Geoinformatics for Environmental Information Collection, Monitoring and Management

Lal Samarakoon
Director, Geoinformatics Center & Visiting Scientist of JAXA
Asian Institute of Technology, Thailand

Geoinformatics Center
Established in 1999 (Self-Funded)

Sustainable Development Goals

At the United Nations Sustainable Development Summit on 25 September 2015, world leaders adopted the *2030 Agenda for Sustainable Development, which includes a set of 17 Sustainable Development Goals (SDGs) to end poverty, fight inequality and injustice, and tackle climate change by 2030*

The objective was to produce a set of universally applicable goals that balances the three dimensions of sustainable development:

- ✓ **environmental,**
- ✓ **social,**
- ✓ **economic.**

Sustainable Development Goals

Source: http://www.globalgoals.org/

Use of Geoinformatics for SDG context ..

- **Environmental/Social resource *Management***
- **Monitoring & Assessment of SDG Key indicators**

Environmental Resources Management

- ✓ Environmental resource management is the management of the interaction and impact of human societies on the environment,
- ✓ It tries to identify factors affected by conflicts that rise between (meeting) **needs** and (protecting) **resources**: *sustainable development*

http://en.wikipedia.org

Needs empowering societies with information, evidence, causes/effects, and importantly, participation of societies/individuals.

Indicators (Goals): Monitor/Asses/Supported by Geoinformatics

Goal 1: Poverty

- ***Proportion below poverty line***
- ***Access to basic needs***
- ***Land Tenure***

Goal 2: End Hunger and Achieve Food Security

- ***Productivity***
- ***% Agriculture lands in sustainable agriculture***
- ***% Agriculture lands under irrigation***
- ***Food prices anomalies***

Note: The indicators are still being discussed and due to be finalized in March 2016.

Indicators (Goals): Monitor/Asses/Supported by Geoinformatics

Goal 6: Sustainable Management of Water

- *Water bodies and water quality*
- *Water Use*
- *Fresh water ecosystems and changes*

Goal 9: Sustainable industrialization

- *CO2 emissions*

Goal 11: Sustainable Cities

- *% Slum and informal settlements*
- *Rate of land consumption rate / population*
- *Disaster/Risk and vulnerable communities*
- *Particle Matter (PM2.5/PM10)*
- *Cities with DRR plans*

Indicators (Goals): Monitor/Asses/Supported by Geoinformatics

Goal 13: Combat Climate Change

- ***Disaster related losses***
- ***Climate related indicators***

Goal 14: Coastal and Marine Development

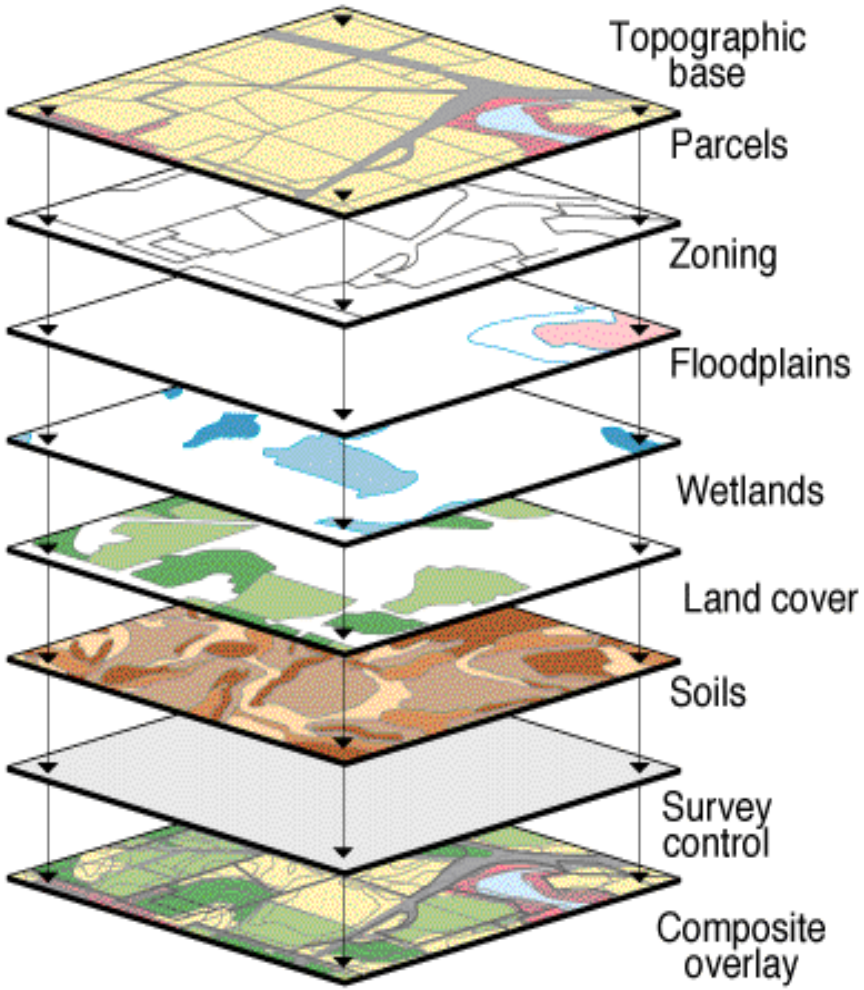
- ***Proportion of fish-stock within sustainable level***
- ***Sustainable use of fishery***

Goal 15: Sustainable use of Terrestrial Eco System

- ***% Forest Area and changes***
- ***% Forest cover under Sustainable Management***
- ***% degraded lands and changes***
- ***Biodiversity + ecosystem values in development plans***

Geoinformatics in Environment Applications

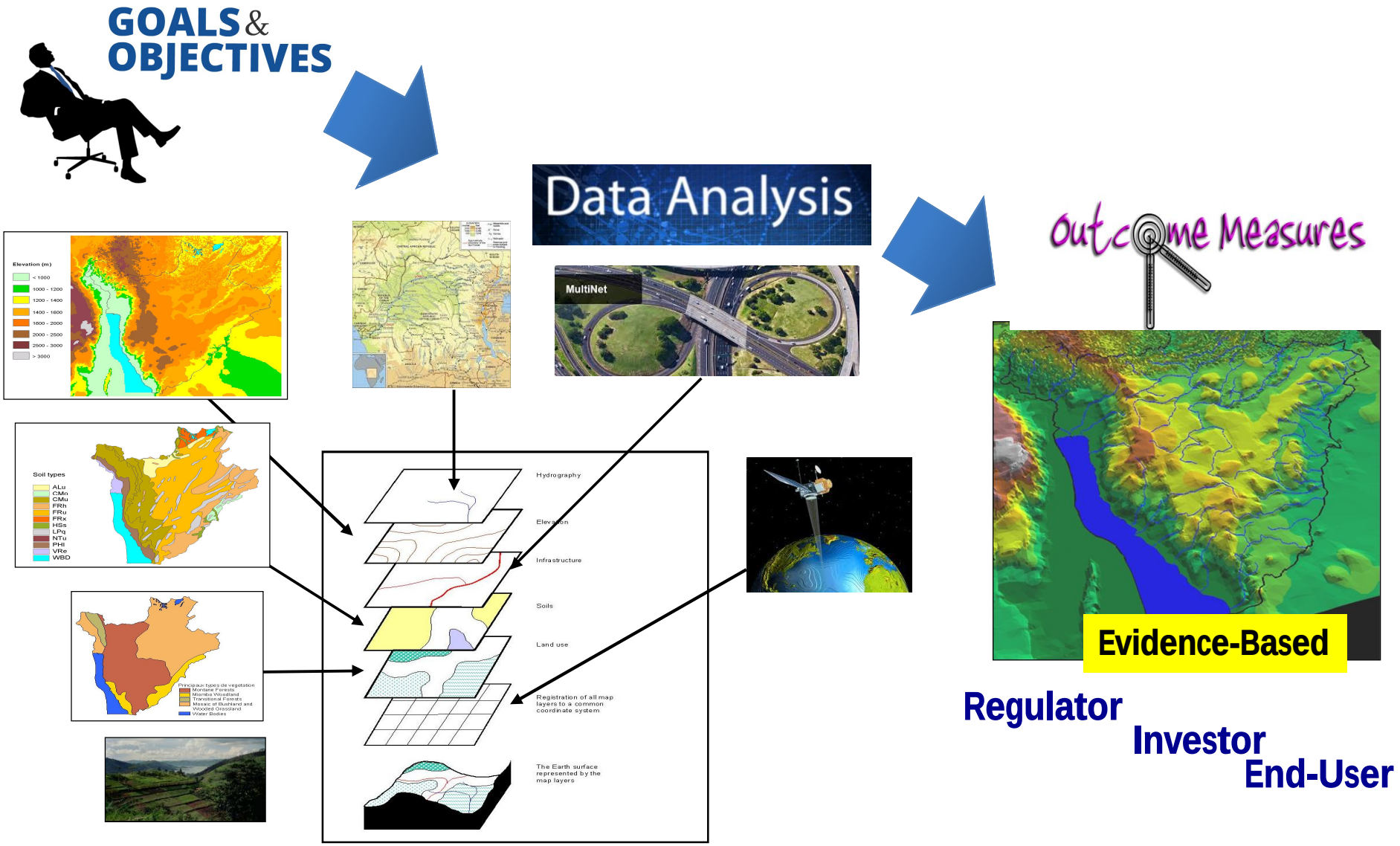
- Location information (RS/GIS)
- Monitoring Changes (RS)
- Spatial variability (RS/GPS)
- Assessing the impact of Development (GIS)
- Simulation of processes in the development and natural environment (Model+GIS+RS+GPS)



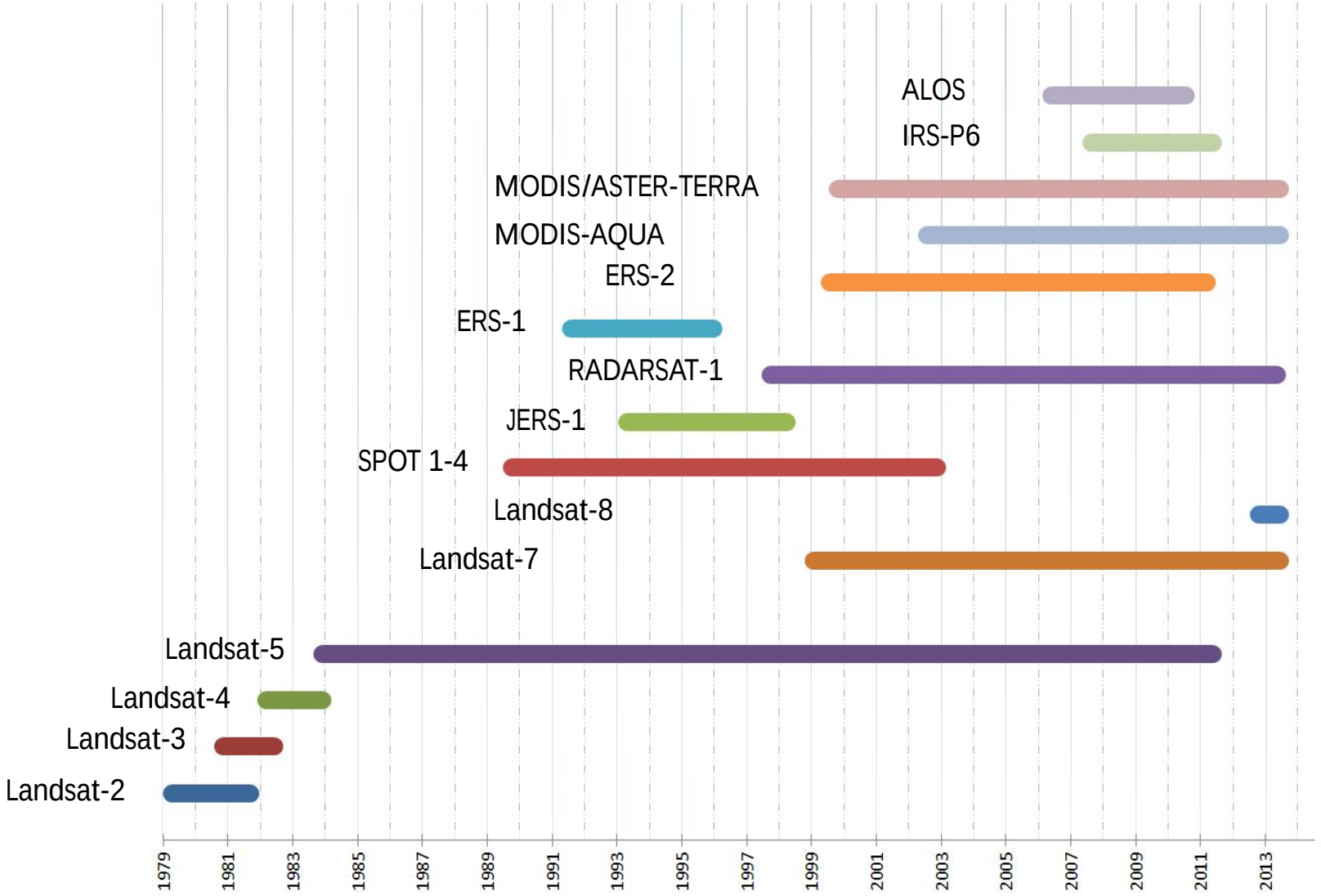
Potential applications.....

- **Natural resources management**
  - Wild life, Forests: assessment, management and protection
  - Water resources: management and conservation
  - Soil erosion and conservation
- **Hazard control**
  - Natural hazards : Floods, Drought, Tsunami etc.
  - Manmade hazards : Dam failures, slope failures
- **Pollution emissions**
  - Airquality moniotoring, Solid waste management
- **Ecosystem health**
  - Defining, Assessing and monitoring ecosystems
  - Land use planning
  - Fishing and ocean resources
- **Climate change**
- **Water resources monitoring**
  - Water quantity, rainfall, water quality,

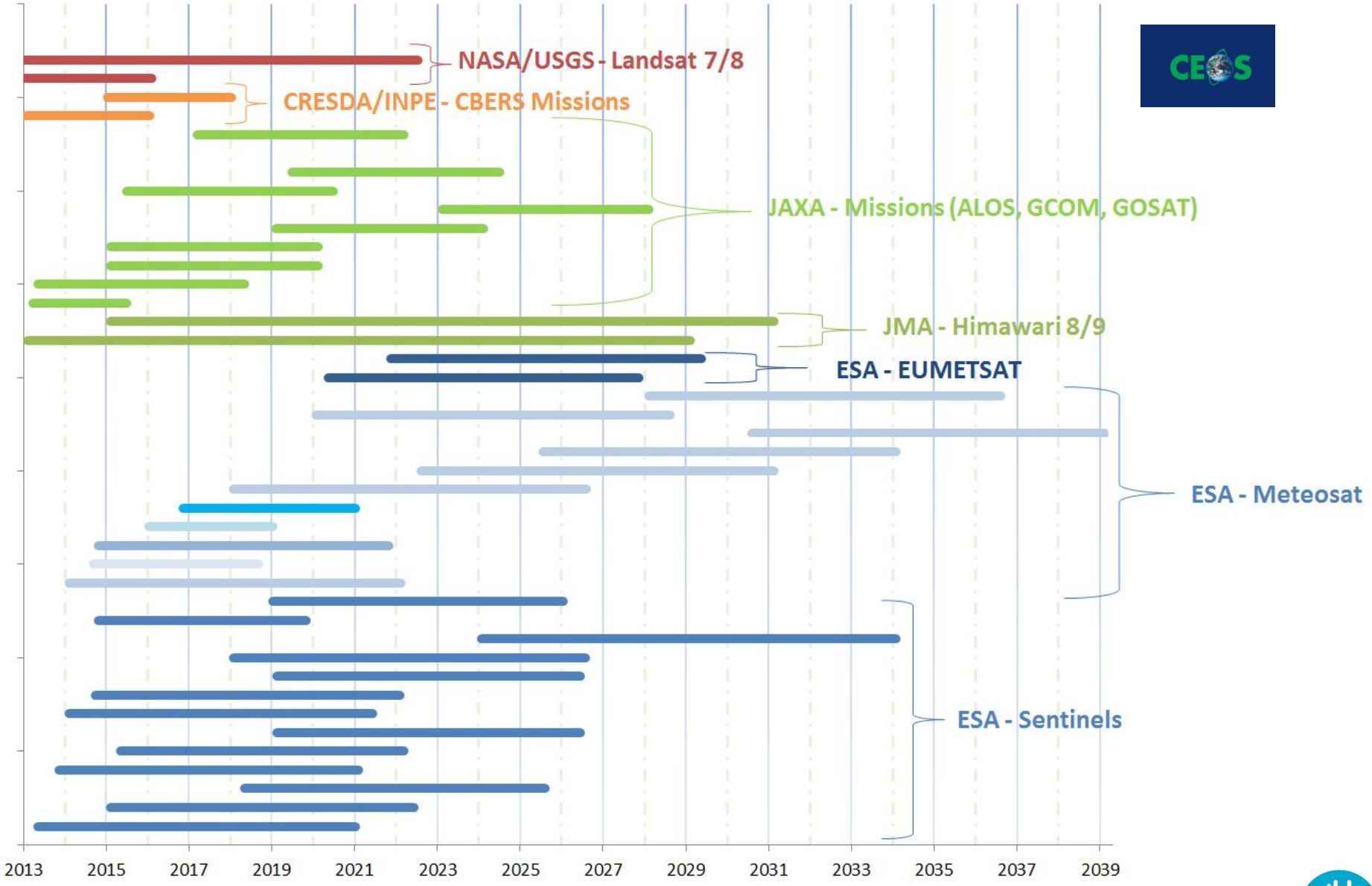
Geoinformatics Application Process

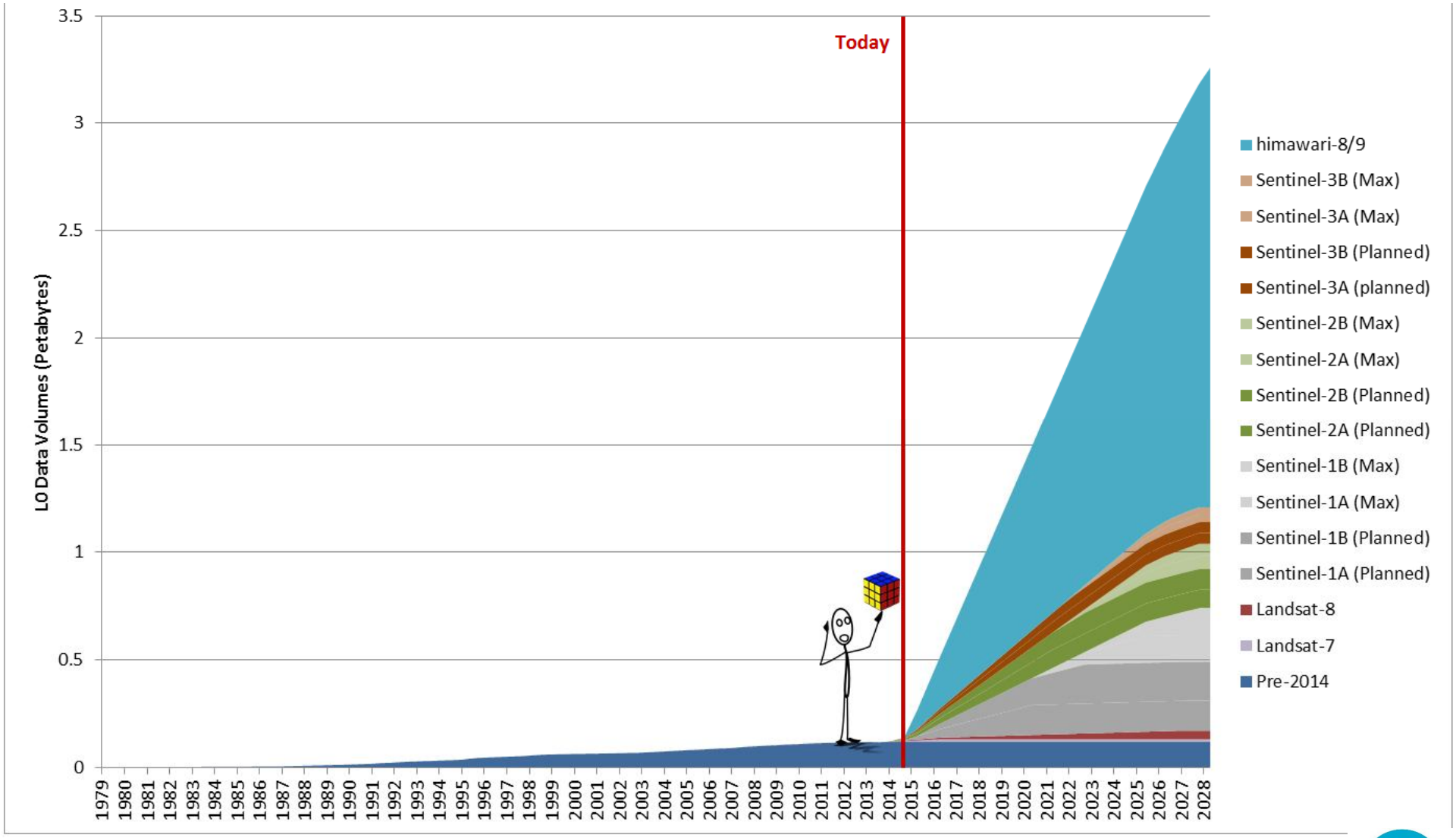


Some Satellite Data of Last 50 years



Challenges Ahead with Satellite Data




Today
L0 Data Volumes (Petabytes)
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himawari-8/9
Sentinel-3B (Max)
Sentinel-3A (Max)
Sentinel-3B (Planned)
Sentinel-3A (planned)
Sentinel-2B (Max)
Sentinel-2A (Max)
Sentinel-2B (Planned)
Sentinel-2A (Planned)
Sentinel-1B (Max)
Sentinel-1A (Max)
Sentinel-1B (Planned)
Sentinel-1A (Planned)
Landsat-8
Landsat-7
Pre-2014

Potential Data sources....

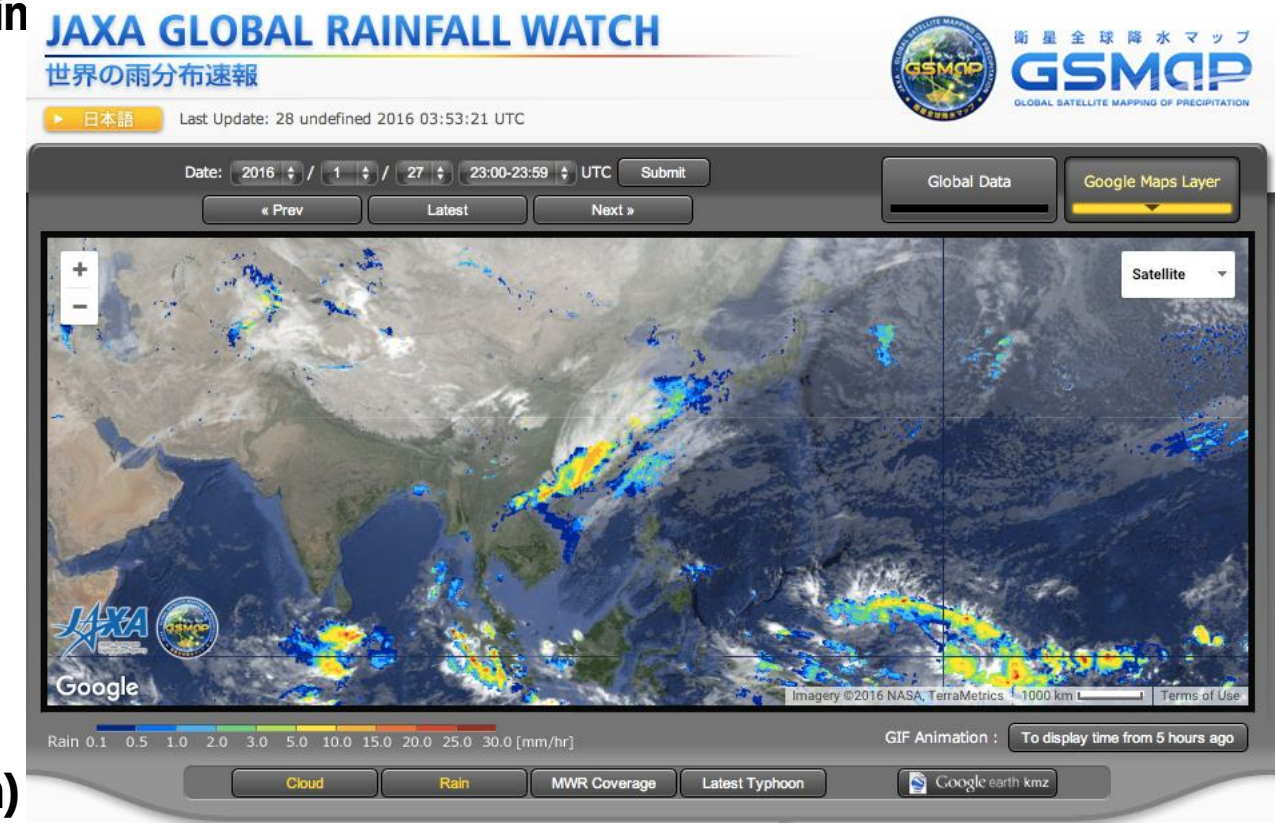
Data Source	Type of data	Format	Resolution	Available on
Natural Earth	Cultural / Physical data	Vector Raster	1:10m, 1:50m, 1:110m	http://www.naturalearthdata.com
Global Map	Land cover, elevation, drainage, etc.	Vector	1km	http://www.gsi.go.jp/kankyochiri/globalmap_e.html
UNEP Environmental Data Explorer	Forest cover, evapotranspiration, temperature	Geospatial		http://geodata.grid.unep.ch/
ASTER GDEM	global elevation data	Raster	30m	http://asterweb.jpl.nasa.gov/gdem.asp

Data Source	Type of data	Format	Available on
NCAR GIS Climate Change Scenarios	Climate data	Vector Raster	http://gisclimatechange.ucar.edu/
Atlas of the Biosphere	environmental variables , soil pH, snow depth etc.	Raster	http://www.sage.wisc.edu/atlas/maps.php
GSMaP	Precipitation data	Raster	http://sharaku.eorc.jaxa.jp/GSMaP_crest/
OpenStreetMap	Crowdsourced data	Vector Raster	http://www.openstreetmap.org/
Gridded Population of the World (GPW)	Socioeconomic Data	Vector	http://sedac.ciesin.columbia.edu/data/collection/gpw-v3
Land Sat	Satellite imageries	Vector Raster	http://landsat.usgs.gov http://earthexplorer.usgs.gov
MODIS	Various Products	Raster	http://modis.gsfc.nasa.gov/data/dataprod/

Global Rainfall Map in NRT

http://sharaku.eorc.jaxa.jp/GSMaP/index.htm

- Started November 14, 2007.
- hourly global rainfall maps in near real time (about four hours after observation) is available.
- Data:
  - TRMM TMI,
  - Aqua AMSR-E,
  - DMSP SSM/I and
  - GEO IR
- Other Contents:
  - Latest 10 hr Browse images
  - 24hr animation
  - KMZ files (Google Earth)



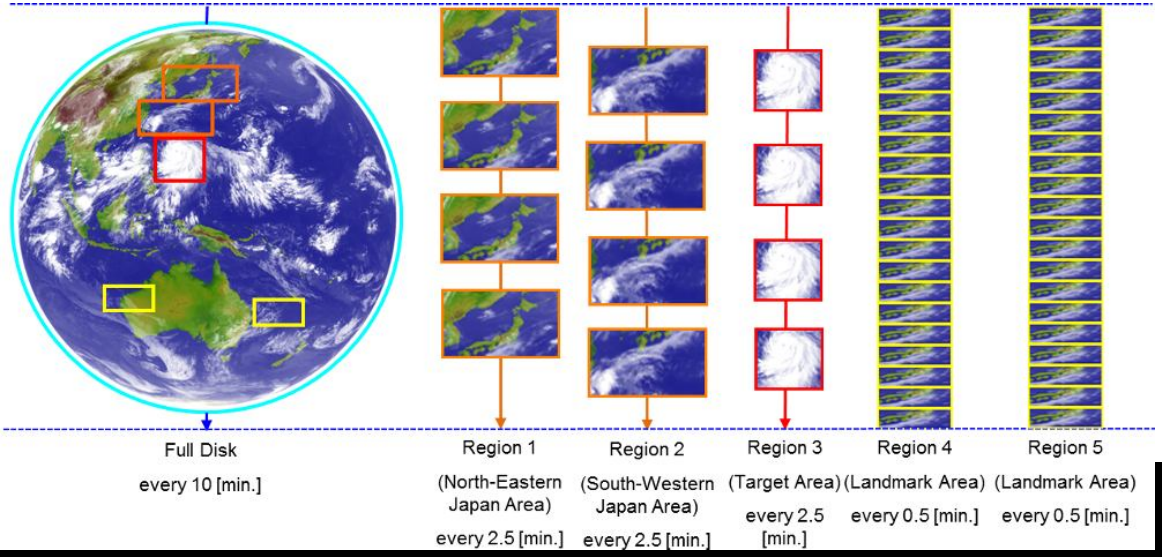
>>Hourly rainfall maps about 4 hours after observation

HIMAWARI-8, 9

HIMAWARI-8

- **Operation start ; Jul 7, 2015 ~ present**
- **Geostationary satellite**
- **Features:**
  - •Multi-Spectral bands :
    3bands for VIS, 3bands for NIR and 10bands for IR.
  - •High Spatial resolution :
    0.5-1 [km] for VIS, 1-2 [km] for NIR/IR.
  - •Frequent observation :
    10 [min] for Full disk.

◆**HIMAWARI-9** is scheduled for launch in 2016.



Wave length [μm]	Himawari-8/9				MTSAT-1R/2	
	Band number	Spatial resolution at SSP [km]	Central wave length [μm]		Channel name	Spatial resolution at SSP [km]
			AHI-8 (Himawari-8)	AHI-9 (Himawari-9)		
0.47	1	1	0.47063	0.47059	–	–
0.51	2	1	0.51000	0.50993	–	–
0.64	3	0.5	0.63914	0.63972	VIS	1
0.86	4	1	0.85670	0.85668	–	–
1.6	5	2	1.6101	1.6065	–	–
2.3	6	2	2.2568	2.2570	–	–
3.9	7	2	3.8853	3.8289	IR4	4
6.2	8	2	6.2429	6.2479	IR3	4
6.9	9	2	6.9410	6.9555	–	–
7.3	10	2	7.3467	7.3437	–	–
8.6	11	2	8.5926	8.5936	–	–
9.6	12	2	9.6372	9.6274	–	–
10.4	13	2	10.4073	10.4074	IR1	4
11.2	14	2	11.2395	11.2080	–	–
12.4	15	2	12.3806	12.3648	IR2	4
13.3	16	2	13.2807	13.3107	–	–

Central wavelengths of the AHIs are "Moment center wavelength" (provided by Exelis).
SSP : sub satellite point

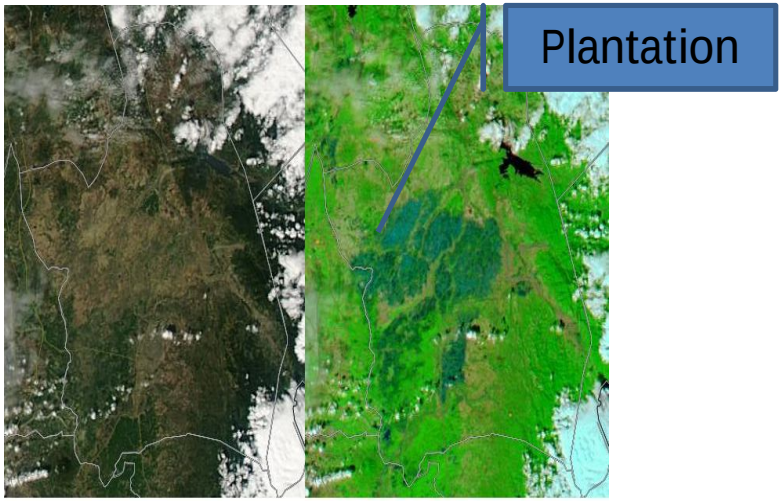
http://www.jma-net.go.jp/msc/en/

©JMA

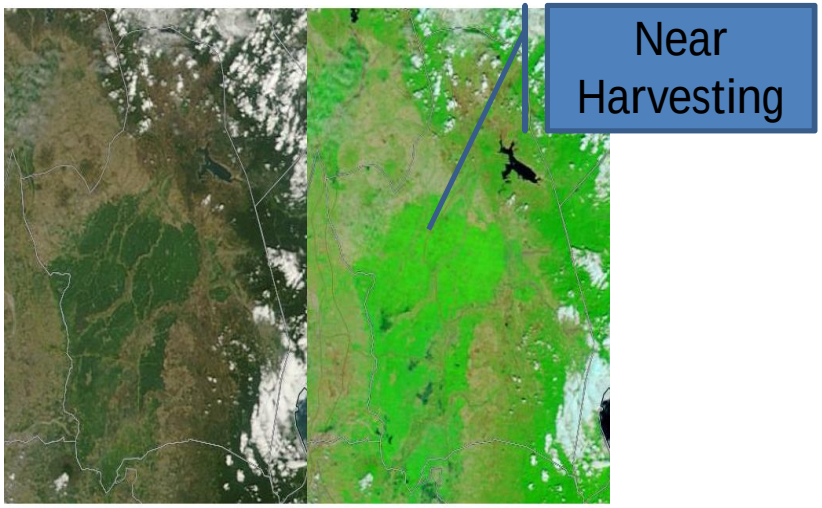
Sustainable Agriculture

- UN Project that global population will reach 10 billion between 2050 and 2100.
- Food production should raised estimated 60 % over next 40 years
- It's essential for human civilization to conserve Agricultural Land, Water, Soil and Infrastructure.
- In order to do that, agricultural practices must change through technology in order to use less and produce more including biotechnological improvements, use of large machineries, precision agriculture, etc.
- In the process of assessing agricultural resources Remote Sensing and GIS gives unique prospective due to it's ability to manage large spatial extent and ability to observe wide variations of data.

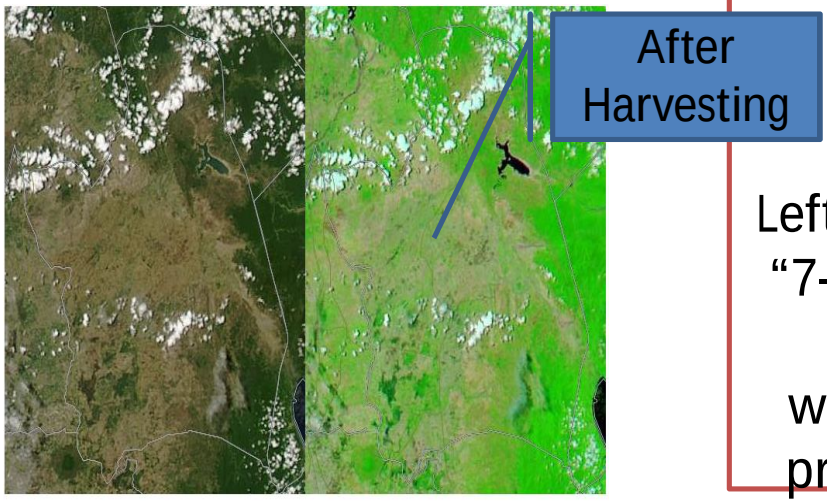
Texture Change in Paddy Areas



2013-01-15



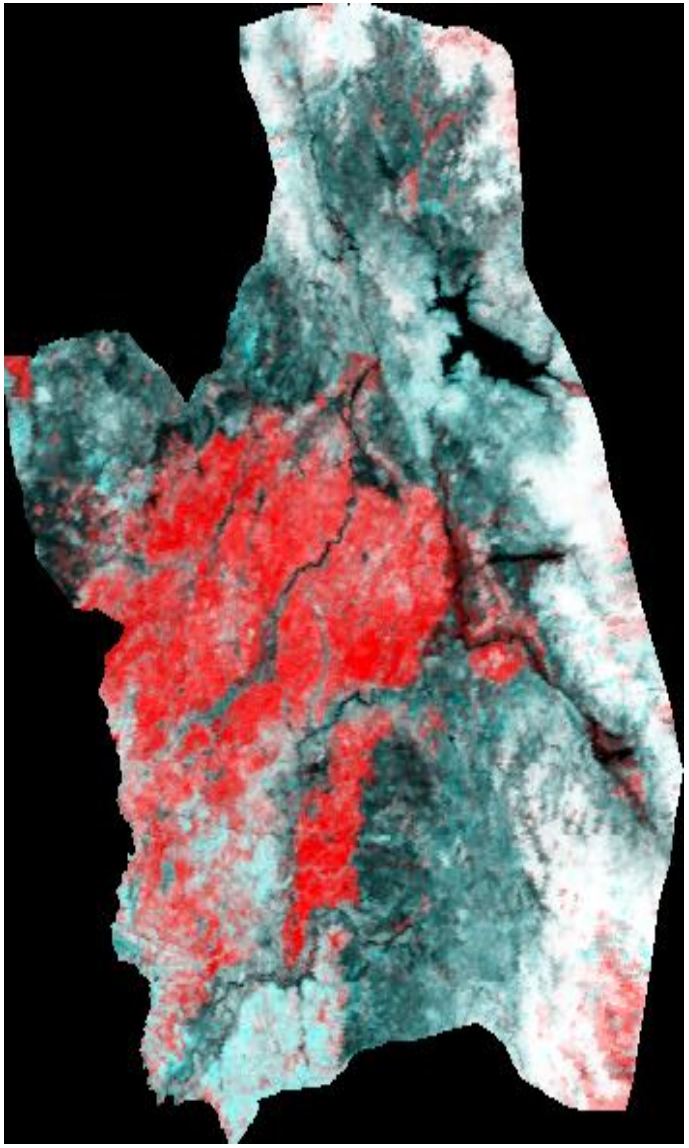
2013-03-02

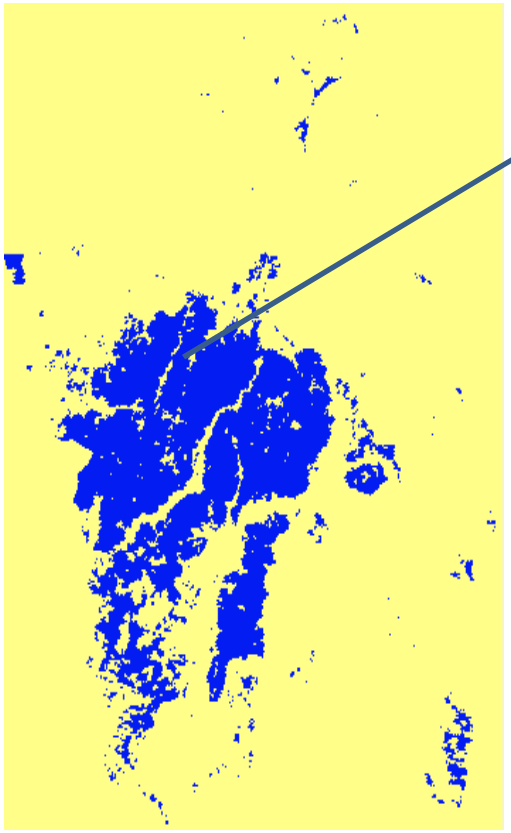


2013-05-05

These Images of Nueve Ecija, Philippines shows variation of Greenness in the Area within interested time period.

Left side shows RGB image and Right side shows "7-2-1" MODIS composite image which is more sensitive to water, vegetation. Using wavelengths other than RGB, we can observe properties that we can't see from Naked Eyes





Using this unique pattern, paddy area can be extracted and statistics can be calculated

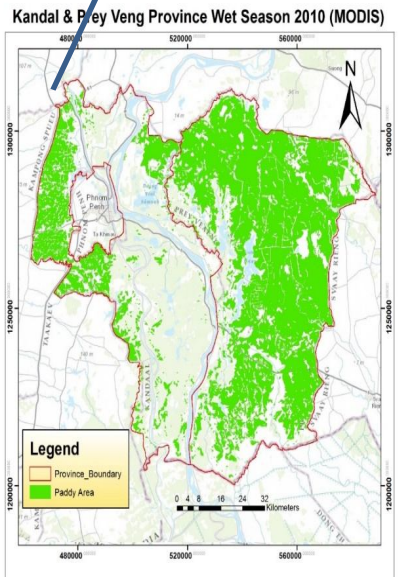
Cloud penetration SAR Data

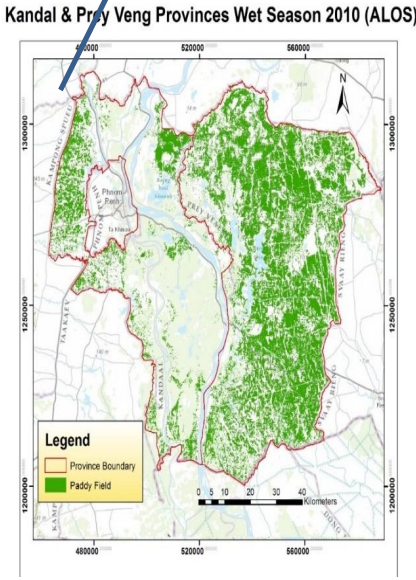
In tropical Regions which, biggest issue is Cloud Cover to continues observations. Microwave Remote Sensing is an ideal solution to overcome this problem.

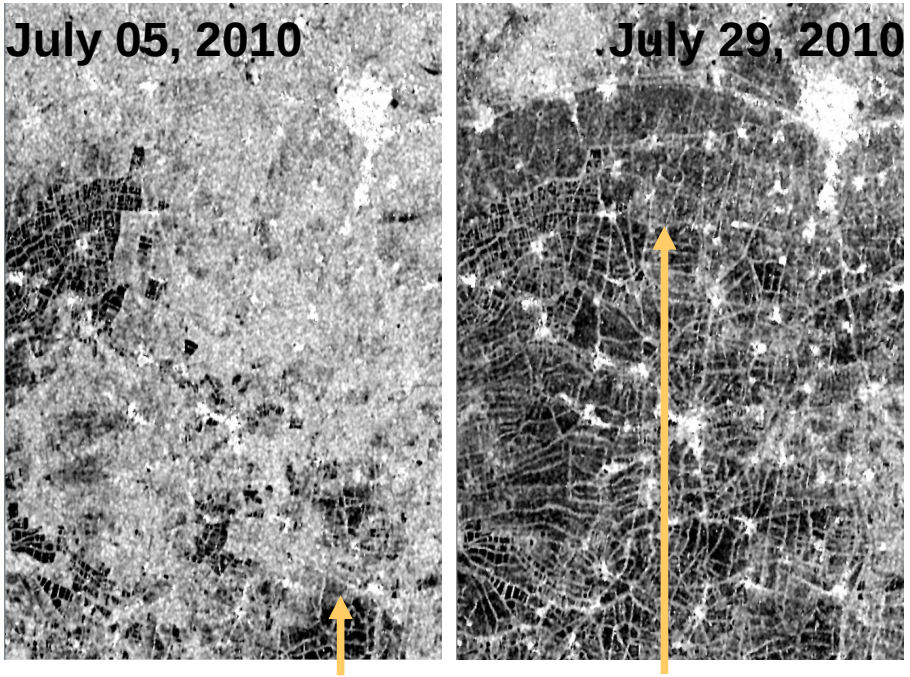
Microwave backscattering properties also behave in the same way as Optical Vegetation Indices like NDVI, EVI which allow us to use same techniques as Optical Remote Sensing

Product from Optical Data

Product from Microwave Data

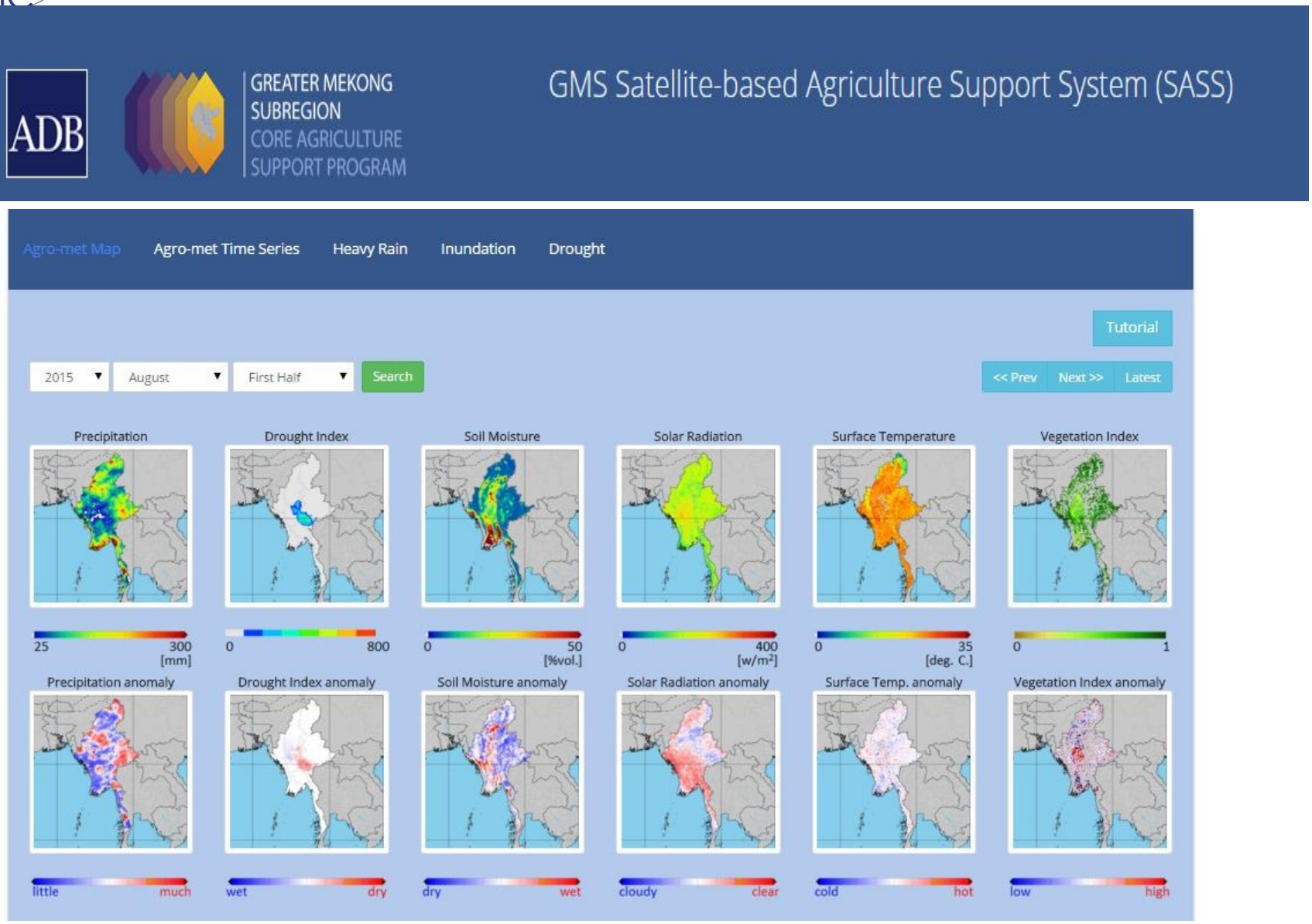






Normal Transplanted Rice

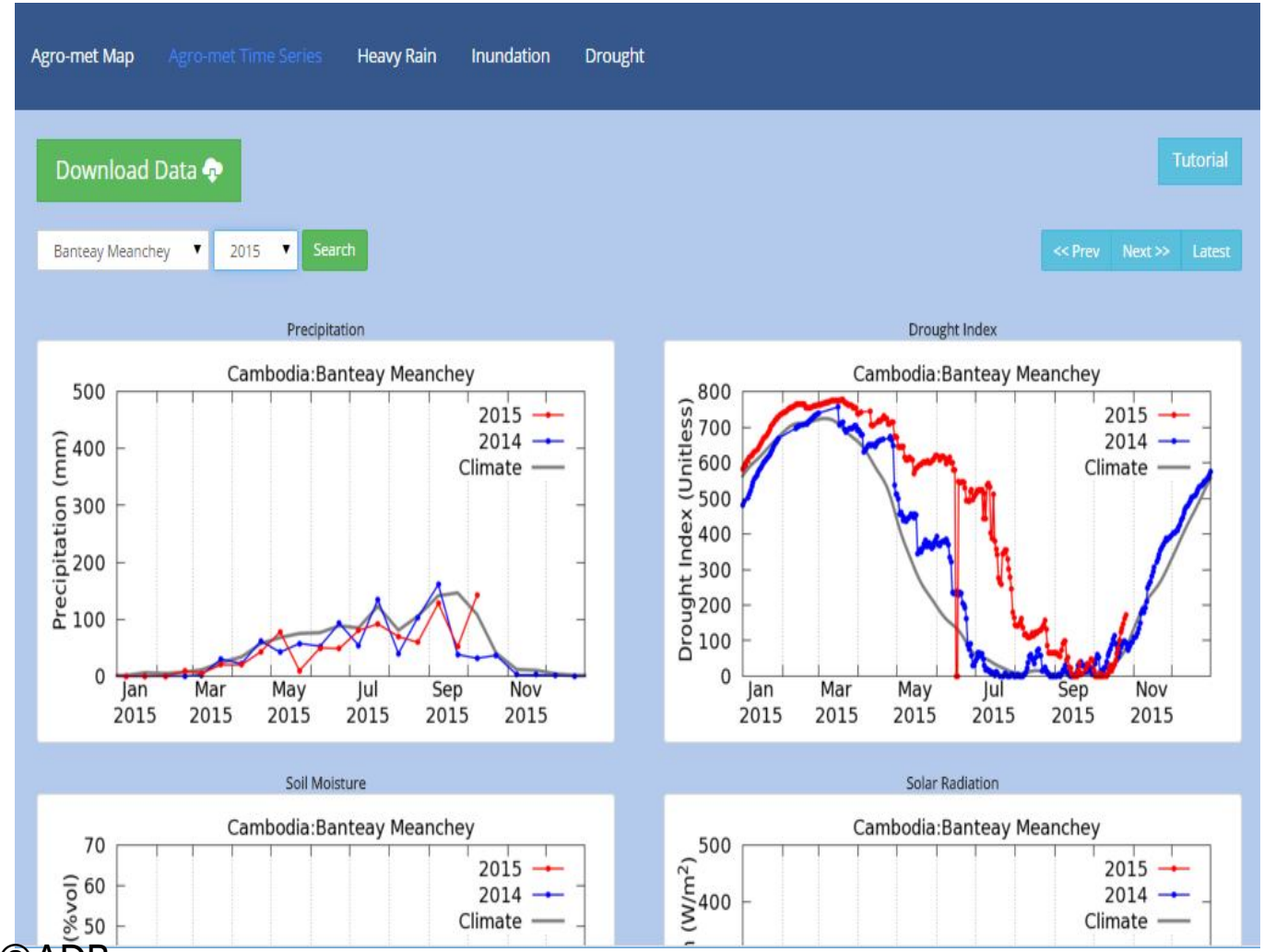
Late Transplanted Rice



Time Series Agricultural Parameters and Anomalies derived from earth observation data which will help to monitor changes, anomalies, and help farmers

GREATER MEKONG SUBREGION
CORE AGRICULTURE SUPPORT PROGRAM

GMS Satellite-based Agriculture Support System (SASS)

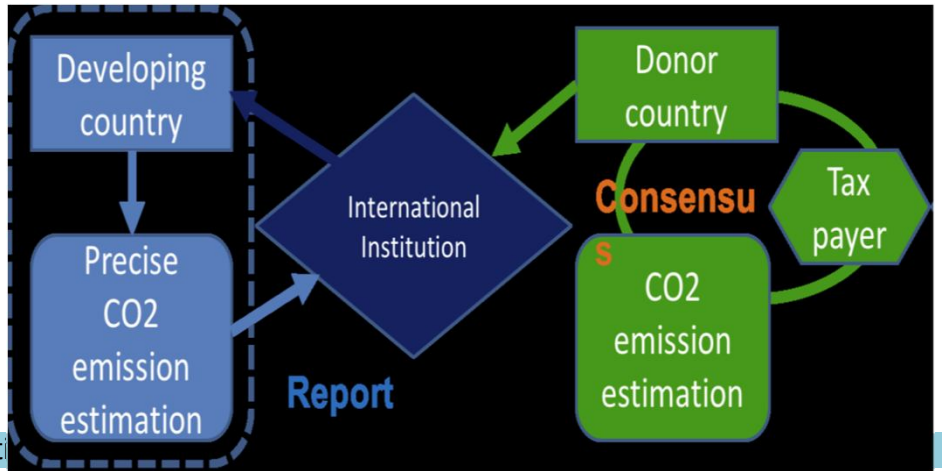


Time Series Agricultural Parameters for Selected Point which will allow to monitor closely

©ADB

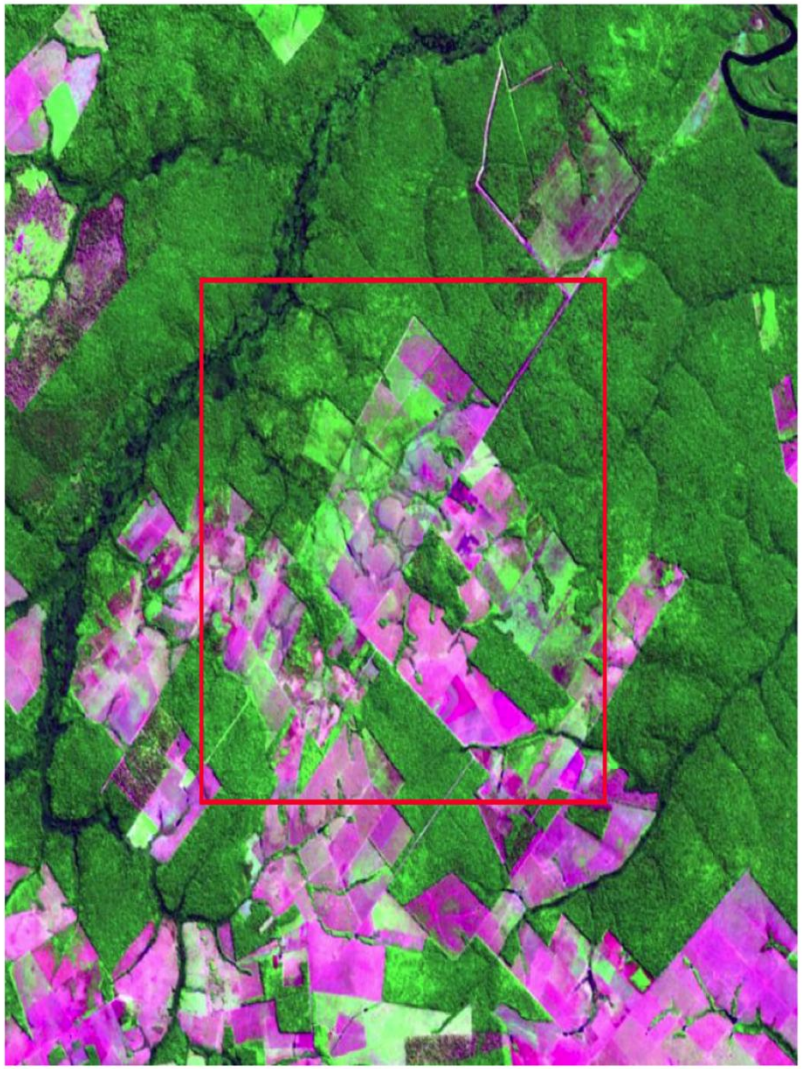
Sustainable Forestry

- Establishing a robust and transparent system for Measurement, Reporting and Verification (MRV) of biomass resources and forestry activities are required for the successful implementation of a REDD+.
- It's proven that Remote Sensing can estimate biomass with errors les than 20 % of field estimates (should not exceed 50 mt/ha for a global biomass map at a resolution of 1 ha).

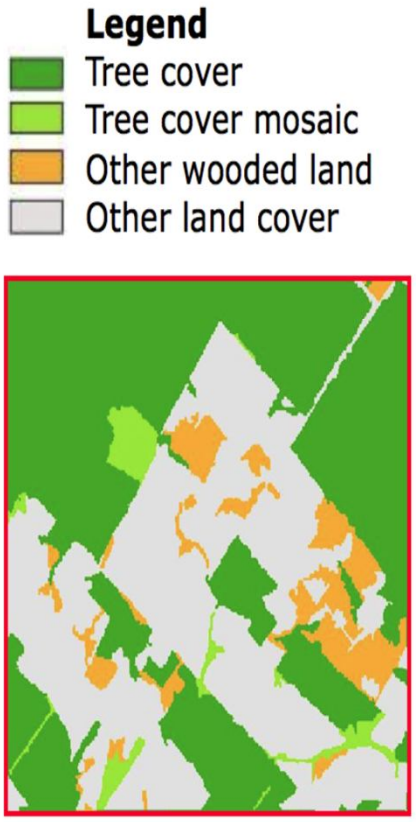


Source: Sawada 2015, Tokola 2015

Forest Cover Mapping from Landsat

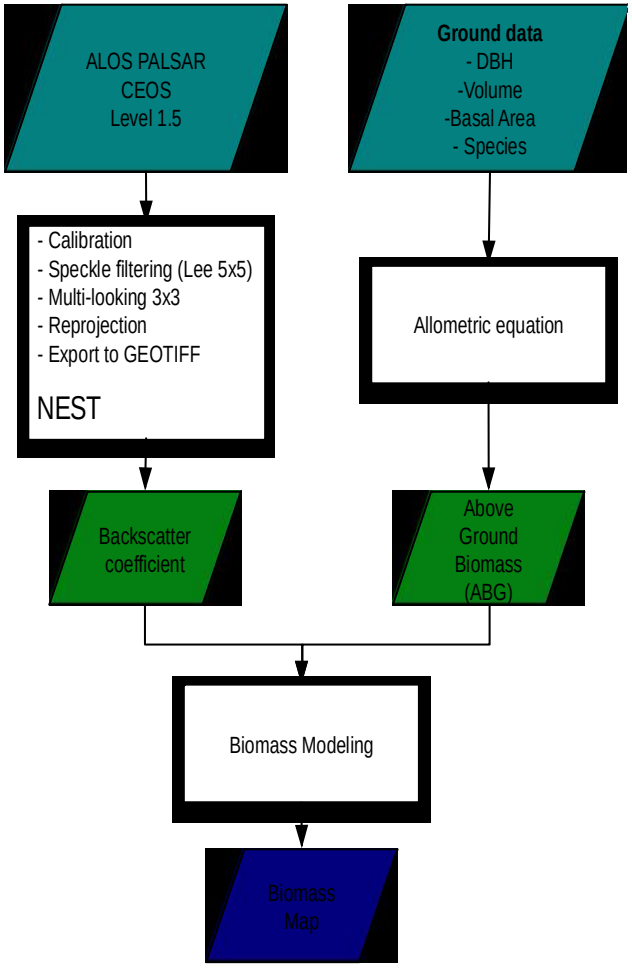


Landsat-5 TM image of 15 June 2005: 20 km x 20 km extract

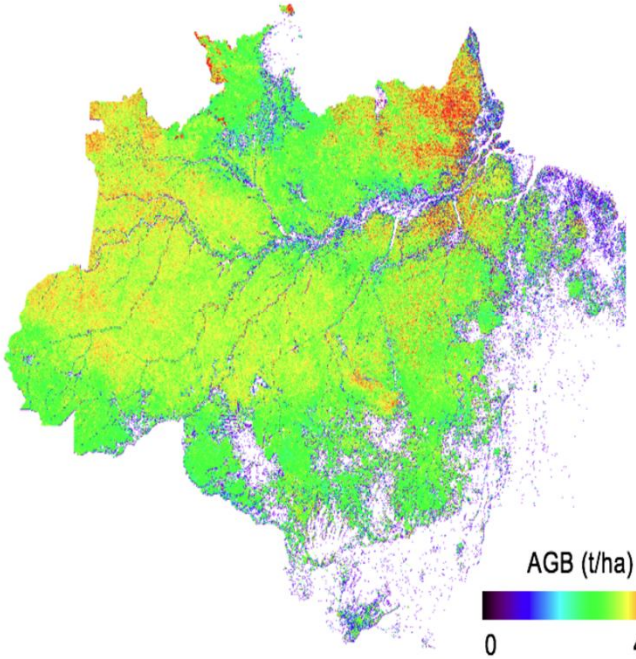


Forest cover map
10 km x 10km window size
Centered at 12°S, 58°W

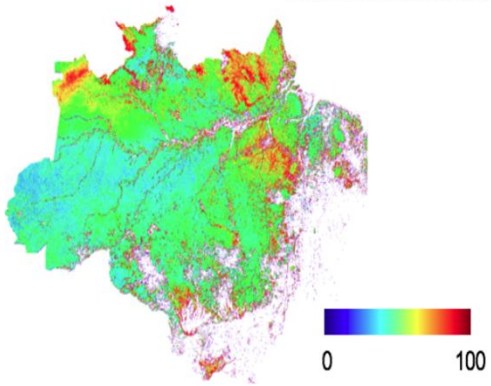
Bio-Mass Estimation from Microwave Remote Sensing Data



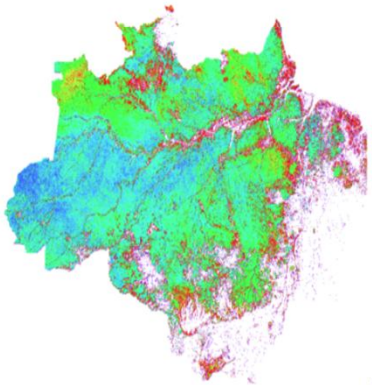
Mapping of Carbon Dynamics in Amazon Forest

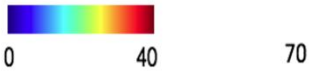


Ensemble Mean AGB



Confidence Intervals





uncertainty(%)

Approx. Total AGB(t)

Ensemble Mean	1.02E+11
SD	2.27E+09
P05	9.85E+10
P95	1.06E+11
Confidence Intervals	7.46E+09

(Uncertainty: 7.3%)

Literature: 1.02E+11
Nogueira(2008), Estimates of forest biomass in the Brazilian Amazon: New allometric equations and adjustments to biomass from wood-volume inventories, doi:10.1016/j.foreco.2008.07.022

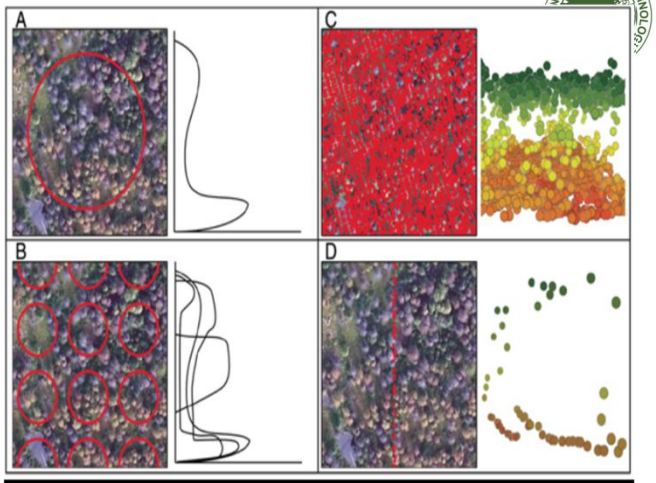
Source: Sawada, 2015

Future Potential - LIDAR

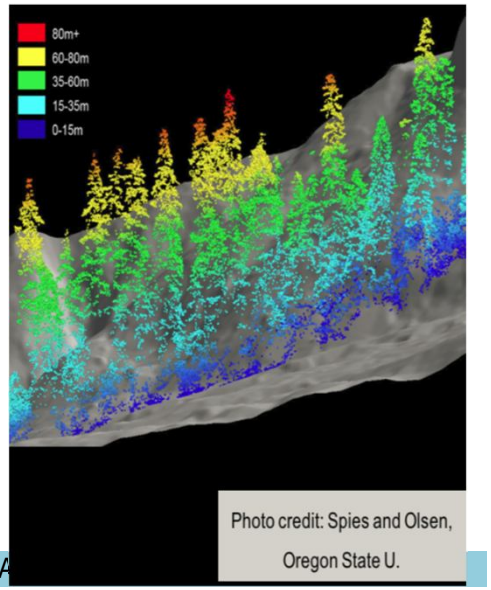
- Light Detection And Ranging (LIDAR) technology uses active sensors Information obtained from lasers to estimate the three-dimensional distribution of vegetation canopies as well as sub canopy topography

- It can be used to estimate tree/stand height, volume, biomass, etc.

- Furthermore, Scientists says that height estimates obtained from LIDAR data have similar or better accuracy than field-based estimates (errors can be even less than 1.0 m for individual tree heights)



A: spaceborne waveform,
B: airborne waveform
C: discrete return scanning LIDAR
D: discrete return profiling LIDAR
(Wulder et al. 2012)

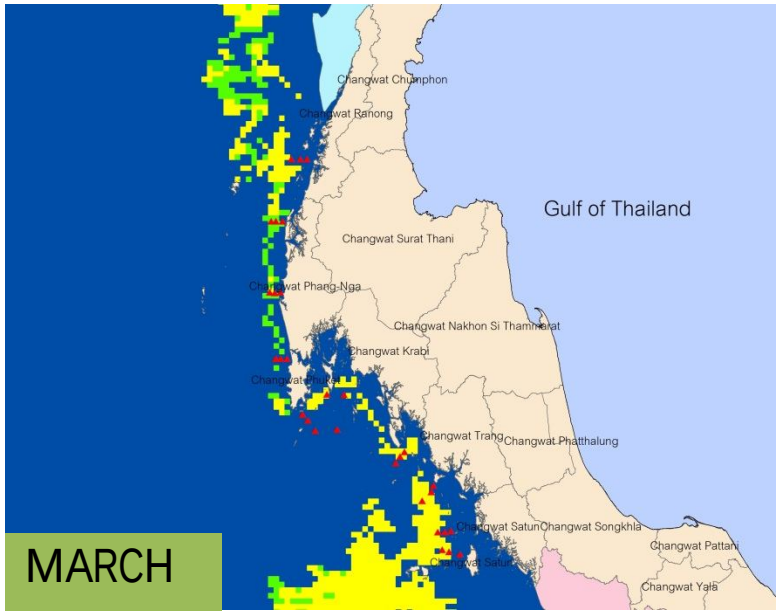


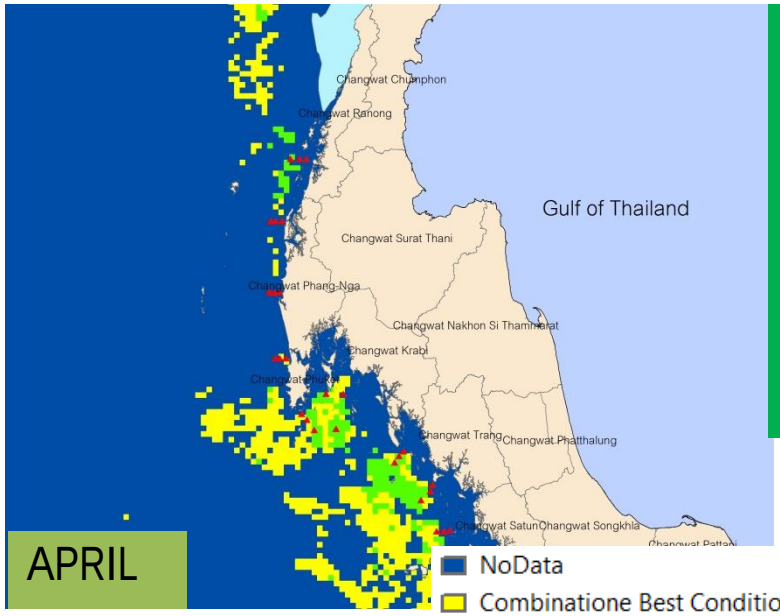
Source: Ussyskhin, 2011

Economic Fish Larvae Mapping and Monitoring

MODIS observed including Chlorophyll-a and Sea Surface Temperature

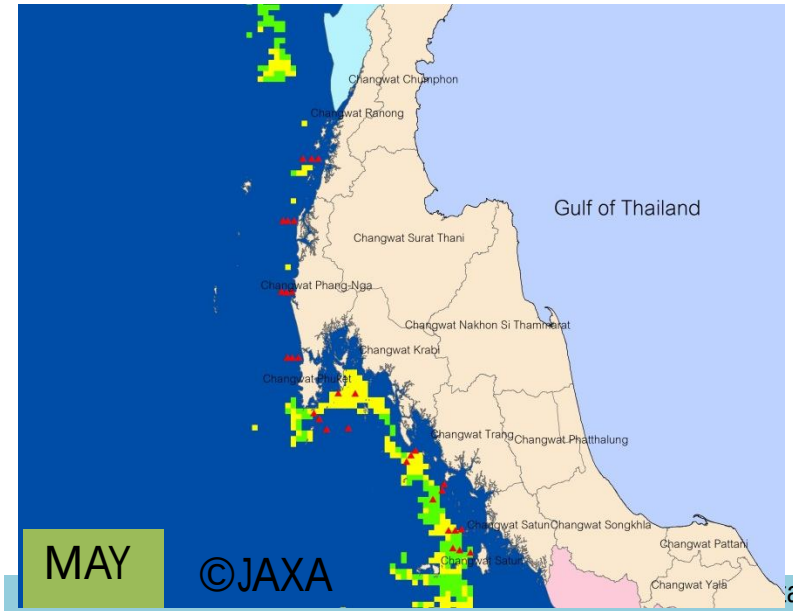
Spatial and Temporal Distribution of "Best" and "Better" Conditions for Fish Larvae (**Andaman Sea**)





Chlorophyll a concentration between 0.5 – 0.9 mg/l is the most preferable condition for fish larvae.

NoData
Combinatione Best Condition Chlorophyll and Better SST
Combinatione Best Condition Chlorophyll and SST



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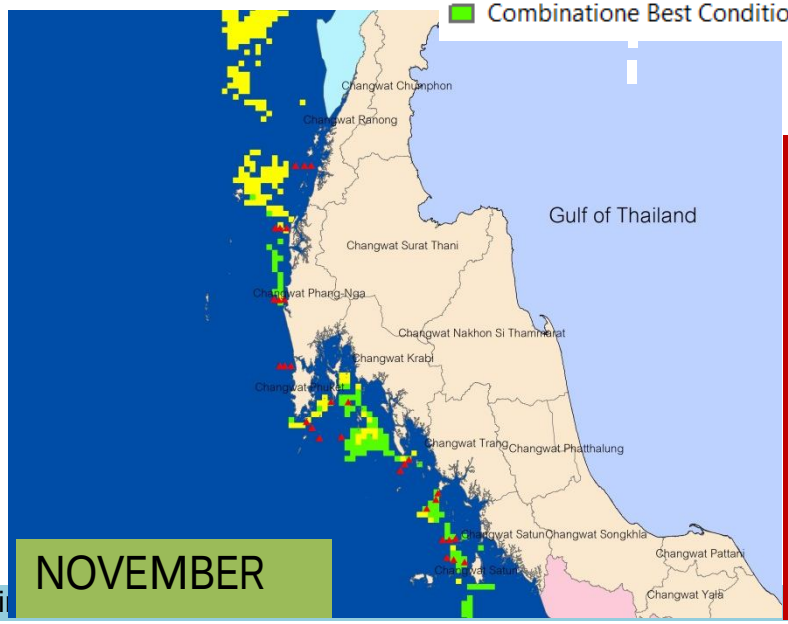
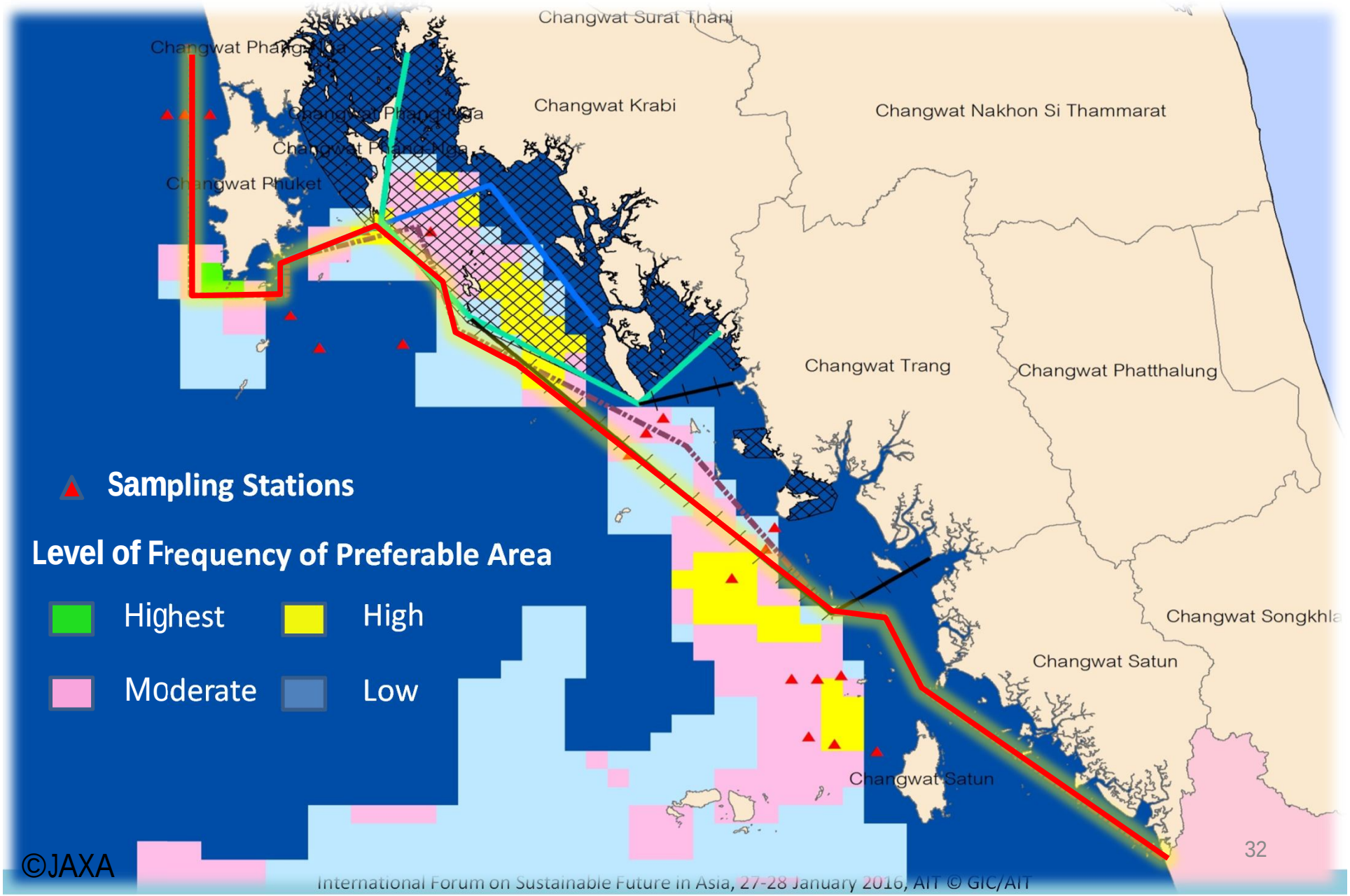
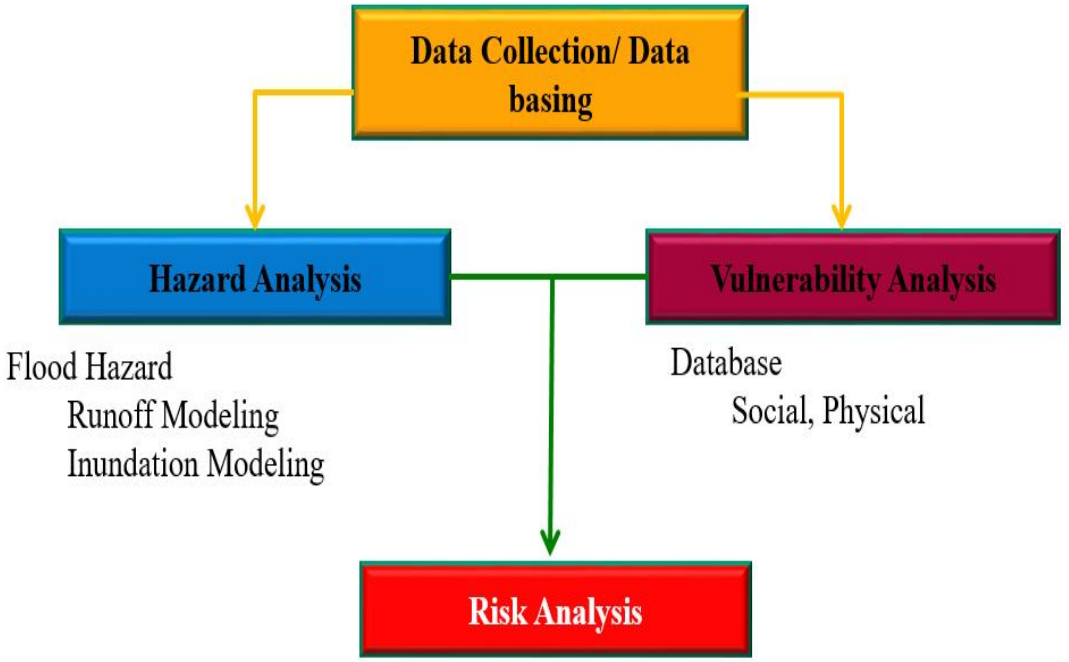


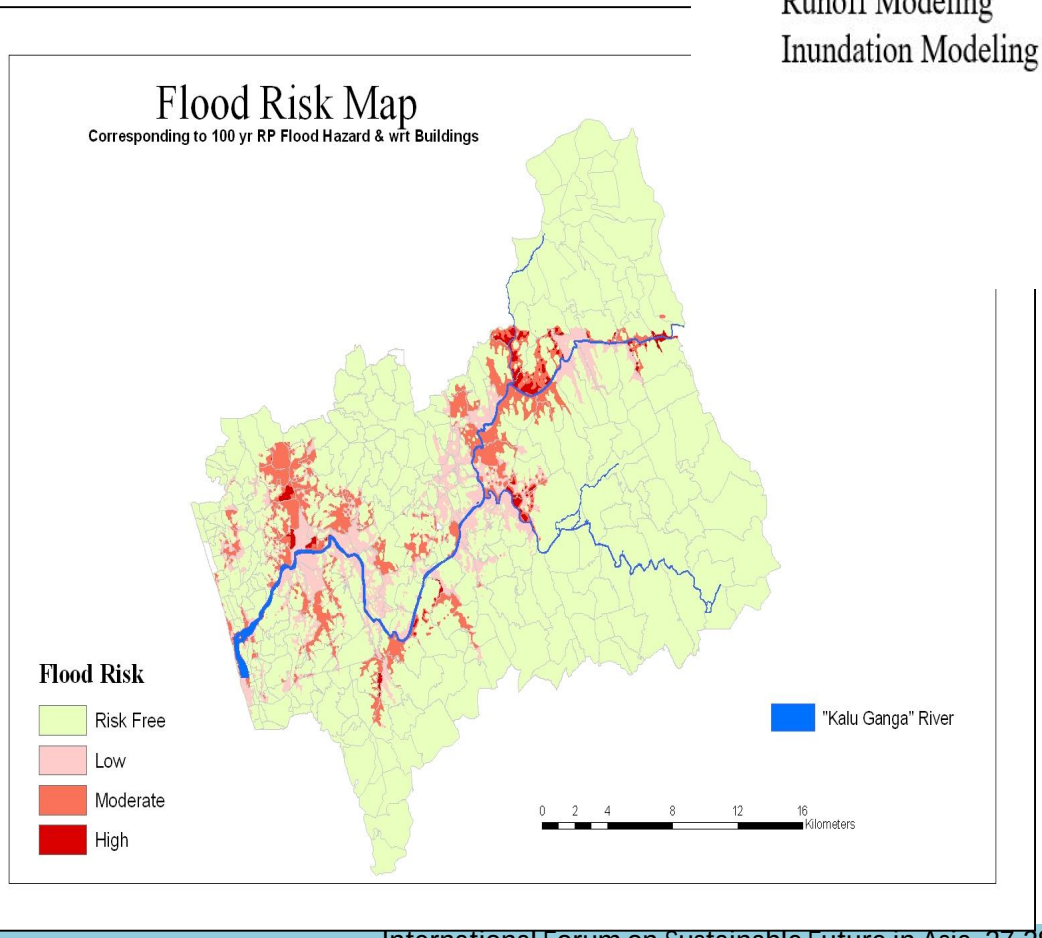
Sea Surface Temperature between 29.5 – 30.5 C and 32.0 – 32.5 C is the most preferable condition for fish larvae.

Conservation Areas and Preferable Areas of Fish Larvae



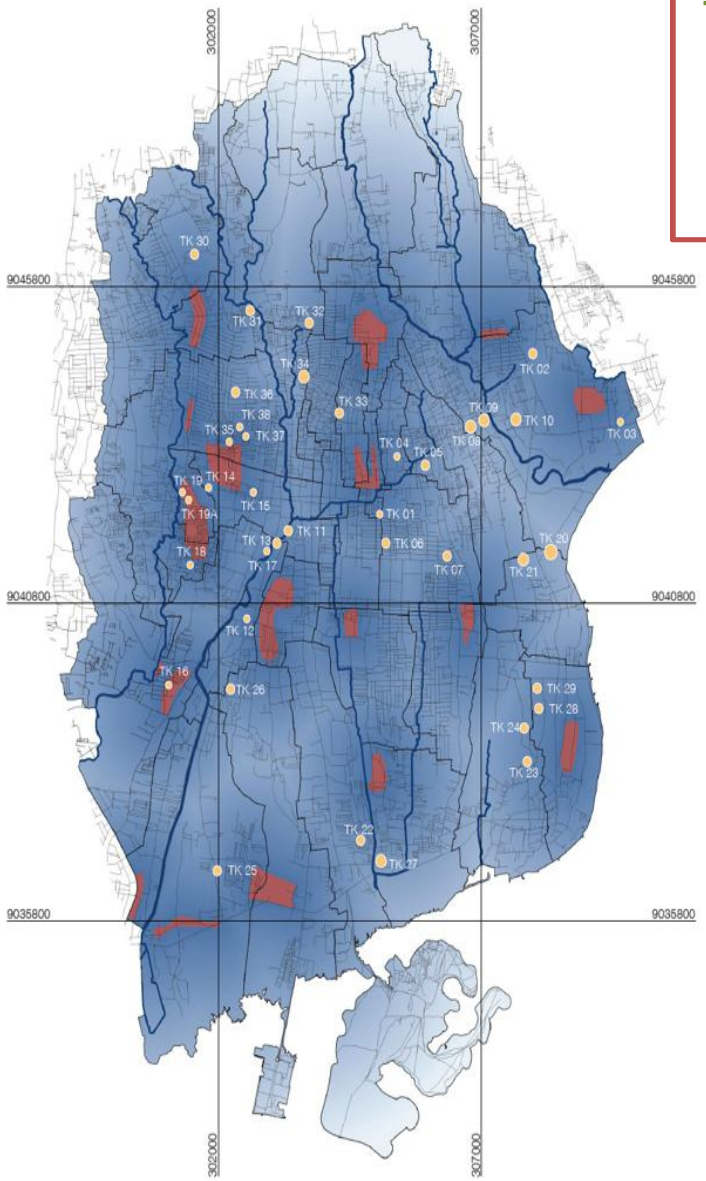
Risk Assessment for resources planning

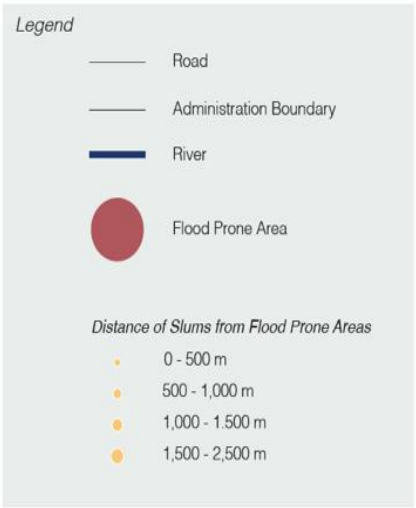




Physical/Economical
Social
Environmental

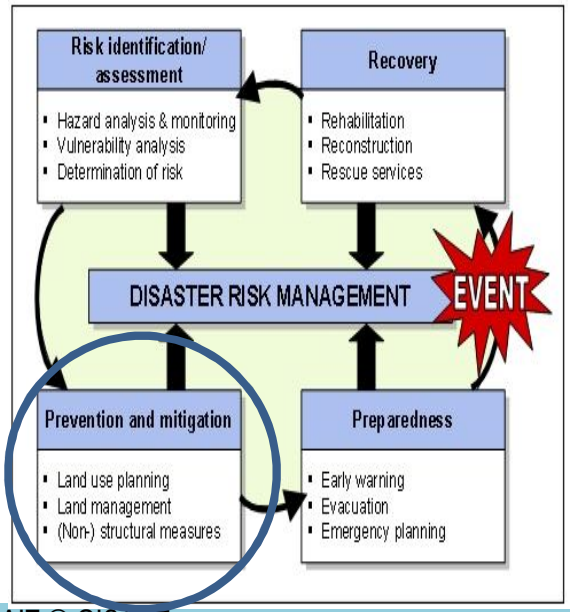
Assessing Proximity of Slums with respect to Flood Prone Area which can be used to prioritize relocation effort of slums in Denpasar, Indonesia





Data Source:
Field Survey 2015
Quickbird Image 2012

Map Projections:
Datum: WGS 84
Projections: UTM 50 (S)



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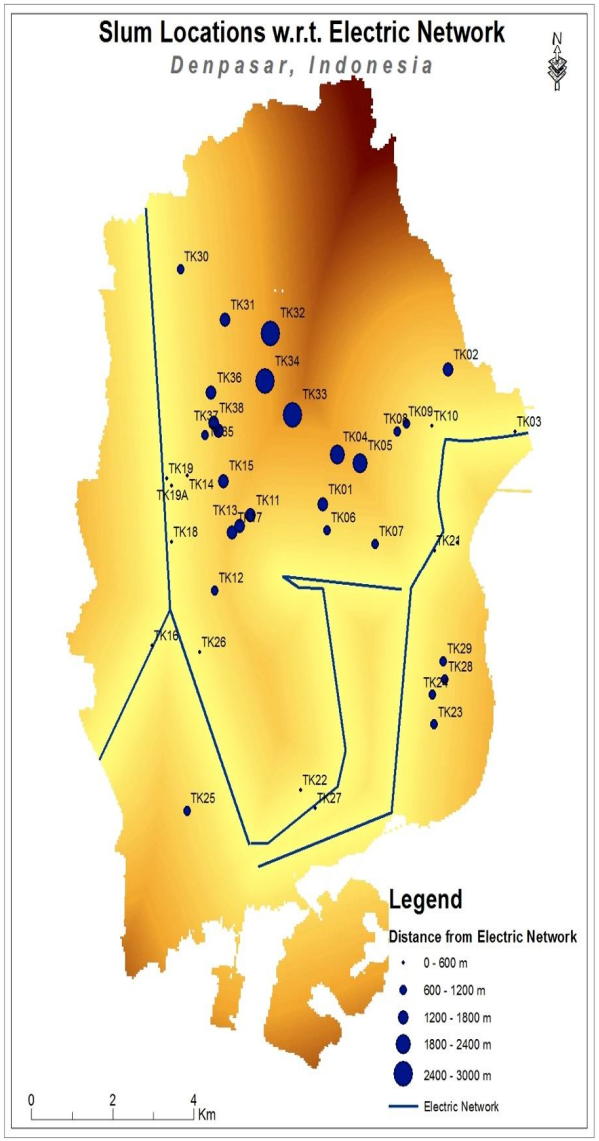
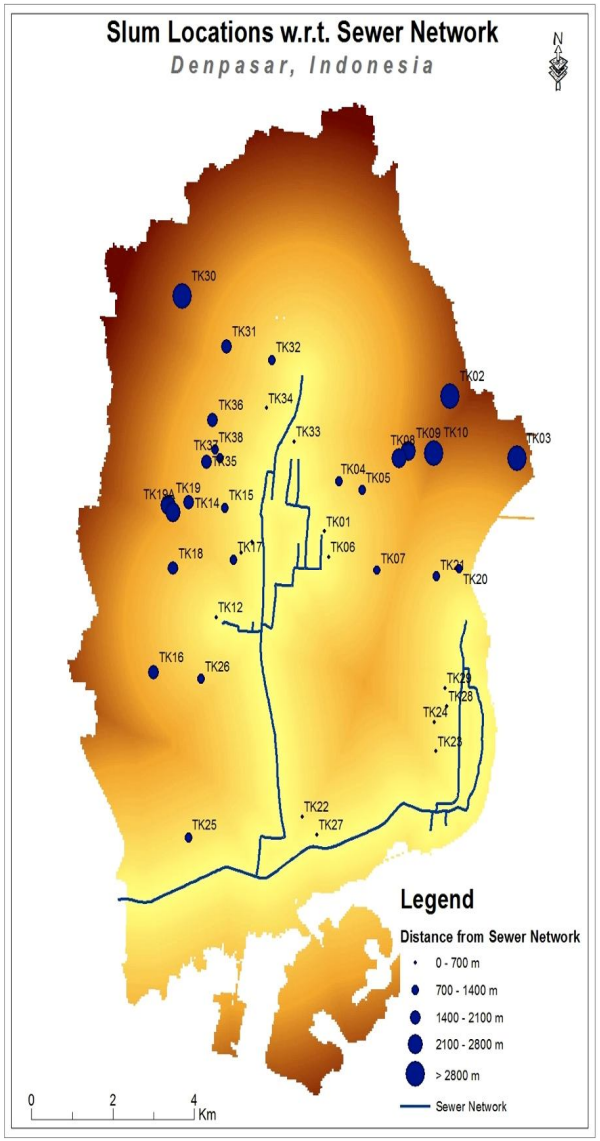
Slum Infrastructure Access Analysis - Denpasar, Indonesia





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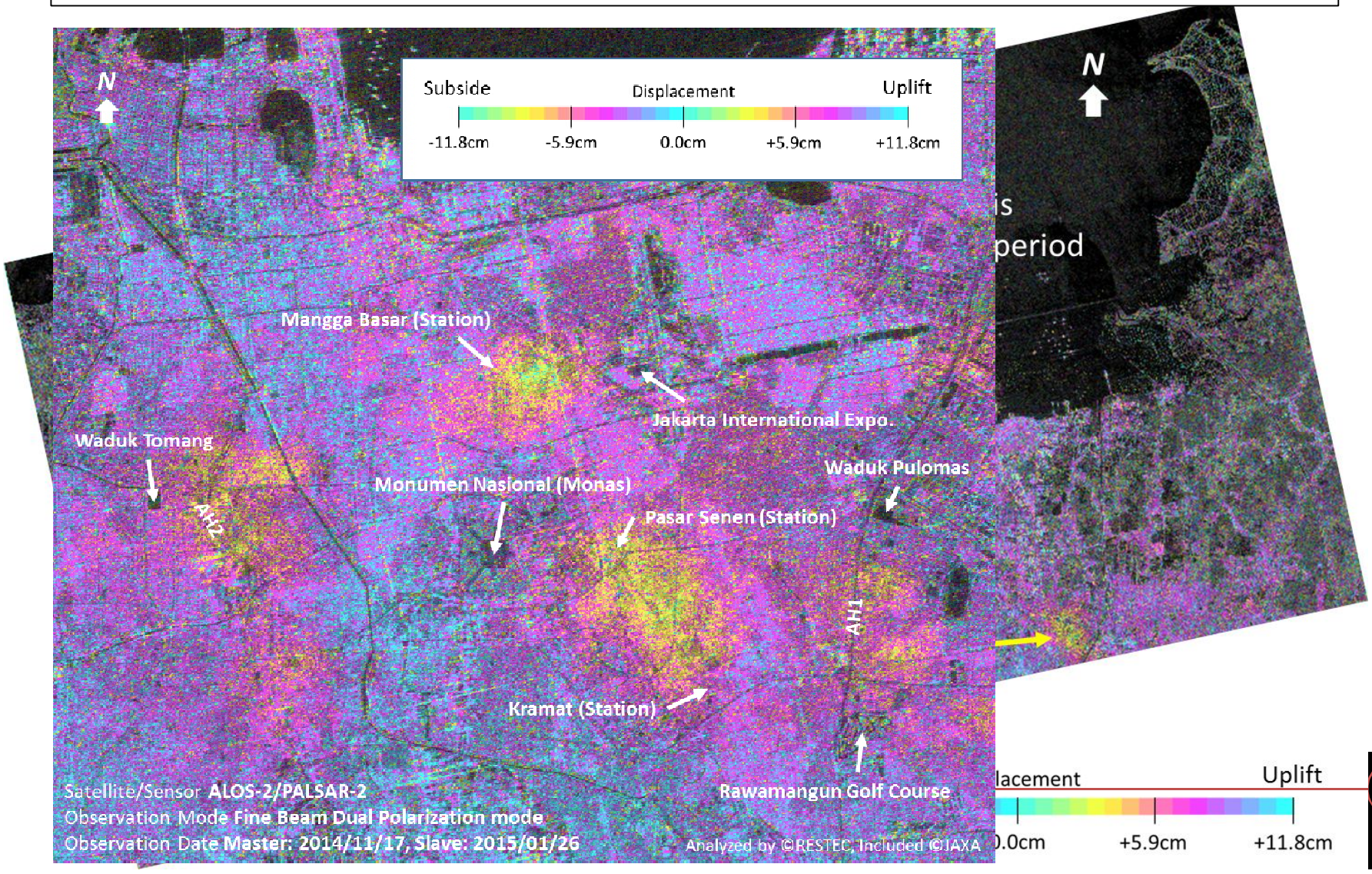
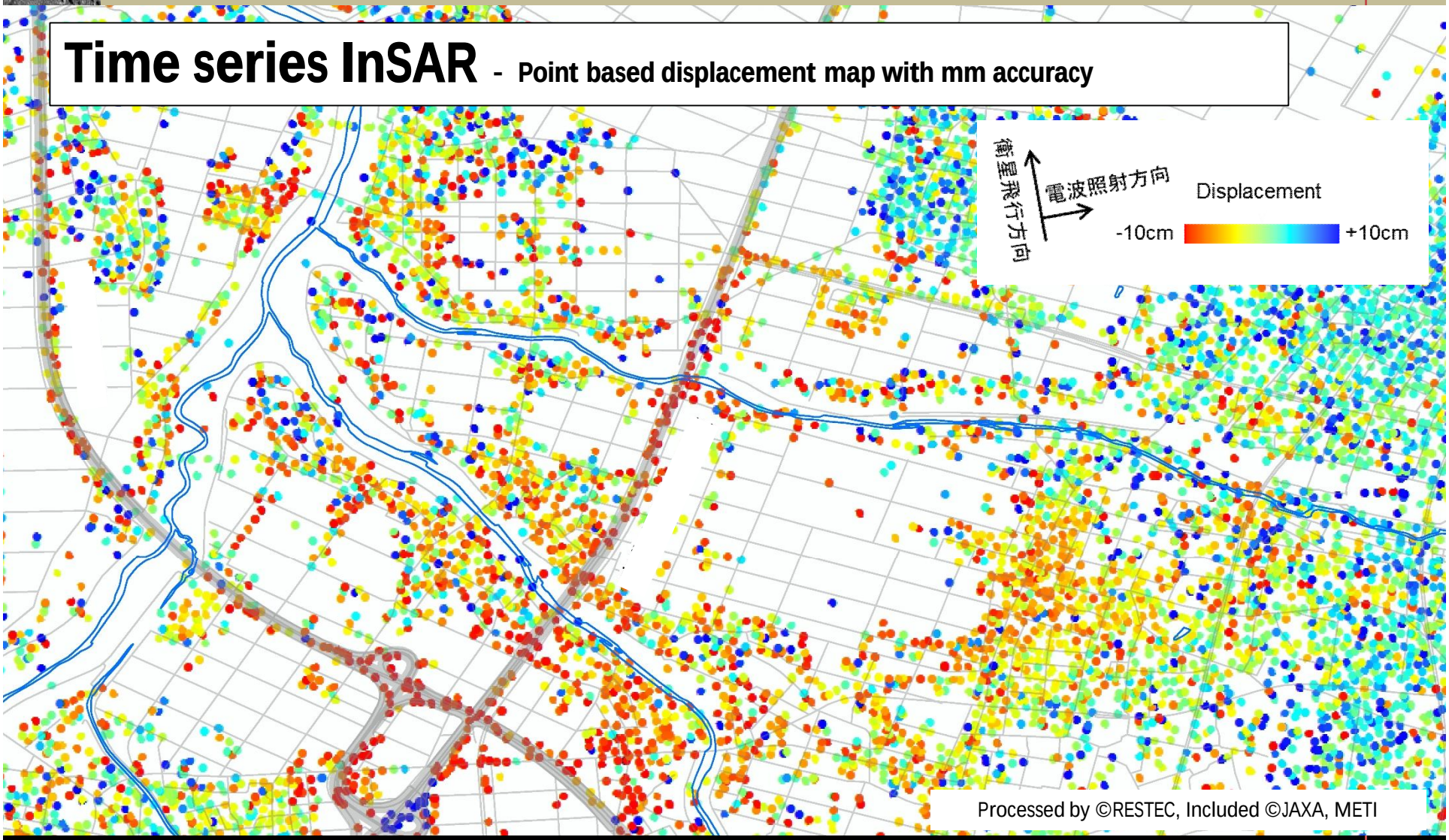
Land Subsidence using InSAR

Ordinary InSAR - Surface displacement information with +/- 1cm accuracy



Land Subsidence using InSAR

Time series InSAR - Point based displacement map with mm accuracy



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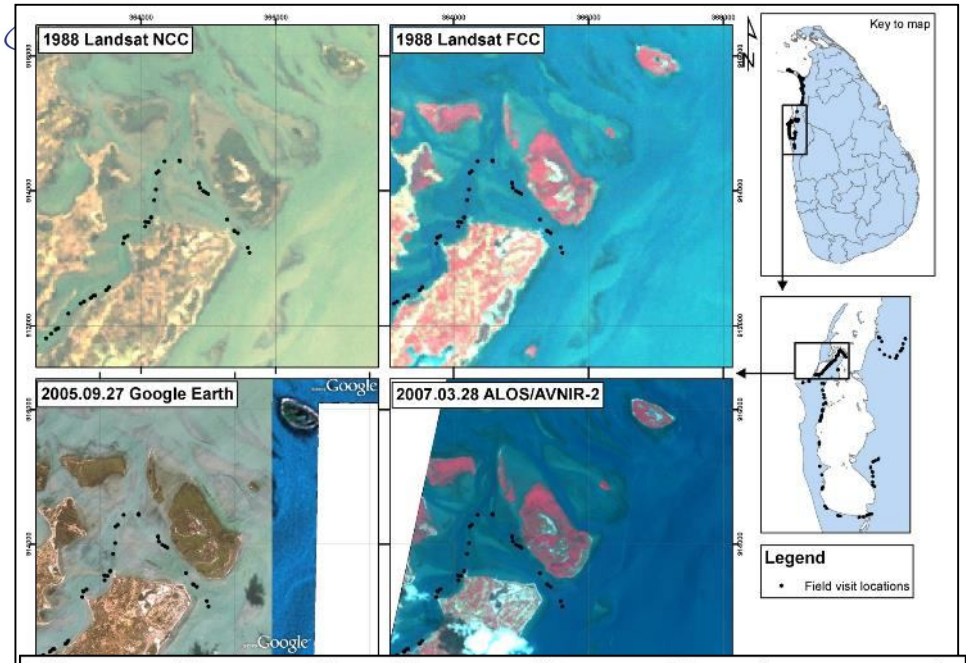
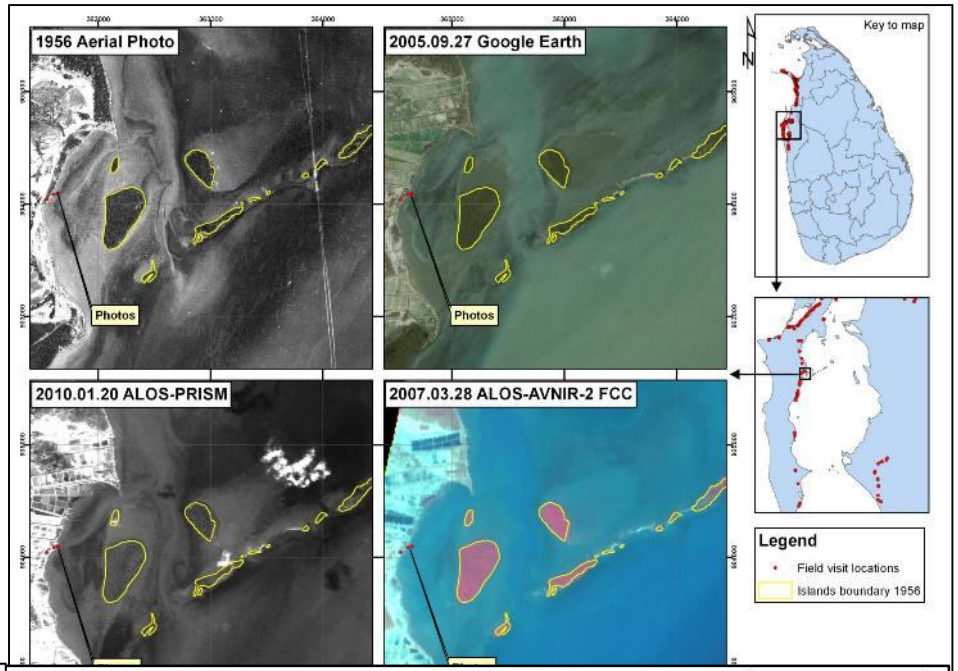
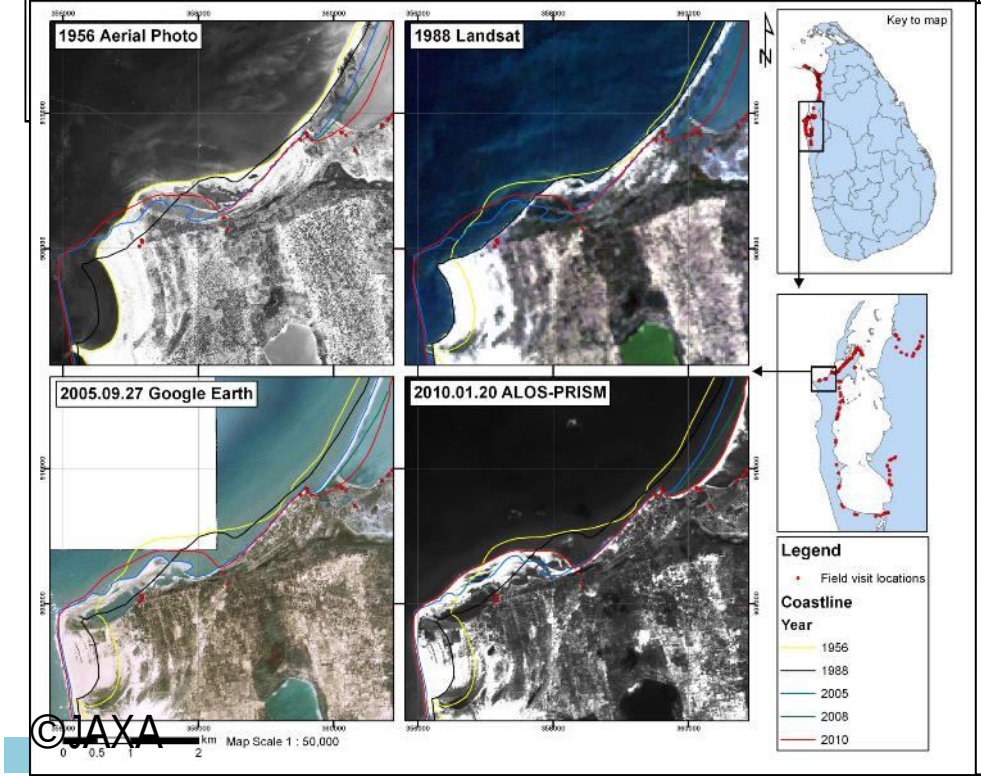
Geoinformatics for Coastal Monitoring System for West coast of Sri Lanka (2012)

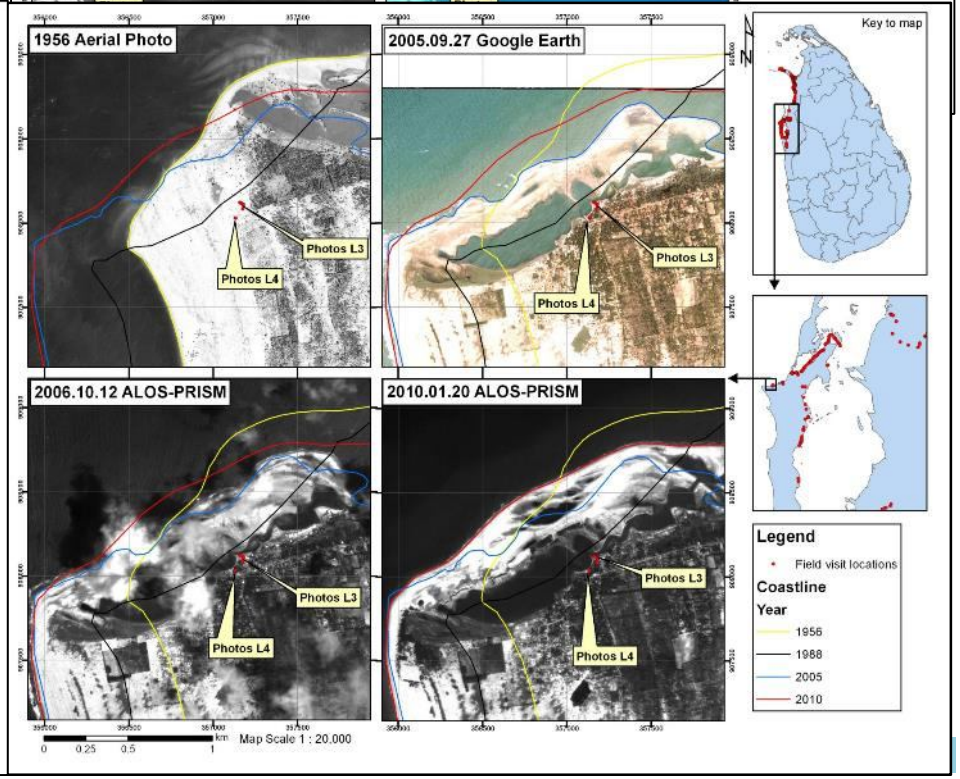
Long-term and short-term morphology changes

Satellite images/ Aerial photographs	Spatial resolution/ Scale	Acquisition date	Source
Aerial Photographs	1 : 20,000	1956	Survey Department Sri Lanka
Landsat MSS	60m	1978	USGS
Landsat TM	30m	1988	USGS
ALOS/ AVNIR-2	10m	2006 – 2010	Japan Aerospace Exploration Agency (JAXA)
ALOS/ PRISM	2.5m	2006 – 2007	JAXA
ALOS/ PALSAR	6.25m/12.5m	2007 - 2010	JAXA
QuickBird	-	2005.09.27	Google Earth

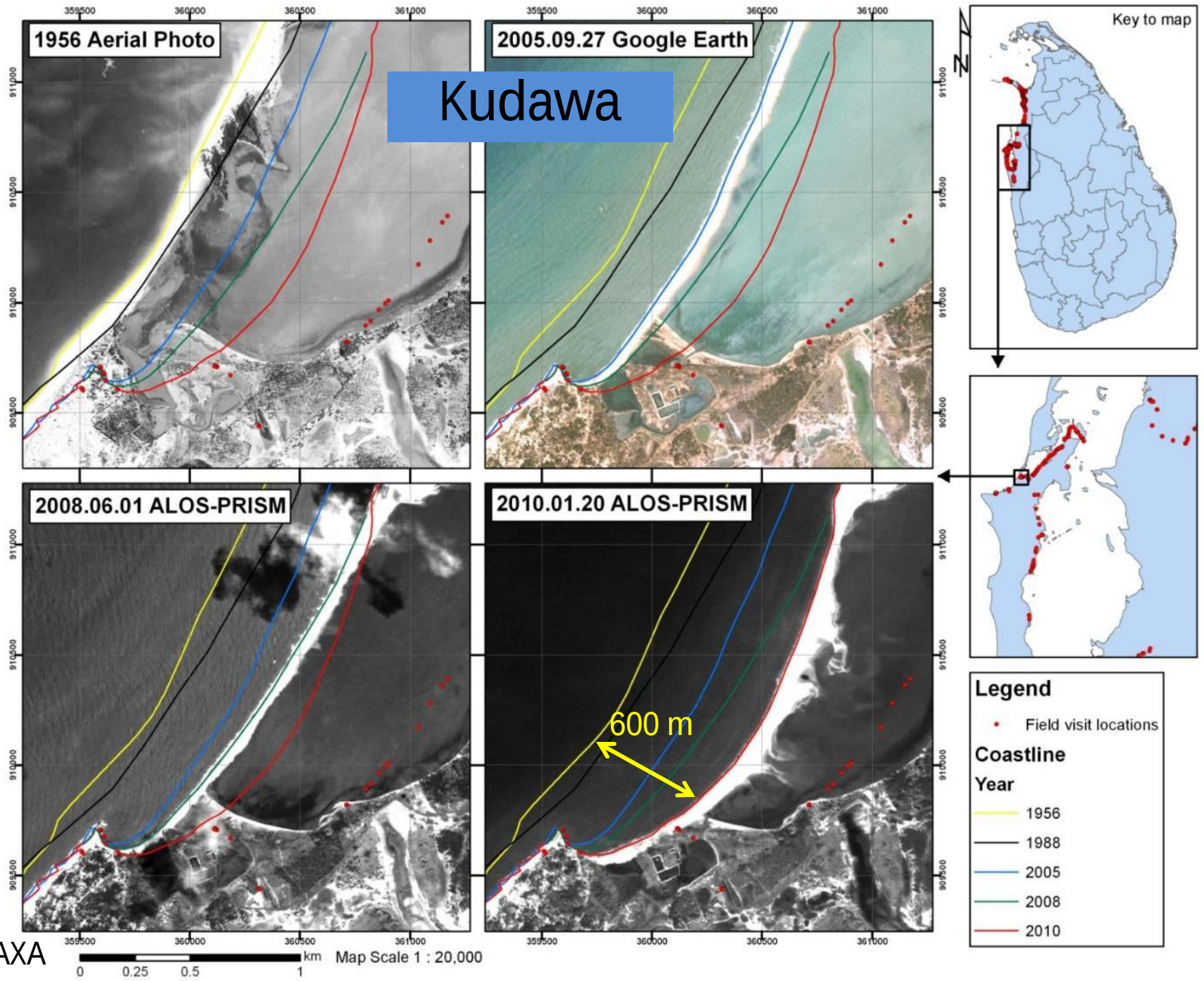

1988 Landsat NCC
1988 Landsat FCC
2005.09.27 Google Earth
2007.03.28 ALOS/AVNIR-2
Key to map
Legend
Field visit locations


1956 Aerial Photo
2005.09.27 Google Earth
2010.01.20 ALOS-PRISM
2007.03.28 ALOS-AVNIR-2 FCC
Photos
Key to map
Legend
Field visit locations
Islands boundary 1956


1956 Aerial Photo
1988 Landsat
2005.09.27 Google Earth
2010.01.20 ALOS-PRISM
Key to map
Legend
Field visit locations
Coastline
Year
1956
1988
2005
2008
2010
Map Scale 1 : 50,000


1956 Aerial Photo
2005.09.27 Google Earth
2006.10.12 ALOS-PRISM
2010.01.20 ALOS-PRISM
Photos L3
Photos L4
Key to map
Legend
Field visit locations
Coastline
Year
1956
1988
2005
2010
Map Scale 1 : 20,000

©JAXA


1956 Aerial Photo
2005.09.27 Google Earth
Kudawa
2008.06.01 ALOS-PRISM
2010.01.20 ALOS-PRISM
600 m
Key to map
N
Legend
Field visit locations
Coastline
Year
1956
1988
2005
2008
2010
359500
360000
360500
361000
910000
910500
911000
909500
0
0.25
0.5
1
km
Map Scale 1 : 20,000

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INTEGRATED TOURISM RESORT PROJECT

GENERAL GUIDELINES FOR INVESTORS

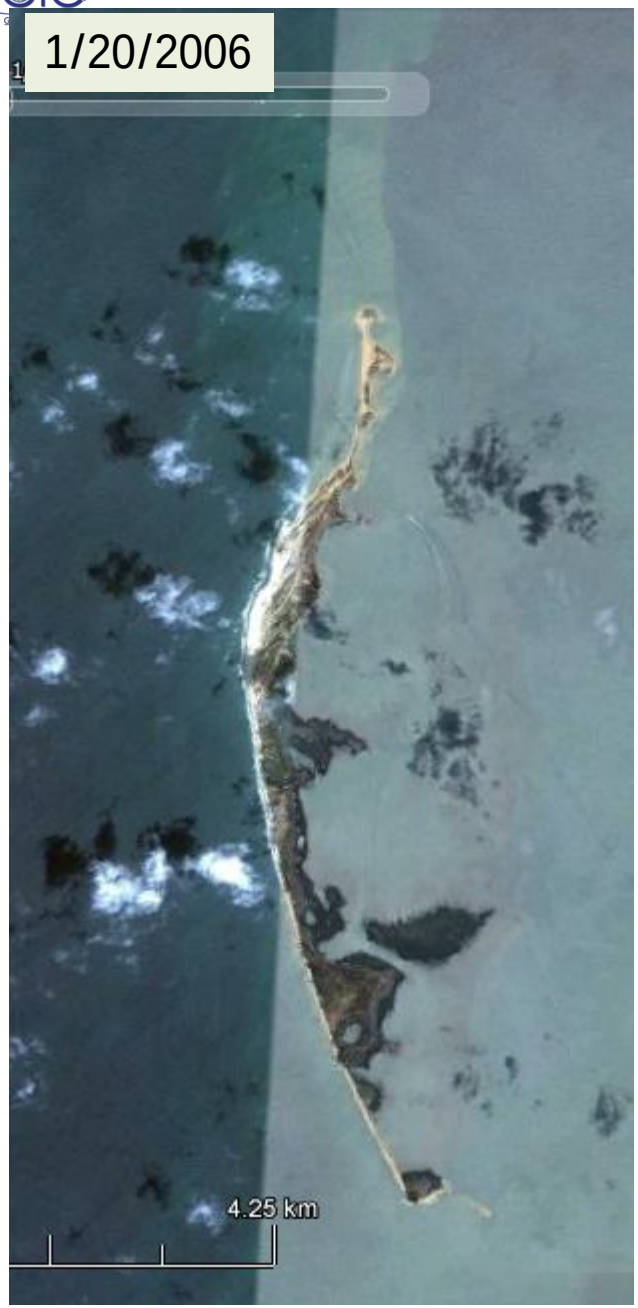
PREPARED BY THE
KALPITIYA INTEGRATED TOURISM RESORT PROJECT OFFICE
(SRI LANKA TOURISM DEVELOPMENT AUTHORITY)

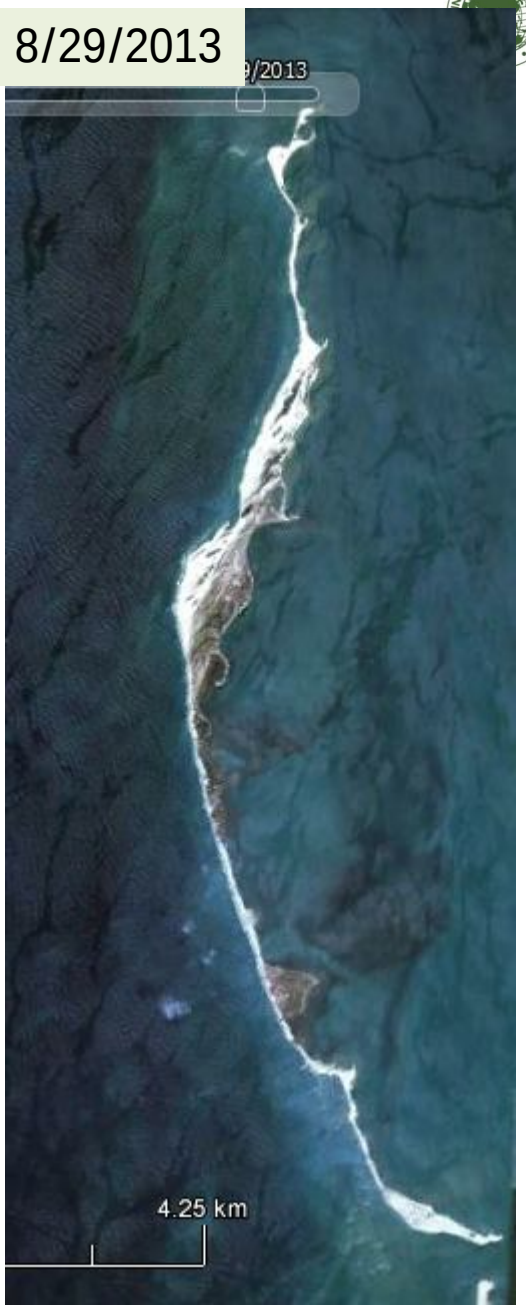
KALPITIYA PROJECT OFFICE
02ND FLOOR, NO. 80, GALLE ROAD, COLOMBO 03. SRI LANKA
TEL: +94 11 2440009 FAX: +94 11 2382622

EMAIL: project.kalpitiya@gmail.com
WEB :www.sltda.lk/kalpitiya

1 - PROJECT PROFILE – INTEGRATED TOURISM RESORT PROJECT IN KALPITIYA

Sector	**Tourism**
Geographical Location	Kalpitiya North Western Province, Puttalam District, (150 Km. North of Colombo)
Responsible Agent(s)	Sri Lanka Tourism Development Authority
Project Description & Rationale / Objectives	Kalpitiya Integrated Tourism Project – Construction of hotels, Entertainment Centres, Golf Courses. Water based accommodation facilities, Water related facilities, Ayurvedic Health Village and Spa, Eco lodge Deluxe hotel as leading product and development landmark, Water sports centre, Boat Service, Aqua centre and museum.
Project Size	**Approx. USD 100 Mn and above for each 25 Ha land area.** **10 Islands at Kalpitiya to be offered to minimum of 10 or more potential investors :** Baththalangunduwa - 124.8 Ha Palliyawatta - 59.4 Ha Uchchamunai - 443.8 Ha Periya Arichchalai - 44.4 Ha Sinna Arichchalai - 16.6 Ha Eramutivu - 90.1 Ha Sinna Eramutivu - 2.1 Ha Eramutivu West - 4.3 Ha Kakativu - 27.2 Ha Mutuwal - 201.3 Ha
Proposed Procurement Process	**Investment Model** a. Foreign Direct Investment , b. Land would be offered on a long term lease basis
Planned Start Date	**Project can be initiated with immediate effect,** by identifying a suitable Island in the required extent and submission of a proposal to the Board of Investment of Sri Lanka
Project Documentation	Potential Investors / Developers are invited for Foreign Direct Investment to set up Tourism Sector Projects to cater to local & Foreign Tourists. The Project Company shall qualify for applicable incentives under the Board of Investment of Sri Lanka.
Current Status	**Initial Project Concept – Investor / Developer** could contact the Board of Investment of Sri Lanka for further details regarding the proposed Project as the Islands are available for Development.
Financing Amount & Structure Required	Land value as determined by the Government Chief Valuer of Sri Lanka and cost of the project should be financed from foreign sources.
Contact Person	1. Mr W A G Jayathilake, Senior Deputy Director (Tourism), BOI 2. Dr D F Jayaweera, Director General , Sri Lanka Tourism Development Authority Email : info.projects@boi.lk, Facsimile : +94112447994





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Re-direction of investment plans

For the urgent decision making, Interim Report of the Project was released on the request of the Sri Lanka Government

Investors in the project area are officially instructed to follow the report for investment planning & EIA studies

Sustainable Resource Management

Policy makers and end-users

Transdisciplinary holistic approach

Concluding

- ✓ Geoinformatics has a tremendous potential in evaluating and monitoring environmental changes and key indicators of SDG,
- ✓ Space based data can use locally, regionally and globally as an evidence based information system to improve the dialog between all the stakeholders,
- ✓ GIC-AIT can contribute to the joint research and applications of the future direction of the forum through research, training and application development using space based technologies and IT services development.