# Coupling of a distributed hydrological model with WRF mesoscale model for assessing the future water resources of Yodo River basin

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## 1. Introduction

Today, the need of regional climate studies has increased due to increased risks associated with the impact of climate change on limited water resources, and basin-scale prediction of water resources are being sought after for gaining insight into the regional and local effect of climate change in the future scenarios. Many researchers have used global climate data to drive hydrological models to assess the impact of climate change on the future water resources [1, 2, 3, 4, 5].

To identify the existing and future water resource problems in the Yodo River basin (Fig. 1), we need a reliable system to assess and disseminate the hydrometeorological information related to the water cycle at basin-scale. Using the coupled hydrometeorological modeling approach, the effect of climate change on the water resources of Yodo River basin was assessed by studying changes in several hydrologically relevant processes.

## 2. Modeling method

### 2.1 Coupled hydrometeorological model

Mesoscale meteorological modeling technique was used to dynamically downscale the regional and global analysis datasets to 3-km resolution at Yodo River basin. WRF (Weather Research and Forecasting) mesoscale model was able to reasonably simulate the important hydrometeorological variables like precipitation, air temperature, wind speed and solar radiation. A distributed hydrological model was modified and enhanced by coupling the output of WRF mesoscale model directly with the distributed hydrological model. The high-resolution meteorological data from WRF model was adapted to be used as the atmospheric forcing in the hydrological model.

### 2.2 Future water resource scenario

The future scenario is simulated by dynamically downscaling the global climate model output using a regional or mesoscale model. The average climate scenario of A1B SRES is studied at Yodo River basin. Community Climate System Model (CCSM) global results for IPCC future scenario are used as initial and boundary conditions for WRF mesoscale model. The present scenario was simulated for the year 2006 and the future scenario was simulated for the period of 2050–2054.

## 3. Results

Annual precipitation in Yodo River basin is projected to be nearly same or slightly less in 2050–2054 period compared to the present scenario (Fig. 2). Fig. 3 shows the change in water flow due to climate change in the future, where the maximum peak discharge has decreased in the future scenario when compared to the modeled present-day scenario. Moreover, the peak discharge seems to have shifted to earlier time periods than the current peak discharges. River discharges during January-June period has also increased at Hirakata observation station. The annual outflow for all the dams were found to decrease in the future except at Amagase (Table 1). All in all, river discharges in Yodo River basin are more likely than not to decrease in the future.

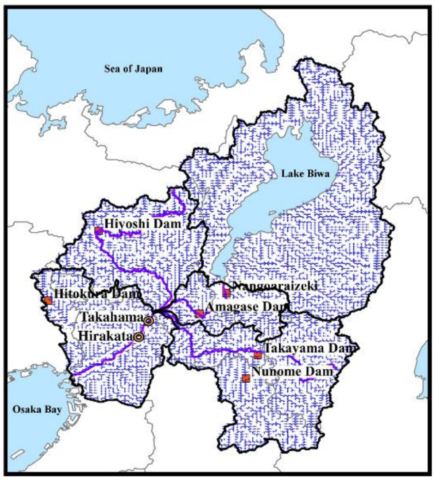


Fig. 1: Yodo River basin.

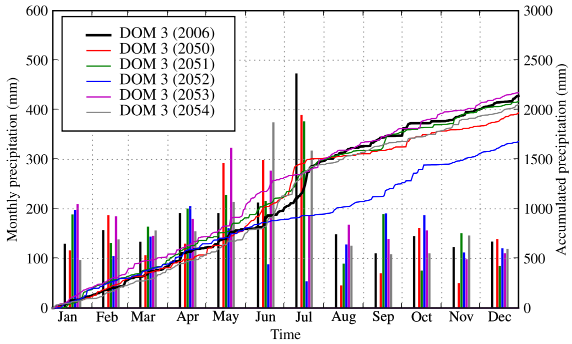


Fig. 2: Precipitation at Yodo River basin by WRF.

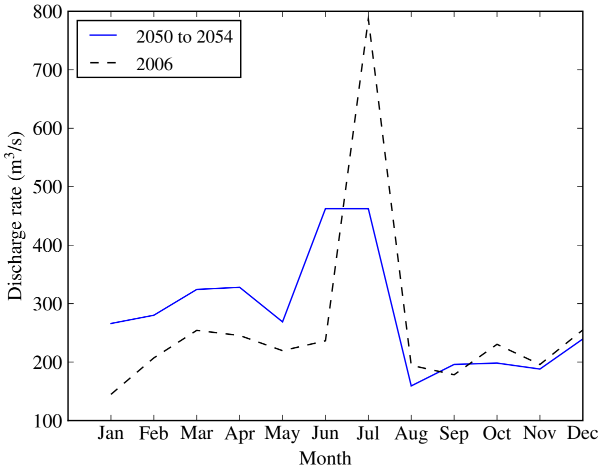


Fig. 3: River discharge at Hirakata.

Table 1: Annual outflow.

| Dam | Outflow ($m^3 \times 10^6$) | |
|---|---|---|
| | 2006 | 2050 to 2054 |
| Amagase | 4348.2 | 5502.1 |
| Hiyoshi | 442.7 | 400.8 |
| Takayama | 302.8 | 247.4 |
| Nunome | 41.7 | 34.3 |

4. Conclusion

Many outcomes of the assessment of water resources of Yodo River basin for the future scenario are likely to be worthwhile for the integrated water resource management. It should be noted that the presented example of the effect of climate change on water resources of Yodo River basin was carried out for only five years time period due to limitation of the current computational resources. The simulation period doubtlessly needs to be extended to longer time periods to observe the long-term trend of change in water resources of Yodo River basin in the future scenarios. Nevertheless, the encouraging results of the presented water resource assessment of Yodo River basin certainly reasserts the need for integrated regional water resource assessment by using the coupled hydrometeorological modeling approach.

References

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Keywords

Coupled hydrometeorological model, WRF model, Yodo River basin, Water resource assessment, Climate change