Developing Efficient Sampling Strategies to Estimate Spatial-Average Soil Moisture in the Lower Arkansas River Valley, Colorado

Amin Haghnegahdar and Jeffrey D. Niemann
Department of Civil and Environmental Engineering, Colorado State University, Fort Collins, CO

Abstract. Soil moisture is an important variable for developing and validating hydrologic models, scheduling crop irrigation, and numerous other applications. Soil moisture can be measured by gravimetric methods or by in situ methods such as time-domain reflectometry (TDR). However, these approaches are time consuming if one needs to estimate the soil moisture repeatedly over large areas, such as the extent of an agricultural field. In this research, we examine the spatial variability of soil moisture within both agricultural and naturally-vegetated fields as part of a broader study in the Lower Arkansas River Valley in southeastern Colorado. The immediate objective is to develop an efficient sampling strategy to estimate the spatial-average soil moisture within fields and sub-sections of fields. This objective includes quantifying how the number of soil moisture measurements affects the uncertainty in the estimate of the spatial-average soil moisture. In addition, the reliability of using one or more strategically located points to characterize the spatial average soil moisture is assessed. The variation of soil moisture within fields and between different fields is also compared. These analyses are conducted using data collected in three agricultural fields (corn and alfalfa) and two naturally vegetated fields, and the spatial average is estimated over a range of spatial scales. The results suggest that the spatial-average soil moisture can be estimated using relatively few monitoring locations, particularly if their locations are selected based on detailed information about the soil moisture pattern. Also, it is observed that the variation of soil moisture values between fields with different vegetative cover is more than the variation within one field. This result implies that regional soil moisture patterns are better characterized by monitor a larger number of fields with relatively few sampling locations in each field.