Researchers find changes in agriculture increase high river flow rates

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Just as a leaky roof can make a house cooler and wetter when it's raining as well as hotter and dryer when it's sunny, changes in land use can affect river flow in both rainy and dry times, say two University of Iowa researchers.

While it may be obvious that changes in river water discharge across the U.S. Midwest can be related to changes in rainfall and agricultural land use, it is important to learn how these two factors interact in order to get a better understanding of what the future may look like, says Gabriele Villarini, UI assistant professor of civil and environmental engineering, assistant research engineer at IIHR—Hydroscience & Engineering and lead author of a published research paper on the subject.

"We wanted to know what the relative impacts of precipitation and agricultural practices played in shaping the discharge record that we see today," he says. "Is it an either/or answer or a much more nuanced one?

"By understanding our past we are better positioned in making meaningful statements about our future," he says.

The potential benefits of understanding river flow are especially great in the central United States, particularly Iowa, where spring and summer floods have hit the area in 1993, 2008, 2013 and 2014, interrupted by the drought of 2012. Large economic damage and even loss of life have resulted, says co-author Aaron Strong, UI assistant professor in the Department of Urban and Regional Planning and with the Environmental

Policy Program at the UI Public Policy Center.

"What is interesting to note," says Strong, "is that the impacts, in terms of flooding, have been exacerbated. At the same time, the impacts of drought, for in-stream flow, have been mitigated with the changes in land use composition that we have seen over the last century."

In order to study the effect of changes in agricultural practices on Midwest river discharge, the researchers focused on Iowa's Raccoon River at Van Meter, Iowa. The 9,000-square-kilometer watershed has the advantage of having had its water discharge levels measured and recorded daily for most of the 20th century right on up to the present day. (The study focused on the period 1927-2012). During that period, the number of acres used for corn and soybean production greatly increased, roughly doubling over the course of the 20th century.

Not surprisingly, they found that variability in rainfall is responsible for most of the changes in water discharge volumes.

However, the water discharge rates also varied with changes in agricultural practices, as defined by soybean and corn harvested acreage in the Raccoon River watershed. In times of flood and in times of drought, water flow rates were exacerbated by more or less agriculture, respectively. The authors suggest that although flood conditions may be exacerbated by increases in agricultural production, this concern "must all be balanced by the private concerns of increased revenue from agricultural production through increased cultivation."

"Our results suggest that changes in agricultural practices over this watershed—with increasing acreage planted in corn and soybeans over time—translated into a seven-fold increase in rainfall contribution to the average annual maximum discharge when we compare the present to the 1930s," Villarini says.

The UI research paper, "Roles of climate and agricultural practices in discharge changes in an agricultural watershed in Iowa," can be found in the April 15 online edition of Agriculture, Ecosystems & Environment.

More information: Gabriele Villarini, Aaron Strong, "Roles of climate and agricultural practices in discharge changes in an agricultural watershed in Iowa," *Agriculture, Ecosystems & Environment*, Volume 188, 15 April 2014, Pages 204-211, ISSN 0167-8809, DOI: 10.1016/j.agee.2014.02.036.

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