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# Future Temperatures and Precipitations in the Arid Northern-Central Chile: A Multi-Model Downscaling Approach

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Downscaling of global climate outputs is necessary to transfer projections of potential climate change scenarios to local levels. This is of special interest to dry mountainous areas, which are particularly vulnerable to climate change due to risks of reduced freshwater availability. These areas play a key role for hydrology since they usually receive the highest local precipitation rates stored in form of snow and glaciers.

In the central-northern Chile (Norte Chico, 26-33ºS), where agriculture still serves as a backbone of the economy as well as ensures the well being of people, the knowledge of water resources availability is essential. The region is characterised by a semiarid climate with a mean annual precipitation inferior to 100mm. Moreover, the local climate is also highly influenced by the ENSO phenomenon, which accounts for the strong inter-annual variability in precipitation patterns. Although historical and spatially extensive precipitation data in the headwaters of the basins in this region are not readily available, records at coastal stations show worrisome trends. For instance, the average precipitation in La Serena, the most important city located in the Coquimbo Region, has decreased dramatically in the past 100 years. The 30-year monthly average has decreased from 170 mm in the early 20th century to values less than 80 mm nowadays. Climate Change is expected to strengthen this pattern in the region, and therefore strongly influence local hydrological patterns.

The objectives of this study are i) to develop climate change scenarios (2046-2099) for the Norte Chico using multi-model predictions in terms of temperatures and precipitations, and ii) to compare the efficiency of two downscaling techniques in arid mountainous regions. In addition, this study aims at iii) providing decision makers with sound analysis of potential impact of Climate Change on streamflow in the region.

For the present study, future local climate scenarios were developed for maximum, minimum temperature and precipitation in the research area based on four different General Circulation Models (GCMs). On the first hand, the Statistical Downscaling Model (SDSM) was used. This model is based on a multiple linear regression method and is best described as a hybrid of the stochastic weather generator and transfer function methods. One common advantage of statistical downscaling is that it ensures the maintenance of local spatial and temporal variability in generating realistic data time series. On the other hand and for comparison purposes, the Change Factor method was used. This methodology is relatively straightforward and ideal for rapid climate change assessment.

The outputs of the HadCM3, CGCM3.1, GDFL-CM2 and MRI-CGCM2.3.2 A1 and B2 scenarios were downscaled with both methodologies and thereafter compared by means of several hydro-meteorological indices for a 55-years period (2045-2099).

Preliminary results indicate that local temperatures are expected to rise in the region, whereas precipitations may decrease. However, minimum and maximum temperatures might increase at a faster rate at higher altitude areas. In addition, the Cordillera mountain range may encounter and longer winters with a dramatic decrease of icing days (Tmax<0°C). As for precipitation, both SRES scenarios for all models return a diminishing tendency, though the A2 scenario results show a faster decrease rate. Results indicate potential strong inter-seasonal and inter-annual perturbations in Rainfall in the region. Consequently, the Norte Chico will possibly see its streamflow strongly impacted with a resulting high variability at the seasonal and inter-annual level.

A probabilistic analysis of the projections of the four GCMs provided a better representation of uncertainties linked with downscaled scenarios. Whereas maximum and minimum temperatures were accurately simulated by both downscaling methods, precipitation simulations returned weaker results. SDSM proved to have a poor ability to simulate extreme rainfall events and few conclusions could be drawn with respect to future occurrences of ENSO phenomena. On the other hand, the change factor method reproduced comparatively better historical precipitations.

Despite all sources of error and uncertainties, which must be taken into account when handling the projections, this study addresses an issue that goes beyond local concerns and aims at developing a better understanding of impacts of climate change in fragile environments such as the arid and semiarid transition zone of north-central Chile. Its additional applied component goes therefore beyond the classical comparative study and aims at supporting stakeholders in their processes of decision making.