Unravelling palaeohydrology: revealing prehistoric landscapes with integrated near surface geophysics.

Philippe De Smedt[1]*, Machteld Bats[2], Marc Van Meirvenne[1]

[1] Research Group Soil Spatial Inventory Techniques, Department of Soil Management, Ghent University, Coupure 653, 9000 Ghent, Belgium

[2] Department of Archaeology, Ghent University, Sint-Pietersnieuwstraat 35, 9000 Ghent, Belgium

*Corresponding author: Fax: +3292646247

Tel: +3292646042

Mail: Philippe.DeSmedt@UGent.be

Abstract

In order to assess the relationship between the environment of a Late Glacial palaeolake ('Moervaart', Belgium (Fig. 1)) and the numerous prehistoric settlements in its vicinity, it is crucial to understand the area's hydrological evolution throughout the Late Glacial and the early Holocene. Therefore, extensive mapping campaigns were set up to detect and characterise buried river systems (Bats et al. 2009). However, creating detailed maps of the palaeotopography that combine spatial continuity with accurate information about vertical facies changes remains a difficult challenge.

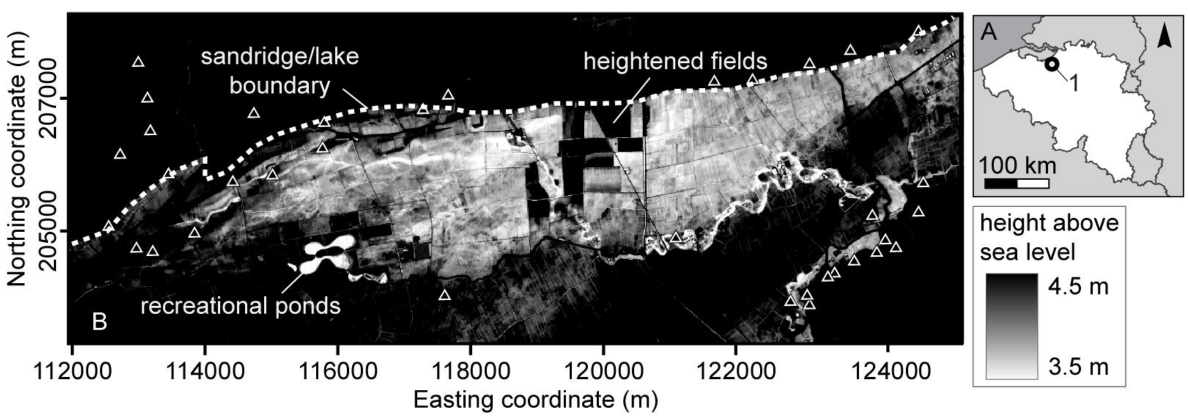

Figure 1: Localisation of the Moervaart palaeolake in Belgium (A) and digital elevation model of the palaeolake (visible as the whitish area), with prehistoric site locations indicated by triangles

For this purpose, we performed a mobile multi-coil electromagnetic induction (EMI) survey, which enabled continuously mapping soil apparent electrical conductivity (ECa), mainly influenced by soil texture. This technique avoids spatial interpolation error and adds vertical sensitivity by combining multiple coil pairs (combinations of transmitter and receiver coils) that simultaneously measure ECa and MSa (apparent magnetic susceptibility) of different soil volumes (Simpson et al. 2009). By using a quad to tow an EMI sensor with four different coil pairs (Dualem-21S, Dualem, Canada), a quasi continuous coverage was obtained: we drove over the sites along parallel lines, 2 m apart, with an in-line resolution of 0.20 m. Additionally, we have developed a method to model the depth to predefined soil horizons by comparing the ECa maps generated by each coil pair, allowing us to accurately model the palaeotopography and buried geomorphological features (Saey et al. 2008 and De Smedt et al, in press).

Based on the resulting data we have located a number of river systems in the area that are characterised by large depth variability and channel types that vary from straight to braided. While the lateral continuity of this mobile EMI survey makes a detailed interpretation of the palaeolandscape possible, the vertical potential added by the use of multiple coil pairs facilitates evaluating these features' impact on the former landscape as well as identifying interesting sample locations for further palaeoenvironmental research (Fig. 2).

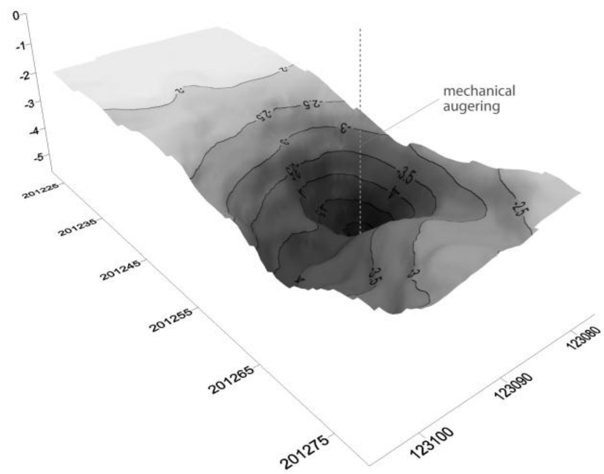

Figure 2: depth model of a palaeoriver segment, based on the EMI data, with a the location of a mechanical augering indicated (dashed line)

Combined with palaeoenvironmental information, these geophysical data allow creating a detailed and accurate reconstruction of the prehistoric landscape harbouring the Late Glacial and Early Holocene settlements in the area.

References

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