
# The LULUCF Data Hub: regional- and national-level discrepancies between independent global datasets and national GHG inventories – insights from country examples on the use of EO.

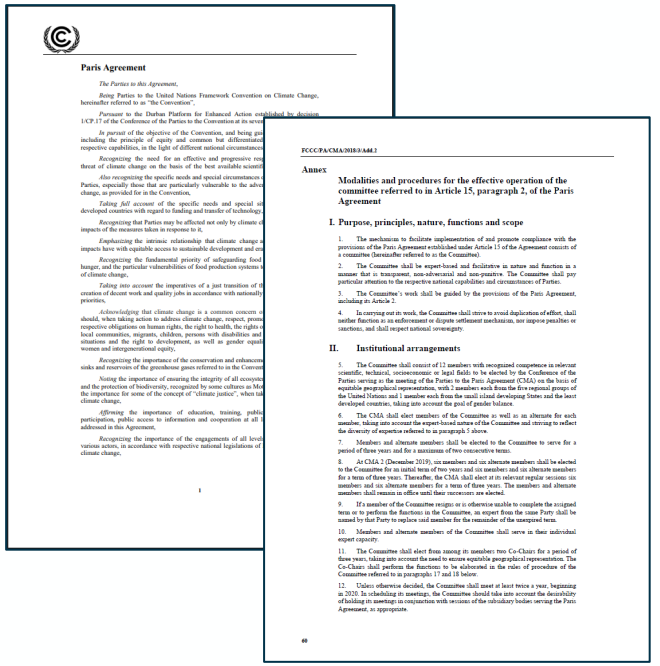
Joana Melo[1], Simone Rossi[1], Frédéric Achard[1], Ramdane Alkama[2], Josep G. Canadell[3], Sandro Federici[4], Pierre Friedlingstein[5,6], David Gibbs[7], Nancy Harris[7], Viola Heinrich[8,9], Michael O'Sullivan[5], Glen P. Peters[10], Julia Pongratz[11,12], Melissa Rose[7], Rosa Roman-Cuesta[1], María J. Sanz[13,14], Clemens Schwingshackl[11], Stephen Sitch[5], Giacomo Grassi[1]

1: European Commission Joint Research Centre (JRC), Italy; 2: Université de Bordeaux, France; 3: CSIRO, Canberra, Australia; 4: Institute for Global Environmental Strategies, IGES, Hayama, Japan; 5: Faculty of Environment, Science and Economy, University of Exeter, Exeter, UK; 6: Laboratoire de Météorologie Dynamique, Institut Pierre-Simon Laplace, CNRS, École Normale Supérieure, Université PSL, Sorbonne Université, École Polytechnique, Paris, France; 7: World Resources Institute, Washington DC, USA; 8: GFZ Helmholtz Centre for Geosciences, Potsdam, Germany; 9: School of Geographical Sciences, University of Bristol, UK; 10: CICERO Center for International Climate Research, Oslo, Norway; 11: Department of Geography, Ludwig-Maximilians-Universität München, Munich, Germany; 12: Max Planck Institute for Meteorology, Hamburg, Germany; 13: Basque Centre for Climate Change (BC3), Bilbao, Spain; 14: Ikerbasque Foundation, Euskadi Pl., 5, 48009 Bilbao, Spain

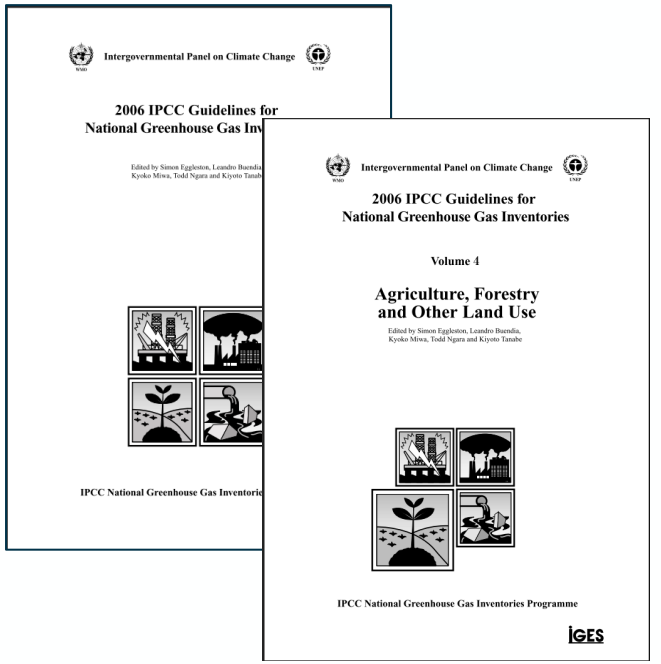
# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

## What is LULUCF ?
## Land Use, Land-Use Change and Forestry

United Nations Climate Change



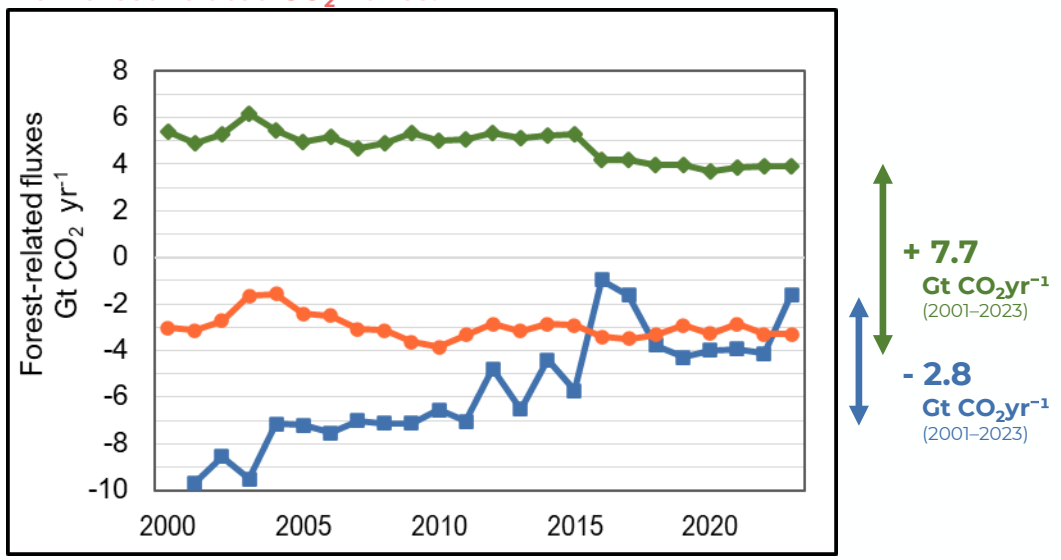

ipcc
INTERGOVERNMENTAL PANEL ON climate change

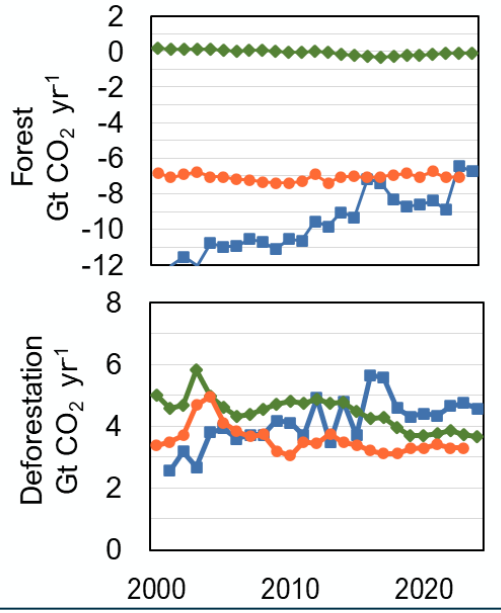


# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

- Land use plays a critical role in achieving the Paris Agreement goals, yet inconsistencies between global carbon models, Earth Observation (EO), and national GHG inventories (NGHGIs) lead to significant mismatches in $CO_2$ emission estimates.
- Most of the differences can already be resolved with a "translation" methodology implemented by the carbon cycle modeling (Grassi et al., 2021; Schwingshackl et al., 2022; Gidden et al., 2023; Grassi et al., 2023; Friedlingstein et al., 2025) and EO (Heinrich et al., 2023; Deng et al., 2025; Gibbs et al., 2025) communities → **Managed land as a proxy for anthropogenic GHG fluxes.**
- **LULUCF Data-Hub**: a platform hosted by the EU Forest Observatory to visualize $CO_2$ emissions and removals as reported by countries to the UNFCCC, alongside independent global land-use emission datasets from the Global Carbon Budget (GCB 2024; Friedlingstein et al., 2025) and the Global Forest Watch (GFW; Gibbs et al., 2025) translated to NGHGI definitions

**For forest-related $CO_2$ fluxes:**




National GHG Inventories (NGHGI) 2025

Global Carbon Budget (GCB) 2025 original/reclassified

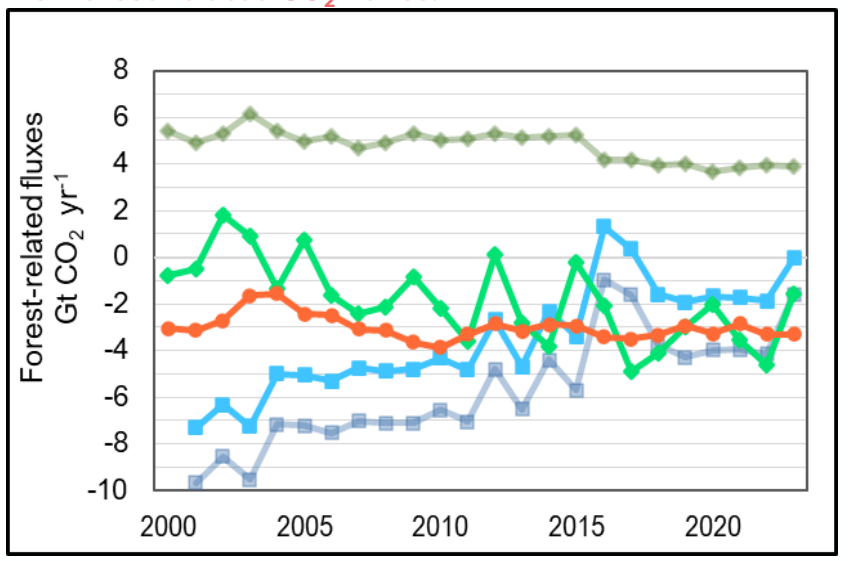
Global Forest Watch (GFW) 2025 original/reclassified

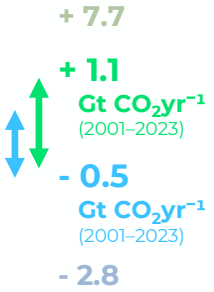
Source: updated from Figure 6, Melo et al. 2025

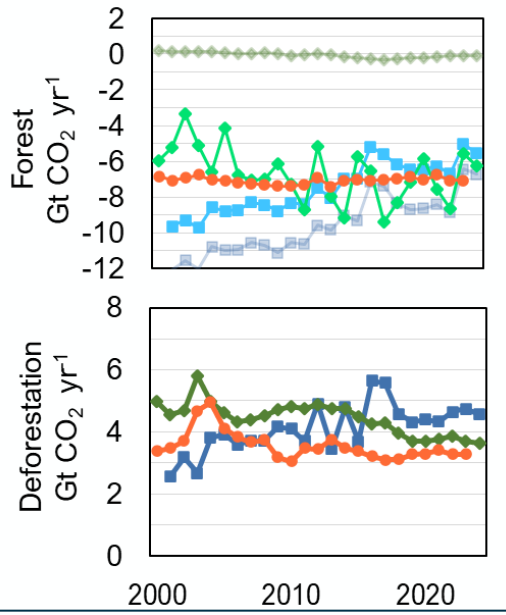
# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

- Land use plays a critical role in achieving the Paris Agreement goals, yet inconsistencies between global carbon models, Earth Observation (EO), and national GHG inventories (NGHGIs) lead to significant mismatches in $CO_2$ emission estimates.
- Most of the differences can already be resolved with a "translation" methodology implemented by the carbon cycle modeling (Grassi et al., 2021; Schwingshackl et al., 2022; Gidden et al., 2023; Grassi et al., 2023; Friedlingstein et al., 2025) and EO (Heinrich et al., 2023; Deng et al., 2025; Gibbs et al., 2025) communities → **Managed land as a proxy for anthropogenic GHG fluxes.**
- **LULUCF Data-Hub**: a platform hosted by the EU Forest Observatory to visualize $CO_2$ emissions and removals as reported by countries to the UNFCCC, alongside independent global land-use emission datasets from the Global Carbon Budget (GCB 2024; Friedlingstein et al., 2025) and the Global Forest Watch (GFW; Gibbs et al., 2025) translated to NGHGI definitions

For forest-related $CO_2$ fluxes:




National GHG Inventories (NGHGI) 2025

Global Carbon Budget (GCB) 2025 original/reclassified

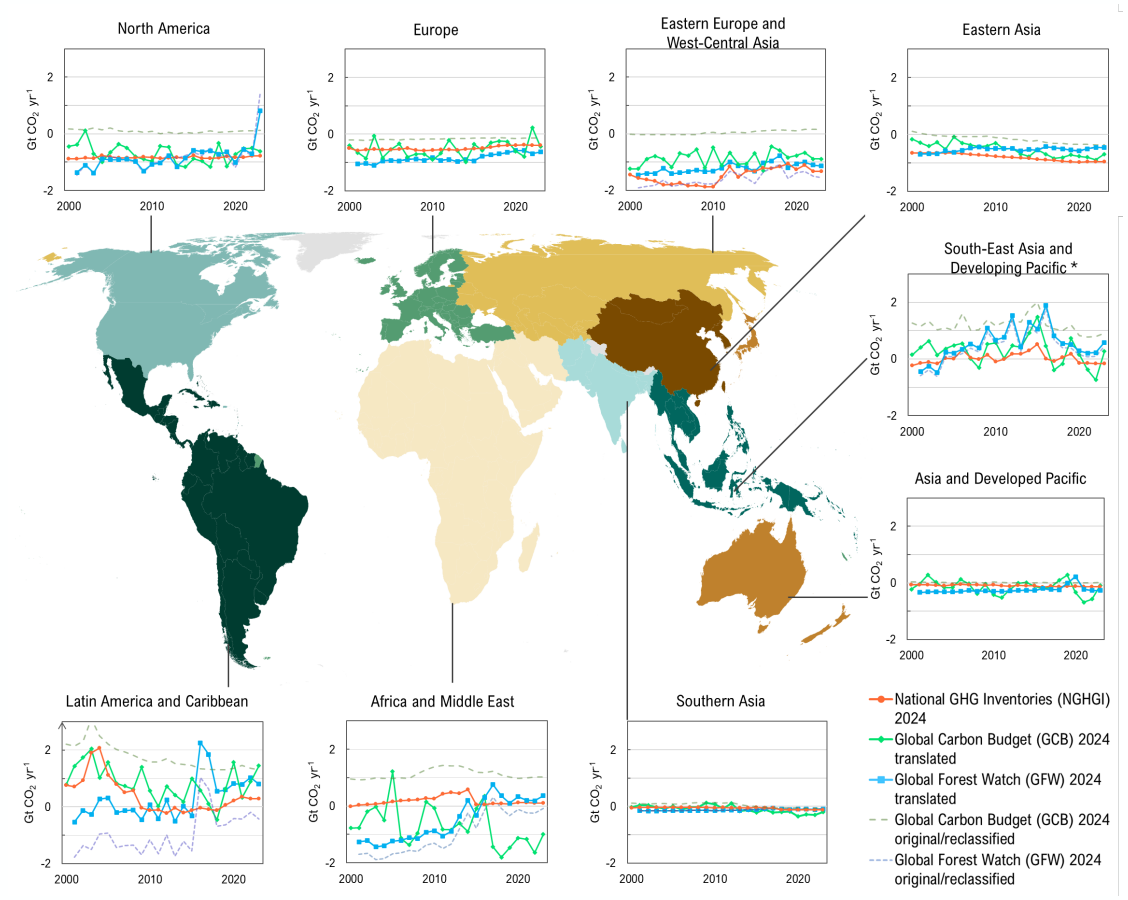
Global Forest Watch (GFW) 2025 original/reclassified

Global Carbon Budget (GCB) 2025 translated

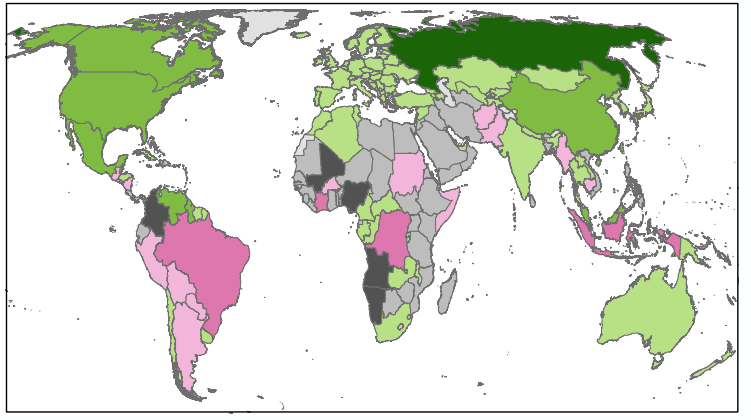
Global Forest Watch (GFW) 2025 translated

# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

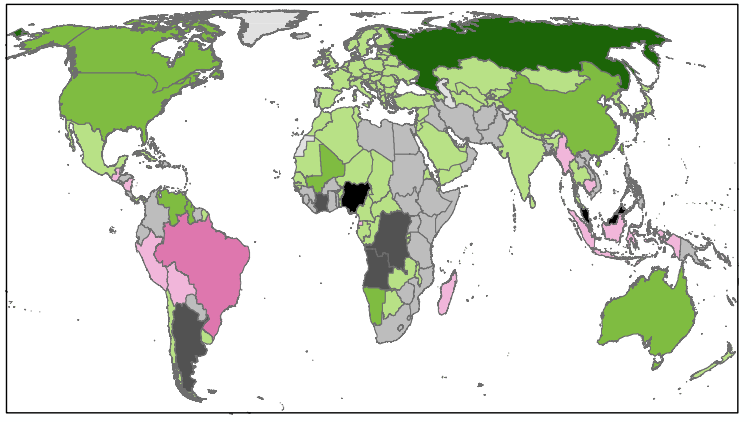
- The translation methodology used by independent datasets effectively addresses well-known conceptual differences related to the definition of anthropogenic emissions and removals at the **global level** and for most countries.
- However, the apparent balance masks substantial differences at the country level.
- For **forest-related $CO_2$ fluxes**, both GCB-translated and GFW-translated tend to differ from NGHGI in the same set of countries (n=14 have differences > 100 $MtCO_2yr^{-1}$)

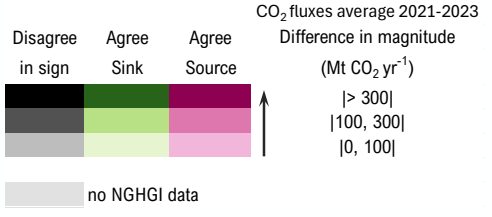



NGHGI vs GCB translated



NGHGI vs GFW translated

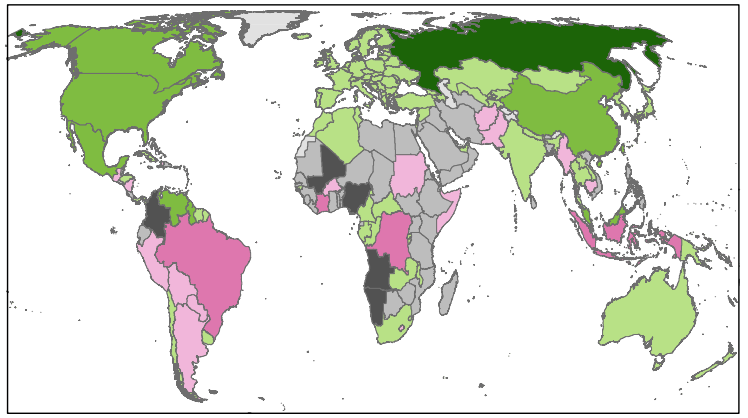




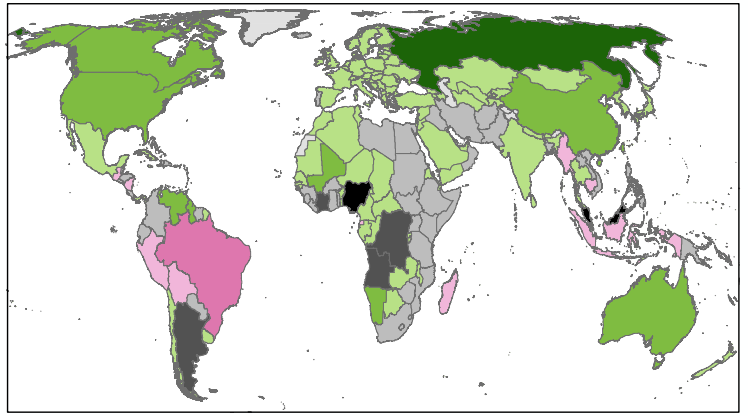

Source: Figure 7 and 8, Melo et al. 2025

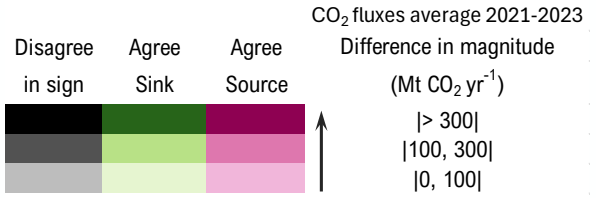
# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

## NGHGI vs GCB translated



## NGHGI vs GFW translated

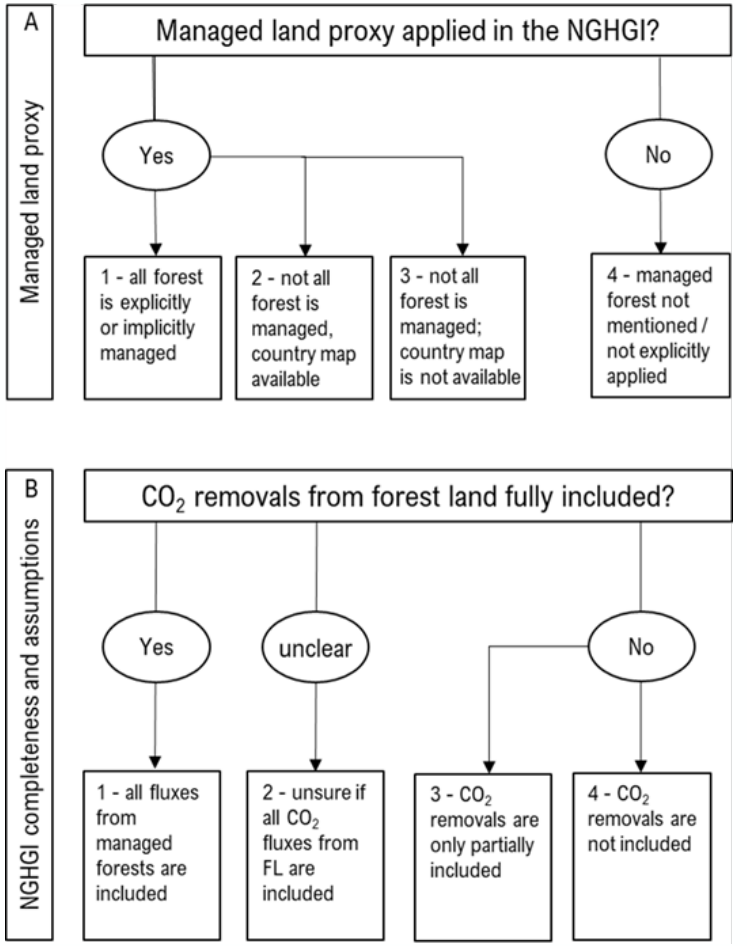





Source: Figure 8, Melo et al. 2025

## Reasons for these differences?

- **inaccurate translation due to the temporal mismatch in the information flow on the use of the *managed land proxy* (e.g., Guyana, Venezuela, Mexico, Colombia, Nigeria, Angola).**

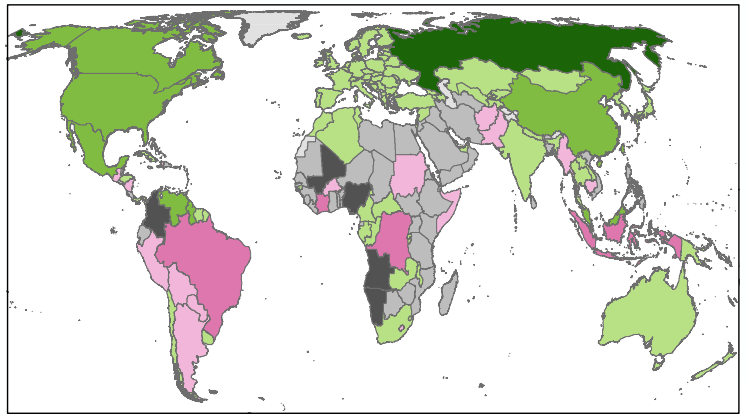



Source: Figure 2, Melo et al. 2025

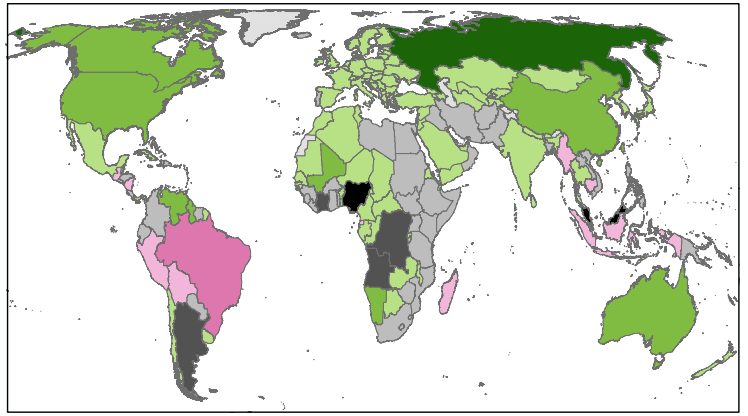
! Future work: continuous update of information on the use of the managed land proxy by Parties to the UNFCCC in the translation methodology used by GCB and GFW

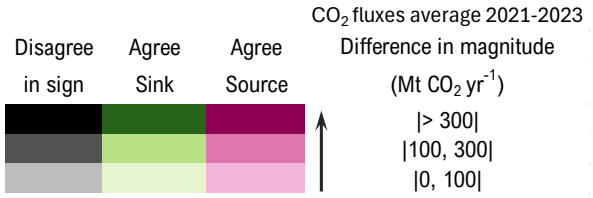
# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

## NGHGI vs GCB translated



## NGHGI vs GFW translated

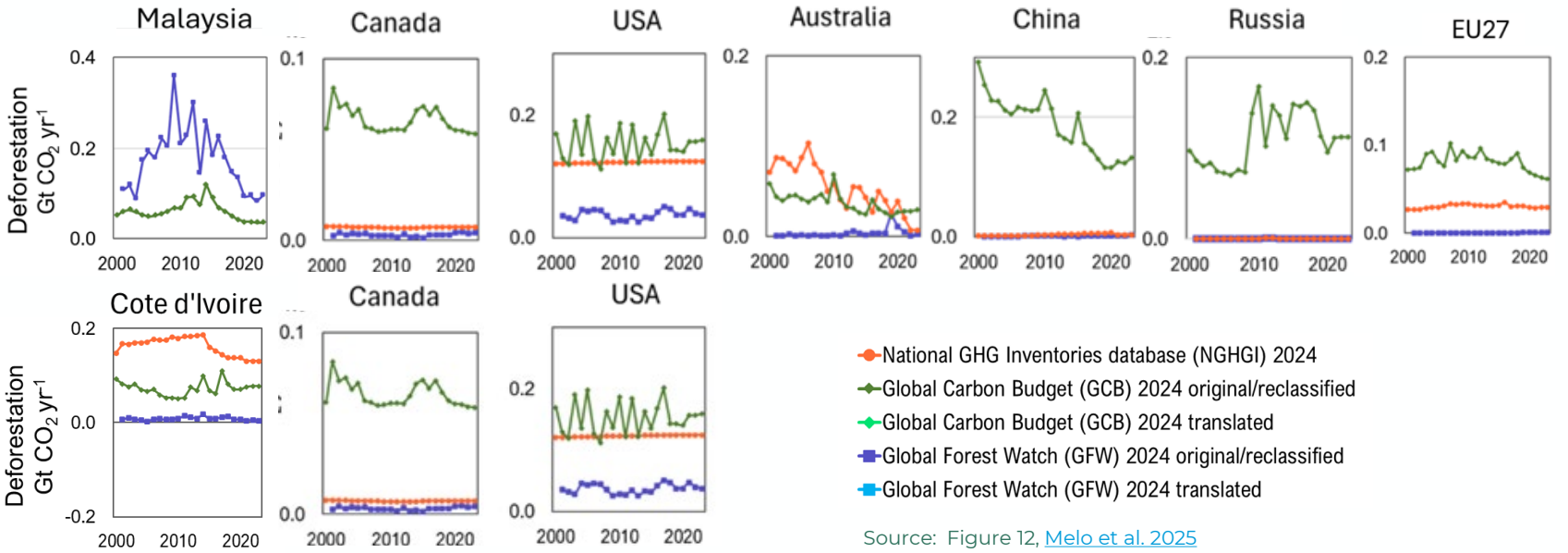





Source: Figure 8, Melo et al. 2025

## Reasons for these differences? *Deforestation*

- **larger emissions from deforestation estimated by GCB compared to NGHGI** for China, Russia, Malaysia, Canada, and EU27 (which aggregated correspond to a 0.45 Gt $CO_2 yr^{-1}$ larger source in GCB-translated)
- **lower emissions from deforestation in GFW compared to NGHGI** in DRC, Cote d'Ivoire, Angola, Argentina, USA, Australia, and Nigeria (aggregating to a 0.86 Gt CO2yr-1 lower source)

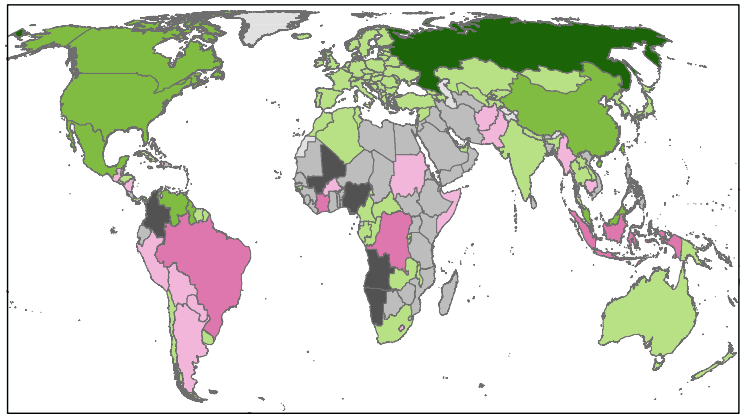



Source: Figure 12, Melo et al. 2025

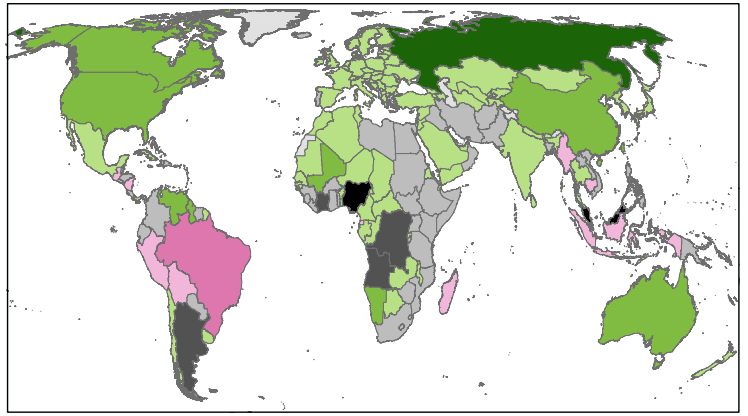
! Future work must explore these differences, especially considering many of these countries are **data rich** and have **well-established NGHGIs**

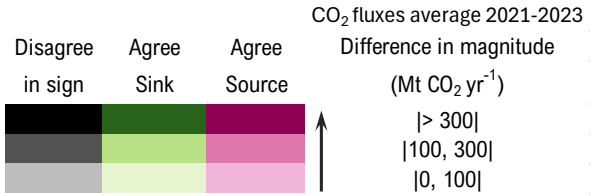
# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

## NGHGI vs GCB translated



## NGHGI vs GFW translated

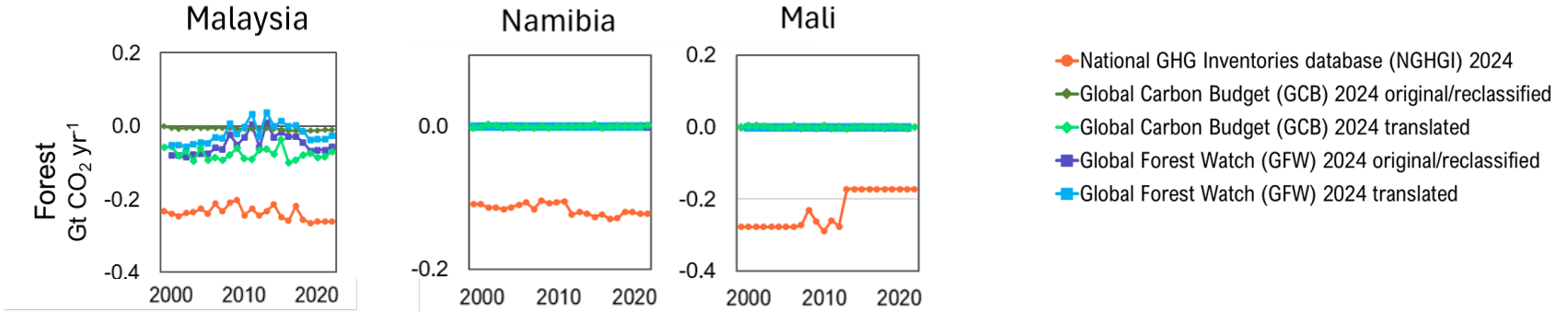





Source: Figure 8, Melo et al. 2025

## Reasons for these differences? *Forest sinks*

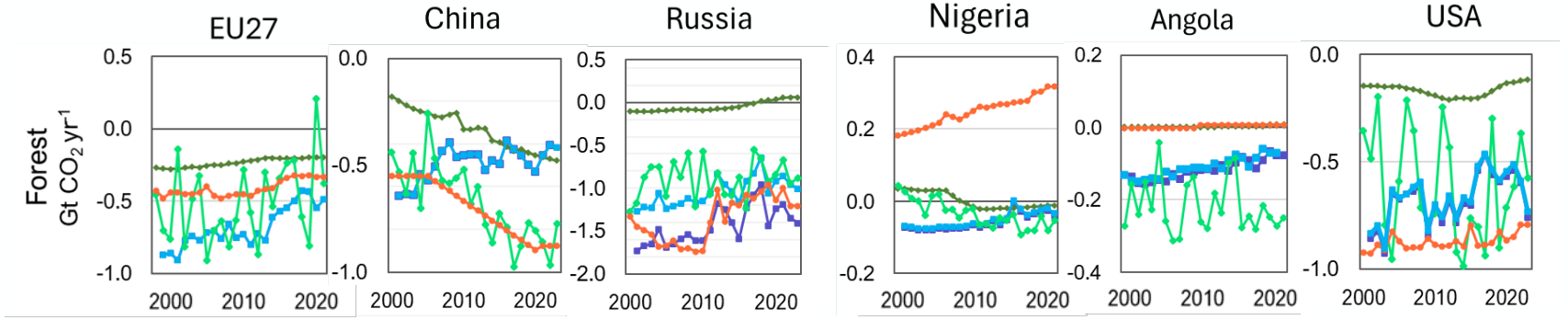
- **Very high** *(implausible?)* **forest sinks in the NGHGI of Mali, Malaysia, and Namibia**




**Malaysia**: In the NGHGI, all forest land is managed (17 Mha), and the net forest sink = -0.24 Gt $CO_2 yr^{-1}$.

**Mali** reports a very large area of forest land of 63 Mha for a total territory of 124 Mha compared to FAO FRA 2020 (13 Mha). **Namibia** reports a very large area of managed forest (66 Mha for a total territory of 82 Mha). Bush encroachment and its thickening are included as forest land; Limitations of the use of the IPCC software are mentioned in the reporting as the reason to include grasslands as forest.

- **Differences in the forest sink >100 $MtCO_2 yr^{-1}$**




! Future work must explore these differences, especially considering many of these countries are **data rich** and have **well-established NGHGIs**

# LULUCF Data-Hub: translation between independent global datasets and national GHG inventories

*LULUCF Data-Hub (EU Forest Observatory)*
*https://forest-observatory.ec.europa.eu/carbon*

*Bulk download from the online repository*
*https://zenodo.org/communities/lulucf-datahub/*

*Data description paper (Melo et al., 2025)*
*https://essd.copernicus.org/preprints/essd-2025-631/*

- *future work*
  - *Continue making available updates and recalculations from NGHGI as they are submitted to the UNFCCC, as well as updates in global carbon cycle model and in EO-based estimates translated to NGHGI definitions;*
  - *strengthening the engagement with NGHGI specialists to improve the transparency of NGHGI data in the LULUCF Data Hub in cases where we are currently making assumptions (e.g., use of managed land proxy, allocation of fluxes from IPCC categories to subcategories), and to secure their support in using the datahub to facilitate communication of NGHGI country data to the other communities;*
  - *work collaboratively across communities on specific country cases to understand the reasons behind persisting disparities in the estimates and to refine translation methodologies as needed.*

- *key recommendations (*as requested by the organizers*)*
  - *For reporting to the UNFCCC, develop and present satellite-based datasets using methodologies consistently with IPCC guidelines and country definitions*
  - *Capacity building works both ways. Aim at co-development of products*
  - *Ensure continuity of data so that every country that wishes to, can use it.*