

D4S Q&A #6

Recent advances in tropical peatland emission quantification

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<https://www.dataforsustainability.com/contact.html>

Carbon emissions from peatlands have been much studied since 2010, as overall regional emissions from SE Asian tropical peatlands became known to be of global concern. While there is interest in peat carbon emission reduction through restoration, actual investments have been limited in part by difficulties in quantification of emissions, and specifically emission reduction after restoration. Ground surveys and monitoring are hampered by the vast scale and inaccessibility of many of the lands involved, while dense vegetation cover and frequent cloud cover complicate remote sensing solutions. However there has been progress in using satellite data in recent years. We propose that using such data pragmatically to calculate proxies could enhance the interest in restoration projects.

Some considerations based on our experience and insights:

Can, and should, tropical peatland carbon emission be measured on the ground?

Gaseous carbon emissions (CO₂, CH₄) from tropical peatlands have been measured on the ground in numerous scientific studies, applying flux chambers and towers. Such research is ongoing, continuously being refined and published. Robust Emission Factors (EFs), defining unit emissions per hectare under specific conditions, are derived by combining findings of large numbers of publications. For individual projects, it is not possible to achieve the level of measurement accuracy that is achieved based on analyzing the broader science base. It is therefore questionable if such project based measurements can credibly be conducted outside of the scientific community.

How useful is tropical peatland subsidence measurement, as an emission proxy?

From well-conducted field studies, across large numbers of measurement locations (dipwells) and over multiple years, accurate peat surface subsidence measurements have been derived and published. These typically report subsidence rates in the 3 to 5 cm/yr range for oil palm and pulp wood plantations that commonly have water table depths (WTD) of -0.5 to -0.75 m om average. Strong relations between subsidence rate and carbon loss and WTD are found, both in time and across different locations. Subsidence measurement has now become an accepted way of determining carbon emission, alongside direct carbon flux measurements. However, it should be noted that while subsidence measurement may seem straightforward, it requires very careful installation and avoidance of disturbance, which in practice are hard to achieve especially in active plantations. Also, this method yields results of limited relevance over periods shorter than 3 years. In our experience, internal plantation company records of subsidence often yield an unrealistic range from 0 to 10 cm/yr, often biased towards very low rates around 1 cm/yr. Therefore, subsidence monitoring for carbon emission estimation is not advised for application outside of the scientific community.

Is it possible to accurately estimate tropical peatland carbon emission from land use?

Current carbon emission estimates often apply land use based EFs derived from the IPCC 2013 Wetlands Guidelines. This has the benefit of ensuring comparability between studies. However the science behind these EFs is somewhat outdated, many new studies were published in recent years. These studies suggest that the relation between EF and WTD is much stronger than that with land use. And within land uses, a wide range of WTDs is reported. Therefore, estimating tropical peatland emissions from land use alone is not considered an optimum approach.

What are the advantages of estimating tropical peatland carbon emission from WTD?

Assessment of recent publications shows not only a convergence of results from three different emission measurement methods (flux chambers, flux towers and subsidence monitoring) but also closer and more confident relations between carbon emission and WTD than could be determined before. We therefore expect that in the near future, EFs will be based mostly on WTD not (just) land use. This will allow calculation of precise emissions reflecting actual rainfall and management conditions, that are variable in time and geographically. In plantations, management efforts to bring up water levels could then be 'rewarded' for reduced emissions, something that is not possible with land use based EFs where emissions are assumed to be constant as long as the same crop is grown. In restoration projects, WTD based EFs will allow monitoring of actual emissions on an annual basis, reflecting rewetting results as well as rainfall variations.

So for a tropical peatland restoration project aiming for carbon emission reduction credits, what is the recommended approach to quantify carbon emission reduction?

In tropical peatland carbon emission reduction projects that we help develop, emissions are quantified by a measured mix of ground monitoring and satellite data. On the ground, a network of dipwells is installed, often randomized along transects within predetermined management zones of similar drainage conditions (often linked to land use). By anchoring the dipwells in the mineral substrate below the peat, and applying strict SOPs for installation and monitoring, both WTD and subsidence data will be obtained. Ground WTD data will be validated with satellite LiDAR measurements of canal water depth below the peat surface (see Q&S #5), and the monitoring system and data will be reassessed if the differences are large. The validated WTD will be used to determine EFs for the management zones, and actual emissions will be determined for zones and the project area.

SELECTED FURTHER READING (D4S PUBLICATIONS)

Subsidence and carbon loss in drained tropical peatlands (link: Subsidence and carbon loss in drained tropical peatlands (<https://bg.copernicus.org/articles/9/1053/2012/>))

Towards robust subsidence-based soil carbon emission factors for peat soils in south-east Asia, with special reference to oil palm plantations (http://pixelrauschen.de/wbmp/media/map12/map_12_01.pdf)

Carbon Emissions from Drained and Degraded Peatland in Indonesia and Emission Factors for Measurement, Reporting and Verification (MRV) of Peatland Greenhouse Gas Emissions (https://www.researchgate.net/publication/323616904_Carbon_emissions_from_drained_and_degr)

[aded peatland in Indonesia and emission factors for measurement reporting and verification MRV of peatland greenhouse gas emissions - a summary of KFCP research r\)](#)

Benefits of tropical peatland rewetting for subsidence reduction and forest regrowth: Results from a large-scale restoration trial (<https://www.nature.com/articles/s41598-024-60462-3>)

Current and future CO₂ emissions from drained peatlands in Southeast Asia (<https://bg.copernicus.org/articles/7/1505/2010/bg-7-1505-2010.html>)

From carbon sink to carbon source: extensive peat oxidation in insular Southeast Asia since 1990 (<https://iopscience.iop.org/article/10.1088/1748-9326/aa5b6f>)