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Modeling of the Cachapoal river watershed as a tool to study precipitation change impacts on water availability for irrigation

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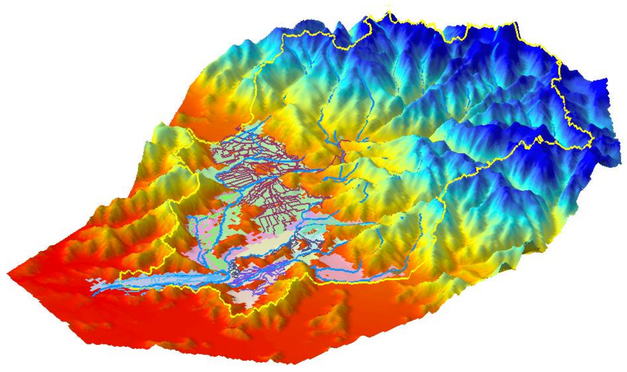
The effect of climate change on the availability of water resources is crucial, especially in irrigated areas. There is insufficient information to understand the response of watersheds to changes in climate which limits the possibilities for planning and adaptation of irrigation systems. In Chile, there is a decline in precipitation and there is probable that this trend will continue. Farmers use river water to irrigate crops and the amount of available water is strongly determined by precipitation. The Cachapoal River basin is located in central Chile, has a flat agricultural area, where irrigation is required, and foothills of the Andes mountains. The objective of this study is to quantify the effect of scenarios of different precipitation probabilities on the availability of water for irrigation in the basin of the Cachapoal River. A weather generator was developed for generate time series of daily precipitation which was selected and sequenced statistically to produce dry, medium, and wet daily series for 100 years. SWAT model was calibrated and validated for the basin and then run for the possible scenarios of dry, medium and wet to provide a comparison of the effect of the different moisture scenarios with different probabilities of rain on surface water availability.

Methodology

SWAT Model Implementation + Weather scenarios → Flow Series for different rain levels → Effect analysis

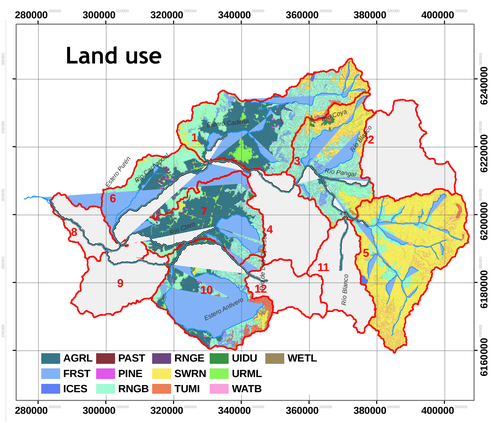
Study Area

- The Cachapoal Watershed is located in the Region of the Libertador Bernardo O'Higgins region, in Chile.
- Comprises 18 communes and 584.000 habitants;
- It starts in the Cordillera de los Andes and ends at the junction with the river Tinguiririca, where begins the Rapel River.



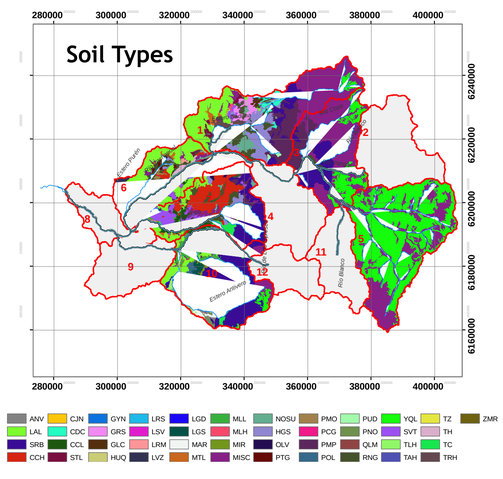
Watershed and model

- SWAT 2009.
- Land use adapted from CIREN, CONAF and Censo Nacional Agropecuario de 2007
- Soil tipes (CIREN
- DEM 90x90m (SRTM)
- 6.250 Km^2



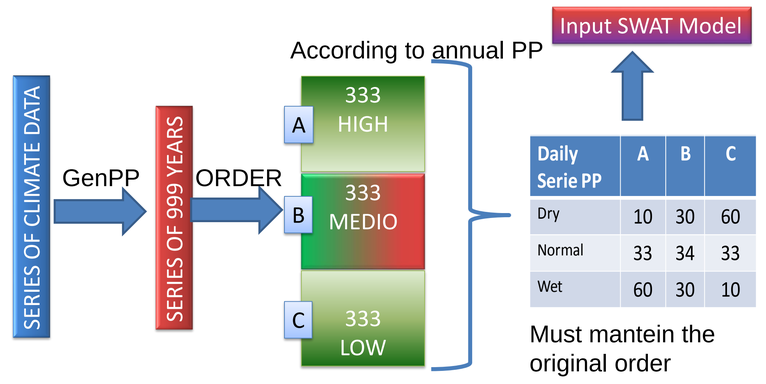
Model Calibration and Validation

- Divided in 12 sub catchment
- 7 weather stations (DGA, DMC)
- Daily Flow series (DGA, Chile)
- 3 calibration point (5; 7 y 9)
- Monthly calibration



Weather generation

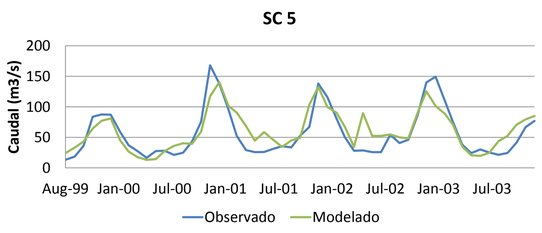
The daily amount of precipitation phenomenon, can be considered of a stochastic nature. This premise can be supported by the fact that associated with each daily event of precipitation, there is a probability of occurrence, which is not necessarily independent of the rain amounts fallen in previous days. In this way we can associate each event a certain probability of occurrence, which depends on previous events, called transition probabilities. These values of transition probabilities are estimated from historical rainfall data series. A process of this kind is called Markov chain process (Richardson, 1981;) Geng et al., 1986; Selker and Haith, 1990). Generating a daily time series of events of days with rain, it is possible to estimate the associated precipitation amount, assuming that this is due to a distribution type Weibull (W. Weibull, 1951).

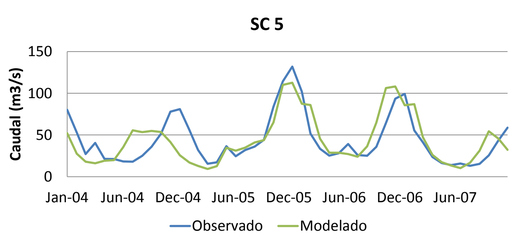


Daily Serie PP	A	B	C
Dry	10	30	60
Normal	33	34	33
Wet	60	30	10

Results

Calibration and validation

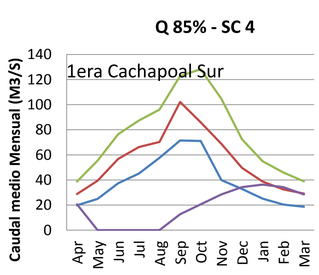


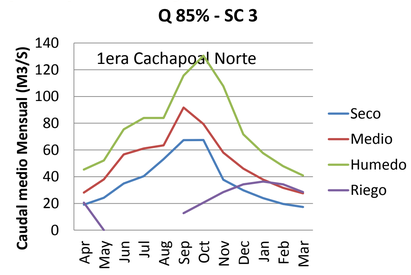


Nash Sutcliffe and R^2.

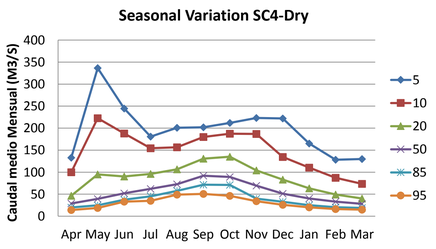
Coef.	Sub Catchment		
	5	7	9
N-S	0,42	0.35	0.69
R2	0,45	0.56	0.76

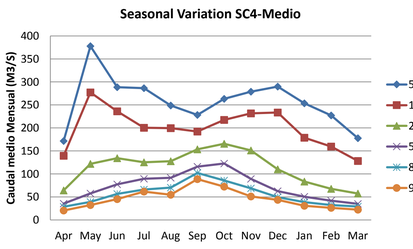
Comparison with irrigation demand (85% probability)

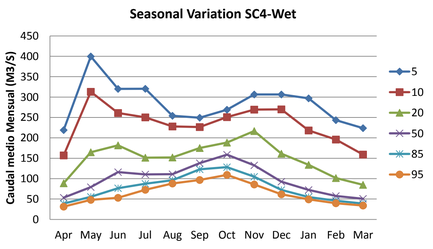


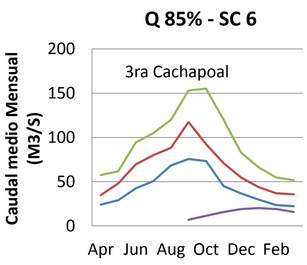


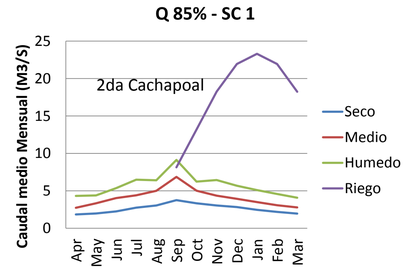
Scenarios flow simulation











Conclusions

Under scenarios of low probability of precipitation in all sub basins occurred flow reductions in annual averages higher than 20%, being the summer months more critics.
In scenarios of high probability of precipitation all sub basins increase the annual averages flow close to 20%, being maximum the effect in summer in the low basins, without snow.
The irrigated areas up stream present water demand according to the availability in medium scenario. Will be affected in dry scenario. The irrigated areas down stream present water demand lower than availability

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