Researchers use satellites to measure inland floods

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Satellites that were designed to measure sea level over the world's oceans can serve a valuable purpose over land, a new study has found.

Researchers used NASA's TOPEX/Poseidon satellite and the European Space Agency's ENVISAT satellite to measure the height and extent of flooding in North America, South America, and Asia.

The study shows that satellites can supplement the measurements that the United States Geological Survey (USGS) gathers from flood gauges on the ground -- at little or no cost, said C.K. Shum, professor of earth sciences at Ohio State University.

"After a flood, we can look back at the satellite data to pinpoint when the flood began, and find out how far the flood waters extended, which is really important for flood modeling," he said.

Satellites such as TOPEX/Poseidon measure the height of land or water by bouncing radio signals off of surfaces and measuring how long the signals take to return. Rough surfaces scatter some of the signal in other directions, and cause errors in a satellite's on board tracking system. This often happens over land. Scientists use "re-tracking" software to fix the errors, and make the satellite's measurements more precise.

That's what the Ohio State software does -- it re-tracks the satellite data, but in a way that enables detailed measurements of water on land.

The key to the software is an algorithm that can tell the difference between water and snow cover. Ohio State postdoctoral researcher Hyongki Lee developed the algorithm and graduate student Manman Zhang applied the algorithm for her doctoral thesis.

Zhang presented the work in a poster session at the American Geophysical Union meeting in San Francisco.

Shum, Zhang, and their colleagues used the software to process TOPEX/Poseidon data from the 1997 Red River flood in the upper Midwest of the United States, an area with abundant farmland and wetlands. They detected flooded regions within four river basins: the Red River Basin in North Dakota and Minnesota; the Missouri River Basin in North Dakota and South Dakota; and the Minnesota River Basin and the Mississippi River Basin, both in Minnesota and Iowa.

The flood happened in April of that year, as winter snows began to melt. Zhang's algorithm differentiated between the scattered radar signal produced by water and by areas still covered by snow. As the floodwaters began to move down the Red River, the satellite measurements provided estimates of flood levels.

After re-tracking, the satellite data agreed with USGS ground measurements taken at the time. For example, the software determined that flood waters in Grand Forks, North Dakota, rose 20 feet (6 meters), which matched data recorded from flood gauges there.

The researchers did the same for the June 2008 Iowa City flood that killed three people and damaged 2 million acres of farmland. They found that they could track the ebb and flow of that flood over a scale of several hours. For that part of the study, they worked with Carrie Huitger, a USGS hydrologist who supplied the flood gauge data.

They performed similar studies with TOPEX/Poseidon data for a flood in the Amazon River Basin, and with ENVISAT data for a flood in southwestern Taiwan -- both with similar results.

The satellites can't be used to forecast a flood because the data isn't processed very quickly and the spatial coverage of the satellite measurements is limited, Shum explained. Even preliminary processing takes hours. But after a flood, such data can add to data collected on the ground, to help scientists better understand how floods happen.

Next, the researchers want to automate the software so that it can build an archive of flood data. Since the satellites are already in orbit collecting the data, there would be little cost beyond building the database and enabling scientists to access it.

In the future, a new satellite may enable more extensive and detailed measurements. Ohio State scientists lead an international team that has proposed the Surface Water Ocean Topography (SWOT) mission. The SWOT satellite will feature dual antennas that will gather high-resolution data over a much wider surface of the earth than is possible with today's satellites.

Source: Ohio State University