

Table 1. Physical properties in the monitored soil vertical profile.

Layer	Texture	Depth (mm)	Sand (%)	Silt (%)	Clay (%)	OC (%)	Bulk density (kg/dm ³)
1	Loam	0~400	34	48	18	0.6	1.41

Table 2. Summary of parameters in the coupling model and range.

Soil type	Parameter	Unit	Description	Range
Loam	θ_s	—	Saturated soil moisture content	0.45
	θ_r	—	Residual soil moisture content	0.05-0.08
	α	mm ⁻¹	Inverse of the air-entry value	0.001-0.004
	n	—	Pore-size distribution index	1.4-1.6
	K_s	mm/h	Saturated hydraulic conductivity	6-10
	l	—	Pore-connectivity parameter	0.5
	a	—	Correction coefficient	0.5-1.0
	B	—	Infiltration distribution curve index	0.3-0.6
	IMP	—	Impermeable surface ratio	0.41
	β	—	Runoff coefficient on impermeable surface	0.9

Table 3. The results of parameters.

Parameter	θ_s	θ_r	α	n	K_s	l	a	B	IMP	β
	(-)	(-)	(mm ⁻¹)	(-)	(mm/h)	(-)	(-)	(-)	(-)	(-)
Value	0.45	0.075	0.0013	1.5	7.95	0.5	0.65	0.36	0.41	0.9

Table 4. The results of evaluation indicators.

Simulation	Rainfall	Items	Depth (cm)	NSE	AE (%)
Calibration	160720	Soil moisture content	10	0.93	1.73
			20	0.59	2.30
			40	0.50	2.24
		Soil average moisture content	—	0.78	1.88
		Discharge coefficient		0.68	
	160724	Soil moisture content	10	0.46	0.68
			20	0.66	0.36
			40	0.80	0.52
		Soil average moisture content	—	0.74	0.42
		Discharge coefficient		0.33	
	160801	Soil moisture content	10	0.66	1.61
			20	0.81	1.46
			40	0.64	1.84
		Soil average moisture content	—	0.87	1.00
		Discharge coefficient		0.61	
	160807	Soil moisture content	10	0.80	1.37
			20	0.39	1.80
			40	0.82	0.52
			—	0.63	1.35
		Discharge coefficient		0.77	
Validation	160818	Soil moisture content	10	0.69	0.66

Simulation	Rainfall	Items	Depth (cm)	NSE	AE (%)
			20	0.71	0.72
			40	0.56	0.68
			—	0.78	0.61
		Discharge coefficient		0.36	
			10	0.65	1.67
170706		Soil moisture content	20	0.70	0.88
			40	0.60	0.14
		Soil average moisture content	—	0.74	0.68
		Discharge coefficient		0.48	
			10	0.73	4.59
170709		Soil moisture content	20	0.36	1.72
			40	0.67	0.91
		Soil average moisture content	—	0.83	1.60
		Discharge coefficient		0.52	

Table 5. Rainfall classification.

24h Rainfall (mm)	0.1-10	10-25	25-50	50-100	100-200	>200
Grade	light rain	moderate rain	heavy rain	hard rain	rainstorm	very heavy rainstorm
	1	2	3	4	5	6

Table 6. Rainfall classification of rainfall events.

Case	1	2	3	4	5	6	7
Rainfall event	160720	160807	170706	160724	160818	170709	160801
Rainfall (mm)	221.8	92	49.4	38.2	35.2	33.4	31.2
Grade	6	4	3	3	3	3	3

Table 7. Calculation results of surface runoff.

Cas e	Rainfall event	Rainfall (mm)	R₁ (mm)	R₂ (mm)	R_z (mm)	C₁	C_z	$\frac{C_z - C_1}{C_1} (\%)$
1	160720	221.80	150.33	199.62	170.54	0.68	0.77	13.24
2	160807	92.00	70.59	82.80	75.60	0.77	0.82	6.50
3	170706	49.40	23.48	44.46	32.08	0.48	0.65	35.42
4	160724	38.20	12.55	34.38	21.50	0.33	0.56	69.70
5	160818	35.20	12.61	31.68	20.43	0.36	0.58	61.11
6	170709	33.40	17.37	30.06	22.57	0.52	0.68	30.77
7	160801	31.20	19.13	28.08	22.80	0.61	0.73	19.67

Note:(1) C₁ is the runoff coefficient on the permeable surface.

(2) C_z is the average runoff coefficient in the study area.

Table 8. The results of vertical groundwater recharge.

Case	Rainfall event	Rainfall (mm)	F (mm)	Groundwater depth(m)		$\overline{\Delta G}$ (mm)	ΔR_v (mm)	Proportion (%)
				Initial	end			
1	160720	221.80	71.47	2.06	1.67	19.79	14.89	75.25
2	160807	92.00	14.40	1.05	0.83	11.16	8.66	77.58
3	170706	49.40	25.92	1.13	1.13	0	0	-
4	160724	38.20	25.65	1.22	1.03	9.54	7.84	82.18
5	160818	35.20	23.02	0.93	0.78	7.61	7.14	93.81
6	170709	33.40	11.64	1.13	1.13	0	0	-
7	160801	31.20	10.59	1.05	0.94	6.60	4.24	64.28
mean								78.62

Note: $\overline{\Delta G}$ is the average groundwater recharge amount (water depth). ΔR_v is the vertical groundwater recharge calculated by GA-HYDRUS model. Proportion means the vertical groundwater recharge accounts for the amount of groundwater recharge.