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

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Focus on SE Asia
Issues in SE Asia

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

- Delhi 153 PM
- Karachi 117
- Dhaka 8
- Beijing 56
- Colombo 28
- Jakarta 21
- Singapore 17

The WHO advises that fine particles of less than 2.5 micrometres in diameter (PM2.5) should not exceed 10 micrograms per cubic meter.
Forest Fires Smoke: Transboundary Haze

An aerial photo shows wildfire burning in Giam Siak Kecil Biosphere forest area, Bukit Batu, Riau, Indonesia. More than 33,300 residents of Riau have already suffered acute respiratory tract infection because of the haze. (31 March, 2014, TEMPO.CO, Jakarta)

Singapore's city-state Pollutant Standards Index shot up on Monday as wild forest fires made the smog and haze sitting on the skyscrapers and landscape the worst it has been in the past seven years. Malaysia also fell prey to the choking smog that spread from the neighboring country.

Residents of Sampit, Indonesia, bike through smog in Sept. 2012. (Photo : Reuters)
El Nino 2015: Indonesia

NOAA ENSO Model Now Forecasting a Supercalifragilistic El Niño for 2015/16 Season (http://wattsupwiththat.com)

Meteorologists say it looks like the biggest such event since the fierce El Niño of 1997-1998.

On average, a healthy El Niño can boost the U.S. economy by about 0.55 percent of Gross Domestic Product, which would translate more than $90 billion this year, an International Monetary Fund study calculated this spring. But it could also slice an entire percentage point off Indonesia’s GDP. “Indonesia gets hit particularly hard because an expected El Niño drought affects the country’s mining, power, cocoa, and coffee industries (Mohaddes, IMF)

Atmospheric and oceanic features reflect an ongoing and strengthening El Niño.

...even a weak El Niño could make 2015 the hottest year on record


- AVHRR-derived variables
  - SST, LST, ALB, NDVI, Vis/NIR reflect
  - Outgoing Longwave Radiation
  - All-sky absorbed solar flux
  - Total Precipitable Water
  - Fractional Cloud Cover
  - Cloud reflectivity
  - Effective Droplet Radius
  - Fire identification
Fall 1997-Spring 1998: Consequences of El Nino event

The fires were detected using AVHRR data with a system developed at NOAA/NESDIS based on the Justice et al. (1996) algorithm.

Modifications to the algorithm, similar to those proposed by Giglio et al. (1999) were made to eliminate residual false signals caused by sun glint, cloud edges, and strong thermal gradients over nonuniform landscape.
Fig. 7. Spatial–temporal patterns of clouds, fires, and smoke over Borneo during July 1997–April 1998 presented as AVHRR/GAC red–green–blue images with fires mapped as a red overlay. Smoke and warm clouds are rendered in yellow. Cold clouds are white. Cloud- and smoke-free ocean and land are dark blue and green, respectively.
Time Series of AVHRR-derived Variables: July 1997 - June 1998

Borneo (●), Celebes (○),
Java-Timor (□), Sumatra (△)

Land Surface Temperature (LST)

Vegetation Index (NDVI)

Visible Reflectance (VIS)
FIG. 9. Histograms of broadband land surface albedo and fractional vegetation greenness in the eastern part of Borneo before and after the second period of fire activity.
Fire effect on cloud microphysics

Large fires affect cloud formation processes. The maritime clouds change to a continental type with reduced rain potential, providing a positive feedback to the existing drought conditions.

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/
Tools

• Remote sensing observations (satellite and airborne)
  – Optical
    • Hyper-spatial resolution multispectral (e.g. IKONOS, Orbview)
    • High resolution multispectral (e.g. Landsat, SPOT)
    • Moderate resolution multispectral (e.g. AVHRR, MODIS, MERIS)
    • Lidars
  – Microwave
    • Passive
    • Radars

• In situ observations and intensive field campaigns
• Modeling and integrative data analysis
• Data and information systems
Synergistic Use of Optical Remote Sensing

**VIIRS**
- 3300 km swath
- Spatial resolution: 400/800m (nadir (Vis/IR))
- Global coverage: 2x/day/satellite

**AVHRR/ MODIS**
- 2048 km swath
- Spatial resolution: 250m, 500m, 1000m
- Global coverage: 2 days

**MISR**
- 360 km
- Spatial resolution: 275m, 550m, 1100m
- Global coverage: 9 days

**Landsat**
- 183 km
- Spatial resolution: 15m, 30m
- 16 day orbital repeat
- Seasonal global coverage

**ASTER**
- 60 km
- Spatial resolution: 15m, 30m, 90m
- 45-60 day orbital repeat
- Global coverage, years

**Commercial Systems**
- ~ 10 km
- Spatial resolution: ~ 1m
- Global coverage, decades, if ever
Non-NASA Missions

- Radars (Radarsat, ALOS, Sentinel-1)
- Optical (MERIS, SPOT, IRS, Sentinel-2)
- Defense Meteorological Satellite Project (DMSP)
Non-NASA Mission: Earth Night Lights Observed by DMSP

Courtesy: Chris Elvidge, NOAA
From DMSP (5km²/6 bits) to VIIRS (742 m²/14 bit)
Indonesia

- Guinness World Records declared in 2008 that Indonesia had the world’s fastest deforestation rate.
- Borneo alone has lost more than 50% of its original forest cover.
- Half of that loss occurred in the past 20 years due to logging, mining, fire, development of palm oil plantations and other habitat-destroying human activities.
Best imagery from Google – persistent cloud cover
Indonesia - 6,189 images of Landsat ETM+ with 50% or less cloud cover from 1999 to 2009

Image of 1999 to 2003 composite for Sumatra and Kalimantan

Courtesy: Matt Hansen, U.Maryland
Annual forest cover loss
Annual forest cover loss

00-01
01-02
Annual forest cover loss

00-01
01-02
02-03
Annual forest cover loss
Annual forest cover loss

- 00-01
- 01-02
- 02-03
- 03-04
- 04-05
- 05-06
- 06-07
NASA SE Asia Projects
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• **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
Synthesis Projects in Asia

- **Atul Jain/University 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
NASA Indonesia Project

- Lisa Curran/Stanford University: Socio-economic and political drivers of oil palm expansion in Indonesia: Effects on rural livelihoods, carbon emissions and REDD

Aerosol Project

- Daral Munroe/Ohio State University: A Comprehensive Statistical Analysis System to Associate Local Land-Cover/Land-Use Change and Regional Aerosol Composition and Concentration
Global Observation of Forest and Land Cover Dynamics

- Coordinated international effort to provide ongoing space-based and *in-situ* observations of forests and other vegetation cover.
- Regional networks are an integral part of GOFC-GOLD
GOFC-GOLD Networks

- South/Central America
  - Red LatinoAmericana de Teledetección e Incendios Forestales (RedLaTIF)

- Africa
  - 2 Southern Africa Networks (Miombo, SAFNet)
  - West Africa Regional Network (WARN)
  - Central Africa (OSFAC)

- Europe
  - South Central and Eastern European Regional Information Network (SCERIN)
  - Balto-Arctic (BARIN)??
  - Caucasus ??
  - Mediterranean ??

- Asia
  - Central Asia Regional Information Network (CARIN)
  - South East Asia (SEARRIN)
  - South Asia Regional Information Network (SARIN)??
Regional Networks: a Critical Component of the GOFC-GOLD Implementation

Providing interface between the Implementation Teams and data users in the regions

GOFC-GOLD ExCom and ITs

GOFC-GOLD Regional Networks

National Needs and Users Within the Region
**Current Activities**

- Regional Workshops have proved very effective in accomplishing many of networks’ goals
  - Build momentum for network activities and regional cooperation
  - Share information about data availability, methodology, and findings
  - Provide methodological and technical training

- **The GOFC-GOLD Regional Network Data Initiative**
  - Disseminate Landsat data to regions with inadequate internet access
  - Broaden regional data collections to include land cover and fire products
  - Provide training in use of remotely sensed data
terima kasih Thank you