Carbon removal options and strategies

GCM meets Munich Re Foundation
26/03/2021

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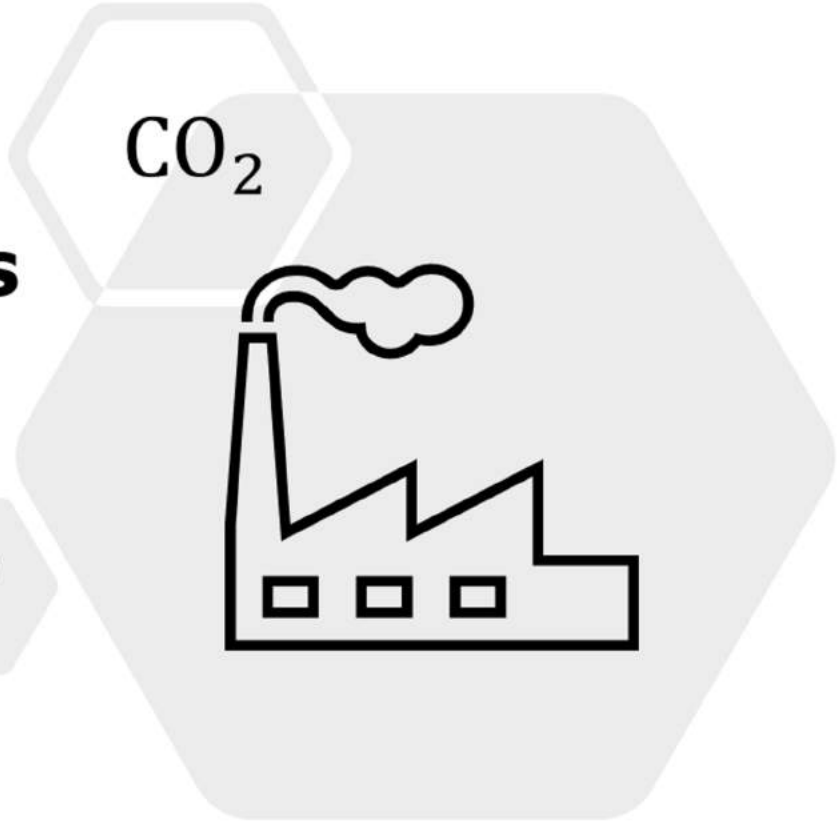
Eberswalde University for Sustainable Development



What if...

Source: https://www.activesustainability.com/climate-change/100-companies-responsible-71-ghg-emissions/

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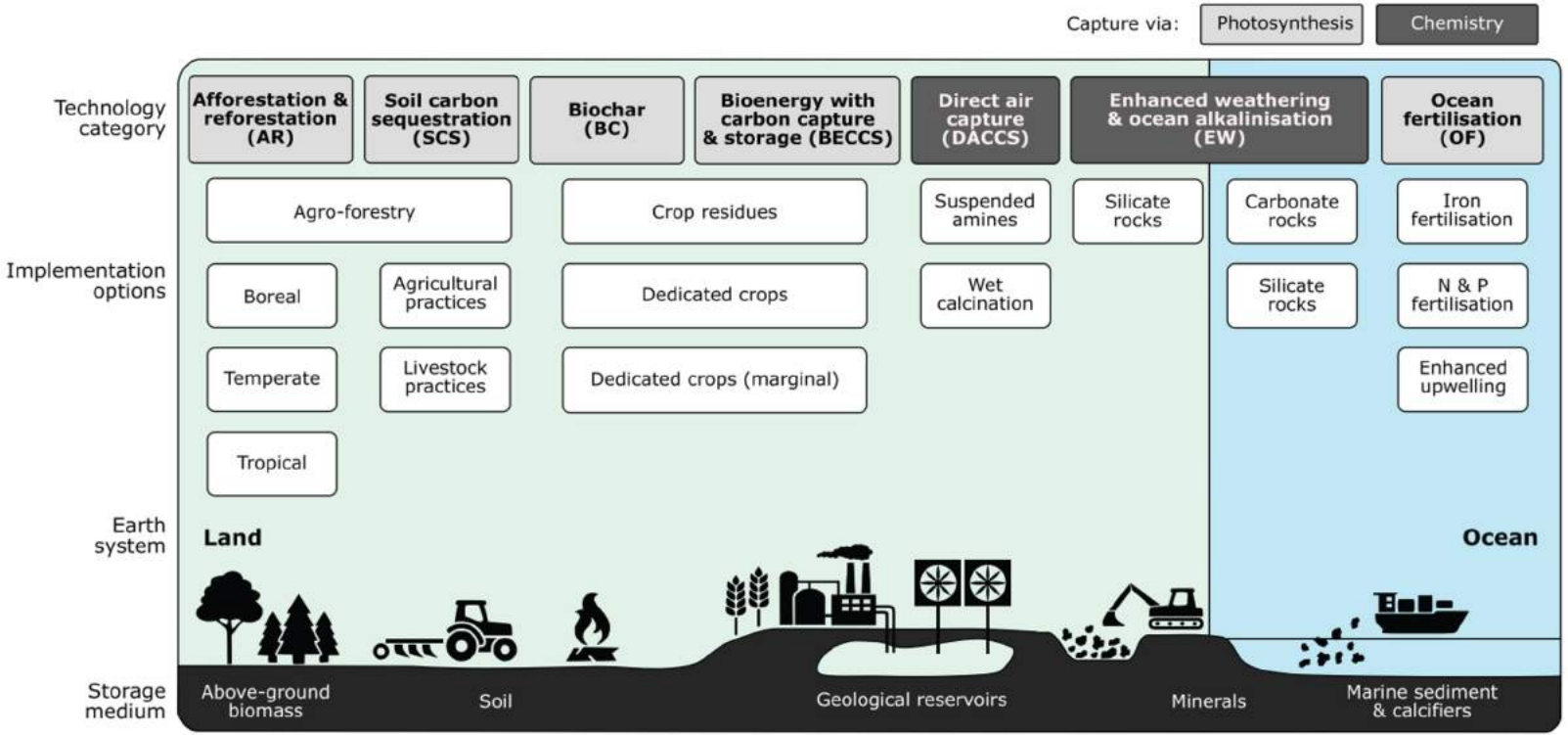
A logical look at removal techniques



Source:https://iopscience.iop.org/article/10.1088/1748-9326/aabf9b/meta

1. Intro: a logical look at removal techniques

2. Analysis of relevant methods (SWOT)

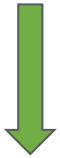
3. Real life example

4. Consulting example

SWOT-Analysis

STRENGTHS - WEAKNESSES ---------- OPPORTUNITIES - THREATS

Indicators



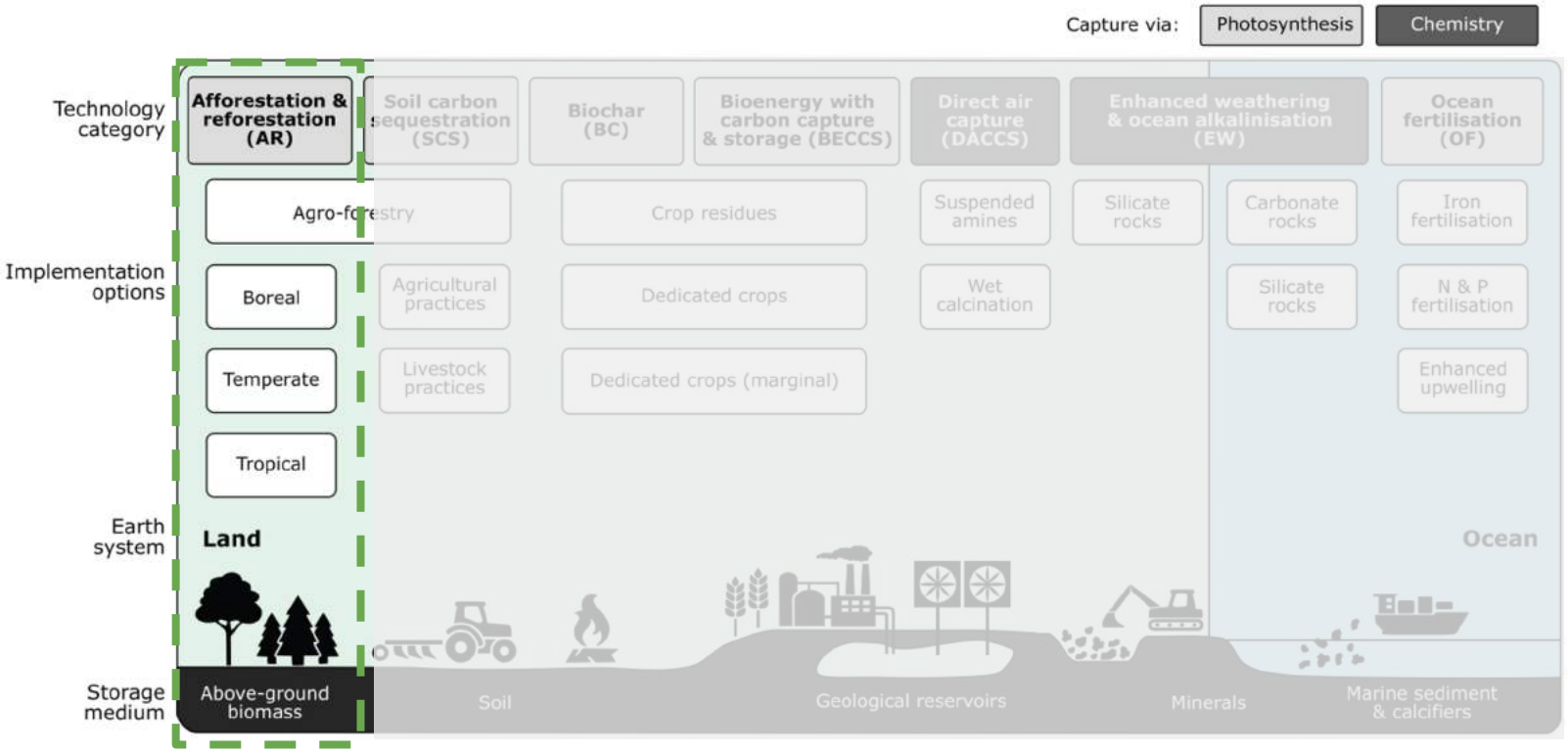
Internal:

- Storage potential
- Costs
- Scope
- Availability
- Permanence
- Resource intensivity

External:

- Environmental Impact (Pre, Post)
- Tech readiness
- Social acceptance
- Ethics

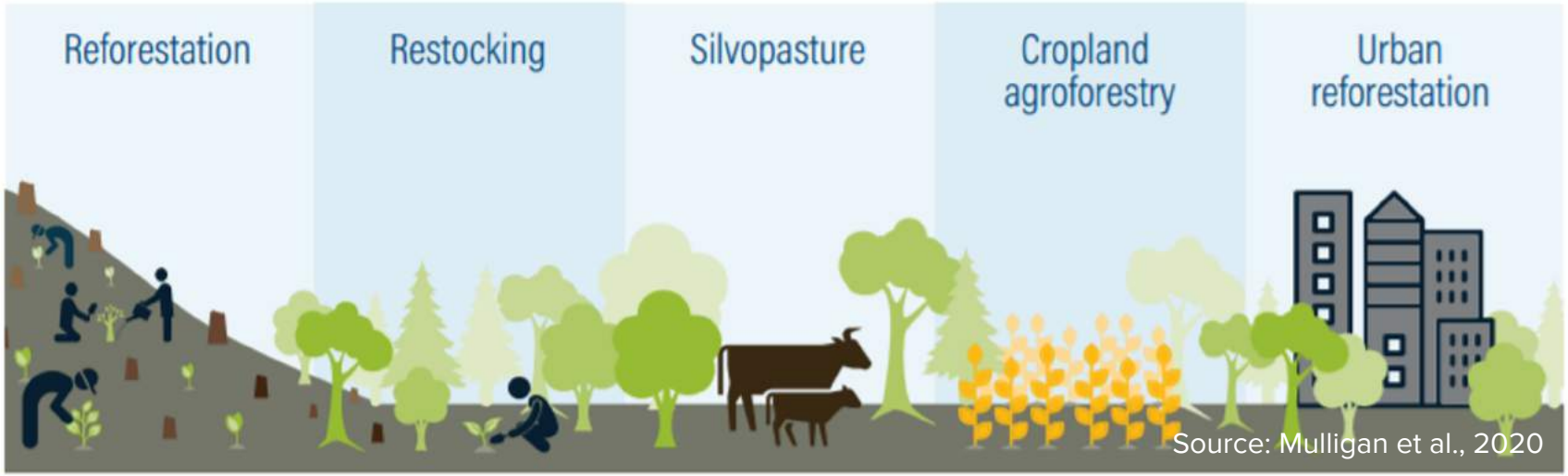
Afforestation & Reforestation (AR)



Afforestation & Reforestation (AR)

Afforestation = planting trees on land not forested for a long time

Reforestation = re-establishment of forests after a temporary condition with less than 10% canopy cover



SWOT-Analysis: Afforestation and Reforestation

STRENGTH

- *Storage potential*: 1,5-5,5 billion t CO2/a
- *Costs:* Low (1-100 $ /t CO2)
- *Scope*: Nearly global
- *Availability*: Abundant resource

WEAKNESS

- *Permanence*: Short-term to long-term
- *Resource intensity*: High in land

S W O T

OPPORTUNITIES

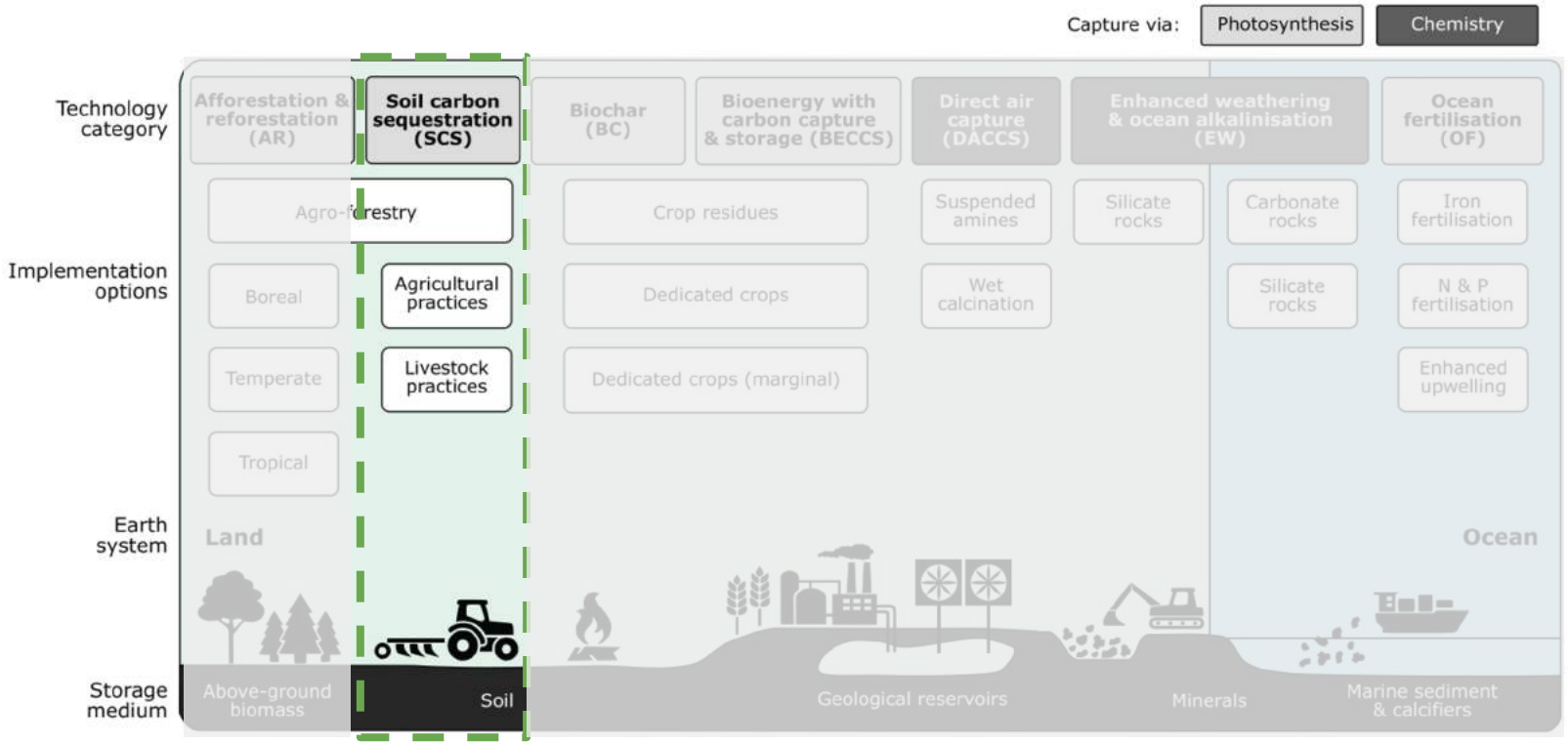
- *Environmental Impacts*: e. g. Habitat
- *Tech readiness*: High
- *Social acceptance*: High
- *Ethics*: Recreation area for humans

THREATS

- *Environmental Impacts*: e. g. Monoculture, Harvesting

Source: IPCC Special Report Chapter 2 and Chapter 4 (2018); Minx et al. (2018); Harper et al. (2018); Keller et al. (2018); Mulligan et al. (2018)

Enhanced soil carbon sequestration (SCS)



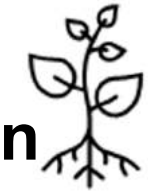
Enhanced soil carbon sequestration (SCS)

- planting of cover crops instead of having bare soil periods to increase photosynthesis

- addition of compost as fertilizer and to store carbon in the soil

Source:https://www.ecosystemmarketplace.com/wp-content/uploads/2018/02/soil-carbon1.jpg

SWOT-Analysis: Enhanced soil carbon sequestration



STRENGTH

- *Storage potential*: 2-5 billion t CO2/a
- *Costs*: Maximum 100 $/t CO2
- *Scope*: Global
- *Availability*: Good

WEAKNESS

- *Permanence*: Short-term to mid-term
- *Resource intensity*: Yes (phosphorus and nitrogen)

S W O T

OPPORTUNITIES

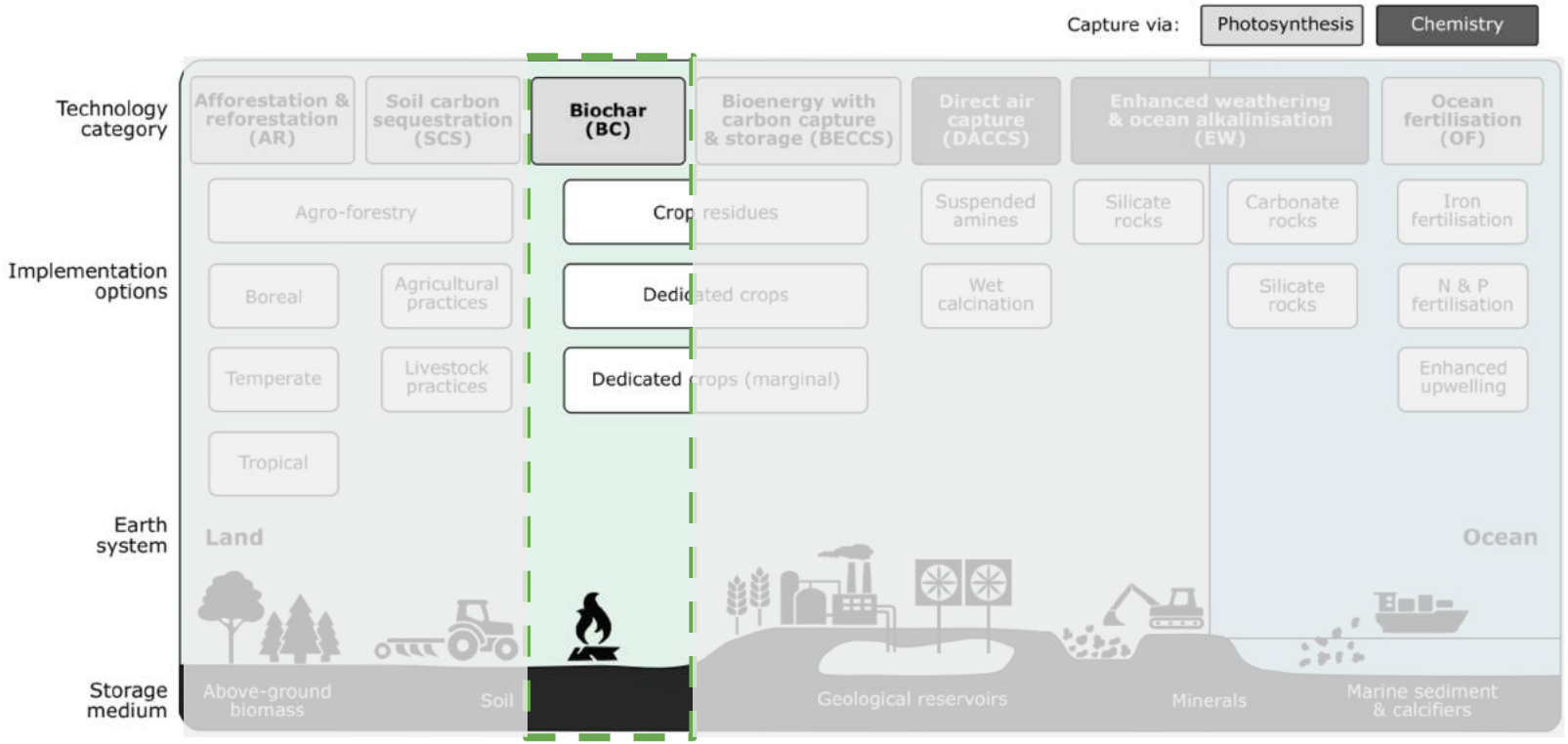
- *Environmental impacts*: Improved soil, water and air quality conditions and agricultural productivity
- *Tech readiness*: Well researched
- *Social acceptance*: High
- *Ethics*: Food security

THREATS

- *Environmental impacts*: Potential increase of N2O emissions, nitrogen and phosphorus

Source: IPCC Special Report Chapter 2 and Chapter 4 (2018)

Biochar / Pyrolysis (BC)



Biochar / Pyrolysis (BC)

- Heating organic matter from plant biomass under low-oxygen conditions (pyrolysis process)

  → gases (CO_2, H_2, CO), H_2O and organic compounds and **biochar**

- Biochar is buried in the soil as fertilizer for agriculture

- Other waste and harmful substances have to be reduced or further processed

Source:https://upload.wikimedia.org/wikipedia/commons/thumb/c/c6/Biochar_pile.jpg/1280px-Biochar_pile.jpg [24.03.2021]

SWOT-Analysis: Biochar/Pyrolysis (BC)

STRENGTH

- *Costs*: 30-120 $/t CO2
- *Scope*: global with regional limitations
- *Permanence*: Long-term
- *Resource intensity*: Low

WEAKNESS

- *Storage potential*: 0.5-2 billion t CO2/a, limited soil holding capacity
- *Availability*: Limited

S W O T

OPPORTUNITIES

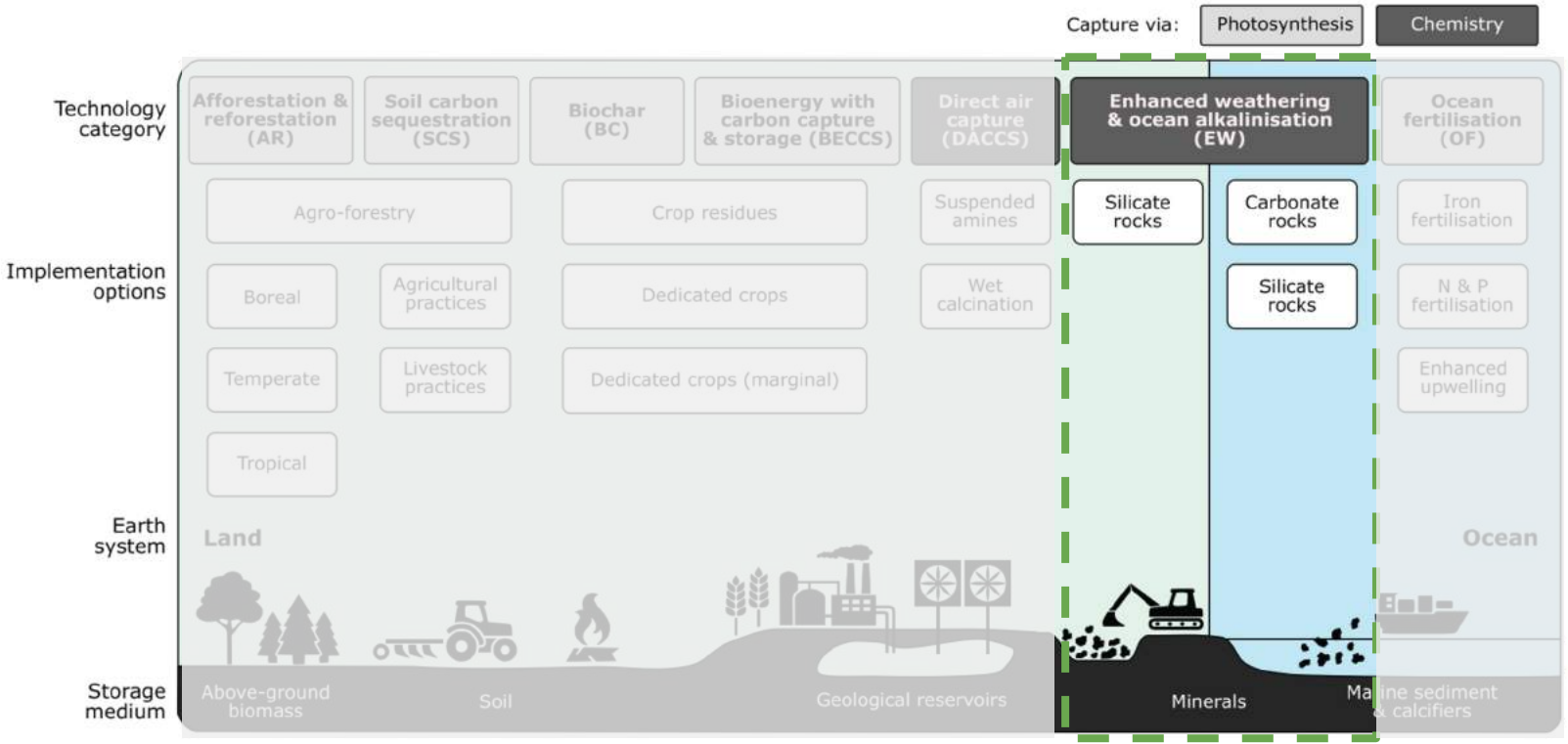
- *Environmental impacts*: Improves soil moisture & fertility, reduces methane and nitrogen emissions of the soil, usage of plant waste and residues

THREATS

- *Pre-environmental impact*: By-products
- *Post-environmental impact*: Potential risk of water and air pollution
- *Tech readiness*: Insufficient
- *Social acceptance*: Low
- *Ethics*: land-use and health risks

Source: IPCC Special Report Chapter 2 and Chapter 4 (2018)

Enhanced Weathering (EW)



Enhanced Weathering (EW)

- Minerals that naturally absorb CO2 (e.g. **basalt**, dunite) are crushed and spread on fields, forests or the ocean; this increases their surface area so that CO2 is absorbed more rapidly

- Rock material on land dissolves in the presence of water & CO2 and is transported via rivers towards the ocean

- Chemical rock weathering currently removes naturally about 1.1 Gt CO2 from the atmosphere

Source:https://www.pik-potsdam.de/en/news/latest-news/enhanced-weathering-of-rocks-can-help-to-suck-co2-out-of-the-air-2013-a-little

SWOT-Analysis: Enhanced Weathering (EW)

STRENGTH

- *Storage potential*: 2 - 4 billion t CO2/a
- *Permancene*: Mid- to long-term
- *Availability*: Moderate

WEAKNESS

- *Costs*: High (50 - 200 $ / t CO2)
- *Scope*: Warm and humid regions

Resource intensivity: Yes, basalt & water

S W O T

OPPORTUNITIES

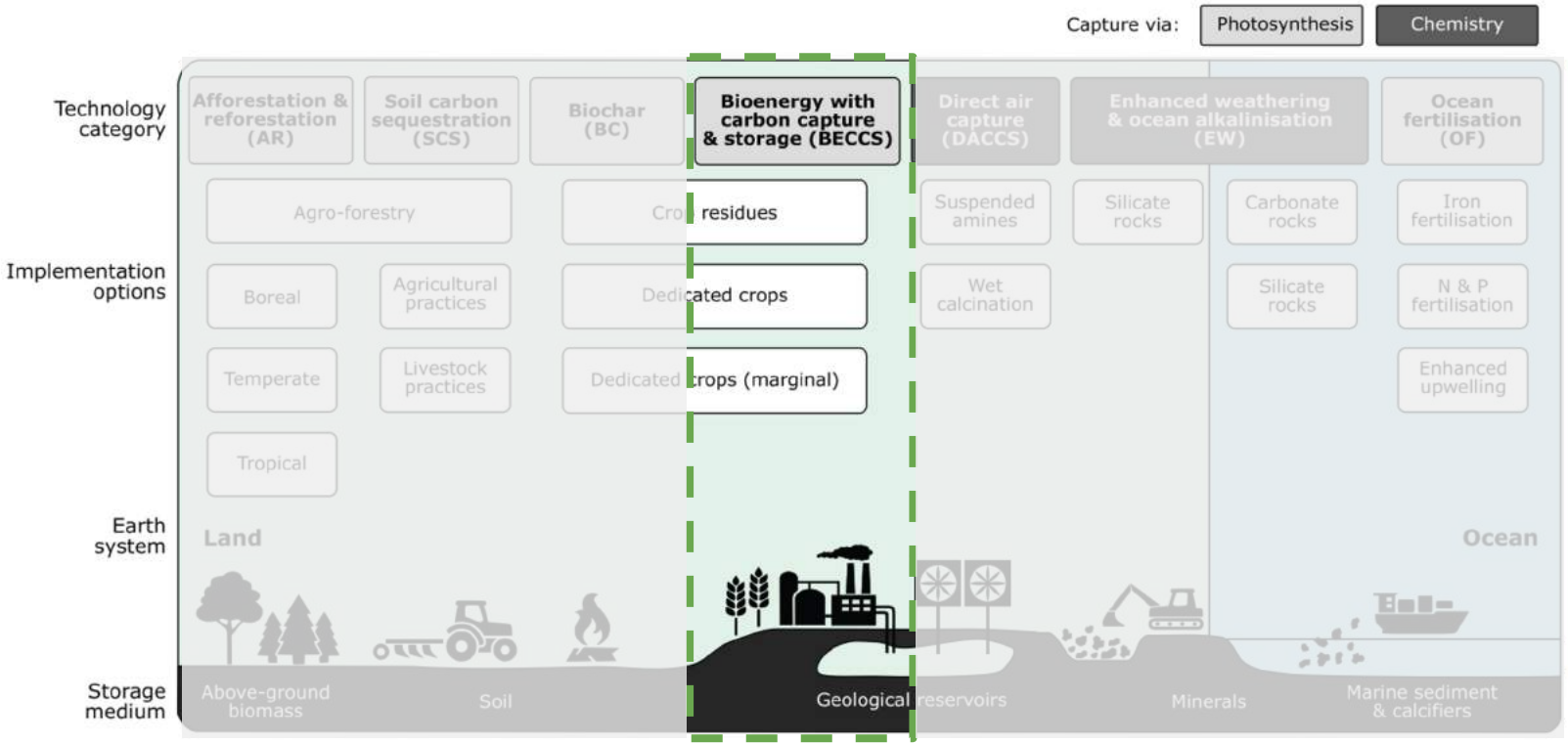
- *Environmental impact* (post): Natural fertilizer
- *Social acceptance*: Moderate

THREATS

- *Environmental impact (pre)*: Mining, grinding & transport
- *Ethics*: Mining, Health
- *Tech readiness*: Low

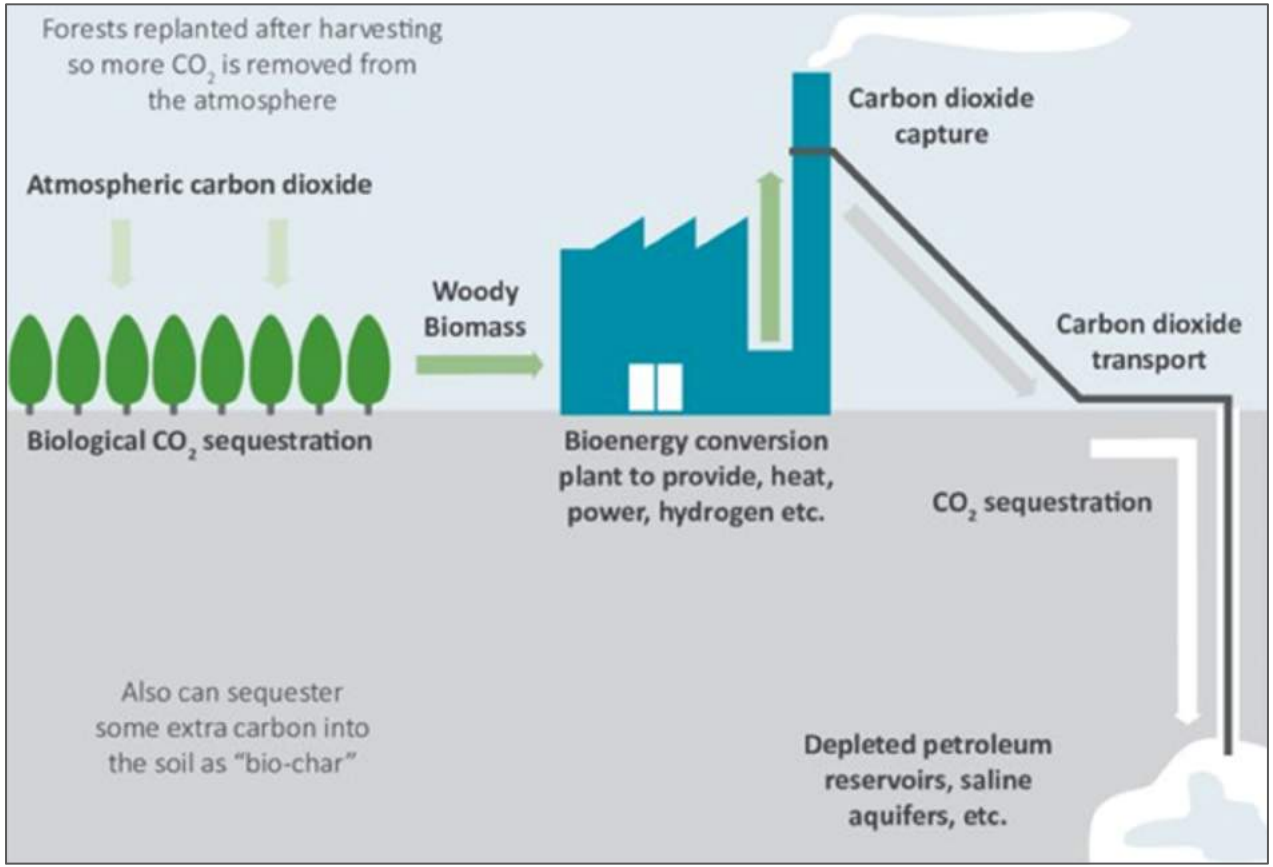
Source: IPCC Special Report Chapter 2 and Chapter 4 (2018)

Bioenergy with carbon capture & storage (BECCS)



BECCS

Bioenergy with Carbon Capture and Storage



Source: Sims et al., 2016
IPCC Special Report Chapter 2 and Chapter 4 (2018)
Global CCS institute (2019)

SWOT-Analysis: BECCS

STRENGTH

- *Storage potential*: 2,5–11 billion t CO2/a
- *Scope*: Global
- *Availability*: Abundant resource
- *Permanence*: Longterm

WEAKNESS

- *Costs*: High (45-250 $ /t CO2)
- *Resource intensity*: High (land, water, fertilizer)

S W O T

OPPORTUNITIES

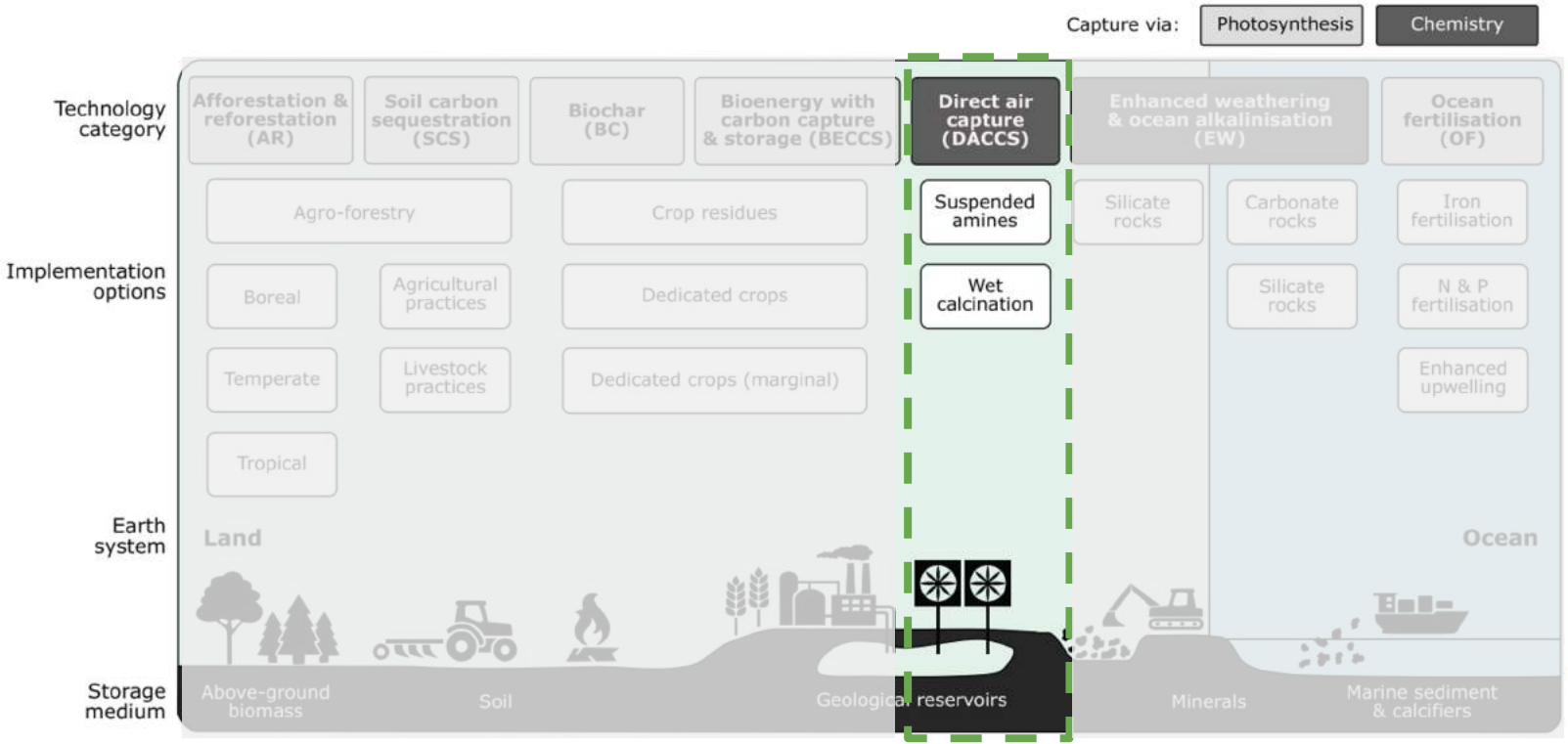
- *Environmental Impact*: Recycling of agricultural residues or garbage
- *Social acceptance*: Controversial but market opportunities

THREATS

- *Environmental Impacts*: Monoculture, harvesting, extra emissions
- *Tech readiness*: Insufficient
- *Ethics*: Land use

Source: IPCC Special Report Chapter 2 and Chapter 4 (2018); Global CCS institute (2019); Fern office UK (2018); Harper et al. (2018); Keller et al. (2018)

Direct Air Capture (DACCS)

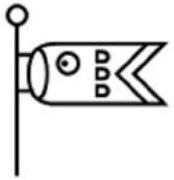


Direct Air Capture (DACCS)

- CO2 is first **captured** in a chemical process by:
  - liquid systems
  - or solid systems
- and then **stored**:
  - in deep geological formations
  - or in the production of chemicals, building materials, fuels, etc.

Source: https://www.scinexx.de/news/technik/erste-kommerzielle-anlage-saugt-co2-aus-der-luft/

SWOT-Analysis: Direct Air Capture (DACCS)



STRENGTH

- *Storage potential*: 0.5–5 billion t CO2/a
- *Scope*: Global
- *Permanence*: Long-term
- *Availability*: Good

WEAKNESS

- *Costs*: High (100–300 $ /t CO2)
- *Resource intensivity*: Energy demand

S W O T

OPPORTUNITIES

- *Ethics*: Good

THREATS

- *Environmental impact*: Leakage concerns
- *Tech readiness*: Low
- *Social acceptance*: Low

Source: IPCC Special Report Chapter 2 and Chapter 4 (2018)

Comparison of Methods

Indicator → / ↓ Method	SP	C	S	A	**P**	**RI**	**EI**	**E**	TR	SoA	**Total**
AR											
SCS											
BC											
EW											
BECCS											
DACCS											

Indicator:
SP Storage Potential
C Costs
S Scope
A Availability
P Permanence
RI Resource Intensity
EI Environmental Impacts
E Ethics
TR Tech Readiness
SoA Social Acceptance

Rating:
Positive
Rather positive
Rather negative
Negative

1. Intro: a logical look at removal techniques

2. Analysis of relevant methods (SWOT)

3. Real life example

4. Consulting example

DACC technologies

Carbon Engineering

- Removal: 0.5 Million tCO_2/year (0.0015%)
- Funding: 90 Million $ (venture funding) + 25 Million federal government
- Storage: Permian Basin (TX, NM)
- Shopify 10.000 t - carbon removal

EXXON OXY bp

Source:https://www.redbubble.com/de/shop/bill+gates

Source: https://iopscience.iop.org/article/10.1088/1748-9326/aabf9b/meta

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Consulting

Munich Re Foundation
From Knowledge to Action

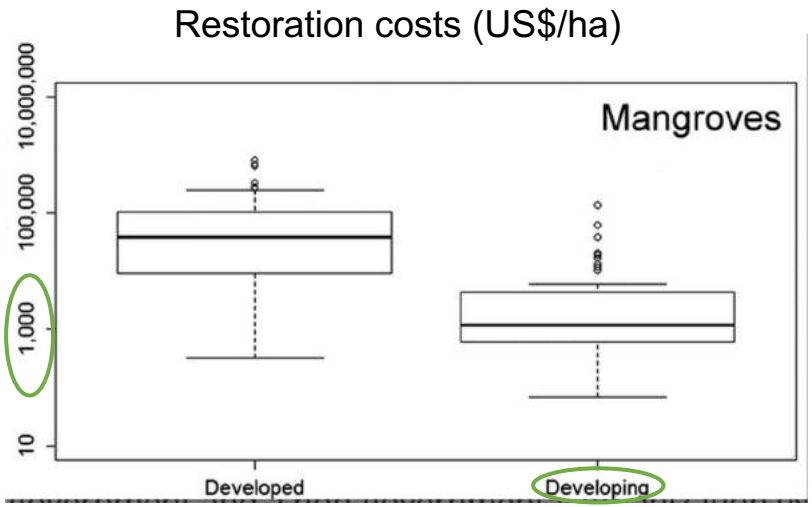
Source: https://www.munichre-foundation.org

Why mangroves?

- Mitigation of the impacts of hurricanes and tsunamis
- Nursery and food source for marine life
- Critical habitat for endangered species

Source: https://www.youtube.com/watch?v=KhLlqdPB_Rs&t=36s

100.000€ for mangroves



Survival rate: **44,7** percent

Soure: Bayraktarov et al., 2016

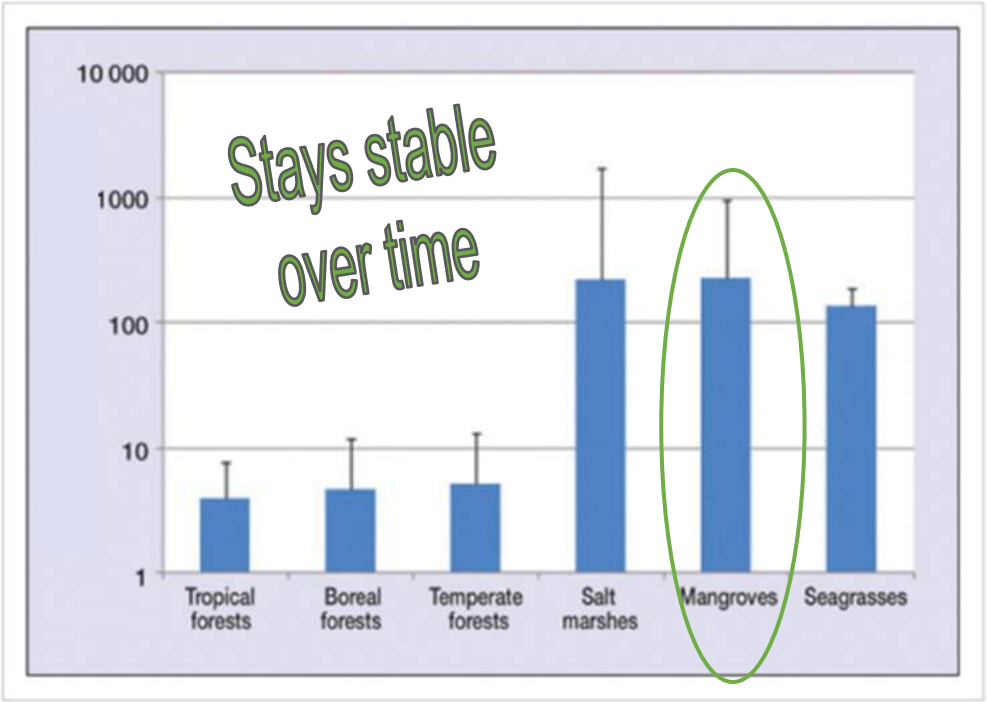
45 hectares of mangroves

CO2 fixation in biomass	
Age of trees	tCO2 per ha/annum
5	88,8
10	12,6
15	-58,1
MEAN	**43,4**

Source: Okimoto et al., 2007

CO2 in biomass 1953 t/a

Carbon burial rate (gCO2/m²a)



Source: Mclead et al., 2011

Carbon burial of ~102 t/a

~2055 t/a within the first **15 years**

Cooperation with Seacology

About Seacology:

- Non profit
- 349 projects in 65 Countries
- Focus on islands
- Linking several issues of different subject areas

Source: Seacology

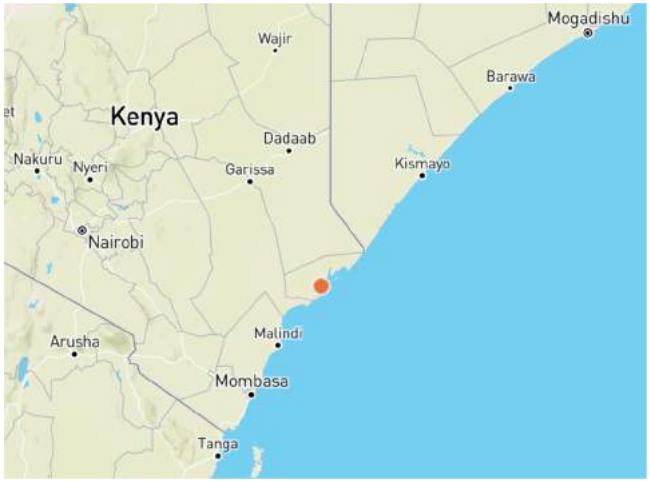
Project examples

- On the Lamu Archipelago
- Covered by about 70%

  of Kenya's Mangrove Forest

- 450 ha of Mangroves

- Establishment of a community forest association

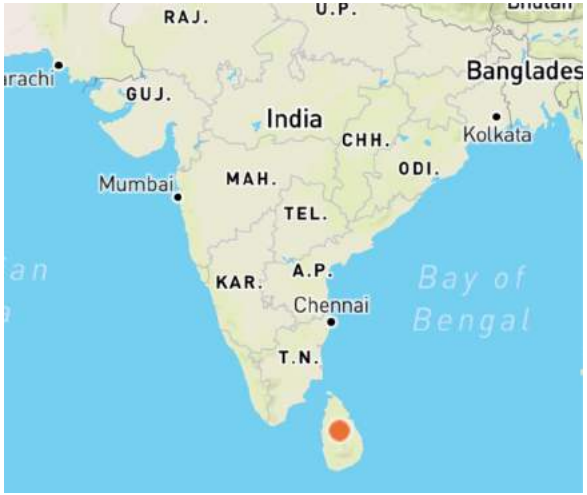


Source: Seacology

Source:https://www.seacology.org/project/matondoni-village/

Project examples

- The Sri Lanka Mangrove Conservation Project
- Largest and most far reaching initiative ever supported by Seacology
- Protection of 8815 ha of mangrove forest
- Numerous co-benefits



Source:https://www.seacology.org/project/sri-lanka-mangrove-conservation-project/
https://www.sudeesa.lk/impero%20%20backup/International%20relation.html

Source: Seacology, Sudeesa

Possible Stakeholders

United Nations
Educational, Scientific and
Cultural Organization

MEKONG
MANGROVE
FORUM

ALNATURA

Sources:https://bangkok.unesco.org/content/take-action-and-work-together-international-day-conservation-mangrove-ecosystem; https://de.wikipedia.org/wiki/; https://www.alnatura.de/

Conclusion

- Numerous approaches.
- Further research is needed.
- Prevention is better than cure.

Source: https://www.medgreeneconomy.org/

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