Vilcanota river watershed Hydrology - Peru: Evolution in a changing climate.

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INTRODUCTION:

- It is important to understand the hydrological behavior of the Vilcanota river watershed, in order to determine water availability and the risk of floods. This will allow us to make better decisions.
- The objective of this research is to analyze the evolution of the hydrology in the Vilcanota river watershed in different climates (present and past).

Fig. N°1: Vilcanota Basin

Study Area:

- Vilcanota river watershed is located in Cusco region in Peruvian Southeast mountain, on the Atlantic slope.
- Main features:
  - Area : 9 585.97 km2
  - Elevation range : 2291 – 5781 msnm
  - Average slope : 0.268 m/m
  - Snow percentage: 1.13 %

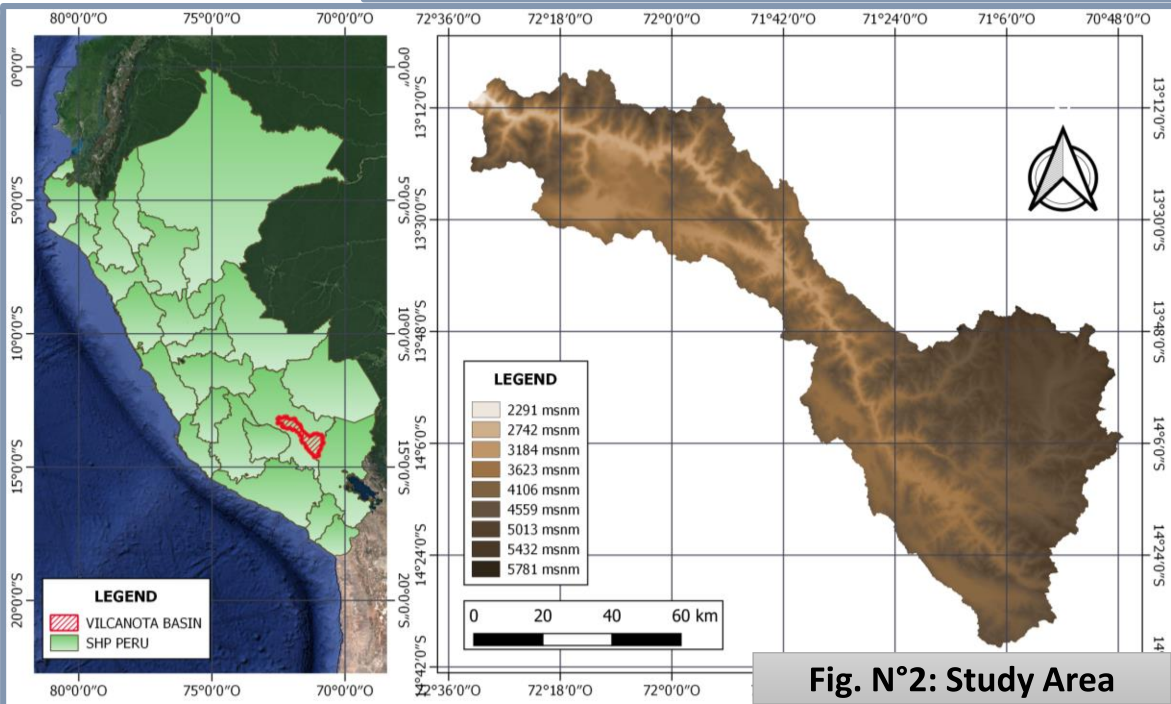


Fig. N°2: Study Area

METHODS:

- The historical data of meteorological forcing were taken from the PISCOp V2.1 database (Aybar et al. 2019), and streamflow measurements, were taken from the Peruvian National Meteorological and Hydrological Service (SENAMHI) database, both in temporary resolution of daily and basin scale.
- Two periods were considered of 1987-1997 and 2006-2016, past and present respectively.
- FUSE was chosen to find the impact of using different model structures (Clark et al. 2008).

RESULTS AND DISCUSSION:

- In the preliminary analysis made for both periods, shown in Fig. N°4, it is observed that both periods show slight differences.
- It should be taken into account that the periods were chosen because one represents the past and the other presents it.

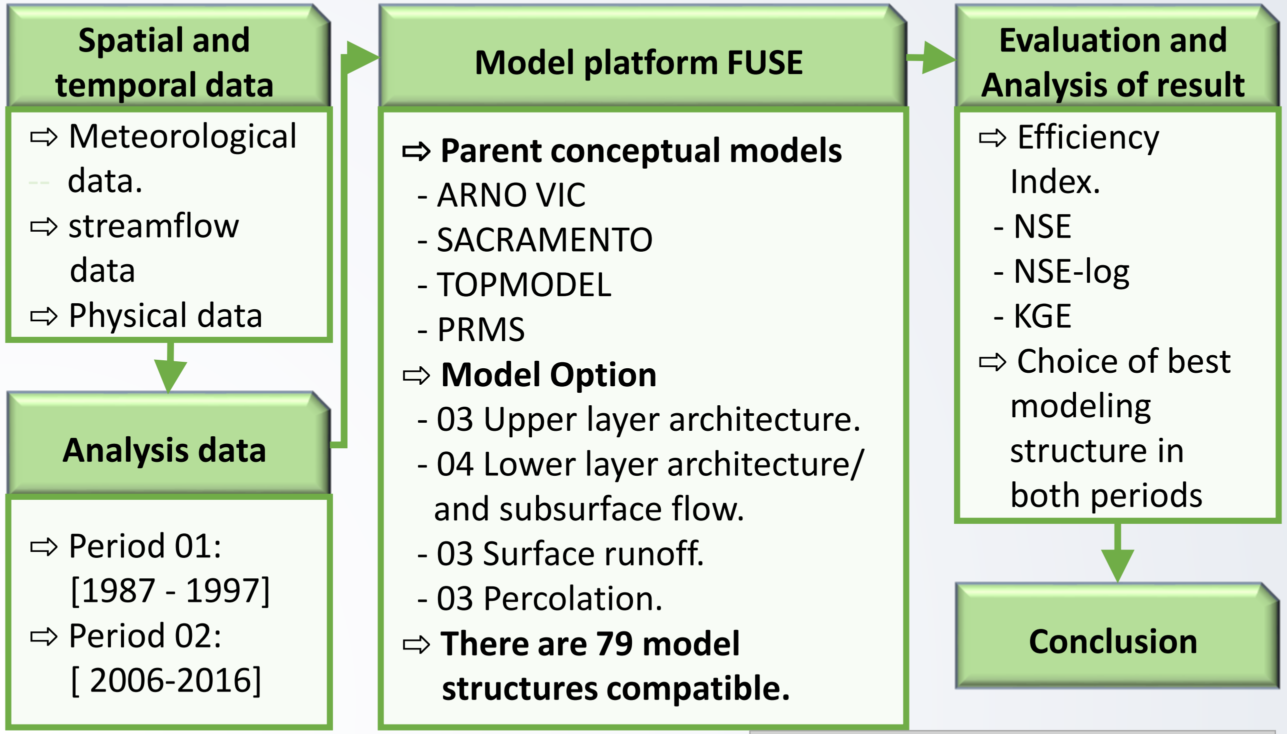
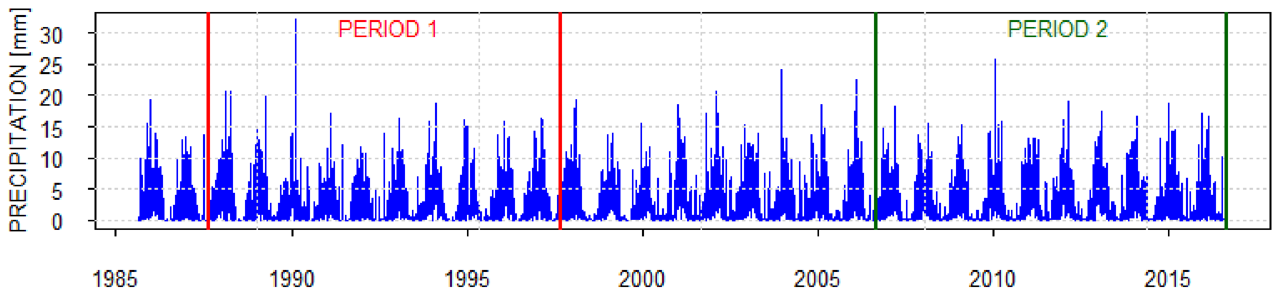


Fig. N°3: Methodology scheme



Description	Period 1	Period 2
Precipitation [mm/year]	718.56	764.03
PET [mm/year]	780.25	796.38
Runoff [mm/year]	379.14	401.06
runoff coefficient [-]	0.5276	0.5249
índice de aridez [-]	1.0858	1.0423

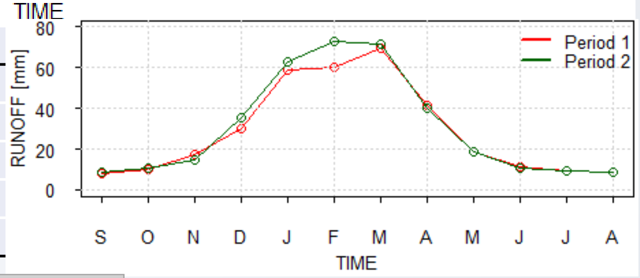


Fig. N°4: Analysis of data

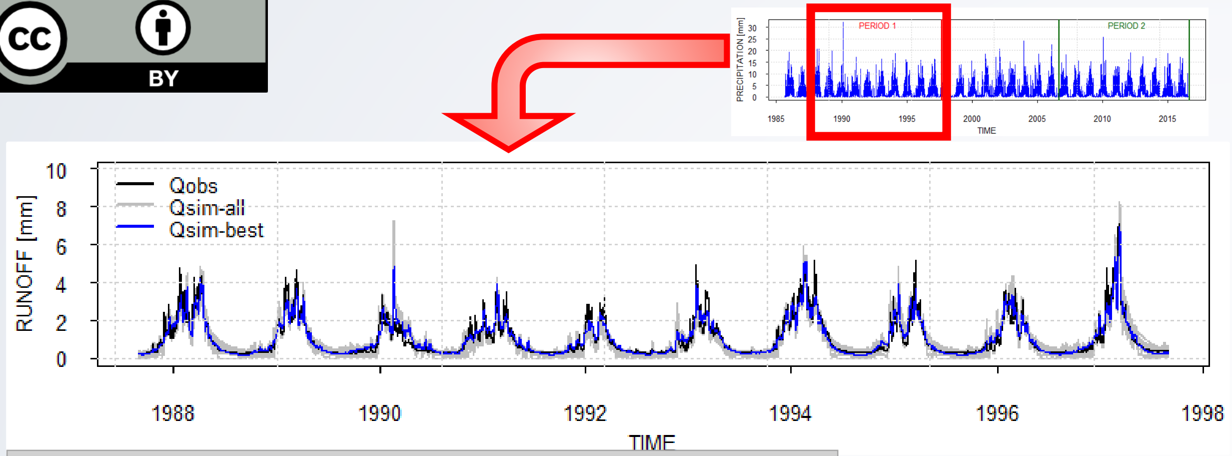


Fig. N°5: hydrological modeling results - period 1

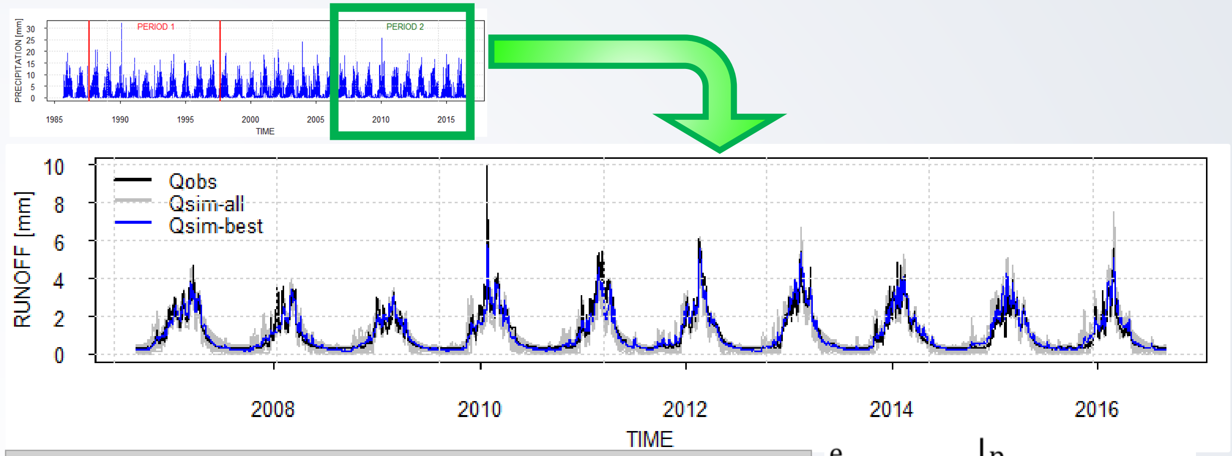


Fig. N°6: hydrological modeling results - period 2

- Good modeling performances were presented with the different modeling structures in both periods, shown in Fig. N°5 and Fig. N°6.
- The different modeling structures, in their great majority, tend to represent well the evolution of hydrology, observing that the impact of the modeling structures is minimal.
- It was determined that in both periods the best modeling structure is the same, shown in the Fig. N°7.

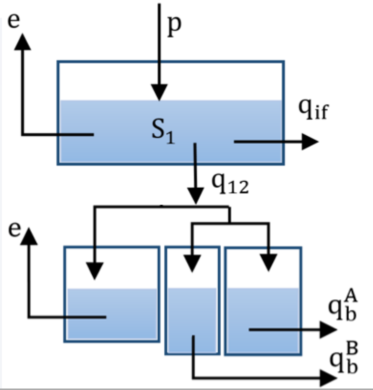


Fig. N°7: Best model structure in both periods

CONCLUSIONS:

- In both periods studied, FUSE adequately represents the hydrological behavior of the basin, presenting only slight differences in performance.
- The best model structure in both periods was similar, resulting in: (1) Upper layer architecture by ARNO VIC, (2) Lower layer architecture by SACRAMENTO, (3) Surface runoff by TOPMODEL, y (4) Percolation by ARNO/VIC.
- In a next stage, these results are considered to be applied to changes in future climates.

REFERENCES:

- Aybar, C., Fernández, C., Huerta, A., Lavado, W., Vega, F., & Obando, O. F. (2019). Construction of a high-resolution gridded rainfall dataset for Peru from 1981 to the present day. Hydrological Sciences Journal, 1-16. doi:10.1080/02626667.2019.1649411.
- Clark, M. P., Slater, A. G., Rupp, E. D., Woods, R. A., Vrugt, J. A., Gupta, H. V.,… Hay, L. E. (2008). Framework for Understanding Structural Errors (FUSE): A modular framework to diagnose differences between hydrological models. Water Resources Research, 44, 1-14. doi:10.1029/2007WR006735, 2008.

APPENDIX:

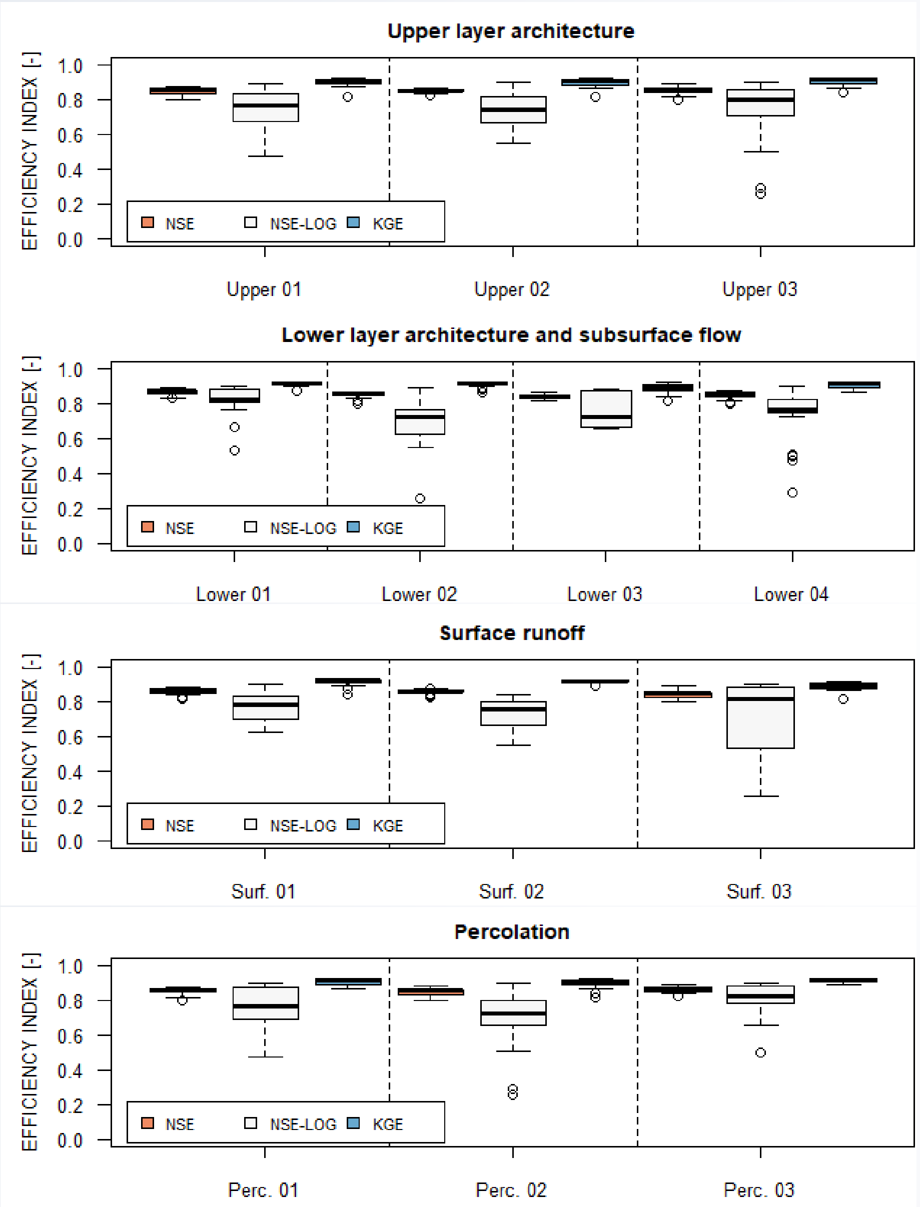


Fig. N°8: Boxplot of the performance obtained in the different model options. - period 1

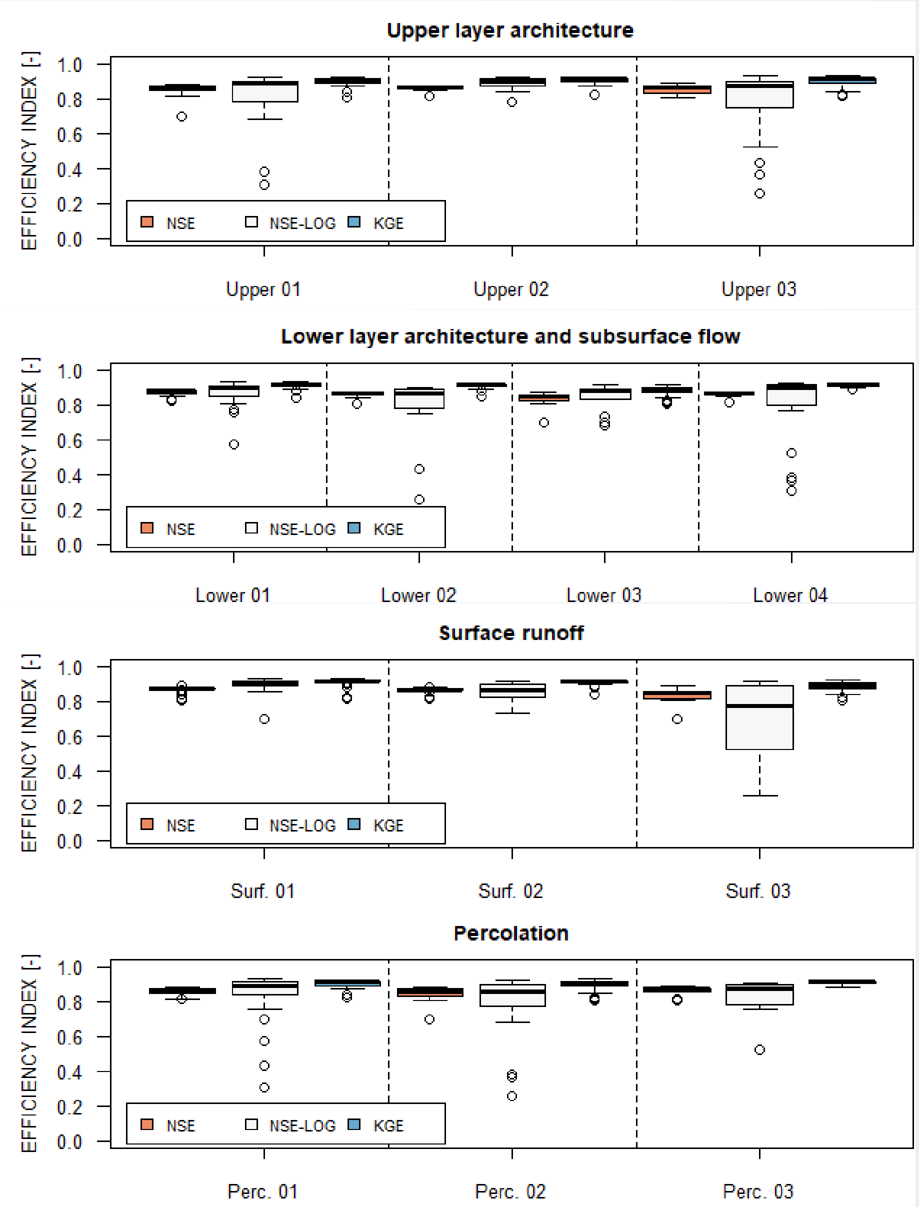


Fig. N°9: Boxplot of the performance obtained in the different model options. - period 2

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EGU General Assembly 2020

Thank you

WRITTEN DESCRIPTION OF PRESENTATION

It is important to understand the behavior and evolution of the hydrology of the basin for past and present periods of time, in order to determine water availability and the risk of increased flow, leading to better decision-making.

Most hydrological studies have focused on the lower and continental Amazon, while the upper Andes system of the Amazon receives much less attention despite being subject to increasing human impacts such as deforestation, mining, energy production hydroelectric and others.

Many authors mention that the greatest limitation in the investigation of water resources in the Peruvian mountains is the complexity of the system, the lack of climate data, as well as in situ observations.

The study area of this research is carried out in the Vilcanota river basin, which is located in the Cusco region, in the southeast Peruvian mountains on the Atlantic slope. Its main characteristics are shown on the first page of the presentation.

As part of the methodology, historical meteorological forcing data was first acquired, which was taken from the PISCO v2.1 dataset, and flow measurements were obtained from SENAMHI. Two modeling periods were considered, the first from 1987-1997 and the second from 2006-2016, which represent the past and present periods respectively.

Initially, it was proposed to work with the SUMMA model, but due to the scarcity and limited information found in the basin and with the intention of being able to meet the research objectives, it was decided to work with the Framework for Understanding Strultural Errors (FUSE) model, which was used to build 79 unique model structures by combining the components of 4 existing hydrological models: PRMS model, NWS Sacramento model, TOPMODEL model and ARNO / VIC model; it should be considered that the model does not perform surface energy balance calculations, it does not explicitly model the interception and storage of water by the vegetation canopy or transpiration and evaporation of the intercepted water, it also does not explicitly simulate the accumulation and ablation of snow; Despite this simplification, the modeling structures are designed to provide a complete relative representation of the best hydrological flows in the subsurface, this in turn allows us to find the impact that arises from using different model structures.

Successively, the modeling results are analyzed and evaluated using different efficiency indices, which allow us to represent the high and low flows, such as the NSE, NSE with logarithmic transformation, and KGE, this with the intention of being able to choose the best modeling structure.

As results of the preliminary analysis made in both periods, it is shown that there are slight differences, where period 2 is slightly more humid than period 1.

In the results shown by the modeling in both periods, a good performance is shown with the different modeling structures. It is also shown that the vast majority of the different modeling structures tend to represent well the evolution of hydrology both in the past period and in the present, resulting in minimal impact due to such modeling structures.

In both periods it was determined that the best modeling structure is similar (shown in Fig. No. 07), this probably due to the slight differences in the preliminary analysis of the data. This similar result gives us greater confidence when using the best modeling structure for future predictions.

In conclusion, it was considered that: (1) In both periods studied, FUSE adequately represents the hydrological behavior of the basin, presenting only slight differences in performance, (2) The best model structure in both periods was similar, resulting in: Upper layer architecture by ARNO VIC, Lower layer architecture by SACRAMENTO, Surface runoff by TOPMODEL, and Percolation by ARNO / VIC, and (3) In a next stage, these results are considered to be applied to changes in future climates.