Combined use of geostatistical and conceptual hydrological models for a preliminary assessment of "undercatch" of precipitation in The Canales Basin (Sierra Nevada, Spain).

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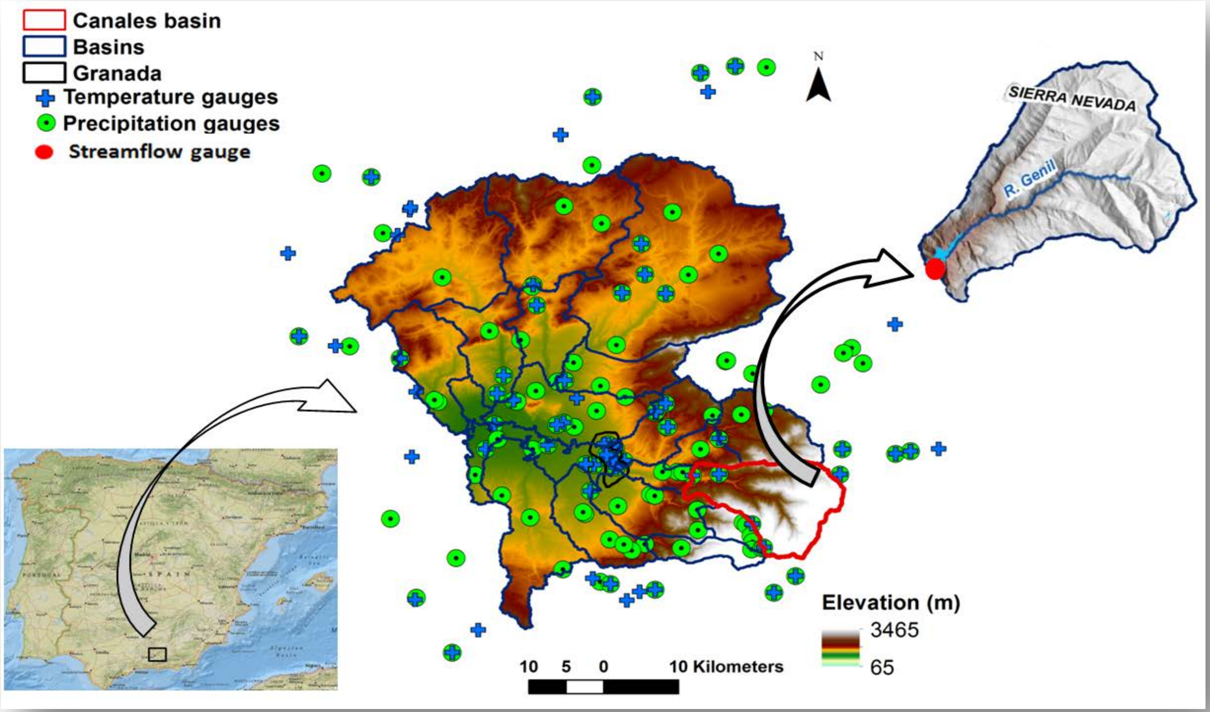
Case study:

Canales River Basin

(Sierra Nevada,Granada,Spain)



Data:

- 1 Streamflow gauge
- 119 precipitation gauges
- 72 temperature gauges

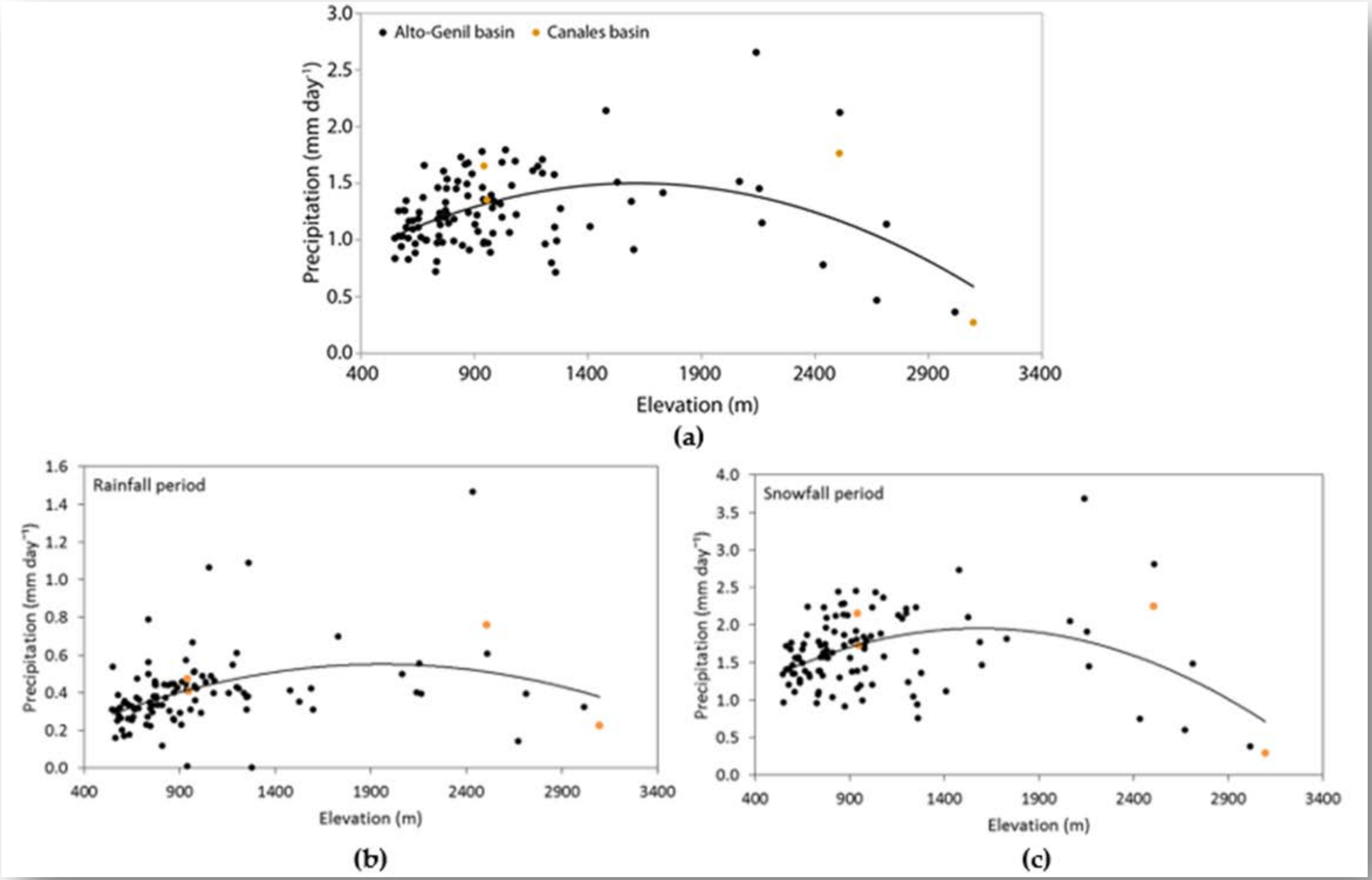
Objectives:

- Identify the best combination of geostatistical and hydrological models to approximate streamflow.
- A global preliminary assessment of the undercatch of solid and liquid precipitation
- Precipitation patterns by analysing spatial gradients with elevation.

Methodology:

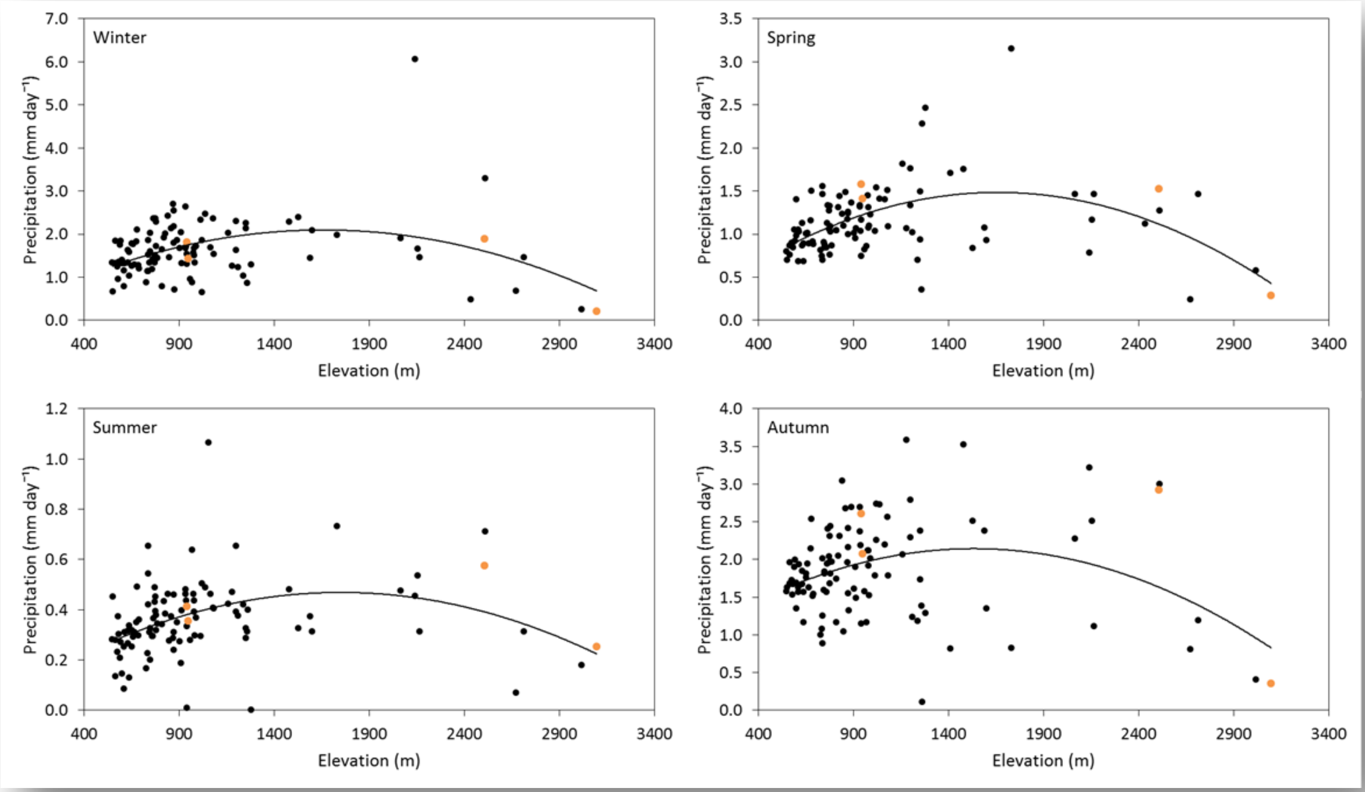
- Different generated fields are employed as inputs of conceptual hydrological models.
- Models includes two parameters to correct the solid and liquid precipitation.
- Three hydrological approaches are used: SRM, HBV and a Témez model with a simple degree-day approach (STM).

Results: Historical Data Analyses



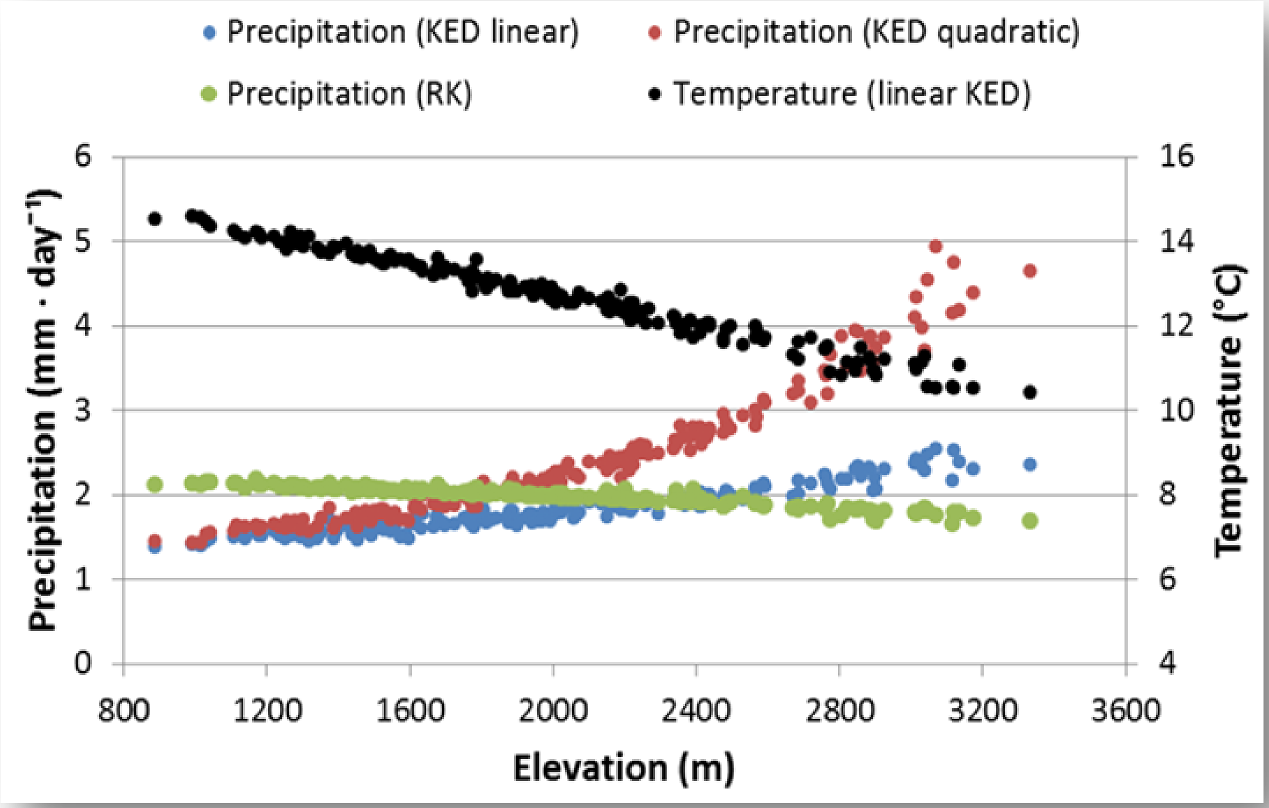
(**a**) Mean daily precipitation data depending on elevation in the Alto Genil basin, where the Canales basin is located. Trend of precipitation with elevation for (**b**) the snowfall and (**c**) rainfall period. Orange dots represent gauges included in the Canales basin.

Results: Historical Data Analyses



Trend of precipitation with elevation for the average year at seasonal scale. Orange dots represent gauges included in the Canales basin.

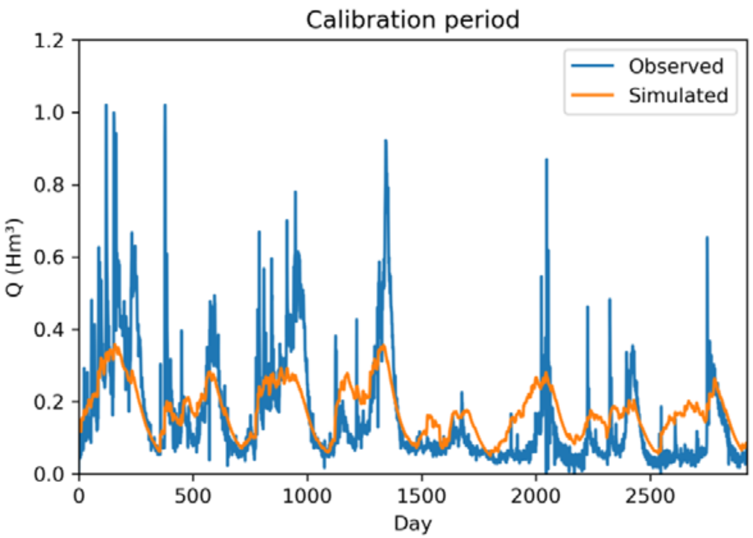
Results: Preliminary Assessment of Precipitation Fields (Geostatistical)

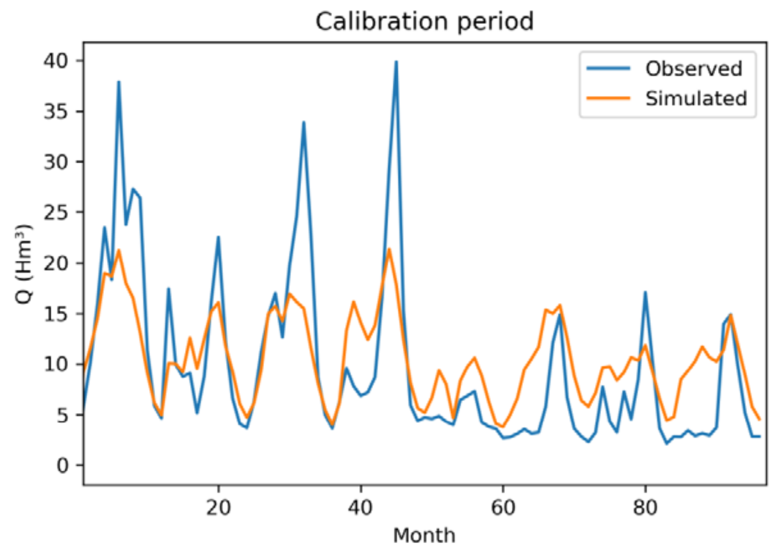


Estimated mean daily temperature and precipitation data depending on elevation in Canales basin.

Results: Snowmelt Runoff Model (SRM) using RK for P & LKED for Tª

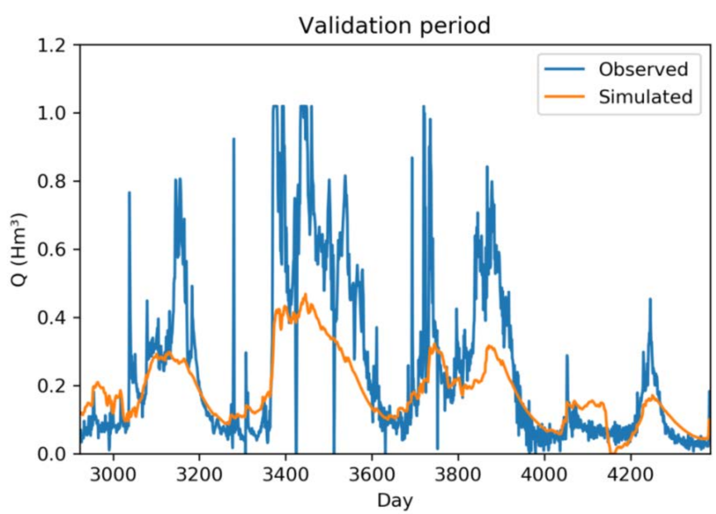
01/10/00 – 30/09/08 (8 years)

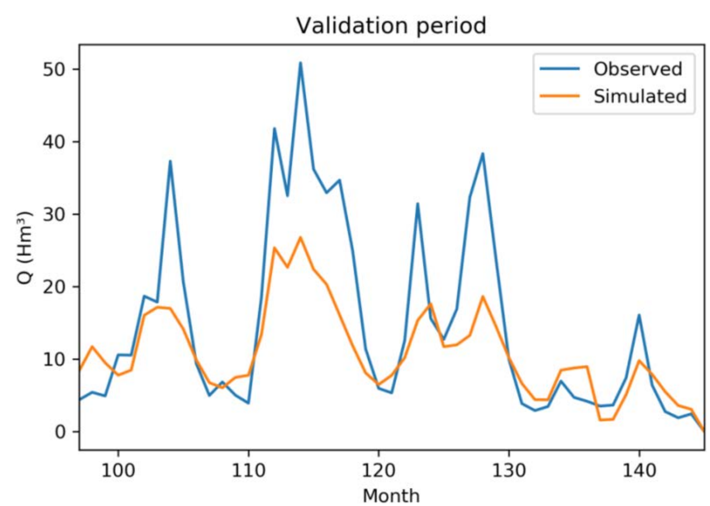




Daily results
NSE = 0.42; R^2 = 0.48
Monthly results
NSE = 0.52; R^2 = 0.60

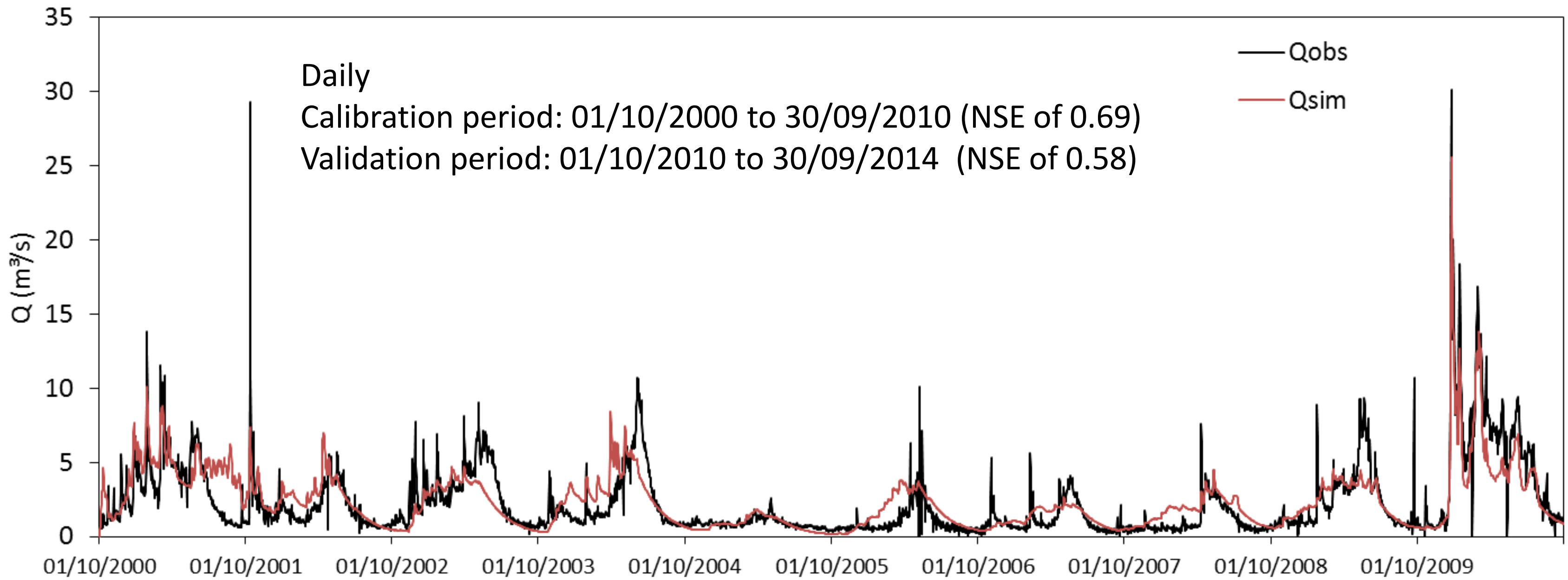
01/10/08 – 30/09/12 (4 years)

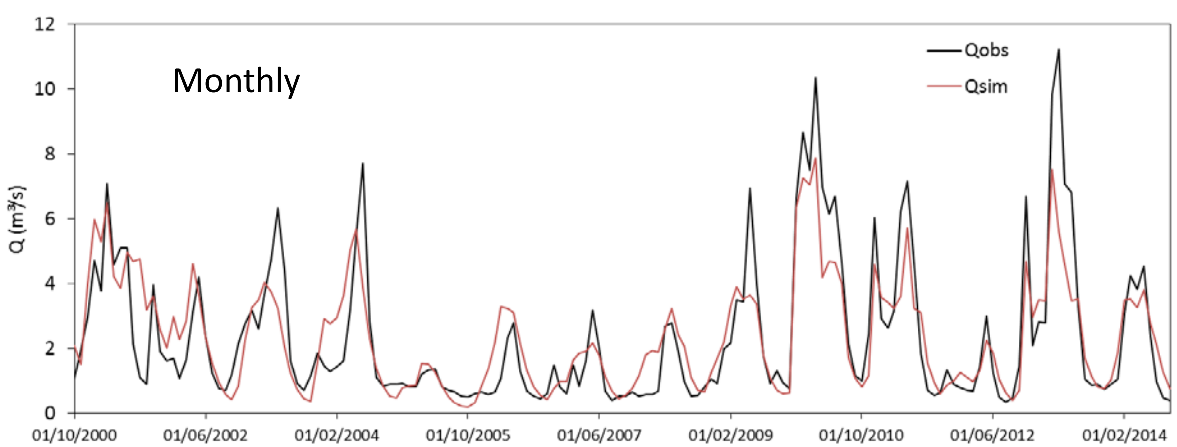


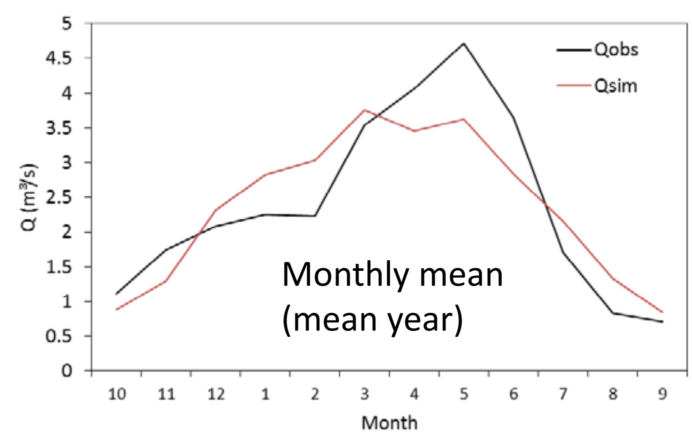


Daily results
NSE = 0.40; R^2 = 0.64
Monthly results
NSE = 0.51; R^2 = 0.81

Results: HBV rainfall-runoff model using RK data for P and LKED for temperature





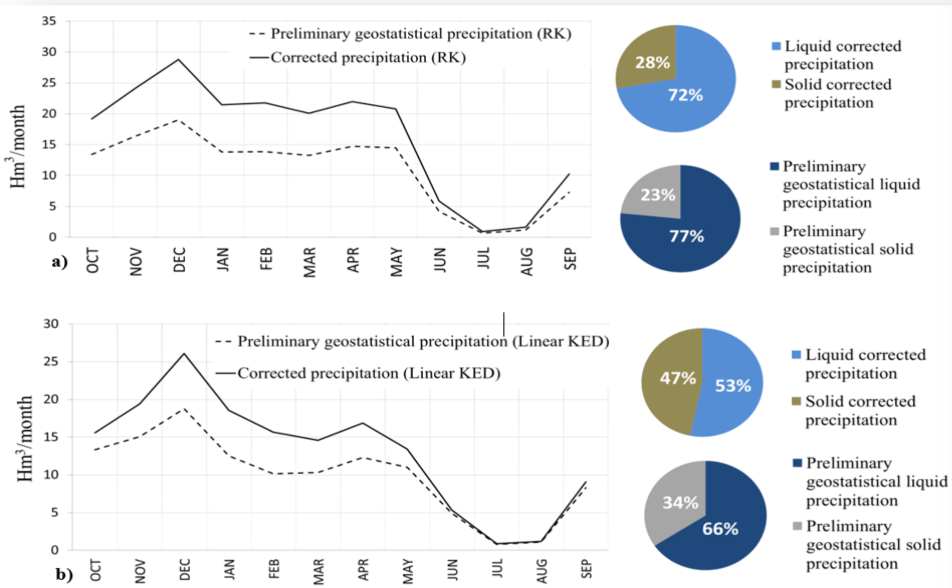


Results: Results of the Conceptual Hybrid Snow-Témez Model (STM)

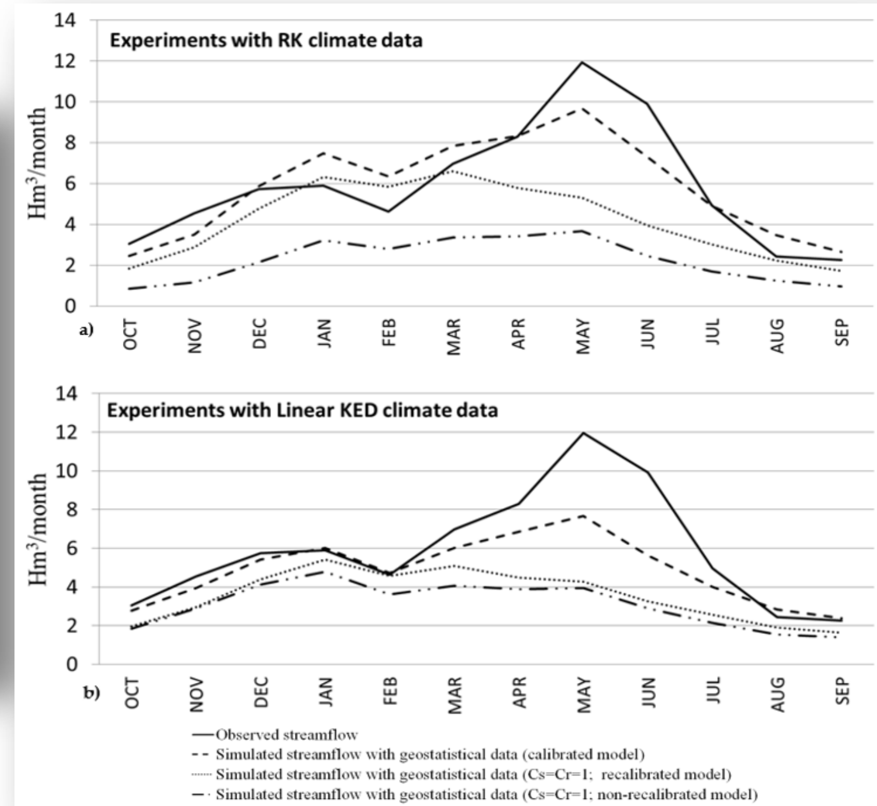
Values of the correction coefficients (Cr and Cs) and goodness of fit to the daily and monthly streamflow data for the calibration and validation periods for each model approach.

	Approach	Cs	Cr	Scale	Calibration				Validation			
					NSE	R^2	RMSE	PBIAS	NSE	R^2	RMSE	PBIAS
(1)	RK (calibrated model)	1.78	1.4	Daily	0.56	0.58	0.15	1.91	0.48	0.52	0.12	−0.35
				Monthly	0.68	0.70	3.39	1.90	0.63	0.67	2.66	−0.36
(2)	RK (non−recalibrated model)	1	1	Daily	0.07	0.57	0.22	61.37	0.03	0.42	0.17	62.33
				Monthly	0.06	0.70	5.79	61.37	−0.001	0.55	4.37	62.33
(3)	RK (recalibrated model)	1	1	Daily	0.38	0.51	0.18	30.18	0.32	0.40	0.14	26.39
				Monthly	0.46	0.64	4.35	30.18	0.42	0.52	3.33	26.39
(1)	Linear KED (calibrated model)	1.8	1.07	Daily	0.28	0.45	0.19	40.01	0.32	0.53	0.14	−18.52
				Monthly	0.57	0.43	4.80	40.00	0.71	0.57	3.29	−18.49
(2)	Linear KED (non−recalibrated model)	1	1	Daily	−0.03	0.38	0.23	63.55	0.38	0.48	0.13	21.72
				Monthly	−0.08	0.48	6.15	63.55	0.49	0.62	3.11	21.74
(3)	Linear KED (recalibrated model)	1	1	Daily	0.05	0.36	0.22	56.60	0.36	0.46	0.14	13.08
				Monthly	0.04	0.45	5.82	56.60	0.47	0.60	3.18	13.11

Results: Results of the Conceptual Hybrid Snow-Témez Model (STM)

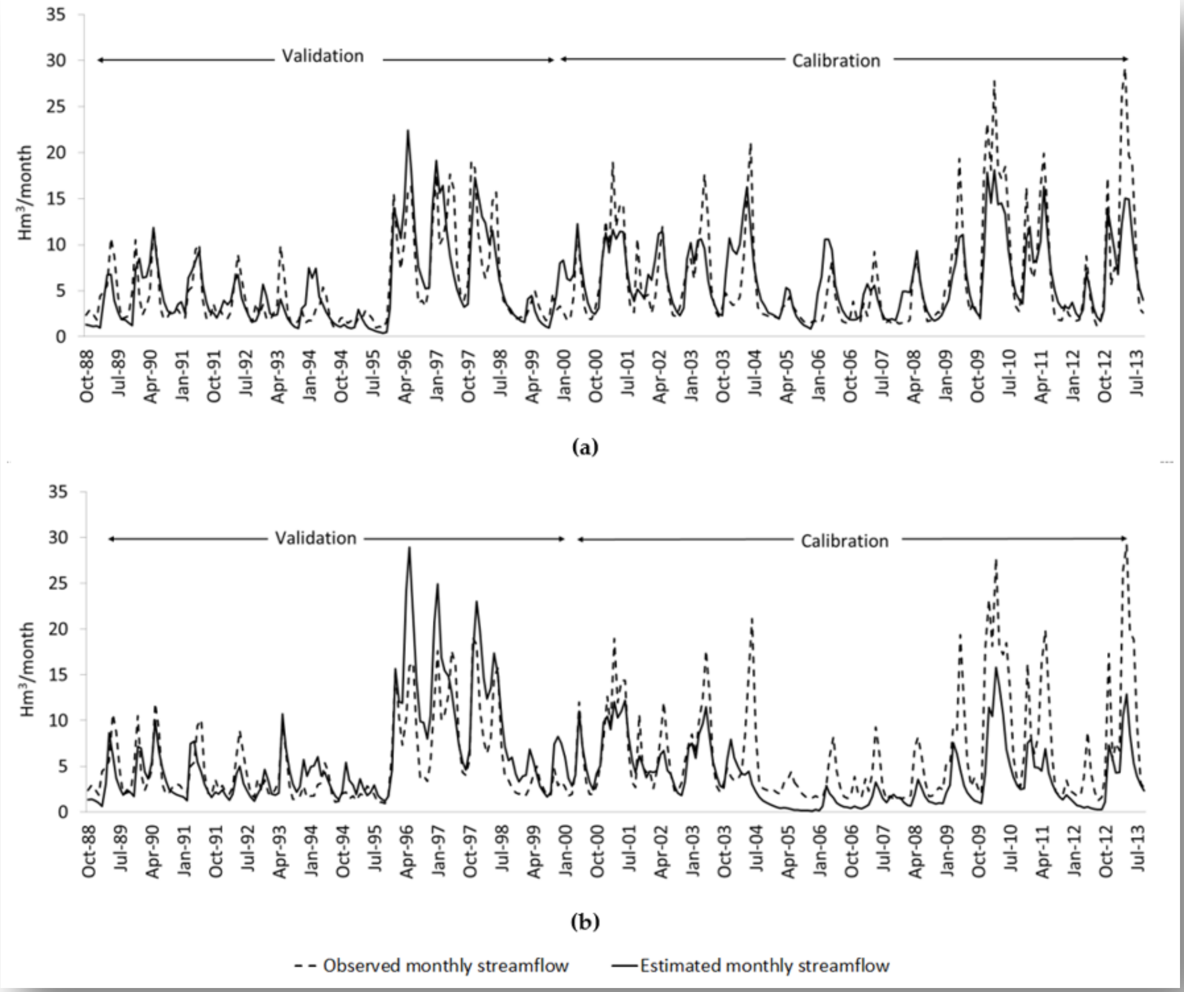


Estimated monthly mean precipitation and its annual distribution between solid and liquid phases (preliminary geostatistical fields vs. corrected fields); (**a**) RK model; (**b**) linear KED model.



Monthly mean streamflow series for the six approaches against the observed data: (**a**) RK model; (**b**) linear KED model.

Results: Results of the Conceptual Hybrid Snow-Témez Model (STM)



Estimated monthly streamflow for the period October 1988–September 2013 with the preliminary climatic fields and the corrected ones: (**a**) RK model; (**b**) linear KED model.

Conclusions:

- This methodology allows for a preliminary assessment of global undercatch in an alpine basin.
- The precipitation pattern within the basin was also analyzed in terms of distribution between solid and liquid phases and the spatial gradient with elevation.
- SRM model obtained the poorest results, the HBV results were acceptable and the STM model obtained the best performance.
- The best combination of geostatistical approaches and STM hydrological models was obtained with the RK approach correcting the solid and liquid precipitation with the calibrated coefficients Cs and Cr, respectively.
- The results of this study show how the efficiency of the models increases upon correcting precipitation.
- In Sierra Nevada, the percentage of time with wind speed above 5 m/s for the snow season (October to May) is considerable, averaging more than 25% and at some points surpassing 50%. This is in agreement with the high values of solid Cs obtained. In addition, the correction of liquid precipitation undercatch, although smaller than that of solid precipitation, can be significant under high wind speeds.
- Correcting the undercatch of precipitation would significantly reduce the negative precipitation gradient in the modified precipitation fields initially predicted by the RK approach.