Mathematical modeling in the Soil-Plant-Atmosphere continuum Part I. Water flow on vegetated surfaces

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February 4, 2025

In this seminar we present an extended Saint-Venant system of partial differential equations (PDE) used as a mathematical tool to simulate and study the water flow over a soil surface with vegetation in a hydrographic basin. This model is based on the general principles of fluid mechanics and has the water depth and velocity as unknowns. The vegetation is taken into consideration using a porosity function (a quantity related to the density of the plant cover) defined over the hydrological basin.

We use a finite volume method (FVM) to discretize the space variable and space derivatives. The resulting system of ordinary differential equations (ODE) sets up the base of the full discrete model which is finally obtained by introducing a fractional time step scheme (to discretize the time variable and time derivatives). Several properties of this model are also investigated and discussed.

Some quantitative validation tests are performed by comparing numerical results with exact solutions or with laboratory-measured data. We also consider some qualitative validation tests by numerically simulating the flow on a theoretical vegetated soil and on a real hydrographic basin.