Sequestration potentials

Historical causes and

Possibilities of materialization

Martin Müller
BBA, Cert.H.E. Natural Sciences
Email: martin.mueller@landwirtschaft.jetzt
Web: https://landwirtschaft.jetzt
13 January 2022

1. Introduction

Besides the reduction of greenhouse gas emissions, the reduction of the CO_2 concentration in the atmosphere is the most urgent issue for stabilizing the climate. A mere reduction of greenhouse gases to net zero does not solve the problem of high CO_2 concentrations in the atmosphere, since CO_2 - unlike methane, for example - is a very long-lived gas over centuries and degrades only very slowly, e.g. through weathering.

In this analysis, the potentials of a change to a plant-based agriculture and food system will be investigated, where these potentials come from and how they can be realized.

2.1 Historical origins of sequestration potentials

More CO_2 has been emitted by deforestation from 6050 BC to the present (2020) than by the burning of all fossil resources combined. The burning of all fossil resources has emitted 1625 Gt CO_2 [6]. Land use change has emitted 2008 Gt CO_2 [7][8].

Today, this cleared land is predominantly used for livestock production and thus represents carbon opportunity costs, i.e. unused potentials of carbon sequestration due to permanent land use for livestock production (pasture, arable land for feed).

Calculation of the objects to be considered:

Object	From	To	Gt CO_2	Reference	Details
Atmospheric abundance (human caused)	1750	2020	1053	https://landwirtschaft.jetzt/wp-content/uploads/2021/01/20210102-LWJ-AAFFGW-Pre-Print.pdf	Page 9, footnote 12
Sequ. potential 30 years	2020	2050	547	https://www.nature.com/articles/s41893-020-00603-4	
Sequ. potential 100 years	2020	2120	810	https://science.sciencemag.org/content/363/6429/eaaw9908	
LUC 8000 BP - 3000 BP	6050 BC	1050 BC	597	https://journals.sagepub.com/doi/abs/10.1177/0959683610386983	
LUC 8000 BP - 1850 AD	6050 BC	1850 AD	1249	https://journals.sagepub.com/doi/abs/10.1177/0959683610386983	
LUC 1850 - 2020	1850	2020	759	https://bg.copernicus.org/articles/10/6323/2013/bg-10-6323-2013.pdf	https://cdiac.ess-dive.lbl.gov/ftp/Smith_Rothwell_Land-Use_Change_Emissions/
LUC 1750 - 2020	1750	2020	882	https://bg.copernicus.org/articles/10/6323/2013/bg-10-6323-2013.pdf	https://cdiac.ess-dive.lbl.gov/ftp/Smith_Rothwell_Land-Use_Change_Emissions/
Coal	1750	2020	787	https://ourworldindata.org/emissions-by-fuel	
Oil	1750	2020	593	https://ourworldindata.org/emissions-by-fuel	
Gas	1750	2020	245	https://ourworldindata.org/emissions-by-fuel	

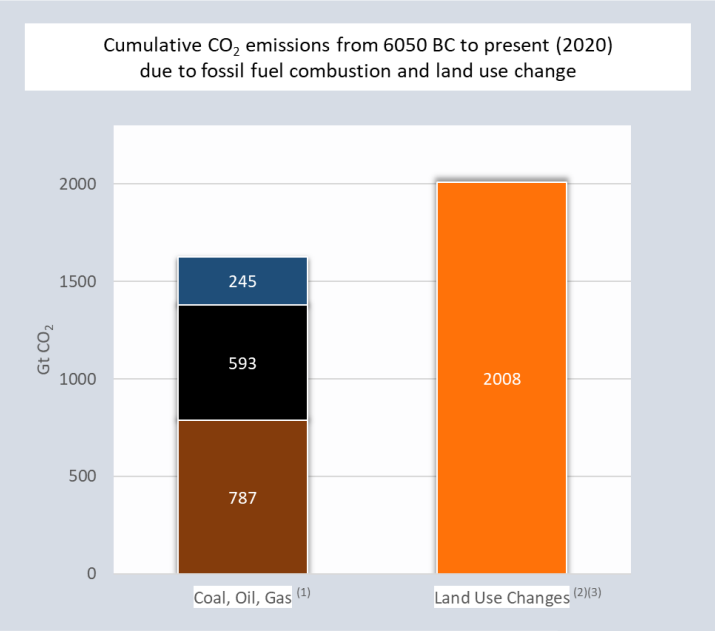

Figure 1: Cumulative CO_2 emissions from 6050 BC to present (2020) due to fossil fuel combustion and land use change

2.2 Sequestration potentials with a shift to a plant-based food system and with global reforestation

A safe CO_2 concentration in the atmosphere for the survival of mankind is 350 ppm [1]. In 2020, the concentration was 413 ppm. To get back to the 350 ppm level, sequestration of 491 Gt CO_2 is required [2]. Technical solutions are lacking and natural weathering, etc. are too slow, so the only quick option is reforestation. Enormous areas are needed for this. A change to a purely plant-based food system frees up an area of 31 million square kilometers [3]. Renaturation (reforestation, conversion back to peatlands, etc.) can sequester up to 547 Gt CO_2 [4] within 30 years and 810 Gt CO_2 [5] within 100 years (= carbon opportunity cost of animal agriculture).

Without considering natural and other processes, the necessary sequestration of 491 Gt CO_2 can be achieved within 27 years by afforestation alone.

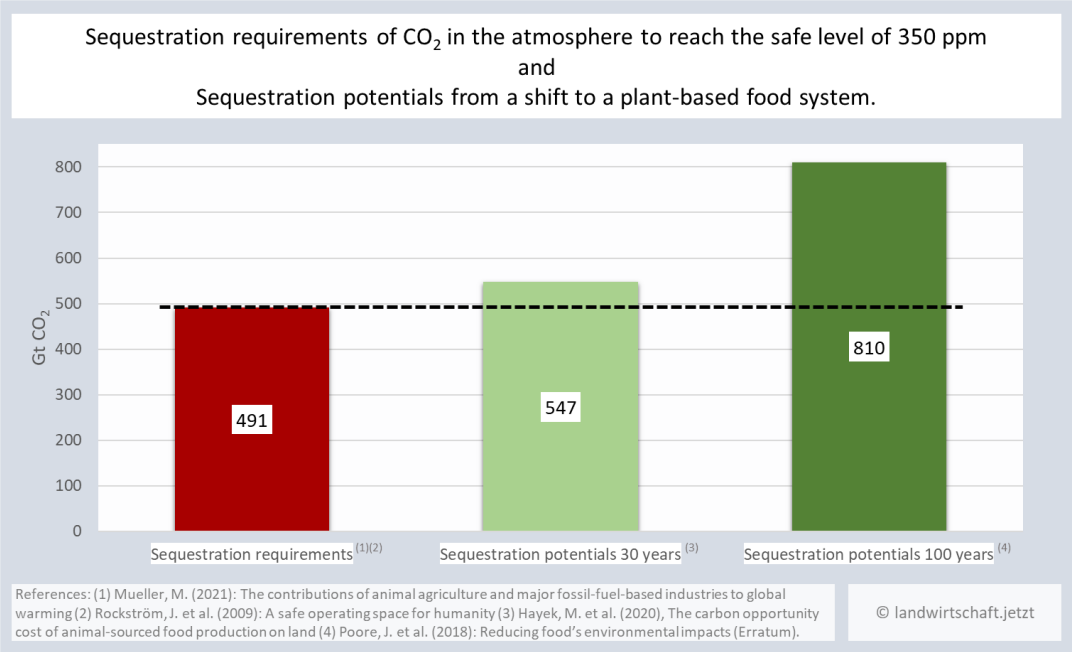

Figure 2: (1),(2) The shown sequestration needs for the year 2020 are calculated as the difference between the CO_2 concentration in the atmosphere in 2020 and the target concentration at 350 ppm, which Rockström et al. define as safe for mankind. Further definitions of the calculation can be found in source (1) on pages 9-10. The specific calculation is: 5,135 x 10^6 Gt x (413–350) x 10^{-6} x (44,009 g mol^{-1}/ 28,966 g mol^{-1}). (3),(4) An immediate switch to a purely plant-based food system will free up land that can sequester up to 547 Gt CO_2 in 30 years or 810 Gt CO_2 in 100 years through reforestation and other renaturation. The sequestration rate is highest in the first decades and then decreases [9].

3. Resources

[1] https://doi.org/10.1038/461472a (S. 473)

[2] https://doi.org/10.13140/RG.2.2.22613.35040/1 (S. 9, Fußnote 12)

[3] https://doi.org/10.1126/science.aaq0216 (S. 5)

[4] https://doi.org/10.1038/s41893-020-00603-4 (S. 1)

[5] https://doi.org/10.1126/science.aaw9908

[6] https://ourworldindata.org/emissions-by-fuel

[7] https://doi.org/10.1177/0959683610386983

[8] https://doi.org/10.5194/bg-10-6323-2013

[9] https://doi.org/10.1126/science.abh3629