Future Change Analysis of Extreme Floods at the Indochinese Peninsula Using Large Ensemble Climate Simulation Data

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New Climate Change Research Program

TOUGOU Program, 2017-2021
Integrated Climate Model Advanced Research Program

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TOUGOU Program, 2017-2021

Theme iv) Water-related Hazard Prediction in Southeast Asia and the Pacific

MRI, Meteorological Research Institute in Japan provides

- multi-ensemble 60km resolution atmospheric and hydrologic dataset for percent and future climate projections, and
- new GCM outputs simulated with 60km AGCM, 20km AGCM, and 5km regional climate model under RCP8.5 scenario for Southeast Asia and the pacific

for Southeast Asia and the Pacific region.

1. Water-related hazard and water resources analysis under climate change
2. Flood and draught hazard and risk assessment

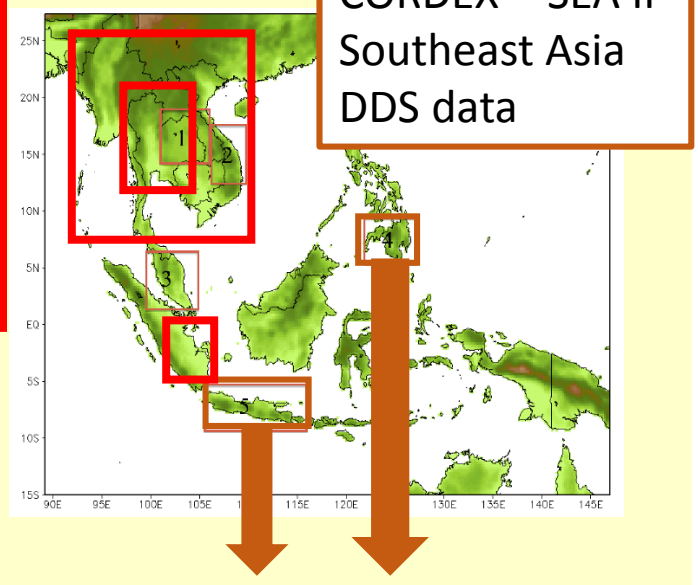
iv. Water-related hazard prediction for Southeast Asia and the pacific

iv(a) Water-related hazard prediction (Kyoto University)

1. **Indochinese Peninsula: Hydrologic prediction (low flow and high flow) applying a newly developed bias collection method,**
2. **Chao Phraya River basin (Thailand): Water resources prediction applying a new land surface model incorporating irrigation scheme,**
3. **Batanhari River basin (Indonesia): Flood prediction and development of flood hazard mapping,**
4. **Red River basin (Viet Nam): Flood prediction and development of flood risk mapping.**

Collaboration with MRI for GCM projections

d4PDF
AGCM20
NHRCM05



iv(b) Prototype development for supporting climate change adaptation measures (ICHARM)

Prototype development for supporting climate change adaptation implementation in Philippines and Indonesia.

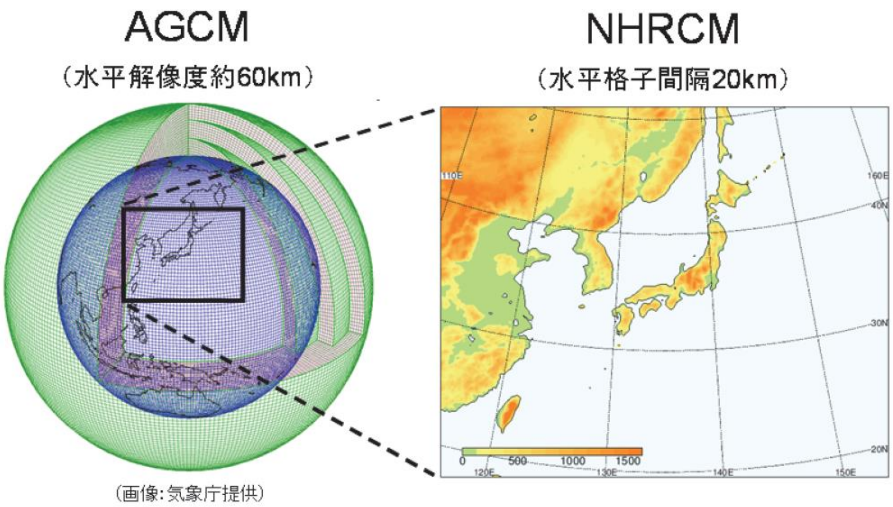
1. **Risk assessment of water-related disasters;**
2. **Field survey for needs and abilities for climate change adaptation; and**
3. **Supporting climate change adaptation for local stakeholders.**

A new opportunity for extreme hydrologic prediction research using Large Ensemble Climate Simulation Data

the database for Policy Decision making Future climate change d4PDF

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

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



（画像:気象庁提供）

The database consists of atmospheric simulations for the globe using MRI-AGCM 3.2H with 60km spatial resolution (Mizuta et al. 2012) and dynamically downscaled simulations using NHRCM with 20km resolution (Sasaki et al. 2011).

The entire globe experiment

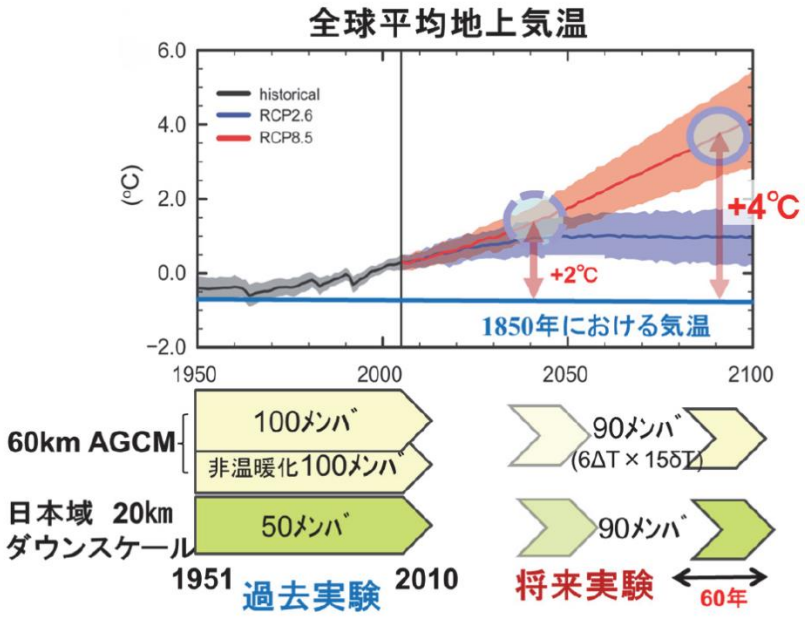
- Historical experiment 1951～2011 × 100 ensemble members
- 4℃ increase experiment 2051～2111 × 90 ensemble members

Downscaled local experiment

- Historical experiment 1951～2011 × 50 ensemble members
- 4℃ increase experiment 2051～2111 × 90 ensemble members

「地球温暖化対策に資するアンサンブル気候予測データベース」利用手引きより

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

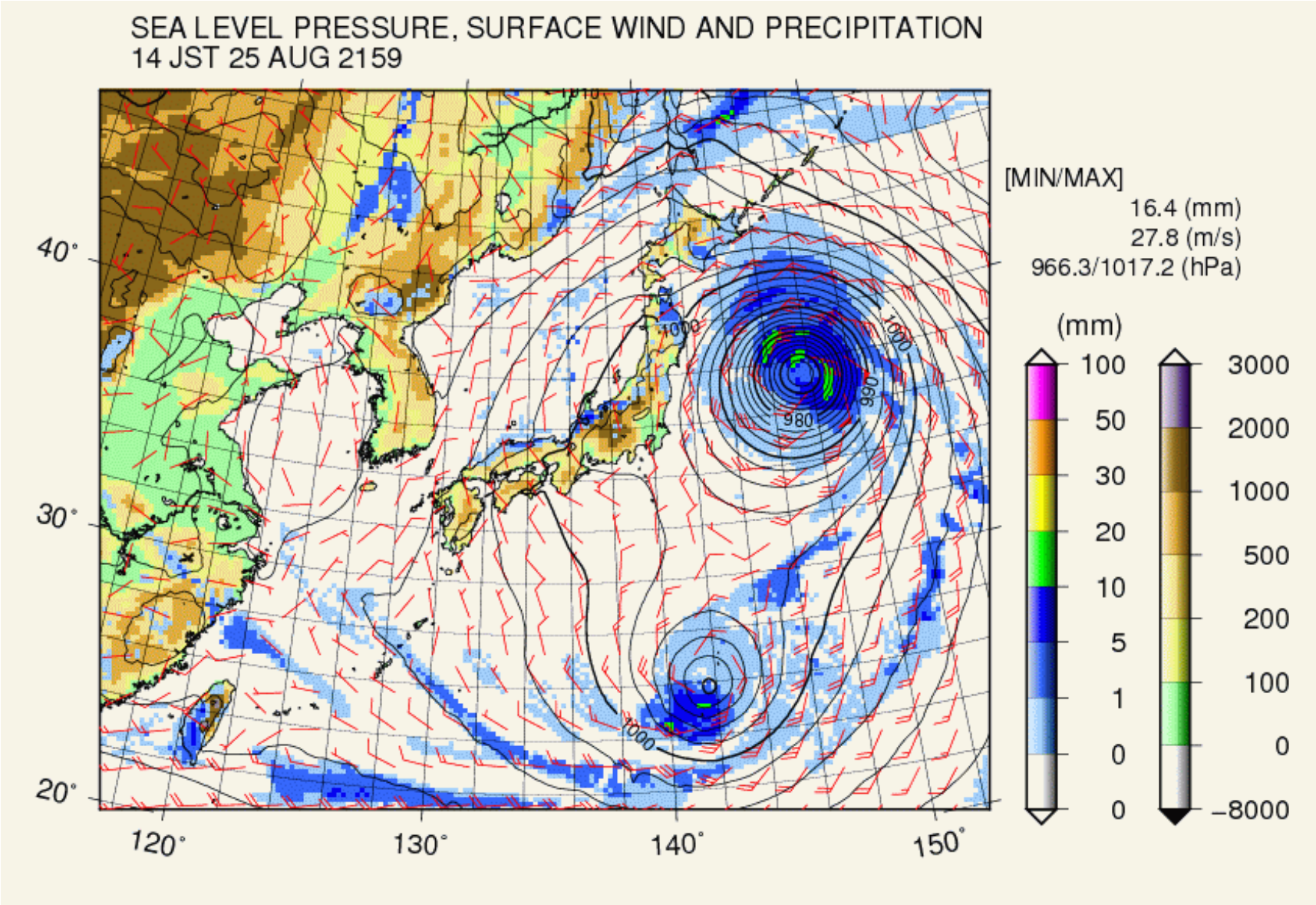


MRI-NHRCM, 20km spatial resolution

- Present Climate Experiments: 50 ensembles of 60 years climate simulation under different boundary conditions, which provides 3,000 years hydrologic time series data.
- The End of 21st Century Climate Experiments (4 degree increase): 15 ensembles of 60 years climate simulation under different initial and boundary conditions for 6 SST settings, which provides 5,400years (= 900years times 6 SSTs) hydrologic time series data.

「地球温暖化対策に資するアンサンブル気候予測データベース」利用手引きより

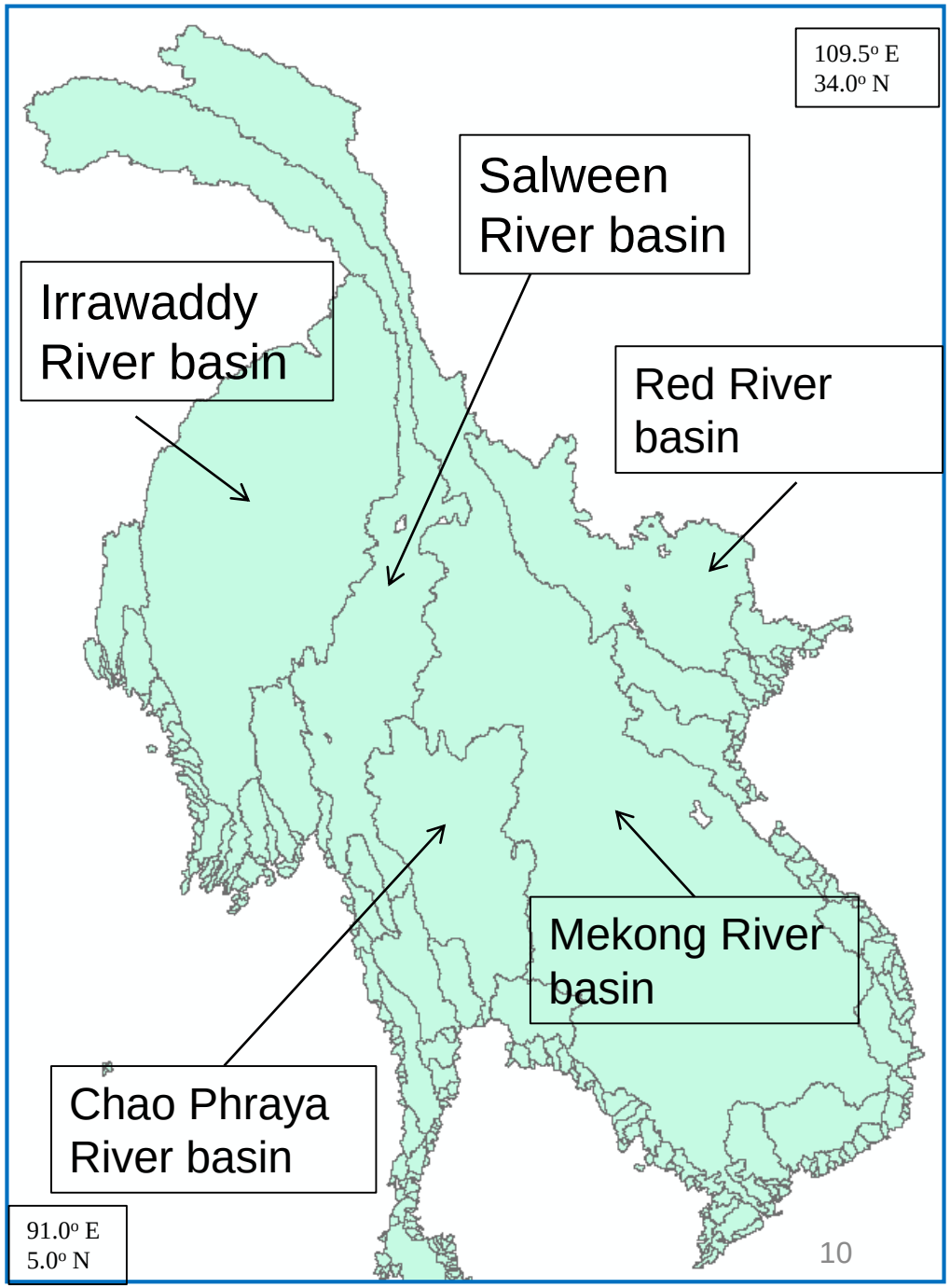
MRI-NHRCM, 20km spatial resolution



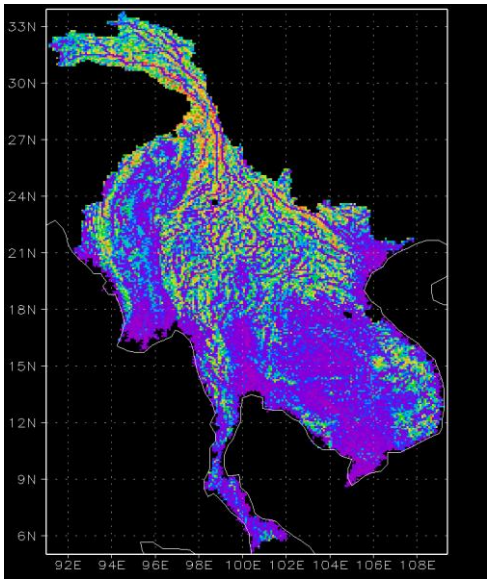
Developed by Mr. Kato at Graduate School of Engineering, Kyoto Univ.

Future Change Analysis of Extreme Floods at the Indochinese Peninsula Using d4PDF

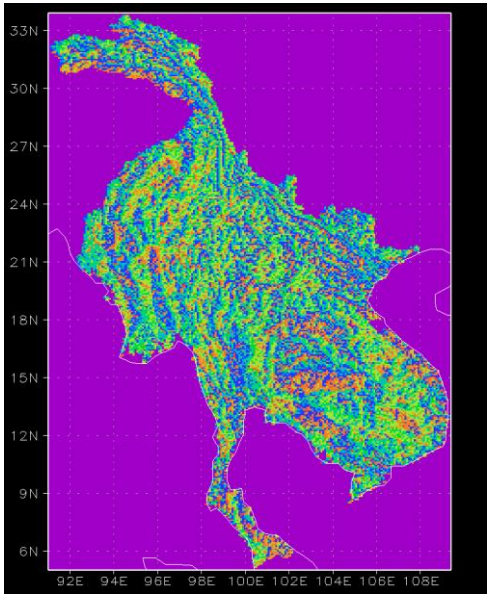
Analysis at Indochinese Peninsula



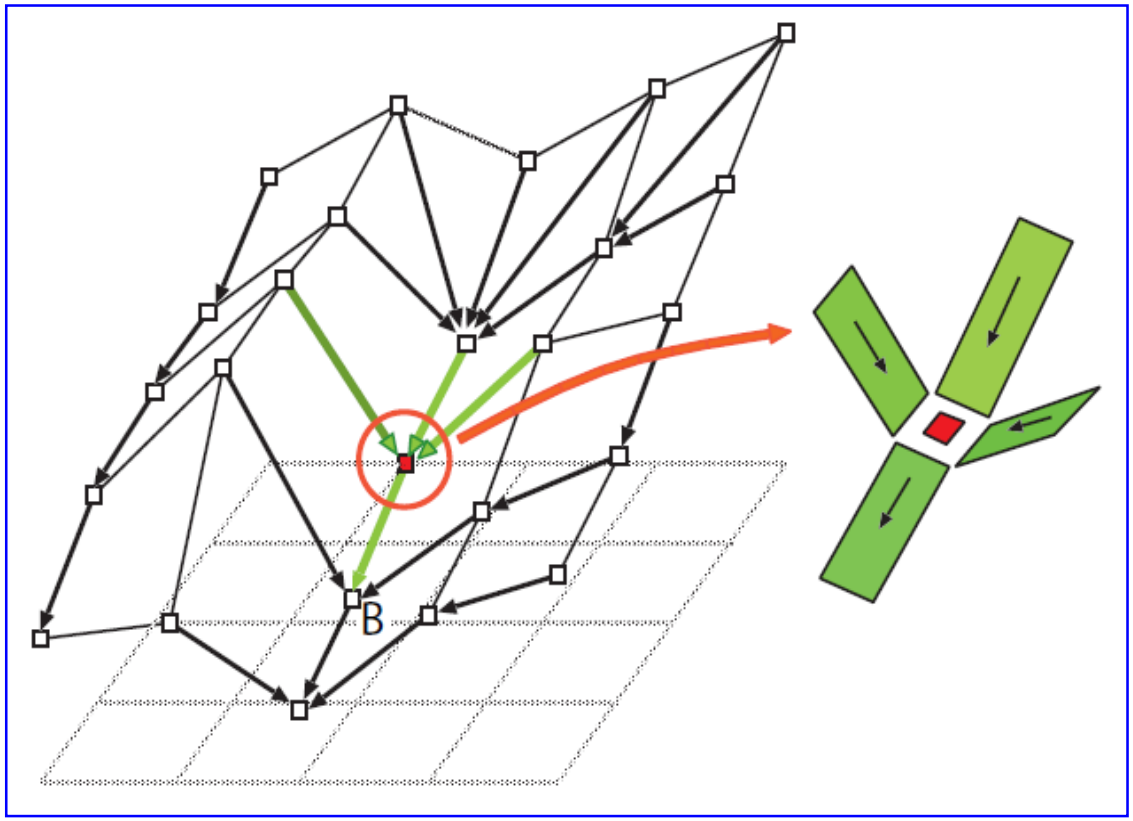
River Flow Routing Model



Elevation

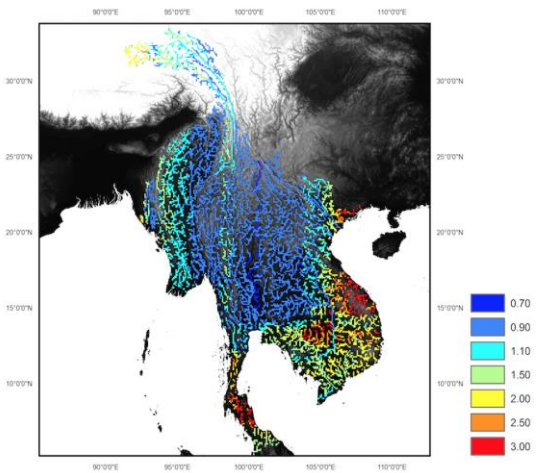


Flow direction

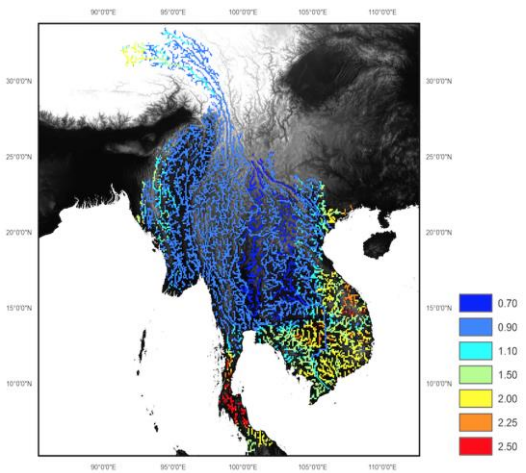


Hydrological Projections at the Indochinese Peninsula under climate change using the d4PDF datasets (P. Hanittinan, 2017)

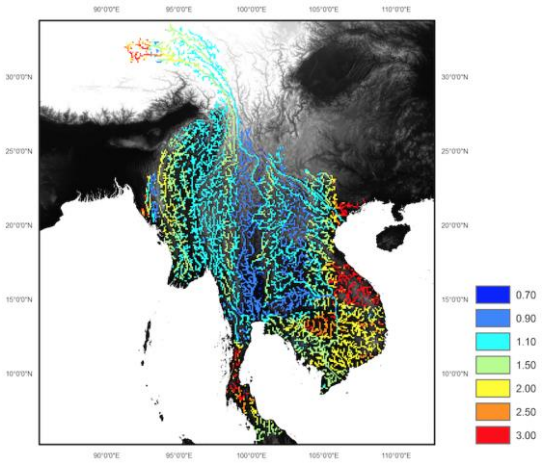
Future Projections of streamflow: mean of the annual maximum discharge



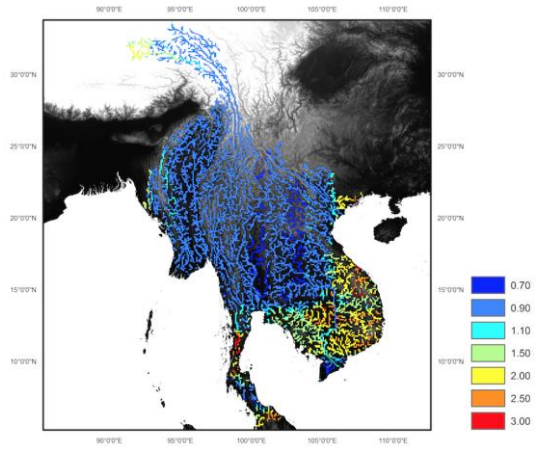
a) CCSM4 (CC)



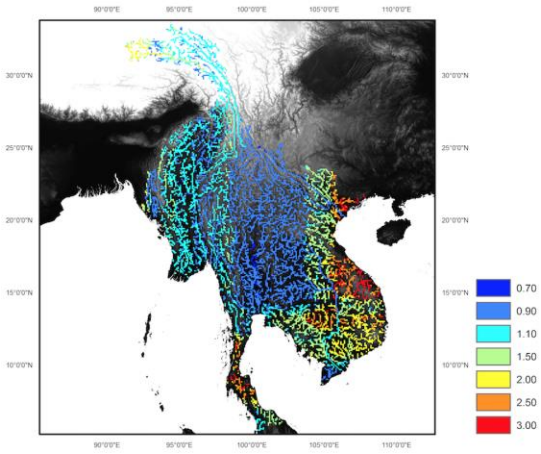
b) GFDL-CM3 (GF)



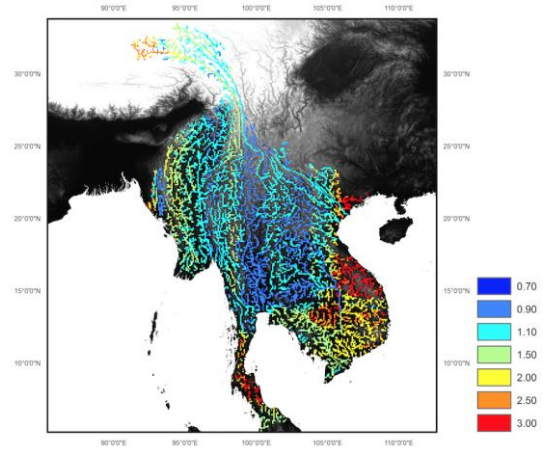
c) HadGEM2-AO (HA)



d) MIROC5 (MI)



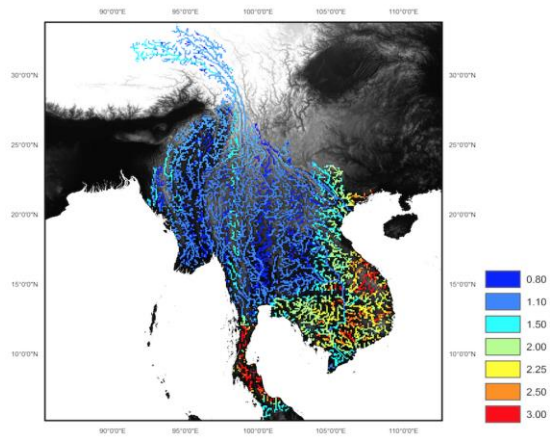
e) MPI-ESM-MR (MP)



f) MRI-CGCM3 (MR)

Hydrological Projections at the Indochinese Peninsula under climate change using the d4PDF datasets (P. Hanittinan, 2017)

Future Projections of streamflow: standard deviation of the annual maximum discharge



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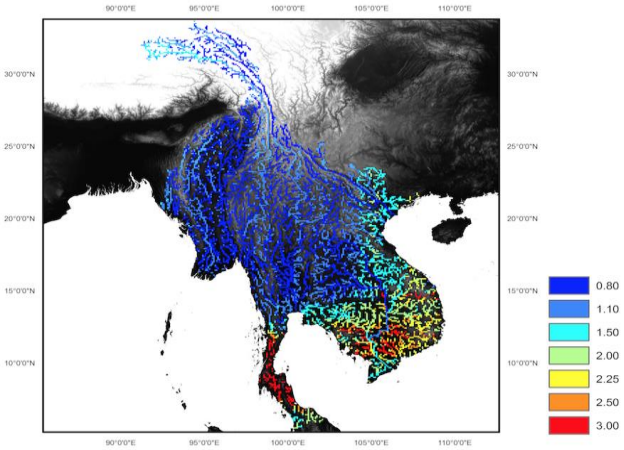
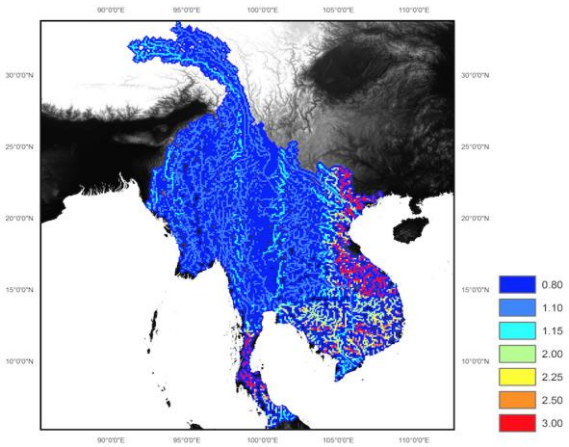
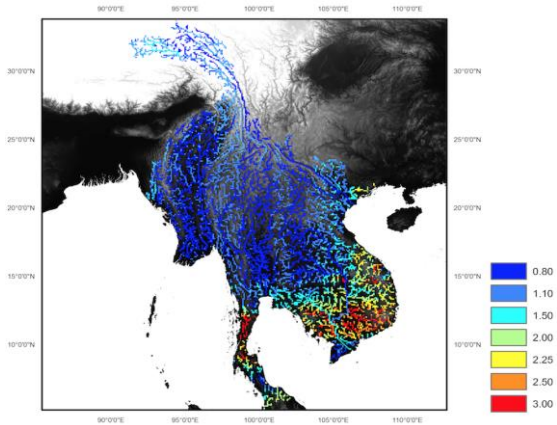


b) GFDL-CM3 (GF)



c) HadGEM2-AO (HA)



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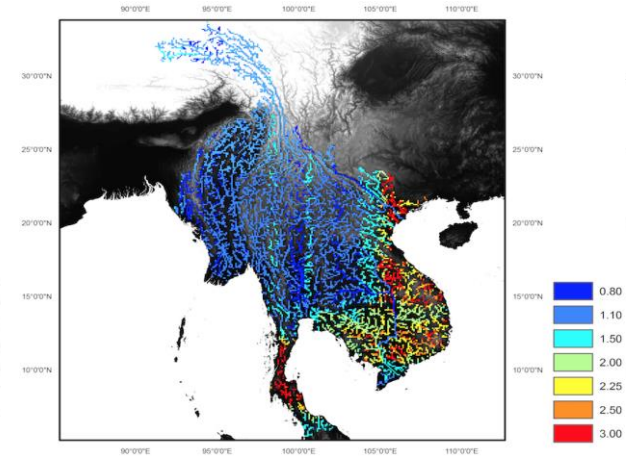

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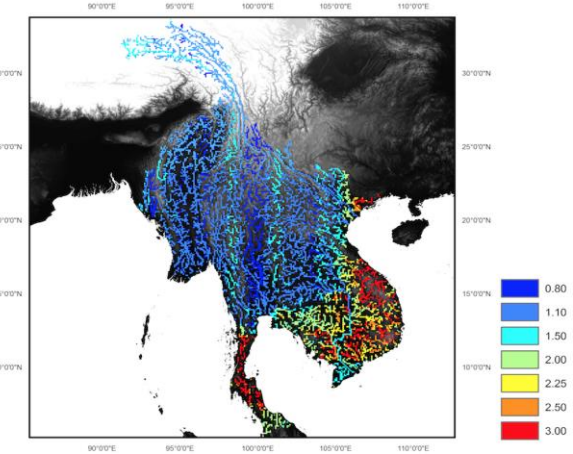


f) MRI-CGCM3 (MR)

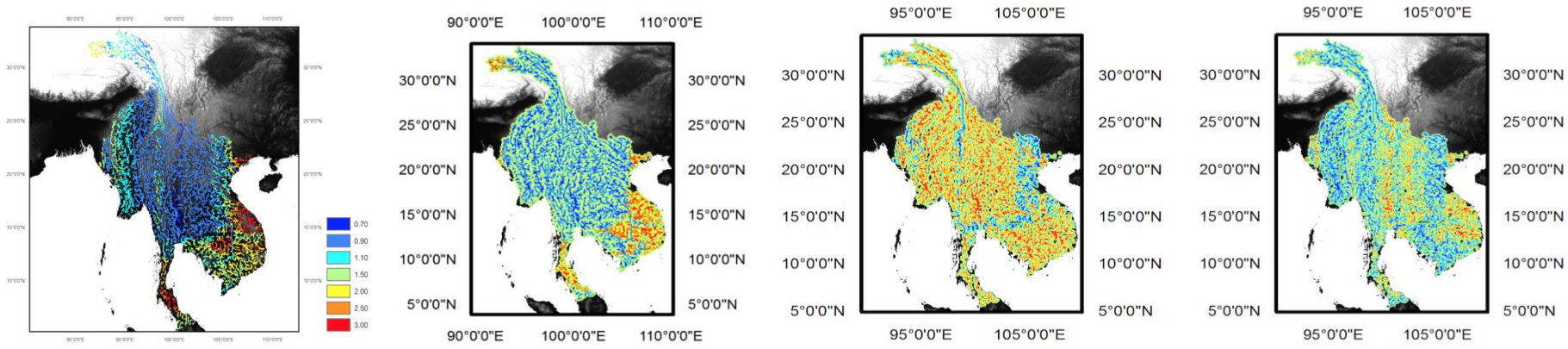
Hydrological Projections at the Indochinese Peninsula under climate change using the d4PDF datasets (P. Hanittinan, 2017)

Concluding Remarks

River discharge projections and its statistical significance

- We found increase change in future river discharge in terms of mean of the annual maximum river discharge, standard deviation, and Q_{95} in all of the SST warming patterns at ***Mekong River Delta***, ***Red River Basin's mouth***, and the ***Southern Indochinese Peninsula*** (changes ratio ranged from 1.10 – 3.00)
- We analyzed the **statistical significance** of these changes and found the difference at 5% significance level at the **Mekong Delta** and the **Southern Indochinese Peninsula**

River discharge projections and its statistical significance under SST warming patterns CCSM4 (CC) scenario



River Discharge ratio | **Statistical significance: U-test** | **Statistical significance: L-test** | **Statistical significance: A-D test**

Conclusions

1) Future flood changes essentially showed a similar trend notwithstanding of SST patterns.

2) Strong increase signals were found at Mekong Delta and southern Indochinese Peninsula for all of the d4PDF SST scenarios.

3) The changes in mean of the annual maximum discharge were statistically significant at 95% confidence level in the Mekong Delta, the southern Indochinese Peninsula, and the mouth of the Red River basin for all of the SST patterns

4) Based on the overall simulated results and the past studies, we found a clear and increasing risk of future floods at the Indochinese Peninsula, especially at the low-lying Mekong Delta and the Southern Indochina regions.

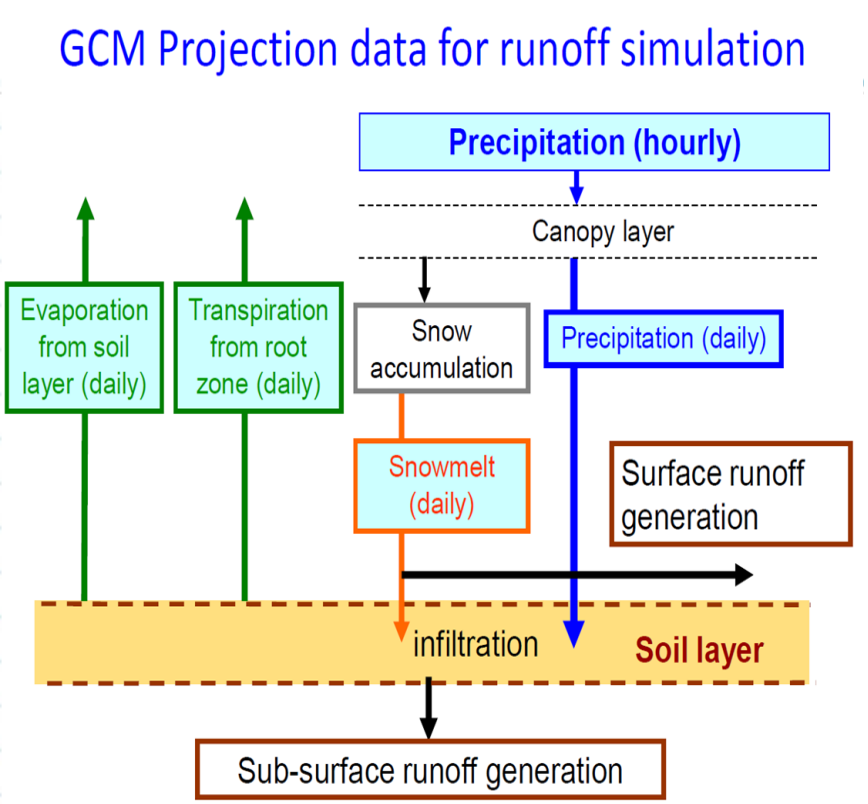
New opportunity for future hydrologic prediction and design

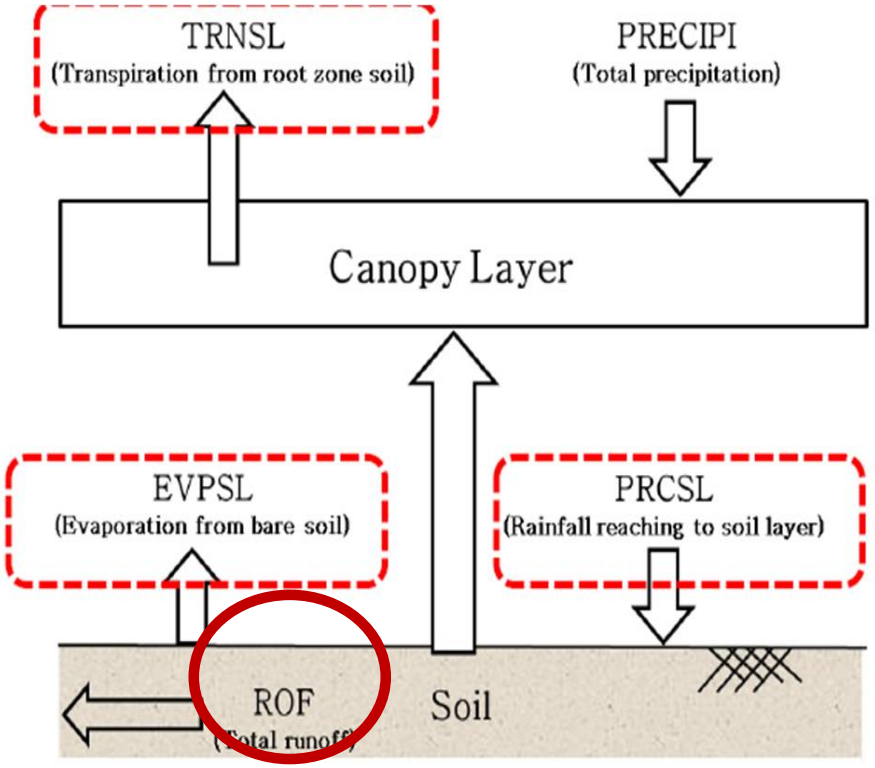
1) To examine the change of probability distributions of hydrologic extremes is possible using the large ensemble climate simulation data.

2) To estimate over 1,000 year-annual maximum extreme events is possible using the large ensemble climate simulation data.


Thank you very much for your attention

Datasets: Input Forcing data





Present Climate (1951 – 2010)

Future Climate) (2051 – 2110)

20th Century → **21st Century**