

Supplementary Materials

1. Initial Parameters Selection

In this study, 21 parameters, which were related to runoff simulation, were first selected from previous literature. Those parameters were selected from six process categories, including runoff, soil, groundwater, evaporation, channel and snow [1,2] (Table S1).

Table S1. Parameters used in the sensitivity analysis.

NO.	Name	Definition	Classification
1	CN2 [1-10]	SCS curve number for moisture condition II	Runoff
2	SOL_K [2,3,6,8]	Soil saturated hydraulic conductivity	Soil
3	SOL_AWC [1,3,4,6-9]	Available water capacity of the soil layer	Soil
4	SOL_BD [1,8]	Moist bulk density	Soil
5	SOL_Z [3,4]	Depth from soil surface to the bottom of layer	Soil
6	ALPHA_BF [2-9]	Base flow alpha factor	Groundwater
7	REVAPMN [1,2,4,6-9,11]	Threshold depth of water in the shallow aquifer required for "revap" to occur	Groundwater
8	GW_DELAY [1-9,11]	Ground water delay	Groundwater
9	GW_REVAP [1-3,5,6,8,9,11]	Groundwater "revap" coefficient	Groundwater
10	RCHRG_DP [1,2,7,9,11]	Deep aquifer percolation fraction	Groundwater
11	GWQMN [1-3,5-9,11]	Threshold depth of water in the shallow aquifer required for return flow to occur	Groundwater
12	ESCO [1-9,11]	Soil evaporation compensation factor	Evaporation
13	EPCO [1-5,7,11]	Plant uptake compensation factor	Evaporation
14	CANMX [2,4,7,11]	Maximum canopy storage	Evaporation
15	CH_N2 [2,5,8,11]	Manning's "n" value for the main channel	Channel
16	CH_K2 [2,5-9,11]	Effective hydraulic conductivity in main channel alluvium	Channel
17	HRU_SLP [2,11]	Average slope steepness	Channel
18	SLSUBBSN [2,3]	Average slope length	Channel
19	OV_N [1,11]	Overland Manning roughness	Channel
20	SFTMP [1,2,6,8,9]	Snowfall temperature	Snow
21	SMTMP [1,2,6,8,9]	Snow melt base temperature	Snow

2. Key Sensitive Parameters Selection

The sensitivity and significance of each parameter were evaluated by the *t*-value and *P*-value, respectively. The *t*-values provided a measure of sensitivity (those larger in absolute values are more sensitive), while the *P*-values determined the significance of the sensitivity (a value close to zero means more significant) [12]. Based on the global sensitivity analysis and one-at-a-time sensitivity analysis in the SWAT-CUP, the parameters ranked according to model sensitivity from high to low were identified. In this study, the model was run 2000 times for sensitivity analysis, and the key sensitive parameters for the monthly and annual runoff simulations are listed in Tables S2 and S3, respectively.

3. Model Parameters Calibration

Those sensitive parameters were automatically calibrated using the sequential uncertainty fitting procedure, version 2 (SUFI-2) algorithm [12] with 2000 model runs. Each sensitive parameter was

calibrated. The optimal values of those parameters for the monthly and annual runoff simulations are listed in Tables S2 and S3, respectively.

Table S2. Key SWAT model parameters, with their final value range and fitted values for monthly simulations.

NO.	parameter	t-value	P-value	Variation	Range	Fitted value
1	ALPHA_BF	45.88	<0.01	Replace v	0.28 to 0.85	0.57
2	CN2	7.51	<0.01	Relative r	0.49 to 1	0.98
3	CANMAX	-4.44	<0.01	Replace	6.68 to 20.05	13.37
4	CH_K2	-3.86	<0.01	Replace	61.53 to 82.59	72.06
5	SLSUBBSN	-3.83	<0.01	Relative	-0.08 to 0.13	0.02
6	SOL_K	3.02	<0.01	Relative	0.21 to 0.65	0.43
7	HRU_SLP	2.72	<0.01	Relative	-0.06 to 0.20	0.07
8	GWQMN	2.69	<0.01	Replace	0 to 1324	677

*Relative means of an existing parameter value are multiplied by the (1+a given value), Replace means the default parameter is replaced by the given value.

Table S3. Key SWAT model parameters, with their final value range and fitted values for annual simulations.

NO.	parameter	t-value	P-value	Variation	Range	Fitted value
1	GWQMN	33.82	<0.01	Replace	0 to 2713	36.62
2	SOL_AWC	24.22	<0.01	Relative	0 to 1	0.87
3	HRU_SLP	-23.40	<0.01	Relative	-0.10 to 1	0.16
4	SOL_K	-22.3	<0.01	Relative	-0.80 to 0.40	0.31
5	SOL_Z	22.06	<0.01	Relative	-1.00 to 0.05	-0.86
6	CANMX	13.96	<0.01	Replace	5.00 to 18.29	17.69
7	SLSUBBSN	12.13	<0.01	Relative	-0.20 to 1.00	0.69
8	CN2	-8.95	<0.01	Relative	-0.30 to 0.50	0.01
9	GW_REVAP	3.65	<0.01	Replace	0.15 to 0.20	0.15

*Relative means of an existing parameter value are multiplied by the (1+a given value), Replace means the default parameter is replaced by the given value.

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