Geophysical Research Abstracts
Vol. 13, EGU2011-3805, 2011
EGU General Assembly 2011

A 1D runoff-runon model : scale and connectivity

Marie-Alice Harel (1), Emmanuel Mouche (1), Jérémy Patin (1), and Emmanuel Ledoux (2)

(1) LSCE - Laboratoire des Sciences du Climat et de l'Environnement, CEA Sacaly, France (mharel@lsce.ipsl.fr), (2) Mines ParisTech, Fontainebleau, France

Rainfall is shared differently between runoff and infiltration depending on spatial scale. At the watershed scale, it has been observed that runoff produced at the outlet generally decreases with the size of the watershed (Cerdan et al., 2004). At plot scale, infiltration is usually modelled as an Hortonian process, but this is rigorously justified only at the core scale, and no other model has been proposed for larger scales. The scale dependence of runoff and infiltration is currently explained by the spatial and temporal variability of precipitations, soil properties, vegetation and topography. Only soil properties spatial variability is considered here. We investigate in a stochastic framework the rainfall partitioning on slopes with random infiltrabilities by means of theoretical developments and numerical simulations.

We consider a variation of infiltrability IM along a 1D slope, under a constant rainfall intensity R of uniform repartition. The infiltration function I is defined either by an Horton law, where I(R)=R if R<IM and I(R)=IM otherwise, or by a law accounting for sub-scale variability I(R) = IM(1–exp(-R/IM)). This exponential law was validated at the plot scale by the experiments of Yu et al. (1997) under natural and simulated rain.
We analyse the influence of (1) the statistical properties associated to the repartition of IM and (2) the infiltration function on the outflow and runoff organisation on the slope. Our first results indicate that (1) and (2) have limited impacts on the outlet runoff. The outflow follows an Hortonian law for sufficiently long slopes, with an effective slope infiltration equal to the spatial mean of IM. However, runoff patterns organize differently depending on (1), and their connectivity is assessed thanks to Allard's function of connectivity (1993).

Linearising the model provides a theoretical guide for the effective laws of repartition. Nevertheless, we are dealing with a highly non-linear model due to the runon phenomenon, which is also responsible for the scale effects observed. A promising guideline may be found in the queuing theory, as recently explored by Jones et al. (2009).