

Table 1 Descriptive statistics of hydrochemistry characteristics of surface water in irrigation and non-irrigation periods in Shiyang River Basin (mg L⁻¹)

Time	Sampling point	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	NH ₄ ⁺	HCO ₃ ⁻	SO ₄ ²⁻	Cl ⁻	NO ₃ ⁻	TDS	pH
Irrigation period	M1	30.25	15.41	5.32	0.85	0.04	54.44	21.68	3.04	1.79	186.22	8.12
	M2	45.24	17.00	6.10	0.98	0.12	65.16	40.60	2.72	2.19	223.22	7.96
	M3	36.49	12.85	6.29	0.86	0.07	62.62	19.89	1.46	2.03	270.86	8.01
	M4	44.28	14.00	8.72	0.96	0.10	62.89	34.96	6.25	8.79	326.14	7.84
	M5	18.11	7.26	9.56	0.33	-	2.21	31.22	2.14	1.40	162.20	7.94
	O1	19.57	6.46	15.57	2.57	0.97	35.34	15.07	7.03	5.74	202.01	8.27
	O2	21.53	13.23	45.45	1.25	0.05	29.39	41.75	19.49	5.92	381.85	8.10
	O3	30.08	10.82	12.99	1.09	1.25	46.36	23.08	5.09	3.18	266.18	7.95
	O4	32.94	16.43	24.71	2.51	0.27	59.37	30.67	12.08	1.37	312.89	7.97
	Average	30.94	12.61	14.97	1.27	0.36	46.42	28.77	6.59	3.60	259.06	8.02
STD	9.43	3.55	12.22	0.72	0.45	19.67	8.85	5.50	2.47	68.22	0.12	
C.V./%	30.49	28.19	81.64	56.98	124.37	42.38	30.78	83.52	68.52	26.33	1.50	
Non-irrigated period	M1	45.80	19.06	7.51	1.40	0.31	74.62	35.12	4.82	3.72	268.64	7.93
	M2	60.41	22.52	9.16	1.06	0.04	83.07	45.08	1.49	1.42	301.17	7.94
	M3	55.80	17.54	9.40	1.03	0.11	77.66	37.39	2.51	2.28	349.33	7.94
	M4	59.38	19.49	12.73	1.14	0.22	95.74	35.02	3.74	2.32	391.83	7.28
	M5	32.05	10.92	12.68	0.47	-	68.07	36.94	2.54	1.20	217.00	7.91
	O1	40.54	12.77	27.98	4.87	5.11	85.18	26.11	14.35	6.05	360.08	8.24
	O2	35.68	18.16	44.82	2.01	-	78.63	28.63	16.09	2.53	446.17	8.03
	O3	51.93	21.47	36.5	4.59	2.83	85.58	35.96	19.28	14.01	520.3	7.96

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O4	27.30	10.45	17.57	1.70	0.42	48.62	18.03	8.48	2.05	257.47	8.05
Average	45.43	16.93	19.83	2.03	1.29	77.46	33.14	8.15	3.95	345.78	7.92
STD	11.53	4.22	12.70	1.50	1.80	12.56	7.37	6.36	3.81	91.41	0.25
C.V./%	25.37	24.93	64.08	73.82	139.57	16.22	22.23	78.03	96.42	26.44	3.11

Table 2 Principal Component Load

Elements	Component		
	PC 1	PC 2	PC 3
Ca ²⁺ (meq/L)	0.897	0.039	-0.001
Mg ²⁺ (meq/L)	0.968	-0.015	0.003
Na ⁺ (meq/L)	0.974	-0.025	0.020
K ⁺ (meq/L)	0.956	0.013	-0.002
NH ₄ ⁺ (meq/L)	-0.036	0.735	0.675
Cl ⁻ (meq/L)	0.980	0.010	0.006
SO ₄ ²⁻ (meq/L)	0.859	-0.025	-0.025
NO ₃ ⁻ (meq/L)	0.001	0.742	-0.670
HCO ₃ ⁻ (meq/L)	0.871	0.033	0.024
% of variance	67.318	11.134	11.130
% of cumulative	67.318	78.452	89.582

Table 3 Changes in water pollution indicators in the Shiyang River Basin

Year	Sewage outlet	Sewage into river (100 million tons)	Compliance emission (100 million tons)	Chemical oxygen demand (10,000 tons)	Ammonia nitrogen emissions (10,000 tons)	Proportion of polluted river section (%)	Eutrophication ratio (%)
1999	—	0.7669	0.0123	—	—	—	—
2000	—	0.8074	0.0129	—	—	—	—
2001	—	0.8479	0.0136	—	—	—	—
2002	—	0.9008	0.1621	—	—	—	—
2003	—	0.9170	0.1621	—	—	—	—
2004	—	0.3134	—	—	—	—	—
2005	—	1.0526	—	—	—	—	—
2006	—	0.9837	—	—	—	—	—
2007	—	0.8787	—	—	—	—	—
2008	—	0.8732	0.5070	—	—	—	—
2009	15	0.2114	—	0.2334	0.1151	—	0
2010	15	0.2116	—	0.2225	0.1097	—	0
2011	11	0.1934	—	0.5699	0.608	12.5%	0
2012	11	0.1944	—	0.5840	0.631	12.5%	0
2013	11	0.1934	—	0.5671	0.649	10.0%	0
2014	11	0.1934	—	0.5699	0.608	10.0%	0
2015	11	0.1934	0.1934	0.5699	0.608	10.0%	0
2016	11	0.3012	0.3012	0.4034	0.428	4.3%	0
2017	7	0.2972	0.2972	0.2144	0.537	4.3%	0
2018	9	0.3185	0.3185	0.2296	0.223	4.3%	0