Sampling Moisture in the Soil Profile

Date: March 31, 2009

Patterns of water replenishment and use give rise to large spatial variations in soil moisture over the depth of the soil profile. Accurate measurements of profile water content are therefore the basis of any water budget study. When monitored accurately, profile measurements show the rates of water use, amounts of deep percolation, and amounts of water stored for plant use.

Getting Good Measurements

Three common challenges to making high-quality volumetric water content measurements are: 1) making sure the probe is installed in undisturbed soil, 2) minimizing disturbance to roots and biopores in the measurement volume, and 3) eliminating preferential water flow to and around the probe. All dielectric probes are most sensitive at the surface of the probe. Any loss of contact between the probe and the soil or compaction of soil at the probe surface can result in large measurement errors. Water ponding on the surface and running in preferential paths down probe installation holes can also cause large measurement errors.

Installing soil moisture sensors will always involve some digging. How do you accurately sample the profile while disturbing the soil as little as possible? Let's consider the pros and cons of five different profile sampling strategies.

Commercial Profile Probes

Profile probes are a one-stop solution for profile water content measurements. One probe installed in a single hole can give readings at many depths. Profile probes can work very well, but proper installation can be tricky and the tolerances are tight. It's hard to drill a single, deep hole precisely enough to ensure contact along the entire surface of the probe. Backfilling to improve contact results in repacking and measurement errors. The profile probe is also especially susceptible to preferential flow problems down the long surface of the access tube.

Trench Installation

Installing sensors at different depths through the side wall of a trench is an easy and precise method, but unless you own a backhoe, the actual digging of the trench can be a lot of work. This method puts the probes in undisturbed soil without packing or preferential water flow problems, but because it involves excavation, it's typically only used when the trench is being dug for other reasons or when the soil is so stony or gravelly that no other method will work. The excavated area should be filled and repacked to about the same density as the original soil to avoid undue edge effects.

Augur Side Wall Installation

Installing probes through the side wall of a single augur hole has many of the advantages of the trench method without the heavy equipment. This method was used by Bogena et al. with EC-5 probes. They made an apparatus (see fig. 3) to install probes at several depths simultaneously. As with trench installation, the hole should be filled and repacked to approximately the pre-sampling density to avoid edge effects. (H.R. Bogena, J.A. Huisman, U. Rosenbaum and A. Weuthen. SoilNet - A ZigBee based soil sensor network and first applications. To be submitted in Sensors, Special Issue: Wireless Sensor Technologies and Applications).

Multiple Hole Installation

Digging a separate access hole for each depth, ensures that each probe is installed into undisturbed soil at the bottom of its own hole. As with all methods, you must take care to assure that there is no preferential water flow into the re-filled augur holes, but a failure on a single hole doesn't jeopardize all the data, as it would if all the measurements were made in a single hole. The main drawback is that a hole must be dug for each depth in the profile. The holes are small, however (just large enough for one probe), so they are usually easy to dig.

Single Hole Installation

It is possible to measure profile moisture by auguring a single hole, installing one sensor at the bottom, and then repacking the hole, installing sensors into the repacked soil at the desired depths as you go. Because the re-compacted soil can have a different bulk density than it had in its undisturbed state, and because the profile has been completely altered as the soil is excavated, mixed, and repacked, this is the least desirable of the methods discussed. Still, single hole installation may be entirely satisfactory for some purposes. If the installation is allowed to re-equilibrate with the surrounding soil and roots are allowed to grow into the soil, relative changes in the disturbed soil should mirror those in the surroundings.

Printed in USA

05-26-15