Story by Kathy Wythe

Historic treasures

Watershed provides real-world information

A historic experimental watershed in the Blackland Prairie of Central Texas is providing a treasure trove of information that the water resource community throughout the United States is using.

For more than 70 years, scientists with the U.S. Department of Agriculture (USDA) have collected hydrologic data such as rainfall, evaporation, runoff, and soil erosion at the Agricultural Research Service (ARS)'s Grassland Soil and Water Research Laboratory's watershed near Riesel, Texas, making it one of the longest continuous, intensively monitored hydrological research sites in the country.

The Riesel experimental watershed, part of the larger Brushy Creek watershed, has approximately 800 acres divided into smaller watersheds. The research staff operates 17 runoff stations, 15 rain gauges, one weather station, and seven shallow groundwater wells.

Dr. Daren Harmel, an ARS agricultural engineer and manager of the watershed, recently co-authored a paper on the history of the Riesel watershed. He said in the mid-1930s, the USDA realized the importance of understanding hydrologic processes on agricultural fields and watersheds. Formerly known as the Blacklands Experimental Watershed, Riesel was one of three experimental watersheds established at that time to analyze the impact of land use practices on soil erosion, flood events, water resources, and the agricultural economy. Of the three, Riesel and the North Appalachian Experimental Watershed near Coshocton, Ohio, are still operating.

At first, USDA researchers asked farmers on the land to keep account of their farming practices, and researchers evaluated the effect of such practices on soil erosion and runoff, Harmel said. They also divided the federally managed land into smaller watersheds and set up different management practices, such as fertilizer application, contour terraces, grassed waterways, and conservation tillage. The researchers then compared the differences.

Through the years, techniques for collecting the information have become more sophisticated. In the early days, laboratory staff often collected data manually from the 40 small watersheds and 57 rain gauges. They were on call 24/7 to collect runoff water quality data during storms. Now the staff handles collection electronically with state-of-the-art instrumentation.

Harmel explained that the advantage Riesel has over other research sites is its field-scale, real-world setup. Some of the fields are planted in corn, wheat, or oats; others are pastures grazed with cattle. One is a native grassland prairie that has never been cultivated. Each small watershed has a defined point for runoff of water that is collected and analyzed. Researchers use the information obtained from each field to make comparisons and draw conclusions about the different management practices.

Over the years, scientists have used Riesel data to make significant contributions to water resources and agricultural research. The developers of watershed computer models, including EPIC (Erosion Productivity Impact Calculator), APEX (Agricultural Policy/Environmental eXtender), and SWAT (Soil and Water Assessment Tool), used the Riesel watershed data to develop their models. These models are now used worldwide to manage field-, farm-, and basin-scale water quality, Harmel said.

Dr. Peter Allen, professor in the Department of Geology at Baylor University, said the department's researchers use the Riesel watersheds for "senior and graduate classes in hydrology as an excellent example of a world-class hydrological field lab with examples of instrumentation from weather stations to weirs."

They also use it as a field test site to examine processes such as infiltration, runoff, and recharge to shallow aquifer systems and their incorporation into models. In addition, they use it to investigate shrink and swell soil behavior of Vertisols, the clay soil found in the Blackland prairie, under changing moisture conditions.

Realizing the importance of the data, a team produced a CD containing measured data and supporting GIS information, maps, and photographs. Members included Harmel, Allen, ARS scientists Drs. Kevin King, Clarence Richardson and Jeff Arnold, and Texas AgriLife Research scientist Dr. Jimmy Williams. Much of this data is also available on the Internet at http://www.ars.usda.gov/spa/hydro-data.

Harmel has put this data to good use in his own research projects.

In one project, he and other researchers tackled the challenge of determining the best method for collecting stormwater quality samples. "Before we started, there was not much research on how best to do that," Harmel said, adding that agencies and universities spend a lot of money on water quality monitoring.

"Many people don't know how difficult it is to operate a successful storm sampling project," he said. Through research, they sought answers to questions such as: "Do I sample every single storm? Do I take small separate samples or composite samples?"

The team also researched the uncertainty inherent in sampling data. "We made the

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(Top photo) USDA employee manually checks runoff measurements at a newly installed station at the Blacklands Experimental Watershed (circa 1937). (Second photo) In the early days, water quality sampling was done manually by USDA employees on-call 24/7 to collect runoff data during storms. Today, most of the samples are collected with automated equipment. (Third photo) USDA began construction at the Blacklands Experimental Watershed in 1937. This is a photo of the Riesel headquarters building on Sept. 1, 1938. (Bottom photo) Streamflow measurements are taken at a Brushy Creek sampling station. This station was located on private land downstream of the federally owned smaller watersheds.

first attempt to quantify the uncertainty of measured stormwater data," he said. "That research seems to be attracting a lot of attention nationally and internationally."

Based on their research, the scientists have prepared a series of papers that outline "how to" guidance for water quality sampling. These publications are available at http://www.ars.usda.gov/spa/hydro-collection.

Because of this research, Harmel has received numerous requests for training from government agencies, consulting firms, and universities.

"Our overriding goal was to determine how to balance efficient spending of monitoring resources and collection of high quality stormwater data," he said.

Kevin Wagner, a Texas Water Resources Institute project manager, said he used the methods suggested in Harmel's research when he began setting up sampling stations for his doctoral research.

"Daren's work was invaluable in helping me get my sites established," Wagner said. "He had already worked out a lot of the kinks through his work at Riesel, which made my site setup much smoother and also saved me a lot of time. I'd still be trying to figure out what to do instead of monitoring."

Harmel and other researchers, including Dr. Monty Dozier with Texas AgriLife Extension Service, are using the Riesel watersheds to research the long-term impact of using poultry litter as a fertilizer and a soil amendment. This research is funded largely by the Texas State Soil and Water Conservation Board.

Harmel said the project has demonstrated the optimal annual litter application rates that can minimize environmental problems and maximize on-farm profit, which is what farmers want to know.

"With what we know from this research, I think we have the opportunity, as the poultry industry grows in Central Texas, to act proactively to prevent water quality problems like we have seen in other areas, instead of waiting to fix it," Harmel said.

Because water supply shortage, flood occurrence, and water quality degradation will increasingly affect the environment and future generations, Harmel said, watershed-based studies will continue to be needed to solve these problems.

"With the Riesel watersheds, we sit here ready and willing to attack these new challenging questions."

(Left photo) Dr. Daren Harmel, agricultural engineer for the USDA's Agricultural Research Service, looks out over the Riesel watersheds. Currently, 17 watershed sampling sites are located on the 800-acre federal facility. (Center photo) Dr. Monty Dozier, Texas AgriLife Extension Service, inside the Y2 station which is used to measure farm-scale water quality impacts of poultry litter fertilizer. (Right photo) Harmel checks the data logger and radio telemetry system at one of the 15 precipitation gauges located on the facility.