

## DETECTION OF SOIL PIPES AND THEIR NETWORK BY ACOUSTIC EXCITATIONS

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Internal soil piping accelerates soil erosion in agricultural fields and plays a vital role in total soil loss. Understanding the physical processes associated with soil piping and estimating its contribution to overall soil loss is difficult due to the lack of direct observations. The locations of soil pipes are usually inferred from surface feature such a flute holes and gully windows. Dye tracer tests are also studied as a method to determine the connectivity and pipe flow velocity. This method requires fluorescein dye to be injected directly into soil pipes at the upper most pipe collapse feature and sampling at multiple pipe collapse features downslope. In this study, an acoustic technique is investigated for mapping soil pipe networks. The concept is that sound waves will propagate through the air-filled soil pipes and couple into the surrounding soil. These soil vibrations (seismic waves) will propagate through the soil to the surface geophones. Measurements were conducted in a small area of the Goodwin Creek experimental site having extensive networks of soil pipes supported by six gully windows. A speaker was placed in the various gully windows and the surface vibrations were measured on two different lines of geophones. The geophone data was converted to frequency domain and the energy content was calculated for each geophone (and speaker location) using the Riemann sum approximation. For each speaker location the S/N, probability density function (PDF) and Z scores were calculated based on the energy. We postulate that the geophones with large vibrations are located above a soil pipe that is connected to the gully window where the speaker is located. Therefore, geophones having good S/N and  $Z > 2$  are considered to be near a large and/or shallow (principle) soil pipe. Geophones having a  $1 < Z < 2$  are assumed to be located near a smaller or deeper (secondary) soil pipe. Planview maps were generated to identify the locations of the primary and secondary soil pipes and their networks. The location of the soil pipes was verified using a cone penetrometer test.

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