Introduction to the APCC and climate change impacts on agriculture

Yonghee Shin/APEC Climate Center
Busan, South Korea

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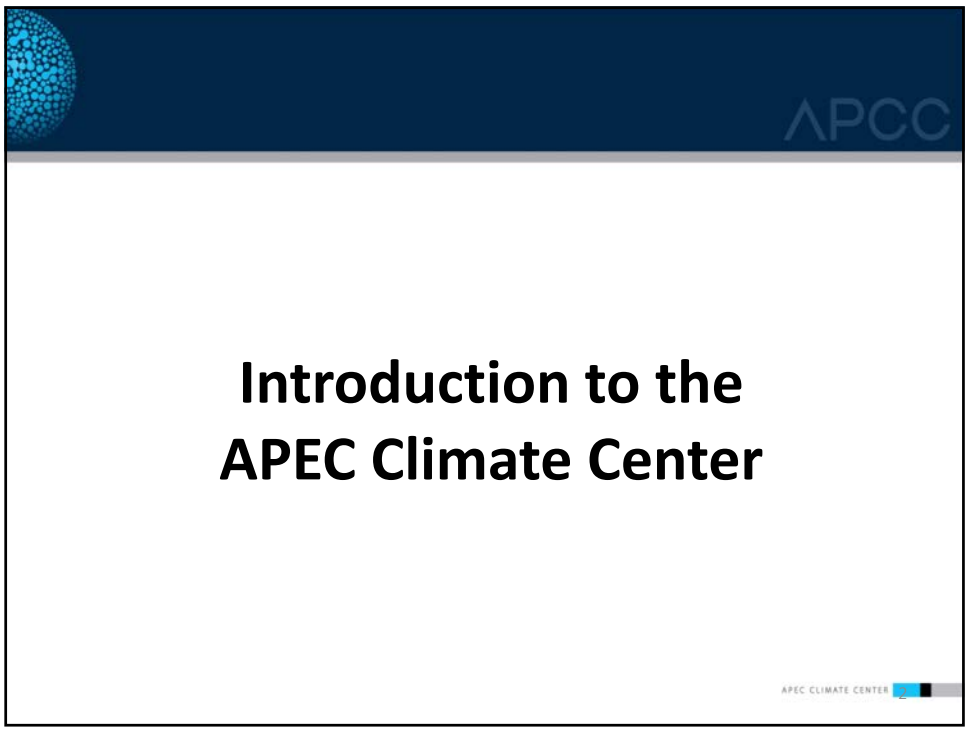


Overview of the APEC Climate Center

- The APEC Climate Center (APCC) is a leading climate information service provider in the Asia-Pacific region.
- APCC provide seasonal climate forecasts and other climate information products and services
- APCC conduct research and development activities and organize capacity building initiatives for scientists from developing economies

History of the APEC Climate Center

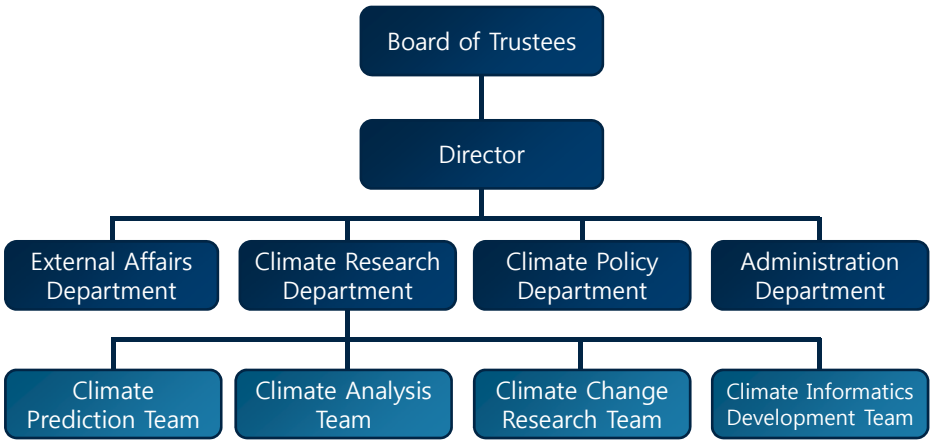
• KMA proposed the establishment of the APEC Climate Network in **1998**

• In **2005**, during the 13th APEC Economic Leaders' Meeting in Busan, Korea, APCC was formally launched

V I S I O N

APCC strives to strengthen scientific and technological cooperation across the APEC region in order to help economies and societies deal effectively with the consequences of current and future climate-related hazards through the provision of climate information, research and technical support

Structure of the APEC Climate Center

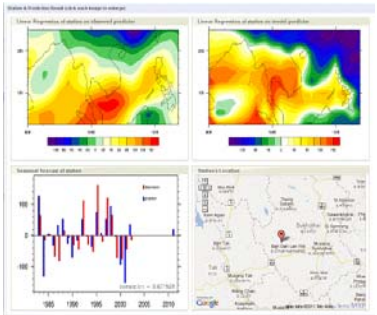


Activities of the APEC Climate Center

1. Climate Science

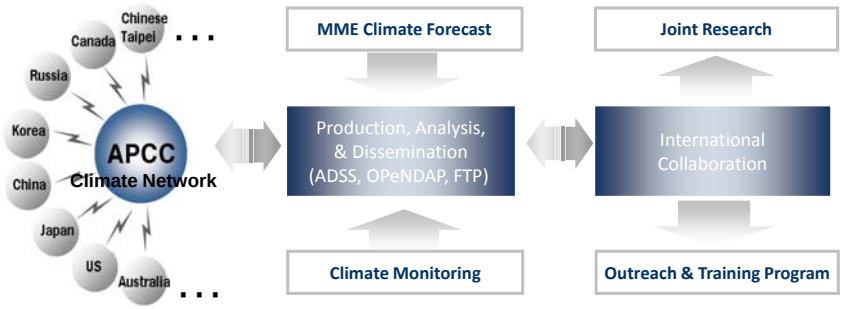
APCC provides operational services such as monthly seasonal outlooks and climate monitoring and prediction products, as well as conducting climate change R&D and supporting online tools and data services

- Seasonal temperature and precipitation outlook
- Drought and flood monitoring,
- 6-month lead coupled MME outlook (ENSO, SST, IOD)



Climate Science: MME Climate Forecast

- Global climate forecast data from **17 institutes** (9 economies)
- Monthly rolling 3-month and 6-month MME climate forecast
- Cooperation on decadal prediction and climate change projection



* ADSS : APCC Data Server System
* OPeNDAP : Open-source Project for a Network Data Access Protocol
* FTP : File Transfer Protocol

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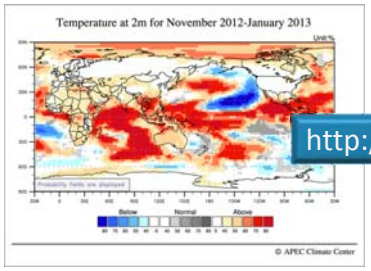
Accessing APCC Forecasts

- Rolling 3-month and 6-month lead forecasts and "State of Our Climate" assessment available on our website
- Climate highlights and forecast outlook
- Detailed monthly and regional prediction and relevant verification
- Forecast information also distributed through our mailing list



http://www.apcc21.org

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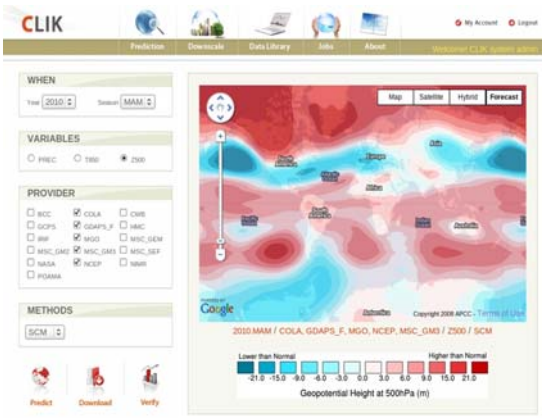
Climate Information Tool Kit (CLIK)



http://clik.apcc21.net

- Innovative, web-based tool for data retrieval and climate prediction
- Customized 3-MON Multi-Model Ensemble Prediction and locally specific downscaling
- Produced over 1,200 MME Prediction & 600 Verification results by user requests
- Since March 2009, 3,882 visitors from 497 cities have accessed and used CLIK
- The visitor count is continuously increasing

Climate Science for Society

2. Societal Applications

APCC strives to respond to societal needs and is beginning to create specialized forums and information products for stakeholders in sectors such as Agriculture, Health, Water Resources Management, and Energy Efficiency

Climate Science for Society

A Fire and Haze Early Warning System for Southeast Asia

- Creation of a prototype Early Warning System (EWS) for Fire Danger Conditions in Indonesia, Malaysia and Singapore by using seasonal forecasts to predict the drought conditions that trigger forest fires
- APCC's expertise in operational seasonal climate forecasting and experience with capacity building and training programs makes it uniquely qualified to carry out this project

APN

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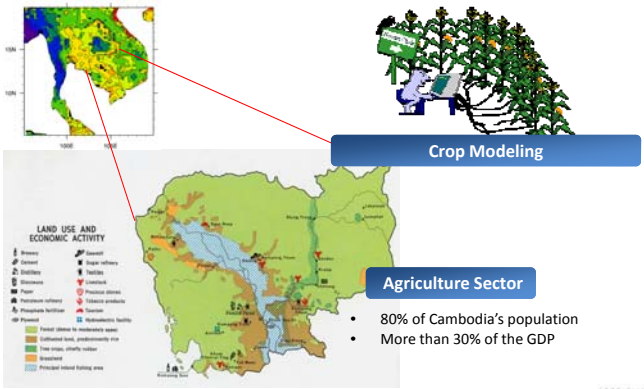
Climate Science: Interdisciplinary Research

Assessing agricultural productivity under the climate change

AR5 Climate Change Scenarios → Downscaled Locally Specific Information

GIS + process-based crop model → Agricultural Production Scenarios → Provincial & National Policy



Crop Modeling

Agriculture Sector

- 80% of Cambodia's population
- More than 30% of the GDP

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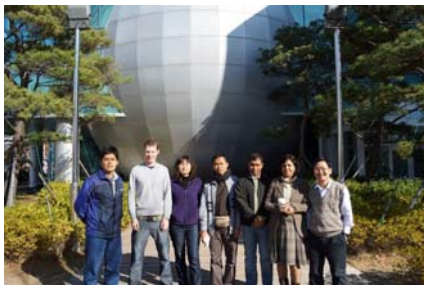
Activities of the APEC Climate Center

3. Capacity Building

APCC engages in various capacity building and training exercises, especially targeting participants from developing countries. Through these activities, we aim to build the adaptive capacity of these groups to produce and access the highest quality information for risk management and strategic planning

Young Scientists Support Program



- APCC supports the research of outstanding young scientists from developing countries as visiting scien tists for a period of approximately 3 months
- APCC provides data, equipment, an d support from our research staff

- The visiting scientists conduct research on themes such as:
  - climate prediction and monitoring
  - climate change and impact assessments
  - climate informatics
  - climate applications to relevant sectors

APCC Training Programs

- 2011: Climate prediction, statistical and dynamical downscaling
  2012a: Climate prediction and applications (agriculture and water resources)
  2012b: Climate variability and seasonal prediction

- The program concludes with final presentations by each trainee in which they explain the significance of climate information for their country and present the climate prediction simulation they created during the hands-on session

- Since its establishment in 2011, APCC trained 109 participants from over 25 countries through CPTP

Activities of the APEC Climate Center

4. International Conferences

APCC hosts several events each year to share the latest knowledge and expertise on climate prediction and applications and to facilitate regional cooperation in developing climate prediction science and technology

APEC Climate Symposium

- Annual event held since 2005
- Highlights state-of-the-art climate prediction techniques as well as the application of climate information for social welfare and economic prosperity
- The 2012 Symposium was held in St. Petersburg, Russia under the theme "Harnessing and Using Climate Information for Decision Making", with a focus on the Agriculture Sector

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VOEIKOV MAIN GEOPHYSICAL OBSERVATORY

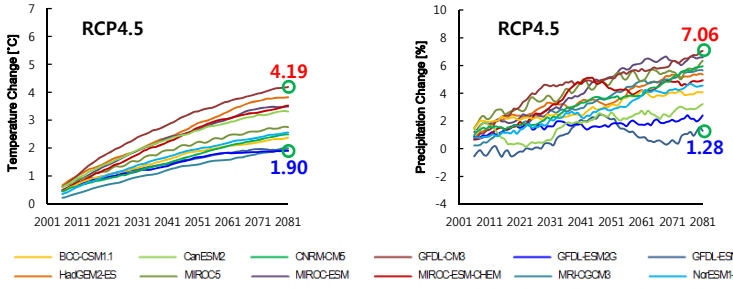
Climate Change Impacts on Agriculture

Study Background

- IPCC AR4 projects that an increase in global mean surface temperature will have a large effect on crops productivity in th e world (Easterling et al., 2007)
- The impact assessment of climate change on crops productivity is important to understanding the global food security
- It is also important to grasp which regions will be vulnerable in the future

Study Background

- General Circulation Model (GCM) climate projections are input into the global scale crop model to estimate the future crop productivity.
- However, there is an uncertainty in the GCM climate projections and emission scenarios.



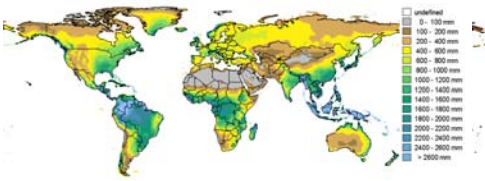
Purpose of Study

- This study aims to estimate the change of future crops productivity on the rice, wheat, and maize in the world using global crop model GAEZ (Global Agro-Ecological Zones).
- The results of impact assessment on the crops productivity expected to help to the policymakers for grasp of vulnerable region and consideration of adaptation measures.

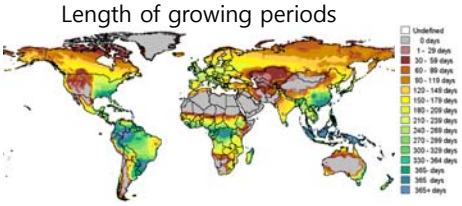
GAEZ Crops Model

- GAEZ model developed by IIASA and FAO was used for the as sessment of global food security in the IPCC AR4
- Potential crop yield is calculated based on the conditions such as climate, soil, and input level

Average annual precipitation



Length of growing periods



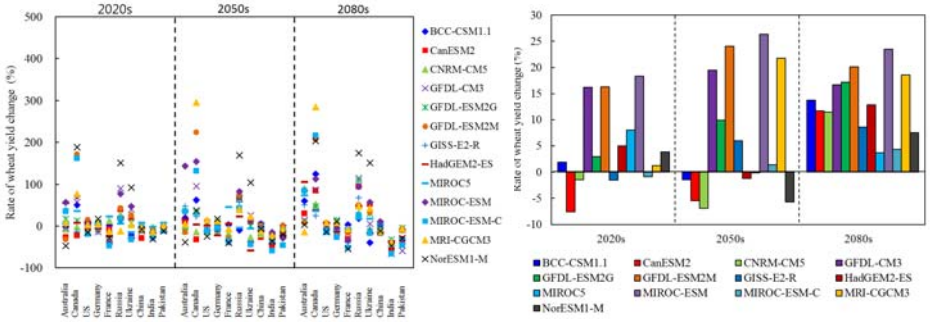
- 2.5′ × 2.5′ crop productivity
- Adaptation (planting dates and varieties)
- CO2 fertilization effect

Simulation settings

Items	Settings
Model	GAEZ model
Study area	Global
Crops	Wheat(16 varieties), Maize(19 varieties), Rice(11 varieties)
Periods	1990s (1991-2000), 2020s (2021-2030), 2050s (2051-2060), 2080s (2081-2090)
GCMs	CMIP5 GCMs
Scenarios	RCP (RCP2.6, RCP4.5, RCP6.0, RCP8.5)
Adaptations	Planting dates, Varieties
Current climates	CRU TS 2.1
Climate conditions	Daily mean temperature [℃], Daily precipitation [mm/day], Daily mean radiation [W/m^2], Daily mean windspeed [m/s]

Results (1)

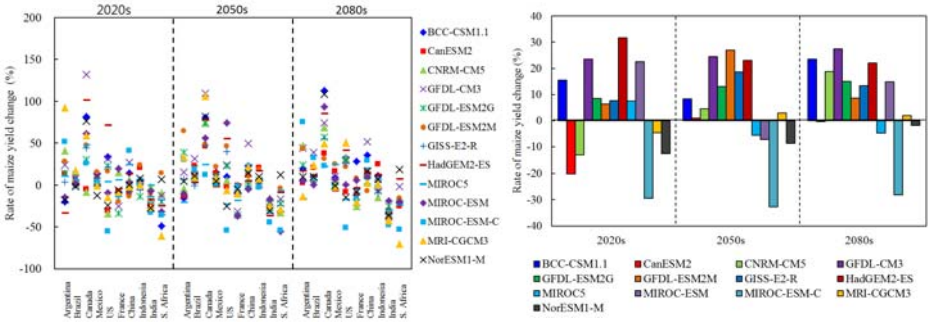
- Wheat yield change for each CMIP5-GCM under the RCP4.5 scenario considering adaptation methods



- In Canada and Russia, there are large uncertainty range in the estimation of wheat yield change.
- Wheat yield will be increase in Canada and Russia.

Results (2)

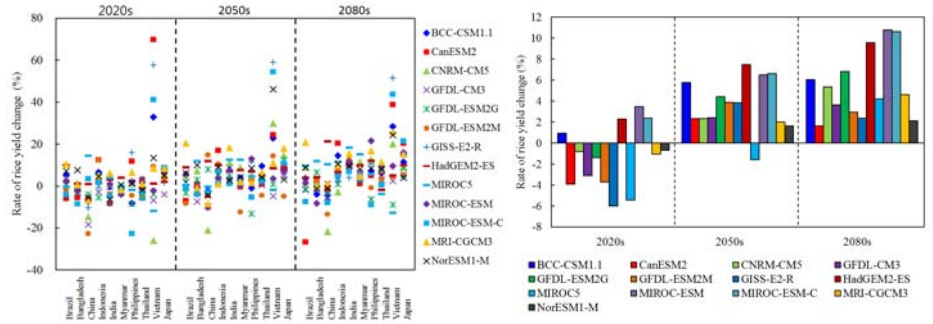
- Maize yield change for each CMIP5-GCM under the RCP4.5 scenario considering adaptation methods



- In Canada, maize yield was estimated it will be increase.
- On the other hand, in India and S. Africa, maize yield was estimated it will be decrease.

Results (3)

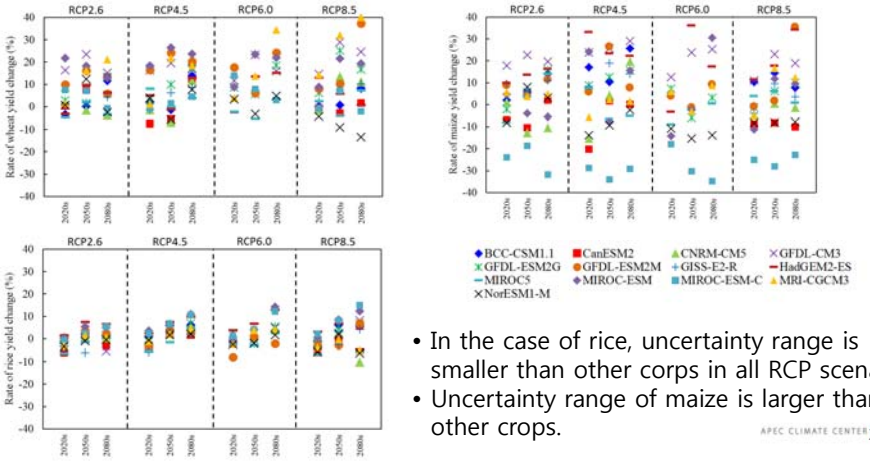
- Rice yield change for each CMIP5-GCM under the RCP4.5 scenario considering adaptation methods



- In the 2080s, all CMIP5-GCM estimated increase of rice yield in average 10 countries.

Results (4)

- Average of crops yield change in top-10 countries for each CMIP5-GCM and RCP scenario considering adaptation methods



- In the case of rice, uncertainty range is smaller than other corps in all RCP scenarios
- Uncertainty range of maize is larger than other crops.

Results (5)

- Estimation of climate change vulnerable country

Wheat	Adaptation methods (OFF)						Adaptation methods (ON)					
	2020s		2050s		2080s		2020s		2050s		2080s	
	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.
Australia	-10.1	69.2	-6.5	76.9	6.0	46.2	5.8	46.2	21.9	30.8	48.2	7.7
Canada	-14.1	69.2	-21.3	69.2	-26.2	84.6	46.1	23.1	63.1	15.4	93.3	0
US	-27.8	100	-48.3	100	-58.3	100	-1.5	38.5	-5.0	61.5	-3.7	69.2
Germany	-16.8	53.8	-34.4	84.6	-48.7	92.3	0.7	30.8	-3.4	69.2	-5.3	69.2
France	-48.8	92.3	-57.4	92.3	-71.1	100	-22.7	76.9	-22.4	76.9	-24.7	92.3
Russia	-18.2	84.6	-39.3	100	-47.4	92.3	32.7	7.7	49.1	15.4	62.2	0
Ukraine	-23.2	84.6	-36.8	92.3	-38.1	92.3	4.1	38.5	-3.3	38.5	14.6	38.5
China	-27.1	100	-61.2	100	-67.8	100	-6.5	92.3	-7.5	69.2	-5.6	69.2
India	-40.5	100	-71.0	100	-91.9	100	-16.7	100	-32.3	100	-45.5	100
Pakistan	-26.3	100	-55.7	100	-70.8	100	-4.2	69.2	-14.9	84.6	-22.6	100

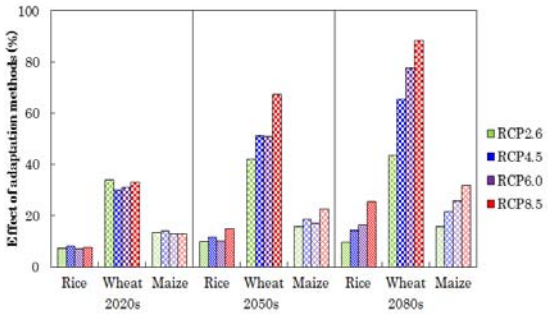
Maize	Adaptation methods (OFF)						Adaptation methods (ON)					
	2020s		2050s		2080s		2020s		2050s		2080s	
	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.
Argentina	-12.7	53.8	-9.1	76.9	-1.6	53.8	5.0	38.5	13.4	38.5	21.6	15.4
Brazil	-6.8	92.3	-4.2	69.2	-6.5	76.9	3.9	23.1	12.0	15.4	14.2	0
Canada	22.1	15.4	20.8	15.4	14.2	23.1	47.5	15.4	56.8	0	56.6	0
Mexico	-6.8	92.3	-14.5	84.6	-14.4	92.3	3.0	30.8	6.1	15.4	5.8	30.8
US	-10.3	46.2	-12.1	61.5	-10.6	38.5	1.7	38.5	2.1	46.2	7.3	38.5
France	-20.7	84.6	-23.7	100	-26.6	100	-11.4	76.9	-11.5	92.3	-10.9	84.6
China	-11.6	84.6	-11.9	84.6	-7.9	84.6	5.4	38.5	11.9	15.4	15.9	7.7
Indonesia	-1.7	61.5	0.2	61.5	-3.0	53.8	3.5	30.8	5.6	38.5	2.7	30.8
India	-31.6	100	-47.5	100	-59.4	100	-18.0	100	-28.4	100	-35.4	100
S. Africa	-48.5	100	-59.6	100	-62.0	100	-26.2	84.6	-26.4	92.3	-24.6	84.6

Results (6)

Rice	Adaptation methods (OFF)						Adaptation methods (ON)					
	2020s		2050s		2080s		2020s		2050s		2080s	
	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.	Aver.	Prob.
Brazil	-6.3	76.9	-10.4	76.9	-12.2	92.3	1.6	38.5	1.9	46.2	1.7	30.8
Bangladesh	-11.9	100	-16.6	92.3	-17.6	92.3	-1.5	61.5	0.5	53.8	0.9	53.8
China	-13.8	92.3	-14.8	84.6	-20.3	100	-7.1	76.9	-3.2	76.9	-3.3	69.2
Indonesia	0.8	30.8	4.1	7.7	4.4	23.1	3.3	23.1	6.5	0	7.0	7.7
India	-14.5	100	-10.5	100	-7.8	92.3	-1.8	61.5	6.3	0	10.7	0
Myanmar	-4.4	92.3	-3.4	76.9	-1.1	53.8	-1.6	69.2	2.5	23.1	5.9	0
Philippines	-7.2	76.9	-5.5	84.6	-2.7	46.2	-0.5	38.5	3.1	23.1	5.7	30.8
Thailand	-5.2	92.3	-1.4	46.2	-2.1	46.2	-1.8	69.2	3.1	7.7	4.5	15.4
Vietnam	-2.5	61.5	1.6	53.8	-5.0	53.8	9.8	38.5	16.9	15.4	14.4	15.4
Japan	1.8	23.1	-0.9	61.5	-2.3	46.2	5.1	7.7	8.3	7.7	11.2	0

Results (7)

- Effect of adaptation methods



- Adaptation effect is large in order of wheat, maize, rice over the all simulation period
- Effect of adaptation method is more big under the RCP8.5 scenario

Summary

- This study quantitatively assessed the impacts of climate change on wheat, maize and rice yield in consideration of the uncertainty of climate projections using GAEZ model
- Uncertainty due to the difference in CMIP5-GCM climate projections and RCP scenarios was estimated
- Vulnerable countries to climate change were estimated
  Wheat(India, France), Maize(S. Africa, India, France),
  Rice(China, Bangladesh, India)
- Adaptation effect is large in order of wheat, maize, rice over the all simulation period

THANK YOU!

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