



# Know your Researcher @ Asian Institute of Technology



Edition December 2010 : Dr Kiyoshi Honda

# Ubiquitous Geoinformatics

Dr. HONDA Kiyoshi

RS & GIS Field of Study

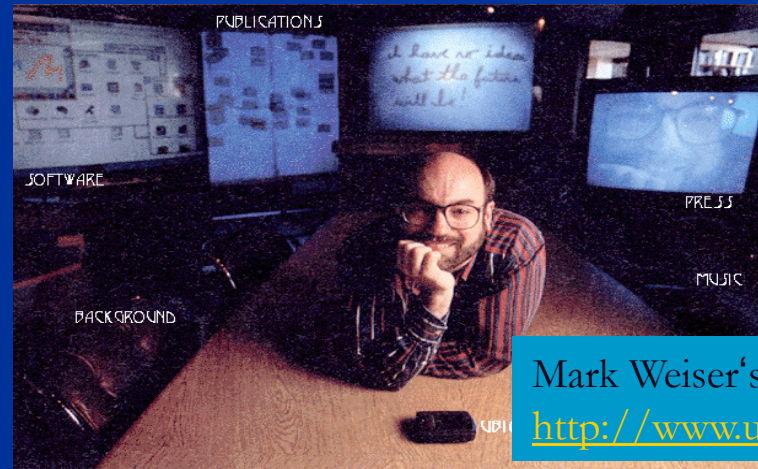
School of Engineering and Technology

AIT

# Ubiquitous

- Exists Everywhere Next to You –  
Computing / Network

Computers and Sensors, which exist everywhere like air and may not be seen, are communicating each other and support our life



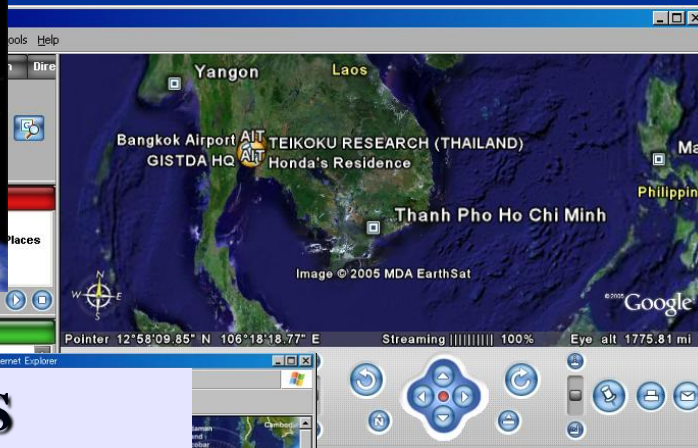
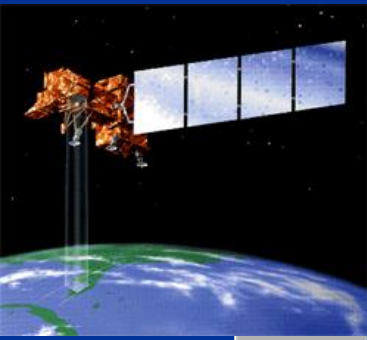
Mark Weiser's home page, Ubiquitous computing  
<http://www.ubiq.com/weiser/> 1988

# Ubiquitous Geo-informatics

supports our life from global, local to personal phase.

We can publish/access/utilize geospatial information from anywhere real time with other ubiquitous resources;

Mobile Internet, PDA, Sensor, HPC and etc.



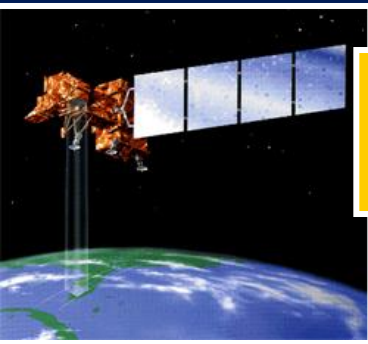
Man Navi  
More LBS



Sensor Network

# Research Framework

Integrate RS, Field Sensor Network, Real Time Geospatial Data on Web.  
Calibrate Models and Simulate Scenarios using High Performance Computing



RS: Local - Regional-  
Global

Sensor  
Network

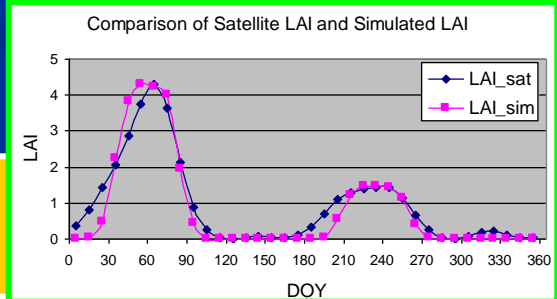


Web GIS for Data Sharing

Real Time  
Mapping

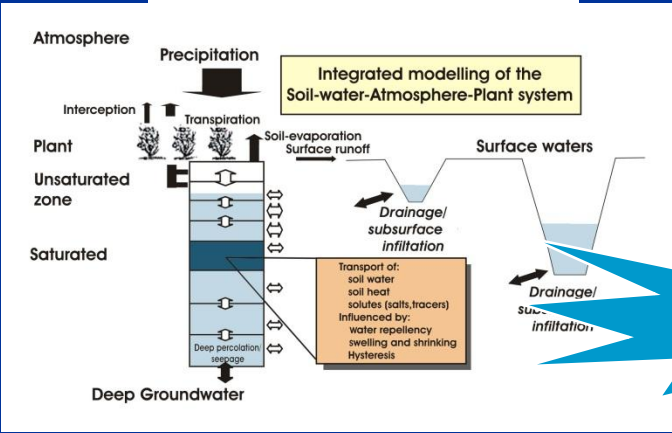


Model  
Calibration



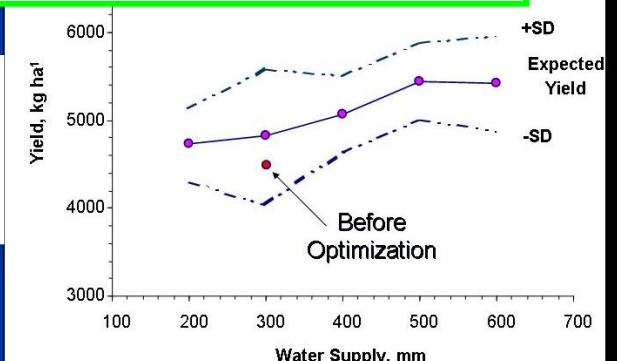
Model

HPC (GPGPU,  
Cluster, GRID)



Scenario  
Simulation

Real Time



# Contents

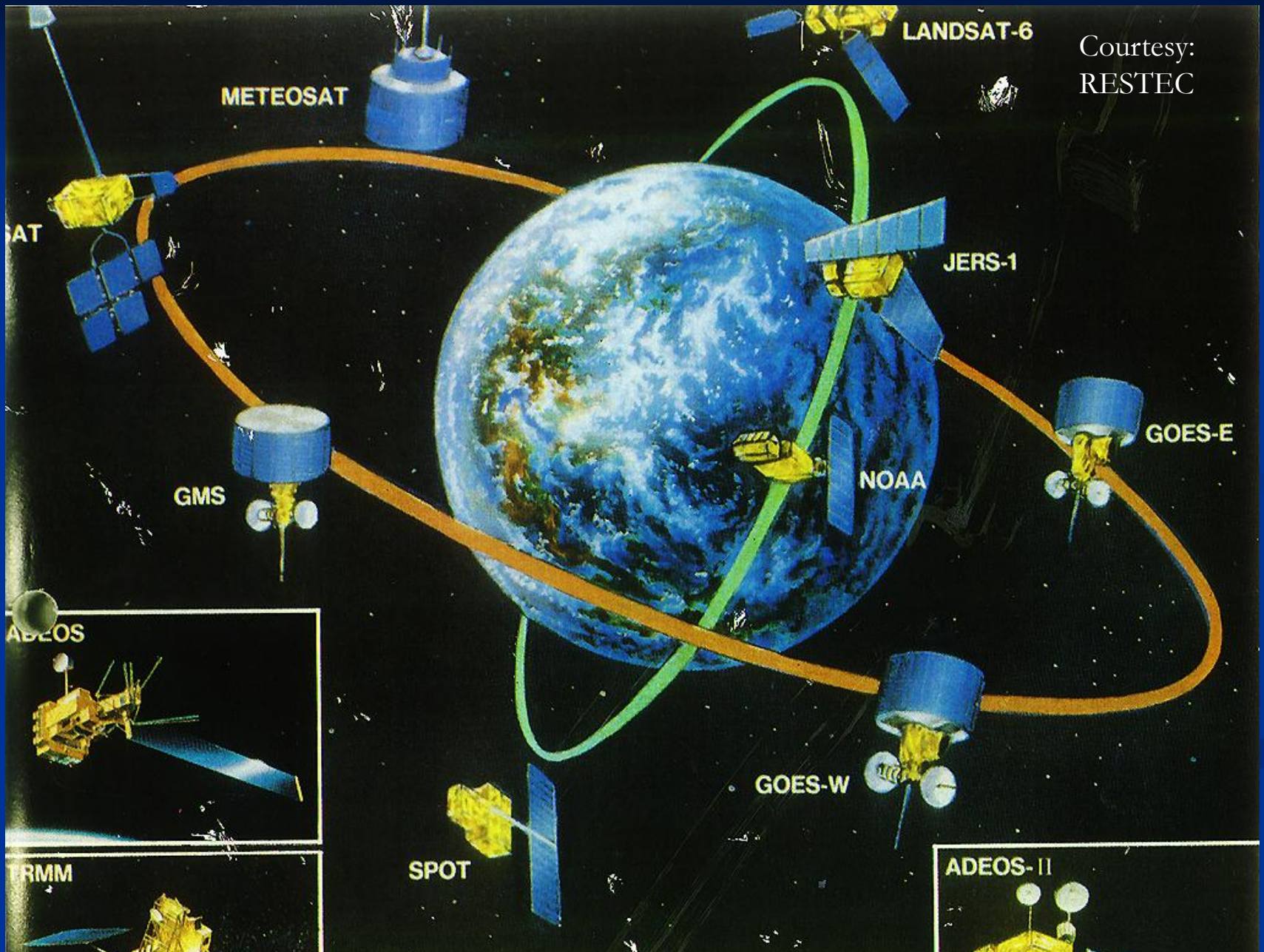
## ■ Topics

- Satellite Remote Sensing Overview
- Field Sensor Network
- Real Time Mapping
- Web GIS
- Modeling and Simulation, Data Assimilation
- High Performance Computing

# Satellite Remote Sensing Overview

Acquiring Near Real Time  
Information on Earth

# Polar Orbit Satellite and Geostationary Satellite





# Several Important Numbers

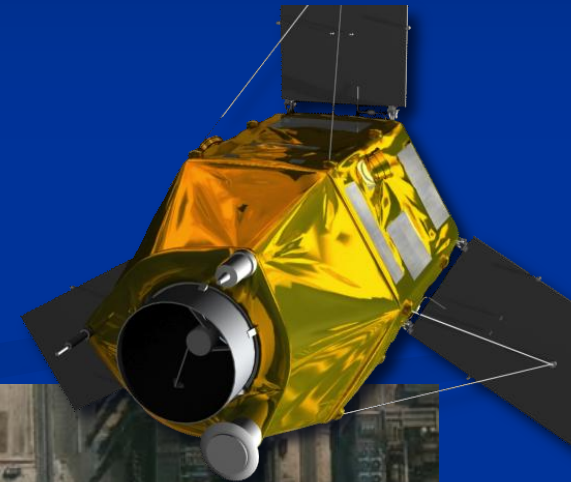
- Radius of Earth
  - approx. 6,300km (a=6377, b=6356, Bessel)
- Altitude of Polar Orbit Satellite
  - 300km - 900km
  - Landsat 705km, JERS-1 568km, SPOT 822km, NOAA 833-870km
- Altitude of Geo-stationary Satellite
  - 35,800km
- Speed of light
  - 300,000km/sec
- Speed of Satellite ( relative to the earth )
  - 6.5km/sec = 23,400km/hour, Jet Passenger Aircraft 900km/h

# Very High Resolution Satellites ( Better than 1m ground resolution )

**Various Commercial Satellite Products are available  
Ideal to identify small objects, to create detail maps  
everywhere on the earth .**

**Ground Resolution ( Data size of the ground )**

<b>IKONOS</b>	<b>100 cm (1m)</b>
<b>GeoEye-1</b>	<b>41 cm</b>
<b>Quick Bird</b>	<b>60 cm</b>
<b>World View-1,2</b>	<b>50 cm</b>
<b>Preiades</b>	<b>50 cm</b>



Preiades Image  
Courtesy: SPOT IMAGE Home Page

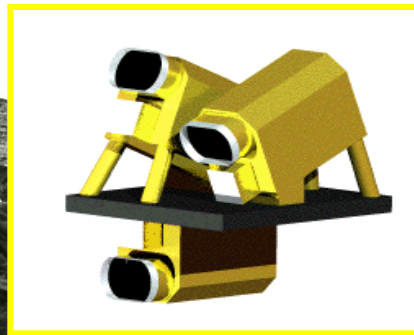
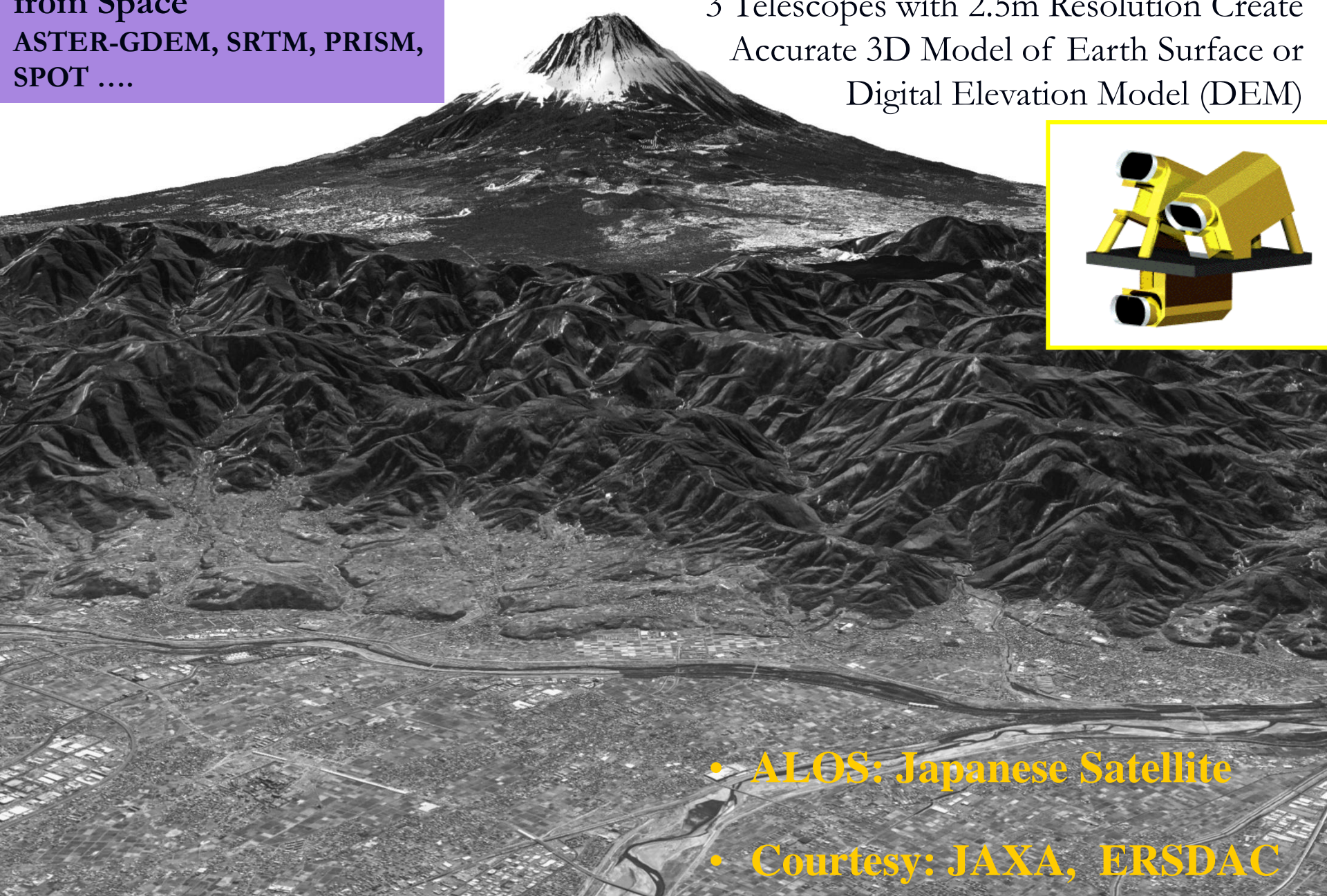


This satellite image of a destroyed bridge in Taiwan was captured after Typhoon Morakot made landfall and produced as much as 109.3 inches of rain, triggering catastrophic mudslides.

Global 3D Data  
from Space  
ASTER-GDEM, SRTM, PRISM,  
SPOT ....

# PRISM on ALOS

3 Telescopes with 2.5m Resolution Create  
Accurate 3D Model of Earth Surface or  
Digital Elevation Model (DEM)



- **ALOS: Japanese Satellite**
- **Courtesy: JAXA, ERSDAC**

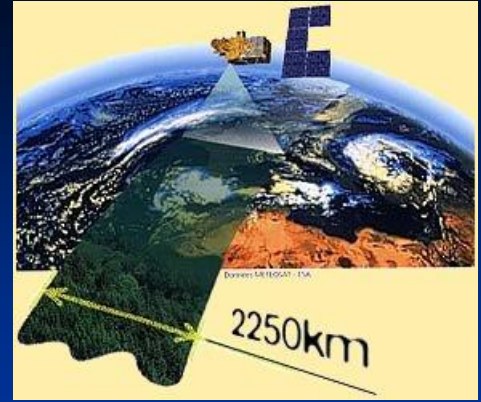
# Low Resolution Satellite Data

- MODIS, NOAA, SPOT Vegetation
- Low Resolution; 250m to 1km, but
- High Multi-Temporal Data

Observing everywhere on the earth 1 or 2 times a day

with Wide View – 2,000km x 5,000km

- Ideal for
  - Global to Regional Monitoring of
  - Dynamic Phenomenon
    - Crop / Vegetation growth, Forest fire, Weather
    - Sea and Land surface temperature and etc.



<http://www.spotimage.fr/home/system/introsat/payload/vegetati/vegetati.htm>



MODIS Image  
Courtesy: NASA

# Field Sensor Network

# Ubiquitous Field Sensor Network

- Small and Low-Cost Sensors
- New Field Platforms
- Mobile Internet
- Real-time field information from anywhere
- Disaster, Agriculture, Logistics, Security, etc.
- Monitoring Panel, Early Warning, Simulation

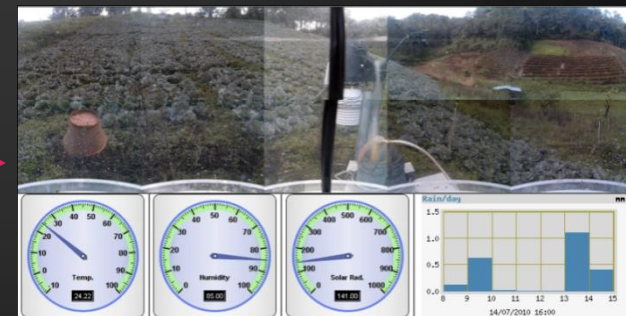


Low Cost Sensor  
CO2: SenseAir



Field Platform  
FieldServer: NARC

Mobile  
Internet



Ubiquitous Field  
Sensor Network

# SOS

## Sensor Observation Service

- Standardization of Sensor Data -> Important for Data Integration
- OGC ( Open Geo-Spatial Consortium) Standards on SWE ( Sensor Web Enablement )
  - **SOS ( Sensor Observation Service )**
  - SPS ( Sensor Planning Service )
  - WNS ( Web Notification Service )
- **Standard query/response by XML**
  - Sensor Metadata( Information on Sensor )
  - Sensor Data
- Interoperability
  - Serve Data to SOS Compliant Applications
  - Monitoring Panel, Early Warning, Simulation System
- SSG provides SOS I/F and SOS Wrapper
  - Cloud Platform for Sensor Back-end Service

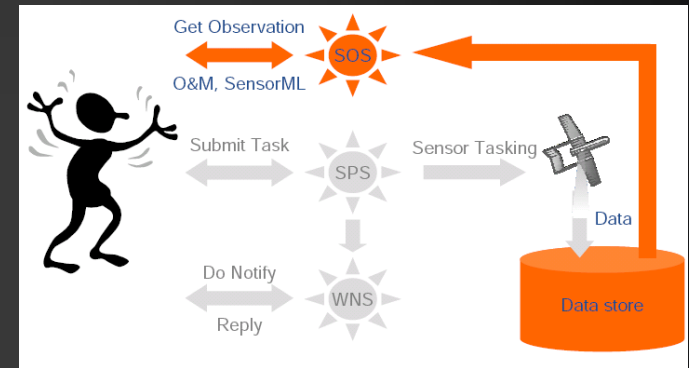
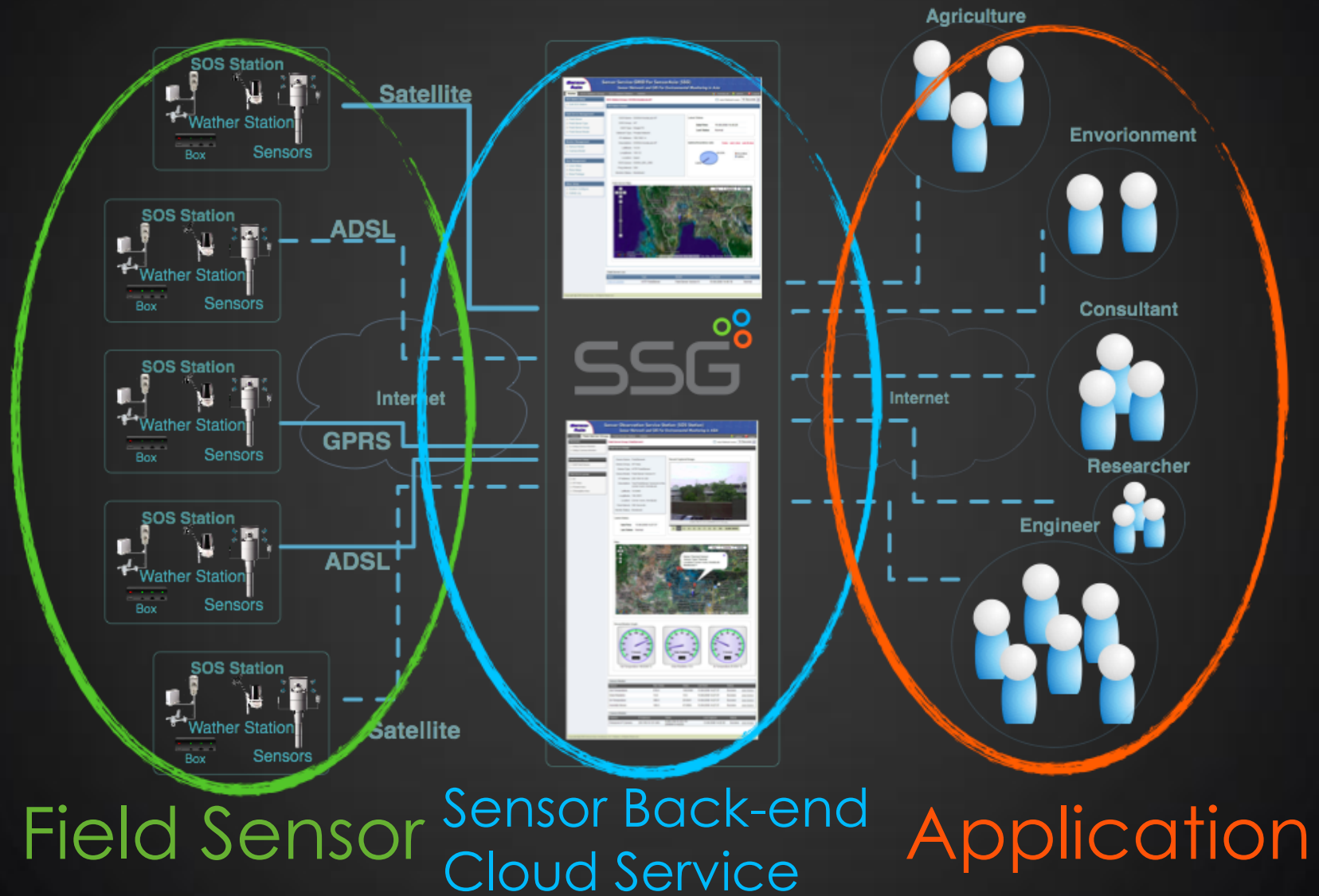


Figure from <http://52north.org>



# Sensor Back-end Cloud Service



# Sensor Asia

## Promoting Field Sensor Network for Various Applications; Agriculture, Disaster, Environment, and etc.

The screenshot shows the Sensor Asia website homepage. At the top, there is a navigation menu with links for Home, Concept, Applications, Conferences & Publications, and About US. The date is displayed as SUNDAY, DECEMBER 5. The Sensor Asia logo is prominently featured, along with a search bar and a search button. Below the navigation, there are two main content areas: FEATURED NEWS and NEWS HIGHLIGHTS. The featured news section highlights a 'Glacier Lake Monitoring system' with a large image of a sensor tower in a mountainous landscape. The news highlights section lists several articles: 'LANDSLIDE MONITORING SYSTEM', 'GLACIER LAKE MONITORING SYSTEM', 'GLOBAL CLIMATE CHANGE', and 'UAV LANDSLIDE SURVEY SYSTEM'. Below the featured news, there are two columns for 'LATEST NEWS', each with a sub-section for 'LANDSLIDE MONITORING SYSTEM' and 'GLACIER LAKE MONITORING SYSTEM', each containing an 'APPLICATION' link and a small image. A 'VIDEO NEWS' section is also present at the bottom right, featuring a video player with a title 'Sensor Service GRID For SensorAsia (SSG) Sensor Network and GIS For Environmental Monitoring in Asia'.

Home   Concept   Applications   Conferences & Publications   About US

**SensorAsia**  
SENSOR MIDDLEWARE TECHNOLOGY

Search

SUNDAY, DECEMBER 5

Subscribe to  
Subscribe to Com  
Subscribe to New

### FEATURED NEWS

#### Glacier Lake Monitoring system

Another test-bed has been setup in the Nepal Himalayas for glacier lake monitoring. Due to global temperatures rising, glacier ice is [...]

### NEWS HIGHLIGHTS

#### LANDSLIDE MONITORING SYSTEM

A landslide monitoring system has been in the Banjarnegara Region of Java, Indonesia. The monitoring system consists of a fieldserver [...]

#### GLACIER LAKE MONITORING SYSTEM

Another test-bed has been setup in the Himalayas for glacier lake monitoring. Due to global temperatures rising, glacier ice is [...]

#### GLOBAL CLIMATE CHANGE

ABC or Atmospheric Brown Cloud is a phenomenon that dark cloud covers over large portion of the continents. It is considered [...]

#### UAV LANDSLIDE SURVEY SYSTEM

A Sensor Web is a type of sensor network which is especially well suited for environmental monitoring. In this study, [...]

### LATEST NEWS

#### LANDSLIDE MONITORING SYSTEM

APPLICATION

#### GLACIER LAKE MONITORING SYSTEM

APPLICATION

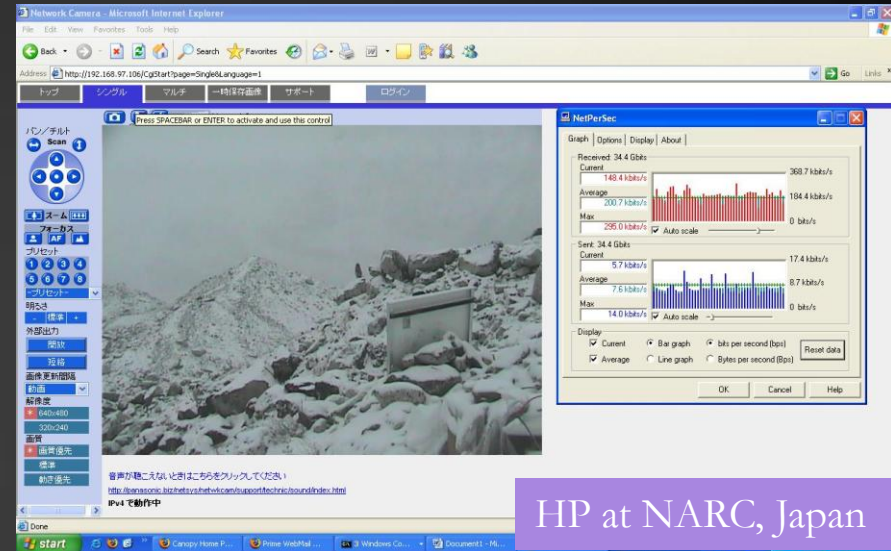
### VIDEO NEWS

Sensor Service GRID For SensorAsia (SSG)  
Sensor Network and GIS For Environmental Monitoring in Asia

# Himalayan Glacier Lake Monitoring

## Real Time Disaster Information under Extreme Condition

- Field Server at Imja Glacice Lake for GLOF ( Glacier Lake Outburst Flood )
- WiFi to the Lake by 2 hops from Namche ( longest segment is 28Km )
- Int'l Team( Nepal, Japan, Thai)



# Food Safety info. Direct to Consumers.

## Promoting Agriculture



The station is set up at ChiangDao, Thailand



The project is organized by University of Tokyo, University COOP in Japan and Fujitsu Design Co., Ltd.

Broadcast data in Univ. Tokyo Canteen



Foster Confidence in safety of food among consumers



農場から食卓まで x ICT  
Farm to Table Experiment with Information and Communication Technology



# Safety of Mountain Flights in the Himalaya



Prokara airport



Jomsom airport

A weather station and a camera were set at a ridge of Annapurna, Himalayas, Nepal



Data Center

## Nepal Wireless



National Trust for Nature Conservation Nepal

To provide air route weather and visibility information to air controller and pilot

The images are acquired at : 16/04/2010 05:25 UTC (0 hour and 3 minutes ago)

\*The panorama image series.

Time Slider (UTC): Latest

Visibility (The latest captured images change in 15 minutes)

	5 min	10 min	15 min
1 Km			
5 Km			
10 Km			

\*Visibility The set of visibility are described in 3 views of images about 1 Km, 5 Km, and 10 Km. as can show the reference distance of visibility below:

~ 1Km	~ 5 Km	~10 Km

Visibility is 0 Km



Data Center

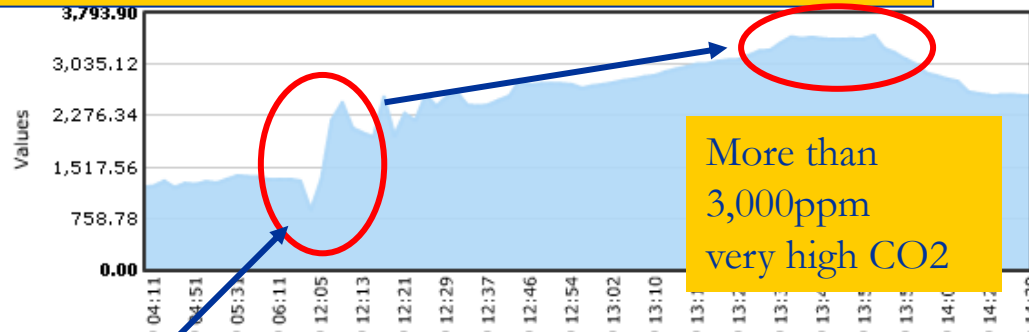


# SSG and SOS Station for Mobile CO2 Observation

## Easy Deployment of Real Time Observation

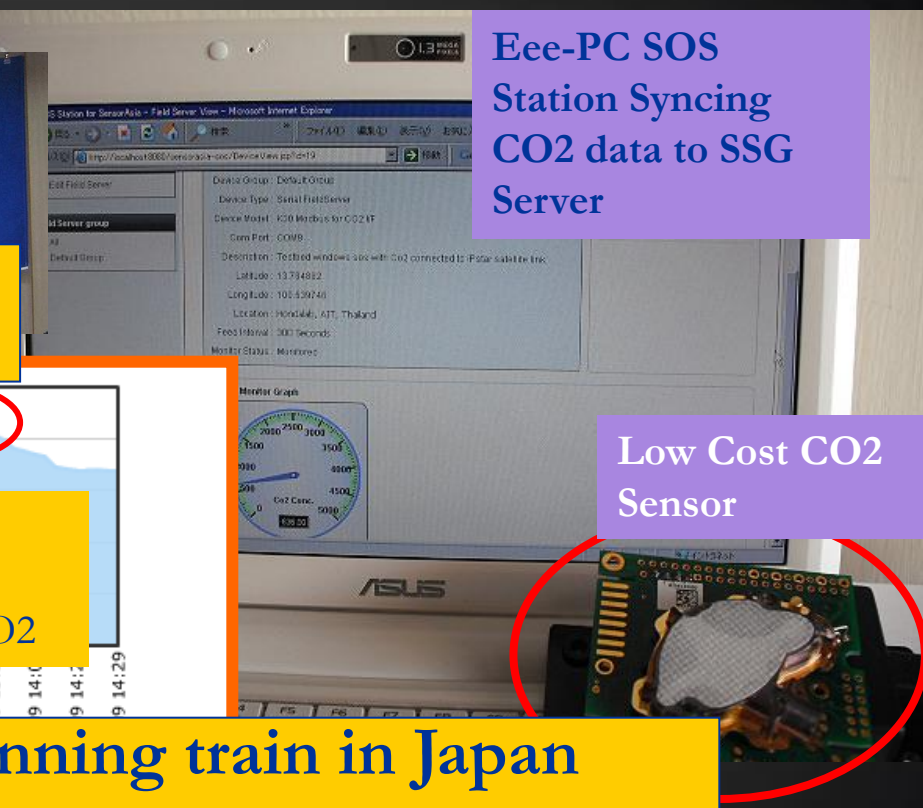
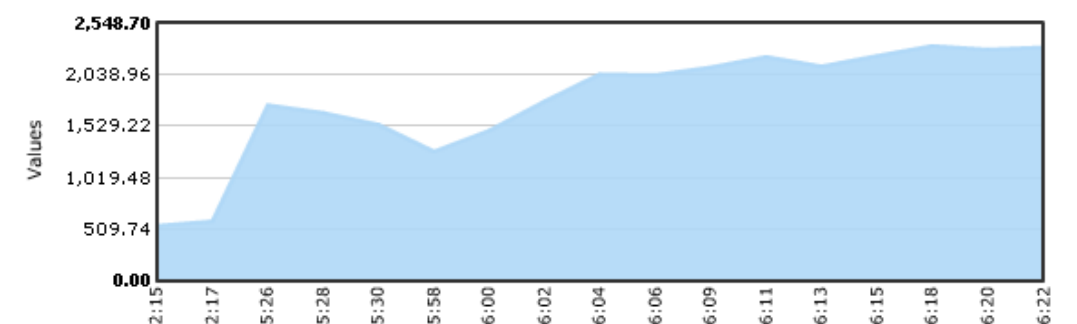


workshop in Korea

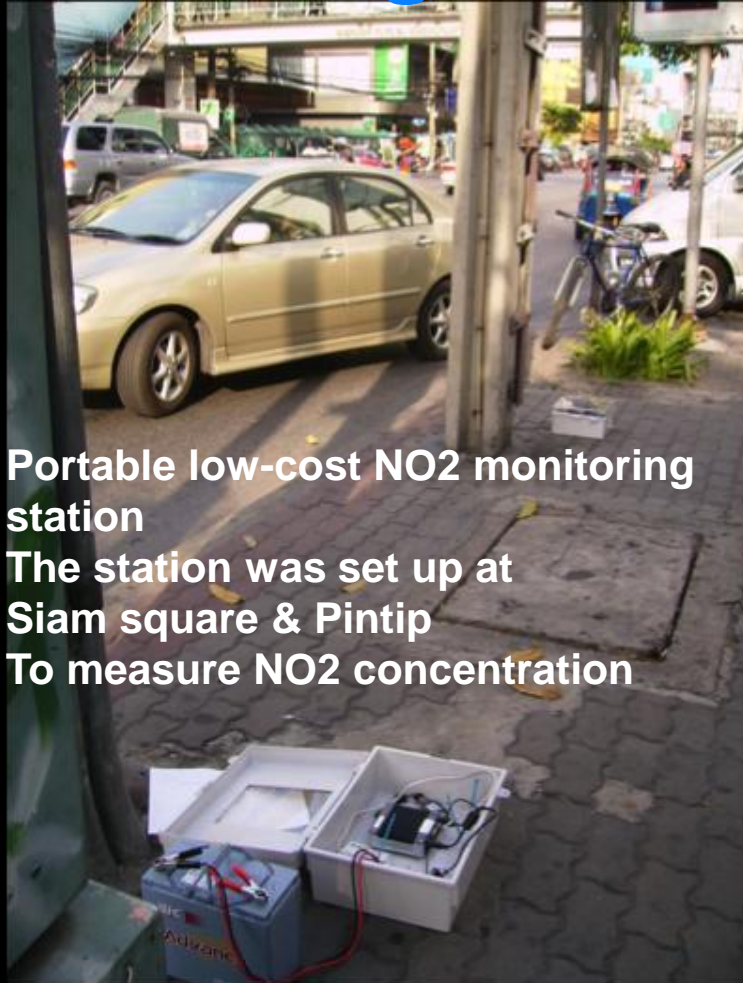


CO2 in a running train in Japan  
Full of people, but good air quality

Monitor Date	Device	Sense
11-05-2009 14:29:27	K30 CO2 FS	K30 C
11-05-2009 14:27:24	K30 CO2 FS	K30 C
11-05-2009 14:25:22	K30 CO2 FS	K30 C
11-05-2009 14:23:19	K30 CO2 FS	K30 C

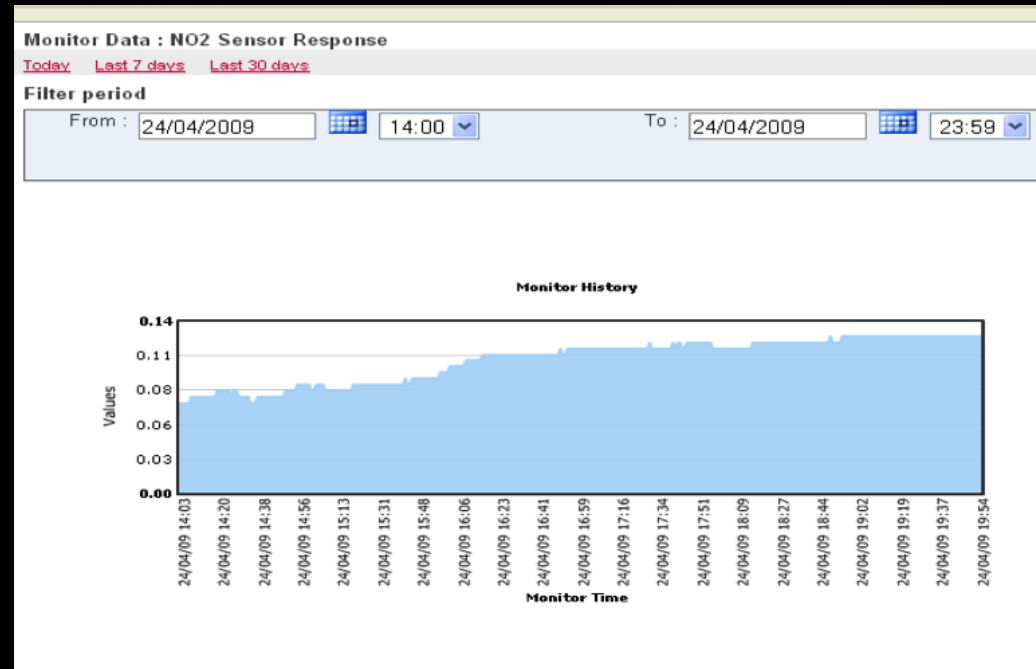


# Monitoring Air Pollution in Bangkok with a portable node



Portable low-cost NO<sub>2</sub> monitoring station  
The station was set up at Siam square & Pintip  
To measure NO<sub>2</sub> concentration

## Measure Air Pollution and Warning



This project is under cooperation with Dr. Ornprapa P.Robert from Sirapakorn

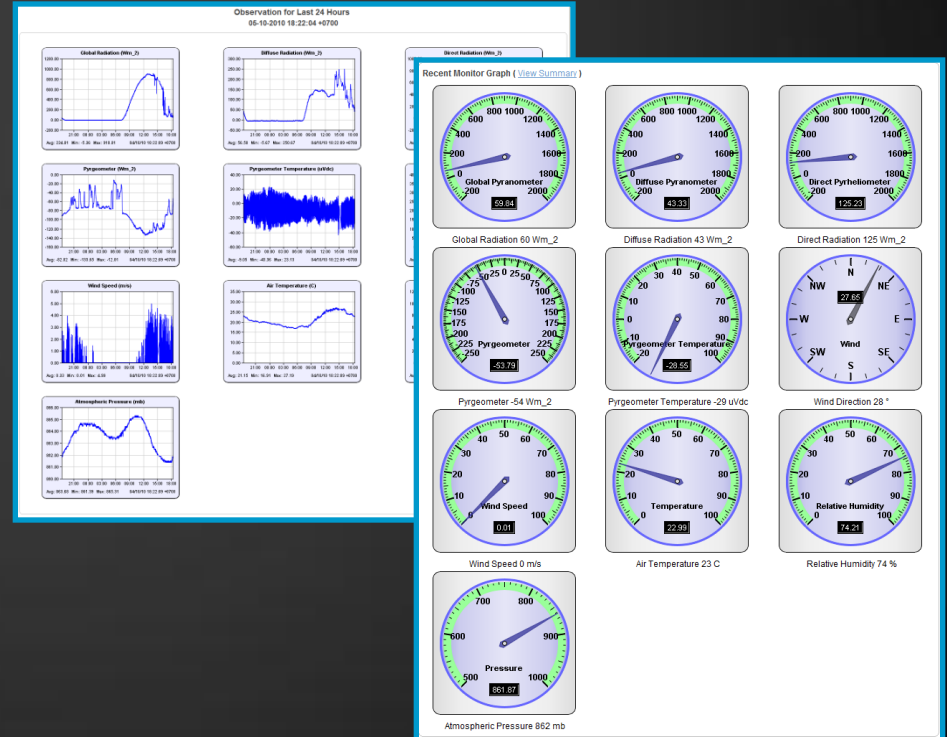
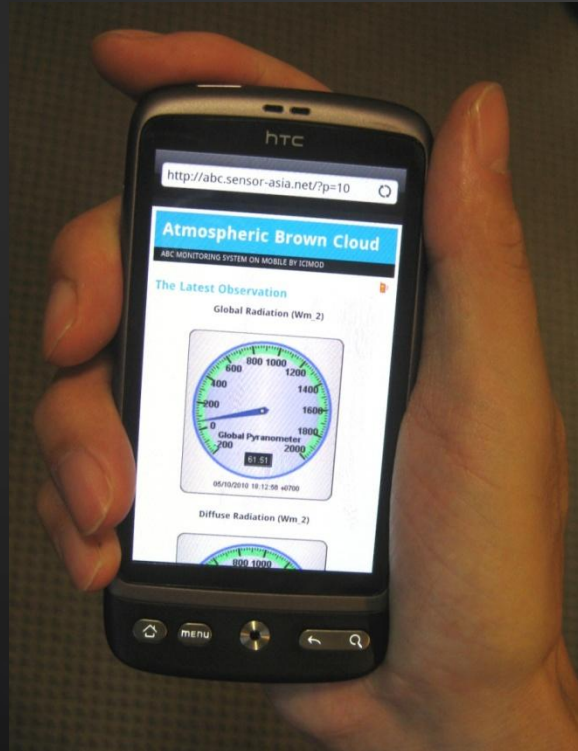
Data Sender

Data Receiver



“Benefiting from earth Observation – bridging the data gap for Adaptation to climate change in the HKH region”

# the Launch of Real-Time Web Visualization on Atmospheric Brown Cloud Observation in Collaboration between ICIMOD and AIT (Honda Lab)





# UAV Landslide Surveying System



The system is used in Japan



## Information while flying to disaster managers, rescue teams

Main Controller for UAV : Aerial 3

Flight Path: Interpolated

Map Satellite Home

Ground View

GPS

Latitude: 35.899411 N°  
Longitude: 140.03102 E°  
Altitude: 28.5 m  
Speed: 12.2 km/h

Laser Range

Height: 28.8 m  
Inclination: -86°

Gyroscope

Roll: -7.73°  
Pitch: 1.81°  
Yaw: 80.42°

Camera

Image: 25521900091248  
ISO: AUTO  
Speed Shutter: 1/1000

A/D Sensor

Temperature: 23.68 °C  
Battery Level: 12.51 V

Servo Board

Pan: 0°  
Tilt: -32°

Command

Start Stop Reload

Webcam Control

Pan (degree): [Slider] 0

Tilt (degree): [Slider] -32

2009-11-03, 06:13:51

Collaboration with Dr.Nagai,  
University of Tokyo, Japan

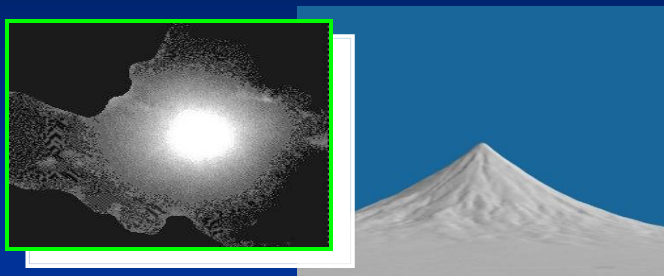
Data Center

Data PI

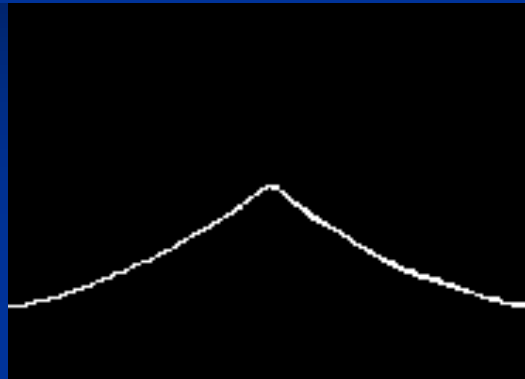
# Real Time Mapping

# Volcano Real Time Mapping System

## Continuously Create Orthophoto from Ground Digital Camera Image -> Real Time Decision Support



DEM

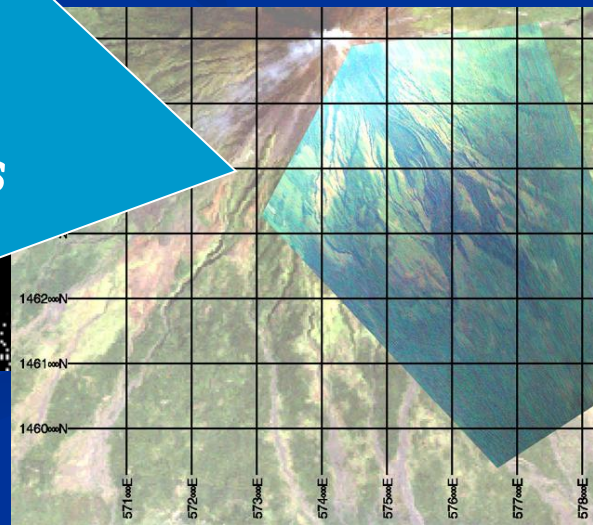


Skyline Matching



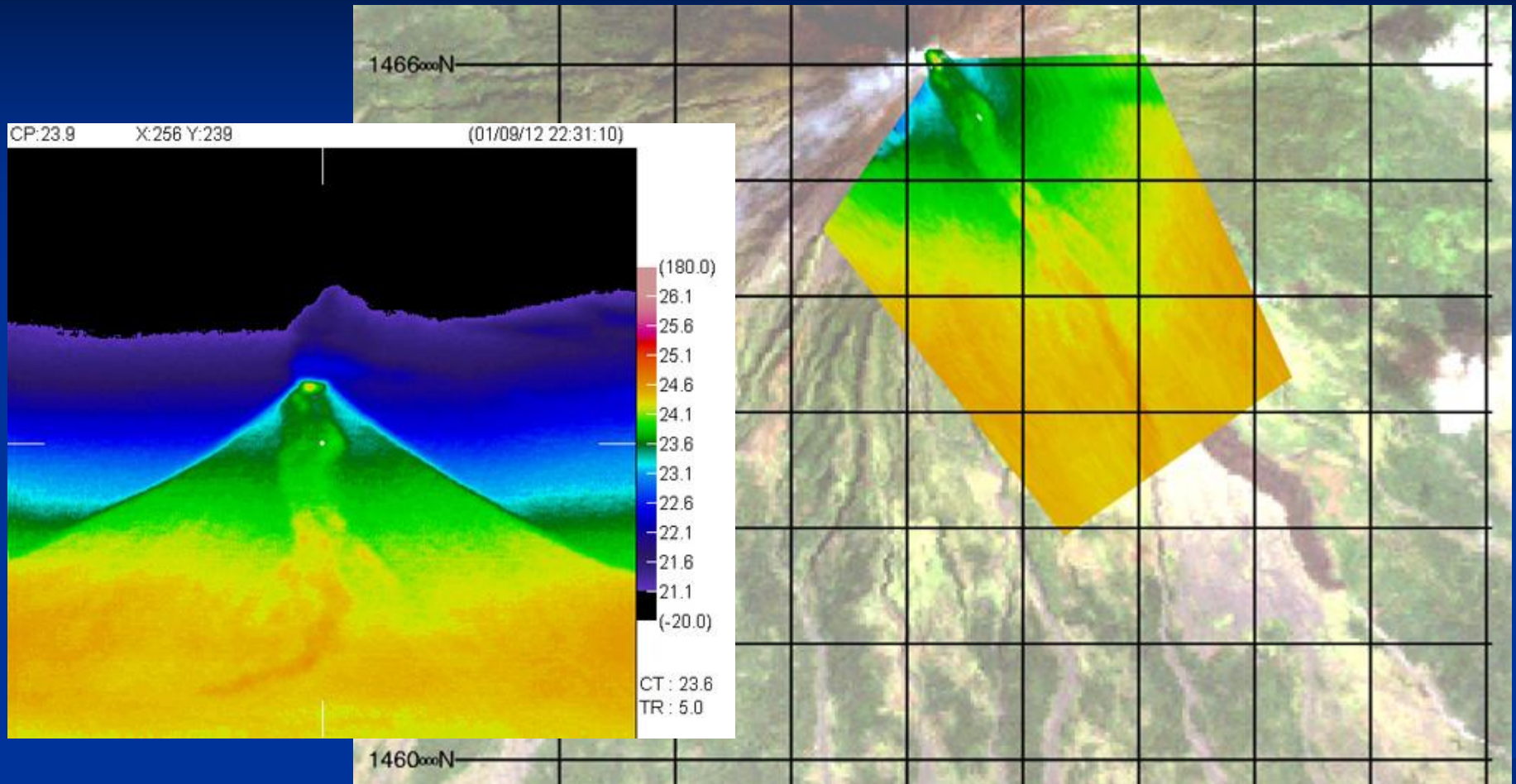
Landscape Image

2 min. for 1<sup>st</sup> image,  
3 sec. from 2<sup>nd</sup> images



# Orthophoto from Thermography Image

## Night Time Monitoring is possible and effective



Real-time volcano activity mapping using ground-based digital imagery:

Kiyoshi Honda, Masahiko Nagai

ISPRS Journal of Photogrammetry and Remote Sensing, vol 57/1-2 pp. 144-153, 2002

# Building Identification from a scenery images

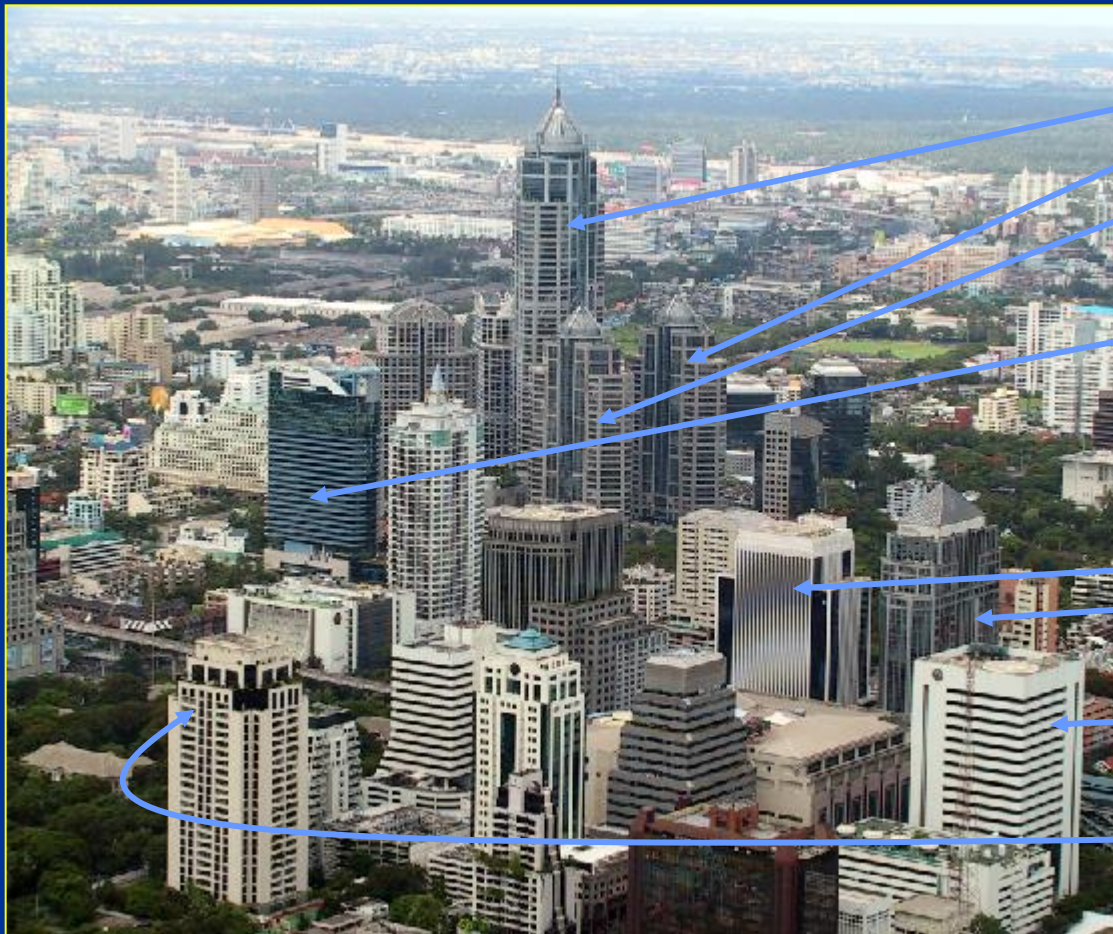
Useful for security, disaster management

N



2D GIS data

Aerial Scenery Photo



# Scenery Image < > 2D Building GIS

Colored circles are linked to various information on 2D GIS such as name, facilities, number of people and etc.



# Web GIS

- Effective for Data Sharing, Data Update and Data Integration
  - RS Data, GIS data, Sensor Data

# Sharing Tsunami Disaster information on Web GIS IKONOS 1m Resolution in KhaoLak Overlaid with Infrastructure Data ( Hotels )



Asian Institute of Technology  
Tsunami Homepage



## Legend

### Layer

#### GPS picture

- Mainpoint
- GPSpic

#### Hotel

- Hotel

#### Basemap

- Landmark
- Road
- Boundary

#### Landsat image

Landsat Image

#### Ikonos image

PhangNga

#### RTAF Aerial photo

Aerial photo Image

#### ASTER image

ASTER Image

Redraw Map





# Tsunami Disaster Mapping for Indian Ocean Coastal Regions

DM Solutions Group

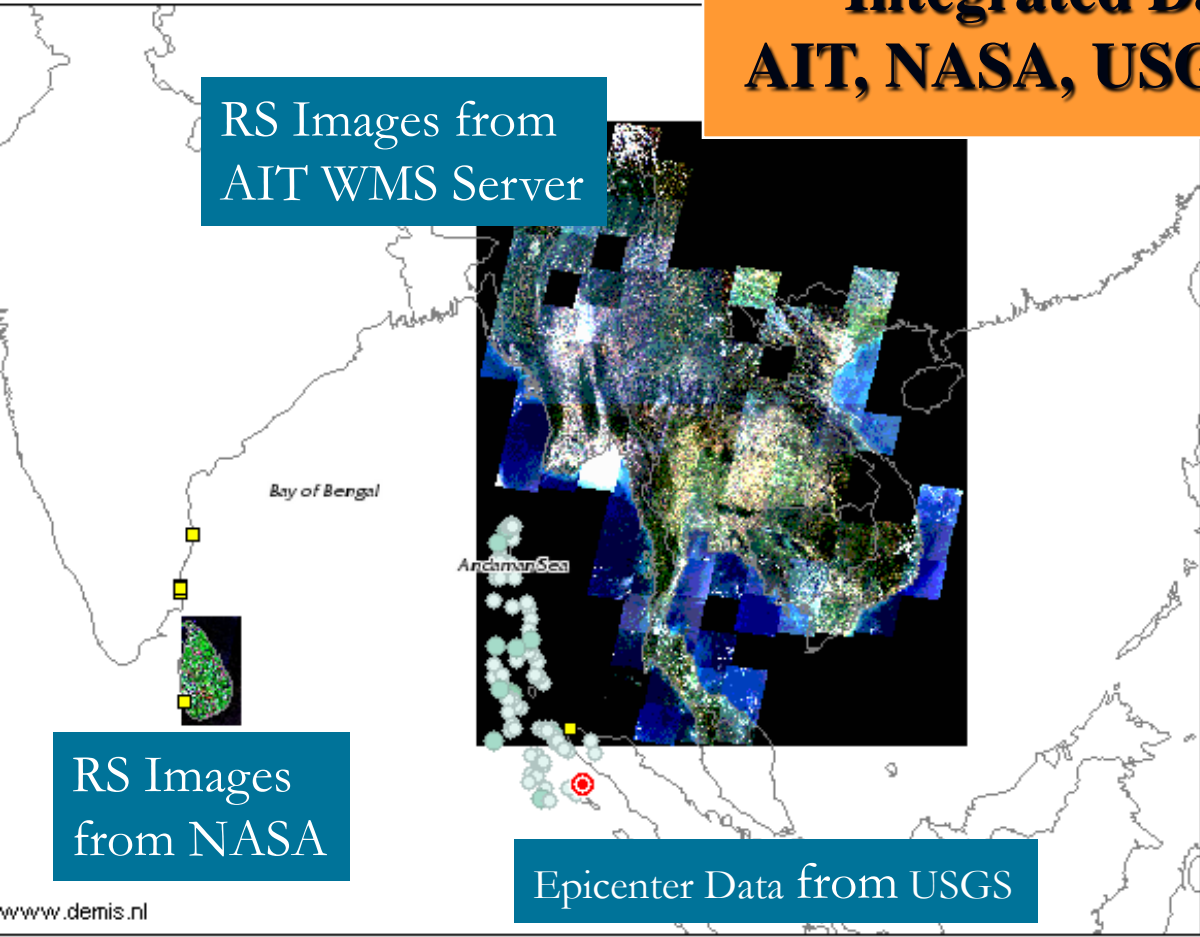
## Multi WMS Server Implementation Integrated Data Visualization from AIT, NASA, USGS on a Server in Canada



RS Images from  
AIT WMS Server

RS Images  
from NASA

Epicenter Data from USGS

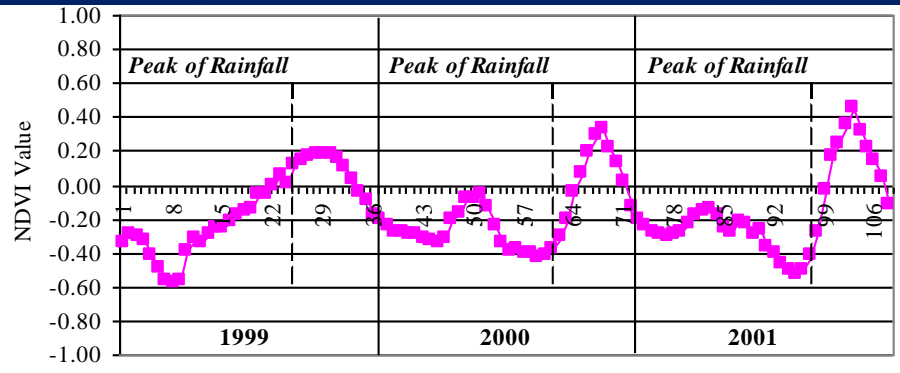


- Earthquake Epicenter [\[info\]](#)
  - 📍 9.0, 2004/12/26 00:58:53 UTC
- Recent Earthquakes [\[info\]](#)
  - 🟢 5.0 - 6.0
  - 🟢 6.0 - 7.0
  - 🟢 7.0 - 8.0
  - 🟢 >8.0
- Fault Lines [\[info\]](#)
- Points of Interest [\[info\]](#)
  - 📍 Click then a point on the map for more information
- Political**
  - World Cities [\[info\]](#)
  - World Oceans Labels [\[info\]](#)
  - Political Borders [\[info\]](#)
  - Coastlines [\[info\]](#)
  - Political Land Mass [\[info\]](#)

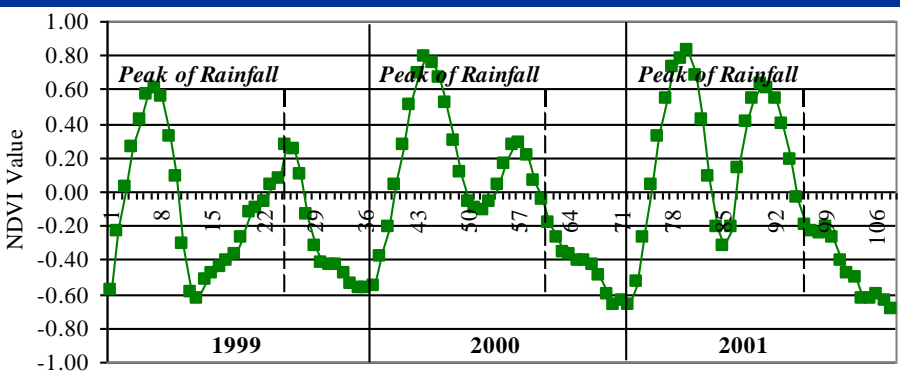
Redraw Map

# Modeling and Simulation

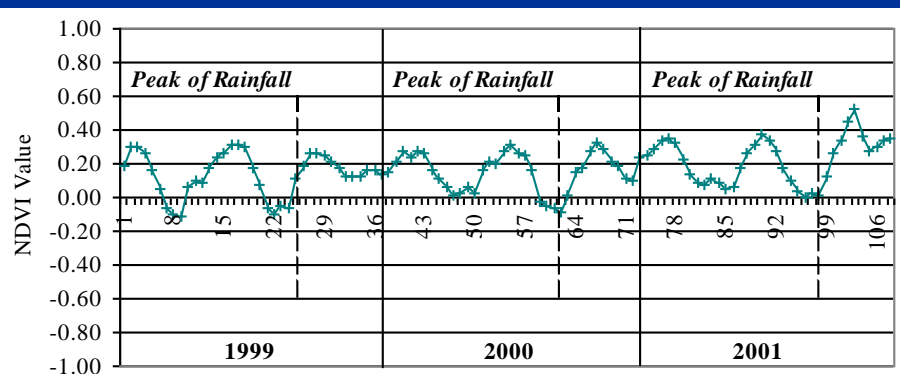
# Multi-Temporal RS data ( SPOT VI ) to identify Irrigated/Non-Irrigated, Number of Cultivation



Non-Irrigated Rice



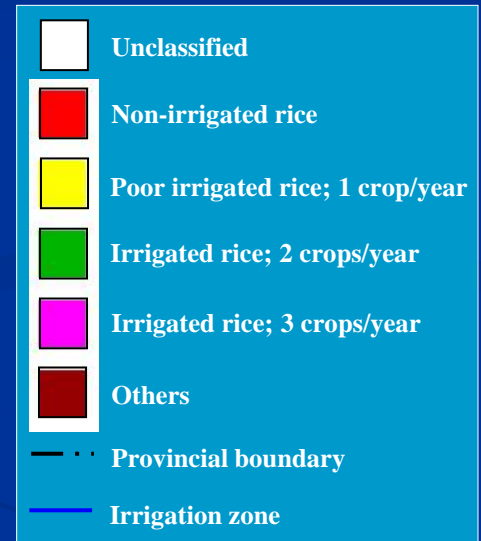
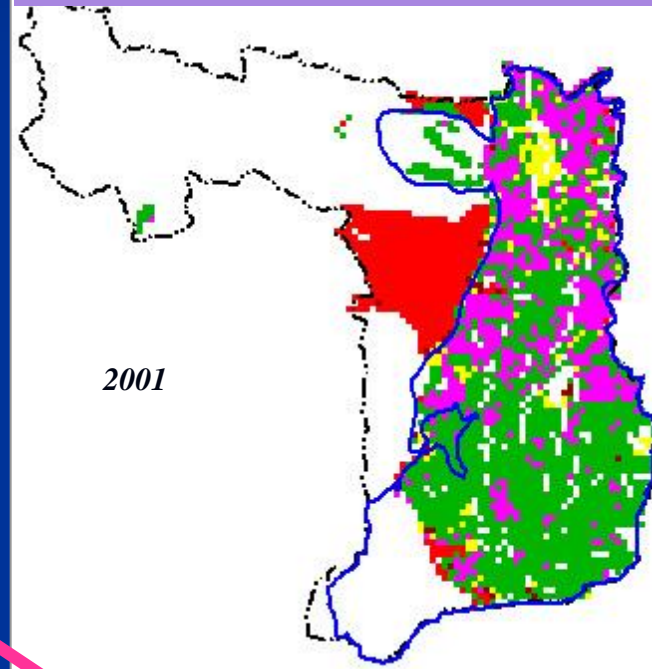
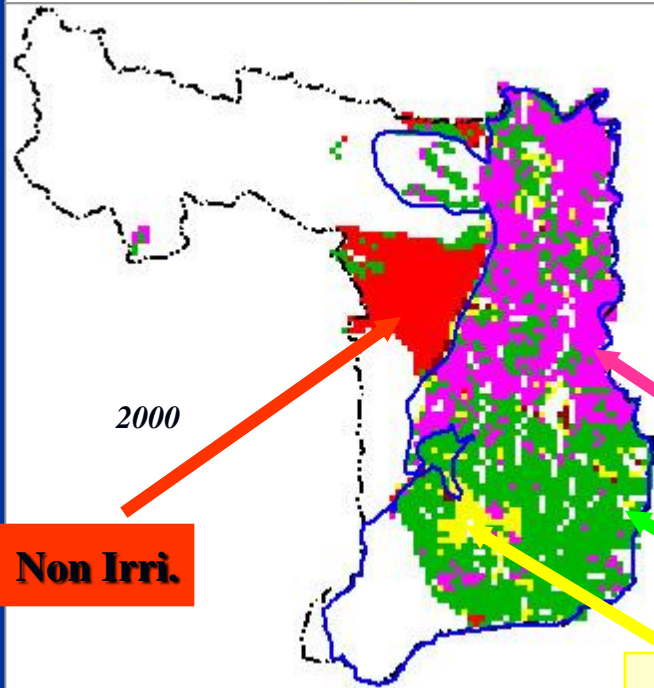
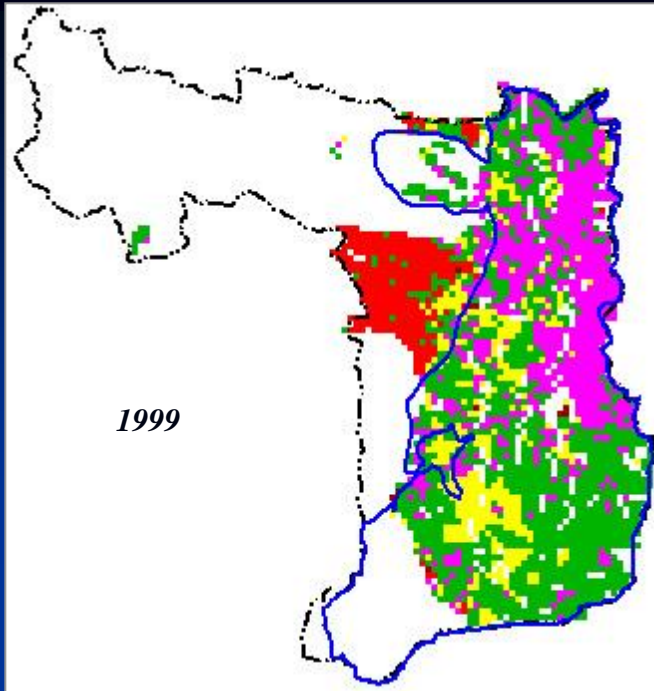
Irrigated rice 2 crops/year  
(Homogeneous)



Irrigated rice 3 crops/year  
(Heterogeneous field)

# Number of Rice Cultivation in Suphanburi, Thailand

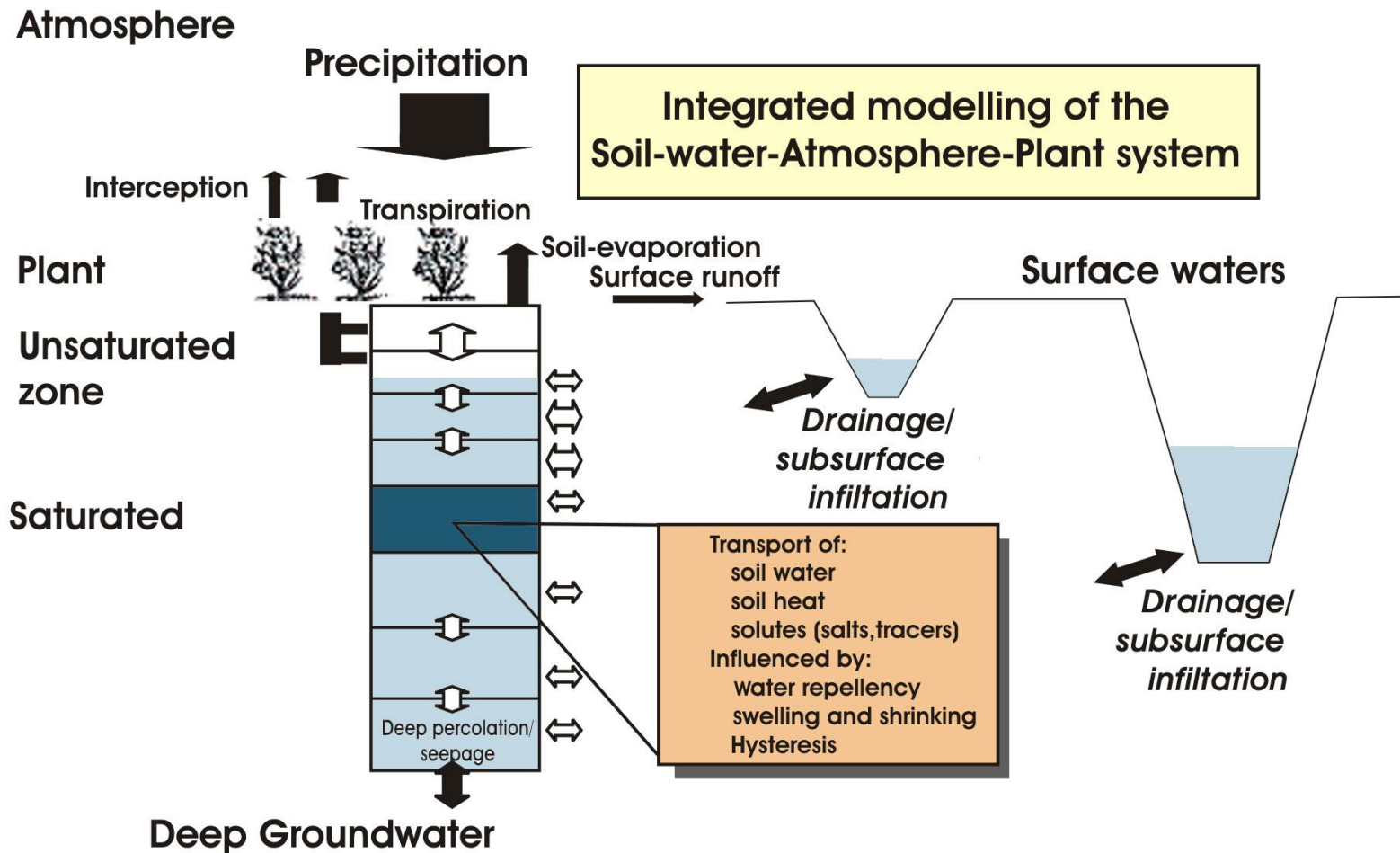
## Dynamic Monitoring of Cropping Activity Contributing to Food Security



# Crop Model Parameter Identification through RS Data Assimilation

Evolve RS Monitoring (Snap Shot ) to  
RS based Modeling and Simulation  
for Scenario Evaluation, Prediction  
and Decision Support

# Soil-Water-Atmosphere-Plant Model (SWAP)



Adopted from Van Dam et al. (1997)  
Drawn by Teerayut Horanont (AIT)

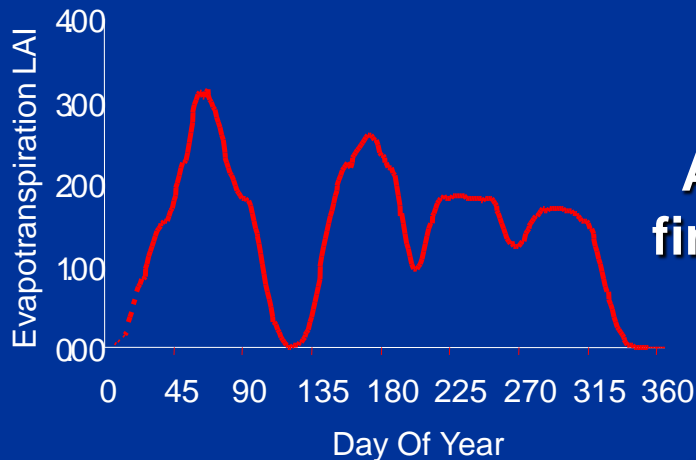
# SWAP Model Parameter Determination Scheme

## - Data Assimilation using RS and GA -



RS Observation

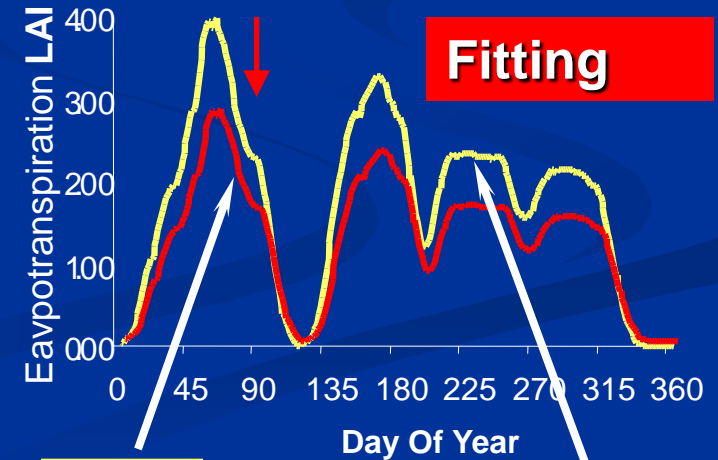
LAI,  
Evapotranspiration



SWAP Input Parameters  
sowing date, soil property,  
Water management, and etc.

SWAP Crop Growth Model

LAI,  
Evapotranspiration

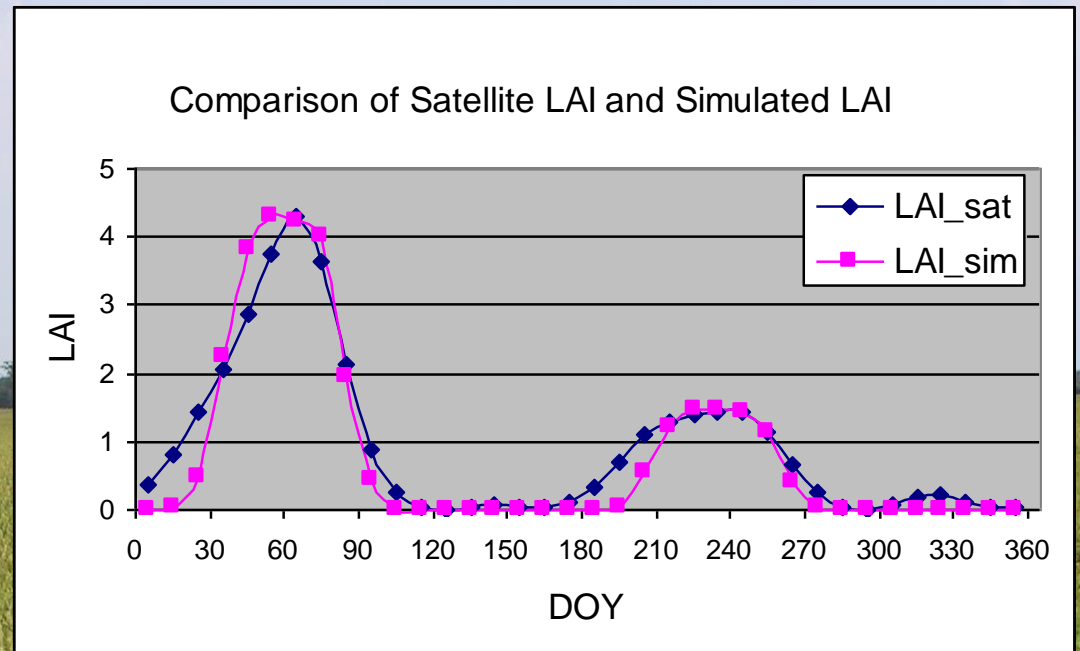


Assimilation by  
finding Optimized  
parameters

By GA

RS

Model

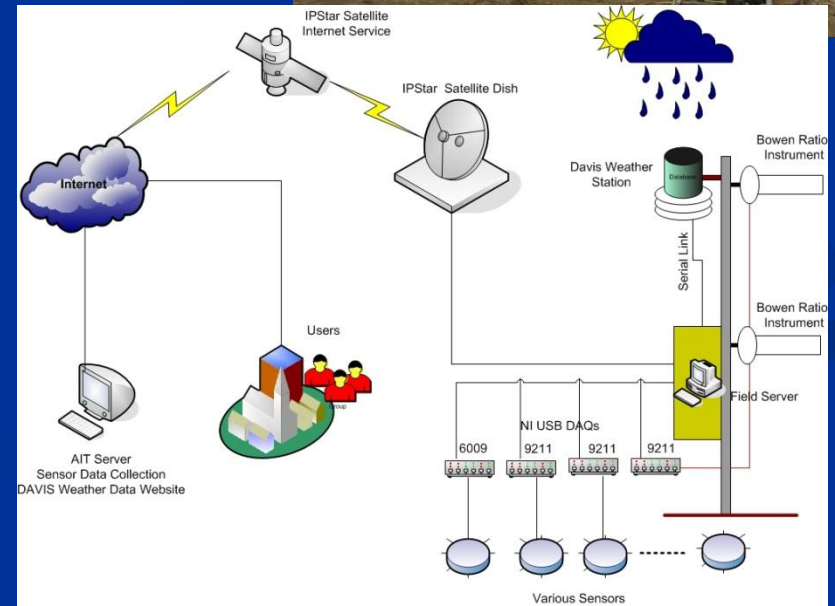
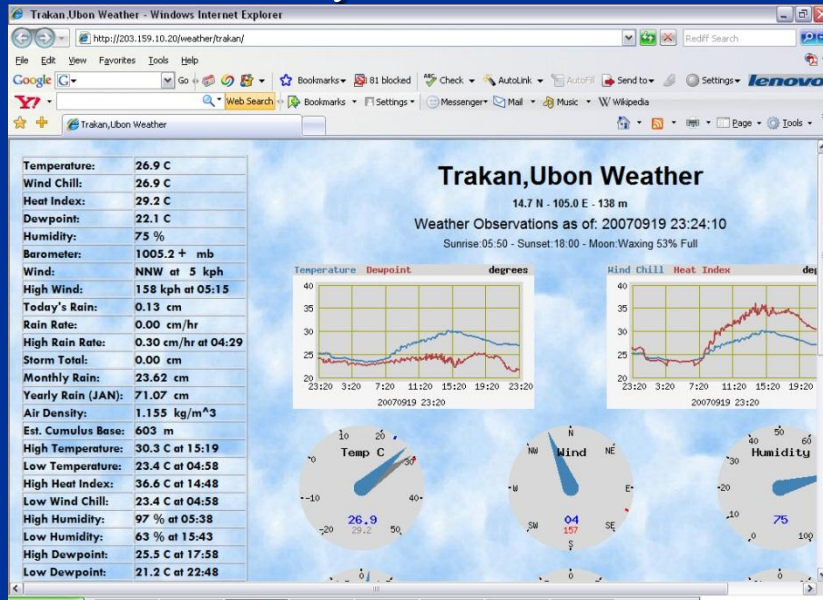


- Suphanburi Province Test Field
- Identify SWAP Crop Model Parameters by Data Assimilation
- Scenario Evaluation
- Decision Support



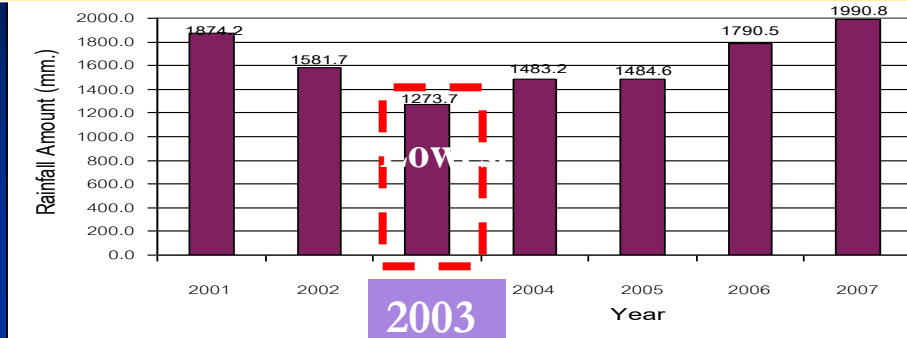
# Draught Monitoring in Thailand

- Model Identification for simulating impact of draught.
- Big damage to agriculture
- Dynamic Water Balance
  - Flux Observation
  - Soil Moisture
- Access to Data through SOS
- Funded by Thai Research Fund

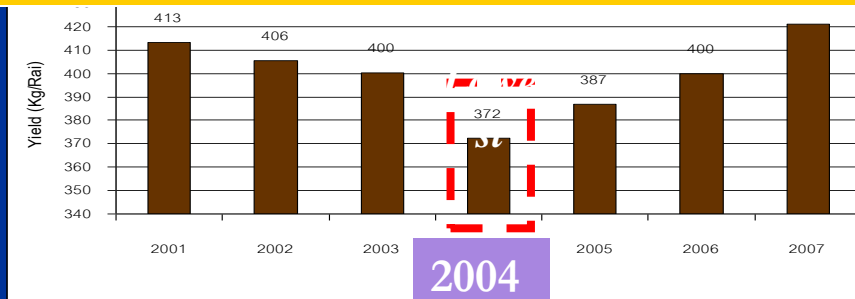


# Simulating Draught Impact

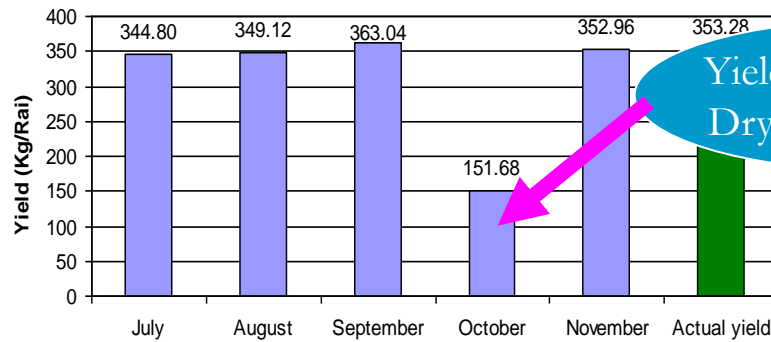
## Annual Rain



## Yield Statistics



## Yield Simulation Under Different Dry Spell Scenarios



- The lowest rainfall appeared in 2003 but the most serious impact on rice yield was found in 2004

## ■ October Rainfall

- 2003 43.6mm
- 2004 3.3mm

- Calibrated model has proven dry spell in October has serious impact

# High Performance Computing

- Accelerate heavy RS data processing, Simulation
- Cluster
  - SWAP-GA-RS Data Assimilation
- GRID
  - XGRID for LMF ( Cloud Removal )
- GPGPU
  - General Purpose Graphic Processing Unit
  - 500 USD -> 480 CPU in one card
  - Low-Cost and High Performance
  - Super Computers in Top 10 effectively connect thousands of GPU
- Utilize GPU to accelerate RS data processing

# GPGPU Computing

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School of Engineering and Technology (SET)  
Asian Institute of Technology (AIT)  
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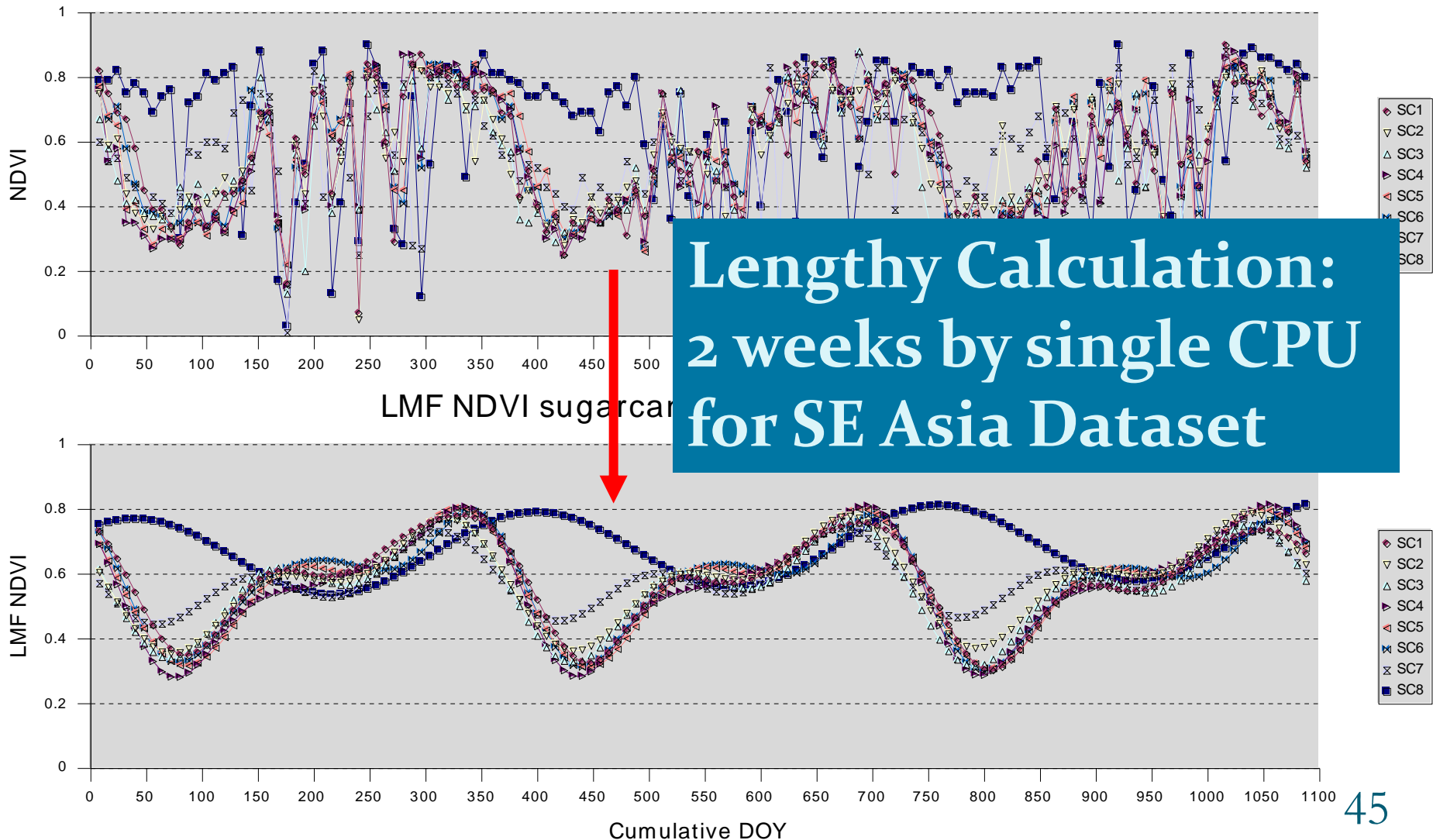
IBM Smart HPC, 8<sup>th</sup> July, 2010  
Intercontinental Hotel



Courtesy of:  
<http://gpulab.imm.dtu.dk>

# LMF Cloud Removal Algorithm

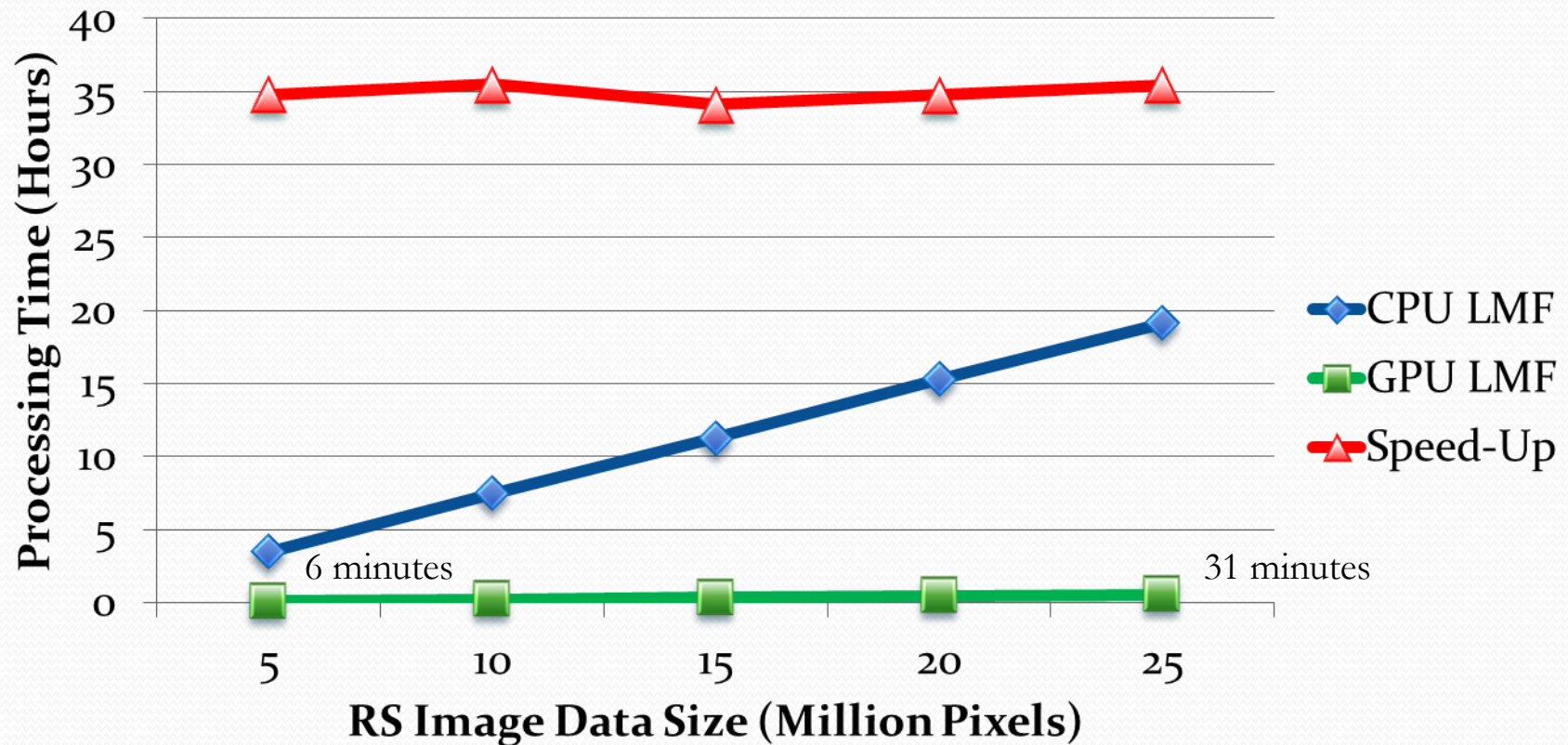
Original NDVI sugarcane patterns (2001-2003)



# CPU vs GPU

## Accelerate 35 times by single GPU

Processing time in hours and speed-up ratio on large data of CPU LMF vs GPU LMF



# GPGPU Workshop

- 26<sup>th</sup> , 27<sup>th</sup> January 2011
- Jointly Organized by
  - AIT
  - Kasetsart
  - Tokyo Institute of Technology
- 26th: Research Presentation
- 27th: Tutorial

# Conclusion

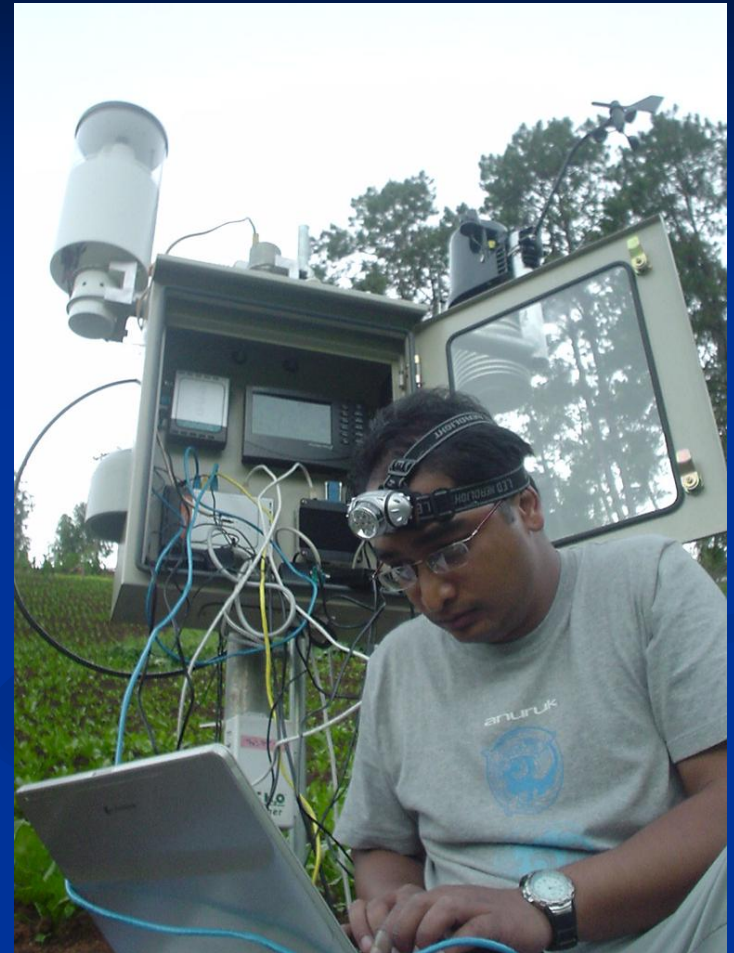
- Ubiquitous Geo-Informatics
  - Integration of Geo-informatics and ICT
    - Remote Sensing
    - Field Sensor Network
    - Real Time Mapping
    - Web GIS
    - Modeling Simulation
    - High Performance Computing
- Contribute to the better life
- Exciting Research and Development in AIT



# Thank you

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Mr. Aadit Shrestha working peacefully  
in Chiang Mai Spinach Field for  
Sensor Network

If you would like to highlight your research activities do send in your inputs to

**[scpo@ait.ac.th](mailto:scpo@ait.ac.th)**