Increasing the global carbon sink

Crazy and not so crazy ideas

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Introduction

Facing the global consequences of anthropogenic climate change, mitigation measures are considered. Besides the reduction of climate-damaging gas emissions, techniques to increase the global carbon sink are being discussed. These techniques have several side effects and uncertainties that must be considered, e.g. the extensive impact on entire ecosystems or negative energy balances. Disadvantages of a technique are marked with a: ⊖. Advantages are highlighted with a: ⊕. This evaluation leads to a division into "crazy" and "not so crazy" ideas. The latter are based on using the natural sequestration of atmospheric carbon by certain ecosystems.

Biocoal production [1]

- Increase of land carbon sink by adding biocoal to the soil
- ⊖ Research needed: biocoal as energy source, long-term stability
- ⊖ Direct utilisation of the base material more effective
- ⊕ Recovery of biomass residues from industry, forestry etc. possible

CCS — Carbon capture and storage [1]

- Prevent CO_2 emissions from stationary point sources (mainly power plants) by capturing the CO_2 from flue gas

Permanent storage in deep geological formations

- ⊖ Research on potential storage sites and consequences are not sufficient
- ⊖ Power plants have 30% lower efficiency, if CO_2 is captured
- ⊖ Transport infrastructure has to be built
- ⊖ Potential risk of CO_2 leakages

BECS— Bioenergy with CO_2 storage

- Energy balance of the bioenergy is critical for useful application
- ⊖ Same restriction as for classical CCS

Carbon capture from ambient air [1]

- ⊖ Low efficiency
- ⊖ High logistic cost
- ⊕ Atmosphere less polluted than flue gases, less filters needed

Marine geoengineering methods [2]

Ocean fertilization

- Iron is the limiting nutrient of phytoplankton
- Growth can be enhanced by adding iron
- ⊖ Toxic algae blooms arise, danger for humans & marine fauna
- ⊖ Change in lowest level of food chain has incalculable consequences

Ocean liming

- Calcium oxide is added to the ocean
- Alkaline water stores more CO_2
- ⊖ Limestone has to be mined and decomposed to calcium oxide → high energetic and logistic efforts
- ⊖ Vast turbidity zones, less photosynthesis, unknown impact on food chain

Enhancement of natural silicate weathering [1, 2]

- The natural weathering process of silicate rocks fixes CO_2
- two approaches of enhancement
  1) adding silicate minerals to agricultural soils
  2) enhance weathering in situ in the Earth´s crust by injecting hot CO_2 gas into the rock
- ⊖ Necessary expansion of mining
- ⊖ Cost- & energy intensive → 1t silicate rock absorbs maximum 1 t CO_2
- ⊖ Considerable environmental damage on local level

Fig. 1

Fig. 2

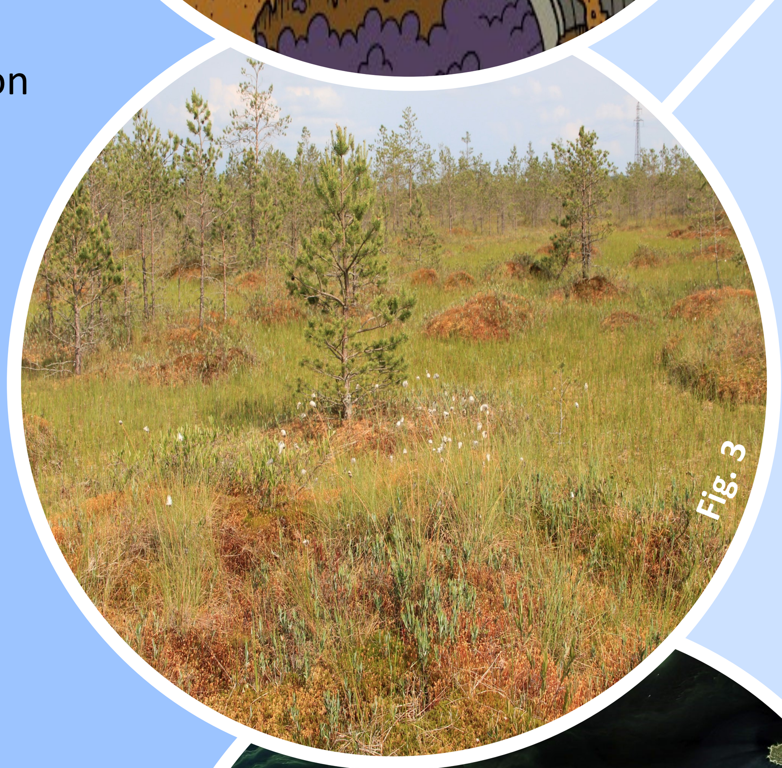

Fig. 3

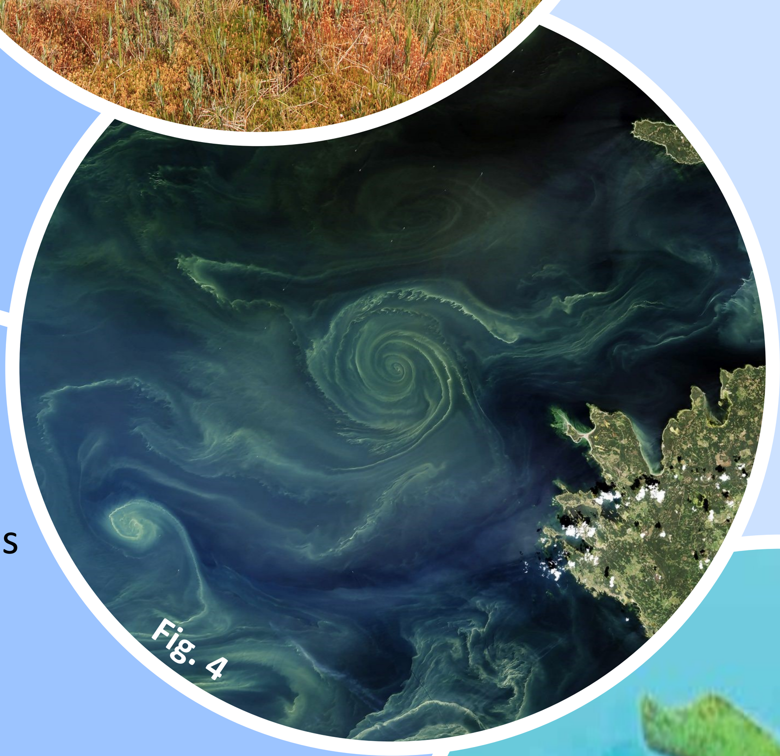

Fig. 4

Fig. 5

Large-scale afforestation/reforestation [2]

- Enlarges the plant and soil carbon sink, as plant and microbial biomass increase
- ⊕ Appropriate especially for degraded land
- ⊕ Ecological benefits
- ⊖ Decreased albedo
- ⊖ Provisional & uncertain storage → tree pests & fires

Peatland protection [3]

- Pristine mires sequester C under water saturated conditions as slightly decomposed biomass
- ⊕ Small C sink: peatlands compensate globally for 1 % of the C emissions from burning fossil fuels
- ⊕ Huge carbon store: 550 Gt C in peat
- ⊕ When drained, the sink becomes a source → peatland protection is climate protection

Protection of seagrass meadows [4]

- Seagrass meadows cover only 0.2 % of the world´s ocean, but sequester about 10 % of the C stored in ocean sediment per year
- Threatened ecosystem: losses of ~ 1.5 % annually, 2/3 lost in inhabited areas
- ⊕ Protection measures: reduction of nutrient loads & preservation of water clarity at coastal waters
- ⊕ When meadows die, the sink becomes a source → protection of seagrass meadows protects the climate

Take – home messages [1, 2]

1. An increased global C sink does not replace the reduction of CO_2 emissions.
2. Many approaches do not comply with the precautionary principle.
3. The more complex the technical solution, the more CO_2 is emitted during installation and maintenance.

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[4] IUCN 2009: The Management of Natural Coastal Carbon Sinks. Accessed 19 June 2020 <https://www.iucn.org/content/management-natural-coastal-carbon-sinks>

Fig. 1: https://pixabay.com/de/photos/wald-b%C3%A4ume-fr%C3%BChling-luftbild-natur-5077552/ [18/06/20]

Fig. 2: https://www.ft.com/content/88c187b4-5619-11e5-a28b-50226830d644 [16.06.20]

Fig. 3: © Karoline Krabbe 2019

Fig. 4: https://cosmosmagazine.com/geoscience/a-phytoplankton-vortex-in-the-baltic-sea/ [18.06.20]

Fig. 5: © Mats Björk, published in: IUCN 2009: The Management of Natural Coastal Carbon Sinks. Accessed 19 June 2020 <https://www.iucn.org/content/management-natural-coastal-carbon-sinks>

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