

Challenges in rainfall-runoff modeling in Paramo basins in Colombia: Implementing a Long Short-Term Memory model in the Chuza River watershed

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In Colombia, close to 70% of drinking water used in the development of economic activities stems from the Paramos. These are Andean ecosystems characterized by high rainfall, low evapotranspiration, the existence of frailejones, and organic soils with a high water storage capacity. Such is the case of Bogota, where nearly 80% of its population and 11 surrounding towns are supplied with water from the Chingaza Paramo. One of the rivers that is part of this system and drains to the Chuza reservoir is the Chuza River, whose basin has an approximate area of 60.2 km² and an average flow of 3.05 m³/s. Given the importance of the Paramo and its enormous sensitivity to climate change, it is essential to know more about its hydrological dynamics in order to generate adaptation and conservation strategies. Thus, in the study here reported, an LSTM model, has been implemented in the Chuza River basin. As daily input data for the model, flow, precipitation, average, minimum and maximum temperature, and evapotranspiration were included. The model was trained using data from 2011 to 2015 and validated with an independent data set from 2017 to 2019. At both stages, good model performance was obtained at the weekly scale, with NSE values of 0.80 and 0.71 and NSElog of 0.70 and 0.69, respectively. By testing with other time steps, like daily and by adding the analysis period to 2, 3 and 5 days, the performance deteriorated. The results indicate that the seasonality of the simulated flows is adequate, however, it is not possible to correctly simulate the maximum and minimum flows, having greater problems when representing the peak flows. It has been shown that one of the greatest difficulties in modeling this type of high mountain ecosystem in the Andes is the lack of continuity, quantity, and quality of the variables measured in the field and therefore the limited possibility of corroborating the modeling results for the dominant hydrological processes involved. In this way, to achieve a better performance of the models, it is necessary to measure additional relevant variables in the system, such as horizontal precipitation, groundwater levels, soil moisture, and cloudiness, among others, to better represent hydrological processes, such as the contribution of groundwater, interflows, and the routing in the basin.