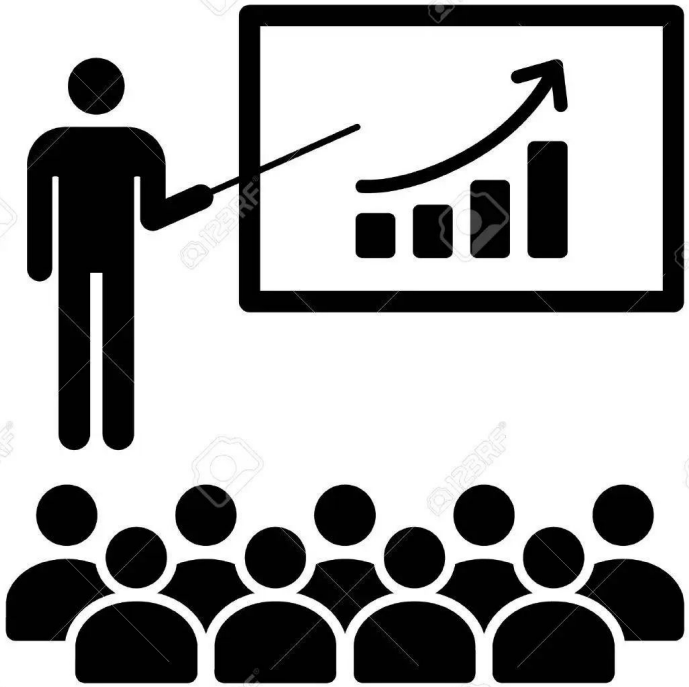
The Potential Role of Forestry for CO2 Removal

Abhilash Desu, Ann-Kristin Knickmann, Kira Bastian, Mali Brueckner, Marcel Bongarzt-Fiegen, Simon Schreck and Valentina Garcia

HNEE - GCM - 2. Semester
Munich Re Seminar Contribution

Hochschule
für nachhaltige Entwicklung
Eberswalde

We:
Policy Advisers



You: German Government

The Potential Role of Forestry for CO2 Removal

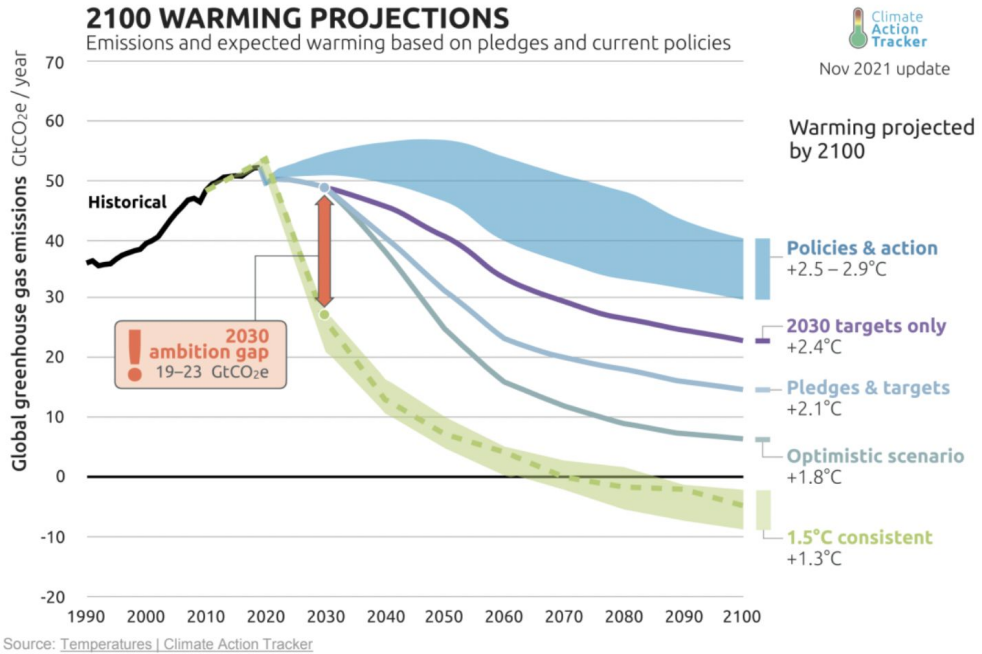
1) Global perspective
   a) CO2 Removal and Forestry
   b) An Outlook to China

2) Focus on Germany
   a) German needs in CO2 removal
   b) Potentials inside Germany

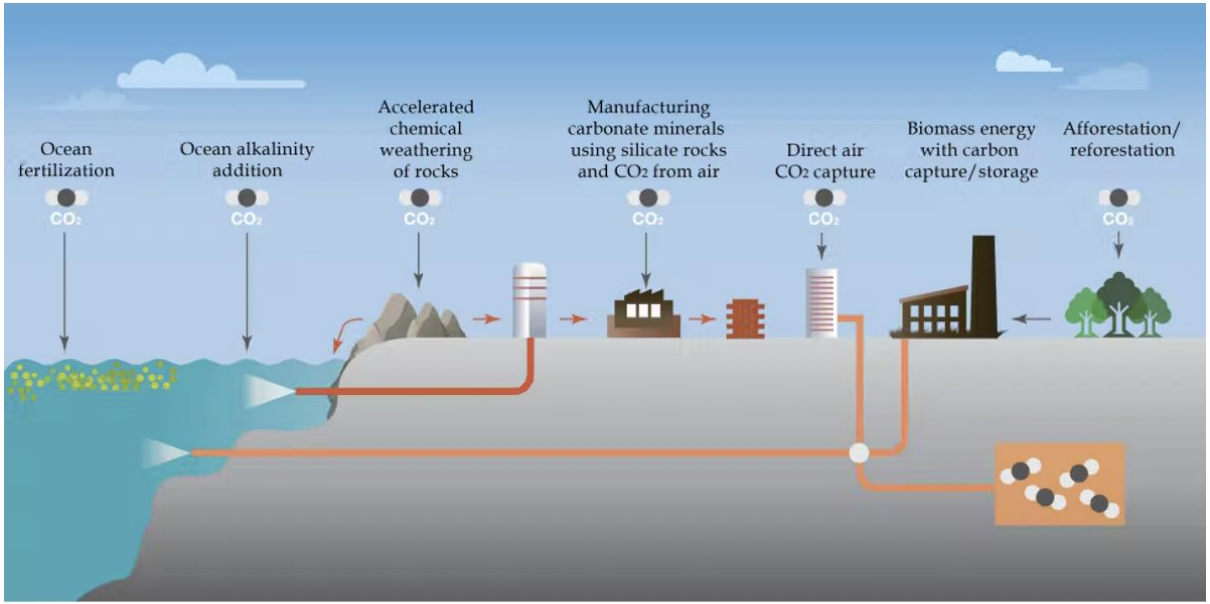
3) Role of bilateral partnerships
   a) The danger of eco-colonialism
   b) Lessons from Ethiopia and Brasil

Introduction

- To reach the target to limit the temperature rise to 1.5C° by the end of the century it is necessary to remove Co2 from the atmosphere
- It's not enough to reduce Co2 emissions - a carbon dioxide removal strategy (CDR) is needed to stick to the 1.5C° scenario and below by the year 2100



Carbon Dioxide Removal (CDR)



'Negative emission' technology comes in many forms. Caldecott et al / SSEE

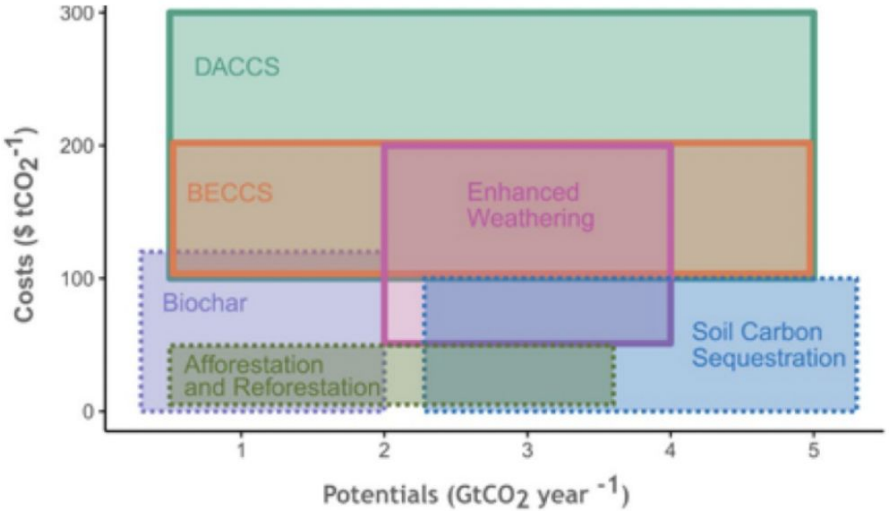
Nature based practices:

- e.g. forestation (afforestation and reforestation), soil carbon sequestration and wetland restoration

Technological alternatives:

- e.g. enhanced weathering, bioenergy with carbon capture and storage (BECCS), and direct air capture and storage (DACCS)

Potentials of Carbon Dioxide Removal (CDR)



Source: Chapter 4 of Special Report Global Warming of 1.5°, IPCC, 2018

- Afforestation and Reforestation are most cost effective and viable compared to their potential of CDR

Benefits/ecosystem services:

- e.g. flood control, air/water filtration, biodiversity, soil quality, climate resilience etc.
- Technological solutions (DACCS/BECCS) present the largest potential, but there are also the most expensive option (at least today and in the foreseeable future)

Advantages:

- -Once developed- easier to up scale and provide more permanent carbon pools due to geological storage

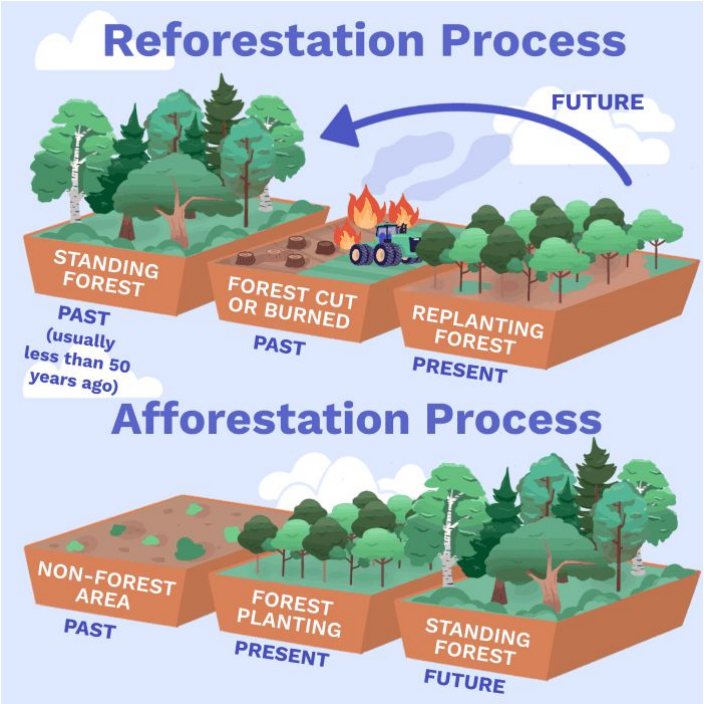
Definition of different forestry techniques

Hochschule
für nachhaltige Entwicklung
Eberswalde

Reforestation:
Def.: *“Is the natural or intentional restocking of existing forests that has been (recently) depleted”*

Afforestation:
Def.: *“Is the establishment of a forest or stand of trees in an area where there was no previous tree cover”*

Preservation:
Def.: “In forestry, forest protection refers to measures to protect forests and tree stands from damage of any kind”



climatescience.org

Hochschule
für nachhaltige Entwicklung
Eberswalde

General pros and cons of forestry for CO2 removal

Pros:

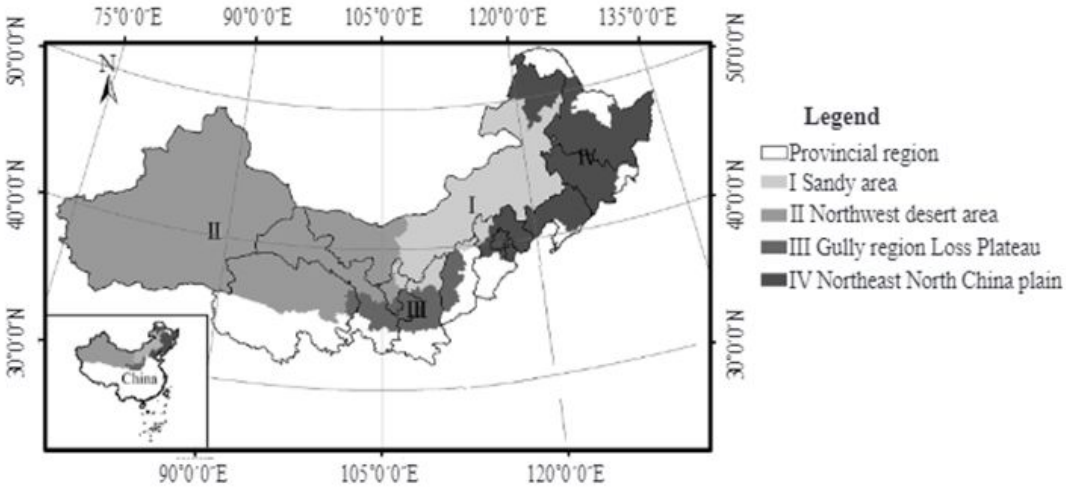
- ready to use techniques
- many positive side effects for nature and humans
  (habitat and biodiversity, recreation, economic benefits, local air quality, etc.)
- comparably cheap
- high theoretical potential of CO2 sequestration

Cons:

- Saturation of sequestration rates after ~25 years
- limited pemanance
- danger of reemission through natural events or changes in policy
- vulnerable to climate change

The Three North Shelter Project (TNSP)`

Hochschule
für nachhaltige Entwicklung
Eberswalde



Source : Wang et.al(2014), The Three-North Shelterbelt Program and Dynamic Changes in Vegetation Cover

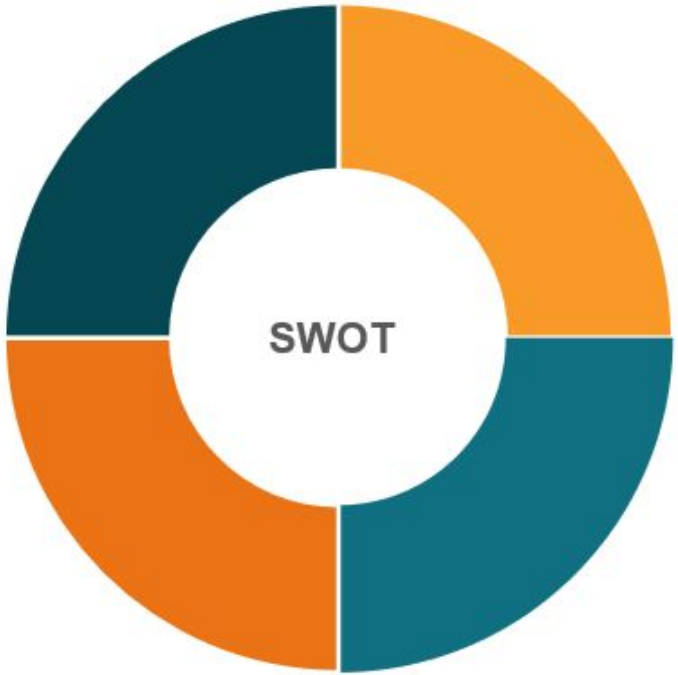
- TNSP includes 559 counties in 13 provinces and aims to create a forest area spanning 400 million hectares which was initiated in the early 1980's.
- TNSP initially aimed towards reducing desertification by afforestation and restoration, also the planted forests could serve as some kind of shield belts.
- Carbon sequestration concept is a much recent addition to the existing strategy.
- The Chinese Government aims to plant around 100 billion trees by 2050
- The project predominantly includes arid and semi-arid parts of northern China, including the Gobi Desert

Strengths:

- Public awareness
- Regional Development
- Reducing the rate of desertification and sand storms
- Increase in vegetation cover

Opportunities:

- Increase in benefits of ecosystem and social system services
- Jos creation and income generation due to timber and increase in agriculture productivity especially fruit plantations



Weakness:

- Desertification rates is reduced but not reversed or eliminated
- Over dependence on non native species
- Ineffective strategy (ex. aerial seeding)
- Economic fragility of the project

Threats:

- Quantification of carbon sequestered by project activities is tricky.
- Land erosion, overgrazing and depleted water tables
- Monoculture forests
- Lack of comprehensive evaluation methodology

Hochschule
für nachhaltige Entwicklung
Eberswalde

Real need : China is among the top 5 GHG emitting countries

Real potential : There is a lot of potential for China to transform considering their economic and technical superiority

But can we quantify China's actions especially concerning CO2 removal in forestry

Hochschule
für nachhaltige Entwicklung
Eberswalde

Germany's pathway to net-zero emissions

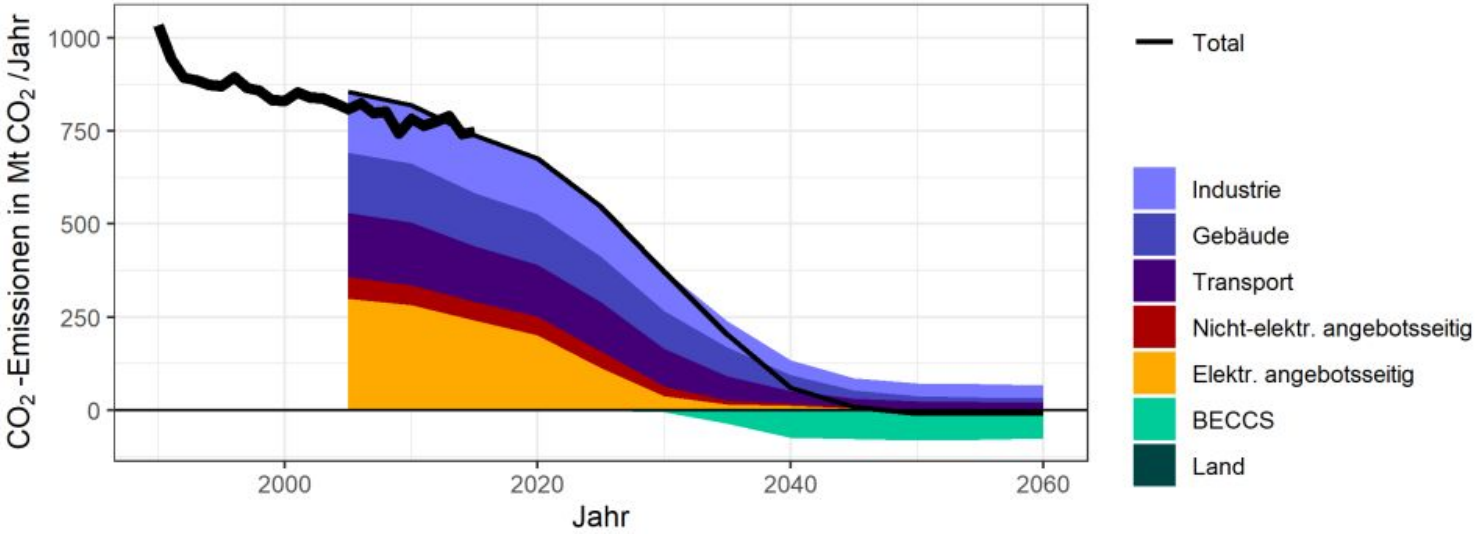
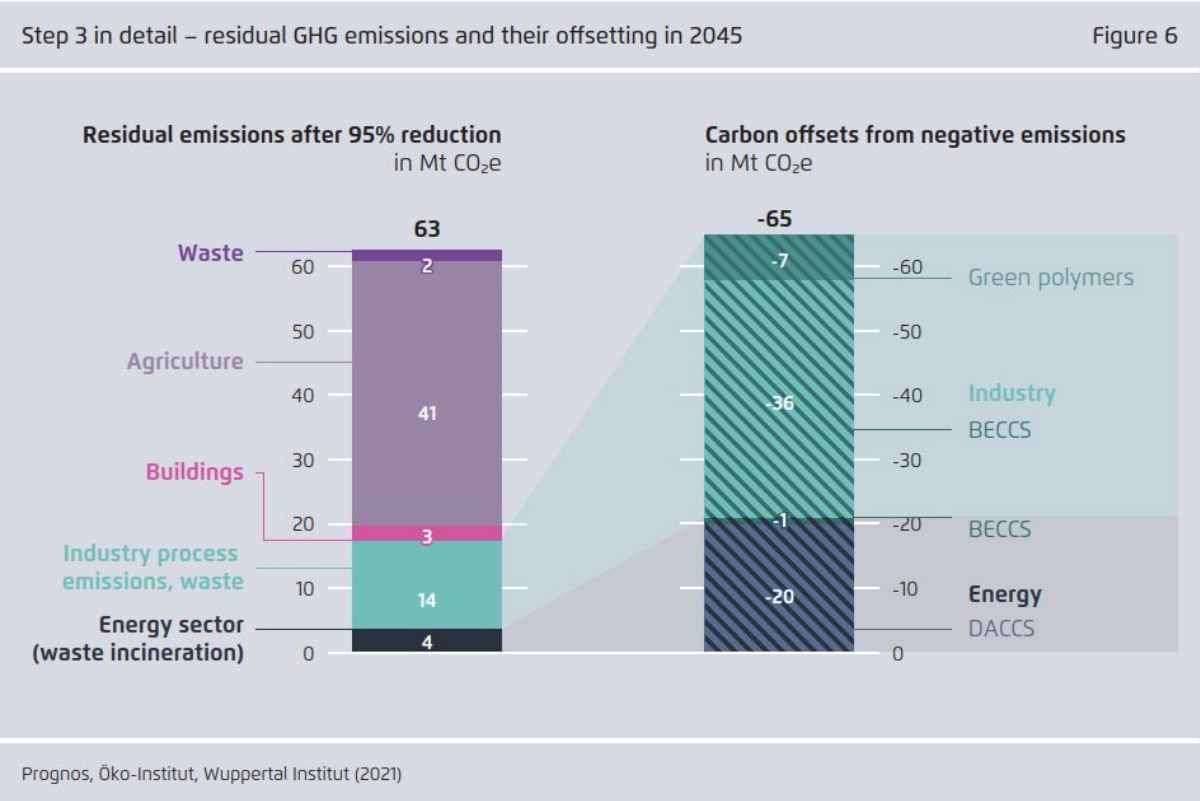


Abbildung 4: CO_2-Emissionen von Deutschland in einem Szenario im Einklang mit den Emissionsreduktionszielen, die im Rahmen des europäischen Green Deal angekündigt wurden (vorläufige Ergebnisse von REMIND im Rahmen des ARIADNE-Projekts).

Source: Mercator Research Institute on Global Commons and Climate Change (MCC) gGmbH: Wissensstand zu CO2-Entnahmen - BEDARF & POTENZIALE, TECHNOLOGIEN & POLITIKINSTRUMENTE, WELTWEIT & IN DEUTSCHLAND.

Offsetting germany's residual emissions



Hochschule
für nachhaltige Entwicklung
Eberswalde

Residual Emissions:

100 MtCO2/year

(average of different studies)

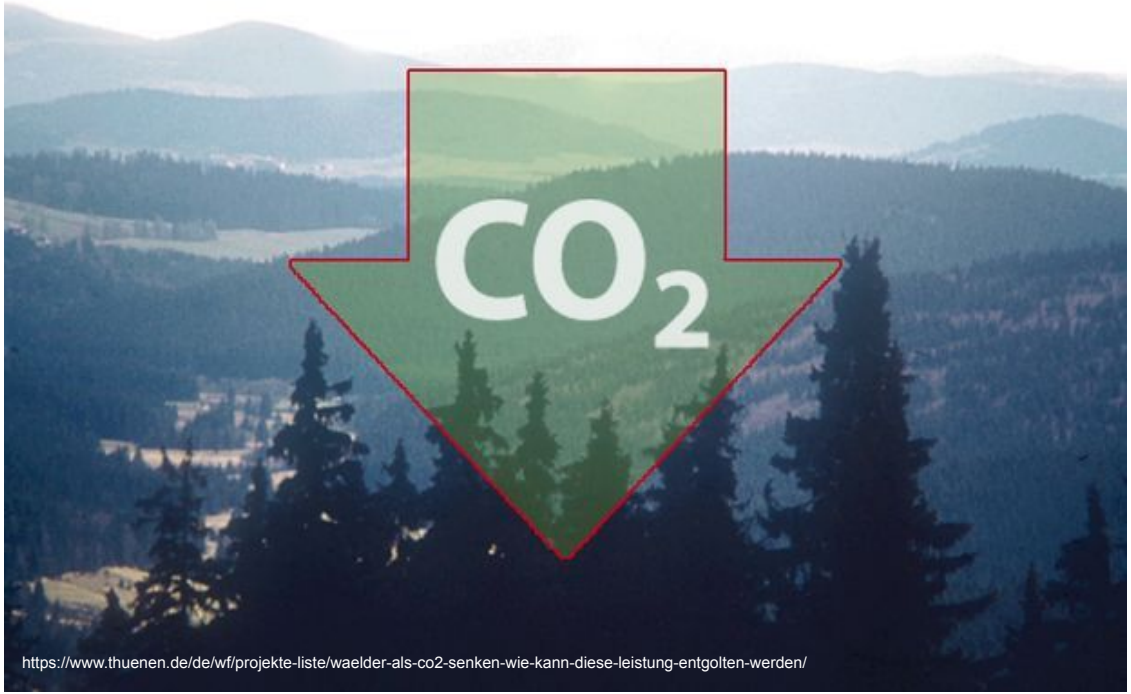
Most scenarios:

Focus on **technological solutions for removing CO2** in
→ BECCS + DACCS

Which role can forestry play in offsetting the residual emissions?

Source: Prognos, Öko-Institut, Wuppertal Institut (2021): Towards a Climate-Neutral Germany by 2045. How Germany can reach its climate targets before 2050, Executive Summary conducted for Stiftung Klimaneutralität, Agora Energiewende and Agora Verkehrswende.

German Forests Today…



https://www.thuenen.de/de/wf/projekte-liste/waelder-als-co2-senken-wie-kann-diese-leistung-entgolten-werden/

… are removing

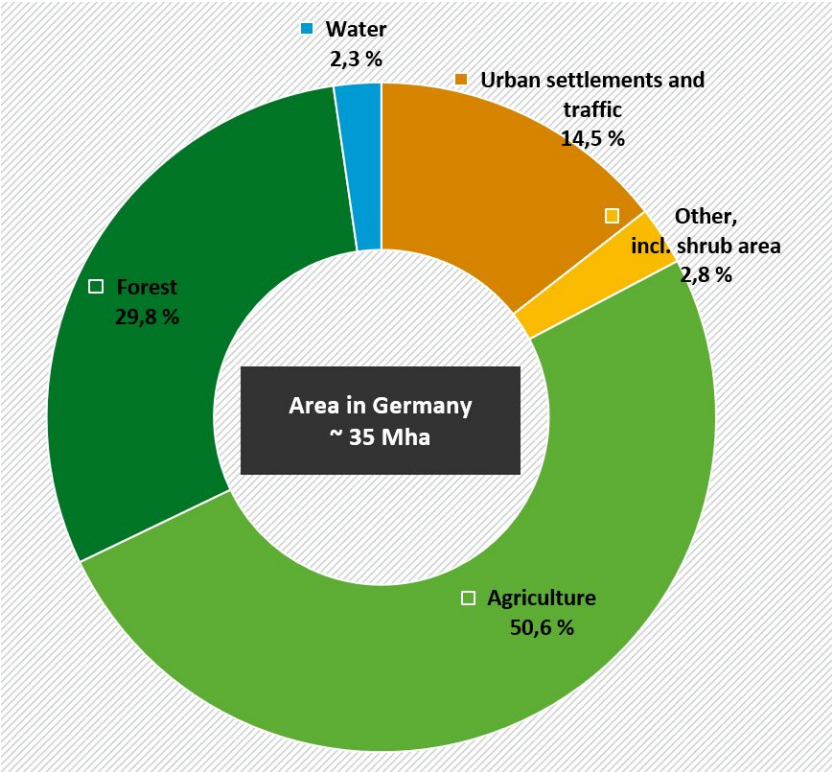
~50 MtCO2/year*

(Already included in emission scenarios.)

→ How much can forestry contribute to additionally remove 100 MtCO2/year ?

*Umweltbundesamt: https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland/emissionen-der-landnutzung-aenderung#veranderung-des-waldbestands-

Low Afforestation Potential in Germany



Source: Statistisches Bundesamt 2021, FS 3 Land- und Forstwirtschaft, Fischerei, R. 5.1 Bodenfläche nach Art der tatsächlichen Nutzung 2020

Land-use conflicts…
… mostly with agriculture
… and traffic and mobility

Estimated available area for afforestation

1 Mha (~3 % of german area)

Average potential in first 20-25 years:

7.3 tCO2/ha/year

→ 7.3 MtCO2/year

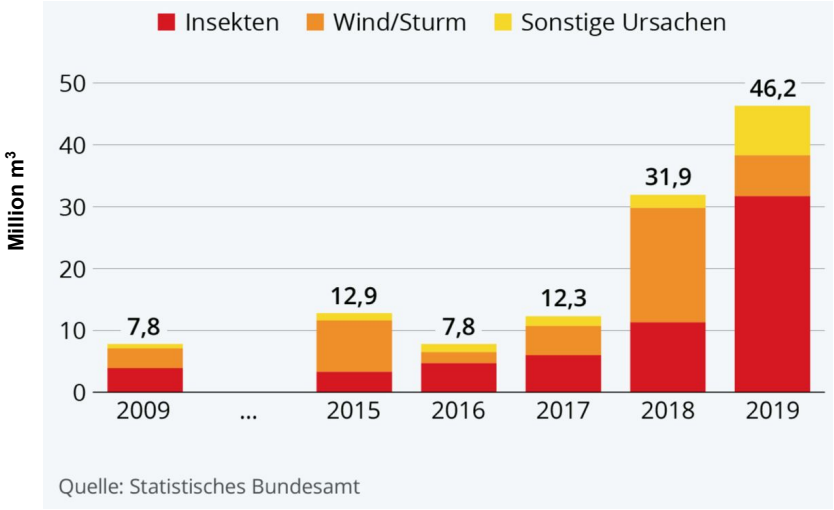
Source: Mercator Research Institute on Global Commons and Climate Change (MCC) gGmbH: Wissensstand zu CO2-Entnahmen - BEDARF & POTENZIALE, TECHNOLOGIEN & POLITIKINSTRUMENTE, WELTWEIT & IN DEUTSCHLAND.

Worrying Condition of German Forests

Direct and indirect impacts of climate change (Storms, droughts, fires, low groundwater levels)

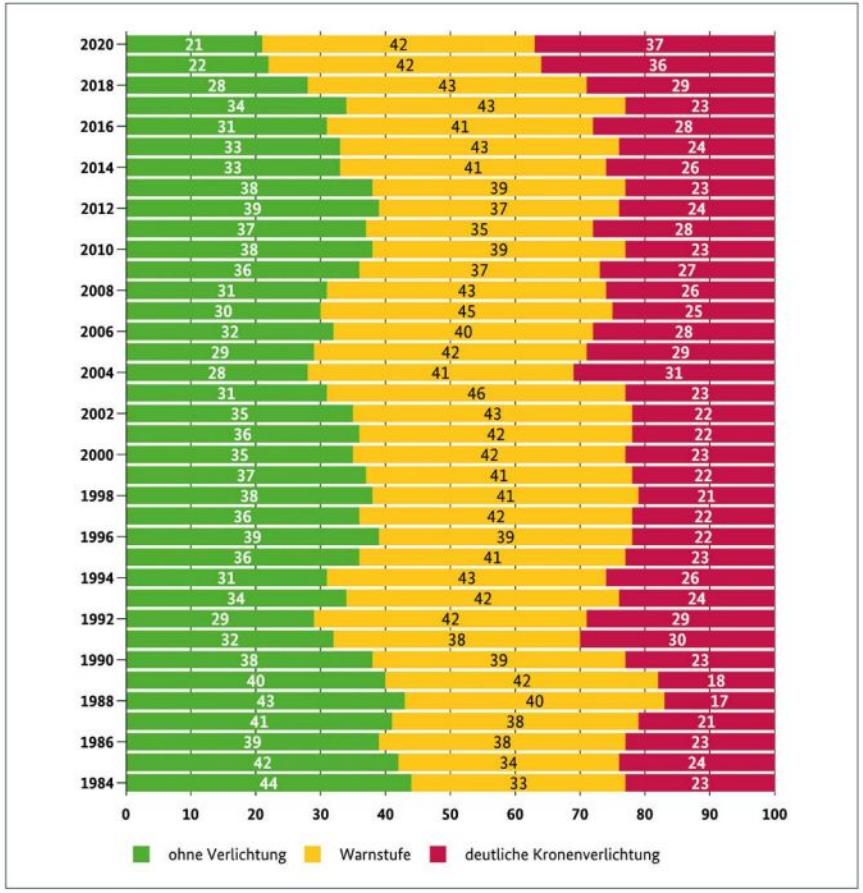
→ **Need for preservation, restoration and sustainable management**

Wood harvest due to insects, storms and other causes



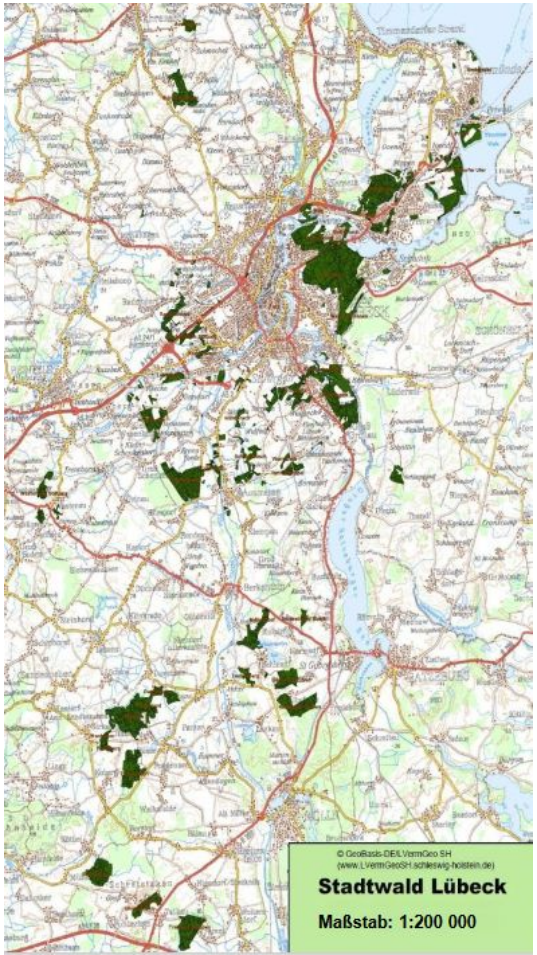
Quelle: Statistisches Bundesamt

Abbildung 10: *Kronenverlichtung in Deutschlands Wäldern seit 1984; Ohne Verlichtung = 0-10 Prozent Kronenverlichtung, Warnstufe = 11-25 Prozent Kronenverlichtung, Deutliche Kronenverlichtung = >25-100 Prozent Kronenverlichtung (Quelle: Thünen-Institut 2021)*



City Forest Lübeck

Location of Lübeck in Germany (source: Wikipedia)



Area of the City Forest in Lübeck (source: Hansestadt Lübeck)

Hochschule
für nachhaltige Entwicklung
Eberswalde

Hochschule
für nachhaltige Entwicklung
Eberswalde

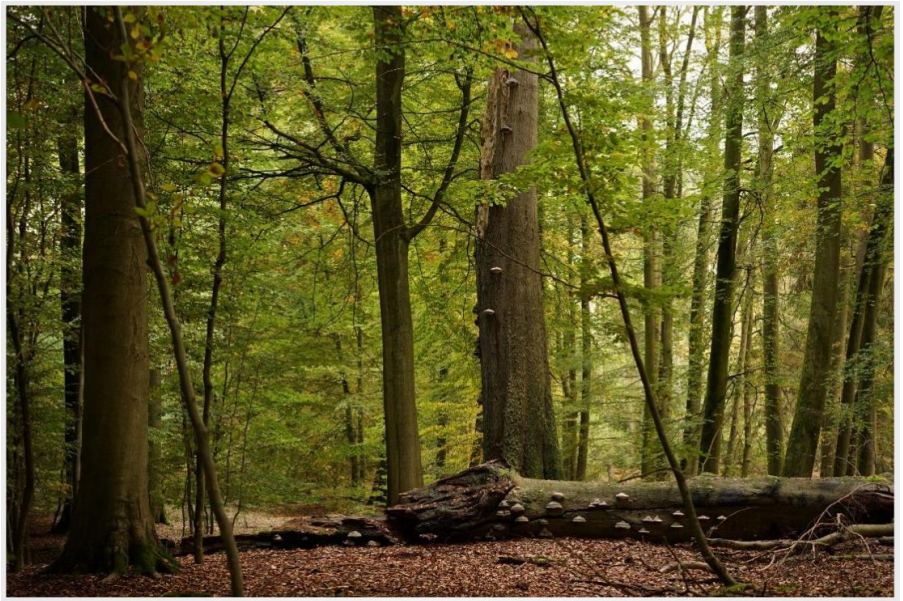
Concept of the City Forest Lübeck

- established 30 years ago
- “integrative process protection” concept

→ close to nature

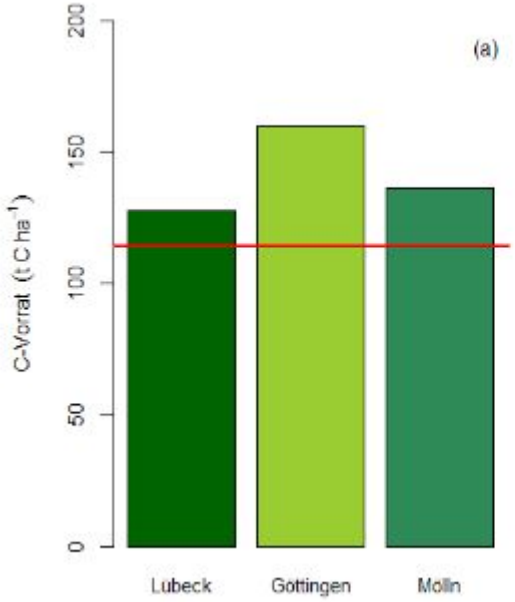
→ sufficiency

→ minimum principle

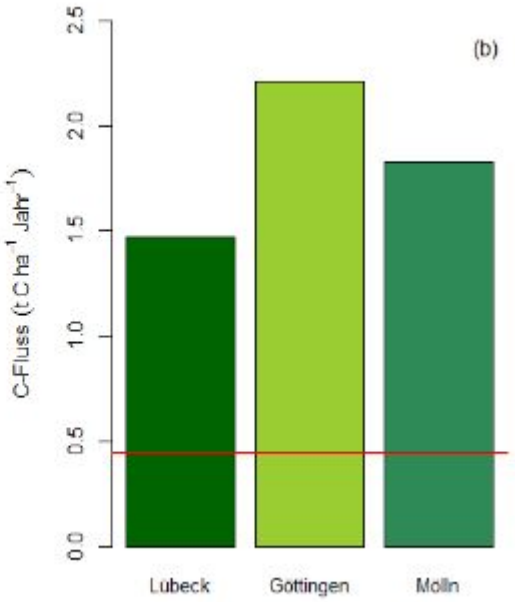


Deadwood in the City Forest Lübeck (source: Hansestadt Lübeck)

Carbon stocks in comparison



C-stock (t C/ha)



C-sink strength (t C/ha/year)

- high carbon stocks
- high carbon sinks

- red line shows average carbon stock and sinks in german forests

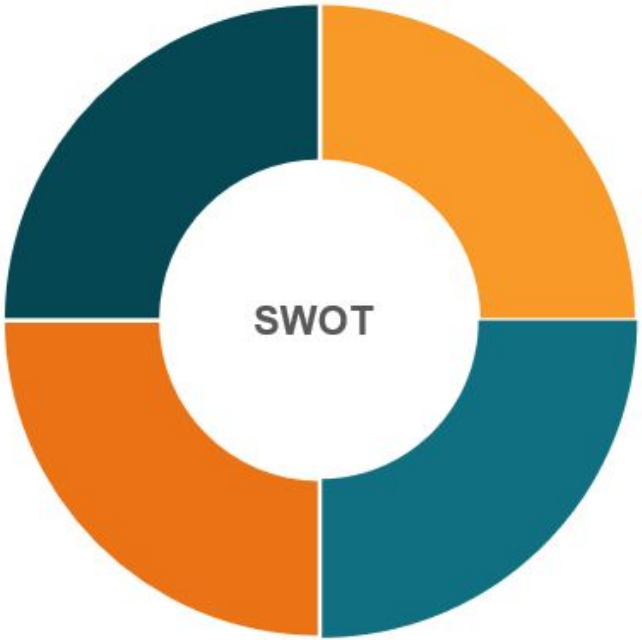
source: FICHTNER, A., STURM, K., SCHMID, M., & VON STEEN, S. A. S. K. I. A. Integrativer Klimaschutz im Wald: Herausforderungen und Handlungsoptionen. *Biodiversität und Klima*, 57.

Strengths:

- storage potential: 22.7 t CO2/ha/year* (104.420 t CO2/year)
- high resilience
- native species
- natural rejuvenation
- long-term low costs
- high quality timber

Weakness:

- scalability
- time intense
- emissions through timber transportation
- short-term high costs



Opportunities:

- storage of CO2 in long lasting wood products
- biodiversity increase
- role model
- clean air for the city
- social acceptance through citizen participation
- scientific research
- low risks

Threats:

- climate change
- extreme weather events
- regulation/ financial issues
- dependency on timber sector for operational costs

*Naturwald Akademie

Can we achieve more negative emission through changing the forest management system in Germany?

Hochschule
für nachhaltige Entwicklung
Eberswalde

- potential is there!
- 11.5 Mha forest area in germany
- Average potential (current forestry system): → approx. 50 Mt CO2/year
- Lübeck 22.7 t CO2/ha/year → 261.05 Mt CO2/year

→ through the integrative process protection concept, approx. five times as much CO2 could be stored in german forests than with the current management system.

Task:
Identify real areas where the “integrative process protection” concept can be applied.

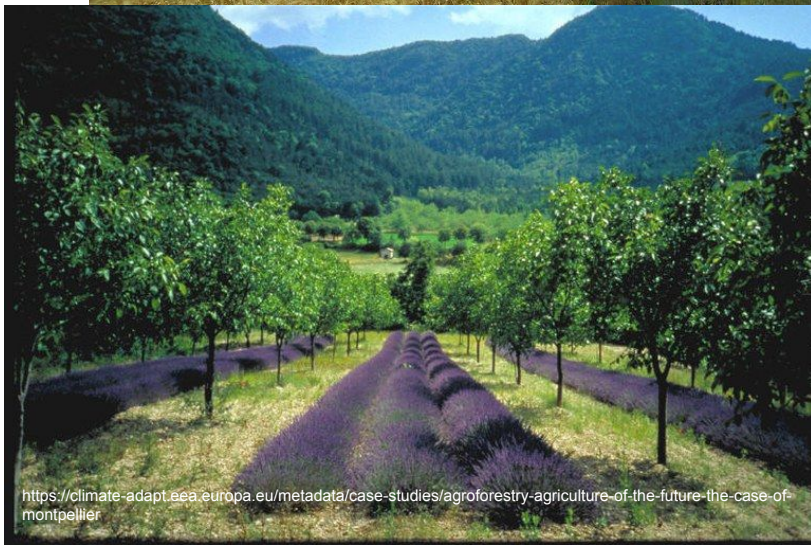
Potential of Agroforestry

- No land-use conflict with agriculture
- Potential: ~2.5 tCO2/ha/year

→ Up to **~30 MtCO2/year** negative emissions
(assuming complete deployment on 11.7 Mha agricultural land)


https://climate-adapt.eea.europa.eu/metadata/case-studies/agroforestry-agriculture-of-the-future-the-case-of-montpellier

- Positive side effects:
  - Reduced soil erosion
  - Enhanced habitat and biodiversity
  - Enhanced microclimate
  - Enhanced land productivity


https://climate-adapt.eea.europa.eu/metadata/case-studies/agroforestry-agriculture-of-the-future-the-case-of-montpellier

Source: Mercator Research Institute on Global Commons and Climate Change (MCC) gGmbH: Wissensstand zu CO2-Entnahmen - BEDARF & POTENZIALE, TECHNOLOGIEN & POLITIKINSTRUMENTE, WELTWEIT & IN DEUTSCHLAND.

Hochschule
für nachhaltige Entwicklung
Eberswalde

Potentials within Germany

National Strategies

- \- Afforestation too little potential
- \+ Focus should be on
  - + Sustainable forest management
  - + Agroforestry

Hochschule
für nachhaltige Entwicklung
Eberswalde

Potentials beyond Germany?

Technical Perspective:

→ Higher sequestration rates in tropical regions

→ Larger available areas

Socio-Economic Perspective

→ Eco-Colonialism ?

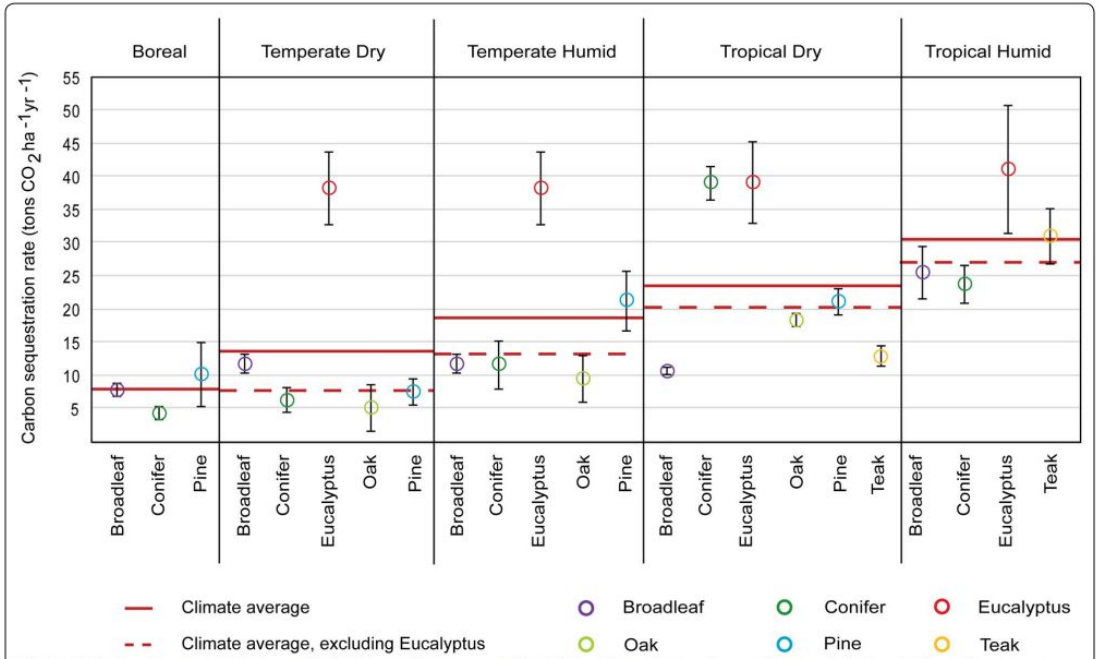


Fig. 4 Carbon sequestration rate (tons CO_2 ha^{-1} $year^{-1}$) of species planted across boreal, temperate, and tropical climates. Each circle represents the average total biomass (above- and belowground) growth rate of the species indicated for a given climate. Error bars indicate the CI95 of their average total biomass growth. The continuous red lines across climates represent the average biomass growth rate for the species included in each climate category, while the dotted red lines represent the average biomass growth rate for all the species in that climate excluding Eucalyptus

Source: Bernal et al. Carbon Balance Manage (2018) 13:22, https://doi.org/10.1186/s13021-018-0110-8

Hochschule
für nachhaltige Entwicklung
Eberswalde

Origin of eco-colonialism

- Land grabbing in the global south for the benefit of the global north
  - e.g. for the extraction of raw materials
- Eviction of people for the purpose of wildlife and nature conservation
  → based on the Understanding of nature as untouched by humans

Eco colonialism and offset concepts

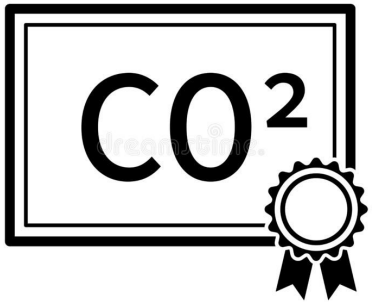
1. eurocentric forms of
   a. knowledge
      -Control of the resources for emission reduction
   b. spatial conception
      -system of property rights
2. unjust global economic relations
   -dominance of the Global North and the distinction between developed and less developed countries
3. neo- imperial policies
   -landgrabbing

“ […] This ‘carbon market’ is another face of the privatizing model of Mother Earth, that has led to the brink of a planetary suicide.”
(AIDESEP, 2010)

Hochschule
für nachhaltige Entwicklung
Eberswalde

REDD+ as one example

most important international package to combat deforestation and forest degradation functioning on the basis of performance-based payments.



Critique:

- sustainable management of forests under REDD+ can open the doors for commercial logging
  - e.g. Indonesia

Chance:

- support realisation of property rights for indiginous people

Hochschule
für nachhaltige Entwicklung
Eberswalde

Can changing land use and forestry frameworks lead to eco-colonialism for carbon removal?

possible Impacts on local communities:

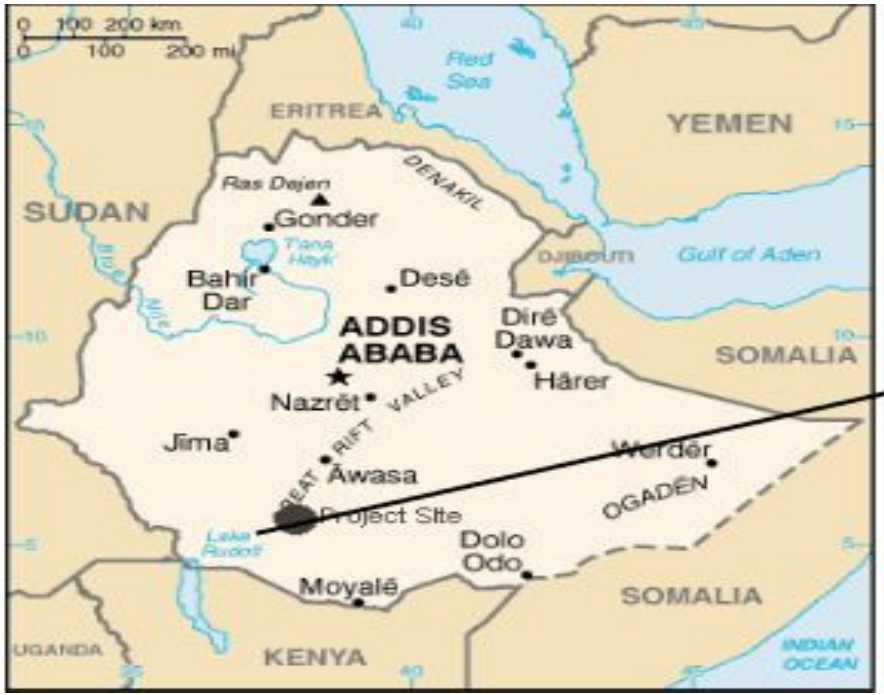
- Change of land use practices
- Loss of incomes
- Exclusion of people not willing to participate
- new dependencies

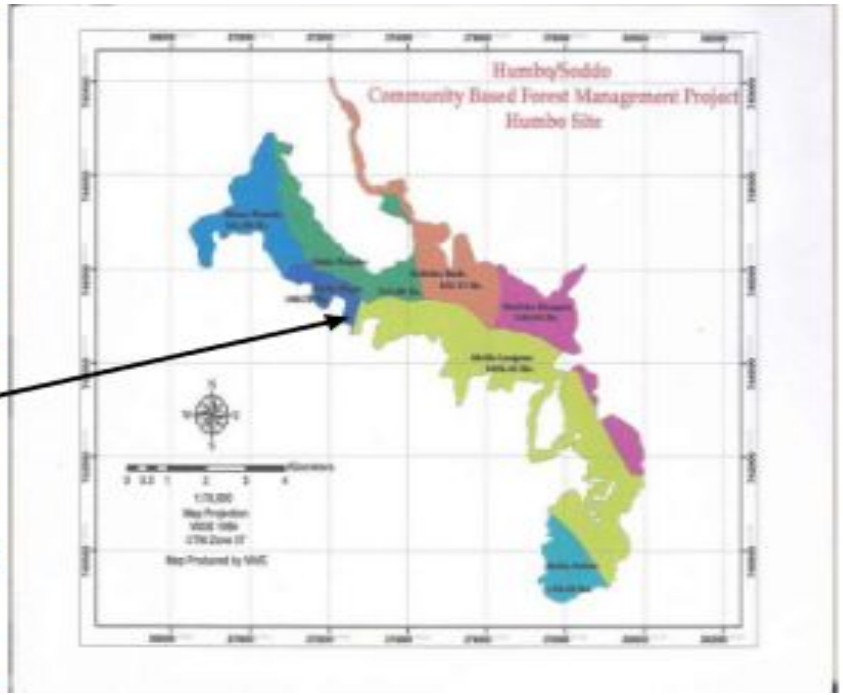
Hochschule
für nachhaltige Entwicklung
Eberswalde

Humbo Assisted Regeneration Project

- Initiated in 2006 by World vision Australia and WVE
- Restoration of 2728 ha;climate change mitigation and conservation
- Reforestation by tree planting,assisted natural regeneration and exclosures
- Managed and protected by 7 village level co-operatives
- First African forestry project registered under CDM

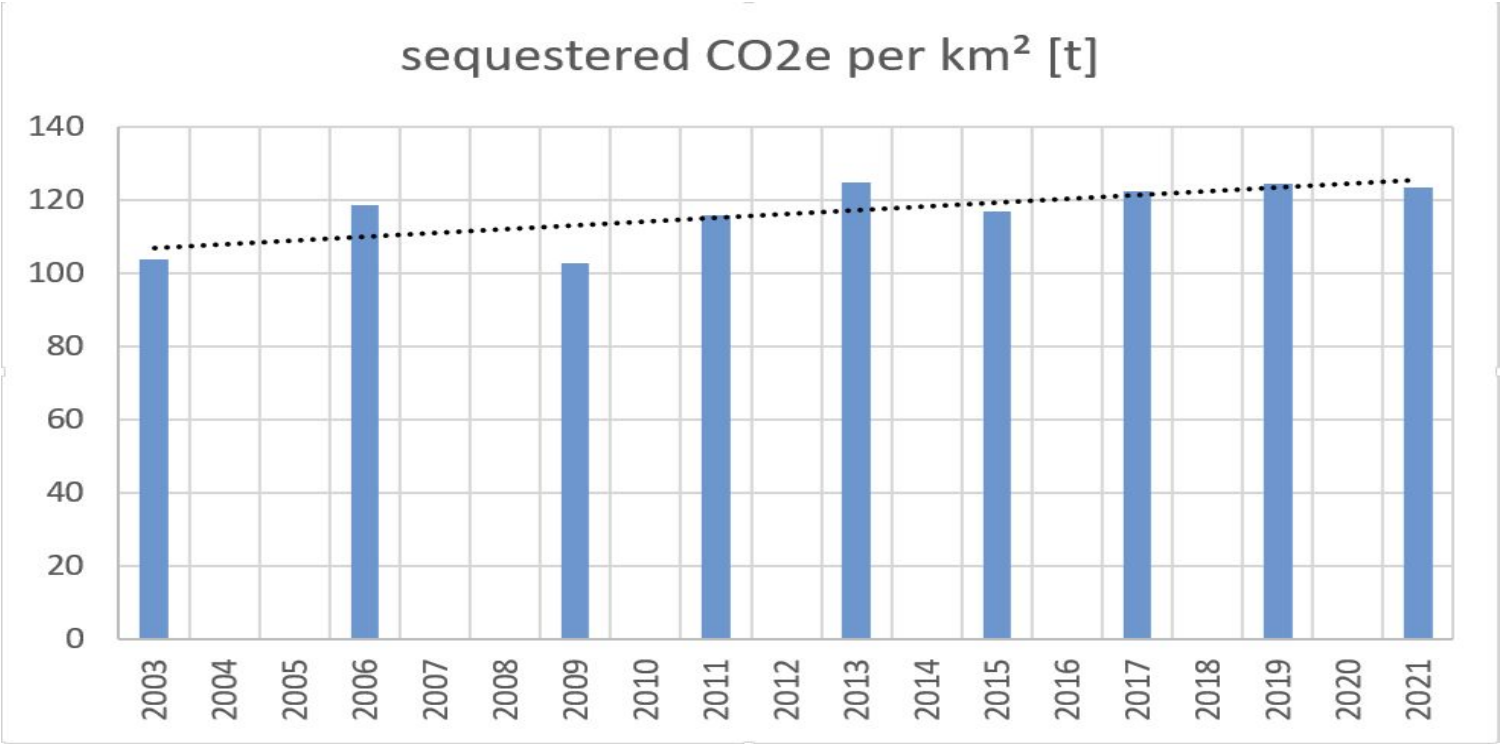
Project Area





Humbo before and after

Cumulative tCO2e Sequestration of Humbo 2003-2021



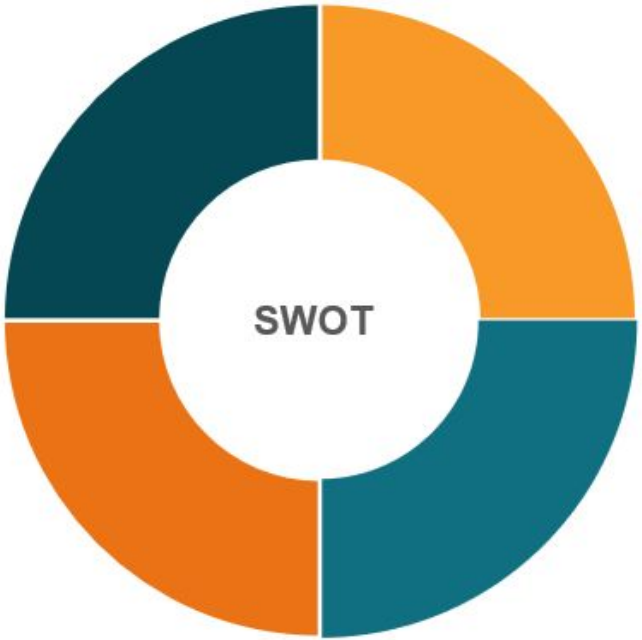
Source:Running et al (2020)

Strengths:

- Storage potential:880,295 tCO2
- Ecosystem stability:High
- Resilience: Microclimates,curb soil erosion,water,nutrition
- Low cost and replicable
- Community Participation:Good
- Income:Attracted carbon credits $726,000

Opportunities:

- Land value:increased
- Income: Employment opportunities i.e bee keeping
- Ethics: Enhanced social-cultural values



Weakness:

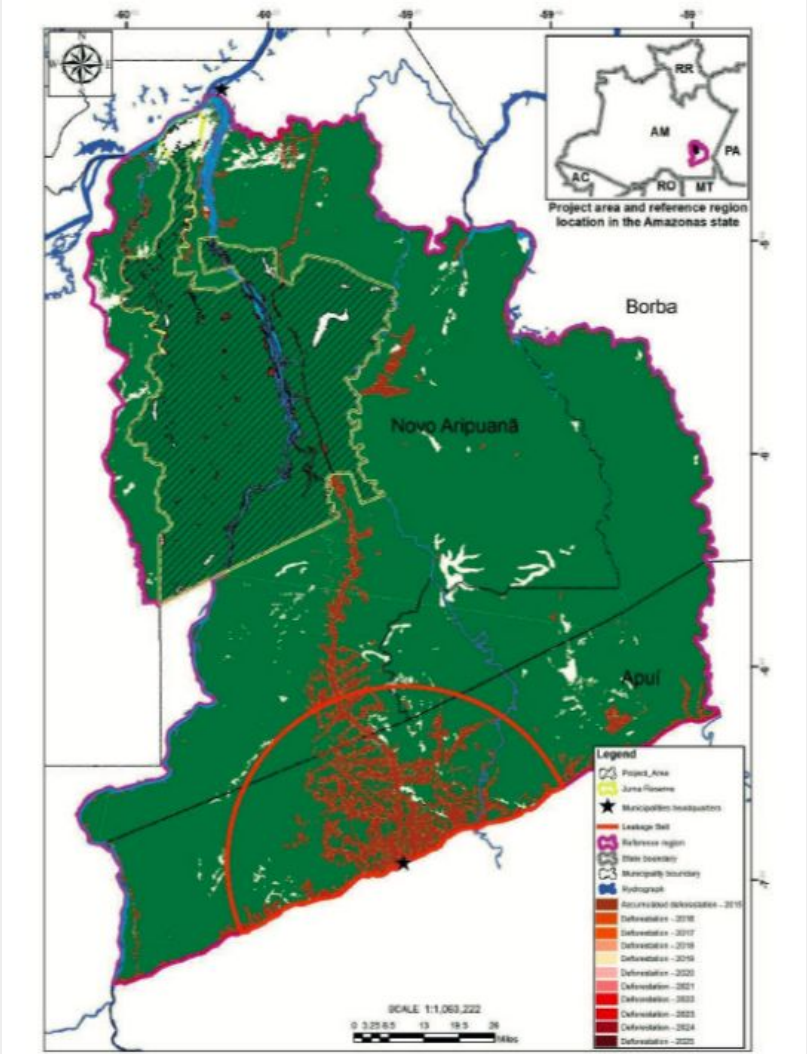
- Duration: Longterm investment
- Income distribution: Unequal
- Social inclusion:Women involved only in the nursery stage
- Technological competence: Low

Threats:

- Environmental impacts: Increased wildlife
- Climate change and adverse weather events

Juma Sustainable Development Reserve (SDR Juma REDD+ Project)

- Established 2006 → 589,612 ha
- Protect forest with high conservation value.
- 1st REDD project in Brazil (2008)
- 1.919 people → 388 families → 41 communities
- Implemented: Amazonas Sustainable Foundation (FAS)
- Partners: Governmental institutions and Marriott International, Inc.



State Law of Env. Services from Amazonas (2020)

Juma Sustainable Development Reserve
(SDR Juma REDD+ Project)

Hochschule
für nachhaltige Entwicklung
Eberswalde

- Baseline scenario:

  prevent the deforestation of tropical forests

  ~329 kha that would release 189 Million tons of CO2 into the atmosphere.

- REDD+ as a financial support to implement measures

- Controversy: Scenario with leakage 2050

- Bolsa Floresta project (from 2010) from FAS, Amazon Fund.

  → 15 conservation units (494 families in 38 locations)

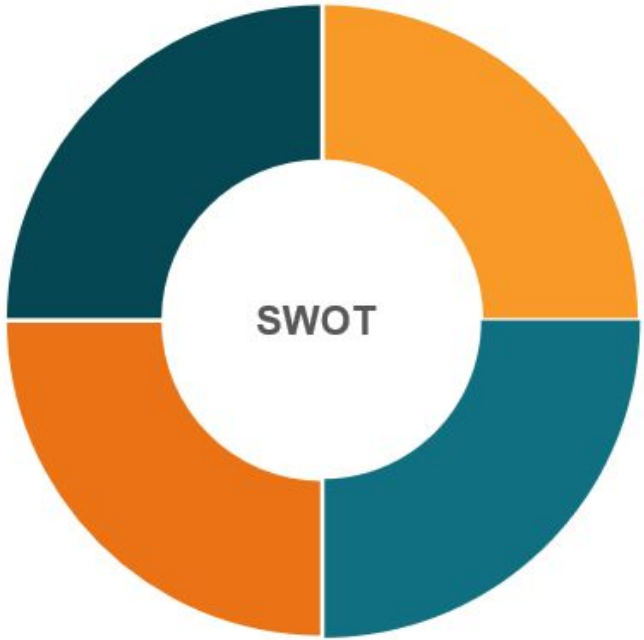
  → objective: was to reduce deforestation and conserve biodiversity through increasing income and empowering resident communities.

Strengths:

- Storage potential: 189 M tCO2
- Long term project (100y)
- Protection and strengthening of biodiversity
- Change to sustainable livelihood of people

Weakness:

- REDD+ :
  Leakage not considered
  Insufficient funding
- Reliability of Investment



Opportunities:

- Land value: increased
- Enhanced social-cultural values
- Positive Environmental Impact

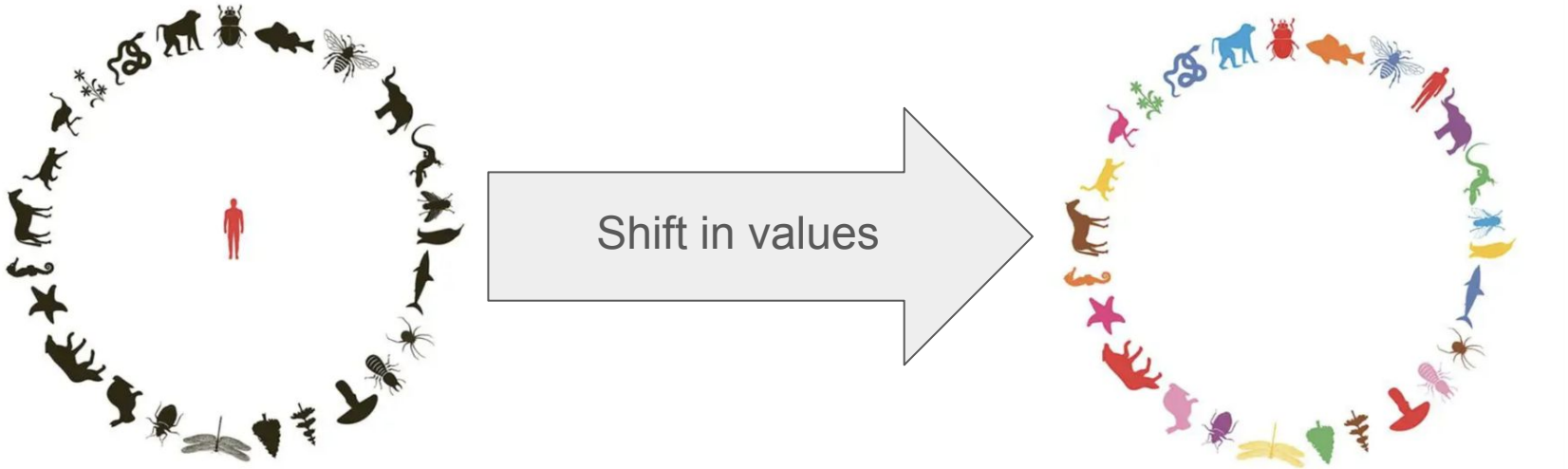
Threats:

- Social Acceptance
- Climate Change
- Illegal fires from the surrounding
- Pressure of exportation of soybean and meat.

Hochschule
für nachhaltige Entwicklung
Eberswalde

strategic starting points to counter eco colonialism

- Regulation or Reformation of Carbon markets
- Involving local communities in the processes and discussions



The Potential of Forestry for Compensating Germany's Residual Emissions

Hochschule für nachhaltige Entwicklung Eberswalde

National Strategies

- \- Afforestation too little potential
- \+ Focus should be on
  - + Sustainable forest management
  - + Agroforestry

Common Threats to Forestry

- \- Climate change
- \- Social acceptance

International Strategies

- \+ Bilateral Partnerships
- \+ Transforming profit-oriented thinking with the help of local knowledge
- \+ Need for a common strategy

References

- Aguilar-Støen, M. (2017, January). Better safe than sorry? Indigenous peoples, carbon cowboys and the governance of REDD in the Amazon. In Forum for Development Studies (Vol. 44, No. 1, pp. 91-108). Routledge.
- Böhm, Kanzler, Pecenka, 2020, Untersuchungen zur Ertragsleistung (Land Equivalent Ratio) von Agroforstsystemen
- Burnett, M. Troy (2016). *Natural Resource Conflicts: From Blood Diamonds to Rainforest Destruction.* Santa Barbara, California: ABC-CLIO LLC.
- Biryahwaho, B. 2011. Trip notes for a visit to Humbo Ethiopia Assisted Natural Regeneration project. February 2011.
- Brown, D.R., P. Dettmann, T. Rinaudo, H. Tefera and H. Tofu. 2010. Poverty alleviation and Environmental Restoration Using the Clean Development Mechanism: A Case Study from Humbo. Ethiopia.
- Cabello, J., & Gilbertson, T. (2012). A colonial mechanism to enclose lands: A critical review of two REDD+-focused special issues. Ephemera: Theory & Politics in Organization, 12.
- Eberle, C., Münstermann, N., & Siebeneck, J. (2019). Carbon Colonialism: A postcolonial assessment of carbon offsetting.
- EPRS | European Parliamentary Research Service, Agroforestry in the European Union, 2020.
- FICHTNER, A., STURM, K., SCHMID, M., & VON STEEN, S. A. S. K. I. A. Integrativer Klimaschutz im Wald: Herausforderungen und Handlungsoptionen. *Biodiversität und Klima*, 57.
- Garcia, B, Rimmer, L, Canal Vieira, L, Mackey, B. REDD+ and forest protection on indigenous lands in the Amazon. RECIEL. 2021; 30: 207– 219. https://doi.org/10.1111/reel.12389
- Greenpeace eV, Hieke, S., Thies, C., & Stoppel, J. (2018). *Wenn Wälder wieder wachsen: eine Waldvision für Klima, Mensch und Natur*. Greenpeace eV.
- Habekuss, F. (2022, March 24). Es geht nicht ohne sie. Zeit. https://www.zeit.de/2022/13/indigene-voelker-naturschutz-klima-un
- Hansestadt Lübeck (2020). Naturnaher “Waldumbau” in FFH Waldlebensraumtypen im Stadtwald Lübeck. [online] https://brandenburg.nabu.de/imperia/md/content/brandenburg/20200124_vortrag_02_waldumbau_knut_sturm_stadtwald_luebeck.pdf (31.03.22)
- Hansestadt Lübeck (n.d.). Stadtwald Lübeck. Demonstrationsflächen. Exkursionsführer. [online] http://www.integrateplus.org/uploads/images/Mediacenter/20151612_Booklet_Luebeck_DE-final.pdf (31.03.22)
- Hansestadt Lübeck (2021). Lübecks europaweit einmaliges Waldmanagement seit 30 Jahren erprobt. Pressemeldung [online] https://www.luebeck.de/de/presse/pressemeldungen/view/137188 (31.03.2022)
- IBernal et al. Carbon Balance Manage (2018) 13:22, https://doi.org/10.1186/s13021-018-0110-8
- Intergovernmental Panel on Climate Change (IPCC), *An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways* (IPCC, 2018).

Hochschule
für nachhaltige Entwicklung
Eberswalde

References

- Juma Sustainable development REserve (2013) Juma Fact Sheet, Marriott spirit to preserve and Funcacion Amazonas Sustentable.
- Jiang, Hong. (2016). Taking Down the “Great Green Wall”: The Science and Policy Discourse of Desertification and Its Control in China. 10.1007/978-3-642-16014-1_19.
- Jaco CDM. 2011. Validation Report for Humbo Ethiopia Assisted Natural Regeneration Project. Report number CR10W0016D. Prepared for the World Bank.
- Journal of Resources and Ecology. 5. 53-59. 10.5814/j.issn.1674-764x.2014.01.006.
- Seddon, N., et al. (2021). Getting the message right on nature-based solutions to climate change. Global Change Biology, 27(8), 1518-1546.
- Mercator Research Institute on Global Commons and Climate Change (MCC) gGmbH: Wissensstand zu CO2-Entnahmen - BEDARF & POTENZIALE, TECHNOLOGIEN & POLITIKINSTRUMENTE, WELTWEIT & IN DEUTSCHLAND.
- Minghong Tan, Xiubin Li (2015), Does the Green Great Wall effectively decrease dust storm intensity in China? A study based on NOAA NDVI and weather station data, Land Use Policy, 43, pp. 42-47, doi: https://doi.org/10.1016/j.landusepol.2014.10.017
- Mølgaard Lehmann, et. al., Sustainability 2020, 12, 5429; doi:10.3390/su12135429
- oekolandbau.de/, Agroforstwirtschaft – Bäume auf Acker und Weide, (https://www.oekolandbau.de/bio-im-alltag/bio-fuer-die-umwelt/klima-und-natur/in-zukunft-mehr-agroforstwirtschaft/)
- Prognos, Öko-Institut, Wuppertal Institut (2021): Towards a Climate-Neutral Germany by 2045. How Germany can reach its climate targets before 2050, Executive Summary conducted for Stiftung Klimaneutralität, Agora Energiewende and Agora Verkehrswende.
- Rafatya, R., Dolphin, G., & Pretis, F. (2020). Carbon Pricing and the Elasticity of CO2 Emissions. *Institute For New Economic Thinking Working Paper Series*, 1-84. doi: 10.36687/inetwp140
- Reserva de desenvolvimento sustentável do juma projecto de REDD+ Amazonas, Brasil (livro electronico): lei estadual de servicios ambientales do Amazonas. 1. ed. Manaus, AM: Fundacion Amazonas Sustentavel, 2020. pdf
- Radaelli, A., Anache, B., Gabriel, D., Caroline J., Queiroz, J., Meijer, M., Costa, M. and Glatzer N. (2019) Bolsa Floresta Project. Effectiveness Evaluation Final Report. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Banco Nacional de Desenvolvimento Econômico e Social (BNDES)
- REDD-Monitor (2017) The Juma Sustainable Development Reserve, Brazil:“A lot of promises that aren´t being kept. [Online] https://redd-monitor.org/2017/03/15/the-juma-sustainable-development-reserve-brazil-a-lot-of-promises-that-arent-being-kept/ (29.03.22)
- Similä, J. and Primmer, E. (2012) Legal analysis of the relationship between WTO law, European state aid and nature conservation law, and economic instruments for biodiversity protection. Policy Mix D6.2. Issue Nº 7
- Suo, X., Cao, S. China’s three north shelter forest program: cost–benefit analysis and policy implications. Environ Dev Sustain 23, 14605–14618 (2021). https://doi.org/10.1007/s10668-021-01260-z
- Sills, E., Atmadja, S., Sassi, C., Duchelle, A., Kweka, D., Resosudarmo, I. and Sunderlin, S. (2014) REDD+on the ground. A case book of subnational initiatives across the globe. CIFOR. ISBN 978-602-1504-55-0

References

- Sturm, K. (2000). Grundlagen und Ziele des integrativen Prozessschutz-Waldbaus. *Lehrke, S. et al.(Hg.): Natura*.
- shz (2015). Verlustgeschäft Stadtwald. [online] https://www.shz.de/regionales/luebeck/verlustgeschaeft-stadtwald-id9578346.html (31.03.22)
- The Juma Sustainable Development Reserve Project: Reducing Greenhouse Gas Emissions from Deforestation in the State of Amazonas, Brazil. Climate, community and biodiversity Alliance (CCBA). 2008 Poject Design document for Validation. V. 5.0
- Unwelt Bundesamt (2022). Emissionen der Landnutzung, -änderung und Forstwirtschaft. [Online] https://www.umweltbundesamt.de/daten/klima/treibhausgas-emissionen-in-deutschland/emissionen-der-landnutzung-aenderung#veranderung-des-waldbestands- (30.03.2022)
- Van der Esch S., Sewell A., Bakkenes M., Berkhout E., Doelman J., Stehfest E., Langhans C., Fleskens L., Bouwman A., ten Brink B. (2021), The global potential for land restoration: Scenarios for the Global Land Outlook 2.
- Veste, Maik & Breckle, S.. (2006). The Green Great Wall - Combating Desertification in China. Geographische Rundschau Internationale Edition. 2. 14-20.
- Wang, Qiang & Zhang, Bo & Zhang, Zhiqiang & Zhang, Xifeng & Dai, Shengpei. (2014). The Three-North Shelterbelt Program and Dynamic Changes in Vegetation Cover
- WVE (World Vision Ethiopia). 2009. Project Design Document (PDD) for Humbo Ethiopia Assisted Natural Regeneration Project.
- Yanai, A., Fearnside, P., Alencastro, P. and Nogueira, E. (2012) Avoided deforestation in Brazilian Amazonia: Simulating the effect of the Juma Sustainable Development Reserve. Forest Ecology and Management. Elsevier, Vol. 282, P. 78-91. https://doi.org/10.1016/j.foreco.2012.06.029
- Naturwald Akademie, Dr. Torsten Welle

Der jährliche Zuwachs beträgt ca. 60.269 VFM. Unter Nutzung der IPCC Formel erhalte ich bei 4.600 ha die 22.7 t

jährlicher Zuwachs (m3)	Holzdichte (t/m3) Wert:0,54 für Laubholz	Biomassefaktor Wert 1,4 für Laubholz	Biomasse in Tonnen	unterirdische Biomasse (t) Wert 1,26	Kohlenstoffanteil Wert 0,495	Kohlenstoff (Tonnen)	Kohlendioxid (Tonnen) Wert= 44/12	Flächengröße [ha]	T/CO2/a
60.269	32.545	45.563	45.563	57.410	28.418	28.418	104.198	4.600	22,7