



POTSDAM INSTITUTE FOR  
CLIMATE IMPACT RESEARCH

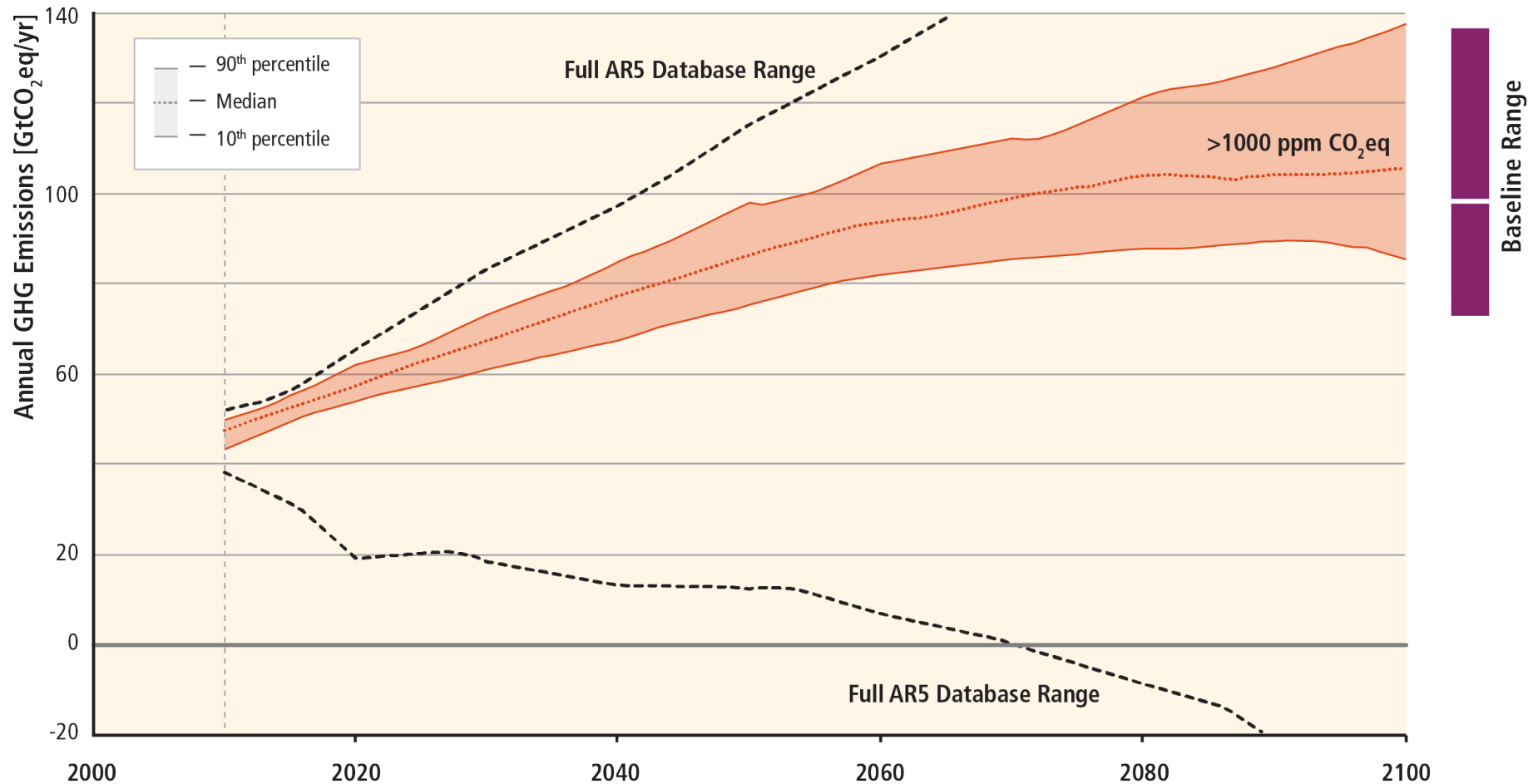
HUMBOLDT-UNIVERSITÄT ZU BERLIN



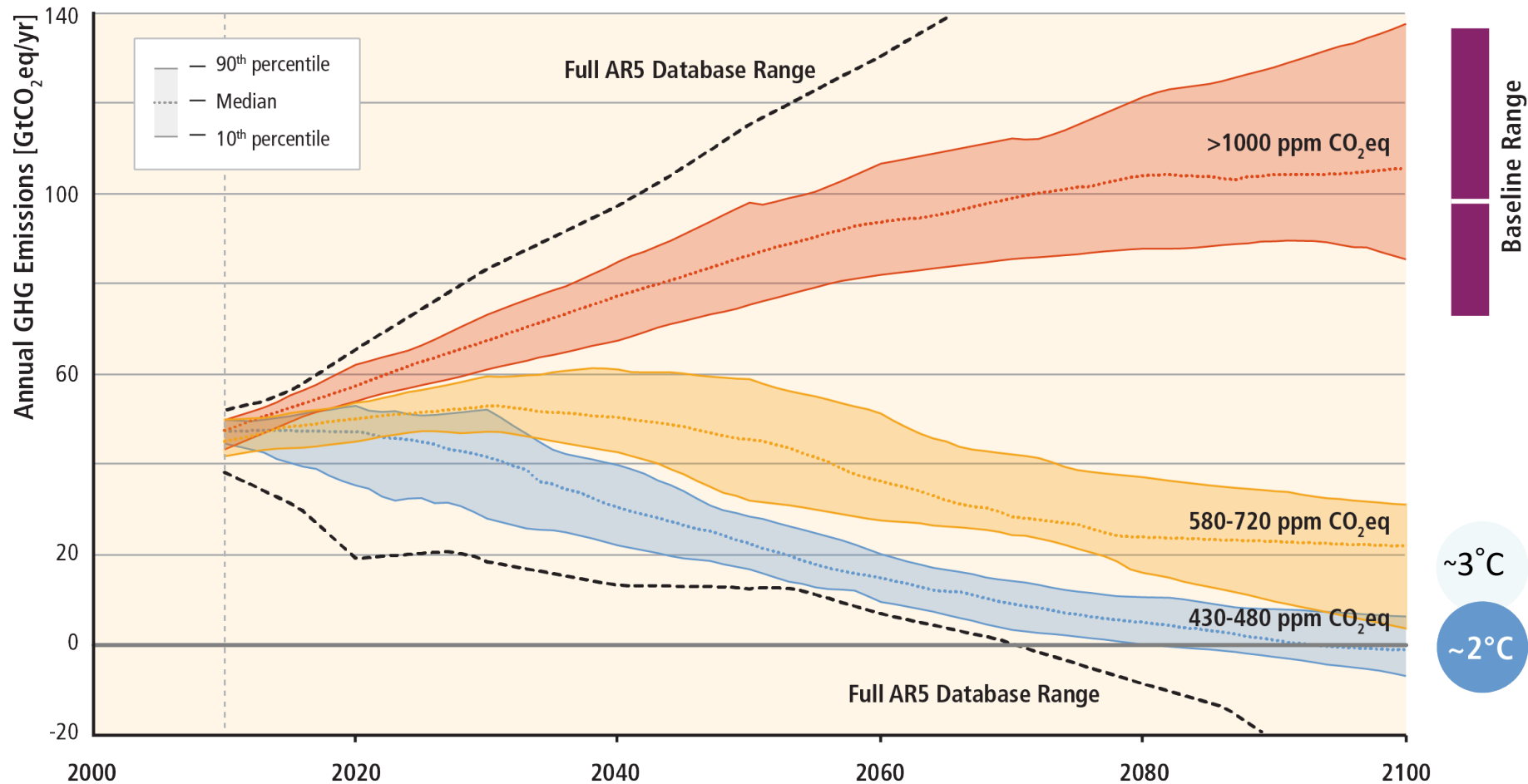
# Climate change and food security

Hermann Lotze-Campen

# Stabilization of atmospheric GHG concentration requires deviation from the baseline – independent of mitigation target



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# Challenges for climate-smart agriculture and land use

- **Rising demand for land-based products and ecosystem services**
- **Direct climate impacts**
  - **Temperature, precipitation, CO<sub>2</sub> [extreme events]**
  - **Water scarcity**
  - **Sea level rise**
- **Indirect climate impacts (from ambitious mitigation)**
  - **Increasing energy prices**
  - **Bioenergy demand**
  - **Forest and biodiversity protection**
  - **Reducing agricultural GHG emissions**

**1** NO  
POVERTY



**2** ZERO  
HUNGER



**3** GOOD HEALTH  
AND WELL-BEING



**4** QUALITY  
EDUCATION



**5** GENDER  
EQUALITY



**6** CLEAN WATER  
AND SANITATION



**7** AFFORDABLE AND  
CLEAN ENERGY



**8** DECENT WORK AND  
ECONOMIC GROWTH



**Land use,  
agriculture,  
and  
SDGs**

**9** INDUSTRY, INNOVATION  
AND INFRASTRUCTURE



**10** REDUCED  
INEQUALITIES



**11** SUSTAINABLE CITIES  
AND COMMUNITIES



**12** RESPONSIBLE  
CONSUMPTION  
AND PRODUCTION



**13** CLIMATE  
ACTION



**14** LIFE  
BELOW WATER



**15** LIFE  
ON LAND



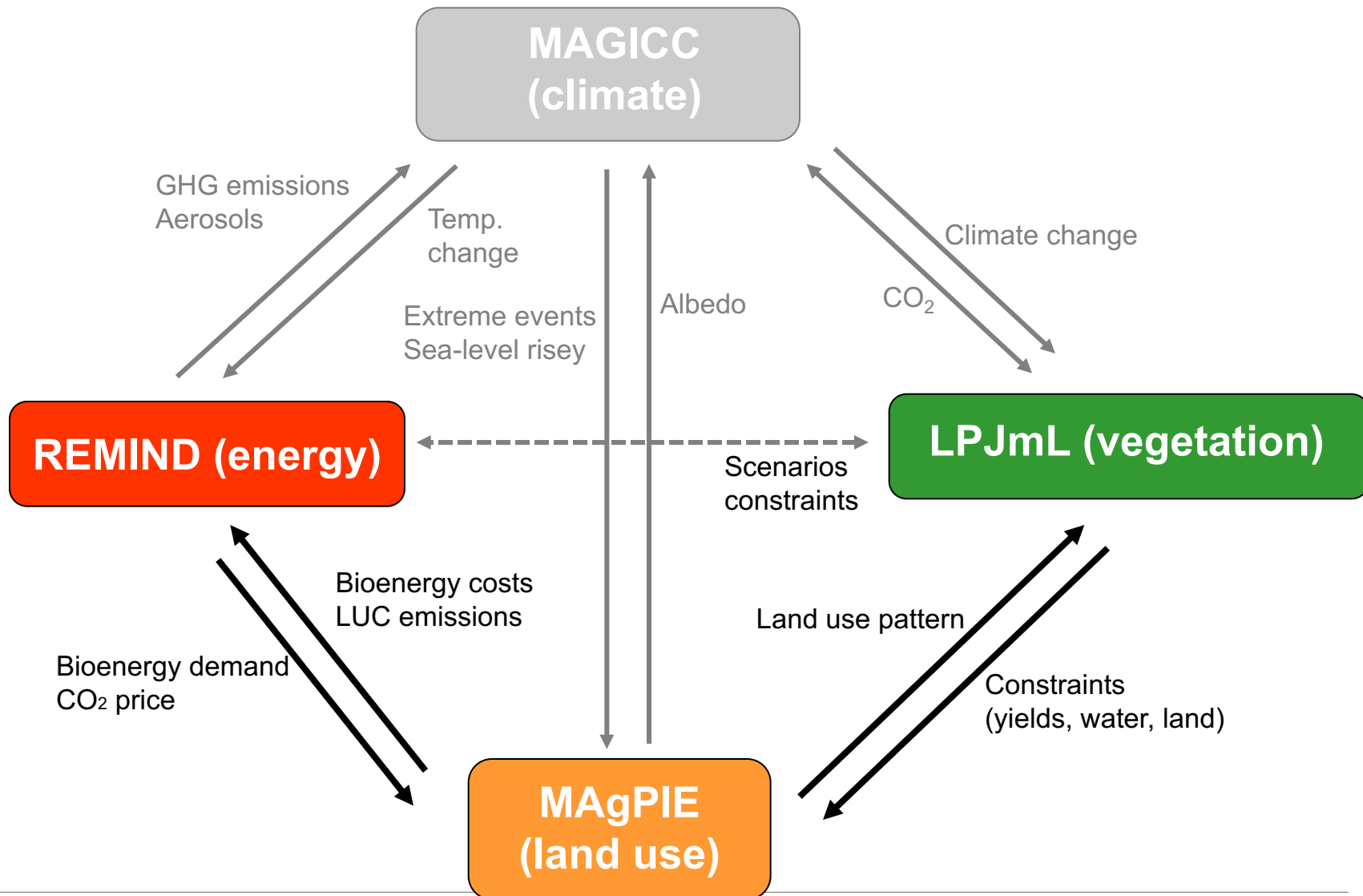
**16** PEACE, JUSTICE  
AND STRONG  
INSTITUTIONS



**17** PARTNERSHIPS  
FOR THE GOALS



# The PIK Integrated Assessment framework

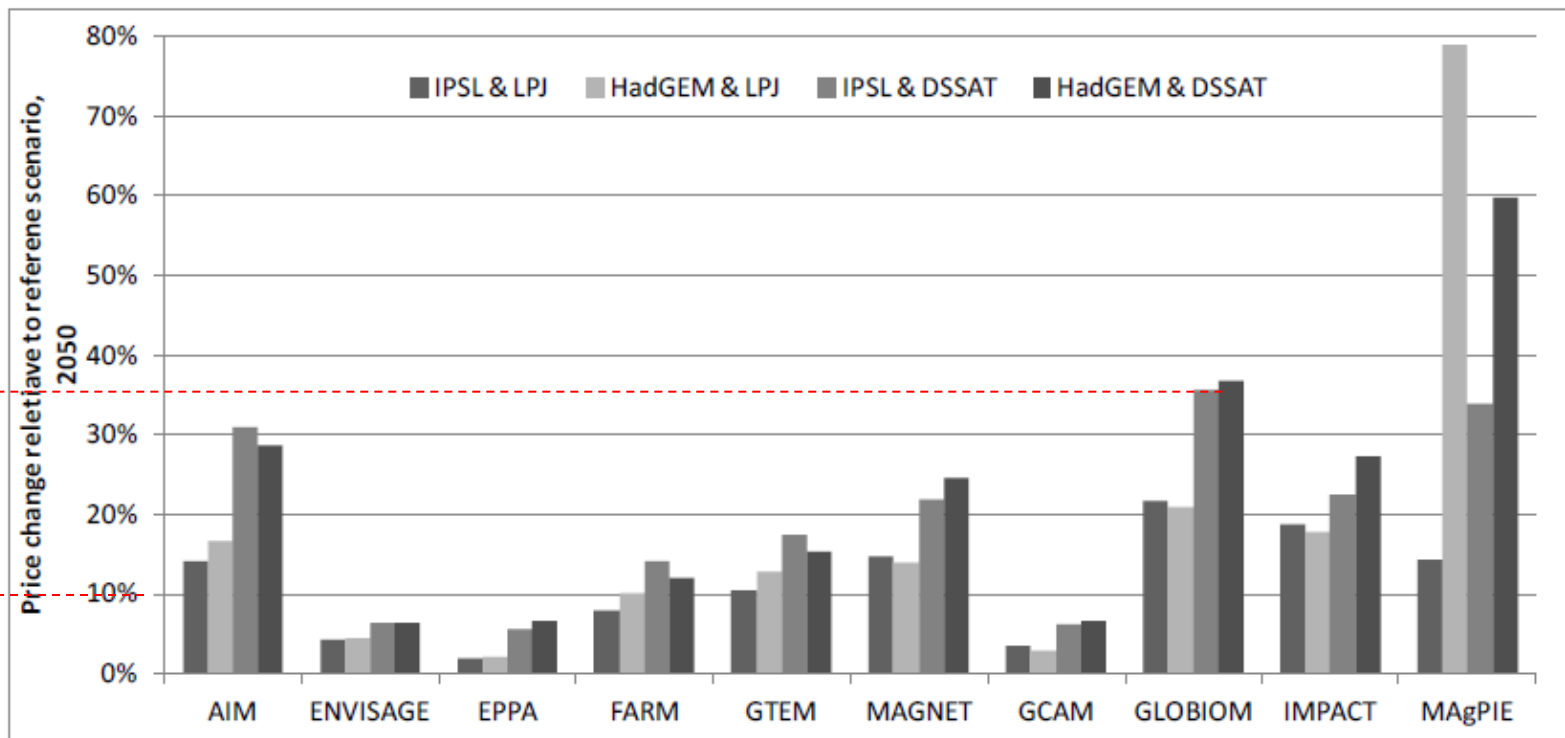


# Land use modelling at PIK

- Development of **long-term scenarios** on global food, feed, forest and bioenergy production
- Analyses of **trade-offs between different land uses**
- Analyses of **agricultural climate impacts** and adaptation options
- Scenarios on **land-use emissions** and mitigation options
- Model coupling around the **energy-land-water nexus**



# Climate-induced agricultural prices changes by 2050 (climate extremes not included)



Source: Model results as of February 15, 2013

Note: All changes relative to the reference scenario for the same year.



# Background paper for World Bank Report

# SHOCK WAVES

## Managing the Impacts of Climate Change on Poverty

World Bank 2015

Biewald, A.; Lotze-Campen, H.; Otto, I.; Brinckmann, N.; Bodirsky, B.; Weindl, I.; Popp, A.; Schellnhuber, H. J. (2015):  
The impact of climate change on costs of food and people exposed to hunger at subnational scale. PIK-Report No.128.  
[www.pik-potsdam.de/research/publications/pikreports/summary-report-no-128](http://www.pik-potsdam.de/research/publications/pikreports/summary-report-no-128)

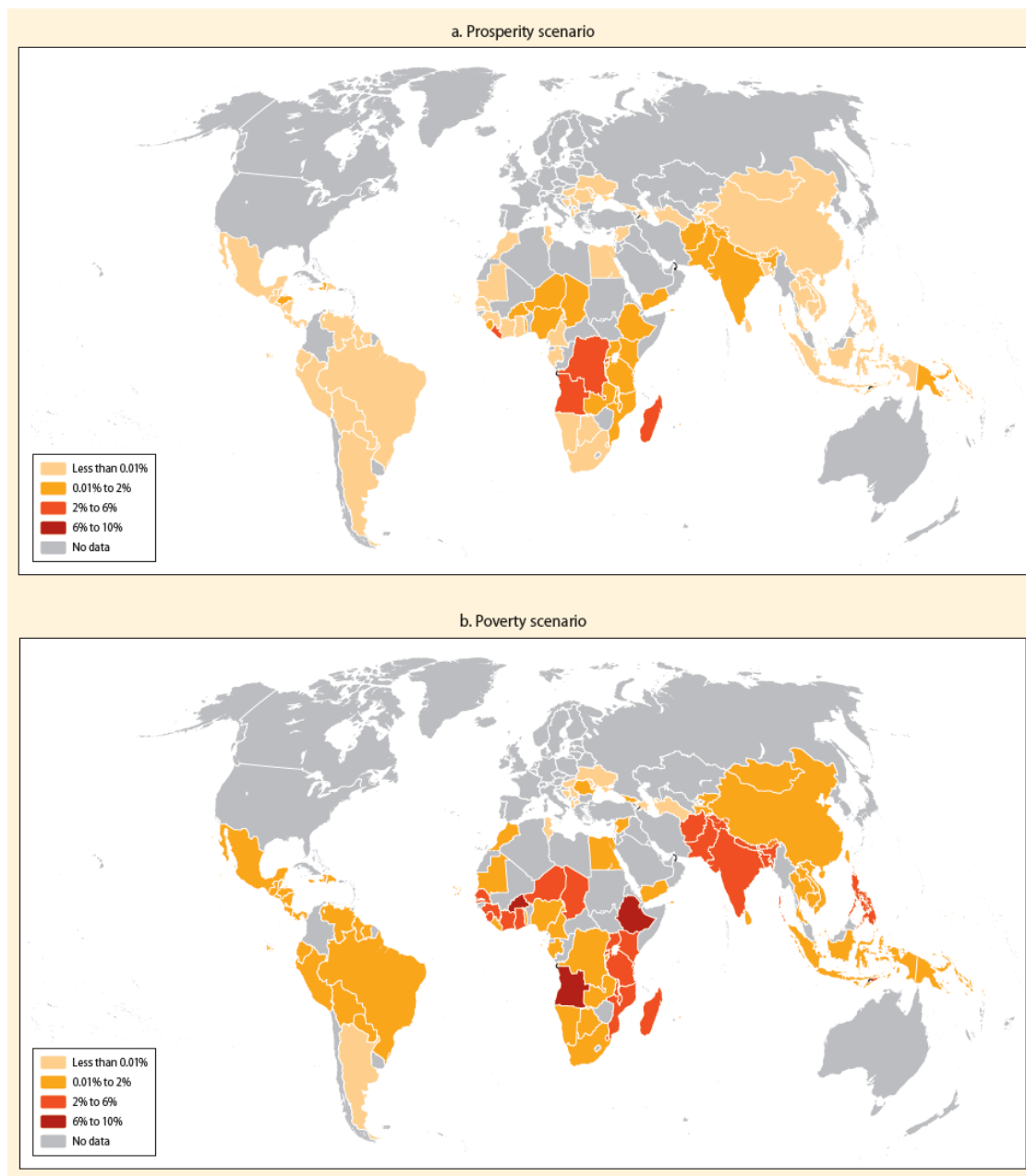


Hermann Lotze-Campen

21 Nov 2017

## MAP 1 Policies that promote good development can reduce the impact of climate change on poverty by 2030

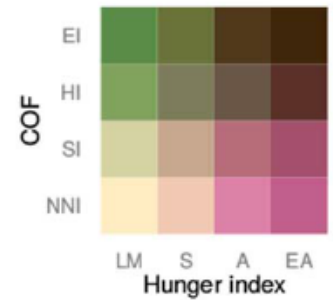
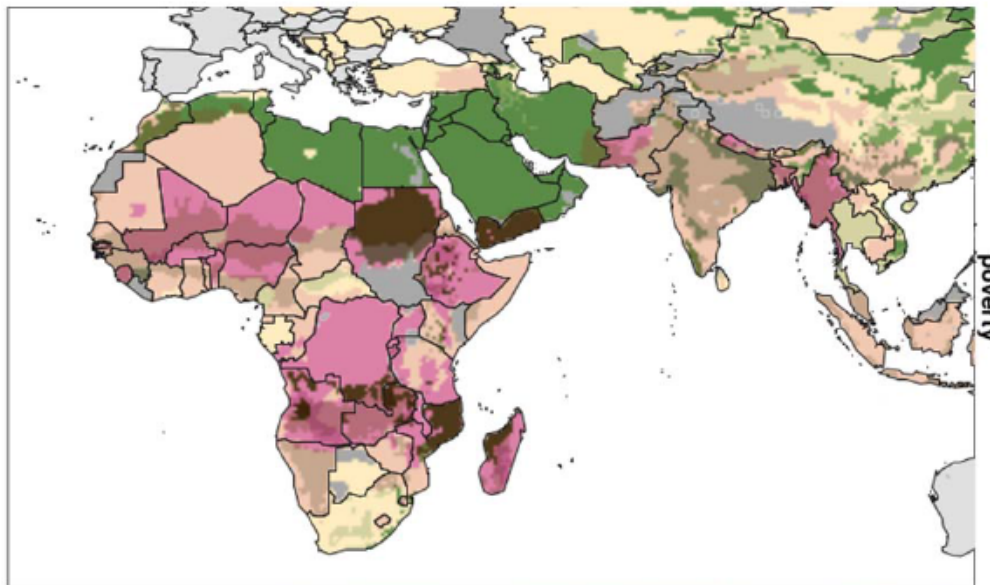
(Increase in number of extreme poor people due to climate change (% of total population))



**„Poverty“ scenario:  
by 2030 ca. 100 mill.  
more people  
threatened by  
extreme poverty**

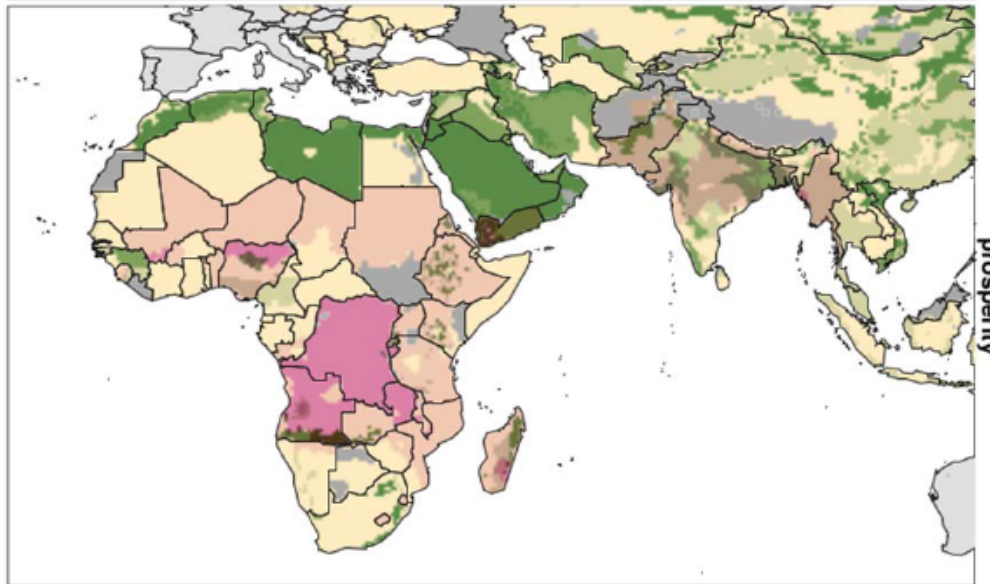
World Bank 2015

21 Nov 2017



Industrialized country  
No data

## The agricultural vulnerability indicator



**„Poverty“ scenario:  
by 2030 ca. 45 mill. more  
people, who are extremely  
vulnerable to hunger, may be  
affected by higher food costs  
due to climate change**

# Climate change adaptation options in agriculture

- **Production risks -> Technology**

- **Soil management, new crop varieties, rotation, irrigation, livestock feed**
- **Expansion/shift of agricultural land**

- **Income risks -> Insurance**

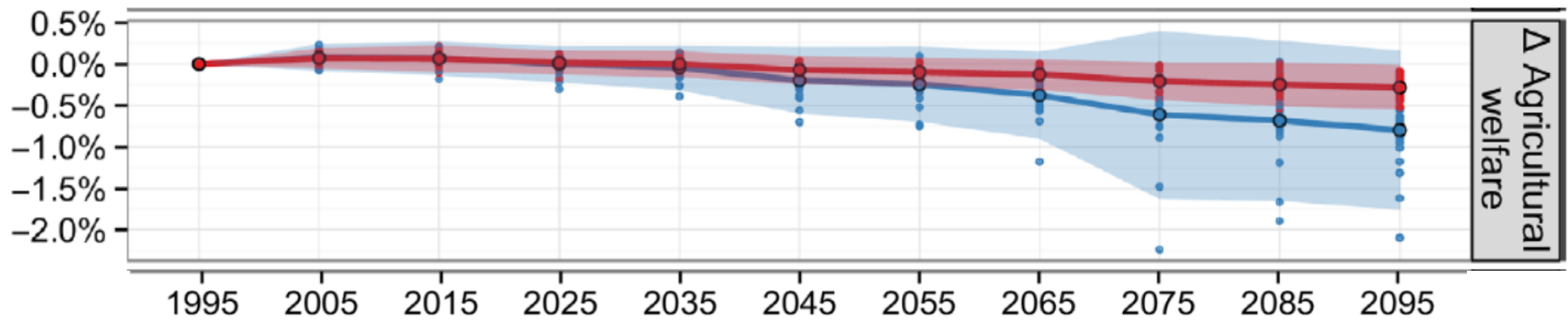
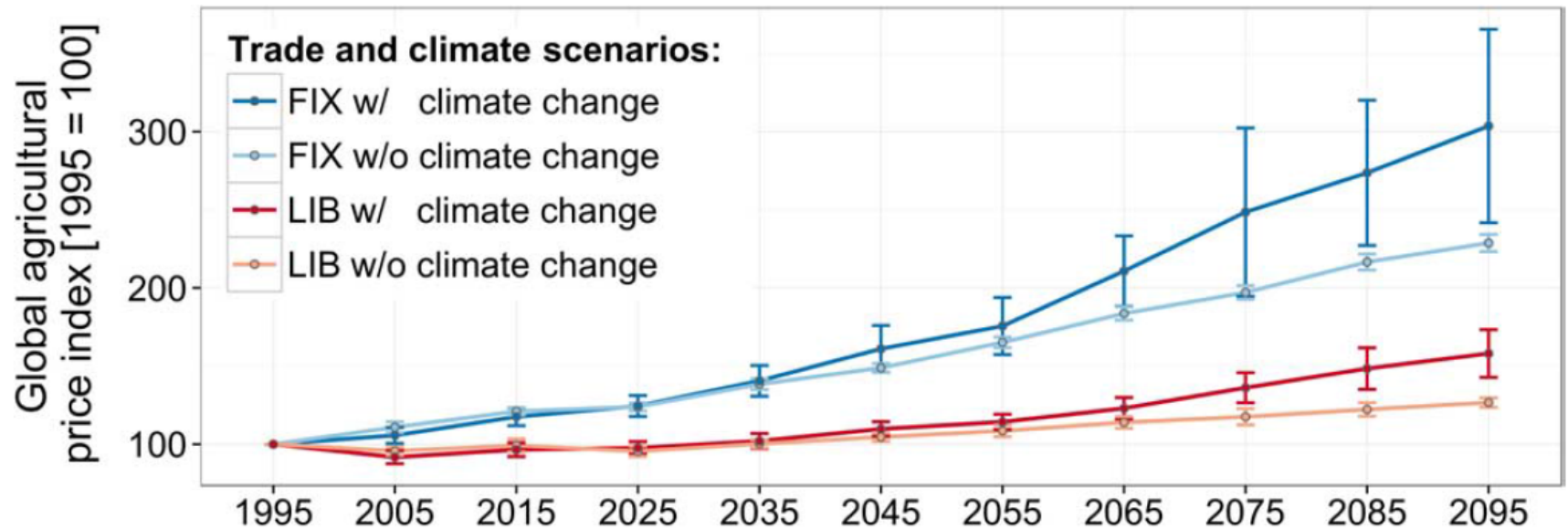
- **Multi-peril insurance**
- **Weather derivatives**

- **Market risks -> Trade**

- **Diversified international trade relations**

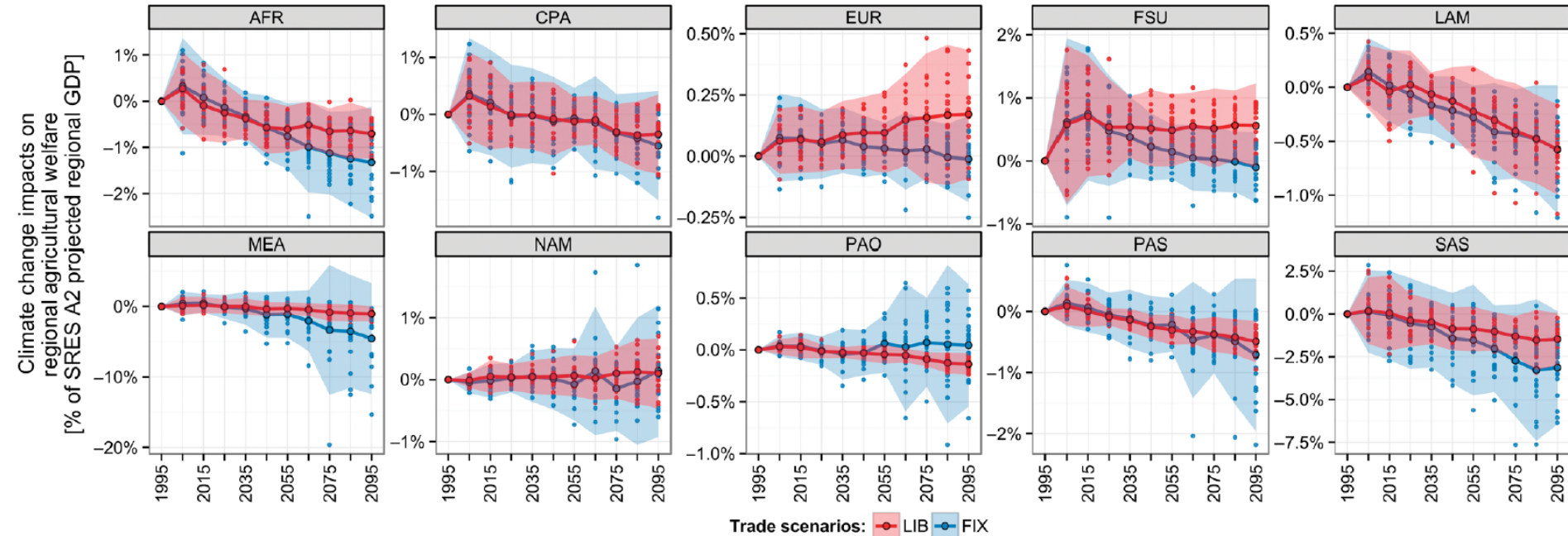
**Lotze-Campen and Schellnhuber 2009**

# Free trade can reduce climate-related economic losses in agriculture



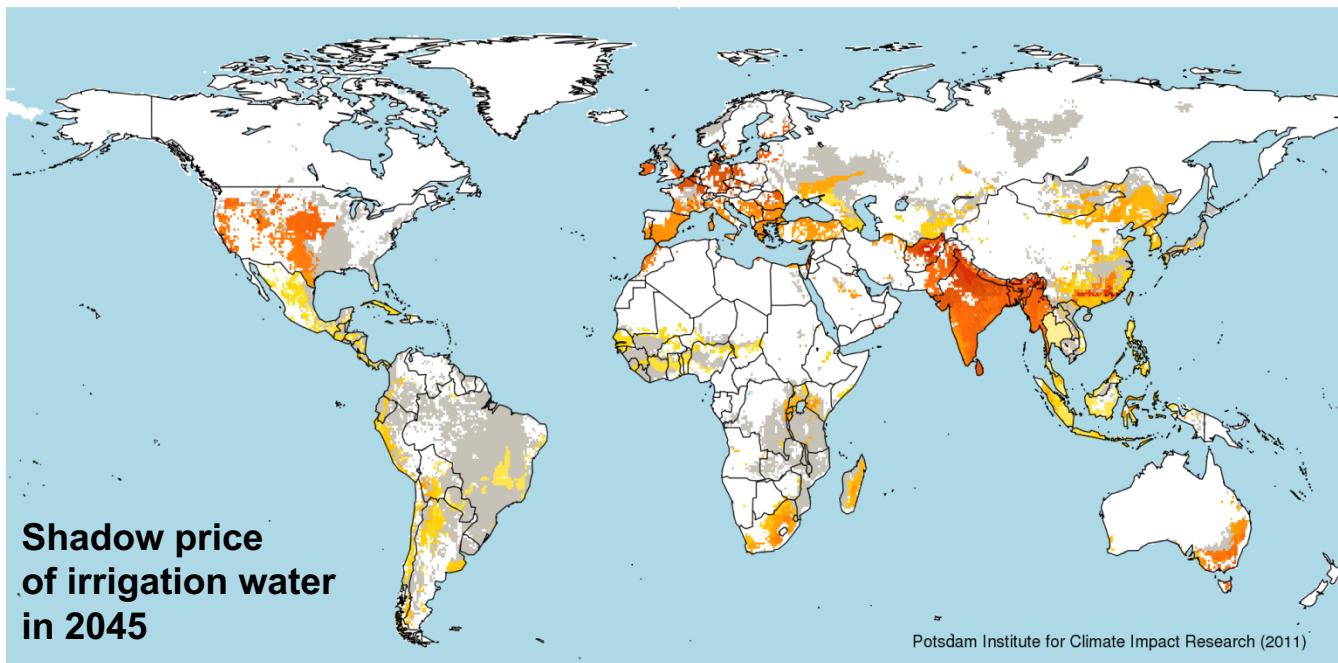
Stevanovic, Lotze-Campen et al. 2016

# Free trade can reduce climate-related economic losses in agriculture



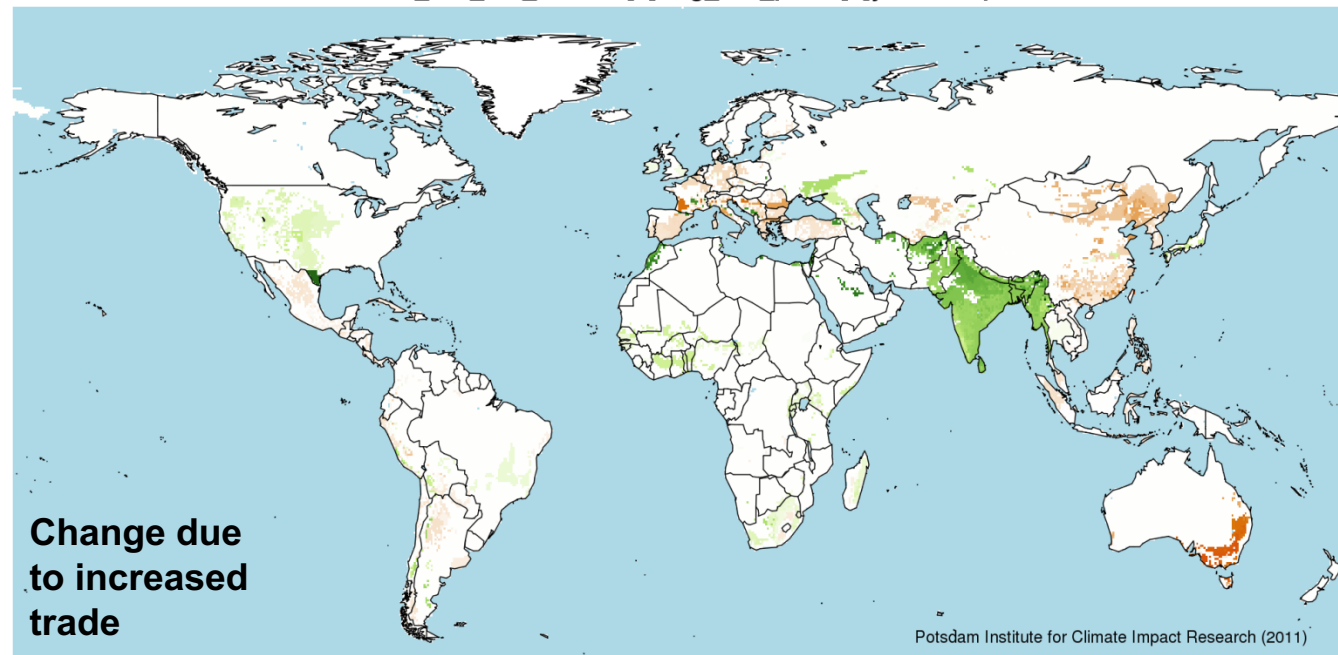
Stevanovic, Lotze-Campen et al. 2016





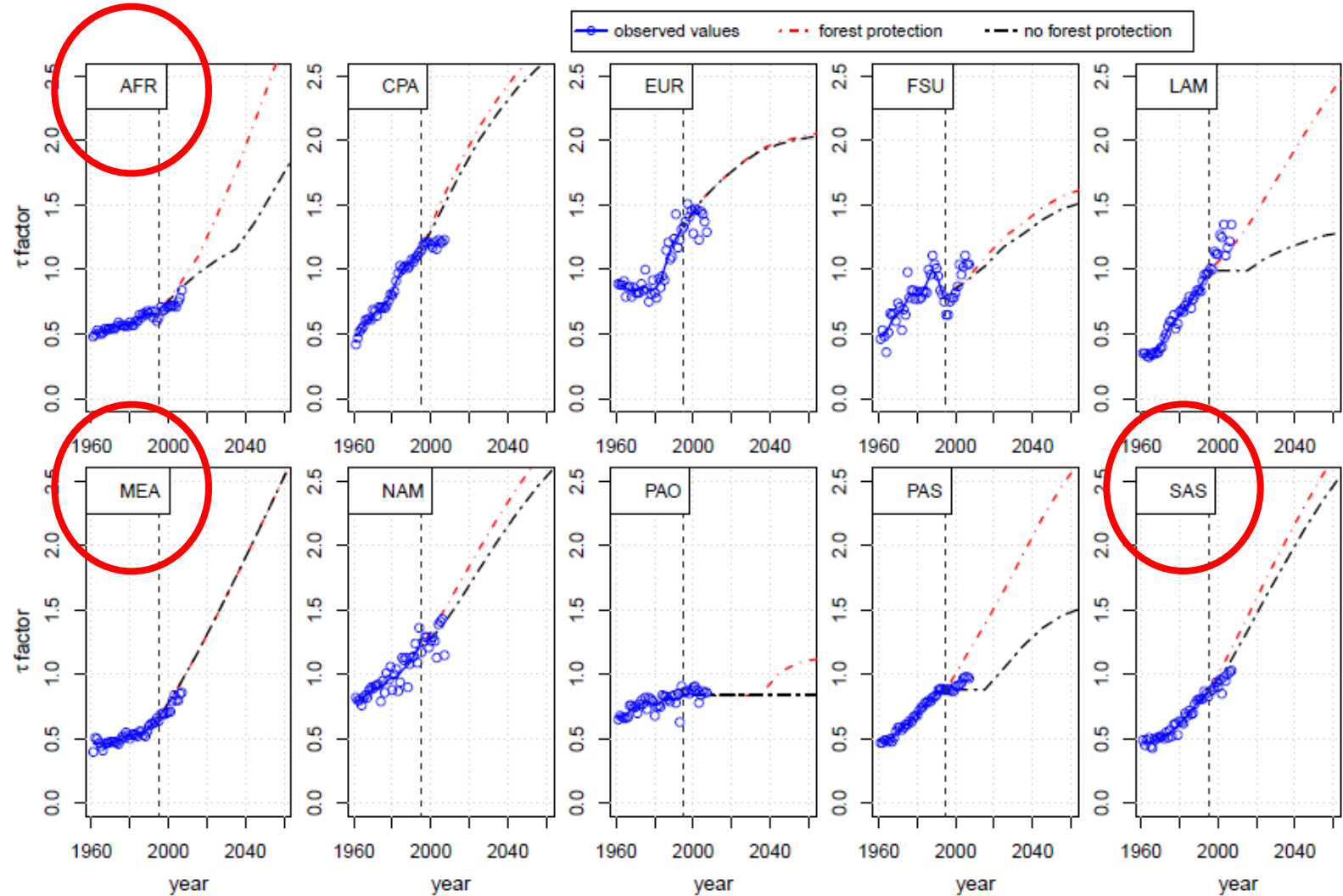
**Change in  
water scarcity  
due to  
increased trade**

**US\$/m<sup>3</sup>**



**Schmitz,  
Lotze-Campen et al.,  
2013**

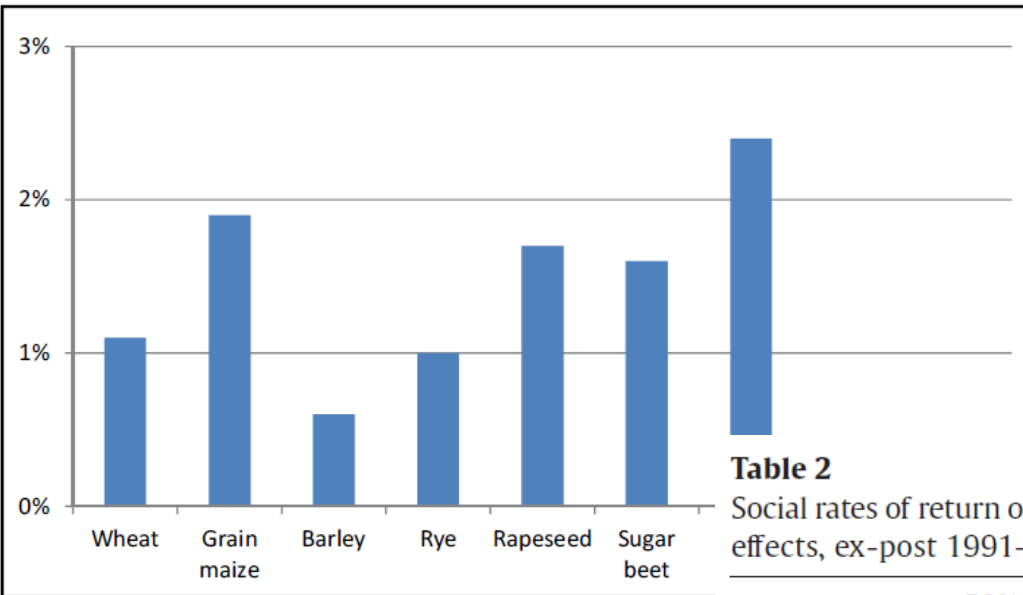
# The role of agric. technological change





## Productivity increase in German agriculture

## Social rate of return of investments into plant breeding



**Table 2**

Social rates of return on investments into plant-breeding research in Germany (market effects, ex-post 1991–2010, in % per year).

	50% TFP through plant breeding		75% TFP through plant breeding	
	R&D investment high	R&D investment low	R&D investment high	R&D investment low
Wheat	83	92	123	136
Maize	2	3	13	14
Barley	5	9	16	20
Rye	7	11	18	22
Rapeseed	10	15	20	26
Sugar beet	18	23	30	36
Potato	77	90	111	129
Pulses	n.a.	n.a.	n.a.	n.a.
<b>Total</b>	<b>21</b>	<b>25</b>	<b>33</b>	<b>39</b>

Source: Own calculations.

**Fig. 3.** Changes in total factor productivity (TFP) in Germany (in % per year). Source: Own calculations based on BMELV

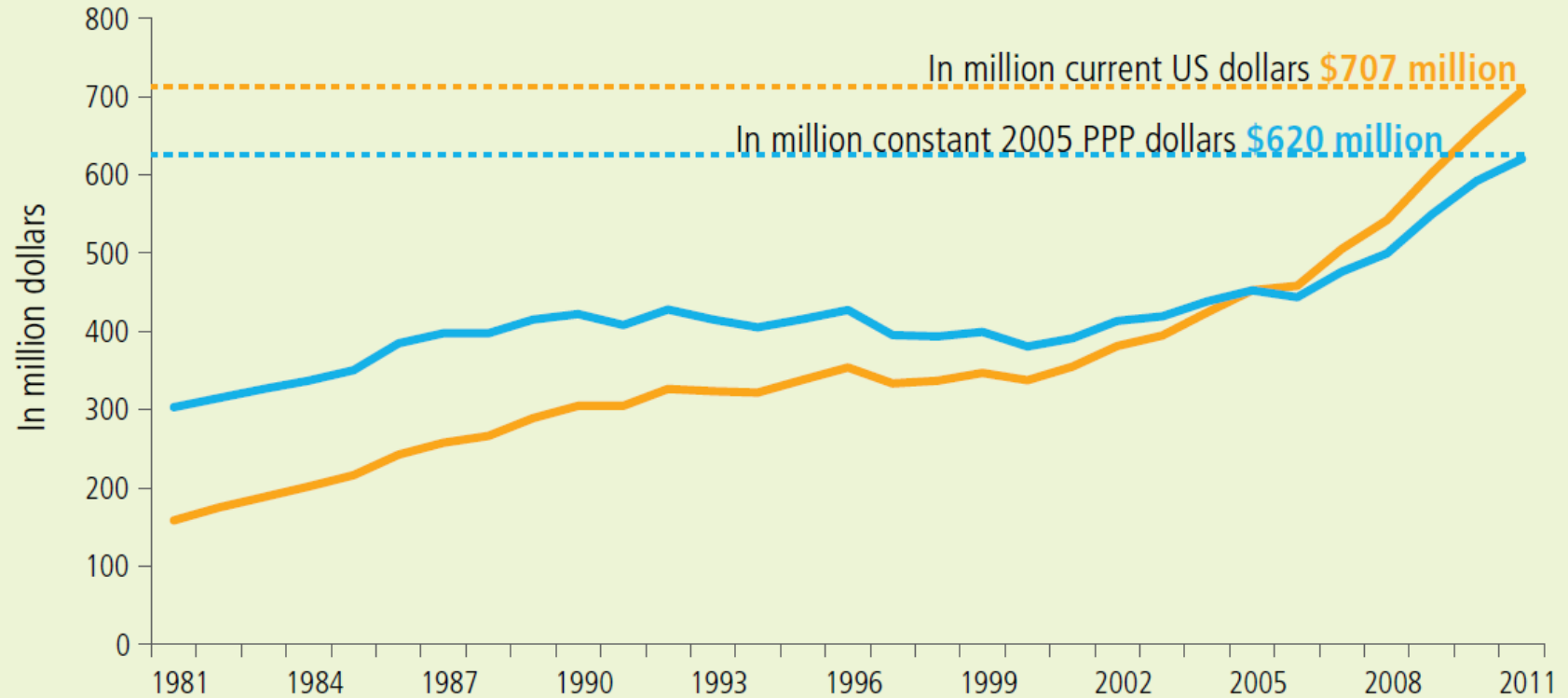
Lotze-Campen et al., Ag. Systems 2015



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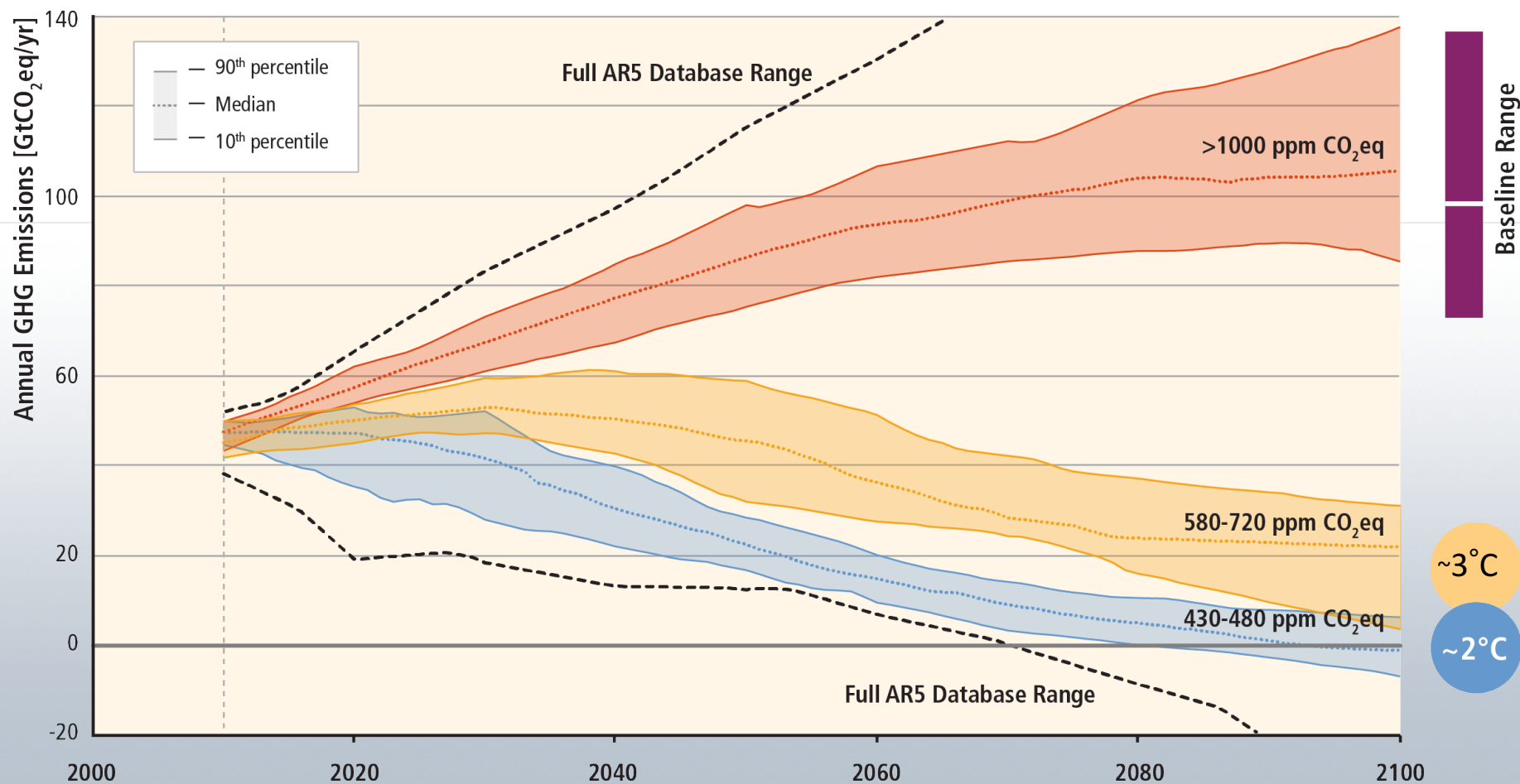
# Important role for international public agricultural research



**R&D expenditure on CGIAR Centers**

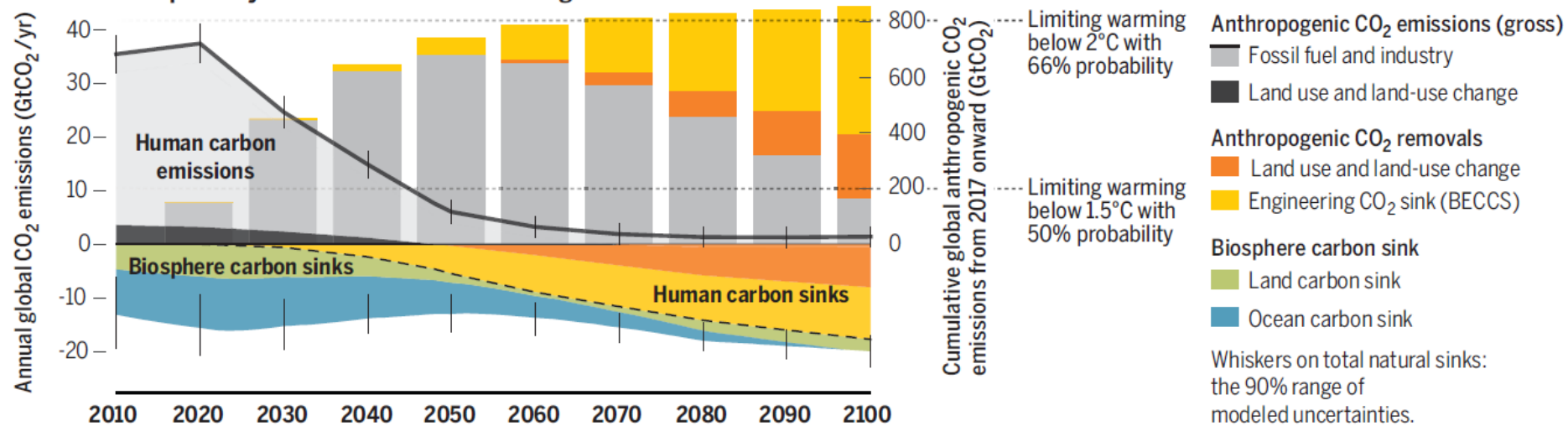
**Beintema et al. 2008, 2013**

# Stabilization of atmospheric GHG concentration requires deviation from the baseline – independent of mitigation target



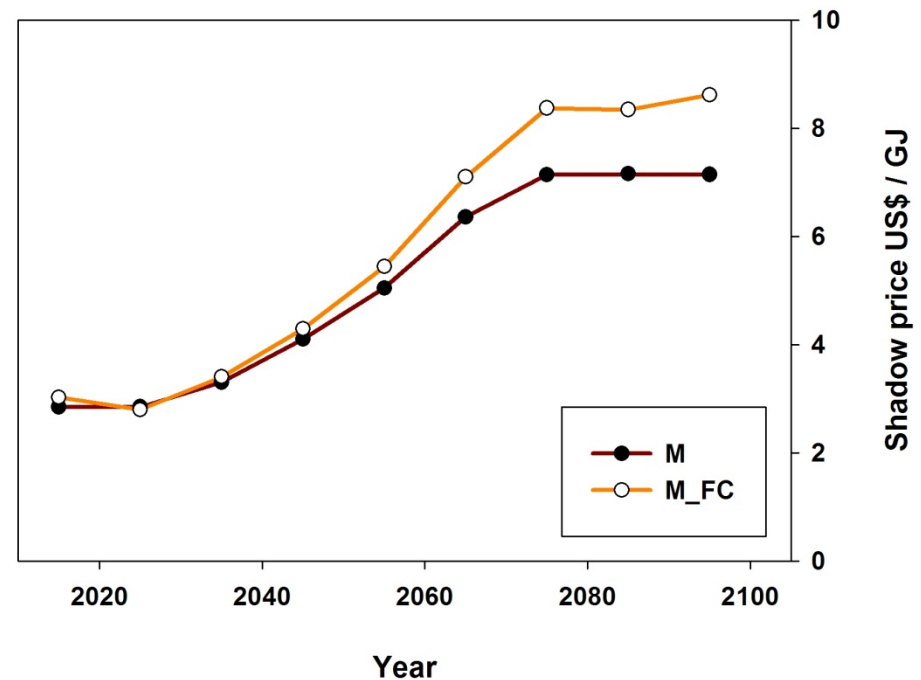
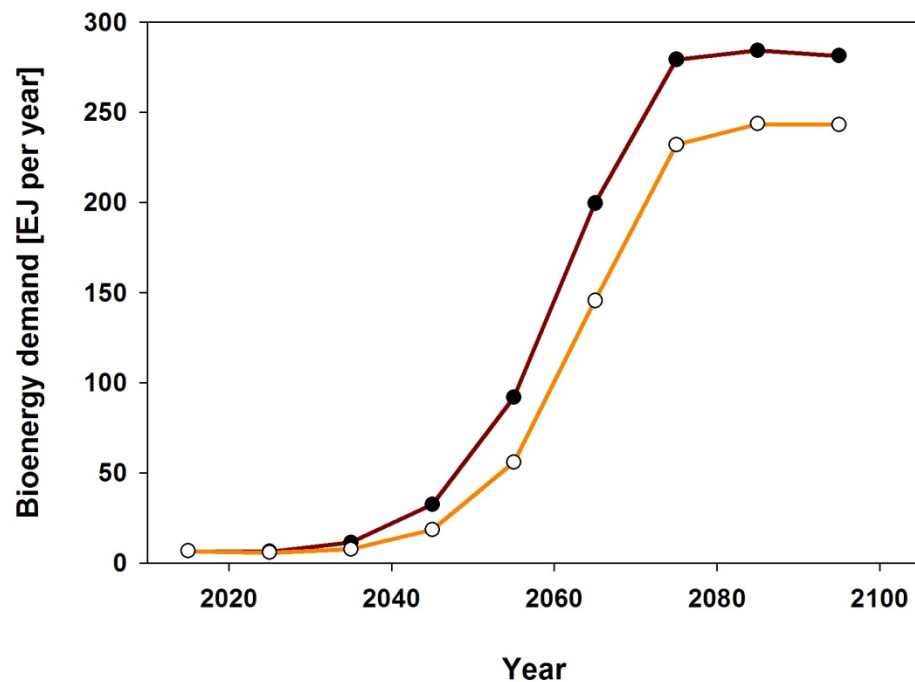
# The challenge to fulfil the Paris agreement

Decarbonization pathway consistent with the Paris agreement



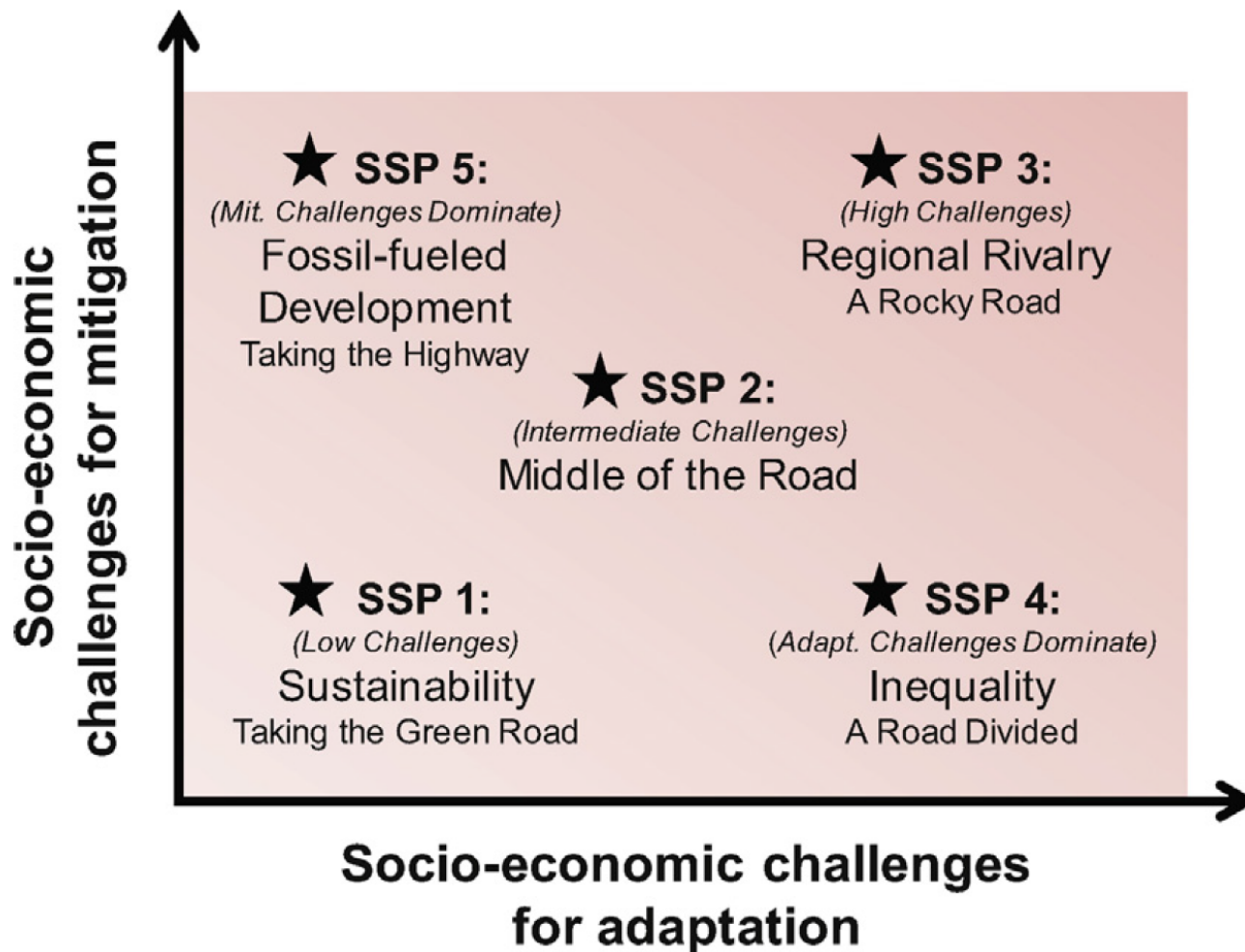
Rockström, Schellnhuber et al., Science 2017

# Bioenergy demand and prices with forest protection



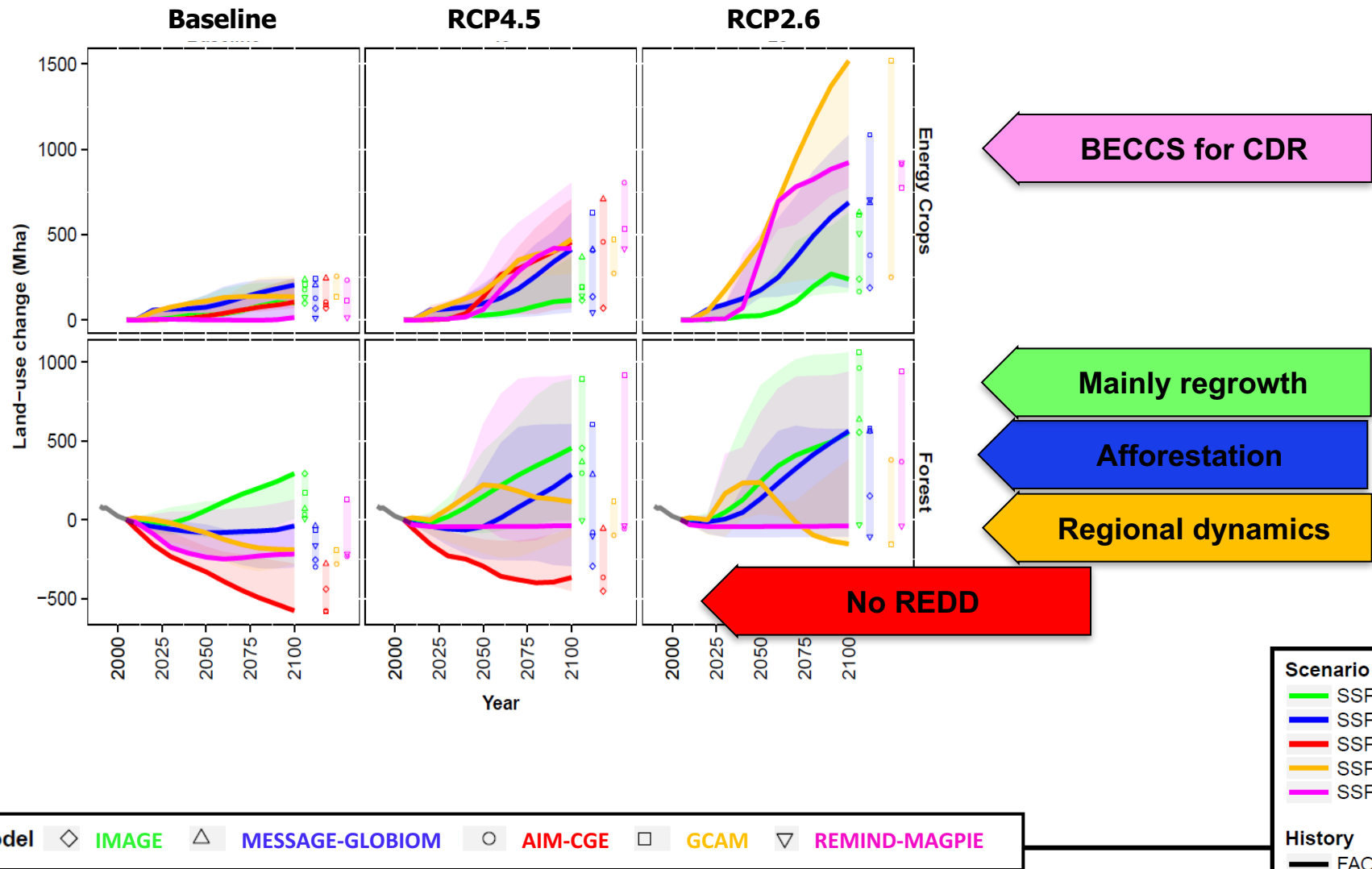
Popp, Lotze-Campen et al., ERL 2011

# Shared Socio-economic Pathways (SSPs)



O'Neill et al. GEC 2015

# Land demand for land based mitigation



# Policy elements for climate-smart agriculture

- **Institutions and incentives**
  - Emission trading or taxation
  - Compensation payments for global public goods (e.g. REDD)
  - Trade reform (re-allocation of resource use)
  - Secure use rights for land and water
- **Innovation and investment**
  - Technology development and transfer
  - Infrastructure
  - Education and extension
- **Insurance:** risk management, social safety nets
- **Information:** monitoring and assessments
- **Integration:** linking different policy areas



**Social safety  
nets**



**Ag. R&D,  
food aid**



**Nutrition  
education**



**Policy  
coherence -  
towards  
linked  
policy  
instruments**

**Nitrogen  
taxation?**

**Water pricing**



**Infrastructure  
investment**



**Education,  
training, R&D**



**Emission  
pricing**



**Marine  
protected areas**



**Nature  
conservation,  
REDD**



**Trade policy**

