Researchers seek to reduce deadly air pollution from cooking emissions

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A $1.5 million grant from the Environmental Protection Agency will help researchers at the University of Colorado Boulder and the National Center for Atmospheric Research measure pollution from residential cooking and better understand a problem that kills millions of women and children each year in the developing world.

According to the EPA, more than 3 billion people worldwide rely on the burning of wood, plant matter, coal and waste for cooking or heating. Exposure to cookstove emissions, particularly indoor exposure, ranks as one of the five worst overall health risk factors in poor developing countries, with the World Health Organization estimating 4.3 million premature deaths per year due to exposure to smoke from traditional cookstoves.

"We're hoping to figure out how to reduce women and children's exposure to air pollutants in sub-Saharan Africa through technology and getting people to think about changes to their behavior," says Mike Hannigan, associate professor of mechanical and environmental engineering at CU-Boulder. Hannigan is the principal investigator on the EPA grant to measure and model air quality and climactic impacts of residential biomass and coal combustion for cooking in west Africa.

"This problem is bigger than malnutrition, and it's a social justice issue because it's disproportionately happening in the developing world and is particularly harmful to women and children," he said.

"You can see the air quality impacts from cooking over open fires, as there is often a haze hanging over remote villages during certain times of day," says NCAR scientist Christine Wiedinmyer, a co-principal investigator on the project. "This not only affects health, but can cause poor air quality regionally and impact the climate."

Hannigan recently attended a reception in Washington, D.C., hosted by the Global Alliance for Clean Cookstoves, where EPA Administrator Gina McCarthy announced $9 million in EPA grant funding for six projects focused on measuring and communicating the benefits of adopting cleaner cooking, heating and lighting practices.

Over the next three years, Hannigan and CU-Boulder applied mathematics Professor Vanja Dukic, along with researchers at NCAR, will study 250 households in northern Ghana to measure the levels of pollutants that adults and children are exposed to from cooking, as well as from burning trash and car pollution.

"We are looking at what effects modern cookstoves could have on the indoor air quality and exposure to pollutants," says Hannigan. "We're also trying to understand to what extent cooking contributes to the outdoor pollution in cities."

Currently three CU-Boulder graduate students and a fourth who graduated in May, as well as one undergraduate student, are involved in the project. Hannigan says he expects the number of students conducting the research to double in the next year.

Some of the households in the study, which began June 1, have been given high-tech cookstoves manufactured in Lesotho, while others received less costly cookstoves manufactured locally in Ghana and a third group will continue the traditional method of cooking over a three-stone fire on the ground. While all participants will cook with biomass or

charcoal fuels typical to the area, Hannigan says the newer cookstove technology burns these fuels more cleanly than an open fire.

In addition to using small, inexpensive sensors to measure levels of harmful pollutants such as carbon dioxide in the homes, the study includes climate modeling that will consider the effect that increased cookstove use could have on regional air quality and climate. Participants' health and behavior will be assessed through surveys.

"If we give them a stove, will they use it? And what drives them in their choice of a stove?" asks Hannigan, noting that a low-emissions cookstove costs the equivalent of a month's salary for a Ghanian household. "Cost is a big deal, so we're trying to understand cooking behavior and choice along with the emissions questions."

A strong partnership with the Navrongo Health Research Center, a local governmental organization that has been conducting public health surveys of the same households for 15 years, is collaborating with the researchers gain access and trust in the Ghanaian community.

The team also is integrating its work into education on the CU-Boulder campus. This past spring, Hannigan taught an elective environmental engineering course titled "Cookstove Assessment" where he shared some of the research data and engaged students in collecting measurements from cookstove experiments in a parking lot at NCAR.

One student group developed a device to measure the energy content of different fuels and collected data that has enhanced the research team's understanding of fuel efficiency. Another student team's study of the emissions involved in making the charcoal that residents use for cooking raised additional questions for the research team to consider.

"It's a wonderful example of teaching and research going together," says

Hannigan. Environmental engineering graduate student Ashley Collier says the project-based cookstove class really enhanced her understanding of the issue.

"Not only did we have the opportunity to experience the traditional and improved methods of cooking being discussed in the class, but we were also able to define and carry out a small-scale research project," says Collier. "It's a really powerful experience to be able to compare your results to published results and put what you are learning into a larger, more global context."

Evan Coffey, who began working with Hannigan during his senior year as an environmental engineering student and has continued to be involved as a research assistant since he graduated in May 2013, said the chance to go to Ghana and conduct fieldwork and train the local team to carry out daily and weekly measurements has been fascinating and rewarding.

"Being there has made it more intimate," says Coffey. "It feels great knowing there's a real-world, practical tie to what we're doing … I think the impact potential of this project is massive."

Provided by University of Colorado at Boulder

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