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PERFORMANCE OF DRAINWAT MODEL IN ASSESSING THE DRAINAGE DISCHARGE FROM A SMALL WATERSHED IN THE PO VALLEY (NORTHERN ITALY)

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ABSTRACT The performance of DRAINWAT, a DRAINMOD based-watershed scale hydrology model, in predicting the water discharge was assessed in a small basin in Northern Italy during 2002-2005. DRAINWAT slightly unpredicted (4%) the total stream drainage flow respect the measured data (549 mm), in calibration (2002-04). The underprediction was 11% in 2004-05 validation period, when snowfall occurred in winter time.

Keywords: DRAINWAT, basin discharge, calibration, validation, North Italy

INTRODUCTION Evaluation of potential nitrogen (N) losses from individual fields is not sufficient to provide an estimate of the actual nitrogen loads reaching the main watercourses and, therefore, these loads are becoming a relevant source of pollution. Along the travel path from a field to the outlet of a watershed several biogeochemical processes may occur, leading to significant changes in the N amount actually leaving the watershed. These processes can be described using models of various complexities including lumped exponential decay model, which uses travel (residence) time from predicted velocities in the ditch-canal network (Fernandez et al., 2002). However, hydrology is a driving variable for accurate predictions of nutrient loadings. In this work, we apply DRAINWAT (Amatya et al., 1997), a DRAINMOD (Skaggs, 1978) based-watershed scale hydrology model with a field and stream routing component to predict the drainage (flow) rates and corresponding velocities in the ditch-canal network in a small watershed in Po valley, North Italy. The results were satisfactory based on the statistics and the limited data that were used.

MATERIALS AND METHODS The case study was conducted on Longhirola watershed, located in the Mantova province, Po valley, Northern Italy, where hydrologic measurements and N inputs at field level, N harvested with crops, and N lost at the outlet of the watershed were recorded during 2002-2005. The watershed, having an area of 65 hectares and comprised within a band of the Mincio River, is characterized by almost flat fields, most of them with rectangular shape. Along the longest sides of the fields, ditches collect the runoff and drainage water and deliver it to the main canal, called Longhirola (Figure 1).

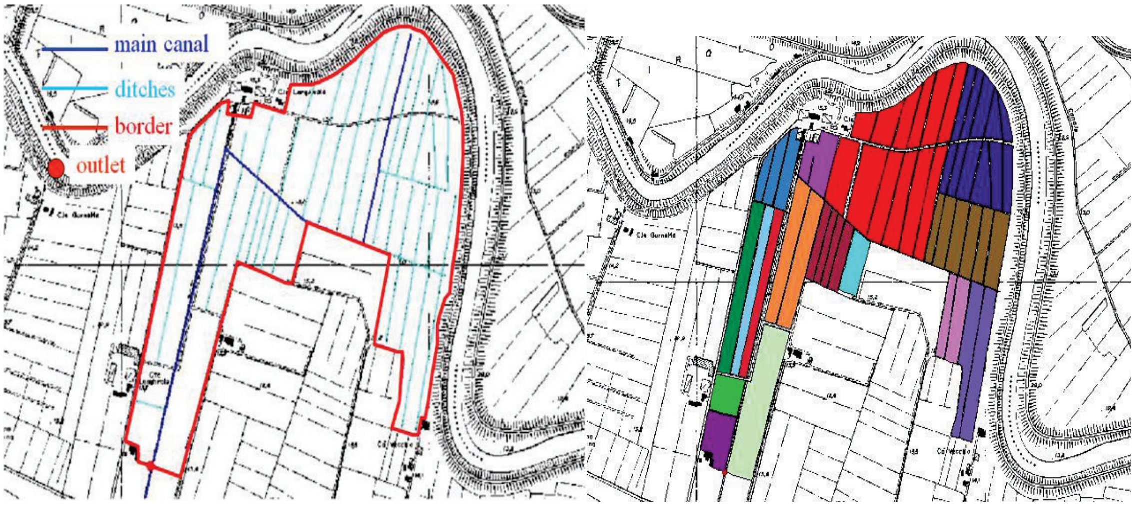

Figure 1. Maps of the Longhirola watershed: surface ditches network (left) and homogeneous field drainage areas delineated for DRAINWAT simulation (right)

The soil in the whole area is homogeneous and according to the USDA land classification system it is a Calcic Ustochrepts fine (montmorillonitic) mixed mesic soil (Borin, 2003). Therefore, an area was considered homogenous when the crop was the same and all water had an analogue drainage. The 65 hectares watershed has its land use as crops (mainly maize and alfalfa) for livestock. The drainage discharge at the watershed outlet was measured every day when the flow occurred using a flow-meter. A detailed description of the site has been given by Bisol (2006). To apply DRAINWAT the watershed was delineated into sixteen different homogeneous fields, runoff and drainage flow from was routed to the main outlet. The model was parameterized with field hydrology parameters like, ditch spacing and depth, surface storage, crop rooting depth, and soil hydraulic properties. Similarly, the cross-sections and bed slopes of main canal parameters were also input to the model. The model then simulated daily flow rates at the watershed outlet using hourly rainfall and daily potential evapotranspiration measured at the nearest weather station. Then the predicted flow was compared with the measured data (Bisol, 2006) .

RESULTS The total stream drainage flow predicted by the DRAINWAT (522 mm) was consistent with the measured data (549 mm), which was only a 4% underprediction for calibration (2002-04) period (Figure 2.a) However, there was an underestimation (236 mm) or 11% compared to the measured (265 mm) data in 2004-05 validation period (Figure 2.b). In both the cases DRAINWAT satisfactorily described the magnitude and timing of drainage discharge. During the calibration some rainy subperiods were monitored with higher frequency and the comparisons gave the satisfactory results based on the R^2-statistics reported in Table 1 and as shown by similar statistics for a DRAINWAT study by Amatya et al. (2004) During the validation period, the higher difference between measured and predicted data derived from December 2004 to mid January 2005, was most likely due to precipitation of snow.

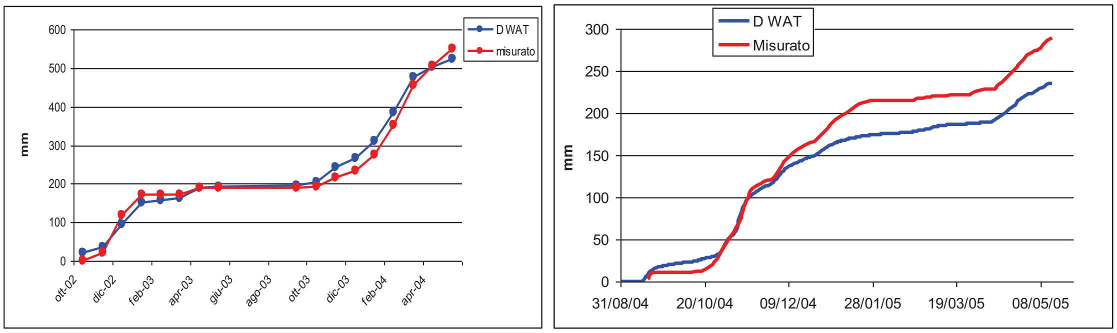

Figure 2. Cumulative time pattern of predicted and measured watershed drainage discharge in the calibration (left plot) and validation (right plot) periods.

Table 1. Comparisons between measured and predicted discharge in subperiods.

Periods	Measured (mm)	DRAINWAT (mm)	Difference (%)	Pearson Corr. Coeff.	R^2
11-23Apr 2003	11.1	12.5	13	0.80	0.76
29Oct-11Nov 2003	9.5	9.9	4	0.75	0.81
9Dec 2003-9Jan 2004	32	31.2	-2	0.85	0.77
18-27 Feb 2004	69.2	59.7	-14	0.61	0.59
9-18Mar 2004	52.2	46.6	-11	0.69	0,.58
15-27 Apr 2004	24	16.3	-32	0.78	0.82
total	198	176.2	-11		

CONCLUSION The consistency of drainage discharge predicted by DRAINWAT with the measured data was considered acceptable, especially considering the minimal field measurements that have been carried out in this study. This is encouraging for DRAINWAT's application in estimating cumulative nutrient load using a simple nutrient model with predicted travel time.

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