
CARTE
DU ROYAUME
DE
SIAM
et des Pays
Circonvoisins
Golfe de Bengala
Royaume de Pegu
Royaume de Siam
Royaume de la Chine
Golfe de Cochinchine
Cochinchine
R.me de Tonquin
R.me de Camboia
Golfe de Siam
Destroit de Malaca
Isle de Sumatra
Isle de Java
Mer des Indes
Equateur autrem.t ligne Equinoctiale
Isles Andemaon
Canal S.t George
Malaca
Pera
Queda
Achem
Destroit de Banca
Destroit de la Sonde
Balon du Roy de Siam
Vaisseau de guerre de sa Majesté

Oct 2006 - Chiang Mai,

attending CEOS Cal/Val Workshop Group Meeting

The NASA Land-Cover/Land-Use Change (LCLUC) Science: Focus on South/Southeast Asia

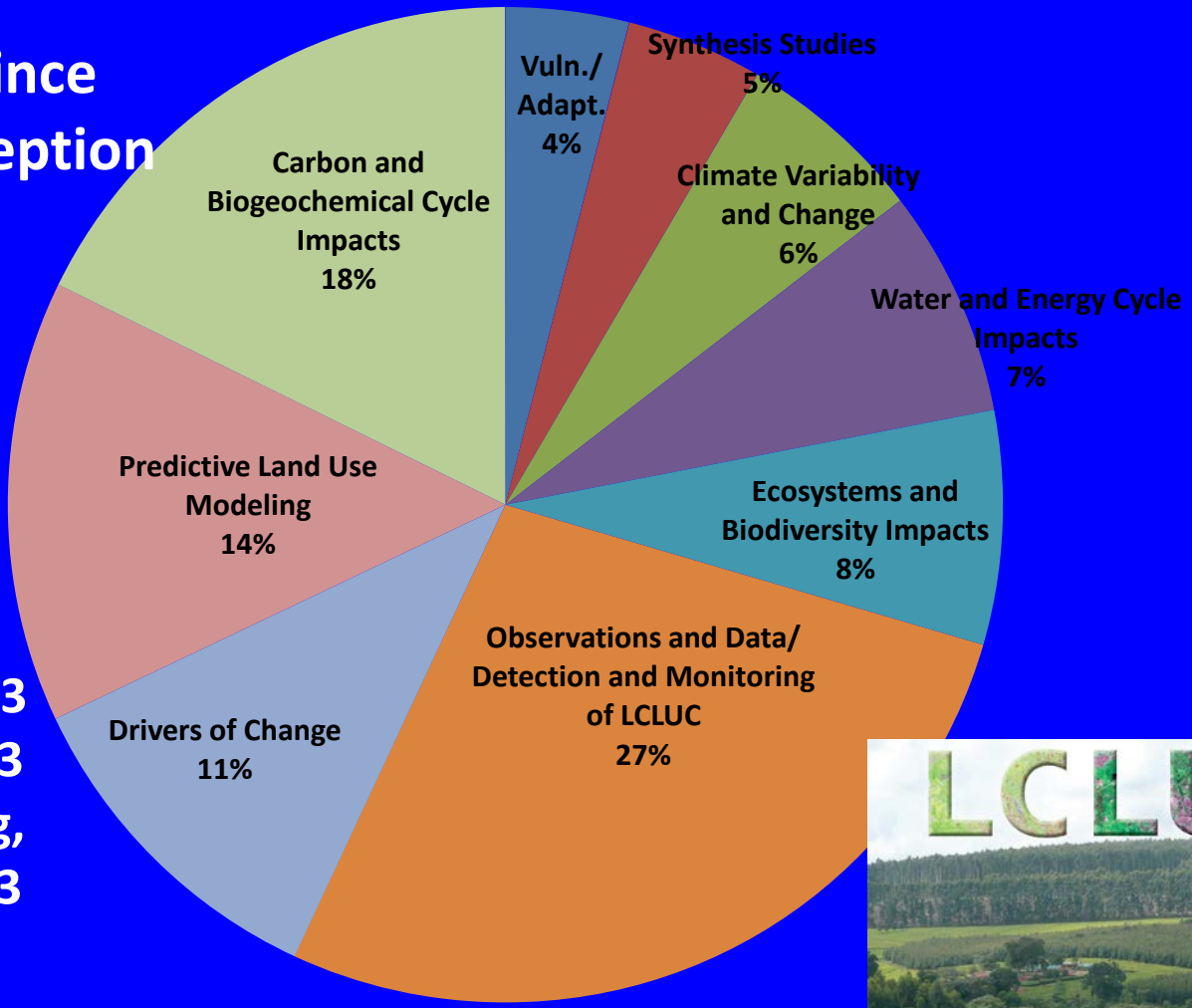
Garik Gutman,
LCLUC Program Manager
NASA Headquarters
Washington, DC

Land-Cover/Land-Use Change Program

- LCLUC is an interdisciplinary scientific theme within NASA's Earth Science program. The ultimate vision of this program is ***to develop the capability for periodic global inventories of land use and land cover from space, to develop the scientific understanding and models necessary to simulate the processes taking place, and to evaluate the consequences of observed and predicted changes***
- http://lcluc.hq.nasa.gov/

LCLUC Program Content

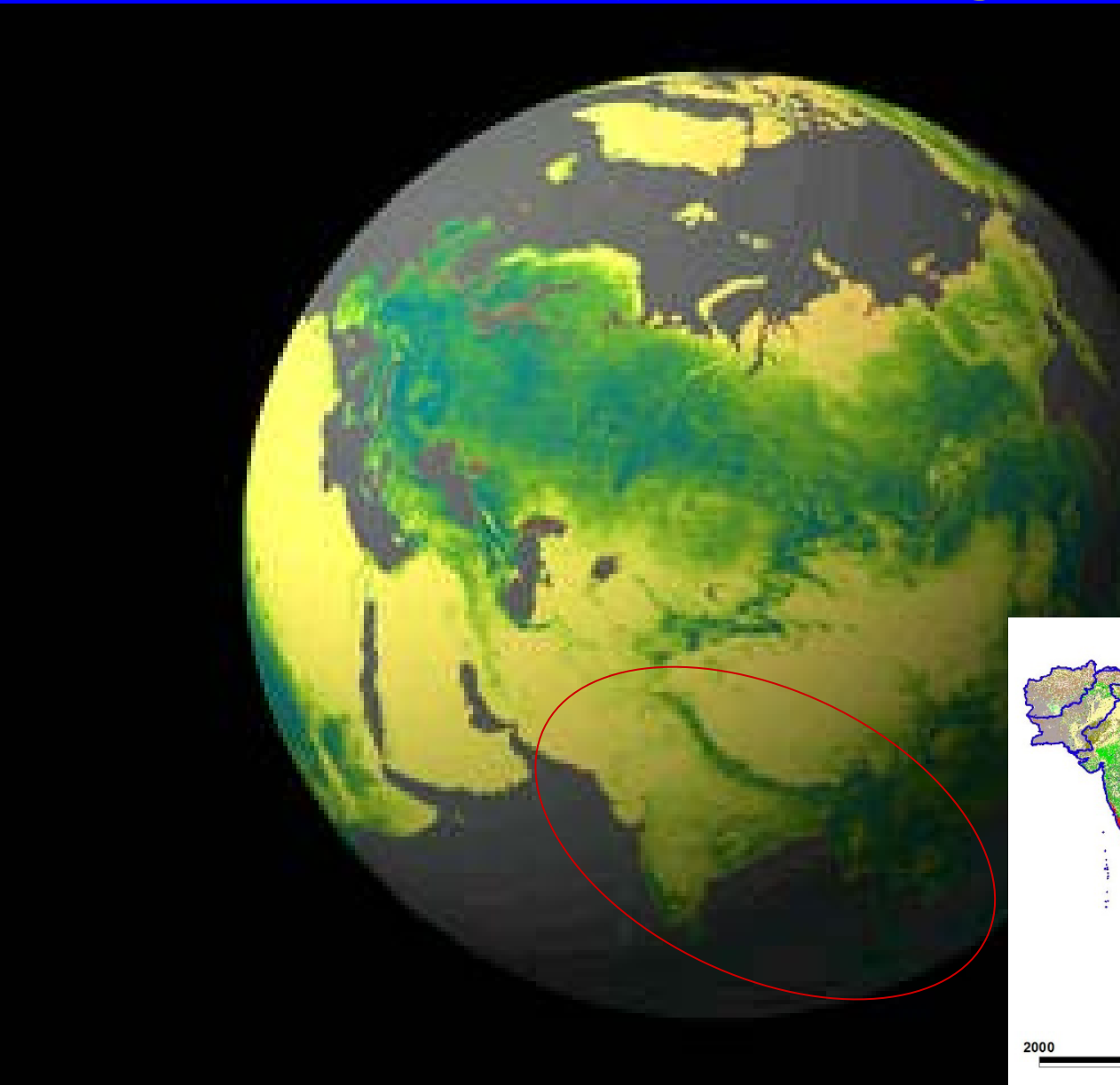
200 projects since Program's inception
Each year ~40 3-yr projects
Total in the Program >200 researchers



Monitoring 1/3
Impacts 1/3
Drivers, Modeling, Synthesis 1/3

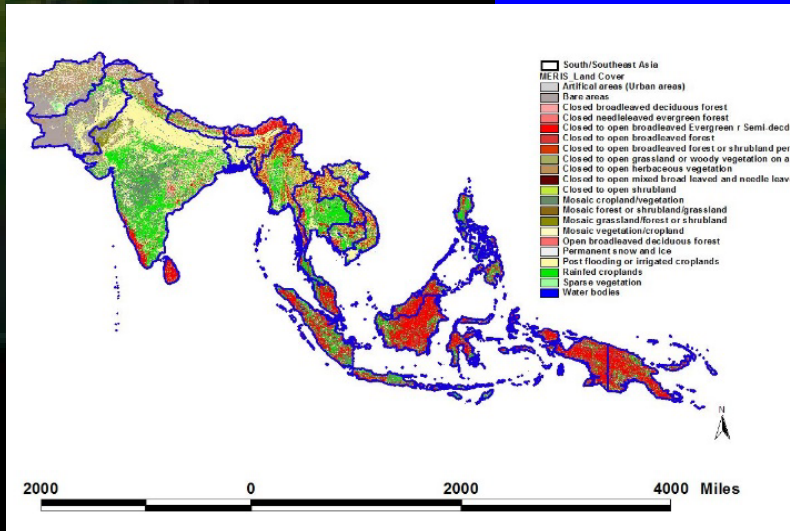
http://lcluc.hq.nasa.gov

South/Southeast Asia Research Initiative (SARI) Region



SARI Lead Project Scientist/
Coordinator

Krishna Vadrevu, NASA
MSFC//U. Maryland



Issues in SARI region

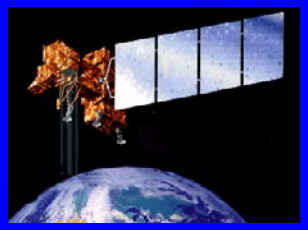
- Rapid pace of economic development
- Cross-border trade and regionalization
- Poverty alleviation and alternative livelihoods
- Biofuel from energy security perspective
- Alternate land uses in the context of climate mitigation
- Emissions/Pollution from Deforestation and Fires
- Industrial pollution

Tools

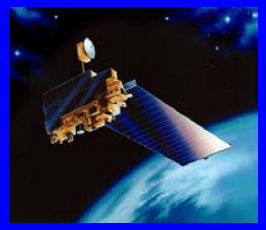
- Remote sensing observations (satellite and airborne)
  - Optical
    - Passive
      - High (1-10m) resolution multispectral (e.g. IKONOS, Orbview)
      - Moderate (10-30m) resolution multispectral (e.g. Landsat, SPOT, Sentinel-2)
      - Coarse (250-1000m) resolution multispectral (e.g. AVHRR, MODIS, MERIS)
    - Active (Lidars)
  - Microwave
    - Passive (e.g. SMAP)
    - Active (Radars) (e.g. Sentinel-1)
- In situ observations and intensive field campaigns
- Modeling and integrative data analysis
- Data and information systems

NASA LCLUC-Relevant Missions

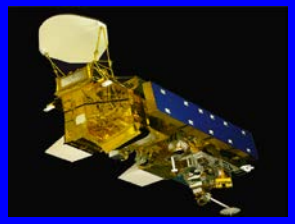
Current Systematic Missions - Observation of Key Earth System Interactions



Landsat 7
4/15/99

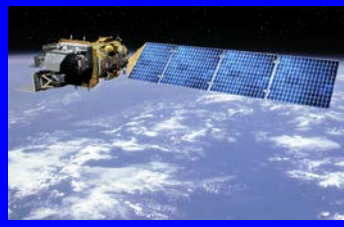


Terra
12/18/99



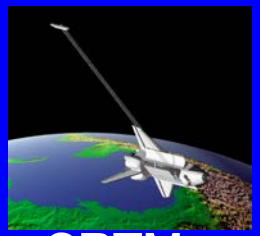
Aqua
5/3/02

Suomi-NPP
10/28/11

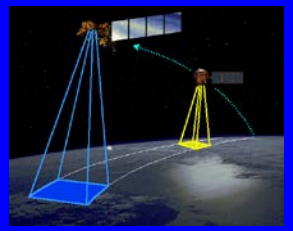


Landsat 8
2/11/13

Past Exploratory Missions - Exploration of Specific Earth System Processes and Parameters and Demonstration of Technologies

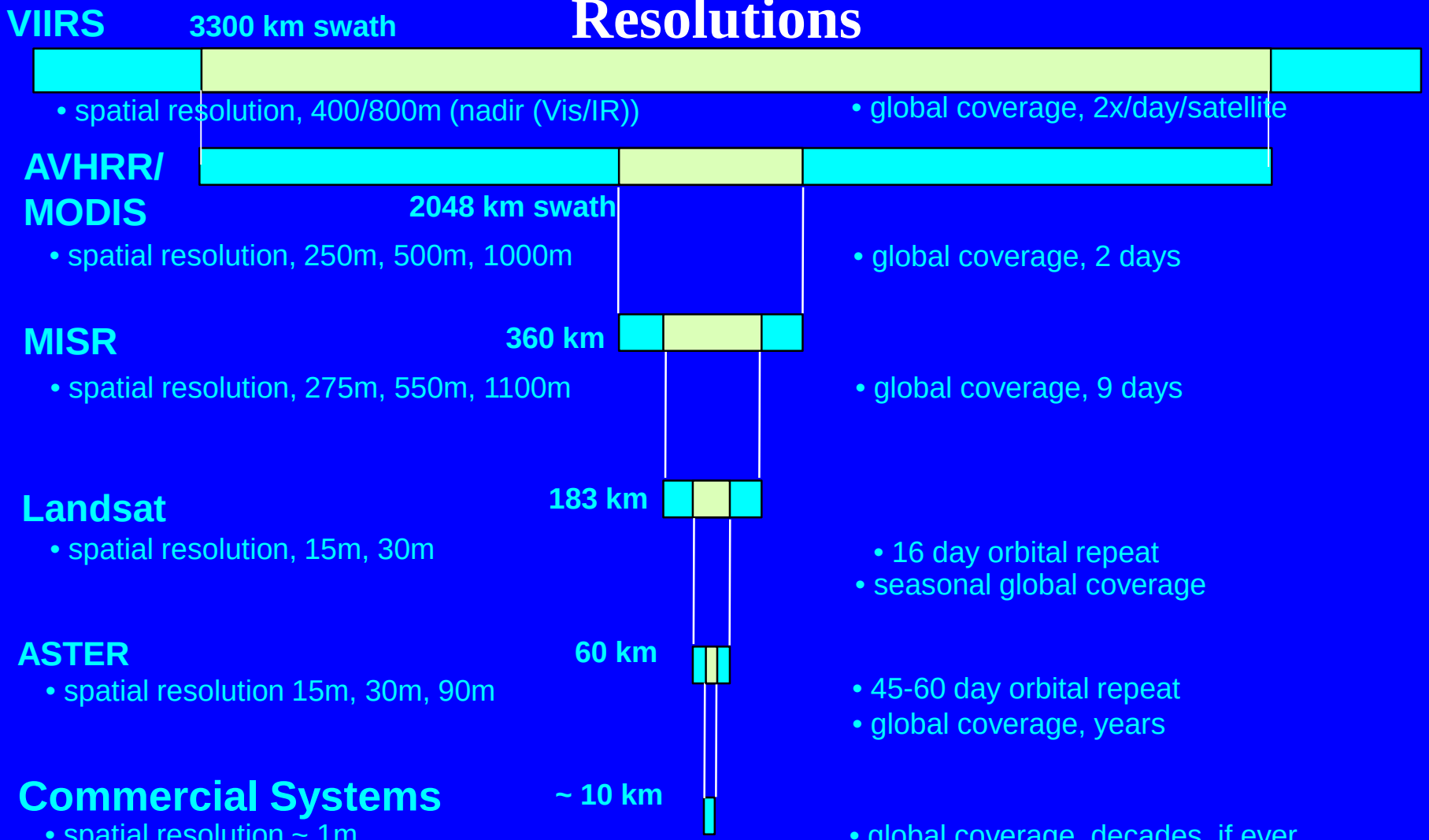


SRTM
2/11/00

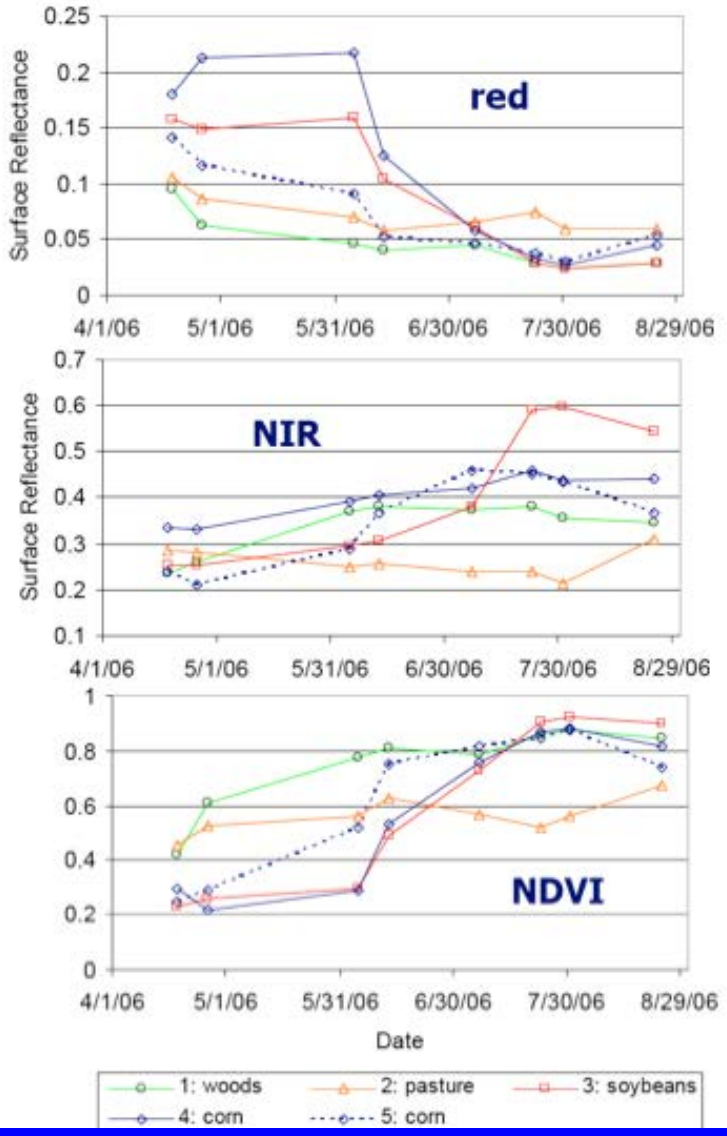


EO-1
11/21/00

Synergistic Use of Optical Sensors at Different Resolutions



Fusing Data From Landsat-like (Moderate Resolution) Sensors: Land-cover phenology at 30 m



- **Red reflectance, near-infrared (NIR) reflectance, and NDVI values for individual fields from central Illinois during the first half of the 2006 growing season**

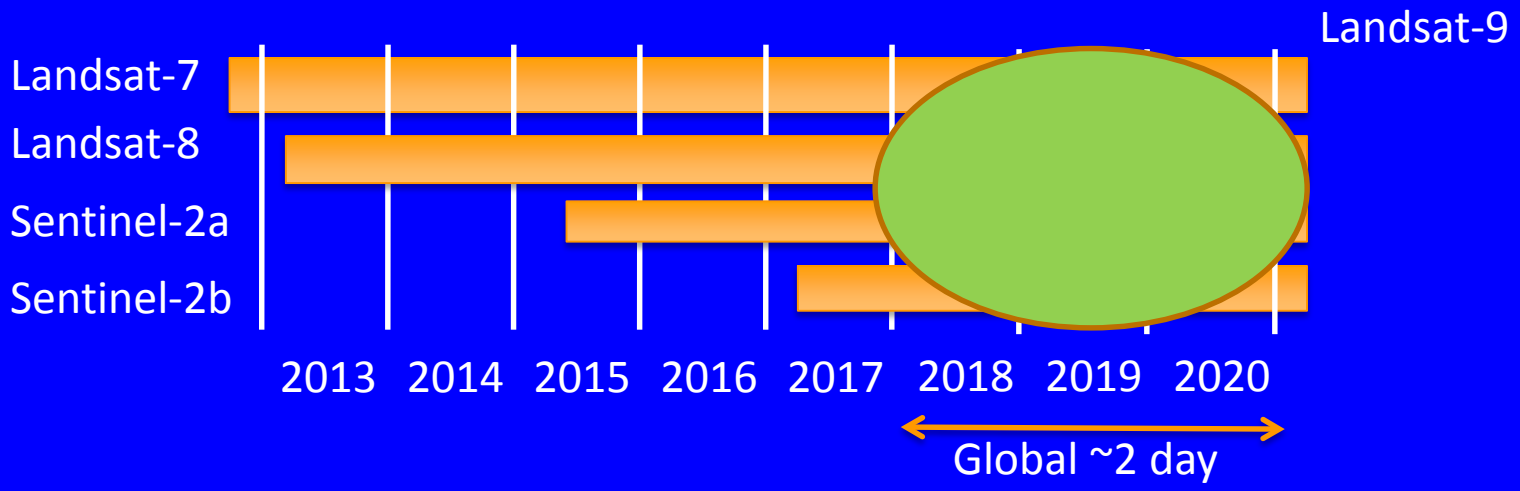
- **Data are combined from Landsat-5, -7, ASTER, and IRS**

Synergistic Use of Sentinel-2 and Landsat Sensor Data

Agriculture monitoring needs ~ 5-day coverage

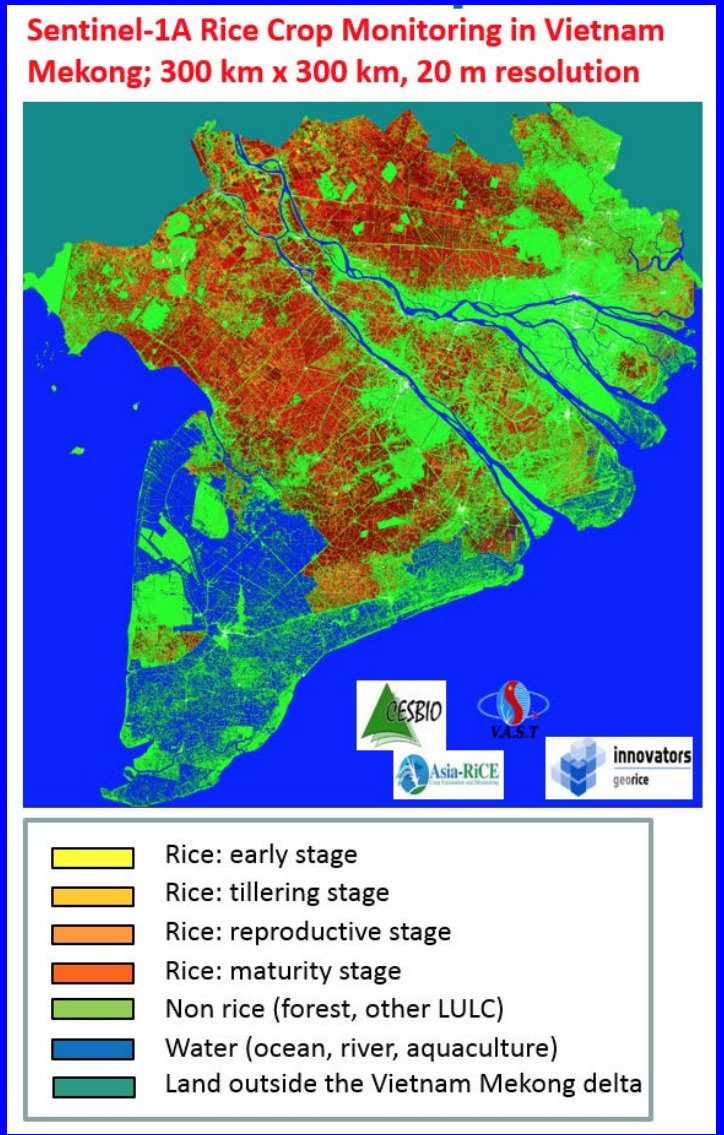
Both sensors have 10-30m coverage in VNIR-SWIR

- Satellite orbits are complementary
  - Landsat-7 & -8 8 days out of phase
  - Sentinel-2a & 2b 5 days out of phase
  - Landsat and Sentinel sun synch orbits precess relative to each other



ESA Sentinel Program

- Radars
  - Sentinel-1a: launched Apr 2014
  - Sentinel-1b: launched Apr 2016
- Optical
  - Sentinel-2a: launched Jun 2015
  - Sentinel-2b: launched Mar 2017



Agricultural Monitoring Needs

Agricultural monitoring has emerged as a key priority for GEO

- Global provisioning of food and water among most critical environmental issues in 21st century
- Maize (2008) and wheat (2010) supply constrictions caused global price spikes and food insecurity
- G20 Ag ministers requested creation of GEO-GLAM (Global Agricultural Monitoring initiative); ratified by CEOS (2011).

Crop assessments (type, condition) require ~weekly data @ <50m resolution

Currently no single remote sensing system satisfies this requirement

- MODIS & MERIS can provide weekly phenology but at regional scales
- Landsat can resolve individual fields, but only seasonally

Hillsides in the Nilgiris being prepared for planting vegetables, shot by Rafeek Manchayil,

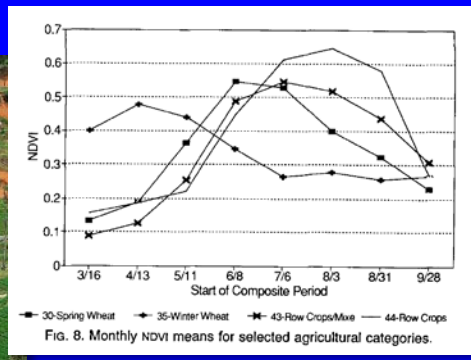
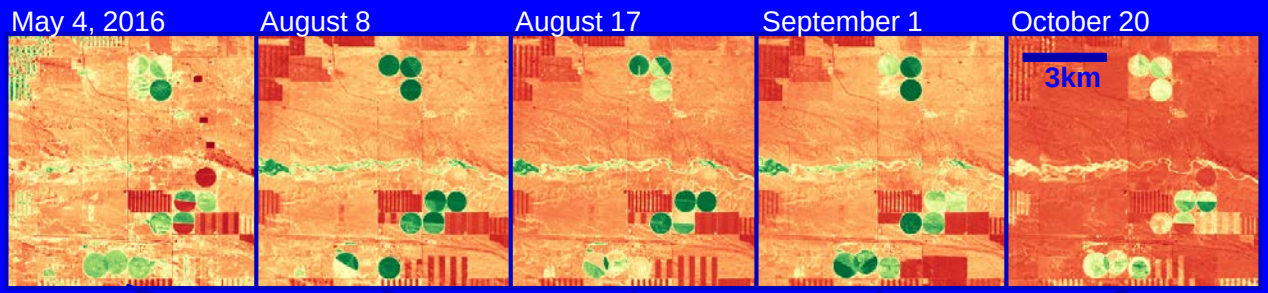
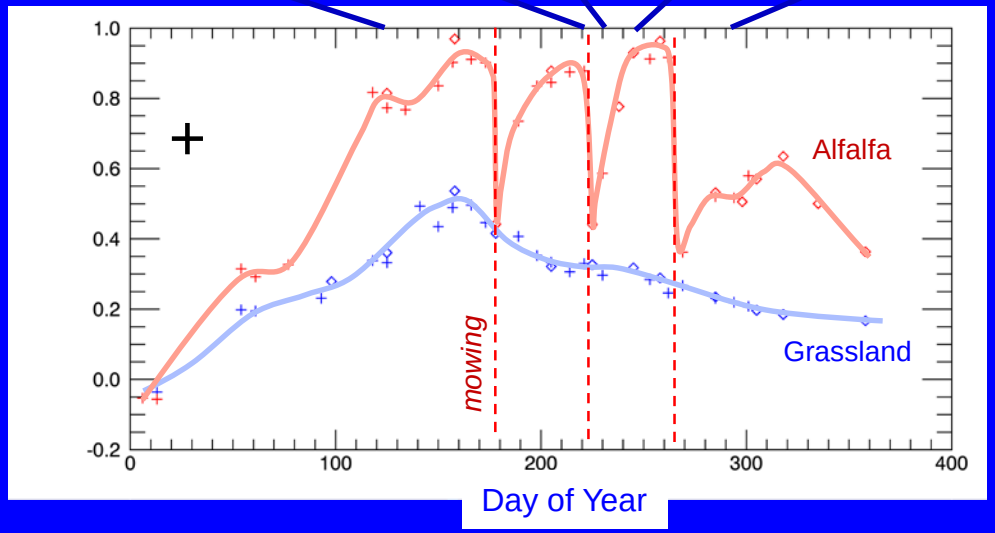


Fig. 8. Monthly NDVI means for selected agricultural categories.

Harmonized Landsat-8/Sentinel-2 Products
Laramie County, WY





Seasonal phenology (greening) for natural grassland (blue line) and irrigated alfalfa fields (red line) near Cheyenne Wyoming observed from Harmonized Landsat/Sentinel-2 data products. The high temporal density of observations allows individual mowing events to be detected within alfalfa fields. HLS Products available from https://hls.gsfc.nasa.gov

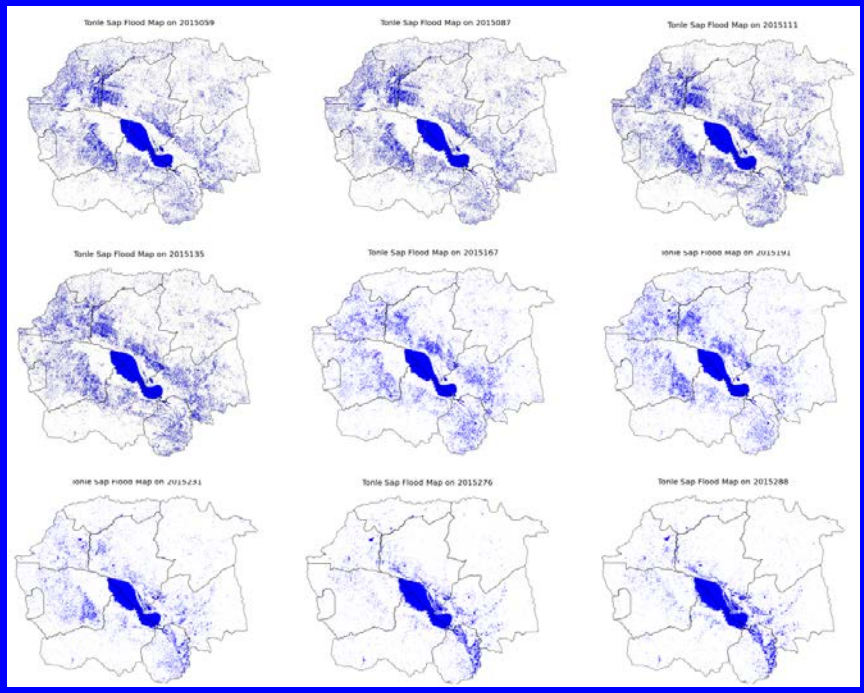
Courtesy: Jeff Masek (NASA GSFC)

Operational algorithms and products for near real time maps of rice extent and rice crop growth stage using multi-source remote sensing

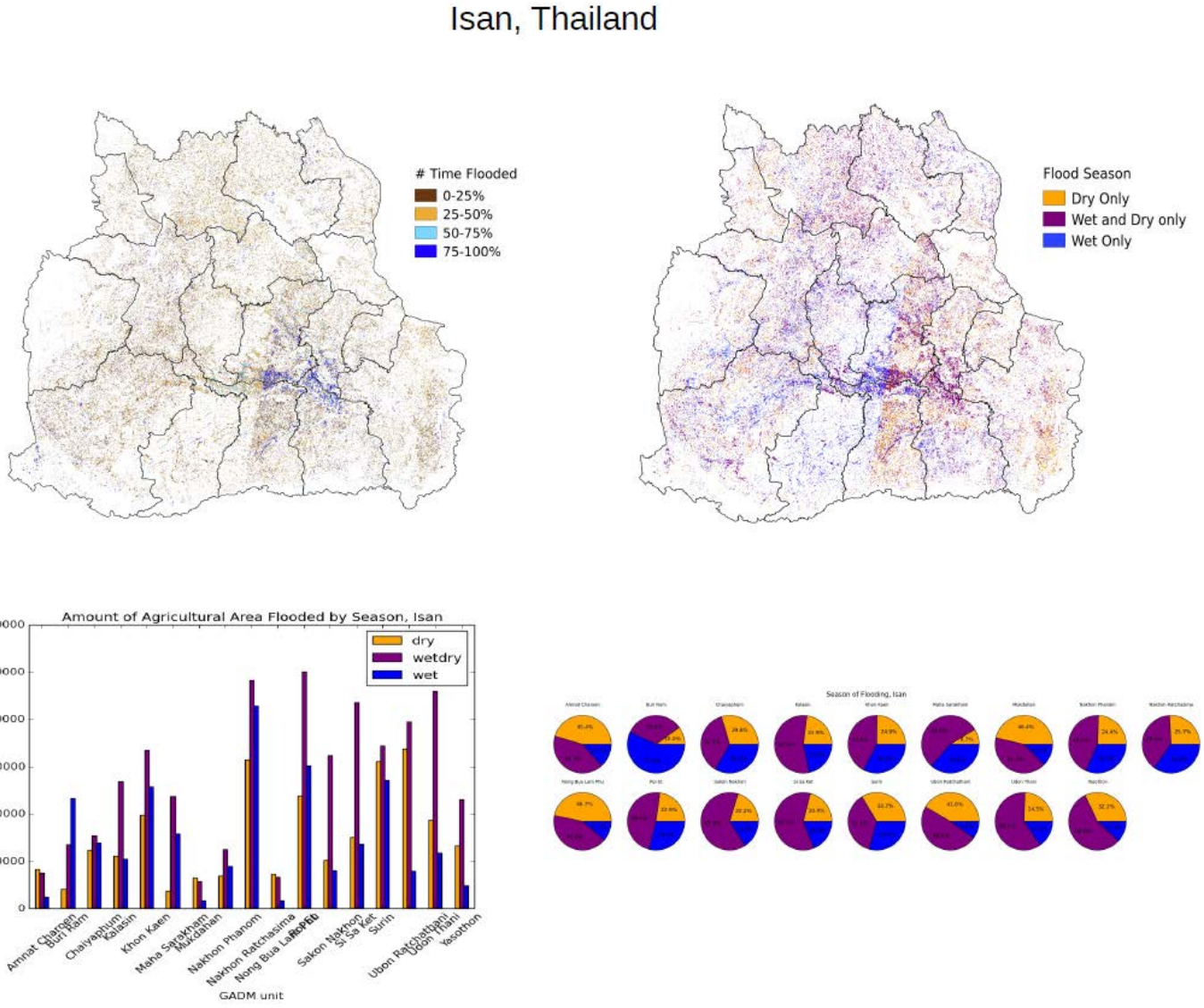
PI: W. Salas, N. Torbick, AGS
Thuy Le Toan, CESBIO; Dirk Hoekman, Wageningen

- Fuse SAR-optical for mapping agricultural conditions; technology transfer with partners
- Sentinel-1, PALSAR-2, Landsat-8, Sentinel-2, Radarsat-2
- Fusion provides more and better information; the approach strives to extract strengths of any / each satellite to complement another platform
- Pilot sites have beta products; begun cal /val coordination with ESA, regional partners (AsiaRice, IRRI, VAST, SERVIR, Ministries,…)

Example Tonle Sap, Cambodia Sentinel-1A Rice Inundation Dynamics Time Series



Agricultural Area Flooded: Isan, Thailand



Pre-SARI and SARI Meetings

Pre-SARI LCLUC Regional Meetings

2009/1: Kohn Kaen, Thailand
2011/11: Hanoi, Vietnam
2013/1: Coimbatore, India

Yangon, Myanmar, Jan ‘16

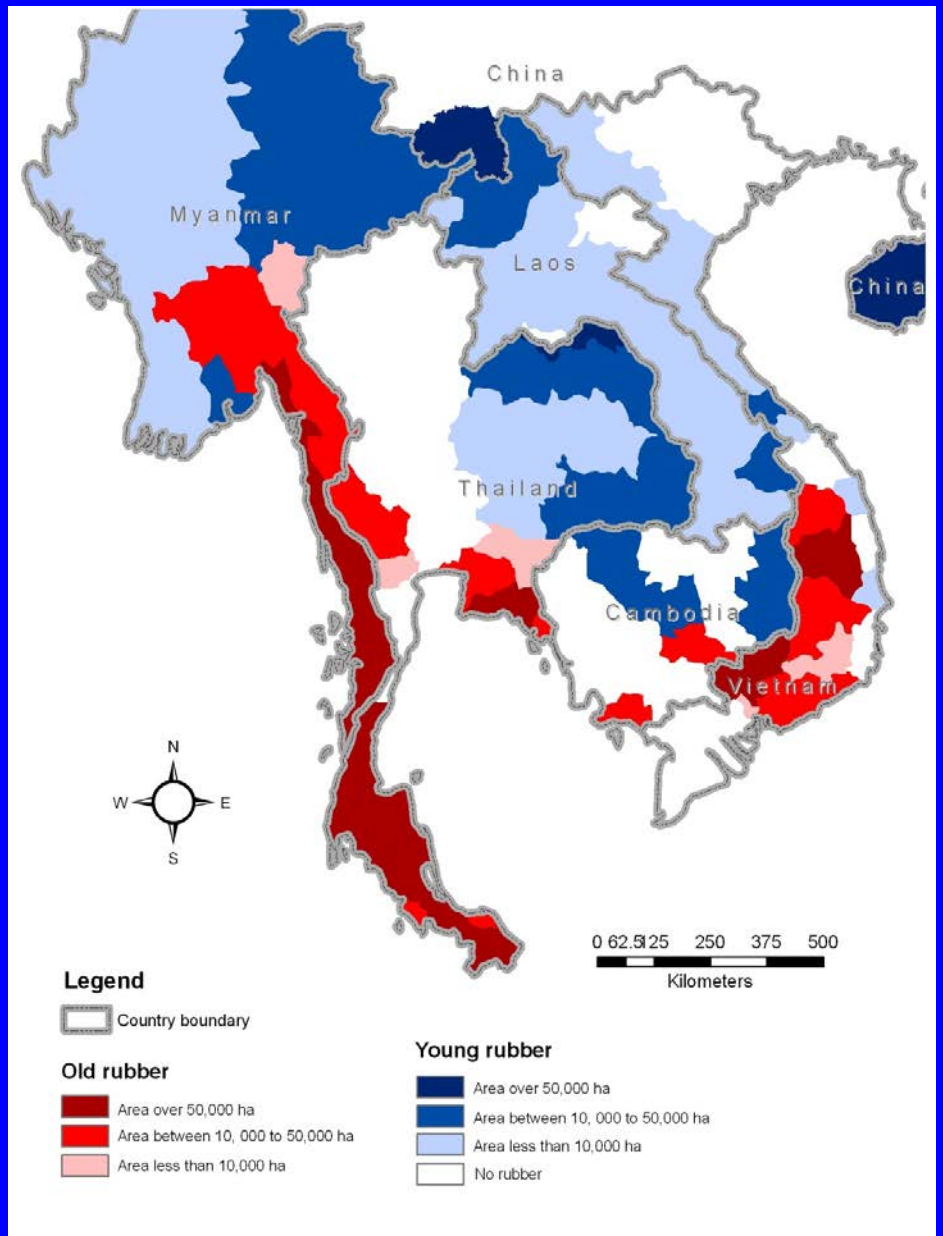
SARI LCLUC Meetings

2015/8 Bogor, Indonesia
2016/1: Yangon, Myanmar
2016/10: Ho Chi Minh, Vietnam
2017/5: New Dehli, India
2017/7: Chiang Mai, Thailand

NASA Pre-SARI Projects

- Jefferson Fox/East-West Center: The Expansion Of Rubber And Its Implications For Water And Carbon Dynamics In Montane Mainland Southeast Asia
- Chandra Giri/ SAIC/USGS EROS Center: Tropical Mangrove Forests: Global Distributions And Dynamics (1990-2005)
- Atul Jain/University of Illinois: Land Cover And Land Use Change And Its Effects On Carbon Dynamics In Monsoon Asian Region
- Xiangming Xiao/ University of Oklahoma: Quantifying changes in agricultural intensification and expansion in monsoon Asia during 2000-2010
- Hanqin Tian/Auburn University: Land Use-Ecosystem-Climate Interactions In Monsoon Asia
- David Skole/Michigan State University: Enhancing Global Observations And Information On Tropical Forest Change Using Landsat Global Data
- Ruth DeFries/Columbia University: Multi-sensor Fusion to Determine Climate Sensitivity of Agricultural Intensification in South Asia
- Steve, Leisz/Colorado State University: Increased Accessibility, Landscape Changes, Rural Transformations, and Urbanization: Impacts of the East-West Economic Corridor from Da Nang, Vietnam, to Khon Kaen, Thailand

Traditional and non-traditional rubber-growing regions



Jeff Fox, EWC, 2010

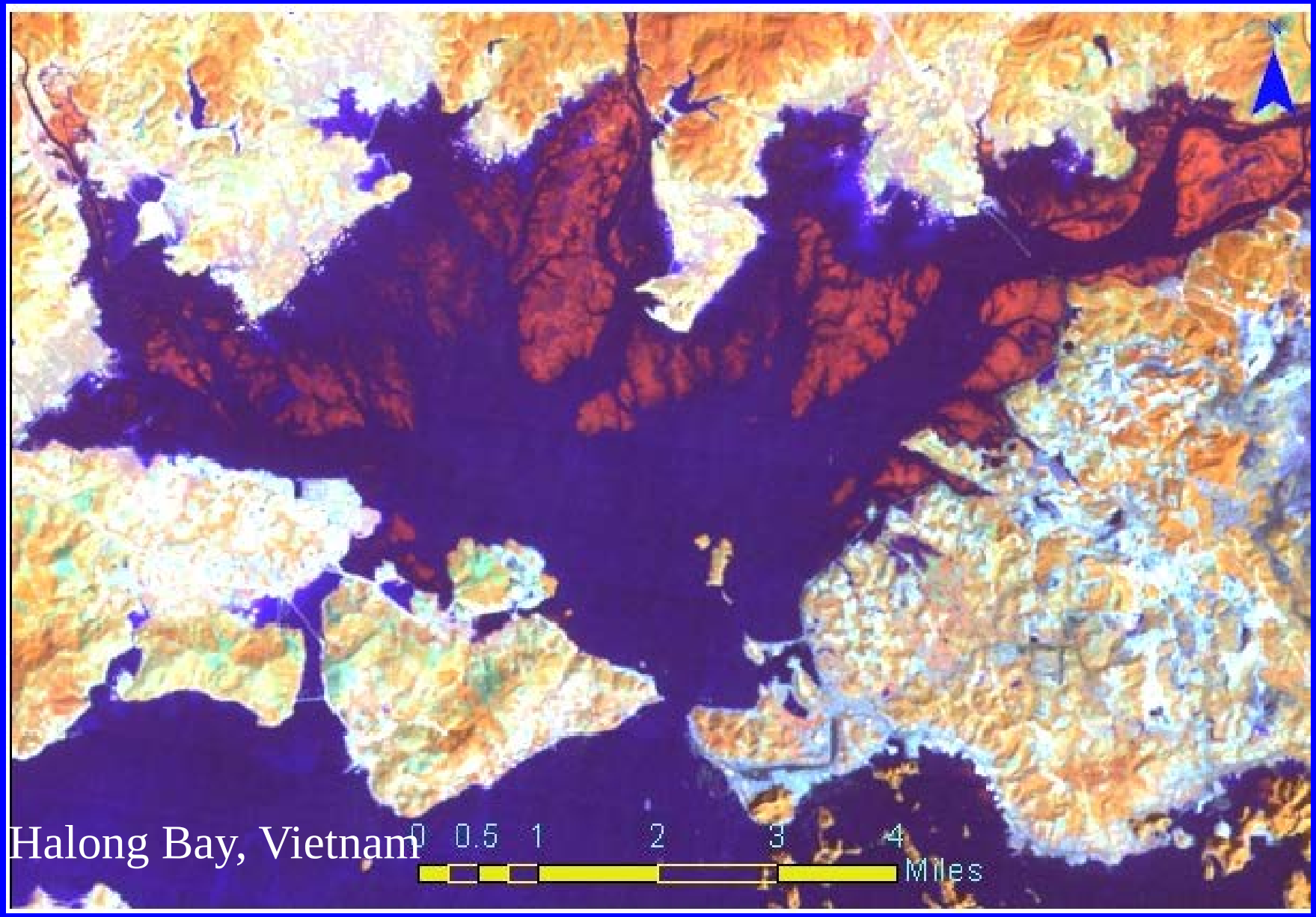
Agriculture vs Fishing/Prawn Farming

- Transition from the agriculture oriented to fishery and shrimp farming or fish processing
- Many paddy fields have been now converted into full time prawn farming units => conflicts between fishermen and ag people
  - Ag is not income generating (production costs especially that of labour, had gone up)
  - Prawn farming is more income generating due to its very high export demand

Mangrove forest declines around world

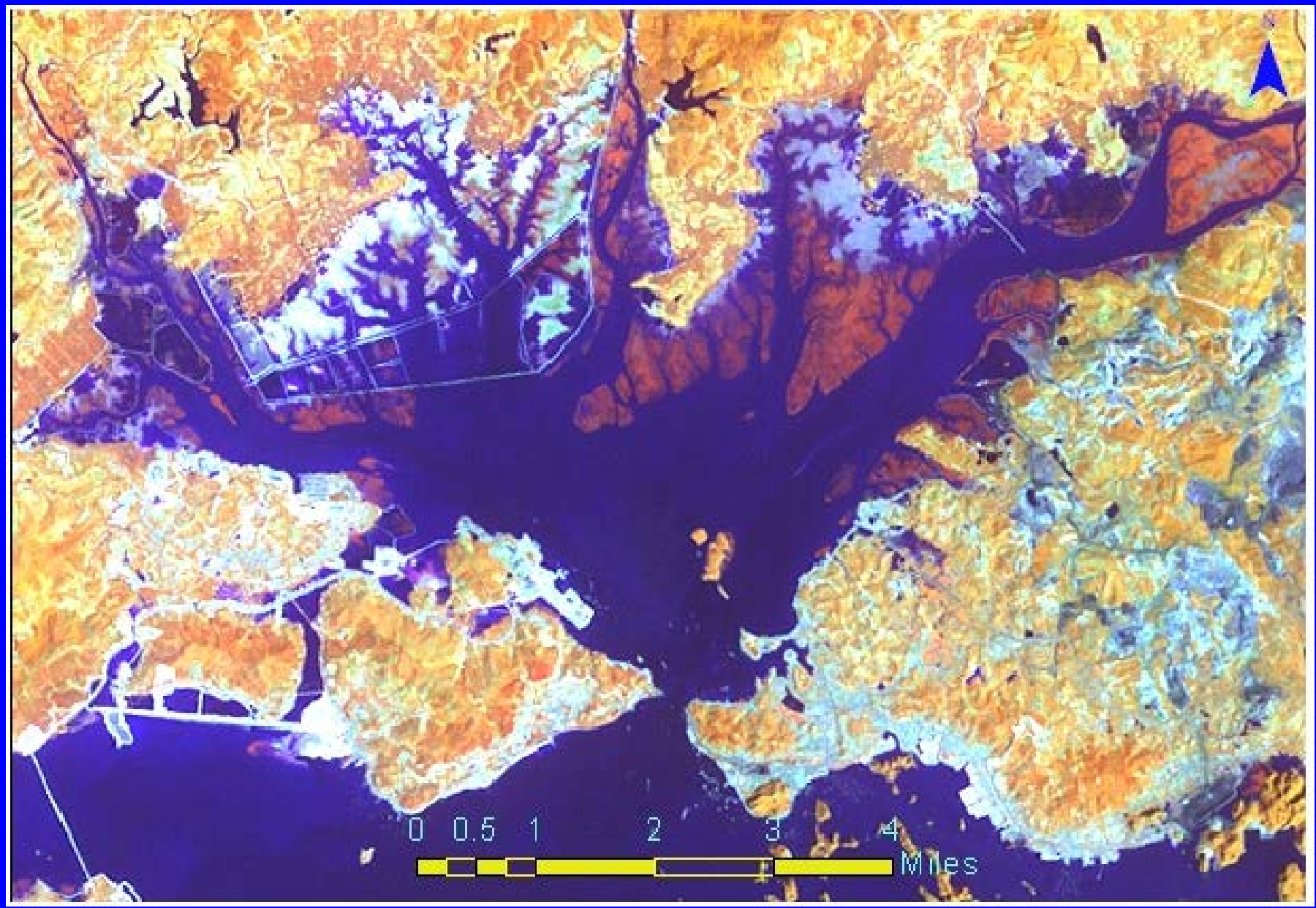
13% is significant, especially as it is disappearing faster than inland tropical forests, Chandra Giri, EPA

The largest tract of remaining mangroves in the world: the Sundarban mangroves on the border between Bangladesh and India (in Red)

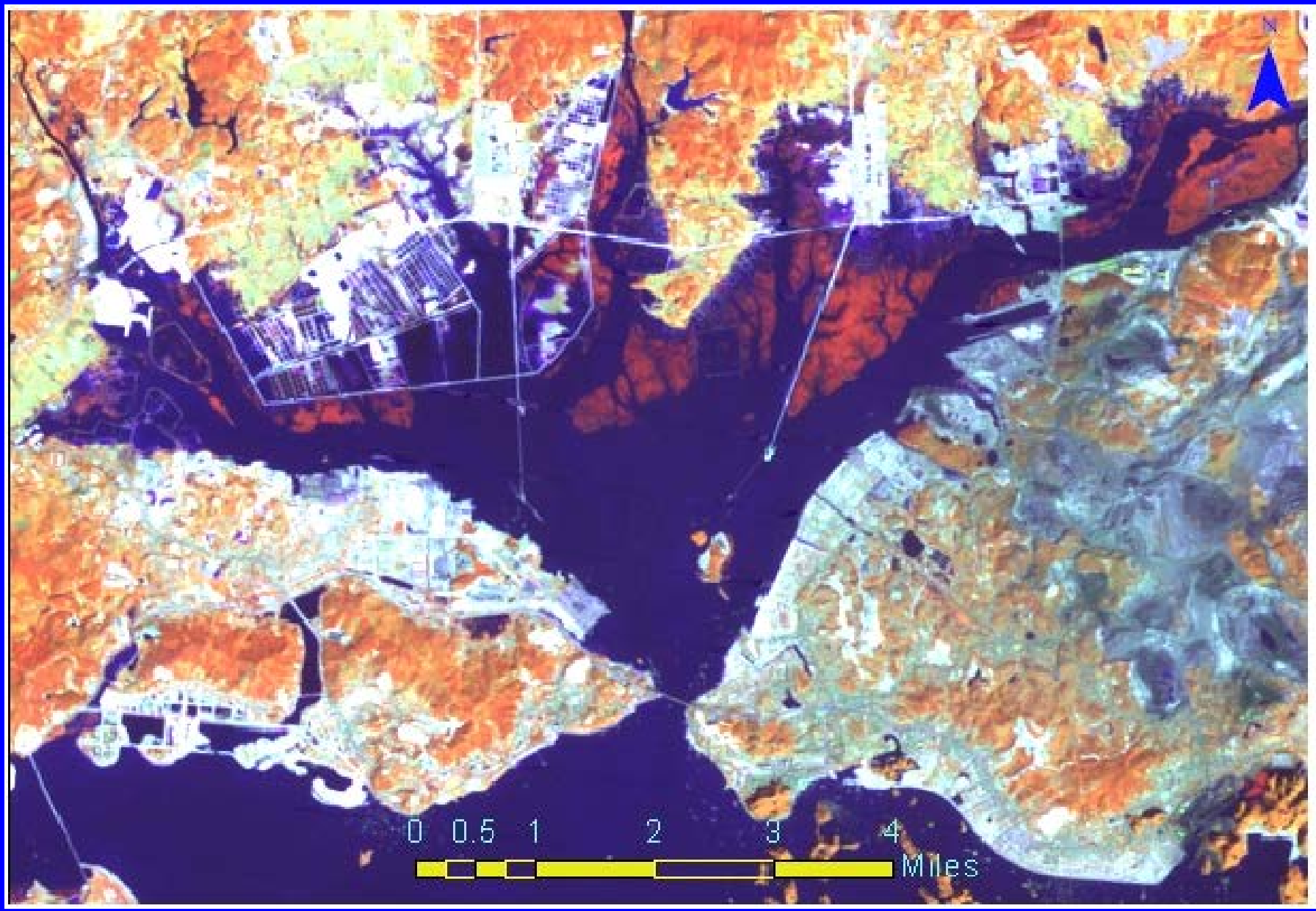


Halong Bay, Vietnam

1990



2001



2009

What We Have Learned During the Past Decade:

Basic Drivers

- Population growth in Southeast Asia drives rapid urban expansion on rural and agricultural lands
- Loss of agricultural lands to urban expansion → deforestation in order to clear land for new fields to meet agricultural demand
- Rise in the prices for rubber and palm → reduced food production and increased food costs

Impacts

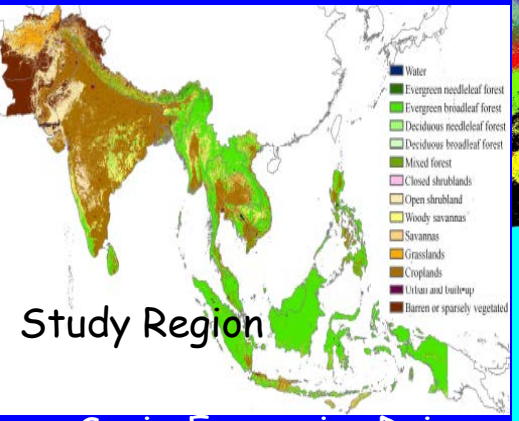
- Large-scale land-cover conversion for agriculture → changes in the carbon cycle
- Biomass burning → degraded air quality & increased emissions
- Increased field size, growth of biofeed stocks, year-round agroforestry, and livestock → ecological impacts

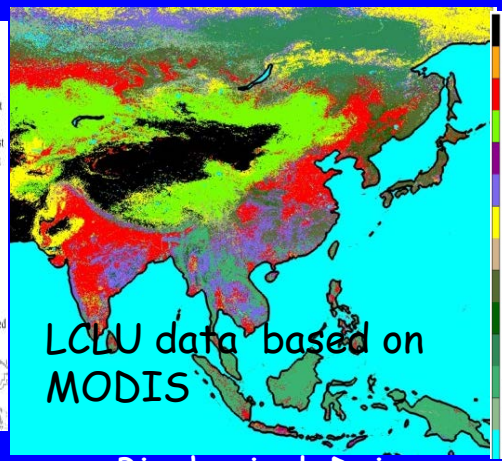
NASA LCLUC Synthesis Projects in SARI Region

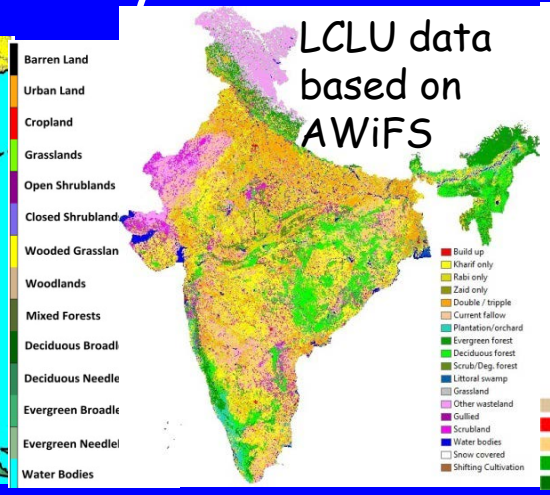
- Atul Jain/U. of Illinois
  - Land Cover and Land Use Changes and Their Effects on Carbon Dynamics in South and South East Asia: A Synthesis Study
- Jeff Fox, East-West Center, Hawaii
  - Forest, Agricultural, and Urban Transitions in Mainland Southeast Asia: Synthesizing Knowledge and Developing Theory
- Peilei Fan, Michigan State U.
  - Urbanization and Sustainability Under Global Change and Transitional Economies: Synthesis from Southeast, East and North Asia
- Seto, Karen , Yale U.
  - Synthesis of LCLUC studies on Urbanization: State of the Art, Gaps in Knowledge, and New Directions for Remote Sensing Science

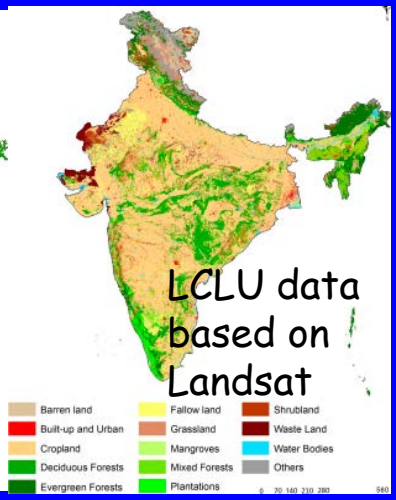
LCLUCs and their Effects on Carbon Dynamics in South and South East Asia: A Synthesis StudyPI:

Atul K. Jain, University of Illinois

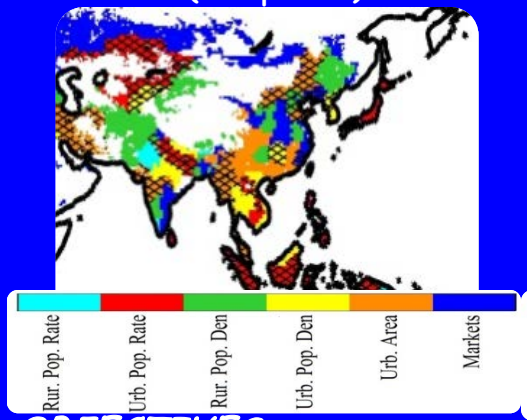




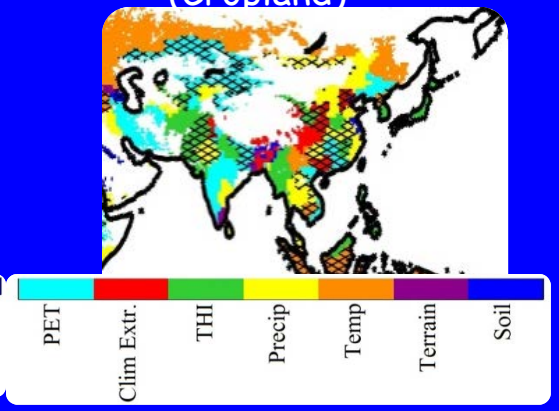




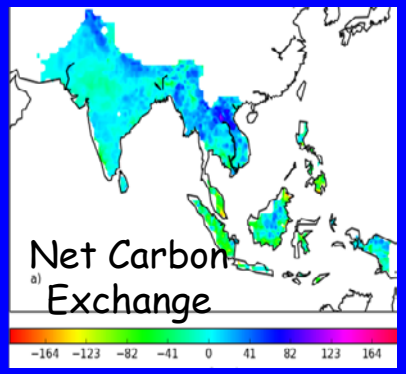
Socio-Economics Driver (Cropland)

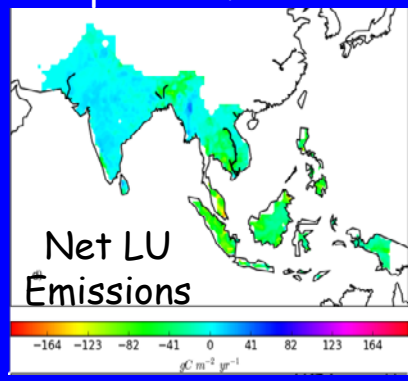


Biophysical Driver (Cropland)



Mean of 9 Terrestrial Biosphere Models





OBJECTIVES:

- To understand the major LCLUC transition activities in the study region (LCLU data)
- To advance our understanding of the causes of LCLUC (Drivers)
- To understand historical effects of LCLUC dynamics on terrestrial C fluxes (Model Results)

Forest, agricultural, and urban transitions in Mainland Southeast Asia: Synthesizing knowledge and developing theory

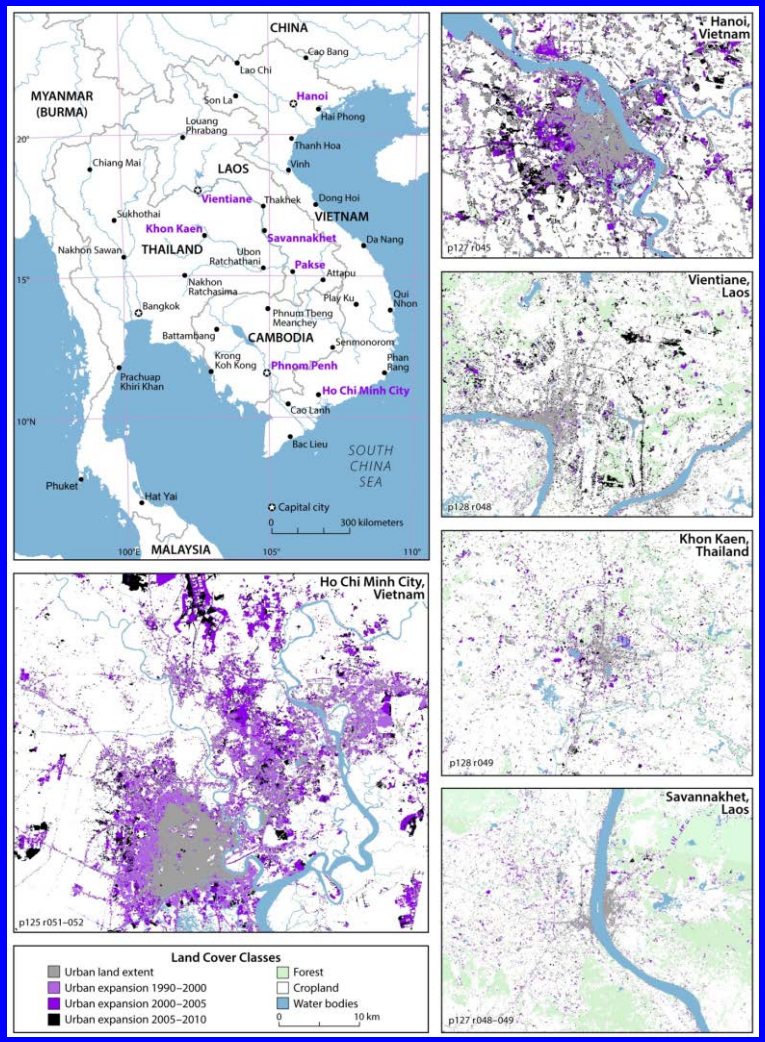
Jefferson Fox (East West Center, Hawaii), Annemarie Schneider, Ian Baird (U. of Wisconsin)

- By 2030, it is anticipated that periurban areas in East Asia will expand by 200 million people, or 40% of total projected urban population growth

- Impacts across multiple scales
  - local effects on farmer livelihoods
  - regional impacts to economic development
  - fragmented governance
- Detrimental environmental impacts
  - increased air and groundwater pollution
  - loss of native vegetation
  - decreases in biodiversity

- Field visits have established that the main land cover change in each urban area is the expansion of built-up area onto agricultural land, while other changes (such as expansion of built-up area onto forested land) are negligible near each city

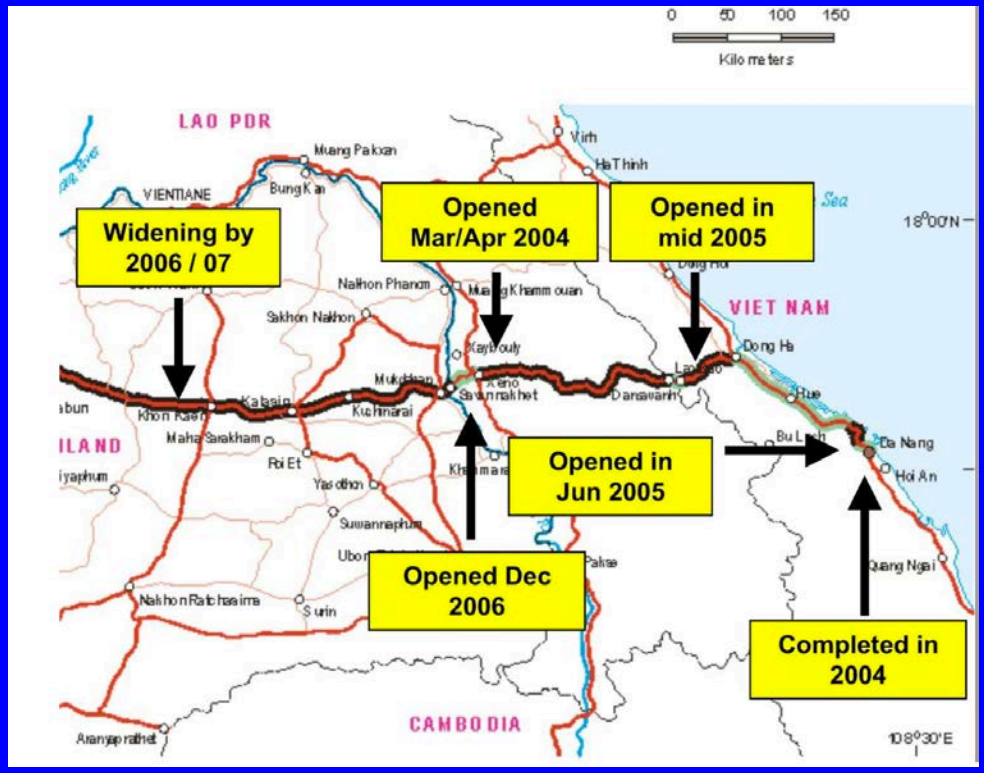
Regional assessment of urban and periurban expansion, 2000-2010



LCLUC in East-West Economic Corridor (Vietnam, Laos, Thailand)

Stephen Leisz, Colorado State U.

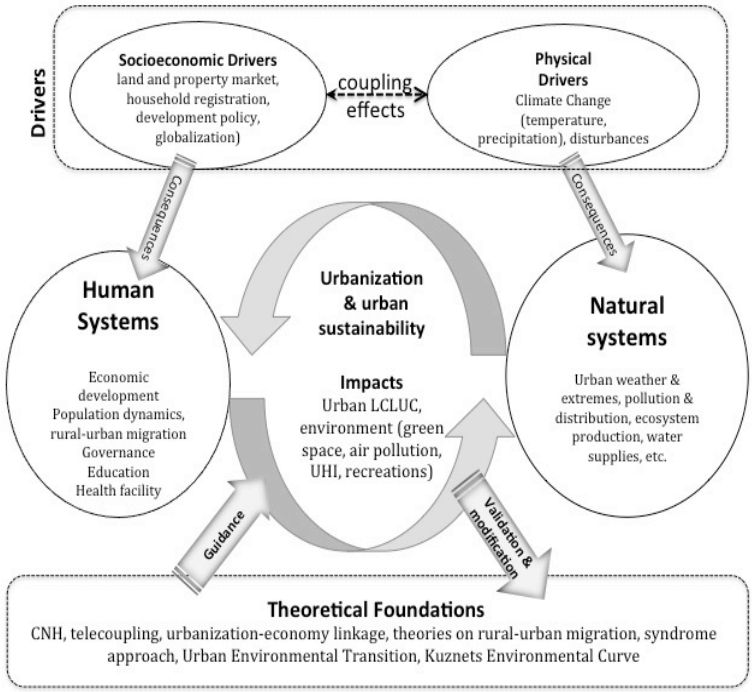
- Initiated in 1992 as part of ASEAN Free Trade Area
- Objective
  - Improve the regions connectivity and key sectors of the economy through improving the transportation infrastructure
- Conclusions
  - EWEC has increased connectivity between countries
  - Changes in farming and livelihood systems in rural areas leading to changes in both the land-use and the land-cover (Vietnam image analysis; evidence from interviews in Laos)



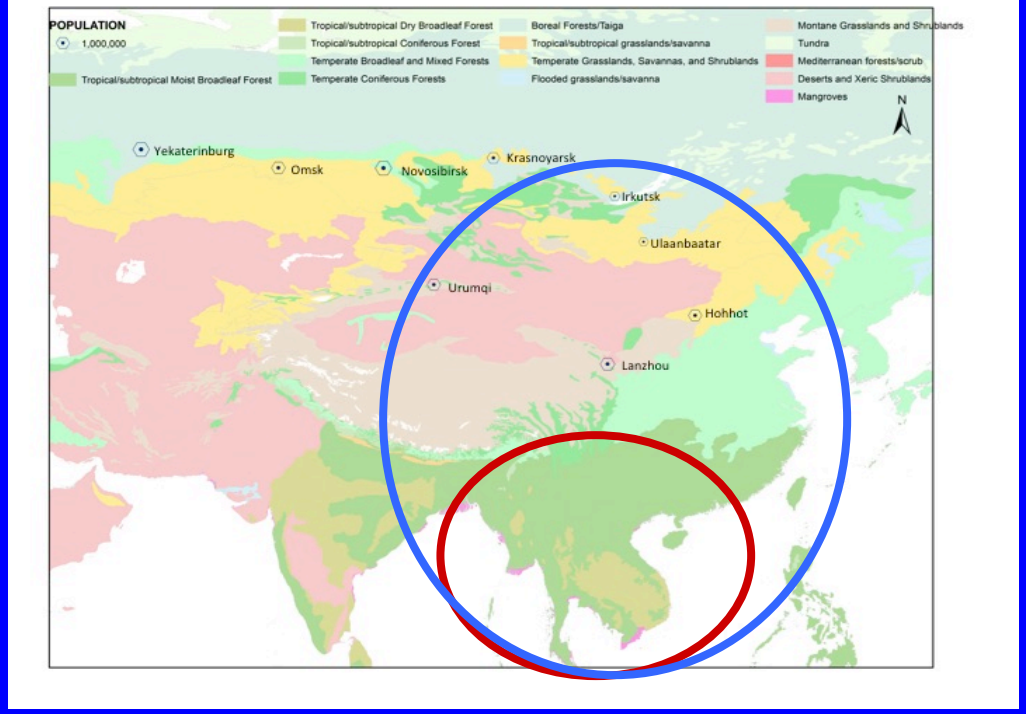
Drivers: tourism, government policies, cross-border investments

Urbanization and sustainability under global change and transitional economies

A synthesis study including SE Asia region



Conceptual framework for understanding drivers, process, and impacts of urbanization and sustainability



SE Asia is a sub-region of project's geographic domain

Research Questions:

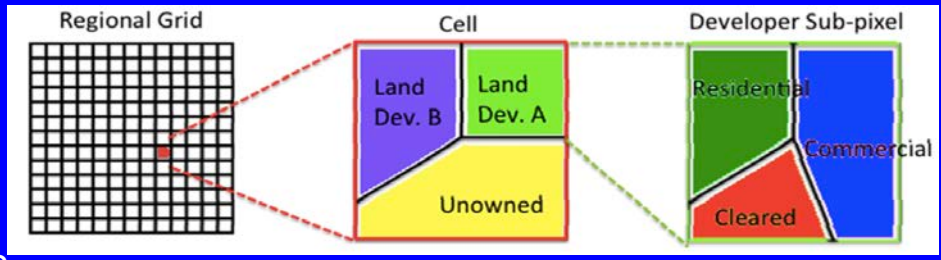
1. What are the spatiotemporal changes of urban expansion within transitional economies?
2. What are the key socioeconomic and biophysical drivers of urbanization and urban sustainability? More specifically, which institutional mechanism is unique and crucial? How well do our models and data explain these changes through the interactions and feedback mechanisms of human and natural systems?
3. How well can we predict the changes in urban LCLUCs and functions based on the derived structure and functions of LCLUC, human systems, and natural systems?
4. What socioeconomic and institutional adaptations have been implemented and how effective have they been? What policy recommendations can be offered to enhance urban sustainability in the near future?

PI: Peilei Fan, Michigan State University

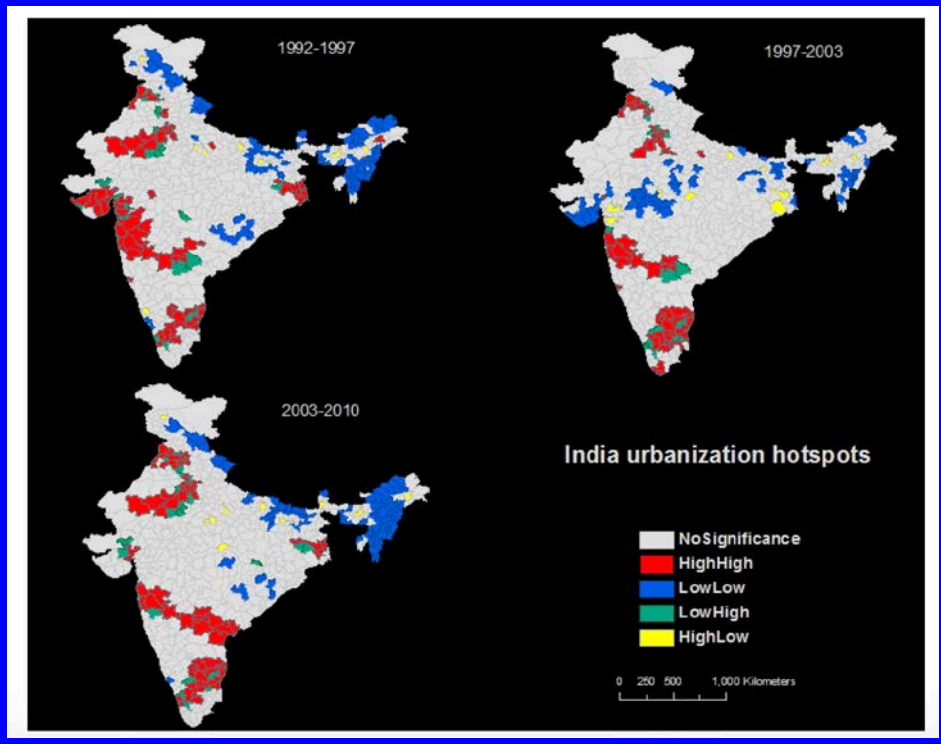
Synthesis of LCLUC studies on Urbanization: State of the Art, Gaps in Knowledge, and New Directions for Remote Sensing Science

Karen Seto, Yale University

- What are the patterns of urban LCLUC globally?
- What are the drivers of urban LCLUC globally?
- How do change detection algorithms characterize urban LCLUC?
- What are best practices for applying urban change detection algorithms?
- What are the effects of urban LCLUC on other LCLU?



Method: multi-level modeling approach to examine how socio-economic and policy factors—represented here by fiscal transfers—at different administrative levels affect growth in “urban hotspot counties” across three time periods (1995-2000, 2000-2005, and 2005-2008)



Results

- counties that are more dependent on fiscal transfers from the central government convert less cultivated land to urban use
- local governments are becoming more powerful in shaping urban land development as a result of local economic, fiscal, and political incentives and through the practical management and control of capital, land, and human resources

NASA-SARI Science

- Based on the pre-SARI projects and
  - LCLUC-2015 selections for South Asia (10 selections)
  - LCLUC-2016 selections for Southeast Asia
    - to be announced in October 2017 (~7 projects)
  - MuSLI-2014 and MuSLI-2017 (~3 selections)
  - About 20 SARI projects are expected to run the next 5 years
  - Inter-Disciplinary Science (IDS) WEF project (1 funded)

Most Recent Addition to LCLUC SARI:

Quantifying human and climate impacts on wetland ecosystems in the Lower Mekong River Basin

IDS Project: Water-Energy-Food Nexus

PI Jiaguo Qi (Michigan State U.)

Science Team:

10 Co-Is (from 3 institutions)

Numerous Regional Collaborators from each country of the Lower Mekong River Basin

Goal:

- Improve our understanding of how human activities (dams and associated irrigation) affect ecological processes in wetlands
- Provide a scientific basis for improved operation of dams to help mitigate the expected effects of climate change

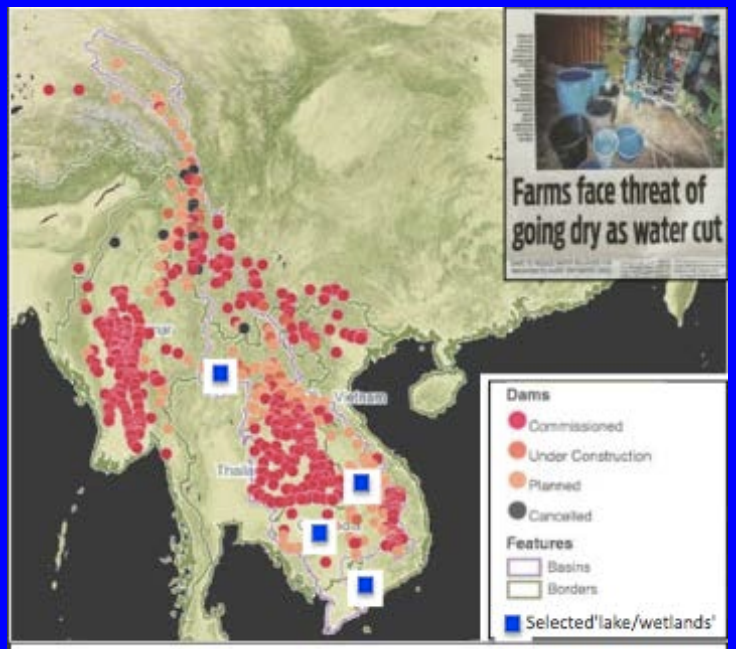


Fig. 1 The Mekong River basin represents a complex interface of coupled human, land and water systems. Millions of people are struggling with challenges resulting from climate change and disruptive water resources competition of hydropower dams. Map on the left shows the locations of existing and planned dams in the basin, while the insert is a picture of local newspaper in Thailand 2016 featuring droughts. The blue squares are selected wetland study sites.


Asia WEF Nexus Workshop
July 11-16, 2017
Nakhon Phanom University, Thailand
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