Introduction to Remote sensing and applications

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Application of Remote Sensing

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Advantage of RS

- Wide Coverage, Periodical Observation
- Variety of Observing Method
- Multi-resolution – Multi-temporal – Multi-spectral
- Global Environment – Local Application
- Hydrology, Oceanography, Global Env. Study, CO_2

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Advantage of RS con't

- Agriculture, Forestry, Fisheries, Ecological Mapping
- Coastal zone management, Health Management, Energy
- Fire, Oil-spill, Volcano, Earthquake, Flood, Ice,
- Land use mapping, Cadastral Mapping, Topographic Map, Change Detection
- Military
- Use wisely by understanding advantage and limitation

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Recent an example of RS application

0 Base map/Back Ground map integrate with web-map server

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Recent an example of RS application

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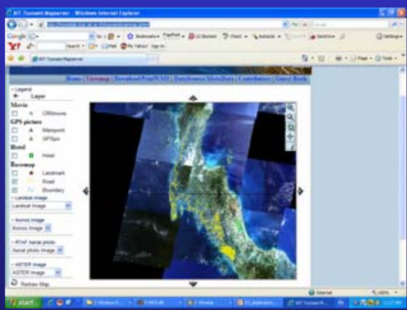
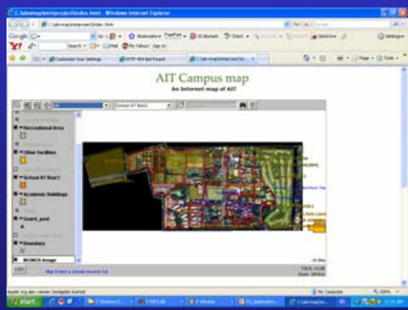
Base map Web map server





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Remote Sensing (LIDAR) for Management of Highway Assets for Safety

Iowa Department of Transportation

Iowa State University ~ University of Missouri-Columbia
Lincoln University ,University of Missouri-Kansas City
University of Missouri-St. Louis,University of Northern Iowa

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Main objective

Utilize light detection and ranging (LIDAR) technology to obtain highway safety-related information.

The safety needs of older drivers in terms of prolonged reaction times were taken into consideration.

(1) identification of crashes that older drivers are more likely to be involved in,
(2) identification of highway geometric features that are important in such crashes
(3) utilization of LIDAR data for obtaining information on the identified highway geometric features
(4) assessment of the feasibility of using LIDAR data for such applications.

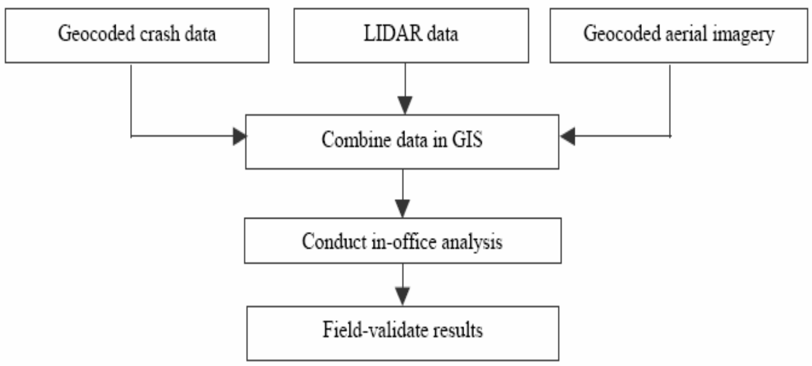

Figure 3.1. Adopted research methodology

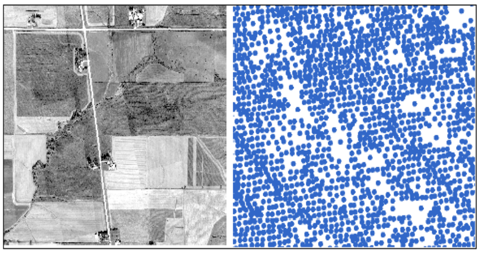

Figure 3.3. Sample orthophoto and converted LIDAR data

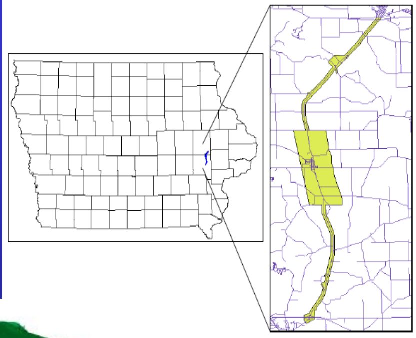

Figure 3.2. Study corridor

Figure 3.4. Sample 3D TIN of the study corridor passing through Solon, Iowa

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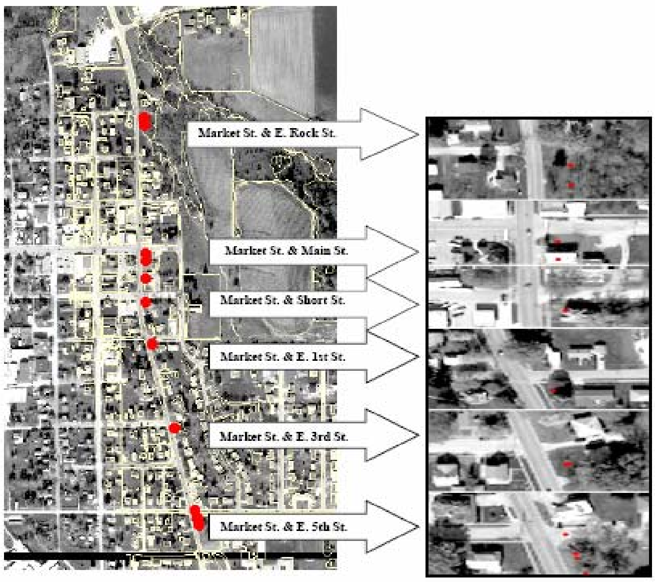

Figure 4.1. Six selected intersections and crash locations

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Figure C.4. Stopped driver's view at the intersection of Market St. and Main St.

Figure C.1. Stopped driver's view at the intersection of Market and East Fifth streets

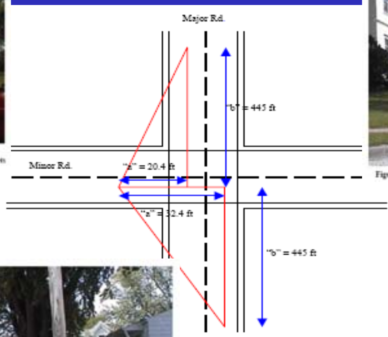

Figure C.3. Stopped driver's view at the intersection of Market St. and Short St.

Figure C.2. Stopped driver's view at the intersection of Market St. and E. First St.

Sight triangles for Case B1,
left turn from the minor road

The distance of the detected potential obstructions refers to the distance of the blue dots obtained during the line-of-sight analysis from the driver stopped on the minor road

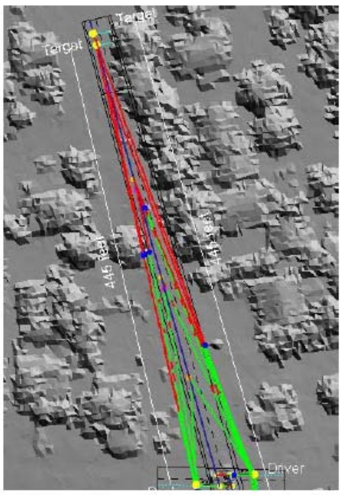

Figure 4.2. Multiple lines of sight at 100-ft interval along the major road (Market St. and E. Fifth St.)

Sixty-nine LIDAR bounds superimposed on 12 orthophoto bounds

summary

-66 potential sight distance obstructions➔ identified by the line-of-sight

-The intersection with the highest crash frequency involving older drivers was correctly found to have obstructions located within the intersection sight triangles.

-LIDAR data can be utilized for identifying potential sight distance obstructions at intersections. The safety of older drivers can be enhanced by locating and rectifying intersections with obstructions in sight triangles.

$30,000 was spent

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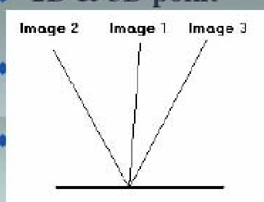
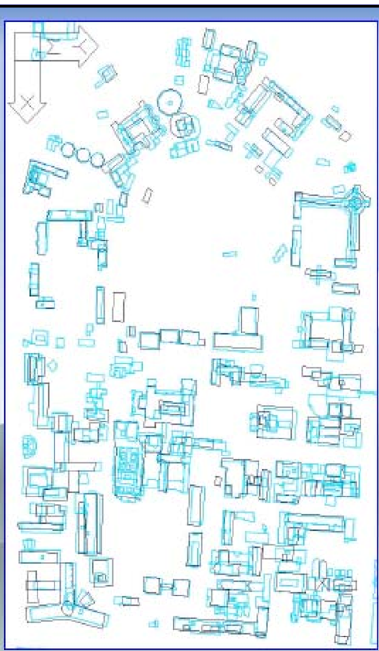
Melbourne *Ikonos* Test Field

- 3-fold image coverage
- 7km x 7km area (Δh < 100m)
- 40 GPS surveyed GCPs
- 19 building control pts.
- sub-pixel, multi-measurements to image features
- 2D & 3D point
- s
- for 2D
- n tests





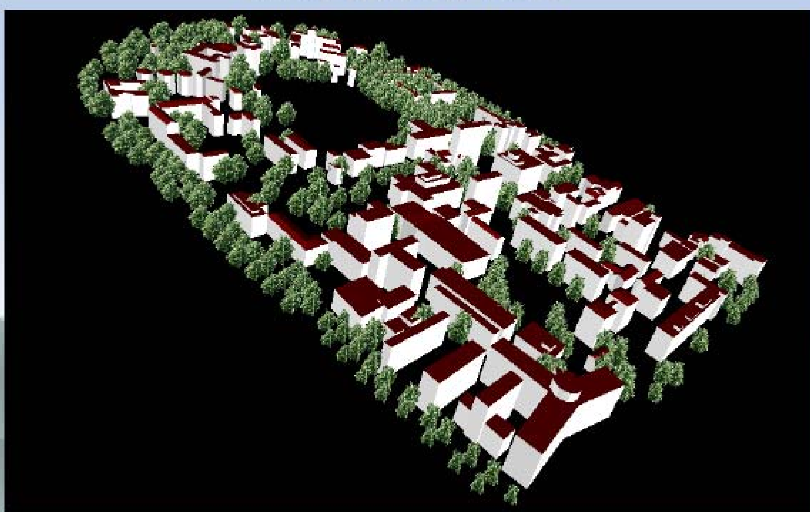
Building Extraction Completeness

***Ikonos* 1m Pan Stereo versus Aerial Photography (1:15K)**

- **Loss of roof structural detail**
- **Omission of 15% of buildings (small & large)**
- **Loss of form & generalisation**
- **Can detect new buildings (even small)**

Factors: shadows, resolution, edge definition, occlusions, noise & artifacts

3D Model of University of Melbourne Campus from *Ikonos* 1m B&W Stereo

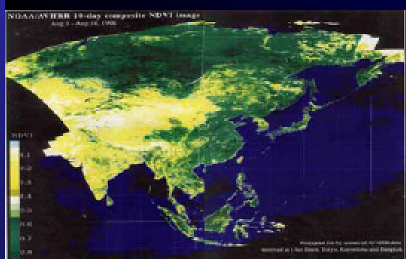


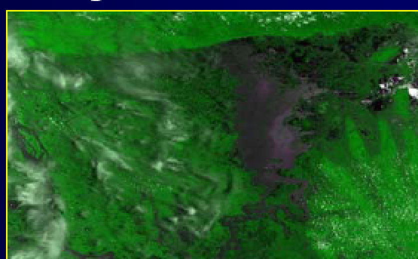
Produced with CyberCity Modeler

Pan-sharpened *Ikonos* 1m ortho-image draped over a DTM

NOAA/AVHRR - MODIS/TERRA Reception, Archiving and Distribution

- NOAA/AVHRR Since 15 November 1997
- TERRA/MODIS Since 25 May 2001
- Archiving all of the received data
- Produce 10days and Monthly NDVI
- Network Data Distribution over Internet for Near Real Time Environment Monitoring





MODIS Installation 22nd May 2001, AIT

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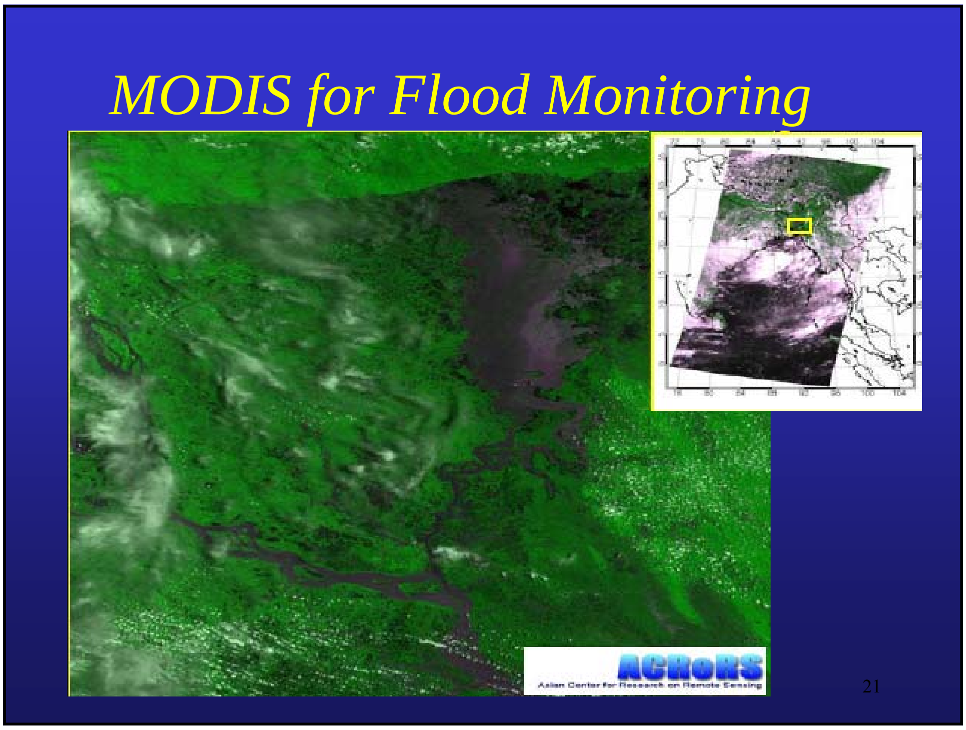
MODIS for Flood Monitoring
ACRoRS
Asian Center for Research on Remote Sensing
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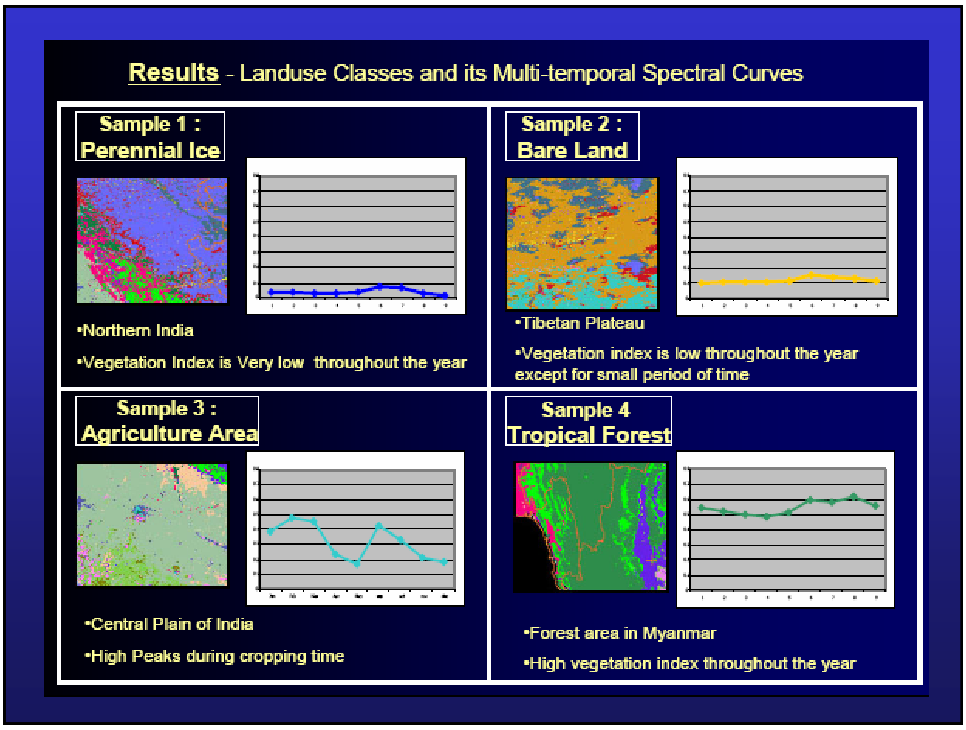
Results - Landuse Classes and its Multi-temporal Spectral Curves
Sample 1 : Perennial Ice
•Northern India
•Vegetation Index is Very low throughout the year
Sample 2 : Bare Land
•Tibetan Plateau
•Vegetation index is low throughout the year except for small period of time
Sample 3 : Agriculture Area
•Central Plain of India
•High Peaks during cropping time
Sample 4 Tropical Forest
•Forest area in Myanmar
•High vegetation index throughout the year

Planting pattern detection

Historical TM image
1989 TM

8 Years Later
1997 TM

Recent TM image for the TREES test site 125/61 on Sumatra
The TM image from 18 August 97 shows new oil palm plantation areas, partly established by replacing old plantations, partly by conversion of forests.

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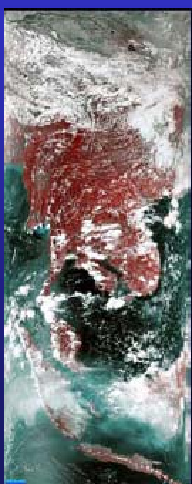
Forest Fire Monitoring from NOAA AVHRR-Thailand



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During the period of 4-16 July 2000, many fires were detected in Sumatra and Kalimantan of Indonesia.

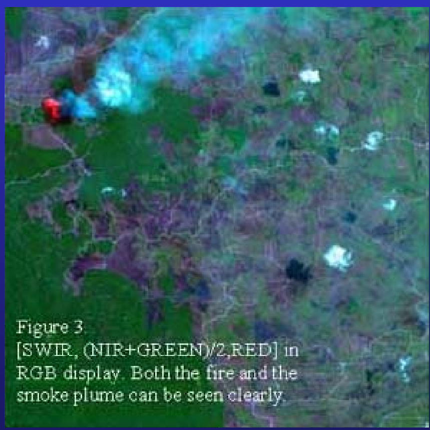

Figure 3 [SWIR, (NIR+GREEN)/2,RED] in RGB display. Both the fire and the smoke plume can be seen clearly.

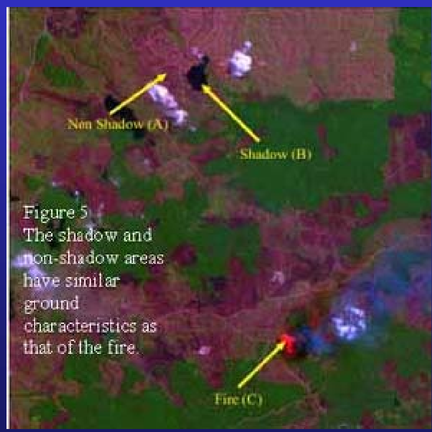

Figure 5 The shadow and non-shadow areas have similar ground characteristics as that of the fire.

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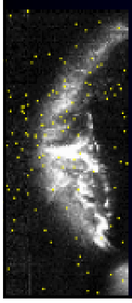
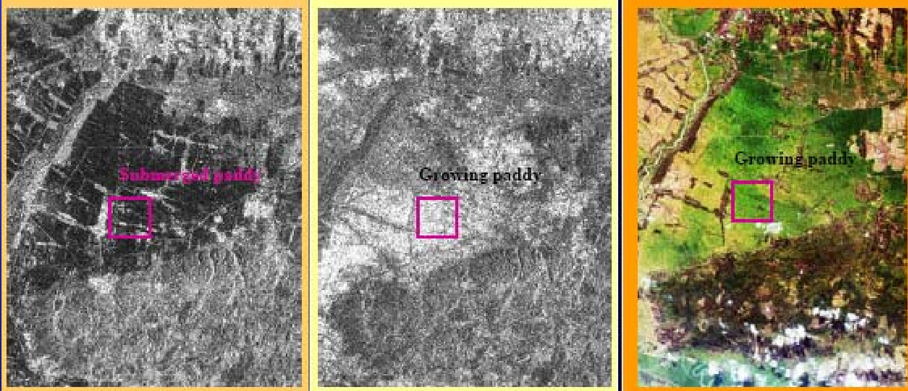
Defense Meteorological Satellite Program[DMSP]

Organizer	Department of Defense(DoD) program run by the Air Force Space and Missile Systems Center(SMC)
Orbit	a sun-synchronous, low altitude polar orbit at the altitude of 830 km / Period 101 min.



Each DMSP satellite monitors the atmospheric, oceanographic and solar-geophysical environment of the Earth. The visible and infrared sensors collect images of global cloud distribution across a 3,000 km swath during both daytime and nighttime conditions.

Rice Growth Monitoring using RADAR Remote Sensing

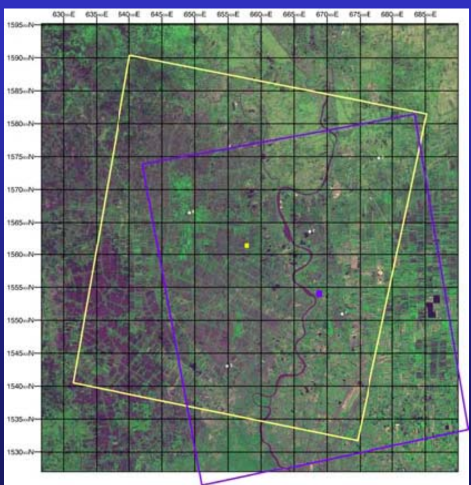


Radar image in March 1997: showing YOUNG PADDY in dark color

Radar image in May 1997: showing GROWING STATE OF PADDY in bright color

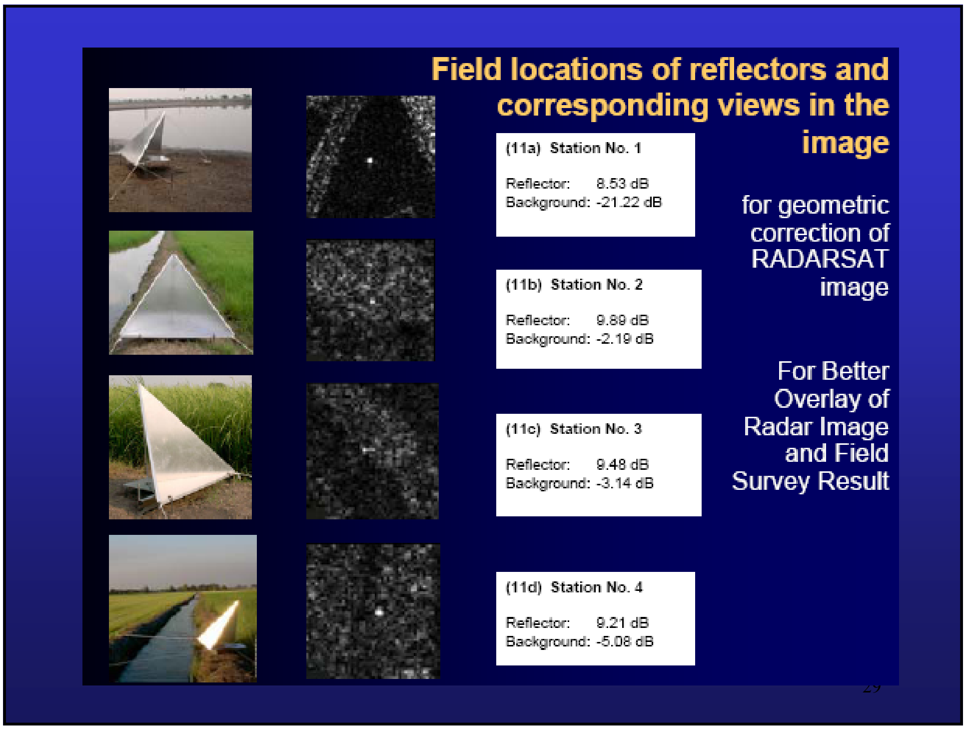
ADEOS image of the same area in May 1997 : TCC showing GROWING STATE OF PADDY

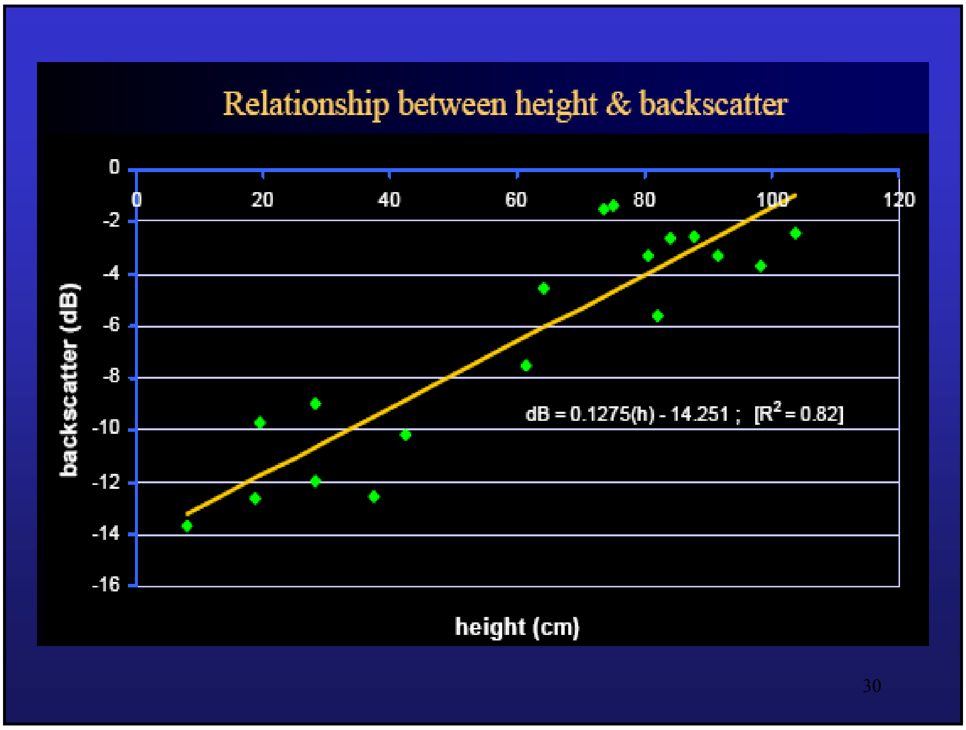
Rice Growth Monitoring Using Near Real Time RADARSAT Fine Beam SAR Data in Pathumthani

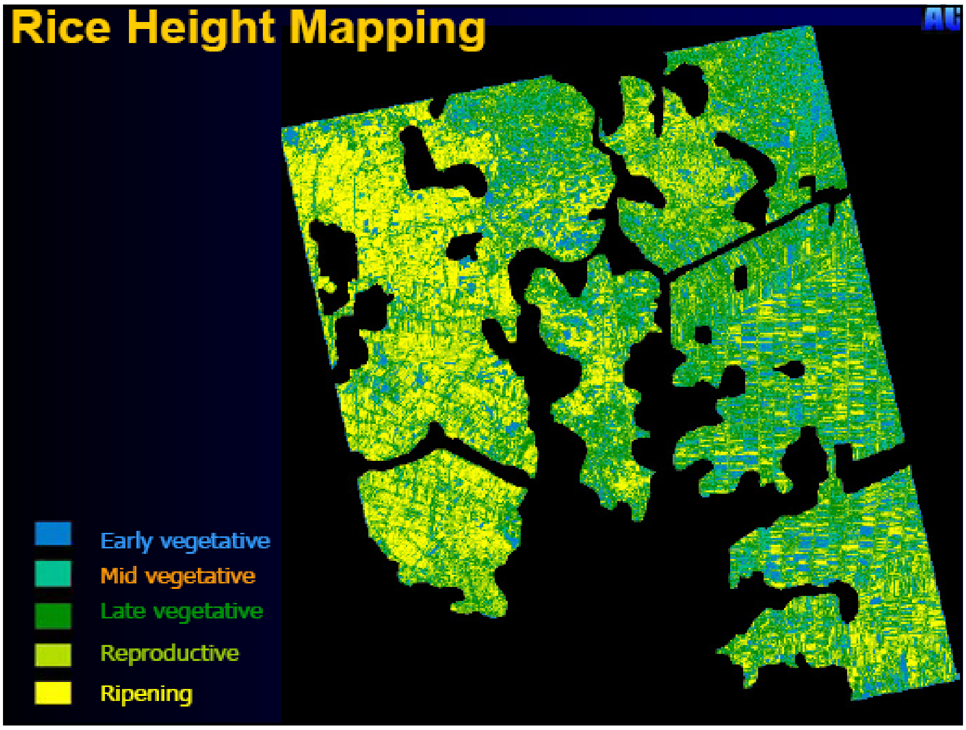


Deployment sites of corner reflectors, plotted On ADEOS AVNIR image

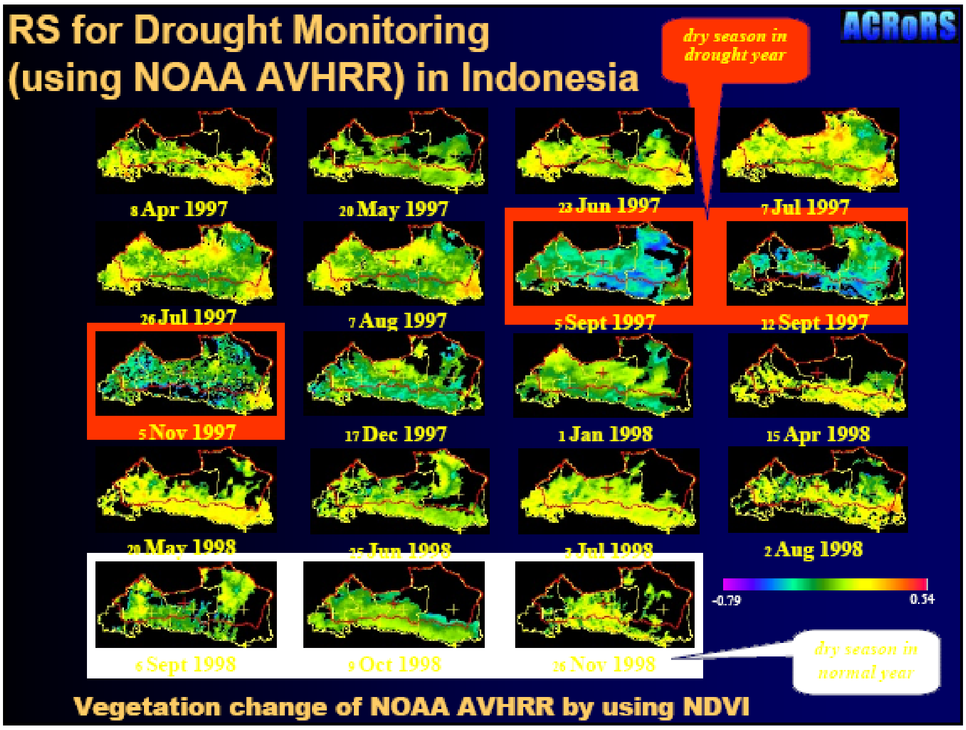
Canada – Japan – Thailand
Within 8 hrs after reception


Field locations of reflectors and corresponding views in the image
(11a) Station No. 1
Reflector: 8.53 dB
Background: -21.22 dB
(11b) Station No. 2
Reflector: 9.89 dB
Background: -2.19 dB
(11c) Station No. 3
Reflector: 9.48 dB
Background: -3.14 dB
(11d) Station No. 4
Reflector: 9.21 dB
Background: -5.08 dB
for geometric correction of RADARSAT image
For Better Overlay of Radar Image and Field Survey Result


Relationship between height & backscatter
backscatter (dB)
height (cm)
dB = 0.1275(h) - 14.251 ; [R2 = 0.82]
0
-2
-4
-6
-8
-10
-12
-14
-16
0
20
40
60
80
100
120
30

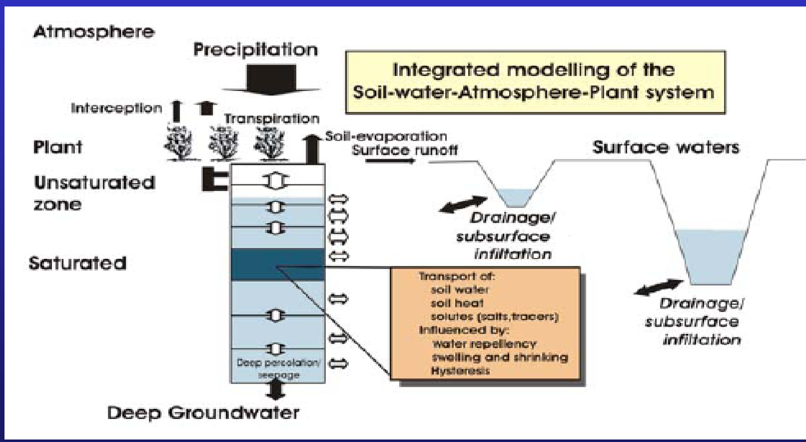


Rice Height Mapping
Early vegetative
Mid vegetative
Late vegetative
Reproductive
Ripening



RS for Drought Monitoring (using NOAA AVHRR) in Indonesia
ACRoRS
dry season in drought year
8 Apr 1997
20 May 1997
23 Jun 1997
7 Jul 1997
26 Jul 1997
7 Aug 1997
5 Sept 1997
12 Sept 1997
5 Nov 1997
17 Dec 1997
1 Jan 1998
15 Apr 1998
20 May 1998
25 Jun 1998
2 Jul 1998
2 Aug 1998
-0.79
0.54
6 Sept 1998
9 Oct 1998
26 Nov 1998
dry season in normal year
Vegetation change of NOAA AVHRR by using NDVI

Soil-Water-Atmosphere-Plant Model (SWAP)



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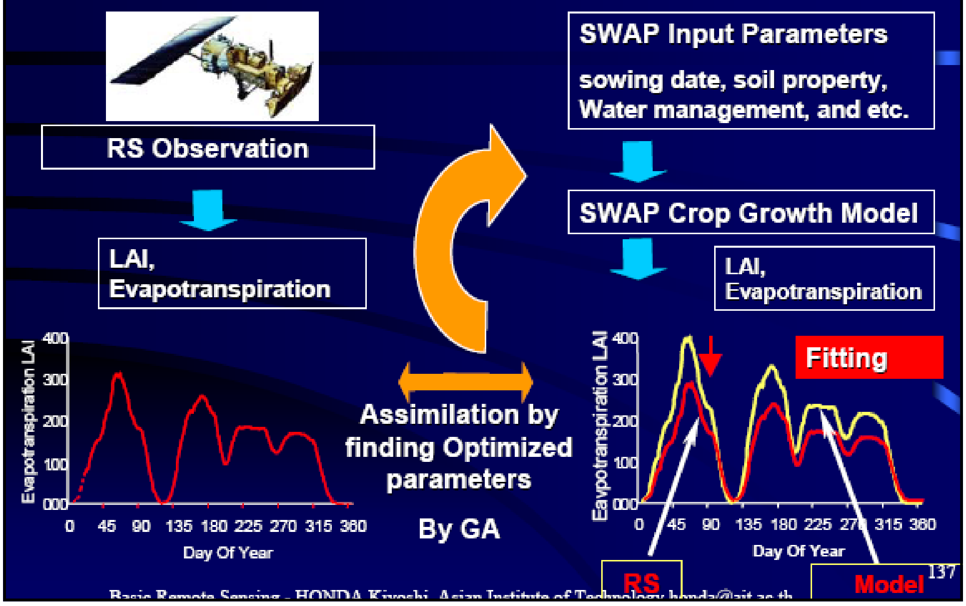
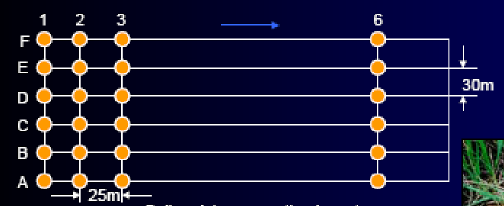
SWAP Model Parameter Determination
- Data Assimilation using RS and GA -



Basic Remote Sensing - HONDA Kiyoshi, Asian Institute of Technology honda@ait.ac.th 137

Soil moisture measurement



Soil moisture sampling layout

Soil sample collected at a sampling point using a 100-cc core barrel

Soil samples oven-dried for 24 hours at 105 °C

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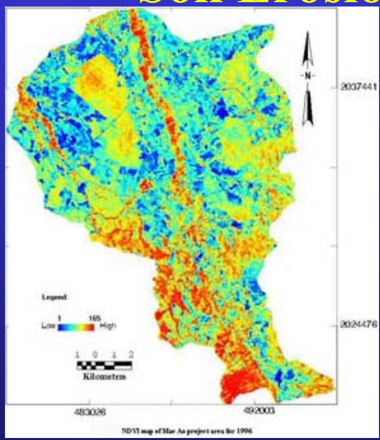
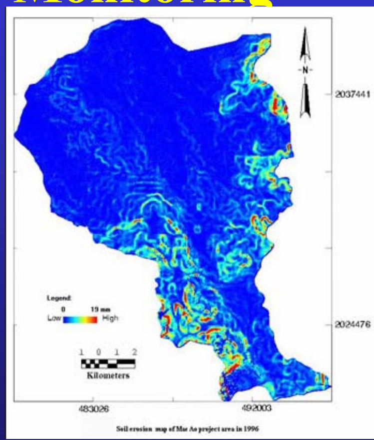
Remote Sensing for Coastal Zone Management Shrimp Farm extension in Chantaburi(1987- 1995)

February 1987:LandSat-TM **August 1997: ADEOS-AVNIR**

Remote Sensing for Coastal Zone Management Shrimp Farm extension in Chantaburi(1987- 1995) Extent of shrimp cultivation increase within ten years period in Chantaburi coastal area is clearly visible. Area shown within yellow square/circle in 1997 image are the area converted to shrimp farms.

Soil Erosion Monitoring





NDVI Map
(Normalized Differential Vegetation Index)

Soil Erosion rate
0.91 mm/year

Soil Erosion Map

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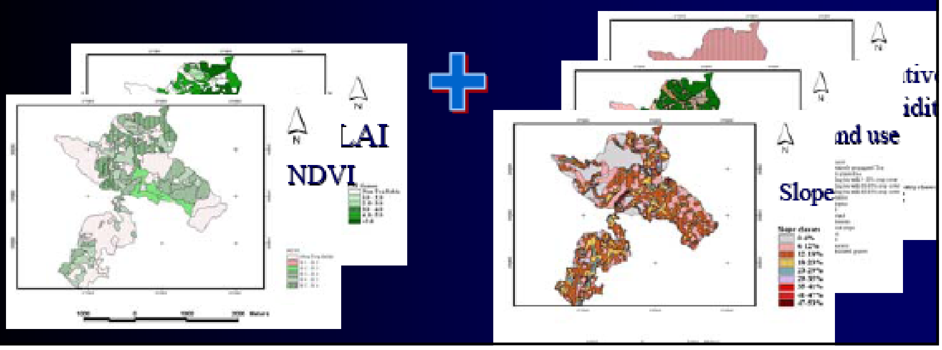
Model for estimating yield using LAI, topographic and meteorological variables

Considered parameters :

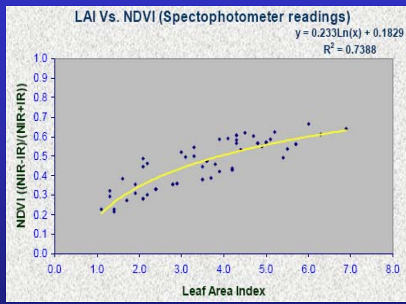
Yield, satellite image derived LAI, topographic and meteorological variables

Method :

- assigning weights for each parameter
- the relationship between average yield and weight of each parameter



Develop a model to find the correlation between LAI and NDVI derived from spectrophotometer readings



Tea yield Model

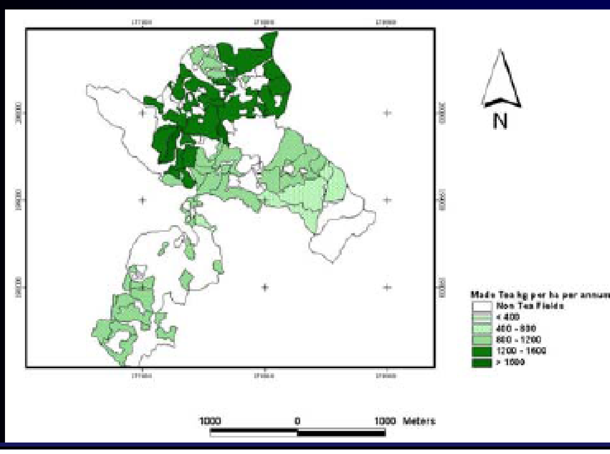
$$Yield = -603.923 + 50.124w_d - 23.5w_r - 14.049w_l + 65.845w_i + 513.54w_a + 39.54w_h + 65.695w_f + 46.338w_e$$

Where;

w_d = Soil depth weight; w_r = Rockiness cover weight; w_l = Landuse type weight

w_i = LAI weight; w_a = Age of tea plantation weight; w_h = Relative humidity weight

w_f = Rainfall weight; w_e = Elevation weight



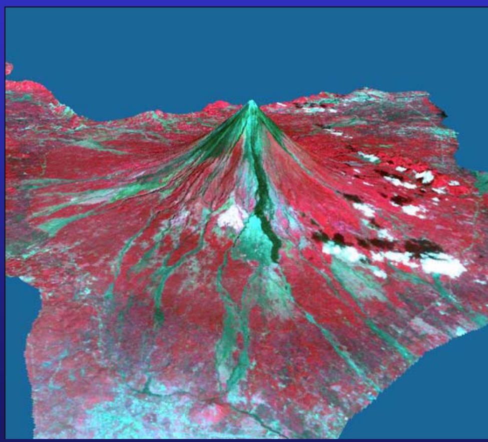
Accuracy = 95%

Predicted average yield map for year 2000 for Westhall estate: 2000 – 1084 kg made tea ha^{-1}

Mt. Mayon Volcano Comprehensive Disaster Prevention Master Plan

GIS Data Development for Planner

- Historical River planform Change by lava, pyroclastic flow, lahar
- Sediment Production Estimation for river structure planning



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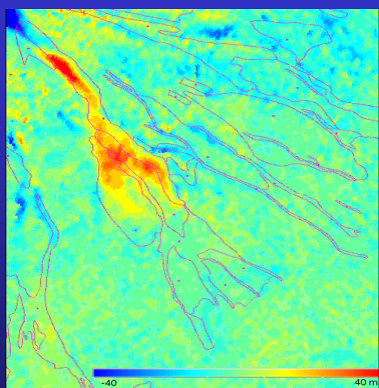
Lava Deposit of Mr. Mayon (Pawa Burabod riverbed)



Estimation of Lava Deposit Height using SAR Interferometry
INSAR result Topographic difference

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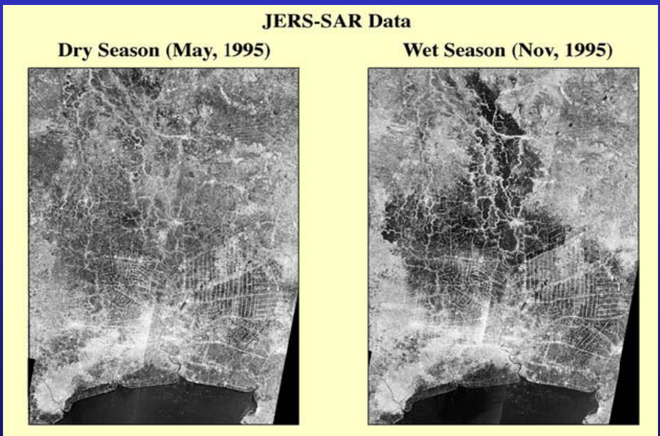
Flood Monitoring using JERS SAR 12 Scenes Mosaic



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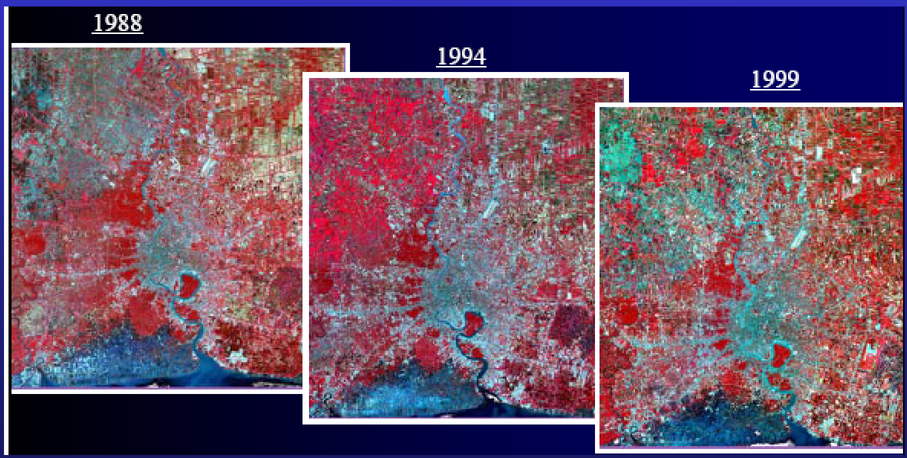
Bangkok Urban Area Expansion 1988 - 1999



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Urban extent from 1988 to 1999 using classified Landsat TM

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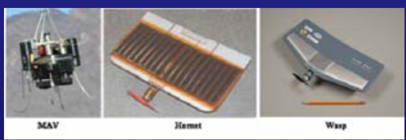
Military



Micro Air Vehicles (MAV)

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GPS

Global Navigation Satellite Systems (GNSS)

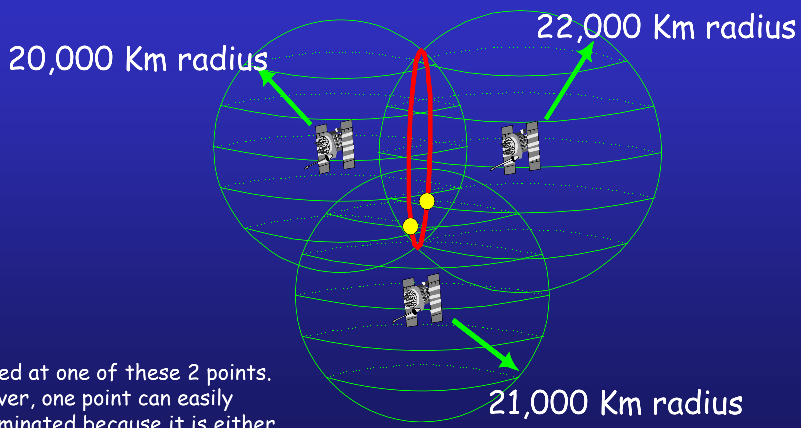
- NAVSTAR
  - USA
- GLONASS
  - Russians
- Galileo
  - Europeans

How GPS works?

- Range from each satellite calculated

  range = time delay X speed of light
- Technique called <u>trilateration</u> is used to determine you position or "fix"
  - Intersection of spheres
- At least 3 satellites required for 2D fix
- However, 4 satellites should always be used
  - The 4th satellite used to compensate for inaccurate clock in GPS receivers
  - Yields much better accuracy and provides 3D fix

Three SV ranges known



Located at one of these 2 points. However, one point can easily be eliminated because it is either not on earth or moving at impossible rate of speed.

Debris flow

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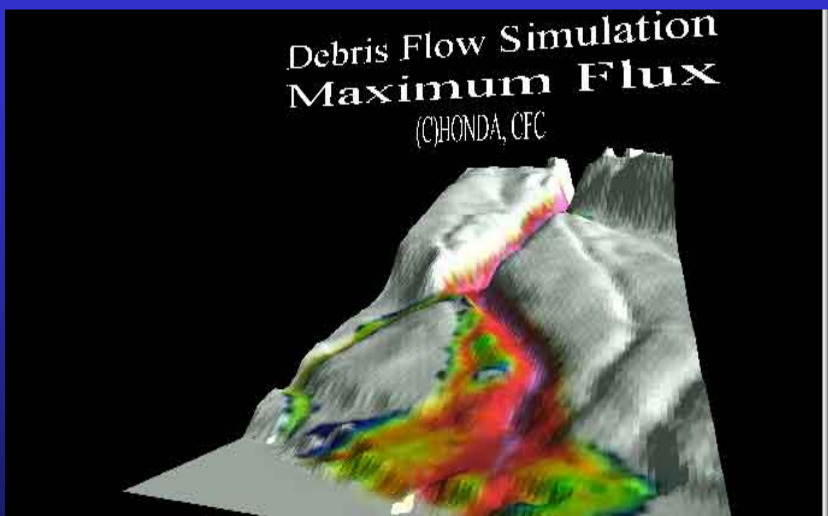

http://www.star.ait.ac.th/~honda/debris.html

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Characteristics of R/S

- Wide Area global 1 scene 185*185km
- Quick 1 scene in 25sec
- Multi Temporal Every 16days
- Multi Spectral 8 bands
- Computer fit digital data - algorithm
- Map Projection UTM
- Example of Landsat 7 Satellite

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Trade-off in Performance

- Spatial Resolution
  (1 observation unit on ground surface)
- 30 m - 250km - 1km
- Temporal Resolution
- 16 days - 1day
- Spectral Resolution
- 7 channel vs 36 channel
- Observation Extent

– 185 km vs 2,300km

- S/N

– 8bits vs 10bits

- cost

– 1 scene 800US$ vs Free (Broadcast)

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Advantage of RS

- Wide Coverage, Periodical Observation
- Variety of Observing Method
- Multi-resolution – Multi-temporal – Multi-spectral
- Global Environment – Local Application
- Application Field
- Hydrology, Oceanography, Global Env. Study, CO_2
- Agriculture, Forestry, Fisheries, Ecological Mapping
- Coastal zone management, Health Management, Energy
- Fire, Oil-spill, Volcano, Earthquake, Flood, Ice,
- Land use mapping, Cadastral Mapping, Topographic Map, Change Detection
- Military
- Use wisely by understanding advantage and limitation

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Limitation

Low resolution

- Spatial Resolution
- Geo-location
- Data Handling

  Format: Local format

  Not enough Support from commercial software

  Projection
- 10bits data
- Difficulty in implementing local processing
- system
- Off-Nadir Observation
- Strong Effect of Bi-directional Reflectance
- BRDF

High resolution

Limitation of High-Reso

Re-Visit Time

2 – 18 days

Cloud Cover Project planning

Spectral Information

Panchromatic to several bands only

S/N

Normally 6-8 bits

Geo-location Distortion by topographic effect

(edge, highmountains)

Off-Nadir Observation Coverage

Several 10km –180km

Cost Usually not free

Sometimes expensive Super-high reso: ExpensiveSatellite Geometry Model: sometimes not open

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Advantage :High and low resolution satellite

Low resolution

High Multi-Temporal
Global Coverage
Multi-Spectral Information
Cloud Free Products
Free Data, Free Software
Series of algorithm for estimating environmental physical parameter.
Local Receiving is feasible
Free for receiving
S band – X band
100,000 US$-500,000US$
Hyper-Spectral Information e.g. 36 ch.
Improved Resolution to 250m-500m
Value Added Data Product, e.g. MODIS
Network Data Distribution, AIT, UT, NASA
Near Real time Monitoring, several hrs.

High resolution

-Advantage of High-Resolution
Easy for interpretation
- Good products line Systematic
High-Precision
- Good search/ordering system
Commercial
- Distributor Easy Handling
Common formats
Supported by various software
Good combination with 1/100,00 –1/50,000 maps
Plenty of Application examples
Improved resolution Multi-Spectral

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Selection between: Low to Moderate Resolution Optical Satellites

•Low to Moderate resolution satellite data with their resolution of 250 to 1km is important to regional to global scale environmental monitoring.
•The advantage of these data are their frequent observation which covers the whole globe within one day. Some satellites have morning and afternoon satellites which gives us twice a day observation.
•In spite of its low spatial resolution, its high multi-temporal capability, high-sensitivity sensors, multi-spectral capability provide us with excellent data and application opportunity.
•Also, recent effort to provide the data in systematic way such as distribution on internet, producing value added data has been enhancing its usability.

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RADAR RS

SAR(Synthetic Aperture Radar)

- **All weather capability**
- **Construction of short-interval time series through cloud cover**
- **crop-growth cycle**
- **Ground Roughness (flat or rigid)**
- **Moisture :**

  - soil moisture
- **Structure :**

  - vegetation height

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Reference:

Assoc.Prof.Dr.HONDA Kiyoshi, Lecture Note .School of Engineering and Technology ,AIT Thailand.

Suggested Web Sites:

- AUSLIG (http://www.auslig.gov.au/)
- Space Imaging (http://www.spaceimage.com/)
- Australian Bureau of Meteorology (http://www.bom.gov.au/sat/intro/paper1intro.shtml)
- JPL Radar Site (http://www.jpl.nasa.gov/radar/sircxsar/)
- Australian geological Survey Organization (http://www.agso.gov.au/)

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END

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