Advances in tropical peatland mapping

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(https://www.dataforsustainability.com/)

For tropical peatland restoration, reliable maps of peat extent and thickness are crucial. Various maps exist presenting peat extent and thickness across SE Asia, but confidence in these is generally low. Why is it so difficult to create accurate peat maps, and what improvement is possible?

Some considerations based on our experience and insights:

What maps exist of peat extent and thickness?

Of the SE Asian countries with substantial remaining peatlands, only Indonesian government agencies produced country-wide official maps of peat extent and thickness. The oldest Indonesia-wide official peat map, published by Wetlands International, used data from the national soil mapping agency Puslitanak that were collected around 2000. A more recent map in the public domain was published by the BBSDLP agency (2011); later products are produced by different agencies and not (or not fully) available in the public domain.

How accurate are existing official Indonesian peat maps?

A characteristic of these maps is that peat extent (boundary location) appears reduced in time, especially for Indonesian Papua where extent was reduced from over 7 million hectare to less than 2 Mha in the BBSDLP map, the latter excluding large lowland swamp areas that do have peat soils according to published field data. Moreover, these maps have coarse peat thickness boundaries and no thickness detail is available for peat deeper than 3 m according to these maps, which is unsuitable for peat carbon stock quantification. Furthermore, most data used is over 10 years old, while peat thickness in many regions is decreasing fast due to peat loss and subsidence (see Insight Report A.1). These maps require careful interpretation when it comes to peat extent, and can not be used for peat thickness models on a project basis.

What is the approach of most peat thickness mapping to date?

Most peat thickness maps are still created by interpolation of field measurements of peat thickness. Usually 'kriging' with GIS software is applied, which can produce results that may look more plausibly 'natural', but in fact introduce artefacts of 'spikes' and 'pits' i.e. unrealistic irregular thickness patterns. There have also been attempts to apply 'machine learning' using satellite images of vegetation, but because most peatlands are now burnt and/or converted to agriculture, the natural relation between vegetation and peat thickness often no longer exists. Another recent attempt to improve peat maps involves creation of dense grids of peat thickness measurements to interpolate between, at 500 m intervals; however, in our observation these data are often model generated, which only confuses matters. In summary: when compared against recent field measurements, we still find that most existing maps of peat thickness are inaccurate.

What is a better approach to tropical peat thickness mapping?

We have demonstrated, in numerous projects, an alternative approach that does not just rely on interpolation between field measurements but utilizes science-based relations between

peat thickness and surface topography as well as the hydrological drainage base. Most peatlands in SE Asia developed in coastal lowlands, as domes separated by rivers and coastlines. The plant growth that results in peat accumulation usually starts in floodplains just above sea and river levels i.e. the 'drainage base' (see Insight Report A.5). Therefore, the peat deposit is defined by a peat surface that can be determined from elevation models, and a peat bottom that can be determined from landscape hydrology characteristics in combination with scarce (but accurate) peat thickness measurements. Recent improvements in elevation model accuracy, using satellite LiDAR, are especially relevant to making this new approach highly accurate.

Why is determining peat extent still complicated?

A limitation of the landscape-based approach to peat mapping is that it does not produce peat boundaries, at least not more accurately than other methods do. The extent of shallow peat must still be derived from field measurements and visual inspection of patterns in vegetation, land use and drainage patterns in satellite images, combined with existing older maps.

Is peatland thickness constant, or should changes in time be monitored?

As most peatland in SE Asia is drained to some extent, and sometimes burnt, peat is lost continuously. Peat thickness therefore decreases in time, and accurate peat maps should be no more than 10 years old. However, updated peat maps do not have to be created 'from scratch' but could build on earlier (accurate) maps by accounting for geographic variations in peat surface elevation loss, that can be determined from field subsidence monitoring or from satellite LiDAR data.

SELECTED FURTHER READING (D4S PUBLICATIONS)

Peatland maps for Indonesia. Including accuracy assessment and recommendations for improvement, elevation mapping and evaluation of future flood risk (https://deltares-deltares-p01-website.s3.eu-central-1.amazonaws.com/app/uploads/2015/03/QANS-Peat-mapping-report-final-with-cover.pdf)

Mapping deep peat carbon stock from a LiDAR based DTM and field measurements, with application to eastern Sumatra (https://link.springer.com/article/10.1186/s13021-020-00139-2)

DeltaDTM: A global coastal digital terrain model (https://www.nature.com/articles/s41597-024-03091-9)