

Supplementary Materials

Climate change and anthropological impacts on a karst aquifer: a multi-statistical assessment

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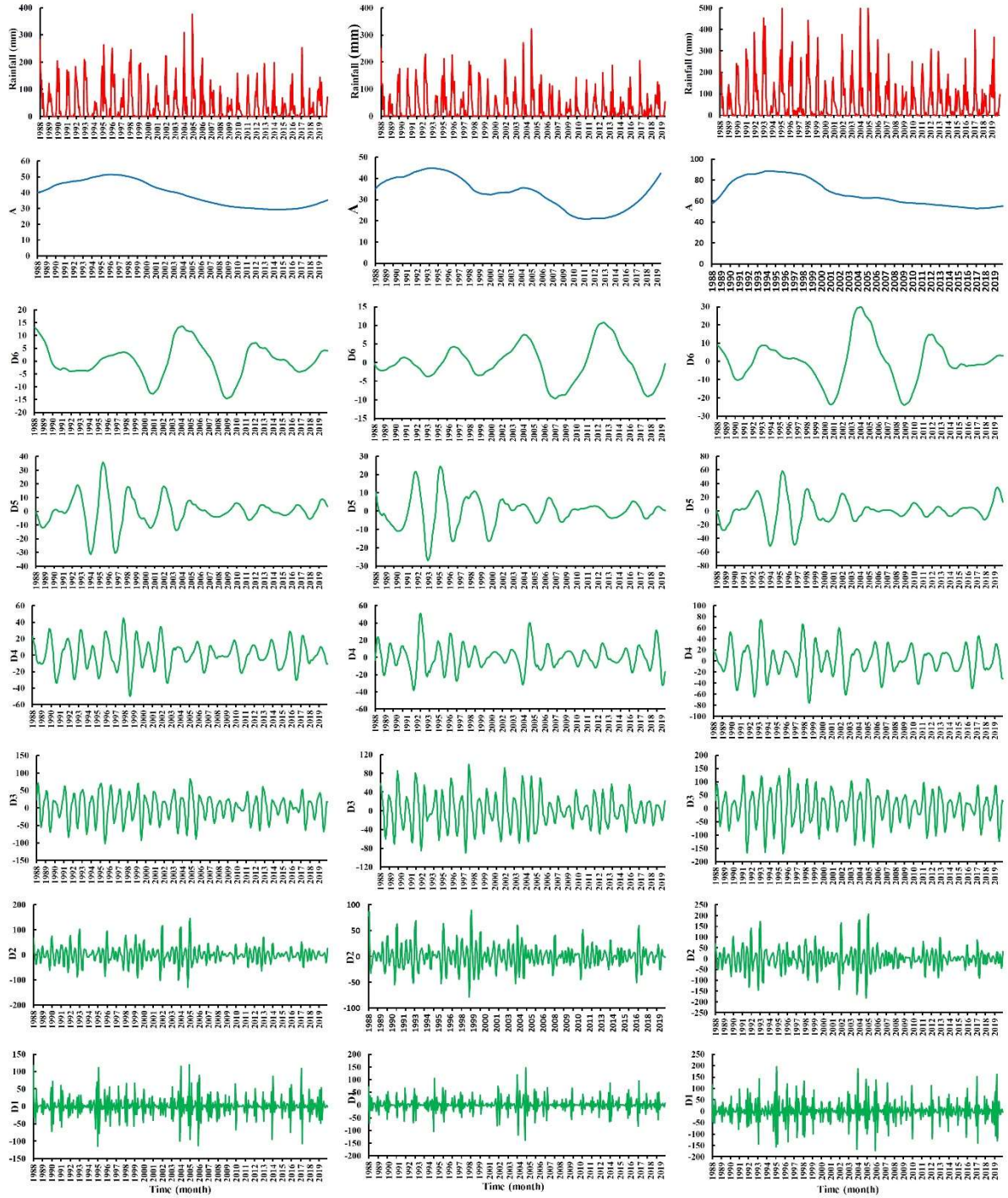


Figure S1 The original, approximate (A), and detailed components (D1-6) of the monthly time series resulted from DWT decomposition: rainfall at Kazerun station (left), rainfall at Parishan station (center), and rainfall at Dasht-Arjan station (right).

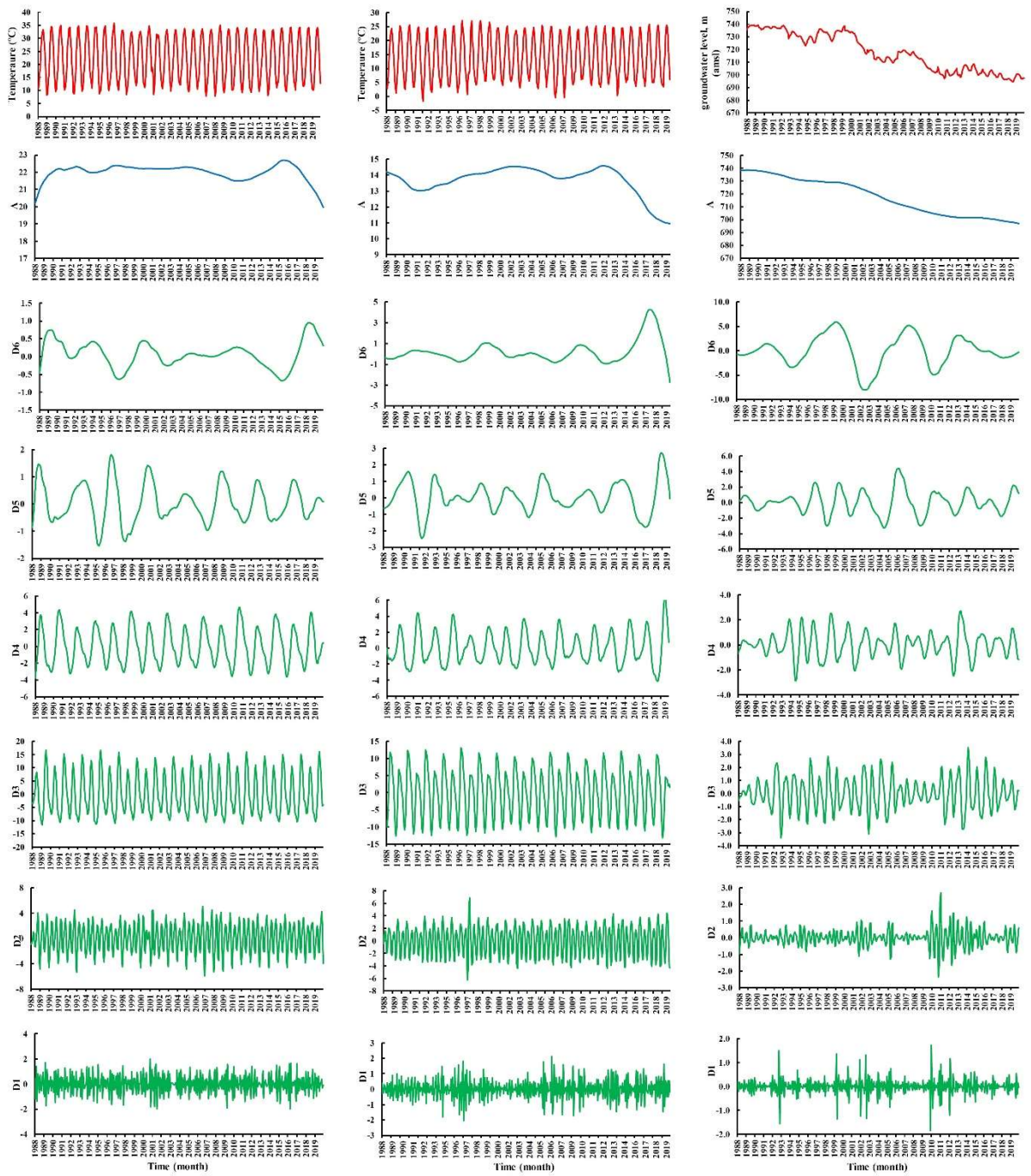


Figure S2 The original, approximate (A), and detailed components (D1-6) of the monthly time series resulted from DWT decomposition: temperature at Parishan station (left), temperature at Dasht-Arjan station (center), and groundwater level at P2 (right).

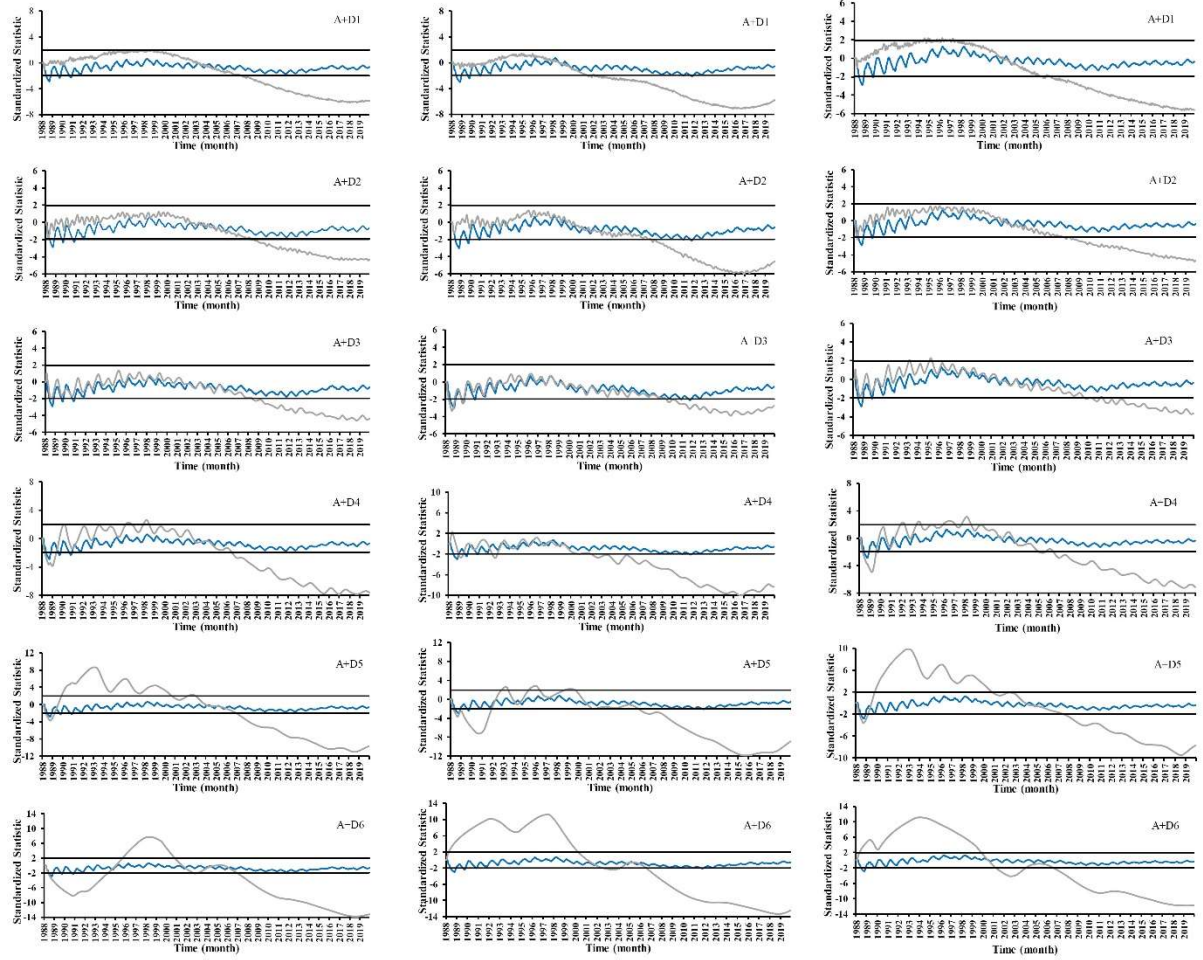


Figure S3 Sequential Mann–Kendall graphs for the original monthly time series versus their (A+Ds) components: rainfall at Kazerun station (left), rainfall at Parishan station (center), and rainfall at Dasht-Arjan station (right). (Blue solid line: progressive trend for the original time series; grey solid line: progressive trend for the A+Ds; black solid line: 95% confidence interval limits).

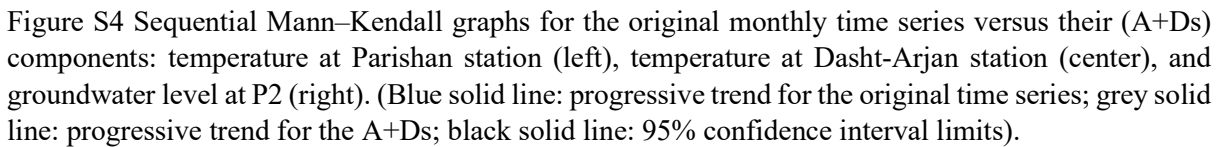


Figure S4 Sequential Mann–Kendall graphs for the original monthly time series versus their (A+Ds) components: temperature at Parishan station (left), temperature at Dasht-Arjan station (center), and groundwater level at P2 (right). (Blue solid line: progressive trend for the original time series; grey solid line: progressive trend for the A+Ds; black solid line: 95% confidence interval limits).

Table S1 The mean relative error (MRE) resulting from the application of the three border extension modes at two decomposition levels on the annual time series.

Station	Series	No. of data	Decomposition level (3)			Decomposition level (4)		
			ZP	SYM	PE	ZP	SYM	PD
Boushigan	Rainfall	32	0.255	0.209	0.218	0.257	0.212	0.340
Kazerun	Rainfall	32	0.266	0.228	0.237	0.290	0.230	0.336
	Temperature	32	0.132	0.019	0.021	0.151	0.021	0.055
Parishan	Rainfall	32	0.283	0.242	0.262	0.328	0.252	0.536
	Temperature	32	0.139	0.018	0.018	0.165	0.018	0.036
Dasht-Arjan	Rainfall	32	0.233	0.198	0.199	0.271	0.211	0.239
	Temperature	32	0.134	0.036	0.037	0.153	0.039	0.056
Piezometer	(P1)	32	0.135	0.005	0.005	0.160	0.005	0.006
	(P2)	32	0.135	0.004	0.004	0.162	0.004	0.004

Table S2 The relative error (RE) resulting from the application of the three border extension modes at two decomposition levels on the annual time series.

Station	Series	No. of data	Decomposition level (3)			Decomposition level (4)		
			ZP	SYM	PD	ZP	SYM	PD
Boushigan	Rainfall	32	0.355	0.389	0.395	0.467	0.336	0.264
Kazerun	Rainfall	32	0.305	0.144	0.321	0.472	0.246	0.438
	Temperature	32	0.942	0.333	0.281	0.996	0.161	0.885
Parishan	Rainfall	32	0.096	0.009	0.126	0.486	0.183	0.683
	Temperature	32	0.699	0.898	1.199	0.744	1.631	0.347
Dasht-Arjan	Rainfall	32	0.188	0.267	0.287	0.626	0.134	0.475
	Temperature	32	1.082	2.111	2.026	1.271	4.265	0.834
Piezometer	(P1)	32	0.895	0.332	0.315	0.898	0.286	0.208
	(P2)	32	0.888	0.162	0.179	0.895	0.201	0.184

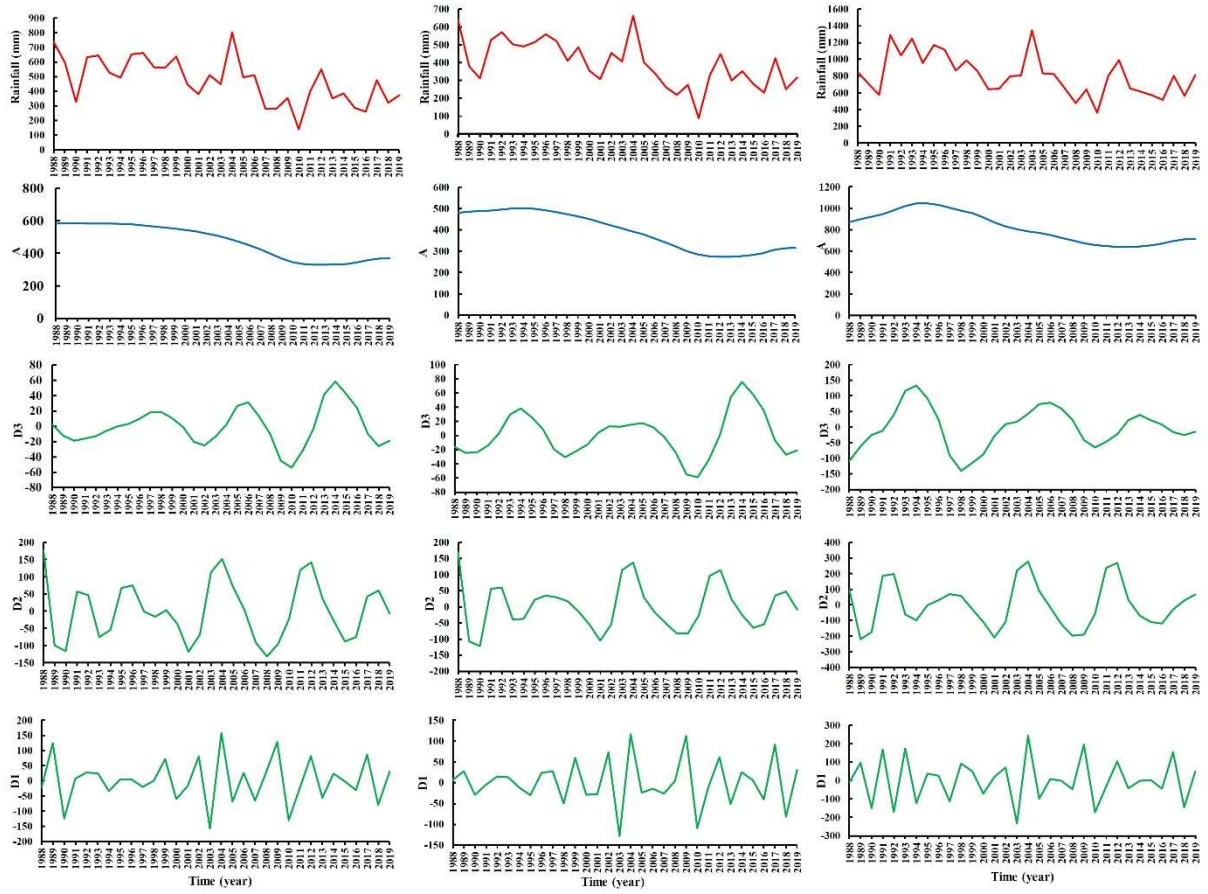


Figure S5 The original, approximate (A), and detailed components (D1-D3) of the annual time series resulted from DWT decomposition: rainfall at Kazerun station (left), rainfall at Parishan station (center), and rainfall at Dasht-Arjan station (right).

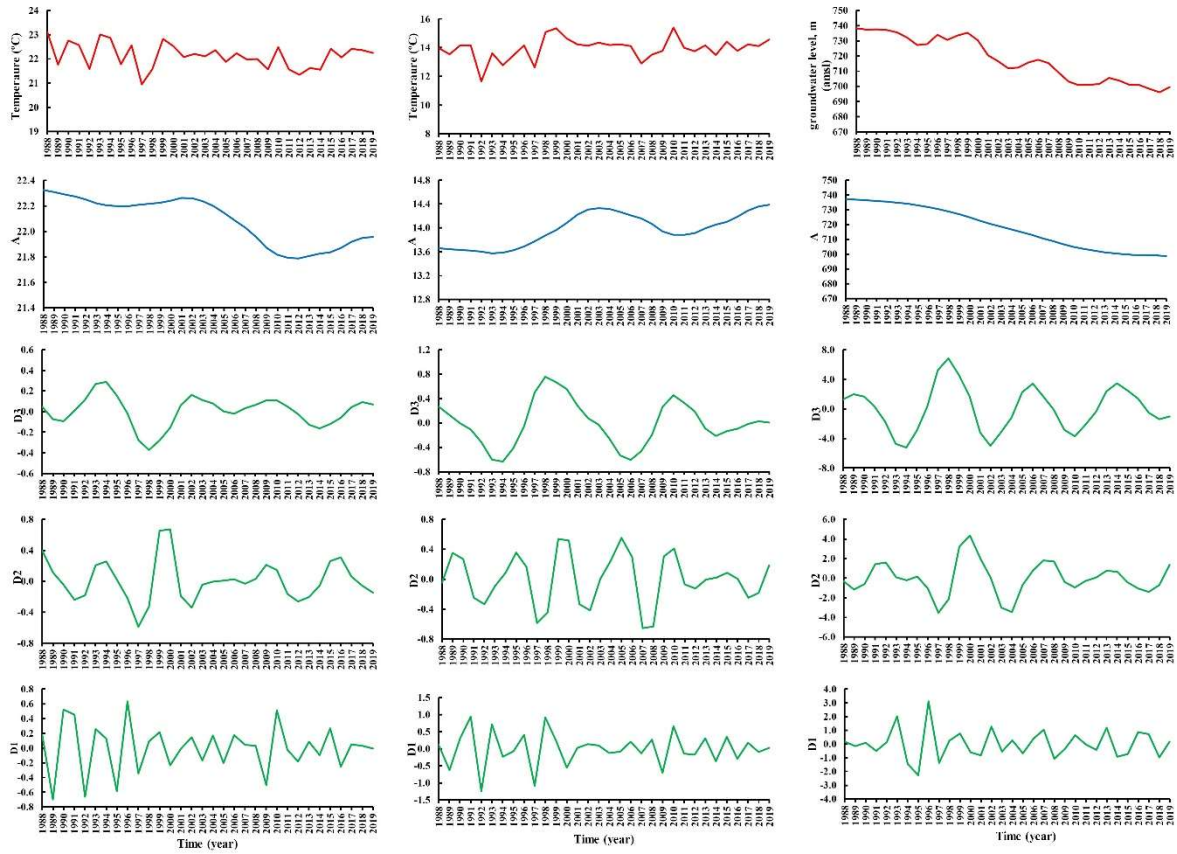


Figure S6 The original, approximate (A), and detailed components (D1-D3) of the annual time series resulted from DWT decomposition: temperature at Parishan station (left), temperature at Dasht-Arjan station (center), and groundwater level at P2 (right).

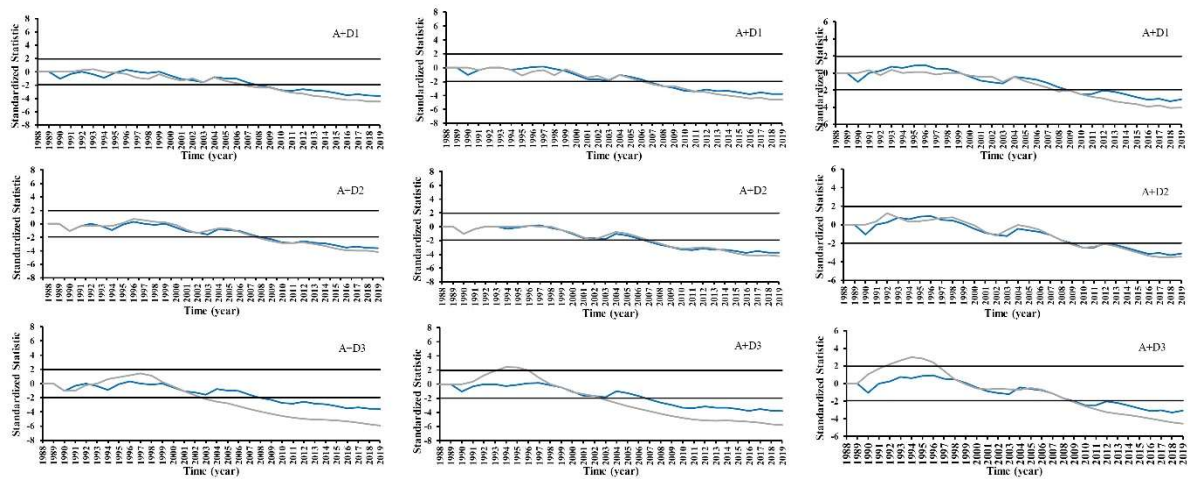


Figure S7 Sequential Mann-Kendall graphs for the original annual time series versus their (A+Ds) components: rainfall at Kazerun station (left), rainfall at Parishan station (center), and rainfall at Dasht-Arjan station (right). (Blue solid line: progressive trend for the original time series; grey solid line: progressive trend for the A+Ds; black solid line: 95% confidence interval limits).

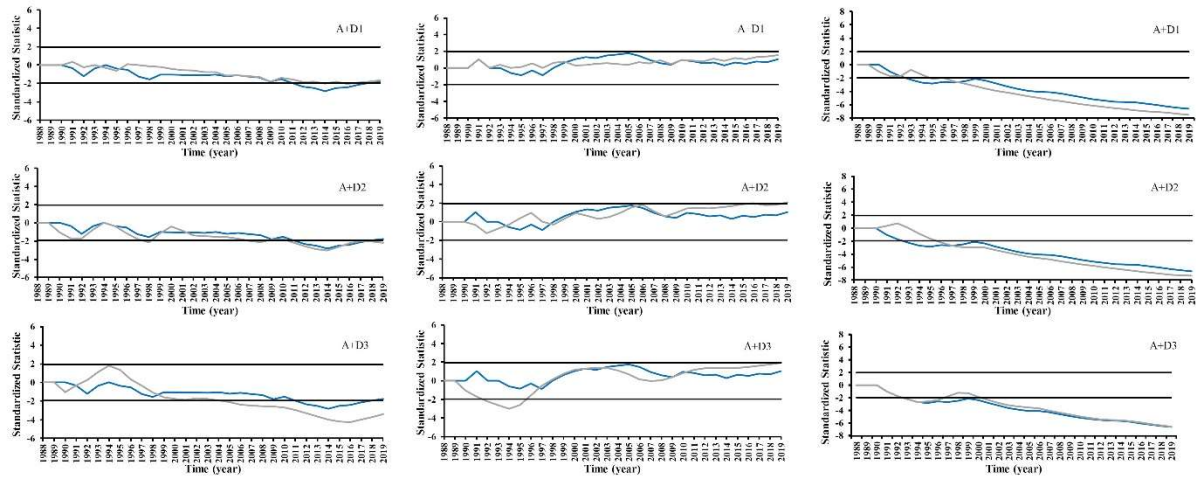


Figure S8 Sequential Mann–Kendall graphs for the original annual time series versus their (A+Ds) components: temperature at Parishan station (left), temperature at Dasht-Arjan station (center), and groundwater level at P2 (right). (Blue solid line: progressive trend for the original time series; grey solid line: progressive trend for the A+Ds; black solid line: 95% confidence interval limits).

Table S3 Monthly and annual SOI data taken from the Australian Bureau of Meteorology
(www.bom.gov.au)

water year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annual
1988-89	14.6	21.0	10.8	-1.1	-5.0	2.4	21.0	14.7	7.4	9.4	-6.3	5.7	7.88
1989-90	7.3	-2.0	-5.0	13.2	9.1	6.7	-0.5	13.1	1.0	5.5	-5.0	-7.6	2.98
1990-91	1.8	-5.3	-2.4	-1.1	-17.3	-8.5	-12.9	-19.3	-5.5	-1.7	-7.6	-16.6	-8.03
1991-92	-12.9	-7.3	-16.7	5.1	0.6	-10.6	-18.7	0.5	-12.8	-6.9	1.4	0.8	-6.46
1992-93	-17.2	-7.3	-5.5	-25.4	-9.3	-24.2	-21.1	-8.2	-16.0	-10.8	-14.0	-7.6	-13.88
1993-94	-13.5	0.6	1.6	-8.2	-7.9	-8.5	-22.8	-13.0	-10.4	-18.0	-17.2	-17.2	-11.21
1994-95	-14.1	-7.3	-11.6	-1.6	0.6	-10.6	-16.2	-9.0	-1.5	4.2	0.8	3.2	-5.26
1995-96	-1.3	1.3	-5.5	-4.0	-2.7	3.5	7.8	1.3	13.9	6.8	4.6	6.9	2.72
1996-97	4.2	-0.1	7.2	8.4	1.1	6.2	-16.2	-22.4	-24.1	-9.5	-19.8	-14.8	-6.65
1997-98	-17.8	-15.2	-9.1	4.1	13.3	-8.5	-24.4	0.5	9.9	14.6	9.8	11.1	-0.98
1998-99	10.9	12.5	13.3	-23.5	-19.2	-28.5	18.5	1.3	1.0	4.8	2.1	-0.4	-0.60
1999-00	9.1	13.1	12.8	15.6	8.6	8.9	16.8	3.6	-5.5	-3.7	5.3	9.9	7.88
2000-01	9.7	22.4	7.7	5.1	12.9	9.4	0.3	-9.0	1.8	-3.7	-8.2	1.4	4.15
2001-02	-1.9	7.2	-9.1	8.4	11.9	6.7	-3.8	-14.5	-6.3	-7.6	-14.6	-8.2	-2.65
2002-03	-7.4	-6.0	-10.6	2.7	7.7	-5.2	-5.5	-7.4	-12.0	2.9	-1.8	-2.2	-3.73
2003-04	-1.9	-3.4	9.3	-2.0	-7.4	-6.8	-15.4	13.1	-15.2	-6.9	-7.6	-2.8	-3.92
2004-05	-3.7	-8.6	-8.0	-11.6	9.1	0.2	-11.2	-14.5	2.6	0.9	-6.9	3.9	-3.98
2005-06	10.9	-2.0	0.1	1.8	-28.6	0.2	14.4	-9.8	-6.3	-7.6	-15.9	-5.8	-4.05
2006-07	-16.0	-1.4	-3.5	12.7	0.1	13.8	-3.0	-2.7	5.0	-5.0	2.7	1.4	0.34
2007-08	5.4	9.2	14.4	-7.8	-2.7	-1.4	4.5	-3.5	4.2	2.2	9.1	13.5	3.93
2008-09	13.4	17.1	13.3	14.1	21.3	12.2	8.6	-7.4	-2.3	1.6	-5.0	3.9	7.57
2009-10	-14.7	-6.0	-7.0	9.4	14.8	0.2	15.2	10.0	1.8	20.5	18.8	24.9	7.33
2010-11	18.3	16.4	27.1	-10.1	-14.5	-10.6	25.1	2.1	0.2	10.7	2.1	11.7	6.54
2011-12	7.3	13.8	23.0	19.9	22.3	21.4	-7.1	-2.7	-10.4	-1.7	-5.0	2.6	6.95
2012-13	2.4	3.9	-6.0	9.4	2.5	2.9	0.3	8.4	13.9	8.1	-0.5	3.9	4.10
2013-14	-1.9	9.2	0.6	-1.1	-3.6	10.5	8.6	4.4	-1.5	-3.0	-11.4	-7.6	0.27
2014-15	-8.0	-10.0	-5.5	12.2	-1.3	-13.3	-3.8	-13.7	-12.0	-14.7	-19.8	-17.8	-8.98
2015-16	-20.2	-5.3	-9.1	-7.8	0.6	-11.2	-22.0	2.8	5.8	4.2	5.3	13.5	-3.62
2016-17	-4.3	-0.7	2.6	-19.7	-19.7	-4.7	-6.3	0.5	-10.4	8.1	3.3	6.9	-3.70
2017-18	9.1	11.8	-1.4	1.3	-2.2	5.1	4.5	2.1	-5.5	1.6	-6.9	-10.0	0.79
2018-19	3.0	-0.1	9.3	8.9	-6.0	10.5	-1.3	-9.0	-10.4	-5.6	-4.4	-12.4	-1.46
2019-20	-5.6	-9.3	-5.5	-0.6	-13.5	-6.8	-0.5	2.8	-9.6	4.2	9.8	10.5	-2.01