CEDA-FLAG - A Hybrid Multi-Regional Environmentally-Extended Input-Output Model for Forestry, Land Use and Agriculture (FLAG)

Topic: World Input-output Modelling and Databases
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Research Question
The Forest, Land, and Agriculture (FLAG) sectors account for approximately one-quarter of global anthropogenic greenhouse gas (GHG) emissions. Despite their significant contribution to global emissions, quantifying FLAG-related emissions remains challenging due to the complexity of global supply chains and the scarcity of emissions factor data. This research addresses the key question: How can we integrate existing models and datasets to develop a more reliable, regionally specific, and comprehensive model for assessing FLAG-related emissions across complex global supply chains?

Method Used
To address this research question, we developed CEDA-FLAG, an innovative hybrid Input-Output model that integrates two state-of-the-art models: Comprehensive Environmental Data Archive (CEDA), a Multi-Regional Environmentally-Extended Input-Output (MR-EEIO) model, and the Comprehensive Accounting of Land-Use Emissions (CALUE) model, which provides country-, process-, and product-specific estimates of agricultural and land-use change emissions. Our method leverages CEDAâ€™s strengths of Input-Output (IO) analysis in tracing economic activity and associated emissions across global supply chains and combines it with CALUEâ€™s granular, physical emissions data from agricultural and land-use activities. By aligning CEDA and CALUE, we built a unified framework that accommodates both spend- and mass-based emission intensity metrics. This integration involved reconciling regional scopes, sectoral classifications, and to create a coherent model capable of assessing FLAG-related emissions with high precision.

Data Used:
The development of CEDA-FLAG relies on two complementary models:
1. CEDA: A renowned MREEIO model that covers 95% of the global economy and provides spend-based emission factors for 400 economic sectors in 149 countries. CEDA enables comprehensive analysis of multi-regional economic activity and emissions embedded in international supply chains.
2. CALUE: A database offering detailed, region-, process-, and product-specific estimates of agricultural and land-use change emissions for 151 agricultural commodities. The CALUE database captures the environmental impacts of land management practices and land-use changes with high granularity.
Through careful alignment of these models, we achieved a harmonized database that combines monetary (spend-based) and physical (mass-based) emission factors, enabling stakeholders to conduct more accurate, regionally specific assessments of FLAG emissions across multiple dimensions.

Novelty of the Research:
The novelty of CEDA-FLAG lies in its ability to bridge a critical gap in FLAG-related emissions accounting by integrating economic and physical models within a unified IO framework. Unlike traditional approaches that rely exclusively on spend-based or physical data, CEDA-FLAG is the first to combine the strengths of both spend-based and mass-based emissions accounting into a single hybrid framework for FLAG sectors. While IO models have been widely used for assessing

emissions in other sectors, this research pioneers the integration of agricultural and land-use change emissions into IO models, providing a more comprehensive picture of FLAG-related emissions.
Key innovations include:
1. Hybrid Approach: The integration of economic and physical activities and emissions within a hybrid MREEIO framework allows for nuanced assessments of FLAG emissions, capturing the impacts of both land management practices and global supply chains.
2. Comprehensive Coverage: By harmonizing CEDA and CALUE, CEDA-FLAG offers regionally specific emissions metrics for 400 economic sectors and 151 agricultural commodities, filling a critical data gap in FLAG emissions accounting.
3. Policy Relevance: The database is explicitly designed to align with emerging reporting frameworks, such as the Science-Based Target Initiative and the GHG Protocol, supporting stakeholders in meeting FLAG-specific reporting requirements.

This research contributes to both the field of Input-Output analysis and the understanding of FLAG emissions, providing new insights into the intersection of economic activity, land-use change, and sustainability. By providing stakeholders with a robust tool to identify emissions hotspots, prioritize mitigation strategies, and evaluate the effectiveness of FLAG-related interventions, CEDA-FLAG supports the transition to more sustainable land-use practices and contributes to global climate goals.