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Climate change · Land-use

CARBON EMISSIONS FROM FUTURE LAND USE

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Teaser

In particular forests buffer the effects of climate change. Two new studies at the Karlsruhe Institute of Technology (KIT) examine this effect in detail. It is possible that indeed this saving natural contribution to carbon storage may be much lower than previously assumed. Especially when deforestation continues. This could make reaching the two-degree target significantly more difficult and further enhance climate change. Current climate models are thus subject to intense scrutiny.

Keywords

Carbon emissions, land use, climate models, two-degree target, atmosphere, plants, ecosystem services, soil, bioenergy crops, afforestation, deforestation, logging, forest, woodland, pesticide, glyphosate, biodiversity, biodiversity, biodiversity, carbon dioxide, CO_2

Is Plants absorb some of our carbon dioxide (CO_2) emissions through photosynthesis and thus contribute significantly to climate protection. But how does the CO2 uptake capacity of land change when forests are cut down and converted into agricultural land? How well do our climate models represent the change? Researchers at the Karlsruhe Institute of Technology (KIT) have investigated these questions in a recent study. They looked at five common climate models to better understand which land use changes affect the extent of CO_2 storage in vegetation and thus also atmospheric concentration. For example, it was important how much leaf area there is in relation to soil area, how much the plants grow, and how long a plant grows before the dead plant material in turn releases CO_2 into the atmosphere.

Humanity currently benefits enormously from worldwide plant growth. Almost one quarter of the CO_2 emitted by humans into the atmosphere is estimated to be taken up by the vegetation. Without this achievement, the warming of the Earth would take place even faster. However, if land use continues to change and forests are cleared for maize or soybean production, this free ecosystem service will decline. The reason: The plants grown now can store significantly less carbon, as well as the soils. On the one hand, arable soils typically contain less plant matter which are instead removed at harvest. On the other hand, agricultural soils also emit more CO_2, as the material decomposes faster and soil erosion is intensified.

Land use influences CO_2 removal potential

However, things can also turn out differently: By appropriate land use - for example through reduced deforestation and afforestation or the cultivation of bioenergy plants in combination with CO_2 capture and storage - plants could net remove CO_2 from the atmosphere and thus reduce their CO_2 concentration (" negative emissions "). The widespread use of such land use projects is therefore an important component of current climate mitigation scenarios - for example, to reach the Paris two-degree target. A team led by KIT researcher Dr. Andreas Krause has worked out in another recent study that it is highly uncertain how much atmospheric CO_2 can actually be captured via such activities. For this purpose, four dynamic vegetation models were combined with corresponding land use scenarios that were previously created by two land use models.

It turns out that the different models calculate very different CO_2 uptake for the afforestation scenarios as well as for the bioenergy scenarios. In particular, the calculated CO_2 removal potential in the vegetation models is in some cases significantly lower than in the land use models, which are usually used to create climate mitigation scenarios. As a result, the ever-growing reliance on negative emissions is a highly risky strategy for achieving the two-degree target. Today's anthropogenic greenhouse gas emissions may not be reversible in this way in the future. According to the authors, the climate models should better represent the impacts of land use change and we need a better understanding of the underlying processes. In particular, the large uncertainty regarding the assumed yields of bioenergy plantations requires further research. More detailed information on pasture grazing intensities and a clear distinction between natural grasslands and intensively managed pastures in observational studies could also help reduce the large uncertainty in carbon content of soils of different land use types.

Deforestation is progressing worldwide

At the moment, however, we are a long way from CO_2 removal through afforestation, as deforestation continues to take place. The problem of ongoing deforestation - especially in tropical areas - is currently particularly serious in South America and parts of Africa. In these regions, areas such as the Amazon Basin could even turn from CO_2 sinks to CO_2 sources and thus decisively promote global warming. Since the 1960s, 20 percent of the original forest land has been lost in the Amazon Basin, as more and more land is used for the cultivation of feed and livestock for export. With the permanent loss of forest land, the area could lose its function as an important CO_2 reservoir for the world. Other negative factors besides deforestation due to changes in land use are droughts, and a strong population growth.

According to a recent analysis by the World Resources Institute (WRI), in 2017 a forest area of 16 million hectares was destroyed worldwide, an area as big as Bangladesh or half the size of Germany. In addition to Brazil (-4.5 million hectares), large-scale deforestation took place in the Democratic Republic of the Congo, but also in Indonesia, Madagascar, Malaysia, Bolivia and Colombia. Colombia, in particular, has experienced one of the most dramatic increases in the rate of forest loss in just one year (2016 to 2017) with an increase of 46 per cent. Despite joint efforts to limit deforestation, WRI reports continued forest loss in the tropics. Natural disasters such as fires and tropical storms are playing an increasingly important role. A key driver of large-scale deforestation, however, is the clearing of forests for agriculture and other uses.

One of the biggest challenges is therefore to stop deforestation. However taking into account population growth and the existing environmentally unfriendly diets in much of the Western world, this can only be achieved with great effort. Another approach is to increase crop yields on existing land so that possibly land presently used for agriculture can be made available for afforestation or the cultivation of second generation bioenergy crops. However, property issues and profitability calculations of course also play an essential role, potentially constraining such a reversal process. Further research is needed to be able to better quantify the contribution of such projects to climate mitigation.

In a recent discussion paper of the National Academy of Sciences Leopoldina "The mute spring - The need for sustainable crop protection" states: "Glyphosate pesticides are used according to the Federal Environment Agency in Germany on about 40 percent of the fields at least once a year, for rapeseed even on up to 90 percent of the fields. If the cultivation of energy crops such as rapeseed and corn, which has been heavily subsidized by political incentives in recent years, continues to increase, a further decline in the diversity of plants, insects and vertebrates in the agricultural landscape must be assumed. Beyond the direct climate effects, an overall assessment would also have to take into account other ecosystem services, such as those resulting from biodiversity. This also applies, in particular, to the cultivation of bioenergy crops.

Technical examination: Dr. Andreas Krause (Karlsruhe Institute of Technology | KIT, Atmospheric Environmental Research | IMK-IFU)

References

Davidson, E. A., de Araújo, A. C., Artaxo, P., Balch, J. K., Brown, I. F., Bustamante, M. M. C., ... Wofsy, S. C. (2012). The Amazon basin in transition. *Nature*, *481*, 321-328. https://doi.org/10.1038/nature10717

Krause, A., Pugh, T. A. M., Bayer, A. D., Li, W., Leung, F., Bondeau, A., , ... Arneth, A. (2018). Large uncertainty in carbon uptake potential of land-based climate-change mitigation efforts. *Global Change Biology*, *24*(7), 3025-3038. doi:10.1111/gcb.14144

Quesada, B., Arneth, A., Robertson, E. & de Noblet-Ducoudré, N. (2018). Potential strong contribution of future anthropogenic land-use and land-cover change to the terrestrial carbon cycle. *Environmental Research Letters*, *13*(6):064023. doi:10.1088/1748-9326/aac4c3

Schäffer, A., Filser, J., Frische, T., Gessner, M., Köck, W., Kratz, W., Liess, M., Nuppenau, E.-A., Roß-Nickoll, M., Schäfer, R. & Scheringer, M. (2018). *Der stumme Frühling – Zur Notwendigkeit eines umweltverträglichen Pflanzenschutzes* (Diskussion Nr. 16). Halle: Nationale Akademie der Wissenschaften – Leopoldina.

Weisse, M. & Goldman, E. D. (2017, 26. Juni). 2017 Was the Second-Worst Year on Record for Tropical Tree Cover Loss. *World Resources Institute* [www.wri.org].

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