Groundwater-surface water interactions at the Laja watershed in the Central Valley of Chile

José Luis Arumí & Diego Rivera & Enrique Muñoz, Ovidio Melo and Max Billib*

University of Concepcin, Agricultural Engineering College, Water Resources Department, Av. Vicente Mendez 595, Chillan, Chile

Leibniz Universitt Hannover, Institute of Water Resources Management, Hydrology and Agricultural Hydraulic Engineering, Germany

jarumi@udec.cl

1. Introduction

Watersheds at the Central Valley of Chile present very well defined groundwater-surface water interactions. However, there is a lack of knowledge about how those systems interact, missing the fact that water that is infiltrating in one point of the watershed and exfiltrating in another one is moving through the groundwater system, being both part of the watershed balance. This document present a discussion about the groundwater-surface interaction that we had identified at the Laja Watershed, (Figure 1) and how those interactions fit with the general trend of the Chilean Central Valley.

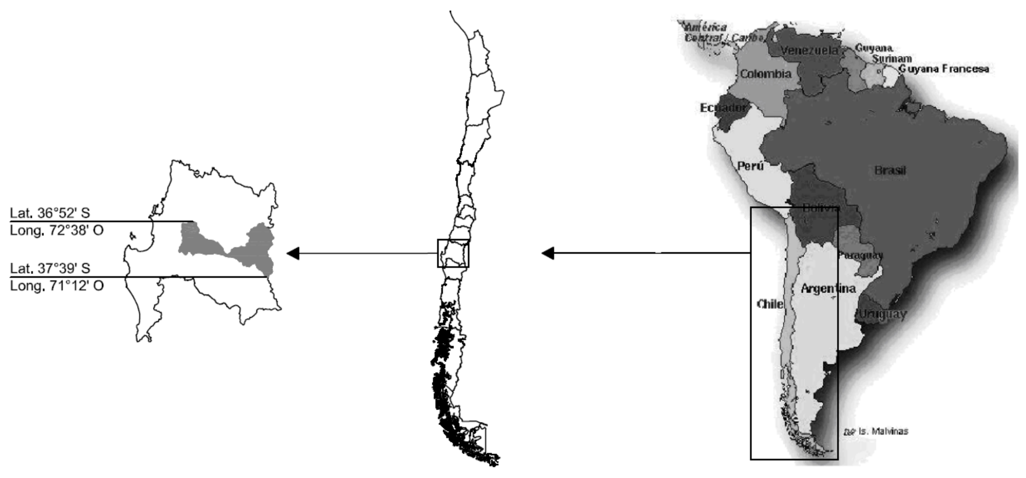


Figure 1: *Location of the Laja Watershed.*

2. Geological background

Chile is located on a tectonic belt where the Nazca Plate subducted under the South American Plate. About 100 million years ago, important tectonic activities created the Andes Mountains. Rivers at the western side of the mountains worked valleys in their movement to the Ocean (Figure 2A). At the south central part of Chile (between Latitudes 33S to 41.5S), more tectonic activity slowly created a depression (Figure 2B), that later was covered by sediments. However, because the rivers already had worked the valleys to the Ocean, the general east-to-west flow direction was conserved (Figure 2C).

In the Central part of Chile, the South westerlies fronts coming from the Pacific Ocean are the main input of water. Because the Andes Mountain acts as an orographic barrier to those fronts, the western side of the Andes Mountain is an important groundwater recharge area. At the Andean piedmont, rivers form valleys with high permeability materials, in which the groundwater deposits tend to be deep and where filtrations from the riverbeds are an important recharge mechanism. At the Easter limit of the Central Valley, the Coastal Mountains acts as a geological control, producing groundwater exfiltration that feed the rivers (2D).

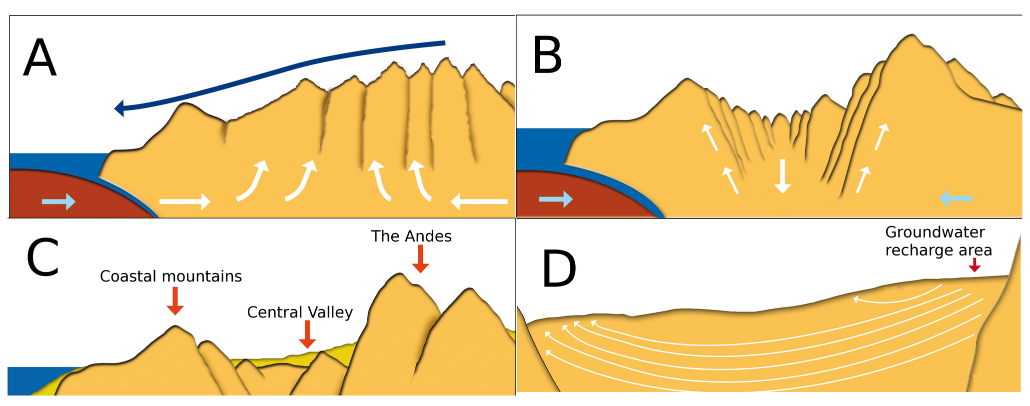


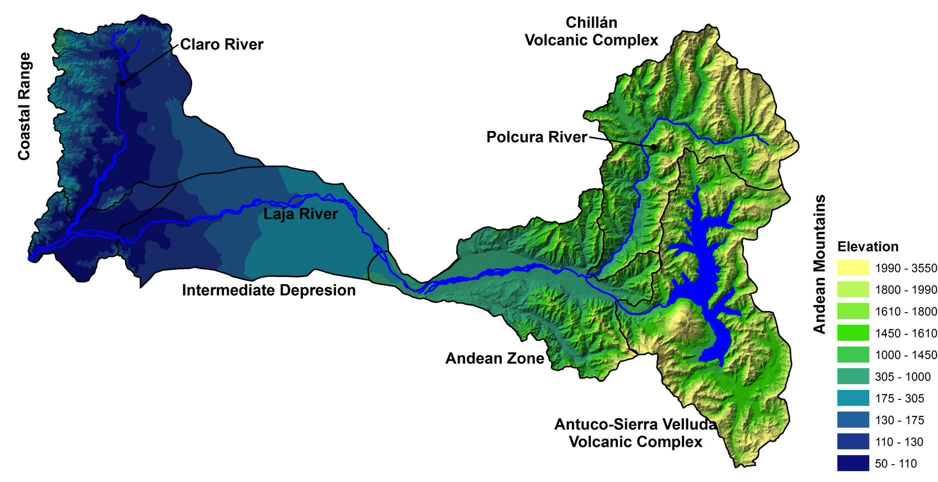
Figure 2: *Evolution of the Central Valley of Chile: A) Tectonic subduction created the Andes Mountains; B) Several foul systems created a central depression which C) later has been filled by sediments; D) Groundwater flow trend at the Chilean Central Valley.*

3. Laja Watershed

The Laja River is the main tributary of the Biobo River born from exfiltrations produced through the barrier of volcanic material that closes the Laja Lake. On its upper part, the river develops in a East-west direction and receives the river Polcura, which its main tributary (Figure 3).

The Laja valley is formed by a series of deposits associated to recent activity of the Antuco Volcano (Thiele et al., 1998). The deposits are concentrated along the valley until the sector of Tucapel where they opened conforming a fan-shaped deposit (Figure 4), which is locally named as Arenales del Laja (Laja's sands). These deposits have a depth of approximately 10 meters and are located over a lahar formation which is several times less permeable. Because of that, the deposits are associated to an aquifer that is recharged by infiltration of rain water and Laja riverbed.

During the summer of the year 2008, we carried out an intensive research work to evaluate potential infiltration of the upper part of the Laja River (Arum et al, 2010). Figure 4 presents a conceptual model of the groundwater system. From that study it was possible to estimate that infiltration from the Upper valley of the Laja River to the groundwater system varies from 4 to 10 m^3/s.



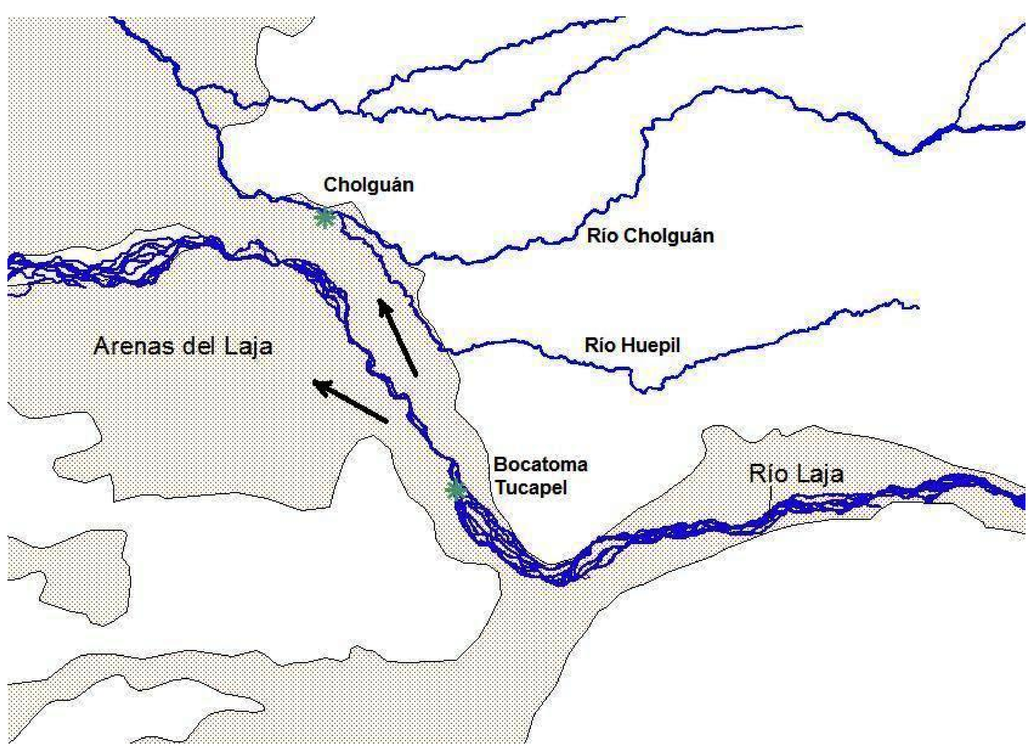


Figure 4: *Conceptual model of the regional groundwater system. The Lajas's sand are colored.*

4. Claro River

Claro River is located at the union of the Laja Sands with the Coastal Mountains (Figure 3). Sistematically, we found that the summer streamflow at the Claro River was abnormally high. Chilean summer corresponds to a dry season (between September to March) so typical Chilean rivers located at the eastern side of the Coastal Mountain will have a very pronounce recession, but the Claro River has an almost constant summer flow (Figure 5), which indicates that the river is feed by the sandy fan groundwater system associate to the Laja river.

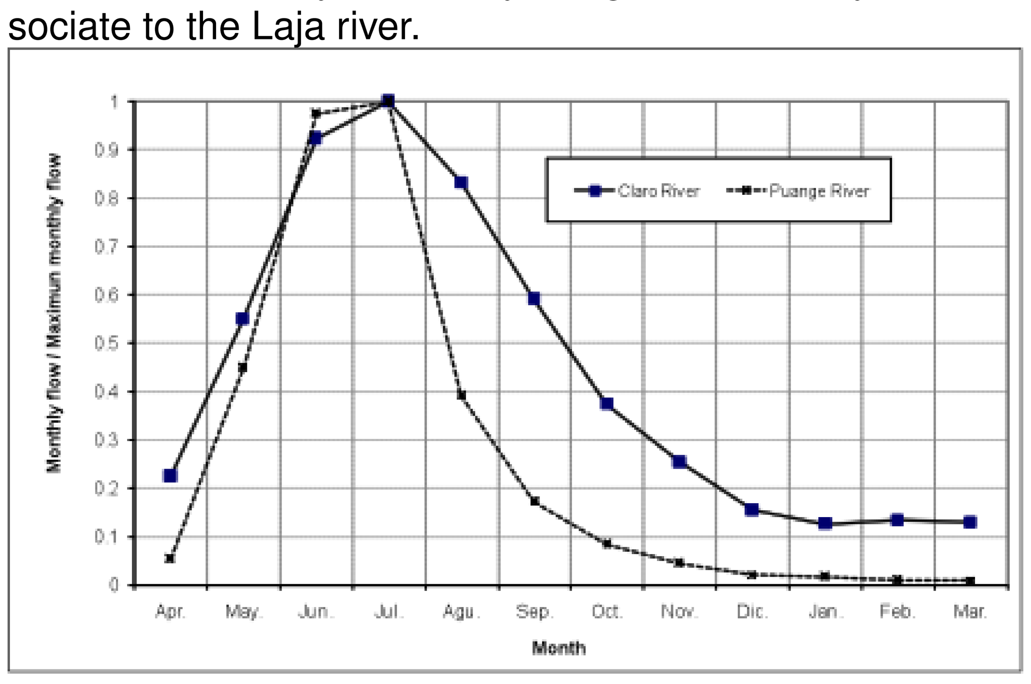


Figure 5: *Comparison between two Chilean Coastal Mountains rivers. The Puange River has not groundwater systems, in contrast, the Claro River receives important groundwater exfiltration.*

5. Conclusions

Groundwater and surface water interactions are identified at the Laja watershed. At the upper part of the Laja River, riverbed infiltration feed the groundwater system located down the valley. The Claro River, located at the boundary between the Central Valley and the Coastal Mountains act as a drain system that received water from the groundwater system.

In spite that the amount of the flow associated to groundwater surface interaction is several times smaller than the average superficial flow, these interactions are very important for the analysis of water availability in dry years, especially if we consider the impact of climate variability in Chilean Hydrology.

6. Acknowledgements

The authors would like to thank the financial support provided by FONDECYT Grants 1110298 and 11090032.

7. References

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