Correction of precipitation records through inverse modeling in watersheds of south-central Chile

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Abstract

Precipitation is the main input in the water balance of watersheds; therefore, correct estimates are necessary for water resources management and decision making. In south-central Chile there is a low density of precipitation gauges (~1 station/675 km2), most of which are located in low-altitude areas. The spatial distribution of precipitation is therefore not properly recorded. In this study an inverse modeling approach is used to estimate the extent to which precipitation amounts must be corrected. Using a lumped water balance model, a factor for correcting precipitation data is calculated for 41 watersheds located in south-central Chile. Then, based on a geo-statistical interpolation, a map for correcting the precipitation amounts is proposed and a validation of these corrections is achieved. The results show that in gently sloping areas, the precipitation records are more representative than in steep mountain areas. In addition, the higher the mountains, the less representative the precipitation records become.

Objective

- Estimate how the precipitation spatial distribution is in south-central Chile despite the low density of rain gauges.

- Estimate the precipitation enhancement due to the orography.

- Propose corrected amounts in order to help for stake holders in water management, analysis and modeling.

Study Area

South-central area of Chile (~34.5° to 39.5°S).

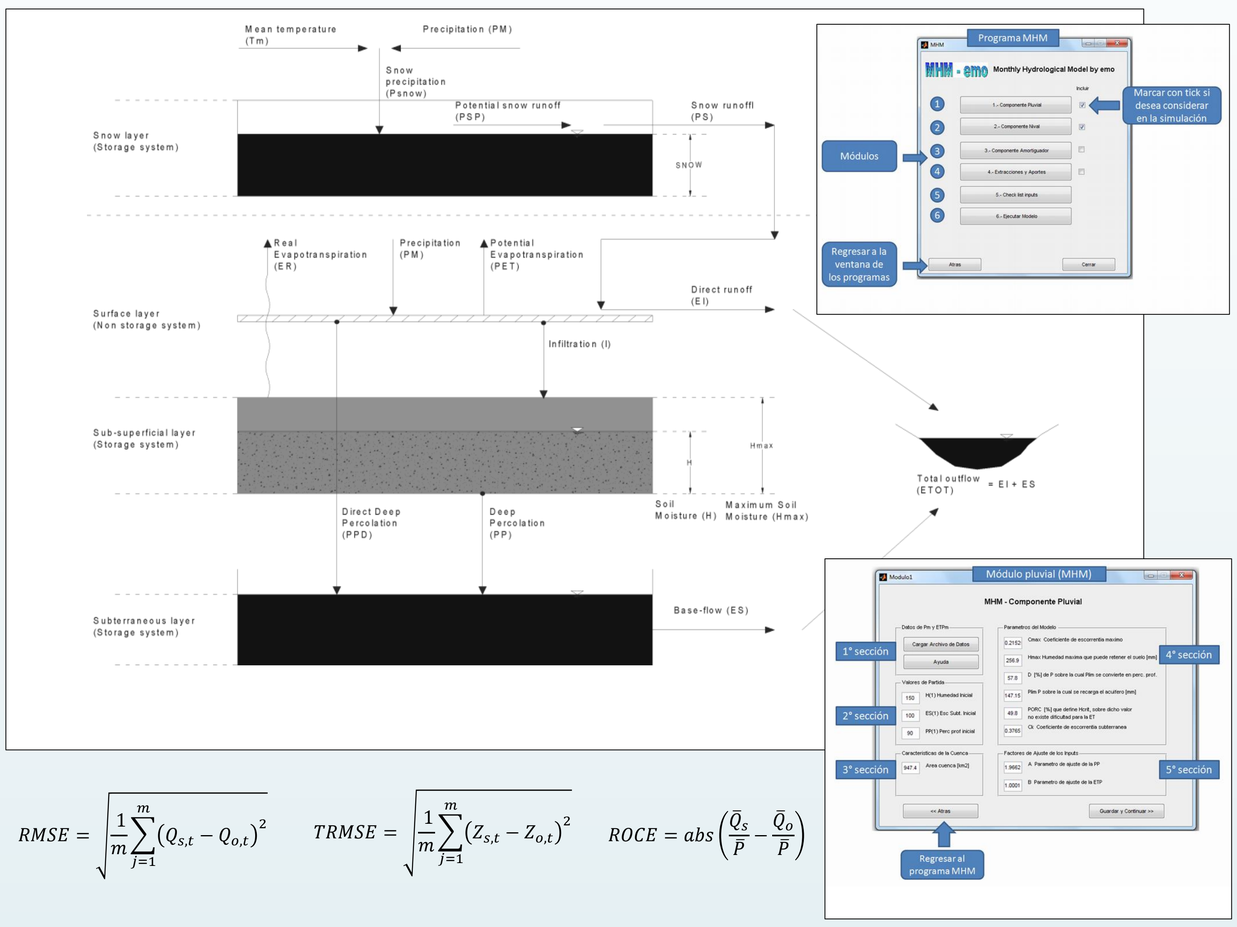
Rain gauge density 1/675 km^2 and is lower in mountainous areas (1/960 km^2)

Results

Methods

Mass balance equation $P - ER - Q = \frac{\Delta S}{\Delta t}$

MHM Moddel (Muñoz, 2010)

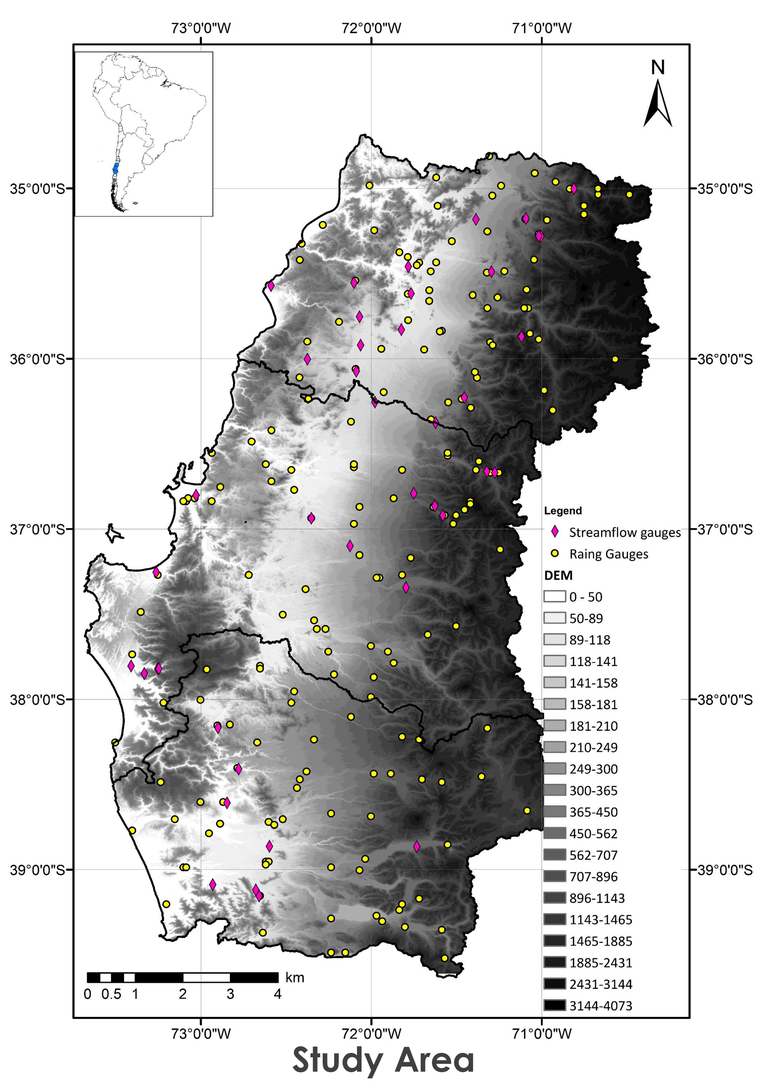


$$RMSE = \sqrt{\frac{1}{m}\sum_{j=1}^{m}\left(Q_{s,t} - Q_{o,t}\right)^2} \qquad TRMSE = \sqrt{\frac{1}{m}\sum_{j=1}^{m}\left(Z_{s,t} - Z_{o,t}\right)^2} \qquad ROCE = abs\left(\frac{\bar{Q}_s}{\bar{P}} - \frac{\bar{Q}_o}{\bar{P}}\right)$$

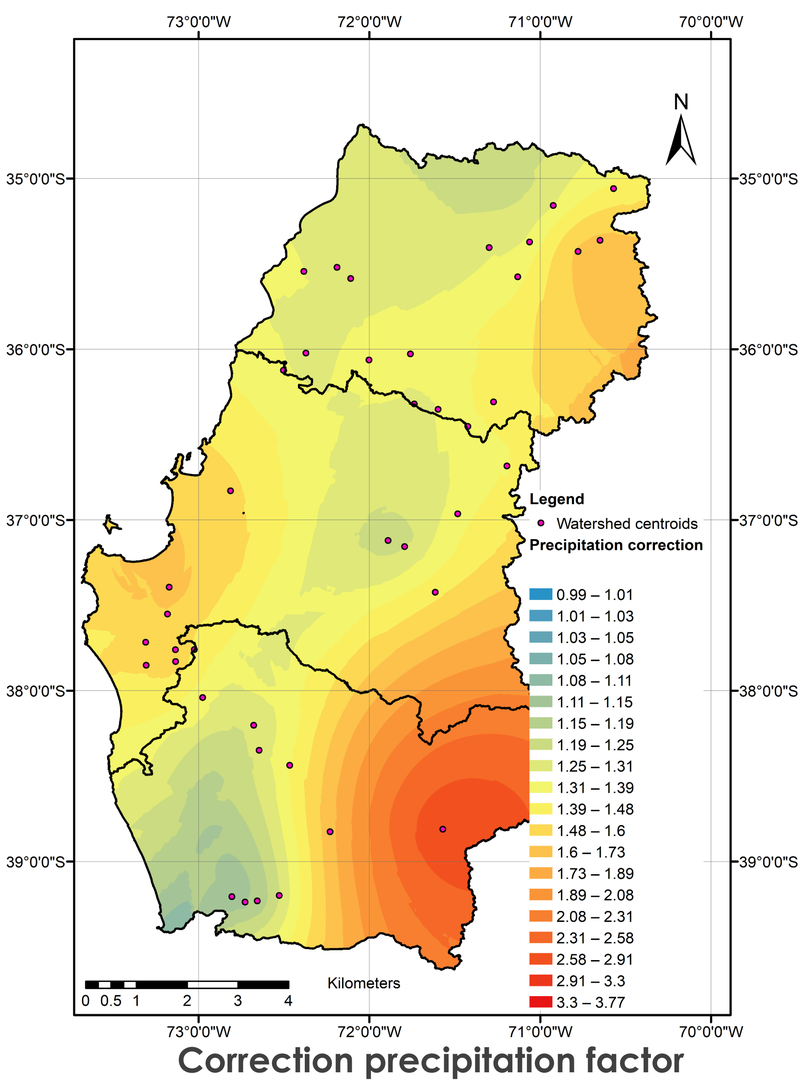
Conclusions

In mountainous areas there is a conspicuous underestimation of precipitation due to the low precipitation gauge density. This underestimation increases along with mountain height, making it necessary to carry out precipitation corrections of up to 3 times the values recorded in the lowest areas.

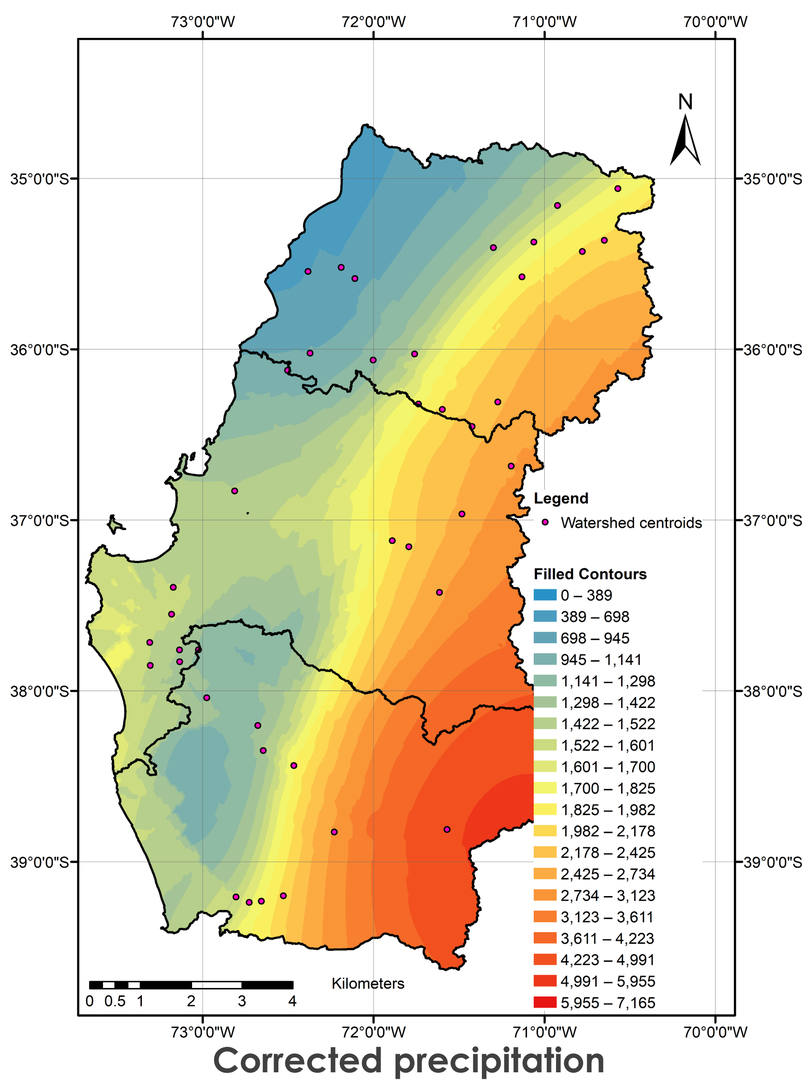
The results show that precipitation is underestimated by up to 3.7 times in some areas. Therefore, precipitation is a great source of uncertainty for modeling and performing precipitation-related studies. The corrected precipitation represent a further step in the precipitation estimation of the watersheds.



Study Area



Correction precipitation factor



Corrected precipitation

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