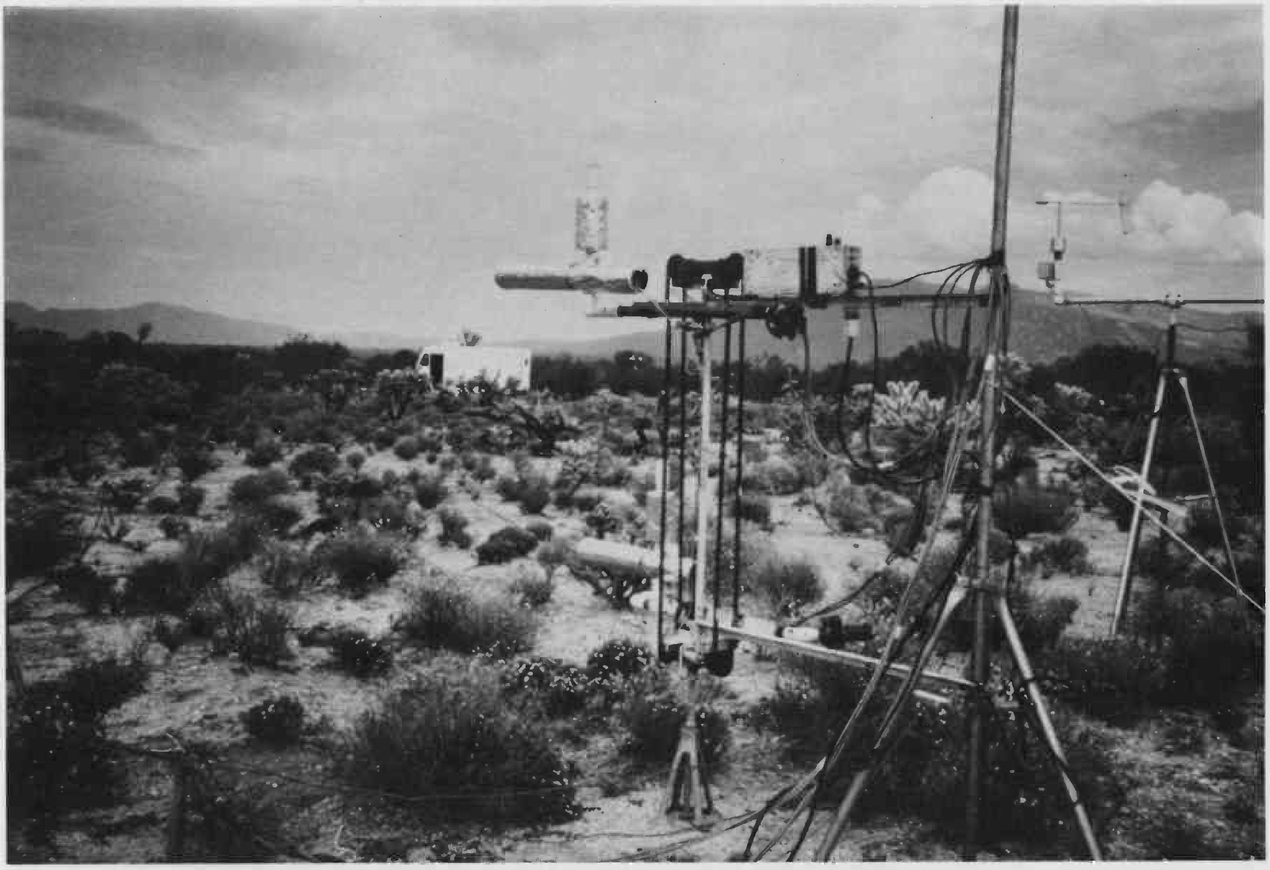


Water Losses Pegged by New Method

An improved system for gauging plants' water use has shown that an acre of Arizona riverbank thicket can lose as much water to the atmosphere as an acre of irrigated alfalfa in a similar environment.

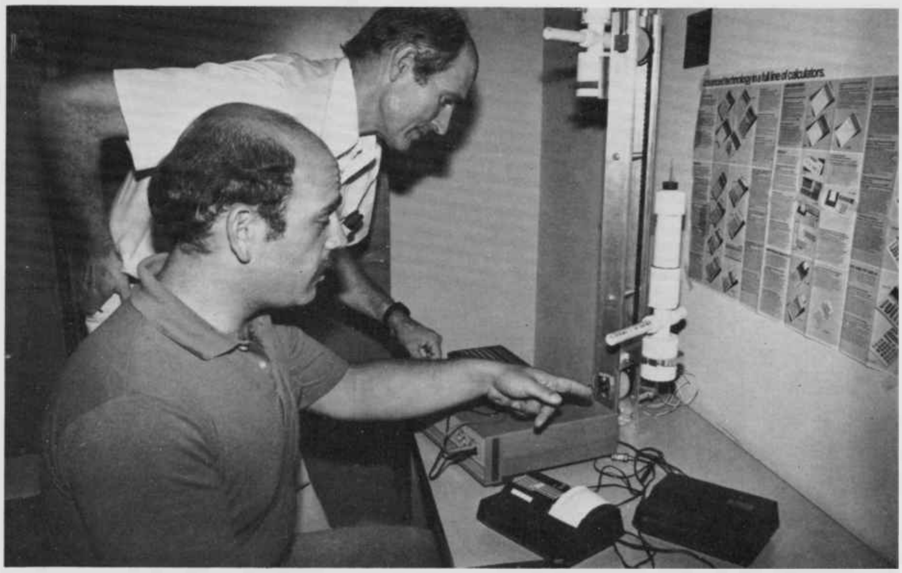
Dr. Lloyd W. Gay of the UA School of Renewable Natural Resources began developing the system seven years ago as an aid to management of streamside (riparian) areas in the Southwest. It may also help in scheduling crop irrigations.

"The riparian plant communities that flourish along the few live streams in Arizona transpire large quantities of water, reducing the supply available for more beneficial urban and agricultural uses," Gay said. The plants include saltcedars, mesquites and other trees. Knowing just how much water the plants pump from the ground into the atmosphere is important for deciding whether to thin them for water conservation.

Previous methods for measuring water loss from riparian plants were laborious, expensive and hard to replicate. Gay's method gives less costly and more reliable readings. It is a refined field application of a 30-year-old theory, assessing water gains and losses indirectly by measuring energy gains and losses directly. This "energy-budget" method can detect differences as small as one-half of one percent in daily water loss from two neighboring locations, compared with an accuracy range of 15 to 20 percent for older methods.

The water loss, or evapotranspiration, includes both the transpiration of water from plant leaves into the atmosphere and the evaporation of

Photograph: Equipment designed by Dr. Lloyd Gay measures the amount of moisture entering the atmosphere from a patch of Sonoran desert. The van housing generator and computer is in the background.



water from soil under the plants.

From saltcedar thickets along the lower Colorado River in June, Gay measured evapotranspiration rates of 10 to 12 millimeters (0.4 to 0.5 inch) per day. Rates from irrigated alfalfa near Tucson in June and July fell in the same range.

In New Mexico, Gay measured water loss from thickets along the Rio Grande and from a comparable area along the Pecos River where woody plants have been cleared and replaced with grasses and other shallow-rooted plants. The treated area was losing only a third as much water as the untreated area.

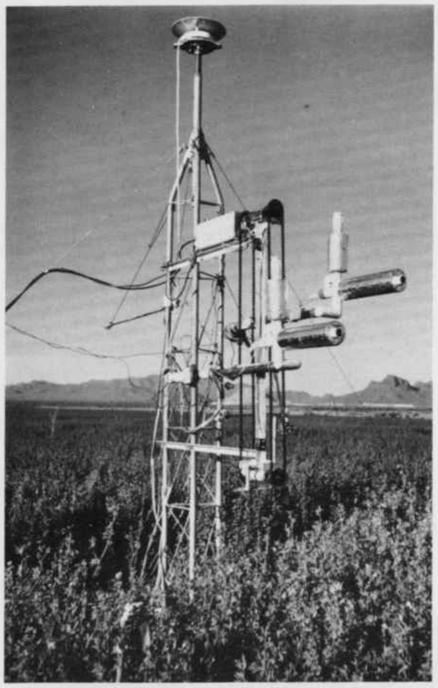
Water supply is just one consideration in management of stream-side land. To the extent it is considered, though, accurate information helps. Gay said, "Data on water use by riparian plant communities will aid in the development of management plans that reconcile potential conflicts among user groups that seek such products as recreation, wildlife, grazing and water supply."

Accurate evapotranspiration estimates could also add precision to the scheduling of crop irrigation, if local estimates were available to irrigators daily and cheaply. Such information would especially suit increasingly popular drip irrigation systems that allow farmers to apply measured amounts of water each day.

In fact, UA agricultural scientists have monitored evapotranspiration rates for some of the pioneering drip irrigation systems in Arizona. In the past two years, Dr. Allan D. Matthias and Dr. Dean A. Pennington have set up automated weather stations at cotton farms near Casa Grande and Stanfield, and used evapotranspiration estimates based on the weather records to help manage and evaluate drip irrigation systems on those farms. The aim is to keep daily water applications at a level even with daily evapotranspiration, except for extra water needs such as leaching of salts.

Gay has taken measurements of evapotranspiration from Arizona fields of alfalfa and wheat in cooperation with Avra Valley farmer Ralph Wong and with the U.S. Department of Agriculture's Water Conservation Laboratory in Phoenix. The system adapts easily to different crops because its energy measurements are taken in the air just above the plants rather than from the plants themselves.

Above: Robert Greenberg (front) and Gay adapt new, compact electronic gear to the evapotranspiration meter. Below: The equipment measures evaporation and transpiration from an Avra Valley alfalfa field.



However, Gay's energy-budget system, while inexpensive compared with other systems of comparable accuracy, would not be practical for taking measurements in every spot where evapotranspiration records would be useful. He is now correlating his measurements with more general and obtainable weather information.

Readings of daily temperatures, humidity and wind have long been used for estimating evapotranspiration rates. However, various formulas based on weather data differ by as much as 100 percent in their estimation of actual evapotranspiration. Gay is making those types of estimates more accurate by calibrating them with local field readings of his energy-budget system.

"Once we calibrate them in the field, we can get exceedingly good evaluations of evapotranspiration by knowing just the maximum midday evaporation and the daily wind total," said Gay. "We can do it with slightly less precision if we know the total solar radiation and the daily wind total."

Weather Records

He has proposed a network of about a dozen automated weather stations around the state for taking appropriate readings and transmitting them to a central computer. Irrigators could get accurate daily evapotranspiration rates for their local areas by tieing into the central computer, or by other communication methods. Another possibility: On-farm computers programmed to account for a regional calibration to the energy-budget method could figure water loss accurately from on-farm weather readings.

Gay's energy-budget readings lose some precision on overcast days and where the plant canopy is patchy. Canopy refers to the area of green foliage you would see from straight overhead, in contrast to uncovered ground. He is working on adjustments for those conditions.

Also, Gay and colleague Robert Greenberg are making the energy-budget system more portable than Gay's original equipment. The system used for most readings so far fills up a van that stays on site for several days of data collection. Most bulky are the 1970s-vintage computer and data-recording equipment that run off a generator. Now, the researchers are adapting much smaller, battery-powered electronics.

They are staying with the type of sensing meters that Gay developed for this method. The contrast in temperature reading between a wet bulb and a dry bulb indicates humidity. The equipment takes simultaneous readings of humidity and air temperature from sensors positioned at two heights above the tops of the plants. In an alfalfa field, for example, the readings are taken about 6 inches and about 25 inches above the plants. The computer translates the difference between readings at the two heights into a measure of the amount of moisture coming from the field into the atmosphere. Evapotranspiration is measured every 12 minutes, with electronic tallying of hourly and daily totals.

The measurements depend on high precision in the temperature readings. Gay uses a pulley system to automatically interchange the sensors between the higher and lower positions. For each 12-minute point, readings are taken by both meters at each of the two heights. That cancels out any variation between the meters. The calculations use temperature readings accurate within a few thousandths of a degree.

"Water conservation is crucial in Arizona," said Gay. "We need to account for our water resources as accurately as we can."

Research assistants monitor older, larger equipment in the van.