From property damage to lost production: How natural disasters impact economics

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When a natural disaster strikes, major disaster databases tend to compile information about losses such as damages to property or cost of repairs, but other economic impacts after the disaster are often overlooked—such as how a company's lost ability to produce products may affect the entire supply-chain within the affected region and in other regions.

Without using the right model to study these losses, the data may give an incomplete picture of the full financial impact of the disaster as it doesn't fully portray business interruptions incurred locally, or by trade partners, after the event. As a result, a locality may receive less than it should in state or federal government recovery support.

In a recent study, published in *Earth System Dynamics*, an interdisciplinary journal devoted to the study of Earth and global change, economists at the University of Illinois partnered with atmospheric scientists and hydrologists from U of I and UCLA, and with the Army Corps of Engineers to capture the characteristics of an atmospheric river—a transporter of water vapor in the sky—that hit the western part of Washington State in 2007. This event resulted in record flooding (a 500-year stream peak event in some parts of the river) and record damages.

The team hopes to show that carefully selecting the characteristics of the extreme weather event under study and the correct model to estimate losses—based on characteristics of the disaster and the affected region,

and on the interdependence between one area and another—can help in determining vulnerability and preparing for future disasters, from an economic standpoint.

"This is quite different from what insurance companies do," explains Sandy Dall'Erba, an associate professor in the Department of Agricultural and Consumer Economics at U of I, and a co-author of the study. "After a disaster, when an insurance company comes, they basically say that your building has been destroyed by this particular amount. And because you were out of the building for, say, a week, you couldn't produce anything for a week. What insurance companies forget, and what our paper is trying to demonstrate is that the total amount of economic losses is much greater."

The ripple effects from a disaster can be significant if major industrial chains are disrupted when infrastructure is comprised. For instance, while the study finds that intersectoral and interregional linkages add up to around 10 percent in standard economic damage estimates in the small rural area chosen in this study, that share could go up to 50-70 percent for a major metropolitan area like Houston, Texas, because of its enormous transportation system and interregional trade.

"Let's say for instance that a company producing tires is flooded. Obviously, no tires are coming from that company," Dall'Erba explains. "The car company, which could be located in a place that wasn't flooded, suddenly is expecting a delay in the tires that are not coming on time anymore. There are all of these connections from one city to the next that are traditionally not accounted for after a disaster."

In his U of I lab, the Regional Economic Applications Laboratory (REAL), Dall'Erba studies very specific disaster events using a technique called input-output—a technique that shows the interdependencies between the sectors within a region and across different regions. He also

teaches this technique in his home department (ACE) on a regular basis.

"We look at each industry. What kind of products and services do they buy? To whom do they sell their goods and services? In the case of Chehalis, Washington, that was flooded in 2007, it was mainly companies selling to other companies, not to individual households. Those are the kinds of links that we try to include in the work we do in REAL, how to understand that level of dependence between one location and other places. We also provide measurements that are very specific to each locality," Dall'Erba says.

Using the input-output technique helped the researchers calculate the actual losses after the event in Chehalis. "We rely on a huge amount of data to do it. We have information from each locality about how each industry is connected to every industry within that locality and outside of that locality so we can understand how dollars flow," he adds.

In addition, they must account for the timing of the event. "While the affected area is very agricultural, the luck it had is that the flood took place in December, way ahead of the growing season of the crop the locality depends the most on, corn. If it had taken place a few months later, the local economy would have experienced much larger losses," Dall'Erba says.

Finally, Dall'Erba's team is particularly careful to account for the location of the companies in charge of reconstruction. "Most of the literature assumes without evidence that reconstruction will dampen the local losses and boost employment. It turns out that for small rural communities—like the one in our study—no local construction company is present or is large enough to be in charge of reconstruction. As such, reconstruction efforts are delivered by companies outside of the affected economy and it is these other localities that see an increase in output and construction jobs," Dall'Erba adds.

The latter part of their study focuses on the future. Assuming that climate change will result in 15 percent more streamflow (water from rivers or streams) for all return periods, the authors find that the total losses would increase from $6.2 million, the figure seen during the actual event, to $8.6 million (a 39 percent increase).

"Adaptation strategies could include, among others, larger floodplains in upstream locations, levees close to critical buildings, and/or developing a more resilient supply-chain," Dall'Erba says. "However it is particularly hard for small rural communities as they do not always have the budget necessary to implement large adaptation projects; yet they have already been more frequently affected by floods than urban areas over the last few decades."

The study, "Tracking an Atmospheric River in a Warmer Climate: from Water Vapor to Economic Impacts," is published in *Earth System Dynamics*.

More information: Francina Dominguez et al, Tracking an atmospheric river in a warmer climate: from water vapor to economic impacts, *Earth System Dynamics* (2018). DOI: 10.5194/esd-9-249-2018

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