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Evaluation of a mechanistic algorithm to calculate the influence of a shallow water table on hydrology sediment and pesticide transport through vegetative filter strips

C. Lauvernet (1), R. Munoz-Carpena (2), and N . Carluer (1)

(1) Irstea, UR MALY, 3 bis quai Chauveau - CP 220, F-69336 Lyon, France (claire.lauvernet@irstea.fr), (2) Agricultural and Biological Engineering. University of Florida. 287 Frazier Rogers Hall, PO Box 110570 Gainesville, FL 32611-0570 (EEUU)

Natural or introduced areas of vegetation, also known as vegetative filter strips (VFS), are a common environmental control practice to protect surface water bodies from human influence. In Europe, VFS are placed along the water network to protect from agrochemical drift during applications, in addition to runoff control. Their bottomland placement next to the streams often implies the presence of a seasonal shallow water table which can have a profound impact on the efficiency of the buffer zone (Lacas et al. 2005). A physically-based algorithm describing ponded infiltration into soils bounded by a water table, proposed by Salvucci and Enthekabi (1995), was further developed to simulate VFS dynamics by making it explicit in time, account for unsteady rainfall conditions, and by coupling to a numerical overland flow and transport model (VFSMOD) (Munoz-Carpena et al., submitted). In this study, we evaluate the importance of the presence of a shallow water table on filter efficiency (reductions in runoff, sediment and pesticide mass), in the context of all other input factors used to describe the system. Global sensitivity analysis (GSA) was used to rank the important input factors and the presence of interactions, as well as the contribution of the important factors to the output variance. GSA of VSFMOD modified for shallow water table was implemented on 2 sites selected in France because they represent different agro-pedo-climatic conditions for which we can compare the role of the factors influencing the performance of grassed buffer strips for surface runoff, sediment and pesticide removal. The first site at Morcille watershed in the Beaujolais wineyard (Rhône-Alpes) contains a very permeable sandy-clay with water table depth varying with the season (very deep in summer and shallow in winter), with a high slope (20 to 30%), and subject to strong seasonal storms (semi-continental, Mediterranean climate). The second site at La Jailliere (Loire-Atlantique, ARVALIS–Institut du Végétal, mainly wheat and maize) is a poorly permeable medium loamy over clay soil, with possible local shallow water tables, slopes around 3% and mild and rainy winter while summer is cool and wet (temperate, oceanic climate). GSA allowed us to interpret the results from the multivariate Monte-Carlo uncertainty analysis and gain insights on the management and placement of the buffer systems.