

Correction: Use of the word "hungry" in fluvial geomorphology refers specifically to water released from dams, although it's true all water will pick up sediment based on its velocity and depth. Russell Dutnell of Riverman Engineering consults on all river erosion issues regardless of value of the assets involved. This story has been updated. Water has been the story of the summer of 2019, with floods and record rainfall, but the true subject of a flood is land that has been inundated, scoured away, and sometimes lost. "Hungry" is the word Russell Dutnell used to describe water released from dams that is free of sediment, and looking to pick up more. But the same word could be used to describe the waters that ran across an already saturated landscape like Oklahoma had in May and June. Dirt is what the water is hungry for. It picks up what it runs across, over and through, like a snowball in an avalanche. "Rivers are naturally sediment-moving machines," said the longtime observer of Oklahoma's rivers and operator of Riverman Engineering. "They move the mountains down to the oceans; it's just what they do." Fluvial geomorphology is the line of expertise for people like Dutnell. They study the physical shapes of rivers and how their channels shift and how they move and redistribute sediment and rocks and trees and houses, as the case may be. He has adopted a matter-of-fact view of the rivers he has watched for so long and says there really is no stopping changes in a river's course. Dramatic changes will only increase as more land is cleared, more area is covered with rooftops and pavement, and the velocity of "hungry" waters increases. "What you're seeing is a natural process. The problem is people like to live in the floodplain, next to the river," he said. "The floodplain is part of the river; it's just not usually active" until you have a flood. As rivers returned to normal levels and the full effects of the 2019 flood are surveyed, the impacts in some areas are dramatic, less so but still noticeable in others. Homes that once stood along the banks of the

Cimarron River at Crescent are now part of the river bottom. Some farmers in the Arkansas River Basin have lost acres of land, scoured down to bare rock, and others have croplands buried under several feet of sand or silt. Two suction dredges, one 12 inches and one 16 inches, now are working to clear the route for barges along the silted-in lower stretches of the Verdigris and Arkansas Rivers. Each is working 24 hours a day (minus maintenance challenges) and moving 250 to 350 cubic yards of material per hour. The 16-inch dredge currently in the Robert S. Kerr Reservoir needs to move an estimated 650,000 cubic yards, according to the Corps of Engineers. The most common dump trucks on the road carry from 10 to 14 cubic yards. So the need at Kerr pool is to move material equal to somewhere between 50,000 and 65,000 dump-truck loads. The Arkansas River channel also shifted through Tulsa, much of which will be noticed mostly by fishermen. Everyone knows about the sinkholes and erosion through the River Parks, but there is one positive effect. An experimental structure worked to create a new sandbar island where endangered least terns are nesting. The Muscogee (Creek) Nation project put a V-shaped rock structure mid-stream near its River Spirit Casino Resort. The design, developed by the Biosystems and Agricultural Engineering Department at Oklahoma State University, was new in 2016 and is under a five-year monitoring plan to gauge its success. But biologists on the river this week confirmed there is a large sandbar and terns are using it. "We've been there twice this week and counted a half dozen adults, three or four chicks and some fledglings loafing there," said biologist Stacy Dunkin with the Corps of Engineers. The structures are designed to create a slow spot in the current where sand can drop out and build up. It's designed to work at flows around 60,000 cubic feet per second, Dunkin said, but the Arkansas hit 275,000 cfs and the water depth hit 23.41 feet in late May. "The fact that it persisted given those historic flows and that it didn't scour out I think is evidence it's working,"

Dunkin said. The U.S. Geological Survey river gauge in Tulsa that reported those maximum flows in May is among dozens across the state that had to be recalibrated after the historic flood, according to Scott Strong, manager at the USGS Tulsa field office. "Most of the sites you read about in the news in May and June will need to be recalibrated," he said. The gauges measure a river's stage to 100th of an inch, so physical changes to the river channel width or gradient at the point where the gauge is located can make a big difference, he said. Accuracy of the gauges is checked regularly, but a historic event like the 2019 flood means all will need a physical site review and testing, he said. Not just the rivers, but upland areas fell to the appetite of hungry waters. When heavy rain hit already saturated ground, the overland flow took out some pond dams, terraces and other soil conservation measures, said Gary O'Neill, state conservationist with the U.S. Department of Agriculture Natural Resource Conservation Service. The floods hit well into the funding cycle for 2019, so much of the help available for farmers to repair those sites will come next fiscal year, he said. Farmers along the Arkansas River, particularly in the Muskogee and Fort Gibson areas, have been hit hard and may have to take advantage of federal programs, some of which might be used to create permanent easements with no more farming. "There is a lot of damage down there; it's incredible," O'Neill said. "There are places where everything is gone, hardly any soil left. The riverbanks changed in places, and some people have lost several acres. The river comes out of its banks and goes to those old flow patterns, the old oxbows." While no state or federal agency tracks the amount of land lost to erosion, the state's most-watched river, the Illinois, has been measured and may be in line for another updated survey to compliment work done by Dutnell several years ago, according to Ed Fite, vice president of water quality with the Grand River Dam Authority. That work used aerial photography to show the first

21 miles of the Illinois River in Oklahoma expanded from an average width of 148 feet in 1958 to 185 feet in 1991. Lower stretches, near Tahlequah, expanded from an average width of 199 feet in 1979 to 239 feet in 1991.

Urban development upstream and clearing of lands along the river continue to exacerbate problems, Fite said. He said his "windshield view" makes him think the river continues to widen. "We have a more flashy river. It rises faster, and it drops faster," he said. "We have removed the land's ability to capture and slowly release the water. That's Mother Nature's way." Dutnell said he "stopped fighting rivers" some years back. He said he consults on a wide variety of situations but before tackling an alteration he weighs carefully the value of assets needing protection "be it infrastructure or an archeological site" against the potential impacts to the stream or river. "I tell people who want to build next to a river to remember, "You're impeding the river; it's not impeding you." If you want to live there, you have to live with whatever the river does." Kelly Bostian 918-581-8357 kelly.bostian@tulsaworld.com Twitter: @KellyBostian