



Enhanced weathering to promote forest health, climate change resilience and carbon sequestration

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Unprecedented and urgent action is needed to limit warming to no more than 2.0 °C and preferably 1.5 °C, above preindustrial levels to reduce the risk of severe climate change. Our ability to achieve these temperature limits depends increasingly on carbon dioxide removal (CDR) strategies, such as land-based enhanced weathering (EW). EW aims to accelerate CO₂ drawdown by increasing carbonate weathering rates through the spreading of crushed rock on land. Recent EW work has focused on managed croplands, while the potential of EW in forests to increase CDR has been largely unexamined. However, a huge body of literature has already addressed the effects of applying crushed rock to forests, yet for another purpose: to reverse the effects of acidification. For decades in northern Europe, large-scale and well-studied national programs have applied crushed carbonate rock to forests and streams to combat the serious threats posed by acidification. Still, the problem is ongoing and widespread: accumulating evidence highlights the serious threats that acidification and nutrient limitations continues to pose to northern forest ecosystems. Here, we examine the negative CO₂ emissions potential of EW in acidified and nutrient-limited forests and identify possible co-benefits, through a synthesis of the rich history of studies of acidification and of applications of rock dust to soils through the lens of CDR. We find that particular, acidified and/or nutrient-limited forests are promising for EW initiatives for two key reasons: 1) chronic acidification/nutrient limitation can severely reduce a forest ecosystem's ability to capture carbon, and therefore increased "natural" carbon sequestration gains are expected to occur from EW in these systems in addition to the "engineered" sequestration through addition of more weathering reactants, and 2) EW in forests is expected to produce an array of high priority ecological co-benefits to forest ecosystems including reversing acidification of soils and freshwaters. We compare relative advantages of enhanced carbonate rock weathering (ECW) versus enhanced silicate rock weathering (ESW) and find that while both carbonate and silicate rock can achieve CDR and improve acidification and nutrient deficiencies, they have different strengths and weaknesses. Our findings show that, by increasing CDR and providing multiple co-benefits, EW in acidified forests has the potential to contribute to the larger scale framework of sustainable development through five of the UN Sustainable Development Goals.