

Evaluation of SWAT Hydrological Model for Streamflow Simulation in Yasu River Basin, Japan

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1. Introduction

Fresh water is one of the fundamental requirement across every sector of life. With numerous utilization, it drives both social and economic sector. Even though its importance is realized, high threats lie towards its future availability. With increased population, water demand is overwhelming at every point of use. Vast pollution and climate change also rises great concerns to its sustainability [1, 2]. Addressing these challenges has been hindered by lack of comprehensive understanding of hydraulic and climatic system. They not only behave in a nonlinear manner but also their interaction is complex as well [3]. It is of great importance to put effort in understanding the natural system of hydrology prior to confronting these critical issues. Hydrological modelling is therefore inevitable as far as decision making is of concern. They play a vital role in water resource management, dynamic interaction of climate, surface and ground water [4].

With different hydrological models already developed, one of the most used is Soil Water Assessment Tool (SWAT) model. It is process based, computationally efficient, and capable of continuous simulation over long time periods [5]. In conducting the modeling procedure, SWAT CUP (Calibration and Uncertainty Procedures) is applied. It integrates various calibration and uncertainty analysis techniques for SWAT in one interface [6]. The main objective of this study entailed simulation of streamflow in Yasu River basin using SWAT hydrological model. Specific aim included conducting parameter sensitivity analysis, model calibration, validation and uncertainty analysis.

2. Model Application

2.1 Study area and dataset

The model was applied in Yasu River basin. It is located in Honshu Island Japan and lies between

coordinates N 35° 07' and E 135° 58'. It originates from Mount Gozaisho and drains into Lake Biwa. The basin has a catchment area of 377 km² with a total length of 65 km from the source to mouth. The watershed has undulating topography ranging from 97 m to 1,235 m above sea level. Four climatic seasons of summer, autumn, winter and spring are experienced around the year. The basin receives high amount of rainfall with a mean of 1,587 mm per annum. **Figure 1** shows the location of the study area.

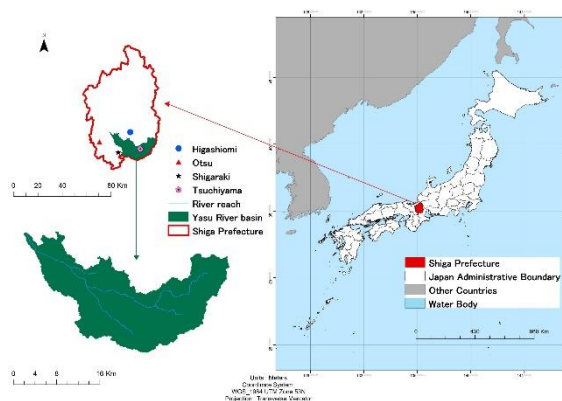


Figure 1: Location of Yasu River basin

Spatial datasets included Digital Elevation Model (DEM), land use and soil data obtained from Shiga prefecture. DEM was used for watershed and sub-basin delineation covering the entire process of flow direction, flow accumulation and stream network generation.

Temporal datasets comprised of climatic and hydrological data from the year 1990 to 2000. Climate data included precipitation, temperature, humidity, wind and solar radiation. Four stations served as the source of climatic data, these included Higashiomi, Otsu, Shigaraki and Tsuchiyama. Hydrological data included discharge from gauging station downstream, reservoir inlet and outlet discharge from Ozuchi and Yasu River Dam.

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2.2 Sensitivity analysis, calibration, validation and uncertainty analysis

Sensitivity analysis was evaluated based on various parameters in the model. Different types of soil and land use in the watershed were catered for during calibration process. Period of calibration ranged from 1992 to 1996 while validation period was from 1997 to 2000. Uncertainty was conducted for both calibration and validation period. The performance of the model was evaluated based on NS (Nash–Sutcliffe) and R^2 (coefficient of determination).

3. Results and Discussion

Sensitive parameters were used for model calibration. The results of the model performance based on NS and R^2 as well as uncertainty analysis evaluated by P and R-factor are as shown in **Table 1** and **2** for the gauging station downstream and Ozuchi Dam respectively. Hydrographs for calibration and validation period at the gauging station are shown in **Figure 2** and **3** respectively.

Table 1: Simulation results at the gauging station gown stream

	Calibration	Validation
NS	0.77	0.88
R^2	0.9	0.89
P-factor	0.74	0.71
R-factor	0.51	0.81

Table 2: Simulation results at Ozuchi Dam

	Calibration	Validation
NS	0.82	0.66
R^2	0.93	0.81
P-factor	0.12	0.17
R-factor	0.77	0.78

4. Conclusion

The study provided an approach for streamflow simulation based on SWAT model in Yasu River basin. Consequently, sensitivity analysis, calibration, validation and uncertainty analysis was carried out.

The optimization technique used gave acceptable results based on evaluation performance. Simulated hydrograph during

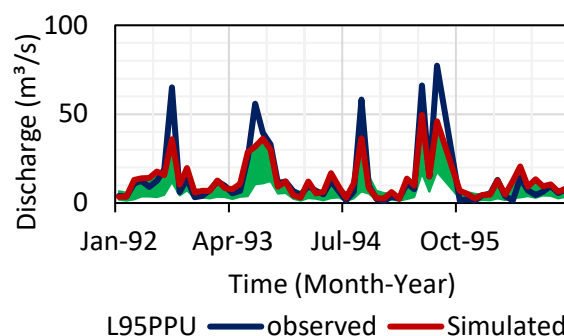


Figure 2: Observed and simulated hydrograph for calibration period

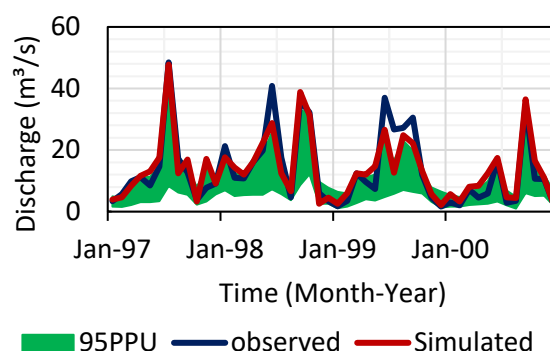


Figure 3: Observed and simulated hydrograph for validation period

calibration and validation period yielded high values of NS and R^2 . The model therefore, can be utilized for critical decision making in Yasu River basin.

Reference

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