

**Table S1** Errors between the calculated NO<sub>3</sub>-N concentration values and the monitored NO<sub>3</sub>-N concentration values for the three machine learning algorithms during the validation period

Machine learning algorithm	Mean absolute error	Root mean square error	Correlation coefficient	Nash efficiency coefficient
LSTM	0.05	0.91	0.98	0.98
RF	1.45	3.59	0.93	0.62
SVR	0.09	2.98	0.94	0.80

**Table S2** Optimal allocation of water resources under wet year in 2025

Hydrological year type	Groundwater exploitation regime	Water source type	Domestic water (10 <sup>4</sup> m <sup>3</sup> )	Industrial water (10 <sup>4</sup> m <sup>3</sup> )	Agricultural water (10 <sup>4</sup> m <sup>3</sup> )	Ecological water (10 <sup>4</sup> m <sup>3</sup> )	Total water consumption (10 <sup>4</sup> m <sup>3</sup> )	Available water (10 <sup>4</sup> m <sup>3</sup> )
Wet year	Current groundwater exploitation regime	Surface water	0	0	0	0	0	1572.00
		Groundwater	10128.41	1021.48	10021.23	284.97	21456.09	22450.66
		Reclaimed water	8.85	0.00	0	14728.71	14737.56	15987.00
		Transferred water	2546.02	53.98	0	0	2600.00	2600.00
		Total water consumption	12683.28	1075.46	10021.23	15013.68	38793.65	42609.66
		Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
		Water supply guarantee rate	100%	100%	100%	100%	100%	
	Groundwater exploitation regime 1	Surface water	0	0	1572	0	1572	1572.00
		Groundwater	7965.79	215.09	8449.23	0	16630.11	21469.20
		Reclaimed water	2117.49	860.37	0	13009.14	15987	15987.00
		Transferred water	2600	0	0	0	2600	2600.00
		Total water consumption	12683.28	1075.46	10021.23	13009.14	36789.11	41628.20
		Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
		Water supply guarantee rate	100%	100%	100%	86.65%	94.83%	
	Groundwater exploitation regime 2	Surface water	0	0	1572	0	1572	1572.00
		Groundwater	7965.79	215.09	8449.23	0	16630.11	17651.93
		Reclaimed water	2117.49	860.37	0	13009.14	15987	15987.00
		Transferred water	2600	0	0	0	2600	2600.00

	Total water consumption	12683.28	1075.46	10021.23	13009.14	36789.11	37810.93
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	100%	100%	100%	86.65%	94.83%	
	Surface water	0	0	1572	0	1572	1572
	Groundwater	7965.79	215.09	8449.23	0	16630.11	16805.84
Groundwater	Reclaimed water	2117.49	860.37	0	13009.14	15987.00	15987.00
exploitation	Transferred water	2600	0	0	0	2600.00	2600.00
regime 3	Total water consumption	12683.28	1075.46	10021.23	13009.14	36789.11	36964.84
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	100%	100%	100%	86.65%	94.83%	

**Table S3** Optimal allocation of water resources under normal year in 2025

Hydrological year type	Groundwater exploitation regime	Water source type	Domestic water (10 <sup>4</sup> m <sup>3</sup> )	Industrial water (10 <sup>4</sup> m <sup>3</sup> )	Agricultural water (10 <sup>4</sup> m <sup>3</sup> )	Ecological water (10 <sup>4</sup> m <sup>3</sup> )	Total water consumption (10 <sup>4</sup> m <sup>3</sup> )	Available water (10 <sup>4</sup> m <sup>3</sup> )
		Surface water	0	0	0	0	0	1572.00
		Groundwater	10128.41	1021.48	10021.23	284.97	21456.09	18086.54
	Current	Reclaimed water	8.85	0	0	14728.71	14737.56	15987.00
	groundwater	Transferred water	2546.02	53.98	0	0	2600.00	2600.00
	exploitation	Total water consumption	12683.28	1075.46	10021.23	15013.68	38793.65	38245.54
	regime	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
		Water supply guarantee rate	100%	100%	100%	100%	100%	
		Surface water	0	0	1572.00	0	1572.00	1572.00
		Groundwater	7965.79	215.09	8364.71	0	16545.59	16545.59
Normal year	Groundwater	Reclaimed water	2117.49	860.37	0	13009.14	15987.00	15987
	exploitation	Transferred water	2600	0	0	0	2600.00	2600.00
	regime 1	Total water consumption	12683.28	1075.46	9936.71	13009.14	36704.59	36964.84
		Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
		Water supply guarantee rate	100%	100%	99.16%	86.65%	94.61%	
	Groundwater	Surface water	0	0	1572.00	0	1572.00	1572.00
	exploitation	Groundwater	7133.65	198.87	5885.04	0	13217.56	13217.56
	regime 2	Reclaimed water	2949.63	876.59	890.03	11270.75	15987.00	15987.00

	Transferred water	2600	0	0	/	2600	2600.00
	Total water consumption	12683.28	1075.46	8347.07	11270.75	33376.56	33376.56
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	100%	100%	83.29%	75.07%	86.04%	
	Surface water	0	0	1572.00	0	1572.00	1572.00
	Groundwater	7896.65	205.32	4406.37	0	12508.34	12508.34
Groundwater	Reclaimed water	2186.63	870.14	2387.95	10542.28	15987	15987.00
exploitation	Transferred water	2600	0	0	0	2600.00	2600.00
regime 3	Total water consumption	12683.28	1075.46	8366.32	10542.28	32667.34	32667.34
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	100%	100%	83.49%	70.22%	84.21%	

**Table S4** Optimal allocation of water resources under dry year in 2025

Hydrological year type	Groundwater exploitation regime	Water source type	Domestic water (10 <sup>4</sup> m <sup>3</sup> )	Industrial water (10 <sup>4</sup> m <sup>3</sup> )	Agricultural water (10 <sup>4</sup> m <sup>3</sup> )	Ecological water (10 <sup>4</sup> m <sup>3</sup> )	Total water consumption (10 <sup>4</sup> m <sup>3</sup> )	Available water (10 <sup>4</sup> m <sup>3</sup> )
Dry year	Current groundwater exploitation regime	Surface water	0	0	0	0	0	1572.00
		Groundwater	10128.41	1021.48	11603.53	284.97	23038.39	14931.44
		Reclaimed water	8.85	0	0	14728.71	14737.56	15987.00
		Transferred water	2546.02	53.98	0	0.00	2600.00	2600.00
		Total water consumption	12683.28	1075.46	11603.53	15013.68	40375.95	35090.44
		Water demand	12683.28	1075.46	11603.53	15013.68	40375.95	
		Water supply guarantee rate	100%	100%	100%	100%	100.00%	
	Groundwater exploitation regime 1	Surface water	0	0	1001.00	0	1001.00	1001.00
		Groundwater	7906.81	74.06	4400.89	0	12381.76	12381.76
		Reclaimed water	2117.49	990.68	2364.36	10514.47	15987.00	15987.00
		Transferred water	2600	0	0	0	2600.00	2600.00
		Total water consumption	12624.3	1064.74	7766.25	10514.47	31969.76	31969.76
		Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
		Water supply guarantee rate	99.53%	99.00%	77.50%	70.03%	82.41%	
		Surface water	0	0	1001.00	0	1001.00	1001.00
		Groundwater	7838.16	129.5	1926.38	0	9894.04	9894.04

Groundwater exploitation regime 2	Reclaimed water	2117.49	882.05	3302.58	9684.88	15987.00	15987.00
	Transferred water	2600	0	0	0	2600.00	2600.00
	Total water consumption	12555.65	1011.55	6229.96	9684.88	29482.04	29482.04
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	98.99%	94.06%	62.17%	64.51%	76.00%	
Groundwater exploitation regime 3	Surface water	0	0	1001.00	0	1001.00	1001.00
	Groundwater	6952.22	71.1	2296.29	0	9319.61	9319.61
	Reclaimed water	2522.77	989.66	2957.19	9517.38	15987.00	15987.00
	Transferred water	2600	0	0	0	2600.00	2600.00
	Total water consumption	12074.99	1060.76	6254.48	9517.38	28907.61	28907.61
	Water demand	12683.28	1075.46	10021.23	15013.68	38793.65	
	Water supply guarantee rate	95.20%	98.63%	62.41%	63.39%	74.52%	