

# Estimation of Adaptation Cost and Risk

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## Overall of this sub-theme

- Collection of data and information on adaptation cost in global scale, and Meta analysis
  - Assessment of risk of adaptation.
- Socio-economic scenario development –based on SSPs
  - A part of Scenario Task Group, and providing scenarios to other teams.
- Development of integrated assessment model reflecting climate change impact & adaptation and mitigation.
  - Model intercomparison among S-10-4.

## Impact and Adaptation (2)

First-level category	Second-level category	Third-level category	Adaptive measures
Food sector	Agriculture	Grains, fruit	Improvement of tolerance and avoidance of high temperatures
	Livestock farming	Livestock, fodder	Avoidance of high temperatures and migration to more suitable locations
	Fisheries	Migratory fish, coastal fish, aquaculture	Adaptation to changes in ecosystems and movement to more suitable locations
Water	Water supply		Securing of reservoirs and groundwater use
	Water demand measures		Improvement of efficiency
	Water environment management		Measures against eutrophication and salt water
	Flood control measures		
Natural ecosystems (vegetation /land)	Forest ecosystems	Natural forests, planted forests, community woodland	Revision of sanctuaries
	Coastal ecosystems	Oceans, freshwater, tidal flats	Reduction of environmental load and riparian forest preservation

Source: Research Committee on Global Warming Effects and Adaptation (MOE, 2012)

# Impact and Adaptations (1)

First-level category	Second-level category	Third-level category	Adaptive measures
Disaster prevention and coastal sector	Changes in land use	Changes in land use/architectural styles	Development of buffer zones/dykes, changes in architectural styles
	Enhancement of disaster prevention systems	Information provision and support	Development of evacuation routes, disaster drills
	Monitoring		Observation
Health	Summer heat		Public health guidance
	Infectious diseases		Vaccination, improvement of sanitation
National/urban life	Safe living	Houses, inhabited areas	Strengthening/movement of buildings
	Healthy living	Heat, water environment	Heat stroke measures, maintenance of health
	Economically affluent living	Heat, diet	Use of weather derivatives, development of new industries
	Comfortable living	Heat	Renovation and pest extermination
	Culture	Ecosystems	Tree planting and preservation

Source: Research Committee on Global Warming Effects and Adaptation (MOE, 2012)

Update this table using IPCC AR5.

# Constraints on adaptations

## Constraints/obstacles

- Physical/ecological
- Technological
- Economic/financial
- Social/cultural
- Institutional
- Information/recognition
- Human resource development

Source: Research Committee on Global Warming Effects and Adaptation (MOE, 2012)

# Adaptation risks

## Risks for human society

- Risks associated with cost burden (adoption expenses, development expenses)
- Development potential as an industry
- Risks associated with changes in land use
- Risks associated with changes in local infrastructure
- Risks associated with growth in energy demand

## Risks for ecosystems

- Impact on ecosystems of selective breeding and changes in tree species, etc.
- Risks associated with ecosystem changes

Source: Research Committee on Global Warming Effects and Adaptation (MOE, 2012)

# Estimation of adaptation costs in global scale

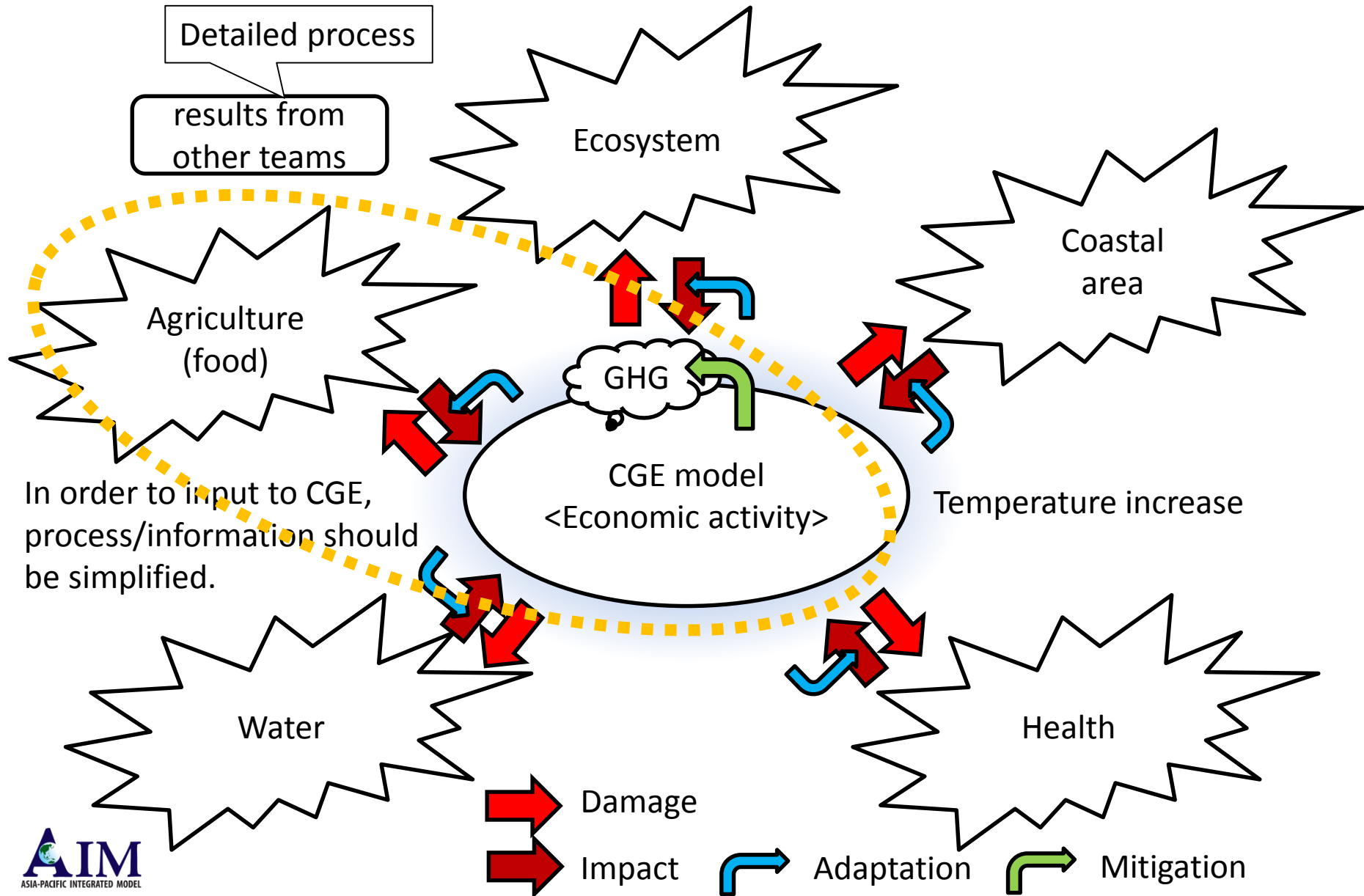
literature	Estimation method		Results on adaptation cost		notes
	Assumptions	Adaptation fields	Annual cost (bil. \$)	ratio to GDP	
World Bank (2006)	Temperature change: 2-3°C	Additional investment to fields with climate risk	9–41	-	US\$ at 2000price
World Bank (2010)	<p><b>Definition of adaptation costs</b> additional costs</p> <p><b>Baseline</b> defined by sector</p> <p><b>GHG scenario</b> IPCC SRES A2</p> <p><b>Climate scenario</b> NCAR, CISRO</p> <p><b>Time period</b> 2010–2050</p> <p><b>Adaptation level</b> recovery to the level without climate damages</p> <p><b>Discount rate</b> 0</p>	<p>Public hardware actions</p> <p><b>Infrastructure</b></p> <p><b>Coastal area</b></p> <p><b>Water supply and river flood</b></p> <p><b>Agriculture</b></p> <p><b>Fishery</b></p> <p><b>Human health</b></p> <p><b>Forestry &amp; ecosystem</b></p> <p><b>Extreme events</b></p>	<p>All area</p> <p><u>Rainy season (NCAR scenario)</u> 89.5–101.8</p> <p><u>Dry season (CISRO scenario)</u> 76.8–88.3</p>	<p><u>Rainy season (NCAR scenario)</u> 0.22–0.12% (2010–49)</p> <p><u>Dry season (CISRO scenario)</u> 0.17–0.11% (2010–49)</p>	US\$ at 2005 price
UNFCCC (2007)	<p><b>Definition of adaptation costs</b> additional costs</p> <p><b>Baseline</b> defined by sector</p> <p><b>GHG scenario</b> IPCC SRES A1B, B1, IS92a</p> <p><b>Time period</b> 2010–2030</p>	<p><b>Infrastructure</b></p> <p><b>Coastal area</b></p> <p><b>Water supply</b></p> <p><b>Agriculture</b></p> <p><b>Forestry &amp; Fishery</b></p> <p><b>Human health</b></p> <p><b>Natural ecosystem</b></p>	<p>8-130</p> <p>1.2(A1B), 1.1(B1)</p> <p>11(A1B), 9(B1)</p> <p>14</p> <p>4-5</p> <p>12-22</p>	-	US\$ at 2005 price
Agrawala S., et al. (OECD) (2010)	<p><b>Definition of adaptation cost</b> investment to reduce damages</p> <p><b>Baseline</b> defined by model</p> <p><b>Climate model</b> AD-DICE, AD-RICE, AD-WITCH</p> <p><b>Time period</b> 2005–2100</p> <p><b>Discount rate</b> 3%</p>	<p><b>Coastal area</b></p> <p><b>Agriculture</b></p> <p><b>Human health</b></p> <p><b>Resident &amp; ecosystem</b></p> <p><b>other vulnerable market</b></p> <p><b>Non-market</b></p> <p><b>Extreme events</b></p> <p><b>Taking into account adaptation related to flow, stock &amp; capacity</b></p>	-	<p>DICE 0.28% in 2100</p> <p>WITCH 0.19% in 2100</p> <p>at NPV</p>	Cost is estimated under optimal adaptation and no mitigation.

# Urgent!

- We need more information about adaptation cost!
- If you know new data, information, report, ..., please introduce to us!
  - Global
  - National
  - Local



# Our concept of impact/adaptation modeling



# Climate change impact and adaptation assessment on food consumption utilizing a new scenario framework

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Hasegawa T., Fujimori S., Shin Y., Takahashi K., Masui T. and A. Tanaka,  
Climate change impact and adaptation assessment on food consumption utilizing a  
new scenario framework,  
*Environmental Science and Technology*, accepted.

## Introduction

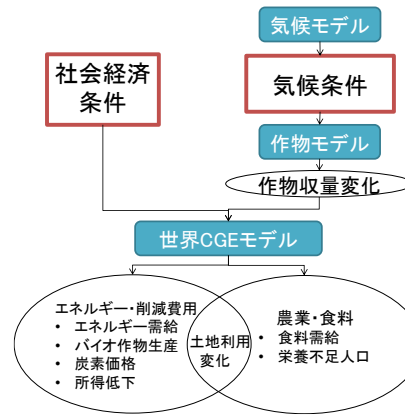
- Climate change(CC) impacts on agriculture & food systems
- Several approaches have been taken
- Existing studies
  - Not quantifying **effects of adaptation measures**
  - Based on SRES, not **RCPs & SSPs**
  - Based on climate data of CMIP3, not **CMIP5**
- Aim
  - Analyze CC impacts on food consumption and **risk of hunger** by using **RCPs & SSPs** based on **multi-GCM** scenarios.
  - Quantify **effects of adaptation measures**

# Scenario settings

Climate conditions

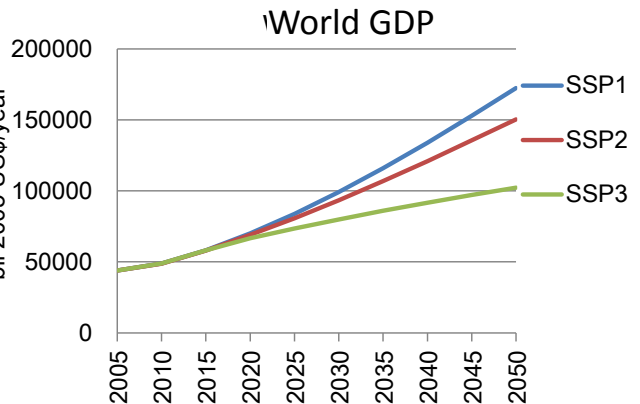
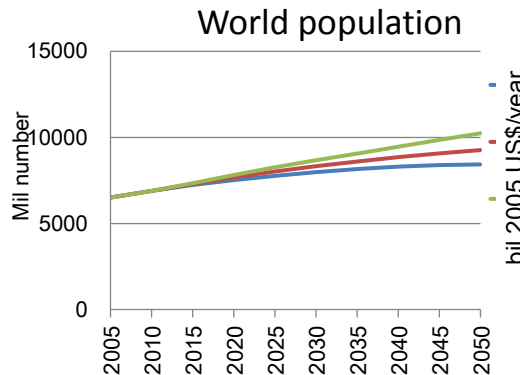
## Socio-economic conditions

		Optimistic SSP1	Middle SSP2	Pessimistic SSP3
Climate conditions	NoCC	Present climate condition assumed		
	With CC	RCP2.6	with/without adaptation in low or middle income countries	
		RCP4.5		
		RCP6.0		
		RCP8.5		

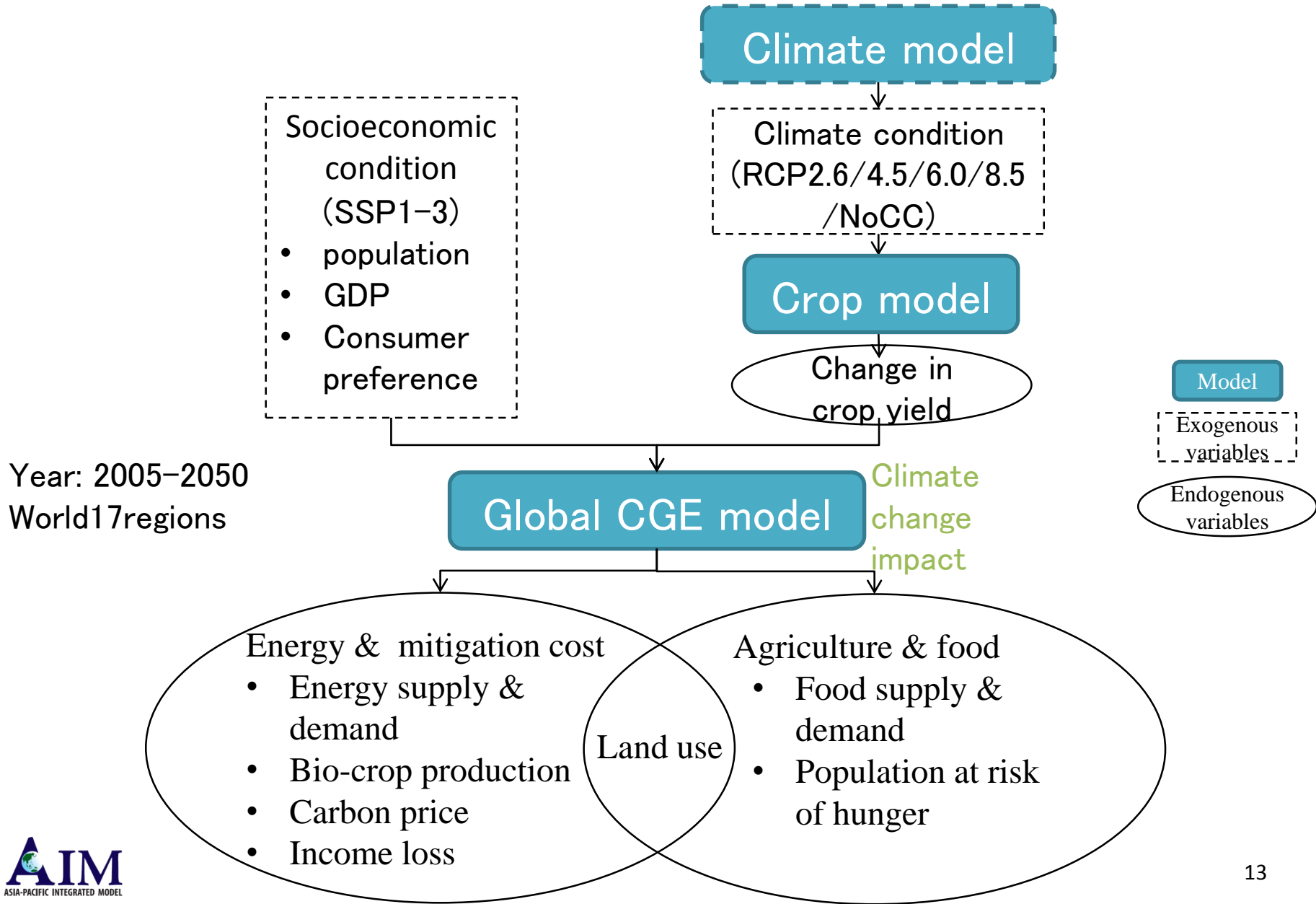


- ▶ Adaptation measures:
  - change in crop variety & planting dates
  - industrial countries: available

“RCP”: Representative Concentration Pathway  
 “SSP”: Shared Socioeconomic Pathway

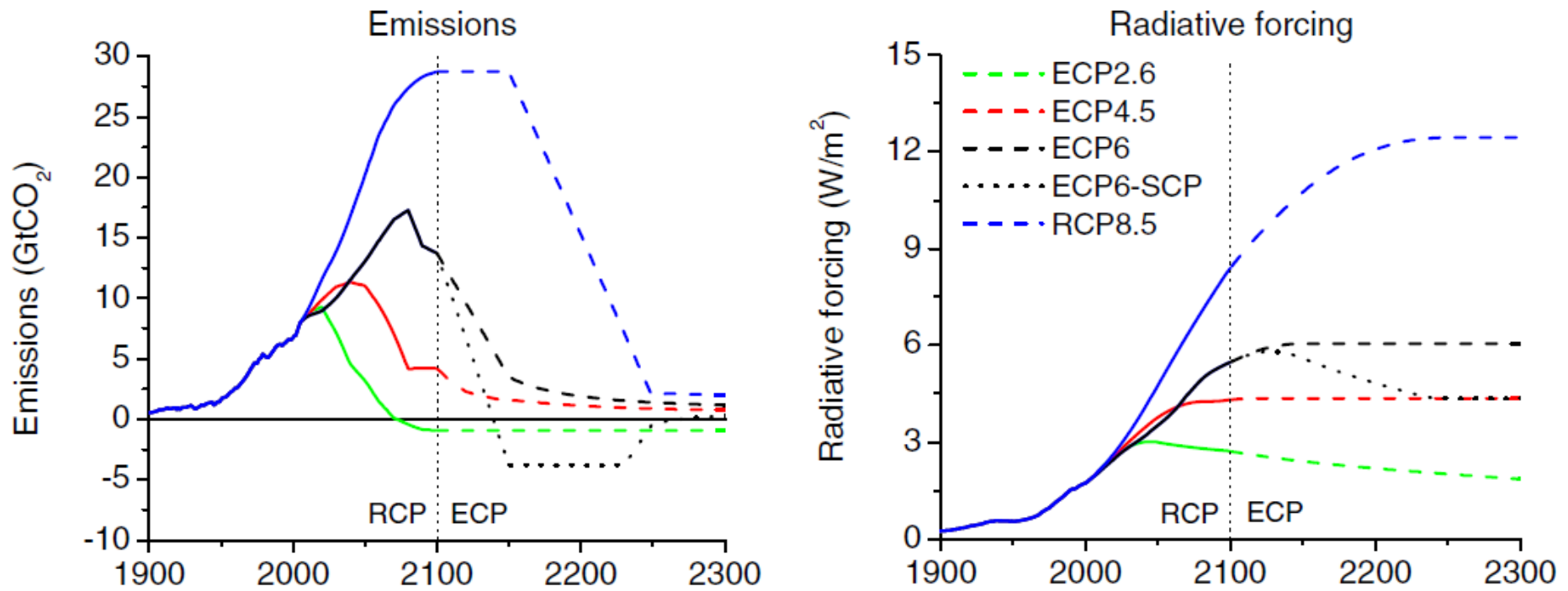


# Modeling framework



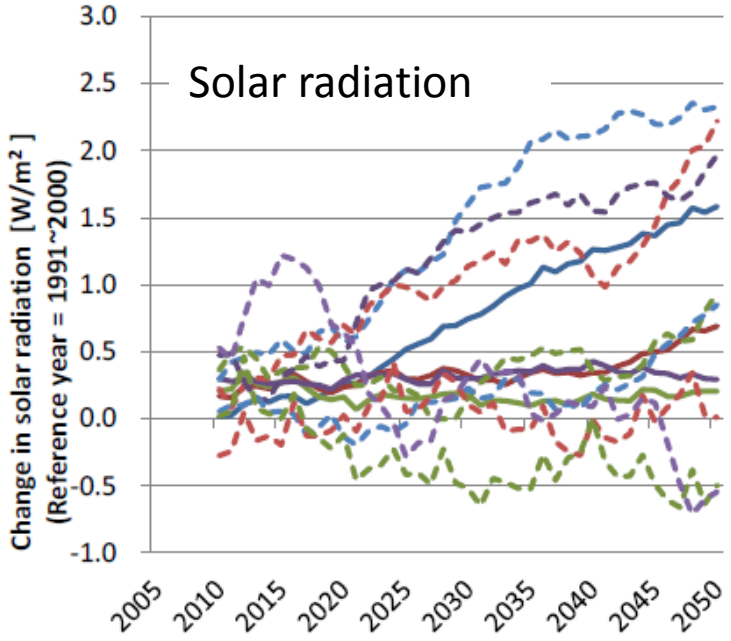
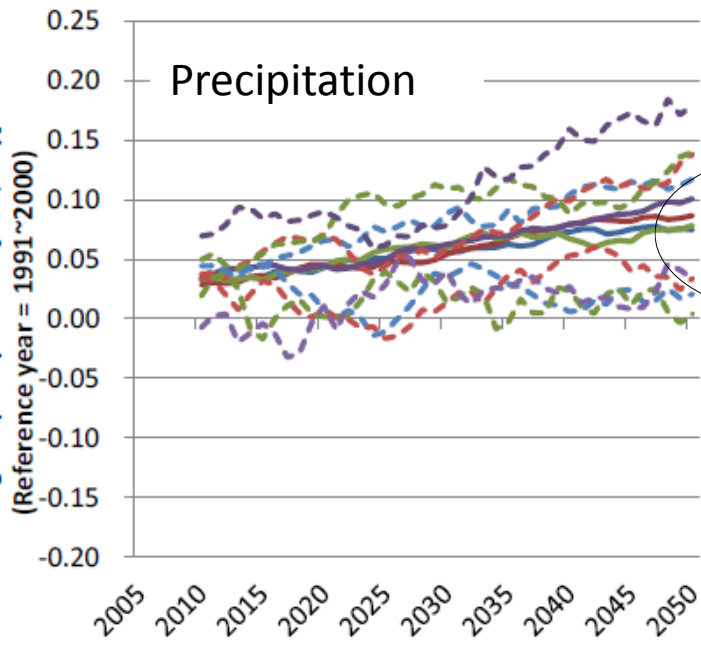
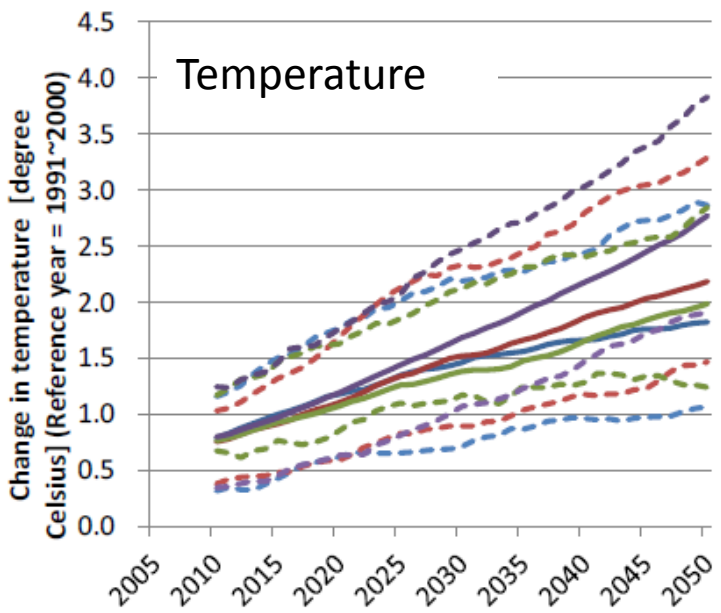
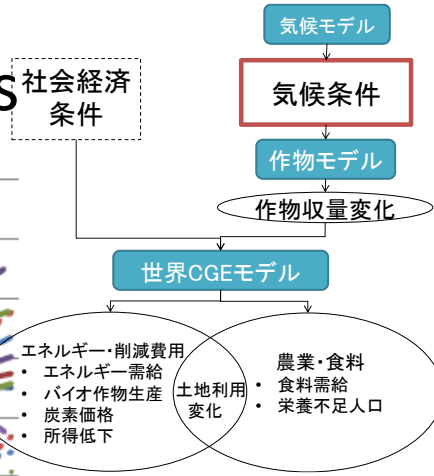
# Representative Concentration Pathway

- CGE model: Emission constraints
- GAEZ crop model: climate condition



**Fig. 11** Extension of the RCPs (radiative forcing and associated CO<sub>2</sub> emissions). ECP is extended concentration pathway. The SCP6to4.5 (supplementary concentration pathway) shows an alternative extension for RCP6 (see main text) (Meinshausen et al. 2011b)

# Global change in climate conditions

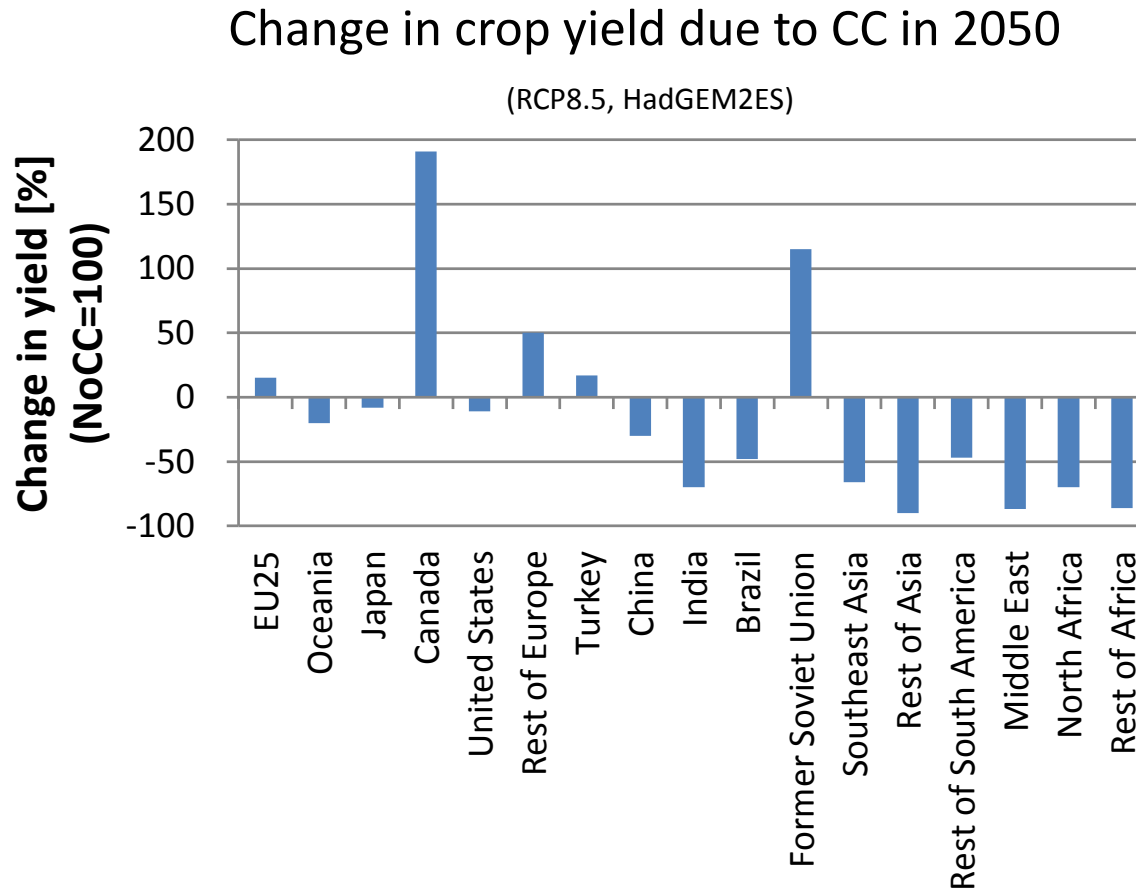


- RCP2.6
- RCP4.5
- RCP6.0
- RCP8.5

Solid lines represents median values and dashed line represents highest or lowest values among multi-GCM models.

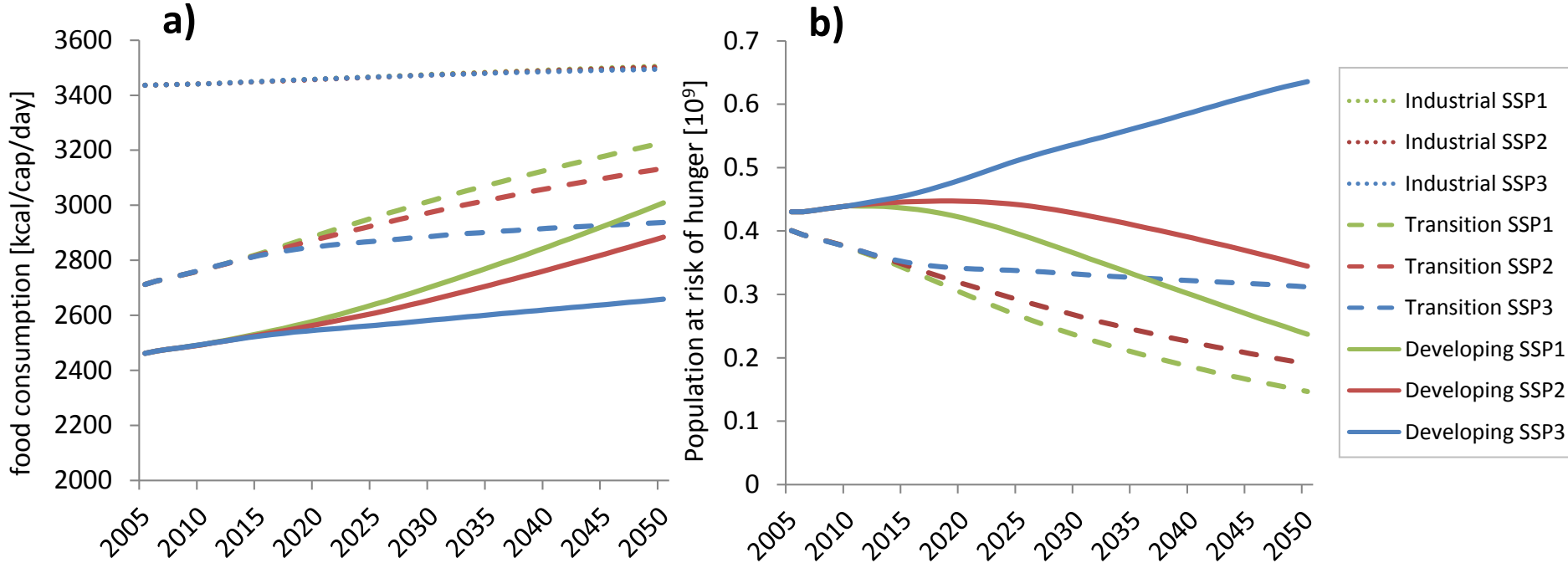
# Crop yields

- Change in crop yield due to CC is calculated M-GAEZ





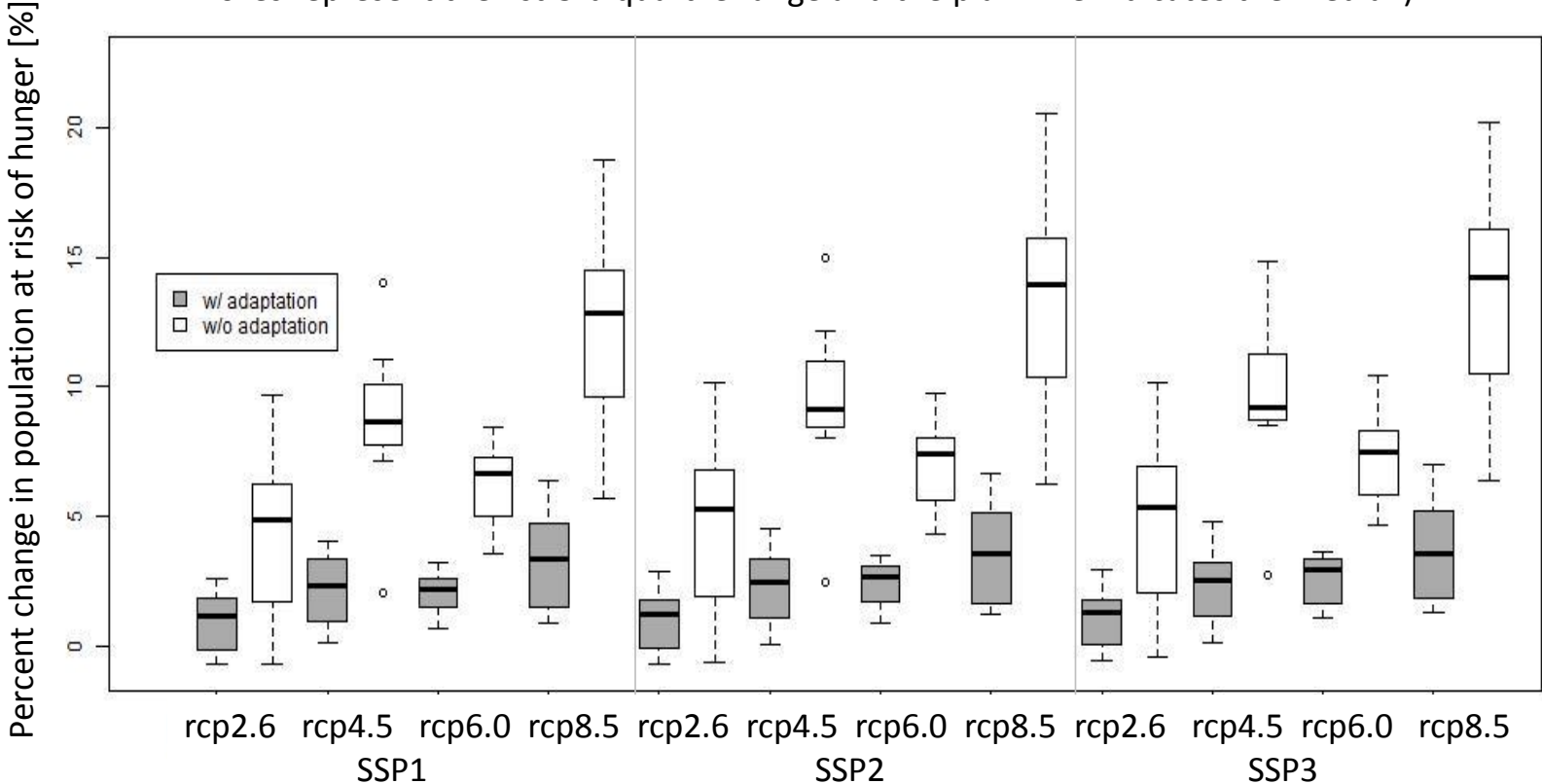
# World food consumption & risk of hunger



a) Per-capita calorie intake and b) Population at risk of hunger under the three SSPs for the cases without climate change in the industrial, transition and developing countries.

# Changes in global population at risk of hunger in 2050 under the SSPs & RCPs

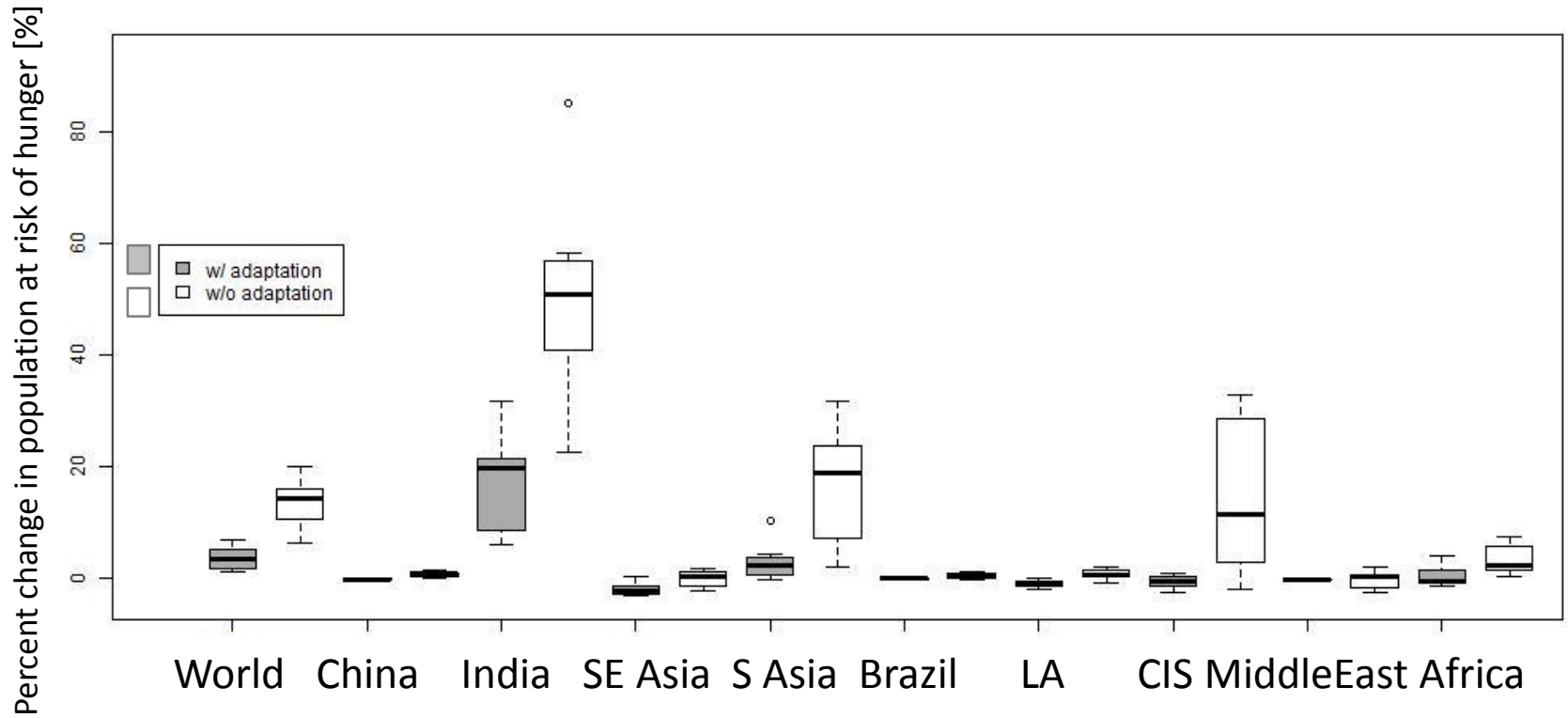
(Boxes and dotted lines show the uncertainty range across the 8 GCMs. Boxes represent the 1st-3rd quartile range and the plain line indicates the median)



- The effectiveness of adaptation measures is significant under the various combinations on socioeconomic, climate and yield conditions and is robust regardless of the level of mitigation efforts to lower GHG emissions at least throughout 2050.

# Population of hunger in 2050: SSP3-RCP8.5

- CC impact on risk of hunger are different across regions because levels of food consumptions and CC impacts vary across regions.
- Due to large CC impact, there is great land scarcity, higher crop prices and low food consumption in India.



# Future works

- taking into account other sectors' impacts and adaptations
  - human health impact through labor force and consumption pattern change.
- taking into account various adaptation risks
  - Cost burden
  - Land use change
  - Energy demand
  - Macro economic system?
  - . . .
- Mitigation and Adaptation

# Ten Actions for Realizing a Low Carbon Asia



**Action 1 Urban Transport**  
Hierarchically Connected  
Compact Cities



**Action 2 Interregional Transport**  
Mainstreaming Rail and Water in  
Interregional Transport



**Action 3 Resources & Materials**  
Smart Ways to Use Materials that  
Realize the Full Potential of Resources



**Action 4 Buildings**  
Energy-Saving Spaces Utilizing  
Sunlight and Wind



**Action 5 Biomass**  
Local Production and  
Local Consumption of Biomass



**Action 6 Energy System**  
Low Carbon Energy System  
Using Local Resources



**Action 7 Agriculture & Livestock**  
Low Emission Agricultural  
Technologies



**Action 8 Forestry & Land Use**  
Sustainable Forestry Management



**Action 9 Technology & Finance**  
Technology and Finance to  
Facilitate Achievement of LCS



**Action 10 Governance**  
Transparent and Fair Governance  
that Supports Low Carbon Asia

Qualitative storylines are quantified.

# GHG Emissions in Asia

