Rock Dust in Farming: A Potential Strategy to Help Close the Climate Gap

19 February 2018

James Hansen

Today's governments are wittingly leaving young people with a grinding, growing climate mess.

Delayed response of climate to human-caused rising atmospheric CO_2 threatens to leave young people a situation out of their control. The primary action required to avoid that outcome is rapid reduction of fossil fuel emissions. However, our "Young People's Burden" paper¹ shows that more is required: it is also necessary to extract CO_2 from the air.

A study led by David Beerling and his group in Sheffield, UK, proposes a change to agricultural practices that could increase the rate of the natural weathering process that removes CO_2 from the air. Logistical infrastructure to apply appropriate (basaltic) rock dust to managed croplands already exists due to the common need to apply crushed limestone to reverse acidification.

Rock dust has potential to improve soil fertility and provide protection against pests and diseases so there is hope that costs could be offset by financial benefits. If it proves feasible to employ such practices on a large scale an important benefit could be reduction of ocean acidification, which threatens marine biocalcifiers such as corals and shellfish. Further study and field assessments are needed to verify benefits and address potential obstacles to large-scale adoption.

The papers abstract is given below and a news release is attached. Media reports are strictly embargoed until 16:00 (GMT) Monday 19 February 2018

Farming with crops and rocks to address global climate, food and soil security

David J. Beerling^{1*}, Jonathan R. Leake¹, Stephen P. Long^{2,3,4}, Julie D. Scholes¹, Jurriaan Ton¹, Paul N. Nelson⁵, Michael Bird⁵, Euripides Kantzas¹, Lyla L. Taylor¹, Binoy Sarkar¹, Mike Kelland¹, Evan DeLucia^{2,3}, Ilsa Kantola², Christoph Müller⁶, Greg H. Rau⁷ and James Hansen⁸

The magnitude of future climate change could be moderated by immediately reducing the amount of CO_2 entering the atmosphere as a result of energy generation and by adopting strategies that actively remove CO_2 from it. Biogeochemical improvement of soils by adding crushed, fast-reacting silicate rocks to croplands is one such CO_2 -removal strategy. This approach has the potential to improve crop production, increase protection from pests and diseases, and restore soil fertility and structure. Managed croplands worldwide are already equipped for frequent rock dust additions to soils, making rapid adoption at scale feasible, and the potential benefits could generate financial incentives for widespread adoption in the agricultural sector. However, there are still obstacles to be surmounted. Audited field-scale assessments of the efficacy of CO_2 capture are urgently required together with detailed environmental monitoring. A cost-effective way to meet the rock requirements for CO_2 removal must be found, possibly involving the recycling of silicate waste materials. Finally, issues of public perception, trust and acceptance must also be addressed.

¹ Hansen, J. et al., Young people's burden: requirement of negative CO₂ emissions, Earth Syst. Dynam 8, 577, 2017.



News Release Draft.

Strictly embargoed until 16:00 (GMT) Monday 19 February 2018

Farming crops with rocks to reduce CO2 and improve global food security

- Enhanced rock weathering involves adding minute rock grains to cropland soils which dissolve chemically taking up carbon dioxide and releasing plant essential nutrients.
- Unlike other carbon removal strategies enhanced rock weathering doesn't compete for land used to grow food or increase the demand for freshwater.
- Other potential benefits include reducing the use of agricultural fertilizers and pesticides, lowering the cost of food production and increasing farm profitability.

Farming crops with crushed rocks could help to improve global food security and capture CO2 from the atmosphere, a new study has found.

The pioneering research by scientists at the University of Sheffield together with international colleagues suggests that adding fast-reacting silicate rocks to croplands could capture CO2 and give increased protection from pests and diseases while restoring soil structure and fertility. Professor David Beerling, Director of the Leverhulme Centre for Climate Change Mitigation at the University of Sheffield and lead author of the research, said: "Human societies have long known that volcanic plains are fertile, ideal places for growing crops without adverse human health effects, but until now there has been little consideration for how adding further rocks to soils might capture carbon.

"This study could transform how we think about managing our croplands for climate, food and soil security. It helps move the debate forward for an under-researched strategy of CO2 removal from the atmosphere - enhanced rock weathering - and highlights supplementary benefits for food and soils.

"The magnitude of future climate change could be moderated by immediately reducing the amount of CO2 entering the atmosphere as a result of burning fossil fuels for energy generation. Adopting strategies like this new research that actively remove CO2 from the atmosphere would contribute this effort and could be adopted rapidly."

The research, published today (19 February 2018) in *Nature Plants*, examined the approach which involves amending soils with abundant crushed silicate rocks, like basalt, left over from ancient volcanic eruptions. As these minute rock grains dissolve chemically in soils, they take up carbon dioxide and release plant-essential nutrients. Critically, enhanced rock weathering works together with existing managed croplands. Unlike other carbon removal strategies being considered, it doesn't compete for land used to grow food or increase the demand for freshwater. Other benefits include reducing the usage of agricultural fertilizers and pesticides, lowering the cost of food

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production, increasing the profitability of farms and reducing the barriers to uptake by the agricultural sector.

Crushed silicate rocks could be applied to any soils, but arable land is the most obvious because it is worked and planted annually. It covers some 12 million square kilometres or 11 per cent of the global land area.

Arable farms already apply crushed rock in the form of limestone to reverse acidification of soils caused by farming practices, including the use of fertilizers. Managed croplands, therefore, have the logistical infrastructure, such as the road networks and machinery, needed to undertake this approach at scale. These considerations could make it straight forward to adopt.

Professor Stephen Long at the University of Illinois Champaign-Urbana, and co-author of the study added: "Our proposal is that changing the type of rock, and increasing the application rate, would do the same job as applying crushed limestone but help capture CO₂ from the atmosphere, storing it in soils and eventually the oceans.

"Global warming is a problem that affects everyone on the planet. Scientists generally have done a poor job of getting across the point that the world must reduce emissions of greenhouse gases from fossil fuels and combine this with strategies for extracting carbon dioxide from the atmosphere to avoid a climate catastrophe.

Professor James Hansen from the Earth Institute at Columbia University and co-author of the work, added: "Strategies for taking CO2 out of the atmosphere are now on the research agenda and we need realistic assessment of these strategies, what they might be able to deliver, and what the challenges are."

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The video below from the Leverhulme Centre for Climate Change Mitigation highlights the approach.

https://www.youtube.com/watch?v=G1WZloWgpAw

Ends

For further information please contact: Amy Huxtable, Media Relations Officer, University of Sheffield, 0114 222 9859

Notes to editors

The Leverhulme Centre for Climate Change Mitigation is funded with an award of £10 million over 10 years from the Leverhulme Trust and includes UK partner institutes (University of Sheffield, University of Southampton, University of Cardiff and the Open University) and international partners (University of Illinois at Champaign-Urbana, James Cook University, University of California – Riverside, and the South East Asian Rainforest Programme).

The Leverhulme Trust was established by the Will of William Hesketh Lever, the founder of Lever Brothers. Since 1925 they have provided grants and scholarships for research and education; today, we are one of the largest all-subject providers of research funding in the UK, distributing approximately £80m a year.

The Department of Animal and Plant Sciences

The Department of Animal and Plant Sciences at the University of Sheffield is home to one of the biggest communities of whole-organism biologists in the UK. Their research covers animals, plants, humans, microbes, evolution and ecosystems, in habitats ranging from the polar regions to the tropics. This work aims to shed new light on the fundamental processes that drive biological systems and help solve pressing environmental problems. Researchers and students work closely with organisations ranging from the UK Environment Agency and the Royal Horticultural Society, to Heineken and Shell, with every student given the opportunity go on an optional field course between second and third year to habitats ranging from the Peak District to Tanzania. Second year students are also given the chance to make wildlife documentaries with the help of BBC film makers. Find out more at www.sheffield.ac.uk/aps.

The University of Sheffield

With almost 29,000 of the brightest students from over 140 countries, learning alongside over 1,200 of the best academics from across the globe, the University of Sheffield is one of the world's leading universities.

A member of the UK's prestigious Russell Group of leading research-led institutions, Sheffield offers world-class teaching and research excellence across a wide range of disciplines.

Unified by the power of discovery and understanding, staff and students at the university are committed to finding new ways to transform the world we live in.

Sheffield is the only university to feature in The Sunday Times 100 Best Not-For-Profit Organisations to Work For 2017 and was voted number one university in the UK for Student Satisfaction by Times Higher Education in 2014. In the last decade it has won four Queen's Anniversary Prizes in recognition of the outstanding contribution to the United Kingdom's intellectual, economic, cultural and social life.

Sheffield has six Nobel Prize winners among former staff and students and its alumni go on to hold positions of great responsibility and influence all over the world, making significant contributions in their chosen fields.

Global research partners and clients include Boeing, Rolls-Royce, Unilever, AstraZeneca, Glaxo SmithKline, Siemens and Airbus, as well as many UK and overseas government agencies and charitable foundations.

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