Comparison between direct measurements and indirect estimations of hydraulic conductivity for slope deposits in North-Western Tuscany, Italy

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Hydraulic conductivity (K) is a relevant engineering geology property of deposits that cover the geological bedrock (Slope Deposits – SD). This parameter is useful for many applications fields such as: simulations of both infiltration and runoff processes, hillslope stability numerical analysis, hydrological studies, soil science and environmental problems.

A wide range of methods are available in the literature in order to estimate K. Anyhow, they can be divided into direct measurement (field and laboratory test) and indirect estimations (eg. correlation from grain size, pedotransfer functions).

However, many factors (eg. SD grain size, bulk density, organic matter, etc.) can affect the K value hence the determination of K within SD is often a challenge. Moreover, the value of K generally shows an high spatial variability requiring a large number of direct measurements to obtain robust spatial estimations. Indirect methods may be used alternatively or in pair with direct methods. However, relations between K and other soil physical properties are generally suitable only for specific type of soils, therefore, the application of those relations are constrained.

In this work a wide (about 200) set of field measurements were performed in North-Western Tuscany in order to assess the variability of K in the vadose zone for SD characterized by different grain size composition.

Measurements were carried out by means of both constant and falling head permeameters, as well as double ring infiltrometer. In the test sites engineering geology properties of SD such as bulk density and depth have been collected, moreover, samples have been collected for laboratory analysis.

A statistical analysis of the K value has been performed for SD characterized by different grain size distribution and geological bedrock. Moreover, a comparison between the field methods have been also performed. Finally, a comparison between measured and estimated values of K has been done in order to assess the reliability of different equations to predict K.

The results show that the K value varies across: different geological settings, the SD profile and the geographic neighborhood of the test site. Moreover, the results highlight that the indirect methods used in this work have to be used carefully in our study area.