Quantification of CO2 removal in a large-scale enhanced weathering field trial on an oil palm plantation in Sabah, Malaysia

ABSTRACT

Modeling studies show that large-scale deployment of enhanced rock weathering on croplands has the potential to reduce levels of atmospheric carbon dioxide by the end of the century. There is, however, a pressing need to verify model predictions through long-term field trials. Here we report results from the first 3 years of an ongoing enhanced weathering field trial, carried out on an oil palm plantation in Sabah, Malaysia. Crushed silicate rock was applied to three hydrologically isolated catchments, and three adjacent (paired) reference catchments were left untreated. The drawdown of atmospheric CO2 was quantified via the export of alkalinity in stream waters and changes in soil carbonate content. The amended and reference catchments were found to have a similar extent of CO2 drawdown via alkalinity export [respectively, 3.8 ± 0.8 (1 SD) and 3.7 ± 0.6 (1 SD) tCO2 ha−1] when all catchments were averaged over the study period (October 2018 to July 2021). However, di□erences were observed between the di□erent catchment pairs (plots): two of the plots displayed a similar extent of CO2 removal for both the amended and reference catchments, but the third amended catchment had a higher extent of CO2 removal of ∼1 tCO2 ha−1 relative to its adjacent reference catchment. The di□erence in CO2 removal rates determined for this plot can likely be attributed to increased weathering of silicateminerals in the amended catchment. Soil carbonate concentrations were on average < 0.2 wt% CaCO3, but we report a small increase of ∼0.03 wt% CaCO3 in the top 30cm of soil in the amended soils relative to the reference catchments. Themagnitude of CO2 drawdown via alkalinity export determined for these agricultural catchments is around an order of magnitude higher than in natural forested catchments in Sabah and similar to that of basaltic catchments. We show that these high weathering rates are primarily driven by weathering of carbonate fertilizers. The data presented from this field trial provide vital contextual information on the real-world e□ cacy and practicalities associated with the implementation of enhanced weathering for atmospheric CO2 removal that will help to inform further trials as well as wider-scale deployment.