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[Modeling framework development on water security under changing climate]

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Development of a modeling framework of the water cycles considering anthropogenic disturbances

There are growing fears of future water shortages, as the world's population increases. Facing the problem, reliable prediction of spatiotemporal distribution of water scarcity and demand estimation are most essential issues to be answered.

In our research, we are developing an integrated modeling framework for assessing the human impacts, such as land use changes, damming, irrigation, and groundwater extractions, on the terrestrial water cycles, as illustrated in Fig. 1. The effect of spatial and temporal variability has taken into account in this modeling framework.

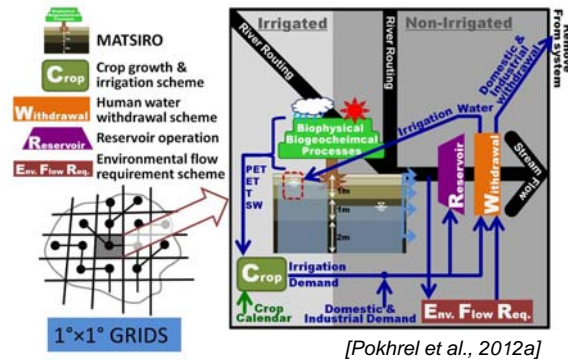


Fig.1 Schematic diagram of the modeling framework

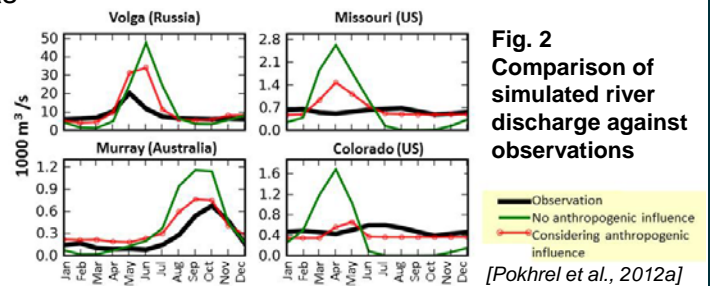


Fig. 2 Comparison of simulated river discharge against observations

As our research achievement, anthropogenic influence on natural water cycles is better reflected with additional model components reproducing human-induced alterations, which lead the improved simulation of river discharge by the models, as shown in Fig. 2.

It enabled to estimate the amount of water withdrawal exceeding local supplies shown in Fig. 3. Also, it is found large amount of human water use in the Indian subcontinent, Middle East, Nile Delta, and western United States are unsustainable.

Also, estimated terrestrial water storage changes (1961-2003) indicate the largest contribution of the unsustainable groundwater use to net sea-level change (Fig. 4).

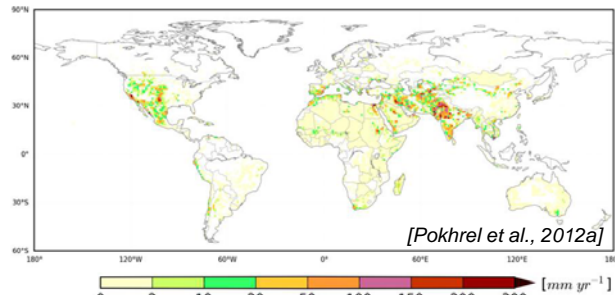


Fig. 3 Water withdrawal exceeding local supplies for the year 2000

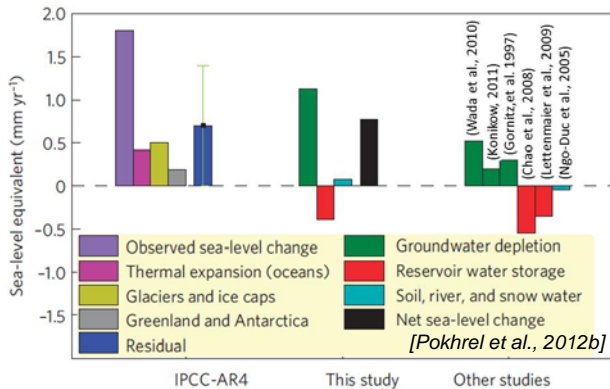


Fig. 4 Estimates of various contributions to the observed sea-level change

References a) Y. Pokhrel, N. Hanasaki, S. Koirala, J. Cho, P. J.-F. Yeh, H. Kim, S. Kanae, and T. Oki (2012a), Incorporating Anthropogenic Water Regulation Modules into a Land Surface Model, J. Hydrometeorology, DOI: 10.1175/JHM-D-11-013.1; b) Y. Pokhrel, N. Hanasaki, P. J.-F. Yeh, T. J. Yamada, S. Kanae and T. Oki, (2012b), Model Estimates of Sea-Level Change due to Anthropogenic Impacts on Terrestrial Water Storage, Nature Geoscience, DOI: 10.1038/NGEO1476