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Evaluation of the EUROSEM model for predicting the effects of erosion-control blankets on runoff and interrill soil erosion by water

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ABSTRACT

The European Soil Erosion Model (EUROSEM, Morgan et al., 1998) is an event-based soil erosion model which predicts runoff and sediment discharge for different environmental conditions. Applying geotextiles or erosion-control blankets (ECB's) on the soil surface significantly affects surface seal formation and topsoil properties and therefore controls runoff and soil erosion rates during a rainfall event. Since these within-storm changes of soil surface characteristics and hydrological conditions are not incorporated in EUROSEM, errors in runoff and soil erosion predictions may occur for soil surfaces covered with ECB's.

Therefore, the objective of this paper is to evaluate and improve the performance of a research version of the physically-based erosion model EUROSEM (EUROSEM-2010; Borselli and Torri, 2010) for simulating the effects of ECB's on runoff and interrill soil erosion by water during intense simulated rainfall events. Results of model simulations are compared with experimental results of interrill erosion using biological (i.e. natural) ECB's and simulated rainfall. Because ECB's applied on the soil surface retard seal formation, the differences between observed and predicted runoff rates and sediment discharges are rather high during the first 20–30 min of the simulated rainstorm. Therefore, a simple approach is proposed to cope with the dynamic evolution of some soil characteristics, i.e. saturated hydraulic conductivity, soil erodibility and soil cohesion, during an intense rainfall event. This time-dependent approach improves the predictions of runoff rate and sediment discharge during the first 20–30 min of a rainfall event and increases the model efficiency (i.e. a measure for the goodness of fit) from 0.84 to 0.98 and from 0.48 to 0.68 for the total runoff volume and soil loss, respectively. For most conditions, the predicted final sediment discharge is still considerably larger than the observed values, which can be partly attributed to the deposition of sediment in the bare soil patches (i.e. inter-weave open areas) of the ECB's, which is not simulated by EUROSEM in this study. This model approach increases our understanding of the effects of ECB's on within-storm changes in hydrological conditions and soil surface characteristics.

1. Introduction

Several models have been developed for simulating various aspects of soil erosion phenomena, e.g. mean annual soil loss (Renard et al., 1997), sediment yield (Van Rompaey et al., 2001), ephemeral gully erosion (Nachtergaele et al., 2001). Models assist in the understanding of hydrological and erosion processes and provide a predictive tool for land use management. The EUROSEM model (Morgan et al., 1998), which is an event-based soil erosion model, is designed to operate for successive short time steps within a storm and has been validated for several environmental conditions, e.g. The Netherlands (Folly et al., 1999), Costa Rica, Mexico, Nicaragua (Veihe et al., 2001), China (Cai et al., 2005) and Kenya (Mati et al., 2006). These studies indicate that EUROSEM can reasonably well simulate total runoff volume and peak discharge in different environments and for different rainfall characteristics. However, similar to other physically-based models, the runoff and erosion predictions contain uncertainty. This uncertainty arises from a variety of sources and is most likely to be due to error in the conceptualisation and in the parameterisation of the model (Konikow and Bredehoeft, 1992). The EUROSEM evaluation studies point to some of the shortcomings of using EUROSEM for runoff and

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