NASA South/Southeast Asia Research Initiative (SARI)

Krishna Prasad Vadrevu

SARI Lead

Deputy Program Manager, NASA LCLUC Program (HQ)

NASA Marshall Space Flight Center

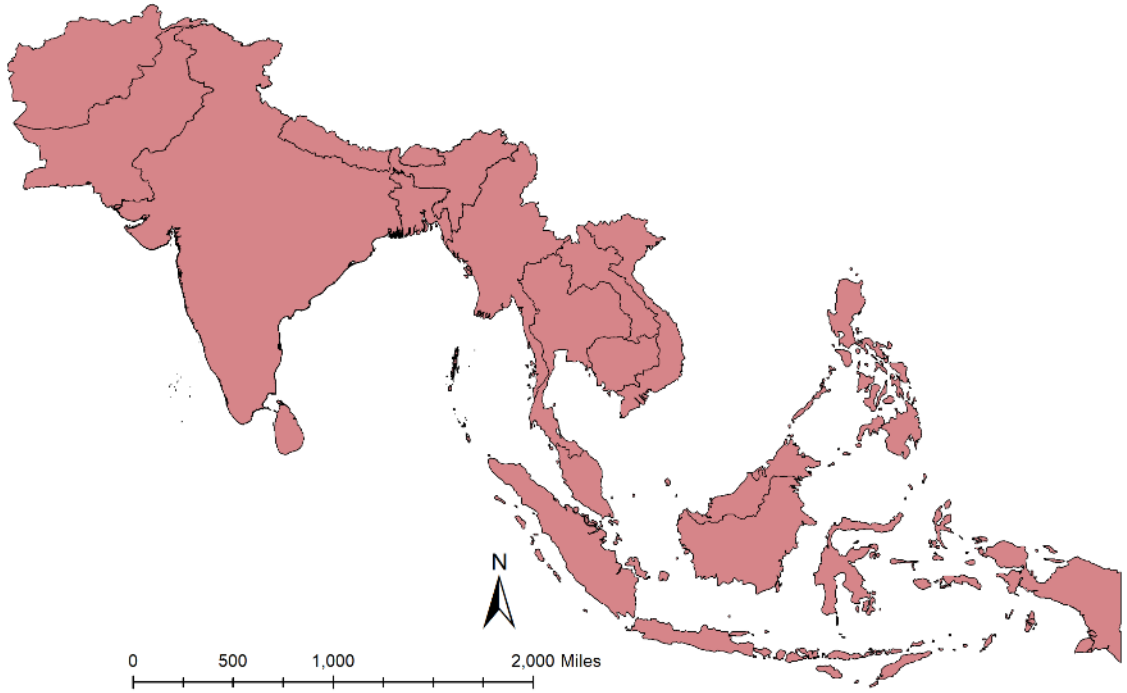
Huntsville, Alabama

SARI

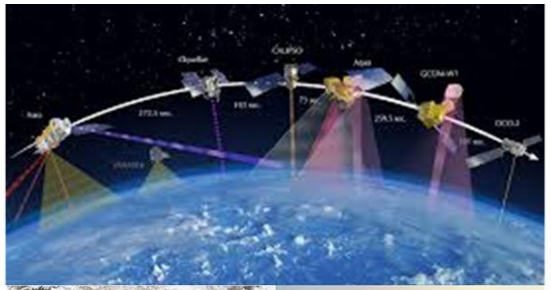
Land-Cover / Land-Use Change Program

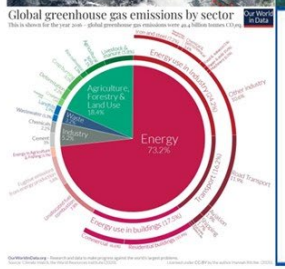
Outline

- Background to the South/Southeast Asia Research Initiative(SARI)
- SARI Projects and Updates
- SARI outputs to date
- SARI Synthesis



International Meeting on Air Pollution in Asia – Inventories, Monitoring and Mitigation





Despite some hurdles
-December holidays
-COVID delays
-TET holidays

Huge Thanks to VNSC and VNUET for their commitment, hardwork and efficiency for pulling this meeting.

Workshop on Land Cover Land Use Change, Southeast Asia, Hanoi, Vietnam – November 5-11th, 2011

https://lcluc.umd.edu/meetings/workshop-land-cover-land-use-change-southeast-asia?page=5

International Workshop on Air Quality in Asia, Hanoi, Vietnam, 2014

https://gofcgold.org/index.php/meetings/international-workshop-air-quality-asia-hanoi-vietnam

A Success Story – Kristofer Lasko, Ph.D 2014-2018 (UMd)
Joint Supervision – Chris Justice and Krishna Vadrevu

Mapping and estimating rice residue burning and associated emissions scenarios in the greater-Hanoi region of Vietnam.

5-publications from Ph.D
-3 greater than 80 citations
-2 greater than 100 citations

<u>Currently, Deputy Branch Manager</u>
Geospatial Engineer Research and Development Center, US Army, Virginia

International Meeting on Land Use and Emissions in South/Southeast Asia , Ho Chi Minh City, Vietnam – October 17-19th, 2016

Vietnam National University-Ho Chi Minh City, Ho Chi Minh City
University of Technology, VNSC, Vietnam

https://sari.umd.edu/meetings/international-meeting-land-use-and-emissions-southsoutheast-asia

How SARI started-Strong interest from regional scientists

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

Total participants =120

US – 18 researchers; Nepal-3; Srilanka-2; Myanmar-1; Afghanistan, Myanmar, Bangladesh-1 each

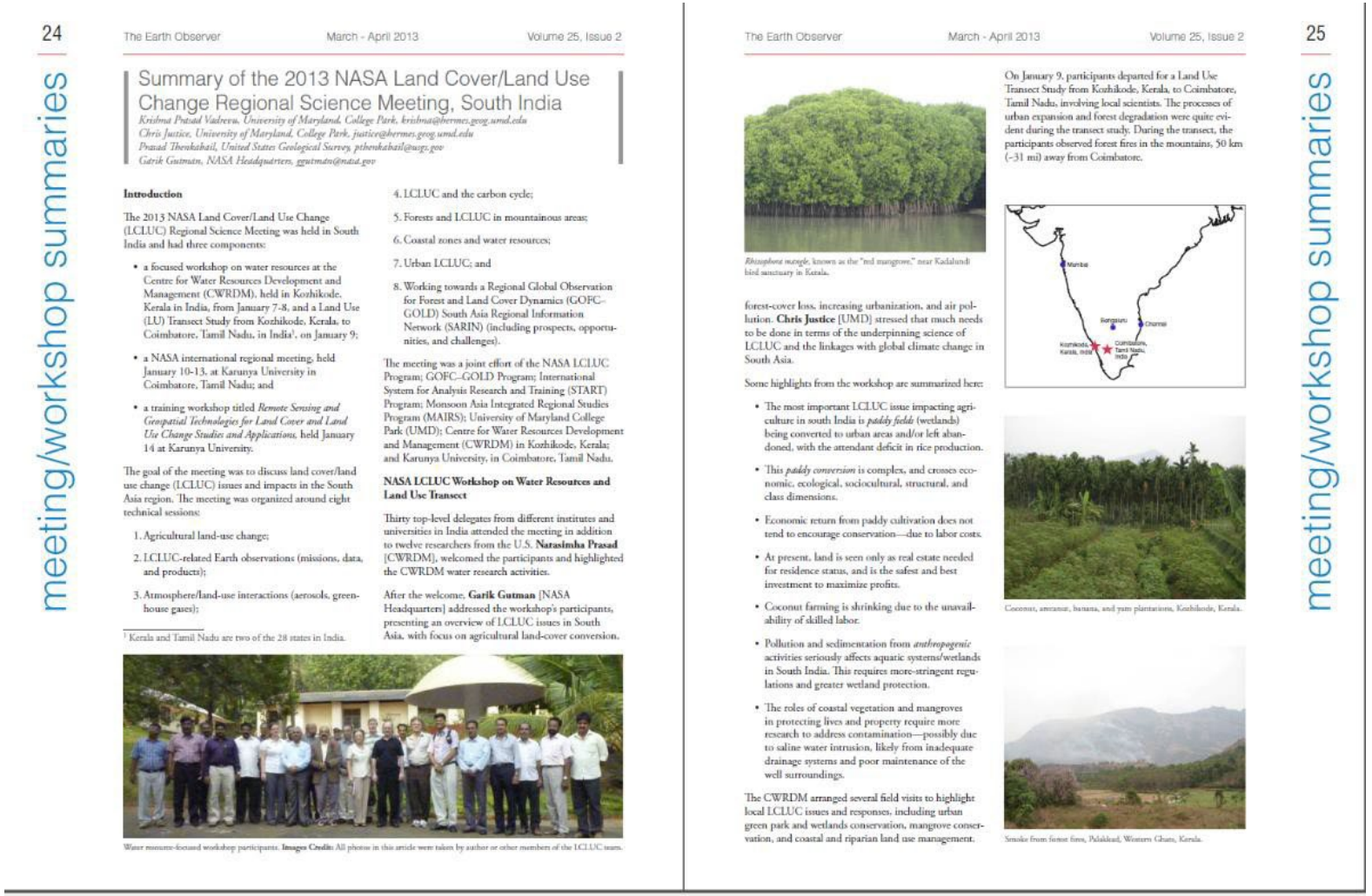
Pakistan, China invited but could not attend – Visa issues

India – University Researchers, Government, Non-Government, NGO's

Needs Identified

- Focus LCLUC thematic areas
- Need for products
- Strengthen Research ties
- Training opportunities
- Student opportunities
- How to strengthen ISRO – NASA collaborations ?
- Data access (how to access ISRO satellite data)

Meeting Summary- SARI Research Needs and Priorities - The Earth Observer



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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); 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.

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meeting/workshop summaries

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

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.

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.

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

NASA Land Cover/Land Use Change (LCLUC) Program
South/Southeast Asia Research Initiative (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.

Dr.Krishna Vadrevu, SARI Lead, NASA MSFC

- Science Advisory Team Formed (2013)
- Science Plan Formulation (mid-2014)
- Presentation at NASA HQ by Science Team (end-2014)
- First SARI ROSES Solicitation (2015)
- SARI Synthesis Solicitation (2021)

-Balancing Act

-Research + outreach activities should be blended to achieve successful science outputs

SARI Projects - ROSES-2015 Selections

S.No	2015	Region	PI	Theme
1	Tropical Deciduous Forests of South Asia: Monitoring Degradation and Assessing Impacts of Urbanization	South Asia	Ruth De Fries, Columbia University	Forest degradation and urbanization
2	Understanding Changes in Agricultural Land Use and Land Cover in the Breadbasket Area of the Ganges Basin 2000-2015: A Socioeconomic-Ecological Analysis	South Asia	Li Ping Di	Agricultural land use
3	Impacts of Afforestation on Sustainable Livelihoods in Rural Communities in India	South Asia	Forrest Fleischman/Texas A&M University	Afforestation and sustainable livelihoods
4	The Future of Food Security in India: Can Farmers Adapt to Environmental Change?	South Asia	Meha Jain, University of Michigan	Food security and adaptation
5	Complex Forest Landscapes and Sociopolitical Drivers of Deforestation - The Interplay of Land-use Policies, Armed Conflict, and Human Displacement in	South Asia	Peter Leimgruber/Smithsonian Institution	Deforestation, armed conflicts and policy
6	Understanding the Role of Land Cover/Land Use Nexus in Malaria Transmission Under Changing Socio-Economic Climate in Myanmar	South Asia	Tatiana Loboda/University of Maryland	Malaria
7	Urban Growth, Land-Use Change, and Growing Vulnerability in the Greater Himalaya Mountain Range Across India, Nepal, and Bhutan	South Asia	Karen Seto/Yale University	Urbanization and vulnerability
8	Landscapes In Flux: The Influence of Demographic Change and Institutional Mechanisms on Land Cover Change, Climate Adaptability and Food Security in Rural India	South Asia	Philip Townsend/University of Wisconsin-Madison	Food security and adaptation
9	Consequences of Changing Mangrove Forests in South Asia on the Provision of Global Ecosystem Goods and Services	South Asia	Jeffrey Vincent/Duke University	Mangroves and Ecosysltem services
10	Spatiotemporal Drivers of Fine-Scale Forest Plantation Establishment in Village-Based Economies of Andhra Pradesh	South Asia	Randolph Wynne/Virginia Polytechnic Institute and State University	Plantations and agricultural transitions

(10 projects over South Asia)

SARI Projects - ROSES-2016 and 2018 Selections

S.No	2016	Region	PI	Theme
11	Agricultural Land Use Change in Central and Northeast Thailand: Effects on Biomass Emissions, Soil Quality, and Rural Livelihoods	Southeast Asia	Varaprasad Bandaru/University of Maryland, College Park	Emissions, soil quality
12	The Agrarian Transition in Mainland Southeast Asia: Changes in Rice Farming - 1995 to 2018	Southeast Asia	Jefferson Fox/East West Center	Rice Farming
13	A Cobra in the Forest? Quantifying the Impact of Perverse Incentives from Indonesia's Deforestation Moratorium, 2011 to 2016	Southeast Asia	Matt Hansen, Umd	Deforestation, moratorium policies
14	Land-Cover/Land-Use Change in Southern Vietnam Through the Lenses of Conflict, Religion, and Politics, 1980s to Present	Southeast Asia	Jessica McCarty, Miami University	Land use change, religion conflicts and policies
15	Land Use Status, Change and Impacts in Vietnam, Cambodia and Laos	Southeast Asia	Son Nghiem/Jet Propulsion Laboratory	Land use change
16	Assessing the Impacts of Dams on the Dynamic Interactions Among Distant Wetlands, Land Use, and Rural Communities in the Lower Mekong River Basin	Southeast Asia	Qi, Michigan State University	Water resources

S.No	2018	Region	PI	Theme
17	Land-Use Transitions in Indonesian Peatlands	Southeast Asia	Mark Cochrane/University of Maryland, Cambridge	Peatlands and land use
18	Divergent Local Responses to Globalization: Urbanization, Land Transition, and Environmental Changes in Southeast Asia	Southeast Asia	Peilei Fan,Michigan State University	Urbanization, land use and pollution
19	Sowtime: Climate Adaptive Agriculture in the Eastern Gangetic Plains	South Asia	Josh Gray,North Carolina State University	Agriculture and climate
20	Shifting Cultivation at a Crossroad: Drivers and Outcomes of Recent Land-Use Changes in Laos PDR	Southeast Asia	Peter Potapov,University of Maryland, College Park	Shifting cultivation, land use drivers
21	New Transitions in Smallholder Agricultural Systems that Promote Increased Tree Cover Outside of Forests	South Asia	David Skole,Michigan State University	Small holder agriculture and Trees outside forests
22	Forced and Truncated Agrarian Transitions in Asia Through the Lens of Field Size Change	Southeast Asia	Lin Yan,South Dakota State University	Agriculture and field size change

(6 projects on Southeast in 2016; 4 on Southeast and 2 on South Asia in 2018; 3 more in 2019)

S.No	2020	PI	Theme
23	Where are the Missing Burned Areas? Global Hotspots of Burned Area - A	David Roy, Michigan State U	Burned area mapping
	Multiresolution Analysis		
24	Global Hotspots of Change in Mangrove Forests	Marc Simard, JPL	Mangrove mapping
25	Multi-Resolution Quantification and Driver Assessment of Hot Spots of Global Forest Disturbance	Alexandra Tyukavina, UMD	Forest disturbance mapping

Synthesis Project – South Asian Countries-2022-2026

- **South Asian smallholder forests and other tree-based systems: synthesizing LCLUC data and approaches to foster a natural climate solution that improves livelihoods – David Skole (MSU)**

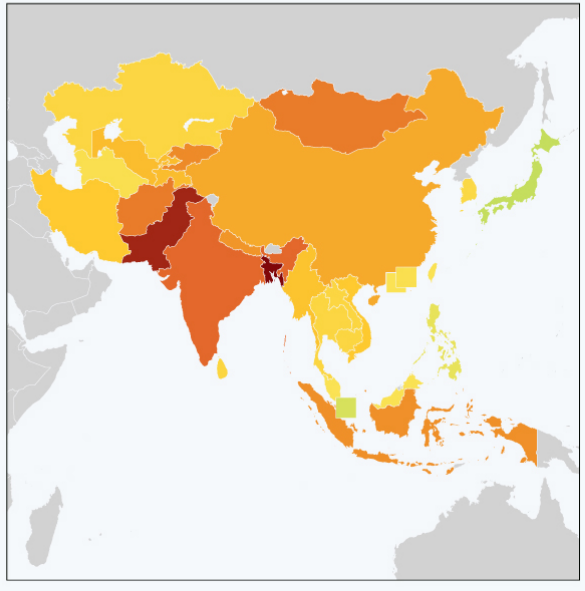
- **Southeast Asia Synthesis – being selected.**

- Some on-going LCLUC and Pollution issues in South/Southeast Asia

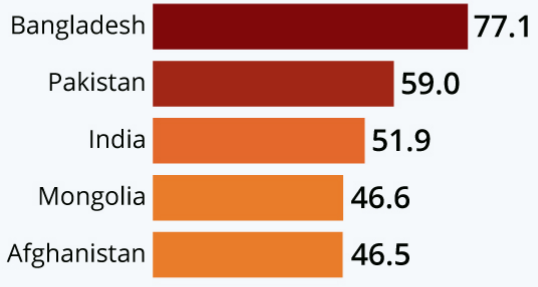
How Air Quality Compares in Asia

Levels of average PM2.5 air pollution in Asian countries/regional economies in 2020 (in µg/m³)

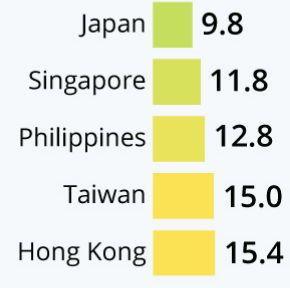
Good (0.0-12.0) | **Moderate** (12.1-35.4) | **Unhealthy** (sens. groups) (35.5-55.4) | **Unhealthy** (55.5+)



Worst air



Best air



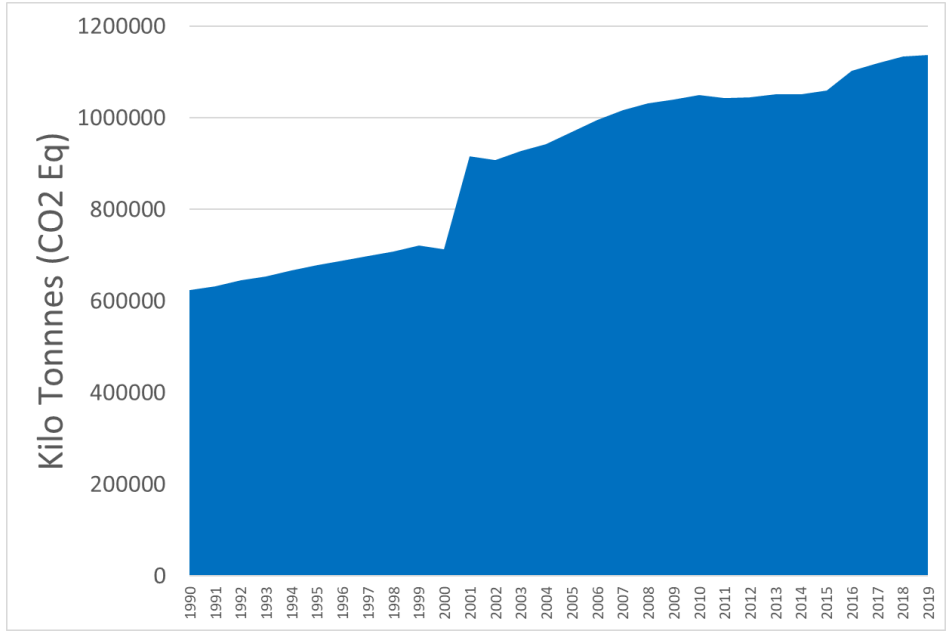
Out of 28 Asian countries were sufficient data exists

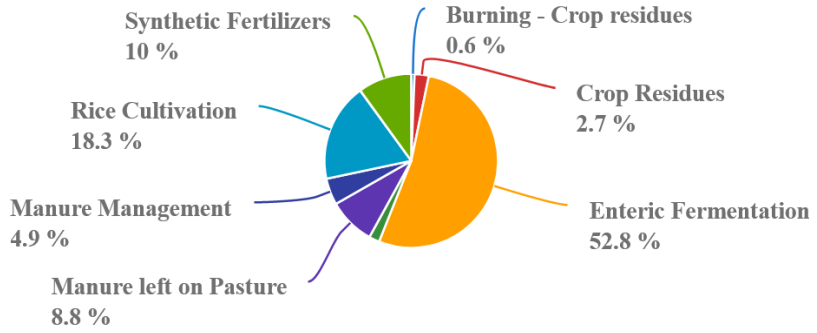
Source: IQAir World Air Quality Index

statista

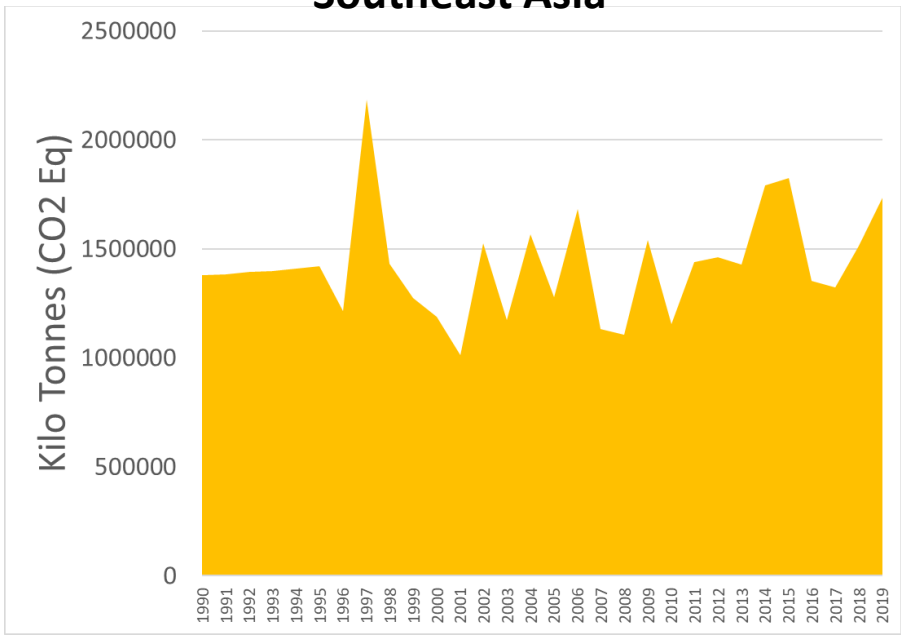
AFOLU (Total CO2 Eq.), Average (1990-2019) (FAOSTAT, 2020)

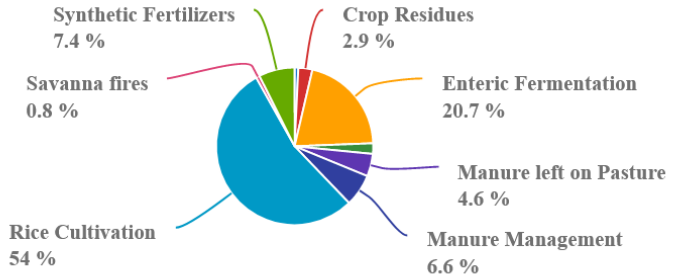
South Asia





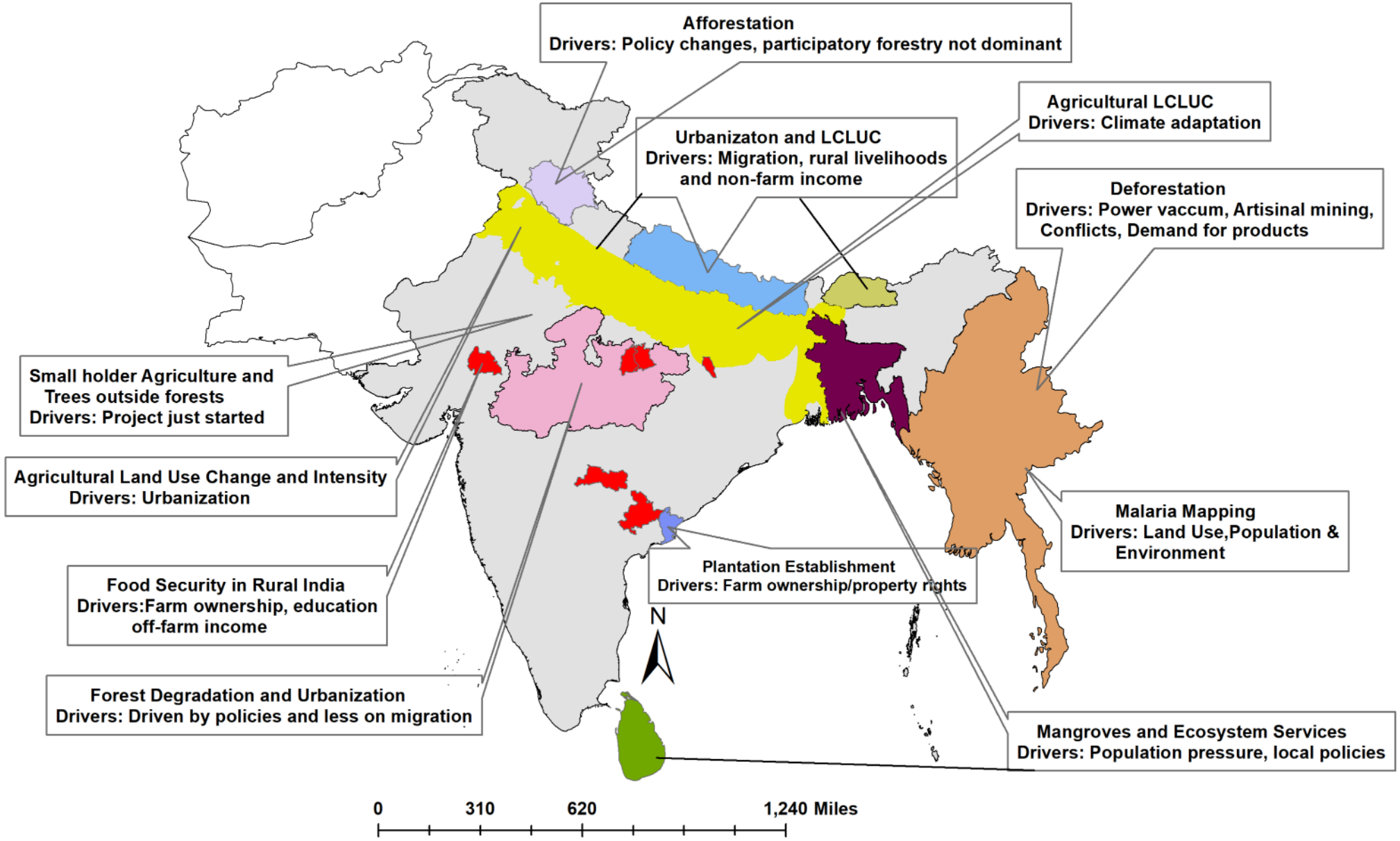
Southeast Asia



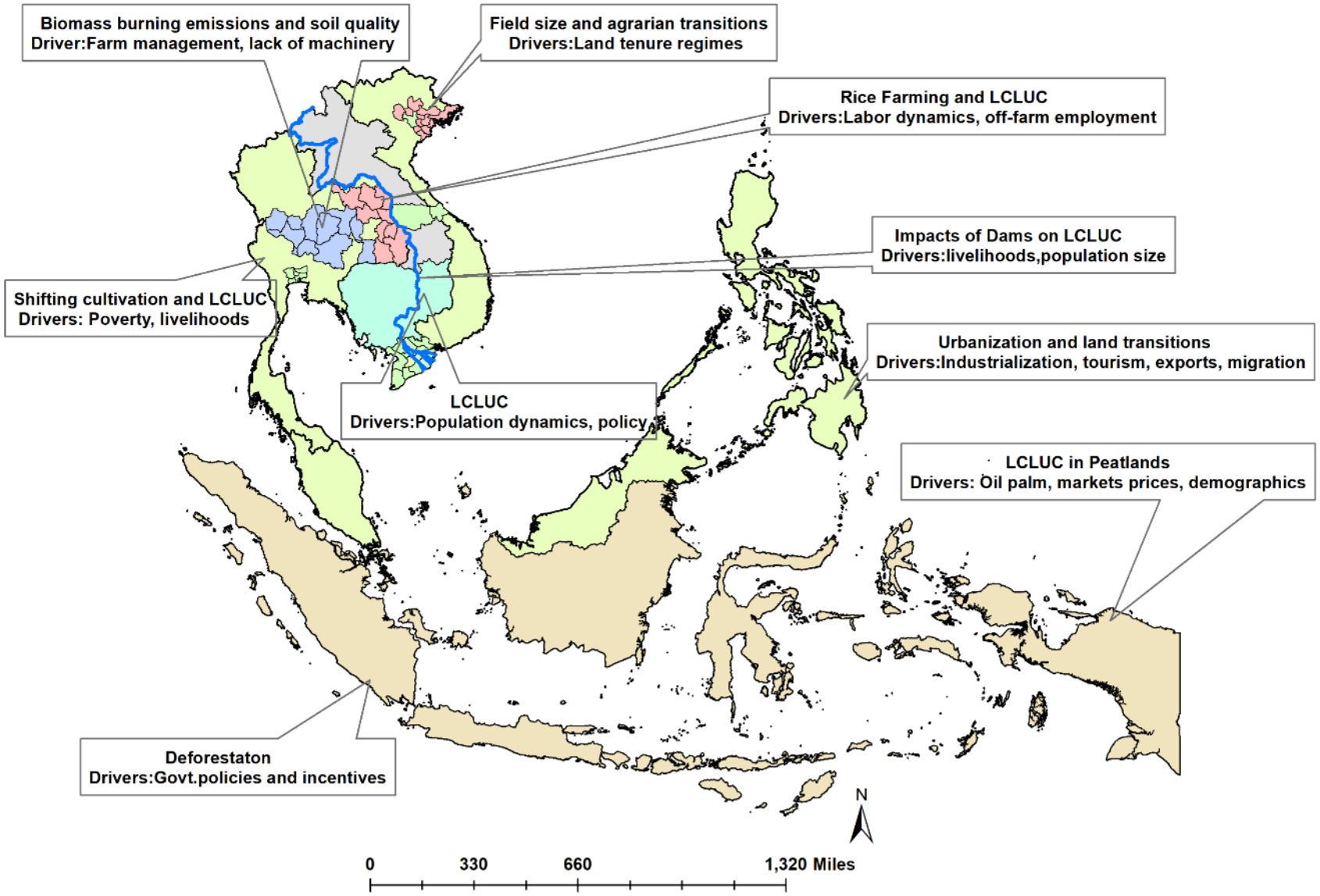


Agriculture, Forests and Other Land Use still is a significant source of net CO2 Emissions in Asia

South Asia – LCLUC Drivers Identified by SARI PI's

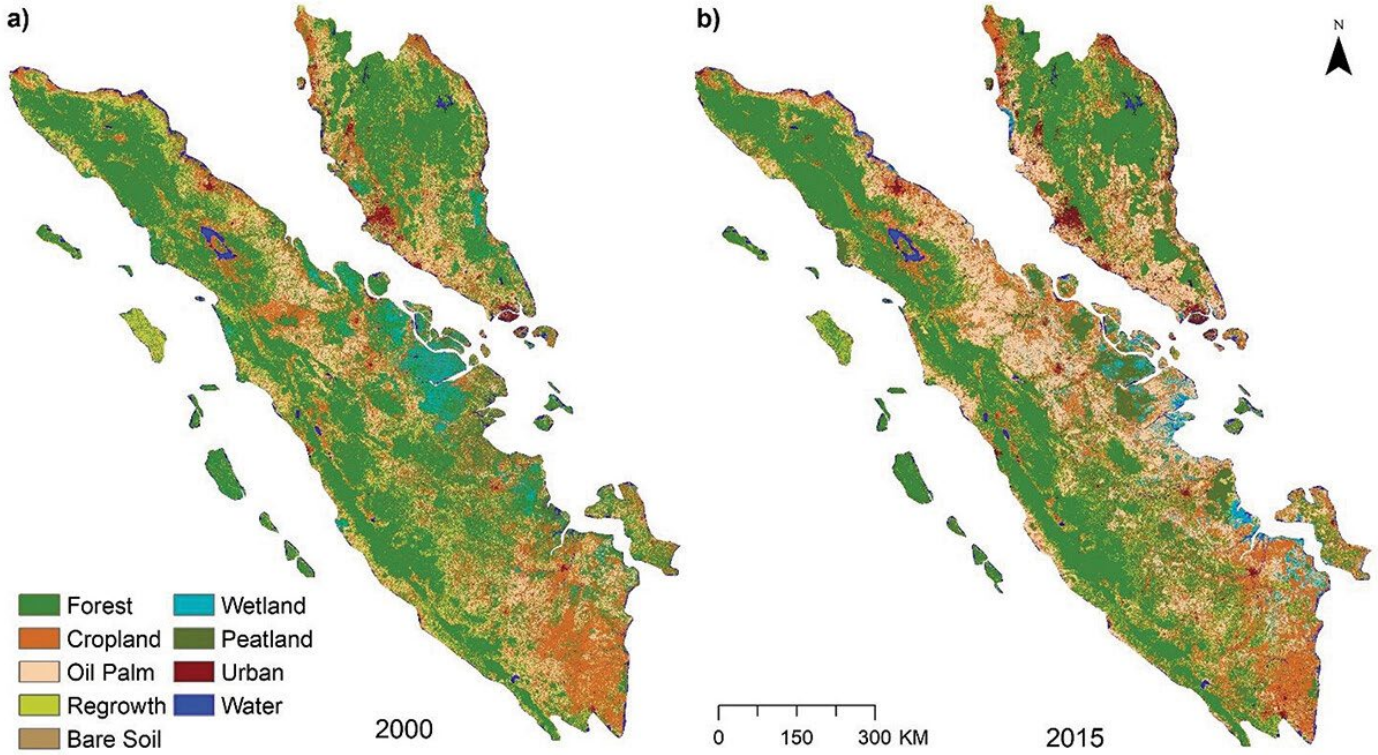


Southeast Asia – LCLUC Drivers Identified by SARI PI's



Oil Palm Plantations are the biggest driver of LCLUC in SEA

Indonesia, Malaysia, and Thailand are home to 80% of the world's oil palm plantations, which is driven by global demand for oil palm-derived products, such as renewable energy, food-based, and health/beauty product



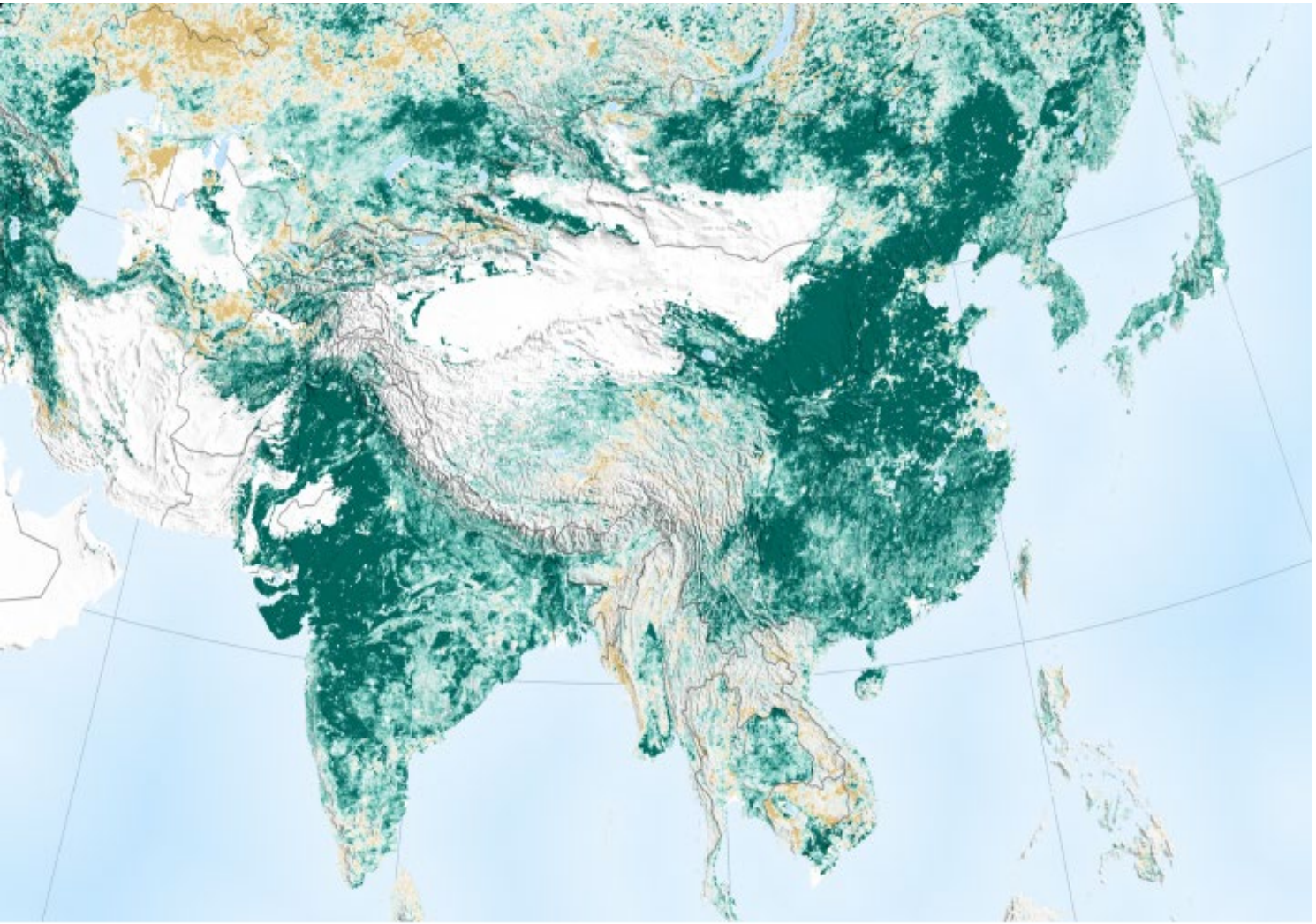
- Forest cover became less fragmented in part due to the rise of large-scale monoculture plantations
- The mean size of oil palm patches almost doubled from 2000-2015
- Patches of forests were replaced by oil palm mostly in the eastern part of Sumatra

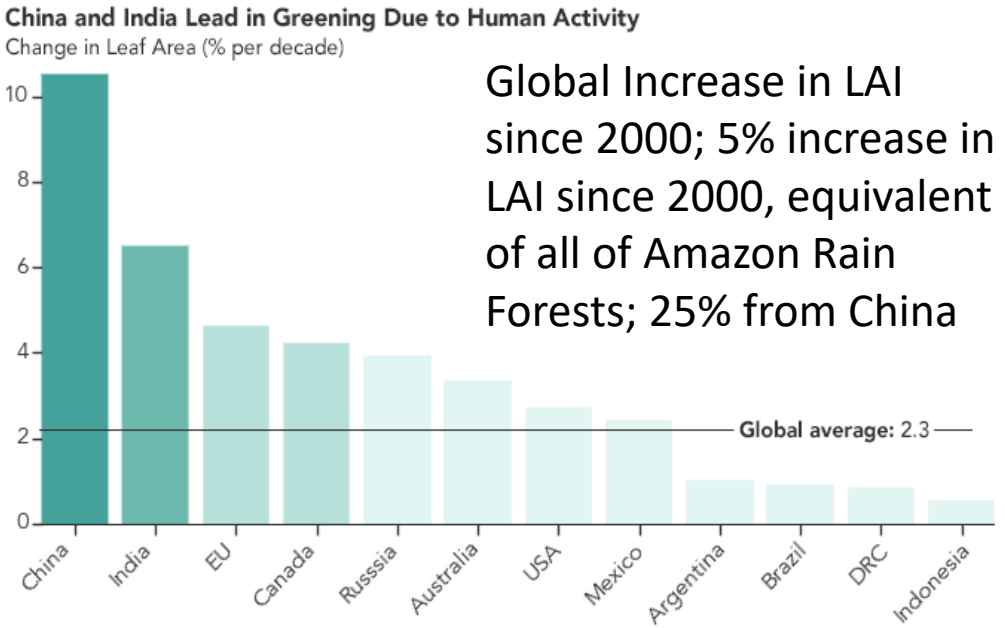
Land cover classification for Sumatra and Western Malaysia for the years of **a)** 2000 and **b)** 2015.

More than half of net deforestation resulted from agricultural expansion (i.e. oil palm and cropland) with total gross forest losses in 2000 attributed to the conversion to cropland, oil palm, and regrowth – less due to Urbanization.

Source: Wagner et al., 2022. IJRS,https://doi.org/10.1080/1747423X.2021.2020918

China and India Lead in Greening

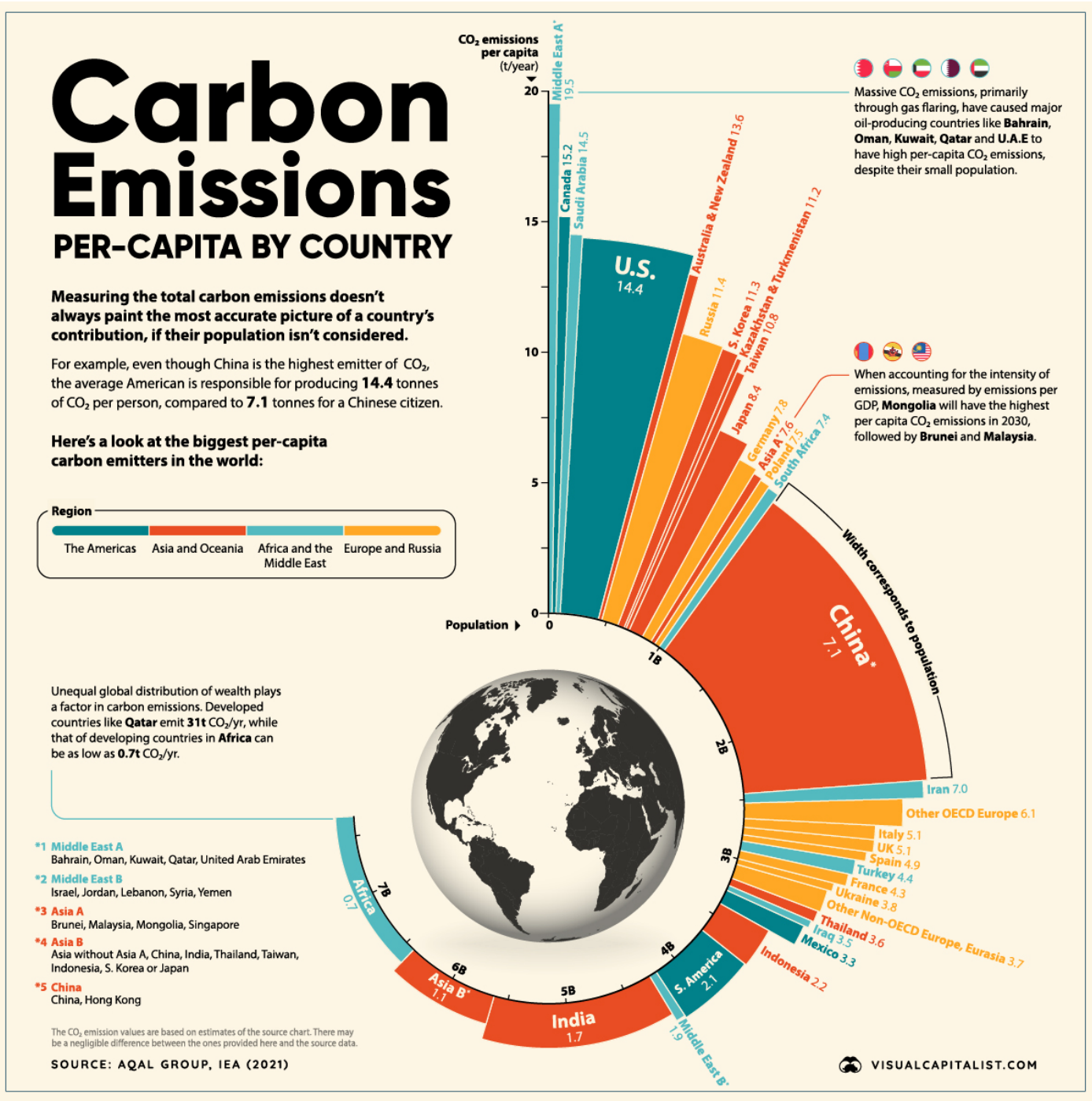




Global Increase in LAI since 2000; 5% increase in LAI since 2000, equivalent of all of Amazon Rain Forests; 25% from China

Global green leaf area has increased by 5 percent since the early 2000s, an area equivalent to all of the Amazon rainforests. At least 25 percent of that gain came in China.

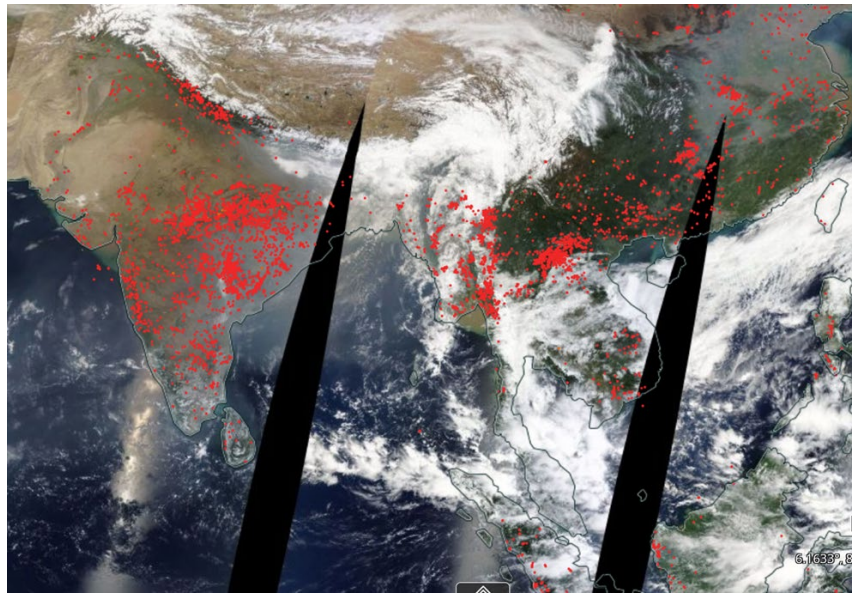
China and India—the world's most populous countries—are leading the increase in greening on land. The effect comes mostly from ambitious tree-planting programs in China and *intensive agriculture in both countries.* (Myneni et al., Nature, 2019)

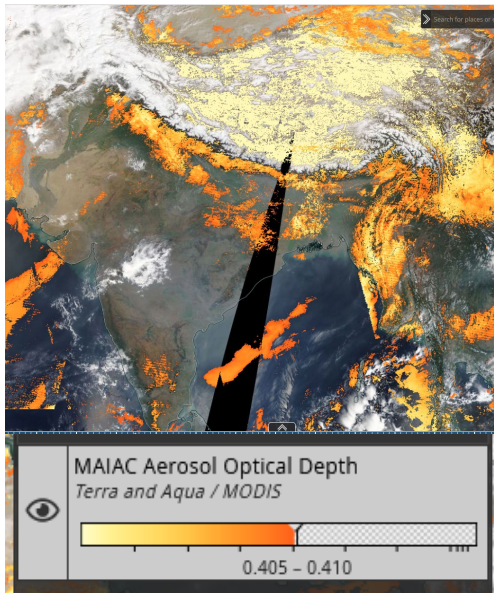


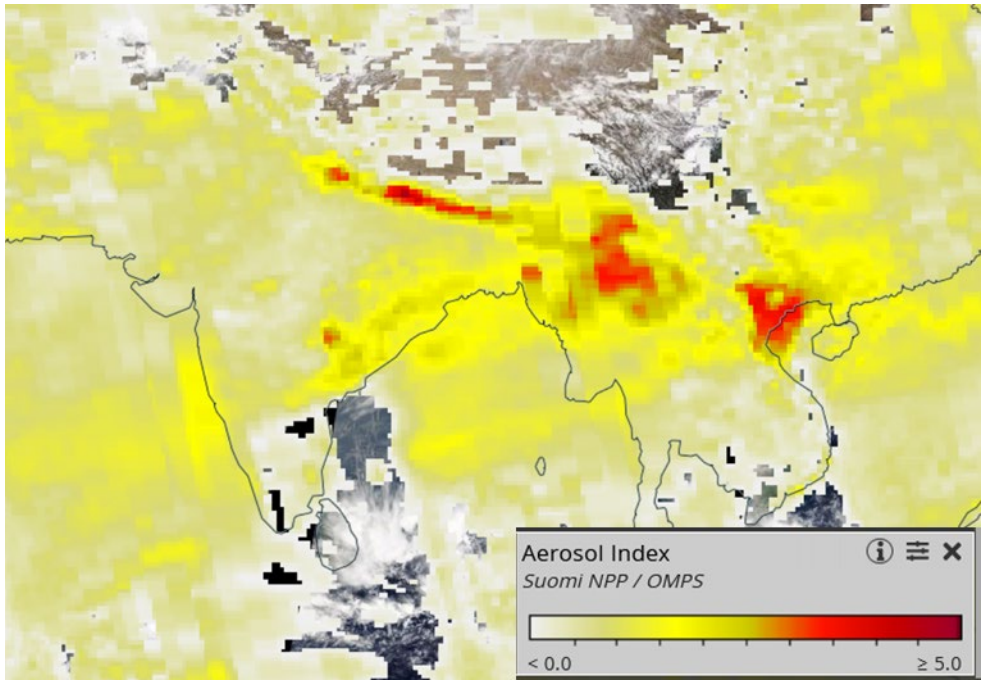
Without entering the political debate on which country is contributing more to global emissions(?) – tackling pollution is important and essential to protecting Life on Land.

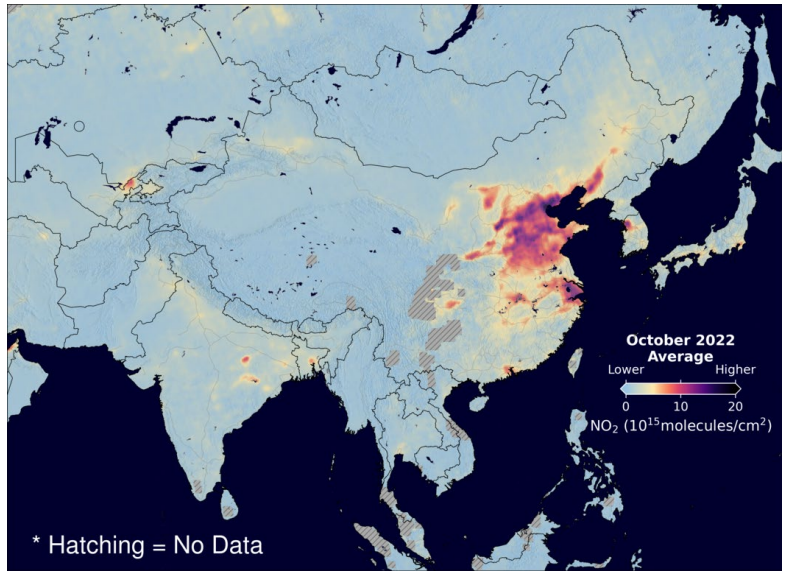
Good Pollution mitigation-related governance reduces environmental burdens, saves environment including ill-health impacts.

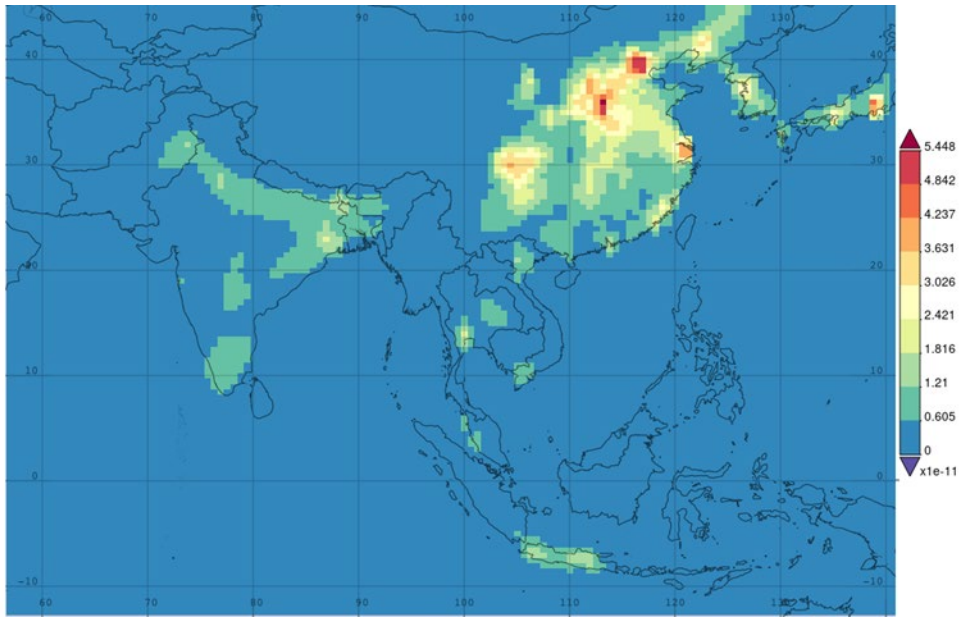
Satellite Data and Products for Air Pollution Studies











Need Robust Calibration and Validation

- SARI Outputs

SARI Meetings

June 24th-26th, 2014

NIES JAPAN

GOFC-GOLD

UNIVERSITY OF MARYLAND

START

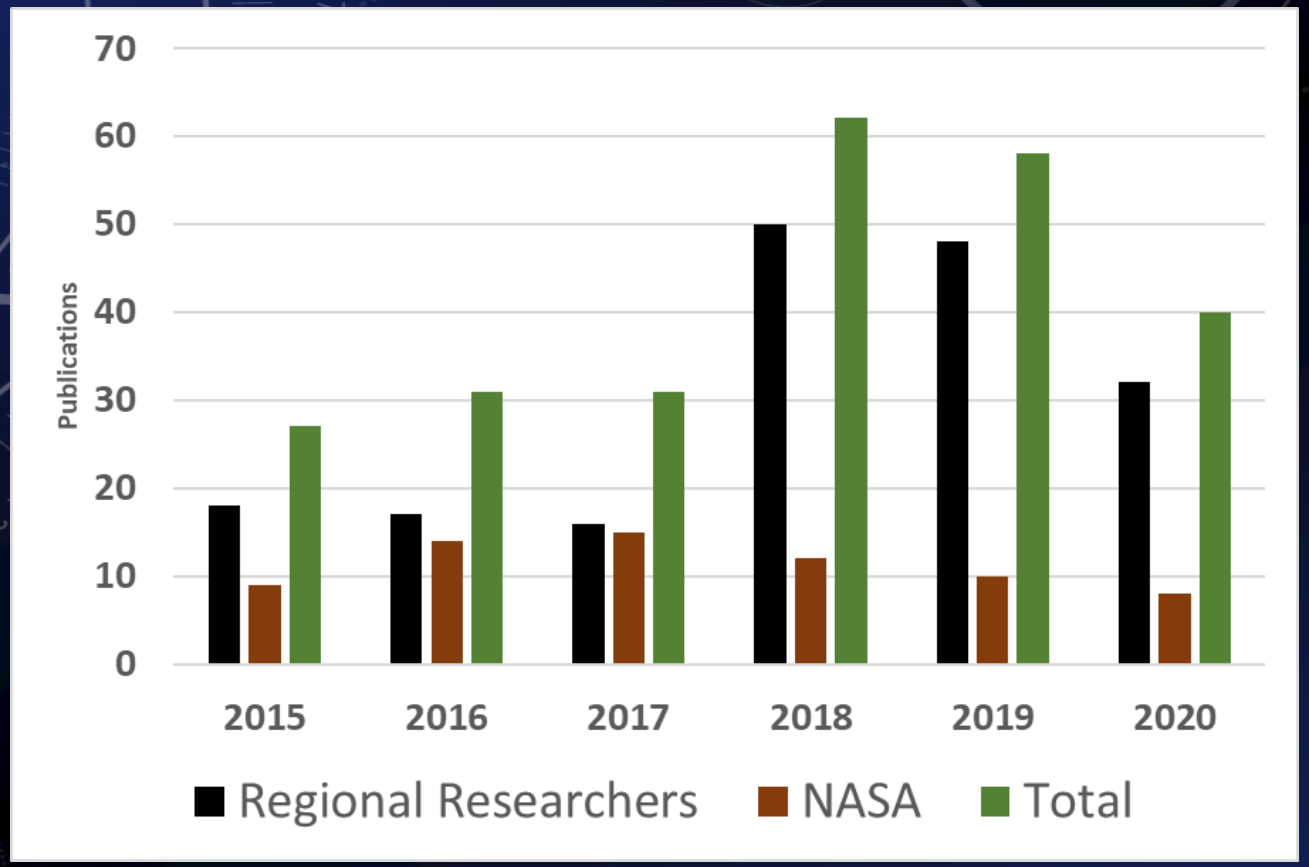
Local Host

VNU UNIVERSITY OF ENGINEERING AND TECHNOLOGY

Collaborations are the Key – SARI Meetings Facilitated by Regional and International partners

SARI 5 YEARS OF SCIENCE

-23 projects and more being added
>250 scientists
>150 institutions
12-different Special Issues in Journals

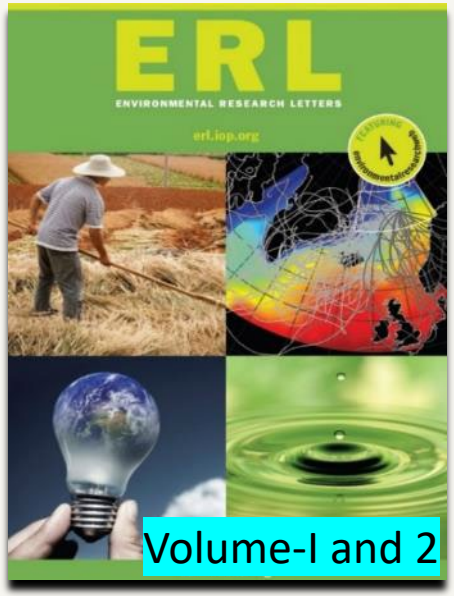


Nearly 350 publications in Peer reviewed journals and Books

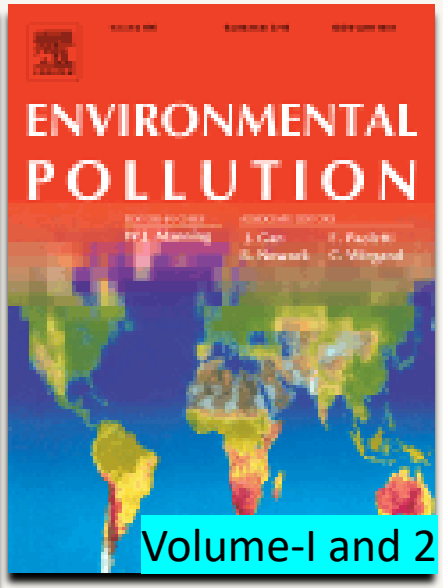
South-Southeast Asia

Oct-2013 – India Meeting – SARI idea proposed
2015-SARI First SARI Solicitation

SARI Special Issues Published in Multiple Journals



Volume-I and 2



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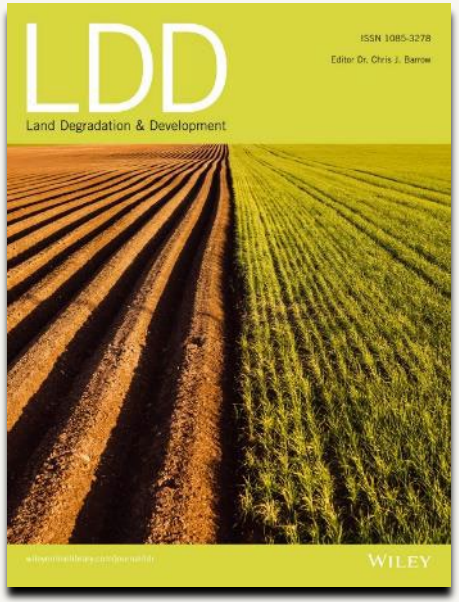
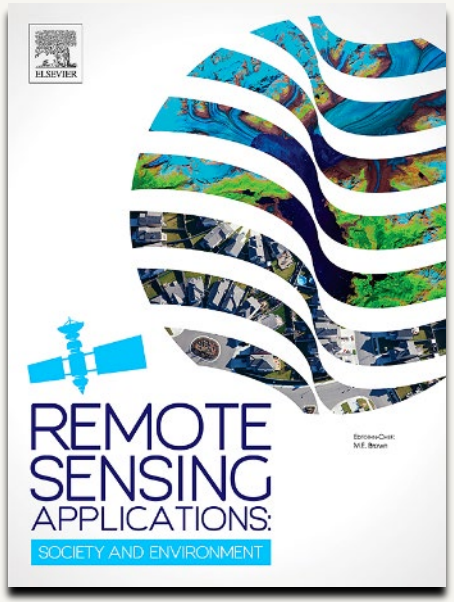
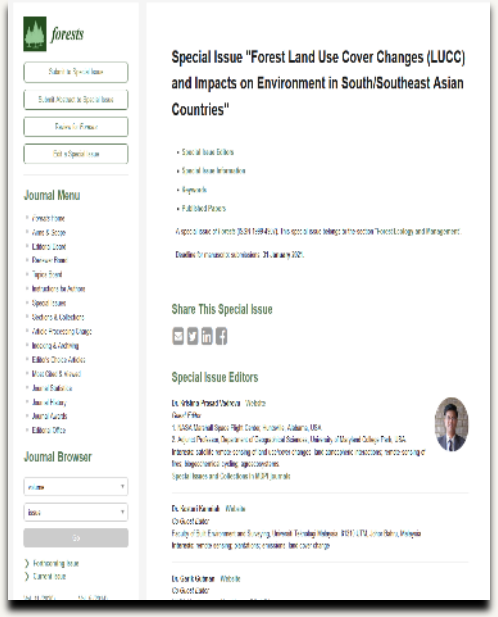
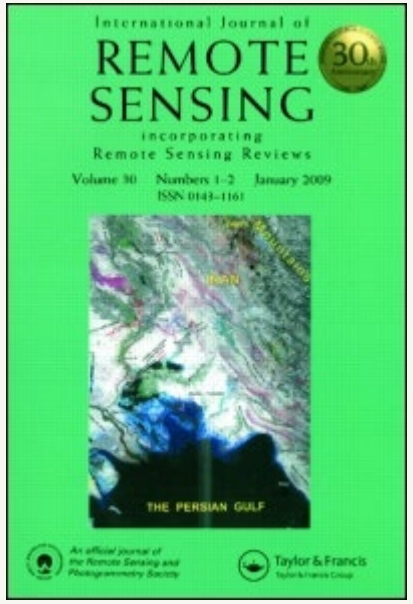








remote sensing

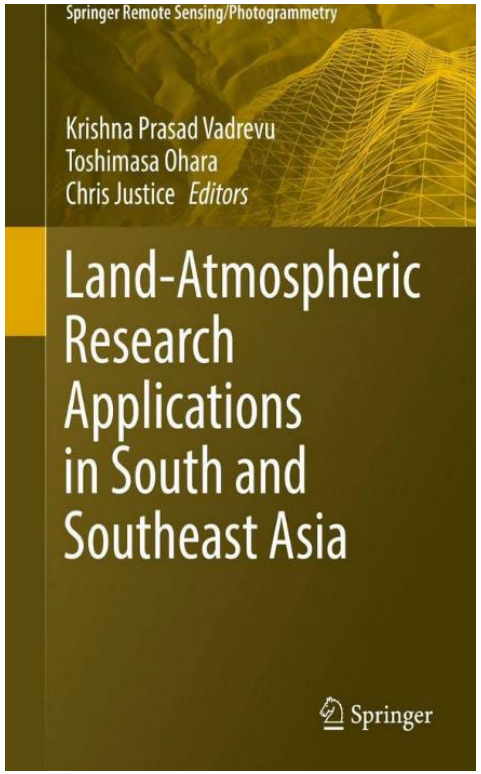
Volume-I

remote sensing

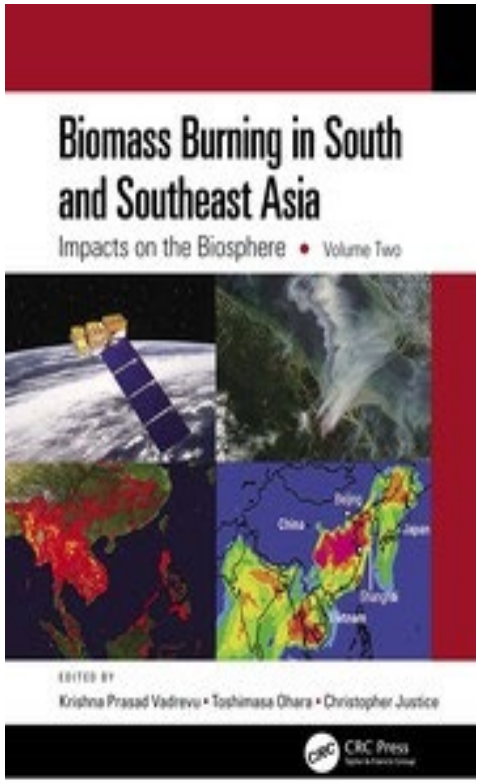
Volume-II

~200 peer reviewed publications in 5-years

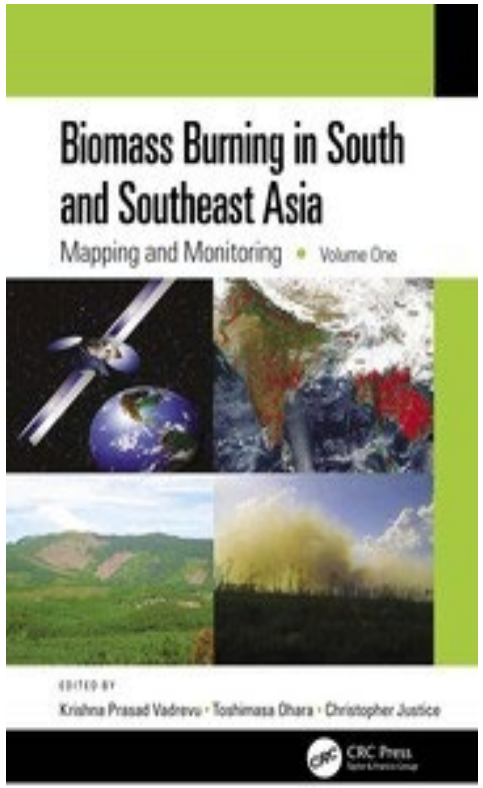
LCLUC/SARI Books



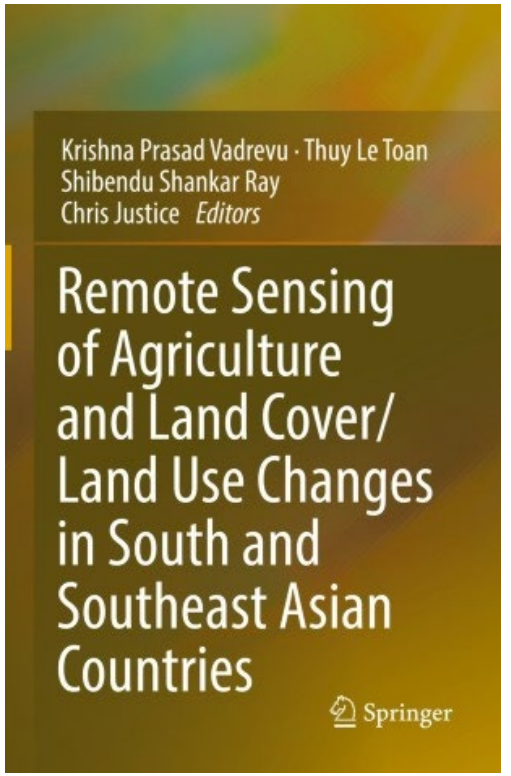
Springer 2018



CRC Press, 2021



CRC Press, 2021



Springer, 2022

Air Pollution in Asia

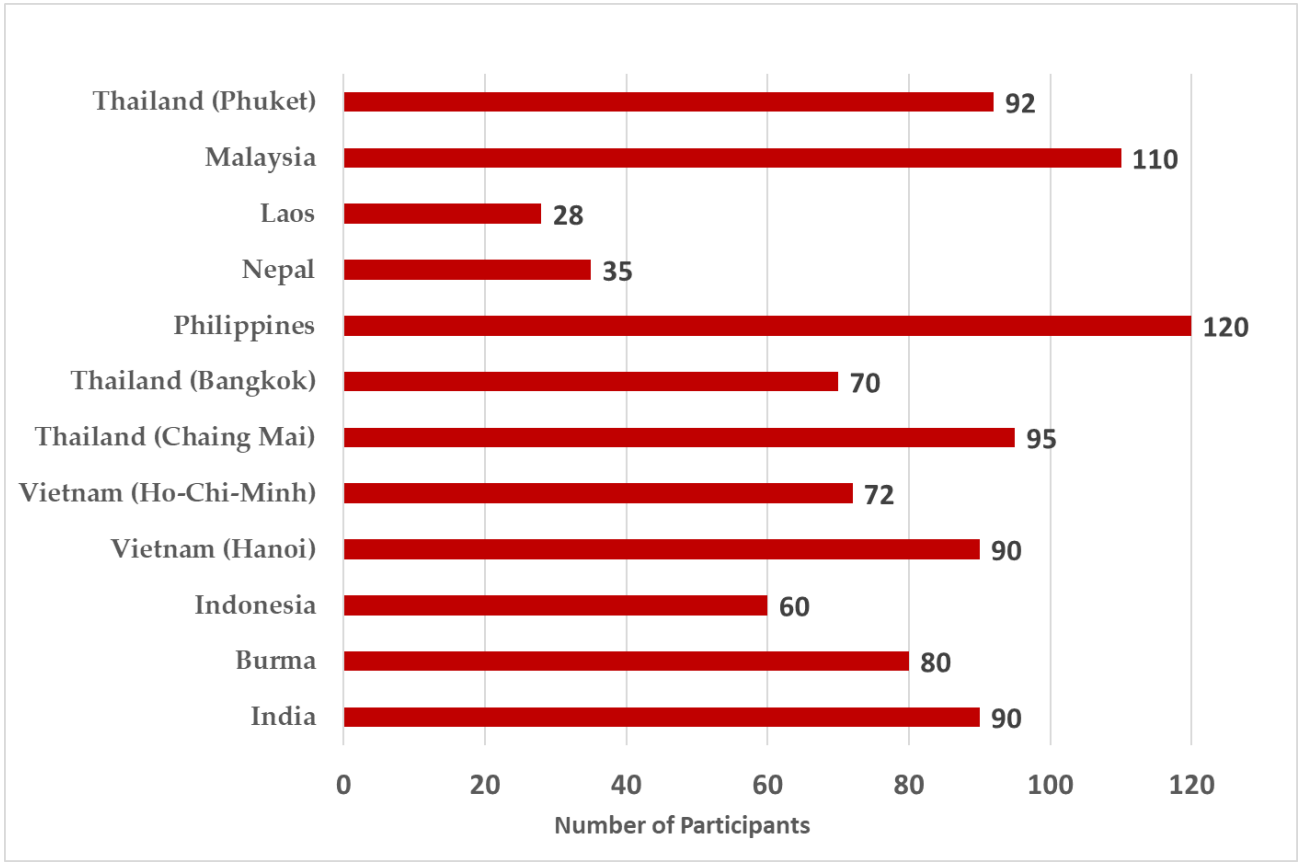
Krishna Vadrevu
Toshimasa Ohara
Chris Justice

Forthcoming

Springer

Springer, 2022

SARI – LCLUC Training Events



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

PSU PRINCE OF SONGKLA UNIVERSITY PHUKET CAMPUS

Certificate of Participation

Awarded to

xxxxxxxxxxxxxxxxxxxxxxxxxxxx

For participating in the international regional science training entitled

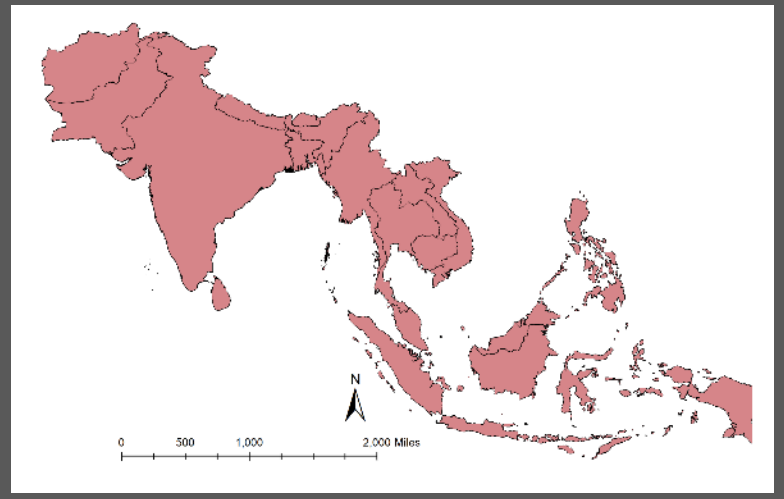
"Remote Sensing of Land-use/Cover Change and Climate Impacts In Coastal Zone", 17-19th December, 2020, Phuket, Thailand

Garik Gutman	Werapong Koedsin	Krishna Vadrevu
NASA LCLUC Program Manager, USA	Dean, Faculty of Technology and Environment, Prince of Songkla University, Thailand	NASA MSFC, SARI Program Scientist, USA

START GOFC-GOLD LCLUC SARI GISTDA

Dr. Gutman (NASA HQ)
and
Prof. Justice (UMd)

Vision, support and guidance to build the SARI regional science initiative



Questions?