



POTSDAM INSTITUTE FOR  
CLIMATE IMPACT RESEARCH

# **Bioenergiepotenziale – eine globale und multi-sektorale Perspektive**

**Alexander Popp**

& Dietrich, Klein, Bauer, Lotze-Campen, Humpenöder, Beringer

# Overview

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2nd generation bioenergy:  
Substantielle Bedeutung im zukünftigen ES

## Ungelöste Fragen

- Kosten-effizientes Bioenergie Potential
- Nachhaltigkeitsaspekte
  - o Nahrungssicherheit
  - o Wassersicherheit
  - o Klimaschutz
  - o Biodiversität



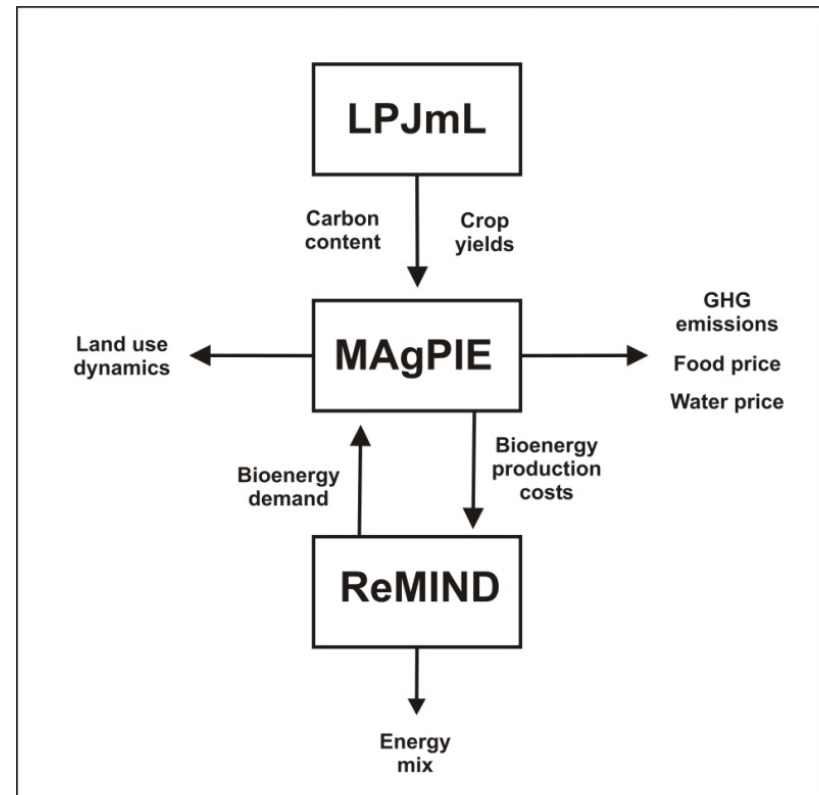
# Objective

Modell framework um den potentiellen Beitrag von Bioenergie zu untersuchen – inkl. der Kosten & Trade-offs

LPJmL - global vegetation and hydrology model

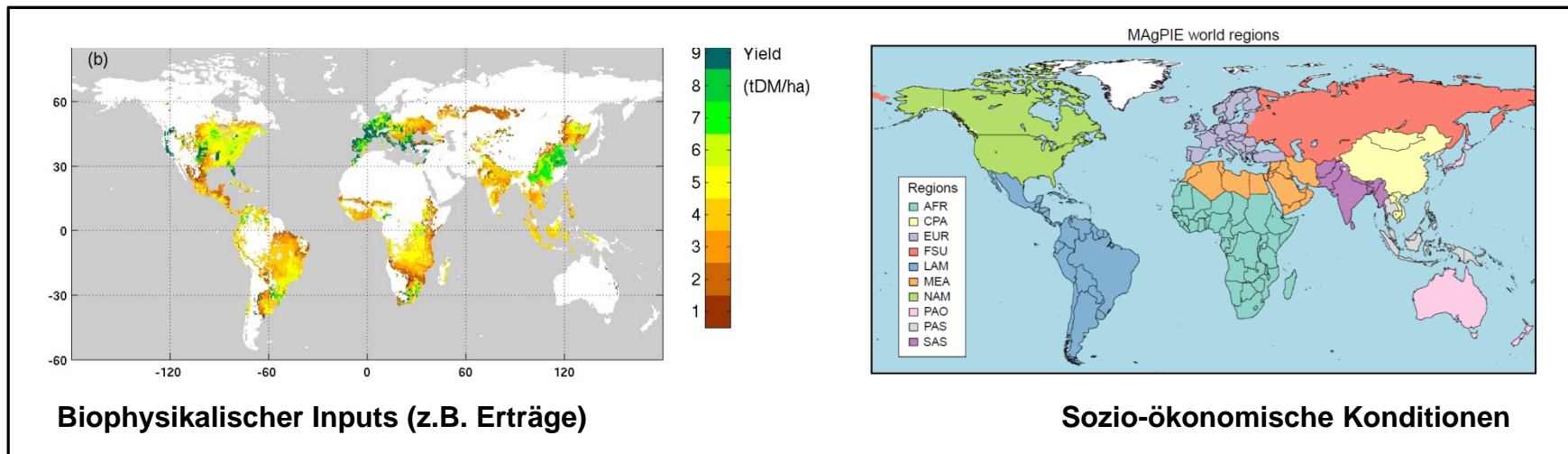
MAgPIE - global land use optimization model

REMIND- global energy-economy-climate model



# MAGPIE

- Ökonomische Optimierung (min. total production costs)
- Gitterzellen ( $0.5^\circ$  resolution), regionale ökonomische Konditionen (10 regions)
- 30 Produktionsaktivitäten (crops, livestock, bioenergy), Bewässerung



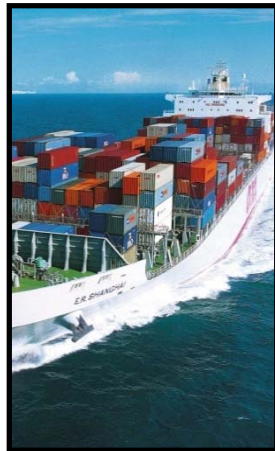
# Trade-offs zwischen Nachfrage, Handel, Landausweitung und Intensivierung

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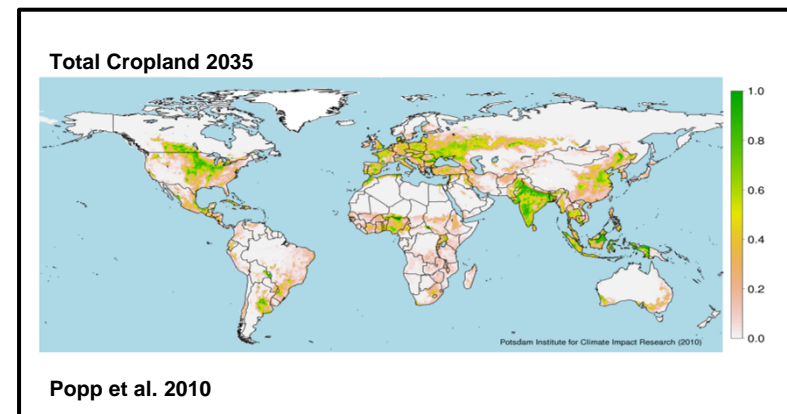
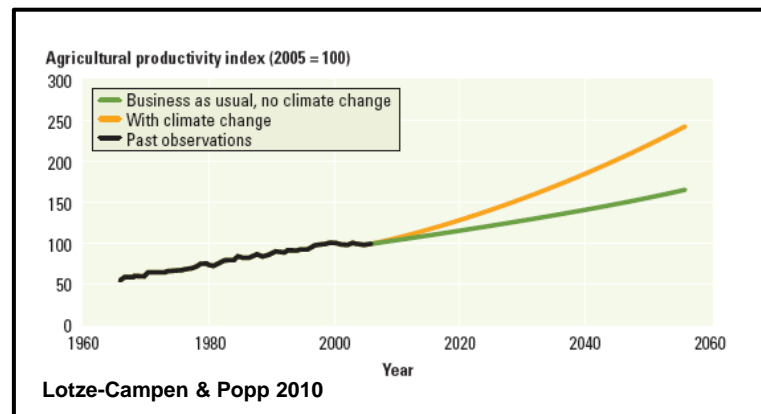
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# MAGPIE

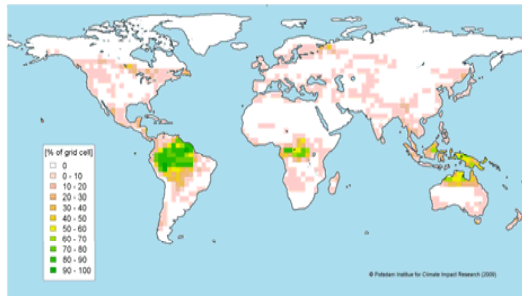
- Ökonomische Optimierung (min. total production costs)
- Gitterzellen ( $0.5^\circ$  resolution), regionale ökonomische Konditionen (10 regions)
- 30 Produktionsaktivitäten (crops, livestock, bioenergy), Bewässerung
- Endogene (kosten-basierte) Landausweitung vs. Ertragssteigerung



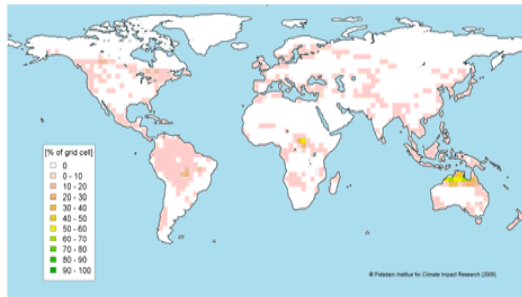
# Scenarien

## Geeignetes Land zur Ausweitung

**Ref & M**



**M\_FC**

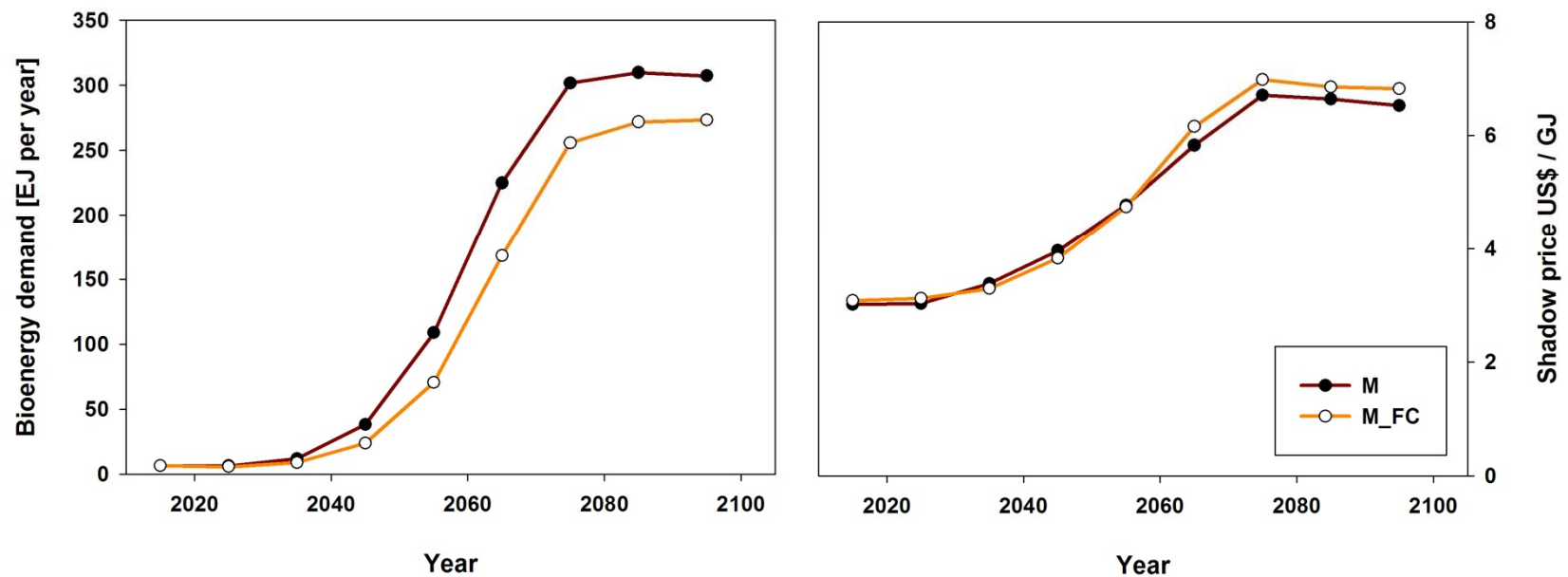


**Ref –**  
Keine Bioenergienachfrage

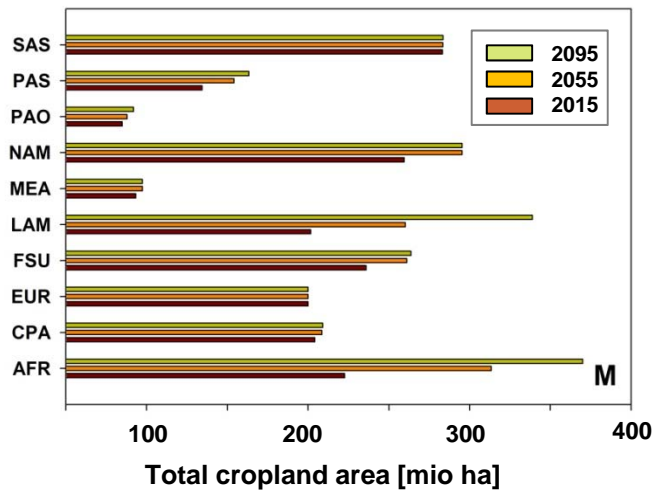
**M –**  
Bioenergie zum Klimaschutz

**M\_FC –**  
Bioenergie zum Klimaschutz  
& Waldschutz

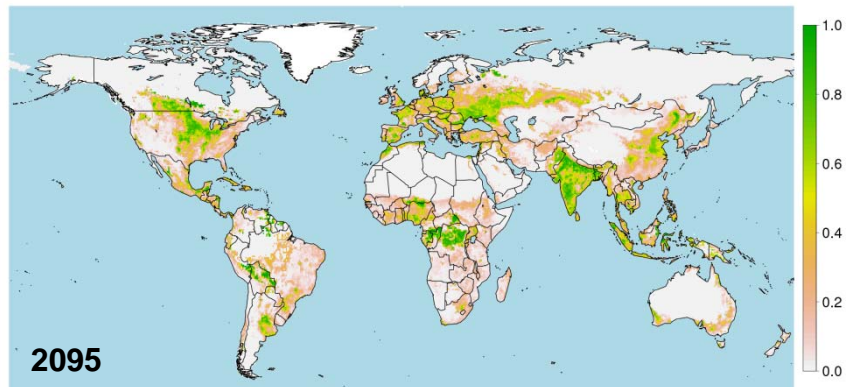
# Ergebnis: Bioenergieproduktion



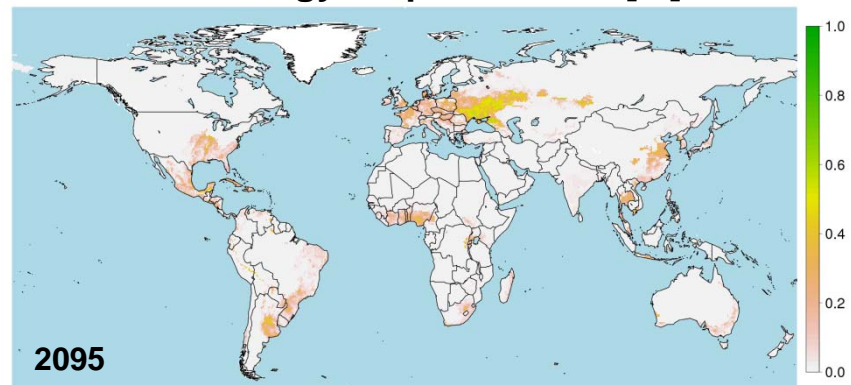
# Ergebnis: Landdynamik



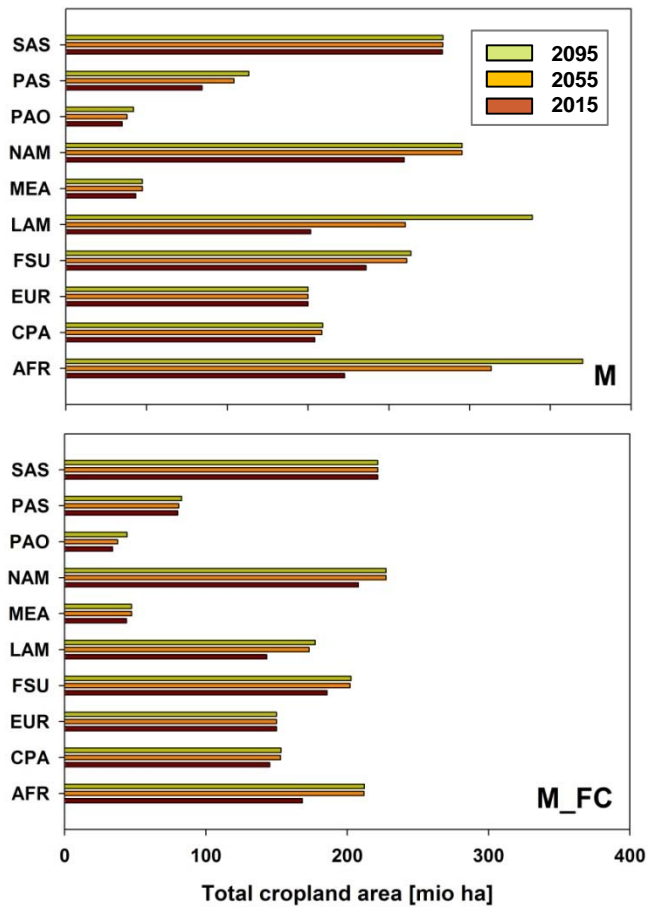
Total cropland share [%]



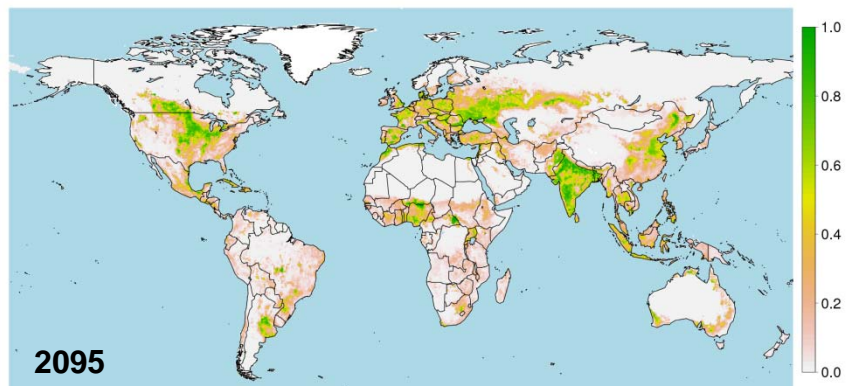
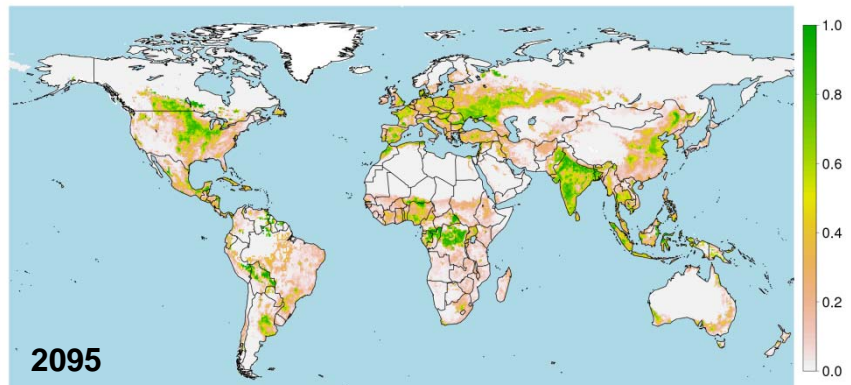
Bioenergy cropland share [%]



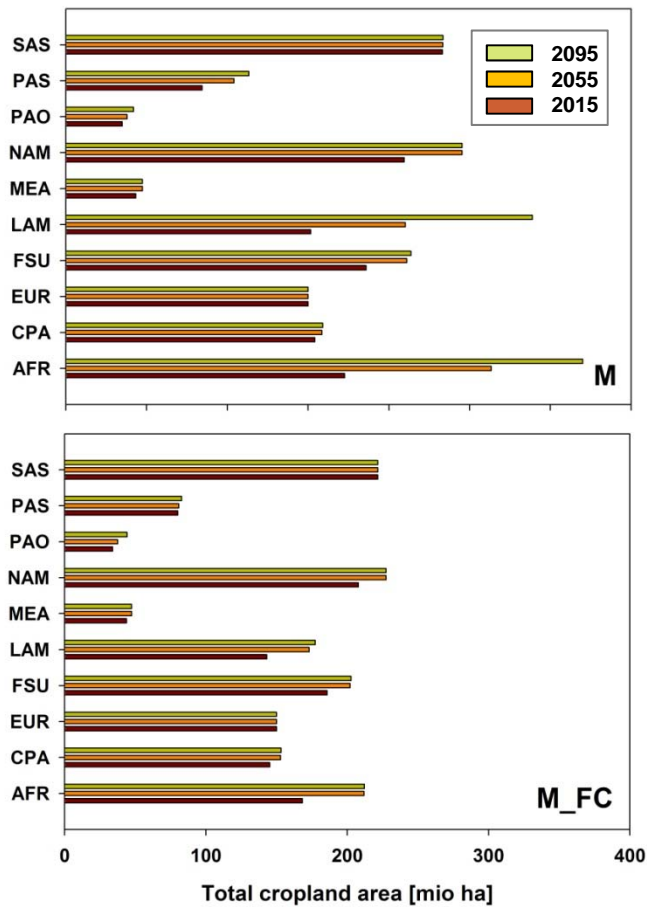
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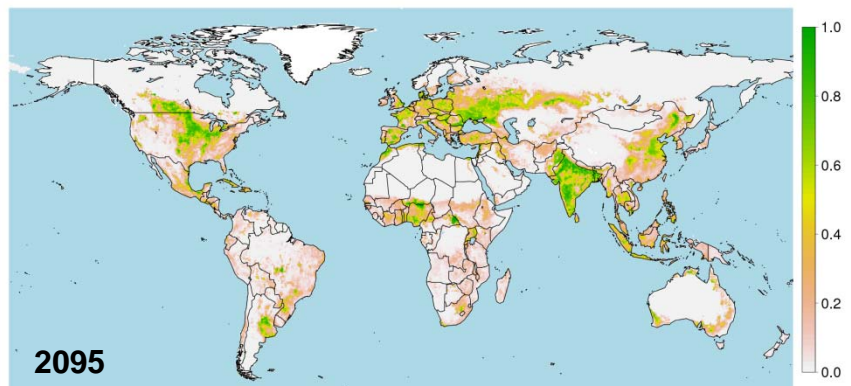
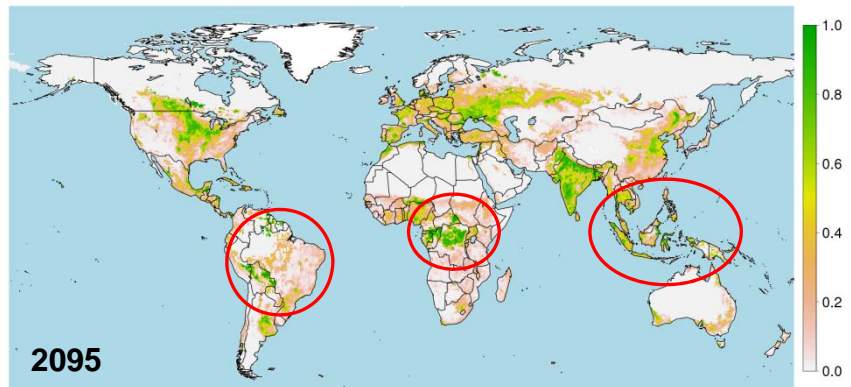
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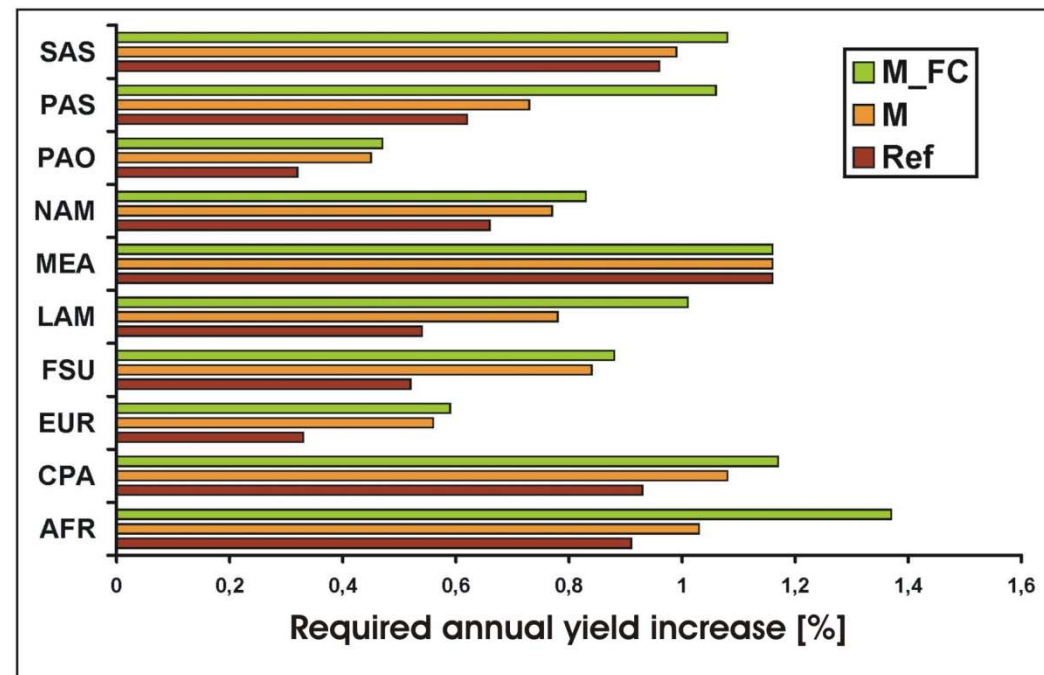
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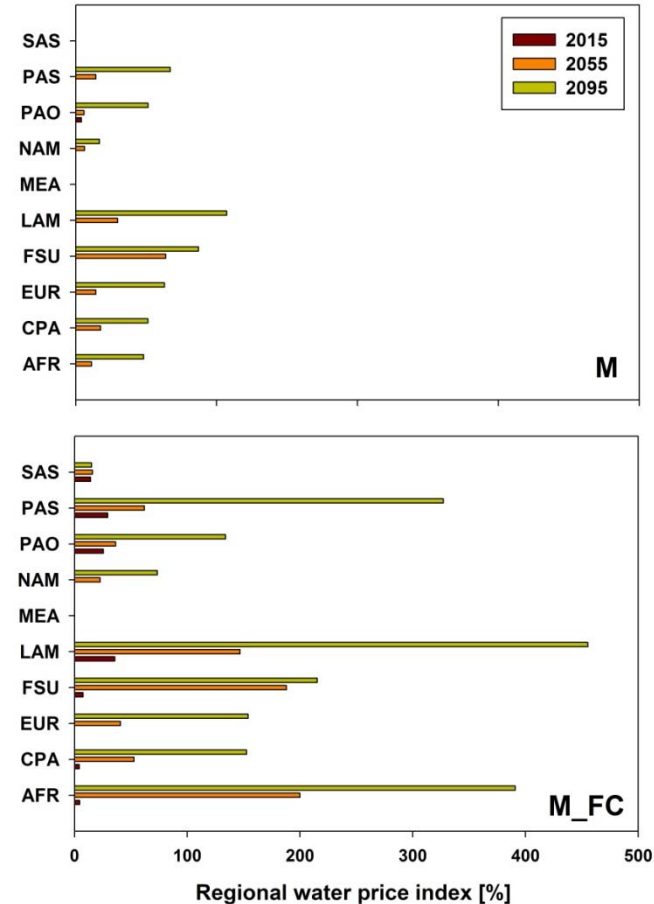
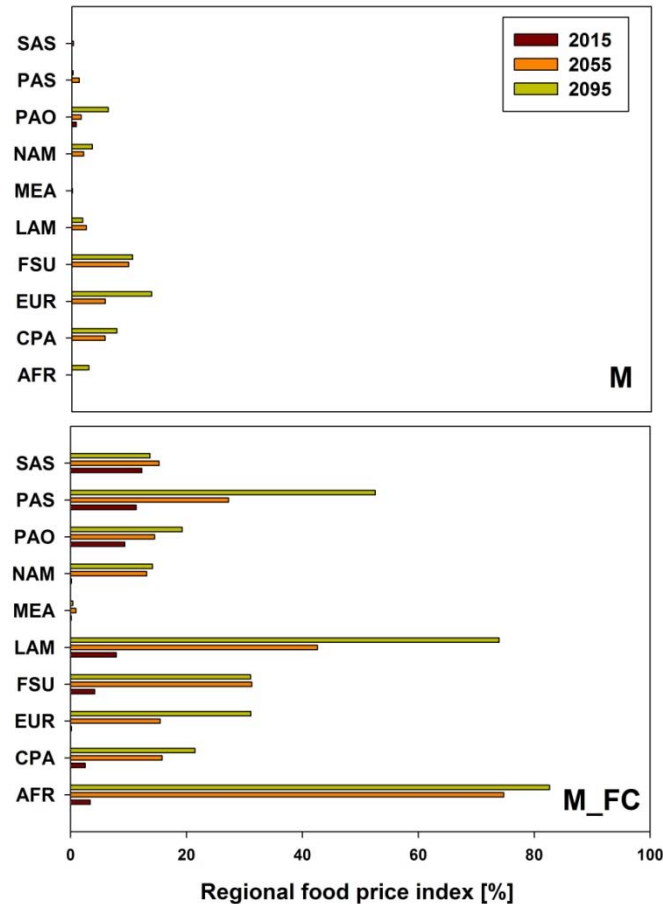
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# Ergebnis: Ertragssteigerung



# Ergebnis: Nahrungs- und Wassersicherheit



# Schlussfolgerung

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Bioenergie (2<sup>nd</sup> generation): kosteneffizienter Beitrag zum ES (CCS)

Einschränkungen der Landverfügbarkeit (Waldschutz):

beeinflusst Bioenergiepotential kurz-, aber nicht langfristig

→ weniger Landverfügbarkeit kann teilweise durch höhere Ertragssteigerungen kompensiert werden

**Aber:** Waldschutz & Bioenergie führt zu verstärkten Konflikten hinsichtlich Nahrungs- und Wassersicherheit

**Integrierte Politik zum Energie-, Landnutzungs- und Wassermanagement benötigt**

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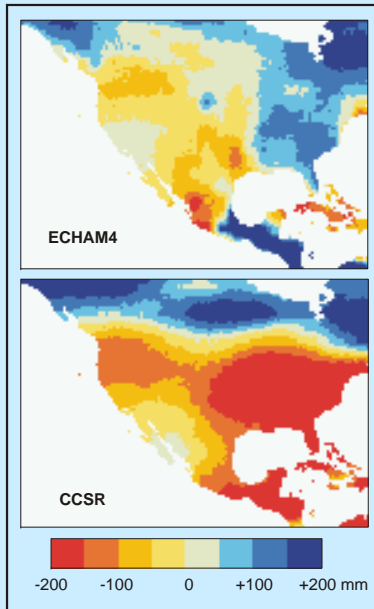
**Vielen Dank für Ihre Aufmerksamkeit!**

Popp, A., Dietrich, J.P., Lotze-Campen H., Klein, D., Bauer, N., Krause, M., Beringer, T., Gerten, D., Edenhofer, O. (2011): ***The economic potential of bioenergy for climate change mitigation with special attention given to implications for the land system.*** Environmental Research Letters 6 034017



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Potsdam Institute for Climate Impact Research

## Climate change (GCM)



## Crop yields

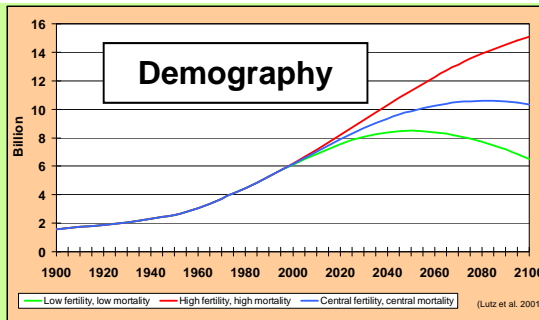
### Land & Water constraints



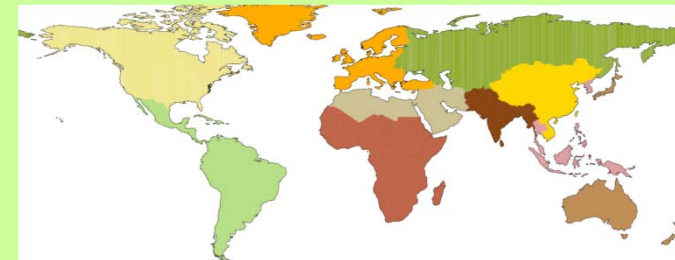
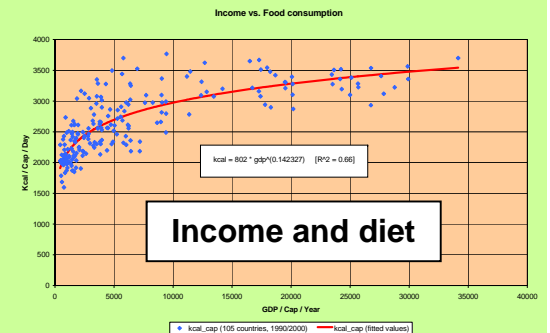
LPJ (50x50 km grid)

## Biophysical inputs

*Lotze-Campen et al. (2008),  
Agricultural Economics*



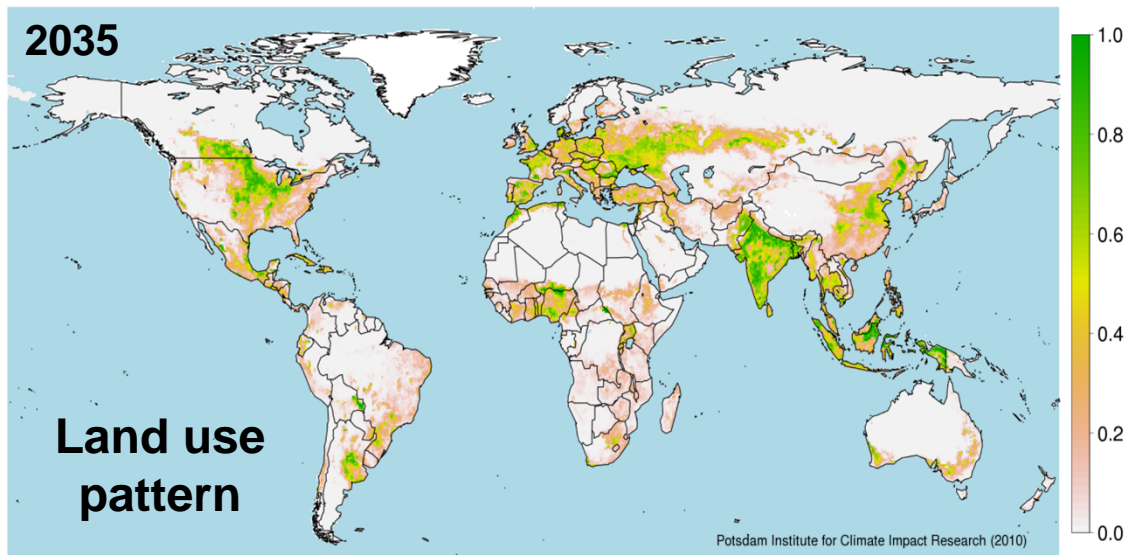
## Socioeconomic inputs



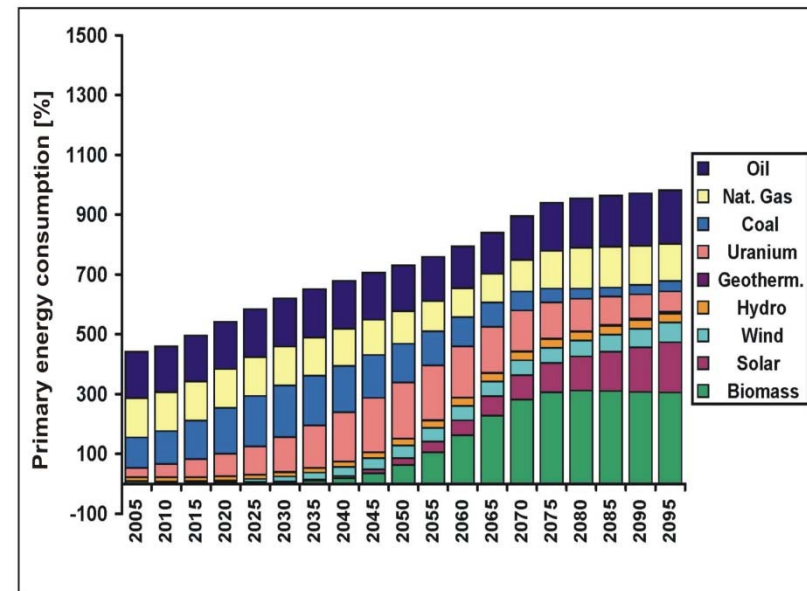
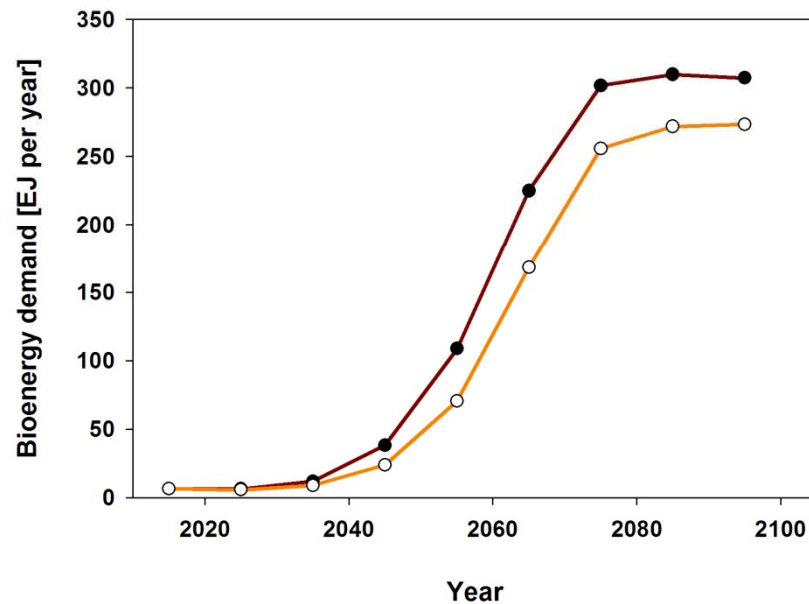
## Food demand, production costs



## Land use dynamics

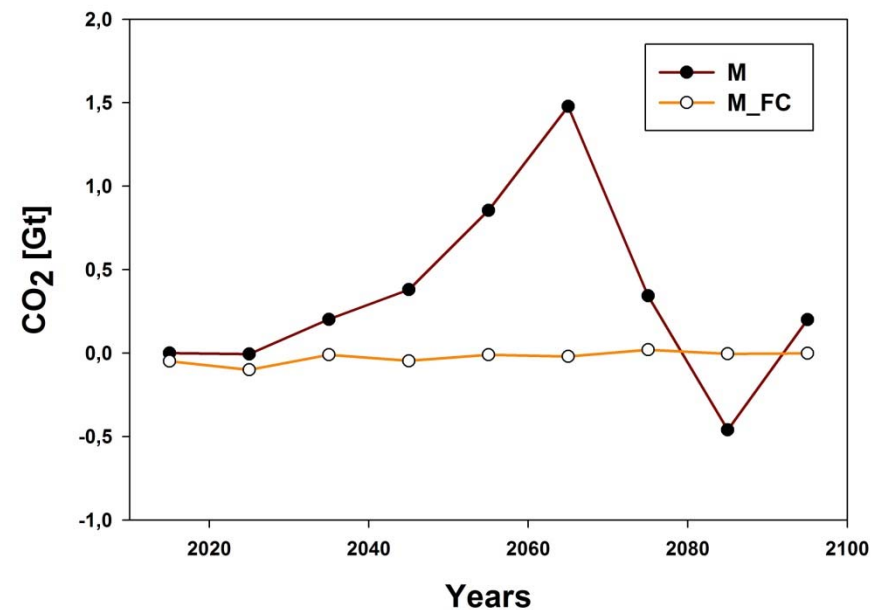


# Results: Bioenergy supply

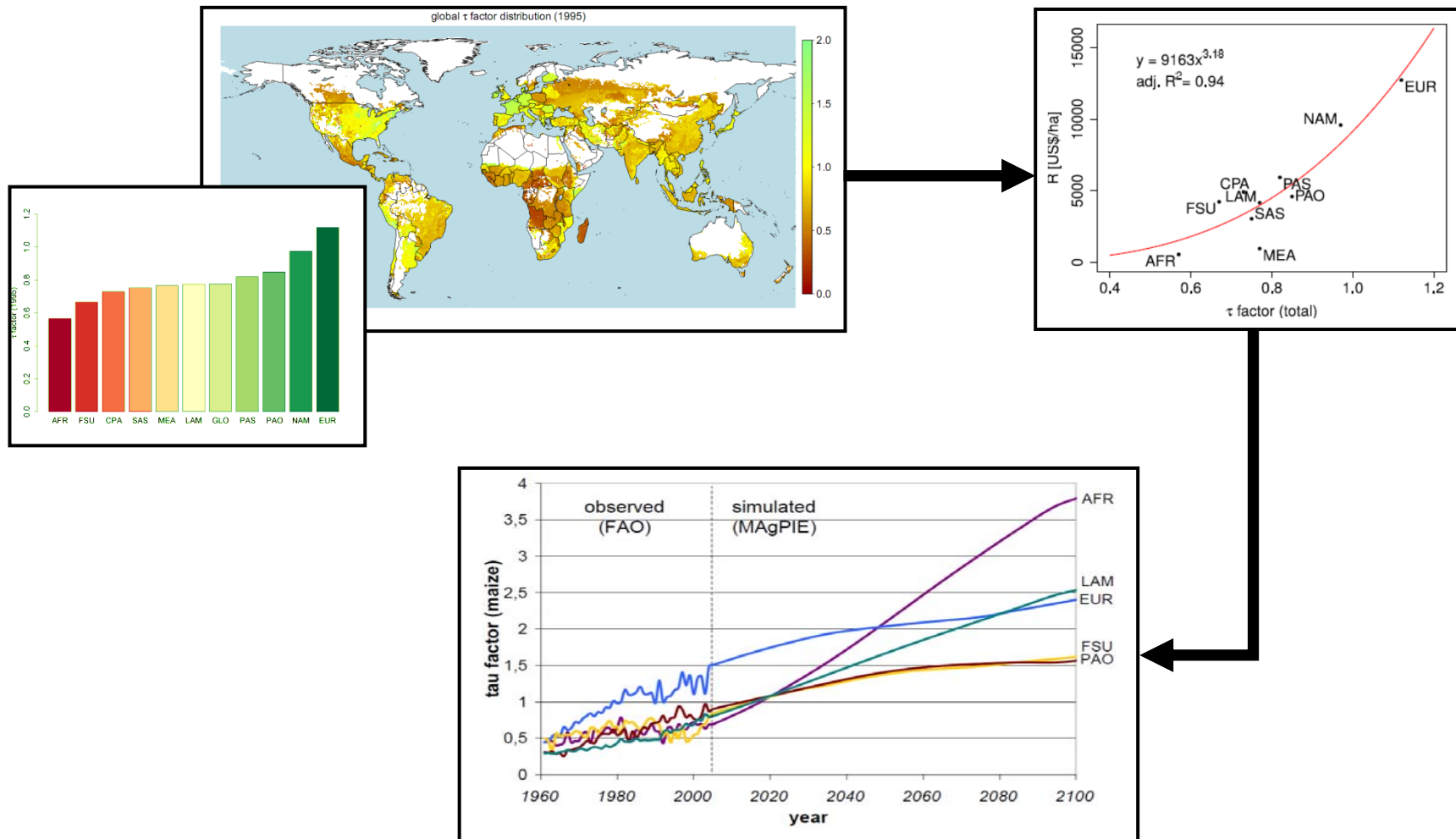


# Results: Additional global CO<sub>2</sub> emissions from land use change due to bioenergy production

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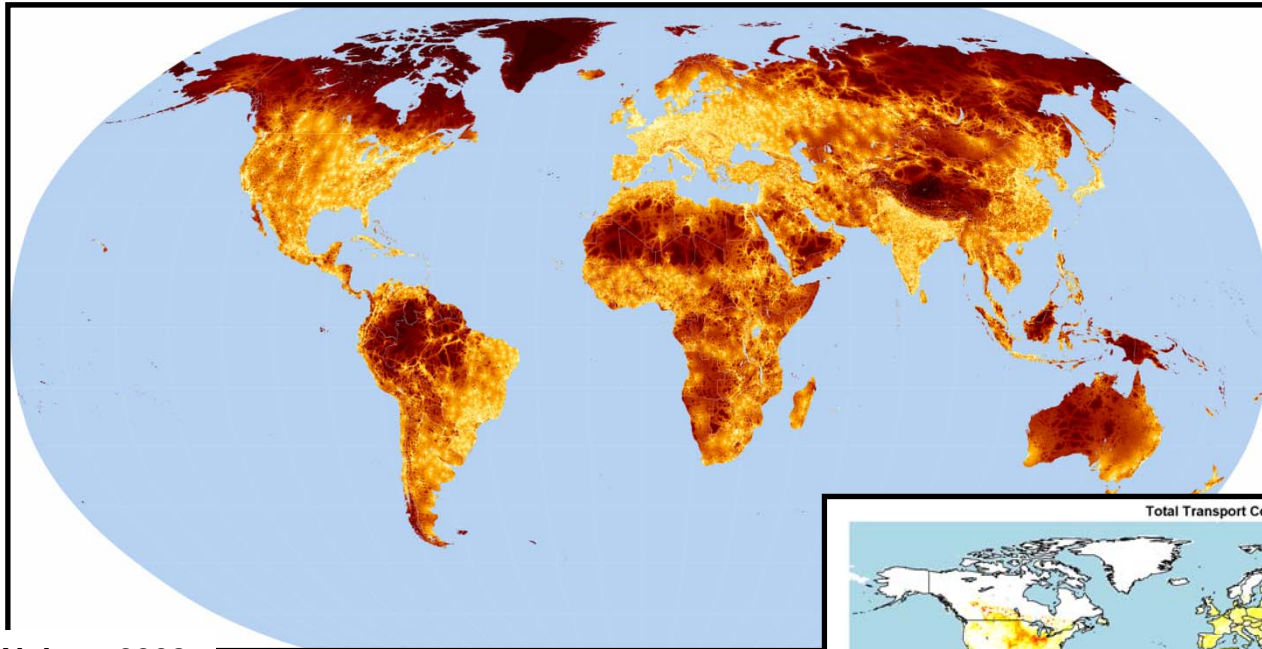


# Yield increases

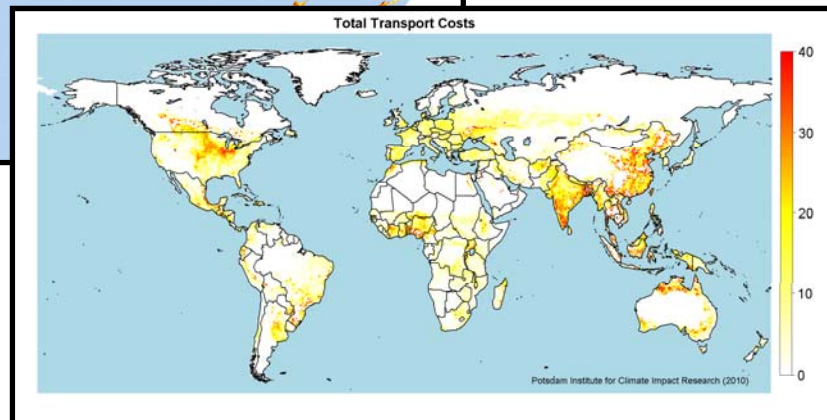


# Land expansion

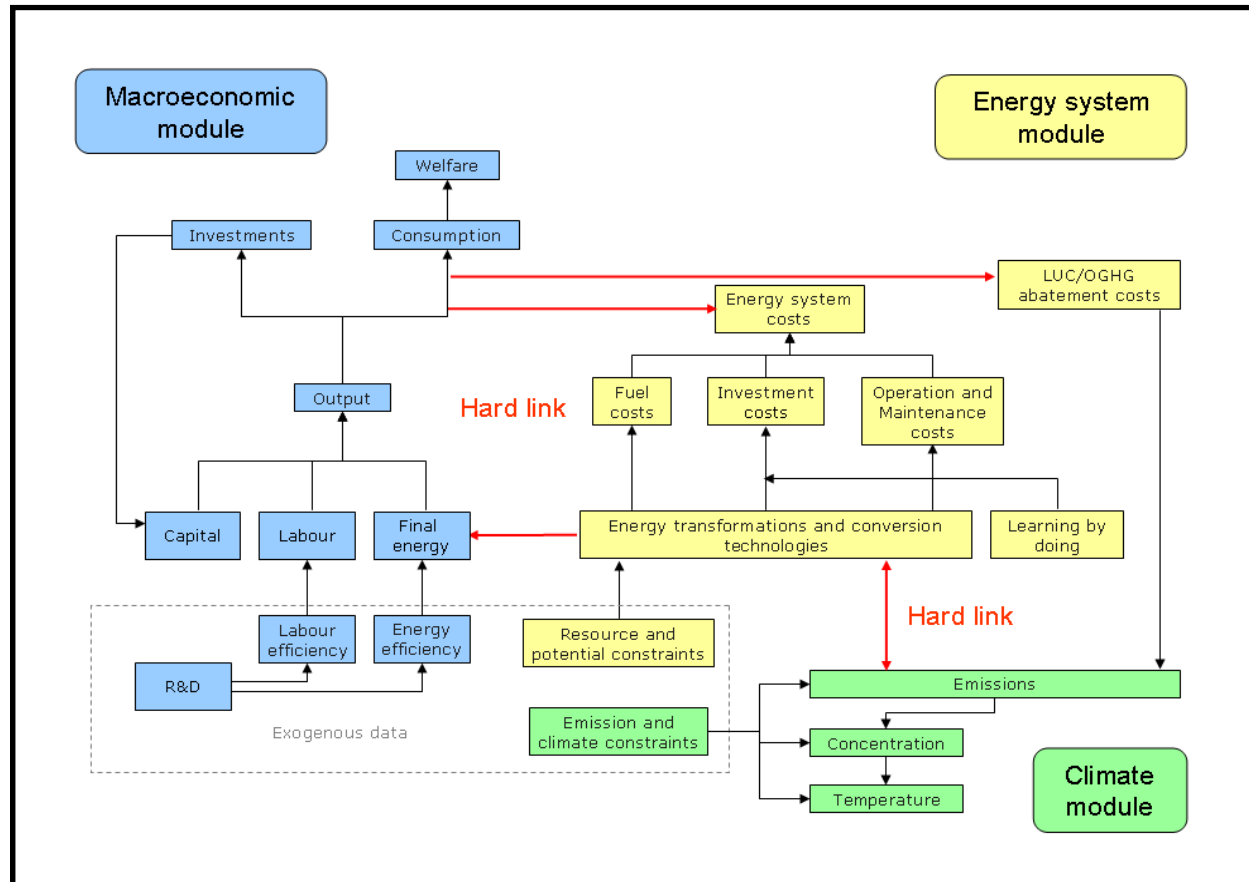
## Travel time to major cities: A global map of Accessibility



JRC, Nelson 2008



# REMINd



Leimbach et al. 2009

# What is an Energy system?

