

LCLUC PROGRAM: UPDATE

Garik Gutman,
NASA Headquarters
Manager, LCLUC Program

April 2019

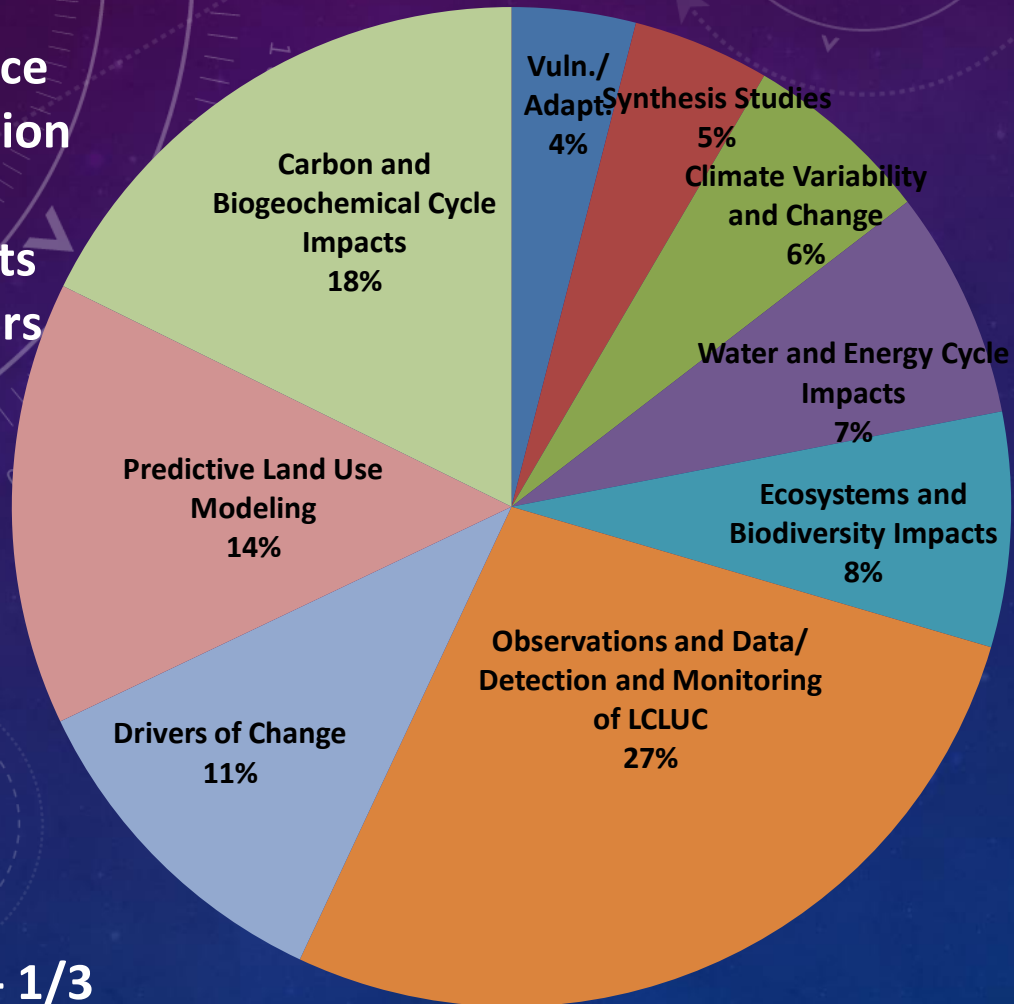


LCLUC Program Content

>300 projects since
Program's inception
Each year:

* ~40 3-yr projects

* ~300 researchers



Impacts - 1/3
Monitoring - 1/3
Synthesis, other - 1/3

LCLUC GLOBAL SCIENCE PROGRAM

- Socio-economic component as an integral part of projects
- Remote sensing component
 - MuSLI (Multi-Source Land Imaging) component
 - Social science is not required
 - Multiple-sensor 10-30m resolution data are to be used
- Pilot Project: Assessment of commercial high-res data
 - Augmentation for selected LCLUC projects
- Regional Initiatives, geographic focus
- Capacity Building/Education component

LCLUC Science Team Meetings

Washington: Spring Blossom

- 2007: Climate/Carbon
- 2008: Joint CC&E Focus Area meeting
- 2009: LCLUC impacts on climate
- 2010: GLS LCLUC products
- 2011: 15th Anniversary (review/update)
- 2011/9: Agriculture (Joint CC&E FA)
- 2012: Urban
- 2013: Wetlands
- 2014: Urban
- 2015: Early Career Scientists (Joint CC&E FA)
- 2016: 20th Anniversary/Industrial Forests
- 2017: Mountains & MuSLI
- 2018: SARI-1: South Asia & MuSLI
- 2019: SARI-2: SE Asia & Caucasus
- 2020: MuSLI (two rounds)+High Res.

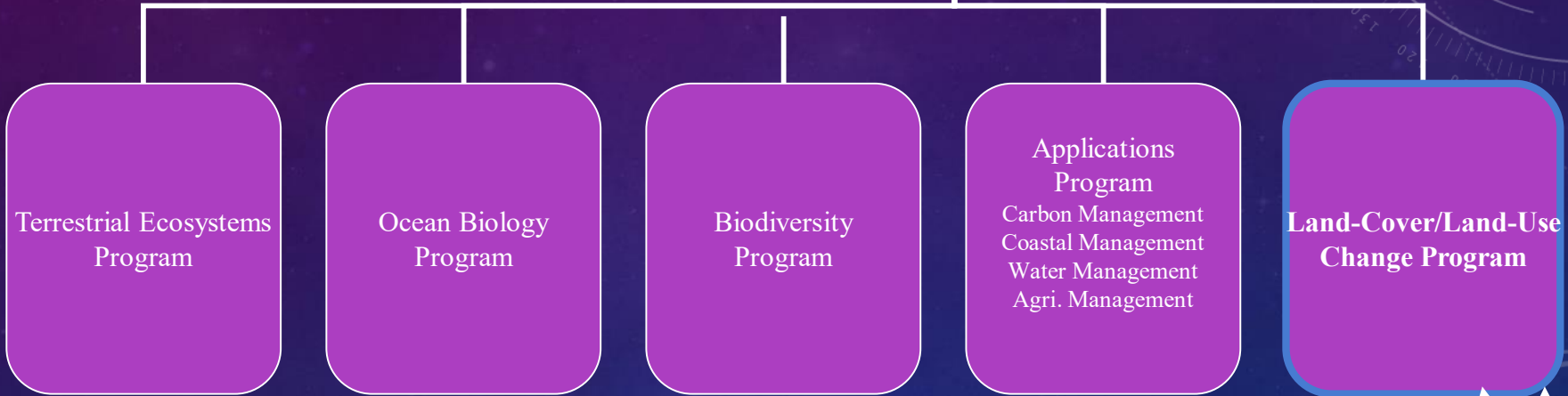
International Regional

- 2007/9: NEESPI/MAIRS Urumqi, China
- 2009/1: MAIRS Kohn Kaen, Thailand
- 2009/9: MAIRS/NEESPI Almaty, Kazakhstan
- 2010/8: NEESPI Tartu, Estonia
- 2011/11: MAIRS Hanoi, Vietnam
- 2013/1: MAIRS Coimbatore, India
- 2013/11: NEESPI/MAIRS Tashkent, Uzbekistan
- 2014/10: NEESPI: Sopron, Hungary
- 2016/1: SARI/MAIRS: Yangon, Burma/Myanmar
- 2017/7: SARI/MAIRS: Chiang Mai, Thailand
- 2018/5: SARI: Manila, Philippines
- 2019/7: SARI: Johor Bahru, Malaysia
- 2020: TBD



INTERNAL LINKAGES @ NASA

**Carbon Cycle
and Ecosystems
Focus Research
Area**



**Water and Energy Cycle
Focus Research Area
*Terrestrial Hydrology***

**Atmospheric
Composition
Focus Area
*Radiation
Science***



EXTERNAL LINKAGES: NATIONAL

- **USGS**
 - Selected Landsat & MuSLI Science Teams
- **USAID through Applications Divisions**
 - SERVIR (acronym standing for Mesoamerican Regional Visualization and Monitoring System in Spanish)
 - PEER (Partnerships for Enhanced Engagement in Research)
- **USFS**
 - Global Forest Observations Initiative (GFOI)
- **Private sector: Planet Lab, Digital Globe**
 - Data Buy

EXTERNAL LINKAGES: INTERNATIONAL

- **GOFC-GOLD**
 - Fire IT office at UMD
 - START Inc. activities
 - Regional Information Networks
- **CEOS/GEO**
 - GFOI
 - GEOGLAM
- **Future Earth**
 - Global Land Program (GLP)
 - NEFI
 - Future Asia
- **SERVIR**
 - SARI (Himalaya and Mekong hubs)
 - The new hub in Latin America
- **EARSeL-LULC Special Interest Group**
 - Joint biennial workshop in Europe
- **ESA and EU institutions**
 - Landsat-Sentinel products under MuSLI
- **NIES (Japan)**
 - Joint annual workshop in Asia
- **GISTDA (Thai Space Agency)**
 - Joint annual capacity building trainings

THE ROLE OF SOCIAL SCIENCE IN LCLUC PROGRAM

- **Social and economic science research includes**
 - **impacts of socio-economic changes on LCLUC**
 - **impacts of LCLUC on society**
 - **adaptation to climate/environmental change of land-use systems**
- **During the last 12 years, the Social/Economics Science component has been a mandatory part of all LCLUC proposals, unless otherwise stated in the solicitation**

INTERNATIONAL REGIONAL INITIATIVES

- **Northern Eurasia's Future Initiative (NEFI, formerly NEESPI)**
 - **LCLUC-2016: Caucasus element**
- **MAIRS under Future Asia**
 - **Coordinated with SARI**
- **South/Southeast Asia Research Initiative (SARI)**
 - **Pre-SARI Projects**
 - **LCLUC-2015: South Asia**
 - **LCLUC-2016: Southeast Asia**
 - **LCLUC-2018: Asia**



Project Scientist
NEFI
Pasha Groisman,
NOAA/UCAR

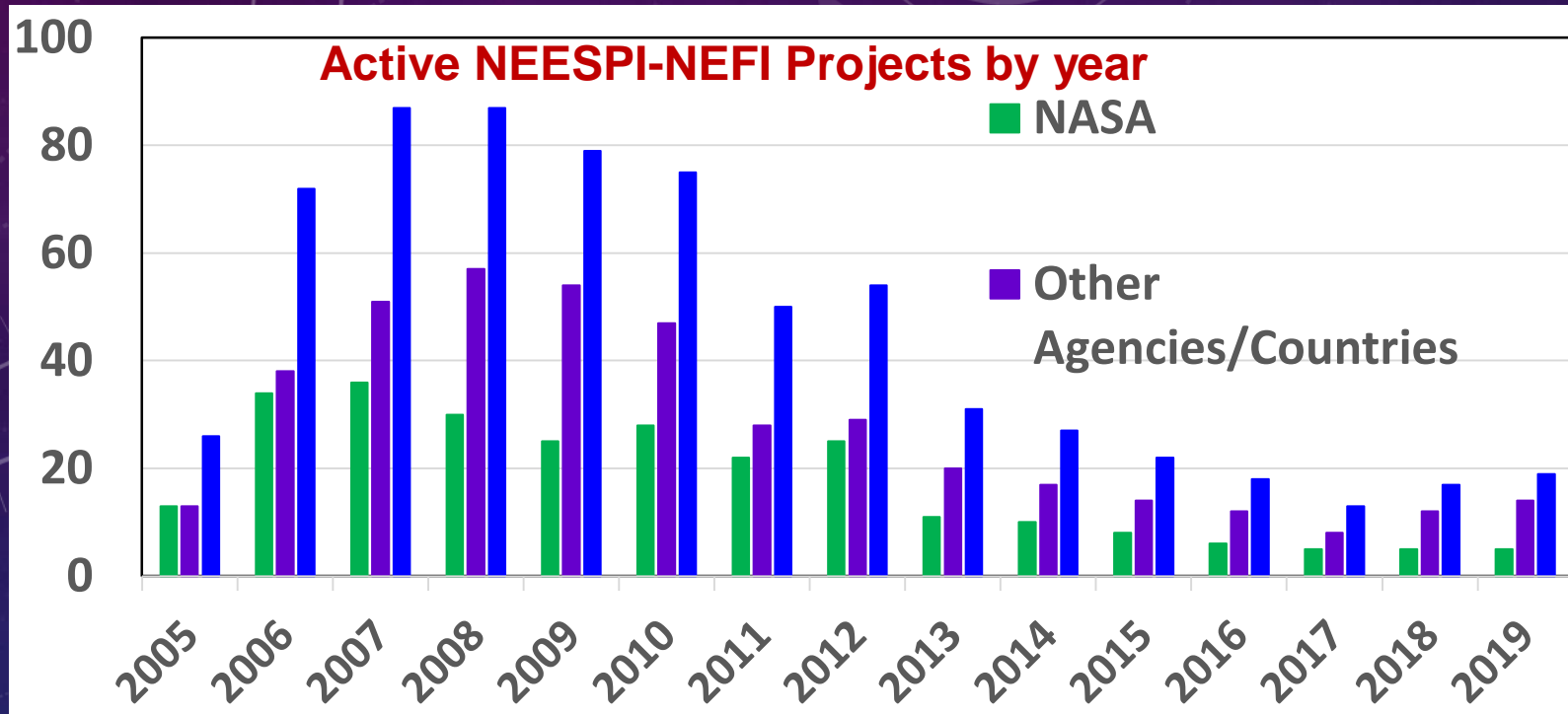


Project Scientist
MAIRS
Jiaguo Qi, MSU



Project Scientist
SARI
Krishna Vadrevu,
NASA MSFC

NEESPI-NEFI ACCOMPLISHMENTS



over 1500
papers and
40 books

>750 scientists
>200 institutions
>170 projects
30 countries

>80 Ph.D. students

NEESPI → NEFI

LCLUC-2016
selected 3 projects
(on Caucasus)

Synthesis by Peilei Fan for Siberia (urbanization)

NEESPI-LCLUC BOOKS



Springer 2010



Springer 2012



Springer 2017

Placeholder
for the Central
Asia book

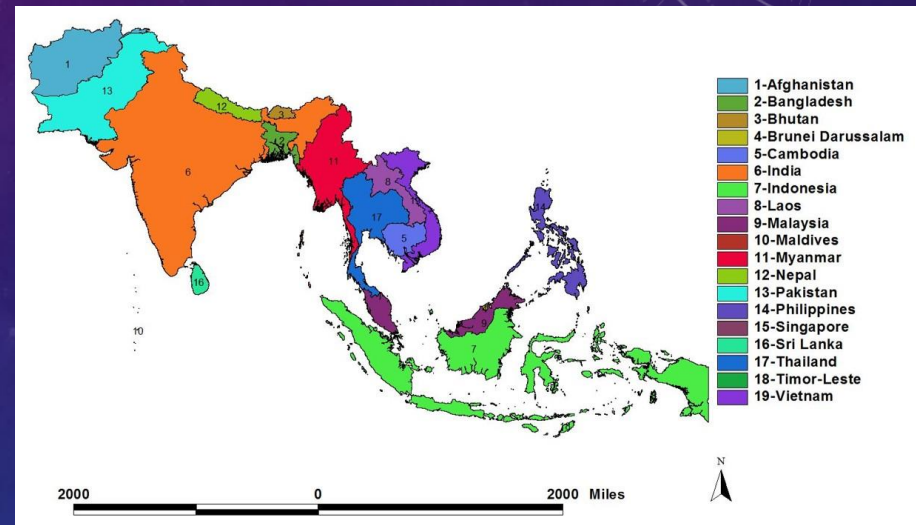
LCLUC in Central Asia to be published in
2018- 2019



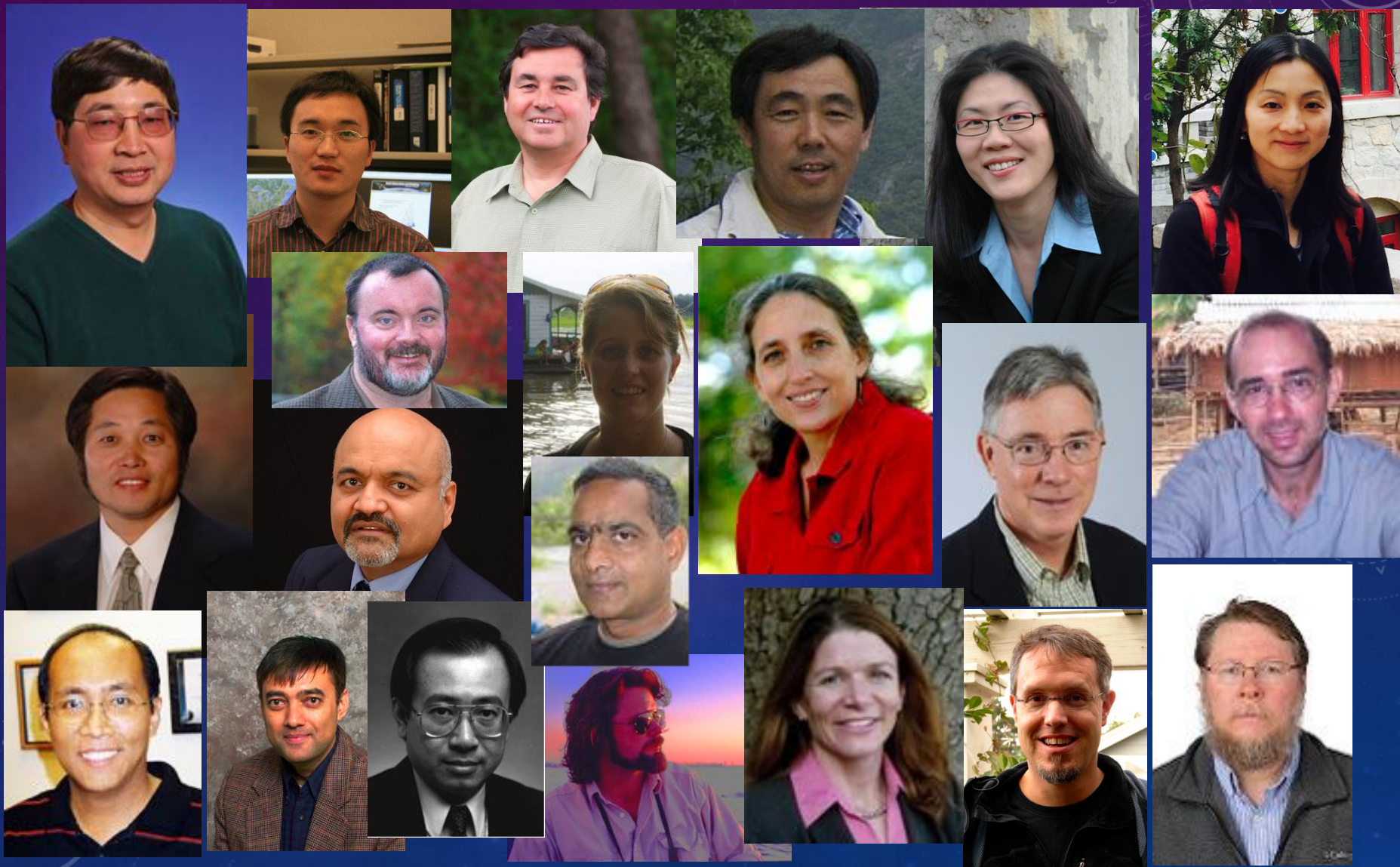
THE SOUTH/SE ASIA RESEARCH INITIATIVE (SARI)

Goal: 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/SE Asia

- 20+ ongoing projects on SARI region
- Interactions with two SERVIR hubs:
 - Mekong and Himalaya
- Series of regional SARI workshops and trainings
- Easy to communicate with researchers and stakeholders (no language barrier)
- Dedicated student support from Universities
- High tech and computer literacy
- It is expected that the program will
 - advance LCLUC science in the region
 - strengthen existing and build new collaborations between US and South/Southeast Asia researchers
 - help develop regional scale LCLUC models useful for decision support



NASA-MAIRS PRE-SARI STUDIES



PRE-SARI SYNTHESIS PROJECTS

LCLUC-2012

LCLUC-2013

- Atul Jain/U. of Illinois

- Land Cover and Land Use Changes and Their Effects on Carbon Dynamics in South and South East Asia: A Synthesis Study



- Jeff Fox, East-West Center, Hawaii

- Forest, Agricultural, and Urban Transitions in Mainland Southeast Asia: Synthesizing Knowledge and Developing Theory

- Peilei Fan, Michigan State U.

- Urbanization and Sustainability Under Global Change and Transitional Economies: Synthesis from Southeast, East and North Asia



- Seto, Karen , Yale U.

- Synthesis of LCLUC studies on Urbanization: State of the Art, Gaps in Knowledge, and New Directions for Remote Sensing Science

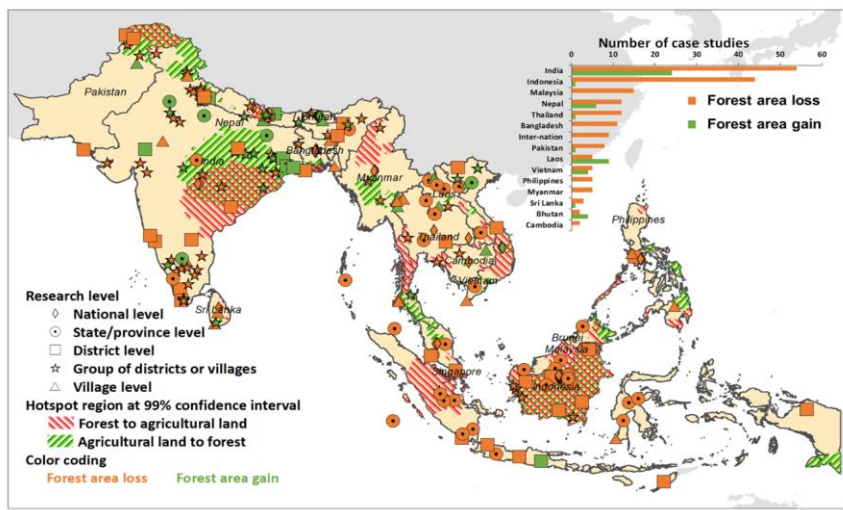


LAND COVER AND LAND USE CHANGES AND THEIR EFFECTS ON CARBON DYNAMICS IN SOUTH AND SOUTHEAST ASIA

PI: ATUL JAIN (U. ILLINOIS)

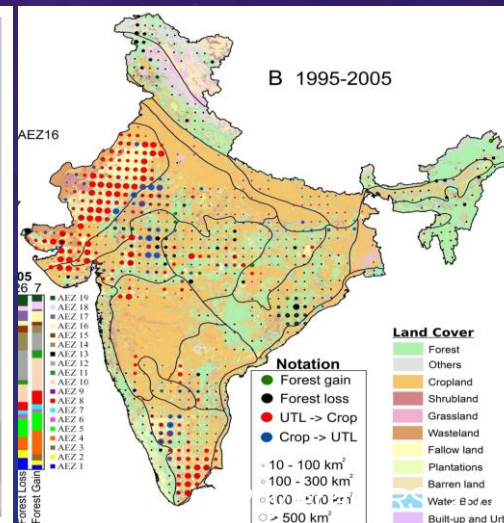


- Data: ESA CCI land cover data to reveal the dynamics of forest and agricultural land from 1992 to 2015
- Hot Spot Analysis technique; principle component analysis; Geographically Weighted Regression model
- The hotspot regions conversions between forest and agricultural land are in Kalimantan, Sumatra, East India, and the Hindu Kush, Himalayan region
- Relative importance of biophysical and socioeconomic drivers varied in different countries
- Roughly equal contributions from biophysical and socioeconomic drivers were observed in Bhutan, Philippines, Sri Lanka, Thailand and Vietnam



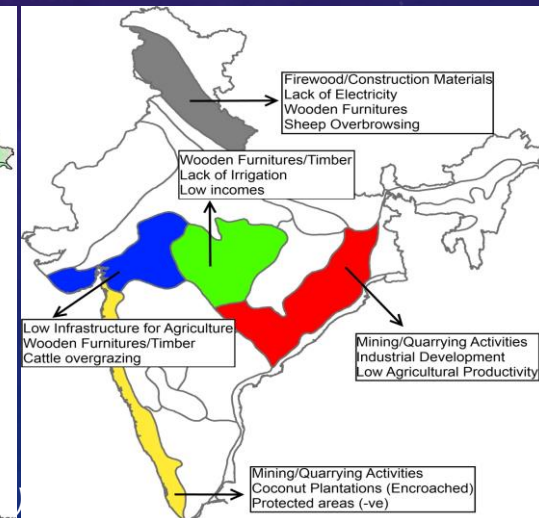
Xu et al. (GCB, 2018)

Spatial distribution of LULCC driver case studies and hotspot regions for LULCCs



Roy et al. (RS, 2017)

LCLUCs specific for India



Meiyappan et al. (REC, 2017)

Drivers of LCLUCs specific for India

FOREST, AGRICULTURAL, AND URBAN TRANSITIONS IN MAINLAND SOUTHEAST ASIA: SYNTHESIZING KNOWLEDGE AND DEVELOPING THEORY

PI: JEFFERSON FOX (EAST WEST CENTER, HAWAII)

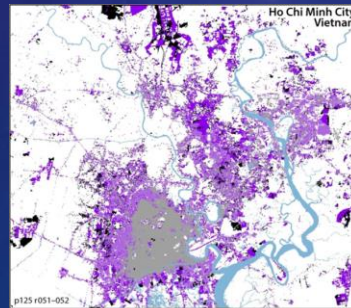


Objectives:

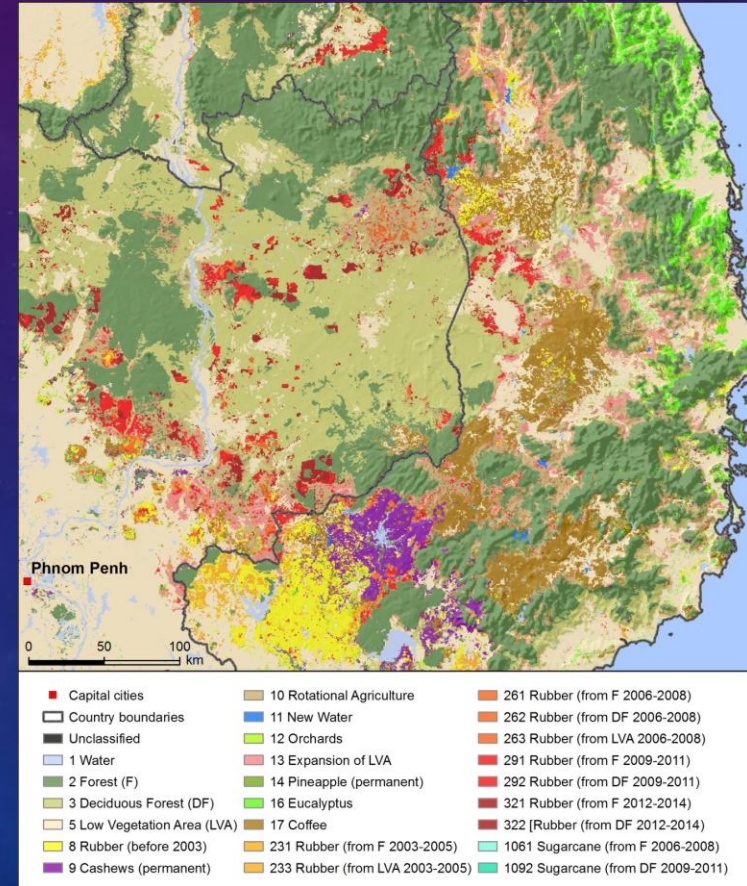
- Synthesize existing approaches for mapping the expansion of upland-boom crops and the growth of urban areas throughout Mainland SE Asia.
- Enhance the conceptual underpinnings of land-change science by linking land changes to local, national, and international drivers.

Methods:

- Map the expansion of urban areas and upland-tree plantations using time-series Landsat data and Google Earth images. Use MODIS EVI time-series data and training areas derived from Landsat classifications to map change at regional scales.
- Conduct focus group discussions and household interviews for a sample of forests, tree plantations, and periurban areas in Cambodia, Laos, and Vietnam to produce an integrated understanding of LCLUC



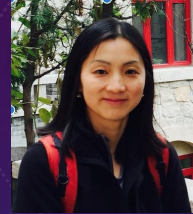
land-cover change classification



- Cambodia and Laos: mainly new rubber
- Vietnam: old and new rubber as well as cashew, coffee, and new eucalyptus plantations

URBANIZATION AND SUSTAINABILITY UNDER GLOBAL CHANGE AND TRANSITIONAL ECONOMIES

PI: PEILEI FAN (MICHIGAN STATE UNIVERSITY)

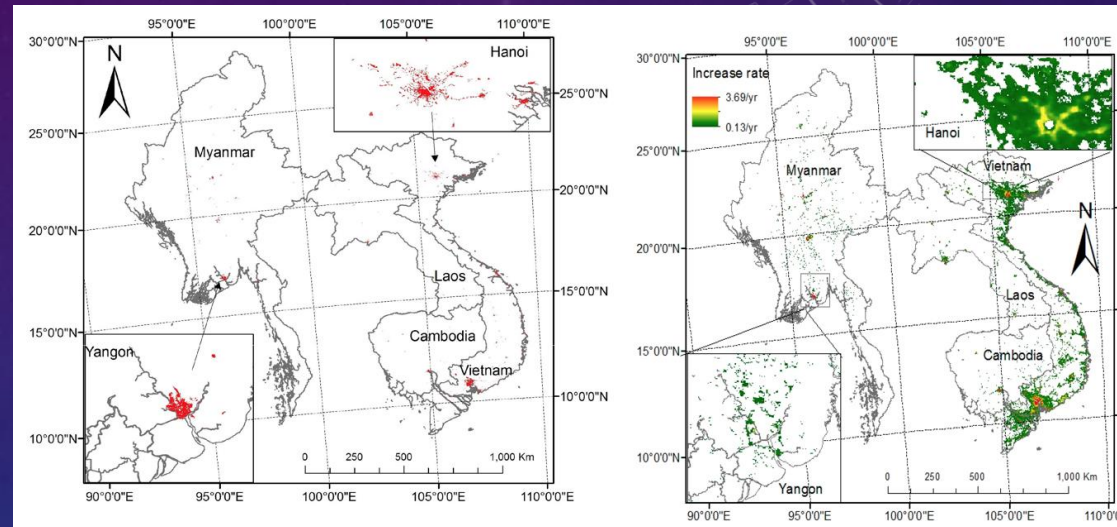


webpage: senacgc.org

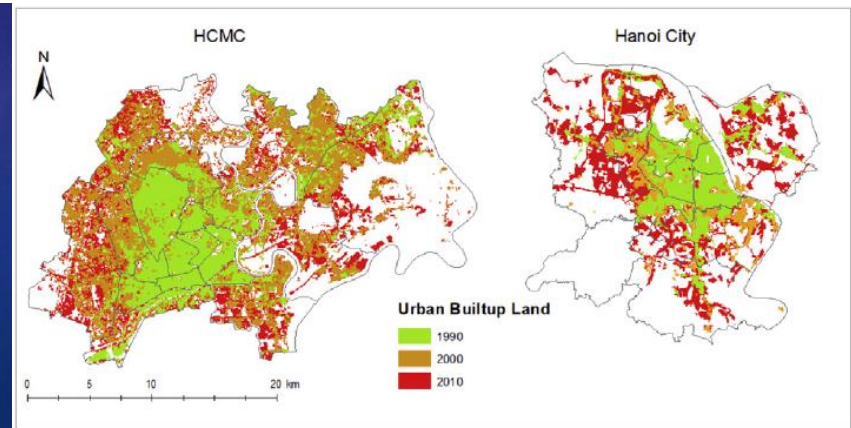
Left: Urban built-up land in Vietnam, Cambodia, Laos, and Myanmar in 2010 with a spatial resolution of 30 m
Right: The increasing trends of DMSP/OLS NTL brightness in 1992-2010

Vietnam: urbanization and sustainability

1. rapid urban land expansion in Vietnam
2. cities >1 million had more rapid growth in urban land & population; most built-up land converted from farmland (Hanoi and HCMC)
3. urban environments ($PM_{2.5}$ and NO_2) in large cities degraded; poverty was alleviated,
4. Coupled dynamics (PLE-SEM)
 - economic dev. influenced urbanization
 - urbanization & economic dev. contributed to environmental deterioration while promoting the social conditions.



- Data: Landsat, DMSP/OLS night time light, MODIS NDVI data, and other ancillary spatial data
- Goal: Develop a 30-m resolution urban built-up map of 2010 for transitional economies in Southeast Asia
- Conclusions
 - Vietnam had the highest proportion of urban built-up area, followed by Myanmar, Cambodia and Laos.
 - Vietnam was also the fastest in new built-up development (increased ~8.8-times during the 18-year study period)



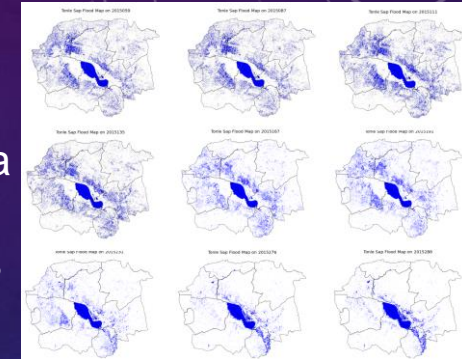
Urban land expansion of HCMC and Hanoi

WHAT WE HAVE LEARNED FROM PRE-SARI SYNTHESIS

- **Population growth => rapid urban expansion on rural and agricultural lands => loss of agri. lands**
- **Prevalent commodity crops (rubber and palm) prices ↑ => deforestation ↑**
- **In Mainland SE Asia the “farming frontier” was reached by the mid-1990s, signaling the end of most rice field expansion but rice production per hectare has increased by an average of 205% => food production ↑ and food costs ↓**
- **In the Himalayan Region migration of young people from rural area to cities and abroad for labor has led to forest increase**
- **Large-scale land-cover conversion for commodity crops => changes in carbon cycle and air quality degradation (due to biomass burning)**
- **The hotspots of conversions: Kalimantan, Sumatra, East India, Mainland SE Asia**
- **Economic development initiatives => regional landscape fragmentation**
- **Vietnam has the highest proportion of urban built-up area and is the fastest in new built-up development; cities >1 million had more rapid growth in urban land & population; urbanization & economic development => environmental deterioration while promoting the social conditions**
- **Counties in India that are more dependent on fiscal transfers from the central government convert less cultivated land to urban use**

ADDITIONAL PRE-SARI NASA LCLUC PROJECTS (MUSLI AND INDUSTRIAL FORESTS)

Courtesy: Nathan Torbick, AG



Tonle Sap, Cambodia
Sentinel-1A Rice
Inundation Dynamics
Time Series

- William Salas, Applied Geosolutions

- Operational Algorithms and Products for Near Real Time Maps of Rice Extent and Rice Crop Growth Stage Using Multi - Source Remote Sensing

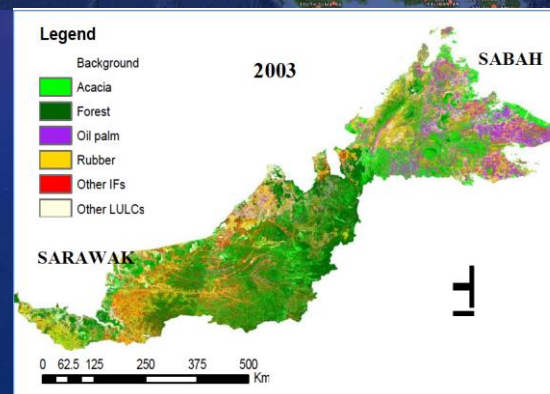
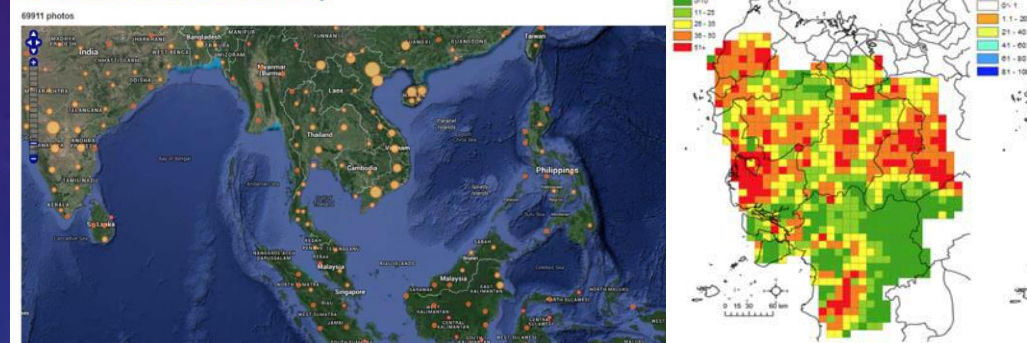
- Jinwei Dong, U. Oklahoma

- Mapping Industrial Forest Plantations in Tropical Monsoon Asia Through Integration of Landsat and PALSAR

- David Skole, Michigan State U.

- Monitoring and Mapping the Area, Extent and Shifting Geographies of Industrial Forests in the Tropics

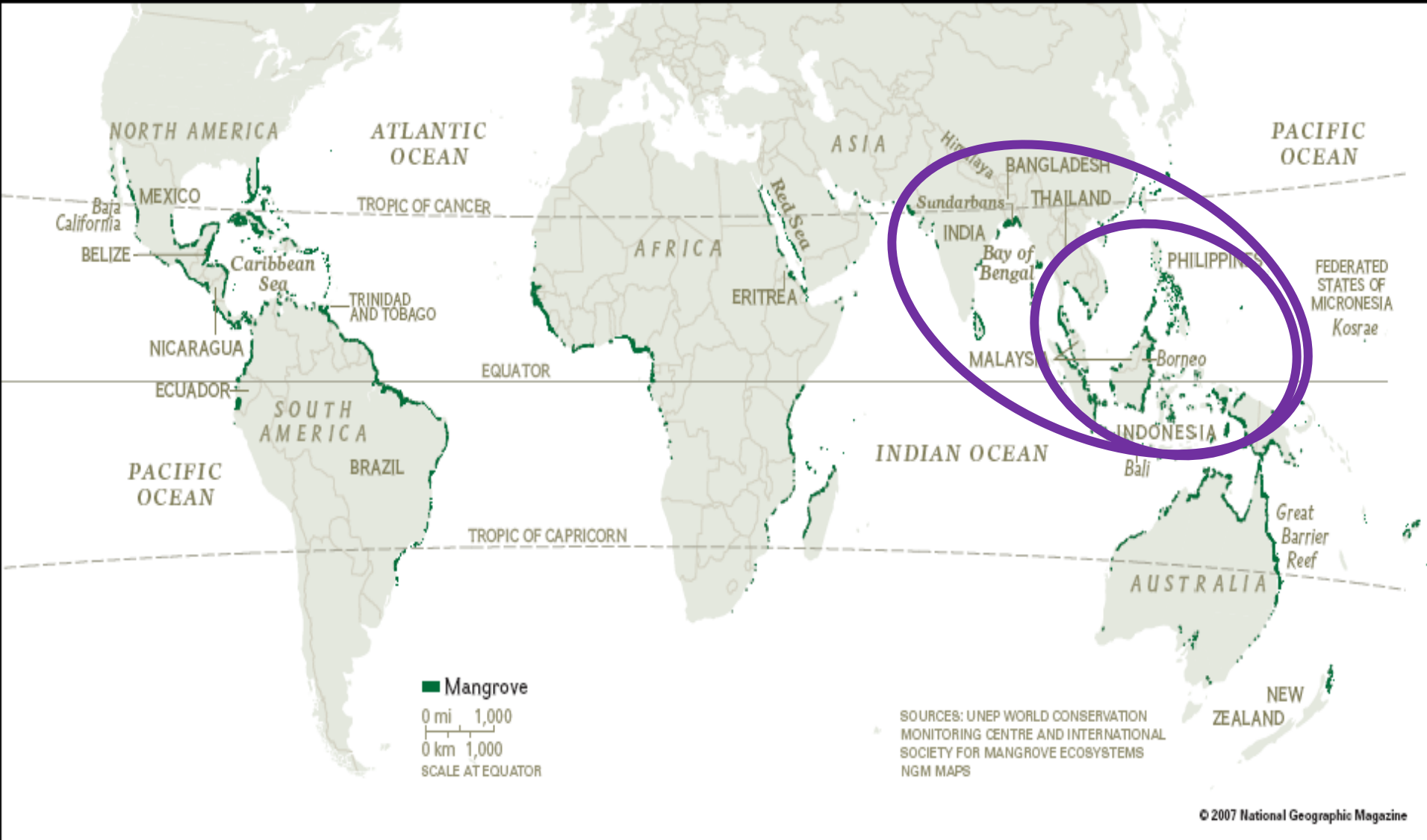
Global Geo-Referenced Field Photo Library



Plantation fractional cover for western West Kalimantan, Indonesia

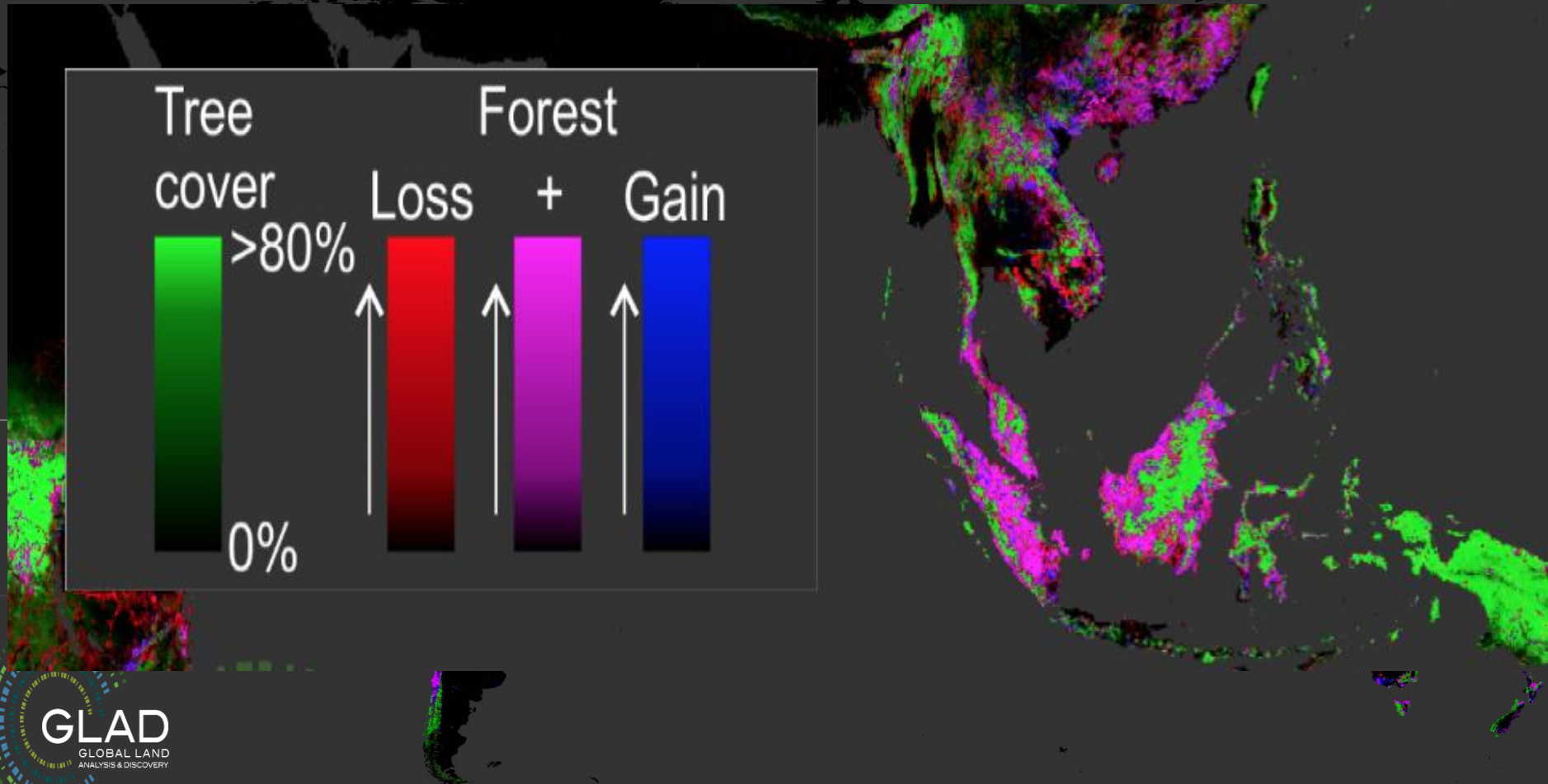
The spectral analysis-based land use/land cover map based the *fC* dataset in Sabah and Sarawak, 2003.

Mangrove forest cover change 1990-2005



Courtesy: Chandra Giri, EPA

Tree Cover Extent and Forest Loss and Gain: 2000-2014

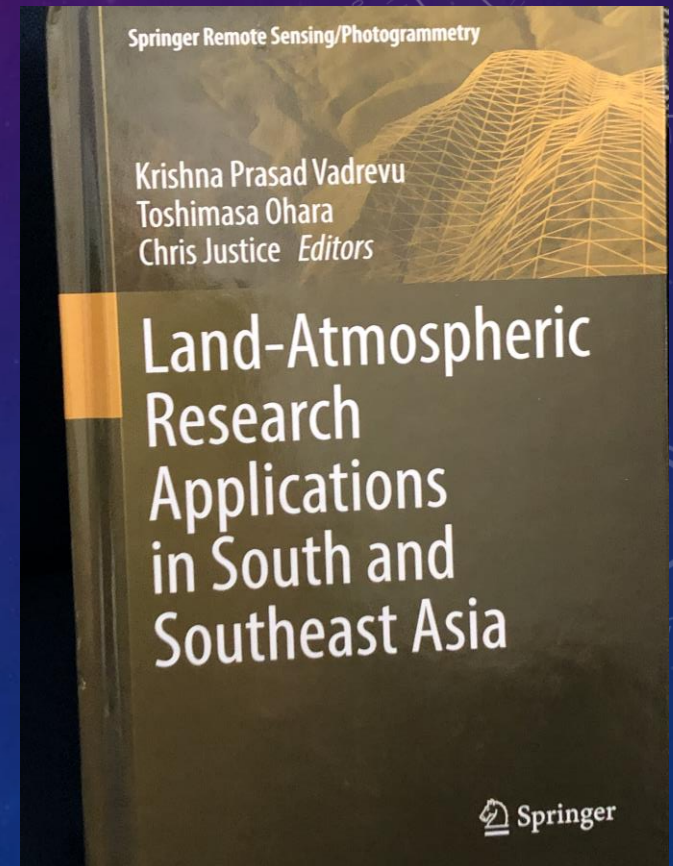


GLAD
GLOBAL LAND
ANALYSIS & DISCOVERY

NASA-SARI SCIENCE

Will be based on the pre-SARI projects and ongoing projects from

- LCLUC-2015 selections for South Asia
- LCLUC-2016 selections for Southeast Asia
- LCLUC-2018 selections on Asia



2018

LCLUC-2016: Ongoing SARI SE Asia Projects

Qi, Jiago Mekong Region	Michigan State U.	Assessing the impacts of dams on the dynamic interactions among distant wetlands, land use, and rural communities in the Lower Mekong River Basin
Hansen, Matt Indonesia	U. Maryland	Quantifying the impact of perverse incentives from Indonesia deforestation moratorium, 2011 to 2016
Fox, Jeff Mainland SE Asia	East-West Center, Hawaii	The agrarian transition in Mainland Southeast Asia: Changes in rice farming 1995 to 2018
McCarty, Jessica Vietnam	Miami U., Ohio	Land-cover/land-use change in southern Vietnam through the lenses of conflict, religion, and politics, 1980s to present
Nghiem, Son Mekong Region	JPL	Land Use Status, Change and Impacts in Vietnam, Cambodia and Laos
Bandaru, Varaprasad Thailand	U. Maryland	Agricultural Land Use Change in Central and Northeast Thailand: Effects on Biomass Emissions, Soil Quality, and Rural Livelihoods

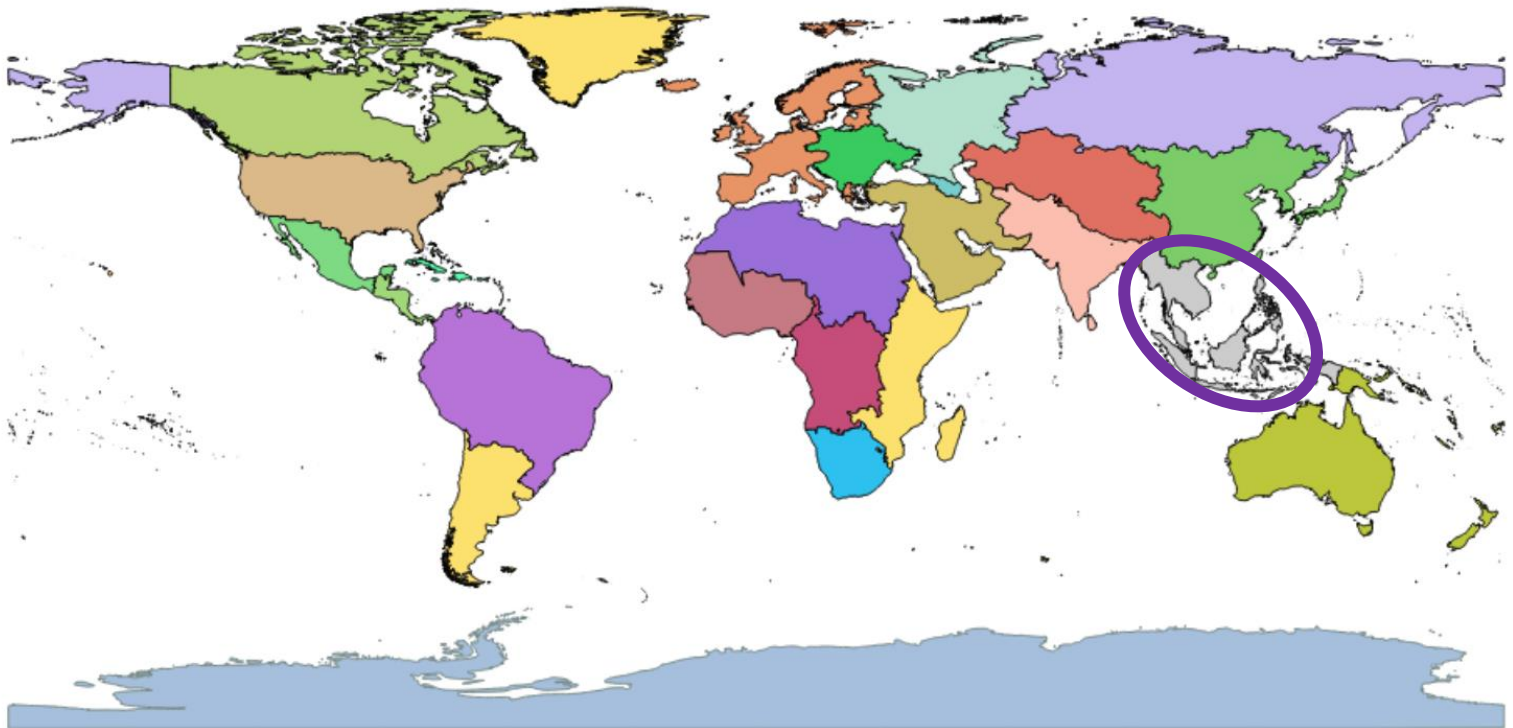
LCLUC-2016: Ongoing NEFI (formerly NEESPI) Projects

Radeloff, Volker Caucasus	U. Wisconsin		Long-term land degradation in the Caucasus
Olofsson, Pontus Caucasus	Boston U.		Comprehensive analysis of thirty years of land change in Georgia: patterns, carbon dynamics and drivers
de Beurs, Kirsten Caucasus	U. Oklahoma		Land Use Patterns and Political Instability as Predictors for the Re-emergence of Malaria in the Caucasus.

DATA PRODUCTS

- *NASA promotes the free and open sharing of data*
- *USGS - Landsat data for free distribution*
- LCLUC expects its PI's to make their data and products available to the broader community
- Data sharing is strongly encouraged
- NASA-USGS Landsat Global Land Surveys: GLS-75, -90, 2000, 2005, 2010
- WELD mosaics
- Global
 - Forest/Change
 - Mangroves/Change
 - Impervious Surfaces/Urban/Change
 - Agriculture/Change
- Projects inventory on maps
- Metadata page on the LCLUC web site – 20+ projects represented (only 3 on SE Asia!)

ALL PROJECTS MAPPED



World

- Global

Oceania

- Australia and Oceania

Europe

- Europe
- Caucasus
- Eastern Europe
- Western Europe
- European Russia

Asia

- Asia
- Siberia and Russian Far East
- Middle East
- East Asia
- Southeast Asia
- South Asia
- Central Asia

Africa

- Africa
- North Africa
- Central Africa
- East Africa
- West Africa
- Southern Africa

Americas

- North America
- Alaska
- Continental U.S.
- Mexico
- Canada
- Central America
- Caribbean
- South America
- Amazon Basin

THE INVENTORY OF SE ASIA PROJECTS

Current Projects Southeast Asia

Displaying 1 - 10 of 10

Principal Investigator Search by Title

- Any - Apply

Principal Investigator	Project Name	Start Date	End Date
Jianguo Qi	Assessing the Impacts of Dams on the Dynamic Interactions Among Distant Wetlands, Land Use, and Rural Communities in the Lower Mekong River Basin	05/01/2018	05/01/2021
Matthew Hansen	A Cobra in the Forest? Quantifying the Impact of Perverse Incentives from Indonesia's Deforestation Moratorium, 2011 to 2016	05/01/2018	05/01/2021
Jefferson Fox	The Agrarian Transition in Mainland Southeast Asia: Changes in Rice Farming - 1995 to 2018	05/01/2018	05/01/2021
Varaprasad Bandaru	Agricultural Land Use Change in Central and Northeast Thailand: Effects on Biomass Emissions, Soil Quality, and Rural Livelihoods	05/01/2018	05/01/2021
Son Nghiem	Land Use Status, Change and Impacts in Vietnam, Cambodia and Laos	05/01/2018	05/01/2021
Jessica McCarty	Land-Cover/Land-Use Change in Southern Vietnam Through the Lenses of Conflict, Religion, and Politics, 1980s to Present	05/01/2018	05/01/2021
Tatiana Loboda	Understanding the Role of Land Cover/Land Use Nexus in Malaria Transmission Under Changing Socio-Economic Climate in Myanmar	05/01/2017	05/01/2020
Karen Seto	Urban Growth, Land-Use Change, and Growing Vulnerability in the Greater Himalaya Mountain Range Across India, Nepal, and Bhutan	05/01/2017	05/01/2020
Ruth DeFries	Tropical Deciduous Forests of South Asia: Monitoring Degradation and Assessing Impacts of Urbanization	05/01/2017	05/01/2020
Krishna Vadrevu	South/Southeast Asia Research Initiative (SARI)	12/01/2015	12/31/2021

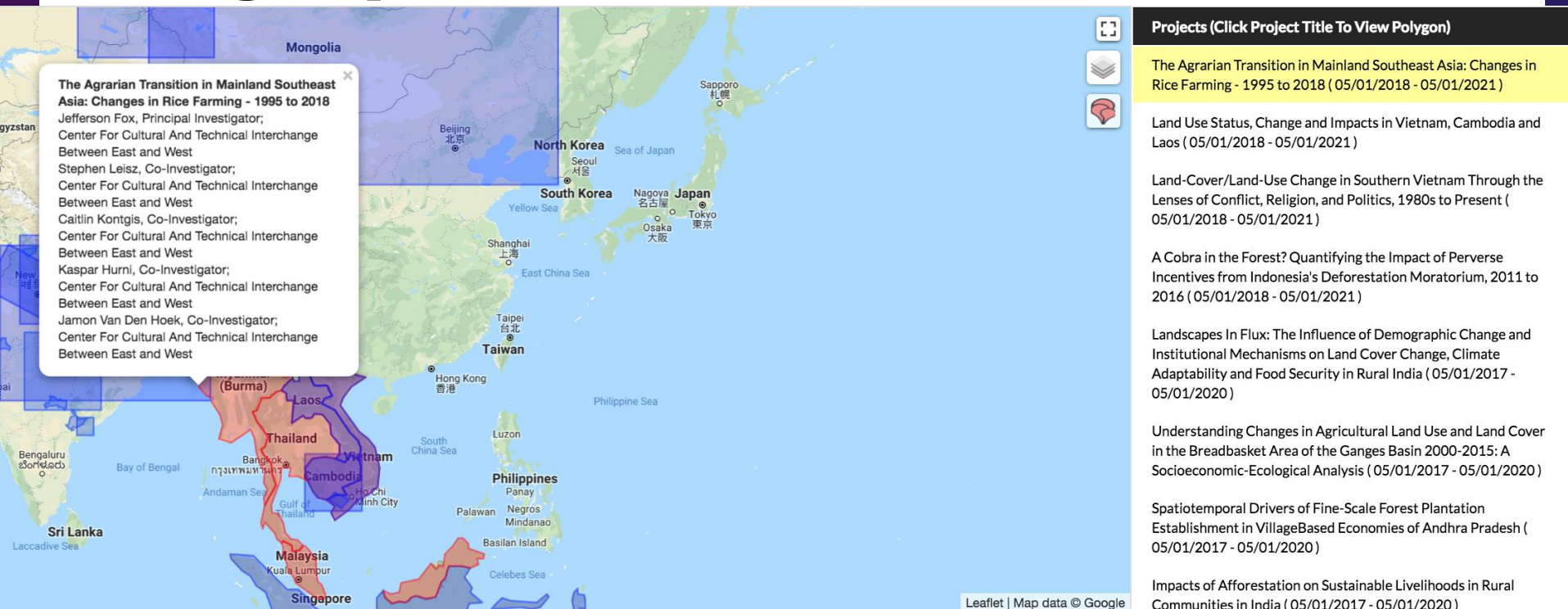
Past Projects Southeast Asia

Displaying 1 - 24 of 24

Principal Investigator	Project Name	Start Date	End Date
William Salas	Operational Algorithms and Products for Near Real Time Maps of Rice Extent and Rice Crop Growth Stage Using Multi - Source Remote Sensing	07/01/2015	07/01/2018
Peilei Fan	Urbanization and Sustainability Under Global Change and Transitional Economies: Synthesis from Southeast, East and North Asia (SENA)	05/01/2015	05/01/2018
David Skole	Monitoring and Mapping the Area, Extent and Shifting Geographies of Industrial Forests in the Tropics	04/01/2014	04/01/2017
Jefferson Fox	Forest, Agricultural, and Urban Transitions in Mainland Southeast Asia: Synthesizing Knowledge and Developing Theory	04/01/2014	04/01/2017
Yuanwei Qin	Mapping Industrial Forest Plantations in Tropical Monsoon Asia Through Integration of Landsat and PALSAR Imagery	04/01/2014	04/01/2017
Atul Jain	Land Cover and Land Use Changes and Their Effects on Carbon Dynamics in South and South East Asia: A Synthesis Study	04/01/2014	04/01/2017
Stephen Leisz	Increased Accessibility, Landscape Changes, Rural Transformations, and Urbanization: Impacts of the East-West Economic Corridor from Da Nang, Vietnam, to Khon Kaen, Thailand	01/01/2013	01/01/2016
Chandrashekhhar Biradar	Quantifying Changes in Agricultural Intensification and Expansion in Monsoon Asia during 2000-2010	05/31/2011	05/30/2014
Xiangming Xiao	Quantifying Changes in Agricultural Intensification and Expansion in Monsoon Asia during 2000-2010	05/31/2011	05/30/2014
Lisa Curran	Socio-economic and Political Drivers of Oil Palm Expansion in Indonesia: Effects on Rural Livelihoods, Carbon Emissions and REDD	04/29/2011	04/28/2014
Hanqin Tian	Land Use - Ecosystem - Climate Interactions in Monsoon Asia	05/01/2008	04/30/2012
Xiangming Xiao	Developing Land Cover Classification Products in Monsoon Asia Over the Period of 2004-2007 Through Integration of Landsat and ALOS/PALSAR Images	04/23/2008	12/03/2010
Jefferson Fox	The Expansion of Rubber and its Implications for Water and Carbon Dynamics in Montane Mainland Southeast Asia	04/10/2008	04/10/2012
Atul Jain	Land Cover and Land Use Change and its Effects on Carbon Dynamics in Monsoon Asian Region	04/01/2008	03/31/2012
Darla Munroe	A Comprehensive Statistical Analysis System to Associate Local Land-Cover/Land-Use Change and Regional Aerosol Composition and Concentration	01/01/2005	01/01/2008
Jefferson Fox	The Role of Land-Cover Change in Montane Mainland Southeast Asia in Altering Regional Hydrological Processes Under a Changing Climate	01/01/2004	01/01/2007
Lisa Curran	Effects of Logging, Plantation Conversion, Biomass Burning and Regrowth on Carbon Dynamics in Bornean Peat and Dipterocarp Forests: Implications for Global Carbon Cycle	01/01/2004	01/01/2007
Ruth DeFries	Reducing Uncertainties of Carbon Emissions from Land Use-Related Fires with MODIS Data: From Local to Global Scale	01/01/2004	01/01/2007
Lisa Curran	Influence of Humans, Climate, and Fire on Forest Ecosystems and Carbon Dynamics in Indonesian Borneo	01/01/2001	01/01/2004
Matthew Hansen	Land Use Change Around Protected Areas in LCLUC Sites: Synthesis of Rates, Consequences for Biodiversity, and Monitoring Strategies	01/01/2001	01/01/2004
Ronald Rindfuss	Simulating of Land Use Dynamics in Southeast Asia: A Cellular Automation Approach	01/01/2001	01/01/2004
Andrew Hansen	Land Use Change Around Protected Areas in LCLUC Sites: Synthesis of Rates, Consequences for Biodiversity, and Monitoring Strategies	01/01/2001	01/01/2004
Ronald Rindfuss	Soils, Water, People and Pixels: A Study of Nang Rong	01/01/1997	01/01/2000
David Skole	Case Studies and Diagnostic Models of the Interannual Dynamics of Deforestation in Southeast Asia: Is the Missing Sink for Carbon in Land Cover Change	01/01/1997	01/01/2000

The LCLUC Mapper

Geographic Areas of Research



Kudos to Indu!

Metadata Page on LCLUC website

Mapping the Expansion of Boom Crops in Mainland Southeast Asia Using Dense Time Stacks of Landsat Data

Project Details:

Forest, Agricultural, and Urban Transitions in Mainland Southeast Asia: Synthesizing Knowledge and Developing Theory

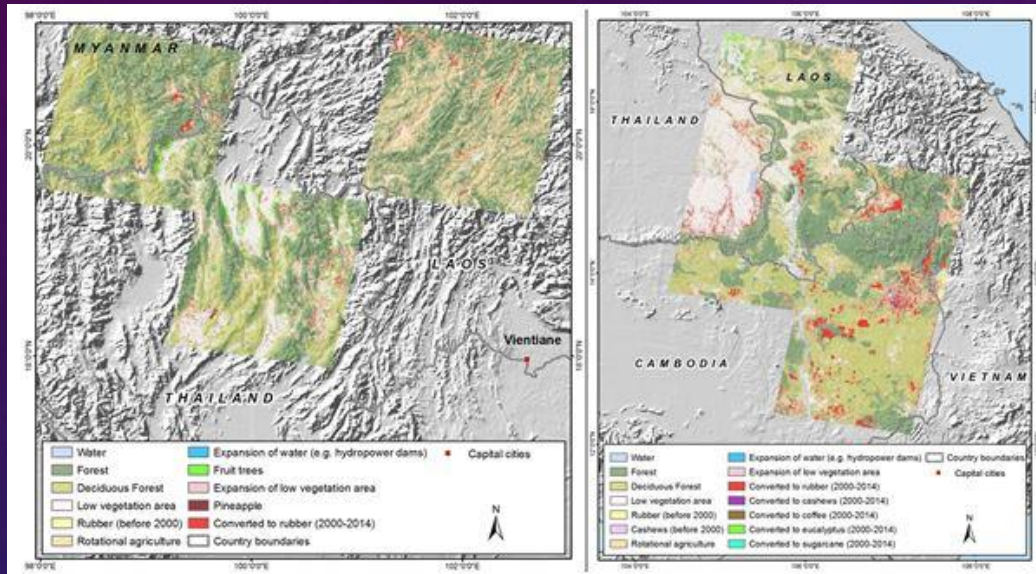
Dataset creator:

Kaspar Hurni

Annemarie Schneider

Andreas Heinimann

Jefferson Fox



Product Details:

- Spatial coverage: Seven Landsat footprints in Mainland Southeast Asia (125050, 125051, 126049, 126050, 129046, 130047, 131046)
- Temporal coverage: 2000-2014; the expansion of boom crops was mapped in 3-year periods (i.e. 2000-2002; 2003-2005; 2006-2008; 2009-2011; 2012-2014)
- Remote sensing data: Landsat 5, 7, and 8 surface reflectance data
- Resolution: 30 meters
- Projection: WGS UTM 48N
- Data Format: GeoTiffs and ESRI shapefiles

Download Link:

Publication: <http://www.mdpi.com/2072-4292/9/4/320>

Data: <https://scholarspace.manoa.hawaii.edu/handle/10125/43976>

MULTI-SOURCE LAND IMAGING (MUSLI)

- Sentinel-1a: launched Apr 2014
- Sentinel-1b: launched Apr 2016
- Sentinel-2a: launched Jun 2015
- Sentinel-2b: launched Mar 2017

- Landsat-7 & - 8 – nominal operations

MuSLI ESA Project Scientist
Benjamin Koetz, ESA
Earth Observations Engineer



MuSLI NASA Project Scientist
Jeff Masek, NASA
Landsat-9 Project Scientist



- Prior efforts to synergistically use Sentinel data along with Landsat-8
 - Joint NASA-UMD-CNES/CESBIO project
 - Sentinel-2 NASA Data Use Preparation team
 - Cross-Calibration (GSFC)

LCLUC-2017 MuSLI Ongoing Projects

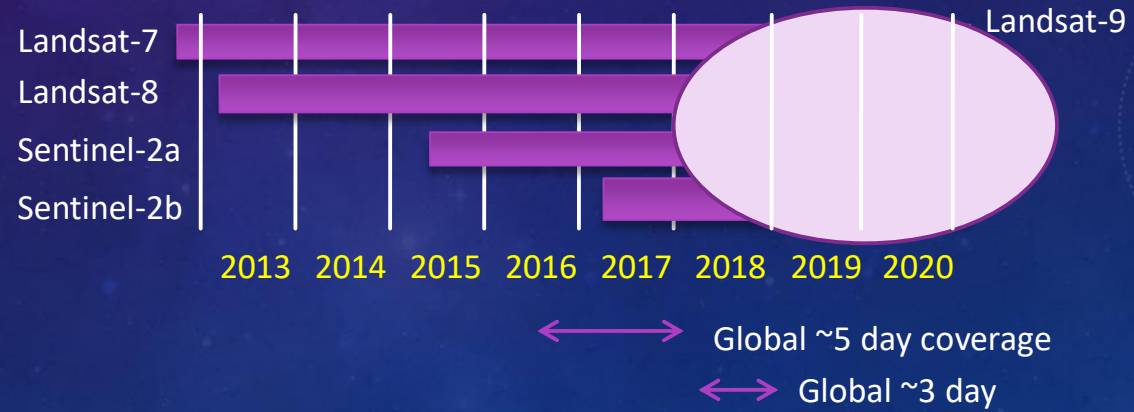
Roy, David Type 1	Michigan State U.	Africa burned area product generation, quality assessment and validation – demonstrating a Multi-Source Land Imaging (MuSLI) Landsat-8 Sentinel-2 capability
Schaaf, Crystal Type 1	U. Massachusetts	Circumpolar Albedo of Northern Lands from Landsat-8 and Sentinel-2
Friedl, Marc Type 1	Boston U.	An Operational Multisource Land Surface Phenology Product from Landsat and Sentinel 2
Anderson, Martha Type 2	USDA	Characterizing Field-Scale Water Use, Phenology and Productivity in Agricultural Landscapes using Multi-Sensor Data Fusion
Campbell, Petya Type 2	UMBC/NASA	Prototyping MuSLI canopy chlorophyll content for assessment of vegetation function and productivity
Skakun, Sergi Type 2	UMD	Crop yield assessment and mapping by a combined use of Landsat-8, Sentinel-2 and Sentinel-1 images
Radeloff, Volker Type 2	U. Wisconsin	Monitoring abandoned agriculture, fallow fields, and grasslands with Landsat and Sentinel-2
Hulley Type 2 Thermal IR	NASA/JPL	A high spatio-temporal resolution Land Surface Temperature (LST) product for urban environments

FUSING MID-RESOLUTION DATA: SENTINEL2 + LANDSAT DATA

- Sentinel-2a: launched in Jun 2015
- Sentinel-2b: launched in Mar 2017
- Landsat-7: launched in Apr 1999
- Landsat-8: launched in Feb 2013
- Landsat-9: planned for Dec 2020

Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage required for Ag monitoring

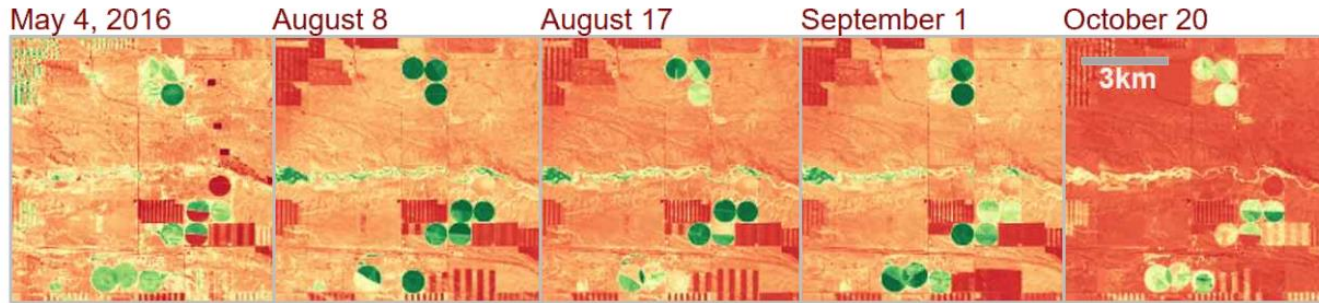
- Both sensors have 10-30m coverage in VNIR-SWIR
- Satellite orbits complementary
 - Landsat-7 & -8 8 days out of phase
 - Sentinel-2a & 2b 5 days out of phase
 - Landsat and Sentinel sun synch orbits precess relative to each other



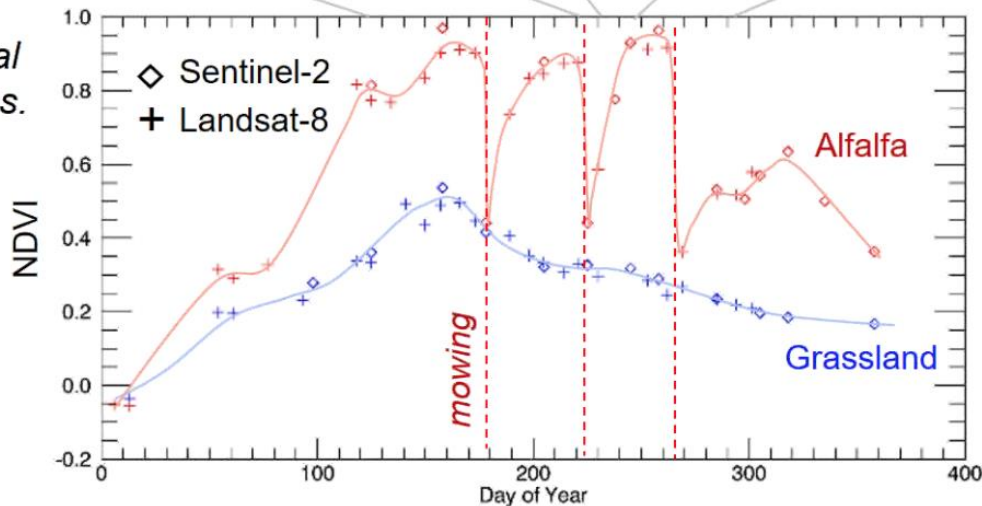
HLS: Harmonized Landsat/Sentinel-2 Products

<https://hls.gsfc.nasa.gov>

Laramie County, WY

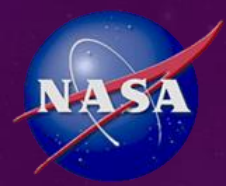


High temporal density of obs. allows individual mowing events to be detected within alfalfa fields.



Seasonal phenology:
Natural Grassland (blue line)
Irrigated Alfalfa (red line)

Courtesy: Jeff Masek, NASA GSFC

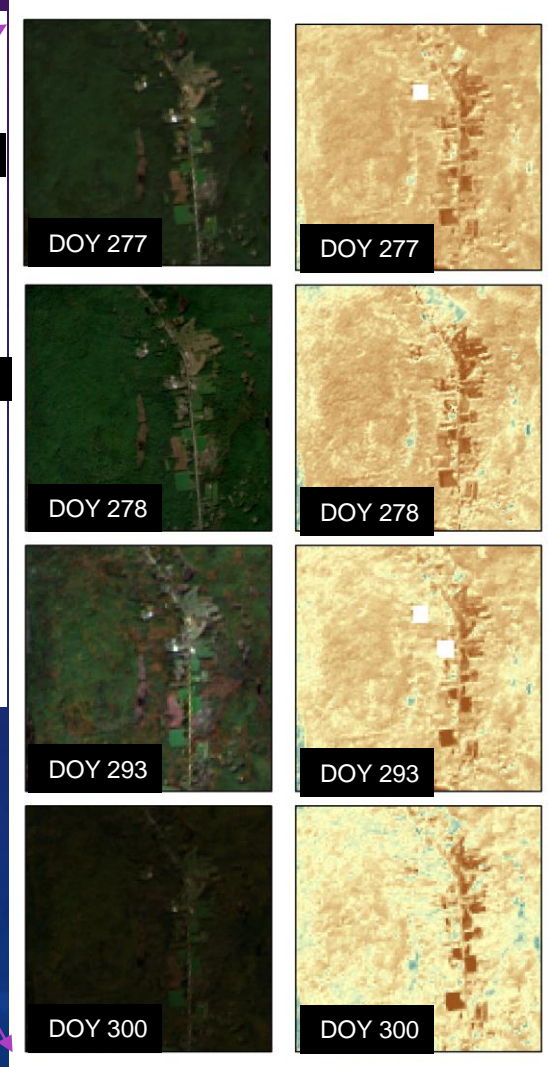
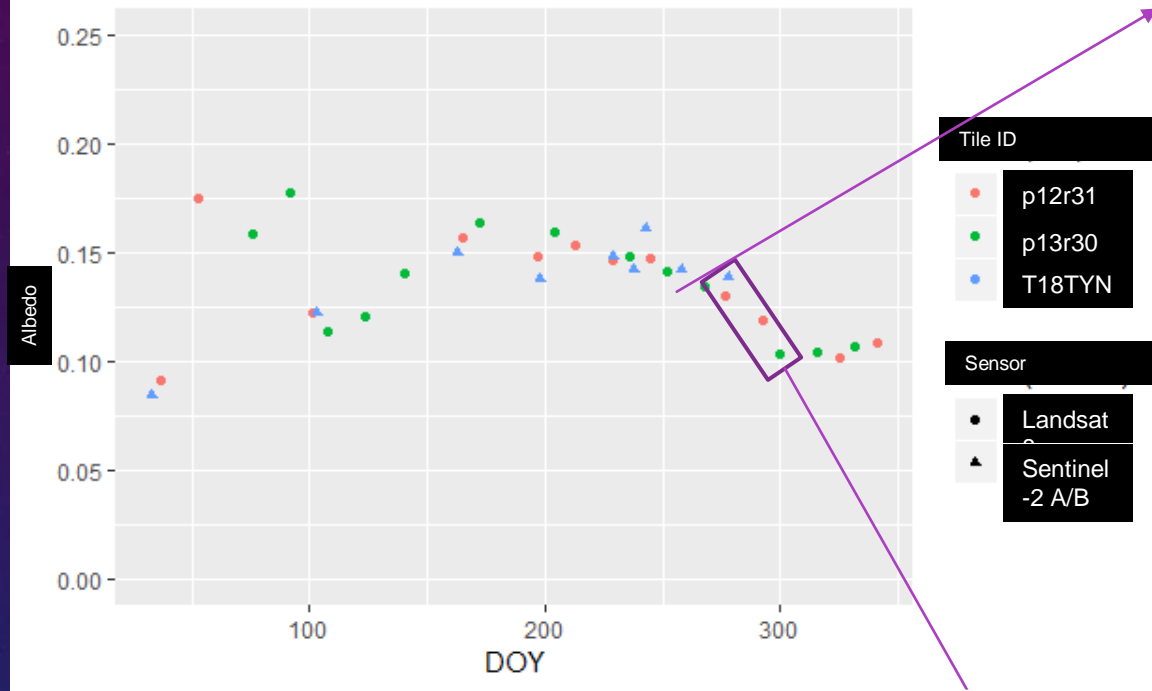


Circumpolar Albedo of Northern Lands from Landsat-8 and Sentinel-2



PI: Crystal Schaaf, U. Massachusetts Boston

Average SW White Sky Albedo during Senescence over Harvard Forest, MA.

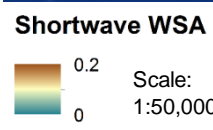


Sensor: Landsat 8
Date: 10/04/2017
Tile: p12r30

Sensor: Sentinel 2B
Date: 10/05/2017
Tile: T18TYN

Sensor: Landsat 8
Date: 10/20/2017
Tile: p12r31

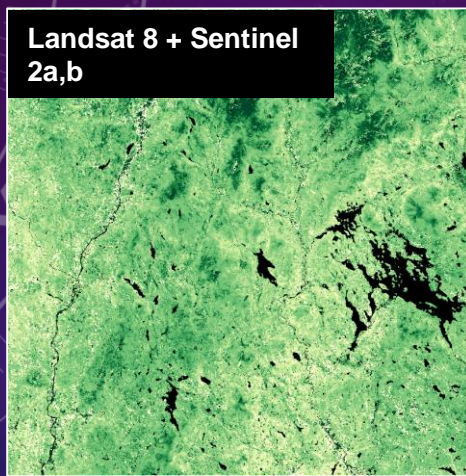
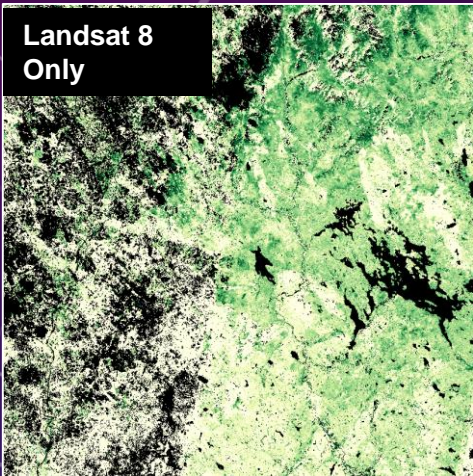
Sensor: Landsat 8
Date: 10/27/2017
Tile: p13r30



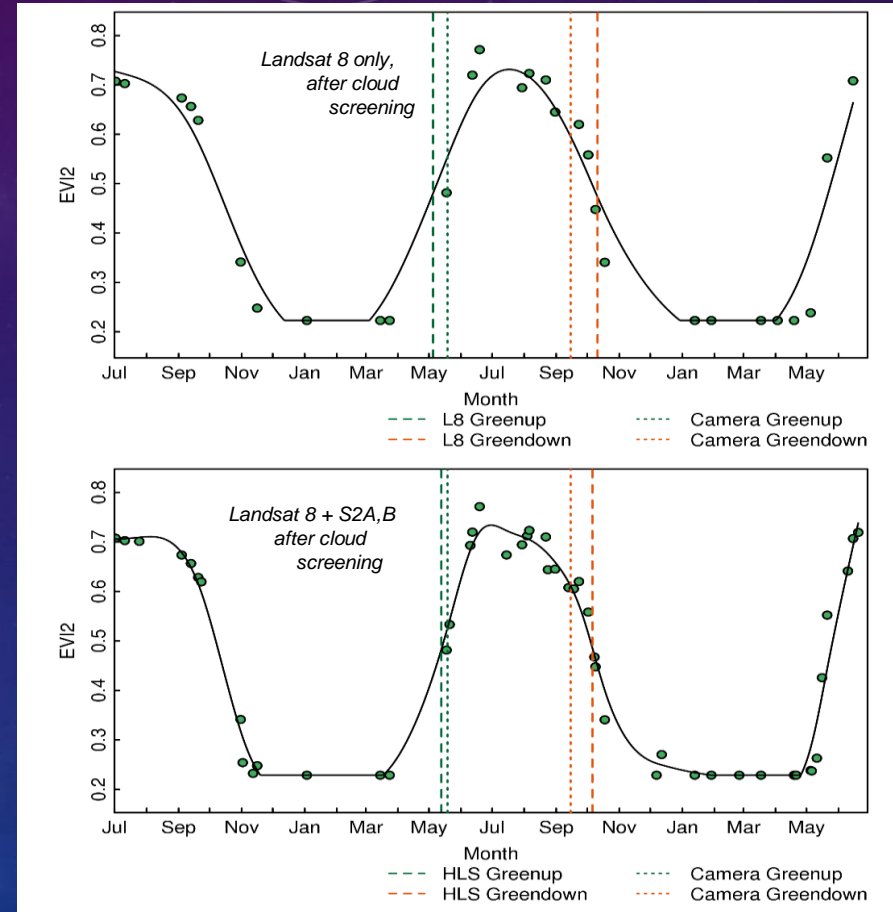
Landsat-8 (30m) and Sentinel-2A/B (20m) shortwave White Sky Albedo (WSA) values over Harvard Forest illustrate the annual phenology and, in particular, the autumn senescence and leaf-drop of the deciduous trees in this mixed forest. Intrinsic surface albedos are generated by coupling appropriate daily MODIS BRDF values with Landsat-8 and Sentinel-2 reflectances.

Satellite-Derived Greenup for Broadleaf Forests: New Hampshire

PI: Friedl, Boston U.



-- No prediction due to insufficient data density



Regression against PhenoCam greenup obs

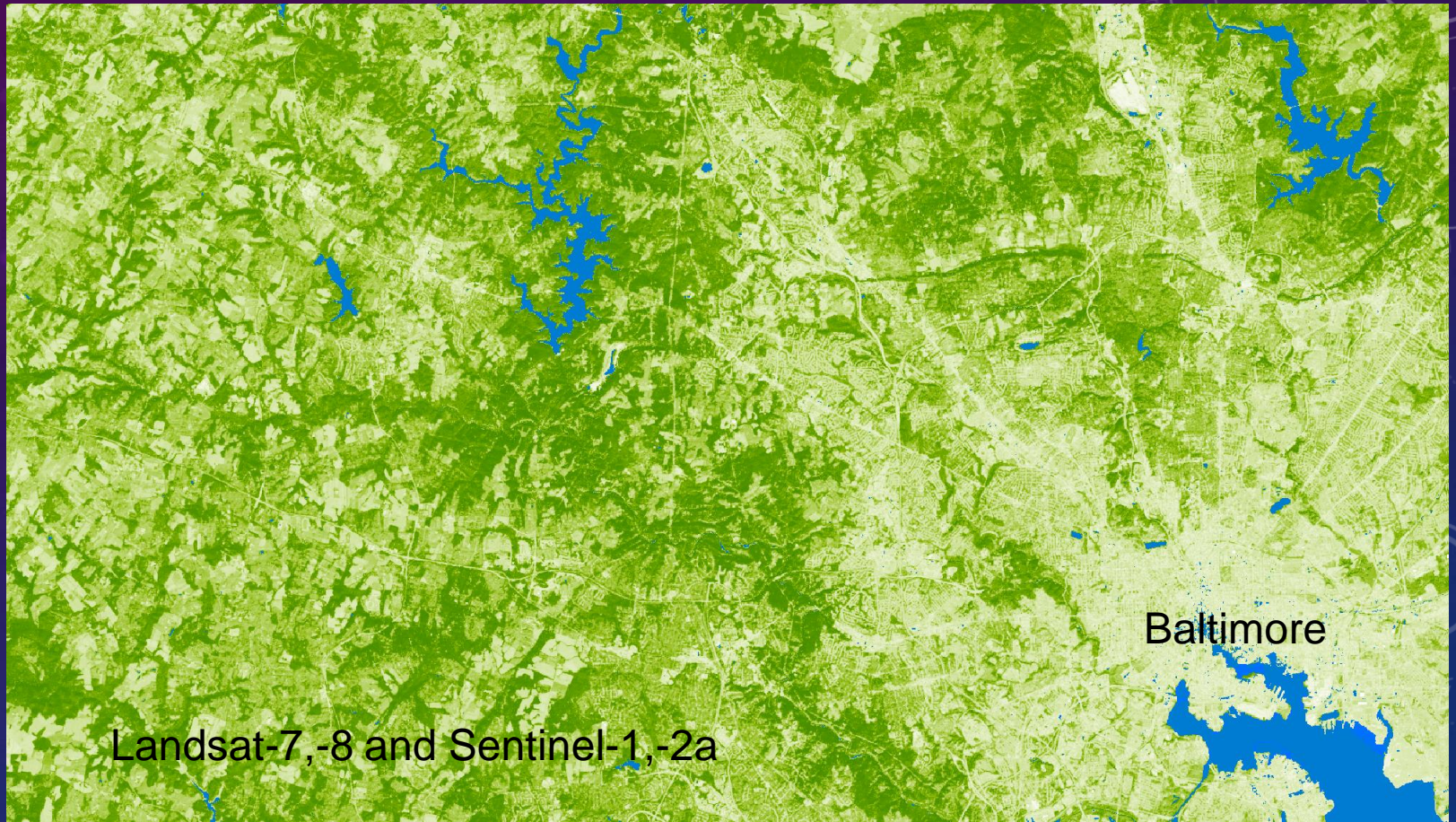
	Landsat8	Sentinel	L8+S2
RMSE	12.6	17.0	8.4
R ²	0.62	0.32	0.81

Courtesy: Doug Bolton, BU

Increased temporal density results in more complete and more accurate retrieval of phenology

Tree Canopy Cover Estimated from Landsats and Sentinel-1, 2

PI: John Townshend, UMD



Courtesy: Saurabh Channan, UMD

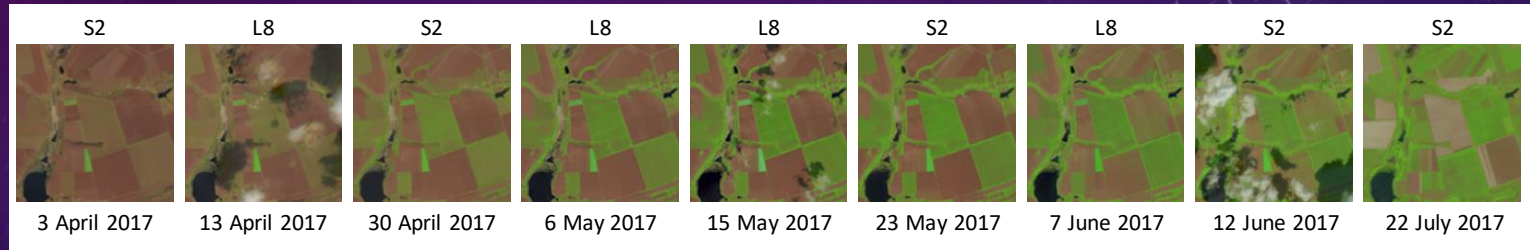
Landsat8 filled most of the gaps caused by SLC off, cloud, cloud shadow, but still some gaps remained.

Combining with Sentinel-1 and -2 removed the remaining gaps.

CROP YIELD ASSESSMENT AND MAPPING FROM LANDSAT-8 AND SENTINEL-2 OBSERVATIONS

PI: Skakun, U. Maryland

Ukraine
(Kirovograd obl.)

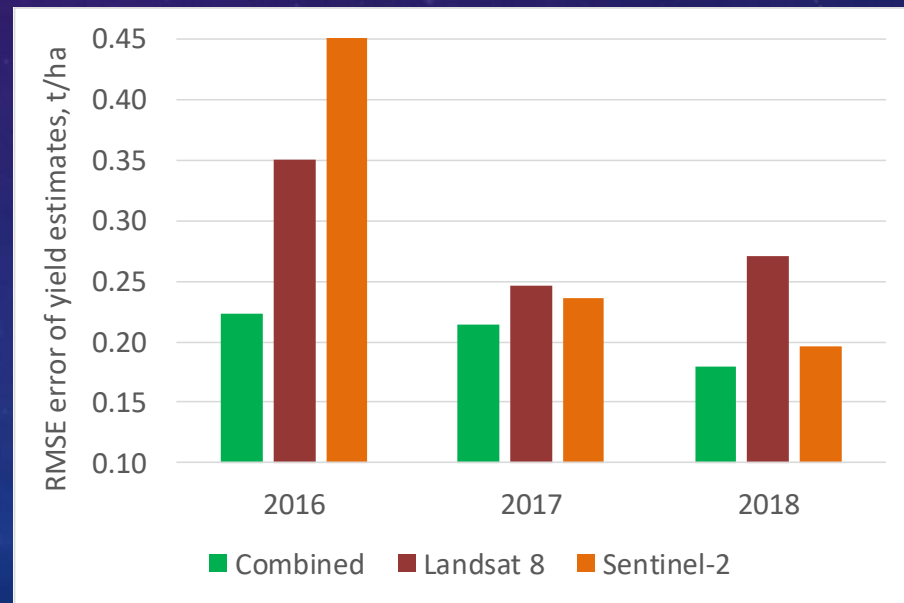


Root mean square error (RMSE) of the relationship between crop yield (ground data) and cumulative satellite-derived vegetation index

Multi-source (L8+S2) reduction in *RMSE* →

2016, 2017 – Sentinel 2a

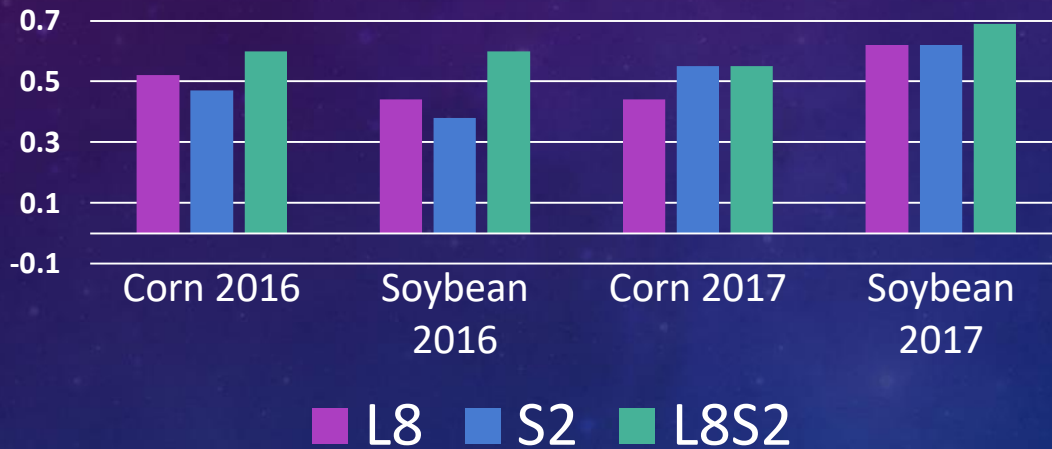
2018 – Sentinel 2a,b



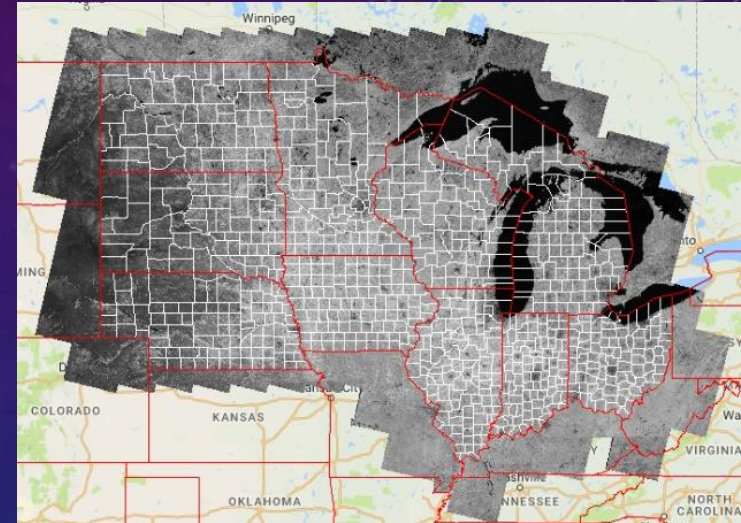
YIELD VARIABILITY EXPLAINED BY LANDSAT-8 AND SENTINEL-2: USA

PI: Anderson, USDA

Correlation (R^2) Between Crop Yields at County Level (USDA) and Max Veg Index derived from Landsat 8, Sentinel 2 and their combination for two years



Courtesy: Feng Gao, USDA



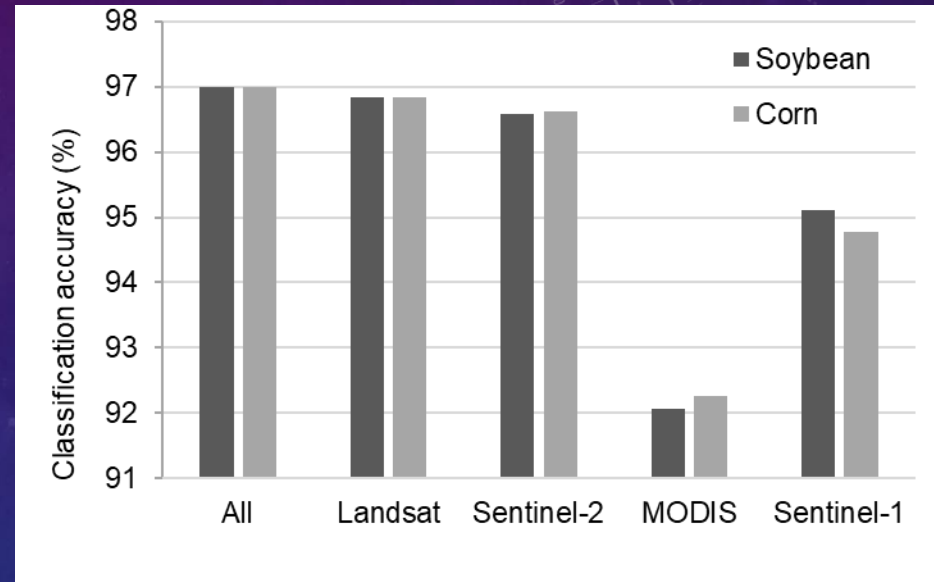
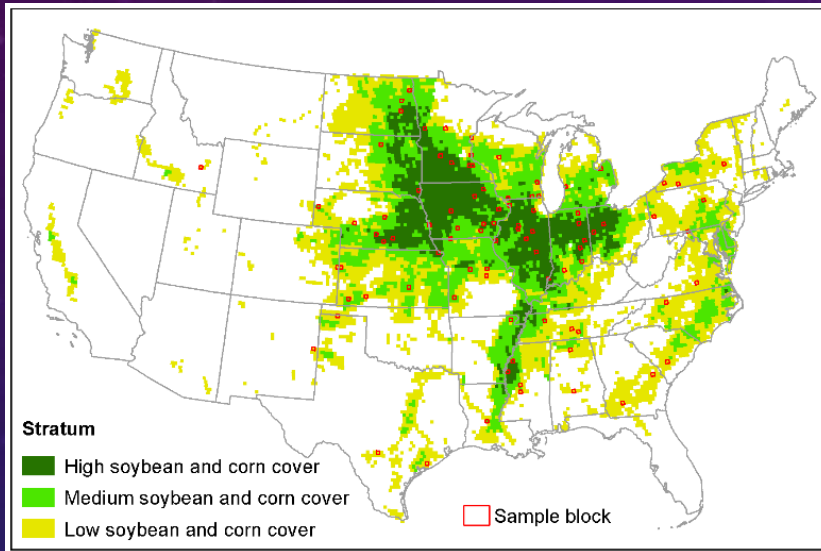
- 10 agricultural States (~600 counties or data points)
- Landsat-8 and Sentinel-2 data used to aggregate TOA reflectance at county level, then compared derived Max EVI2 to crop yields (corn and soybeans) at county level reported by USDA
- the combination of L8 and S2 shows better capability in explaining the yield-VI relationships

INTEGRATING LANDSAT 7, 8 AND SENTINEL 2 DATA IN IMPROVING CROP TYPE IDENTIFICATION AND AREA ESTIMATION

PI: Hansen, U. MD

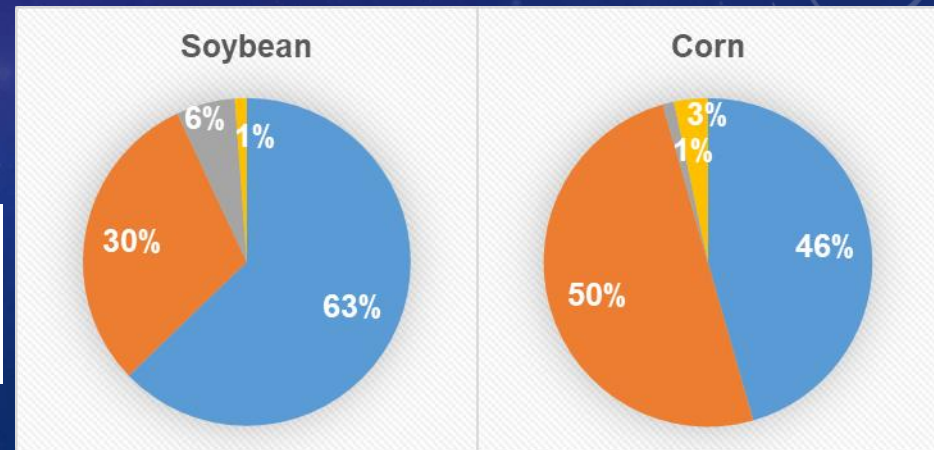
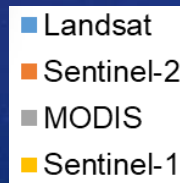
20km x 20km sample blocks (n=75)

Average classification accuracy
(CDL as cal/val)



Data usage as the most important feature for classification:

Landsat is more useful for soybean.
Sentinel 2 is more useful for corn.
Together better than either separately.

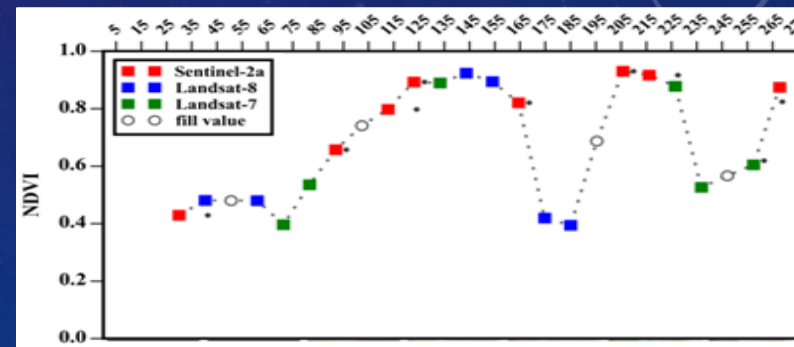
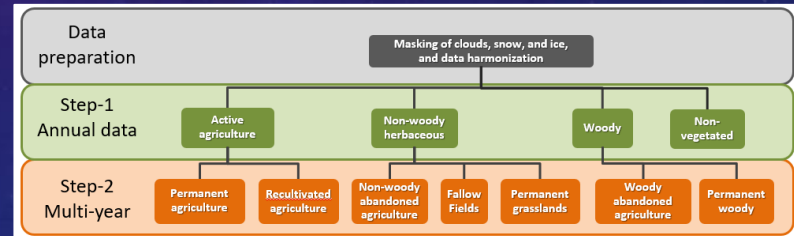
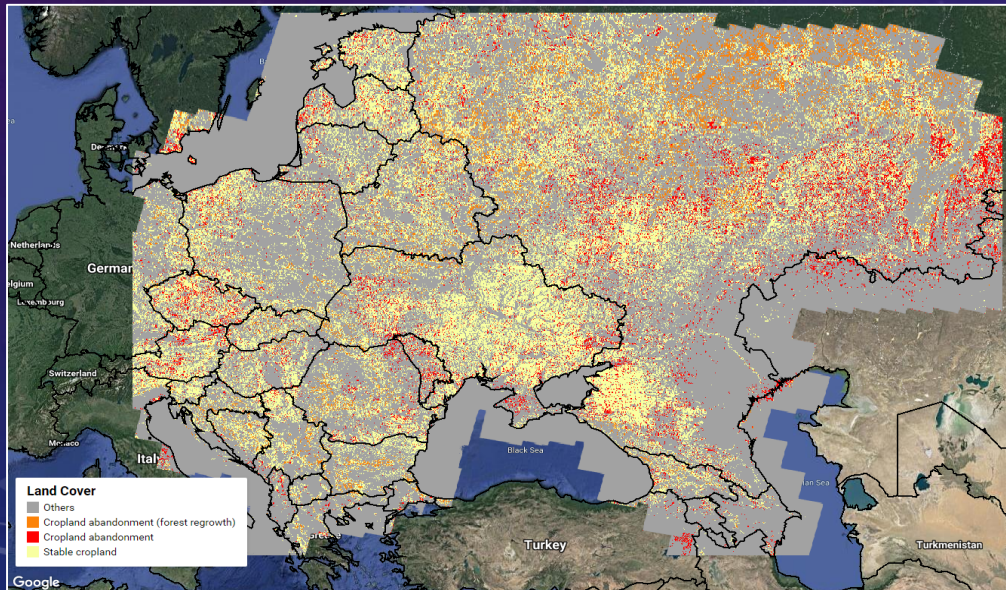
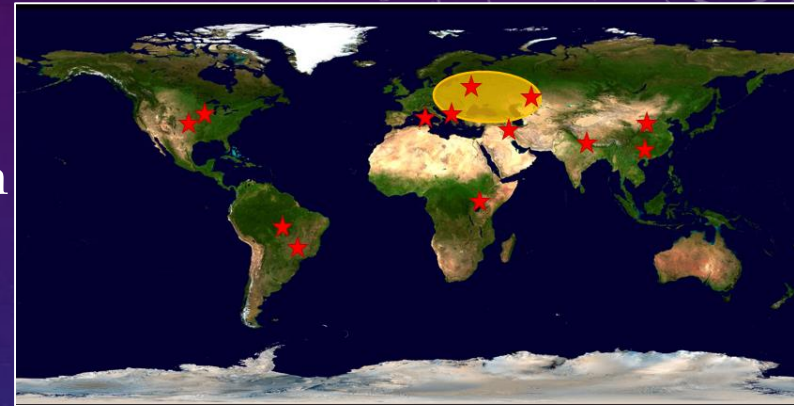


Song *et al.* in prep.

MONITORING THE DYNAMICS OF ABANDONED AGRICULTURE, FALLOW FIELDS AND GRASSLANDS

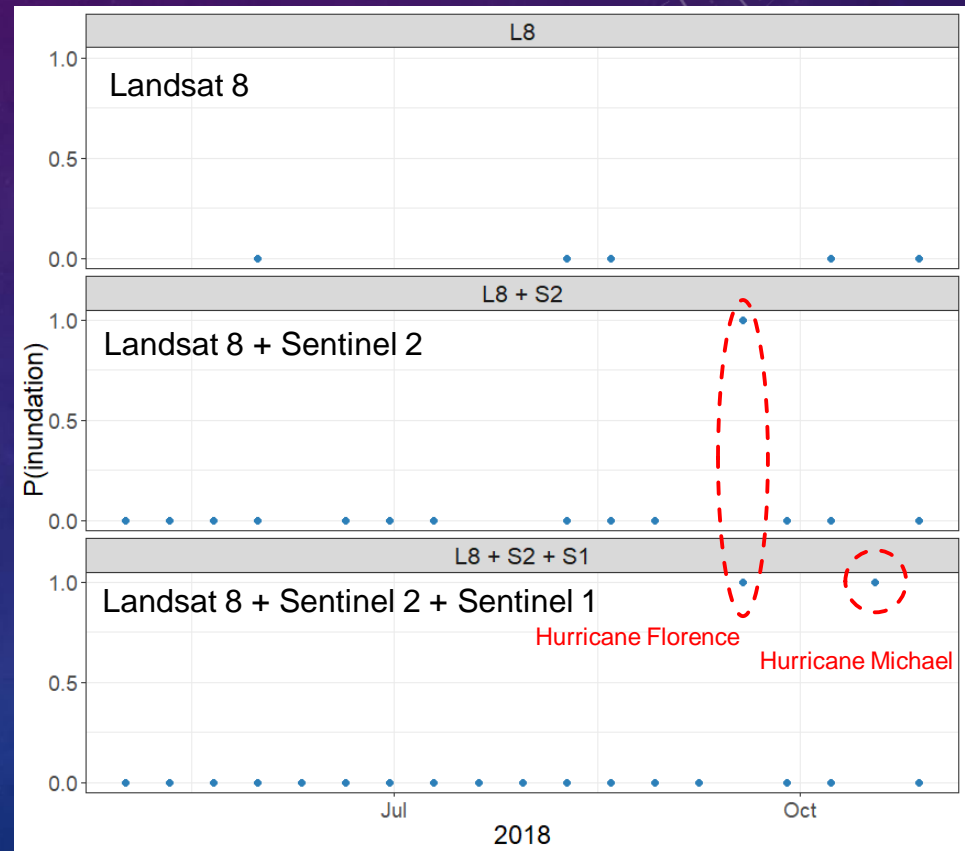
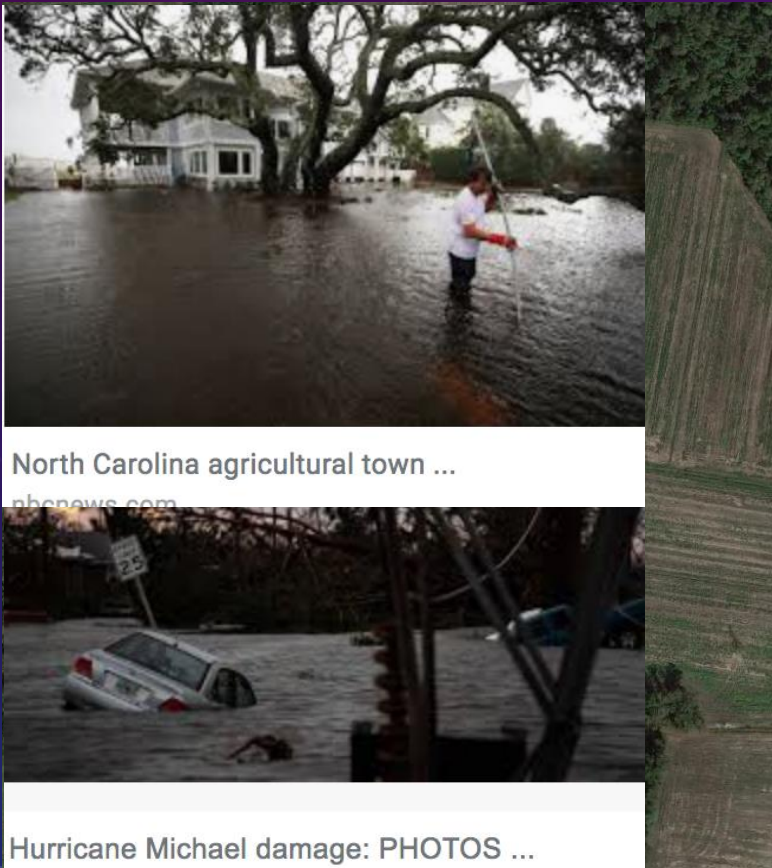
PI: RADELOFF (U. WISCONSIN)

- Goal: to map agricultural abandonment routinely for large areas
- Two-step classification process based on all Landsat and Sentinel-2 data
- 13 global test footprints; one regional proof-of-concept



FUSING MID-RESOLUTION OPTICAL AND MICROWAVE (RADAR) DATA FOR MAPPING INUNDATION IN NORTH AMERICA

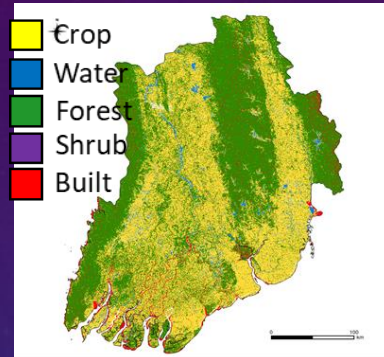
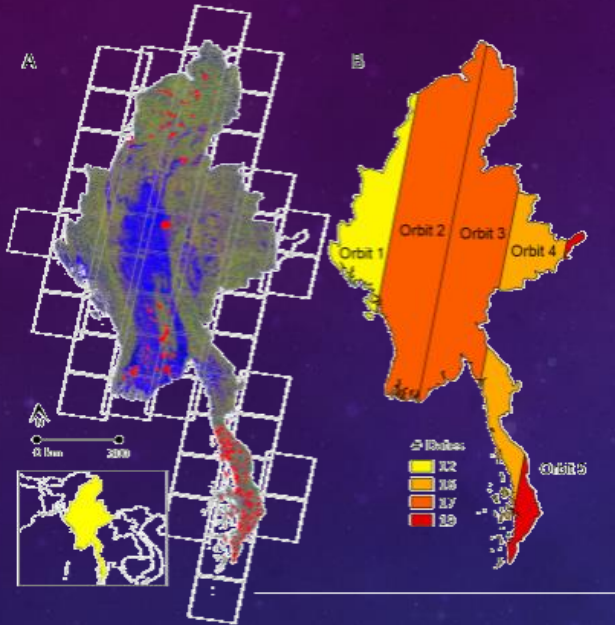
PI: Cheng Huang, U. Maryland



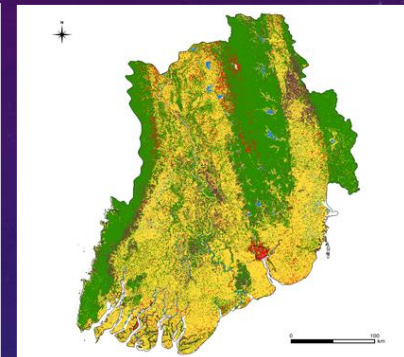
Two flooding events over crop fields in N. Carolina: 1) Hurricane Florence in Sep 2018 - captured by L8 + S2, 2) Michael in Oct 2018 Hurricane L8+S2+S1. These events are not captured by L8 data alone.

Operational Algorithms and Products for Near-Real-Time Maps of Rice Extent and Rice Crop Growth Stage Using Multi-Source Remote Sensing

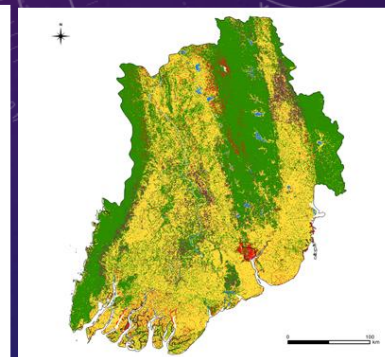
PI: Salas, Applied Geosolutions



P2+S1
P2+S1

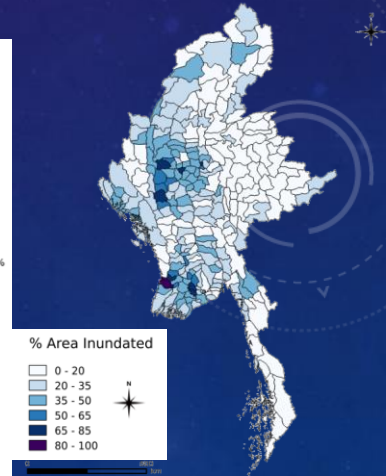
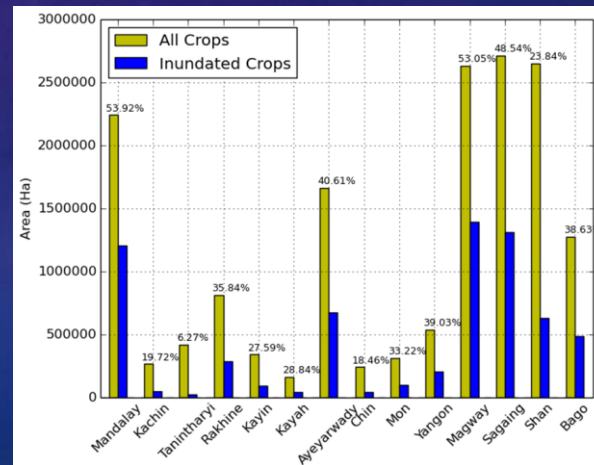


L8+P2
P2+L8



L8+P2+S1
P2+L8+S1

Courtesy of Nathan Torbick, AG



MuSLI approach improves food security mapping in S/SE Asia

Multi-source Imaging of Infrastructure and Urban Growth Using Landsat, Sentinel and SRTM

PI: C. Small (Columbia Univ.)

Co-I: S. Nghiem (NASA-JPL)

Combine multi-season optical land cover fractions with multi-season microwave backscatter to map impervious surface.

Continuous **Substrate** **Vegetation** **Dark** land cover fractions from standardized spectral mixture model.

Multi-season Substrate moment (Mean/StdDev = μ/σ) distinguishes stable impervious surfaces from variable moisture soils.

High density of corner reflectors gives persistent high VV backscatter in multi-season mean $VV\mu$

2015 Sentinel-2 **SVD** μ/σ + Sentinel-1 $VV\mu$

2000 Landsat 7 **SVD** μ/σ + SRTM $VV\mu$

Continuous Infrastructure Index = **S** μ/σ $VV\mu$

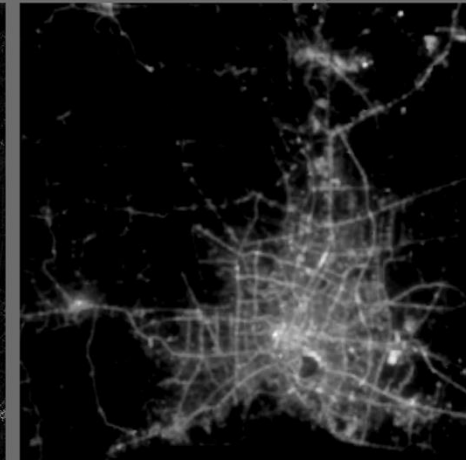
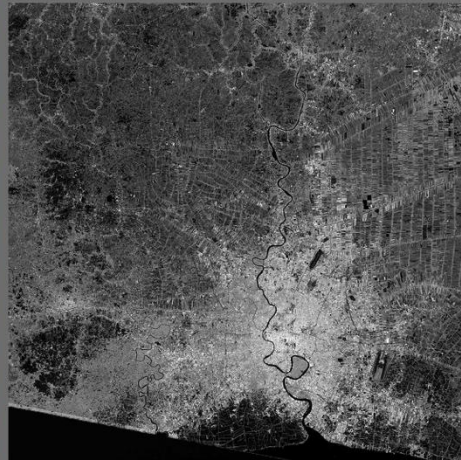
Comparison of the infrastructure index to the night light for Bangkok clearly distinguishes the built area better than either optical or microwave alone

S2 Multi-season Land Cover **S** μ/σ **V** μ/σ **D** μ/σ

S1 Multi-season Microwave Backscatter $VV\mu$

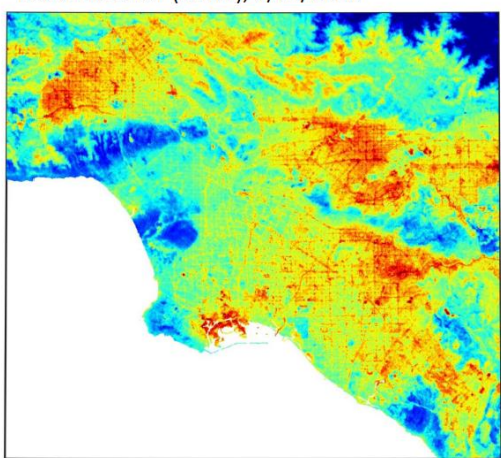
Continuous Infrastructure Index

VIIRS annual night light



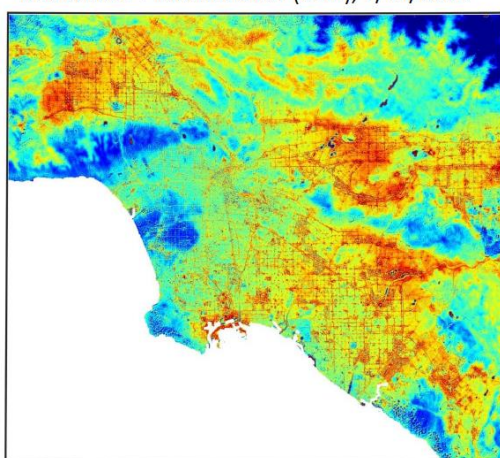
SHARPENING OF COARSE RESOLUTION THERMAL IR IMAGES WITH MID-RESOLUTION OPTICAL IMAGES

ECOSTRESS LST (100m), 7/14/2018



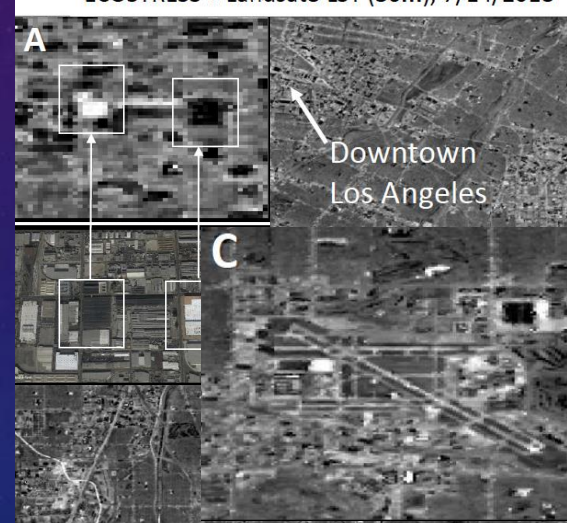
K

ECOSTRESS + Landsat 8 LST (30m), 7/14/2018



K

ECOSTRESS + Landsat8 LST (30m), 7/14/2018



ECOSTRESS Land Surface Temperature Imagery averaged into 100m cells and sharpened with Landsat 30m optical data for Los Angeles county, Ca

ECOSTRESS observations: throughout the diurnal cycle every week, while Landsat only the morning temperatures twice a month, at best

Distinguishing fine-scale thermal features of individual building roofs and transport network infrastructure (roads, runways)

A: upper thermal image vs Google Earth image

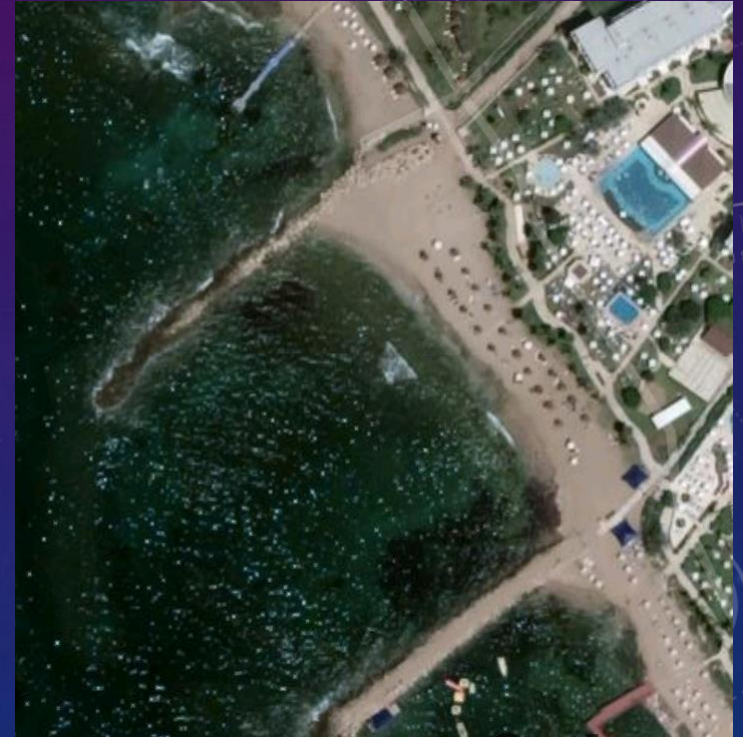
Courtesy: Glynn Hulley, NASA JPL

NEW SENSORS FOR LCLUC STUDIES ON ISS

- ECOSTRESS: ECOsystem Spaceborne Thermal Radiometer Experiment on ISS
 - Prototype HypsIRI Thermal Infrared Radiometer (PHyTIR)
 - 5 spectral bands in the 8-12.5 μm range+1.6 μm (69m x 38m)
- DESI: DLR Earth Sensing Imaging Spectrometer
 - 235 spectral channels with ground res. 30m
- GEDI: Global Ecosystem Dynamics Investigation
 - high resolution laser ranging observations of the 3D structure of the Earth
 - three lasers produce eight parallel tracks of observations
 - each laser fires 242 times per second and illuminates a 25 m spot (a footprint) on the surface over which 3D structure is measured

HIGH-RESOLUTION COMMERCIAL IMAGERY DATA

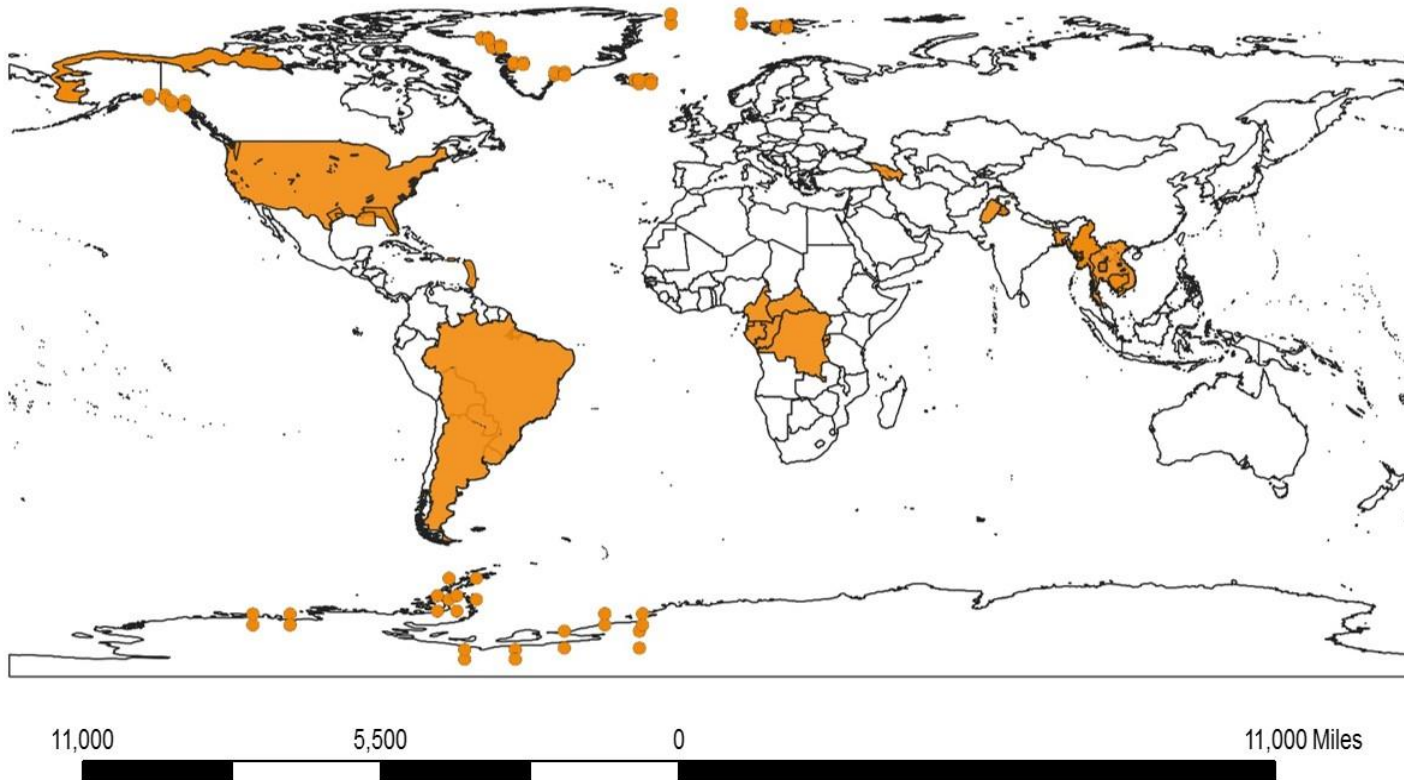
- NASA is assessing the value for research and applications of two commercial data vendors with high-resolution imagery data: Planet Labs and Digital Globe
- Assessment's goal is to determine value for advancing NASA research and applications activities and objectives
 - basic quality geophysical information (stability, characterization, etc.)
- Provided a positive assessment and a consequent data purchase, it is expected that all LCLUCers will have free access to a very rich, dense dataset in 2020 from **Planet Labs** over land including coastal zone and cryosphere
- **Digital Globe** data have been and will be available from NASA GSFC through the NASA-NGA agreement
- Initial reports are due Apr 29



Location of Data Buy Projects

Courtesy: Krishna Vadrevu (NASA MSFC)

Digital Globe Data Study Area Locations



LCLUCers	
Walsh	Rittger
Campbell	Molthan
Skakun	Zaitchik
McCarty	Hu
	Mannino

Campbell	UMBC	Roy	Michigan State U.
Hansen	UMD	Skakun	U. Maryland
McCarty, J.	Miami U. , Ohio	Vadrevu	NASA MSFC
LCLUCers		Walsh	U. North Carolina

LCLUC HIGH-RES PILOT STUDIES: THE MAGNIFICENT SEVEN



10:50-11:00 Krishna Vadrevu, NASA MSFC

11:00-11:10 Matt Hansen, U. Maryland

11:10-11:20 Jessica McCarty, Miami U.,
Ohio

11:20-11:30 David Roy, Michigan State U.

11:30-11:40 Sergii Skakun, U. Maryland

11:40-11:50 Petya Campbell, NASA/UMD

11:50-12:00 Steve Wolk, U. North Carolina

EDUCATION AND OUTREACH

- **E-Newsletters**
- **Webinars**
- **One-pagers**
- **Statistics:**
Information on
students graduating
in LCLUC is needed
- **LCLUC website and**
Facebook page

LCLUC Webinars series

- Projects have been presented during 2014-18 (Urban, Urban-Ag transitions, Ag, SARI)



Land-Cover / Land-Use Change Program

NASA LCLUC SARI Webinar Series 2018

	<p>Dr. Tatiana Loboda, Department of Geographical Sciences, University of Maryland</p>	
<p>18th December, 2018 11:00 AM to 12:00 PM EST</p>		
<p>Dr. Forrest D. Fleischman NASA LCLUC SARI Webinar Series 2018</p>		

	<p>Dr. Peter Leimgruber [Director Smithsonian Conservation Biology Institute's (SCBI)]</p>	
<p>28th November, 2018 3:00 - 4:00 PM EST</p>		
<p>Ryan Huang [Nicholas School of the Environment, Duke University]</p>		

SARI webinar held on 28th Nov 2018

	<p>Dr. Krishna Vadrevu [NASA Marshall Space Flight Center (MSFC)]</p>	
<p>13th November, 2018 3:00 - 4:00 PM EST</p>		
<p>Dr. Meha Jain [Assistant Professor, University of Michigan]</p>		

SARI webinar held on November 13, 2018

LCLUC IN THE MEDIA

“Five of the week’s best science picks” (Sept 4, 2018)

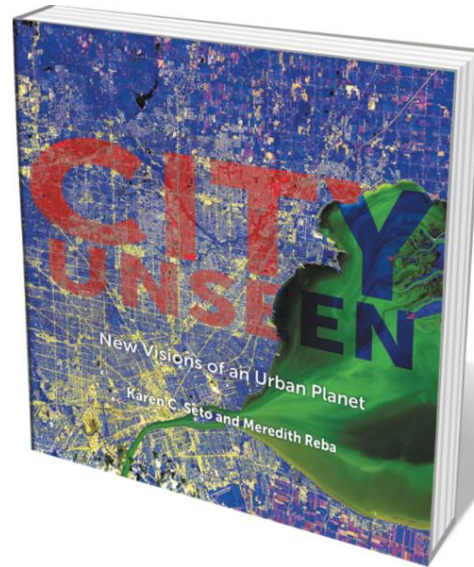
nature
International weekly journal of science

“Reveals things the human eye can’t see”

TIME

“...familiar places on Earth suddenly seem foreign and reshape our understanding of them”

-Kathryn Sullivan, NASA Astronaut



City Unseen: New Visions of an Urban Planet

Karen Seto and Meredith Reba
Yale University Press (2018)

Cities are a tug-of-war between nature and humanity – their configuration shaped by topography even as they mould the environment in and around them. This stunning study by Karen Seto and Meredith Reba explores this uneasy symbiosis through surreally hued satellite

images of 100 cities. Snaps of Phoenix, Arizona, taken 31 years apart reveal serious urban sprawl, and a shot of grain fields around Semikarakorsk, Russia, is a controlled riot of colour and line with the verve of early modernist art.

Also: Karen received the 2019 AAG Outstanding Contributions to Remote Sensing Award



SOCIOECONOMIC DATA AND APPLICATIONS CENTER (SEDAC)

A Data Center in NASA's Earth Observing System Data and Information System (EOSDIS) — Hosted by CIESIN at Columbia University

Search SEDAC...

Data



From the Landsat Science News Digest for January and February 2019:

“The Global High Resolution Urban Data from Landsat data collection contains the two companion data sets produced by NASA Goddard Space Flight Center (PI Brown de Colstoun) and University of Maryland (Cheng Huang)”

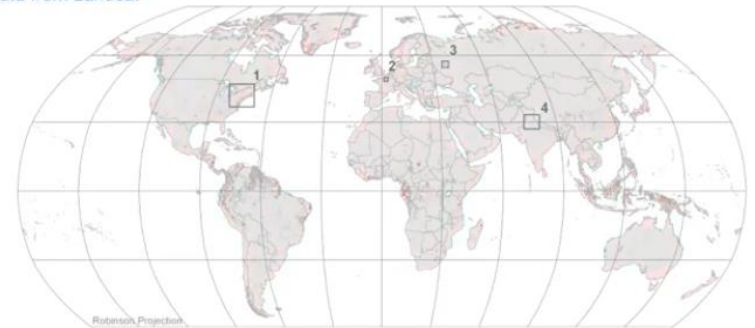
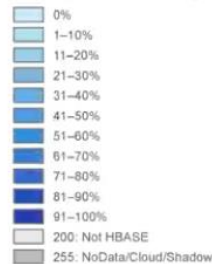


Hanoi, Vietnam from Landsat

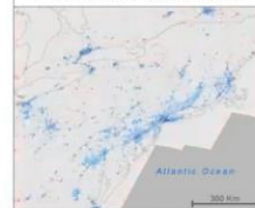
Global Man-made Impervious Surface (GMIS) Dataset From Landsat, 2010: Impervious Surface Percentage

Global High Resolution Urban Data from Landsat

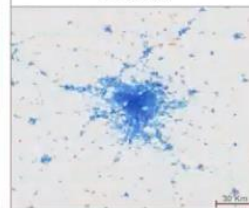
Impervious Surface Percentage



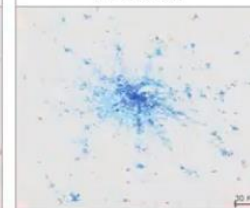
1 - NORTHEAST UNITED STATES



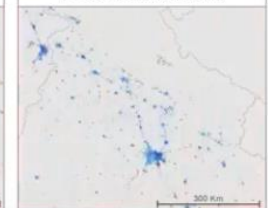
2 - PARIS



3 - MOSCOW



4 - GREATER NEW DELHI



The Global Man-made Impervious Surface (GMIS) Dataset From Landsat, part of the Global High Resolution Urban Data from Landsat collection, consists of global estimates of fractional impervious cover derived from the Global Land Survey (GLS) Landsat dataset for the target year 2010. The GMIS dataset consists of two components: 1) global percent of impervious cover; and 2) per-pixel associated uncertainty for the global impervious cover. These layers are co-registered to the same spatial extent at a common 30m spatial resolution. The spatial extent covers the entire globe except Antarctica and some small islands. This dataset is one of the first global, 30m datasets of man-made impervious cover to be derived from the GLS data for 2010 and is a companion dataset to the Global Human Built-up And Settlement Extent (HBASE) dataset.

- LCLUC Global Products (available since 2015)
 - Global Man-made Impervious Surfaces
 - Global Human Built-up And Settlement Extent

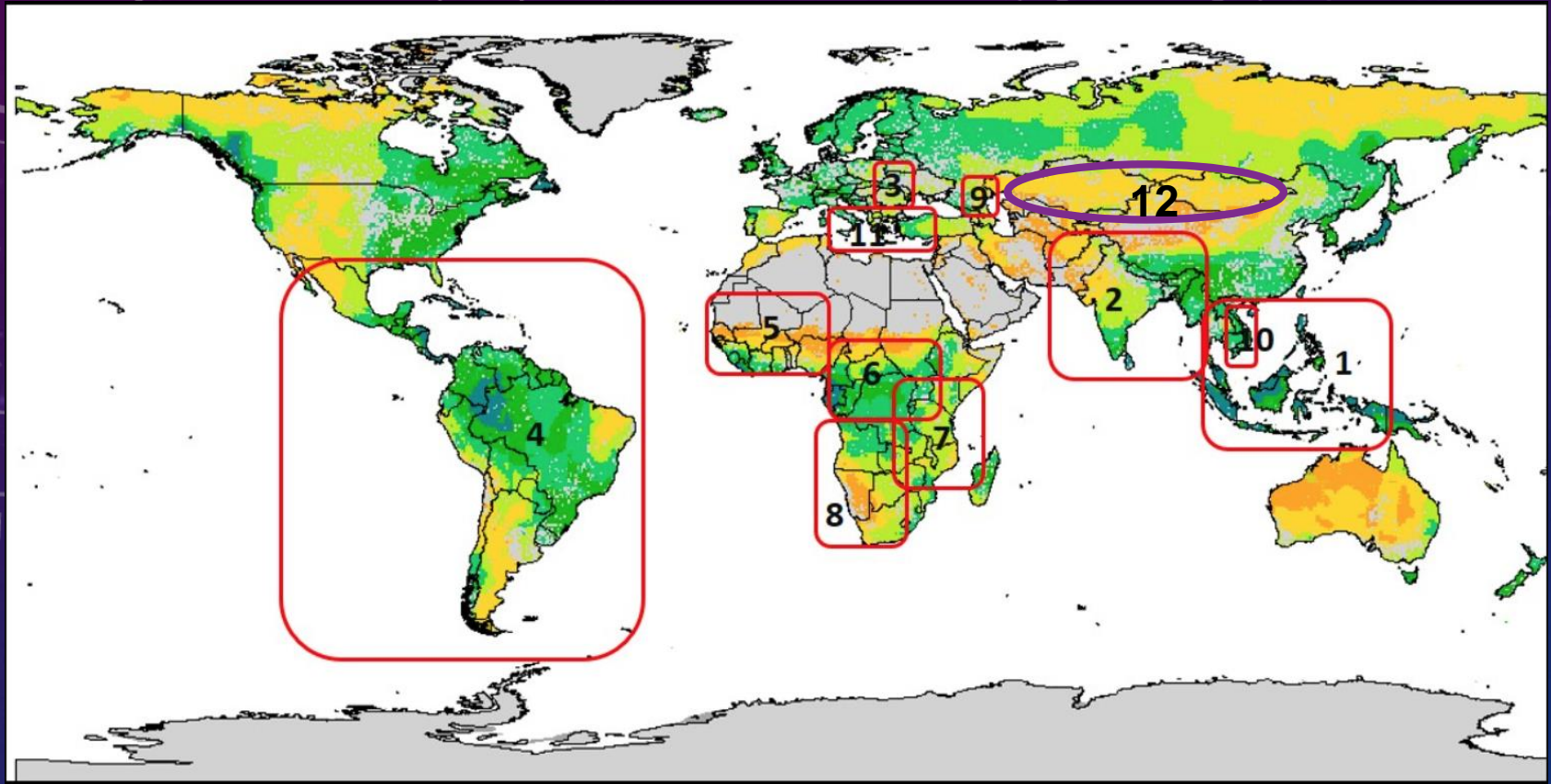
Promoting the Program in SE Asia: LCLUC Envoy to Vietnam

PI: Son Nghiem, JPL

- Coordinated with State Department and US Embassy in Hanoi, May 2018
- Science Envoy from State Department
 - Prof. Margaret Leinen (AGU Past President) opened the Hanoi meeting
- Diplomatic Reception
 - Prof. Noi Nguyen, Rector of Vietnam National University, Hanoi University
- Press/Media Coverage
 - BBC, VOA, MSN, Facebook, VOV TV, US Embassy, VN Express, Laotian Times, and 38 others



LCLUC Capacity Building: GOFC-GOLD Regional Networks



1. Southeast Asia Regional Research and Information Network (SEARRIN);
2. South Asia Regional Information Network (SARIN);
3. South Central European Regional International Network (SCERIN);
4. Red Latinoamerica de Teledeteccion e Incendios Forestales (RedLaTIF);
5. West African Regional Network (WARN);
6. Observatoire Satellital des Forets d'Afrique Central (OSFAC);
7. Miombo Network (MIOMBO);
8. Southern Africa Fire Network (SAFNET);
9. Caucasus Regional Information Network (CaucRIN);
10. Mekong Regional Information Network (MekRIN);
11. Mediterranean Regional Information Network (MedRIN);
12. Central Asian Regional Information Network (CARIN)

TRANS-ATLANTIC TRAINING (TAT) INITIATIVE

NASA-ESA regular training sessions in Eastern Europe for students and post-docs, open for any satellite data users and stakeholders

- Six TAT sessions by now
 - June 2013 in Prague, Czech Rep.
 - June 2014 in Krakow, Poland
 - April 2015 in Prague, Czech Rep.
 - July 2016 in Zvolen, Slovakia
 - June 2017 in Pecs, Hungary
 - June 2018 in Zagreb, Croatia
- The 7th is planned for June 2019 in Novi Sad, Serbia
- As a rule, conducted in conjunction with the GOFC-GOLD SCERIN network workshops
- Co-funded by NASA and ESA
- Various, state-of-the-art land remote sensing methods and applications: Forestry, Agriculture, Urban
- Lectures and hands-on practical exercises from NASA and ESA optical and microwave experts



TAT-2015 in Prague: Introductory lecture by Dr. Gutman on the current NASA space assets for studying land surface processes

TAT-2019 in Novi Sad: will do the same

SARI Capacity Building Activities

- SERVIR
- GISTDA
- SilvaCarbon
- LCLUC
 - after/before each regional meeting



Tanita



Perry



SARI-LCLUC Regional Training, 31st May-2nd June, 2018 Philippines

ARTSA
ASEAN RESEARCH AND TRAINING CENTER FOR SPACE TECHNOLOGY AND APPLICATIONS

ARTSA IN BRIEF
This center increases the capability of personnel knowledge and research development in the region as well as establishes and expands the network of academic knowledge and research collaboration among ASEAN countries that will benefit to natural resource, environmental management, and emergency response of the region.

The operational concept of the center is to increase ASEAN personnel capacity on the area of space technology and geo-informatics applications and raise awareness for all levels as well as strengthen the network of academic knowledge and research collaboration through conventional classroom training on the job training, research projects, academic network, etc.

GOALS

1. To provide services in education and trainings, knowledge sharing and enhancement, and awareness raising in Geo-informatics.
2. To conduct research applications and innovations, and collaborations in areas related to Geo-Informatics for ASEAN countries and worldwide.

TARGET GROUPS
ASEAN government agencies, private organizations, academic institutes, universities, and schools, and other relevant organizations.

BENEFITS

1. Establish extensive networking of space technology and applications in ASEAN.
2. Use Geo-Informatics to respond to current regional situation, problems, and disasters.
3. Enhance the country development and strengthen the cooperation among ASEAN countries for regional competitiveness and prosperity.

ASEAN COMMUNITY
R&D DELIVERY
TECHNOLOGY TRANSFER
SPACE & GI
APPLICATIONS & SOLUTIONS

GISTDA ACADEMY
190 Phrayothai Road, Chatuchak, Bangkok 10900 Thailand
Tel. (+66 2561 4504 to 5 4 431 432 Fax (+66) 2561 4503 Email: artsa@gistda.or.th
www.artsa.center.org

LCLUC-2019

- Theme: All LCLUC-related topics (Forests, Ag, Urban, etc.)
- Eligibility:
 - proposers (both PI and Co-Is) should have their Ph.D. degree awarded no earlier than 2014, so that at the time of submission of the full proposal (March 2020) a proposer would be no more than 6 years after the Ph.D. degree.
 - No restriction on the time after Ph.D. is imposed on collaborators
- Regions of interest
 - Latin America (non-LBA)
 - Mediterranean (eastern)
 - Central Asia
 - Western Asia (west of India)
- Due date step-1 Aug 1, 2019; step-2 Mar 3, 2020

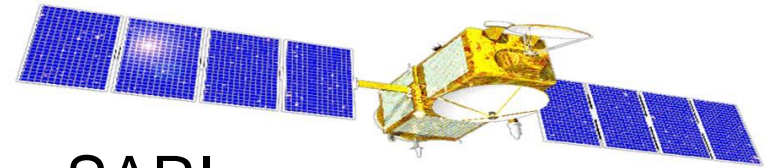
Important Meetings in 2019



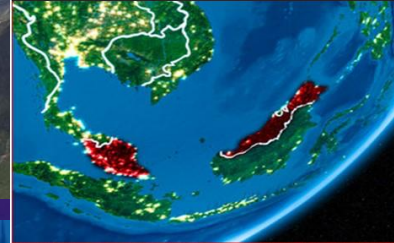
4th Open Science Meeting 2019

Transforming Land Systems for People and Nature

April 24 - 26, 2019 • Bern, Switzerland



SARI



living planet symposium

13-17 May 2019 | Milan



Abstracts due April 30

The Fourth

COSPAR Symposium

Small Satellites for Sustainable Science and Development



November 4 - 8, 2019 | Daniel Hotel, Herzliya, Israel

Local Host



FACULTY OF BUILT ENVIRONMENT & SURVEYING

Meeting Location:

Johor Bahru, Malaysia

Register!

Meeting date:

Monday, July 22, 2019 to Wednesday, July 24, 2019

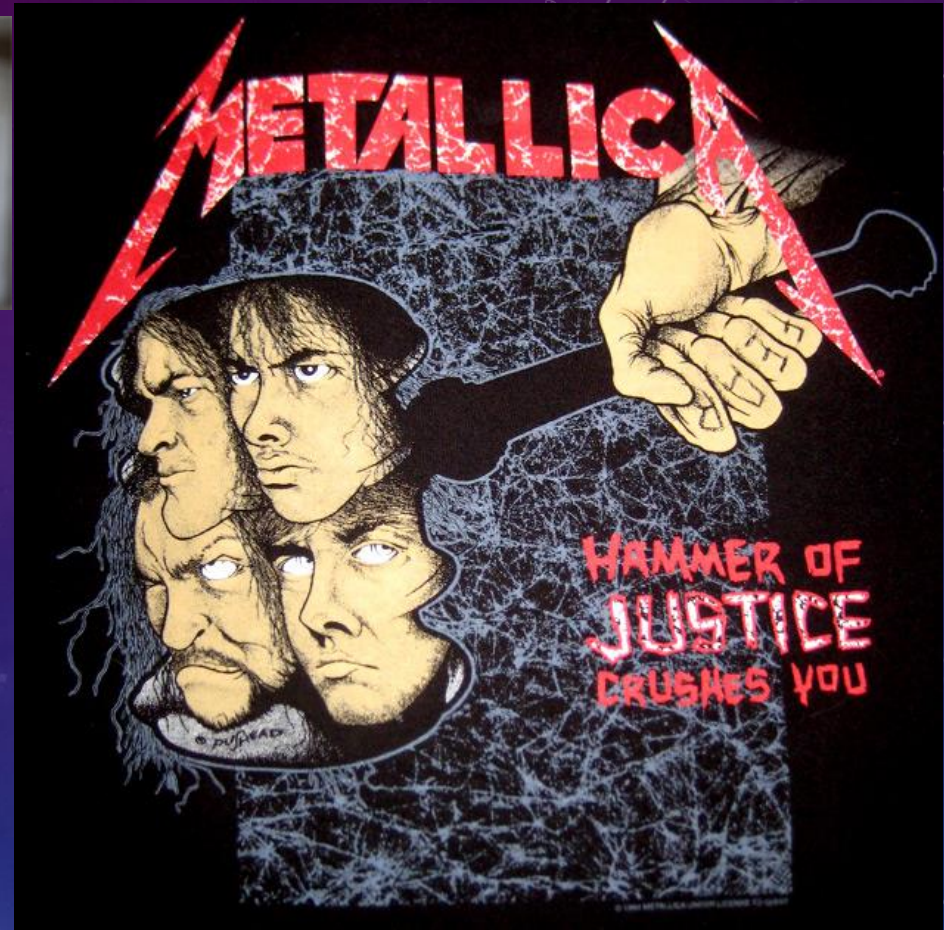
Training dates:

Thursday, July 25 to Saturday, July 27

THANKS GO TO



- Organizers: C. J. and Co.
- Mary, Jack, Catherine, Indu, Meghavi
- Sponsors: KBRwyle Government Services



To All LCLUCers: Enjoy Spring Blossoms

