Hydrologic calibration of BASINS/WinHSPF using genetic algorithm

Calibration hydrologique de BASINS/WinHSPF utilisant l'algorithme génétique

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RÉSUMÉ

En terme de TMDLs (Total Maximum Daily Loads), le rôle du flux standard et des charges de pollution diffuse est très important. Dans cette étude, les BASINS 4.0 et WinHSPF ont été utilisés comme des travaux préparatoires afin d'estimer le flux standard et les charges de pollution diffuse de la rivière Whangyong. L'algorithme de coefficient d'influence et l'algorithme génétique ont été utilisés afin de calibrer les paramètres du ruissellement de WinHSPF. La fonction objectif du problème d'optimisation est la somme des carrés des résidus normalisés du flux observé et calculé. L'algorithme de coefficient d'influence a été utilisé afin d'estimer les paramètres du ruissellement et déterminer la valeur des paramètres du ruissellement comme le paramètre optimal dans lequel la somme des carrés des résidus normalisés devient minimum. Après la calibration du WinHSPF, en utilisant des données de flux mesurées et recueillies avec les intervalles de huit jours pendant 2 ans, les résultats de calibration a montré une correspondance relativement bonne entre les valeurs observées et les valeurs calculées.

ABSTRACT

Standard flow and diffuse pollution loads are critical for determining total maximum daily loads. In this study, Better Assessment Science Integrating point & Non-point Sources (BASINS 4.0) and the Hydrologic Simulation Program–Fortran (WinHSPF) were used to estimate the standard flow and the diffuse pollution loads of Whangyong River. Influence coefficient algorithm and genetic algorithm were used to calibrate the runoff parameters of the WinHSPF. The objective function of the optimization problem is the sum of the squares of the normalized residuals of the observed and calculated flow. After calibrating the WinHSPF, using measured flow data collected with intervals of 8 days, the calibration results showed a relatively good correspondence between the observed and the calculated values.

KEYWORDS

BASINS4.0/WinHSPF, calibration, genetic algorithm, influence coefficient algorithm, standard flow.

1 INTRODUCTION

Standard flow of the Whangyong River (Youngsan River Watershed, Korea) was estimated using BASINS 4.0/WinHSPF of US EPA. Normally, the parameters of WinHSPF are calibrated manually by trial and error, but this method lacks objectivity. Therefore, we used GA (Gen and Cheng, 1997) and Influence coefficient algorithm (Becker and Yeh, 1972; Cho et al., 2010) to optimize the parameters of WinHSPF and estimate the standard flow and total maximum daily loads (TMDLs) of the Whangyoung River.

2 METHODS

DEM of Whangyong River watershed and the Land use map of the area were prepared for the application of BASINS. We used the automatic delineation function of BASINS 4.0 (developed from the MapWindow, an open source GIS software) to draw the layer of subbasin and watershed required for the operation of BASINS and WinHSPF. The hourly weather data and daily weather data of Gwangju meterorological office was used for the application of WinHSPF. With these layers and Watershed Data Management (WDM), WinHSPF was launched, we used an influence coefficient algorithm and GA to calibrate the runoff parameters. Phased iterative process was used to determine the runoff parameters of the model in which the sum of the squares of the normalized residuals of the observed and calculated flow was minimized as the optimum parameters. The 11 final calibration parameters are LZSN, INFILT, KVARY, AGWRC, DEEPFR, BASETP, UZSN, NSUR, INTFW, IRC of Pervious Land and NSUR of Impervious Land. The flow data used in the calibration for TMDLs was the measured flow collected in 2009 and 2010 at intervals of 8 days.

3 RESULTS AND DISCUSSION

By launching WinHSPF from BASINS, and producing the HSPF UCI (User Control Input) file, a WinHSPF project concerning Whangyong River was made (Fig. 1). The difference between predicted and observed flows for the Whangyong River are shown in Fig. 2. The measured flow data and the calculated flow data corresponded fairly well. This calibrated runoff parameter was used to estimate the standard flow of Q275 low flow of the Whangyong River. The estimated standard flow for each year ranged from 1.63 - 3.88 m^3/sec. and the average standard flow of the last ten years, in other words, the standard flow of Korean TMDLs was 2.71 m^3/sec.

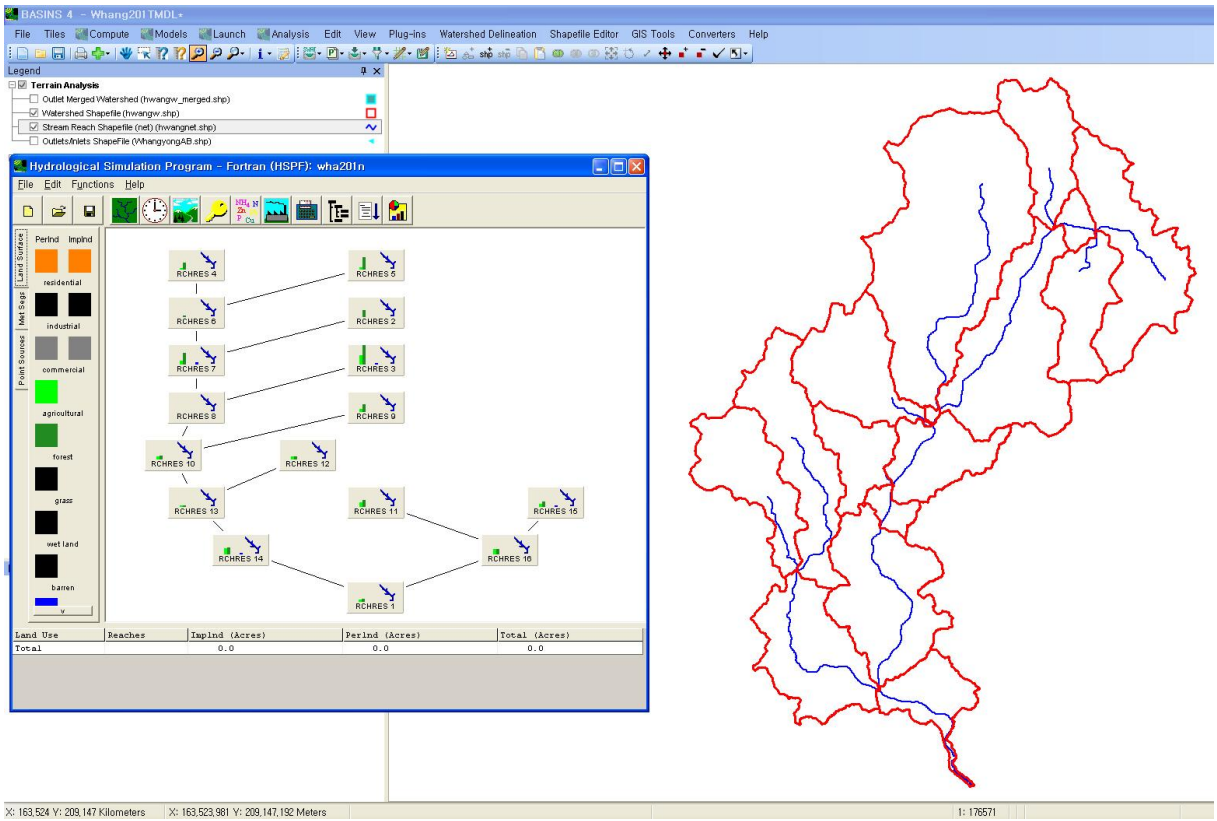

Figure 1. WinHSPF for Whangyong River.

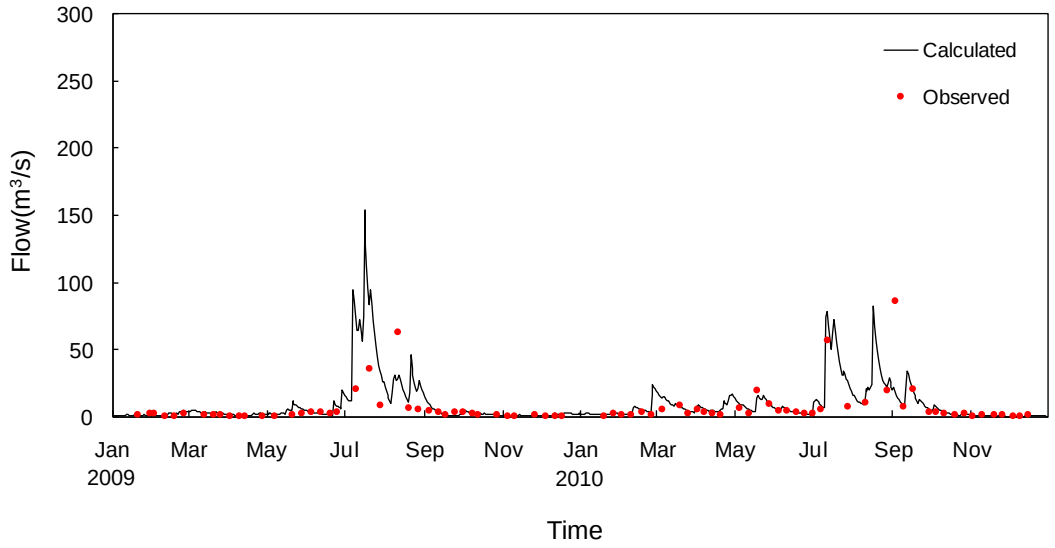

Figure 2. Calibration results of Whangyong River flow

4 CONCLUSION

1) BASINS 4.0 and WinHSPF of US EPA was successfully applied to Whangyong River in Korea.
2) Influence coefficient algorithm and GA was used to calibrate the runoff parameters of WinHSPF. Calculated flow of calibration properly descripts the measured flow.
3) The estimated standard flow of the Whangyong River was 2.71 m^3/sec.

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