Geophysical Research Abstracts
Vol. 14, EGU2012-8372-1, 2012
EGU General Assembly 2012

Soil depth map definition on a terraced slope for a following distributed, high resolution, numerical modelling analysis

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The soil thickness represents a key data for every environmental analysis involving soil, but its determination is not always simple. In this particular case, the study area is represented by a small terraced slope (0.6 km2) of Valtellina (Northern Italy), and the soil depth map is necessary for a coupled hydrogeological-stability analysis in a raster environment. During this work geometrical/morphological and geostatistical interpolation techniques were tested to obtain a satisfying soil depth map. At the end, the final product has been validated with geo-electrical resistivity inverse models.

In this particular context, the presence of dry-stone retaining walls is of primary importance, since they have an influence on the morphology of the entire area as well as on the physical processes of water infiltration and slope stability. In order to consider the dry-stone walls in the analysis, it is necessary to have base maps with an adequate resolution (cells 1 m x 1 m).

Assuming that the walls might be founded on bedrock or in its proximity, it was decided to use the heights of walls and the distribution of rock outcrops as soil depth input data. It was impossible to obtain direct measures with the knocking pole method, being pebbles frequently presents in the backfill soil . Except zero depth values, 682 measures were performed.

The initial data set was divided into two subsets in order to use one as training points (76 % of the total) and the second as test points (24 %). Various techniques were tested, from linear multiple regressions with environmental predictors, to ordinary kriging, regression kriging with the same environmental variables, and Gaussian stochastic simulations. At the end, the best result was obtained with co-kriging, using a soil depth class map drawn from the field measures as co-variable. The result is a little bit guided but it was the only solution to obtain a map that partially takes into account the morphology of the slope.

To verify the goodness of the map, Direct Current Earth Resistivity Sections (ERI) were acquired on a small area (about 3200 m2) of the slope in order to characterize the effective soil thickness on the base of the contrast with the overburden bedrock. From their analysis and interpolation and from the subsequent comparison with the previously estimated soil depth map, it is possible to notice that the geostatistical map is able to well reproduce the soil thickness between 0 and 1.5 m but for higher depths it tends to underestimates the real value, probably due to the influence of the input data.