

Emerging Science Themes from the LCLUC Science Team Meeting on Land-Cover/Land-Use Change Processes in the Monsoon Asia Region

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The Meeting Structure and Its Objectives

The NASA Land-cover and Land-use Change (LCLUC) Program Science Team Joint Meeting with Monsoon Asia Integrated Regional Study (MAIRS), Global Observation of Forest and Land Cover Dynamics (GOFD-GOLD), and Southeast Asia SysTEM for Analysis, Research and Training (SEA START) Programs on Land-cover and Land-use Change Processes in the Monsoon Asia Region was held January 12-17, 2009, in Khon Kaen, located in northeastern Thailand. The Mekong Institute of Khon Kaen University hosted the meeting. The Mekong Institute is an inter-governmental organization involved in the development of the region and coordinated with governments within the greater Mekong sub-region, including Cambodia, Lao People's Democratic Republic (PDR), Myanmar (Burma), Thailand, Vietnam, and the Yunnan Province and the Guangxi Autonomous Region of China. Over 100 participants joined the meeting representing Cambodia, Canada, China, Finland, India, Indonesia, Japan, Lao PDR, Malaysia, Myanmar (Burma), Philippines, South Korea, Switzerland, Thailand, United States, and Vietnam. The meeting also included a National Science Foundation (NSF)-Asia Pacific Network (APN) for Global Change Research working session on Carbon Dynamics and Forest Functioning.

The objectives of this meeting were to provide an inter-agency and international forum for scientists to discuss recent research findings and methods in tropical regions, as well as to share information on programs and satellite and ground-based observing systems, with an emphasis on Southeast Asia. The education component is an important part of all the programs holding

this joint meeting. On the last day of the meeting **Ji-anguo Qi** [Michigan State University], **Mutlu Ozdogan** [University of Wisconsin—Madison], **Piyachat Ratana** [University of Arizona], and **Alfredo Huete** [University of Arizona] gave a training session on LCLUC and climate change that included sessions on geospatial technologies, geospatial methods, and applications for forest mapping, change detection, biophysical retrievals and validation in tropical regions and hydrology. The agenda for this meeting, as well as presentations and posters, can be found at the LCLUC website at: lcluc.hq.nasa.gov. The following passages summarize the scientific issues presented and discussed at the meeting.

LCLUC Drivers in Southeast Asia

The meeting focused on the use of satellite data to study land-use change in Southeast Asia, with particular emphasis on the human dimension, which is extremely important in this densely populated region. The meeting highlighted the need for increased collaborative and cooperative research in order to better understand inter-connections within the region. The land-use science themes for the meeting included urban and agricultural expansion and the resultant deforestation. Population growth in Southeast Asia drives rapid urban expansion in the region, which often occurs on rural and agricultural lands. Population increases paired with loss of agricultural lands to urban expansion lead to further deforestation in order to clear land for new fields to meet agricultural demand. A recent rise in the prices for commodity crops such as rubber and palm has further complicated this issue and led to reduced food production and increased food costs. Large-scale land-cover conversion for agriculture leads to altera-



LCLUC Meeting participants pose for a group photo at a local-scale farm in Kham Muang village, Khao Suan Kwang district, Khon Kaen, Thailand.



Meeting participants visited a banana grove intercropped with vegetables and learned about subsistence agriculture in Thailand.

Photo credit: Kelley O'Neal

tions in the carbon cycle and degraded air quality from increased biomass burning and the associated particulate emissions.

The population of Southeast Asia is growing rapidly and most of that growth is occurring in urban areas. In 2000, approximately only 30% of the Asian population lived in urban areas, but by 2015 it is predicted that 15 mega-cities with populations exceeding ten million will be located in Asia [Fu (*Chinese Academy of Sciences*) and Ailikun (*Chinese Academy of Sciences*)]. This rapid urban population growth occurs in response to economic growth and job availability. In addition, privatization of housing, development of the land market, domestic and foreign investment, and increased motorization all lead to population growth in cities [Schneider (*University of Wisconsin—Madison*)]. Although the current economic downturn may slow the rural exodus somewhat, the long-term trend is likely to continue. Current scenarios of urban expansion often indicate encroachment on agricultural lands and green spaces at the urban and rural interface, but progressive urban planning policies offer hope for mitigating these losses in the future [He (*Beijing Normal University*)].

An interesting exception to this trend toward population growth in urban centers can be found in many rubber growing regions in Southeast Asia. In these areas, the increased global demand for rubber drives up the price of rubber and actually drives local-scale population migrations from cities to rural areas [Mongkol-sawat (*Khon Kaen University*)].

Agricultural expansion is necessary to generate the food required to support population increases in the region, replace fields lost to urban expansion, and respond to new pressures from the increasing prevalence of commodity crops. The effect of commodity crops on food production in the region is parallel to the biofuels situation in the U.S., where decreased food production has led to an increase in food prices. Currently, rubber is an important cash crop in Southeast Asia. The crop offers economic returns that have nearly quadrupled since 1998, during which time the land planted with rubber

increased from 20,000 ha to 380,000 ha [Mongkol-sawat]. Global demand and the resultant economic boost in rubber return have driven local-scale village farm decisions to supplement food crops with rubber as a cash crop and large-scale agriculture operations to clear more forested land for rubber cultivation [Thongmanivong (*National University of Laos*)]. Since rubber requires several years to reach harvest maturity, most local-scale village farms choose to intercrop rubber with food crops, such as cassava, as an investment for the future [Vityakon (*Khon Kaen University*)].

Meeting participants got a chance to witness these conditions firsthand as they travelled to two agricultural areas in the region: a *local-scale village farm* and a *subsistence farm*—see photos accompanying this article. At the *local-scale village farm*, participants got a chance to walk through fields planted with eucalyptus, cassava, and cassava intercropped with rubber. They also had a chance to talk with the farmers about the agricultural practices they use. At the *subsistence farm*, participants toured the land and saw vegetable gardens intercropped with bananas, rice paddies, and a fishpond. The host family talked to them about the economic problems that they face and how they are working to reduce their debt. The field trip offered contrasting views of village-scale farming practices. The *local-scale village farm* contained subsistence food crops as well as cash food and commodity crops while the *subsistence farm* strived to be a sustainable system but offered little additional income.

Deforestation is also occurring rapidly within the region and is driven primarily by the need for additional agricultural lands. The montane forests of Southeast Asia are of particular concern as they offer ideal growing conditions for rubber [Fox (*University of Hawaii*)]. The primary method of deforestation is slash and burn, which results in increased greenhouse gas emissions, and degrades air quality during burning events. One particularly hazardous air quality event occurred in August 2005 in Malaysia when PM10 levels reached almost 600 $\mu\text{g}/\text{m}^3$ due to slash and burn deforestation on Sumatra [Mahmud (*Universiti Kebangsaan Malaysia*)].



Cattle graze in harvested rice paddies near Kham Muang village.

Photo credit: Kelley O'Neal



Meeting participants walked through a cassava field intercropped with young rubber trees and spoke with village farmers about agricultural practices. **Photo credit:** Kelley O'Neal

Carbon exchange programs in the region seek to use offsets and crediting as a poverty reduction tool, which in turn will help reduce deforestation in the region [Skole (*Michigan State University*)]. Meeting participants were particularly interested in discussing the scientific underpinning of the international initiative to Reduce the Emissions from Deforestation and Degradation (UN REDD). The emerging science themes from the meeting highlight the importance of the human dimension in driving land-cover changes in Southeast Asia.

The Role of Remote Sensing and Modeling in Regional Studies

The processes and impacts of land-use change, driven largely by regional and global economies, continue to play a central role in regional science. The importance of hotspot identification and quantifying local-scale processes are emerging as paths to a better understanding of the interactions between land use, ecosystems, and carbon cycling within the region. Satellite data at all resolutions, but especially the Landsat archive and hyper-spatial data, play an important role in land-cover mapping and monitoring. South and Southeast Asian countries (e.g., India, China, and Thailand) are leading a revolution in satellite remote sensing with the increasing number of low-cost satellites launched and planned; the missions are providing valuable data for current and future LCLUC research. Data processing methods and accuracy assessments are becoming standardized, and automated change-detection methods are emerging with multiple resolution data sources. Participation of Asian international space agencies in programs such as the Global Land Survey-2010, led by NASA and the USGS, are particularly important. A coordinated acquisition strategy to ensure adequate time-series data for land-cover monitoring is a high priority for international programs, such as GOFC-GOLD and the Group on Earth Observations (GEO).

Land-use information is now being included in land-atmosphere interaction studies and coupled models to better understand human-environment interactions such as Asian Brown Cloud and Monsoon processes. There is increasing interest in sustainability issues con-

cerning food and water supply, urban development, and conversion of subsistence agriculture to monoculture as well as in land-use projections for future planning and mitigation. Land-use science is integral to understanding regional processes and promoting sustainable practices in the Southeast Asia region. In addition to strengthening on-going collaborations in the region with NASA LCLUC scientists and initiating a number of new collaborations, the meeting provided a firm foundation for an enhanced land-use component to the international MAIRS program.

Future Plans

This meeting gave a boost to activities in SEA START and GOFC-GOLD/South East Asia Regional Information Network (SEARIN). Several steps were discussed to enhance the structure and functioning of MAIRS. Collaborative efforts will continue at the Fall LCLUC Science Team Meeting conducted jointly with GOFC-GOLD/Northern Eurasia Regional Information Network (NERIN) and MAIRS to be held September 15-20 in Almaty, Kazakhstan. This meeting will focus on monitoring land cover, land use, fire and water resources in agricultural and arid regions of Northern Eurasia. The upcoming Spring LCLUC Science Team Meeting will be held March 31-April 2, 2009 at the Bethesda North Marriott located in Bethesda, MD (see lcluc.hq.nasa.gov for details.)

Meeting Presentations Referenced in the Article

- Fox, J. *The role of land-cover change in MMSEA in altering regional hydrological processes under a changing climate.*
- Fu, C. and Ailikun. *MAIRS overview and progresses.*
- He, C. *Modelling urban expansion scenarios in Beijing, China under the restriction of the water resource and land use policy.*
- Mahmud, M. *Land use change research projects in Malaysia.*
- Mongkolsawat, C. *A comparative study of land use changes along the Mekong River at the border of Thailand and the Lao PDR.*
- Schneider, A. *Monitoring and modeling urbanization in China: A mixed methods and multi-scale approach.*
- Skole, D. *Carbon2Markets: Value chains from carbon and agro-forestry products in Southeast Asia.*
- Thongmanivong, S. *Land cover and land use change in Sing District, Luangnamtha Province, Lao PDR.*
- Vityakon, P. *Land-use change and its impact on soil and land resources in Northeast Thailand.* ■