Beacons of the Past

Visualising LiDAR on a large scale

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The Project

The *Beacons of the Past* (*BotP*) project was developed by the Chilterns Conservation Board (CCB) to investigate the Chiltern Hills of Southern Britain, a landscape that has a pivotal role in understanding human colonisation of upland spaces in post-glacial Britain, the development of farming on marginal soils, and the evolution of power and regional tensions of the later prehistoric period.

The Chilterns Area of Outstanding Natural Beauty (AONB) provides an ideal test case for a landscape-scale, high resolution archaeological LiDAR study. The key reason for this is the Chiltern woods. Over 22 % of the 833 km^2 AONB is today covered by woodland (more than double the average for England - National Forest Inventory 2017[1] and Forest Research Statistics 2019[2]), and about 60 % of this has been found to be "ancient woodland," continuously wooded since before AD 1600 (Natural England, Ancient Woodland Inventory 2012[3]).

Environment Agency (EA) LiDAR data has wide, and growing coverage of the UK. In the Chilterns, large areas are still yet to be surveyed by EA, with completion planned by 2021. The EA data which does exist for the region has often been flown at 1m resolution. At this resolution many archaeological features are not identifiable. This is particularly exacerbated under tree cover, where ground point densities are inevitably lower than for open ground.

A bespoke LiDAR dataset was therefore viewed as being of great benefit for enriching the understanding of this landscape, and through funding from the National Lottery Heritage Fund and other partners, the largest bespoke high-resolution archaeological LiDAR survey yet undertaken in the UK was commissioned. Encompassing 1400 km^2 (Fig. 1) and flown at a minimum resolution of 16ppm, extending to 27ppm in open ground, utilising the Riegl Q1560 LiDAR sensor, the survey offers not only the potential to reveal hundreds of new archaeological sites, but also in keeping with the mission of the CCB, point cloud data can be used to record and monitor tree canopy and hedgerow health.

Where the data overlaps with EA existing data, comparisons can be made to observe erosion and monument preservation between the EA survey and the project's, and any future re-flying of the region by the EA can also be used for comparison to the *BotP* survey.

Visualisation approaches

The last few years have seen vigorous research into the creation of different visualisation techniques of LiDAR datasets in order to maximise the visibility of archaeological remains within them. The fallibility of single directional hillshade as a technique is well-understood by knowledgeable LiDAR practitioners, but with the ever-growing acknowledgement of LiDAR's effectiveness for archaeological survey, and the growing availability and ease of use of datasets mean there are large numbers of users relying solely on a single hillshade.

Whilst it is agreed that there is much customisation of hillshade processing which can be done to tease out more information (Figure 2), the BotP team supports Štular et al.[4] in the assertion that there is no single best visualisation method but that sky view factor (SVF) if preferred over hillshade in most instances (Fig. 2). Due to the prodigious scale of the survey, analysis of the data will rely heavily on the assistance of citizen science (see below). Therefore the visualisations that are presented to the public must make maximum use of the wide array of possibilities, rather than limit the visibility of features to the sole use of hillshades. Current layers offered are (above hillshade) SVF and Local Relief Model (LRM), but other methods, particularly the new 'combined visualisation' approach of Kokalj and Somrak, are being tested.[5]

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[1] https://www.forestresearch.gov.uk/tools-and-resources/national-forest-inventory/

[2] https://www.forestresearch.gov.uk/tools-and-resources/statistics/statistics-by-topic/woodland-statistics/

[3] https://naturalengland-defra.opendata.arcgis.com/datasets/45d3eebaebf847ac8c9f328091af5571_0

[4] Štular, B., Kokalj, Ž., Oštir, K., & Nuninger, L. (2012). Visualization of lidar-derived relief models for detection of archaeological features. Journal of archaeological science, 39(11), 3354-3360.

[5] Kokalj, Ž., & Somrak, M. (2019). Why Not a Single Image? Combining Visualizations to Facilitate Fieldwork and On-Screen Mapping. *Remote Sensing*, 11(7), 747.

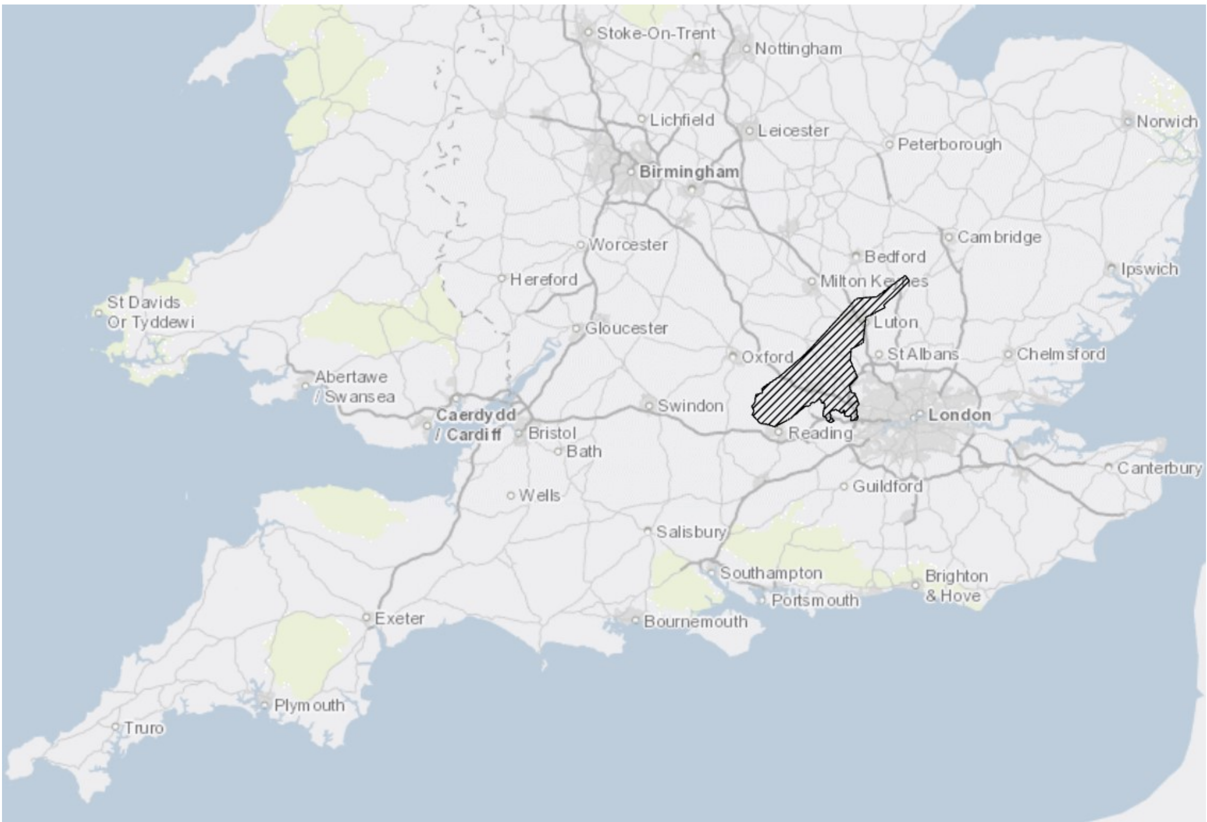


Fig. 1. Location of Chilterns Hills in the United Kingdom; lined area is the coverage of LiDAR survey.(© CCB; basemap © Crown copyright)

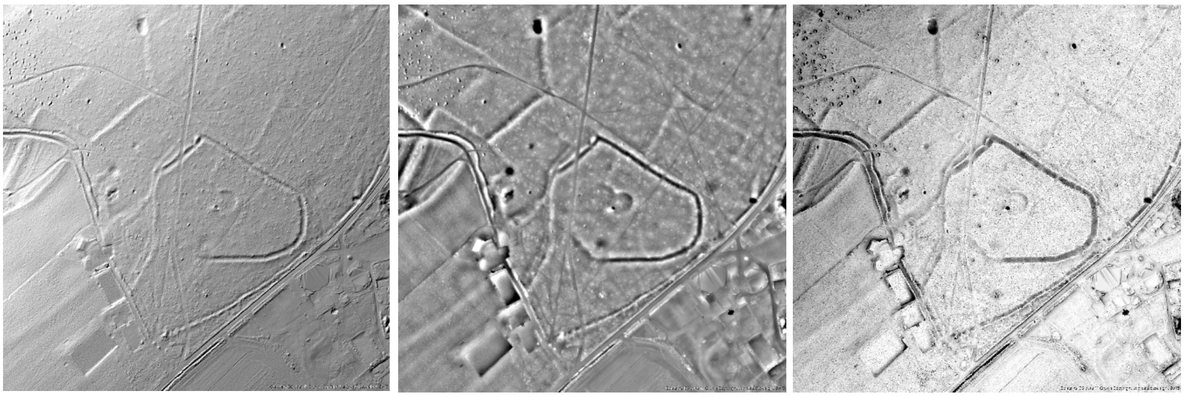
The growing publication of tailored, easy to use software, and ever developing computing technology with decreasing costs, have made 3D visualisation methods far more accessible, and it remains to be tested whether these have advantages of interpretability over traditional 2D approaches. *BotP* offers comparative trials of survey for archaeology across the two methods, to see whether 3D really does offer a more efficient, more interpretable alternative, and whether potential negative aspects such as expedience or cost are mitigated by greater effectiveness.

Citizen Science

The project has worked to create a bespoke web-GIS and heritage asset management system, to allow ready, free, licence-less access to view data layers including several LiDAR visualisations, aerial photography, and large scale modern and historic mapping. Following on from the arguments of the project has put the task of interpreting the landscape into the hands of the public, understanding that 'experts' do not know the landscape as well as those who live in it, work in it, and in many cases have spent decades exploring it. [6]

Figure 2 Two single hillshade images of Maiden Bower hillfort, Bedfordshire, produced using RVT 1.3, of the same area: note the different levels of detail discernible in different parts of the image, and in particular the presence-absence of subtle field boundaries to the east and north of the hillfort., depending on the illumination azimuth. © CCB

[6] Duckers, G. L. (2013). Bridging the 'geospatial divide' in archaeology: community-based interpretation of LIDAR data. *Internet Archaeology,* 35.



a *b* *c*

Fig. 3. Three visualisations of Greenfield Copse, Oxfordshire. a) single hillshade; b) LRM; (c) SVF. Note the increased visibility of prehistoric field systems in northeast of (b) and greater detail of small features at southwest of c). (© CCB)

This approach has the benefit of assisting to interpret and map archaeology over the vast survey area. Papers by Duckers[7], Curley *et al.* [8], and Lambers *et al.*[9] have reported on the 'efficiency' of different techniques for analysts, both expert and non-expert. The *BotP* web portal explicitly asks its citizen users which visualisation technique they have used for recognising a feature, so a large dataset will be created showing the preference for and effectiveness of the different visualisation techniques offered to them.

A citizen science approach also allows a route to unprecedented engagement with the public. Not only is this data type relatively restricted to expert users, but geographic information systems (GIS) are also generally restricted to professional users, by both licence fees and knowledge barriers to their use. We are presenting a simple, user-friendly, well-documented GIS system which allows engagement with audiences, many of whom will never have heard of LiDAR or GIS, and indeed many of whom may not otherwise have been interested in archaeology. It may also form a useful learning tool for archaeology or geography students, or professionals as CPD training.

A full range of activities beyond just the citizen science LiDAR transcription, including workshops, talks, activity days, and field-checking sessions, run across the AONB, opens access up to an even wider range of participants, with 1.6 million people living within 8 km of the AONB, and the more than 50 million visits the AONB attracts every year.[10]

Conclusion

Beacons of the Past is shedding light on the previously hidden landscapes of the Chiltern Hills. The challenges of both terrain extremes and sheer scale of datasets make the survey a perfect testing ground for a wide array of visualisation techniques and blended methodologies. Harnessing the power of Citizen Science will maximise both the number of features identified and provide an indication of the most reliable approaches for rapid identification and transcription of archaeological features from raster images.

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[7] *Ibid.*

[8] Curley, D., Flynn, J., & Barton, K. (2018). BOUNCING BEAMS REVEAL HIDDEN ARCHAEOLOGY. *Archaeology Ireland, 32*(2), 24-29. Retrieved from https://www.jstor.org/stable/26565779

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[10] https://www.chilternsaonb.org/conservation-board/management-plan.html (Accessed: 19 July 2019)