Geophysical Research Abstracts
Vol. 16, EGU2014-11242-1, 2014
EGU General Assembly 2014

Development and testing of a tensiologger: a tensiometer with a built-in datalogger

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Water-filled tensiometers are widely used for measuring matric potential in the range between 0 and approximately -90kPa in soils. When placed in variably-saturated soil horizons, they correctly measure the pressure head both in unsaturated and saturated conditions. Modern tensiometers consist of a porous ceramic cup filled with water that is connected to a pressure transducer. Tensiometers are commercially available in different models, and can be logged with data loggers. Logging requires either cabling to connect the tensiometers to a data logger, or a wireless connection. Cables hamper field operations and can be unpractical because of the distances involved. Commercially available systems with wireless data communication with a central datalogger do not come cheap. We therefore developed a simple water-filled tensiometer with a build-in datalogger, which we called a tensiologger.

The tensiologger is assembled using a porous ceramic cup ($Al2O_3$ sinter material with bubble point > 15 bar, UMS GmbH Munich, Germany) filled with degassed demineralised water for transferring the pressure head to the pressure transducer. This cup is screwed onto a small housing with a capsulated logger circuit consisting of a pressure transducer, a temperature sensor for temperature measurement and for temperature correction of the pressure transducer, a memory for 32k measurements, and a microcontroller for logging the data. This loggercircuit is screwed onto an extension tube of 25 mm diameter that contains a replaceable battery and an optical interface at the top (extending from the soil surface). The data can be retrieved from the logger by means of a readout unit that is placed over the optical interface. This readout unit is connected to a USB port of a portable PC with logger software developed in Visual Basic. The cost of all parts including the printed circuit board is 220€ (excluding labour cost for making screw connections and assembling).

The tensiologger was tested over a 8-month period at a grassland site in Blegny, Belgium. We installed tensiologgers at three different locations along a slope and at 15, 45, and 75 cm depth. At the lowest topographic location, we measured groundwater levels with a diver, which allowed us to know when soil is saturated. During or after rainfall events, tension peaks were detected at all depths with a little retardation along the profile, and positive pressure head values were measured as the soil became saturated. Higher on the slope, where drilling problems impede piezometer installation, positive tensions were measured sporadically at 75 cm and 45 cm depth. In dry periods, air bubbles developed in the cups of the shallow tensiologgers, and so cups had to be refilled with degassed water.