The South/Southeast Asia Research Initiative (SARI) Update and Meeting Objectives

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Abstract

Land Use/Cover Change (LU/CC) is one of the most important types of environmental change in South and Southeast Asian countries. Several studies suggest that LU/CC in these countries is in large part driven by population growth and economic development. In the region, changes that are most common include urban expansion, agricultural land loss, land abandonment, deforestation, logging, reforestation, etc. To address the research needs and priorities in the region, a regional initiative entitled South Southeast Asia Regional Initiative (SARI) has been developed involving US and regional scientists. The initiative is funded by NASA Land Cover, Land Use Change program. The goal of SARI is to integrate state-of-the-art remote sensing, natural sciences, engineering and social sciences to enrich LU/CC science in South Southeast Asian countries. In the presentation, LU/CC change research in SARI countries will be highlighted including the drivers of change. For example, in South Asia, forest cover has been increasing in countries like India, Nepal and Bhutan due to sustainable afforestation measures; whereas, large-scale deforestation in Southeast Asian countries is still continuing, due to oil palm plantation expansion driven by the international market demand in Malaysia and Indonesia. With respect to urbanization, South and Southeast Asian countries contain 23 megacities, each with more than 10 million people. Rapid urbanization is driving agricultural land loss and agricultural intensification has been increasing due to less availability of land for growing food crops such as in India, Vietnam, and Thailand. The drivers of LUCC vary widely in the region and include such factors as land tenure, local economic development, government policies, inappropriate land management, land speculation, improved road networks, etc. In addition, variability in the weather, climate, and socioeconomic factors also drive LU/CC resulting in disruptions of biogeochemical cycles, radiation and the surface energy balance of the atmosphere. The presentation will also highlight SARI collaborative activities with space agencies, universities and non-government organizations including data sharing mechanisms in the region.
The South/Southeast Asia Research Initiative (SARI)
Update and Meeting Objectives

Krishna Prasad Vadrevu
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Presentation topics

• Background to the SARI initiative

• Meeting Objectives
How it started - strong interest in a SARI from local scientists

Jan-10-13th, 2013-Regional Science Meeting, Coimbatore

Total participants =120
US – 18 researchers
Nepal-3; Srilanka-2; Myanmar-1; Afghanistan, Myanmar, Bangladesh-1 each
Pakistan, China invited but could not attend – Visa issues
India – University Researchers, Government, Non-Government, NGO’s
Meeting Summary—Need for SARI

NASA The Earth Observer

Summary of the 2013 NASA Land Cover/Land Use Change Regional Science Meeting, South India

Introduction

The 2013 NASA Land Cover/Land Use Change (LCLUC) Regional Science Meeting was held in South India and had three components:

1. A focused workshop on water resources at the Center for Water Resources Development and Management (CWRDM), held in Kollur, Kerala, India, from January 7-8, and a Land Use/Land Cover Transect Study from Kollur, Kerala, to CoochBehar, West Bengal, India, on January 9.

2. A NASA international regional meeting held January 10-15, at Kyoto University in Kyoto, Japan.


The goal of the meeting was to discuss land cover/land use change (LCLUC) issues and impacts in the South Asia region. The meeting was organized around eight technical sessions:

1. Agricultural land use change;

2. LCLUC-related Earth observations (missions, data, and products);

3. Airborne/satellite interactions (arrays, geospatial, greenhouse gases);

4. LCLUC and the carbon cycle;

5. Forests and LCLUC in montane areas;

6. Coastal zones and water resources;

7. Urban LCLUC;

8. Working towards a Regional Global Observation for Forests and Land Cover Dynamics (GOCPCGOLD) South Asia Regional Information Network (MAFRED) (including prospects, opportunities, and challenges).

The meeting was a joint effort of the NASA LCLUC Program, GOCPCGOLD Program, International System for Analysis Research and Training (START) Program, Monsoon Asia Integrated Regional Studies Program (MARSIP), University of Maryland College Park (UMD), Center for Water Resources Development and Management (CWRDM), in Kollur, Kerala, and Kyoto University in Kyoto, Japan.

The LCLUC Workshop on Water Resources and Land Use Transect

Thirty top-level delegates from different institutions and universities in India attended the meeting in addition to twelve researchers from the U.S. Naval Postgraduate School (NPSWED), welcomed the participants and highlighted the CWRDM water research activities.

After the welcome, Garth German (NASA Headquarters) addressed the workshop’s participants, presenting overviews of LCLUC issues in South Asia, with a focus on agricultural land-cover change.

On January 9, participants departed for a Land Use Transect Study from Kollur, Kerala, to CoochBehar, West Bengal, India, involving local scientists. The process of urban expansion and forest degradation were quite evident during the transect study. During the transect, the participants observed forest fire in the mountains, 50 km (-31 mi) away from CoochBehar.

Some highlights from the workshop are summarized here:

1. The most important LCLUC issue impacting agriculture in South India is paddy fields (wetlands) being converted to urban areas and/or left abandoned, with the attendant deficit in rice production.

2. This paddy conversion is complex, and crosses ecosystem, ecological, institutional, structural, and class dimensions.

3. Economic returns from paddy cultivation do not tend to encourage conservation—due to labor costs. At present, land is seen only as a real estate needed for residence status, and is the safest and best investment to maximize profits.

4. Government farming is shrinking due to the unsustainability of shifted labor.

5. Pollution and sedimentation from anthropogenic activities seriously affects aquatic systems and wetlands in South India. This requires stringent regulations and greater wetland protection.

6. The role of coastal vegetation and mangroves in protecting loss and property requires more research on salinity alleviation—possibly due to saline water intrusion, likely from inadequate drainage systems and poor maintenance of the salt water serpentine.

7. The CWRDM arranged several field sites to highlight local LCLUC issues and responses, including urban green parks and wetland conservation, mangrove conservation, and coastal and riparian land use management.

SARI - Goal

SARI is NASA LCLUC Program funded regional initiative

To develop an innovative research, education, and capacity building program involving state-of-the-art remote sensing, natural sciences, engineering and social sciences to enrich LCLUC science in South/Southeast Asia.
Involving National Researchers and Practitioners – Universities, Institutes and Operational Agencies;

Strong emphasis on Applied Research with regional / national societal applications and benefits.

Facilitate strengthening regional/national projects through co-design and collaborations;
SARI Regional Needs Meetings funded by NIES, Japan and several international/regional partners
Collaborations are the Key!
SARI Agriculture Meeting – New Delhi

- Total Meeting Participants = 94
- Total Presentations – 42;
- Meeting Outputs – IJRS Special Issue
International Journal of Remote Sensing
Submit your papers to this special issue on Remote Sensing of Agriculture in South/Southeast Asia
Deadline: 31 December 2017

South/Southeast Asian countries are growing rapidly in terms of population, industrialization and urbanization. One of the key challenges in the region is food security. Although total food production and productivity has increased in the region because of additional land area converted to agricultural land use during 1960’s to 2000 and improved varieties and crop management, growth rate of food production in recent times has slowed down, mostly due to loss of agricultural lands related to increasing urbanization and industrialization and less optimal use of available technology. Further, the weather and climate systems in the region, driven primarily by monsoon variability are characterized by extreme weather events, resulting in droughts or flooding which can impact agricultural production. In this region, monitoring the agricultural crop production in a timely manner is essential to predict and prepare for disruptions in the food supply. Further, improved and up-to-date information on agricultural land cover and associated land use practices can help in understanding the role and response of the agricultural sector to environmental change and for improved land management and planning.

Despite the progress in remote sensing and geospatial technologies, little emphasis has been placed on developing robust methods for operational mapping/monitoring of cropped areas and forecasting crop production. In most countries of South/Southeast Asia, the mapping efforts have focused on the classification of land cover types and generalize cropland areas into a single or limited number of thematic classes. Crop-specific LLC information is currently limited to very few countries in.

http://explore.tandfonline.com/cfp/est/tres-remote-sensing-in-asia-cfp

Eds: Krishna Vadrevu, Vinay Dadhwal, Garik Gutman and Chris Justice
Agriculture and Food security

- Landscapes In Flux: The Influence of Demographic Change and Institutional Mechanisms on Land Cover Change, Climate Adaptability and Food Security in Rural India

- The Future of Food Security in India: Can Farmers Adapt to Environmental Change?


Urban

- Urban Growth, Land-Use Change, and Growing Vulnerability in the Greater Himalaya Mountain Range Across India, Nepal, and Bhutan

Human Health

- Understanding the Role of Land Cover/Land Use Nexus in Malaria Transmission Under Changing Socio-Economic Climate in Myanmar
Forests

- Spatiotemporal Drivers of Fine-Scale Forest Plantation Establishment in Village-Based Economies of Andhra Pradesh

- Consequences of Changing Mangrove Forests in South Asia on the Provision of Global Ecosystem Goods and Services

- Complex Forest Landscapes and Sociopolitical Drivers of Deforestation - The Interplay of Land-use Policies, Armed Conflict, and Human Displacement in Myanmar

- Impacts of Afforestation on Sustainable Livelihoods in Rural Communities in India

- Tropical Deciduous Forests of South Asia: Monitoring Degradation and Assessing Impacts of Urbanization
SARI - Peer Reviewed Publications
2018 - SARI LCLUC regional meeting in Philippines
   Meeting: March 17-18-19
   Training: March 20-21-22

2018 - LCLUC and Emissions Meeting in Laos
   Dates: TBD
   Training

2018 - LCLUC in Mountain Environments, Bhutan
   Dates: TBD
   Training
LCLUC in SARI
Countries and Meeting
Objectives
Significant increase in Agricultural Land Area (x 1000ha) in Several South and Southeast Asian Countries:
Vadrevu et al., 2017, ERL (in press)

Data Source: FAO, 2015
Agriculture

- Long-term Food Security is a major concern for the region;

- Agricultural production and land use is changing
  - Crop water requirements;
  - Extreme events (flooding and drought (almost every year!))
  - Adaptation options needs to be explored to address food security questions

- RS data needed to monitor agriculture (within season) and forecast crop production (integrating Landsat+ Sentinel + other high resolution data);

- Transitioning from research to operational products
  - 3-year research projects (e.g. 6-different teams working on Rice mapping in Mekong; coordination required and transitioning from research to operations;
    - Crop type and area statistics
    - Production estimates
    - Yield forecasting
    - GEOGLAM working on some of the above activities.
1997-2016 – possible because of strong validation data at a plot scale from Farm service bureau; such data may not be available in S/Seast Asia
Significant decrease in Forest Area (x 1000ha) in Several South and Southeast Asian Countries
Vadrevu et al., 2015, ERL (in review)

Data Source: FAO, 2015

ERL (in review)
Urbanization is occurring rapidly at the cost of agriculture and forest lands.

Currently, 28.33% of South/Southeast Asian population lives in urban areas and it is estimated that by 2030, more than 55% of the population will be urban.

Urban sprawl has been increasing in different cities at the cost of agricultural lands, ecologically sensitive and natural areas.

Increasing Urbanization is resulting in air, water and solid waste pollution problems in most cities.

**LCLUC interactions in urban environments are poorly understood and need immediate attention.**
Nearly 60% of world's population is in Asia (4.5 billion people)
Nearly 2/3rd of world population growth is in Asia
Nearly 50 million people are being added every year!
GHG emissions from LUCF sector seems decreasing significantly in South Asia

Vadrevu et al., 2015, ERL (in review)
GHG emissions from LUCF in Southeast Asia seems decreasing in Southeast Asia too, however, not rapidly as in South Asia.

Some of the drivers to be discussed in this meeting.
Population and Energy Use

### Top Ten Coal Consumers of Asia

- **China**: 3,976,116
- **India**: 801,030
- **Japan**: 203,846
- **South Korea**: 136,482
- **Indonesia**: 75,784
- **Taiwan**: 61,218
- **Thailand**: 53,777
- **Pakistan**: 41,500
- **Philippines**: 30,000
- **Malaysia**: 25,632

### Consumption of Oil by Asian Countries

- **China**: 10,276
- **Japan**: 3,621
- **India**: 2,268
- **South Korea**: 1,409
- **Indonesia**: 1,283
- **Singapore**: 1,185
- **Thailand**: 1,009
- **Malaysia**: 539
- **Pakistan**: 440
- **Philippines**: 302
- **Bangladesh**: 113
- **Sri Lanka**: 91
- **Cambodia**: 43
- **Nepal**: 18

(Source: US Energy Information Administration, 2012)

### Energy Use

- **Population**
  - 1970: 1.4x10^9
  - 2010: 3.4x10^9

- **Energy Use (Thousand Tonnes of Oil Equivalent)**
  - 1970: 100,000
  - 2010: 900,000

(Source: US Energy Information Administration, 2012)
Fires and smoke in Indonesia (6/19/2016) – Also a Recurring Event
Fires, Riau province, Indonesia, June, 2013, 2016
Meeting Focus

- Review regional and national science initiatives, relating to LCLUC in the region;
- Review the causes and impacts of LCLUC specific to agriculture, forests, urban and coastal ecosystems in the Asian region;
- Review GHG and SLCP emission estimates from different sources in the Asian region;
- Review latest updates on atmospheric correction algorithms;
- Review latest research specific to aerosols; biomass burning and emissions modeling;
- Strengthen the SARI activities in the region.
Meeting Sessions

- **Session-1** – Agricultural Land Use/Cover Changes
- **Session-2** – Land Atmospheric Interactions
- **Session-3** – Urban Land Use/Cover Changes
- **Session-4** – Forest Land Use/Cover Changes
- **Dedicated Poster Session**
- **Panel Discussions (Day-2)**: Research needs;
- **Discussion Session (Day-3)**: User needs and priorities.
Current Meeting Outputs

Special Issue:

Remote Sensing of Land Use/Cover Changes (LU/CC) in South/Southeast Asia

Editors:
- Krishna Vadrevu, NASA MSFC)
- Andreas Heinimann (Univ. of Bern, Switzerland)
- Chris Justice (Univ. of Maryland, USA)
- Garik Gutman (NASA HQ)

Deadline: March 31st, 2018
Welcome to SARI

The goal of SARI is to develop an innovative regional research, education, and capacity building program involving state-of-the-art remote sensing, natural sciences, engineering and social sciences to enrich Land Cover/Land Use Change (LCLUC) science in South Asia. Our objectives are twofold. First, we aim to advance LCLUC science in the region. Second, we endeavor to strengthen existing and build new collaborations between US and South Asia researchers in the areas of LCLUC research. To address LCLUC science, SARI will utilize a systems approach to problem-solving that examines both biophysical and socioeconomic aspects of land systems, including the interactions between land use and climate and the interrelationships among policy, governance, and land use. A central component of this initiative will be the use of geospatial data from both remotely sensed and in situ sources and models. To strengthen the theoretical underpinnings of LCLUC science in the South Asian region, SARI will facilitate:

a) new partnerships with space agencies, universities and non-government organizations;
b) novel and regionally-appropriate methodologies and algorithms for LCLUC products;
c) data sharing mechanisms;
d) leadership training;
e) international workshops to identify regional priorities, discuss and share scientific findings;
f) capacity building programs; and

g) international student/researcher exchanges, including among LCLUC scientists in the region.

SARI will serve as a facilitator and catalyst for LCLUC research in South Asia. The outputs will be beneficial to the U.S., South Asia and international researchers and will serve as a model for interdisciplinary research that links LCLUC science with NASA assets.