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Assessing the potential of soil carbonation and enhanced weathering to sequester atmospheric CO_2, through Life Cycle Assessment: a case study for Sao Paulo State, Brazil

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Scientists generally agree that, by 2100, the annual extraction of an average of 3.3 Gt of carbon equivalent from the atmosphere will be necessary to limit the increase in global average temperature to 2°C relative to pre-industrial levels (Smith et al., 2016). A greenhouse gas (GHG) removal technology (GGRT) is one that can remove a GHG from the atmosphere. Enhanced silicate rock weathering for long-term CO_2 sequestration has considerable potential as a GGRT, but depends on the availability of suitable rocks coupled with proximity to locations where it can be applied. Extracting, processing, transporting and applying ground rock to land consume energy and thus generate GHG emissions, which must be balanced against the sequestration potential.

In this study, we i) assess the environmental impacts of the practice, using existing basalt rock quarrying in Sao Paulo (SP) state by considering the emissions associated with the rock extraction, comminution, transport and application through a Life Cycle Assessment (LCA) approach; ii) estimate the contribution of the different processes involved with soil carbonation and enhanced weathering and iii) assess the potential net CO_2 removal of Sao Paulo agricultural land through soil carbonation and weathering of basalt rock.

Our results show that enhanced weathering and carbonation respectively emit around 75 and 135 kg CO_2eq per tonne of CO_2eq removed (considering an average quarry to field distance of 65 km.) We underline transportation as the principal process negatively affecting the practice and establish a limiting road travel distance from quarry to field of 540 $\pm$ 65 km for carbonation and 990 $\pm$ 116 km for enhanced weathering. Above these distances, the GHG emissions exceed the potential sequestration. The application of crushed basalt at 1 t/ha to all of Sao Paulo State's 12 million hectares of agricultural land could capture around 1.3 to 2.4 Mt CO_2eq through carbonation and enhanced weathering, respectively. If 50 t/ha is applied, the sequestration potential could reach up to 40 to 76 % of the total Sao Paulo State emissions in 2016 through carbonation and enhanced weathering respectively, assuming no loss in the effectiveness of basalt at high application rates.

This study lowers previous net sequestration estimates from Kantola et al. (2017) by around 50% and, as various techniques are increasingly promoted as efficient solutions to remove or sequester CO_2, it emphasizes the need to consider the practice in its entirety to show the limitations and potential caveats. The holistic approach of LCA helps identify processes with the most impact and their significance. However, its accuracy and reliability is inevitably limited by the amount, quality and representativeness of the input data. Therefore, detailed studies on each process stage should be conducted to increase accuracy, focusing on local practices especially transport.

References:

1. Kantola et al., 2017, Potential of global croplands and bioenergy crops for climate change mitigation through deployment for enhanced weathering. https://doi.org/http://dx.doi.org/10.1098/rsbl.2016.0714
2. Smith et al., 2016, Biophysical and economic limits to negative CO_2 emissions. https://doi.org/10.1038/nclimate2870