Estimating Agricultural Water Use

Kenneth Seasholes
Arizona Department of Water Resources

Estimates of agricultural water use in Arizona are subject to significant uncertainty and variation. The estimation difficulties are a result of many factors, including incomplete and inconsistent reporting practices, practical limitations of measurement techniques, privacy concerns and definitional issues. When evaluating water use numbers, it is both useful and appropriate to recognize the limitations inherent in those estimates.

Definition of use

One of the most fundamental challenges in compiling water use data is the meaning of the term "use" itself. In a typical irrigation situation, use could be narrowly defined in terms of the consumptive use (CU) of the crop, or more broadly defined by the total water withdrawn (i.e., pumped or diverted). Before it is available for use by the crop, withdrawn water is often subject to conveyance losses, which includes evaporation and seepage from canals, laterals and ditches. Water on a field is then consumptively used by the plants (CU is a combination of transpiration, tissue storage and evaporation from the surrounding soil). Some water can also percolate below the root zone, and some may be available down-slope as tailwater. Tailwater, in turn, may be evaporated, recycled to the same field, delivered to another field or returned to a surface water supply. The method of accounting for the complex interplay of these factors can easily lead to double-counting and/or under-counting. The "best" approach will depend on the intended purpose, but estimates that debit withdrawals and credit return flows tend to offer the most complete picture of the water resource impact of agricultural activity.

Sources of information

Researchers, agencies and others that compile statistics often must rely on disparate and imperfect data. Water use data within the Active Management Areas (AMAs) is by far the most detailed, publicly accessible and complete, (all irrigation districts and rights over ten acres are required to report annually), though even those records have limitations, particularly with regard to unmeasured tailwater reuse and reporting from combined delivery points.

Outside of AMAs, some measured uses are reported and compiled (for instance, many irrigation districts submit reports to the federal government). However, privacy concerns generally make these records incomplete or unavailable to researchers or state agencies. In areas where direct water use data are unavailable, use can be estimated from crop statistics, weather data and energy records.

The Arizona Agricultural Statistics Service collects and compiles crop data that are published at the county level. This effort—lead by the USDA, with cooperation from the University of Arizona and the Arizona Department of Agriculture—involves field, mail and telephone enumeration, and is particularly useful for evaluating broad trends in agriculture. Along the Colorado River, the Bureau of Reclamation administers an ambitious water use estimation effort (LCRAS) that relies on crop identification from satellite data. Imagery is acquired and on-the-ground crews conduct a rigorous field survey (a sample) that results in detailed and statistically valid crop data.

Deriving water use from crop types requires estimation of several parameters. Average consumptive use values for major crops have been developed for several areas of the state, but these require adjustment for factors that vary annually, including local climate conditions, yield and length of growing season. The crop CU must also be adjusted to account for efficiency factors, which take into account irrigation technique, management practices, soil types, slope, distribution uniformity, salinity, etc. These factors are rarely known with precision over a wide scale, and often rely on the professional judgment of the person compiling the data.

Outside of AMAs and Irrigation Non-Expansion Areas (INAs), where metering of irrigation wells is not required, withdrawals can be estimated from natural gas or electricity records. If a discharge tests for a well is performed, a conversion factor from energy consumed (kwh or BTU) to water withdrawn can be calculated. If only the energy records are available, an even rougher estimate can be made based on the depth-to-water and an assumed pump efficiency factor.