




Research and development of forest carbon monitoring methodologies for REDD+

WG3: FOREST CARBON TRACKING (FCT)
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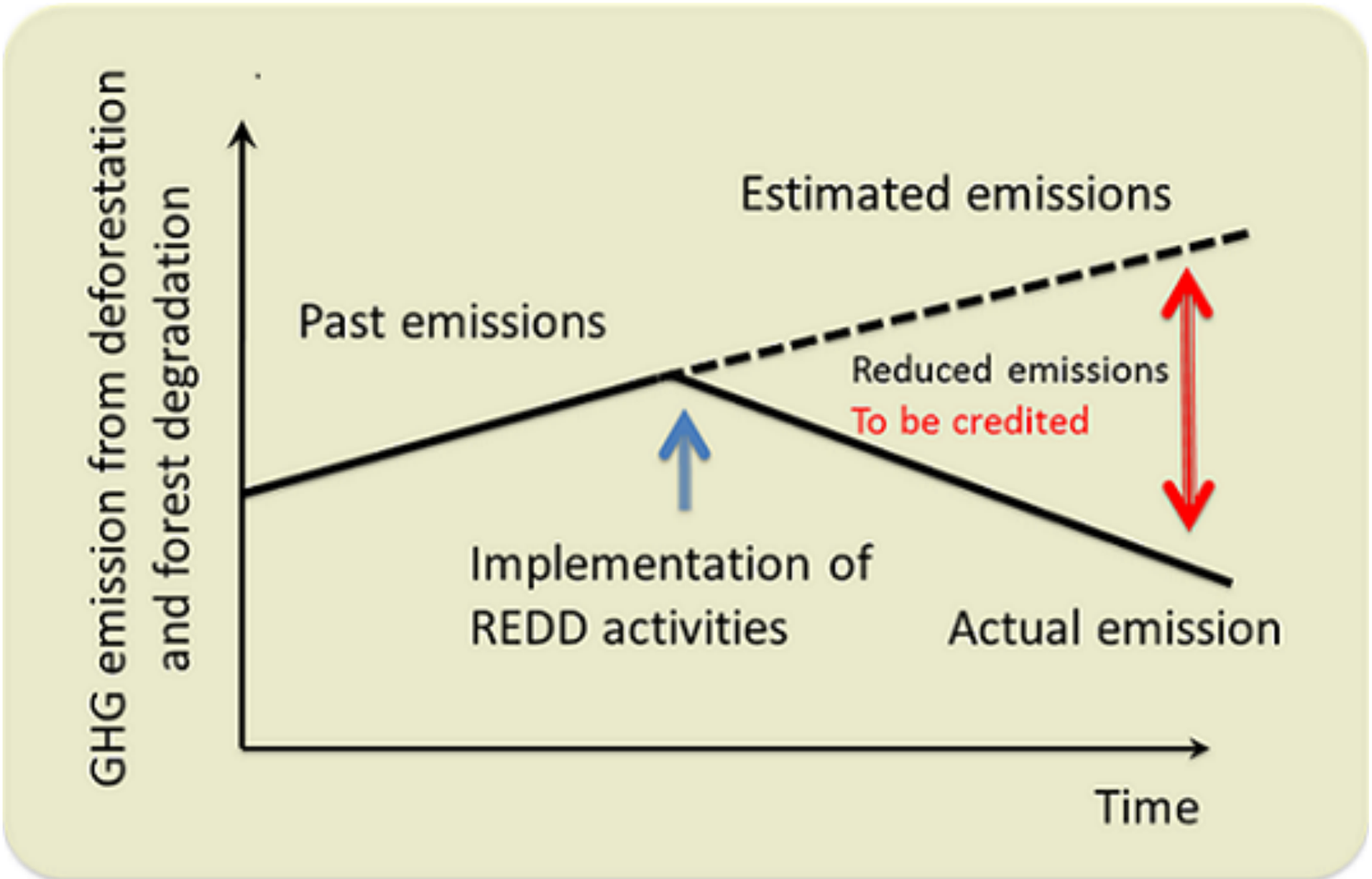
Basic Concept of REDD-plus

Economic incentives are provided with respect to the difference between the reference level and emissions in cases where deforestation and forest degradation have actually been curbed.



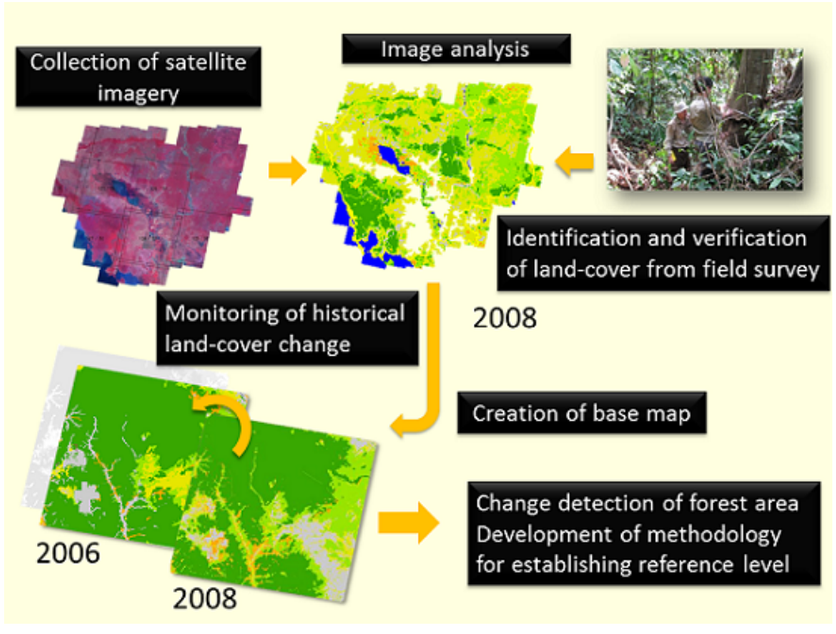
The core idea of REDD is that reward the reduction of green house gas emission from forests.

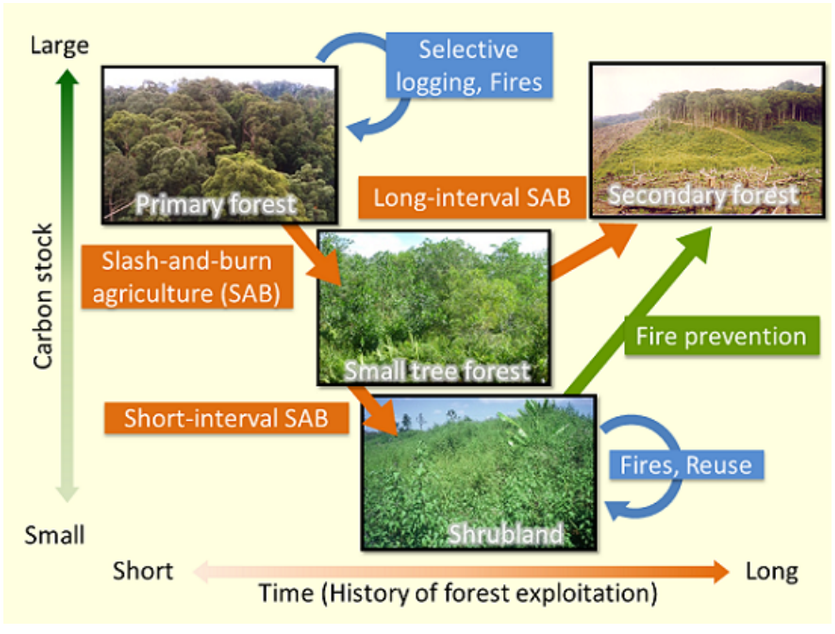
Source: FFPRI REDD R&D Center HP

The REDD R&D Center in FFPRI

- On July 2010, "REDD Research and Development Center (REDD R&D Center)" was launched within the Forestry and Forest Products Research Institute (FFPRI).

- The REDD R&D Center is working on strengthening the measurement, reporting and verification (**MRV**) system of monitoring greenhouse gas emissions and developing the technologies required to establish reference levels of emissions.





Development of methods for:

- **monitoring GHG emission and removal**
- **estimating the reference level**

How to estimate nationwide forest carbon stocks

- To establish national forest monitoring systems, use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating forest carbon stocks and forest area changes.

$$\text{Total carbon stock} = \Sigma\ (\text{Forest area}_i \times \text{Averaged carbon stock}_i)$$

- The method is the calculation of carbon stock by monitoring forest land and summing up the forest area and its averaged carbon stock for important forest types.

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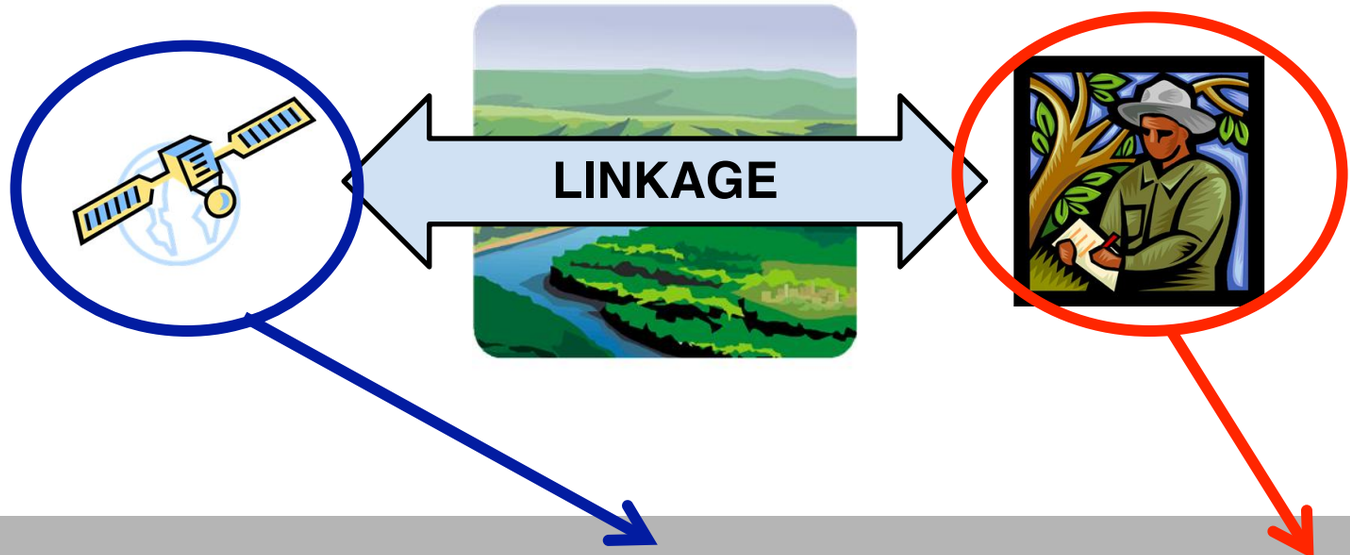

Total carbon stock = Σ (Forest area$_i$ x Averaged carbon stock$_i$)

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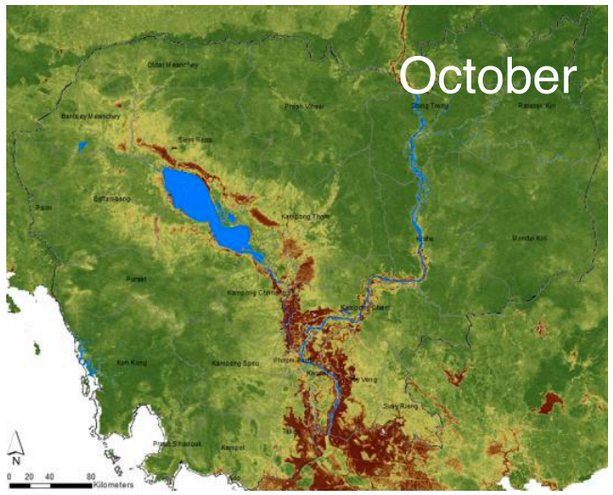
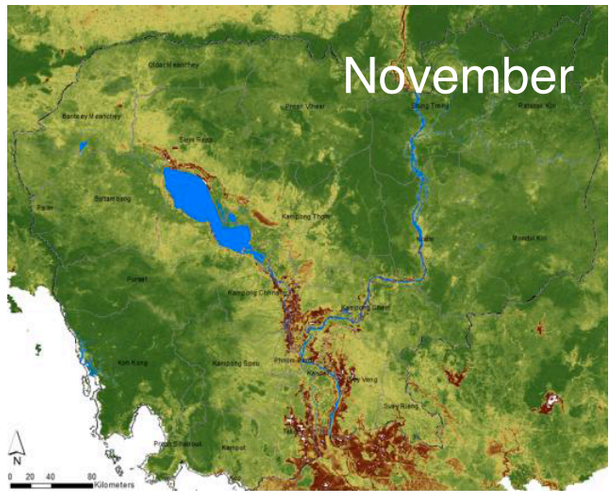
Monitoring land uses and land-use changes using remote sensing techniques

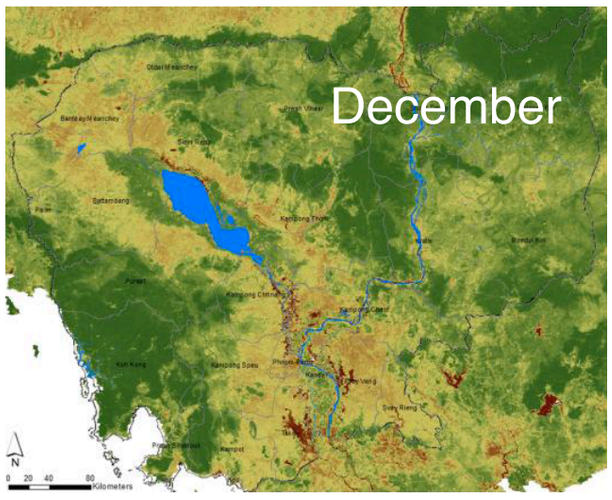
Total carbon stock = Σ (Forest area$_i$ x Averaged carbon stock$_i$)

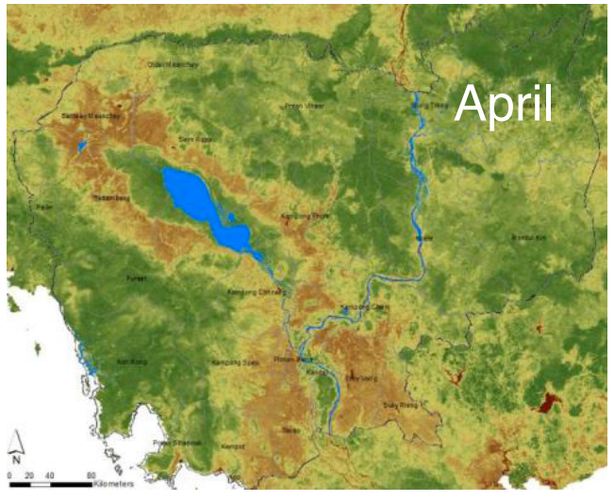
The present challenges of RS techniques:
“ Automatic classification in seasonal forest”

Issue of seasonality in seasonal forests



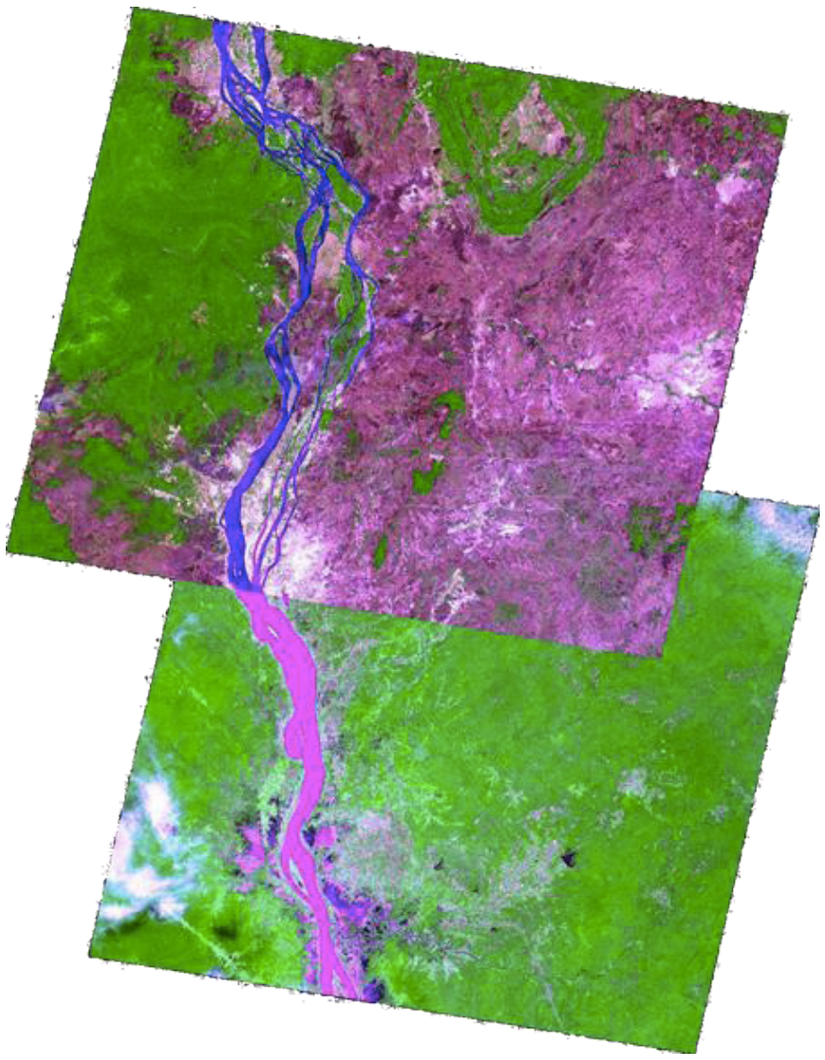




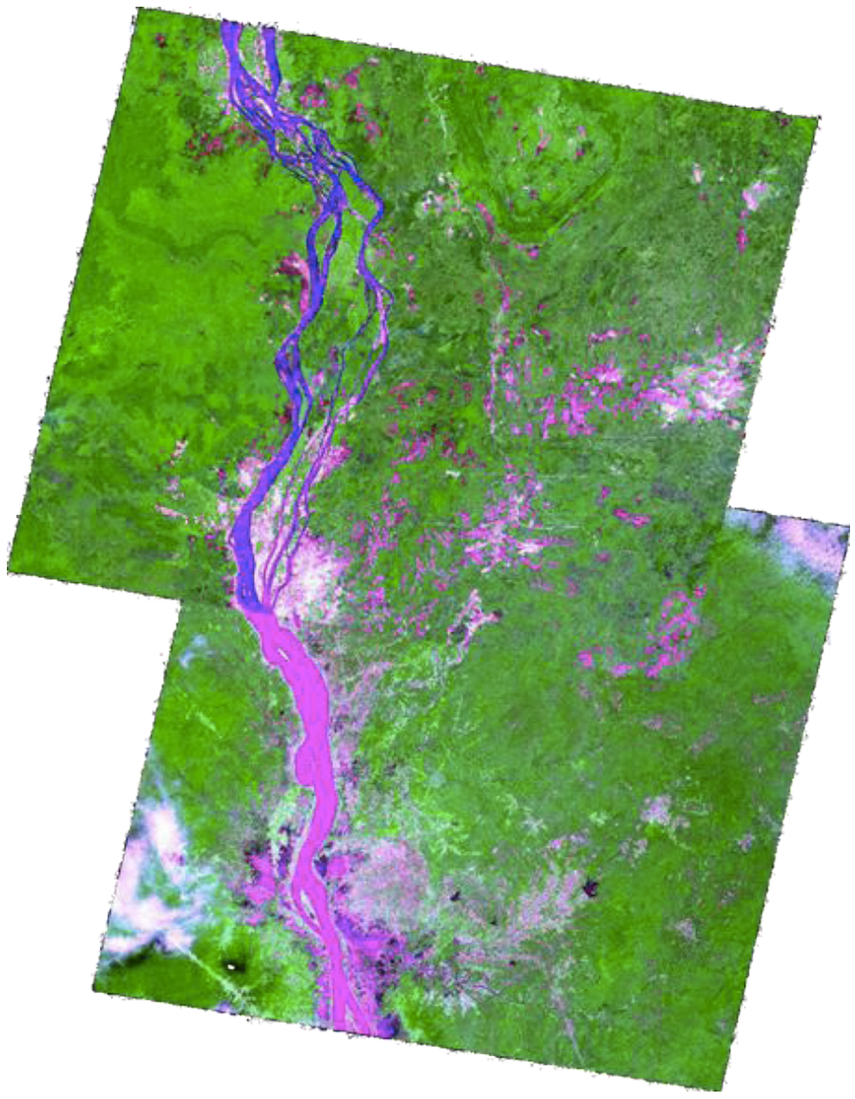


NDVI values in deciduous forests highly fluctuate according to the season.

Standardization of images with algorithm for reducing the effect of seasonality



SPOT images (upper: the end of dry season, lower: the beginning of dry season)



Reduction of effect of seasonality by standardizing images with developed algorithm.

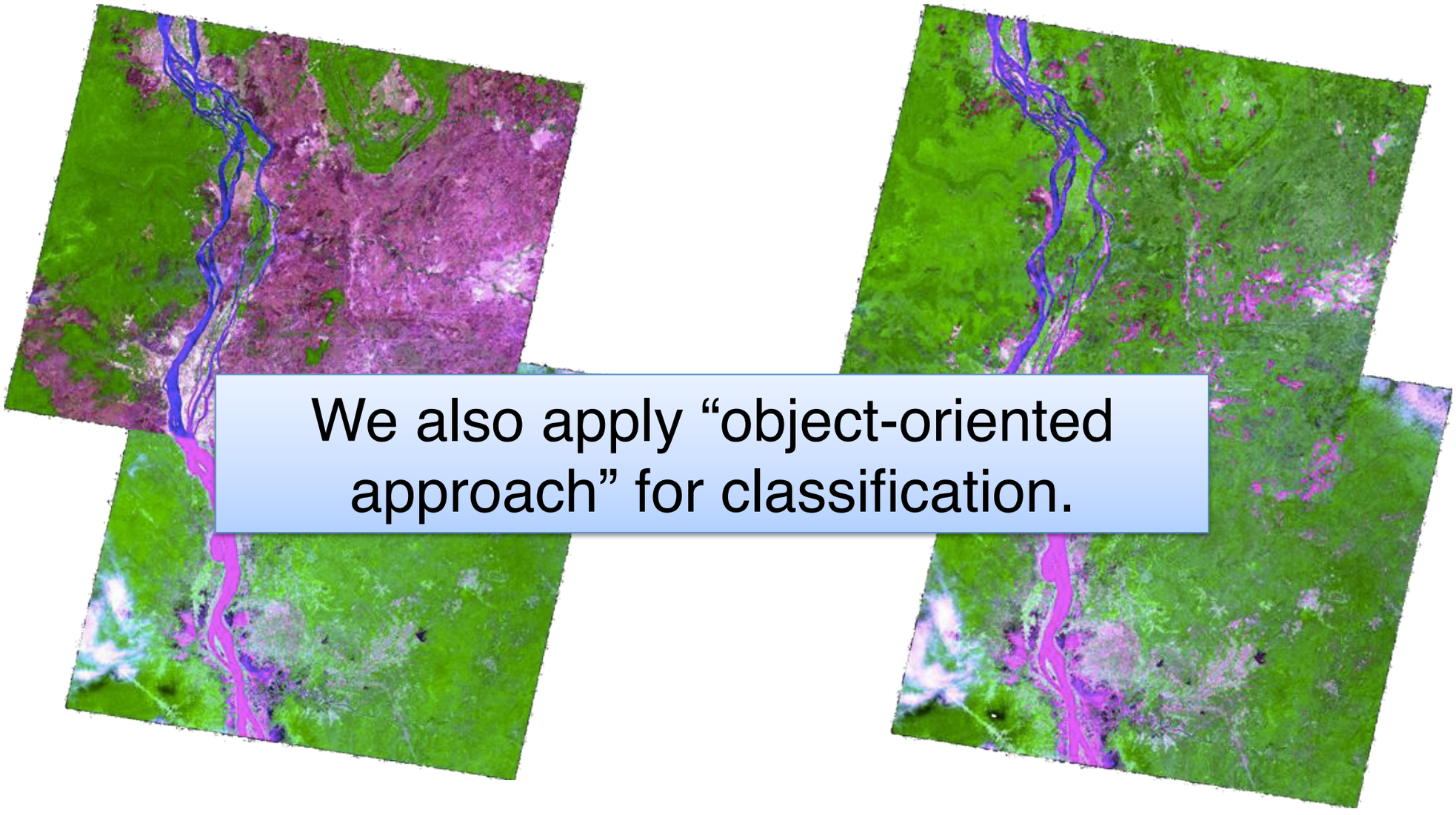
Standardization of images with algorithm for reducing the effect of seasonality

SPOT images (upper: the end of dry season, lower: the beginning of dry season)

The effect on the different stages of dry season is found in the classification result.

Reduction of effect of seasonality by standardizing images with developed algorithm.

Standardization of images with algorithm for reducing the effect of seasonality

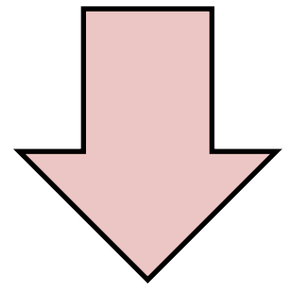


We also apply “object-oriented approach” for classification.

SPOT images (upper: the end of dry season, lower: the beginning of dry season)

Reduction of effect of seasonality by standardizing images with developed algorithm.

Monitoring forest carbon stocks by ground measurements under a sampling system



Total carbon stock = Σ (Forest area$_i$ x Averaged carbon stock$_i$)

The present challenges of ground base sampling:
“ Development of accurate and simplified measuring methods”

How to estimate averaged carbon stock

- **Applying Permanent Sampling Plots (PSPs)**
- **Estimating biomass using allometry equations**
- **Require appropriate forest type classifications for reduction of uncertainty**
- **Possible to estimate carbon stock changes with repeated measurements**

Example of forest type classifications

Cambodia	Malaysia
Evergreen forests (including Semi-evergreen forests)	Lowland dipterocarp forests
Deciduous forests	Hill dipterocarp forests

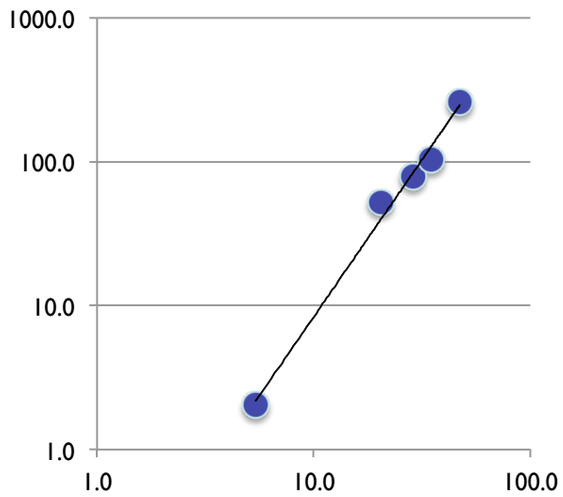
Approach to raise the estimation precision

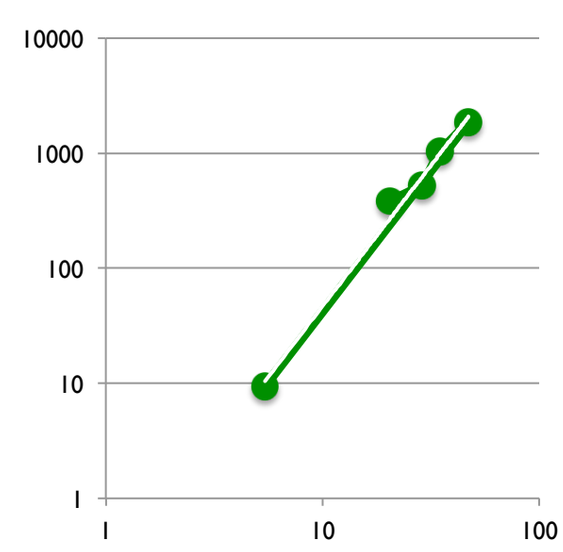
Set up distinct stake within each sampling plot

Mark measuring position

Make clear rules for DBH measuring

Develop of new allometry equations in blank biomes





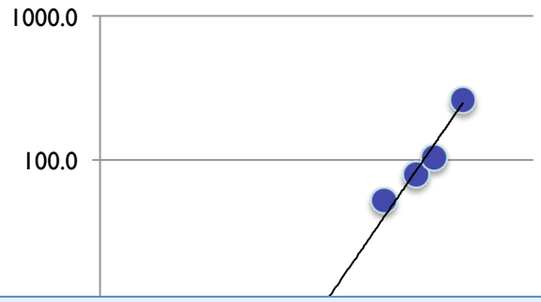
Destructive sampling in Cambodia

[Tropical monsoon forests]

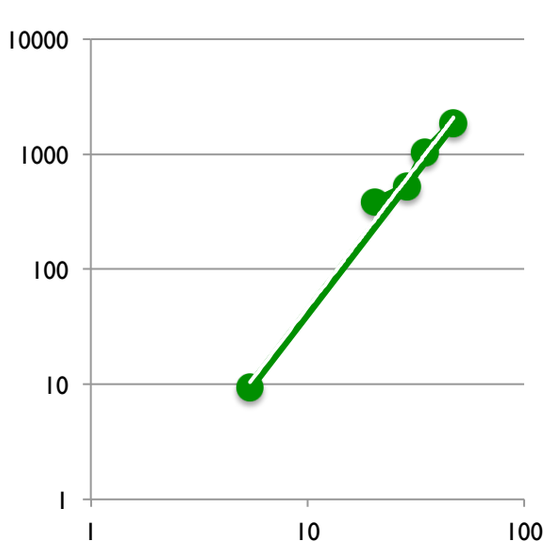
Destructive sampling in Paraguay

[Alto Parana forests]

Develop of new allometry equations in blank biomes



We are developing allometry equations including belowground parts



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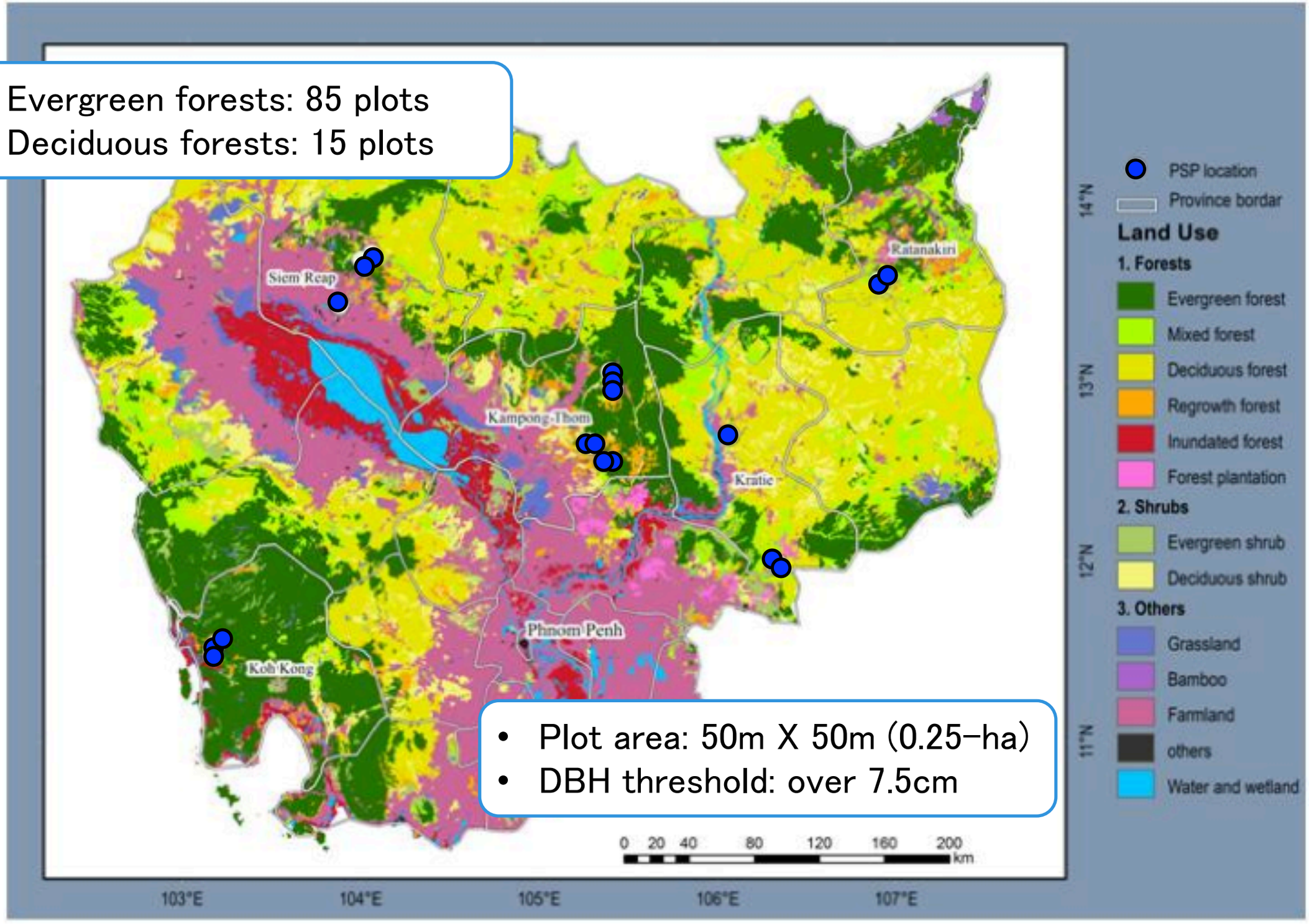
Case study for carbon stock estimation using PSPs data - Cambodia's case-

Forest cover map (2006) and locations of FA's PSPs in Cambodia

- Evergreen forests: 85 plots
- Deciduous forests: 15 plots



- Plot area: 50m X 50m (0.25-ha)
- DBH threshold: over 7.5cm

National-wide forest carbon stocks in Cambodia (tentative)

Forest Types	Forest Area (2006) Unit: ha	Average Carbon Stock (2000～2001) Unit: Mg-C/ha	Carbon Stock Unit: Tg-C
Evergreen Forests (inc. Semi-evergreen forests)	5,031,540	163.8 ± 7.8	824.2 ± 39.2
Deciduous Forests	4,692,098	56.2 ± 6.7	263.9 ± 31.3
Total	9,723,638		1,088.1 ± 50.2

Source: Samreth et al. (In Press)
Values of carbon stocks are shown as average with SE

For establishment of long-term monitoring systems

Need act from not only scientists

But also local people!

- Building capacity in our counter-part countries
- Development of simplified techniques with high accuracy

Conclusions

- For estimating CO_2 emissions from deforestation and forest degradation at a national scale, combination of remote sensing and PSP approaches could provided reasonable accurate estimations.

- Technical challenges in forest monitoring include automatic land cover classification by remote sensing (RS) and accurate/simplified methodologies for carbon stock by ground based measurement (GBM)

- For RS, we have tried standardization of satellite images with algorithm for reducing the effect of seasonality in tropical monsoon forests. For GBM, we have developed allometry equations in blank biomes (e.g. tropical monsoon forest & eastern Paraguay forest).

- We estimate tree carbon stocks for tropical forests in Cambodia applying a simplified method. We also calculated required plots number at the national scale with 5% precision at a 95% CI.

Thank you for your attention

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Hill Dipterocarp Forest, Malaysia