Enhancing Water Resources Management By Means of New Non-Invasive Soil Moisture Sensors

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**Abstract.** Soil moisture is a key variable for understanding water fluxes at the land surface and for supporting water and soil management in many applications, like irrigation scheduling, flood, and landslide prediction. Several methods have been developed to monitor soil moisture ranging from point-scale invasive soil moisture sensors to large scale remote sensing products. The former can provide high accurate measurements at different soil depths. However, their application is limited by the strong variability of the soil-plant systems and by the difficulties to install and maintain these instruments for long-term monitoring. On the contrary, remote sensing products cover large areas but they only detect the surface soil layers. Moreover, the signal is strongly disturbed by vegetation and land cover. For these reasons, so far, hydrological observation systems and networks maintain for instance by environmental agencies or land reclamation consortium do not integrate soil moisture measurements. In this contribution we present and discuss recent advancements of a non-invasive soil moisture method that emerged to fill this gap, called cosmic-ray neutron sensing (CRNS). The contribution covers current sensor developments, accuracy and uncertainty in the detected signal and estimated soil moisture and data integrations in current monitoring systems. A specific application for monitoring the main components of the soil water balance in real time at an agricultural site is presented, as example. An overview of future activities is also discussed.