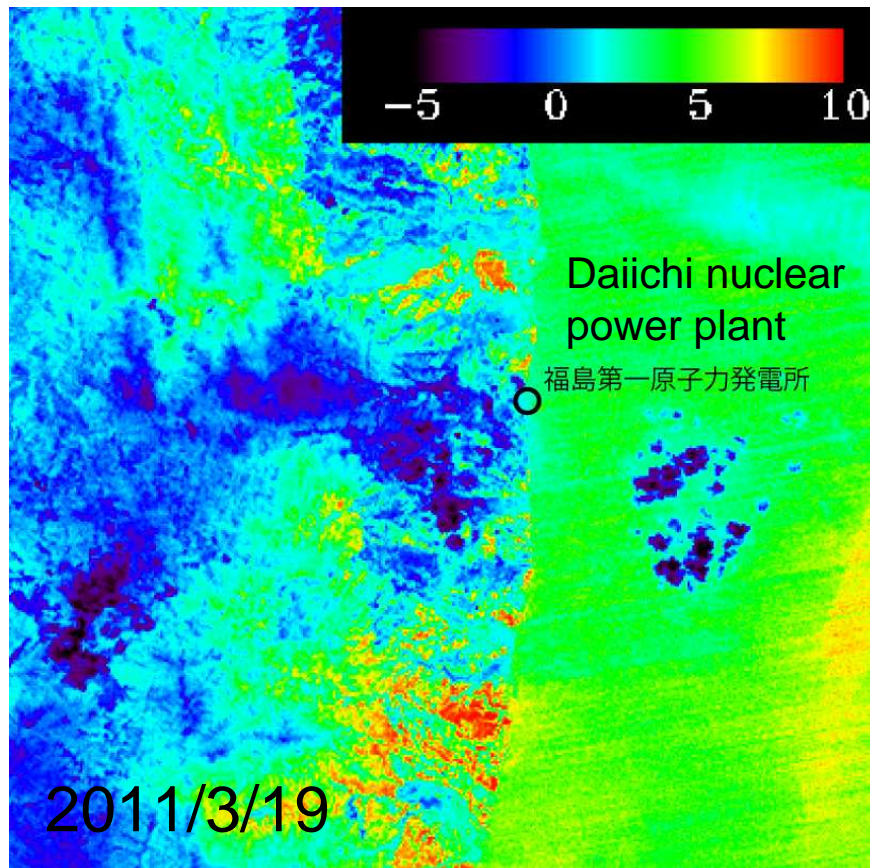
(d) 2011/3/28



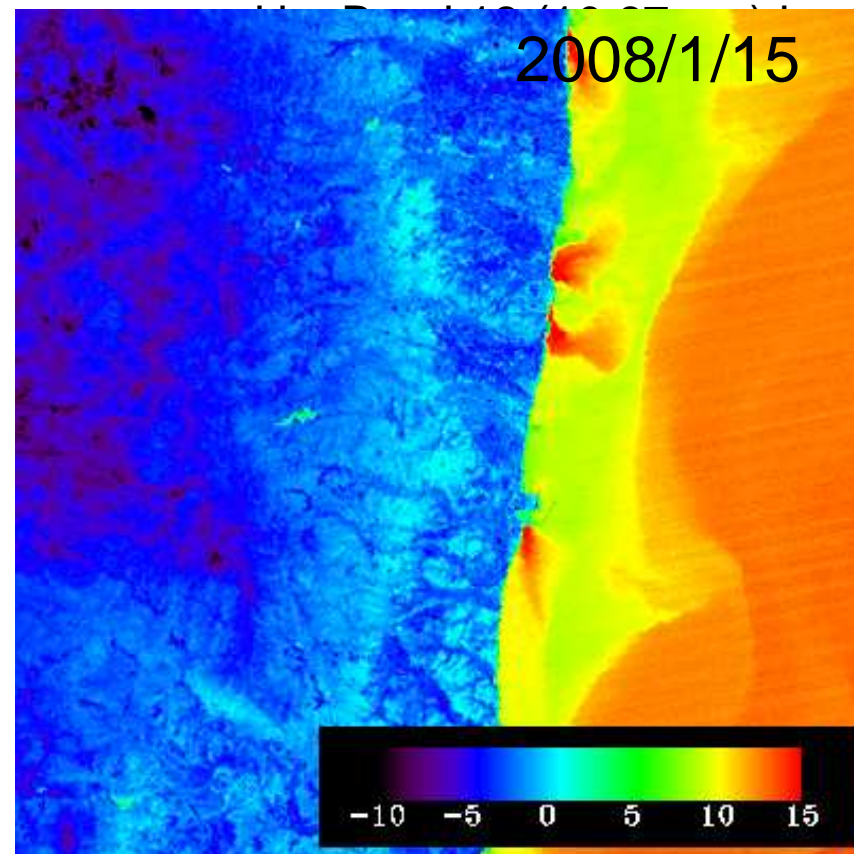
Minami-Soma

Considerable erosion and remaining water, even two weeks after the earthquake

# ASTER Night-time Thermal Image Covering Fukushima

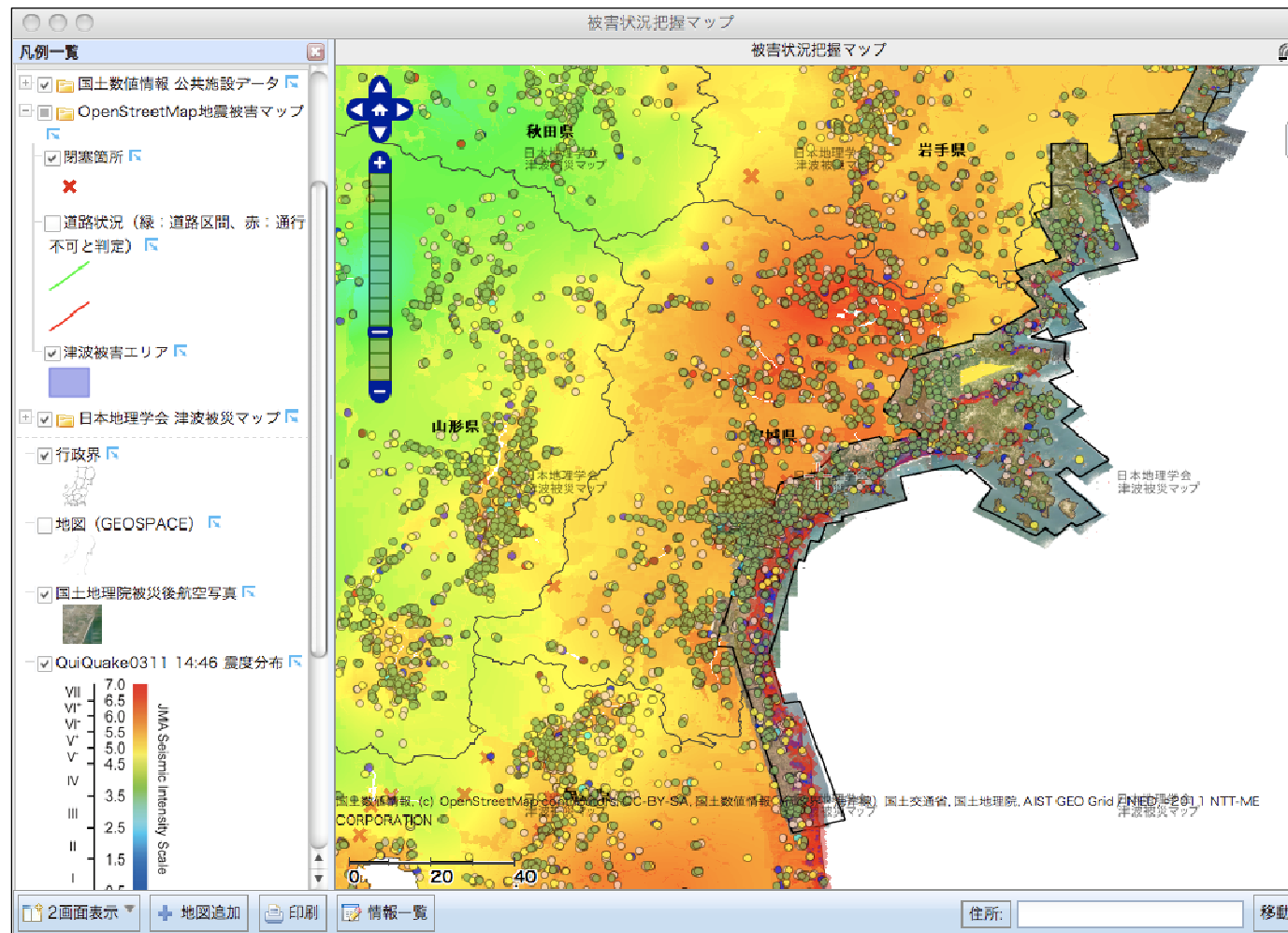


This ASTER night time thermal image covering Fukushima shows the Daiichi nuclear plant as observed by ASTER. The amount of heat radiation as



© METI/NASA processed by ERSDAC,  
analyzed by GEO Grid AIST.

# Utilization of GEO Grid Contents by Other Portal



ALL311 activity operated by NIED (<http://all311.ecom-plat.jp/>) utilizes GEO Grid and other contents through WMS.

# Platform for data integration and mashup

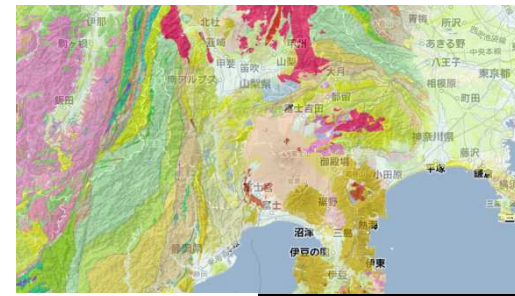


## Data Integration Quiz (**Don't ask Google**)

What knowledge can be obtained by integrating following data?

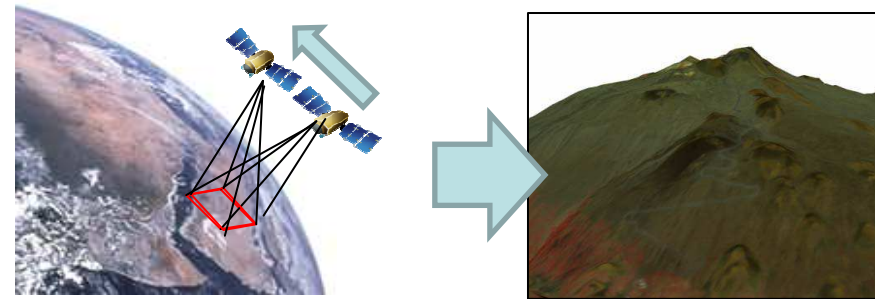
### 1. Geological Map

- Geological Survey of Japan is a part of AIST
  - sedimentary rocks,
  - volcano rocks,
  - granitic rocks etc.



### 2. 3D Elevation Model

- Created by our ASTER Satellite
  - Produce 3D-model by stereo-matching



### 3. Real Time Rain Sensors

- Provided by JMA(japan meteorological agency)

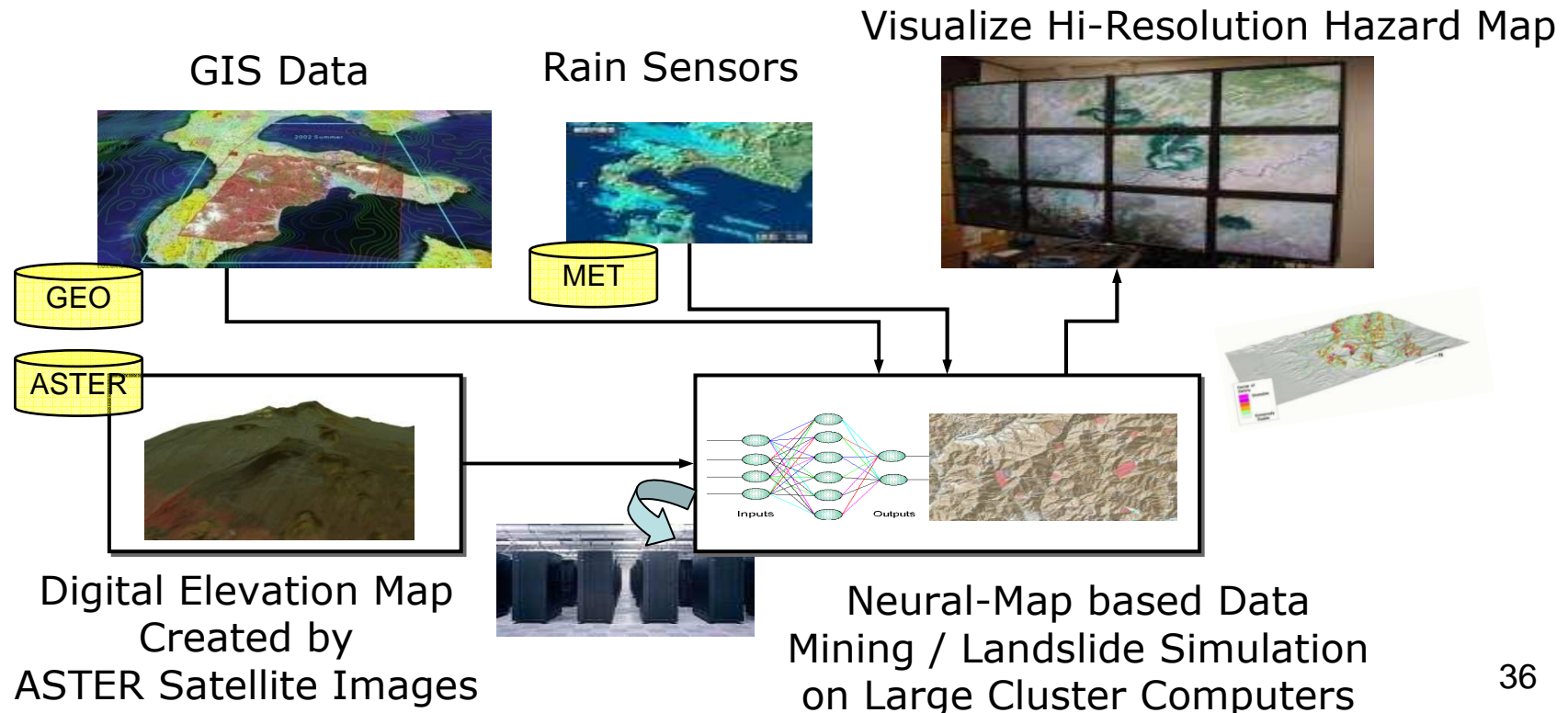


## Answer: Hazard Map for Landslide

(One typical application of GEO Grid)

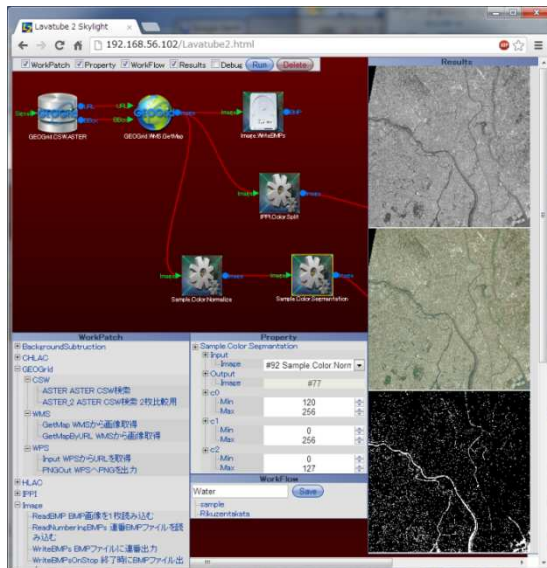
### Key R&D Technologies

1. Distributed Database Integration (Linked Open Data/OGSA-DAI etc.)
2. Data Mining & Simulation on the Cloud (Neural-Net)
3. Multi-Screen Visualization (Tiled Wall Software)

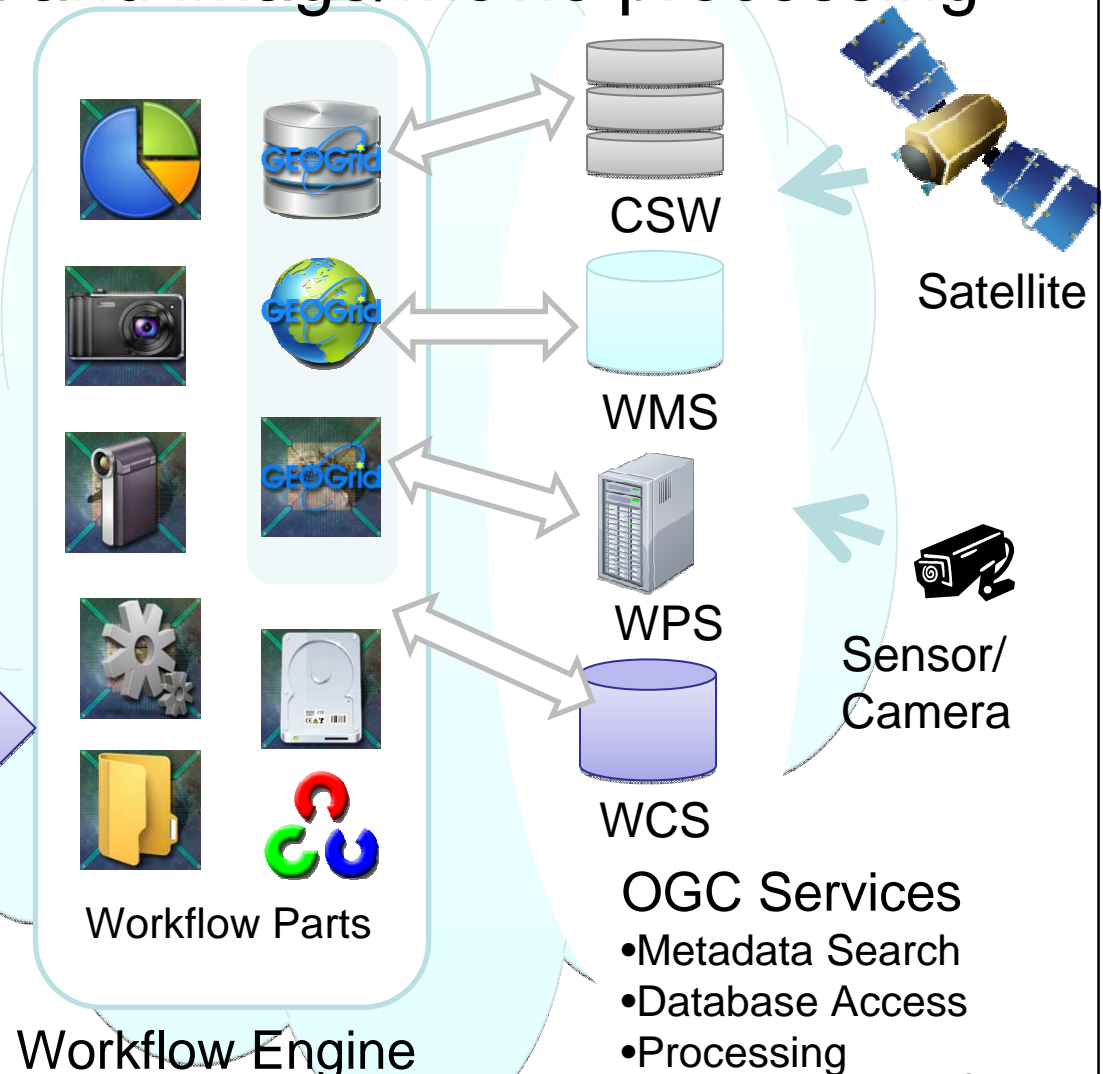


## Our yet another Workflow Engine: **Lavatube** for spacio-temporal data and image/movie processing

1. Support rest-based OGC (OpenGeospatial Consortium) services
2. Support various image/movie processing modules
3. Provide High-Level interaction



Browser Interface(HTML5)  
or Windows engine





# GEO Grid

Grid-based e-infrastructure for geosciences

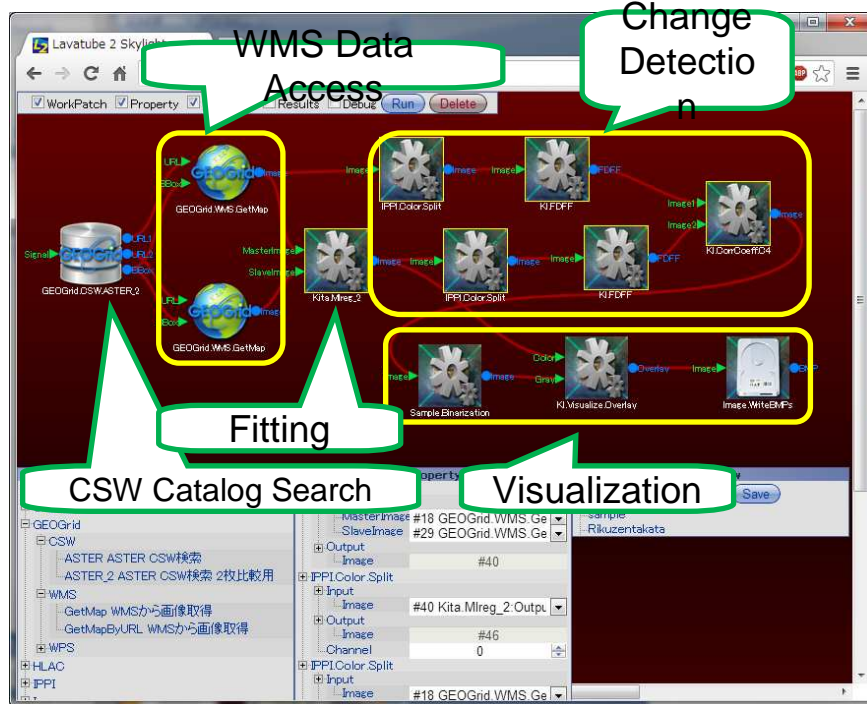
## Example: Change Detection Application of GEO Grid

1. Metadata Search(OGC CS-W) for a specific area
2. Data Acquisition(OGC WMS) for 2 satellite images
3. Position/Color Fitting of satellite images
4. Change Detection
5. Visualization (on browser /google earth)



3.11 Damaged Area (Rikuzentakada City)

Construction of Temporal Residential Space on High ground area



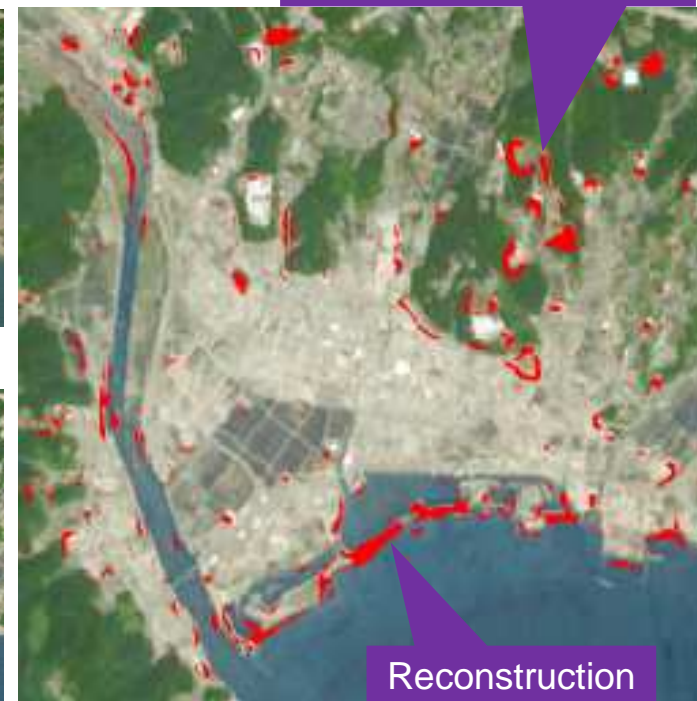
Workflow constructed with Lavatube



2011.06



2012.06



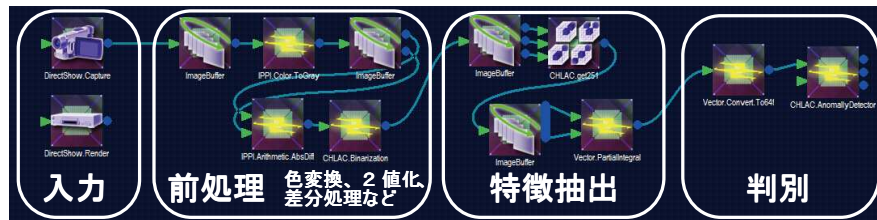
Result

Reconstruction of Breakwater

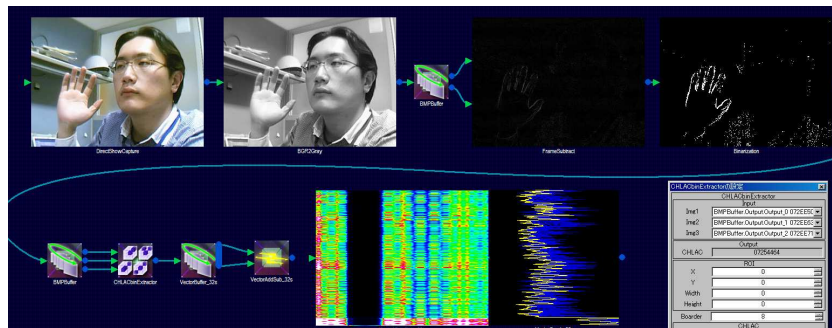


## Features of Lavatube

### Data-flow GUI



### Visualize Execution Status



Easily understand what is happening

### XML based workflow representation



```
<?xml version="1.0" encoding="UTF-8" >
<root>
<DirectShowCapture>
<Input>
<Signal>01D8BCA4</Signal>
</Input>
<Output>
<BMP>01D8C5C0</BMP>
</Output>
<DeviceNumber>1</DeviceNumber>
<CaptureSize>
<Width>640</Width>

```

XML Representation of a Workflow

### Rich Image Processing Units

More than 100

Covers OpenCV functions

### Create Dialog Box Dynamically

Parameter::Cnt width;  
Parameter::Cnt height;  
Parameter::CSize size;

パラメータ変数

普通の変数と同じ感覚で扱える



設定ダイアログを動的生成

No Interface Builder

# Summary

- Japan has proclaimed strong push on geospatial Information (G-空間)
- The most natural disaster-proof society in the world, in order to ensure a safe and healthy lifestyle
- Geospatial Information Open Data Platform is needed for promoting creative business
- GEO Grid – experienced platform made of standards

