Leverhulme Centre for Climate Change Mitigation (LC^3M)

Full publication listing through to January 2022

2021

40) Mercure, J.-F., Salas, P., Vercoulen, P., Semieniuk, G., Lam, A., Pollitt, H., Holden, P.B., Vakilifard, N., Chewpreecha, U., Edwards, N.R. & Vinuales, J.E. (2021) Reframing incentives for climate policy action. *Nature Energy*, **6,** 1133-1139.

39) James, R., Bullock, L., Larkin, C. & Matter, J. (2021) Geological solutions for carbon dioxide removal. *Geoscientist* (autumn), 16-22.

38) Gomez-Casanoas, N., Blanc-Betes, E., Moore, C.E., Bernachi, C.J., Kantola, I. & DeLucia, E.H. (2021) A review of transformative strategies for climate mitigation by grasslands. *Science of the Total Environment*, **799,** 149466.

37) Vakilifard, N., Kantzas, E.P., Edwards, N.R., Holden, P.B. & Beerling, D.J. (2021) The role of enhanced weathering deployment with agriculture in limiting future warming and protecting coral reefs. *Environmental Research Letters*, **19,** 094005.

36) Lewis, A.L., Sarkar, B., Wade, P., Kemp, S.J., Hodson, M.E., Taylor, L.L.,Yeong, K.L., Davies, K., Nelson, P.N., Bird, M.I., Kantola, I.B., Masters, M.D., DeLucia, E., Leake, J.R., Banwart, S.A. & Beerling, D.J. (2021) Effects of mineralogy, chemistry and physical properties of basalts on carbon capture potential and plant-nutrient element release via enhanced weathering. *Applied Geochemistry*, **132,** 105023.

35) Spence, E., Cox, E. & Pidgeon, N. (2021) Exploring cross-national public support for the use of enhanced weathering as a land-based carbon dioxide removal strategy. *Climatic Change*, **165**, art. 23 https://doi.org/10.1007/s10584-021-03050-y.

34) Horton, P., Long, S.P., Smith, P., Banwart, S.A. & Beerling, D.J. (2021) Technologies to deliver food and climate security through agriculture. *Nature Plants*, **7**, 250–255.

33) Epihov, D.Z., Saltonstall, K., Batterman, S.A., Hedin, L.O., Hall, J.S., van Breugel, M., Leake, J.R. & Beerling, D.J. (2021) Legume-microbiome interactions unlock mineral nutrients in regrowing tropical forests. *Proceedings of the National Academy of Sciences, USA*, **118,** e2022241118. https://doi.org/10.1073/pnas.2022241118.

Paper #33 reports enhanced weathering by N_2-fixing legumes trees in tropical forests facilitated by the recruitment of a below-ground microbiome that also benefits neighbouring trees.

32) Cox, E., Spence, E. & Pidgeon, N. (2021) But They told us it was safe! Carbon dioxide removal, fracking, and ripple effects in risk perceptions. *Risk Analysis*. https://doi.org/10.1111/risa.13717.

31) Cox E., Spence, E. & Pidgeon, N. (2021) What people think about Carbon Dioxide Removal. Leverhulme Centre for Climate Change Mitigation, University of Sheffield, U.K. [White Paper] Available at http://lc3m.org/publications/

30) Cox, E., Boettcher, M., Spence, E. & Bellamy, R. (2021) Casting a wider net on ocean NETs. *Frontiers in Climate*. https://doi.org/10.3389/fclim.2021.576294.

29) Taylor, L.L., Driscoll, C.T., Groffman, P.M., Rau, G.H., Blum, J.D. & Beerling, D.J. (2021) Increased carbon capture by a silicate-treated forested watershed affected by acid deposition. *Biogeosciences*, **18**, 169–188.

2020

28) Blanc-Betes, E., Kantola, I.B., Gomez-Casanovas, N., Hartman, M.D., Parton, W.J., Lewis, A.L., Beerling, D.J. & DeLucia, E.H. (2020) In silico assessment of the potential of basalt amendments to reduce N_2O emissions from bioenergy crops. *GCB Bioenergy*, **13**, 224-241.

Paper #28 reports first evidence from LC^3M field trials for consistent mitigation of N_2O fluxes from US corn-belt soils over three growing seasons following basalt amendment.

27) Beerling, D.J., Kantzas, E., Lomas, M.R., Wade, P., Eufrasio, R.M., Renforth, P., Quirk, J., Sarkar, B., Andrews, G., James, R.H., Pearce, C.R., Khanna, M., Koh, L., Quegan, S., Pidgeon, N.F., Janssens, I.,

Hansen, J. & Banwart, S.A. (2020) Potential for large-scale CO_2 removal via enhanced rock weathering with croplands. *Nature*, **583**, 242-248.

Paper #24 develops the theory to simulate the weathering of particle size distributions, and an initial nation-by-nation assessment of CO_2 removal potential by enhanced weathering constrained by current and future energy policy scenarios using an advanced and robust computationally efficient modelling approach.
[Commentary on #26: News & Views, *Nature*, **583,** 204-205; Editorial, *Nature*, **583,** 167-168, 2020]

26) Cox, E., Spence, E. & Pidgeon, N. (2020) Public perceptions of carbon dioxide removal in the United States and the United Kingdom. *Nature Climate Change*, **10**, 744-749.

25) MacDougall, A.H., Frölicher, T.L., Jones, C.D., Rogelj, J., Matthews, H.D., Zickfeld, K., Arora, V.K., Barrett, N.J., Brovkin, V., Burger, F.A., Eby, M., Eliseev, A.V., Hajima, T., Holden, P.B., Jeltsch-Thömmes, A., Koven, C., Mengis, N., Menviel, L., Michou, M., Mokhov, I.I., Oka, A., Schwinger, J., Séférian, R., Shaffer, G., Sokolov, A., Tachiiri, K., Tjiputra, J., Wiltshire, A. & Ziehn, T. (2020) Is there warming in the pipeline? A multi-model analysis of the Zero Emissions Commitment from CO_2. *Biogeosciences*, **17**, 2987–3016.

24) Kelland, M.E., Wade, P.W., Lewis, A.L., Taylor, L.L., Sarkar, B., Andrews, M.G., Lomas, M.R., Cotton, T.E.A., Kemp, S.J., James, R.H., Pearce, C.R., Hartley, S.E., Hodson, M.E., Leake, J.R., Banwart, S.A. & Beerling, D.J. (2020) Increased yield and CO_2 sequestration potential with the C_4 cereal *Sorghum bicolor* cultivated in basaltic rock dust-amended agricultural soil. *Global Change Biology*, **26**, 3658–3676.

Paper #24 reports the first evidence from mesocosm experiments that amendment of a UK agricultural soil with crushed basalt increased yields of the C_4 crop Sorhum and introduced a detailed 1-D soil profile PhreeqC reactive transport model for simulating rock grain weathering and carbon capture.

23) Pidgeon, N. (2021) Engaging publics about environmental and technology risks: frames, values and deliberation. *Journal of Risk Research*, **24**, 28-46.

22) Cox, E., Spence, E. & Pidgeon, N. (2020) Incumbency, trust, and the Monsanto effect: stakeholder discourses on greenhouse gas removal. *Environmental Values*, **29**, 197-220.

2019

21) Cox, E., Royston, S. & Selby, J. (2019) From exports to exercise: how non-energy policies affect energy systems. *Energy Research and Social Science*, **55**, 179-188.

20) Beerling, D.J. (2019) Can plants help us avoid seeding a human-made climate catastrophe? *Plants, People, Planet.* **1,** 310-314.

19) Andrews, M.G. & Taylor, L.L. (2019) Combating climate change through enhanced weathering of agricultural soils. *Elements*, **15**, 253-258.

18) Cox, E. & Edwards, N.R. (2019) Beyond carbon pricing: policy levers for negative emissions technologies. *Climate Policy*, **19**, 1144-1156.

17) Smith, P., Adams, J., Beerling, D.J., Beringer, T., Calvin, K.V., Fuss, S., Griscom, B., Hagemann, N., Kammann, C., Kraxner, F., Minx, J.C., Popp, A., Renforth, P., Vicente-Vicente, J.L. & Keesstra, S. (2019) Land-management options for greenhouse gas removal and their impacts on ecosystem services and the sustainable development goals. *Annual Review of Environment and Resources*, **44,** 255-286.

16) Lawrence, D. M. et al (including Val Martin, M). (2019) The Community Land Model version 5: Description of new features, benchmarking, and impact of forcing uncertainty. *Journal of Advances in Modeling Earth Systems*, **11,** 4245-4287.

2018

15) Arnold, S.R., Lombardozzi, D., J-F Lamarque, T. Richardson, L.K. Emmons, S. Tilmes, S.A. Sitch, G. Folberth, M.J. Hollaway, M. Val Martin (2018) Simulated global climate response to tropospheric ozone-induced changes in plant transpiration, *Geophysical Research Letters*, **45.** https://doi.org/10.1029/2018GL079938

14) Eufrasio-Espinosa, R.M. & Koh, L.S.C. (2019) The UK Path and the Role of NETs to Achieve Decarbonisation. In: Shurpali N., Agarwal A., Srivastava V. (eds) Greenhouse Gas Emissions. Energy, Environment, and Sustainability. *Springer, Singapore*. pp. 87-109.

13) Spence, E., Pidgeon, N. & Pearson, P. (2018) UK public perceptions of Ocean Acidification – The importance of place and environmental identity. *Marine Policy*, **97**, 287-293.

12) Cox, E., Pidgeon, N., Spence, E. & Thomas, G. (2018) Blurred lines: the ethics and policy of greenhouse gas removal at scale. *Frontiers in Environmental Science*, **6,** 1-7.

11) Beerling, D.J., Leake, J.R., Long, S.P., Scholes, J.D., Ton, J., Nelson, P.N., Bird, M.I., Kantzas, E., Taylor, L.L., Sarkar, B., Kelland, M., DeLucia, E., Kantola, I., Müller, C., Rau, G. & Hansen, J. (2018) Farming with crops and rocks to address global climate, food and soil security. *Nature Plants*, **4**, 138-147.

Paper #11 reported the first detailed evidenced-based synthesis advancing our understanding of how enhanced rock weathering could operate with agricultural systems to sequester carbon and promote food and soil security

[Commentary on #11: Editorial *Nature* **554**, 404-405, 2018]

10) Singh, M., Sarkar, B., Sarkar, S., Churchman, J., Bolan, N., Mandal, S., Menon, M., Purakayastha, J. & Beerling, D.J. (2018) Stabilization of soil carbon as influenced by clay mineralogy. *Advances in Agronomy*, **148,** 33-52.

9) Mercure, J.-F., Pollitt, H., Viñuales, J.E., Edwards, N.R., Holden, P.B., Chewpreecha, U., Salas, P., Sognnaes, I., Lam, A. & Knobloch, F. (2018) Macroeconomic impact of stranded fossil fuel assets. *Nature Climate Change*, **8,** 588-593.

8) Shaw, C., Hurth, V., Capstick, S. & Cox, E. (2018) Intermediaries' perspectives on the public's role in the energy transitions needed to deliver UK climate change policy goals. *Energy Policy*, **116,** 267-276

2017

7) Hansen, J., Sato, M., Kharecha, P., von Schuckmann, K., Beerling, D.J., Cao, J., Marcott, S., Masson-Delmotte, V., Prather, M.J., Rohling, E.J., Shakun, J., Smith, P., Lacis, A., Russell, G. & Ruedy, R. (2017) Young people's burden: requirement of negative CO_2 emissions. *Earth System Dynamics*, **8**, 577-616.

6) Beerling, D.J. (2017) Enhanced rock weathering: biological climate change mitigation with co-benefits for food security? *Biology Letters*, 13, 20170149.

5) Kantola, I.B., Masters, M.D., Beerling, D.J., Long, S.P. & DeLucia, D.H. (2017) Potential of global croplands and bioenergy crops for climate change mitigation through deployment for enhanced weathering. *Biology Letters*, **13,** 20160714.

4) Edwards, D.P., Lim, F., James, R.H., Pearce, C.R., Scholes, J., Freckleton, R.P. & Beerling, D.J. (2017) Climate change mitigation: potential benefits and pitfalls of enhanced rock weathering in tropical agriculture. *Biology Letters*, **13,** 20160715.

3) Lawford-Smith, H. & Currie, A. (2017) Accelerating the carbon cycle: the ethics of enhanced weathering. *Biology Letters*, **13,** 20160859.

2) Taylor, L.L., Beerling, D.J., Quegan, S. & Banwart, S.A. (2017) Simulating carbon capture by enhanced weathering in croplands: an overview of key processes highlighting areas of future model development. *Biology Letters*, **13,** 20160868.

1) Pidgeon, N.F. & Spence, E. (2017) Perceptions of enhanced weathering as a biological negative emissions option. *Biology Letters*, **13,** 20170024.