

## **Adaptation and rise: Little Ice Age challenges and social responses on the Trans-Tisza Region (Hungary)**

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The studied 4.128 km<sup>2</sup> Central European lowland region includes the Hortobágy landscape, a UNESCO World Heritage site and one of the most extensive protected natural grasslands of Europe. In the evolution of this semi-natural landscape human-nature interactions were characterised by gradual but extremely serious settlement abandonment during the 13th–17th centuries. The identification of the agents shaping this process has been widely discussed in the Hungarian landscape historiography.

The statistical analysis of medieval archaeological sites indicating settlements showed that elevation means in the early period of the Little Ice Age (LIA) (mid-13th – mid-16th centuries) were significantly higher than in the Medieval Warm Epoch (MWE) (mid-10th – mid-13th centuries) ( $p \leq 0.01$ ;  $n=549$ ;  $\alpha=0.05$ ). This result supported our hypothesis that waterside settlements of the plain displaced vertically from the MWE to the LIA.

Secondly, a GIS based zonal analysis suggested a strong spatial connection between the geomorphological zones (riparian, deep floodplain and sand plateau), the agro-ecological suitability zones (good-excellent, medium and low) and the population zones (with stable settlement pattern, deserted and uninhabited). E.g. the elevation means of archaeological sites in deserted zones proved significantly lower than those with stable settlement pattern ( $p \leq 0.01$ ;  $n=381$ ;  $\alpha=0.05$ ). Similarly, a statistical investigation of grain remains ( $n_{archaeological\ site}=79$ ;  $n_{taxon}=751$ ;  $n_{findings}=4.8$  millions) of the Great Hungarian Plain (GHP) indicated that the early phase of the LIA saw the spreading of moorland plants and rye, the cereal most resistant to humidity and cool. When the relation of settlement patterns to soil conditions was analysed by ANOVA linear model, a significant spatial correlation appeared between the extension of the high and medium agro-ecological suitability zones and the number of settlements in each population zone of the five microregions ( $R^2=0.46$ ;  $p \leq 0.01$ ;  $df=18$ ).

In conclusion, our results refer to rising water levels in the early phase of the LIA, which may have been a causal factor behind the serious late medieval settlement abandonment in the GHP. They also suggest that soil conditions determined the spatial pattern of settlements. From an environmental aspect, flood free surfaces and suitability for farming were decisive in the premodern population density of this wetland landscape. Historical data likewise show that the population of deserted villages migrated towards floodless areas with excellent soil conditions where a rapidly growing town network emerged in the early phase of the LIA. The croplands of abandoned villages were converted into pastures for extensive cattle husbandry managed by towns – a typical way of farming in the Hungarian lowlands.