The South/Southeast Asia Research Initiative (SARI)

Progress, Gaps and Priorities

Krishna Prasad Vadrevu
NASA Marshall Space Flight Center

Land-Cover / Land-Use Change Program

NIES JAPAN

UNIVERSITY OF MARYLAND

GOFC-GOLD
GLOBAL OBSERVATION FOR FOREST AND LAND COVER DYNAMICS

NASA

Presentation Outline

- Background to the SARI initiative
- SARI – Southeast Asia Projects
- Gaps and Priorities
- SARI Outputs
  - Meeting and Training Events
  - Publications
  - On-Going Collaborations
  - 4-Year Output Summary
  - Forthcoming Events

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

Krishna Prasad Vadrevu, University of Maryland, College Park, krishna@hermes.geog.umd.edu
Chris Justice, University of Maryland, College Park, justice@hermes.geog.umd.edu
Prasad Thenkabail, United States Geological Survey, pthenkabail@usgs.gov
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

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

- a focused workshop on water resources at the Centre for Water Resources Development and Management (CWRDM), held in Kozhikode, Kerala in India, from January 7-8, and a Land Use (LU) Transect Study from Kozhikode, Kerala, to Coimbatore, Tamil Nadu, in India[1], on January 9;
- a NASA international regional meeting, held January 10-13, at Karunya University in Coimbatore, Tamil Nadu; and
- a training workshop titled *Remote Sensing and Geospatial Technologies for Land Cover and Land Use Change Studies and Applications*, held January 14 at Karunya University.

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. Atmosphere/land-use interactions (aerosols, greenhouse gases);
4. LCLUC and the carbon cycle;
5. Forests and LCLUC in mountainous areas;
6. Coastal zones and water resources;
7. Urban LCLUC; and
8. Working towards a Regional Global Observation for Forest and Land Cover Dynamics (GOFC–GOLD) South Asia Regional Information Network (SARIN) (including prospects, opportunities, and challenges).

[1] Kerala and Tamil Nadu are two of the 28 states in India.

The meeting was a joint effort of the NASA LCLUC Program; GOFC–GOLD Program; International System for Analysis Research and Training (START) Program; Monsoon Asia Integrated Regional Studies Program (MAIRS); University of Maryland College Park (UMD); Centre for Water Resources Development and Management (CWRDM) in Kozhikode, Kerala; and Karunya University, in Coimbatore, Tamil Nadu.

NASA LCLUC Workshop on Water Resources and Land Use Transect

Thirty top-level delegates from different institutes and universities in India attended the meeting in addition to twelve researchers from the U.S. **Narasimha Prasad** [CWRDM], welcomed the participants and highlighted the CWRDM water research activities.

After the welcome, **Garik Gutman** [NASA Headquarters] addressed the workshop's participants, presenting an overview of LCLUC issues in South Asia, with focus on agricultural land-cover conversion,

Water resource-focused workshop participants. **Images Credit:** All photos in this article were taken by author or other members of the LCLUC team.

Rhizophora mangle, known as the "red mangrove," near Kadalundi bird sanctuary in Kerala.

forest-cover loss, increasing urbanization, and air pollution. **Chris Justice** [UMD] stressed that much needs to be done in terms of the underpinning science of LCLUC and the linkages with global climate change in South Asia.

Some highlights from the workshop are summarized here:

- 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.
- This *paddy conversion* is complex, and crosses economic, ecological, sociocultural, structural, and class dimensions.
- Economic return from paddy cultivation does not tend to encourage conservation—due to labor costs.
- At present, land is seen only as real estate needed for residence status, and is the safest and best investment to maximize profits.
- Coconut farming is shrinking due to the unavailability of skilled labor.
- Pollution and sedimentation from *anthropogenic* activities seriously affects aquatic systems/wetlands in South India. This requires more-stringent regulations and greater wetland protection.
- The roles of coastal vegetation and mangroves in protecting lives and property require more research to address contamination—possibly due to saline water intrusion, likely from inadequate drainage systems and poor maintenance of the well surroundings.

The CWRDM arranged several field visits to highlight local LCLUC issues and responses, including urban green park and wetlands conservation, mangrove conservation, and coastal and riparian land use management.

On January 9, participants departed for a Land Use Transect Study from Kozhikode, Kerala, to Coimbatore, Tamil Nadu, involving local scientists. The processes of urban expansion and forest degradation were quite evident during the transect study. During the transect, the participants observed forest fires in the mountains, 50 km (~31 mi) away from Coimbatore.

Coconut, arecanut, banana, and yam plantations, Kozhikode, Kerala.

Smoke from forest fires, Palakkad, Western Ghats, Kerala.

March/April 2013

http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/earth_observer.php

SARI - Goal

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.

Thanks to the Vision of Garik, Chris and SARI core team members.

NASA ROSES Ongoing SARI Projects - 2016-Current

- Assessing the Impacts of Dams on the Dynamic Interactions Among Distant Wetlands, Land Use, and Rural Communities in the Lower Mekong River Basin
- Land Use Status, Change and Impacts in Vietnam, Cambodia and Laos
- Land-Cover/Land-Use Change in Southern Vietnam Through the Lenses of Conflict, Religion, and Politics, 1980s to Present
- A Cobra in the Forest? Quantifying the Impact of Perverse Incentives from Indonesia's Deforestation Moratorium, 2011 to 2016
- The Agrarian Transition in Mainland Southeast Asia: Changes in Rice Farming - 1995 to 2018
- Agricultural Land Use Change in Central and Northeast Thailand: Effects on Biomass Emissions, Soil Quality, and Rural Livelihoods
- 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
- Landscapes In Flux: The Influence of Demographic Change and Institutional Mechanisms on Land Cover Change, Climate Adaptability and Food Security in Rural India
- Urban Growth, Land-Use Change, and Growing Vulnerability in the Greater Himalaya Mountain Range Across India, Nepal, and Bhutan
- Understanding the Role of Land Cover/Land Use Nexus in Malaria Transmission Under Changing Socio-Economic Climate in Myanmar
- Complex Forest Landscapes and Sociopolitical Drivers of Deforestation - The Interplay of Land-use Policies, Armed Conflict, and Human Displacement in Myanmar
- The Future of Food Security in India: Can Farmers Adapt to Environmental Change?
- Impacts of Afforestation on Sustainable Livelihoods in Rural Communities in India
- Understanding Changes in Agricultural Land Use and Land Cover in the Breadbasket Area of the Ganges Basin 2000-2015: A Socioeconomic-Ecological Analysis
- Tropical Deciduous Forests of South Asia: Monitoring Degradation and Assessing Impacts of Urbanization
- The Global Land Rush: A Socio-Environmental Synthesis

LCLUC Gaps and Priorities
Feedback From Regional Meetings

Agriculture and Forestry

Agriculture

- Need for Robust Crop Inventory and Monitoring Systems
- Documentation on best practices will be useful
- Use of Microwave data for mapping different crops (not just Rice)
- Up-to-date info on crop area, planting dates, crop condition, yield, production, forecasting, estimation
- Linkages with Water Resources

Forests

- Mapping of secondary forests and regrowth
- Illegal logging, human caused disturbances
- Deforestation impacts
- Forest height in SARI countries
- Forest productivity and stratification
- Forest fire threat
- Pest and disease spread

Needs More Attention

LCLUC

General LCLUC

- How to link LCLUC research to be useful for Sub-national Decision Making
- Need for highly accurate products
- Scaling aspects - How can small case study results be upscaled to a larger ones (both biophysical and socioeconomic

Data and Methods

- Data Fusion
- SAR Data for LCLUC
- Bayesian inference (degree of confidence by combining multiple info/priors)
- Agent based modeling including Integrated assessment models

Priorities

- Land Use Change and Consequences At Large Spatial Scales – IMPACT Research
- Linking Patterns to Processes (on ground, seems lost !) – Strong Stories
- Land Use Outcomes (both positive and negative)
- Feedback Effects
- Meta-analysis very much required
- Good in case studies - Single local cases (Addressing so what question?)
- Solution-oriented studies

Priorities

- Interactions (more emphasis needed)
  - Agriculture-Water; Forest-Urban; Agriculture-Urban; Agriculture-Forests; Urban-Rural; Land-Sea
  - Land-atmosphere interactions (surface hydrology, radiative balance; hydrometeorology, cover changes and atmospheric pollution)
  - Land Use and Climate
  - Land degradation and soil pollution, and their subsequent effects on ecosystems and landscape quality.
  - Land-Water-Atmosphere-Biosphere
  - LCLUC Integrated Assessment Models

SARI Outputs

SARI Focus and Priorities

SARI Focuses on building research collaborations between the US and regional scientists

Meetings/Workshops help in identifying Needs and Priorities for the region (NASA LCLUC calls)

Training events are integral to SARI (eg: 3-day training after the meeting)

SARI Research Needs and Priorities – Meetings/Workshops Funded by International/Regional partners

Collaborations are the Key
Chiang Mai Meeting Facilitated by 20-Different Organizations

National Astronomical Research Institute of Thailand

Chiang Mai University

Sponsors and Partners

NIES JAPAN

GOFC-GOLD
GLOBAL OBSERVATION FOR FOREST AND LAND COVER DYNAMICS

UNIVERSITY OF MARYLAND

NASA

SERVIR

SARI

GEOGLAM
Global Agricultural Monitoring

Asia-RiCE
Crop Estimation and Monitoring

START
global change SysTem for Analysis, Research & Training

adpc

RESEARCH UNIVERSITY NETWORK THAILAND

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

SESE

RCCES

ASARU
Atmospheric Science and Astronomy Research Unit
Lampang Rajabhat University

Philippines Meeting, 2018

University of Philippines
Institute of Environmental Science and Meteorology

Sponsors and Partners

NIES JAPAN
GOFC-GOLD
GLOBAL OBSERVATION FOR FOREST AND LAND COVER DYNAMICS
UNIVERSITY OF MARYLAND
NASA
SERVIR
SARI
EOFSAC
GEOGLAM
Global Agricultural Monitoring
Asia-RiCE
Crop Estimation and Monitoring
START
global change SysTem for Analysis, Research & Training
NARIT
JAXA
adpc
CESBIO
APN
ASIA-PACIFIC NETWORK FOR GLOBAL CHANGE RESEARCH
VNSC
Liftoff your Dream

201 participants – 22 countries representation
3-day meeting + 3-day training

LCLUC Meeting, Philippines, 2018

201 participants – 22 countries representation

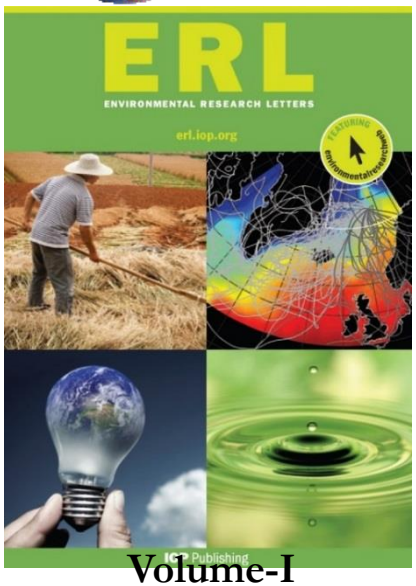
3-day meeting + 3-day training

LCLUC Training, Philippines, 2018

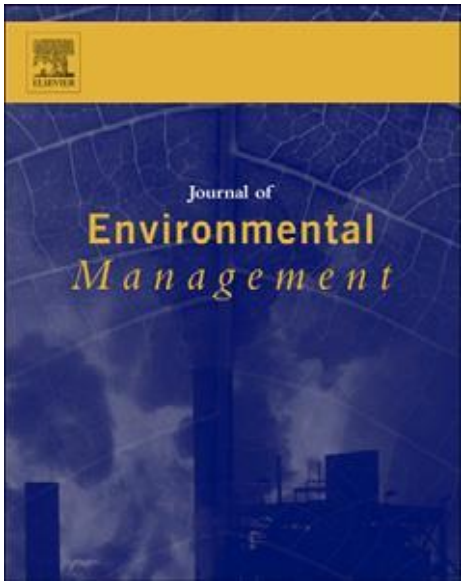
>100 Participants

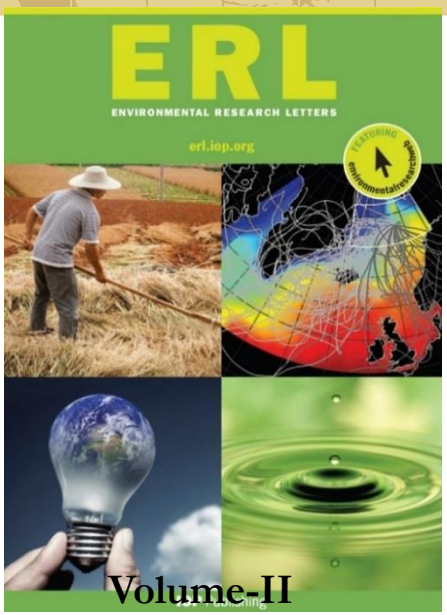
University of Philippines

For SARI – Research Outputs are Priority!

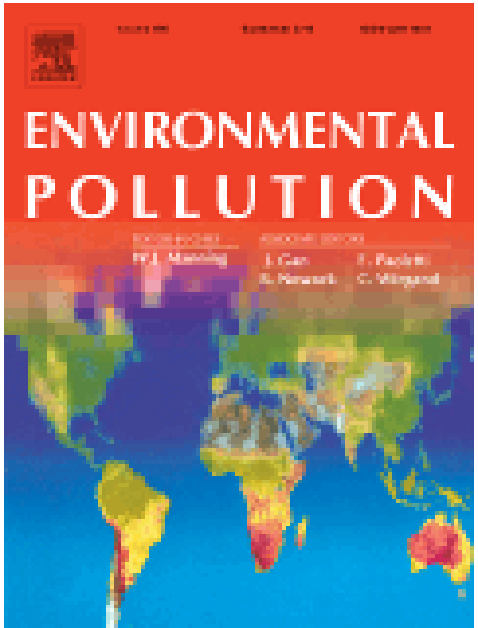


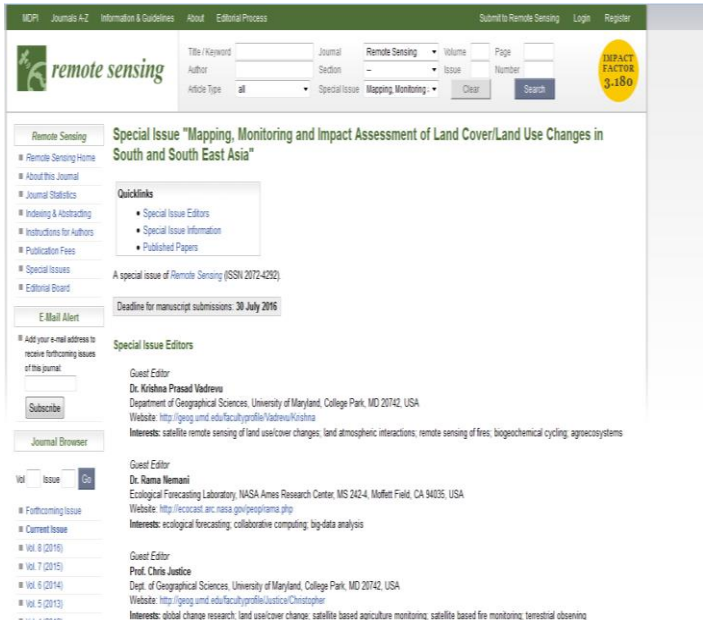
Volume-I





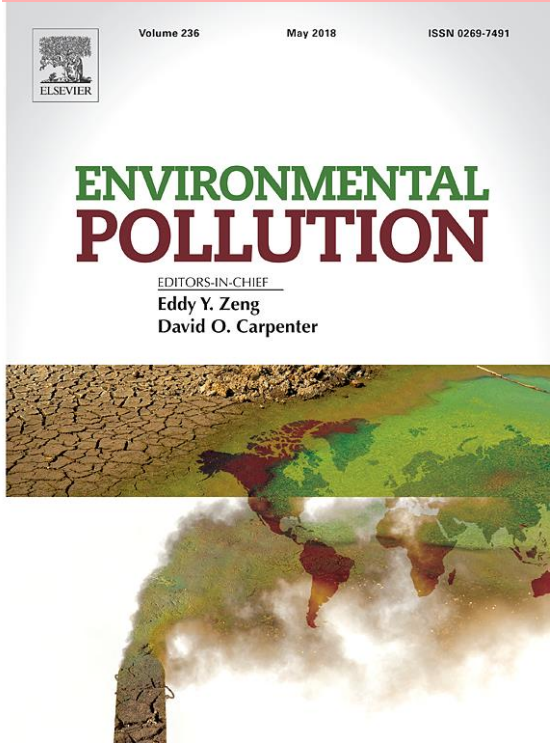
Volume-II





3-Different Outputs of the Recent Meeting

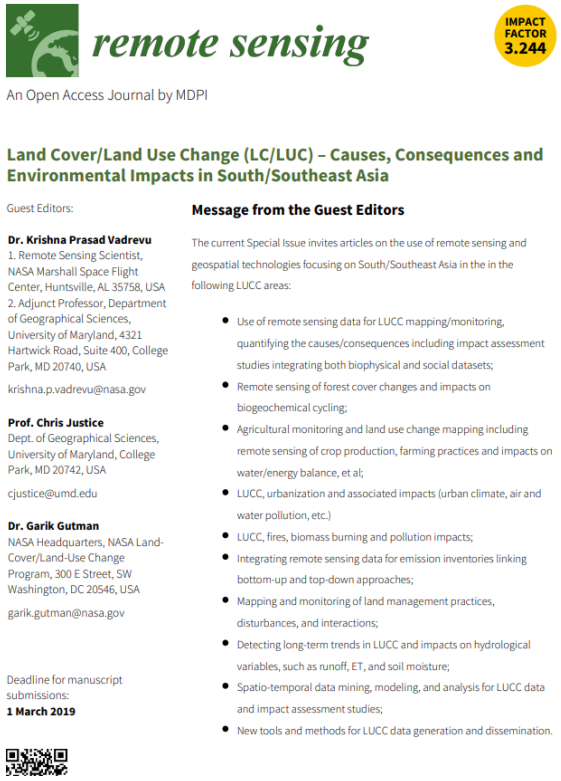
Journal Special Issue



Guest Editors

Dr. Krishna Vadrevu (NASA)
Dr. Toshimasa Ohara (NIES)

Journal Special Issue



Guest Editors

Dr. Krishna Vadrevu (NASA)
Prof. Chris Justice (Umd)
Dr. Garik Gutman (NASA)

2-Volume Book

CRC Press
Taylor & Francis Group

Biomass Burning in South/Southeast Asia – Volume-1 Inventory, Mapping and Monitoring

Biomass Burning in South/Southeast Asia – Volume-2 Impacts on Biosphere

Book Editors

Dr. Krishna Vadrevu (NASA)
Dr. Toshimasa Ohara (NIES)
Prof. Chris Justice (Umd)

Summary of the 2018 NASA LCLUC–SARI International Regional Science Meeting

Krishna Prasad Vadrevu, NASA's Marshall Space Flight Center, USA; krisvkp@umd.edu
Mylene Cayetano, University of the Philippines Diliman, mcayetano@iesm.upd.edu.ph
Gay Jane Perez, University of the Philippines Diliman, gpperez1@up.edu.ph
Toshimasa Ohara, National Institute of Environmental Studies, tohara@nies.go.jp
Chris Justice, University of Maryland, College Park, cjustice@umd.edu
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

South and Southeast Asian countries account for more than 25% of the global population. The annual population growth rate (averaged across all the countries in the area)[1] is ~1.25% per year. This rapid rate of growth is coincident with rapid economic development, which has led to substantial land-use change (e.g., the conversion of forested areas to agriculture and agricultural areas to residential and urban uses) in this area, which in turn has a significant impact on the environment. Further, increased land-cover and land-use changes (LCLUC) in the region are impacting forest resources, biodiversity, regional climate, biogeochemical cycles, and water resources. To address the LCLUC issues in the framework of NASA's South/Southeast Asia Research Initiative (SARI), an international science meeting was held in the Quezon City, Metro Manila, the Philippines, May 28-30, 2018.[2]

The organizers of this meeting included **Krishna Vadrevu** [NASA's Marshall Space Flight Center (MSFC), U.S.—*SARI Lead*], **Garik Gutman** [NASA Headquarters, U.S.—*LCLUC Program Manager*], **Chris Justice** [University of Maryland, College Park (UMCP), U.S.—*LCLUC Project Scientist*], **Toshimasa Ohara** [National Institute of Environmental Studies (NIES), Japan], **Tsuneo Matsunaga** [NIES, Japan], and **Atul Jain** [University of Illinois, Urbana-Champaign, U.S.]. **Mylene Cayetano** [Institute of Environmental Science and Meteorology (IESM), University of Philippines (UP) Diliman] and **Gay Perez** [IESM, UP Diliman] served as local hosts. Eighteen other local and international organizations sponsored the event, which also served as a forum for the Global Observations of Forest and Land Cover Dynamics (GOFC–GOLD) Southeast Asia Regional Network to discuss important research needs and priorities.

In total, 202 participants from 21 different countries from Asia, Europe, and the U.S. attended the meeting—see the group photo below. Scientists from five different space agencies in the region were represented, including the Japan Aerospace Exploration Agency (JAXA), the Space Technology Institute of Vietnam and Vietnam National Space Center (VNSC), the Indian Space Research Organization (ISRO), the Geo-Informatics and Space Technology Development Agency of Thailand (GISTDA), and the Indonesian National Institute of Aeronautics and Space (LAPAN). Representatives from several international programs also participated, e.g., the Group on Earth Observations (GEO) Global Agricultural Monitoring [GEOGLAM], GOFC–GOLD, and NASA SERVIR.[3] In total, 103 organizations were represented at the meeting. Prior to the meeting, local hosts also organized a two-day field visit to Mount Pinatubo, a volcano that erupted in June 1991, to observe how the eruption impacted local land cover and land use—see *An Excursion to Mount Pinatubo 27 Years After Its Eruption* on page 36.

[1] The countries considered part of South/Southeast Asia for purposes of this calculation are Afghanistan, Pakistan, Nepal, India, Bhutan, Bangladesh, Sri Lanka, Timore-Leste, Brunei, Philippines, Cambodia, Laos, Malaysia, Myanmar, Vietnam, Indonesia, and Thailand. Note that in the Maldives, annual population growth is negative (-0.07).

[2] The 2017 LCLUC–SARI International Science Meeting was summarized in the November–December 2017 issue of *The Earth Observer* [**Volume 29**, **Issue 6**, pp. 40-47—*https://eospso.nasa.gov/sites/default/files/eo_pdfs/Nov_Dec_2017_color_508.pdf*].

[3] SERVIR is not an acronym; it is derived from a Spanish word meaning "to serve."

Philippines Meeting Summary

Published in the NASA Earth Observer

Sep-Oct-2018

Documenting Regional Research Needs and Priorities - Meeting Summaries

24 The Earth Observer March - April 2013 Volume 25, Issue 2

meeting/workshop summaries

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

Krishna Prasad Vadrevu, University of Maryland, College Park, krishna@hermes.geog.umd.edu
Chris Justice, University of Maryland, College Park, justice@hermes.geog.umd.edu
Prasad Thenkabail, United States Geological Survey, pthenkabail@usgs.gov
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

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

- a focused workshop on water resources at the Centre for Water Resources Development and Management (CWRDM), held in Kozhikode, Kerala in India, from January 7-8, and a Land Use (LU) Transect Study from Kozhikode, Kerala, to Coimbatore, Tamil Nadu, in India[1], on January 9;
- a NASA international regional meeting, held January 10-13, at Karunya University in Coimbatore, Tamil Nadu; and
- a training workshop titled *Remote Sensing and Geospatial Technologies for Land Cover and Land Use Change Studies and Applications*, held January 14 at Karunya University.

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. Atmosphere/land-use interactions (aerosols, greenhouse gases);
4. LCLUC and the carbon cycle;
5. Forests and LCLUC in mountainous areas;
6. Coastal zones and water resources;
7. Urban LCLUC; and
8. Working towards a Regional Global Observation for Forest and Land Cover Dynamics (GOFC–GOLD) South Asia Regional Information Network (SARIN) (including prospects, opportunities, and challenges).

[1] Kerala and Tamil Nadu are two of the 28 states in India.

The meeting was a joint effort of the NASA LCLUC Program; GOFC–GOLD Program; International System for Analysis Research and Training (START) Program; Monsoon Asia Integrated Regional Studies Program (MAIRS); University of Maryland College Park (UMD); Center for Water Resources Development and Management (CWRDM) in Kozhikode, Kerala; and Karunya University, in Coimbatore, Tamil Nadu.

NASA LCLUC Workshop on Water Resources and Land Use Transect

Thirty top-level delegates from different institutes and universities in India attended the meeting in addition to twelve researchers from the U.S. **Narasimha Prasad** [CWRDM], welcomed the participants and highlighted the CWRDM water research activities.

After the welcome, **Garik Gutman** [NASA Headquarters] addressed the workshop's participants, presenting an overview of LCLUC issues in South Asia, with focus on agricultural land-cover conversion,

40 The Earth Observer November - December 2017 Volume 29, Issue 6

meeting summaries

Summary of the 2017 LCLUC-SARI International Science Meeting

Krishna Prasad Vadrevu, NASA's Marshall Space Flight Center, krishna.p.vadrevu@nasa.gov
Chris Justice, University of Maryland, College Park, cjustice@umd.edu
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

South/Southeast Asian countries have the highest population growth rate worldwide and account for more than 25% of the global population. This population growth—together with rapid economic development—is leading to the conversion of forested areas to agriculture and agricultural areas to residential and urban uses, with significant impact on ecosystem services. Increased land cover and land-use changes in the region are impacting forest resources, biodiversity, regional climate, biogeochemical cycles, and water resources. To address these issues in the framework of NASA's Land Cover/Land Use Change (LCLUC) Program-funded South/Southeast Asia Research Initiative (SARI), an international science meeting was held in Chiang Mai, Thailand, July 17–19, 2017. The National Astronomical Research Institute of Thailand (NARIT), based in Chiang Mai, hosted the meeting.

NASA LCLUC-SARI meeting participants in Chiang Mai, Thailand. Photo credit: NARIT team

The goal of the meeting was to review the availability, potential, and limitations of different satellite data sources and methodologies for land-use mapping, quantification, monitoring, and environmental impact in South/Southeast Asia. Overview presentations described research accomplishments and the current state of scientific information on these topics. The meeting included a poster session with 40 presentations. In total, 165 participants from 16 countries from Asia, Europe, and the U.S. attended the meeting. Scientists from other space agencies also attended, including representatives from the Japan Aerospace Exploration Agency (JAXA), the Space Technology Institute (of Vietnam) and Vietnam National Space Center (VNSC), the Geo-Informatics and Space Technology Development Agency (GISTDA) of Thailand, the International Centre for Integrated Mountain Development (ICIMOD) in Nepal, as well as representatives from international programs, including the Global Observation of Forest and Land Cover Dynamics (GOFC–GOLD) and Group on Earth Observations' (GEO) Global Agricultural Monitoring [GEOGLAM]. After the meeting, 95 early-career scientists from different countries participated in a three-day, hands-on training, focused on the use of remote sensing and geographic information systems (GIS) for LCLUC applications. The local hosts also organized a two-day field visit that gave meeting participants an opportunity to observe local land-cover and land use changes in and around Inthanon National Park in Chiang Mai—see *Field Visit to Inthanon National Park* on page 41.

The meeting had the following objectives:

- to review regional and national science priorities, relating to LCLUC in the region;
- to review the causes and impacts of LCLUC specific to agriculture, forests, urban, and coastal ecosystems;
- to review greenhouse gases (GHGs) and aerosol sources, sinks, and impacts; and
- to strengthen the SARI activities.

Toward those ends, the agenda was organized around the following four themes:

- agricultural LCLUC;
- emission inventories and land-atmosphere interactions;
- urban LCLUC; and
- LCLUC and forestry.

24 The Earth Observer May - June 2016 Volume 28, Issue 3

meeting summaries

Summary of the 2016 Land-Cover Land-Use Change Regional Science Team Meeting

Krishna Prasad Vadrevu, University of Maryland, College Park, krishna@umd.edu
Chris Justice, University of Maryland, College Park, cjustice@umd.edu
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

South/Southeast Asia is experiencing a population boom accompanied by rapid economic development that has had significant impact on ecosystems in the region. A growing population requires more places to live and work, so existing agricultural areas are rapidly being converted to residential and urban areas. Said population must also be fed, which means that even more forests are being cleared and converted to agricultural fields. Dramatic increases in land-cover and land-use change (LCLUC) inevitably impact virtually all aspects of the regional ecosystem—e.g., forest resources, biodiversity, regional climate phenomena, biogeochemical cycles, and water resources. Developing appropriate and effective land-use policies is essential to sustainable development of the countries in the region.

To address these issues, the International LCLUC Regional Science Team Meeting (STM) was held January 12–18, 2016, in Yangon, Myanmar (previously known as Rangoon, Burma). This international meeting provided a forum to discuss LCLUC and its impacts with a regional focus, in the context of the emerging South and Southeast Asia Regional Initiative (SARI). The goal of SARI is to develop an innovative research, education, and capacity-building program involving state-of-the-art remote sensing, natural sciences, engineering, and social sciences, which will enrich LCLUC science in South/Southeast Asia. More details about the SARI can be found at *www.sari.umd.edu*.

NASA's LCLUC Program organized the meeting, in collaboration with the University of Maryland, College Park (UMCP), the global change SysTem for Analysis, Research and Training (START), and the international Global Observation for Forest and Land Cover Dynamics (GOFC–GOLD) Program. The president of Myanmar endorsed the meeting, with guidance from the Ministry of Environment, Conservation and Forests (MOECAF) and the Department of Geography at the University of Yangon, Myanmar, which hosted the meeting. The LCLUC STM itinerary included an optional field trip on January 12, 2016, to visit Bago, a small city located 50 miles northeast of Yangon and its environs, which is in the southwestern part of the country. During the field trip the delegates and local participants discussed local LCLUC issues relating to forestry, agriculture, and urban areas—including the cultural aspects of Myanmar. To learn more, see *Field Trip to Bago—An Ancient Capital and Modern Example of LCLUC Issues in Myanmar* on the next page.

More than 150 participants from 12 different countries attended the meeting. The nations represented included India, Sri Lanka, Nepal, Thailand, Indonesia, Vietnam, Singapore, the U.S., Japan, Myanmar, Germany, and Switzerland. The meeting included scientific sessions that addressed regional and international programs in South/Southeast Asia; agriculture and water resources; forest cover mapping and monitoring; urbanization; and land-atmosphere interactions, including fires. Discussion

The Earth Observer September - October 2018 Volume 30, Issue 5 35

meeting summaries

Summary of the 2018 NASA LCLUC–SARI International Regional Science Meeting

Krishna Prasad Vadrevu, NASA's Marshall Space Flight Center, USA; krishnap@umd.edu
Mylene Cayetano, University of the Philippines Diliman, mscayetano@stems.upd.edu.ph
Gay Jane Perez, University of the Philippines Diliman, gjperez1@up.edu.ph
Toshinasa Ohara, National Institute of Environmental Studies, tohara@nies.go.jp
Chris Justice, University of Maryland, College Park, cjustice@umd.edu
Garik Gutman, NASA Headquarters, ggutman@nasa.gov

Introduction

South and Southeast Asian countries account for more than 25% of the global population. The annual population growth rate (averaged across all countries in the area)[1] is ~1.25% per year. This rapid rate of growth is coincident with rapid economic development, which has led to substantial land-use change (e.g., the conversion of forested areas to agriculture and agricultural areas to residential and urban uses) in this area, which in turn has a significant impact on the environment. Further, increased land-cover and land-use changes (LCLUC) in the region are impacting forest resources, biodiversity, regional climate, biogeochemical cycles, and water resources. To address the LCLUC issues in the framework of NASA's South/Southeast Asia Research Initiative (SARI), an international science meeting was held in the Quezon City, Metro Manila, the Philippines, May 28–30, 2018.[2]

The organizers of this meeting included **Krishna Vadrevu** [NASA's Marshall Space Flight Center (MSFC), U.S.—*SARI Lead*], **Garik Gutman** [NASA Headquarters, U.S.—*LCLUC Program Manager*], **Chris Justice** [University of Maryland, College Park (UMCP), U.S.—*LCLUC Project Scientist*], **Toshimasa Ohara** [National Institute of Environmental Studies (NIES), Japan], **Tsuneo Matsunaga** [NIES, Japan], and **Atul Jain** [University of Illinois, Urbana-Champaign, U.S.]. **Mylene Cayetano** [Institute of Environmental Science and Meteorology (IESM), University of Philippines (UP) Diliman] and **Gay Perez** [IESM, UP Diliman] served as local hosts. Eighteen other local and international organizations sponsored the event, which also served as a forum for the Global Observations of Forest and Land Cover Dynamics (GOFC–GOLD) Southeast Asia Regional Network to discuss important research needs and priorities.

In total, 202 participants from 21 different countries from Asia, Europe, and the U.S. attended the meeting—see the group photo below. Scientists from five different space agencies in the region were represented, including the Japan Aerospace Exploration Agency (JAXA), the Space Technology Institute of Vietnam and Vietnam National Space Center (VNSC), the Indian Space Research Organization (ISRO), the Geo-Informatics and Space Technology Development Agency of Thailand (GISTDA), and the Indonesian National Institute of Aeronautics and Space (LAPAN). Representatives from several international programs also participated, e.g., the Group on Earth Observations (GEO) Global Agricultural Monitoring [GEOGLAM], GOFC–GOLD, and NASA SERVIR.[3] In total, 103 organizations were represented at the meeting. Prior to the meeting, local hosts also organized a two-day field visit to Mount Pinatubo, a volcano that erupted in June 1991, to observe how the eruption impacted local land cover and land use—see *An Excursion to Mount Pinatubo 27 Years After Its Eruption* on page 36.

[1] The countries considered part of South/Southeast Asia for purposes of this calculation are Afghanistan, Pakistan, Nepal, India, Bhutan, Bangladesh, Sri Lanka, Timore-Leste, Brunei, Philippines, Cambodia, Laos, Malaysia, Myanmar, Vietnam, Indonesia, and Thailand. Note that in the Maldives, annual population growth is negative (-0.07).

[2] The 2017 LCLUC-SARI International Science Meeting was summarized in the November–December 2017 issue of *The Earth Observer* [**Volume 29, Issue 6**, pp. 40–47—*https://eospso.nasa.gov/sites/default/files/tse_pdfs/Nov_Dec_2017_color_508.pdf*].

[3] SERVIR is not an acronym; it is derived from a Spanish word meaning "to serve."

NASA LCLUC-SARI meeting participants in Quezon City, Philippines. Photo credit: University of Philippines, Diliman team

Bottom-Up Approach

Inputs to NASA ROSES LCLUC calls

Training Events –Collaborations with SARI researchers
Dr. Qi – Michigan State University

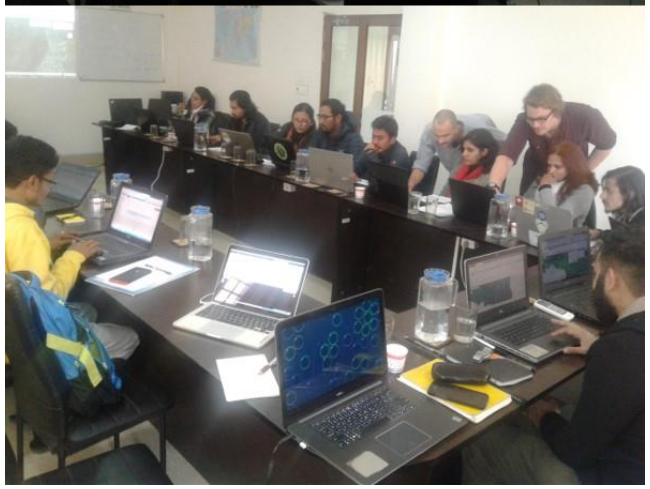
- 25-participants from South/Southeast Asian countries attended the training at the National University of Laos, Laos

- Fundamentals of remote sensing
- SAR remote sensing for Agricultural applications
- UAV's application for Cadastral mapping
- Hyperspectral remote sensing
- Hydrological Modeling at a Watershed Scale

Advanced Remote Sensing and GIS training in Vientiane,Laos

August 18-20th, 2018

Training Events –Collaborations with SARI researchers
Dr. Jeff Fox – East West Center, Hawaii



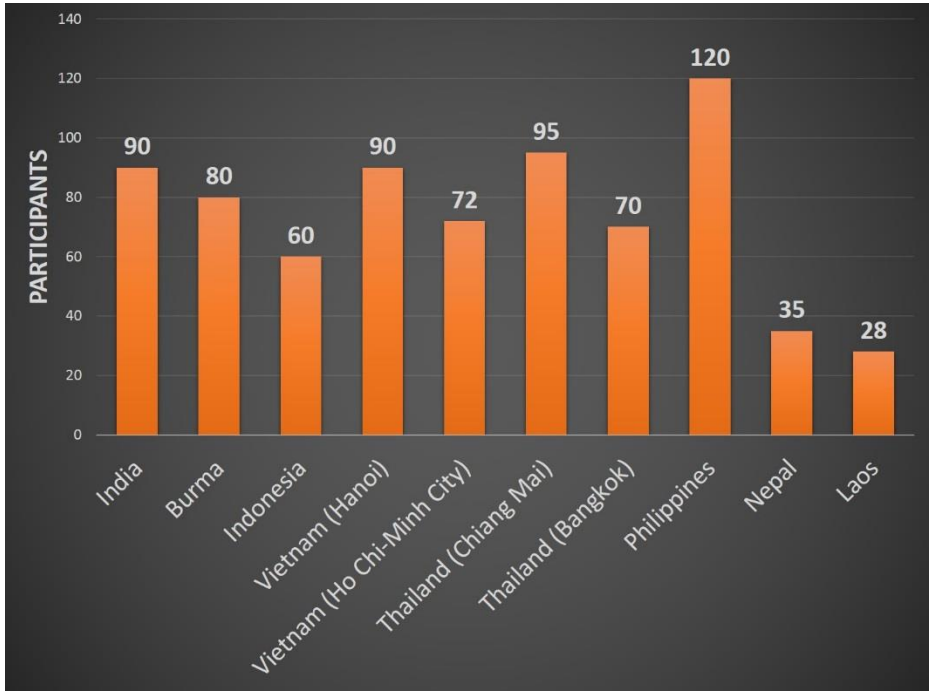
Day-1 -Introduction to GEE
-Coding, calculating vegetation indices, visualization, exporting

Day-2 Satellite image analysis in GEE
-Topographic correction, pre-processing, classification including accuracy assessment

Forest Cover Mapping in Nepal - 2-Days of Focused Training using Google Earth Engine

Nepal, December 3-4th, 2018

Training Events –Early Career Researchers



Certificate of Participation

This is to certify that

has participated in the training sessions on

Remote Sensing and Geospatial Technologies for Land Cover and Land Use Change Studies and Emissions Modelling
October 20th, 21st and 23nd, 2016

Presented by NASA Land-Cover/Land-Use Change Program, South/Southeast Asia Research Initiative (SARI) and the University of Maryland College Park
Hosted by Ho Chi Minh University of Technology, Vietnam

Prof. Nguyen Phoc Dan
HCMUT, Vietnam

Dr. Krishna Prasad Vadrevu
NASA MSFC, SARI Program Scientist

Prof. Chris Justice
NASA LCLUC Project Scientist

START IHDP • IGBP • WCRP

NASA LCLUC

UNIVERSITY OF MARYLAND

Promoting Open Source Tools and Cloud Computing Platforms (Ex: GEE)

Thanks to all our all our trainers for the help

NASA – GISTDA Training Events (2019-2021)

NASA LCLUC -GISTDA collaboration

2-Training events per year
-One at the GISTDA campus and second one at a local University in Thailand

-NASA LCLUC to facilitate international trainers; GISTDA along with KMUTT to facilitate local logistics

Training Location:
Chonburi Campus, GISTDA

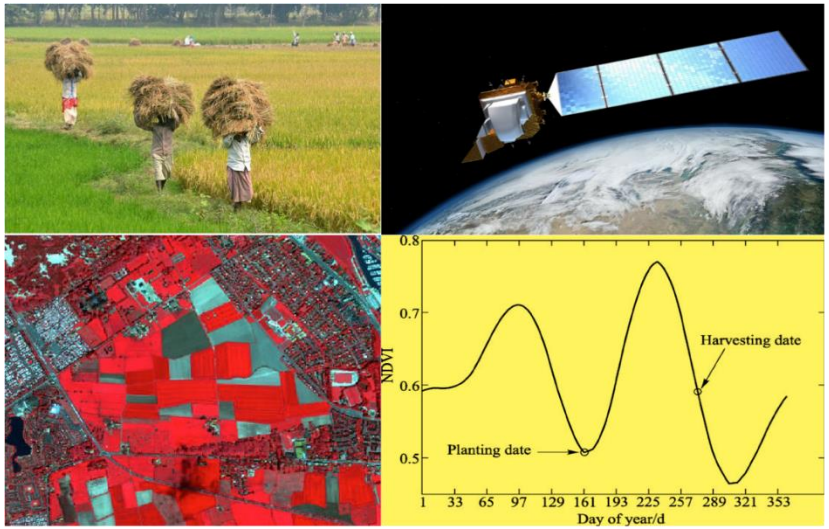
Training dates: (Tentative)
October 14-18th, 2019

Contact:
Dr. Krishna Vadrevu
Email: krishna.p.vadrevu@nasa.gov

Building Collaborations and Organizing Events with Equal Cost-Share Can be a Good Strategy

ISRO – NASA LCLUC program Connections Strengthened – SARI Agriculture Meeting, New Delhi, May, 2017

Operational Mapping/Monitoring of Agricultural Crops in South/Southeast Asian Countries –Research Needs and Priorities, New Delhi, May, 2017



The Earth Observer September - October 2017 Volume 29, Issue 5

Summary of the 2017 South/Southeast Asia Research Initiative Agricultural Workshop

Krishna Prasad Vadrevu, NASA's Marshall Space Flight Center, krishna.p.vadrevu@nasa.gov
Chris Justice, University of Maryland, College Park, cjustice@umd.edu

Introduction

South/Southeast Asian countries are growing rapidly in terms of population, industrialization, and urbanization. As a result of this growth, one of the key policy challenges facing the region is *food security*—conditions "…when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life."[1] Although total food production has increased in the region since 1960 due to land area having been converted to agricultural use, more recently it has decreased, mostly due to loss of productive agricultural land due to urbanization and industrial development. Furthermore, the region is experiencing variability in the timing of the monsoon and extreme weather events, resulting in drought or flooding, which impact agricultural production. Monitoring crop production in a timely manner is essential to predict and prepare for disruptions in the food supply. To achieve such timely monitoring requires improved and up-to-date information on agricultural land-use practices.

Although there has been significant progress in remote sensing and geospatial technologies over the past few decades, there has been little emphasis placed on developing robust methods for operational mapping and monitoring of areas devoted to crops. In South/Southeast Asia generally, most mapping efforts to date have focused on the broader classification of land cover types and generalized cropland areas into a single or limited number of thematic classes. Only a few countries have access to up-to-date crop type information. There is an urgent need to make this near-real-time information more readily available to stakeholders and to enhance national and regional operational systems for monitoring agricultural crops.

To address these issues and the potential and limitations of different remote sensing data and methods for agricultural applications, an international workshop, titled *Operational Mapping/Monitoring of Agricultural Crops in South/Southeast Asian Countries—Research Needs and Priorities*, took place May 2-4, 2017, at the Guru Gobind Singh (GGS) Indraprastha University in New Delhi, India—see **Photo 1** below. The workshop was organized as a part of the South/Southeast Asia Research Initiative (SARI)[2] activities.

The workshop was organized into four sessions:

- Global/regional programs in agriculture;
- computational tools and decision-support systems for agricultural research;
- biophysical parameter retrievals, crop type, area and yield mapping and monitoring; and
- regional land and agriculture mapping and monitoring activities.

[1] Definition from the Food and Agriculture Organization of the United Nations. See *www.fao.org/forestry/13128-0e6f36f27e0091055bec28ebe830f46b3.pdf* for details.

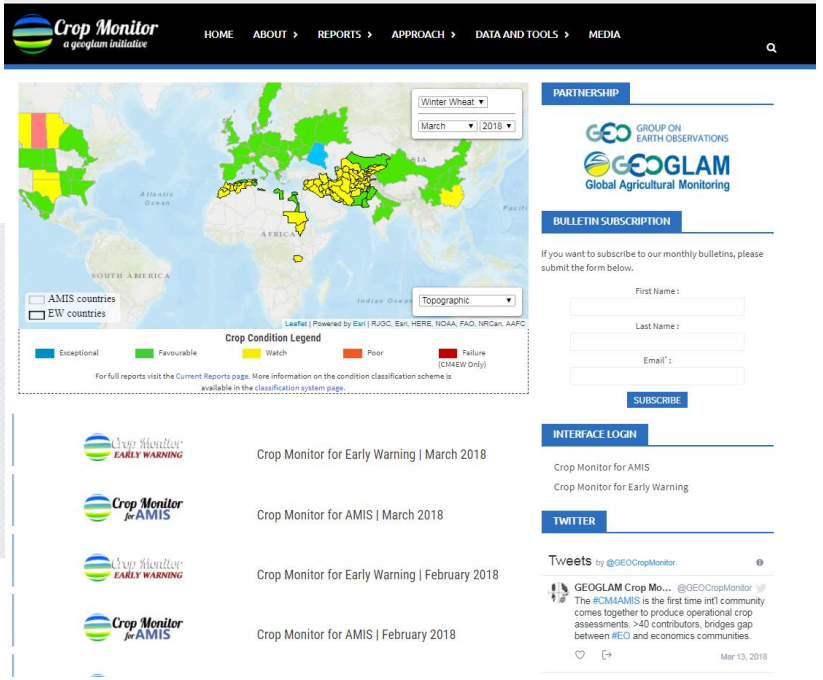
[2] SARI was initiated by NASA's Land Cover and Land Use Change (LCLUC) Program to promote innovative regional research, education, and capacity-building activities involving state-of-the-art remote sensing, natural sciences, engineering, and social sciences to enrich LCLUC science in South/Southeast Asia (*www.sari.umd.edu*). Learn more about recent activities of NASA's LCLUC Science Team on page 39 of this issue.

Photo 1. SARI Agricultural Workshop Participants—New Delhi, India. **Photo credit:** GGS Indraprastha University Team

Mahalanobis National Crop Forecast Center (India) – Ministry of Agriculture – NOW CONTRIBUTING TO GEOGLAM ACTIVITIES

MNCFC

GEOGLAM



Mahalanobis National Crop Forecast Centre (MNCFC) is an office of Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India. The Centre provides in-season crop forecasts and assessment of drought condition using state of the art techniques and methodologies developed by Indian Space Research Organization (ISRO).

Contribution to GEOGLAM

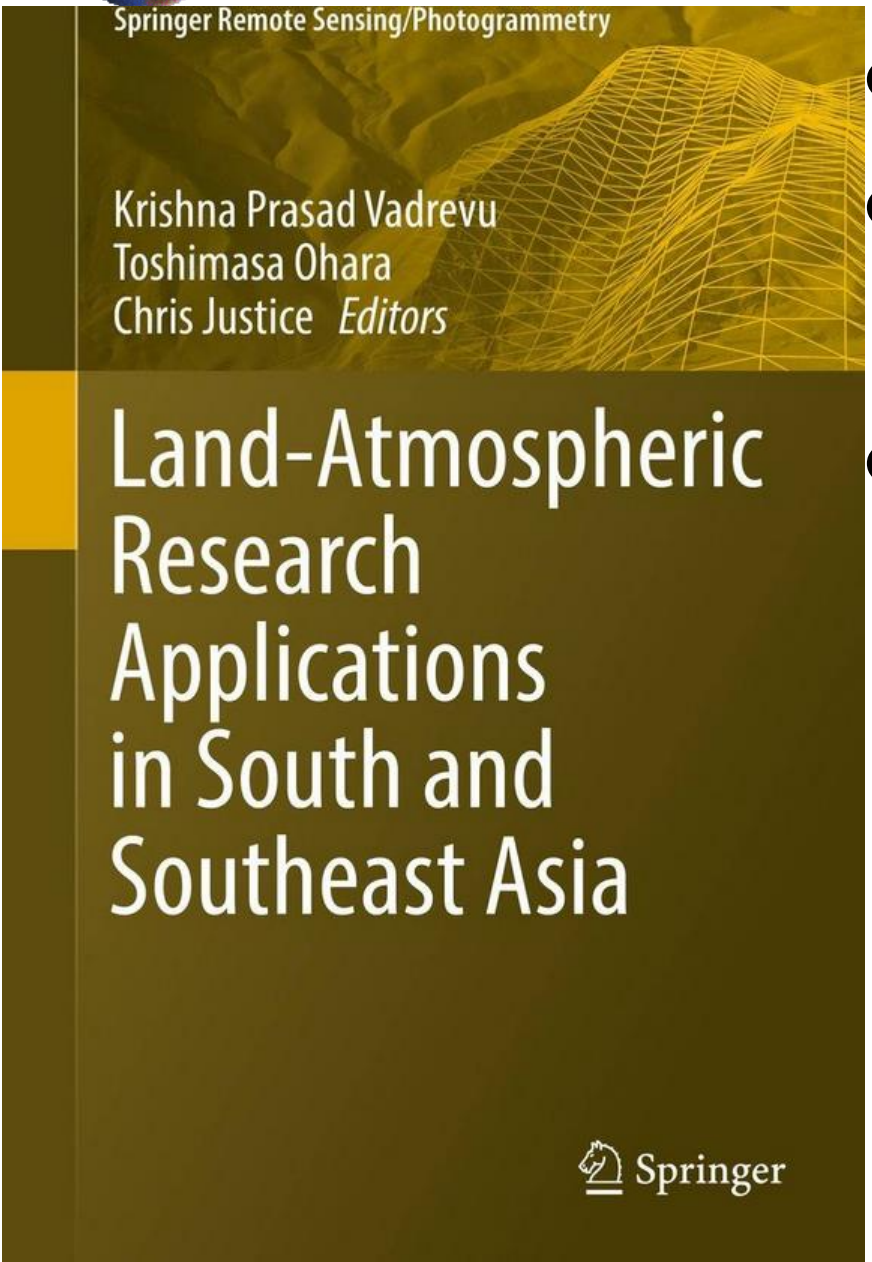
-Crop forecasts
-Crop calendars
-Crop yield and prediction
-Drought information

GEOGLAM initiative strengthens the international community's capacity to produce and disseminate relevant, timely and accurate forecasts of agricultural production at national, regional and global scales through the use of Earth Observations (EO) including satellite and ground-based observations.

ISPRS-GEOGLAM-Mahalanobis National Crop Forecast Center (India) – SARI Supported Meeting, February 2019, India

Continue these Meetings and Trainings through ISRO Collaboration – WGCapD Umbrella

Book Published (2018)



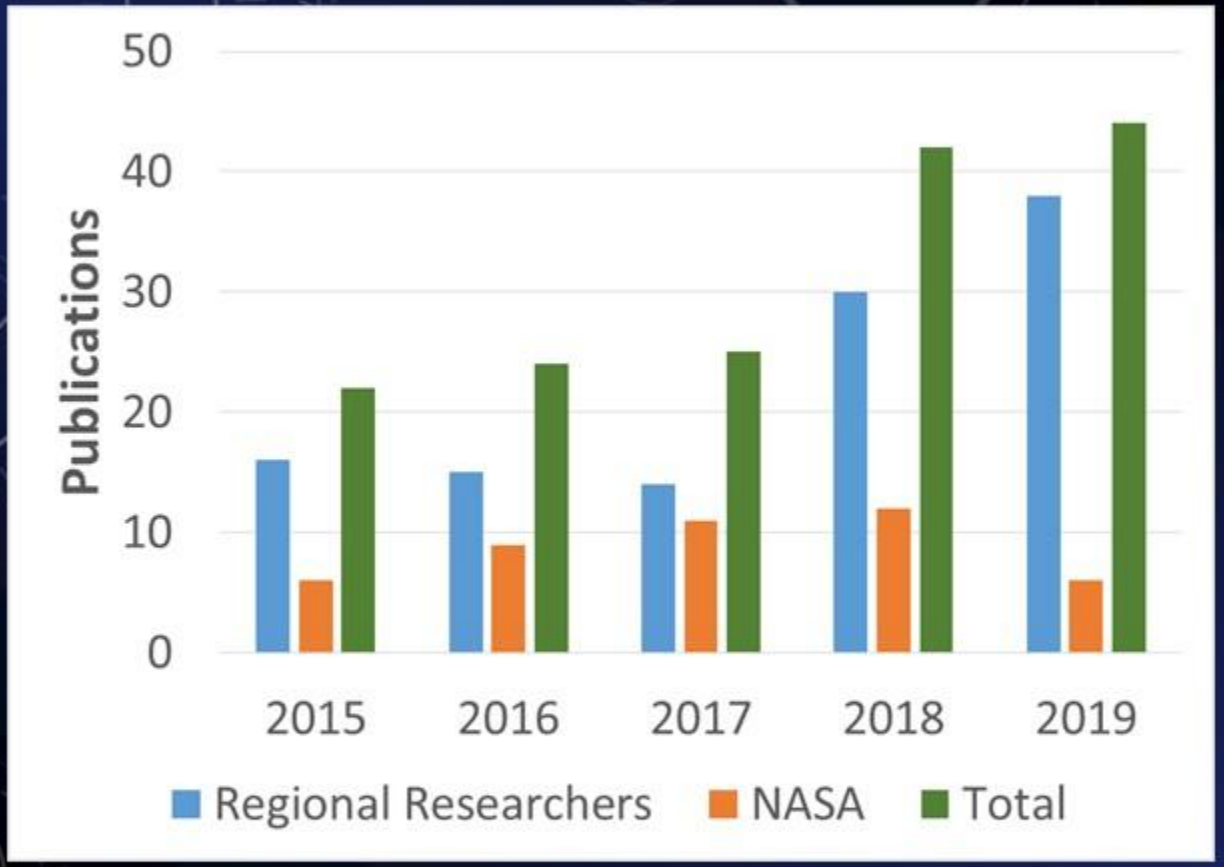
- 30 Chapters
- 101 (authors + co-authors)
- 732 pages

One of the Top Downloaded Books List for 2018 – within 4-months of Publication - Springer

SARI: RECENT 4 YEARS OF SCIENCE

Over 150 papers and 3 books 4th to be announced

9-different Special Issues in Journals

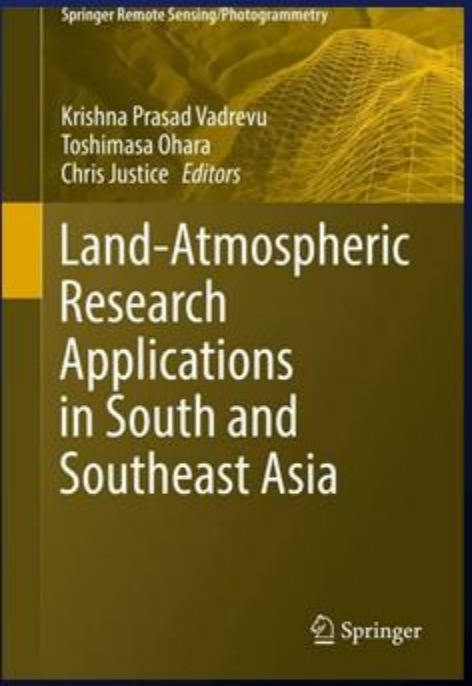


>200 scientists
>100 institutions
>18 projects

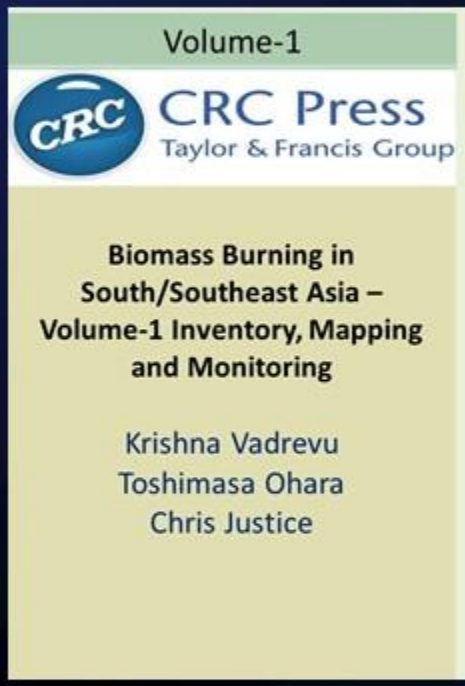
South-Southeast Asia

Oct-2013 – India Meeting – SARI idea proposed
2015-SARI formed; 2016- 1st SARI proposals funded;

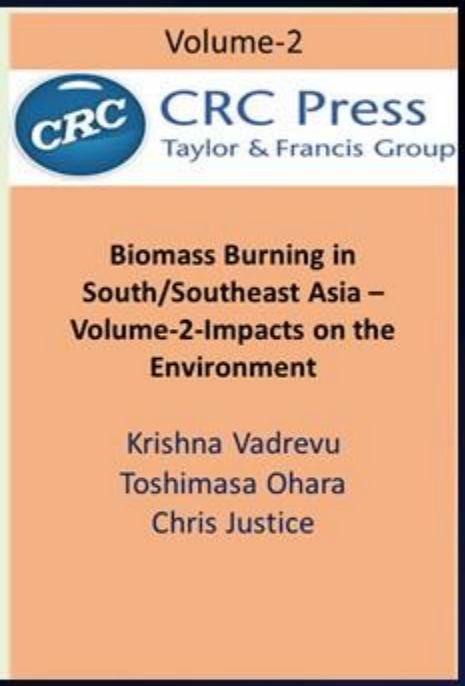
SARI-LCLUC BOOKS



Springer 2018



CRC Press, 2019

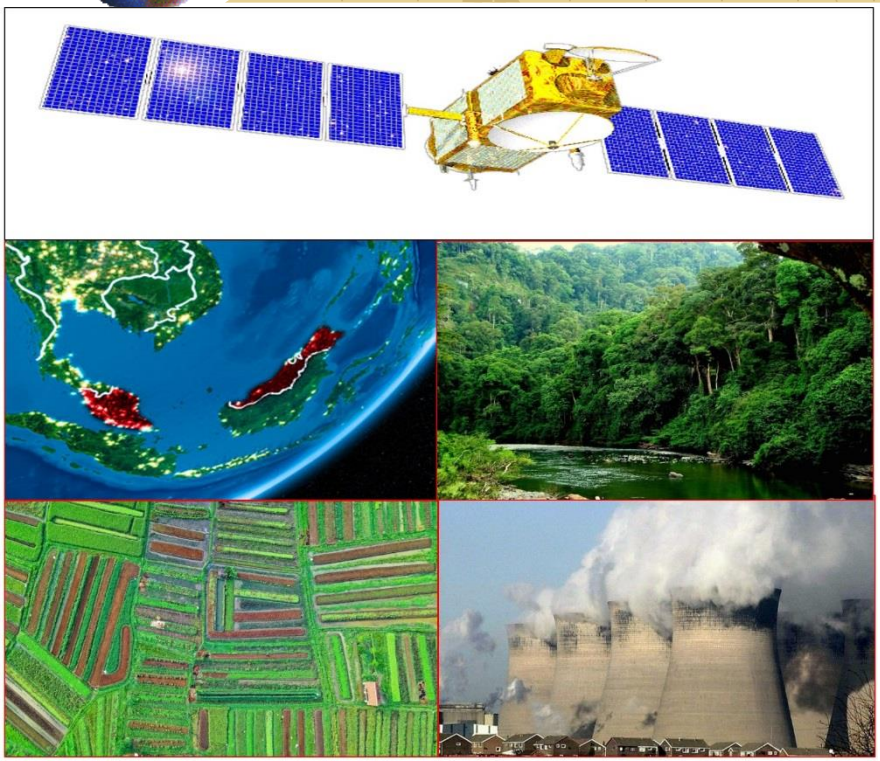


CRC Press, 2019

Springer, 2020

Biomass Burning – 2-Volume Books To be Published in 2019
CRC Press

Land Use/Cover Changes, Environment and Emissions in South/Southeast Asia – An International Regional Science Meeting



Local Host

UTM UNIVERSITI TEKNOLOGI MALAYSIA FACULTY OF BUILT ENVIRONMENT & SURVEYING

Sponsors and Partners

NASA, NIES JAPAN, SARI, UNIVERSITY OF MARYLAND, SERVIR, GEOGLAM, Asia-RiCE, HARVEST, START, GOFC-GOLD, JAXA, CESBIO, VNSC, ILLINOIS, CEOS WGCapD

Johor Bahru, Malaysia

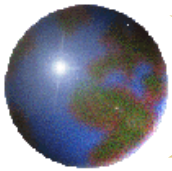
Meeting Dates:
07/22/2019 to 07/24/2019

Training Dates:
07/25/2019 to 07/27/2019

157 Participants already Registered

SARI forthcoming meetings (2018-2019)

- 2019 - NASA LCLUC-GISTDA training, Thailand
  - Training: October 15-18, 2019
- 2020 - SARI-WEF nexus meeting and training, Cambodia
  - Meeting: February, 2020
  - Training: TBD
- 2020 - SARI LCLUC all-hands, TBD
  - Meeting (TBD)
  - Training (TBD)
- 2020 - SARI-GEOGLAM Agriculture - ISRO collaboration
  - Meeting (TBD)
  - Training (TBD)



Thank you for your attention

Questions?