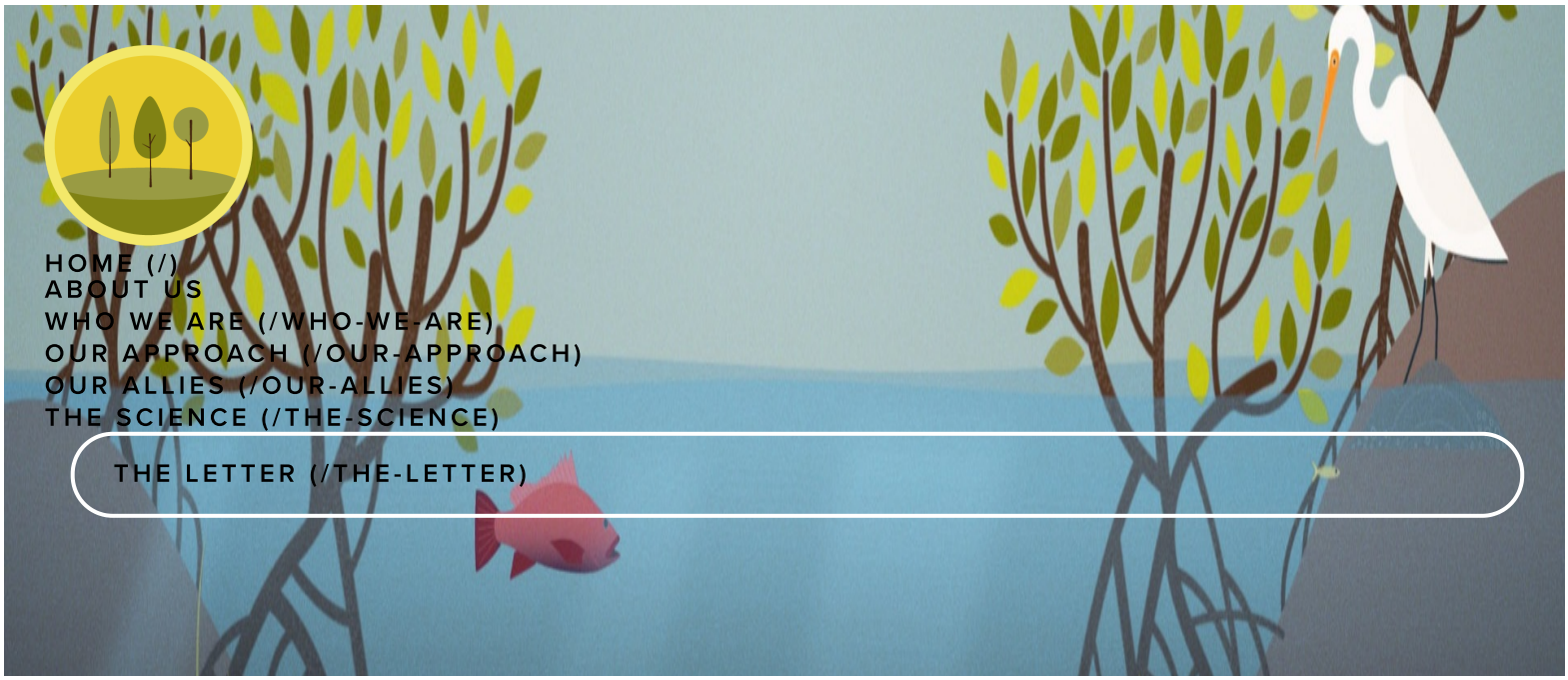

Averting Climate Breakdown by Restoring Ecosystems

A call to action

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Summary:

A recent estimate suggests that around one third of the greenhouse gas mitigation required between now and 2030 can be provided by carbon drawdown through Natural Climate Solutions. Natural Climate Solutions, roughly speaking, mean ecological restoration. Yet they have so far attracted only 2.5% of mitigation funding, and far too little political attention.

Given that they have major advantages over alternative negative emissions strategies and can also deliver wide ecological and social benefits, we call for a great increase in the attention and spending devoted to Natural Climate Solutions, as part of a massively enhanced global effort to prevent both climate breakdown and ecological collapse.

Rationale

1. There is now a broad consensus among climate scientists that the reduction of current greenhouse gas emissions will be insufficient to avert 1.5°C or more of global heating. This is because mitigation efforts have probably been left too late to avoid this critical threshold.

2. This means that the gap will have to be bridged by Negative Emissions Strategies: in other words, drawing greenhouse gases that have already been released out of the atmosphere and sequestering them.

3. In most climate abatement models, there is a strong emphasis on Bio-Energy with Carbon Capture and Storage (BECCS). This means growing biomass in plantations, burning it in power stations to produce electricity, capturing carbon dioxide from the exhaust gases and burying it in geological formations.

4. Unfortunately, any deployment of BECCS on a scale sufficient to cause significant climate abatement is likely also to cause either humanitarian or ecological disaster. For example, a commonly-cited pathway (RCP4.5) would require the establishment (https://doi.org/10.1002/2016EF000469) of plantations on either 1.1 billion ha of the world's most productive agricultural land (this is three times the total area of India) or on 50% of the land currently occupied by natural forests. Even on a pathway that involved a far greater mitigation of industrial emissions (RCP2.6), BECCS still requires massive land use. The result would be either to risk mass starvation or to replace, on a global scale, vibrant and diverse ecosystems with industrial monocultures.

5. Moreover, plantations on this scale would require around a doubling (https://doi.org/10.1002/2016EF000469) of the total nitrogen currently used in agriculture. The excessive use of nitrogen fertiliser already has disastrous ecological consequences. A large proportion of any greenhouse gas savings from BECCS will be negated by nitrous oxide emissions. Productive biomass plantations are also likely to require irrigation water, which is already in deficit in many areas. If forests are converted to biomass plantations, any carbon saved is likely to be more than offset by carbon losses from the soil (https://www.nature.com/articles/s41467-018-05340-z), incurred during conversion.

6. Another option is direct air capture (https://www.vox.com/energy-and-environment/2018/6/14/17445622/direct-air-capture-air-to-fuels-carbon-dioxide-engineering). Here too there are potential problems, above all the cost, which is likely to be high, and the carbon-heavy infrastructure it requires, that, if deployed at the requisite scale, could help push us past crucial climate tipping points before its positive impacts were felt.

7. So what cheap and effective Negative Emissions Strategies remain? The answer is the cluster of possibilities known as Natural Climate Solutions (NCS). A recent analysis (https://doi.org/10.1073/pnas.1710465114) identifies cost-effective NCS that could be implemented immediately, and suggests that these could provide **37%** of the greenhouse gas mitigation required to ensure a good (66%) chance of stabilising warming to below 2°C between now and 2030. The total potential could be much higher: it did not consider marine ecosystems, and investigations into the scope for carbon savings on land are still at an early stage.

8. Yet Natural Climate Solutions receive only around (https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2015/) **2.5%** of the money allocated for climate mitigation.

9. As the Intergovernmental Panel on Climate Change has warned (https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/sr15_headline_statements.pdf), there is a major difference between the likely impacts of 1.5° and 2°C of global heating. The 2015 Paris Agreement (https://unfccc.int/sites/default/files/english_paris_agreement.pdf) commits its parties to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels". As there is considerable unexplored potential for NCS, it is likely to be able to make a major contribution towards preventing more than 1.5°C of global heating, in combination with much more ambitious emissions reduction programmes than have been deployed so far. More research is urgently required, to realise the full potential of NCS.

10. Any deployment of NCS must avoid the problems that have beset (https://www.grain.org/article/entries/5322-how-redd-projects-undermine-peasant-farming-and-real-solutions-to-climate-change) some REDD+ (Reducing Emissions from Deforestation and forest Degradation) projects. In common with all other interventions, NCS projects must work with the free, prior and informed consent of indigenous people and other local communities. The benefits must flow to these communities. NCS should be deployed in such a way that it strengthens rather than undermines their landrights, economic security and wellbeing. Good governance of these projects (https://www.sciencedirect.com/science/article/pii/S1389934111001614) is inseparable from the principles of equity and justice.

11. However, there are some excellent examples of community-based ecological restoration and protection, with major carbon benefits. Projects such as mangrove defence in Vietnam (https://www.equatorinitiative.org/2017/08/03/community-based-restoration-and-management-of-mangroves-in-lap-an-lagoon-thua-thien-hue/) and watershed restoration in Ghana (https://www.equatorinitiative.org/2017/08/08/participatory-landuse-planning-and-management/) could set a benchmark for future initiatives.

12. It is also essential to ensure that NCS does not compete with the need to feed a growing global population. It should not remove highly productive agricultural land from food growing. It may, however, be an appropriate use of land whose yields are low, where it could also supply an enhanced income to local people.

13. Monocultural plantations of commercial tree species should not be treated as Natural Climate Solutions. As a new paper in Nature (https://www.nature.com/articles/d41586-019-01026-8) shows, 45% of the land area nations have so far pledged to allocate for carbon drawdown is being used for this purpose. Plantations have a lower capacity for carbon storage than natural forest, tend to harbour a much lower diversity of wildlife, and often cause major social and ecological harms.

14. There is considerable overlap between the most effective Natural Climate Solutions identified so far, and the priorities of the global ecology, conservation and rewilding movements. NCS involves not only the recovery of vegetation, soils and substrates, but also of certain crucial animal species and foodwebs.

15. Some work has already been done to identify the most effective Natural Climate Solutions. The greatest in terms of gross impact (https://www.carbonbrief.org/analysis-how-natural-climate-solutions-can-reduce-the-need-for-beccs), because of the size of the potential areas at stake, appear so far to be the protection and restoration of existing forests and the reforestation of deforested land.

16. The protection of existing ecosystems is crucial not only because of their potential to hold or accumulate carbon, but also because mature systems with a high degree of integrity and diversity tend to be more resistant (https://doi.org/10.1016/j.biocon.2010.07.024) to the impacts of climate change and other ecological shocks than simplified ones. Simplified ecosystems are vulnerable to cascading trophic collapse, that may be accompanied by major losses of carbon.

17. The greatest potential for reforestation occurs on former tropical rainforest land that has been cleared for large-scale ranching, palm oil plantations and timber production. The most promising opportunities identified so far have been mapped in a global spatial dataset (https://zenodo.org/record/883444).

18. There are, however, unresolved questions (https://www.nature.com/articles/d41586-019-00122-z) concerning the emission of climate-changing chemicals by trees, such as isoprene and terpene. This issue requires further investigation.

19. Carbon sequestration in tropical rainforests can be enhanced by boosting the populations of certain megaherbivores, particularly forest elephants and rhinos in Africa and Asia and tapirs in Brazil, which spread and help to germinate (http://advances.sciencemag.org/content/1/11/e1501105) the seeds of trees that have a high carbon content (large-seeded trees that evolved to be spread by megaherbivores are often characterised by high biomass and dense wood). They could be seen as natural foresters, maintaining and extending their own habitats.

20. There is also likely to be high potential for reforestation in mid-latitudes, where the climate is wet and mild. At high latitudes and altitudes, or where soil is particularly thin or rainfall low, the mitigation benefits of carbon sequestration through forest growth are outweighed by a reduction in albedo (https://doi.org/10.1111/gcb.12483), as pale (often snow-covered) land is replaced by darker trees. But where tree growth is strong, it makes carbon-sense to reforest. A recent paper (https://doi.org/10.1002/2016GL071459) shows where the boundaries lie in North America. There is an urgent need for similar mapping exercises elsewhere.

21. Here too, carbon sequestration can be strongly mediated by wildlife. One paper (https://doi.org/10.1002/ecs2.1501) suggests that when wolves occurred at natural densities across the boreal forests of North America, their suppression of herbivory by moose resulted in carbon storage equivalent to the tailpipe emissions of between 33 and 71 million cars.

22. There are major potential savings through the restoration of other ecosystems and species. One field that needs further investigation is fire-suppression in areas of low to intermediate rainfall. Certain species turn out to be highly effective at preventing intense and extensive wildfires (https://doi.org/10.1098/rstb.2017.0443). In Africa, the white rhino has been identified as a key agent of fire suppression

(https://link.springer.com/article/10.1007%2Fs10021-007-9109-9). Rhino and elephant conservation and restoration are beginning, in some circumstances, to look like powerful carbon storage strategies (https://doi.org/10.1098/rstb.2017.0440).

23. Though the area of forested and formerly-forested land is much greater, the fastest accumulation of carbon occurs in a different set of ecosystems: vegetated coastal habitats, such as mangroves, saltmarsh and seagrass beds. Here, carbon can be sequestered 40 times faster (https://doi.org/10.5194/bg-2-1-2005) per hectare than in tropical forests. One estimate suggests that the top metre of the world's vegetated coastal ecosystems locks up the equivalent (https://www.nature.com/articles/nclimate2763) of the annual emissions of 9.7 billion cars. Excitingly, these ecosystems can be created at extraordinary speed, as recent coastal realignment schemes (http://www.ecrr.org/Portals/27/Case%20studies/Managed%20realignment%20featured%20case%20study.pdf) have demonstrated.

24. Here too, healthy food webs turn out to be crucial: in one recently-documented case (https://www.nature.com/articles/nclimate2763), the removal of predatory crabs and fish by recreational fishers led to the obliteration of the entire saltmarsh platform through erosion, as rising populations of herbivorous crabs and snails eradicated the plants that had stabilised it.

25. One reason why these ecosystems accumulate carbon so effectively is that they are water-logged and therefore largely anoxic. The mud accumulated by mangroves or saltmarsh tends to be black (or very dark), with a remarkably high carbon content. In the absence of oxygen, sequestered carbon tends to be stable.

26. The same applies to other water-saturated soils. Though peat covers only 3% of the world's land, it stores one-third of all soil carbon (https://www.nature.com/articles/nature21048). The carbon it contains is highly vulnerable to loss through deforestation, drainage, drying, burning, conversion to agriculture and industrial extraction. Conversely, the restoration of peat domes, mires and fens offers further great potential (https://link.springer.com/chapter/10.1007/978-3-319-71788-3_12) for carbon withdrawal.

27. The storage capacity of aerated soils is uncertain, but, because of their global extent, is likely to be large. It urgently requires more investigation. Key questions concern the potential for drawdown and the likely carbon stability or instability of soils in agricultural use. Some extreme claims (https://www.ted.com/talks/allan_savory_how_to_green_the_world_s_deserts_and_reverse_climate_change) have been made concerning this potential, which, as a recent review (http://www.fcrn.org.uk/projects/grazed-and-confused) suggests, we should treat with scepticism. Aerated soils could in some circumstances offer strong carbon-saving potential, but this will vary greatly from site to site (https://www.sciencedirect.com/science/article/pii/S0048969718306089) and treatment to treatment, and can be realised only with a highly granular approach.

28. Even less is known about potential sources and sinks of marine carbon. For example, a major question concerns the impact of trawling and dredging on carbon in seabed sediments. One estimate, for the Northwest European continental shelf, suggests that at least 70% of all carbon in its seas and coasts is stored in shelf

sediments. In this region alone, the top 10 cm of sediments (https://www.uk-ssb.org/shelf_seas_report.pdf) contain between 6bn and 19bn tonnes of carbon. In other words, the seabed carbon store is of great importance.

29. A recent paper (https://doi.org/10.1016/j.ecoser.2018.10.013) suggests that while the mean annual burial rate for organic carbon is 2 kg/ha, trawlers might cause the resuspension of 18kg/ha per year, averaged across the entire shelf area (51m ha) of the United Kingdom's Exclusive Economic Zone. It is uncertain how much of this carbon, exposed to oxygen in the water column, is remineralised, and what the balance of impacts (https://www.nature.com/articles/s41598-018-23925-y.pdf) might be. One study suggests that repeated trawling in the north-western Mediterranean has caused a reduction in organic carbon storage (https://doi.org/10.1073/pnas.1405454111) in the top 10cm of sediments of up to 52%. Given that, by 2002, some 2 billion hectares, or 75%, of the world's continental shelves were trawled every year (https://doi.org/10.1046/j.1467-2979.2002.00079.x), and that this figure is likely to be even higher today, the total impact could be enormous.

30. There is also likely to be a considerable, but so far unmeasured, carbon opportunity cost of trawling. Trawling first destroys, then prevents the re-establishment of, the biotic crusts that once covered much of the seabed on the world's continental shelves. Many of these crusts were composed of filter-feeders (such as oysters and other bivalves) that extracted carbon from the water column, sequestering it as calcium carbonate, often building substantial reefs. When these were smashed, not only was this storage potential lost, but the underlying sediments became exposed to disturbance and, potentially, enhanced oxidation. Protecting shelf seas from trawling and dredging could make a significant contribution to carbon sequestration.

31. Not all ecological restoration will contribute to the withdrawal of atmospheric greenhouse gases; some instances may have the opposite effect. There may still be good reasons for implementing them, especially if the climate impact is small. But in all cases we should act on the basis of the widest possible knowledge and understanding.

32. Because the carbon storage of most revitalised ecosystems will at some point reach equilibrium, Natural Climate Solutions should, by and large, be seen as near-term strategies, which will be most effective in bridging the mitigation deficit during the first half of this century. However, it is essential that, once restored, these ecosystems, the carbon they store and the life they harbour, are maintained and protected.

33. NCS should not be seen as a substitute for the rapid and comprehensive decarbonisation of industry and agriculture. We need both to leave fossil fuels in the ground and to extract greenhouse gases from the air. The age of offsets is over. Natural Climate Solutions will not help to prevent climate breakdown if they are used as an excuse to delay mitigation, and to avoid the hard choices it necessitates.

34. There are three crucial opportunities over the next two years for ensuring that Natural Climate Solutions receive the global attention they deserve. The first is the special Climate Summit (http://www.un.org/en/climatechange/un-climate-summit-2019.shtml) convened by the UN Secretary-General in New York, in September 2019. The second is the crucial 15th Conference of the Parties to the Convention on

Biological Diversity in Beijing in autumn 2020. The third is the UN Climate Change Conference (COP 26) in November 2020, which is the summit at which nations are meant to propose their new "nationally determined contributions". These contributions should include new commitments to Natural Climate Solutions.

35. Given that Natural Climate Solutions can support the protection of both the atmosphere and biological diversity, they could be seen as providing a bridge between these processes and an opportunity to coordinate efforts to protect our life support systems. We call for all three meetings to embrace the aims outlined in this document.

36. The United Nations has announced a Decade on Ecosystem Restoration (https://www.unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity), from 2021-2030. We should combine our efforts to ensure it is successful.

37. As a measure of this commitment, and in view of the urgency of both the climate and ecological crises, we urge governments rapidly to match the likely potential of Natural Climate Solutions with concomitant levels of spending and political engagement.

38. However, it is essential that this money and effort is not withdrawn from other crucial measures, such as energy demand reduction and the replacement of fossil fuel plant with clean technologies. All climate mitigation and drawdown measures are currently underfunded, and there is an urgent need for governments to respond to our existential climate crisis with much greater political and financial commitment. The extra funding for NCS should be **additional**. Some of this funding should be spent on research, with the aim of rapidly identifying further opportunities for NCS.

39. In advancing Natural Climate Solutions, there is no requirement to put a price on ecosystems, let alone rebrand the world's living systems as "natural capital". Carbon savings can and should be quantified, however, while remembering that this aim must be combined with restoring and protecting ecosystems and supporting the people who defend them.

40. We call for governments and civil society to prioritise the protection and restoration of natural ecosystems, support the indigenous peoples and local communities who are the frontline defenders of many living systems and investigate and realise the full potential of Natural Climate Solutions with the speed and urgency our climate and ecological crises demand.

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