Downscaling of global climate predictions into local scale water resources information

Core Research for Evolutional Science and Technology (CREST), supported by Japan Science and Technology Agency (JST)
Innovative Technology and System for Sustainable Water Use:
Development of well-balanced urban water use systems adapted for climate change

Water Resources Group

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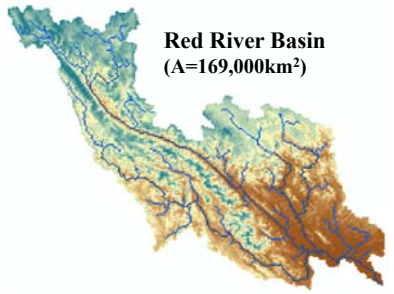
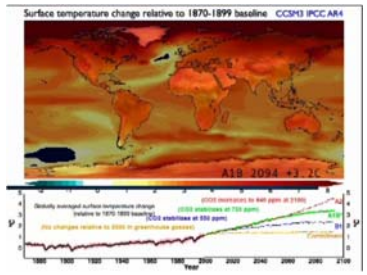
Introduction Water Resources "Under Pressure"

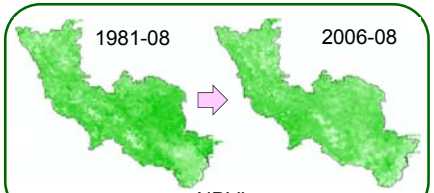


Climate Change

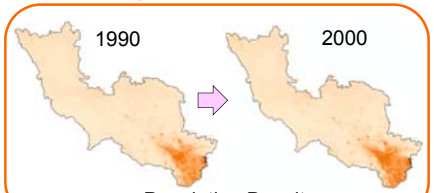


http://www.vets.ucar.edu/vg/IPCC_CCSM3/index.shtml

Land Use/Land Cover Change



Population Growth



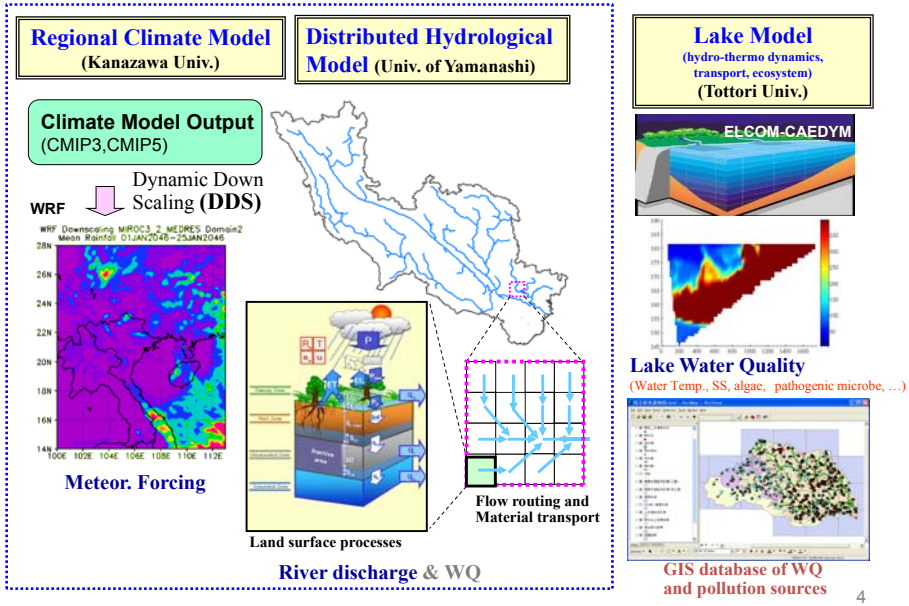
Objectives

In order to create innovative strategies for urban water use under climate change, comprehensive hydro-meteor. predictions will be necessary to evaluate changes in climate and hydrological conditions in watersheds resulting in dynamic variations of water quantity and quality.

Future prediction (projection) of basin-scale water resources

- Total amount of surface water resources
- Changes in water quality of river & lake

Research Framework



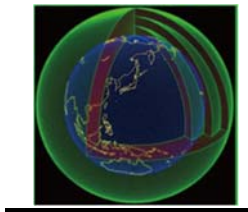
(1) Developing Dynamic Downscaling Method by Numerical Weather Prediction Model

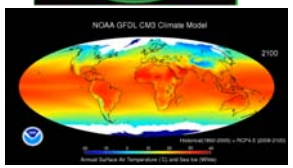
(by Dr. Kenji TANIGICHI, Kanazawa Univ.)

GCM output (Current/Future Climate)

Dynamic Downscaling (DDS)

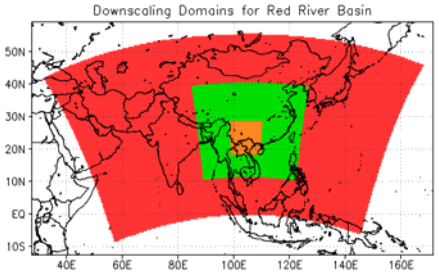
Regional Meteor. data (for basin-scale hydro. simulation)





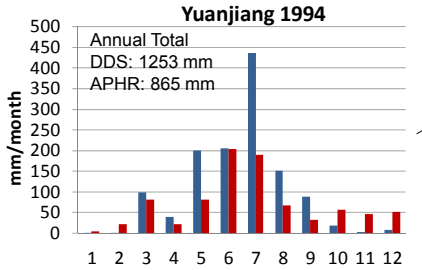
http://www.gfdl.noaa.gov/visualizations-climate-prediction

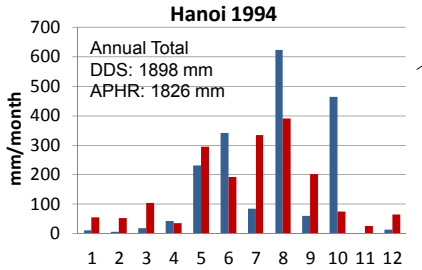
Weather Research and Forecasting model **(WRF)**

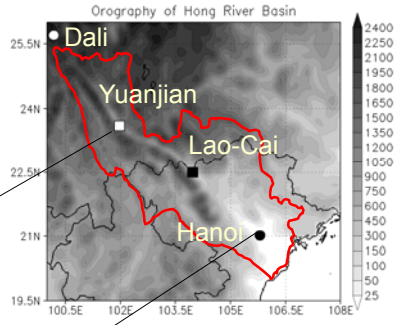


- Nested for three different resolution domains.
- Spatial resolutions: 90km, 30km and 10km
- Time steps: 360sec, 120sec, and 30 sec
- Full year of 1994 (Wet year), 2000 (Dry year)

Seasonal Variation of Monthly Precipitation





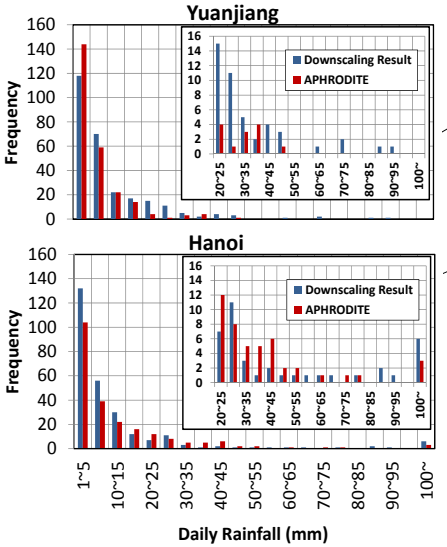


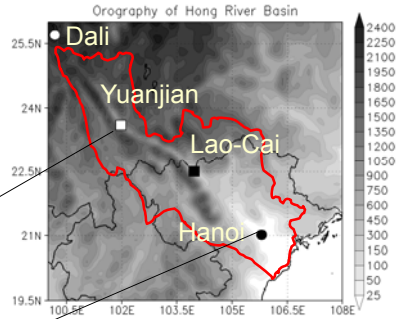
:DDS result by WRF :APHRODITE

In rainy season
(mainly from May to Oct.)
overestimation in almost entire part of target

In dry season
(from Dec. to Mar.)
underestimation

Characteristics of Daily Precipitation





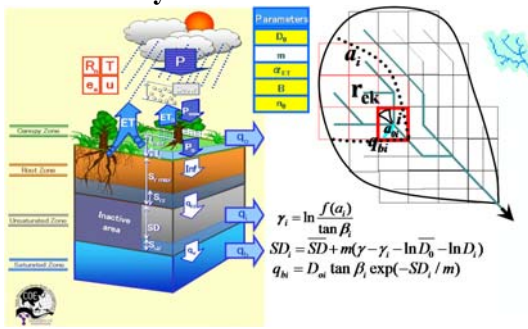
:DDS result by WRF :APHRODITE

- In mountainous region (Yuanjiang), no large difference in frequency of precipitation smaller than 20-25 mm/day between DDS and APRODITE results. However, the cases with precipitation larger than that level are more frequently found in DDS results.
- The frequency of heavy rainfall is clearly larger in DDS at Hanoi.

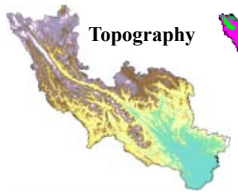
(2) Hydrological Simulation in Red river basin

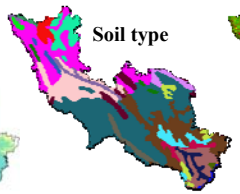
Model: YHyM/BTOPMC

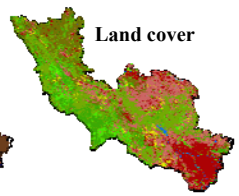
Model Grid: 3km x 3km



GIS Data:



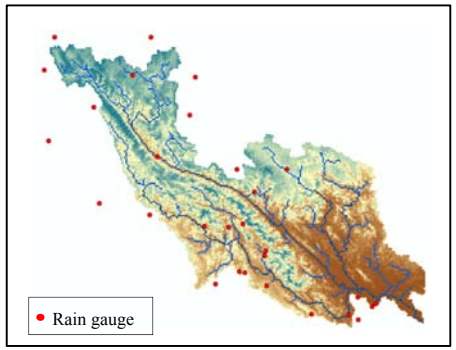




Precipitation Data

(1) Observed (Gauged) data
(1991-2000)

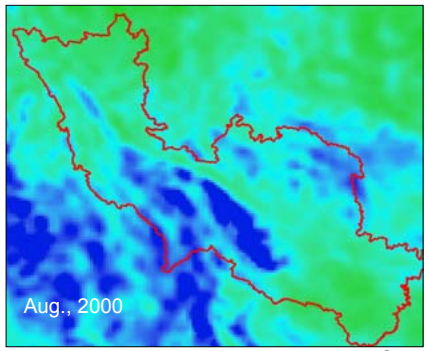
for Calibration/Validation of Hydrological Model



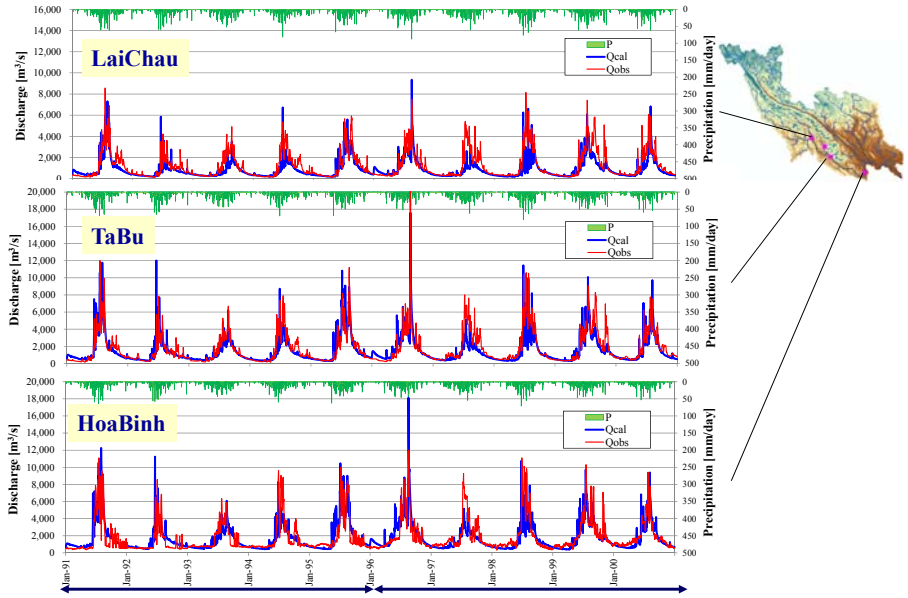
(2) Dynamic downscaling
(Output of WRF: 10km grid)

Current Climate (JRA25)
- Wet year-1994
- Dry year-2000

Future Climate
(ECHAM5, CCCMA47: A1B)
- Wet year
- Dry year

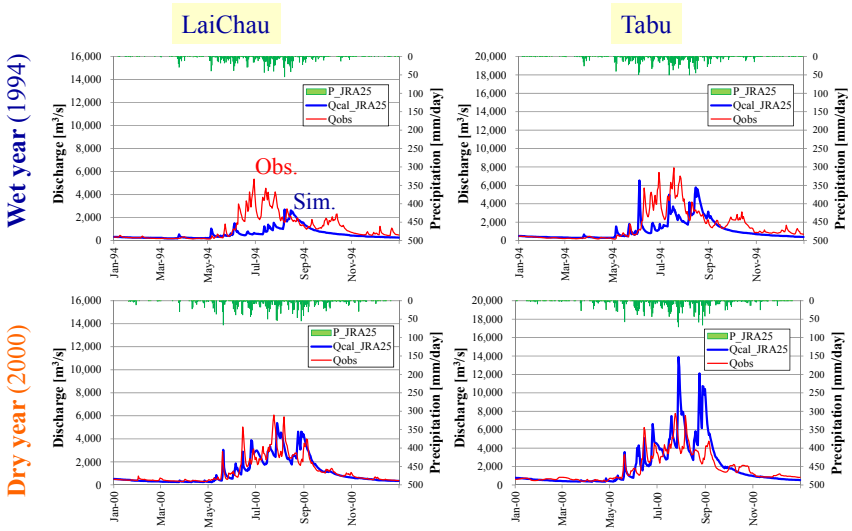


Calibration/Validation of Hydrological Simulation



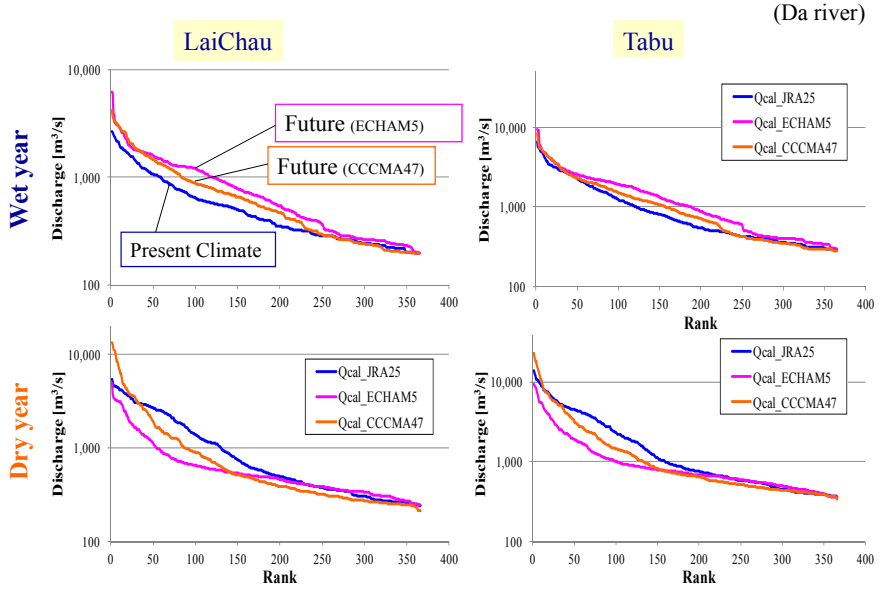
Calibration: 1991-1995 Validation: 1996-2000

Application of DDS Output for Hydrological Simulation



Future Projection of River Discharge using DDS output

(Da river)



Summary

Downscaling method of global climate predictions into local scale water resources information was presented.

Dynamic Downscaling (DDS) of GCM output → Basin-scale hydrological simulation

- DDS results show clear seasonal cycle. However, precipitation is overestimated in rainy season. It is worth to investigate other microphysics and cumulus parameterization.
- Distributed Hydrological Model (DHM) was applied for Red river basin. It was confirmed that DHM can provide reasonable simulated discharge in the Red River Basin (using gauged precipitation).
- Change of Flow regime under future climatic condition was simulated. The simulation can provide useful information for water resources management under changing climate.