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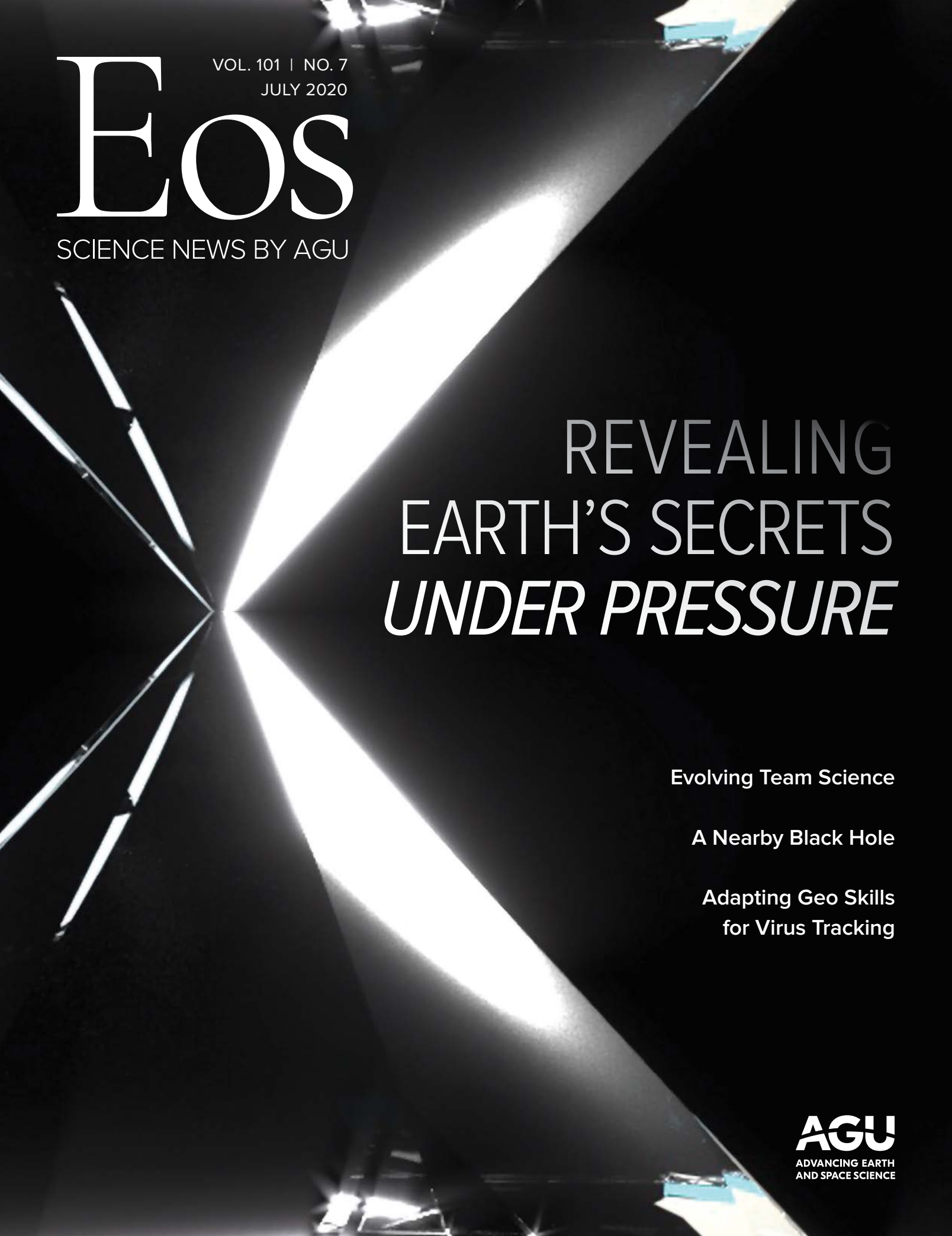


REVEALING EARTH'S SECRETS *UNDER PRESSURE*

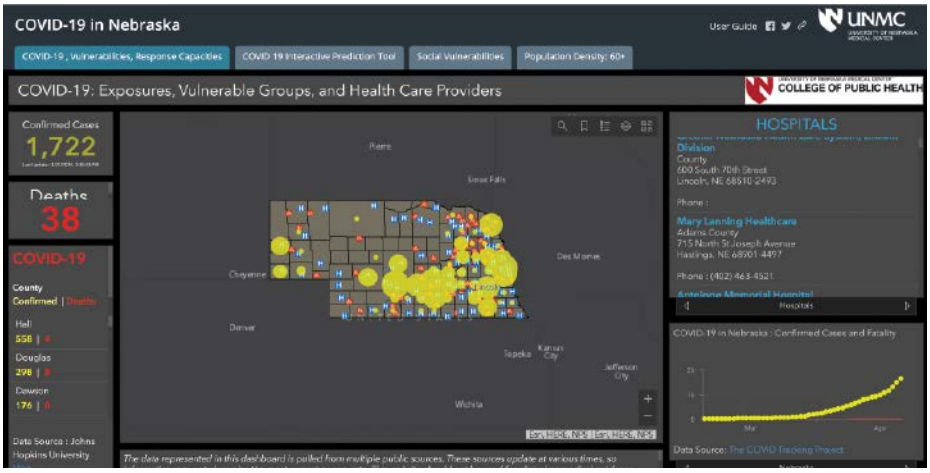
Evolving Team Science

A Nearby Black Hole

Adapting Geo Skills for Virus Tracking

AGU
ADVANCING EARTH AND SPACE SCIENCE

Geoscientists Help Map the Pandemic



The mapping tool can help responders visualize where outbreaks are trending or where they may spike in the future.

The global pandemic threw a wrench into the field and lab work of most geoscientists.

But not Babak Fard. An environmental data scientist at the University of Nebraska Medical Center (UNMC) College of Public Health in Omaha, Fard has leveraged his interdisciplinary background to track and predict coronavirus disease 2019 (COVID-19) infection risks to Nebraskans.

He and his colleagues created a dashboard tool (bit.ly/Neb-COVID-19) that can help responders visualize where outbreaks are trending or where they may spike in the future. The tool is helping health care providers and public policy leaders get supplies and resources to the areas of Nebraska that need them most.

Geohealth at Work

While a doctoral student at Northeastern University in Boston, Fard mapped the risk of heat waves to residents of Brookline, Mass., using a framework tool. The project was part of AGU's Thriving Earth Exchange, in which scientists work on a problem that advances community solutions.

"We wanted to look at how these extreme temperatures affect public health," said Fard, adding that the issue has become a global concern. The team identified the hazard (heat waves) and vulnerabilities that can lead to adverse reactions to the hazard. Using these data, team members created a regional map of communities with the highest risks of detrimental outcomes associated with heat waves.

Vulnerabilities are a set of social factors that play important roles in how people react to hazards, said Fard. "For example, age is a very important factor in [heat waves]," he noted, adding that different studies show that nonwhite and minority groups are more vulnerable as well.

The team used data on vulnerabilities to identify populations at the highest risk using something called a risk framework. The more vulnerabilities a person has—age, minority status, reliance on public transportation—the higher the risk is. "One purpose of the risk framework is to enable the decision-makers to prioritize their resources to different areas that need attention during a crisis," said Fard, adding that with limited budgets and supplies, this information is crucial for prioritizing responses.

In his new position at UNMC, Fard used the bones of the risk framework his team built for heat waves for a new purpose: predicting coronavirus risks.

The tool is helping health care providers and public policy leaders get supplies and resources to the areas of Nebraska that need them most.

"The Centers for Disease Control and Prevention (CDC) identifies 15 sociodemographic variables to calculate social vulnerabilities," said Fard, noting that the data are from the U.S. census. He explained that these factors can be grouped into four categories: socioeconomics, household composition and disability, minority status, and housing and transportation. Each category gets a value, and the values are averaged to represent the risk of COVID-19 infection to the population within a geopolitical boundary, in this case, a county.

Mapping a Pandemic

And the information is all easy to read on a map. It has been highly successful for those inside the state and in neighboring states as well. Fard noted that during April there were more than 2,200 views of the dashboard tool each day on average.

The map can reveal insights into disease spreads, showing patterns and predicting virus hot spots. These data allow health professionals and government agencies to plan ahead—something Fard called adaptive capacity. "It's any measure that can help in reducing the vulnerability," he said, and can include anything from increasing the number of beds in intensive care units to addressing transportation issues.

These maps might be a crucial tool for pandemic responders, said Kacey Ernst, an epidemiologist and program director of epidemiology at the University of Arizona who was not involved with the research. "We might want to enhance our level of testing to catch more cases [in a certain area] or put up a testing center if there's an area where people would have to take the bus or public transport when they're ill to get tested," she said.

"I was impressed that [Fard] was looking at a multitude of underlying factors that might influence what the numbers would say," said Ernst. She added that she was particularly impressed with the hospital data they included. "I appreciated the fact that he didn't just put up the case numbers—that he was trying to delve a little more deeply."

Ernst said it's important to look beyond the number of cases and into why the cases are there. "It's absolutely critical to really understand the underlying population and how that might influence what you see, in terms of both differences in how diseases are reported and in how testing is being conducted."

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The Power of Interdisciplinary Research

The project is a perfect example of how geoscientists can think and apply their skills outside the traditional bounds of their research. "As geoscientists, we know how to work with maps and do geospatial analyses," said Fard, adding that medical geologists can go one step further and study the effect of geological factors on health. He noted that geospatial skills can add a lot of value for crisis responders who need a visual picture of where to focus.

Ernst agreed and said it is imperative, especially during a pandemic, for scientists to look critically at every data source and try to understand its limitations and caveats. "Many geoscientists do sort of broader scales, spatial scales," she said, adding that often, geoscientists "get that blessing and curse of spotty data, and you have to learn how to figure out what it actually means and what you can do with it."

In the increasingly connected world, interdisciplinary research like Fard's may become the norm, not the exception. For Ernst, this is already the case. "I am a strong proponent of interdisciplinary research teams—that's pretty much how I do all my work," she said. "It makes the research really strong when you have teams that are diverse and able to look at data from different angles."

Fard said that the framework tool is a larger part of the Nebraska Emergency Preparedness and Response effort. And although it is currently being used for COVID-19, "this framework is going to continue to be beneficial in other situations that might come up in the future," such as floods and other natural hazards.

The framework provides mayors, hospitals, and relief workers information for planning and disaster response. Fard said he hopes that seeing the success of the coronavirus framework will "inspire other organizations to use it for their purposes."

By **Sarah Derouin** (@Sarah_Derouin), Science Writer

Oktoberfest's Methane Rise Is the Wurst

Millions of people convene at large festivals like Carnival in Rio de Janeiro and Dia de los Muertos in Mexico City. These gatherings are more than just wild parties or cultural heritage, however—they're a rich trove of scientific data. Researchers now have calculated the methane emissions associated with Oktoberfest, a harvest celebration typically held in the fall, in Munich, Germany. (The 2020 event has been canceled.) The scientists found that Oktoberfest's area-normalized methane flux was about half that of an average dairy farm. Festivals—often unaccounted for in emissions inventories—can be significant, albeit temporary, sources of greenhouse gases, the team concluded.

Beer, Sausage, and Methane

At Munich's Oktoberfest, typically held over 16 days, revelers consume more than 8,000,000 liters of beer and copious amounts of grilled sausage, fish, and oxen. But the natural gas used to heat Oktoberfest's massive tents and power its grills consists primarily of methane, which is a potent greenhouse gas: Kilogram for kilogram, methane traps roughly 30 times as much energy as carbon dioxide.

Jia Chen, an electrical engineer focused on environmental science at the Technical University of Munich, and her colleagues set out to quantify Oktoberfest's methane emissions. "Festivals could be a notable methane source even though they have not yet been included in the existing emissions inventories," said Chen. "Oktoberfest is the largest folk festival worldwide."

Many Rounds for Science

In 2018, Chen and her collaborators walked and biked around the 2.5-kilometer perimeter of the Oktoberfest site carrying portable methane sensors. The team made 94 rounds with the instruments, which were about the size of a backpack and weighed roughly 11 kilograms. "It's good exercise," said Chen.

The sensors determined gas concentrations by pumping air into a cavity and then measuring the attenuation of different wavelengths of laser light. The team combined these data with wind information to accurately estimate methane fluxes. "The higher the wind speed, the lower concentration we will measure because the methane is more diluted," said Chen.

The researchers found that on average, about 7 micrograms of methane per second were being emitted from each square meter of the Oktoberfest premises. That's significant and only about a factor of 2 smaller than the flux escaping from a dairy farm, the team noted.

Roughly 20% of these emissions can be ascribed to biogenic methane produced by attendees' exhalations and flatulence, Chen and her colleagues calculated on the basis of published estimates (bit.ly/human-emissions). The remainder, the researchers suggest, likely derived from incomplete combustion in gas-powered heaters or cooking appliances.

These results were published in *Atmospheric Chemistry and Physics* (bit.ly/Oktoberfest-emissions).

"Festivals could be a notable methane source even though they have not yet been included in the existing emissions inventories."

Allowed In the Next Time

In 2019, the researchers returned to Oktoberfest, this time on the actual premises. "We were allowed to go inside," said Florian Dietrich, an engineer at the Technical University of Munich and a member of the team. "We went closer to the sources."

This time, they made measurements with portable methane sensors and also collected air samples. Back in the laboratory, they determined the ratio of ethane to methane in the samples to shed light on the origin of the emissions—biogenic sources produce very little ethane, whereas fossil fuels (e.g., natural gas) typically contain ethane. The results are being prepared for publication.

"There are so many different sources of methane," said Ben Poulter, a carbon cycle scientist at the NASA Goddard Space Flight Center in Greenbelt, Md., not involved in the research. "Studies like this help individuals understand their greenhouse gas footprint a little bit better."

By **Katherine Kornei** (@KatherineKornei), Science Writer