Partnership for the Tropical Forest Margins

ASB

Policy*brief* 36

Reassessing peat-based emissions from tropical land use

Peat-based emissions from South-east Asia amount to globally relevant numbers, which are uncertain and contested. The Reducing Emissions from Deforestation and Degradation through Alternative Land Uses in Rainforests of the Tropics (REDD-ALERT) project has been part of this dynamic and now reflects on the lessons learnt at the science-policy interface.

Key findings

1. Peatland emissions involve high values with large uncertainties, and still evolving perspectives on factors underlying the variability.
2. While drainage of peatland certainly contributes to an increase in emissions, factors beyond drain depth have major influence.
3. Surface flux measurements involve both plant and peat-based respiration; various approaches now exist to disentangle the two.
4. Mass balance methods, based on measured subsidence with correction for compaction and/or use of ash as internal conservative tracer, are in general agreement with flux measurements.
5. New IPCC default values are differentiating between land uses on peat, using the means of all credible data sets.
6. Prominent roles for national scientists in all steps of the process helped to secure legitimacy of politically sensitive, but salient science, performed with highest standards of transparency.
7. The carbon accounting method for oil palm accepted by the Roundtable of Sustainable Palm Oil (RSPO) is aligned with the new IPCC default values.

Implications

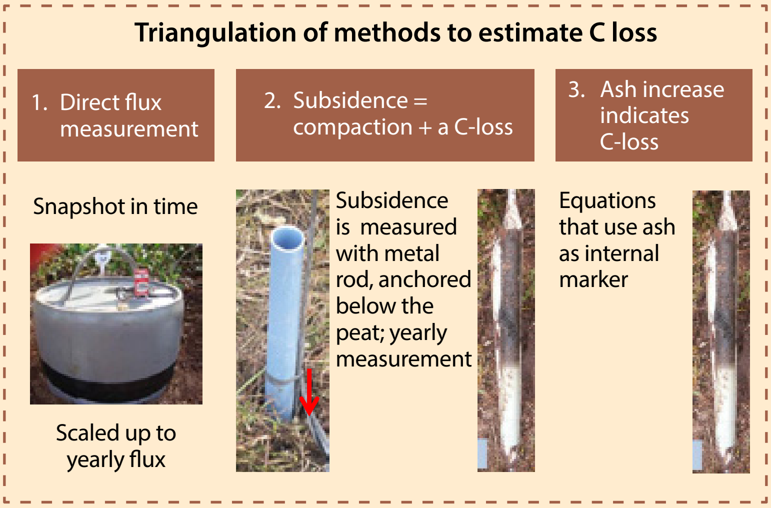
- Efforts to quantify, understand and reduce land-based emissions of greenhouse gasses need to acknowledge uncertainties in current data.
- Current emission estimates that respond only to depth of drainage are not reliable.
- Photosynthetically active vegetation contributes to the CO_2 emissions at the soil surface, but only the peat-based emissions count as net loss.
- Where methods based on different accounting approaches can be reconciled, concerns over bias in the estimates are reduced; a multiple method approach is needed for combining short and longer term effects.
- Current estimates for fast-growing timber species with effective biological N_2 fixation are higher than those for oil palm. The new default values are considered to be too low by some, too high by other stakeholders; further data is needed.
- Networks of international and national scientists should be involved from the early stages of identifying policy-sensitive environmental issues.
- The default values reduce default carbon foot-print estimates for palm oil, but still show that USA and European standards cannot be met if >5% of palm oil is produced on peat (as is currently the case).

1. High values with large uncertainties: salient issues, requiring legitimacy and credibility

The carbon stocks in 1 m of peat (200-864 t C ha^{-1} m^{-1}; Shofiyati et al., 2010) are one to three times those in the aboveground biomass of an oldgrowth rainforest; peat profiles can be several m deep, so their carbon storage is huge. Although the aboveground biomass of forests on peat is less than that on mineral soils, converting natural forest on peat leads to much higher carbon emissions, for two reasons: 1) if fire is used in land clearing, or escapes in the landscape due to land clearing elsewhere, several dm of peat can burn, 2) in drained peat soils microbes can decompose the substrate and lead to a subsidence rate of several cm per year, with additional subsidence due to compaction of the peat.

While nobody doubts that the emissions per ha are high, there is substantial variation between the existing data collected so far. Public attention focussed on the high end of the spectrum. Lower values are part of the peer-reviewed literature as well. There is fierce debate in the scientific community on which data and methods to trust. In such circumstances, science needs to be credible, salient and legitimate – the latter implying that scientists with vested interests in either high or low values will be scrutinized, as happens.

Box 2: Three methods were compared:



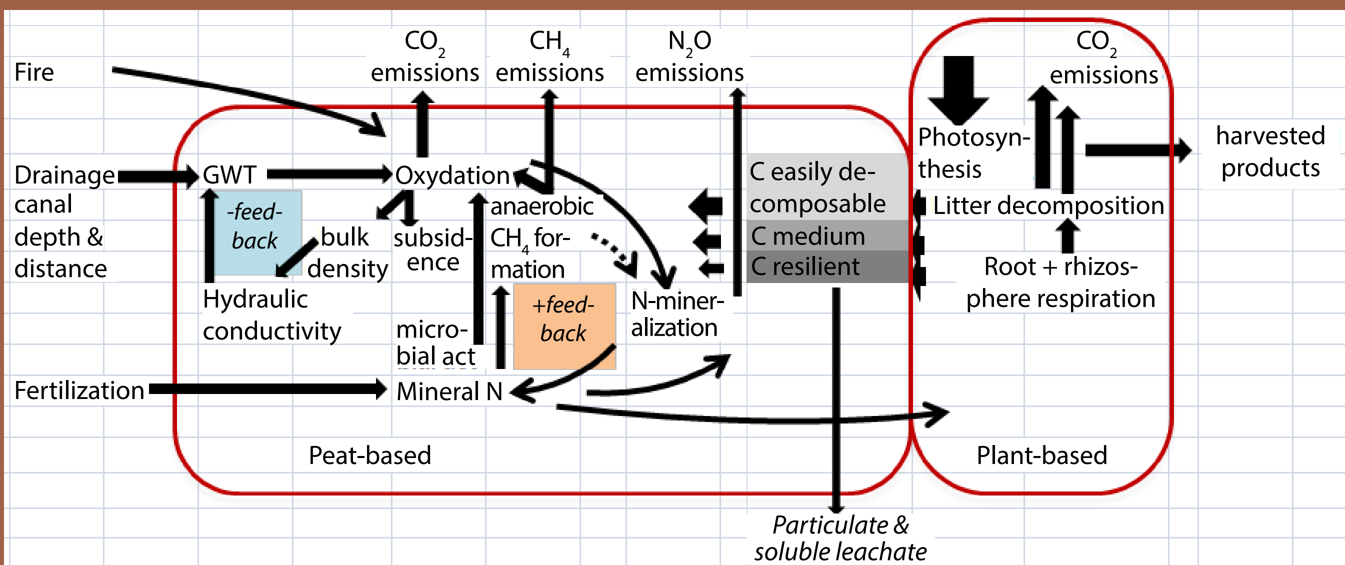
Flux at soil surface: emissions at the soil surface can be quantified from the increase in gas concentration in a sample chamber; some, however, is root respiration and not peat decomposition

Subsidence: if a rod is anchored below the peat, it can be used to measure subsidence; some of this is due to compaction, rather than peat decomposition

Ash as internal marker: ash does not decompose, and its increase in concentration is proportional to peat emissions

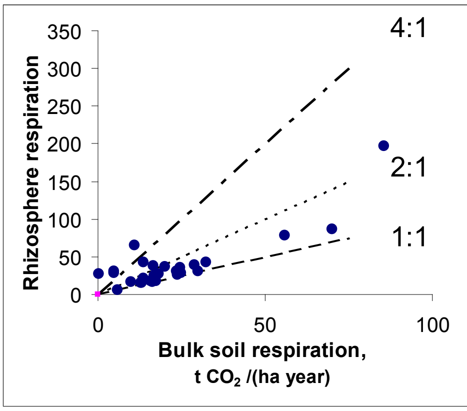
Box 1: Formation and destruction of peat

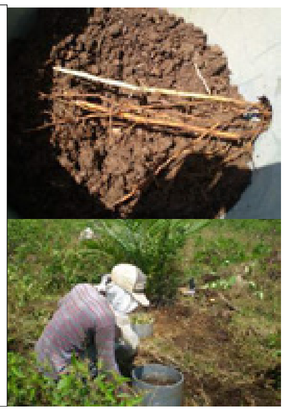
Peat is formed in conditions where the annual decomposition of organic matter is less than the annual input, and material accumulates. Once root contact with underlying mineral soil is severed, nutrient cycling is restricted, and lower nutrient contents can further slow down decomposition, while the high water storage of peat creates a wet environment. Often the initial trigger for peat formation is poor drainage. Destruction of peat follows the reverse process, with drainage and nutrient enrichment interacting in breakdown of what took hundreds or thousands of years to accumulate.



Trunks of deeprooted trees that only partially burned show how far the surface level subsided (due to compaction and decomposition) after land clearing by fire; in this case in TanJaBar (Jambi, Indonesia) approximately 1 m

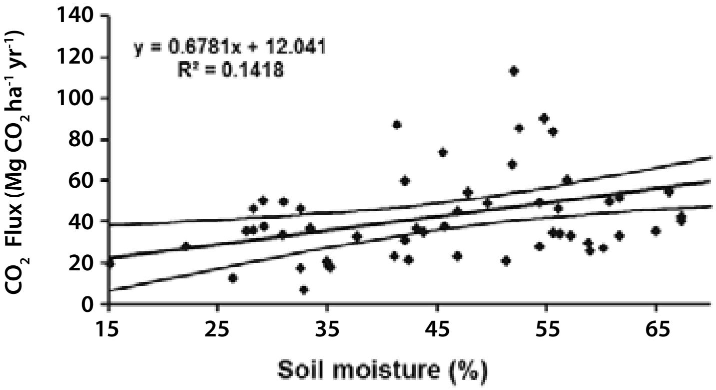
Rhizosphere chambers emit 1-4 times more CO_2 than bulk soil chamber



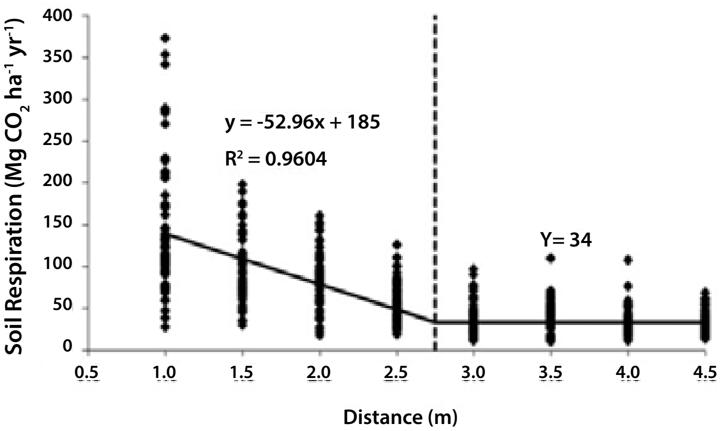


2. Factors beyond drain depth

Some studies find clear relationships between depth of drainage and emissions, others don't, or even see evidence of reverse relations where wetter soil has higher emissions. There is much variation in peat density and maturity, and it may well be that the interactions can be better understood if more comprehensive data become available. There is growing evidence that nutrient availability, in response to fertilizer or use of N_2 fixing trees speeds up peat decomposition.



CO_2 flux measurements as a function of the soil moisture content of the top 20 cm of the profile (Marwanto and Agus, 2013)



CO_2 flux measurements as function of distance to 15-year old oil palm (Dariah et al., 2013)

3. Surface flux: plant and peat-based respiration

The challenge for flux measurements is that they show a lot of variation at multiple scales and cannot be easily integrated to annual values. Furthermore, the contribution of root respiration can be estimated, but not measured directly. Flux measurements fluctuate over the year, but also in a day-night cycle, with the highest values around noon and the lowest at dawn. This may well reflect the dynamics of root respiration rather than temperature effects (Marwanto and Agus, 2013). Emissions are also highest close to oil palms and decrease towards the zone in between palm trees – again; root respiration may be the cause. Peat-based respiration accounted for 86 % of 44.7±11.2 and 71 % of 47.8±21.3 Mg CO_2 ha^{-1} yr^{-1} of weighted surface flux, respectively for the 6 and 15 year old plantations (Dariah et al. 2013).

4. Mass balance methods

The mass balance methods that quantify subsidence, or the disappearance of organic matter from the increase in ash content, operate best at time scales of a year or more (NB, there is swell and shrink at short measurement intervals). The primary challenge for subsidence methods is the contribution of compaction – while the standard methods for assessment of bulk density may have some bias. The ash-as-tracer method depends on assumptions of what ash content of undisturbed peat would have been for locations where it now is increased.

Bottomline is that approximate agreement between two or three methods gives confidence that flux rates are reasonable, but we need to accept ranges of uncertainty around midpoint values.

Box 3: Terminology

The peat literature has settled on a rather peculiar terminology, where the ecologically relevant dis-tinctions between the substrates that are decomposed (***peat*** versus recent ***photosynthates***) is confounded with terms that refer to respiration actors: ***heterotrophs*** versus ***autotrophs***, without or with photosynthesis as primary source of energy. The fact is that a substantial share of the respiration of recent photosynthates is done by microbes in the rhizosphere of plants, or consuming products of root turnover, hence this is heterotrophic. Dariah et al. (2013) is the first paper to clarify that the relevant distinction is peat- versus root-based respiration. There is a further possibility that the presence of plant roots increases the heterotrophic decomposition of peat: root-induced peat-based respiration; underlying mechanisms can be the change of aeration with root channels allowing gas exchange, and/or what is known as priming of microbial activity. This complicates the interpretation of any spatial association of roots and respiration and is ignored in all literature to date.

5. New IPCC default values differentiate between between land uses on peat

In October 2013 the Inter-government Panel on Climate Change accepted a revision of the measurement methods for wetlands, which include new default values for tropical peat soils brought into cultivation. Discrepancies between data sets and contested interpretation of outliers was reason for fierce debates, before the defaults were defined as means of the accepted data sets. An important step in the debate was to separate the Acacia plantation forestry and oil palm data. The former is mostly based on one study site, but is higher than what is now accepted for oil palm. A reason for this split can be that N_2-fixing Acacia might enrich the N content of peat and hence speed up microbial breakdown, whereas elsewhere microbes remain N-limited. It may also be, however, that a different (less mature) type of peat was converted to these plantations, with higher vulnerability.

6. Complex science –policy interfaces

Indonesian scientists are contributing to the increasing body of empirical evidence, and to the identification of factors other than drain depth as predictors of site-specific emissions. Scientific debate at universities and government research centres, has overcome the suspicion that foreign agenda's are dominating the debate. Accepting considerable spread around midpoint values, there is now widespread acknowledgement that reducing peat-based emissions, whether inside or outside forests, is an important part of national strategies to reduce emissions from what was considered to be a business as usual scenario.

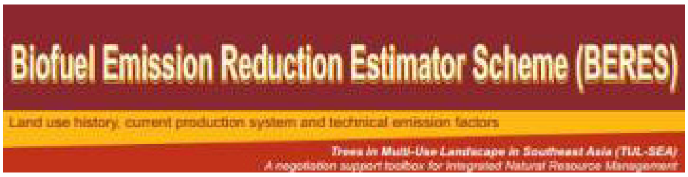
Table 1. Selected default values from the new Wetland chapter accepted by IPCC in Oct 2013

Land use category	Emission Factor (tonnes CO_2-C ha^{-1} yr^{-1})	95% Confidence Interval	
Forest Land and cleared Forest Land (shrubland), drained	5.3	-0.7	9.5
Plantations, drained, unknown or long rotations	15	10	21
Plantations, drained, short rotations, e.g. Acacia,	20	16	24
Plantations, drained, oil palm	11	5.6	17
Plantations, shallow drained (typically less than 0.3 m), typically used for agriculture, e.g. sago palm	1.5	-2.3	5.4
Cropland and fallow, drained	14	6.6	26
Cropland, drained – paddy rice	9.4	-0.2	20
Grassland, drained	9.6	4.5	17

Approved IPCC text: online by Nov 2, 2013.

7. Roundtable of Sustainable Palm Oil (RSPO) method aligned with the new IPCC default values

As the hottest debates over peat emissions have been in relation to oil palm plantations, it is relevant that key sources used by the Round-table for Sustainable Palm Oil were already aligned with what the IPCC has now accepted as default values. If more than 5-10% of palm oil in an aggregated trade flow is derived from peat, it will be difficult to meet existing standards for biofuels in Europe.



ICRAF published a Biofuel Emission Reduction Estimator Scheme (BERES) spreadsheet model with defaults for oil palm on peat linked to drain depth

http://www.worldagroforestry.org/sea/Publications/files/leaflet/LE0154-09.PDF

Roundtable for Sustainable Palm Oil produced a tool for life-cycle analysis, including peatland usage

http://www.rspo.org/file/RSPO_PalmGHG%20Beta%20version%201.pdf

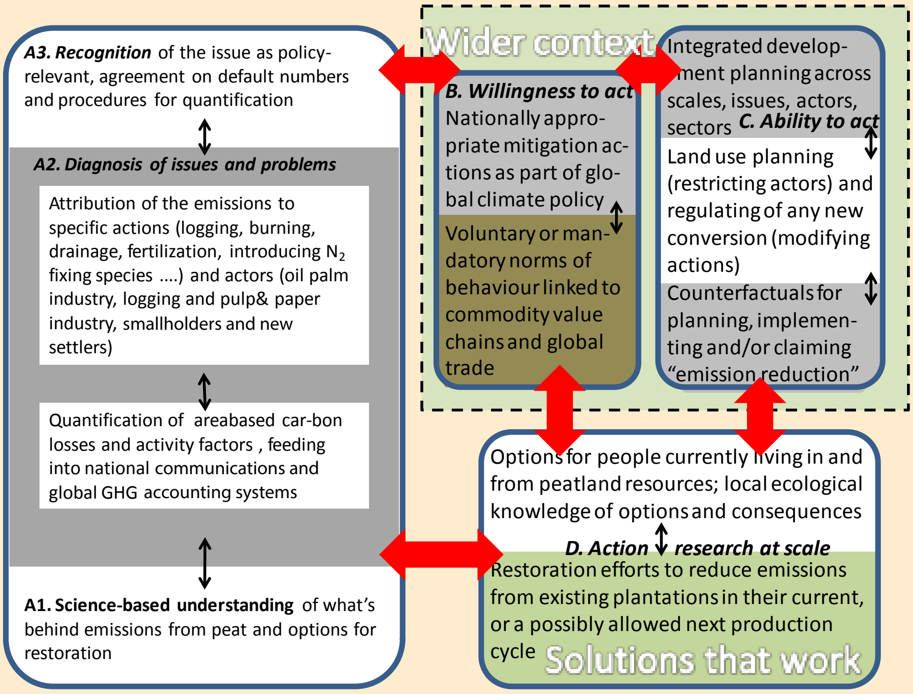
Outlook

At least four conditions need to be met before solutions that work can emerge:

A. Basic understanding of the science, diagnosis of issues and recognition of the quantities involved and methods to quantify

B&C. Willingness and ability to act on the issue in its wider policy and development context

D. Action research at scale that tests approaches in their social context



The results reported here cover mostly A1, A2 and A3, but in interaction with the willingness to act (B). Broader partnerships with local government are need for C, and with development oriented NGO's for D – with the likelihood that the underlying science and its theories of change will be challenged and will have to change themselves.

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The ASB Partnership for the Tropical Forest Margins is working to raise productivity and incomes of rural households in the humid tropics without increasing deforestation or undermining essential environmental services.

ASB is a consortium of over 90 international and national partners with an eco-regional focus on the forest–agriculture margins in the humid tropics, with benchmark sites in the western Amazon Basin of Brazil and Peru, the Congo Basin forest in Cameroon and DRC Congo, southern Philippines, northern Thailand, and the island of Sumatra in Indonesia.

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