Researchers track the environmental impact of brick kilns in South Asia

September 14 2017, by Rob Jordan

Bricks dry outside a kiln in Bangladesh. Credit: Faizul Latif Chowdhury/Wikimedia Commons

Stephen Luby's epiphany came to him 30,000 feet up in the air. The Stanford epidemiologist was flying over India when he realized the view

from his window seat was adequate to identify brick kilns on the ground below. The insight was startling for its potential to shed light on an environmental nightmare that kills thousands of people every year.

Luby, a professor of medicine, and a team of Stanford researchers including political scientist Francis Fukuyama and geophysicist Howard Zebker are following up on Luby's insight to revolutionize brickmaking in South Asia, an industry that burns coal, biomass and even tires to dry hand-molded clay into the ubiquitous building material. Brick kilns across South Asia have a global warming impact equivalent to that of all passenger cars in the U.S., and air pollution from these kilns kills tens of thousands of people each year as a result of respiratory and cardiovascular disease, according to Luby.

Starting in Bangladesh, the novel collaboration is working to measure kilns' health effects and incentivize kiln owners to switch to cleaner technologies.

"We're doing something completely novel here," Luby said.

First find the kilns

Before they could reach out to kiln owners, the researchers had to figure out the number and location of kilns, which are poorly regulated and tracked. That's where Luby's Jet Airways flight comes in.

"I got to thinking: Well, wait a minute, if I can do this sitting in a plane, we must be able by remote satellite to detect (kilns) as well," Luby said of his aha moment.

When Luby's plane touched down, he looked up Stanford satellite data experts. He found Zebker, a professor of electrical engineering and geophysics and an authority on developing space-borne radar systems

and using remote sensing data to study earthquakes, volcanoes, polar ice movements and other phenomena. "This being Stanford, I can send him an email, and he says 'Yeah, sure, let's have coffee.'" Luby looped in Fukuyama, a senior fellow at the Freeman Spogli Institute for International Studies, to help him understand related governance issues and formulate a politically effective message of change.

One form this message will take is a public website allowing people to locate information about kilns in their area and to learn ways of nudging kiln owners toward making their operations more efficient and profitable. Site users will be able to pinpoint kilns that violate ordinances on proximity to communities and design standards, among others, and join a larger discussion among public and private sector stakeholders.

"It won't just be an outdated report nobody sees," Luby said.

Crucial to the planned website – and the entire initiative – is the Sentinel 1 satellite launched by the European Space Agency in 2015. It provides publicly available images of Earth at a resolution about the size of a racquetball court (30 by 30 feet). Armed with that data and GPS locations of kilns found by ground teams, electrical engineering graduate student Abhilash Sunder Raj developed a model that understands what kilns looks like from space. Sunder Raj adjusted his algorithm to account for seasonality (kilns don't run in the rainy season from November to March) and to avoid false positives such as household fires and furnaces. The model worked so well that it even found kilns the ground team had missed.

"We are able to find these needles in a haystack very, very accurately," Sunder Raj said.

Serious health risk

They may look innocuous from space, but kilns are outsized threats on the ground. In Bangladesh, a single brick kiln puts out up to 48,000 kilograms of carbon monoxide in one season. Multiply that by the country's 8,000 or more kilns, and you have a catastrophe for health and global warming. Researchers in Bangladesh have found dangerous airborne particulates at average levels more than 90 times greater than World Health Organization-recommended levels. The result: hundreds of thousands of people who live downwind from kilns are at elevated risk for cardiovascular and respiratory disease.

Although the kilns are clearly a health risk, few good data exist about the magnitude of the problem. Alex Yu, a postdoctoral scholar in infectious disease, is trying to fill in those gaps and learn whether other sources of pollution contribute to health problems to an extent that even if brick kilns were less polluting, the health issues would continue. He is comparing rates of asthma, pneumonia and carbon monoxide, among other air-related illnesses, in villages with and without kilns.

"There are chimney stacks everywhere pouring out black smog," Yu said of the dystopian landscape he witnessed on the outskirts of Dhaka, Bangladesh's capital city. "You walk one block and your body is covered by a thin layer of soot."

In addition to contaminating air, the kilns degrade soil around them as workers dig it up to be made into the clay that will be molded, heated and dried into bricks. Runoff from stripped patches of land damages the fertility of surrounding cropland, making it harder to grow food and compounding the kilns' health effects, Yu said.

Incentives for change

Shifting the brick-making paradigm in Bangledesh and other countries that rely on the polluting kilns will require shifting incentives. Leo

Kirby, a graduate student in the International Policy Study program and a research assistant to Fukuyama, is looking at how to most effectively align the interests of stakeholder groups in Bangladesh and how to identify effective approaches to behavior change in a country where the rule of law has limited reach.

"It's a great example of the challenges of changing policy in an environment of weak governance," Kirby said. "Existing regulations are imperfectly enforced at best. So, to change behavior, you have to change the incentive structures."

Kirby's interviews with brick kiln owners, international NGOs and various environmental and community organizations will serve as the basis for a case study for a policy reform training program Fukuyama runs for mid-career public officials in developing countries.

Nina Brooks, a doctoral candidate in the Emmett Interdisciplinary Program in Environment and Resources, will talk with kiln owners to better understand what constrains decisions to adopt improved efficiency. The Stanford team is working with Greentech Knowledge Solutions, a Delhi-based leader in improving brick kiln efficiency.

Luby is approaching the climate community to help support the transformation of the brick kiln sector in Bangladesh and, ultimately, across South Asia. The improvements in efficiency will pay for themselves, but stakeholders will need support to achieve this more favorable equilibrium.

Provided by Stanford University

impact-brick-kilns.html