HEINRICH BÖLL STIFTUNG
ECOLOGY

VOLUME 44.7

Re-Greening the Earth

Protecting the Climate through Ecosystem Restoration

By Christoph Thies

RE-GREENING THE EARTH

HEINRICH BÖLL STIFTUNG
PUBLICATION SERIES ECOLOGY

VOLUME 44.7

Re-Greening the Earth

Protecting the Climate through Ecosystem Restoration

By Christoph Thies

Edited by the Heinrich Böll Foundation

The Author

Christoph Thies holds a PhD in Ecological Chemistry from the University of Oldenburg in Germany. He joined Greenpeace Germany in 1988 and is an expert on forest and climate related issues.

Published under the following Creative Commons License: http://creativecommons.org/licenses/by-nc-nd/3.0 . Attribution – You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work). Noncommercial – You may not use this work for commercial purposes. No derivatives – If you remix, transform, or build upon the material, you may not distribute the modified material.

Re-Greening the Earth
Protecting the Climate through Ecosystem Restoration
By Christoph Thies
Volume 44.7 of the Publication Series Ecology
Edited by the Heinrich Böll Foundation 2018

Editorial design: feinkost Designnetzwerk, S. Langer (based on the origin layout by State Design)
Copy-Editing: Nozomi Horibe
Printing: ARNOLD group, Großbeeren
ISBN 978-3-86928-182-7
ISBN 978-3-86928-184-1 (anthology)

This publication can be ordered from: Heinrich-Böll-Stiftung, Schumannstr. 8, 10117 Berlin, Germany
T +49 (0)30 28534-0 **F** +49 (0)30 28534-109 **E** buchversand@boell.de **W** www.boell.de

CONTENTS

INTRODUCTION

The land sector is part of the climate problem today, but it can become part of the climate solution in the future. Currently, emissions from the land sector—primarily from industrial agriculture and forest and peatland destruction—contribute to global warming and dangerous climate change. As a result, the CO_2 content in the atmosphere continues to increase and is already at levels that, if not decreasing, would likely see global temperature rise exceed 1.5°C above pre-industrial levels. The world's natural ecosystems, however, acts as vital carbon sinks that absorb and sequester CO_2 from the atmosphere, thereby regulating the climate system. The protection and restoration of natural ecosystems, particularly forests, peatlands and coastal ecosystems, can therefore promote CO_2 uptake from the atmosphere and contribute to climate and biodiversity protection.

There is a growing consensus that more CO_2 must be removed from the air. It is estimated that a cumulative amount of 100 to over 1,000 billion tons of CO_2 must be removed within this century, depending on the speed and the extent to which emissions will be cut. If emissions from burning fossil fuels and other greenhouse gas emissions can be reduced quickly enough, the necessary CO_2 uptake can be achieved by protecting and restoring natural sinks, thereby avoiding untested and potentially risky Carbon Dioxide Removal (CDR) technologies.

Land ecosystems and terrestrial carbon

On the earth's surface, there are large reservoirs of carbon, which regulate the global climate and provide the basis for all terrestrial plants and animals. These carbon pools consist mostly of the world's soils and, to a smaller extent, trees and other vegetation. They exist in various natural ecosystems such as forests, peatlands, savannas, steppes, and also extending to areas where the land meets the sea, in mangroves, salt marshes, seagrasses and other coastal ecosystems.

Some 600 million years ago, marine organisms and plants colonizing the formerly barren lands, turned the earth into a large battery. This battery charged itself by converting sunlight into stored energy in forms of organic matter in living vegetation, other living biomass, soils, and fossilized biomass—vast reserves of coal, oil and gas, which started forming underground some 350 million years ago.[1]

After a long period of equilibrium, humans began discharging this battery 12,000 years ago by cultivating crops and herding animals. By burning, logging, grazing, draining, and flooding forests and other natural ecosystems, organic matter in vegetation and soils was depleted more quickly than the battery could recharge. This depletion has accelerated vastly in the last 120 years. About half of the global vegetation biomass has been lost in the last 2,000 years compared to what it would be in a world without human activity.[2] Almost a quarter of this loss occurred in just the last 120 years.[3]

These activities, together with the emissions from depleting soils (particularly in peatlands) and fossil fuel combustion in the last 150 years, led to rapidly increasing amounts of carbon accumulating both in the atmosphere and in the oceans, causing climate change and ocean acidification. Carbon is being depleted from the land and underground and is now in dangerous excess in the oceans and atmosphere. Climate change and ocean acidification are threatening many land and sea species with extinction and massively impacting terrestrial and marine ecosystems (see figure 1).

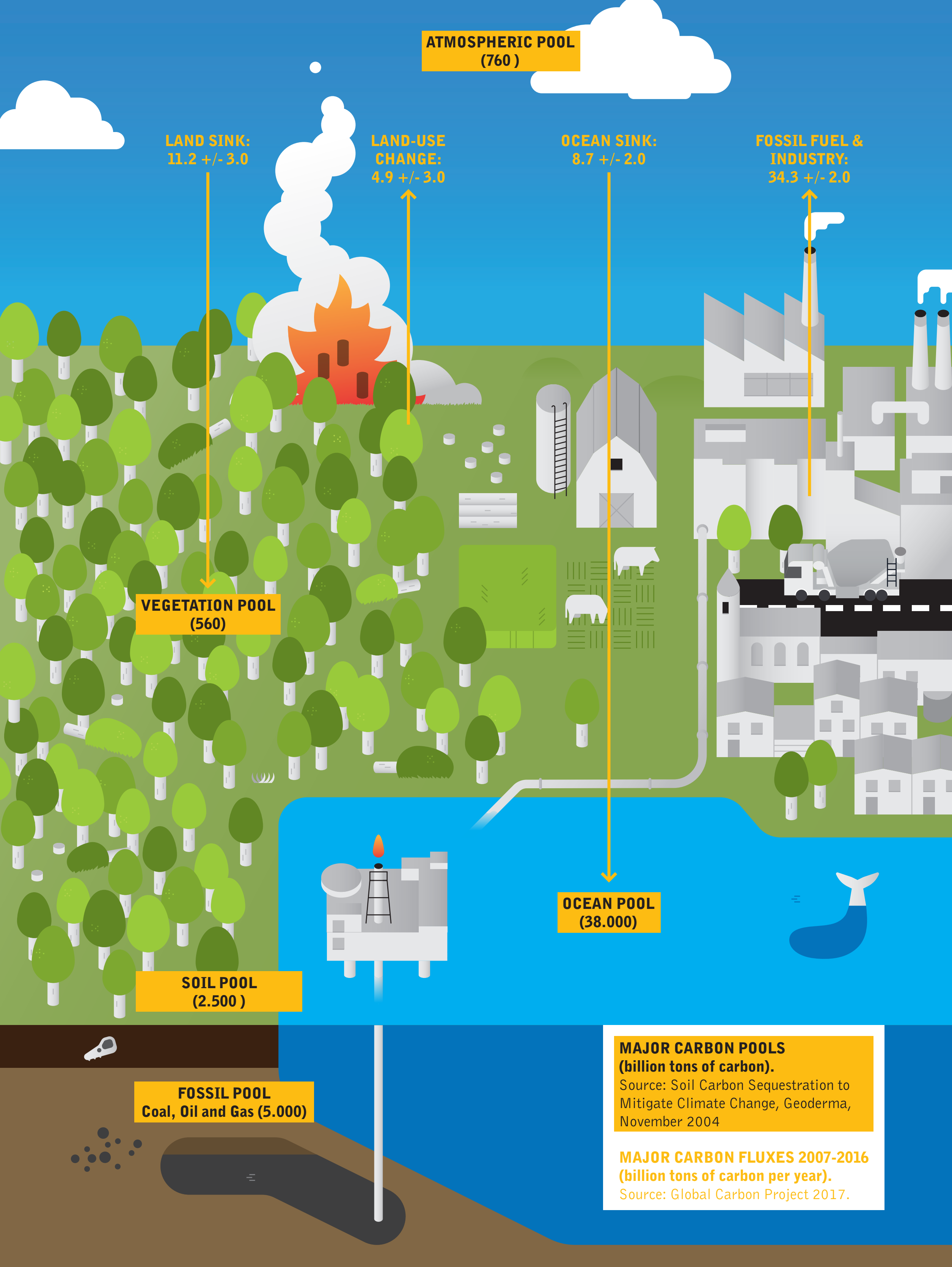
---

[1] Schramski, J. R., et al. (2015). Human domination of the biosphere: Rapid discharge of the earth-space battery foretells the future of humankind. *Proceedings of the National Academy of Sciences*. 112(31), 9511–9517. http://www.pnas.org/content/112/31/9511

[2] Erb, K-H., et al. (2017). Unexpectedly large impact of forest management and grazing on global vegetation biomass. *Nature*. 553, 73-76. https://www.nature.com/articles/nature25138

[3] Schramski, J. R., et al. (2015). op. cit.

Figure 1: Carbon Cycle



The difference between fossil and terrestrial carbon pools

Terrestrial carbon regulates the climate differently than coal, oil, and gas, which make up the fossil carbon pool. Fossil carbon is more or less permanently locked up underground and would remain there if we don't dig it up and burn it.

By contrast, terrestrial carbon is in permanent exchange with the atmosphere.

Soils and vegetation are subject to both growth and decomposition. Growth is generated by vegetation absorbing CO_2 from the air with the help of sunlight, storing carbon in the biomass of growing trees and plants, and passing some of it through their roots on to the soils. Vegetation acts as bridge between the atmospheric carbon pool and the (much larger) soil carbon pool.

Decomposition, in contrast, releases CO_2 back into the air and is caused largely by burning forests and other lands, logging trees and subsequent felling damage to other trees and skidding damage to the soil, as well as harvesting plant biomass from other lands. It also is caused by droughts, storms, and heatwaves. If decomposition dominates growth, the ecosystem is in process of destruction; if growth is faster than decomposition, it is in process of restoration.

Burning fossil fuels is an irreversible process moving carbon from the fossil pool to the atmospheric pool. Through the restoration of global vegetation, however, a good part of the lost carbon from the terrestrial carbon pool from past destruction could be restored within decades. In other words, while stopping fossil fuel combustion is the most important task in reducing CO_2 emissions, halting the destruction of and restoring forests and other land ecosystems is key in removing CO_2 from the atmosphere and reversing the trend of rising CO_2 concentrations.

Forests are crucial for CO_2 uptake

To mitigate climate change and protect biodiversity and ecosystems, terrestrial carbon pools must be urgently prevented from losing more of the carbon they have accumulated over centuries and millennia. Restoring at least a small part of the lost vegetation biomass is a fast and environmentally friendly way to combat dangerous climate change by removing large amounts of CO_2 from the air. The majority of global plant biomass is stored in the world's largest plants, the trees of the forests. Forests are the most important natural land carbon sink. Stopping deforestation, allowing forests to recover some of the deforested areas, protecting ancient forests from logging, and allowing managed forests to grow back towards their natural growing stock and native tree composition are the most important natural climate solutions.

The estimated global potential for CO_2 uptake through forest restoration is of the order of 400 billion tons in the 21st century. According to the calculation by Kartha and Dooley, imposing social constraints to ensure food security as well as biophysical constraints would provide a cumulative potential of 370–480 billion tons within the 21st century.[4]

The extent of forest restoration can be impacted by an increased frequency of regional fires, droughts, and heatwaves. Die-back and reduced growth of trees also temporarily reduce the global forest carbon uptake. These risks increase with global warming, so it is crucial for the rate and intensity of climate change to be minimized with fast and deep emission cuts to maintain the significant potential that ecosystem restoration holds over the 21st century.

It is important to highlight that the protection and restoration of forests and other ecosystems accomplish much more than just reduce greenhouse gas concentrations in the atmosphere and increase the CO_2 uptake. Based on ecologically and socially adequate principles (see the restoration principles developed by the Climate, Land, Ambition and Rights Alliance (CLARA) below), restored natural ecosystems protect biodiversity, filter air and water bodies, increase clean water supply, help prevent coastal floods and soil erosion, serve as biodiverse habitats that strengthen livelihoods of Indigenous Peoples and local communities, and enhance climate resilience in droughts, fires, storms, floods, and other extreme weather. In short, they pave the way towards realizing the 2015 Sustainable Development Goals (SDGs).

---

[4] Kartha, S. and Dooley, K. (2018). Land-based negative emissions: risks for climate mitigation and impacts on sustainable development. *International Environmental Agreements: Politics, Law and Economics*. 18(1), 79–88. https://link.springer.com/article/10.1007/s10784-017-9382-9

Forest ecosystem restoration

Forest restoration can provide the backbone for additional CO_2 sequestration in this century. There are two ways to do this:

- Protecting primary forests from logging and allowing other forests to grow and be restored through natural forest management with reduced logging rates and impacts
- Halting deforestation and reforesting lost forests

Protecting and restoring existing forests

For successful forest restoration, logging rates must be limited in many forest regions. Furthermore, measures such as logging bans in primary and other valuable and/or vulnerable forests, drastic reduction of felling, skidding, road-building damage, forest fire prevention and control, and reduction of herbivore overpopulation (e.g. trophy hunting) must be put into place. These combined measures would minimize soil and vegetation damage; enable forest regrowth as well as additional carbon uptake.

Forests and the wood they provide form an important part of the bioeconomy. A crucial sustainability criterion for a bioeconomy with nature protection and natural climate solutions is the balance between what to leave and what to take—in other words, the balance between the share of the growing biomass left to nature for biodiversity and natural CO_2 uptake and the share harvested and used for cutting CO_2 emissions and replacing fossil and other non-renewable resources.

Therefore, a new balance between forests and wood harvest for the benefit of the forest is needed. In a recently published *Forest Vision* for Germany by the Öko-Institut for Greenpeace, Germany's forest growth in the 21st century under different management assumptions could have significant potential for future CO_2 uptake: within this century, over 2 billion tons of additional CO_2 could be absorbed in Germany's 11 million hectares of forest alone.[5]

As Table 1 shows, this forest vision offers decisive advantages compared to a Business as Usual (BAU) scenario in the 90-year modelling period from 2012–2102; annual growth is 7 percent higher, annual CO_2 sequestration by the forest and its harvested wood is 77 percent higher, and annual wood harvest is only 25 percent lower. In the year 2102, the growing stock is 42 percent higher, the growing stock of larger trees (above 60 cm BHD) is 169 percent higher, and the deadwood stock is 18 percent higher.

It cannot be expected that the CO_2 uptake potential everywhere else in the world would be the same as that of Germany. There is an enormous potential, however, as global secondary forest cover is over 200 times larger than Germany's forest area. Even if the global average of additional CO_2 uptake would be only half of that of Germany,

---

[5] Böttcher, H., et al. (2018). *Forest Vision Germany: Description of methodology, assumptions and results*. Öko-Institut e.V. https://www.greenpeace.de/files/publications/20180228-greenpeace-oekoinstitut-forest-vision-methods-results.pdf

it would result in some 200 billion tons of additional CO_2 uptake in the world's secondary forests. Restoration of secondary forests offers the single biggest natural CO_2 uptake potential without requiring any additional land.

At the same time, demand for wood is increasing; wood is being promoted to replace aluminum, steel, cement, and fossil fuels, thus contributing to the reduction of fossil fuel emissions. Allowing forests to restore themselves and grow back to their natural capacity with reduced logging would make wood a rare and limited resource.

Table 1: Different scenarios of forest management (study by Ökoinstitut on Germany's forests 2012-2102)

	Unit of measurement	Scenario «base» business as usual	Scenario «forest vision» ecological forest management
Growing stock in forests	Billion m^3 in 2102	5	7.1
Forest growth	m^3 per year and hectare	9.3	9.9
CO_2 uptake in forest vegetation*	Million t CO2 per year 2012–2102	17.2	48.2
Total CO_2 uptake**	Million t CO2 per year 2012–2102	31.9	56.3
Growing stock large trees (>60 cm diameter)	Billion m^3 in 2102	0.6	1.7
Deadwood stock	m^3 per hectare in 2102	22.5	26.2
Annual wood harvest rate	m^3 per year and hectare 2012–2102	6.8	5.1
	Million m^3 per year in 2102	71.8	61.8
Share of forest area excluded from logging	%	4.1	16.6

*stored in stems, branches, leaves, roots

**stored in forest biomass and dead wood, litter, soil and wood products

Reduced wood supply, however, can still imply increased wood use if we make more from less. This can be achieved by using wood in cascades of products. Various long-lived and short-lived products could be created using only otherwise unusable wood residue in product chains for bioenergy. Wasteful use such as burning massive amounts of fresh wood for bioenergy or throw-away paper products must be drastically reduced and largely phased-out.

Wood products cannot absorb CO_2 from the air; they can only store the carbon that the living tree removed from the atmosphere before. The only way that CO_2 can be absorbed from the air with additional benefits for biodiversity is to have more trees and to allow them to grow old and large. Every single tree cut down unnecessarily or too early means less carbon uptake from the atmosphere.

Halting deforestation and reforesting lost forests

Successful reforestation will require significant areas of formerly forested lands. This will be required mostly in tropical regions where forests have been replaced by cropland, pasture, and settlements in the last decades and also in temperate regions where forests have been cleared in the more distant past. Policy incentives must be put in place to ensure that the drivers of deforestation are addressed, including cattle pastures, soy, oil palm, and other crops.

Furthermore, a major effort must be put into involving Indigenous Peoples and other communities of traditional forest and land users. Not only are their full participation and prior informed consent vital, but also their rights and livelihoods must be respected in the decision-making in reforestation.

It is also likely that there will be many other demands for these lands from a growing population, such as to expand croplands. Such demands could pose a challenge in finding former forest lands that have the potential to be reforested, particularly in the tropics.

A global land-use vision would help address competing land-use demands. It could demonstrate how the expansion of agricultural lands can be halted through a diet with less meat, reduced food waste, bioenergy downsized to biomass waste instead of dedicated energy-croplands or fresh wood, soil restoration, and so forth. This must be complemented with mobility and other land-planning concepts that reduce the expansion of built-up land (settlements, roads, and other infrastructure).

Restoration principles

1. **To ensure restoration is good for people it must**
    - **Respect the rights of local and indigenous people.** Many of the most promising areas for forest restoration are under the legal or customary ownership of local forestdependent people. Their right to free, prior and informed consent (FPIC) about what happens to their land must be respected and promoted.
    - **Respond to local needs.** To be resilient and just, restoration strategies must respond to local needs and conditions. When led by local people, forest restoration can provide many everyday benefits like providing food and strengthening local peoples' connection to the forest.
    - **Promote social justice and equality.** Women, the poor and marginalised groups are especially dependent on forests. Restoration activities should therefore promote their rights and benefit their everyday lives.
    - **Promote good governance.** Forest restoration will only be successful if there is good governance of forests that ensures meaningful participation of local communities in decision-making.

2. **To ensure restoration is good for biodiversity it must**
    - **Support ecosystem protection.** Restoration should foster natural forest features such as having a variety of local and endemic species, rather than cultivating monoculture tree plantations which have low biodiversity value.
    - **Promote environmental co-benefits.** Restoration projects should explicitly aim to achieve broader environmental benefits in the local area – such as improved water quality, ecosystem productivity and soil fertility.
    - **Support biodiverse landscapes.** Restoration should reconnect fragmented primary and natural forests, increase natural features of secondary forests (such as decaying wood), increase tree cover in agricultural areas via agroforestry, and balance different land uses. Creating larger biodiverse landscapes – rather than targeting individual areas enhances the resilience of restored areas.

3. **To ensure restoration is good for climate it must**
    - **Promote strong ecosystems.** Biodiverse ecosystems (rather than plantations) are more resilient to environmental changes like increased pests, forest fires and disease. This is particularly important as a warming planet will see an increase in such environmental disasters.
    - **Protect existing carbon stocks.** Primary forests, natural wetlands and grasslands store large amounts of carbon and they should not be compromised.
    - **Increase overall climate ambition.** The remaining carbon budget is so small that increased efforts in all sectors are necessary. There are social and ecological limits to how much climate action can be achieved by forests. Restoration should therefore be additional to emission reductions in other sectors and not used to compensate, or «offset», lowered ambition.

Above principles are from Restoration Statement.
https://fern.org/restorationprinciples. Copyright 2018 by Fern.

Paris Climate Agreement and limiting global warming to 1.5°C

The Paris Agreement to avert catastrophic climate change and limit global warming to 1.5 degrees compared to pre-industrial levels poses a significant challenge to governments and societies around the world. However, this goal can still be achieved. We have the options and pathways to stay below 1.5 degrees; what is lacking is the political will in many countries to prioritize and implement them. Current commitments are far from this target, and measures to mitigate climate change must be ramped up significantly. This entails massive emissions cuts and eliminating CO_2 emissions from fossil fuel combustion and greenhouse gas emissions from forest destruction, agriculture, and many other sources.

In addition to fast and more stringent emissions reductions, many of the 1.5°C scenarios developed over the past few years envision large-scale implementation of technologies to remove CO_2 from the atmosphere and bury it underground or in the oceans.[6] According to some scenarios, several hundreds of billions of tons of CO_2 would need to be taken out of the atmosphere; the actual numbers would depend on the speed and extent of emission cuts in the near and medium-term future. These involve technologies called Negative Emission Technologies (NETs) or Carbon Dioxide Removal (CDR) technologies with chemical CO_2 capture and geological storage, which are untested, especially on a large scale, and could cause significant adverse impacts that put both human communities and natural ecosystems at great risk.[7]

There has been growing unease and criticism regarding such unsustainable assumptions about the large-scale implementation of CDR in such scenarios. Some recent climate mitigation modeling, therefore, have explored alternative, more profound, and far-reaching mitigation options that have not been considered in mainstream 1.5°C scenarios and that pave the way for a climate trajectory that depends much less on CDR and avoids temperature overshoot (see *Modelling 1.5°C-Compliant Mitigation Scenarios Without Carbon Dioxide Removal* in this publication).

Similarly, the contributions to this publication also demonstrate that more transformative visions for the 1.5°C goal are both feasible and urgently required. They unlock additional mitigation potential to drastically reduce the amount of CO_2 uptake needed.

Gambling with untested and potentially risky technologies
The widely proposed option for land-based CDR is large-scale afforestation (monoculture plantations of fast-growing exotic trees), either alone or in

---

[6] Minx, J. C., et al. (2018) Negative Emissions–Part 1: Research landscape and synthesis. *Environmental Research Letters*. 13(6). http://iopscience.iop.org/article/10.1088/1748-9326/aabf9b/pdf

[7] ETC Group, Biofuelwatch and Heinrich Böll Foundation (2017). *The Big Bad Fix. The Case Against Climate Geoengineering*. Nairobi/Berlin/Ottawa.

combination with another contested technology: bioenergy with carbon capture and storage (BECCS). Typically, in BECCS, plantation wood is combusted in power stations and the arising CO_2 is chemically captured and buried under high pressure in underground geological formations.

Only a few pilot BECCS plants have been in operation so far, removing some 20 million tons of CO_2 per year from the atmosphere, or a negligible 0.5 per mille of current annual CO_2 emissions. There are large uncertainties surrounding the technological, social, and economic feasibility of scaling up BECCS. For one, the significant land requirement for BECCS in many assessments imply serious social and ecological risks: It is estimated that between 380 million hectares (approximately the area of India) and more than the equivalent of all land currently used for crop cultivation would be required for BECCS.[8,9] Monoculture plantations are also more vulnerable to climate change than biodiverse forests as they are susceptible to droughts, excessive heat, and fire.

Land-based CDR technologies, therefore, are a dangerous «quick-fix» to gamble with. We must take timely and adequate action today to avoid risky reliance on them in the future. There are not only fundamental uncertainties regarding their technological feasibility, but BECCS also could have unacceptable social and ecological impacts.

---

[8] Smith P., et al. (2016). Biophysical and economic limits to negative CO_2 emissions. *Nature Climate Change*. 6, 42–50. https://doi.org/10.1038/nclimate2870

[9] Burns, W. and Nicholson, S. (2017). Bioenergy and carbon capture with storage (BECCS): the prospects and challenges of an emerging climate policy response. *Journal of Environmental Studies and Sciences*. 7(4), 527–534.

Natural Climate Solutions – window of opportunity

While forest protection and restoration are prominent natural climate measures for removing CO_2 from the atmosphere, other land and coastal ecosystems offer potential as well. A 2017 paper by Griscom and co-authors identifies a range of what they call «Natural Climate Solutions.» According to their study, two-thirds of all natural climate solutions to mitigate climate change lie in forest protection, management, reforestation, and restoration.[10] They found, however, that one-fifth of the total potential lies in grazing-land management and restoration, together with other agricultural measures. Furthermore, 14 percent of all natural climate solutions to mitigate climate change that they identified were in the protection and restoration of peatlands and coastal ecosystems.

Forests and other ecosystems have a significant potential to sequester CO_2 over the course of the 21st century, but this opportunity is limited. Their CO_2 uptake will eventually reach saturation and is regionally reversible when ecosystems degrade, collapse, or become otherwise destroyed. The risk of ecosystem degradation and destruction increases with rising temperatures and unfolding global climate change. Carbon sequestration in natural ecosystems, therefore, must not be (mis)used to offset or compensate fossil fuel and industry emissions, which, in contrast, are irreversible. Forest and ecosystem restoration, therefore, must be undertaken in conjunction with full and rapid decarbonization and restructuring of the energy and industrial sectors (see *A Managed Decline of Fossil Fuel Production, Another Energy is Possible* and *Zero Waste Circular Economy. A Systemic Game-Changer to Climate Change* in this publication).

Drastically ramped-up national mitigation targets, political measures, and economic incentives to speed up and intensify emission reductions in all sectors are crucial in ensuring that the additional CO_2 uptake required in this century stay within the lower range of the estimates (e.g. 100–400 billion tons). If this were the case, it can be achieved by protecting and restoring forests and other natural ecosystems, provided that national targets, measures, and incentives are being developed for the protection and restoration of natural sinks as well.

The current lack of ambitious climate targets pushes the amount of CO_2 uptake required over the course of this century towards the upper end of the estimates (e.g. 400 to over 1000 billion tons of CO_2 cumulatively)—a magnitude of carbon dioxide

---

[10] Griscom, B. W., et al. (2017). Natural Climate Solutions. Proceedings of the National Academy of Sciences. 114 (44), 11645–11650. http://www.pnas.org/content/114/44/11645

removal that is impossible to achieve through Natural Climate Solutions. This would require the deployment of technologies such as BECCS, which are either untested or potentially involve high risks for local people, natural carbon sinks, native biodiversity, water cycles, and soil erosion, thus being incompatible with the sustainable development goals (SDGs). Such largely hypothetical methods of removing CO_2 from the atmosphere are therefore dangerous to bank on as they may prove unfeasible or socially and ecologically unacceptable.

If every sector steps up ambition and does its utmost to rapidly phase out emissions and increase natural CO_2 uptake, the window of opportunity to stay below 1.5°C of global warming can be kept open without putting our natural ecosystems even further at risk. Natural climate solutions have high potentials and provide a robust basis for immediate global action to improve ecosystem protection and restoration. They can provide a remedy not only for climate change, but also for biodiversity, soil and water threats, and help to remain a safe operating space of our planetary boundaries. Humanity and nature depend on intact ecosystems as much as on a stable climate.

ECOLOGY
VOLUME 44.7

Re-Greening the Earth

Protecting the Climate through Ecosystem Restoration

The boxed set *Radical Realism for Climate Justice – A Civil Society Response to the Challenge of Limiting Global Warming to 1.5°C* includes the following soft-cover volumes:

VOLUME 44.1
A Managed Decline of Fossil Fuel Production

VOLUME 44.2
Another Energy is Possible

VOLUME 44.3
Zero Waste Circular Economy
A Systemic Game-Changer to Climate Change

VOLUME 44.4
Degrowth – A Sober Vision of Limiting Warming to 1.5° C

VOLUME 44.5
System Change on a Deadline
Organizing Lessons from Canada's Leap Manifesto

VOLUME 44.6
La Via Campesina in Action for Climate Justice

VOLUME 44.7
Re-Greening the Earth: Protecting the Climate through Ecosystem Restoration

VOLUME 44.8
Modelling 1.5°C-Compliant Mitigation Scenarios Without Carbon Dioxide Removal

ISBN 978-3-86928-182-7

Heinrich-Böll-Stiftung
The Green Political Foundation
Schumannstraße 8, 10177 Berlin, Germany
+49 (0)30 285340 info@boell.de www.boell.de