



# Advances in tropical peatland water table depth monitoring

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***Water table depth (WTD) below the surface is the key control on tropical peat decomposition and carbon emission, as well as the health of the swamp forest that formed the peat in recent millennia. Robust relations between WTD and emissions were established in recent years, allowing determination of carbon budgets based on WTD information. So, what methods exist to measure WTD, and what are the pros and cons?***

*Some considerations based on our experience and insights:*

### **Why are WTD time series needed, does a single measurement not suffice?**

Tropical peatland water levels fluctuate with rainfall and evapotranspiration, being lower during droughts. In regions with high rainfall variability, the annual WTD fluctuation range can exceed 1 m in some years, while being less than 0.5 m in others. To determine an 'average' WTD that can be used in carbon emission calculations, this variation must be captured in a time series of measurements, preferably a record of monthly measurements over at least 3 years. The longer the record, the more confident the emission estimate will be.

### **Measuring WTD on the ground seems simple and reliable, but is this true at a large scale?**

On the ground, WTD is usually measured in 'dipwells', perforated PVC tubes that are inserted in auger holes. This brings advantages of replicability and verification. However, data integrity issues are common. Apart from these risks, the cost and effort of installation and frequent monitoring can be high, especially for large studies / projects that can involve hundreds of dipwells. Therefore, field monitoring systems should be carefully planned and well supervised, and independent verification with satellite data enhances confidence.

### **So what are these data issues in field monitoring?**

The following issues occur in our experience: [a] dipwell location bias can be accidental (e.g. easy-access locations that are not representative for the larger area) or intentional (e.g. a lower peat surface to demonstrate higher water level); [b] installation errors may limit water level fluctuations (e.g. insufficient perforation holes); [c] the ground surface may be measured incorrectly; [d] reading / writing errors by staff; [e] numbers can be 'made up' altogether.

### **How many measurement locations are needed to determine a robust WTD?**

This depends on the size of the area of interest, as well as the variation in hydrological conditions within it. It is best to first divide a project / study area into relatively uniform zones, e.g. 'drained for agriculture', 'peat swamp forest more than 500 m from a canal'. Each zone should then have sufficient measurement points, where 3 is usually considered the minimum. The shorter the monitoring record, the more measurement points are needed for confident quantification of WTD ('space for time' principle).



### **Can tropical peatland WTD be measured using LiDAR, from space?**

LiDAR (laser) technology can accurately measure the elevation of both the peat surface and water surface in canals, i.e. the water table depth below the peat surface (CWD). Satellite LiDAR (available since 2018) has low spatial density compared to airborne LiDAR, but brings the advantage of repeat measurements over the years, and it comes at no acquisition cost. Once the CWD is known, it may be used as a proxy for WTD as the difference is usually found to be less than 0.1 m (this is explained by the very high water transmission capacity of tropical peat). However, this method is only valid in areas with canal systems, and best combined with field monitoring as a validation data source.

### **Can tropical peatland WTD be measured using optical and radar data, from space?**

In colder-climate peatlands that typically have low vegetation, WTD may be estimated from optical and radar satellite soil moisture detection. In tropical peatlands this approach was recently demonstrated for areas with limited vegetation cover. However, most tropical peatlands (industrial plantations, forest, restoration areas) have a dense tree/shrub cover, that varies in time with crop cycles and tree regrowth rates, rendering such approaches useless. Possibly this method may be of some value in future used in parallel with more accurate but geographically sparse field and LiDAR measurements.

### **SELECTED FURTHER READING (D4S PUBLICATIONS)**

[Subsidence and carbon loss in drained tropical peatlands \(https://bg.copernicus.org/articles/9/1053/2012/\)](https://bg.copernicus.org/articles/9/1053/2012/)

[A new method for rapid measurement of canal water table depth using airborne LiDAR, with application to drained peatlands in Indonesia \(https://www.mdpi.com/2073-4441/12/5/1486\)](https://www.mdpi.com/2073-4441/12/5/1486)

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