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How restoring natural forests can stem climate change and revive rural communities

Return of the trees

Fred Pearce

Return of the trees – How restoring natural forests can stem climate change and revive rural communities

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Cover photo: Community forest campaign in Tbeng Village, Cambodia. (Photo: Un Yarat, U.S. Embassy. Flickr.com/CC)

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Trees in agricultural landscape bring additional nutrition and other resources to farmers.
(Photo: Nepal, Hanna Aho)

In populated agricultural landscapes, there is huge potential for increasing carbon storage by reviving trees and woodlands through agroforestry.

Executive summary

To have a fair chance of limiting global temperature rise to a maximum of 1.5 degrees Celsius, it will be necessary to remove at least 500 billion tonnes of CO_2 from the atmosphere.

The best way to do this is to work with local communities to restore degraded forest ecosystems. As this report shows, this is entirely possible.

It must, however, go hand in hand with halting forest loss and reducing fossil fuel consumption. Not instead of.

Governments around the world have made pledges such as the Bonn Challenge to support restoration and reforestation projects, but even if the Bonn challenge is successful it would only remove 50 billion tonnes, 10 per cent of what is needed.

More is needed and with political will, it's certainly possible from the tropics to the boreal forests.

Restoring ancient Caledonian pine forests in Scotland. (Photo: Lewis Davies)

In populated agricultural landscapes, there is huge potential for increasing carbon storage by reviving trees and woodlands through agroforestry.

As our case studies show, locally managed community forests have a track record of delivering successful, pro-poor, sustainable forest restoration.

Properly done, this would have the co-benefits of stemming the planet's catastrophic loss of biodiversity, respecting customary land rights and bringing clear benefits to rural communities.

Governments need to do more to support forest restoration, but it will always be true that such projects must, at one and the same time, benefit people and ecosystems as well as respect the planet's carbon budget.

Farmers are often seen as the enemies of forests. But they may provide the fastest and easiest way to increase global tree cover and capture carbon on the land.

Planting Trees in Katbare, Ethiopia. (Photo: Trees for the future, Flickr.com/CC)

FOREST RESTORATION
with local communities

FIGHTING CLIMATE CHANGE WITH FORESTS

←1.5°C
Paris Agreement

To keep temperature rises below 1.5°C, we must:

- Bring fossil fuel emissions to zero by 2050
- Absorb 500 bn tonnes of CO_2 from the atmosphere
- Stop forest destruction

A safe solution?
Restore forests to store more carbon!

WHY FORESTS ARE ESSENTIAL

Healthy forests provide:

1. Clean air
2. Cooler air
3. More biodiversity
4. Social, economic & spiritual values
5. Clean water cycles

- Forests currently cover 30% of the Earth's land area.
- Forests are home to more than 50% of the planet's terrestrial species.
- Forests store 1 trillion tonnes of carbon.

Introduction

Deforestation hasn't ended. But it has slowed, and in some parts of the world a counter-revolution is gaining force. From Nepal to Costa Rica and Scotland to the southern flank of the Sahara Desert, people are actively bringing back natural diverse forests. They are doing this as much for their own good as for the good of nature. The evidence is growing that with the right assistance, such forest restoration could start happening in many other places, too.

The 2014 New York Declaration on forests pledged to achieve zero deforestation round the world by 2030, restore 150 million hectares of degraded landscapes and forestlands by 2020 and "significantly increase the rate of global restoration thereafter, which would restore at least an additional 200 million hectares by 2030".[1] The UN Sustainable Development Goals and the Convention on Biological Diversity also highlight the need to restore terrestrial ecosystems by 2020. Hence, the building blocks are starting to emerge for a restoration of the world's forests.

This would be good for the climate. Forests store carbon, can cool the climate and provide a buffer against climate change. Forest restoration draws carbon back down from the atmosphere (known as negative emissions), which will be crucial for limiting warming to 1.5 degrees.

This would be great for nature. The world's forests are home to more than half the planet's terrestrial species, and their continued loss has been a major cause of global biodiversity loss. Forest restoration cannot bring back lost species, but it can provide refuges for many currently threatened species.

It would be good for people. Restored forests provide myriad benefits for humans within and beyond the forests. Besides forest products, such as timber, fruits and berries, the benefits include clean local air and water, control of floods and soil erosion, moderation of local weather extremes, improved rainfall and soil quality for local crops, and protection of rivers and the fish that live in them.

Forest losses have impoverished many; their return would benefit still more. The restoration of forests should be seen as a social movement as much as an ecological objective or climate "fix". Governments can catalyse this process, but it will be sustained by the support, engagement and often control of forest communities themselves.

The restoration of forests should be seen as a social movement as much as a climate solution.

1 http://forestdeclaration.org/about/

WE NEED TO RESTORE FORESTS

This graph shows the current state of global land areas suitable for forests. Efforts should focus on restoring fragmented and degraded forests.

28%
Forests converted to agriculture or other land uses.

15%
Intact ecologically diverse forests.

37%
Fragmented forests
Forests managed for productive use (e.g. timber) or fragmented by roads.

20%
Degraded forests
Forests that have lost their full capacity to provide ecosytem services.

DEGRADED FORESTS
Promising opportunities

2x

An area of land and forest twice the size of Canada is currently degraded.

In one year: 11.1 bn tonnes CO_2

In 60 years: 666 bn tonnes CO_2

If only tropical degraded forests were restored, within 60 years 666 billion tonnes of CO_2 would be captured.

Restoring degraded forests would help us achieve the goals of the Paris Agreement.

Which to be fullfilled requires the removal of 500 billion tonnes of CO_2.

WOODLANDS IN AGRICULTURE
An untapped potential

2x Almost twice the size of Brazil is potentially available for adding trees in agricultural landscapes.

CALL TO ACTION

Community-led forest restoration is the safest way to remove CO_2 from the atmosphere and a key ingredient in the fight against climate change.

We need to cut CO_2 emissions from human activities.

Binding actions are needed at EU and international levels to restore forests and stop forest destruction.

Local communities are key to restoring damaged forests.

Local communities are the best guardians of the forests and can stop forest loss.

The **CARBON** conundrum

The Paris Climate Agreement saw the world agree to halt global warming well below 2 degrees Celsius and to aim for 1.5 degrees. The science for achieving that is simple. According to the UN's Intergovernmental Panel on Climate Change (IPCC), the temperature limit of 2 degrees would require early emission cuts and eliminating emissions of carbon dioxide (CO_2) from fossil fuel burning, deforestation and land-use change to reach net zero emissions by mid-century. But to meet the 1.5 degree target will certainly require more. It will require substantial "negative emissions" – the deliberate and organised removal of CO_2 from the atmosphere. So a key question is how to deliver that.

IPCC author Joeri Rogelj has calculated this challenge in tonnes of CO_2. He estimates that to limit warming to 1.5 degrees will probably require limiting total future emissions of CO_2 to less than 300 billion tonnes. Bringing CO_2 emissions to net zero by mid-century would fall far short of that target; it would allow total emissions of around 800 billion tonnes. So we will need to suck CO_2 back out of the air. On his estimates, those so-called "negative emissions" would have to amount to roughly 500 billion tonnes.[2]

In a previous report, Fern surveyed the various technological options available for achieving negative emissions.[3] The most feasible all involve harnessing photosynthesis in plants to convert atmospheric CO_2 into living tissue. In practice, that usually means trees, because of their high carbon density. So we need to bring back forests.

The world's forests still store the equivalent of almost a trillion tonnes of carbon. Adding 500 billion tonnes of CO_2 equivalent or 136 billion tonnes of carbon to that store would require a 14 per cent increase in forest cover.[4]

This is clearly a huge task. One possible route is by planting dedicated plantation forests as "carbon stores". A second route is to plant fast-growing "bioenergy forests" to supply timber for burning in power stations. The emissions would be captured and buried – a system often called Bioenergy with Carbon Capture and Storage (BECCS).

Both these options have serious drawbacks. Specifically if they are monocultures, plantations would be vulnerable to climate change itself, because droughts, excessive heat and fire could all make the plantations much more fragile than intended. And treating forest bioenergy as carbon neutral has proved to be a misconception, as well as using dedicated land for bioenergy production.[5] The industrial use of forest biomass for energy drastically changes the ecology of woodlands in ways that seriously reduce the ability of forests to store carbon.[6] This is already evident in European Union (EU) forests that are being harvested more

2 Rogelj 2015: http://www.nature.com/nclimate/journal/v5/n6/full/nclimate2572.html?foxtrotcallback=true
3 http://www.fern.org/goingnegative
4 Houghton 2012: https://link.springer.com/chapter/10.1007%2F978-94-007-4159-1_4
5 http://www.easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf
6 Schulze 2012: http://onlinelibrary.wiley.com/doi/10.1111/j.1757-1707.2012.01169.x/abstract

A researcher collecting data about the amount of carbon dioxide (2008). (Photo: Nanang Sujana, CIFOR. Flickr. com/CC)

intensely for biomass energy.[7] Also, CCS is not a proven technology, so it is difficult to rely upon.

Both these options would also accelerate the global loss of biodiversity.[8] And they would cause conflicts, because they would require huge amounts of land, potentially displacing forest dwellers, herders and peasant farmers, and thus cause human rights violation and likely hunger.[9]

A third option is to restore natural biologically diverse forests. This has so far received remarkably little attention from the climate community, but it would be much more compatible with both ecological imperatives and the needs of people living in and near forests.

Such natural forests would nurture rather than destroy biodiversity. They would also generally store more carbon, particularly in their soils.[10] Their storage of carbon would also be more secure, because biologically diverse forests are less vulnerable than monocultures to fires, pests and drought.[11] Finally, they could provide multiple benefits for communities from sustainable harvesting, often improving food security and reducing poverty. They would be part of local communities rather than fenced-off enclaves.

7 http://www.fern.org/sites/fern.org/files/8090%20Birdlife%20Europe%20Wood%20Energy%20Outlook%20FINAL%20230617_0.pdf and EASAC 2017: http://www.easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf
8 Williamson 2016: http://www.nature.com/news/emissions-reduction-scrutinize-co2-removal-methods-1.19318
9 Haberl 2013: http://iopscience.iop.org/article/10.1088/1748-9326/8/3/031004/meta
10 Achat 2015: https://www.nature.com/articles/srep15991
11 Felton 2016: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4705065/

The LAND conundrum

The scale of forest restoration needed to deliver enough negative emissions to meet climate targets will exceed any international targets discussed so far. The 2011 Bonn Challenge[12] called for the initiation by 2020 of projects to restore 150 million hectares of forests, a land area half the size of India. That could eventually yield around 50 billion tonnes of CO_2, just a tenth of the amount implied by Rogelj's calculations.

There is little "spare" land on the planet today. And around two-thirds of current and former forest lands are claimed under customary or traditional land ownership, much of it not recognised by governments.[13] The prospect of dedicating large areas of this land to absorbing atmospheric CO_2 therefore raises fears of a massive land grab.

This would be unworkable and is certainly unacceptable. So, to succeed, restored forests will need to work with and complement local customary land needs and rights.

The good news is that this can be achieved, for we are not in a zero-sum game. There is considerable potential to restore natural biodiverse forests in a way that is socially and economically useful for the communities that currently occupy the land, and does not infringe their land rights.

Restored forests can and often should be managed by the people that live in and around them, and for their benefit. This is not a trade-off, but a win–win. There is growing evidence that community and indigenous management of forests is better for the forests, their biodiversity and their carbon storage than much state or commercial management.[14]

Re-greening of the planet will take many forms. It will involve recreating former forests through reforestation, restoring degraded forest land, and enhancing tree cover in agricultural landscapes. It is about rewilding forest areas, but very often also about "rehumanising" and restoring a connection to the land. Done correctly, it can be pro-poor and a force for democracy and a fairer future. Done correctly, it can increase the sustainability of many uses of forests, including harvesting for construction materials, firewood and food supplies. Done correctly, it can also reinforce the existing roles of forests as anchors of ecosystems and the services they bring.

But forest restoration alone will not save the climate. An excessive reliance on its benefits to soak up CO_2 would be both unjust and unsustainable. Emissions from energy, heating, transport and industrial sectors must be reduced to zero as soon as possible; agricultural emissions must be reduced as dramatically and swiftly as possible, whilst still maintaining food security. With that achieved, restoration of the planet's forests could limit warming to what is already unavoidable.

12 http://www.bonnchallenge.org/
13 https://www.oxfam.org/en/research/common-ground
14 Stevens 2014: https://www.wri.org/sites/default/files/securingrights-full-report-english.pdf, and Agarwal 2016: http://rightsandresources.org/en/publication/community-governance/#.WXdfeljyuUk

A third of the earth's forests has been lost during the last 5000 years.

Box 1: **Deforestation around the world**

Forests cover 30 per cent of the Earth's land area.[15] Through deforestation humans have altered the planet's landscape and atmosphere for centuries.[16]

The mid-20th century saw a rapid acceleration of large-scale forest clearance, particularly in the tropics. A key driver of deforestation, especially in Latin America, is large-scale commercial agriculture that accounted for 73 per cent of deforestation in tropical and sub-tropical regions between 2000 and 2010.[17] Over the past 25 years, the carbon stocks in forest biomass have decreased by almost 11.1 billion tonnes of carbon, equivalent to an increase of 1.6 billion tonnes of carbon dioxide per year or about 40.7 billion tonnes of carbon dioxide over 25 years in the atmosphere.[18]

But deforestation now appears to be slowing. The rate of forest loss since 2010 has been around 6.5 million hectares a year, only 60 per cent of what it was for the previous two decades.[19]

The cumulative loss has nonetheless been huge: approximately a third of the earth's forests has been lost during the last 5000 years.[20] The climate impact of past land use and land cover change is estimated to be equivalent to 40 per cent of all warming between 1850 and 2010.[21]

Of the regions of the world with climate and soils currently suitable for forests, just 15 per cent still retain large blocks of intact ecologically diverse forests. A further 37 per cent has forests that are either managed for productive use such as timber, or are fragmented by roads. Of the remainder of the former forest land, 20 per cent is degraded with much-reduced forest density, and 28 per cent is devoid of forest, mostly converted to agriculture or for human settlements.[22]

This creates an opportunity for restoring forests – particularly in the vast fragmented, managed and degraded forests that cover more than half of potential forested areas, but also for developing agroforestry in farming landscapes that used to be forests.

15 http://www.fao.org/3/a-i4793e.pdf
16 http://www.wsl.ch/staff/niklaus.zimmermann/papers/QuatSciRev_Kaplan_2009.pdf
17 http://www.fao.org/3/a-i5588e.pdf
18 http://www.fao.org/3/a-i4793e.pdf
19 FAO 2015: http://www.fao.org/3/a-i4808e.pdf
20 http://www.fao.org/3/a-i5588e.pdf
21 https://www.atmos-chem-phys.net/14/12701/2014/acp-14-12701-2014.pdf
22 http://www.wri.org/resources/maps/atlas-forest-and-landscape-restoration-opportunities

Box 2: **Forest degradation and restoration**

Forest degradation is the decline of the capacity of a forest to produce ecosystem services such as the provision of forest products, support to biodiversity or carbon storage as a result of environmental and anthropogenic changes. Degradation does not involve a reduction of the forest area, but rather a quality decrease. Droughts, fires, pests, diseases and erosion are environmental changes that cause degradation. Human-caused degradation may follow from over-harvesting, wrong management measures, grazing, pollution and forest fragmentation. Often forest degradation is caused by multiple factors and environmental changes can also be human-induced.

Overall, more carbon is lost due to degradation and disturbance than deforestation in the tropics.[23]

Degradation and decrease in forest biodiversity makes forests less resilient and less able to adapt to environmental changes such as climate change.[24]

Degraded ecosystems can often recover naturally over time. Restoration is enabling or accelerating this recovery. It aims to recover ecological functionality and human well-being.[25] Restoration in the short-to-medium term however is very unlikely to bring back previous biodiversity-rich intact forests or other ecosystems.

An area of land that has been burned and cut. Central Kalimantan, Indonesia.
(Photo: Nanang Sujana, CIFOR. Flickr.com/CC)

23 http://science.sciencemag.org/content/early/2017/09/27/science.aam5962
24 EASAC 2017 : http://www.easac.eu/fileadmin/PDF_s/reports_statements/Forests/EASAC_Forests_web_complete.pdf
25 Maginnis et. al, 2005: In: ITTO Restoring forest landscapes. An introduction to the art and science of forest landscape restoration. ITTO Technical series no. 23.

The TRACK RECORD of forest restoration

Restoration of forests is not new. Many parts of the world have been deforested repeatedly through history, recovering each time either as a result of natural regrowth or deliberate planting. There is growing archaeological evidence, for instance, that parts of the apparently pristine Amazon rainforest is regrowth following an era of pre-Colombian urbanism.[26]

If we left them alone, many of the world's forests would recover with time.[27] Such natural recovery is well worth stimulating. Natural forests contain more biodiversity and will usually absorb more carbon than monoculture plantations, as well as being more resilient to climate change and other threats. However, planting designed to mimic natural recovery has benefits because it can speed up a process that might otherwise take centuries.

In recent times, a few tropical countries have bucked the trend of rampant deforestation by significantly increasing their forest cover. We discuss two of them, Nepal and Niger, in our case studies. Another is Costa Rica, which saw its forest cover decline from 75 per cent in 1940 to 20 per cent by the late 1980s, mostly through clearing for cattle ranches. But once the government began paying land users to nurture new forests, the forests recovered – to more than 50 per cent.[28]

The governments of other countries have big restoration plans too, particularly in Africa. Ethiopia has committed to restoring millions of hectares of degraded forest lands, building on work in Tigre, a province that bore the brunt of the famines there in the 1970s and 1980s.[29] Countries south of the Sahara Desert in 2016 initiated the Great Green Wall, a planned barricade of trees 15 kilometres wide and 8000 kilometres long. They want it to contain more than a billion trees and to hold back the advancing desert.[30] China has planted trees across much of the Loess Plateau along the Yellow River to reduce soil erosion and sediment in the river.[31]

But the picture for government-inspired planting projects is mixed. Vietnam is trying to restore the mangroves that once protected its coastline from tidal surges. Some were destroyed by the US during the Vietnam War, and others were cleared for shrimp ponds. Since 2001, some 20,000 hectares have been replanted. While the restoration has worked in the south of the country, where local communities designed in social benefits such as the cultivation of clams and crabs by women, community involvement in the north has been minor. Thus communities have often lost livelihoods and therefore have little interest in maintaining the mangroves.[32]

Nearly 20 years ago, the government of the Philippines attempted to restore forests in the Cordillera Central mountain range on Luzon Island. But a post-project government review concluded that it had foundered because it failed to engage local communities and the

26 Heckenberger 2007: http://rstb.royalsocietypublishing.org/content/362/1478/197.long?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Philosophical_Transactions_B_TrendMD_0
27 Lamb 2005: http://science.sciencemag.org/content/310/5754/1628.full
28 Arriagada 2012: http://le.uwpress.org/content/88/2/382.refs
29 http://blog.worldagroforestry.org/index.php/2016/11/10/water-reward-land-restoration-flows-ethiopias-dry-zone/
30 https://www.newscientist.com/article/mg23130902-500-a-wall-of-trees-across-the-sahara-is-cool-but-we-dont-need-it/
31 http://www.worldbank.org/en/news/feature/2007/03/15/restoring-chinas-loess-plateau
32 http://www.wri.org/our-work/project/world-resources-report/mangrove-restoration-and-rehabilitation-climate-change

financial incentives were captured by local elites.[33] A second project in the same area reached a similar "moderately unsatisfactory" conclusion.[34]

Much successful tree planting happens outside the purview of government. In Kenya, the Green-Belt Movement of Nobel prize-winner Wangari Maathai has planted over 50 million trees on farms and in villages. In some African savannah lands, farmers have nurtured the natural regeneration of some 200 million trees since the 1980s to enhance their crops (see Niger case study).

Elsewhere, forests have recovered where farmers have abandoned their fields and headed for cities to work. That has happened in a large boundary zone between forest and savannah in Cameroon over the past 20 years.[35] According to Ed Mitchard of the University of Edinburgh, "In central Cameroon, the forest is coming back really fast." This is exciting news especially in a country where illegal logging and agricultural conversion are driving forest loss.

The same thing has happened in Puerto Rico, where natural regeneration raised forest cover from just 6 per cent in 1960 to 60 per cent, following the widespread abandonment of agricultural land. One geographer called the transformation "proportionately, the largest event of forest recovery anywhere in the world during the second half of the 20th century".[36]

Such findings suggest that forest restoration on a large scale is possible, and that active support and ownership by local communities can often be the key.

Box 3: **Temperate restoration**

Two examples from developed temperate nations show forest restoration on a large scale over longer timeframes. European colonists largely cleared the forests of New England for timber and pulp by the mid-19th century. But the agricultural land has been gradually abandoned since then, and forests have returned through natural recolonisation.[37]

After centuries of heavy grazing, large parts of Southern Sweden were devoid of forests by the mid-19th century.[38] But then concerted replanting began, and continued for more than a century. The replanting was, however, mostly of utilitarian monocultures of conifers designed for timber production.[39]

33 https://www.ifad.org/evaluation/reports/acp/tags/philippines/486/y2007/1886649
34 https://operations.ifad.org/documents/654016/768657fe-a7b7-4c22-a297-7ea6d38ec8e6
35 Mitchard 2009: http://journals.ametsoc.org/doi/abs/10.1175/2009EI278.1
36 Rudel 2000: http://onlinelibrary.wiley.com/doi/10.1111/0033-0124.00233/abstract
37 Foster 1992: https://www.jstor.org/stable/2260864?seq=1#page_scan_tab_contents
38 Ed. Lagerås P, 2016, Environment, Society and the Black Death: An Interdisciplinary Approach to the Late-Medieval Crisis in Sweden, Oxbow Books
39 https://www.wri.org/sites/default/files/WRI_Restoration_Diagnostic_Case_Example_SouthernSweden.pdf

Clear cuts have become common in the boreal landscape. 44 per cent of the productive forest lands in Inari, Finland – within an overall area of 2,682 square kilometres – has been logged. Once felled these trees can take around 170 years to grow back in this unforgiving climate. (Photo: Fern)

Box 4: **Boreal restoration**

Large regions of boreal forests are managed intensively with clear cutting being a dominant method. This has put biodiversity at risk. Recent experiences from Finland indicate that switching to continuous cover cultivation can have benefits to species that have decreased due to clear cutting, but also provide a better carbon balance, equal or higher revenues for forest owners and benefit local bilberry picking.[40] Increasing rotation times and allowing forests to mature combined with more natural methods that promote forest resilience and lower harvesting rates could increase the capacity of boreal forests to decarbonise the atmosphere.[41]

Continuous cover cultivation in Åland, Finland. (Photo: Panu Kunttu)

40 Pukkala 2016: https://forestecosyst.springeropen.com/articles/10.1186/s40663-016-0068-5, Tahvonen and Rämö, 2016: http://www.nrcresearchpress.com/doi/10.1139/cjfr-2015-0474#.WYxKjrpuJPY

41 Bhatti 2012: https://link.springer.com/chapter/10.1007/978-94-007-4159-1_10/fulltext.html

RESTORING degraded forests

Degraded forests store significantly less carbon than natural forest ecosystems.[42] So future forest restoration strategies are likely to give priority to bringing back forests degraded by land use in the recent past. This is where forest restoration can most easily fit into existing land uses. Estimates for degraded land vary enormously, but the World Resources Institute puts the figure at around two billion hectares, an area twice the size of Canada.[43]

Though often dismissed as "wasteland" ripe for development, degraded forests are often a valuable resource in their own right, retaining much of their biodiversity and rapidly capturing carbon from the atmosphere as it regrows.[44]

It is dangerous to assume that such land is freely available for formal forest recovery projects, however. Even if not cultivated or grazed, it is often vital to poor communities for foraging, hunting and shifting cultivation.[45] Moreover, it mostly has customary owners, whose rights must be respected. The wins for people, ecosystems and the climate must lie in combining existing sustainable uses of degraded forest with the restoration of those forests, often under a regime of customary ownership.

The benefits of such a strategy could be huge. One researcher, Richard Houghton of the Woods Hole Research Center, estimates that if degraded tropical forests were allowed to regrow they could capture up to three billion tons of carbon annually for around 60 years, until the forests were fully grown.[46] That would be a total of 180 billion tonnes of carbon added to the global forest carbon store, or 666 billion tonnes of CO_2 removed, which would be slightly more than Rogelj's 500 billion tonnes negative-emissions target. Houghton sees this as potentially "providing a bridge to a fossil-fuel-free world".[47]

Others have made similar calculations. The Stockholm Environment Institute found that forest restoration in tropical areas alone could absorb 220–330 billion tonnes of CO_2, with a further 150 billion tonnes from reforestation. That number could be increased, perhaps dramatically, if forest restoration efforts were systematically extended to the temperate and boreal regions.[48]

Though often dismissed as "wasteland" ripe for development, degraded forests are often a valuable resource in their own right, retaining much of their biodiversity and rapidly capturing carbon from the atmosphere as it regrows.

42 Keith, 2009 http://www.pnas.org/content/106/28/11635.full.pdf
43 Gibbs 2014: http://www.sciencedirect.com/science/article/pii/S0143622814002793
44 Edwards 2010: http://rspb.royalsocietypublishing.org/content/278/1702/82.short
45 Miyake 2012: http://www.sciencedirect.com/science/article/pii/S0743016712000770
46 Houghton 2012: https://link.springer.com/chapter/10.1007%2F978-94-007-4159-1_4
47 Houghton 2015: http://www.nature.com/nclimate/journal/v5/n12/full/nclimate2869.html?foxtrotcallback=true
48 Kartha & Dooley 2016: https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-08-Negative-emissions.pdf

Natural forest store more carbon than managed or degraded forests. Their protection is essential to protect the climate. (Photo: Natural beech forest, Romania, Hanna Aho)

Trying to conserve and enhance forests while making more productive use of them, rarely works – even when the motive is climate protection. Take the case of forests in the EU. In 2009, the EU introduced the Renewable Energy Directive; one of its aims was to increase the burning of wood for energy. The intention was that cut forests should always regrow. But the result has been to reduce the amount of CO_2 that the EU's forests absorb from the atmosphere each year.

In the EU, it is estimated that by 2030 the EU forest management sink will have been reduced by 35 per cent (compared to 2010 baseline).[49] This is a result inter alia of more intensive use of the forests. Rather than restoring degraded forests and advancing their ability to absorb carbon, forest management is reducing the EU's forest carbon sink.

Despite such bad news, however, the wider picture is of a huge global potential for forest recovery as a strategy for ecological recovery and moderating the final toll of global warming.

49 Impact Assessment of LULUCF Regulation 2016: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0249&from=EN

AGROFORESTRY as a carbon strategy

Forest restoration can take many forms. That includes the restoration of fully functioning forest ecosystems, particularly in areas with low populations and under the control of indigenous forest-dwelling communities. Sometimes that restoration may amount to "rewilding".[50] More usually, however, restored forests – while replete with biodiversity and rich in carbon – will also be harvested by humans and be under the control of local communities.

But restoring forest ecosystems is only one part of returning trees to landscapes. Many trees do not grow in forests, and some never have. They are parts of other ecosystems, such as grasslands and wetlands, or in modern times of farming landscapes – in woodlands and fields, around villages and as boundary markers and shelter breaks.

One recent study found that more than 40 per cent of agricultural lands globally had at least 10 per cent tree cover. Many woodlands in agricultural landscapes have been all but invisible to those measuring land use and calculating carbon budgets, because of technical failings in remote sensing systems. A recent attempt to find this "invisible" woodland put its extent at 470 million hectares. That is an area two-thirds the size of Australia.[51]

There is clearly potential to increase tree cover in farms yet further, especially given the growing popularity of agroforestry techniques. Another study estimated the total land area potentially available for forest recovery within agricultural landscapes at 1.8 billion hectares, compared to only around half a billion hectares of potentially recoverable closed forest.[52]

In practice, the boundary between forest and agricultural landscapes is often fuzzy, and constantly shifting. In the past, such transitional zones usually occurred where forests were in retreat. In future, they will hopefully occur where forests are advancing, or where farmers are integrating tree use and forestry into their land use in new ways. Farmers are often seen as the enemies of forests. But they may provide the fastest and easiest way to increase global tree cover and capture carbon on the land.

In the past transitional zones between forest and agricultural land were usually connected to forests in retreat. In future, they will hopefully occur where forests are advancing, or where farmers are integrating tree use and forestry into their land use in new ways.

50 https://www.wildeurope.org/index.php/restoration/national-strategies/a-wind-of-change-in-western-europe
51 Bastin 2017: http://science.sciencemag.org/content/356/6338/635
52 Stanturf 2014: https://www.researchgate.net/publication/266082155_Contemporary_forest_restoration_A_review_emphasizing_function

What could restoration DELIVER US?

We should be wary of overstating the short-term climatic potential of forest restoration. Absorbing CO_2 from the atmosphere into growing trees is a slow process. So, while burning fossil fuels or biomass delivers an instant CO_2 hit, that gas can only be recovered slowly. Any negative emissions strategy, even if begun now, would likely be pulling temperatures back after an overshoot above the 1.5 degree target. This overshoot might involve unacceptable social or ecological impacts; it could even exceed some tipping-point in the climate system that once crossed can never be recovered.[53]

Moreover, negative emissions are a one-off gain. After several decades to a hundred years, the growth of forests slows down. They continue to absorb CO_2 but gradually. So, however great the potential drawdown of CO_2 from the air from restoring the planets forests, it emphatically does not offer an alternative to bringing CO_2 emissions from fossil fuels and land-use to zero as soon as possible. That said, the climate gains from forest restoration would be real – and could head off the worst of climate change while delivering many other social and ecological benefits.

The Paris Agreement has brought new focus on the need both to end forest loss and to begin a planetary restoration of natural forests. It is a task that should be taken in hand at once, and governments need to be centre stage in driving that process.

Box 5 suggests a set of guiding principles that governments and policy-makers should follow. But there is no blueprint. Nurturing woodlands within a wetland or grassland ecosystem will be very different from allowing a rainforest to re-grow. Neither the politics nor the ecology of planting in a densely populated tropical agricultural landscape will be anything like those for doing the same thing in a more sparsely populated boreal landscape.

But it will always be true that such projects must, at one and the same time, benefit people and ecosystems as well the planet's carbon budget.

Forest restoration does not offer an alternative to bringing CO_2 emissions from fossil fuels and land-use to zero as soon as possible.

53 Kartha and Dooley 2016: https://www.sei-international.org/mediamanager/documents/Publications/Climate/SEI-WP-2016-08-Negative-emissions.pdf

Managing fire is a part of adapting to climate change and protecting forests. Prescribed fires create more diversity and reduce crowded brushes that fuel wildfire. (Photo: The Sycan Marsh Preserve, US, Lisa McNee, BLM. Flickr.com/CC)

Box 5: **Guiding principles of forest landscape restoration**[54]

The restoration of forested landscapes involves regaining the ecological functions of forests, including their benefits to humans and their capacity to store carbon. It should integrate several guiding principles, including:

Recognising land rights and embracing local stakeholders. Many lands earmarked for forest recovery will be under the legal or customary ownership of indigenous groups and forest communities. Those rights must be respected – because that is just, and because local people have knowledge of the land that others do not, and because failure to do so will almost certainly result in the failure of forest restoration.

Being inclusive. Local people's right to free, prior and informed consent (FPIC) must be respected. Besides the human rights imperative, there is an added environmental benefit to ensuring local people are involved early and actively, as this makes it much more likely that the forest restoration project will be successful and long-lasting.

Focusing on landscapes. The aim should be to restore entire landscapes rather than individual sites, and to do this by balancing interdependent land uses – including protected areas, agroforestry, farming systems, small-scale plantations or managed woodlands, and human settlements.

54 Adapted from Hanson et al. (2015), based on Maginnis (2005) http://www.wri.org/sites/default/files/WRI_Restoration_Diagnostic_1.pdf

Restoring ecological functions. This means providing rich wildlife habitat, reducing erosion and floods, and introducing resilience against climate change and other disturbances.

Ensuring multiple benefits. In some places, trees will enhance food production by binding and fertilising soil and providing shade for crops. In other places, they will create a closed-canopy forest capable of providing forest produce while restoring a full range of protective ecological functions. In yet other places, forest recovery may protect coastlines from flooding or maintain wetlands and other hydrological systems.

Recognising that a suite of interventions for restoration are possible. Some strategies will make way for "nature to take its course" – by curtailing grazing to allow natural regrowth of trees, for instance. Others will involve more active intervention, including direct tree planting and nurturing.

Tailoring actions to local conditions. Everywhere has its own local social, economic and ecological contexts; there is no "one size fits all" in forest restoration. Moreover, restoration strategies will need adjusting over time as environmental conditions, human knowledge, and societal and economic values change.

Avoiding conversion of natural ecosystems. Tree cover should not be increased beyond what would be natural for a particular location. Nor should restoration cause any loss of wetlands, grasslands or other ecosystems. Forests do not have primacy. Their restoration should complement, not undermine, other ecosystems.

Protecting Food Security. Forest restoration and agroforestry must be complimentary and supportive of local communities' production of and access to sufficient nutritious food. Undermining food security in the name of climate action is not acceptable or sustainable.

Restored forests will need to work with and complement local customary land needs and rights.

Case studies

Any radical departure in policy-making needs models for success – or at any rate examples that illuminate the path ahead. To revive the planet's forests, we need a range of models representing success in different geographies, different biomes and different social settings. Here are four that may help. None is entirely successful. Indeed all show evidence of how faulty policy-making can hold things back. But they illustrate the issues. In particular, they highlight the importance of local people for successful forest recovery – not as passive "stakeholders" but as active and often dominant partners in the enterprises. Because without them, even the best ecological blueprints with the best carbon inventories will fail.

Community control and less pressure on forests have allowed natural regeneration of Sal trees (Shorea robusta) in Sundhar, Nepal. (Photo: Hanna Aho)

Case study 1: **NEPAL**

ASIA

Mountainous temperate forest

In the past quarter-century, Nepal has developed a successful system for community management of its forests in the foothills of the Himalayas, which are some of the most densely populated parts of the country.[55] The 1993 Forest Act created 17,000 autonomous community forest user groups, with rights to manage and control access to the forests. Since then, the national forest cover has increased by a fifth, one of the fastest rates of forest recovery in the world.[56]

How has this happened? For one, communities have now exclusive right to regulate harvesting of forests. There are also rules that user groups must follow, such as spending at least a quarter of forest revenues on forest management, including planting. The results have been impressive. In 2009, the 1.6 million hectares of community forests were estimated to contain 183 million tonnes of carbon, and to be adding to that carbon stock at a rate of 3 million tonnes a year.[57]

Several studies have contrasted the growth of community forests with the deforestation still rampant in government-managed areas.[58] They show that community forests also suffer fewer fires and less illegal felling, and that community planting and management has increased forest density by an average of 30 per cent. Soils have improved. Watersheds containing the forests have been protected from soil erosion and landslides.[59] Meanwhile, changes in agriculture and fodder harvested from forest foliage has reduced pressure on the forests from grazing.

In Nepal restoration of forests has sprung from the needs of local communities who suffered from forest degradation.

"The forest was so sparse one could see people walking on the hills. Our people had a long way to get to water source and find fodder for livestock," explains Ramhari Chaulagai, the chair of community forest Piple-Pokhara in Makwanpur district.

The restored forests have delivered rising income for both the communities themselves and the nation.[60] The management norms have also delivered improved social cohesion and equality, with equal representation for women in leadership positions and land set aside for

55 Nagendra 2004: http://www.pnas.org/content/104/39/15218.full
56 Niraula 2013: http://www.sciencedirect.com/science/article/pii/S0301479713002429
57 Stevens 2014: https://www.wri.org/sites/default/files/securingrights-full-report-english.pdf
58 Paudel 2013: http://www.cifor.org/publications/pdf_files/OccPapers/OP-81.pdf; Gautam 2004: http://www.bioone.org/doi/abs/10.1505/ifor.6.2.136.38397
59 http://www.fern.org/sites/fern.org/files/fern_community_forestry_nepal.pdf
60 https://www.wri.org/sites/default/files/WRI_Restoration_Diagnostic_Case_Example_Nepal.pdf. But communities also benefit in other ways, such as having better access to timber products, medical plants and water

Sakuntala Thapa and Kamala Paudel protect, manage and gather products from Sundhar ("Beautiful") community forest with other volunteers of the community. (photo: Hanna Aho)

the poorest. During the long civil war that followed a Maoist rebellion, forest user groups were among the few local institutions that continued to function.[61]

The restoration of forests has been especially marked in the Chure region (also called Churia), where community management delivered an increase in the cover of dense forests between 1992 and 2014 of 42,000 hectares.[62]

But all is not well. Far from lauding the success and further empowering the communities, in 2014 the government in Kathmandu appeared intent on resuming direct control. It declared Chure's forests, which cover a seventh of the country, as a conservation area, and brought in the World Bank's Global Environment Facility and the environment group WWF to draw up new conservation plans.

Amid escalating protests, communities complained that they were not consulted about the change in status of their forests. Bharati Pathak, general secretary of Federation of Community Forest Users, Nepal (FECOFUN), called it an attack on community control of forests and a potential precursor for private takeover.[63]

In the end, to assuage the concerns, WWF started a three-year project to employ community forest user groups to reforest some 4000 hectares of land, mostly degraded by sand and gravel extraction.[64] The life of the project has recently been extended, but concern remains that communities are not automatically given control of their forests.

61 https://www.cambridge.org/core/journals/environmental-conservation/article/resilience-of-community-forestry-under-conditions-of-armed-conflict-in-nepal/1B122A224F9FB319B0C1F05940CC56CF

62 Pokharel 2015: https://assets.helvetas.org/downloads/changing_face_of_churia_a4printed.pdf

63 http://news.trust.org//item/20150225195543-zyjn7/ and http://www.csrcnepal.org/pages/details/campaign/churecampaign

64 http://wwf.panda.org/?306790/Safeguarding-land-and-lives-in-Nepals-fragile-Churia

Case study 2: **NIGER**

AFRICA

Tropical forest

"A decade ago this land was dismissed as lost to the desert," said ecologist Mamadou Diakite. But he was smiling beneath the shade of a tree, one of hundreds growing vigorously all around him on land previously abandoned by local millet farmers. The growth of these trees, and hundreds of millions more in a remote region of West Africa on the edge of the Sahara desert, is the result of local farmers abandoning long-standing advice from government experts to uproot trees on their fields – and to nurture them instead.

What is today called Farmer-Managed Natural Regeneration is thought to have begun in the mid-1980s in Dan Saga, a village in the Maradi region of Niger, which suffered hugely from Sahel droughts in the 1970s. The story is that some young men returned to their fields late in the season after working abroad. In a rush, they planted their crops without first clearing their land of woody plants. To their surprise, their grain yields were better than in neighbouring fields that had been cleared. When the same thing happened the next year, the village got the message: trees were good for their crops (Chris Reij, personal communication).

So from then on, when preparing their land for planting, farmers cultivated stems growing from stumps in their fields. The resulting trees fixed nitrogen, stabilised soils and dropped leaves that maintained soil moisture. And before long, the trees were providing firewood, animal fodder and other products, as well as shading crops and villages from wind and sun.[65] The message spread. "It was slow to take off, but now they all want to do it," Diakite said. "The land is coming back into production."

This version of agroforestry on the desert fringes is essential a return to traditional pre-colonial farm practices. It gathered pace in the 1990s after the Niger government rescinded old laws that said all trees were government property and stopped fining farmers for cutting branches.[66] It has extended across 5 million hectares of Niger. The 200 million extra trees benefit yields of millet and sorghum on more than a million farms, which typically gain an income of about US $1000 per year from selling products such as wood, fodder, fruit, pods and leaves. The trees capture from the atmosphere an estimated 30 million tonnes of carbon.[67]

For a long time this grass-roots revolution was invisible to outsiders. It had been under way for twenty years before Western development professionals discovered it. Among the first was Chris Reij, then of the VU University Amsterdam. He said in an interview: "I had been away for ten years. When I went back in 2004, I drove 800 kilometres east from the capital Niamey, and I thought, bloody hell, there are trees everywhere. You couldn't see villages because they were

65 https://www.wri.org/sites/default/files/WRI_Restoration_Diagnostic_Case_Example_Niger.pdf
66 Pye-Smith 2013: http://www.worldagroforestry.org/downloads/Publications/PDFS/BL17569.pdf
67 Reij 2009: https://core.ac.uk/download/pdf/6257709.pdf

A decade ago this land was dismissed as lost to the desert, but now the land is coming back to production, says ecologist Mamadou Diakite. (Photo: Fred Pierce)

hidden behind trees".[68] Subsequently, satellite images taken by the US Geological Survey confirmed the re-greening.

Farmer-Managed Natural Regeneration of the region's native trees has proved much more effective than government efforts in the 1970s to "hold back the desert" by creating shelter belts of trees. Planted away from fields, most of those trees went untended and died. There are now fears that the same fate awaits trees that the international community wants to plant in a rerun, now known as the Great Green Wall project, which would pass through southern Niger.

68 https://www.newscientist.com/article/mg19726491-700-interview-cant-see-the-desert-for-the-trees/

Case study 3: **SCOTLAND**

EUROPE

Temperate and boreal forest

Bill Ritchie is proud to show off his smallholding on the northwest coast of Scotland. Once it was a tenanted scrap of sheep pasture overlooking the Atlantic Ocean. Now Ritchie claims his 11 hectares is "possibly the most biodiverse spot on the west coast of Scotland". All he did was clear out the sheep and watch the trees return.

He is not alone. This remote corner of Scotland is being transformed. Until a quarter century ago, his tenancy and its neighbours were mean, cramped enterprises known as crofts. They were surrounded by thousands of hectares of bare hillsides run as giant sheep-and-shooting estates by their landlords, the Vestey family, who are best known as international beef traders who a century ago pioneered turning South American rainforests into cattle ranches.

Now, after its purchase by former crofter fisherman Ritchie and the other tenants, the 8400-hectare North Assynt Estate is a greener and more biologically diverse place. The crofters have put in 800 hectares of woodland, which is now providing them with a much better livelihood. They now get income from stag hunting and benefit from tourists following the "North Coast 500" road, marketed as Scotland's answer to Route 66.[69]

The purchase became a watershed for land reform in Scotland, where since the notorious highland clearances two centuries ago most of the land has been held in large estates. Many other communities have since raised funds to buy out their landlords. And across Scotland, land reform and a growing desire to restore the country's former forests have formed a potent political brew.

There are sometimes conflicts between those who want to "rewild" Scotland and those who want to prioritise profits – notably over how many deer should be allowed to roam.[70] But mostly, the two impulses co-exist. Forests provide more jobs than grouse moors or sheep farms, whether in vistas for tourists or hazel for fish traps, refuges for stags and cattle or inspiration for artists.[71]

Reforesting Scotland is not a project; it is a movement with diverse intensely local projects, rooted as much in community activism as in environmentalism.

69 https://www.visitscotland.com/see-do/tours/driving-road-trips/north-coast-500/
70 http://www.theassyntcrofters.co.uk/snh-in-assynt/
71 https://www.theguardian.com/uk-news/2013/aug/10/scotland-land-rights

David McPhail is protecting planted trees by installing vole guards. (Photo: Lewis Davies)

Near the North Assynt Estate, a local community charity has bought a 1200-hectare estate planted with native woodland. They have established a native tree nursery.[72] Another part of the Vestey landholding, covering 18,000 hectares and including four striking mountains, was bought in 2005 by the Assynt Foundation, a local charity created for the purpose. Much of the land is bog and mountain, but the Foundation has big plans for expanding its 750 hectares of lowland birch, rowan and willow woods, as well as bringing in tourists, building artists' studios and establishing new croft tenancies for locals.

Overseeing this patchwork of new community forests is the Coigach-Assynt Landscape Partnership, which collaborates with other local landowners, including conservationists at the John Muir Trust, to connect up fragments of native woodland. The aim, says woodland officer Elaine MacAskill, is to provide habitat corridors for wildlife, as well as establishing tree nurseries, orchards, tourist paths, fuelwood projects, and some cattle grazing in the undergrowth. Her 80,000-hectare terrain is one of the largest landscape restoration projects in Europe.

Reforesting Scotland is not a project; it is a movement with diverse intensely local projects, rooted as much in community activism as in environmentalism.

"Restoring the land and the people" is its slogan. The desire to humanise landscapes that were once run by absentee landlords is intense. So is a belief that bringing back trees will create cultural and economic assets as well as carbon sinks.[73] It may offer a template for the diverse motives and possibilities for democratic forest restoration in many other post-industrial societies in temperate lands.

72 https://culagwoods.org.uk/index.php/little-assynt-estate/
73 https://www.reforestingscotland.org/

Its pillars include the Trees for Life project, dedicated to replanting the ancient Caledonian pine forest that once covered much of the Highlands. Community woodlands abound. It has even inspired some big landowners to embrace rewilding. Flat-pack furniture heir Paul Lister has planted a quarter-million native pine trees in his 9000-hectare glen north of Inverness, and hopes to populate his forest with locally extinct lynx, elk and more.[74]

"Communities across Scotland are increasingly taking up the opportunity to buy their land and plant forests that are bringing significant social, economy, environmental and cultural benefits," says Megan MacInnes of Community Land Scotland. "This is part of a land reform agenda driven by the Scottish government, which aims to bring 400,000 hectares of land under community control by 2020."

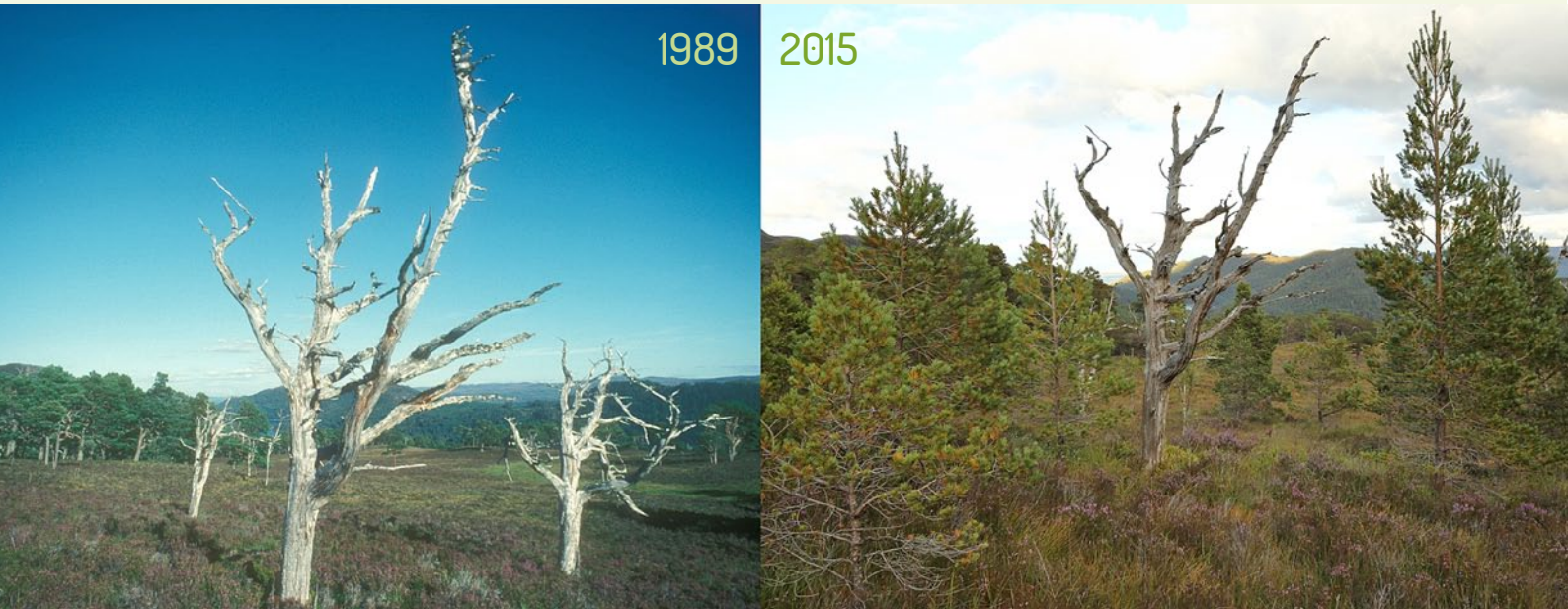
In the south of Scotland, another local charity called the Borders Forest Trust is building a small forest empire in the otherwise largely treeless Moffat Hills. It includes 2500 hectares of former livestock farm in and around the Carrifran valley, where its members have so far planted 600,000 native trees collected from local stock.

The activists here are not crofters, but mostly retired academics and conservationists, said trustee Hugh Chalmers, as he clambered through the forested valley. They bring binoculars as well as spades. They want to return the valley to "the rich diversity of native species that existed there … 6000 years ago". Seventeen years after planting began, the trees are above head height, undergrowth is appearing and a profusion of wild flowers have invaded the wet gravel beds down by the Carrifran stream. The trees are well on the way to storing their anticipated 120,000 tonnes of carbon.

Money plays a part in Scottish forest restoration. All these projects get grants from the Scottish government. At one stage, the Assynt crofters were paid to plant trees and paid again for sparing their land from sheep. But back at his croft, Ritchie is revelling in regenerating woodland. After the trees came pine martens and badgers, he said. "But what we really need are bears," added his partner Mandy Haggith. They have not been seen in these parts for two millennia, but "they are the best seed-spreaders in woodlands."

74 http://www.alladale.com/

Highlands are getting back their tree cover. (Photo: Trees for Life project)



Case study 4: **Xingu basin, Amazon**
BRAZIL

SOUTH AMERICA

Tropical forest

Y Ikatu Xingu means "Save the Xingu's Good Water" in the language of the Kamayura people, who live in the upper reaches of the River Xingu, one of the major tributaries of the Amazon. It is the name of a locally led project to bring forests back to the river's watershed, after deforestation by cattle ranchers and soya farmers caused water supplies to dry up and fish to disappear. Spearheaded by indigenous women collecting seeds from their forests for sale to landowners in deforested areas, it could be a blueprint for reversing the destruction of the forests of the Amazon.

The Xingu basin stretches from cerrado grasslands of the state of Mato Grosso, in the far south of Brazil, for 1600 kilometres till it joins the Amazon in the rainforest near its delta. Over the past quarter-century, the Xingu basin has suffered some of the fastest deforestation in the world. Mato Grosso alone has lost 140,000 square kilometres of forest, a quarter of the total Amazon loss.[75] This has seriously damaged both the river and the ecology of the Xingu Indigenous Park, where the river begins and where more than a dozen small indigenous groups live.

In 2004, these indigenous communities launched the Y Ikatu Xingu project, first to stop deforestation and then to restore up to 300,000 hectares of forests along the river. The aim was to safeguard livelihoods that rely on the natural environment, including the river itself.[76]

One of the project's hallmarks is to restore forests primarily by scattering seeds, using machinery commonly employed by farmers for crops. This is much cheaper than planting saplings, especially in remote areas. Direct seeding also mimics natural regeneration and has resulted in much higher tree densities.[77]

The project is a rare instance of ranchers, indigenous peoples and poor rural communities working together in a common cause to protect and enhance a common good. But it is led by indigenous communities, who created the Xingu Seed Network to gather native seeds for forest restoration. The network now has more than 400 collectors in 21 municipalities and currently sells seeds for 200 different tree species. Most of the collecting groups are led by women, empowering them within communities as well as generating income.[78]

NGOs such as the Instituto Socio Ambiental, a co-founder of the seeds network, buy the seeds from the collectors and sell them on to landowners.[79] There is a thriving market among landholders who want to plant trees on their land. In part they have been reinstating forest

75 http://www.rufford.org/projects/silvia_barbosa_rodrigues
76 Durigan 2013: http://rstb.royalsocietypublishing.org/content/368/1619/20120165.short
77 Campos-Filho 2013: http://www.tandfonline.com/doi/abs/10.1080/10549811.2013.817341
78 https://www.socioambiental.org/pt-br/noticias-socioambientais/rede-de-sementes-do-xingu-completa-dez-anos-de-historia and http://sementesdoxingu.org.br/site/
79 https://ourworld.unu.edu/en/mighty-agro-lobby-threatens-reforestation-of-amazon

Xingu basin,Brazil. (Photo: A C Moraes. Flickr.com/CC))

cover to comply with Brazil's Forest Code, though revisions to the code have recently reduced those requirements. But they are also indirectly helping protect the water supplies on which they depend.

These are early days. So far the project has restored some 3,200 hectares of forests along the river, just 1 per cent of the eventual target. But the Xingu Seeds Network has spread from Mato Grosso into neighbouring Para state and inspired other initiatives such as the Amazon Portal Seeds Network. It surely holds lessons for the future recovery of the world's largest rainforest.

There is clear potential to scale up. The Brazilian government has been developing plans for what it calls "silvopasture", planting trees on existing cattle-ranches, as part of a strategy for recovering some of the carbon lost through past deforesting of the Amazon.[80] Seeds networks organised by indigenous communities would be an obvious way of achieving this.

Indigenous control of forest territories has been central to the dramatic reduction in deforestation in the Amazon over the past 15 years. Their entrepreneurship in seeds could be the genesis for a future restoration of forests.

80 http://www.wri.org/blog/2016/10/restoring-degraded-land-latin-america-can-bring-billions-economic-benefits

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To limit global warming to 1,5 degrees we must reduce emissions as soon as possible, stop forest loss and restore forests. One cannot be done without the others.

Tree seeds extraction in Sadore, Niamey, Niger. (Photo: Brad Hounkpati. Flickr.com/CC))

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