RECLAMATION Managing Water in the West

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The Knowledge Stream
Research Update

Improving Evapotranspiration Estimates for Better Water Management

Measuring evapotranspiration rates for wetlands and open water in the Upper Klamath Lake, Oregon

Bottom Line

ET is an important element in any water budget, and more accurate measurements can help provide more effective water management and planning. To improve ET estimates in the Upper Klamath River Basin, as recommended by the 2007 National Research Council, this study provided two seasons of detailed, measured data for estimation of wetland ET and open water evaporation.

Better, Faster, Cheaper

These high-quality data and analyses will be invaluable for future planning use (e.g., climate change, water rights transfer, improved water management) in the Klamath River Basin, as well as other areas in the Western United States.

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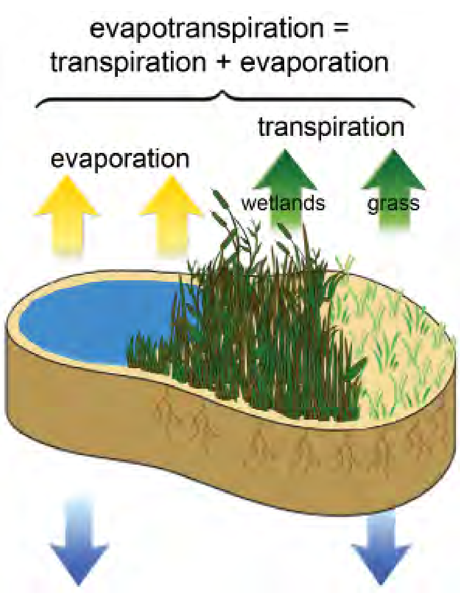
Problem

The health and well-being of many ecosystems and water for agriculture, people, and cities depend on effective water management planning, including water allocations and water budgets. These water budgets cover more than inflows and outflows from rivers and reservoirs, they must also account for evaporation from open water and transpiration from plants—"evapotranspiration" (ET). Knowing how much water is lost to ET from various sources (e.g., shallow water, wetlands, grasses, and croplands) is key for deciding optimal water-use strategies. Yet ET estimates have been elusive and are usually lumped together with other substantial water-budget components.

In the Upper Klamath Basin, California and Oregon, water allocation has become difficult in recent years as droughts have increased in the face of continued high water demands. Upper Klamath Lake is central to water distribution, supplying water downstream to the Klamath River and irrigation diversions, as well as providing habitat for various species within the lake and surrounding wetlands. Potential land changes (from croplands to wetlands) and climate changes are among the water management challenges in this contentious basin that make quantifying ET losses even more critical in future planning to:

- Understand future changes in the marsh ET in view of potential climate changes.
- Determine the amount of water wetlands would require in re-establishing wetlands.



How evapotranspiration works.

Solution

To improve understanding of ET losses from open water on the Upper Klamath Lake and wetlands at the Upper Klamath Lake National Wildlife Refuge on the northwest side of the lake, this Reclamation's Science and Technology Program research project teamed up with the U.S. Geological Survey. ET was measured from May 2008 through September 2010. Two wetland sites that were almost 100 percent influenced by the wetland, rather than other factors like shoreline or water, were carefully chosen: (1) a monoculture of bulrush and (2) a mixture of bulrush, cattail, wocus, other vegetation, and open water. To continuously monitor ET at the wetland sites, the eddy-covariance method was used. To monitor open water lake evaporation at two additional sites during the warmer months, the Bowen-ratio energy-balance method was used. Reference ET (ETr, a standardized rate for a reference crop such as alfalfa or grass) was also calculated and the wetland ET rates were divided by ETr to develop crop coefficients (Kc). The Kc values can now be used to estimate wetland ET at other sites

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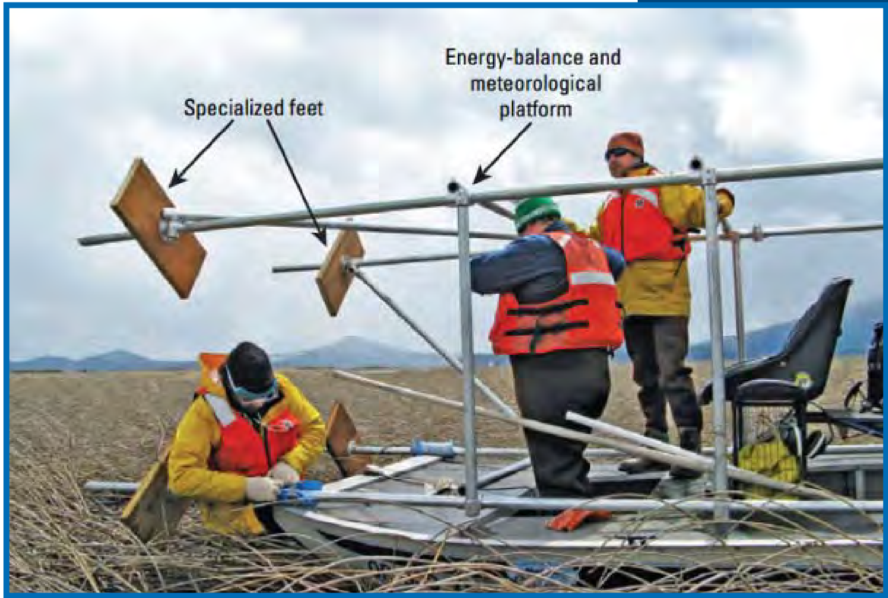
in the future as a function of ETr (ET=Kc x ETr). The wetland ET values were also compared to ET for alfalfa and pasture grass, two crops that are prevalent in the area. Application and Results: Wetland ET rates varied with the annual life cycle, increasing through the spring and early summer to a late summer peak, and then dropping off into the fall. Seasonal patterns of open water evaporation were similar to those of wetland ET, but with less of a seasonal cycle. Overall, measured open water evaporation was 20 percent greater than wetland ET during the same periods. The table below compares the mean 2008 through 2010 ET in meters (m) to that for alfalfa and pasture grass:

	Alfalfa Comparison (190-day average growing season)		Pasture Comparison (195-day average growing season)	
	Alfalfa ET	**Wetland ET**	**Pasture ET**	**Wetland ET**
Growing Season	0.838	0.779	0.671	0.789
Non-Growing Season	0.159	0.159	0.149	0.149
Annual	0.997	0.938	0.820	0.938

During the 190-day average alfalfa growing season, wetland ET (0.779 m) is about 7 percent less than alfalfa reference ET (0.838 m). During the 195-day average pasture growing season, wetland ET (0.789 m) is about 18 percent greater than pasture ET (0.671 m). ET from the wetland during 2008 through 2010 (0.938 m) is about 43 percent greater than the fallowed cropland ET (0.655 m) measured in a 2000 study.

For example, replacing pasture with a wetland would require more water, as in a growing season. This is important to consider when taking croplands out of production and converting to marshes.



Setting up the ET monitoring equipment for the wetland. Specialized feet support the platform for equipment that measures available energy and meteorological data needed to calculate ET.

Future Plans

This information can now be used as input for models that can simulate ground water/surface water interactions and water quality analysis. These models will allow Reclamation to analyze various water delivery management scenarios and changing land use by analyzing the potential changes, in light of changing water demands, land use, and climate variability. In basins with high levels of controversy, these high-quality data will be invaluable for planning and demonstrating compliance with proposed mitigation measures.

Data gathered in this study will be used locally in the Klamath River Basin Study to understand water demands for wetlands and the Upper Klamath Lake. These data will also be used in broader study areas, such as the Westwide Climate Risk Assessment, as information for wetlands and shallow lake evaporation in similar conditions.

"Knowing the ET from the lake and surrounding wetlands will improve our planning ability, as now we can more accurately include this information to analyze and predict the physical response of the watershed to measured conditions in the basin."

Mark Spears
Hydraulic Engineer,
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More Information

Stannard, D.I., M.W. Gannett, D.J. Polette, J.M. Cameron, M.S. Waibel, and J.M. Spears. 2013. *Evapotranspiration from Wetland and Open-Water Sites at Upper Klamath Lake, Oregon, 2008 – 2010.* U.S. Geological Survey Scientific Investigations Report 2013 - 5014, 66 p. Available at:

http://pubs.usgs.gov/sir/2013/5014.

www.usbr.gov/research/projects/detail.cfm?id=6485