Center for Sustainability Science and Strategy

Global Change Forum 47

Food Security in Africa under a Changing Climate Navigating the Energy and Agricultural Transition to Net Zero

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Background & Purpose

Main Objective

Create an **integrated modeling framework** that captures **global dynamics** (economic growth, trade, emissions, climate) alongside local detail (water basin management, agricultural practices) with particular focus on **Sub-Saharan Africa**

Challenges

1. Improve living standards and reduce poverty.
2. Enhance food security under growing populations and uncertain climate impacts.
3. Develop renewable energy sources for a green transition.
4. Attain net zero emissions in line with global climate goals.

Why This Matters

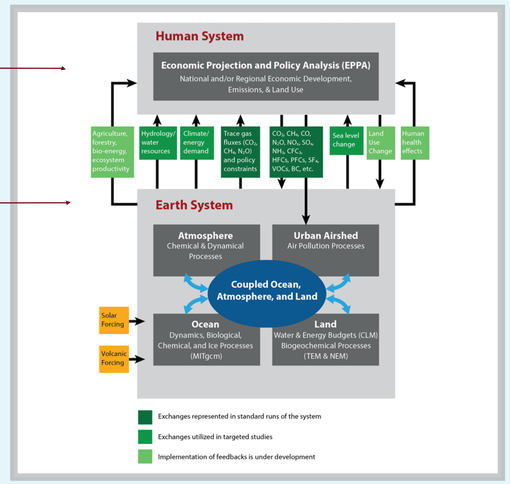
Africa's population and economic growth: major share of global GHG emissions and among the most vulnerable to climate impacts.

Proposed Integrated Modeling Framework

MIT Integrated Global System Modeling (IGSM) framework

EPPA (Economic Projection and Policy Analysis)

Global, multi-region, multi-sector Computable General Equilibrium (CGE) model.



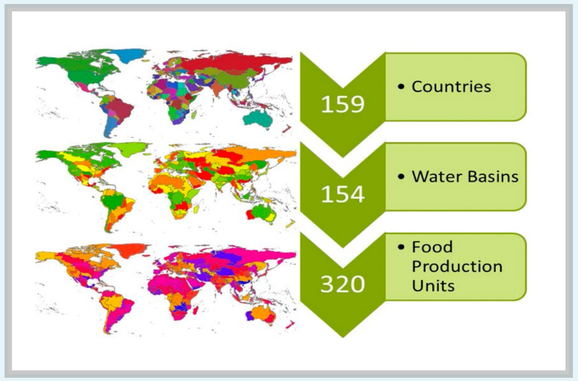
MESM (MIT Earth System Model)

Projects climate and Earth system responses

IFPRI (International Food Policy Research Institute)

IMPACT (International Model for Policy Analysis of Agricultural Commodities and Trade)

Partial equilibrium, agriculture-focused model with high spatial resolution (320 food-producing units across 159 countries).



Water Resources System (WRS)
Model developed by MIT and IFPRI, which links directly with the **IGSM framework** and is the **irrigation water supply component of IMPACT**

EPPA ↔ IMPACT:

- Exchange of prices, quantities, yields, land use, and emissions.
- Agricultural sectors in EPPA replaced/expanded by IMPACT's detailed representation.

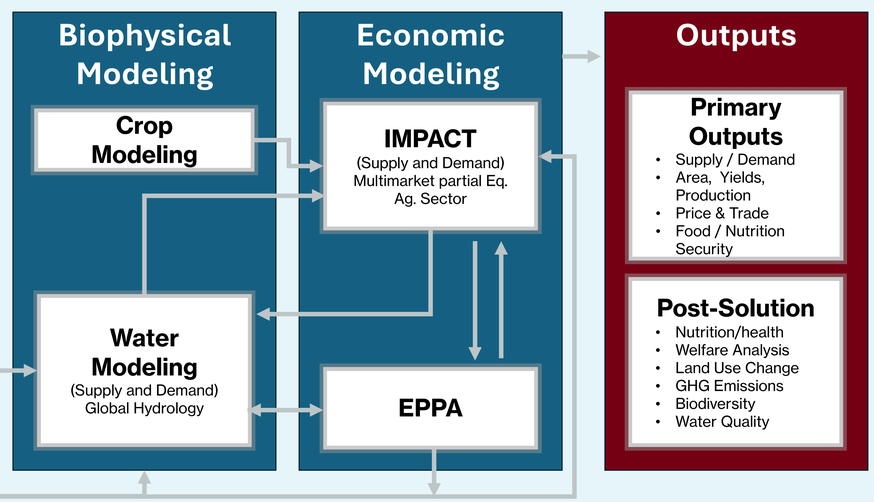
EPPA ↔ WRS:

- Non-agricultural water demand (from EPPA) and hydropower/cooling water availability (from WRS).

MESM ↔ IMPACT & WRS:

- Climate outputs (temperature, precipitation) to drive crop yields, water availability, hydropower potential, and labor productivity feedback.

Linkages



Horizon December 2026

Research Plan

1. **Mapping Parameters & Scales**
2. **Harmonize Base Year:** Ensure consistency among model inputs (e.g., agricultural production, trade flows) using a benchmarking routine.
3. **Build Model Linkages:**
   - Develop iterative coupling (EPPA–IMPACT, EPPA–WRS, MESM → sector models).
   - Use a block decomposition algorithm to solve for internal consistency in agricultural markets.
4. **Establish Harmonized Baseline**: Run the newly linked models repeatedly until convergence in key variables (prices, crop outputs, water demands).
5. **Scenario Analysis:**

Expected Outcomes

- **Novelty:** First-of-its-kind global framework linking a detailed agricultural-water model to an IAM with full economic and climate feedback.
- **Policy-Relevant Insights:**
  - Quantification of costs and benefits of different land-use strategies
  - Guidance on hydropower development vs. irrigation priorities under various climate scenarios.
  - Credible estimates of how Africa's development pathways influence – and are influenced by – global climate policy.
- **Scalability:** While focused on Africa, the approach is extensible to other world regions seeking to manage climate, energy, and agricultural transitions.