3rd Nano- Satellite Symposium

Kokura, Japan, 12-13 Dec. 2011

Potential Application of Nano-Satellite for MRV

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Japan Government Commitment at COP17

Japan Government Commitment at COP17

During the COP17, Japan announce two initiatives;

1. Japan's Vision and Actions toward Low-Carbon Growth and a Climate-Resilient World

2. African Green Growth Strategy: Toward Low-Carbon Growth and Climate Resilient Development“

Japan Government Commitment at COP17

1. Japan's Vision and Actions toward Low-Carbon Growth and a Climate-Resilient World

1. Cooperation among developed countries: efforts on technological innovation towards further emissions reductions
2. Cooperation with developing countries: dissemination and promotion of technologies and the establishment of a new market mechanism
3. Support for developing countries: special consideration for vulnerable countries

(http://www.mofa.go.jp/policy/environment/warm/cop/lowcarbongrowth_vision_1111.html)

Japan Government Commitment at COP17

2. Goal and Principles of the "African Green Growth" Strategy

< Goal >

① Assist African countries to pursue **"African Green Growth"** (adaptation + mitigation) pathways

② Aim at green growth by promoting mitigation efforts as well as overcoming challenges of African countries in adaptation area.

< Principle >

(1) Combination of adaptation and mitigation

(2) Enhancement of country ownership

(3) Enhancement of partnership between public and private sector

(4) Improvement of coordination among development partners for the future climate finance

(http://www.mofa.go.jp/announce/announce/2011/12/1207_01.html)

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2. Goal and Principles of the "African Green Growth" Strategy

- **Sectoral efforts in the Strategy**

(1) Energy
(2) Agriculture
(3) Forest
(4) Disaster reduction
(5) Water supply (including sanitation)
(6) Transportation
(7) Cross-sectoral issues

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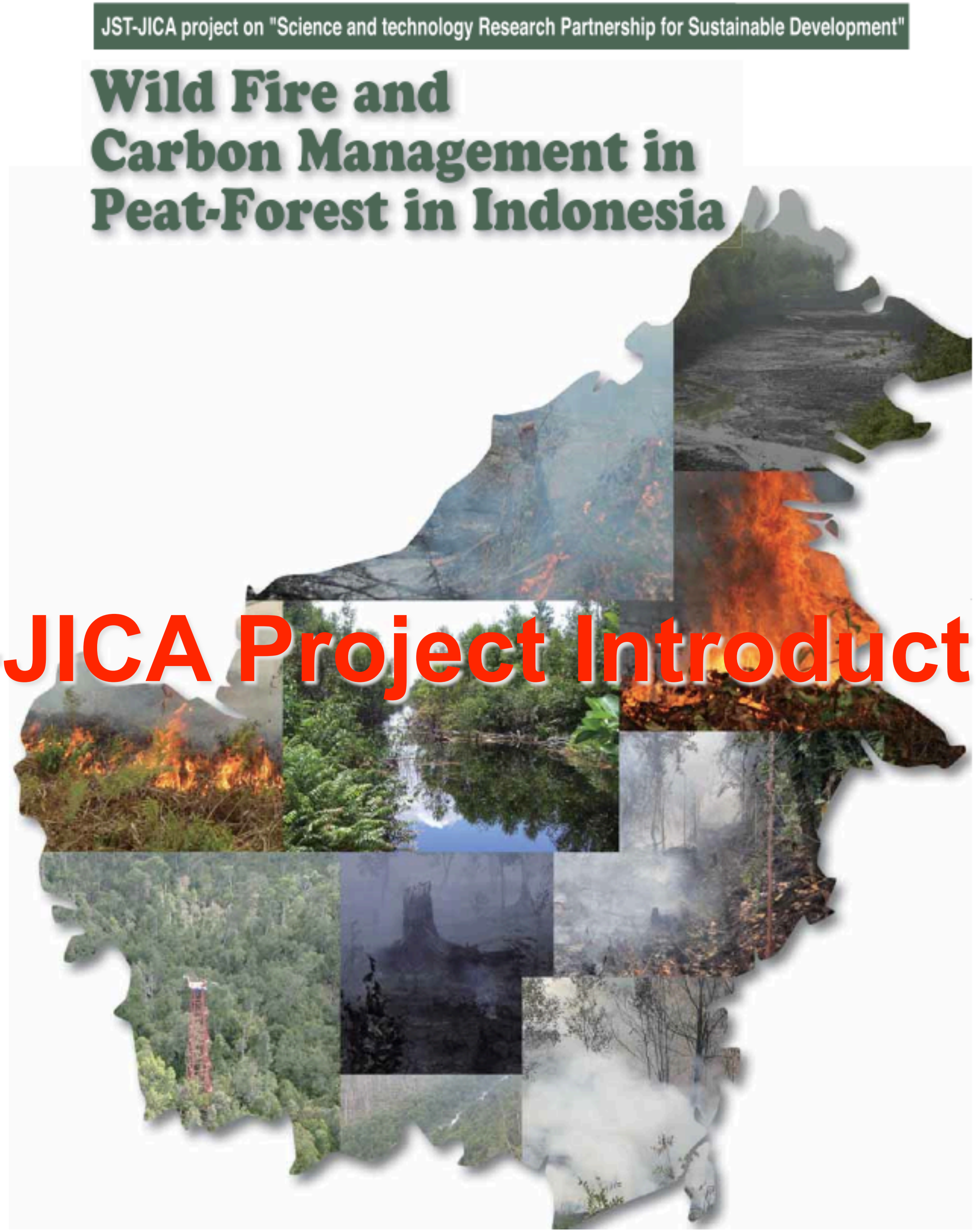
(7) Cross-sectoral issues

As for cross-sectoral issues, it is required to promote human resource development, enhancement of institutional capability, data collection, knowledge sharing and accumulation, as well as domestic and international policy dialogue on climate change in a gender sensitive manner. From this view point, the technical cooperation assisting African countries to elaborate low-carbon growth strategies should be considered.

The way to promote the utilization of CDM and **bilateral offset credit mechanism** in Africa as well as to enhance the related capacity development should be considered, taking into account the importance of establishing a financial mechanism for climate change and the utilization of green technologies.

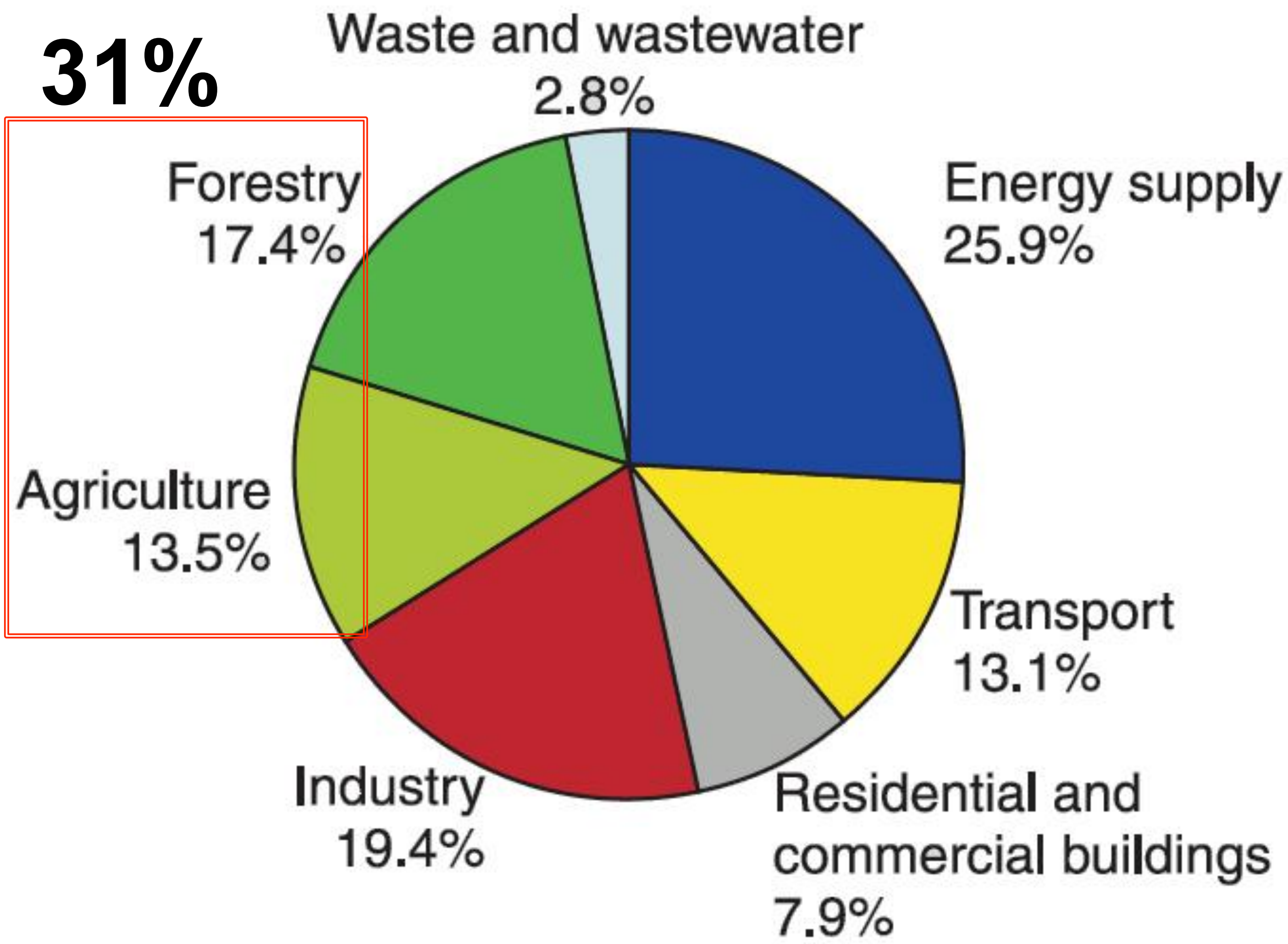
In some sectors, the enhanced utilization of private finance is useful for sustainable economic development and technology transfer. In this regard, increasing private finance catalyzed by public finance and introducing a base of pyramid business are required. As one of these efforts, Japan is now carrying out the "three L" projects named after "Lighting" (support for electrification), "Lifting" (improving the industrial infrastructure), and "Linking" (improving communications networks) , and will continue its efforts.

Because of the importance of the understanding of climate change policy among general public including local communities, information dissemination and advocacy on climate change policy should be promoted.



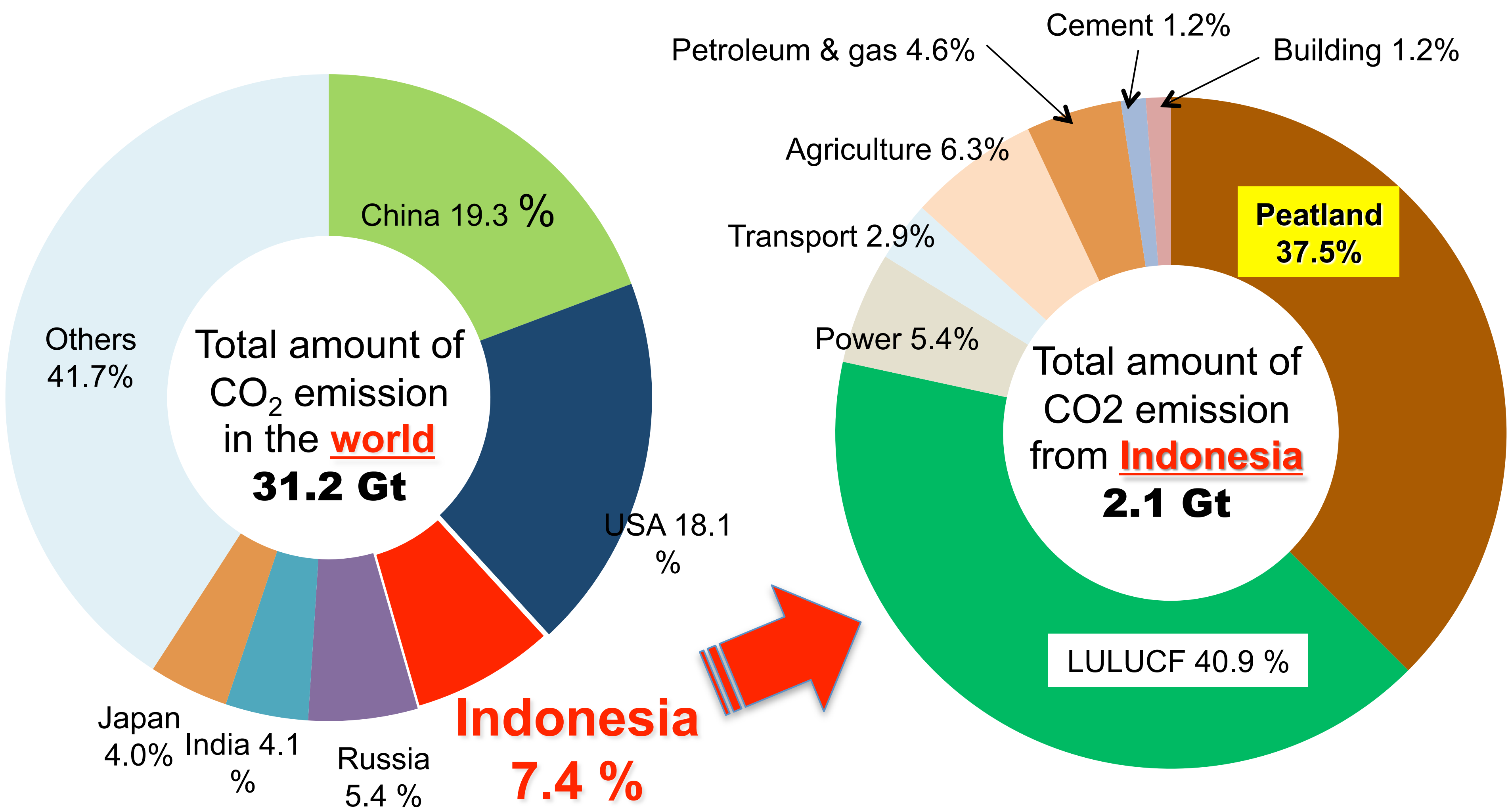
JST-JICA Project Introduction

GHGs emission by sector (IPCC2007)



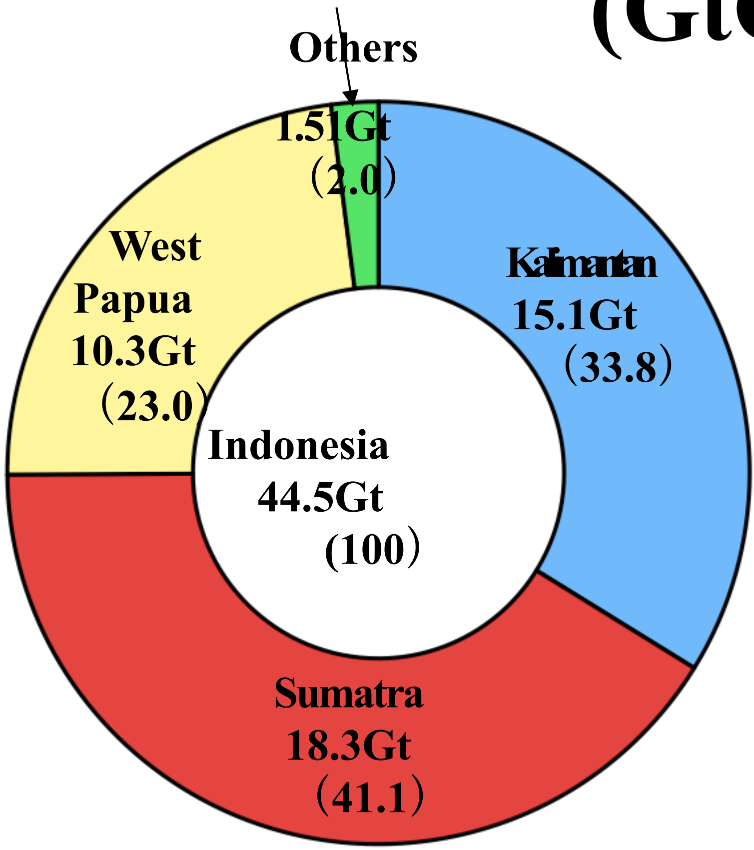
http://www.bioenergywiki.net/File:Global_GHG_emissions_IPCC_2007a.jpg

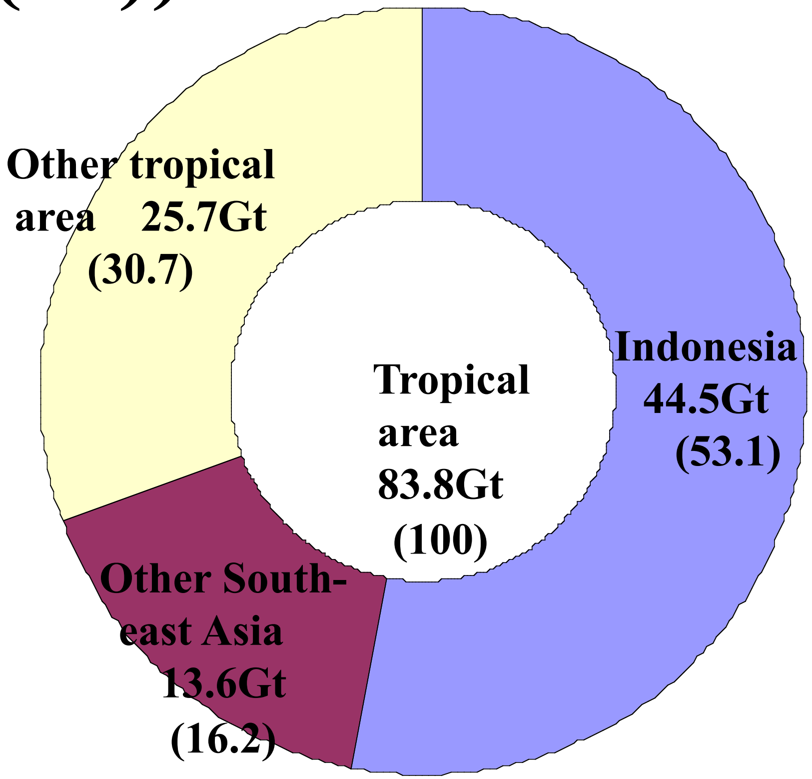
Total amount of CO_2 emission in 2005



Source: http://www.eia.doe.gov/iea/carbon.html
Source: Indoneisa's green house gas abatement cost curve (DNPI. 2010)

Amount of Carbon in Tropical Peat (GtC (%))



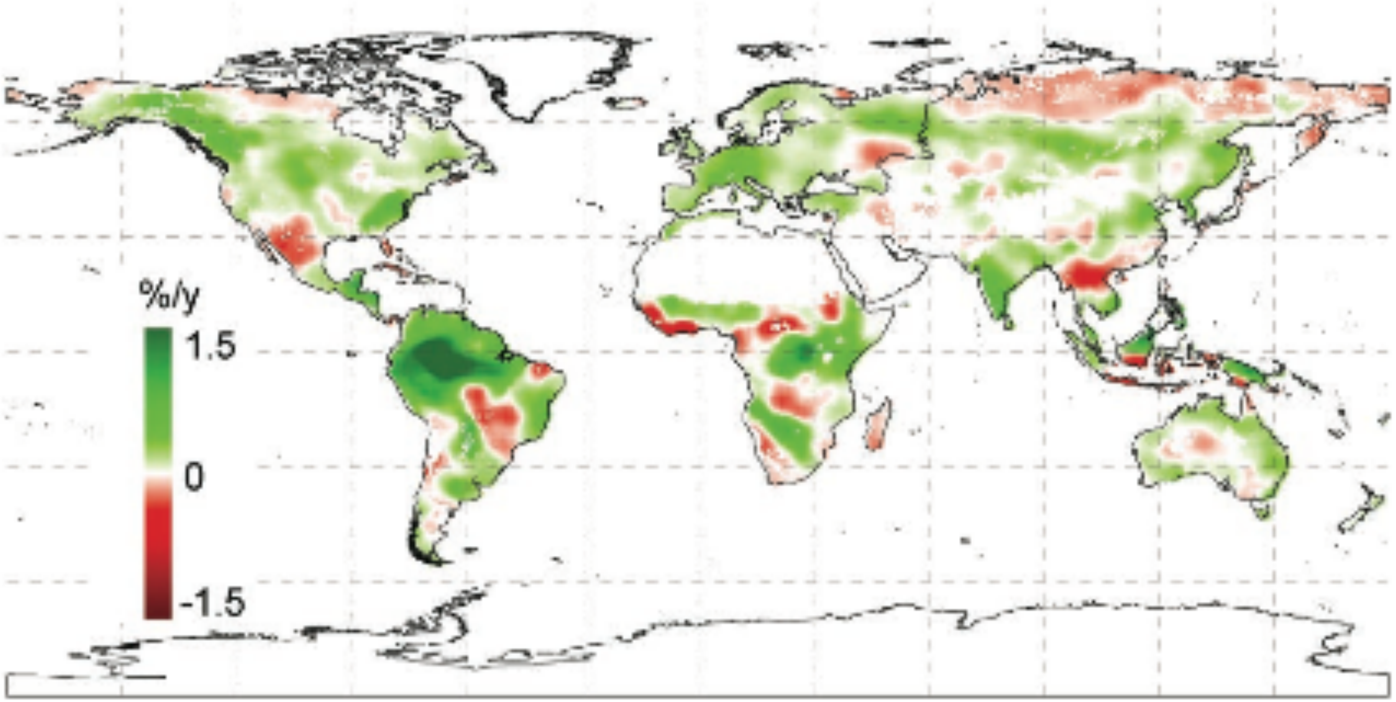


(From Maria Strack ed., 2008: Peatlands and Climate Change. International Peat Society, 223pp.)

Crisis of Climate Changes

Net primary production increased 6% (3.4 petagrams of carbon over 18 years) globally during 1982 to 1999

Fig. 2. Spatial distribution of linear trends in estimated NPP from 1982 to 1999. NPP was calculated with mean FPAR and LAI derived from GIMMS and PAL data sets.



www.sciencemag.org SCIENCE VOL 300 6 JUNE 2003

We present a global investigation of vegetation responses to climatic changes by analyzing 18 years (1982 to 1999) of both climatic data and satellite observations of vegetation activity. Our results indicate that global changes in climate have eased several critical climatic constraints to plant growth, such that net primary production increased 6% (3.4 petagrams of carbon over 18 years) globally. The largest increase was in tropical ecosystems. Amazon rain forests accounted for 42% of the global increase in net primary production, owing mainly to decreased cloud cover and the resulting increase in solar radiation.

Ramakrishna R. Nemani, *et al*： Climate-Driven Increases in Global Terrestrial Net Primary Production from 1982 to 1999. *Science 300, 1560 (2003);*

Net primary production decreased 1% (0.55 petagrams of carbon over 10 years) globally during 2000 to 2009

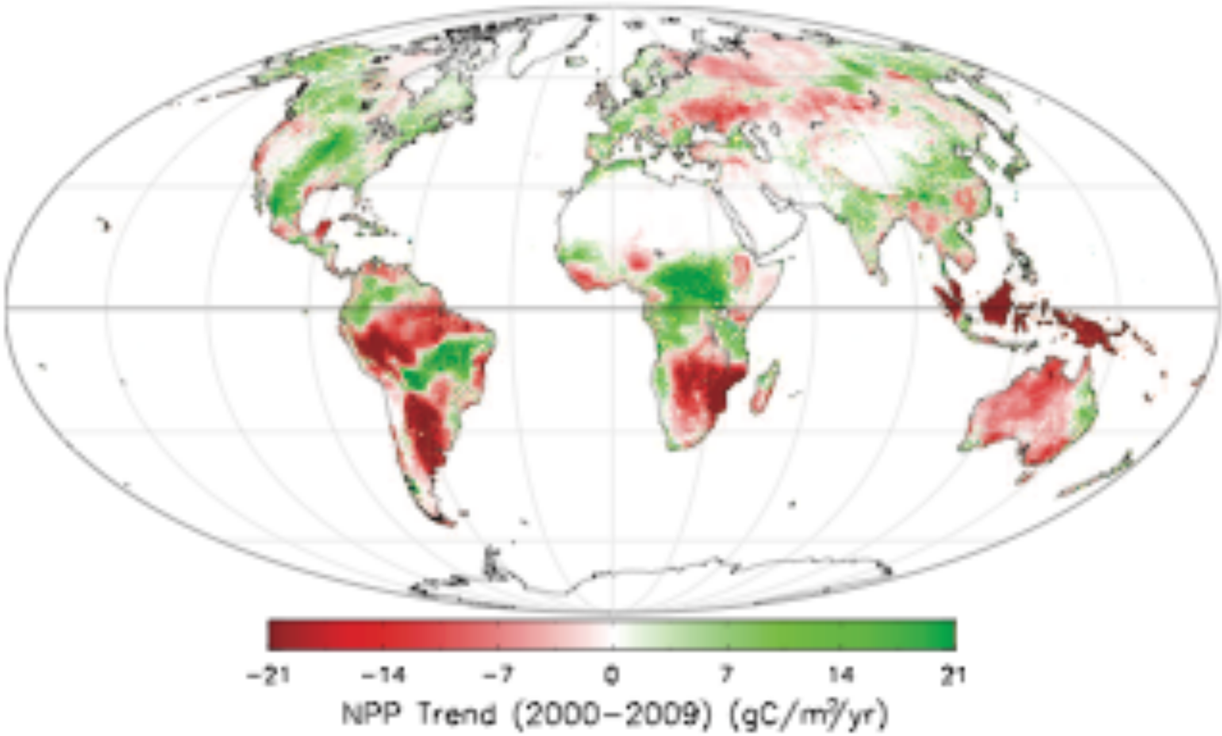
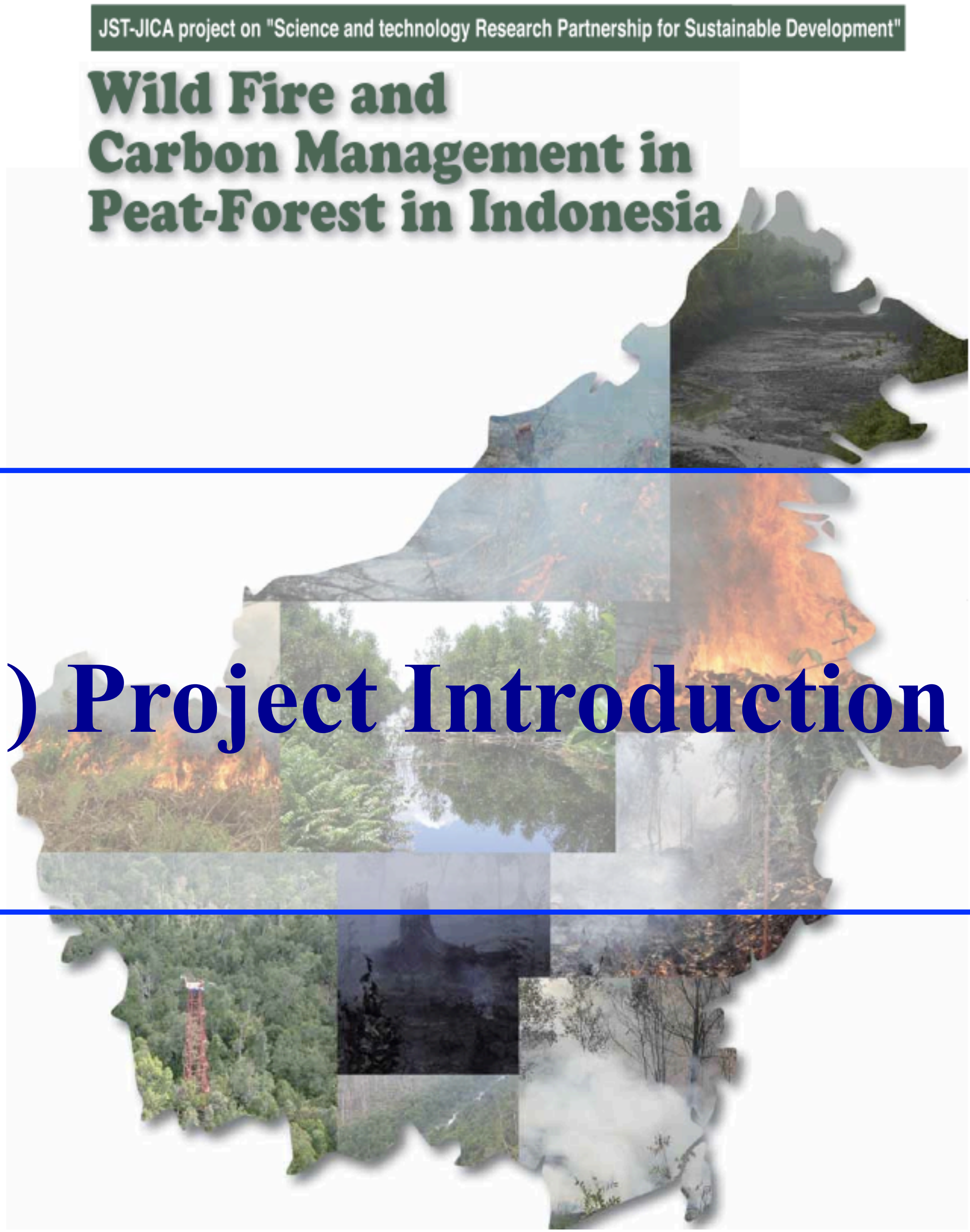


Fig. 2. Spatial pattern of terrestrial NPP linear trends from 2000 through 2009 (SOM text S1) (*8, 10*).

The past decade (2000 to 2009) has been the warmest since instrumental measurements began, which could imply continued increases in NPP; however, our estimates suggest a reduction in the global NPP of 0.55 petagrams of carbon. Large-scale droughts have reduced regional NPP, and a drying trend in the Southern Hemisphere has decreased NPP in that area, counteracting the increased NPP over the Northern Hemisphere.

Maosheng Zhao, *et al.:* Drought-Induced Reduction in Global Terrestrial Net Primary Production from 2000 Through 2009 *Science 329, 940 (2010)*



(1) Project Introduction

JST-JICA project for MRV in peatland

- The **tropical peatland** is a significant carbon reservoir, but it has become a crucial CO_2 emission source recently due to the drainage (development works) and wild fire.

- Hokkaido University Group is conducting long-term monitoring at Central Kalimantan's peatland in close cooperation with Indonesian experts by **JSPS** Core University Program since 1997.

- "*Wild Fire and Carbon Management in Peat-Forest in Indonesia*" project has been conducted supported by **JST-JICA** since 2010

- The Group concluded that **eight parameters** are essential to establish **reliable and comprehensive MRV system in peatland**.

JST-JICA project for MRV in peatland

JST-JICA Project [Wild Fire and Carbon Management in Peat-Forest in Indonesia]

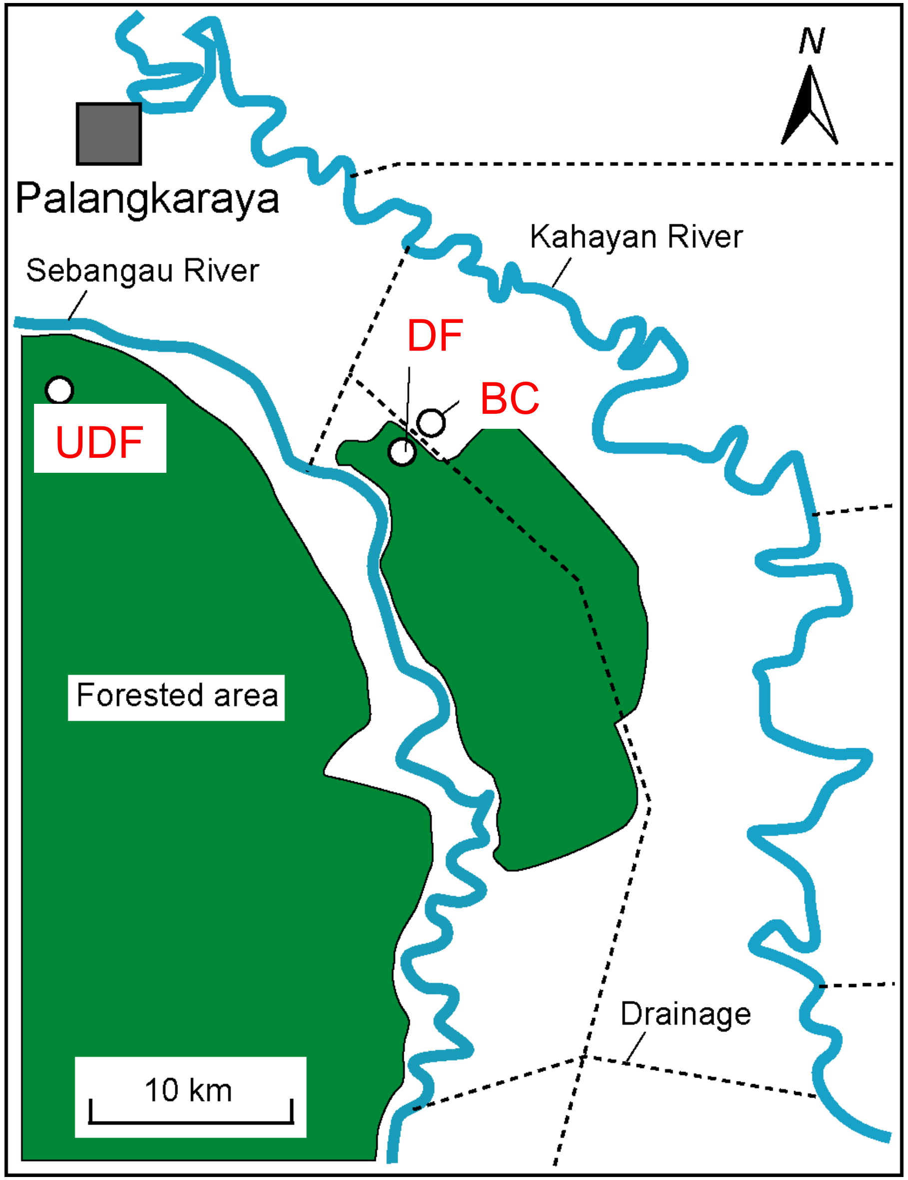
- Central Kalimantan, Indonesia
- Peatland area in Mega Rice Project site

CO_2 observation towers at

UDF：(Un-drained Peat)

DF：(Drained Peat)

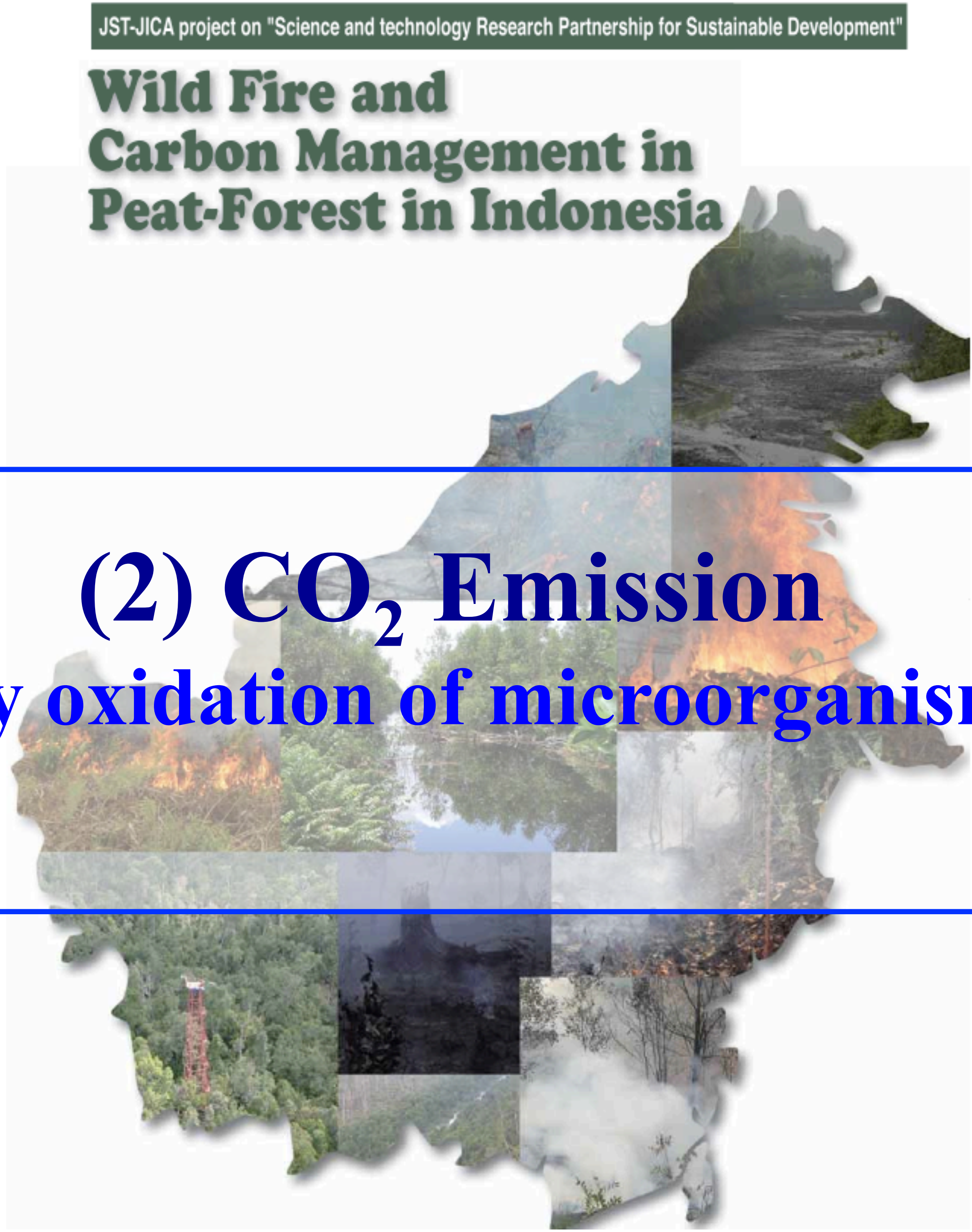
BC：(Burnet Peat)



Various Study Topics:

- GHG Flux (CO_2, CH_4, N_2O) measuring
- Fire Detection and Protection
- Water Table Monitoring and Management
- Peatland Ecology
- Soluble Carbon Monitoring
- Peatland Subsidence Monitoring
- etc.

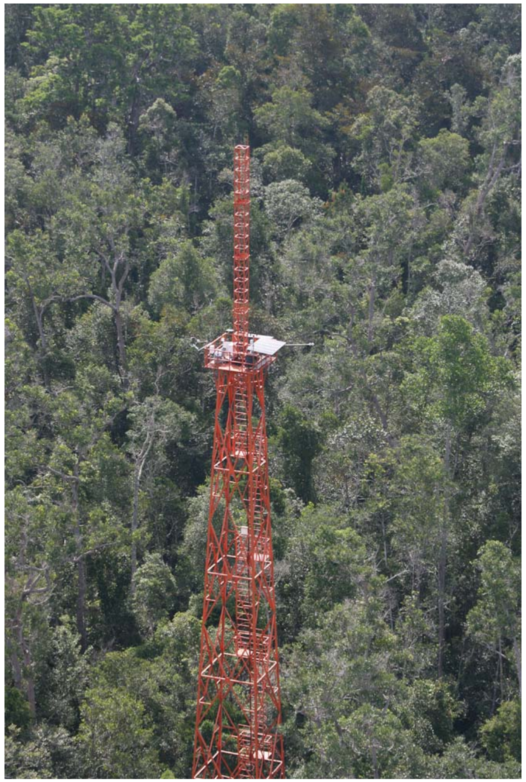
→Monitoring was started from 1997.



(2) CO_2 Emission

a) by oxidation of microorganisms

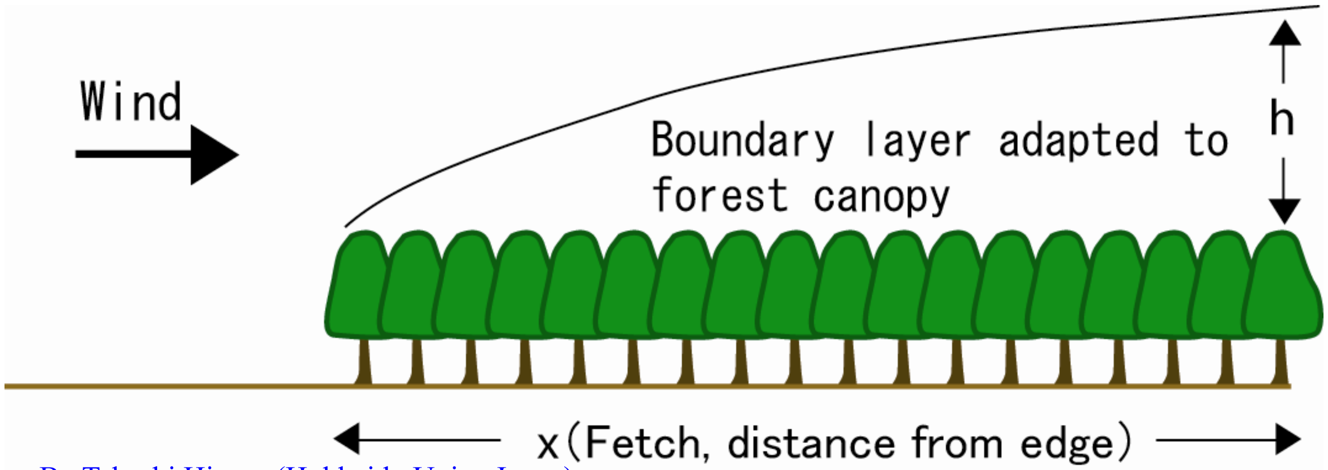
Eddy covariance technique



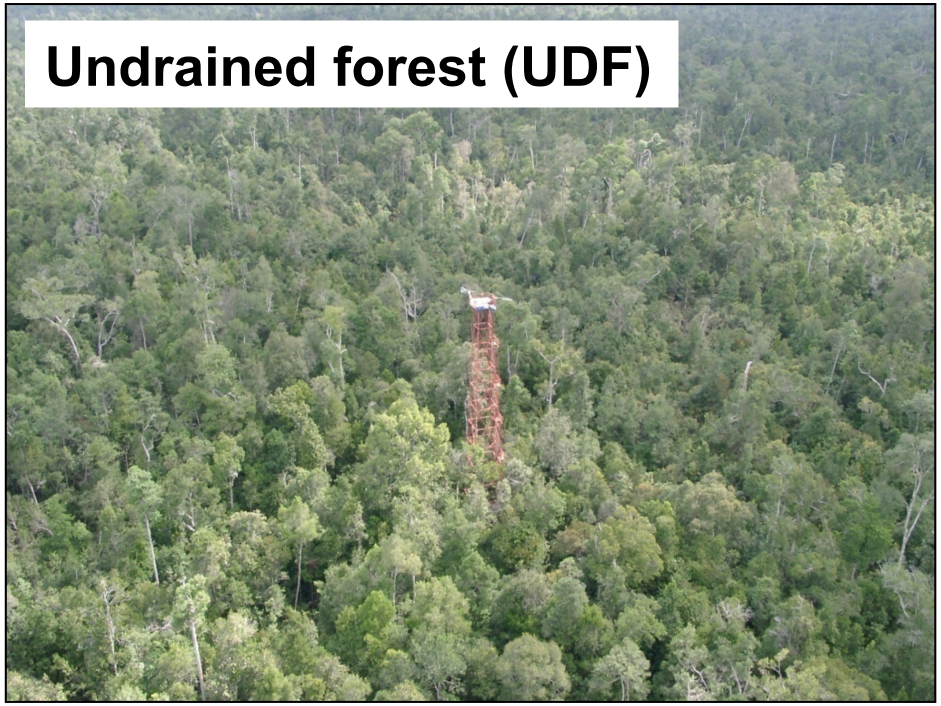
CO_2 flux (Net ecosystem CO_2 exchange) is calculated as the covariance of vertical wind speed and CO_2 density.

Within the boundary layer, vertical flux is almost constant.

If flux is measured at an appropriate height within the boundary layer, we can obtain flux averaged spatially over the fetch.



By Takashi Hirano (Hokkaido Univ., Japan)



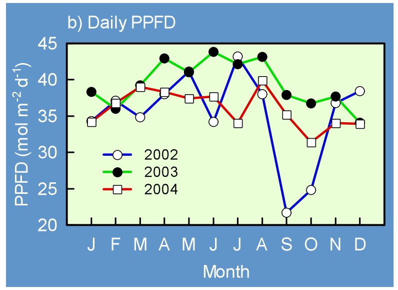
Undrained forest (UDF)

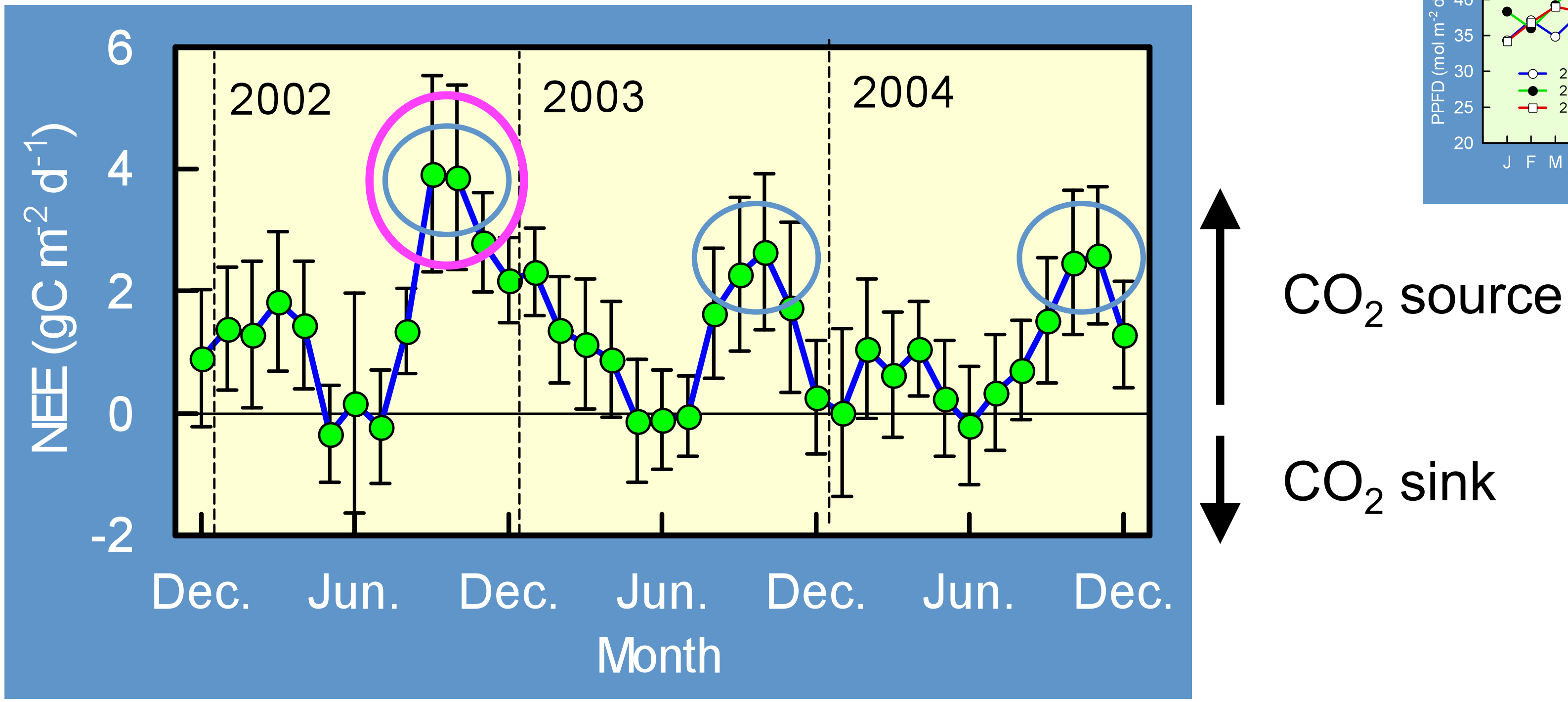
Burnt forest after drainage (BC)

Drained forest (DF)

By Takashi Hirano (Hokkaido Univ., Japan) (Unpublished)

Seasonal variation in NEE (net ecosystem CO_2 exchange) in DF site





- NEE was positive or neutral throughout 3 years (CO_2 source).
- CO_2 emission was the largest in the late dry season, partly due to the shading effect by smoke from farmland fires.
- CO_2 emission was the largest in 2002, an El Nino year, because of dense smoke from large-scale fires.

By Takashi Hirano (Hokkaido Univ., Japan)
(Unpublished)

Inter-site comparison of annual CO_2 balance

May 2004 to May 2005, Unit: gC m^{-2} yr^{-1}

Site	GPP	RE	NEE	Peat decomposition
UDF (undrained)	4000	4103	103	→ -1.4 mm yr^{-1}
DF (drained)	3287	3724	437	→ -6.1 mm yr^{-1}
BC (burnt & drained)	1075	1899	824	→ -11.6 mm yr^{-1}

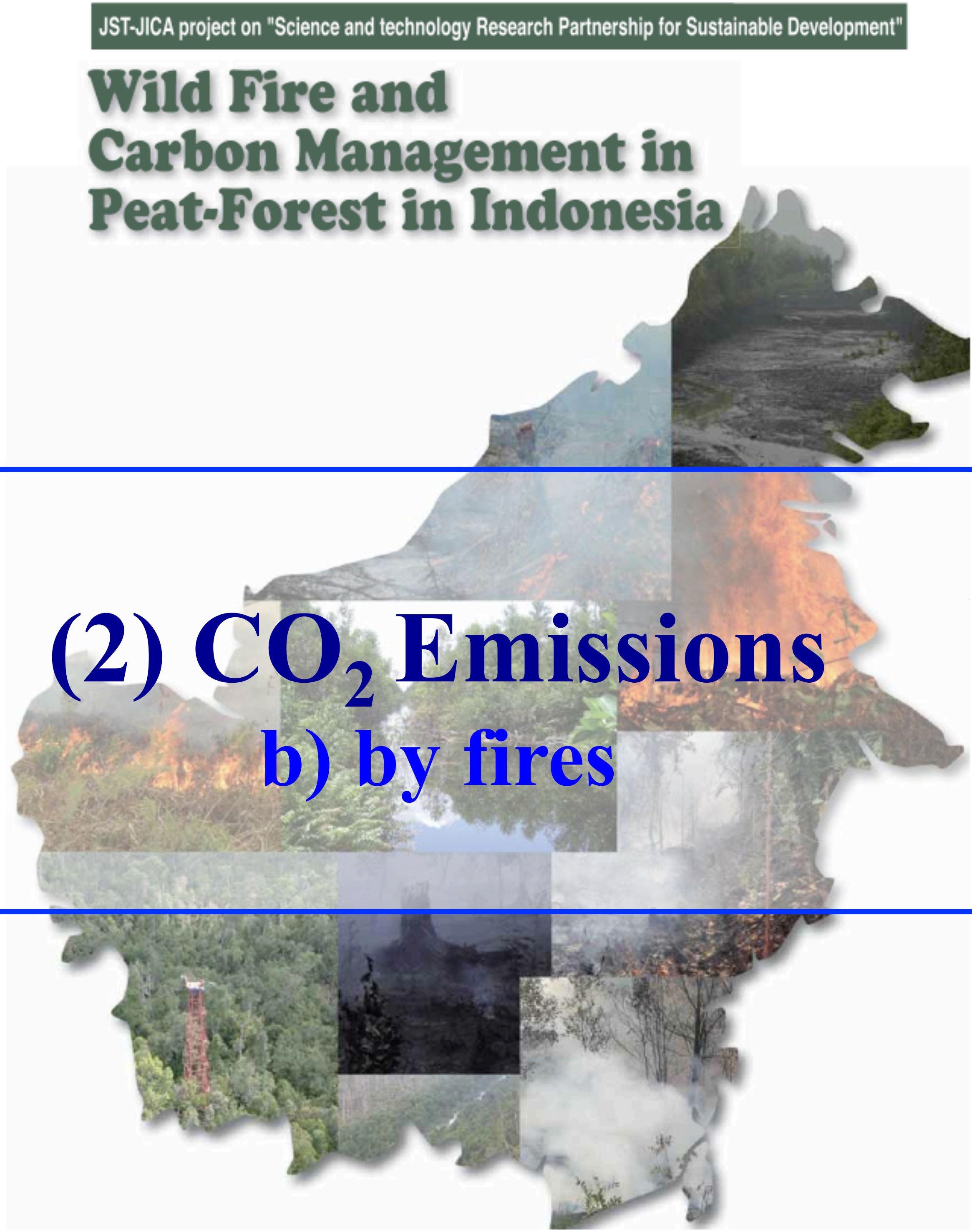
Positive NEE (CO_2 source strength): BC > DF > UDF

UDF also functioned as a CO_2 source to the atmosphere.

Results of peat sampling

- Peat growth rate in Indonesia : 1 - 2 mm yr^{-1} (Sorensen 1993)
- Carbon accumulation rate in Palangkaraya: 56 gC m^{-2} yr^{-1} (0.8 mm y^{-1}) (Page et al. 2004)

By Takashi Hirano (Hokkaido Univ., Japan)
(Unpublished)

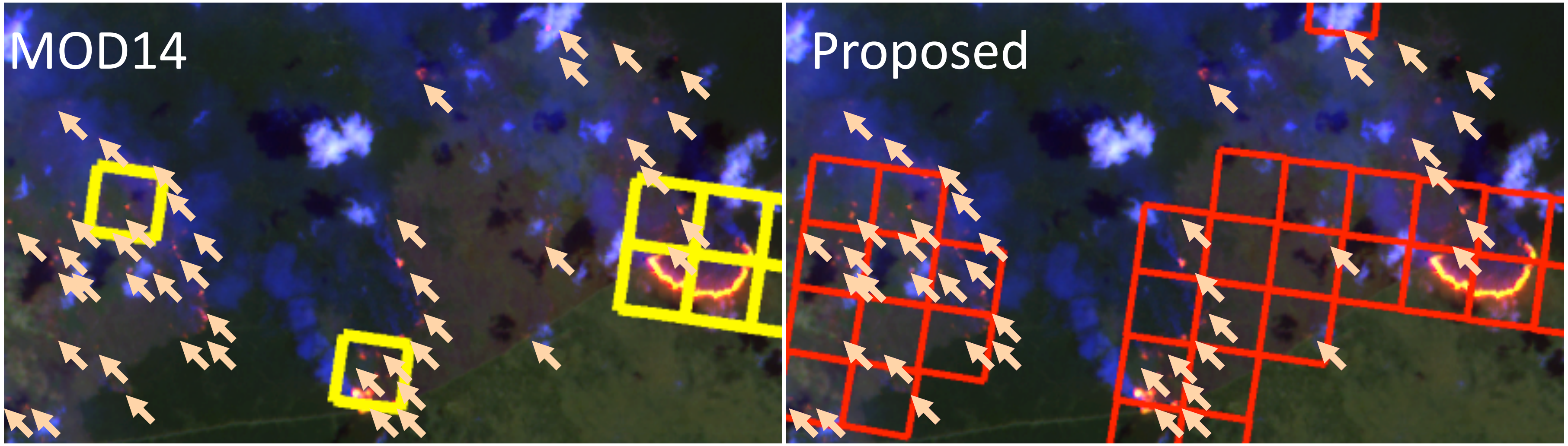


(2) CO_2 Emissions

b) by fires

Fire Detection

New Generation Fire Detection

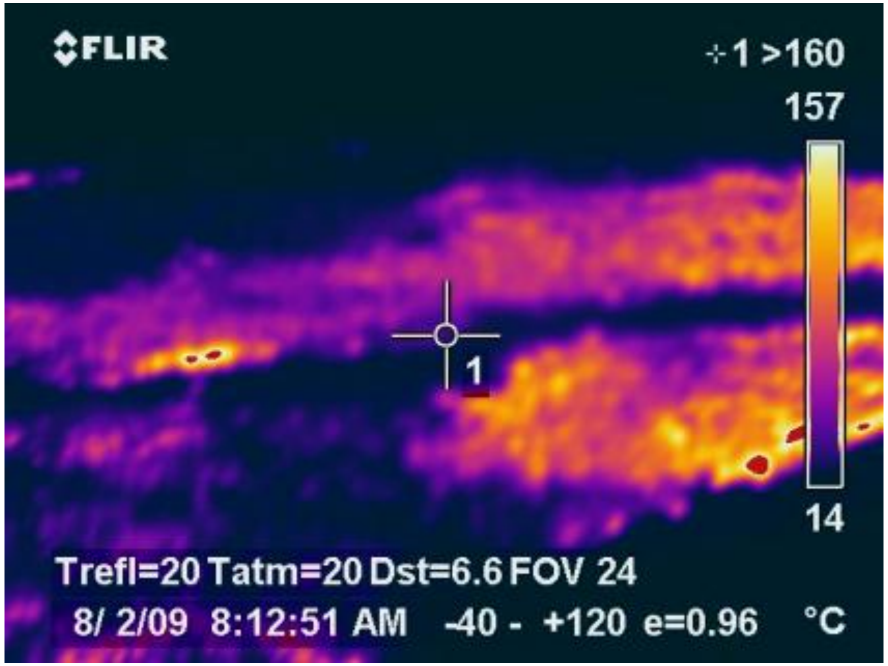


- Doubled S/N ratio (ASTER comparing to MOD14, and Algorism Improvement)
  - **80% more HS** and & **10% less False Alarm**
  - Smoldering, small fire or slush and burn
  - Geographical distribution is completely different
  - Suitable to decide firefighting strategy and confirm extinction

Example of Thermograph Image of flight observation

RGB

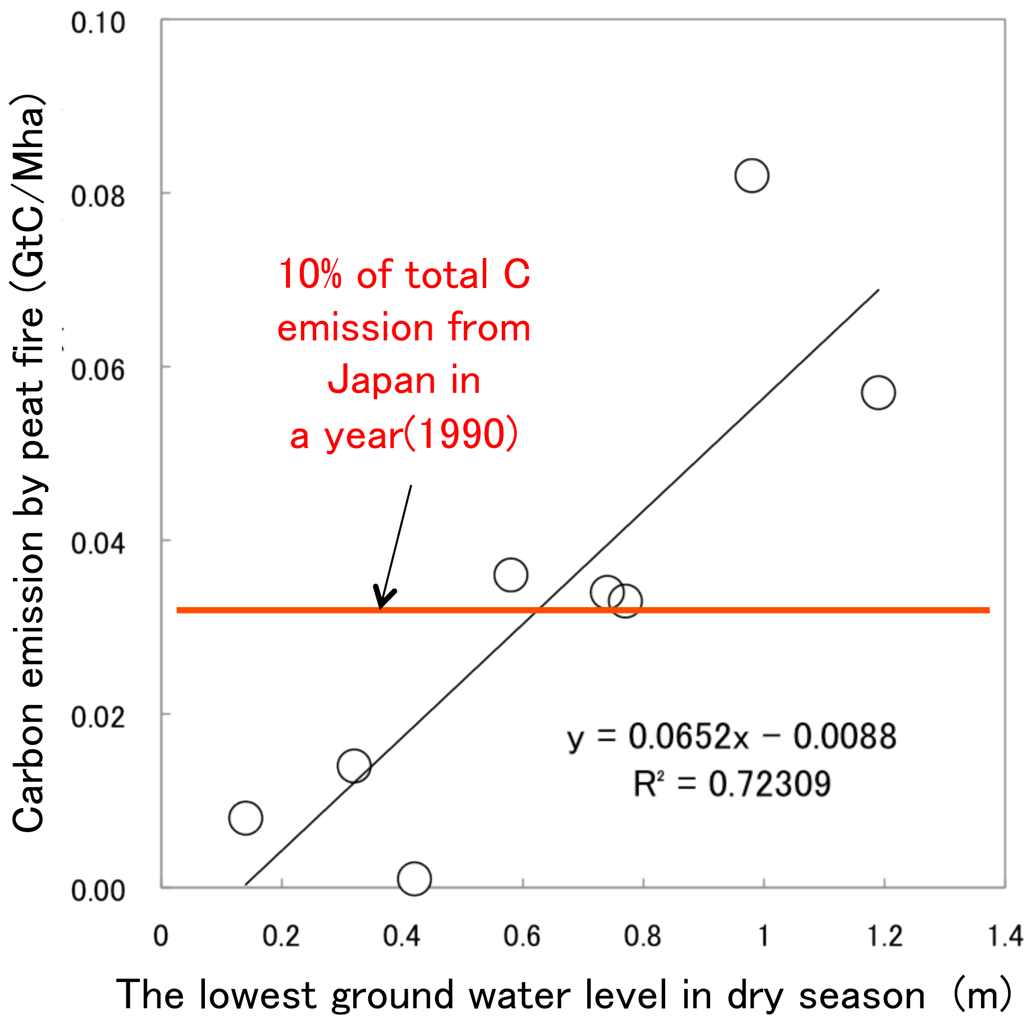
IR

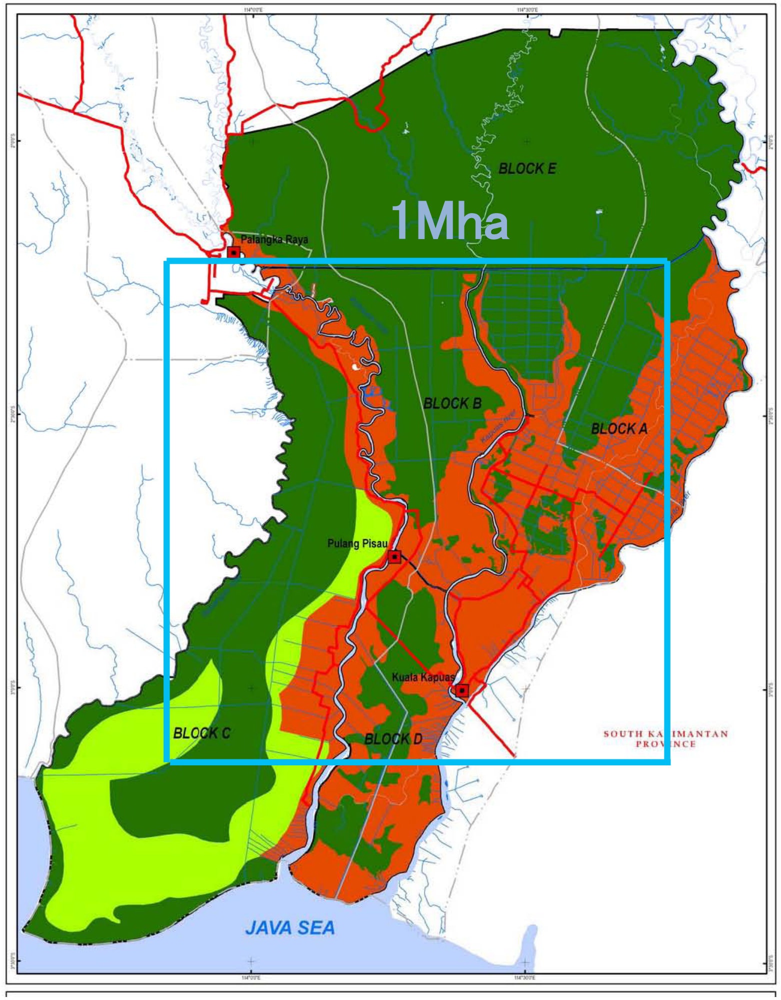


UAV (Unmanned aerial vehicle) flight observation and Wireless Sensor Network are indispensable as well as ground observations.

Toshihisa Honma, Hokkaido University, Japan

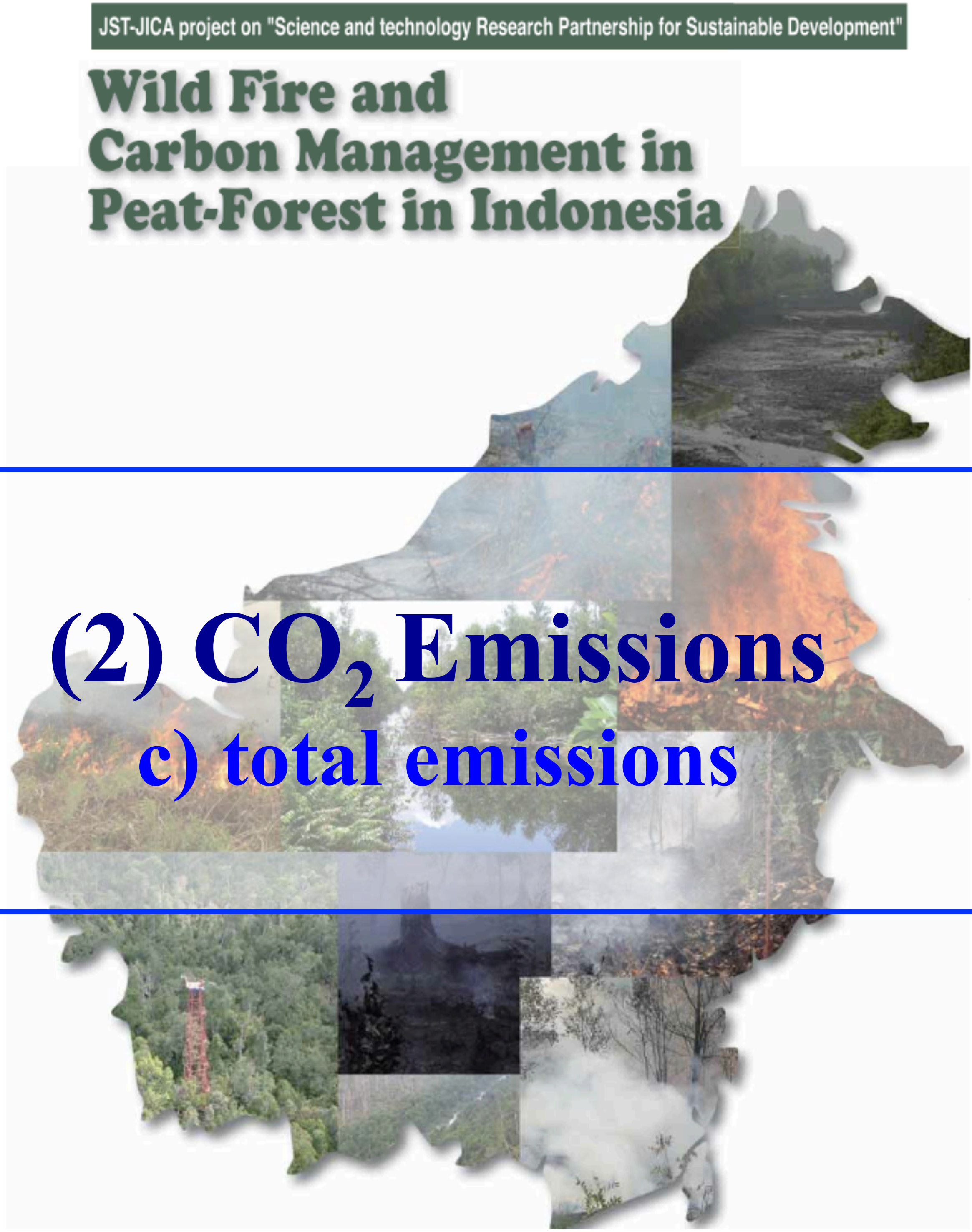
Relation ship between the lowest ground water level in peatland and total amount of carbon emission in Mega rice project area (Data of carbon emission is offered by Dr. Erianto Indra Putra)



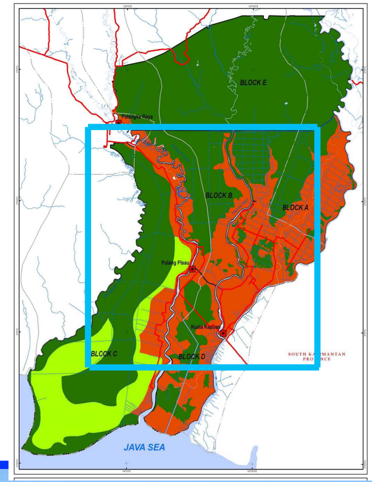


(2) CO_2 Emissions

c) total emissions

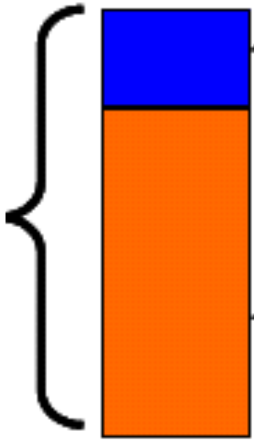


COP15 Poster



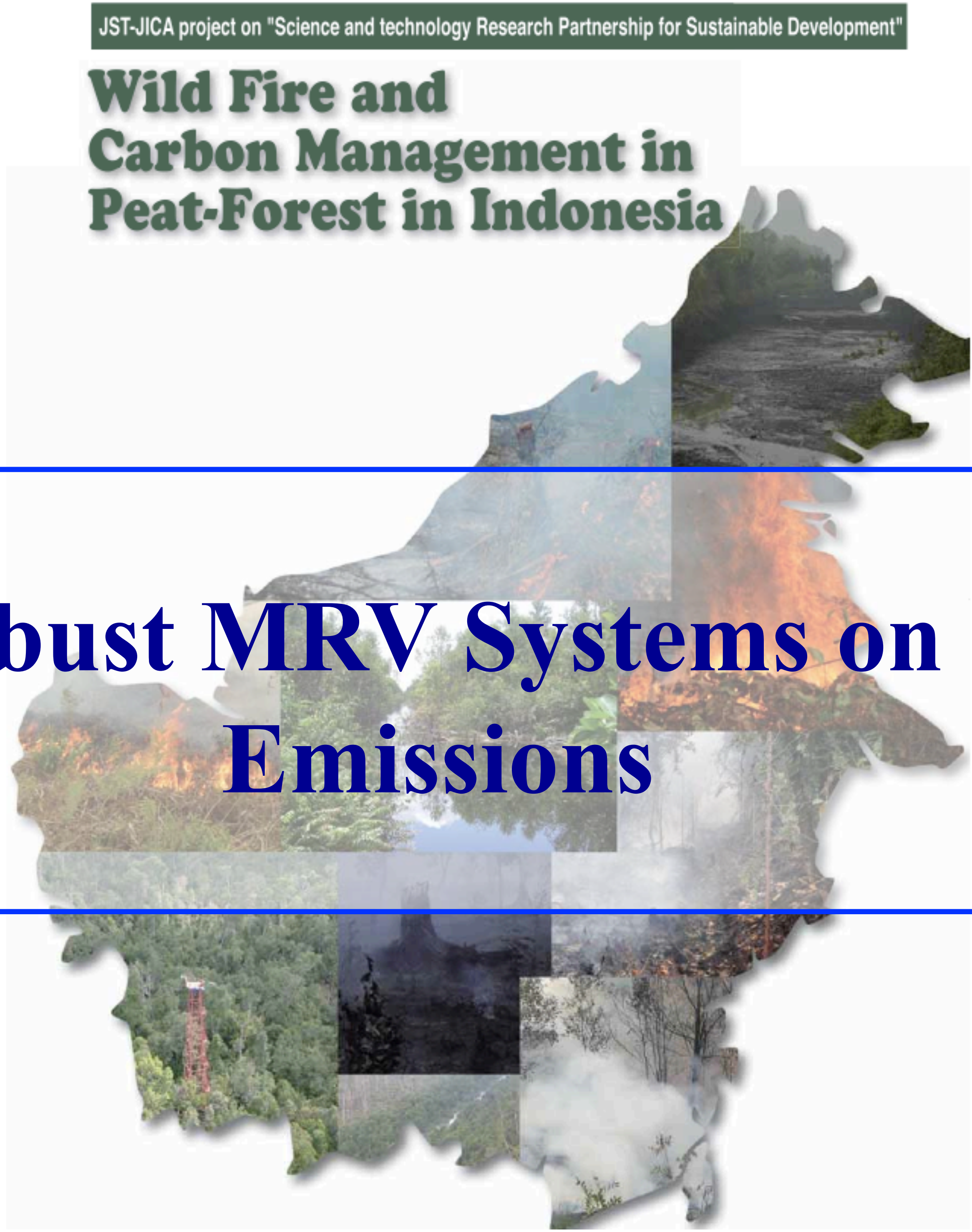
Amount of carbon dioxide emitted annually from the tropical peatland per 1 million ha.
(Indonesia has 20 times the size of this tropical peatland.)

Amount of carbon dioxide emitted by microbial degradation (About 3 % of the total emission from Japan in 1990.)



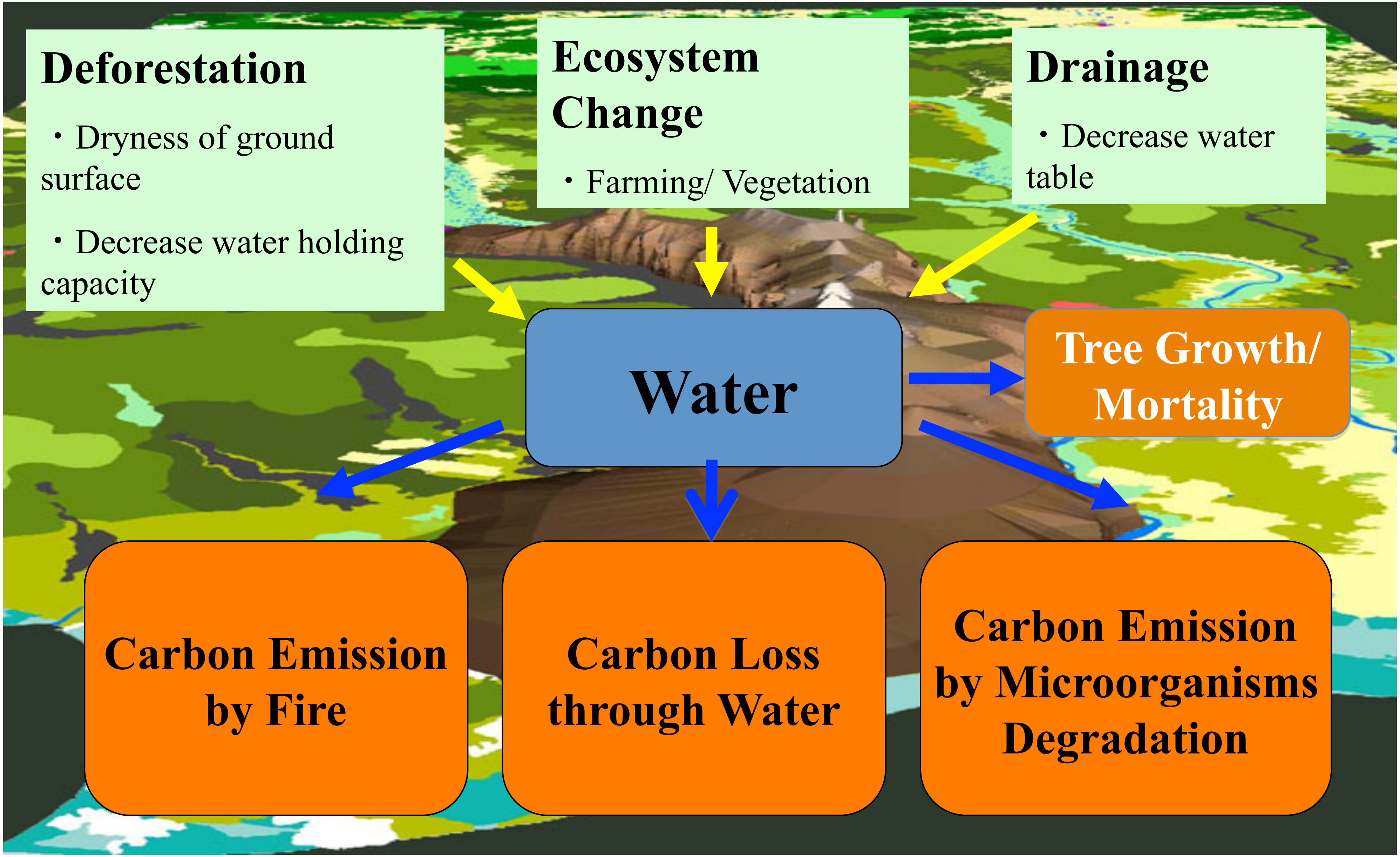
About 13% of the total emission from Japan in 1990.

Amount of carbon dioxide emitted by peat fire (About 10 % of the total emission from Japan in 1990.)



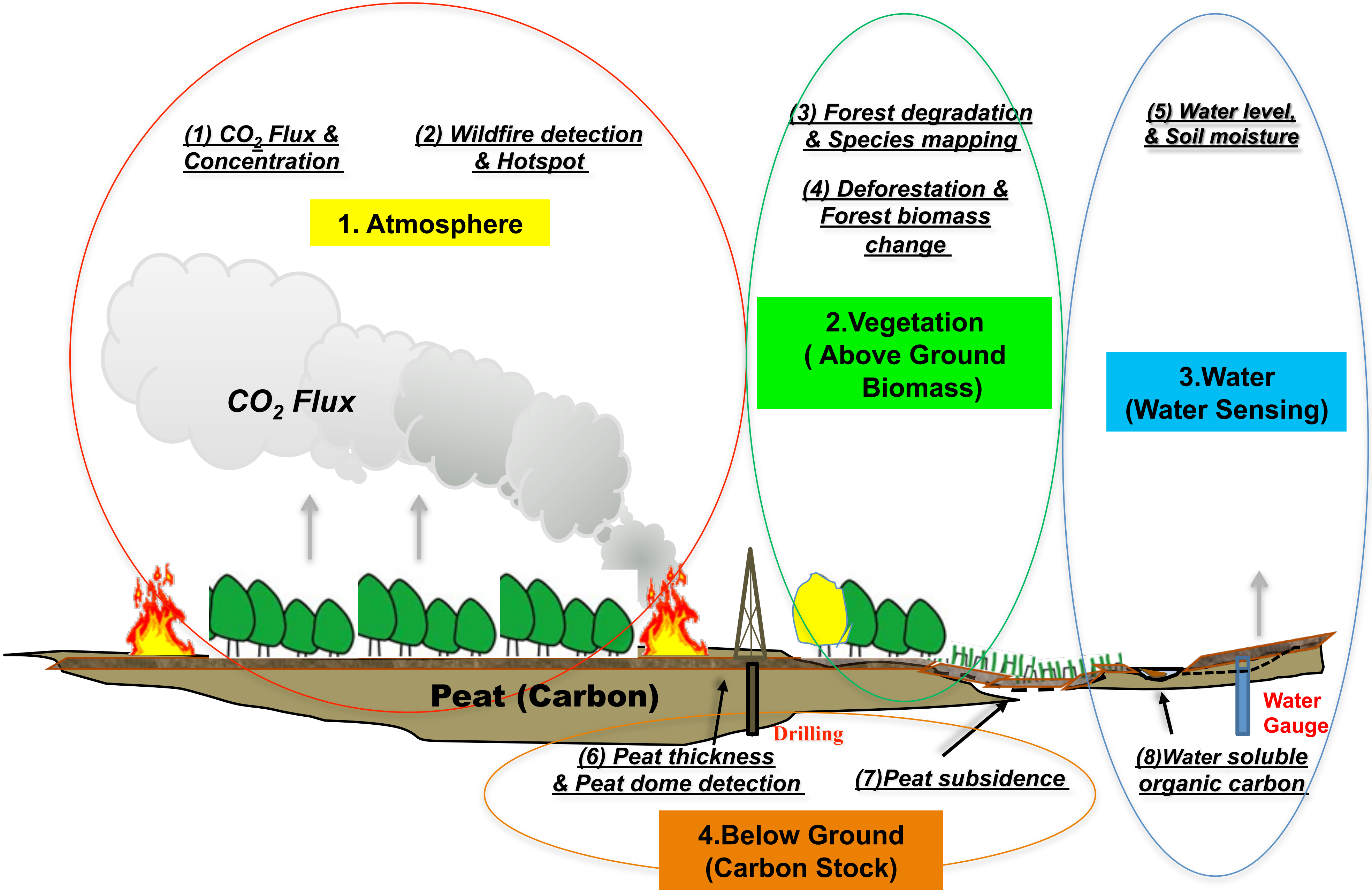
(3) Robust MRV Systems on CO_2 Emissions

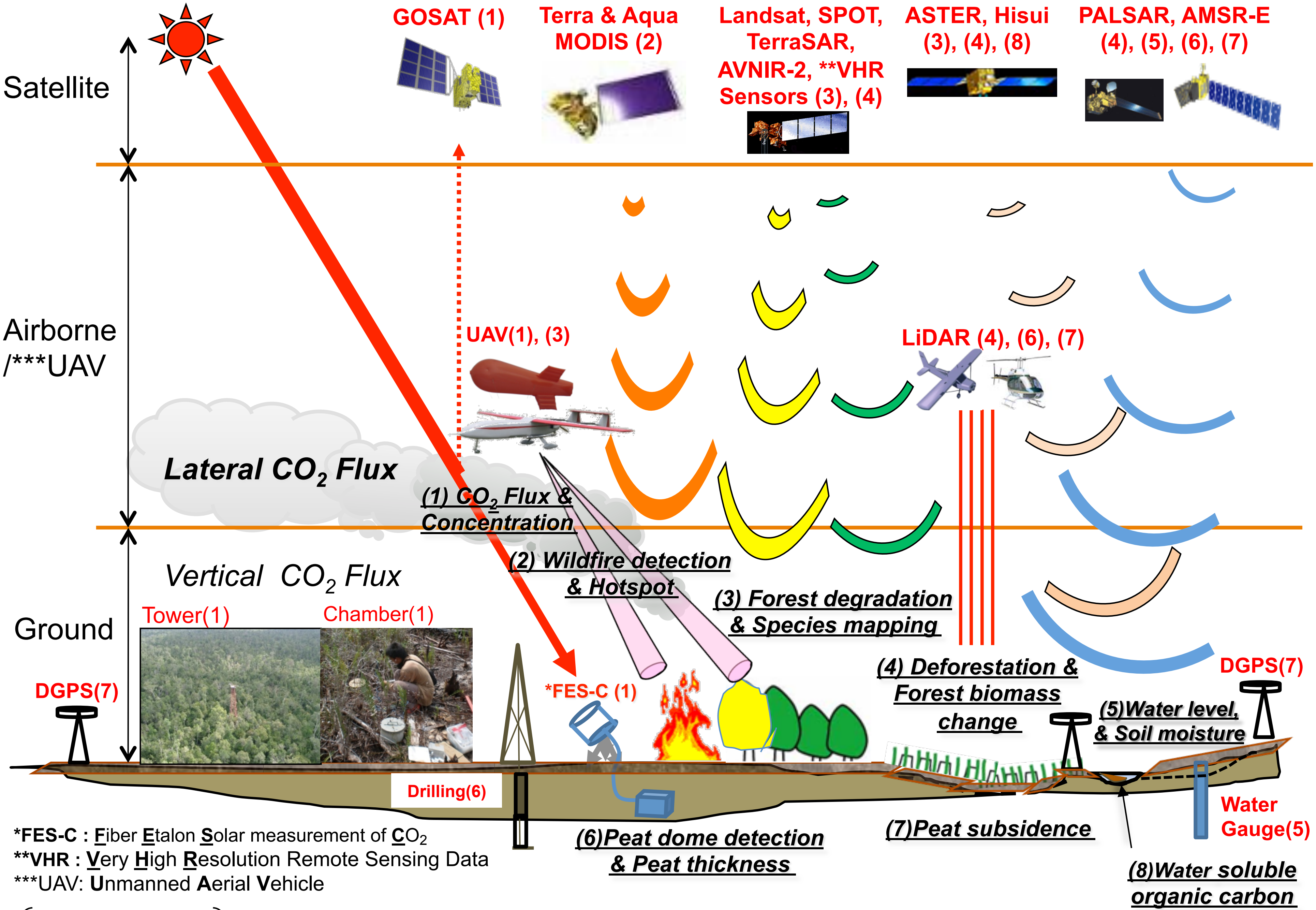
What Factors Regulate Carbon in Tropical Peat?



What is the key element of MRV in peatland?

→ *eight elements*





*FES-C : Fiber Etalon Solar measurement of CO_2
**VHR : Very High Resolution Remote Sensing Data
***UAV: Unmanned Aerial Vehicle

Red: Instrument
Black: Target

Key Elements of Peatland Mapping (MRV System)

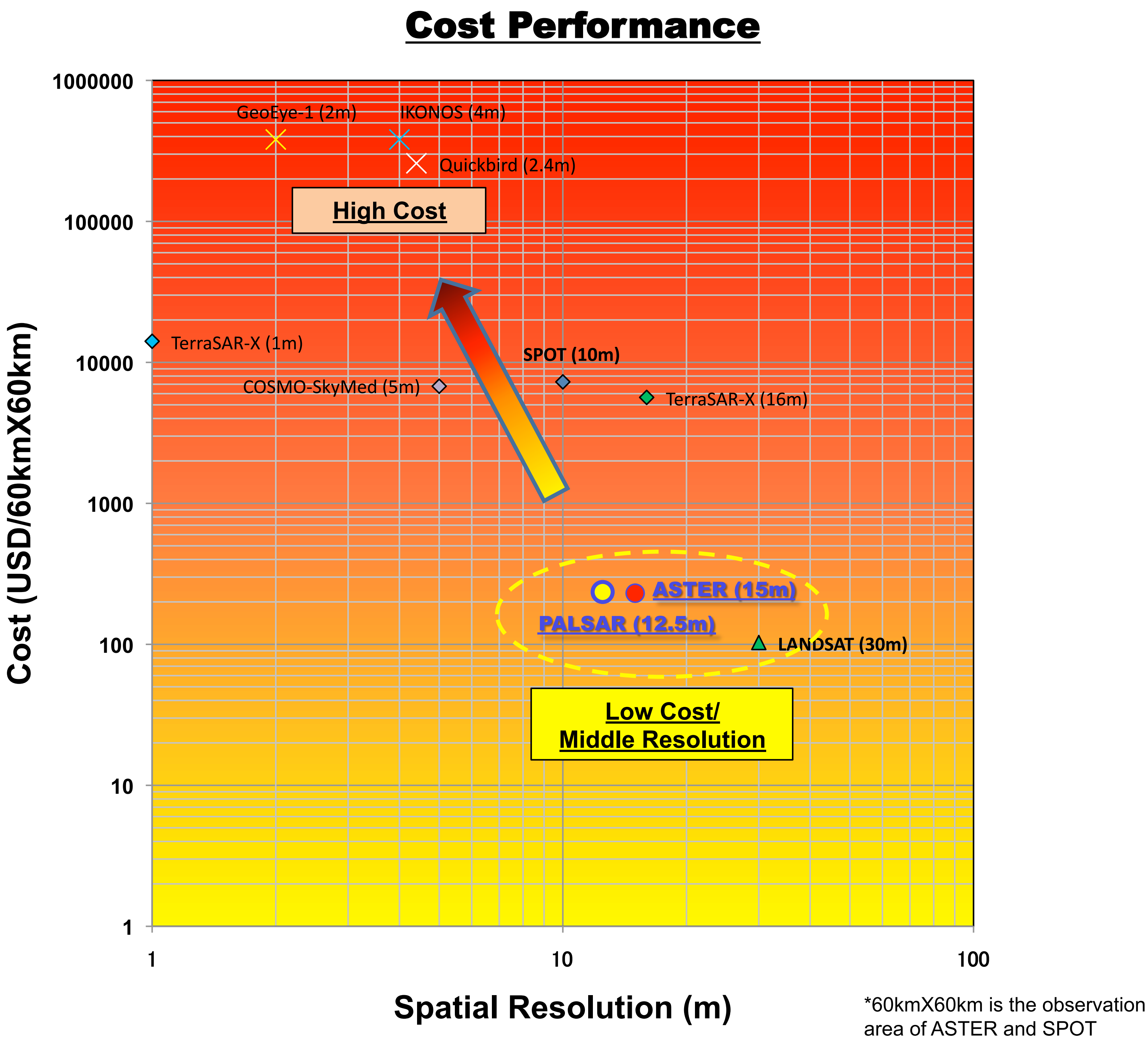
Potential Use of Nano (Micro)-Satellite for MRV

•Advantage of Nano (Micro)-Satellite

1)Frequent observation
2)On-demand design for special purposes
3)Low-cost development & operation
4)Complement data for large-scale satellite

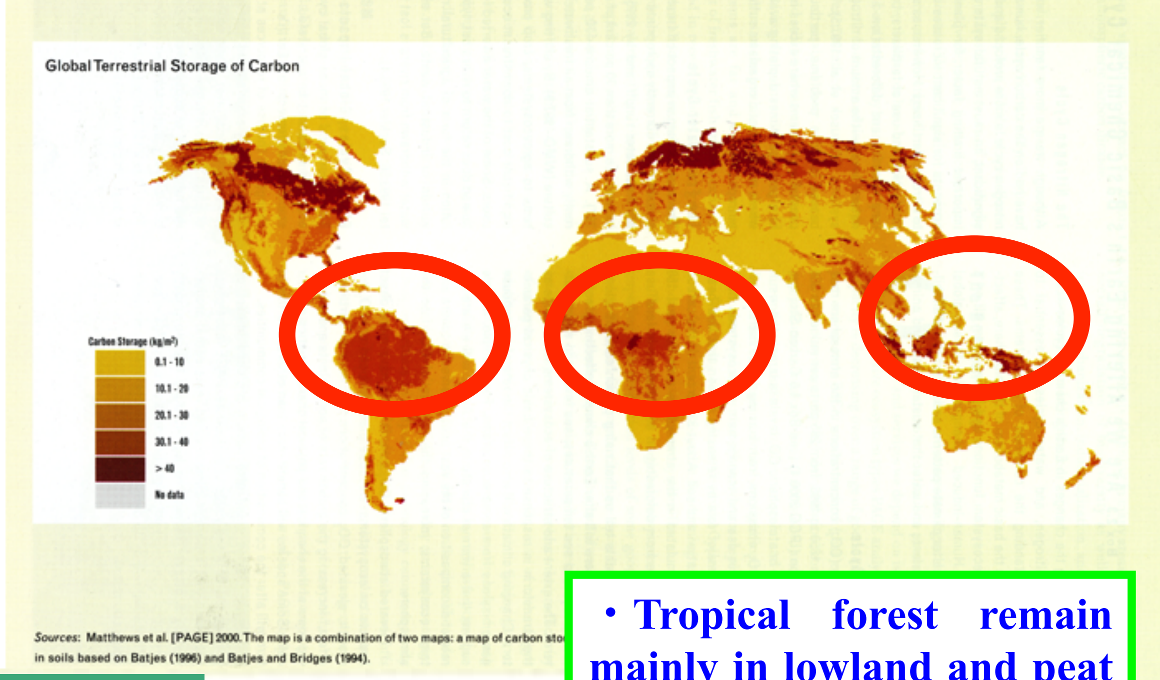
•Requirement to Nano (Micro)-Satellite

1)Scientific reliable data
2)Stable operation
3)User-friendly data especially for developing countries


Cost Performance
Cost (USD/60kmX60km)
1000000
100000
10000
1000
100
10
1
1
10
100
Spatial Resolution (m)
GeoEye-1 (2m)
IKONOS (4m)
Quickbird (2.4m)
High Cost
TerraSAR-X (1m)
COSMO-SkyMed (5m)
SPOT (10m)
TerraSAR-X (16m)
ASTER (15m)
PALSAR (12.5m)
LANDSAT (30m)
Low Cost/
Middle Resolution
*60kmX60km is the observation area of ASTER and SPOT

Forest Cover and Soil Carbon Content

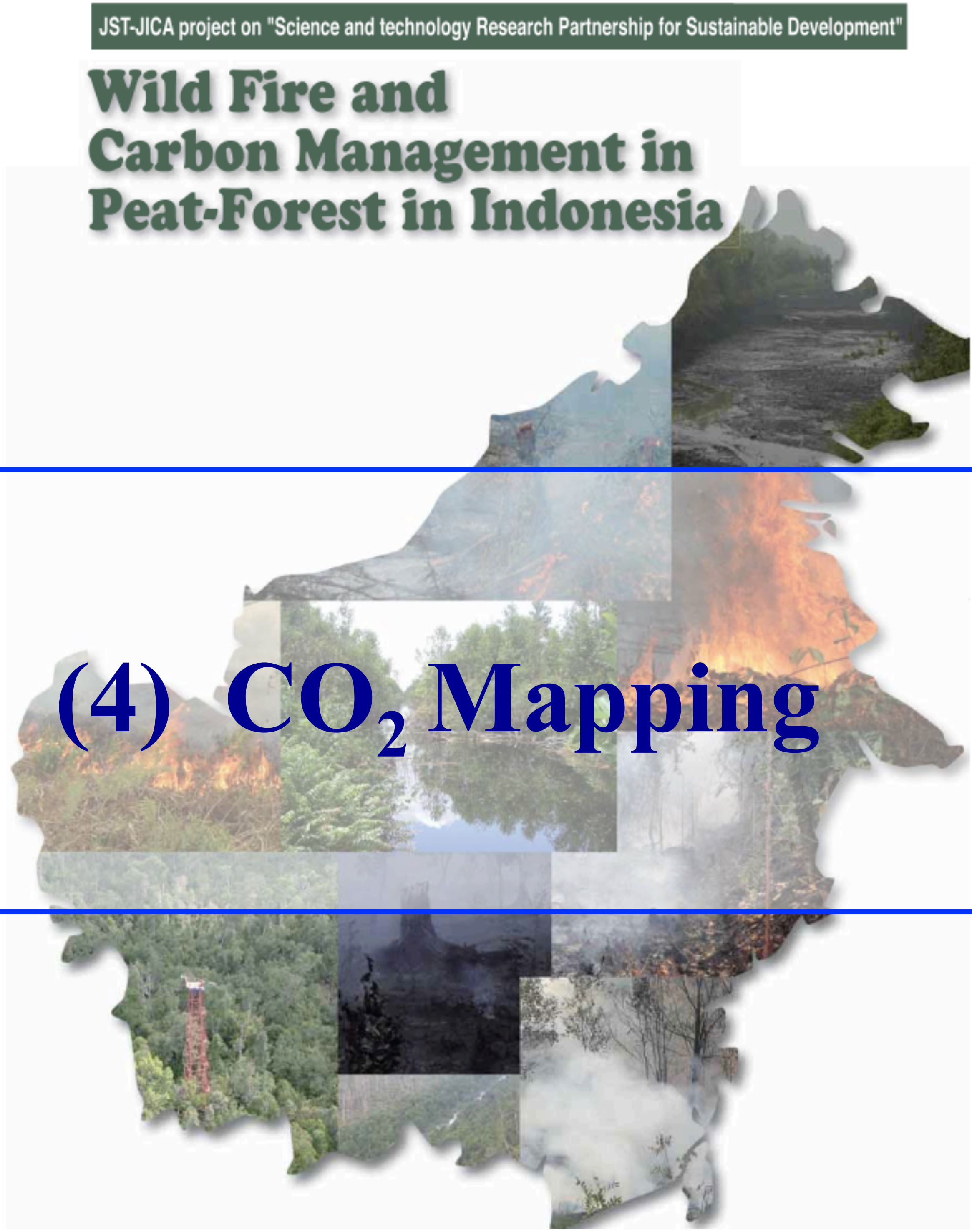
Soil carbon content



Forest cover

From World Resources 2000-2001, ELSEVIER SCIENCE 2000

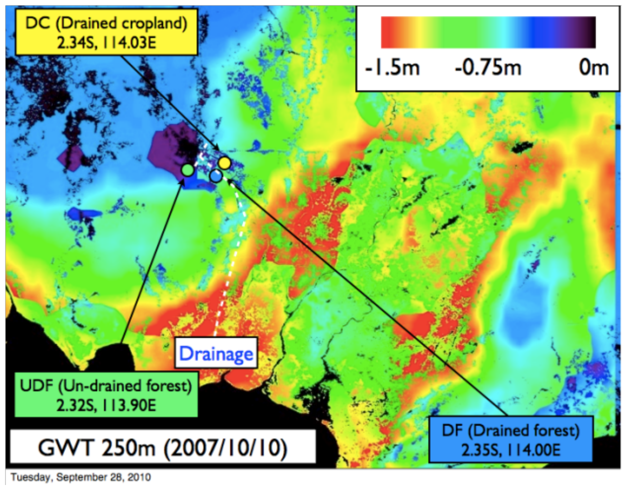
- Tropical forest remain mainly in lowland and peat (red circles), thus soil carbon content is high under the peat-forestry
- Destruction of peat-forest ascribe into “lager carbon emission” and “biodiversity loss”



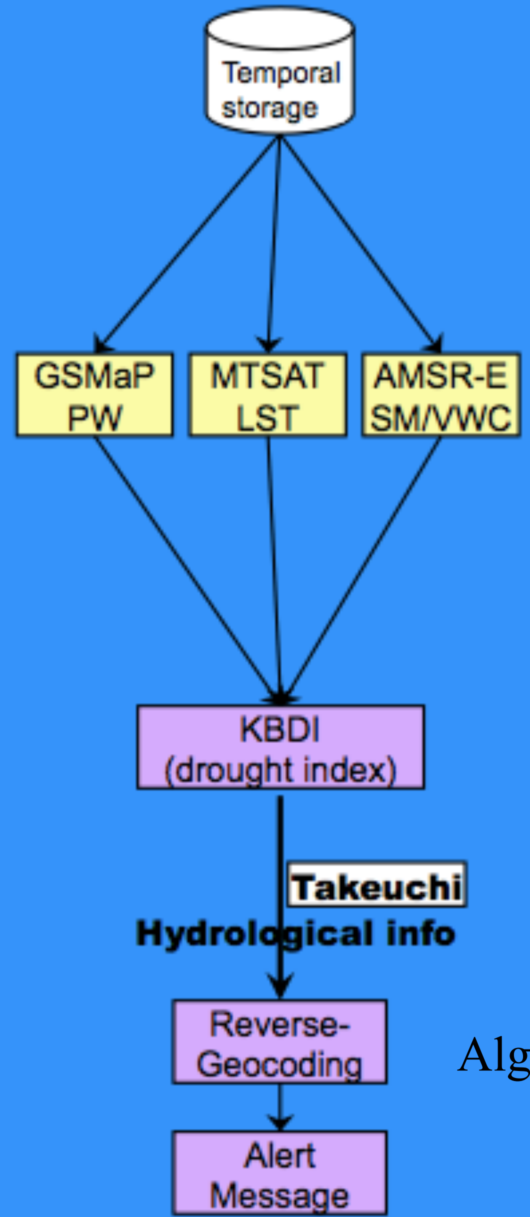
(4) CO_2 Mapping

Water Table is Key for Peatland Ecosystem!!

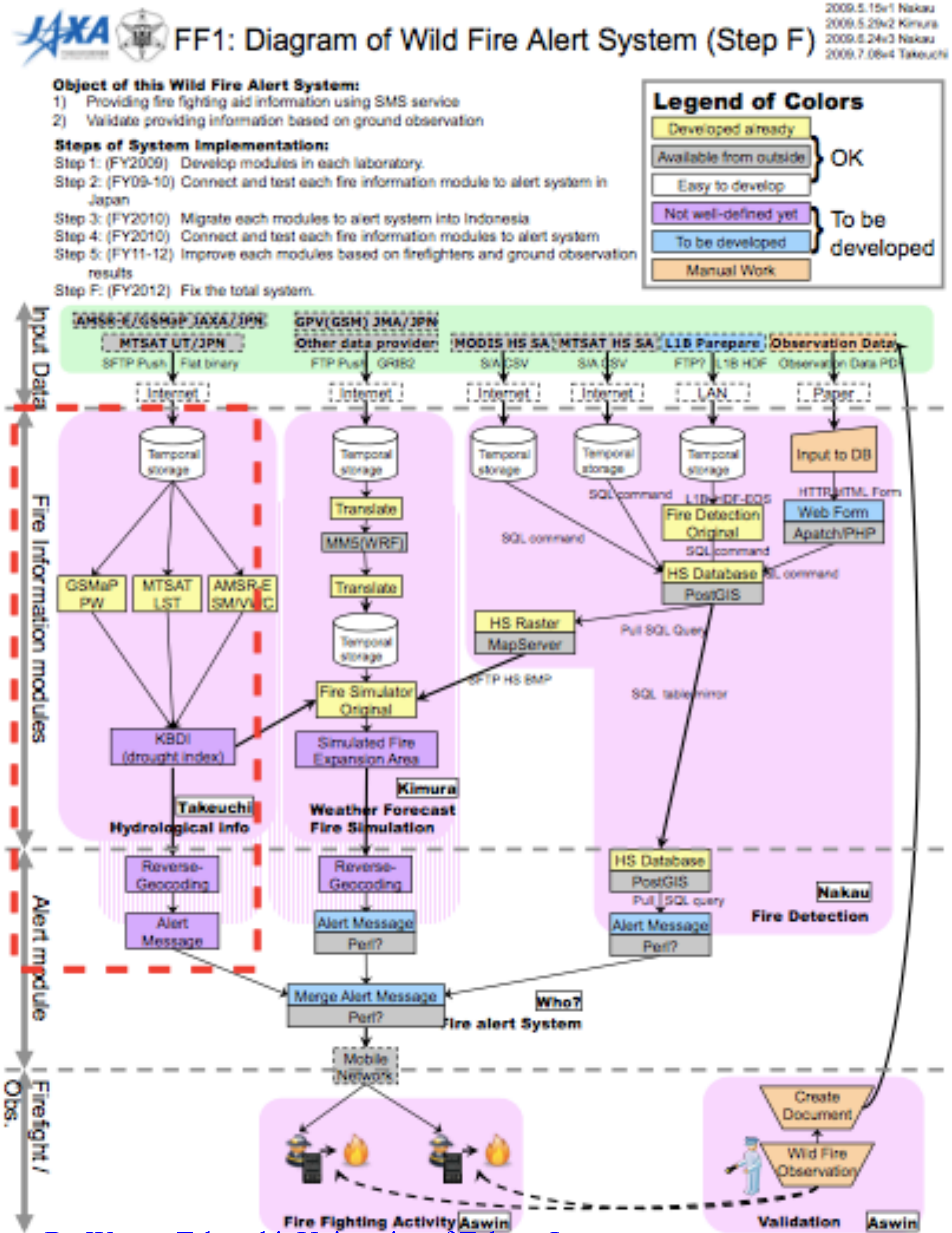
1) Oxidation
2) Fire Factors
3) Tree growth and Mortality
4) DOC



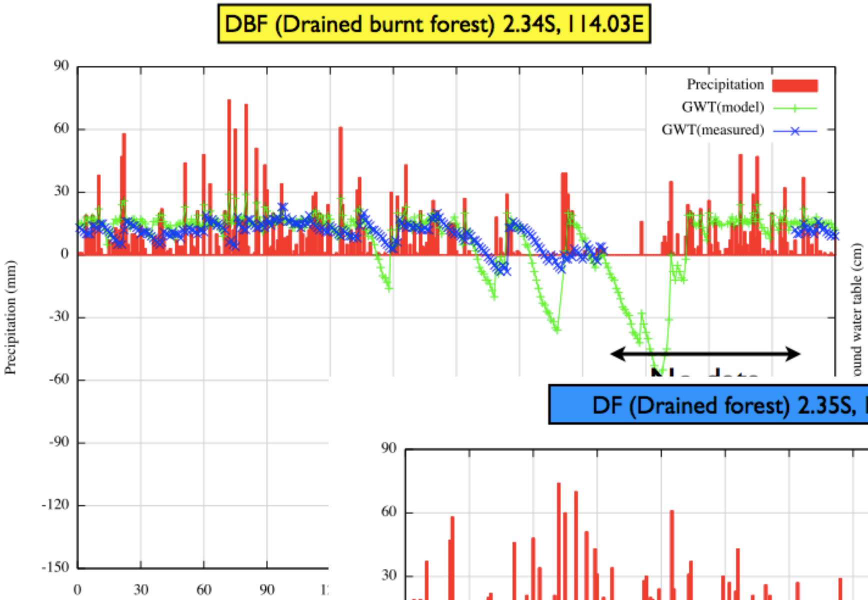
Peat moisture estimation (U-Tokyo)

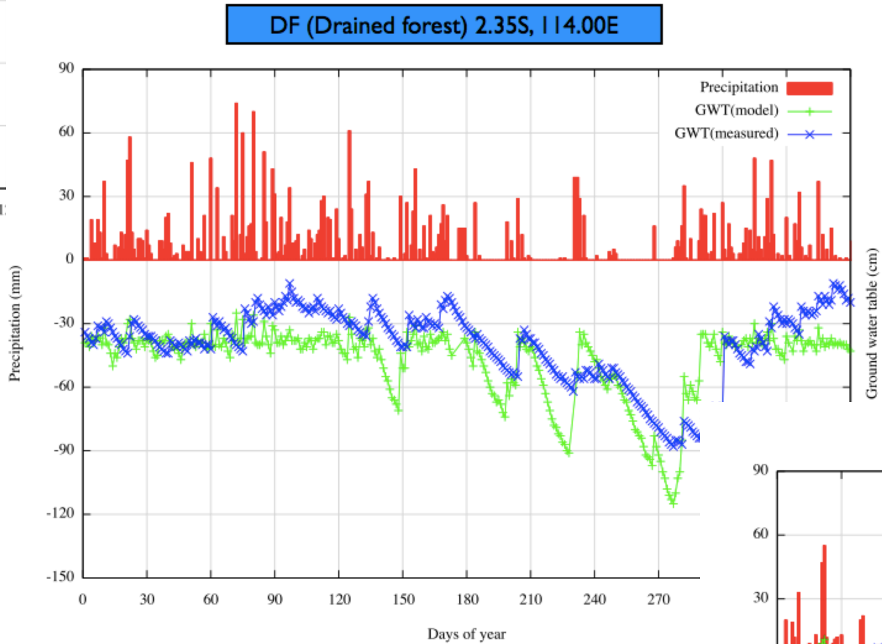


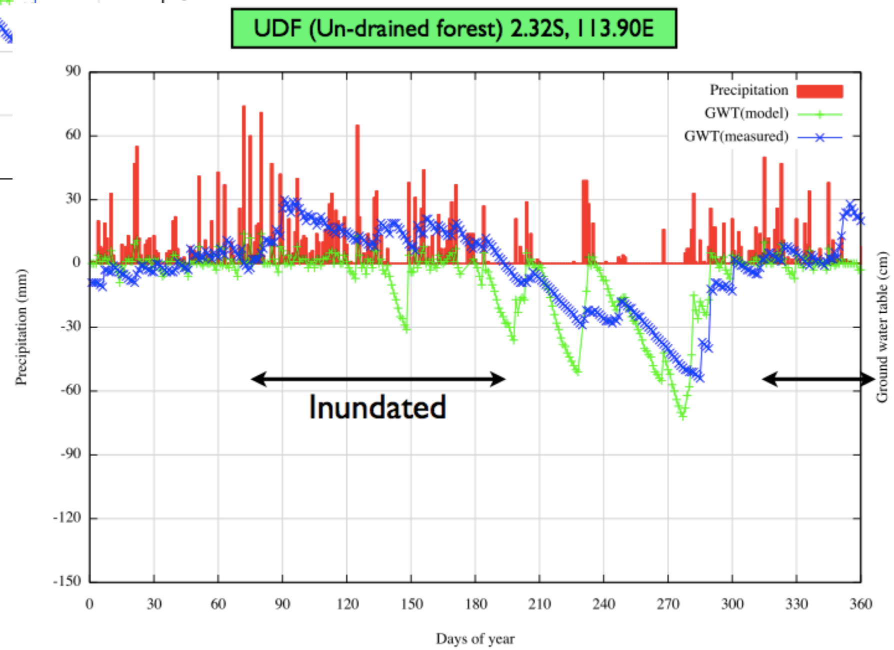
Algorism



By Wataru Takeuchi, University of Tokyo, Japan







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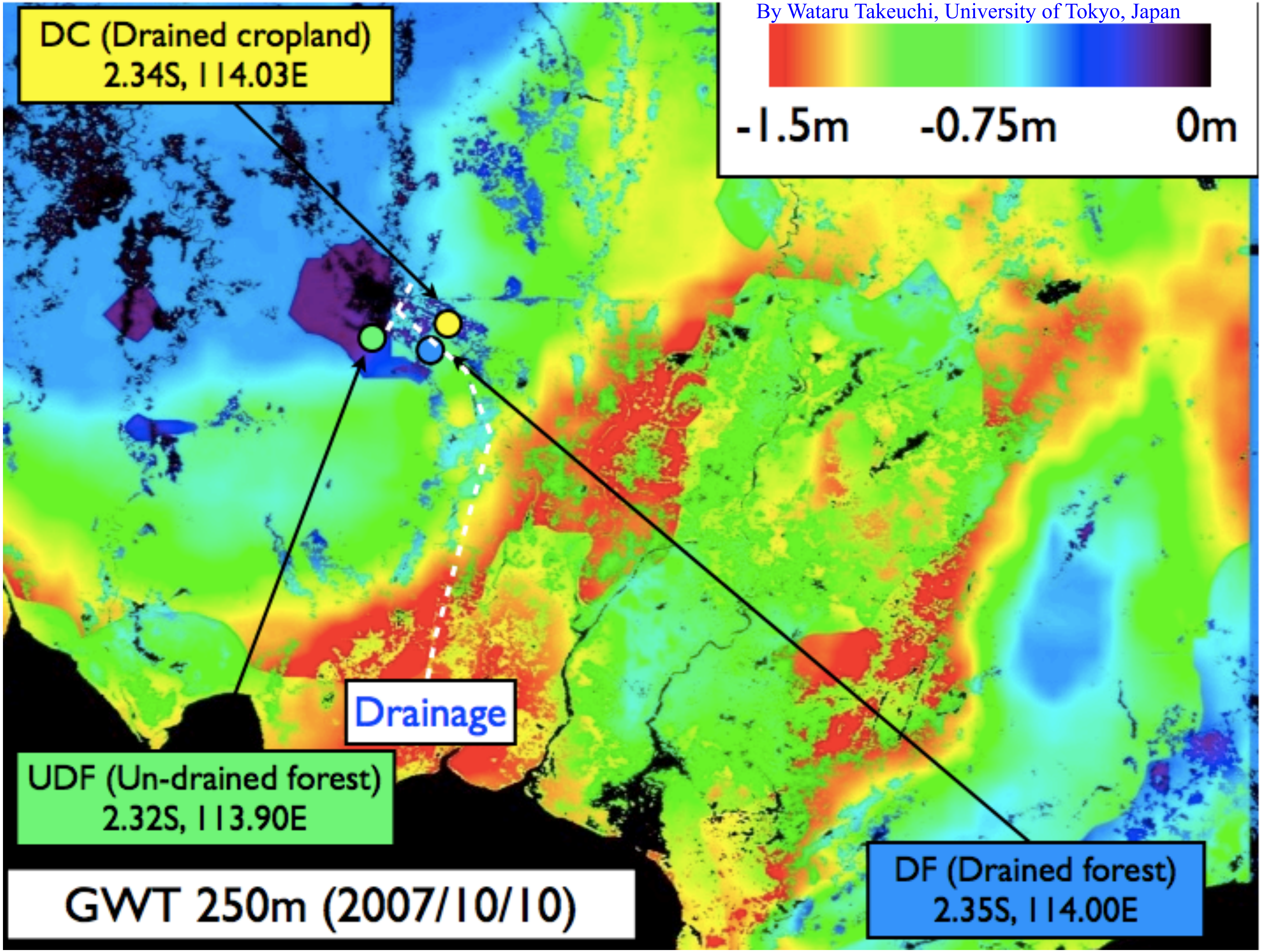
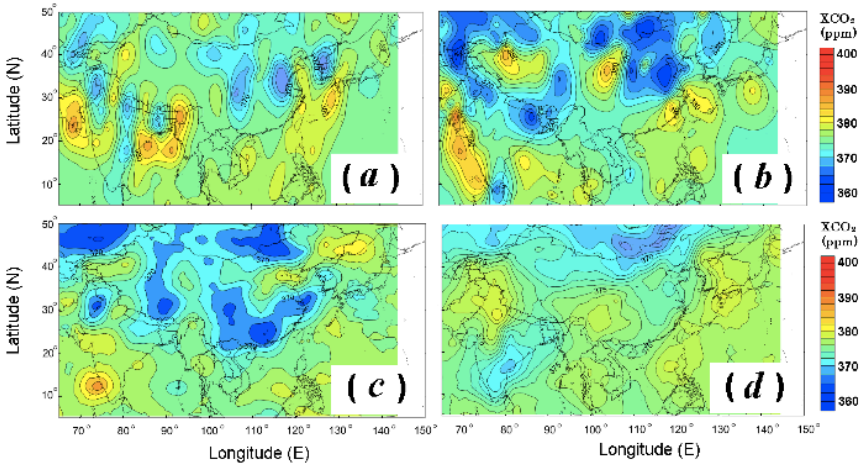
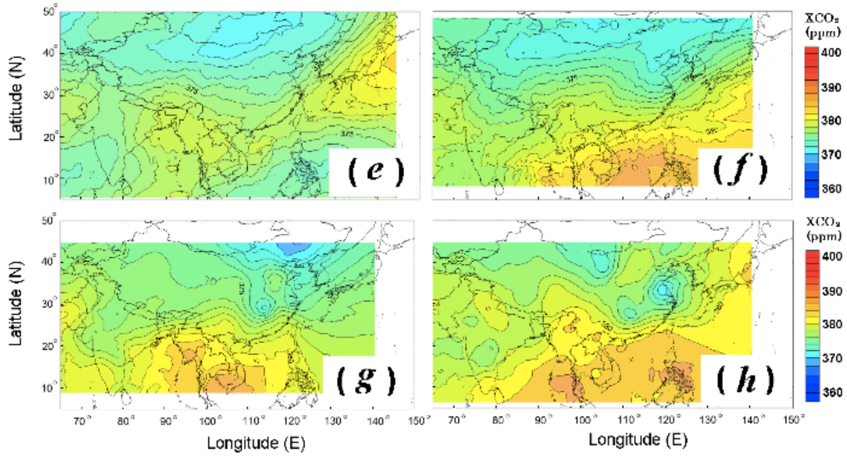

By Wataru Takeuchi, University of Tokyo, Japan
-1.5m
-0.75m
0m
DC (Drained cropland)
2.34S, 114.03E
Drainage
UDF (Un-drained forest)
2.32S, 113.90E
DF (Drained forest)
2.35S, 114.00E
GWT 250m (2007/10/10)

CO2 mapping by GOSAT data

by Yang LIU and Wang Xiufeng (unpublished)





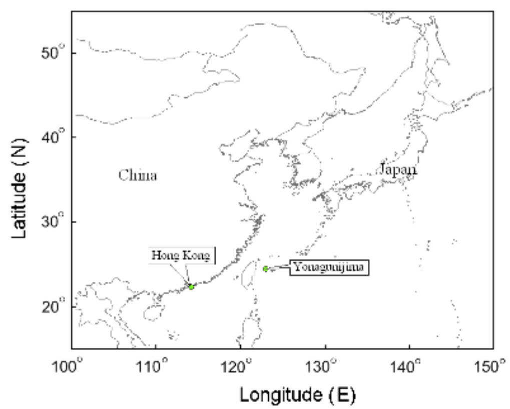


Fig. 4.2 Location of WMO WDCGG data in Hong Kong and Yonagunijima station.

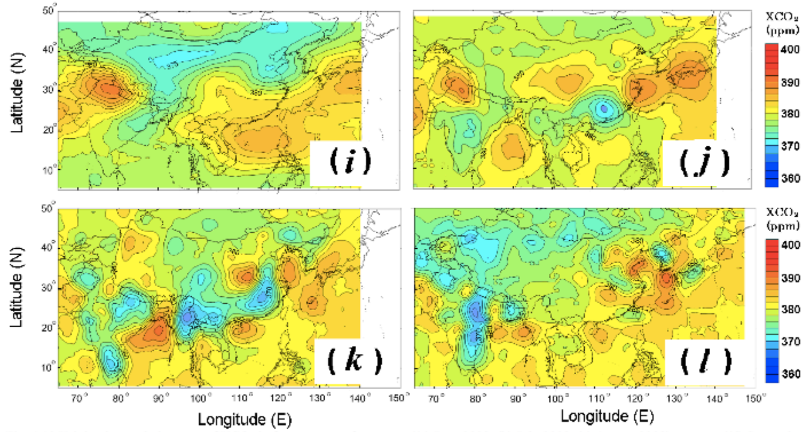


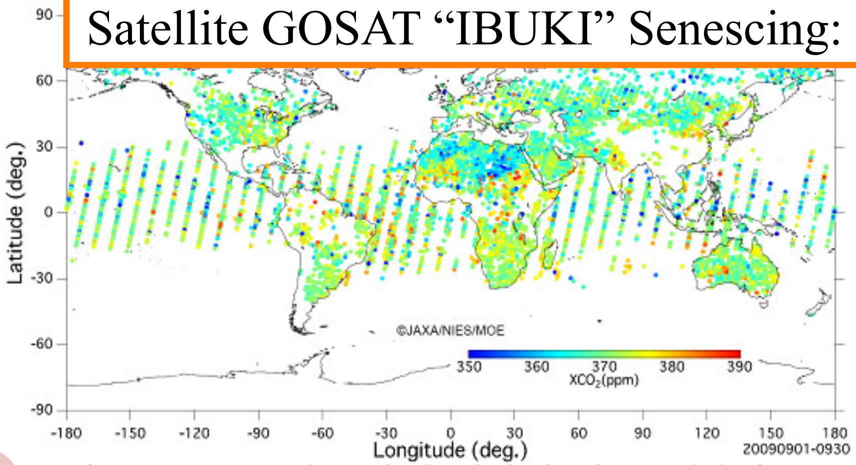
Fig. 4.10 Kriging interpolation map of XCO_2 in four seasons of: summer ((a) June 2009, (b) July 2009, (c) August 2009); autumn ((d) September 2009, (e) October 2009, (f) November 2009); winter ((g) December 2009, (h) January 2010, (i) February 2010) and spring ((j) March 2010, (k) April 2010, (l) May 2010).

Top-down
- satellite
- airplane
- inverse model

Integrated, practical carbon budget map

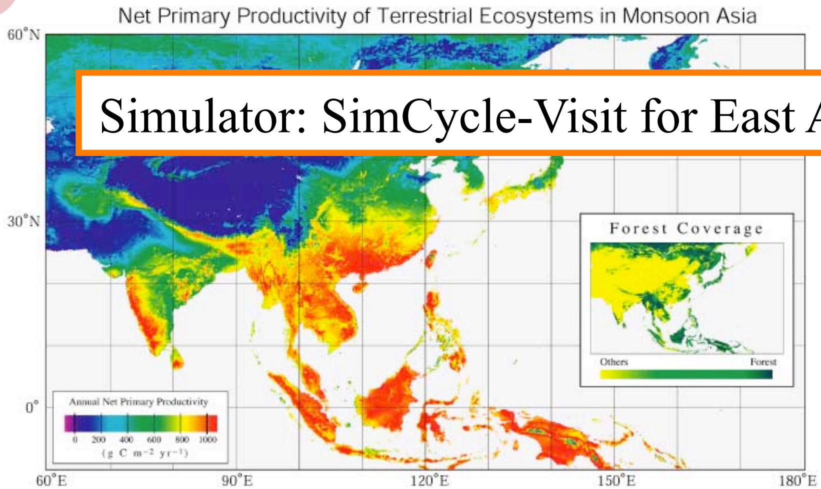
Bottom-up
- field survey
- flux obs.
- process model

Satellite GOSAT "IBUKI" Senescing: CO2

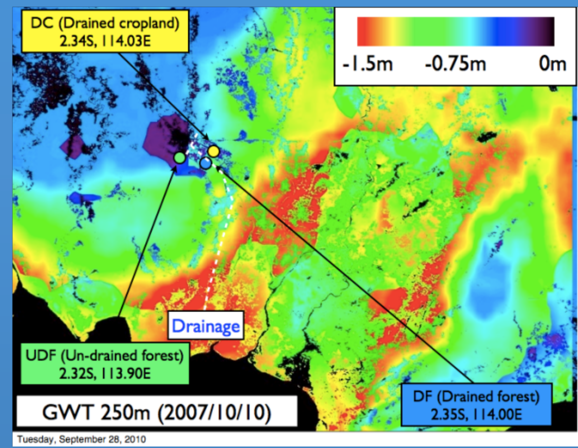


Column averaged dry air mole fraction distribution of carbon dioxide for the month of September, 2009, obtained from IBUKI observation data (unvalidated) By JAXA

Simulator: SimCycle-Visit for East Asia



Carbon-Water Simulator



- **Carbon Emission by Fire**
- **Carbon Loss through Water**
- **Carbon Emission by Microorganisms Degradation**
- **Tree Growth/Mortality**


Thank you for your attention