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C A D A F Project

CArbon **D**ynamics of **A**mazonian **F**orests

May 2010 to May 2014

Japan – Brazil Partnership Program – JBPP

SATREPS

Consortium: FFPRI, IIS – UT, INPA and INPE

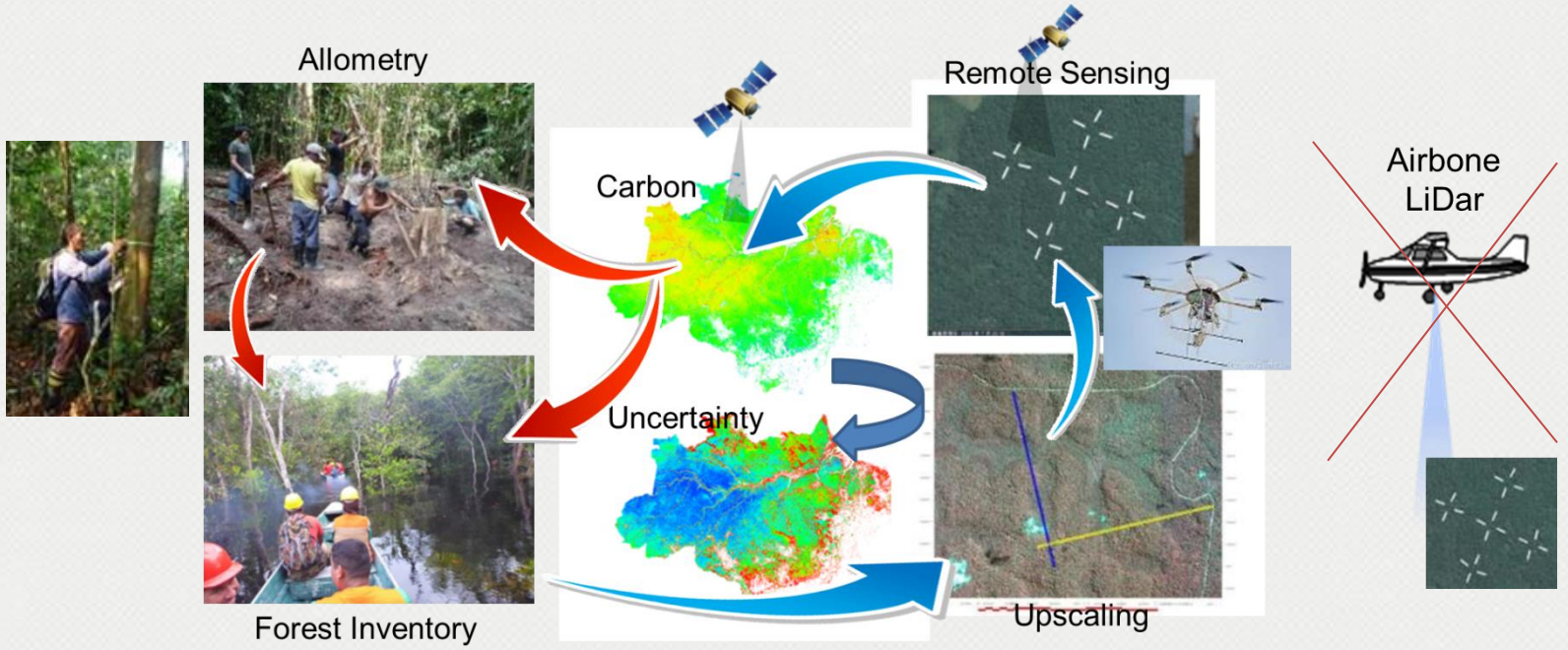
by

Moriyoshi Ishizuka & Niro Higuchi

Carbon dynamics of Amazonian forests
SATREPS Project （CADAF 2010.5-2014.5)

Project Purpose

To develop an evaluation technique on a large-scale carbon dynamics of Brazilian Amazon forests.



Integrating ground-based forest carbon Inventory and remote-sensing

PROJETOCADAF
CARBON DYNAMICS OF AMAZONIAN FOREST

SATREPS

Science and Technology Research Partnership for Sustainable Development

39 countries 78 projects (3 to 5 years : 2008 –)

Japan Science and Technology Agency (JST)		Japan International Cooperation Agency (JICA)
Science and technology • Promoting science and technology, encouraging innovation		**International cooperation** • ODA, development assistance
Meeting global needs • Resolving global issues and contributing to the science and technology community		**Meeting local needs** • Capacity development to address issues emerging as local needs in developing countries
Japan's capabilities • World-leading technology, proven research capacity • Soft power		**Developing countries' capabilities** • Direct experience, knowledge, and data needed for research on global issues • Potential to contribute to the global economy through new markets and industries

Background

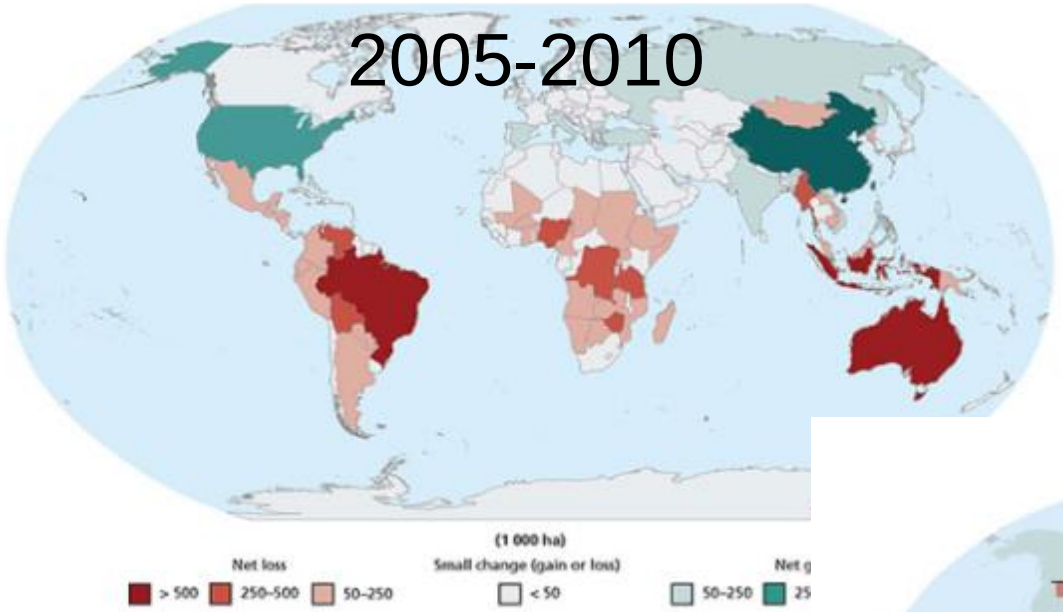
Deforestation and forest degradation are the second leading cause of global warming. Among others, forests in Amazon store world largest amount of carbon, and deforestation of Amazonian forests became one of the prime global Issues.

Since 2005, Parties to the UNFCCC have been negotiating a mechanism known as REDD—Reducing Emissions from Deforestation and Degradation—to provide an incentive for developing countries to prevent deforestation, which has been expanded to REDD+ that involves the conservation or enhancement of forest carbon stocks through sustainable forest management.

The REDD+ scheme is realized with accurate quantitative evaluation of carbon emission reduction achieved by the prevention of deforestation and forest degradation. To proceed REDD+, therefore, the development of the precise methodologies to evaluate carbon stock change of forests is urged.

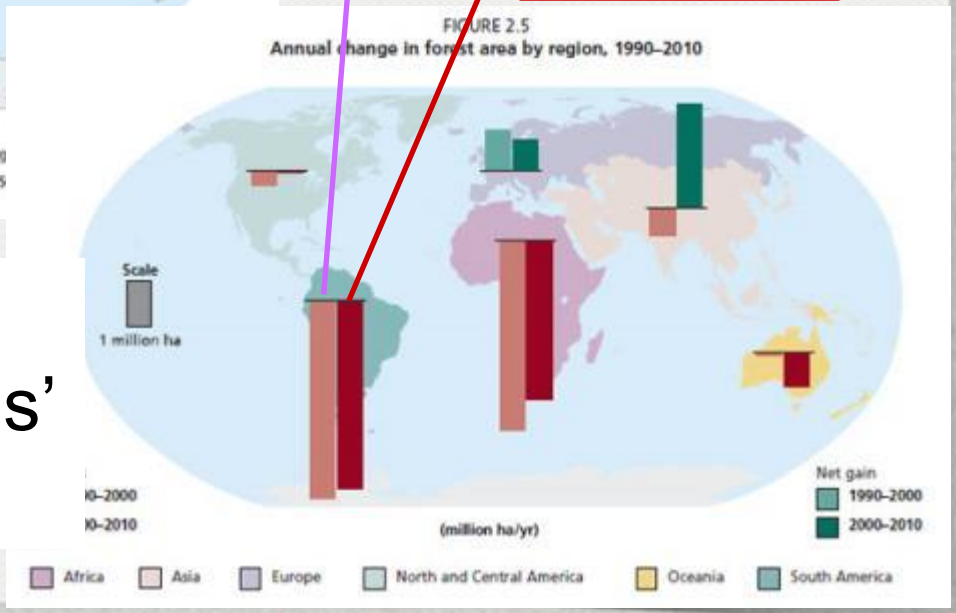
Background: Global Needs

Annual changes in forest area by country



1990-2000

2000-2010



Brazil's Amazon moist forest is one of the worlds' most threatened forests

Background: Meeting local needs

Brazilian government's target for reducing deforestation rates

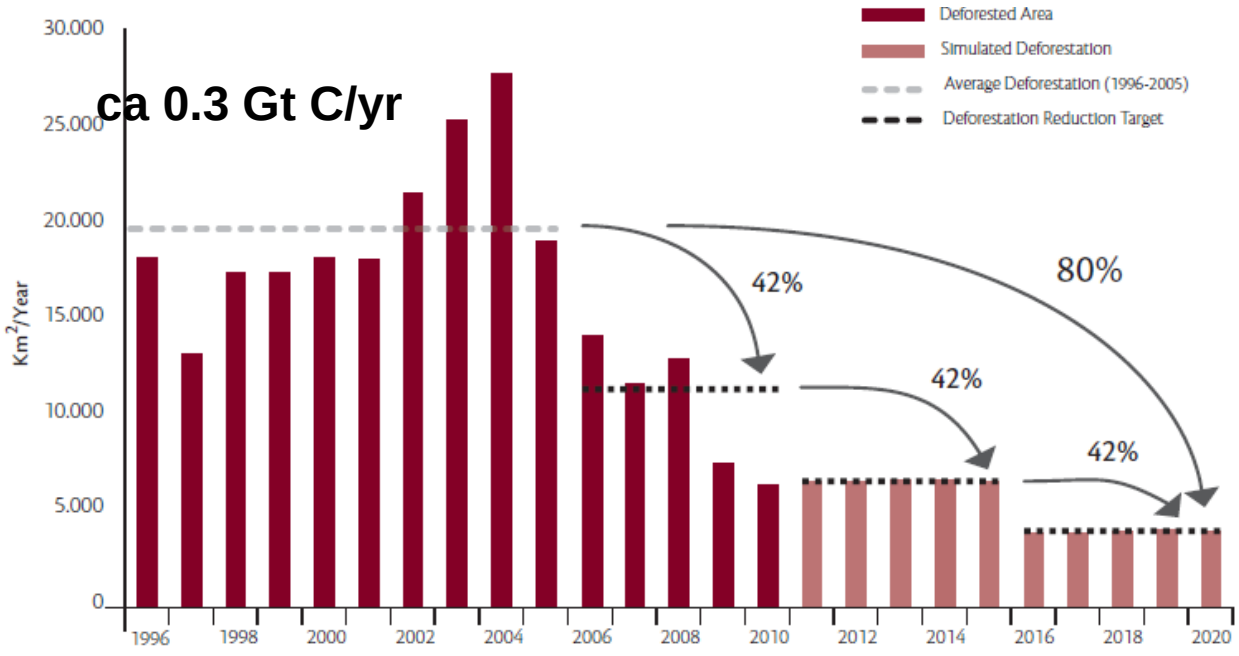


Figure 4. Brazilian government's target for reducing deforestation rates by 42% in each five-year period up to 2020, according to the voluntary commitment made in Copenhagen. The baseline of 1996-2005 will be revised every ten years. Source: MMA (2009).

REDD+ has potential to provide such incentives.

Background: Developing countries capabilities

CADAF aims to contribute for developing REDD+ MRV (Measurement, Reporting and Verification) system for Brazilian Amazon

MRV for REDD+

Methodological guidance in SBSTA31 (COP15, 2009) requests

- to use Latest **IPCC guidelines**
- to **establish robust and transparent national forest monitoring systems** are requested.
- to use **a combination of remote sensing and ground-based forest carbon inventory** for estimating emissions and removals.

CADAF Project: **Purpose and Outputs**

Project Purpose

An evaluation technique on a large-scale carbon dynamics of Brazilian Amazon forests is developed.

Expected Outputs

1. A continuous forest inventory (CFI) system to survey carbon dynamics in central Amazon is established.

2. A relationship between forest types and carbon dynamics of primary and selectively logged forest is identified.

3. Carbon dynamics maps are developed, using the data from CFI system and remote-sensing information.

Implementation structure

Background (Global Issue) :
Carbon emission of Amazon forests, REDD+

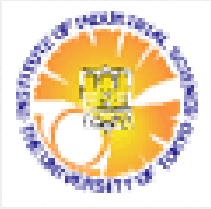
Establishment of Forest Inventory System

Monitoring Deforestation & Forest Degradation

Representative Organization

Linking Forest Inventory & Remote-sensing

Mapping Carbon Stock



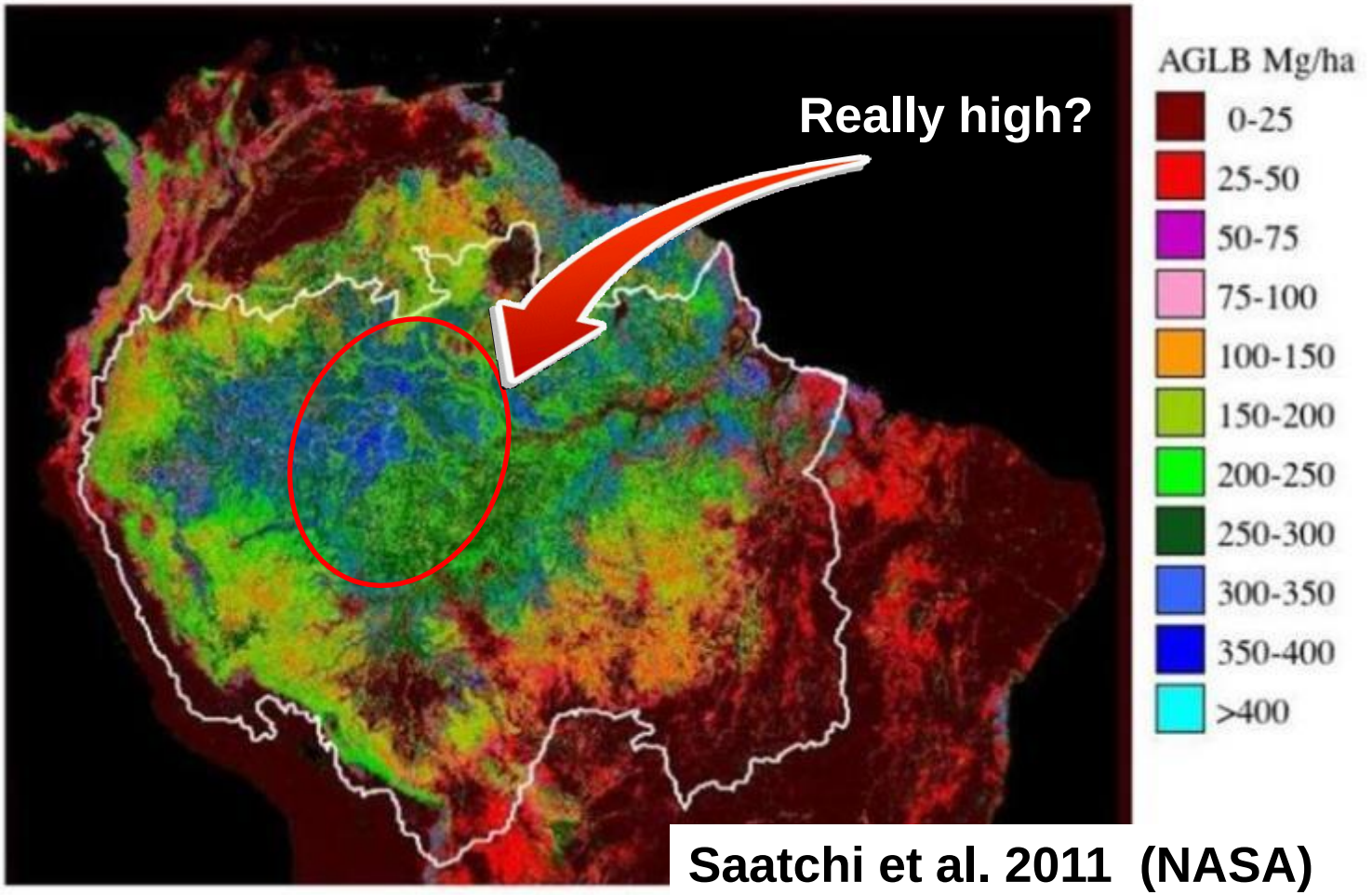
Forestry and Forest Products Research Institute, Japan

Institute of Industrial Science, the University of Tokyo

Evaluation techniques for large-scale carbon dynamics in Amazon forests

Contribution to REDD+ and sustainable forest management of Amazon forests

CADAF Project: What is new?

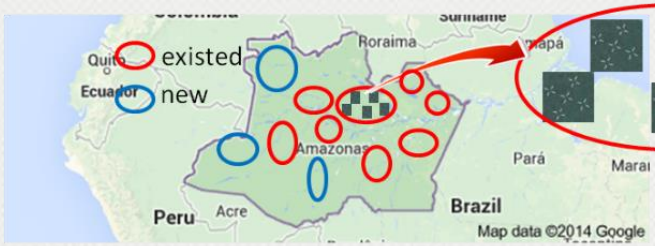


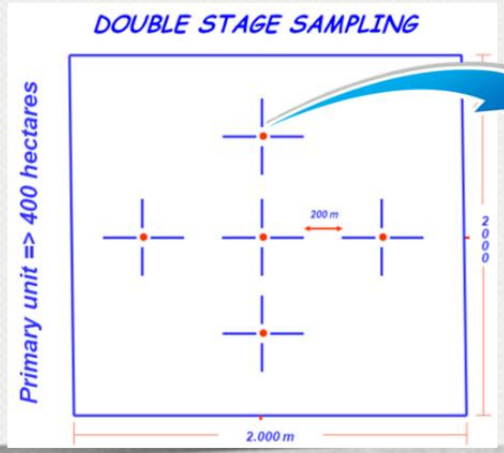
Saatchi et al. 2011 (NASA)

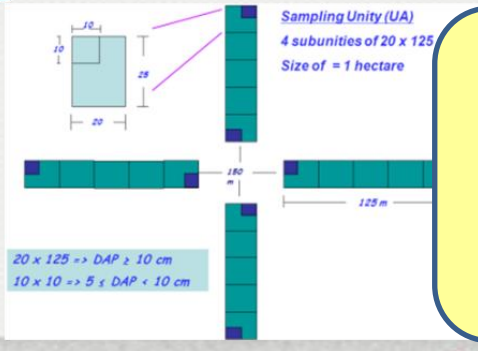
Fig. 1 Loc
plots scattered across the basin.

plots scattered across the basin.

Establishment of Carbon Inventory System
Continuous Forest Inventory (CFI)







3 new sites 351 plots (1st measurement)
8 existing sites 861 plots (2nd measurement)
Total 1,212 plots

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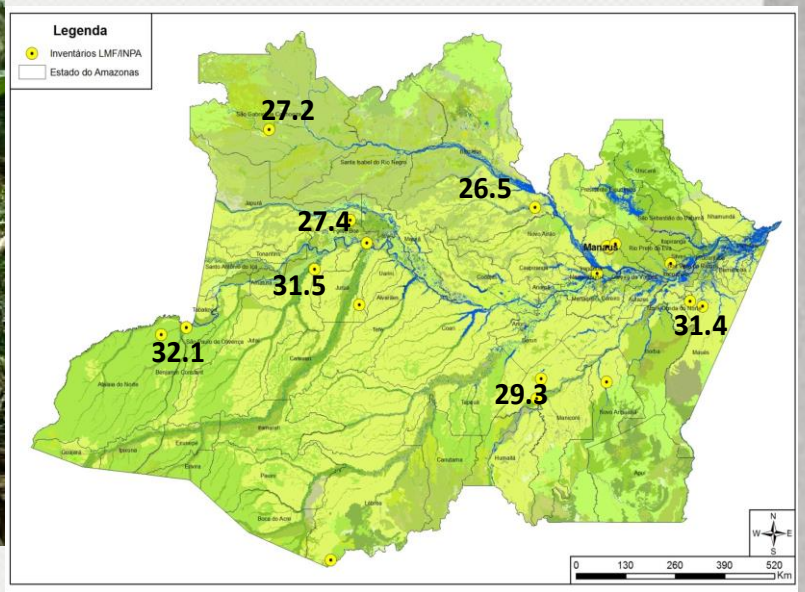
Establishment of Carbon Inventory System
Continuous Forest Inventory (CFI)

Measuring *H*dom



Spatial distribution of *H*dom

***H*dom** (≈canopy height) is the dominant height of fallen trees which defined as the average height of the uppermost quintile in *DBH* class

*H*dom is used for tree biomass equation (allometry) and forest biomass estimation from satellite data >>>

Development of a Pan-Amazonian Allometry

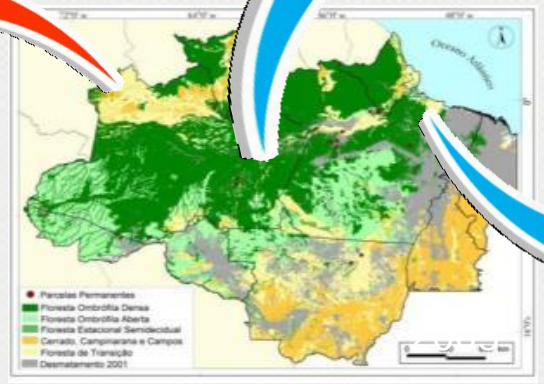
Biomass estimation equations for trees

Aboveground

Belowground

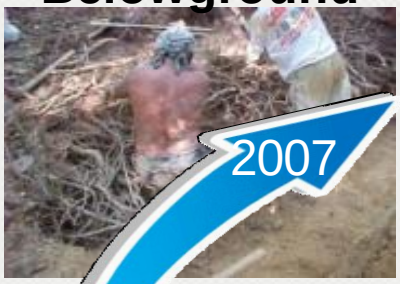
CADAF

2010



2007

Belowground

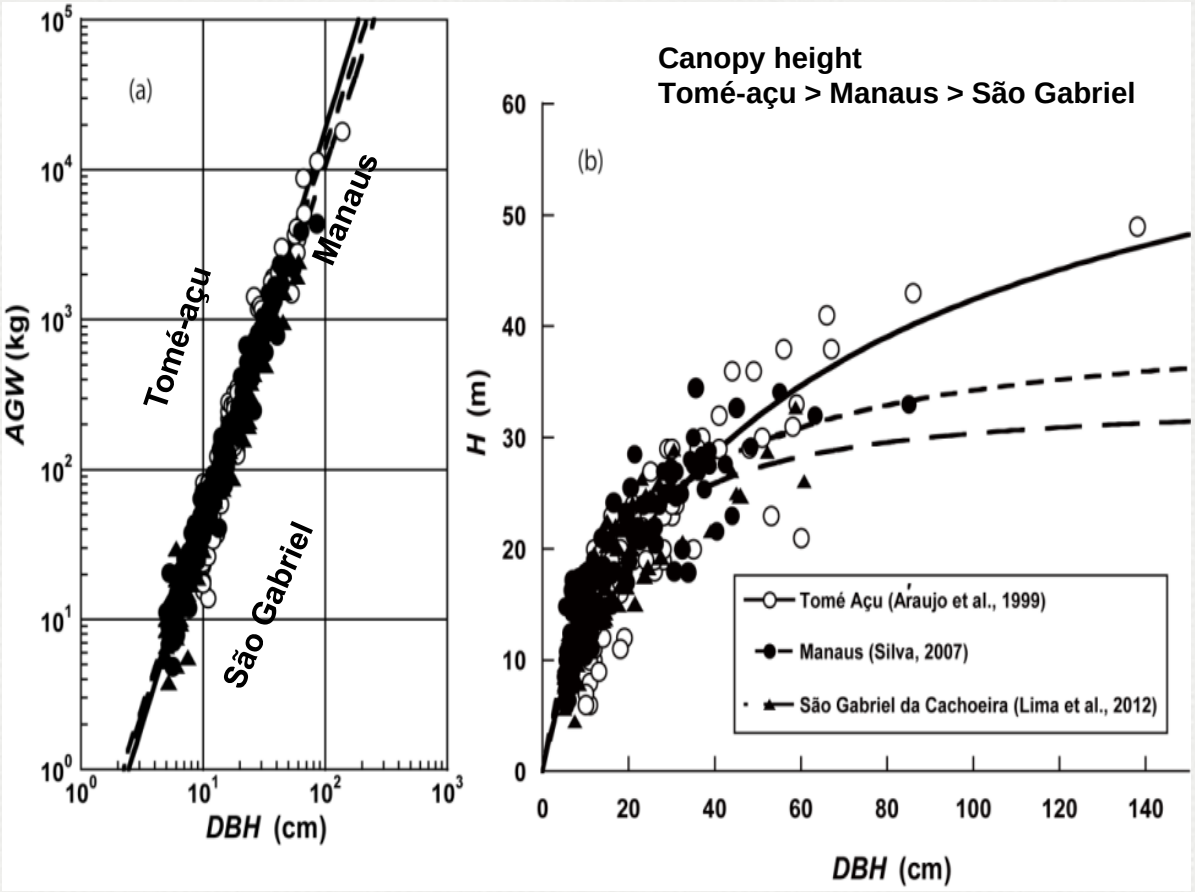


Aboveground

1999

Aboveground

Lima et al. 2012



Above-ground biomass (kg)

Lima et al. 2012

Differences in the allometric equations among three Amazonian regions were partly explained by the differences in the canopy height .

Pan-Amazonian allometric model for above-ground biomass(AGW)

Site-specific model in Manaus

$AGW = (1.20 * D^{1.92})$

Uncertainty = ±14.2 -23.03%

reduce uncertainty

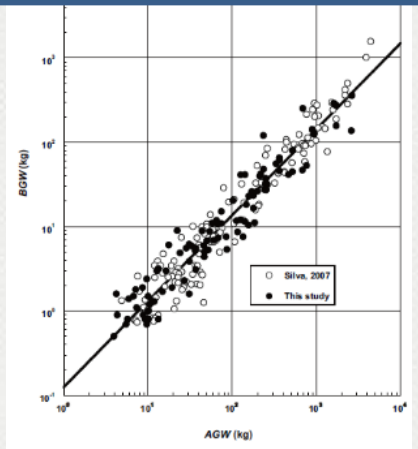
*H*dom for Manaus site

Pan-Amazonian model

$AGW = \{(1.20 * D^{1.92}) * (H_{dom}/28.5)\}$

Uncertainty = ±12.3%

Pan-Amazonian allometric model for below-ground biomass(BGW)



The common *AGW* – *BGW* relationship is expressed as an **isometric relationship**: *BGW* = 0.136*AGW*, which indicated that the fraction of *BGW* to *AGW is* **13.6**% as a constant (Lima et al. 2012).

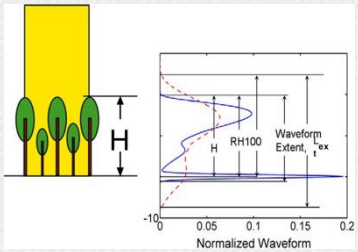
Lima JNA, Suwa R, Ribeiro HPGM, Kajimoto T, Santos J, Silva PR, Souza SAC, Barros CP, Noguchi H, Ishizuka M, Higuchi N (2012) Allometric models for estimating above- and below-ground biomass of tropical rainforests at São Gabriel da Cachoeira in upper Rio Negro, Brazilian Amazon. Forest Ecology and Management 277: 163–172

Development of Carbon Stock Map
Using the data from CFI system and remote-sensing

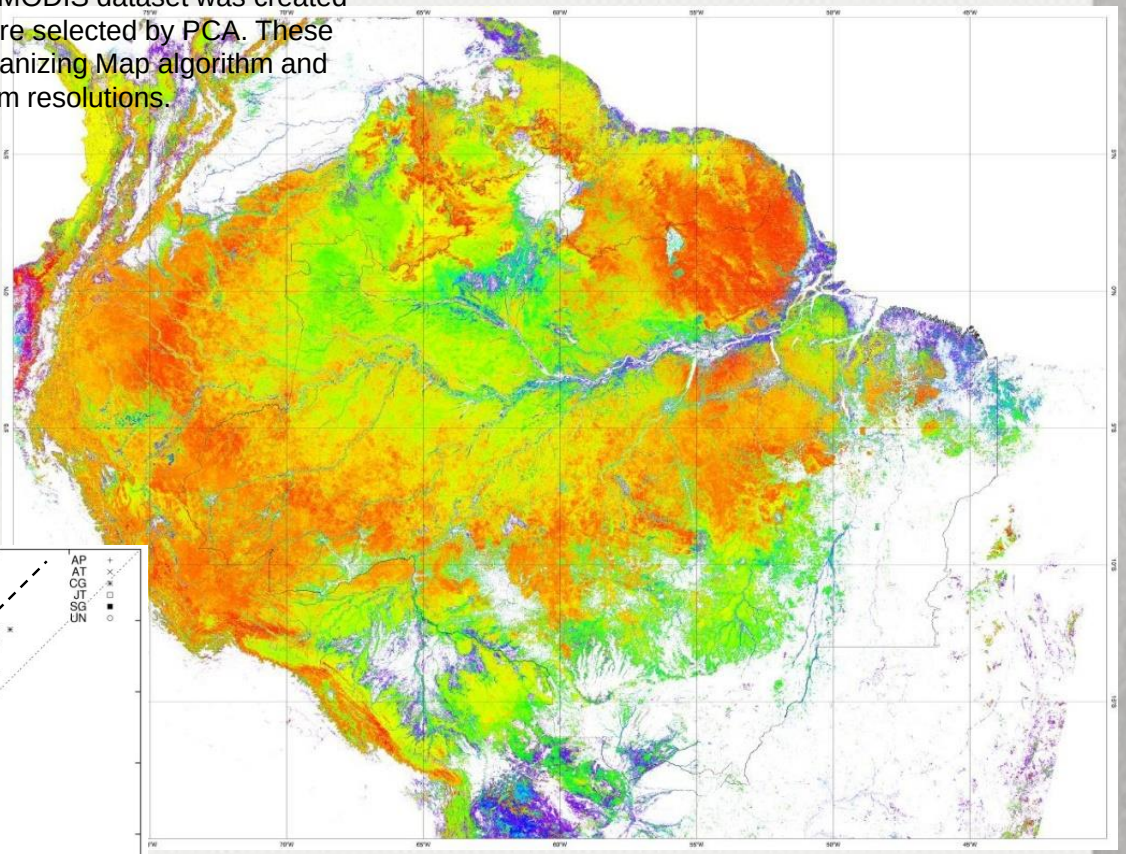
Canopy height estimation

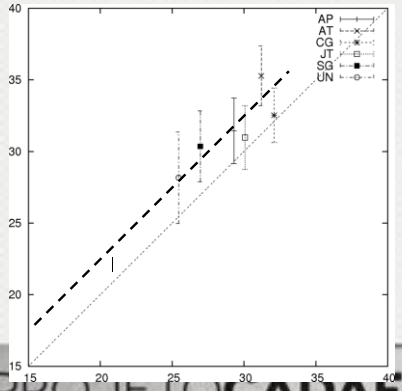
A map of estimated RH100
(Canopy height map)

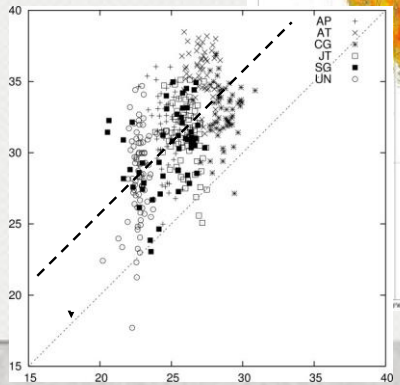
Using waveform data of ICESat/GLAS (2007) ,RH 100 and other height metrics values were calculated. Cloud-free 8-day composite MODIS dataset was created and 12 components of environmental parameters were selected by PCA. These data with training dataset were classified by Self-Organizing Map algorithm and used to scale-up GLAS data to RH100 map with 500m resolutions.



Schematic definitions of lidar-derived vegetation height(H), RH100 for one waveform on a flat terrain. (S. Lee et al. 2011)







Validation from H_{dom} (left: fallen trees; right D-H allometry)

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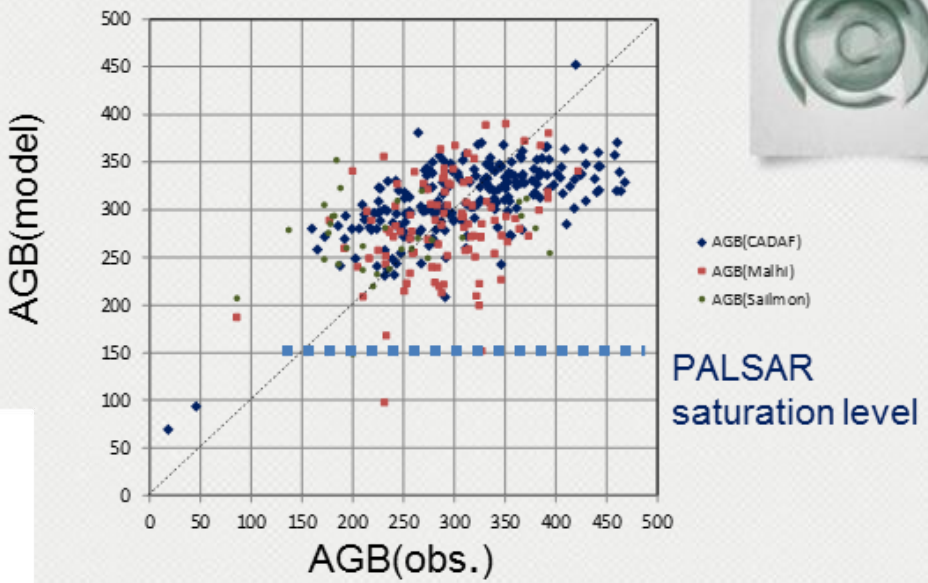
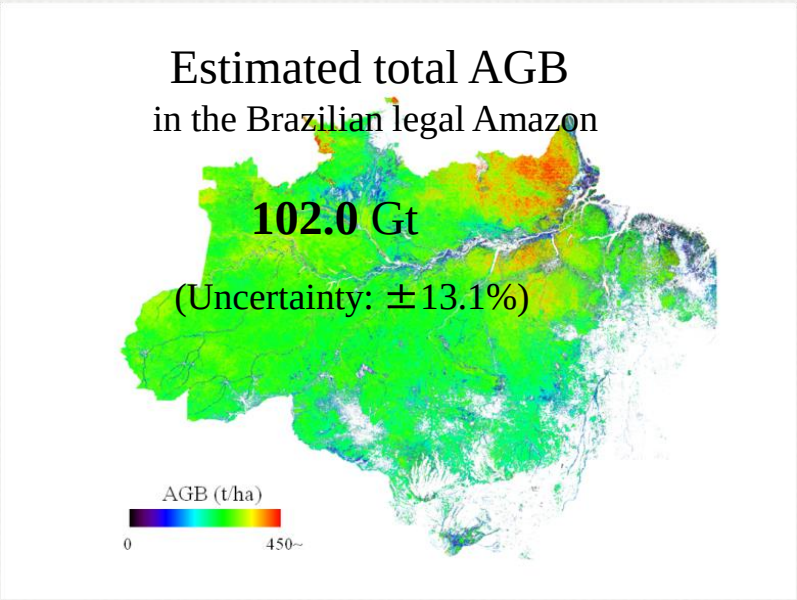
Biomass estimation modeling

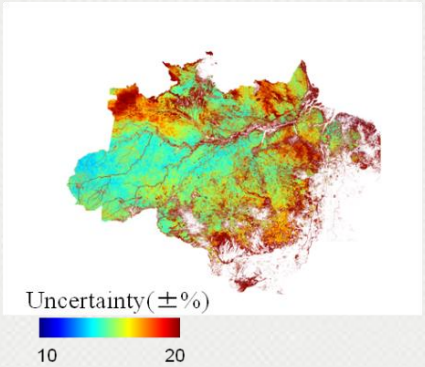
AGB modeling
- determine f(RH10,…,RH100),
- calculate ΔAGB =AGB - f(RH10,…,RH100),
- determine Δ AGB=g(x), then
  AGBmodel = f (RH10,..., RH100)+g (x)

$$AGB_{model} = f(RH10,\ldots,RH100)+g(\mathbf{x})$$



Plots data outside of the Amazonas state are added from Malhi et al. (2006) and Salimon et al. (2011).





- Sampling density affects greatly on the uncertainty of AGB estimation. To reduce uncertainty, inventory site should be set up in the regions with high uncertainty.

Today's presentations (9:00-)

#1 Continuous Forest Inventory System of Amazonas State

>>> Establishing more than 1,000 CFI plots in central Amazon

Adriano Lima

#2 Comparison of carbon allometric equation(s) in 4 sites in Amazonian forests

>>> Integrating allometric equations across the Amazon

Gabriel Ribeiro

#3 Forest biomass distribution pattern in the upper Rio Negro inferred from floristic composition and topography

>>> Reducing uncertainty of carbon stock estimation

Rempei Suwa

Today's presentations (10:30-)

#4 Stock and dynamics of forest carbon in the Amazonas state

>>> The first evaluation based on CFI plots

Francisco Higuchi

#5 Stock and dynamics of fine roots in the Amazonas state

>>> The first evaluation from the central Amazon

Adélia Sampaio and Lucas Ourique

#6 Carbon stock in Amazonian tropical forests: What do CADAF's estimates tell us?

>>> Characterize at global scale

Takuya Kajimoto

Today's presentations (14:00-)

#7 Using oxygen stable isotope to study growth pattern of hiperdominant species in Amazon forest

>>>Introducing a new technology

Flávia Durgante

#8 Recovery process of tree biomass after selective logging with moderate logging intensity in an Amazonian forest

>>>Toward the SFM system in Amazon

Tatsuya Otani and Adriano Lima

Today's presentations (15:10-)

9 Map of National Carbon Emissions Inventory
>>>Invited from INPE

Thelma Krug

#10 The use of quad-copter drone in obtaining remote sensing data for CFI >>>Toward a new technology

Carlos Celes

#11 Characteristics of spatial and vertical structure of CFI plot derived from UAV camera/laser

Takahiro Endo

#12 Carbon dynamics maps for Brazilian Amazon using the data from CFI system, remote sensing techniques and satellite images
>>>CADAF's carbon mapping

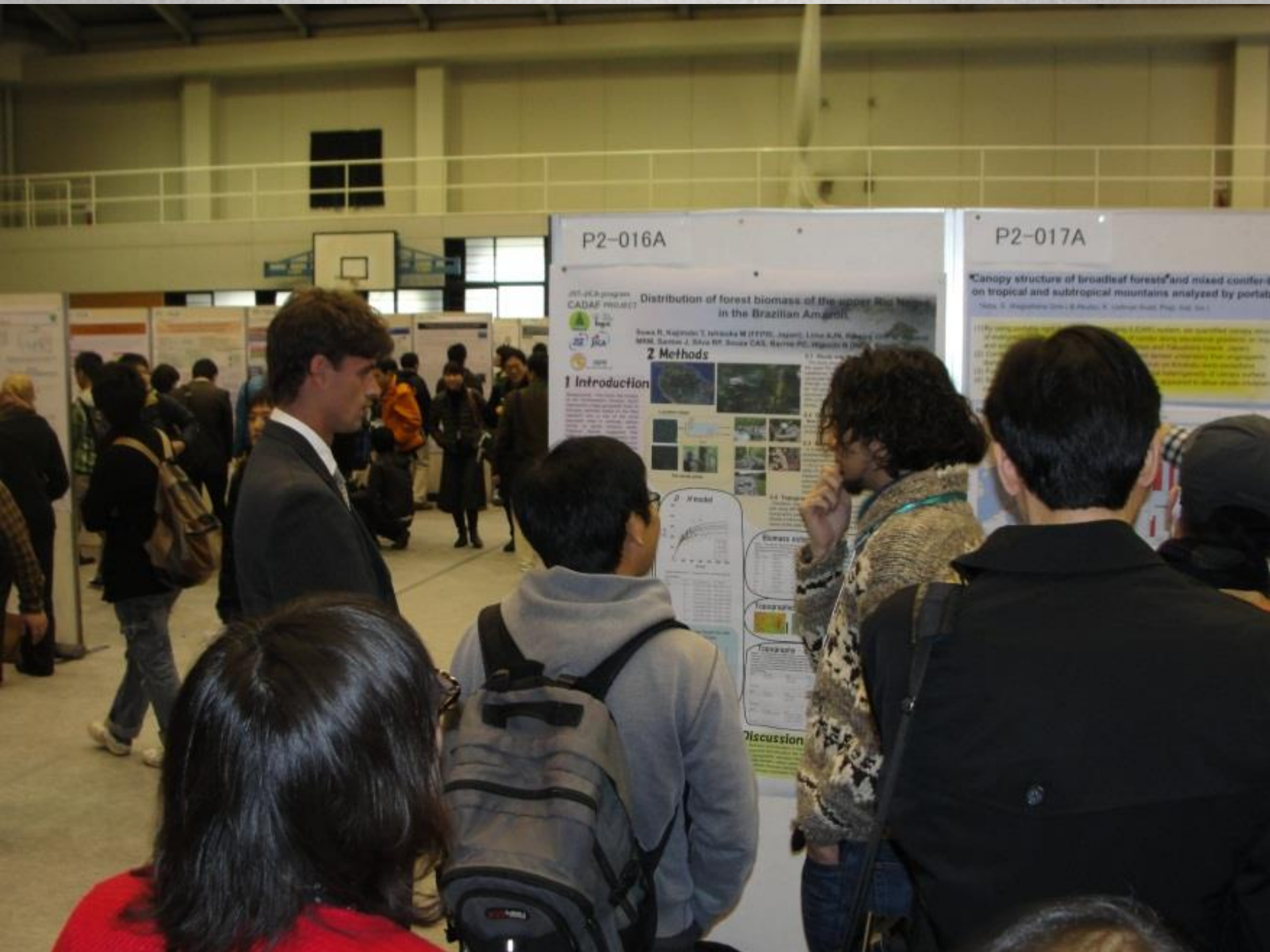
Haruo Sawada

CADAF team

Brazil	Japan
Permanent staff	**Permanent staff**
1. Niro Higuchi – INPA	Moriyoshi Ishizuka - FFPRI
2. Joaqu	
3. Moac	
4. Dalto	
5. Yosio	
6. João	
7. Egídio	
8. Alber	
9. Adria	
Tempora	
1. Rosea	
2. Franc	
3. C. Ad	
4. Carlos	
5. Márci	
6. Gabri	
7. Rosiane O. Silva - MSc student	
8. Lucas K. Ourique - MSc student	
9. Felipe S. Ramos - MSc student	

icers:
1. Milton Sakurai
2. Fernando da Silva

Technical Exchange


P2-016A
Distribution of forest biomass of the upper Rio Negro in the Brazilian Amazon
2 Methods
1 Introduction
P2-017A


JAXA
JAXA


Hdam


IX CURSO DE
MANEJO FLORESTAL
INPA
CNPq


MC.BOY
MICO BOY

Forest inventory data set (n = 2503 plots)

Sites	year	n
Before CADAF		**1272**
São Gabriel da Cachoeira	2010	100
Mil Madeireira Ltda (Itacoatiara)	2010	119
Benj.Constant and Atalaia do Norte	2011	105
Jutaí	2011	104
EMBRAPA (Rio Preto da Eva)	2011	18
Resex Capanã Grande (Manicoré)	2012	118
Resex Rio Unini	2012	136
Resex Auati-paraná	2012	130
Flona do Pau-rosa (Maués)	2013	132
Resex do Baixo Juruá	2013	123
Reserva Biol.Abufari (Baixo Purus)	2013	146
Under CADAF		**1231**

Amazonas – Site distribution