

Assessing the efficiency of changes in land use for mitigating climate change

Timothy D. Searchinger, Stefan Wirsenius, Tim Beringer & Patrice Dumas

Nature **564**, 249–253 (2018) | [Download Citation](#)

A Publisher Correction to this article was published on 10 January 2019

This article has been updated

Abstract

Land-use changes are critical for climate policy because native vegetation and soils store abundant carbon and their losses from agricultural expansion, together with emissions from agricultural production, contribute about 20 to 25 per cent of greenhouse gas emissions^{1,2}. Most climate strategies require maintaining or increasing land-based carbon³ while meeting food demands, which are expected to grow by more than 50 per cent by 2050^{1,2,3,,2,4}. A finite global land area implies that fulfilling these strategies requires increasing global land-use efficiency of both storing carbon and producing food. Yet measuring the efficiency of land-use changes from the perspective of greenhouse gas emissions is challenging, particularly when land outputs change, for example, from one food to another or from food to carbon storage in forests. Intuitively, if a hectare of land produces maize well and forest poorly, maize should be the more efficient use of land, and vice versa. However, quantifying this difference and the yields at which the balance changes requires a common metric that factors in different outputs, emissions from different agricultural inputs (such as fertilizer) and the different productive potentials of land due to physical factors such as rainfall or soils. Here we propose a carbon benefits index that measures how changes in the output types, output quantities and production processes of a hectare of land contribute to the global capacity to store

carbon and to reduce total greenhouse gas emissions. This index does not evaluate biodiversity or other ecosystem values, which must be analysed separately. We apply the index to a range of land-use and consumption choices relevant to climate policy, such as reforesting pastures, biofuel production and diet changes. We find that these choices can have much greater implications for the climate than previously understood because standard methods for evaluating the effects of land use^{4,5,6,7,8,9,10,11} on greenhouse gas emissions systematically underestimate the opportunity of land to store carbon if it is not used for agriculture.

Access options

Rent or Buy article

Get time limited or full article access on ReadCube.

from **\$8.99**

[Rent or Buy](#)

All prices are NET prices.

Subscribe to Journal

Get full journal access for 1 year

We are sorry, but there is no personal subscription option available for your country.

[More Information](#)

Additional access options:

[Log in](#) | [OpenAthens](#) | [Shibboleth](#)

Data availability

LPJmL modelling results, in the form of global carbon and native net primary productivity maps, are available at <https://doi.org/10.1594/PANGAEA.893761>. The different datasets used to run LPJmL for this study are publicly available and described in Supplementary Information along with links. Any other materials