INFLUENCE OF CLIMATE CHANGE ON FUTURE WATER AVAILABILITY IN THE MAPACHO RIVER SUB-BASIN, CUZCO - PERU, USING SWAT MODEL

ABSTRACT

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Abstract

The study analyzed the impacts of climate change on future water availability in the Mapacho River sub-basin, Cuzco - Peru; evaluating three different global climate models (GCM) CSIRO.Mk3.6.0, GFDL-ESM2M and MIROC5 under emission scenarios RCP4.5 and RCP8.5. This approach used the Soil and Water Assessment Tool (SWAT), simulating the daily discharge in two scenarios: near future (2020-2050) and far future (2070-2100). The statistics show an acceptable performance in the calibration period (NSE = 0.68, RMSE = 13.5 and PBIAS = 1.5%) and validation (NSE = 0.64, RMSE = 27.44 and PBIAS = -18.3%). It is concluded that the annual discharges, for the near future period, present a variation from -14.4 % to 14.30% and from -7.55% to 19.89%, for RCP4.5 and 8.5, respectively.

Keywords: Water availability, Climate change, PISCO v.2.1, Flows, SWAT.

Materials and methods

Data

- The sub-basin of the Mapacho River has an area of 5496.6 km2.The average annual discharge (2007-2018) in the headwater of the sub-basin is 35.98 m3/s
- Gridded information PISCO-Precipitation v2.1 and maximum and minimum temperature v1.1, with a spatial resolution of 0.1 ° (10km) and three GCM data models (Pcp, Tmax, Tmin) for two scenarios (RCP 4.5 and RCP 8.5), with 0.25º resolution (25km - 25km).
- The DEM (Geoserver of the Ministry of Environment of Peru), land cover (GlobeLand30) and soil type (FAO 8km).
- Modeled daily, a calibration and validation stage covers the period 2008 -2018.

Methodology

- Correction of bias and validation of GCM products (CSIRO.MK3.6.0, GFDL-ESM2M and MIROC5) using PISCO.
- SWAT modeling process: 21 sub-basins, simulation period 2007-2018, sensitivity analysis Calibration (January 1, 2008 - December 31, 2010) and validation (January 1, 2011 - June 30, 2013) using SWATCUP.
- Simulation of daily flows for the near future (2020-2050) and distant future (2070-2100).

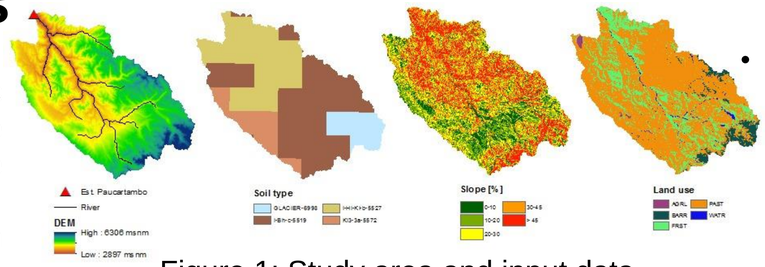

Figure 1: Study area and input data

Results

Average percentage difference (%) of the flow compared to the current state (2008-2018)

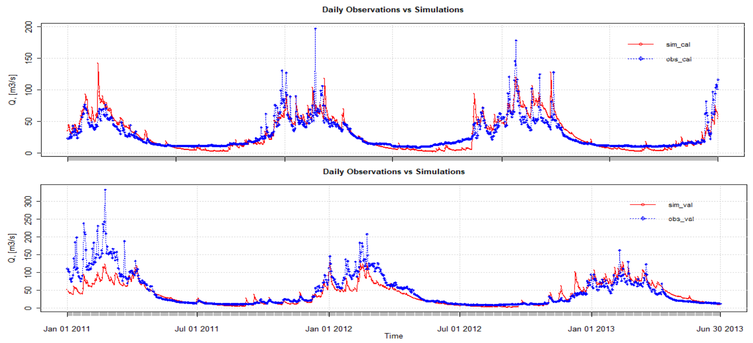

Figure 2: Calibration (top) and validation (bottom) of the SWAT hydrological model.

Months December to April, RCP 4.5 in the near and distant future, variations ranging from -12.3% to 7.1% and from -7.4% to 10.8%, and RCP8.5 variations ranging from -6.7% to 19.9% and from 24.1% to 90.9 %.

Table 1: Average percentage difference (%) of the flow compared to the current state (2008-2018)

RCP	Mes	CSIRO.Mk3.6.0		GFDL-ESM2M		MIROC5	
		Near Future	Far Future	Near Future	Far Future	Near Future	Far Future
RCP 4.5	Annual	0.44	-0.81	-14.14	-11.00	14.30	11.43
	Dec-Apr	-0.67	-5.73	-12.28	-7.44	7.11	10.81
	May-Nov	10.45	12.52	-17.48	-16.44	54.72	18.93
RCP 8.5	Annual	-0.83	31.86	-7.55	15.58	19.89	99.19
	Dec-Apr	-2.26	30.54	-6.67	24.06	19.88	90.94
	May-Nov	3.39	29.31	-5.76	-5.72	25.00	132.08

Conclusions

- The projections of annual discharges in the far future for RCP 8.5 indicate a probable increase of 15.58% to 99.2% in the water supply, while in the wet season variations from 24.1% to 90.9% could be obtained, which it could cause possible floods.
- However, for RCP 4.5 the annual discharges in the near and far future are very varied, that is, there would be variations that could generate underestimations or overestimations with respect to the historical flow period (2008-2018), in the order of -14.14% to 14.30% and -11% to 11.43, for the near and distant future, respectively.

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