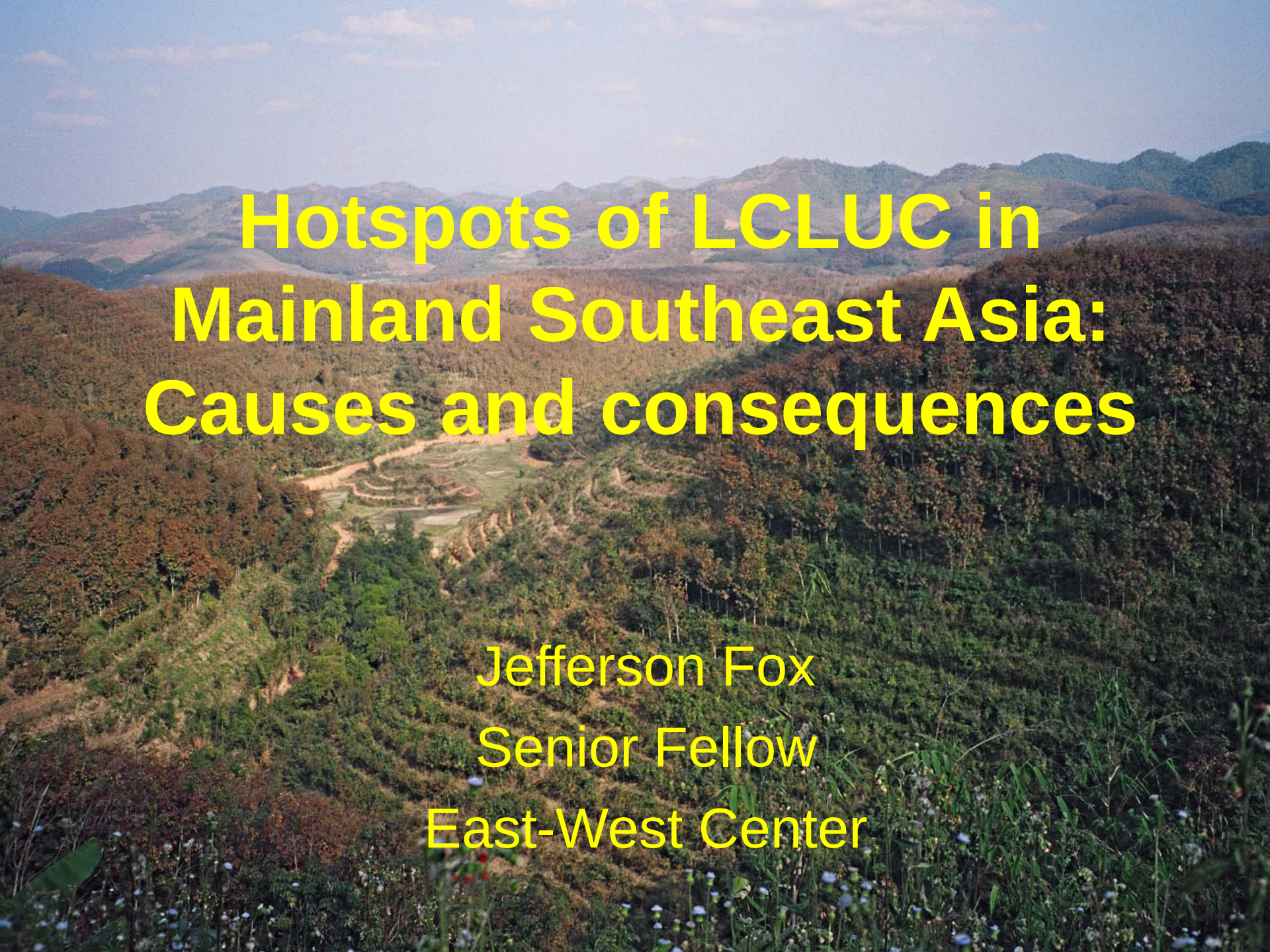


Hotspots of LCLUC in Mainland Southeast Asia: Causes and consequences

Jefferson Fox
Senior Fellow
East-West Center

Outline of talk

- Background on mainland Southeast Asia
- Changes in the lowlands
  - Agriculture expansion
  - Periurbanization
  - Loss of natural wetlands and expansion of aquaculture
  - Causes and consequences
- Changes in the uplands
  - Deforestation/afforestation
  - Loss of shifting cultivation
  - Expansion of protected areas
  - Expansion of perennial agriculture
  - Causes and consequences
- Other changes—roads, dams, and mines
- Summary

1,959,292 Sq Km.

226,900,000 people

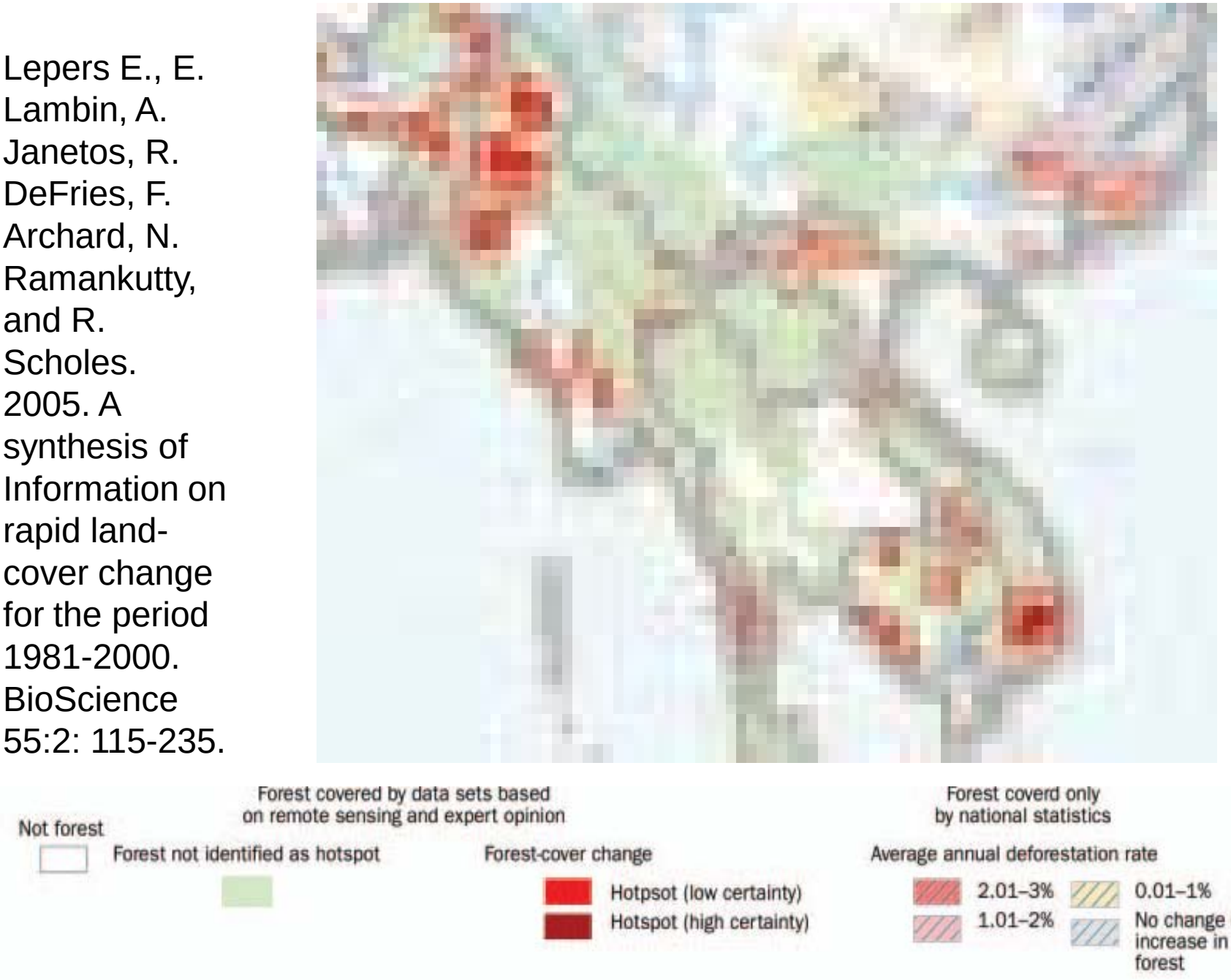
115 people/

Sq km

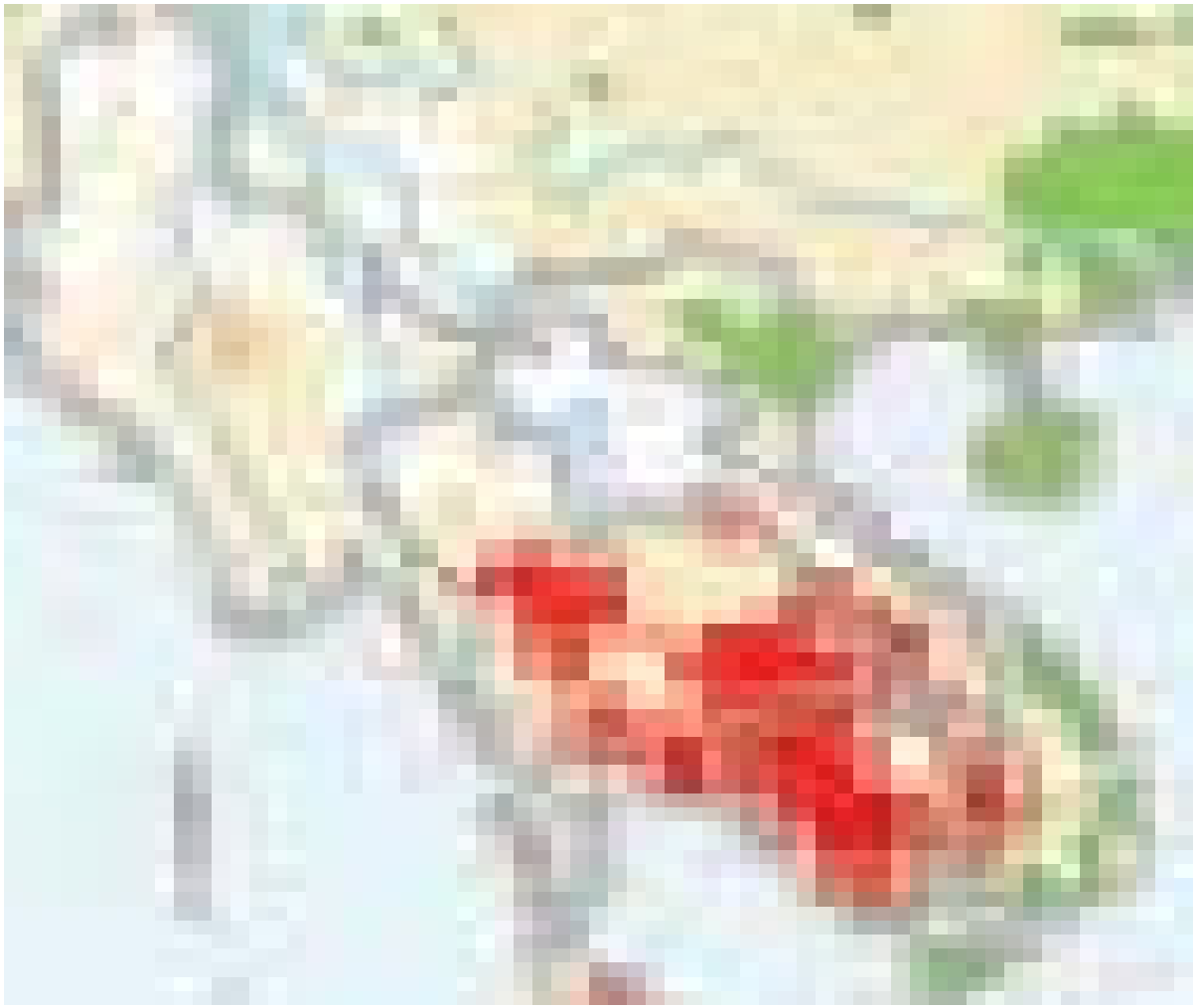
Population Growth

Country	2008	% increase 1990-2008	Pop density (sq km)
Cambodia	14,800,000	1.7	75.16
Laos	6,300,000	2.1	26.25
Myanmar	50,000,000	1.1	63.24
Thailand	67,800,000	0.6	127.32
Vietnam	87,300,000	1.2	253.48
Xishuang-banna	700,000	??	36.55
Total	226,900,000	1.33	115.81

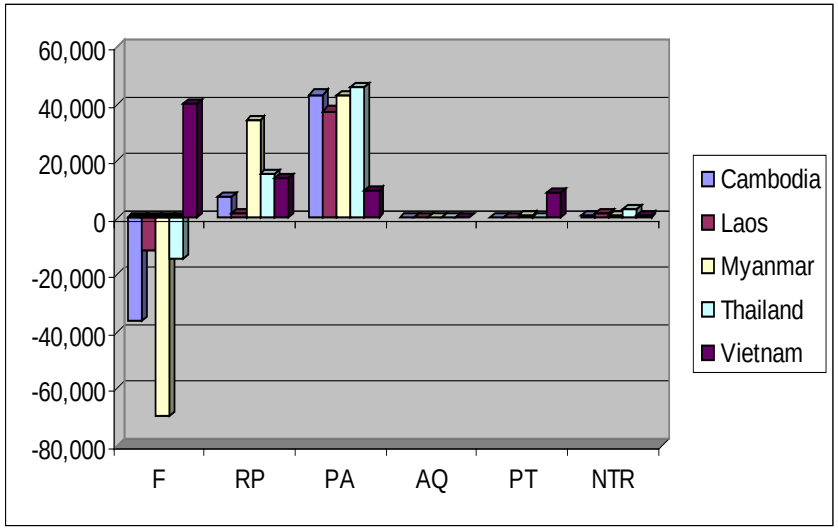
Lepers E., E. Lambin, A. Janetos, R. DeFries, F. Archard, N. Ramankutty, and R. Scholes. 2005. A synthesis of Information on rapid land-cover change for the period 1981-2000. BioScience 55:2: 115-235.



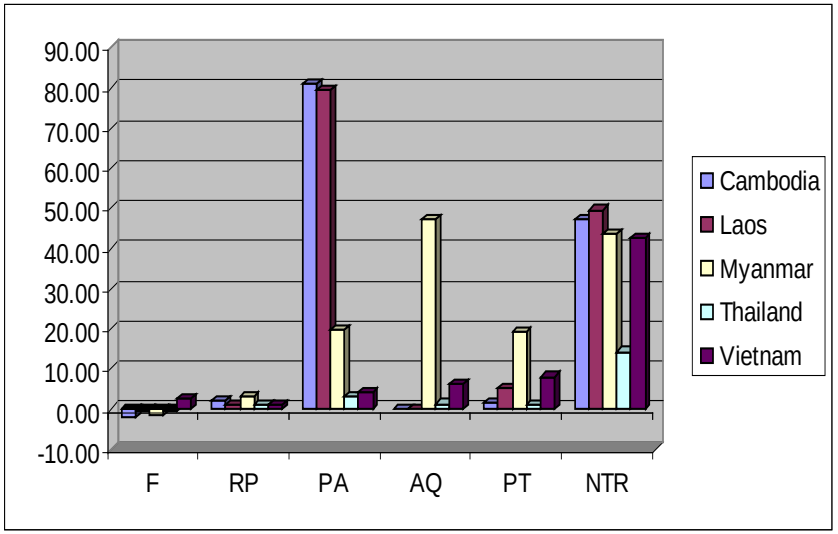
Lepers E., E. Lambin, A. Janetos, R. DeFries, F. Archard, N. Ramankutty, and R. Scholes. 2005. A synthesis of Information on rapid land-cover change for the period 1981-2000. BioScience 55:2: 115-235.



Hotspots of LCLUC in Mainland Southeast Asia (1990 to 2008)



Total area in square kilometers



Annual rate of increase in %

F= forest; RP = rice/paddy; PA = protected area; AQ = Shrimp aquaculture; PT = Perennial trees; NTR = non-traditional rubber. Numbers from FAOSTAT; FAO World Forests; World Bank World Development Indicators; IUCN Protected Areas.

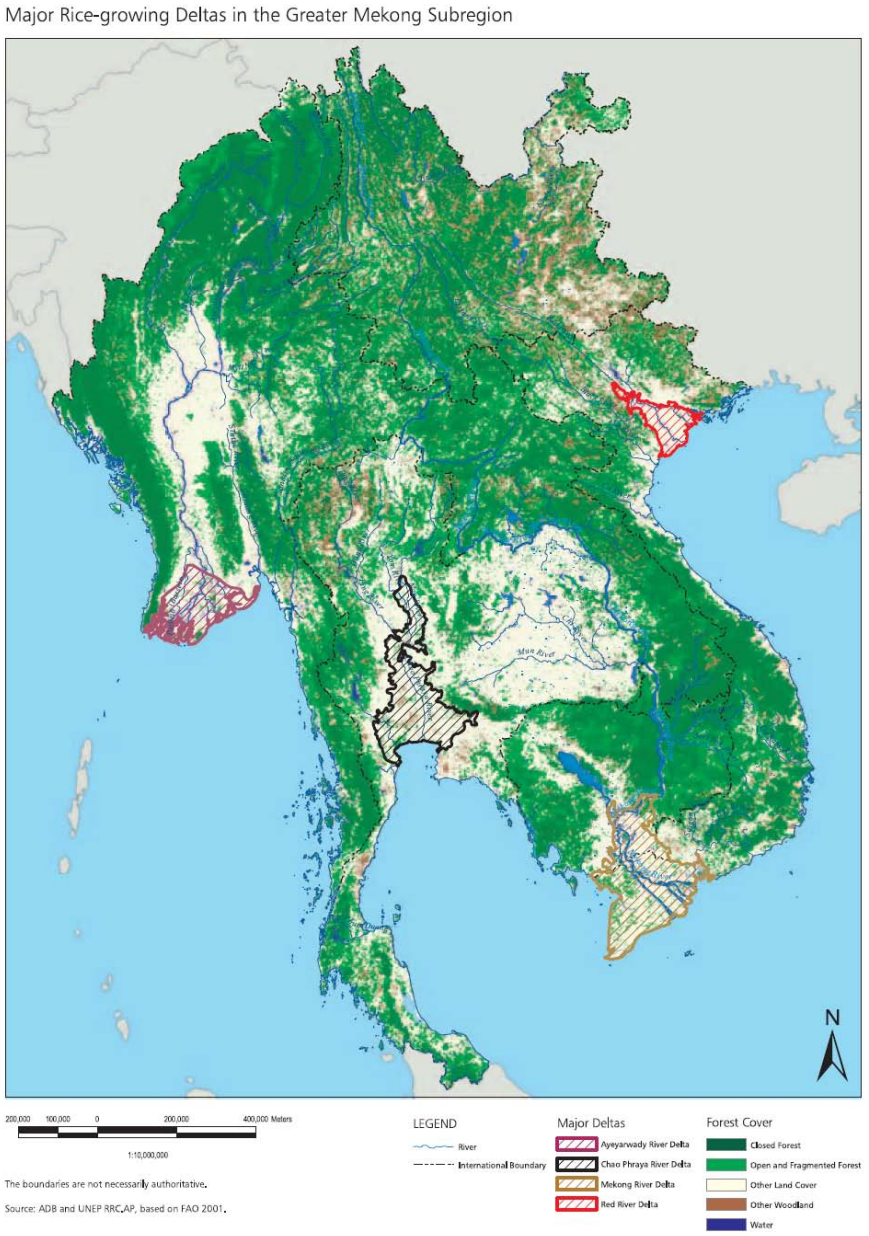
Changes in the lowlands

- Changes in the lowlands
  - Expansion of agricultural in the lowlands
  - Expansion of urban and periurban areas
  - Loss of natural wetlands and expansion of aquaculture

Expansion of agricultural in the lowlands

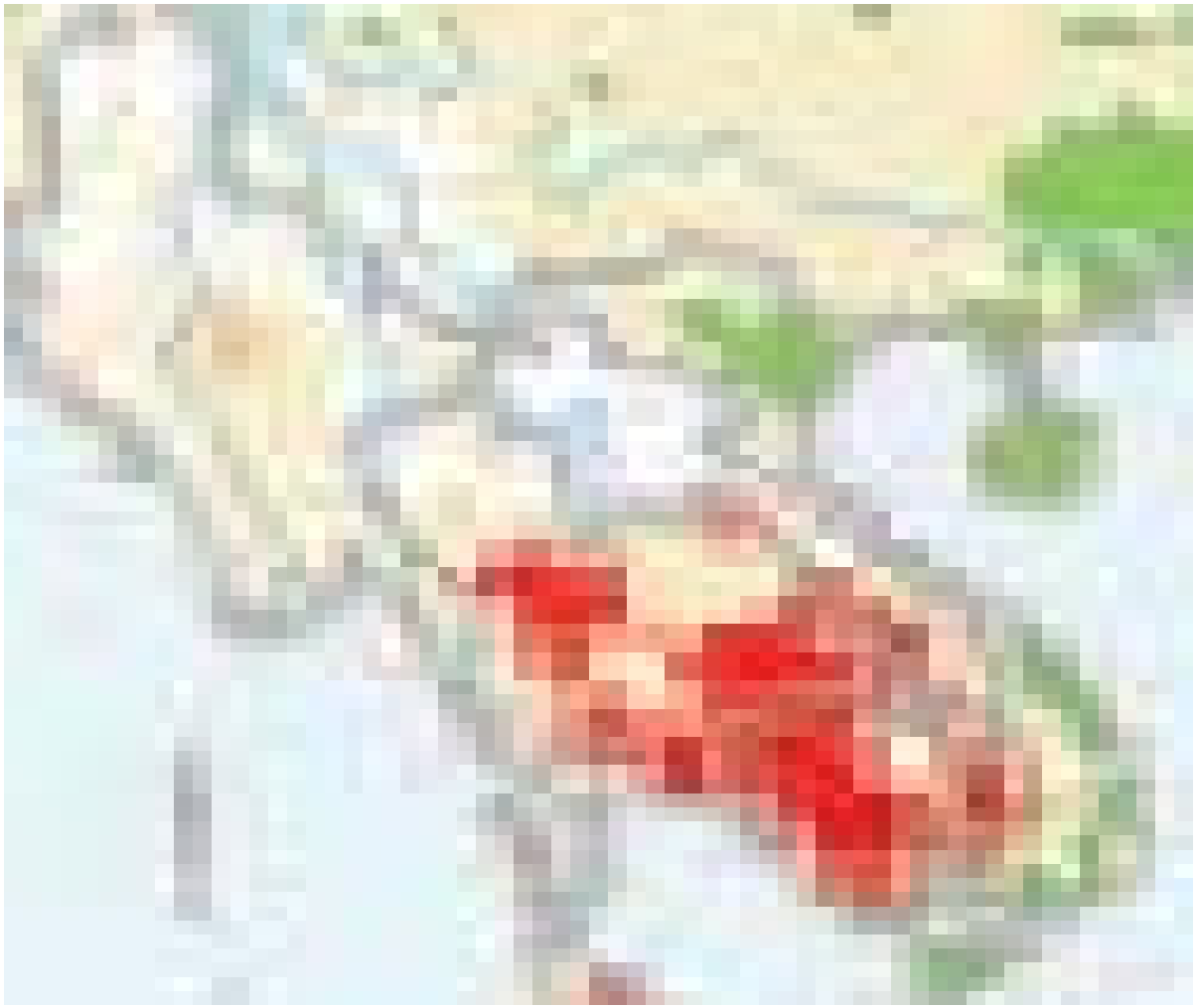
Country	ΔRice Area (sq km) 1980-2008	ΔRice %/year	ΔMaize Area (sq km) 1980-2008	ΔMaize %/year
Cambodia	7,584 (Delaware)	1.92	1,181	7.42
Laos	1,318 (Rhode Island)	1.03	1,955	11.24
Myanmar	34,400 (Maryland)	3.07	2,199	5.80
Thailand	15,561 (Connecticut)	0.91	-5,905	-2.64
Vietnam	13,715 (Puerto Rico)	1.14	6,941	5.47
Total	72,578 (>West Virginia)	1.59	6,371	1.43

Major rice-growing deltas in mainland Southeast Asia



ADB. 2004. Atlas of Greater Mekong Subregion. Manila

Lepers E., E. Lambin, A. Janetos, R. DeFries, F. Archard, N. Ramankutty, and R. Scholes. 2005. A synthesis of Information on rapid land-cover change for the period 1981-2000. BioScience 55:2: 115-235.



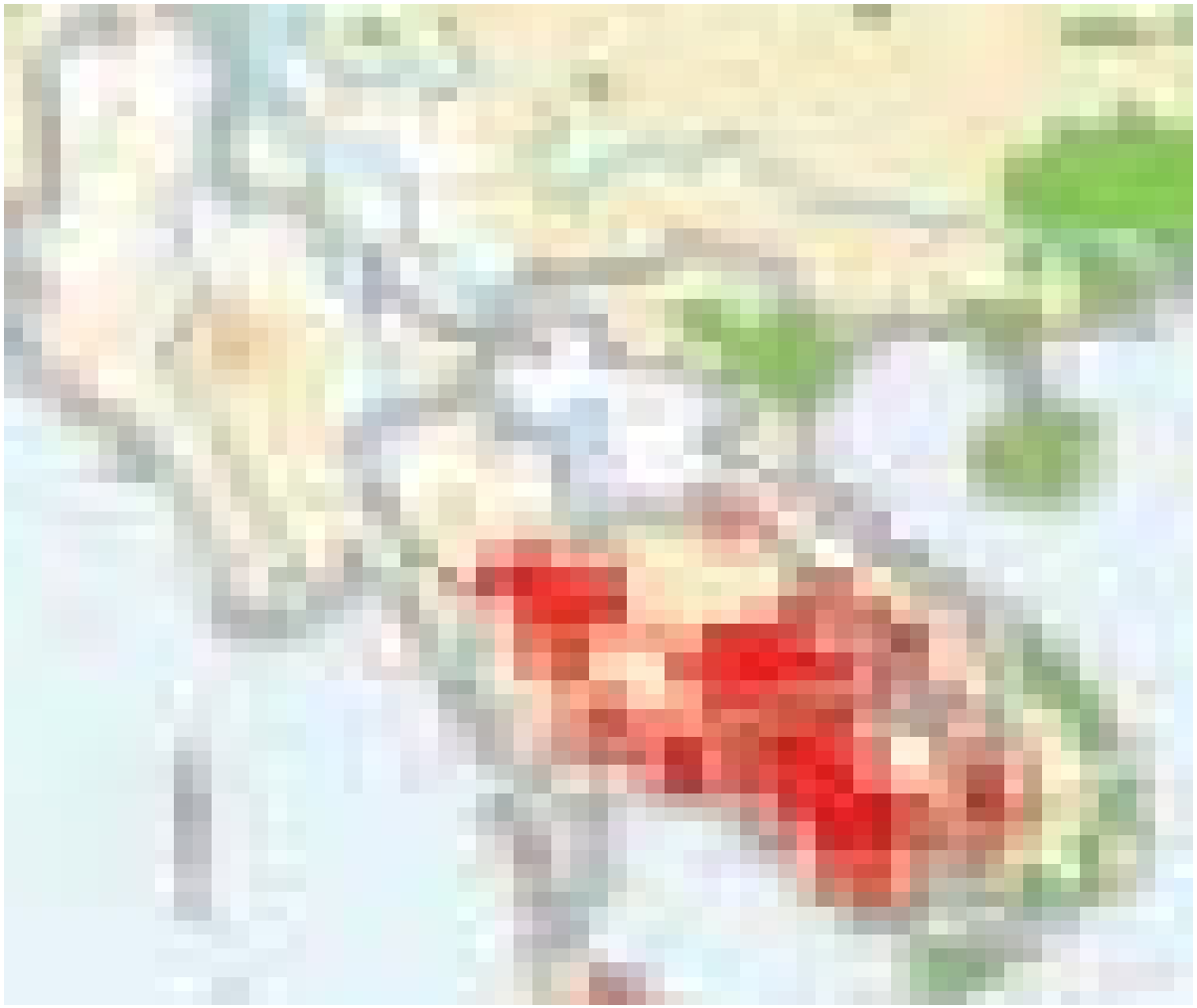
Example of factors driving changes in lowland crops (Xishuangbanna)

- In 2004 China abolished the grain tax that restricted farmer's ability to choose the crops they planted.
- This allowed lowland farmers to benefit from expanding and evolving domestic markets for fresh vegetables and tropical fruits.

- There has been rapid expansion of market gardening. Entrepreneurs from Hainan have introduced commercial banana production on land contracted from smallholders, using labor brought in from other parts of the country.
- These and other factors have contributed in lowland areas to a shift away from paddy rice production, a diversification of sources of income, and more opportunistic household based land-use decisions.

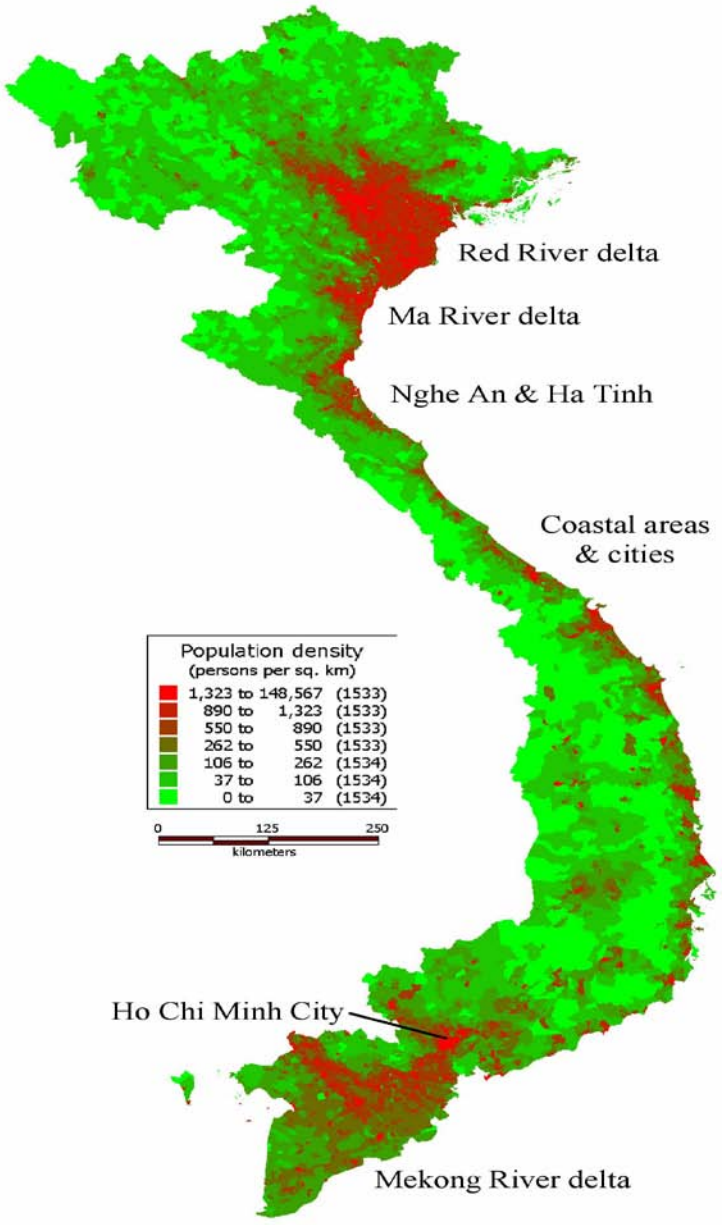
- It is now possible to relieve constraints on land, labor, and capital through new mechanisms such as loans, futures trading (on rubber), hiring labor from within XSB and other parts of the country.
- This is changing the economics of scale and the calculus of financial decision-making for households.
- Difficult to predict whether the outcome will drive land use patterns towards larger scale monocropping plantation model or to a more diverse mixed farming system.

Lepers E., E. Lambin, A. Janetos, R. DeFries, F. Archard, N. Ramankutty, and R. Scholes. 2005. A synthesis of Information on rapid land-cover change for the period 1981-2000. BioScience 55:2: 115-235.



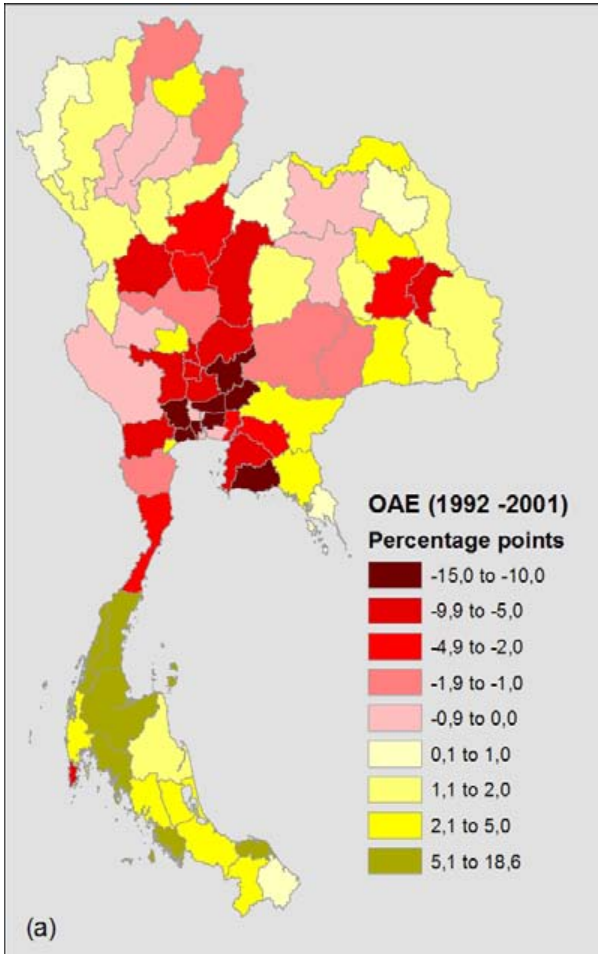
Periurbanization

Population density map
of Vietnam, 1999



Change in the percentage of provincial areas occupied by farms (1992-2001)

OAE : *Agricultural Statistics of Thailand,* various editions (cited in Leblond. 2008).

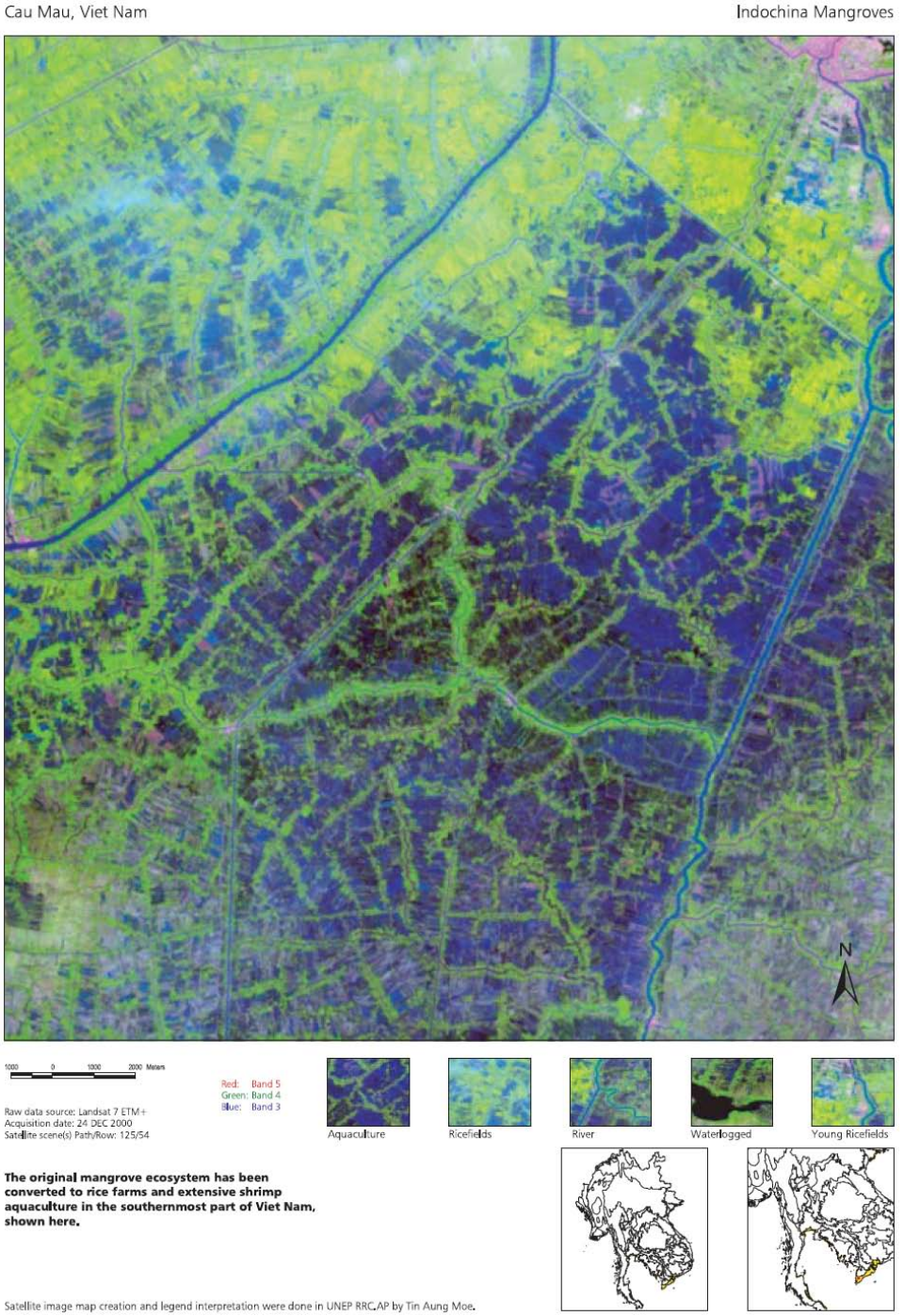


Loss of natural wetlands and expansion of aquaculture

Swamp forests near Bangkok have been converted to prime rice growing areas

ADB. 2004. Atlas of Greater Mekong Subregion. Manila

The mangrove ecosystem has been converted to extensive shrimp aquaculture along the southern coast of Vietnam.



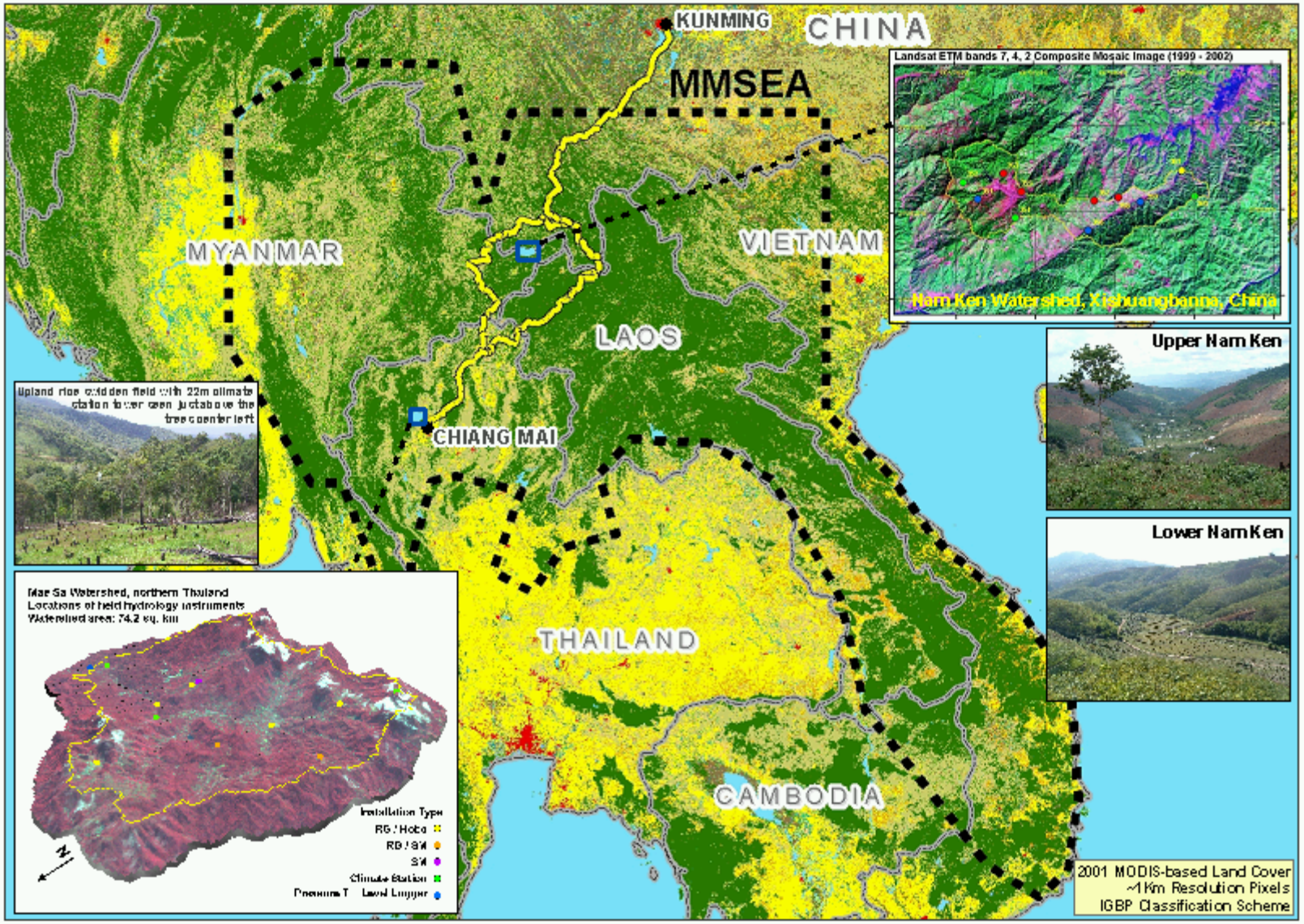
ADB. 2004. Atlas of Greater Mekong Subregion. Manila

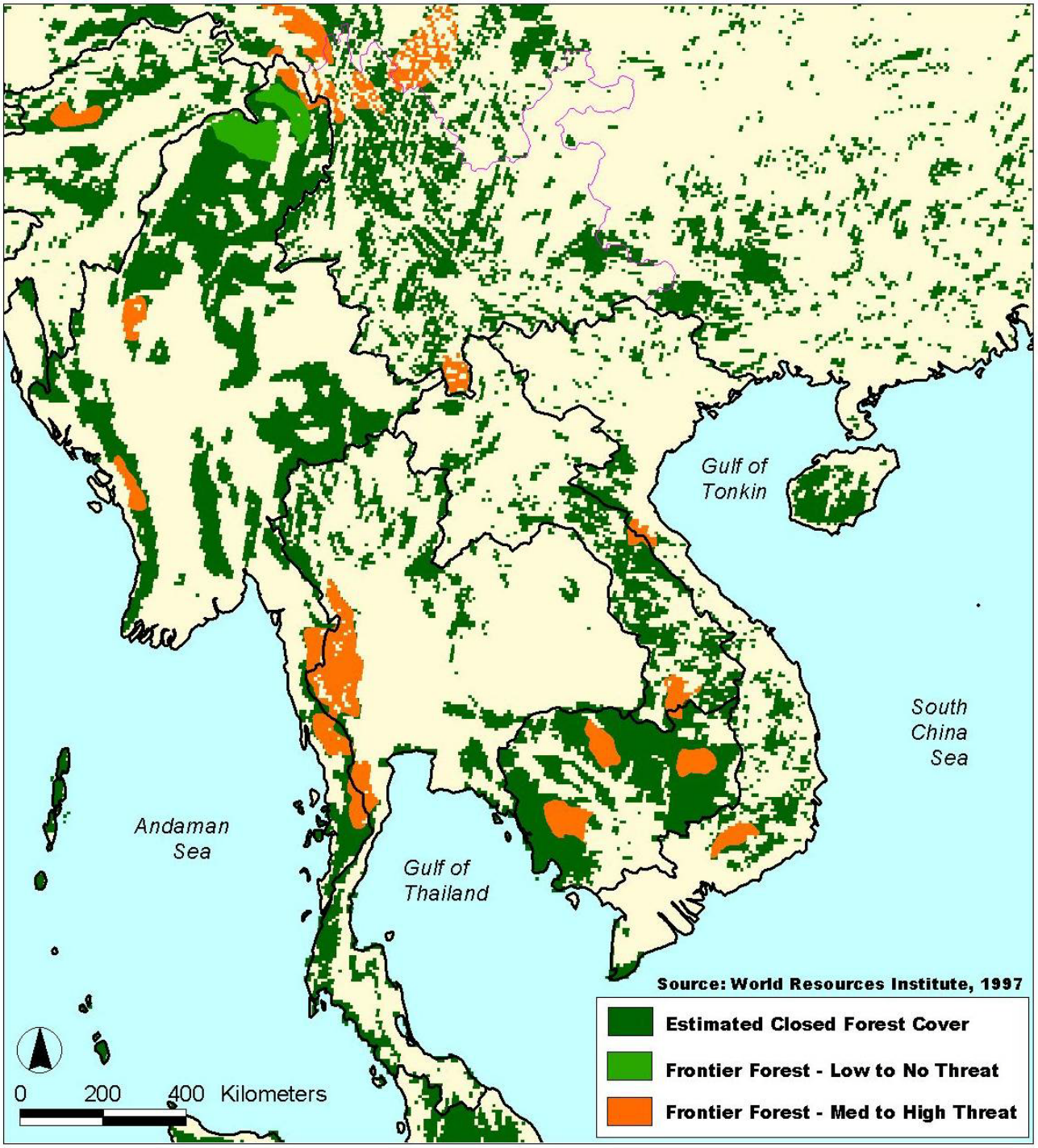
Environmental consequences of changes in the lowlands

- Expansion of agricultural in the lowlands
  - Loss of wetland habitats, loss of biodiversity
- Expansion of urban and periurban areas
  - Loss of agricultural land, increased population densities, expansion of road networks
- Loss of natural wetlands and expansion of aquaculture
  - Loss of biodiversity, loss of environmental services—buffering, fish habitat, etc.

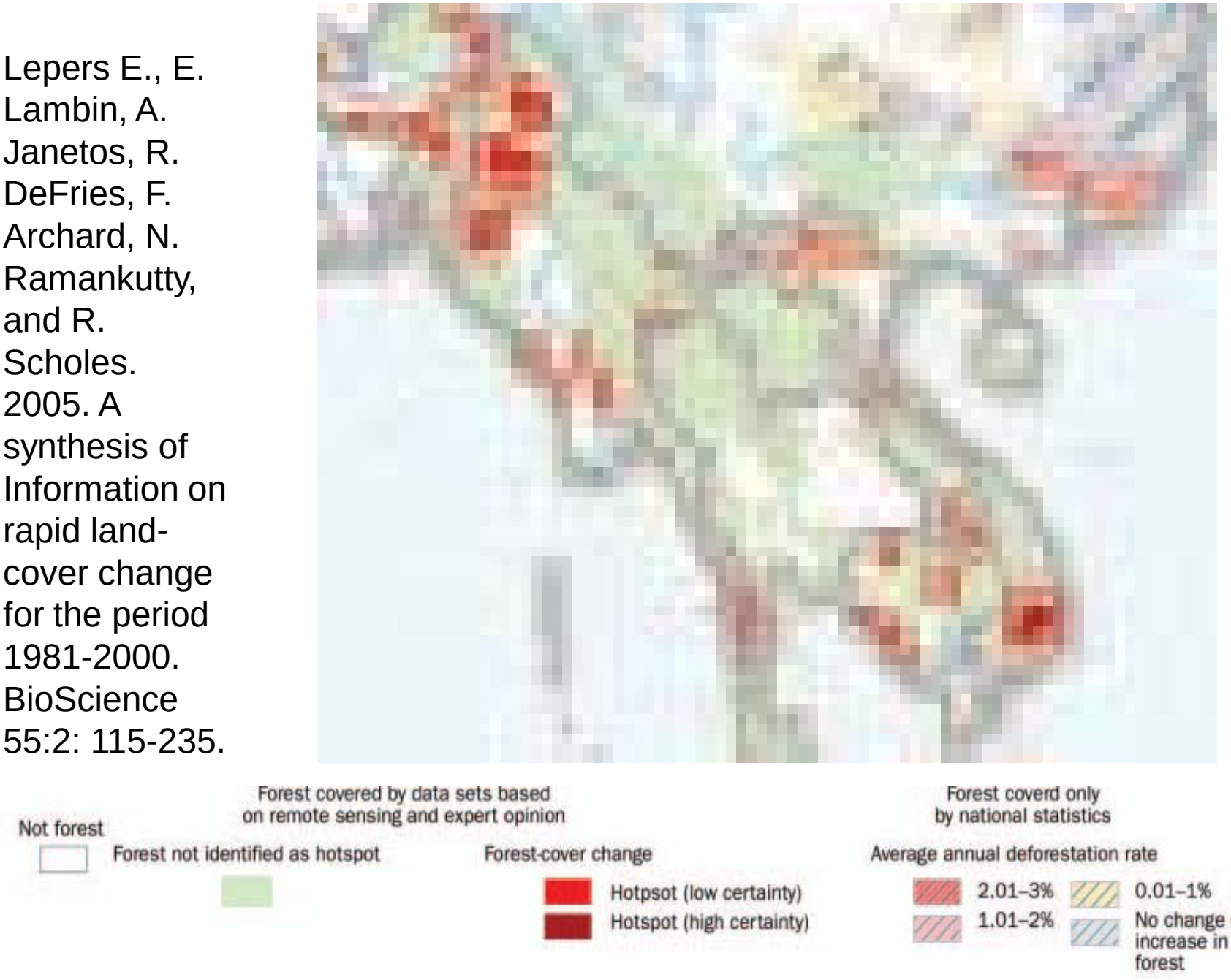
Changes in the uplands

- Changes in the uplands
  - Deforestation/afforestation
  - Loss of shifting cultivation
  - Expansion of protected areas
  - Expansion of commercial agriculture
  - Causes and consequences


KUNMING
CHINA
MMSEA
MYANMAR
VIETNAM
LAOS
CHIANG MAI
THAILAND
CAMBODIA
Landsat ETM bands 7, 4, 2 Composite Mosaic Image (1999 - 2002)
Nam Ken Watershed, Xishuangbanna, China
Upper Nam Ken
Lower Nam Ken
Upland rice swidden field with 22m climate station tower seen just above the tree crown left
Mae Sa Watershed, northern Thailand
Locations of field hydrology instruments
Watershed area: 74.2 sq. km
Installation Type
RG / Hobo
RG / SM
SM
Climate Station
Pressure T Level Logger
N
2001 MODIS-based Land Cover
~1 Km Resolution Pixels
IGBP Classification Scheme

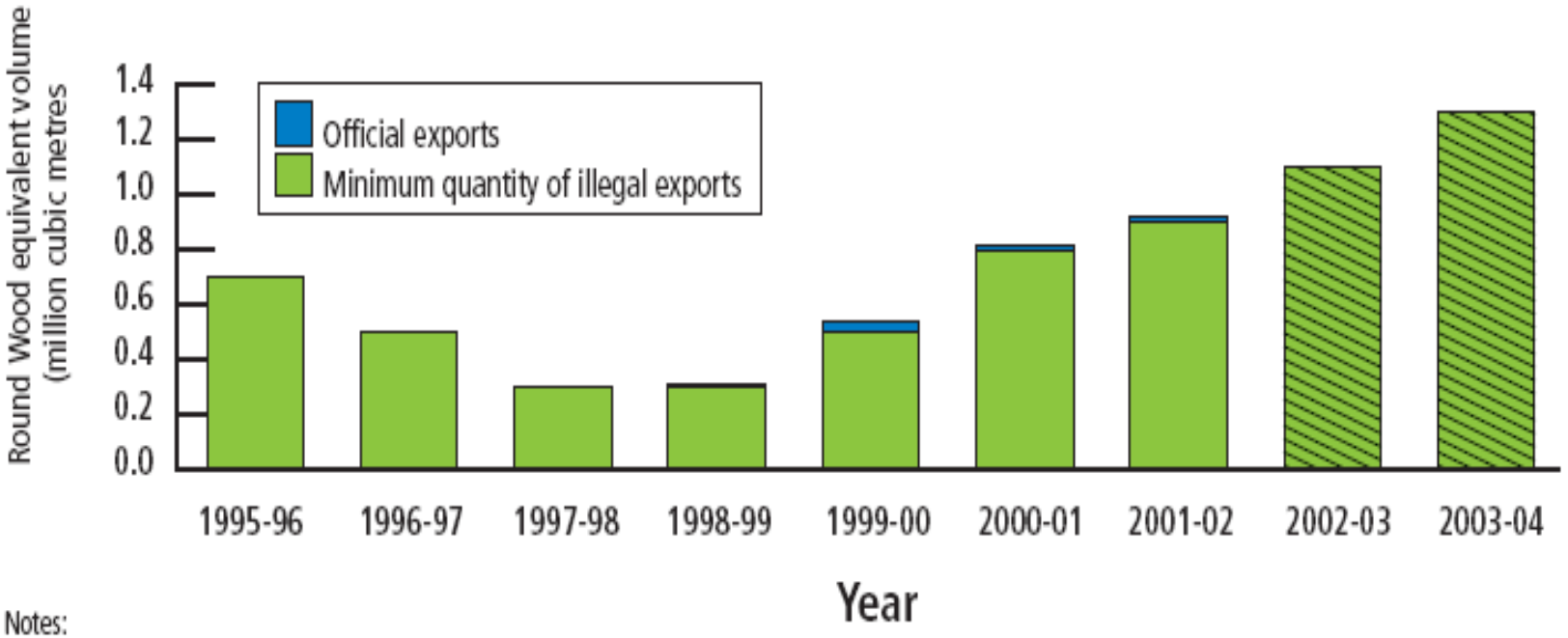

Gulf of Tonkin
South China Sea
Andaman Sea
Gulf of Thailand
Source: World Resources Institute, 1997
Estimated Closed Forest Cover
Frontier Forest - Low to No Threat
Frontier Forest - Med to High Threat
0 200 400 Kilometers

Lepers E., E. Lambin, A. Janetos, R. DeFries, F. Archard, N. Ramankutty, and R. Scholes. 2005. A synthesis of Information on rapid land-cover change for the period 1981-2000. BioScience 55:2: 115-235.



Deforestation: Myanmar, Cambodia, and Vietnam

CHART 2: A COMPARISON OF BURMESE TIMBER EXPORTS TO CHINA AS REPORTED BY THE SLORC/SPDC AND BURMESE TIMBER IMPORTS AS REPORTED BY CHINA: MILLION M³ RWE[88, o]



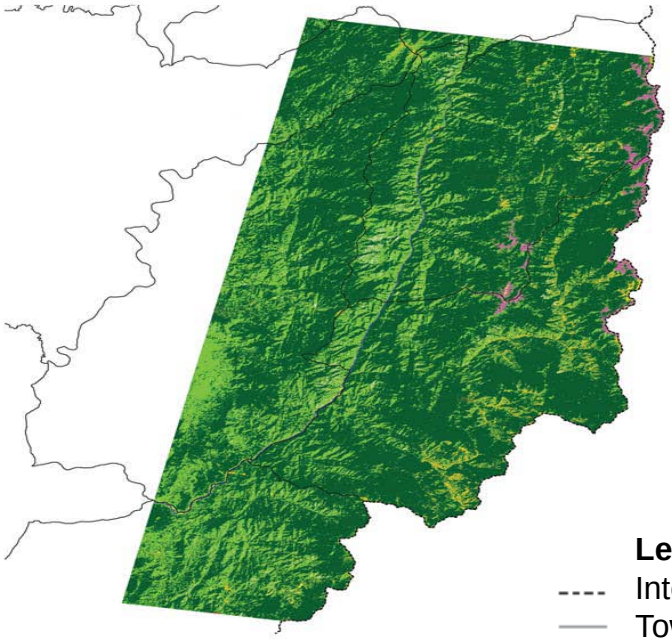
Notes:

1. Import data have been converted to give RWE volumes.
2. Minimum quantity of illegal exports equals total imports of Burmese wood into China (according to China) minus total exports to China according to SLORC/SPDC.
3. The height of each column equals total imports of Burmese wood into China (according to China).

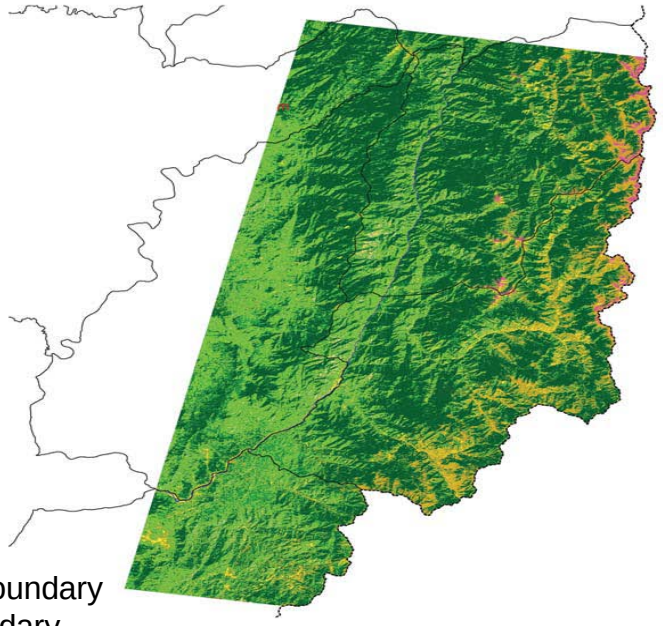
Global Witness. 2009.

Global Witness: Land Cover Map Kachin State

Land cover map of Eastern Kachin State (1991)
(Landsat 5TM 132-42)



Land cover map of Eastern Kachin State (2005)
(Landsat 7ETM+ 132-42)

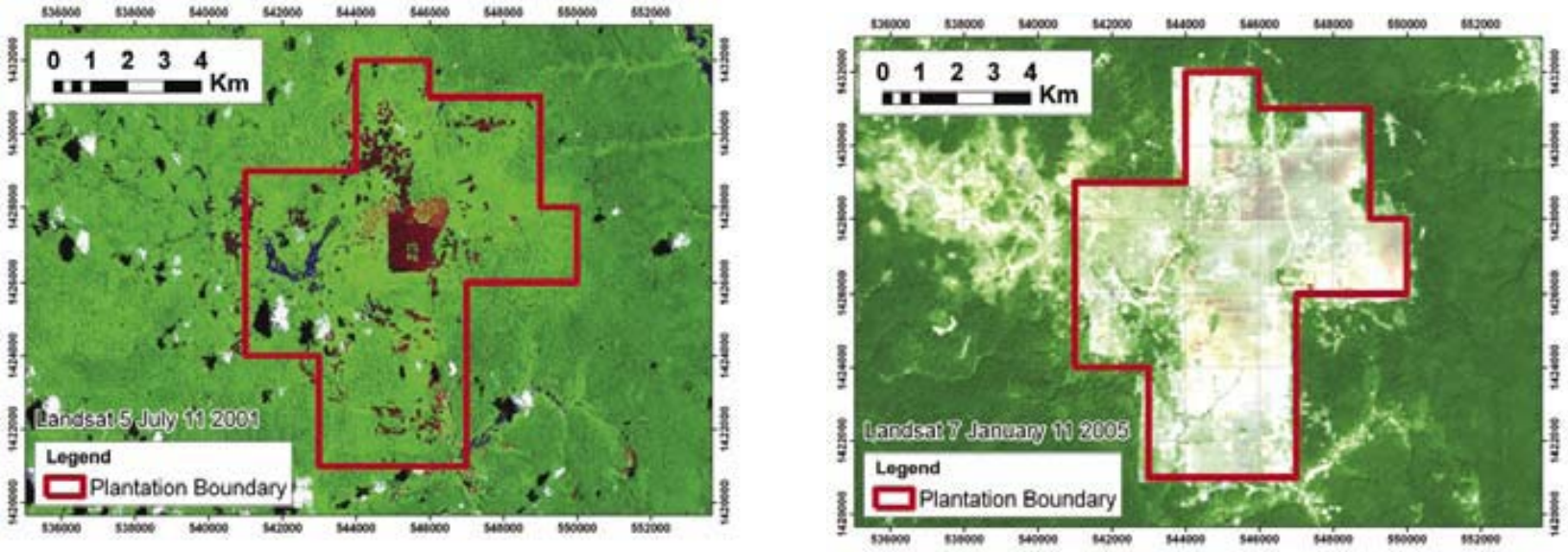


Legend

- International Boundary
- Township Boundary
- Good forest
- Degraded Forest
- Bamboo
- Agricultural land
- Scrub and grass
- Water
- Snow

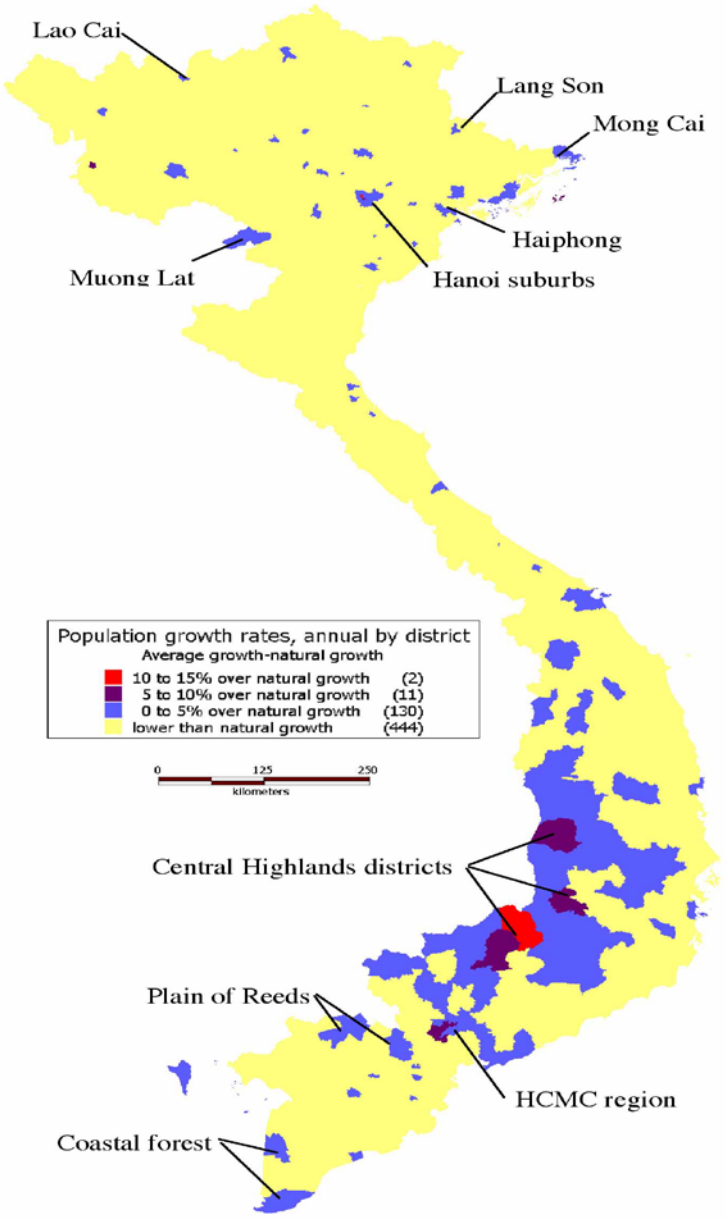
Global Witness. 2009.

Anatomy of an Illegal Logging Operation (Cambodia)



Comparison of forest cover in and around Tumring as seen from satellite in 2001 and 2005. The top left hand side of the 2005 satellite image shows deforestation outside the rubber plantation boundaries (Global Witness. 2007)

Vietnam population growth by district, 1999

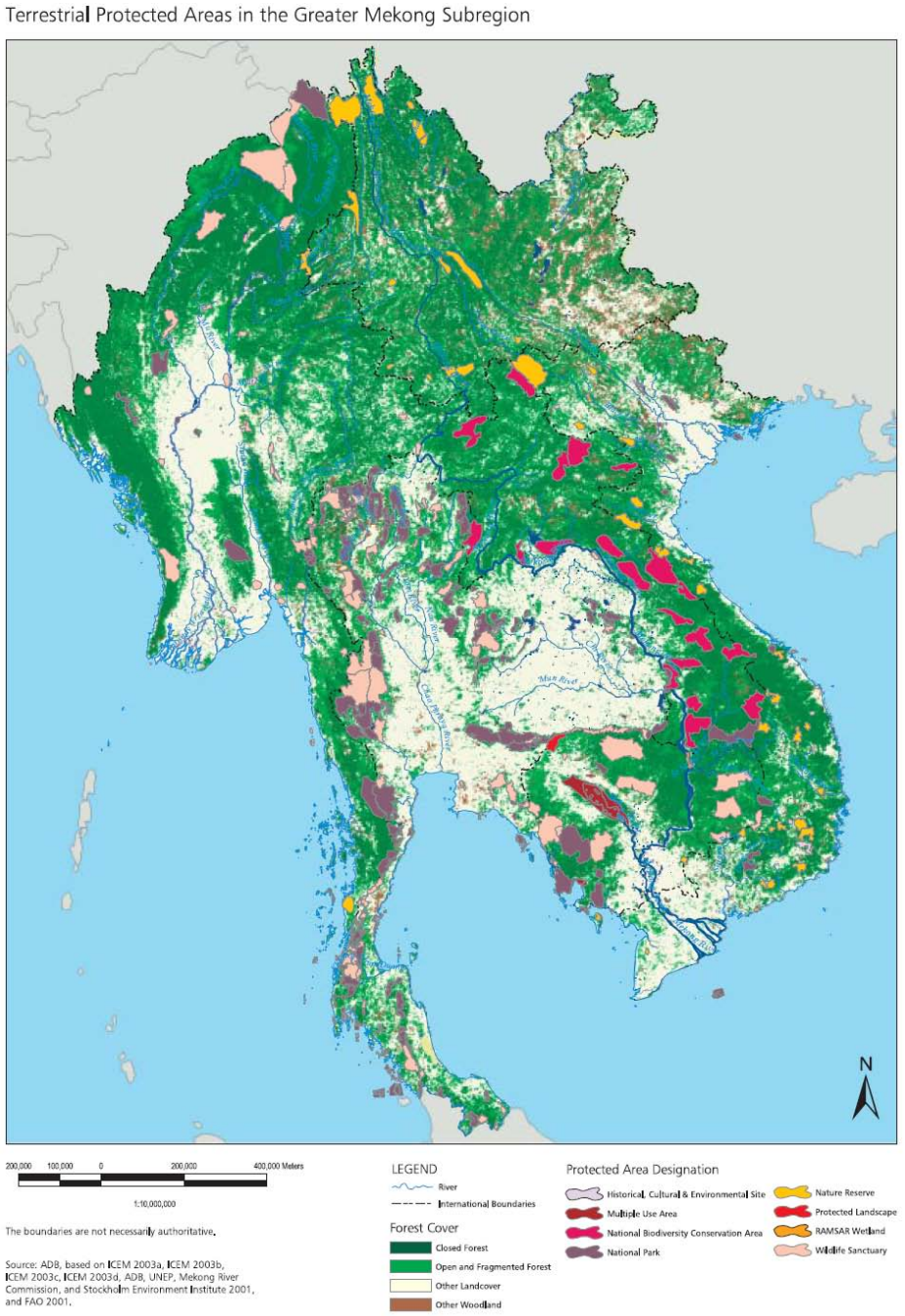


Drivers of Change

- Deforestation in these three examples (Myanmar, Cambodia, and Vietnam) was not driven by small holders and their needs for firewood and poles but by national government working primarily illegally (but occasionally legally) to capture rents and to convert land to private purposes.

Expansion of protected areas

Driver of change: National and international concern for protecting forests and other landscapes



ADB. 2004. Atlas of Greater Mekong Subregion. Manila

The Lost of Swidden

- Throughout Southeast Asia shifting cultivation is rapidly giving way to commercial agriculture driven by domestic demand and regional trade agreements.
- Swiddeners have always been dynamic, migrating, adopting new crops, and frequently changing the ways they farmed.
- What is different now is the scale and magnitude of the change.

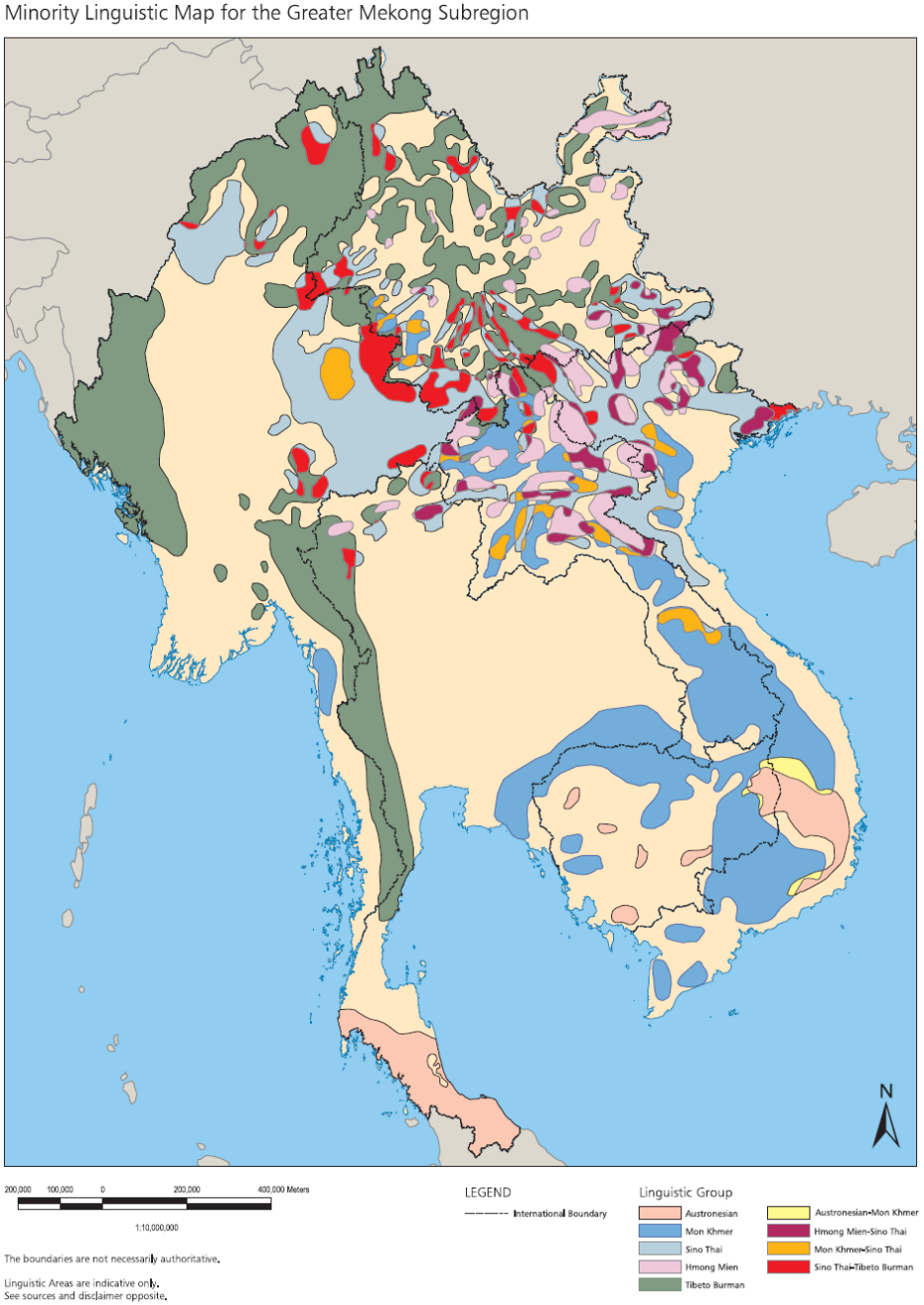
But swidden is difficult to measure

- Swiddening is a diverse, complex, and dynamic system that researchers have difficulty seeing and defining, much less measuring.
- Swidden is a smallholder category and government agents find it difficult to add up all those temporally and spatially divergent and dynamic smallholders.
- The very existence of swidden has long been a politically contentious issue.

Policy and other drivers of change

1. Classifying swiddeners as ethnic minorities within nation-states
2. Dividing the landscape into forest and permanent agriculture
3. Expansion of forest departments
4. Rise of conservation
5. Resettlement, privatization and commoditization of land and land-based production
6. Expansion of market infrastructure and the promotion of industrial agriculture
7. Growing trend toward a transition from rural to urban livelihoods and expanding urban-labor markets

Upland and the distribution of ethnic minorities



ADB. 2004. Atlas of Greater Mekong Subregion. Manila

Example: Northern Thailand

- 1960s and 70s forest reserve status was declared over large areas in the north except flat lowlands in major valleys;
- Subsequently various reserve forests were declared protected national parks and wildlife sanctuaries;
- People living in protected areas were not eligible to apply for official land tenure documents;
- Most people living on these lands belonged to ethnic minority groups and could not apply for Thai citizenship;

- Anti-shifting cultivation programs forced conversion of rotational forest fallow systems in many areas into fixed field agriculture that required use of purchased chemicals to replace agronomic and ecological functions of forest fallows;
- Opium crop substitution programs and expansion of road access brought introduction of new crops—cabbage, potatoes, temperate flowers;
- Expansion of tourism brought incentives to develop resorts, golf courses, vacation homes;
- Expansion of urban and industrial areas into farmlands surrounding urban industrial areas.
- Shifts into more intensive multiple cropping systems in productive farm lands surrounding growing urban industrial centers.

Environmental consequences

- Biodiversity—natural and anthropogenic
- Watershed hydrology/soil erosion
  - Permanently converted hillslopes are often plagued by accelerated erosion and shallow landslides
  - The biggest contributors to high river sediment loads, however, may be road systems that make commercial agriculture possible
  - Water quality is now threatened by the growing use of fertilizers and pesticides; and surface and ground water extraction for irrigation increasingly results in stream desiccation

Environmental consequences

- Carbon. Above-ground carbon may decline more than 90% when systems with long fallows give way to rotation systems with short fallows or are replaced by continuous annual crops .
  - Declines up to 60% may occur when swiddening is converted to oil palm.
  - Reductions of soil organic carbon on the order of 10-40% result from the conversion to continuous annual cropping.
  - The largest declines are associated with mechanically established plantations. Within some intensely-managed systems these changes may be practically irreversible.

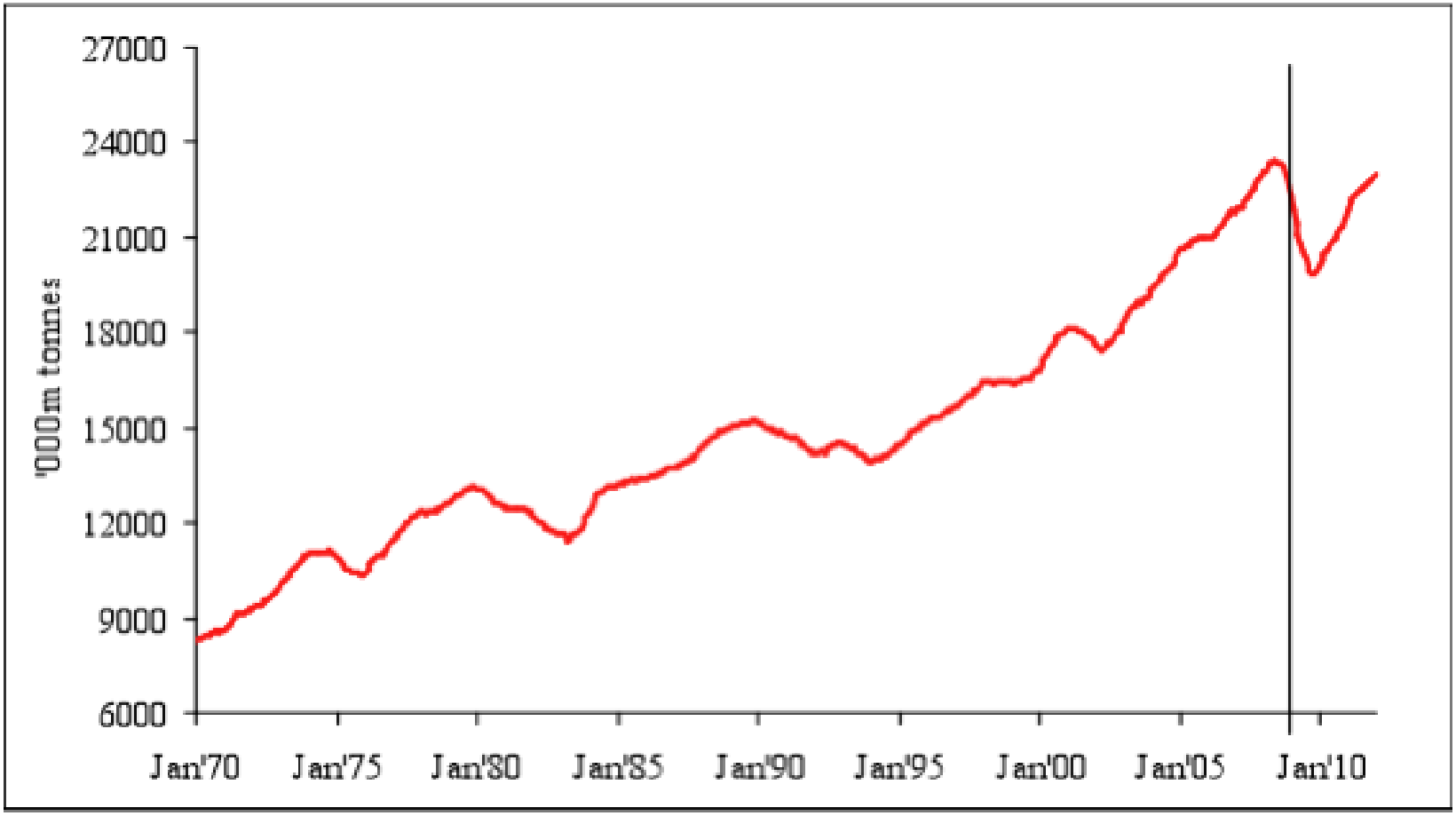
Socioeconomic consequences

Swidden farmers are proactively responding to the political and economic “drivers of change” in the region.

At the household level these responses have included:

- Both the intensification and “dis-intensification” of swidden land-use
- Adoption of cash crops
  - The pursuit of income exclusively through cash cropping has left some farmers with large debts, including those overcommitted to coffee production in the central highlands of Vietnam
- Redeployment of household labor,
- Adopting broader (often non-rural) livelihood aspirations and strategies

Global total rubber consumption, 1970-2011

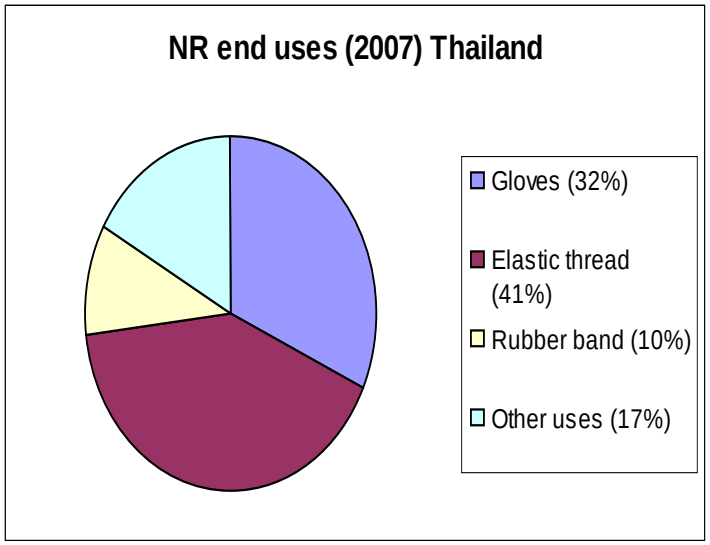


Prachaya. 2009.

NR price forecasts to 2011

Prachaya. 2009.

World total rubber consumptions (NR and SR)



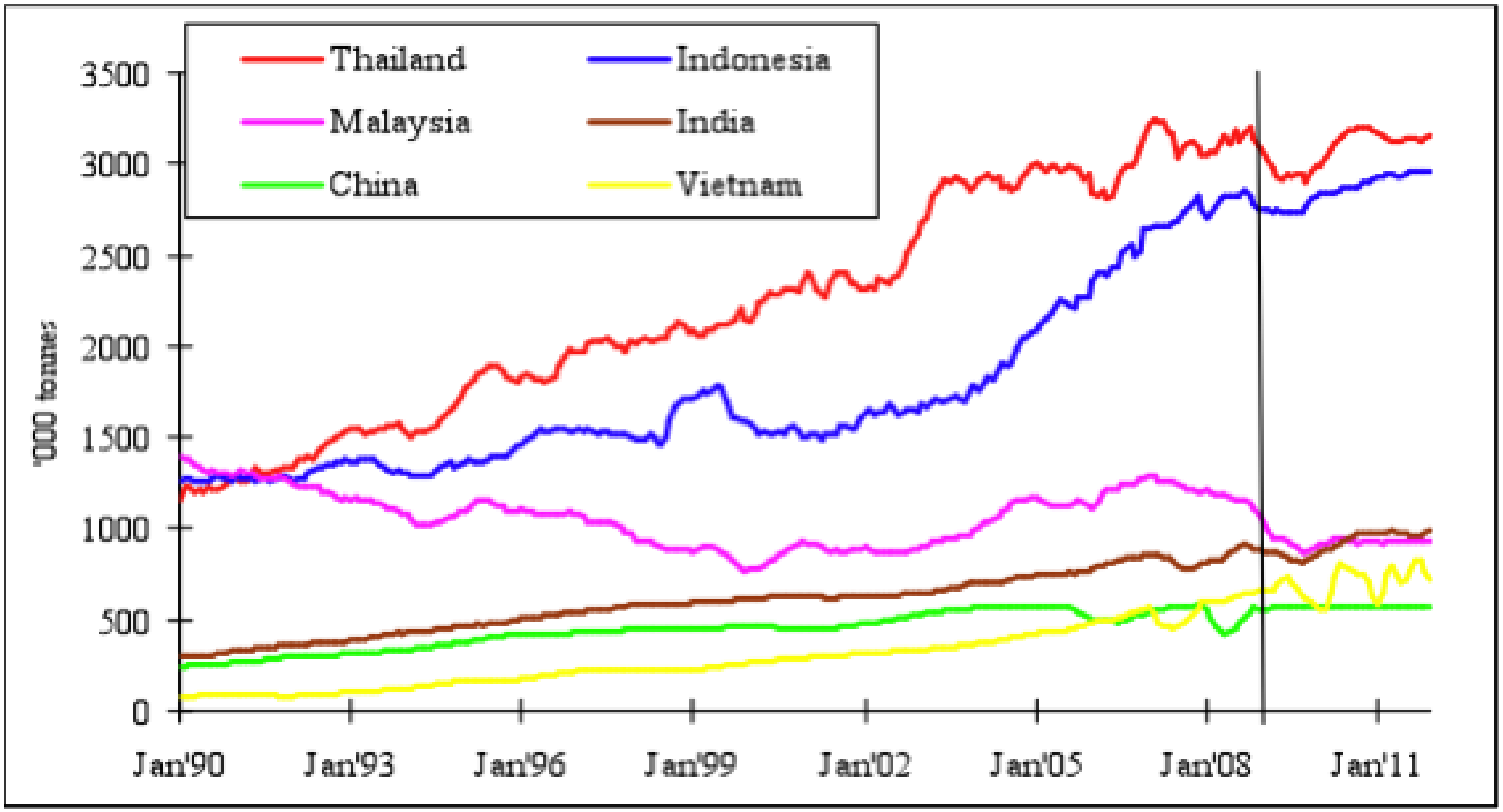
- **Aggregate rubber demand is:**
- **58-59% for tires.**
- **40-42% for general rubber goods (GRG)**

Prachaya. 2009.

Expansion of Perennial Commercial Crops: Rubber is a hot commodity

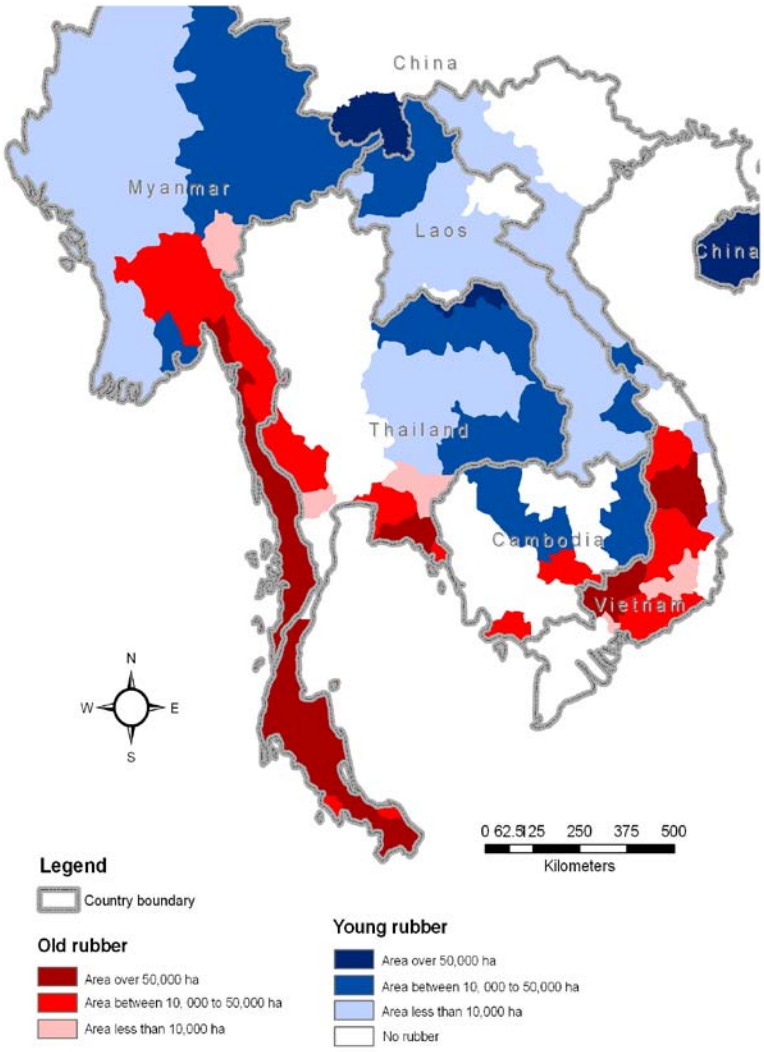
- World rubber consumption has increased at a rate of 5.77 percent per year since 1900 to about 22.1 million tons in 2008
- 9.6 m tons for natural rubber (NR)
- 12.5 for tons synthetic rubber (SR)

NR production in major countries, 1990-2011

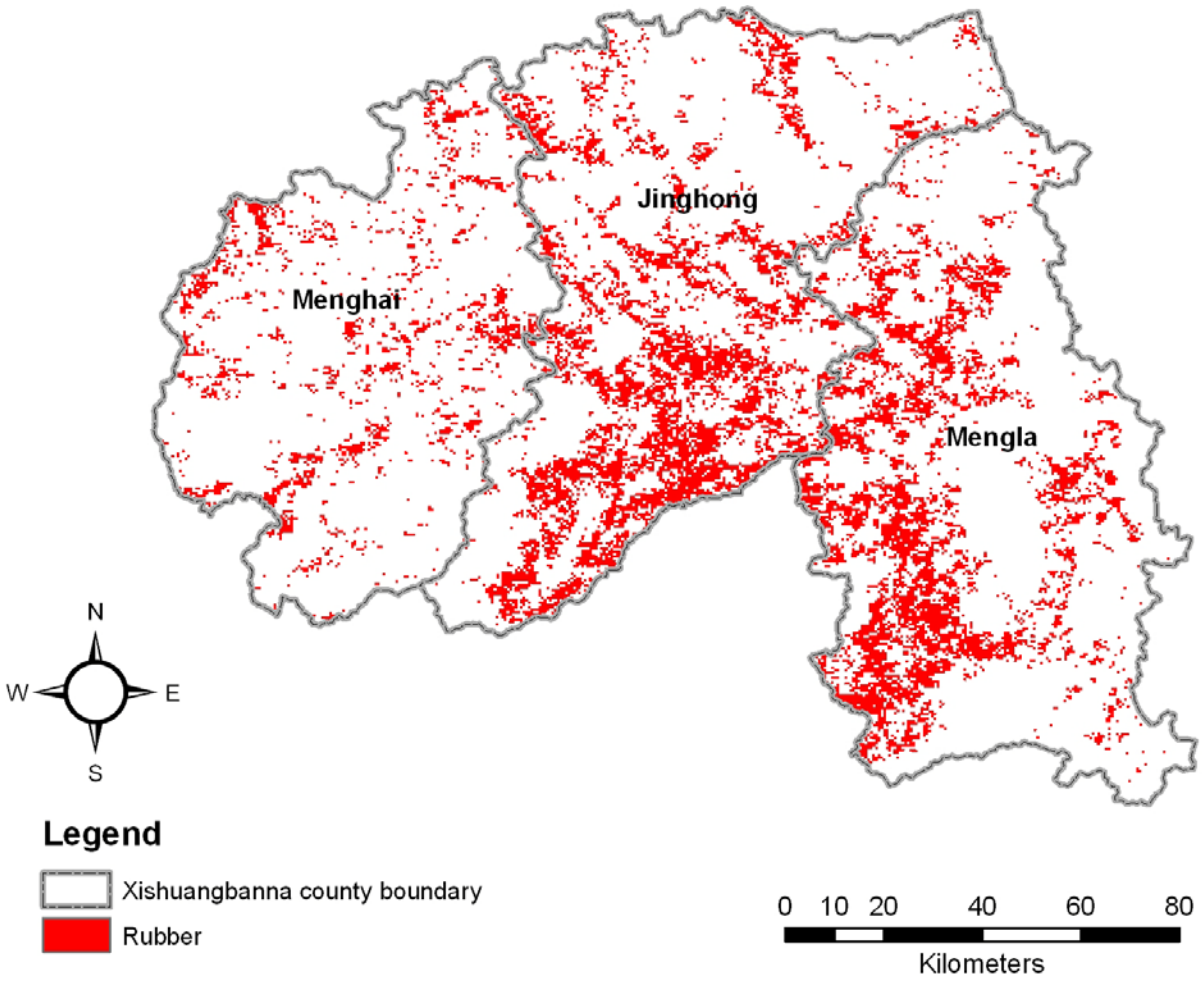


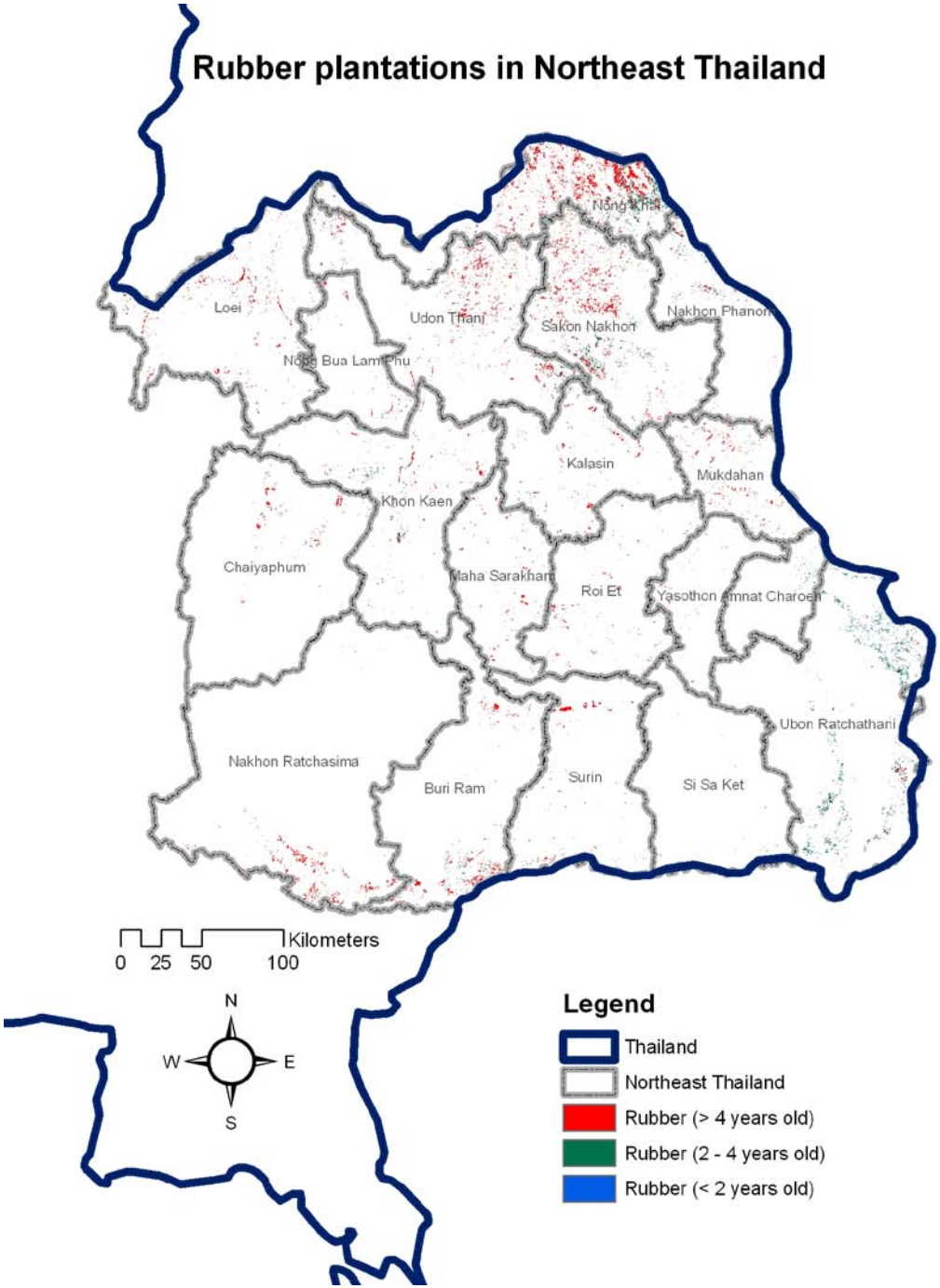
Prachaya. 2009.

Traditional and non-traditional rubber-growing regions

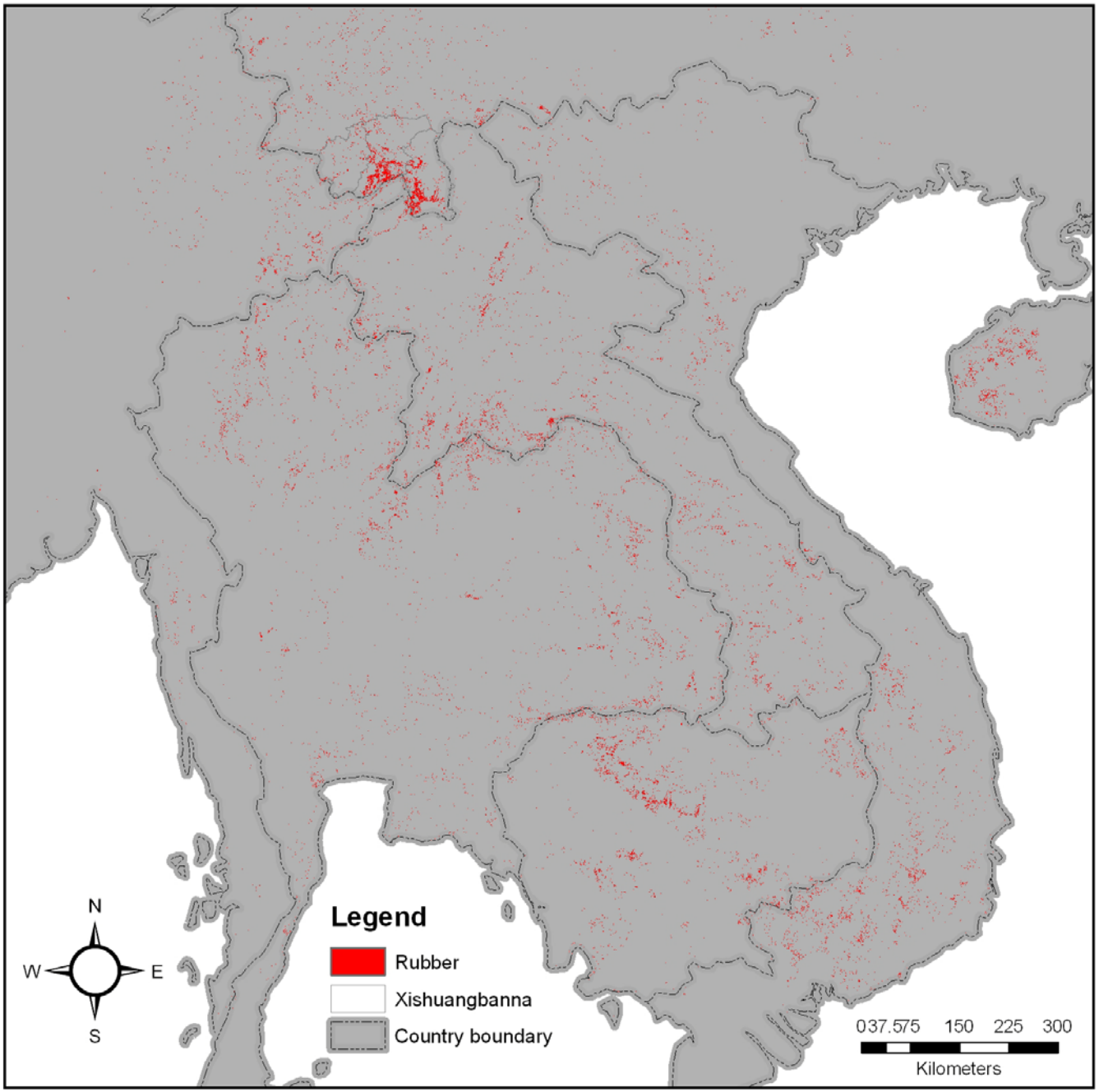


Rubber plantations in Xishuangbanna, Yunnan, China




Rubber plantations in Northeast Thailand
Loei
Udon Thani
Sakon Nakhon
Nakhon Phanom
Kalasin
Mukdahan
Khon Kaen
Chaiyaphum
Maha Sarakham
Roi Et
Yasothon
Amnat Charoen
Ubon Ratchathani
Nakhon Ratchasima
Buri Ram
Surin
Si Sa Ket
0 25 50 100
Kilometers
N
W
E
S
Legend
Thailand
Northeast Thailand
Rubber (> 4 years old)
Rubber (2 - 4 years old)
Rubber (< 2 years old)

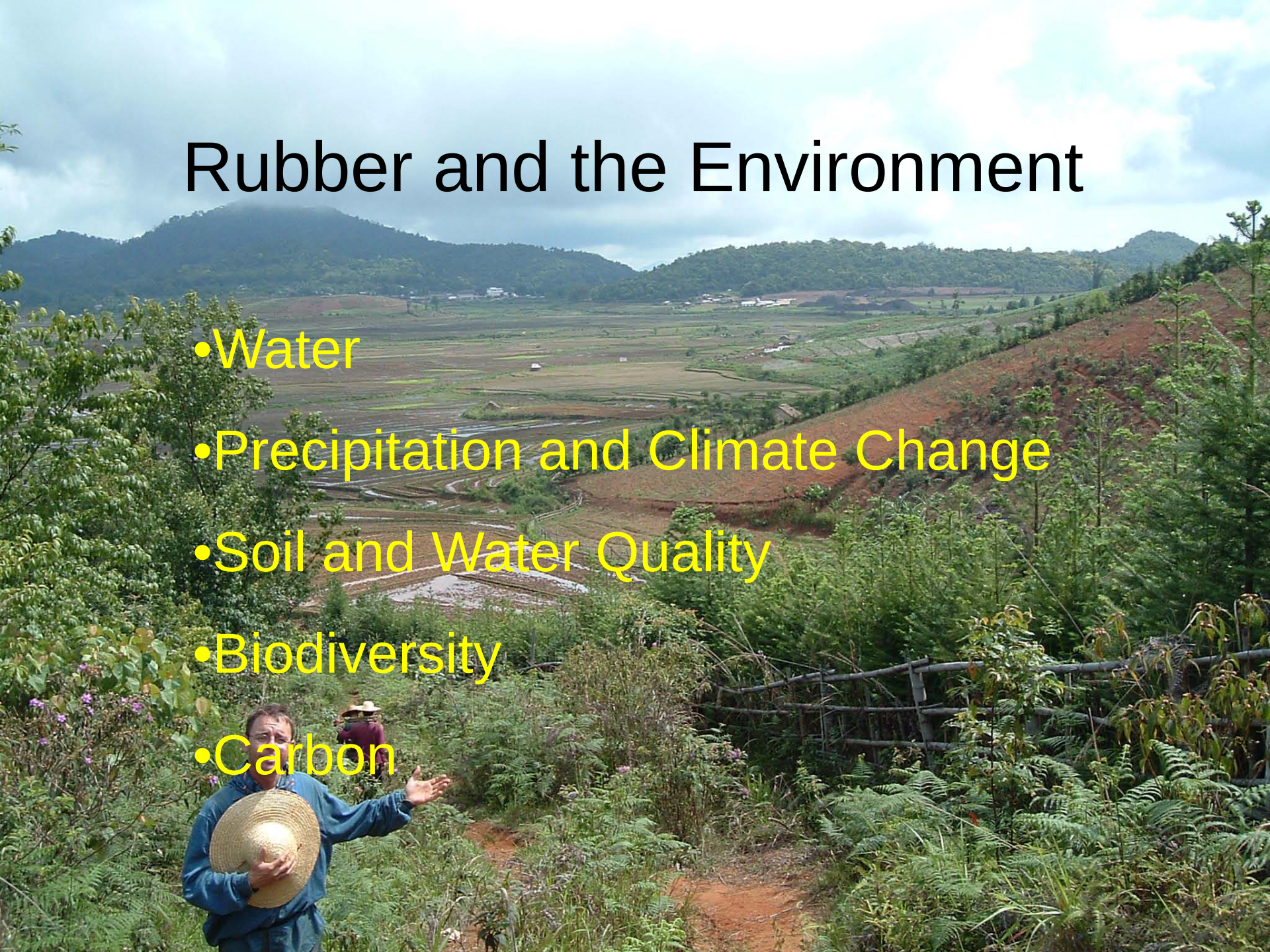
Rubber distribution in 2009 in MMSEA derived from MODIS 250m NDVI time series



Rubber Estimates (2008)
(non-traditional rubber areas)

Country	Area (ha)
Northeast Thailand	348,063 (Thai Rubber 2007)
Xishuangbanna, China (1950s)	334,000 (Reuters 2008)
Laos (1994)	140,665 (NAFRI 2008)
Cambodia	107,901 (ANRPC 2009)
Northeast Myanmar (Kachin and Shan States)	68,723 (Hly Myint 2008)
Vietnam	58,100 (AgroInfo 2008)
Total	1,057,452

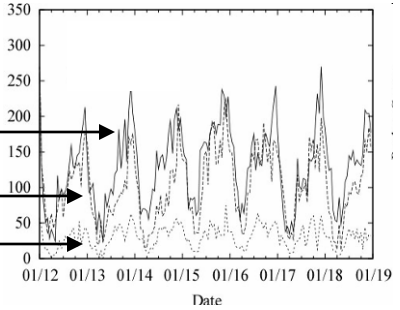
Rubber and the Environment



- Water
- Precipitation and Climate Change
- Soil and Water Quality
- Biodiversity
- Carbon

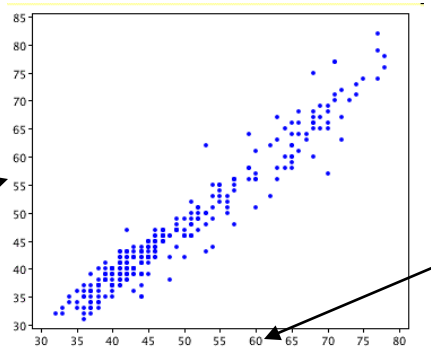
Energy, Water, and Carbon Flux Observations

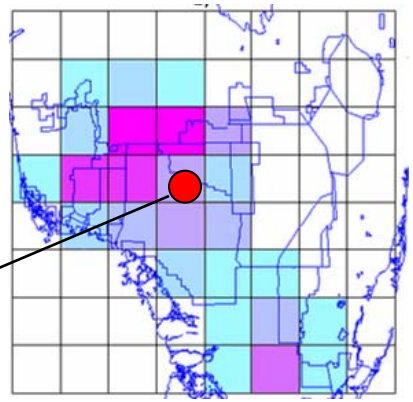
- Direct measurement of ecosystem fluxes over rubber for comparison with fluxes of other major land covers



- Validation points for model testing

Tower



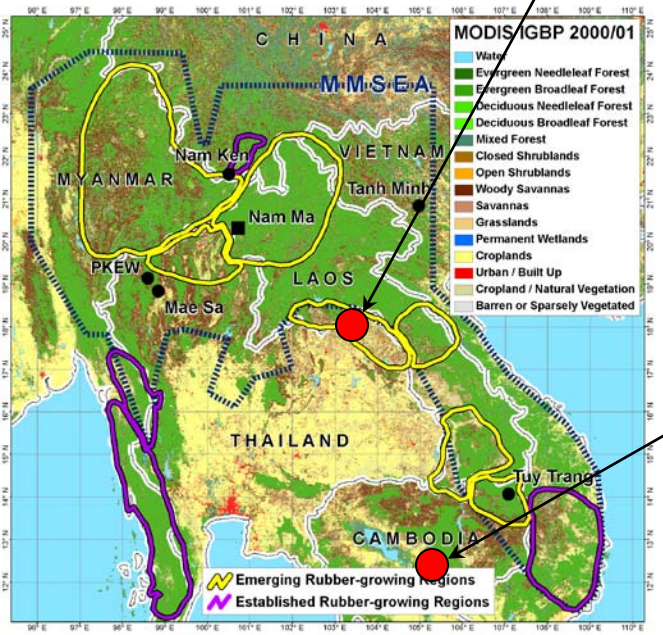


Model

Measurement Strategy

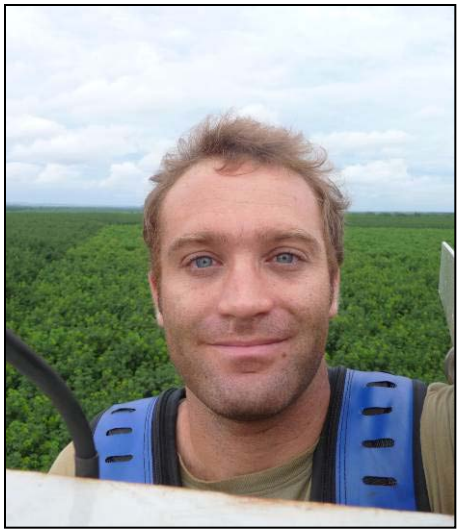
- Focus on rubber
- Utilize existing data for non-rubber sites
- Set up state-of-the-art flux towers within representative rubber plantations
  - **Eddy covariance technique**
    - Evapotranspiration
    - Carbon dioxide exchange
    - Sensible heat exchange
  - **Complete energy balance**
    - Radiation
    - Soil heat flux
    - Biomass energy storage
  - **All relevant micrometeorological variables**
- Biometric observations of carbon storage
  - Live biomass
  - Leaf litter fall
  - Course woody debris fall
  - Soil carbon storage
  - Soil respiration

Field Sites



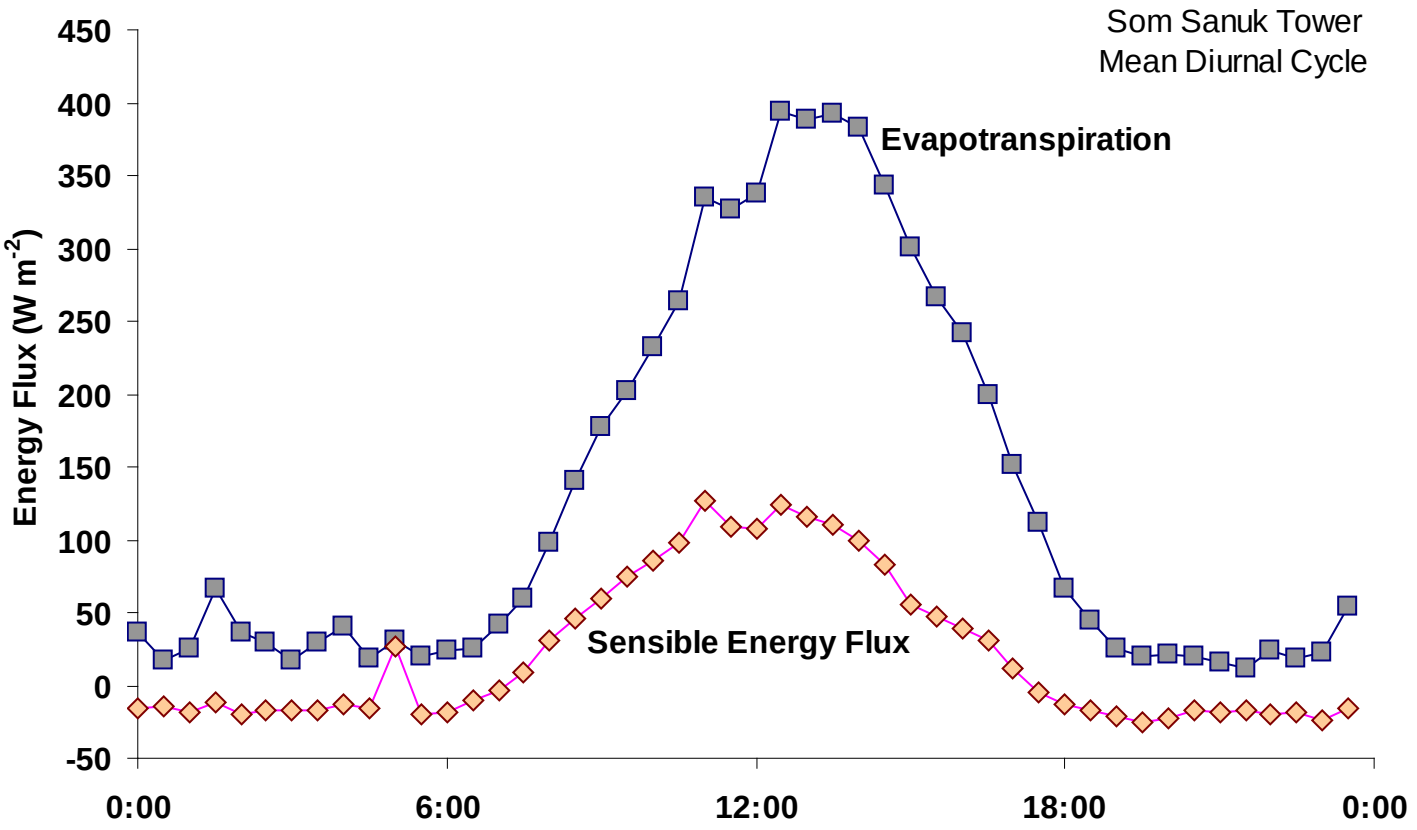
NORTHEASTERN THAILAND: Som Sanuk Tower

CAMBODIA: CRRI Tower

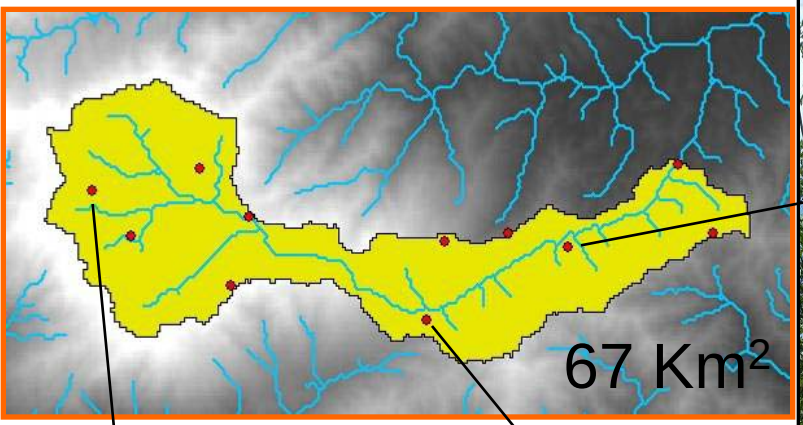


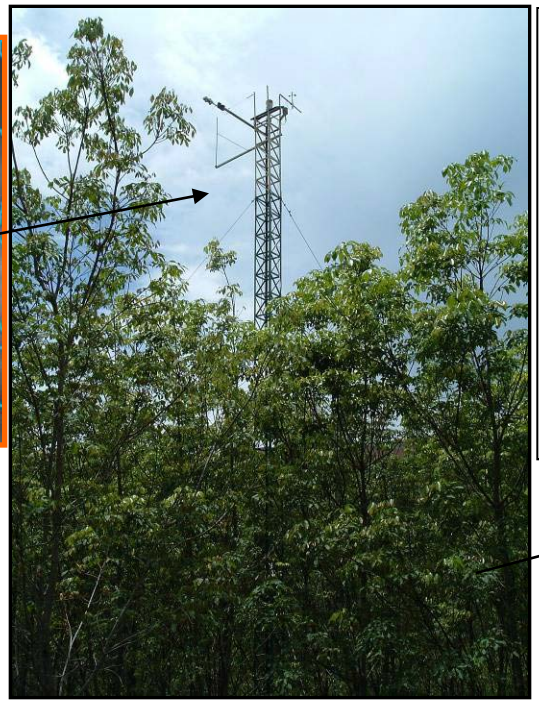
Observations

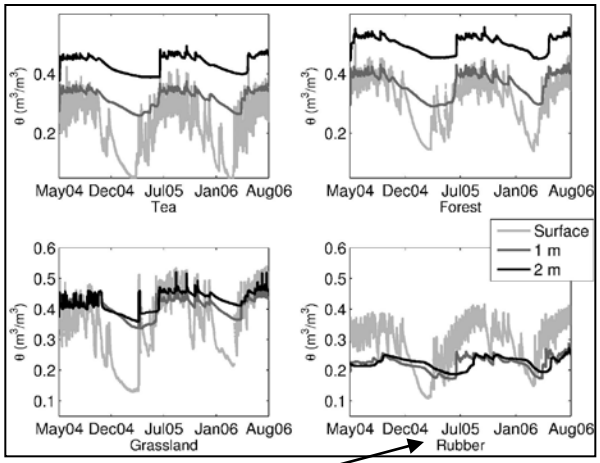
Preliminary results show that the amount of energy use for ET vs. energy used to heat air is very high, suggesting very high rates of water use by rubber.

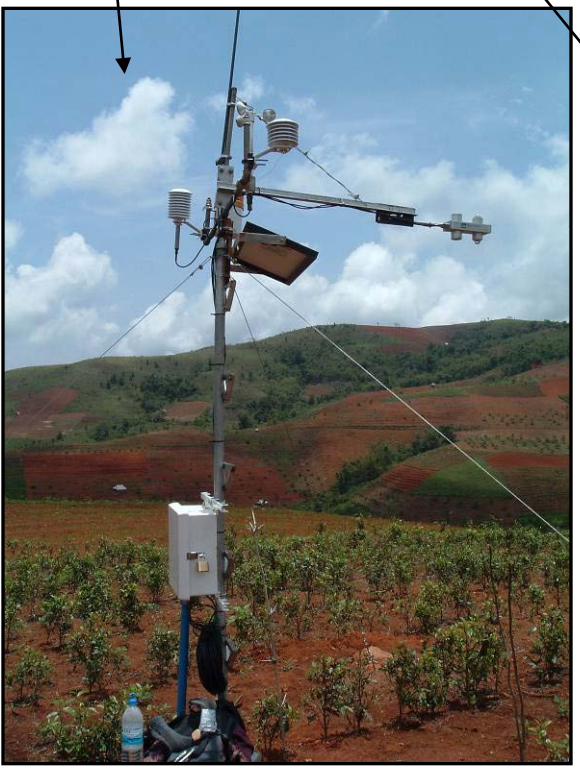


CHINA: Nam Ken Field Sites









This preliminary result is consistent with findings from our previous NASA-funded project in which Maite Guardiola (2008) found evidence of higher water use by rubber, particularly in the dry season.

Soil and Water Quality

- Erosion has accelerated and stream sediment loads have increased where repetitive cultivation is performed on steep slopes without appropriate conservation methods;
- Permanent conversion of hill slopes and road building have increased the risk of landslides;
- Use of pesticides and fertilizers to sustain commercial agriculture has reduced water quality.

(R. C. Sidle *et al*., *Forest Ecol. Manage*. 224, 199 (2006); T. Forsyth, A. Walker, *Forest Guardians*, *Forest Destroyers* (Univ. of Washington Press, Seattle, WA, 2008); I. Douglas, *Geog. Res.* 44, 123 (2006))

Biodiversity and Carbon

- The conversion of both primary and secondary forests to rubber threatens biodiversity and may result in reduced total carbon biomass.

(J. Qiu, *Nature* 457, 246 (2009); H. M. Li *et al.*, *Biodivers. Conserv*. 16, 1731 (2007); H. M. Li *et al.*, *Forest Ecol. Manage*. 225, 16 (2008))


Rubber and human livelihoods
Do people benefit from these land-use transition? Are their winners and losers? Who are they?

Historically NR has predominantly been smallholders' crop

Country	Upper limit for small holdings (ha)	Share of smallholdings in rubber planted area (%)
Malaysia	40.50	93
Thailand	40	90.5
India	20	88.4
Indonesia	25	85
Sri Lanka	20	64
China		50
Vietnam		32
Laos		23

Drivers of Change: Xishuangbanna

Summary of land-use policy

- **1951—Decision on Cultivating Rubber Trees** established an order to begin cultivating rubber for national defense and industrial construction.
- **1956—Jing Hong state rubber farm** was established.
- **1978/79—Household Responsibility System** returns agriculture lands to farmers under long term lease arrangements.
- ***1981/83—Liangshanyidi*** returns freehold and contracted forest lands and swidden fields to farmers.
- **1984—Policy on stabilization of 'swidden and forest land.'**
- **Late1980s—State subsidies for the production of rubber removed.**
- **2002—Grain for Green program** encourages farmers to return sloping agricultural lands to forest through reforestation.
- **1998—Natural Forest Protection Program** (logging ban) ban prohibits cutting trees in natural forests..

- **1998—State farms reorganized into semi-private corporations.**
- **Abolition of grain tax** that restricted farmer's ability to choose the crops they planted.
- **Guangdong province has a policy that emphasizes planting grain.**
- **Sloping Lands to Forest program**. This program pays farmers to convert their swidden fallows into tea plots.
- **1992—Private companies and spin-off state industries can registered for regional opium substitution and poverty alleviation programs**.
- **2006—A decision appears to have been made to stop the expansion of rubber in Xishangbanna**.

These policies sought to:

- Decollectivize communal land and return it to individuals to promote market crops
- Restrict swidden and settle shifting cultivators at lower elevations and less steep slopes
- Integrate state farms and individuals farmers into the market economy without eliminating political and ideological forces
- Promote rubber production

Drivers of Change: Thailand

Summary of land-use policy

- 1970s—Thai government decides to investigate the possibility of introducing rubber in the northeast as a viable commercial tree crop as an alternative to cassava production
- 1989—Office of Rubber Replanting Aid Fund (ORRAF) began providing smallholders in the northeast, those with less than 2.4 ha (of land, with technical advice, free seedlings and fertilizer, low-cost credit for labor costs (including family labor), material inputs (especially herbicides), and other income generating activities.

- 2004—ORRAF provides technical advice on cultivation and free seedlings to households with up to 1 to 1.25 ha (6-8 rai) of land.
- ORRAF also supports smallholder activities such as fish ponds, livestock, crops, and handicrafts in order to aid farmers to maintain their livelihoods between the time they plant rubber and begin to tap.
- ORRAF assists households with extension information, provides low-cost credit, and supports community organizations and the formation of rubber cooperatives.
- The low-cost credit ORRAF makes available for rubber cultivation comes from the Bank of Agriculture and Cooperatives (BAAC). These funds pay for labor, fertilizer, and other materials.

These policies sought to:

- Develop a specific pattern of rubber expansion around nucleus villages targeted by ORRAF interventions.
- The first wave of rubber growers usually played a key role in building up social capital and managing rubber cooperative structures.
- Once these rubber institutions were firmly established and fully functional, ORRAF withdrew its support community.
- This experience also helped farmers to develop marketing channels and establish a viable marketing system across a network of ORRAF supported rubber cooperatives.
- As in Xishuangbanna, with the support of government programs such as ORRAF, smallholder rubber farmers in Northeast Thailand have greatly increased their household wealth.

Drivers of Change: Laos (Myanmar, Cambodia, Northwest Vietnam)

Summary of land-use policy

- In the absence of a dedicated extension system, the Government of Laos promotes foreign investments in the rubber sector as a win-win solution to alleviate poverty in remote rural areas and to generate income from export commodities.
- Due to the immature nature of the industry in Lao PDR, its expansion relies on external inputs of knowledge and investments from state and private entrepreneurs from neighboring countries, particularly China, Vietnam and Thailand.
- As a result of poor governmental regulations, a large range of institutional arrangements for rubber production have emerged in the recent years.
- A number of variations of each type (smallholders, contract farming, and concessions) exist according to who provides the main factors of production, i.e. land, labour, capital, market outlet and technical knowledge.

Land, Labor, and Capital in Laos

Arrangements	**Farmers' input**	**Benefits for farmers**
Smallholder (self-financed, sometimes credit from government)	•Land •Labor •Capital	All profit—latex and timber goes to farmer (farmers seek market on their own)
Contract Farming (promoted in North)	•Land •Labor	Profits from latex (not timber) sales are shared among farmers and investors (investors purchase products)
Concession (promoted in South)	•Labor	Farmers are paid monthly wages

Contract Farming with Large (Formal) Investors

- How are contracts made?
  - Officially, villagers' voluntary commitment must be secured before provincial contracts are made
  - In implementation, top-down, incomplete village consultation, semi-coercive
- What are the typical arrangements?
  - Five inputs: land, labor, capital, technique, and marketing
  - "2+3" is officially promoted (v 70%/ c 30%) and confirmed by provincial contracts
    - Villagers contribute land and labor
    - Company provides capital, technical extension, and market access
    - After tapping, villagers obtain 70% of the profits, company 30%.

In Reality

"1+4" is predominant in implementation (v 30%/ c 70%)

- Villagers provide land
- Company solely manages plantation for 3 to 5 years or until tapping, paying villagers for their labor input or relying on hired laborers from elsewhere
- After the partition, villagers obtain 30% of the land/trees, and company 70%.
- No clear arrangement of market channels.
- Only one Lao company and a joint venture succeed in cases of "2+3". All Chinese companies resort to "1+4".
- Similar to concession.

Agrarian transition—Two Views

1. The long-term outcome of the capitalization of agriculture is the polarization of the countryside into capitalists farmers and landless laborers (Bernstein 2002). We are seeing this in Laos, Cambodia, Myanmar, and Northwest Vietnam
2. Capitalist farming can stimulate small-scale entrepreneurship and socioeconomic differentiation, with the attendant persistence of small family farms (Rigg 2005). We are seeing this is Xishuangbanna and Northeast Thailand

Socioeconomic consequences

- In China and Thailand where the governments provides committed and effective support to smallholders, there is evidence that rubber farming can improve livelihood of the villagers.
- There are risks associated with this—food security, disease, pests, weather, etc., but in short-term many people have done well economically.

- But in countries (Laos, Myanmar, Cambodia) where the governments can not provide committed and effective support to smallholders, rubber farming can result in farmers losing access to their land, becoming laborers on plantations owned by others, coercion, disputes over terms and wages, overlapping and unclear land designation, lack of alternative income sources for remote villagers, corruption.

Other ‘hotspots’ of change

- Mines
- Roads
- Dams

New road networks in the region

Economic Corridors in the Greater Mekong Subregion

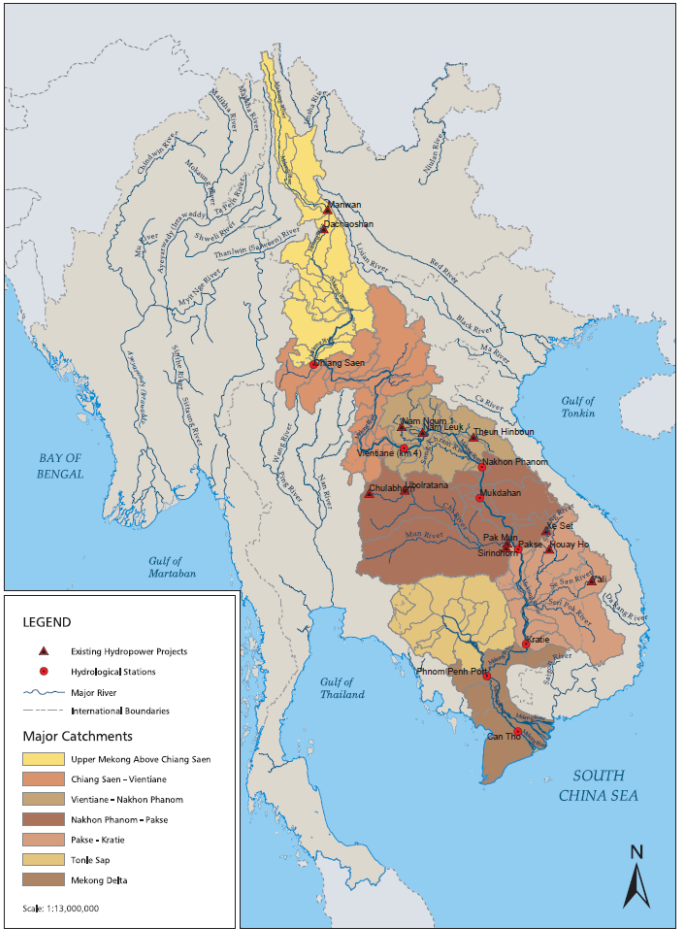
The boundaries are not necessarily authoritative.

Source: ADB

ADB. 2004. Atlas of Greater Mekong Subregion. Manila

Existing and Proposed Dams

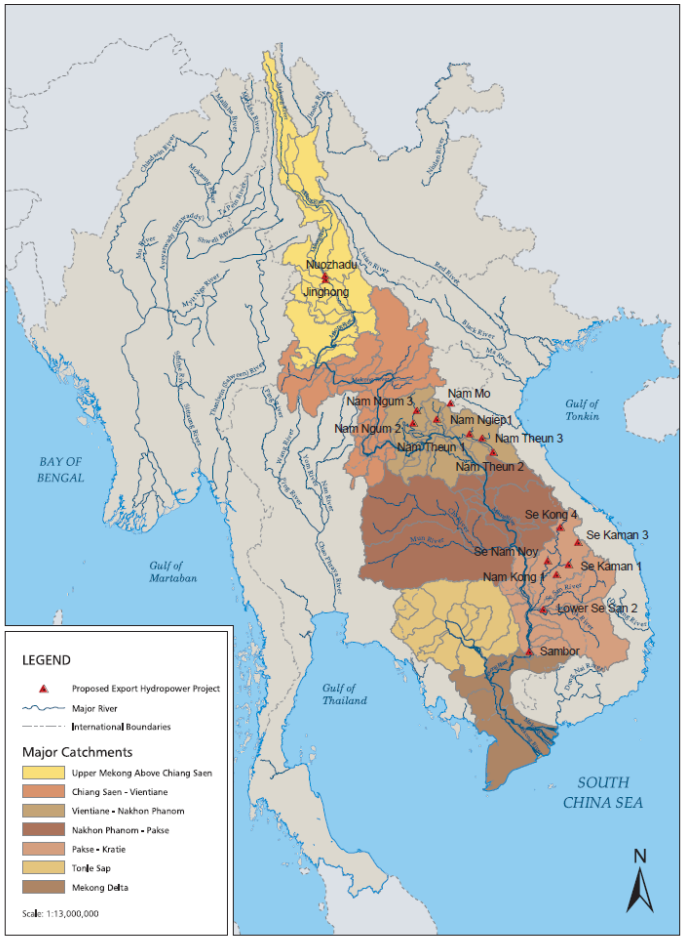
Major Hydrological Stations and Existing Hydropower Projects in the Mekong River Basin



The boundaries are not necessarily authoritative.

Source: ADB, based on ADB, UNEP, Mekong River Commission, and Stockholm Environment Institute 2001.

Proposed Export Hydropower Projects in the Mekong River Basin



The boundaries are not necessarily authoritative.

Source: ADB, based on ADB, UNEP, Mekong River Commission, and Stockholm Environment Institute 2001.

ADB. 2004. Atlas of Greater Mekong Subregion. Manila

Broader changes

- All of mainland Southeast Asia is a ‘hotspot of change’ or rather a ‘landscape of change’
- Some of these changes (expansion of protected areas) cannot be detected from space
- Some of the changes are not being monitored in meaningful ways (periurbanization)

- Drivers of change are diverse but international interests and national policies play important roles
- Small farmers also play major roles in landscape change. Farmers are by no means passive recipients of international plans and national policies.
- Where the social and environmental consequences of change are being documented and studied, they tend to be view individually (i.e., spread of rubber or periurbanization) not holistically.

- Not only are many of these changes and their drivers/consequences linked, when viewed holistically their consequences may be greater than the sum of the individual parts.
- Hypothesis that new and emerging diseases may occur in areas of great change. In other words areas of periurbanization, agrarian transitions, and habitat alterations are more likely to be source of new disease than more stable areas (subsistence agriculture or modern cities).
- In dynamic regions such as Southeast Asia we need to be less concerned with ‘hotspots’ of change in order to examine more closely ‘landscapes’ of change.