Land use change and water quality over the past 25 years in northern Chile - The case of the arid Huasco Valley

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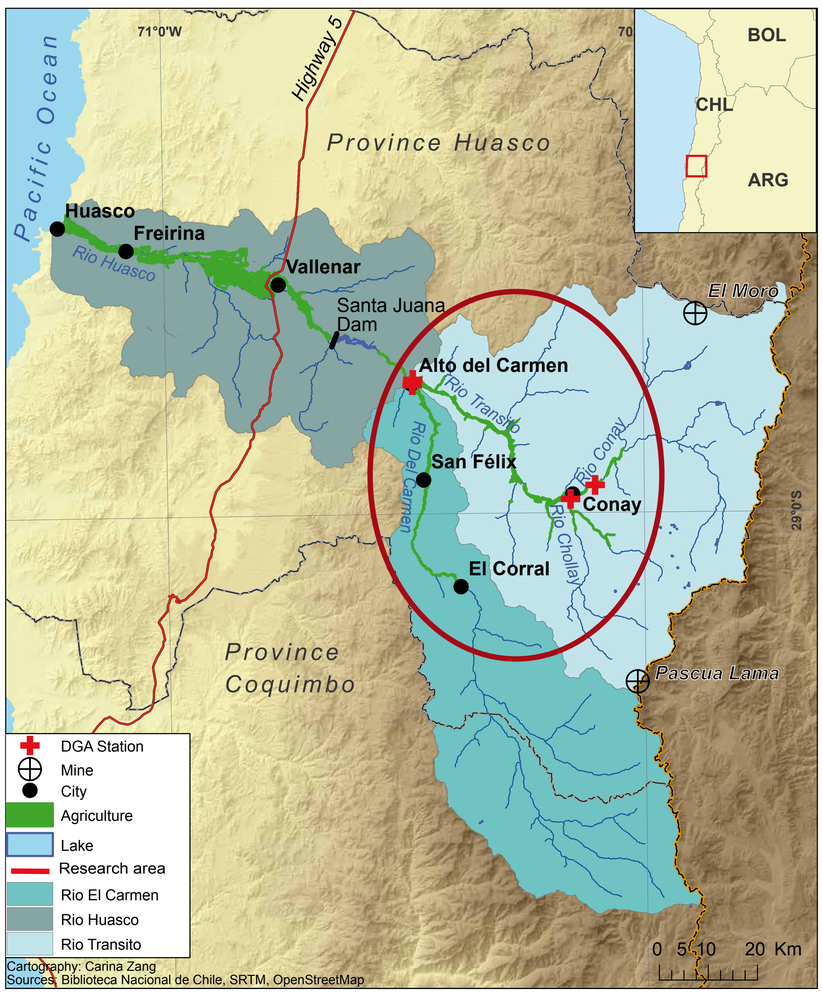
Background

The Huasco catchment (9.850 km^2) is located in the Atacama Region and with only 50-130 mm rainfall per year classified as an arid Mediterranean climate with rainy periods during winter. The regional economy is mainly based on mining and agriculture. Intensification of agriculture was possible due to the Santa Juana Dam built in 1995 (volume 166 Mm^3) and an extensive irrigation canal system. It is important to note that since 1981 water is completely privatized in Chile and can be traded like any other good.

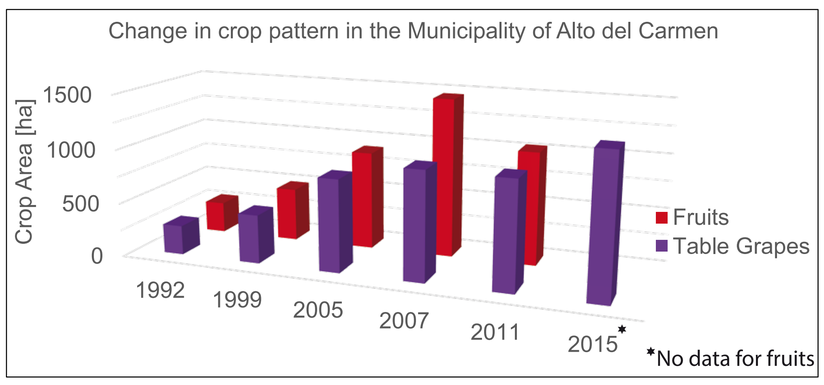
Agriculture (Table Grapes)

Rio Huasco, Photos: Carina Zang



Agricultural change and risks of water contamination

A. Agriculture: The agricultural area in the Huasco Valley has nearly doubled in the last 25 years. The cultivation of cash crops, especially table grapes for export has increased considerably. In order to ensure the quality of exported crops the use of agrochemicals has expanded significantly. Especially in the research area the number of groundwater wells was augmented to satisfy the additional demand for irrigation water. Agricultural mismanagement has led to extended desertification in northern Chile. This results in an increased transport of soil material to rivers during extreme weather events like March 2015.

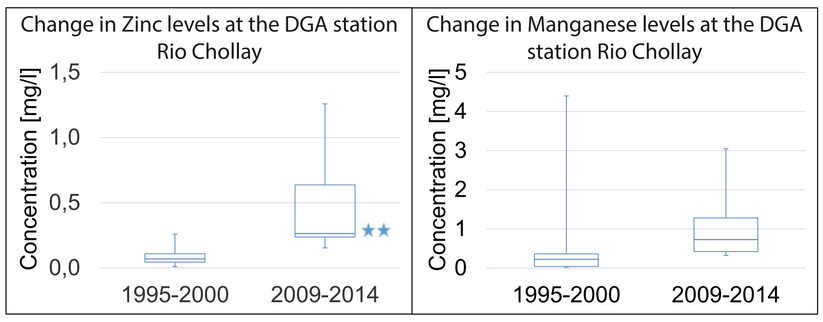


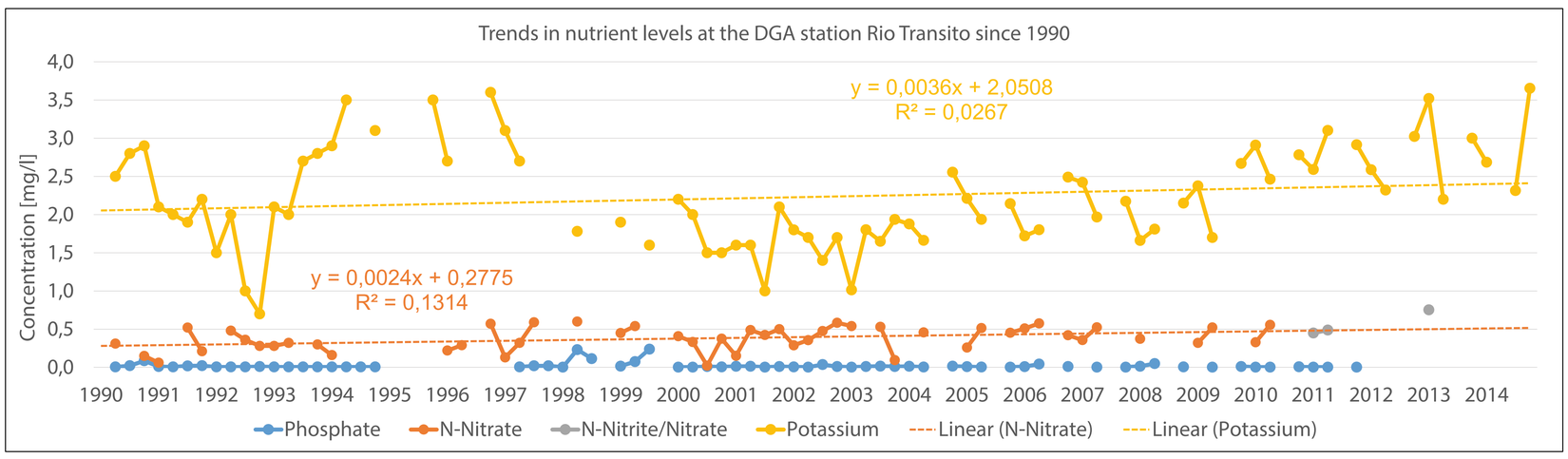
B. *Mining:* Historically the only mines where located in the lower part of the Huasco Valley. These small plants were mainly extracting iron. Since 2000 international companies gained interest in mining gold and copper deposits in the high mountain region. Eight new mining projects are now being planned. The constructions for the first project, the Pascua Lama Mine, started in 2009.
An additional problem is the lack of control and mismanagement of tailings in Chile.

C. *Waste Water:* The population in the Huasco Province has increased by 12% between 1992 and 2012. In rural areas waste water treatment is lacking and the use of septic tanks (without monitoring) is common. This leads to a high risk of waste water leaching from septic tanks to the groundwater.

Analysis of available water quality data

The national water authority (DGA) is responsible for monitoring all water resources in Chile. The DGA dataset is the only publicly available information on water quality in Chile. Water quality is measured three to four times a year at different locations throughout every catchment. Measured chemical parameters (up to 45 different ones) and detection limits vary between years which hampers comparisons. So far tests for pesticides or bacteria have not been conducted. In the upper catchment area of the Huasco Valley the DGA has taken samples mainly at four different sites for the last 25 years: Rio Transito, Rio Carmen, Rio Chollay and Rio Conay.





	Al	As	Ca	Cu	EC	Cr	Fe	Mn	Mo	$N\text{-}NO_3$	Ni	Pb	K	SO_4	Zn
Rio Transito	0,6689	0,5867	-0,1846	0,4171	-0,3852	0,0682	0,5449	0,4407	-0,2630	0,0742	-0,2064	-0,2490	-0,2189	-0,1966	0,3930
Rio Conay	-0,1935	0,2579	-0,4085	-0,2083	-0,3281	-0,1643	-0,0151	-0,1967	-0,5187	-0,0481	-0,3918	-0,4739	-0,1432	-0,4495	-0,3399

Correlation between nutrient concentration [mg/l] and discharge [m^3/s] measured at the same location on the basis of monthly data

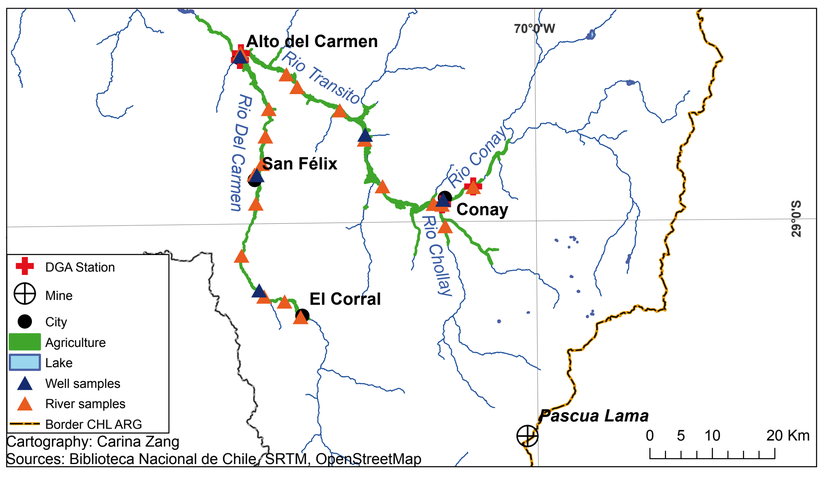
Results

There is no significant trend in agricultural nutrients detectable, except a slight increase for Potassium. Phosphate and Nitrate levels were relatively low but have not been measured since 2011. Most parameters show a good correlation to discharge except Nitrate. Its unregular pattern cannot be explained by natural factors. Existing differences between stations cannot only be explained by differences in land use.
Concerning mining only few parameters show variations since the construction of the Pascua Lama mine.

→ Available dataset not sufficient to draw substantial conclusions

Conclusion and further research

No direct effect of the intensification of land use can be detected with the publicly available dataset. Excluding the outliers in the nitrogen dataset no trend can be observed. The climatic situation - especially missing rainfall could be the linking factor for explaining the detected low levels of nitrogen/phosphor. In general a possible contamination pathway is irrigation water perlocating pollutants. As the irrigation technique is experiencing a shift towards high technical irrigation, water efficiency increases and risks of pollutants leaching into the groundwater are expected to decrease. Important factors for the lixivation of agrochemicals are timing and distribution of chemicals, slope, type of crop, and especially management practices. With different farm sizes most of the mentioned factors vary. Based on these assumptions the next proposed research step is to analyse the direct or indirect effect of farm size, crops and management practice on water quality in the river and in wells.



Planned water quality sampling sites

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