Macroeconomic impacts of climate change associated with changes in crop yields

Shinichiro Fujimori[1,2], Toshichika Iizumi[3], Tomoko Hasegawa[1,2], Jun'ya Takakura[1], Kiyoshi Takahashi[1], Yasuaki Hijioka[1]

[1] Center for Social & Environmental Systems Research, National Institute for Environmental Studies, Japan
[2] International Institute for Applied System Analysis (IIASA), Austria
[3] Institute for Agro-Environmental Sciences, National Agriculture and Research Organization, Japan

E-Mail: fujimori.shinichiro@nies.go.jp

Background

Changes in agricultural yield due to future climate change will affect land use, production volume, and prices in the agriculture sector, as well as macroeconomic indicators such as gross domestic product (GDP). The macroeconomic effects of changes in agricultural yield are not well understood in terms of: 1) uncertainties regarding land-use adaptation (yield calculation method), 2) the amplitude of the CO2 fertilization effect, 3) the use of multiple climate models, and 4) the level of mitigation policy. This study considered these four key factors and clarified macroeconomic impacts due to crop yield changes using a novel integrated assessment framework consisting of a global gridded crop model, an economic model, and a land-use allocation model.

Methods

A crop model (Crop Yield Growth Model with Assumptions on climate and socioeconomy: CYGMA [1]), a land use distribution model (integration Platform for Land-Use and Environmental Modelling: AIM/PLUM [2]) and a global computable general equilibrium model (AIM/CGE) [3] were used as the main tools.

Scenario list

scenario number	Socioeconomic condition	Climate condition	Aggregate method	CO_2 fertilization	Mitigation
1	SSP2	NoCC	base		
2	SSP2	NoCC	change		
3	SSP2	RCP8.5	harv		
4	SSP2	RCP8.5	change		
5	SSP2	NoCC	harv	X	
6	SSP2	RCP8.5	base	X	
7	SSP1	NoCC	base		
8	SSP1	RCP8.5	base		
9	SSP3	NoCC	base		
10	SSP3	RCP8.5	base		
11	SSP2	RCP2.6	base		
12	SSP2	RCP2.6	base		X

GCM list

Code	Model name
ge2m	GFDL-ESM2M
hg2e	HadGEM2-ES
ipsl	IPSL-CM5A-LR
mes_	MIROC-ESM
ne1m	NorESM1-M

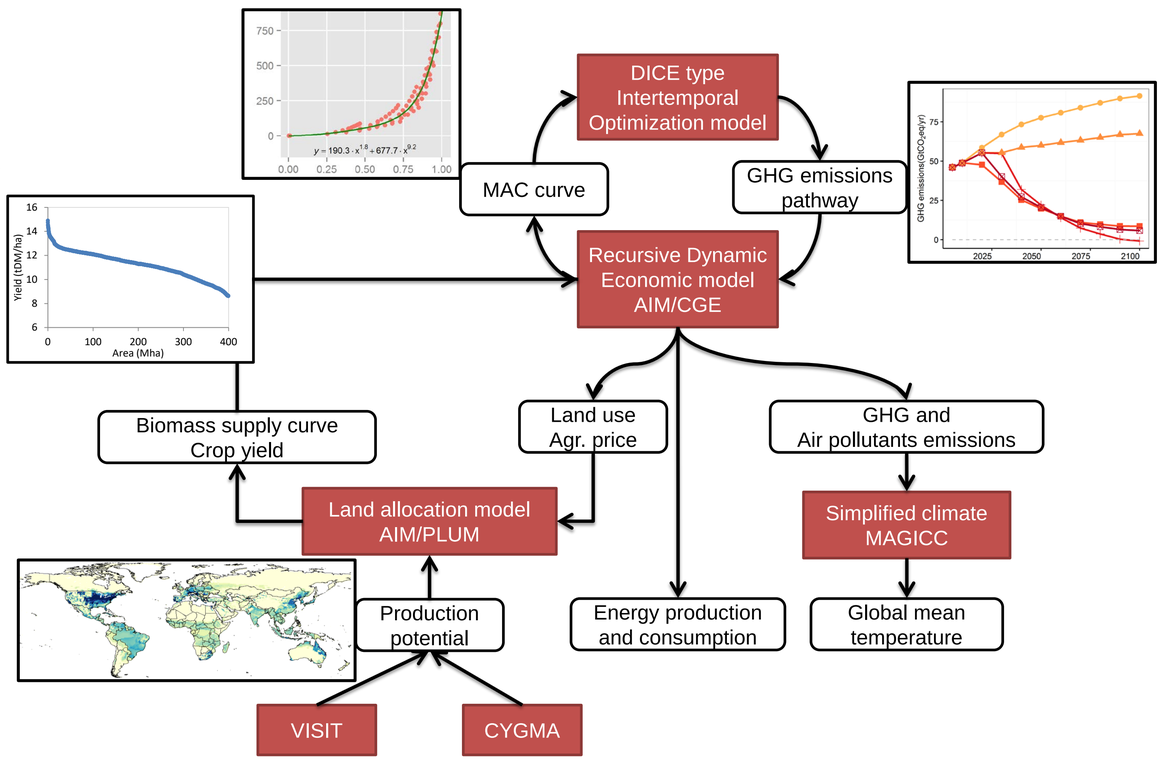

Fig.1 Framework of the simulation

Results & Discussion

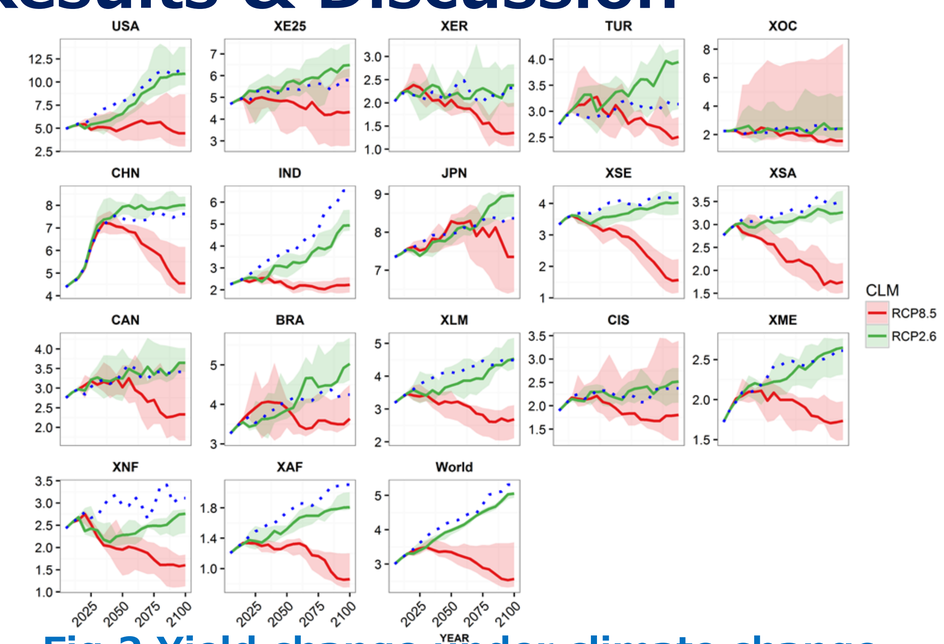

Fig.2 Yield change under climate change

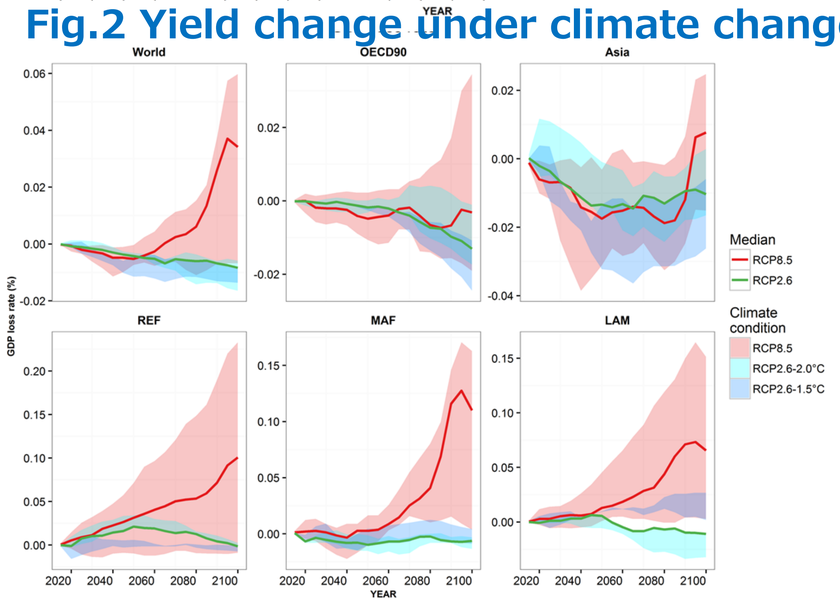

Fig.3 GDP change rate by RCPs and 1.5 degree.

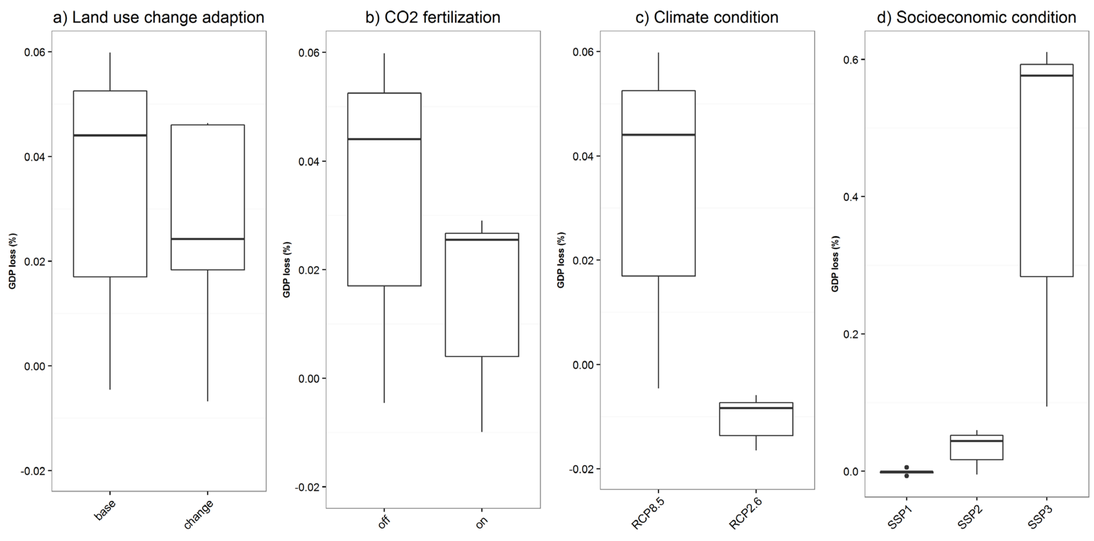

Fig.4 Estimated GDP change in 2100

It was found that the CO2 fertilization effect and land-use adaptation did not lead to distinct differences in the macro economy, and were smaller (0.02 - 0.06% of GDP) in amplitude than the economic impacts of climate change in other sectors, such as human health. However, the impacts on the agricultural sector varied greatly depending on socioeconomic assumptions, and these factors had a greater influence (0.6%) under a pessimistic world scenario, characterized by a large population increase and low income. The differences between a temperature rise of 1.5 and 2.0°C were not clearly identified and, therefore, further studies with more climate information are required.

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References

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