High-resolution Land Cover Mapping Projects in JAXA/EORC

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JAXA satellite data source products for LCLUC
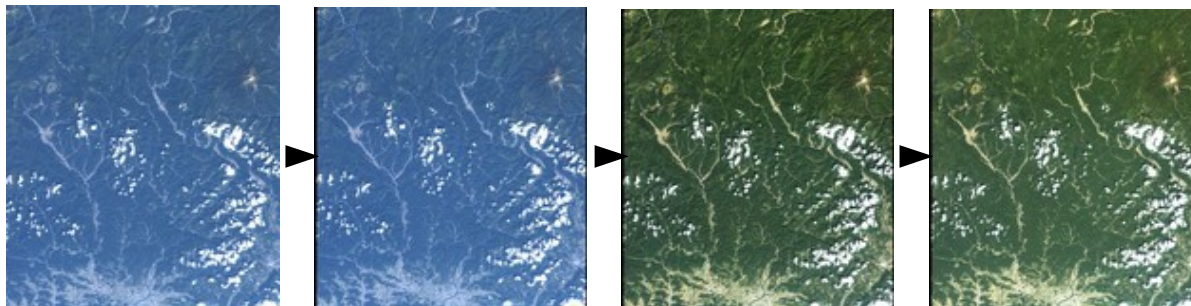
ALOS/AVNIR2 -HLP (high-level products)

2006~2011

10 m resolution

Japan/Vietnam/Indonesia etc.

Ortho-rectification,

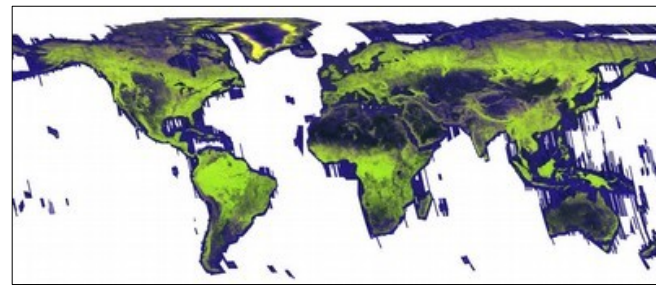atmospheric correction,

slope correction

JERS, PALSAR, PALSAR-2 global mosaic
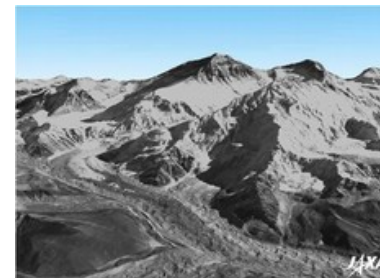
Resolution = 25 m,

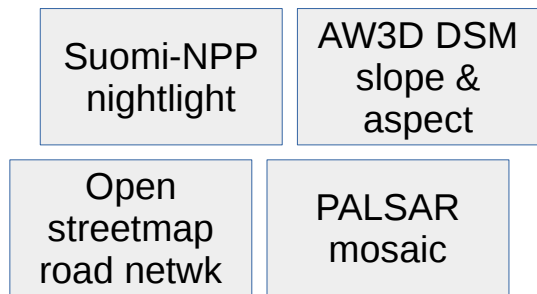Year = 2007, 2008, 2009, 2010, 2015, 2016

Polarization = HH, HV

ALOS World 3D (AW3D) digital surface model
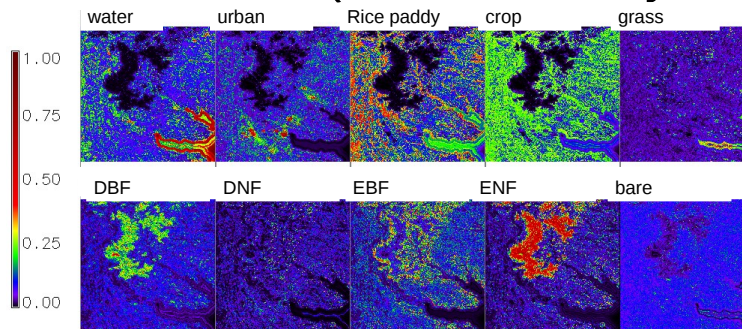
Resolution = 5 m, 30 m

Classification algorithm "saclass" ... KDE (kernel density estimation)

Meta data

| Suomi-NPP nightlight | AW3D DSM slope & aspect |
| Open streetmap road netwk | PALSAR mosaic |

KDE →

water   urban   Rice paddy   crop   grass

DBF   DNF   EBF   ENF   bare
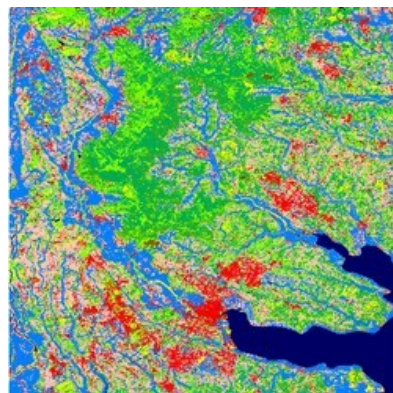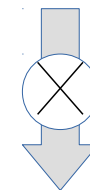
1.00
0.75
0.50
0.25
0.00

Training data

Prior probability for each category

Multi-temporal AVNIR2HLP data

...

KDE

⊗

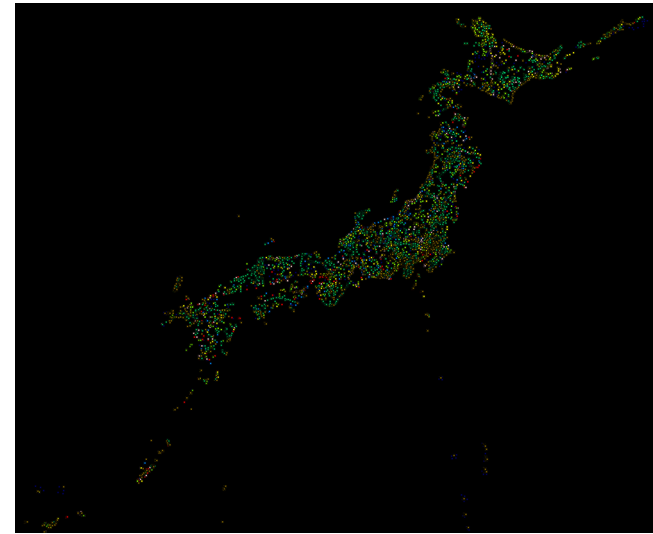Landcover map

| 水域 | Water |
都市域	Urban
水田	Rice
畑地	Farm
草原	Grass
落葉広葉樹	Forest: decid. broad
落葉針葉樹	Forest: decid. needle
常緑広葉樹	Forest: evergr. broad
常緑針葉樹	Forest: evergr. needle
裸地	Barren

JAXA High-resolution landcover map, Japan
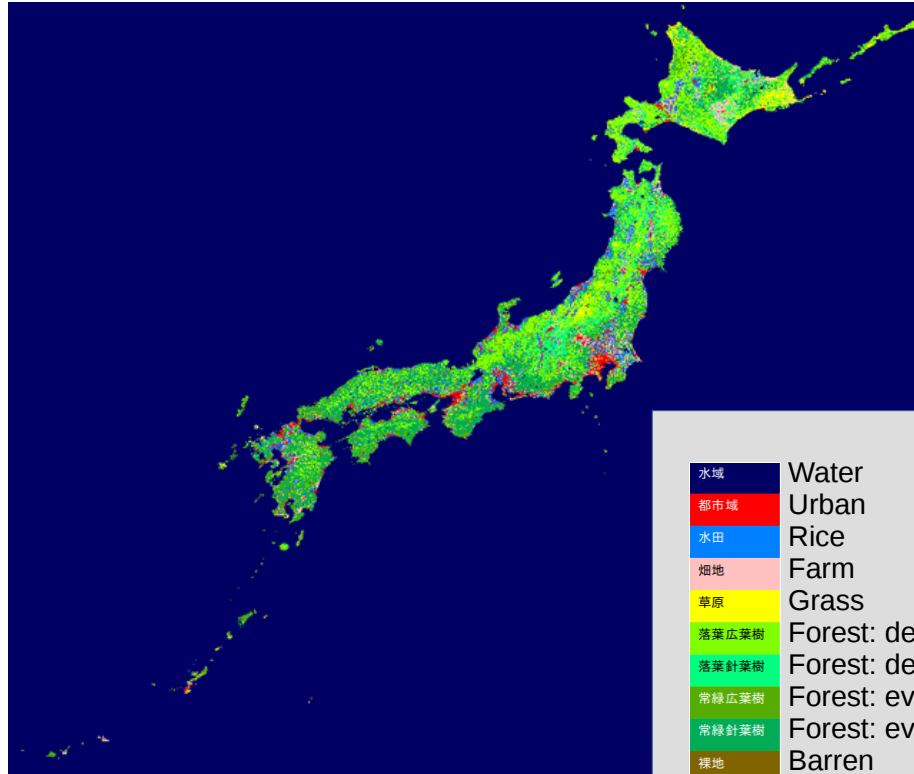
|	
水域	Water
都市域	Urban
水田	Rice
畑地	Farm
草原	Grass
落葉広葉樹	Forest: decid. broad
落葉針葉樹	Forest: decid. needle
常緑広葉樹	Forest: evergr. broad
常緑針葉樹	Forest: evergr. needle
裸地	Barren

Training data

10 m resolution, 10 categories including rice paddy field, Representing 2006~2011
Overall accuracy ~ 80 % … If evergreen and deciduous are integrated, more than 90%.

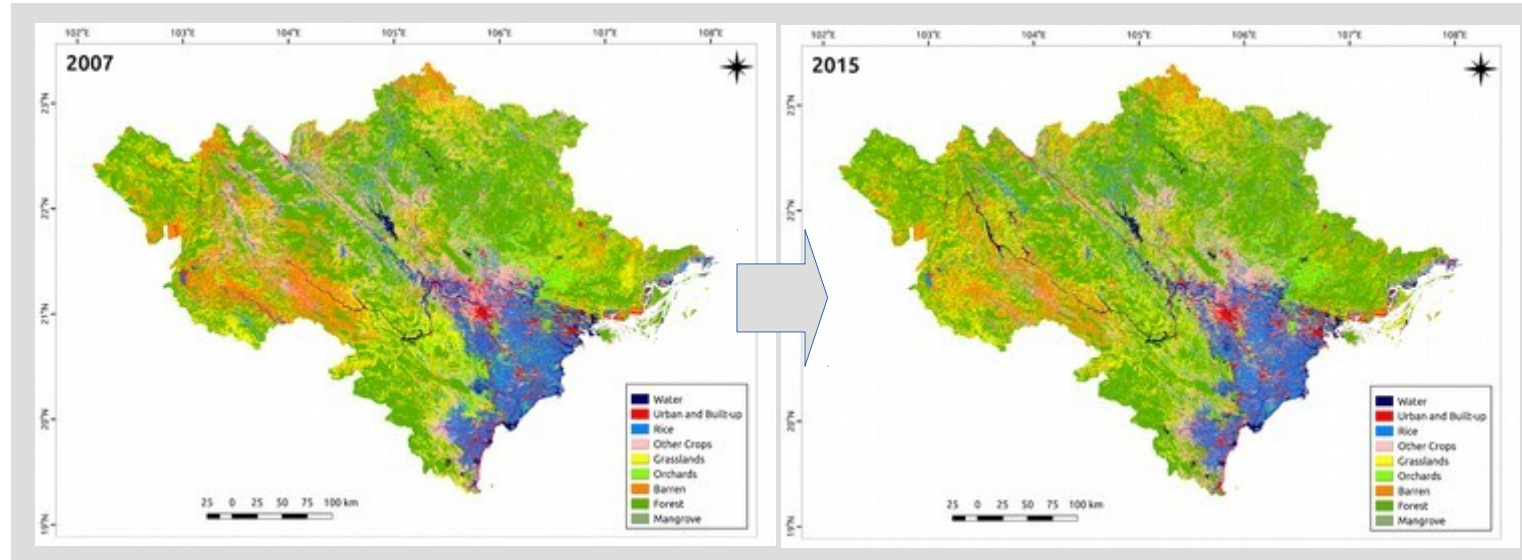# Landcover change after the nuclear disaster in Fukushima
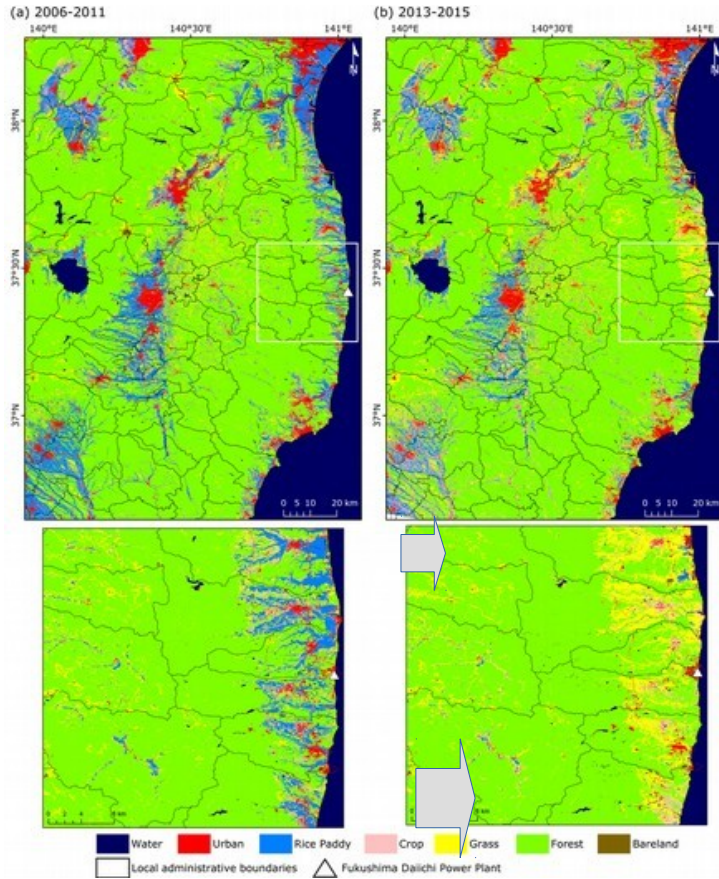
BEFORE
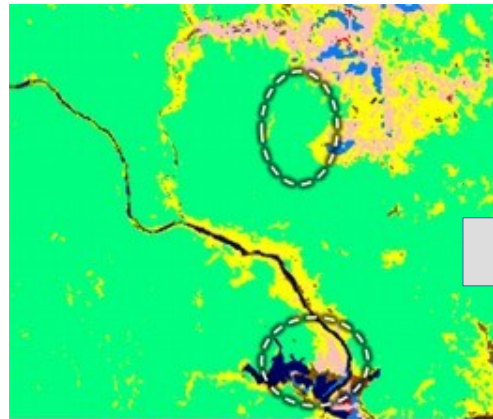(ALOS/AVNIR2; 2006-2011)

AFTER
Landsat 8; 2013-2015)
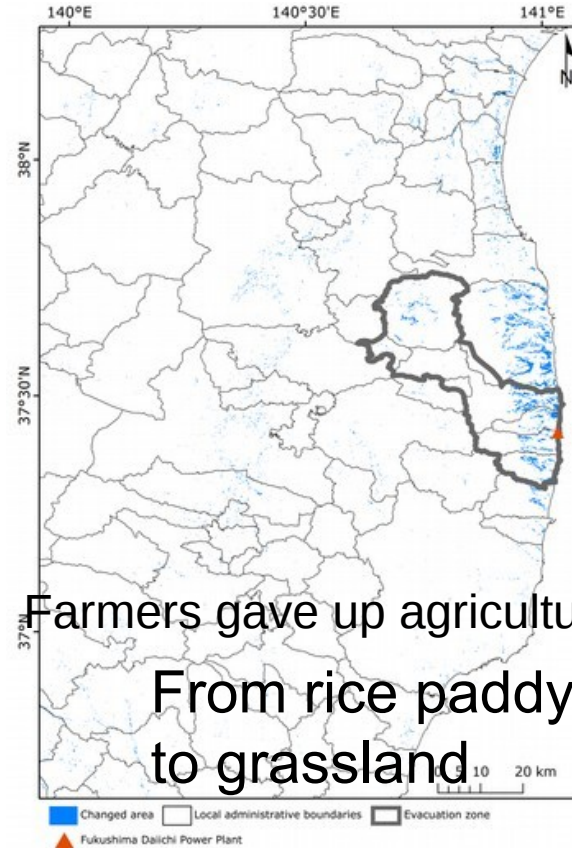
Farmers gave up agriculture.

From rice paddy
to grassland

Ishihara & Tadono, 2017, Scientific Reports
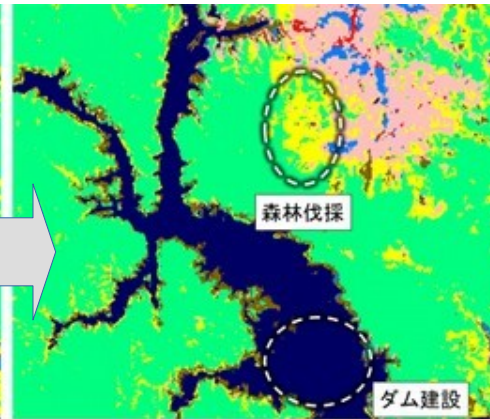
JAXA High-resolution landcovermap, North Vietnam
15 m resolution. Source: Landsat, PALSAR, ASTER, SuomiNPP, etc.

2007

2015

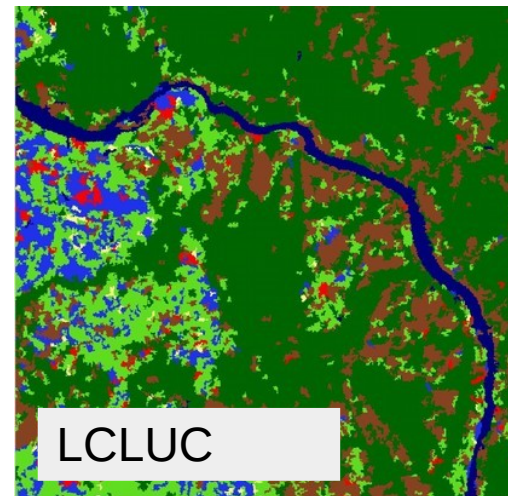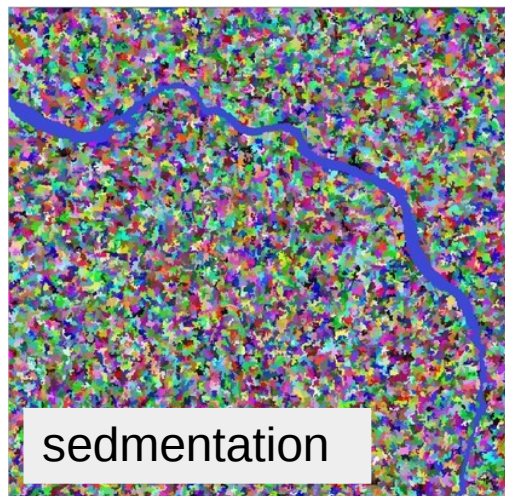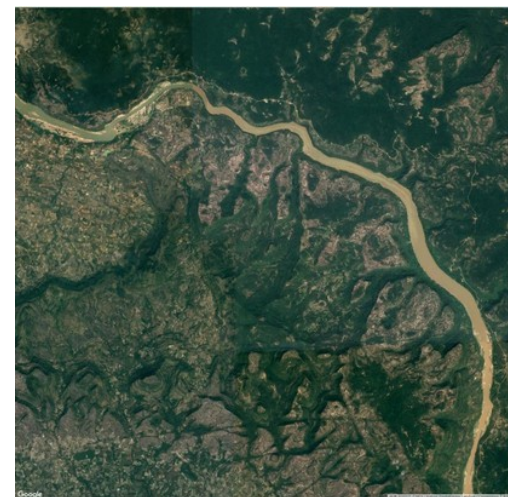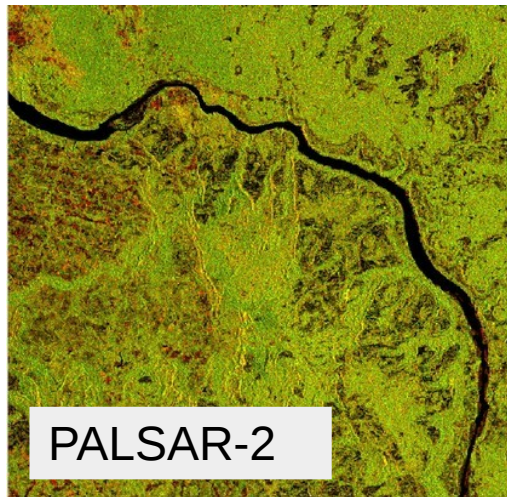Hoang Thanh Tung et al.

East Thailand Agriculture Monitoring (Pa Chan Area) with HAII

MYANMAR
LAOS
Chiang Rai
Mae Hong Son
Chiang Mai
Lampang
THAILAND
Sukhothai
Phitsanulok
Ayuthaya
★ Bangkok
Pattaya
CAMBODIA
WETN
Gulf of Thailand
Koh Tao
Koh Pha Ngan
Koh Samui
Surat Thani
Phang Nga
Phuket
Phi Phi Island
Koh Lanta

Google map

30km

Google map

PALSAR-2

sedmentation

LCLUC
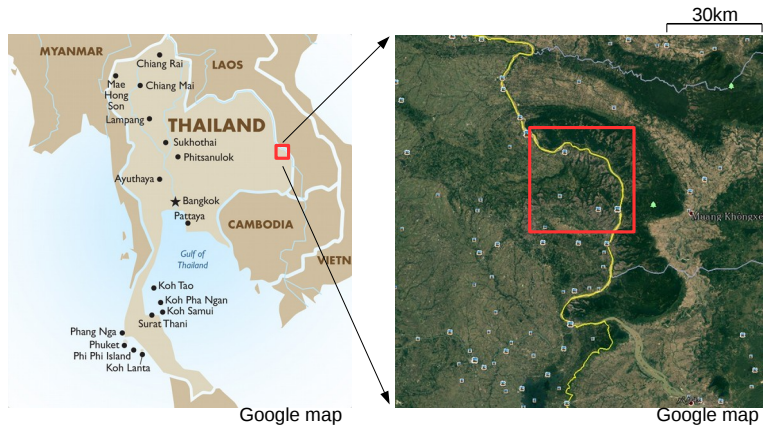
landcover
- water
- urban
- rice paddy
- cassava
- forest
- rubber
- rockout

0 1 2 3 4 5 km
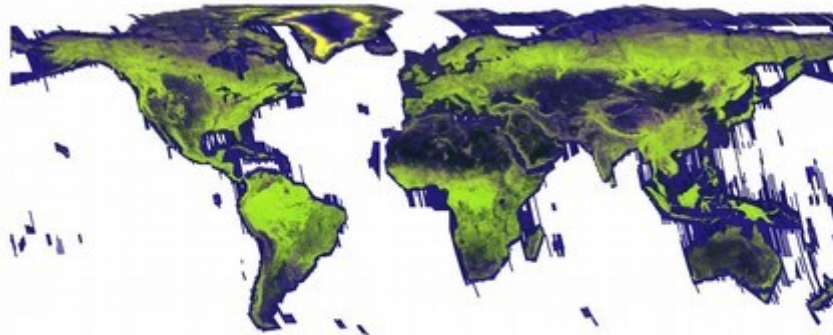
Kenlo Nasahara &
Seiya Ishibashi
(JAXA / Univ Tsukuba)

ALOS-2/PALSAR-2
ScanSAR multi-temporal
RSGISlib segmentation
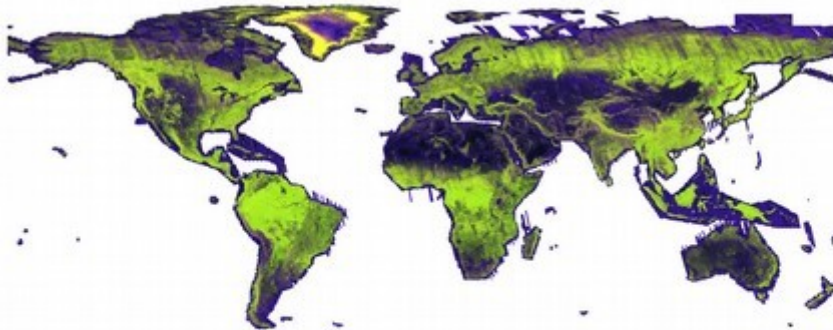Python random forest

Overall Accuracy = 0.80

JAXA Global Forest / non-Forest map
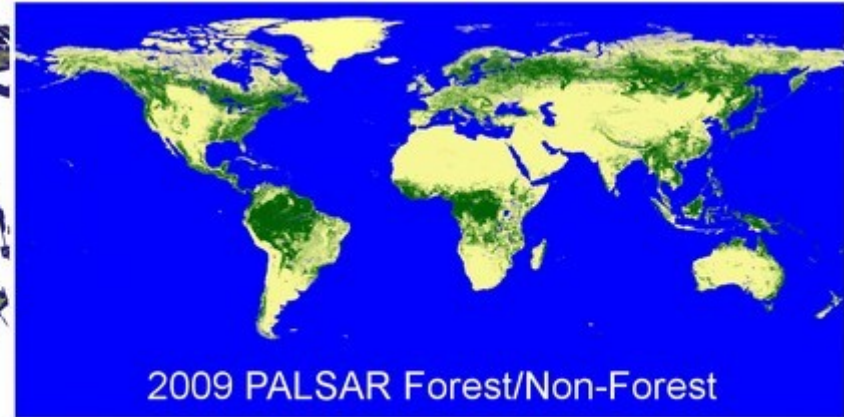## 25 m resolution. 2007, 2008, 2009, 2010, 2015, 2016

ALOS, ALOS-2

2009 PALSAR 25m Mosaic

2009 PALSAR Forest/Non-Forest

2015 PALSAR-2 25m Mosaic
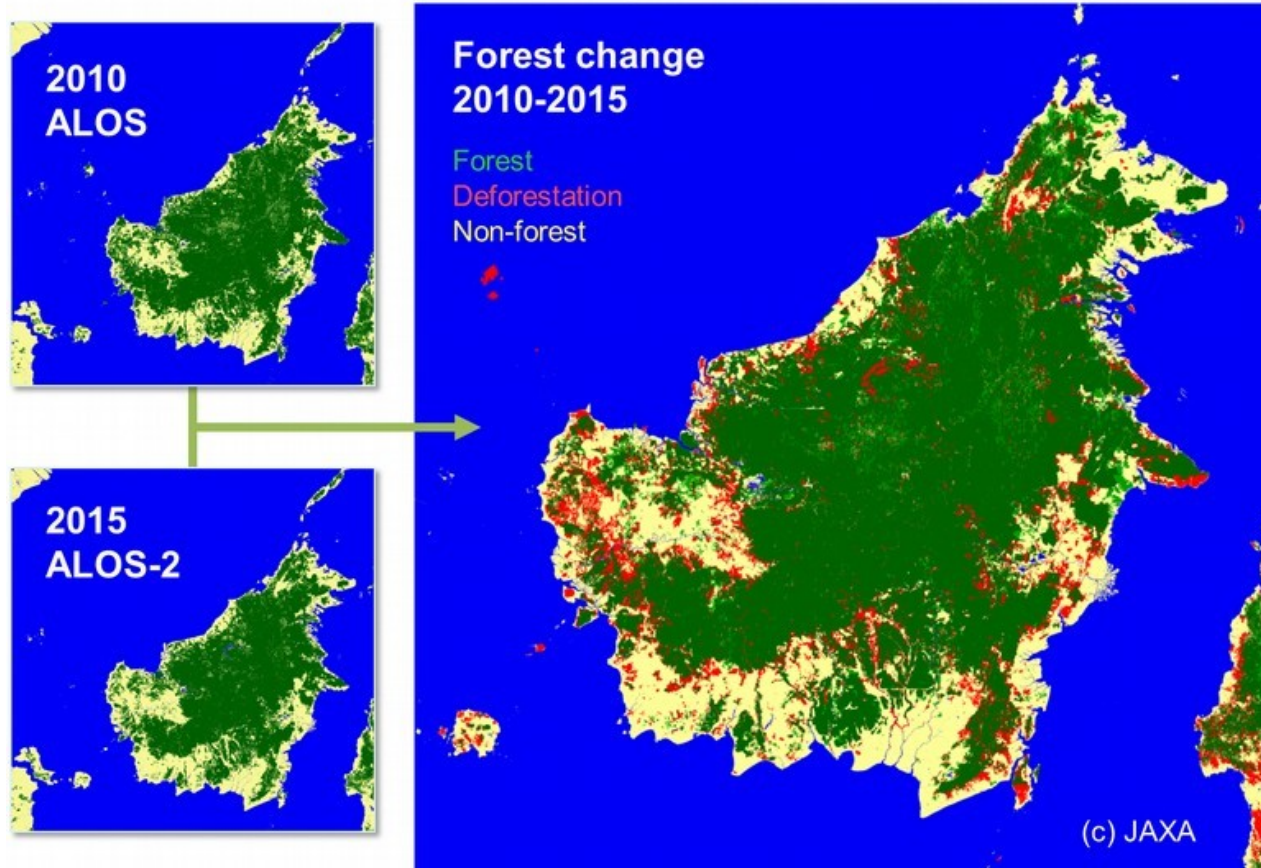
2015 PALSAR-2 Forest/Non-Forest

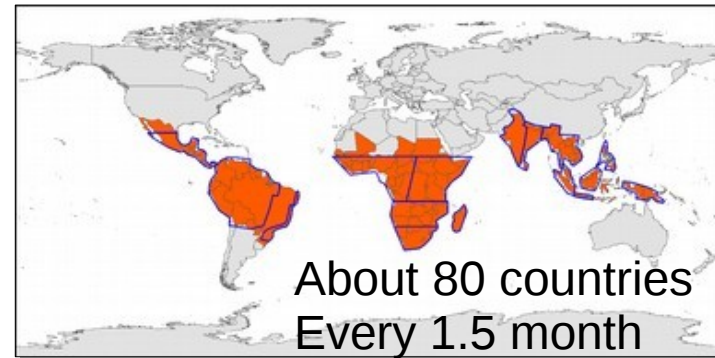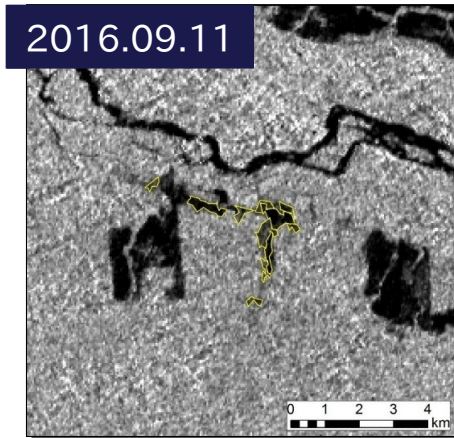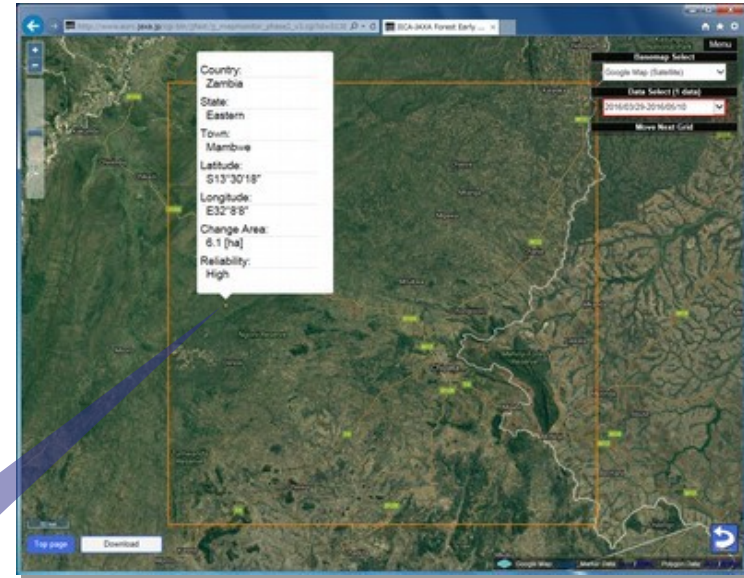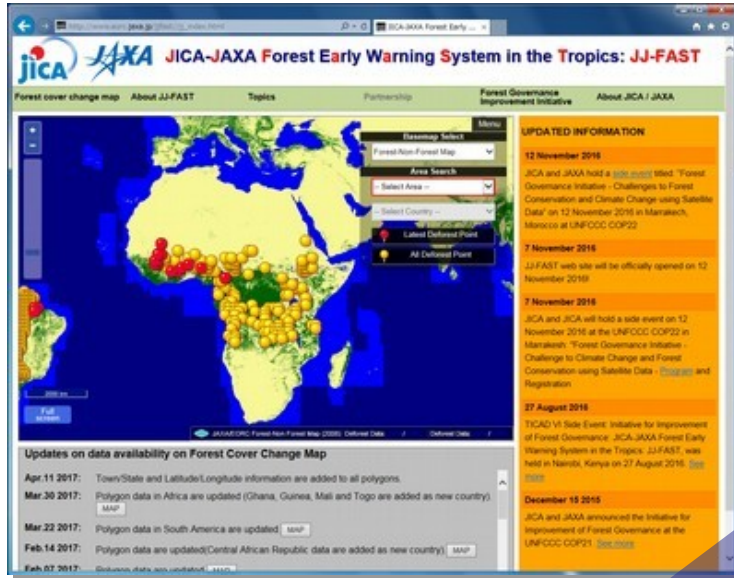(c) JAXA

JAXA Global Forest / non-Forest map
25 m resolution. 2007, 2008, 2009, 2010, 2015

ALOS, ALOS-2

Forest change in Borneo

JJFAST: JICA-JAXA Forest Early Warning System in the Tropics

2016.09.11

About 80 countries
Every 1.5 month

Released in November 2016.

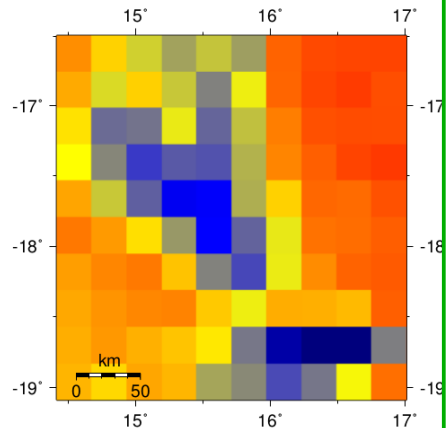# DBUX: database unmixing

… spatial-temporal data fusion technology

Mizuochi et al., 2014

High temporal, low spatial

Fusion !!

Low temporal, high spatial

High temporal, High spatial

Available data

		Available data
2001/04/10	Match-up	2001/04/10
.		.
2001/05/23	**predict** →	*2001/05/23*
2001/05/24	Match-up	2001/05/24
.		.
.		.
2001/07/11	**predict** →	*2001/07/11*
.		.
.		.
2001/08/11	**predict** →	*2001/08/11*
2001/08/12	Match-up	2001/08/12
2001/08/13	**predict** →	*2001/08/13*
.		.
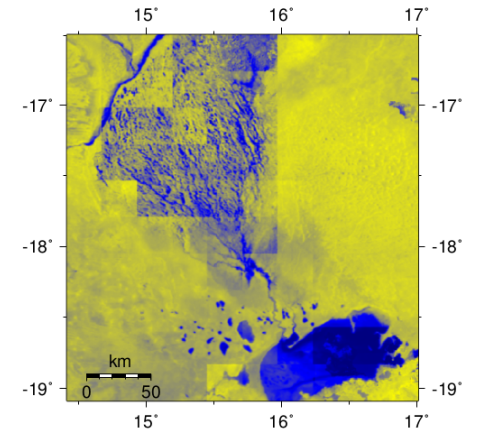
DBUX: database unmixing

AMSR-E, 2 (NDPI) → MODIS scale (MNDWI) → Landsat scale (MNDWI)

2008/02/24, Namibia
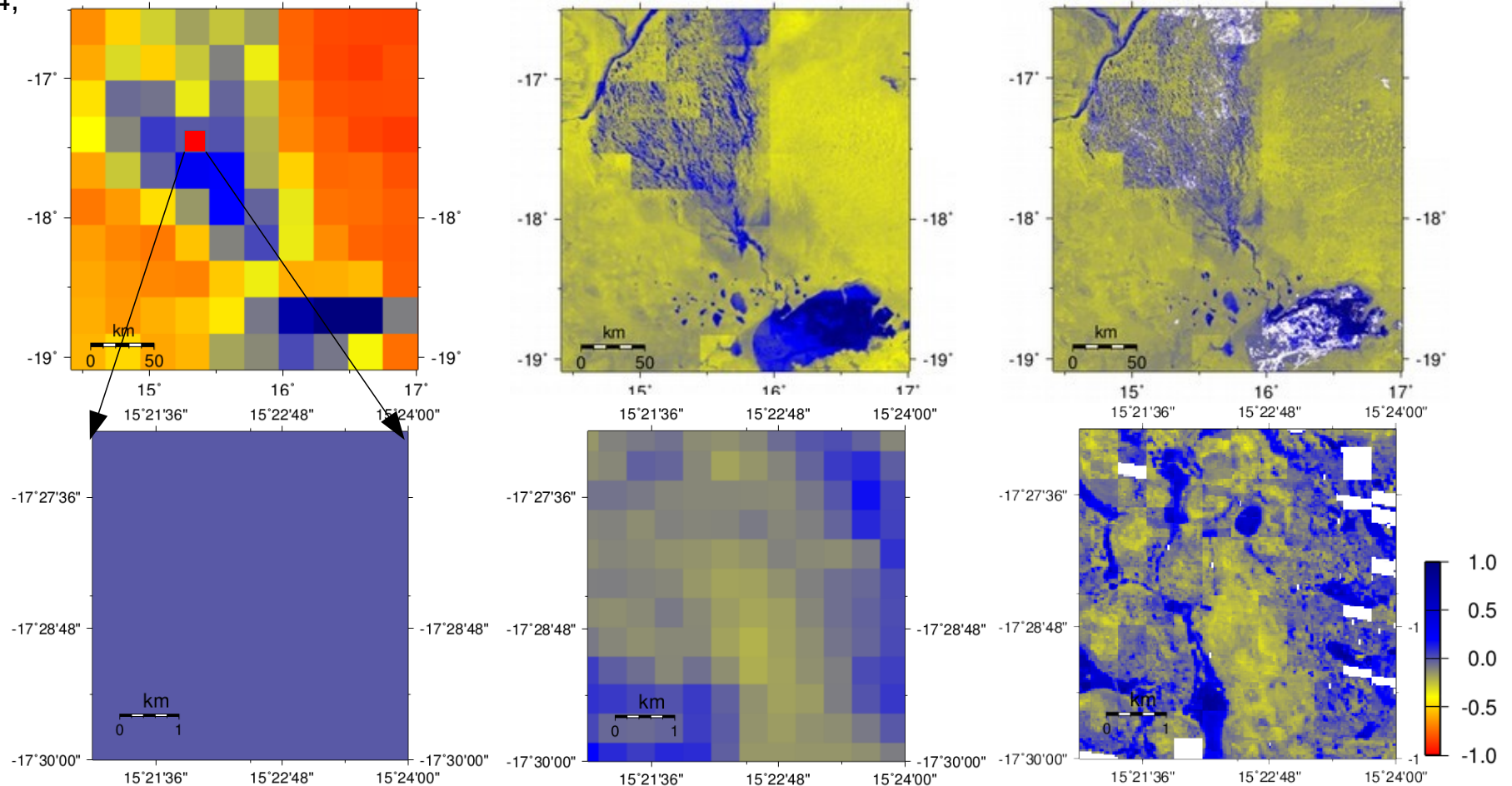
Groun truth … SACLAJ:
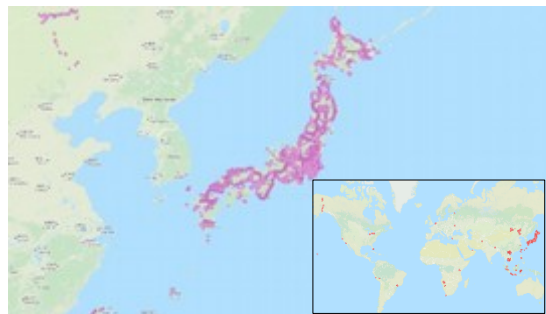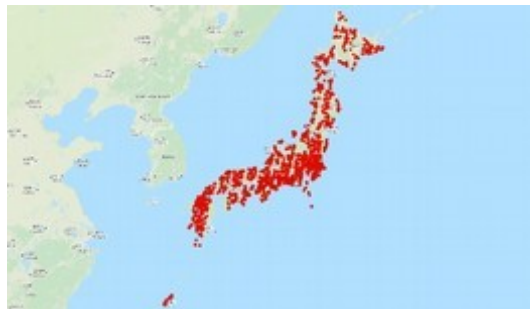## Site-based dataset for Assessment of Changing Landcover by JAXA
… An in-situ database for training and validation of LCLUC maps

SACLAJ-Gref

SACLAJ-Rref

SACLAJ-DCP

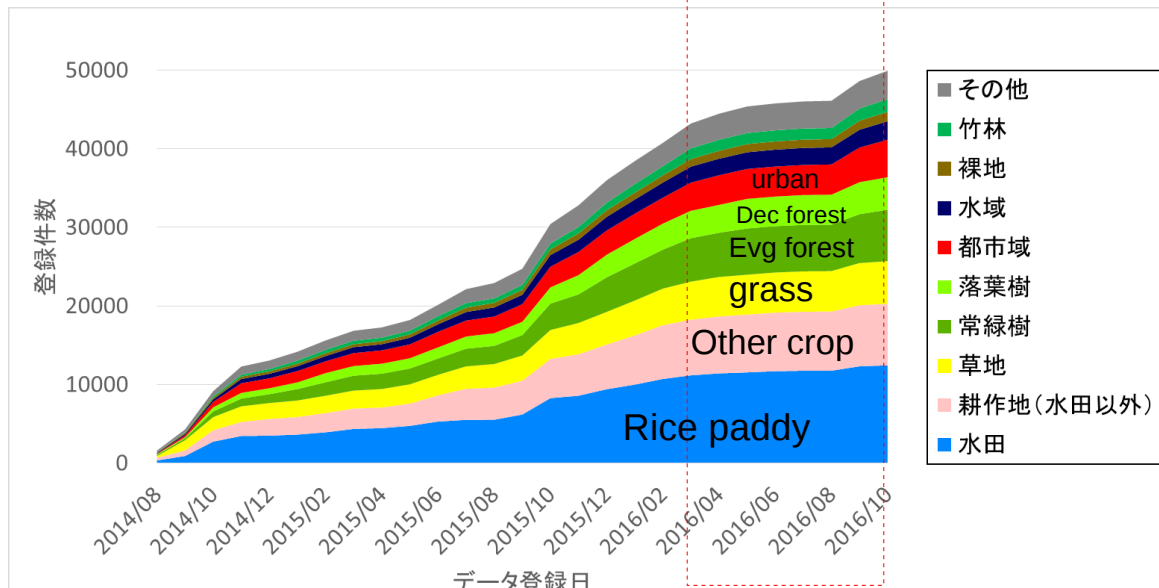|	凡例
■	その他
■	竹林
■	裸地
■	水域
■	都市域
■	落葉樹
■	常緑樹
■	草地
■	耕作地（水田以外）
■	水田

urban
Dec forest
Evg forest
grass
Other crop
Rice paddy

登録件数

データ登録日

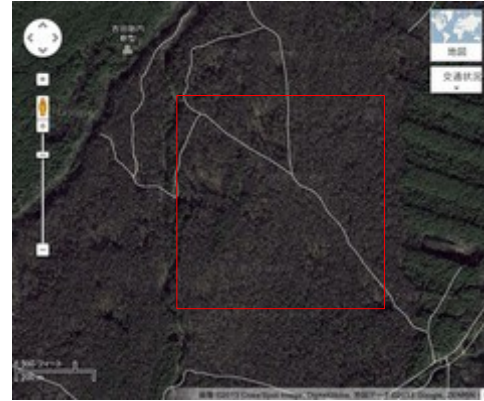**SACLAJ Web**

Groun truth ... JAXA Super Site 500

Ideal field-sites for validation of ecological remote sensing.
Flat and homogeneous in 500 m x 500 m → MODIS, GCOM-C, etc.
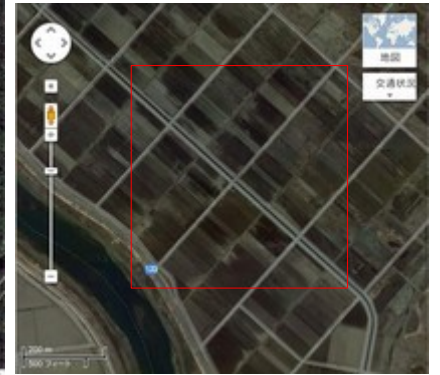Overlap with existing networks (Fluxnet, LTER).

Tomakomai 苫小牧
Deciduous
broad leaf forest

Uryu 雨龍
Evergreen
needle leaf forest
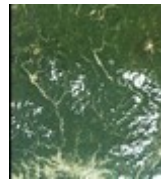
Fuji-Hokuroku 富士北麓
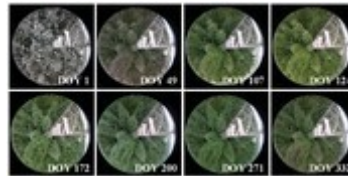Deciduous needle leaf
forest

Mase 真瀬水田
Rice paddy

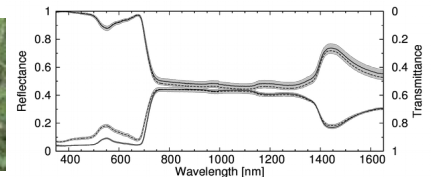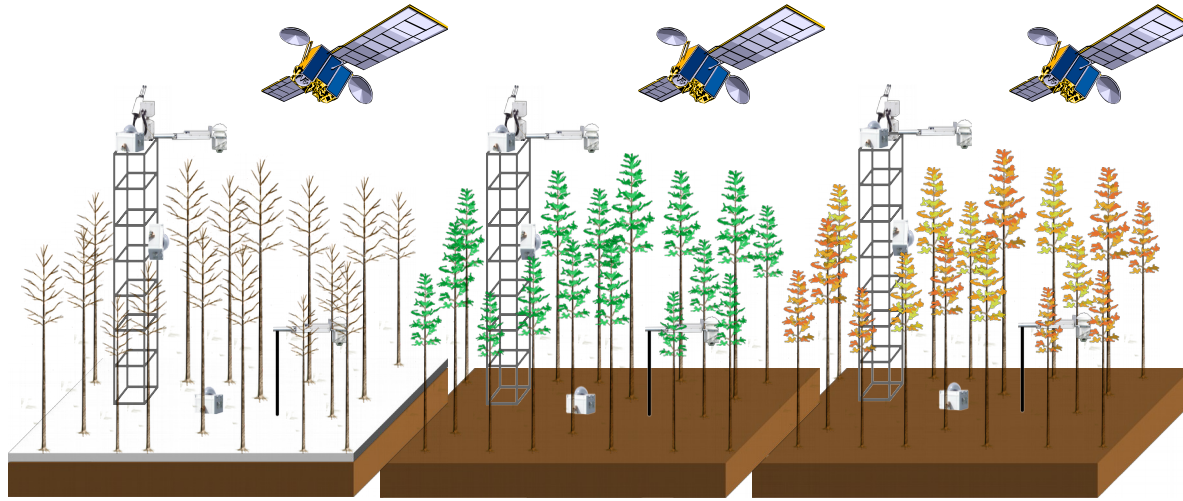biometrics flux   UAV   RS   PEN   LAI   spectrum   etc...

Groun truth ... Phenological Eyes Network

2003〜

A continuous, biology-oriented, ground truth network for remote sensing.
JAXA Super Sites 500 belong to this network also.

Automatic Digital Fish-Eye Camera
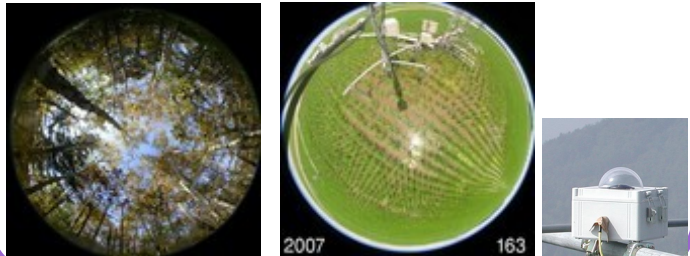
Automatic spectrometer
(VIS/NIR/SWIR)
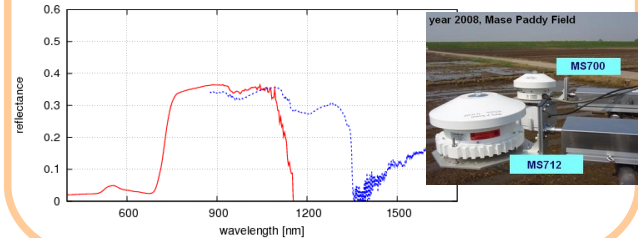
Sunphotometer (for aerosol)

Aerosol size distribution at Tsukuba
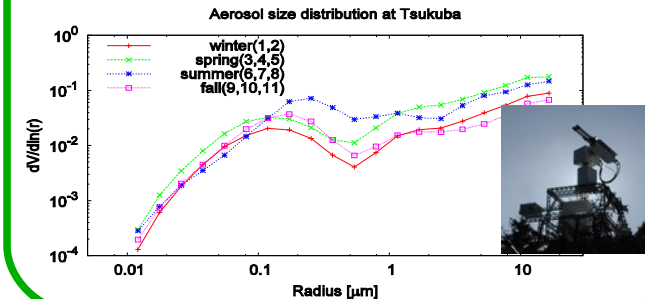
Good practice: Time-lapse camera

→ Phenology = Seasonal change of plants

Ceder forest

Larch forest
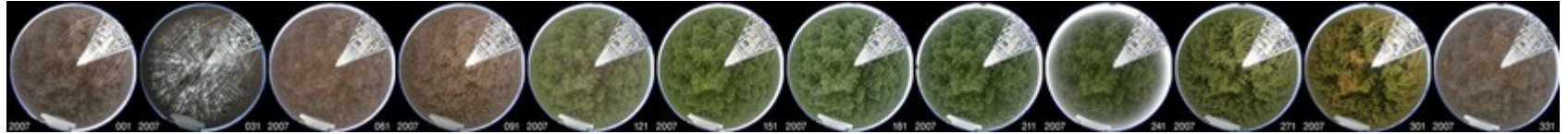
Hardwood forest
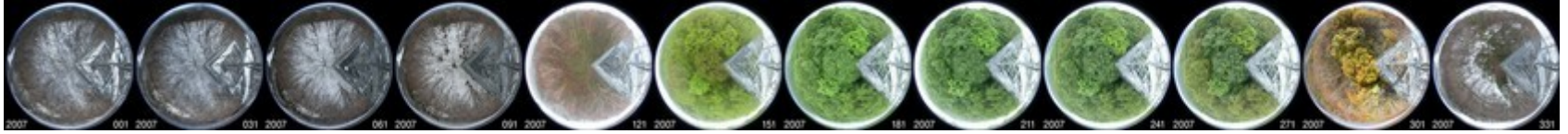
Rice paddy field
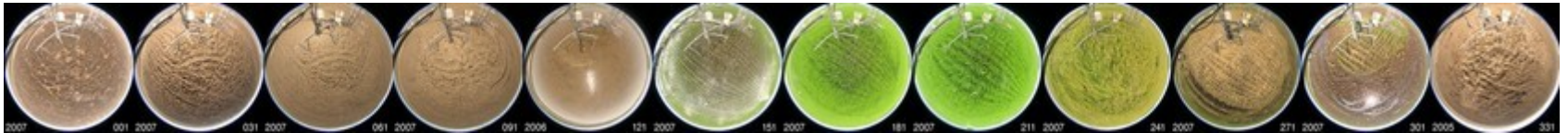
Grassland
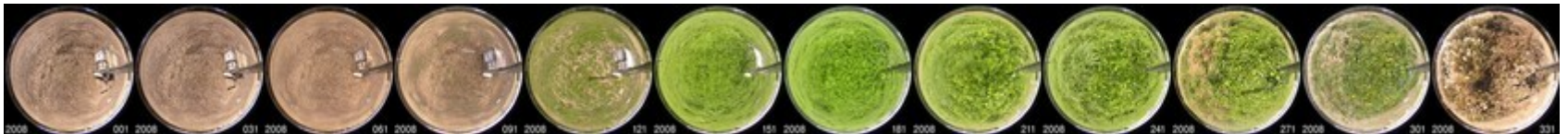
A good key of landcover and climate change impacts!

Good practice: Rephotography

... Direct and clear evidence of LCLUC!

Reforestation in China

2003/09/10

2006/09/06

Koyanagi et al., 2008

Deforestation in Japan (deer bite!)

1963

1997

2004

昭和38年（1963年）の正木峠

平成9年（1997年）の正木峠

平成16年（2004年）の正木峠

Ministry of Environment, Japan http://kinki.env.go.jp/nature/odaigahara/pamphlet/pamphlet_index.html

Good practice: Rephotography

... Direct and clear evidence of LCLUC!

Reforestation

2003/09/10   2006/09/06

Why not share and open the ground (in-situ) data?

Deforestation
in Japan
(deer bite!)

昭和38年（1963年）の正木峠   平成9年（1997年）の正木峠   平成16年（2004年）の正木峠

Ministry of Environment, Japan http://kinki.env.go.jp/nature/odaigahara/pamphlet/pamphlet_index.html

JAXA LCLUC New satellites Coming soon!

Global optical imager … ADEOS/AVNIR, ADEOS2/GLI, GOSAT/CAI →
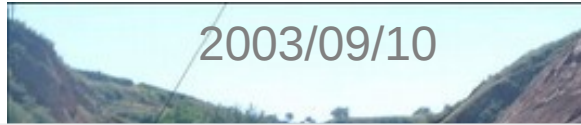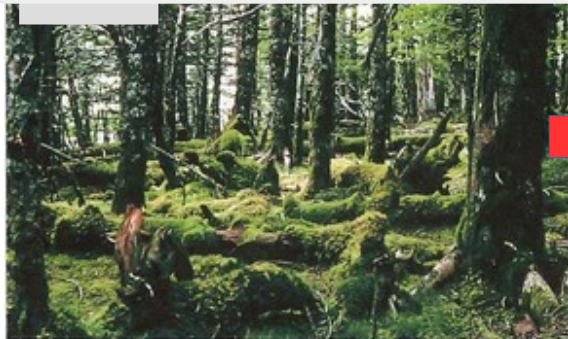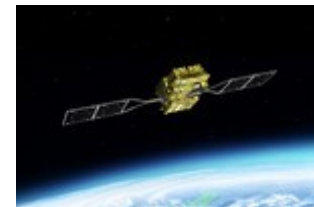
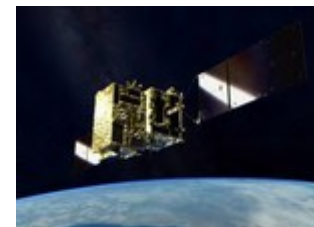→ GCOM-C (**G**lobal **C**hange **O**bservation **M**ission-**C**limate), 2017~

     17 bands, swath: 1150 km, IFOV: 250 m ~ 1000 m

High-resolution optical imager ... JERS/OPS → ASTER, ALOS/AVNIR2

→ Advanced Optical Satellite (ALOS-3), 2020 or 2021 ~

     6 bands, swath: 50 km ~ 70 km, IFOV: 0.8 m ~ 3.2 m

SAR … JERS/SAR → ALOS/PALSAR → ALOS2/PALSAR2

→ Advanced Radar Satellite (ALOS-4), 2020 or 2021 ~

     IFOV/Swath: 1 m ~ 3 m / 25 km, 3 m ~ 10 m / 200 km, 10 m ~ 25 m / 700 km, Band: L

Vegetation Lidar on ISS (International Space Station) … a new series!

    MOLI   (**M**ulti-footprint **O**bservation **L**idar and **I**mager), ????~

     Lidar: 25 m footprint, 150 Hz PRF
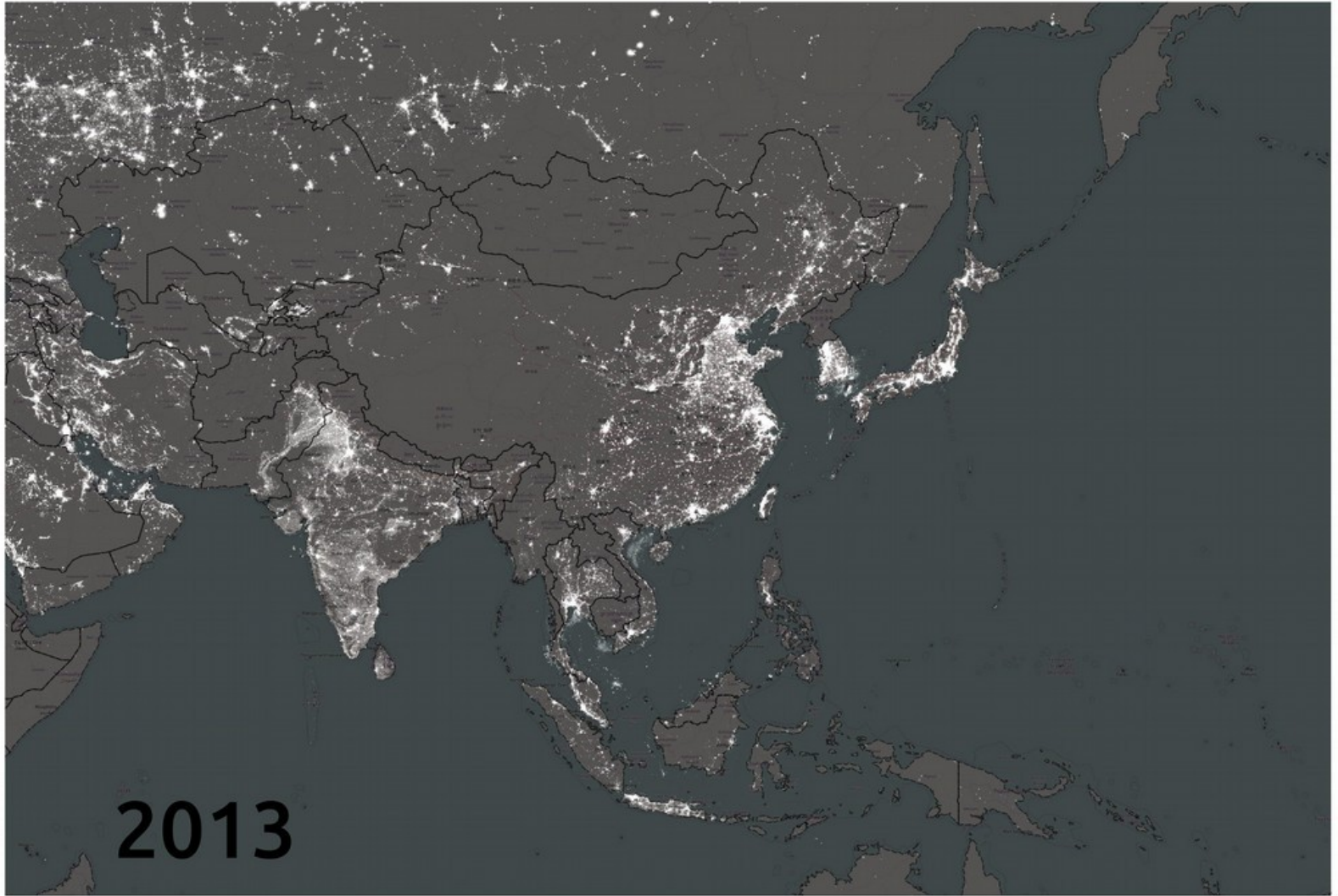   Imager: 3 bands … green, red, NIR, IFOV=5 m, swath=1000 m
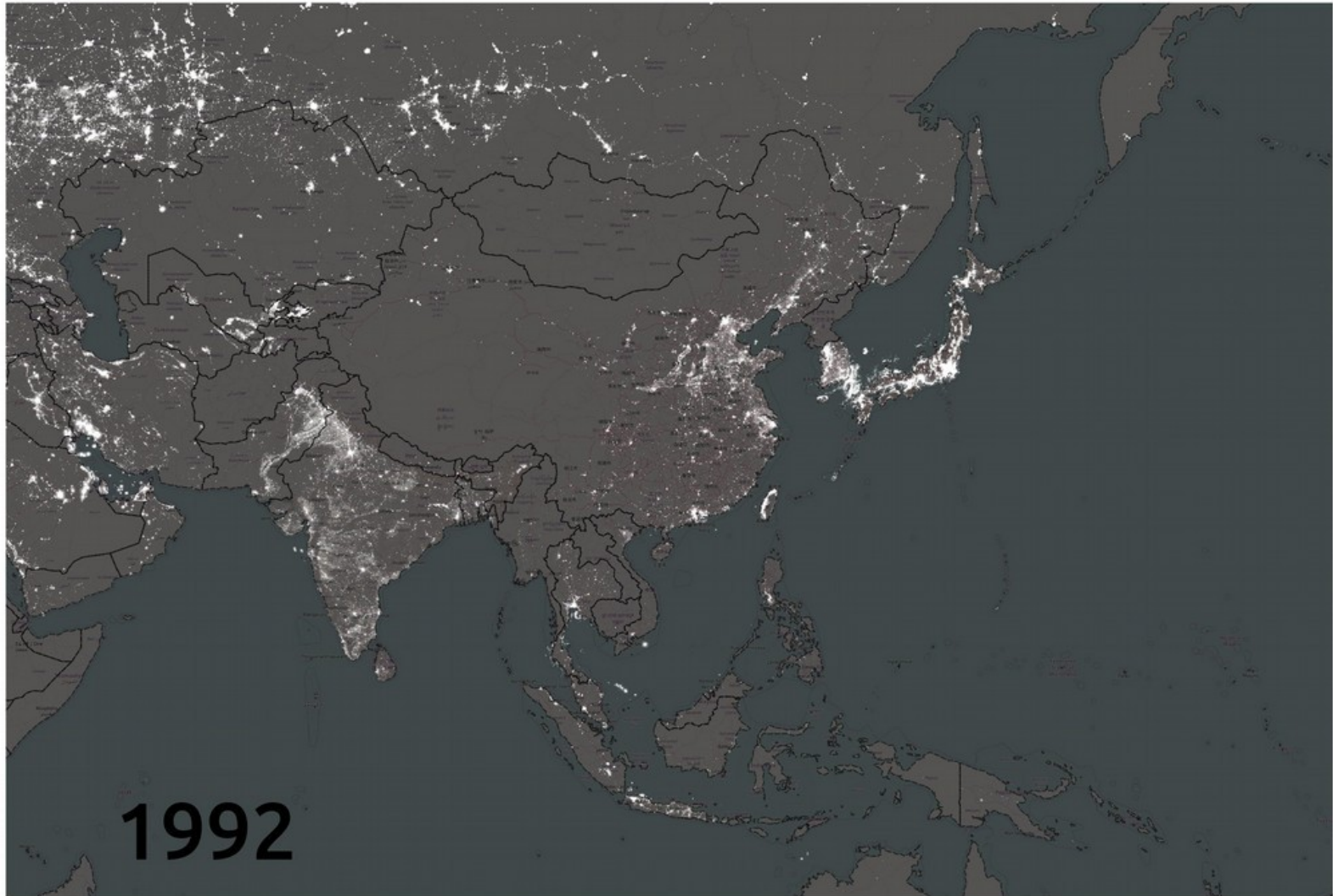
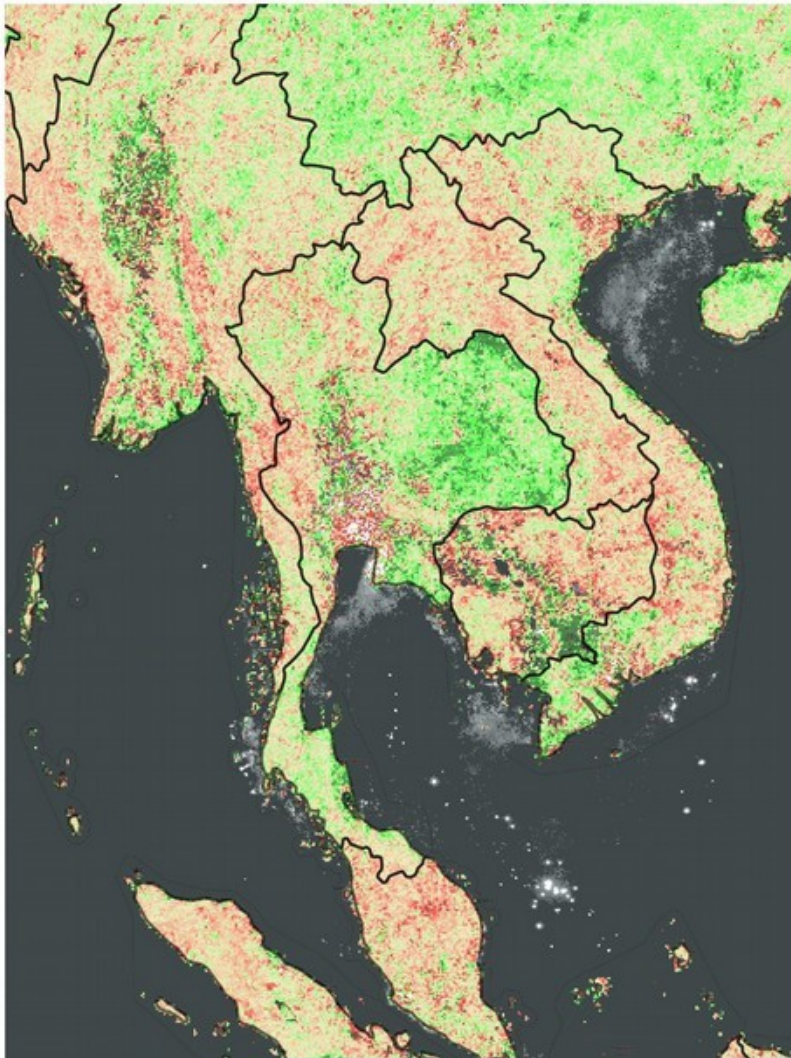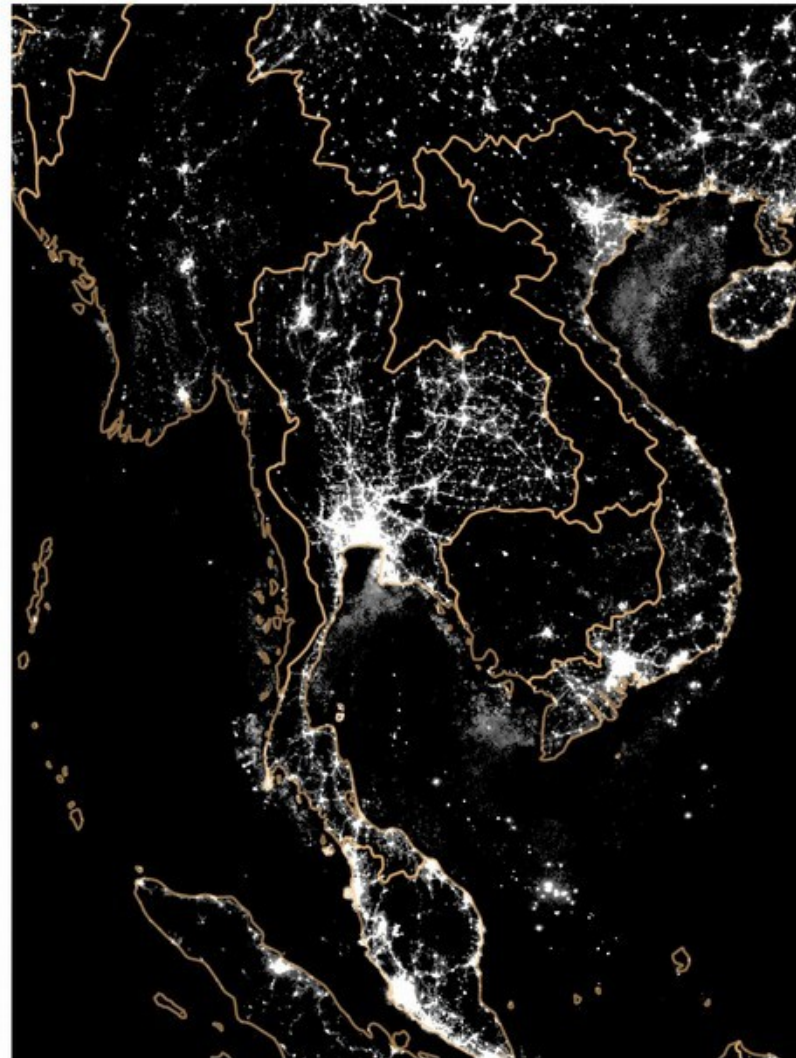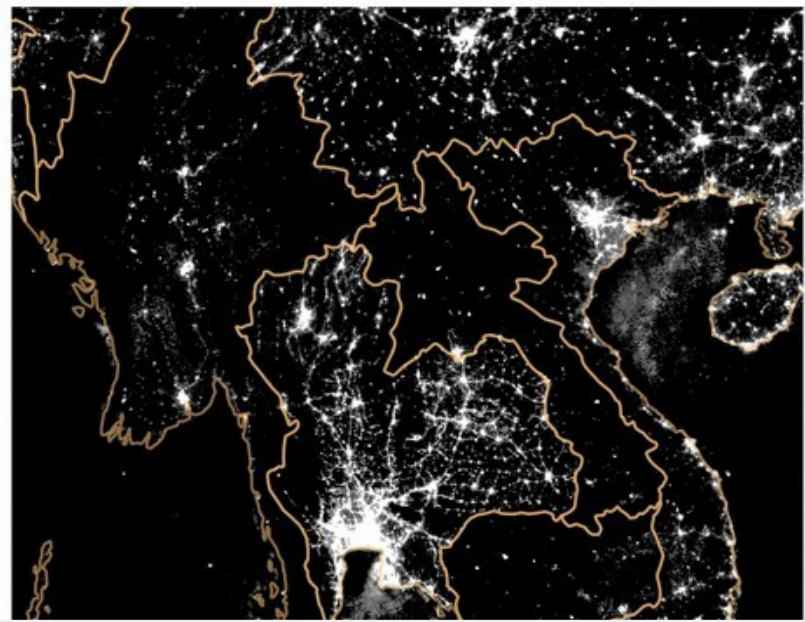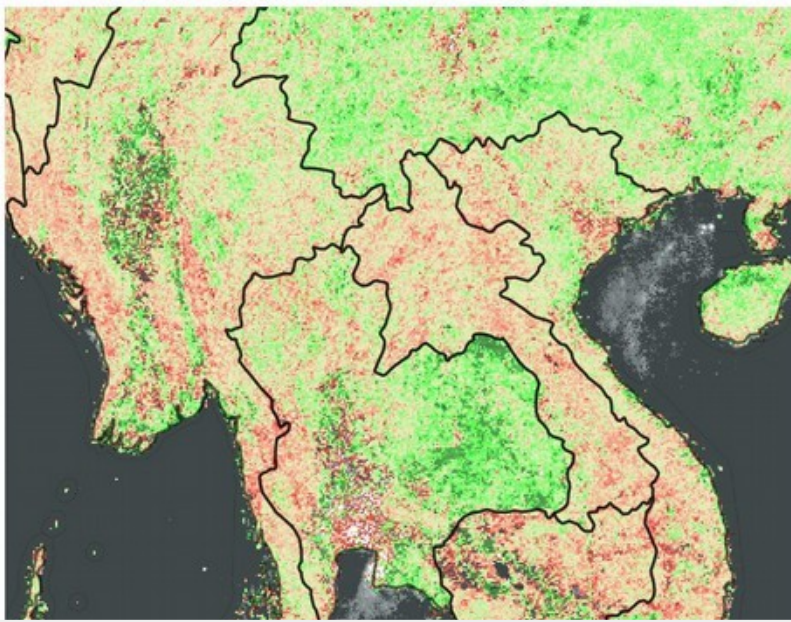1992

DMSP/OLS

2013

DMSP/OLS

MODIS NDVI change (red: increase,green: decrease)
[2014~2016] - [2003~2005]

DMSP/OLS 2013

0   500   1000 km

Environmental Kuznets Curve?

Table 10

Trends in forest area in countries where a national forest transition (switch from net forest loss to net forest expansion) between 1990 and 2015 is likely or possible (K ha).

Country	1990	2000	2005	2010	2015
Transition likely					
Burundi	289	198	181	253	276
Gambia	442	461	471	480	488
Ghana	8,627	8,909	9,053	9,195	9,337
Rwanda	318	344	385	446	480
Bhutan	2,507	2,606	2,656	2,705	2,755
India	63,939	65,390	67,709	69,790	70,682
Laos	17,645	16,526	16,870	17,816	18,761
Philippines	6,555	7,027	7,074	6,840	8,040
Vietnam	9,363	11,727	13,077	14,128	14,773
Cuba	2,058	2,435	2,697	2,932	3,200
Costa Rica	2,564	2,376	2,491	2,605	2,756
Dominican Republic	1,105	1,486	1,652	1,817	1,983
Puerto Rico	287	450	463	479	496
Transition possible					
Cape Verde	58	82	84	85	90
Cote D'Ivoire	10,222	10,328	10,405	10,403	10,401
Sierra Leone	3,118	2,922	2,824	2,726	3,044
Malaysia	22,376	21,591	20,890	22,124	22,195
Thailand	14,005	17,011	16,100	16,249	16,399
Trinidad and Tobago	241	234	230	226	368

Keenan et al., 2015