MEDITERRANEAN MOUNTAINOUS LANDSCAPES
an historical approach to cultural heritage based on traditional agrosystems
MEMOLA

MINISTERIO DE CIENCIA E INNOVACIÓN
Instituto Geológico y Minero de España

UNIVERSIDAD DE CÓRDOBA

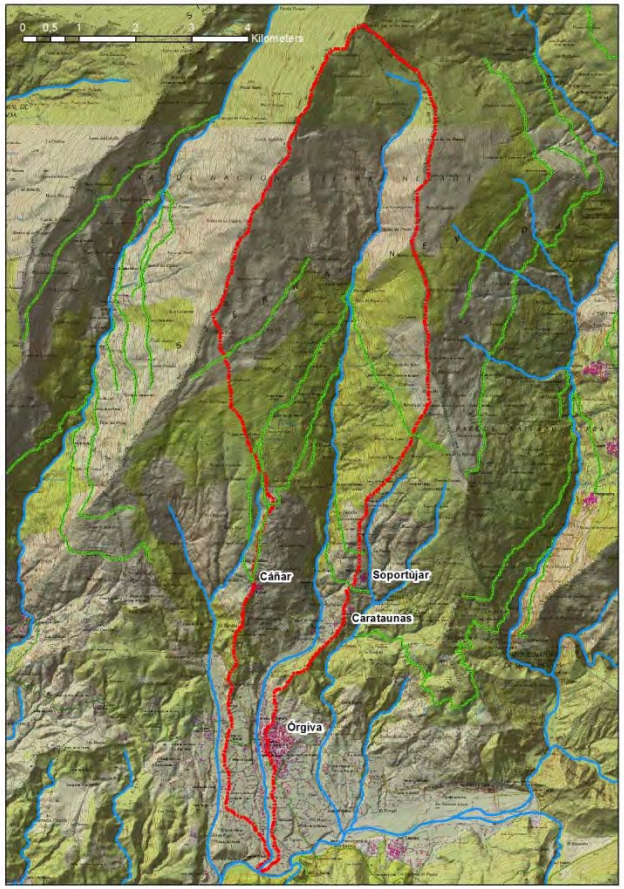
MEMOLA Final Meeting

Granada. November 6th–8th 2017

Human impact in Sierra Nevada hidrology and hidrogeology.

Javier Herrero, Crisanto Martín Montañés, María José Pérez-Palazón, Rafael Pimentel, María José Polo

CHICO RIVER HYDROLOGICAL BASIN

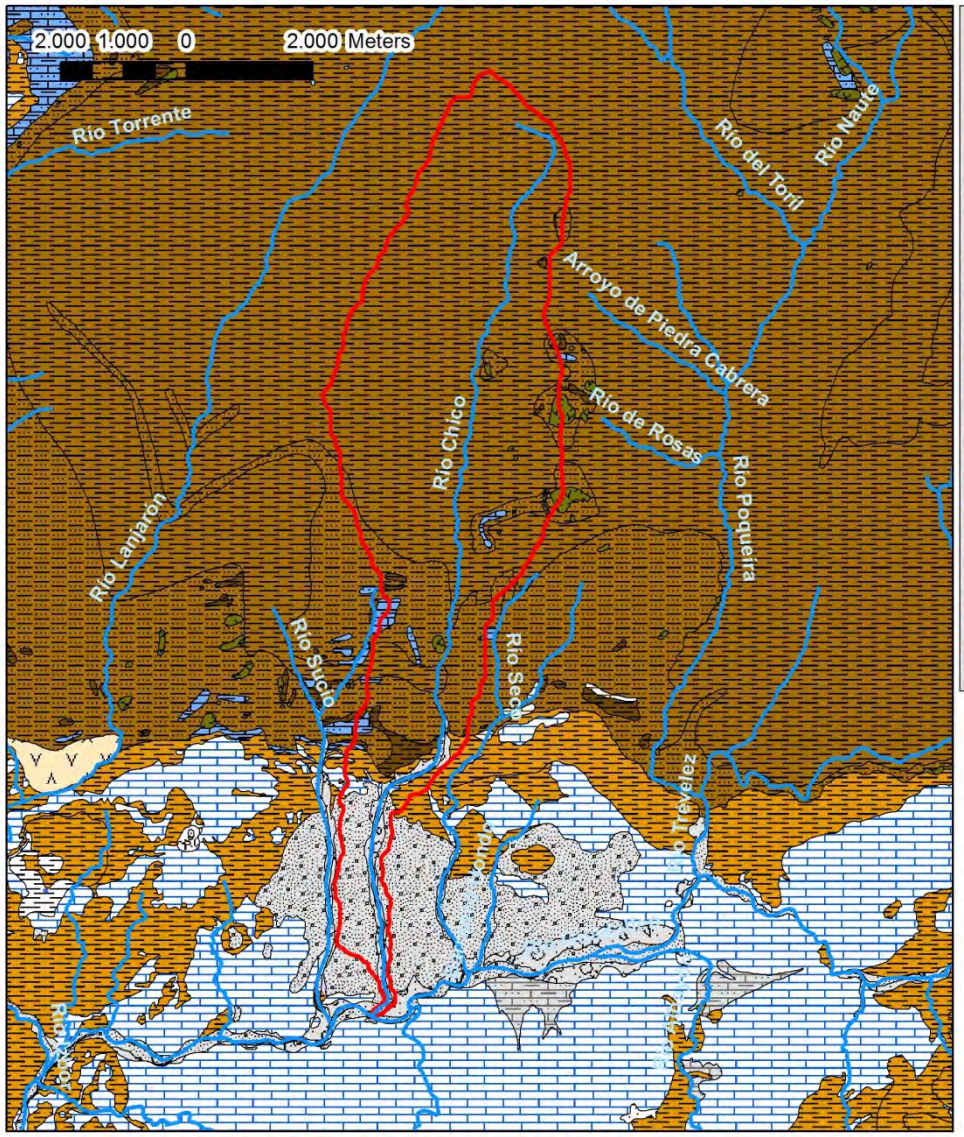


Chico river basin, tributary of Guadalfeo river, is located in the municipal terms of **Cáñar, Soportújar, Órgiva and Carataunas** (south Spain)

To the north is limited by the E-O crest of **Sierra Nevada** (Tajo de los Machos); to the south by the Guadalfeo river and the first foothills of **Sierra de Lújar**; to the east by the hydrological divide with **Seco and Poqueira rivers basins** and to the west by **Sucio and Lanjarón rivers** (Martín Montañés et al., 1984).

It is located on the southern edge of the **Sierra Nevada Natural Park** and is characterized by high altitudes, which means that a considerable rainfall part occurs as snow in the period from late October to early May.

GEOLOGICAL FRAMEWORK



Legend

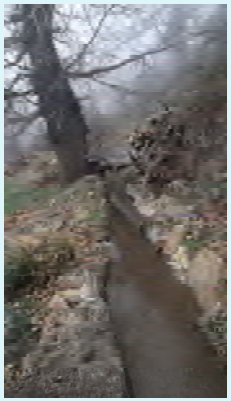
- Caliches y costras carbonatadas
- Aluviales y fondos de valle
- Canchales y derrubios de ladera
- Conglomerados, arenas, limos y margas con gasterópodos
- Terraza baja
- Travertinos
- Mármoles brechoides. Roca de falla
- Mármoles. Localmente esquistos y yesos
- Rocas carbonatadas. Mármoles si existe metamorfismo
- Esquistos claros. Localmente cuarcitas y cuarzomicaesquistos
- Esquistos grafitosos, cuarcitas y cuarzomicaesquistos
- Gneises
- Intercalaciones tectónicas de micaesquistos y cuarcitas
- Micaesquistos y localmente cuarcitas
- Anfibolitas

From a regional geological point of view, the Chico River basin is framed within the Internal Zones of the Betic cordillera. This domain includes the tectonic complexes known as Nevado-Filábride, Alpujárride and Maláguide of which, only the first two, surface in the study area.

CHANNELS SYSTEM

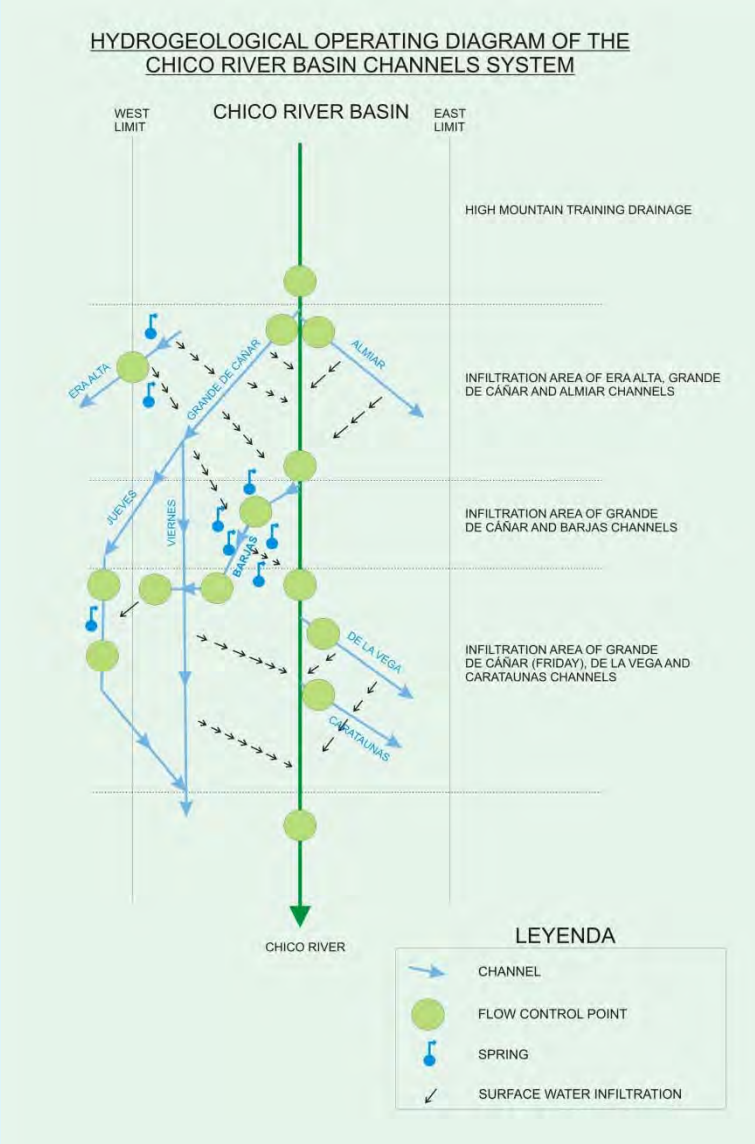
Chico river basin channel system is distributed as follows:

- **Left margin**: From highest to lowest we have the **Almiar, de la Vega and Carataunas** channels.
- **Right margin**: following the same order, we have the **Era Alta** channels (the water is taked from a ravine that descends directly from the Cañada del Tajo de los Machos), **Grande de Cáñar** channel, with its two branches called Viernes and Jueves, and the **Barjas** channel with its branch of the Hijuela.



This system of channels (irrigation and losses) makes possible the infiltration of much of the water taken from the river. We have considered three main zones of infiltration in this work :

- Infiltration area of **Era Alta, Grande de Cáñar** and **Almiar** channels.
- Infiltration area of **Grande de Cáñar** and **Barjas** channels.
- Infiltration area of **Grande de Cáñar, de la Vega** and **Carataunas** channels.



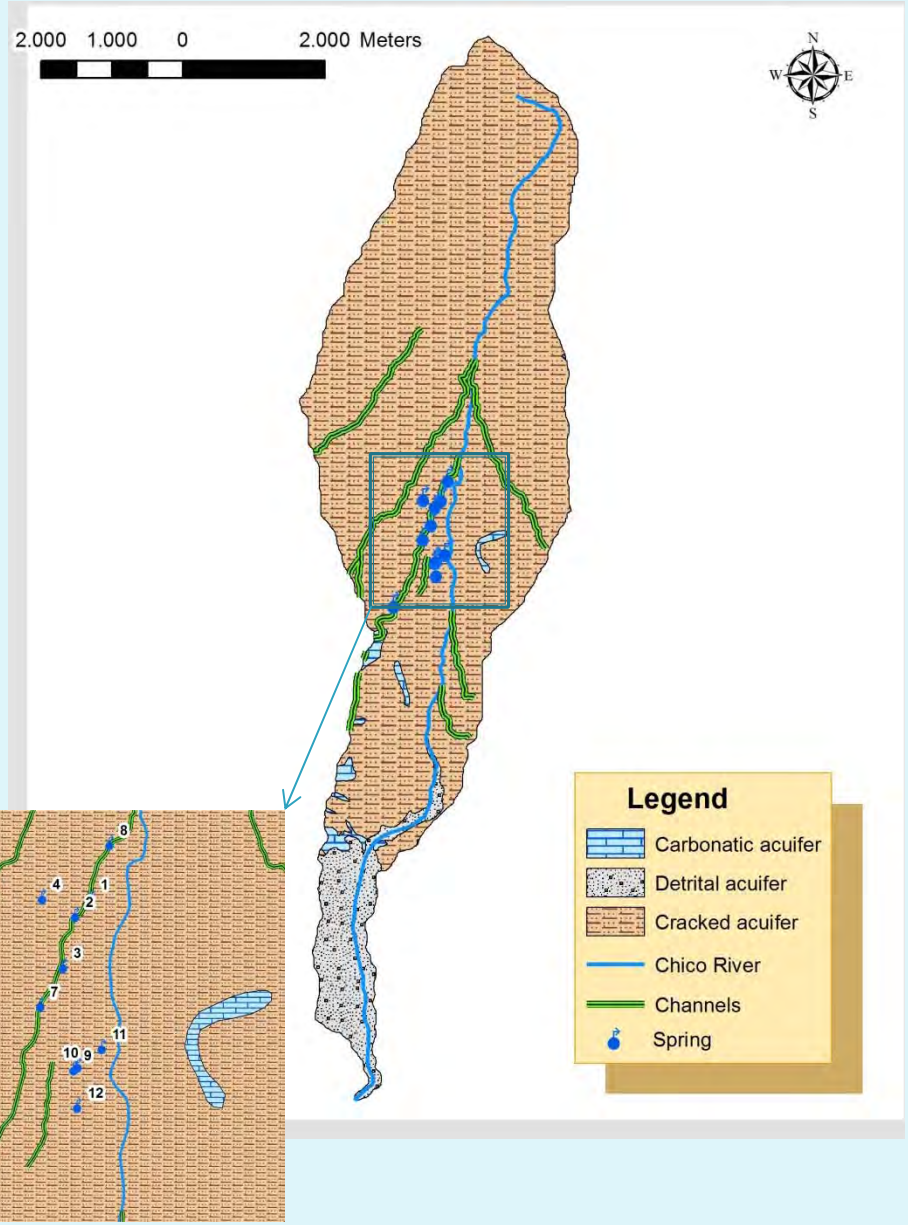
HYDROGEOLOGICAL FRAMEWORK

In Chico River basin three acuifer formations can be differentiated:

- **Cracked acuifer**: Nevadofilábrides and alpujárrides shales.
- **Carbonatic acuifer**: Set of outcrops of carbonates (marbles and limestones).
- **Detrital acuifer**: Recent detrital materials.

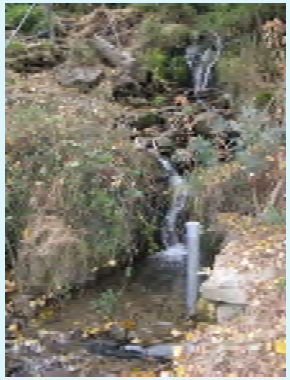
Name	Ref. map.	Q (L/s)	Assigned origin
Fuente del Partidor	1	0,1	Remnant Grande channel
Fuente del Nogal	2	1	Remnant Grande channel
Fte. de la Hoya del Caballo	3	1	Remnant Grande channel
Fuente Alta del Partidor	4	1	Remnant Grande channel
Fuente del Pueblo Alto	5	20	Acuifer and careo Cerro Man
Fuente de la Alberquilla	6	5	Remnant Grande and Barjas channels
Fuente Oscura	7	0,1	Remnant Grande channel
Surgencia Barjas-Ventajas	8	0,1	Remnant Grande channel
Remanente Barjas 1	9	0,1	Remnant Barjas channel
Remanente Barjas 2	10	0,1	Remnant Barjas channel
Remanente Barjas 3	11	0,1	Remnant Barjas channel
Nueva captación abast.	12	5	Acuifer and remnant Barjas channel

In the study area, and focusing on the area considered as an influence of Barjas channel, a total of 12 springs have been inventoried with flow rates almost always lower than 1L/s. The Barjas channel flows incorporating several of the springs considered as remnants of Grande de Cáñar channel.



METHODOLOGY AND DATA

The control of the flows (Barjas channel, Cerro Man and Pueblo Alto spring) has been carried out by **Odyssey Capacitance Water Level Logger** that measure, with a determined frequency, the level in a surface of water by means of capacitance and store the value in a data logger. In the periodic controls of the equipments have been carried out with **OTT C2 small current meter** for the subsequent elaboration of cost curves for flow rates calculation. For the installation of the equipment it was necessary the **channels conditioning**.

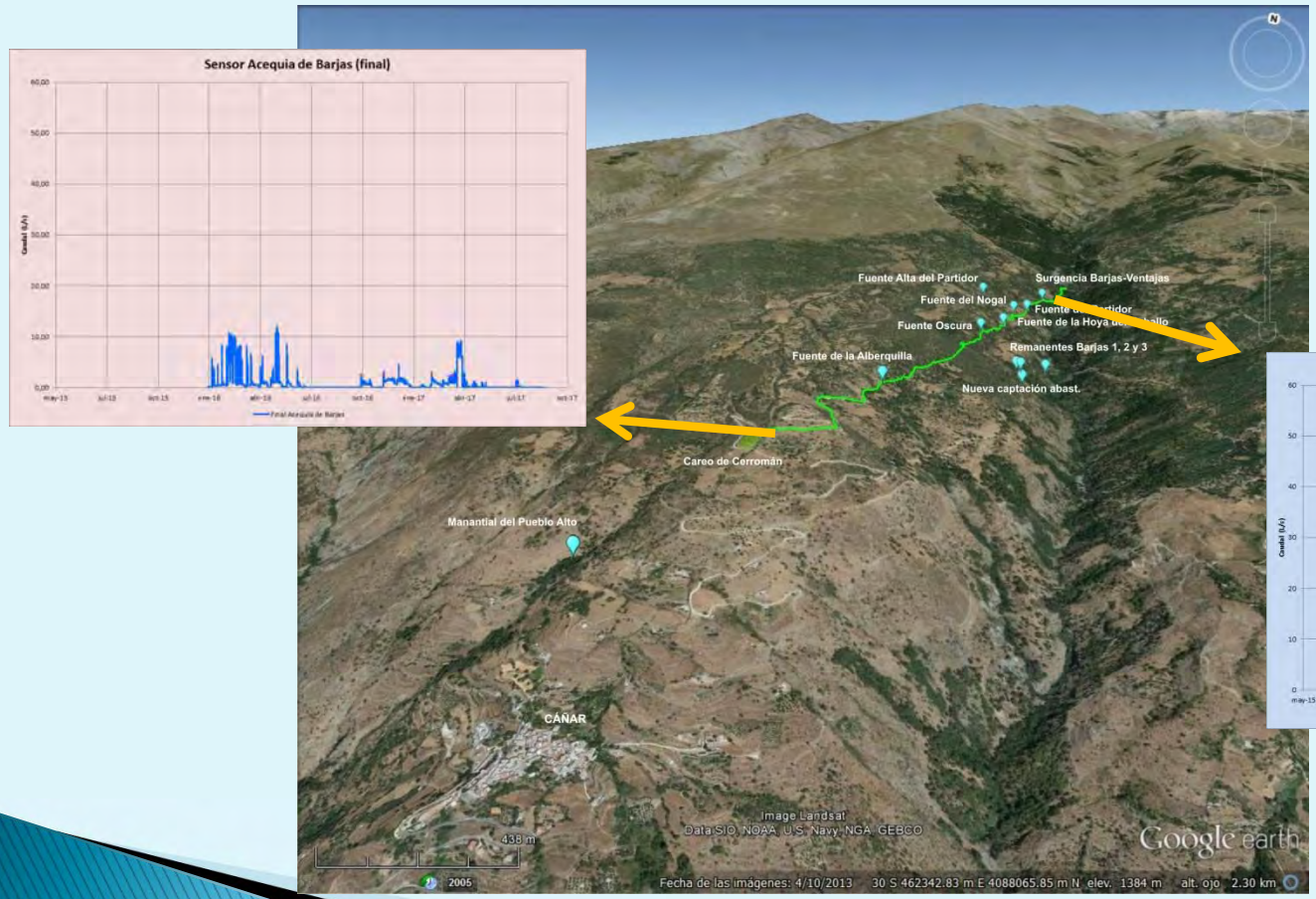


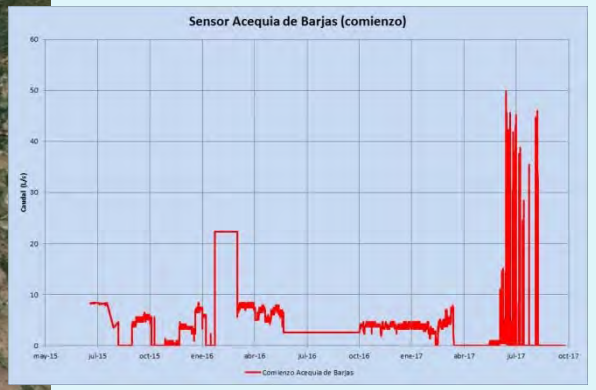
Site			Location
Name	Number	Serial Number	
CERROMAN	1	4418	Derivation of Grande de Cáñar and Barjas channels towards the careo
VIERNES	2	4417	Parrillas Ravine upstream of Pueblo Alto spring
VIERNES-PA	3	4571	Parrillas Ravine downstream of Pueblo Alto spring
PUEBLO ALTO	4	4572	Pueblo Alto spring (procurement for supply)
BARJAS-1	5	4569	Barjas channel start
BARJAS-2	6	4570	Barjas channel end (in Cerro Man to 29/03/17, after in Hijuela end)

BARJAS CHANNEL

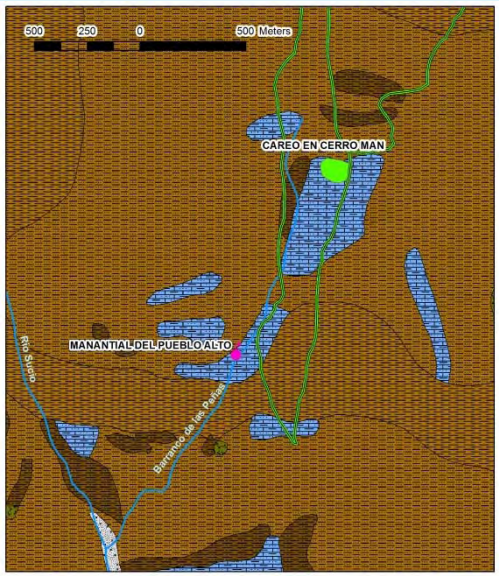
Control point	2015/16 (m^3/year)	2016/17 (m^3/year)	Media (m^3/year)
Channel start (Bco. de las Ventajas)	176.931	74.410	125.670
Channel end (Cerro Man)	22.883	17.438	20.160

From these data it is deduced that, considering an **irrigation return of 80%** of the water used, the annual volume that is incorporated to the aquifer by the surface water use with the Barjas channel will be about **85,000 m^3/year**.



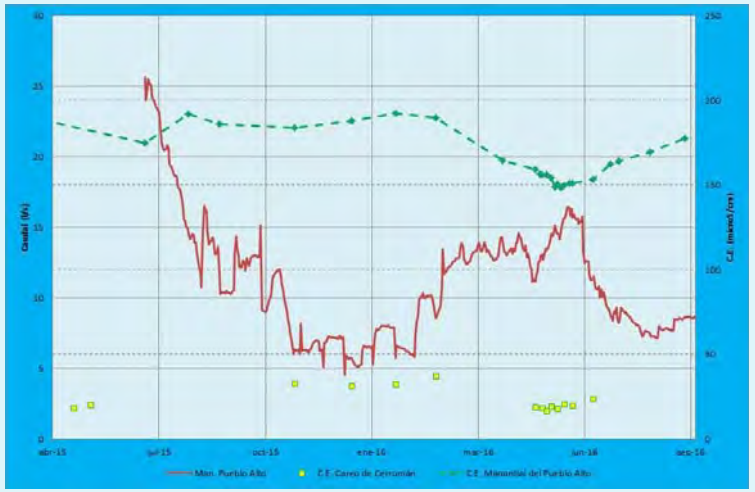


CERROMÁN–PUEBLO ALTO SYSTEM



The "**careo" effect** results in an increase in the Pueblo Alto spring discharge with a response time of approximately **30 days**.

Another argument in favor of the relation between the careo and the spring is the **water electrical conductivity (E.C.) reduction**. We can see that this decreases when the arrival of the water "careada", with C.E. very low, and increases when the artificial contribution of snowmelt water decreases.



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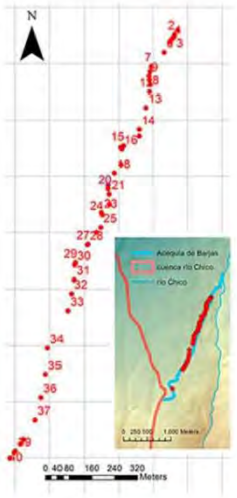
ACEQUIA OF BARJAS

a)



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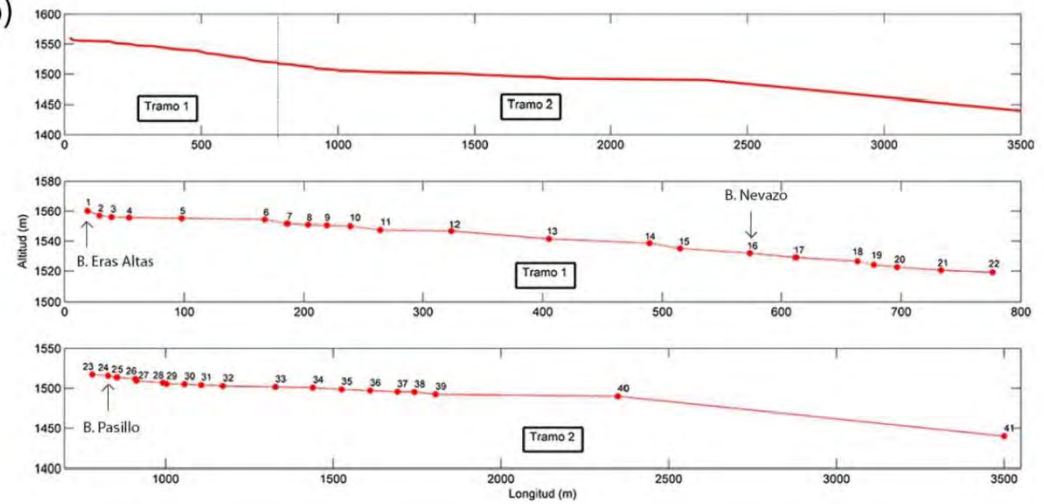

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ACEQUIA OF BARJAS

Marta Saez de Rodrigáñez

"Water circulation Capacity of the Acequia of Barjas (Cáñar). Potential impact at local scale"

DFH. University of Córdoba.

D6.2 MEMOLA's report on "Ecosystem services existing in the study case".

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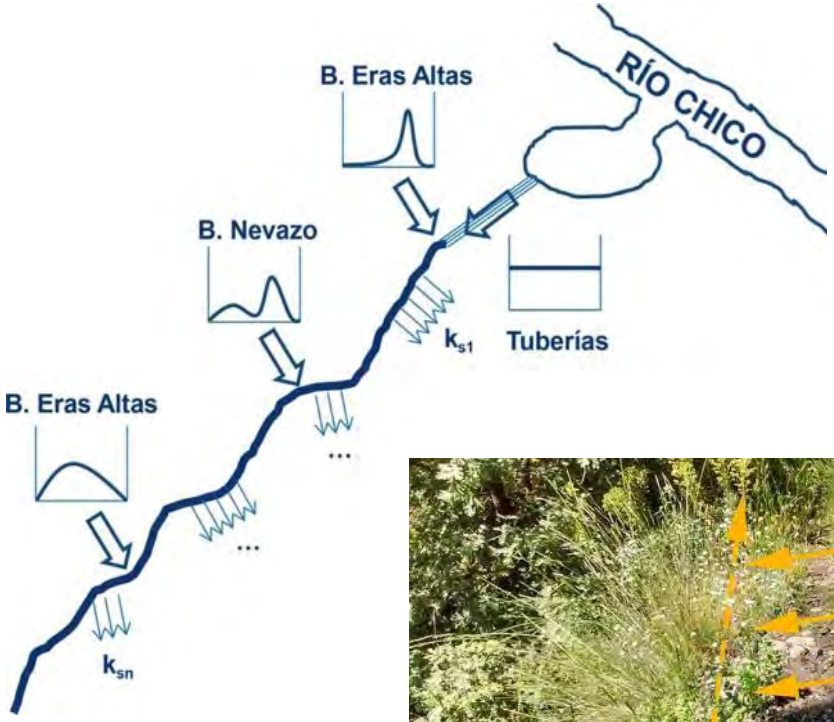
ACEQUIA OF BARJAS



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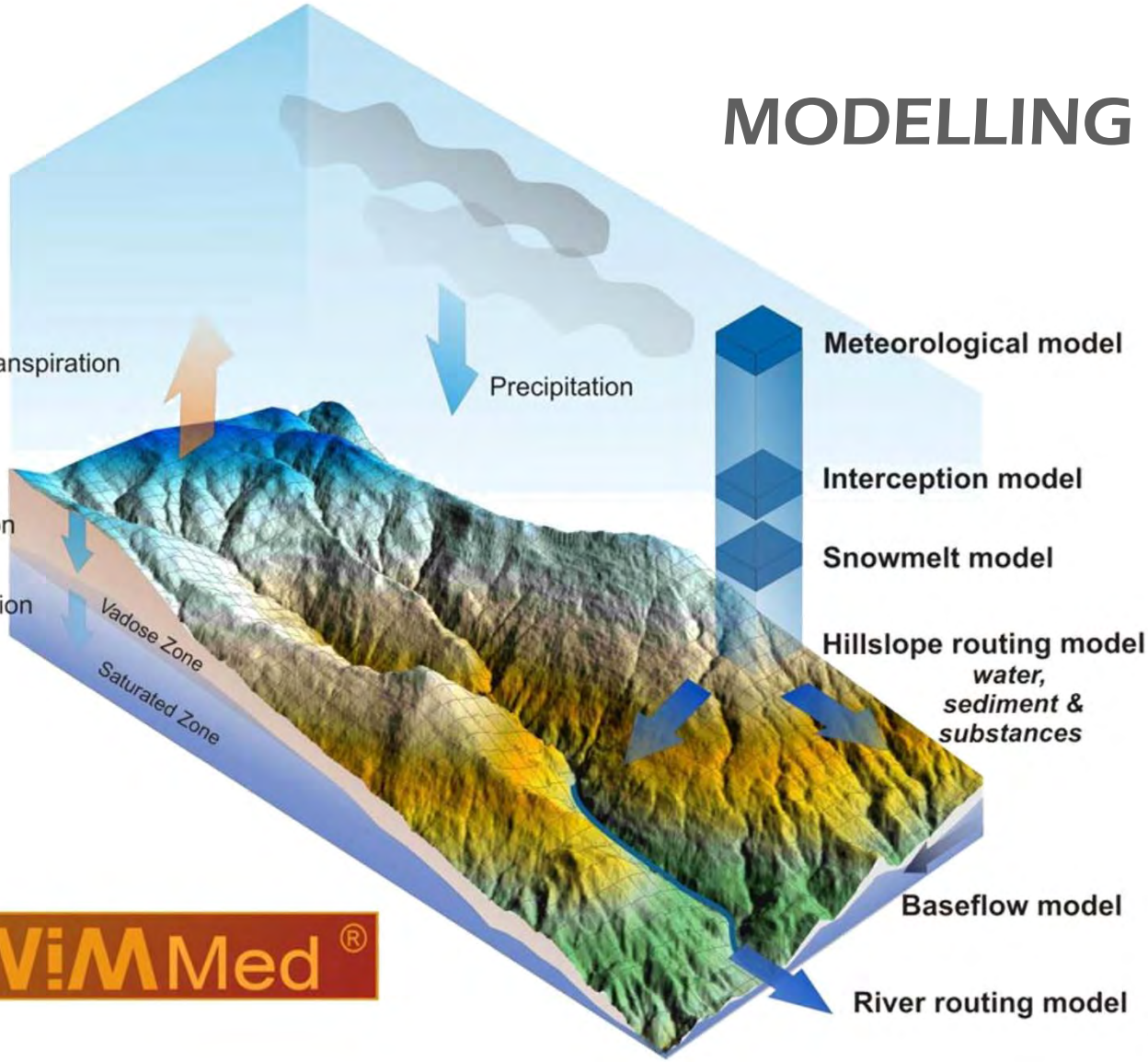
MODELLING



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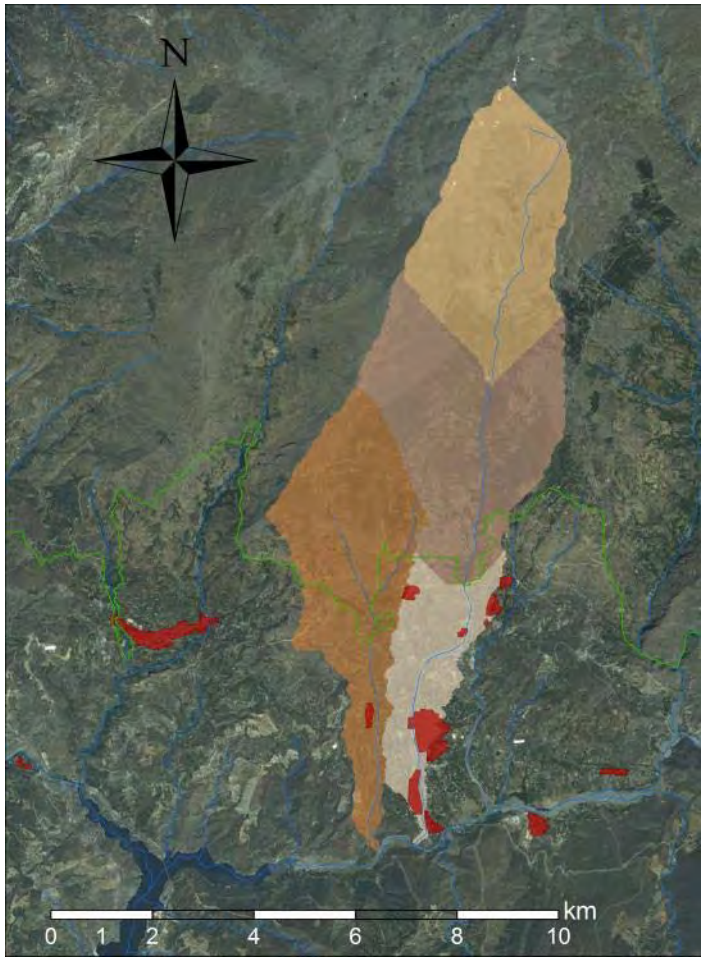
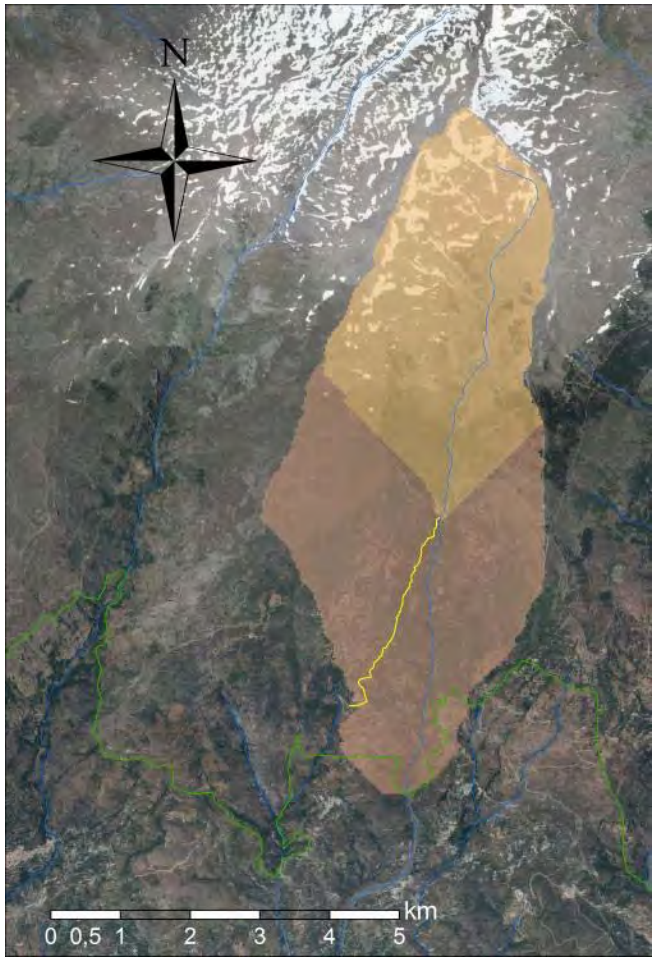
RIVER CHICO BASIN





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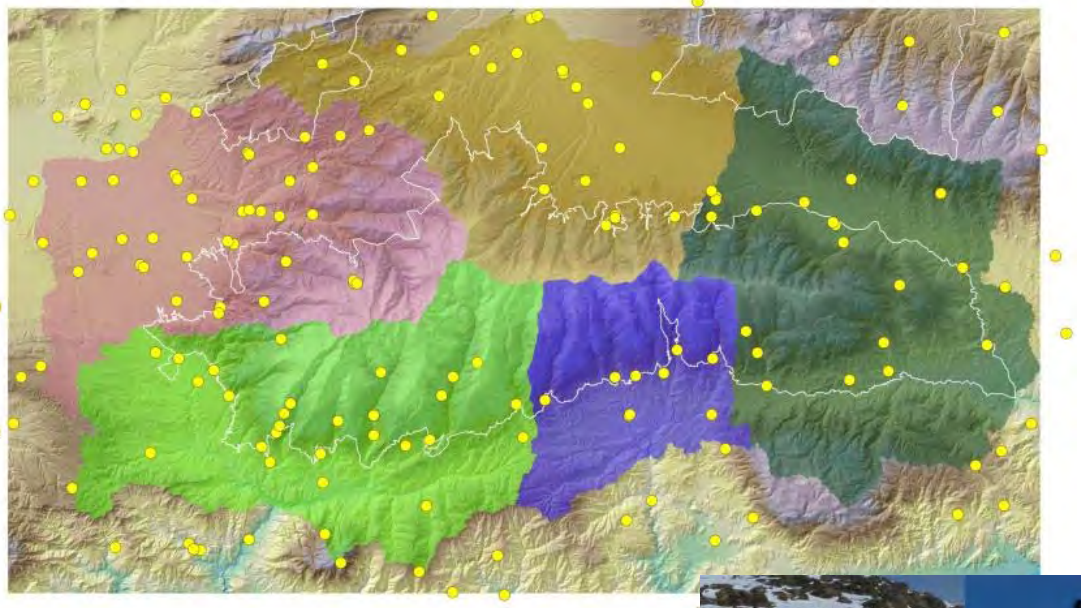
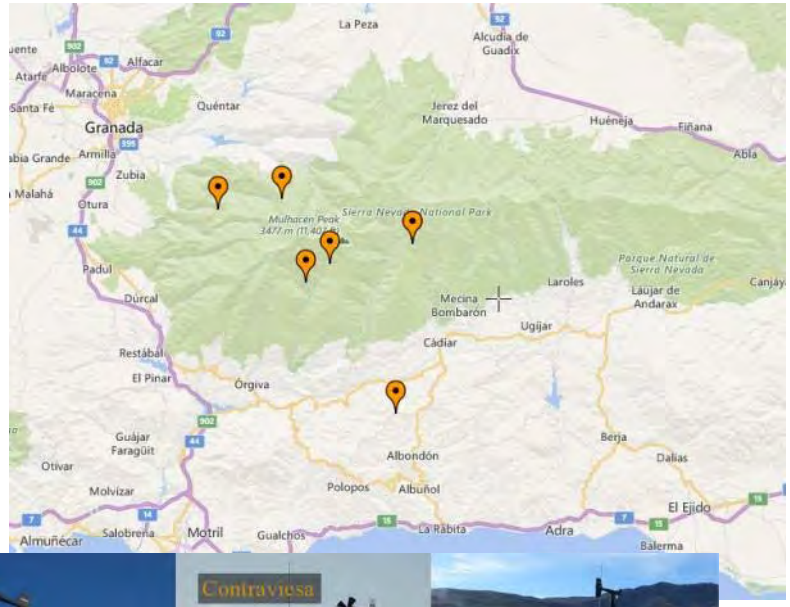
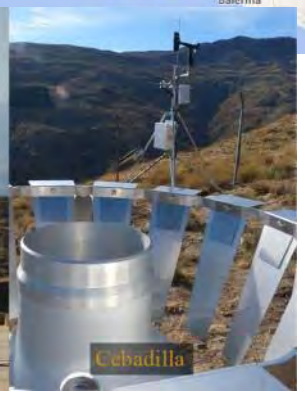
WEATHER DATA

1950-2017



2004-2017





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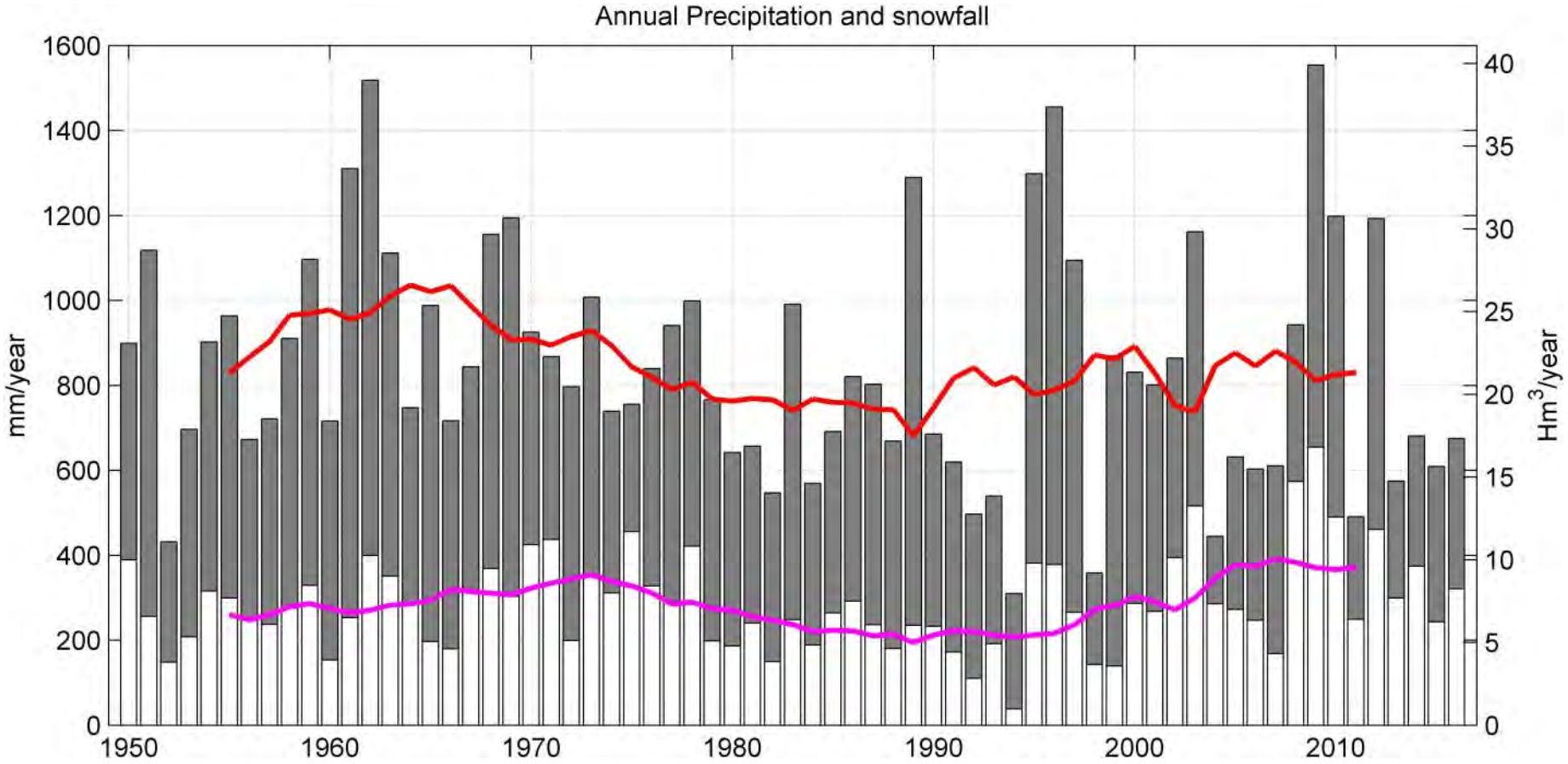
PRECIPITATION/SNOWFALL



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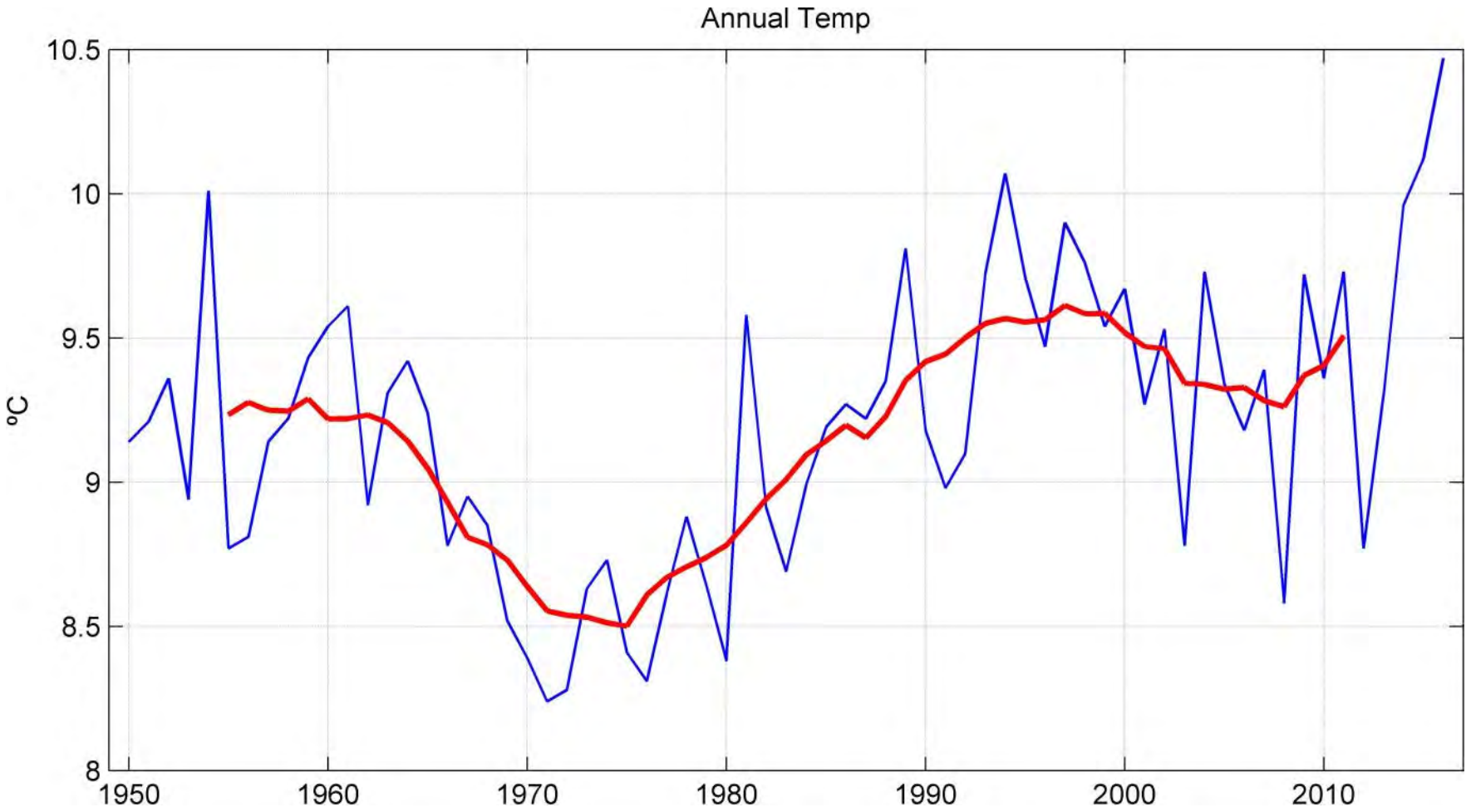
TEMPERATURE



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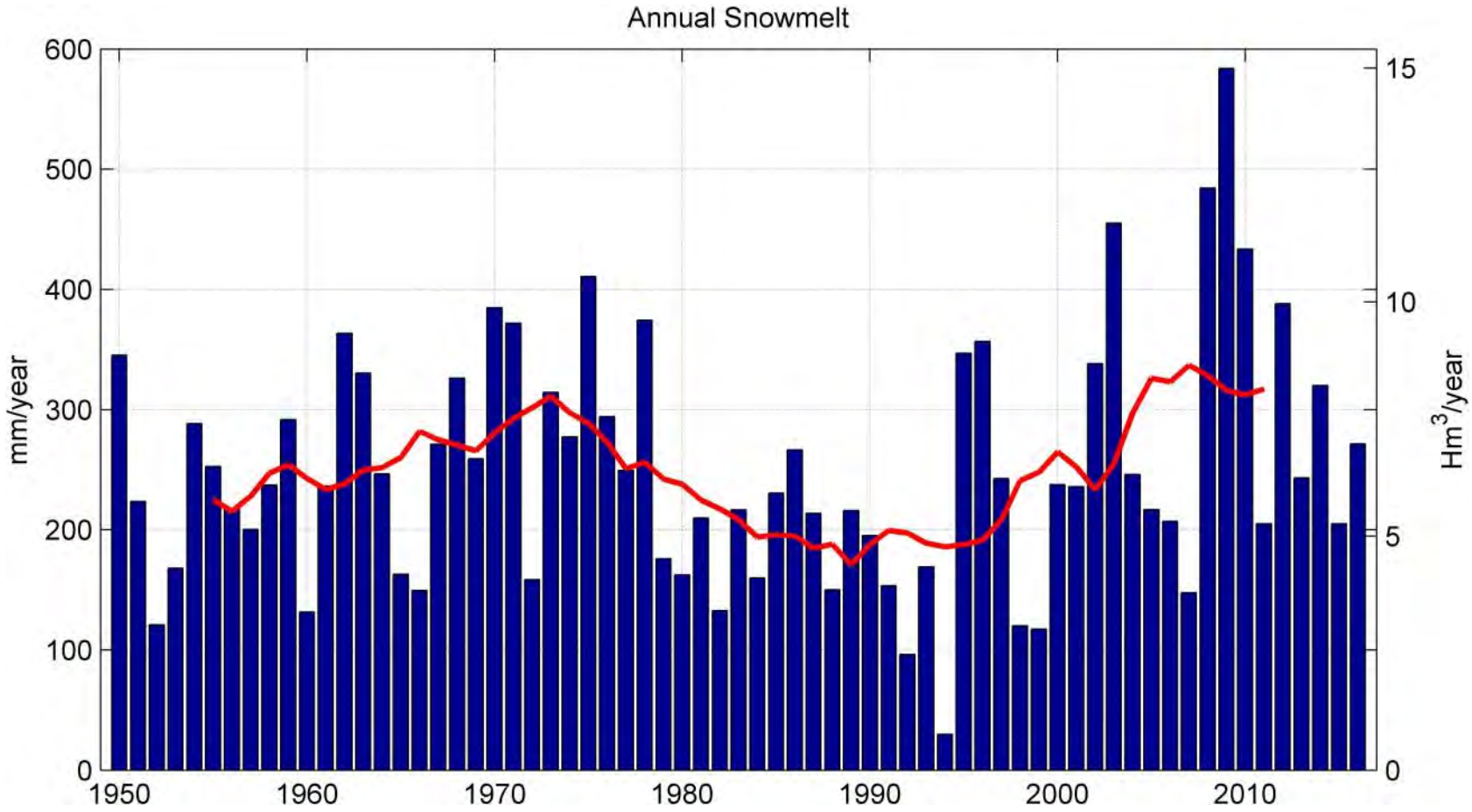
SNOWMELT



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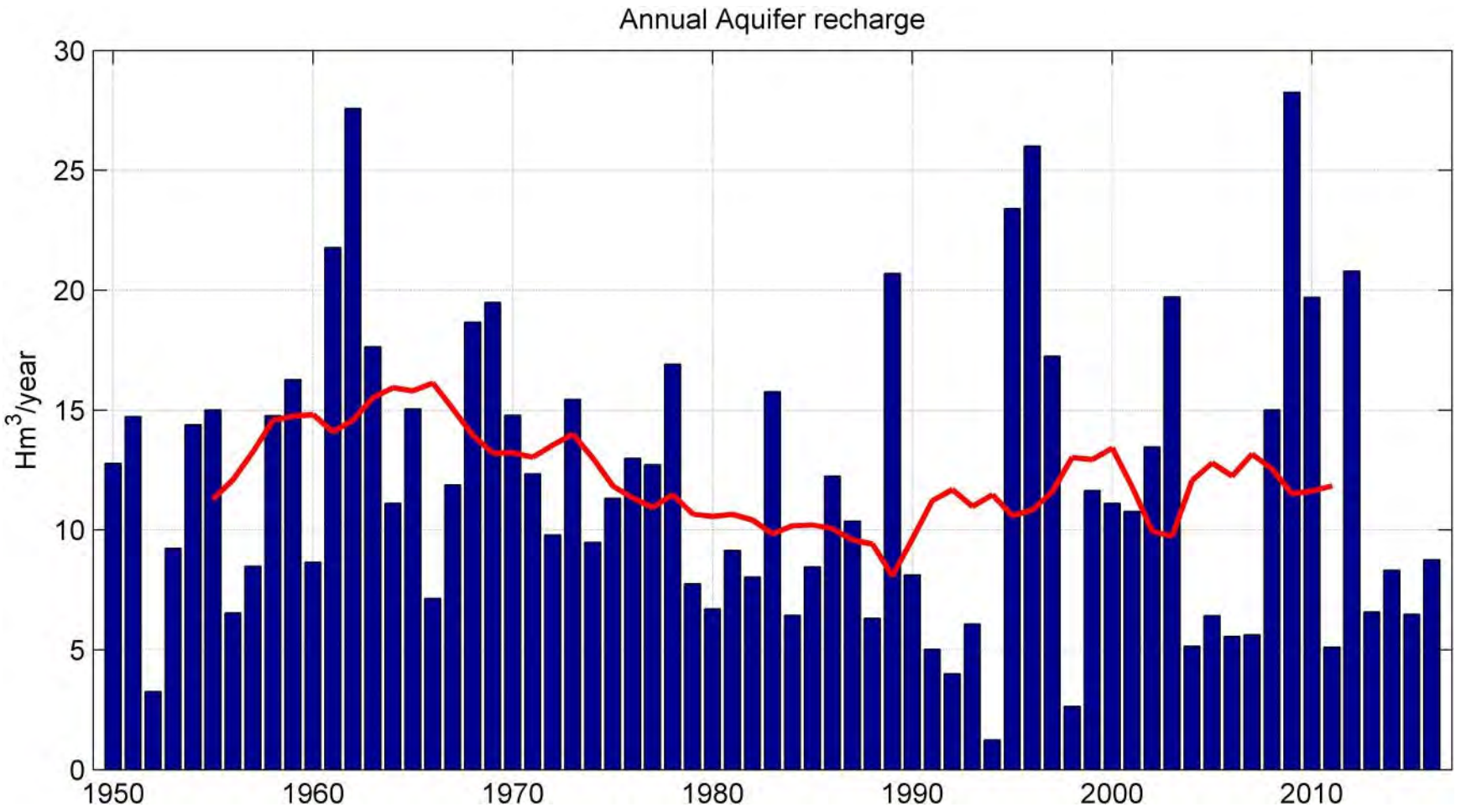
AQUIFER RECHARGE



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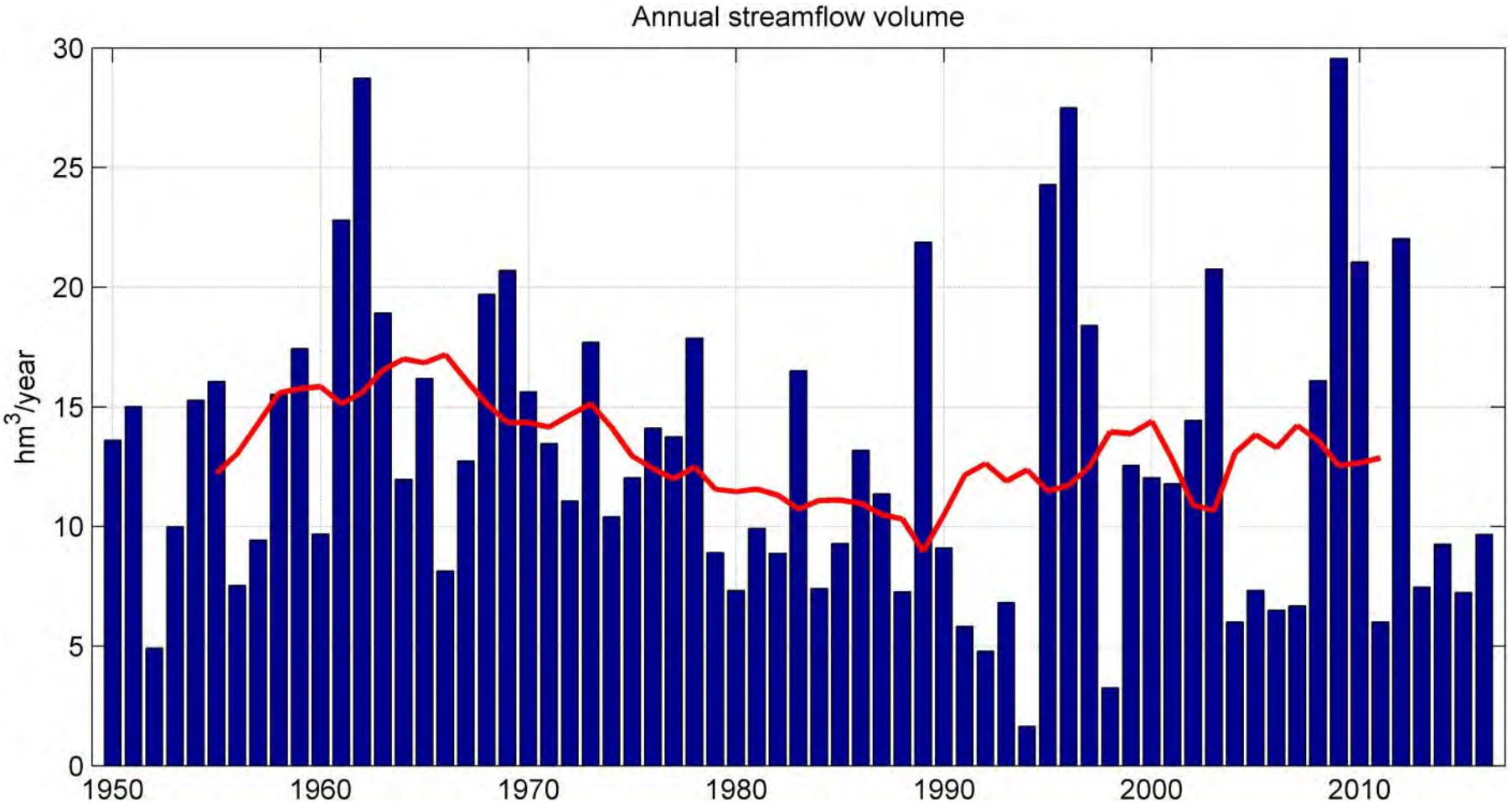
RIVER FLOW



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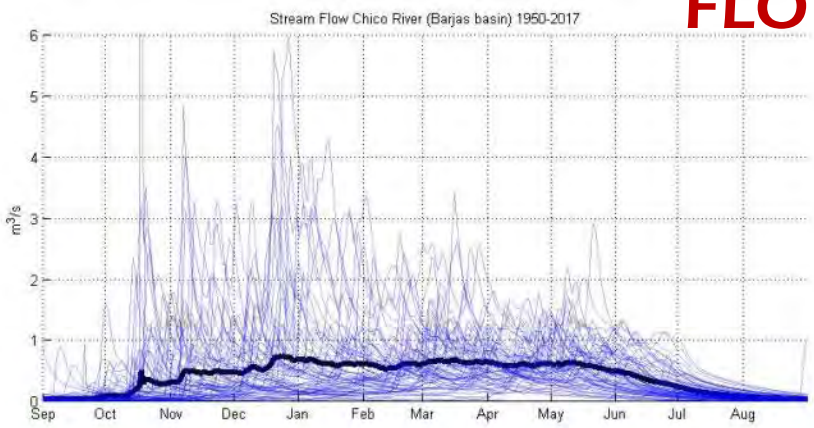
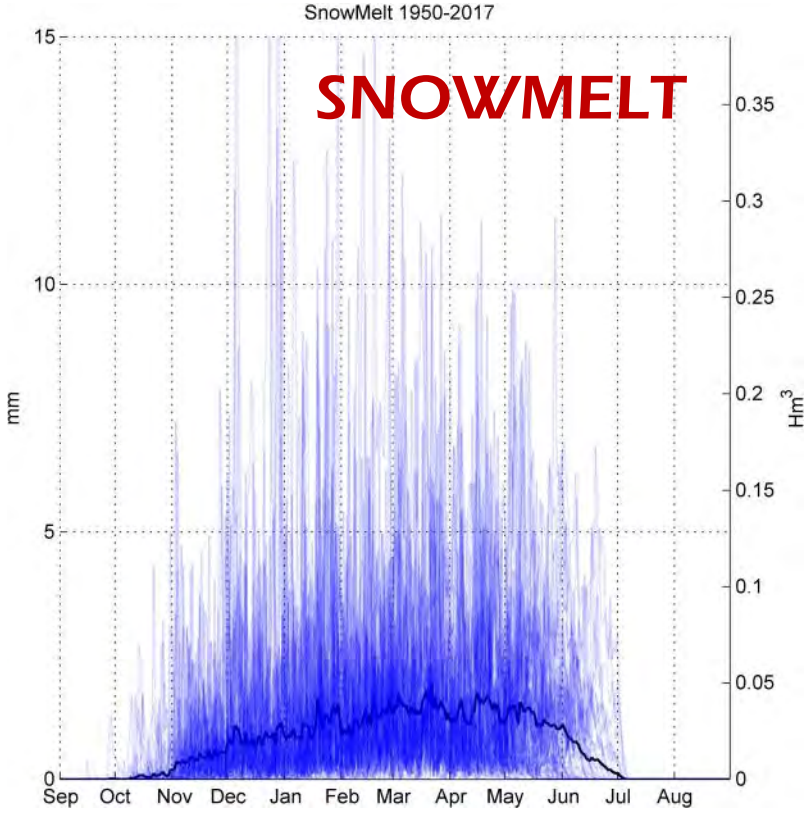
FLOW



SNOWMELT



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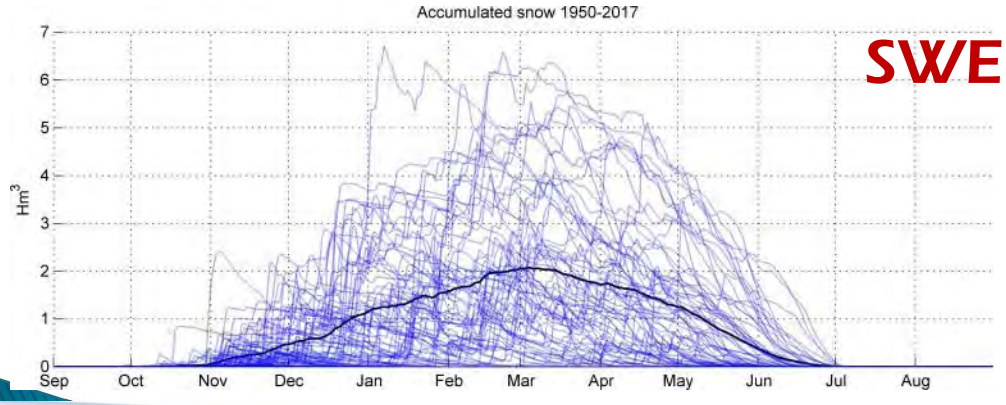

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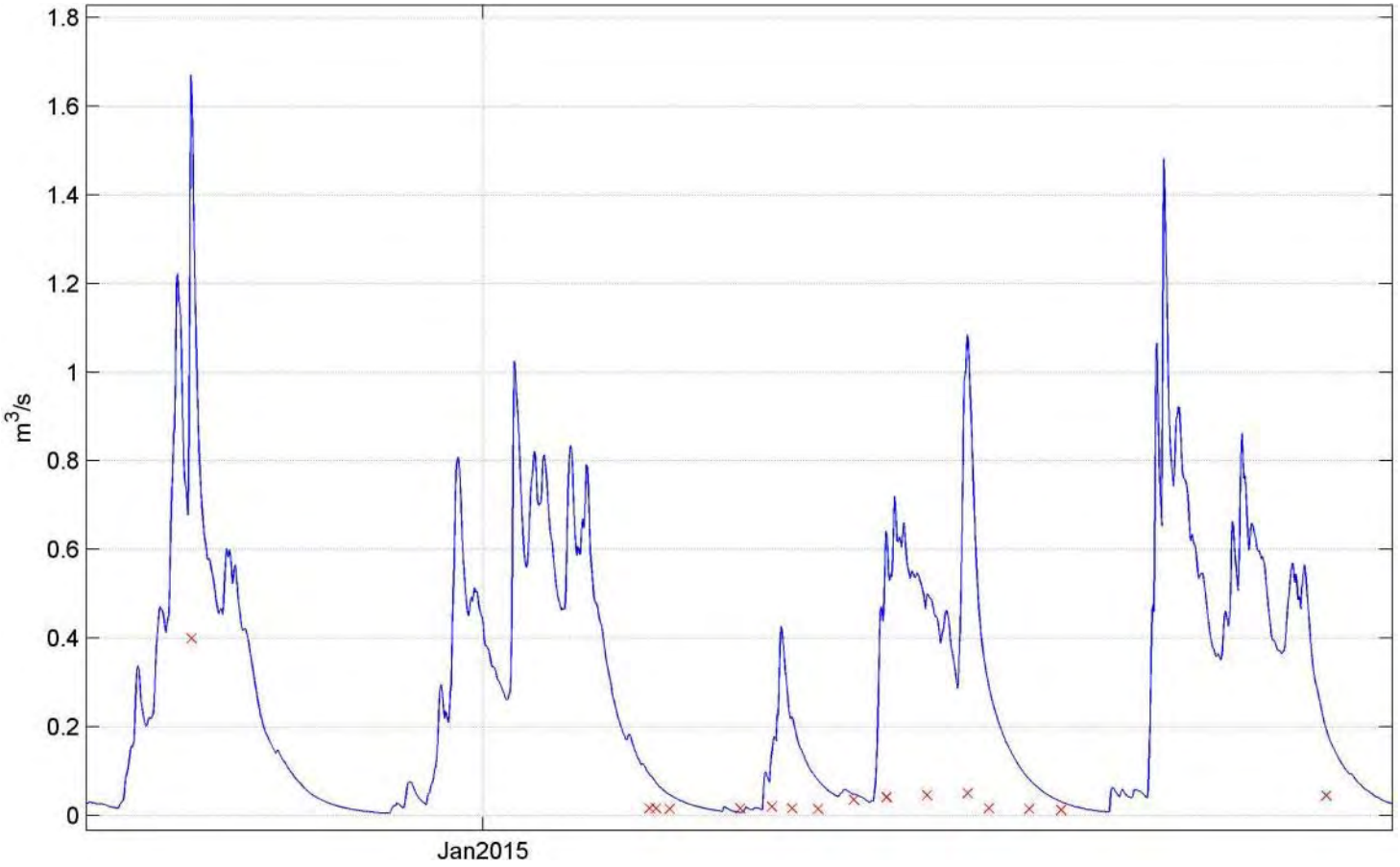
MODEL vs MEASUREMENTS



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CONCLUSIONS

- Acequias as complex system. 0.4 m³/s out of the basin from 0.6 m³/s average stream flow.
- Hydrological role of Barjas in local hydrology not clear
- 3-way interaction Acequias-Snow-Baseflow . 1-month time scale
- Impact over the river flow depends on the spatial redistribution

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