Salinization and sodification in irrigated agricultural areas in arid regions, Northern Patagonia Argentina

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INTRODUCTION

The north of Patagonia, (38º 35' to 39º 14' S; 66º 33' to 68º 35'W) is one of the great agricultural areas under irrigation of arid regions of Argentina. It includes the Lower Valley of the Neuquén River (LVNR, 9.500 ha) and the Upper Valley of the Río Negro (UVRN, 81.000 ha), with mainly fruit trees and vineyards. Aridisols and Entisols (Apcarian *et al.*, 2006, 2014, Echenique *et al.*, 2007, 2013), are developed on different levels of fluvial terraces and alluvials fans. The climate is arid mesothermal (Thornthwaite) with annual rainfall less than 200 mm, concentrated mainly in winter; average temperatures 15.3 ºC, with hot summers and cold winters, high evotranspiration and wide daily temperature range. These conditions make irrigation essential to cultivate during 7 months per year. The quality of the irrigation water is C1S1 (USDA). Irrigation practices produce rising of the water table. It is common to observe discontinuous saline efflorescences on the soil surface. The aim of this work is inform the presence and current increases of salinization and sodification processes promoted by used and management in irrigated soils of arid regions.

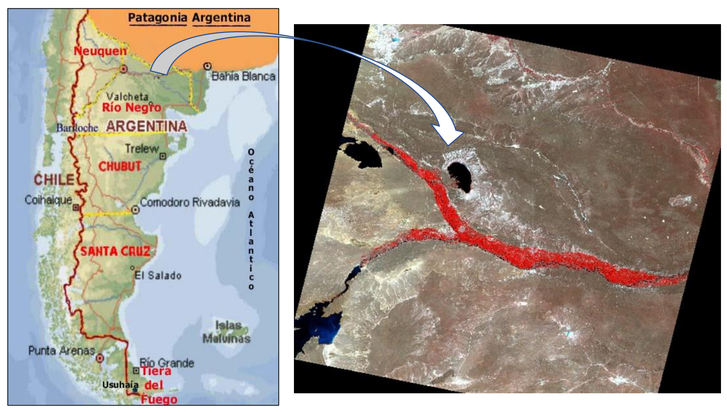


Figure 1. Location of the Northern Patagonia, Argentina.

METHODOLOGY

The information came from two areas: a) UVRN: Planialtimetry was carried out in two catenary transects across the different levels of fluvial terraces (T1, T2, T3); 136 soil profiles were described, sampled, analyzed and classified according to conventional standards (Soil Taxonomy). The fluctuation of the water table during spring, summer and winter was recorded. The chemical composition of the groundwater was analyzed in 8 soil modal profiles (Apcarian *et al.*, 2014). b) LVNR: 3 landscape units (LUs): high fluvial terrace, (UFT), alluvial fan (AF) and low fluvial terrace (LFT), with viticultural use, and with drip irrigation only; experimental units (EU) were established on each LU, with 3 repetitions. In each EU 46 soil samples were extracted at two depths, in summer and in autumn during 2 years. The pH and EC were analyzed. The spatial and temporal variability in geostadistics maps of each LU shows inter-row pH and EC (Salaberry, 2017).

RESULTS

Upper Valley of the Negro River (UVRN): Sodification and salinization processes affected to Sodic Aquicambids (T1) and Durinodic Natrargids (T2). Salinization is present with different intensity in soils of T1 and T2, with EC from 4 to 20 dS/m without meeting the characteristics of salic horizons. During the irrigation season (spring and summer) the elevation of the water table was observed, mainly in depressed areas.

Table 1. Depth and seasonal fluctuation of the water table in the study area. (T2 (*) depreseed area in the T2).

Terrace	Depth of the water table (cm)						
(T)	Transect1				Transect 2		
	Winter	Spring	Summer		Winter	Spring	Summer
T1	144	91	77		172	108	87
T2	174	123	116		243	201	171
T2(*)	-	-	-		100	60	40
T3	224	161	185		266	240	145

The pH of the water table fluctuates from 7 to 8. The EC of the water table is 2 to 13.06 dS/m (T1), 2 to 2.24 dS/m (T2) and < 0.8 dS/ m near the river (T3).

Salinization is produced by raising the water table and capillary elevation of salts by evapotranspiration, depositing the salts up to the surface. The high EC of groundwater affects the process (Imbellone *et al.*, 2010)

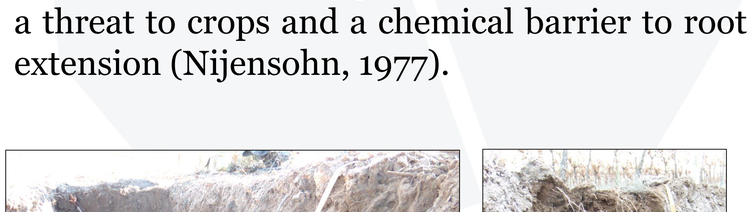


Figure 4. Example of a map of spatial variability of the CE on the surface on the LFT. March 2013 (T2). The lateral dimensions are expressed in cm.

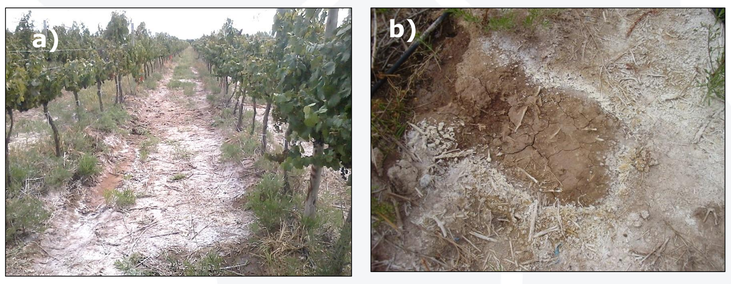


Figure 5. a) Salinity in the inter-row of the vineyard, b) Effect of the wet dropper bulb moving the salts towards the center of the row.

Salt washing occurs only under the drippers, moving the salts toward the edge of the wet bulb and concentrating on the inter-row. This is a threat to crops and a chemical barrier to root extension (Nijensohn, 1977).

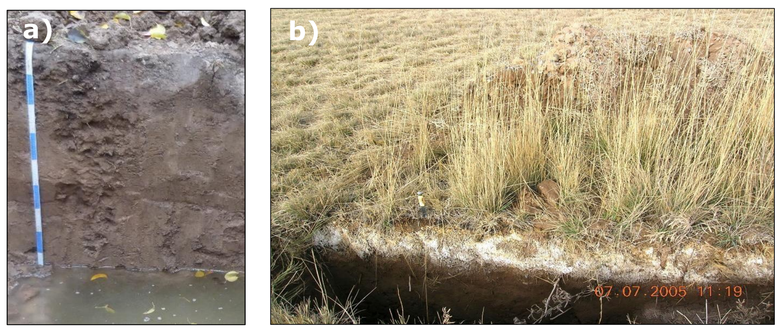
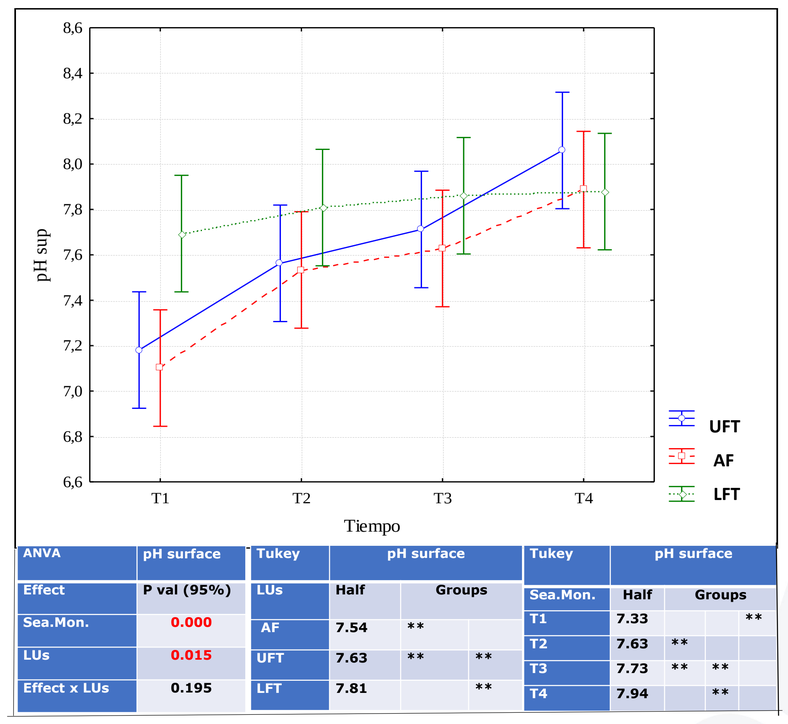


Figure 2. Salinization: Natural process in the absence of precipitation for washing salts. In irrigated valleys of arid regions, the process is accentuated by elevation of the water table, dominating the ascending accumulation of salts by capillary ascent and subsequent precipitation in the upper part of the profile or to the surface. a) Sodic Aquicambids, b) Saline efflorescences on the soil surface.

Lower Valley of the Neuquén River (LVNR): EC and pH values increased in the inter-row of the vineyards in all of LUs, being > in the LFT.

Figure 6. Also in the Lower Valley of the Neuquen River the influence of the water table in the low fluvial terrace accentuates the salinization process.



ANVA	pH surface
Effect	P val (95%)
Sea.Mon.	0.000
LUs	0.015
Effect x LUs	0.195

Tukey	pH surface		
LUs	Half	Groups	
AF	7.54	**	
UFT	7.63	**	**
LFT	7.81		**

Tukey	pH surface		
Sea.Mon.	Half	Groups	
T1	7.33		**
T2	7.63	**	
T3	7.73	**	**
T4	7.94		**

Figure 3. Surface pH measured over two years in summer and autumn. (T1 & T2: Summer & autumn year 1,T3 & T4: Summer & autumn year 2, LUs: Landscape units, Sea.Mon.: Seasonal monitoring)

CONCLUSIONS

Upper Valley of the Río Negro: areas with > salinization are recognized in slightly depressed sectors (T1, T2) with > elevation of the water table, and > EC in the water table.

Lower Valley of the Neuquén River: drip irrigation produced an increase of salinity in the inter-row of the vineyards, not observing salt washing.

In both valleys, depressed positions in the landscape and anthropic action through irrigation accelerate the salinization processes.

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GLOBAL SYMPOSIUM ON SALT-AFFECTED SOILS

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