Output of Project S14-5

Qian ZHOU

National Institute for Environmental Studies

ASIA-PACIFIC INTEGRATED MODEL

MiLAi

Strategic Research on Global Mitigation and Local Adaptation to Climate Change [S-14]

NIES JAPAN

What's Project S14?

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Strategic Research on Global Mitigation and Local Adaptation to Climate Change [S-14]

Strategic R&D Area Project "S-14" of the Environment Research and Technology Development Fund

Strategic Research on Global Mitigation and Local Adaptation to Climate Change [MiLAi]

TOP | OVERVIEW | MEMBERS | LINKS | JAPANESE

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What's Project S14?

S14: Professor Oki Taikan

The University of Tokyo

S14-5: Section head:

Dr. Hijioka Yasuaki

S14-5(2)

Dr. Hanasaki Naota

Dr. Qian ZHOU

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What did we do in Project S14-5(2)?

Mission: Establishing theoretical and technical foundation for coupling Global Hydrology model H08 and CGE model

PI: Dr. Hanasaki Naota

Dr. Zhou Qian

Focus: Water constraints on global hydropower and thermoelectric supply capability under climate change

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Background: hydropower supply

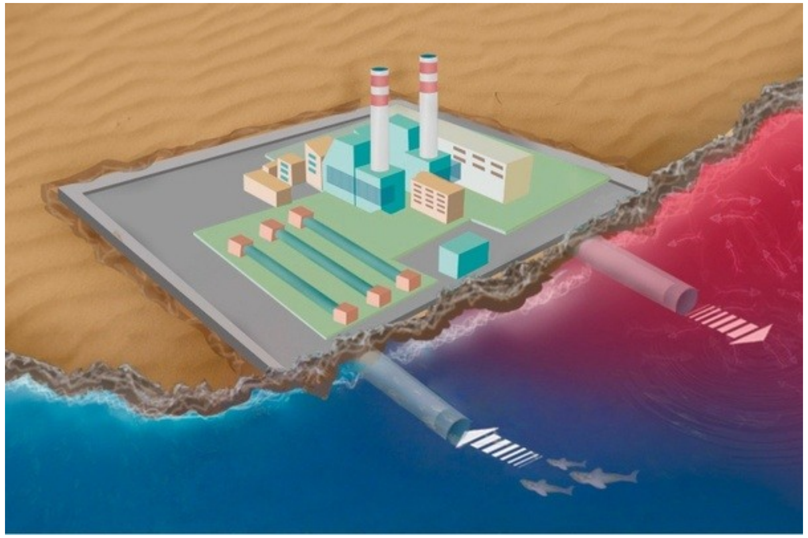
- Currently, hydropower is a dominant renewable resource due to its low cost and low greenhouse gas (GHG) emissions (IEA, 2012).

- However, hydropower potential is effected by climate change

Background: thermal power supply

Climate change

Cooling water shortage



Thermal power plant shut down

How climate change constraints hydropower and thermal power supply capability through water ?

Hydropower 2

Climatic Change

Economic consequences of global climate change and mitigation on future hydropower generation

--Manuscript Draft--

Manuscript Number:	CLIM-D-16-00501R3

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Hydropower 1

MODEL-BASED ANALYSIS OF IMPACT OF CLIMATE CHANGE AND MITIGATION ON HYDROPOWER

Qian ZHOU[1], Naota HANASAKI[2], Shinichiro FUJIMORI and Yasuaki HIJIOKA[5]

Zhou et al. 2016

Thermal power 1

Journal of Japan Society of Civil Engineers, Ser. B1 (Hydraulic Engineering), Vol. 73, No. 4, I_79-I_84, 2017.

AN ANALYSIS ON HYPOTHETICAL SHOCKS REPRESENTING COOLING WATER SHORTAGE USING A COMPUTABLE GENERAL EQUILIBRIUM MODEL

Qian ZHOU[1], Naota HANASAKI[2], Jun'ya TAKAKURA[3], Shinichiro FUJIMORI[4], Kiyoshi TAKAHASHI[5] and Yasuaki HIJIOKA[6]

Key Words : cooling water shortage, thermoelectric sectors, capital productivity, CGE model

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Thermal power 2 and 3

On the way……

Under preparation

Model-Based Analysis of Impact of Climate change and Mitigation on Hydropower

Qian ZHOU, Naota HANASAKI, Shinichiro FUJIMORI, Yoshimitsu MASAKI and Yasuaki HIJIOKA

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Research Questions

This paper aims to address following research questions:

- What is the state-of-the-art knowledge on the impact of climate change on hydropower?
- What are the potential key interactions of combining physical models and economic models in terms of hydropower in global and regional scales?
- How significant such interactions are?

Method

- Global Hydrology model
- AIM/CGE model

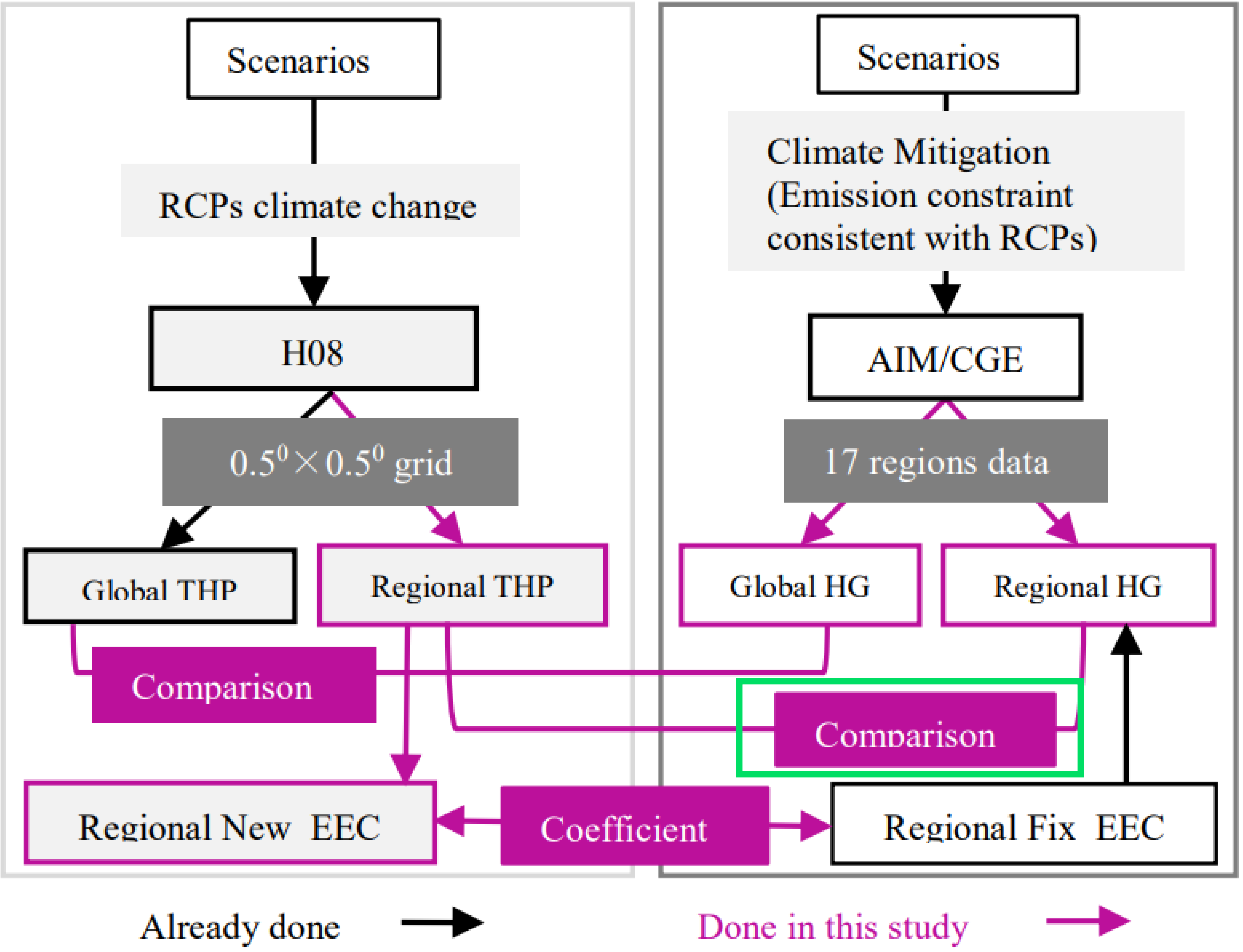

Fig.1 Framework of this study

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Results

IAM model Fix the hydropower supply capability

Physical model

Economic model

Supply potential is variable

Electricity Generation increase fast

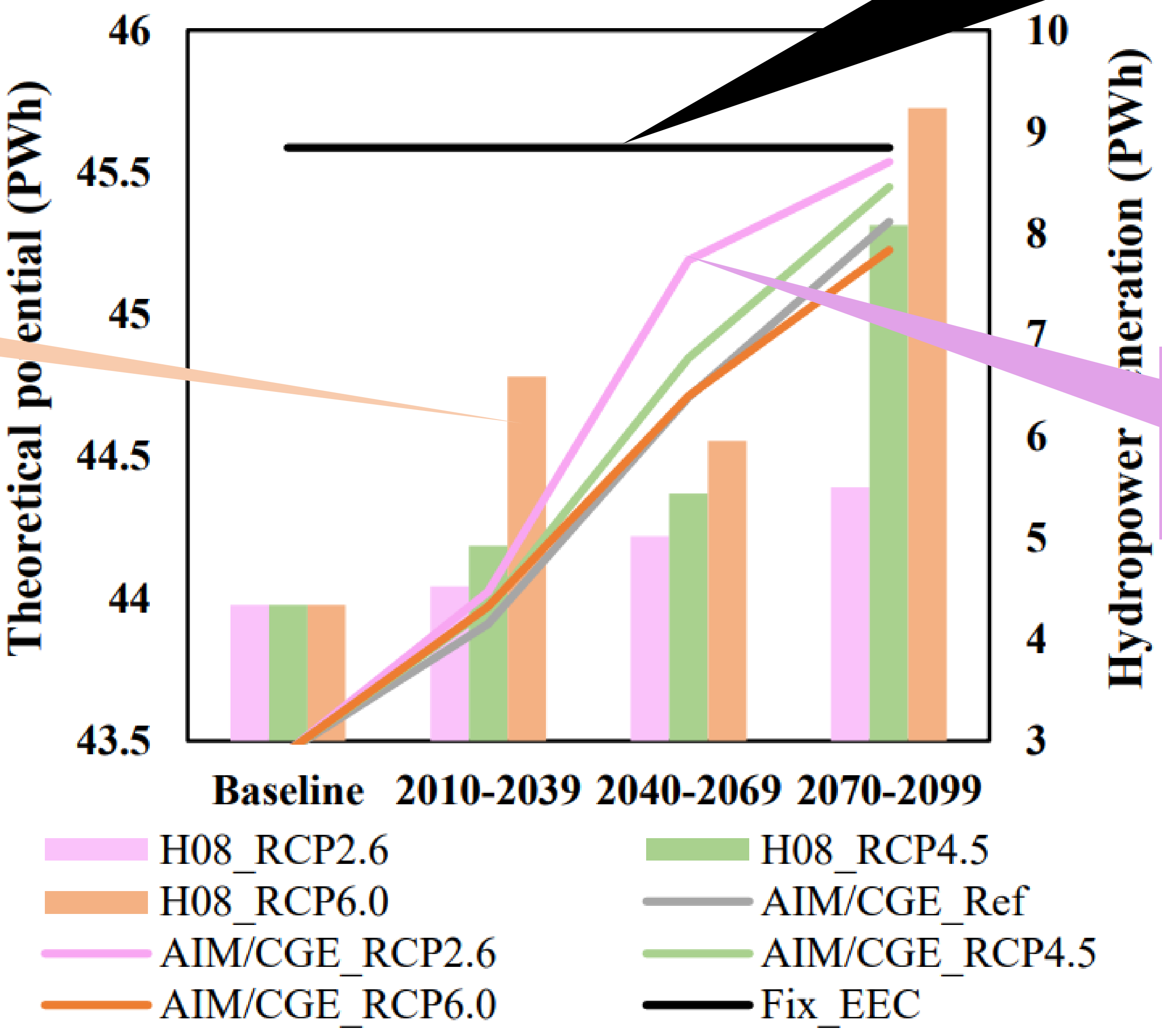

Fig.2 Global hydropower THP/HG and Fixed EEC; Baseline of H08: 1960-1989; Baseline of AIM/CGE: 2005

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Results

Global hydropower supply potential is variable

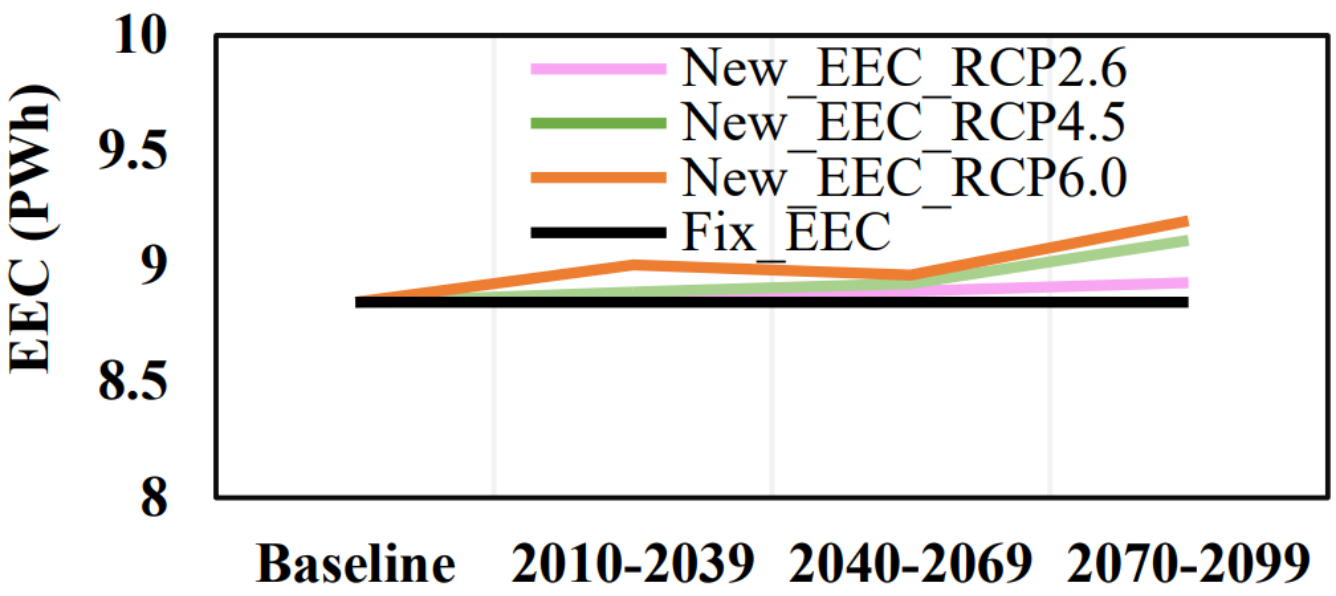

Fig.3 Trends in EEC

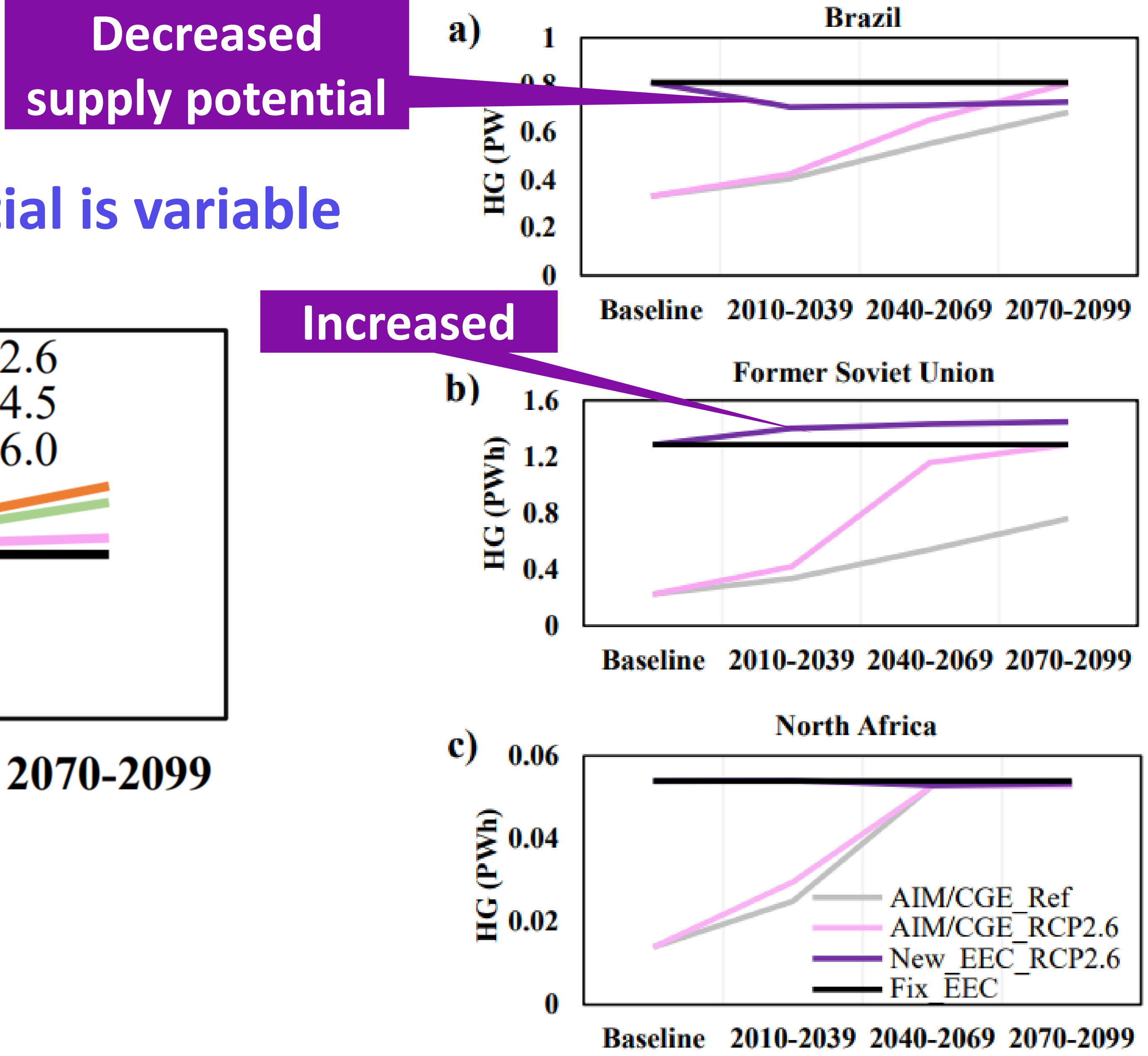

Fig.4 Regional trends in HG, EEC: **a)** Brazil; **b)** Former Soviet Union and **c)** North Africa

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Results

Climate change impact on hydropower potential
Mitigation impact on hydropower generation

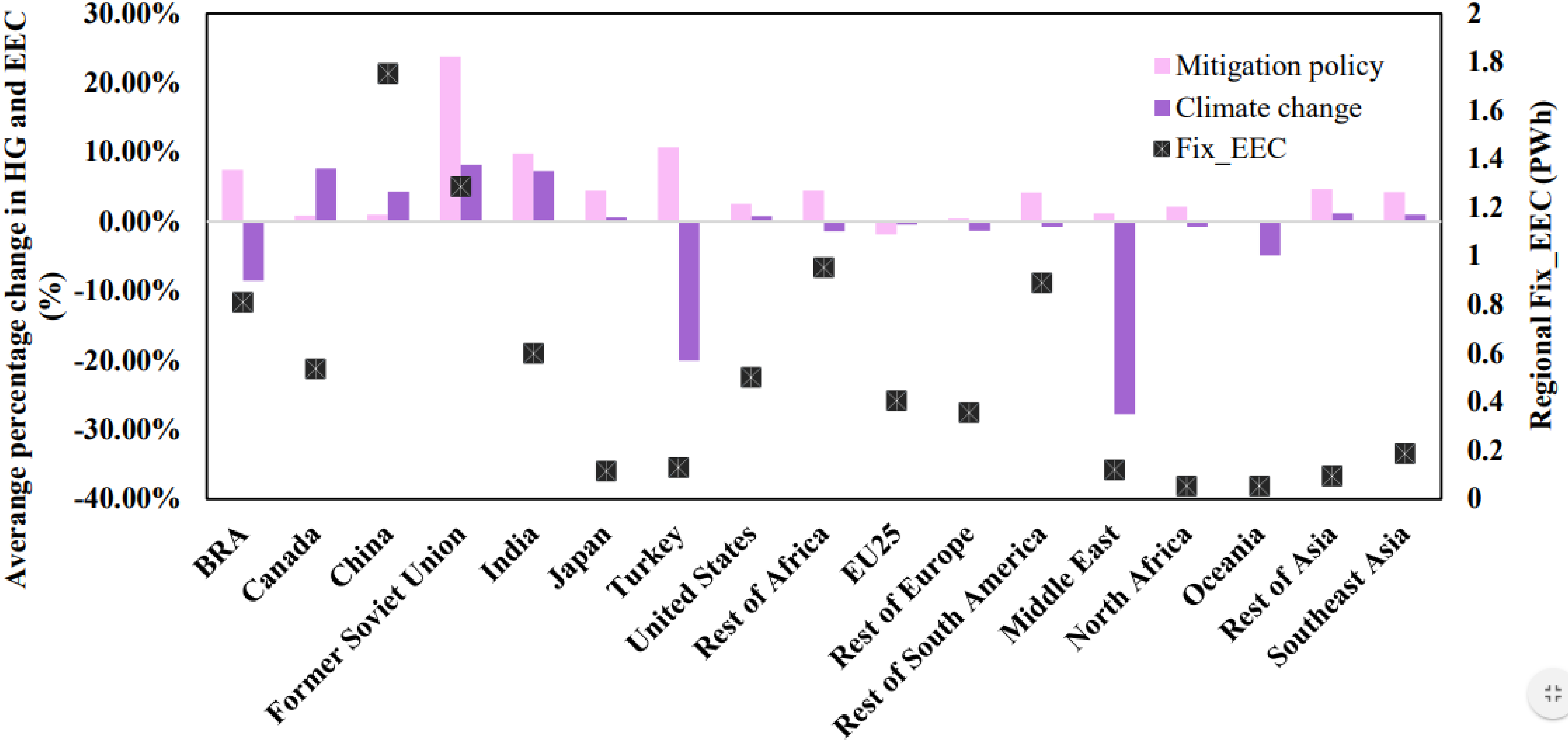

Fig.5 Fix_EEC: regional Fix_EEC set in AIM/CGE model; Mitigation policy: average percentage changes in regional HG normalized by Fix_EEC due to mitigation policy; Climate change: average percentage changes in EEC nominalized by regional Fix_EEC due to climate change; With *VS.* without mitigation policy: HG in AIM/CGE_RCP2.6 *VS.* AIM/CGE_Ref; with *VS.* without climate change: New_EEC in H08_RCP2.6 *VS.* Fix_EEC.

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Questions

Is climate change impact on hydropower potential is negligible?

How to quantify economy consequence of hydropower potential change?

Hydropower 2

Climatic Change
Economic consequences of global climate change and
generation
--Manuscript Draft--

Manuscript Number:	CLIM-D-16-00501R3
Full Title:	Economic con generation
Article Type:	Research Artic
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Corresponding Author's Secondary Institution:	
First Author:	Qian Zhou, Ph
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Order of Authors:	Qian Zhou, Ph Naota Hanasa Shinichiro Fuji Yoshimitsu Ma Yasuaki Hijiok
Order of Authors Secondary Information:	
Funding Information:	The Environm Technology D the Ministry of
Abstract:	Hydropower g power supply. be affected by models. In this under two phy Integrated Mod quantify the ec on hydropowe of climate chan hydropower ge was little overa the MAHG ave in RCP8.5). W product (GDP) mitigation polic implementatio hydropower ag there would be positive effects regions.

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Hydropower 1

B1 (Hydraulic Engineering), Vol. 72, No. 4, I_19-I_24, 2016.

MODEL-BASED ANALYSIS OF IMPACT OF CLIMATE CHANGE AND MITIGATION ON HYDROPOWER

Qian ZHOU[1], Naota HANASAKI[2], Shinichiro FUJIMORI and Yasuaki HIJIOKA[5]

Key Words : Climate change, mitigation policy, theoretical hydropower economically exploitable capability

1. INTRODUCTION

Hydropower is a dominant renewable source to generate electricity in the world today. Currently, hydropower accounts for 16% of the worldwide electricity power supply and 86% of the total renewable electricity energy source. This is due to its low cost, low greenhouse gas (GHG) emission, and relatively high reliability compared to other renewable source of energy.

Climate change is a big concern of the society. To stabilize the climate, considerable reduction of GHG emission is required accompanied by gradual shift from fossil fuel to renewable energy. Stringent climate mitigation policy would increase demand of the hydropower because it emits no GHG. On the other hand, hydropower is dependent on streamflow which is influenced by hydrological change (e.g.

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Thermal power 1

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Key Words : cooling water shortage, thermoelectric sectors, capital productivity, CGE model

1. INTRODUCTION

Fresh water is indispensable to sustain humans' lives and society. Among various use of water, power plant cooling is one of major water usages in the world. Globally 19.9 EJ/yr of electricity is produced[1]. Among various technology, 16.5 EJ/yr (81%) was generated by thermal power in 2010[1]. Here the primary energy sources of thermal power includes gas, oil, coal, nuclear, and biomass. The

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On the way……

Under preparation

Hydropower 2

Economic consequences of global climate change and mitigation on future hydropower

Qian ZHOU, Naota HANASAKI, Shinichiro FUJIMORI,

Yoshimitsu MASAKI and Yasuaki HIJIOKA

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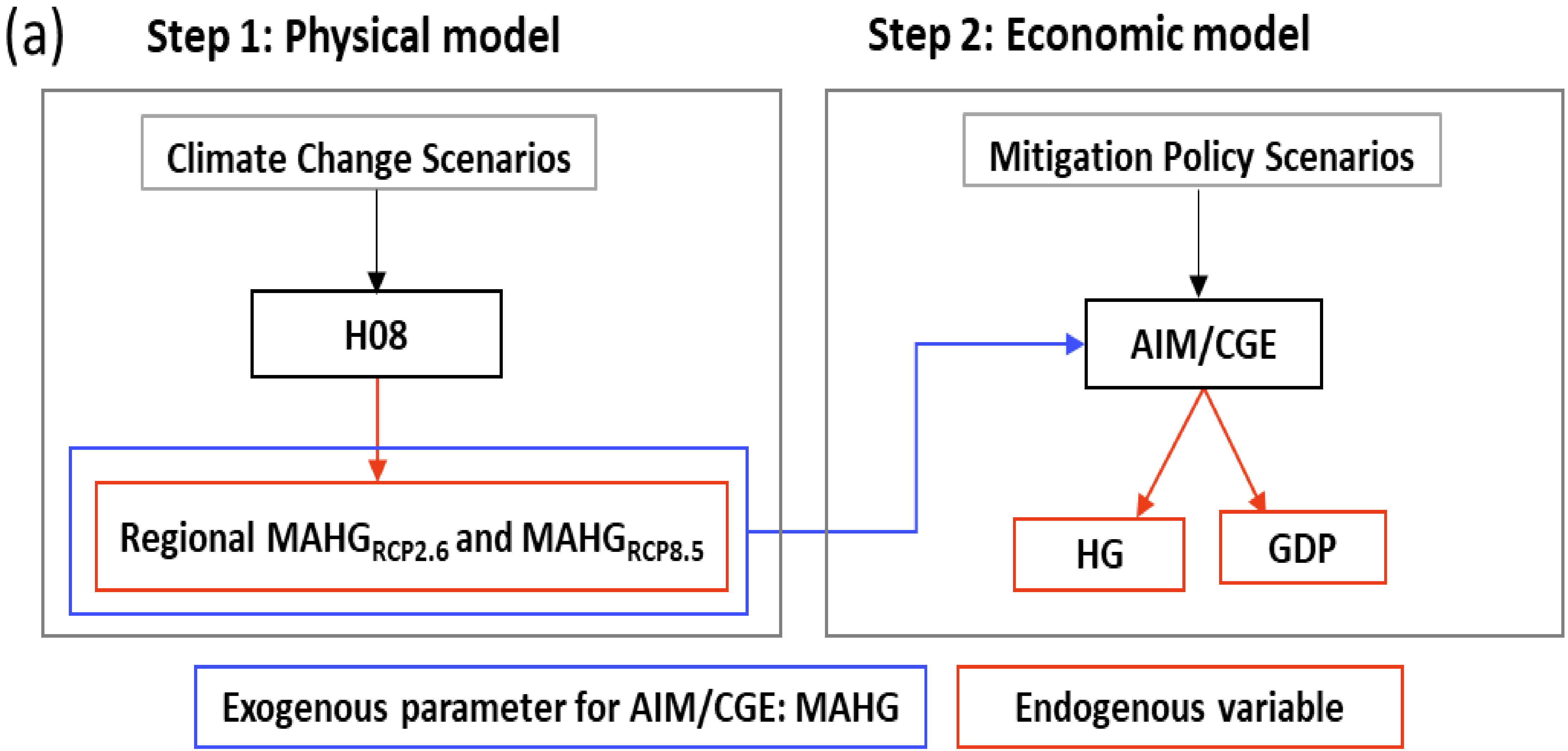
Methodology

How to quantify economy consequence of hydropower potential change?



Results *Hydropower Generation change*

no Mitigation

Mitigation

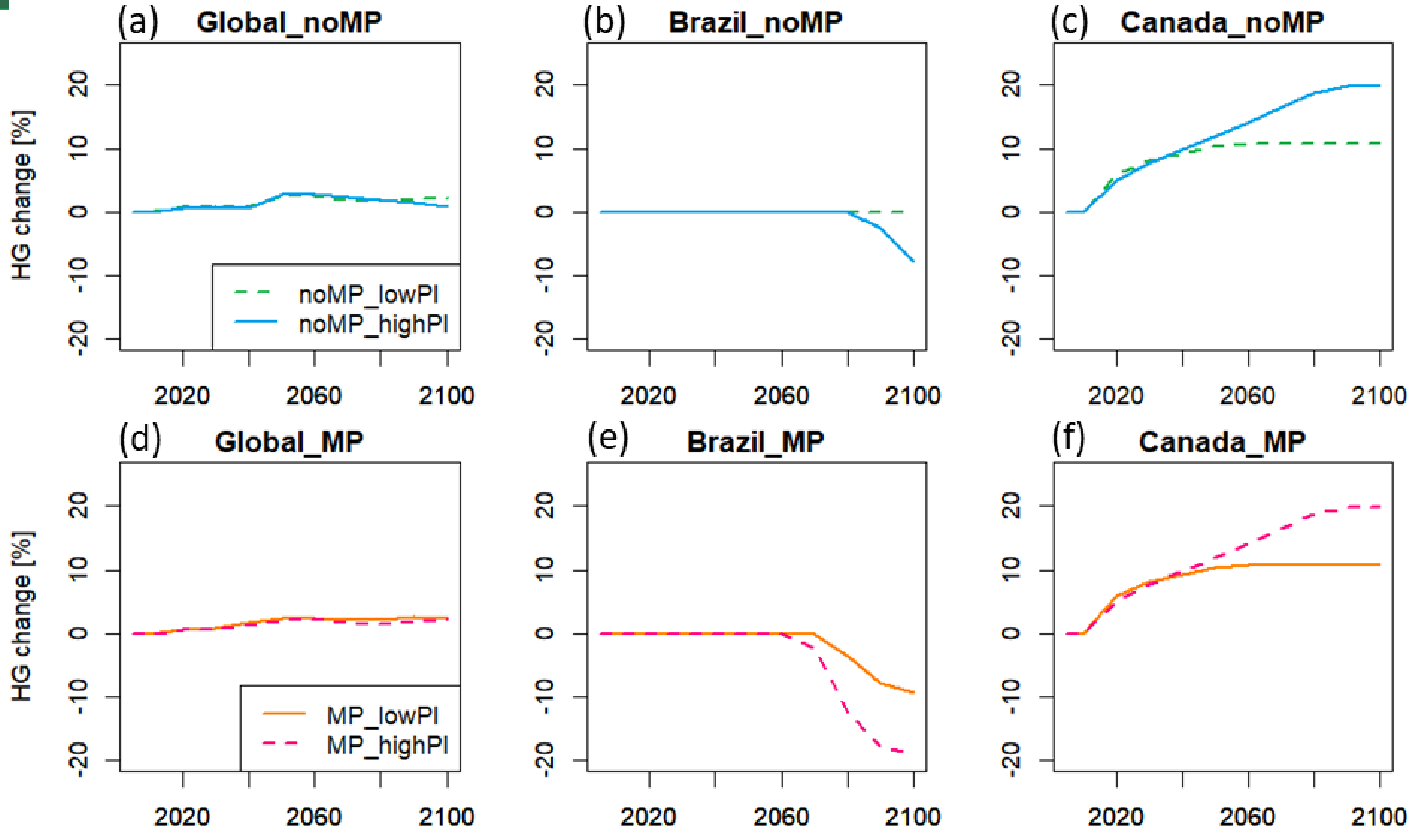


Figure 4. Magnitude of hydropower generation changes

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Results *Why GDP changes is different in these regions?*

no Mitigation

Mitigation

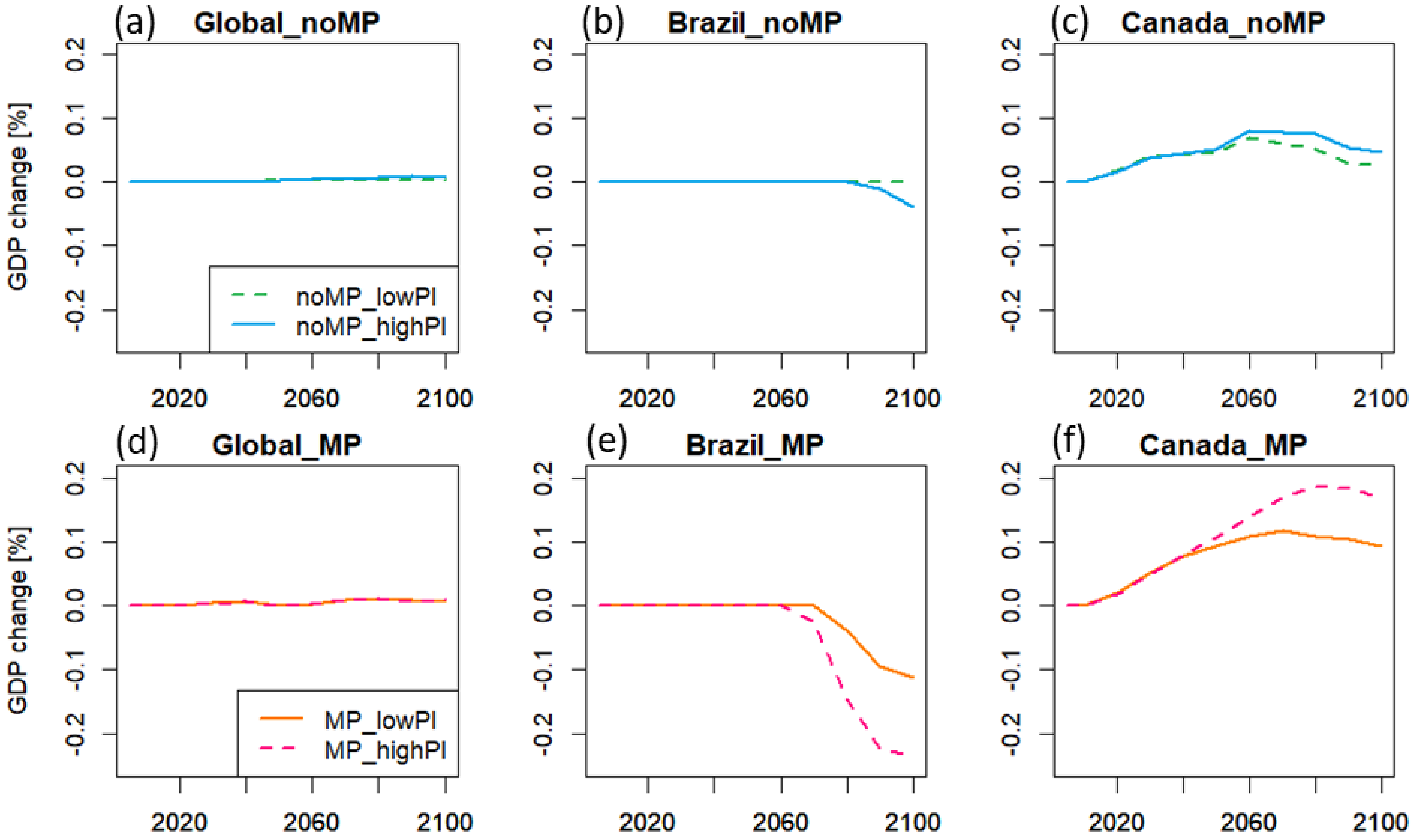

Figure 4. Magnitude of GDP changes

Results *GCMs uncertainty analysis for GDP*

no Mitigation

Mitigation

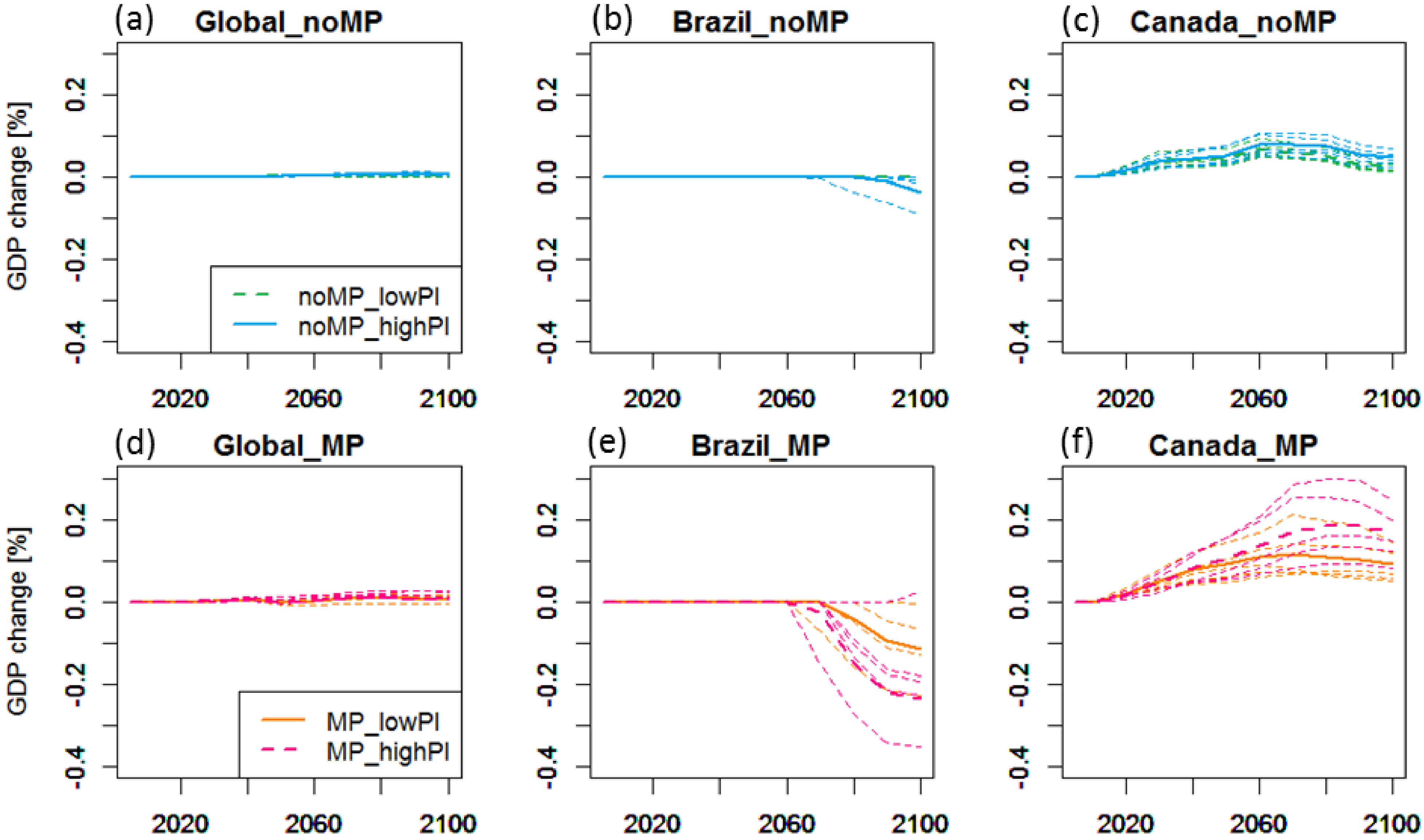

Figure 9. Magnitude of GDP changes due to individual and ensemble GCM based MAHG shocks

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1. INTRODUCTION

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Thermal power 1

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Key Words : cooling water shortage, thermoelectric sectors, capital productivity, CGE model

1. INTRODUCTION

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Thermal power 2 and 3

On the way……

Under preparation

Thermal power 1

An Analysis on Hypothetical Shocks Representing Cooling Water Shortage Using a Computable General Equilibrium Model

Qian ZHOU, Naota Hanasaki, Jun'ya TAKAKURA, Shinichiro FUJIMORI,
Kiyoshi TAKAHASHI and Yasuaki HIJIOKA

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Background

- In 2007, nuclear and coal-fired plants in the Tennessee Valley Authority system were forced to shut down or curtail operations because intake water exceeded 90 F (32.2° C) for 24 hours
- In 2003, France lost the electricity production of 7% to 15% of nuclear capacity for 5 weeks (DOE, 2012)

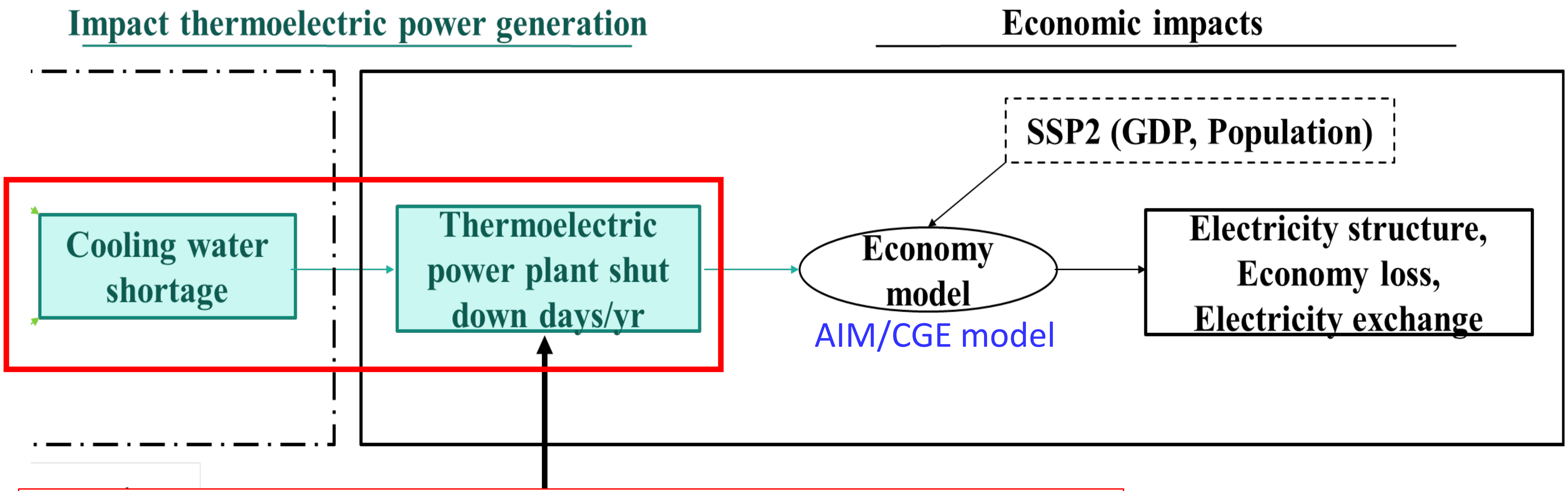
Research Question

- What is the socio-economic consequence of giving a certain intensity of shock representing the shortage of cooling water in thermal power sectors under the framework of a computable general equilibrium model?

- How the shock in thermal power sectors propagates into the global economy.

Method: Framework

- *How to numerate cooling water shortage for CGE input data?*
- *How to connect cooling water shortage with CGE model?*



Hypothetical Shocks:
4 days/year power plants shut down: 4/365≈1% reduction

Result: How were electricity and GDP changed?

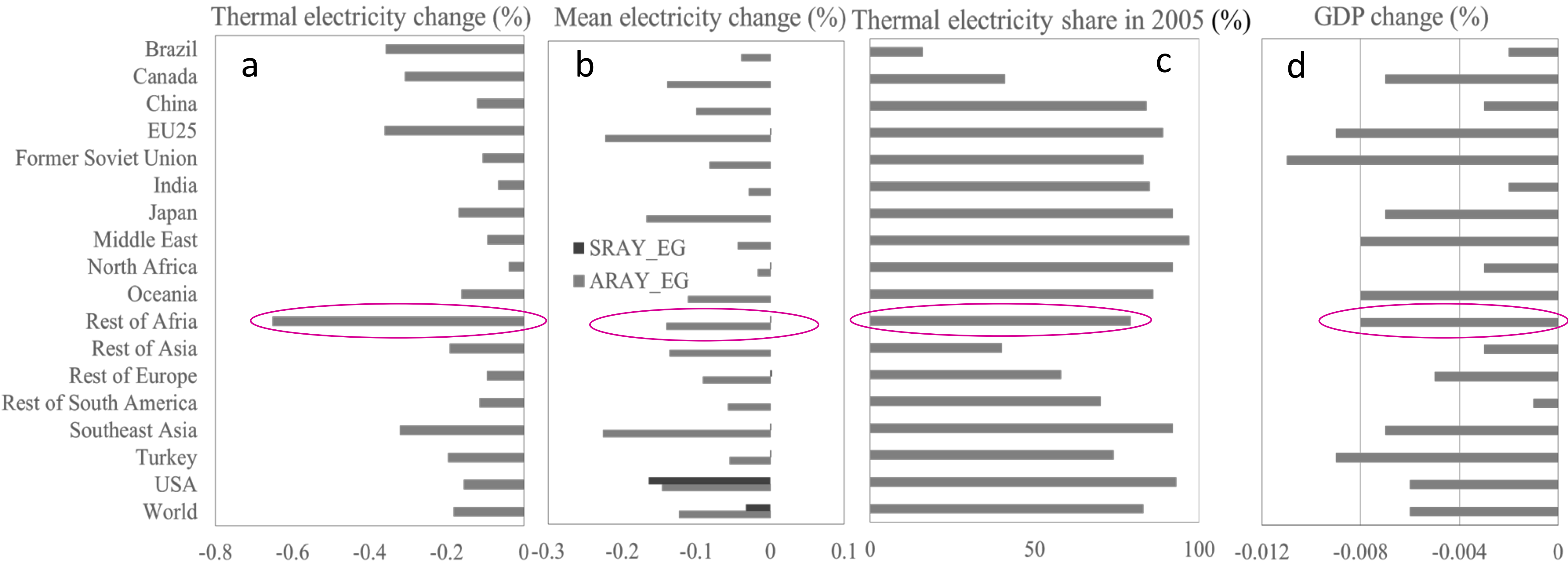


Fig. 3

(a) Thermal power change compared with baseline in 2050 in ARAY scenario.

(b) Mean difference in electricity generation (EG) from the baseline (between 2005 and 2100).

(c) The rate of thermal electricity production to total electricity production in 2005.

(d) GDP change compared with baseline in 2050 in ARAY scenario

Hydropower 2

Climatic Change

Economic consequences of global climate change and mitigation on future hydropower generation

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On the way……

Under preparation

Thermal power 2 and 3

Topic 1: Global thermal power usable capacity reduction from cooling water consumption shortage attributable to climate change

Topic 2: Economic consequences of cooling water shortage impact on thermoelectric supply capability under climate change

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Results

- How climate change impact the global thermoelectric usable capacity?

- 5 GCMs
- RCP2.6 and RCP8.5

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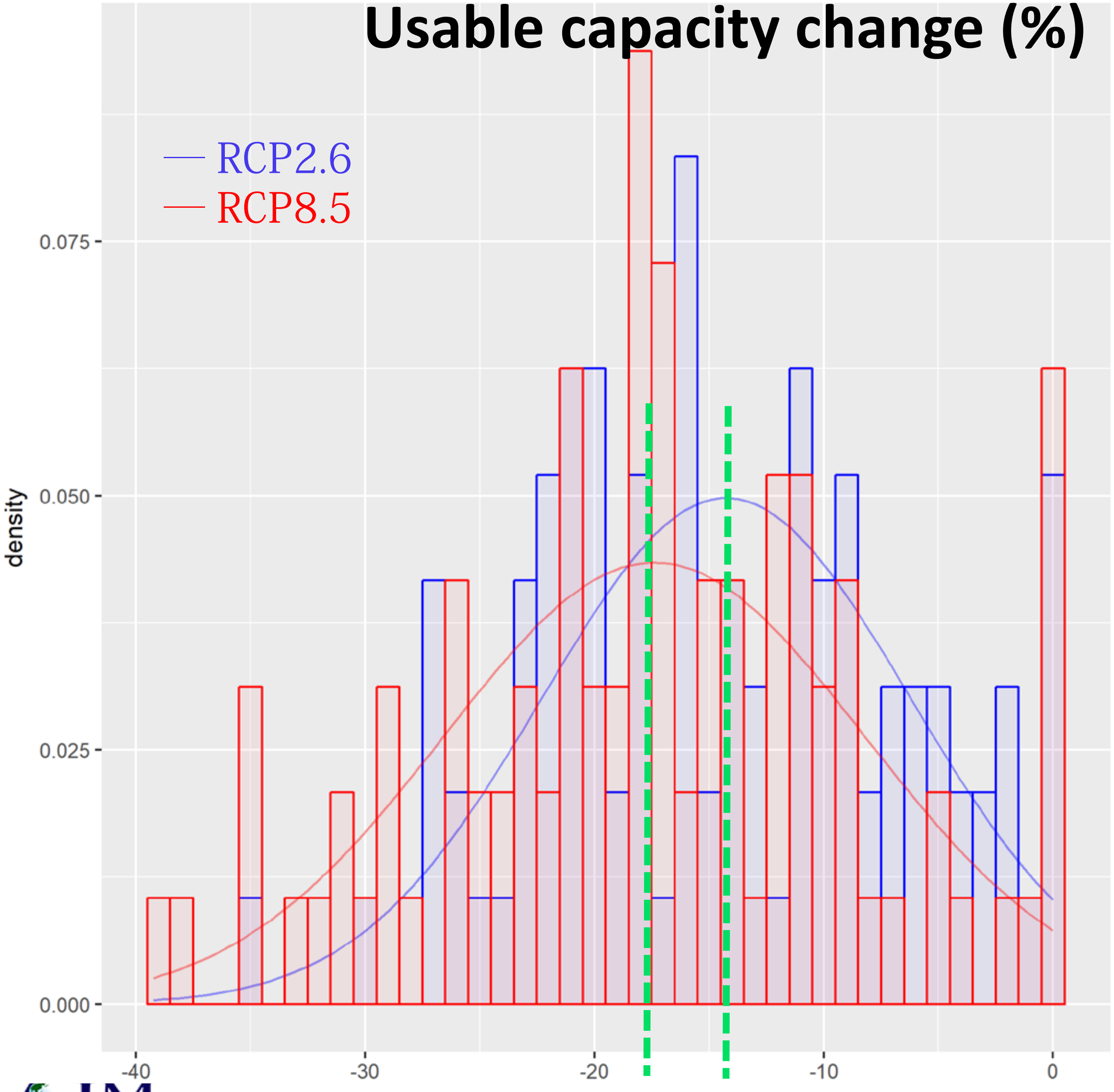
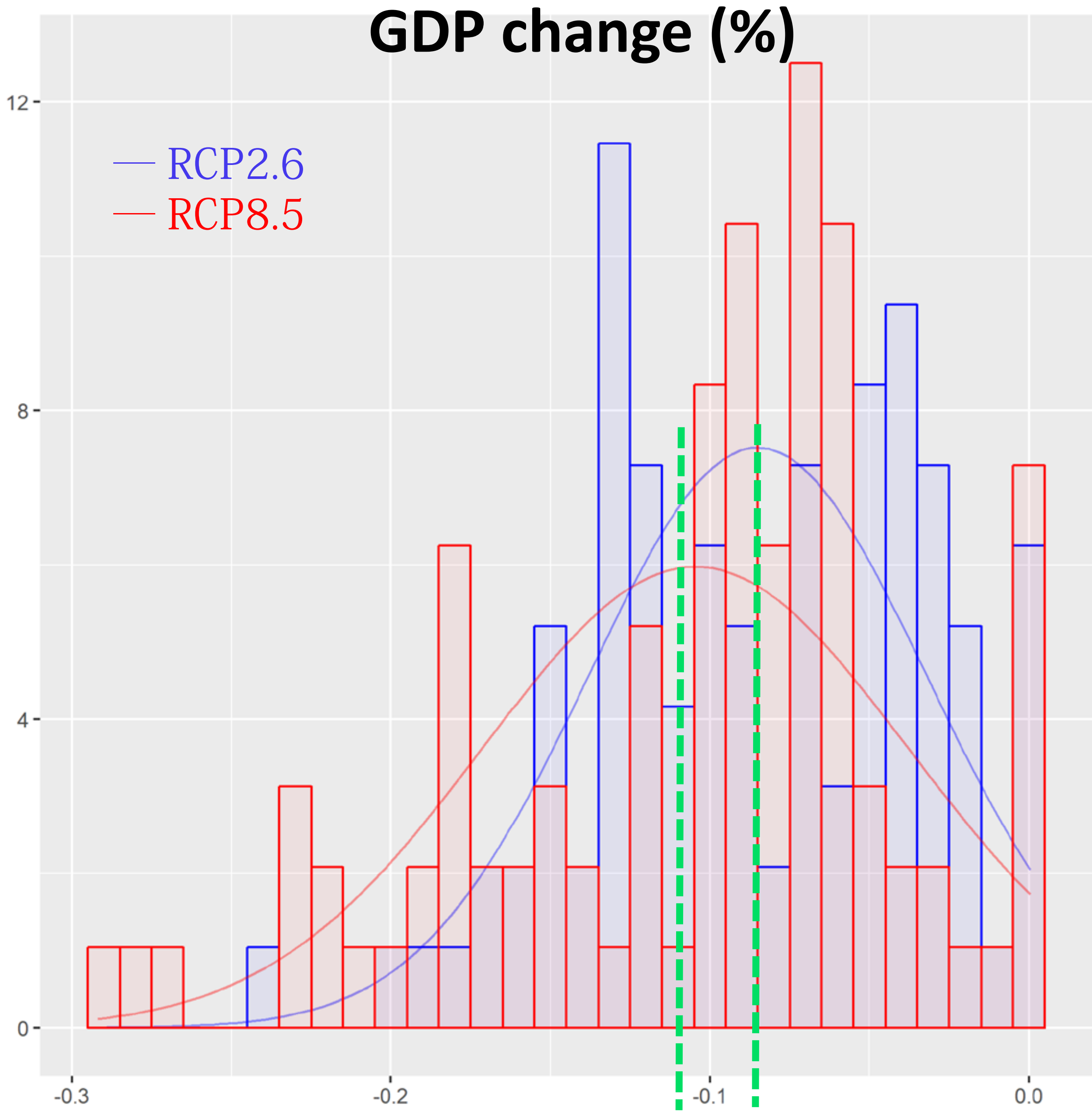
Results

USA

GCM: MIROC Data: 2005-2100





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Summary

- Climate change impact on hydropower and thermoelectric potential should not be negligible in IAM

Acknowledgements

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Thank you very much for your attention!

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