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Devastating floods on the Mississippi this year have given researchers a rare opportunity to study how the river deposits the muds that build coastal marshes.

SEDIMENTOLOGY

Studies spy on a river's rage

Investigation into this year's Mississippi floods could shape coastal restoration plans.

BY GWYNETH DICKEY ZAKAIB
IN VENICE, LOUISIANA

The research vessel *Acadiana* rolls with the waves in the Gulf of Mexico, 10 kilometres off the coast of Louisiana. Scientists and crew members scan the murky waters. Suddenly, triggered by an acoustic signal, a cluster of bright-yellow buoys comes bobbing up to the surface.

The captain steers towards the floats, which carry a radar instrument that has spent the past 20 hours on the sea floor. The device has been measuring the velocity of the water pouring from the Mississippi River, where floodwaters have risen to levels not seen in decades. "There's

a raging torrent coming out," says Carol Lutken, associate director for research programmes at the Mississippi Mineral Resources Institute in Oxford, Mississippi, which helped to organize the expedition. "It's like a fire hose."

The survey earlier this month is part of an ongoing interdisciplinary effort by researchers to learn how the flooding river discharges water and where it deposits its sediment load. Those muds could have a role in restoring the diminishing marshes along the Louisiana coast. The flood "is a catastrophic event, but it's a rare opportunity to understand the physics of the Mississippi delta," says Federico Falcini, a physical oceanographer at the University of Pennsylvania in Philadelphia, and

one of the project coordinators.

Heavy rains across the Mississippi watershed in April led to devastating floods far up the waterway, forcing entire communities to evacuate. On 14 May, as the high water moved into Louisiana, the US Army Corps of Engineers began opening floodgates in the Morganza Spillway, some 450 kilometres upstream of the gulf. Their purpose was to divert water into the Atchafalaya River, which follows its own course to the sea. The move spared developed areas downstream — including the cities of Baton Rouge and New Orleans. It also set up the ideal conditions for a direct comparison of river dynamics and sediment deposition in two very different waterways. ▶

► The Mississippi is hemmed in by a system of embankments and kept open for shipping by constant dredging. It reaches the sea in a few long, narrow channels, flanked by diminishing marshlands. By contrast, the less-controlled Atchafalaya emits a diffuse plume, which exits through networks of bifurcating channels and feeds a growing marsh called the Wax Lake Delta. Using satellites to compare the discharge of the two rivers, and the *Acadiana* to verify the satellite measurements of the Mississippi, Falcini and his colleagues will try to determine the conditions that build healthy wetlands. “The theory is, if you can tune the channel geometry on the Mississippi River Delta, maybe it will do something like what the Wax Lake is doing: spreading and making deposition just in front of the river,” says Falcini.

He and Douglas Jerolmack, a geophysicist at the University of Pennsylvania, hope to validate a model in which the faster water is moving as it exits a river, the farther into the sea it will carry sediment (F. Falcini and D. J. Jerolmack *J. Geophys. Res.* doi:10.1029/2010JF001802; 2010). This relationship would be especially important during floods, which carry unusually heavy loads of sediment that contribute to marsh-building along the coast. “We’re going to learn a whole lot that we’ll use to inform and expand our model,” says Jerolmack.

Falcini’s team is one of a few groups studying

the floods for clues to restoring the wetlands, which buffer the coast from hurricanes, floods and storm surges by absorbing water and wave power. The US Geological Survey says that nearly 43 square kilometres of Louisiana’s coastal marshes have been disappearing each year since 1985, owing to sea-level rise, subsidence and sediment deficit.

As a result, the open waters of the gulf are creeping closer to New Orleans, increasing its vulnerability to hurricanes. “We’re conscious that if we don’t do something to save the landscape, the entire coast will be gone,” says Steve Mathies, executive director of the Louisiana Office of Coastal Protection and Restoration in Baton Rouge, which is developing a plan for coastal restoration.

Some scientists say that the best way to save the coast is to divert more of the Mississippi’s floodwaters upstream to increase the amount of sediment reaching the marshes, but they don’t know how to ensure that the sediment will be captured where it is needed. Falcini’s model suggests that one way would be to widen channels that feed into the ocean, so that the water slows down and sediments settle out.

The researchers are using satellites to track sediment concentration at the water’s surface,

among other variables. They will validate those data using velocity measurements and samples gathered by the *Acadiana*. In the coming weeks, the floodwaters will subside, and project collaborators will fly a helicopter along the 250 kilometres or so of coastline between the Atchafalaya and Mississippi deltas, landing at regular intervals to take sediment samples and discover where the flood has added or eroded soil. Taken together, these measurements should help to determine which river characteristics can be tuned to build healthy marshes. Independent teams working farther up the river will add detail.

Besides shaping restoration plans, says Mathies, projects such as Falcini’s could also help to build support for restoration measures, which will be expensive and could meet resistance from stakeholders such as fishermen and shipping interests. “We need to be able to show people what the returns will be,” says Mathies.

Louisiana officials have started to take a “generational view” of coastal restoration, accepting that long-term benefits trump short-term interests, says Robert Twilley, a coastal-systems ecologist at the University of Louisiana at Lafayette. The trick to maintaining a healthy coastline is to minimize the damage from floods while maximizing the benefits, he adds. “We need to think how we can reconfigure the river to accomplish both flood control and restoration.” ■

Top: Sediment pours from the Atchafalaya on 1 June in a more diffuse flow than from the faster Mississippi. Bottom: The rivers have strikingly different deltas.