Citizen science and crowdsourcing

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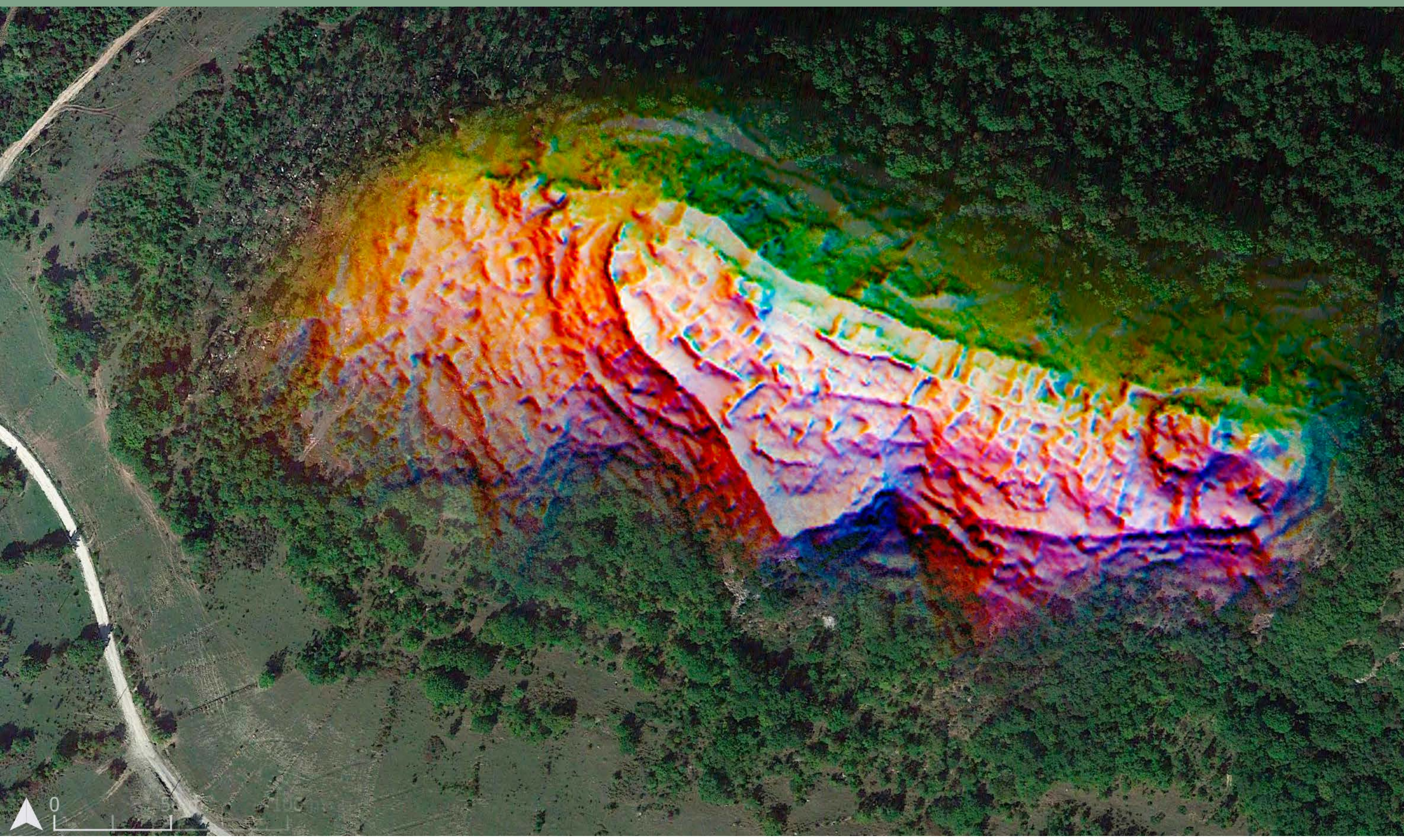
EAC GUIDELINES 10

GUIDELINES FOR THE USE OF AIRBORNE LASER SCANNING (LIDAR) IN ARCHAEOLOGY

Edited by Rebecca Bennett and Dave Cowley



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Archaeological surveyors stand beside the sign for Lidar church in Øystre Slidre municipality, Innlandet County, Norway. Image supplied by Innlandet County Council, Norway

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Cover: Transition between satellite imagery and LiDAR visualization (VAT combined), showing the pre-Roman and later Medieval hillfort of Santa Maria dei Vignali (Pescolanciano, Italy). Image by Giacomo Fontana for the Ancient Hillforts Survey, Texas Tech DARE Lab

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2.6 Citizen Science and Crowdsourcing

Karsten Lambers, Rebecca Bennett, Wouter Verschoof-van der Vaart

Citizen Science has different definitions (Vohland et al., 2021) but essentially refers to the involvement of avocational volunteers, or citizen researchers, in scientific research. Going beyond dissemination and outreach, citizen science aims at a close collaboration and participatory knowledge production between scientists and citizen researchers. Volunteer contributions can help to bypass professional bottlenecks in data collection (hence 'crowdsourcing', short for 'outsourcing to the crowd'). Citizen science projects can also benefit from the ideas, knowledge and skills of citizen researchers in project design, data analysis and interpretation, and dissemination and outreach, although not many projects reach that level of involvement yet.

In archaeology, citizen science can take on different forms (Gibb, 2019; Smith, 2014). An increasingly common application is the search for archaeological target features in remote sensing data (e.g. Duckers, 2013). ALS-derived digital elevation models (DEMS, i.e. the broad term that includes DTM, DFM and DSM) are particularly well suited for citizen science projects. For example when visualised as shaded relief models, DTM and DSM are intuitively readable with little or no prior training. ALS models also provide an unusual and engaging way for people to view a landscape and the sense of discovery and exploration provided by this new perspective is very attractive to participants.

While the quality of crowdsourced data from such projects has been debated (e.g.,Casana, 2020), suitable technical and project design can help ensure it has value (Bourgeois et al., 2024; Sims and Knight, 2021). However, the process of designing high quality, engaging and valuable citizen science research is complex. A number of aspects have to be taken into account in order to ensure that citizen researchers and heritage professionals alike benefit from a citizen science project:

- **Establishing the scope of the project:** The range of archaeological feature classes visible in ALS-generated DEMs is broad (section 2.4) comprising features on or close to the surface that leave traces in the microtopography (section 1.3). Neither more deeply buried features nor indirect traces such as vegetation or soil marks are usually visible. The character of features that are being sought and the way in which they are expressed in the data needs to be clearly explained to participants. Supporting heritage management professionals also need to understand from the outset the likely character of the outputs.
- **Data and visualisation:** For better visibility, certain target feature classes and/or terrain types require different visualisations of the ALS-derived DEM (see section 2.2) that might be less easy to interpret for citizen researchers than a shaded relief. This can be overcome by providing multiple visualisations side by side and enhanced training.
- **Comparative data:** It is important for citizen researchers to have access to additional information to assist interpretation. Google or Bing feeds provide easy access to contemporary aerial photography and are a minimum requirement to reduce false identifications. Ideally access to historic mapping and a simplified version of existing historic environment records should also be provided to enrich the user experience and reduce false identifications.
- **Defining the task:** Data interpretation is often time-consuming, repetitive and tedious. To keep citizen researchers engaged, prior consideration should be given to classes of archaeological target features that are easily recognizable. Features with recurring traits are best suited as targets. A careful delimitation of the study area can help to ensure a minimum number of instances. While such choices facilitate a learning effect (and also recognition of "objects of confusion" i.e. modern or natural features that may have the same form as archaeological ones), they may at the same time limit the research potential.

- **Grade of engagement and training:** Data collection needs to be regularised and standardised to ensure comparable output, which often requires training. Apart from such minimum requirements, citizen researchers should be free to choose their own level of engagement in order to facilitate a broad participation. This level may be determined by the invested time or by the level of training they are willing to take. Thus, simple tasks should be defined such that even a brief engagement generates useful data, while more time and/or training enables citizen researchers to engage in more complex tasks. The gradation and continuation of training and support has been shown to be key to volunteer researcher engagement and satisfaction.
- **Communication:** Citizen researchers should be well informed about the scientific purpose to which they are invited to contribute. The entire project needs to be clearly outlined, including steps that may not involve citizen researchers. Ideally, citizen researchers can interact with the scientists in easy and straightforward ways, to comment on their work and to contribute their own ideas, and they are kept informed about and engaged with the progress until the end. Increasingly it is seen as desirable to allow citizen researchers to fully connect with all aspects of the research design, data capture, evaluation and outputs of a project, but this requires commensurate resources and skill from the professional team.
- **Impact:** There should be adequate engagement of local/national heritage data managers in the project planning processes to ensure that digital outputs of the citizen scientists' work can contribute to publicly available cultural heritage datasets, ensuring long term accessibility and impact.

In the following we discuss recent examples of archaeological citizen science projects that used ALS data, focussing on applications, challenges and benefits.

Thinking about feature types

While a trained and experienced cultural heritage professional might be expected to record all features that are of potential importance from the ALS data, a more selective approach is needed for the successful integration of citizen science into mapping projects as not every archaeological feature type is suitable. Principally feature types for identification need to be:

- recognisable in the data (i.e. of appropriate size and scale in comparison to the resolution of the ALS)

and

- appear in a high enough quantity that the volunteers remain engaged. The quantity of a particular feature type also ensures that volunteers become familiar enough to detect potential features with increasing confidence and reject possible objects of confusion, e.g., roundabouts and round barrows.

Careful consideration should be given to establishing the framework of archaeological feature types that citizen scientists are being asked to identify so that by and large they meet these criteria of recognisability and quantity. For example, while Roman marching camps may have distinctive attributes in their most common form (such as complex entrances, parallel sides and rounded corners) that meet the recognisability criteria, if these features are very rare in the study area, (for example the Netherlands where only a handful are known) they fail to meet the quantity threshold required for a good feature type candidate for citizen science projects.

Heritage Quest, Netherlands

Heritage Quest (Erfgoed gezocht in Dutch) was a large-scale citizen science project in the central Netherlands collaboratively conducted 2019-2022 by Leiden University, Erfgoed Gelderland and Landschap Erfgoed Utrecht (Bourgeois et al., 2024; Lambers et al., 2019). Its goal was to map archaeological remains of frequently occurring feature classes in about 2100 km² of the hilly and forested terrain of the Veluwe (Gelderland) and the Utrechtse Heuvelrug (Utrecht). Earlier research had uncovered important prehistoric and medieval remains in these regions, but the extent of the study area and the good preservation under forest cover necessitated an upscaling of archaeological research well beyond previous efforts. Two parallel approaches were chosen: an automation project using computational methods (see section 2.5 and 4.5) and a citizen science project, both based on the same set of open ALS data (AHN2, see www.pdok.nl).

The citizen science project consisted of two parts, online and on-site. Considering the size of the task, the online project was designed to enable a broad international participation. The project team chose the Zooniverse (www.zooniverse.org) in order to reach the large community of citizen researchers active on that platform. Since most Zooniverse projects are not related to archaeology, the project team expected little prior knowledge and thus designed a low-threshold task. For the Veluwe three archaeological target classes were defined: prehistoric barrows, Celtic fields and early modern charcoal kilns (in Utrecht replaced by mediaeval cart tracks). These classes account for a large portion of the archaeological record of the region, are clearly visible in ALS-derived models and have easily recognisable, repetitive traits. On Zooniverse two visualisations of the ALS-derived DTM were provided: the more intuitive shaded relief and the more abstract, yet often clearer, simple local relief model (Figure 25).

After a brief introduction, the citizen researchers were asked to mark first any barrow that they saw, then any Celtic field, then any charcoal kiln (or cart track) in either visualisation before they moved on to the next image pair. The intuitive bilingual user interface was completed by a tutorial, information about the project, a forum, and contact details.

Thanks to the low threshold and the easy yet attractive task, over the course of five and a half months more than 6600 citizen researchers participated online and marked more than 315,000 instances of potential archaeological features across all target classes. The project team aggregated transcriptions where multiple

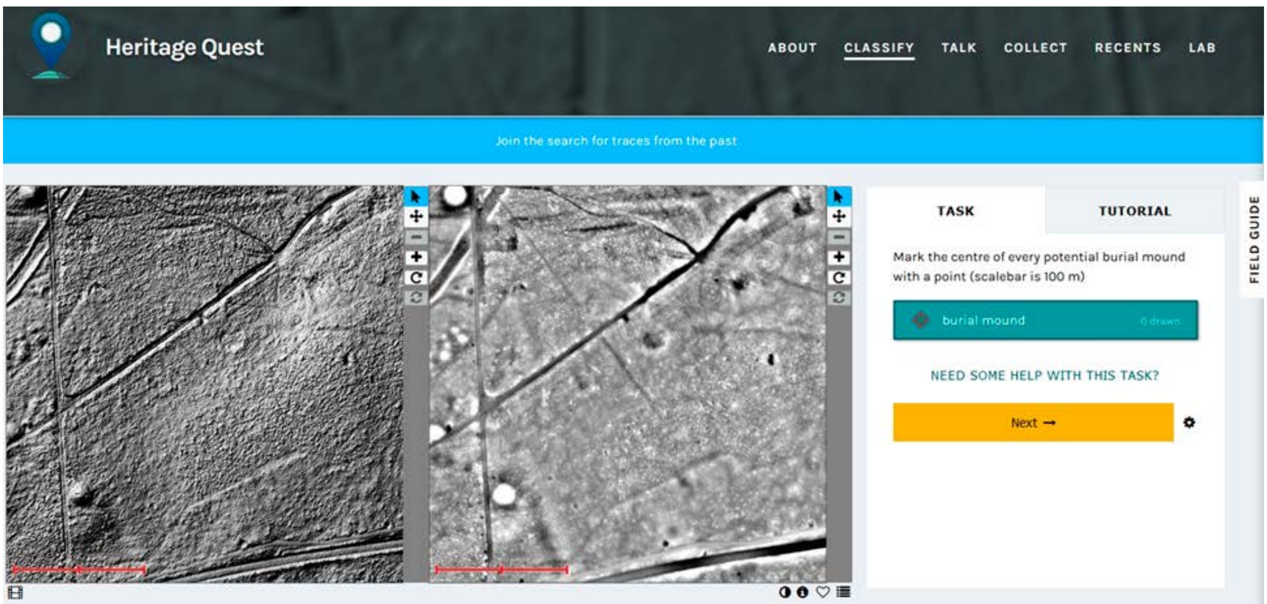

Figure 25: The Heritage Quest mapping interface on Zooniverse showing the two ALS-derived images with different visualizations and the current task (after Lambers, Verschoof-van der Vaart, and Bourgeois 2019)

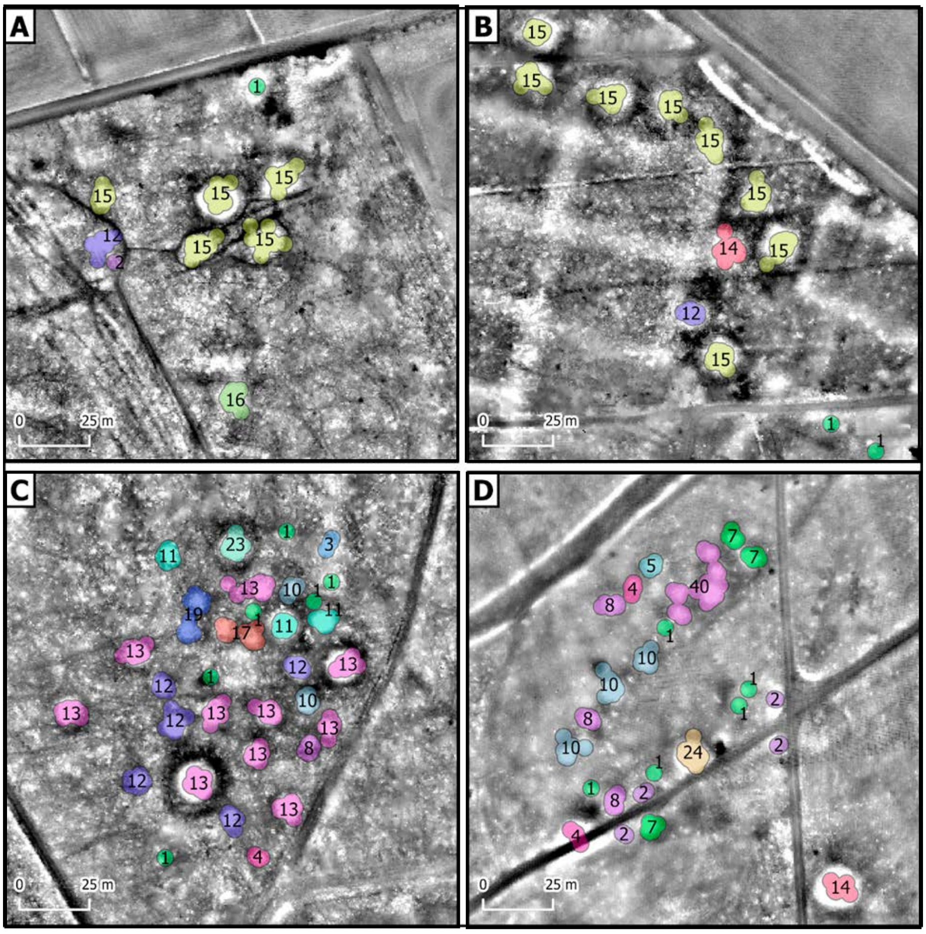

Figure 26: Various results from the aggregation of dense concentrations of potential barrows marked in the Heritage Quest project. The numbers refer to how many different users marked the same location (after Bourgeois et al., 2024)

markings referred to the same feature (Figure 26). The aggregated results were then evaluated in the second, on-site phase of the project. Over six weeks, the project team visited almost 450 potential barrows in the field with the help of local volunteers, many of whom had participated in the online project. Through field observation and coring, it was determined whether the marked spots were barrows or not. Since the field-checked barrows had been carefully selected to span the whole range from one-to-many markings, this gave us a reliable indication of the correlation between the number of online identifications and the probability of the marked feature being a barrow, which could then be extrapolated to the remaining barrows. Counting only barrows with a probability above 50%, the citizen science project more than doubled the number of barrows (918 known plus 1351 newly discovered), with similar numbers achieved for Celtic fields (14.2 km² plus 23.8 km²).

At the end of the project, the corresponding data were handed over to the responsible heritage authorities for further use, along with a metadata explaining their origin and nature.

Heritage Quest was designed as a low-threshold citizen science project that generated simple output. Yet, thanks to high participation and careful evaluation, the large amount of generated data could be turned into qualitative knowledge gain (Bourgeois et al., 2024). The correlation evidenced between the number of markings by citizen researchers and the actual presence of archaeological features is a good example of the 'wisdom of the crowd', and the citizen researchers made valuable contributions well beyond their assigned tasks. For example, their interest in World War Two remains prompted a follow-up project ("Scars of War") dedicated to mapping traces of modern conflict in the same set of ALS data (Verschoof-van der Vaart and Kaptijn, n.d.)

Community ALS Portals, UK

Over the last 10 years in the UK there has been a lot of interest in engaging local communities with the cultural and natural heritage of their landscapes, principally through partnership projects financed by the National Lottery Fund. Commissioned ALS surveys have often been a key tenet of the archaeological projects funded in this way, in order to broaden engagement with and understanding of the historic environment, often for areas with no existing ALS coverage. The tasks available and level of engagement of citizen scientists have varied between projects and have undoubtedly matured as these projects have progressed, had their outcomes evaluated and learnt from each other. This decade of community ALS project delivery is providing a wealth of collective knowledge that has rarely been featured in academic publications, due to the lack of formal participation of universities and academics in the community heritage sector. Consequently the evaluation and lessons learnt from these projects is not easily found in the public domain, for example being subsumed into the general project evaluation reports to funding organisations (Lees, 2017; Romain, 2017), and spread of best practice relying on professional networks and word of mouth (Sims and Knight, 2021). Consequently, a strong recommendation for any project considering a citizen science element would be to seek out professionals from a range of such projects for advice and support at an early stage.

Projects in the south of England provide examples of how the practice of citizen science ALS projects has evolved over recent years. Most of the earliest UK projects integrated volunteers in a traditional role of ground observations to augment the records of features identified by professional specialists, such as the “Secrets of the High Woods” project based in the South Downs National Park (Figure 27). The value of the local knowledge and broad expertise of citizen researchers was recognised early in the fieldwork phases, allowing feedback to the professional team who were concurrently transcribing further areas of the 325 km^2 ALS coverage (Carpenter et al., 2016).

Subsequent projects, including the Kent Lidar Portal and Cranborne Chase Lidar Portal have sought to include citizen scientists in data assessment as well, using an online interactive webmap to facilitate transcriptions. The webmap presents a variety of ALS visualisations (multidirection hillshades of the DTM and DSM and a local relief model of the DTM), alongside historic maps, aerial photographs, and historic environment records. In contrast to the Heritage Quest project, the aim of the portals is to facilitate the recording of a wide range of potential archaeological features visible in the ALS-derived visualisations, though the categories of features are prescribed by drop-down lists to make data recording swifter and more consistent. A team of professionals and trained volunteers undertake the quality assessment of the feature transcriptions and give ongoing feedback and support to the volunteer community.

Figure 27: Volunteers with tablets adding field observations to features identified from the ALS-derived visualisations © South Downs National Park Authority / Anne Purkiss

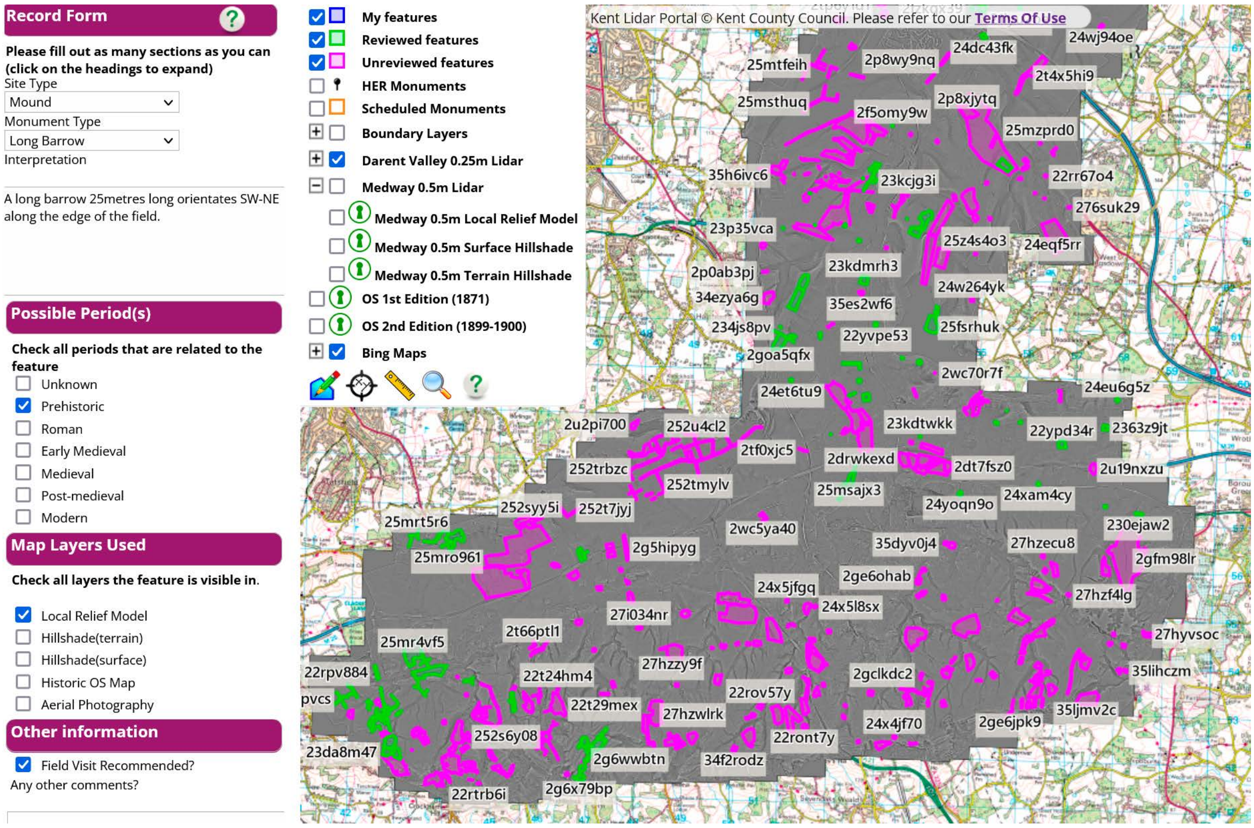

Figure 28: Interactive mapping interface for Kent Lidar Portal showing feature data form and range of comparative data including modern and historic maps and aerial photographs. Features are coloured by review status

To facilitate data management and review to professional heritage standards, portals have been designed using open-source Historic Environment Records Open System software (Figure 28). This allows for the easy use of linked vocabulary and standardised geospatial and data formats, facilitating import and export from and to regional historic environment records (HERs). The latter helps to ensure the legacy of the citizen scientists' work by directly contributing to the official record of the historic environment, ensuring access to the data for future research and supporting its protection via the planning process. Key to the success of data structure and transfer to the HERs has been the inclusion of regional curators at the planning stage to formulate and review the suggested data schema, particularly the monument typologies.

The Kent and Cranborne Chase projects are ongoing at the time of writing (2024) so full reporting and evaluation has yet to be completed. However, interim evaluation suggests that the portals have been very successful both in the engagement, training and enjoyment of volunteers and in the contributions of previously unknown features to the archaeological record. The outcomes have also underpinned field survey and excavation work involving volunteers, contributing to an improved understanding of the landscape by both local people and professionals.

In conclusion, citizen science has the potential to mobilise substantial numbers of volunteers who contribute a broad range of interests, skills and knowledge and bring a lot of time and dedication to the archaeological analysis of ALS data. Just like automation (section 2.5), this can lead to an enriched understanding (in quantitative and qualitative terms) of the archaeology of even well studied landscapes, and also to higher levels of engagement of citizens with their heritage. It is important to underline two key aspects of successful citizen science projects: 1) a high level of engagement on the part of the involved researchers and heritage managers and; 2) a careful project design appropriate for the task at hand. As the examples above show, there is not a standard approach but rather many different ways of doing citizen science. Archaeology and heritage management have only begun to realise the full potential of citizen science, and the archaeological analysis of ALS data is a particularly promising application.