Future Flood and Food Risks under Climate Change

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LETTERS

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Global flood risk under climate change

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A warmer climate would increase the risk of floods[1]. So far, only a few studies[2,3] have projected changes in floods on a global scale. None of these studies relied on multiple climate models. A few global studies[4,5] have started to estimate the exposure to flooding (population in potential inundation areas) as a proxy of risk, but none of them has estimated it in a warmer future climate. Here we present global flood risk for the end of this century based on the outputs of 11 climate models. A state-of-the-art global river routing model with an inundation scheme[6] was employed to compute river discharge and inundation area. An ensemble of projections under a new high-concentration scenario[7] demonstrates a large increase in flood frequency in Southeast Asia, Peninsular India, eastern Africa and the northern half of the Andes, with small uncertainty in the direction of change. In certain areas of the world, however, flood frequency is projected to decrease. Another larger ensemble of projections under four new concentration scenarios[7] reveals that the global exposure to floods would increase depending on the degree of warming, but interannual variability of the exposure may imply the necessity of adaptation before significant warming.

of data availability. Specifically, daily runoff data for multiple AOGCMs were not available in the public domain, such as in the data portal of CMIP3.

Here, we used outputs of the latest 11 AOGCMs participating in CMIP5 (ref. 10) to compute a global projection of changes in flooding and evaluate its consistency and spread. Daily runoff data of two sets of AOGCM simulations were employed in this study: historical simulations (1850–2005) forced by natural (for example, volcanic and solar) and anthropogenic (for example, greenhouse gases and ozone) forcings, and future simulations (2006–2100) forced by the Representative Concentration Pathway (RCP) scenarios[7]. The RCP spans a range of radiative forcing from 2.6 to 8.5 W m^{-2} and represents various possible climate outcomes[11].

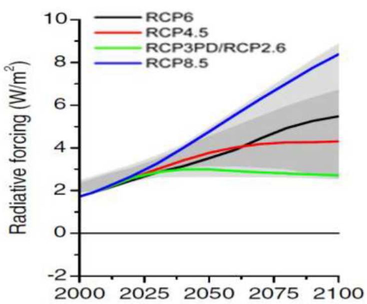
A change in flooding between a present (20C) and a future (21C) time period was obtained as a change in the return period (probability) of a river discharge having a particular magnitude. Following previous studies[3,12], a river discharge corresponding to a 100-year flood in 20C was selected as the particular magnitude. The time series of simulated annual maximum daily river discharge in 20C (1971–2000) and 21C (2071–2100) were fitted respectively to an extreme distribution function; subsequently, the magnitude

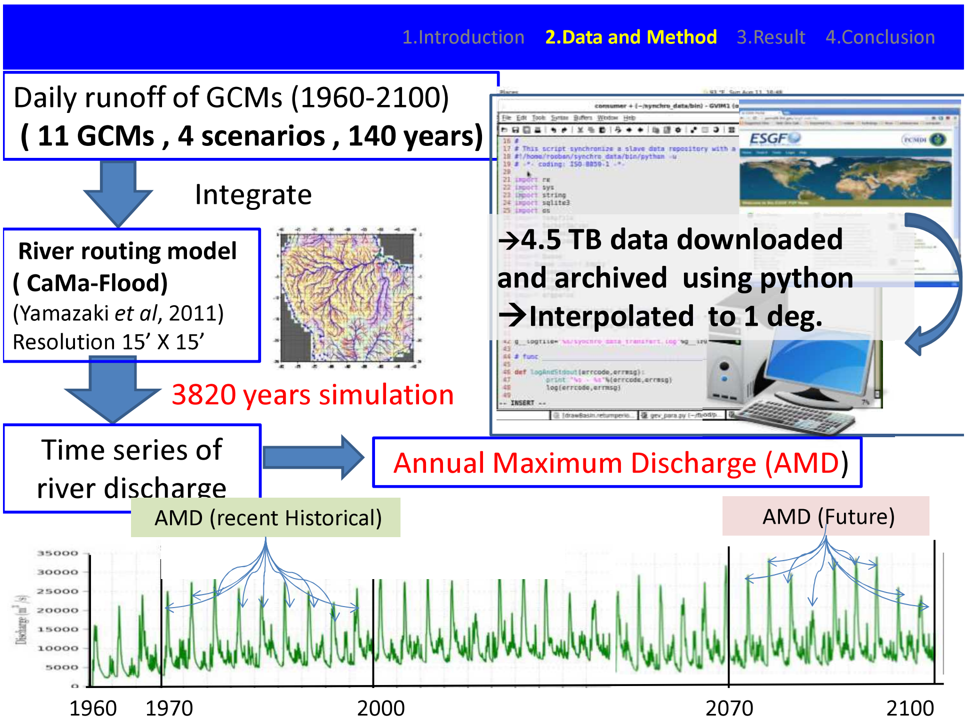
Data and Model

Data (GCMs and Scenarios)

Climate Model	Resolution	RCP scenario availability			
		2.6 (8)	4.5 (11)	6.0 (5)	8.5 (11)
BCC-CSM1.1	128 × 64	Y	Y	Y	Y
CCCma-CanESM2	128 × 64	N	Y	N	Y
CMCC-CM	480 × 240	N	Y	N	Y
CNRM-CM5	256 × 128	Y	Y	N	Y
CSIRO-Mk3.6.0	192 × 96	Y	Y	N	Y
GFDL-ESM2G	144 × 90	Y	Y	Y	Y
INM-CM4	180 × 120	N	Y	N	Y
MIROC5	256 × 128	Y	Y	Y	Y
MPI-ESM-LR	192 × 96	Y	Y	N	Y
MRI-CGCM3	320 × 160	Y	Y	Y	Y
NCC-NorESM1-M	144 × 96	Y	Y	Y	Y

- We used the latest **CMIP5** data (*Taylor et al., 2011*) which are under **RCP** scenarios.





Estimating the future changes in return period

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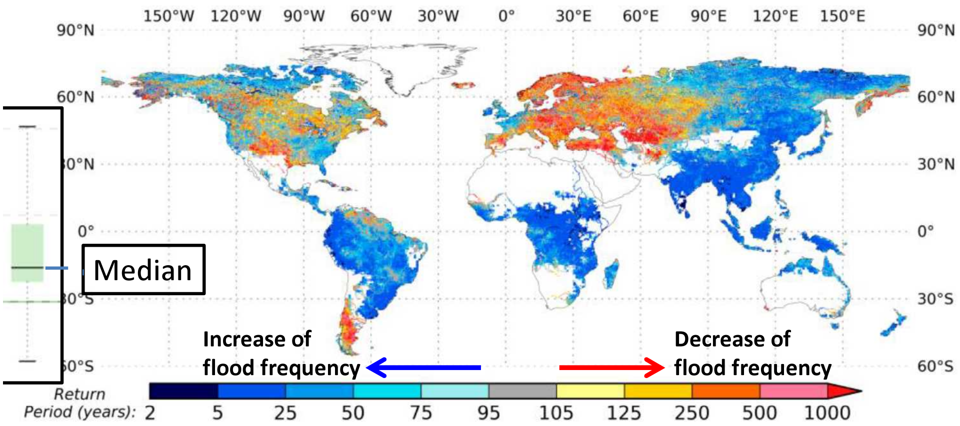
Future Return Period (RCP8.5)

on 2.Data and Method **3.Result** 4.Conclusion



- Flood frequency is expected to increase in many regions of South Asia, South East Asia, Africa and South America.
  (where precipitation and extreme precipitation increase)
- Flood frequency is expected to decrease in a part of Europe.

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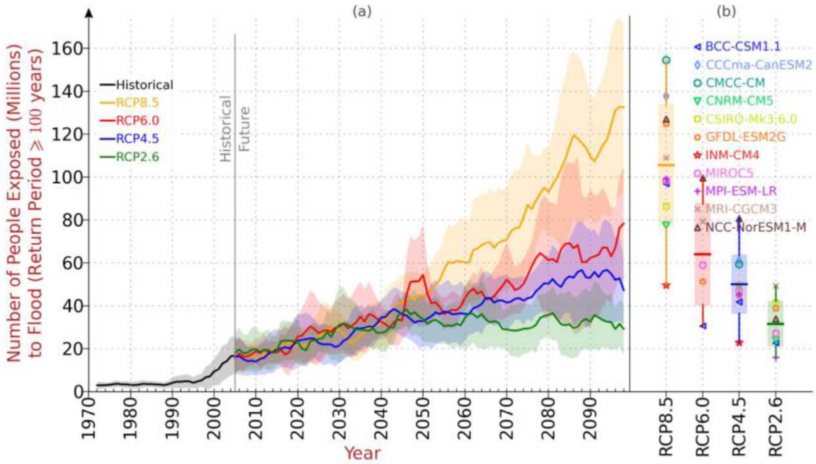
Also, we calculated “Exposure”.

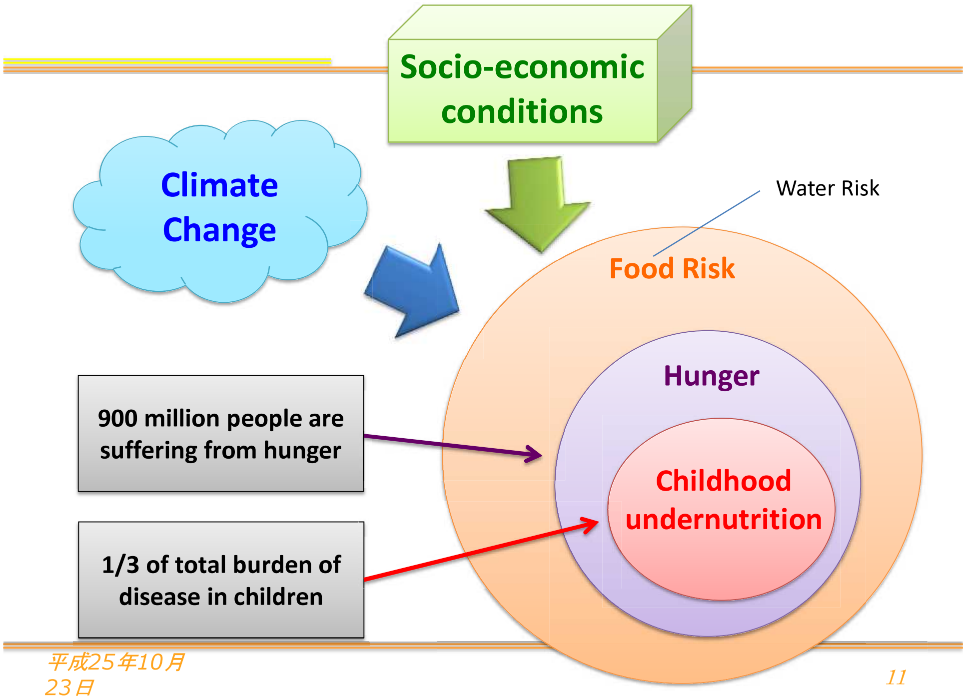
Here, “exposure” is “population in potential inundation areas (with > 100-yr floods)” as a proxy of risk.

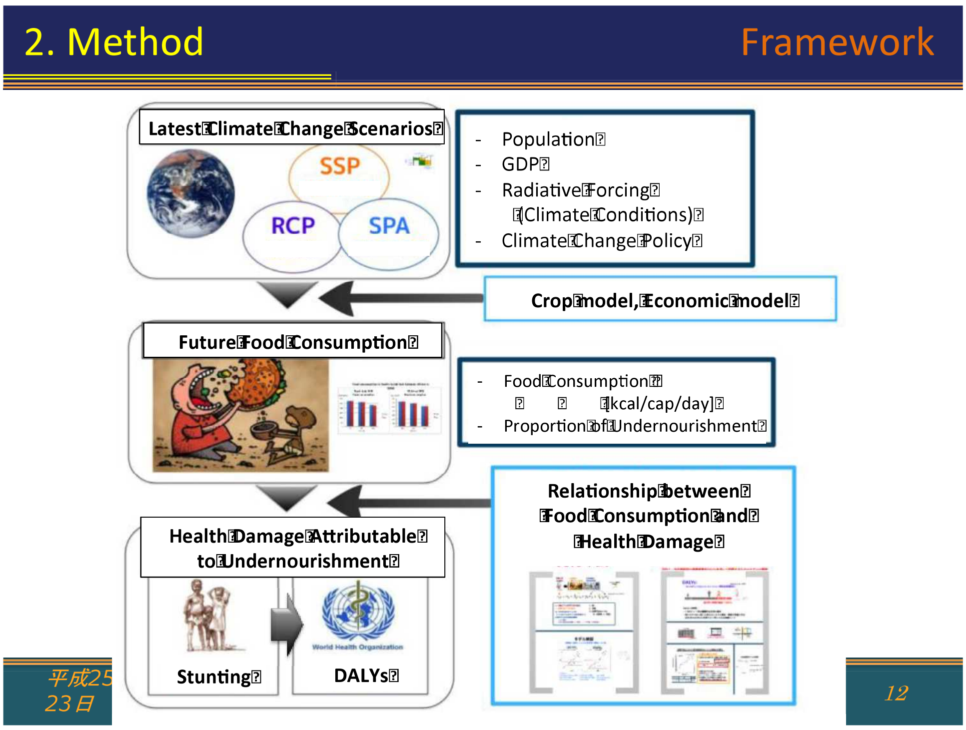
Global Exposure Change (100-yr Flood)



- Population varied according to UN medium growth scenario
- Shaded region show 1 standard deviation
- RCP8.5: 26 (10-42) times more in 21C (2071-2100) [20C (1971-2000): ~4 million]
- RCP2.6: 8 (2-14) times more in 21C

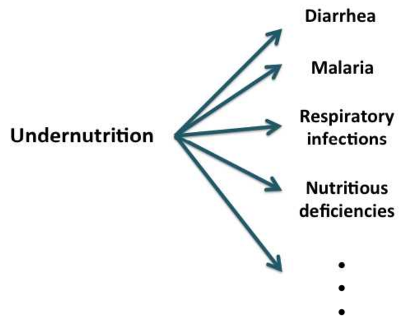
Future Food Risk under Climate Change


Socio-economic conditions
Climate Change
Water Risk
Food Risk
Hunger
Childhood undernutrition
900 million people are suffering from hunger
1/3 of total burden of disease in children
平成25年10月23日
11


2. Method
Framework
Latest Climate Change Scenarios
SSP
RCP
SPA
- Population
- GDP
- Radiative Forcing (Climate Conditions)
- Climate Change Policy
Crop model, Economic model
Future Food Consumption
- Food Consumption [kcal/cap/day]
- Proportion of Undernourishment
Relationship between Food Consumption and Health Damage
Health Damage Attributable to Undernourishment
Stunting
DALYs
World Health Organization
平成25
23日
12

2. Method — What undernutrition causes

Undernutrition can cause various diseases



DALYs Attributable to Childhood Underweight (DAtU)

Quantify the relationship between DAtU and undernutrition

2. Method — Future scenario framework

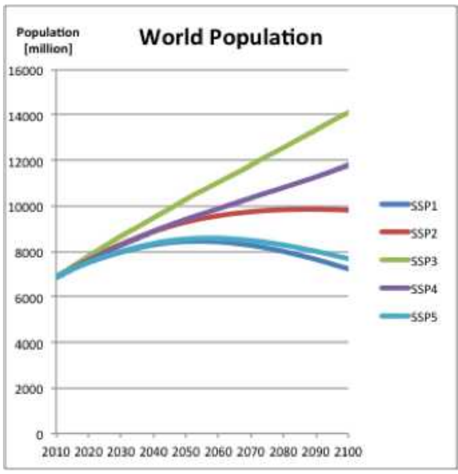
Combination of the scenarios

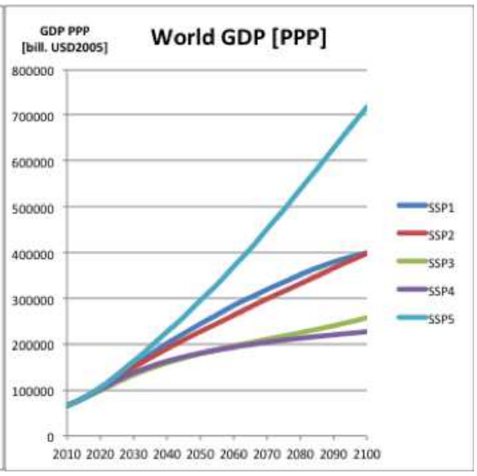
	RCP2.6	RCP4.5	RCP8.5
SSP1	SSP1 Policy	SSP1 BAU	
SSP3		SSP3 Policy	SSP3 BAU

SSP: Shared Socio-economic Pathways
RCP: Representative Concentration Pathways
BAU: Business As Usual

	RCP2.6	RCP4.5	RCP8.5
SSP1	SSP1 Policy	SSP1 BAU	
SSP2		SSP2 Policy	SSP2 BAU
SSP3		SSP3 Policy	SSP3 BAU

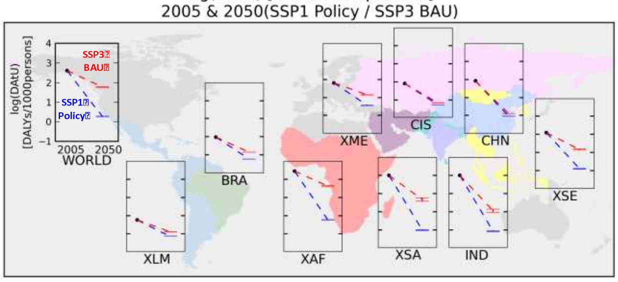
3. Scenarios — Examples of SSPs





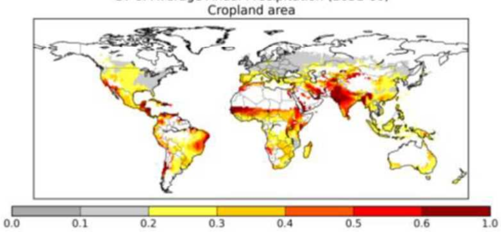
4. Result and Discussion — Climate models

log(DAtU) [DALYs/1000persons]
2005 & 2050(SSP1 Policy / SSP3 BAU)



Errorbar: Differences in 12 GCMs

CV of Average Anual Precipitation (2051-60)
Cropland area



Thank you very much
for your attention.

This is the introduction to
some aspects of my research.