Integrated regional analysis and exploration of resource management options: Central Rift Valley of Ethiopia

PhD Proposal

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Background: Location
Background: The Central Rift Valley (CRV) in Ethiopia

- 38°00’-39°30’ E and 7°00’-8°30’ N
- About 1 million ha
- 150 km southwest of the Addis Ababa,
- Lakes: Ziway, Abyata and Langano,
- Major rivers: Bulbula, Meki and Katar
- Population: about 1.5 million
Background…..

• Elevation: 1600 - 3000 masl
• Annual rainfall: 600 - 1600 mm
  – About 70% in the rainy season (July to September)
• Average annual daily temperature: 14 - 19 °C
• Soils:
  – Western part
    • Cambisols, Luvisols and vertisols.
  – Around Lake Ziway
    • Vertic Andosols and Fluvisols.
  – Eastern part
    • Luvisols, Nitosols and Vertisols.
Problems in the CRV

• Low agricultural productivity
• Over-exploitation of water resources
• Deforestation
• Soil degradation
• Overgrazing

• POVERTY
Low agricultural productivity
Falling water tables in National Wetland Park

![Graph showing falling water tables over time with two lines: one for Lake Abyata and one for irrigated area. The graph has a y-axis labeled 'area (ha)' ranging from 0 to 20,000 and an x-axis labeled 'year' ranging from 1970 to 2010. The area decreases significantly from about 18,000 ha in 1970 to around 8,000 ha in 2000, and then stabilizes at about 4,000 ha. The irrigated area increases from about 2,000 ha in 1970 to around 16,000 ha in 2010.}
Energy needs and deforestation are closely linked
Increased land degradation
Poverty: Part of population in Poverty Safety Network Program
Opportunities: Small holders irrigation

- Irrigated agriculture along Lake Ziway and its tributaries has increased to about 10,000 ha providing new income.
Opportunities: Tourism
Competing claims for resources /conflict of interest/ Multiple goals

Nature and recreation

Irrigation

Forestry

Agro-industries

Livestock

Food Security

Urbanization

Climate change & Variability

Multiple goals of stakeholders
Objectives

Analyze and explore resource use and management options in the CRV given the available resource base, constraints and goals of stakeholders.

Specific objectives of this study are:

- To identify policy views and development objectives of stakeholders in the CRV;
- To spatially and/or temporally characterize the biophysical, economic and climate resource base and evaluate it for alternate production systems under current and changing climatic conditions;
- To identify robust land and water management strategies and policy options, and explore their contribution to realization of stakeholders’ objectives such as increasing food production, income, water use efficiency, and labor productivity;
- To identify potential synergies, trade-offs and conflicts among various development objectives in view of livelihood improvement and sustainability.
Methodology

Interactive Multiple Goal Linear programming techniques (IMGLP)

Main research steps
1. Resource inventory and assessment of current land use systems
2. Land evaluation and design of alternative Land Use Systems (LUS)
3. Quantification of biophysical production possibilities and input-outputs
4. Identification of constraints
5. Identification of stakeholders, policy objectives and plausible scenarios (incl. climate change)
6. Interactive Multiple Goal Linear Programming
7. Evaluation of model outputs and analysis of policy instruments
1. Resource inventory and assessment of current LUS

Land and water resources
- Slope map: from existing DEM
- Overlay of resource maps
- Reclassification of soil map based on diagnostic soil characteristics
1. Resource inventory….

Climate resources

- Seasonal and annual rainfall
- Coefficient of Variability
- Temperature
- Potential evapotranspiration

Characterization of climatic resources
1. Resource inventory….

Socio-economic resources

- Population data:
  - Gender and age
  - Labor availability
- Roads, markets:
  - Vicinity and accessibility to basic infrastructure
2. Land evaluation and design of alternative Land Use Systems (LUS)

Homogeneous land units (LUs)
2. Land evaluation ....

LUTs are evaluated by matching their requirements with diagnostic qualities of the available LUs

Homogeneous Land Units (LU)

Land evaluation and design of alternative Land Use Systems (LUS)

Alternative Land Use Types (LUT): crop/livestock with well-defined management
3. Quantification of biophysical production possibilities
and input-outputs

- Biophysical production possibilities are quantified.
- Optimal mix of inputs required to realize these production possibilities is defined.
- Each LUS will be defined by its inputs and outputs.
4. Identification of constraints

- Biophysical constraints:
  - Land and water constraints
  - Agronomic constraints (e.g. rotations)
- Socio-economic constraints:
  - Labor availability
  - Capital availability
5. Identification of stakeholders objectives

- Identification of stakeholders
- Assess stakeholders policy views
- Identify objectives of stakeholders
6. Development of scenarios

• Plausible scenarios
  – Stakeholder policy views
  – Resource availability (land and water)
  – Alternative LUS
  – Market conditions

• Probabilistic scenarios
  – Climate change/variability
  – Adaptation strategies (e.g. through alternative LUS)
7. Interactive Multiple Goal Linear Programming (IMGLP)

- IMGLP model is developed using General Algebraic Modeling System (GAMS) software
- Model is run iteratively for each goal with stakeholders
- Tradeoffs among different objectives
- Plausible and probabilistic scenarios
- Sensitivity analysis (objective function and model variables)
1. Socio-economic resources

2. Climatic resources

3. Land and water resources

4. Homogeneous Land Units (LU)

5. Land evaluation and design of alternative Land Use Systems (LUS)

6. Alternative Land Use Types (LUT)

7. Stakeholders' policy views and objectives (plausible scenarios)

8. Biophysical constraints

- Evaluated scenarios
- Robust management options
- Trade-offs

9. Socio-economic constraints

10. Interactive multiple goal linear programming (IMGLP)

11. Quantification of land use systems

12. Drainage

13. Soil

14. Slope

15. Land use

16. Admin. boundary

17. Population

18. Capital

19. Infrastructure

20. Temperature

21. Rainfall

22. Rainfall CV

23. PET

24. Rainfall amount

25. CV

26. Land and water resources

27. Biophysical constraints

28. Socio-economic constraints

29. Climate change/variability scenarios (Probabilistic scenarios)

30. Input and output matrix

31. Stakeholders' policy views and objectives (plausible scenarios)
Expected results

• Potentials and constraints of resource base
• Prospects for land use and policy options
• Impact of climate change/variability on regional production potentials
• Identification of synergies and trade-offs among development objectives
Thank you