

Overview:
Southeast Asia
LCLUC trends
and ongoing
issues

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Background

- Over the last several decades peninsular and insular Southeast Asia (SEA) have experience extremely rapid land-use and land-cover changes.
- Review of SARI projects in SEA with focus on—1) loss of forests and expansion of tree crops; 2) changes in lowland agricultural systems; and 3) urbanization. (sorry no wetlands, coastal resources)
- New changes on the horizon



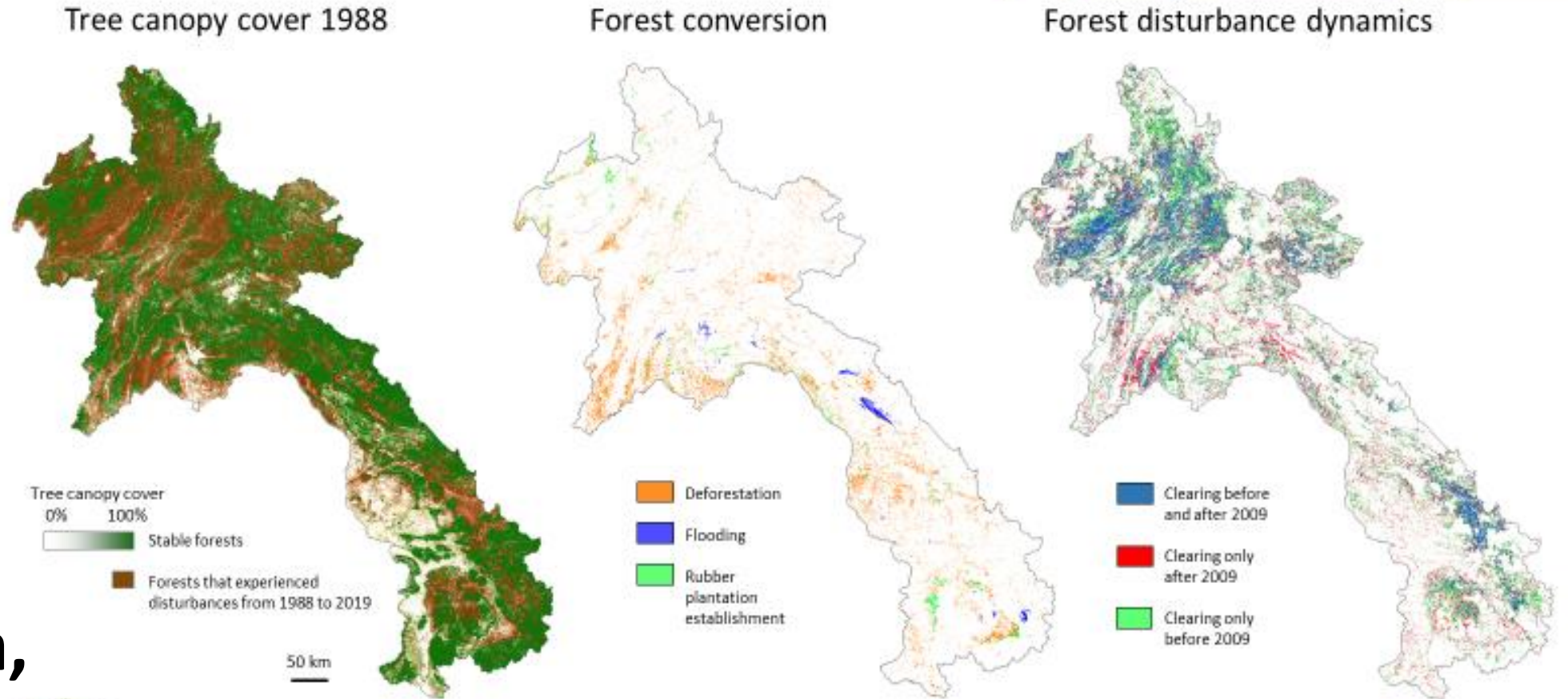
SARI and Deforestation in Southeast Asia

- Oil palm plantation mapping with Landsat and synthetic aperture radar: Examples from Malaysia and Peru. Naiara Pinto, NASA JPL.
- Shifting cultivation at a crossroad: Drivers and outcomes of recent land-use changes in Laos PDR. Peter Potapov, University of Maryland.
- Land Use Status, Change and Impacts in Vietnam, Cambodia and Laos, Son Nghiem, NASA Jet Propulsion Laboratory
- Forest Change and Oil Palm Expansion in Southeast Asia: Historical Patterns, Socioeconomic Drivers, and Future Projection. Laixiang Sun, University of Maryland
- Forest, agricultural, and urban transitions in Mainland Southeast Asia: Synthesizing knowledge and developing theory. J. Fox, and K. Hurni, East-West Center; A. Schneider, University of Wisconsin, Madison

Shifting cultivation at a crossroads in Lao PDR.

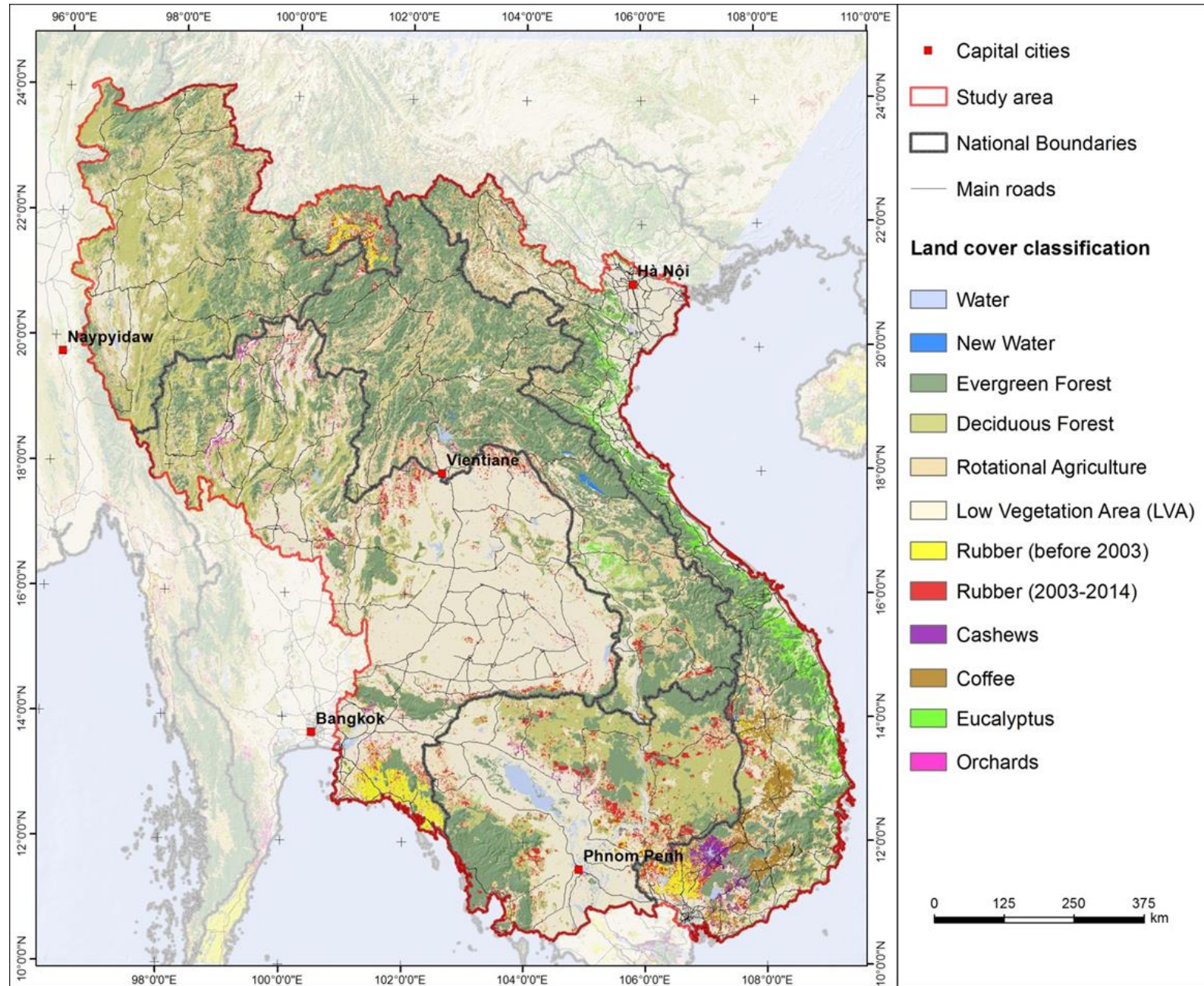
P. Potapov,
J. Silva,
A Tyukavina,
and
R. Traldi

Forest area change and its drivers: map data



Expansion of rubber: Historical and recent rubber-growing areas

Hurni and Fox 2018



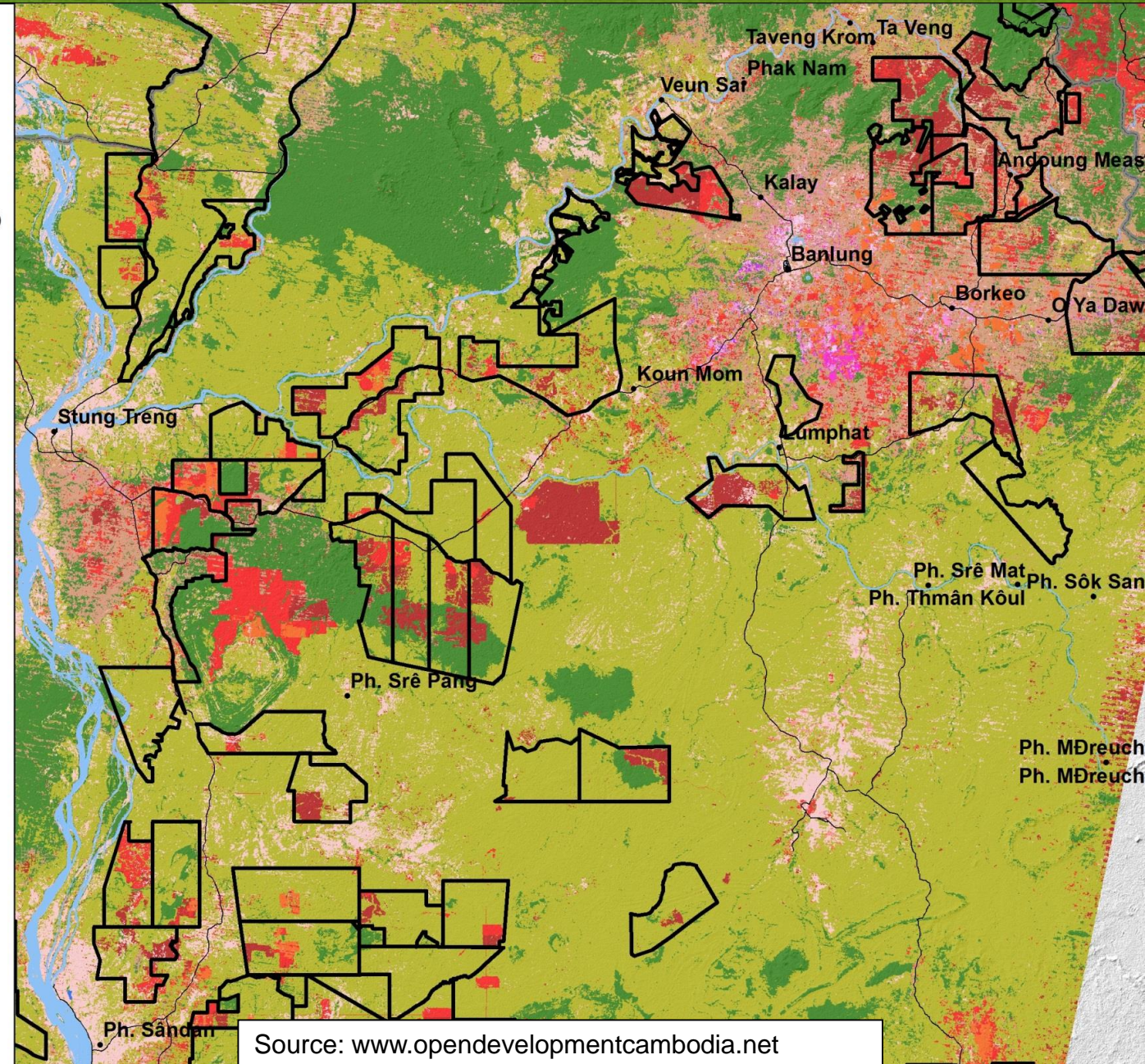
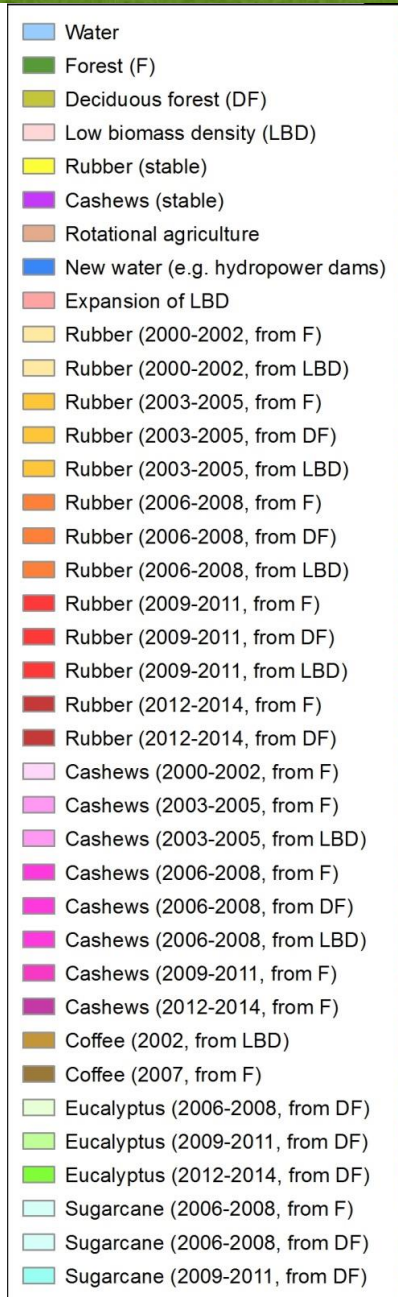


Summary of Changes in Land Use

- 44,000 sq km of rubber have been planted since 2003;
- 68% of rubber is planted on forest land;
- 32% on low vegetation area;
- Tree crops occupy about 8% of the landscape (half of that is rubber).

In Laos and Cambodia the governments promote foreign investments in the industrial plantations as a win-win:

- alleviates poverty in remote rural areas;
- By giving land rights to concessionaires, investors provide state revenues, wage labor, infrastructure, technical expertise, new technology, and increased production.



Source: www.opendevdevelopmentcambodia.net

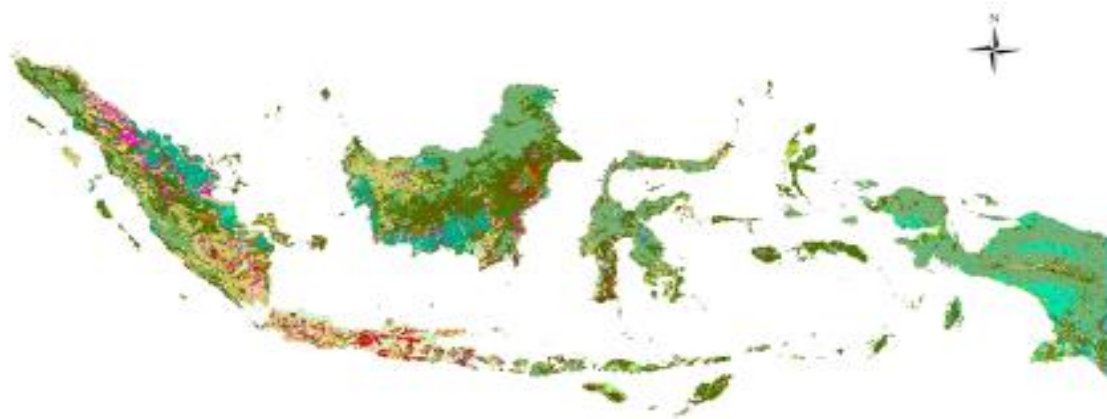
- Ethnic minority farmers losing access to land
- Overlapping and unclear land designations
- Lack of alternative income sources for remote villagers.



Expansion of Oil Palm

(Professor Laixiang SUN, Department of Geographical Sciences, University of Maryland)

Land Cover 1990



Land Cover 2015

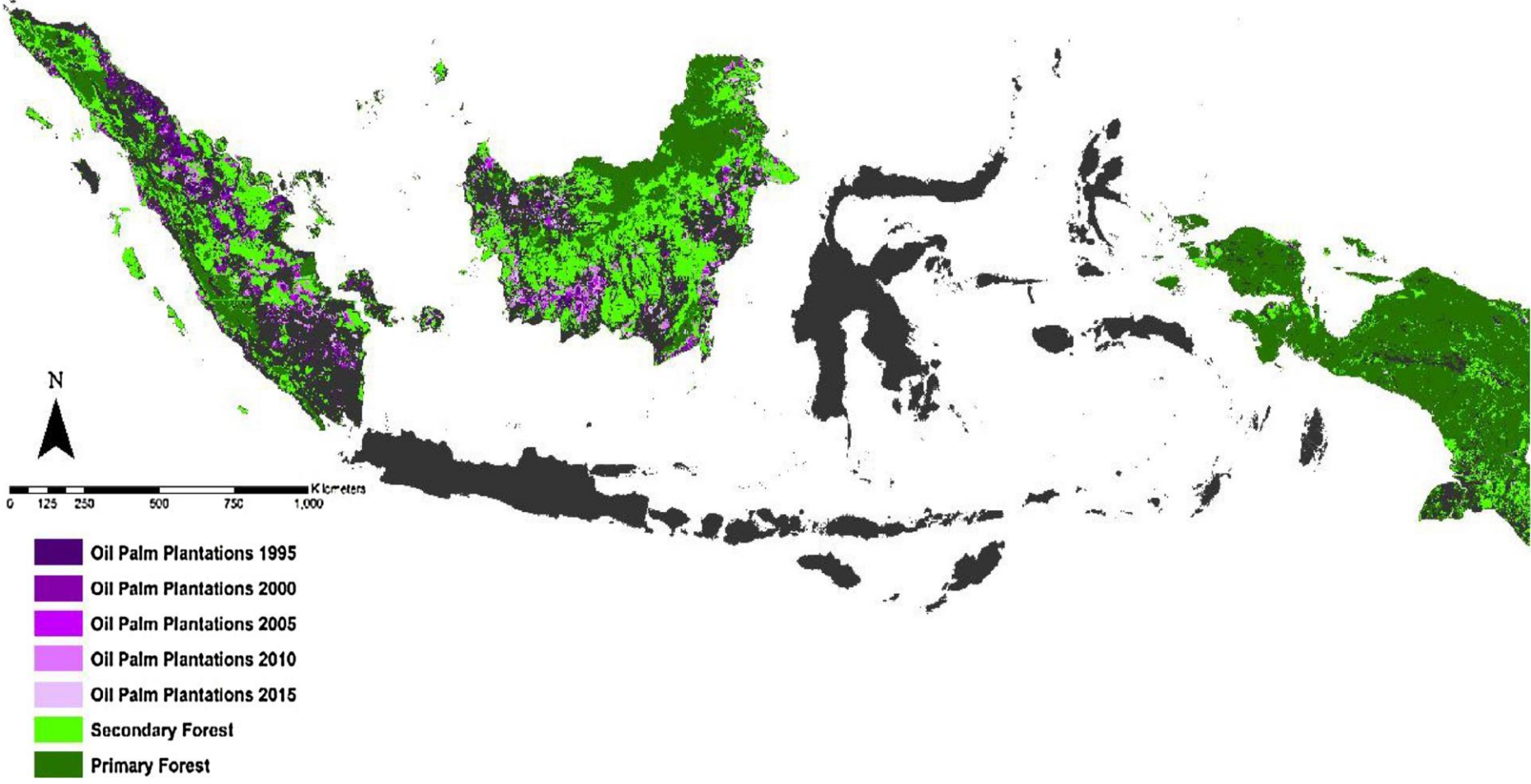


Data Source: Ministry of Environment and Forestry (MoEF)
Projection: WGS 1984 Cylindrical Equal Area

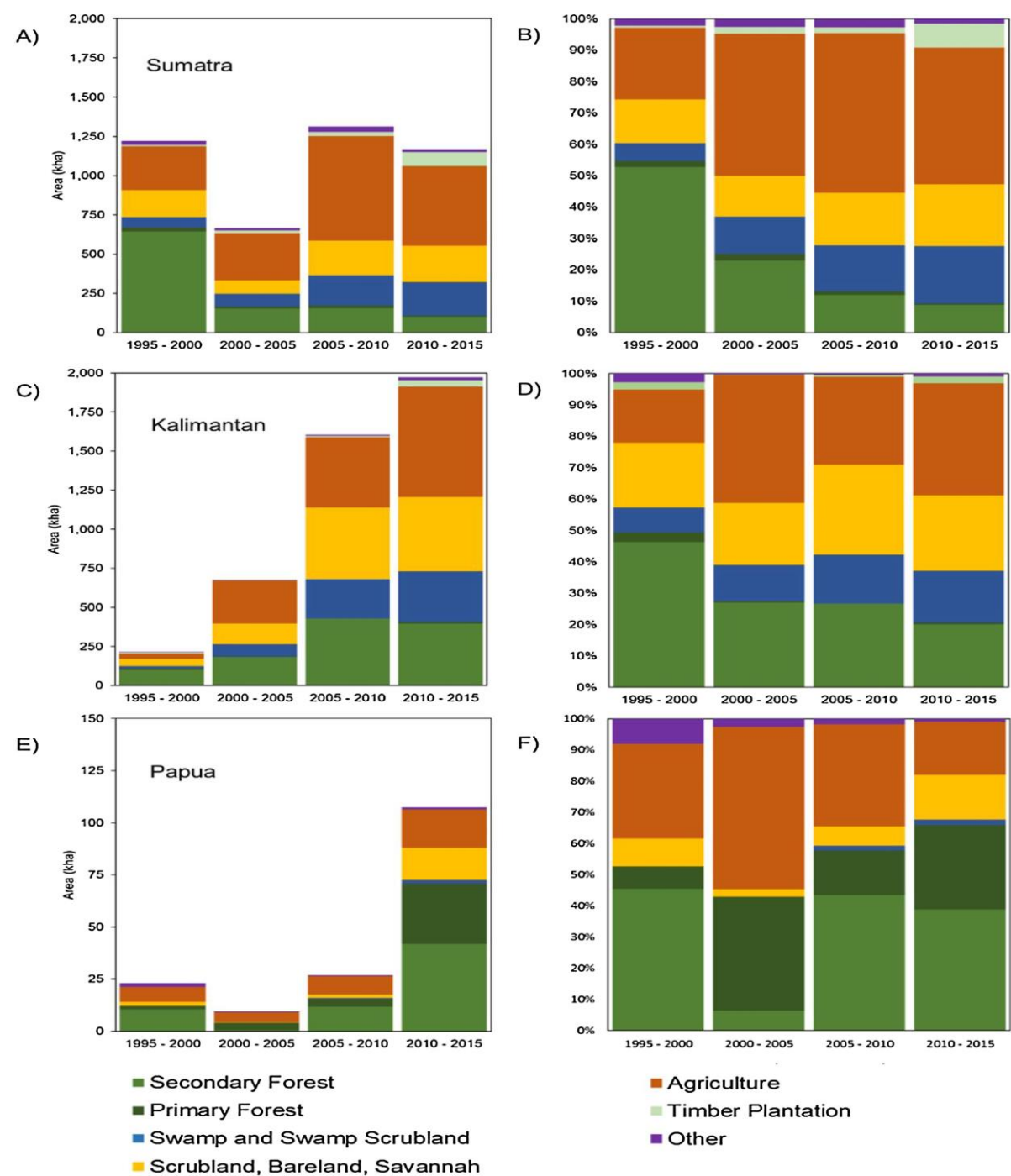


Shifting patterns of oil palm driven deforestation in Indonesia

G. Austin, A. Mosnier, J. Pirker, I. McCallum, S. Fritz, P. Kasibhatla. 2017. *Land Use Policy* 69:41-48



Area (A, C, and E) and B) Proportion (B, D, F) of each land cover category converted to oil palm plantation in Sumatra, Kalimantan and Papua.



Enhanced Vegetation Index EVI from MODIS Terra

LCLUC in
Vietnam:
Impacts and
Implications

Son Nghiem
and Science
Team, JPL



Nighttime Light from OLS in NASA VIIRS mask



Let There Be Light

Long An and Binh Thuan Provinces

The Kingdom of Dragon Fruit (*Hylocereus undatus*)



Rice Paddy Conversion: Mekong Delta

2019 field data supported by results from Landsat and VHR analyses.



Aquaculture:

- Fish
- Shrimp
- Eel
- Frog



Orchards:

- Mango
- Papaya
- Guava



Crops:

- Corn
- Melon
- Sweet Potato



Summary of Deforestation and Expansion of Tree Crops

- 44,000 sq. km of rubber have been planted since 2003; 68% of rubber planted on forest land; Tree crops occupy about 8% of the landscape (half of that is rubber).
- There were 111,000 sq. km of industrial-scale oil palm plantations in Indonesia in 2015, Since 2005 the rate of expansion has doubled to approximately 6,000 sq. km annually.
- Fruit/other tree crops?? Not enough information of summarize amount or rate of fruit tree expansion in the region—but it is significant and is not generally being mapped.

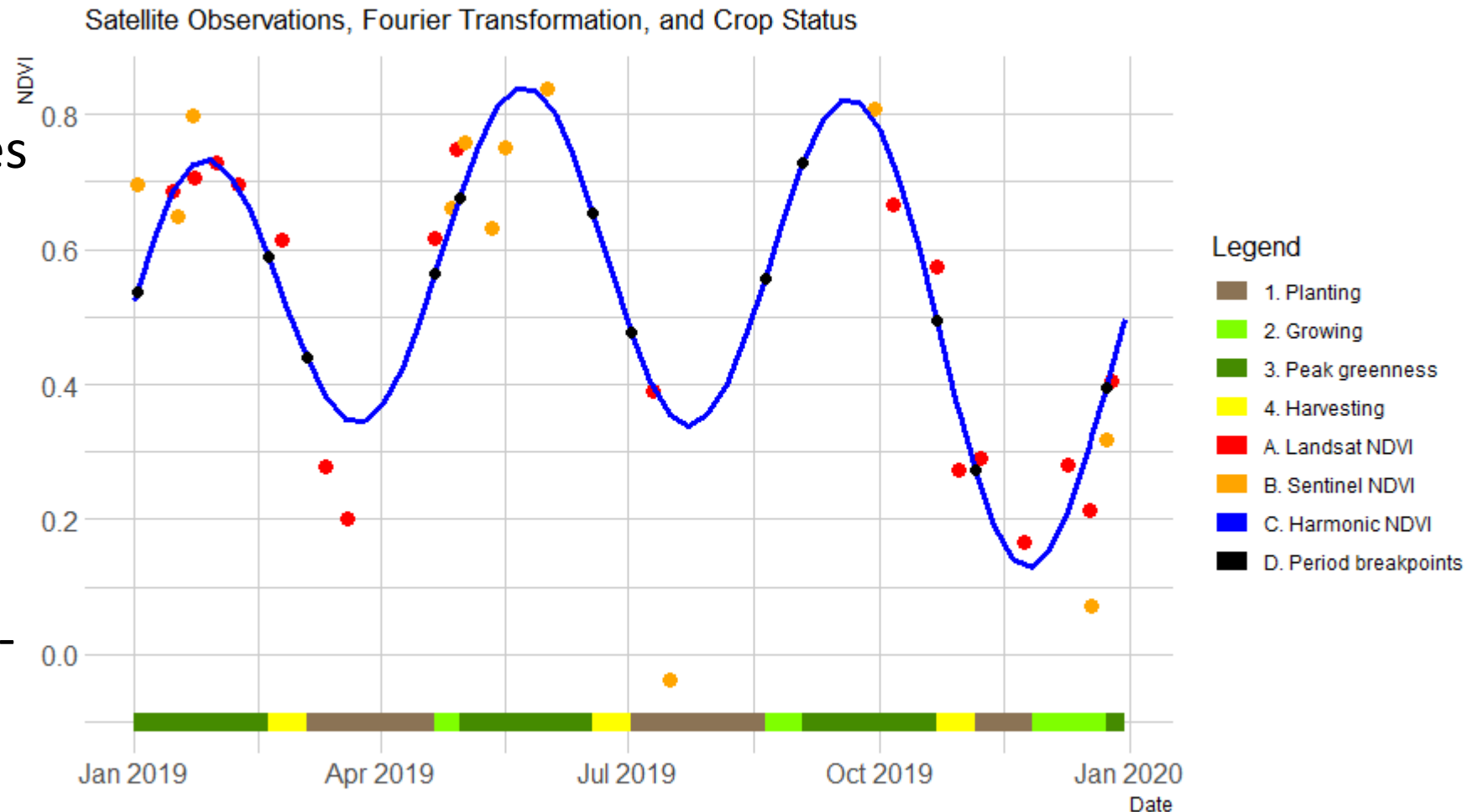


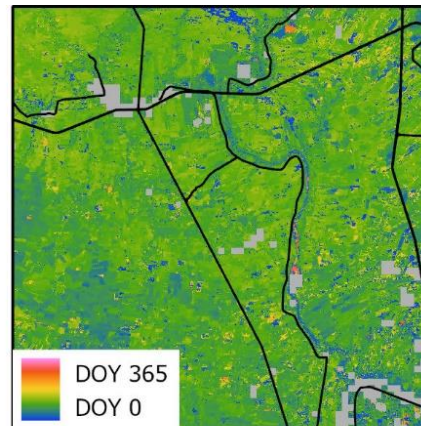
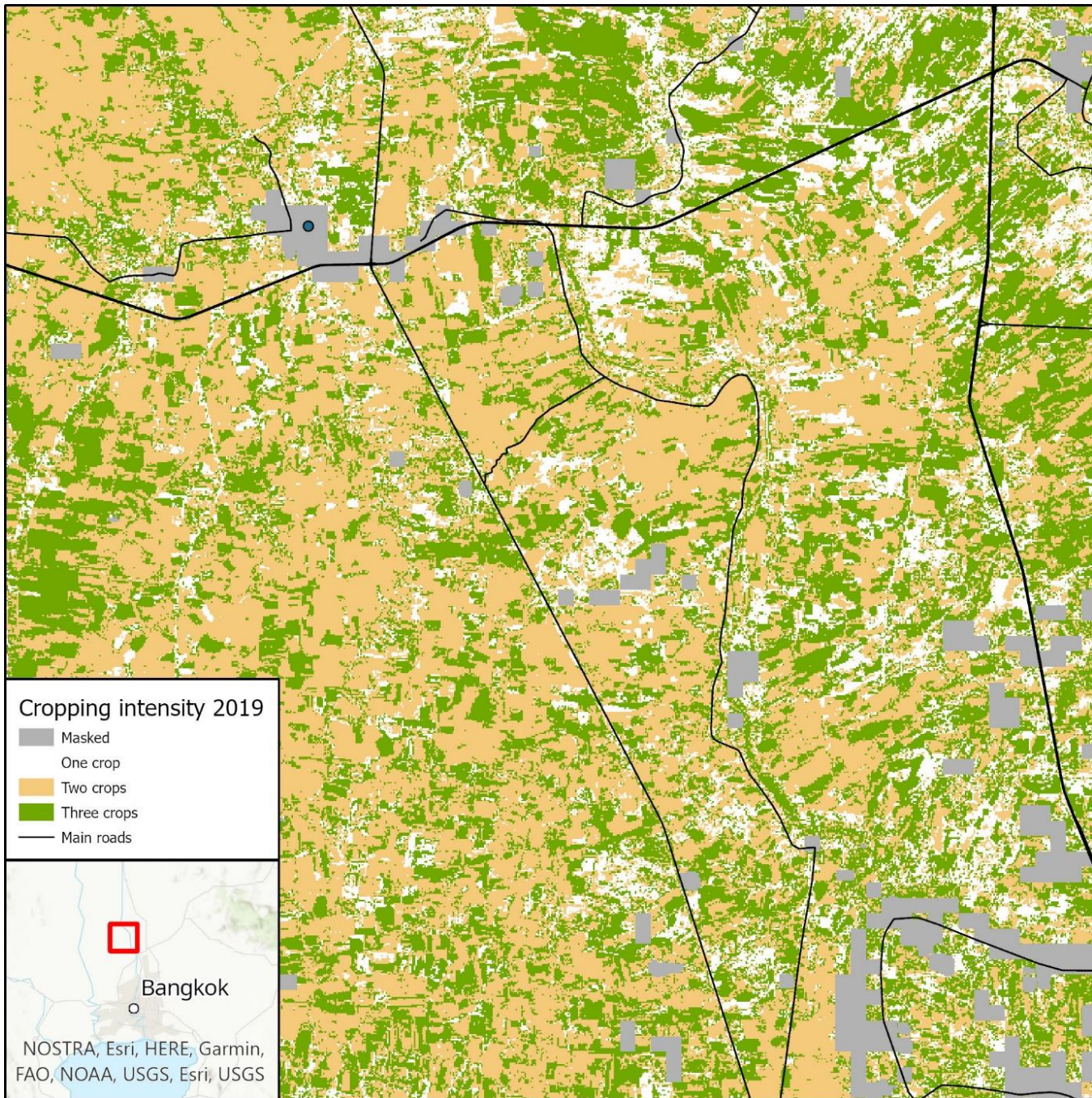
SARI and Rice transition in Southeast Asia

- The Agrarian Transition in Mainland Southeast Asia: Changes in Rice Farming - 1995 to 2018. J. Fox, K. Hurni, and J. Van Den Hoek, EWC
- Land-Cover/Land-Use Change in Southern Vietnam Through the Lenses of Conflict, Religion, and Politics, 1980s to Present, Jessica McCarty, Miami University
- Agricultural Land Use Change in Central and Northeast Thailand: Effects on Biomass Emissions, Soil Quality, and Rural Livelihoods. Varaprasad Bandaru, University of Maryland
- Forced and Truncated Agrarian Transitions in Asia Through the Lens of Field Size Change. Lin Yan and David Roy, Michigan State University

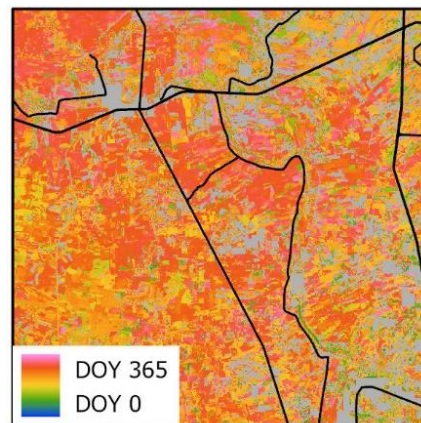
The Agrarian Transition in Mainland Southeast Asia: Changes in Rice Farming - 1995 to 2018. J. Fox, K. Hurni, and J. Van Den Hoek, EWC

To obtain detailed information on land management practices (e.g. planting and harvesting periods) and cropping intensities, we apply the fourier transformation (harmonics) to a time-series of vegetation index values

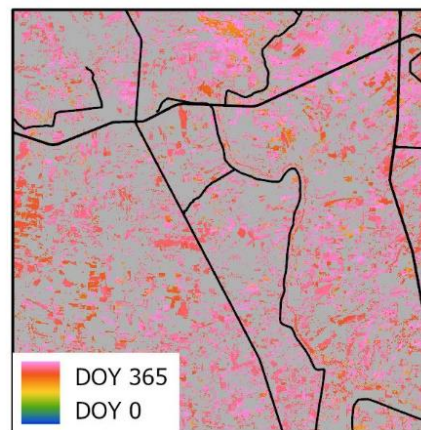




Planting day crop 1



Planting day crop 2



Planting day crop 3

Google Earth images 2019 accuracies for (>70%). Median field size = 1.6 ha.

Forced and Truncated Agrarian Transitions in Asia Through the Lens of Field Size Change. Lin Yan and David Roy, Michigan State University, J. Fox, EWC



Sentinel-2
109 x 109 km tile
over Bangkok
(tile T47PPR)

Sentinel-2B
false color
(SWIR1, NIR, red)
January 27th 2020

10980 × 10980 10 m pixels

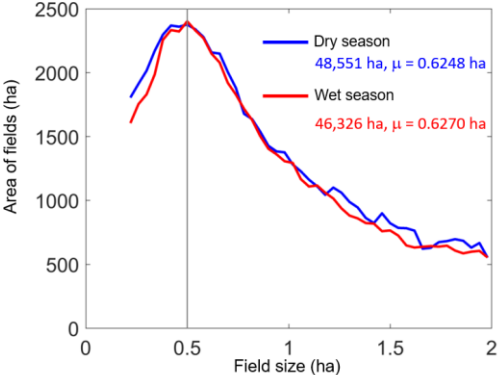
(SWIR1 band resampled from
20m to 10m)

Forced and Truncated Agrarian Transitions in Asia Through the Lens of Field Size Change.

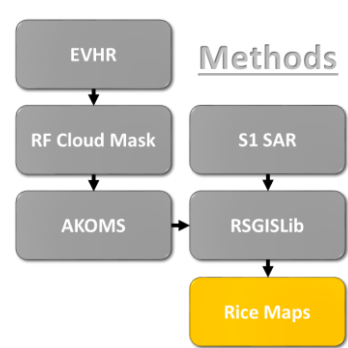
Lin Yan and David Roy, Michigan State University



Field size histogram by area of fields (only considering fields ≤ 2 ha)



4.6% less area planted in wet season
0.5 ha is the most common rice field size (vs. ~ 0.8 ha in survey results)



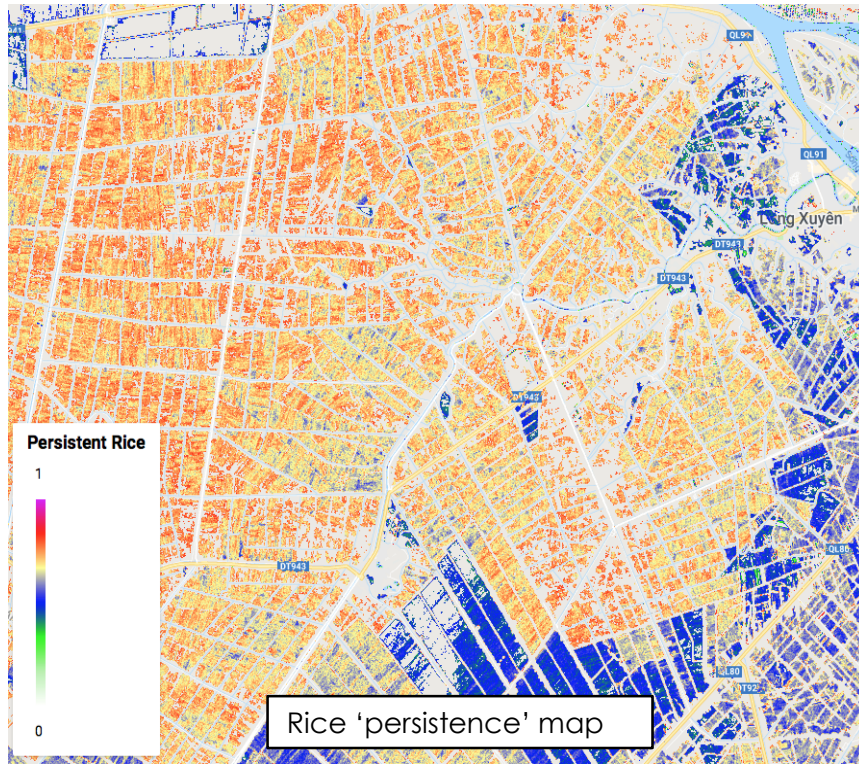
Methods

Land-Cover/Land-Use Change in Southern Vietnam Through the Lenses of Conflict, Religion, and Politics, 1980s to Present, Jessica McCarty, Miami University

Results

Our multi-modal approach provides a more accurate representation of very-small fields due to the ability of 0.3 – 0.5 m resolution WorldView data to discriminate field boundaries. Integrating Sentinel-1 backscatter harmonics on a per-object basis provides multiple observations to monitor changes in crop cover and inundation of rice paddies when cloud free observations are scarce.

Normalized Rice Persistence: The rice binary maps were summed and divided by number of images in stack, for each pixel generating a normalized measure of 'rice persistence'.



Normalized Water Persistence: An inverse method to rice mapping also enables a normalized water persistence image to be generated





Summary of changes in lowland agricultural systems

- It is not easy to map rice fields
 - small plots, but also heterogeneity in plot size, and crops grown—not always rice
 - persistent cloud cover during the main growing season
 - environmental variability (floods, droughts)
- We are making progress by approaching it from different sides...
 - Mapping water frequency; mapping plot sizes
 - Mapping cropping intensity, and land management timing
 - Using different sensors (Landsat, Sentinel, Sentinel radar, WorldView helps with this, e.g. pre-processing level of available data ('analysis ready data'), choices in terms of resolution (spatial, temporal), sensor types (active/passive)

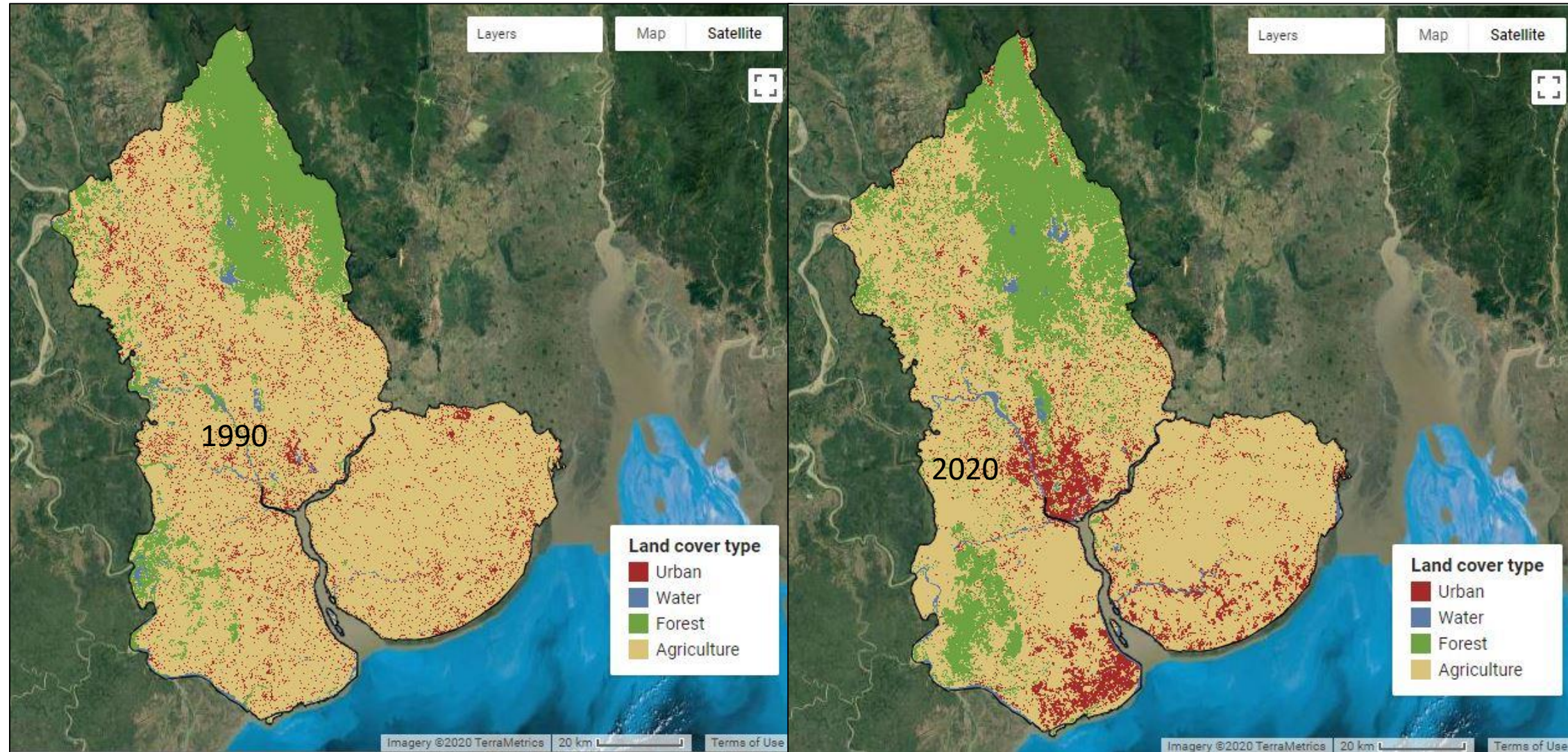


Urbanization

- Divergent local responses to globalization: urbanization, land transition, and environmental changes in Southeast Asia. Peilei Fan, Michigan State University
- Forest, agricultural, and urban transitions in Mainland Southeast Asia: Synthesizing knowledge and developing theory. J. Fox, and K. Hurni, East-West Center; A. Schneider, University of Wisconsin, Madison
- Coupled Natural-Human Systems and Emerging Infectious Diseases: Anthropogenic environmental change and avian influenza in Vietnam. S. Saksena, et al. EWC.

Yangon,
Myanmar

Peilei Fan,
Michigan
State
University

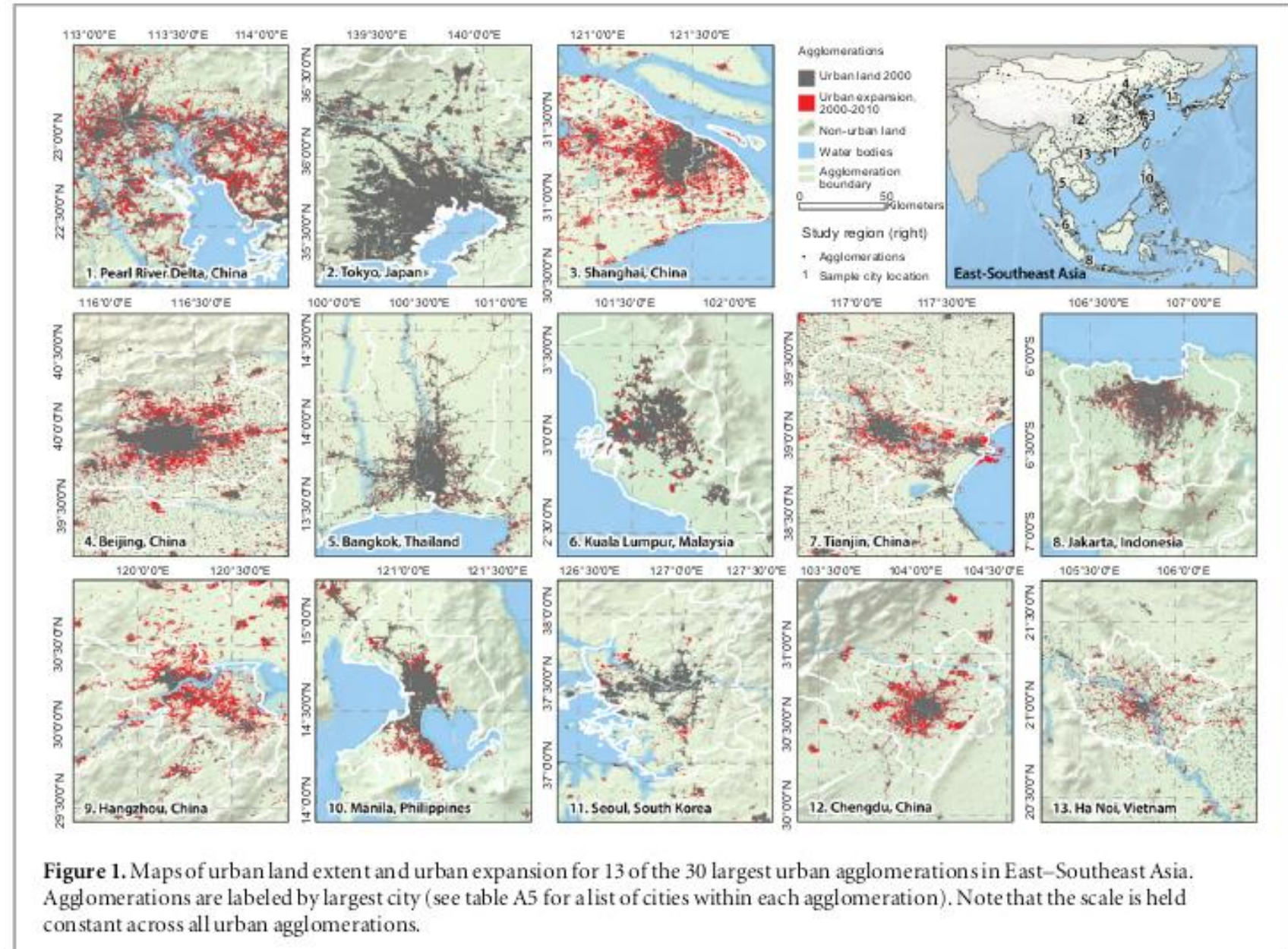


17.9% increase (150.3 km²) in urban land from 1990-2020

A new urban landscape In East-Southeast Asia 2000-2010

A. Schneider

Environmental
Research
Letters 10 (2015)



Urban classification of urbanization in Vietnam using 2006 agricultural data: The importance of peri-urbanization

- Fraction of households whose main income is from agriculture, forestry, and aquaculture;
- Fraction of households whose land is under agriculture, forestry, and aquaculture;
- Fraction of houses using modern forms of toilet (pour flush or septic);
- Vegetation density, measured by the Normalized Difference Vegetation Index (NDVI) derived from MODIS.

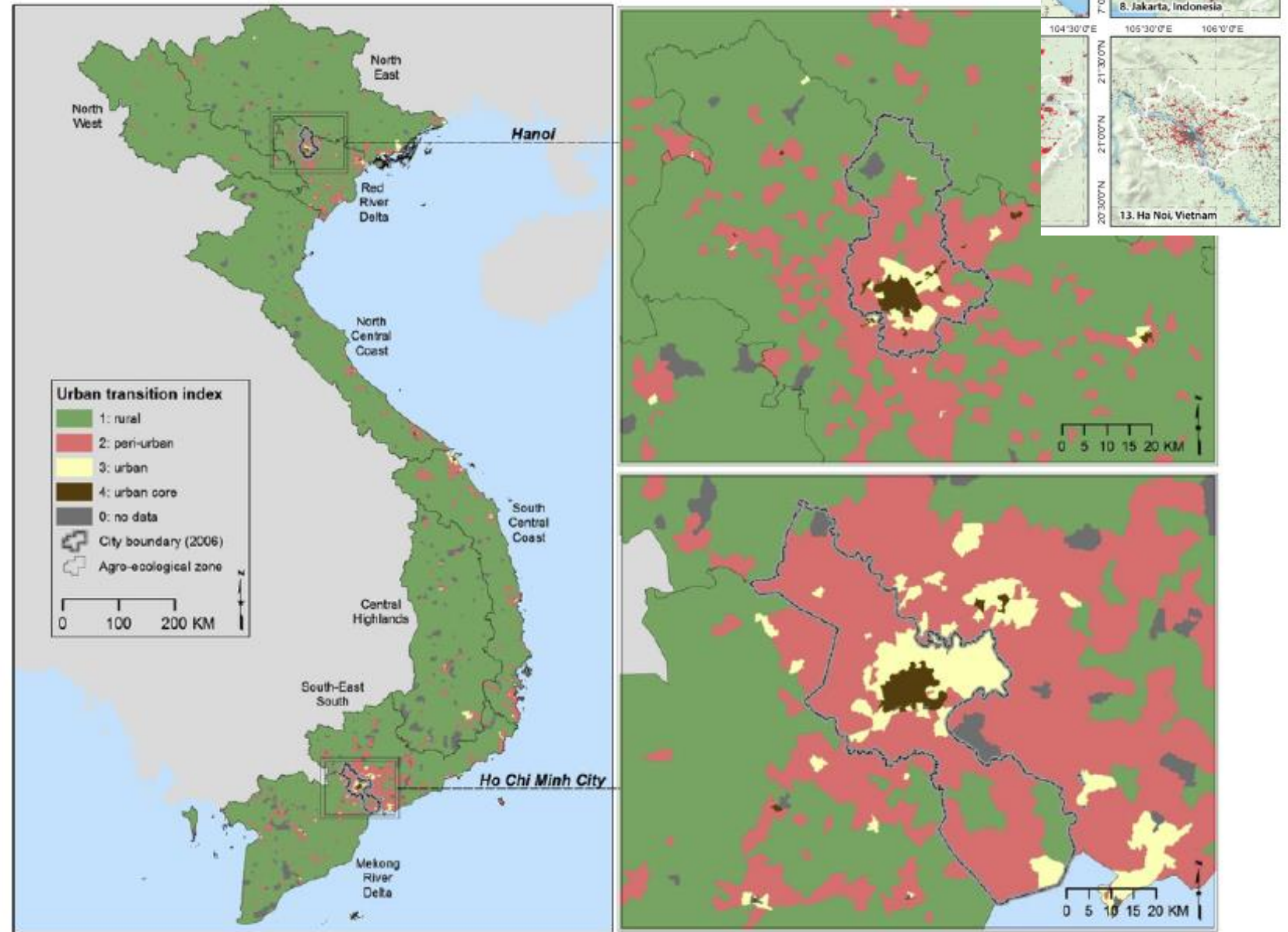



Fig. 2. Urban classification map of Vietnam.



Summary of changes in urbanization

- Little work has been done by SARI funded research on urbanization in Southeast Asia.
- Seto and Schneider have both done extensive work in East Asia so methods exist.
- But more work needs to be done on this topic in Southeast Asia
- We need a better understanding of peri-urbanization in Southeast Asia



Prospective: Where do we go from here in Southeast Asia

- Rapid expansion of large scale agribusinesses (rubber and oil palm expanding to other tree crops orchards, coffee, fast-growing trees for pulp and paper).
 - People are eating less rice and more meat and vegetables—mapping of vegetables and livestock farming—particularly cows—where are they?
- Rapid development of new infrastructure—dams, roads, solar energy—what are the impacts of these developments on LCLUC?
- Rapid urbanization in primary and secondary cities. What are the impacts on LCLUC in terms of peri-urbanization, ground water extraction, waste management, etc. Coastal cities are sinking due to ground water extraction—Chaussard et al. 2013 used SAR data to map subsidence in Jakarta.
- Geographically, we have maps of peninsular SEA and maps of insular SEA, but no one (except Hansen's global product) has mapped all of SEA (from China to PNG). Changes in tree cover, low-land land use, urbanization