Co-production of healthy, sustainable food systems for disadvantaged communities

Integrating Environmental Life Cycle Assessment and Land Use Modelling to Guide Sustainable Agriculture

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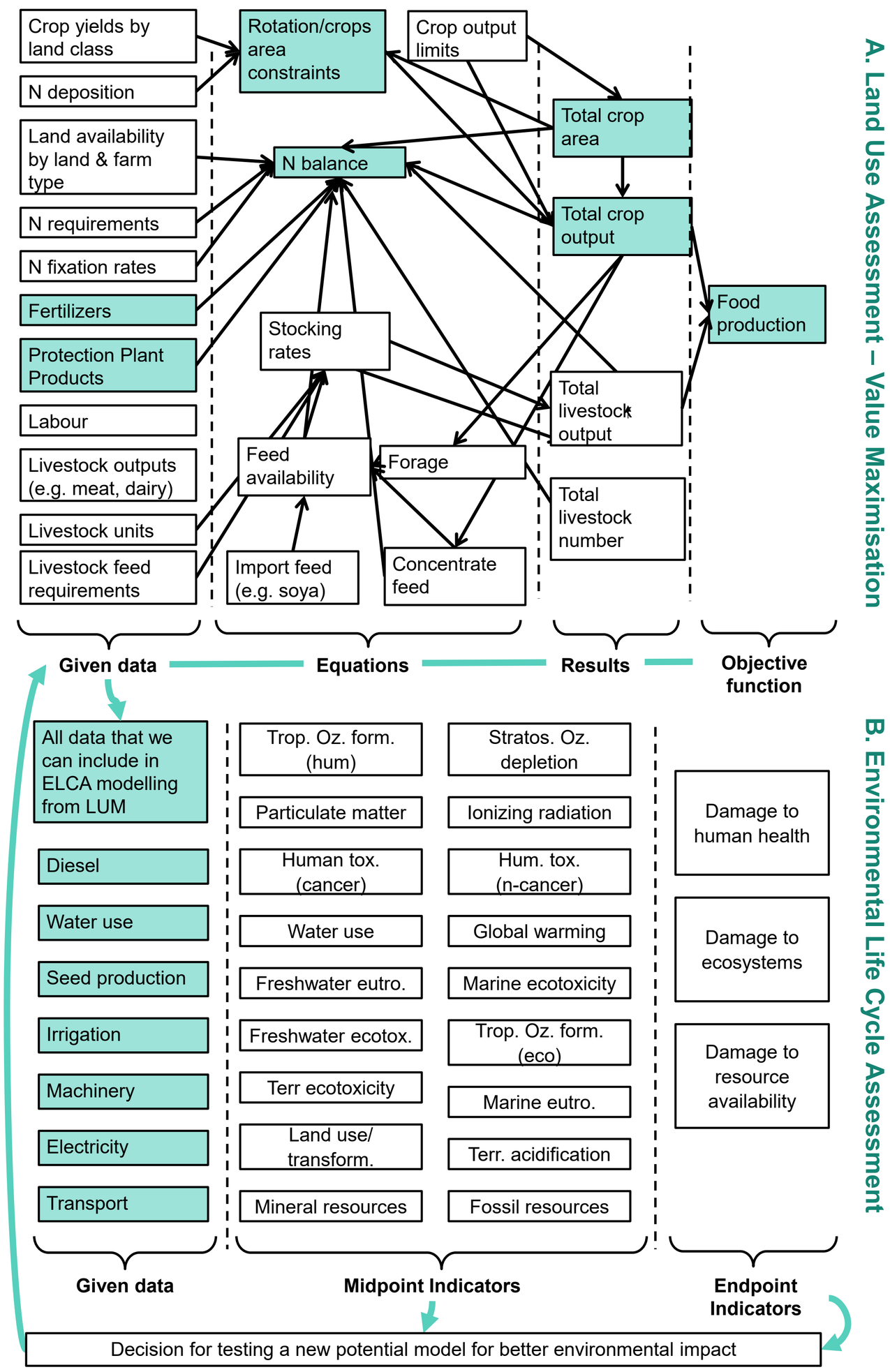
Introduction

Environmental Life Cycle Assessment (ELCA) is a key method for evaluating environmental impacts in food systems, but it often lacks the spatial and temporal resolution needed to capture dynamic land-use practices. **Land Use Modelling (LUM)** complements ELCA by simulating how land-use changes—driven by climate, policy, or socio-economic factors—affect ecosystem services, productivity, and long-term sustainability.

Objectives

By integrating ELCA and LUM, we propose a novel, comprehensive framework for assessing both environmental and economic impacts of development strategies (Anastasiadis et al., 2013). This approach bridges the methodological divide, enabling a more holistic evaluation of agricultural systems.

Methodology



Graph 1. Schematic of the optimal Land Use model combined with ELCA (Adapted from Smith et al., 2018; Smith et al., 2019)

Data specifications

The analysis takes several flows in consideration to combine economic and environmental impacts. For example, concerning fertilizers:

1. Types of fertilizers used (proportion)

Nitrogen, Phosphorus, Potassium, Urea, Ammonium nitrate, Manure, etc.

1. Amount used in litres per hectare per year
2. Number of applications per hectare per year
3. Price per litre, including variation per year

Case Study – Crop Research Unit, University of Reading, Sonning, UK

We apply our combined ELCA and Land Use modelling method to the LIBERATION crop rotation experiment at the University of Reading's Sonning Farm. This EU-funded project tested how increasing crop rotation diversity affects yield stability, soil health, and ecosystem services.

Why this case study?

- Real-world field data from a long-term experiment (2013–2017)
- Three rotation types: simple, standard, and diverse systems
- Drought resilience tested using rain-out shelters
- Indicators measured: crop yield, canopy temperature, soil microbial activity, pest regulation
- Ideal for ELCA–Land Use modelling: spatially and temporally explicit, multi-impact dataset

This trial offers a rare opportunity to analyse how **management intensity and system complexity** shape agricultural sustainability across environmental dimensions.

SDGs benefits

Supports long-term food production and resilience, ensuring food security for current and future generations.

Informs decision-making for the economic, social, and environmental sustainability of food systems.

Provides multi-level insights into the environmental impacts of agricultural practices, supporting climate-responsive strategies.

Promotes improved land use management that enhances ecosystem services, resource efficiency, and biodiversity.

References

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