

Córdoba-Ariza et al., 2024. Disclosing the effects of climate, land use, and water demand as drivers of hydrological trends in a Mediterranean river basin. *Limnetica*, 43(2), 2024.

**SUPPLEMENTARY INFORMATION**

**Table S1.** Yearly hydrological characteristics for the study period. *Características hidrológicas para el periodo estudiado.*

*Missing data:* the hydrological year of 1965, the period 1972 - 1975, and the hydrological year 1971 had a continuous gap of 52 days.

	<b>n</b>	<b>Mean</b>	<b><math>\sigma</math></b>	<b>SE</b>	<b>min</b>	<b>max</b>	<b>Q<sub>5</sub></b>	<b>Q<sub>25</sub></b>	<b>Q<sub>50</sub></b>	<b>Q<sub>75</sub></b>	<b>Q<sub>95</sub></b>	<b>IQR</b>
<b>1960</b>	366	1.62	5.13	0.27	0.09	75.51	5.64	1.21	0.61	0.30	0.12	0.91
<b>1961</b>	365	0.94	1.85	0.10	0.01	27.94	2.18	1.30	0.45	0.22	0.03	1.08
<b>1962</b>	365	0.83	1.24	0.07	0.07	10.74	2.37	0.89	0.53	0.30	0.09	0.59
<b>1963</b>	365	3.75	12.47	0.65	0.06	143.00	13.74	1.80	1.07	0.68	0.16	1.12
<b>1964</b>	366	1.58	4.39	0.23	0.04	63.03	3.23	1.63	1.07	0.27	0.06	1.36
<b>1966</b>	365	2.17	10.49	0.55	0.02	143.00	6.15	0.93	0.45	0.11	0.05	0.82
<b>1967</b>	365	0.86	3.40	0.18	0.00	43.60	1.70	0.84	0.22	0.03	0.00	0.81
<b>1968</b>	366	0.28	1.07	0.06	0.00	16.75	0.97	0.16	0.07	0.02	0.01	0.14
<b>1969</b>	365	4.13	19.18	1.00	0.00	206.01	12.32	1.66	0.27	0.05	0.00	1.61
<b>1970</b>	365	1.17	2.89	0.15	0.00	39.64	5.74	1.00	0.27	0.03	0.00	0.97
<b>1971</b>	365	5.89	21.83	1.14	0.00	230.01	17.00	3.10	1.00	0.23	0.00	2.87
<b>1972</b>	92	10.44	35.44	3.69	0.48	290.00	48.62	5.00	3.10	0.80	0.48	4.20
<b>1976</b>	366	0.45	1.50	0.08	0.01	14.71	1.14	0.25	0.20	0.18	0.01	0.07
<b>1977</b>	365	4.51	20.94	1.10	0.40	244.00	10.20	1.47	0.99	0.68	0.40	0.79
<b>1978</b>	365	1.59	7.09	0.37	0.04	109.00	4.32	0.94	0.43	0.28	0.04	0.66

<b>1979</b>	365	1.48	9.39	0.49	0.04	132.67	1.88	0.30	0.08	0.04	0.04	0.26
<b>1980</b>	366	0.80	2.01	0.11	0.00	22.00	3.00	0.66	0.25	0.20	0.00	0.46
<b>1981</b>	365	0.37	0.64	0.03	0.00	9.60	0.80	0.52	0.30	0.10	0.00	0.42
<b>1982</b>	365	3.77	24.01	1.26	0.00	400.00	8.68	0.96	0.40	0.01	0.00	0.95
<b>1983</b>	365	0.32	0.66	0.03	0.00	5.80	1.20	0.30	0.10	0.01	0.00	0.29
<b>1984</b>	366	1.33	4.73	0.25	0.00	62.20	4.15	0.80	0.52	0.10	0.00	0.70
<b>1985</b>	365	0.67	2.69	0.14	0.00	42.80	1.54	0.52	0.30	0.10	0.01	0.42
<b>1986</b>	365	2.04	11.11	0.58	0.00	158.75	4.60	1.32	0.40	0.05	0.00	1.27
<b>1987</b>	365	1.01	2.47	0.13	0.05	31.60	3.36	1.12	0.30	0.10	0.05	1.02
<b>1988</b>	366	4.43	18.52	0.97	0.05	210.00	9.90	1.80	0.84	0.40	0.10	1.40
<b>1989</b>	365	0.67	4.19	0.22	0.01	70.00	1.20	0.40	0.10	0.05	0.01	0.35
<b>1990</b>	365	1.29	5.20	0.27	0.05	65.00	2.44	0.80	0.50	0.10	0.05	0.70
<b>1991</b>	365	2.85	11.22	0.59	0.05	157.00	6.91	1.80	1.12	0.10	0.10	1.70
<b>1992</b>	366	3.42	15.32	0.80	0.05	167.00	8.23	1.32	0.50	0.10	0.05	1.22
<b>1993</b>	365	3.30	8.63	0.45	0.00	77.29	11.53	2.20	1.13	0.64	0.01	1.56
<b>1994</b>	365	0.72	0.65	0.03	0.00	6.12	1.57	0.96	0.80	0.26	0.00	0.70
<b>1995</b>	365	2.33	13.81	0.72	0.00	219.94	4.33	0.88	0.60	0.41	0.00 <sup>a</sup>	0.47
<b>1996</b>	366	2.43	12.21	0.64	0.07	218.73	6.68	1.65	0.73	0.31	0.10	1.34
<b>1997</b>	365	1.86	6.99	0.37	0.10	98.09	5.01	1.22	0.65	0.39	0.17	0.83
<b>1998</b>	365	0.78	1.01	0.05	0.00	11.21	1.86	0.84	0.71	0.41	0.00	0.43
<b>1999</b>	365	0.93	1.93	0.10	0.00	30.86	1.82	0.89	0.71	0.50	0.07	0.39
<b>2000</b>	366	0.36	2.83	0.15	0.02	47.24	0.32	0.17	0.12	0.07	0.02	0.10
<b>2001</b>	365	0.29	1.68	0.09	0.02	31.24	0.46	0.26	0.10	0.07	0.04	0.19
<b>2002</b>	365	1.06	6.69	0.35	0.02	104.76	2.33	0.23	0.09	0.05	0.03	0.17
<b>2003</b>	365	1.05	3.52	0.18	0.02	41.45	4.05	0.62	0.16	0.08	0.03	0.54
<b>2004</b>	366	2.63	8.71	0.46	0.08	90.38	11.14	1.37	0.47	0.20	0.10	1.17
<b>2005</b>	365	0.49	1.56	0.08	0.09	21.77	0.97	0.36	0.22	0.15	0.11	0.22

<b>2006</b>	365	2.10	8.33	0.44	0.18	87.31	7.10	0.78	0.39	0.28	0.22	0.50
<b>2007</b>	365	0.41	1.41	0.07	0.02	15.34	0.75	0.28	0.19	0.10	0.03	0.18
<b>2008</b>	366	0.24	0.80	0.04	0.02	11.35	0.61	0.22	0.10	0.07	0.03	0.15
<b>2009</b>	365	0.49	1.30	0.07	0.02	12.58	1.36	0.43	0.18	0.08	0.03	0.35
<b>2010</b>	365	0.80	1.68	0.09	0.03	17.18	4.21	0.60	0.16	0.12	0.07	0.48
<b>2011</b>	365	0.87	3.49	0.18	0.00	40.11	2.00	0.59	0.24	0.03	<0.01 <sup>b</sup>	0.55
<b>2012</b>	366	1.35	6.57	0.34	0.00	75.78	2.75	0.61	0.33	0.15	<0.01 <sup>b</sup>	0.46
<b>2013</b>	365	0.71	1.72	0.09	0.05	26.63	1.99	0.73	0.35	0.20	0.08	0.53
<b>2014</b>	365	0.65	5.73	0.30	0.05	107.58	0.80	0.27	0.19	0.16	0.05	0.11
<b>2015</b>	365	0.87	3.79	0.20	0.19	60.88	1.52	0.45	0.42	0.40	0.32	0.05
<b>2016</b>	366	0.27	0.14	0.01	0.09	0.86	0.45	0.40	0.24	0.16	0.09	0.24
<b>2017</b>	365	0.54	1.58	0.08	0.04	21.48	1.71	0.44	0.21	0.12	0.05	0.31
<b>2018</b>	365	0.24	0.72	0.04	0.02	11.91	0.59	0.18	0.12	0.07	0.03	0.11
<b>2019</b>	365	1.70	14.12	0.74	0.03	255.78	2.50	0.47	0.25	0.15	0.04	0.32
<b>2020</b>	366	3.92	22.48	1.17	0.07	252.83	5.41	1.25	0.56	0.23	0.12	1.02

**Table S2.** Main statistical descriptors of the daily stream flow discharge and its statistical distribution extracted from the different Flow Duration Curves. *Principales estadísticos del caudal diario y de su distribución estadística tomados de las curvas de duración de flujo.*

All variables are in m<sup>3</sup>/s, and n stands for the number of days in each recorded decade.

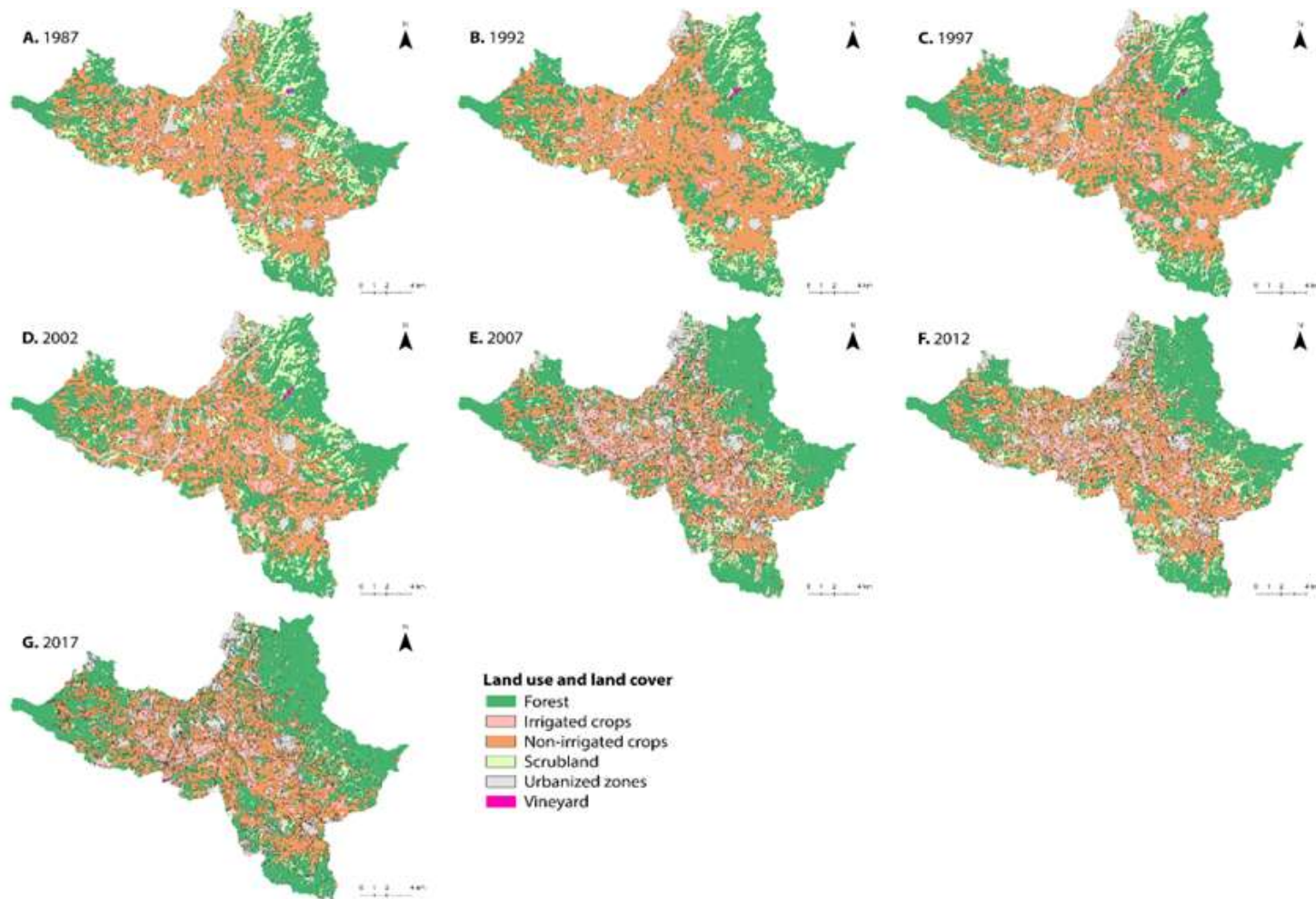
Time lapse	n	Mean	$\sigma$	SE	min	max	Exceedance discharge at (%)					IQR	FSD
							5	25	50	75	95		
<b>All seasons</b>													
1961 - 2020	20547	1.60	9.59	0.07	0.00	400.00	4.10	0.83	0.33	0.11	0.01	0.72	15.75
1961 - 1970	3653	1.73	8.47	0.14	0.00	206.01	5.34	1.16	0.45	0.13	0.01	1.03	15.24
1971 - 1980	2284	2.77	15.01	0.31	0.00	290.00	7.40	1.07	0.40	0.16	0.01	0.91	21.99
1981 - 1990	3652	1.59	10.68	0.18	0.00	400.00	3.49	0.80	0.30	0.10	0.00	0.70	15.47
1991 - 2000	3653	1.90	9.20	0.15	0.00	219.94	4.93	1.12	0.66	0.19	0.02	0.93	9.84
2001 - 2010	3652	0.96	4.69	0.08	0.02	104.76	2.70	0.44	0.20	0.09	0.04	0.34	16.10
2011 - 2020	3653	1.11	9.07	0.15	0.00	255.78	2.00	0.46	0.27	0.15	0.04	0.30	9.63
<b>Winter</b>													
1961 - 2020	5086	2.21	12.15	0.17	0.00	400.00	6.15	1.12	0.45	0.21	0.08	0.91	17.14
1961 - 1970	903	1.67	4.15	0.14	0.03	63.03	6.15	1.30	0.68	0.35	0.07	0.95	11.53
1971 - 1980	573	3.48	18.34	0.77	0.08	290.00	7.44	1.30	0.72	0.21	0.08	1.09	13.33
1981 - 1990	902	2.43	15.99	0.53	0.00	400.00	5.79	0.96	0.40	0.16	0.05	0.80	18.56
1991 - 2000	903	3.51	13.21	0.44	0.10	218.73	10.23	1.91	1.01	0.76	0.15	1.15	12.23
2001 - 2010	902	1.26	4.91	0.16	0.02	82.21	4.93	0.50	0.24	0.11	0.06	0.39	23.33
2011 - 2020	903	1.36	11.98	0.40	0.02	252.83	2.04	0.43	0.29	0.19	0.12	0.24	8.38
<b>Spring</b>													
1961 - 2020	5152	2.01	9.95	0.14	0.00	219.77	5.00	1.12	0.64	0.30	0.10	0.82	9.82
1961 - 1970	920	2.46	12.28	0.41	0.01	206.01	6.15	1.30	0.78	0.44	0.11	0.86	9.50
1971 - 1980	552	3.52	15.88	0.68	0.00	217.00	10.20	1.47	0.76	0.30	0.12	1.17	17.11
1981 - 1990	920	1.96	8.68	0.29	0.05	158.75	4.62	1.20	0.66	0.37	0.10	0.83	8.76
1991 - 2000	920	2.02	8.07	0.27	0.05	157.00	4.62	1.33	0.80	0.50	0.10	0.83	7.61

2001 - 2010	920	1.49	6.29	0.21	0.04	104.76	4.75	0.78	0.44	0.26	0.12	0.52	13.18
2011 - 2020	920	1.20	8.39	0.28	0.03	219.77	2.27	0.75	0.44	0.24	0.16	0.51	6.58
<b>Summer</b>													
1961 - 2020	5152	0.42	2.06	0.03	0.00	79.50	1.10	0.39	0.15	0.05	0.00	0.34	10.60
1961 - 1970	920	0.22	0.36	0.01	0.00	5.34	0.84	0.25	0.11	0.03	0.00	0.22	10.84
1971 - 1980	552	1.03	3.35	0.14	0.00	50.50	5.00	0.52	0.15	0.04	0.00	0.48	40.40
1981 - 1990	920	0.28	0.41	0.01	0.00	4.00	0.96	0.40	0.10	0.01	0.00	0.39	14.70
1991 - 2000	920	0.68	3.86	0.13	0.00	79.50	1.20	0.63	0.32	0.07	0.00	0.55	6.07
2001 - 2010	920	0.27	0.98	0.03	0.02	20.21	0.75	0.23	0.12	0.07	0.03	0.16	8.25
2011 - 2020	920	0.30	0.65	0.02	0.00	8.98	0.78	0.33	0.17	0.10	<0.01	0.23	6.67
<b>Fall</b>													
1961 - 2020	5157	1.79	10.75	0.15	0.00	255.78	4.41	0.68	0.20	0.07	0.00	0.61	27.50
1961 - 1970	910	2.59	10.73	0.36	0.00	143.00	7.87	1.58	0.42	0.06	0.00	1.52	23.88
1971 - 1980	607	3.01	16.98	0.69	0.00	230.01	5.00	0.68	0.29	0.08	0.00	0.60	20.48
1981 - 1990	910	1.71	11.21	0.37	0.00	210.00	3.80	0.52	0.10	0.01	0.00	0.51	48.40
1991 - 2000	910	1.41	9.04	0.30	0.00	219.94	2.96	0.94	0.32	0.10	0.01	0.84	12.87
2001 - 2010	910	0.81	4.77	0.16	0.02	87.31	1.73	0.23	0.11	0.07	0.03	0.16	18.40
2011 - 2020	910	1.60	10.74	0.36	0.00	255.78	3.44	0.42	0.23	0.09	<0.01	0.33	17.49

**Table S3.** Transition matrix of land use areas from 1987 to 2017. *Matriz de transición de las áreas de uso del suelo desde 1987 hasta 2017.*

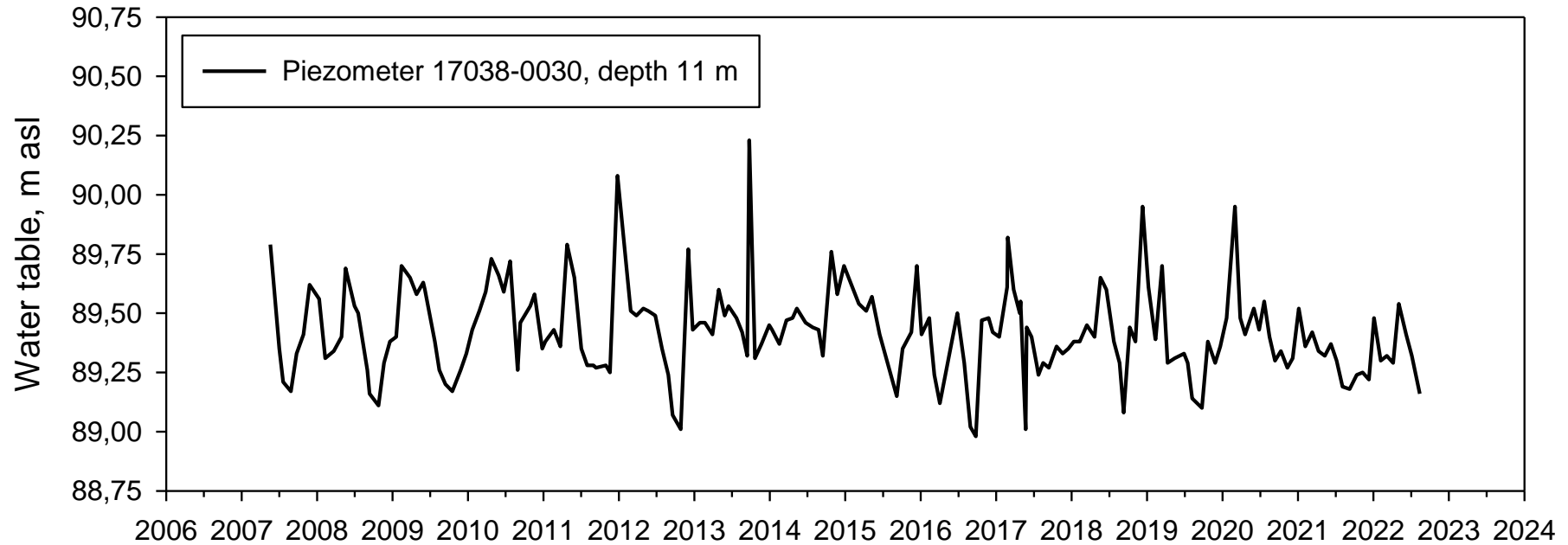
<b>Transition from 1987 to 2017</b>	<b>Type of change</b>	<b>Area (ha)</b>	<b>% Area of the basin</b>
No change	No change	17370.3	57.60%
Shrubland to forests	Increase in forest	3131.37	10.38%
Rainfed crops to irrigated crop	Increase in irrigated crop	1783.62	5.91%
Irrigated crops to rainfed crop	Increase in rainfed crop	1280.61	4.25%
Rainfed crops to forest	Increase in forest	1167.03	3.87%
Rainfed crops to urban zones	Increase in urban zones	1067.13	3.54%
Forest to Scrublands	Increase in scrublands	886.41	2.94%
Rainfed crops to Scrublands	Increase in scrublands	668.16	2.22%
Forest to rainfed crop	Increase in rainfed crop	578.88	1.92%
Scrublands to rainfed crop	Increase in rainfed crop	341.46	1.13%
Forest to irrigated crop	Increase in irrigated crop	192.96	0.64%
Scrublands to urban zones	Increase in urban zones	191.07	0.63%
Forest to urban zones	Increase in urban zones	190.08	0.63%
Irrigated crops to forest	Increase in forest	156.87	0.52%
Irrigated crops to urban zones	Increase in urban zones	144.45	0.48%
Sparse vegetation to urban zones	Increase in urban zones	140.85	0.47%
Urban zones to rainfed crop	Increase in rainfed crop	121.05	0.40%
Scrublands to irrigated crop	Increase in irrigated crop	103.5	0.34%
Urban zones to forest	Increase in forest	102.24	0.34%
Rainfed crops to sparse vegetation	Increase in sparse vegetation	95.22	0.32%
Sparse vegetation to rainfed crop	Increase in rainfed crop	79.2	0.26%

Urban zones to Scrublands	Increase in scrublands	66.87	0.22%
Irrigated crops to Scrublands	Increase in scrublands	61.02	0.20%
Urban zones to irrigated crop	Increase in irrigated crop	30.69	0.10%
Sparse vegetation to irrigated crop	Increase in irrigated crop	27.27	0.09%
Forest to sparse vegetation	Increase in sparse vegetation	25.74	0.09%
Sparse vegetation to Scrublands	Increase in scrublands	22.68	0.08%
Sparse vegetation to forest	Increase in forest	20.07	0.07%
Urban zones to sparse vegetation	Increase in sparse vegetation	16.83	0.06%
Scrublands to sparse vegetation	Increase in sparse vegetation	15.3	0.05%
Irrigated crops to sparse vegetation	Increase in sparse vegetation	15.03	0.05%
Rainfed crops to vineyards	Increase in vineyards	9.27	0.03%
Vineyard to rainfed crop	Increase in rainfed crop	8.64	0.03%
Vineyard to irrigated crop	Increase in irrigated crop	5.4	0.02%
Scrublands to vineyards	Increase in vineyards	4.23	0.01%
Urban zones to vineyards	Increase in vineyards	2.25	0.01%
Vineyard to forest	Increase in forest	1.98	0.01%



**Figure S1.** Available land use and land cover maps from 1987 to 2017. Original data from the Cartographic and Geological Institute of Catalonia (Institut Cartogràfic i Geològic de Catalunya). Source: <https://www.icgc.cat/en/Downloads/Vector-maps/Cobertes-del-sol/Mapes-de-cobertes-Evolucio-i-canvis-del-territori>. *Mapas de uso del suelo disponibles desde 1987 hasta 2017.*





**Figure S2.** Water-table evolution in one piezometer in the Onyar River alluvial aquifer, located between the villages of Campllong and Riudellots de la Selva (484938, 4638441 UTM). Summer low levels happens almost annually. The low amplitude of the annual water table oscillation (<1m, approx.) is due to the control of the stream that is almost continuously perennial at this location. *Source: ACA (2002). Evolución del nivel freático en un piezómetro en el acuífero aluvial del Río Onyar, situado entre los pueblos de Campllong y Riudellots de la Selva (484938, 4638441 UTM). Los bajos niveles en verano ocurren casi anualmente. La baja amplitud de la oscilación anual del nivel freático (<1m, aprox.) se debe al control del arroyo que es casi continuamente perenne en esta ubicación.*