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Downscaling flows in the water–food–energy nexus

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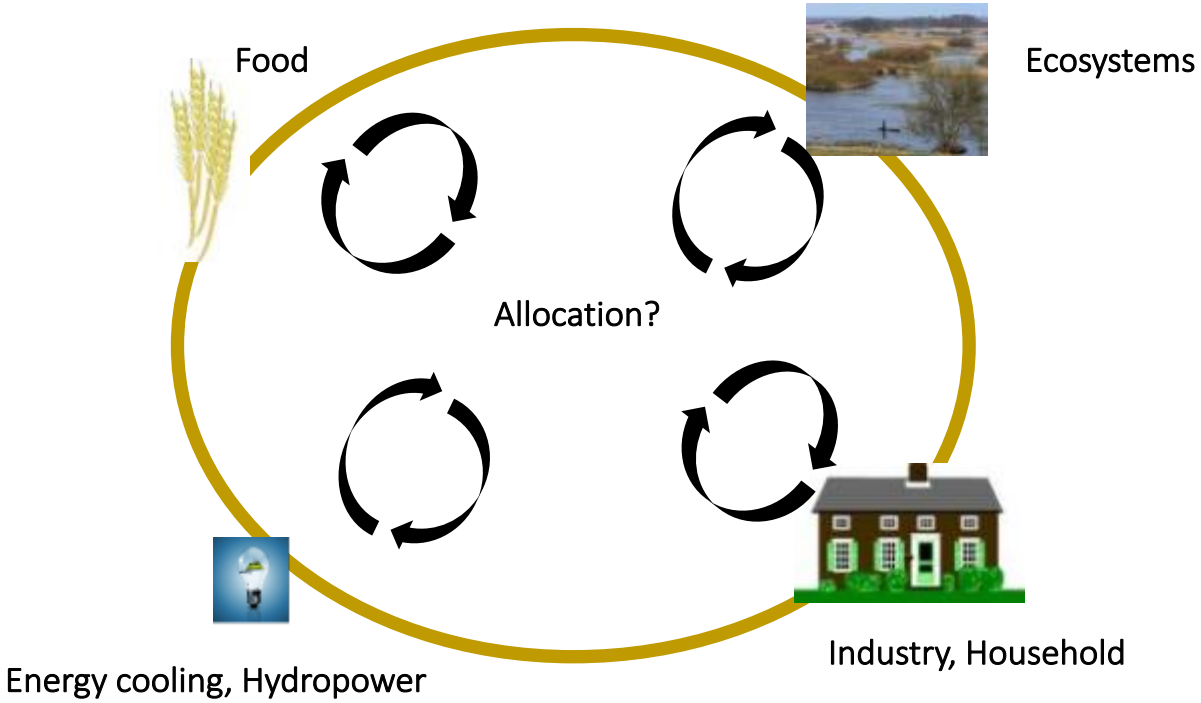
Photo courtesy Gert Jan Bollen

Allocation of different resources



How much water needed for food production?

How much energy needed for food production and water supply?

How much water needed to produce energy?

Food-Water-Energy Nexus

nature sustainability
ANALYSIS
https://doi.org/10.1038/s41893-019-0418-8

Integrated scenarios to support analysis of the food–energy–water nexus

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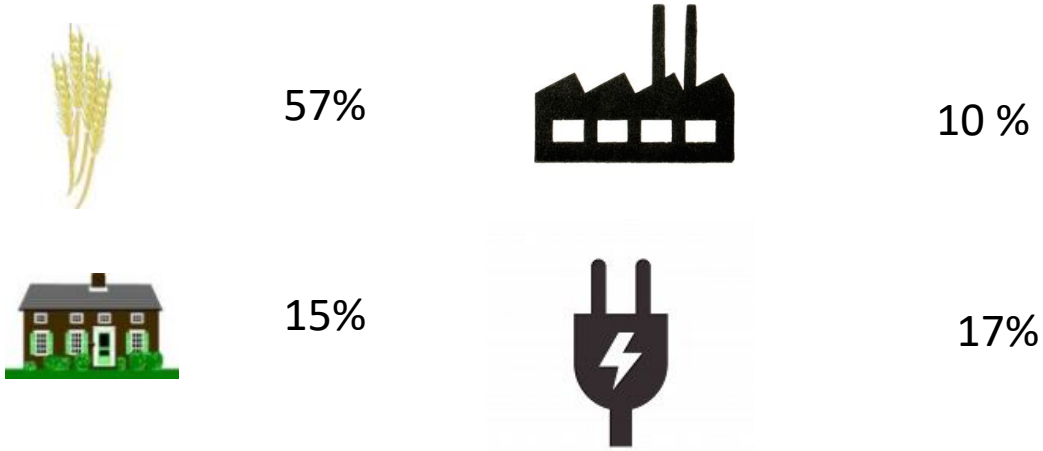
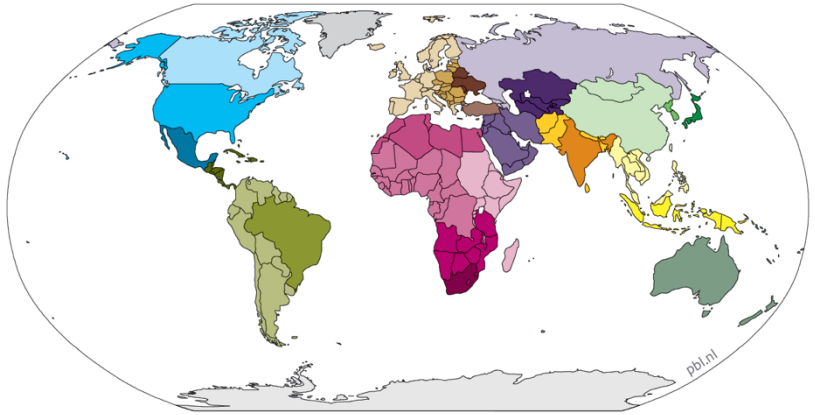
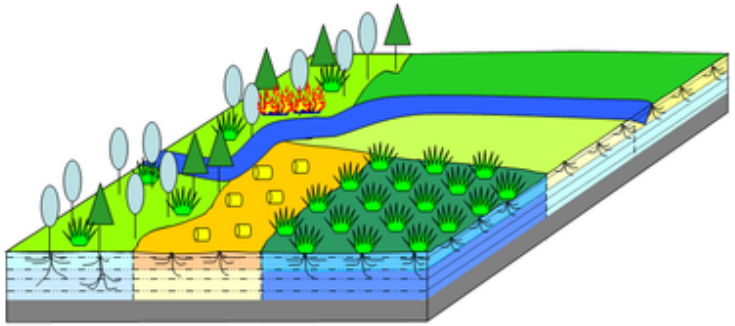


Current use of water

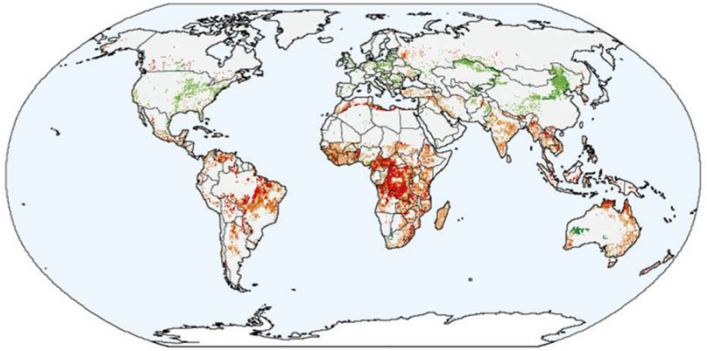
Integrated Assessment Model

IMAGE model with 26 socio-economic regions

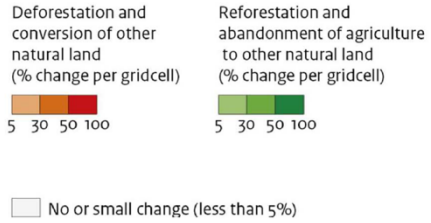




LPJ-ml (Gerten et al. 2011):
Crop growth, Hydrological model, water withdrawal per sector



SSP2
Middle of the road



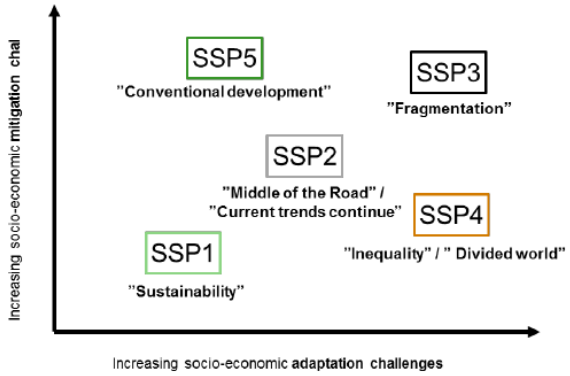
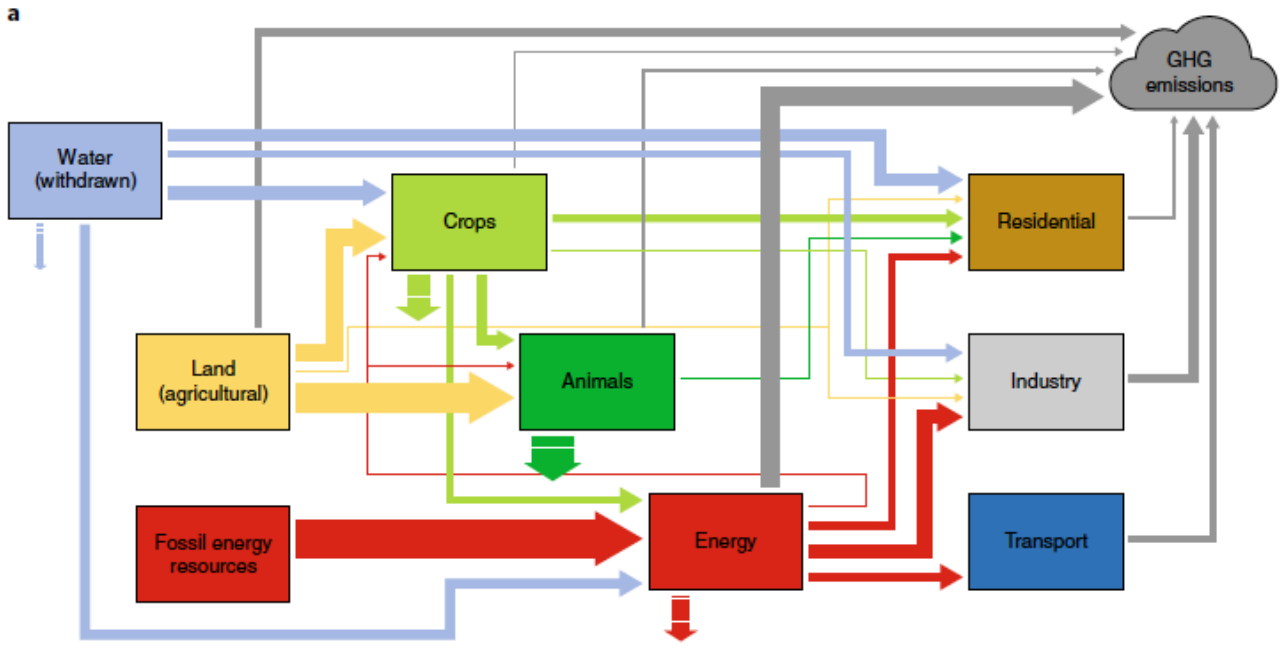
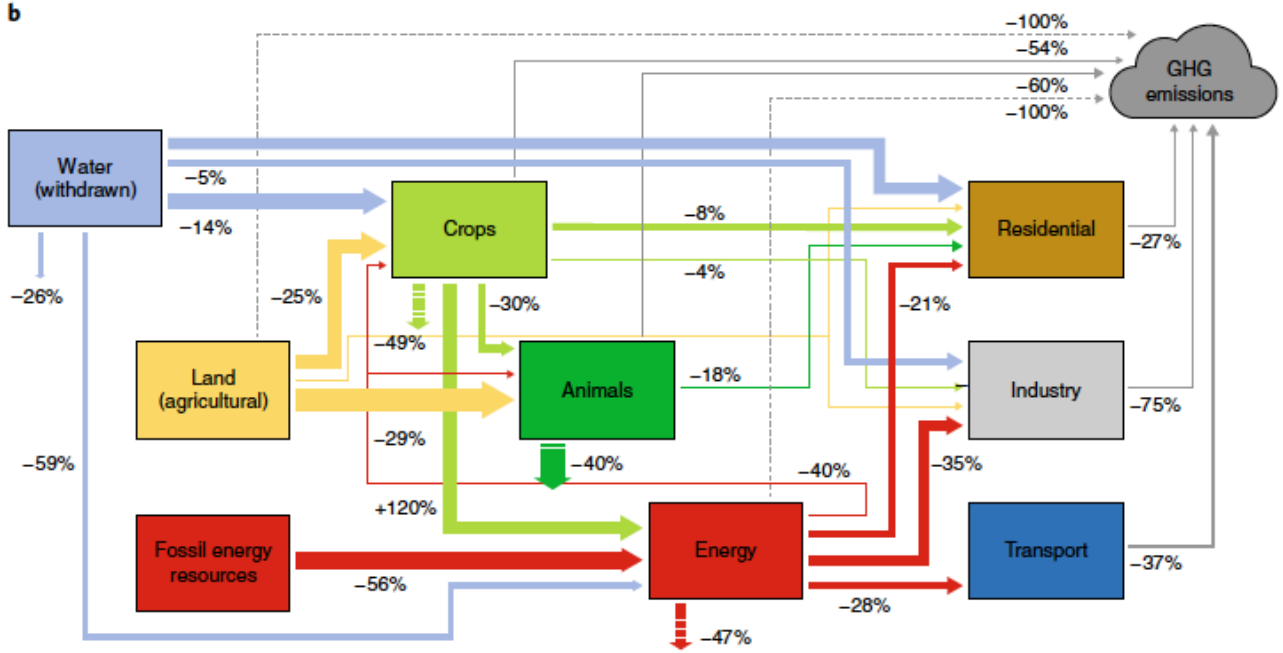


IMAGE (Stehfehst et al. 2016) is an ecological-environmental model framework that simulates the environmental consequences of human activities worldwide. It represents interactions between society, the biosphere and the climate system to assess sustainability issues such as climate change, biodiversity and human well-being. The objective of the IMAGE model is to explore the long-term dynamics and impacts of global changes that result from interacting socio-economic and environmental factors.

- Socio-Economy in 26 regions
- Land-Use and hydrology at 5 (or 30) minute resolution
- Use of climate scenarios and Shared-Socio-economic Pathways



Reference Scenario 2050



Response Scenario 2050

Integrated scenarios

Response Scenario:

1) Low meat-intensive diet
2) Increase agriculture yields
3) Reduce food waste
4) Climate Policy

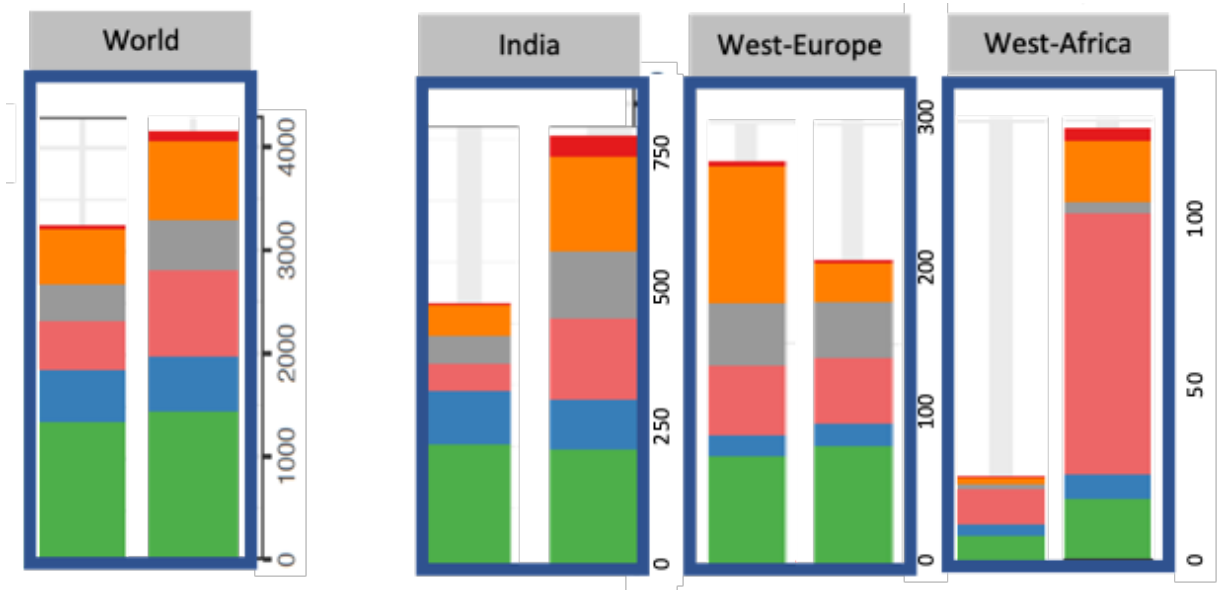
Results:

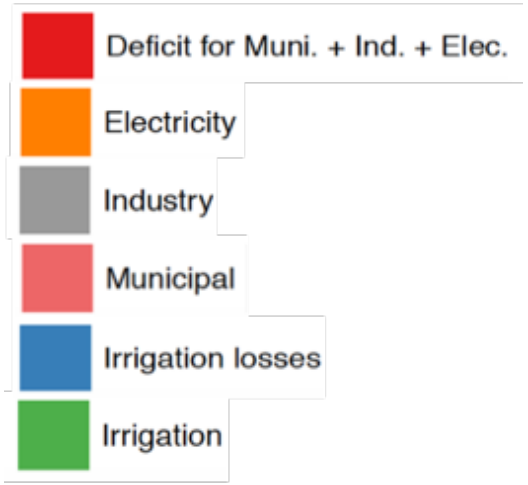
Without response scenarios:

- food and energy use +60%
- Water use +26 %

Van Vuuren et al. 2019, Bijl et al. 2018

Water withdrawal per sector for SSP2 in 2050





- Global Increase (**26%**):
- Electricity generation (+220 km^3/y) **+ 40%**
- Municipal (+370 km^3/y) **+ 70%**

Large differences between regions:
West Europe decrease
West Africa large increase

Bijl et al. 2018

frontiers in Environmental Science

ORIGINAL RESEARCH
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Check for updates

Modeling the Effects of Future Growing Demand for Charcoal in the Tropics

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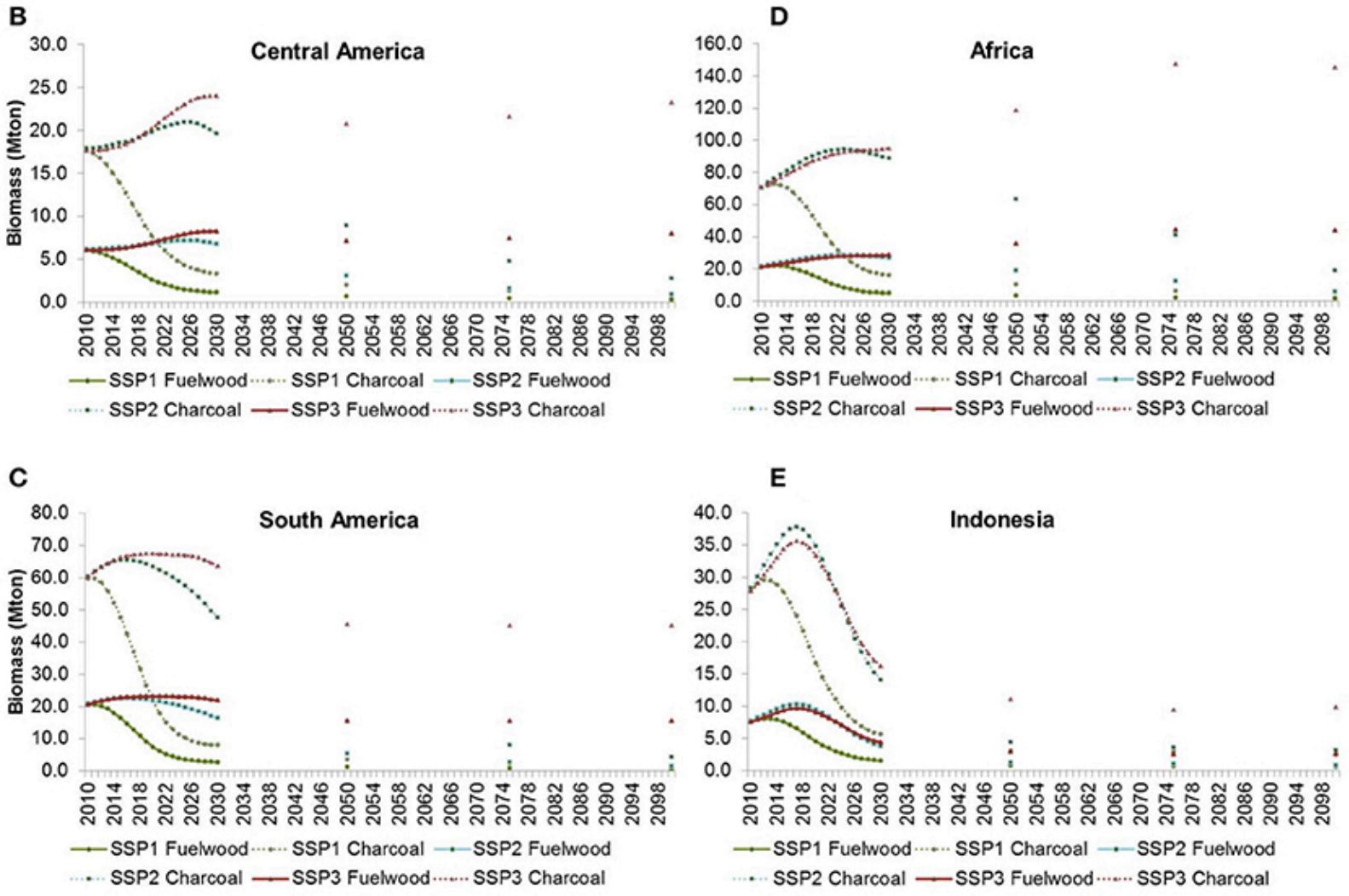
Up and downscaling Biomass for energy

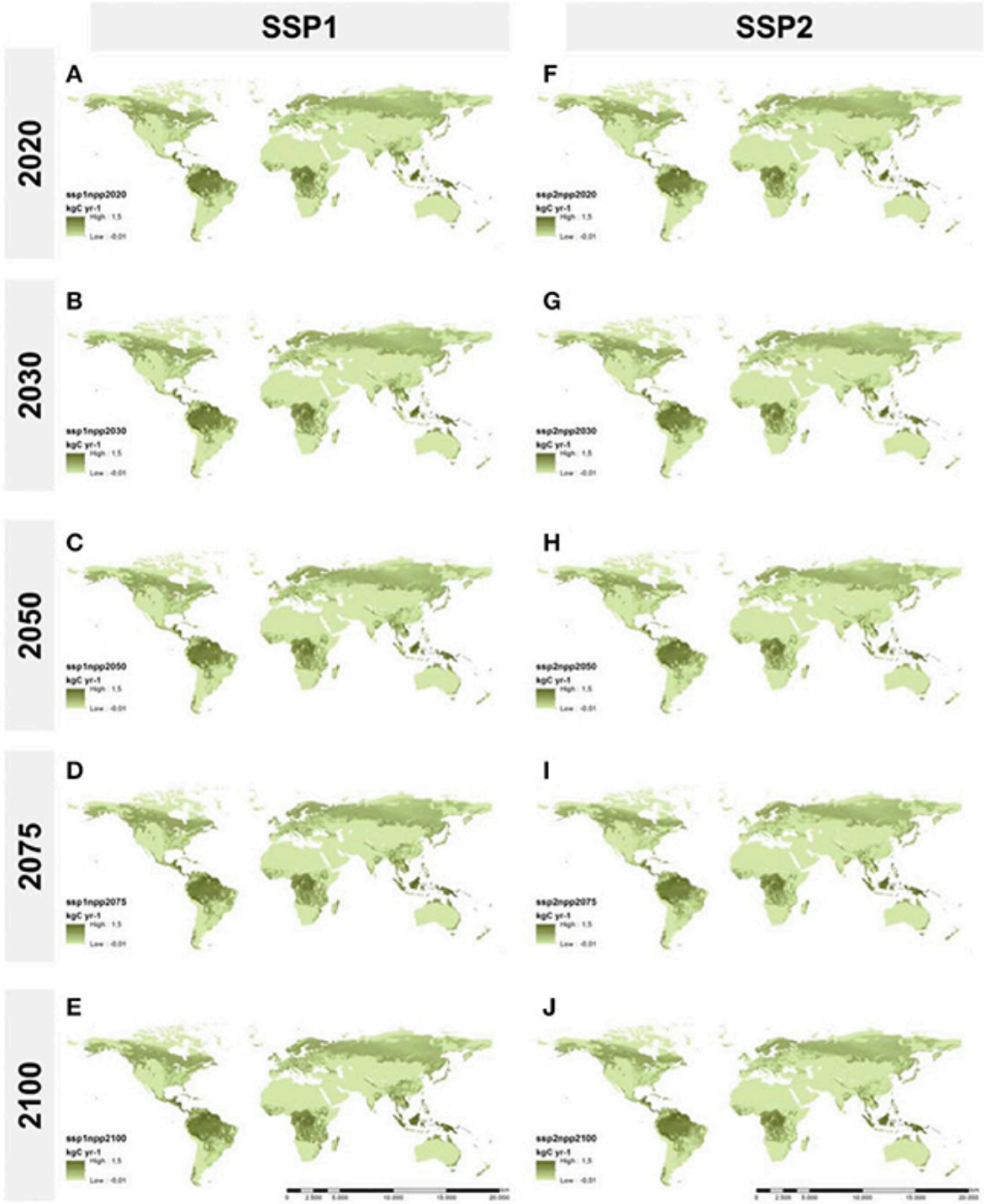
- Demand from Integrated Assessment Model
- Supply from LPJ-Guess, biomass production

Traditional energy demand per socio-economic region (from IMAGE)

For SSP1, SSP2 and SSP3



Santos et al. 2017



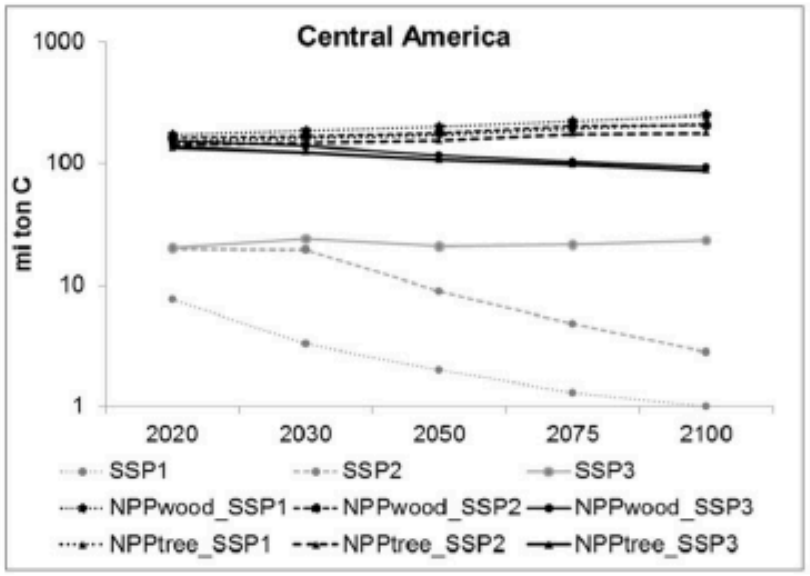
Santos et al. 2017

Biomass Energy Supply

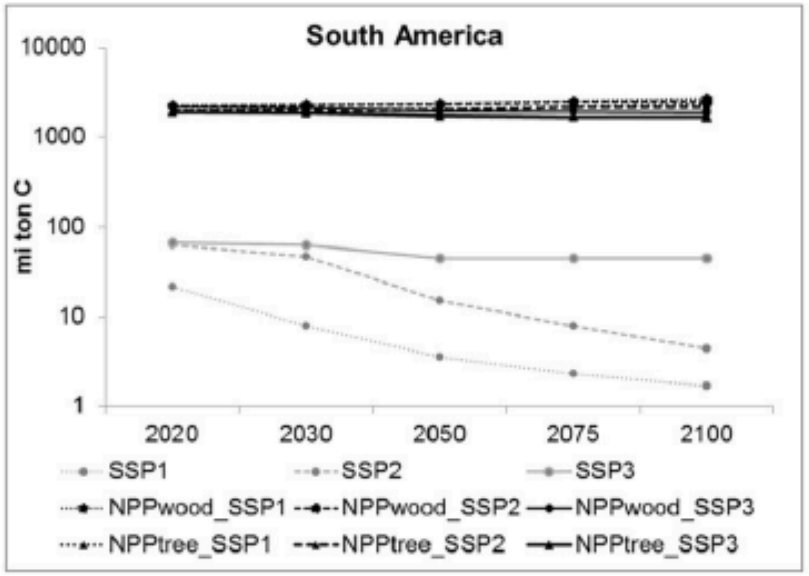
Match demand and supply:
Demand per region

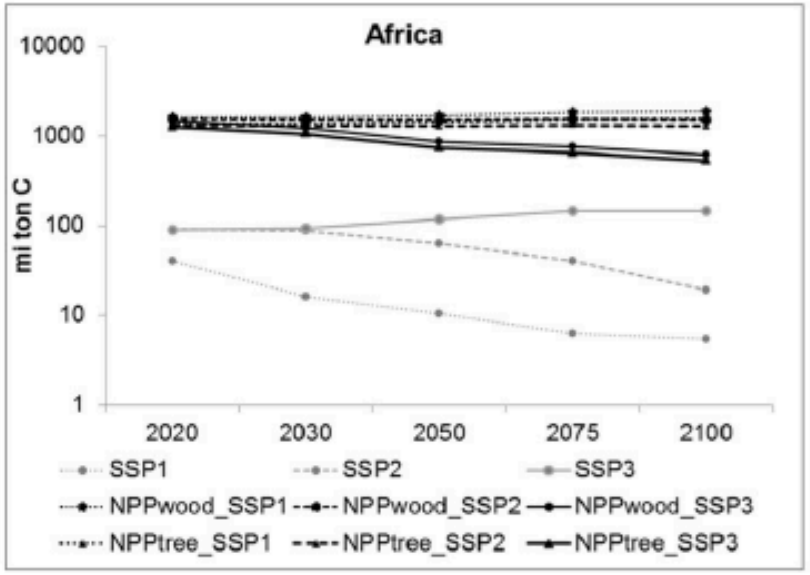
- Supply calculated with LPJ-Guess on 5 minute resolution.
- Based on NPP (net primary production) of wood production in non-protected forests

Supply larger then demand



C





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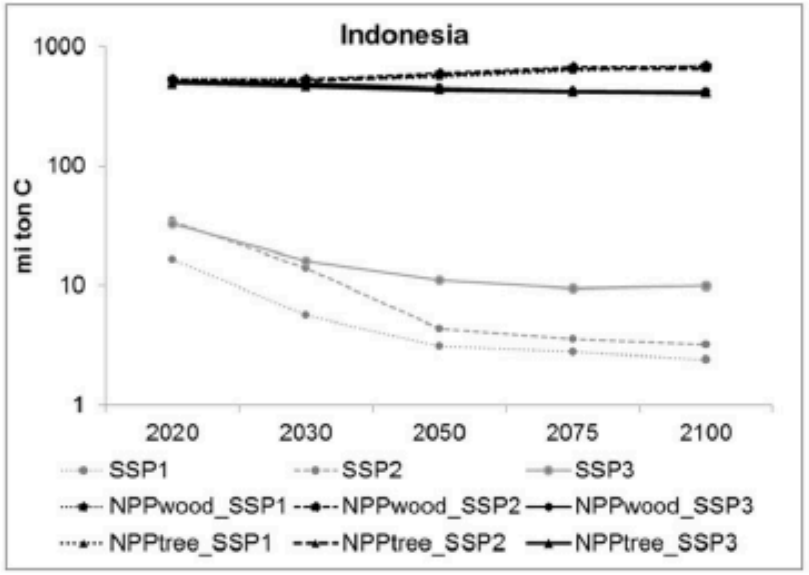
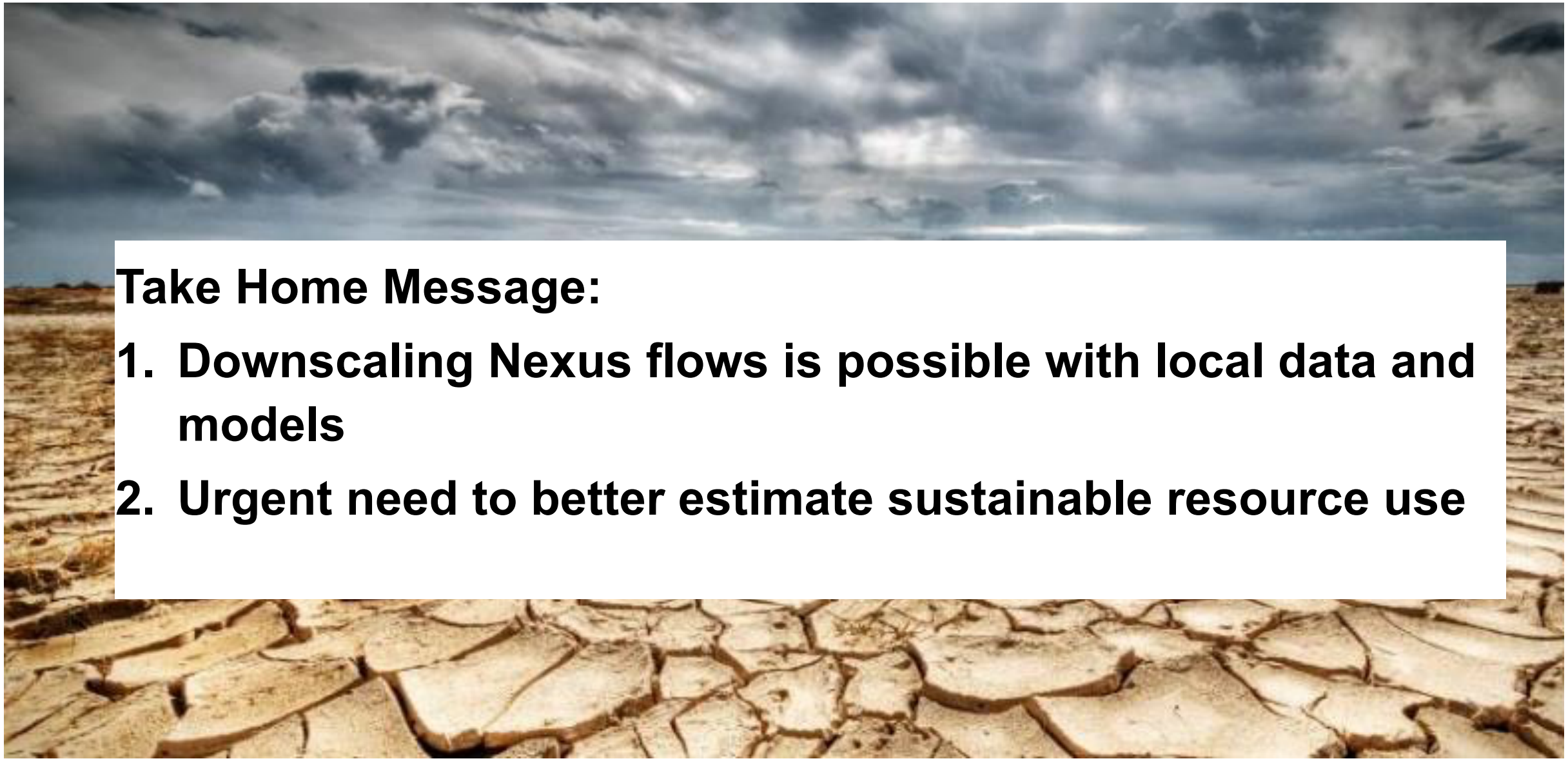


For the four regions with highest biomass/charcoal demand we find larger potential suppy then demand
But: also other services

Santos et al. 2017



Take Home Message:

1. **Downscaling Nexus flows is possible with local data and models**
2. **Urgent need to better estimate sustainable resource use**