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Measures of rainfall erosion at the plot scale in Central Italy

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Monitoring the erosion processes is of the utmost importance in order to test the applicability of soil erosion models, to establish procedures for the estimation of the factors affecting erosion and finally to establish soil conservation measures. For this purpose an experimental station “Le Masse” for soil erosion measurements has been recently created by the Department of Civil and Environmental Engineering of the University of Perugia. The station includes replicated plots oriented parallel to a 16% slope. Total runoff is trapped in sediment tanks and soil loss is measured after each erosive event: the runoff concentration is measured by a standardized sampling procedure and corrected by a calibration curve in order to quantify the actual concentration that multiplied by the total runoff gives the soil loss. Climatic data are also recorded at the experimental site. For all the plots measures of both rainfall storms and sediments trapped allowed the calculation of the event erodibility factor, K_e.

During the first year of the experimental station exercise all the Wischmeier plots were maintained fallow and cultivated parallel to slope and 13 erosive events occurred. The number of erosive events varied from one per month in the period between February to August to a maximum of four event in November and December. No erosive events occurred in March. The storm erosivity factor Re was low ranging from a minimum of 16,8 MJ mm ha^{-1} h^{-1} to a maximum of 85,97 MJ mm ha^{-1} h^{-1}. The event soil loss and runoff measurements from replicated plots have been analysed in order to evaluate the applicability of the Universal Soil Loss Equation (USLE) and USLE-based models (RUSLE, USLE-M, USLE-MM) in the study area at different temporal scales.

With the aim of determining a soil erodibility index K usable for the prediction of the event soil loss, a regression analysis between the measured unit soil loss and the different erosivity indices has been performed. The linear correlation between the measured unit soil loss (SL_e/LS) and R_e (typical of the USLE model) was low at the event time scale. This because the USLE was designed to predict annual erosion (with high value of the erosivity factor R), whereas the rainfall events measured at the new experimental station of ‘Le Masse’, had a low intensity with R_e<90 MJ mm ha^{-1} h^{-1}. However an increasing correlation coefficient was detected for R_e>38 MJ mm ha^{-1} h^{-1}. The erosivity index including runoff amount ($Q_R \times R_e$, typical of the USLE-M model) is more correlated with the soil loss with a correlation coefficient higher than 0.9 for R_e>38 MJ mm ha^{-1} h^{-1}. The higher value of r^2=0,67 (or r^2 =0,72 removing a particularly severe event affecting appreciably the mean results and r^2 =0,91 for R_e>38 MJ mm ha^{-1} h^{-1}) was obtained by using a power relationship between SL_e/LS and the erosivity index including runoff amount ($Q_R \times R_e$). Therefore, according to the USLE scheme, the coefficient of proportionality could be considered as a constant erodibility factor for the considered period.

The applicability of the USLE and USLE-M models for erodibility factor was also tested. The measured unit plot soil loss, SL_e/L·S, has been compared with the corresponding values: SL_{RUSLE}/L·S, estimated with the RUSLE model and $SL_{\mathrm{USLE-M}}$/L·S, estimated with the USLE-M model both with the K_{RUSLE} quantified by the RUSLE method. The SL_{RUSLE}/L·S values typically overestimate the measured values for low erosive events, but the overestimation decreases for highly erosive events. In other words a stationary value of the factor K_{RUSLE} typically overestimates the soil erodibility and the gap between the simulated and the estimated values is not constant due to the unexplained variability (both between experimental schemes and within replicated plots) that characterize the measured SL_e/L·S and the corresponding K_e. Conversely the USLE-M better estimates the low events and underestimates the higher events. Finally a value for the erodibility factor Km has been quantified for the experimental area as the coefficient of proportionality between the SL_e/LS and $Q_R \times R_e$ measured in some events (from the 1st to the 6th). This value enabled to obtain, for the remaining events, the smallest mean absolute error (MAE) between the estimated (by USLE-M model with Km) and the measured data when compared with the MAE obtained using SL_{RUSLE}/L·S and $SL_{\mathrm{USLE-M}}$/L·S.