METER
ENVIRONMENT

SOIL SENSORS HELP THOUSAND-YEAR-OLD LEVEES PROTECT RESIDENTS OF THE SECCHIA RIVER VALLEY

In Italy, on January of 2014, one of the Secchia river levees failed, causing millions of dollars in flood damage and two fatalities. Concerned with preventing similar disasters, scientists and geotechnical engineers are using soil sensors to investigate solutions in a project called, INFRASAFE (Intelligent monitoring for safe infrastructures) funded by the Emilia Romagna Region (Italy) on European Funds.

Professor Alberto Lamberti, Professor Guido Gottardi, Department of Civil, Chemical, Environmental, and Materials Engineering, University of Bologna, along with Prof. Marco Bittelli, University of Bologna professor of Soil and Environmental Physics, installed soil sensors along some transects of the Secchia river to monitor water potential and piezometric pressure. They want to study properties of the compacted levee "soil", during intense flooding. Bittelli comments, "Rainfall patterns are changing due to climate change, and we are seeing more intense floods. There is a concern about monitoring levees so that we can, through studying the process, eventually create a warning system."

WHAT ARE THE LEVEES MADE OF?

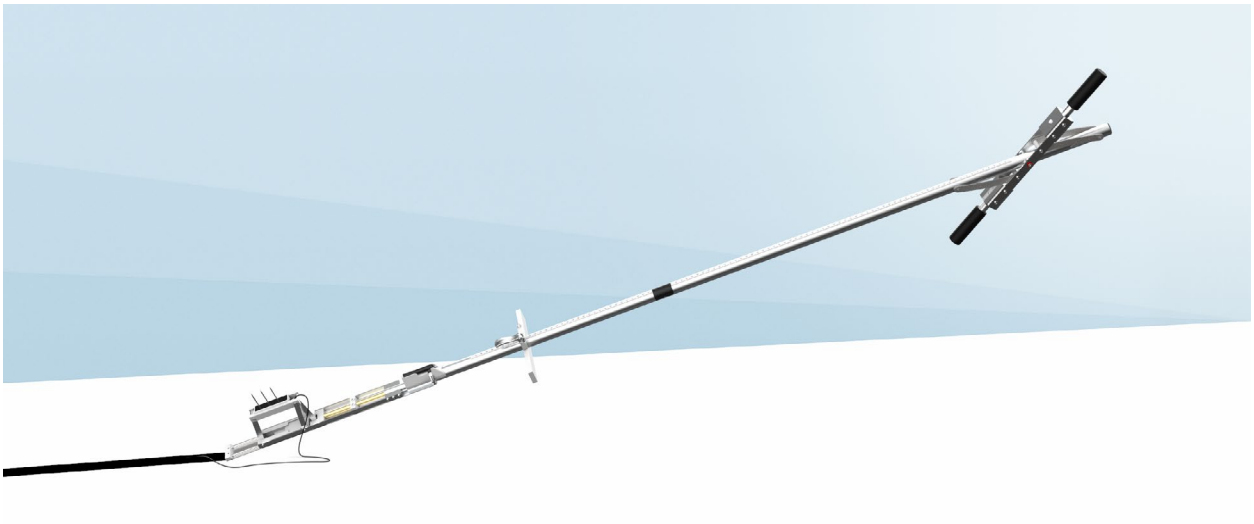
Amazingly, some of these levees are very old, built at the beginning of the second millennium to protect the Secchia valley population from floods. "These rudimentary barrages were the starting point of the huge undertakings, aiming at the regulation and stabilization of the river, which were gradually developed and expanded in the following centuries…building up a continuous chain all along the river." (Marchii et. al., 1995)

Unlike natural soil with horizons, the soil that makes up the levees is made up of extremely compact clay and other materials, which will pose challenges to the research team in terms of sensor installation. The team will use METER soil sensors to determine when the compacted material that makes up the levees gets so saturated it becomes weak. Bittelli says, "We are looking at the mechanical properties of the levees, but mechanical properties are strongly dependent on

hydraulic properties, particularly soil water potential (or soil suction). A change in water potential changes the mechanical properties and weakens the structure." This can happen either when a soil dries below an optimal limit or wets above it; the result is a weakened barrier that can fail under load.

SOIL SENSORS PRESENT INSTALLATION CHALLENGES

To solve the installation problems, the team will use the specialized TEROS installation tool to insert their water content sensors. Bittelli says, "Our main challenge is to install sensors deep into the levees without disturbing the soil too much. It's very important to have this tool because clearly, we cannot dig out a levee; we might be the instigator of a flood. So it was necessary for us to be able to install the sensors in a relatively small borehole." The researchers will install the sensors farther down than the current tool allows, so they are modifying it to go down to eight or ten meters. Bittelli explains, "We used a prototype installation tool which is two meters long. We modified it in the shop and extended it to six meters to be able to install water content sensors at further depths."

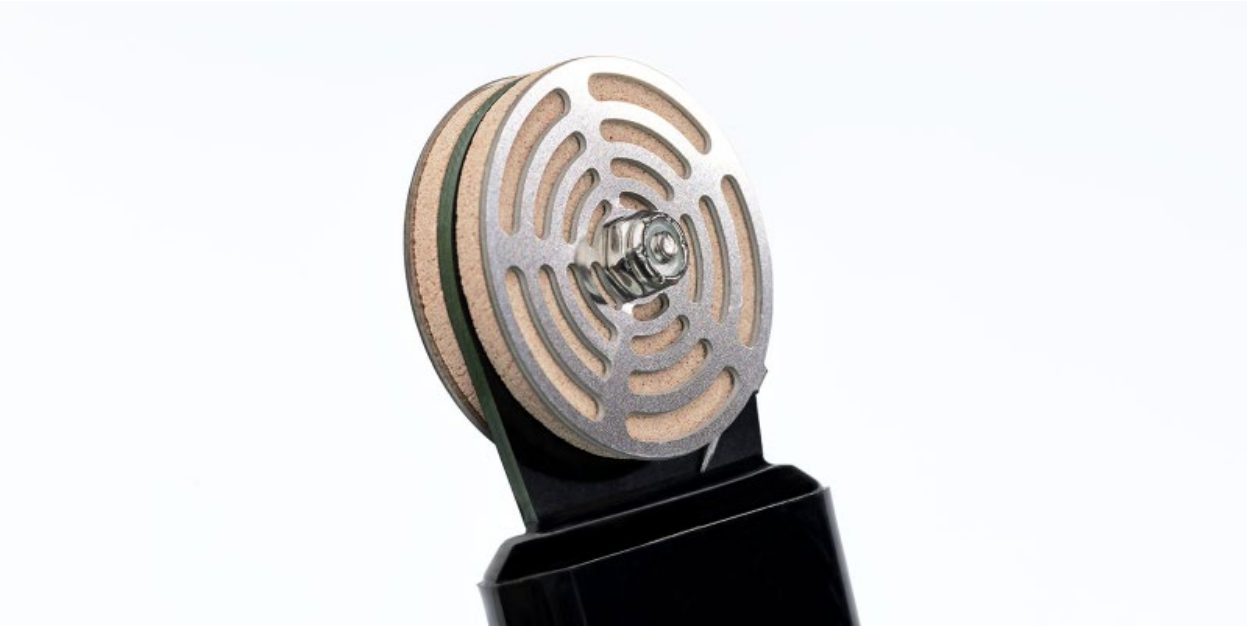


TEROS installation tool

Another challenge facing the research team is how to install water potential sensors without disturbing the levee. Marco explains, "We placed an MPS-6 (now called TEROS 21) into a cylinder of local soil prepared in the lab. A sort of a muffin made of soil with a water potential sensor inside. Then we lowered the cylinder into the borehole, installed the sensor inside, and then slid it down into the hole. Our goal is to try and keep the structure of the soil intact. Since the cylinder is made of the same local soil, and it is in good contact with the borehole walls, hydraulic continuity will be established."

Unlike installing water content sensors, matric potential sensors don't need to be

installed in undisturbed soil but only require good contact between the sensor and the bulk soil so liquid water can easily equilibrate between the two. The researchers are also contemplating using a small camera with a light so they can see from above if the installation is successful.



TEROS 21 water potential sensor

FIND OUT MORE

The researchers will collect data at two experimental stations, one on the Po river, and one on the Secchia River. So far, the first installation was successfully performed, and data are collected from the website. Bitteli says the first installation included water content, temperature, and electrical conductivity sensors, water potential sensors, and tensiometers connected to a wireless network that will transmit all the data to a central office for analysis.

You can read more about this project and how it's progressing here.

Discover METER soil sensors

Download the "Researcher's complete guide to water potential"