Recent progress of the climate change impacts assessment and adaptation strategy development in the Japanese governmental program

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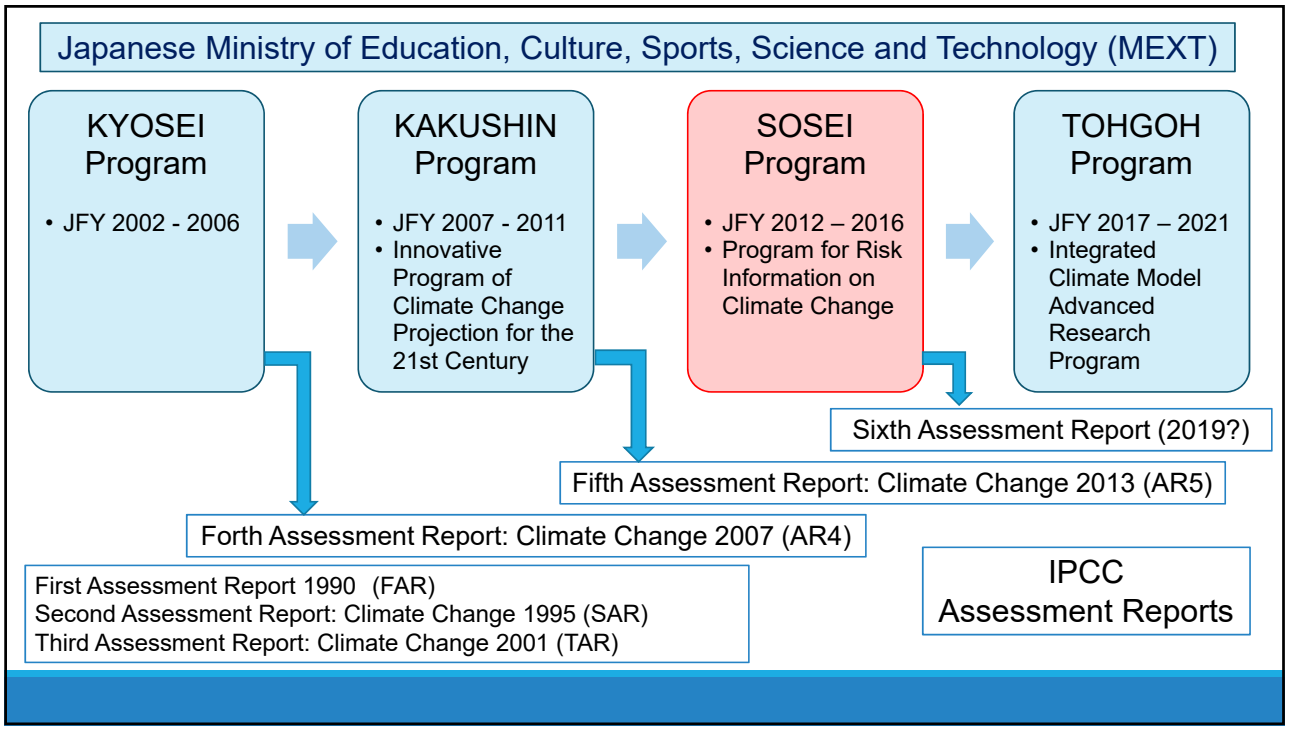
INTERNAL WORKSHOP OF THE WG-CLIMATE OF ICID
AGRICULTURAL WATER MANAGEMENT UNDER THE CHANGING CLIMATE
OCTOBER 11, 2017,
WORLD TRADE CENTER, MEXICO CITY



"What is the Program for Risk Information on Climate Change?"

SOSEI Program

The aim of this program is to generate basic information required for managing various risks resulting from climate change.

Using the world-class supercomputers, such as Earth Simulator, we are pursuing research and development in which all themes are organically linked. Our research and development include prediction and diagnosis of imminent global climate change expected to occur within a few years or decades, research on greenhouse gas emission scenarios and associated long-term climate change projections, development of probabilistic climate change projection techniques, and development of technology for precise impact assessment, etc.

Theme D

Precise impact assessments on climate change

- Climate change impacts on natural hazards
- Climate change impacts on water resources
- Climate change impacts on ecosystem and biodiversity

http://www.jamstec.go.jp/sousei/eng/index.html

Theme D: Precise impact assessments on climate change

How will global warming change typhoons, floods, landslides, and river flows as well as the forests and ocean? This research theme, "**Precise impact assessment on climate change**," aims to scientifically demonstrate the connection between global warming and natural disasters and to look 100 years into the future to see how serious it may become. For these purposes, we use two analytical methods - - - - - - In this research theme, we are carrying forward research using the above two analytical methods ("probability assessment of future impact" and "future impact assessment based on the worst-case scenario") and are actively exchanging views under the three research sub-themes:

- climate change impacts on natural hazards
- **climate change impacts on water resources**
- climate change impacts on ecosystems and biodiversity

a	Assessment of socio-economic impacts on water resources and their uncertainties under changing climate
b	Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles

SOUSEI Program for Risk Information on Climate Change
気候変動リスク情報創生プログラム

Theme D-ii
Climate change impacts on water resources

(a) Assessment of socio-economic impacts on water resources and their uncertainties under changing climate
sub-leader: **Kenji Tanaka (Kyoto University, DPRI)**

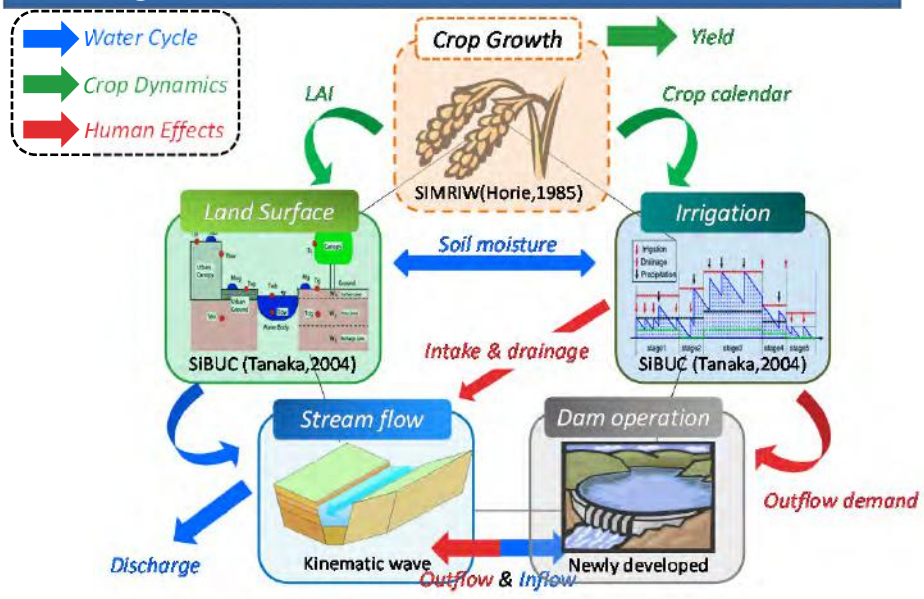
This team mainly predicts and assesses the changes in water supply in the major rivers of Japan, the impact on rice farming, hydropower, etc.

(b) Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles
sub-leader: **Taikan Oki (University of Tokyo, IIS)**

This team predict and assess how the actual water cycle and available water resources will change on a global scale with inclusion of human impact.

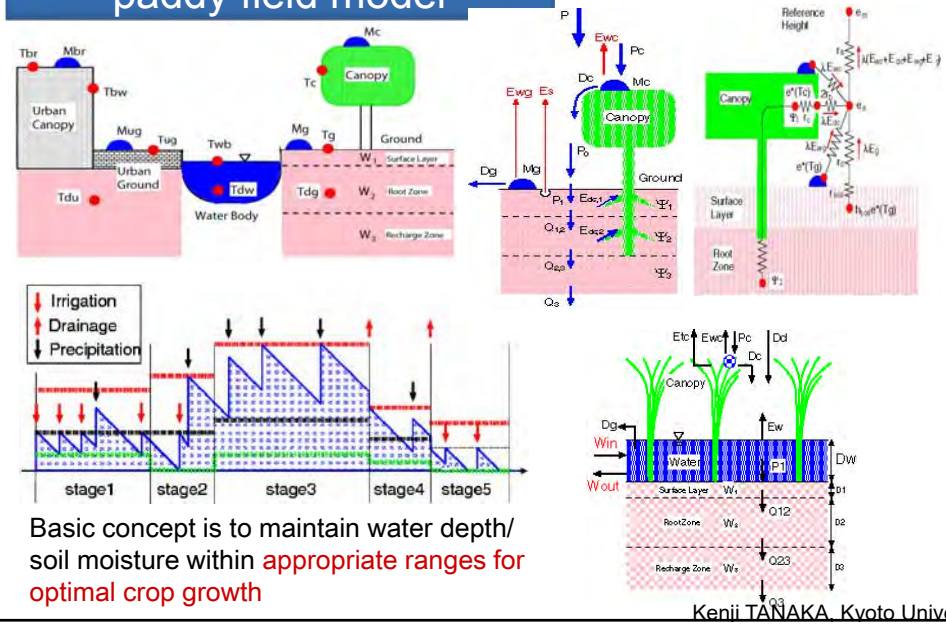
Kenji TANAKA, Kyoto University (2016)

Integrated Water Resources Model



Kenji TANAKA, Kyoto University (2016)

Land surface model SiBUC paddy field model



Basic concept is to maintain water depth/ soil moisture within appropriate ranges for optimal crop growth

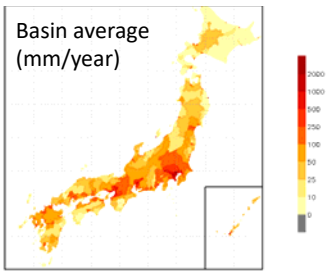
Kenji TANAKA, Kyoto University (2016)

Water Stress

- Water stress for each river basin (16,000 rivers)
- Water demand from each sector
  - agriculture: irrigation model (SiBUC)
  - industrial and domestic:

National Land Numerical Information Download Service
Report of Japanese Water Resources in 2011 (MLIT)

Total water demand

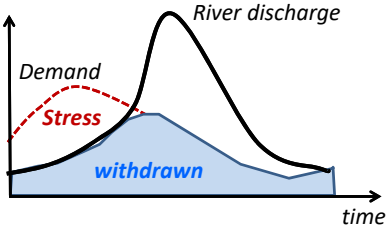


Cumulative withdrawal to demand ratio

$$CWD = \sum (W_i / D_i)$$

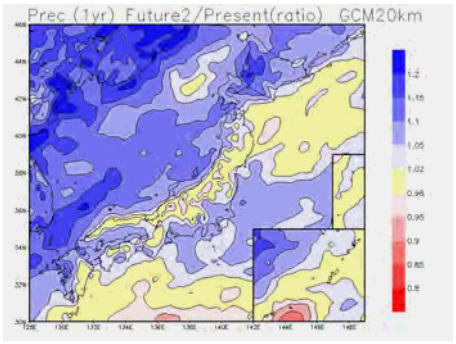
Hanasaki (*HESS*, 2008)
D: daily demand [MCM]

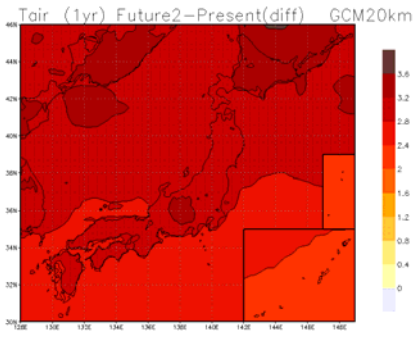
⇒seasonal water stress

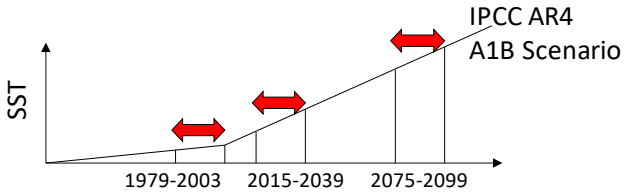


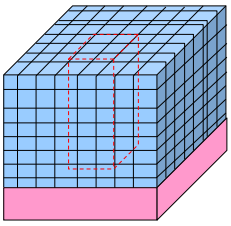
Kenji TANAKA, Kyoto University (2016)

Climate change projected by MRI-AGCM3.2S



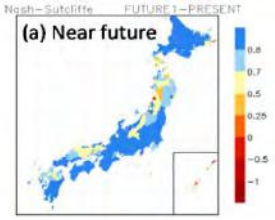


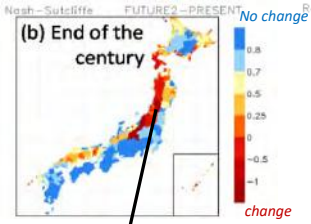




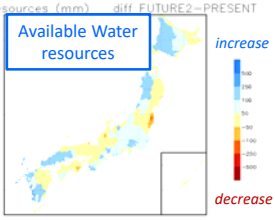
Kenji TANAKA, Kyoto University (2016)

Impact of climate change on water resources in Japan

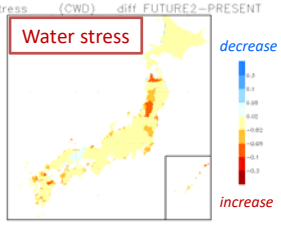




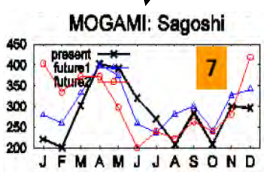
Change of river regime



WR=Prec-Evap



CWD (considering seasonal change)



Accelerated hydrological cycle, reduction of snowfall
In spite of the increase in available water resources, water stress will increase in Tohoku region

Influence on dam operation and rice production

Kenji TANAKA, Kyoto University (2016)

Summary

- This study addresses the impact of climate change on Japanese water resources using integrated in-land hydrological model.
- Impact of climate change on river discharge is expected to be larger in the snowy region of Japan.
  In spite of the increase in available water resources, shift of seasonal cycle would lead to the negative influences on the water availability for agriculture and hydropower.
- Snow process, which is highly dependent on topography, is crucial in the assessment of water resources. More discussions are needed on how to utilize the information of many ensembles of low resolution GCMs.

Kenji TANAKA, Kyoto University (2016)

Welcome to d4PDF

Planning for adaptation to global warming will be based on impact assessments of disasters, agriculture, water resources, ecosystems, human health, and so on, in each region. For each impact assessment, detailed projections of extreme events such as heavy rainfall, heat wave, drought, and strong wind are required at the regional scale as well as projections of climatological temperature and precipitation. An unprecedentedly large ensemble of climate simulations with a 60 km atmospheric general circulation model and dynamical downscaling with a 20 km regional climate model have been performed to obtain probabilistic future projections of low-frequency local-scale events. The simulation outputs are open to the public as a database called "Database for Policy Decision-Making for Future Climate Change" (d4PDF), which is intended to be utilized for impact assessment studies and adaptation planning for global warming.

http://www.miroc-gcm.jp/~pub/d4PDF/index_en.html

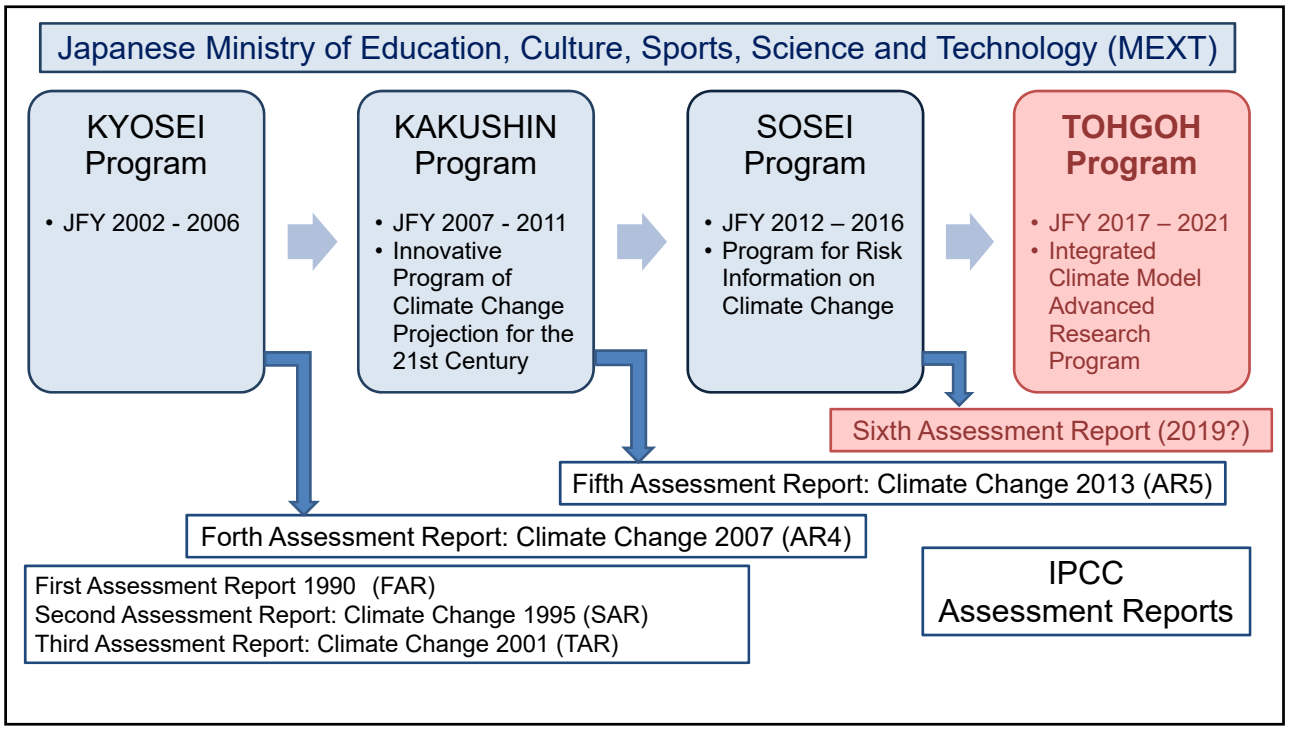
Characteristics of d4PDF

(1) The d4PDF consists of outputs from global warming simulations by a global atmospheric model and from regional downscaling simulations covering the Japan area by a regional climate model with horizontal grid spacing of 60 km and 20 km, respectively. The climate of the latter half of the 20th century is simulated for 6000 years (3000 years for the Japan area), and the climate 4 K warmer than the pre-industrial climate is simulated for 5400 years, to see the effect of global warming.
(2) From large ensemble simulations, probabilistic future changes in extreme events are available directly without using any statistical models. In addition, the results enable the assessment of probabilistic change in localized severe events that have large uncertainty from internal variability.
(3) The simulation outputs are open to the public, which is intended to be utilized for impact assessment studies and adaptation planning for global warming. Plannings that are consistent between the problems and regions are expected by using the common dataset.
(4) Total data size is 2PB. The data is provided through the server by the Data Integration and Analysis System (DIAS). http://www.miroc-gcm.jp/~pub/d4PDF/about_en.html

http://www.miroc-gcm.jp/~pub/d4PDF/about_en.html

database for(4) Policy Decision making for Future climate change (d4PDF)

- A large ensemble climate dataset
  - simulated with 20km Non-hydrostatic Regional Climate Model (NHRCM) around Japan area
- Data ensemble
  - 60 years for 50 observational SST perturbation ensemble for present climate (3,000 years data)
  - 60 years for 6 future SST prediction ensemble and their 15 perturbation ensemble (5,400 years data)
- **Stable and reliable frequency analysis is possible**



Challenges

- Integrated assessment of climate change impacts on hydrology and water use
  - integrated in-land hydrological model
  - cross-disciplinary approach
  - inter-sectorial approach
- Co-design and co-production
  - academicians and practitioners
  - Researchers and decision/policy makers

Thank you for your attention