IAM-IAV-ESM linkage in AIM project - Focusing spatial resolution issues -

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[1]National Institute for Environmental Studies

[2]University of Seoul

[3]National Agriculture and Food Research Organization

AIM project's research publications based on IAM-IAV-ESM linkage

- Published
  - Hanasaki N., Fujimori S., Yamamoto T., Yoshikawa S., Masaki Y., Hijioka Y., Kainuma M., Kanamori Y., Masui T., Takahashi K., Kanae S. (2013) A global water scarcity assessment under Shared Socio-economic Pathways - Part 1: Water use. Hydrology and Earth System Sciences, 17 (7), 2375-2391
  - Hanasaki N., Fujimori S., Yamamoto T., Yoshikawa S., Masaki Y., Hijioka Y., Kainuma M., Kanamori Y., Masui T., Takahashi K., Kanae S. (2013) A global water scarcity assessment under Shared Socio-economic Pathways - Part 2: Water availability and scarcity. Hydrology and Earth System Sciences, 17 (7), 2393-2413
  - Hasegawa T., Fujimori S., Shin Y., Takahashi K., Masui T., Tanaka A. (2014) Climate change impact and adaptation assessment on food consumption utilizing a new scenario framework. Environmental Science and Technology, 48, 438-445
  - Ishida H., Kobayashi S., Kanae S., Hasegawa T., Fujimori S., Shin Y., Takahashi K., Masui T., Tanaka A., Honda Y. (2014) Global-scale projection and its sensitivity analysis of the health burden attributable to childhood undernutrition under the latest scenario framework for climate change research. Environmental Research Letters, 9 (6), 064014-064022
  - Hasegawa T., Fujimori S., Takahashi K., Masui T. (2015) Scenarios for the risk of hunger in the twenty-first century using Shared Socioeconomic Pathways. Environmental Research Letters, 10 (1), 014010-014017
  - Hasegawa T., Fujimori S., Shin Y., Tanaka A., Takahashi K., Masui T. (2015) Consequence of Climate Mitigation on the Risk of Hunger. Environmental Science & Technology, 49 (12),
  - Hasegawa T., Fujimori S., Takahashi K., Yokohata T., Masui T. (2016) Economic implications of climate change impacts on human health through undernourishment. Climatic Change, 1-14
  - Hasegawa T., Park C., Fujimori S., Takahashi K., Hijioka Y., Masui T. (2016) Quantifying the economic impact of changes in energy demand for space heating and cooling systems under varying climatic scenarios. Palgrave Communications.
- Submitted / Under review
  - Hasegawa et al., Development and Application of a Global Land-use Allocation Model Linked to an Integrated Assessment Model.
  - Fujimori et al., Downscaling Global Emissions and Its Implication Derived from Climate Model Experiments.
  - Zhou et al., Economic consequences of global climate change and mitigation on future hydropower.

ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

Our incentives for IAM-IAV-ESM coupling

- International research trend
  - The SSP-RCP scenario framework
  - Increasing focus on the analyses of the sustainable development goals
- Domestic research project funding
  - MOEJ-S14 research project for integrated analyses of global mitigation and local adaptation
  - NIES research program for proposing integrated solution of multiple environmental problems toward sustainable society

ASIA-PACIFIC INTEGRATED MODEL

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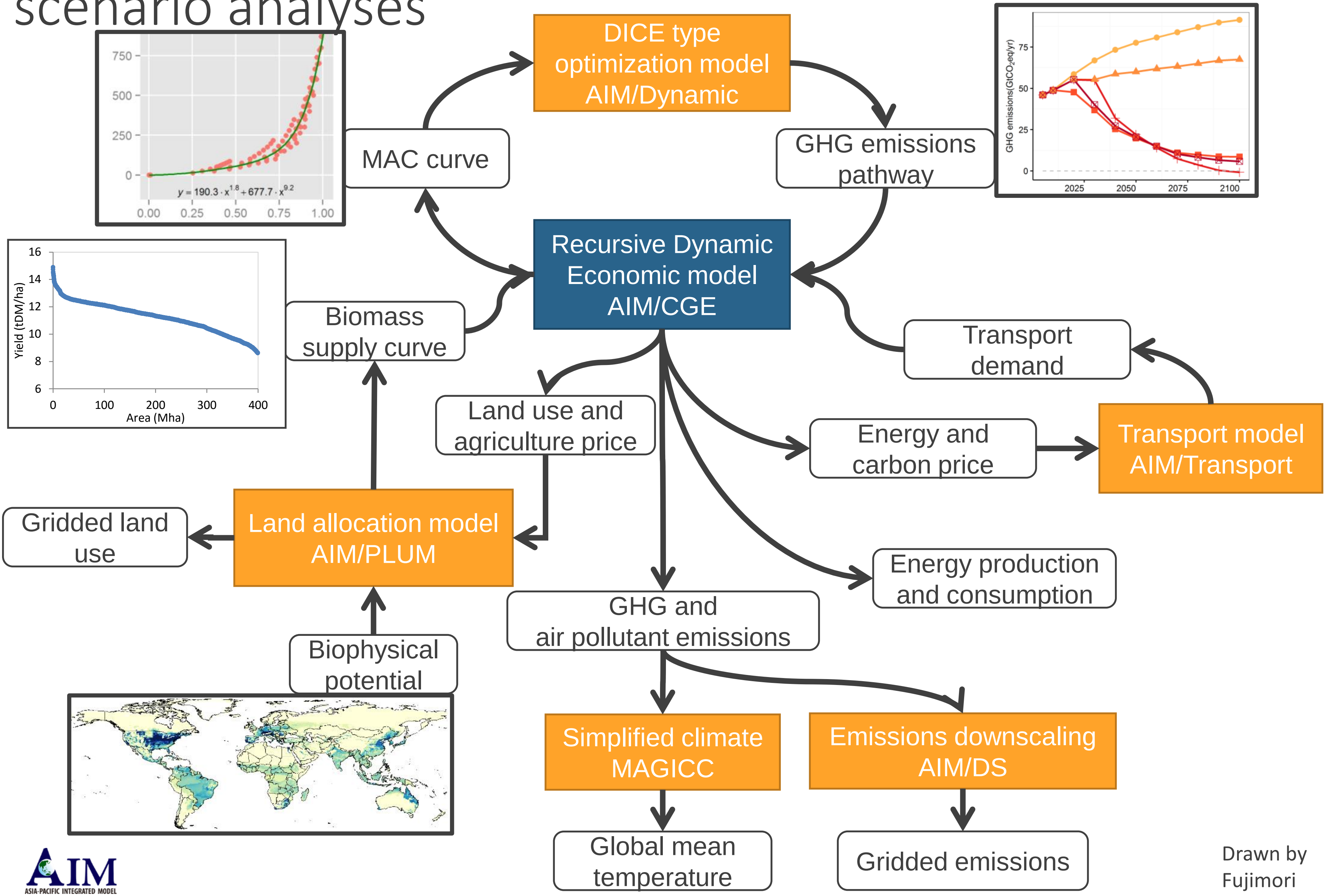
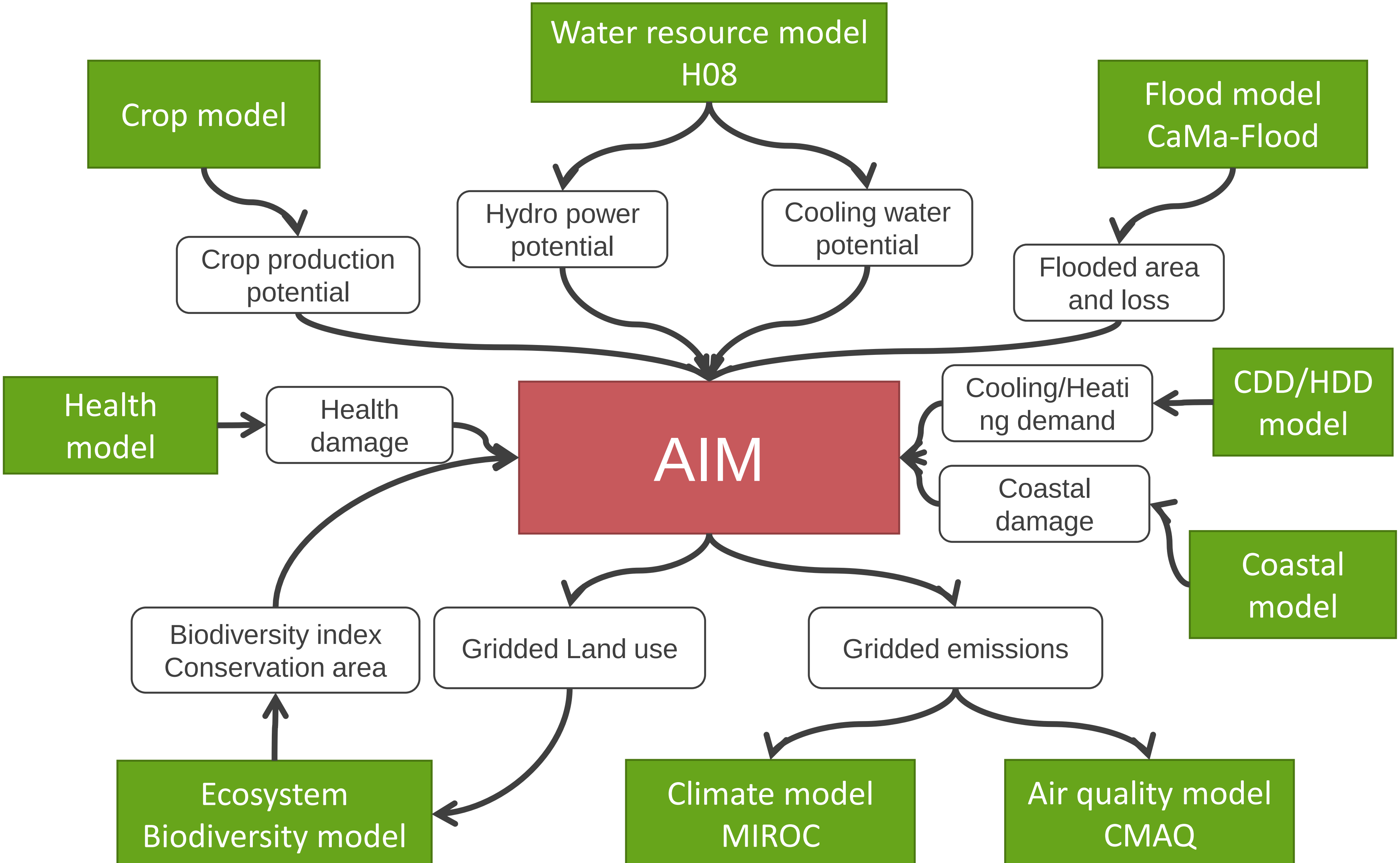
Current AIM/CGE interaction for the integrated scenario analyses



Drawn by Fujimori

AIM/CGE interaction with external IAV&ESM models



AIM ASIA-PACIFIC INTEGRATED MODEL

Drawn by Fujimori

Typical challenges in linking IAM and IAV

- Spatial resolution gap
  - Aggregation / Disaggregation
- Limited number of scenario cases analyzed in IAV models
  - Impact response functions (sensitivity analyses)
- Choice of variables transferred between models
  - Avoidance of double-counting
  - Formulation in the CGE model
- Difficulty in reflective interaction between IAM and IAV
  - Land-use model as a key module for most interactions

Spatial aggregation / disaggregation

- Aggregation (IAV -> IAM ; 0.5° -> 17 regions)
  - Crops productivity
    - Food-health analysis
  - Cooling/Heating Degree Days
    - Cooling/Heating service and energy demand analysis
  - Hydropower potential based on river runoff change
- Disaggregation (IAM -> IAV/ESM; 17 regions -> 0.5°)
  - Spatial GHGs/Aerosol emission scenarios
    - Input to MIROC ESM
  - Spatial land-use scenarios
    - Input to ecosystem-biodiversity model

AIM ASIA-PACIFIC INTEGRATED MODEL

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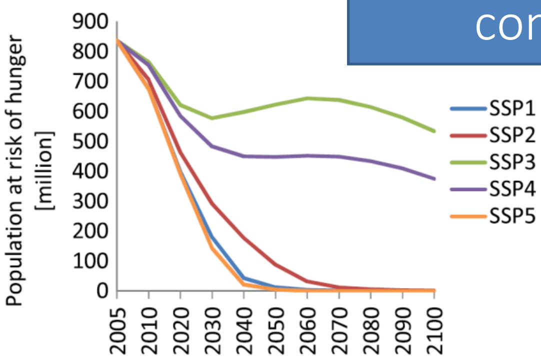
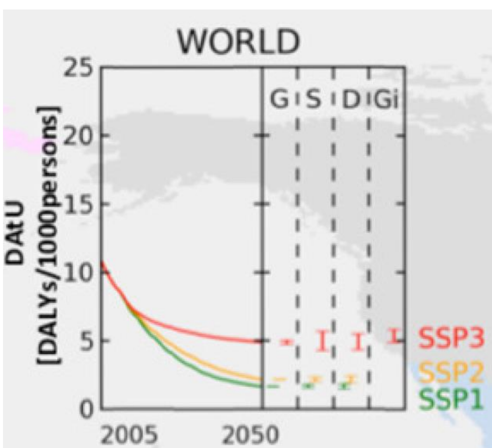
Impacts of climate change on food-health and its economic implications



Hasegawa et al., 2015,ERL



Ishida et al., 2014

Socio-economic conditions

Climate change

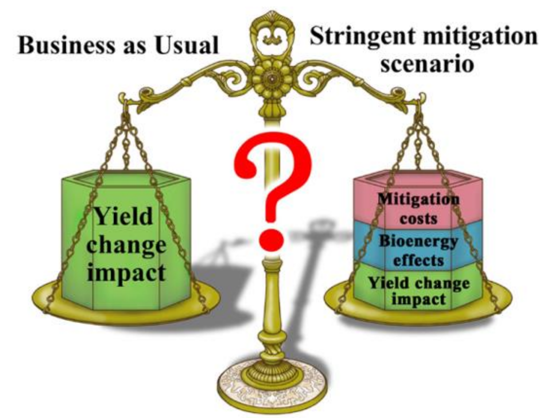
Adaptation

Hasegawa et al., 2014

Mitigation

Hasegawa et al., 2015, EST

Undernourishment/ Risk of hunger



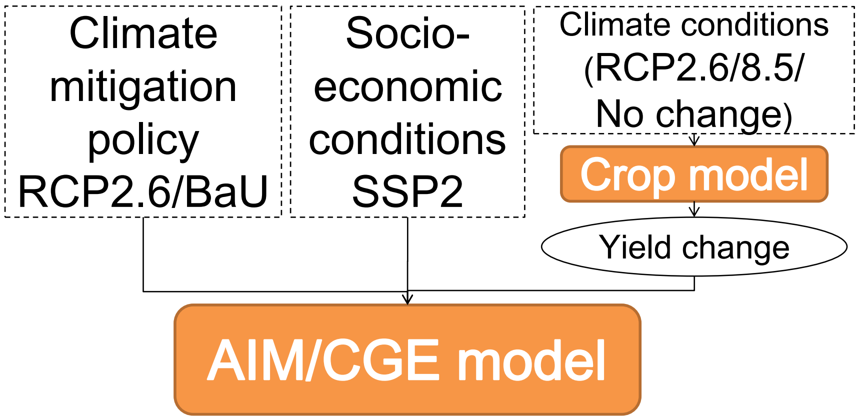
Health impacts

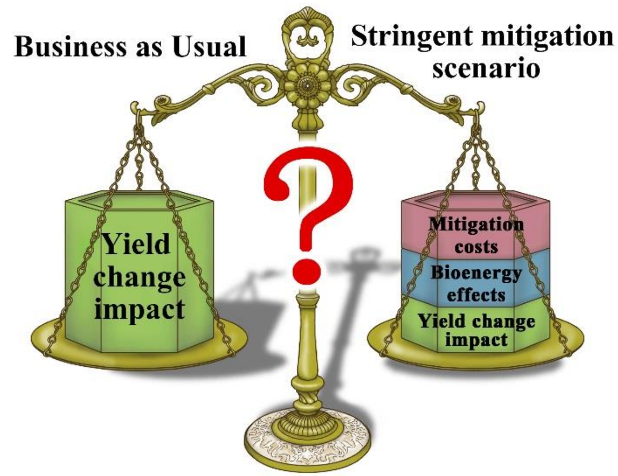
Economic implications

Hasegawa et al., 2016

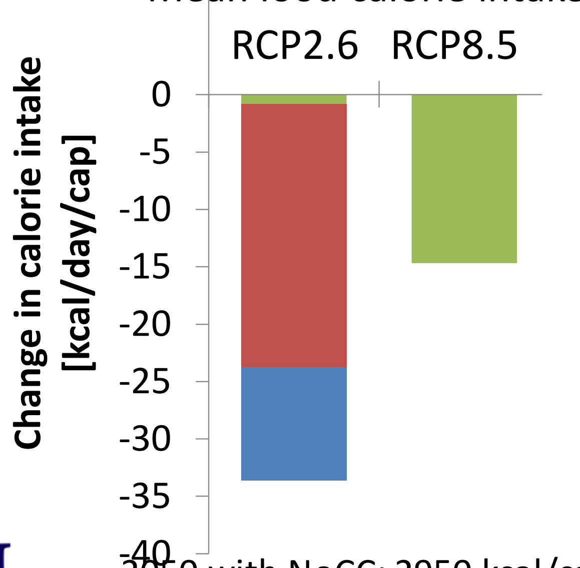
Consequence of Climate Mitigation on the Risk of Hunger

Methods

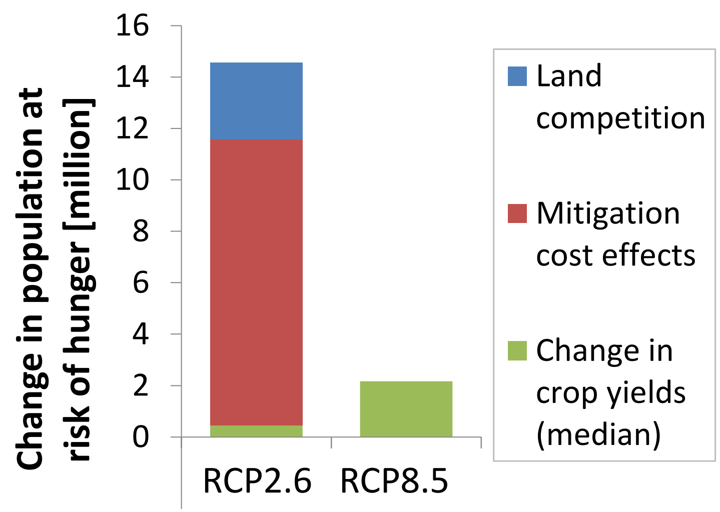




Mean food calorie intake



Global population at risk of hunger



2050 with NoCC: 2950 kcal/cap/day
2005: 2680 kcal/cap/day

2050 with NoCC: 90 mil.
2005: 830 mil.

ASIA-PACIFIC INTEGRATED MODEL

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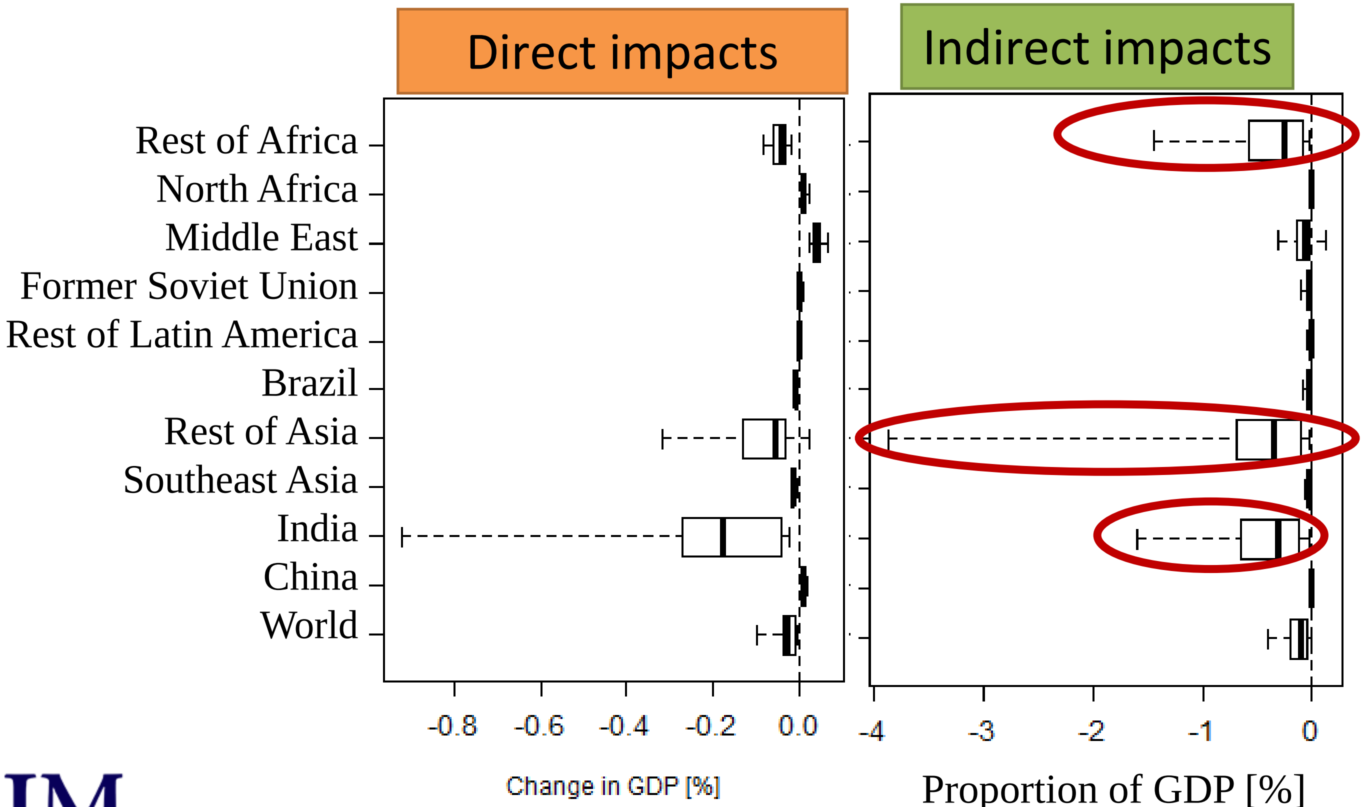
Economic implications of health impacts through undernourishment: SSP3-RCP8.5 in 2100

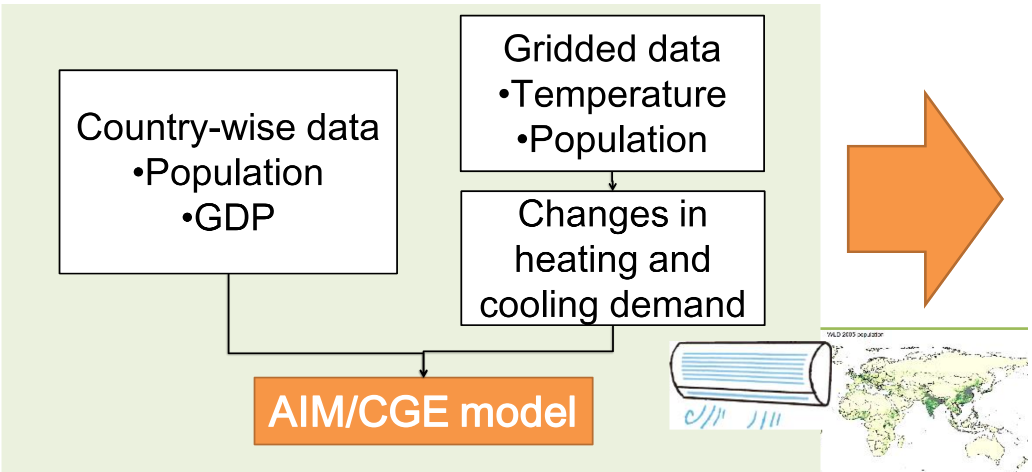
- Direct impacts (changes in labor force & healthcare costs): -0.1–0.0% of Global GDP
- Indirect impacts (value of lives lost): -0.4-0.0% of Global GDP; -4.0% at most in regional levels

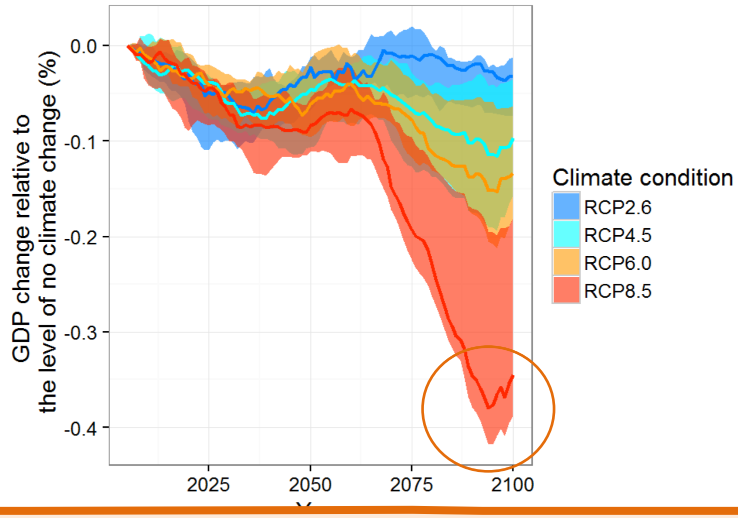


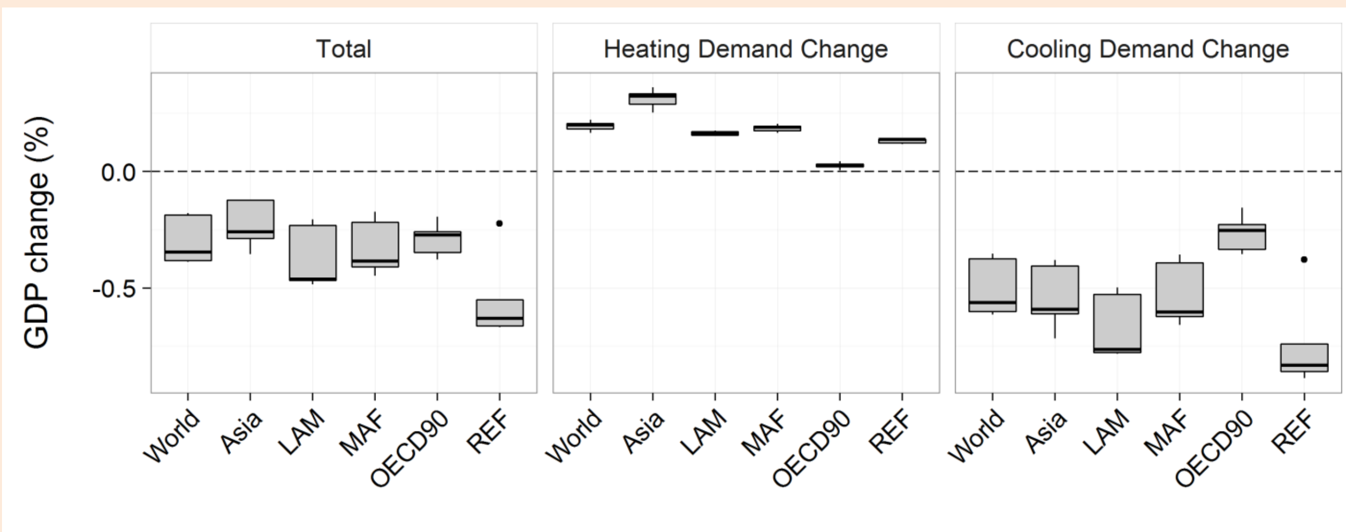
ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

Economic impact of changes in energy demand for space heating and cooling systems under varying climatic scenarios

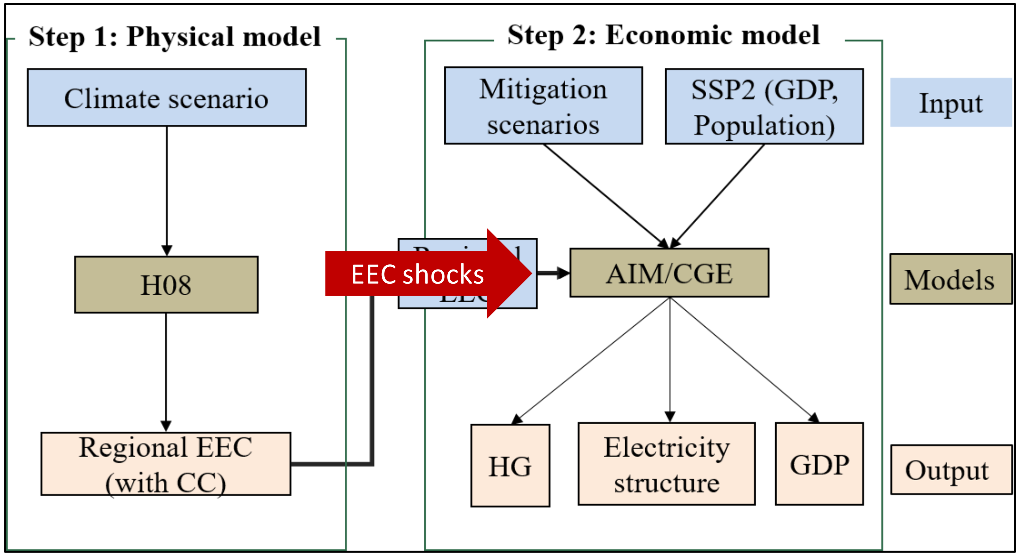






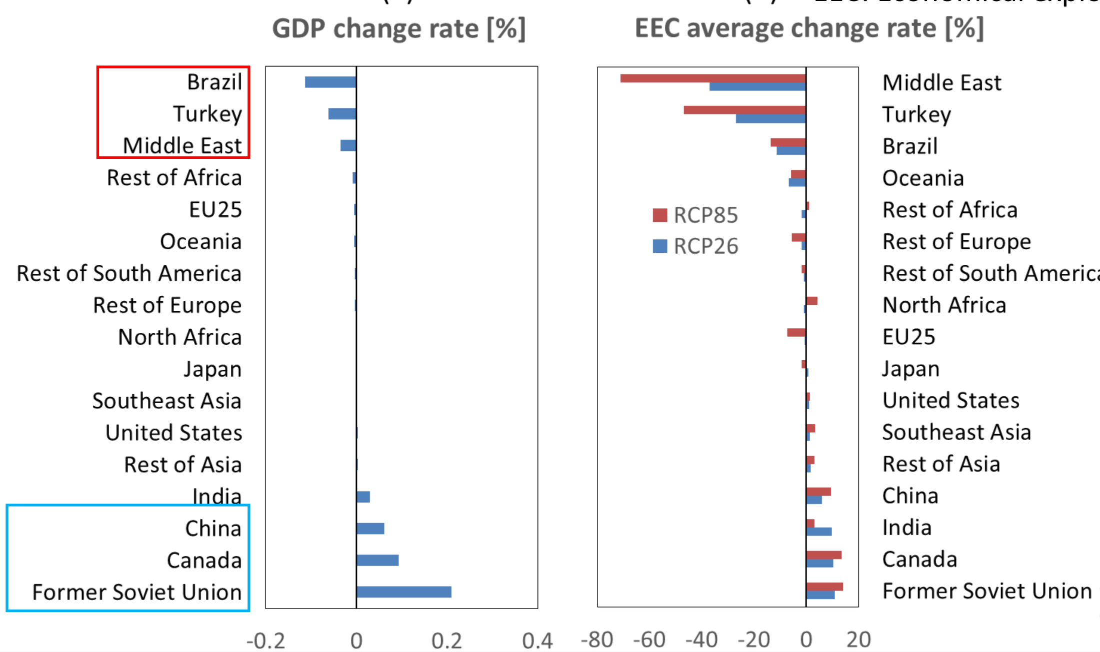
Zhao et al. Submitted.

Economic consequences of global climate change and mitigation on future hydropower



(a)

(b) EEC: Economical exploitable capacity



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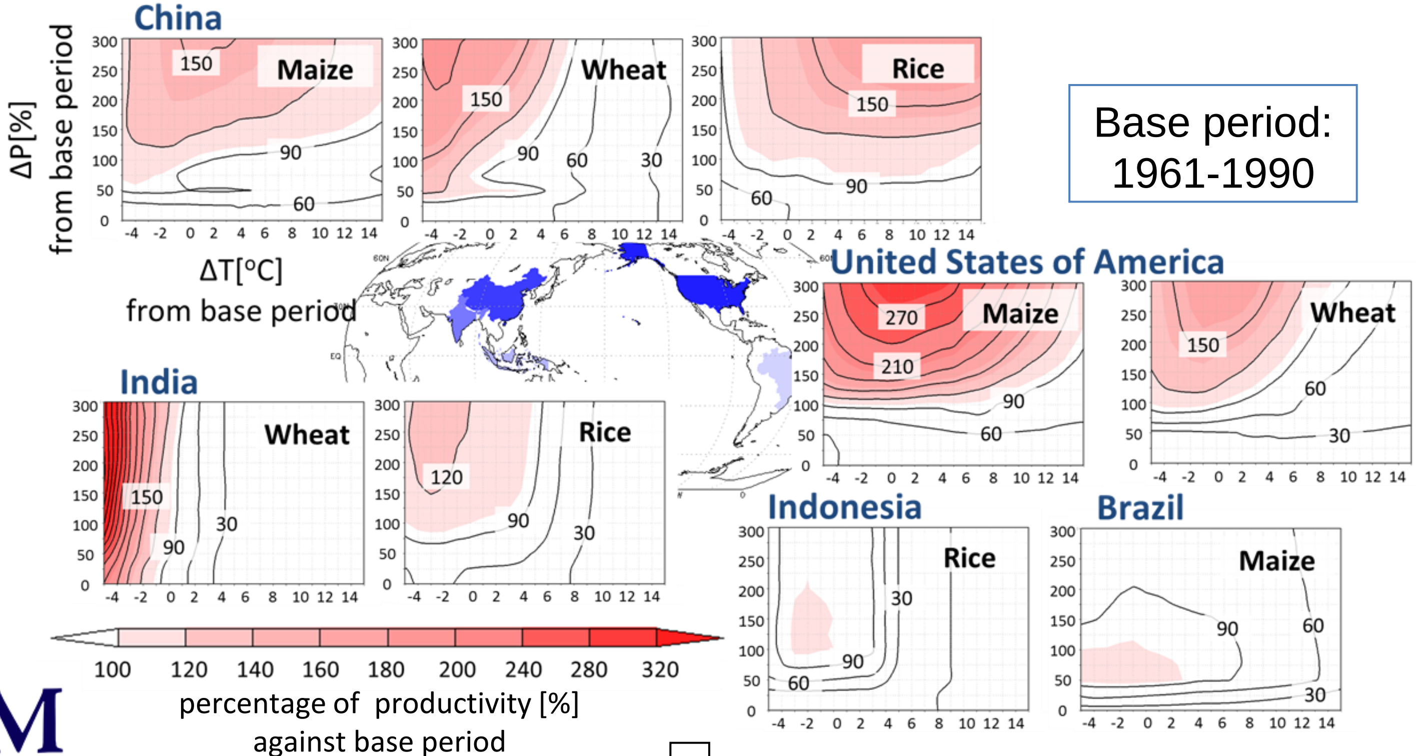
Development of impact response functions

- The impact response function is a database of country-averaged data from sensitivity analyses calculated by a process-based model.
- We developed an impact response function for productivities of maize, wheat, paddy-rice and other 11 crops with two explanatory variables, change in annual mean temperature (ΔT) and change in annual mean precipitation (ΔP), using the M-GAEZ model.



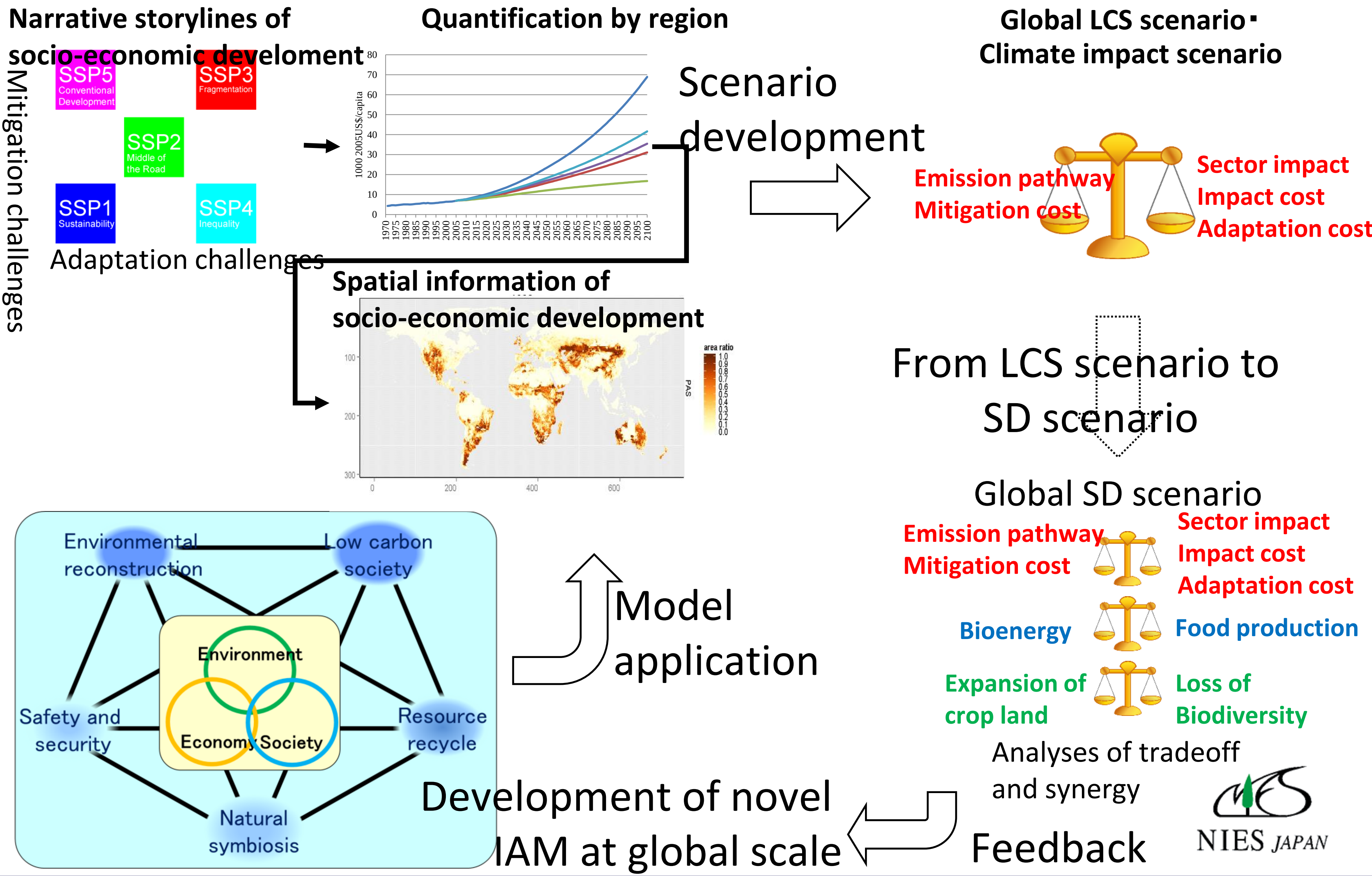
Incentives for IAM-IAV-ESM coupling

- International
  - The SSP-RCP framework
  - Increasing focus on the analyses of the sustainable development goals
- Domestic research project funding
  - MOEJ-S14 research project for integrated analyses of global mitigation and local adaptation
  - NIES research program for proposing integrated solution of multiple environmental problems toward sustainable society

NIES Research Program: Development of global SD scenario

(1) Development of novel global IAM and quantitative SD scenarios using the IAM

(2) Downscaling of the quantified socio-economic scenarios



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Summary of the talk

- Most of the recent efforts for linking IAM-IAV in the AIM project have been the consideration of climate change impacts on specific sectors in AIM/CGE.
- Based on the development of tools for spatially downscaling the CGE results (e.g. AIM/PLUM for land-use scenario), we are going to extend the integration with IAV & ESM models further.