The **20th (!)** AIM workshop
23-24 January 2015: Tsukuba

Recent activities of NIES AIM/Impact team and global climate risk analyses

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Topics

- Research projects and international collaboration
- Introduction to ICA-RUS project (ERTDF S-10 project; Study on global climate risk management strategies)
- Adaptation analyses at global scale

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Ongoing research projects on impacts and adaptation

NIES Climate Change Research Program

- Project 2: Climate change and global risk assessment [Takahashi, Hijioka, Hanasaki, Masaki, Su, Tanaka; 2011.4-2016.3]

The Environment Research & Technology Development Fund (ERTDF) funded by the MoE, Japan

- S-10: Integrated research on the development of global climate risk management Strategies [Takahashi, Hanasaki, Hijioka, Su, Tanaka; 2012.4-2017.3]
- S-8: Comprehensive research on climate change impact assessment and adaptation policies [Harasawa, Hijioka, Hanasaki, Takahashi; 2009.4-2014.3]
  - Assessment of climate change impacts in Japan considering feasibility of realizing a safe and secure climate change adaptive society

Contribution to international academic activities

- **Agricultural Model Inter-comparison and Improvement Project (AgMIP)** [Fujimori, Hasegawa, Masui, Takahashi]
- **Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP)** [Hanasaki, Masaki]
- **Impacts and Risks from High-End Scenarios: Strategies for Innovative Solutions (EU-IMPRESSIONS)** [Takahashi, Hanasaki, Masui]
- **IPCC**
  - AR5 (WGII)
    - LA of Ch. 19 (Emergent risks and key vulnerabilities) [Takahashi]
    - CLA of Ch. 24 (Asia) [Hijioka]

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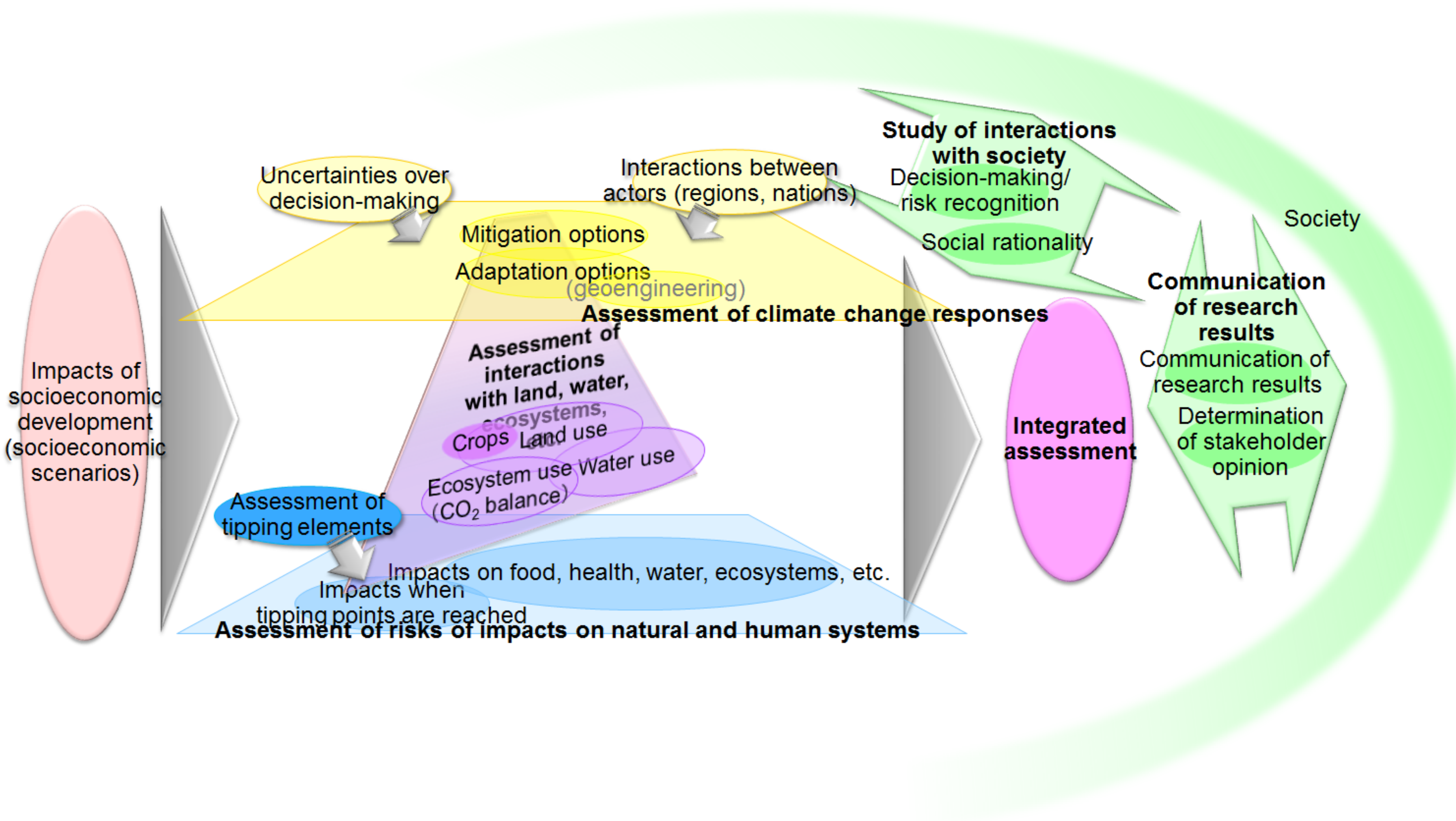
ICA-RUS (FY2012-16)

Integrated Climate Assessment – Risks, Uncertainties and Society

- Objective
  - To propose strategies of global climate risk management
- ‘Integration’ in ICA-RUS
  - Coherent consideration of mitigation and adaptation for managing global climate risks
- Risk management in ICA-RUS
  - Comprehensive assessment of climate change risks
  - Explicit consideration of uncertainties
  - Consideration of every possible options

2nd annual report of the project (English version) published in Sep. 2014.
http://www.nies.go.jp/ica-rus/en/index.html

Overview of the ICA-RUS research activities



3 Steps for developing risk management strategies in ICA-RUS

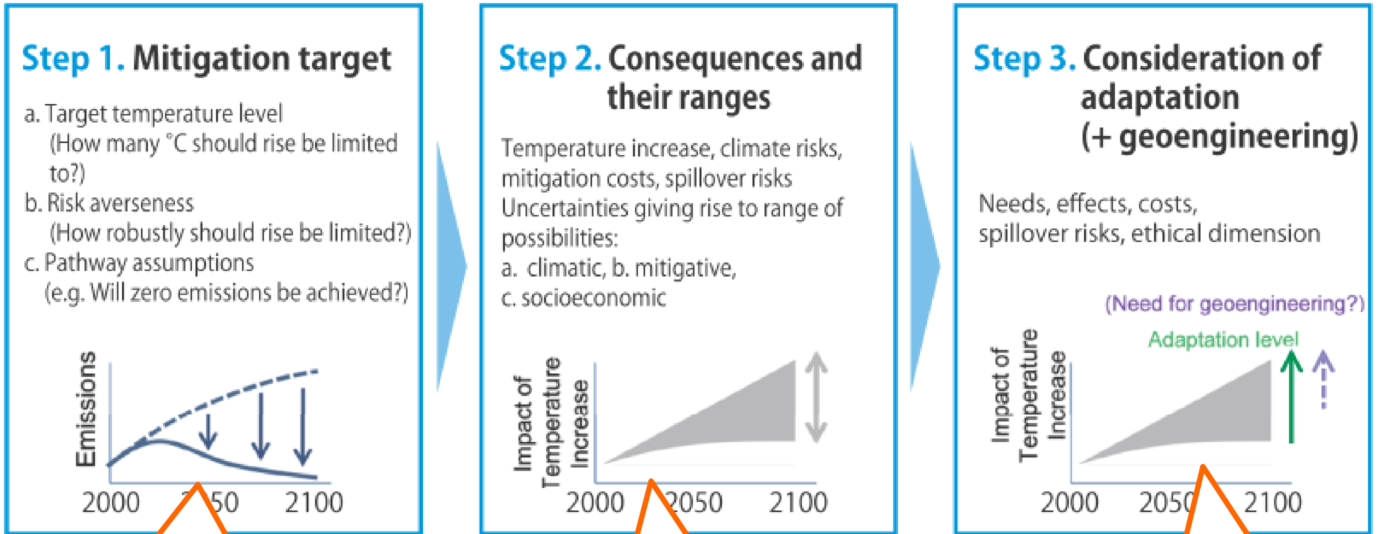


Figure I-1 "Str ... ICA-RUS

Each risk r
choice of r

Mitigation cost and clim
are estimated under the c
mitigation target.

For keeping the climate change risks below the acceptable level, further responses like adaptation or geoengineering are considered.

The mitigation target is defined by target temperature level and risk averseness that is substituted by the assumed climate sensitivity.

Finally, the deliverables from those three steps constitute a risk management strategy.

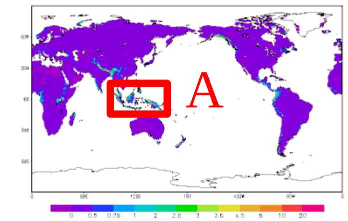
Six risk management strategies examined in the first version due March 2015

Strategy Case Name	GMT target (℃) from pre-industrial	Climate sensitivity assumed in estimating emission pathway (℃)
TG15_CS30	1.5	3.0
TG15_CS45	1.5	4.5
TG20_CS30	2.0	3.0
TG20_CS45	2.0	4.5
TG25_CS25	2.5	3.0
TG25_CS45	2.5	4.5

Impact variables projected for the interim report

Sector	Organization	Impact variables	Data size	Resolution	Period	Scenarios
Agriculture	NIAES	Yield (Rice, Spring wheat, Winter wheat, Maize, Soybean） Production (same as above)	6GB	1.125	2006–2099; Annual	4RCP * 5GCM * 3SSP
Water resource	NIES	River discharge Surface runoff Population with water stress	4GB	0.5	1981–2005, 2001–2099; annual	4RCP * 5GCM * 3 SSP
Terrestrial ecosystem	NIES	NPP/NEP Carbon in biomass Carbon in soil Soil erosion Vegetation fire Nitrogen effuluence	60 GB	0.5	1950–2099; annual	4RCP * 5GCM * 3 SSP
Flood	Tokyo Institute of Tech	Flooded population (100yr-RP) Flooded GDP (100yr-RP)	30 GB	0.5	1980–2099; annual	4RCP * 5 GCM * 3 SSP
Human health	Tsukuba Univ.	Heat stress mortality Malaria incidence Dengue fever incidence	0.5 GB	0.5	1981–2000, 2020s, 2050s, 2080s; decadal mean	4 RCP * 5 GCM * 3 SSP
Ocean	Hokkaido Univ	Anoxic zone	1GB	1.0	1861–2099; annual	4 RCP * 9 GCM

Impacts expected for each risk management strategy

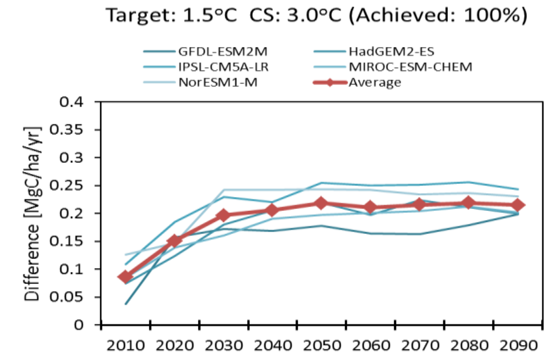


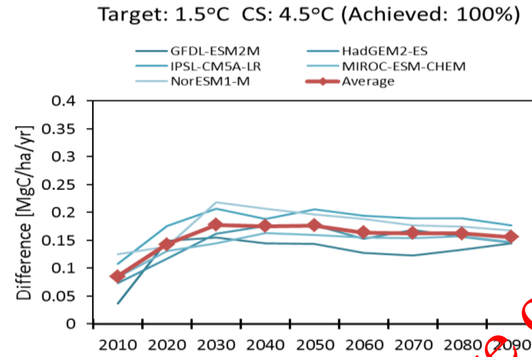
＜Soil erosion＞Area A; SSP3

Assumed CS 3.0℃ 4.5℃

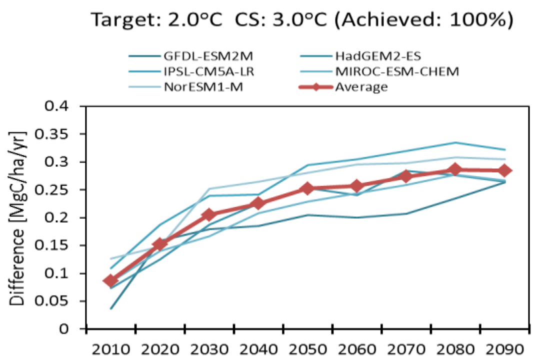
Upper limit of GMT

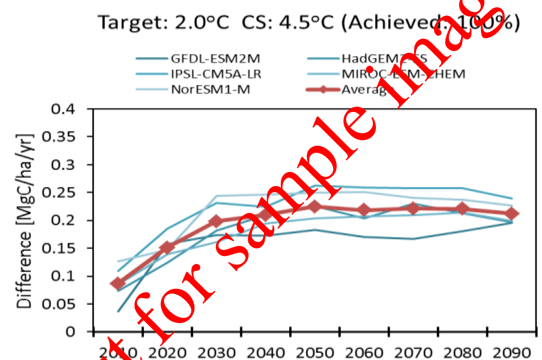
1.5℃



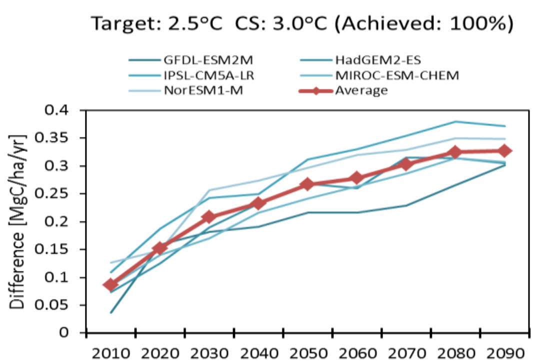


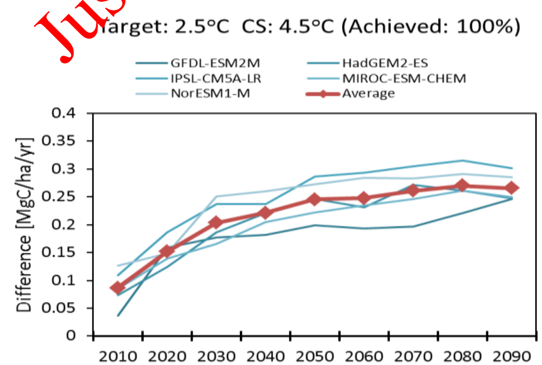
2℃





2.5℃





Summary table of sector risks for each management strategy

- Based on the summary table, we will be able to discuss various impact variables for the six risk management strategies at once.

Risk management strategies

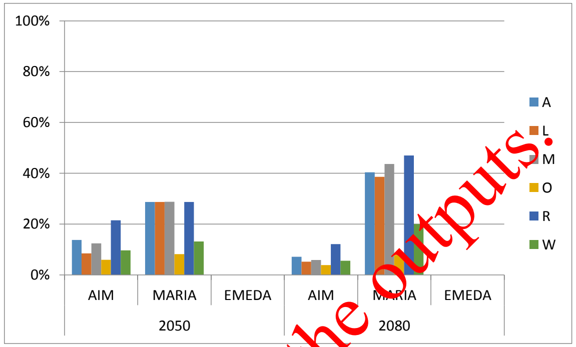
Sector impact variables

Response analyses for each risk management strategy

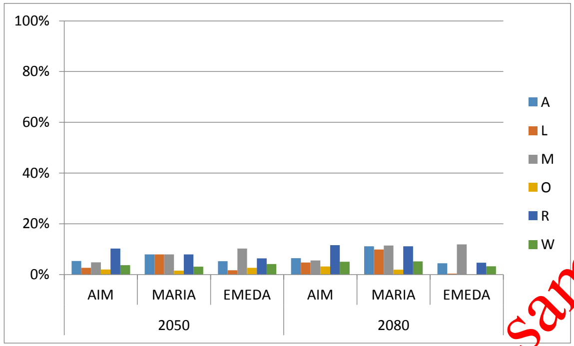
- Mitigation costs are also examined for each risk management strategy using multiple IAMs (GRAPE, AIM, MARIA, EMEDA).
- Results for mitigation analyses and results for risk analyses are compared each other to discuss the characteristics of the examined 6 risk management strategies.

- TG: Temperature increase is limited below a specified target.
- CS: Climate sensitivity assumed in the estimation of cost-minimal mitigation pathway.

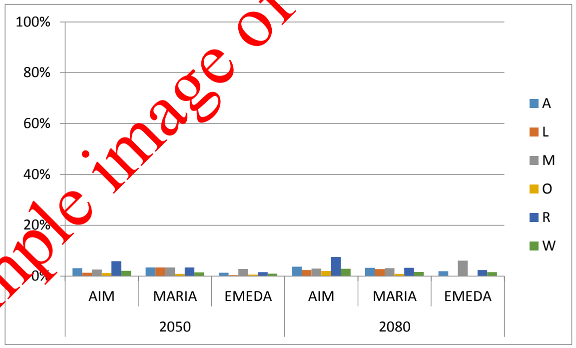
Consumption loss (%)



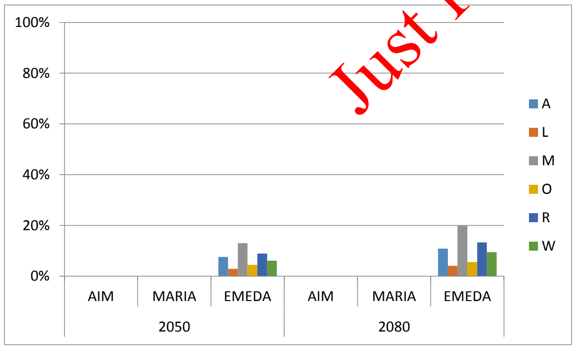
TG15_CS30



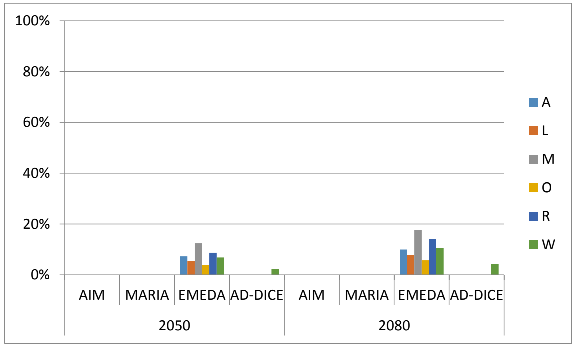
TG20_CS30



TG25_CS30



TG20_CS45



TG25_CS45

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Adaptation pathways in agriculture: A case study for global wheat production

- Agricultural adaptation has the potential to reduce the negative impacts of climate change on crop yields.
- Adaptation pathways, which describe the temporal sequences of necessary adaptation, are helpful for illustrating the timing and intensity of adaptation required to address climate change.
- We present nation-wise adaptation pathways for global wheat production through the 21st century.
- Considering the lead time needed to introduce adaptation, we also discuss the advantage of foreseeing the adaptations required in the future.
- The results suggest the importance of explicitly considering temporal dimension of adaptation, especially for systematic or transformative adaptations that require substantial lead time after planning.

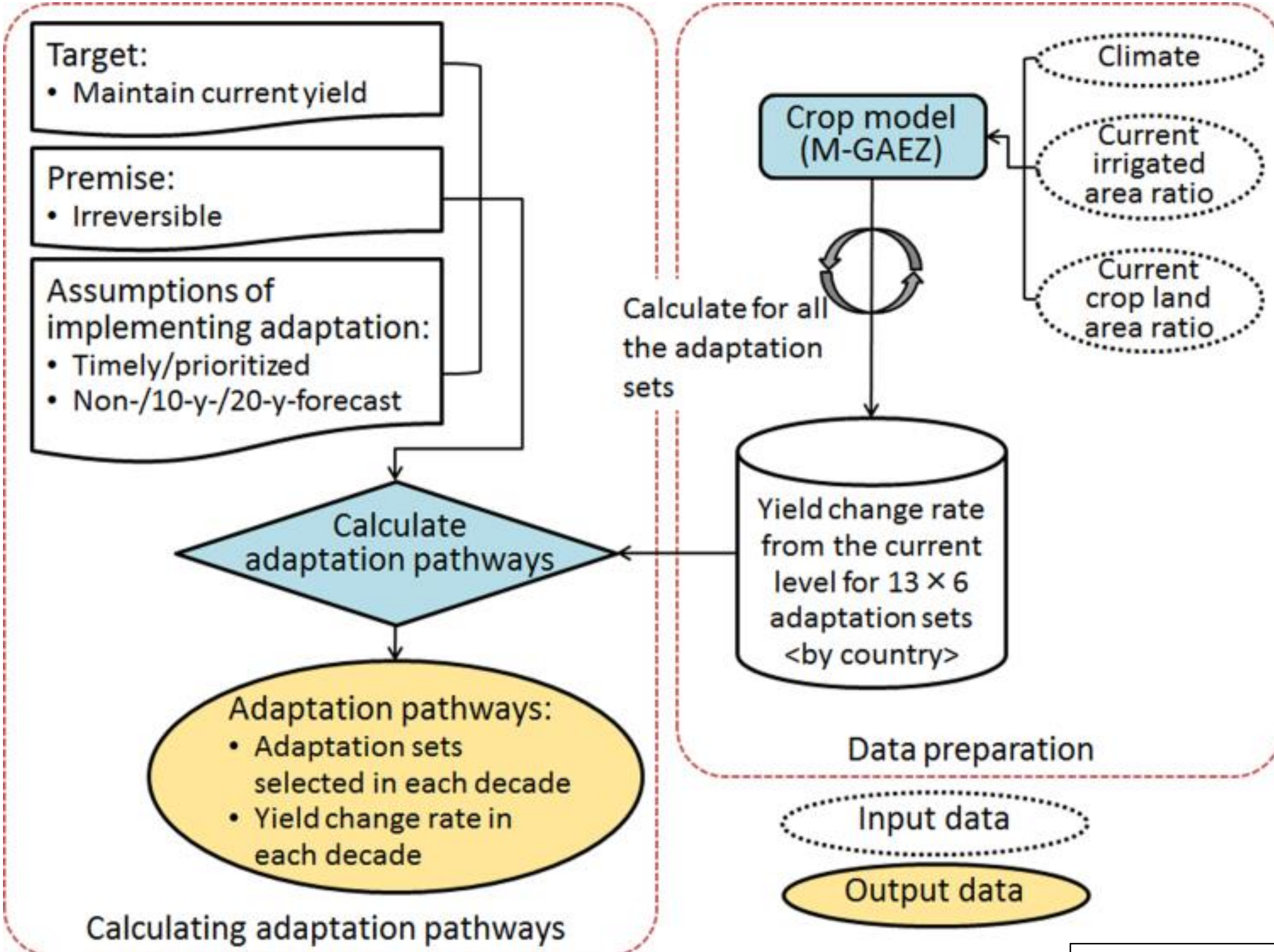
Tanaka et al. (Submitted)

Adaptation options for crops production

Adaptation	Why it might help	Why it might not help
Shift planting date	Take advantage of lengthened growing season	Less useful where current growing season length is not limited by cold temperatures
Switch varieties	Other existing varieties better suited to new climates	More suitable varieties not always available
Switch crops	Other crops more suitable to new climates	Hot countries have nothing to switch to
Expand area	Climate change could expand suitable area	Less true in the tropics; possible soil constraints; expansion may come with significant environmental costs
Expand irrigation	Helps alleviate moisture constraints	Can be expensive; often requires large government investment; many places have limited water resources
Diversify income	Non-farm income sources less climate sensitive	Rural non-farm economy linked to agricultural productivity
Migrate	Some areas might be hurt less than others by climate change	Urban areas already strained

Adapted from; Burke & Lobell: "Climate Change and Food Security"

Model framework: Adaptation pathways for wheat yield



Tanaka et al. (Submitted)

Simulation design

- Crop model: M-GAEZ model (Masutomi et al., 2009)
- Climate scenarios: MIROC-ESM model (RCP8.5/RCP2.6)
- Simulation period: 1990s and 2010s-2090s
  - Adaptation pathways for the period from 2010s to 2090s with the objective of maintaining country-average wheat yield in 1990s has been investigated.
- Adaptation options：

"Expansion of irrigated area" and " Switch/Development of heat-tolerant varieties"

- Irrigation：**13 levels** of adaptation
  - Level 0 (No Adapt) -------------> Level 10 --> Level 11 --> Level 12

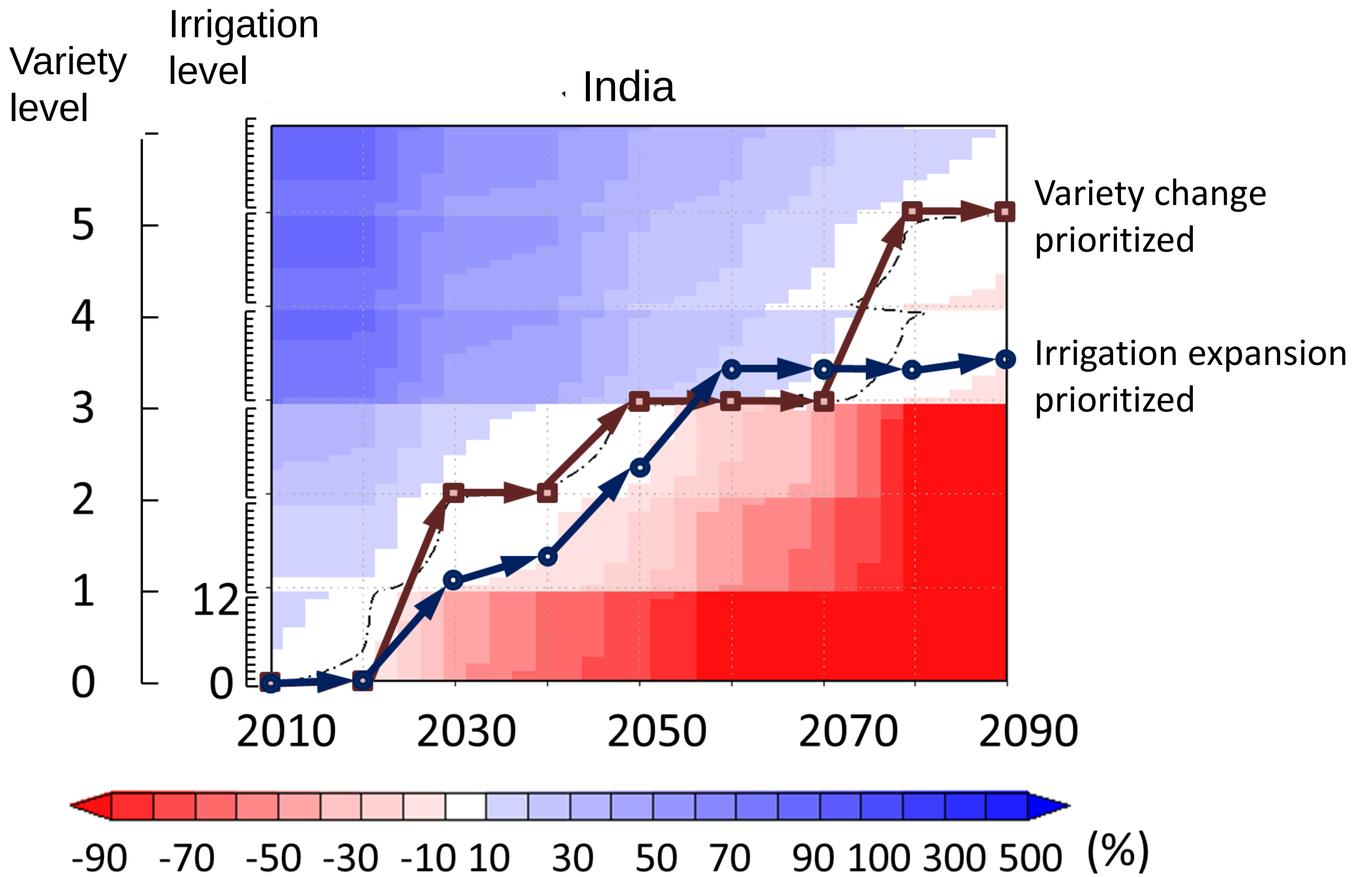
Level 0 (No Adapt)	Level 10	Level 11	Level 12
No change from the current irrigation	Increase in irrigation intensity by 10% per level at the currently irrigated area	Expansion of irrigated area to the presently rain-fed area (by 20%)	Expansion of irrigated area to the presently rain-fed area (by 50%)

- Varieties：**6 levels** of adaptation
  - Level 0 (No Adapt) -------> Level 1 ------------------------------> Level 5

Level 0 (No Adapt)	Level 1	Level 1 → Level 5	Level 5
Choice from the limited varieties	Choice from the varieties currently available	Easing of high-temperature limit	Removal of high-temperature limit

Adaptation pathways for wheat production in India

Image of adaptation pathways (shift in adaptation levels) and crop yield



Crop yield change from current yield（Red：Decrease, Blue：Increase）

Tanaka et al. (Submitted)

Conclusions

- The first version of ICA-RUS risk management strategies will be published in March 2015.
  - Translated version will be also available by summer.
- We still don’t know well how to consider adaptation in global impact analyses. We need to add study cases. Consideration of adaptation in impact analyses must be a very important and interesting research problem in the coming years.
- We will try our best to keep reporting good news in the future AIM-workshops also.

Common analyses cases for climate risk assessment and for response assessment in ICA-RUS project

	Cases for analysis up to Risk Management Strategy (Preliminary Version)	Expansion of cases for Risk Management Strategy (Final Version)	Additional comments
Climate risk assessment	Total of 60: Consist of the following combinations of climatic and socioeconomic scenarios: ● Climatic scenarios: 20 (4 RCP emission scenarios× 5CMIP5 climate models) ● Socioeconomic models: 3 (SSPs)	● Add 2 SSP socioeconomic scenarios. ● Conduct impact assessment incorporating changes in socioeconomic conditions due to mitigation policy, to enhance consistency with response assessment.	● Assess each RCP using at least 5 common climate model outputs. ● Periodization for assessment: present (1981-2000), near future (2020s), mid-term (2050s), and long-term (2080s).
Response assessment	Total of 4: SSP2 adopted as baseline socioeconomic scenario (described below). Cases leading to mitigation targets (radiative forcing level) assumed by emission scenarios up to SSP2 considered. → RCP6.0 → RCP4.5 → RCP2.6 → RCP2.6 (limited BECCS)	● Add response assessment of cases leading to each RCP mitigation target (radiative forcing level) from SSPs other than SSP2. ● Consider constraints on scale of implementation of mitigation option other than BECCS.	● Whichever combination of baseline socioeconomic scenario and mitigation targets is used, mitigation options can be combined in numerous ways to achieve it. Analysis of cases incorporating constraints on the scale of implementation of specific mitigation options will therefore also be added. ● For the preliminary version of risk management strategy, analysis of SSP2 → RCP 2.6 will consider cases that do and do not limit BECCS use.