

ECOLOGY AND GROUNDWATER: A CASE STUDY IN A TRANSBOUNDARY LATIN-AMERICAN RIVER (LAUCA RIVER)

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River Lauca is a small river shared by Chile and Bolivia (18°-19°South latitude) defining an endorreic basin at the high plateau of the Los Andes mountains range, about 4,000 m.a.s.l. Natural drainage of Cotacotani lagoon yields the upwards flows of the river, reaching an average of 2.6 m³/s in the Chilean side. After crossing the countries boundary, surface flow diminishes down to almost zero near the Coipasa Salar. Geographic boundaries between both countries were established about two centuries ago (“divortium aquarum”).

Bolivia shares with Chile a frontier of many kilometers, where Lauca river is the only water source of importance at the highlands (fig 1). Surface and groundwater are used in both sides due to demands for freshwater, agricultural and cattle. The use of groundwater at the Chilean side may decrease surface water, which have been distributed for both countries according to international agreements. (Maira & Murillo de la Rocha, 2004)
In that sense, the effect of groundwater withdrawal in the Chilean side is very important in case it has an effect over surface flows of the river.

Isotopic techniques are a powerful tool in order to define water origins. Stable isotopes deuterium and ¹⁸O were used for this purposes. Several samples of groundwater yield from deep wells at the Chilean range were analyzed to conclude that pumped groundwater has a minimum effect on surface Lauca river water, less than 20%. Talking about water quality, Lauca river has a low conductivity (770 µS/cm) which may allow dilution, and decreasing of Arsenic and Boron, naturally existing in its waters. Azapa valley, located far West of Lauca Basin, is supplied by Lauca river sources through Lauca Canal, Chapiquiña Hidro Power Plant and Azapa Canal. Irrigation of this valley, with a medium electric water conductivity (1500 µmhos/cm; 500 mg/l Na-Ca/SO₄) (Risacher, Alonso y Salazar, 1996) has been developed for more than 50 years, were the main export product are olives (Fig.2). Before extracting groundwater resources, it is necessary continually to evaluate their total volume, its dynamic, its quality and the long distance effect of extractions.

Each population of a species has a **range of tolerance** and resource needs. At Lauca basin, flora, fauna and human beings have developed under extreme conditions of cold, ultraviolet radiation and salty soils and waters. The peasants at the Altiplano lands (Aymaras and Chipayas), usually have to tolerate alternative periods of droughts and rains, and these have been sharpened during the last decades. The average annual precipitation is 380mm, concentrated from december to march and the annual potential evaporation is 1,500mm. The scarcity of water is one of the most limiting factor for socioeconomic development (Ríos y Aparicio, 2007)
Though, this extreme conditions are variable from time to time or at different location within the altiplano ecosystem, each population has optimal conditions to thrive. **If** these conditions are further stressed for economic reasons, no flora, fauna or humans can move its tolerance range into historical time, and this would produce irreversible ecological changes.

Geographical and historical references.

This study is empirical in nature due to the involvement of the authors in stream research on concepts such as ecological discharge, trophic ecology, and ground waters dynamic. It supports an historical perspective, because ancient disagreement with Bolivia for using its waters into the Chilean side, did the diplomatic relationships between both countries were broken since 1962.

Transboundary river basin has, from a legal point of view, a condition of international river following International Rights specially those from Montevideo Declaration of 1933 (Maira & Murillo de la Rocha, op.cit.) International planning is of immense and immediate significance both for the future of human quality of life and for the protection

of our planet's unique and precious natural resources. According to the UNESCO analysis, the scarcity of fresh waters in localized areas will be the 21st century's second most pressing global issue (the first will be population). As freshwater scarcity increases, conflict over how to allocate scarce water resources will continue to grow. Since national borders usually cut across watersheds, much of this conflict, as well as attempts to solve or prevent it, is likely to be international in scope.

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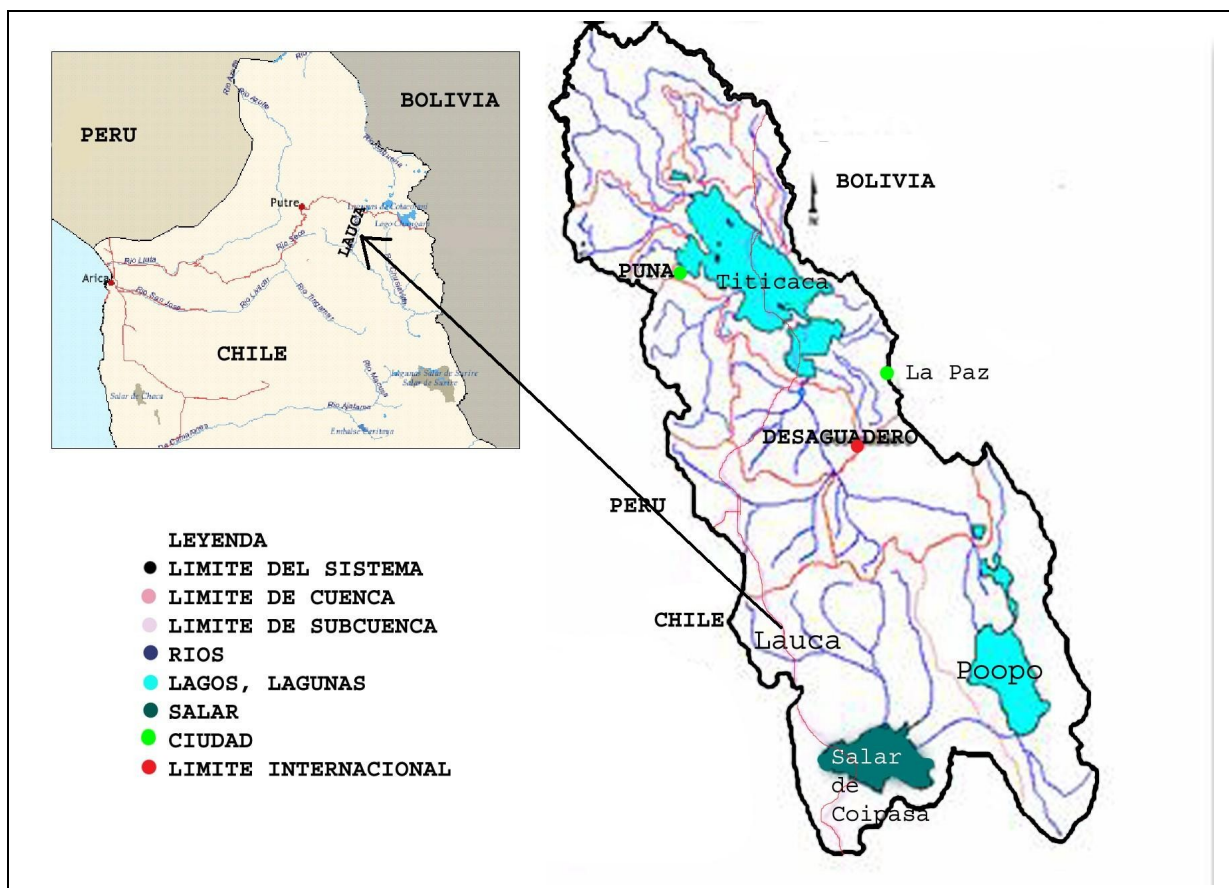


Fig. 1 Titicaca, Desaguadero, Poopo and Coipasa System and its connection whit Lauca River.
Source: Original design.

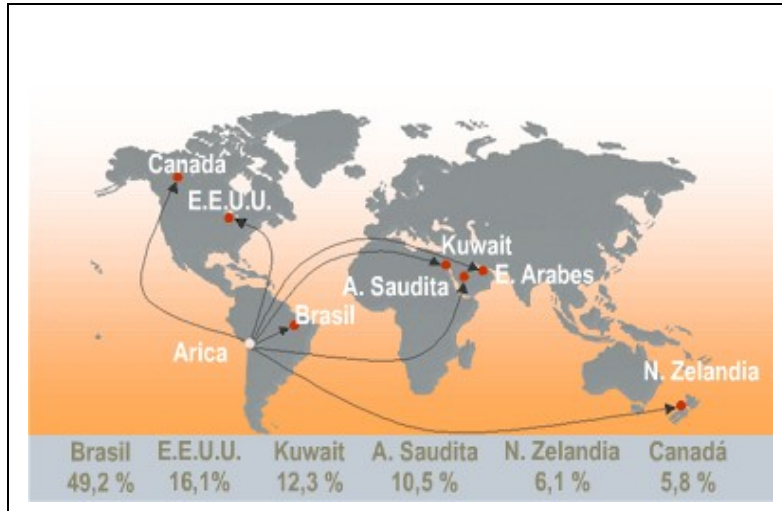


Fig. 2 Exportation volume from Azapa Valley toward the world
 Source: Universidad De Tarapacá. Arica, Chile. 2008