Climate change risks in Japan and Studies in Japan on the risks

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CIGS workshop

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Topics

- Global/regional/national impacts of climate change and consideration of a long-term target
  - Integrated Climate Assessment – Risks, Uncertainties and Society (MOE ICA-RUS project)
- Climate change impacts on sectors in Japan
  - Assessment of climate change impacts and adaptation strategy on whole Japan and local government (MOE S8 project)
- Climate impacts on food and agriculture in Asia

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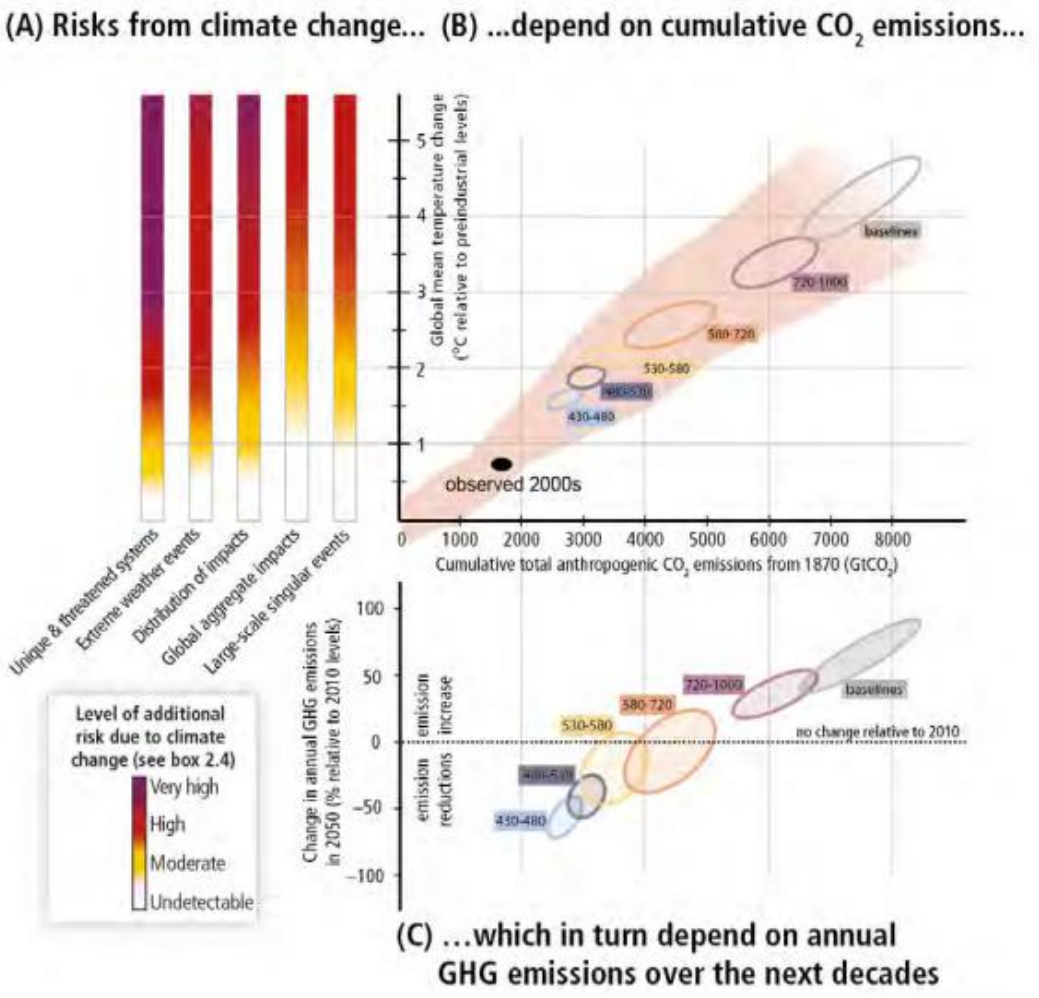
Consideration of long-term climate stabilization targets based on climate impact analyses

- Impact analyses for supporting decision-making on mitigation policies (incl. long-term targets)
  - Comprehensiveness of the analyses (global coverage; sectors)
  - Long-term viewpoint
- Impact analyses for supporting decision-making on regional/national/local adaptation policies
  - Various scales and sectors
  - Both short-/long-term viewpoint

Example of climate risk analyses for supporting decision-making on mitigation policies: IPCC-AR5 (Synthesis Report)

- Basically, climate risks need to be understood and considered comprehensively and globally.
  - To be compared with costs for achieving mitigation targets
- For example, understanding climate impacts only in China and Japan is not enough for discussing long-term mitigation policies.

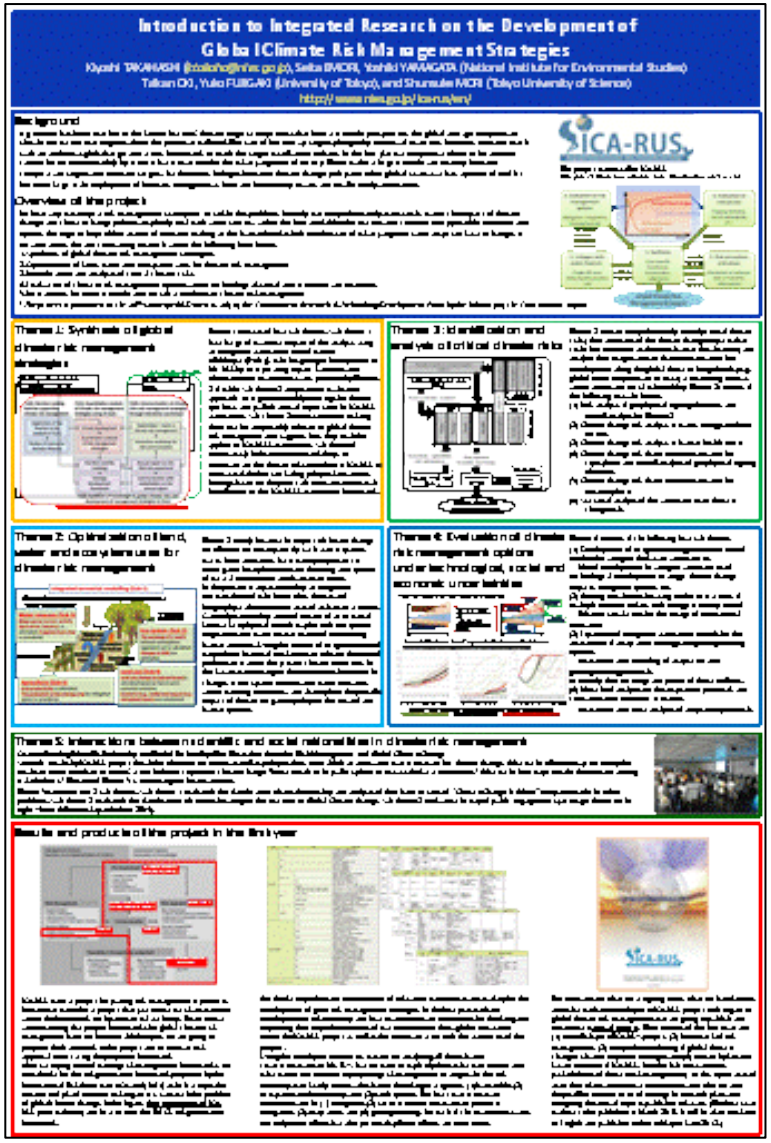


IPCC-AR5-SYR (2014) Figure SPM.10

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



Development of Global Climate Risk Management Strategies

Background

UNFCCC COP16, Cancun Accord :

'2 degree' temperature target agreed? ('1.5 degree' also mentioned)

However, …

- *Gap between '2 degree' and bottom up targets from each country*
- *Decision of targets involves value judgment (not purely scientific)*
- *Scientific uncertainty between temperature and emission targets*
- *Linkages between climate policy and water/food security etc.*

➡ *From a long-term perspective, reconstruction of rational strategies to live with uncertain climate risks is needed (Global Climate Risk Management Strategy)*

Aim

- Critical climate risks
- Linkages with water/food etc.
- Risk management options
- Risk perception/values

Scientific information

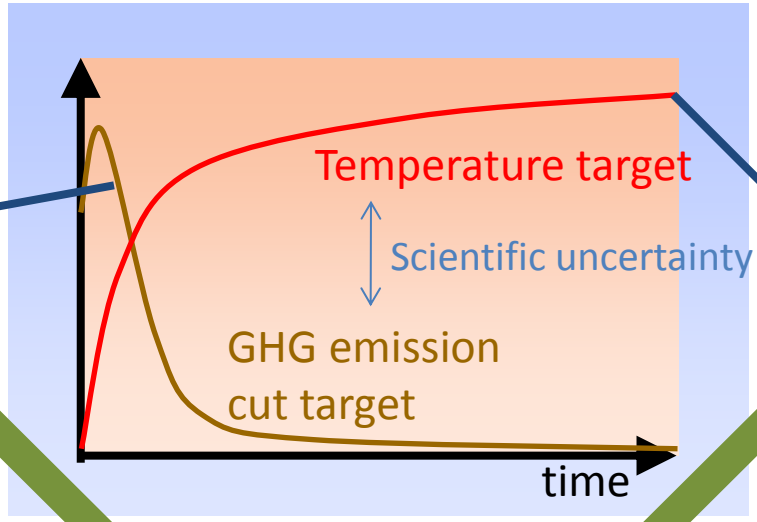
⬇

Risk Management Strategies

⬇

Support decision making on national/international climate policies

Development of Global Climate Risk Management Strategies



4. Evaluation of risk management options

(Mitigation, Adaptation, Geoengineering)

Cost-benefit
Potentials
Side-effects
Uncertainty

3. Evaluation of critical risks

(Tipping elements, Social vulnerability etc.)

Constraint
Uncertainty

2. Linkages with water, food etc.

(Trade-offs over water/land/ecosystem use)

Constraint
Uncertainty

1. Synthesis

(Cost-benefit, Constraints, Uncertainties, Judgments)

Scientific Rationality

Social Rationality

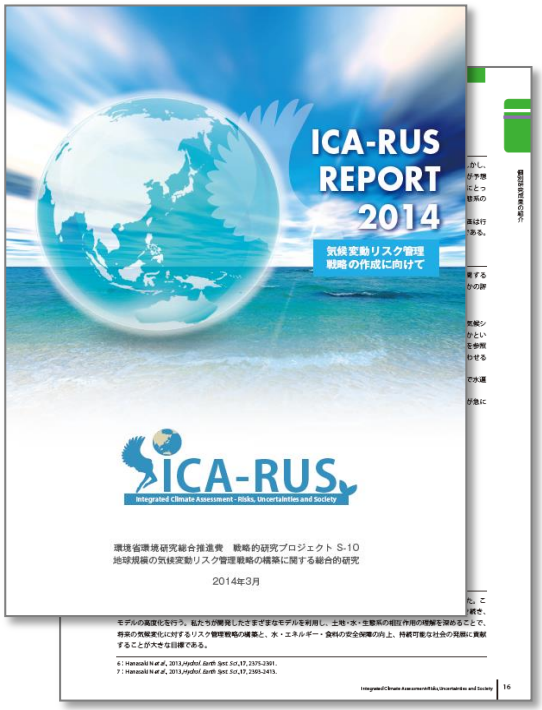
5. Risk perception and values

(Formation of opinions, Role of Scientific information)

Global Climate Risk Management Strategies

ICA-RUS annual reports

- The ICA-RUS annual reports (in English) were published in March 2013 and March 2014.
  - http://www.nies.go.jp/ica-rus/en/materials.html
- Concept of the project and preliminary findings are introduced.



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Research gaps and hot topics of impact research

- Costs of inaction / benefits of climate policy
- Projections of impacts considering future socio-economic development
- Evaluation of adaptation options
- Projections of impacts of extreme events
- Communication of uncertainties in impact projections
- Economics of adaptation
- Detection and attribution of observed impacts

Large-scale (>$3mil./year) research projects on adaptation or related matters in Japan

- **Environment Research & Technology Development Fund "S-8"**
  - **Ministry of Environment**, FY2010-14, 12 sub-teams, Assessment of climate change impacts and adaptation strategy on whole Japan and local government
- **Environment Research & Technology Development Fund "S-10"**
  - **Ministry of Environment**, FY2012-16, A comprehensive research on the development of global climate risk management strategies
- **Research Program on Climate Change Adaptation**
  - **Ministry of Education, Culture, Sports, Science and Technology**, FY2010-14, 12 programs, downscaling, assimilation, simulation for CC adaptation
- **Development of mitigation and adaptation technologies to address global warming in the agriculture, forestry and Fisheries**
  - **Ministry of Agriculture, Forestry and Fisheries**, FY2010-14 , 7 programs
- **Program for risk information on climate change (Sousei-Program)**
  - **Ministry of Education, Culture, Sports, Science and Technology**, FY2012-16 , 4 teams with some other projects

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Framework of S-8 Project (FY2010-2014)

Assessment of climate change impacts and adaptation strategy on whole Japan and local government

Socio-Economic Scenarios

Climate Scenarios

【Theme 1】Research on highly reliable quantitative assessment of climate change impacts throughout Japan

Climate Scenario downscaler

Economic assessment

Integrated assessment model

Simplified assessment method

Regional assessment method

Feedback from local government

Feedback from developing country

【Theme 2】
Research on impact assessment and comprehensive adaptation policies at the local government level

Local government consortium

【Theme 3】
Research on indexes of vulnerability and adaptation effects in the Asia-Pacific Region

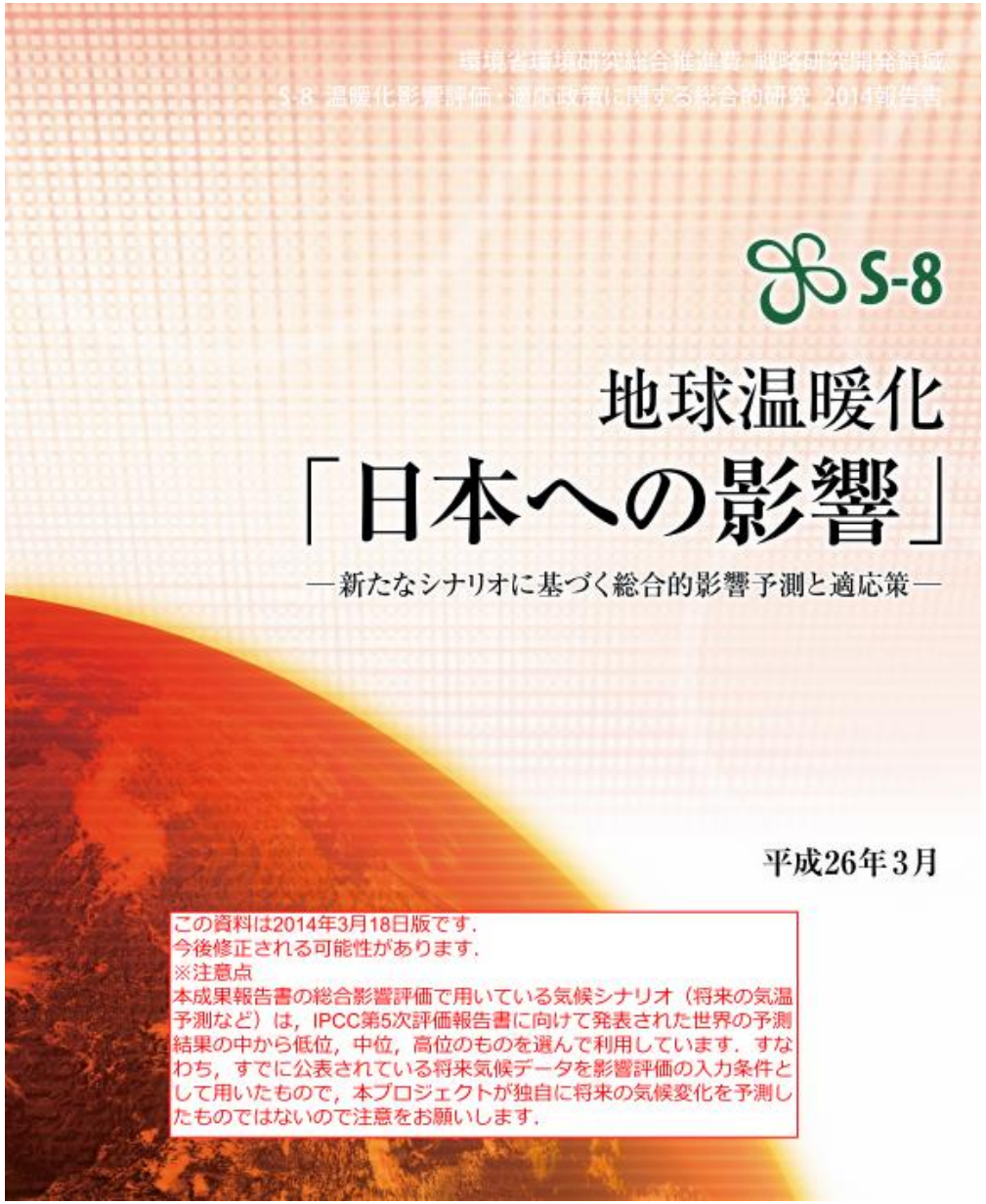
Various impact and adaptation studies in the Asia-Pacific region

Transmission of research results to domestic and international policymaking

Objectives of S-8 project

- To assess climate change **impact assessment** focusing on **whole Japan** under different GHG concentration stabilization scenarios and adaptation strategies
  - Utilization of **new climate scenario** with high accuracy and resolution
  - Development of advanced model for assessment of climate change impacts and **adaptation strategy**
- To develop a planning method for **adaptation strategy** focusing on **Japanese local government and** developing countries in Asia-Pacific region
  - Development of **simplified tool** to assess the impacts of, and vulnerabilities and adaptation to, climate change
  - Consideration of **uncertainty** in the assessment

S-8 research report (published in March 2014)



- The report (in Japanese) which compiled research findings were published in March 2014.
- https://www.nies.go.jp/whatsnew/2014/20140317/20140317.html
- English version will be released soon.

Features of S-8 Research Report 2014

- Impact analyses based on IPCC new scenarios (CMIP5 climate projections based on the RCP scenarios; Socio-economic conditions assumed to be unchanged in future)

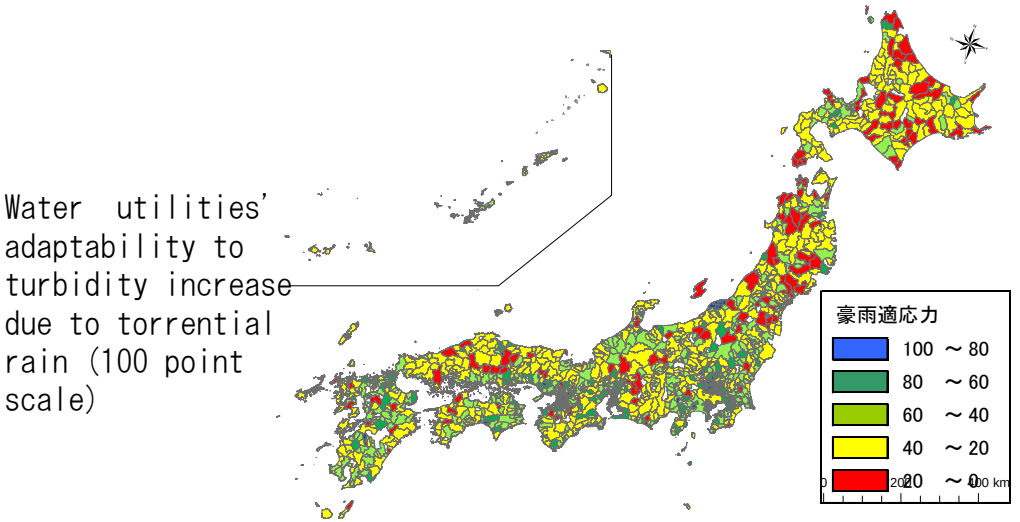
- Improvement of impact projection models and extension of the sector coverage for more comprehensive and detailed analyses.

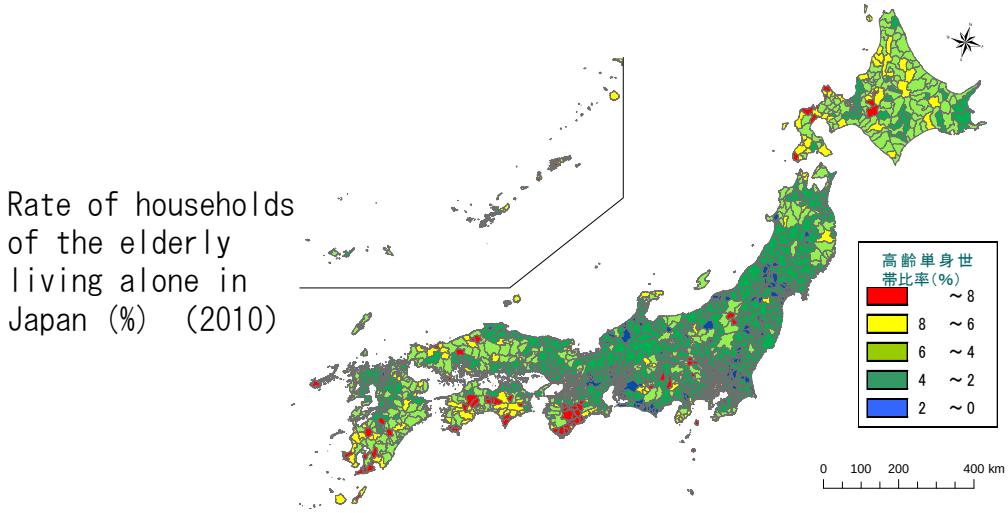
- Consideration of adaptation measures

Impacts on water resource

Leader : Satoshi TAKIZAWA (Univ. of Tokyo)

- **Objective**
  - To project changes in the amount and quality of water resources caused by climate change and to assess impacts caused by changes to water supply and industrial water works
  - To investigate impacts on water supply stability that are posed by changes in water-related damage due to climate change and assesses the future impacts by incorporating socio-economic change such as population aging rate
- **Results**
  - Suspended solid, river flow
  - Indices of water utilities' adaptability to climate change

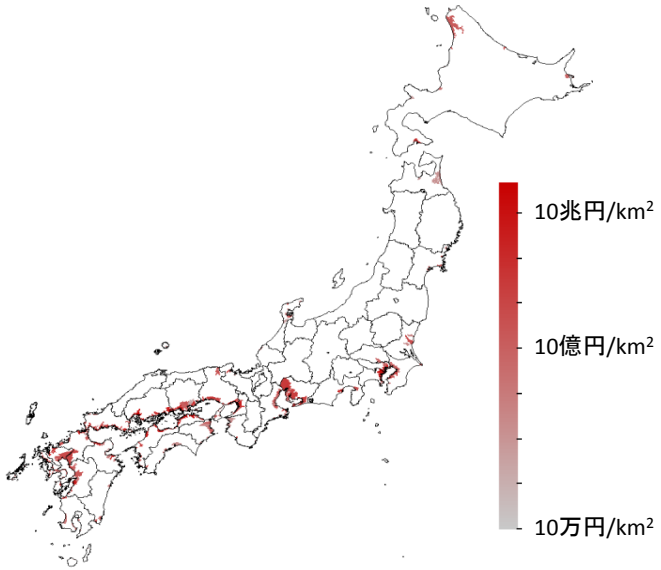


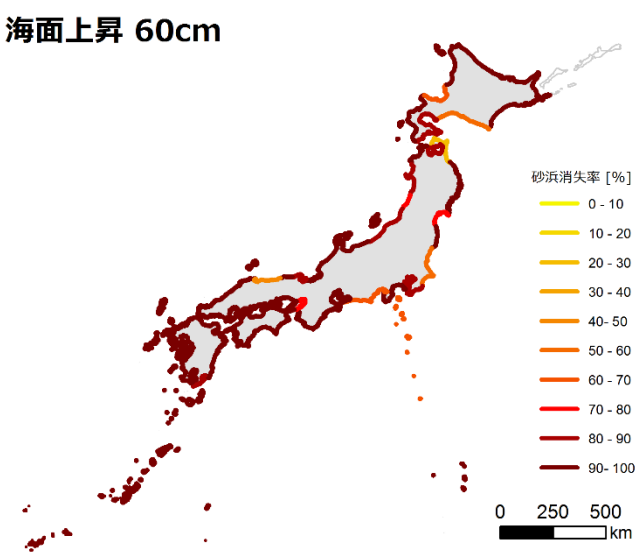


Disaster risks

Leader : So KAZAMA（Tohoku Univ.）

- **Objective**
  - To compare natural disasters of different scales, regional characteristics and phenomena by quantitative assessment and resultant calculation of economic damages
- **Results**
  - Flood, Landslide, Storm surge flooding, Loss of sand beach and tidal flats



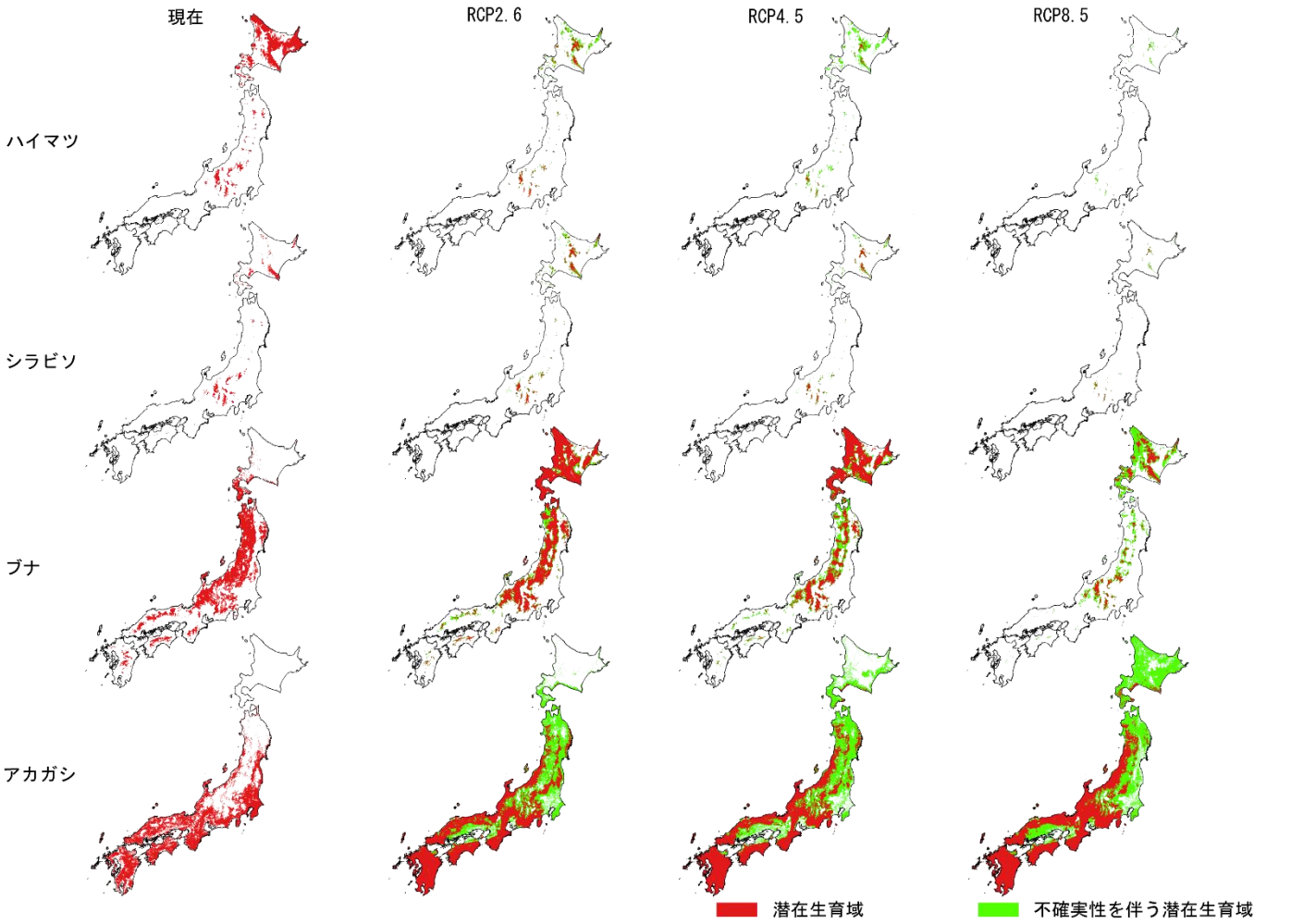


(left)Damage cost of storm surge when sea level rises by 60cm (right)Rate of sand beach loss around 2100

Sector impacts and adaptation：S-8-1(5)

Impacts on natural vegetation
Leader : Nobuyuki TANAKA（Forestry and Forest Products Research Institute)

- **Objective**
  - To quantitatively project impacts of future climate change on natural forest, evaluate uncertainty and propose adaptation measures.
- **Results**
  - Potential habitats of *Pinus pumila*, *Abies veitchii*, *Fagus crenata*, *Quercus acuta*



Potential habitats of the four dominant species in each climatic zone under the current climate and those projected using future climate scenarios that are based on three RCPs. The potential habitats were determined by the medians of the probabilities based on four GCMs (MIROC5, MRI-CGCM3.0, GFDL-CM3 and HadGEM2-ES) under each RCP from 2081 to 2100. Potential habitats with uncertainty represent the areas that were projected to be potential habitats based on any of GCMs.

Objective of the syntheses analyses and impact indices analyzed

- Objective

➢ To assess various distinct climate stabilization levels, impact level according to adaptation policy, and its adaptation effect using a state-of-the-art climate scenario utilized in IPCC Fifth Assessment Report.
  - Radiative forcing scenarios：RCP2.6, 4.5, 8.5
  - Climate models：MIROC5 (Japan, Univ. of Tokyo/NIES/JAMSTEC), MRI-CGCM3.0 (Japan, JMA-MRI), GFDL CM3 (USA, GFDL), HadGEM2-ES (UK, UKMet)
  - Base period：1981-2000, Future：mid-21c (2031-2050), late-21c：2081-2100)

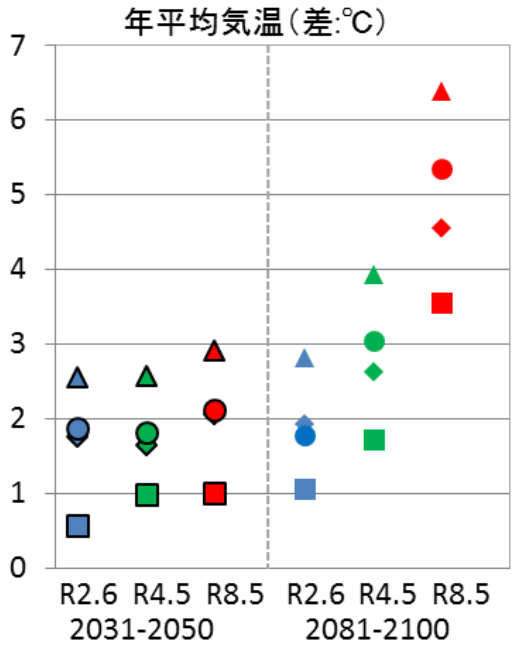
- Impact indices(Blue color denotes consideration of adaptation)

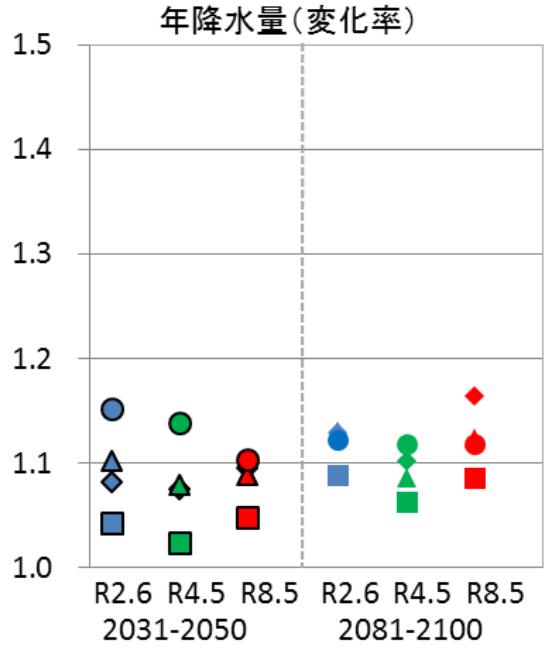
– Water resources (quantity: river flow, quality: chlorophyll a),
– Coast/disaster prevention (flood: flood damage cost, sediment disaster: landslide probability, landslide damage cost, storm surge disaster: storm surge damage cost, coastal erosion: sand beach loss rate, sand beach damage cost, tidal flat loss rate, tidal flat damage cost)
– Ecosystem (natural vegetation: *Pinus pumila* potential habitat, *Abies veitchii* potential habitat, *Fagus crenata* potential habitat, *Fagus crenata* damage cost, *Quercus acuta* potential habitat)
– Agriculture/food production (rice: yield, fruits: continuing rate of suitable cultivation area for Citrus unshiu and Citrus tankan respectively)
– Health (summer heat: heat stress excess mortality, heat stroke death damage cost, the number of hospital inpatients for heatstroke, infection disease: Aedes albopictus distribution).

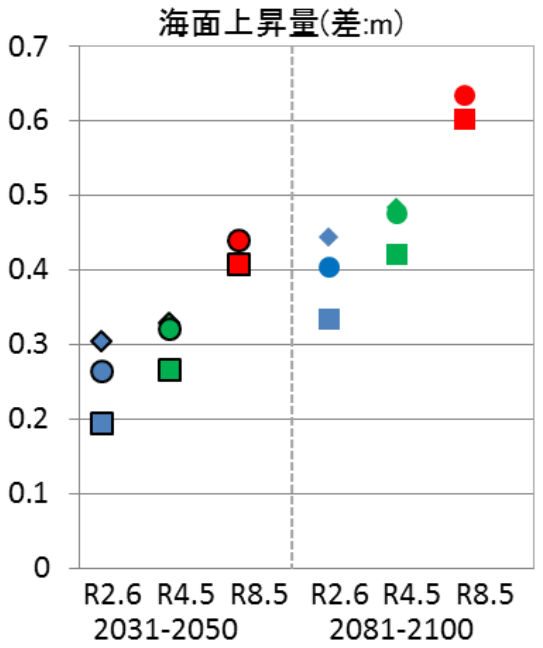
Features of the synthesis analyses

- Quantitative analyses of climate change impacts on multiple sectors based on identical climate scenarios
- Comparison between climate stabilization levels and corresponding impacts
- Consideration of uncertainty in climate projection based on multiple climate model outputs
- Regional overview of multi-sector impacts

Climate scenarios (Japan-mean)

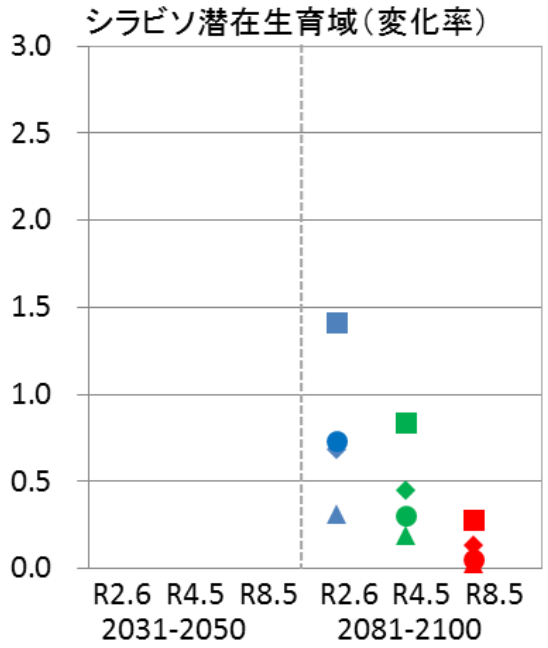


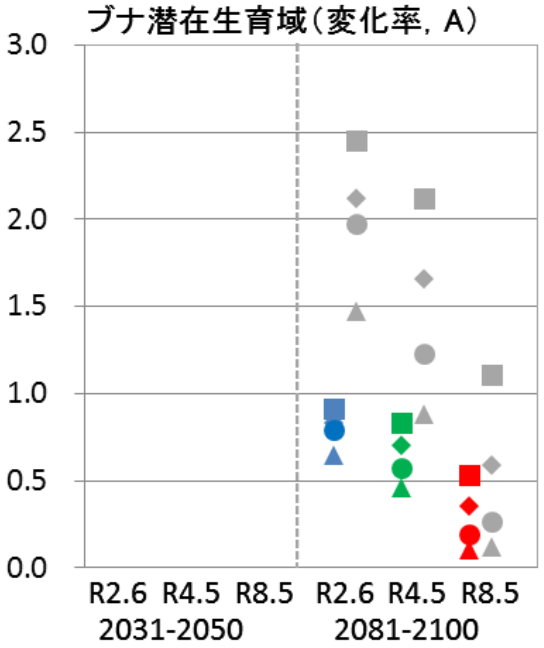


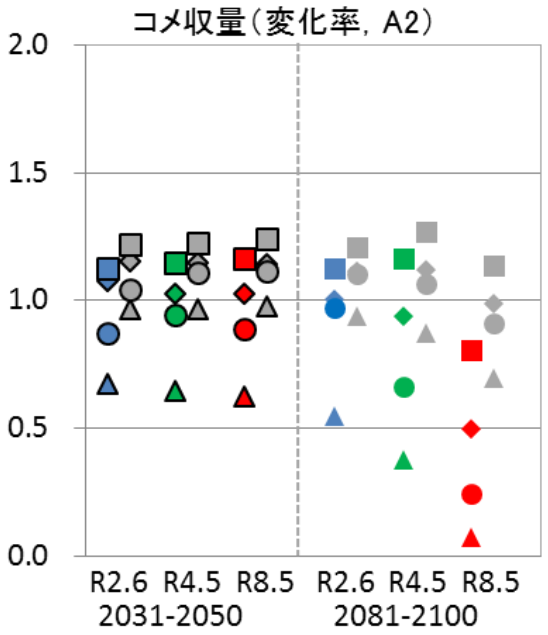


- **RCPシナリオ**
  - R2.6：RCP2.6(**青色**)，R4.5：RCP4.5(**緑色**)，R8.5：RCP8.5(**赤色**)
- **気候シナリオ**
  - MIROC5：◆，MRI-CGCM3.0：■，GFDL CM3：▲，HadGEM2-ES：●
- **値の意味**
  - **差：基準年**(1981-2000)**と将来**(2031-2050，2081-2100)**の差分**
  - **比：基準年**(1981-2000)**を1とした場合の将来**(2031-2050，2081-2100)**の比率**

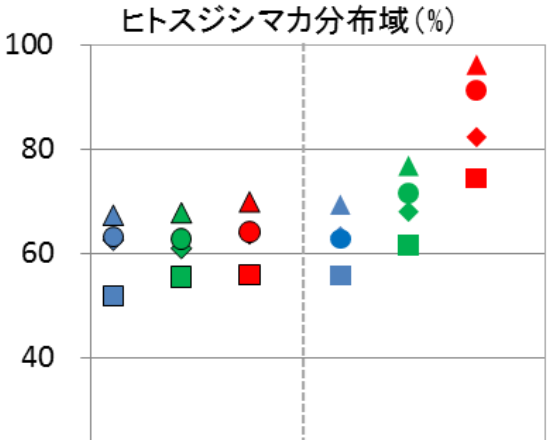
Sector impact indices (Japan-mean)







- **マーカーがない図：**評価未実施
- **灰色マーカー：**適応策を講じた場合



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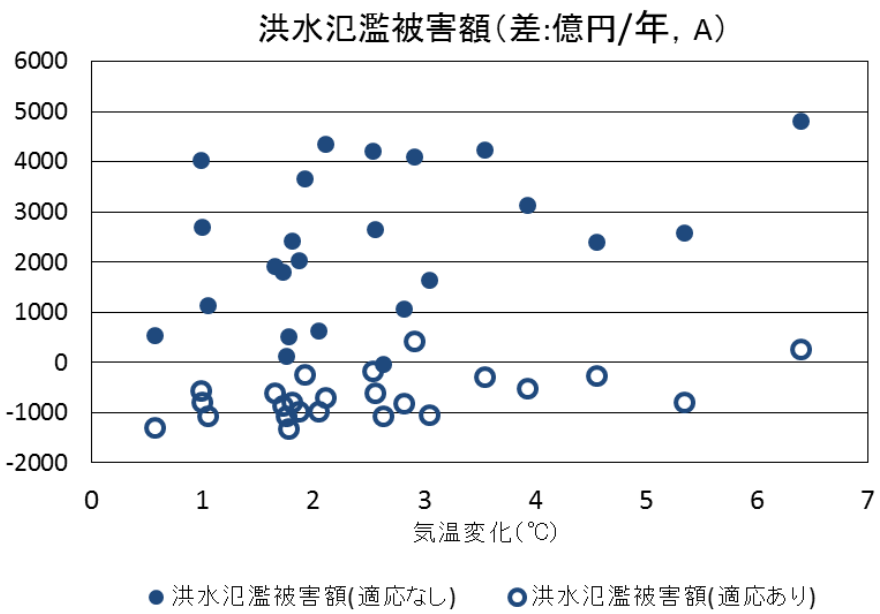

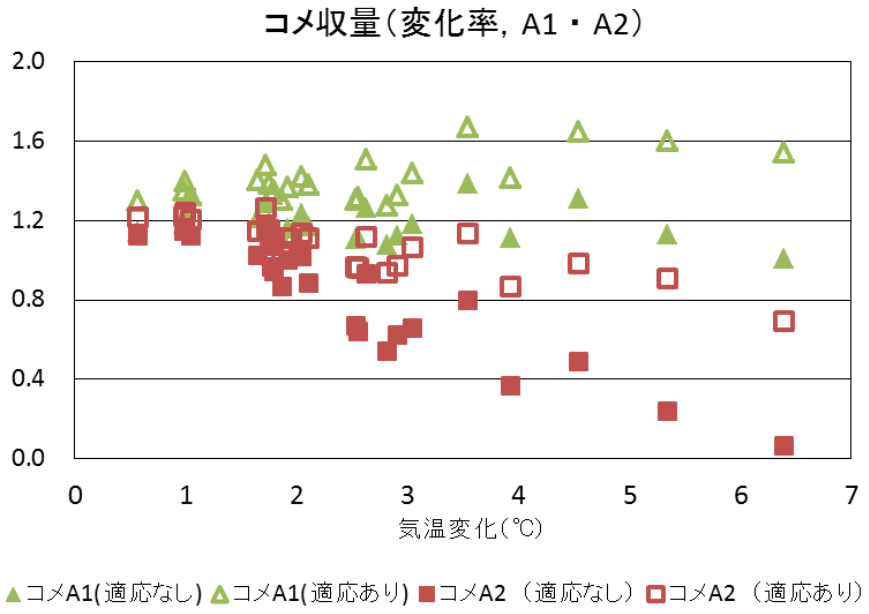

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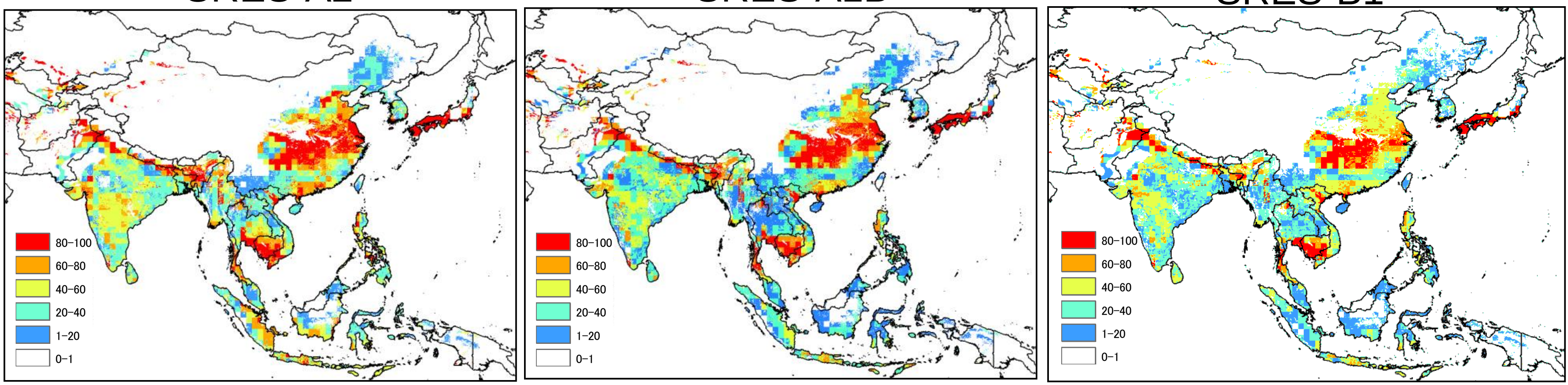
Example of impact assessment considering uncertainty of climate projection

Crop productivity assessments using plural GCM projections evaluated in IPCC-AR4

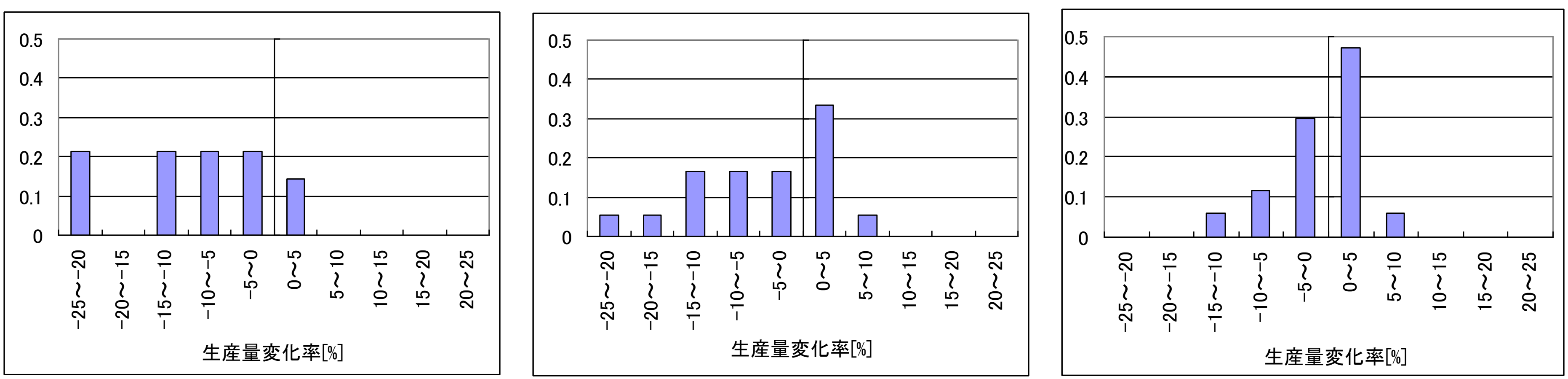
Impact on rice productivity

Masutomi Y. et al. (2009) ***Agric.Ecosyst.Environ.***,131,281-291

SRES-A2 SRES-A1B SRES-B1



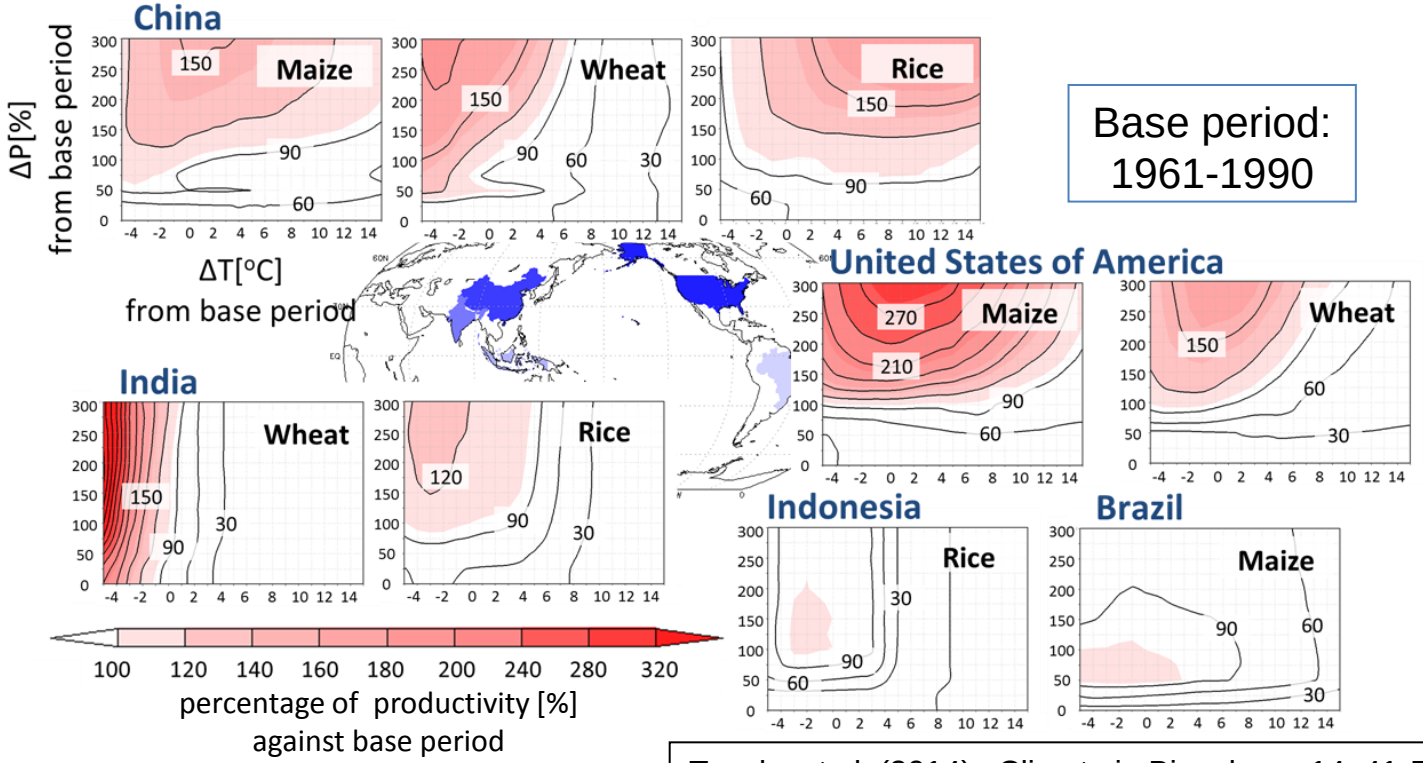
Probability of crop productivity decrease [%] (with CO2 fertilization；2080s-1990s)



PDFs of estimated productivity change (Asia；with CO2 fertilization； 2080s-1990s)

Development of an impact function of global crop productivity for climate change policy support models.

- The impact function is a database of country-averaged data from sensitivity analyses calculated by a process-based model.
- We developed an impact 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.

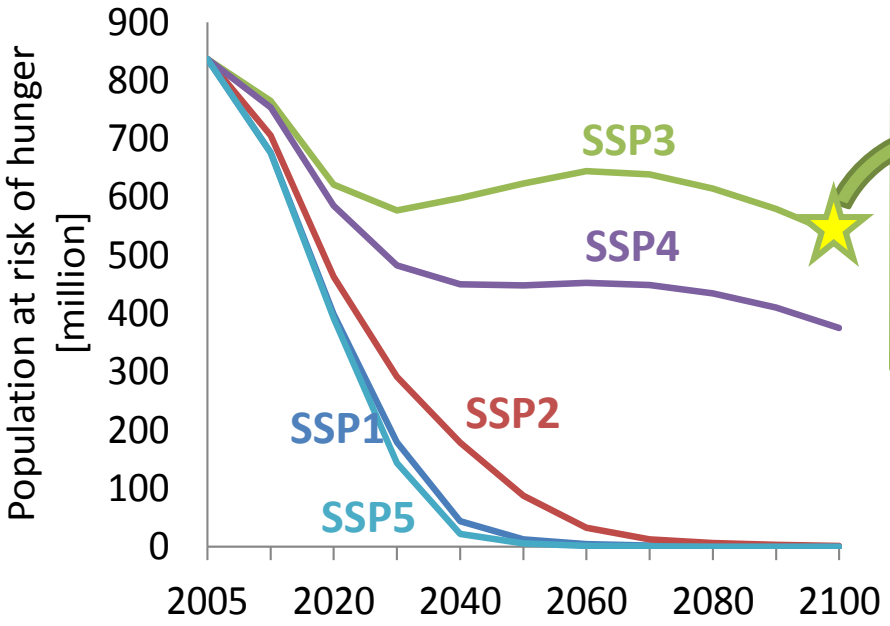


Base period: 1961-1990

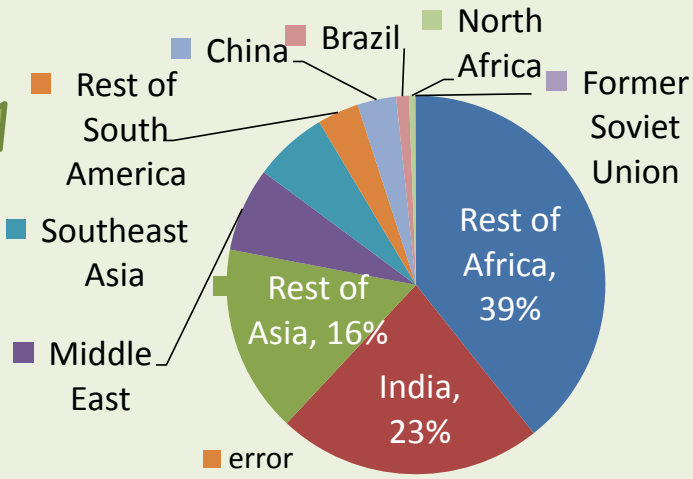
Tanaka et al. (2014) . Climate in Biosphere, 14, 41-56. (in Japanese)

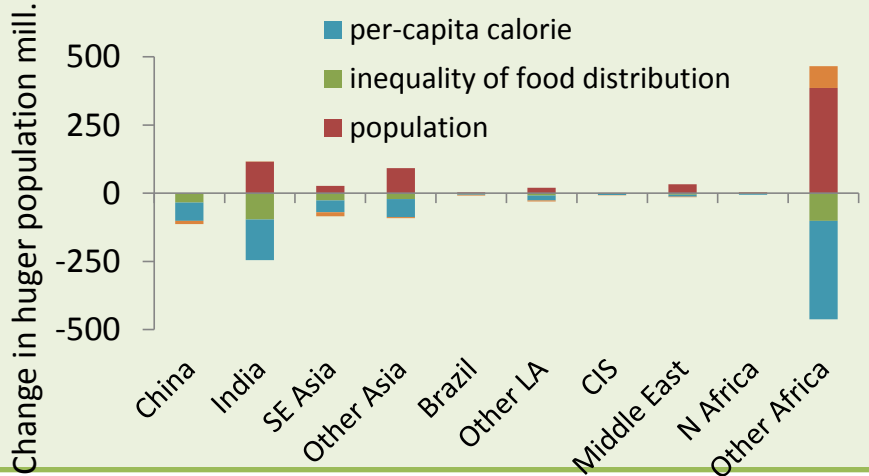
The 21st-century Scenarios of risk of hunger using SSPs

- 21st-century risk of hunger differs among SSPs depending on socio-economic situations
- Regional distribution of the risk depends greatly on population growth, improvement of inequality in food distribution and increase in food consumption



In **the most pessimistic scenario** (**SSP3**), more than 500 million people face risk of hunger





Hasegawa et al. in review

Conclusions

- With the purpose of proposing strategies for global climate risk management, ICA-RUS project is ongoing in Japan from April 2012.
  - Two annual reports (in English) have been published.
  - http://www.nies.go.jp/ica-rus/report/ICA-RUS_REPORT_2013_eng.pdf
  - http://www.nies.go.jp/ica-rus/report/ICA-RUS_REPORT_2014_eng.pdf
- Comprehensive analyses of climate risks in Japan have been conducted in MOE S-8 project.
  - Research report in Japanese was published last March and the translated version will be released soon.
  - http://www.nies.go.jp/s8_project/symposium/20141110_s8br.pdf