Geophysical Research Abstracts, Vol. 7, 08520, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08520

Application of an event-based distributed rainfall-runoff model to a small Southern Italy catchment: model calibration and validation

P. Versace, B. Sirangelo and D. Biondi
Department of Soil Defence, University of Calabria, Italy

A first set of applications of the RISE model, performed for a small Southern Italy catchment, the Turbolo Creek basin (29 km2), are described.

The RISE (Runoff by Infiltration and Saturation Excess) model is a distributed, event-based model, which considers both conceptual and physically-based schemes for the description of the hydrological processes.

The model has been essentially conceived for applications to small and medium size catchments, and designed with a stepwise approach, maintaining a realistic description of the processes that are assumed to be dominant in controlling storm runoff production and saturated area space-temporal dynamics.

RISE works on a regular grid according to the DEM (Digital Elevation Model) resolution, and allows the spatially distributed description of precipitation and topographic features.

The modelling framework consists of two modules aimed at simulating runoff generation and runoff routing respectively.

The schematisation of runoff generation assumes that the soil column of each cell is divided into two interacting layers, representing unsaturated and saturated condition, with a boundary moving up and down depending on water table level dynamics.

The mean value of soil moisture on the upper soil layer is updated by solving a water balance equation using vertical fluxes only: an infiltrated precipitation input controlled by a hortonian mechanism, and a downward moisture flux that recharges the grid cell water table.

Subsurface lateral flow in the saturated soil layer is routed to channel with an explicit scheme, as proposed for the DHSVM model.

The model computes different contributions to surface runoff (overland and channel flow): infiltration excess, saturation excess, exfiltration of soil water (return flow), subsurface flow (from hillslope to channel), direct precipitation on channel. All these local contributions are conceptually routed to the catchment outlet with a Geomorphologic IUH: the adopted approach is based on a rescaled geomorphologic width function, which accounts for the different scales of velocity taking place on hillslopes and stream network, coupled with a probability density function of travel times derived from the convective diffusion equation.

Eight events were investigated. Model parameters were set as uniform over the entire domain. Some of them were determined by available maps or by field surveys; the remaining were estimated by calibration, with the SCE-UA algorithm, against a single event characterised by a fairly complex shape.

Antecedent conditions were determined by the simulation of groundwater recession from full saturated state, which allowed the derivation of water table position for different wetness states. A 'warm up period', including observed precipitation, was also considered before simulation of each event.

A two step approach was taken in the validation of the RISE model. First a traditional split-sample test was carried out; only initial soil moisture condition, that a preliminary sensitivity analysis suggested to have a major impact on model response, was calibrated as a black-box parameter for the remaining events.

The model performed well in reproducing the overall shape of the outflow hydrographs, including peak flows and recession limbs.

In the second validation step emphasis was focused on the question of a more general validity and physical soundness of the proposed approach: this task was performed testing the model against hydrological common sense, without the benefit of data. This can be considered a subjective practice; nevertheless it allows the judgement of how reasonable the structure, the underlying assumptions and the behaviour of internal catchment processes are. Moreover, present data limitations for testing internal model accuracy serve to guide future experimental and modelling research.

Several qualitative assessments were considered: ì) evaluation of model ability in reproducing different runoff generation mechanisms through the analysis of the different components in simulated catchment response; ìì) evaluation of estimated runoff production spatial distribution, and of simulated behaviour of internal variables (such as water table depth and soil moisture); ììì) evaluation of model response plausibility for ‘virtual’ applications representing different hydrological situations (such as a drought period or a long duration rainfall event).

To conclude, the results suggested, as stated by previous studies, that catchment runoff is mainly produced by saturation excess mechanism, while hortonian overland flow is associated only with high intensity rainfall; the analysis of internal variables behaviour also illustrated model ability to realistically represent the role of different catchment landscape units on storm runoff production.