CIFOR

World Agroforestry

GFOI Global Forest Observations Initiative

Peat greenhouse gas emission factors

Concepts, applicability, and research needs

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Peatlands in their natural state

- **Are flooded,** with **vegetation organic matter inputs exceeding** their **decomposition rate**

⇒ Are <u>active soil C sinks</u> (e.g. 1 Mg C ha^{-1} y^{-1}, tropics) (Hergoualc'h & Verchot 2011)

⇒ Have accumulated large carbon reserves in their soil over millennia

- Their soil is a:

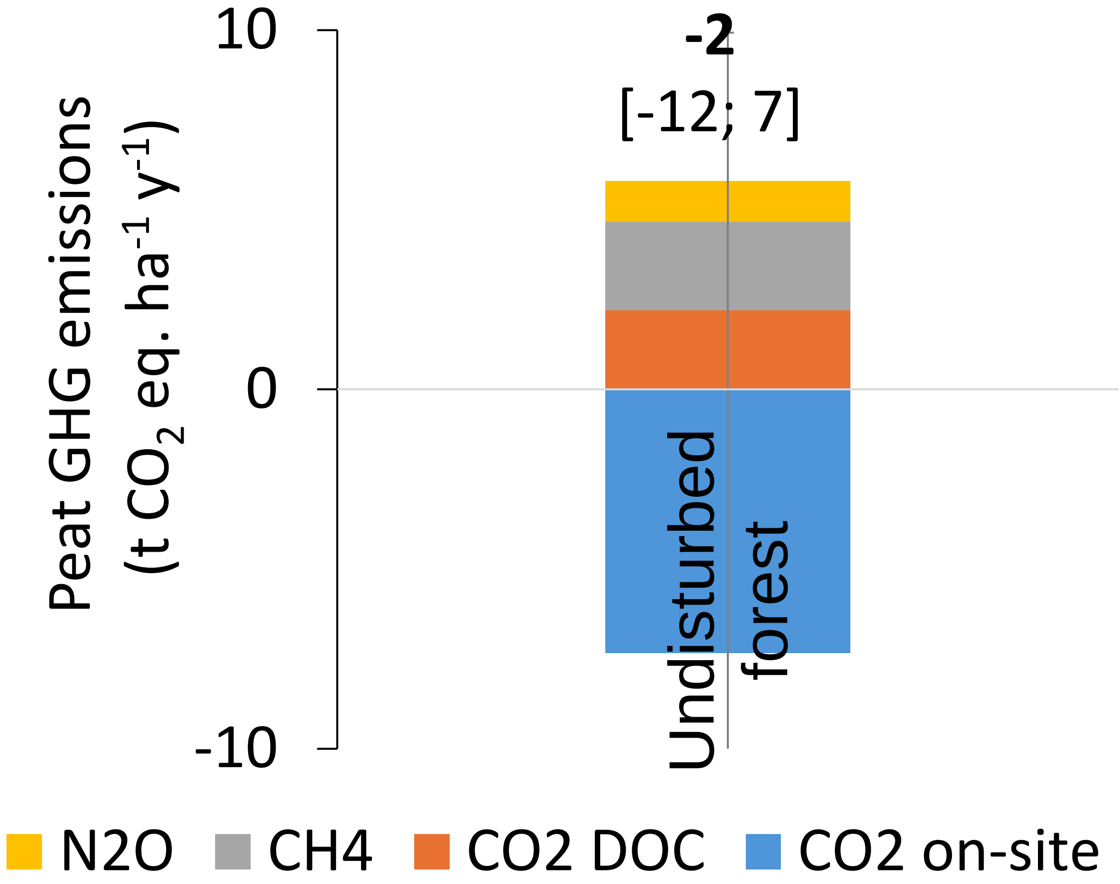
  Net CO_2 sink

  Large CH_4 source

  N_2O source

} Net GHG sink / small GHG source

Depending on ecosystem / region

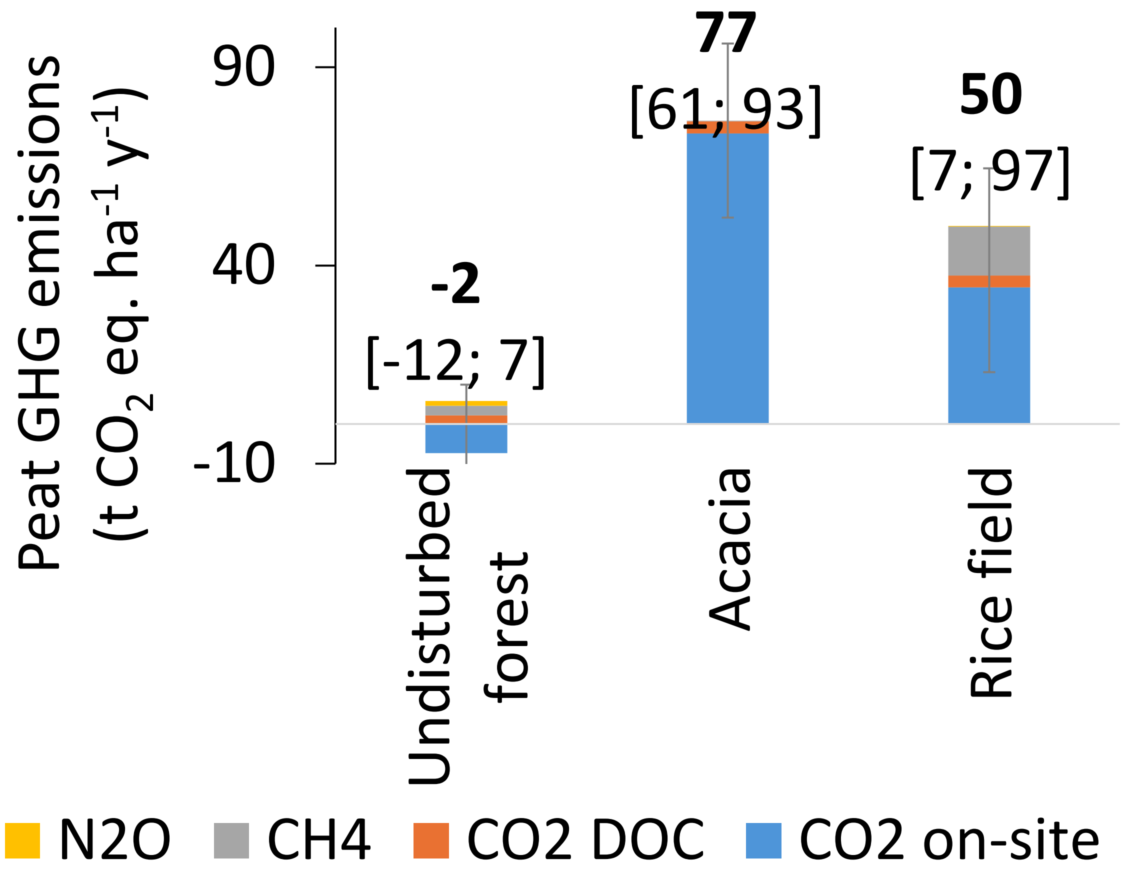


Degraded peatlands

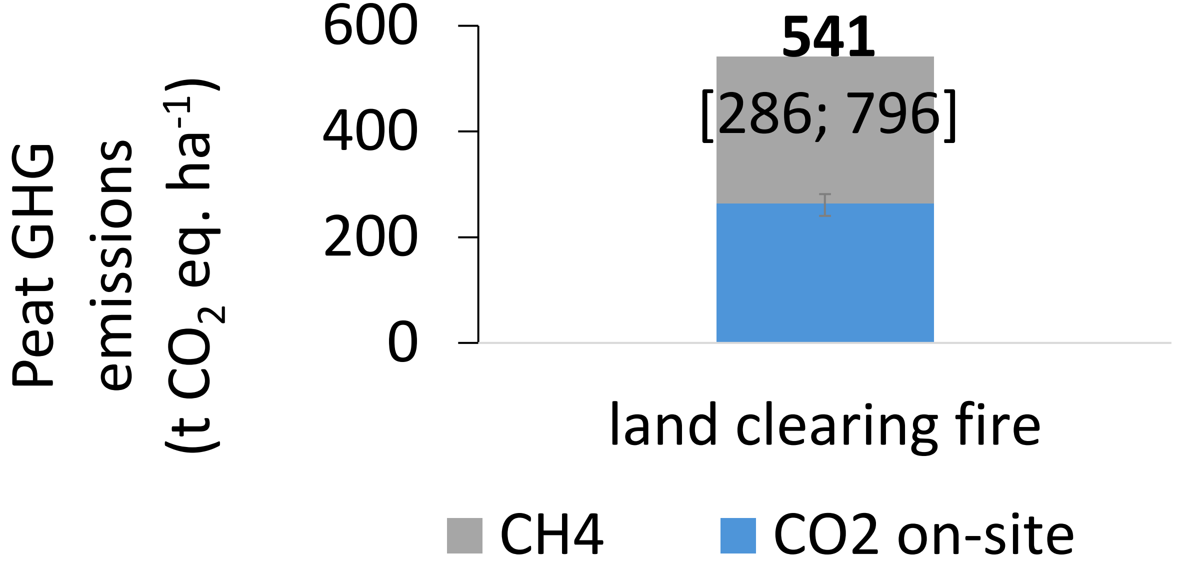
- **Are major GHG emitters**
- After land-use change the soil is:

Net CO_2 source
CH_4 source
N_2O source

} Net GHG source

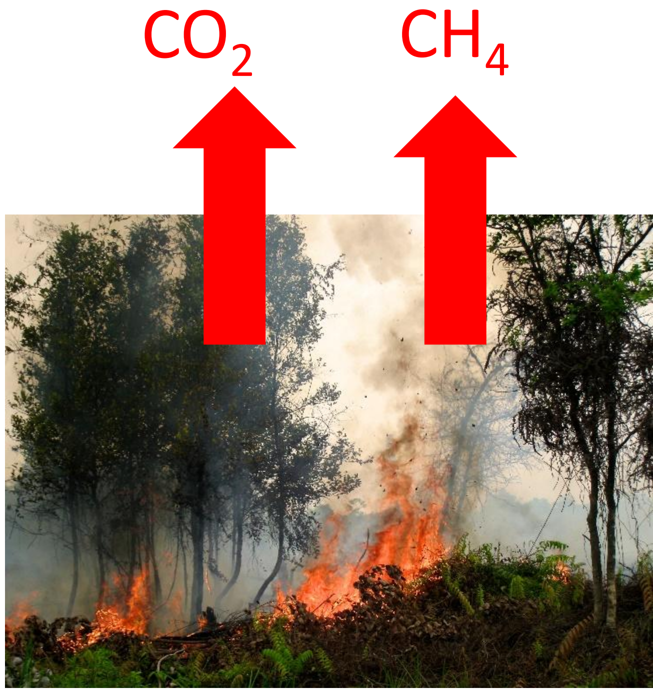


(Hergoualc'h et al. 2018)



- **Fires**: Massive GHG emissions

How are peat emission factors (EF) measured and computed? (IPCC guidelines)



- **Peat EF for fires**

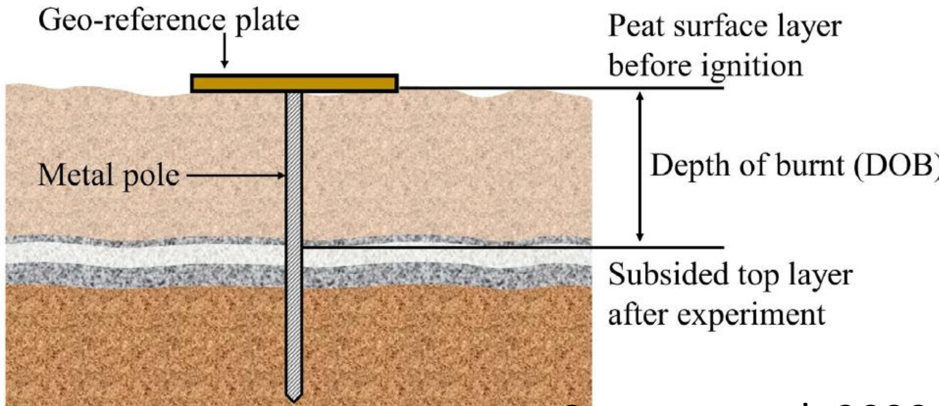
Product of Mass burnt, Combustion factor, EF_{GHG}

- **Mass peat burnt** = f(burn depth, soil bulk density) (direct measurement, remote sensing)

  Distinction between wildfire / prescribed fire

- **Combustion factor** (<u>% mass burnt</u>) (direct measurement in vitro / in situ)

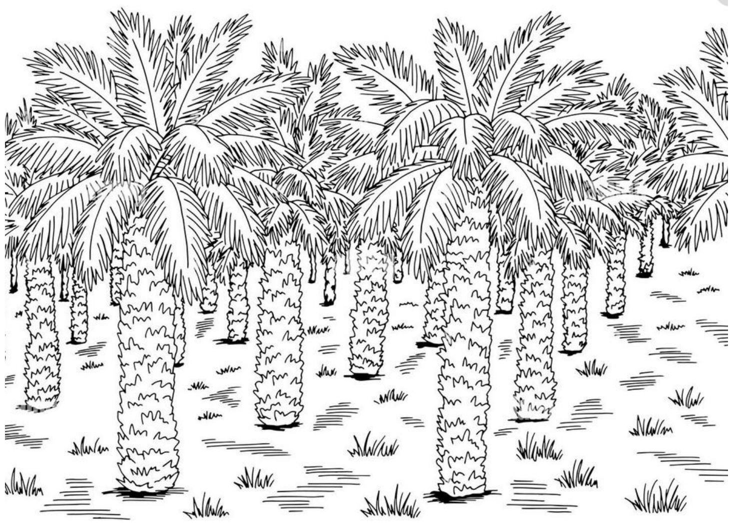
- **EF_{GHG}**: <u>Mass of GHG produced per mass of peat combusted</u> (direct measurement in vitro / in situ)



Santoso et al. 2022

Peat EF of a land use

On-site CO_2, CH_4, N_2O



Off-site CO_2

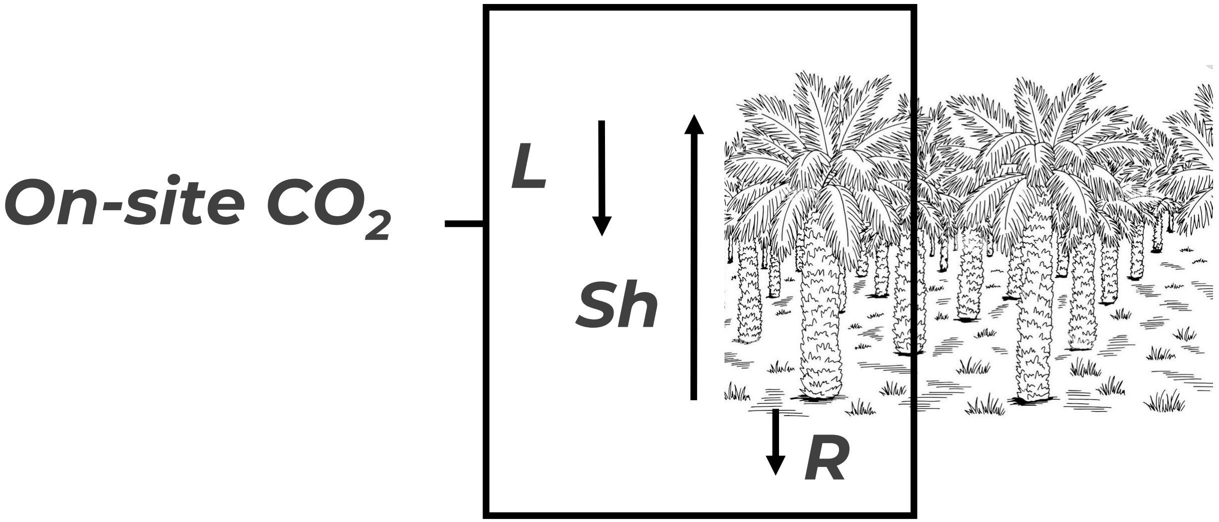
- **Off-site peat CO_2 EF**: Dissolved / Particulate organic carbon exported from drained soils

  Discharge of channels draining the land (in situ)

  DOC/POC concentration of discharged water (in vitro)

- **On-site peat CH_4, N_2O EF**: Emissions / uptakes of CH_4, N_2O from the soil & drainage ditches

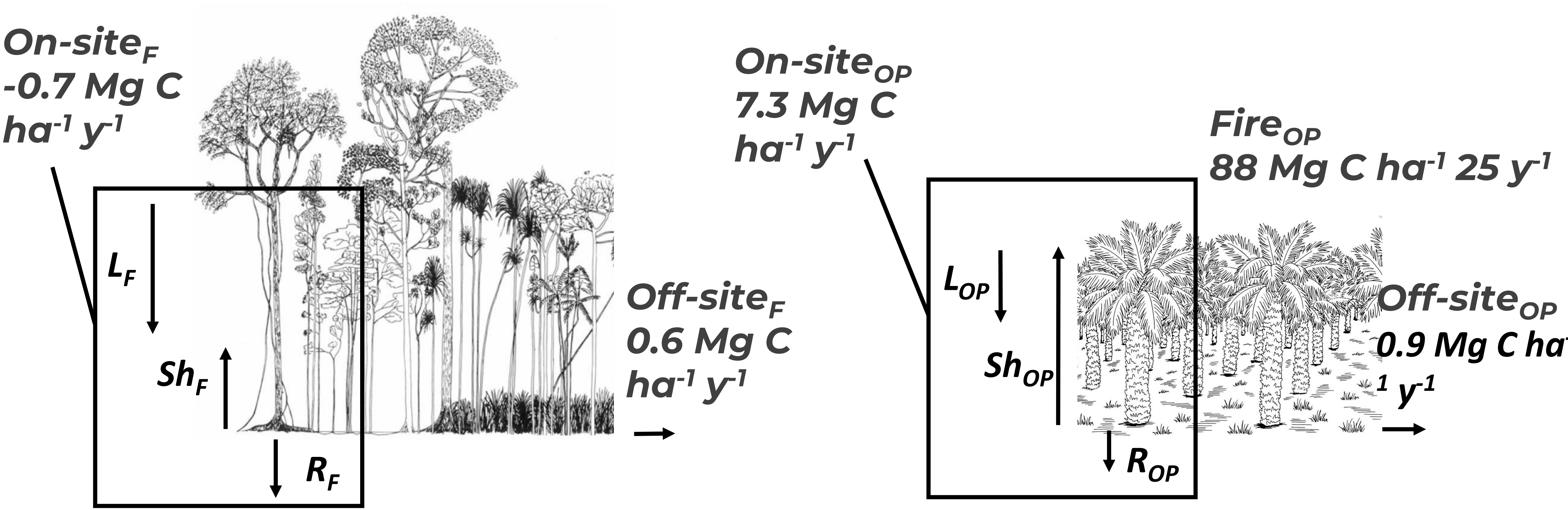
Peat EF of a land use



- **On-site peat CO_2 EF**: Balance of inputs from litterfall (L) and roots (R) and outputs from heterotrophic soil respiration (Sh)

- Heterotrophic soil respiration = Total soil respi. – root respi.
- **Peat CO_2 loss ≠ Soil respiration**
- **Peat CO_2 loss ≠ Heterotrophic soil respiration**

Example Southeast Asia: CO_2



FOREST: Soil CO_2 balance
-2.5 Mg C ha^{-1} 25 y^{-1}

OIL PALM: soil CO_2 balance
293 Mg C ha^{-1} 25 y^{-1}

⇒ **Conversion forest** to **oil palm plantation**: **296 Mg CO_2-C ha^{-1} 25 y^{-1} from the peat only** (Murdiyarso et al. 2024)

Conclusions

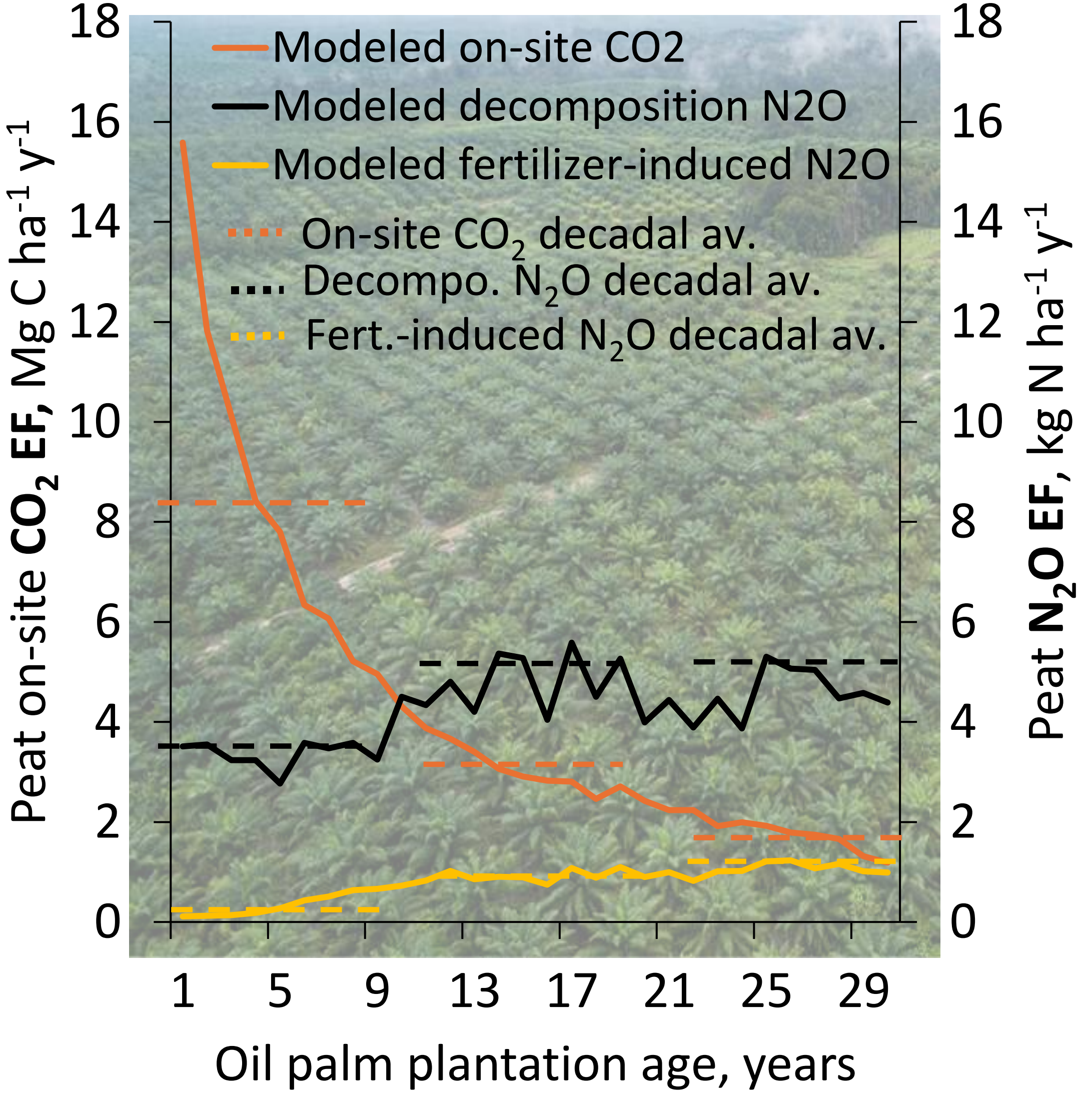
- **IPCC Tier 1 defaults** for the tropics based on data almost exclusively from Indonesia

  ⇒ **Estimates** and **land classes not representative** of **American / African** countries

- **Class gaps** (tropics): **Mountain** peatlands, **Undrained** degraded lands

- IPCC encourages **Tier 2 EF** (Country/Region-specific data) / **Tier 3 EF** (modelled emissions)

  E.g. **Process-based modeling** oil palm plantations (Swails et al. 2022)




Thank you

Kristell Hergoualc'h

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FROM THE AMERICAN PEOPLE

Norad

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References

- Hergoualc'h K, Carmenta R, Atmadja S, Martius C, Murdiyarso D, Purnomo H (2018) Managing peatlands in Indonesia: Challenges and opportunities for local and global communities. CIFOR Infobrief 205.
- Hergoualc'h K, Verchot LV (2011) Stocks and fluxes of carbon associated with land-use change in Southeast Asian tropical peatlands: a review. Global Biochem. Cycles, 25, GB2001, doi:2010.1029/2009GB003718.
- Murdiyarso D, Swails E, Hergoualc'h K, Bhomia R, Sasmito SD (2024) Refining greenhouse gas emission factors for Indonesian peatlands and mangroves to meet ambitious climate targets. Proc. Natl. Acad. Sci. U.S.A., 121, e2307219121.
- Santoso MA, Christensen EG, Amin HMF et al. (2022) GAMBUT field experiment of peatland wildfires in Sumatra: from ignition to spread and suppression. International Journal of Wildland Fire, 31, 949-966.
- Swails E, Hergoualc'h K, Deng J, Frolking S, Novita N (2022) How can process-based modeling improve peat CO2 and N2O emission factors for oil palm plantations? Science of the Total Environment, 839, 156153.