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Soil and climatic risks investigation of field production on farms

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Hungary has already developed its own land use strategy. As a next step in realization investigation the soil and climatic risk has to be investigated on regional level. Our main objective is to develop a method for risk assessment of field production on farms.

Our experimental site is plow-land in the east part Hungary on Nagy-Sárrét on the frontier of Báránd (Figure 1). The landscape is plain 83-89 m high above the sea level with moderate warm and dry climate. Different soil types were evolved according to the depth of groundwater (1-3 m). The climatic conditions, the soil texture together with the micro relief determinate the evolution of inland inundation and drought.

The nearest synoptic station is in Debrecen, 35 km far away from the investigated area. The average temperature is 10,5°C. In the examined time slice (1981-2010) the amount of temperature has increased. The nearest precipitation measurement station is in Sáp, 9,7 km far away from Báránd where the 30 year average rainfall is 580 mm.

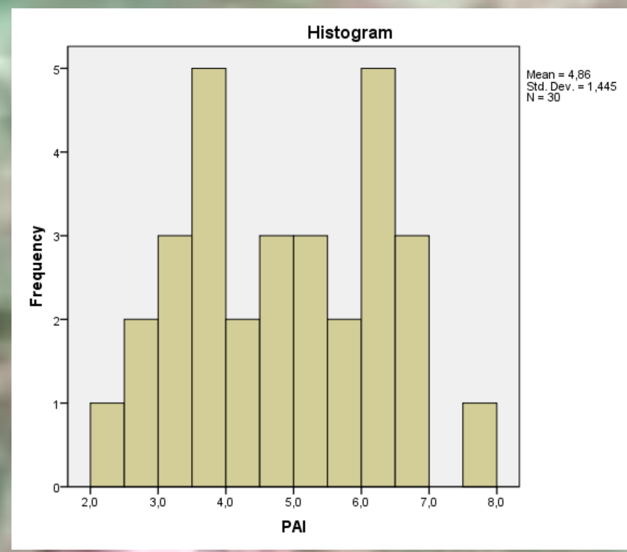

Figure 2

Pálfai aridity index (PAI) was calculated and the years were classified by PAI (Table 1). Figure 1 shows the distribution of the index. The mean of the PAI values of the 30 years (1981-2010) is 4.86, the standard deviation is 1.445.

The frequency of drought years has not increased (Figure 2), however, the rate of extreme years has risen. The wettest and the driest year were both in the past ten years.

Next we clustered the past 30 years with k-mean centroid method by PAI. The results are in Table 2.

Then a discriminant test was run (Figure 3) to find and prove the discriminant effects of the most important weather factors which determine the aridity character of a year. The yearly mean temperature (°C), the yearly precipitation amount (mm) and the precipitation amount of the vegetation period (mm) were chosen as discriminant variables. 80,0% of originally grouped cases were correctly classified. The Wilks lambda is 0.206, the canonical correlation is 0.874. The 1. and the 2. discriminant function separate the wet and dry years (Figure 3 and 4) successfully.

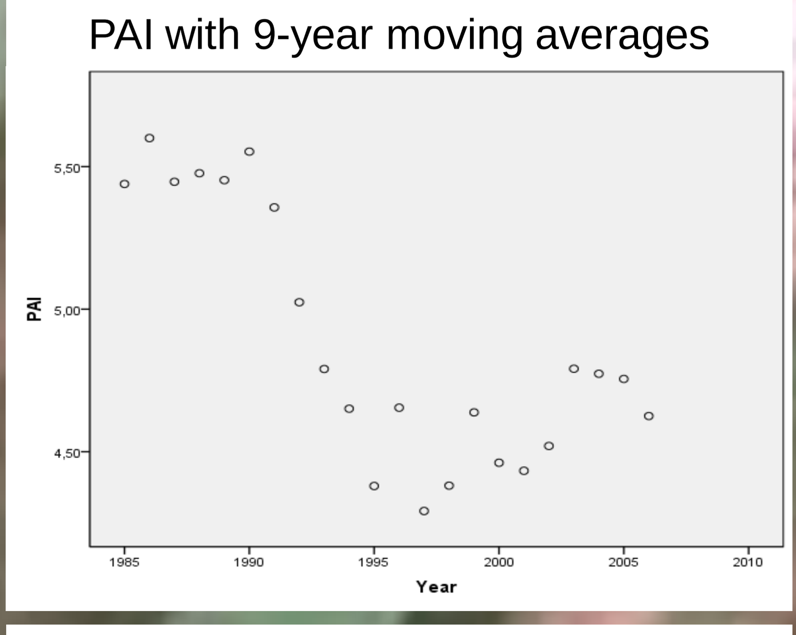

Figure 3

$$PAI = \frac{t_{IV-VIII}}{P_{X-VIII}} \cdot 100$$

$t_{IV-VIII}$: average temperature from April to August

P_{X-VIII}: weighted precipitation amount from previous October to August

Weights: October 0.1, November 0.4, December-April 0.5, May 0.8, June 1.2, July 1.6, August 0.9

YEAR	PAI	Qualification
1981	4,77	droughtless
1982	4,96	droughtless
1983	6,58	druoght
1984	6,14	druoght
1985	4,56	droughtless
1986	6,22	druoght
1987	6,28	druoght
1988	5,20	druoght
1989	4,25	droughtless
1990	6,21	druoght
1991	3,58	droughtless
1992	6,85	druoght
1993	5,92	druoght
1994	5,46	druoght
1995	4,46	droughtless
1996	3,28	droughtless
1997	3,09	droughtless
1998	3,00	droughtless
1999	3,77	droughtless
2000	6,05	druoght
2001	3,59	droughtless
2002	6,72	druoght
2003	7,77	druoght
2004	2,87	droughtless
2005	3,03	droughtless
2006	3,87	droughtless
2007	5,44	druoght
2008	3,61	droughtless
2009	5,89	druoght
2010	2,42	droughtless

Pálfai aridity index

YEAR	Deviance from the mean
1981	-83,62
1982	-159,12
1983	-162,32
1984	-62,12
1985	-31,02
1986	-220,52
1987	-121,12
1988	-58,92
1989	-30,52
1990	-95,12
1991	51,98
1992	-113,62
1993	-88,02
1994	-109,82
1995	32,28
1996	307,48
1997	7,58
1998	248,28
1999	196,38
2000	-205,02
2001	89,18
2002	-92,12
2003	-113,92
2004	189,38
2005	113,78
2006	18,28
2007	47,38
2008	45,18
2009	-3,32
2010	402,98

Deviance from the mean rainfall

Table 1

K-mean clustering with centroid method

1	2	3	4	5
extremely wet	wet	interim	dry	extremely dry
2010	1991	1981	1983	2003
	1996	1982	1984	
	1997	1985	1986	
	1998	1988	1987	
	1999	1989	1990	
	2001	1994	1992	
	2004	1995	1993	
	2005	2007	2000	
	2006		2002	
	2008		2009	

Table 2

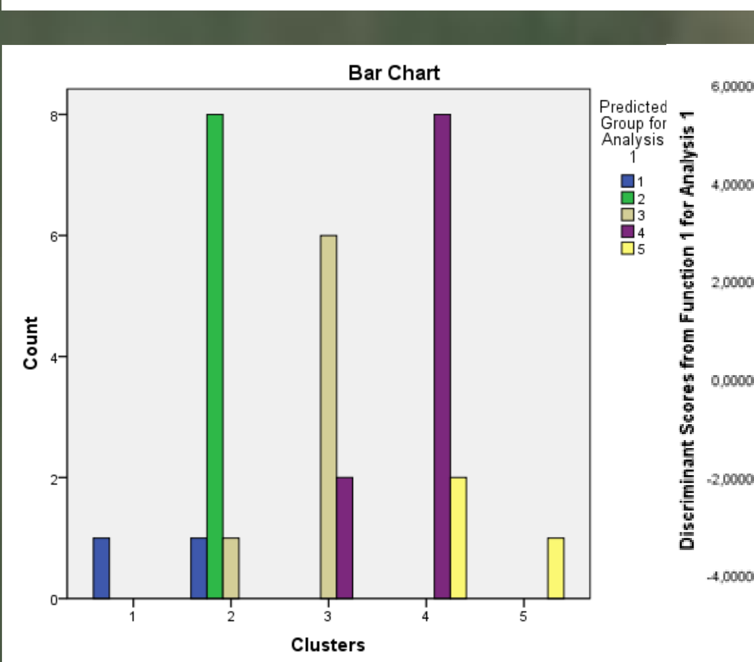

Figure 4

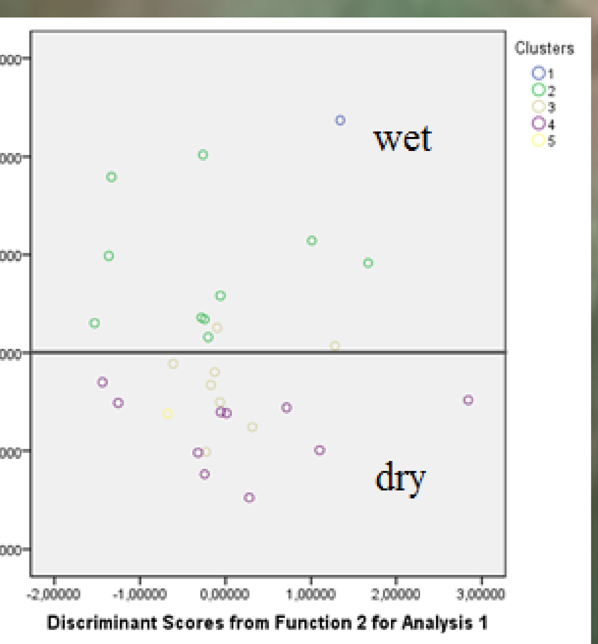

Figure 5

We made a soil analysis at area which is especially endangered by salinization (north from Báránd). The measuring process was: soil profiles were excavated and soil samples were examined in laboratory.

There is thick humus layered silty loam textured soil with high organic compound content in this area. The main soil problems caused by Na, salinity, pH and high clay content. We bordered the difference degree of salinization and increased inland inundation areas with GIS tools, and we revised with the experience from area review. Figure 6 shows the vertical profile of the pH, salinity and absorbed Na in some typical soil section.

We have shown that though drought risk has not increased in the past 30 years in this region, the risk of salinization can force us to conclude that some parcels have to be taken out of cultivation (Figure 7).

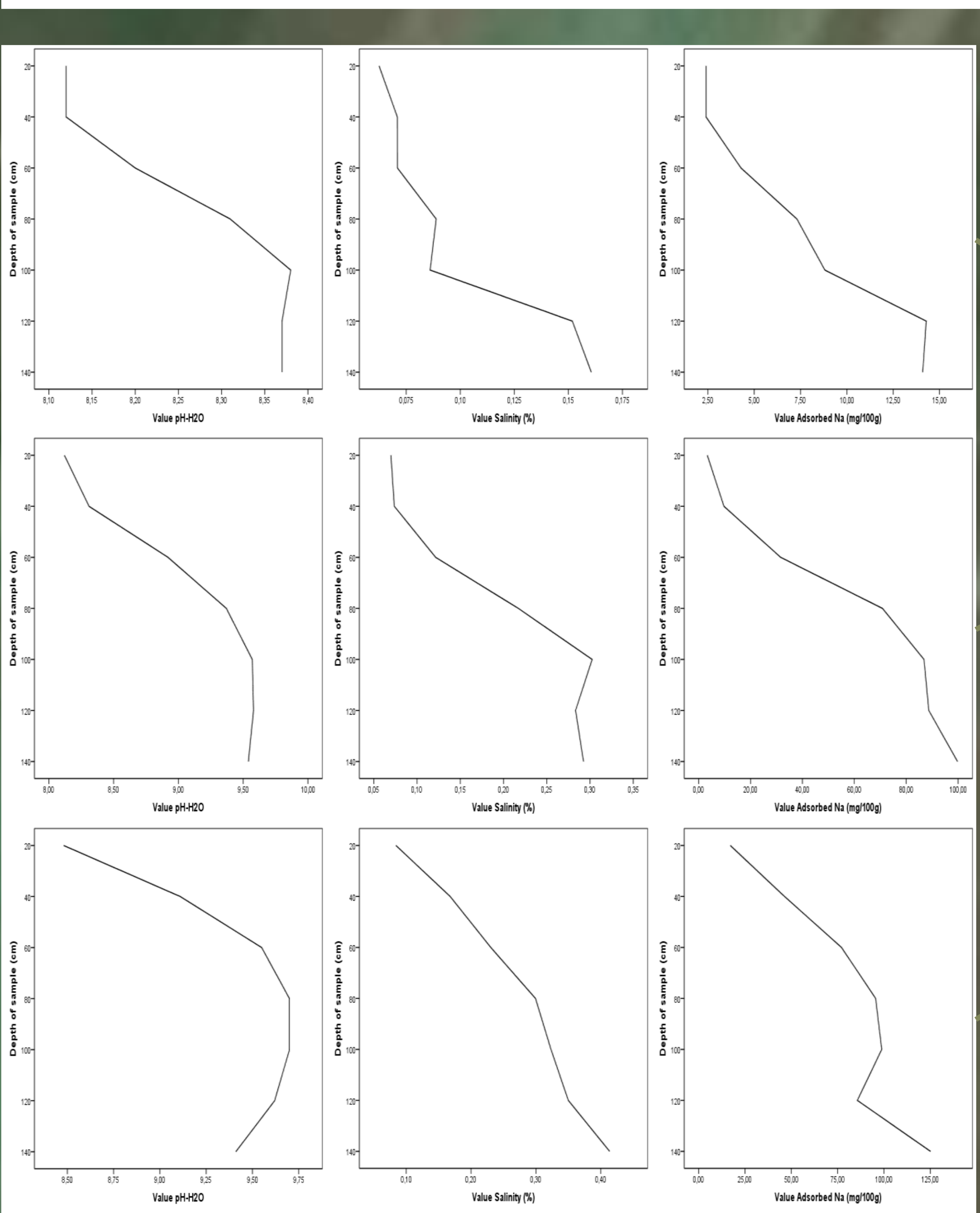

Figure 6

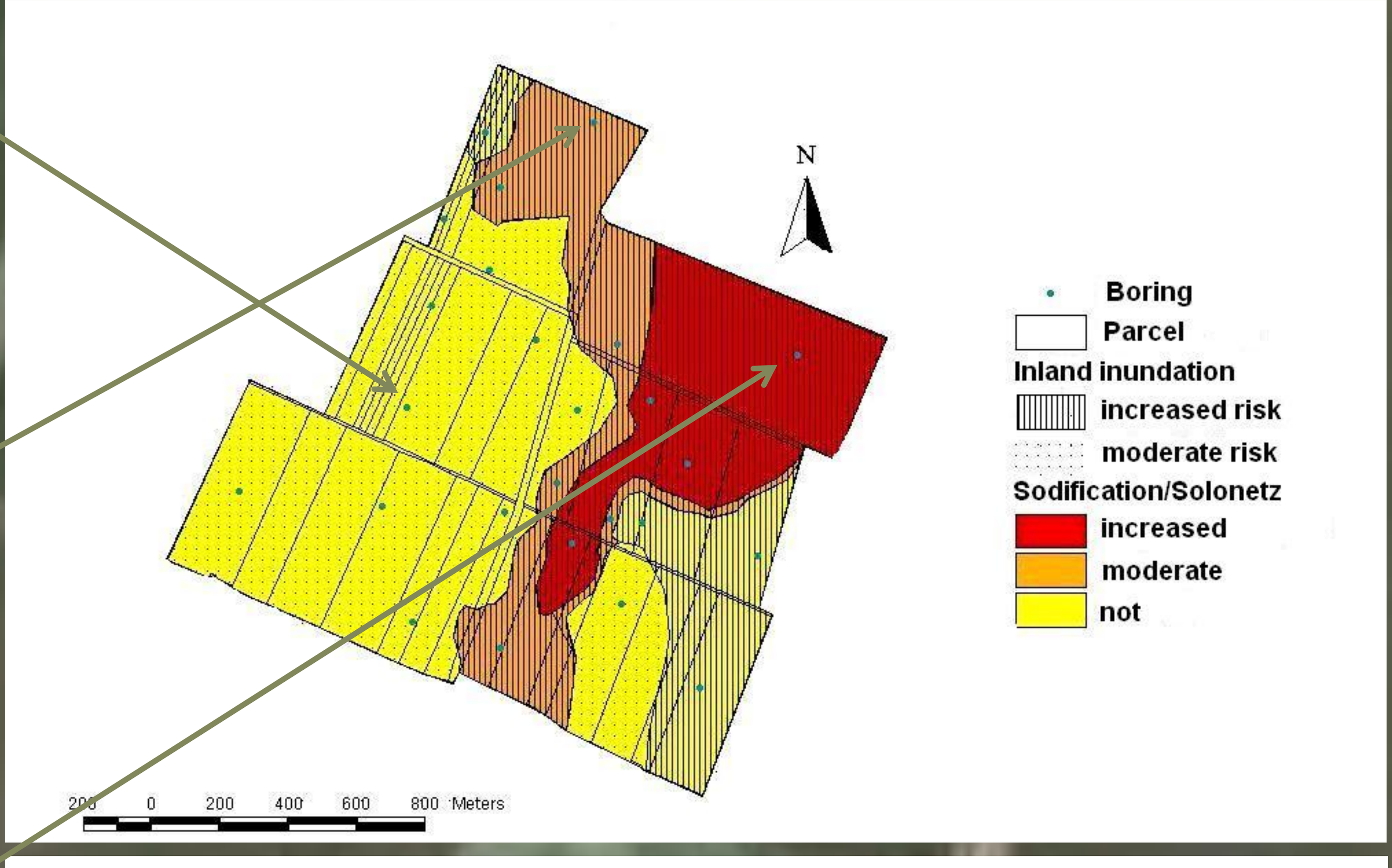

Figure 7

Figure 1

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