Organic carbon losses in waters draining peatland oil palm plantations in South East Asia

By Sarah Cook[1]

Why are tropical peatlands important?

Peatlands are areas where thick layers of organic matter has accumulated [1]. Whilst they only cover around 2-3% of the world's land surface area their carbon storage exceeds that of the global vegetation pool [2], making them important stores of carbon. Tropical peatlands are distributed across Central and South America, Africa and Asia, and store the equivalent of nearly one fifth of all peatland carbon worldwide [2]. Consequently, under natural conditions, tropical peatlands constitute vast reservoirs of soil carbon and are a significant component of the global carbon cycle.

Conversion of tropical peatlands into oil palm plantations

Southeast Asia contains the largest resource of tropical peat [2]. However, tropical peatlands are frequently exploited for economic benefit and conversion to other land-uses is common throughout Southeast Asia[3]. More than 25% of tropical peat is now under oil palm plantations (OPP). This type of conversion requires substantial land modifications, namely drainage and deforestation (Figure 1). This can lead to lead to significant perturbations to the peat's carbon reservoirs resulting in the release of stored carbon [4,5].

Figure 1. Destruction of a peat swamp forest through deforestation and drainage (left) to create an oil palm plantation (right), along with a photo of an artificial drainage channel used to maintain a low water level.

Dissolved organic carbon… the missing link

One form in which peat carbon can be released is via the leaching of organic carbon from the surrounding terrestrial landscape into freshwater systems. Once here it can be degraded both biologically and chemically liberating CO_2 (carbon dioxide), CH_4 (methane) and CO (carbon monoxide) into the atmosphere[4] (Figure 2). However, dependable carbon loss estimates from OPP on tropical peat are few [6], particularly with regards to organic carbon losses occurring in the drainage waters. At present, this aquatic component remains largely overlooked but could represent a hidden and potentially important contributor to global greenhouse gas (GHG) emissions.

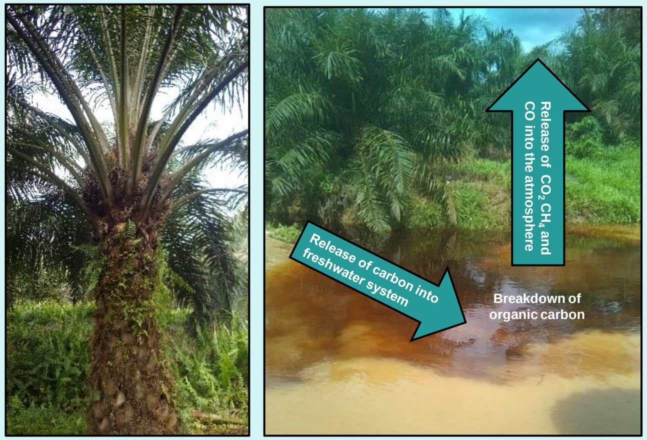

Figure 2. Photo of an palm oil tree (left) and photo to illustrate the release of organic carbon (dark brown water) into water draining a peatland oil palm plantation.

Research aim and implications

This research aims to monitor the concentrations of organic carbon in water draining from two oil palm estates and nearby stands of tropical peat swamp forest (TPSF) in Sarawak, Malaysia. In addition, two recently deforested TPSF sites were also monitored. The results will be used to help quantify carbon emissions from this land-use change, thereby supporting more sustainable plantation management, as well as potentially helping countries, such as Malaysia, to better monitor, report and verify their land-based GHG emissions.

What we have found out so far ….

Organic carbon concentrations have been calculated for the oil palm estates and forest sites, over the past 9 months (August 2015-April 2016) (Figure 3).

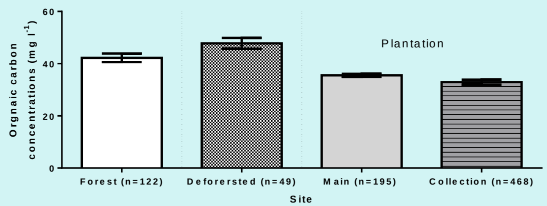

Figure 3. Organic carbon concentrations (mg l^{-1}) for the main and collection drains within the plantation estates and the forest sites, from August 2015 – April 2016. Bars indicate standard error of the mean.

The quality of the organic carbon (August 2015-April 2016) was assessed using specific ultra-violet absorption at 254nm ($SUVA_{254}$). This can be used to give an indication of how like the organic carbon will be converted into gaseous carbon[7] ; **high $SUVA_{254}$ = high aromaticity = recalcitrant carbon = low likelihood of being converted into CO_2** . The $SUVA_{254}$ values were then converted into percentage (%) aromaticity[7] (Figure 4).

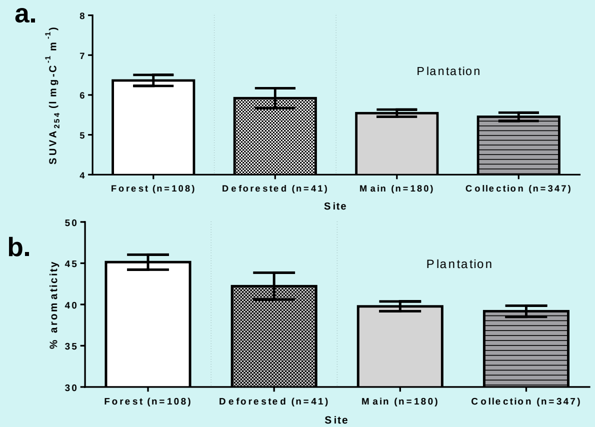

Figure 4. Mean (a) $SUVA_{254}$ data and (b) percent aromaticity data for the main and collection drains within the plantation estates and the forest sites, from August 2015 – April 2016. Bars indicate standard error of the mean. * Percent aromaticity was calculated using the equation outlined in Weishaar et al (2003); *Aromaticity (%) = (6.52*$SUVA_{254}$) + 3.63*

Initial mean organic carbon concentrations range from **32.9 to 35.5 mg l^{-1}** in the plantation collection drains and main drains, respectively (Figure 3). Average organic carbon concentrations within the forest sites are **42.2 mg l^{-1}.** The highest organic carbon concentrations are found within the deforested sites **(47.8 mg l^{-1}).**

In general, the waters draining the plantation estates exhibit lower SUVA and % aromaticity values (Figure 4) compared with the more intact forest sites and thus, the carbon is more likely to be converted into CO_2. Subsequently, organic carbon losses from plantation drainage waters could be important contributors to global GHG emissions. This trend is also exhibited by deforested sites suggesting a transition from more recalcitrant to more labile carbon during the deforestation process. Continued work will help to build a fuller picture into the temporal dynamics of this aquatic carbon component.

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