D4S Q&A #7

Recent advances in tropical peatland mapping

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

For tropical peatland restoration, to reduce carbon emissions or for other reasons, reliable maps of peat extent (location) and thickness are needed, as well as the peat carbon stock available for emissions. Various maps exist presenting peat extent and thickness across SE Asia, but confidence in these is generally low and maps for specific areas are often created on a project basis. Why is it so difficult to create accurate peat maps, and is it possible to create a single regional map that is useful at the project scale?

Some considerations based on our experience and insights:

How accurate are existing official maps of peat extent, thickness and carbon stock?

Of the three SE Asian countries with large remaining expanses of peatland, only Indonesian government agencies produce updated official maps of peat extent and thickness, with maps for Malaysia and Brunei being old and often not available digitally in the public domain. The oldest Indonesian-wide official peat map, published by Wetlands International, used data from the national mapping agency Puslitanak that were collected around 2000. A more recent map in the public domain was published by the BBSDLP agency (2011); later national products are produced by different agencies and not (or not fully) available in the public domain. A characteristic difference between these maps is that peat extent appears reduced in time; this is especially evident for Indonesian Papua where the mapped peat extent was reduced from over 7 million hectare in the WI/Puslitanak map to less than 2 Mha in the BBSDLP map, the latter excluding large lowland swamp areas that do have peat soils according to existing 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 makes them unusable for peat carbon stock quantification. Furthermore, most data used in these mapping exercises are over 10 years old, while peat thickness in many regions is decreasing fast due to decomposition and fires following drainage. In conclusion, we find that these national official maps need to be interpreted carefully when it comes to peat extent, and can not be used for peat thickness models on a project basis.

What is the approach of official peat thickness maps to date?

Peat thickness maps in SE Asia are still mostly created based on interpolation of field measurements of peat thickness only, which is a traditional approach. In recent years, interpolation is increasingly done by 'kriging' using GIS software, which can produce results that may look more plausibly 'natural', but in fact introduce artefacts of 'spikes' and 'pits' i.e. more irregular peat thickness patterns than occur in reality. There have also been attempts to apply 'machine learning' to make use of optical satellite images of vegetation and other datasets, but these are hampered by the reality that most peatlands are now burnt and/or converted to agriculture, and the relation between vegetation, surface wetness and peat thickness has largely been lost. 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 measurements are often not field data but model generated, which only confuses matters. In summary: when compared against recent field measurements, we still find that existing official maps of peat thickness are highly inaccurate.

What is a better approach to tropical peat thickness mapping, in our opinion?

We have demonstrated an alternative approach that does not just rely on interpolation between field measurements only but also utilizes scientific insights in the relations between peat thickness and surface topography as well as the hydrological drainage base. Most peatlands in SE Asia develop in coastal lowlands, as domes separated by rivers and coastlines. The plant growth that results in peat accumulation usually starts in frequently inundated floodplains just above sea and river levels i.e. the 'drainage base'. 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.

An additional advantage of a landscape-based approach to mapping peat thickness is that it allows determination of the depth of peat that is actually at risk of drainage, and therefore to decomposition. Only peat carbon stock above the drainage base is available to carbon emission, and can be included in emission projections that underpin carbon credit schemes to fund restoration.

A limitation of the landscape-based approach to peat mapping is that it does not produce peat boundaries, at least no more accurately than other methods do. The extent of shallow peat must still be derived from field measurements and inspection of patterns in vegetation and land use, 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 will therefore decrease 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 can 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)