Impacts of rising food and bioenergy demand on land and water use

Hermann Lotze-Campen

Potsdam Institute for Climate Impact Research (PIK)

ESSP Workshop "Bioenergy and Earth Sustainability", Brazil, 19.07.08

Key messages

Research

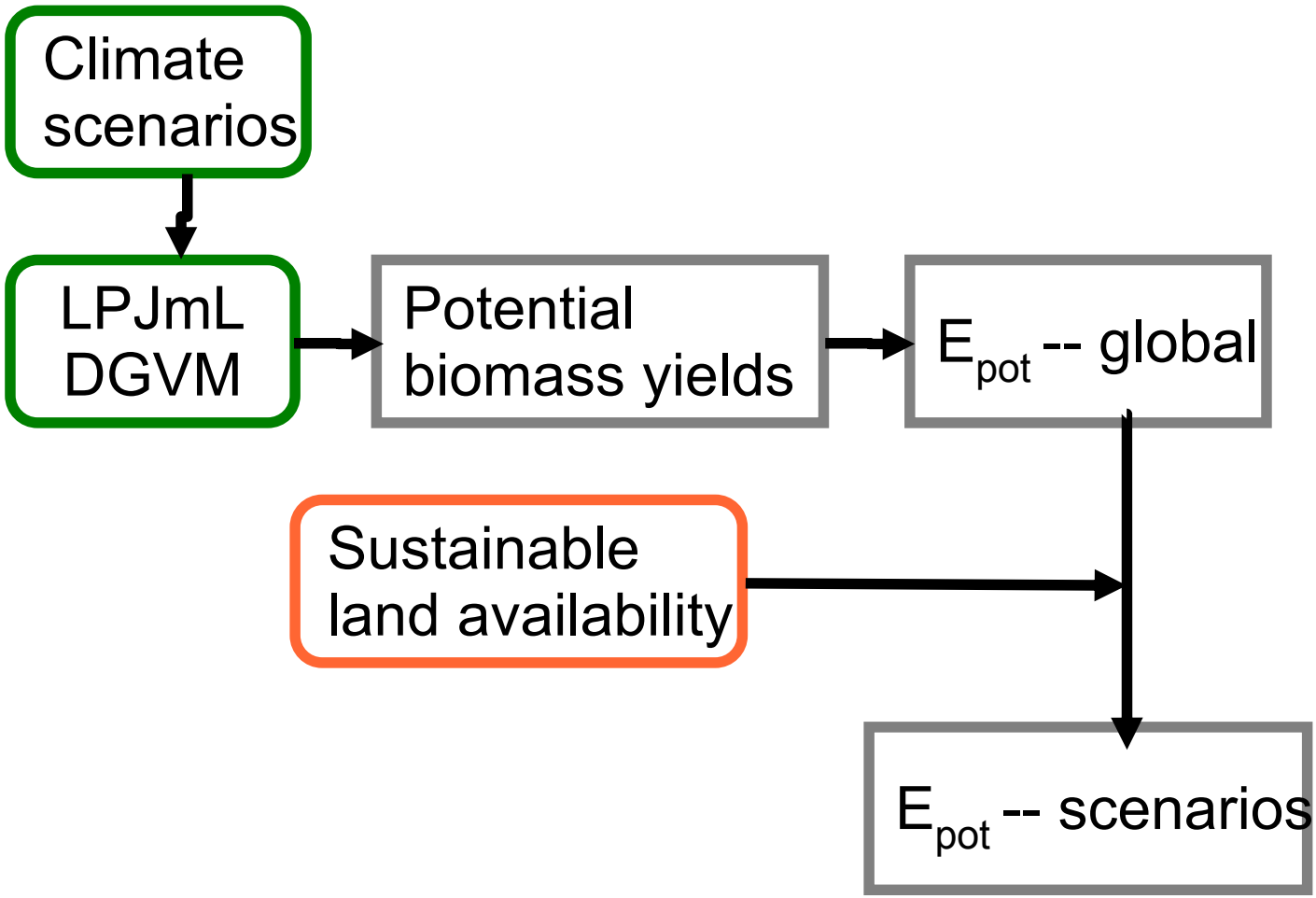
- Sustainable bioenergy production in 2050: ~50-150 ExaJoule?
- Land availability for agricultural expansion (pasture?)
- Role of technological change (ag. production, energy conversion)
- Role of international trade
- Climate change and yields (CO_2 fertilization?)
- Food demand patterns?

Policy

- Potential of bioenergy for rural development
- Critical assessment of bioenergy subsidies (ag. policy, climate policy)
- Global land use management (land use planning, land rights)
- Forests/Biodiversity as a global common good
- Water management and pricing

P I K

Area-based modelling approach



Beringer, Lucht, Loose et al. (to be submitted)

LPJmL biomass simulations

fast-growing temperate and tropical trees

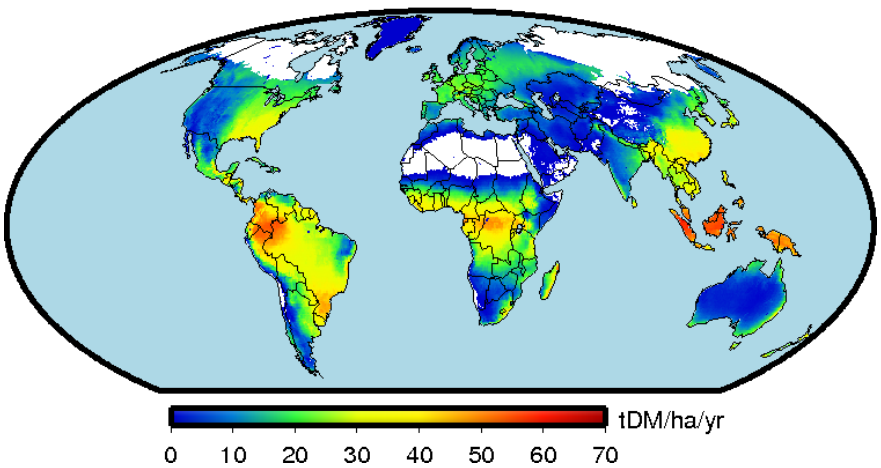
90% above-ground biomass harvest every 8 years
re-growth from stump (SRWC)

highly productive grass: Miscanthus, Panicum

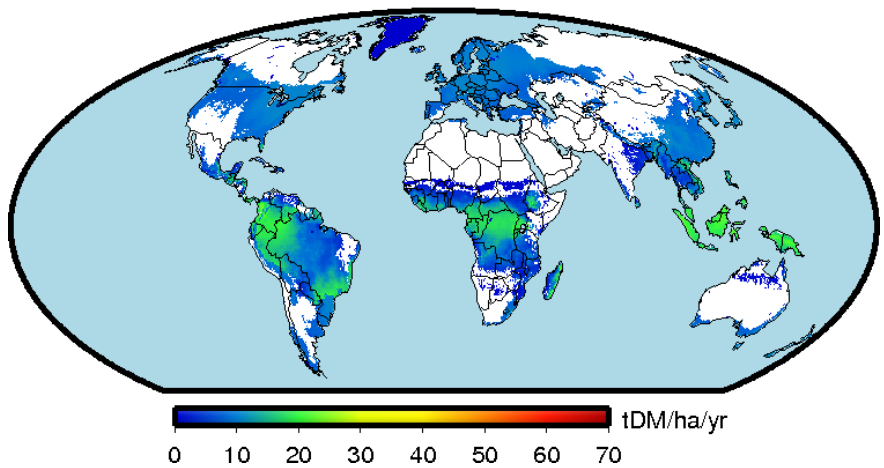
C4 species with low chilling sensitivity
harvest after growing season

Plantations can be irrigated (with river-routing).

Yield potential - grass

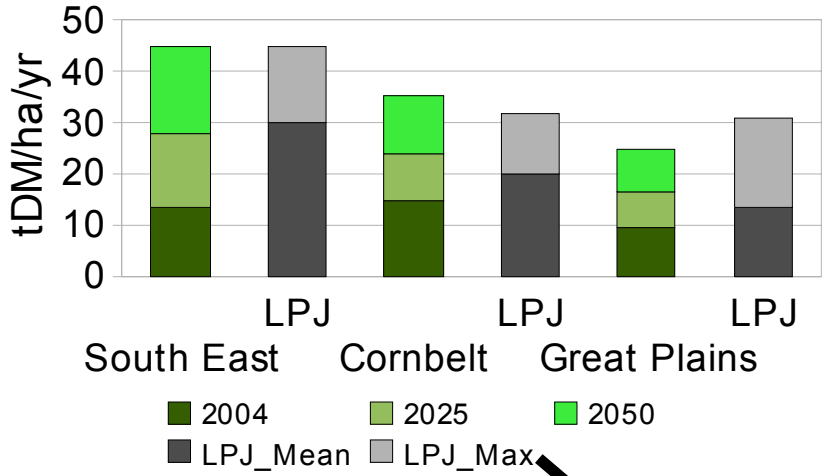


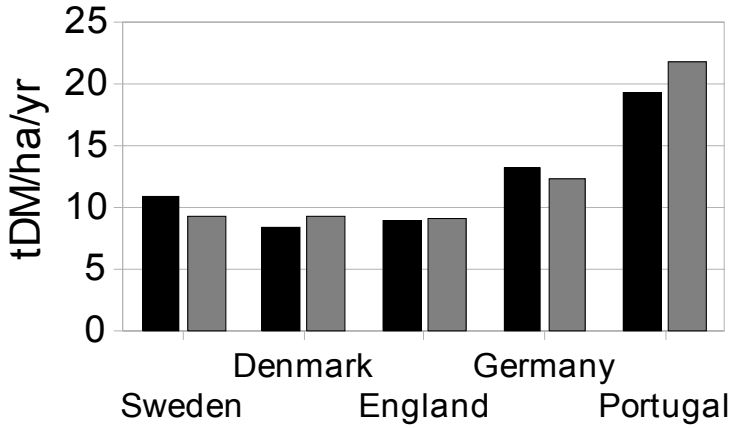
Yield potential - trees

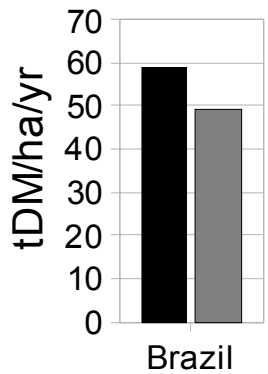


Beringer, Lucht, Loose et al. (to be submitted)

Validation of simulated yields







Beringer, Lucht, Loose et al. (to be submitted)

Land availability - scenarios

Food security

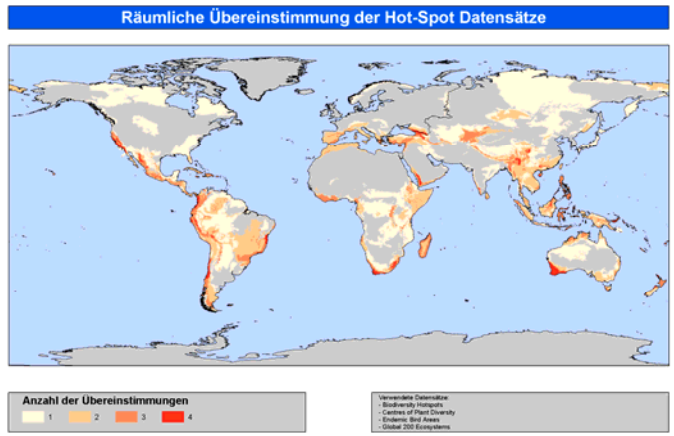
A) Expansion of current agricultural areas by 120 Mha (FAO, 2002)

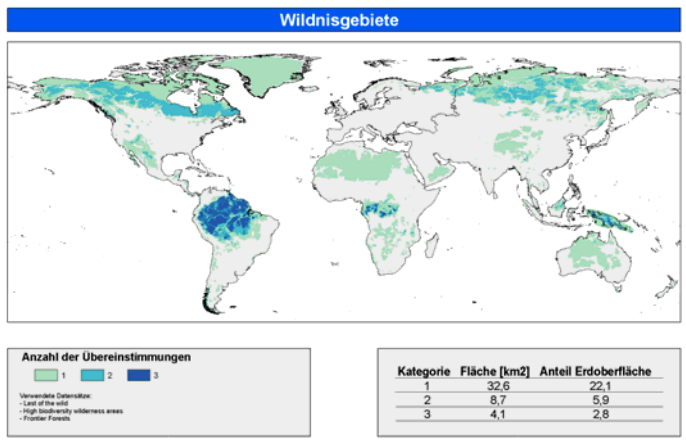
B) Protection of existing agricultural areas

Biodiversity/Wildernis

	Wildernis			Biodiversity			
Spatial overlap	3	2	1	4	3	2	1
A	100%	100%	100%	80%	50%	30%	20%
B	100%	100%	0%	80%	50%	0%	0%

Based on: Biodiversity Hotspots, Centers of Plant Diversity, Endemic Bird Areas, Global 200 Ecosystems, High-Biodiversity Wilderness Areas, Frontier Forests, Last of the Wild





Beringer, Lucht, Loose et al. (to be submitted)

Land availability - scenarios

Food security

A) Expansion of current agricultural areas by 120 Mha (FAO, 2002)

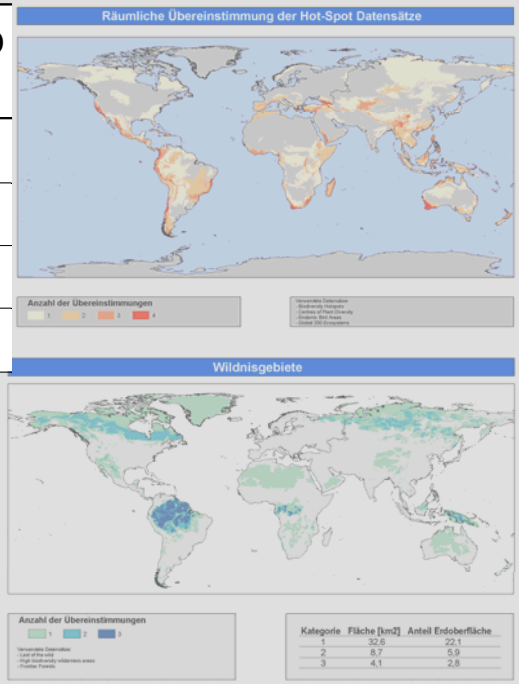
B) Protection of existing agricultural areas

Biodiversity/Wil

	Wilde	
Spatial overlap	3	2
A	100%	100
B	100%	100

Biodiversity Nature	Food security	Scenario
A	A	1
B	A	2
A	B	3
B	B	4

Based on: Biodiversity Hotspots, Centers of Plant Diversity, Endemic Bird Areas, Global 200 Ecosystems, High-Biodiversity Wilderness Areas, Frontier Forests, Last of the Wild



Beringer, Lucht, Loose et al. (to be submitted)

Results

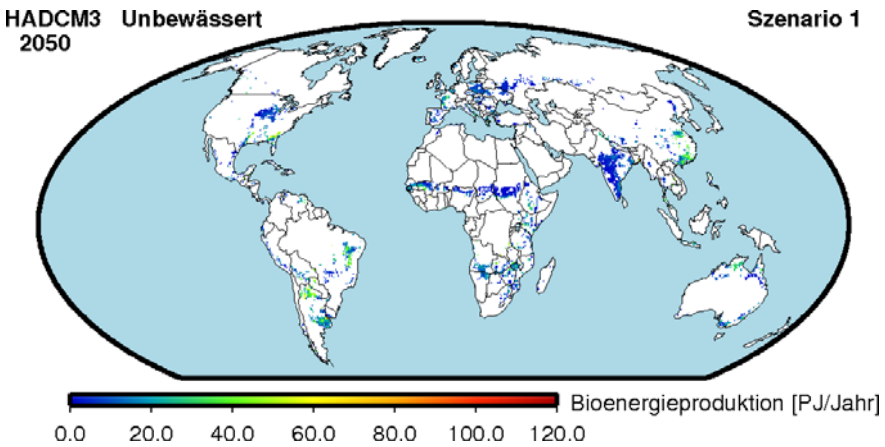
Energy potential	43 – 140 EJ/yr
Plantation area	300 – 600 Mha

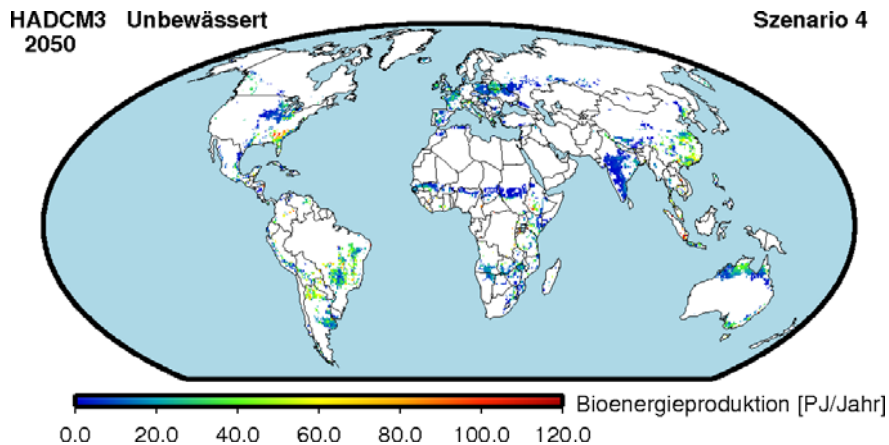
moderate protection

Biodiv/Wilderness

Cropland

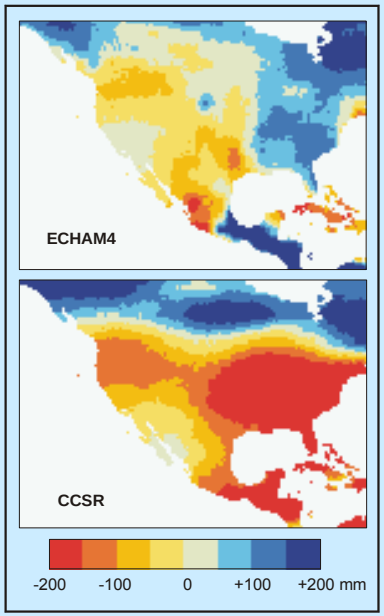
strong protection





contact: tim.beringer@pik-potsdam.de

Climate change (GCM)



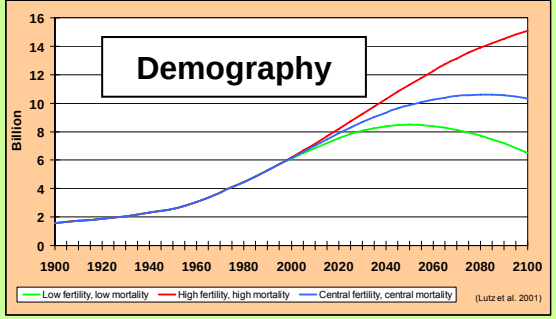
Crop yields

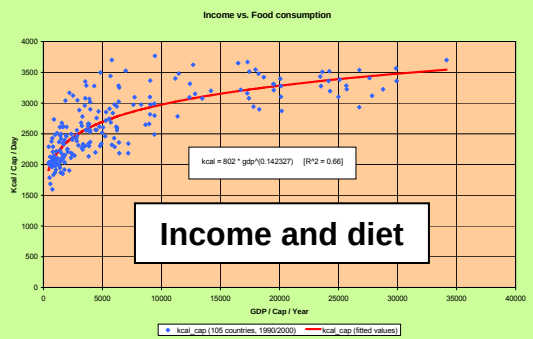
Land & Water constraints

Cereals | Sugar beets | Oilseeds | Pulses

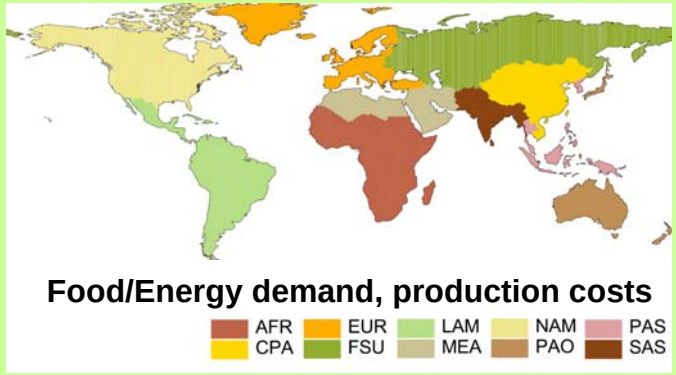
LPJ (50x50 km grid)

Biophysical inputs





Socioeconomic inputs



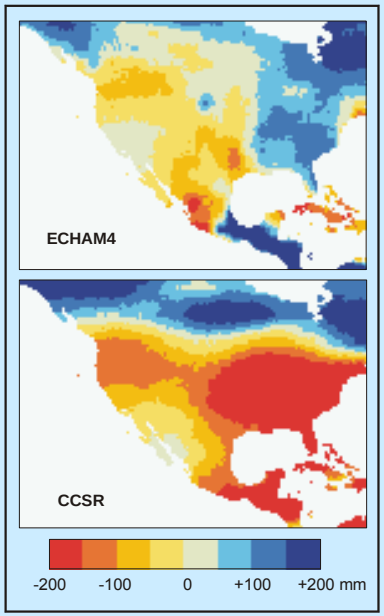
(1) MAgPIE – a global land use optimisation model

- 2200 grid cells (3° resolution), 10 economic regions
- 30 production activities (13 crops, livestock, irrigation, bioenergy, land conversion)
- rotational constraints
- internal feed balances, international trade
- (quasi-)endogenous technological change

Lotze-Campen et al., in press

PIK

Climate change (GCM)



Crop yields

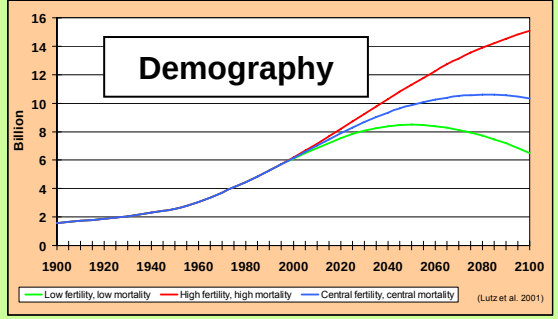
Land & Water constraints

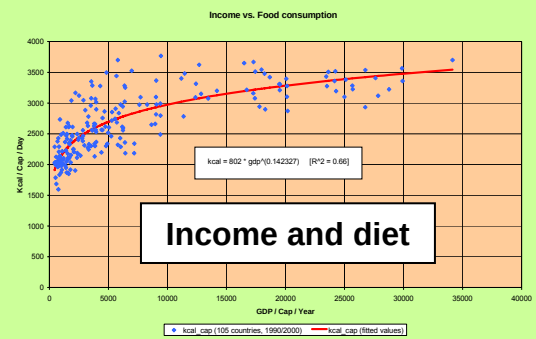
Cereals | Sugar beets | Oilseeds | Pulses

LPJ (50x50 km grid)

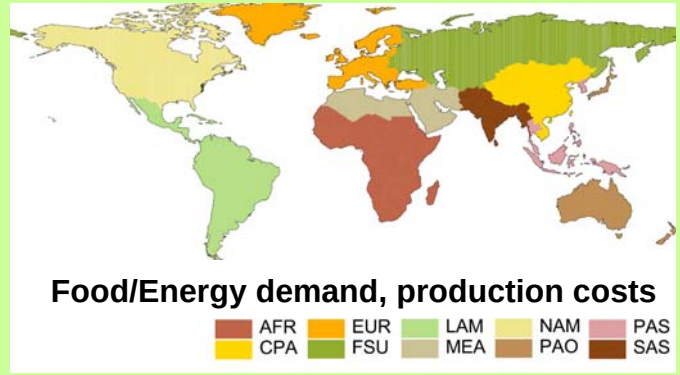
Biophysical inputs

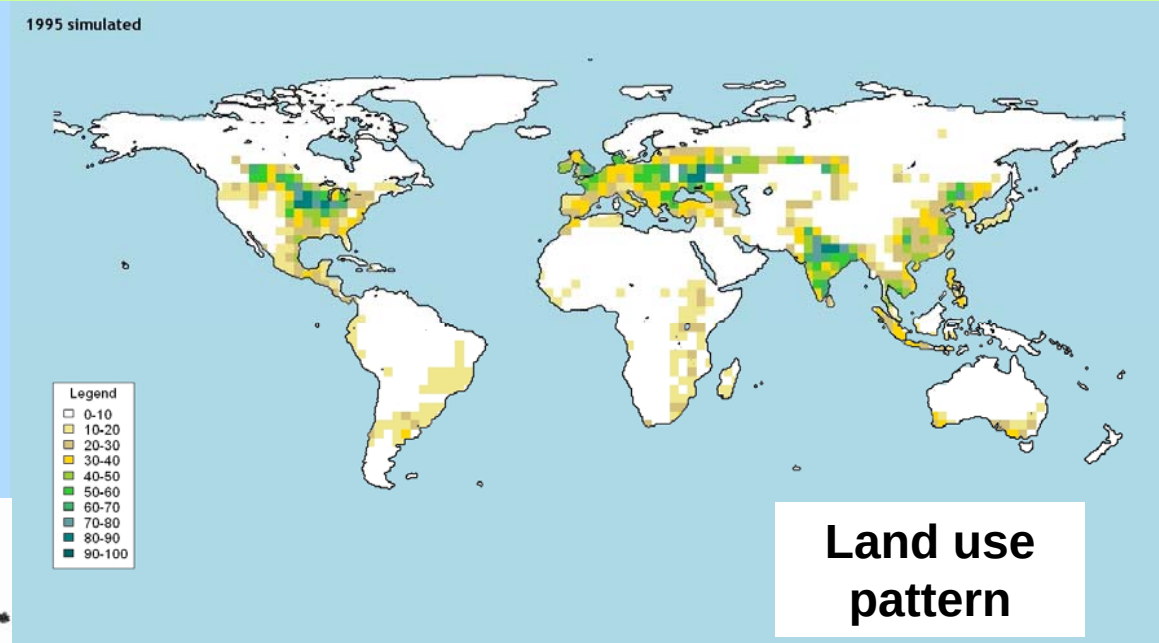
Lotze-Campen et al., in press





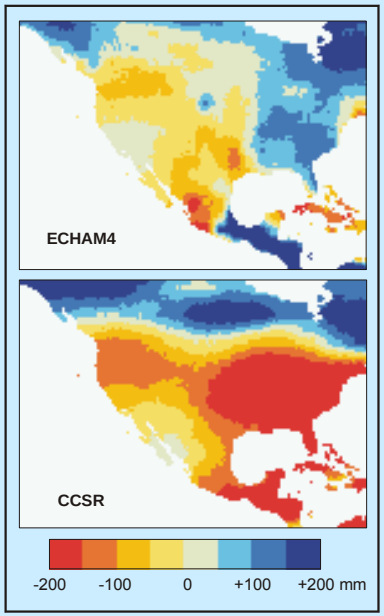
Socioeconomic inputs

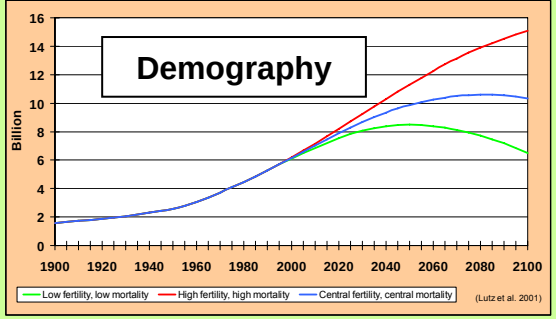


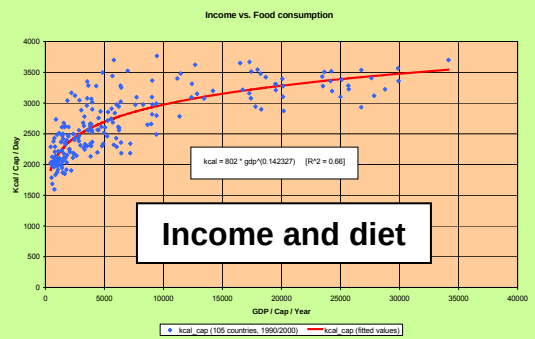


P I K

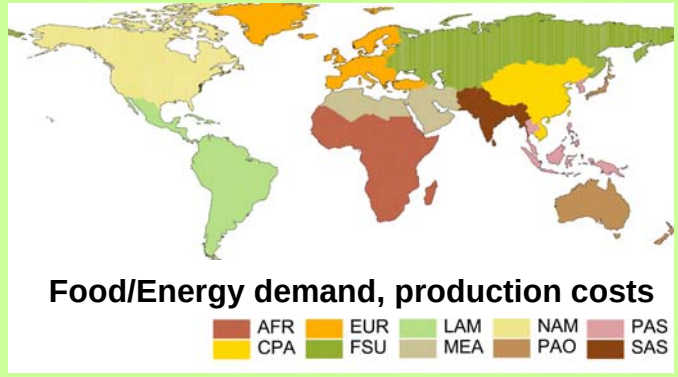
Climate change (GCM)







Socioeconomic inputs



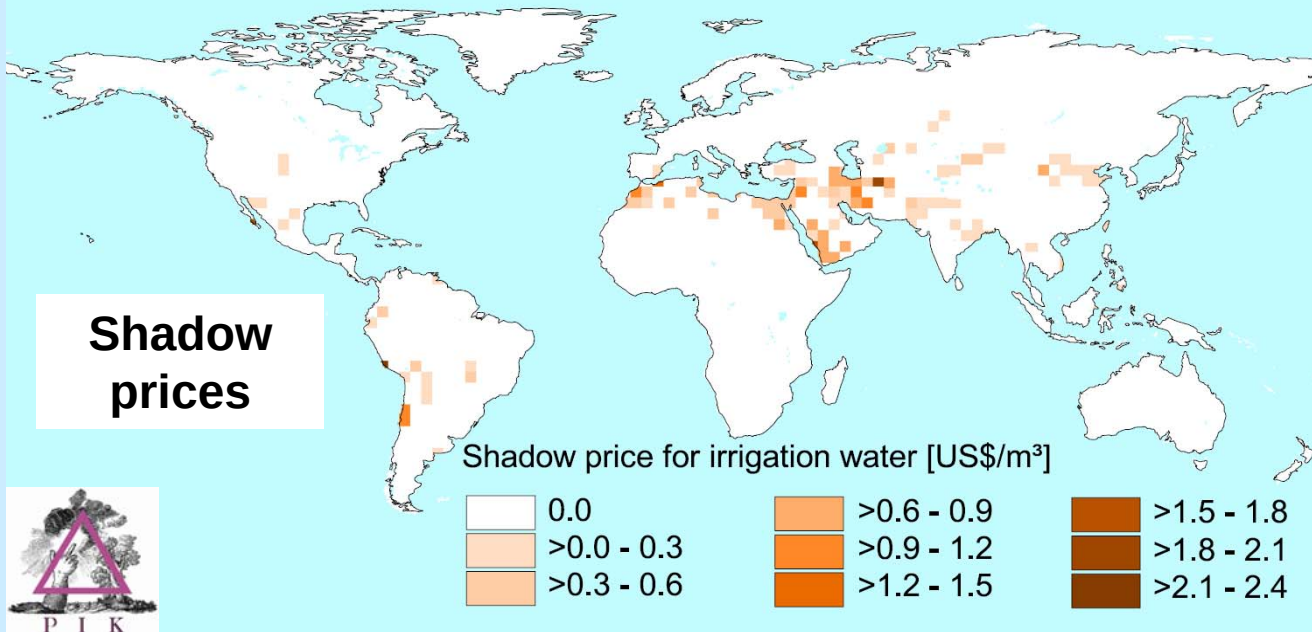
Crop yields

Land & Water constraints

Cereals | Sugar beets | Oilseeds | Pulses

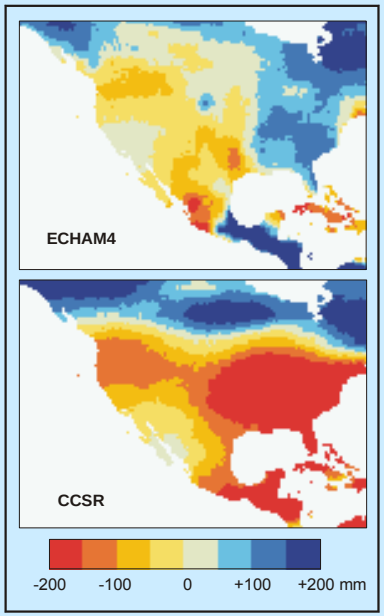
LPJ (50x50 km grid)

Biophysical inputs



Lotze-Campen et al., in press

Climate change (GCM)



Crop yields

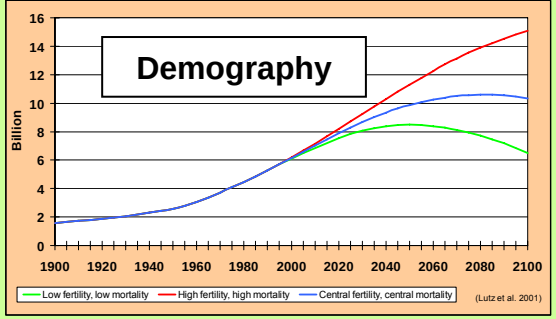
Land & Water constraints

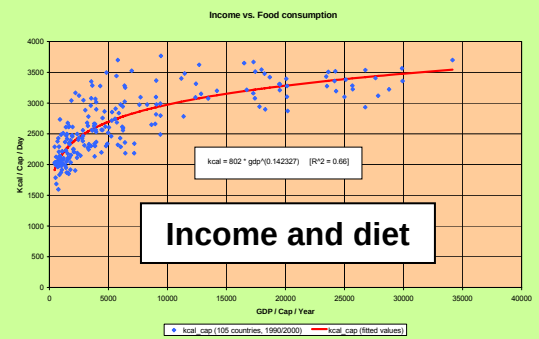
Cereals | Sugar beets | Oilseeds | Pulses

LPJ (50x50 km grid)

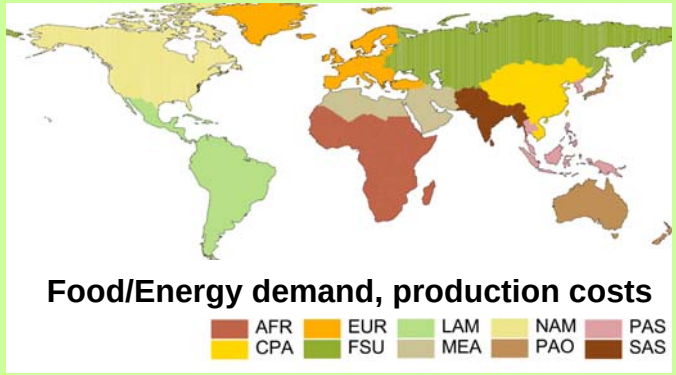
Biophysical inputs

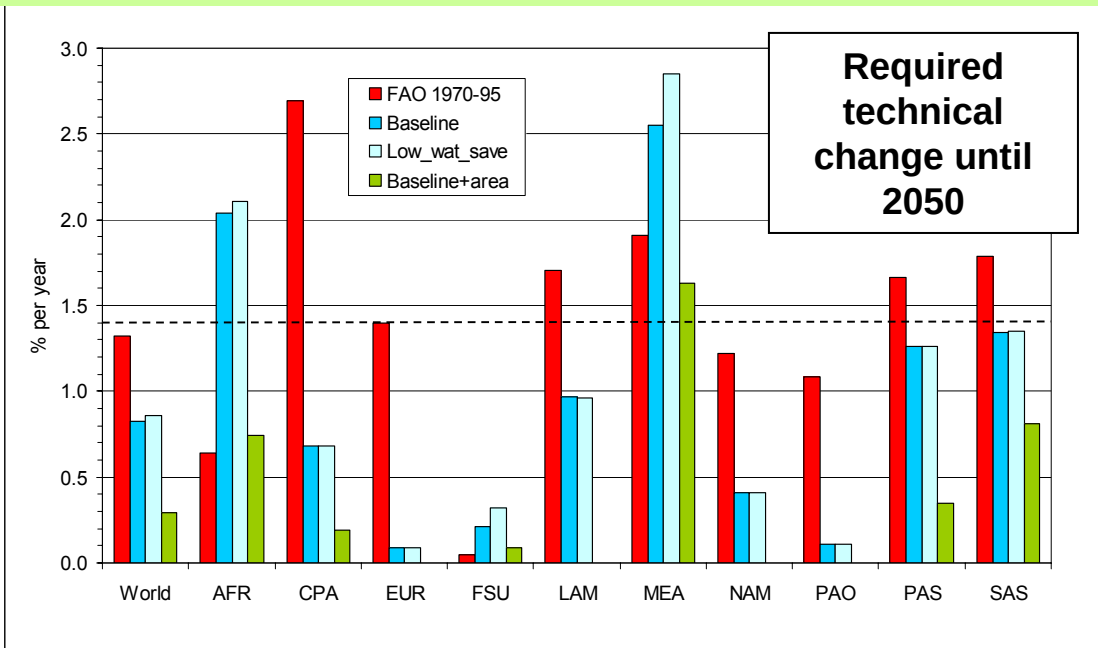
Lotze-Campen et al., in press





Socioeconomic inputs



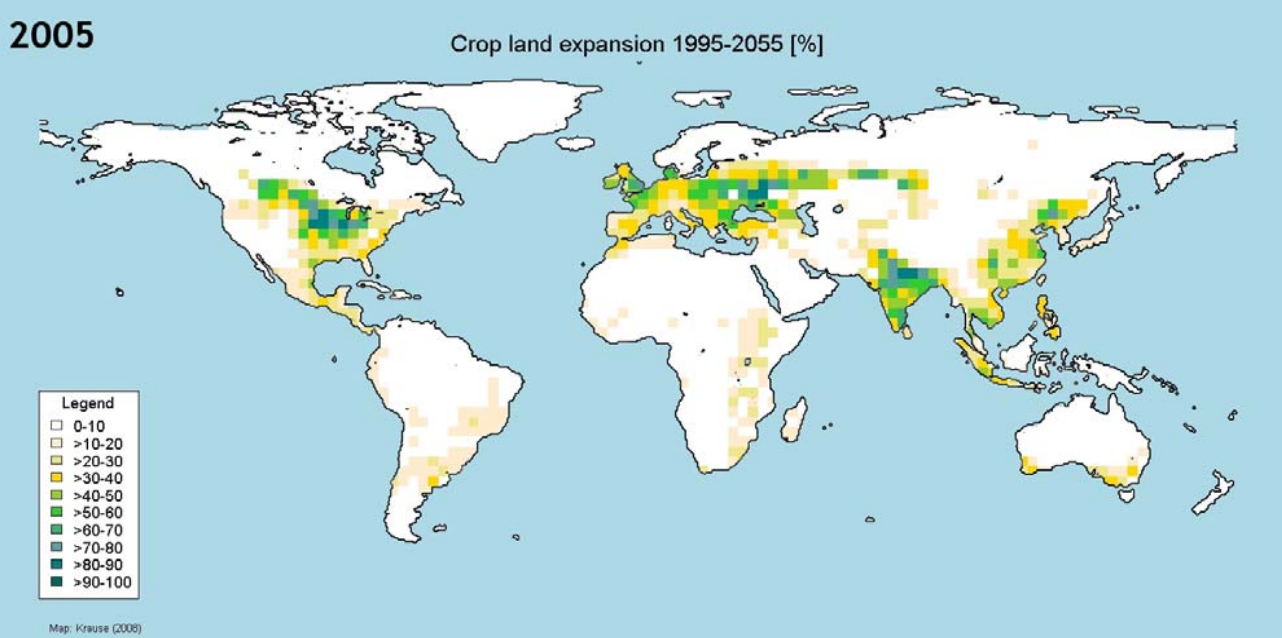


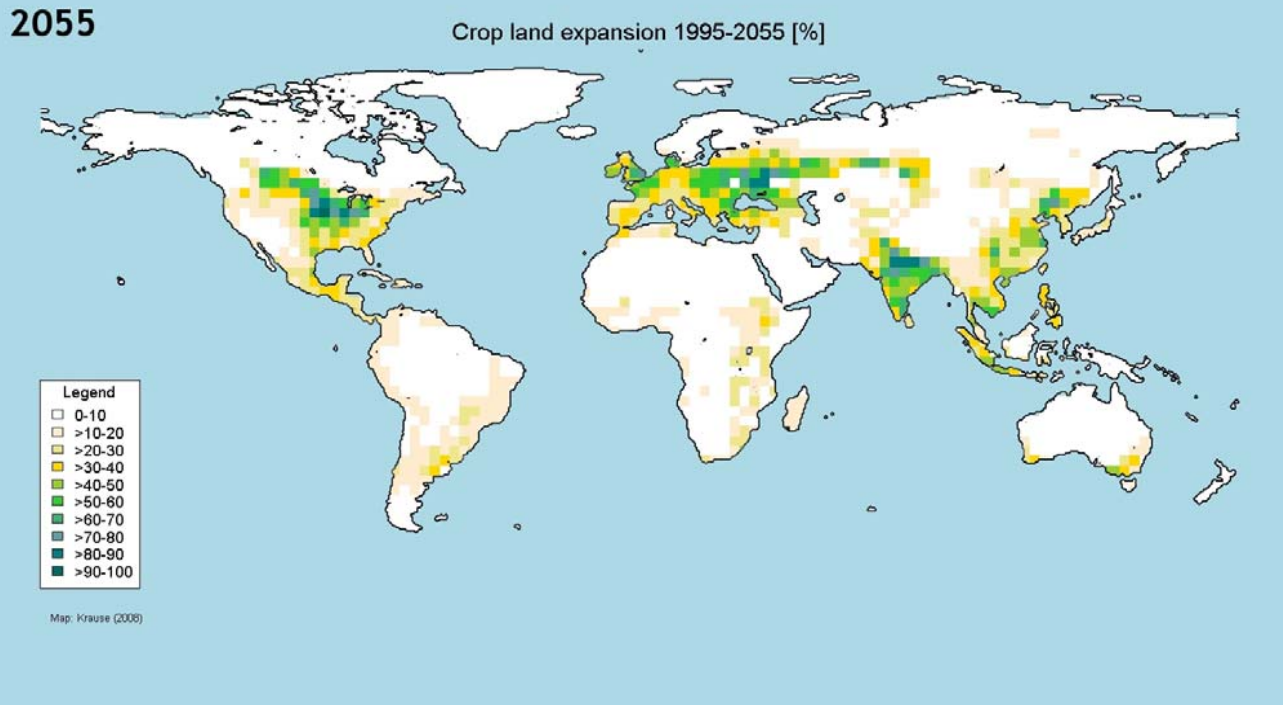
P I K

Scenario:

100 EJ Bioenergy in 2050

Cropland expansion max 250 mio. ha (~18%)





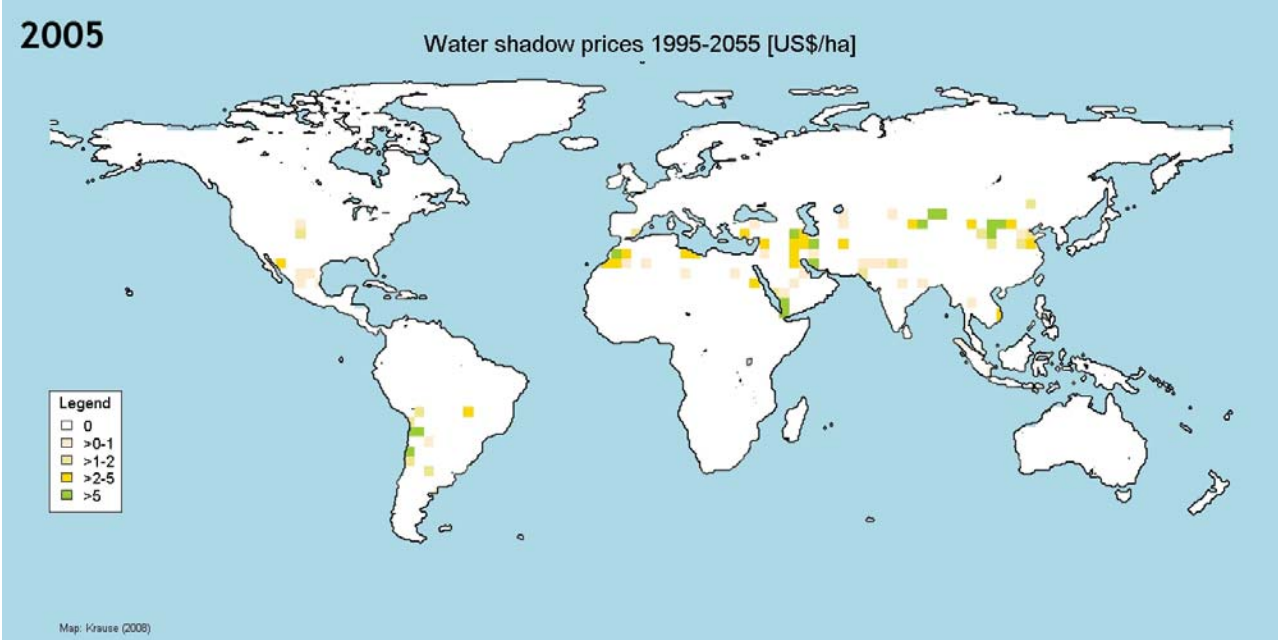
PIK

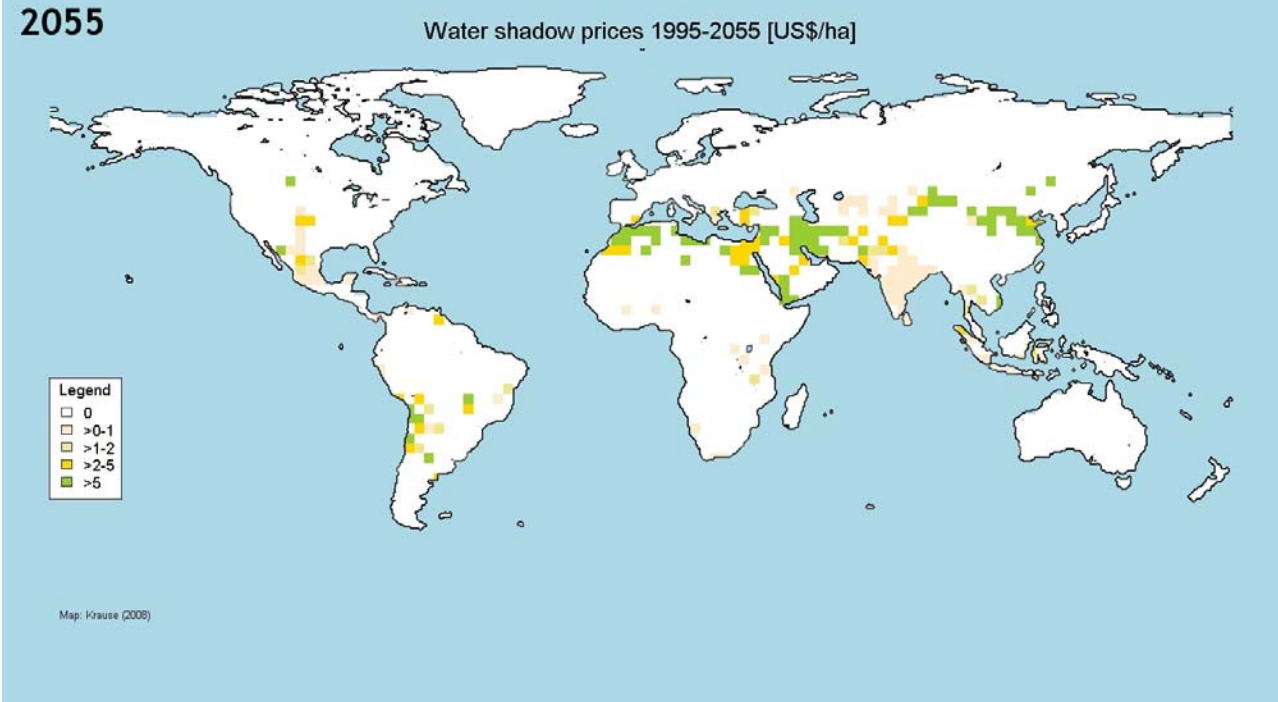
Lotze-Campen et al., preliminary results

Scenario:

100 EJ Bioenergy in 2050

No cropland expansion



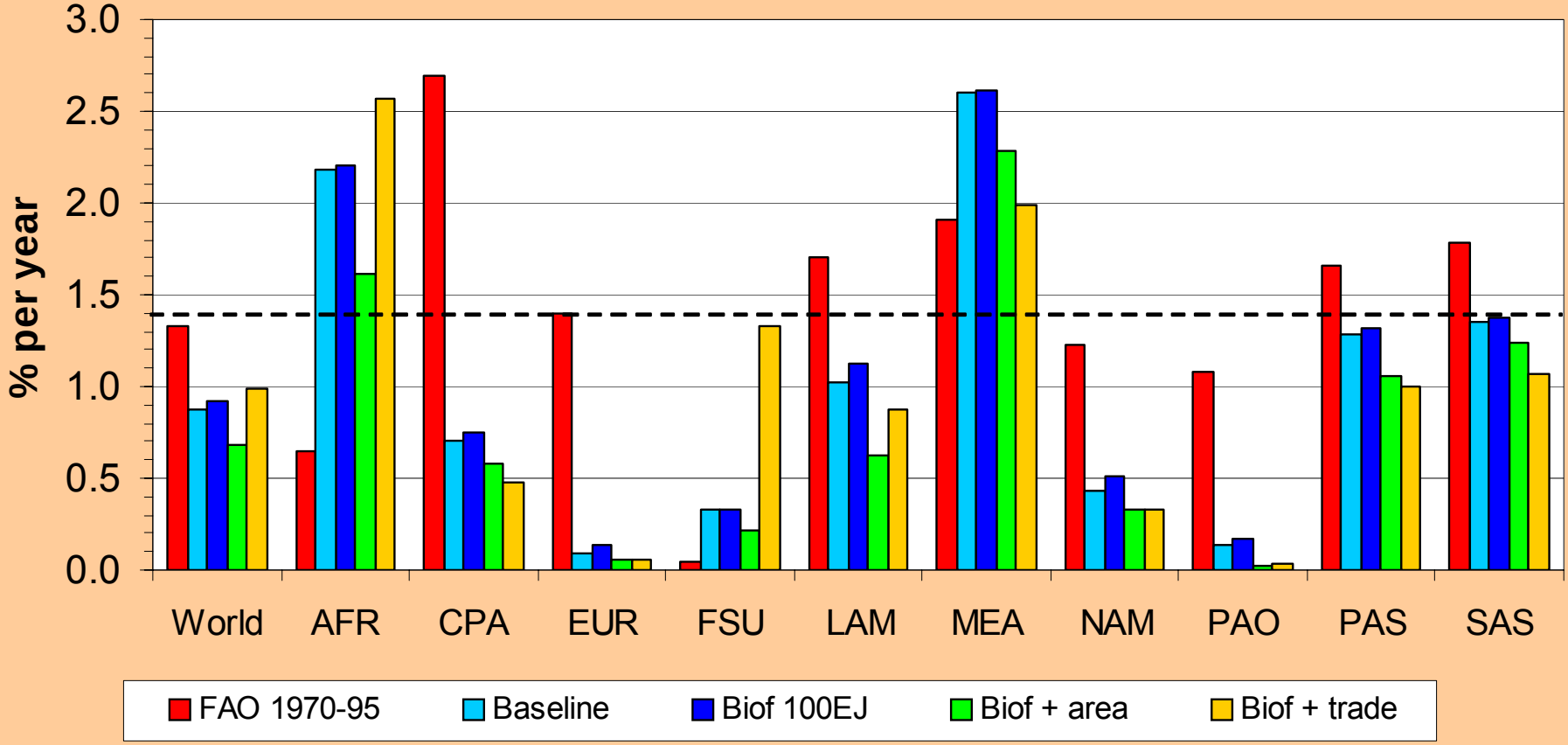


PIK

Lotze-Campen et al., preliminary results

Required rates of technical change in agriculture (2005-2055)

- Baseline plus various biofuel scenarios -



Lotze-Campen et al., preliminary results