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Linking lacustrine dynamics to climate variability: application to lake Titicaca basin, South America.

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The northern part (56000 km^2) of the Altiplano endoreic catchment is a high mountainous basin drained by the Lake Titicaca at 3810 m a.s.l. elevation. The Desaguadero River is the only outlet of the lake towards the southern part of Altiplano. The climate is cold and semi-arid, but the lake plays a regulating role as a result of its water surface area (8500 km^2). The mean annual hydrological regulation of the Lake Titicaca yields two principal features: i) the rainfall is slightly more important than the affluent input, ii) the losses by evaporation are predominant (90%) (Roche et al. 1992).

A two-parameter conceptual model has been developed (Makhlouf and Michel, 1994). This model is based on i) dividing the watershed into two entities, a soil reservoir and a lake reservoir, ii) calculating a monthly water balance for each reservoir. The input data include the rainfall, and, in order to estimate evaporation rate, the air temperature, the extraterrestrial radiation and the astronomical mid-month daylight hours. Output data are the lake level and the Desaguadero discharge (Condom, 2002). The first parameter is equivalent to a soil water capacity while the second one is a smoothing factor for input data.

Hydrological observations for the recent period 1965-1990 are used to calibrate the model. Parameters are sized by optimizing the Nash criteria, and the final value of parameters is selected according to the FAO soil map. Simulated results are in good agreement with the observations (Nash=0.93 for lake water level, Nash=0.79 for Desaguadero discharge).

Some simulations were carried out with different climatic conditions. In the first one, we tested the response of the lake to a variation of the seasonality at the present time:

theses results highlight the role of the water storage in the soil reservoir. The second one is based on several rainfall and air temperature paleo-scenarios (6 Kyr BP): some of them explain the drastic shrinkage of the water level ($\sim$100 m in 500 years). Lastly, GCM outputs were processed as forcing data in the hydrological model, but this methodology faced to downscaling issue and quality data in mountain areas.

In conclusion, simulations show that lake Titicaca basin is sensitive as much to yearly rainfall as to the seasonal variability, while the role of air temperature is less important.

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