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Considerations regarding the agronomical variables associated to the performances of SWAT model simulations in the Romanian eco-climatic conditions

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Abstract

The main objective of the study is to optimize the agronomical variables for prediction of water quality at river basin scale for various time intervals using the numerical modeling of the cumulative impact of agricultural operations due to the use of chemical inputs and specific tillage. SWAT (Soil & Water Assessment Tool) model was developed to determine with reasonable accuracy the effect of potential management decisions regarding the water use, sediment transport, and chemical transformations of substances discharged into surface waters in rural ungauged basins. The information flow must start with the adaptation of the inputs required by the SWAT model for the accurate definition of Hydrological Response Units that include unique combinations between slope, soil type, and land use/land cover. All thematic layers must be related to the same coordinate system using the 1970 stereographic projection and Dealul Piscului 1970 geographic coordinate system that are in force in Romania. The meteorological inputs used in SWAT include rainfall, maximum and minimum temperature, solar radiation, relative humidity and wind speed. The prediction of SWAT model considering the diffuse sources of pollution (land areas with intensive agriculture) were analyzed considering the cropping technologies used in various Romanian hydrographical basins, i.e. Ialomita River, Calmatui River, Teleajen River, and Mostistea River. The main constraints observed in the use of SWAT model for efficient predictions in various control sections can be adjusted by the careful selection/adaptation of inputs, the optimal calibration/sensitivity analysis of the model, and the updating of information regarding the land use/land cover in a specific river basin.

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Keywords: nitrates; phosphates; numerical model; nitrogen processes; crop growth parameters.

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1. Introduction

The monitoring of water quality must be performed at the scale of the river basin. The dedicated numerical models should be used to extend the results of monitoring in time and space, taking into account the hydrological and geomorphological conditions of riverbeds. The parameters that influence mostly the pollutants load of a watercourse are dilution flow, transport capacity, dispersion and biodegradation capacities of pollutants, as well as the oxygen intake by re-aeration and photosynthesis (Oprea and Dunea, 2008). Water quality is influenced by the characteristics of the river basin, namely the land use / land cover, and geology of the basin, the seasonal influence, the river flow, and the chemical properties of tributaries water of the main channel. Important factors in the quantitative balance of surface waters are precipitation and snowmelt with quantitative and qualitative influences, mainly because of surface transport of sediment, pesticides, fertilizers, germs etc. (Neitsch et al., 2011). The current knowledge about the water cycle at basin scale is relatively incomplete due to some random and complex processes, which are difficult to measure or estimate in an integrated way. Furthermore, the hydrological and water quality data for the rivers that form a river system are often dispersed or discontinuous, making difficult to assess the information regarding the river flow in view of insuring the water resources management in case of flood risk or high pollutants load. If the monitoring data are missing, the most reliable support for making pollutant load predictions of surface waters in catchment areas that are not covered by continuous measurements within a surveillance or operational monitoring program is the use of numerical geo-models. **SWAT** (*Soil & Water Assessment Tool*) model was developed to determine with reasonable accuracy the effect of potential management decisions regarding the water use, sediment transport, and chemical transformations of substances discharged into surface waters in rural ungauged basins (Srinivasan et al., 2010).

SWAT quantifies also the pollutant loads from point sources (Arnold et al., 2012) and provides predictions of the influence of land management practices on crops in a particular catchment area and thus, on water quality in various control sections of the main channel. An extended literature review regarding the use of SWAT model pointed out the future trends of model utilization, together with an assessment of the strengths and weaknesses of the model (Gassman et al., 2007). Recently, another study of literature has examined the impact of SWAT utilization for the assessment of specific processes in river basins (Pechlivanidis et al., 2011). A significant increase of the use of SWAT model to estimate or predict specific environmental problems was observed in the recent years such as:

- identification of critical areas that contribute mostly to the pollutant load in a river basin (Manciola et al., 2005; Niraula et al., 2013);
- impact assessment of individual land management strategies at basin scale (Naramngam and Tong, 2013; Sommerlot et al., 2013);
- evaluation of the potential impact for growing area enlargement of “energy crops” on the quality condition of main channel (Einheuser et al., 2013);
- or to model flow rates and sediment quantities in rural areas (Shrestha et al., 2013).

In addition, SWAT was used to determine the effect of surface runoff in an agricultural catchment on a lagoon in order to estimate future sediment depositions (Santra and Das, 2013). Other studies have examined the separated and combined impact of future climate change and land use/ land cover on the river main channel (Kim et al., 2013). Furthermore, the SWAT model allowed the evaluation and improvement of the numerical modeling applied at basin scale to characterize the impact of climate change on water resources and ecosystems’ stressors (Luo et al., 2013). Application of SWAT model has facilitated the estimation of the land use and basin specific conditions effects on water quality, on sediments and nutrients load in an ungauged section of a river basin (Iordache et al., 2012). SWAT model provided predictive values of the loads with different forms of nitrogen and phosphorus because of the cumulative effect of the land use/land cover and the contribution of point sources i.e. wastewater treatment plants, and direct discharges (Dunea et al., 2013).

The paper presents the main adaptations to the SWAT input files required to simulate various scenarios regarding the impact of agricultural operations on the water quality in Romanian river basins.