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MODÉLISATION DES PETITS BASSINS VERSANTS EN MILIEU RURAL :
Problématique des modèles fortement paramétrés

Thèse présentée
à la Faculté des études supérieures et postdoctorales de l'Université Laval
dans le cadre du programme de doctorat en Génie Civil
pour l'obtention du grade de Philosophiæ Doctor (Ph.D.)

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FACULTÉ DES SCIENCES ET DE GÉNIE
UNIVERSITÉ LAVAL
QUÉBEC

2012

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Abstract

It is important to know and quantify diffuse pollution, and especially to help farmers to adopt best management practices. In order to control river pollution, a model simulating the fate of pollutants and identifying the best management practices can be of a great help, especially for small rural watersheds, which are increasingly polluted but rarely or not monitored. The model in this study, which begins to be used in Quebec, is the Soil and Water Assessment Tool (SWAT), a highly parameterized model.

Calibration of models at the watershed scale is challenging because of the possible uncertainties that may exist in the form of process simplification, processes not accounted for by the model, and processes in the watershed that are unknown to the modeller. The challenge is even greater in the case of a daily evaluation of model performance on small agricultural watersheds with limited data. With SWAT, only few case studies have been conducted on small agricultural watersheds with limited data. The time step in water quality modelling is usually monthly or annual and good fits are rarely obtained using a daily time step, given the scarcity of data. However, a daily time step better represents the dynamics of pollutants in the river especially for the fast reacting small watersheds and provides more realistic simulation results.

So, to improve daily performance in modelling water quality in small agricultural basins with limited data with a highly parameterized model, our objective is twofold: 1) to propose a methodology to obtain better daily performance in modelling flow (Q), Suspended Solids (SS) and total phosphorus (TP) in small watersheds with little data and 2) to apply the methodology to a case study for a small agricultural catchment with limited data.

The proposed modelling methodology is based on the evaluation of the two calibration approaches with SWAT, single-objective and multi-objective, and the resolution of the problems encountered (misrepresented biomass, absence of water in the drains, too high surface runoff, unbalanced internal model components and a loss of performance of predicting flows).

Although the daily model performance in terms of suspended solids and total P is still not optimal, it has been improved thanks to the new methodology. The results showed that (i) the model performance depends not only on the choice of calibration approach, but essentially on the selection of influential parameters; (ii) the multi-objective calibration estimating all parameters related to all measured variables at once is the best approach to model Q, TSS and TP; (iii) changing weights does not improve model performance; (iv) with a single-objective optimization, an excellent water quality modelling performance may hide a loss of performance of predicting flows and unbalanced internal model components; and (v) manual adjustments after calibration of some parameters and modifications of some software routines can greatly enhance performance in water quality.

After application of the new methodology on the study area, the watershed Ruisseau du Portage, 21.41 km^2, Quebec, Canada, best management practices for the purpose of reduction of TP were simulated with SWAT (fertilizer application, tillage, crop conversion).