Py-RAMID: A modularized two-way coupling framework to simulate complex adaptive water systems

Chung-Yi Lin[a], Y. C. Ethan Yang[a,*], Keyvan Malek[c], Jennifer C Adam[d]

[a]Department of Civil and Environmental Engineering, Lehigh University, Bethlehem 18015, P.A., USA.
[c]Department of Civil and Environmental Engineering, Cornell University, Ithaca 14850, N.Y., USA.
[d]Department of Civil and Environmental Engineering, Washington State University, Pullman 99164, W.A., USA.

LEHIGH UNIVERSITY
CAWS
COMPLEX ADAPTIVE WATER SYSTEMS

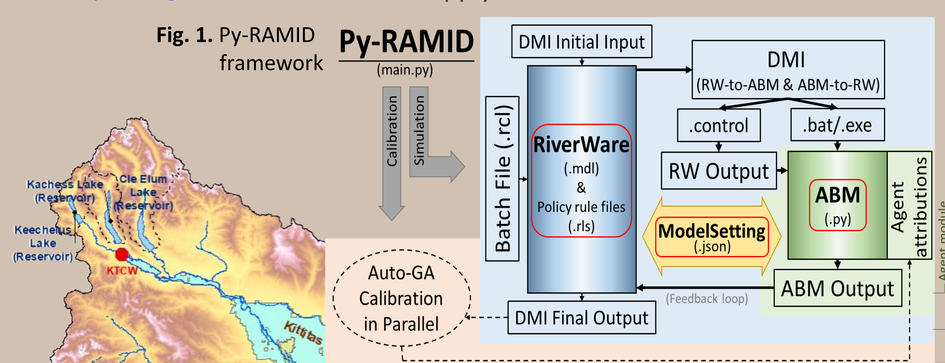
Summery

The two-way coupling technique is gaining attention in studies of complex adaptive. Most existing modeling frameworks lack user-friendly mechanisms to smoothly model interactions between human actors and the water system to address co-evolution challenges in coupled natural-human systems. Therefore, we developed a **Python package of Riverware (a river-reservoir routing model) and Agent-based Modeling (ABM, a human decision model) Interface for Developers, Py-RAMID**, to fulfill this specific need. Results show that coupled model built by Py-RAMID can capture short-term and long-term hydrological and irrigation diversion dynamics. In future, we plan to include the uncertainty and sensitivity analysis features in the next version of Py-RAMID to help modelers identify dominated policy rules in the RW model and equifinal parameter sets of coupled models.

Complex Adaptive Water Systems

Hydrological Process Water Supply Infrastructures Water Users

Fig. 1. Py-RAMID framework



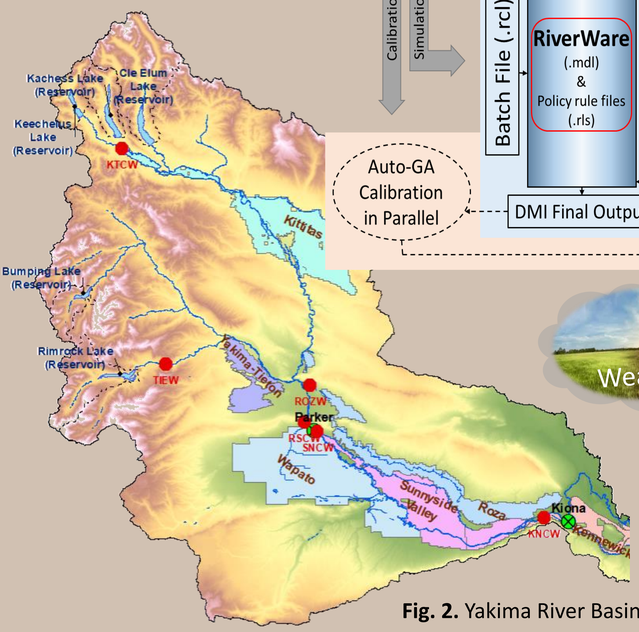


Fig. 2. Yakima River Basin

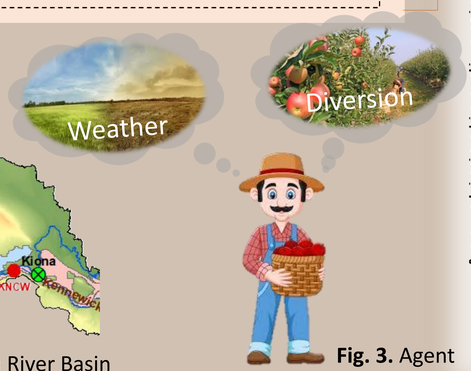


Fig. 3. Agent

Coupled-YAKRW Simulation schema

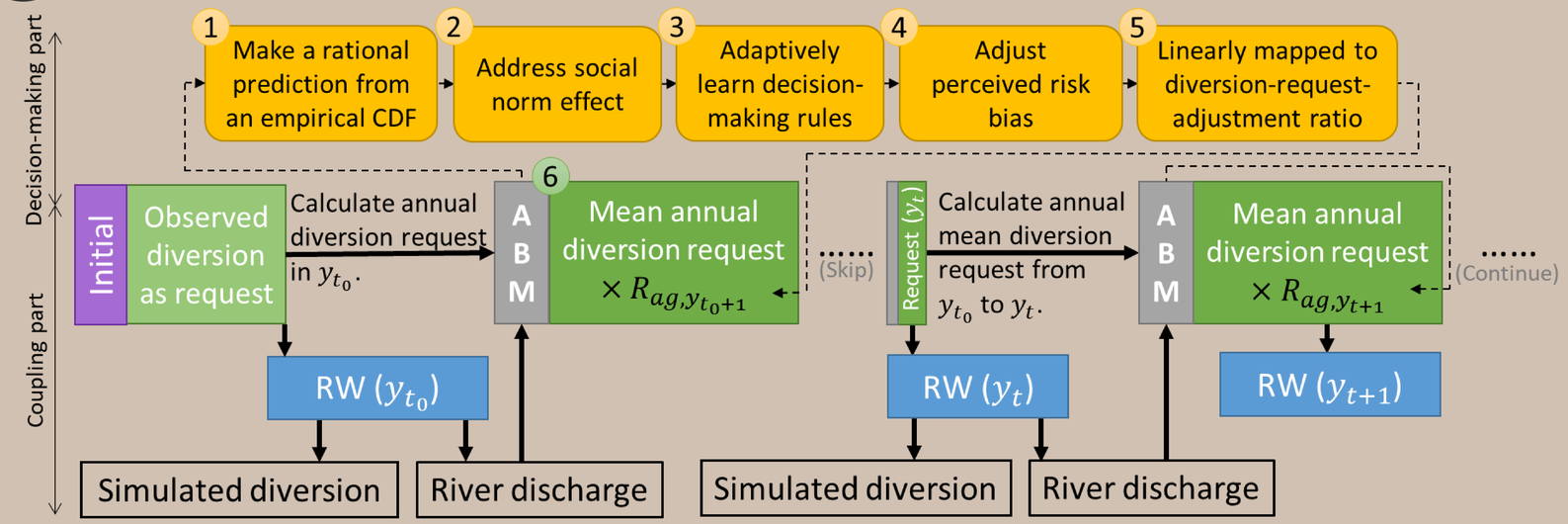


Fig. 4. Coupled-YAKRW simulation schema. Yellow boxes are agent decision-making processes (dotted thin arrows), which output the ratio (*Rag, yt*) that is used to adjust the mean annual diversion request (circle number 6) and to simulate the next year by RW. Annual mean diversion request is computed using all historical annual diversion request records before the current year. Solid arrows connecting diversion requests (green boxes) and RW model (blues boxes) show information flow in the coupling process.

Results

Baseline model (No ABM) With social network Without social network

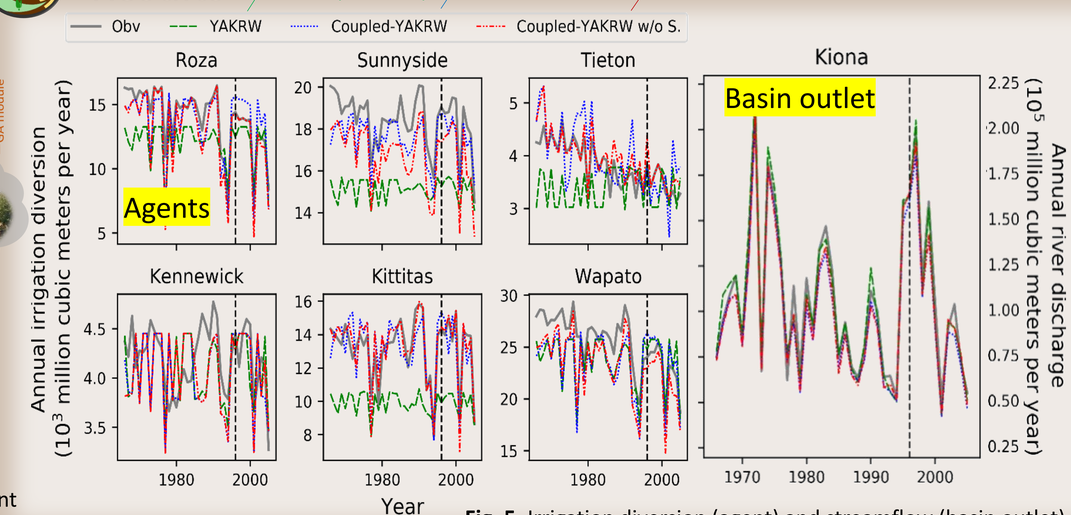


Fig. 5. Irrigation diversion (agent) and streamflow (basin outlet)

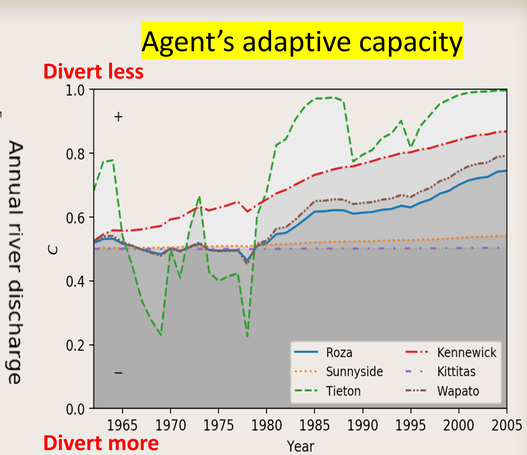


Fig. 6. Agent's adaptive state variable (*C*)