

Simulation of hydrological processes and effects of engineering projects on the Karkheh River Basin and its wetland using SWAT2009

ABSTRACT

Limited water supply is one of the major restrictions in development and agricultural activities in numerous countries, especially in arid and semi-arid regions. Wetlands are constantly affected by anthropogenic factors such as engineering projects and landscaping. Therefore, simulation of hydrologic processes and modeling the factors involved are important. In this study, Soil and Water Assessment Tool (SWAT) was used to simulate the hydrologic process in the Karkheh River Basin (KRB) in southwest Iran and to evaluate the impacts of engineering projects on its wetland (Al Hawizeh) located in the Iran-Iraq border. Calibration, validation, and uncertainty analysis were performed using Sequential Uncertainty Fitting Ver. 2 (SUFI2), which is one of the program interfaces with SWAT, in the Package SWAT Calibration Uncertainty Programs (SWAT-CUP). To assess the goodness of calibration and validation, four measures were applied: (i) percentage of data bracketed by 95% prediction uncertainty or P-factor (95PPU) calculated at 2.5% and 97.5% intervals of the simulated variables, (ii) R-factor, which is the ratio of average thickness of the PPU, (iii) Nash-Sutcliffe coefficient (NSE), and (iv) determination of coefficient (R^2). Stream flows from four gauge stations combined with 14 synoptic stations were used for calibration (1987-1990) and validation (1991-1994). The P-factor values for these stations ranged from 0.64 to 0.84 and from 0.65 to 0.79 for calibration and validation, respectively. These results showed reasonable accuracy according to literature. NSE values were also acceptable, ranging from 0.52 to 0.8 and from 0.62 to 0.72 for calibration and validation, respectively. R^2 values were also within an acceptable range. The calibration and validation results were then used to simulate two watershed scenarios (with and without a dam). In addition, annual flow volumes (AFVs) for two downstream stations (Hamidiyeh and Pay e Pol) were computed. AFV is defined as the volume of water that discharges from catchment at the desired output during a year. The results showed that the flows during 1987-2000 (before dam construction) and 2001 to 2010 (after dam construction) were significantly reduced after the Karkheh dam construction. The corresponding AFVs for the Hamidiyeh and Pay e Pol stations were 8.92×10^{11} and 1.04×10^{12} m³ in 1987-2000 and 2.57×10^{11} to 3.94×10^{11} m³ in 2001-2010. Thus, the AFVs before and after dam construction were reduced to 6.34×10^{11} and 6.53×10^{11} m³ for the Hamidiyeh and Pay e Pol gauges, respectively. Consequently, flow reduction affected the wetland area, in which the surface area of the wetland was reduced and dust emission was increased.

Keyword: Simulation; SWAT model; SUFI-2; Uncertainty analysis; Engineering projects; KRB