Clean Waters and Agriculture

We Can Have It Both Ways!

Hydraulic engineer Daniel Wren makes adjustments to the floating instrument platform used in Goodwin Creek Experimental Watershed near Batesville, Mississippi. The platform is used for data collection and development of acoustic technology for field measurement of sediment transport.

PEGGY GREB (D558-1)

ARS scientists nationwide are testing techniques that range from the hands-on to the hi-tech as they help agriculture and waterways coexist in a cost-effective, environmentally friendly fashion.

"The key to this challenge is proper management of the land and soils," says Matt Römkens, director of ARS's National Sedimentation Laboratory (NSL) in Oxford, Mississippi. "We need to develop economically effective ways to keep soils in place and to keep the nutrients in the soil from entering and polluting our waters."

Martin Locke, research leader of NSL's Water Quality and Ecology Research Unit, says that it's not just agricultural soils that are of concern. "There are many important influences on water quality—including urban and industrial activities, natural runoff, and erosion," he says.

Excessive erosion threatens land and water alike, carving into valuable farm acreage and unleashing sediments that pollute and clog waterways and fill reservoirs, says Carlos Alonso, leader of NSL's Watershed Physical Processes Research Unit.

And runoff of nutrients from farms and urban sources has been linked to oxygen depletion in large bodies of water such as the Gulf of Mexico. The nutrients feed algal blooms that use up the water's oxygen when the algae die and decompose.

Römkens says great progress has been made at Oxford toward gauging and minimizing agriculture's contribution to water pollution and waterflow's impact on agriculture.

He says these gains represent only part of decades-long ARS efforts to allow both healthy waterways and agriculture to exist within the same ecosystems. One of these projects—monitoring 14 vital U.S. watersheds—has been incorporated into USDA's Conservation Effects Assessment Project. Other contributions include participation in best-management practices and total maximum daily loads (TMDL) projects.

TMDLs represent pollution levels that water bodies can tolerate and still meet water-quality standards. Established through the Clean Water Act, they're among the tools NSL scientists use to target environmentally friendly ways to reduce significant water contamination from agricultural sources. TMDLs also identify appropriate uses for water bodies.

"TMDLs are a widely accepted yardstick for measuring success in water-pollution abatement," says Locke. "All ecosystems can tolerate some level of pollution. Our challenge is to help define levels that will allow ecosystem improvement."

NSL is located in uplands east of the Mississippi River Delta, in an area known for erodible soils that surrender large amounts of sediment. "The lab was established in 1958 to help counter a history of exploitative agricultural methods that resulted in excessive erosion in western Tennessee and north-central Mississippi," says Römkens. "Over the years, the scope of NSL's work has grown to where its research now has international significance."

The Oxford researchers have examined ways to thriftily control streambank erosion and make up for past watershed abuse. These efforts include placing large woody debris structures and willow cuttings in streams and their banks and planting switchgrass hedges. (See "Saving Little Topashaw," *Agricultural Research,* May 2004, pp. 4-6.)

Ears in the Water

On technology's cutting edge, NSL scientists are using automated and acoustic sampling to assess sediment's impact on waterways and dams and then using computer modeling to analyze this data and make predictions. Hydraulic engineers Roger Kuhnle and Daniel Wren, with collaborators at the University of Mississippi, are using acoustic technology to measure transport rate of sand and gravel in streams. The resulting data can reveal details about upstream erosion.

In addition, Wren and other collaborators are improving use of a core-drilling technique, called "vibracoring," for

PEGGY GREB (D562-1)

Soil scientist Martin Locke (left) and biologist Wade Steinriede inspect samples of water runoff that filtered through a switchgrass *(Panicum virgatum)* strip at the edge of a cottonfield. Locke and colleagues are studying conservation tillage and edge-of-field practices in Delta cotton systems that should lessen concerns about degradation of water resources from eroded soil.

PEGGY GREB (D560-1)

Ecologist Matthew Moore (left) and University of Mississippi collaborator Robbie Kröger examine water quality in a vegetated drainage ditch in the Delta. Moore and other ARS scientists at Oxford have found that these ditches can mitigate contamination of agricultural runoff.

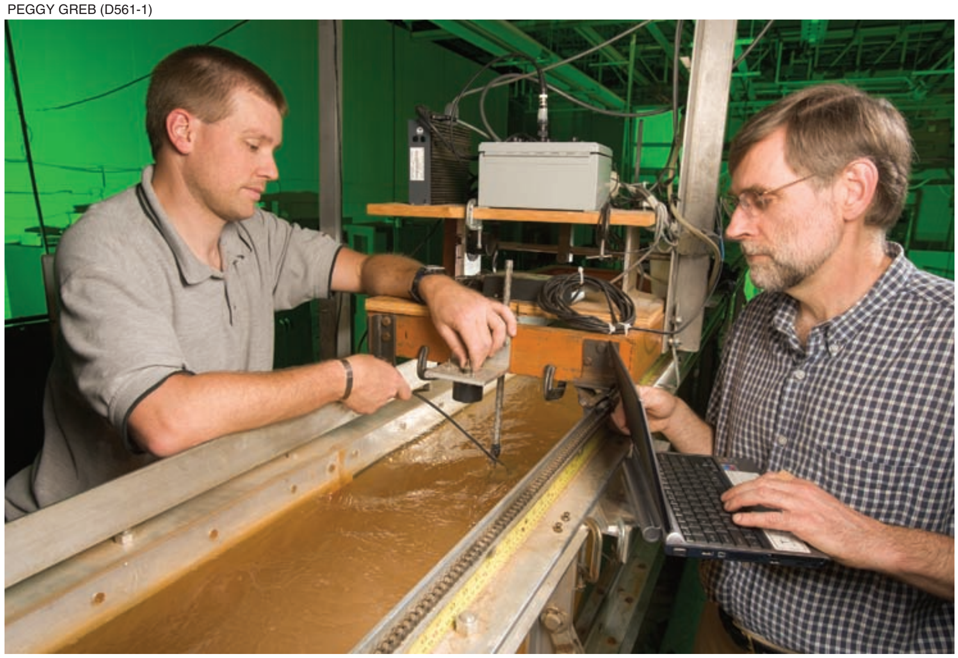
gauging sediment's impact on aging reservoirs. They're particularly interested in how vibracoring helps detect rates and patterns of sediment collection that affect reservoirs' holding capacities. And in a separate project with USDA's Natural Resources Conservation Service (NRCS), Wren is focusing on limiting erosion of levee embankments by wind-generated waves.

Meanwhile, data collected from the Delta region's waterways is helping NSL scientists improve computer programs and models used to evaluate effects of management practices on entire watershed systems. Agricultural engineer Ron Bingner is working with AnnAGNPS (Annualized Agricultural Nonpoint Source) water quality prediction technology, through cooperation with NRCS and other locations, to simulate environmental processes and evaluate their impact on downstream and adjacent watershed elements.

Hydraulic engineer Eddy Langendoen is using field studies and a computer modeling technique he created called "CONCEPTS" (Conservational Channel Evolution and Pollutant Transport System) to assess the stability of specific channel reaches. CONCEPTS accurately depicts stream and streambank processes and helps researchers predict channelization's effects.

(For more on NSL's hi-tech approach to Clean Water Act requirements, see "Helping States Slow Sediment Movement," *Agricultural Research,* December 2003, pp. 12-14.)

PEGGY GREB (D561-1)



Technician Glenn Gray (left) adjusts the acoustic sensor while hydraulic engineer Roger Kuhnle prepares to collect data on the model stream channel at the National Sedimentation Laboratory. This experiment uses acoustic technology to map changes in sand dunes on the bottom of the channel and measure the concentration of sediment suspended in the water.

Filtration Is Key at Florence

At ARS's Coastal Plains Soil, Water, and Plant Research Center in Florence, South Carolina, the emphasis is on filtering nutrients and other pollutants—such as livestock waste—out of flowing water before it reaches rivers and streams.

As with NSL, the Florence lab was established to address problems unique to a specific region. And it, too, has seen its scope expand to cover global concerns.

"We concentrate on natural-resource problems in agriculture, particularly those related to manure, cotton, water, and soil," says soil scientist Patrick Hunt, the lab's research leader.

"The soils in the southeast Coastal Plain are very sandy and hold very little water," says Ariel Szogi, another soil scientist. "This makes runoff from farms and livestock operations an especially big problem, one that has grown along with a jump in animal production over the past decade."

Florence is where soil scientist Matias Vanotti, Szogi, and Hunt developed a landmark, three-stage hog-manure management system that separates solids and liquids, removes ammonia, recovers soluble phosphorus, and processes the solids into plant fertilizer. (See "Blue Lagoons on Pig Farms?" *Agricultural Research,* March 2005, pp. 14-15.)

Other significant work at Florence includes studies on use of constructed wetlands to filter wastes and nutrients from flowing waters. "Wetlands are nature's way of filtering impurities out of waterways," says Hunt. "Since most farmers don't have direct access to wetlands, it may be worthwhile for the wetlands to be brought to them."

He says constructed wetlands have been used for decades for municipal wastewater treatment. "They work on the principle of denitrification, a process in which microorganisms convert nitrogen that's in plant-available form into an inert gas."

Hunt, Szogi, agricultural engineer Kenneth Stone, and other Florence researchers have found that constructed wetlands can remove about half of total suspended solids in water and about 60 percent of nitrogen.

"The keys to constructed wetlands systems are marsh plants, aeration, and drainage," says Hunt. "You want a sloped bottom and shallow water at the entry point. The shallow water ensures that you get interaction with oxygen, which is crucial."

New View of Drainage Ditches

This filtration concept is also being evaluated at other ARS locations, such as NSL; the National Soil Erosion Research Laboratory in West Lafayette, Indiana; and the National Soil Tilth Laboratory in Ames, Iowa. Edge-of-field management techniques such as field borders, filter strips, stiff-grass hedges, and forested riparian zones are being tested.

Oxford ecologists Matthew Moore and Charles Cooper are studying vegetated drainage ditches. Says Moore, "Though often considered mere conduits for water transport, ditches can act as wetlands, with vegetation capable of removing excess nutrients in runoff water."

Moore says recent NSL studies done with Arkansas State University and scientists from Germany showed that nutrient concentrations were reduced by 14 to 78 percent, depending on nutrient and species. And, he adds, "most pesticides currently in use can be mitigated within these ditches."

Key to successful efforts to have both clean waters and effective agriculture is information—ideas and recommendations from the people ARS aims to help with its studies, products, and strategies.

One way of gathering this input is by holding working conferences, such as one hosted by NSL in Oxford last fall. More than 150 guests—including private-farm owners, natural-resource and farm managers, and scientists from within and outside the federal government—took part, contributing ideas gained from long experience to address gulley erosion.

"These conferences give ARS's customers, stakeholders, and partners a clear understanding of the agency's research activities," says ARS Mid-South Area director Ed King. "In return, we receive feedback on the primary issues attendees believe a particular laboratory or program should be addressing over the next decade. This input helps forge a future that will ensure both healthy waterways and productive crop and livestock operations."—By **Luis Pons,** ARS.

This research is part of Water Resource Management (#201) and Soil Resource Management (#202), two ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

To reach scientists mentioned in this story, contact Luis Pons, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; phone (301) 504-1628, fax (301) 504-1486, e-mail lpons@ars.usda.gov. ✷

ROB FLYNN (K9508-8)

Soil scientists Patrick Hunt (left) and Matias Vanotti examine a sample of nitrifying pellets that can remove nitrogen in a hog-manure management system.

PEGGY GREB (D564-1)

The small invertebrates being sampled by technician Lisa Williams and ecologist Charles Cooper are found in wetlands and ditches, where they are excellent indicators of the current quality of water and provide a way to measure improvements from in-field and edge-of-field conservation practices.

COPTERVIEWS.COM (D033-1)

In Duplin County, North Carolina, a full-scale wastewater treatment system (foreground) that replaced the swine lagoon.