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Understanding hydrological and nitrogen interactions by sensitivity analysis of a catchment-scale nitrogen model

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Nitrogen is present in both terrestrial and aquatic ecosystems and research is needed to understand its storage, transportation and transformations in river catchments world-wide because of its importance in controlling plant growth and freshwater trophic status (Vitousek et al. 2009; Chu et al. 2008; Schlesinger et al 2006; Ocampo et al. 2006; Green et al., 2004; Arheimer et al., 1996). Numerous mathematical models have been developed to describe the nitrogen dynamics, but there is a substantial gap between the outputs now expected from these models and what modellers are able to provide with scientific justification (McIntyre et al., 2005). In fact, models will always necessarily be simplification of reality; hence simplifying assumptions are sources of uncertainty that must be well understood for an accurate model results interpretation. Therefore, estimating prediction uncertainties in water quality modelling is becoming increasingly appreciated (Dean et al., 2009, Kruger et al., 2007, Rode et al., 2007). In this work the lumped LU4-N model (Medici et al., 2008; Medici et al., EGU2009-7497) is subjected to an extensive regionalised sensitivity analysis (GSA, based on Monte Carlo simulations) in application to the Fuirosos catchment, Catalonia. The main results are: 1) the hydrological model is greatly affected by the maximum static storage water content (Hu_max), which defines the amount of water held in soil that can leave the catchment only by evapotranspiration. Thus, it defines also the amount of water not retained that is free to move and supplies the other model tanks; 2) the use of several objective functions in order to take into account different hydrograph characteristic helped to constrain parameter values; 3) concerning nitrogen, to obtain a sufficient level of behavioural parameter sets for the statistical analysis, not very severe criteria could be adopted; 4) stream water concentrations are sensitive to the shallow aquifer parameters, especially the nitrification constant (Knitr-aquif) and also to the certain soil parameters, like the mineralization constant (Kmin), the annual maximum ammonium uptake (MaxUPNH4) and the mineralization, nitrification and immobilisation thresholds (Umin, Unitr and Uimmob). Moreover the results give a clear indication that the hydrological model greatly affects the streamwater nitrate and ammonium concentrations; 5) result shows that the LU4-N model succeeded in achieving near-optimum fits simultaneously to flow and nitrate, but not ammonium; 6) however, the optimum flow model has not produced a near-optimum nitrate model. The analysis of this result indicated that calibrating the flow-related parameters first, then calibrating the remaining parameters instead of calibrating all parameters together, may not be the best strategy as pointed out for another study by McIntyre et al., 2005 ; 7) a final analysis seems also to support the idea that to obtain a satisfactory nitrogen simulation necessarily the flow should be acceptably represented, which lead to the conclusion that observed stream concentrations may indirectly help to calibrated the rainfall-runoff model, or at least the parameters to which they are sensitive.