Current status of global modeling
&
Asian Sustainable Development Implications of Climate Change Mitigation Scenario

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2018-2019 activities

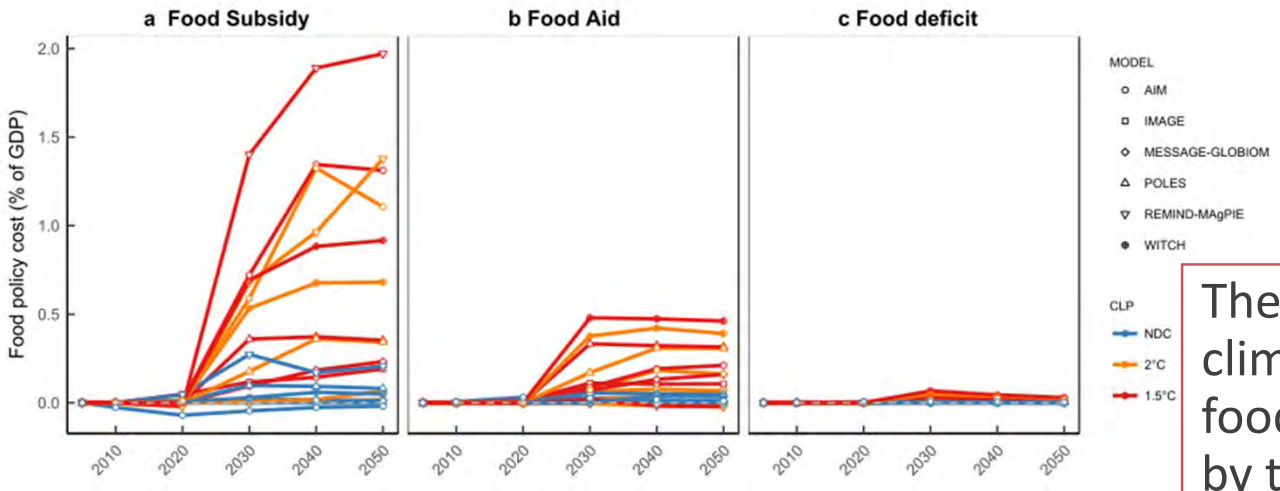
- International projects
  - ✓ CD-LINKS: multi-sectoral assessment (SDGs) → Just finished
  - ✓ EMF33; Bioenergy → Almost finalized
  - ✓ AgMIP; Food security → Phase 3 starts
  - ✓ COMMIT; National mitigation assessments → Ongoing
  - ✓ IPBES and WWF study (The Bending the Curve); Ecosystem → Ongoing
  - ✓ ENGAGE; Feasibility study → Just started
- Topics
  - ✓ Deep decarbonization
    - ➢ Global and national
  - ✓ Broader sustainability assessments
    - ➢ Food, water, land, energy and ecosystem
    - ➢ Land related issues
  - ✓ Climate change impact economics

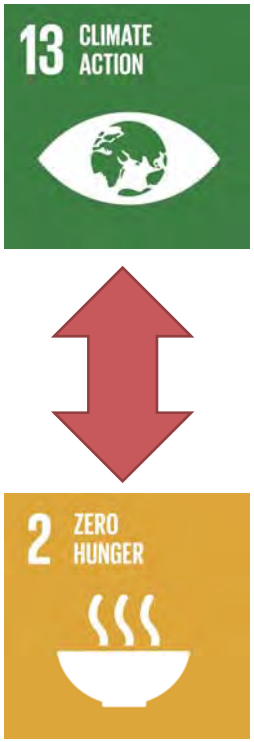
Food security: how to avoid the adverse side effects

ARTICLES
https://doi.org/10.1038/s41893-019-0286-2
nature sustainability

A multi-model assessment of food security implications of climate change mitigation

Shinichiro Fujimori[1,2,3*], Tomoko Hasegawa[2,3,4], Volker Krey[3], Keywan Riahi[3,5], Christoph Bertram[6], Benjamin Leon Bodirsky[6], Valentina Bosetti[7,8], Jessica Callen[3], Jacques Després[9], Jonathan Doelman[10], Laurent Drouet[7], Johannes Emmerling[7], Stefan Frank[3], Oliver Fricko[3], Petr Havlik[3], Florian Humpenöder[6], Jason F. L. Koopman[11], Hans van Meijl[11], Yuki Ochi[12], Alexander Popp[6], Andreas Schmitz[9], Kiyoshi Takahashi[2] and Detlef van Vuuren[10,13]





The adverse side effects of climate change mitigation on food security can be avoided by the little financial support

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Proposal for the new scenarios in AR6

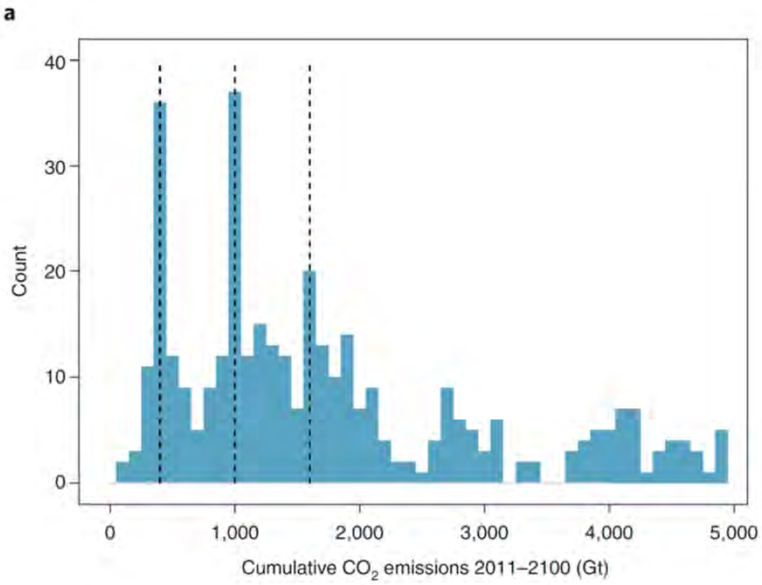
comment

A new generation of emissions scenarios should cover blind spots in the carbon budget space

Future emissions scenarios for the IPCC Sixth Assessment Report should explore the carbon budget space in a systematic manner, which would be robust to the updates of latest climate science, so that policy implications can be adequately assessed.

Shinichiro Fujimori, Joeri Rogelj, Volker Krey and Keywan Riahi

- Point out the SR 1.5 scenarios issues associated with the carbon budget approach
- Propose new scenario protocol for AR6



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A national mitigation study

nature COMMUNICATIONS

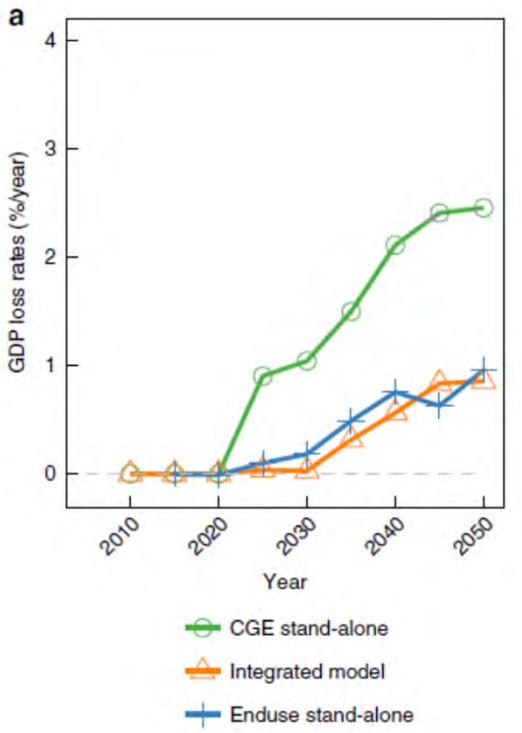
ARTICLE

https://doi.org/10.1038/s41467-019-12730-4 OPEN

Energy transformation cost for the Japanese mid-century strategy

Shinichiro Fujimori[1,2,3*], Ken Oshiro[1], Hiroto Shiraki[4] & Tomoko Hasegawa[2,3,5]

The costs of climate change mitigation policy are one of the main concerns in decarbonizing the economy. The macroeconomic and sectoral implications of policy interventions are typically estimated by economic models, which tend be higher than the additional energy system costs projected by energy system models. Here, we show the extent to which policy costs can be lower than those from conventional economic models by integrating an energy system and an economic model, applying Japan's mid-century climate mitigation target. The GDP losses estimated with the integrated model were significantly lower than those in the conventional economic model by more than 50% in 2050. The representation of industry and service sector energy consumption is the main factor causing these differences. Our findings suggest that this type of integrated approach would contribute new insights by providing improved estimates of GDP losses, which can be critical information for setting national climate policies.



- Great achievement in the model integration
- Very political important message that macro economic cost of 80% reduction in GHG emissions in Japan is cheep!!

https://doi.org/10.1038/s41467-019-12730-4

Biodiversity:

nature COMMUNICATIONS

ARTICLE

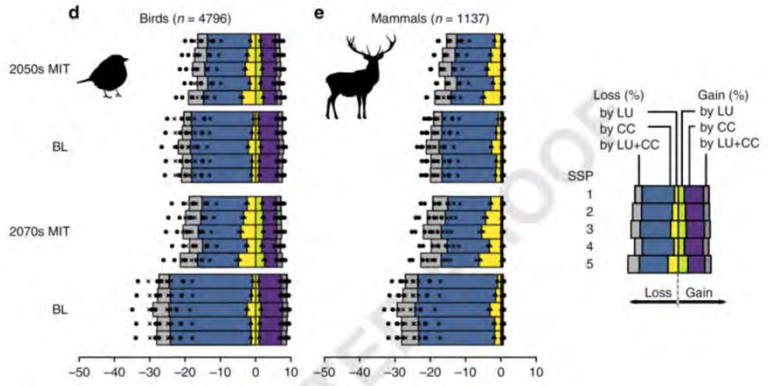
https://doi.org/10.1038/s41467-019-13241-y OPEN

Biodiversity can benefit from climate stabilization despite adverse side effects of land-based mitigation

Haruka Ohashi[1*], Tomoko Hasegawa[2,3], Akiko Hirata[1,3], Shinichiro Fujimori[4], Kiyoshi Takahashi[3], Ikutaro Tsuyama[5], Katsuhiro Nakao[6], Yuji Kominami[7], Nobuyuki Tanaka[8], Yasuaki Hijioka[3] & Tetsuya Matsui[1]

Limiting the magnitude of climate change via stringent greenhouse gas (GHG) mitigation is necessary to prevent further biodiversity loss. However, some strategies to mitigate GHG emission involve greater land-based mitigation efforts, which may cause biodiversity loss from land-use changes. Here we estimate how climate and land-based mitigation efforts interact with global biodiversity by using an integrated assessment model framework to project potential habitat for five major taxonomic groups. We find that stringent GHG mitigation can generally bring a net benefit to global biodiversity even if land-based mitigation is adopted. This trend is strengthened in the latter half of this century. In contrast, some regions projected to experience much growth in land-based mitigation efforts (i.e., Europe and Oceania) are expected to suffer biodiversity loss. Our results support the enactment of stringent GHG mitigation policies in terms of biodiversity. To conserve local biodiversity, however, these policies must be carefully designed in conjunction with land-use regulations and societal transformation in order to minimize the conversion of natural habitats.

- Are land-based mitigation measures really harmful for the biodiversity?
- No climate change impacts should be more than that!!



Climate change impact economics

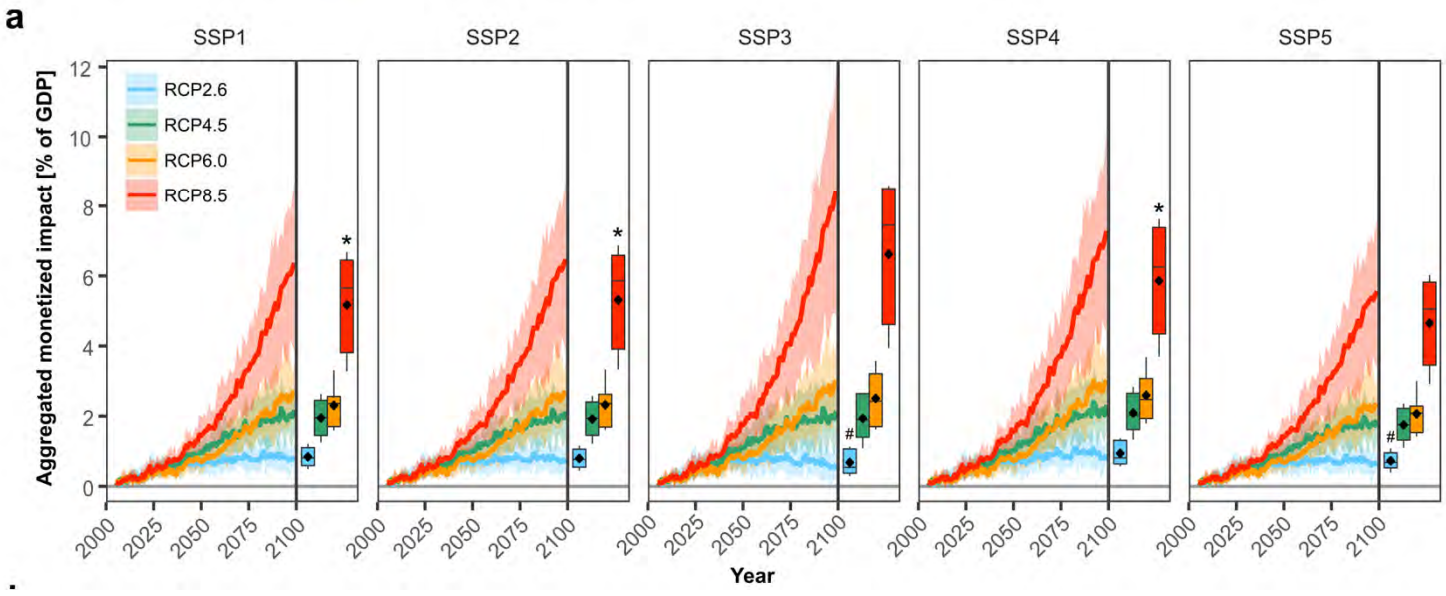
nature climate change

LETTERS

https://doi.org/10.1038/s41558-019-0578-6

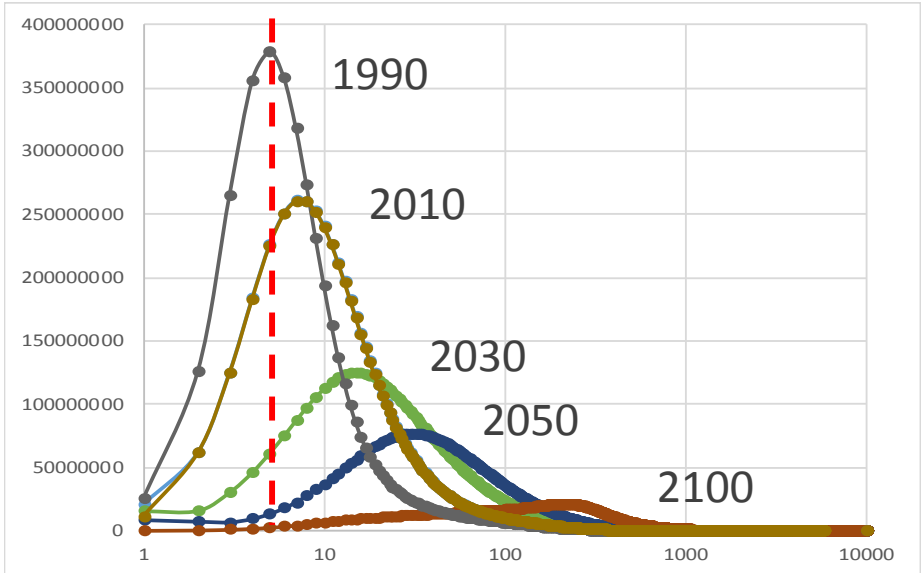
Dependence of economic impacts of climate change on anthropogenically directed pathways

Jun'ya Takakura[1*], Shinichiro Fujimori[2], Naota Hanasaki[3], Tomoko Hasegawa[4], Yukiko Hirabayashi[5], Yasushi Honda[6], Toshichika Iizumi[7], Naoko Kumano[8], Chan Park[9], Zhihong Shen[7], Kiyoshi Takahashi[1], Makoto Tamura[10], Masahiro Tanoue[5], Koujiro Tsuchida[11], Hiromune Yokoki[12], Qian Zhou[13], Taikan Oki[14,15] and Yasuaki Hijioka[3]



Priorities in 2020

- Asian assessments
  - ✓ Mid-century strategy post-Paris Agreement
- Multi-sectoral assessments
  - ✓ Mitigation and SDG implications
    - ➢ Land-energy-water-ecosystem
- Economic aspects of climate change mitigation and poverty



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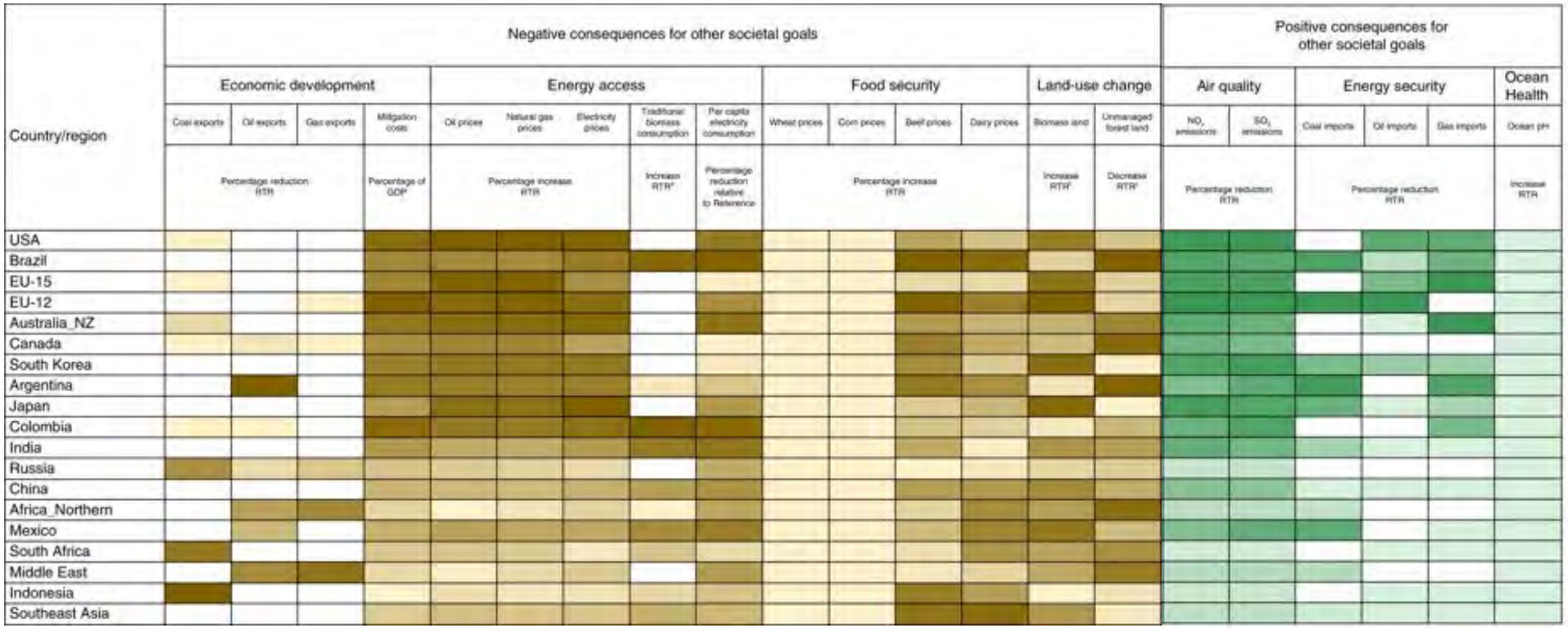
Asian Sustainable Development Implications of Climate Change Mitigation Scenario

Shinichiro Fujimori in prep.
Authors to be determined

Introduction

- Paris Agreement
  - ✓ → long-term climate goal: well below 2 degree
  - ✓ Negative or zero emissions are needed in the latter half of century
- Climate change mitigation actions can have various effects
  - ✓ SDGs implications?
- Asia occupies large share in economy and emissions
  - ✓ 40% of emissions come from Asia in 2010

Earlier studies



- Implications of sustainable development considerations for comparability across nationally determined contributions
- NDCs are assessed

Iyer et al. (2018)

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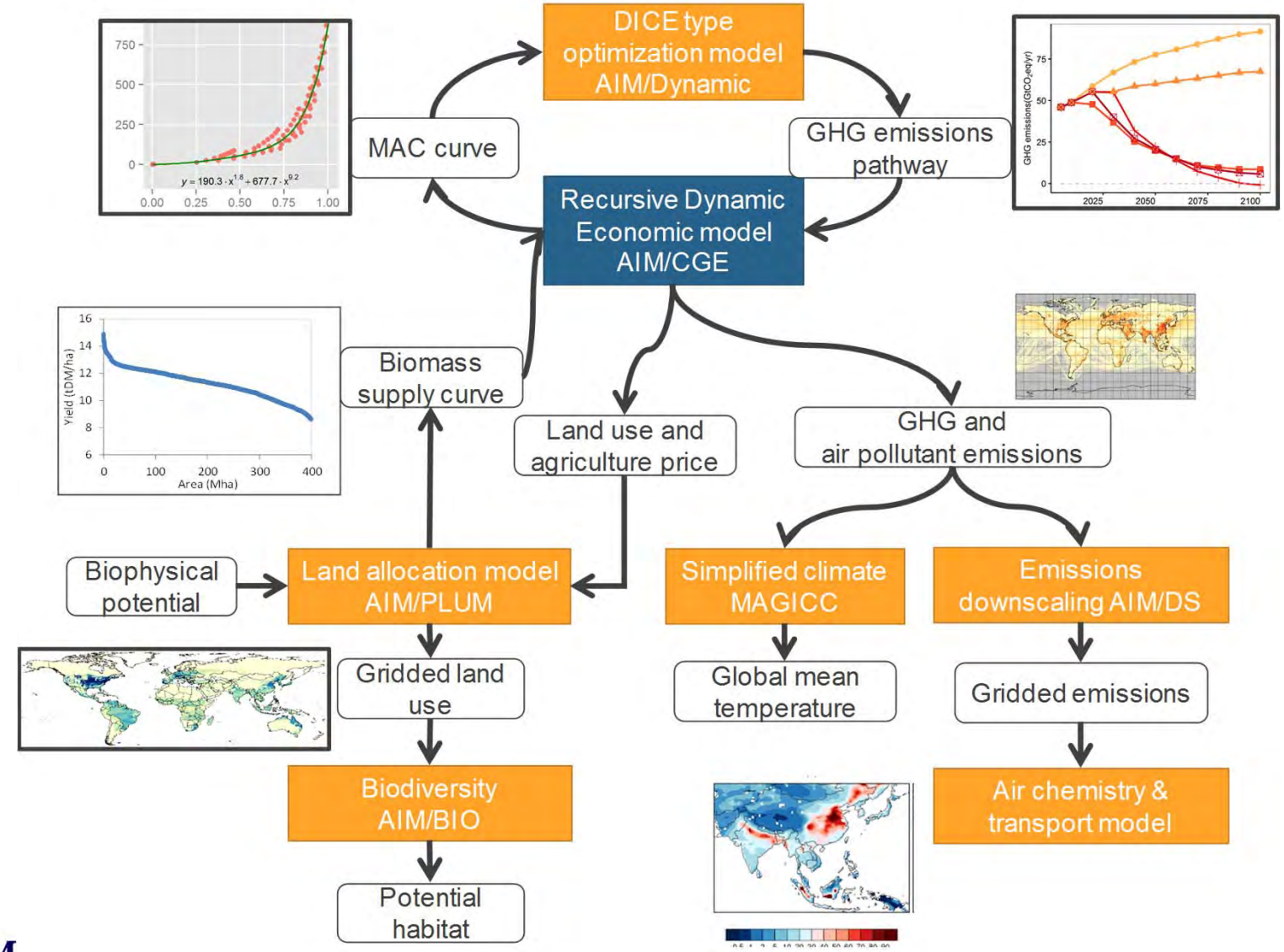
Objectives

- Explore Asian sustainable development pathways by implementing climate change mitigation actions
- Long-term goals are considered
  - ✓ Zero and negative emissions conditions
- Multi aspects are considered

Method



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Indicators

SDGs	Field	Indicators	Unit
SDG2	Hunger	Risk of hunger (2.1) Food price index	Population No unit
SDG3	Health	Number of deaths caused by air pollution (3.9.1)	Population
SDG6	Water	Number of population under water stress (6.4.2)	Population
SDG7	Energy	Renewable energy share in the total final energy consumption (7.2.1) Energy intensity	Ratio GJ/$
SDG8	Labor	Unemployment rates (8.5.2)	%
SDG9	Economy	GDP Manufacturing value added as a proportion of GDP (9.2.1)	2005US$/year Ratio
SDG12	Consumption	Food waste (12.3.1)	Mt/year
SDG15	Life on land	Forest area Mean species richness (Biodiversity index)	Area No unit

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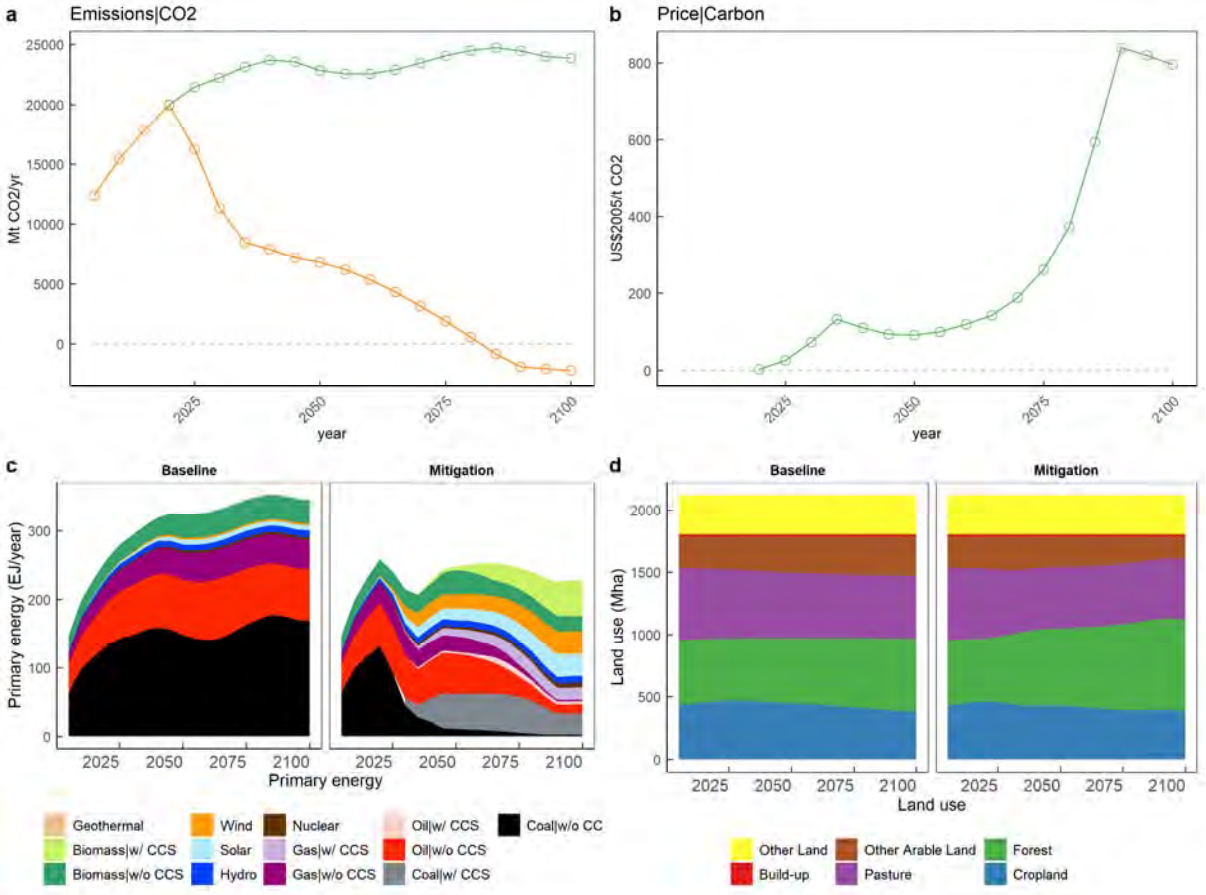
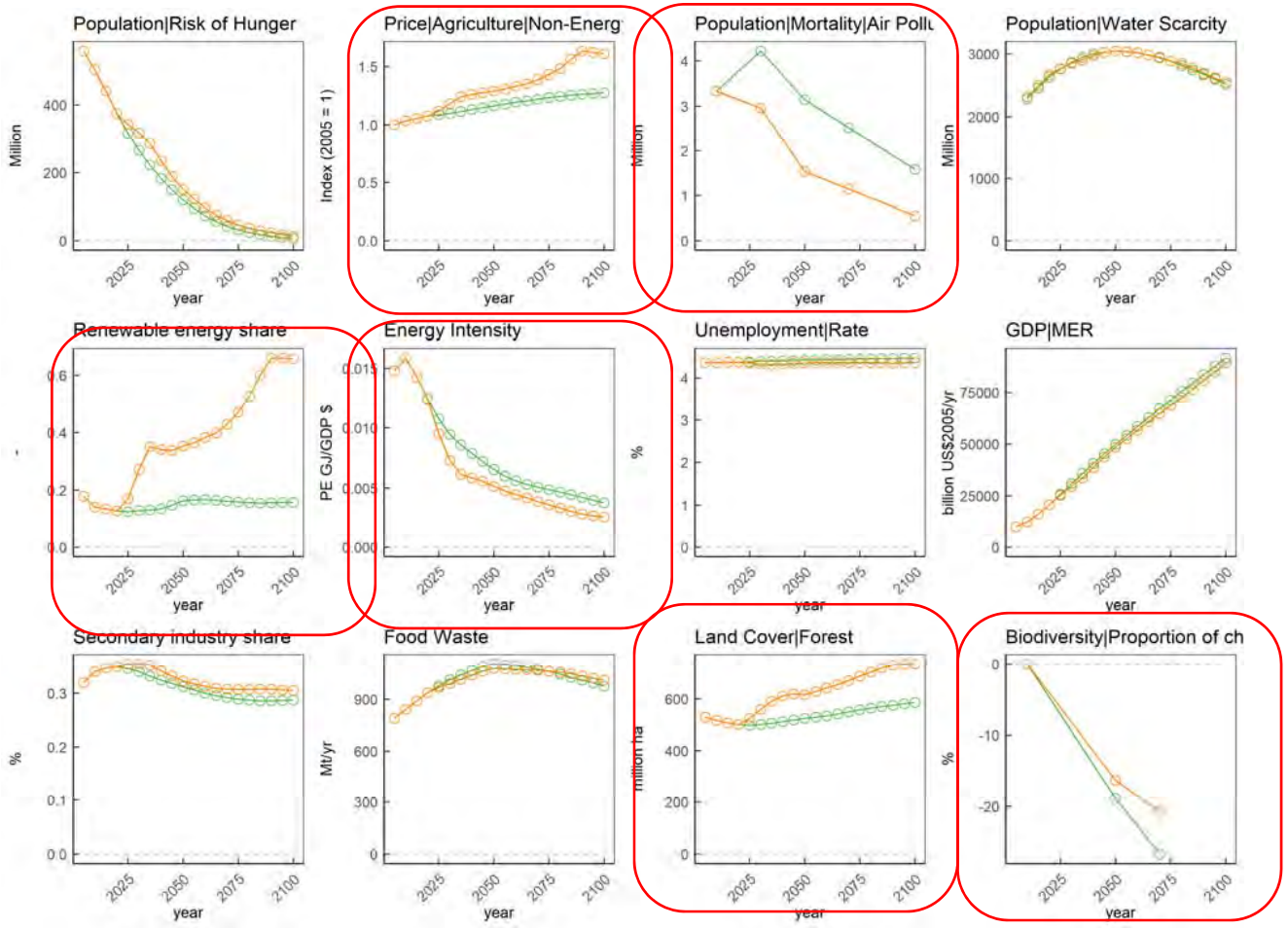
Model revisions

- AIM/CGE Model
  - ✓ Employment rate
    - ➢ Simple wage unemployment function is implemented
  - ✓ Food loss and waste generation
    - ➢ Generation factors through supply chain and consumption stages are taken from a FAO report
    - ➢ Low countries: relatively larger waste in production and storage
    - ➢ High countries: relatively larger waste in consumption phase
  - ✓ Water consumption representation
- Water scarcity assessment
  - ✓ Relatively simple method without hydrological process
  - ✓ H08 run-off data is used
- AIM/BIO integration with AIM/CGE and AIM/PLUM

Results – main features of the mitigation scenario



Results – multi aspects



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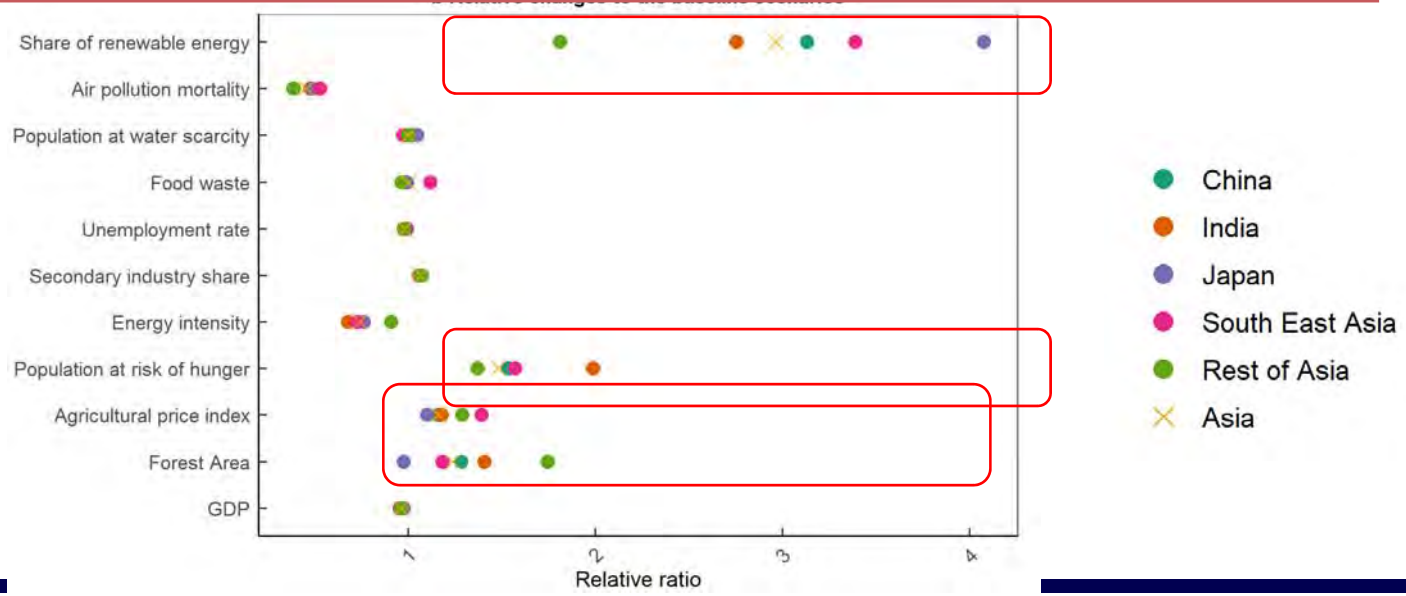
Results – regional implications: relative changes in the mitigation scenario to the baseline

- Renewable energy share varies
  - ✓ Japan changes drastically (from 10% to 50%)
  - ✓ Low in rest of Asia partly due to traditional biomass
- Population at risk of hunger
  - ✓ India : increases due to the climate policy
- Food price and forest area show relatively large variation
  - ✓ Land-use related
  - ✓ Dependent on carbon stock, land rent and emissions
  - ✓ Low income countries are relatively sensitive
- Air pollution are basically benefited
- Energy intensity
  - ✓ All countries with variations



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Discussions

- Many benefits in climate change mitigation, which would enhance the achievements of some SDGs.
  - ✓ Air pollution
  - ✓ Energy: Renewable energy and Energy intensity
  - ✓ Forest area
  - ✓ Employment (small)
- Meanwhile, there are also trade-offs between climate change mitigation and other SDGs
  - ✓ Agricultural related indicators (hunger, prices and biodiversity)
  - ✓ GDP (small)

Discussions

- Asian uniqueness
  - ✓ Mostly similar to global results
  - ✓ Some differences
    - ➢ Population at risk of hunger and air pollution mortality
    - ➢ Share of renewable energy
- Regionally varied in Asia
  - ✓ Relative changes to current and baseline scenarios
- Land related indicators are dependent on the agricultural conditions like price, land rent and national food policy
  - ✓ To better understand how to resolve the trade-offs of climate change mitigation, we need more elaboration

Conclusions

- This study explores Asian sustainable development pathways
- Special focus on the effects of climate change mitigation
- Co-benefits and trade-offs are confirmed
- Asia shows almost similar picture to the global one
- Land-related indicators varied across countries

Earlier studies (2)

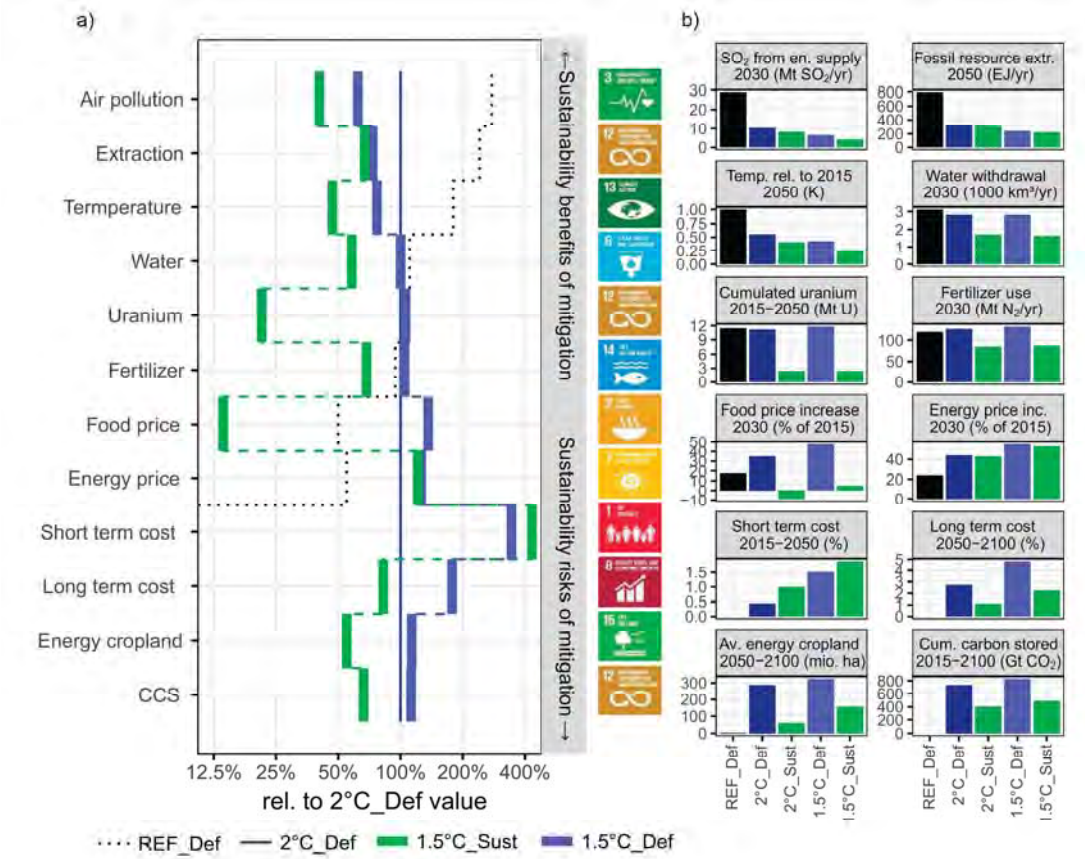

Figure 2. Comparative analysis of both policy approaches and long-term targets. Sustainability indicators for 2 °C and 1.5 °C scenarios with mitigation-only policy (Def) and combined sustainability policy package (Sust). Panel (*a*) shows values relative to the 2 °C_Def scenario in logarithmic scale, panel (*b*) shows the absolute values for all five main scenarios and additionally indicates the time/time-span shown. All values are global totals or averages. Indicators are arranged such that the most pronounced sustainability benefits of mitigation sit on top, and the most severe sustainability risks at the bottom. This ranking is based on the relative values, and does not imply a normative weighting of the different dimensions which can only emerge from broad public deliberations. Please note that the 2 °C_Sust scenario is only shown in panel (*b*), in order to provide a clear overview in panel (*a*). A version of panel a including 2 °C_Sust is provided as supplementary figure S2.

- 1.5 degree is assessed
- Additional policies are taken into account

Bertram et al. (2018)

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Earlier studies (3)

Table 8
Synergies and trade-offs between different objectives (as covered in this study). Colours indicate synergies (green) and trade-offs (red).

	Eridicate hunger	Halting biodiversity loss	Access to energy	Reduce air pollution	Mitigate climate change	Access to clean water	Balance nitrogen cycle
Eradicate hunger					More emissions from increased production (fertliser, land expansion, tractors) (*)	Increased water use for agriculture (*)	More emissions from increased production (fertliser, manure) (*)
Halt biodiv. Loss	Less land for food production (*) Preservation of ecosystem services helps safeguard long-term food supply			Intact ecosystems contribute to better air quality	Fewer CO_2 emissions from land conversion and agriculture, new CO_2 sinks (*)	More gradual and uniform water flow, cleaner water Increased water use by permanent vegetation	More contribution of ecosystems in balancing nitrogen cycle
Access to energy	Increases income opportunities due to reduced time for fuel collection, better health.	Less disturbance of local biodiversity for food collection		Less indoor and urban air pollution (*)	New emissions from modern energy offset by reduced traditional energy emissions (*)	Water requirement for power generation (small) (*)	
Reduce air pollution	Less negative impact of air pollution on crop yields	Less air pollutions impacts on biodiversity (*)	Higher energy prices		Depends on which air pollutants are reduced (*).	Less water pollution	Helps to reduce nitrogen deposition (*)
Mitigate clim. Change	Reduces negative impacts on yields (but also positive impacts) (*) Bio-energy competes for land with food production	Reduces negative impacts of climate change (*) Additional land for bio-energy (*)	Higher energy prices (*)	Less emissions of air pollutants due to lower fossil fuel use (*)		Negative impacts on precipitation patterns and evapotranspiration reduced (*)	Some positive impact N_2O emission reduction (*)
Access to clean water	Improved water for cooking Competition between agriculture and domestic purposes						
Balance nitrogen cycle	Reduction of fertilizer use (but also prevents toxic fertilizer levels)	Reduces pollution		Reduces air pollution	Some reduction of N_2O emissions		

Note: * denotes that the linkages is addressed quantitatively by the modelling framework.

Van Vuuren et al. (2015)

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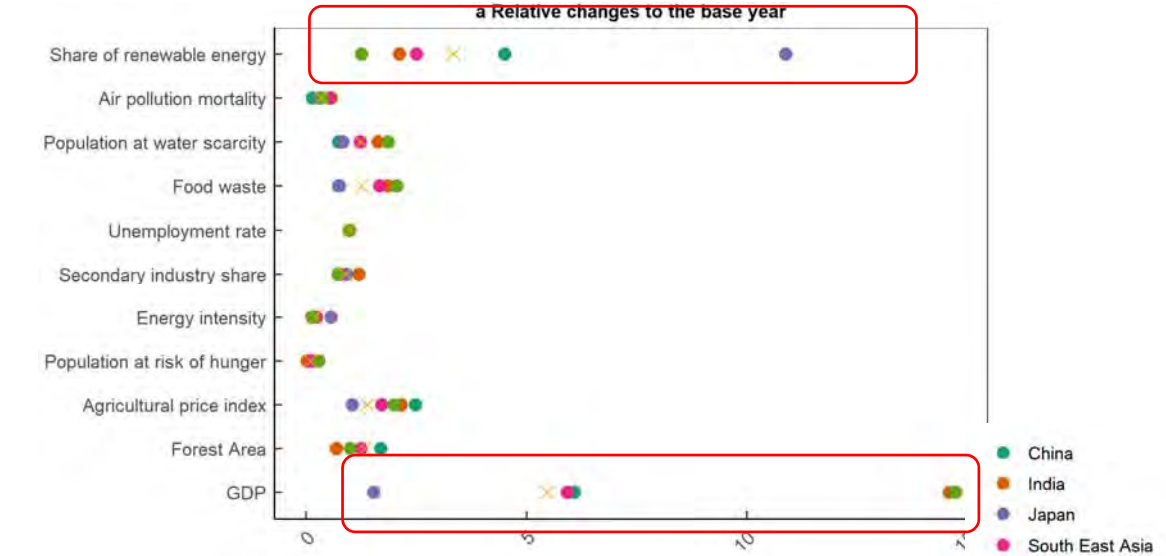
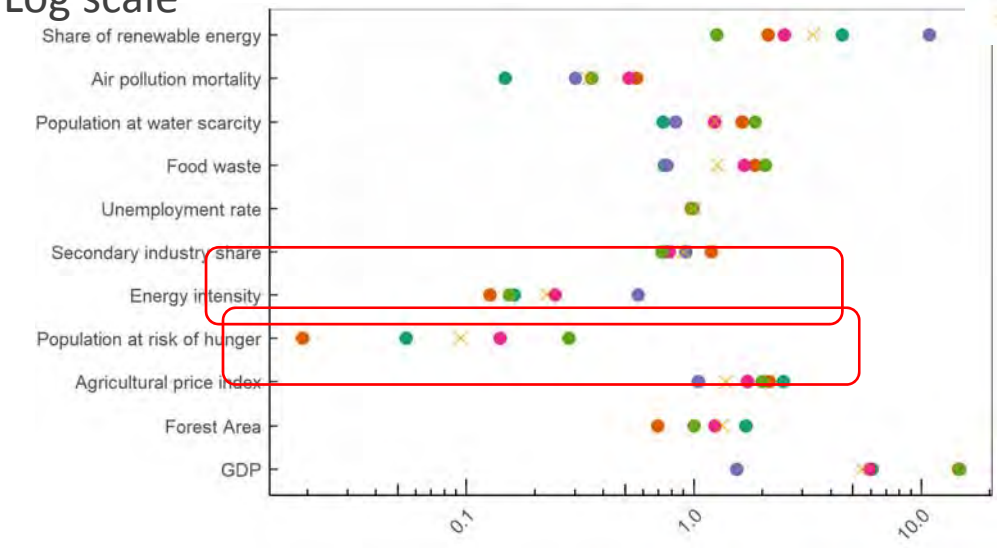
Results – regional implications: relative changes in the mitigation scenario to the base year

- Renewable energy share varies
  - ✓ Japan changes drastically (from 5% to 50%)
  - ✓ Low in rest of Asia partly due to traditional biomass
- GDP depends on the assumptions
- Population at risk of hunger
  - ✓ India shows drastic decreases
- Energy intensity
  - ✓ Japan shows less changes while other regions do more
  - ✓ Dependent on the autonomous energy efficiency assumptions

Absolute



Log scale



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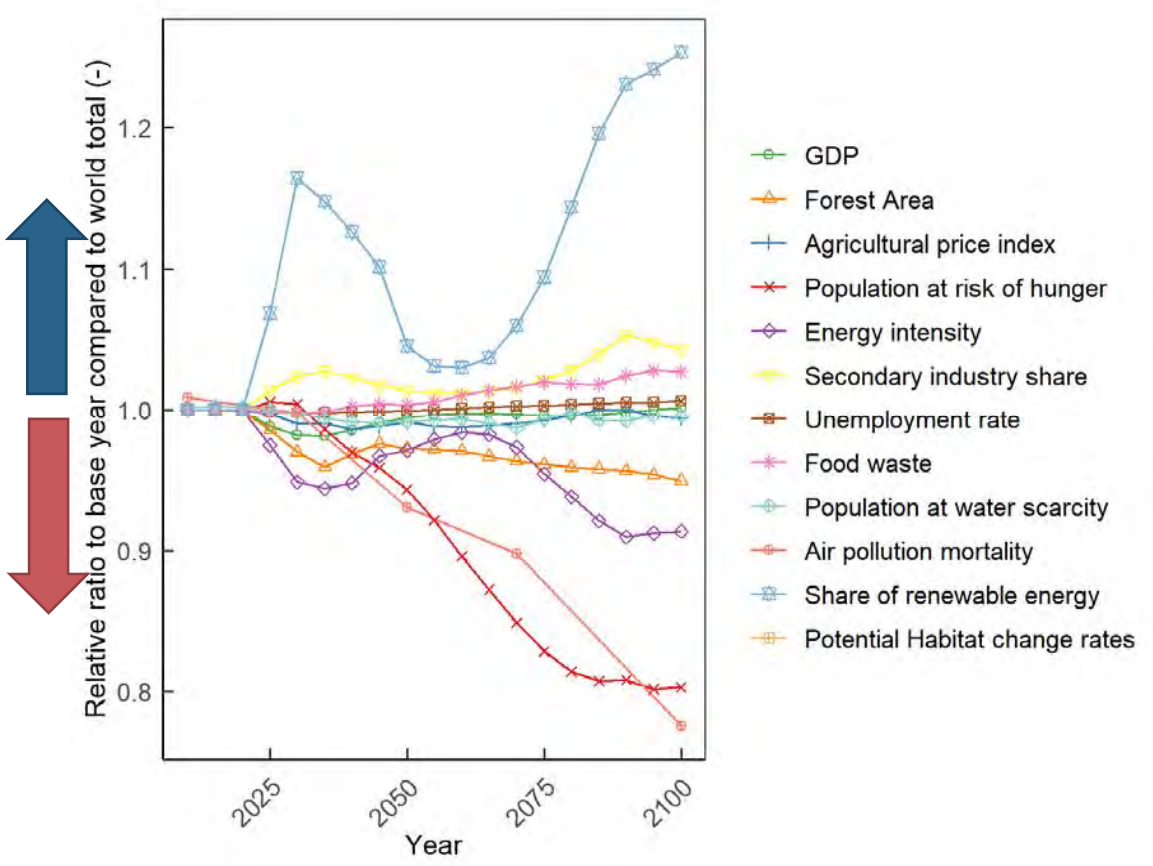
Results – comparison with the global results

$$IndexAsia_{t,i} = \frac{X_{t,i,\text{"Asia","mitigation"}}}{X_{t,i,\text{"Asia","baseline"}}}$$

$$IndexWorld_{t,i} = \frac{X_{t,i,\text{"World" "mitigation"}}}{X_{t,i,\text{" World" ," baseline"}}}$$

$$\text{Displayed Index}_{t,i} = \frac{IndexAsia_{t,i}}{IndexWorld_{t,i}}$$



- Large in Asia than the world
  - ✓ Renewable energy share
  - ✓ Secondary industry share
- Small in Asia than the world
  - ✓ Population at risk of hunger
  - ✓ Air pollution mortality

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