

Climate mitigation effects on food security: multi global economic modelling comparison

Tomoko Hasegawa^{1,2}; Havlik, Petr²; Fujimori, Shinichiro^{1,2}; Valin, Hugo²;
Fellmann, Thomas; Kyle, Page; Lotze-Campen, Hermann; Mason-D'Croz,
Daniel; Ochi, Yuki; Perez-Dominguez, Ignacio; Stehfest, Elke; Takakura,
Jun'ya; van Meijl, Hans.

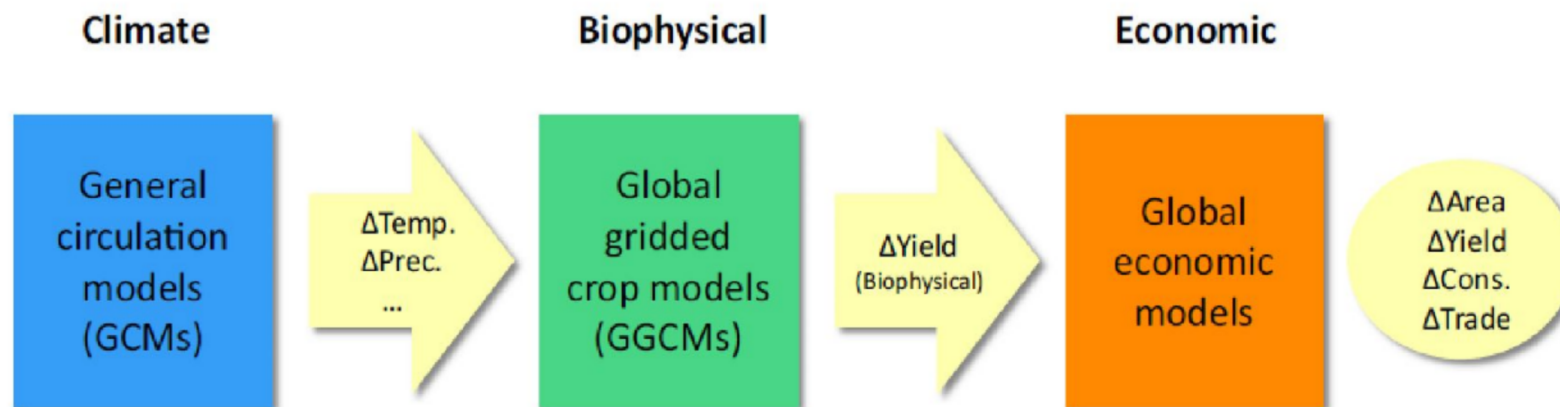
1. National Institute for Environmental Studies (NIES),
2. International Institute for Applied Systems Analysis (IIASA)

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Key policy-relevant questions in Global Econ Modeling Team (AgMIP Phase 1)

- **What is the future of agricultural prices?**
- **How will agricultural production and food consumption evolve?**
- **How will climate change impacts and mitigation affect...**
 - **Prices**
 - **Land use**
 - **Trade**
 - **Undernourishment**

Modeling climate impacts on agriculture: linking biophysical and economic effects (AgMIP Phase 1)



Source: Nelson et al., PNAS (2014)

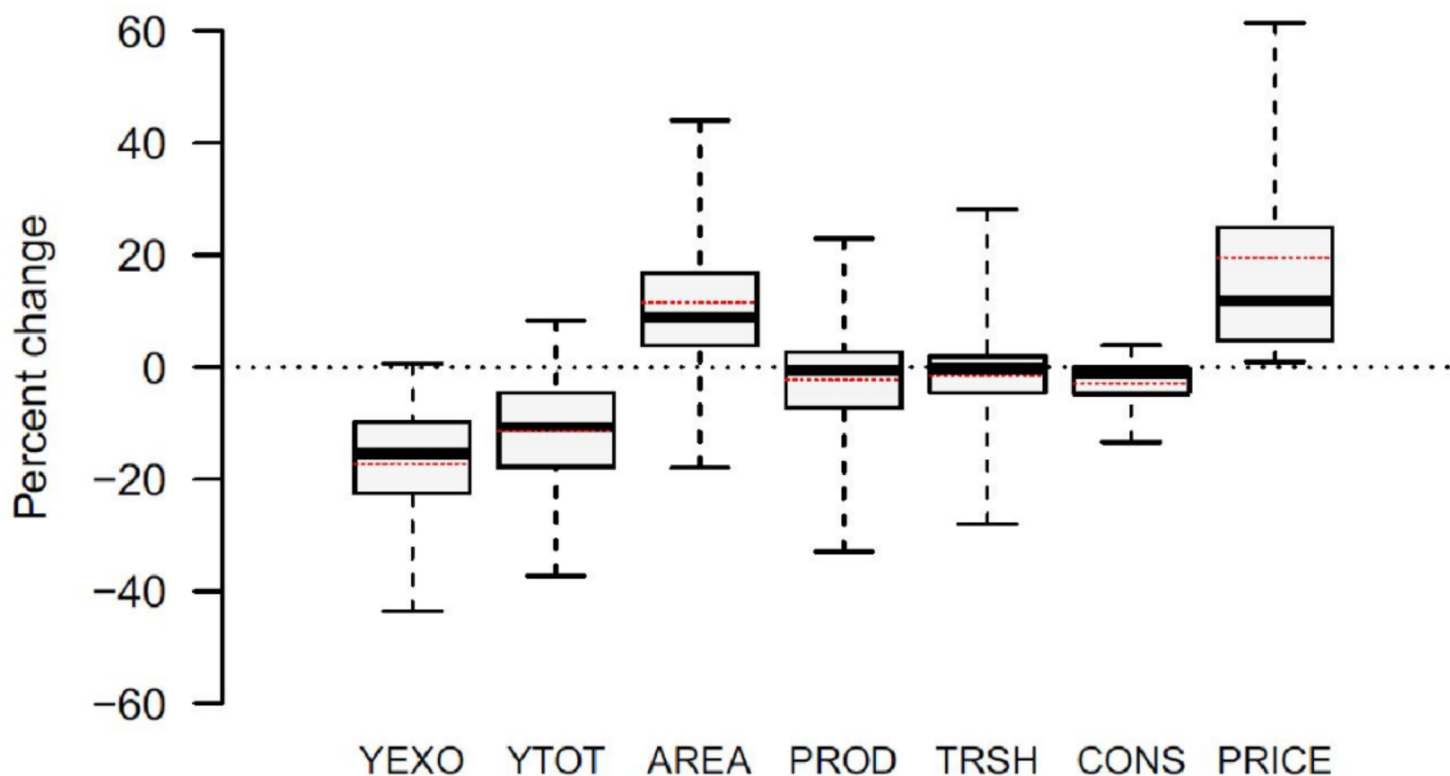
10 global economic modeling groups participated

- Australian Bureau of Agricultural and Resource Economics and Sciences – GTEM
- Food and Agriculture Organization of the UN – ENVISAGE
- International Food Policy Research Institute – IMPACT
- International Institute of Applied Systems Analysis – GLOBIOM
- LEI Wageningen UR – MAGNET
- MIT – EPPA
- National Institute for Environmental Studies (Japan) – AIM
- Potsdam Institute for Climate Impact Research – MAgPIE
- PNNL/Maryland Joint Global Change Research Institute – GCAM
- USDA Economic Research Service – FARM

- [Note:] RC CAPRI team ran all scenarios after Phase 1]

Climate change impacts in 2050

(percent change relative to baseline without climate change in 2050, 2 GCMs x 5 crop models)

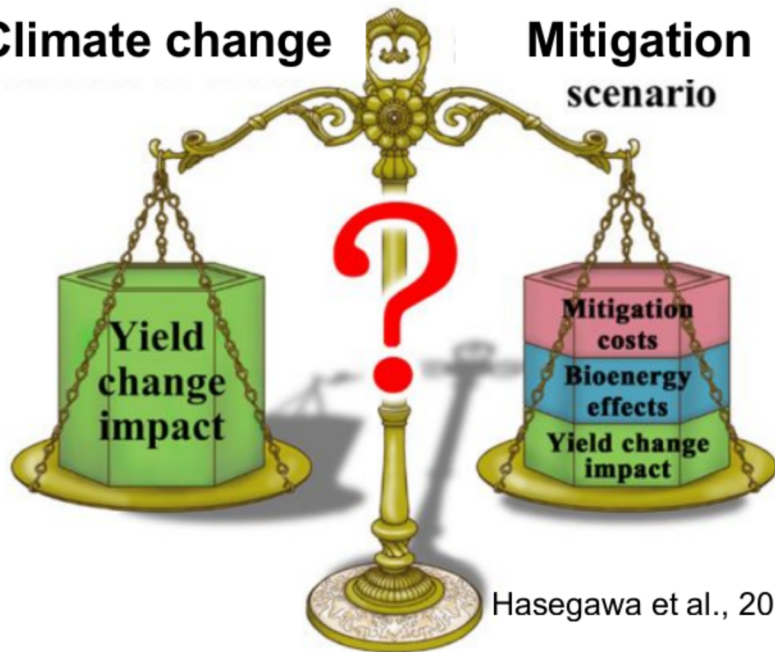


Source: Nelson et al., PNAS (2014)

Climate-induced food insecurity: Trade-offs between mitigation and food security

Climate change

Mitigation
scenario



Hasegawa et al., 2015

Yield change likely affects food consumption.

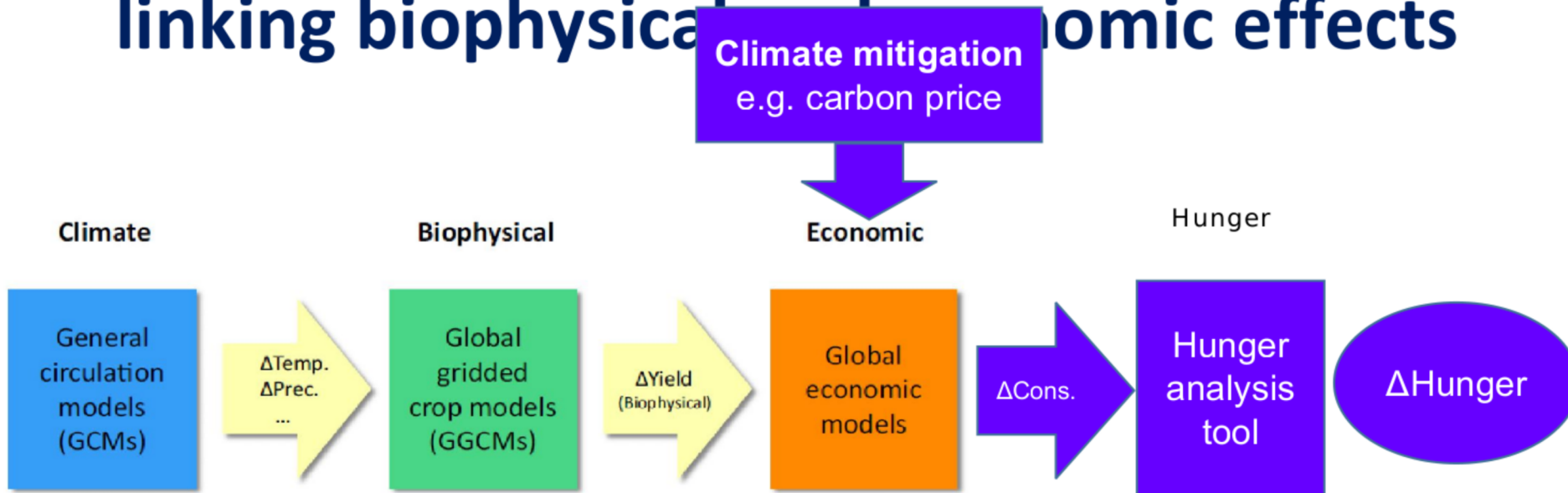
Land-based mitigation measures (e.g. bioenergy, afforestation) would compete with food production through land and water resources.

Economic impact would be caused by stringent mitigation aiming 2°C target.

Which is better, baseline or mitigation worlds in terms of food security?

→ Comprehensive analysis of climate-induced food security.

Modeling climate impacts on agriculture: linking biophysical and economic effects



Source: Nelson et al., PNAS (2014)

Impact flows from mitigation to hunger

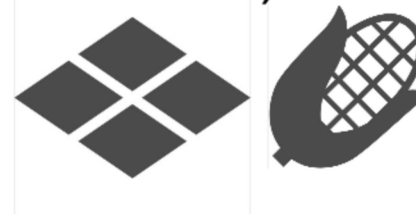
Climate mitigation



→ **Carbon price** on emissions and agricultural commodities

→ More profit from mitigation (e.g. bioenergy production)

→ Implement mitigation options on land



→ Less cropland area for food

→ Less productivity of food crops (high-yield land becomes unavailable.)



→ **Reduce food production**

→ **Increase food price**

→ **Decrease food consumption**

→ **More hunger risk**

Scenario setting in AgMIP

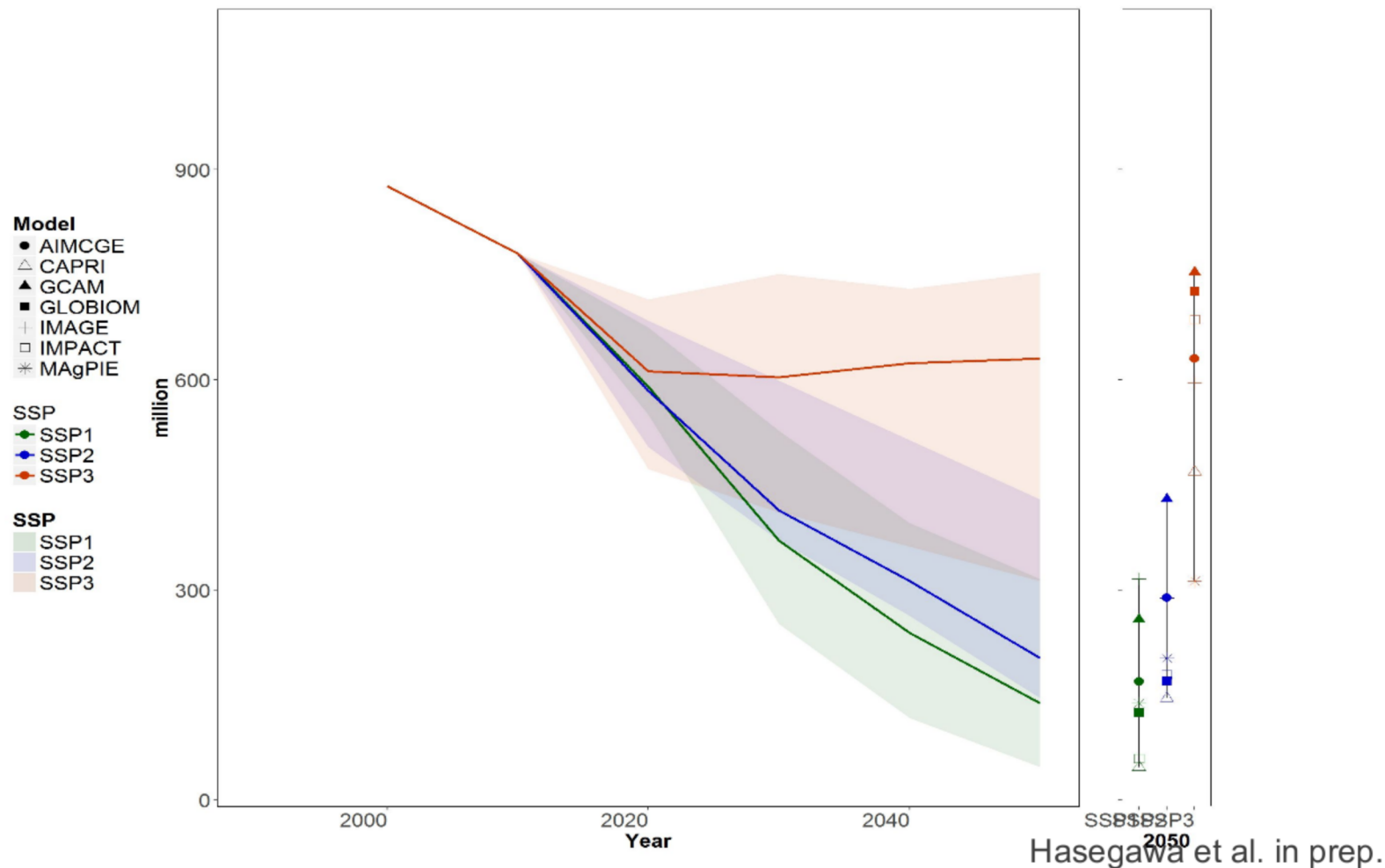
	Climate	Mitigation	Focus	SSP1 'Sustainability'	SSP2 'Middle of the Road'	SSP3 'Fragmentation'
A	No	No	Reference			
B	Med RCP6.0	No	Climate impacts			
C	No	Yes	Mitigation impacts			
D	Low RCP2.6	Yes	Mitigation impacts + residual climate impacts			

- 2000 to 2050
- 2 crop models (LPJML and PDSSAT)
- 2 climate models (HadGEM2-ES and IPSL-CM5A-LR)

Global hunger population trend in baseline scenarios

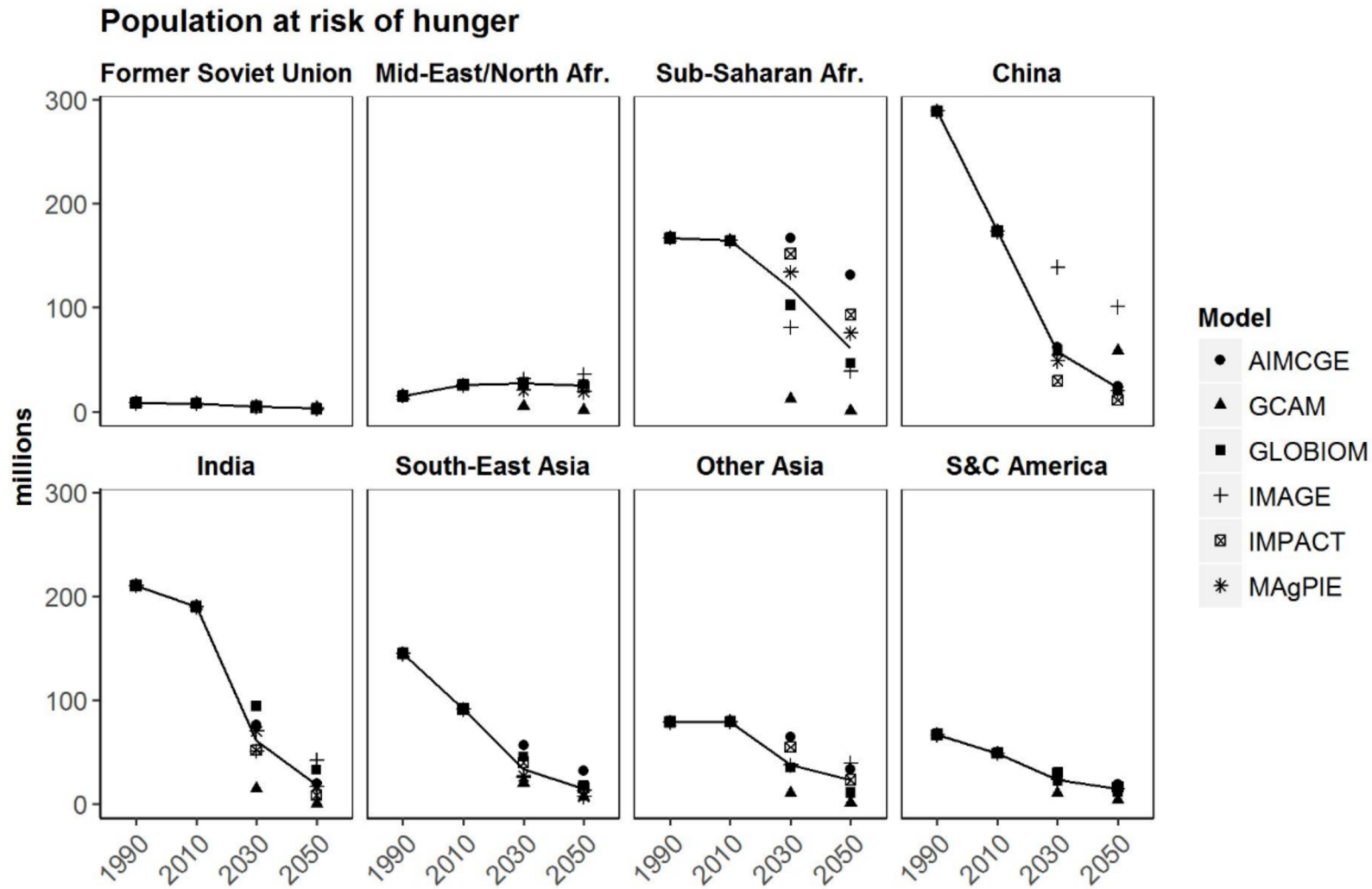
- Economic developments (SSPs) induce large variations of future hunger risk.

Undernourishment



Regional undernourishment: SSP2 baseline

- Large number of undernourishment is expected to remain in Sub-Saharan Africa and South Asia in mid-century

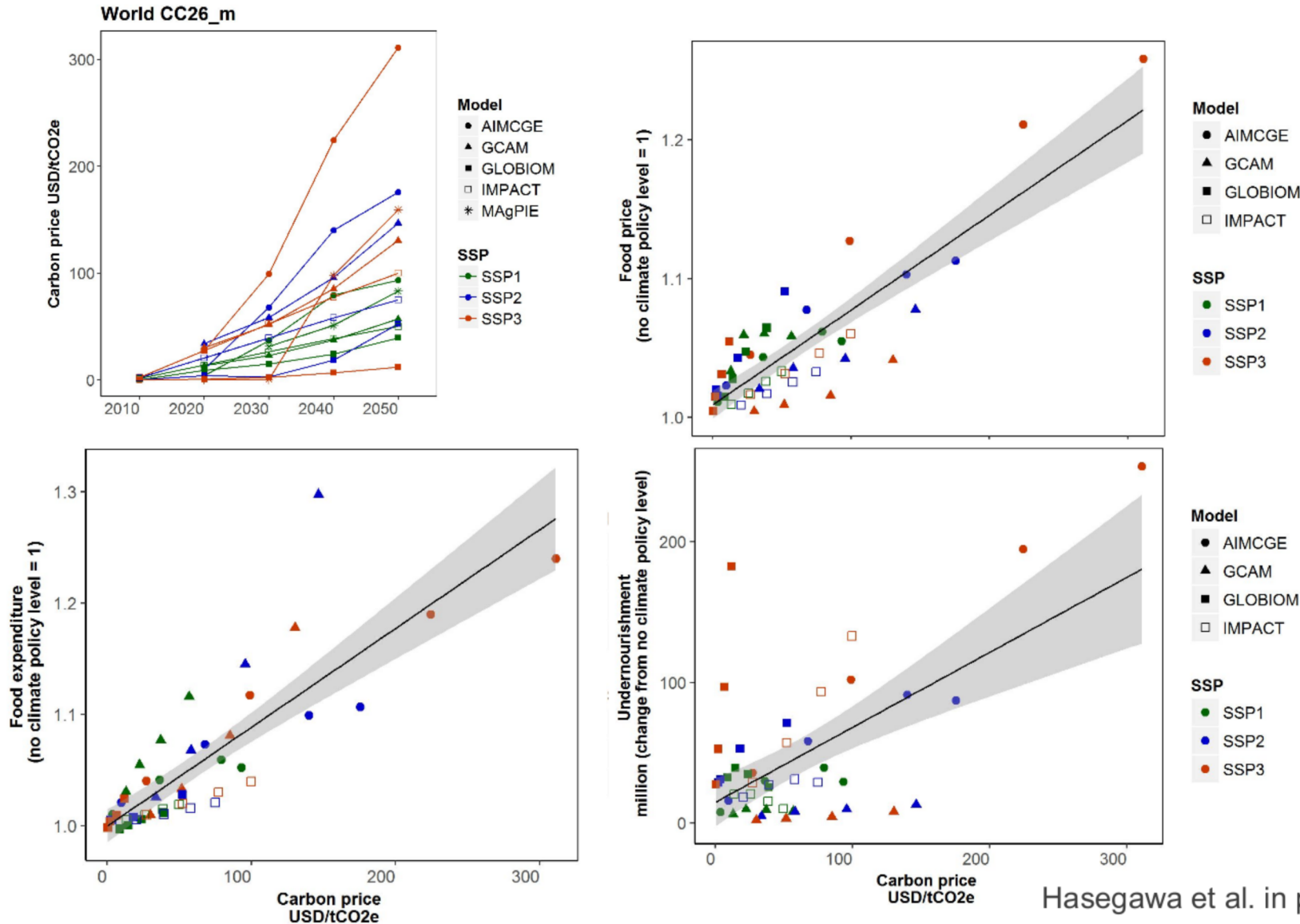


Hasegawa et al. in prep.

Trade-offs between climate mitigation and food security indicators by 2050

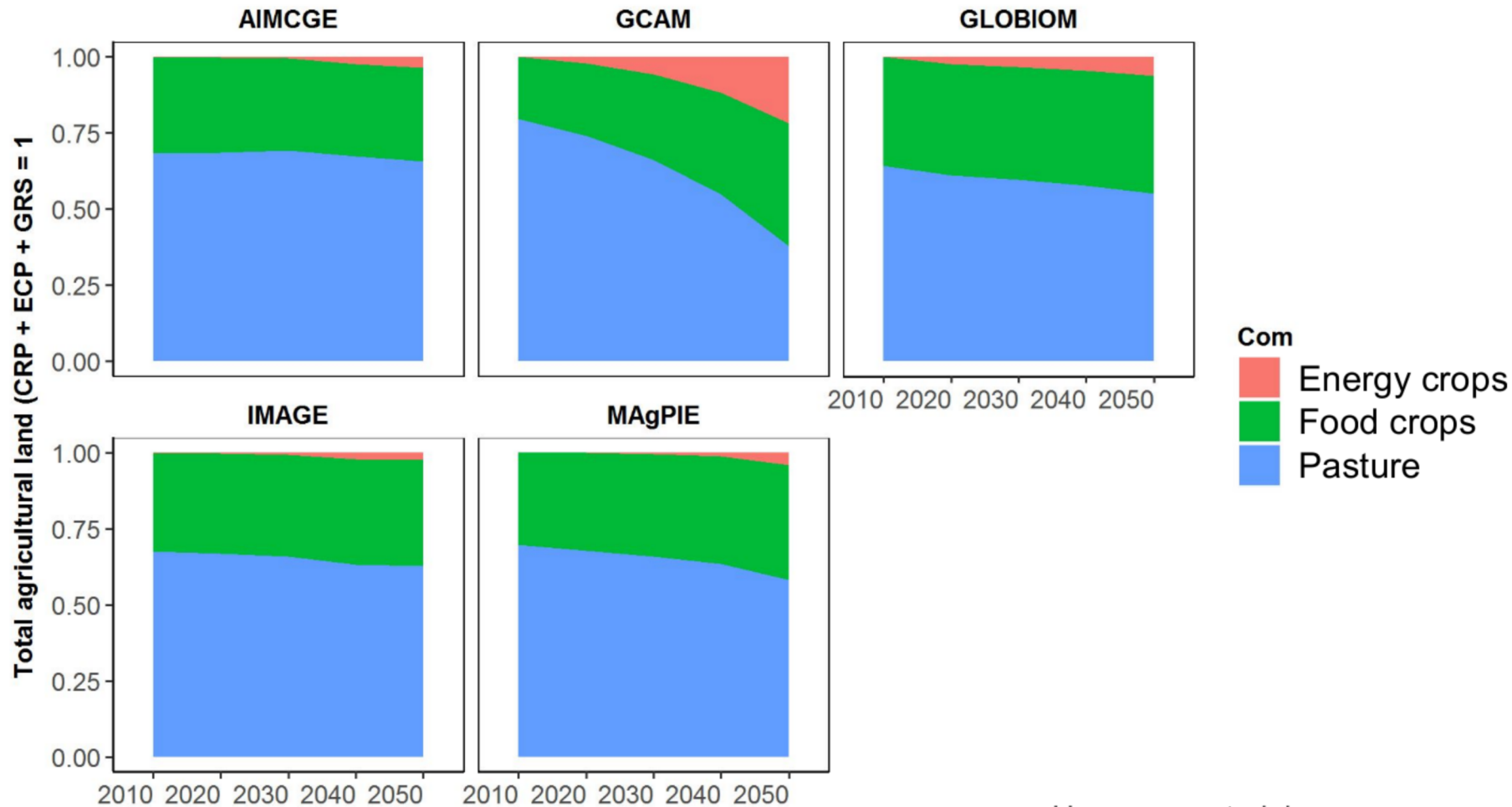
Food price and expenditure linearly increases along with carbon price.

→ The strong mitigation leads less food access and more food insecurity.



Land-use under climate mitigation

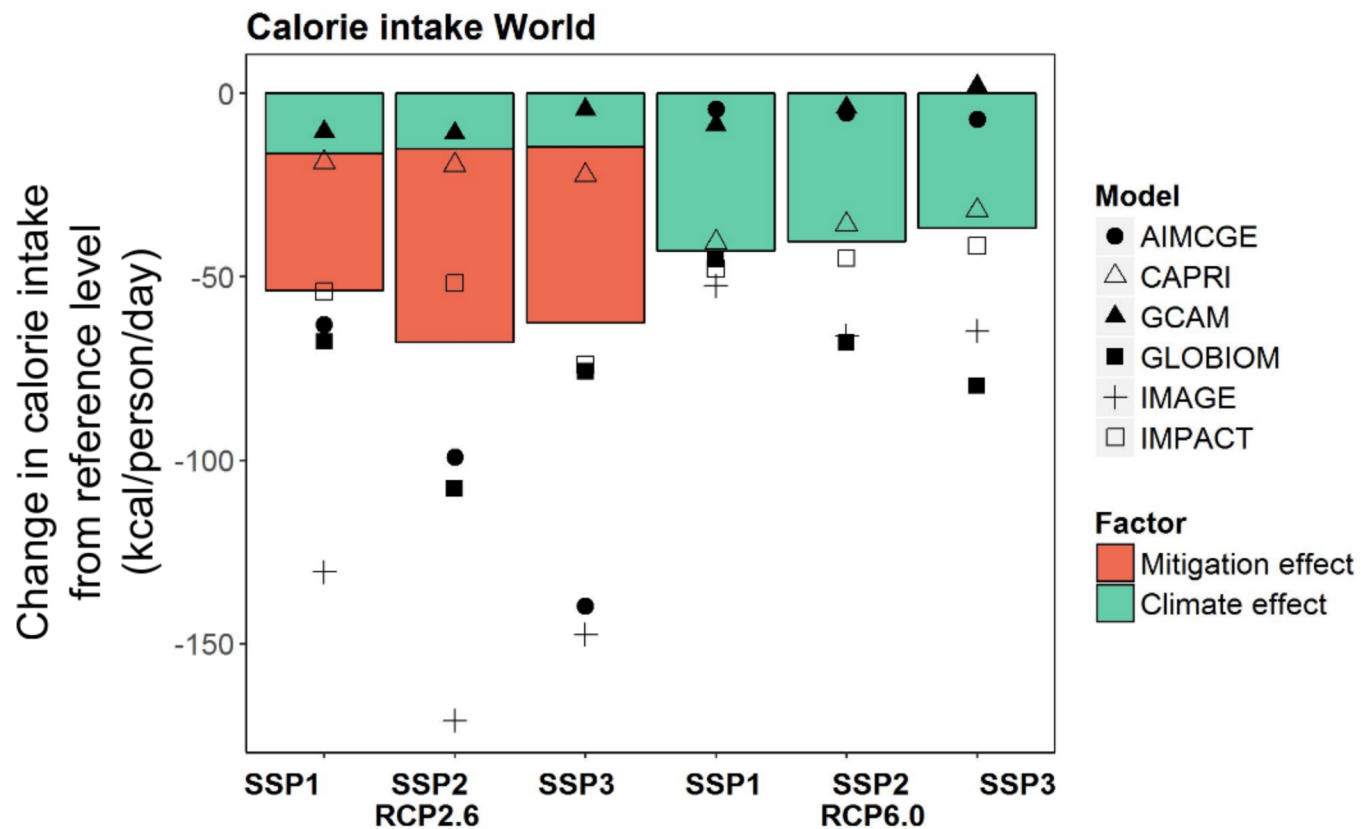
The degree of land use change varies across models depending on mitigation costs, a set of options



Hasegawa et al. in prep.

Climate-induced global food insecurity

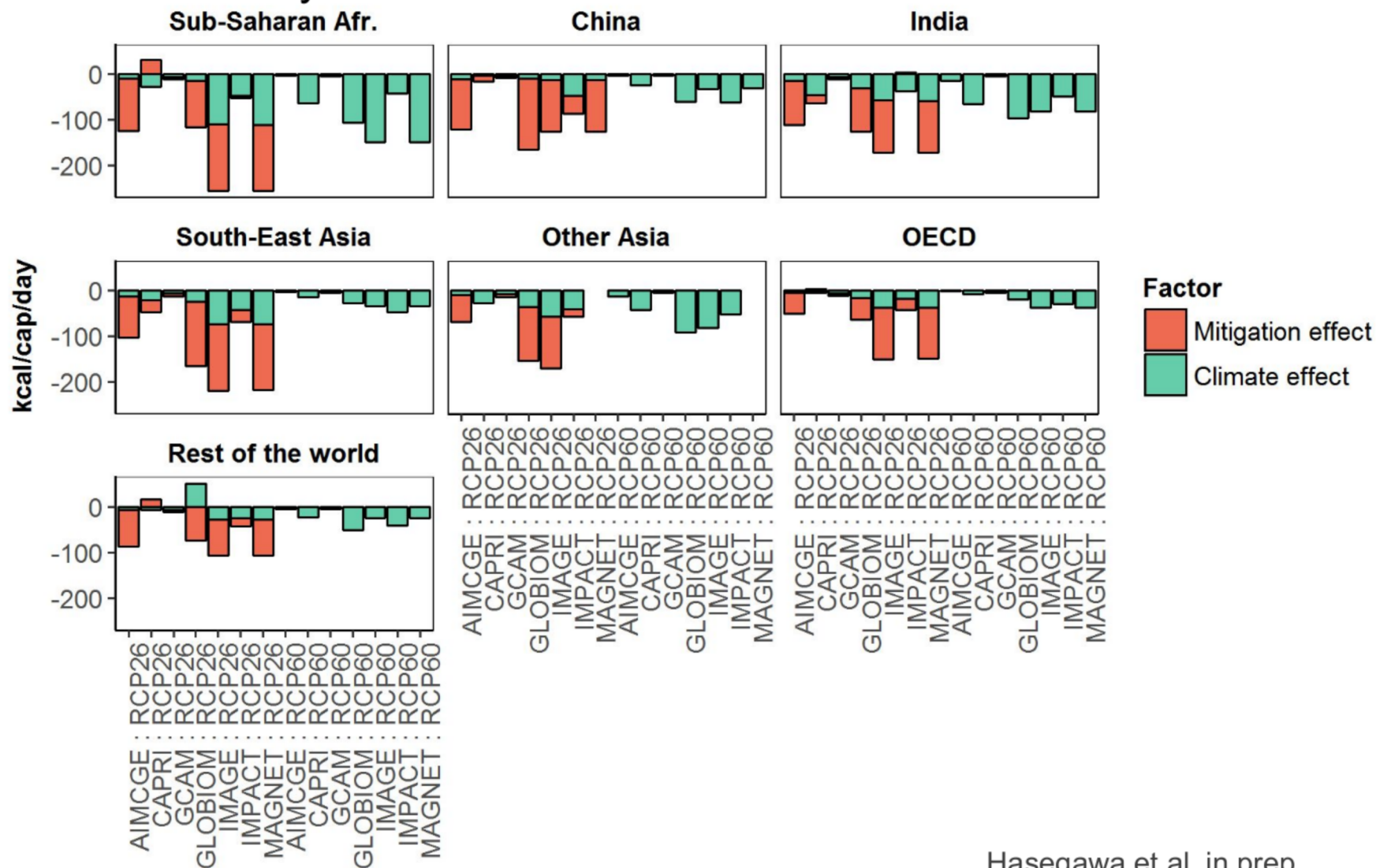
- Strict emissions cuts could indirectly lead to more people at risk of hunger compared to the case with no policy.
- The degree of the effects varies across models and SSPs.



Hasegawa et al. in prep.

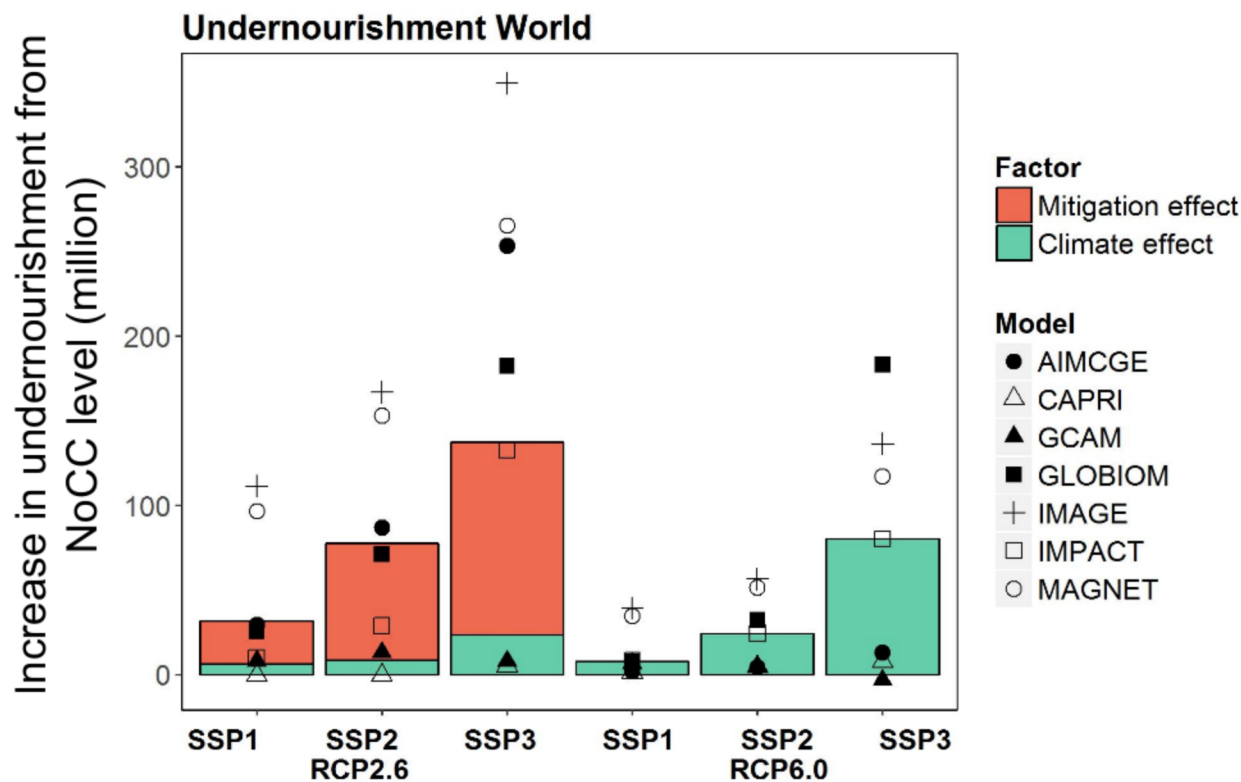
Regional impact on food intake in SSP2 2050

- Under climate mitigation, the global risk of hunger can be dominated by South Asia and Sub-Saharan Africa



Climate-induced global risk of hunger

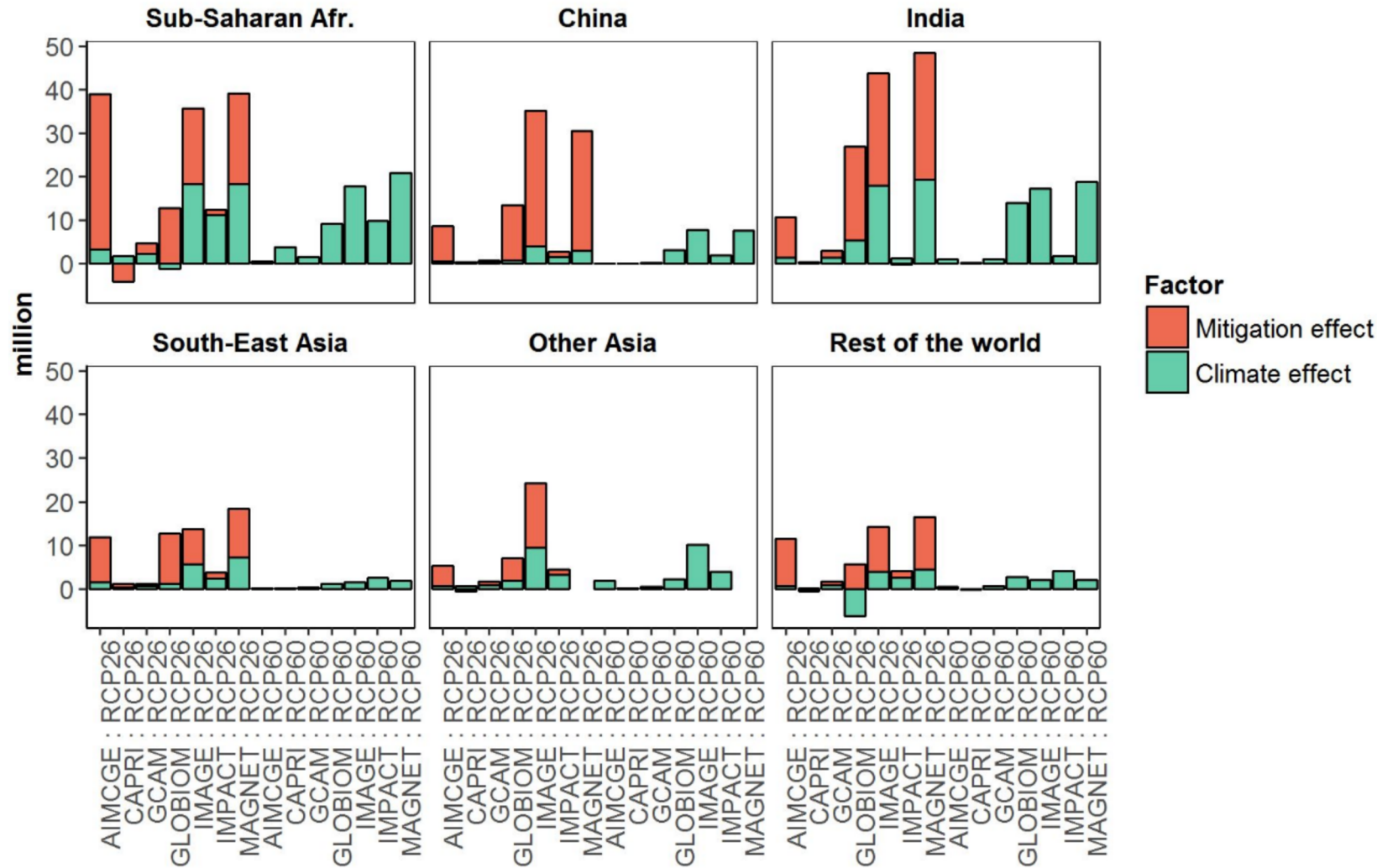
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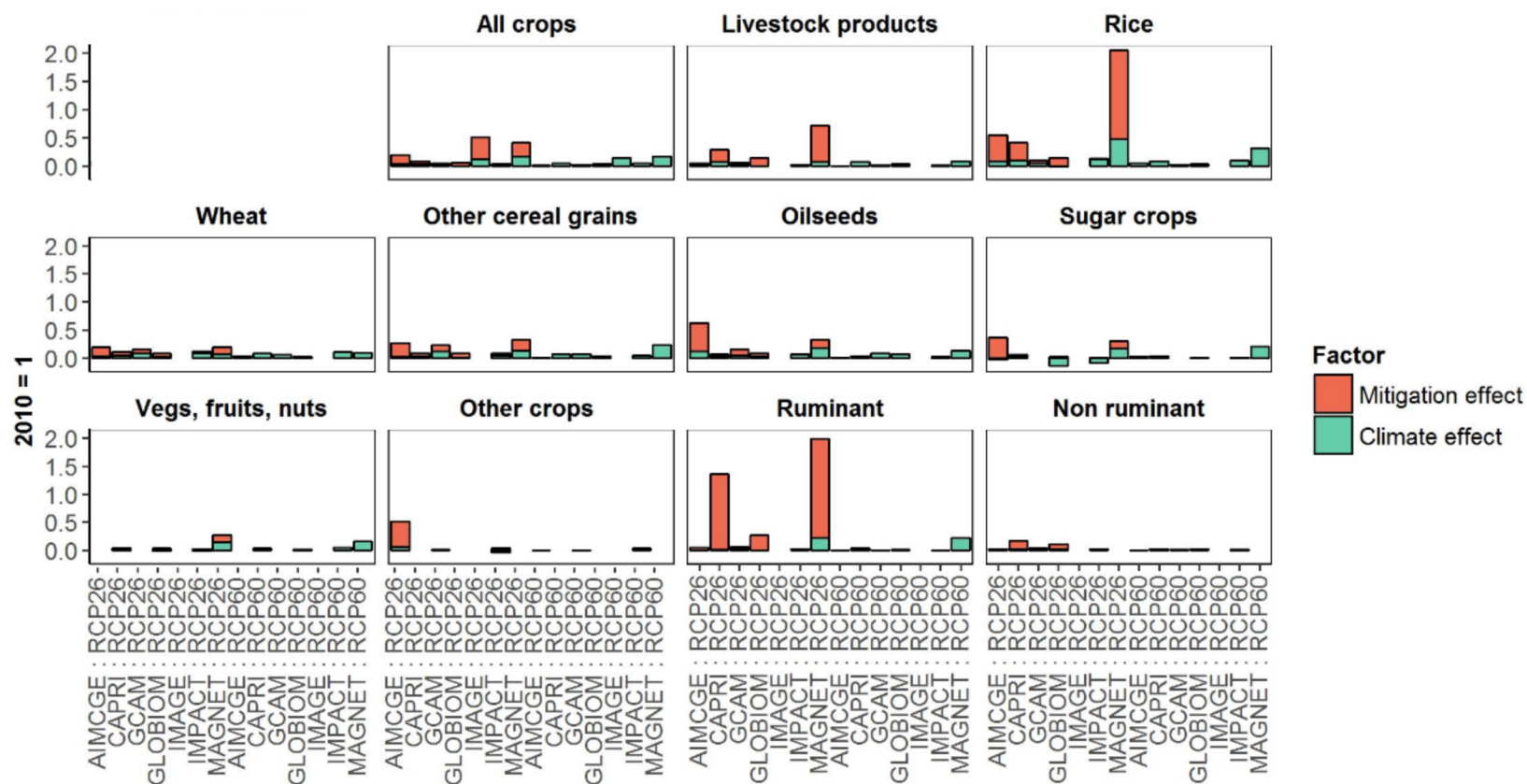
Regional impact on hunger in 2050

- Global risk of hunger is dominated by South Asia and Sub-Saharan Africa under climate mitigation.

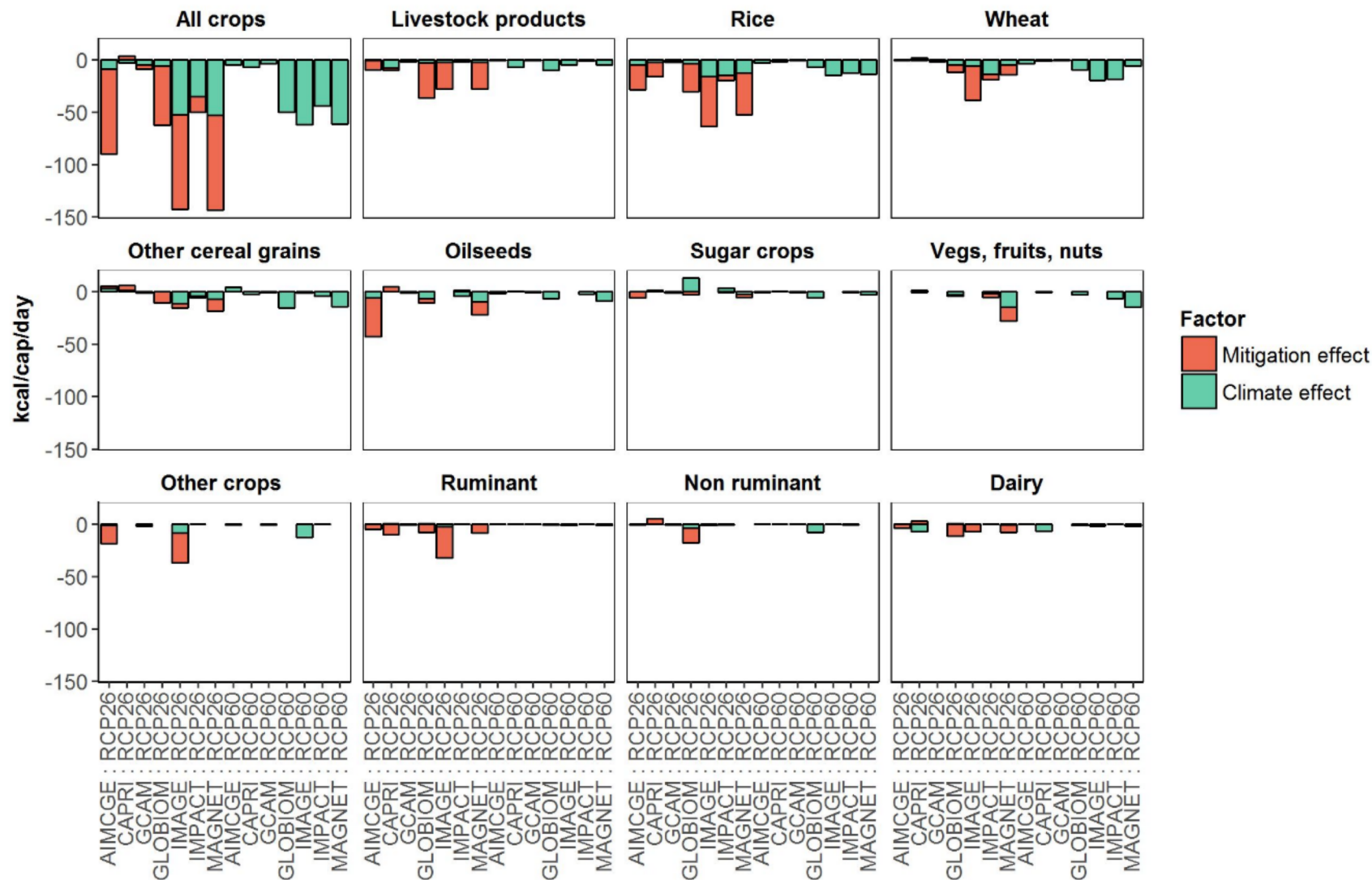


Impact on food prices by commodities in SSP2 2050 global average

- Carbon-intensive products (e.g. ruminant, rice) show relatively large increase in prices under climate mitigation.



Impact on food intake by commodities in SSP2 2050 global average



Conclusion

- A first attempt of comprehensive assessment about climate-induced food security using multiple global economic models.
- Most economic models agreed that the strict emissions cuts can help maintain the crop yields, but could indirectly lead to more people at risk of hunger.
- Increase in the global risk of hunger in 2 °C scenario is expected to be dominated by South Asia and Sub-Saharan Africa regardless to SSPs.
- Necessary to implement complementary measures (e.g. food aid) together with mitigation measures.

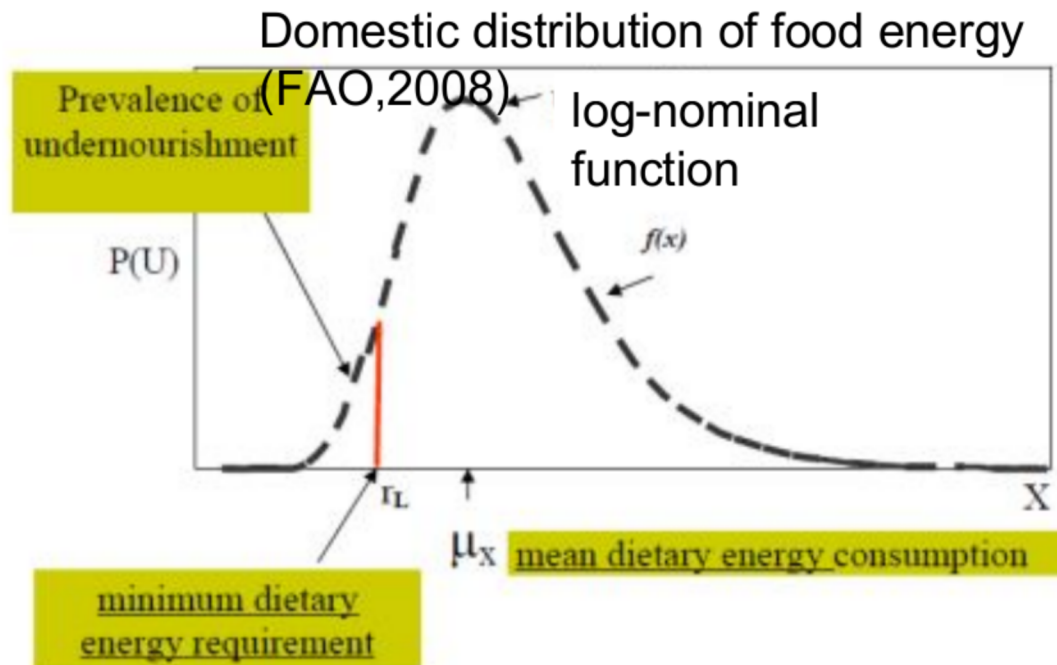
Supplementary

Multi-model hunger analysis tool

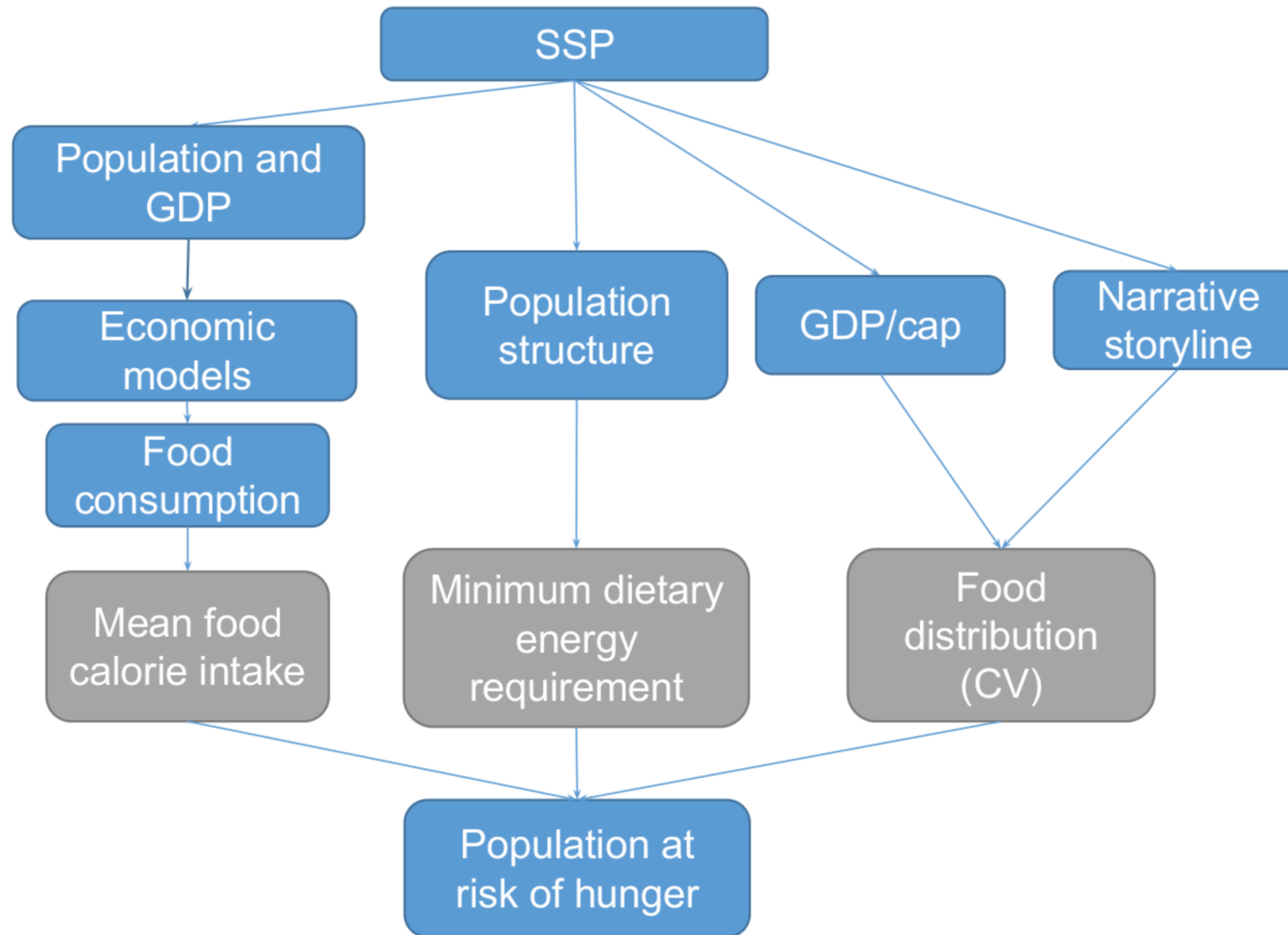
- Calculate population at risk of hunger
- FAO approach
- FAO's >100 country-level estimation
 - Capture income and food distribution at country level
- Use different parameters according to data availability
- Regions mapping
 - Native regions
 - AgMIP regions (in case of unavailable native regions.)
- Units
 - kcal/day/person (direct use or base-year adjustment to FBS)
 - Mt/year, \$/year (in case of unavailable calorie; used as a change ratio from base year.)

FAO approach for estimating pop. at risk of hunger

- Key parameters:
 - Mean food calorie intake
 - Minimum dietary energy requirement
 - Coefficient of variation (CV) of food distribution



Data process



Food distribution improvement with income increase

Inequality

Equality

