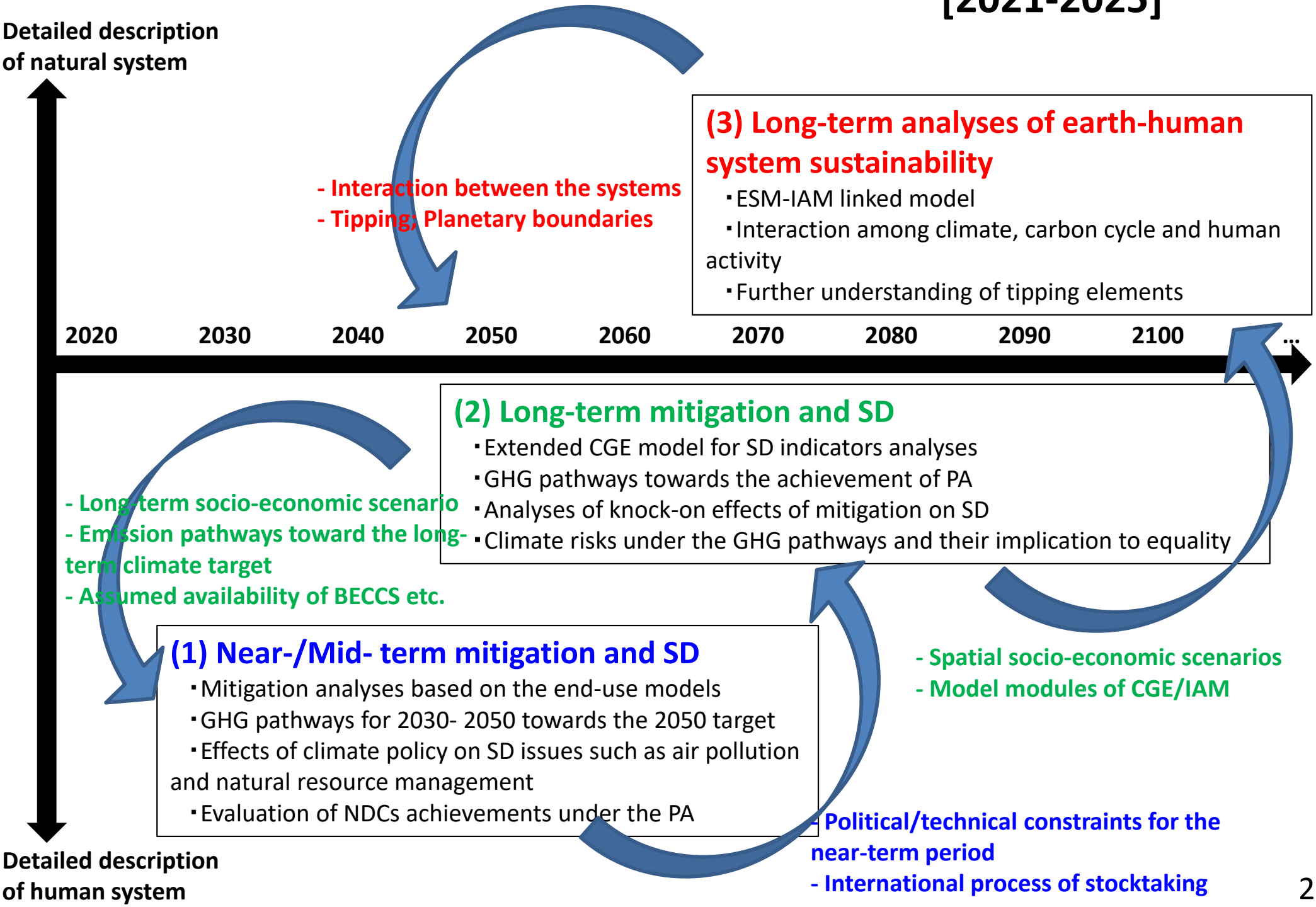
Global Model Studies in AIM

Kiyoshi Takahashi

The 28th AIM workshop @ NIES [Online]

14 September 2022

Global analyses of decarbonization and sustainable development [2021-2025]



On-going projects on the AIM global model

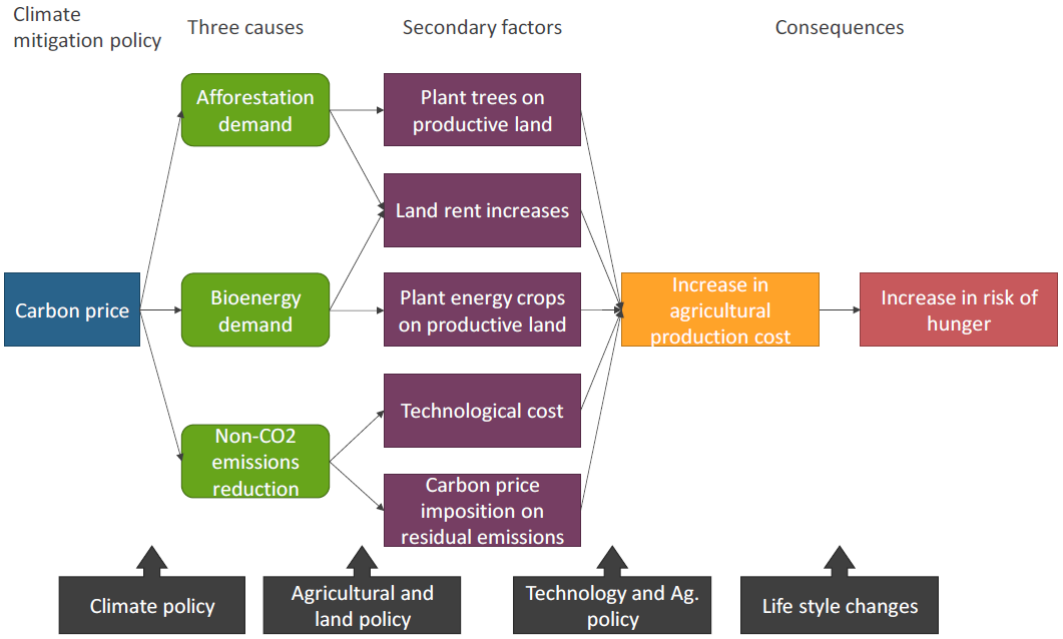
- Funded by Ministry of Environment
  - 2-2002: Global analyses of climate mitigation for achieving net-zero emissions and sustainable development (Takahashi)
  - 1-2101: A Study on global decarbonization pathways considering technological, economic and social feasibility (Fujimori)
  - S-20-3: Research on mitigation to climate change and environmental impacts caused by short-lived climate forcers (Hanaoka as a theme leader)
  - SII-6-2: Development of global scenario model for effectiveness evaluation of the Minamata Convention on Mercury (Hanaoka as a project member)
- In-kind contribution to internationally coordinated activity
  - ENGAGE: EU horizon 2020 project ended at 2022 Sep. National and global studies and SDGs.
  - ELEVATE: New EU horizon project started at 2022 Sep. More focus on national circumstances.
  - AgMIP: agricultural model intercomparison moving to 4th phase

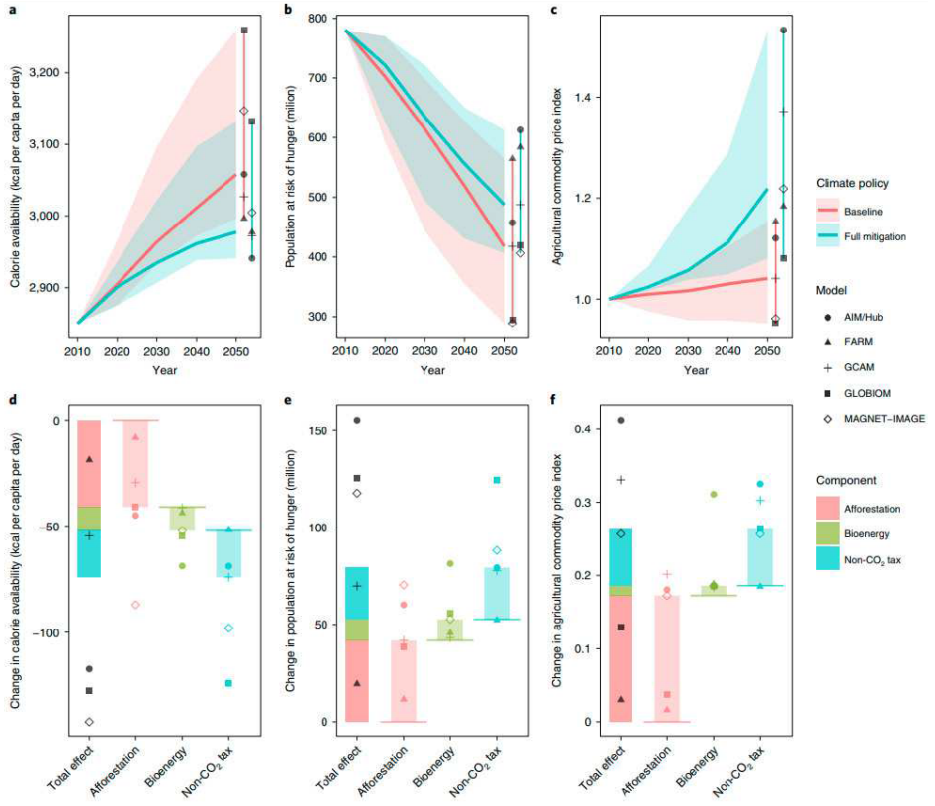
Recent major topics of the AIM's global model study

- Integrated analyses of climate impacts
  - Economic loss caused by climate impacts (Takakura et al., 2019)
  - Development of climate impacts emulator (Takakura et al., 2021)
- Food security (hunger risk and malnutrition) caused by crop yield change and mitigation policies
  - Impacts of climate policies on food intake and hunger risk (Hasegawa et al., 2018; Fujimori et al., 2022)
  - Impact of change in extreme climate on hunger risk (Hasegawa et al., 2021)
  - Nutritious implication of dietary change from meat to fish (Xia et al. , in prep)
- Interrelationship between climate change and biodiversity
  - Impacts of climate change and climate policy (land-use change) on biodiversity (Ohashi et al., 2019 ; Hirata et al., in prep)
  - Impact of ecosystem conservation on potential renewable energy (Wu et al., 2019; Nyairo et al., 2022)
- Wildfire, air pollution, linkage with ESM
  - Climate impacts on wildfire and its implication on human health (Park et al., 2021; Park et al., in prep.)
  - Operational application of GEOSChem and linkage with other models (Jansakoo et al, in prep.)
- Social issues
  - Climate policies and income distribution using AIM/PHI (Fujimori et al., 2021)
- Climate and SDGs
  - Side effects of climate policies on the SDGs indicators (Fujimori et al, 2020; Liu et al., 2021; Zhao et al., 2022)
- Global energy technology models
  - Global mitigation analyses considering new technologies (hydrogen, ammonia, synfuel) using AIM/Technology (Oshiro and Fujimori, 2022)
  - Global mitigation analyses using AIM/Enduse[Global] (-> Dr. Hanaoka's talk on SLCFs and Decarbonization in Asia; Hanaoka et al., under review)

Decomposition analyses of impacts of climate policies on food security (AgMIP output)

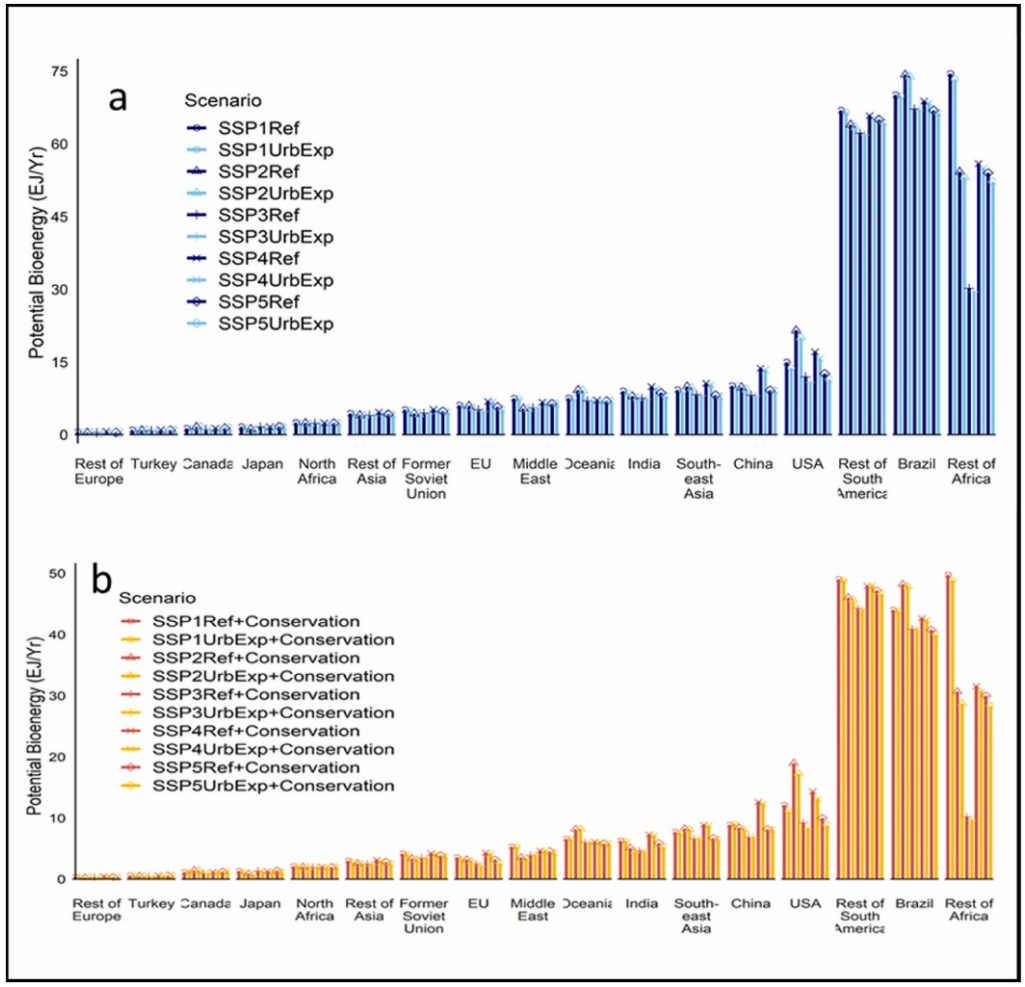
Using six global agroeconomic models, we showed the extent to which three factors—non-CO_2 emissions reduction, bioenergy production and afforestation—may change food security and agricultural market conditions under 2 ° C climate-stabilization scenarios.
Results showed that afforestation (often simulated in the models by imposing carbon prices on land carbon stocks) could have a large impact on food security relative to non-CO_2 emissions policies (generally implemented as emissions taxes).



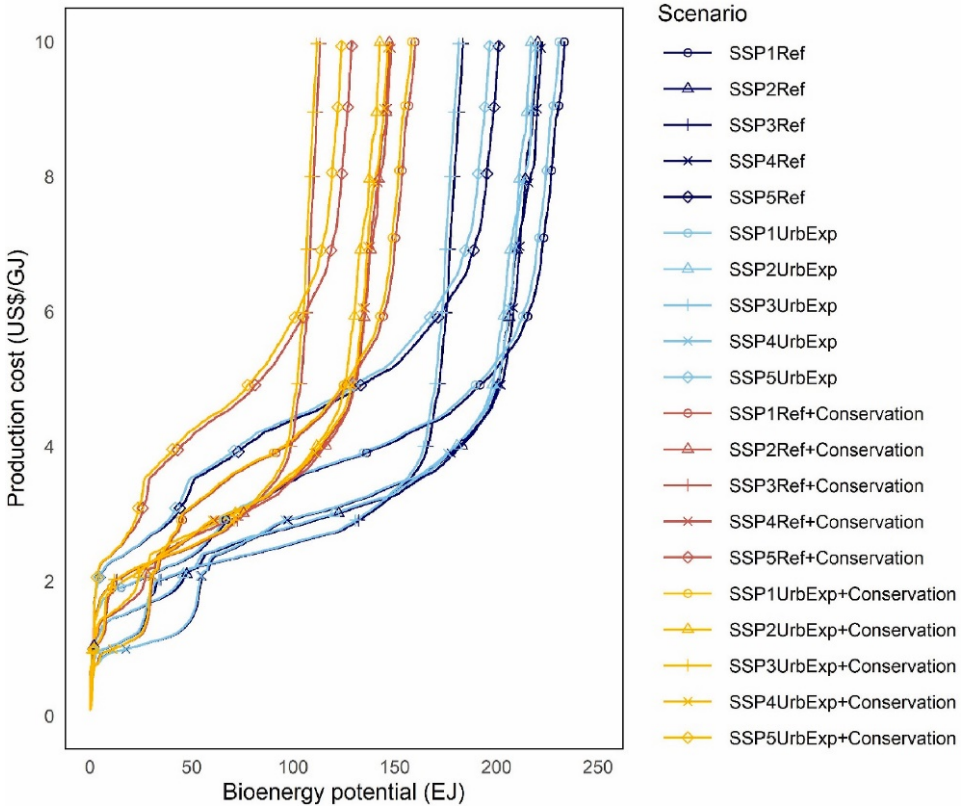


Fujimori, Wu and et al. (2022) Nature Food

Socio-economic trajectories, urban area expansion and ecosystem conservation affect global potential supply of bioenergy



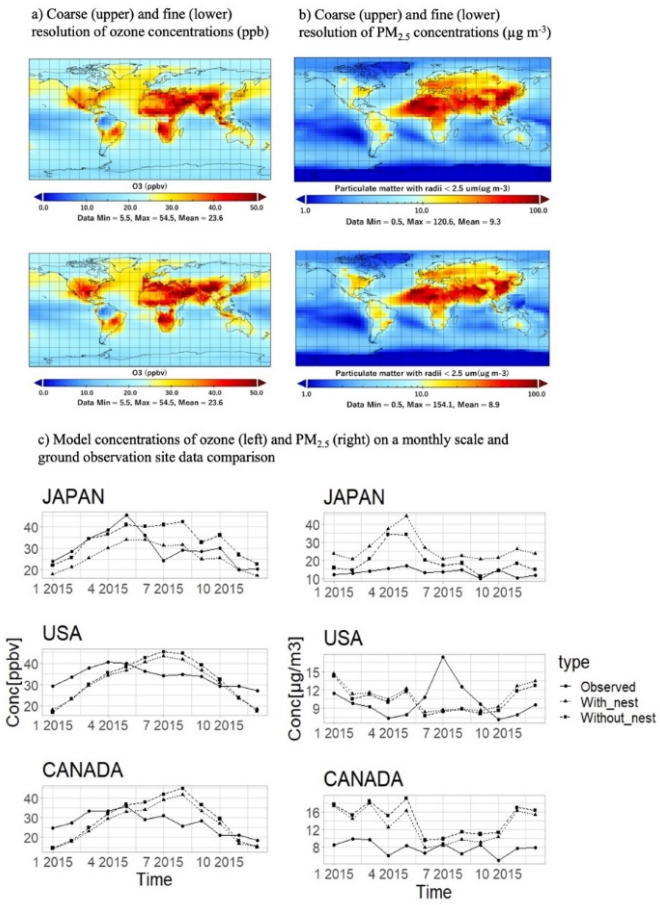
Risper et al. (2022) Biomass and Bioenergy



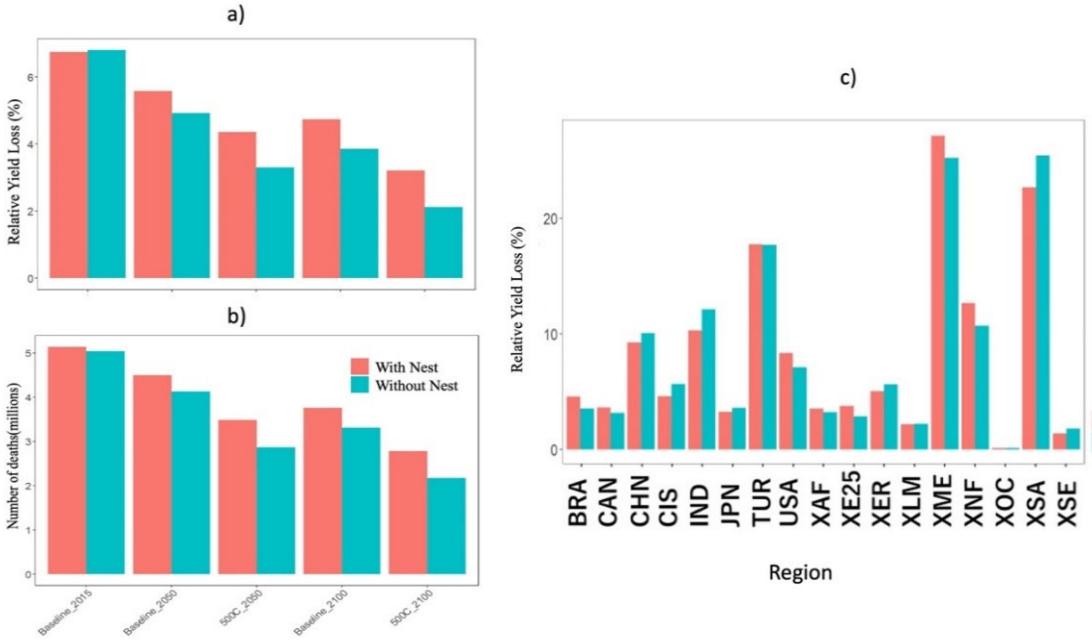
- Highlights
  - A sustainable socio-economic pathway yields the highest bioenergy potential.
  - Urbanization impact insignificant at global but more pronounced at regional level.
  - By shrinking land area, ecosystem conservation severely impacts bioenergy potential.

Air pollution study new possibility

Operational application of GEOSChem and linkage with other models



Comparison with observation by monitoring stations



Health and yield changes

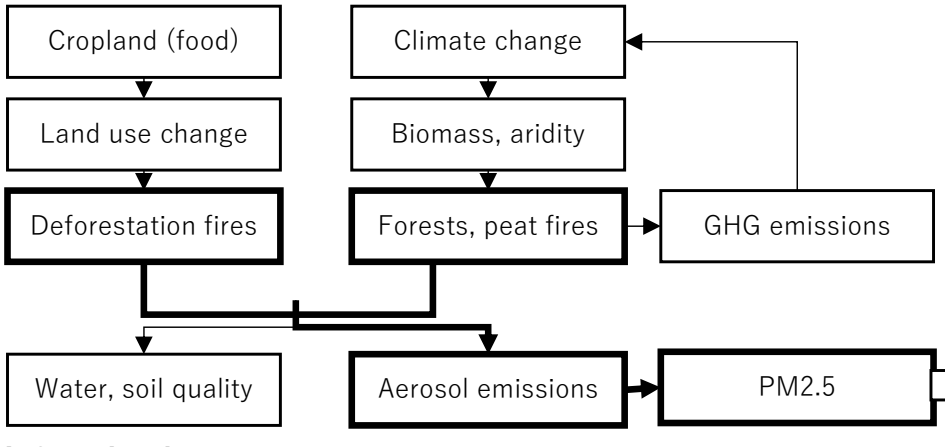
- Many more interesting topics would be raised where we can take an advantage of being operated by a global IAM team
- Interaction with climate and air pollution

Jansakoo et al. (in prep)

Climate and Socioeconomic Impact on Fire PM2.5 Mortality

land use change for **cropland (food)** on deforestation fires

Carbon cycle in soil-vegetation-atmosphere



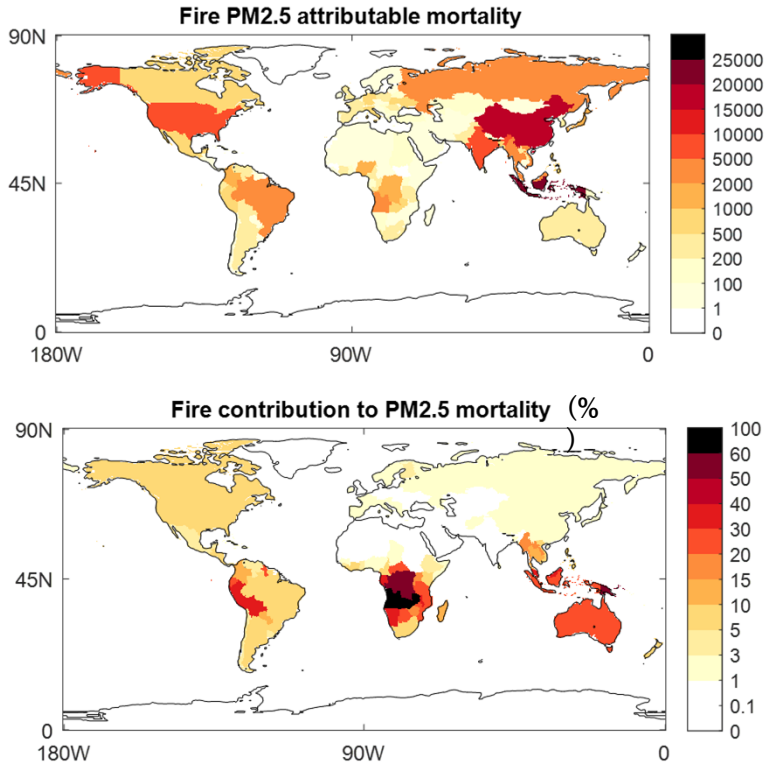
Life in land, water, and sanitation

Health and well-being

(Martin et al., 2019)

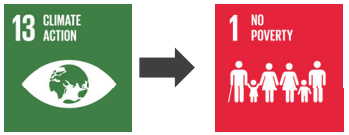
Health and well-being

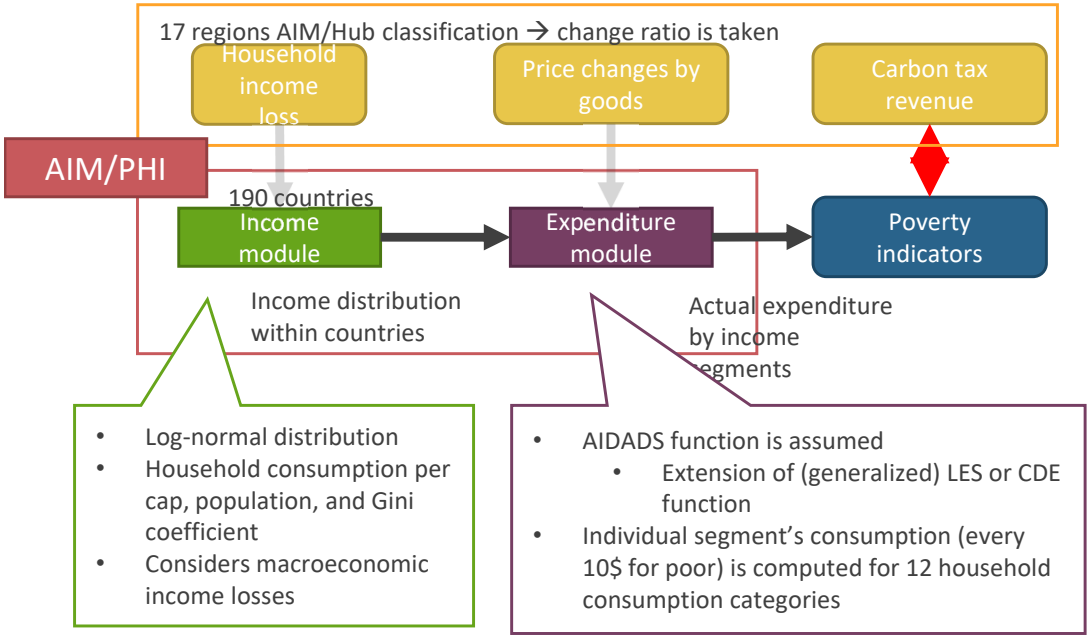
About 100,000 people are died due to fire driven PM2.5. Fire-PM2.5 mortality has severe inequality by country because fire contribution is higher in Africa and equatorial Asia.

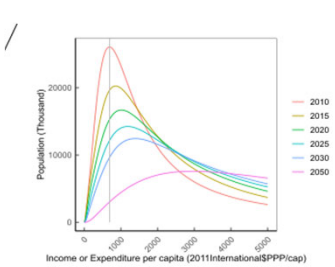


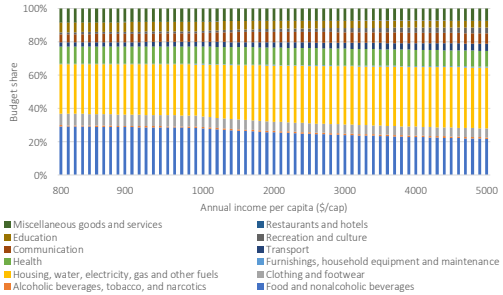
Park et al. (in prep)

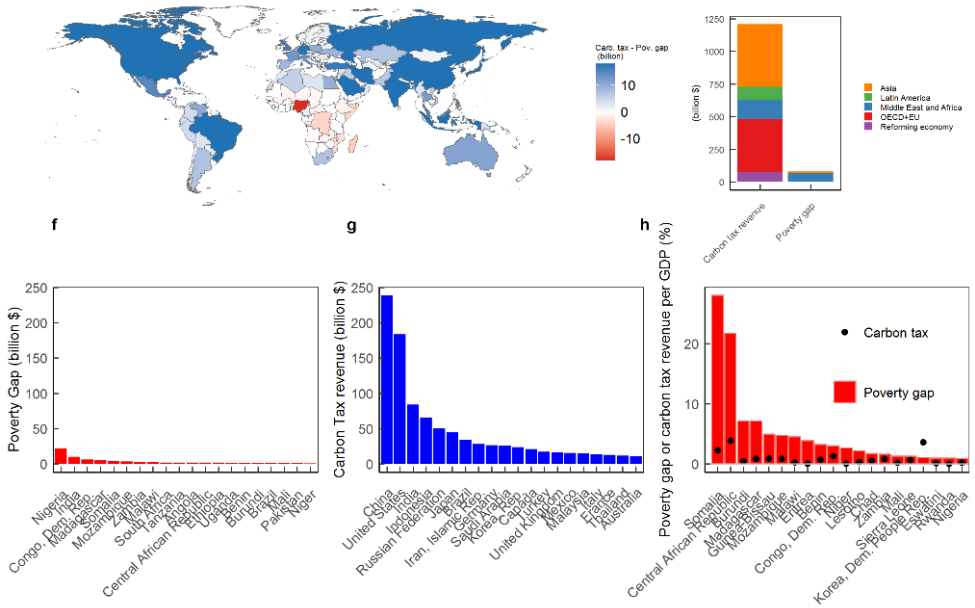
Country-wise poverty gap and carbon tax comparison (bil. $)











- Carbon tax is much larger than poverty gap
- Small potion of carbon tax via International transfer might help poverty eradication

Fujimori et al. (2020) *Environ. Resear. Lett.*

Another example of synergy/tradeoff analysis - CO_2 vs Hg -

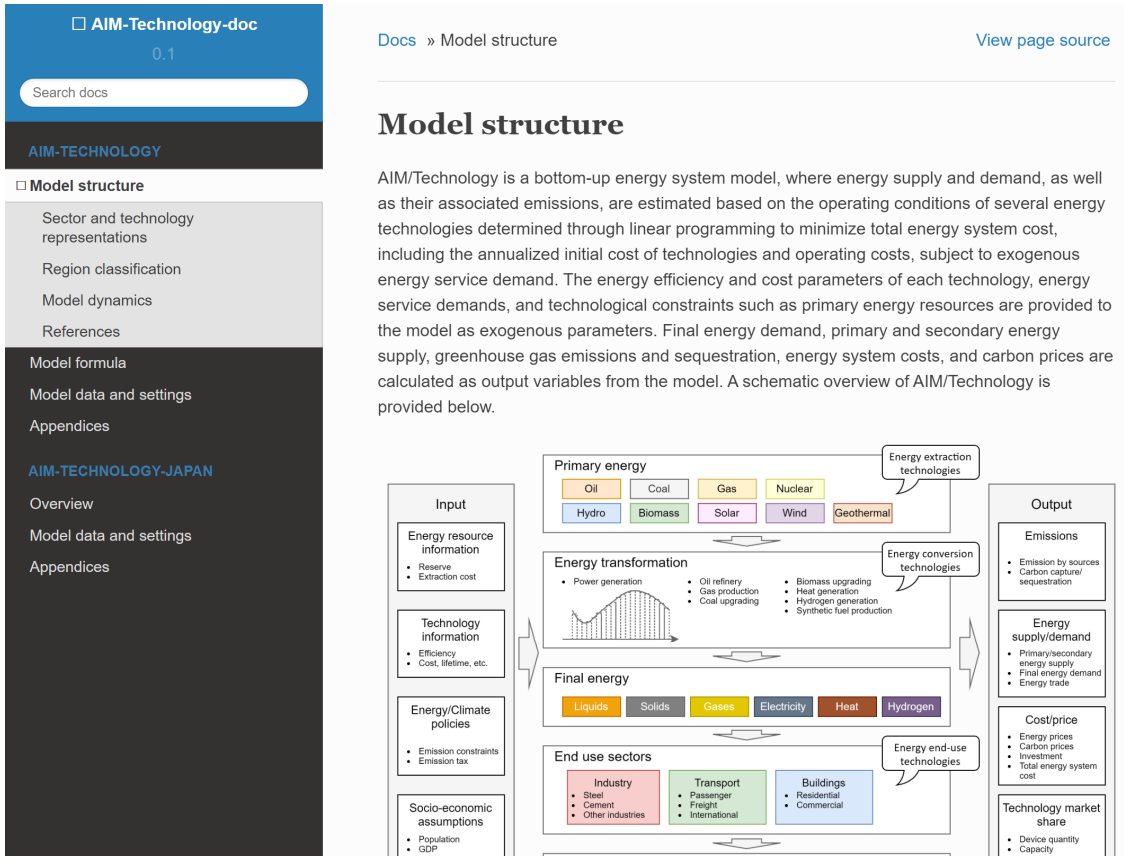
a) **Low-carbon scenario (toward 2℃ target)**

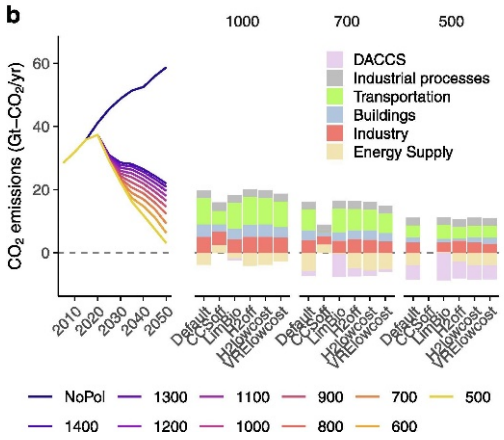
b) **Carbon-neutrality scenario (toward 1.5℃ target)**

Figures are deleted for avoiding copyright issues.

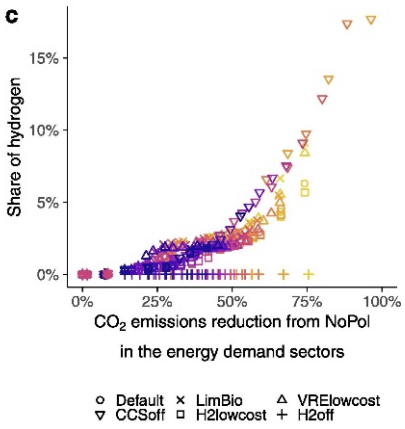
Hanaoka, T., Nakajima, K., … ..Takaoka, M. (Under review) *Resources, Conservation and Recycling*

Energy system model [AIM/Technology]





GHG



CO2 reduction and hydrogen-based energy (inc. synfuel)

- Hourly resolution in power demand-supply
- New technologies (hydrogen, ammonia, synfuel)
- More advancement will come out!!

Oshiro and Fujimori (2022) *Applied Energy*

Intended outcomes of the global study in AIM

- Provision of objective evidences and views on long-term targets and policies at global scale (to policymakers as well as to public citizens)
  - Communication of uncertainties
- Provision of boundary conditions for regional/national /local policy analyses
- Improved comprehensive understanding of global risks and proposition of potential strategies for managing them.
  - Linking multiple disciplines for not overlooking important interrelations and feedback effects
- Contribution to science via publications, especially assessed by IPCC
  - International model intercomparison projects for methodological sophistication and frontier progress
  - Maintenance of research infrastructure such as the development of SSPs

Last year's AIM national activity outcome
→ IAMC level community activity (SWGs on national scenarios)

nature climate change

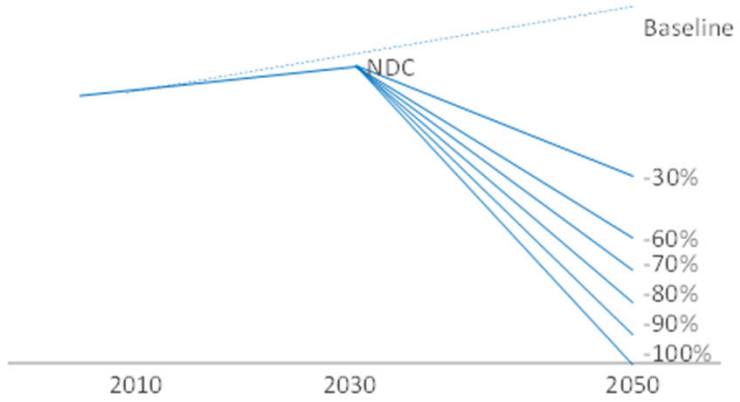
PERSPECTIVE

https://doi.org/10.1038/s41558-021-01048-z

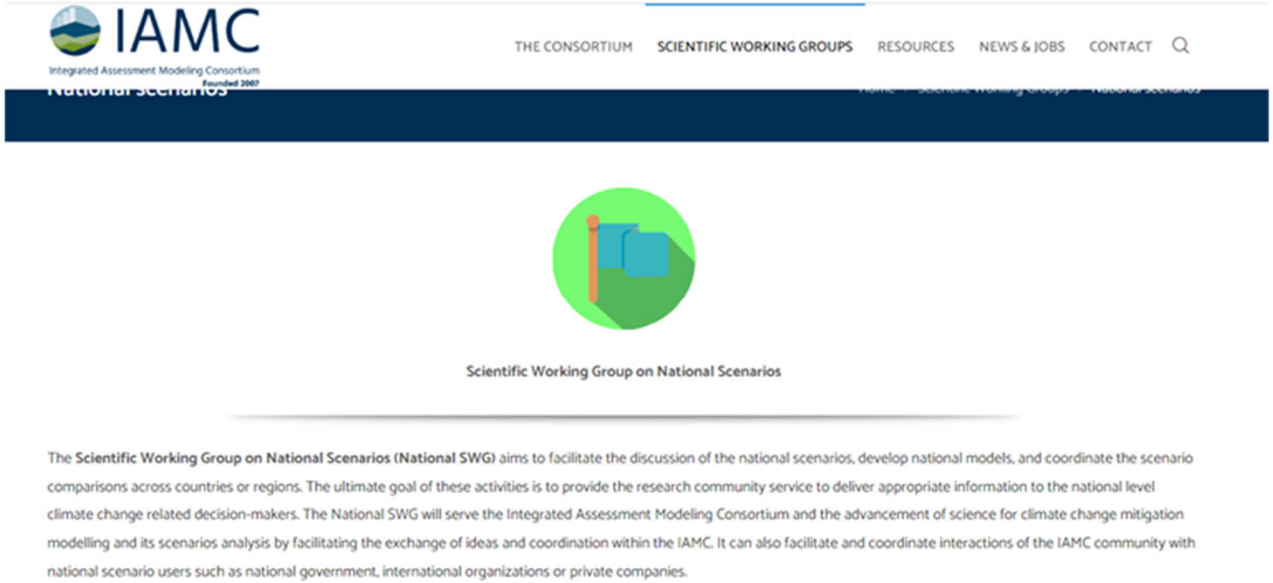
Check for updates

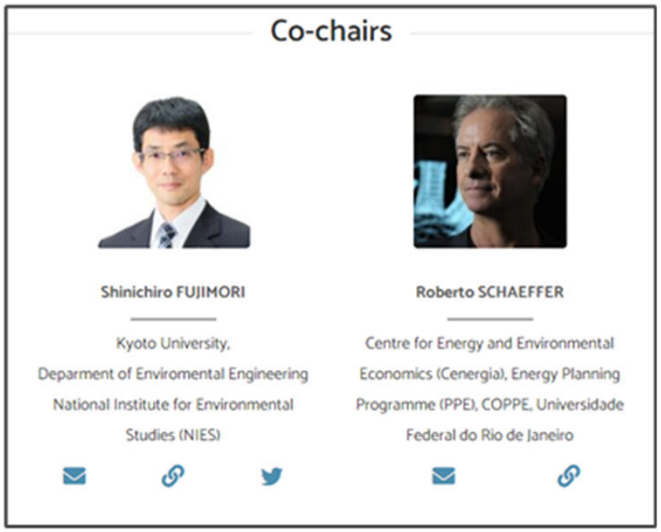
A framework for national scenarios with varying emission reductions

Shinichiro Fujimori[1,2,3] ✉, Volker Krey[3], Detlef van Vuuren[4,5], Ken Oshiro[1], Masahiro Sugiyama[6], Puttipong Chunark[7], Bundit Limmeechokchai[7], Shivika Mittal[8,9], Osamu Nishiura[1], Chan Park[10], Salony Rajbhandari[7], Diego Silva Herran[2,11], Tran Thanh Tu[12], Shiya Zhao[1], Yuki Ochi[13], Priyardarshi R. Shukla[9], Toshihiko Masui[2], Phuong V. H. Nguyen[14], Anique-Marie Cabardos[3] and Keywan Riahi[3,15]



1. We proposed a standardized set of scenario framework for national scenarios
2. Enhance the international community to centrally coordinate the national scenarios to keep the comparability among nations





Good news: Prof. Fujimori was awarded the IAMC Award for Extraordinary Contributions to the field of IAM in 2021

Global model study in AIM
- Missing elements / Research gaps -

- Improved consideration of social aspects
  - Economic growth and development
  - Inequality
  - Conflicts and migration
- More comprehensive analyses of human health
- Further integration with biodiversity studies
- More consistency between spatial scales
- Contribution to the integration phase of the SSP-RCP framework
  - Unconsidered feedbacks between climate policies, climate impacts and development