USGS
science for a changing world

Economic Resilience through "One-Water" Management

Disruption of water availability leads to food scarcity and loss of economic opportunity. Development of effective water-resource policies and management strategies could provide resilience to local economies in the face of water disruptions such as drought, flood, and climate change. To accomplish this, a detailed understanding of human water use and natural water resource availability is needed. A hydrologic model is a computer software system that simulates the movement and use of water in a geographic area. It takes into account all components of the water cycle—"One Water"—and helps estimate water budgets for groundwater, surface water, and landscape features. The U.S. Geological Survey MODFLOW One-Water Integrated Hydrologic Model (MODFLOW-OWHM) software and scientific methods can provide water managers and political leaders with hydrologic information they need to help ensure water security and economic resilience (fig. 1).

USGS science can help individuals, communities, and state and national leaders to answer questions, such as:

- *Given the likely changes in population, land use, and climate, will we have enough water to support drinking water, irrigation, and economic development?*
- *What will happen to our water supply if we pump more groundwater to irrigate crops?*
- *Will using groundwater decrease water level in the aquifer, cause salt-water intrusion, or deplete flow in nearby streams?*
- *How is it possible to analyze and conjunctively manage surface and groundwater resources for the benefit of our nation and neighboring countries?*

USGS MODFLOW-OWHM with the FARM PROCESS: Water Supply-and-Demand Analysis

FEATURES

Estimates irrigation needs
Simulates water transfers
Simulates surface-water deliveries to farms
Estimates groundwater pumpage
Estimates recharge
Simulates stream, canal, and drain networks

CAPABILITIES

Estimates supply—natural and artificial recharge
Analyzes water use and movement
Simulates a broad range of water uses, from irrigated to dry land farming
Estimates native and riparian vegetation water use
Provides supply-and-demand information for water markets

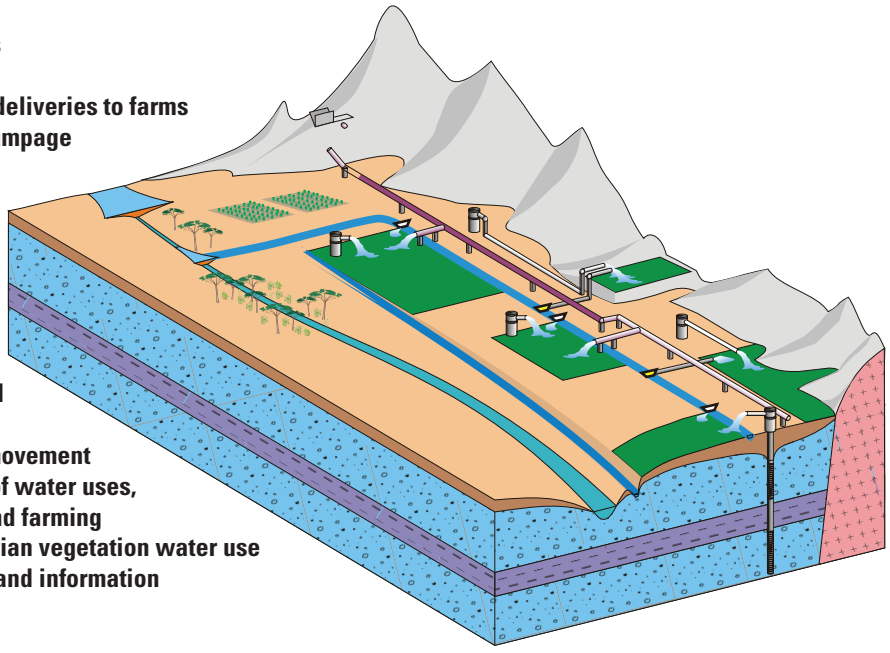

Figure 1. 2013 MODFLOW One-Water Integrated Hydrologic Model. Our current model is capable of simulating fully coupled groundwater/surface-water interaction, flows across the landscape, and water use to account for water everywhere in the simulated system—"One Water." The supply-and-demand modeling framework is connected to natural and human uses. All USGS hydrologic modeling software have fully documented and open-source code that is available free-of-charge at *http://water.usgs.gov/software/lists/groundwater/*

MODFLOW One-Water Integrated Hydrologic Model

USGS software provides a platform to simulate and analyze all factors in a defined hydrologic system. Our science informs long-term policy and governance decisions, as well as short-term operational and prediction simulations. The software is being used to gain information about a wide range of water systems across the United States and elsewhere in the world, including on both micro- and macro-agriculture water systems and transboundary aquifers, at scales of single to multiple watersheds (fig. 2).

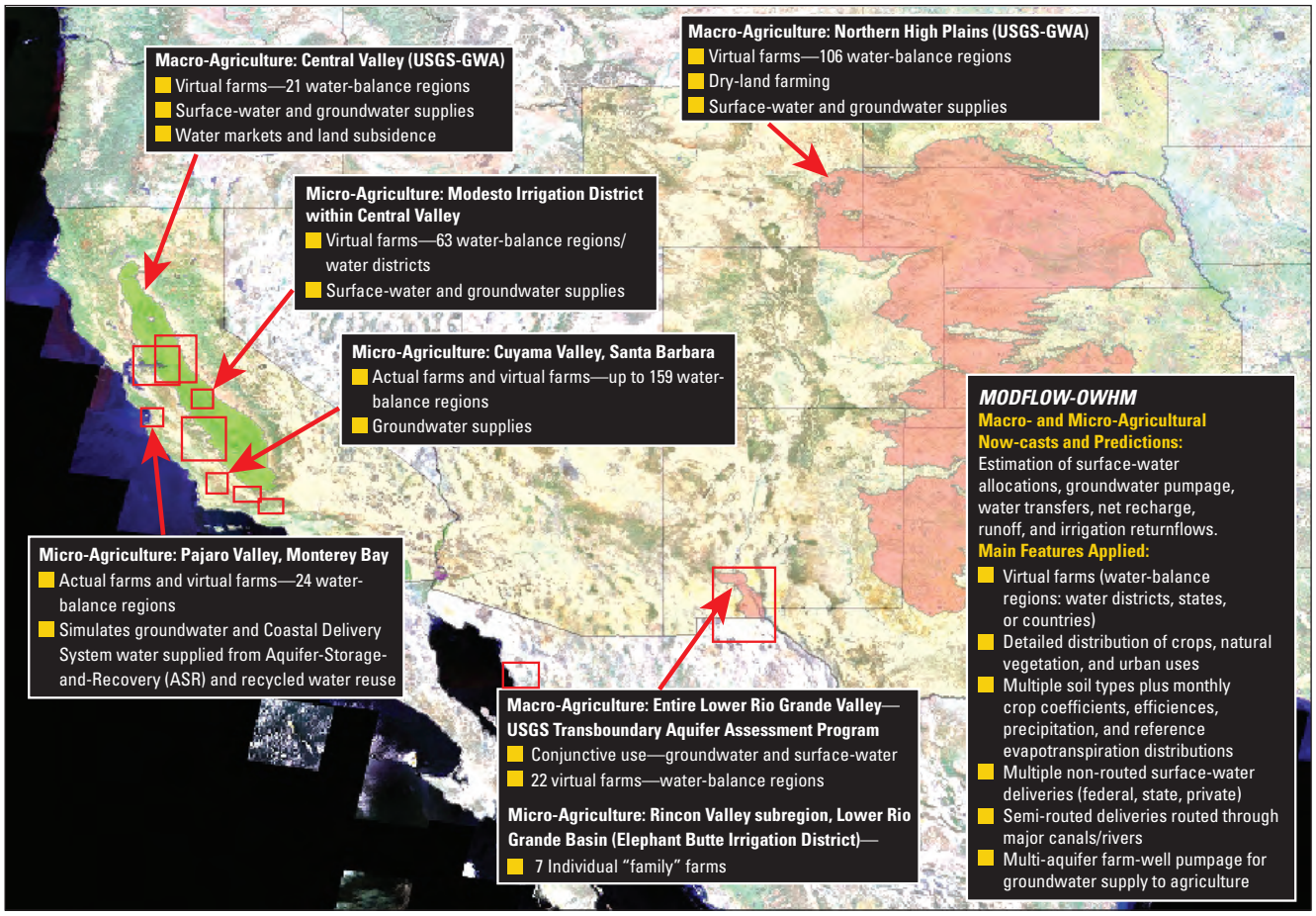

Figure 2. U.S. Geological Survey applications of MODFLOW One-Water Integrated Hydrologic Model in the United States.

The 2013 MODFLOW One-Water Integrated Hydrologic Model has several advantages over traditional groundwater models:

- Can analyze water availability with few data. Management scenarios start simply and add complexity without the need for separate indirect estimates of pumpage, recharge, evapotranspiration, runoff, or surface-water deliveries—these hydrologic components of use and movement are computed inside the model. Collection of additional hydrologic information can supplement internal estimates, and data can easily be added as they are gathered to help provide more detailed hydrologic budgets.
- Uses fundamental data as input, so less preprocessing of data and prior estimation are required.
- Is easy to update model because the code is modular and the data are fundamental.
- Makes it easy to understand and analyze the use and movement of water through conjunctive use and sustainability analysis and climate-change adaptation analysis.
- Saves time and money for constructing, operating, and updating existing models.
- Facilitates operational and prediction simulations, as well as testing of policies or governance.

TECHNICAL CONTACTS Randall T. Hanson • USGS • rthanson@usgs.gov • 619.225.6139 • http://www.usgs.gov
Wolfgang Schmid • CSIRO • wschmid@csiro.au • +61.2.6246.5793

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