METER
ENVIRONMENT

SOIL MOISTURE SENSORS AID FORENSIC SCIENCE IN TIME OF DEATH ESTIMATES

EXTENDING TIME OF DEATH ESTIMATES

Forensic scientists are looking at better, more accurate ways of determining the post-mortem interval, or time of death. When a human body decomposes, microbes and nematodes become abundant in the soil surrounding the body. The types and maturity of these organisms may be a means of determining the time of death, but thus far most studies have focused on short post-mortem time frames.

That's why Stacy Taylor, her advisor, Dr. Jennifer DeBruyn, and their research team at the University of Tennessee are using cutting-edge molecular techniques and classical microscopic techniques to try and extend the time frames over which this approach could be used to determine how long it's been since victims have died.

MONITORING DRAMATIC SOIL CHANGES

Taylor, a winner of the National Institute of Justice Graduate Research Fellowship in STEM, working in conjunction with the UT Anthropology Research Facility, is measuring biological and chemical changes in soil composition brought about by long-term human decomposition. She says, "We are looking at a combination of soil chemistry, microbial ecology, and some of the soil animals, particularly the nematodes, to get an entire food web approach in understanding all of the nutrient cycling that is occurring in these systems. We want to look at the soil chemistry patterns and microbial/nematode succession to see if these cross-inform each other."

Taylor explains some of the changes in soil composition that occur during both vertebrate and invertebrate decomposition, "Basically, any time you have a decomposition event that is not composed of plant litter, it creates what's called a "hot spot" of nutrient enrichment. Unlike plant litter, which decomposes very slowly, with a vertebrate system you have a tremendous amount of protein and fat. You also

have a lot of calcium, magnesium, sodium, and potassium. And when you put a large load of these things into the soil, you get a huge change in soil organic composition, nutrient availability, and soil moisture. So you're essentially dealing with massive changes in a very localized soil environment."

DECOMPOSITION ALSO CHANGES THE SOIL WATER

Taylor and her adviser Dr. Debruyn had the fairly new idea to insert METER soil moisture, temperature and electrical conductivity sensors connected to data loggers into the soil in these hot spots, to see what kind of interesting data would turn up.

The TEROS 12 is an updated version of the sensor Taylor used in her research

She says they've been surprised at how informative and eye-opening this has been. She explains, "These hot spots change the ionic strength of the soil water. And that is highly correlated to electrical conductivity, which is measured by the soil moisture sensors. A change in ionic strength potentially impacts the salinity of the soil. Some of those changes have been shown to persist for well over a year, which is what these soil sensors are showing. I take an hourly reading, and the sensors are producing the most amazing data."

Taylor says the sensors were inserted into the soil surface, so they could measure the impact the decomposition produced immediately on the upper layer of soil. They took soil cores at 16 centimeters to measure soil pH and EC, and they also used RT-1 air temperature sensors to track accumulated degree days which are based on ambient air temperature and correlate with maggot growth and development rates.

IDENTIFYING TIME MARKERS

Taylor says that soil changes (in particular EC and temperature) are not just general deviations but show clear stages as decomposition progresses through time, indicating they might be useful as time markers. She explains, "We are tracking a succession of events. These events happen at particular time points and are associated with certain decomposition stages (i.e, bloat, active decay, advanced decay, or skeletonized remains). For example, you might see traces of increased electrical conductivity followed by a drop. If that drop happens at the same stage of decomposition, over and over, then you know that you have a time marker. And when you gradually accumulate some of these time markers, that can potentially inform some of the existing estimates of how long something has been there."

WHAT'S THE FUTURE?

Taylor says the implications of this study will help nail down many of the intrinsic controls on the decomposition process. And once they understand that, they'll have a better idea how to employ these estimates of post mortem interval, which will bring better justice and more peace to the families of crime victims. About the future of the research, she says, "This is the kind of study that you want to replicate at other human decomposition facilities that vary by altitudes, weather, soils, and more. You need to be able to look at a variety of environments just to see what happens." You can read more about Stacy's project here.

Discover METER soil moisture sensors and data loggers.

To learn more about how to measure soil moisture, read "Soil moisture: the science behind the measurement".