Carbon loss associated with land-use change in tropical peatlands: methods and estimates

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THINKING beyond the canopy

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Methodological approaches

Stock change approach

Before

C_F

After

C_{OP}

$C_{loss} = C_F - C_{OP}$

C_{loss} rate $= C_{loss}$ / life time

Flux change approach

Before

$C_{in\ F}$ $C_{out\ F}$

$\Delta C_F = C_{in\ F} - C_{out\ F}$

After

$C_{in\ OP}$ $C_{out\ OP}$

$\Delta C_{OP} = C_{in\ OP} - C_{out\ OP}$

C_{loss} rate $= \Delta C_F - \Delta C_{OP}$

$C_{loss} = C_{loss}$ rate $\times$ life time

Carbon loss estimates

Literature review

- Southeast Asian peatlands
- C stocks, peat C fluxes
- 56 studies

2 publications

- Murdiyarso D, Hergoualc'h K, Verchot LV (2010) Opportunities for reducing greenhouse gas emissions tropical peatlands. PNAS 107, 19655-19660
- Hergoualc'h K., Verchot L.V. (2010) Stocks and fluxes of carbon associated with land-use change in Southeast Asian tropical peatlands: a review. Submitted to Global Biochemical Cycles.

Carbon loss from wildfires

Stock change approach

Land-use type before fire	C stock loss (Mg C ha^{-1})		
	Burnt vegetation	Burnt peat	Total
Intact forest	152 ± 36	285 ± 67	436 ± 77
Logged forest	35 ± 36	285 ± 67	320 ± 77
Oil palm plantation	32 ± 9	285 ± 67	316 ± 67
Acacia plantation	28 ± 2	285 ± 67	313 ± 68

C loss: 65 – 90% from peat

Peat forest conversion to oil palm

Combination of the 2 methodological approaches

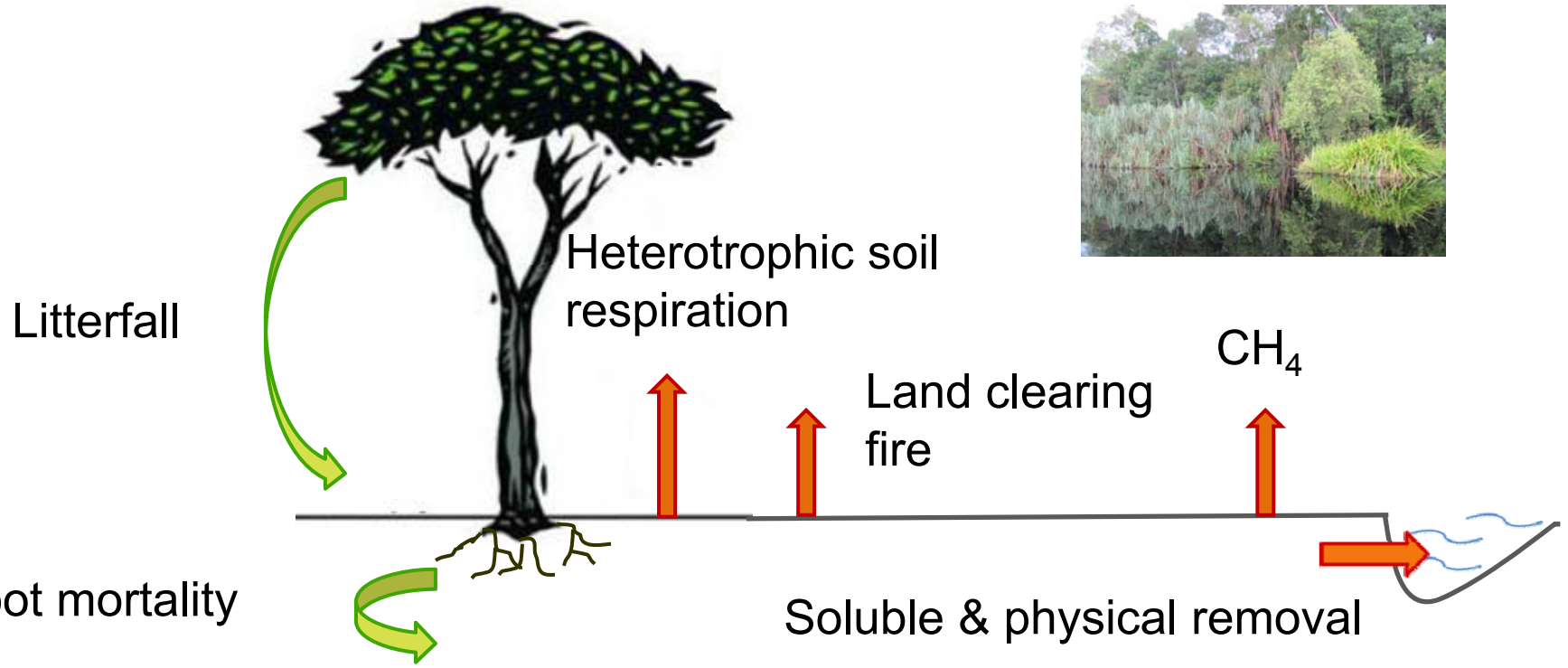
Stock change approach: Aboveground biomass C loss

Flux change approach: Peat C loss

Peat C stock changes: Difficulties & Limits

- Peat depth (up to 20 m), compaction, limited number profiles
- Presence logs, high water table level $\Rightarrow$ bulk density?
- How to select the right 'before land use change' site?
- How to address peat compaction, shrinkage & decomposition caused by land-use change?

C fluxes into and out of the peat

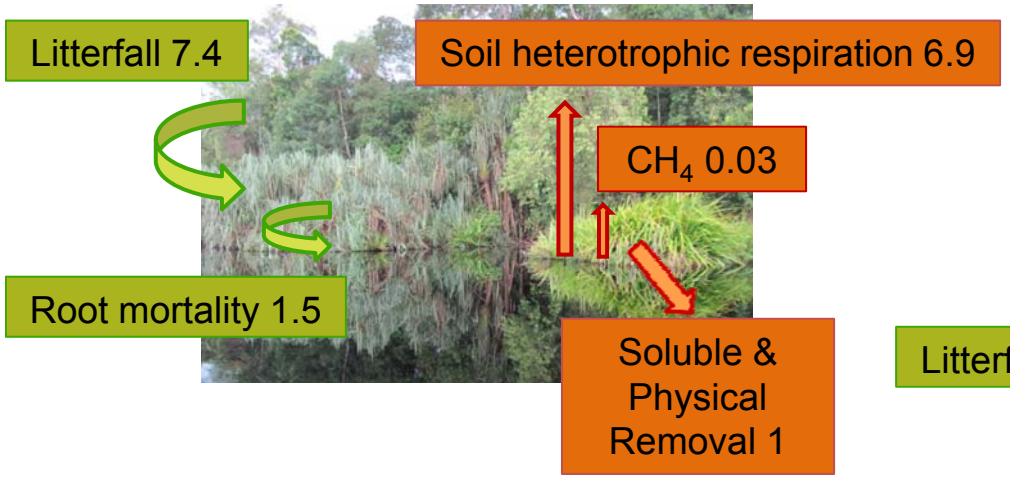


Heterotrophic soil respiration = peat oxidation = peat decomposition

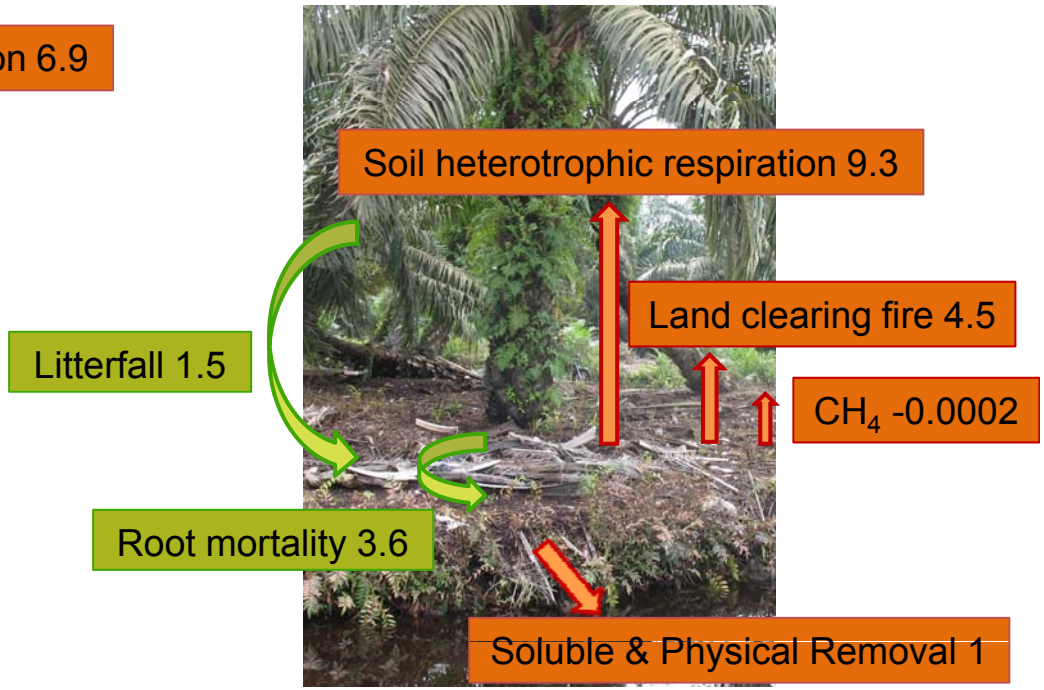
Heterotrophic soil respiration = Total soil respiration - root respiration

Peat C balances in the forest and in the oil palm plantation

Before



After



$$\Delta C_{peat\ F} = C_{in\ peat} - C_{out\ peat}$$
$$= 1.0\ Mg\ C\ ha^{-1}\ y^{-1}$$
$$= \mathbf{25\ Mg\ C\ ha^{-1}\ 25\ y}$$

$$\Delta C_{peat\ OP} = C_{in\ peat} - C_{out\ peat}$$
$$= -\ 9.8\ Mg\ C\ ha^{-1}\ y^{-1}$$
$$= \mathbf{-\ 245\ Mg\ C\ ha^{-1}\ 25\ y}$$

Peat forest conversion to oil palm plantation

Before

After

$\Delta C_{peat\ F}$ = 25 Mg C ha^{-1} 25 y

$C_{Abvgrnd\ biomass\ F}$ = 182 Mg C ha^{-1}

- 270 Mg C ha^{-1} 25 y

-158 Mg C ha^{-1} 25 y

$\Delta C_{peat\ OP}$ = - 245 Mg C ha^{-1} 25 y

$C_{Abvgrnd\ biomass\ OP}$ = 24 Mg C ha^{-1}

⇒

C loss = 428 Mg C ha^{-1} over 25 years

C loss: 63 % from peat

Conclusions

- Very large carbon loss
- C loss: 60-90% from the peat

⇒ **REDD** mechanism should **prioritize peat swamp forests**

- Gaps knowledge on C cycle in tropical peatlands

⇒ Greenhouse gas accounting methods: heterotrophic soil respiration (N inputs), allometric models specific to peat swamp forests

💣 General misunderstanding :

Peat heterotrophic soil respiration ≠ Peat C loss

- N_2O: Global warming potential 300

⇒ Increase in N_2O emissions due to land-use change in tropical peatlands?

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