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Cultural landscape. Geomorphometric studies in the Chełmno Land

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Research on prehistoric settlement has gone forward significantly in recent years thanks to developments in spatial data processing and analysis technologies. New tools offering a broader range of analyses have been adapted to archaeological needs with the application of methodology typical of the geographical sciences, resulting in an obvious change of approach to settlement research. The way in which data are treated has also touched the Archaeological Record of Poland project. The process has been guided by recommendations included in studies

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concerning systems of spatial information (Smith *et al.* 1987; Clarke 2001; Gotlib *et al.* 2007) and the usefulness of these developments have been evaluated repeatedly (Miałdun *et al.* 2005; Zapłata 2011). The practical implementation of GIS technologies in archaeological projects has also become increasingly frequent (Gawrysiak and Reda 2011; Jankowska *et al.* 2012; Kalicki and Jedynak 2012).

One such project was the geospatial inventorying of ARP objects in Chełmno Land (Kozioł *et al.* 2014). A GIS database was prepared, including a digital map of this region of Poland localizing effectively georeferenced archaeological sites. Data edition and database query are supported by online services (Kozioł *et al.* 2014). GIS Open Source technology and connecting the base with a Desktop tool have created a platform for complex analyses of the extra resources of geospatial data.

Chełmno Land is a district in Poland with a rich and organized prehistoric settlement from the Mesolithic to the early Middle Ages that lends itself well to the application of modern noninvasive surveys and analytical methods. The GIS database prepared for the region contains 6500 sites with their exact location, filtering data by category: location, physiographic location, chronology, culture, determination of records status, description of risks, soil thickness and subtypes. The results were exported as an Excel file, generating a digital map for a given group of sites. Then all the vector and raster maps resulting from the study and generated from prebuilt packages of spatial data were integrated in one system. Further data processing include cartometric map accuracy analysis, selection of attributes (SQL) and analysis by spatial relations, neighborhood analysis, equidistant (buffers), network analysis, overlapping and intersecting sets of data, geocoding, interpolation, geostatistics and visibility analysis.

The results of research on representative archaeological sites has constituted the starting point for a more general analysis based on the creation of spatial models grounded in the digital terrain model (DTM) correlated with soils, agricultural and hydrological vector maps. This part of the spatial analysis was based on GIS software designed for complex analysis. Methodology based on the use of the topographical positions index (TPI) (Weiss 2001) was also applied. TPI is a primary indicator of topography, obtained on the basis of data from the DTM, that allows the automatic classification of forms of terrain, e.g., shape complexity index (SCI). On the basis of the primary indicators, it is also possible to calculate topographic secondary indicators, which are used for example to determine the influence of the topography effect on various ecological phenomena. The other topographic secondary indicators, such as: specifying the degree of erosion (EROS), solar radiation (SRAD), potential drainage network density (DDENS), compound topographic index (CTI), wind exposure potential (WINDE), have also been taken into account in the complex analysis. The latter were standard in geographical or ecological research (Lach and Kozioł 2009), but were not tested on the large-scale on archaeological sites. The expected results of the project can greatly expand the range of questions posed in case studies concerning the reconstruction of prehistoric settlement. They bring in more modern documentation of archaeological sites, enabling at the same time a reconstruction of their position in the broader context of an archaeological landscape. The use of tools typical of geographic analysis can help in many cases to determine settlement preferences in particular periods of history, taking into account such factors as ground relief, distance from water sources, visibility and lighting, location in relation to possible transport routes. All of these factors are usually taken into account in settlement research, but require labor-intensive studies related to analyzing different types of sources, including maps and not always precise topographical sketches.

Gathering in a single database all information on the environmental context of archaeological sites, combined with data collected from the surface, but also found in the course of archeological research, makes a comprehensive analysis of settlement contexts much easier.

Establishing a directory of possible issues, to be resolved by spatial data analysis, gives grounds for evaluating the effectiveness of this method in further studies on settlement patterns. Adding survey results to a database accessible via the Internet will facilitate their wider use by other researchers.

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