SONTEK RIVERSURVEYORS, THE NEW M9 & S5, TACKLE TOUGH QUESTIONS – AND TOUGH CONDITIONS – DURING MISSISSIPPI FLOOD

As the Mississippi River rose to dramatic levels and overtopped its banks in June 2008, homes flooded, crops were destroyed, and big questions loomed. Hydrologists have long grappled with the dynamics of floodplains beyond the Mississippi's levees – do floodwaters travel over flooded cropland, or does the floodplain simply store water?

"The theory is that floodplains including agricultural areas, especially where crops are growing, offer so much resistance to flow that conveyance is negligible," says Jim Slowikowski, field coordinator with the Illinois State Water Survey in Urbana, Ill. "The opposing view is that while water velocities are greatly reduced, the sheer magnitude of the floodplain areas represent significant conveyance. Our plan was to measure total flow of the river in an area with little or no floodplain, with subsequent measurements at locations that included floodplain areas of differing widths and land uses. We were looking to find out how much flow was in the floodplain as opposed to the main channel."

Using the SonTek RiverSurveyor M9 & M5 systems, which automatically optimizes acoustic frequency and cell size to deliver high-resolution data in water of nearly any depth, researchers were able to conduct a 2-kilometer transect across the Mississippi River's floodplain during the devastating 2008 flood.

During the massive floods of 1993, that was extremely difficult to do. Even a year ago, it would have required at least two different flow instruments and a great deal of data management to get a clear look at bathymetry and flow in both the shallow floodplains and the raging channels.

Slowikowski reassembled a team that had worked together studying the catastrophic Mississippi River floods in the mid-'90s – himself, Dr. Art Schmidt of the University of Illinois, and John Sloat of SonTek/YSI – to use the latest technology to study levee breaches and floodplains along 40 miles of the river's path below Lock and Dam 20 near Canton, Mo.

Sloat brought two RiverSurveyor acoustic Doppler profiler (ADP) systems, the "M9" and "S5", which were in the finishing stages of development at SonTek's laboratories in San Diego. He was accompanied by SonTek software and field engineer Muthiah Radhakrishnan, who put the systems' software through its paces.

"It was kind of a perfect storm," Sloat says. "We all knew that this was a once-in-a-lifetime chance – a chance to put our thoughts and ideas to the test in about the most difficult conditions you're going to meet."

The 2008 Mississippi River flood provided a challenging proving ground for two SonTek RiverSurveyor systems compared side-by-side on this skiff – triple frequency 9-beam (M9) on the left and dual-frequency five beam (S5) on the right,. (Pictured from left) Jim Slowikowski, Muthia Radhakrishnan and John Sloat, along with Art Schmidt (not pictured) transected the river channel and flood plain, gathering high-resolution depth, discharge and flow data.

SonTek/YSI, founded in 1992 and advancing environmental science in over 100 countries, manufactures affordable, reliable acoustic Doppler instrumentation for water velocity measurement in oceans, rivers, lakes, harbors, estuaries, and laboratories. Headquarters are located in San Diego, California.

+1 858 546 8327 Fax +1 858 546 8150 inquiry@sontek.com www.sontek.com

Both RiverSurveyor systems operate on multiple acoustic frequencies, which allows reliable, detailed depth, velocity and discharge data collection across thousands of meters of river and floodplain. The S5 model features five beams – four 3.0 MHz angled beams and a 1.0 MHz vertical beam. The RiverSurveyor M9 has dual four-beam arrays operating at 3.0 MHz and 1.0 MHz, and a 0.5 MHz vertical beam for depth measurements at a range of up to 80 meters. Both RiverSurveyor units offer internal power and telemetry (Bluetooth or radio link); integrated, state-of-the-art, high-precision real-time kinematic (RTK) GPS; dedicated low-frequency beam for depth; and PC and Windows Mobile software for real-time data collection.

"What better chance to beta-test these instruments than in a 500-year flood?" remarks Slowikowski.

Extreme Conditions

As the river's flow blasted past 400,000 cfs and the floods spread to roads and woodlots more than a mile from the Mississippi's banks, the team put the ADPs through their paces in an array of extreme conditions.

"We had velocities in the floodplains of a few tenths of a foot per second to 5 to 6 feet per second in the main channel," says Schmidt. "We were pushing our ways through the floodplains, zigzagging through the trees and brush to find a path. The weather was challenging, too. We had some days in the upper 80s and low 90s, and other days we were working in thunderstorms."

The data set they collected may be among the most complete of its type.

Because the RiverSurveyors can automatically change frequencies and adjust cell size internally, the instruments can build a single data file with the optimum resolution for the depth at which they are working, changing as they go, says Sloat. The result: "we can look at very high-resolution data across a variety of conditions, all in one data file," he says. "The power of this instrument is its flexibility. It will really work wherever you use it."

Schmidt agrees. "The beauty of this instrument is that we could go from right at the edge of the floodplain – in about one foot of water – and with the same instrument go all the way across the channel, which was 45 to 50 feet deep, and all the way back to the other edge in one-foot-deep water," he notes. "We have pictures of ourselves in 1993 wading with point-velocity probes two miles back from the levees, because once the depth was less than 1.5 meters, the old Doppler profilers couldn't do much. With the new instrument, if you can get a boat in there, you can get a reading. The configuration of these instruments opens up a lot of possibilities to examine what's happening in the water column."

Slowikowski points out that the RiverSurveyor features a fast-sampling, low-frequency vertical beam dedicated to precise depth measurement. "As long as the bed is there to get something off of, you're going to get a depth measurement," he says.

Easy to Deploy

In addition to its flexibility in the field, the RiverSurveyor is designed for ease of use. In addition to the instruments' capacity to handle internal adjustments automatically, the RTK system is plug-and-play simple to activate.

"It's a nice, small, easy-to-deploy instrument," Schmidt points

A dedicated vertical beam in the new SonTek RiverSurveyor allowed researchers to precisely map the bottom of a break in this Mississippi River levee – vital insight into the performance of levees during the devastating 2008 flood.

John Sloat of SonTek/YSI field tested the RTK capabilities of SonTek's new RiverSurveyor system as he and colleagues studied floodwater behavior across the river channels and floodplains.

out. "We showed up in the parking lot of a motel, pulled the instruments out of the box, had some lumber and aluminum, and in about an hour, we had mounts that worked excellently." Linking the RiverSurveyor's GPS navigation unit to its RTK base station – a process that takes minutes rather than hours – offers extremely accurate positioning data to accompany depth and flow readings, he adds.

Notes Sloat, "we mounted the RTK to a tripod, set the tripod on the ground, turned it on and drove away. The whole operation took four or five minutes."

Deploying the new RiverSurveyor ADP – even activating its RTK system – during the 2008 Mississippi River flood was simple. (From left) Jim Slowikowski, Muthia Radhakrishnan and Art Schmidt put two RiverSurveyors through their paces.

Another improvement over earlier RiverSurveyor models is the new instrument's capability to send data to a mobile phone as well as a laptop.

"A mobile phone is very portable and uses much less power than a computer," Schmidt notes. "In the past, getting ready for a field trip was always an exercise in lugging 12-volt marine batteries and even a generator. Without all those batteries, you can use a tiny kayak or a shallow-draft boat. With a mobile phone in a waterproof case, all of a sudden you have an extremely versatile instrument – you can get to a lot of places you could never get into before.

"And with the mobile phone connection, we can shut things off so we're not using any power except onboard the instrument," he adds. "When we get to the other side, we can get the data on our mobile phone."

Important Answers

The data from the team's 2008 research could be invaluable to hydrologists, engineers and policymakers charged with developing strategies to deal with floods along rivers like the Mississippi, says Slowikowski. Understanding the interactions between levees and floodplains during flood events will help guide discussions on levee design for years to come. Being able to collect data to support those discussions – quickly, conveniently and more accurately than ever – will help make sure that the best science available can make it to the table.

"All the technology is the same as what we've had for the past several years, but adding the different aspects of the technology together and having them work together seamlessly, it's just so much more of a robust data collection system," says Slowikowski. "It's so much more robust that I think I can do a better job on whatever I'm trying to use it for."

Schmidt appreciates the quality of the data and enjoys the excitement of pushing new frontiers in data collection. "One of the things I study is how we can measure things better," he says. "I was like a kid in a candy shop with these new instruments. Having a single instrument that can provide this type of precise, high-resolution data for an unprecedented range of conditions will open the door to much better understanding of river systems, and ultimately allow for better management of our water resources."

The ability of the SonTek RiverSurveyor to automatically optimize frequencies and cell size allowed researchers to create a single, high-resolution data file to study the movement of floodwaters across various depths.

SonTek/YSI
9940 Summers Ridge Road
San Diego, CA 92121
Tel: +1 858 546 8327
Fax: +1 858 546 8150
Email: inquiry@sontek.com
Web: www.ysi.com

SonTek
YSI incorporated