# At soil erosion lab, the rain is feigned, but the results are real

*by Mike Lee*

Outside Edward Beighley's lab, the skies were clear and the air balmy.

Inside, Garth Brooks was crooning "Raindrops on the windshield/There's a storm moving in," and the San Diego State University professor was predicting heavy rain - about 1.5 inches over the next few hours.

SHOWER POWER - Keywords: water, irrigation, rain, sprinklers, soil, hydraulics, erosion, Mother Nature. CNS Illustration courtesy of Daniel Wiegard. As co-director of one of the largest soil erosion testing centers in the country, Beighley would know.

In a matter of minutes, he can dial up a downpour inside his nondescript workshop.

His rain machine is enormous: 323 square feet of metal covered by about 18 inches of dirt and crisscrossed by pipes and hoses. Thanks to heavy-duty hydraulic cylinders, one end can be tilted nearly to the ceiling some three stories high. At the other end, huge barrels are positioned to catch the runoff.

The idea is to mimic the outdoor environment, including hillside slopes and rainfall up to 6 inches an hour, so Beighley and his students can test how different soils and erosion control techniques work under almost any condition.

A rainstorm without proper soil stabilization measures "can be catastrophic for the environment," said Beighley, who started at the lab in 2004.

Along with his own research, he does contract work for government agencies and private companies that want a wide variety of products tested. The testing is a dirty job created by the Clean Water Act, which has pushed the development of storm-water control techniques nationwide. Despite that demand, there's only a handful of comparable facilities in the United States. That means SDSU's lab, paid for by Caltrans as part of a $3.2 million study in the late 1990s, already has projects scheduled into 2009.

Though erosion is a natural phenomenon - think of the Grand Canyon - it has been dramatically increased in some places by humans. One reason is that large paved surfaces collect water and send it rushing downhill, gathering sediment and scouring bare lands below. Another is that exposed topsoil at construction sites can easily be washed or blown away if nothing is holding it down.

The university's erosion control facility is credited with updating the best management practices for state highway construction projects and helping control erosion after the massive 2003 fires in San Diego County.

"The thing about San Diego State's lab is that it's practical research. What we learn today, you apply tomorrow," said Mike Harding, a storm-water erosion consultant in San Diego who has helped design, build and operate the lab.

REPLICATING RAIN

One recent day, Beighley's students set the rainmaker to test soils that the U.S. Environmental Protection Agency had imported from Phoenix and Las Vegas. In the corner was a large pile of typical Southern California dirt that will be used for other experiments.

The desert soil sat in see-through tubs, marked with tracking numbers. Some of them already had been hauled onto the elevated platform where they were placed in racks and hooked to sterilized jars that would capture runoff once the rain began.

This experiment was designed to measure whether chemicals used to lock soil in place have the potential to damage waterways. The products already had passed toxicity tests, but Beighley was investigating the possibility of more subtle changes to water chemistry. For instance, an increase in phosphorus or nitrogen could promote the growth of algae in a stream.

In the weeks leading up to the homemade rainstorm, Beighley's crew had sprayed the boxes with several common chemicals used to control erosion. Between applications, the samples were cooked with heat lamps to replicate desert conditions.

Eventually, they were placed under the sprinklers. The irrigation system pressurized with a whoosh and rain swept across the soil pans in precisely measured spurts. After 150 wet minutes, the runoff was taken to the chemistry lab for analysis. Nothing in the experiment is left to chance - not even the size of the rain drops. Their diameter is based on the height of their fall, their velocity and the nozzles, which are machined at various sizes. To calibrate the system to a real rainstorm, scientists at SDSU placed pans of baking flour on the platform and gave them one shot of water. When the flour dried, the spots where the drops hit formed small balls. The pellets were hardened in an oven and measured to make sure they matched natural drops.

Even the water used in experiments is treated with reverse osmosis to ensure its rainlike purity. Too many minerals in the water can decrease erosion and invalidate experiments.

"We do our best to eliminate all of the variables we can," Beighley said.

DEMAND SWELLS

San Diego State researchers regularly are contracted by companies to test new erosion control products.

These include chemicals, silt fences, fiber rolls, soil blankets, filter bags, compost and specific types of plants. Each can be arranged or applied in various ways, meaning the options are virtually endless.

Two main concepts drive the products. One group is aimed at slowing water so that silt and contaminants settle out. The other tries to keep soil on the ground so it stays put in heavy wind or rain. "It's really site-dependent," Beighley said. "There is no one thing that does it all."

Without product testing, it's tough to interest big buyers such as Caltrans or major home builders.

"People want to know, does this work, and if it does work, under what conditions does it fail?" said Ben Northcutt, executive director of the International Erosion Control Association in Steamboat Springs, Colo.

The size of the industry and the scope of its products have exploded so that in the last five years, attendance has doubled at the association's annual conference.

"There is just somebody always out there coming up with a new idea," said Northcutt. "By and large, it's the fact that the regulatory impacts are getting people's attention now."

The Clean Water Act of 1972 spawned a national list of polluted waterways and forced agencies and companies to clean them up. Regulators initially focused on the big, obvious polluters such as factories and sewage systems, but now they are scrutinizing more diffuse sources of contamination.

That shift helped generate state funding for the lab and related efforts to find "best management practices." Harding, the storm-water consultant, said results from the lab's initial study "are still considered the standard by which a lot of national and international research is compared against."

Today, sediment control is a routine part of private and public development projects. California's transportation department estimates that between 2 percent and 5 percent of total construction costs pay for erosion controls. On major projects such as an interstate interchange, the storm-water bill can run into the millions of dollars.

As helpful as lab tests can be, Bell said weather conditions routinely force changes in the field.

"It's a pretty big (machine)," she said of SDSU's erosion simulator. "But it can't replicate the soil of an entire project."

FIRE AND FRONDS

In the weeks leading up to the Cedar fire, Harding and his late wife, Carol Forrest, had been testing erosion control products at SDSU's lab. Their curiosity was sparked by a product called guar, a bean imported from India that is used for everything from stiffening ice cream to making cloth.

When mixed with wood fiber and native plant seed and then sprayed on disturbed land, guar also worked wonders for soil stabilization. "It was like, 'Holy moly, this stuff is amazing,'" Harding said. "When it came time to do the actual work on the fires, there wasn't much of a question about what we were going to use." Teams of contractors applied the guar glue over roughly 1,000 acres in San Diego County.

"Wherever the high priorities were because of the slope conditions or where that erosion and mud flow might have an impact, that's where it was sprayed," Harding said. Crews also deployed fiber rolls to slow the movement of water and limit sediment loss. The combined efforts reduced sediment movement by better than

95 percent from untreated areas, Harding estimated.

"What we did was very effective, and we will probably do very similar techniques again when we have other fires," he said. On a smaller scale, Beighley is working with the city of San Diego to see if he can use ground palm fronds in fiber rolls, which also are known as "wattles."

The loglike devices are popular at construction sites, where they commonly are snaked across hillsides to slow storm-water runoff. Their exterior typically is a mesh that holds together rice straw, a waste material from Northern California farms. The devices degrade slowly while providing soil stabilization.

Now Beighley is investigating whether he can take a local waste product- fronds that fall or are trimmed from city trees - and replace the rice straw.

"There is no other use for palm fronds," he said. "If this stuff works, it's basically a free raw material source for a company that wants to build these things."

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