Supplementary data

Water sources	Places	Sites	Samples
Rivers	Vacas, Cuevas, Tupungato and Mendoza rivers in Punta de Vacas. Cuevas River in Puente del Inca. Horcones Superior and Horcones rivers at Mt. Aconcagua Confluencia Camp.	7	42
Ice bodies	Horcones Inferior Glacier and Mt. Tolosa rock glaciers conglomerate.	2	34
Groundwaters	Vertiente del Inca, La Salada Stream, Confluencia Nueva Spring, Confluencia Vieja Spring and geothermal waters of "Copa de Champagne" and "Viejo Túnel", both in "Puente del Inca".	6	41
Precipitations	Collectors at Laguna de Horcones and Confluencia Camp, both in the Mt. Aconcagua Park	2	4
Snow basins	Valle Azul, Los Puquios and Santa María	3	33

Table S1 Sampling along the melting period 2013-2014 in Cordillera Principal geological province. Ice body type classification corresponds to the official inventory of glaciers (IANIGLA-ING, 2015a). Sites refers to quantity of sampling sites for each water source

Station 2 and HI Glacier streamflow	MDS HI m3/s	Soil MDT °C	Air MDT °C	DMaxT °C	DMinT °C	max-min °C
Mean	2.09	7.17	4.90	3.55	0.77	2.72
SD	0.95	3.15	3.35	4.35	3.30	3.02
VC%	45.34	43.90	68.31	122.56	430.53	111.07
Max	4.88	11.60	10.68	11.27	6.41	11.27
Min	0.52	1.35	-3.65	-5.95	-7.28	-5.95

Rock glaciers streamflow	MDS Tolosa m3/s
Mean	0.02
SD	0.01
VC%	70.80
Max	0.05
Min	0.00

Station 1	Atm Press hPa	Air MDT °C	DMaxT °C	DMinT °C	RH%
Mean	706.44	11.12	17.82	4.74	37.27
SD	1.55	2.88	3.41	2.66	17.39
VC%	0.22	25.89	19.15	56.17	46.67
Max	710.04	16.57	24.84	11.20	97.60
Min	703.11	2.89	6.25	-0.53	13.60

Station 1	Soil DMT °C	Wind Dir.°	W mean vel.	W max vel.	SWE (mm)	Incid. Rad.
Mean	12.58	173.07	1.87	15.83	0.00	274.66
SD	2.71	55.19	1.16	3.09	0.00	54.84

VC%	21.57	31.89	62.08	19.53		19.97
Max	17.25	349.05	6.04	22.80	0.00	330.99
Min	6.39	16.36	0.14	7.94	0.00	64.56

Table S2 Mean values (Mean), standard deviation (SD), % variation coefficient (VC %) and maximum (Max) and minimum values (Min) for stations 2 and 1 weather stations. Mean daily streamflow (MDS) of Horcones Inferior Glacier (HI) and Tolosa rock glaciers conglomerate (Rock glaciers streamflow). Atmospheric pressure in hPa (Atm Press hPa), mean daily air temperature in ºC (Air MDT), daily maximum and minimum temperature in ºC (DMaxT and DMinT, respectively), maximum and minimum mean daily temperature (max-min), relative humidity in % (RH%), mean daily soil temperature in ºC (Soil MDT), wind direction in degrees (Wind Dir º), mean and maximum wind velocity in m/s (W mean/max vel.), snow water equivalent in mm (SWE) and incident solar radiation in W/m^2 (Incid. Rad.)

Site-water source / (mean/range)	$\delta^{18}O$ ‰	$\delta^{2}H$ ‰	d‰
Cuevas River Pte. del Inca	-17.5/-18.2- to -16.9	-134.3/-136.5 to -132.2	3.9/0.0-8.9
Cuevas River PV	-18.2/-18.8 to -17.9	-136.8/-141.3 to -134.0	6.8/0.0-9.4
Tupungato River PV	-19.3/-19.6 to -18.9	-144.9/-147.5 to -142.5	6.3/0.0-9.9
Vacas River PV	-19.3/-19.5 to -19.1	-145.5/-147.5 to -143.8	7.1/0.0-9.0
Horcones Inferior Glacier	-20.2/-21.0 to -18.8	-151.1/-157.3 to -139.4	10.7/8.2-12.8
Tolosa rock glaciers conglomerate	-17.0/-17.5 to -15.6	-129.7/-131.6 to -127.6	4.2/-3.1 a 8.9
Valle Azul stream	-17.2/-17.6 to -16.1	-131.8/-133.4 to -129.6	2.3/-4.7 a 7.6
Los Puquios snow basin	-17.0/-17.5 to -16.0	-129.9/-131.6 to -123.4	4.9/0.0-8.4
Santa María stream	-18.1/-18.5 to -17.35	-138.3/-141.3 to -134.8	5.12/4.3-8.1
Groundwater	-18.4/-20.2 to -17.4	-139.8/-154.3 to -132.8	6.3/-1.8 a 10.3
Puente del Inca geothermal	-18.3/-18.4 to -18.2	-141.3/-141.8 to -140.8	4.3/4.4-6.26
Summer precipitation	-9.8/-10.9 to -8.7	-57.3/-66.2 to -48.5	20.9/20.7-21.1

Table S3 Mean and range water stable isotopes and deuterium excess (d) composition values for different water sources. PV refers to the samples taken in “Punta de Vacas” site. Pte. del Inca refers to the samples in “Puente del Inca” location

Site-water source / (mean/range)	(me/L) Na^{+}	(me/L) K^{+}	(me/L) Ca^{+2}	(me/L) Mg^{+2}
Cuevas River Pte del Inca	8.67/5.00-11.00	0.03/0.00-0.10	10.30/8.40-13.80	3.67/2.80-5.30
Cuevas River PV	6.08/2.20-15.00	0.05/0.00-0.10	9.80/5.70-12.50	3.26/1.30-7.40
Tupungato River PV	3.85/1.30-13.00	0.00/0.00-0.00	6.33/4.00-15.20	2.77/1.90-3.30
Vacas River PV	0.83/0.70-1.10	0.00/0.00-0.00	3.64/2.40-4.70	1.57/1.20-2.00
Horcones Inferior Glacier	1.44/0.80-3.00	0.05/0.00-1.00	4.52/2.30-10.30	1.67/0.80-5.30
Tolosa rock glaciers	0.27/0.10-0.40	0.00/0.00-0.00	5.86/4.00-8.10	2.82/0.60-4.50
Valle Azul stream	0.36/0.30-0.40	0.00/0.00-0.00	2.46/1.40-3.60	1.35/0.60-2.10
Los Puquios snow basin	0.80/0.50-1.10	0.00/0.00-0.00	1.05/0.40-3.00	0.26/0.20-1.20
Santa María stream	0.55/0.20-1.10	0.00/0.00-0.00	1.41/0.80-2.30	0.56/0.30-0.80
Groundwater	1.29/0.20-10.00	0.01/0.00-0.30	21.29/3.30-29.60	6.29/1.00-10.50
Puente del Inca geothermal	275.20/110.00-550.00	3.50/1.00-5.00	47.65/40.50-57.90	8.67/2.60-15.60

Table S4 Mean and range cations values for the different water sources

Site-water source / (mean/range)	**(me/L) HCO_3^-**	**(me/L) SO_4^{-2}**	**(me/L) Cl^-**
Cuevas River Pte del Inca	2.51/1.97-2.78	10.90/9.60-12.10	8.20/6.10-11.00
Cuevas River PV	1.99/1.73-2.44	9.51/7.70-14.20	5.51/3.10-12.30
Tupungato River PV	1.87/1.73-2.03	6.88/4.40-14.20	3.28/1.10-12.10
Vacas River PV	1.63/1.42-1.84	3.63/2.50-5.00	0.54/0.30-1.30
Horcones Inferior Glacier	1.42/0.96-3.55	5.33/2.50-11.70	0.70/0.10-1.30
Tolosa rock glaciers	1.74/1.09-2.40	6.80/4.40-9.20	0.34/0.00-1.70
Valle Azul stream	1.48/1.13-1.80	2.30/1.00-3.30	0.27/0.00-1.20
Los Puquios snow basin	1.42/1.09-2.33	0.44/0.10-1.90	0.15/0.00-0.70
Santa María stream	1.47/1.22-1.80	0.74/0.10-1.30	0.24/0.10-0.70
Groundwater	3.16/1.84-4.62	23.10/1.00-31.30	1.13/0.00-7.30
Puente del Inca geothermal	27.09/23.80-28.11	83.70/26.00-343.80	213.80/77.20-311.30

Table S5 Mean and range anions values for the different water sources

Site-water source / (mean/range)	pH	EC (µS/cm)
Cuevas River Pte del Inca	7.72/7.68-7.75	1839/1473-2205
Cuevas River PV	8.0/7.80-8.15	1461/544-2094
Tupungato River PV	7.60/6.87-8.03	834/626-1031
Vacas River PV	7.82/7.13-8.10	566/391-665
Horcones Inferior Glacier	7.41/7.41-7.41	674/424-1033
Tolosa rock glaciers	7.74/6.84-8.19	809/640-1093
Valle Azul stream	8.05/7.28-8.90	431/286-515
Los Puquios snow basin	8.12/7.72-8.64	144/98-176
Santa María stream	7.87/6.59-8.41	238/121-324
Groundwater	7.63/6.72-8.60	2187/1340-2950
Puente del Inca geothermal	6.24/6.19-6.29	22682/20500-23440

Table S6 pH and electric conductivity (EC) for the different water sources

Event	Date	MODIS	Rangers	Cache.	Polv.	PV
Light snowfall in Tolosa rock glaciers conglomerate (and something in Horcones Inferior Glacier) areas	November 14th & 19th to 21st 2013	X	X			
Light snowfall	November 25th 2013	X	X	X		
Rain	December 25th 2013		X	10.5 mm		
Light snowfall	January 16th to 18th 2014	X	X	X	X	X
Light snowfall	January 26th to 27th 2014	X	X			
Light snowfall	February 14th to 18th 2014	X	X	X	X	
Light snowfall	February 24th & 25th 2014	X	X	X	X	
Light snowfall	March 1st & 2nd 2014	X	X	X	X	

Table S7 Precipitation records from weather stations, MODIS satellite imagery (MODIS) and Mt. Aconcagua Park Rangers (Rangers) daily records. Cache. and Polv. refers to Cacheuta and Polvaredas National Hydric Resources Secretariat weather stations, respectively. PV refers to Punta de Vacas station, dependent on the National Meteorological Service (SMN)

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Mean
MMS 1957-2017	**21**	**20**	**22**	**28**	**48**	**84**	**101**	**81**	**54**	**34**	**27**	**23**	**45**
1968	15	15	14	13	19	23	46	56	39	18	15	13	24
2004	23	22	24	24	26	43	75	71	46	28	24	23	36
2010	20	19	17	19	20	30	44	54	41	27	20	18	27
2011	13	13	16	18	29	49	68	58	46	28	20	18	31
2013	**17**	**16**	**16**	**20**	**36**	**73**	**79**	**54**	**36**	**25**	**21**	**18**	**34**
Dry year %	85	83	79	66	55	52	62	73	77	74	75	79	72
2013%*	**81**	**78**	**72**	**71**	**76**	**87**	**78**	**67**	**67**	**74**	**79**	**79**	**76**
Monthly Hm^3	56	55	57	76	123	224	270	195	144	88	72	59	**1419**
2013 Monthly Hm^3	45	43	43	54	96	196	212	145	96	67	56	48	**1101**

Seasonal contribution	**1957-2017 Hm^3**	**Year %**	**2013 Hm^3**	**Year %**	**2013** ** **%**
Jun-Aug	169	12	136	12	81
Sep-Nov	256	18	193	18	75
Dec-Feb	**689**	**49**	**552**	**50**	**80**
Mar-May	304	21	220	20	72
Total	**1419**	**100**	**1101**	**100**	**78**

Table S8 Mendoza River mean monthly streamflow record (MMS) in m^3s^{-1} (DGI, 2018) and some extreme dry years (1968, 2004, 2010-11). 2013 %*: refers to 2013 percentage regarding 1957-2017 average. Every year refers to July-June hydrological cycle (p.e.: 2013 year starts in July 2013 and ends in June 2014) obtained from National Secretariat of Hydric Resources (SRH). Long term monthly and seasonal contribution (Hm^3 and %) is showed. 2013** refers to the proportion of 2013 seasonal streamflow regarding the 1957-2017 values

	Mean		Mean	2004	2010	2011	2013

	(1987-2015)	(1987-2016)				
Winter SWE (mm)	616		451	320	432	**310**
SWE% regarding '87-´15 record			73	52	70	**50**
Mean (Dec- Mar) temperature in ºC		14.5	14.7	13.7	15.1	**14.6**
Temperature% regarding `'87-'16 record			101	94	104	**101**

Table S9 Portillo (3000 m a.s.l.; 32.84ºS – 70.12ºW) winter snow water equivalent (SWE) in mm and summer (December-March) temperature data from El Yeso Embalse Station (2475 m a.s.l.; 33.65ºS – 70.07ºW). The same dry years as Table S8 are showed. Source: Barrios (2018)

Site	**Altitude m asl**	**Since**	**Until**	**$\delta^{18}O$ ‰**	**$\delta^{2}H$ ‰**	**d‰**
Confluencia Camp	3433	February 5th, 2014	March 15th, 2014	-10.9	-66.2	20.7
Laguna de Horcones	3043	December 19th , 2013	April 2nd, 2014	-8.7	-48.5	21.1
Mean				-9.8	-57.3	20.9

Table S10 Stable water isotopes precipitation (from collectors) composition

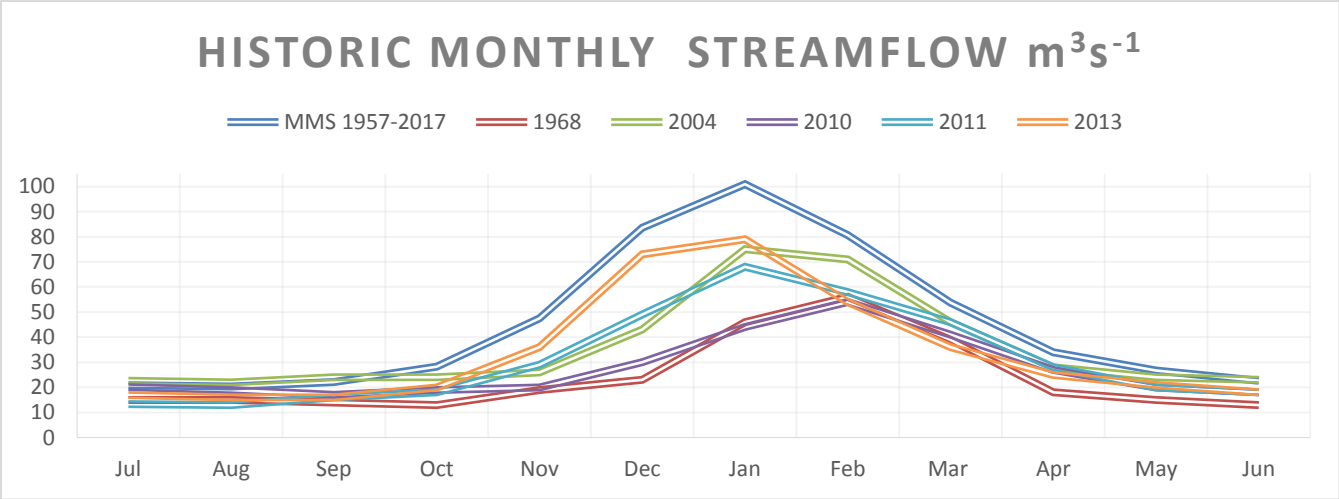

Figure S1: Historic Mendoza River mean monthly streamflow in m^3s^{-1} (MMS). The mean monthly streamflow from 1957 to 2017 (DGI, 2018) presents the maximum streamflow on January, a 2^{nd} maximum on December and a 3^{rd} one in February, corresponding to a "mitigate glacial regime" according to the Parde genetic classification of solid feeding fluvial regimes (Bruniard, 1994). Many drought periods are plotted below this mean values line, including the 2013 year analyzed in this work. The more extreme dry years in record (1968 and 2010), are also with a maximum discharge month displaced to February, which corresponds to an "ultra-glacial regime", according to the Parde classification

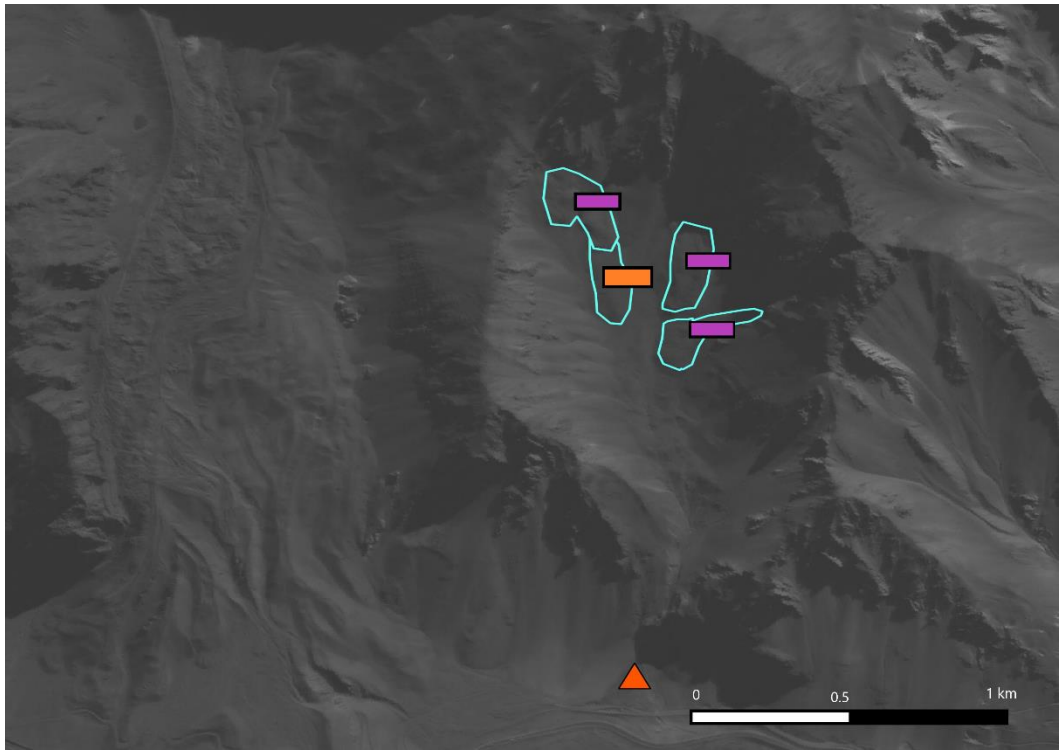

Figure S2: Tolosa Rock glaciers conglomerate ice bodies shape, according to the National Glacier Inventory (IANIGLA-ING, 2018a). The purple color indicates active rock glacier facie.The orange, refers to inactive rock glacier facie. Just one of the 3 rock glaciers shows an inactive facie (the left one). The red triangle indicates the streamflow measurement site. Image: Alos

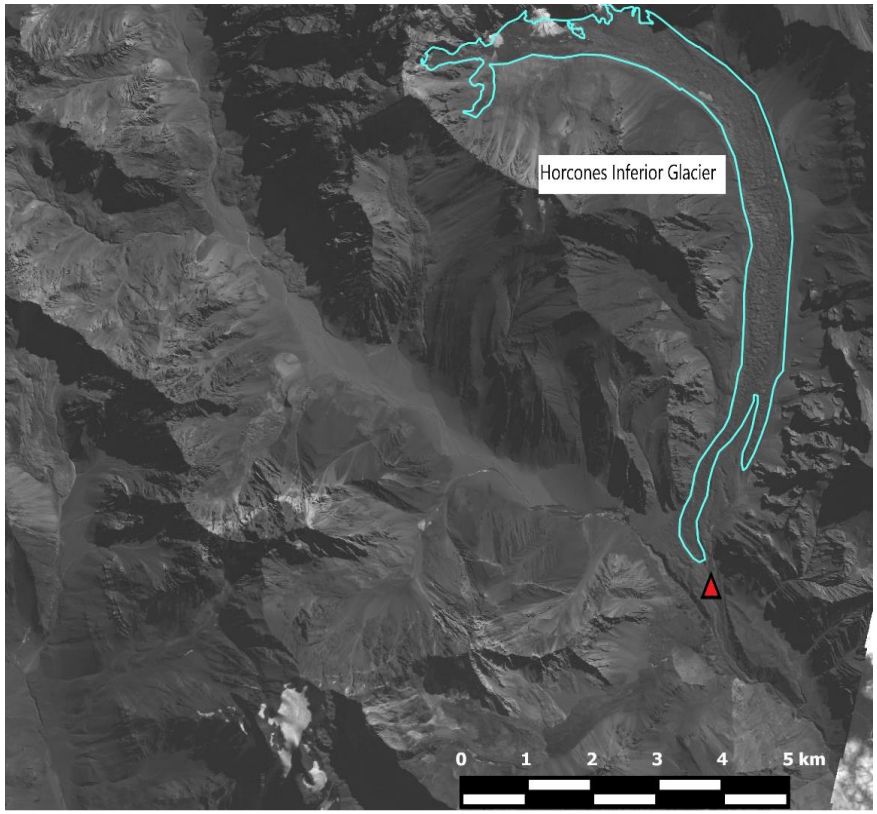

Figure S3: Horcones Inferior Glacier shape, according to the National Glacier Inventory (IANIGLA-ING, 2018a). The red triangle indicates the streamflow measurement site. Image: Alos