CERIS : Civil Engineering Research and Innovation for Sustainability

Parsimonious and physically-based models to evaluate streamflow, soil loss and pollution in watersheds in the interior of São Paulo

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Summary

The lack of hydrological data in Brazil is a recurrent problem in many regions, especially in hydrometric data, sediment yield and water quality. The research by simplified models has increased in the last decades, however, the estimation of hydrossedimentological data from these more sophisticated models demands many variables, which must be adjusted for each natural system, which makes it difficult to apply. At times it is necessary to respond quickly without much precision in the results, in these situations, simpler models with few parameters can be the solution. The objective of this research is to evaluate different modelling tools used estimate streamflow, sediments yield and nutrients loads values, and namely to compare the results obtained from a physically-based distributed hydrological model (SWAT) with the results from a lumped hydrological, the Soil Conservation Service (SCS-CN) and the Generalized Watershed Loading Function (GWLF) model. Both models use the curve number (CN) concept, determined from land use, soil hydrologic group and antecedent soil moisture conditions and were run with a daily time step. We are particularly interested in understanding under which conditions the use of each model is to be recommended, namely when does the addition effort required to run the distributed model leads to effective better results. The input variables and parameters of the lumped model are assumed constant throughout the watershed, while the SWAT model performs the hydrological analysis at a small unit level, designated as hydrological response units (HRUs), and integrates the results at a sub-basin level. In relation to the flow simulation, the results of the two models were highly influenced by the rainfall data, indicating that, possibly, faults or measurement errors could have negatively influenced the results. Therefore, it was proposed to apply the distributed model with high-resolution grids of daily precipitation to verify the efficiency of its results when compared to rainfall data. For simulation of sediment, nitrogen and phosphorus, SWAT performs a more detailed simulation and thus provides slightly better results. The use of the SWAT was also extended to simulate the influence of reservoir, in order to verify the potentiality of the model, in relation to the simulation. The models also were used to identify which are potential impacts of the ongoing land use changes. The scenarios were: I - Current scenario, II - trend scenario, with the increase of urban land and replacement of the exposed soil and part of the native forest by agricultural use; III - desirable scenario complements the trend urban growth with the replacement of exposed soil and part of the agricultural use by reforestation. The methodologies were applied on two watersheds located in the Southeast of Brazil. The first one is the Jacaré-Guaçu river basin, included in the Water Resources Management Unit 13 (UGRHI-13), upstream of Cruzes river confluence, with an area of 1934km2. The second watershed is the Atibaia River Basin, a part of Water Resources Management Unit 5 (UGRHI-5). It has an area of 2817.88km2 and covers municipalities of the states of São Paulo and Minas Gerais.

Keywords

SWAT, GWLF, parsimonious lumped hydrological model, distributed hydrological model.