Probability maps help sniff out food contamination

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Tracking down the source of fresh food contamination can be difficult and time-consuming. Credit: Randy Montoya

Uncovering the sources of fresh food contamination could become faster and easier thanks to analysis done at Sandia National Laboratories' National Infrastructure Simulation and Analysis Center (NISAC).

The study, in the *International Journal of Critical Infrastructures*, demonstrates how developing a probability map of the food supply network using stochastic network representation might shorten the time it takes to track down contaminated food sources. Stochastic mapping shows what is known about how product flows through the distribution supply chain and provides a means to express all the uncertainties in potential supplier-customer relationships that persist due to incomplete

information.

If used on a larger scale, such methods also might assess the vulnerability of food supplies to wide-scale, deliberate contamination.

Tracking down the source of fresh food contamination can be difficult and time-consuming. Stephen Conrad (6924) says difficulties in adequately characterizing connections and product flows among producers, distributors and suppliers can contribute to significant uncertainty in assessing the risk of foodborne illness.

"This is often a serious problem when there is an outbreak of food poisoning in a particular region and the healthcare authorities cannot quickly trace the source of the outbreak," Stephen says.

When an outbreak occurs, epidemiologists must interview affected people to track down where foodborne exposures happened. Often those interviews take place weeks after the exposure, leading to inaccurate or incomplete information and making it difficult to pinpoint a likely food culprit. Once the tainted food has been identified, investigators must trace up through the food distribution supply chain to locate the source of contamination.

Stochastic food chain mapping could prevent more healthy food from being lost to outbreak concerns. Credit: Randy Montoya

"Epidemiologists involved in trace back start behind the eight ball," Stephen says. "They attempt to reconstruct the pathway the contaminated food has traveled through the distribution network well after the fact. "

Even at the supply chain level, investigating how food moves through the system is daunting. Stephen says supply chains vary widely from one food marketing system and agricultural sector to another. Some supply chain parts change frequently. Even within a single agricultural sector, some parts of the food supply chain may be characterized by enduring supplier/customer relationships, while others may be market-based and highly transitory.

Even industry insiders may not understand the supply chain map. Many only know "one up and one down"—that is, they know only their direct supplier and direct customer. Some information about customers and suppliers can be proprietary and therefore hard to get, Stephen says.

In 2011, sprouts were the focus of a serious E. coli outbreak in Europe, but tracing contaminated products to their source proved difficult.

Sandia researchers applied the stochastic mapping technique to test data from the fresh sprout sector in a single state in the U.S., using a case study of the edible seed sprout distribution system as the basis of their computational model.

"Stochastic network representation provides the ability to incorporate and express the uncertainties using probability maps," Conrad explained.

"The method enables effective risk analysis and designing robust food defense strategies."

Future work for the team will include scaling the analysis up to the company or industry level as well as mapping commodity flows into, out of and within a geographic region.

Ultimately, NISAC intends to work with partners in business and federal and state agencies to ascertain whether the agencies have a business case for adopting the method. If there is, the team will seek to help achieve wide acceptance of using data analysis to assess risk.

Building on techniques and knowledge developed at NISAC over the past four years, the work was initiated with funding from Sandia's Laboratory Directed Research and Development program and continued with funding from the Department of Homeland Security.

"If stochastic mapping was widely used now, perhaps outbreaks, such the recent ones involving salmonella, could be more quickly tracked down and contained. Quicker containment would benefit not only consumers but also the farmers who grow fresh food for our nation and who can be severely impacted economically by uncertainties and market restrictions on sales of their products caused by delays in pinpointing an outbreak's source," Stephen says.

More information: The International Journal of Critical Infrastructures article, "The value of utilizing stochastic mapping of food distribution networks for understanding risks and tracing contaminant pathways," written by Conrad, W.E. Beyeler and T.J. Brown, appeared in Volume 8 of the 2012 publication.

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