SEEG
Sistema de Estimativa de Emissão de Gases do Efeito Estufa

**Technical Workshop for GHG Emissions Estimation: Exploring the SEEG Framework for India**

Observatório do Clima

# Land Use Sector: Methods

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Imazon

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Workshop Support:

VASUDHA FOUNDATION Green ways to good earth! | SHAKTI SUSTAINABLE ENERGY FOUNDATION | OAK FOUNDATION | EDF ENVIRONMENTAL DEFENSE FUND Finding the ways that work

# Land Use Change

## *GHG Emissions 1990-2013*

SEEG
Sistema de Estimativa de Emissão de Gases do Efeito Estufa


***Technical Team***

- Amintas Brandão Jr.
- Brenda Brito
- Carlos Souza Jr.



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Observatório do Clima

# Presentation Layout

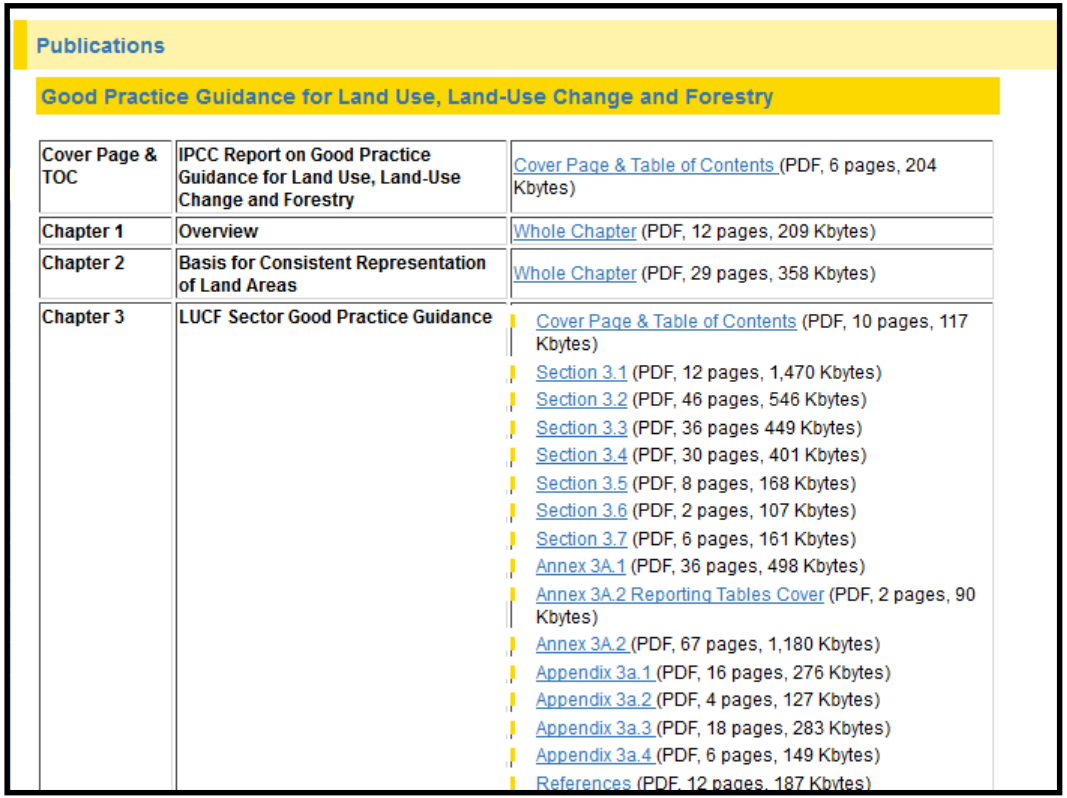


1. Background
2. Method 1 – Inventory approach
3. Method 2 – Deforestation approach (proxy)
4. Lessons learned
5. Challegens

# Background

# IPCC Guidelines





**Publications**

**Good Practice Guidance for Land Use, Land-Use Change and Forestry**

| | | |
|---|---|---|
| **Cover Page & TOC** | **IPCC Report on Good Practice Guidance for Land Use, Land-Use Change and Forestry** | Cover Page & Table of Contents (PDF, 6 pages, 204 Kbytes) |
| **Chapter 1** | **Overview** | Whole Chapter (PDF, 12 pages, 209 Kbytes) |
| **Chapter 2** | **Basis for Consistent Representation of Land Areas** | Whole Chapter (PDF, 29 pages, 358 Kbytes) |
| **Chapter 3** | **LUCF Sector Good Practice Guidance** | Cover Page & Table of Contents (PDF, 10 pages, 117 Kbytes)<br>Section 3.1 (PDF, 12 pages, 1,470 Kbytes)<br>Section 3.2 (PDF, 46 pages, 546 Kbytes)<br>Section 3.3 (PDF, 36 pages 449 Kbytes)<br>Section 3.4 (PDF, 30 pages, 401 Kbytes)<br>Section 3.5 (PDF, 8 pages, 168 Kbytes)<br>Section 3.6 (PDF, 2 pages, 107 Kbytes)<br>Section 3.7 (PDF, 6 pages, 161 Kbytes)<br>Annex 3A.1 (PDF, 36 pages, 498 Kbytes)<br>Annex 3A.2 Reporting Tables Cover (PDF, 2 pages, 90 Kbytes)<br>Annex 3A.2 (PDF, 67 pages, 1,180 Kbytes)<br>Appendix 3a.1 (PDF, 16 pages, 276 Kbytes)<br>Appendix 3a.2 (PDF, 4 pages, 127 Kbytes)<br>Appendix 3a.3 (PDF, 18 pages, 283 Kbytes)<br>Appendix 3a.4 (PDF, 6 pages, 149 Kbytes)<br>References (PDF, 12 pages, 187 Kbytes) |

# IPCC Guidelines



## Assumptions

1- Os fluxos de carbono de e para a atmosfera são produto das mudanças nos estoques de carbono da biomassa e do solo;

2- Essas mudanças dependem das taxas de mudanças do uso da terra e da prática que causou a mudança (ex.: queima de floresta, exploração madeireira, etc).

# IPCC: Tiers

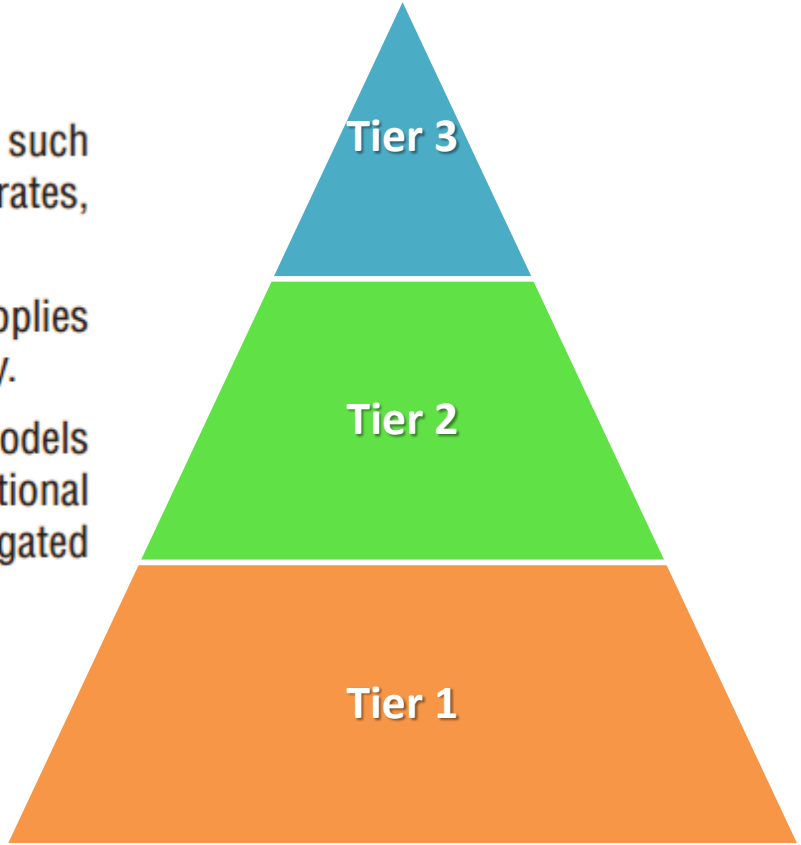


Tier-I approach employs activity data that is relatively coarse, such as nationally or globally available estimates of deforestation rates, agricultural production statistics, and global land cover maps.

Tier-II uses the same methodological approach as Tier 1 but applies emission factors and activity data that are defined by the country.

Tier-III approach uses higher order methods, including models and inventory measurement systems tailored to address national circumstances, repeated over time and driven by disaggregated levels.

Source: India (2012)



# Method 1 – Inventory approach

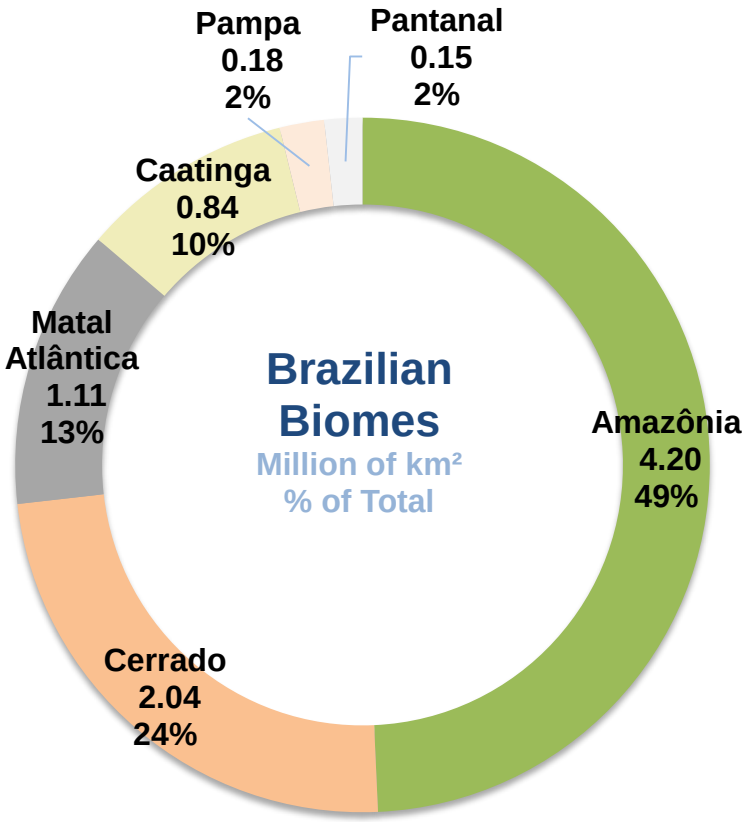
# Inventory approach (simplified)



- IPCC: Tier 2
- Land Use maps (primary data)
- Biomass maps (Amazonia) and Literature (others biomes)
- Emissions and Removals of GHG

# Brazilian biomes



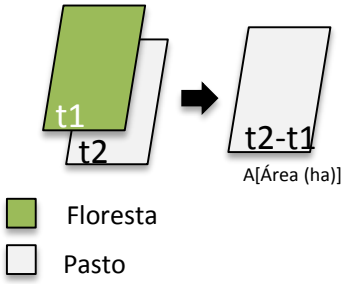




Fonte: MCTI (2010)

# Emissions: simplified diagram



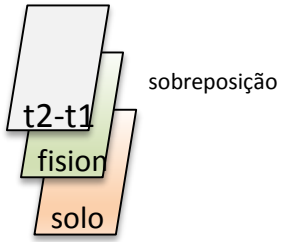
## Step 1: calculate the type and amount of transition (ha)




***Exemplo***
Floresta Não Manejada (FNM) para Pastagem Plantada (Ap)

A = FNM - Ap

## Step 2: identify where the transition happened (vegetation and soil)




***Exemplo***
FNM – Ap em
*Floresta Ombrófila Aberta Montana (Am) – Grupo fisio (V1)
*Solo latossolo (S1)

Ci = Estoque médio de carbono na fisionomia (tCha-1)

Csolo = Estoque médio de carbono no solo (tCha-1)

## Step 3: use the correct equation to estimate the emission/removal

E = A (ha) * Carbono (tC/ha)

Área calculada na Transição

Resultado da sobreposição entre fisionomia e solo

***Exemplo***
Emissão acima do solo
Ei = A x (Ci – Pec)

Emissão do estoque de carbono do solo
Esi = A x Csolo x (fc(t0)-fc(t1))x(t/2)/20

fc = fator de alteração do carbono

Emissão total
E = Ei + Esi

# Emission: main equations



**Abordagem 1: Método dos incrementos e perdas.**

$$\Delta C = \sum_{ijk} A_{ijk} \times (C_I - C_L)_{ijk}$$

Onde:
$C$: Mudanças no estoque de carbono em toneladas por hectare
$C_I, C_L$: Incrementos e perdas anuais de carbono, em toneladas por hectare/ano
A: Área de terra em hectares
Ijk: índices que correspondem ao tipo de clima i, tipo de vegetação j, e prática de manejo k

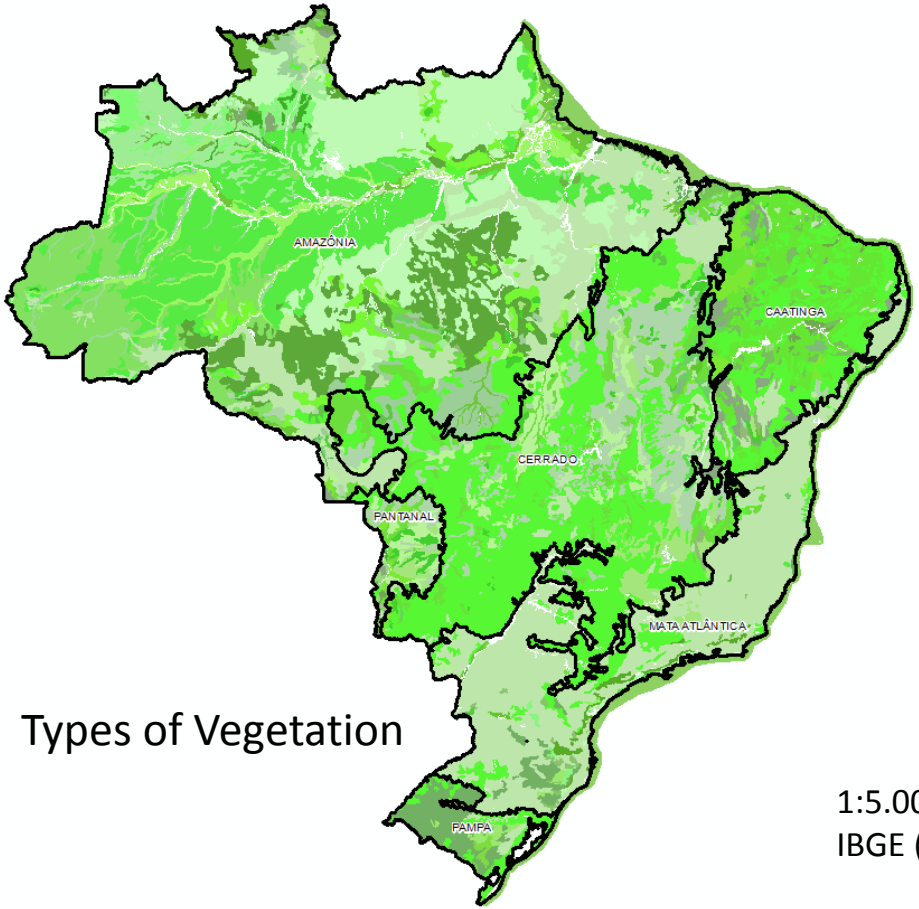
**Abordagem 2: Método das duas medições de estoques de carbono**

$$\Delta C = \sum_{ijk} (C_{t2} - C_{t1})/(t2 - t1)$$

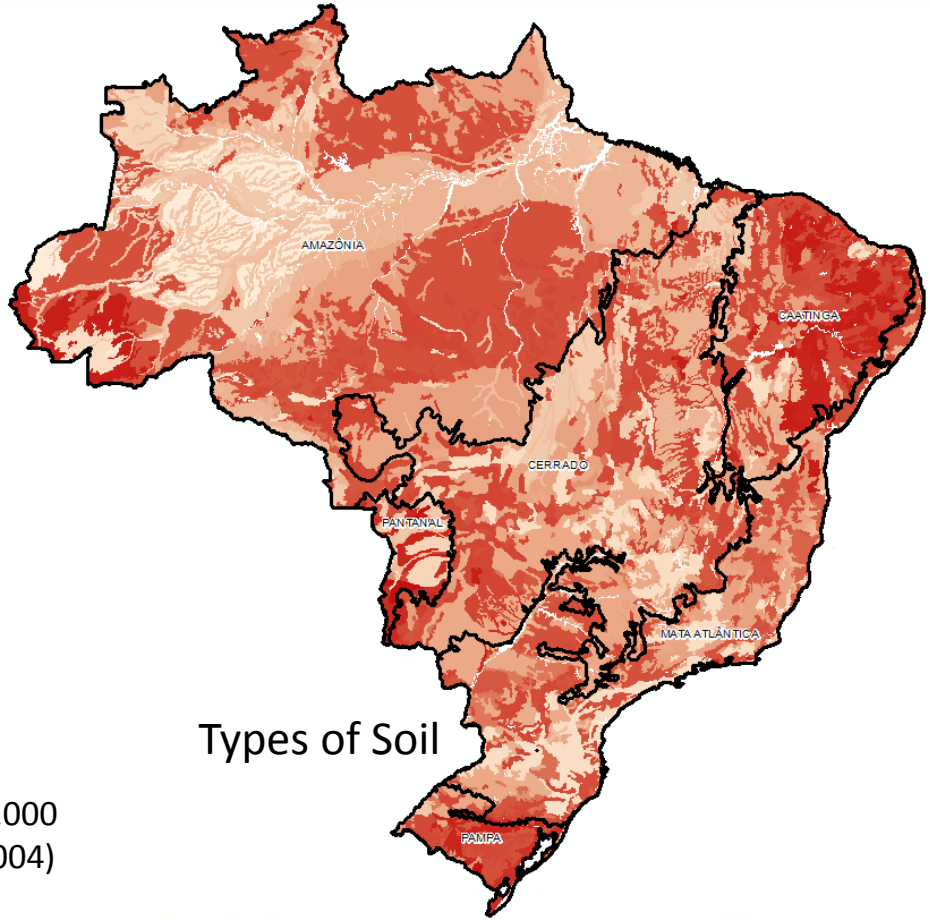
Onde:
$\Delta C$: Mudanças no estoque de carbono em toneladas por hectare
$C_{t1}, C_{t2}$: Estoques de carbono do reservatório nos tempos no início e final do período considerado.
$t1, t2$: ano de início e fim do período considerado.

# Maps: vegetation and soil






Types of Vegetation




Types of Soil

1:5.000.000
IBGE (2004)

# Removals: simplified diagram



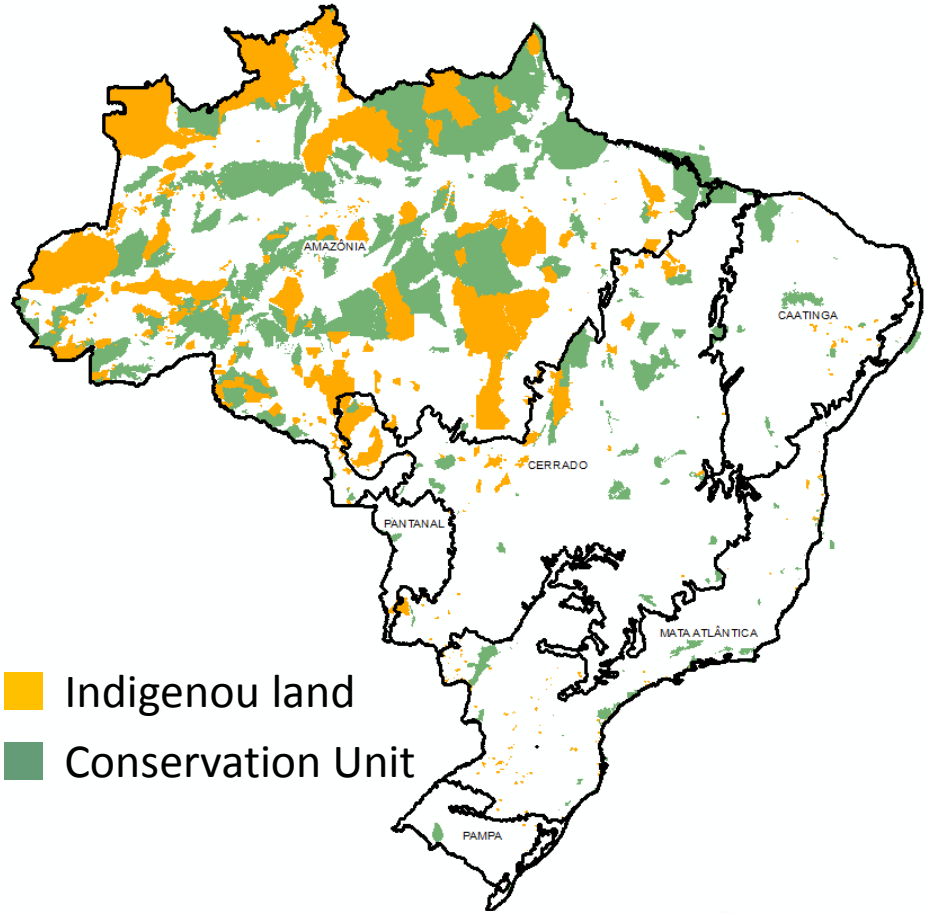
Protected Area (ha)

✖

Removal factor 0.62tCha-1Year-1

=

Removal of emissions tCha-1Year-1



# Land use Map: legends



## Brazilian Maps IPCC

**Tabela 3** - Categorias de uso da terra

| Abreviatura | Categoria | Categoria IPCC |
|---|---|---|
| FNM | Floresta não manejada | Floresta (*Forest*) |
| FM | Floresta manejada | |
| FSec | Floresta secundária | |
| CS | Floresta com extração seletiva | |
| Ref | Reflorestamento | |
| GNM | Campo não manejado | Campo (*Grassland*) |
| GM | Campo manejado | |
| GSec | Campo com vegetação secundária | |
| Ap | Pastagem plantada | |
| Ac | Área agrícola | Área agrícola (*Cropland*) |
| S | Área urbana | Área urbana (*Settlements*) |
| A | Rios e lagos (área não manejada) | Área alagada (*Wetlands*) |
| Res | Reservatórios (área manejada) | |
| O | Outros usos | Outros usos (*Other land*) |
| NO | Área não observada | |

# Transition Matrix



| Abreviatura | Categoria |
|---|---|
| FNM | Floresta não manejada |
| FM | Floresta manejada |
| FSec | Floresta secundária |
| CS | Floresta com extração seletiva |
| Ref | Reflorestamento |
| GNM | Campo não manejado |
| GM | Campo manejado |
| GSec | Campo com vegetação secundária |
| Ap | Pastagem plantada |
| Ac | Área agrícola |
| S | Área urbana |
| A | Rios e lagos (área não manejada) |
| Res | Reservatórios (área manejada) |
| O | Outros usos |
| NO | Área não observada |

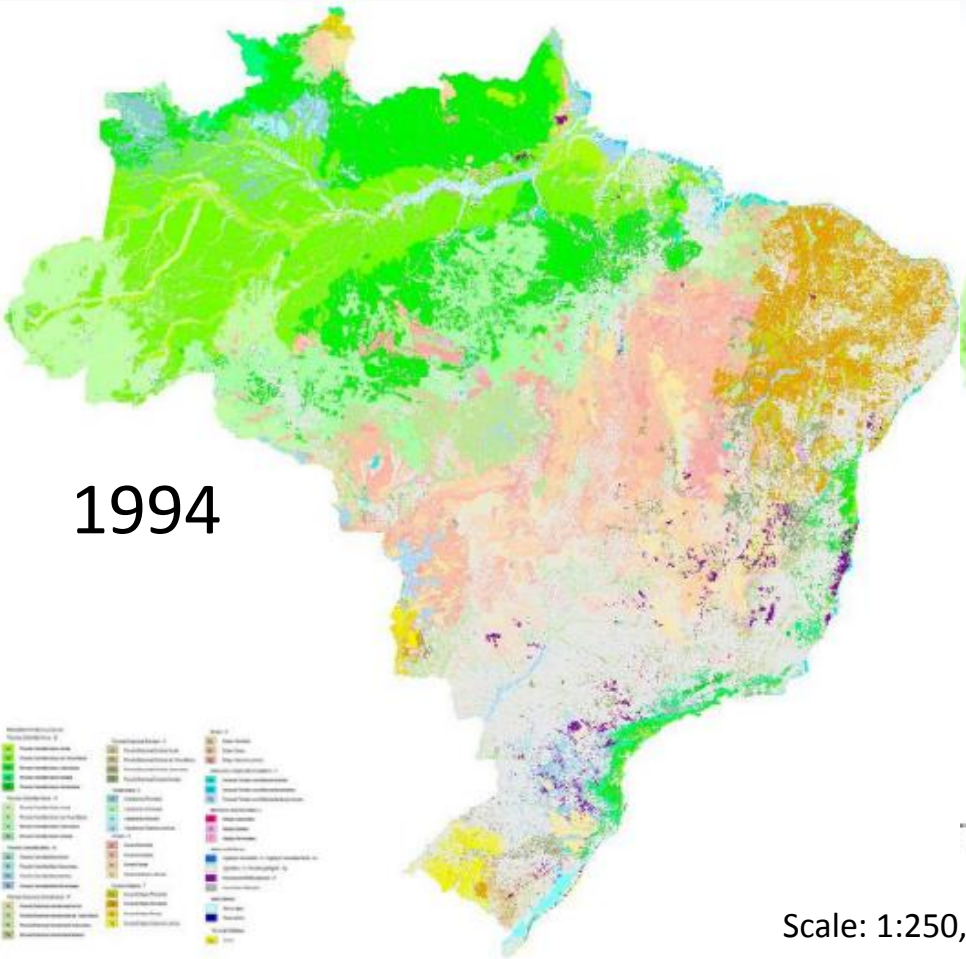
Células escuras são transições não-permissíveis ou desprezíveis para efeito de calculo de emissões.

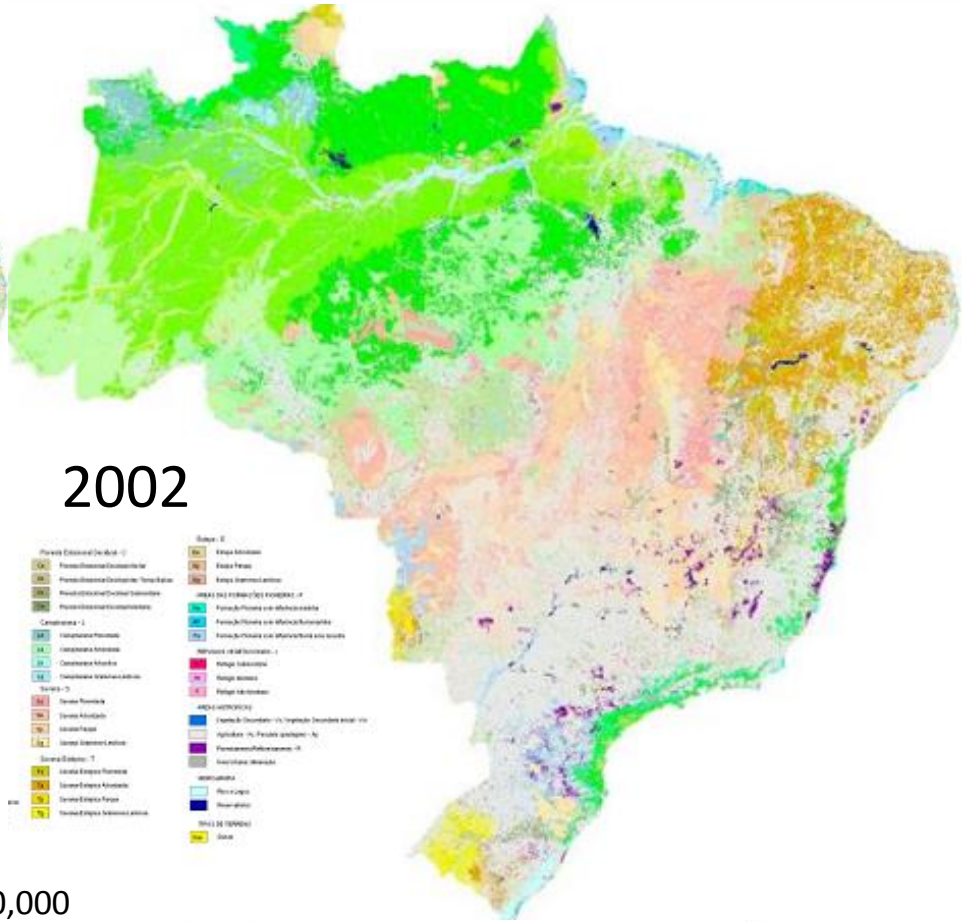
**Tabela 5** - Matriz de transições possíveis

| | | 2002 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FNM | FM | FSec | Ref | CS | GNM | GM | GSec | Ap | Ac | S | A | Res | O | NO |
| 1994 | FNM | | | | | | ■ | ■ | ■ | | | | ■ | | | |
| | FM | ■ | | | | | ■ | ■ | ■ | | | | ■ | | | |
| | FSec | ■ | ■ | | | ■ | ■ | ■ | ■ | | | | ■ | | | |
| | Ref | ■ | ■ | | | ■ | ■ | ■ | | | | | ■ | | | |
| | CS | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| | GNM | ■ | ■ | ■ | | ■ | | | | | | | ■ | | | |
| | GM | ■ | ■ | ■ | | ■ | ■ | | | | | | ■ | | | |
| | GSec | ■ | ■ | ■ | | ■ | ■ | ■ | | | | | ■ | | | |
| | Ap | ■ | ■ | | | ■ | ■ | ■ | | | | | ■ | | | |
| | Ac | ■ | ■ | | | ■ | ■ | ■ | | | | | ■ | | | |
| | S | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | |
| | A | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | |
| | Res | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | |
| | O | ■ | ■ | | | ■ | ■ | ■ | | | | | | | | |
| | NO | | | | | | | | | | | | | | | |

# Land Cover/Use Maps (example)






Scale: 1:250,000

# Transition Matrix (example)

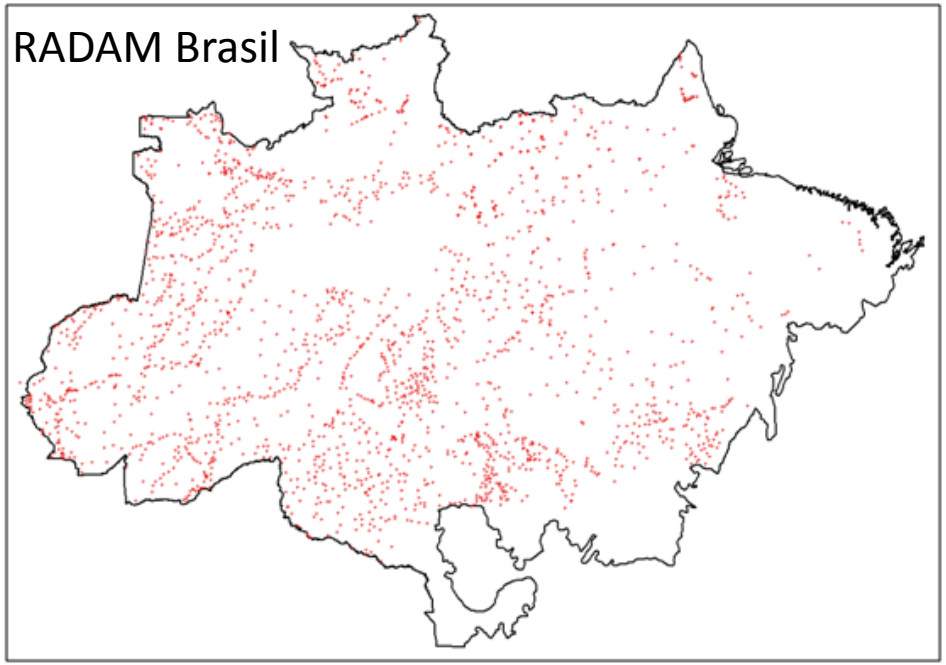


**Tabela 31** - Áreas das transições identificadas no Brasil no período 1994 a 2002 (em hectares)

| | | Uso da Terra em 2002 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FNM | FM | FSec | Ref | CS | GNM | GM | GSec | Ap | Ac | S | A | Res | O | NO | Total 1994 |
| Uso da Terra em 1994 | FNM | 380.334.740 | 67.211.736 | 119.957 | 97.953 | 255.844 | | | | 23.704.282 | 7.269.559 | 204.357 | | 139.916 | 12.477 | 1.042 | 479.351.863 |
| | FM | | 64.282.538 | 12.967 | 6.447 | 3.268 | | | | 727.289 | 85.143 | 22.997 | | 429 | 5.069 | 0 | 65.146.147 |
| | FSec | | | 55.743 | 641 | | | | | 685.481 | 169.927 | 1.138 | | 1 | 715 | 0 | 913.646 |
| | Ref | | | 56 | 5.606.076 | | | | 0 | 96.422 | 64.064 | 1.402 | | 36 | 0 | 0 | 5.768.056 |
| | CS | | | | | | | | | | | | | | | | 0 |
| | GNM | | | | 33.076 | | 50.239.117 | 6.107.088 | 185 | 2.404.383 | 2.095.423 | 39.959 | | 6.319 | 387 | 6 | 60.925.944 |
| | GM | | | | 95 | | | 4.785.945 | 25 | 24.262 | 58.937 | 559 | | 0 | 0 | 0 | 4.869.823 |
| | GSec | | | | 216 | | | | 2.694 | 13.137 | 717 | 48 | | 0 | 0 | 0 | 16.813 |
| | Ap | | | 994.827 | 88.301 | | | | 8.429 | 108.107.791 | 2.896.830 | 263.004 | | 1.787 | 2.946 | 1.598 | 112.365.513 |
| | Ac | | | 75.328 | 84.414 | | | | 175 | 3.188.716 | 97.555.719 | 224.906 | | 774 | 740 | 5 | 101.130.776 |
| | S | | | | | | | | | | | 2.359.127 | | | | 0 | 2.359.127 |
| | A | | | | | | | | | | | | 14.289.017 | 66.445 | 67 | 0 | 14.355.529 |
| | Res | | | | | | | | | | | | | 1.489.299 | | 0 | 1.489.299 |
| | O | | | 10 | 21 | | | | 0 | 11.446 | 534 | 1.425 | 472 | 0 | 310.330 | 0 | 324.238 |
| | NO | 0 | 0 | 309 | 2.863 | 321 | 0 | 0 | 0 | 779.265 | 148.807 | 4.851 | 0 | 97 | 1.796 | 15.079 | 953.388 |
| | Total 2002 | 380.334.740 | 131.494.273 | 1.259.197 | 5.920.103 | 259.433 | 50.239.117 | 10.893.033 | 11.508 | 139.742.473 | 110.345.662 | 3.123.773 | 14.289.489 | 1.705.101 | 334.527 | 17.730 | 849.970.160 |

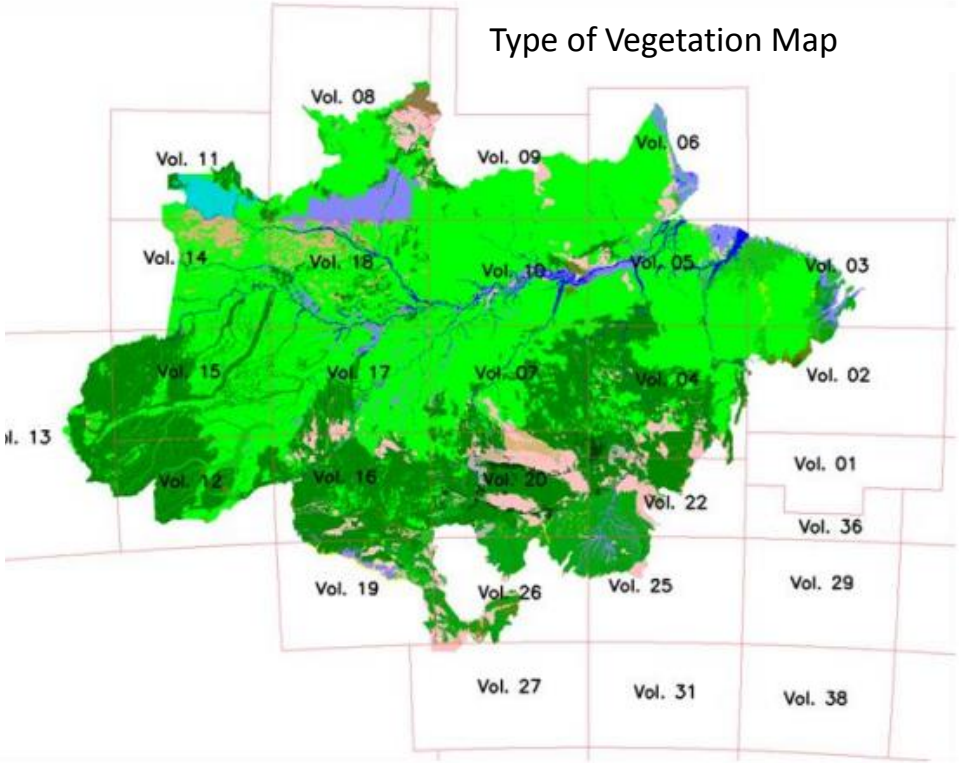
# Biomass Map Amazonia





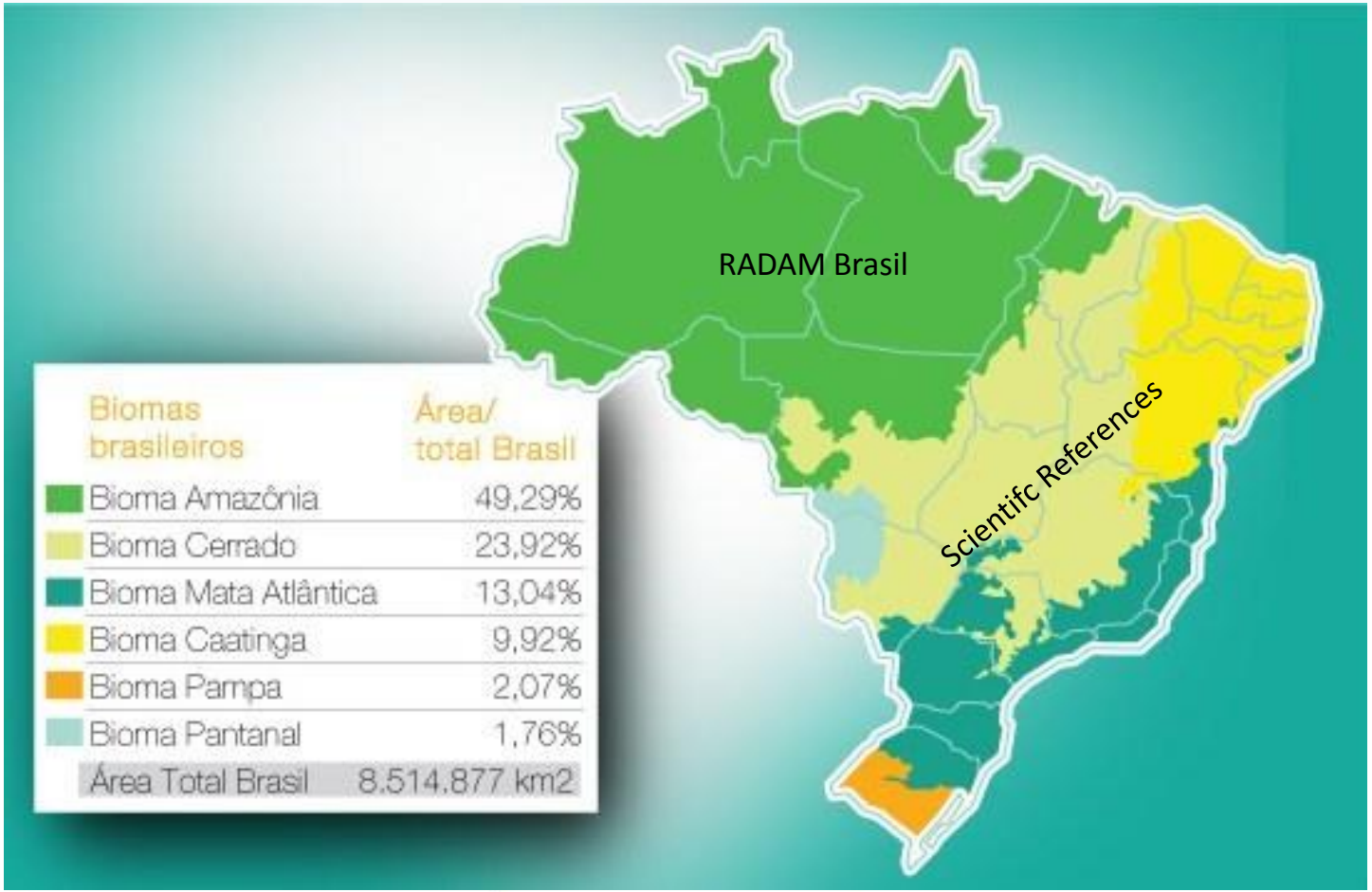

Sample points from (1971 – 1986)

Type of Vegetation Map



# Biomass info – Other Biomes





# Equations for each transition



| Transições | A | Ac | Ap | CS | FM | FNM | FSec | GM | GNM | GSec | NO | O | Ref | Res | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 0 | | | | | | | | | | | A*(S-O) | | 0 | |
| Ac | | 0.0 | A*(AvAgr-Pec) | | | | A*(AvAgr-Rebf*(T/2)) | | | A*(AvAgr-RebG*(T/2)) | | A*(avAgr-O) | A*(AvAgr-(IncrRef*(T/2))) | A*(avAgr-Res) | A*(avAgr-S) |
| Ap | | A*(Pec-avAgr) | 0.0 | | | | A*(pec-Rebf*(T/2)) | | | A*(Pec-RebG*(T/2)) | | A*(Pec-O) | A*(Pec-IncrRef(T/2)) | A*(Pec-Res) | A*(Pec-S) |
| CS | | | | | | | | | | | | | | | A*(C-S) |
| FM | | | A*(C-Pec) | A*(C-(C*pCS)) | A*Remf*T | | A*(C-(Rebf*(T/2))) | | | | | A*(C-O) | A*(C-(IncrRef*(T/2))) | A*(C-Res) | A*(C-S) |
| FNM | | A*(C-avAgr) | A*(C-Pec) | A*(C-(C*pCS)) | A*Remf*(T/2) | 0.0 | A*(C-(Rebf*(T/2))) | | | | | A*(C-O) | A*(C-(IncrRef*(T/2))) | A*(C-Res) | A*(C-S) |
| FSec | | A*(C*avFsec-avAgr) | A*(C*avFsec-Pec) | | | | A*Refb*T | | | | | A*(C-avFsec-O) | A*(C*avFsec-(IncrRef*(T/2))) | A*(C*avFsec-Res) | A*(C*avFsec-S) |
| GM | | A*(C-avAgr) | A*(C-Pec) | | | | | 0.0 | | A*(C-RebG*(T/2)) | | A*(C-O) | A*(C-IncrRef*(T/2)) | A*(C-Res) | A*(C-S) |
| GNM | | A*(C-avAgr) | A*(C-Pec) | | | | | 0 | 0 | A*(C-RebG*(T/2)) | | A*(C-O) | A*(C-IncrRef*(T/2)) | A*(C-Res) | |
| GSec | | A*(C*avGsec-avAgr) | A*(C*avGsec-Pec) | | | | | | | A*RebG*T | | A*(C-avGsec-O) | A*(C*avGsec-incrRef*(T/2)) | A*(C-avGsec-Res) | A*(C*avGsec-S) |
| NO | | | | | | | | | | | | | | | |
| O | | A*(O-avAgr) | A*(O-Pec) | | | | A*(O-Rebf*(T/2)) | | | A*(O-RebG*(T/2)) | | 0.0 | A*(O-IncrRef*(T/2)) | A*(O-Res) | A*(O-S) |
| Ref | | A*(avRef-avAgr) | A*(avRef-Pec) | | | | A*(AvRef-(Rebf*(T/2))) | | | A*(AvRef-RebG*(T/2)) | | A*(avRef-O) | 0.0 | A*(avRef-Res) | A*(avRef-S) |

All equations are based on IPCC guidelines

# Emissions/Removals for each transition



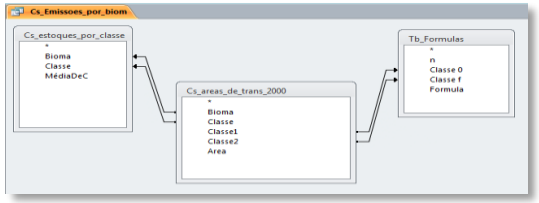
**Tabela 32** - Emissões líquidas de $CO_2$ no Brasil no período 1994 a 2002 (em Gg)

| | | Uso da Terra em 2002 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FNM | FM | FSec | Ref | CS | GNM | GM | GSec | Ap | Ac | S | A | Res | O | NO | Total 1994 |
| Uso da Terra em 1994 | FNM | 0,0 | -611.178,7 | 56.600,5 | 26.552,9 | 40.777,1 | | | | 8.934.056,6 | 2.148.849,4 | 81.094,5 | | 64.609,7 | 5.501,6 | 0,0 | 10.746.863,5 |
| | FM | | -1.169.085,1 | 6.251,3 | 1.775,0 | 720,9 | | | | 356.771,5 | 42.239,1 | 8.026,5 | | 220,7 | 2.943,5 | 0,0 | -750.136,5 |
| | FSec | | | -9.540,8 | 15,3 | | | | | 98.241,1 | 30.529,9 | 264,5 | | 0,1 | 144,7 | 0,0 | 119.654,8 |
| | Ref | | | 6,2 | 0,0 | | | | 0,0 | 15.412,4 | 11.243,1 | 348,5 | | 8,2 | 0,0 | 0,0 | 27.018,4 |
| | CS | | | | | | | | | | | | | | | | 0,0 |
| | GNM | | | | -3.608,9 | | 0,0 | 0,0 | 7,4 | 125.953,9 | 143.478,8 | 4.352,6 | | 748,4 | 40,0 | 0,0 | 270.972,1 |
| | GM | | | | -12,0 | | | 0,0 | 0,3 | 1.054,9 | 3.690,4 | 52,6 | | 0,0 | 0,0 | 0,0 | 4.786,2 |
| | GSec | | | | -34,3 | | | | -118,6 | 20,4 | 15,1 | 2,2 | | 0,0 | 0,0 | 0,0 | -115,2 |
| | Ap | | | -46.638,4 | -14.565,0 | | | | 56,1 | 0,0 | 57.256,5 | 15.712,4 | | 96,1 | 180,7 | 0,0 | 12.098,4 |
| | Ac | | | -4.493,5 | -14.408,9 | | | | 0,2 | -50.588,3 | 0,0 | 10.194,6 | | 26,3 | 26,5 | 0,0 | -59.243,1 |
| | S | | | | | | | | | | | 0,0 | | | | 0,0 | 0,0 |
| | A | | | | | | | | | | | | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| | Res | | | | | | | | | | | | | 0,0 | | 0,0 | 0,0 |
| | O | | | -0,8 | -3,9 | | | | 0,0 | -712,8 | -22,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | -740,1 |
| | NO | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| | Total 2002 | 0,0 | -1.780.263,8 | 2.184,5 | -4.289,9 | 41.498,0 | 0,0 | 0,0 | -54,5 | 9.480.209,6 | 2.437.279,9 | 120.048,4 | 0,0 | 65.709,5 | 8.836,9 | 0,0 | 10.371.158,7 |

# What Imazon did



- Access Tool

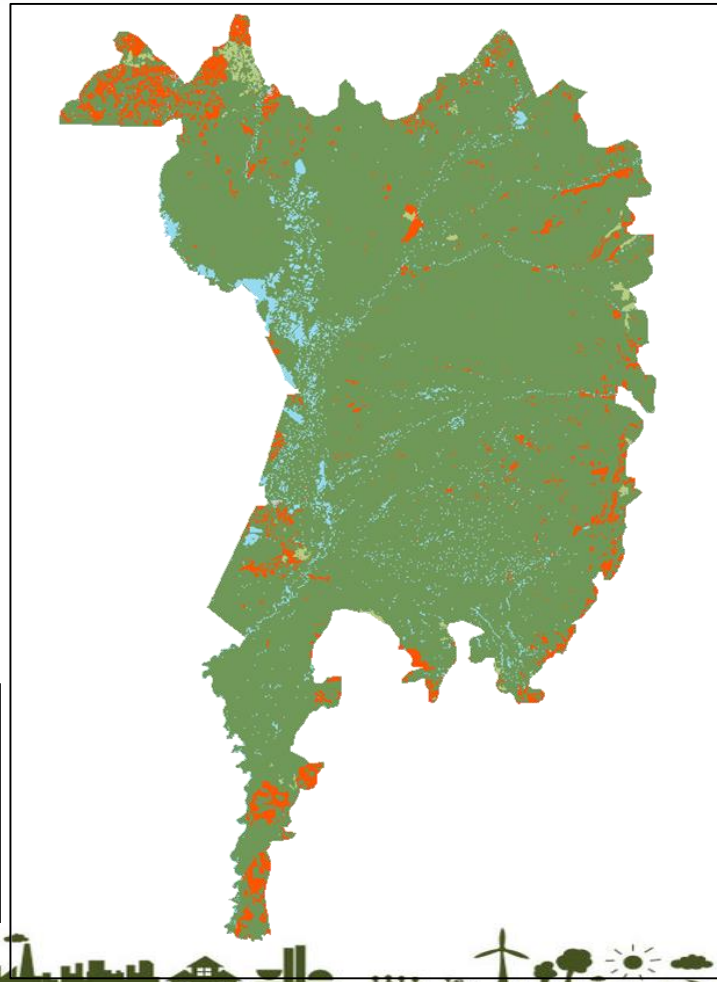



- Calibration and validation with inventory maps (1994-2002)

# Example – Pantanal Biome




Inventory Shapefiles



Attribute Table from the Shapefiles

Attributes of TRANSICAO_CO2_PANTANAL_pol

| FID | Shape | linkcolumn | bioma | volradam | uf | geocodigo | municipio | reseigena | ano_ai | ano_uc | c_agp_solo | c_agrp_veg | c_pret | c_1994 | c_2002 | cagr_1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Polygon | 1 | PANTANA | Vol. 26 | MT | 5102504 | Cáceres | | 0 | 0 | S1 | V4 | CS | AP | VS | Ap |
| 1 | Polygon | 10 | PANTANA | Vol. 26 | MT | 5102504 | Cáceres | | 0 | 0 | S1 | V4 | CS | | AP | FNM |
| 2 | Polygon | 100 | PANTANA | Vol. 26 | MT | 5102504 | Cáceres | | 0 | 0 | S1 | V9 | SA | | AP | FNM |
| 3 | Polygon | 1000 | PANTANA | Vol. 26 | MT | 5102504 | Cáceres | | 0 | 0 | S2 | V5 | FA | | AP | FNM |
| 4 | Polygon | 10000 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 5 | Polygon | 10001 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 6 | Polygon | 10002 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 7 | Polygon | 10003 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 8 | Polygon | 10004 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 9 | Polygon | 10005 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 10 | Polygon | 10006 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |
| 11 | Polygon | 10007 | PANTANA | Vol. 27 | MS | 5001102 | Aquidauana | | 0 | 0 | XXXXXX | XXXXXX | RIOS_LAGOS | RIOS_LAGOS | RIOS_LAGOS | A |

# Example – Pantanal Biome



Brazilian Inventory

**Tabela 30** - Emissões líquidas de $CO_2$ no bioma Pantanal no período 1994 a 2002 (em Gg)

| Uso da Terra em 1994 | Uso da Terra em 2002 | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FNM | FM | FSec | Ref | CS | GNM | GM | GSec | Ap | Ac | S | A | Res | O | NO | Total 1994 |
| FNM | | -984,49 | | | | | | | 115.722,02 | 14.055,53 | 924,14 | | 9,66 | 174,26 | | 129.901,1 |
| FM | | -3.755,91 | | | | | | | 18,56 | 0,05 | | | | | | -3.737,3 |
| FSec | | | | | | | | | | | | | | | | 0,0 |
| Ref | | | | | | | | | | | | | | | | 0,0 |
| CS | | | | | | | | | | | | | | | | 0,0 |
| GNM | | | | | | | | | 3.865,30 | 328,48 | 0,74 | | | | | 4.194,5 |
| GM | | | | | | | | | | | | | | | | 0,0 |
| GSec | | | | | | | | | | | | | | | | 0,0 |
| Ap | | | -273,34 | | | | | 1,88 | | 1.022,03 | 36,95 | | | | | 787,5 |
| Ac | | | -0,21 | | | | | | -1.757,62 | | | | | | | -1.757,8 |
| S | | | | | | | | | | | | | | | | 0,0 |
| A | | | | | | | | | | | | | | | | 0,0 |
| Res | | | | | | | | | | | | | | | | 0,0 |
| O | | | | | | | | | -14,76 | -0,50 | | | | | | -15,3 |
| NO | | | | | | | | | | | | | | | | 0,0 |
| Total 2002 | 0,0 | -4.740,4 | -273,6 | 0,0 | 0,0 | 0,0 | 0,0 | 1,9 | 117.833,6 | 15.405,6 | 961,9 | 0,0 | 9,7 | 174,3 | 0,0 | 129.372,9 |

Imazon Tool

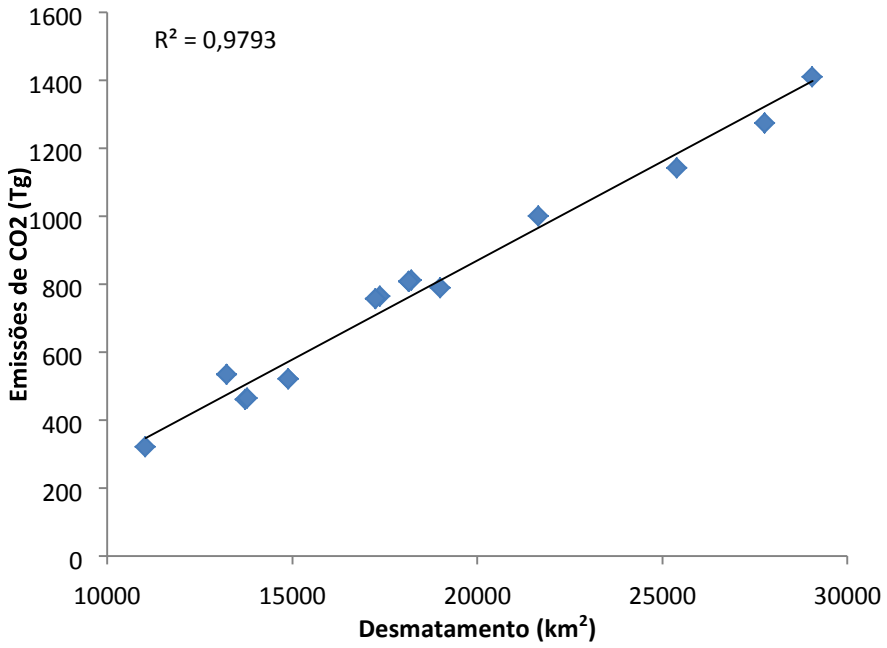
| classe1 | FNM | FM | FSec | Ref | CS | GNM | GM | GSec | Ap | Ac | S | A | Res | O | NO | Total | relatorio MCT | # | % de # |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FNM | 0.00 | -984.49 | | | | | | | 115,229.28 | 14,211.41 | 824.18 | | 8.30 | 152.49 | | **129,288.7** | 129,901 | 612 | 0% |
| FM | | -3,755.91 | | | | | | | 18.46 | 0.44 | | | | | | **-3,737.0** | 3,737 | 0 | 0% |
| Fsec | | | | | | | | | | | | | | | | | | | |
| Ref | | | | | | | | | | | | | | | | | | | |
| CS | | | | | | | | | | | | | | | | | | | |
| GNM | | | | | | 0.00 | 0.00 | | 3,803.54 | 352.75 | 0.00 | | | | | **4,156.3** | 4,195 | 38 | 1% |
| GM | | | | | | | 0.00 | | | | | | | | | **0.0** | 0 | 0 | |
| GSec | | | | | | | | | | | | | | | | | 0 | 0 | |
| Ap | | | -267.57 | | | | | 2.06 | 0.00 | 1,204.58 | 17.38 | | | | | **956.5** | 788 | 169 | -21% |
| Ac | | | -0.21 | | | | | | -1,988.73 | 0.00 | | | | | | **-1,988.9** | 1,758 | 231 | -13% |
| S | | | | | | | | | | | 0.00 | | | | | **0.0** | | | |
| A | | | | | | | | | | | | 0.00 | 0.00 | 0.00 | | **0.0** | | | |
| Res | | | | | | | | | | | | | 0.00 | | | **0.0** | | | |
| O | | | | | | | | | -6.14 | -0.05 | | | | 0.00 | | **-6.2** | 15 | 21 | 140% |
| NO | | | | | | | | | -12.61 | | | | | | | **-12.6** | 0 | 13 | |
| **Total** | **0.00** | **0.00** | **-0.21** | **0.00** | | **0.00** | **0.00** | **0.00** | **-2,007.49** | **-0.05** | **0.00** | **0.00** | **0.00** | **0.00** | **0.00** | **128,656.7** | **129,373** | **716** | **0.55%** |

#<1%

# Method 2 – Deforestation approach (proxy)

# Deforestation - Proxy





# Deforestation - Proxy



| Biomes | Total (tCO2) | Average 1994-2002 (tCO2) |
|---|---|---|
| Amazônia | 8.465.226.000 | 1.058.153.250 |
| Cerrado | 2.622.510.540 | 327.813.817 |
| Caatinga | 343.820.831 | 42.977.604 |
| Mata Atlantica | 728.886.016 | 91.110.752 |
| Pampa | 136.159.616 | 17.019.952 |
| Pantanal | 757.050 | 94.631 |

# Deforestation - Proxy



| Biomes | Average 1994-2002 (km²/year) |
|---|---|
| Amazônia | 19.141 |
| Cerrado | 15.698 |
| Caatinga | 5.905 |
| Mata Atlantica | 2.617 |
| Pampa | 2 |
| Pantanal | 962 |

# Deforestation - Proxy

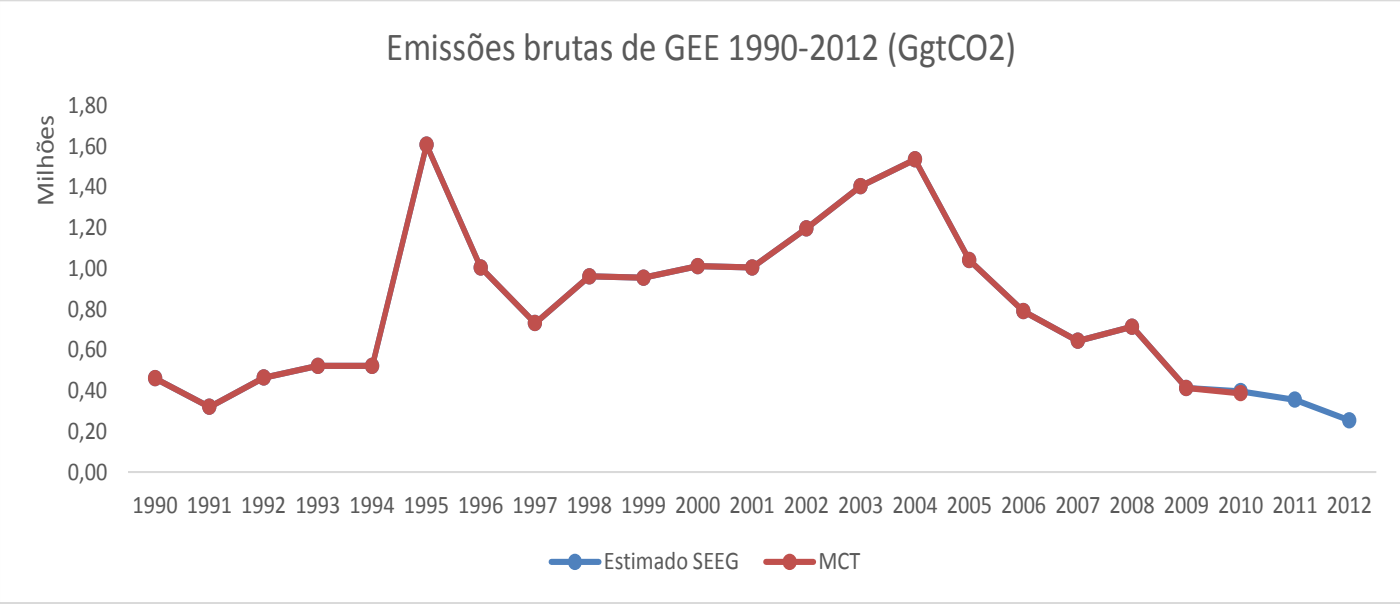


| Bioma | Dado | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| Amazônia | Deforestation ($km^2$) | 14.286 | 11.651 | 12.911 | 7.464 | 7.000 | 6.418 | 4.571 |
| | % from average (1994-2002) | 0,75 | 0,61 | 0,67 | 0,39 | 0,37 | 0,34 | 0,24 |

# Deforestation - Proxy



| Bioma | Data | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|---|---|---|
| **Amazônia** | Emissions ($tCO_2$) | 789.740 | 644.080 | 713.730 | 412.620 | 386.970 | 354.793 | 252.689 |



# Deforestation Data Available to Estimate the GHG Emissions from 1990-2013

| Biome | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Amazônia | | | | | | | | | | | | | | | PRODES |
| Caatinga | | | | | | | | | | | | | | | PMDBBS |
| Cerrado | | | | | | | | | | | | | | | PMDBBS and Lapig |
| Mata Atlântica | | | | | | | | | | | | | | | PMDBBS / SOS Mata Atlântica |
| Pampa | | | | | | | | | | | | | | | PMDBBS |
| Pantanal | | | | | | | | | | | | | | | PMDBBS |

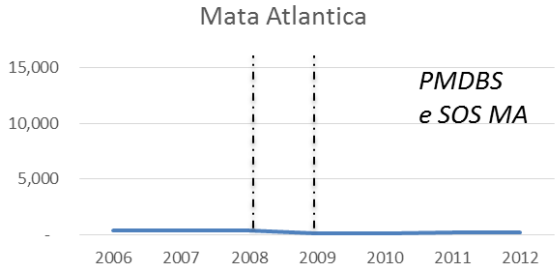
**Transition**
**Forest - Deforestation**

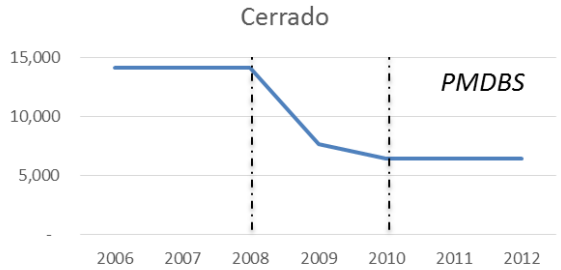
**Estimated Annual Deforestation Rate (km²/n years)**

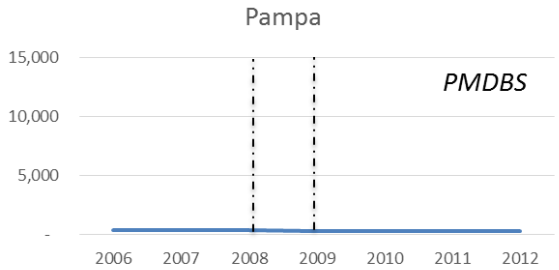
**Mapped Deforestation Rate (km²/year)**

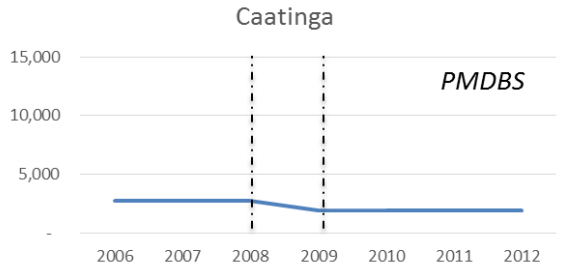
# Deforestation - Proxy

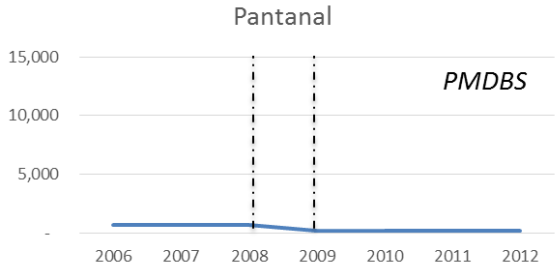


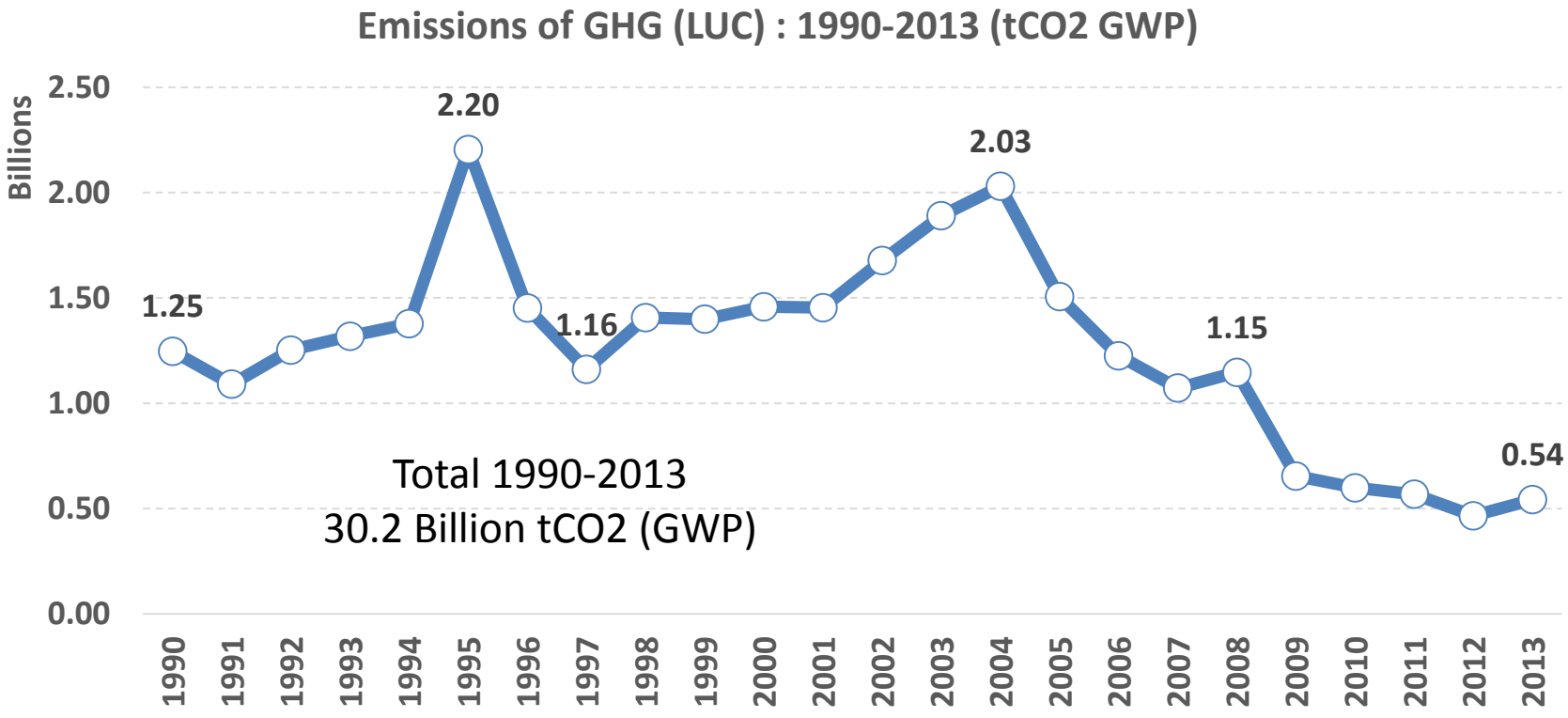



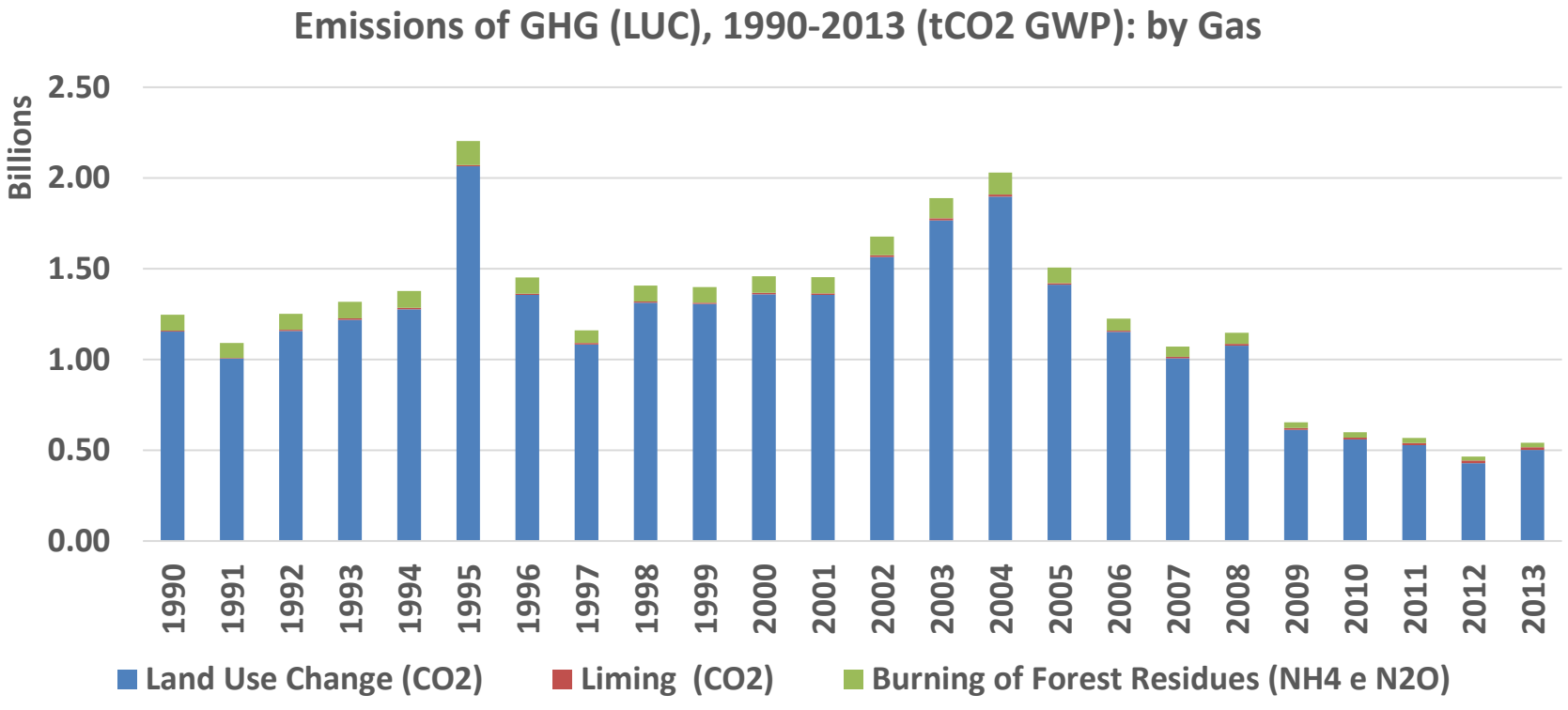



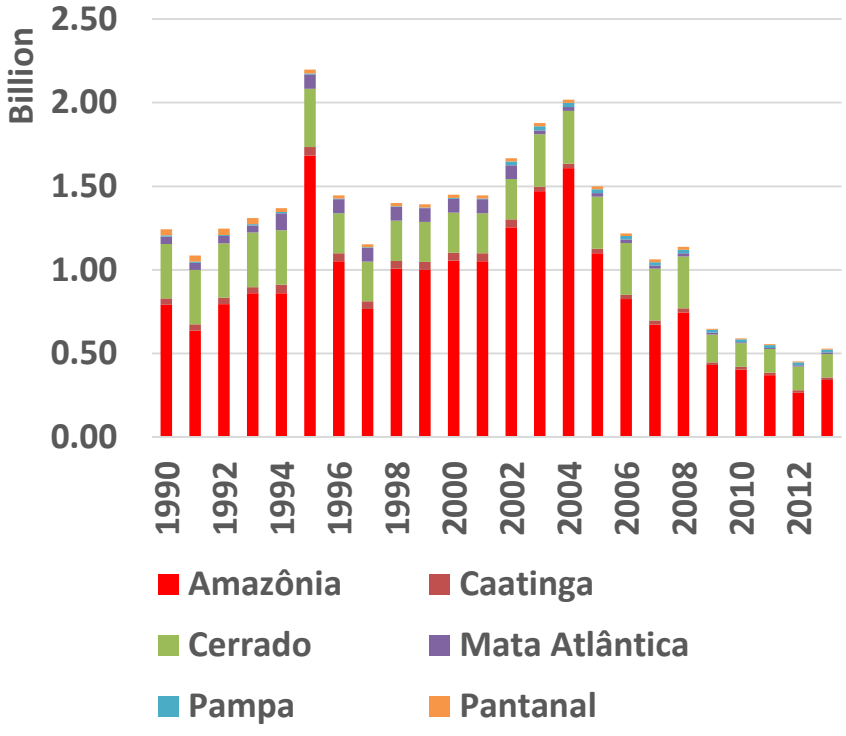




Emissions of GHG (LUC) : 1990-2013 (tCO2 GWP)
Billions
2.50
2.00
1.50
1.00
0.50
0.00
1.25
2.20
1.16
2.03
1.15
0.54
Total 1990-2013
30.2 Billion tCO2 (GWP)
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

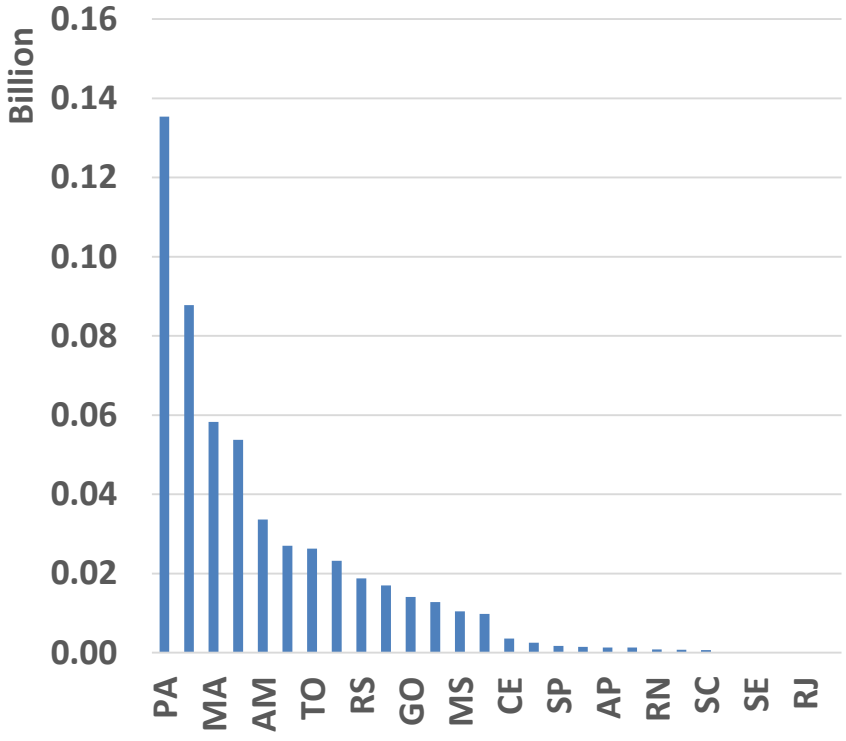

Emissions of GHG (LUC), 1990-2013 (tCO2 GWP): by Gas
Billions
2.50
2.00
1.50
1.00
0.50
0.00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Land Use Change (CO2)
Liming (CO2)
Burning of Forest Residues (NH4 e N2O)

## Emissions of GHG (LUC), 1990-2013 (tCO2 GWP): by Biome

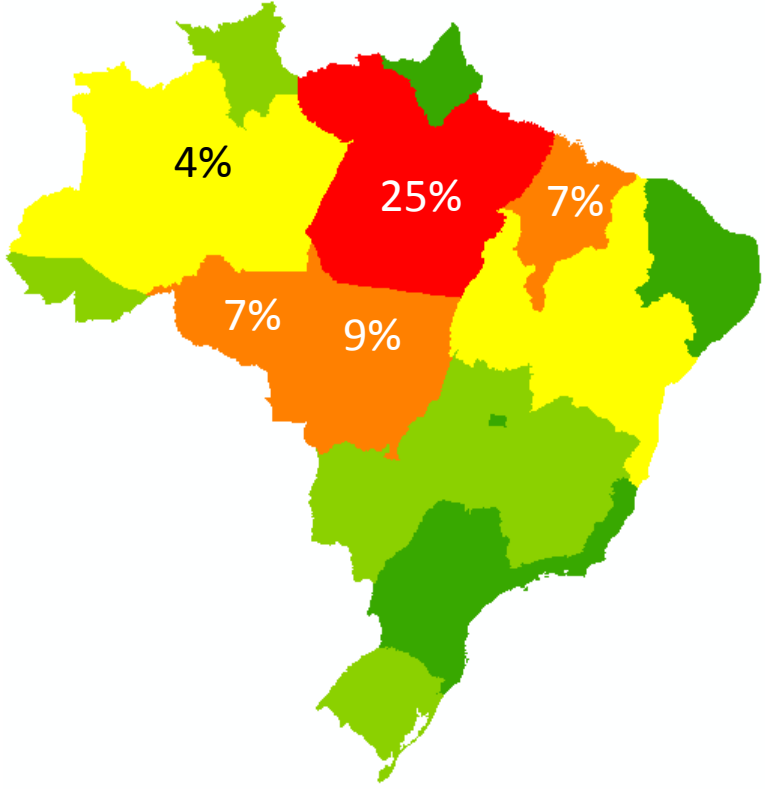


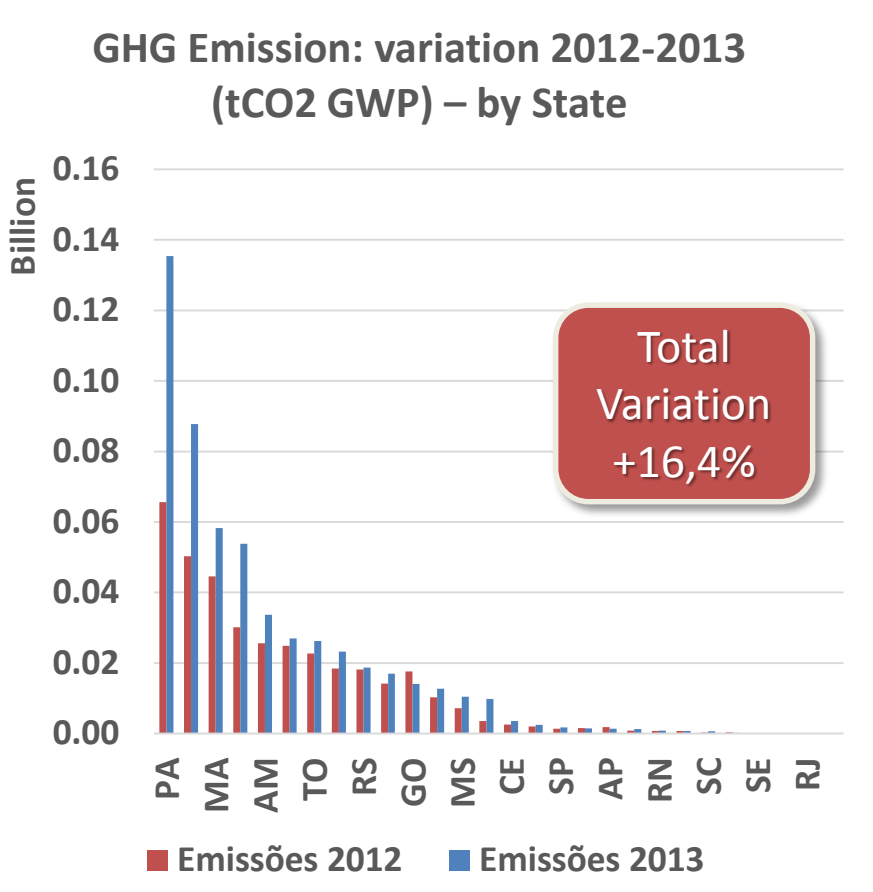

## Proportion of the Total GHG Emissions (%): 1990-2013

## Emissions of GHG (LUC) in 2013 (tCO2 GWP): by State




## Proportion of GHG Emission in 2013 (%)




GHG Emission: variation 2012-2013
(tCO2 GWP) – by State
Billion
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
PA
MA
AM
TO
RS
GO
MS
CE
SP
AP
RN
SC
SE
RJ
Emissões 2012
Emissões 2013
Total Variation +16,4%


Variation 2012-2013

# Lessons learned



- IPCC method of Emissions/Removals
- Brazilian Minister of Technology approach of Estimations of Emissions/Removals
- Documentation – Important in all phases
- Network of institutions

# Challenges



- Data quality and availability
- Methodologic improvements are necessary (ie Removal Equations)

SEEG
Sistema de Estimativa de Emissão de Gases do Efeito Estufa

**Technical Workshop for GHG Emissions Estimation: Exploring the SEEG Framework for India**

Observatório do Clima

# Land Use Sector: Methods

*Thank You ! / Obrigado !*

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Imazon

April 2015, New Delhi

Workshop Support:

VASUDHA FOUNDATION Green ways to good earth!
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EDF ENVIRONMENTAL DEFENSE FUND Finding the ways that work