Carbon Store (and dynamics) of mangroves

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What we know

- C pools of mangrove and peat forests are among the largest ecosystem C pools in the tropics.
- The quantity of C susceptible to loss due to land cover change and global climate change is inherently greater than in upland forests.
- If true, the CO_2 equivalence (global warming potential) of mangrove & peat forest ecosystems may very well be the highest in the world.
- The unique features and ecosystem services of mangroves and peat forests make them especially valuable as sites for REDD+ strategies.

Land-use change affecting mangroves

- 1-2% deforestation per year globally
- 25% loss in SE Asia 1980-2005
- Functionally extinct within 100 years?

Currently, on average, between 2-7% of blue carbon sinks are being lost annually:

Rice/Agriculture

Aquaculture

Road development /hydrological disruptions

Coastal development

TWINCAM - The tropical wetlands initiative on climate change adaptation and mitigation

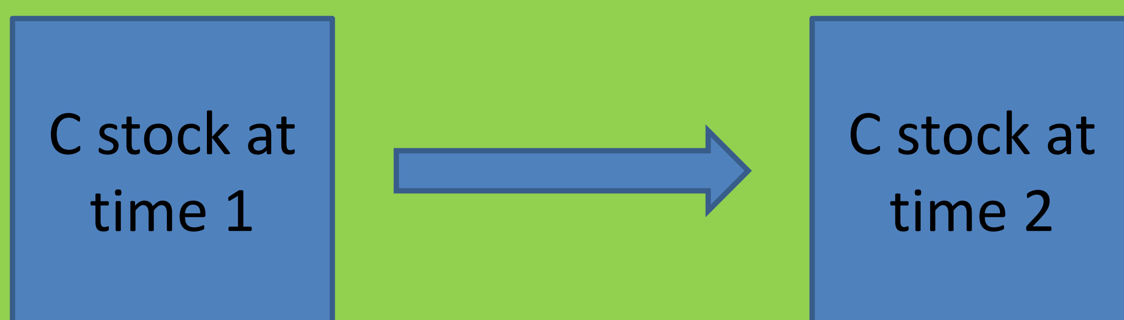
The Tropical Wetlands Initiative-Ongoing Studies

- Better quantification of ecosystem C pools of tropical wetlands - globally
- Development of rapid assessment/MRV techniques
- Emission factors from land use/land cover change.
  - Deforestation
  - Fire
  - Oil palm and other land uses
  - Aquaculture
- Rates of sequestration in restored sites

Stock Difference Method

$$\Delta C = \frac{(C_{t2} - C_{t1})}{(t_2 - t_1)}$$

ΔC = annual carbon stock change in the pool
C_{t1} = carbon stock in the pool at time t_1
C_{t2} = carbon stock in the pool at time t_2



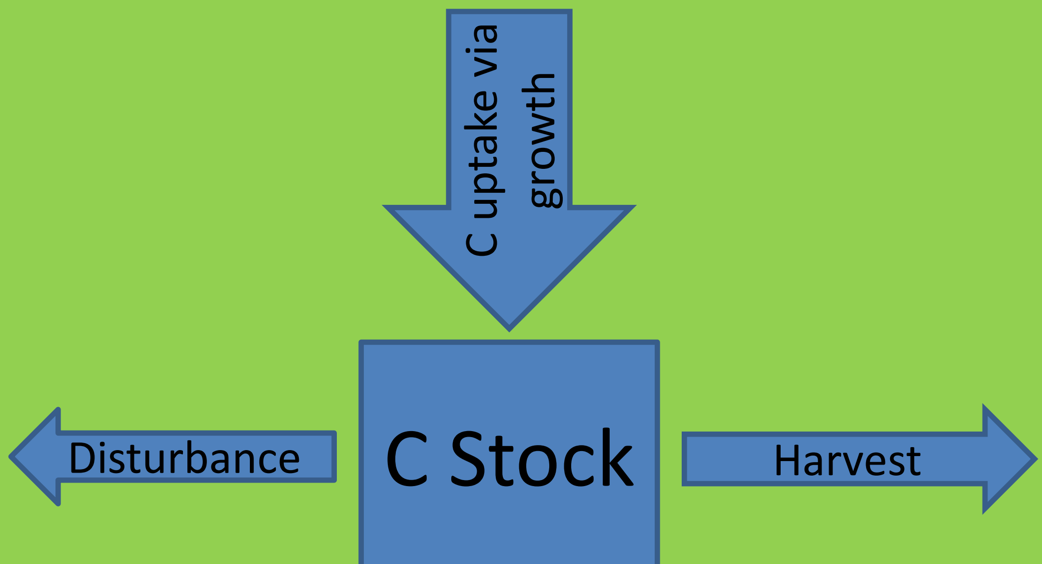
Gain-Loss Method

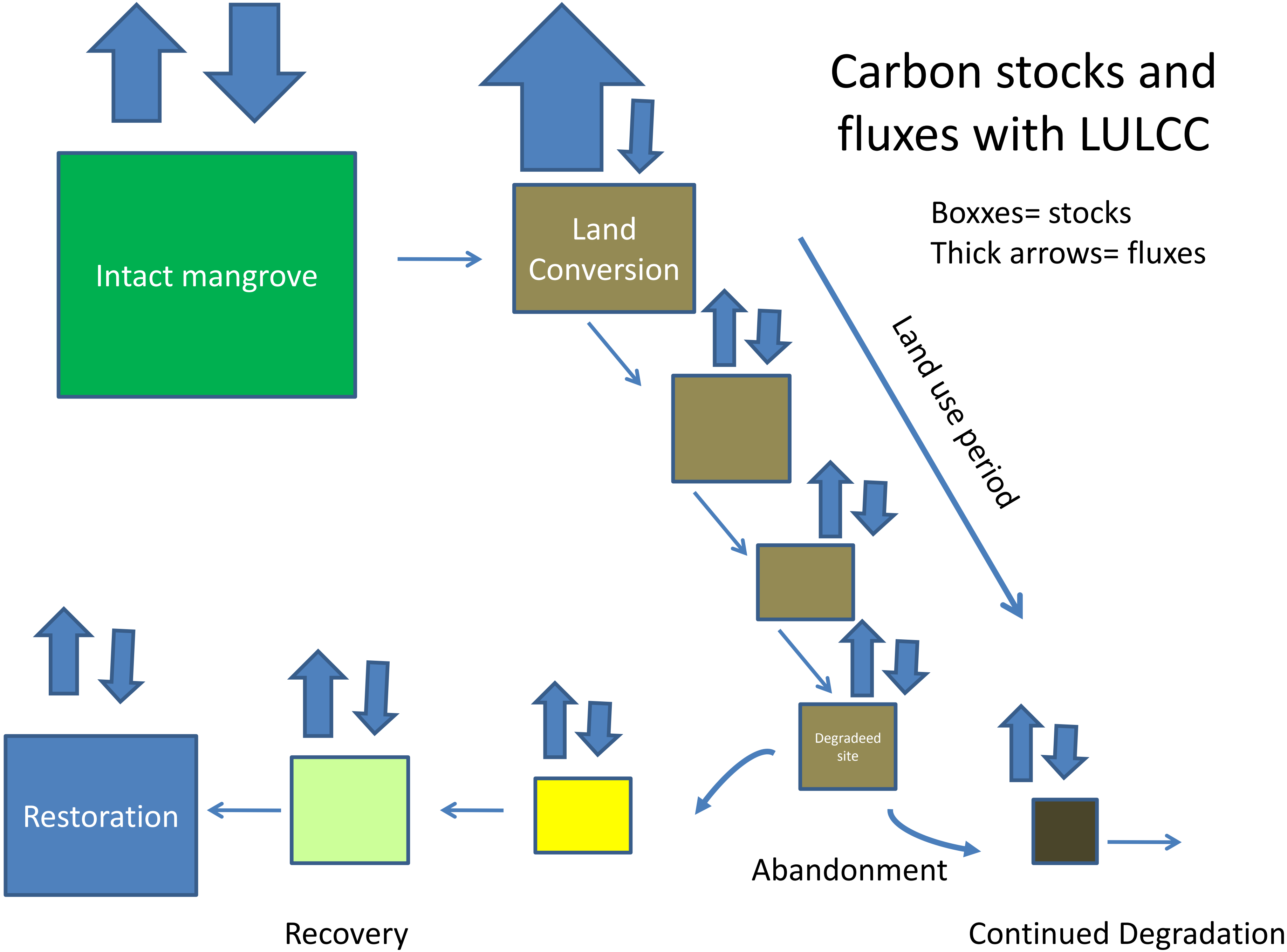
$$\Delta C = \Delta C_G - \Delta C_L$$

ΔC = annual carbon stock change in the pool

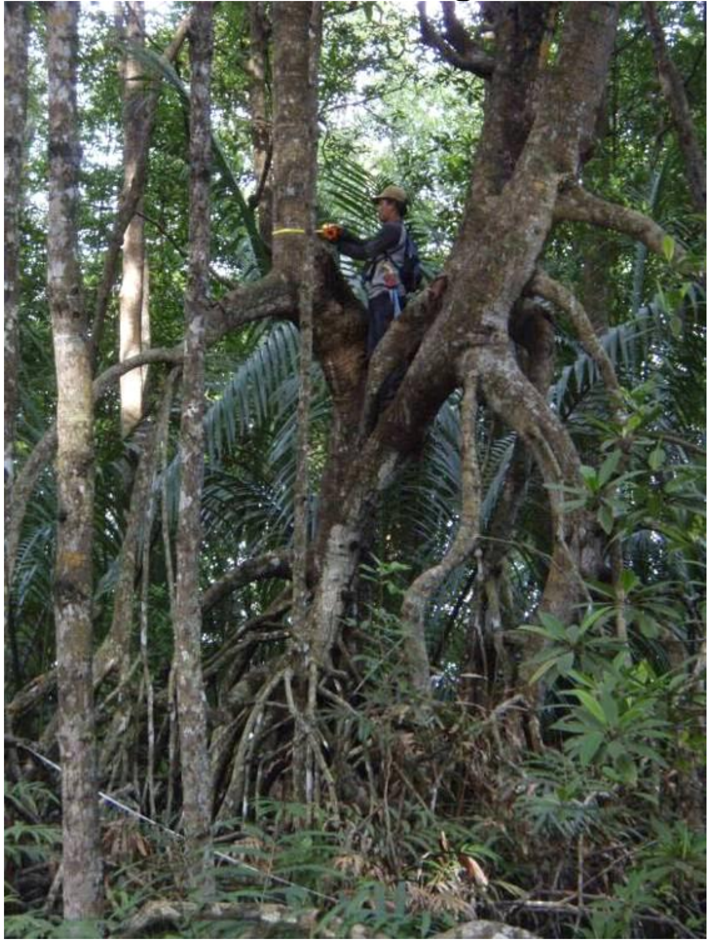
ΔC_G = annual gain of carbon, tonnes

ΔC_L = annual loss of carbon, tonnes




Carbon stocks and fluxes with LULCC
Boxxes= stocks
Thick arrows= fluxes
Intact mangrove
Land Conversion
Land use period
Degradeed site
Abandonment
Restoration
Recovery
Continued Degradation

Protocols for the Measurement, Monitoring, and Reporting of Structure, Biomass, and Carbon Stocks in Mangrove Forests



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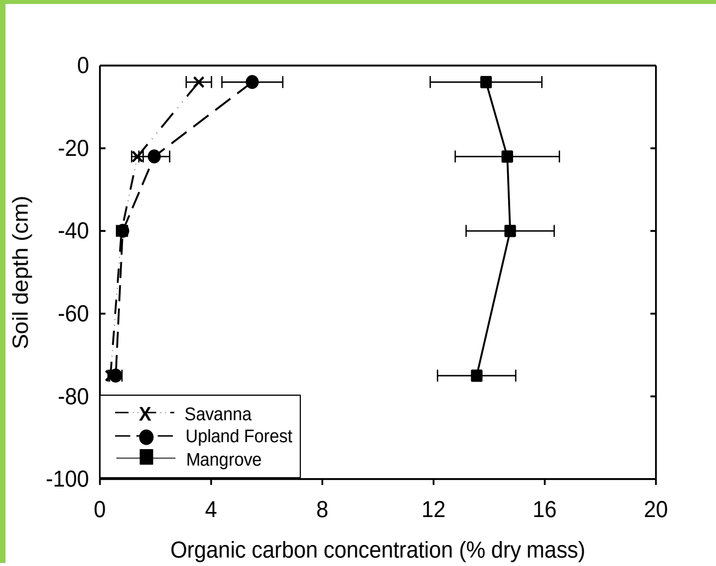
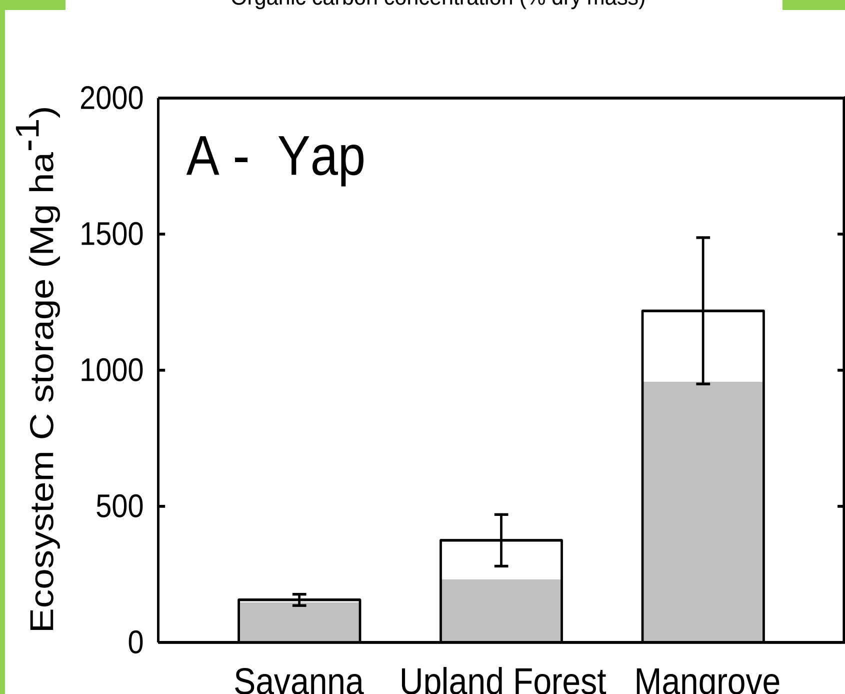
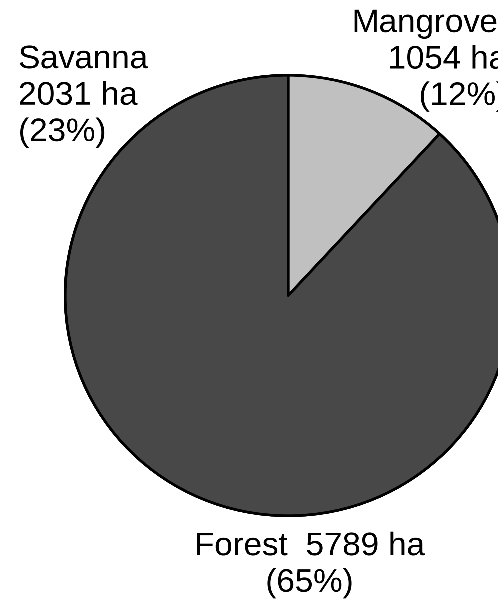


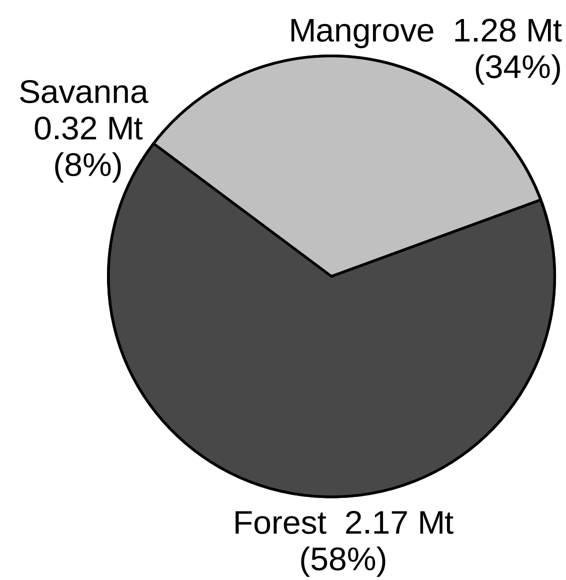


Yap

Land Area



Carbon Stock



C to CO2e mult x 3.67

Donato et al. (In review)


Thanks
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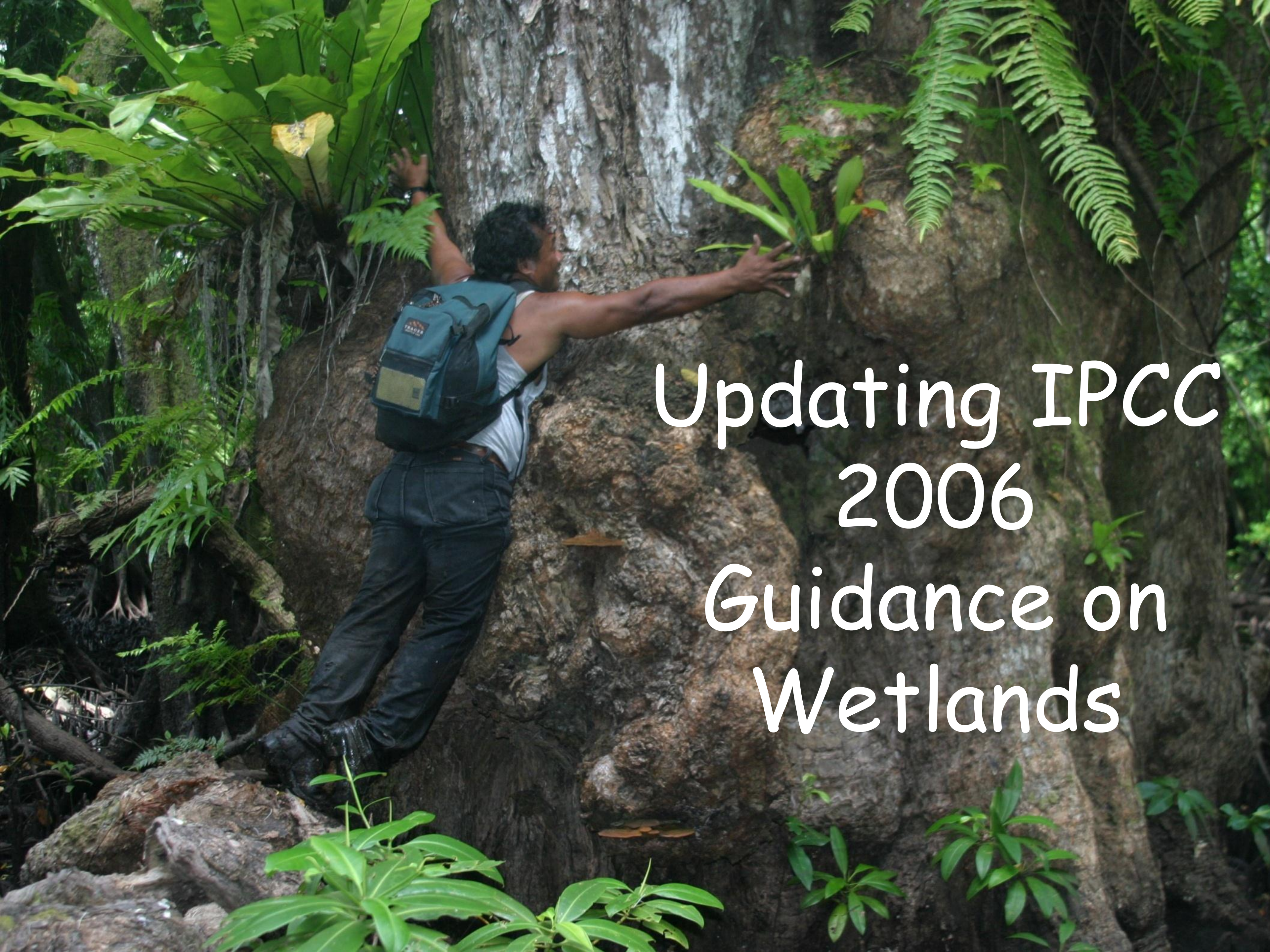
Updating IPCC
2006
Guidance on
Wetlands

BOG 2 Plenary Report – 1 April 2011

BOG 2 Identified Three topics for discussion:
Coastal Wetlands
Freshwater Wetlands
Constructed wetlands for wastewater treatment

Conclusions- Since 2006 there have been significant advancements in science and methods development relating to carbon stocks, emissions, and land use in the worlds wetlands and this new information can be incorporated into *2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands.*"

Preliminary assessment of feasibility of estimating stocks and emission factors

	Wetland types							
List of Management/Activities	Tidal freshwater wetland	Mangrove	Saltmarsh	Seagrass	Riparian	Seasonally flooded	Freshwater marsh	Freshwater swamp
#cleared (biomass combusted or equiv.)	NA	Y	Y	Y	Y	Y	Y	Y
cleared and filled (urban)	Y	Y	Y	NA	Y	Y	Y	Y
cleared and drained	Y	NO	Y	NA	Y	Y	Y	Y
cleared and aquaculture	NO	Y	NA	NO	NA	NA	Y	NA
cleared +drained +agriculture	Y	Y	Y	NA	Y	Y	Y	Y
*waste water	NO	Y	NO	NO	Y?	NA	Y	Y?
changes in hydrology (including SLR)	Y	Y	Y	NO	Y	Y	Y	Y
restoration	Y	Y	Y	Y	Y	Y	Y	Y
fire	NA	NA	NA	NA	Y	Y	Y	Y
+grazing	NA	NA	Y	NA	Y	Y	Y	NA

NA = not applicable

NO = not feasible (not enough data likely to be available or not important)

Y = yes, likely to be feasible (Tier 1 or 2)

Yellow = most important

Different from other systems because of the emissions from organic soils

*Overlaps with other proposed Chapters

+ Overlaps with Agriculture

Proposed chapters for the ***2013 Supplement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*** arising from the IPCC scoping meeting – Geneva Switzerland (2011).

- Overview Chapter Background – request from UNFCCC and Policy Relevance
- Chapter 1: Introduction
- Chapter w – **COASTAL WETLANDS**
- Chapter x **FRESHWATER WETLANDS (in addition to peatlands chapter and contents)** *Covers seasonally Flooded Wetlands, Riparian, Swamps, marshes etc)*
- Chapter y - **CONSTRUCTED WETLANDS – Wastewater Treatment**
- ***Organic soils***
- ***Peatlands***

Chapter – **COASTAL WETLANDS**

(coastal wetlands are those that are tidally influenced and include mangroves, saltmarsh, seagrass and tidal freshwater systems)

- Introduction, what these are and how they differ from types in 2006 GLs
- Important and unique characteristics of these wetland types (e.g. Soil- organic vs mineral; Hydrology and water quality; and Vegetation types)
- Methodologies: Activities, management practices and Land uses and how these effect Biomass and C stocks, and CO_2 and non CO_2 Emissions (use 5 IPCC pools)
- Methodologies: Restoration, Creation, and recovery of wetlands – sequestration and changes in emissions
- Default values
- Good Practice Issues
  - Uncertainty assessment (Quality and quantity of data)
  - Completeness, Time Series consistency, QA/QC
- Relationships to other chapters – e.g. Constructed wetlands and wastewater treatments, prevention of double-counting
- Appendices - Future Methodological developments – globally? What do we know and don't know areas for further development
- Activities that may be significant for individual categories of wetlands include clearance (followed by biomass combustion, filling, drainage, aquaculture, conversion to agriculture); changes in hydrology; application of waste water; restoration and fires. The impacts of these need specific methodologies.

Thanks again!

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Potential Carbon footprint of land cover change in mangrove

Assumptions:

- Mangrove ecosystem Carbon mean =1053 Mg/ha
- 100% loss of abovegd carbon = 161 Mg/ha
- 100% loss of belowgd tree carbon= 108 Mg/ha
- 25% loss of soil carbon = 200 Mg/ha
- Sum loss 469 Mg/ha
- CO_2 equiv 1723 Mg/ha

Based on data from 24 mangrove forests from the Asia Pacific (Donato et al. 2011).

Estimating global C storage and emissions

- Global scaling made difficult from uncertainties in mangrove area by structural type

- The global C storage in mangroves: ~ 3.6 - 19 Pg C (13 – 70 Pg CO_2 equiv.)

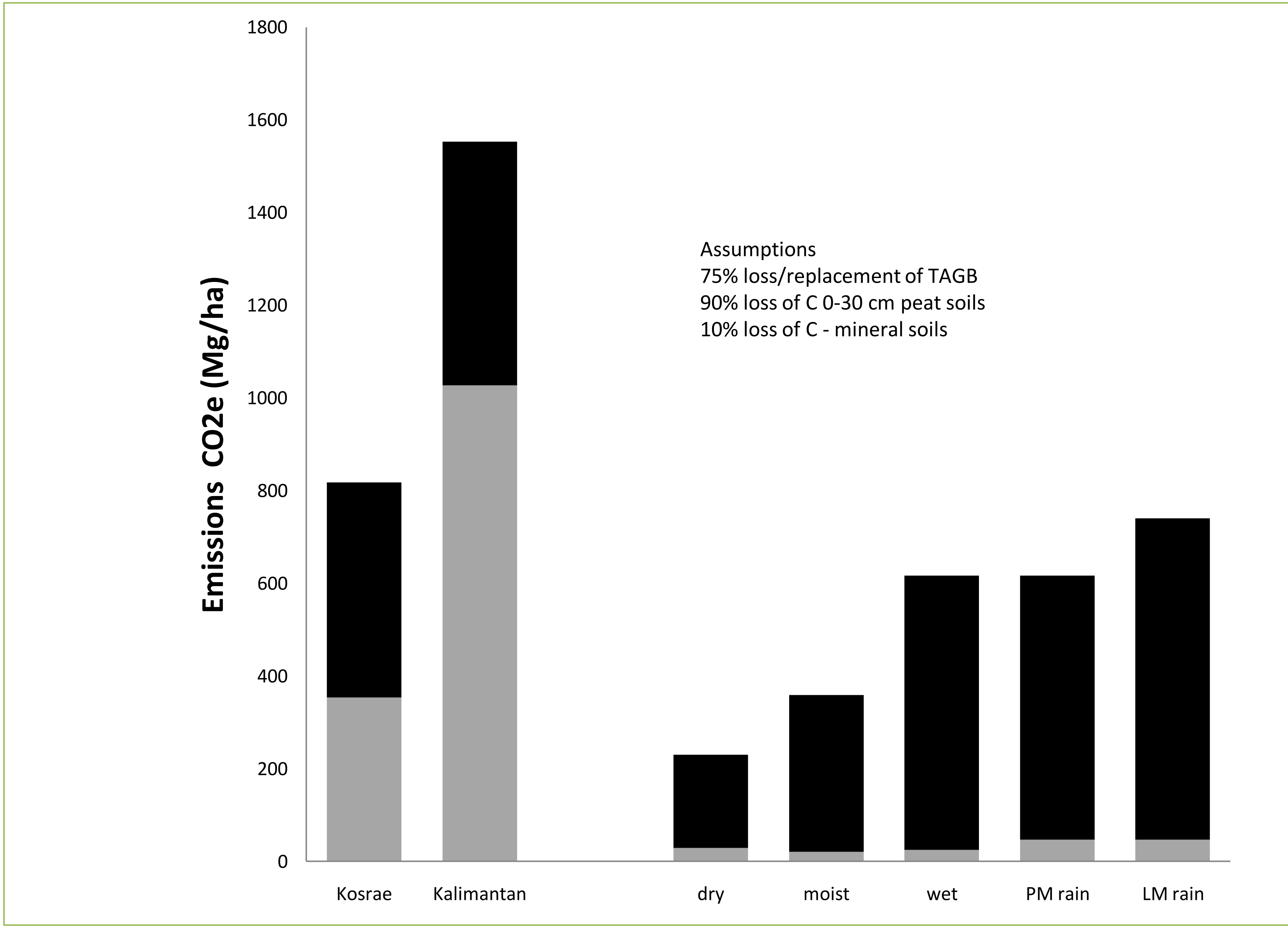
  → ~ 4-23% increase over peat swamps alone (Donato et al., 2011)

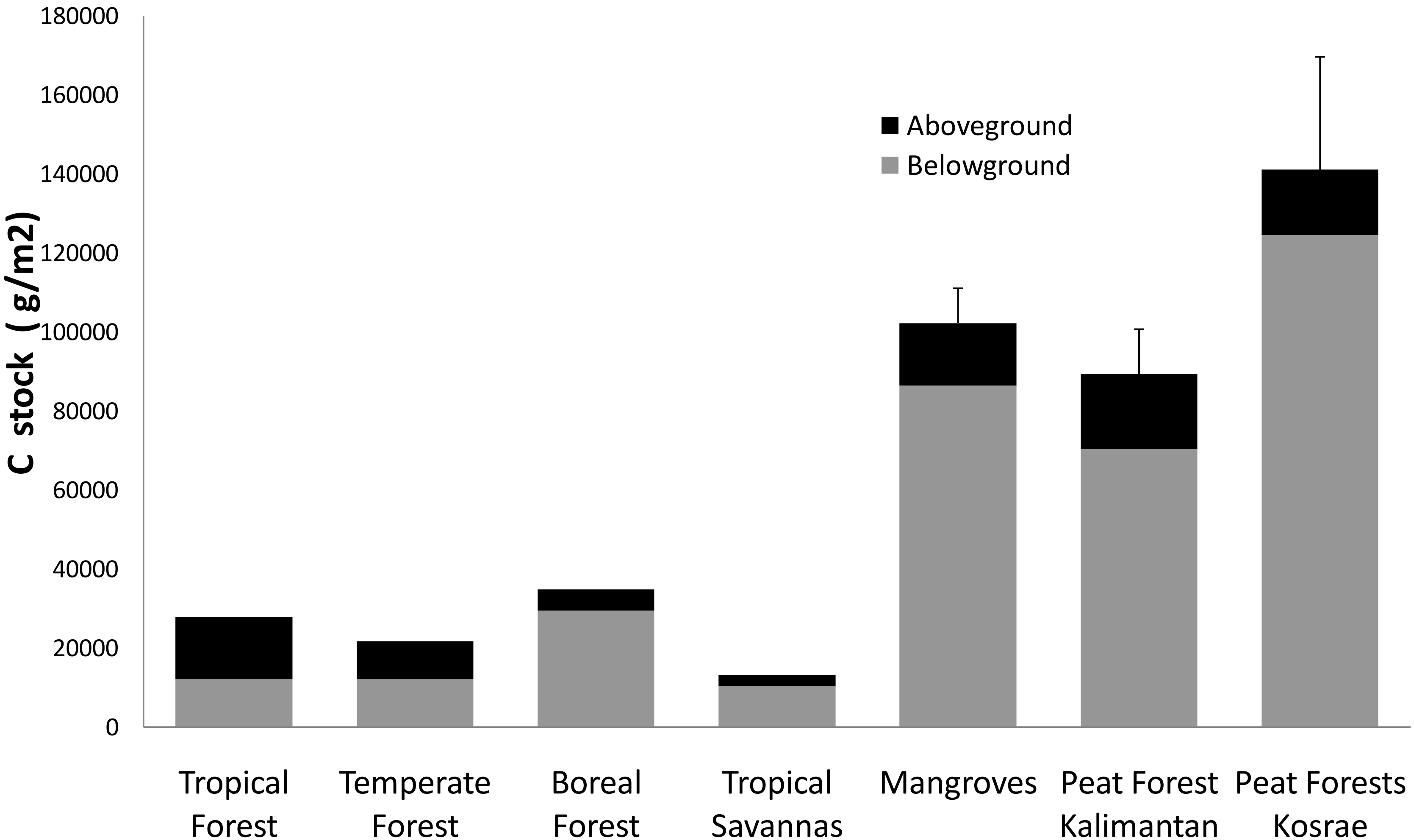
- Global emissions from mangrove conversion: 0.02 – 0.12 Pg yr^{-1} (0.07 – 0.44 Pg CO_2 equiv.)

  → … Or as much as:

  - 40% of peat swamp emissions
  - 10% of current emission estimates from deforestation (despite only 0.7% of tropical forest area)

Donato et al. (2011)


Emissions CO2e (Mg/ha)
1800
1600
1400
1200
1000
800
600
400
200
0
Kosrae
Kalimantan
dry
moist
wet
PM rain
LM rain
Assumptions
75% loss/replacement of TAGB
90% loss of C 0-30 cm peat soils
10% loss of C - mineral soils



Data are from: Uplands - IPCC, 2001: Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change ; mangroves - Donato et al. (2011) ;and peat forests - Murdiyarso et al 2010 .