The hydrological regime of the Iberá and Pantanal wetlands and the potential impacts of Climate Change

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Motivation

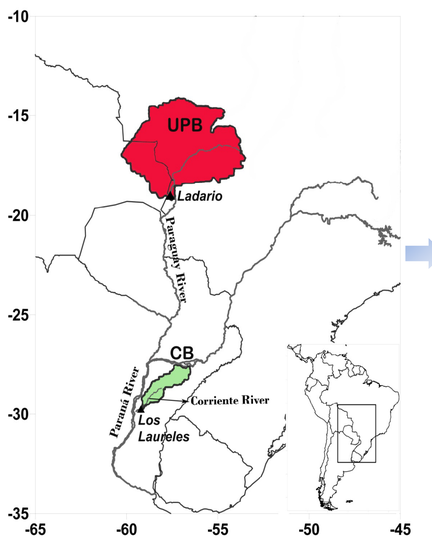
The La Plata Basin (LPB) in southeastern South America hosts the **Pantanal and Iberá wetlands**, the largest continuous freshwater wetlands in South America. They host several flora and fauna species unique in the world, some of them vulnerable and threatened. Wetlands are ecosystems characterized for being covered or saturated by water for all or part of the year. Therefore, the hydrological regime is determinant for their presence and permanence. Both land use changes and climate variability and change modify the hydrological conditions of the systems and consequently could affect the wetlands biodiversity. A detailed knowledge of the hydrological variability in the region will be an important tool for the development of better management practices and adaptation strategies for the conservation of the region.

Objectives

Evaluation of the ability of the Variable Infiltration Capacity (VIC) hydrology model to estimate river discharges downstream of the Iberá and Pantanal wetlands

Estimate future hydrological scenarios in the study area considering changes in precipitation and temperature for the 21st century derived from the ECHAM5/MPI-OM Global Climate Model

Data and Methodology



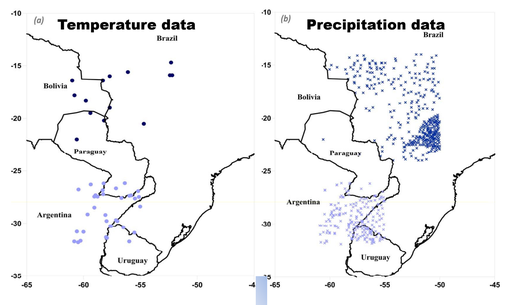
• **The Variable Infiltration Capacity (VIC) hydrology model** (Liang,1996) was used to simulate the present water balance and to assess the potential impacts of future climate change on the hydrology of the Corriente (**CB**) and Upper Paraguay (**UPB**) basins, which include the Iberá and Pantanal wetlands, respectively.

• The model was implemented over the basins at a 1/8º grid spatial resolution.

• Runoff provided by the VIC model was routed using an offline routing model enabling the computation of streamflow at selected closure points within a basin (Los Laureles in **CB** and Ladario in **UPB**).

• The quality of VIC in simulation the hydrological cycle was assesed by the the Nash-Sutcliffe coefficient of efficiency (**NSE**).

$$NSE = 1 - \frac{\sum_{t=1}^{T} (Q_0{}^t - Q_m{}^t)^2}{\sum_{t=1}^{T} (Q_0{}^t - \bar{Q}_0)^2}$$



• **The meteorological forcing data** used for the model calibration are daily time series of maximum and minimum temperature and precipitation for the period 1990-1999 (baseline period). All meteorological data was gridded into the 1/8° grid using the Kriging method.

• **Observed monthly streamflow data** for the period 1990-1999 at the two gauging stations used to calibrate the VIC model results were provided by the Argentine Water Resources Secretary and the Brazilian Water Resources Agency respectively.

The delta change approach was used for constructing climate change scenarios data sets and assess projected changes in flows of the Upper Paraguay and Corriente rivers.

This method consists in adding a change factor to the baseline period time series of climate observations. The change factors (percentage change in precipitation and absolute change in temperature) were derived by calculating the differences between annual mean projected and baseline daily maximum and minimum temperature and precipitation simulated by the **ECHAM5/MPI-OM**. These model outputs were chosen for this study as it is one of the best GCM in representing the present climate in LPB (Saurral 2010) as compared with others included in the WCRP-CMIP3 multi-model dataset.

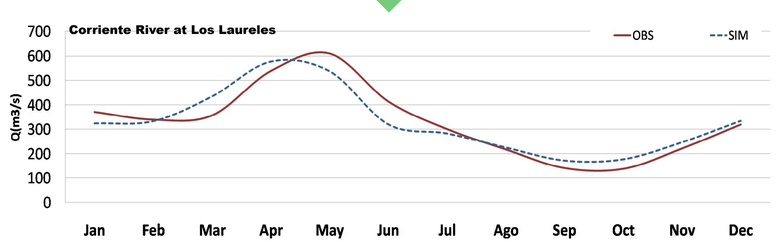
• This new meteorological data set were used as input for the hydrological model

• Three future time slices (2020-2029, 2050-2059 and 2080-2089) and three emissions scenarios (A1B, A2 and B1) were considered.

VIC model performance

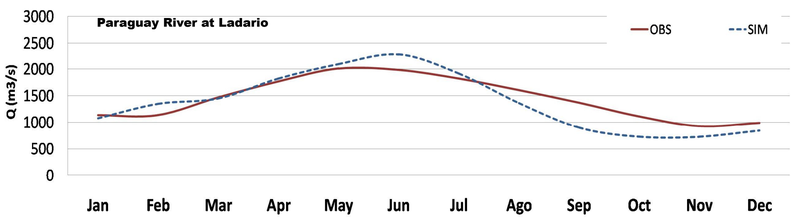
• The flat topography of this basin leads to low runoff ratios in Los Laureles, at the outlet of Iberá. Despite this, the VIC model reasonably represents the annual cycle and variability**, which is reflected in a model efficiency (NSE) of 0.68**.

• Although the model tends to delay the peak in May, **the annual cycle is properly represented as well as the mean streamflow** with a difference between the mean simulated and observed values of 0.1%.



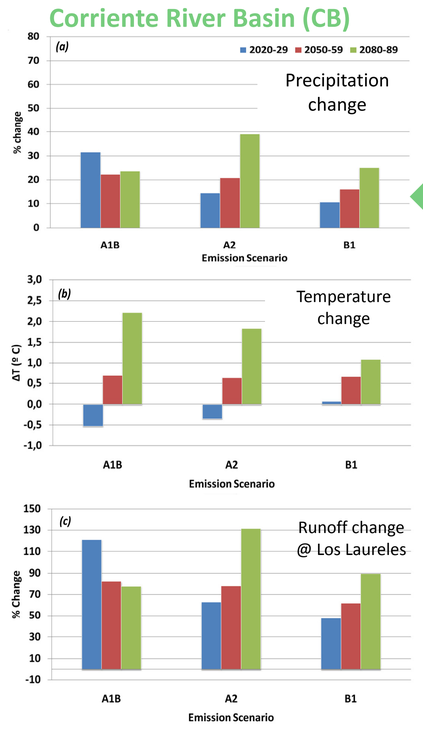
► **The VIC model represents adequately the annual cycle and the mean streamflow of the Paraguay River with a negative bias of 4.5%**, although it systematically overestimates the maximum and reduces the duration of the flood season.

► In this case, the NSE is negative but the highest number of rainfall stations considered in the **UPB** shows an improvement of the hydrological model performance in this basin in comparison with previous studies (Su et al. 2009; Saurral 2010).



Future hydrology scenarios in the Pantanal and Iberá wetlands

Corriente River Basin (CB)

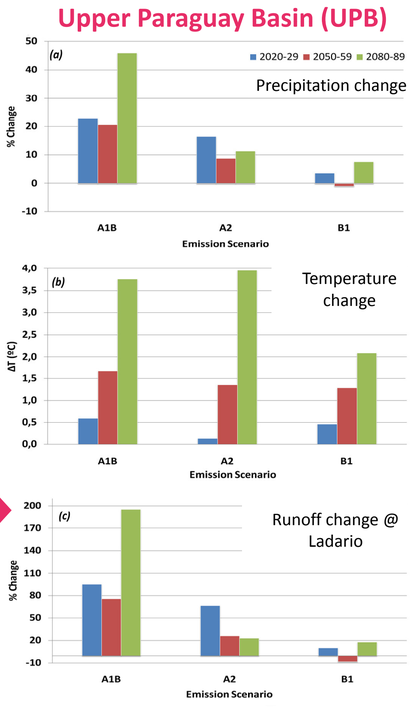


► **The changes in precipitation and temperature** result in amplified and probably exaggerated increments in the Corriente River streamflow for all time slices and scenarios.

► In all cases, **streamflow increments** are consistent with the positive changes in precipitation projected for this basin although the relative streamflow changes are up to 3 or 4 times larger than the corresponding rainfall changes estimated by the GCM for the Iberá wetland region.

Projected temperature, rainfall and streamflow changes with respect to the baseline period (1990-1999) for CB and UPB

Upper Paraguay Basin (UPB)



► **Temperature changes** are larger than the ones obtained for the Iberá wetlands .

► **Precipitation changes** for the region are highly variable between the three emissions scenarios.

► **Changes in streamflow** of the Paraguay River at Ladario result principally from the changes in precipitation.

Conclusions

► Although water resources are dependent upon two main primary variables, precipitation and temperature, the first one has the greatest effect on changes in runoff in the two analyzed basins. Projected warming and its subsequently effect in increasing the evapotranspiration and reducing the runoff do not compensate the increment in precipitation. Moreover, positive changes in rainfall in the Paraguay and Corriente basins resulted in amplified changes in streamflow.

► There are many uncertainties in the hydrological projections presented in this study mainly associated to climate change scenarios. However, the ability of the VIC model to simulate the basic features of the streamflow annual cycle of the Corriente and Upper Paraguay rivers and its use considering temperature and precipitation outputs from a GCM that represents adequately regional present climate allow us to make a first order assessment of the potential impacts of climate change on two of the largest world's freshwater wetlands.

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