



Advances in tropical peatland emission quantification

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Investments in peatland restoration have been held back by difficulties in quantification of the resulting emission reduction. 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 emission proxies, combined with field data, 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 match the level of measurement accuracy of the broader science base. It is therefore questionable if project based measurements are useful.

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

Recent publications show similar results from three different carbon emission measurement methods: flux chambers, flux towers and subsidence monitoring. From well-conducted field studies, across large numbers of measurement locations (dipwells) and over multiple years, accurate peat surface subsidence records 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 with mean water table depths (WTD) of -0.5 to -0.75 m. However, reliable monitoring is rarely achieved outside controlled studies, especially in active plantations.

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 However, the science behind these EFs is somewhat outdated.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 recent 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 no longer considered the best approach by experts.

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

We 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

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to bring up water levels could then be 'rewarded' for reduced emissions, which is impossible with land use (crop) based EFs. In restoration projects, WTD based EFs will allow monitoring of actual emissions on an annual basis, reflecting rewetting results.

So 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 'hybrid' combination 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 (see Insight Report A.2). 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 may be validated with satellite LiDAR measurements of canal water depth below the peat surface (see Insight Report A.2), 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_degraded_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>)