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A comparison of WEPP and SWAT for modeling soil erosion of Torogh watershed in Khorasan Razavi Province

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Abstract

Soil and water conservation is important for the Torogh reservoir area in Khorasan razavi province, and quantification of soil loss is a significant issue. In this study, two widely used models-the Water Erosion Perdiction Project (WEPP) and the Soil and Water Assessment Tool (SWAT)-were applied to simulate runoff and sediment yield for the Torogh watershed in the Torogh reservoir area. The models were run and the simulated runoff and sediment yield values were compared with the measured runoff and sediment yield values. In the calibration period, the model efficiency (E_{NS}) values for the WEPP and SWAT were 0.864 and 0.711 for runoff, and 0.847 and 0.678 for sediment yield, respectively. In the validation period, the E_{NS} values for WEPP and SWAT were 0.835 and 0.690 for runoff, and 0.828 and 0.818 for sediment yield, respectively. The results of E_{NS} and the other criteria indicate that the results of both models were acceptable. WEPP simulation were better than SWAT in most cases, and could be used with a reasonable confidence for soil loss quantification in the Torogh watershed.

Keywords: WEPP, SWAT, Sediment yield, Runoff, Calibration.

1. Introduction

Computer simulation models are increasingly popular for predicting soil loss to quantify the processes of detachment, transport and deposition of eroded soil. It is necessary to validate soil erosion models for Torogh area to evaluate the effects of different management practices on soil erosion and to select the best management practices. Soil erosion models can be divided into empirical and physically based models. Empirical models usually establish relationships between runoff, sediment yield and precipitation, plants, soil types, landuse types, tillage styles, water conservation measures and so on. They are still used because of their simple structure and ease of application. Since they are based on coefficients, they cannot describe or simulate the erosion process as a set of physical phenomenea. The Universal Soil Loss Equation (USLE) is the most widely used empirical erosion model (Wischmeier and Smith, 1965). It is used to estimate soil erosion from an area simply as the product of empirical coefficients, which must be accurately evaluated. Original values of the coefficients were derived from field observation in different areas of eastern U.S., but they have been expanded with time using information from researchers who have applied the USLE in other countries (Romero et al., 2007). Physically based models can describes the physical mechanism of sediment yield in detail and can simulate the individual components of the entire erosion process by solving the corresponding equation. Based on this, it is stated that physically based models have a wider range of applicability and are also generally better in assessing both spatial and temporal variability of the natural erosion processes. The WEPP model is a physically based model that simulates sediment yield and deposition using a spatially and temporally distributed approach (Flanagan and Nearing, 1995). This study aimed at evaluating the application of two models-WEPP and SWAT-in the Torogh Reservoir area. These models have been tested on many agricultural watersheds. However, there have been few comparisons of the simulations of soil erosion between these two models; WEPP has been compared to models of the same or relevant module of SWAT sediment simulation. The WEPP model has been compared with USLE, the Erosion Productivity Impact Calculator (EPIC), the Areal Nonpoint Source Watershed Environment Response Simulation (ANSWERS) and other models for runoff and soil erosion (Romero et al., 2007). Since the WEPP is a process-based continuous Universal Soil Loss Equation (MUSLE), this paper will mainly discuss the differences between the empirical and physical modules of the two models.