

# Assessing the land-energy nexus in Southern Africa: An integrated assessment and scenario approach

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# Land-Energy Nexus

- 70% of Sub-Saharan African households rely on firewood and charcoal for cooking.
- Contrasting views on the impact of woodfuel harvesting on forests:
  - Key driver of deforestation *versus*
  - Contributor to forest degradation and localized deforestation
- Impact is site specific => 'hot spots' of unsustainable woodfuel use

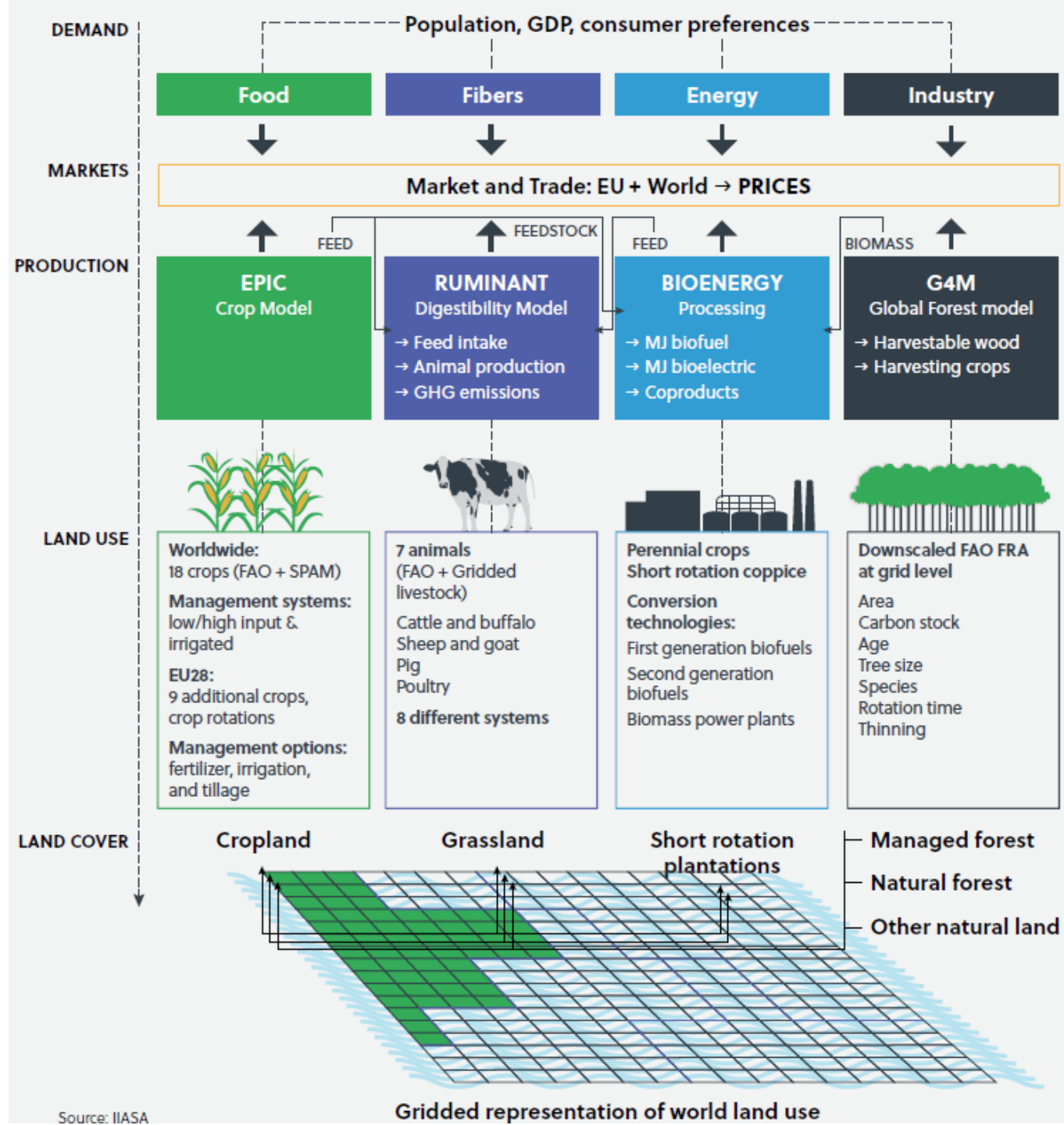


# Motivation and objective

- Part of the ISWEL project: Larger study of the **land-water-energy trade-offs** in the Zambezi river basin.
- Documented strong interactions and trade offs between **household energy demand** in the form of woodfuel (firewood and charcoal) and **deforestation/ forest degradation** in Southern Africa.
  - Firewood and charcoal make up between 70% (Zambia) and 89% (Malawi) of the national energy consumption (IDLO 2011 and Kambewa and Chiwaula, 2010)
  - Charcoal production is considered one of the primary causes of forest degradation in Malawi and Zambia (Day et al. 2013, MNREM 2017).
- LULUCF analysis often do no take into account the energy-land nexus in African countries.
- **Aim:** To assess the impact of woodfuel demand on land use and forest change in Malawi and Zambia using an integrated modelling framework

# GLOBIOM

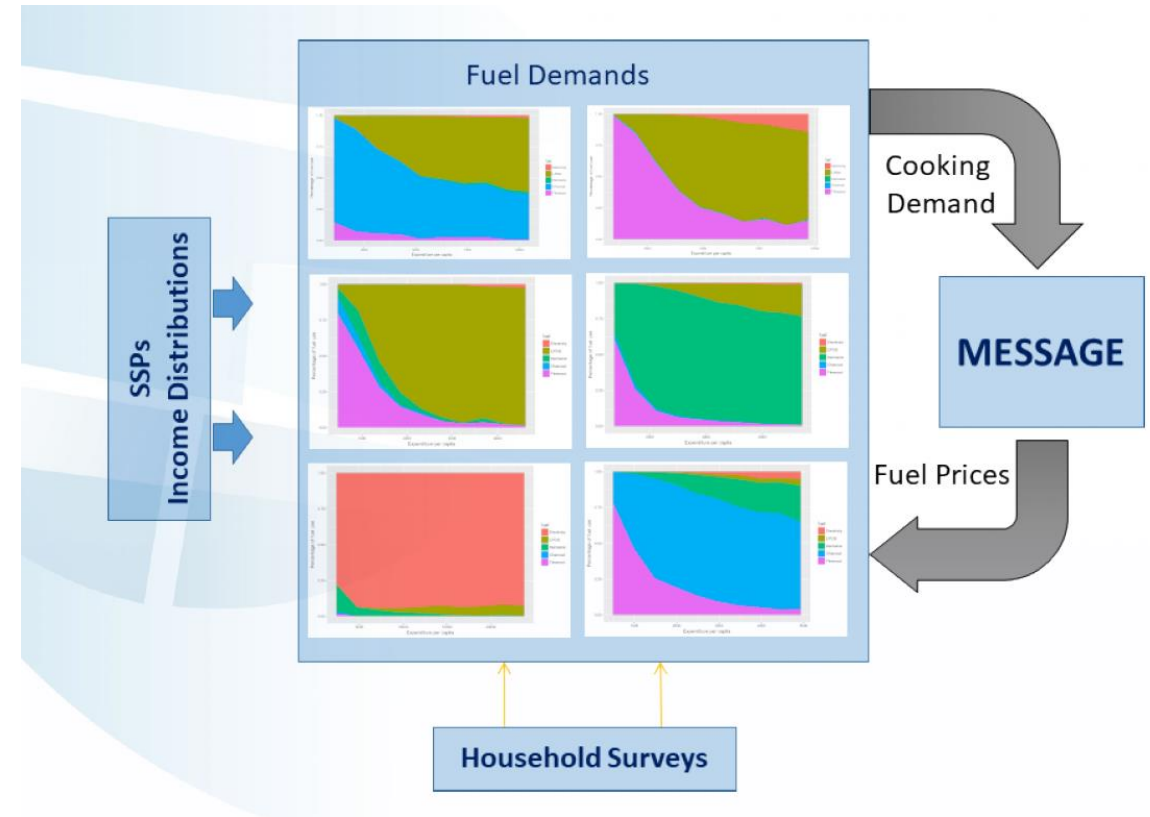
- Global scale model based detailed spatial resolution (>200k cells)
- Partial equilibrium and land use model
  - Agricultural, wood, and bioenergy markets
  - 30+ world regions and Zambezi basin countries
  - Bilateral trade flows based on spatial equilibrium approach
- Bottom-up approach
  - Explicit description of production technologies a la Leontief
  - Technologies specified by production system and grid cell
  - Water availability/demand in Zambezi basin at 21 subbasin level



# MESSAGE-Access

- Provides projections for fuelwood and charcoal household demand as a function of income, prices, annualized stove costs and inconvenience costs.
- National household survey data calibrate household preferences for cooking options in the base year
- Future demands are projected using:
  - Price trends from the MESSAGEix IAM (Huppman et al 2018)
  - Future demographics and income (Samir KC & Lutz 2017; Crespo Cuaresma et al 2017)
  - National projections for Gini coefficient (Rao et al 2019)

MESSAGE-access flowchart



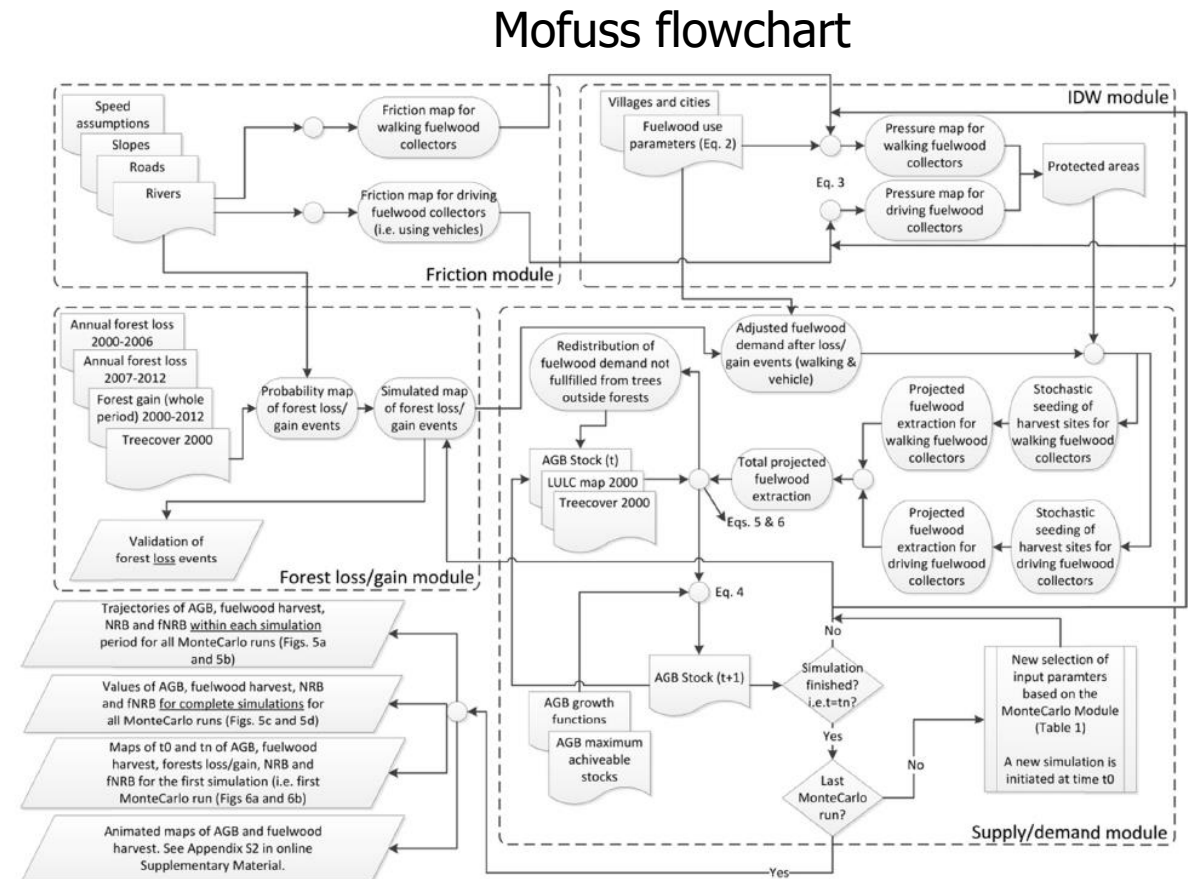
Source: Poblete-Cazenave & Pachauri 2018 09 April 2019

EGU: Session HS5.2.1



# Mofuss (Modeling fuelwood savings scenarios)

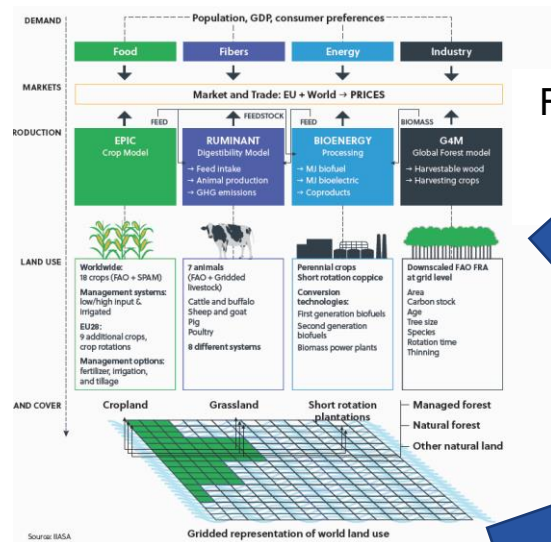
- Spatially explicit and dynamic landscape model that simulates the effect of *residential* woodfuel harvesting on local vegetation.
- Projects woodfuel harvesting sites, accounting for forest supply, distance, accessibility and local demand.
- Main inputs are high resolution data on land cover, transport infrastructure and population combined with forest growth and friction parameters.



Source: Ghilardi et al. (2016)

# Model framework

## GLOBIOM

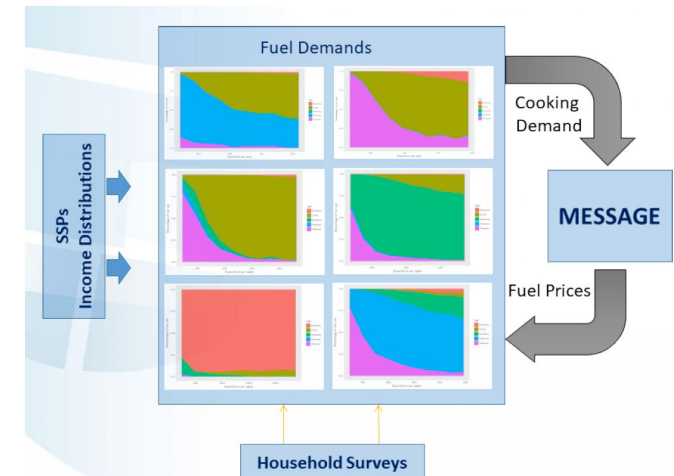


## SSP Income and population projections

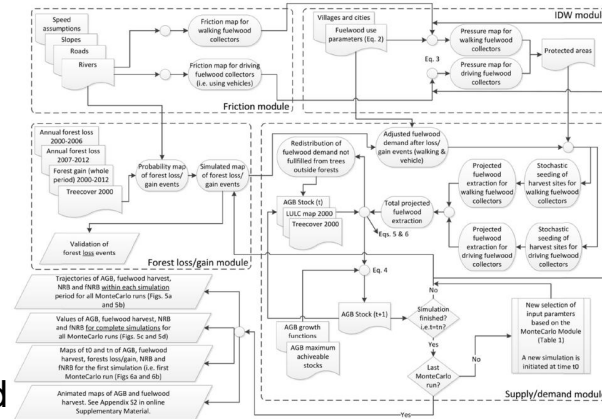
Forest change as a consequence of agricultural and commercial forestry drivers (ha)

Demand projections for household firewood and charcoal (GJ)

## MESSAGE-Access



## Mofuss



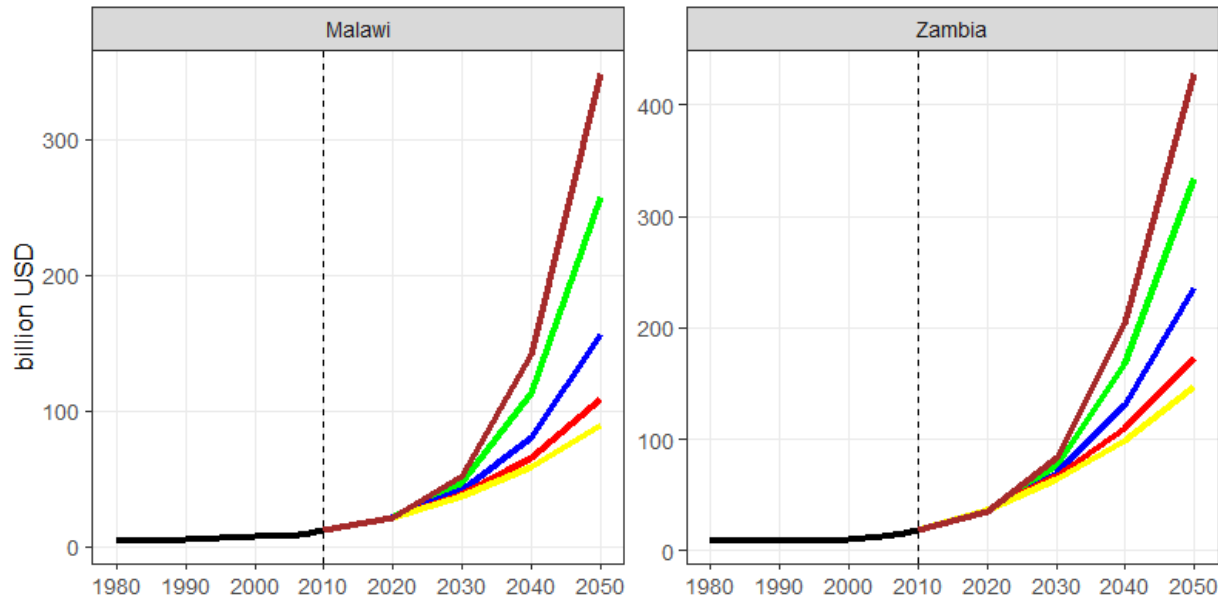
Demand for biomass for household energy (firewood and charcoal – M3)

Land use change (ha) and GHG emissions(CO2eq)

Supply-demand balance, Non Renewable Biomass and fraction of Non-Renewable Biomass

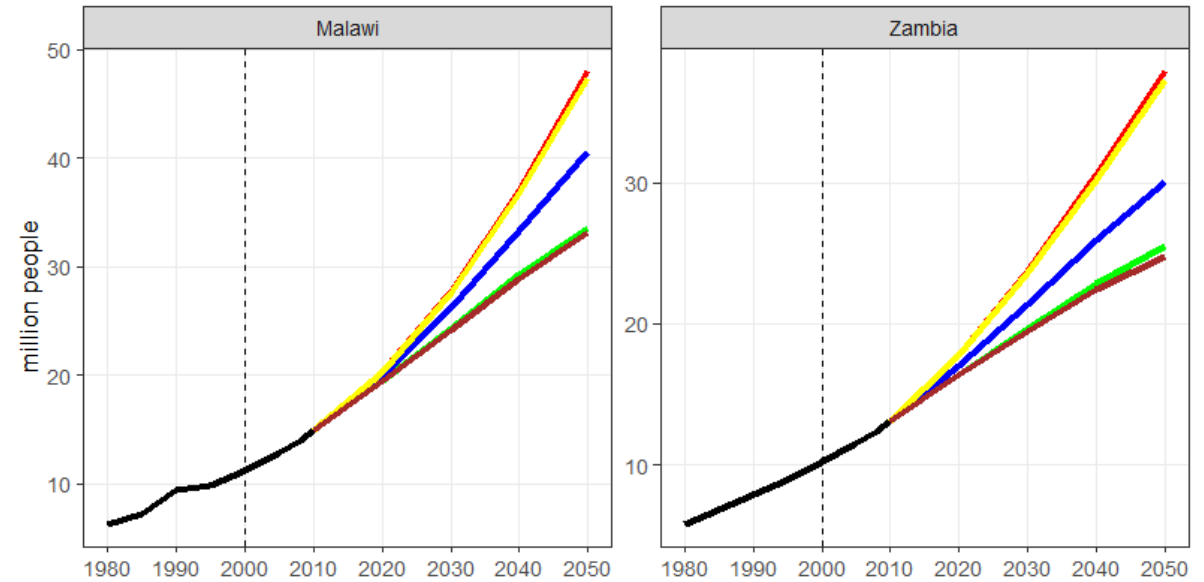
# Scenario assumptions based on Shared Socioeconomic Pathways

GDP projections: 2000-2050



— Historical    — SSP1    — SSP2    — SSP3    — SSP4    — SSP5  
 — SSP1    — SSP3    — SSP5

Population projections: 2000-2050



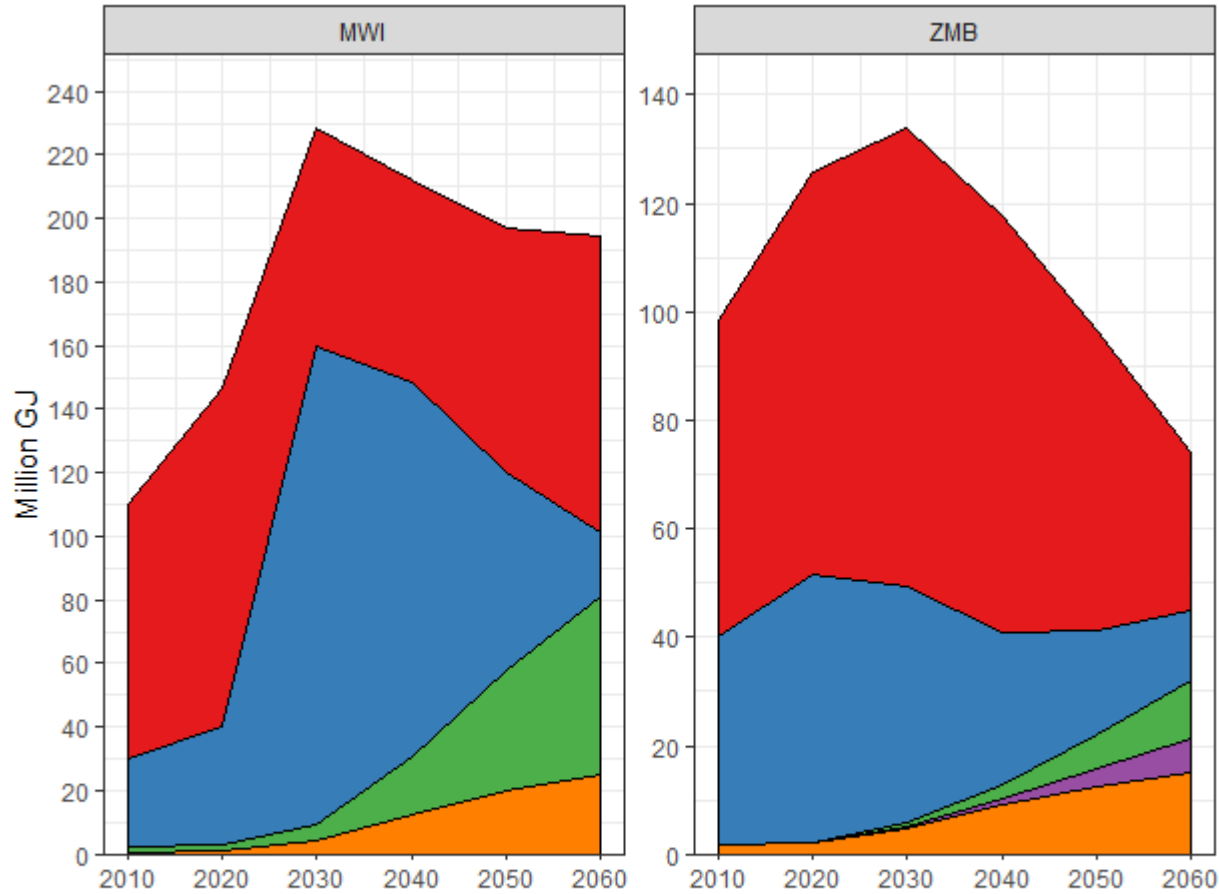
— Historical    — SSP1    — SSP2    — SSP3    — SSP4    — SSP5  
 — SSP1    — SSP3    — SSP5



# BAU: Household energy demand from MESSAGE-Access

Household energy demand projections (GJ)

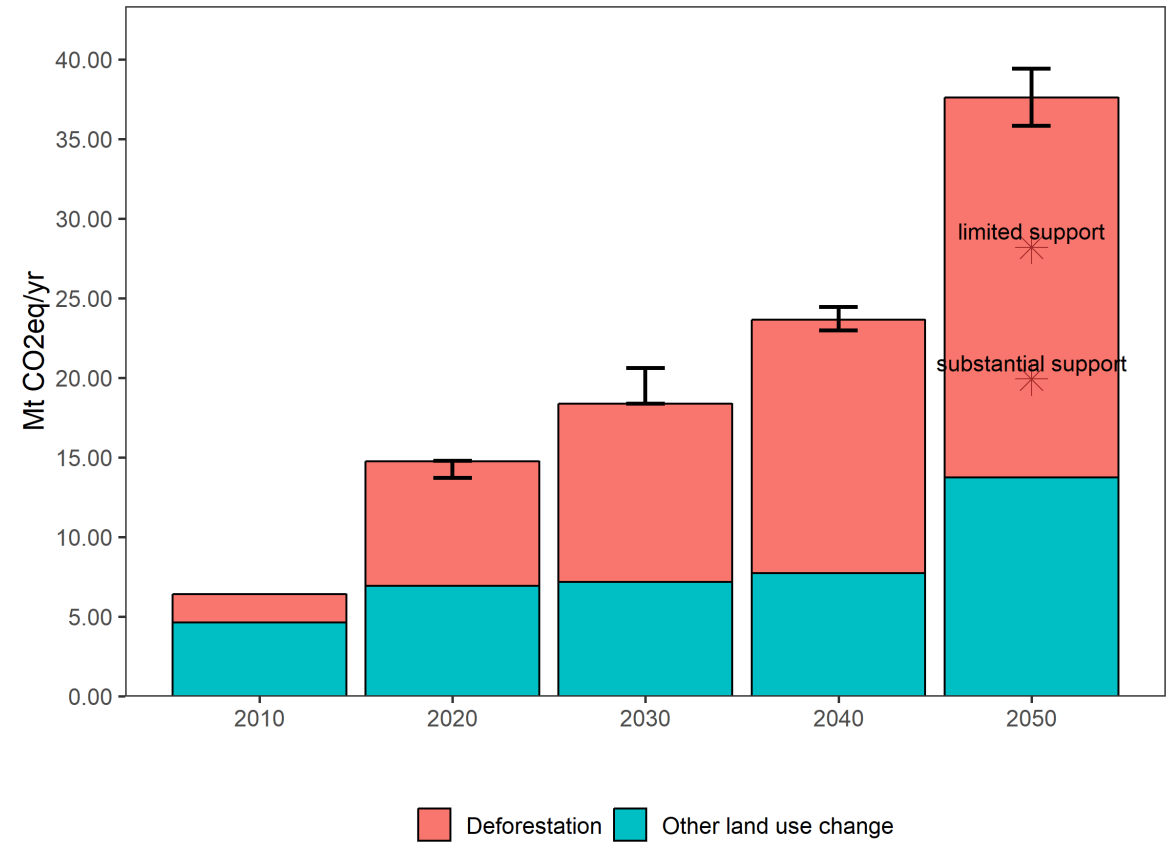
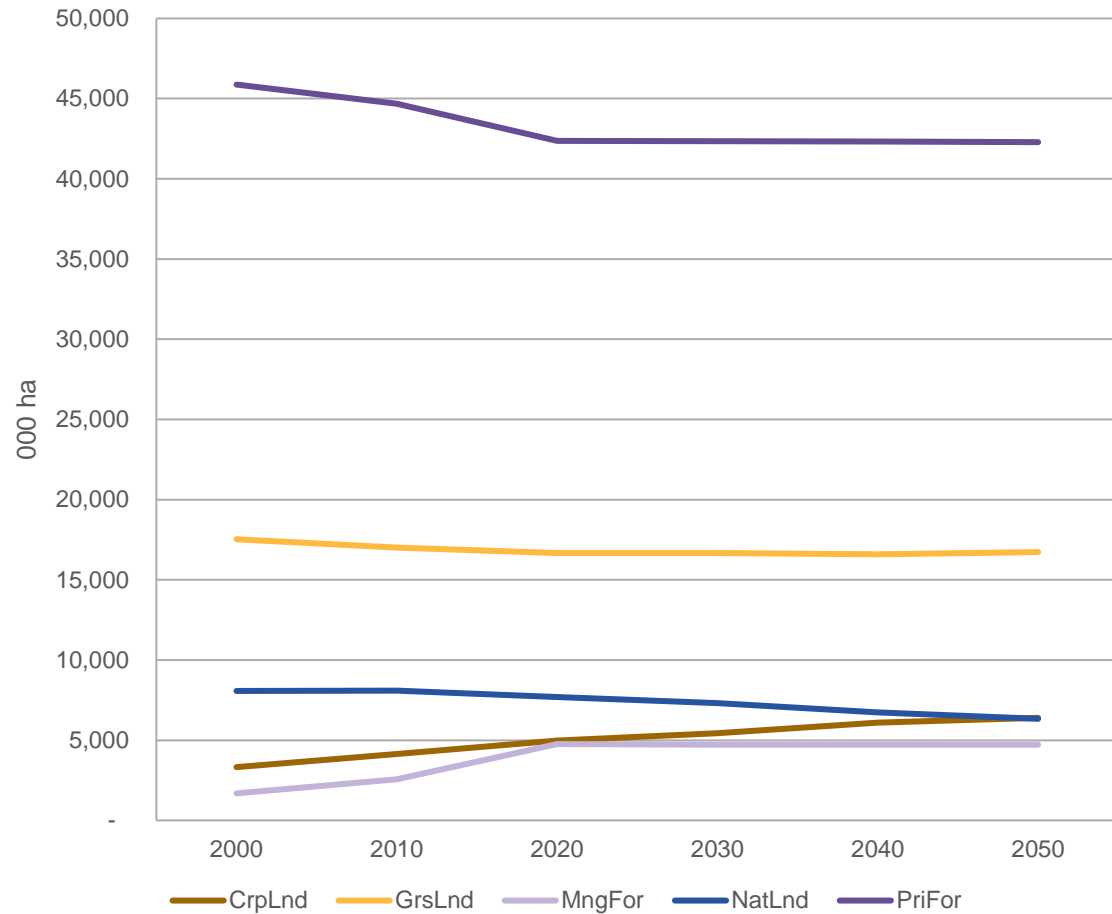
Forest area equivalent (ha)



■ firewood 
 ■ charcoal 
 ■ kerosene 
 ■ lpg 
 ■ electricity

■ firewood related 
 ■ charcoal related

# BAU: Deforestation and GHG emissions from GLOBIOM



# Conclusions

- Land-Energy challenges and issues in Southern Africa are relevant due to the heavy reliance on woodfuel for energy changing population dynamics
- Forest degradation and loss from woodfuel harvesting may be underestimated
- Impacts of forest degradation can be highly localized and react dynamically based on changes in land use
- Integration of detailed household demand models, spatially explicit woodfuel demand and supply models and agricultural land use models is a way forward to account for the woodfuel demand, harvesting practices, and regeneration

# Future Work

- Run Mofuss at high spatial resolution (100m)
- Finish model integration
- Linking household energy demand across models
- Impact of woodfuel collection on forest degradation
- Model alternative energy scenarios
- Linking deforestation and forest degradation with hydrological modelling

**Name**  
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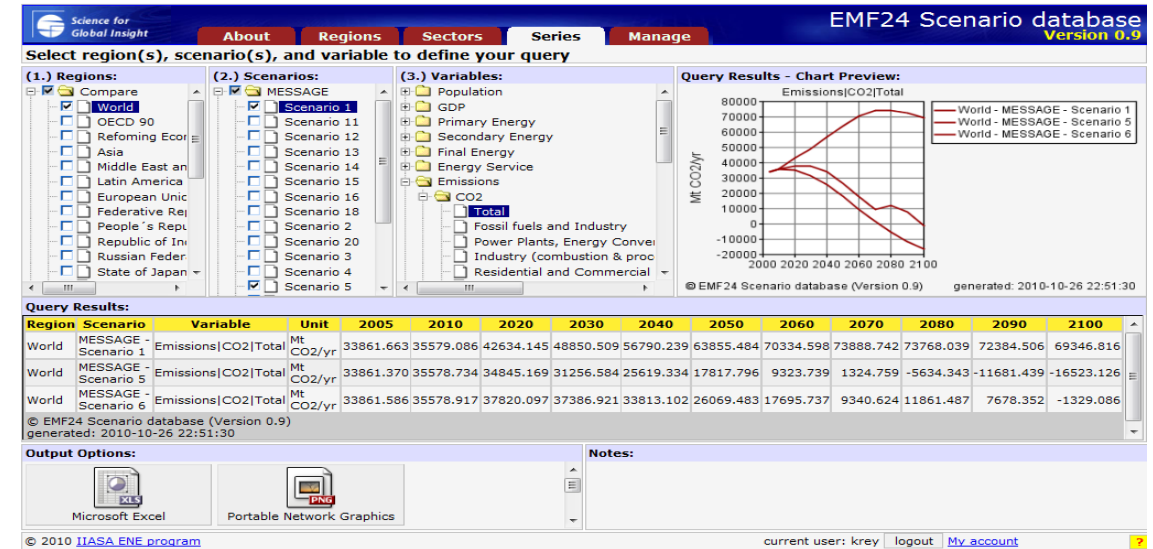


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