Water and Energy Simulation Toolset (WEST)

Basin-wide socio-hydrologic water balance for integrated resource planning

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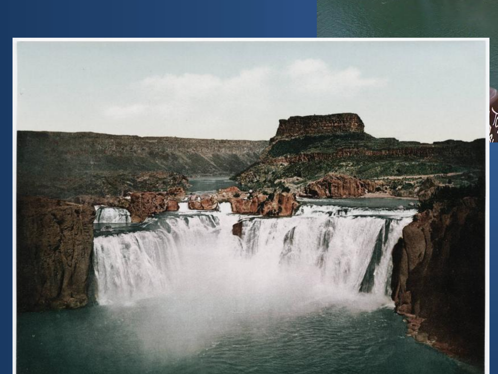
Water and energy resource development planning does not properly account for cross-system interdependencies

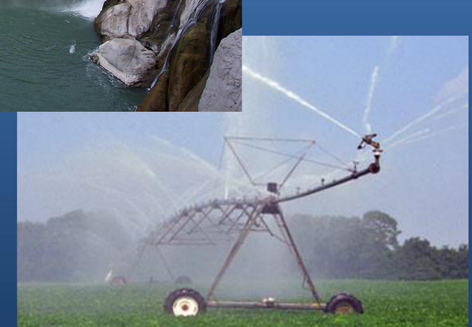
The two primary uses of water in the United States are for electricity generation and agricultural production. Whereas electricity generation accounts for 41% of all freshwater withdrawal in the United States, it only makes up 3% of total consumption. In contrast to energy uses, agriculture is responsible for 37% of freshwater diversion, but approximately 80% of consumption. Although electric utilities have attempted to incorporate one-way hydrologic dependence in their planning process, the full economic, environmental, and social interdependency between water and power systems has not been captured.

This project's goal is to develop a set of computer simulation tools that analyze water availability scenarios that are most relevant to energy and water resource planning

A useful toolset has the following characteristics:

- Incorporates the full basin water balance including human and physical responses, as well as surface water and ground water responses
- Minimizes the number of inputs, parameters, and overall complexity
- Simulates multiple decades of past behavior, and projects multiple decades of future behavior
- Easily and appropriately incorporates projections of changing climate





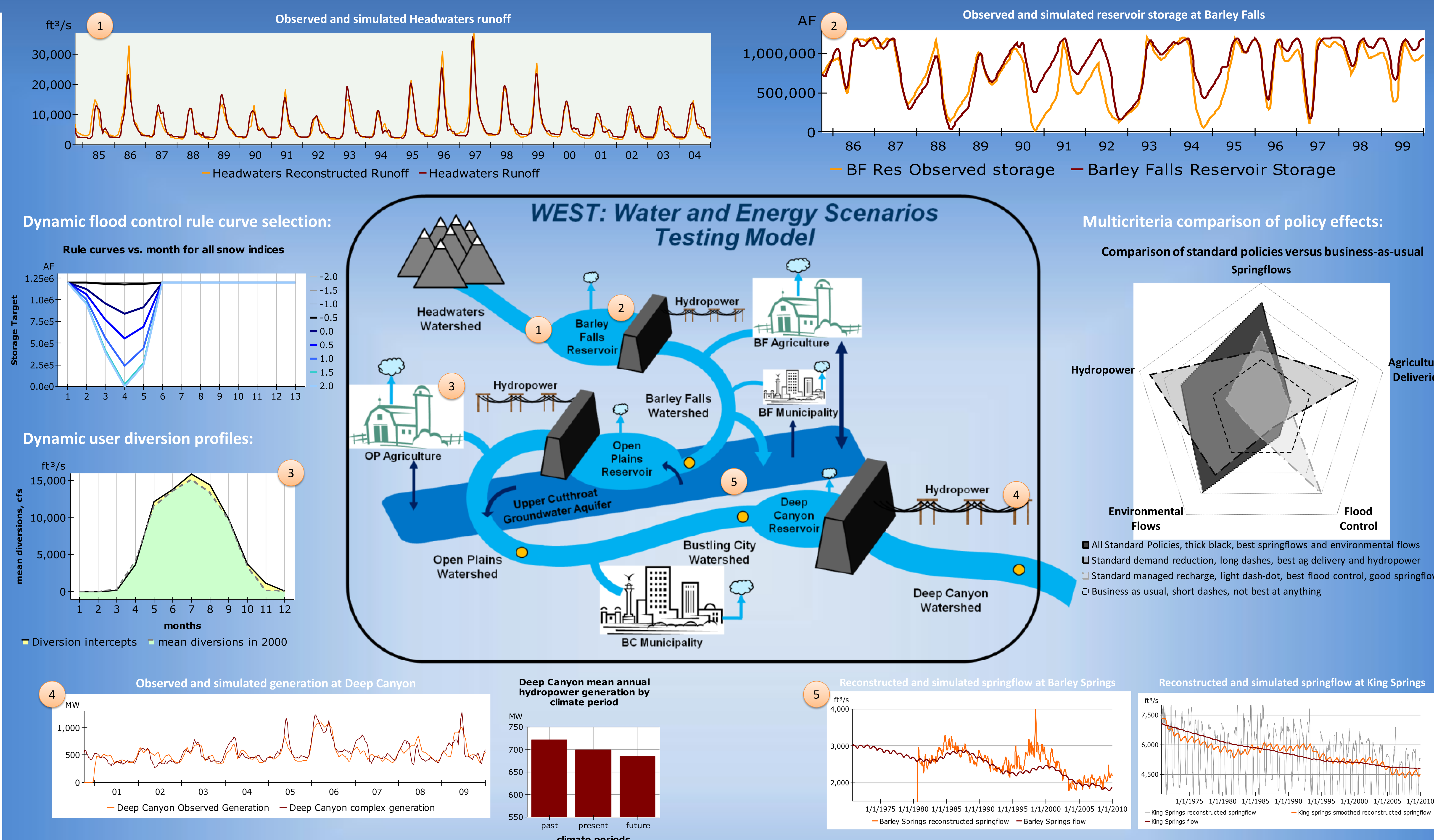


Figure 1: Diagram of WEST components interlinked to represent the Upper Snake River, along with selected results from the simulation

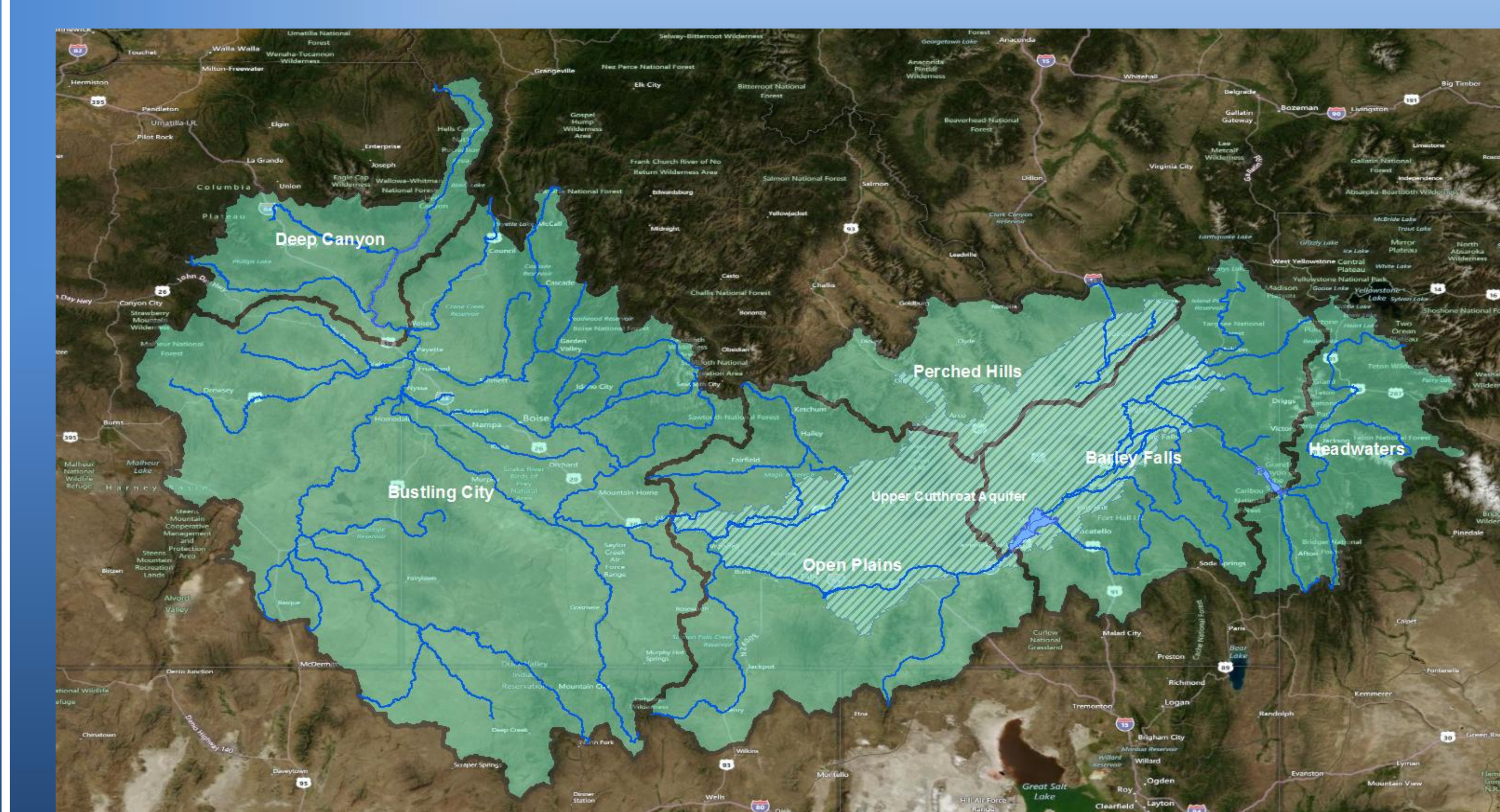


Figure 2: Geographic representation of the Snake River Basin study area

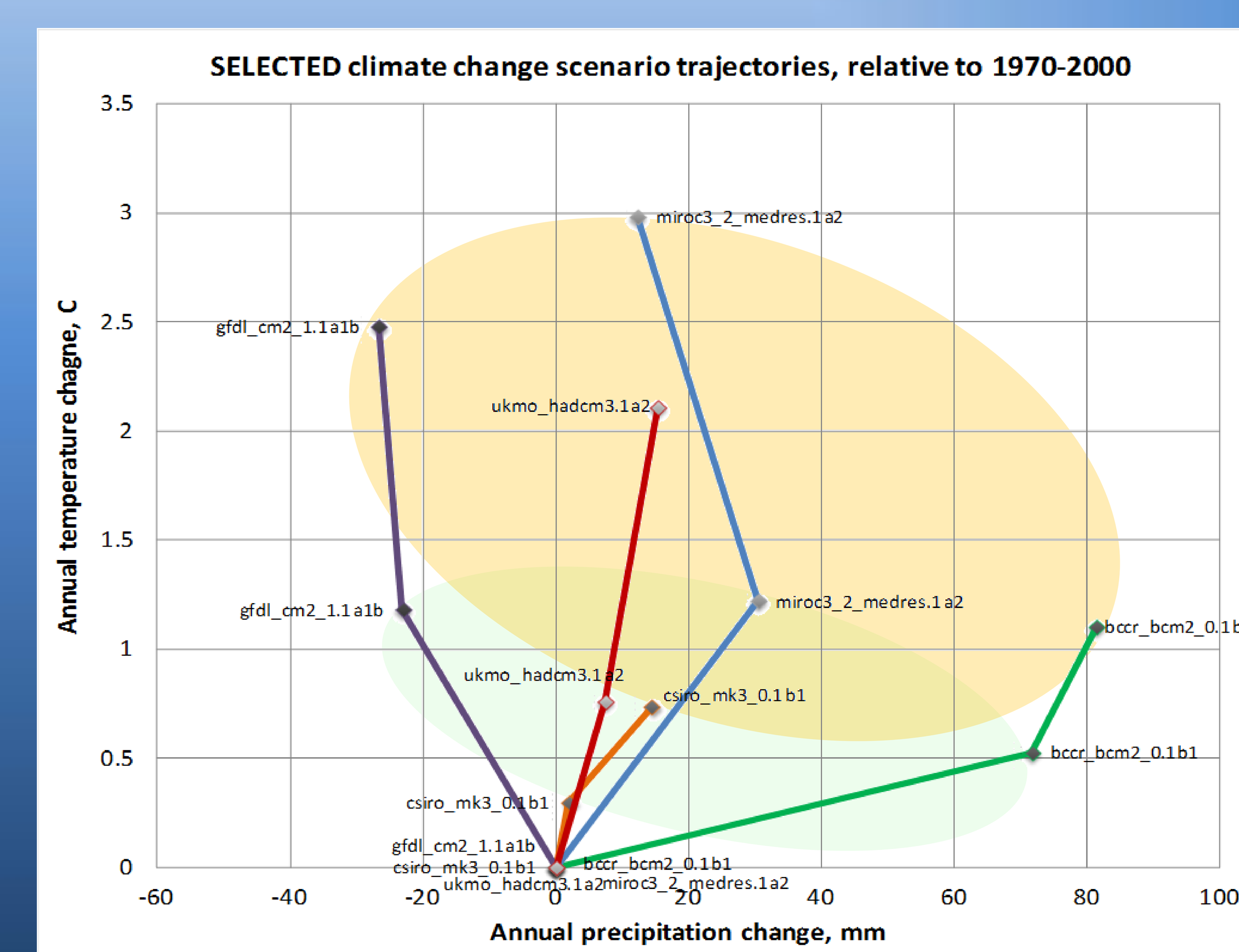


Figure 3: Climate change trajectories for the Snake River Basin

The WEST framework was developed to provide object-oriented dynamic models of energy-relevant monthly water balance components

Because WEST is object-oriented, building new basin models becomes a drag-and-drop exercise. Figure 4 shows the components that have been built and calibrated for the Snake River system.

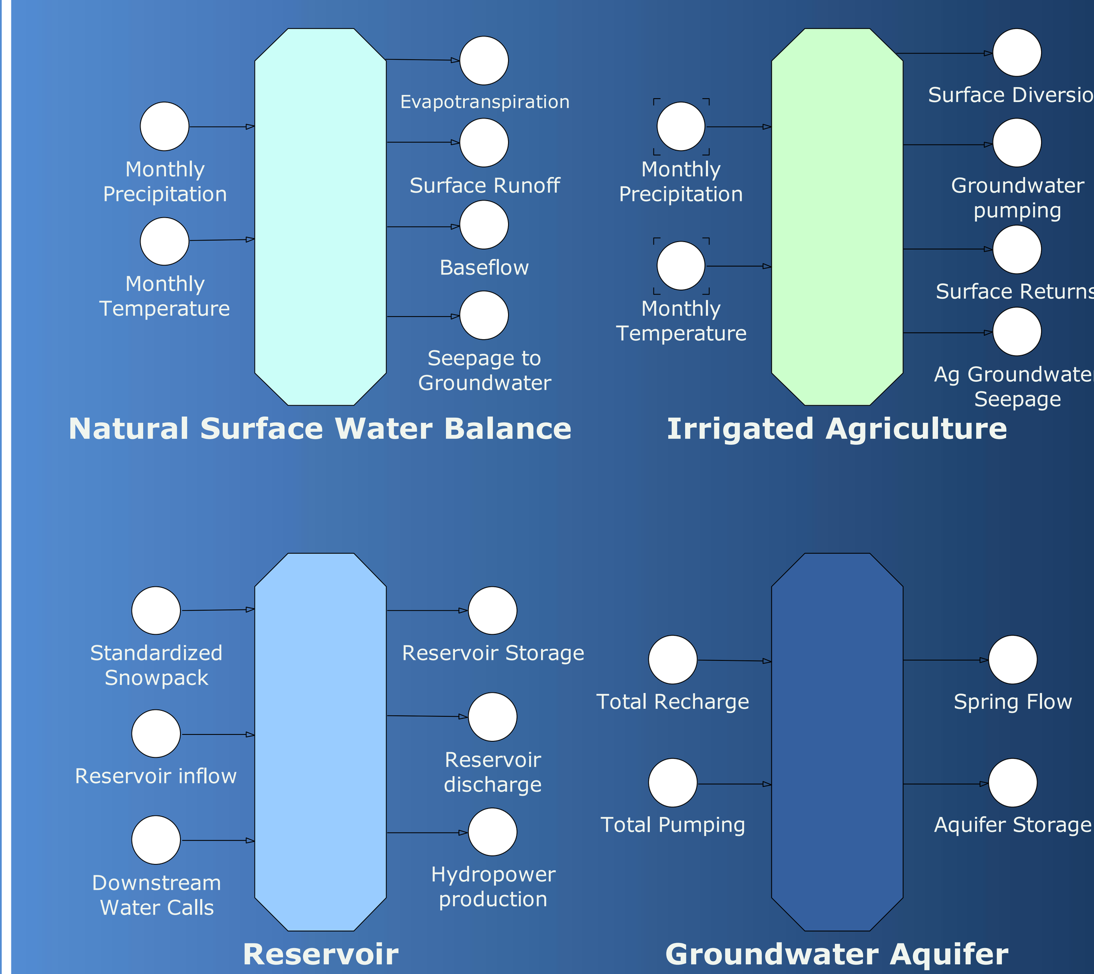


Figure 4: WEST objects that interconnect to build a full-basin water balance

The WEST proof-of-concept model shows good fit to historic data and improves upon state-of-the-art water balance methods

As illustrated in figure 1, runoff, reservoir storage, and agricultural diversions fit well to observed data. Improvements over state-of-the-art include:

- No assumption of perfect foresight: the simulated reservoir and agricultural human-guided operations respond only to real-time data
- Fully endogenous behavior: Monthly precipitation and temperature are the only inputs to the model
- Scalability: WEST models have been applied to catchments from 500 to 50,000 km^2