Chloride impact in abiotic and biotic factors of prairie soil ecosystems

Beverly Álvarez-Torres[1] and Thomas M. DeSutter[1] | 1 Department of Soil Science, School of Natural Resource Sciences | North Dakota State University, Fargo, ND

INVESTING IN EFFECTIVE RECLAMATION

NDSU NORTH DAKOTA STATE UNIVERSITY

Abstract | Brine spill from the energy industry in Williston Basin contains up to 90% dissolved halite (NaCl). Based on U.S. Geological Survey National Produced Waters Geochemical Database v2.3, brine water samples from Bakken formation have an average of 189,300 ppm of chloride, 757 times higher than the 250 ppm chloride limit established for drinking water in North Dakota and other states. The objective of this poster is to examine the impact of high Cl- concentration in the abiotic and biotic factors of brine-impacted soils located at prairie ecosystems.

Introduction | As a result of brine water spills, chlorinated salts have been added to the soil, water, and food chain of some of the 1,889 species living in the prairie ecosystem, distributed 85 mammals, 318 birds, 15 reptiles, 12 amphibians, and 87 freshwater fish (The Nature Conservancy, 2002). The reclamation of brine-impacted soil is crucial to preserving biodiversity, protecting water quality, as well as returning the land to productive levels acceptable to landowners and regulatory agencies.

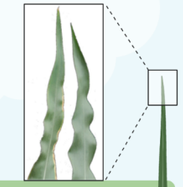
Methods | A database with relevant literature review was created using single tag searches in Google Scholar and Mendeley as “chloride", “brine spill”, “prairie ecosystem”, “soil food web”, “grassland biodiversity”, “prairie biodiversity", “saline soil”, “sodic soil” or by advanced searches in Web of Science combining tags using the format: ((“A1”) AND ("B1" OR “B2”)).

Results | The analysis identified organisms in the first and second trophic levels, their role in the prairie ecosystem, and possible environmental consequences due to changes in Cl- pools, and fluxes after a brine spill.

Impacts:

- Contribute to the understanding of the Cl- pathway, and its toxicity at different trophic levels
- Highlights the importance of considering both biotic and abiotic factors in reclamation strategies

Scan QR code for contact information and references



A high Cl- concentration in the maize shoot affects the photosynthetic process resulting leaf-tip burning. (Geilfus, 2019)

Cl- movement in the soil is faster than in water due to its negative charge, so it travels downgradient, in some cases for years, to wetlands when it reaches groundwater. (Preston et al., 2019)

Salty diets in differential grasshopper (*Melanoplus differentialis*), a crop pest, reduce survival and alter the body physiology by increasing the average femur length. (Peterson et al., 2021)

Soil salinity decreases nematode populations, resulting in an increase of microbial biomass because predators are absent from the soil food web. (Ries, 2020)

Terrestrial fungi involved in soil nutrient cycling, such as Basidiomycetes, Ascomycetes, and Deuteromycetes, diminish in population in solutions with [NaCl] higher than 5%. (Tresner and Hayes, 1971)

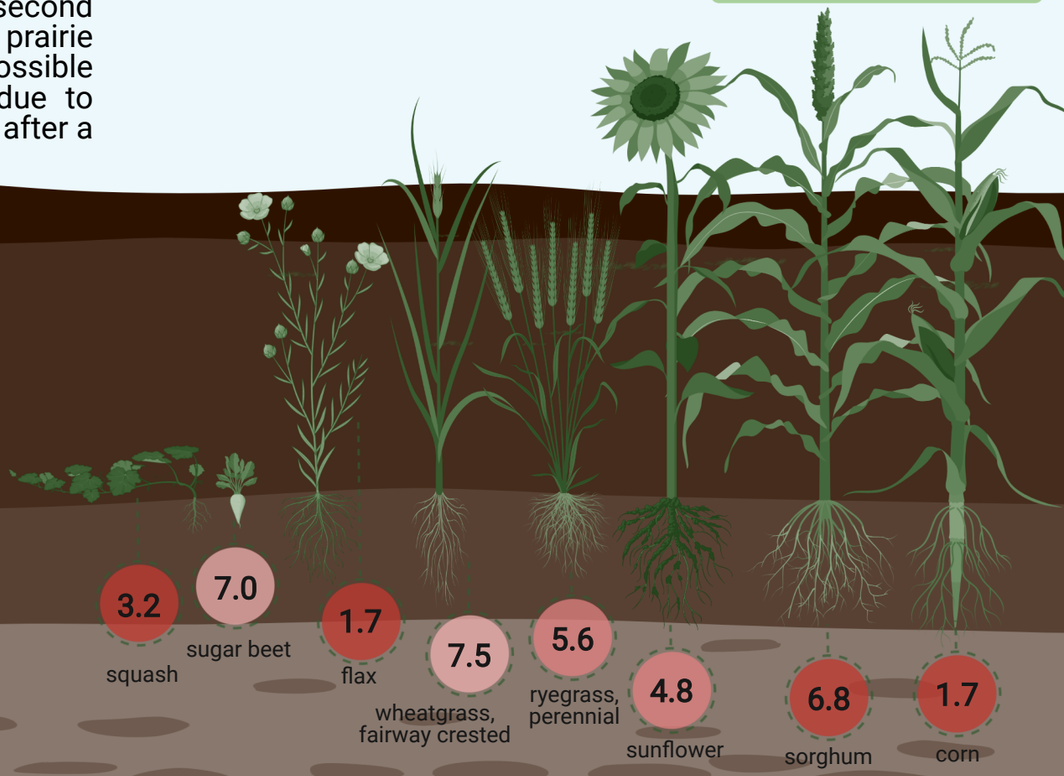
The high levels of sodium chloride reduce the size and survival rate of earthworms, an organism that helps to stabilize soil structure and create macropores. (Sharif et al., 2016)

Among the characteristics of brine-impacted soils are: (i) high soil electrical conductivity values in soil saturated paste (ECe; dS/m), (ii) negative osmotic potential, and (iii) high soil Na concentrations, which are factors that decrease crop yield, limit seed germination, and decrease soil water uptake, respectively. (Green et al., 2020)

1'
2'
3'
4'
5'
6'

Abiotic factors: soil, water

Biotic factors: primary producers, primary consumers



Crop and grass tolerance based on salinity (ECe, dS/m) at initial yield decline. (Maas and Hoffman, 1977; Tanji and Kielen, 2002)

sensitive | moderately sensitive | moderately tolerant | tolerant | unsuitable for crops