Projection of river discharge in Japan under climate change

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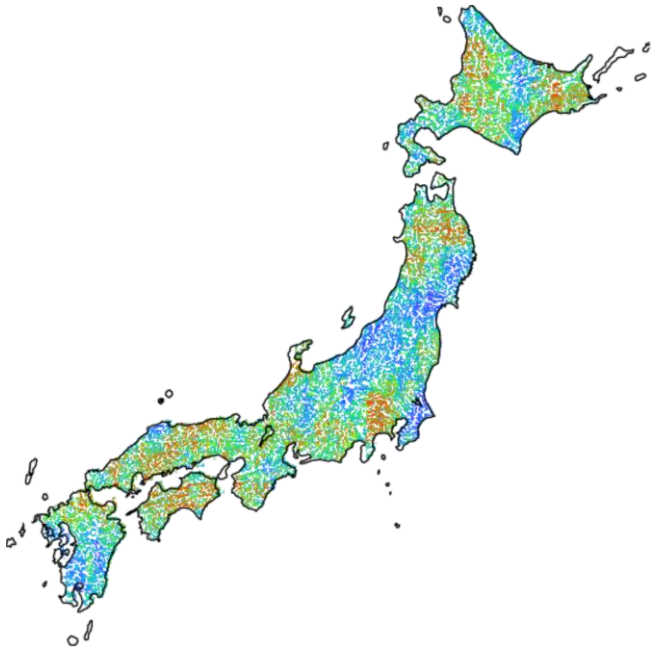
Motivations

- How will river discharge change under climate change?
- Where will hotspots of river discharge change come out in Japan?
- The change of river discharge will have effect on what?
- How do we adapt the change?

Method of Analysis

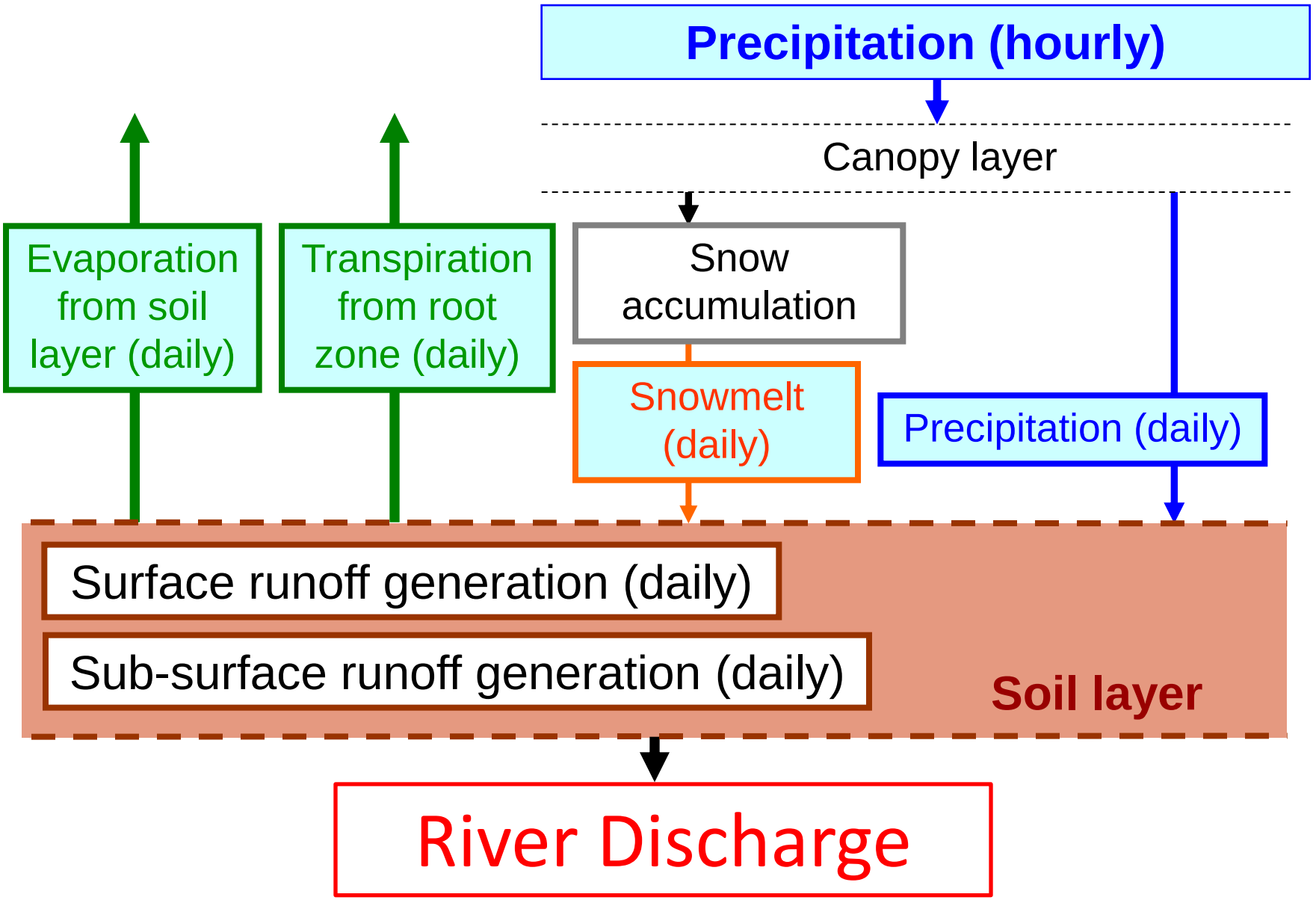
20km resolution GCM output

1km resolution distributed hydrologic model at Japanese catchments for 75 years runoff simulations

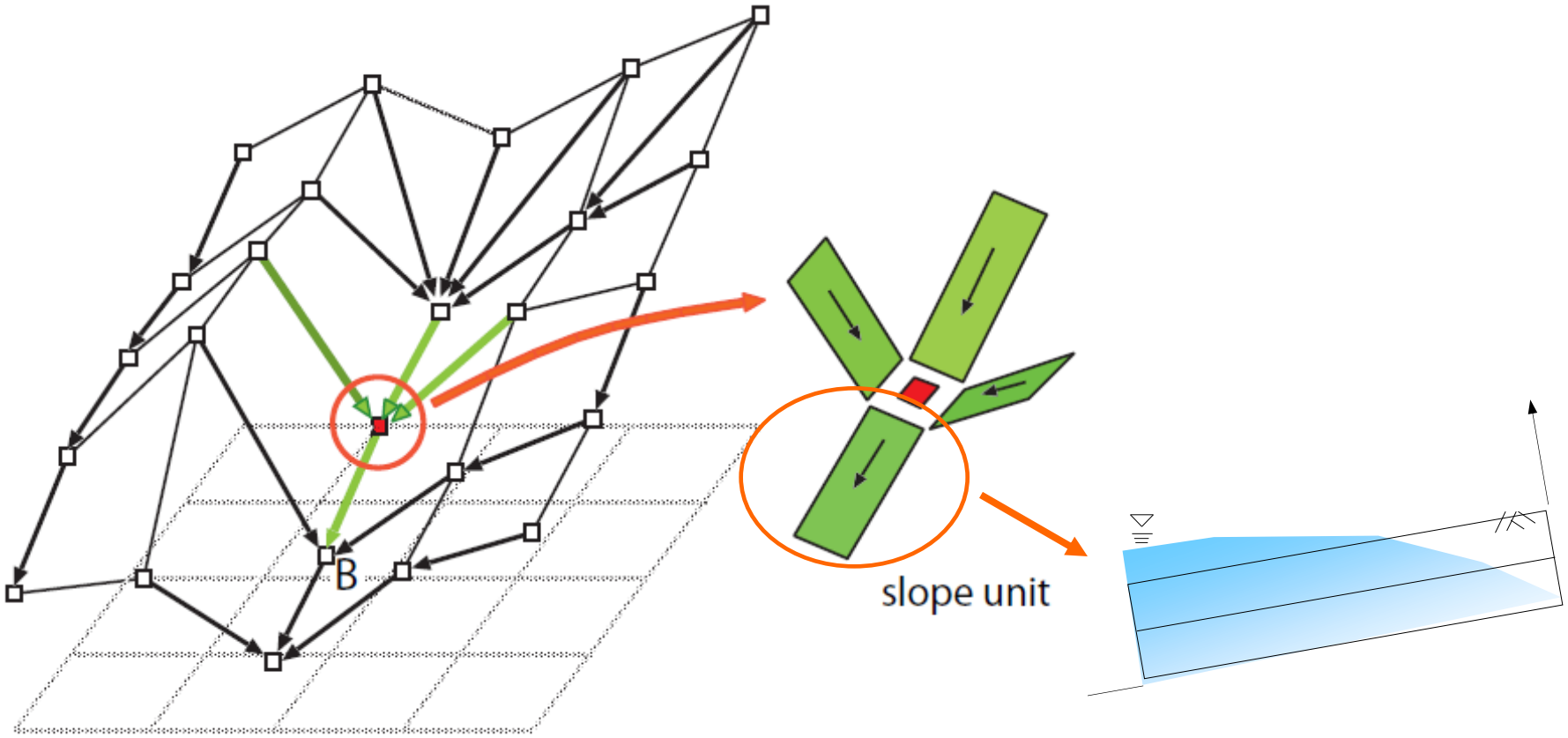


Examine the changes of flood risks, drought risks, and the change of water resources.

GCM Projection data for runoff simulation

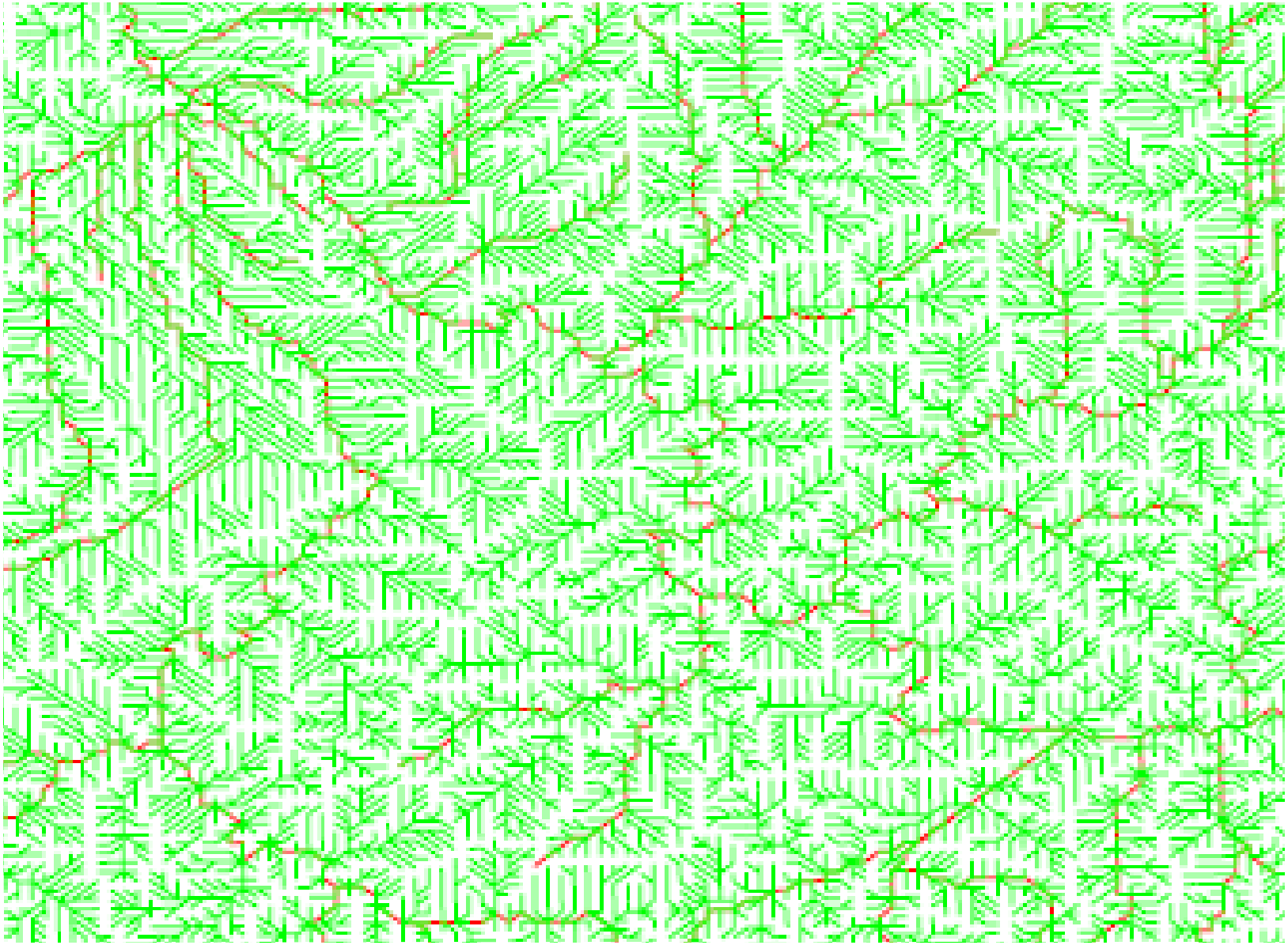


Hydrologic Flow Modeling

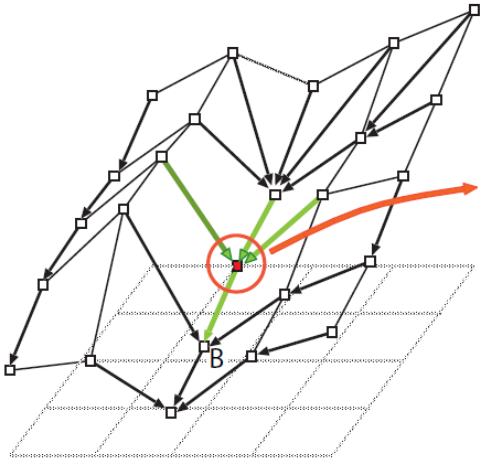


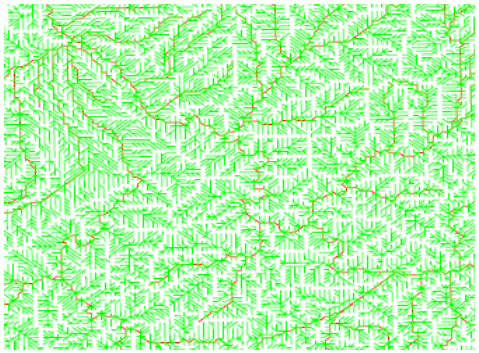
A flow direction map with 1 km spatial resolution is developed. Then, runoff is routed according to the flow direction map using one dimensional kinematic wave flow model .

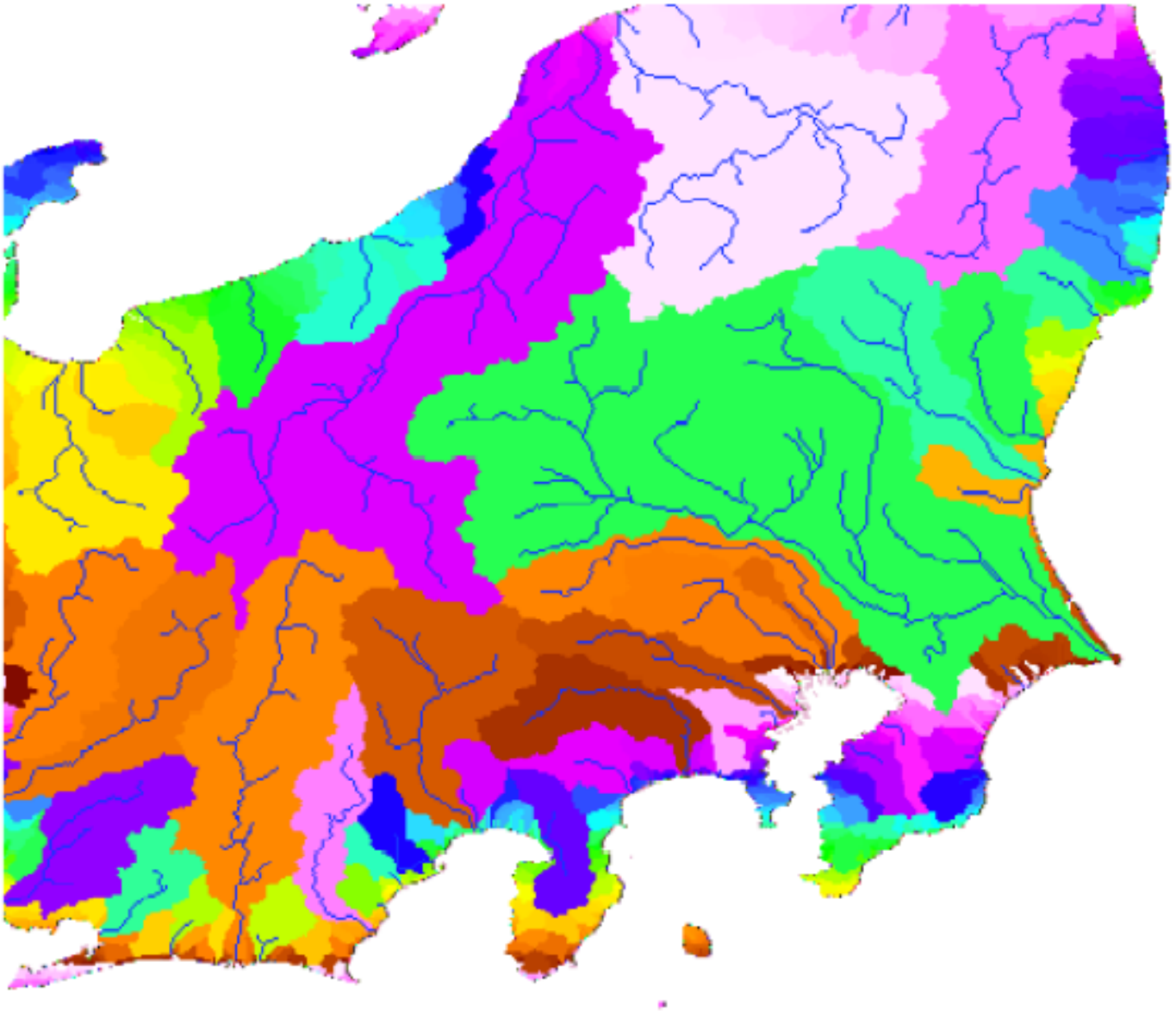
1 km flow direction map using GTOPO 30



Flow direction modeling in Kanto region







Runoff projections using MRI-AM20km

Ishikari River

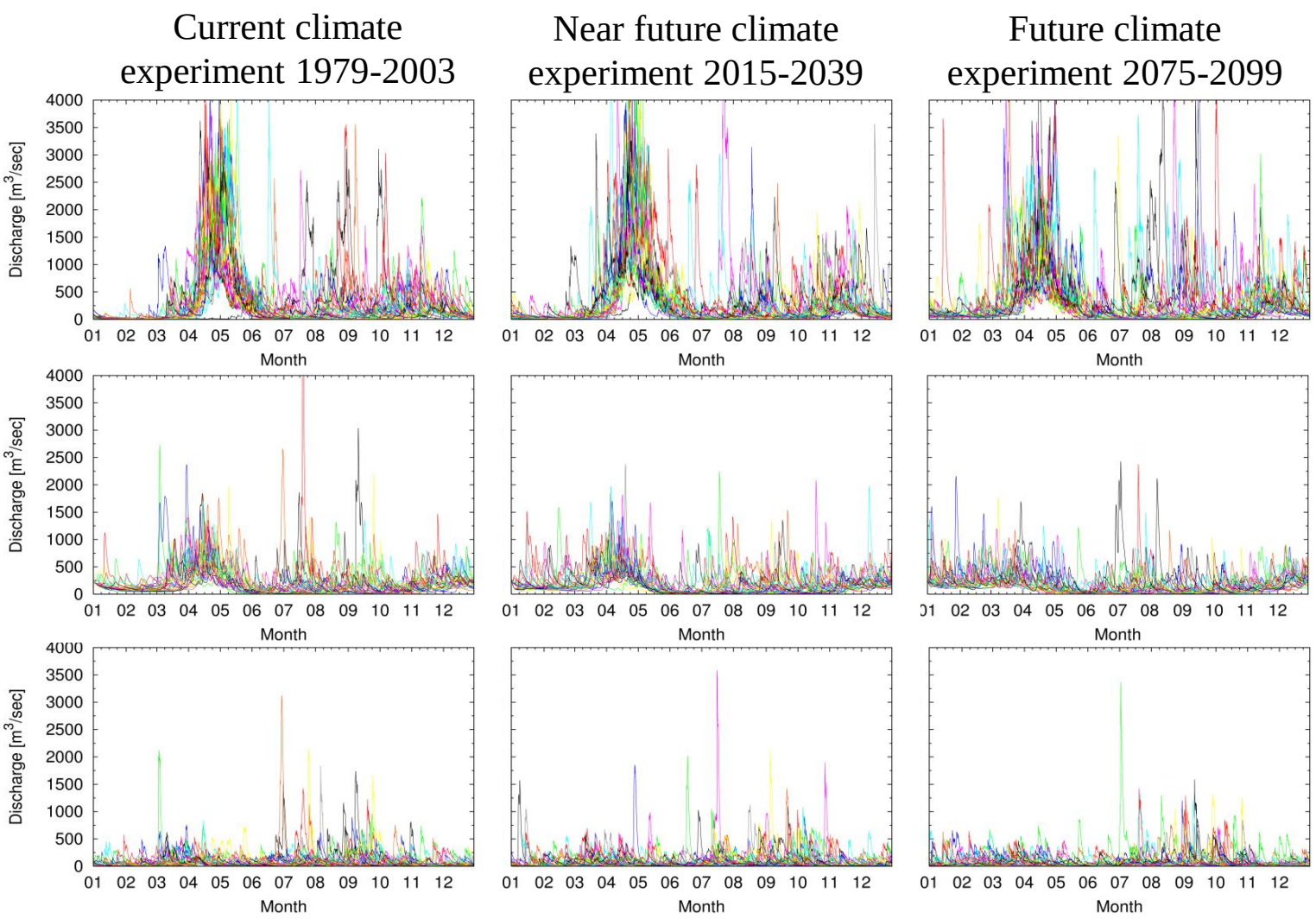
Hokkaido region

Mogami River

Northern Japan

Abukuma River

Northern Japan

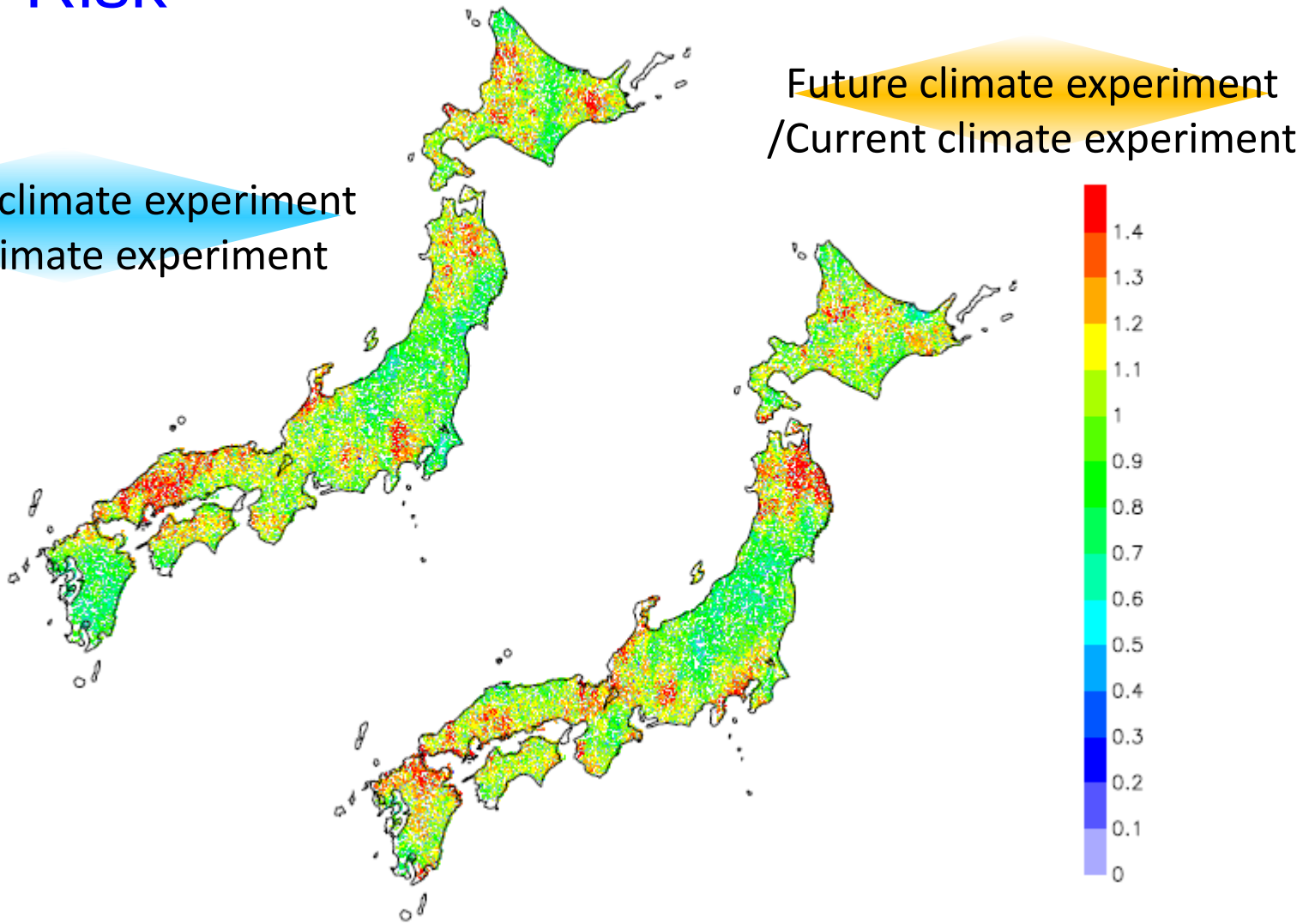


Change of mean annual maximum hourly discharge

Flood Risk

Near future climate experiment
/Current climate experiment

Future climate experiment
/Current climate experiment

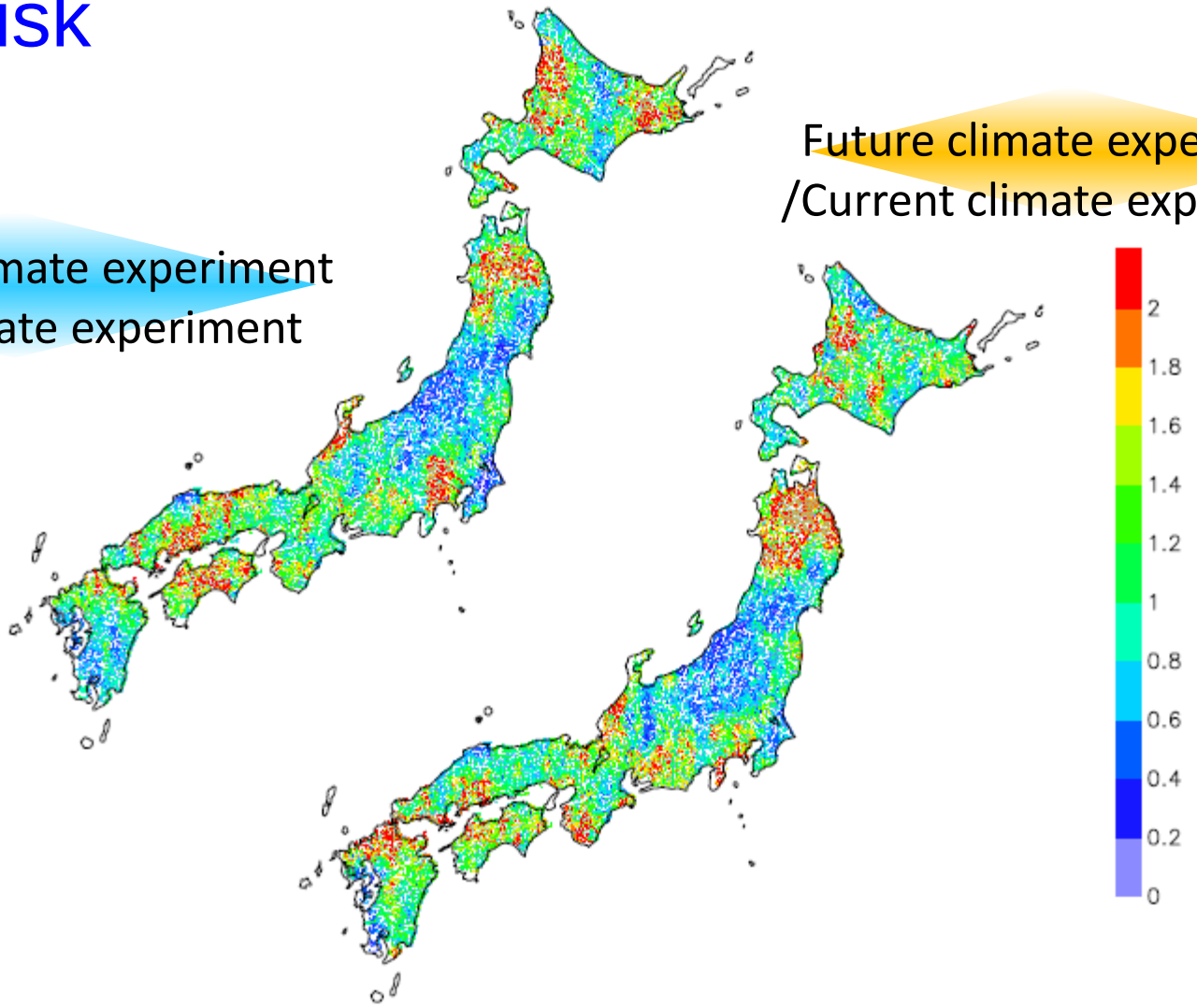


Change of standard deviation of annual maximum hourly discharge

Flood Risk

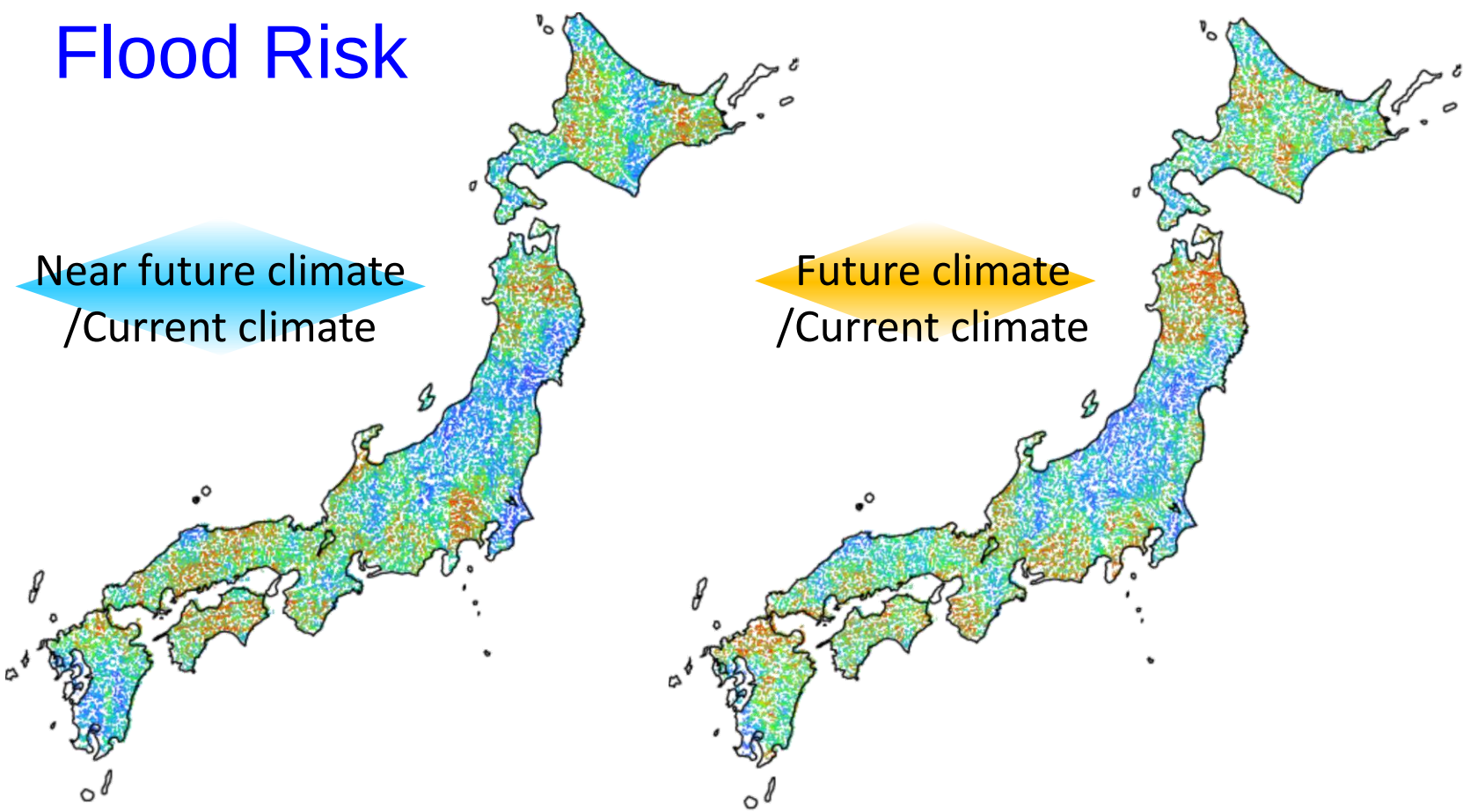
Near future climate experiment
/Current climate experiment

Future climate experiment
/Current climate experiment



Change of 100-year annual maximum hourly discharge

Flood Risk

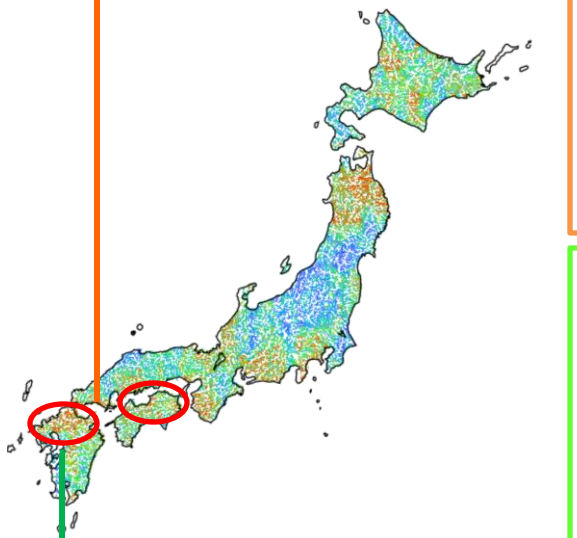


Quintiles of river discharge with 100-year return period estimated using GEV distribution.

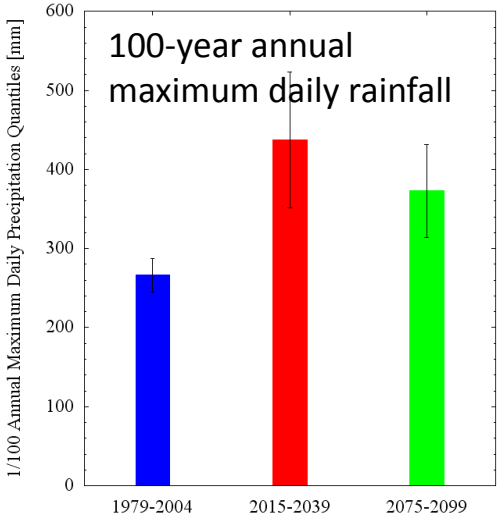
Reason for the change of annual maximum hourly discharge

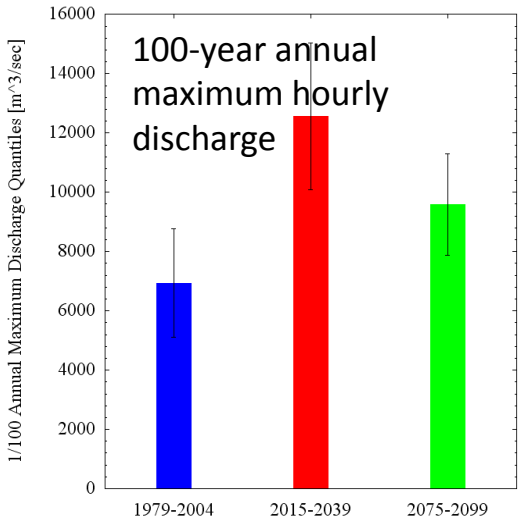
Flood Risk

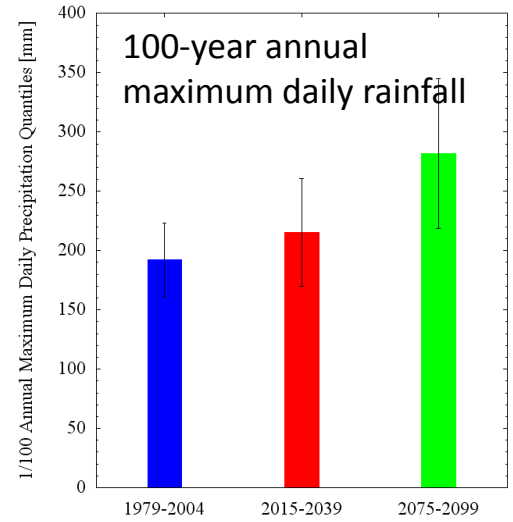
Yoshino River basin

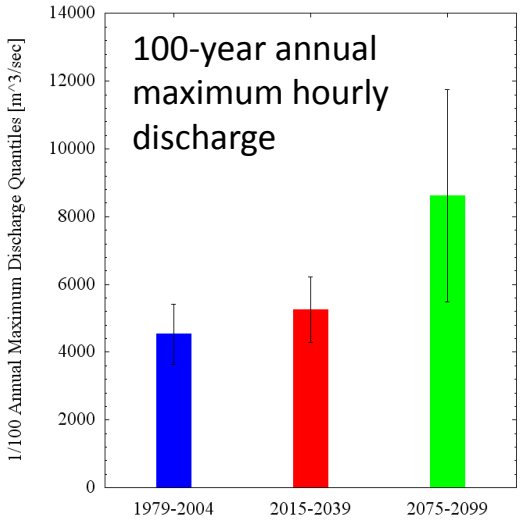


Chikugo River basin

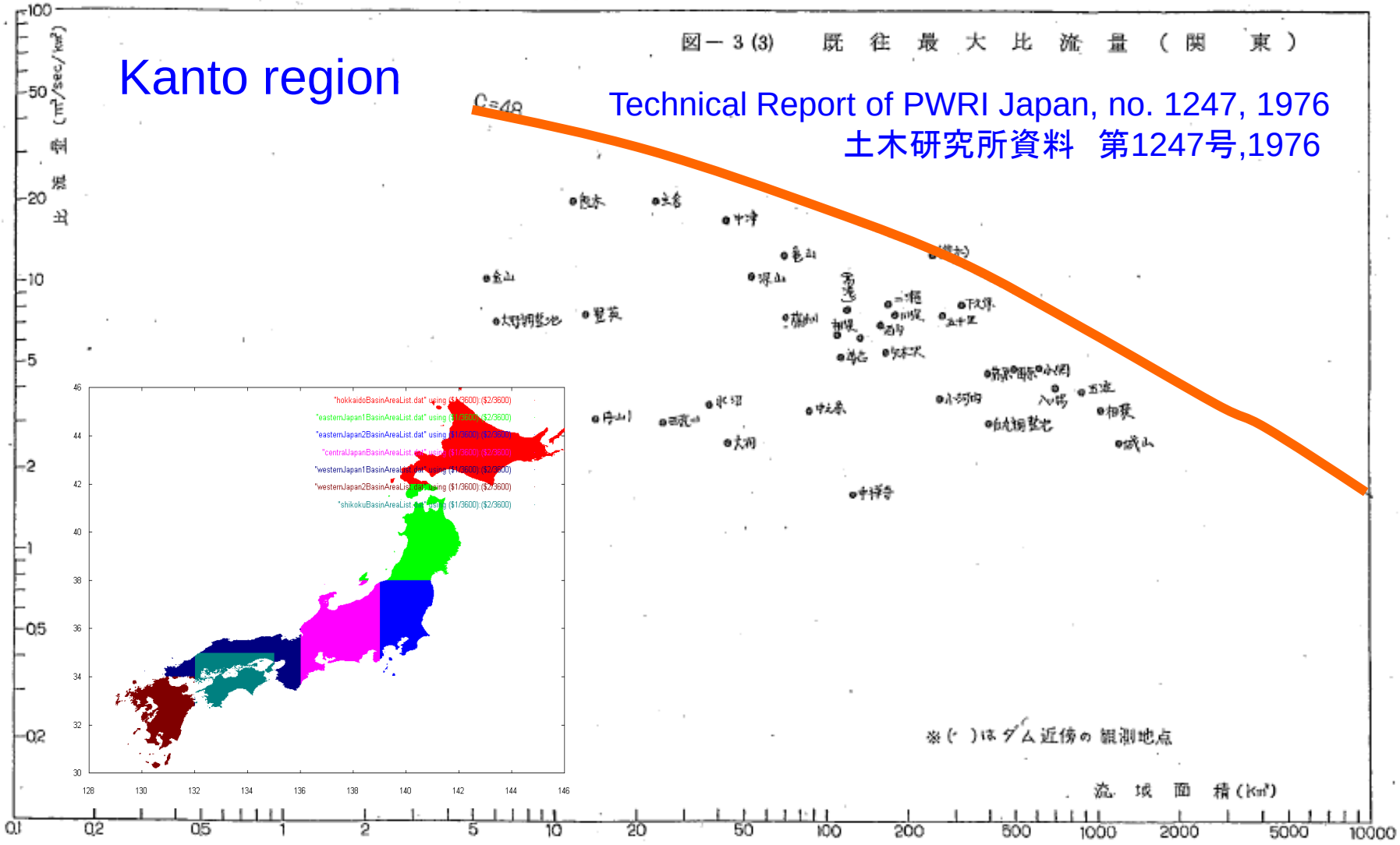




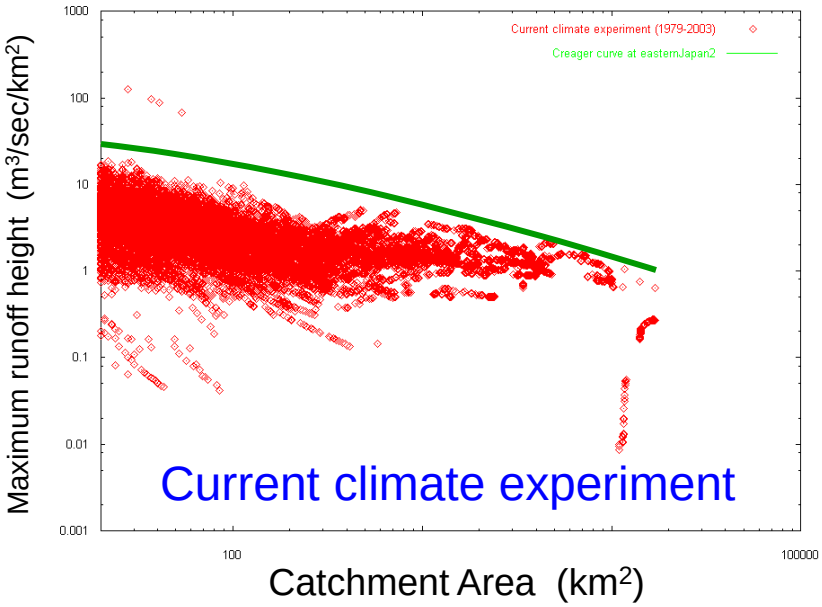


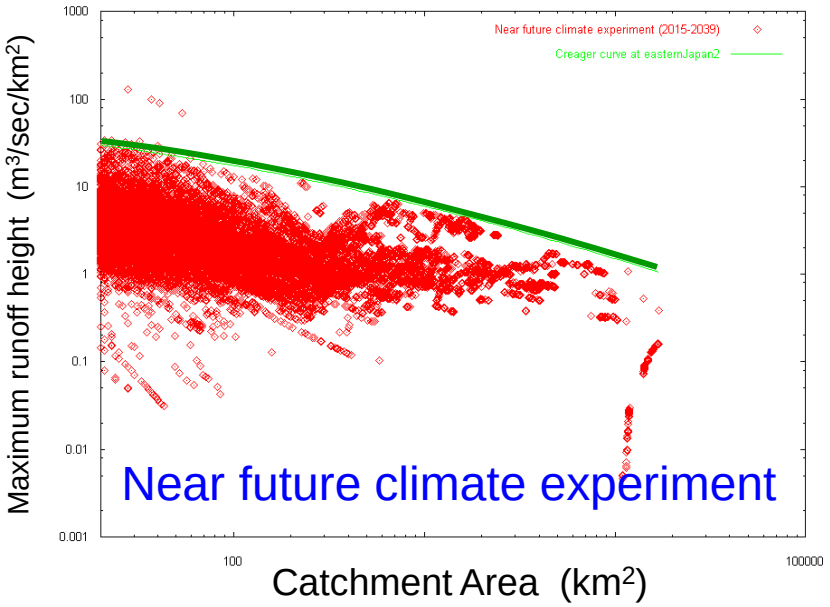


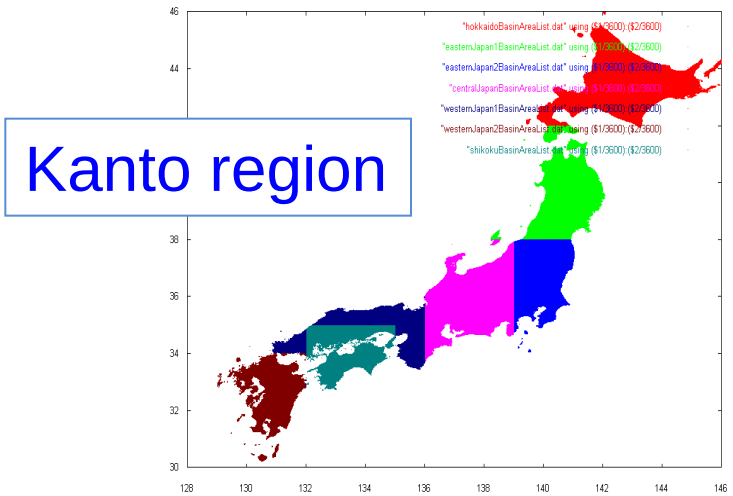
Design flood discharge for dam reservoir construction

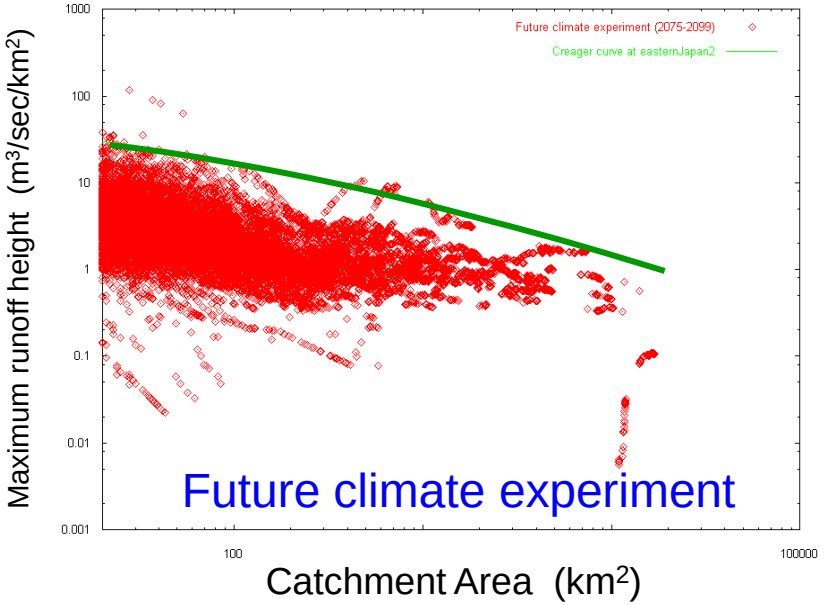


Maximum flood discharge at Kanto region



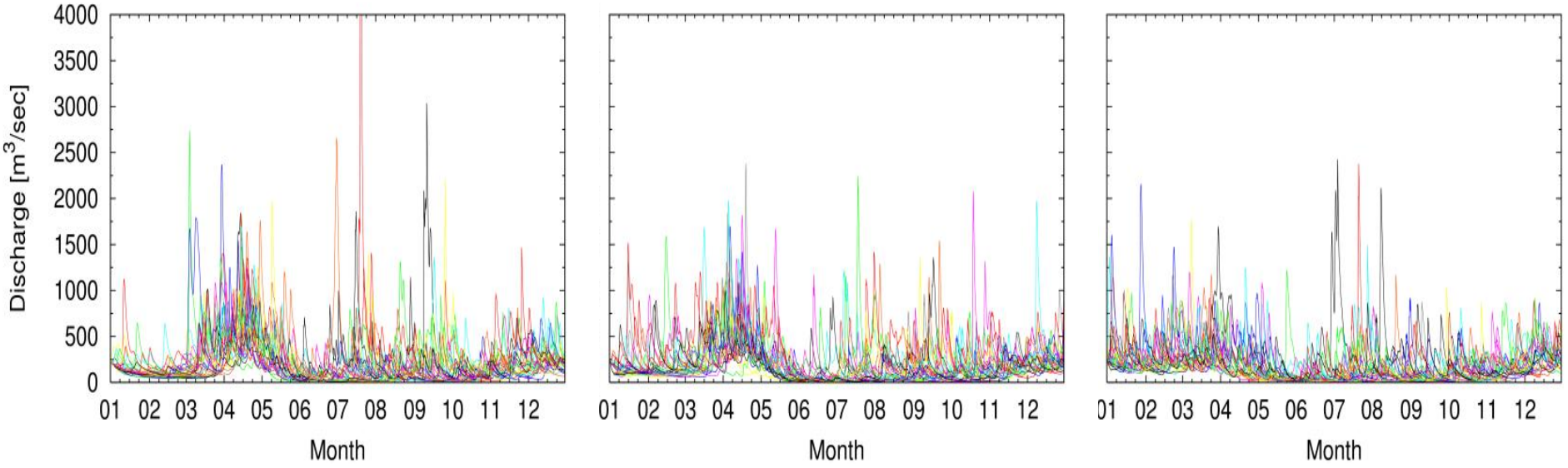






Change of water resources

Runoff simulations at Mogami River, Northern Japan

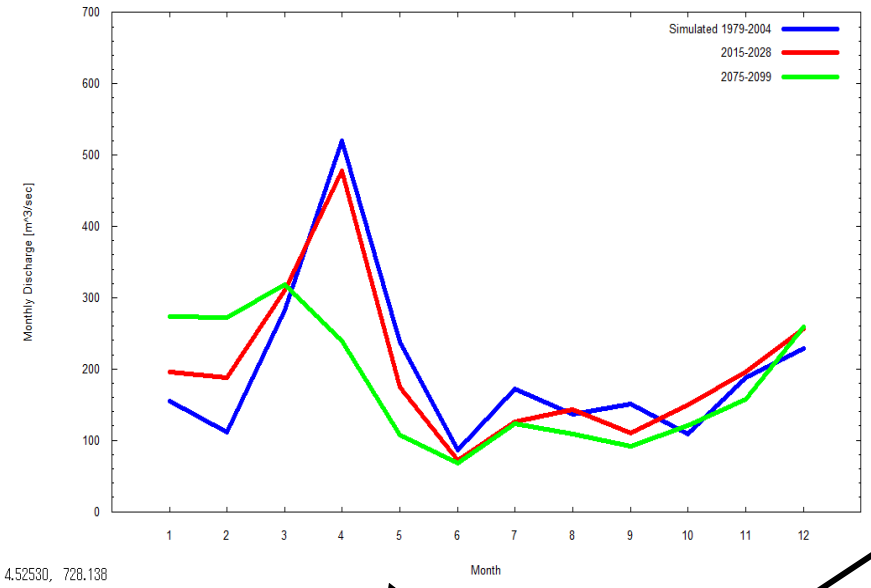


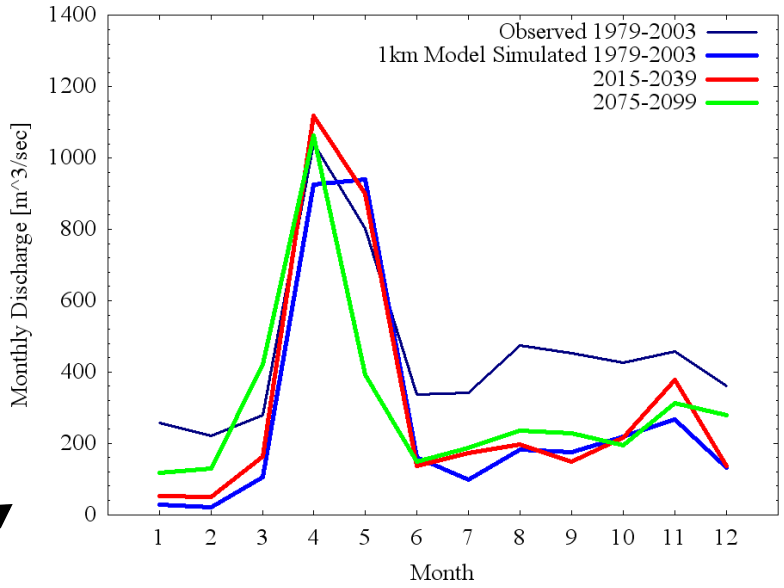
Current climate experiment 1979-2004

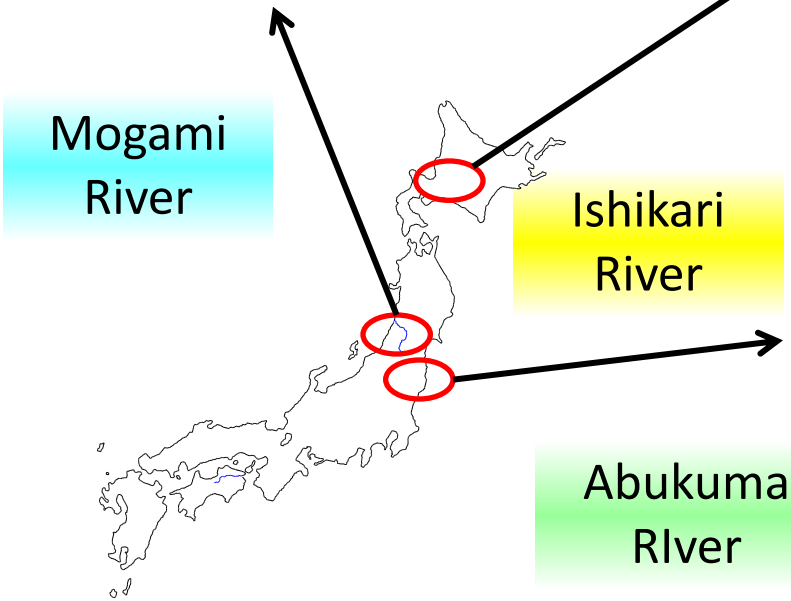
Near future climate experiment 2015-2039

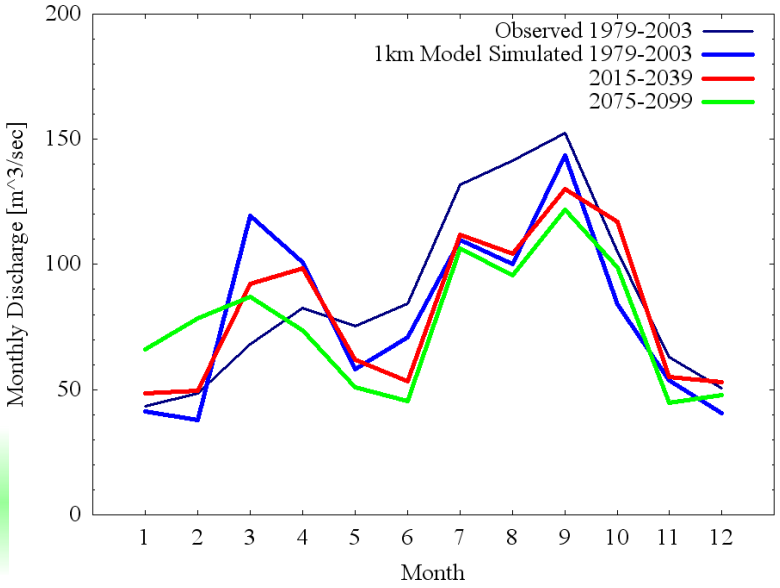
Future climate experiment 2075-2099

Change of monthly discharge in snow melting season

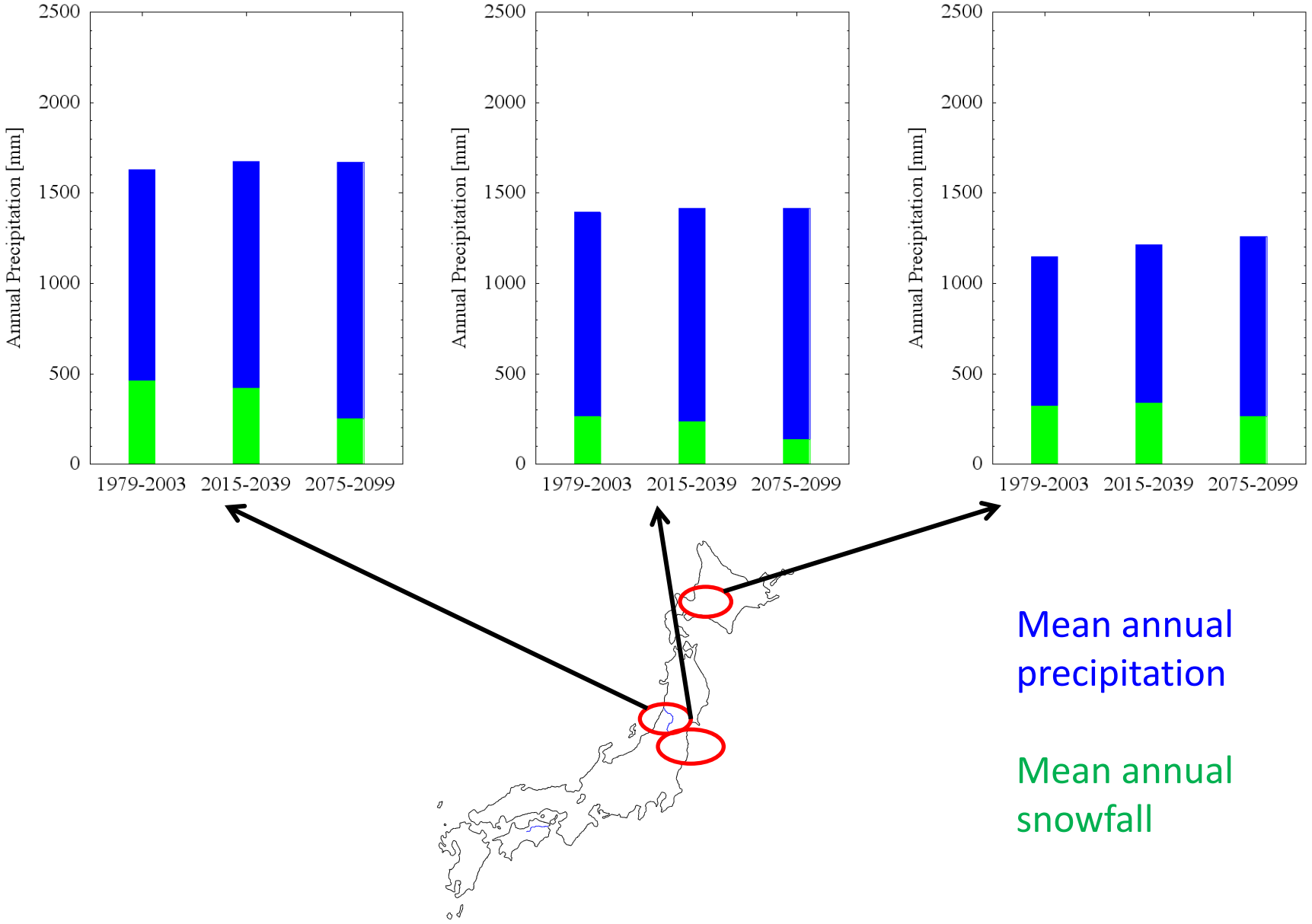




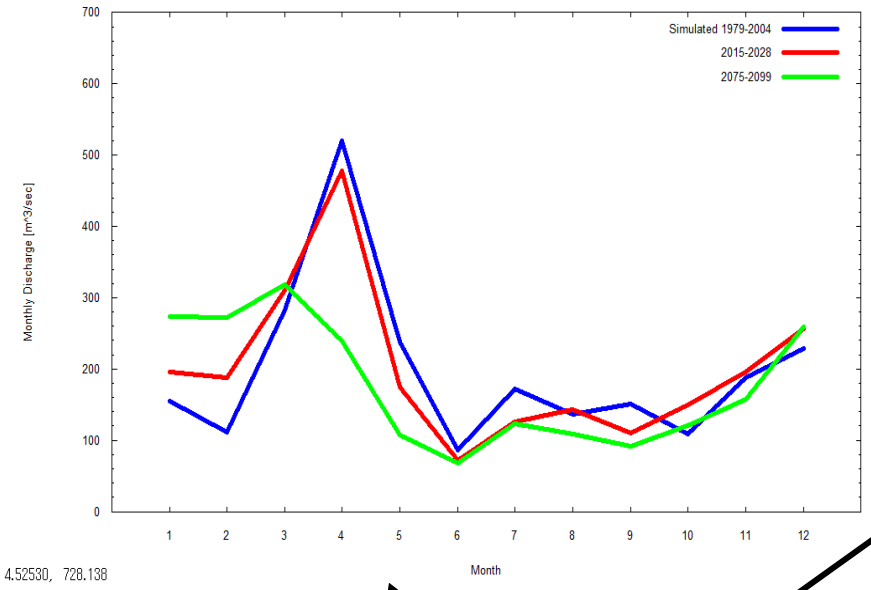


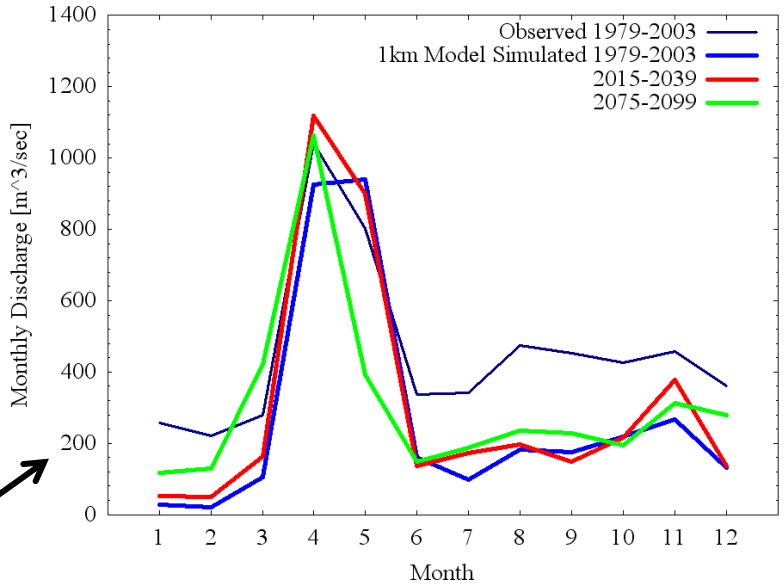


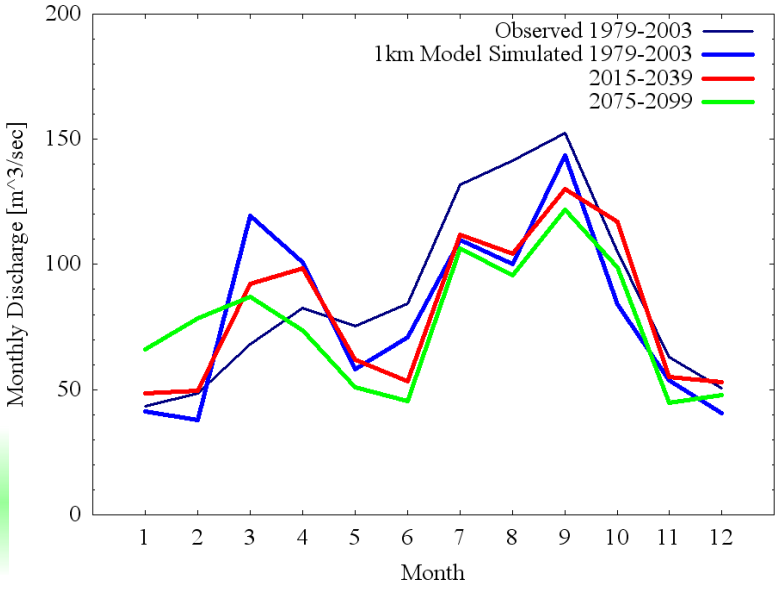
Change of annual snow fall

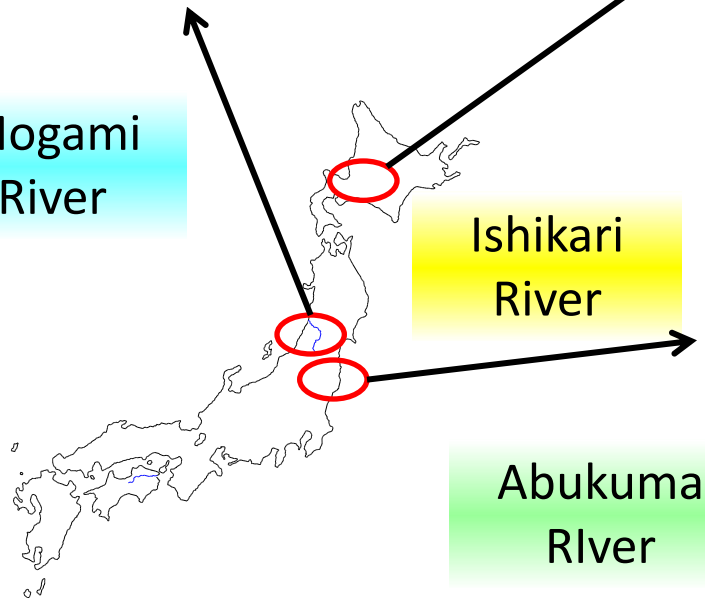


Change of monthly discharge in snow melting season









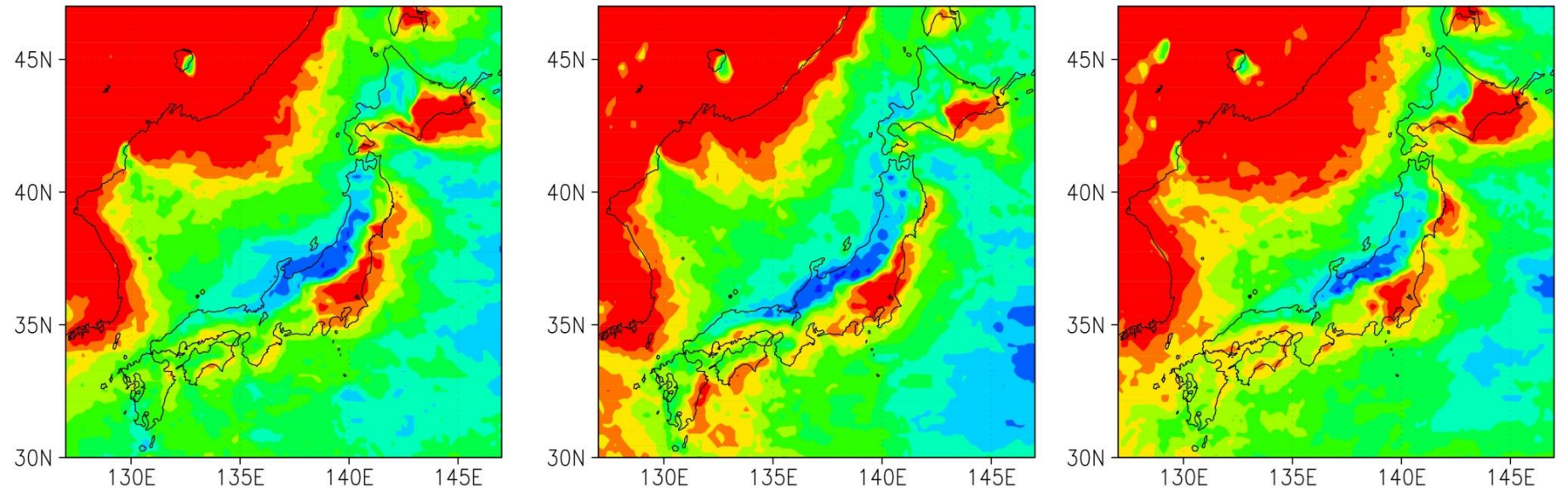
Mogami River

Ishikari River

Abukuma RIver

Change of mean annual maximum consecutive non-rainy days

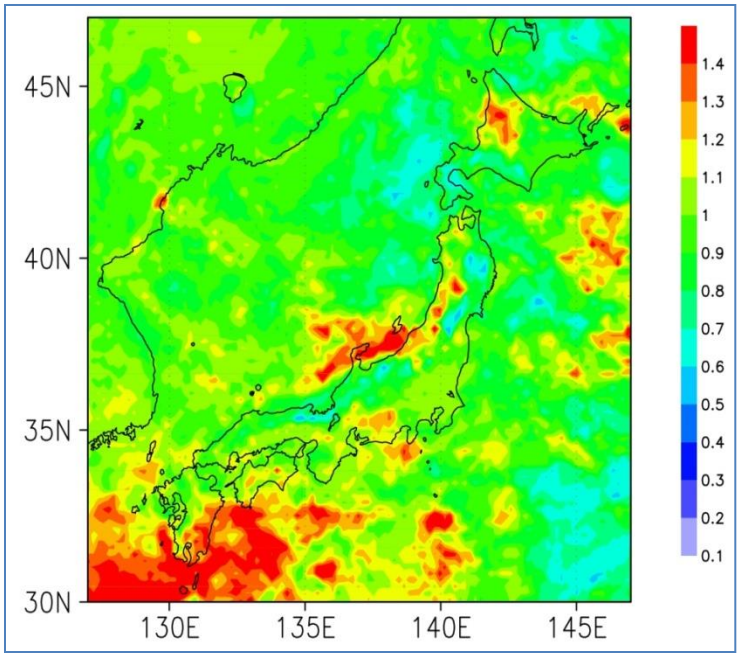
Drought Risk



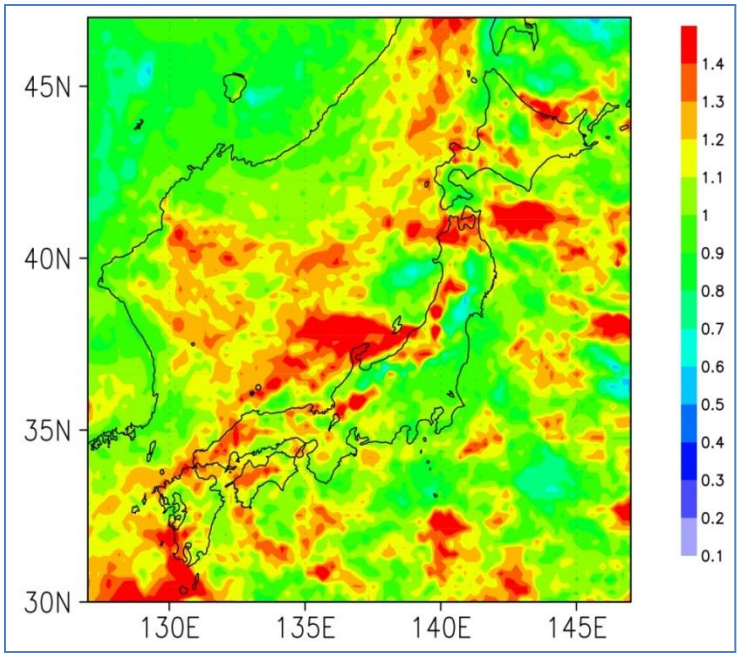
(a) current climate　　(b) near future　　(c) future

Non-rainy day : daily rainfall is less than 1mm

Change of mean annual maximum non-rainy days

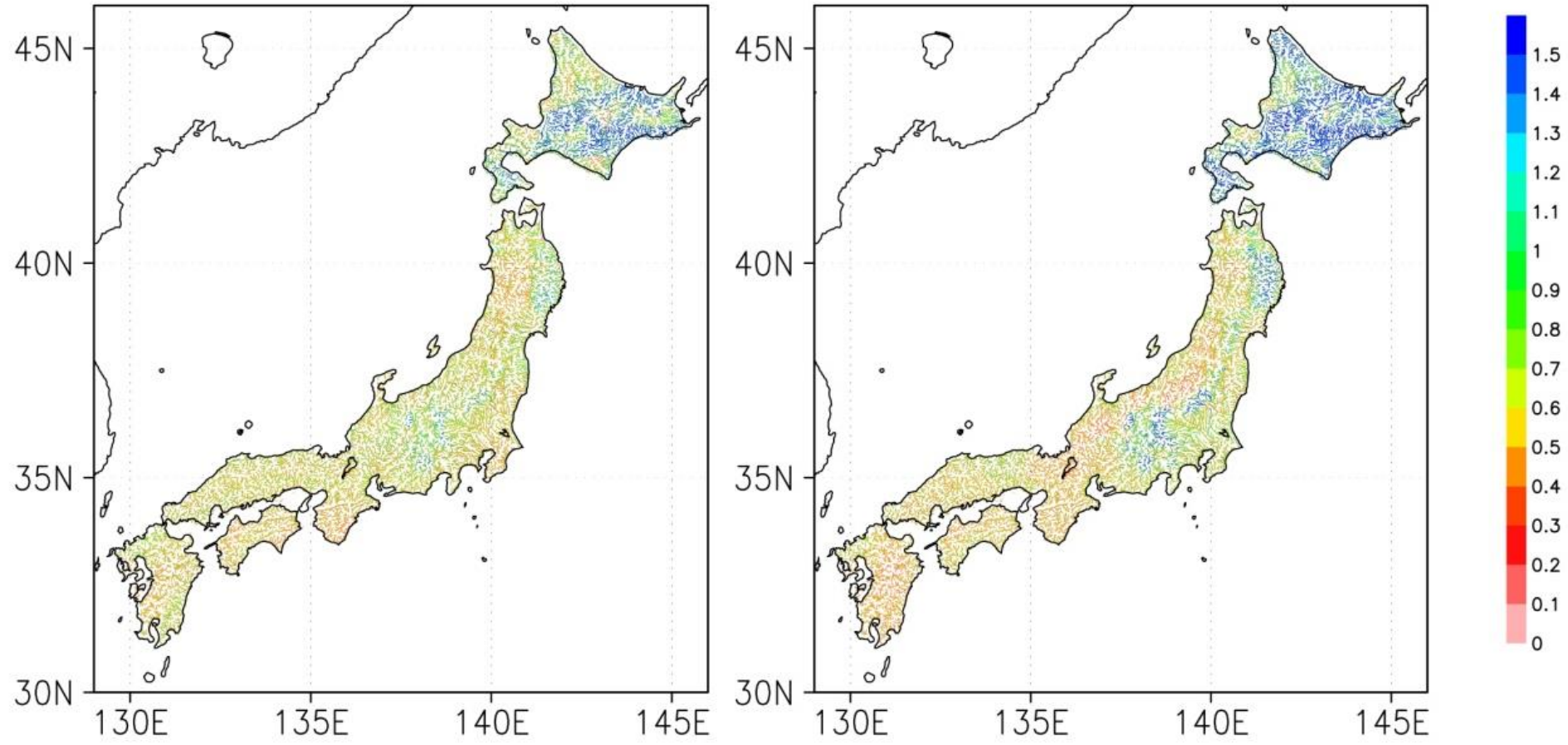


Near future climate
/Current climate



Future climate
/Current climate

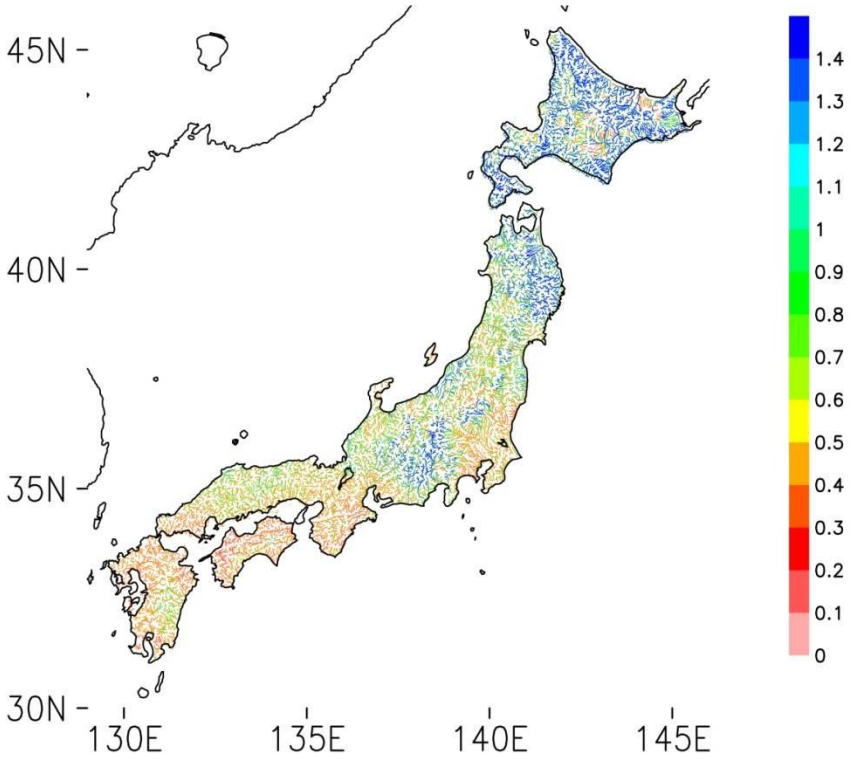
Change of the mean of the 10th daily discharge in ascending order in a year



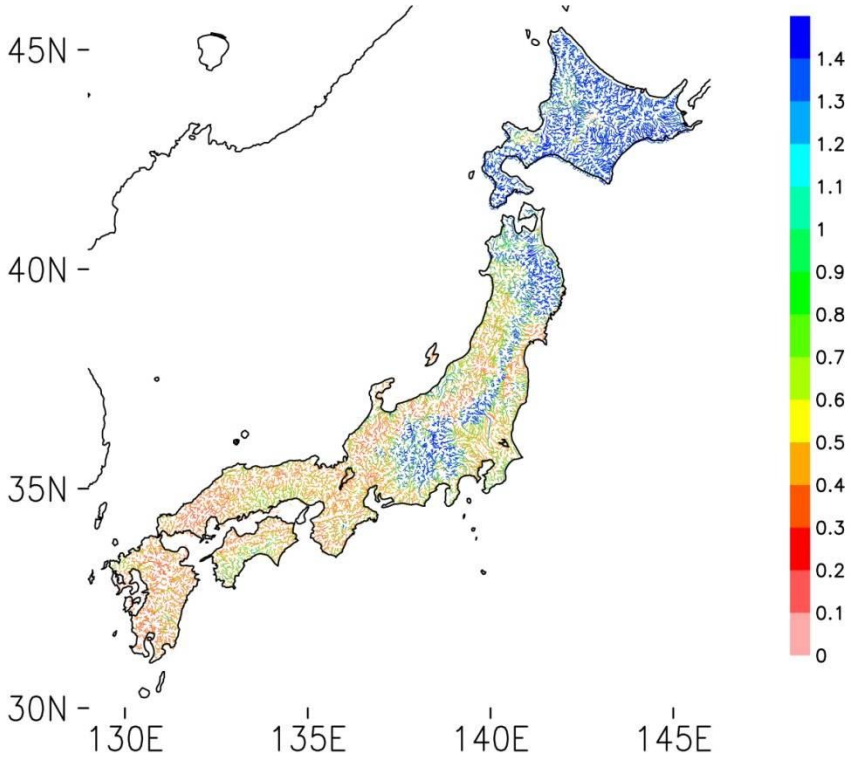
Near future climate
/Current climate

Future climate
/Current climate

Change of the 10-year 10th daily discharge in ascending order in a year using Weibull distribution

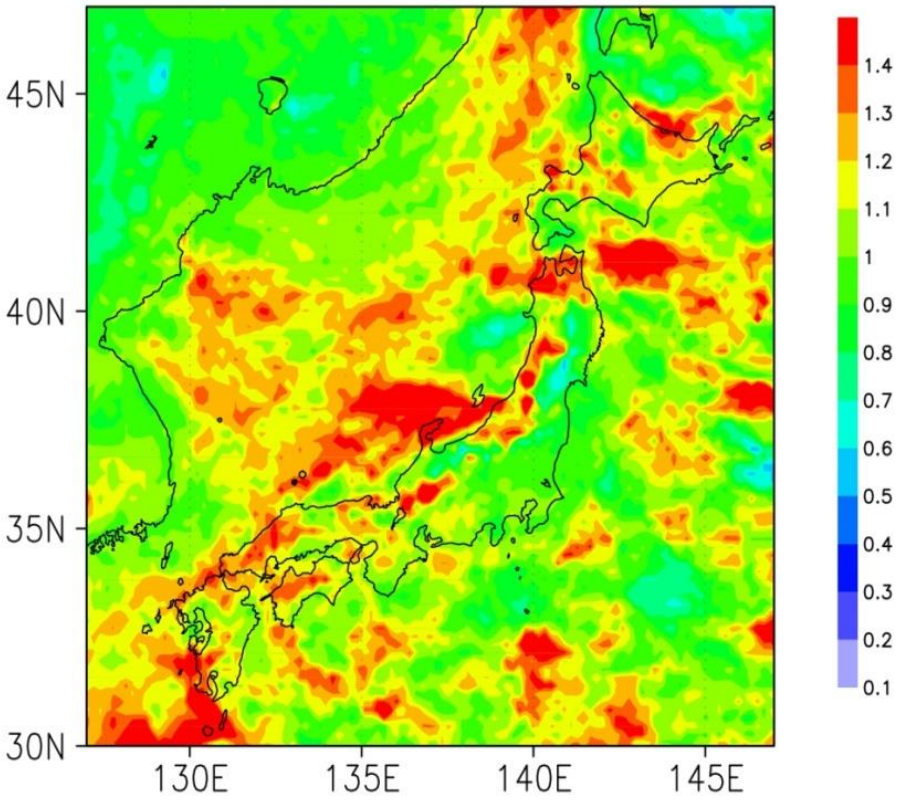


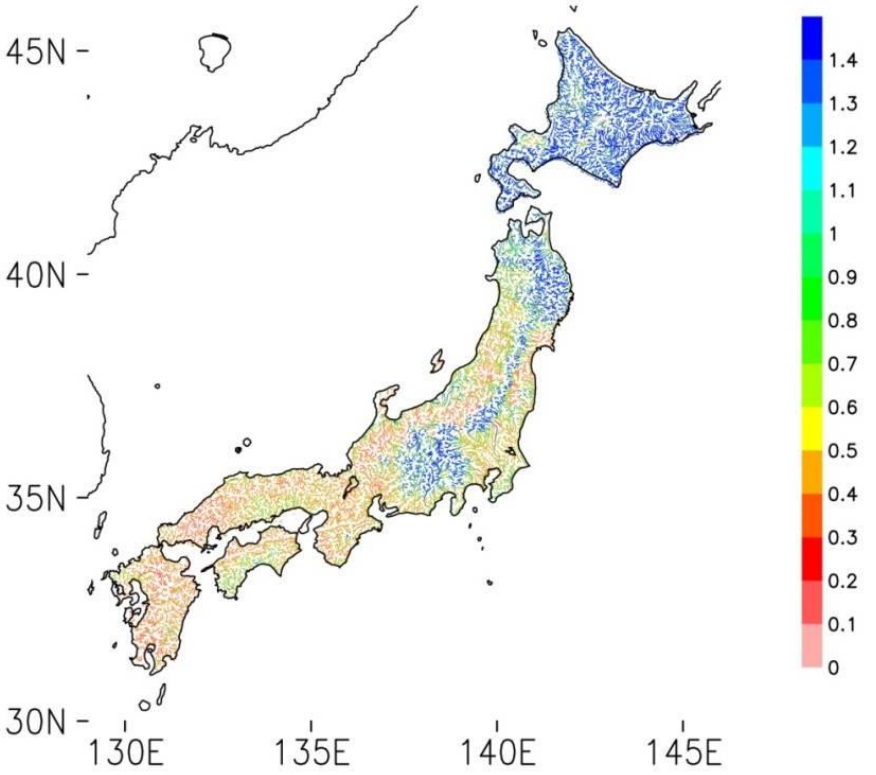
Near future climate
/Current climate



Future climate
/Current climate

Change of annual maximum non-rainy days and 10-year 10th daily discharge in a year





Findings

1. Clear changes of hourly flood peak discharge, daily drought discharge (last 10^{th} discharge) and monthly discharge were detected;
2. For each discharge, the degree of the changes differs according to location; and
3. The changes appear in the near future climate experiment, which become clearer in the future climate experiment.

Acknowledgement: The GCM projection data was provided by MRI, Japan Metrological Agency through KAKUSHIN project. The research is conducted cooperatively with DPRI, KU and MRI.

Summary

Through the 75 years runoff simulations for Japanese catchments, the findings are summarized as follows:

1) A clear change of temporal and spatial discharge patterns appears;
2) The degree of the change differs according to location;
3) In northern Japan, river discharge for the future climate is smoothened because of the decrease of snow melting;
4) In southern Japan, the flood peak discharge increases because of higher short term precipitation , which leads to the increase of flood risk;
5) In southern Japan, the 355th daily discharge in descending order in a year decreases, which leads to the increase of drought risk;
6) The discharge change appears in the near future climate experiment.