Advances in Soil Moisture Science: New in situ soil moisture measurements from NRCS

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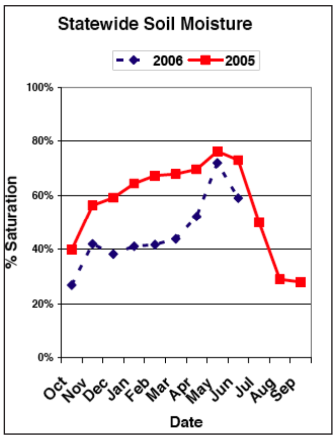
There is a new technology in the world of soil moisture monitoring and research, the Stevens Hydroprobe sensor, which measures soil moisture and soil temperatures. This technology is being used by the Natural Resources Conservation Service (NRCS) to better measure impacts of dry or wet soils on seasonal run-off. The study and management of soils is one component of the NRCS mission, which includes the conservation of soil, water, air, plants, and animals -- the "SWAPA" resources. Climate and hydrology serve as a common thread, linking all of the various resources, and detailed quality data are key to better understanding. In particular, data from these new soil moisture and temperature sensors are useful for improving seasonal water supply outlooks and on-the-ground irrigation decisions but also have a broader range of scientific applications, including drought monitoring and climate change.



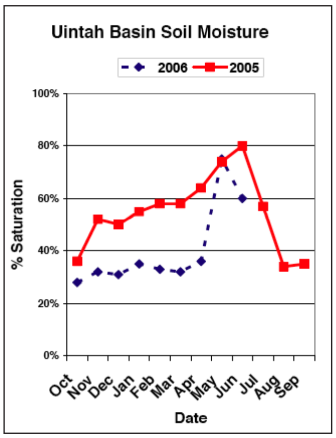


Figure 14a: (Left) Using new sensors, soil moisture chart for the state of Utah for 2005 and 2006 is generated by compiling monthly averages of soil moisture from various watershed basins around the state.

Figure 14b: (Right) Soil moisture chart for Uintah Basin in 2005 and 2006 plotted using monthly averages of soil moisture collected from10-16 different sites.

As of 2005, the agency has installed over 1000 of these sensors, according to Dr. Thomas Pagano, water supply forecaster of the NRCS National Water and Climate Center (NWCC) in Portland, Oregon. Many of these sensors are in the mountains of the Western US, coupled with the SNOTEL network, while many are also part of the Soil Climate Analysis Network (SCAN) in regions including Hawaii, Puerto Rico, the Eastern US, and even Antarctica. In the Western US, Utah has developed excellent geographic coverage of sensors and has acquired a long enough period of record to generate realtime graphical products for users. These include soil moisture time series charts (Figures 14a and 14b) and a state Soil Moisture Update Report, available on the web (see URLs below). These complement the basic suite of tabular products available at the NWCC webpage.

The primary objective is to measure soil moisture and temperature, although other data such as capacitance and conductance are also available from the sensors. The sensors are typically placed at 2, 8, and 20 inch depths in the soil to measure these parameters at 10-16 sites within each large basin. Sensor readings are weighted in proportion to corresponding depths (Figure 14c). The 2 inch depth sensor represents the first 6 inches of soil starting at the soil surface, the 8 inch sensor represents the next consecutive 9 inches of soil and the 20 inch sensor measures the following consecutive 12 inches with a total measurement of 26 inches of soil. Each month, NRCS generates graphs of the data (Figures 14a and 14b) which display the average percentage of ground saturation for each watershed basin and region being measured.

Already these data are being used to improve the water supply outlooks; Randall Julander, Snow Survey Supervisor for the Utah NRCS, says that based on preliminary results on a small Utah watershed, Centerville Creek, the data recorded using these sensors saw "substantial improvement in predictive capability over using snow data alone." By knowing the soil moisture deficit, one can better estimate the anticipated seasonal runoff efficiency; are the soils full and will the snowmelt directly feed the streams? Or will the soils capture most of the moisture? "These data should also give us a better handle on significant sublimation events" indicated Dr. Pagano. "Before, if the snow was disappearing, it would be hard to know if it was going into the soils or disappearing into the sky. Now we can track that as it happens and adjust accordingly."

Julander's experience has been that these sensors are a low maintenance, reliable technology that provides a consistent, unified method of measuring soil moisture. Based on initial successes, NRCS plans to implement these sensors at all SNOTEL sites in Utah, Nevada, and the Sierras. At this pace, it should not be long until this investment matures into quantitative improvements in water supply forecasts and management practices. In time, this data stream may also become an indispensable part of the national and global climate monitoring network.

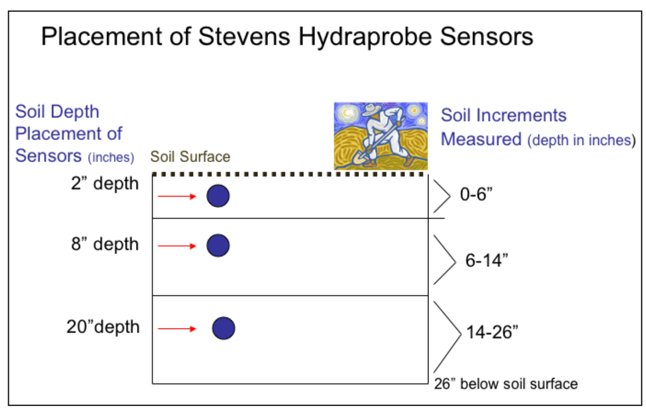


Figure 14c: Descriptive graph of sensor placement within soil where 3 sensors are used at every site within each watershed basin.

On the Web

- NRCS: Climate Information, including soil moisture charts and the Utah Soil Moisture Update Report: http://www.ut.nrcs.usda.gov/snow/climate/
- NRCS: Field Office Guide to Climatic Data: http://www.wcc.nrcs.usda.gov/climate/foguide.html

The Intermountain West Climate Summary is published monthly by Western Water Assessment, a joint project of University of Colorado and NOAA/ESRL Physical Sciences Division; researching water, climate and societal interactions.