New study describes method to save lives in chemical attacks

July 10 2017

A new study by Kiran Bhaganagar, associate professor of mechanical engineering at The University of Texas at San Antonio, and her research group, Laboratory of Turbulence Sensing & Intelligence Systems, is taking a closer look at the damage caused by chemical attacks in Syria. The Syrian Civil War, ongoing since 2011, has seen hundreds of people killed through the use of chemical weapons.

Chemical agents are different from explosive chemicals, which cause localized destruction through force. Sarin gas, for example, a nerve agent which has been used in many attacks in Syria, can diffuse into the atmosphere and spread for hundreds of miles.

Turbulence is also an important player in diffusing the released chemical to kilometers away from the source of release. Bhaganagar's expertise in "taming turbulence" is making a difference in predicting this very critical problem of chemical terrorism facing the world.

With the world moving towards smart buildings and smart cars, the concept of developing an intelligence system for chemical plume trajectory is critical for national safety against impending chemical threats. Funded by US Department of Army Edgewood Chemical and Biological Center (ECBC), Bhaganagar's team is developing an early warning prediction system for these attacks. This is an intelligence system that uses a weather research forecasting model (WRF) with local sensor data to predict air-borne release chemical plume. Local turbulence and the type of the gas dictates the direction of the plume path.

Bhaganagar and her team simulated on a supercomputer the same conditions as a recent Syrian gas attack on a small town of Khan Shaykhun, in which as many as 100 people may have been killed.

The intelligence system relies on solving an intricate set of thousands of mathematical equations and processing millions of data within few minutes. This is done on supercomputing processing systems with 50,000 graphical core units working simultaneously to predict the plume path in real-time. Using this intelligence system and local conditions in Khan Sheikhoun, the team was able to predict exactly how far and high the gas would spread, and at what speed. When they compared the simulation data to the actual details of the real attack, they found that they matched. The model worked and could realistically warn potential victims of a chemical attack to flee the area.

Bhaganagar's study demonstrates that local wind and terrian conditions and atmospheric turbulence make chemical attacks even more deadly than previously understood, and proposes that analysis of the wind and the use of data-collecting drones could make for an early warning system that would allow people in potentially deadly areas to evacuate before the gas reaches them.

The challenge in developing the intelligence systems is to obtain the local wind, turbulence surface and chemical gas sensing data. Currently, the team is demonstrating using aerial drones that scan the region in the vicinity of the chemical source and get point-point sensing data. This is what is known as mobile sensing.

"We are moving from traditional single-point stationary sensors to novel concept of mobile sensing which is low cost, fast collection of sensing data and very accurate," said Bhaganagar. "This is the next step. We will deploy low-cost aerial drones to collect wind and gas concentration sensing data. We can alert people to danger within minutes."

"The human cost of this conflict is rising daily, and it doesn't have to," she said. "Through collaboration and innovation, we can save lives."

More information: Kiran Bhaganagar et al, Assessment of the plume dispersion due to chemical attack on April 4, 2017, in Syria, *Natural Hazards* (2017). DOI: 10.1007/s11069-017-2936-x

Provided by University of Texas at San Antonio