Webinar Series on Climate Change Projection for Disaster Risk Reduction in Asia-Pacific Region, Fifth Webinar with the Republic of Korea, 27 February 2026

Projection of Multiscale River Flood Changes Across Japan using Ensemble Climate Dataset

Disaster Prevention Research Institute

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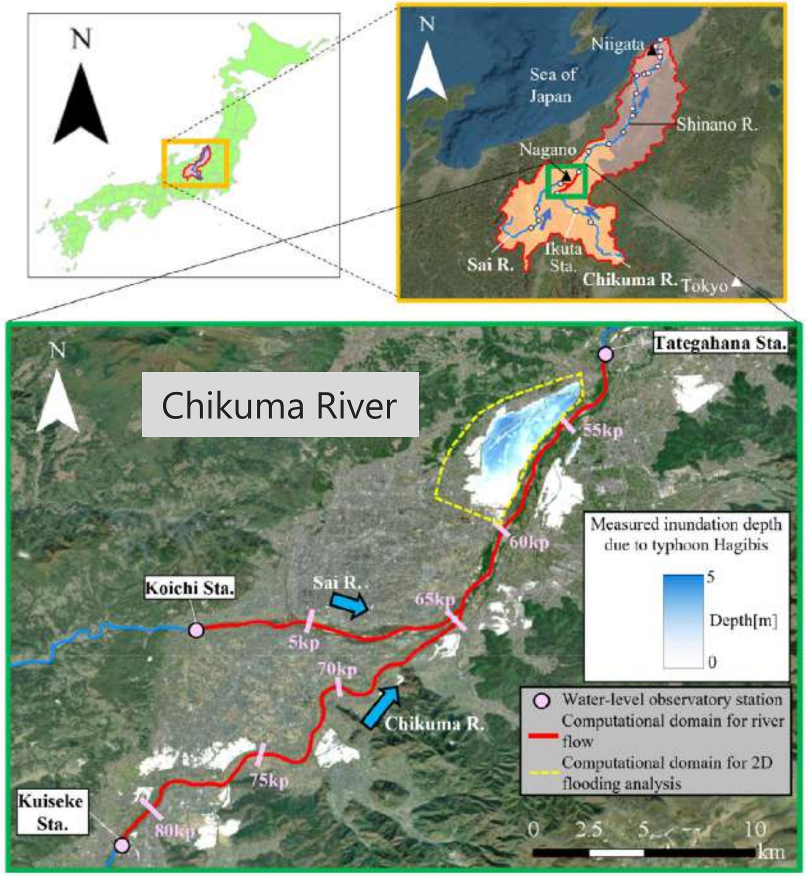
Flood Disasters in Japan



Typhoon Hagibis, Oct. 2019

Death or missing people: 94

Damaged and flooded houses: 96,572

Nikkei: https://www.nikkei.com/article/DGXMZO50952200T11C19A0000000/

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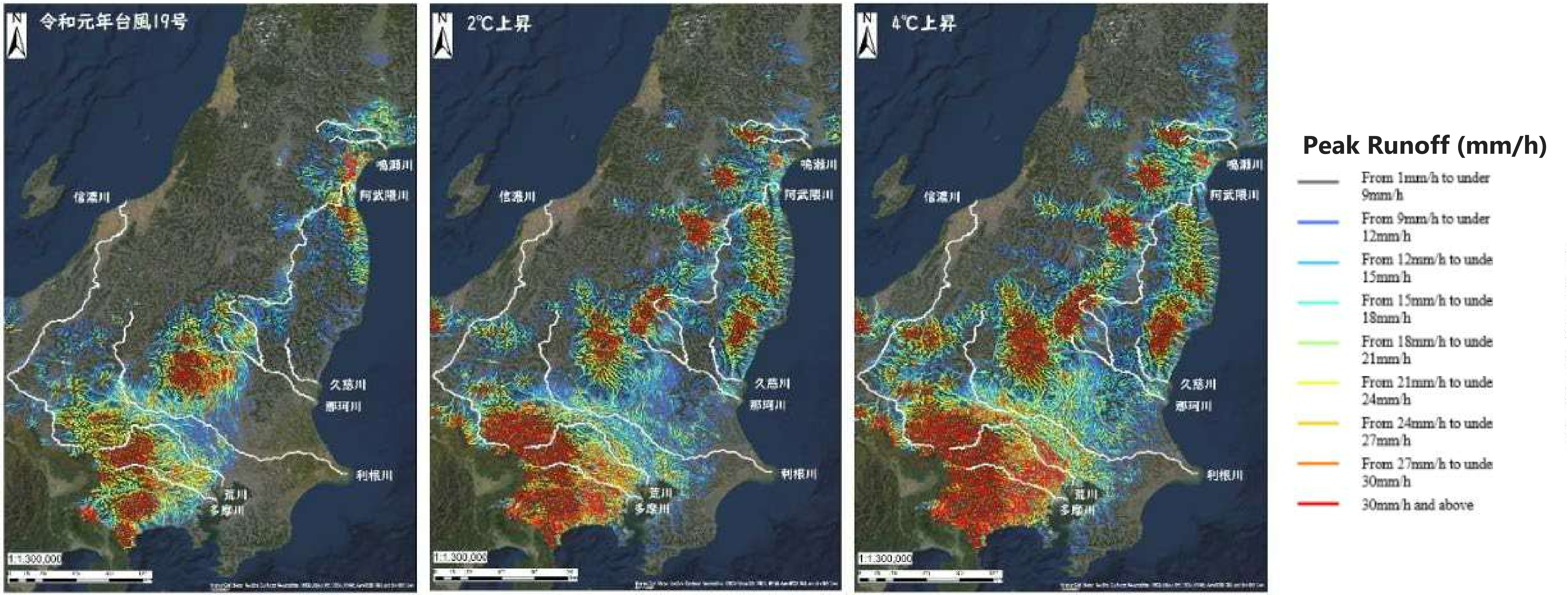
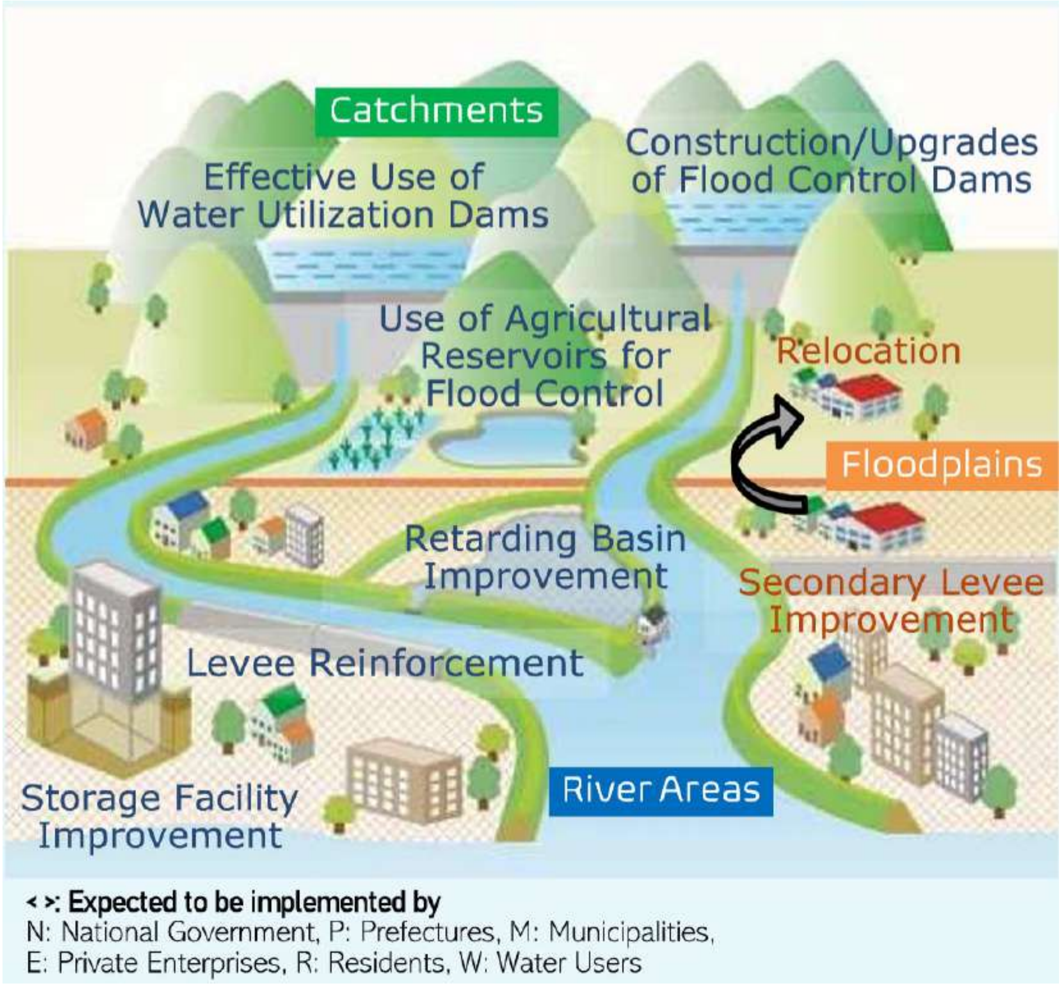
Pseudo Global Warming (PGW) of Typhoon Hagibis

Control **2K** **4K**



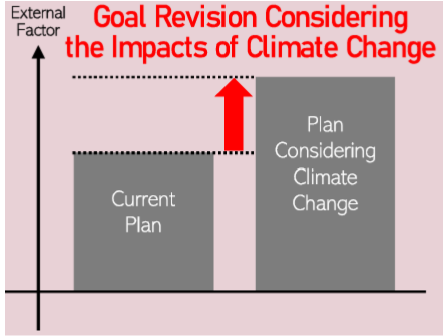
Multi-model, multi-scenario Event Attribution Project under Ministry of Environment (MoE), Japan
https://www.env.go.jp/en/press/press_01744.html

Adaptation Measures by Japanese Government



https://www.mlit.go.jp/river/kokusai/index.html

***River Basin Disaster Resilience and Sustainability by All** - Japan's New Policy on Water-related Disaster Risk Reduction*



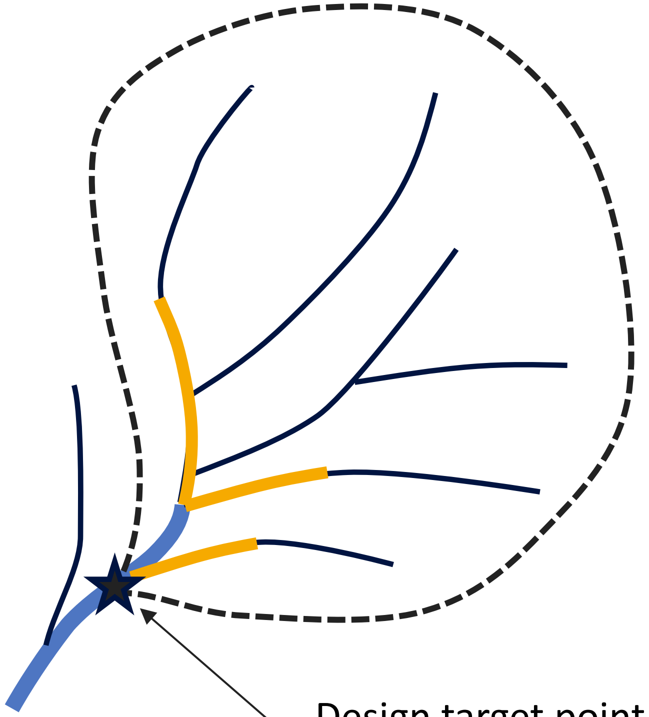
Design target considers climate change under 2K

Conventional flood control
Structural measures implemented mainly in river areas and floodplains

New policy
Measures in any kind of place in river basins by cooperating all stakeholders by involving private enterprises and residents.
The measures include 1) flood prevention, 2) exposure reduction, and 3) disaster resilience

Climate Change Projections of Floods

A: Climate change adaptation in “Flood Control”

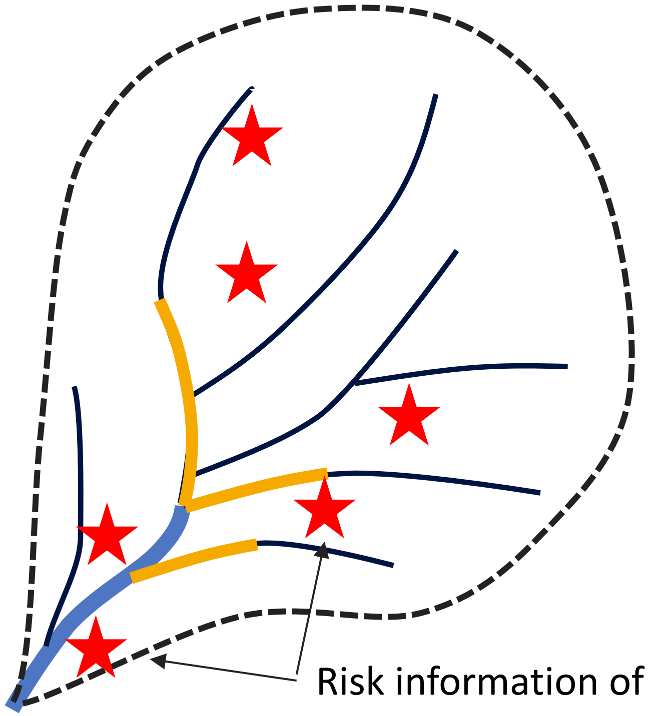


Design target point

→ Identify upstream basin
→ Design rainfall
→ Design flood

Consider CC impact for updating design rainfall (by MLIT)

B: Climate change adaptation for “**River Basin Disaster Resilience**”

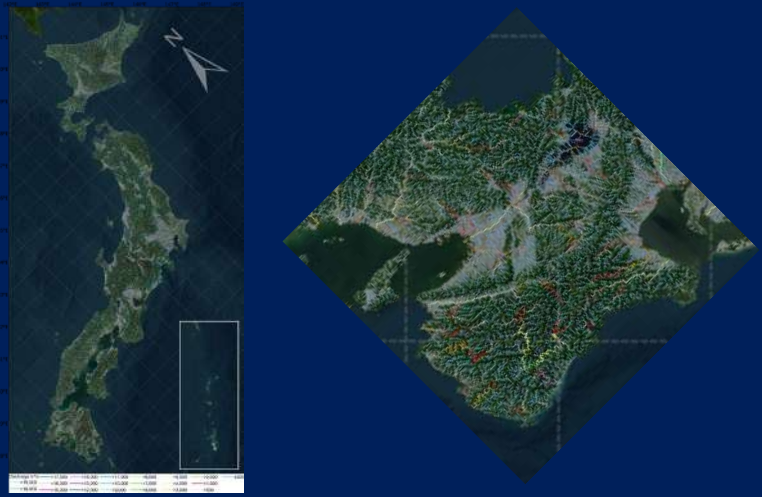


Risk information of flood inundation

- Frequency
- Depth
- Climate Change Impacts

Two Important Technological Innovations

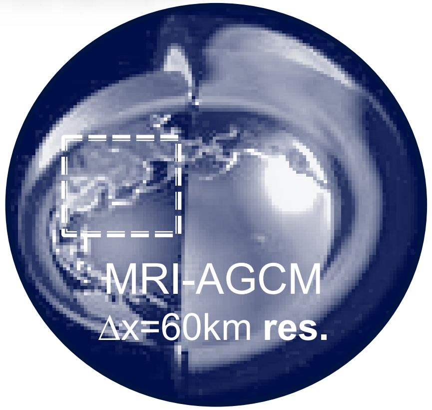
Ensemble Climate Dataset



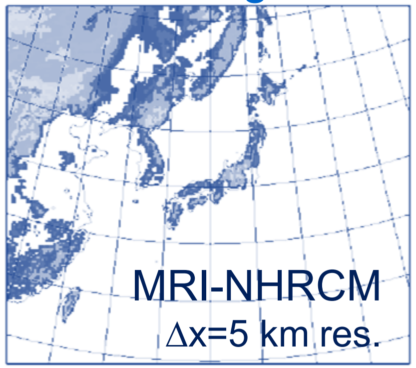
Large Domain Distributed
Hydrologic Modeling

Ensemble Data: d4PDF-5km

Model



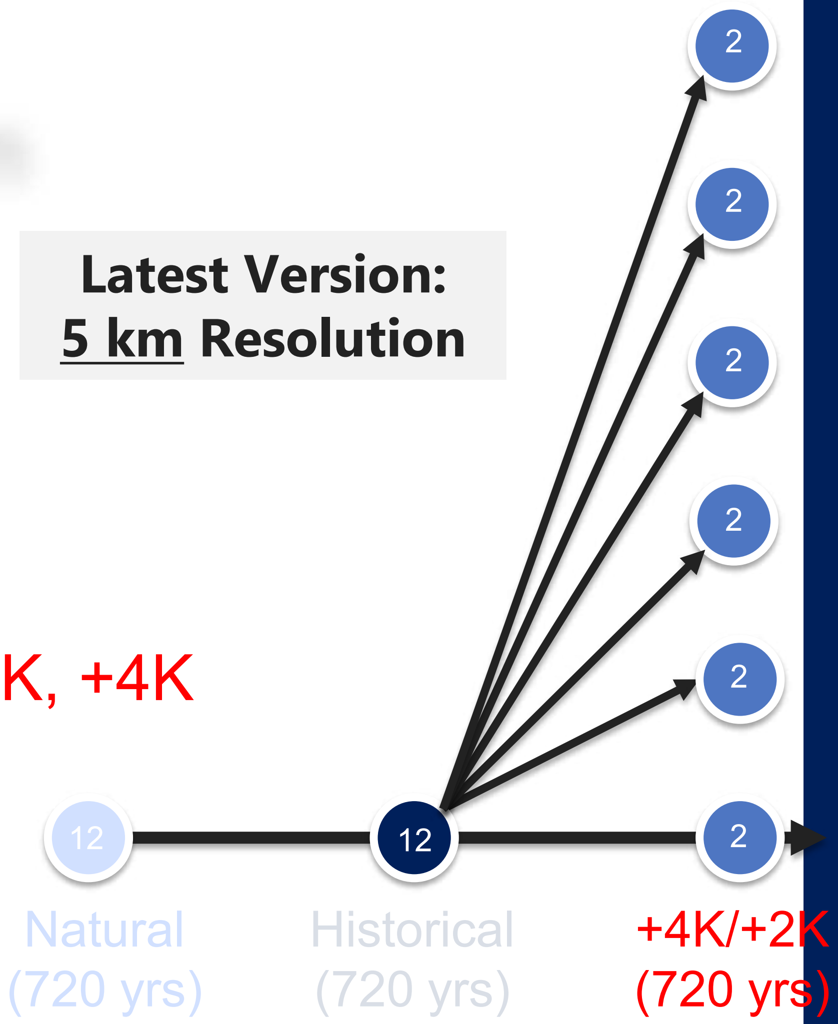
Downscaling to EA



Exp. Configuration

- One ensemble
  - 60yrs
- Initial perturbation
  - 12 for historical/Nat.
  - 12 for future
- Future climate
  - Global mean temp. +2K, +4K
- SST/Sea ice
  - Historical
    - COBE2-SST
  - Future
    - SSTs from CMIP5

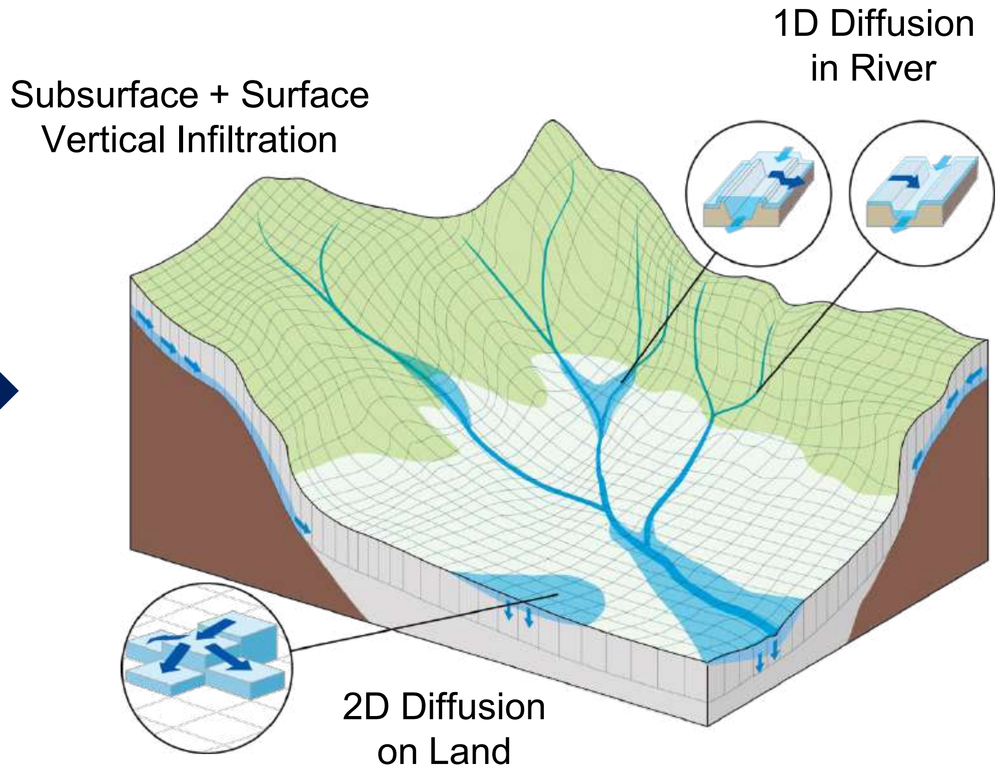
Latest Version:
5 km Resolution



Kawase et al., JGR, 2023

Rainfall-Runoff-Inundation (RRI) Model – Application to whole Japan (150 m)

Input
- Rainfall
- DEM
- Land Cover
- Cross Sec.



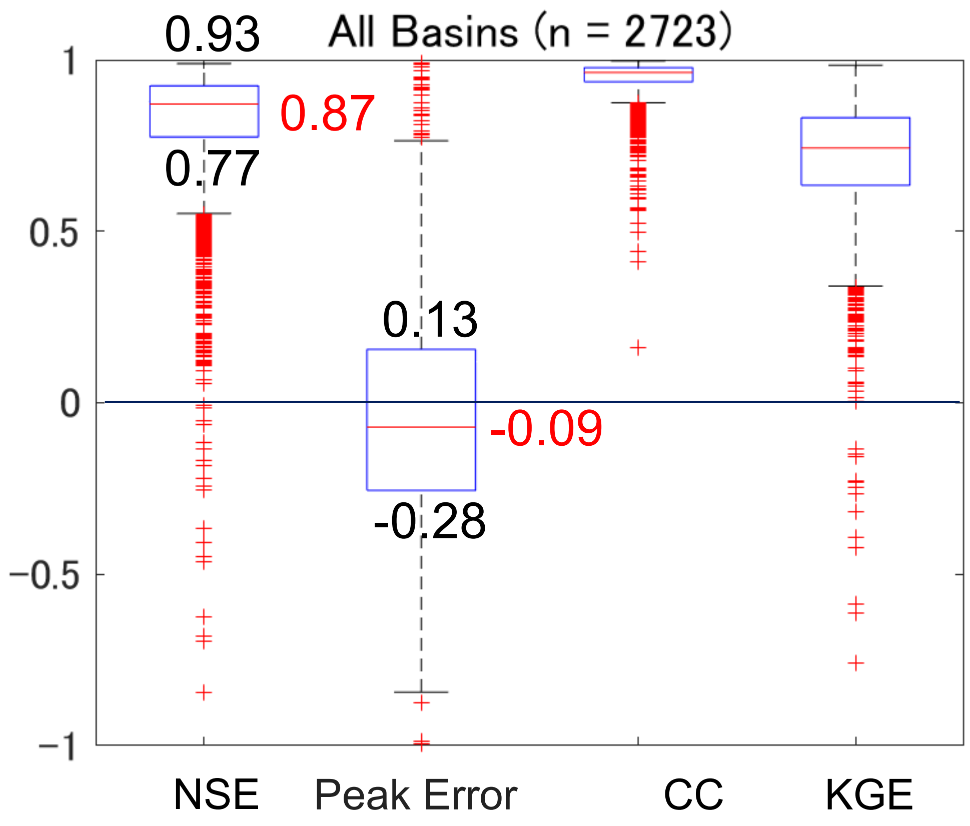
Output
- Discharge
- W. Level
- Inundation

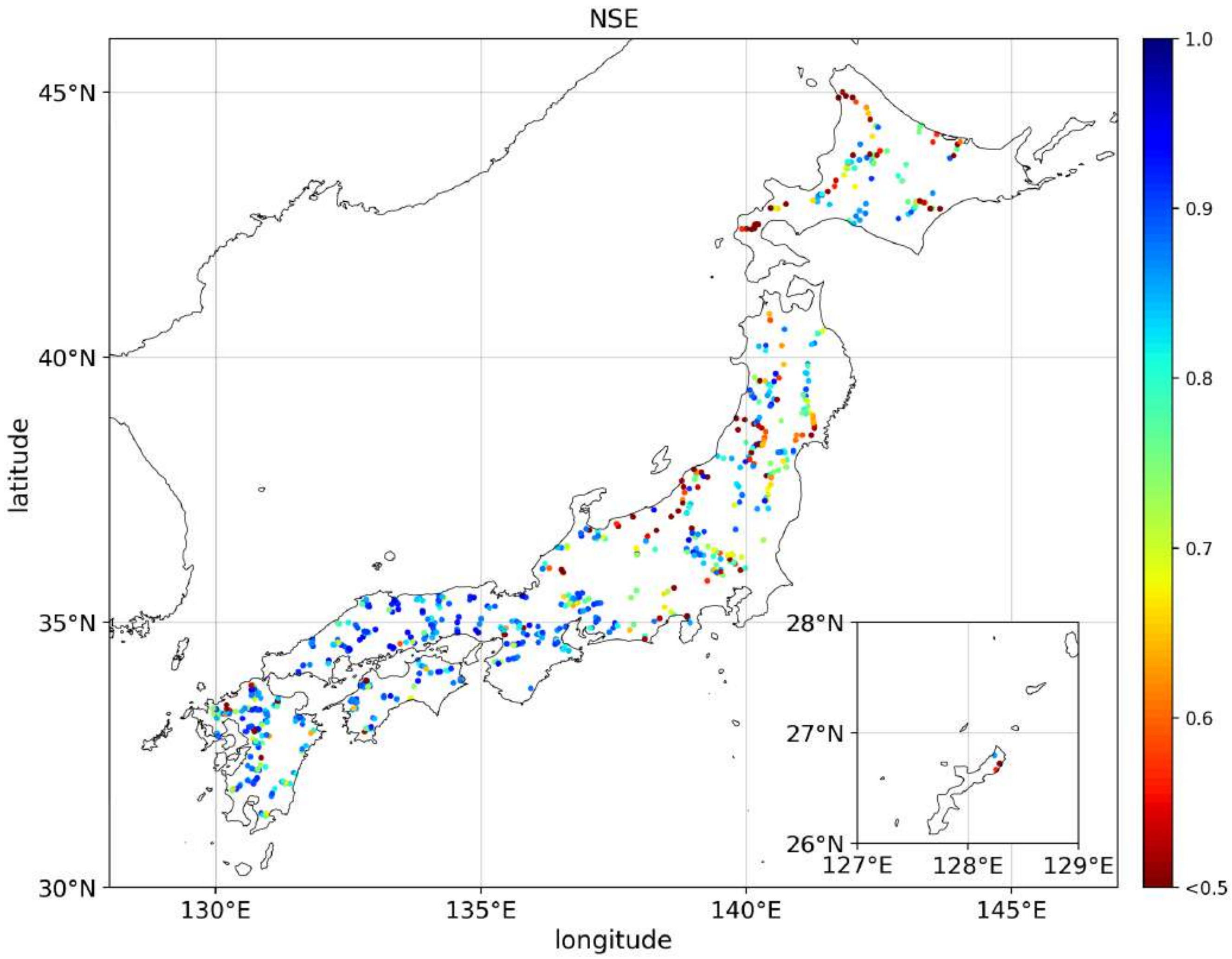
- Two-dimensional model capable of simulating rainfall-runoff and flood inundation simultaneously
- The model deals with slopes and river channels separately
- At a grid cell in which a river channel is located, the model assumes that both slope and river are positioned within the same grid cell

Sayama, T. et al.: Rainfall-Runoff-Inundation Analysis of Pakistan Flood 2010 at the Kabul River Basin, *Hydrological Sciences Journal*, 57(2), pp. 298-312, 2012.
Sayama, T. et al.: Hydrologic Sensitivity of Flood Runoff and Inundation: 2011 Thailand floods in the Chao Phraya River basin, Nat. Hazards Earth Syst. Sci., 15, 2015.
Sayama, T. et al. Ensemble flash flood predictions using a high-resolution nationwide distributed rainfall-runoff model, Progress in Earth and Planetary Science, 2020.

Rainfall-Runoff-Inundation (RRI) Model

(At 711 sites、Total 2733 events)





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Sayama et al.: PEPS, 2025

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Storm Event Selection Method for Large Ensemble Dataset

Aggregating Grid Events

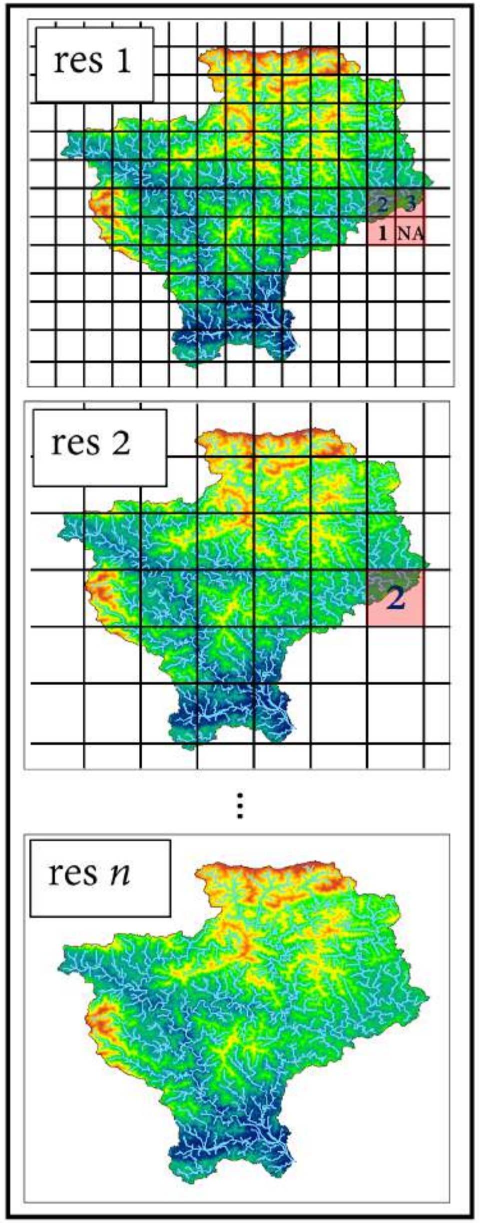
(AGE method)

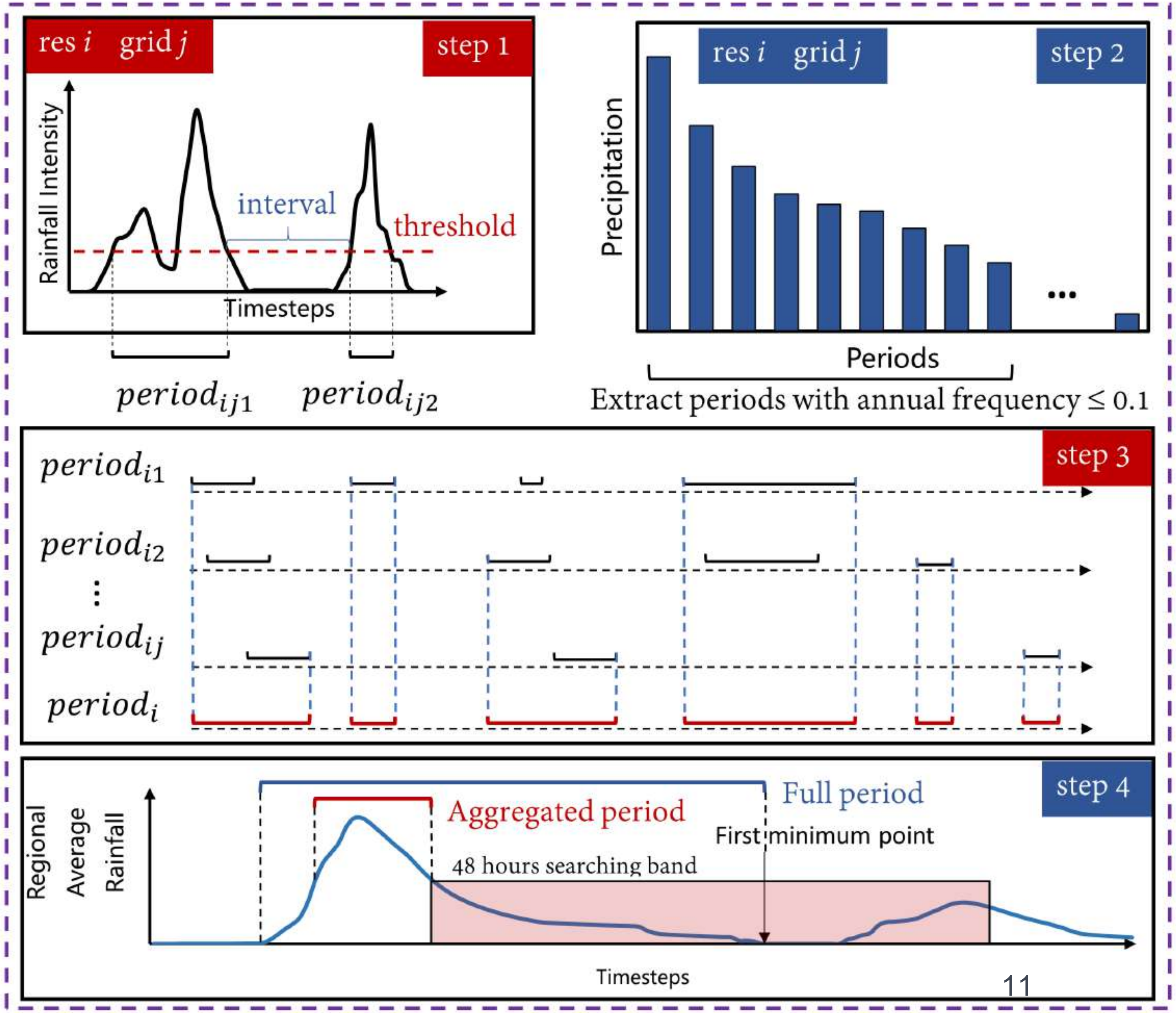
Advantages

- Reduce 50 times calculation
- No need for simplification or modification on hydrologic models

Approximate concentration time

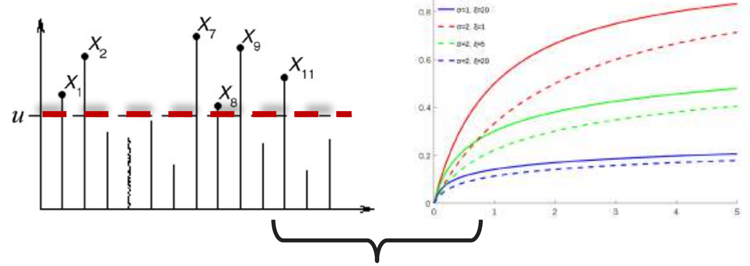
Area (km²)	Duration
0~200	6 h
200~500	12 h
500~5000	24 h
≥ 5000	48 h





Estimation of Flood Quantiles at Each River Grid-cell of the RRI Model

Peak Over Threshold (POT)

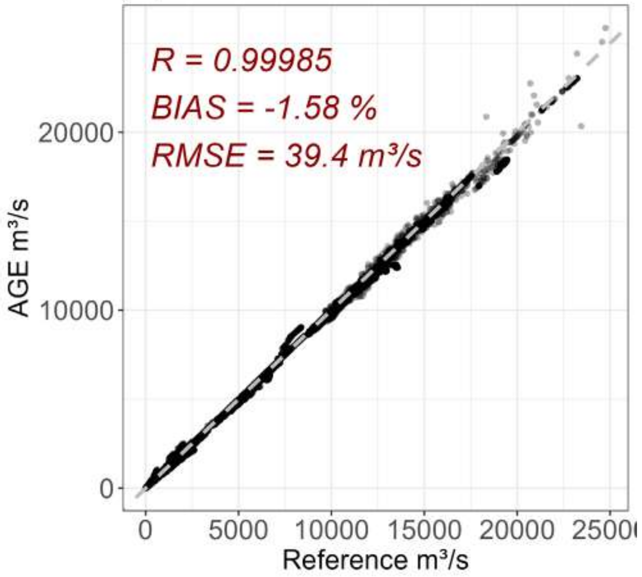


Reference: All valid precipitation events

To be evaluated: Events extracted by the **AGE method**

d4PDF → Event set → RRI model → Top 72 discharges → POT → Quantiles

(b) Watari



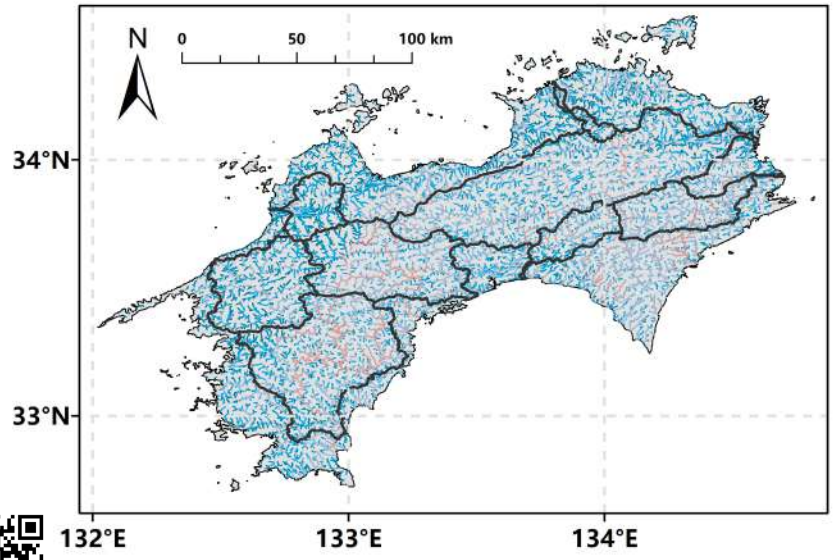
$$R = \frac{\sum(y_e-\overline{y_e})(y_r-\overline{y_r})}{\sqrt{\sum(y_e-\overline{y_e})^2\sum(y_r-\overline{y_r})^2}}$$

$$BIAS = \frac{\sum y_e - \sum y_r}{\sum y_r} \times 100\%$$

$$RMSE = \sqrt{\frac{1}{n}\sum(y_e - y_r)^2}$$

$$CI\ ratio = \frac{y_{97.5\%} - y_{2.5\%}}{y_e} \times 100\%$$

(c) 100-year Return Period



Discharges evaluation

Chen, Sayama, et al., Journal of Hydrology, 2025

Quantiles evaluation

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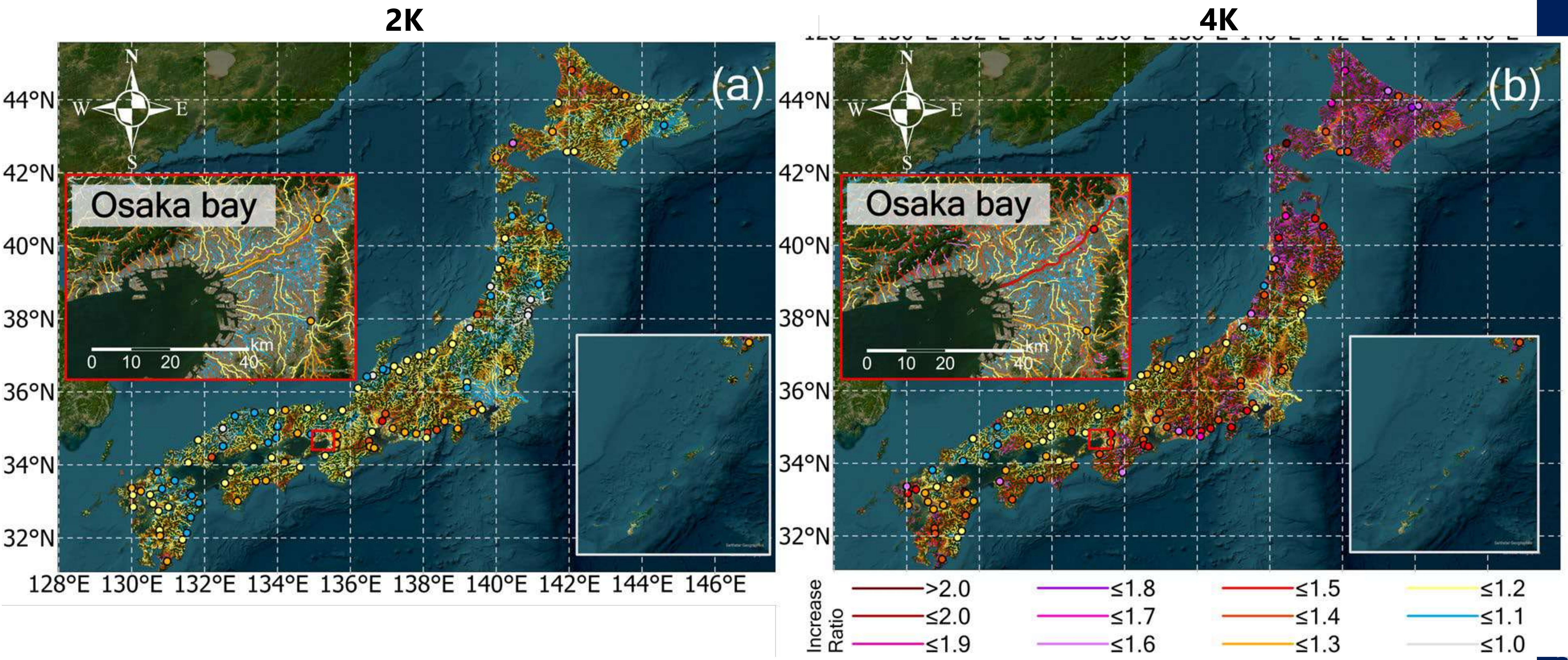
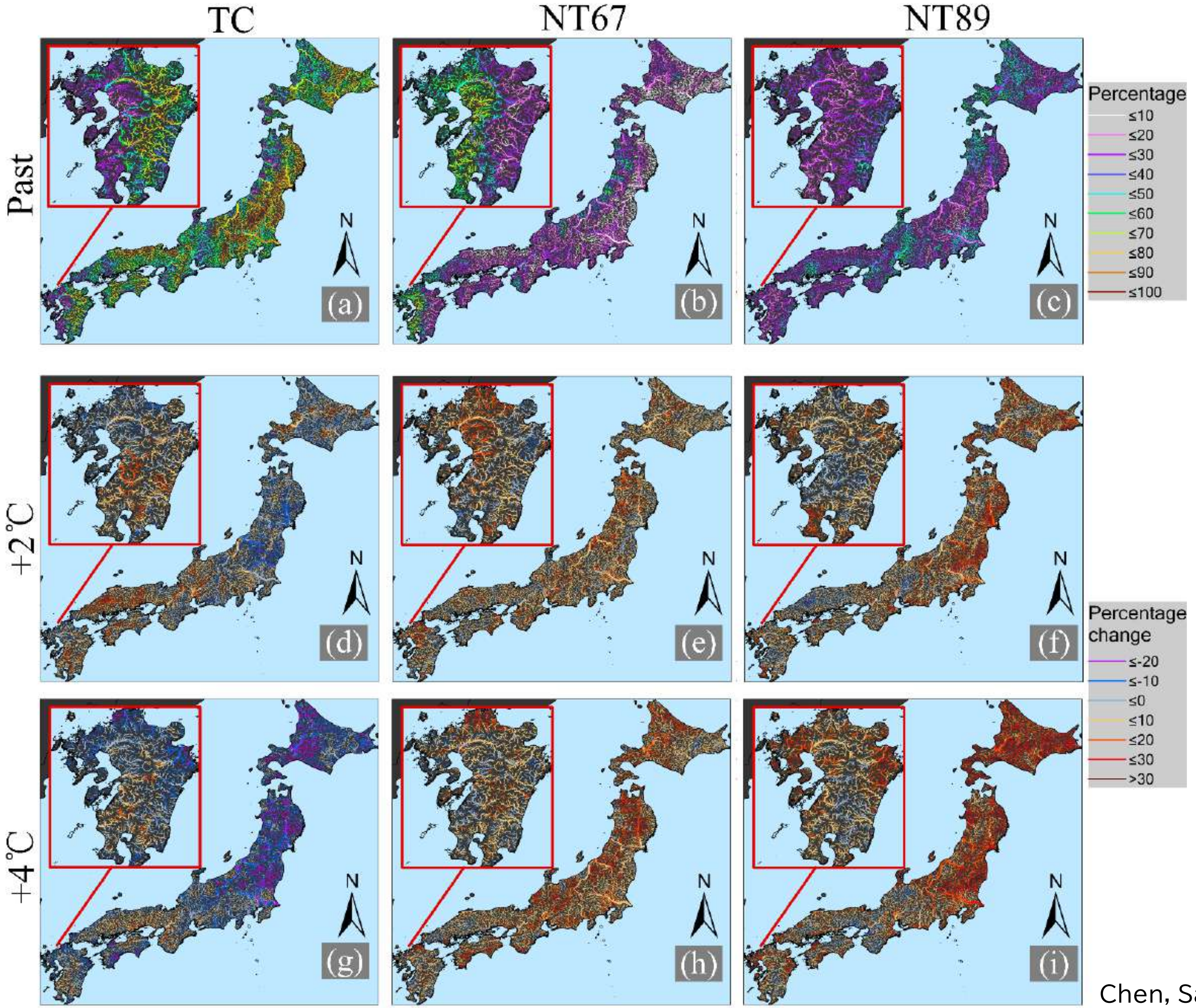
Impacts of Climate Change on 100-year Flood



Chen, Sayama, et al., Earth' s Future, 2025

More Frequent of Severe Floods by Induced by Non-Typhoon



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Chen, Sayama, et al., Under Review

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Toward a More Resilient and Connected East Asia

1. Climate change is already altering flood risks

Our climate has already in the last 20 years and will continue to change

3. Climate change adaptation requires regional cooperation

There is potential in East Asia to share tools, data and projections for mutual benefit

2. Ensemble-based, science-driven assessments are essential

We need high-resolution ensemble projections to understand and prepare for future flood risks

4. Cooperation can be built on existing platforms

International program such as UNESCO-IHP offer official platform to facilitate collaboration

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