MARKUS HILPERT, PHD, HAS A QUIRKY ROUTINE WHEN REFUELING HIS CAR. SAYS THE ENVIRONMENTAL ENGINEER: “I’M ALWAYS LOOKING DOWN.” BY REGULATION, GAS STATIONS ARE PAVED WITH THICK SLABS OF CONCRETE TO PROTECT THE SOIL BELOW. BUT NO SURFACE IS COMPLETELY IMPENETRABLE, SAYS THE ASSOCIATE PROFESSOR OF ENVIRONMENTAL HEALTH SCIENCES.

There’s always a possibility that errant drops of fuel can travel through the concrete and contaminate the soil and groundwater below, potentially affecting the health of nearby communities who rely on well water.

Hilpert models the mechanics of particle permeation—the paths that different types of materials take as they move through granular substrates like soil, sand, and concrete. Due to its high vapor pressure, gasoline evaporates in all directions, including down. In 2017, Sustainability published Hilpert’s analysis of how small quantities of fossil fuel infiltrate concrete. Petroleum particles are attracted to granular surfaces like concrete, and his team found that nearly half of the diesel and gasoline they poured out slowly but surely worked its way through concrete slabs. The smaller the drop, the more likely the infiltration.

Hilpert’s academic training draws on physics, civil engineering, ecology, hydrology, and geoinformatics, giving him an expansive view of the ground beneath our feet as a living ecosystem: “You have a significant amount of biological activity,” he says. “It’s a habitat.”

Hilpert’s holistic view extends beyond the city limits and into the rural exurbs, which are home to industrial animal agriculture. From 2012–2014, he led a study examining the role of concentrated animal feeding operations, or CAFOs, in soil contamination. In samples taken from a former storage site for chicken waste on Maryland’s Eastern Shore, a region heavily populated by CAFOs, the team found that the soil retained the genetic material of antibiotic-resistant bacteria, years after the site had been repurposed.

“If you live in the countryside,” says Hilpert, “this manure can be spread everywhere.”
Each industrial chicken farm houses tens of thousands of animals in close proximity, and each of those birds receives antibiotics as a matter of course. As a result, both antibiotic byproducts and antibiotic-resistant bacteria accumulate in the inordinate amount of manure the birds produce.

As an industry practice, that waste—chicken litter to industry insiders—is mounded into massive piles, which, by state regulation, typically sit undisturbed for a set number of months, under the assumption that pathogens die off during that time. After this waiting period, the piles may legally be dispersed throughout the region for use as fertilizer, an application for which supply wildly exceeds demand.

Hilpert’s team analyzed the bacteria in soil samples taken from the area surrounding those piles of litter. In addition to recording the soil content of the antibiotic tetracycline, they documented a particularly worrisome effect of a basic fact of bacteriology—bacteria can absorb genetic traits from their neighbors. The team found that “naïve” soil bacteria had picked up DNA from antibiotic-resistant bacteria in the chicken manure, allowing them to pass the trait to other bacteria, without ever having been exposed to antibiotics themselves.

“You have these bacteria in the soil,” says Hilpert. “And then, you can potentially have people who are exposed to the soil—you could have children who play with the soil.” Furthermore, as rainwater trickles through the soil and becomes groundwater, rural Americans who rely on well water may also be exposed to the antibiotic-resistant bugs, without ever even touching the soil, itself.

Soil warrants a closer look, says Hilpert. In rural and urban communities alike, the consequences of its contamination could be a matter of life or death.

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