Geospatial Approaches to Mapping Archaeological Deposits in Dynamic Landscapes: The Battlefield of Waterloo, Belgium

In recent years, battlefield archaeology has made important contributions to our understanding of pivotal conflicts in human history. Archaeological evidence, in the form of buried artifacts and soil features, has enhanced or in some cases refuted historical accounts of these events. The unique formation processes associated with battlefield sites – typically very short-term events spread over large areas – means that this evidence can be quite elusive and that many traditional archaeological prospection methods (such as test pitting/trenching) are relatively ineffective (Connor and Scott 1998).

This has led to the adoption of alternative prospection methods, most notably the systematic use of conventional handheld metal detectors. These basic geophysical (referring to a suite of methods used to measure subsurface physical properties in order to identify targets of interest) instruments enable efficient recovery of small metal debris from the shallow topsoil horizon, allowing for the delineation of areas of combat and spatial reconstruction of troop movements based primarily on dropped or fired ammunition (Scott et al. 1989). One limitation of the technique is the limited depth of investigation (typically 30-40 cm at most) which severely reduces effectiveness in deeply buried sedimentary environments such as colluvial (hillslope erosion) or alluvial (riverine deposits) settings. In these challenging settings, conventional metal detector surveys may produce spatially biased datasets which could impact the interpretation of the archaeological record.

The Battlefield of Waterloo in Belgium, where Napoleon Bonaparte was famously defeated by an Allied coalition in June of 1815, is an example of a landscape that has been impacted by the recent accumulation of colluvial deposits, primarily related to mechanized agriculture and devegetation. As such, some archaeological deposits of interest related to the battle have been buried under thick layers of colluvium, particularly in areas susceptible to slope erosion. Furthermore, above-ground evidence of the battle is no longer present on the landscape due to these topographic changes. Therefore, terrain analysis using high-resolution datasets which have proven very effective in other areas of conflict archaeology (e.g., van der Schriek and Beex 2017) is of only limited use. Thus, the only means to examine the physical evidence of this important conflict is through subsurface investigation, either in the form of (invasive) archaeological investigations at a relatively small scale or non-invasive (primarily geophysical) prospection methods.

In order to more efficiently target archaeological investigations and select appropriate methodological approaches at Waterloo, as well as to aid in the interpretation of artifact scatters which may have been affected by post-depositional processes, it is important to accurately identify changes in the landscape and delineate areas where colluvial deposits are present. The existing mapping of these deposits is relatively coarse (based on interpolation of boreholes on a 75 m grid) and perhaps outdated, as it is based off soil surveys undertaken in the 1950s and 1960s (Louis 1973). Geophysical surveys indicate that these deposits can be identified based on electrical conductivity contrasts related to diagnostic differences in soil texture, which plays an important role in susceptibility to slope erosion (French 2016). While the high spatial resolution of these surveys allows for very fine discrimination of these contrasts, it is impractical to scale these surveys up across the entire battlefield landscape (which measures over 1000 hectares).

The analysis of multi-temporal and multi-spectral optical remote sensing data at medium to high resolutions, now commonly deployed in landscape archaeology and enabled by Big Data approaches (Orengo and Petrie 2017), has also shown potential for the identification of colluvial deposits, based primarily on vegetation indices compiled from red and near-infrared reflectance (in turn related to soil moisture retention and thus texture). This data readily allows for the examination of much larger areas of the landscape. Terrain data (elevation and its derivatives) is also very useful as a collateral dataset for identifying these deposits, as they are primarily situated in the low-lying valley bottoms beneath sufficiently steep slopes. Limited invasive sampling, however, has shown that thick deposits also exist in areas upslope and thus it can not simply be assumed that this material is confined to the bottomlands. Finally, historic evidence in the form of contemporary maps and landscape models provides a longer-term diachronic perspective to examining changes in the landscape over the past couple of centuries.

A geospatial framework of analysis enables the integration of these disparate datasets – archaeological, geophysical, topographic, remote sensing, pedological, and historical cartography – to produce a more robust model of the landscape that can then be tested and refined through a programme of invasive sampling. Ultimately, the goal is to better understand how the landscape has evolved in the time since the battle and to determine how this has impacted the archaeological record that remains today. This is investigated using case studies from select areas of the battlefield to explore the ways in which multi-disciplinary approaches can shed light on the long-term spatial variability of conflict sites and in turn contribute to our understanding of these important historical events.

References

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