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Acidity addition in the Mississippi watershed drives agricultural CO_2 emissions

TIM JESPER SUHRHOFF[1,2], CHRIS REINHARD[3], YOSHIKI KANZAKI[3], SHOU-EN TSAO[2], BECK WOOLLEN[2], TOM REERSHEMIUS[4], JAMES E. SAIERS[2], SHUANG ZHANG[5], PETER RAYMOND[2] AND NOAH J. PLANAVSKY[2]

[1]Yale Center for Natural Carbon Capture
[2]Yale University
[3]Georgia Institute of Technology
[4]Newcastle University
[5]Texas A&M University

Atmospheric pollution and fertilizer addition acidify agricultural soils. To prevent run-away acidification, limestone addition to soils—referred to as liming—has been common practice in US croplands for over 80 years[1]. This process boosts yields and increases soil pH[2], but is typically considered a CO_2 source (e.g., by the IPCC[3]). Here we argue that this is conceptually mistaken and produces counterproductive incentives given that more effective pH management may help to reduce agricultural greenhouse gas emissions[2,4].

We present an alternative framework via which emissions are instead attributed to acidity addition and demonstrate that carbonate addition to fields should be considered carbon dioxide removal (CDR) compared to the counterfactual. We compile twelve decades of data for the Mississippi River catchment which demonstrate that this framework is consistent with trends observed in the catchment since 1900 and that agricultural liming in one of the largest agricultural catchments in the world has been a net CO_2 sink. Furthermore, our results suggest that CO_2 emissions from soil acid-base reactions are larger than currently assumed and depend on land use history.

Our results have significant implications for the assessment of enhanced carbonate weathering as a form of CDR. If acid-base related emissions are set by acidity inputs, the weathering of carbonate rocks may be a more efficient pathway to achieve CDR compared to silicate rock-based approaches. However, the potential change in timescales related to acid-derived CO_2 emissions should be considered carefully and deployment of a large amount of silicate rock powder before carbonates are used may also be prudent in many cases. Collectively, these considerations underscore that optimized soil pH management can significantly reduce agricultural GHG emissions, highlighting the need for revised agricultural policies.

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