Contributing REDD-plus through research and development of forest carbon monitoring methodologies -Endeavors of REDD R&D Center-

森林炭素モニタリング手法の研究・開発を通した、REDDプラスへの貢献

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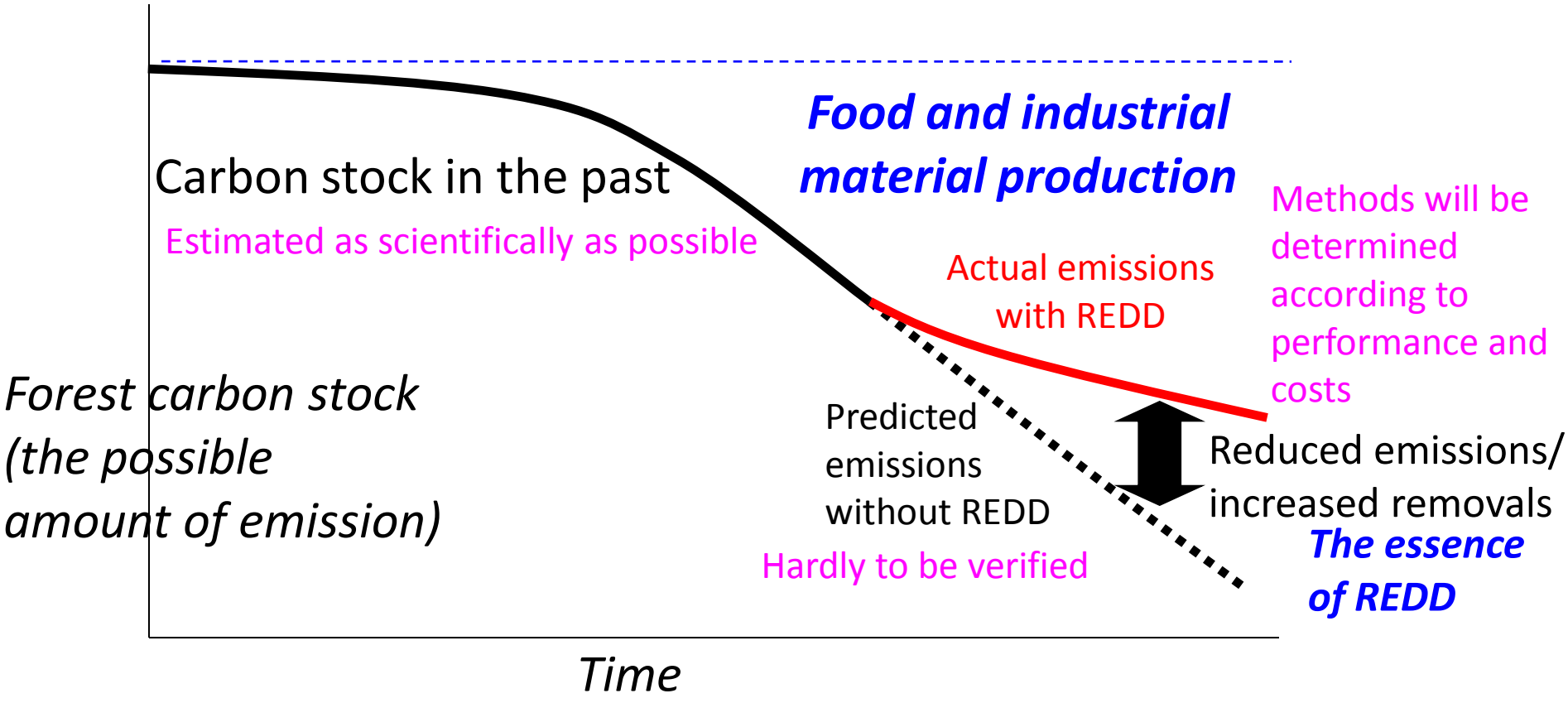
REDD R&D Center, FFPRI

What will we do by REDD?

人がREDDでやろうとしていること



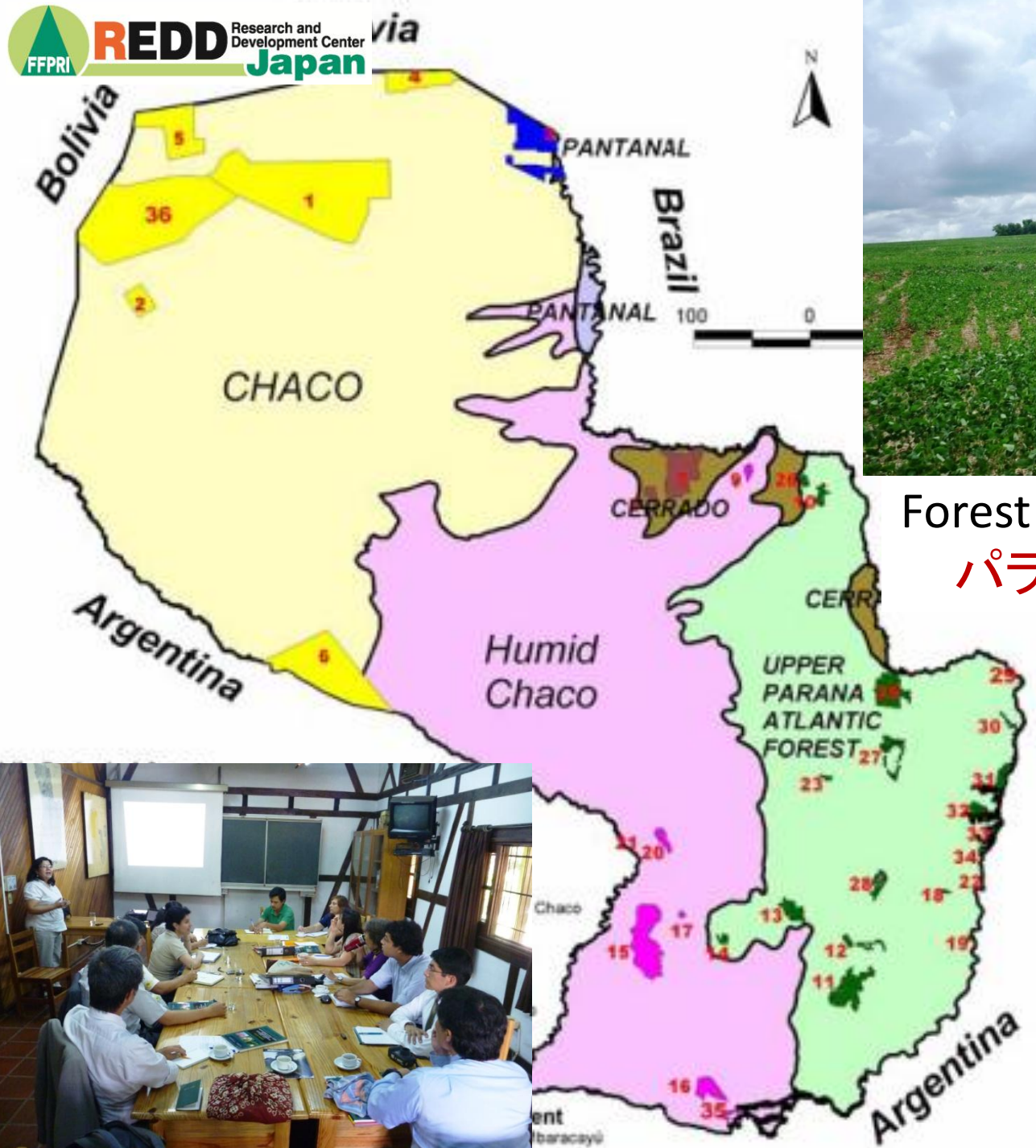
REDD Research and Development Center Japan
FFPRI

Cambodia
Seasonal
forest

カンボジア
季節林

Forest conversion in Malaysia

マレーシアの農地転換



Forest conversion in Paraguay

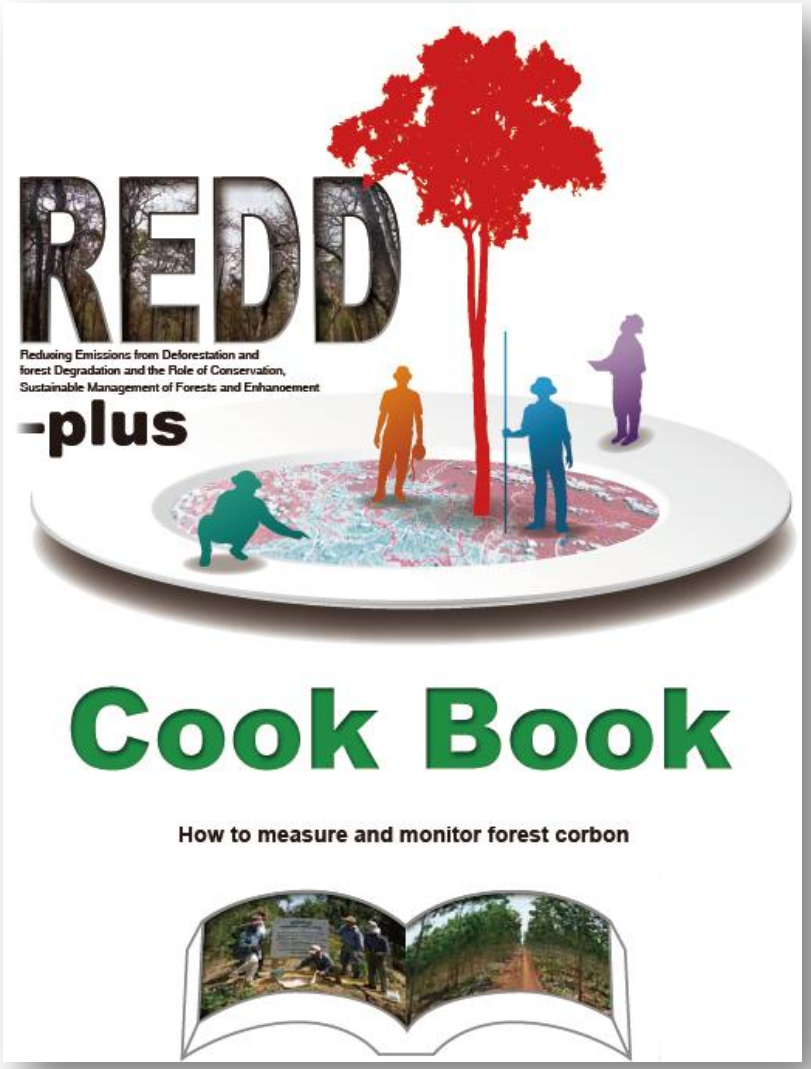
パラグアイ農・牧地転換

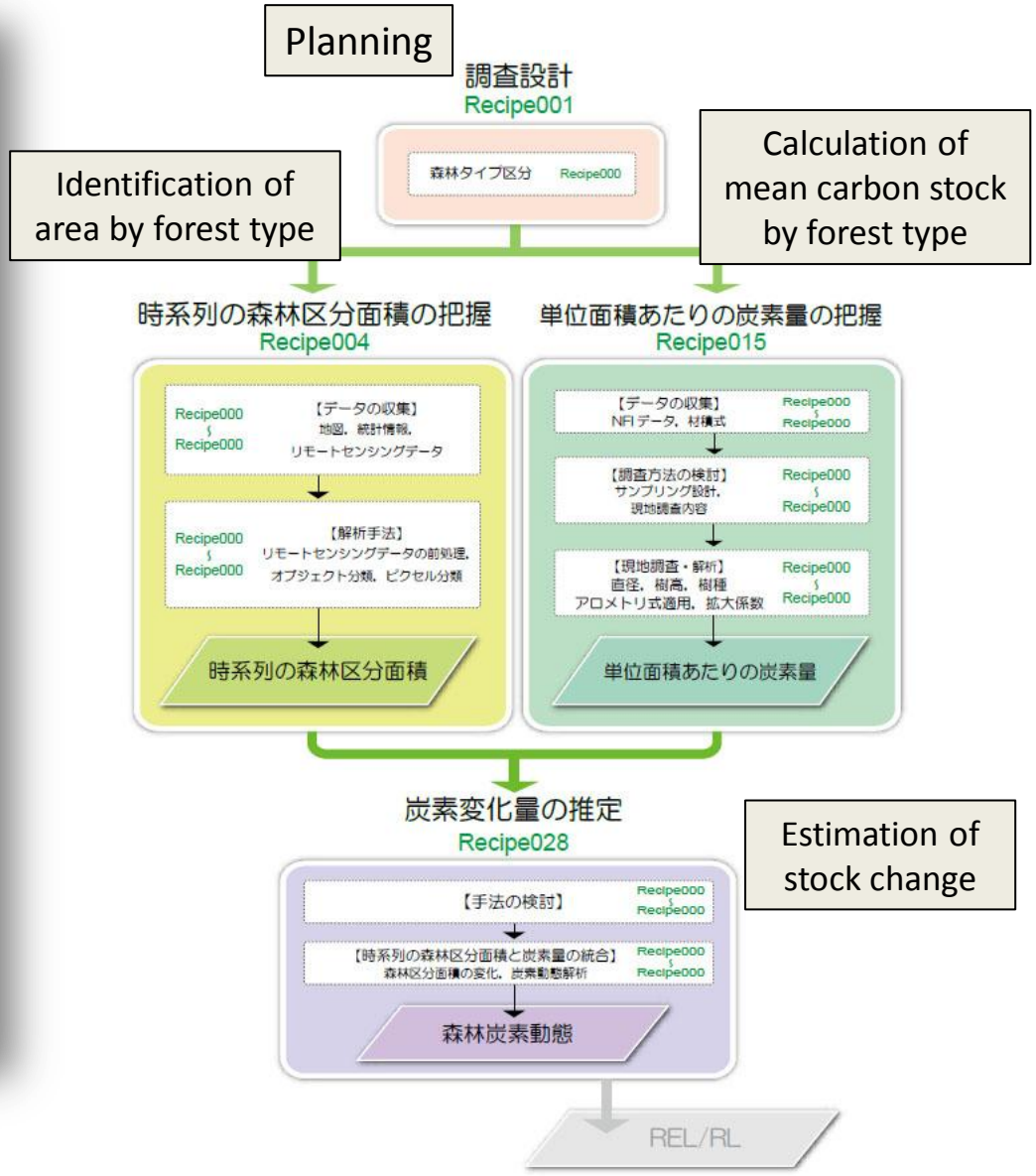
Agriculture and pasturing

FFPRI REDD Research and Development Center Japan

Preparation of guide book for REDD+

REDDプラスのための解説書の作成





A flow for estimating GHG emissions/removals and REDD effect (emission reduction)

森林炭素蓄積量変化とREDD効果の推定手順

Forest carbon stock = Forest area x Averaged carbon stock per land area

基本式は　森林炭素蓄積量＝Σ（森林面積 x 面積当たり平均炭素蓄積量）

Base map ← Ground truth

↓

Series of remote sensing images

↓

DD areas detection by monitoring forest land

↓ ← **Carbon stock per land area for main forest types**

Estimates of carbon stock change (GHG emissions/removals)

↓ ← **Scenario emissions without REDD**

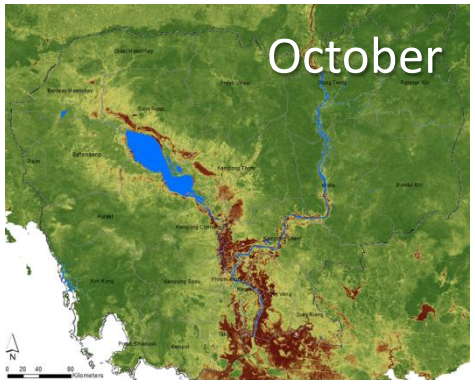
Estimates of REDD effects (GHG emission reduction)

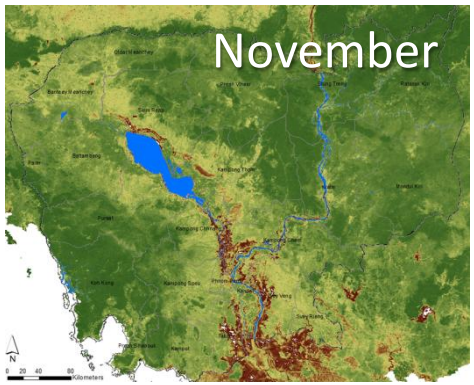
The present challenges

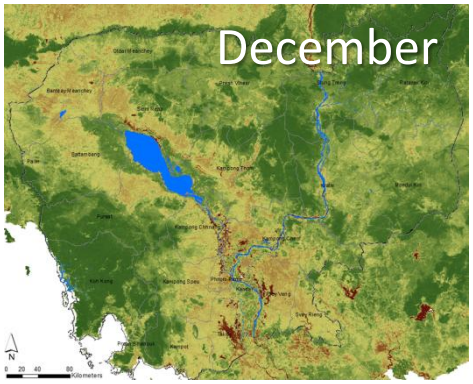
- Automatic classification 自動分類
- Accurate /simplified meth. 精度向上/簡素化

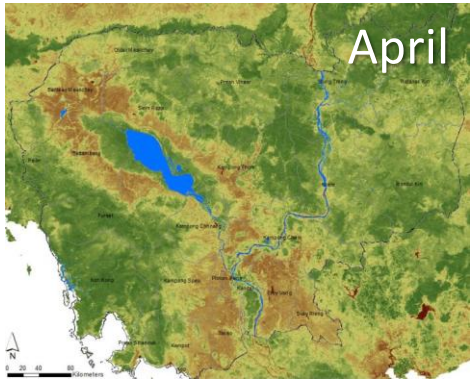
REDD Research and Development Center Japan

Issue of seasonality
季節性の問題



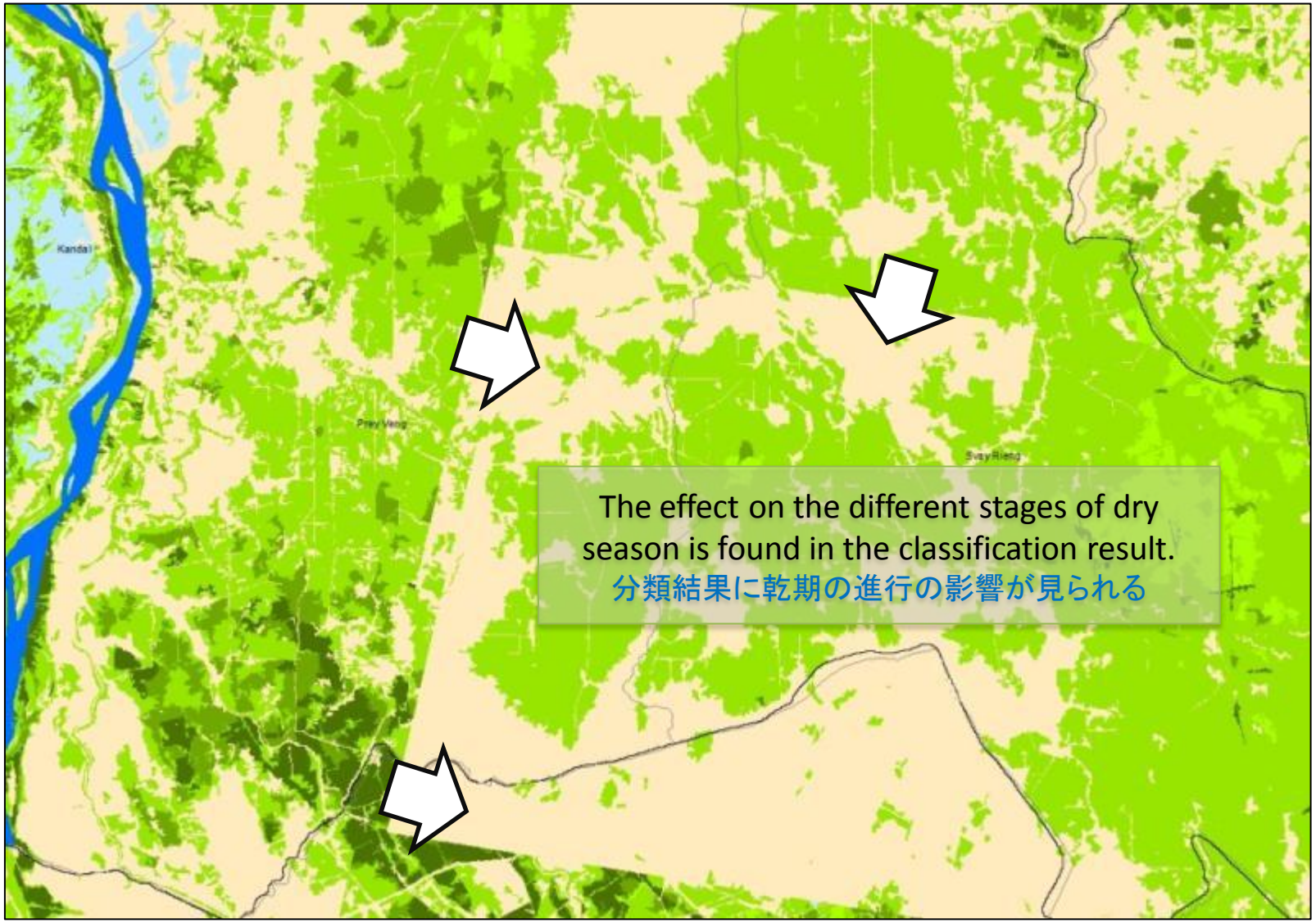






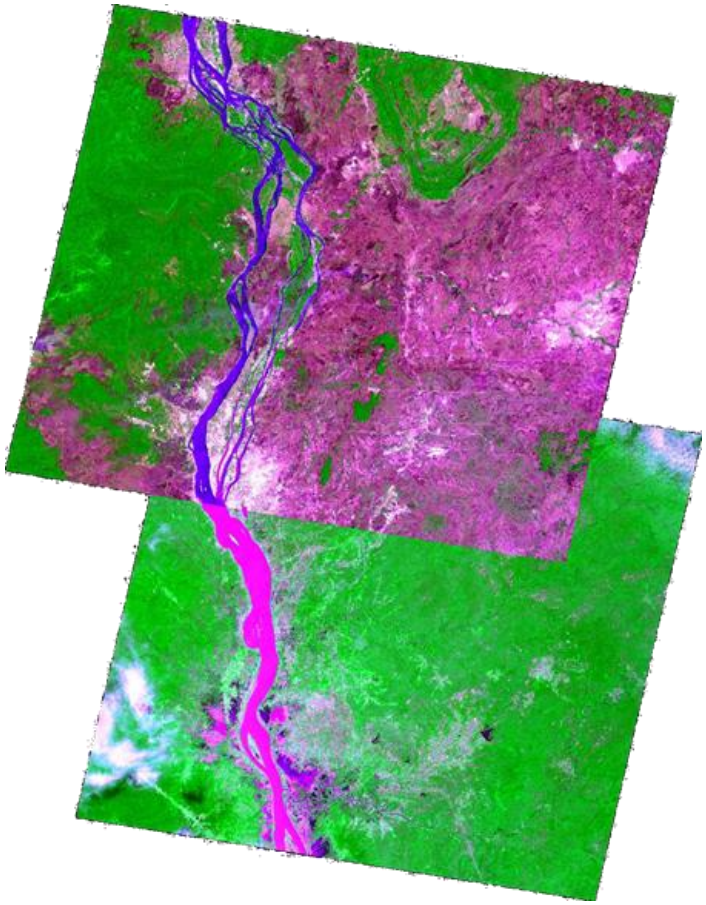
Effects of seasonality in automatic classification

自動分類における季節性の影響



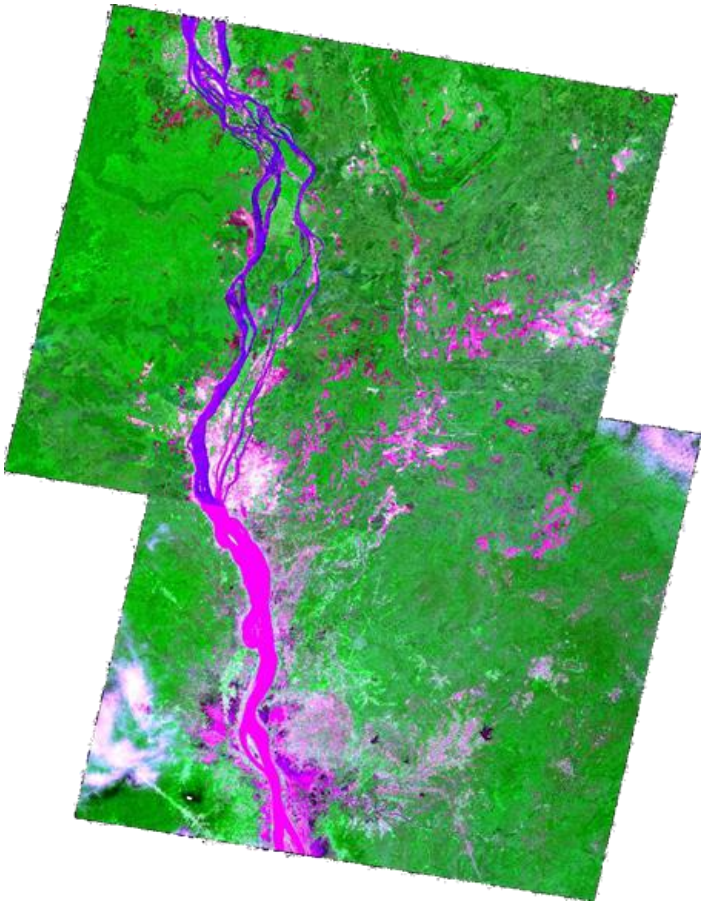
Standardization of images with algorithm for reducing the effect of seasonality

季節性を軽減するアルゴリズムによる画像の標準化



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

SPOT衛星画像（上：乾期後半、下：乾期初旬）

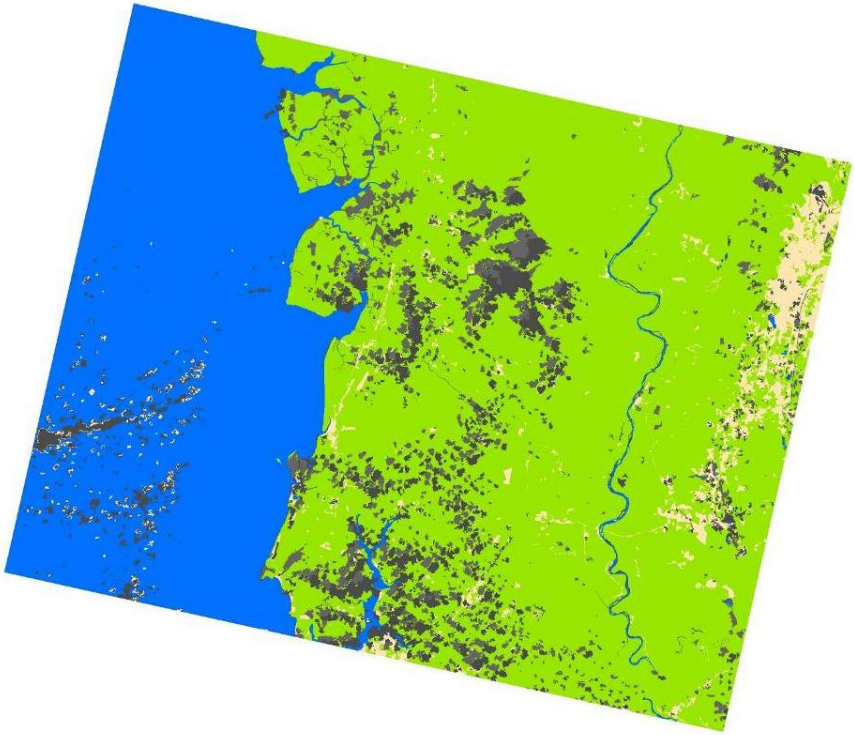


Reduction of effect of seasonality by standardizing images with developed algorithm.

画像を開発したアルゴリズムで標準化し、季節性の影響を軽減

Producing mosaic image using multiple images within a year

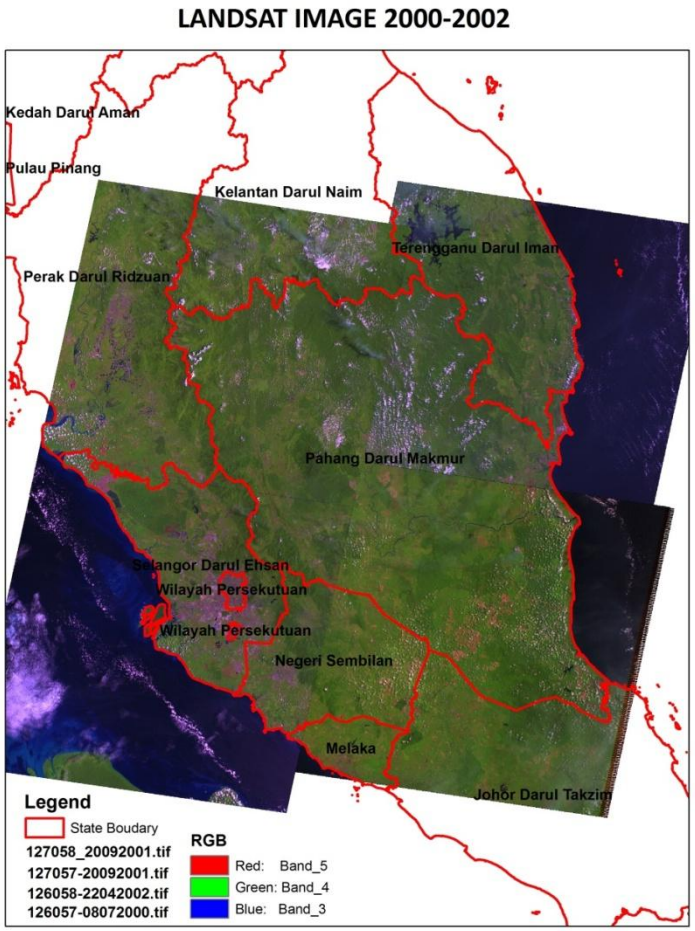
1年以内の複数画像を用いたモザイク画像の作成



Clouds and their shadows effects on the classification results.

雲とその影が分類結果に影響を与える。

森林	Forest
非森林	Non-forest
水域	Water
雲	Cloud
雲影	Shadow

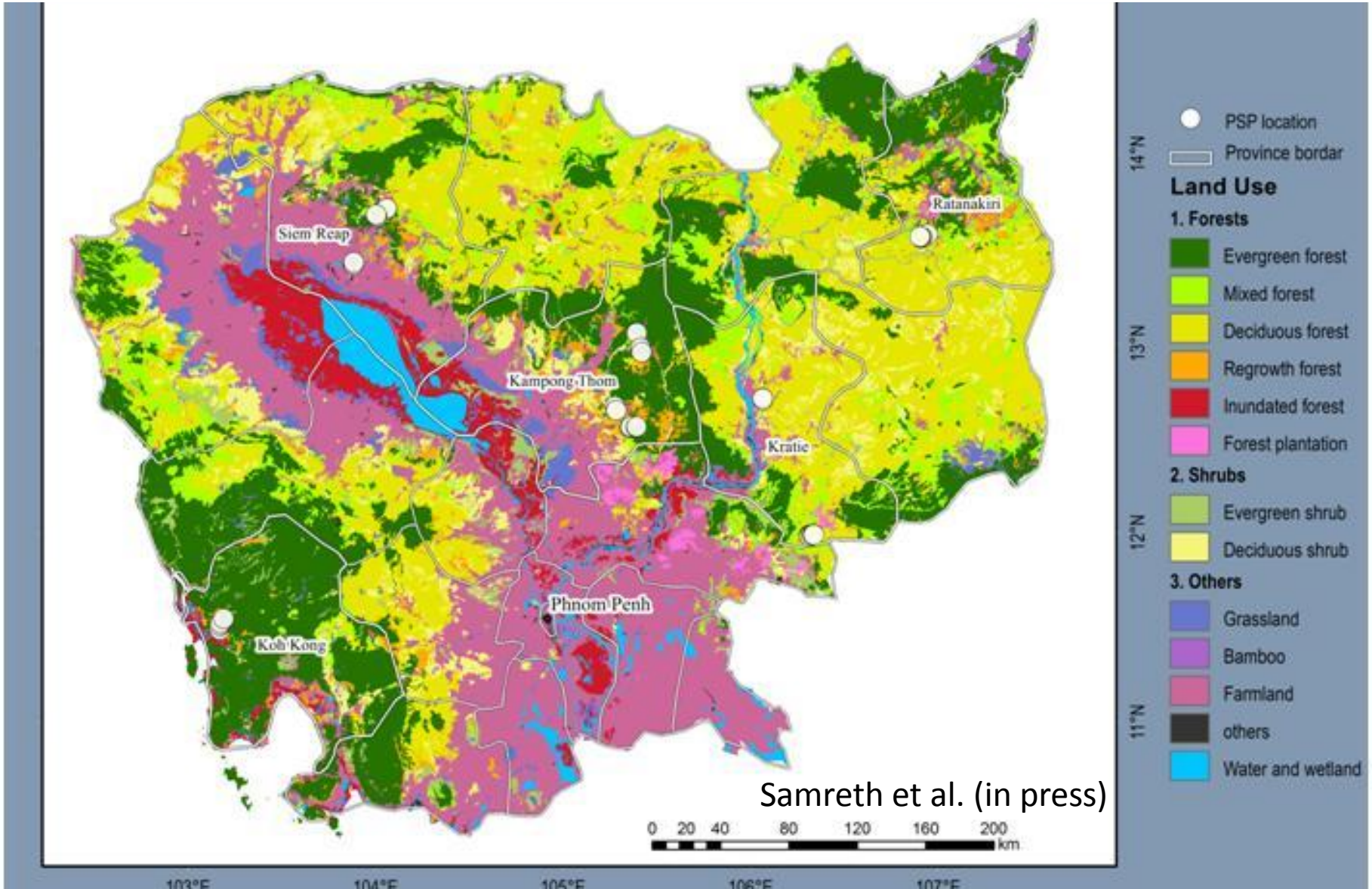


It is need to produce mosaic image with multiple images within a year.

1年以内の複数画像を用いたモザイク画像を作成することが必要

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

カンボジア森林分布図と長期調査プロット位置



Samreth et al. (in press)

The nationwide forest carbon stock in Cambodia (A tentative figure)

カンボジアの森林炭素蓄積量（暫定値）

Forest type	Forest area In 2006 ha	Averaged carbon stock In 2000-2001 Mg-C ha^{-1}	Total carbon stock Tg-C
Evergreen forest*	5,031,540	163.8 ± 7.8	824.2 ± 39.2
Deciduous forest	4,692,098	56.2 ± 6.7	263.9 ± 31.3
Total	9,723,638		1,088.1 ± 50.2

* Including Semi-evergreen forest.

Carbon stocks are shown in mean ± standard error.

Samreth et al. (in press)

Required number of sample plots for av. carbon stock at a 5% level of precision and a 95% confidence level
長期調査プロット必要数（5%危険率・95%信頼度）

≒USD 336,000

- 336 plots 336プロット
  - 260 for evergreen forest, 76 for deciduous forest
- Since most developed countries designed their national forest inventories (NFIs) at 5% level of precision and 95% confidence level, a sampling design using 336 plots may be acceptable for most countries.

  先進国のNFIの設計と同じ精度で、この結果は受け入れられるであろう
- Forests in the PSPs are sometimes destroyed. A sufficient number of extra plots are vital in the region under pressure of land-use change and heavy wood extraction. Required number of plots should be monitored to be able to add extra plots if necessary.

  森林減少・劣化が進む地域ではプロットが破壊される。プロット数は余裕を持たせた方が良い。必要数をモニタリングし、必要に応じて追加する

Available allometry equations for tropical tree biomass

熱帯林木のバイオマス推定式

Generic equations for tropical trees		Sufficient
Specific equations for trees in		
Biomes	Tropical rainforest	Existing
	Tropical monsoon forest	
	Evergreen forest	Less
	Deciduous forest	**None**
	Tropical semi- arid forest	None?
	Peat swamp forest	**Few**
	Mangrove forest	Existing
	Others	
	Secondary forest of t. rainforest	Existing
	Shrub community	Less
	Palm forest	Less
	Bamboo forest	Less

バイオマス調査とマニュアル

Destructive biomass sampling and its manual

A manual of simplified destructive sampling of tree biomass using an excavation machine

重機を利用した樹木バイオマスの
簡易化された破壊調査マニュアル vol.1
May, 2011

Khmer and Spanish versions are under preparation

Photo8_ 1 Removal of branches with leaves

(5) Remove all branches with leaves from the stem using a chainsaw and hand saws.

Separate stems and branches to avoid confusing thin stems with branches.

Photo8_ 2 Separating leaves from branches

(6) Separate leaves from branches on the tarpaulin.

Photo8_ 3a Weighing fresh leaves

(7) Weigh fresh leaves and branches.
Measure the fresh weights of leaves (FW_l) and branches (FW_b) using a spring balance or a bowl balance. Record these weights (FW_l and FW_b) and the type of tare used.

FW_l must be measured first, because leaves dry faster than branches.

For large amounts, divide the samples into sizes convenient for weighing.

Photo8_ 1 Measuring the area and height of the mound

(8) To calculate the volume of the soil mound, measure its area and height.

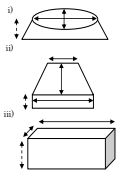


Fig.8_ 2 Measuring the mound's area and height

Mound shape and measurement point (see solid line)
i) Elliptical : long and short span
ii)Trapezoid: long side, short side and height of trapezoid
iii) Square : 2 sides

The height of the mound are measured at 4-5point for average. (see broken line)

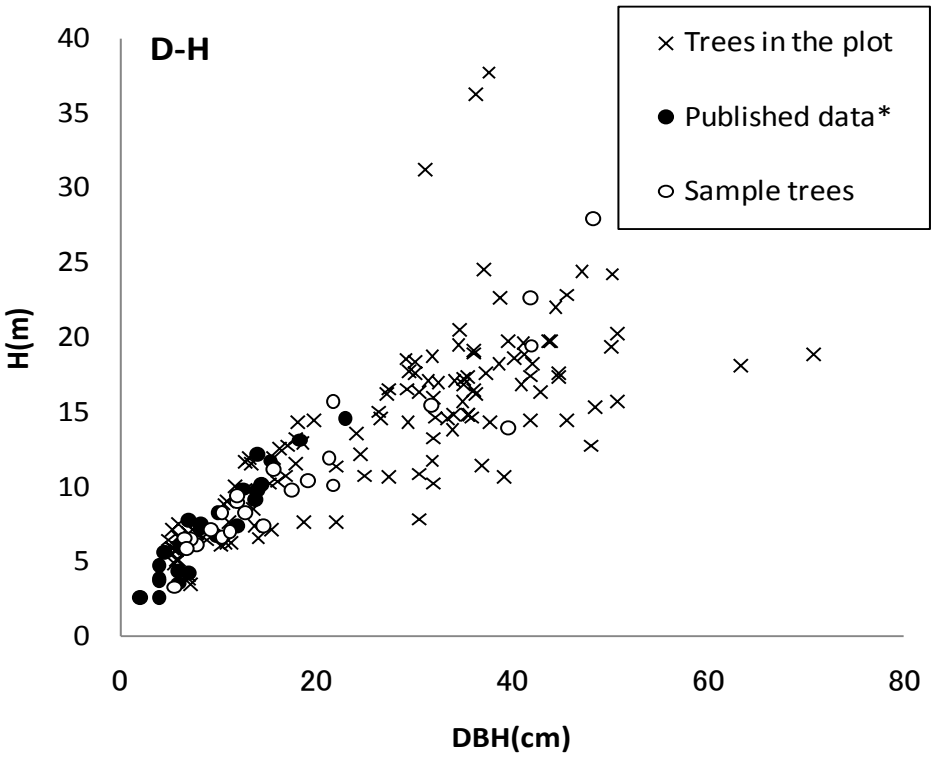
(9) Make 1m×1m sample plots on the mound.

The number of sample plots depends on the size of mound.

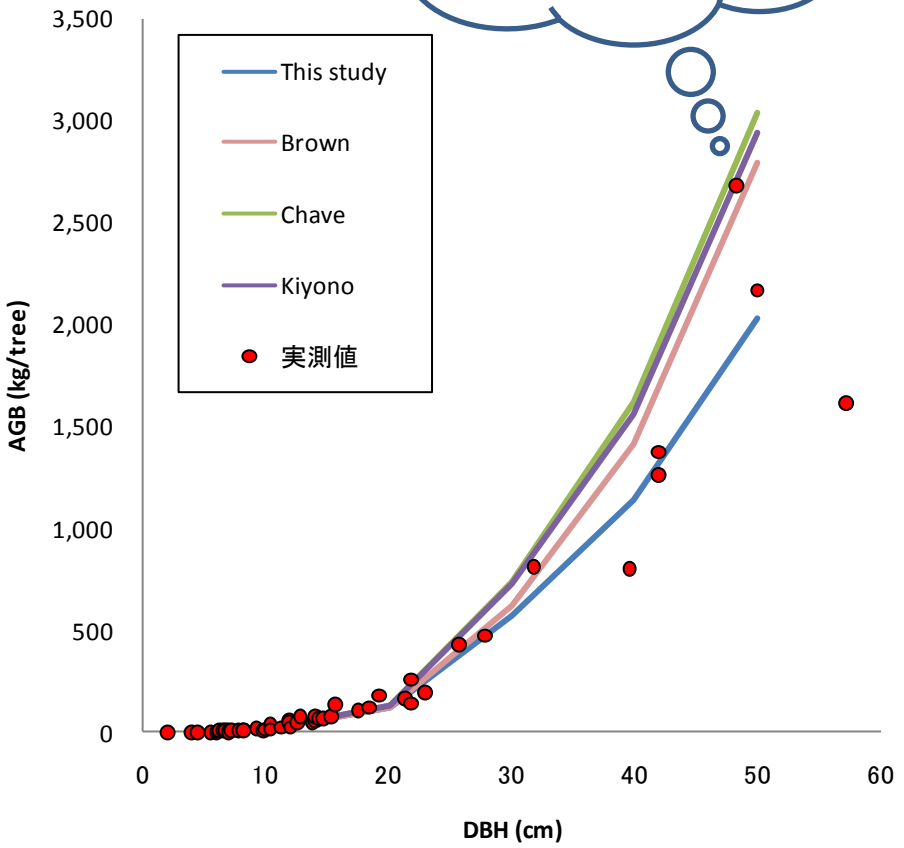
Measure the height of sample plots.

Allometry equations for deciduous forest tree biomass in Indochina

インドシナ落葉林木のアロメトリ式



Generic equations make overestimates
汎用式では過大推定

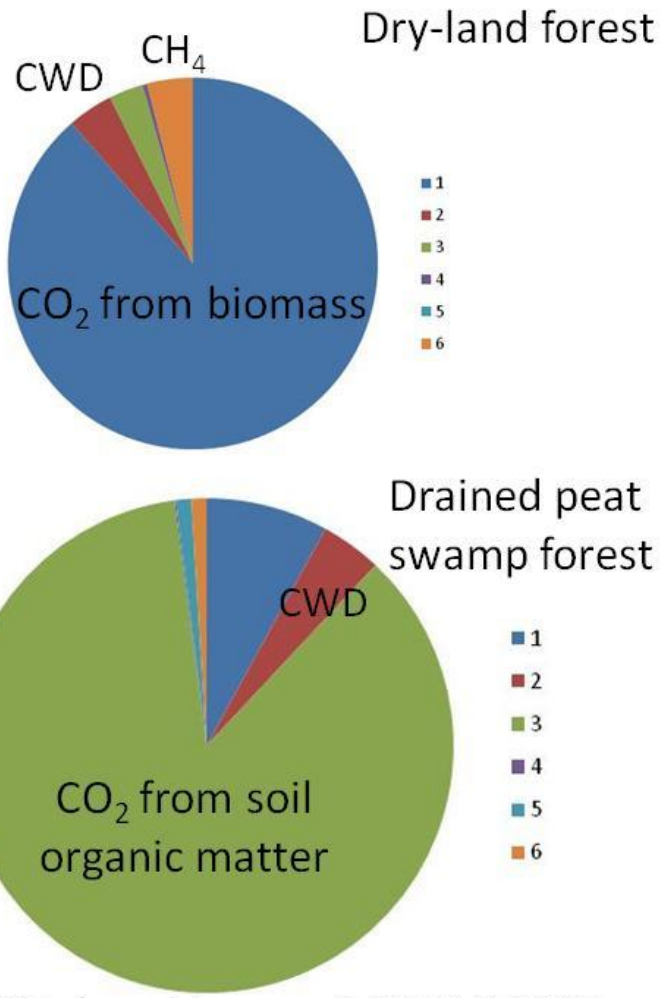


Monda et al. (unpublished)

重要排出経路を優先する

Importance assessment

Modified from Kiyono et al. (2011)



1:CO_2 from biomass, 2:CWD, 3:SOM, 4:N_2O biomass burning, 5:SOM mineralization, 6:CH_4 biomass burning

	Subcategory	Estimates with the project data (Mg-CO_2 ha^{-1} $10\ y^{-1}$)	Importance
Dry land forest in the test-site in Cambodia			
CO_2	Biomass (aboveground and belowground)	377 (108-517)	89%
CO_2	Deadwood, litter	16 (0-19)	4%
CO_2	SOM	13 (5-22)	3%
N_2O	Fire	2 (0.3-3)	0.4%
N_2O	SOM mineralization	0	0%
CH_4	Fire	17 (3-31)	4%
	Total	425 (116-592)	100%
Drained peat swamp forest in the test-site in Indonesia			
CO_2	Biomass (aboveground and belowground)	60 (39-83)	8%
CO_2	Deadwood, litter	37 (29-43)	4%
CO_2	SOM	762	86%
N_2O	Fire	1 (1-1)	0.1%
N_2O	SOM mineralization	9 (0-37)	1%
CH_4	Fire	9 (7-11)	1%
	Total	878 (838-937)	100%

Conclusions

- The nationwide forest carbon stock has rarely been monitored in tropical countries. However, in wider regions covered by permanent sampling plots (PSPs), we can expect a reasonably accurate estimation of carbon stock and its trends by using the PSP data with equations for converting carbon stock and moderately classifying forest types via satellite imagery.長期調査プロットが広域配置されていれば衛星リモセンで森林炭素を推定できる
- As a feasibility study for applying a simplified method to estimate CO_2 emissions from deforestation and forest degradation in tropical forests, we estimated the nationwide forest tree biomass carbon stock in Cambodia.カンボジアで始めた
- By repeating this calculation, we could monitor the trend of forest carbon stock on a national scale.繰り返し計測すればトレンドが分かる
- 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).技術的課題はリモセンの自動計測、正確で簡易な地上調査
- For the issue of seasonality in a seasonal forest, we have tried standardization of satellite images with algorithm for reducing the effect of seasonality.. For GBM, we have selected biomes important and less data and devised allometry equations specific to them.季節性の課題については季節の影響を減らす画像処理に取り組んでいる。地上調査では重要であるにもかかわらずデータのないバイオーム（生物群系）のアロメトリ式を開発している
- A “Cook-book - How to measure and monitor forest carbon” is under preparation by FFPRI and will compile our latest knowledge in forest carbon measurement and monitoring.森林総研の技術解説書には森林炭素の計測とモニタリングの最新の知見が収録される予定

Thank you for your attention.

ご清聴ありがとうございました。

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