Potential Role of Native Bush in the Chaco for Mitigation of Dryland Salinity in Grasslands

A. Glatzle[1], R. Schultze-Kraft[2], R. Mitlöhner[3]

[1] Estación Experimental Chaco Central, Cruce de los Pioneros, Paraguay; *present address:* INTTAS, Loma Plata 1045 – Chaco, Paraguay;

[2] University of Hohenheim (380), D-70593 Stuttgart, Germany; [3] University of Göttingen, D-37077 Göttingen, Germany

Natural Conditions

The Paraguayan Chaco:

- Alluvial plain with sediments from the Andes
- Dominant soil types: Luvisols, Cambisols and Gleysols
- Climate semi-arid to sub-humid, 500-1200 mm, summer rainfall
- In the humid parts: temporarily waterlogged "water camps"
- Discharge areas of ground water within a belt (75 x 500 km) with a shallow, saline ground water table (sometimes <150 cm), particularly around lagoons and water camps
- Recharge areas close to Andes (water table depth >30 m)
- Large-distance ground water flow rate very low (<1 m yr $^{-1}$)

The natural vegetation is predominantly a drought-deciduous thornshrub thicket

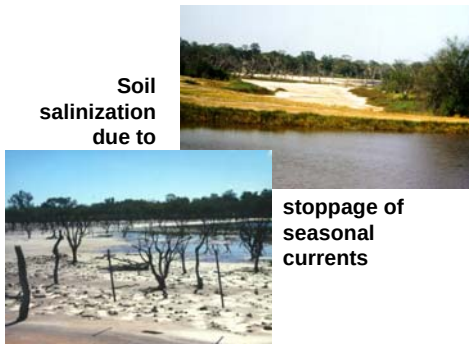
Natural salinity in the "discharge areas" of saline ground water: Capillary ascension and salt outcrops at the edges of water camps

The Problem

- Bush clearing and grassland establishment has reached a rate of approx. 100.000 ha yr^{-1} in the Paraguayan Chaco
- Land clearing at sites with a high water table promotes dryland salinity due to capillary ascension of saline ground water
- Stoppage of seasonally dry currents also promotes a rise of the downstream saline water table due to an increased hydrostatic pressure
- A few centimetres of difference of the mean depth of the water table may cause a grassland either to grow vigorously or to die off

Soil salinization due to inappropriate land clearing

Soil salinization due to stoppage of seasonal currents



Role of Native Bush

When bush is cleared for pasture establishment, the water table rises and the saline ground water is diluted. This is due to the reduced transpiration (lower leaf area index), reduced rooting depth, and hence increased infiltration rate of rain water in grassland as compared to bushland. Therefore, capillary ascension of saline groundwater (though diluted) and soil surface salinization are more frequent in pastureland than in bushland.

Depth of water table and conductivity of ground water under grassland and bushland in the Paraguayan Chaco

(Taken from: Nitsch, M. 1994. Versalzungsgefährdung von Böden im östlichen Zentralchaco als Folge nicht angepaßter Rodungsmaßnahmen. BGR, Hannover, Germany)

	Grassland	Bushland
Depth of water table (cm)	205	213
Electrical conductivity (mS cm^{-1})	40.5	61.6

Means of weekly measurements at three different sites over four months

Most of the Chacoan native woody species such as *Prosopis ruscifolia* and *Bulnesia sarmientoi* are capable of producing tremendously high suction capacities (up to >50 bar) as measured with a Scholander device, enabling them to absorb water from a rather saline environment: Water absorption should be possible from a solution with an electrical conductivity of up to 65 mS cm^{-1}.

This suggests that native bush, whose rooting depth easily reaches the ground water level in areas prone to salinity, is able to relower rapidly the water table, reconcentrating the ground water up to a maximum salinity level, after the water table had risen and the ground water had been diluted following a rain water infiltration event. Therefore, Chacoan bush plays a crucial role for the mitigation or avoidance of soil salinization.

Experimental Approach

Hypothesis:

- As potential evapotranspiration exceeds twice the annual rainfall in the Chaco, native xerophytic bush could obviously transpire much more water if transpiration was not limited by soil water availability (drought and high tension) and/or by high concentration of salts in the soil solution (high osmotic potential).
- It is assumed therefore that even a reduced bush density could fulfil its ground-water regulatory function in an associated pasture, transpiring rapidly excess rain water in the soil reached by the bushes' rooting system.
- Sylvopastoral use should constitute the compromise of producing beef while keeping the risk of dryland salinity at a tolerable level in areas with a shallow water table.

Maintaining large bush strips around water camps and river courses prone to dryland salinity seems to be important to keep the saline ground water table at a low level

Experimental design to define the permissible extent of bush clearing:

- At two representative water camps prone to dryland salinity, a strip of bush, 50 m wide, will be cleared along the gradient towards the centre of the water camp.
- Perpendicularly to this strip, three lines (along three different depths of the water table) with a series of boreholes for ground water observation are installed from inside the bush right across the grass strip.
- Weekly observations will provide information on the level of the water table and the variation of the ground water salinity as affected by rainfall and by the distance from the edge of the bush.
- Dynamics of soil salinity and humidity along the soil profile are measured with permanently installed conductivity sensors and tensiometers.