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Coupling rainfall observations and satellite soil moisture for predicting event soil loss in Central Italy

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The accuracy of water soil loss prediction depends on the ability of the model to account for effects of the physical phenomena causing the output and the accuracy by which the parameters have been determined. The process based models require considerable effort to obtain appropriate parameter values and their failure to produce better results than achieved using the USLE/RUSLE model, encourages the use of the USLE/RUSLE model in roles of which it was not designed. In particular it is widely used in watershed models even at the event temporal scale. At hillslope scale, spatial variability in soil and vegetation result in spatial variations in soil moisture and consequently in runoff within the area for which soil loss estimation is required, so the modeling approach required to produce those estimates needs to be sensitive to those spatial variations in runoff. Some models include explicit consideration of runoff in determining the erosive stresses but this increases the uncertainty of the prediction due to the difficulty in parameterising the models also because the direct measures of surface runoff are rare. The same remarks are effective also for the USLE/RUSLE models including direct consideration of runoff in the erosivity factor (i.e. USLE-M by Kinnell and Risse, 1998, and USLE-MM by Bagarello et al., 2008). Moreover actually most of the rainfall-runoff models are based on the knowledge of the pre-event soil moisture that is a fundamental variable in the rainfall-runoff transformation. In addiction soil moisture is a readily available datum being possible to have easily direct pre-event measures of soil moisture using in situ sensors or satellite observations at larger spatial scale; it is also possible to derive the antecedent water content with soil moisture simulation models. The attempt made in the study is to use the pre-event soil moisture to account for the spatial variation in runoff within the area for which the soil loss estimates are required. More specifically the analysis was focused on the evaluation of the effectiveness of coupling modeled or satellite-derived soil moisture with USLE-derived models in predicting event unit soil loss at the plot scale in a silty-clay soil in Central Italy. To this end was used the database of the Masse experimental station developed considering for a given erosive event (an event yielding a measurable soil loss) the simultaneous measures of the total runoff amount, Q_e (mm), and soil loss per unit area, A_e (Mg·ha^{-1}) at plot scale and of the rainfall data required to derive the erosivity factor *Re* according to Wischmeiser and Smith (1978), with a MIT=6 h (Bagarello et al., 2013; Todisco et al., 2012). To the purpose of this investigation only data collected on the λ = 22 m long plots were considered: 63 erosive events in the period 2008-2013, 18 occurred during the dry period (from June to September) and the other 45 in the complementary period (wet period). The models tested are the USLE/RUSLE and some USLE-derived formulations in which the event erosivity factor, R_e, is corrected by the antecedent soil moisture, θ, and powered to an exponent $\alpha > 0$ (α =1: linear model; $\alpha \neq 1$: power model). Both soil moisture data the satellite retrieved ($\theta = \theta_{sat}$) and the estimates ($\theta = \theta_{est}$) of Soil Water Balance model (Brocca et al., 2011) were tested. The results have been compared with those obtained by the USLE/RUSLE, USLE-M and USLE-MM models coupled with a parsimonious rainfall-runoff model, MILc, (Brocca et al. 2011) for the prediction of runoff volume (that in these models is the term used to correct the erosivity factor R_e). The results showed that: including direct consideration of antecedent soil moisture and runoff in the event rainfall-runoff factor of the RUSLE/USLE enhanced the capacity of the model to account for variations in event soil loss when soil moisture and runoff volume are measured or predicted reasonably well; the accuracy of the original USLE/RUSLE model was always the lowest; the accuracy in estimating the event soil loss of a models with erosivity factor that includes the estimated runoff is always overcome by at least one model that uses the antecedent soil moisture θ in the erosivity index; the power models generally, at Masse, work better than the linear. The more accurate models are that with the estimated antecedent soil moisture, θ_{est}, when all the database is used and with the satellite retrieved soil moisture, θ_{sat}, when only the wet periods' events are considered. In fact it was also verified that much of the inaccuracy of the tested models is due to summer rainfall events, probably because of the particular characteristics that the soil assumes in the dry period (superficial crusts causing higher runoff): in this cases, high soil losses are observed in association to low values of soil moisture, while the simulated

runoff assume low values too, since they are based on the antecedent wetness conditions. Thus, the analyses were repeated excluding the summer events. As expected, the performance of all the models increases, but still the use of θ provides the best results. The results of the analysis open interesting scenarios in the use of USLE-derived models for the unit event soil loss estimation at large scale. In particular the use of the soil moisture to correct the rainfall erosivity factor acquires a great practical importance, since it is a relatively simple measurable data and moreover because remote sensing soil moisture data are widely available and useful in large-scale erosion assessment.

Bagarello, V., Di Piazza, G. V., Ferro, V., Giordano, G., 2008. Predicting unit soil loss in Sicily, south Italy. Hydrol. Process. 22, 586-595.

Bagarello, V., Ferro, V., Giordano, G., Mannocchi, F., Todisco, F., Vergni, L., 2013. Predicting event soil loss form bare plots at two Italian sites. Catena 109, 96-102.

Brocca, L., Melone, F., Moramarco, T., 2011. Distributed rainfall-runoff modeling for flood frequency estimation and flood forecasting. Hydrol. Process. 25, 2801-2813.

Kinnell, P. I. A., Risse, L. M., 1998. USLE-M: empirical modeling rainfall erosion through runoff and sediment concentration. Soil Sci. Soc. Am. J. 62, 1667-1672.

Todisco, F., Vergni, L., Mannocchi, F., Bomba, C., 2012. Calibration of the soil loss measurement at the Masse experimental station. Catena 91, 4-9.

Wischmeier, W. H., Smith, D. D., 1978. Predicting rainfall-erosion losses – A guide to conservation planning. Agriculture Handbook 537, United Stated Department of Agriculture.