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Relationship between soil properties and natural grassland vegetation on sodic soils

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Summary. Salinity, pH, climate, and moisture content, along with topographical data were compared between plant associations, to define key factors affecting soil salt accumulation and establishment of natural vegetation. The extreme values found in some associations are explained by the spatial distribution of the studied points.

Key words: plant associations, salt accumulation, spatial distribution.

1. Introduction

This paper aims to introduce shortly the factors affecting the unique pattern of natural vegetation of salt-affected soils in Hortobágy, Hungary. It complements earlier researches (Tóth & Jozefaciuk 2002; Tóth & Kuti 2002; Tóth et al. 2001) done at the same study site "Nyírőlapos", Hungary. With the study of long-term data (climate, EC_a, pH, soil moisture content) we attempt to support earlier hypothesis: soil water regime, climate, and altitude are the key factors in soil salt accumulation processes, which are strongly correlated with the spatial distribution of plant associations.

2. Study area

The study area "Nyírőlapos" is located in the Great Hungarian Plain, in the Hortobágy National Park, Hungary. It covers about 0.48 sq. km (600 × 800 m) of sodic grasslands. The area is nearly flat, with maximum 2 m relative altitude difference. The climate is subhumid with a minimum 419 mm precipitation per year. Monthly average temperature is between –2 (Jan) and 21°C (Jul). The area is typical for clayey Solonetz type soils in Hungary. Clay content is ca 40%, hydraulic conductivity is extremely low: 0.006–0.014 cm/day in horizon B (Tóth & Józefaciuk 2002).

3. Methods

Data used in this paper were collected from January 1994 to June 2001 during 19 field measurements.

Watertable was monitored by 4 wells. Bulk soil electrical conductivity (EC_a) measurements were carried out with three month intervals since November 1994, at 420 georeferenced, and leveled points by a Martek SCT 12 type instrument. Field measured EC_a data is highly influenced by actual soil moisture content, hence data collected at different points and time are not comparable. To solve this problem 20 measurement points were chosen to be sampled for laboratory calibration (in 1:2.5 suspension for $EC_{2.5}$ laboratory measurements). Linear regression was used to calculate $EC_{2.5}$ values for all measurement points (Douaik 2005). $EC_{2.5}$ has a significantly lower correlation with actual soil moisture content hence data can be compared independently from time and point of measurement. Calibration soil samples were collected from 10 cm increments to the depth of 40 cm.

4. Results and discussion

4.1. Soil moisture regime

Soil moisture regime is mainly controlled by precipitation, potential evapotranspiration (PET), and watertable depth. These factors have different impact in different depth levels of the soil. According to our results PET determines moisture content of the surface down to 10 cm depth, between 10–20 cm lays a transitional zone where main factors are PET and watertable depth also. Correlation between soil moisture content and watertable depth increase from 20 to 40 cm (Tab. 1). The direct effect of precipitation is negligible, due to the extremely low hydraulic conductivity.

4.2. Plant associations

Table 1. R2 values between soil moisture content; precipitation, PET (Potential Evapotranspiration), and watertable depth Significance: *0.05; precipitation and PET: n=21, watertable depth: n=36

	Soil moisture content			
	0–10 cm	10–20 cm	20–30 cm	30–40 cm
Precipitation	0.002	0.000	0.014	0.021
PET	0.419	0.344	0.135	0.037
Watertable depth	0.059	0.196	0.406*	0.493*

Mean $EC_{2.5}$ values of the plant associations are shown in Figure 1. The associations in the figure are ordered by mean altitude above sea level.

The mean altitude of *Salvio-Festucetum sulcatae* is the highest in the study site (89.63 m). This correlates with the lowest mean $EC_{2.5}$ (863 and 1010 $\mu S \cdot cm^{-1}$ in the layers 0–20 and 0–40) and pH values (6.5, 6.2 and 6.4 at the depths 10–20, 20–30 and 30–40 respectively). It indicates clearly a leaching process. Meanwhile pH normally increases from 0–10 cm to 30–40 cm at this association its decreases. The lowest relative difference between $EC_{2.5}$ (0–20 cm) and $EC_{2.5}$ (0–40 cm) and moderate pH in 0–40 cm means that leaching has an effect down to 40 cm.

Camphorosmetum annuae is the next association down in the toposequence, with a mean level of 89.16 m. Contrary to *Salvio-Festucetum sulcatae*, this association shows the highest ECe values (in 0–20 and 0–40 cm also), and second highest pH values. Although the relatively big difference between $EC_{2.5}$ 0–20 and $EC_{2.5}$ 0–40 shows that salt content maximum is not at the surface, it is clear that leaching has very limited effect here.

Achilleo-Festucetum pseudovinae has significantly lower $EC_{2.5}$ and pH values again.

Altitude, climate, and water regime do not explain these results. More data are needed to understand the phenomenon. Figure 2 shows spatial distribution of the mentioned plant associations.

Salvio-Festucetum sulcatae and *Achilleo-Festucetum pseudovinae* forms mostly big flat continuous patches, where water has enough time to infiltrate and induce leaching process. *Camphorosmetum annuae* occurs in isolated points surrounded by slopes. At these points runoff of precipitation begins immediately and leaching is limited. Leaching is further limited by the extremely low hydraulic conductivity of the *Natric* horizon.

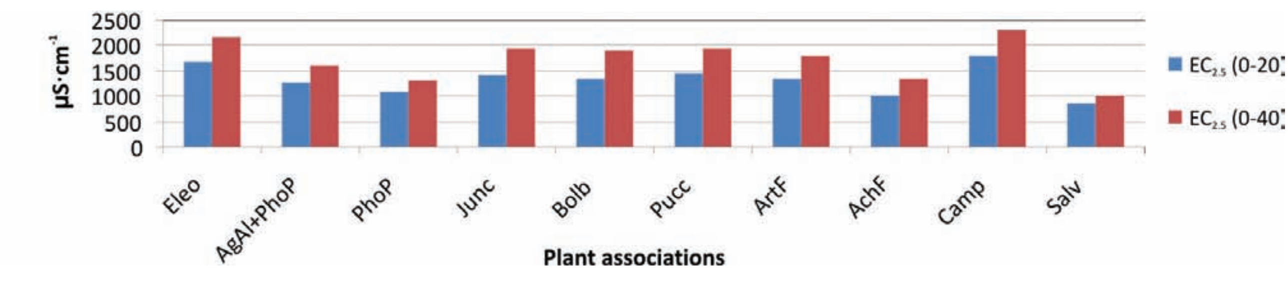

Figure 1. Mean $EC_{2.5}$ values of plant associations. (Eleo: *Eleochari-Alopecuretum geniculati*, AgAl: *Agrosti-Alopecuretum pratensis*, PhoP: *Pholiuro-Plantaginetum tenuiflorae*, Junc: *Juncus gerardii*, Bolb: *Bolboschoenetum maritimae*, Pucc: *Puccinellietum limosae*, ArtF: *Artemisio-Festucetum pseudovinae*, AchF: *Achilleo-Festucetum pseudovinae*, Camp: *Camphorosmetum annuae*, Salv: *Salvio-Festucetum sulcatae*)

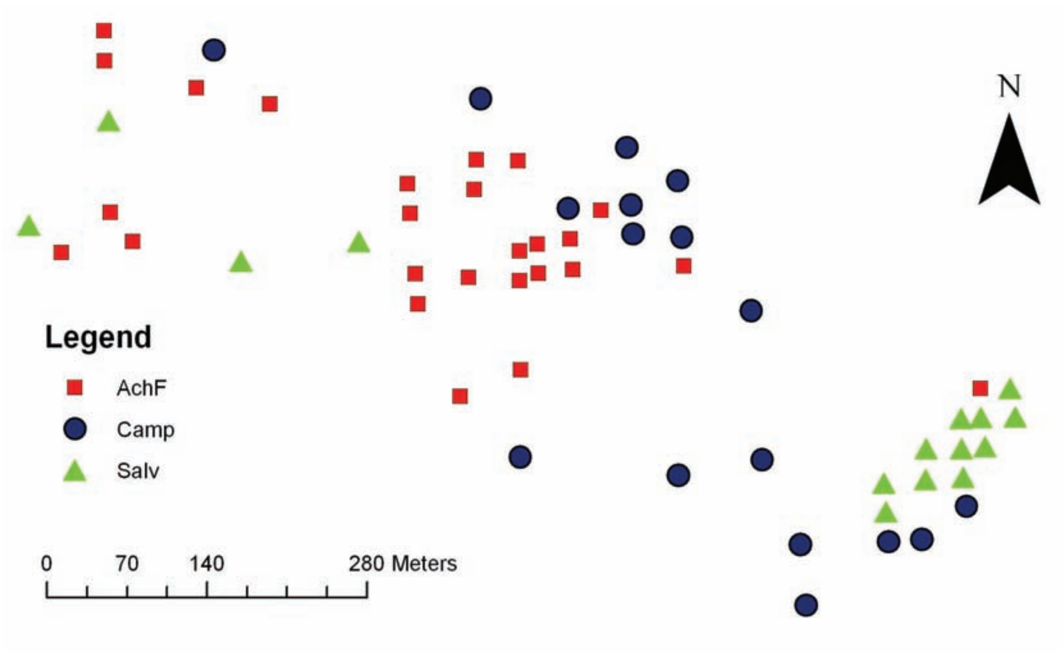

Figure 2. Spatial distribution of plant associations

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