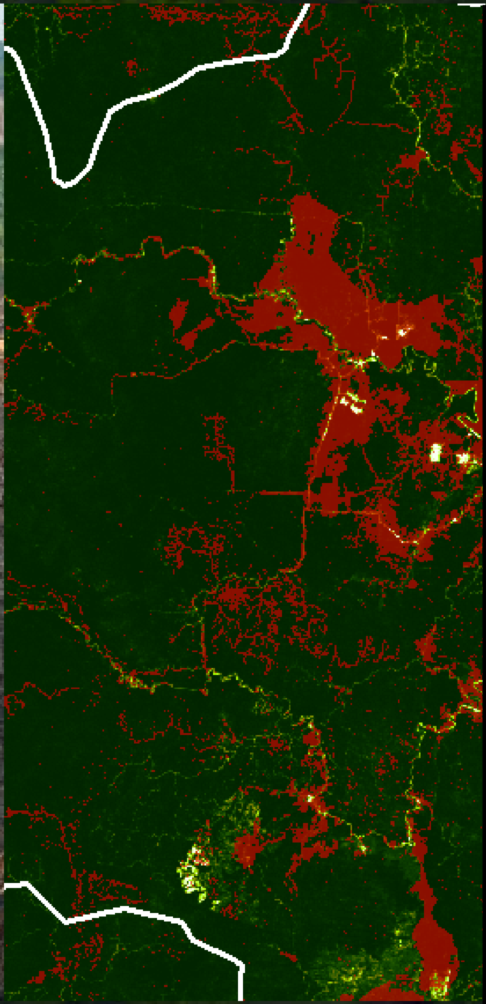
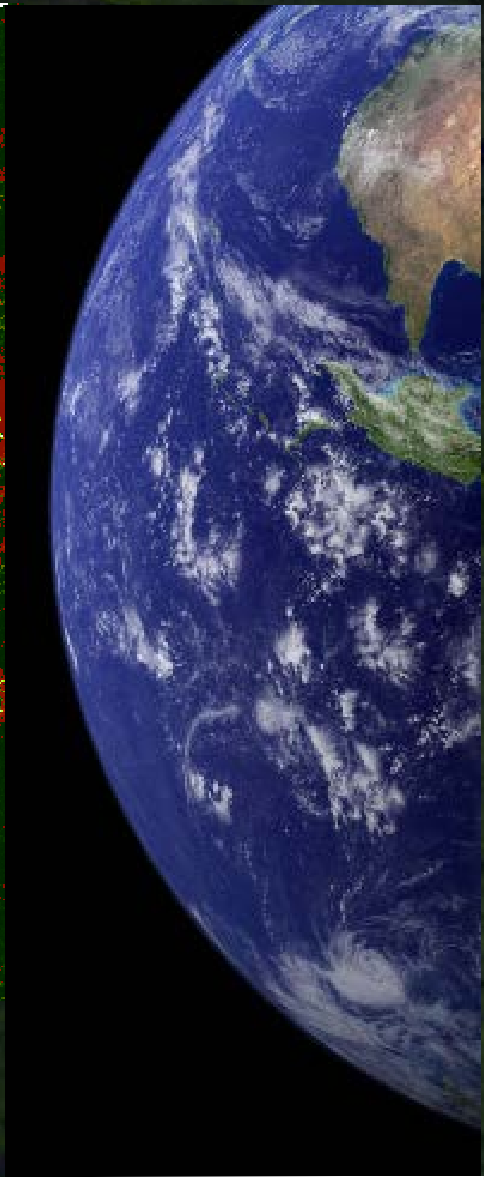
Case Study: Adapting Global Datasets for Forest Carbon Accounting in Berau





REDD Learning Exchange, November 11, 2014

Peter Ellis & Bronson Griscom

The Nature Conservancy
Protecting nature. Preserving life.

4 Steps to Adapting Global Datasets

1. Decide on pools and fluxes to include.

2. Conduct accuracy assessments.

3. Calibrate, modify, rebuild.

4. Calculate emissions and overall uncertainty.

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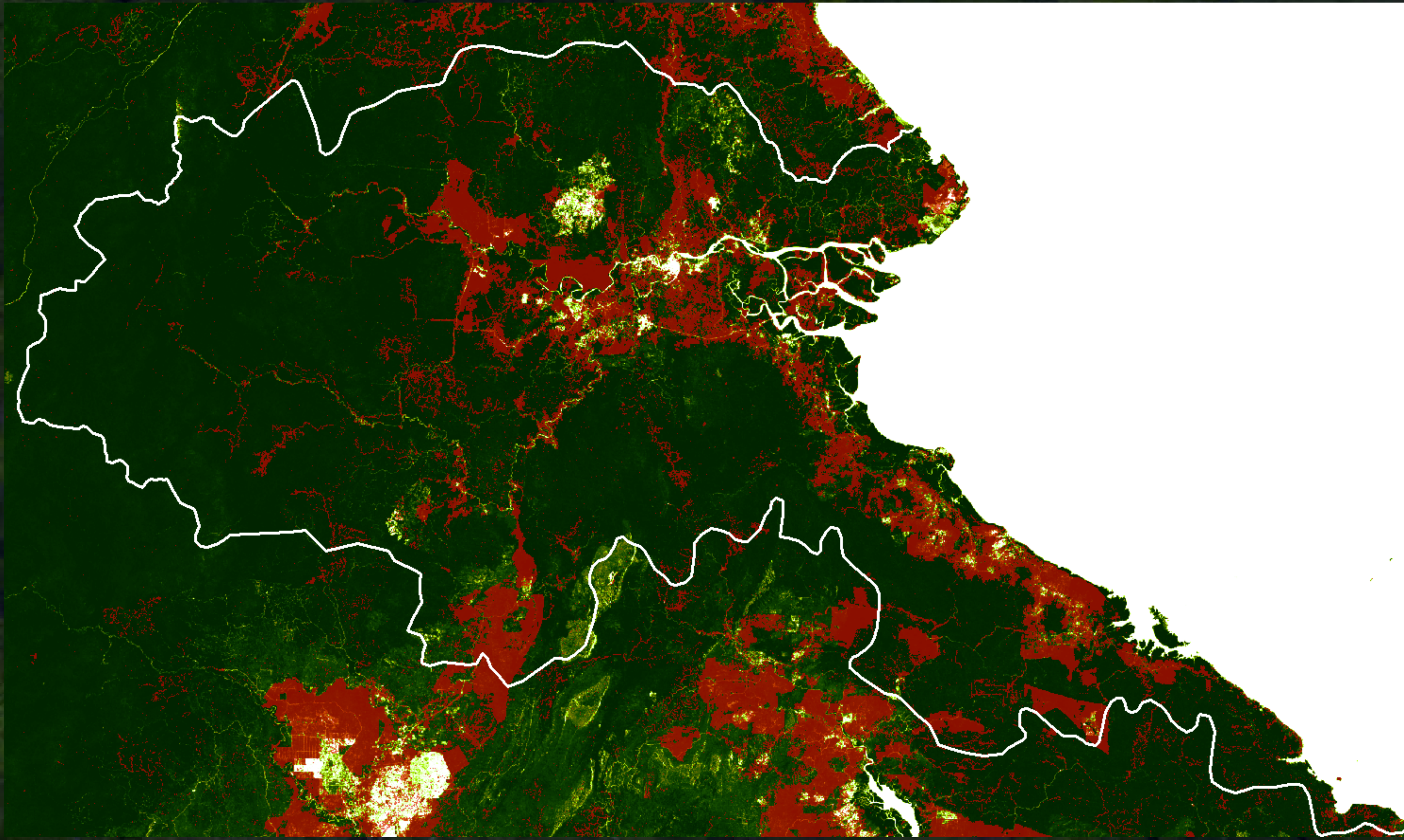
Step 2: Conduct accuracy assessments - Hansen dataset (AD)



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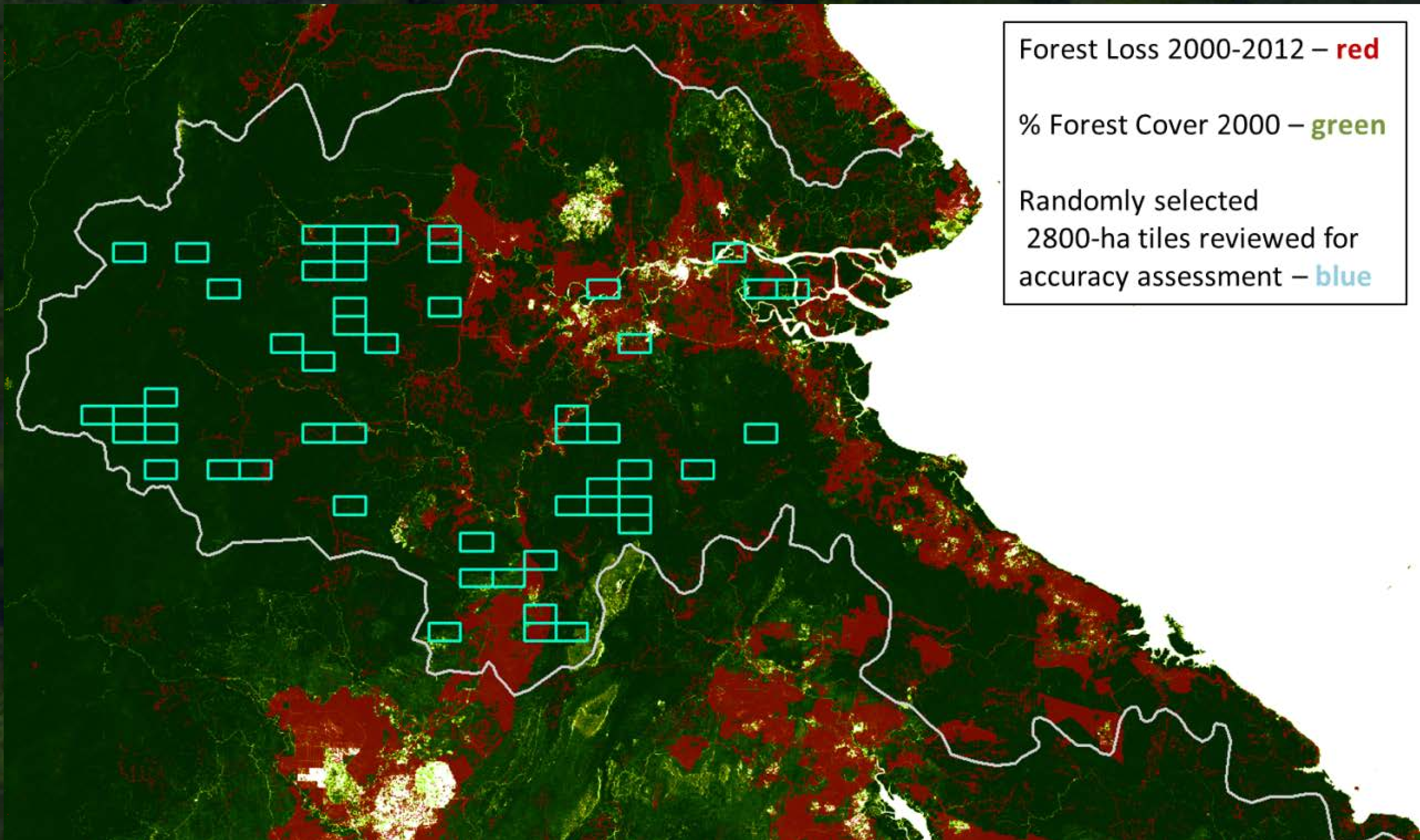

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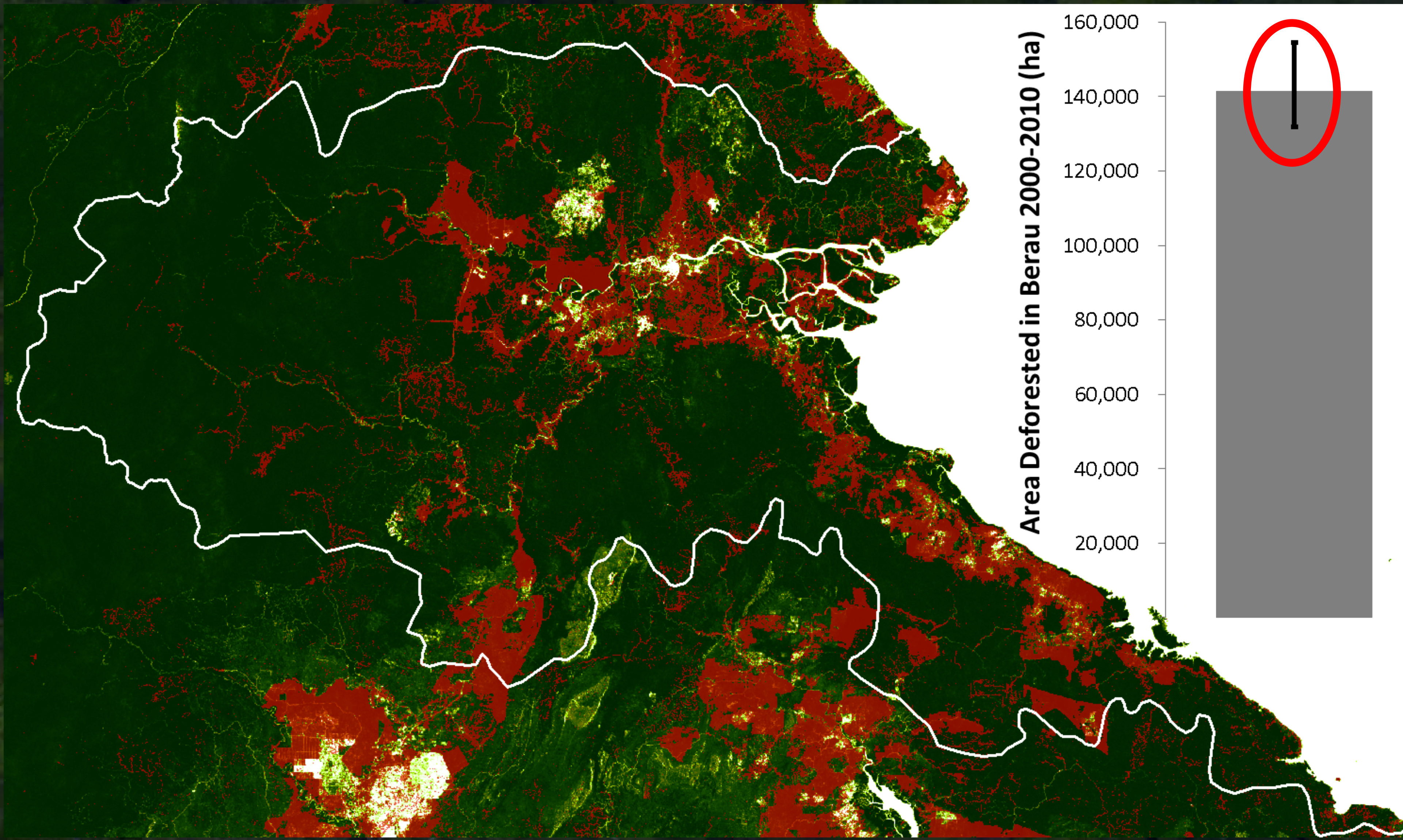

4 Steps to Adapting Global Datasets

1. Decide on pools and fluxes to include.
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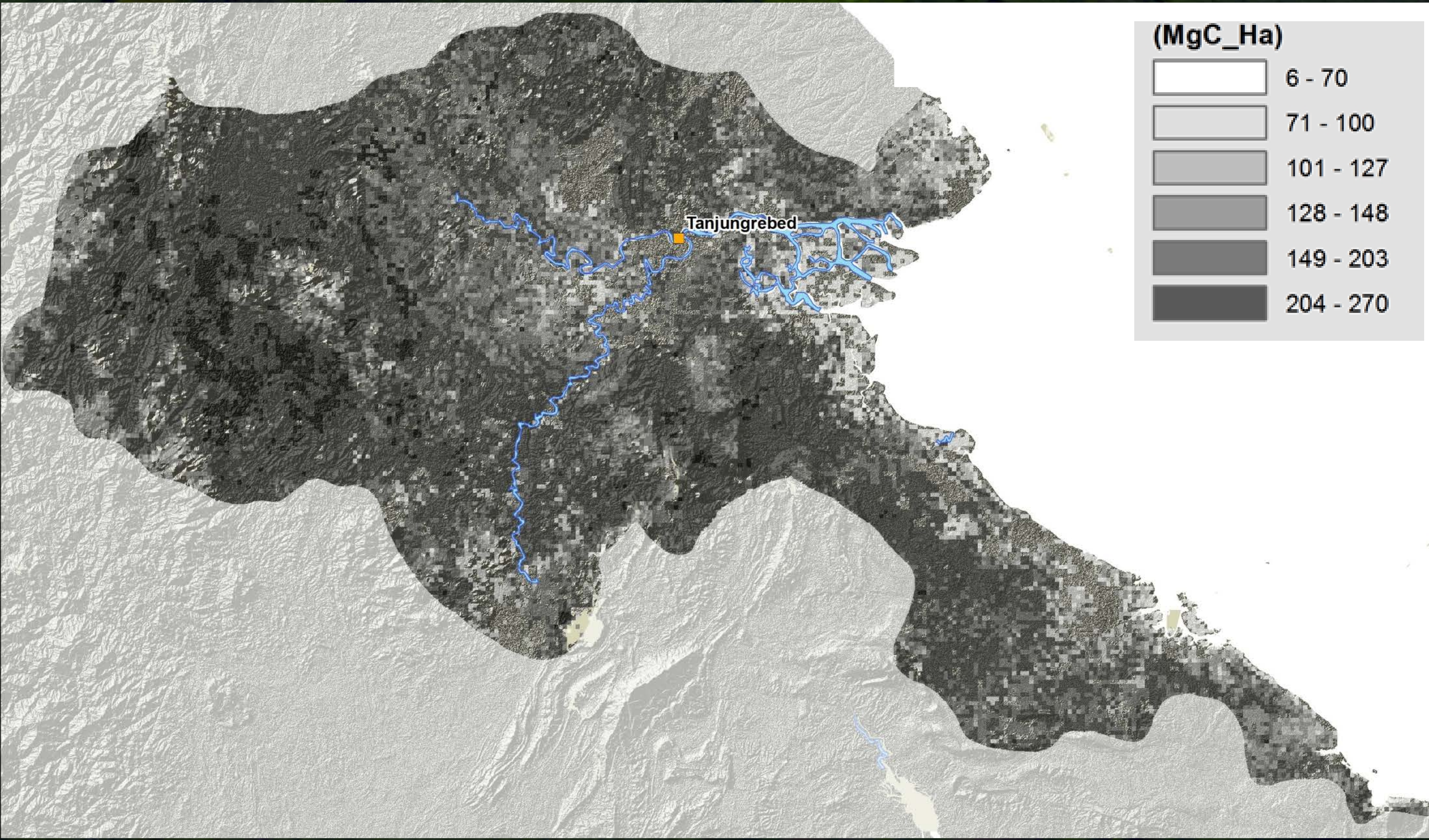
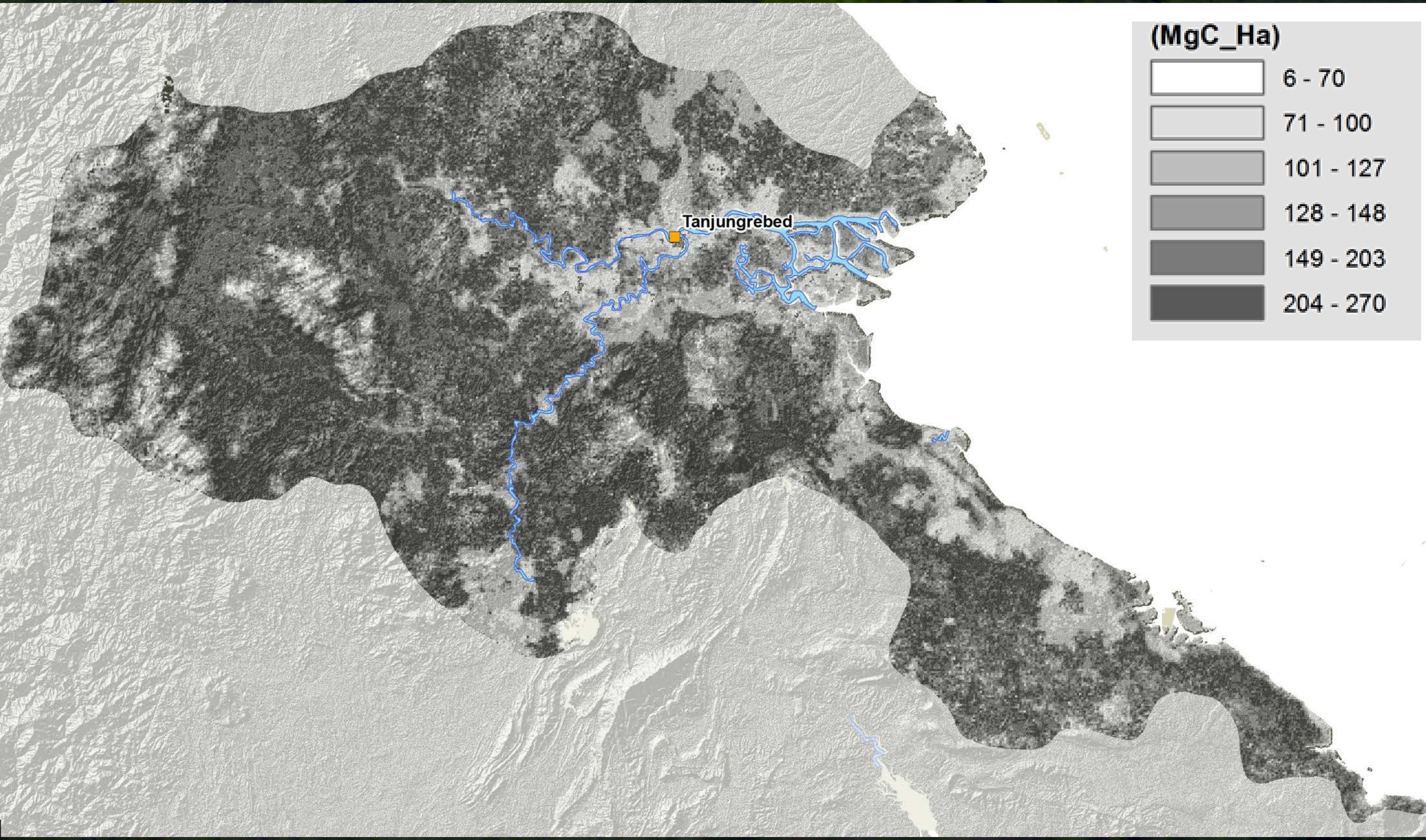
Step 3: Calibrate, modify, rebuild: biomass map (EF).

Saatchi *et al.* 2011

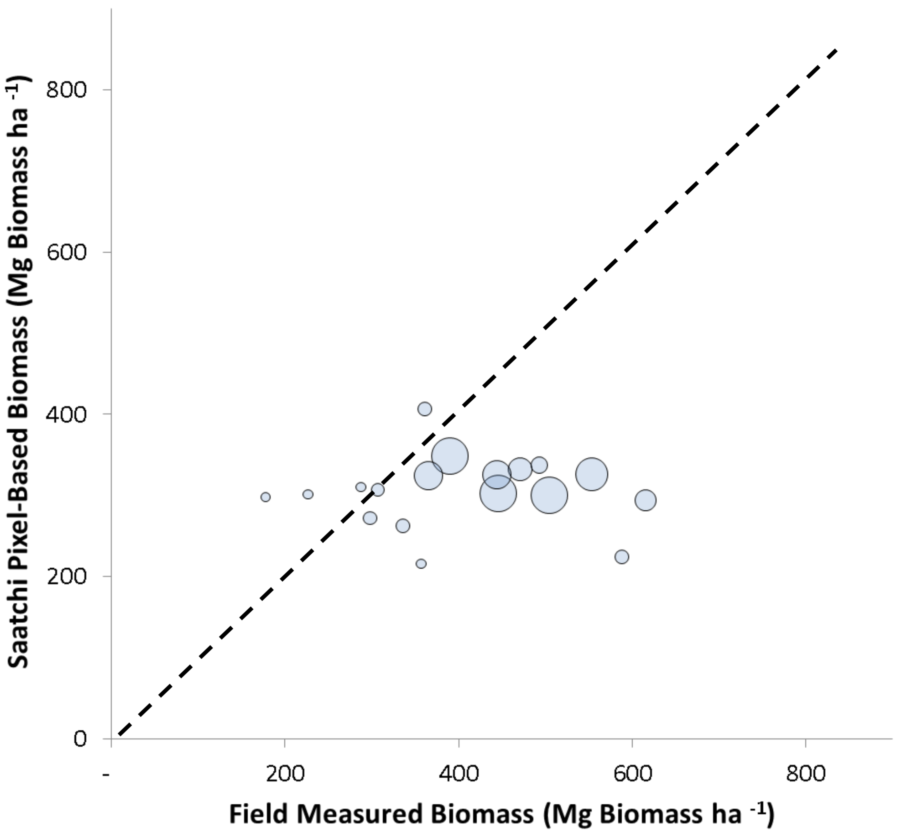


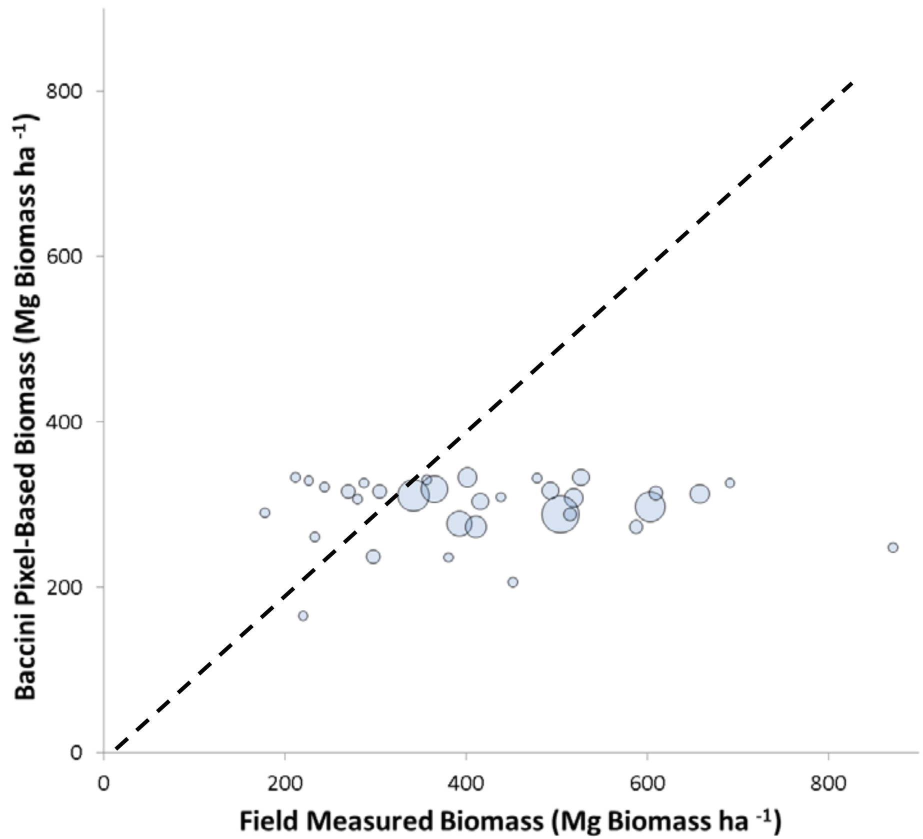
Step 3: Calibrate, modify, rebuild: biomass map.

Baccini *et al.* 2012



Step 3: Calibrate, modify, rebuild: biomass map.

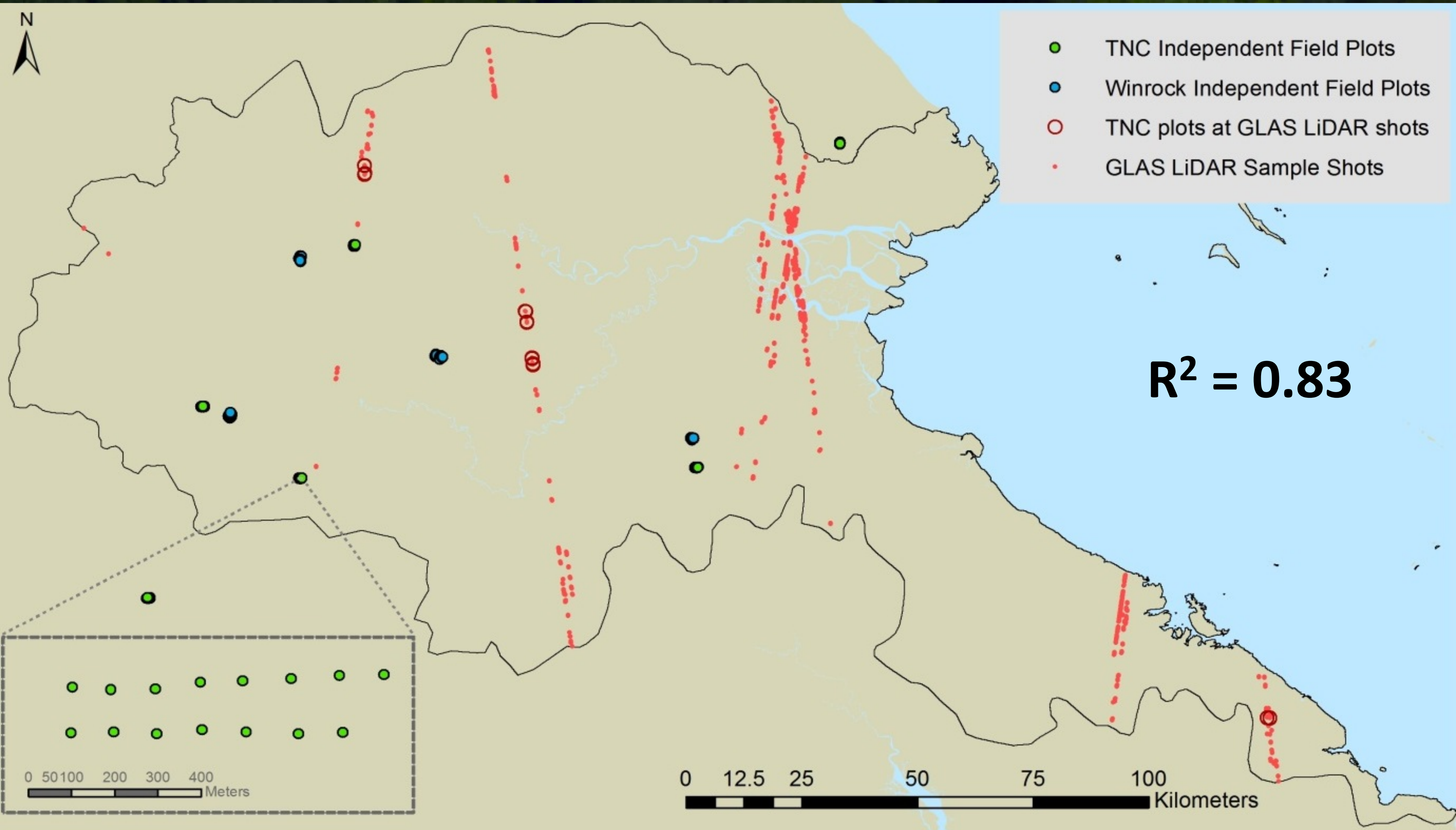




Saatchi et al. 2011

Baccini et al. 2011

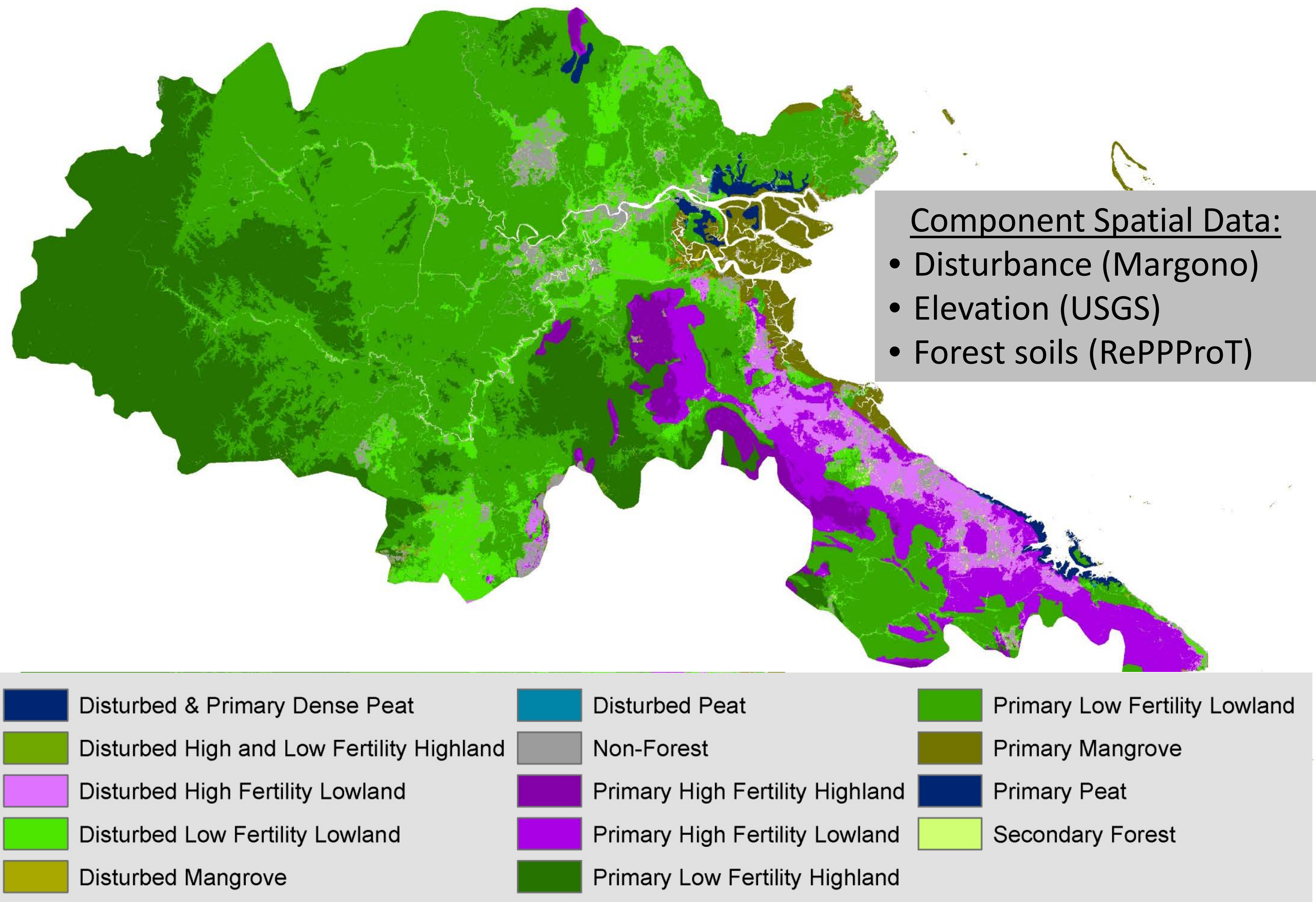
Step 3: Calibrate, modify, rebuild: biomass map.



$R^2 = 0.83$

N = 7575

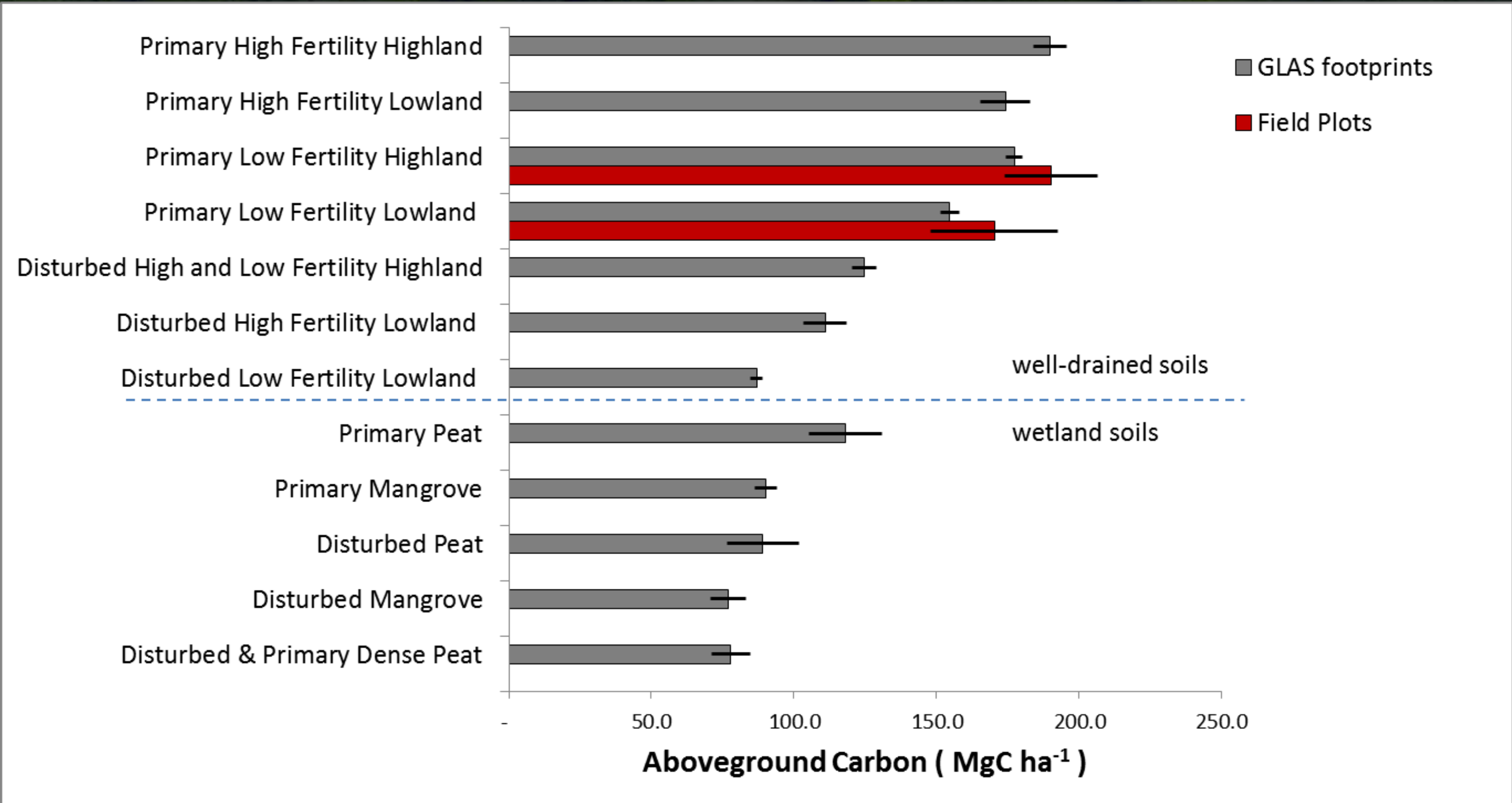
Step 3: Calibrate, modify, rebuild: biomass map.



Component Spatial Data:

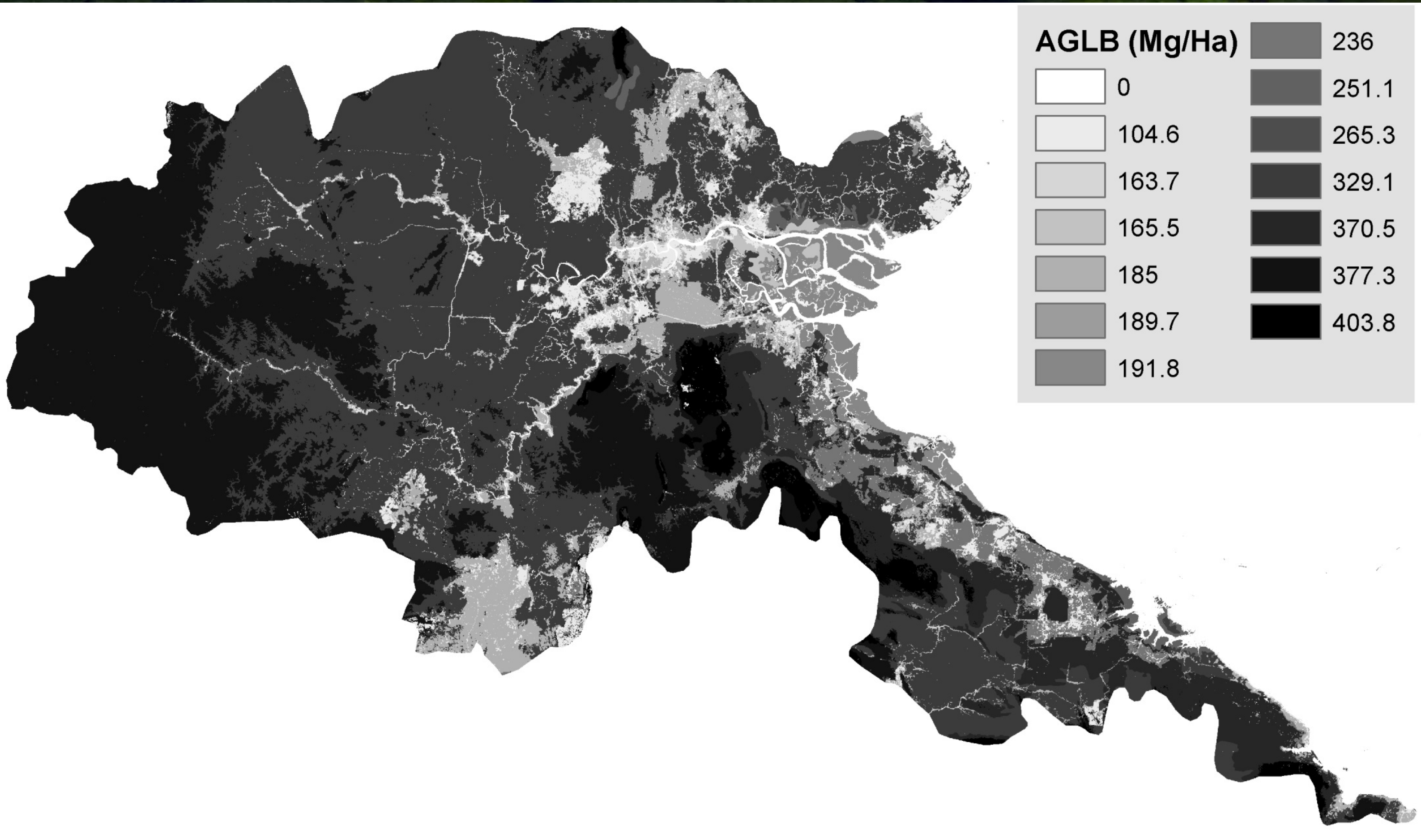
- Disturbance (Margono)
- Elevation (USGS)
- Forest soils (RePPProT)

Step 3: Calibrate, modify, rebuild: biomass map.



ANOVA F-Statistic = 311

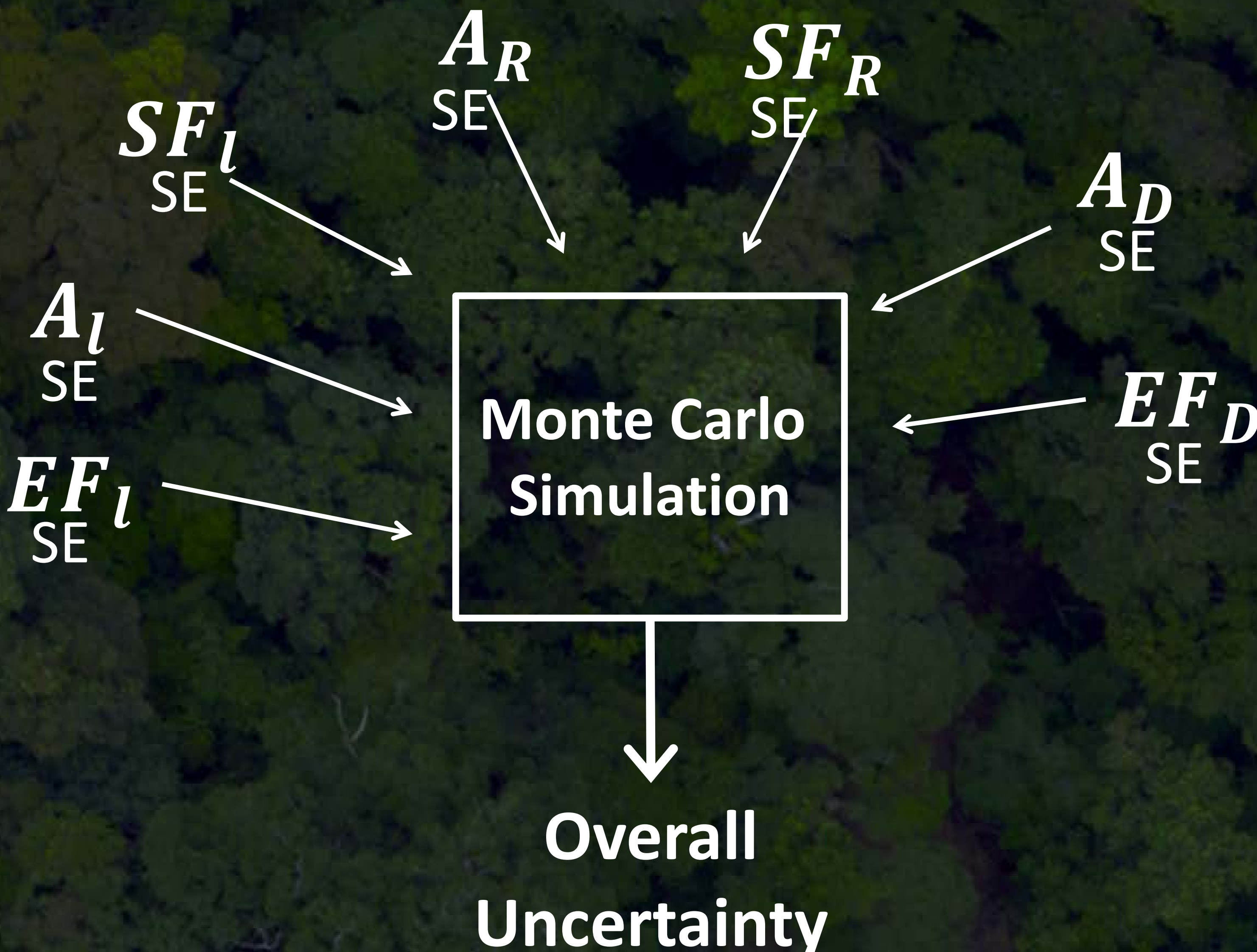
Step 3: Calibrate, modify, rebuild: <u>biomass map</u>.



4 Steps to Adapting Global Datasets

1. Decide on pools and fluxes to include.
2. Conduct accuracy assessments.
3. Calibrate, modify, rebuild.
4. Calculate emissions and overall uncertainty.

Step 4: Calculate emissions and uncertainty.

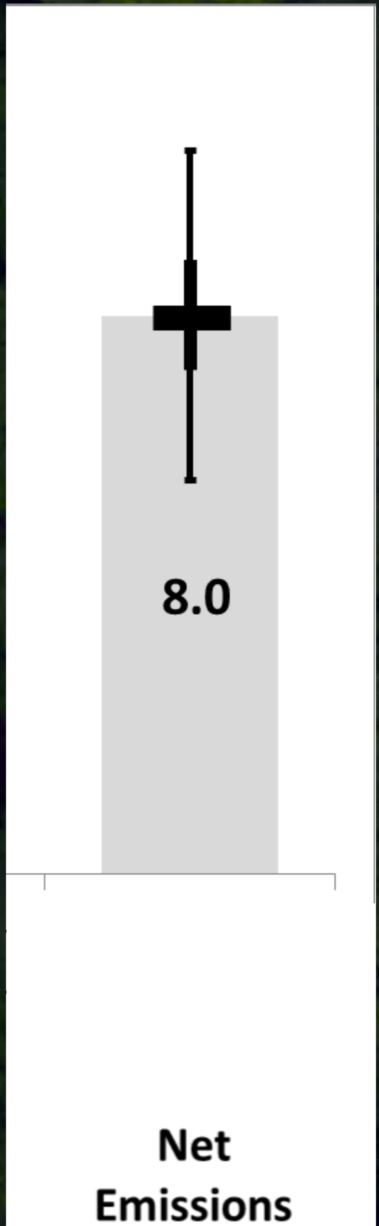


Step 4: Calculate emissions and uncertainty.

And the magic number is… **8.0**

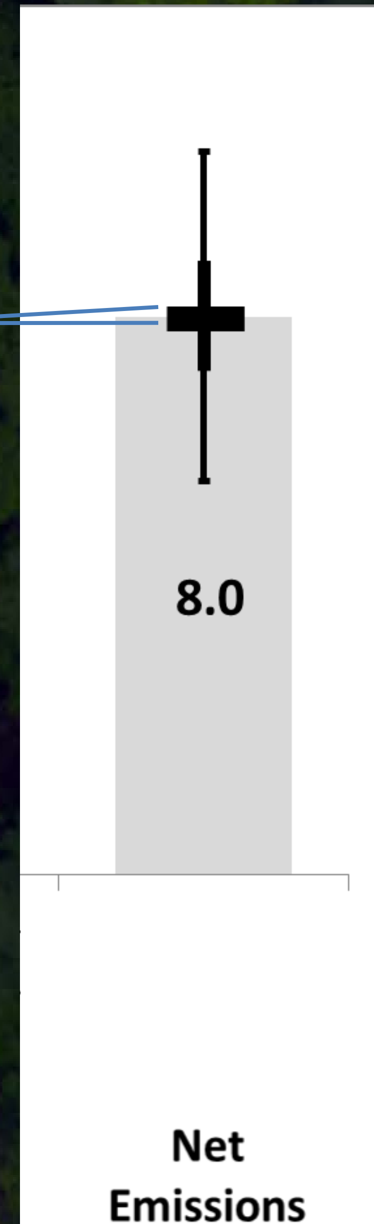
Step 4: Calculate emissions and uncertainty.

8 million tonnes net CO_2 Flux from land use change in Berau every year between 2000 and 2010



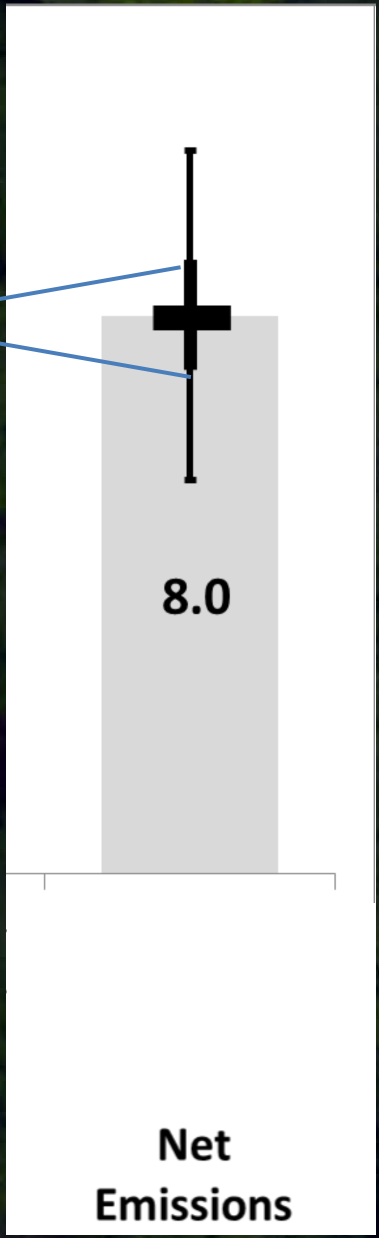
Step 4: Calculate emissions and uncertainty.

Biomass map and Forest Loss



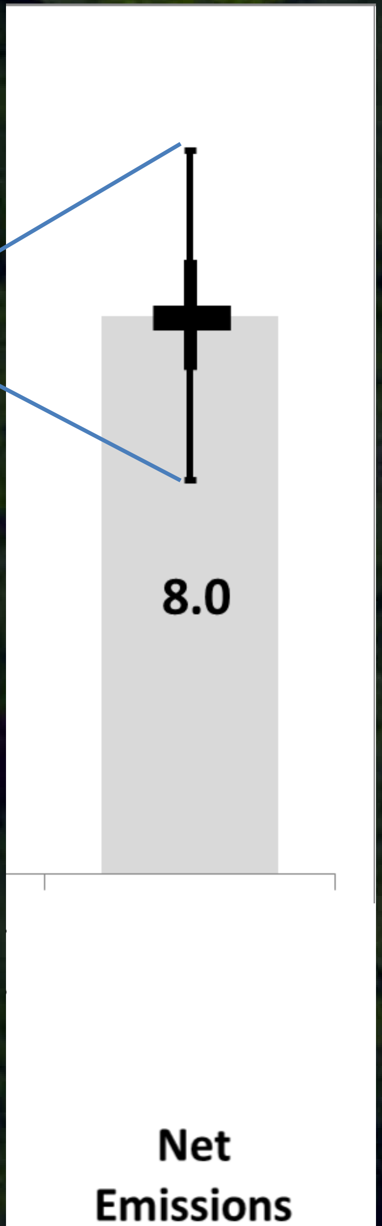
Step 4: Calculate emissions and uncertainty.

Parameters with “known” uncertainty

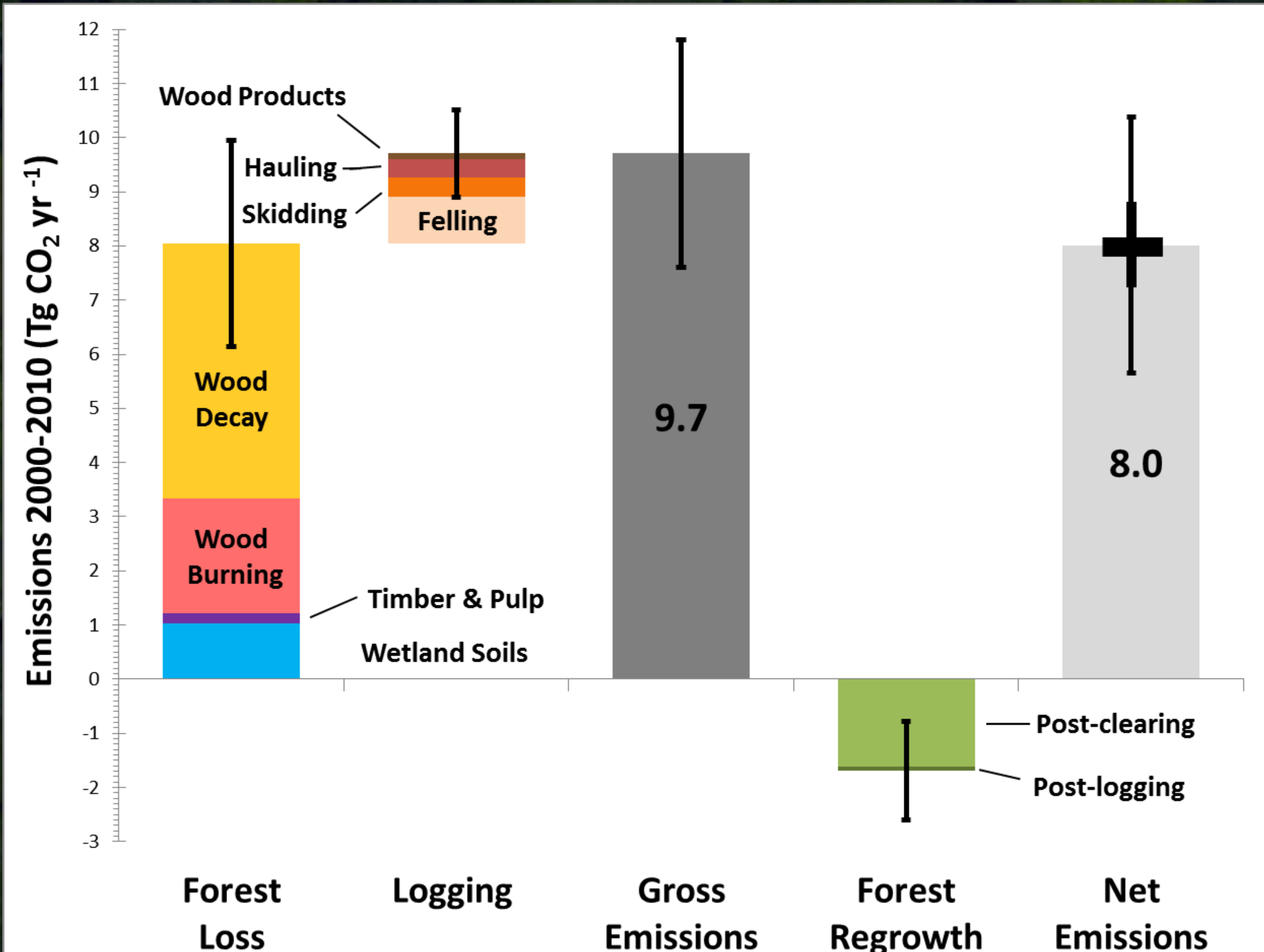


Step 4: Calculate emissions and uncertainty.

Comprehensive uncertainty (including parameters with "unknown" uncertainty)



Historic LULUCF Carbon Emissions in Berau



Terima Kasih!

Peter Ellis

pellis@tnc.org

USAID FROM THE AMERICAN PEOPLE

Norad

RAFT Responsible Asia Forestry and Trade

Extra Slides

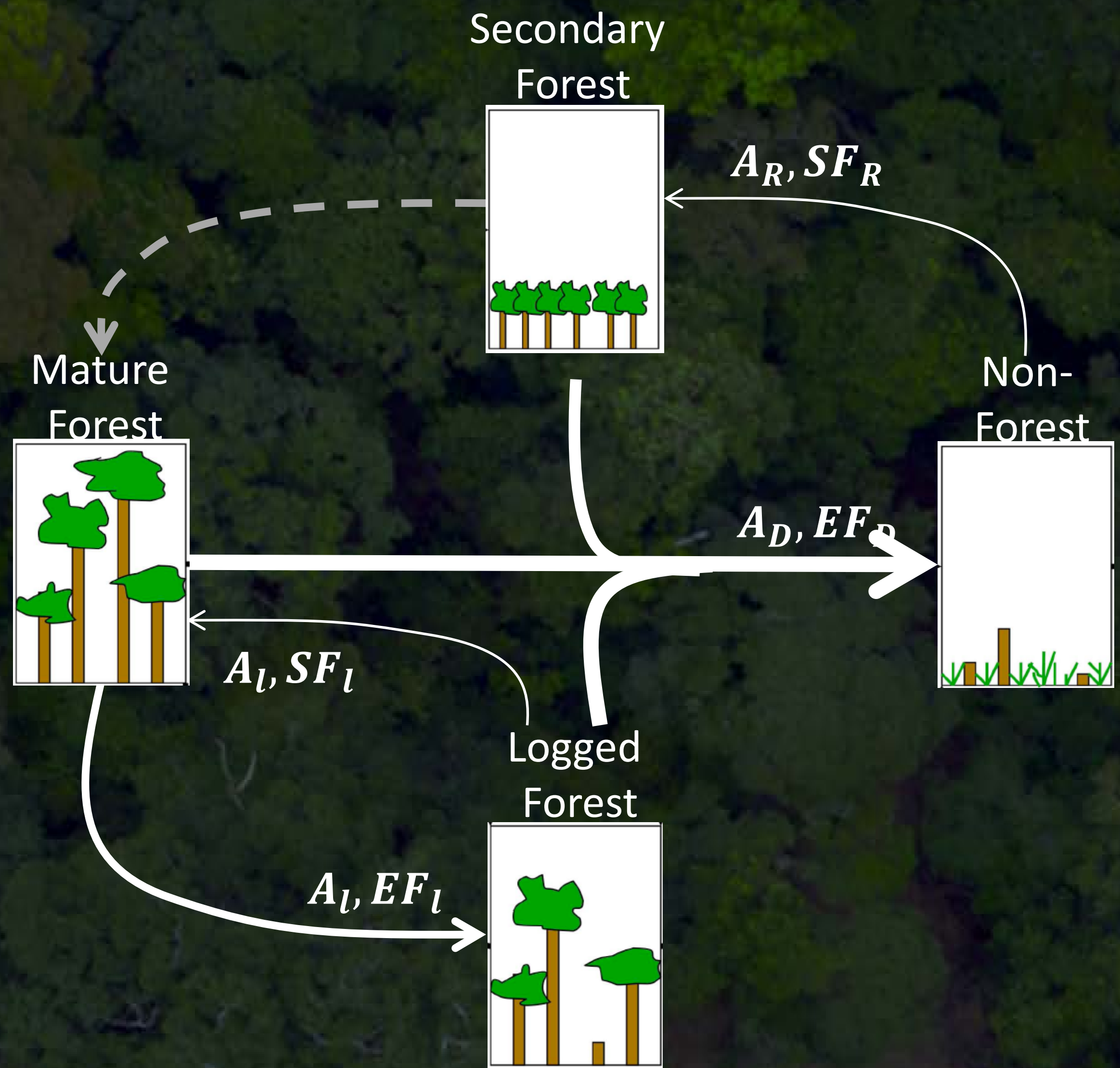
4 Steps to Adapting Global Datasets

1. Decide on the pools and fluxes to include.
2. Conduct accuracy assessment of forest loss activity data.
3. Calibrate, modify, rebuild.
   a. Compile forest strata data to build benchmark biomass map.
   b. Use GLAS to calculate average biomass per forest strata.
   c. Collect degradation activity data.
   d. Gather gain-loss degradation emissions data.
   e. Review literature for other input parameters.
4. Calculate emissions and uncertainty.
   a. Assign uncertainty envelope to all input parameters.
   b. Translate calculations into comprehensive emissions equation.
   c. Use Monte Carlo simulation to propagate uncertainty.
   d. Identify opportunities to reduce uncertainty.

Gain-Loss Accounting

$$\Delta C = (A_l * EF_l + A_D * EF_D) - (A_l * SF_l + A_R * SF_R)$$

$$\Delta C = \Delta C_L - \Delta C_G$$



Step 1: Decide on the pools and fluxes to include.

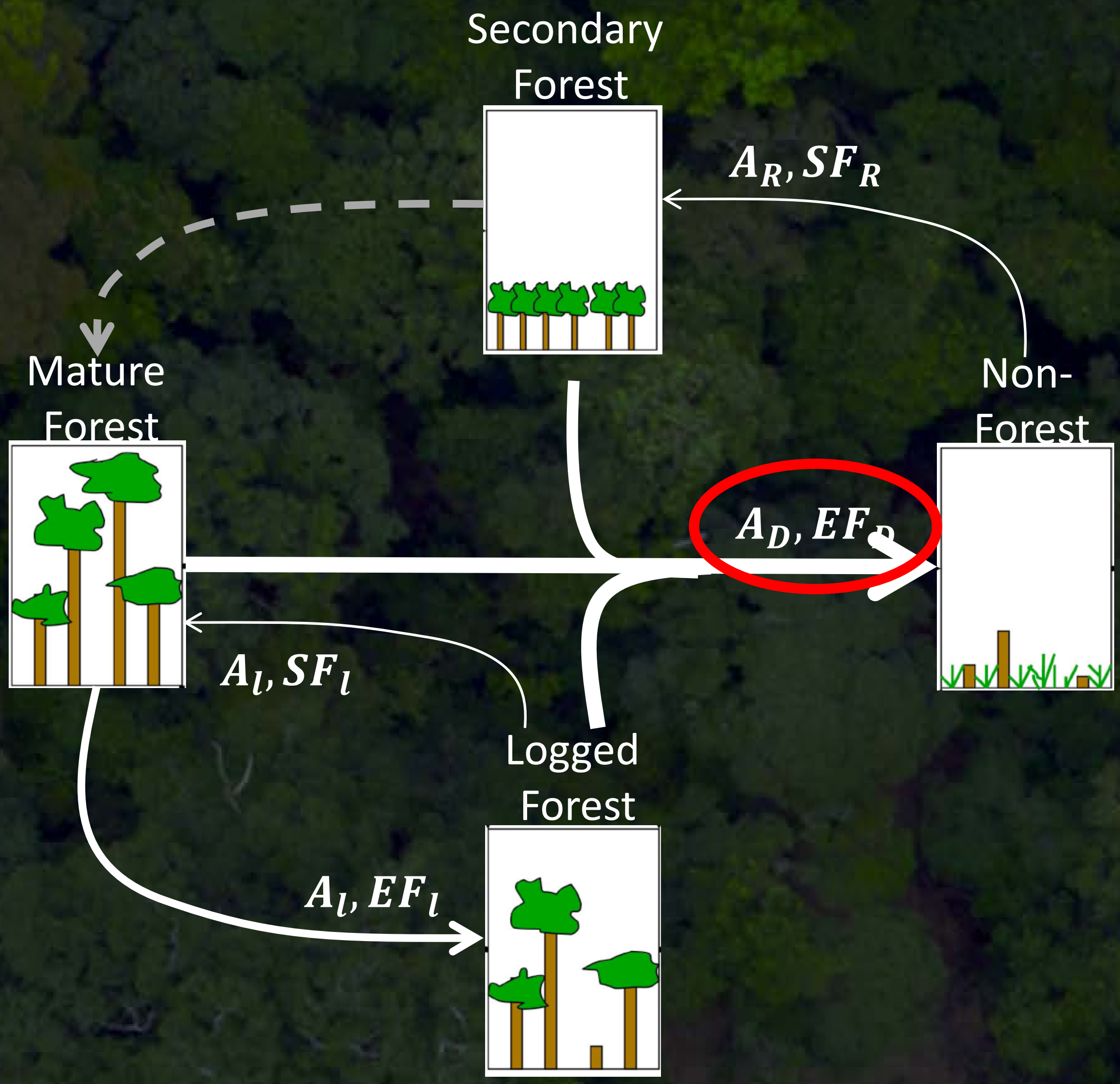
Pools

- Above-ground live woody biomass (AGLB)
- Below-ground live woody biomass (BGLB)
- Dead woody biomass (DB)
- Litter (LI)
- Soil carbon in wetlands (SCw)
- Soil carbon in uplands (SCu)

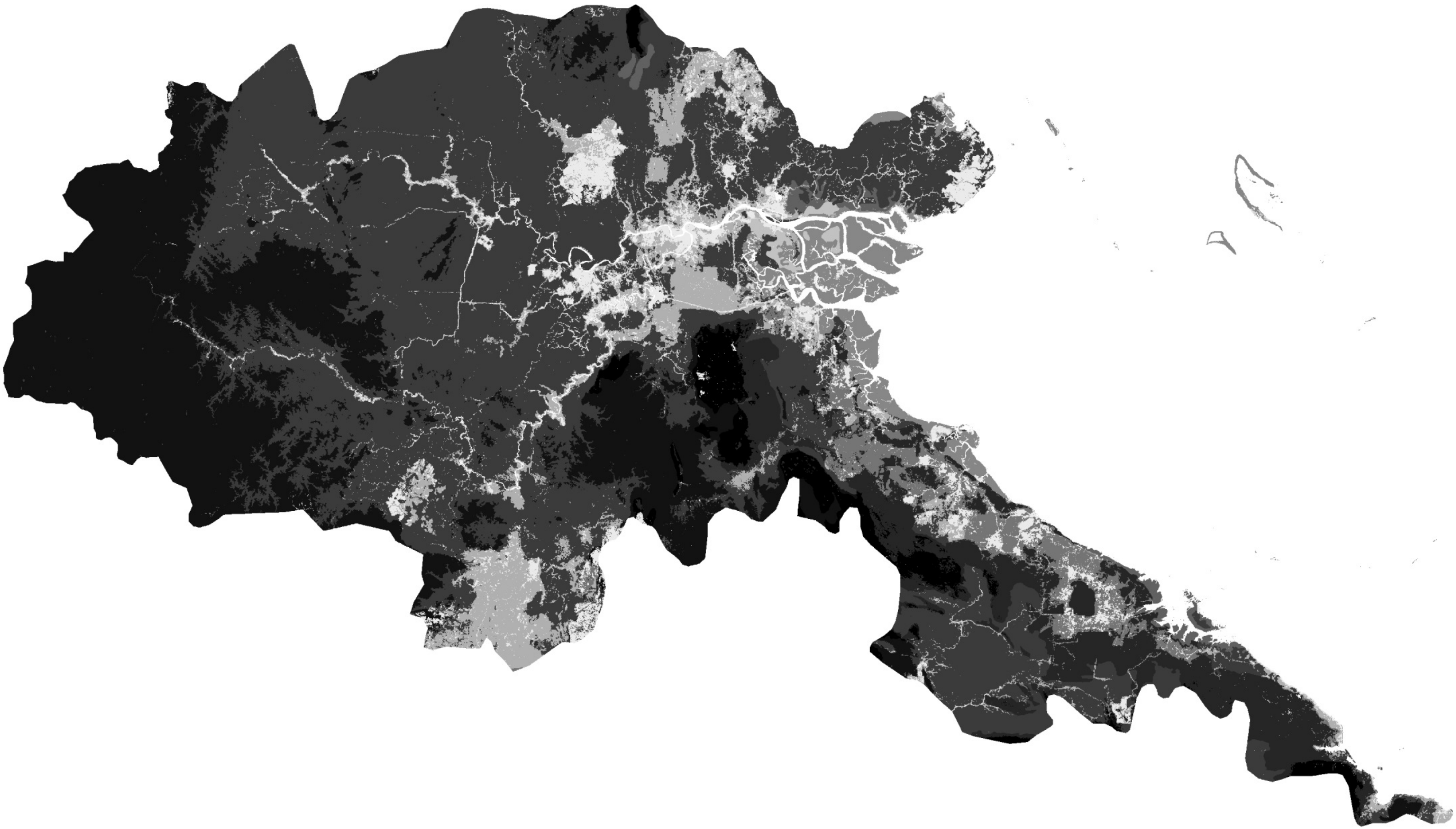
Fluxes

- Natural disturbance Forest Loss
- Anthropogenic Forest Loss
- Fire Emissions
- Decay Emissions
- Degradation from legal logging
- Degradation from illegal logging
- Degradation from fuel wood collection
- Degradation from low-intensity fire
- Secondary forest regrowth
- Regrowth after degradation

Forest Loss Emissions



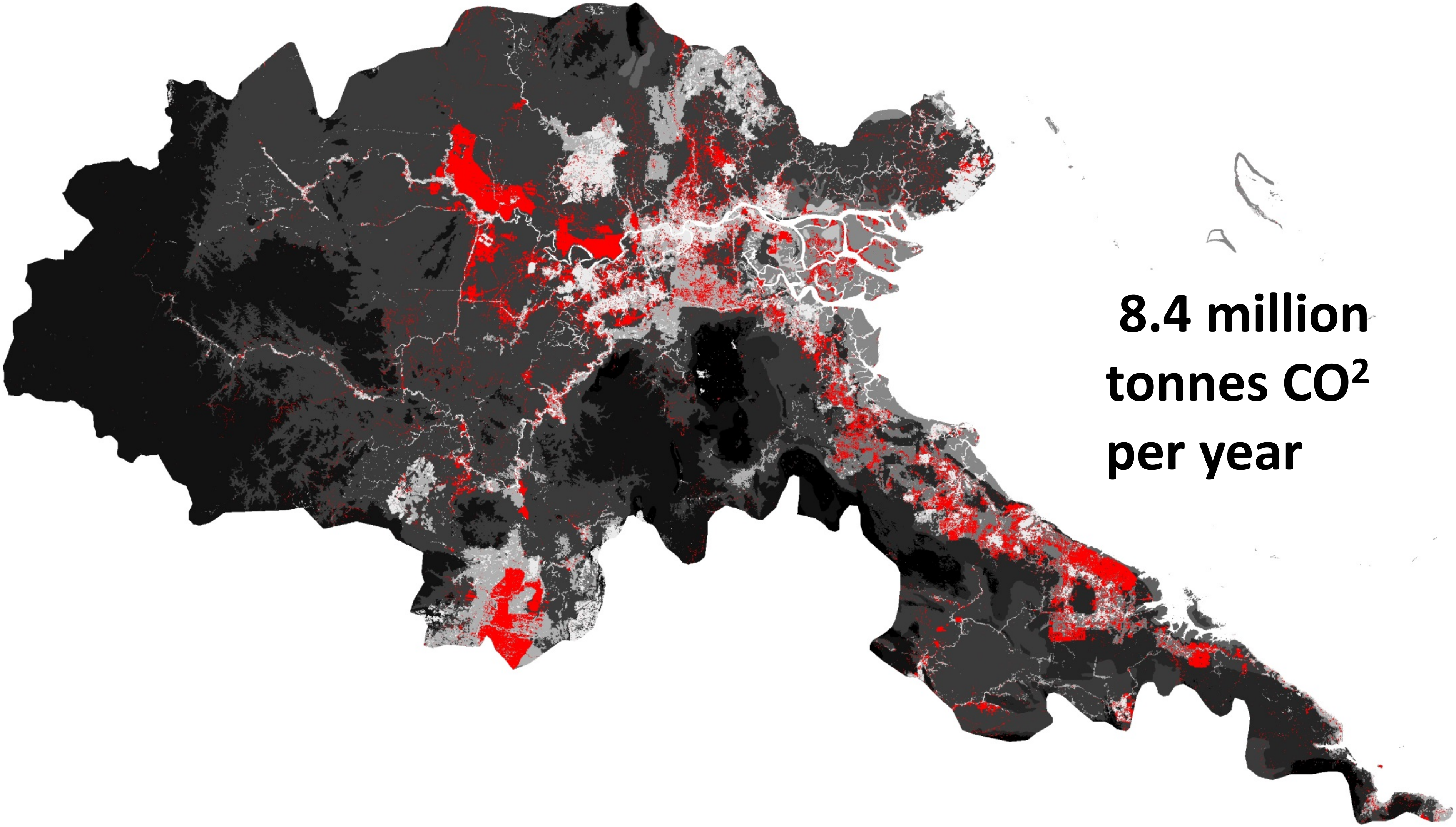
Forest Loss Emissions = Biomass Map



EF_D

TNC/Baccini

Forest Loss Emissions = Biomass Map * Forest Loss

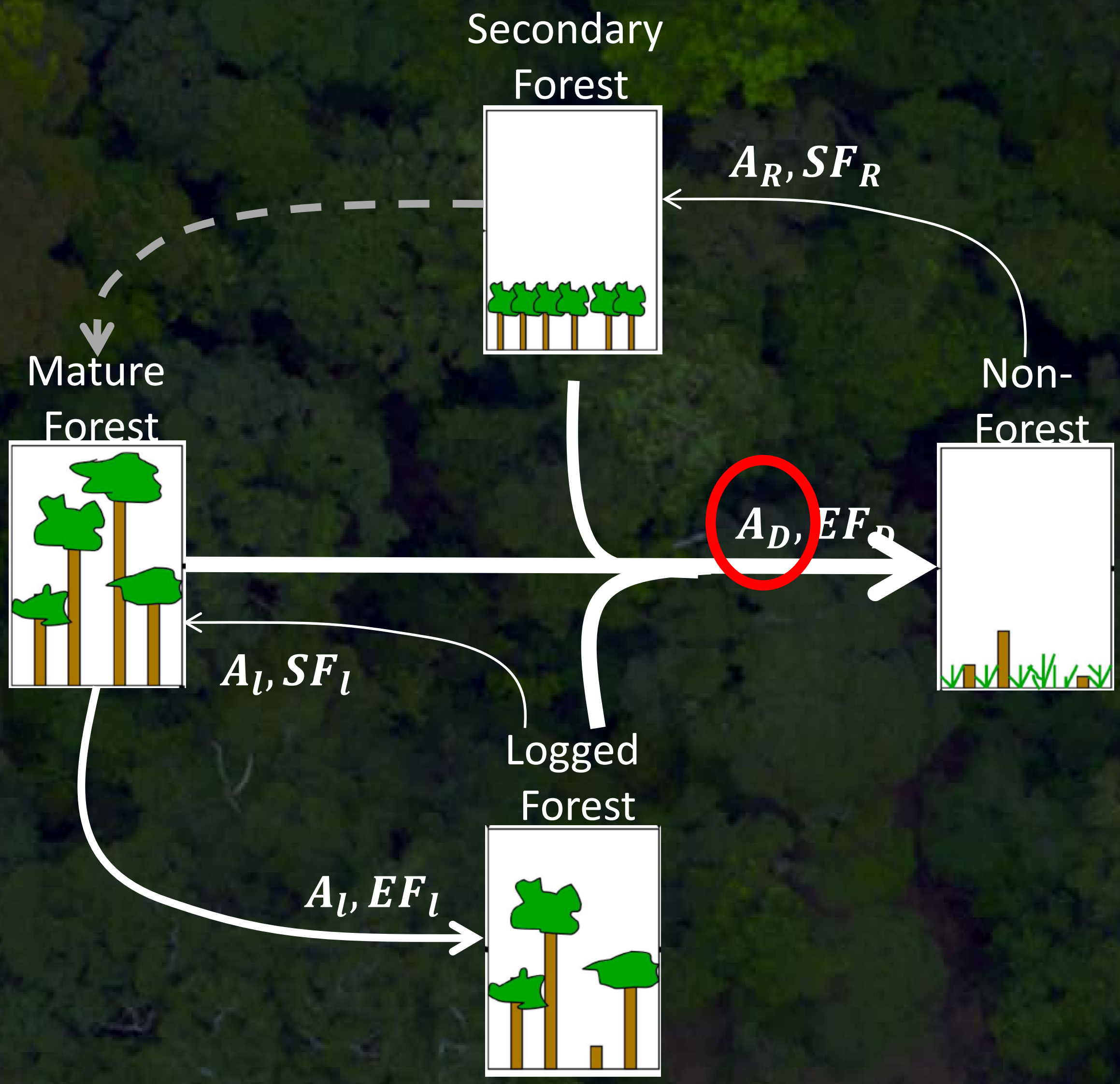


8.4 million tonnes CO^2 per year

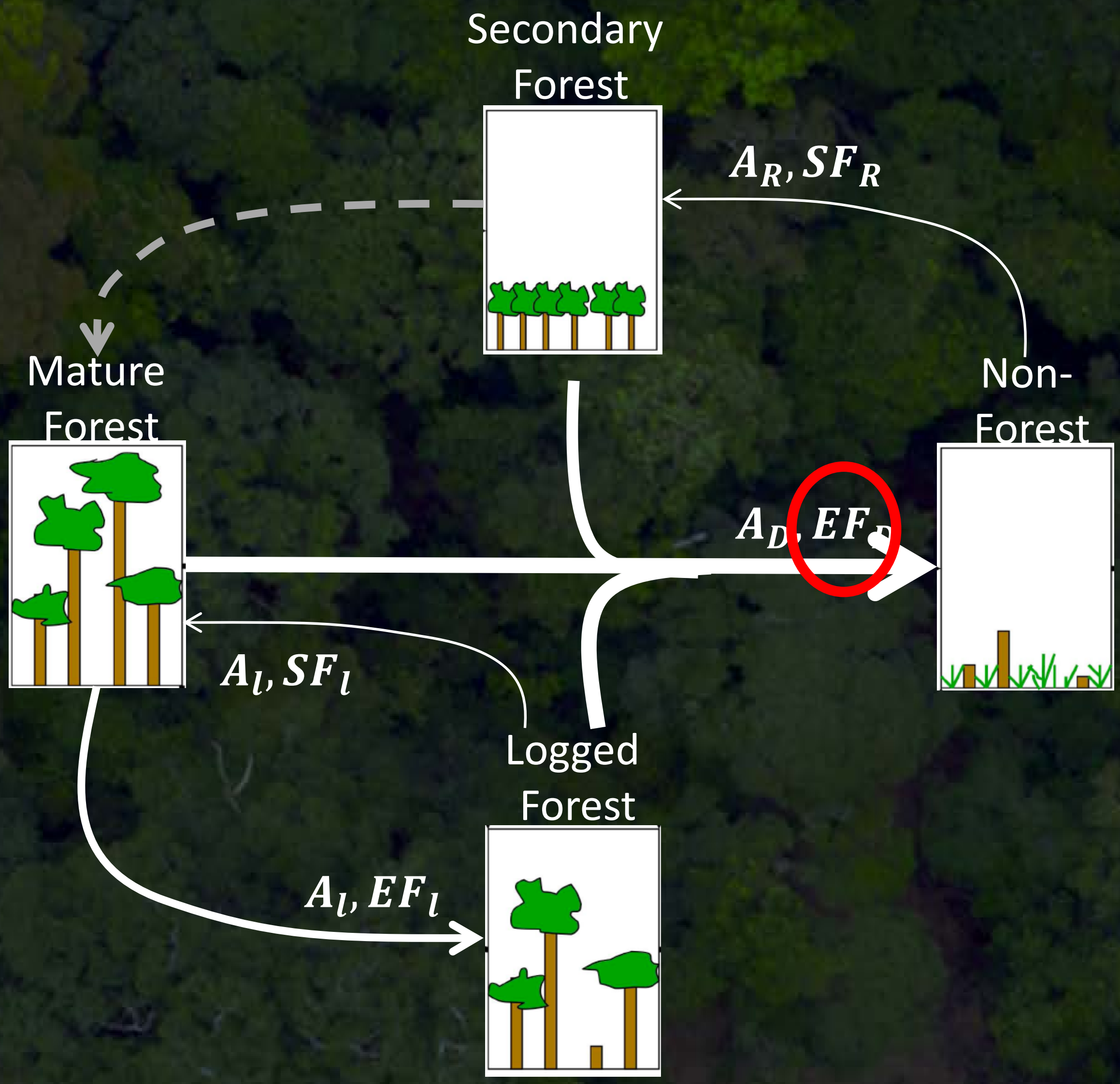
$EF_D * A_D$

TNC/Baccini * Hansen

Area of Loss (Activity Data)

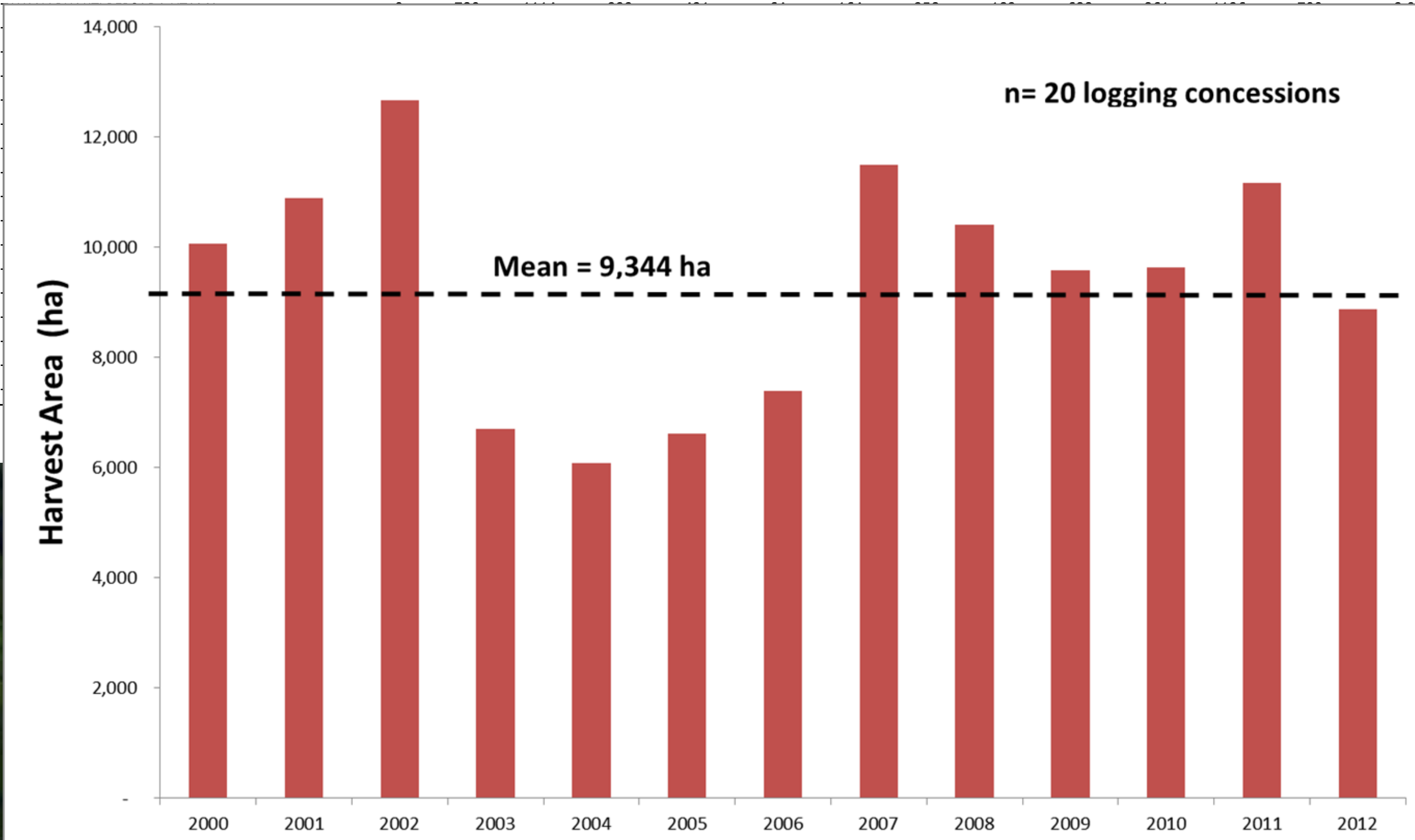


Emissions Factor (Biomass Map)



Step 5: Collect degradation activity data.

Logging Concession Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2000-2010 Average
PT INHUTANI 1 UNIT LABANAN	2046	2046	2046	0	0	0	0	1102	1790	1056	1526	1308	1250	10,087
PT INHUTANI 1 UNIT SAMBHARATA	1465	1465	1465	0	0	0	809	1433	1603	1127	1765	2223	1465	9,366
PT KARYA LESTARI	611	219	1090	971	657	834	537	527	183	0	0	682	633	5,631



Step 6: Gather gain-loss degradation emissions data.

Global Change Biology

Global Change Biology (2014), doi: 10.1111/gcb.12386

Carbon emissions performance of commercial logging in East Kalimantan, Indonesia

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PO 118526, Gainesville, FL 32611-8526, USA, ‡Cen
32641, USA

Abstract

Adoption of reduced-impact logging (RIL) me
remaining tropical forests. We developed two
(reduced CO_2 emissions) due to RIL. The indi
concessions. We determined that a correction f
sions certified by the Forest Stewardship Co
(N = 6), did not have lower overall CO_2 emissi
hand, FSC certified concessions did have lower
evidence of a range of improved practices usin
criteria and indicators, and associated RIL prac
commonly used field metrics are not reliable
simple distinction between certified and nonc
investments in improved logging practices. To
pose the more explicit term 'RIL-C' to refer to t
and that result in measurable emissions reduct
reductions, certification standards need to expl

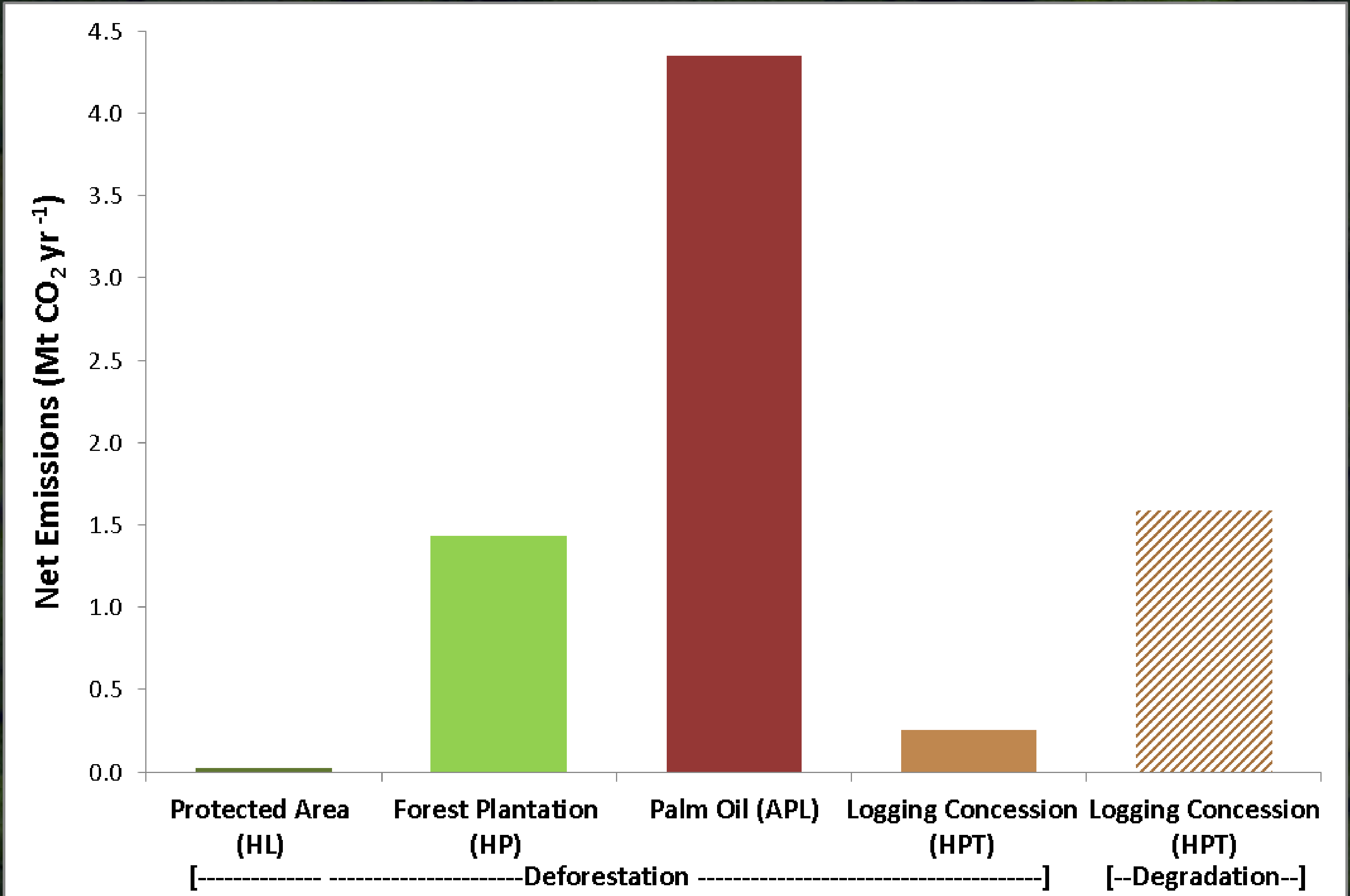
Keywords: Borneo, carbon emissions, CO_2, Dipteroc

Received 6 March 2013; revised version received 6 July

Step 6: Review literature for other input parameters.

Step 7: Assign uncertainty envelope to all input parameters.

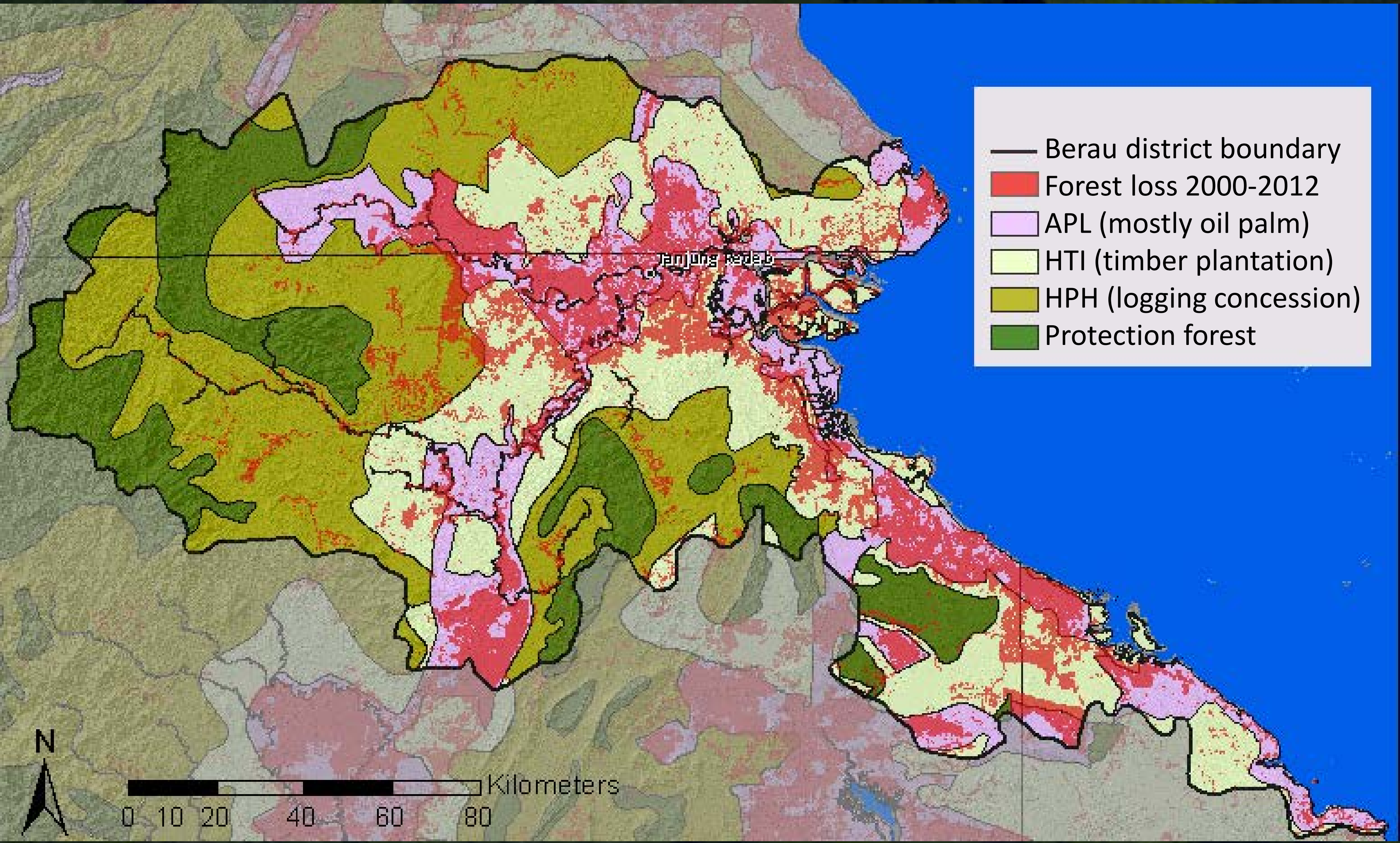
Emissions Drivers



Derived from "Spatial Plan" produced by the Ministry of Forestry in 2010. GIS data layer used for analysis comes via the World Resources Institute.

** Degradation in logging concessions includes forest loss detected by Hansen associated with Haul Roads (669 ha)

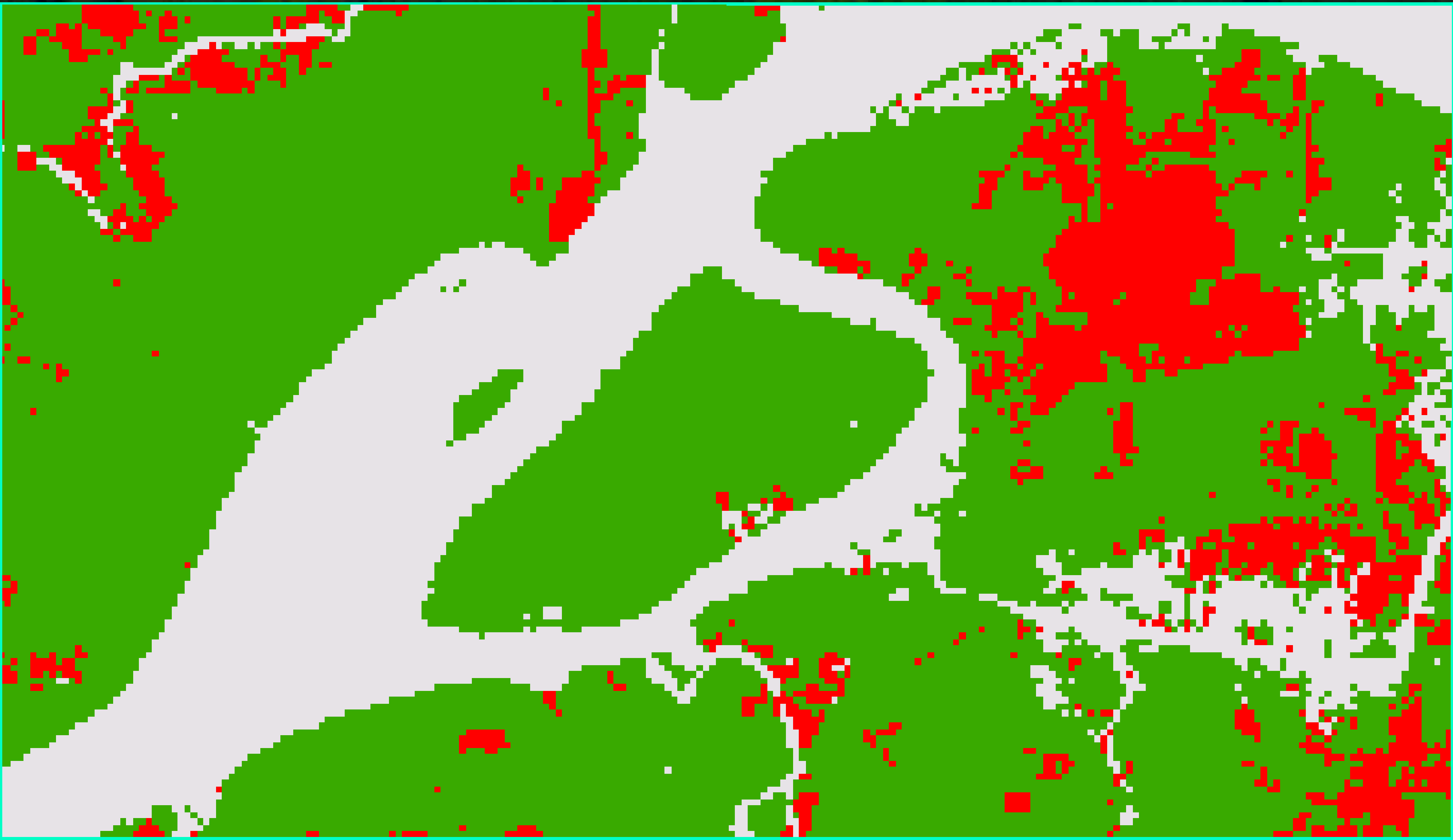
Emissions Drivers



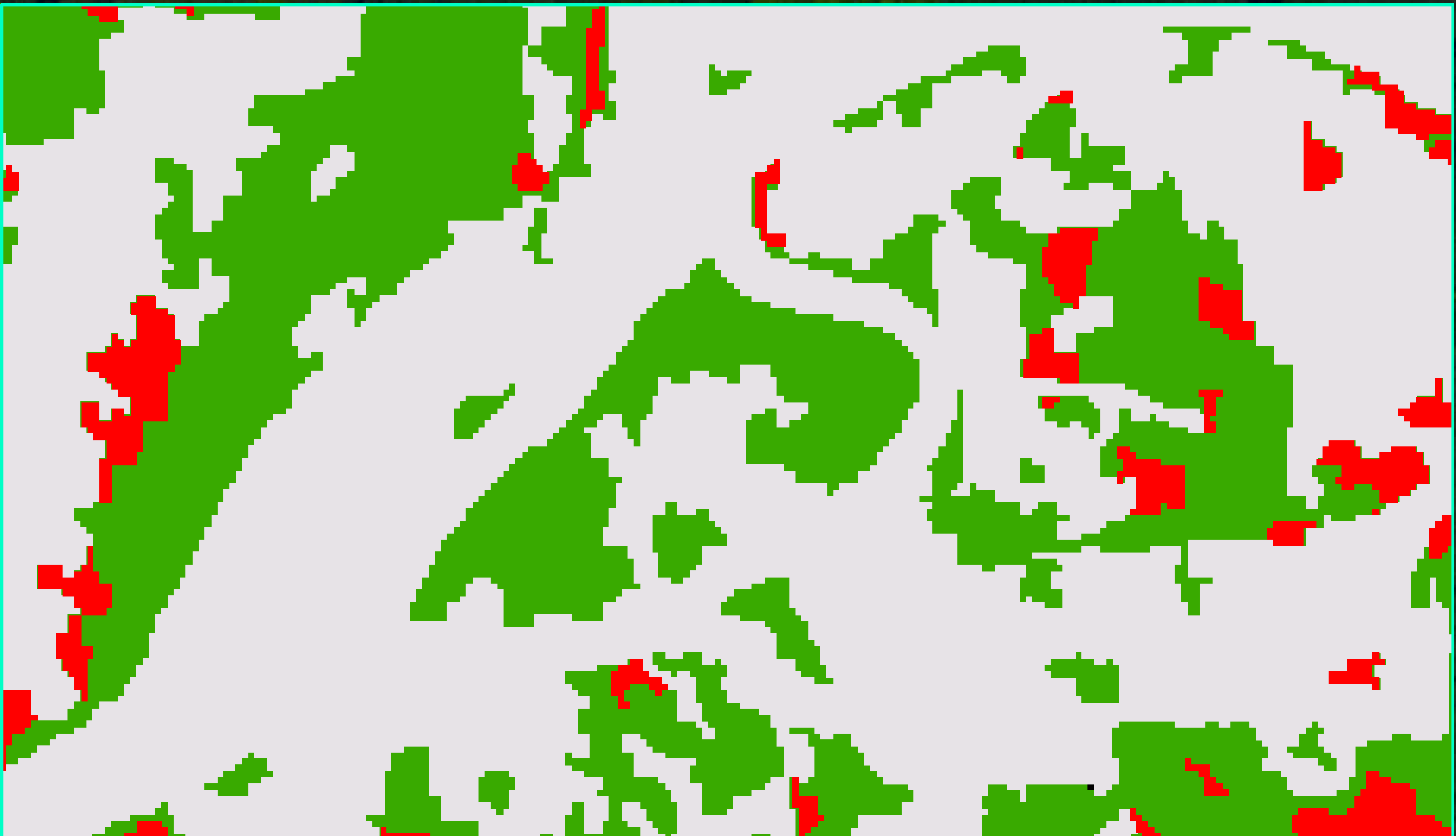
Reference Imagery: Landsat 2000

Reference Imagery: SPOT 2009

Hansen Change

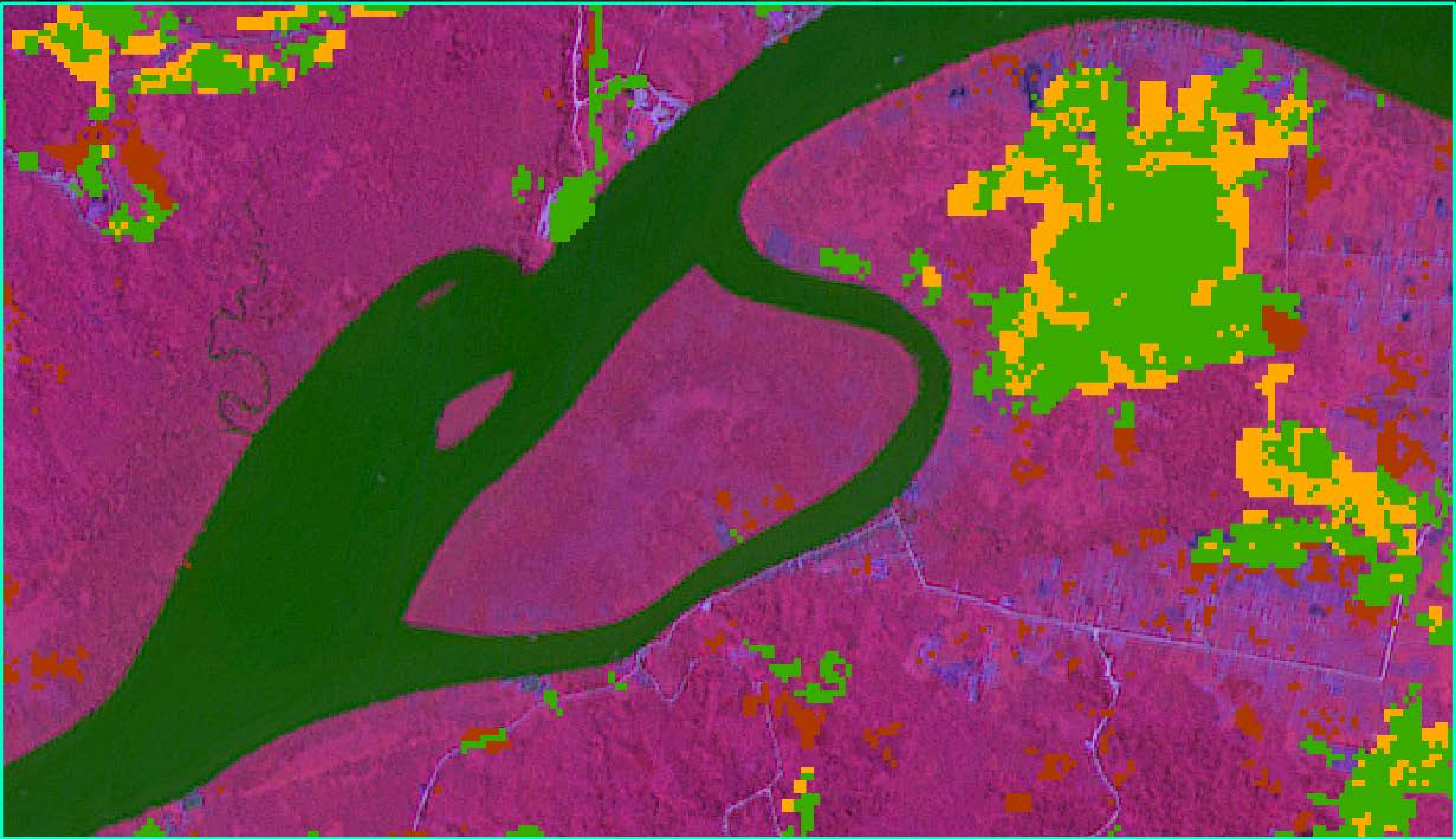


Forclime Change



Hansen Accuracy Assessment Results

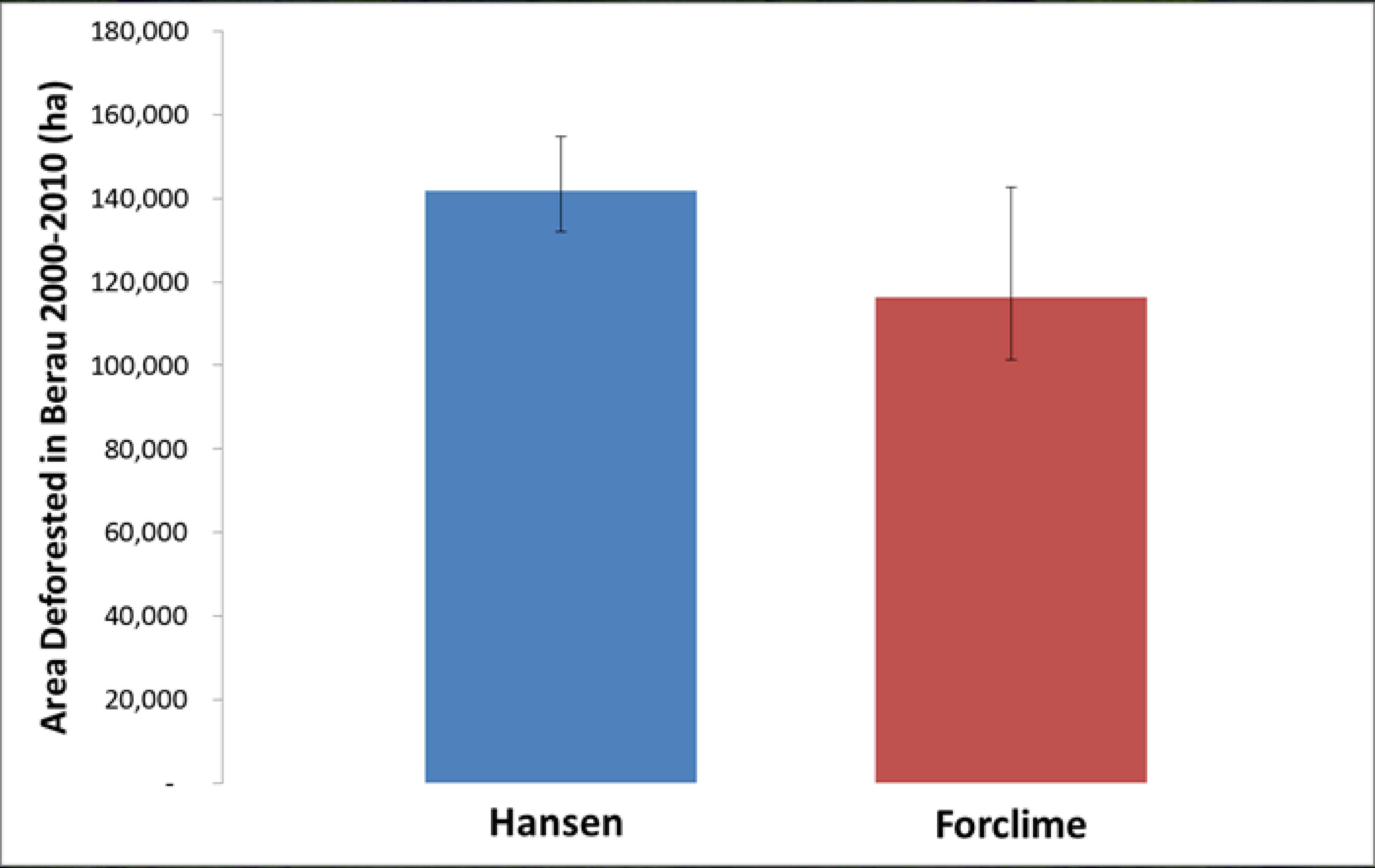
Error of Comission – **red** Error of Omission – **orange** No Error – **green**



Forclime Accuracy Assessment Results

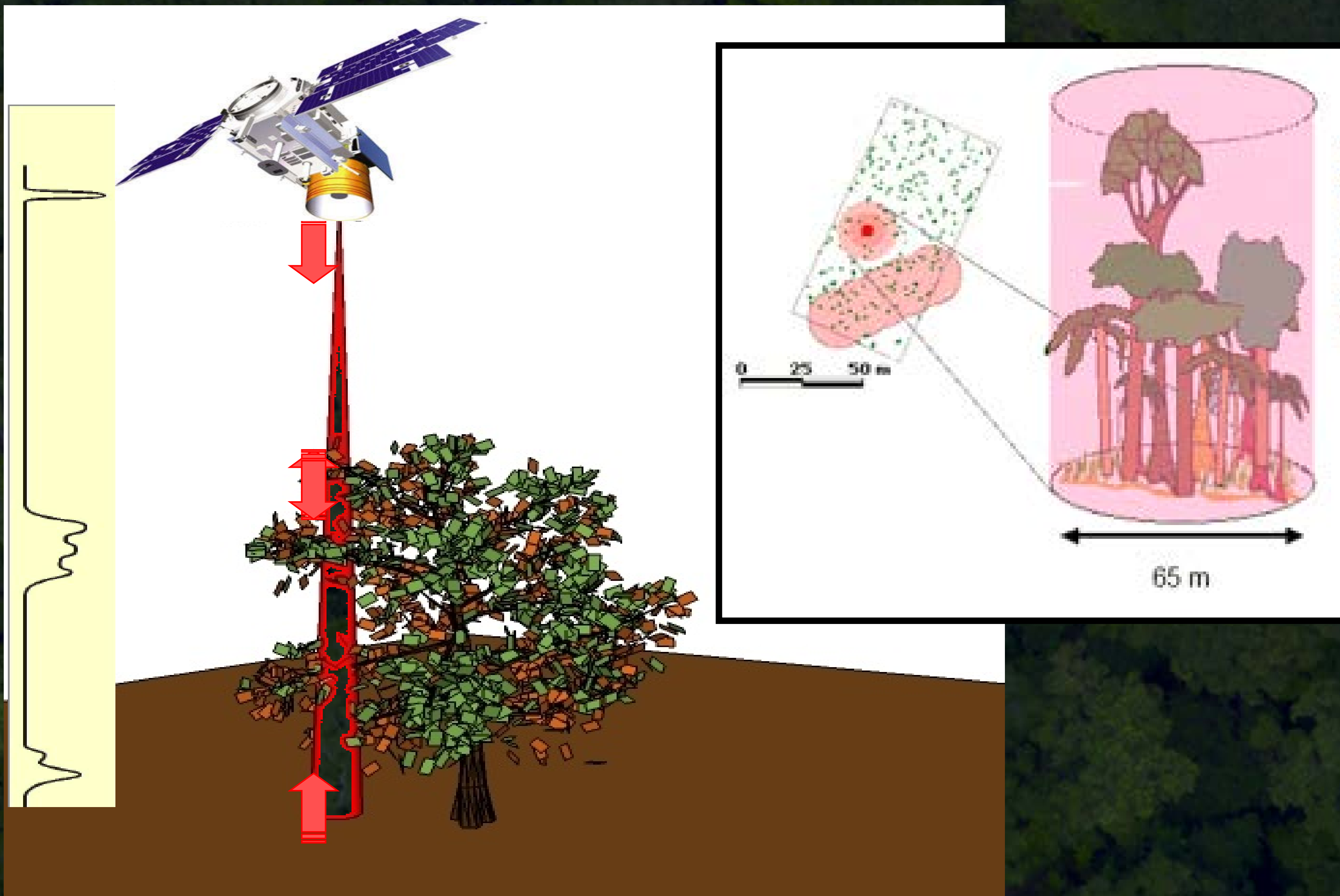
Error of Comission – **red** Error of Omission – **orange** No Error – **green**

Forest Loss Accuracy Assessment: Results



Step 4: Use GLAS to calculate average biomass per forest strata.

Geoscience Laser Altimeter System (GLAS)



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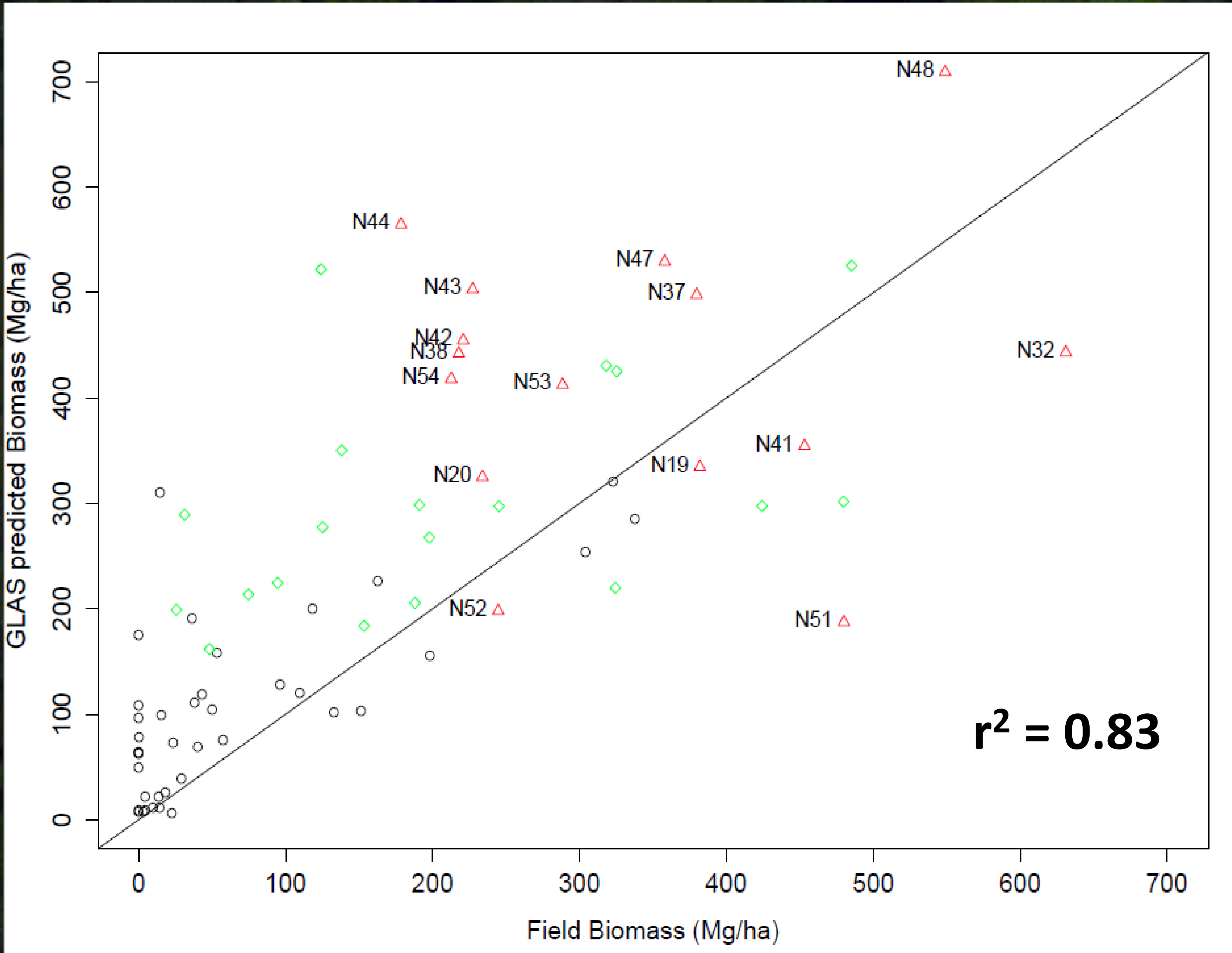
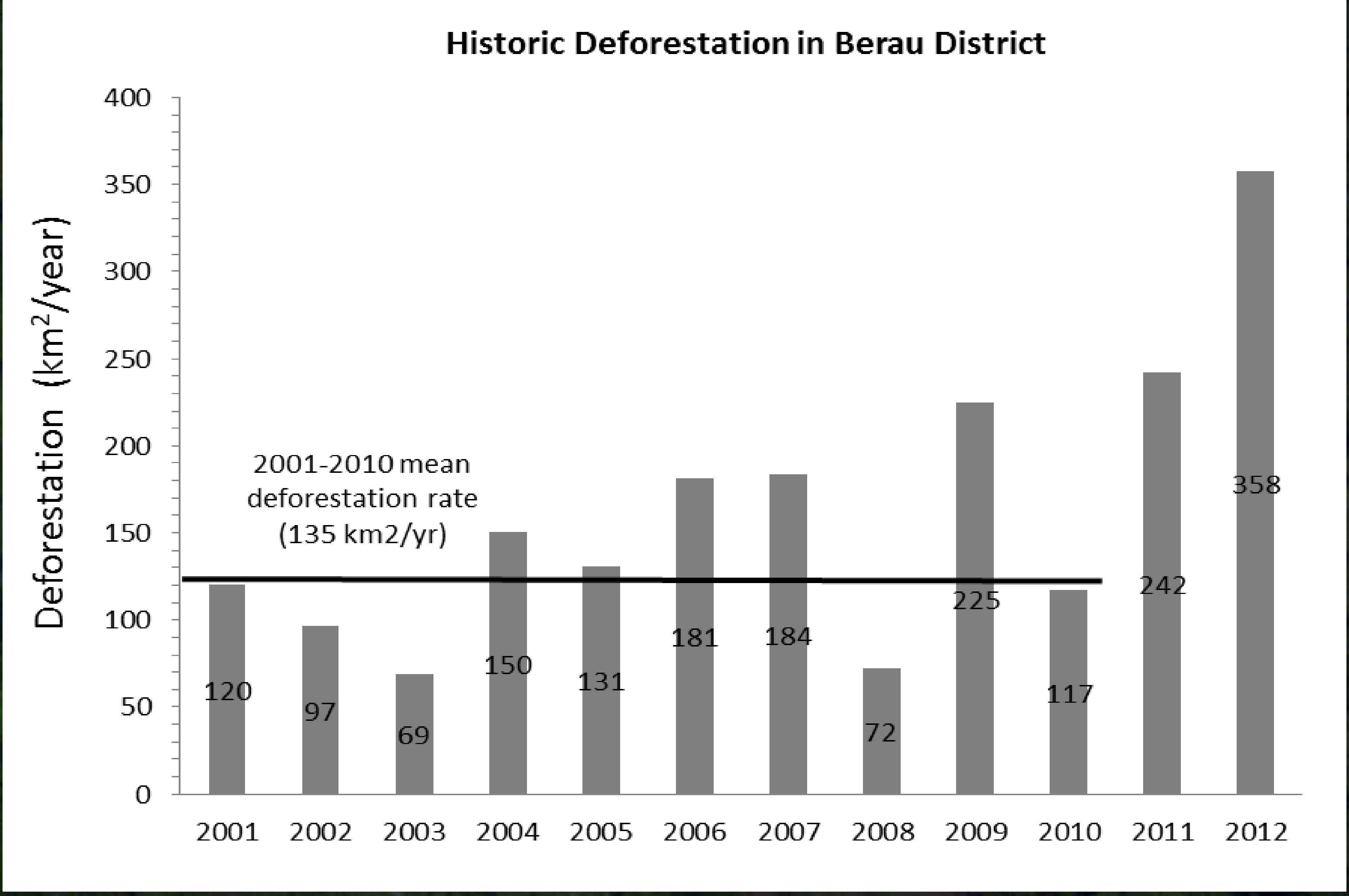
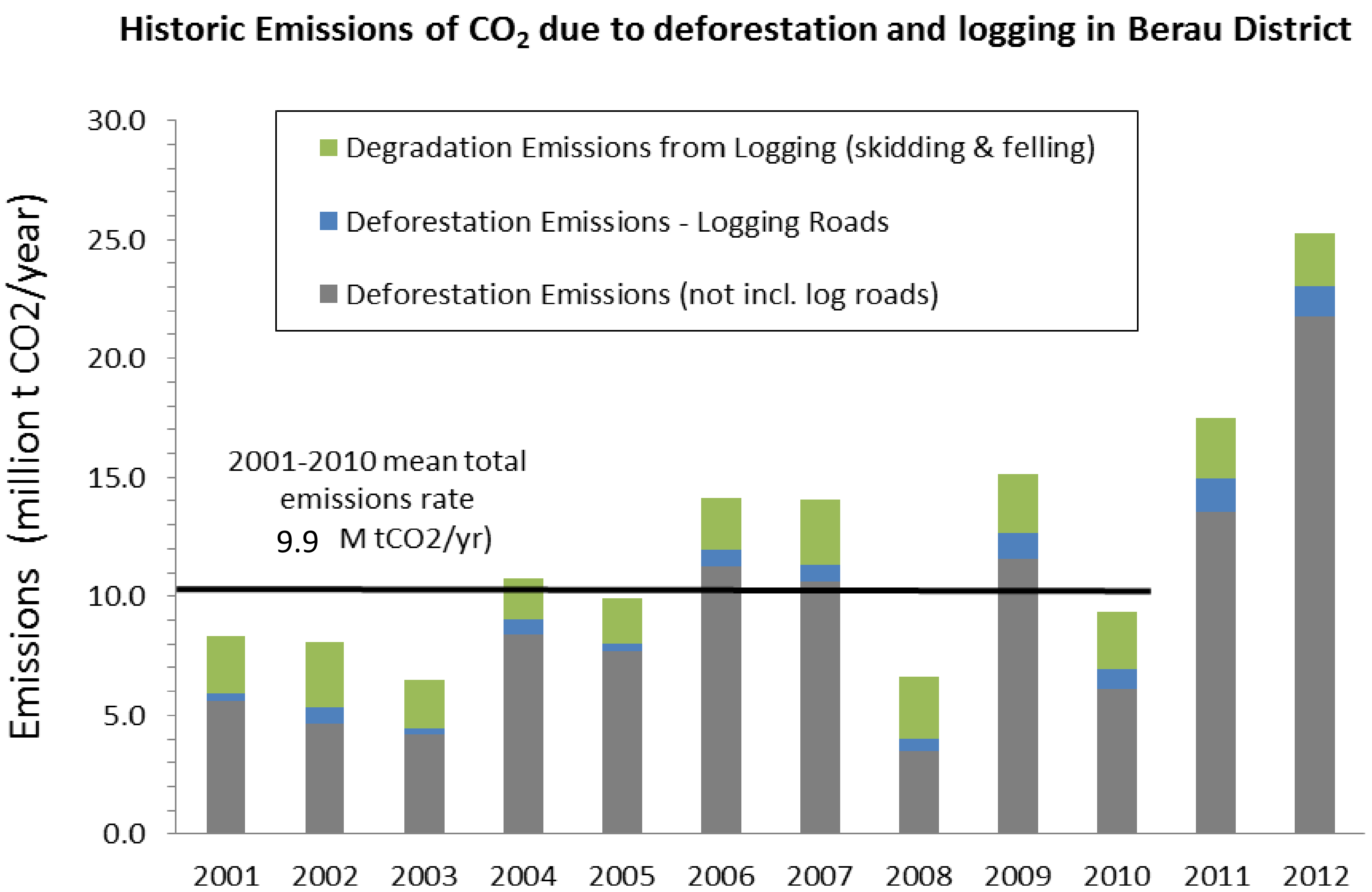


Deforestation Over Time

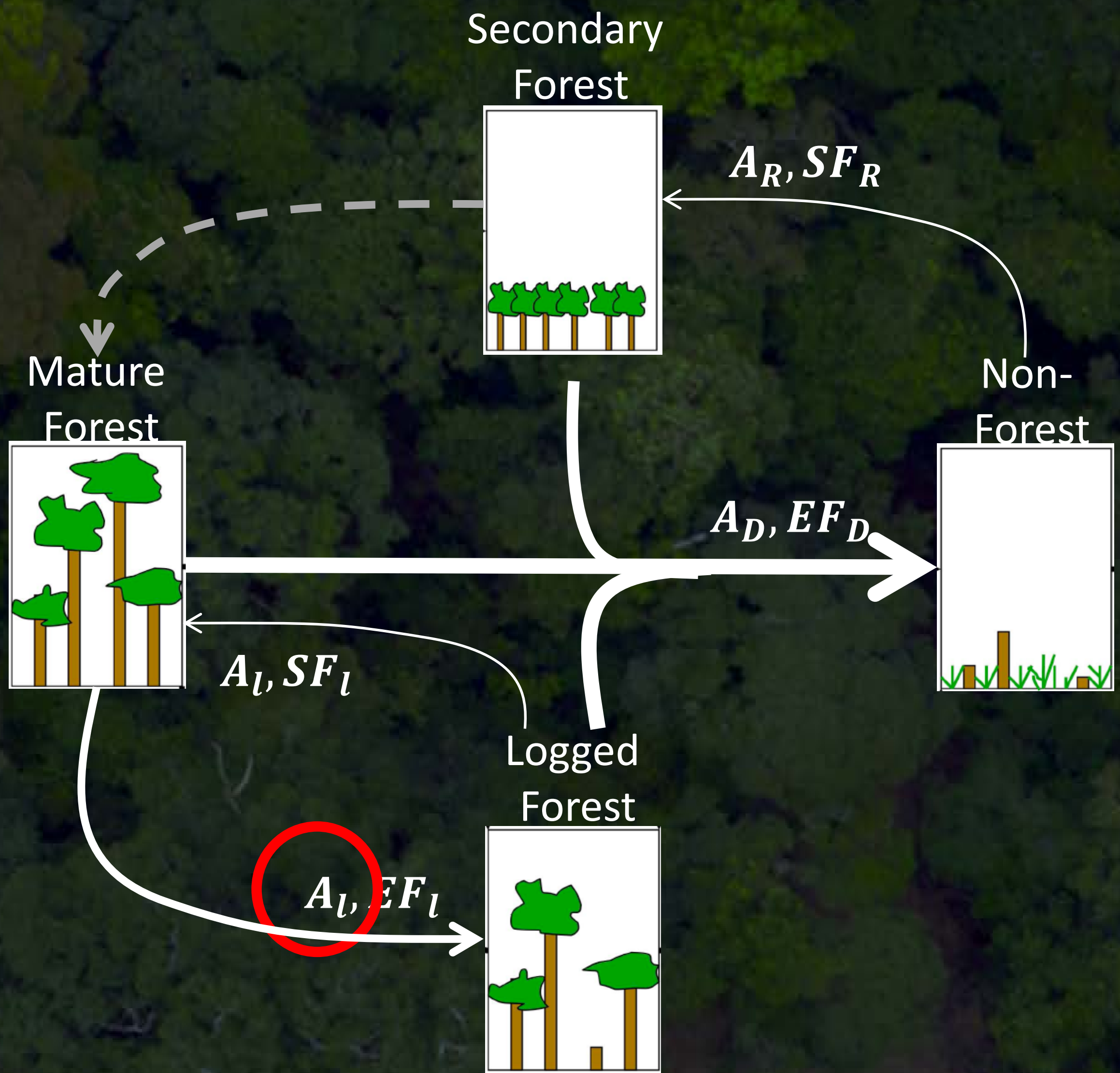


Emissions Over Time



Source: TNC 2014, unpublished

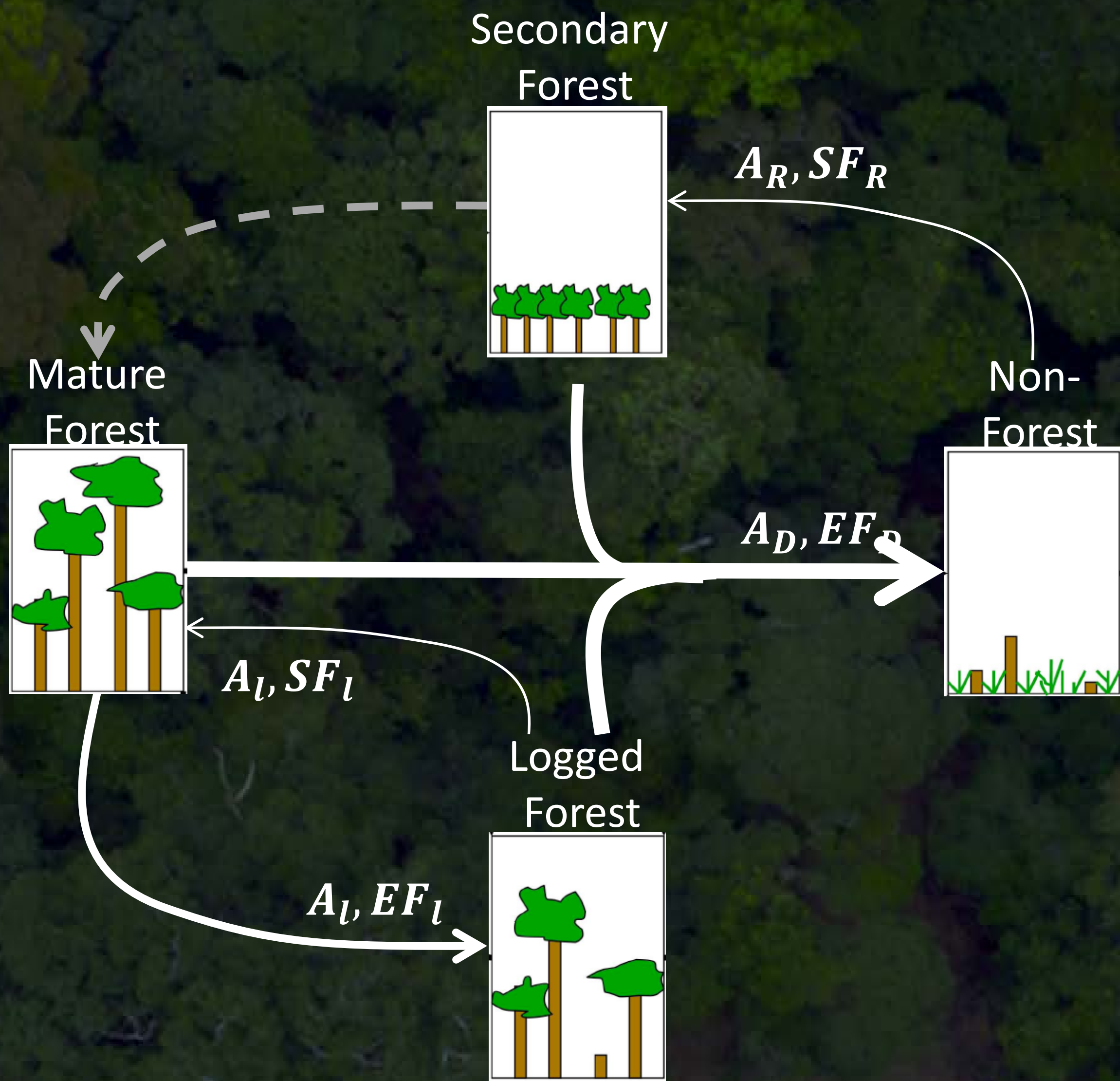
Logging Emissions



Step 9: Translate calculations into comprehensive emissions equation.

$$\Delta C = (A_l * EF_l + A_D * EF_D) - (A_l * SF_l + A_R * SF_R)$$

$$\Delta C = \Delta C_L - \Delta C_G$$



TNC Approach: Gain-Loss Method

IPCC Gain–Loss Equation 2.4:

$$\Delta C = \Delta C_L - \Delta C_G$$

Carbon Flux = (Defor Emissions + Logging Emissions) − (Defor Uptake + Logging Uptake)

$$\Delta C = (A_D * EF_D + A_l * EF_l) - (A_R * SF_R + A_l * SF_l)$$

A_D	EF_D	A_l	EF_l	A_R	SF_R	A_l	SF_l
Approach 3* Hansen	Tier 3 TNC-Baccini	Approach 2/3 Hansen/GOI	Tier 3 TNC	Approach 3* Hansen	Tier 2 Lit Review	Approach 2/3 Hansen/GOI	Tier 3 STREK

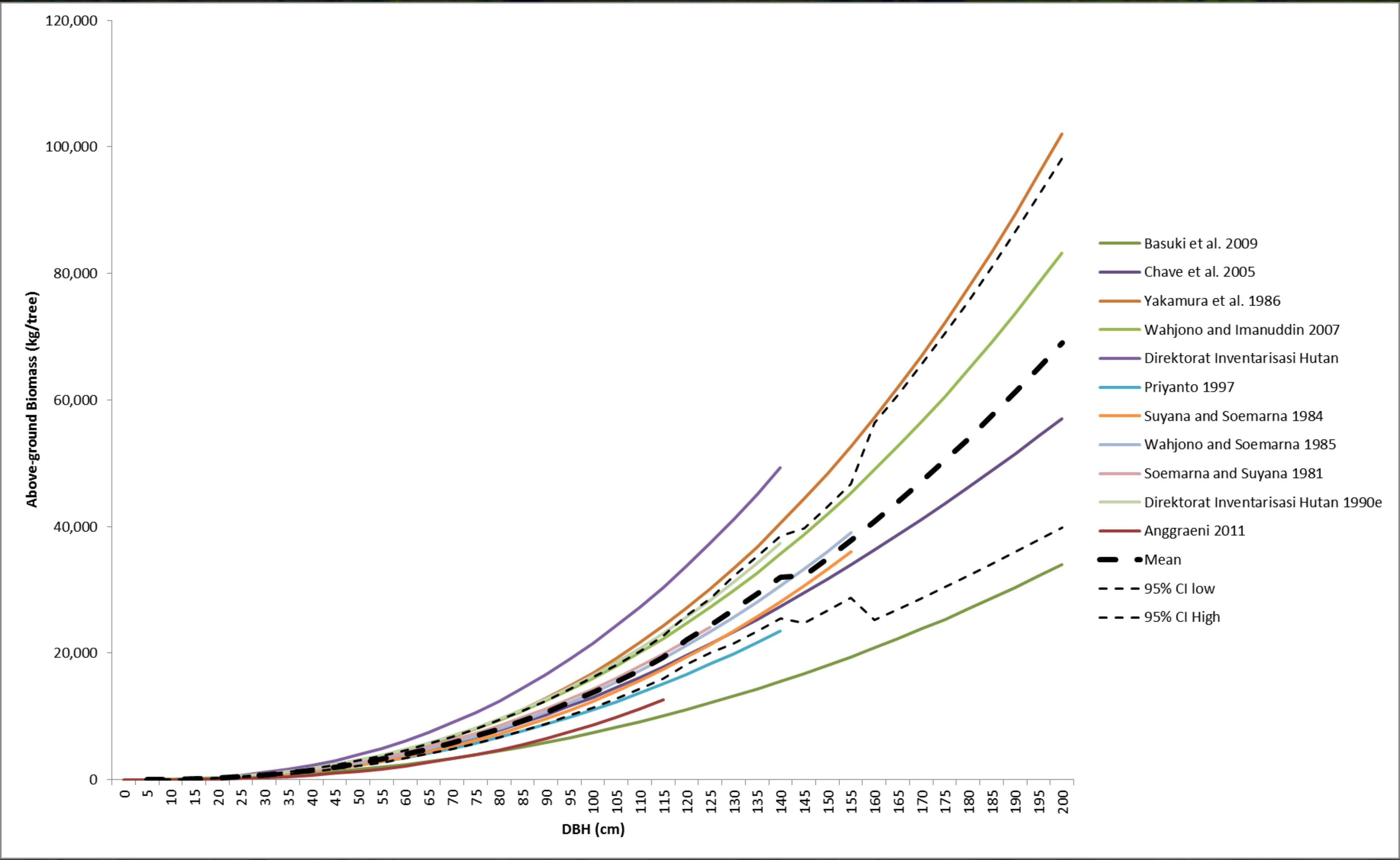
Tier 3 Uncertainty Analysis

Table A1. Description of variables and associated data methods used for emissions calculations.

Variable	Variable description	Mean value	Units	Data type	Data sources.
$\Delta C\ (t)$	Total net carbon flux (emissions) in Berau	104.4	Mt CO_2	Spatial, raster (60 x 60m)	TNC analysis of all datasets listed below
$\Delta C_D(t)$	Net carbon flux (emissions) from deforestation	84.4	Mt CO_2	Spatial, raster (60 x 60m)	TNC analysis of various listed below
$\Delta C_L(t)$	Net carbon flux (emissions) from legal commercial logging	29.2	Mt CO_2	Spatial, vector	TNC analysis of various listed below
$\Delta C_S(t)$	Net carbon flux (sequestration) in secondary forests	9.3	Mt CO_2	Spatial, raster (60 x 60m)	TNC analysis of various listed below
$A_D(t)$	Area of deforestation during time *t*	109,787	ha	Spatial, raster (60 x 60m)	Hansen et. al. 2009*
AGB_{DL}	Above-ground biomass after post-defor. timber extraction	185.6	$t\ C\ ha^{-1}$	Constant	This study
AGDB	Aboveground dead biomass prior to deforestation	15.2	$t\ C\ ha^{-1}$	Constant	Brown and Lugo 1992, others
$AGDB_L$	Aboveground dead biomass due to commercial logging	43.0	$t\ C\ ha^{-1}$	Constant	This study
AGLB	Aboveground live biomass prior to deforestation	168.9	$t\ C\ ha^{-1}$	Constant	Baccini et. al. 2012 (TNC field data for validat.)
$A_L(t)$	Area of legal commercial logging in HPH	113,016	ha	Tabular data	Wahyudi pers. comm.
$A_R(t)$	Area of 2° forest regrowth in areas cleared before start of time *t*	63,647	ha	Spatial, raster (60 x 60m)	Miettinen et. al. 2011
$BGDB_L$	Belowground dead biomass due to commercial logging	13.2	$t\ C\ ha^{-1}$	Constant	This study
BGLB	Belowground live biomass prior to deforestation	39.6	$t\ C\ ha^{-1}$	Constant	TNC field data; Baccini et. al. 2012
CC	Combustion completeness of initial deforestation burn	0.49	proportion	Constant	van der Werf et al. 2010
CS_L	Carbon sequestration rate in logged forests	1.8	$t\ C\ ha^{-1}\ yr^{-1}$	Constant	Ruslandi personal communication
CS_S	Carbon sequestration rate in secondary forests	3.98	$t\ C\ ha^{-1}\ yr^{-1}$	Constant	Pan et. all 2011 (with Mokany et. al. 2006)
DK_w	Assumed linear decay rate of dead wood	0.055	$t\ C\ ha^{-1}\ yr^{-1}$	Constant	VCS 2012
EF	Charcoal (elemental) fraction	0.04	proportion	Constant	Nogueira et al. 2008, Malhi et al. 2006, others
FDF	Fraction of deforested land burned within following year[1]	1.00	proportion	Constant	This study
FDR	Fraction of deforested land regrows to forest annually	0.024	proportion	Spatial, raster (60 x 60m)	Dewi and Ekadinata 2011
FLM	Fraction of logging roads in concessions "maintained."	0.012	proportion	Constant	This study
FMWP	Fraction of RWB processed into medium-term wood products	0.63	proportion	Constant	Winjum et. al. 1998, GOI MoF.
FMWPE	Fraction of medium-term wood products emitted	0.28	proportion	Constant	VCS 2012 (20-year modelling period)
FPF	Fraction of deforested land where all AGLB harvested for pulp	0.17	proportion	Constant	Ministry of Forestry; all HTI forest plantations
FSR	Fraction of concessions logging "second rotation" cutting blocks	0.67	proportion	Constant	Griscom and Ellis professional judgement
FSWP	Fraction of RWB lost in short-term wood products	0.33	proportion	Constant	Winjum et. al. 1998, GOI MoF.
FTF	Fraction of roundwood biomass from post-defor. timber extraction	0.08	proportion	Constant	TNC field data
FWP	Fraction of roundwood biomass emitted from wood products	0.51	proportion	Constant	VCS 2012
RWB_L	Roundwood biomass from logging	11.15	$t\ C\ ha^{-1}$	Constant	TNC field data
SC	Soil biomass in peatlands and mangroves prior to deforestation	56.7 to 893.6	$t\ C\ ha^{-1}$	Constant (dep. on type)	Wayunto et. al. 2004, Murdiyarso et. al. 2010
SCD	Depth of organic soils	0.75 to 2.1	m	Constant (dep. on type)	Wayunto et. al. 2004
SDD	Average depth of draining occurring on cleared organic soils	0.60	m	Constant	Hooijer et. al. 2010
t	Reference time period	10	years	Constant	This study

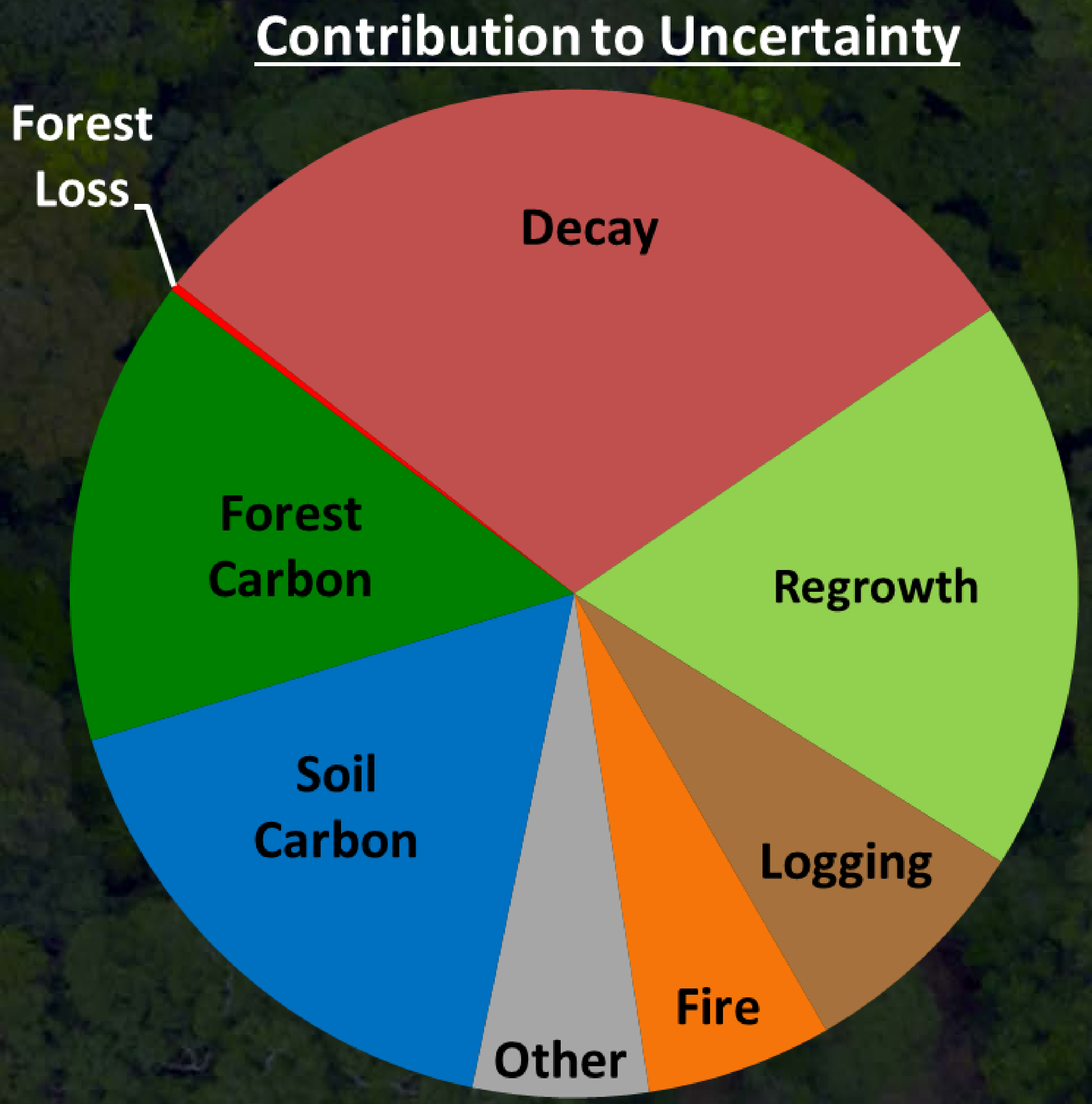
* Dataset used for analysis is not yet published, but methods are based off of Hansen et. al. 2009.

[1] Calculated as the fraction of deforestated land occurring out of land zoned for HTI (Forest Plantation).

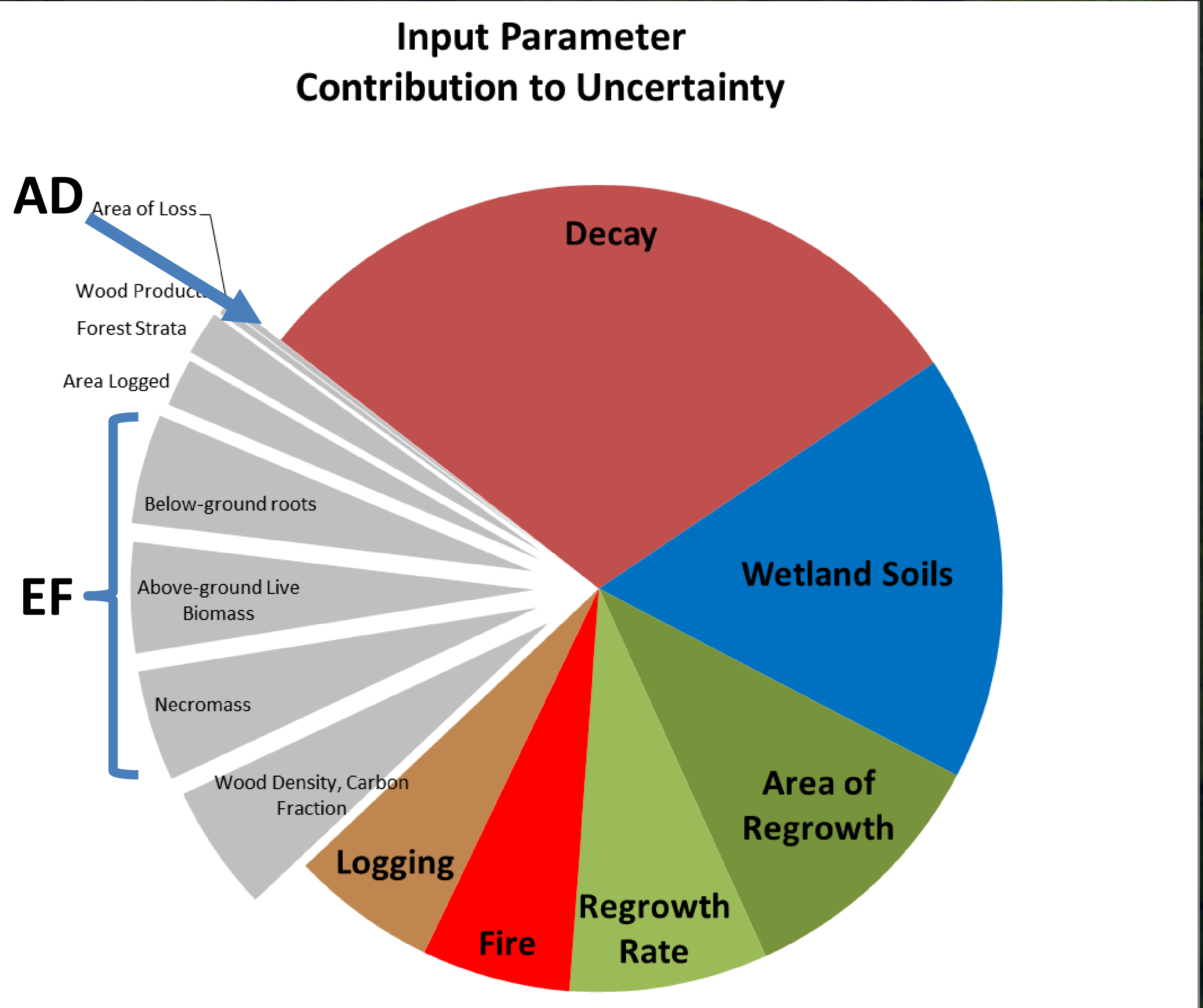


Above-ground Biomass (kg/tree)
120,000
100,000
80,000
60,000
40,000
20,000
0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200
DBH (cm)
Basuki et al. 2009
Chave et al. 2005
Yakamura et al. 1986
Wahjono and Imanuddin 2007
Direktorat Inventarisasi Hutan
Priyanto 1997
Suyana and Soemarna 1984
Wahjono and Soemarna 1985
Soemarna and Suyana 1981
Direktorat Inventarisasi Hutan 1990e
Anggraeni 2011
Mean
95% CI low
95% CI High

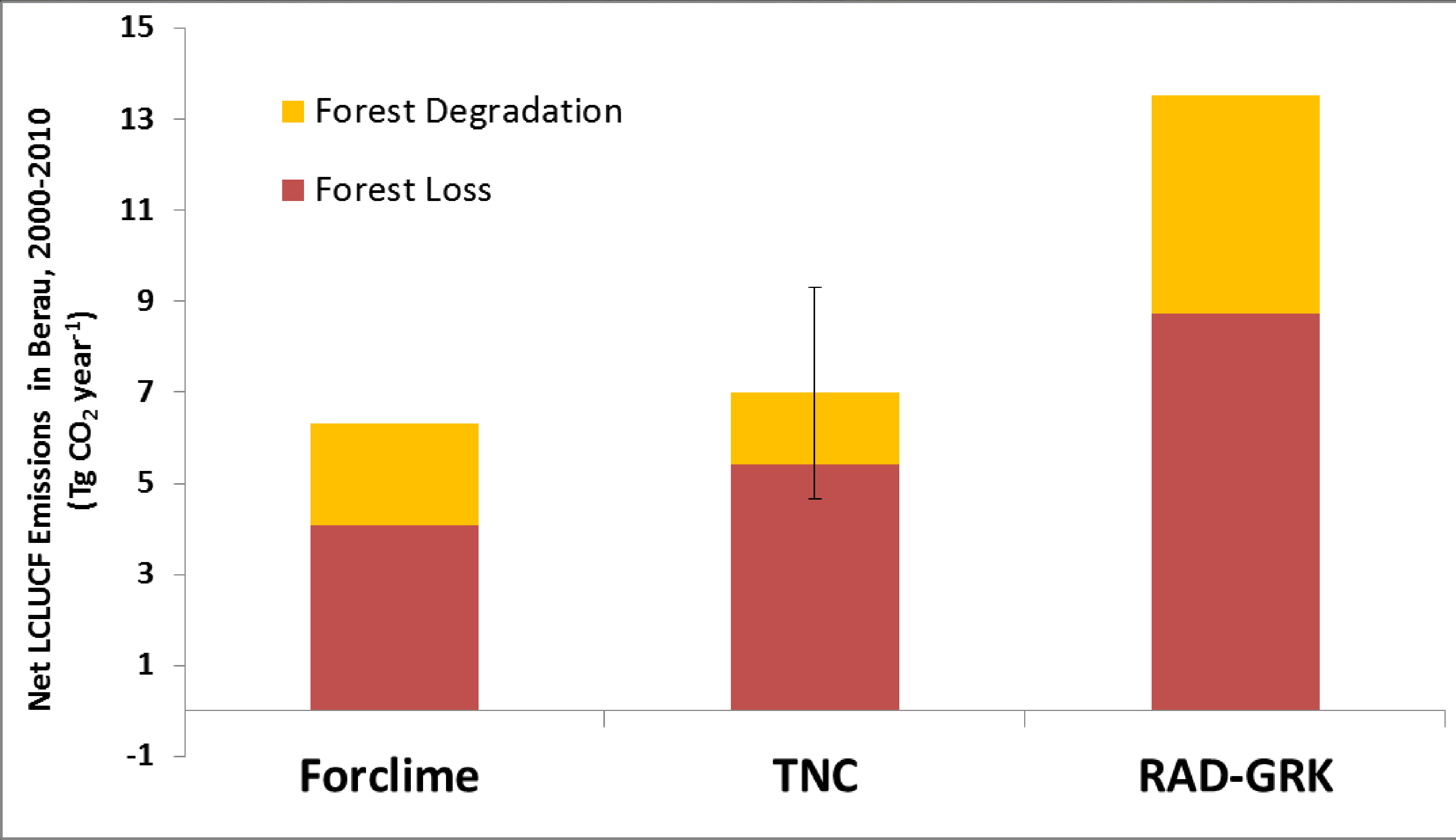
Step 4: Calculate emissions and uncertainty.



Step 11: Identify opportunities to reduce uncertainty.



Compare to Other Estimates



Compare to Other Studies

	Forclime	**TNC**	**MOFOR**
Method	Stock-difference	Gain-loss	Stock-difference
Activity Data	Foclime Landcover Maps	Hansen + Benchmark Biomass Map	MOFOR Landcover Maps
C Stocks Data	MOFOR plots, **other?**	GLAS footprints (Baccini)	MOFOR Plots
Fluxes	Loss, Logging, Regrowth	Loss, Logging, Regrowth	Loss, (Logging), Regrowth
Pools	AG, BG	AG, BG, **SC, DC**	AG, BG?
Loss Factor	Conversion-based	Process- Based	Conversion Based

Historic LULUCF Carbon Emissions in Berau