



Project # 13-C-AJFE-PU

Methodology for Assessing Changes in Soil Organic Carbon

Implications of the recent updates in the Harmonized World Soil Data for assessing land use emissions



Motivation and Objectives

- Induced land use changes (ILUC) due to biofuels may generate emissions. These emissions are known as ILUC emissions.
- ILUC emissions were estimated using economic models (e.g. GTAP-BIO) and emissions models (e.g. AEZ-EF).
- The AEZ-EF model (Plevin et al., 2014) uses and combines different emission factors to generate ILUC values for biofuel pathways. One major component is soil organic carbon (SOC).
- Original SOC estimates in the AEZ-EF model built based on version 1.1 of the Harmonized World Soil database (HWSD).
- The newest version of HWSD is (version 2.0) has been published in 2023.
- This paper aims at revising the AEZ-EF model to use version 2 of HWSD with some modifications for a few countries including US, Canada, and Australia to improve their regional SOC maps.

Data

➤ Harmonized World Soil Database (HWSD) Version 2 (2023) by FAO and IIASA:

- Constructed using the Digital Soil Map of the world (DSMW) and the WISE30Sec (Batjes, 2016) database.
- Nachtergaele et al. (2012) stressed low reliability of this map for the North America and Australia

➤ Revision for US:

- SOLUS integrates multiple USDA databases to train a machine learning model and predict soil properties for the continental US.

➤ Revision for Australia

- The CSIRO map: Estimates are obtained combining field observations and using a Quantile regression forest to harmonize estimates.

➤ Database analyzed for Canada:

- The Soil landscapes of Canada (SLC) 100m is constructed by training a machine learning model with field property data, climate and soil covariates.

Methods

- The following formula is used to calculate SOC:
$$SOC_{smu,tops} = (OCC_{smu,depth} * BD_{smu,depth} * depth(cm))$$
- Aggregation is made at the topsoil level (0-30cm)

➤ Harmonization process:

- Step 1: Filtering non-productive lands (deserts and wetlands)
- Step 2: Evaluation of land cover product choice effects and year: MODIS (Sulla-Menashe and Friedl, 2022) and circa2000 (Ramankutty et al., 2008).

Comparison of versions 1.2 and 2 of HWSD

- The estimates of the newest HWSD version 2 shown a weighted area average soil carbon of 48.05 MT/Ha. Version 1.2 showed 75.69 MT/Ha for all land types.

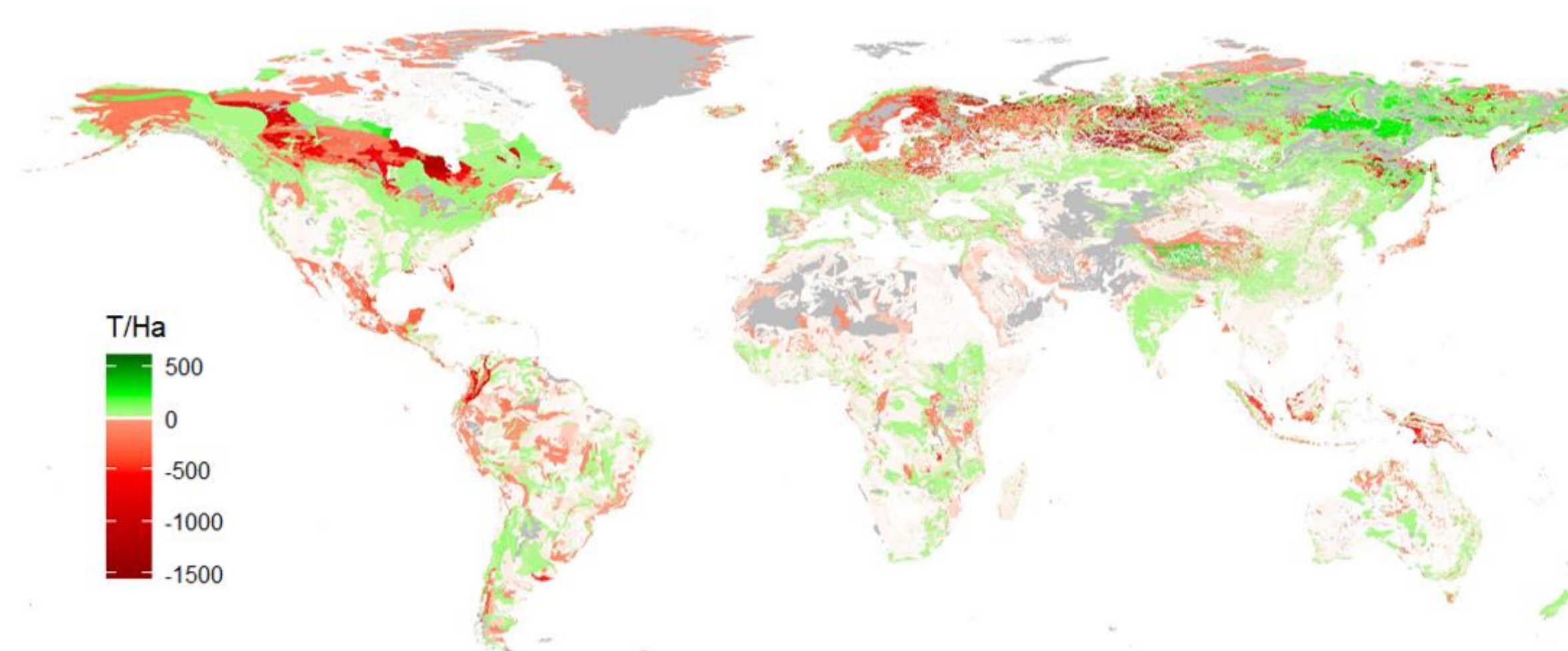


Fig 1. Spatial distribution of differences in SOC across HWSD versions (Version 2.0 – Version 1.2) in Tons per hectare.

Spatial comparison of SOC data across databases



Fig. 2 Spatial distribution of differences in SOC: SOLUS – HWSD Version 2.0 in Tons per hectare

- Estimates were aggregated by GTAP-BIO 19 regions and 18 AEZs and then reintroduced in the AEZ-EF to assess emission factors for diverse land conversions.
- There is a high heterogeneity in estimated SOC across official databases. The same analysis was made to Australia and Canadian databases, and heterogeneity was also observed.

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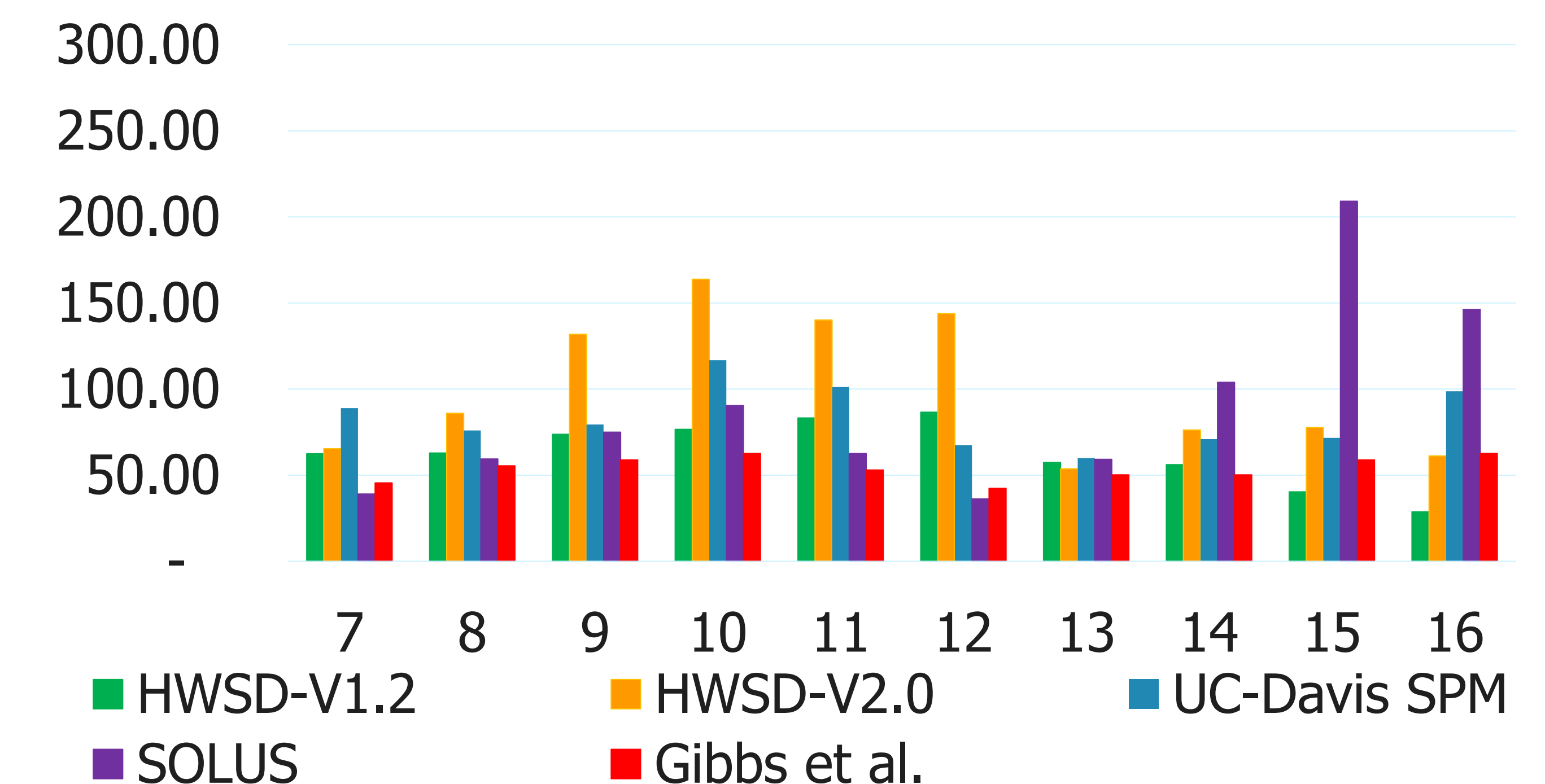


Fig 3. United States Weighted average SOC (MT/Ha) in Cropland across databases

Impacts of revisions in SOC on ILUC values of two SAF pathways

- For a specific application in biofuels assessment, the updated databases highlights a moderate reduction in ILUC values for soybean pathways.
- This comparison was made after updating the model to the newest IPCC guidelines.
- Land cover choice does not present large variation for the showcased pathways and in general for all biofuel pathways.

ILUC Pathway	Current (circa2000, old SOC)	Circa2000 (Updated SOC)	MODIS2001 (Updated SOC)
USOY	18.03	17.64	17.68
GLBSOY	18.01	15.95	15.89

Table 1. Comparison of ILUC factors by pathways in g CO₂e MJ⁻¹

Conclusions

- We adopted the new HWSD with revisions in the US and Australia only with Canada needing further assessment.
- The updated emission factors derived from revised SOC reveal that prior estimates used in ILUC modeling may have overstated emissions.
- Land cover choice does not affect the final factors at large proportions. Therefore, the estimates presented are replicable and users will be capable of doing their own assessment regarding this aspect.

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