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UNEP

IPCC Expert Meeting on Reconciling anthropogenic land use emissions

9-11 July 2024 - European Commission, Joint Research Centre - Ispra Italy

European Commission

Towards modelling NGHGI-consistent land-use fluxes with the bookkeeping model BLUE

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Introduction

LULUCF flux estimates from NGHGIs and from bookkeeping models are not directly comparable but need a harmonisation (see e.g., Grassi et al., 2023). The harmonisation requires that the indirect anthropogenic fluxes on managed land are quantified. So far, Dynamic Global Vegetation Models (DGVMs) have been used for this purpose.

Here we present an advanced version of the bookkeeping model BLUE (Hansis et al., 2015) that considers indirect anthropogenic effects. BLUE is one of three bookkeeping models used in the Global Carbon Budget (Friedlingstein et al., 2023) and in the harmonisation study of Grassi et al. (2023). The new version of BLUE enables 1) the estimation of LULUCF fluxes including indirect anthropogenic effects and 2) the estimation of indirect anthropogenic fluxes on all terrestrial areas (known as natural land sink). These advancements will make it possible to obtain a NGHGI-consistent LULUCF flux estimate from BLUE without the need to additionally use DGVMs.

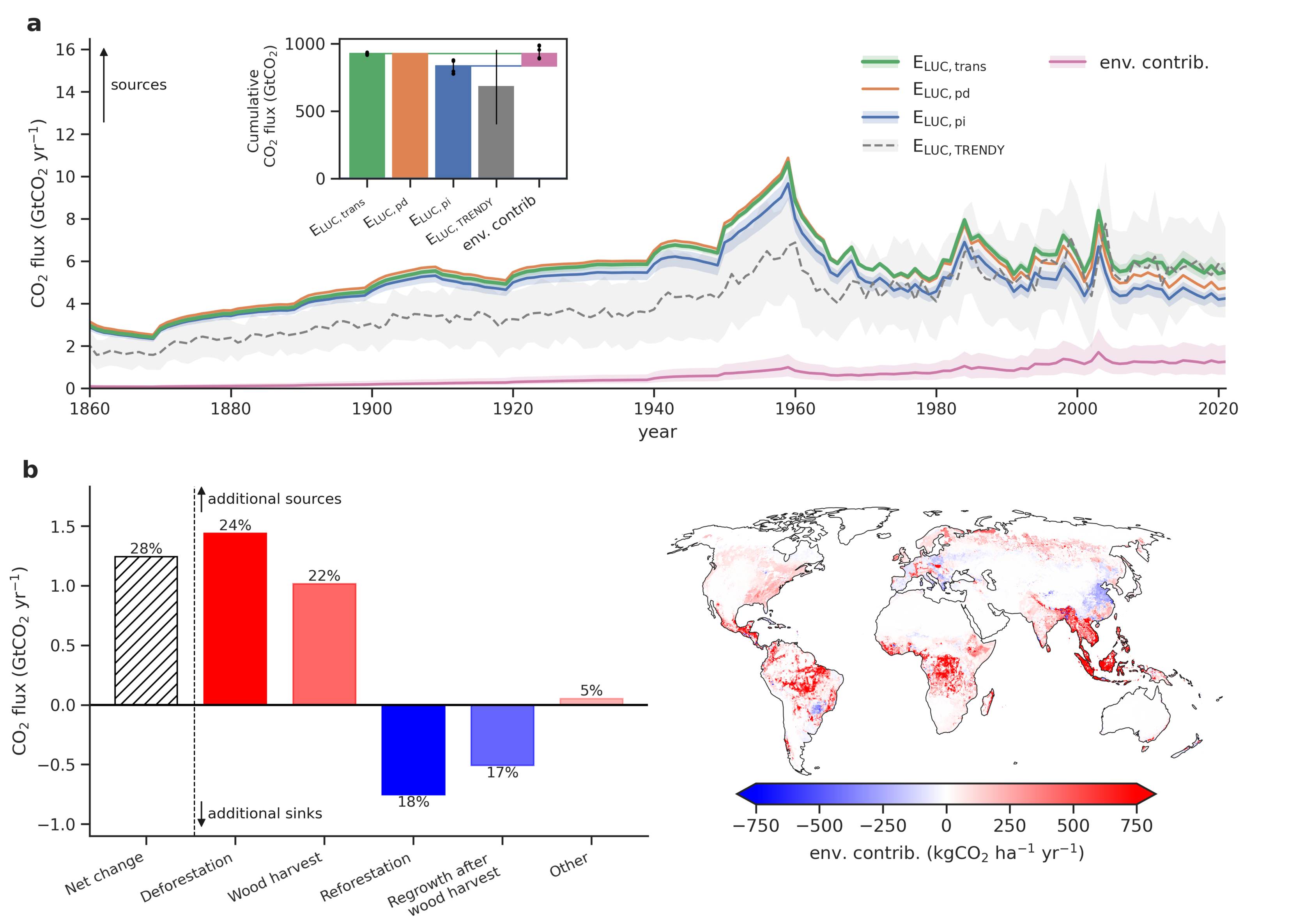

Figure 1: Effects of different environmental conditions on land-use change emissions (E_{LUC})
(a) Comparison of global annual E_{LUC} estimates from three simulations with the bookkeeping model BLUE applying transient ($E_{LUC,trans}$), present-day ($E_{LUC,pd}$), and pre-industrial ($E_{LUC,pi}$) carbon densities and from Dynamic Global Vegetation Models (DGVMs) from the TRENDY project ($E_{LUC,TRENDY}$). $E_{LUC,trans}$ minus $E_{LUC,pi}$ yields the environmental contribution (env. contrib.) to E_{LUC}, i.e., the additional sinks and sources due to environmental effects. The inset in (a) shows the corresponding global cumulative values (1850-2021).
(b) Env. contrib. to E_{LUC} of major land-use transitions and land-management types averaged over 2012-2021.
(c) Spatial distribution of the environmental contribution to E_{LUC} averaged over 2012-2021.

Results

1) Accounting for indirect effects in BLUE

Including indirect anthropogenic effects in BLUE results in 14% higher LULUCF emissions in 2012-2021 ($E_{LUC,trans}$ vs. $E_{LUC,pd}$ in Figure 1a). The main reason are higher emissions from deforestation and from wood harvest (Figure 1b), which are partly compensated by larger removals from reforestation and regrowth after wood harvest. The indirect anthropogenic fluxes estimated by BLUE result in a sink of 11 $GtCO_2$/yr in 2012-2021, which is consistent with another estimate from Gasser et al. (2020). The BLUE sink estimate is 19% lower compared to previous approaches using preindustrial land cover, as it considers the historical loss and degradation of forest cover.

2) Reproducing NGHGI estimates of LULUCF with BLUE

Summing the land-use fluxes and the indirect anthropogenic fluxes masked by a map of managed land will deliver a LULUCF flux estimate that is conceptually consistent with NGHGIs (Figure 2).

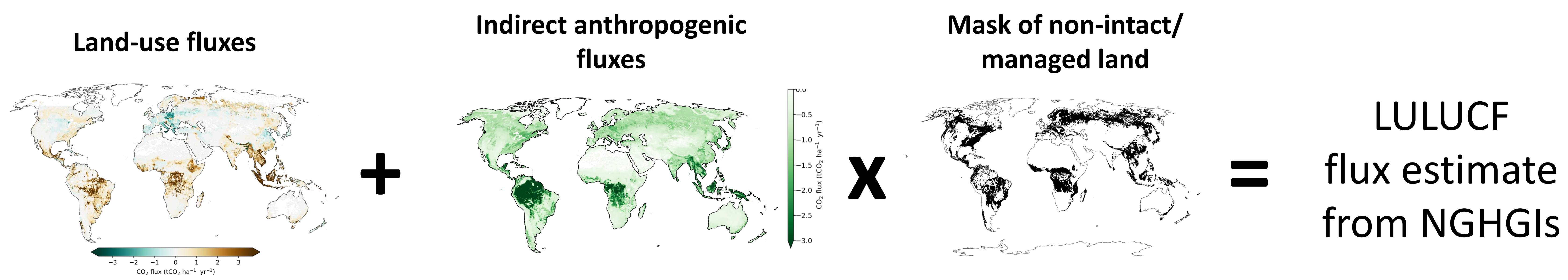

Figure 2: Conceptual schematic for obtaining NGHGI-consistent LULUCF fluxes with the bookkeeping model BLUE

References:

- Dorgeist, L., Schwingshackl, C., Pongratz, J.: A consistent budgeting of terrestrial carbon fluxes, *in review*.
- Friedlingstein, P., et al.: Global Carbon Budget 2023, Earth Syst. Sci. Data, 15, 5301–5369, https://doi.org/10.5194/essd-15-5301-2023, 2023.
- Gasser, T., Crepin, L., Quilcaille, Y., Houghton, R. A., Ciais, P., and Obersteiner, M.: Historical CO2 emissions from land use and land cover change and their uncertainty, Biogeosciences, 17, 4075–4101, https://doi.org/10.5194/bg-17-4075-2020, 2020.
- Grassi, G., Schwingshackl, C., et al.: Harmonising the land-use flux estimates of global models and national inventories for 2000–2020, Earth Syst. Sci. Data, 15, https://doi.org/10.5194/essd-15-1093-2023, 2023.
- Hansis, E., S. J. Davis, and J. Pongratz, Relevance of methodological choices for accounting of land use change carbon fluxes, Global Biogeochem. Cycles, 29, 1230–1246, https://doi.org/10.1002/2014GB004997, 2015.