Sodic alkaline wastewater affects soils in an urban agricultural system of Ouagadougou, Burkina Faso

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Introduction

To meet fresh food requirements of rapidly increasing population of cities in the semi-arid tropics, low quality irrigation water in urban gardens is often used. Since 2006 farmers in the industrial area of Ouagadougou irrigate their intensively managed fields with sodic alkaline wastewater which leads to a rapid accumulation of sodium (Na) in the soil. This causes irreversible soil degradation and productivity losses. We examined the alkalinity and the Na concentration of the irrigation water and assessed the effects of Na and bicarbonate (HCO_3^-) loaded industrial wastewater on soil properties.

Highlights

- Irrigation with sodium rich wastewater in semi-arid regions leads to an increase of sodium in the soil
- Soil water movement lead to a sodium contamination of the subsoil in the area
- Sodium stress on crops forces farmers to abandon their fields

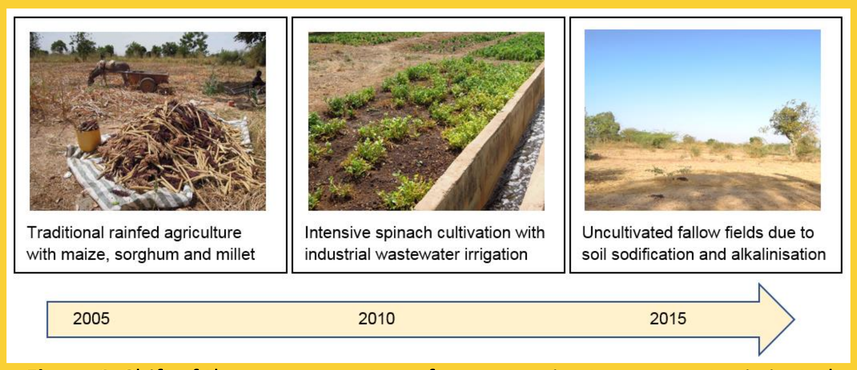

Figure 1. Shift of the agro-ecosystems from extensive to wastewater irrigated crop production, resulting in a loss of farmland in the Kossodo industrial area of Ouagadougou, Burkina Faso.

Methods

- 45 randomly selected fields were analyzed for pH, electrical conductivity (EC) and exchangeable cations (cobalt hexamine chloride method)
- Five soil samples per field were taken, at 0 – 20 and 20 – 40 cm depth
- Wastewater originating from tanneries and beverage industry (n=4) and well water (n=4) samples were analyzed for pH, EC and cations
- Farmer interviews: information on irrigation and cultivation practices used over the last decade
- Mapping of crops and fields; aerial photograph taken in October 2014

Results and Discussion

- **Wastewater:** pH values from 8.5 to 9.8; Na concentrations of 300 to 1200 mg l^{-1}
- **Soil:** Lixisol, dominated by kaolinite
- **Wastewater irrigation** increased:
  - Soil pH by up to 2 units
  - EC by 14 % to 500 % and
  - Na up to 28 times
    compared to initial soil conditions.
- Continuous and short term irrigation with sodic wastewater led to Na accumulation in the soil
- Higher Na accumulation at 20 – 40 cm depth than in the topsoil
- Also high Na concentrations in the subsoil of non-irrigated fields indicating sodification due to soil water movement
- During five years the number of fallow fields doubled and irrigated fields declined
- Stagnating groundwater and the seepage originating from the industrial wastewater channel cause a reduction of soil quality

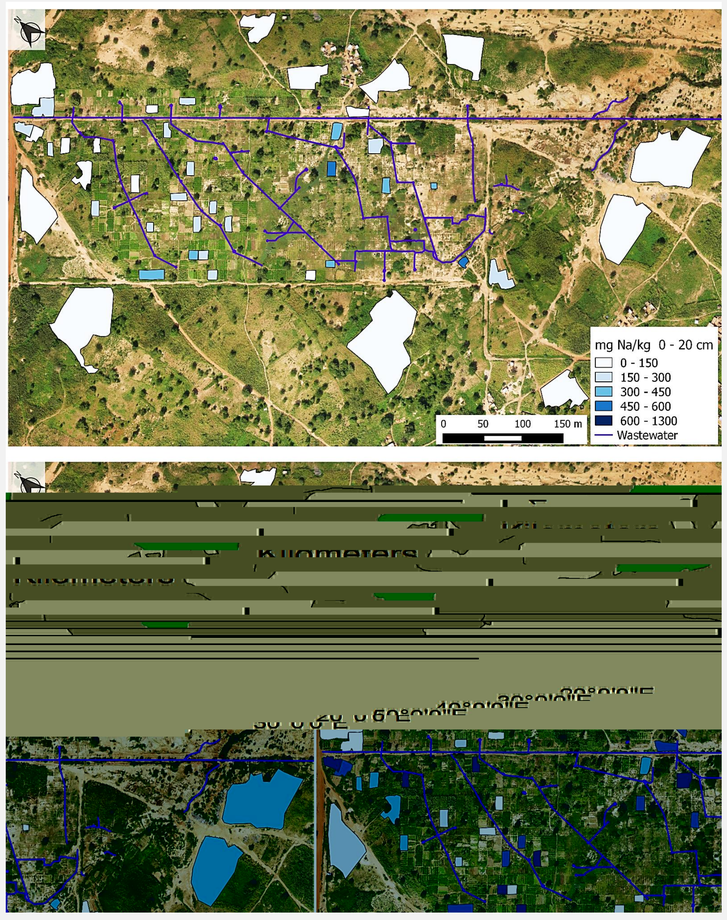

Figure 2. Map of urban gardens in industrial area of Ouagadougou displaying levels of exchangeable Na concentration in top and subsoil (January 2015); Aerial photograph by Dr. J. Schlesinger.

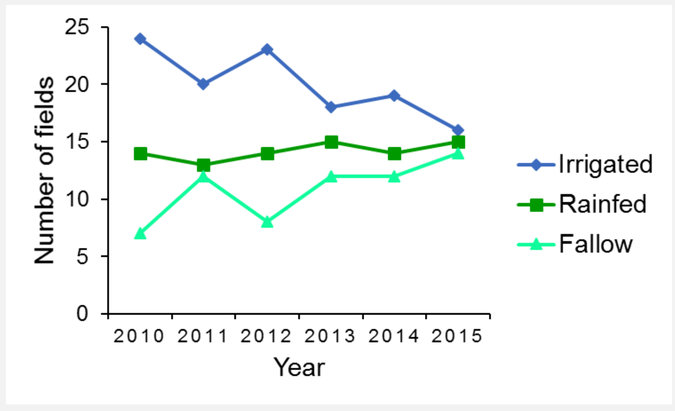

Figure 3. Count of fields (n = 45) under different agricultural management strategies between 2010 and 2015 in industrial area of Ouagadougou.

Conclusions

- Dissolved Na percolated vertically and horizontally, thereby contaminating the subsoil and the surrounding non-irrigated area
- Na contaminated fields were lost for further cultivation
- Na in wastewater needs to be reduced before water release into the environment

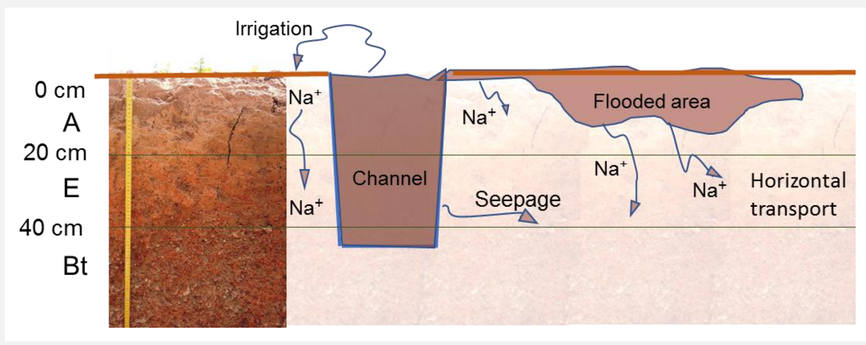

Figure 4. Pathways of soil sodification due to application of industrial wastewater in irrigated urban agriculture of Ouagadougou, Burkina Faso.

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