

5.7 Thinking topographically about the landscape around Besançon (Doubs, France)

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ABSTRACT

This paper focuses on the use of LiDAR (Light Detection and Ranging) data for the study of rural landscapes in the context of regional archaeological analyses. In particular, we concentrate on using LiDAR to highlight the importance of activities other than habitation, as well as the use of areas outside the modern ploughzone. It has frequently been said that one of the major challenges to archaeological landscape survey is the incorporation of uplands, marshes, forests and other areas we term ‘outside the ploughzone’. Such areas are normally surveyed primarily through fieldwalking, but we suggest that LiDAR may make a significant contribution, although there are serious practical and methodological problems to overcome. Further, we argue that including these areas will alter the overall picture of rural landscapes in unexpected ways. The potential and challenges of integrating these areas and activities into landscape and regional scale research are sketched in this paper. We use a recent LiDAR survey as a case study to explore these issues. The project was funded by the Regional Council of the Franche-Comté for the LIEPPEC project, led by the USR 3124 and LEA ModelTER, and is based in the hinterland of Besançon, Doubs, France.

The area surrounding Besançon is now largely forested, resulting in a dependence on the interpretation of the LiDAR model to guide field prospection. This paper provides some early results from the Forêt de Chailluz, north of Besançon; we use LiDAR to refocus the picture from one dominated by questions of settlement, settlement patterns and agriculture to one incorporating questions about complex networks of sites and activities, distributed across a wider range of landscape contexts. Using these initial results, we reflect on how LiDAR survey fits into the dynamic area of survey, landscape and regional archaeology.

KEYWORDS

LiDAR, survey, regional perspectives, remote sensing, rural landscapes

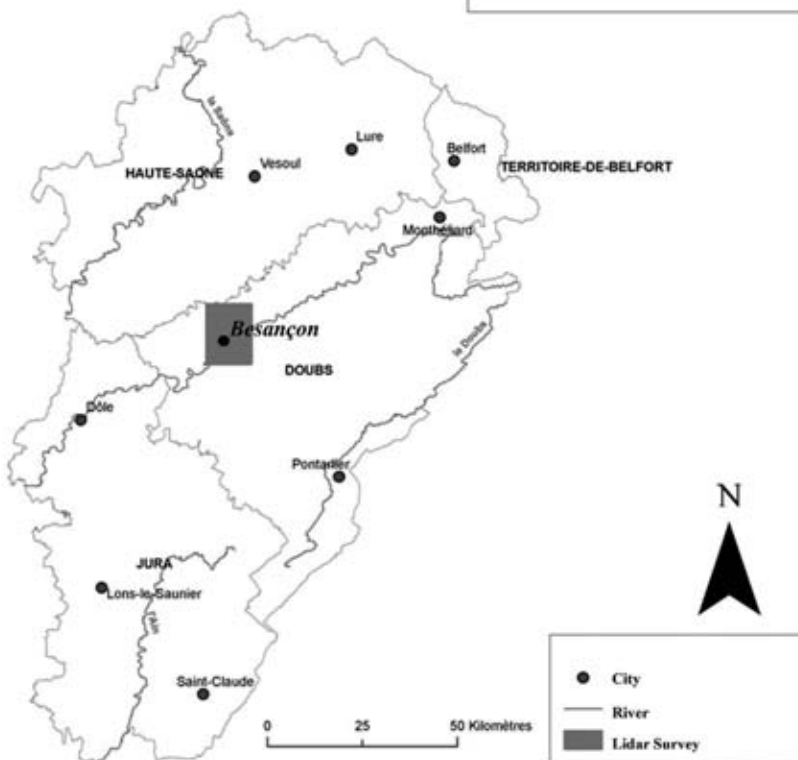
INTRODUCTION: LIDAR SURVEY IN REGIONAL AND LANDSCAPE RESEARCH

The archaeological study of local and regional long-term landscape change can be approached from many perspectives. Survey Archaeology, Regional Analysis and Landscape Archaeology are three major, inter-dependent approaches to this subject, employed to study how people exploited and experienced their surroundings, addressing questions including: How did natural and social resources and contexts influence the creation and development of settlement? Conversely, how did past societies manage and develop their surroundings to reshape the landscape? How are the cumulative results of these actions reflected in the modern landscape?

Based on a case study at Besançon (Doubs, France) (fig.1), for which we present some preliminary results, this paper attempts to illustrate some ways in which LiDAR survey can be used to address these questions. We open by situating our research in the context of fieldwalking and aerial survey archaeology,



Figure 1. The location of the Besançon LiDAR survey. Image: R. Opitz, Lieppeç / MSHE C.N. Ledoux



and Landscape and Regional Studies. We then focus on evidence, identified through the LiDAR survey, from the modern Forêt de Chailluz. This evidence provides new information on the development of the local rural economy, the organisation of the landscape, and the shifting boundaries of the forest. Based on these results, we discuss key methodological points on the use of LiDAR survey in micro-regional contexts, and note other areas where LiDAR can contribute.

RESEARCH CONTEXT

Many recent projects combine 'a landscape approach with traditional spatial and temporal systematics, to incorporate the dynamic scale of landscape analysis with the fine-scaled spatial and temporal analysis of patterns characteristic of traditional archaeological practice,' (Anschuetz et al. 2001, 191-192; Kantner 2008 for an overview) in producing regional studies. Within this framework, it is possible to ask a wide variety of questions. Regardless of the specific questions at hand, the biases of fieldwalking surveys and aerial photographic surveys will strongly influence the conclusions reached, because the vast majority of our systematically collected data on the settlement and, more broadly, on the organisation of the rural world comes from these surveys. The result is that many projects focus on patterns of habitation and agriculture, the two activities most often represented in survey data. In contrast, small features representing other, complementary aspects of the economy (e.g. surface mines, limekilns, charcoal platforms, and small quarries) are often under-represented. Far from a lack of interest in activities beyond settlement and the agriculture at the micro-regional and regional scale, the problem is the lack of data. Features and sites representing activities other than settlement and agriculture, although included in thematic studies and interpretations, are not identified in large enough quantities to be used in the type of formal spatial analysis widely employed in micro-regional and regional survey analyses. The bulk of the data describes settlements, while some local and larger studies include agriculture by incorporating information on field systems in addition to data on settlements (e.g. Favory 1988; Boyer et al. 2003) and off-site records such as ceramic scatters linked to agricultural practices, most commonly manuring (e.g. Wilkinson 1994, 2004; Nuninger 2003; Bintliff et al. 2007; Poirier et al. 2008; Bertonecello & Nuninger 2010). It is unusual to find a study which integrates all the structures which represent the many activities found in the rural landscape.

Secondly, systematic fieldwalking surveys usually try to sample across all landscape zones, but the majority of the data produced is concentrated in the modern agricultural landscape, where archaeological visibility is good (fig.2) but which represents only a small subset of past landscape zones. While aerial photography is effective in a broader range of landscape areas, its capabilities are significantly diminished in forests. This is particularly problematic for regions like the Franche-Comté in France where 45% of the surface is wooded, or Tuscany in Italy and Karst in Slovenia, where upwards of 60% of the area is under forest. Researchers have developed specific methodologies for uplands (e.g. Walsh & Richer 2006; Walsh et al. 2009; Riera et al. 2010 for examples), for wooded and scrub areas (e.g. Bommeljé & Doorn 1987; Doyen et al. 2004; Dupouey et al. 2007; Pautrat 2003), and at the other extreme for undersea areas (Gaffney et al. 2007). While the amount of research on 'marginal' parts of the landscape has greatly increased, projects focused on the ploughzone and different 'marginal' parts of the landscape are usually conducted separately and the two are not always well integrated.

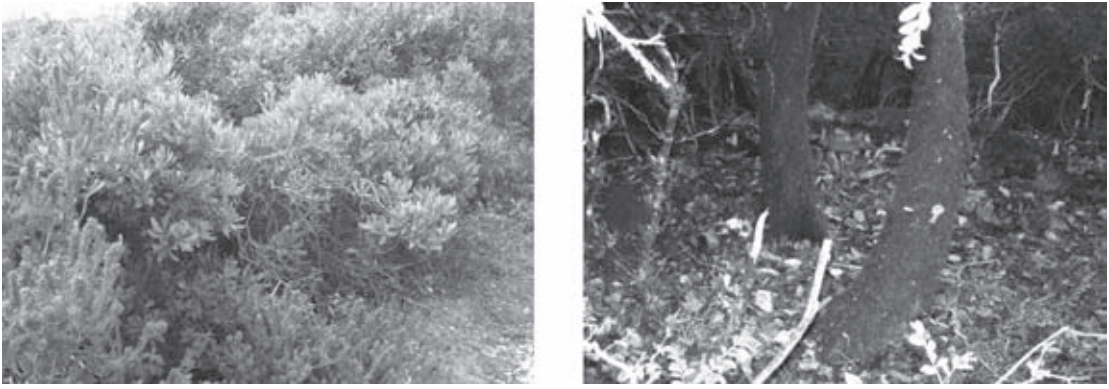


Figure 2. Dense vegetation in both Mediterranean (left) and Continental (right) European landscapes poses serious problems for fieldwalkers wishing to survey outside the ploughzone.
Image: R. Opitz, P. Mosca Lieppec / MSHE C.N. Ledoux

The problematic implications of the lack of synthetic work incorporating both lowlands and uplands and other marginal zones have been noted many times (e.g. Cambi 2000; Bintliff & Kuna 2000; Bintliff 1994 and critically reiterated by R. Benton in his review of the *Populus* series; Benton 2001, 628-629). This disjunction calls for techniques that can be used to produce data on a large scale, analogous to those created through systematic fieldwalking, and so improve the integration of 'other' landscape areas – outside the ploughzone – into survey and subsequently regional analyses, while (ideally) opening up avenues for thinking more broadly about interactions between people and place and landscape beyond a collection of sites in an environmental background.

LiDAR (also known as light detection and ranging or airborne laser scanning) is a relatively new survey tool, increasingly used by archaeologists since 2004 (Sittler 2004). LiDAR is a technology that produces accurate and dense topographic data, similar to that recorded with a GPS or total station, by scanning the surface of any object with a laser and recording aspects of the returned waveform. LiDAR survey creates a very accurate and detailed model of the terrain in all unbuilt areas, including those obscured by forest or scrub, because some laser pulses will penetrate the vegetation canopy. It is particularly effective in areas outside the modern agricultural landscape, including uplands and other so-called marginal zones, because topographic remains are generally well preserved in these areas outside the ploughzone. LiDAR can be used for detailed planning of monumental remains or individual sites (e.g. Devereux et al. 2005; Corns & Shaw 2009), but it also can be used to systematically identify and characterise many small sites and features across the landscape. In this way it can vastly increase the amount of data we have on past human activities in the rural milieu (e.g. Sittler et al. 2007; Crutchley 2009).

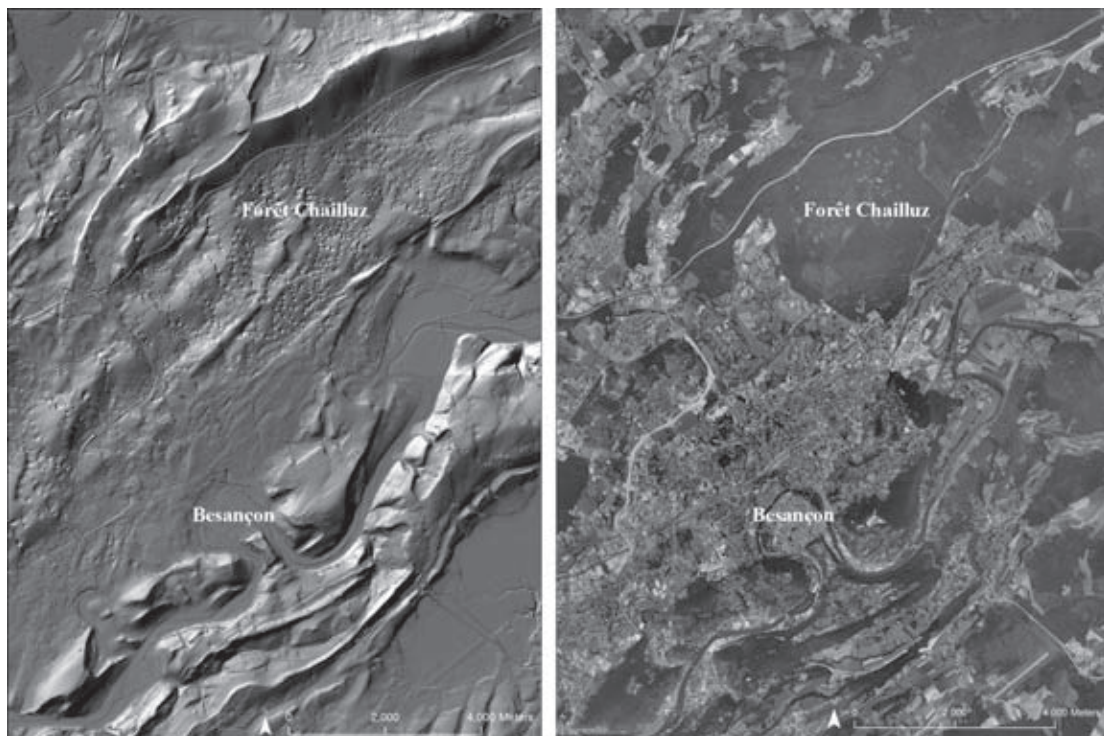
We suggest that LiDAR can play a role, alongside fieldwalking data, in bringing these 'marginal' landscape areas more fully into the regional picture. At the same time, the continuous nature and detailed characterisation of the physical form of the terrain provide multiple avenues for getting off-site and exploring the physicality and experience of places. These applications are illustrated using examples from an ongoing study of the area around Besançon.

MODERN LAND USE AND RESEARCH HISTORY AT BESANÇON

The area surrounding the town of Besançon (Roman *Vesontio*) in eastern France (fig.3) is a heavily wooded karstic landscape, dominated by a large forest to the north of the town and a marsh and further woodland to the south. Besançon has been an urban centre since the first Iron Age and, after becoming *Vesontio* in the Roman period, continued as a regional centre, remaining an important town throughout the Late Antique, Medieval and Modern periods.

The city of Besançon itself is well studied, thanks to extensive rescue excavations. In contrast, little is known about the archaeology of the surrounding area. A LiDAR survey commissioned in April 2009 has revealed the remains of previously unknown buildings, almost 200 limekilns, more than 2,000 charcoal burning platforms, dozens of quarries of various types and networks of field boundaries in the

Figure 3. (left) The hillshaded bare earth DTM of the study area. (right) Air Photo mosaic of the study area. The LiDAR survey for Besançon covers an area of 140 km² and includes the Marais Saône to the south and the Forêt de Chailluz to the north of the urban centre. The discrete return LiDAR data was collected at a nominal resolution of 0.5m (8pts/m²), with up to 4 returns per pulse. The data was initially processed by the providers (AeroData France), and reclassified by the authors using Terrascan and Terramodeler to generate improved bare earth models. Multiple hillshades were produced for visual inspection, in parallel with visualisation of the point clouds for individual areas. Image: R. Opitz, L. Nuninger, Lieppe / MSHE C.N. Ledoux



woods. These sites and features now represent the majority of archaeological information about the local rural area. The LiDAR survey is the basis for an ongoing campaign of fieldwork, concentrated on the Forêt de Chailluz and its adjacent pastures and meadows. The importance of the LiDAR dataset in this study area forces us to think seriously about the potential role of topographic data, the physical forms of past landscape elements encapsulated in the modern landscape, and the relationship between LiDAR and field survey.

It is widely agreed that one of the advantages of remote sensing survey, including LiDAR, is its rapidity compared to any other form of extensive survey. A further advantage is the significant increase in the number of features recorded in the area studied: often by as much as 50% outside areas heavily degraded by modern land use (Nuninger et al. 2008). However, systematic surface survey is needed to confirm and correct the interpretation of the LiDAR data and to provide chronological evidence (e.g. Risbol et al. 2006; Georges-Leroy et al. 2008a, b). The following sections present some initial results for part of the Forêt de Chailluz and outline two of the main challenges in the interpretation of combined LiDAR and surface surveys.

OUTSIDE THE PLOUGHZONE: EXAMPLES FROM THE BESANÇON SURVEY

Field clearance in the Forêt de Chailluz

The Forêt de Chailluz is 1,673 ha in its present-day extent. Systematic inspection of the LiDAR data shows that evidence of clearance and the establishment of field systems is concentrated in a 400 ha area in its northwest corner (fig.4). While this area is well within the modern and medieval forest and is now very much outside the ploughzone, it probably once formed part of the agricultural landscape. Through study-

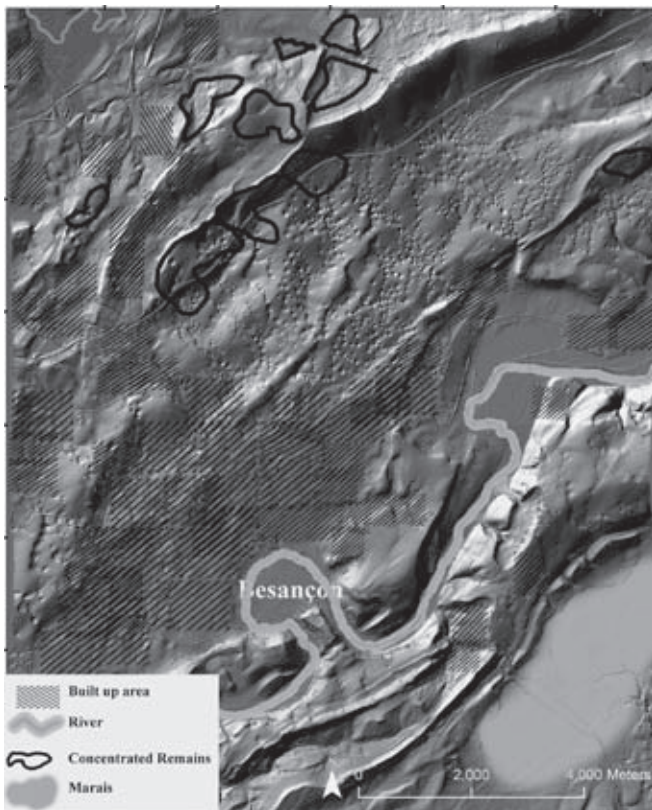
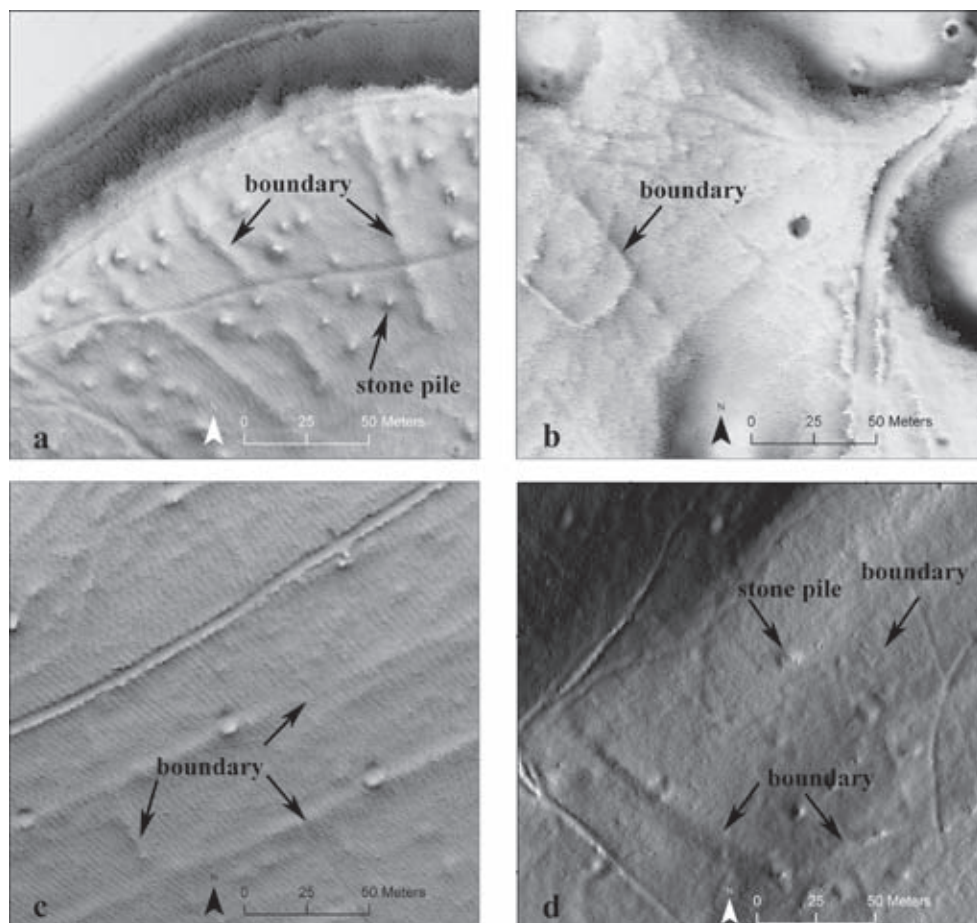


Figure 4. Areas with concentrations of stone piles and the remains of stone, rock-cut, or ditch and mound field boundaries in the forest are outlined in red. Almost a quarter of the modern forest contains evidence of organised field systems predating the current, and long established, system of parcels. Image: R. Opitz, C. Fruchart, Lieppec / MSHE C.N. Ledoux. See also the full colour section in this book

Figure 5. Traces of at least three field systems have been identified in the north-west part of the Forêt de Chailluz. (a) Field system characterised by broad linear boundaries and recut bedrock. (b) Field system characterised by narrow stone and earth mounds and small fields. (c) Field system characterised by long narrow fields. (d) Stone piles typical of those appearing throughout the field systems. Image: R. Opitz, C. Fruchart, Lieppe / MSHE C.N. Ledoux



ing the evidence for clearance, we pursue a more detailed understanding of the changing character and shifting boundaries of the forest.

The LiDAR model reveals evidence for several phases of activity in the north-west area, including at least three separate field systems (fig.5). One extensive field system is characterised by a combination of broad, linear concentrations of regular width formed by seemingly unworked or heavily eroded stones and natural topographic features, possibly recut for emphasis, to define individual fields. A second distinct system has smaller, discontinuous fields bounded by narrow, linear earth and stone mounds. A third has a regular grid of long, narrow fields. Stone piles of various constructions, sizes and distributions appear throughout the field systems, and occasionally outside of them. This diversity suggests several distinct phases of activity, and clearance for different purposes. Field boundaries and stone piles are much less common in the rest of the forest, except for one small area close to the village of Brailans, which probably corresponds to activity surrounding that village. The absence of features representing clearance in the central part of the forest suggests that this area remained wooded.

Outside the forest within a mixed meadow and woodland area, known as L'Ermitage, we find a fossilised system of small fields, with further underlying linear field boundaries. The same pattern of small fields and occasional underlying linear boundaries can be found in the recently forested Les Vallieres, nearby. At this point any link between these areas and the remains in the Forêt de Chailluz is uncertain.

However, the possibility that the underlying linear boundaries are related to the broad linear field boundaries seen in the Forêt de Chailluz, and that they cross the border of the modern forest, is suggested based on their size and alignment. The marked difference in their appearances can be explained by the differences in later land use and preservation conditions inside and outside the forest. Studying these field systems through the LiDAR survey presents remains inside and outside the forest together in a single dataset, highlighting possible links and alignments across land use zones.

Habitation in the forêt de chailluz

Within the north-west area, the LiDAR survey has also revealed the remains of a collection of buildings, paths, associated enclosures and other features, shown in Figure 6. Concentrations of stone mounds in this area, if they belong to the same phase as the buildings, may represent either burial monuments or field clearance. These features, originally identified in the LiDAR model, were further characterised on the basis of fieldwalking evidence and are interpreted as delimiting buildings and enclosures. Identifications of the buildings were made on the basis of findings of numerous nails and metal objects, small quantities of ceramics retrieved through test pitting, and areas of rich dark earth, distinct from the typical clay soils in this area.

The chronology of these buildings and enclosures has not yet been established, and will likely require excavation and scientific dating. Based on the present evidence we can draw a few preliminary conclusions. This group of structures is cut by the pre-17th-century Chatillon-Besançon border trench (fig. 7). Further, these buildings and enclosures can be supposed to pre-date the 14th century as they are not mentioned in historical texts or maps, which provide fairly detailed records from the middle of the 14th century. The metal-detected and surface ceramic finds within these features suggest activity here in the late La Tene or Gallo-Roman period. Many of the lime kilns in this area cut the field boundaries and enclosures, and are probably later. These features are probably prior to the 17th century, as from that period the area was reserved for the supply of wood for buildings, as attested by archival evidence and a mid-18th-century map.

Figure 6. The buildings and enclosures shown here appear to belong to a separate phase than the extensive field system characterised by broad linear mounds. Surface and metal detecting finds suggest a late La Tene or Gallo-Roman date for these features. The main enclosures are indicated by arrows. *Image: R. Opitz, Lieppec / MSHE C.N. Ledoux*

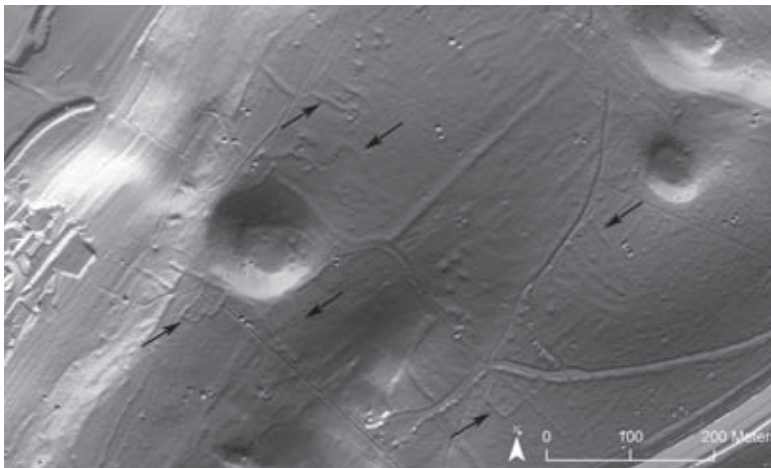


Figure 7. A limekiln (a) cuts a field boundary (b) which in turn cuts the remains of a building (c) in Bois de la Lave, in the northwest part of the Forêt de Chailluz.

This type of series of features can be used to establish relative dates. *Image: R. Opitz, C. Fruchart, Lieppec / MSHE C.N. Ledoux*

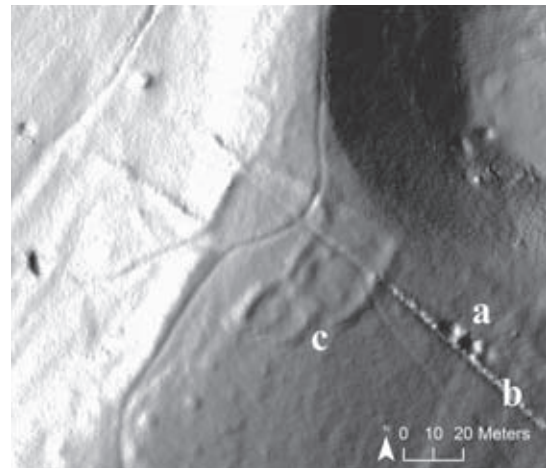
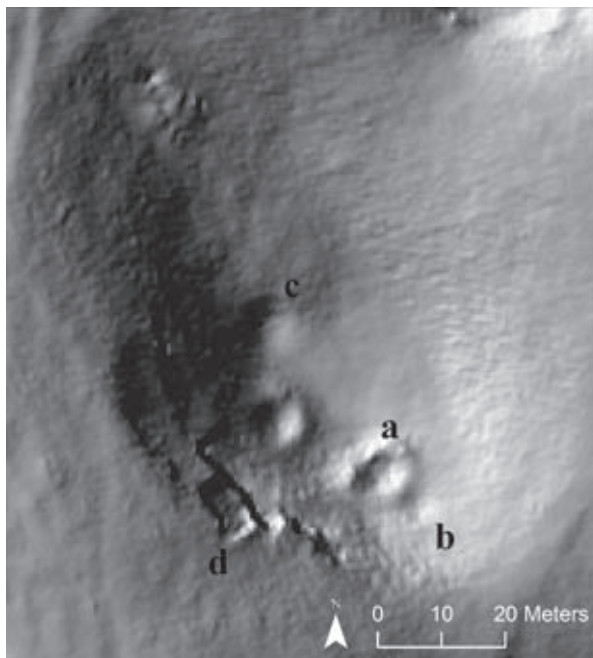


Figure 8. The 'feature set' of limekiln, quarry, claypit and charcoal burning platform, grouped together inside a doline, occurs frequently in the Forêt de Chailluz. a: limekiln; b: claypit; c: charcoal burning platform; d: quarry. *Image: R. Opitz, C. Fruchart, Lieppeç / MSHE C.N. Ledoux. See also the full colour section in this book*



The possible presence of settlement in this area during the late La Tene or Gallo-Roman period, indicating the forest had been cleared (or not yet developed) at this time, would fit well with larger regional trends. This group of buildings can be compared with two other groups of small buildings from the local area, one excavated during the construction of the LGV (the new high-speed railway line) (Goy 2009) and dating to the Gallo-Roman period and the other with extensive Gallo-Roman surface finds, interpreted as a sanctuary or temple. The sites are located respectively 3.5 and 1.5 km further north along the road leaving Besançon for the north-west. Taken together, these sites begin to form a picture of suburban residences and religious sites along the main road outside an important town.

Focus on special purpose sites: limekilns, small quarries, clay pits and charcoal burning platforms

In addition to the buildings and field systems described above, that seem to indicate settlement and agricultural or pastoral activity within what is now forest, the LiDAR survey provides evidence for other economic activities which are likely to have been carried out in or near a forested environment. Notably, a large number of limekilns, quarries, charcoal burning platforms and claypits have been recorded. These features seem to broadly follow two organisational schemes. In one, a single feature of each type appears, creating a set of features that would allow the complete process of lime production to take place in a single locale. This 'feature set' arrangement is frequently found inside dolines, the broad natural basins typical of karstic terrain and found throughout the forest (fig. 8). In this process we can suppose that stone is cut from the side of the doline and broken into small pieces. The kiln is constructed, partly dug into the sloping ground. Clay to cover the layers of burning stone is dug just opposite the kiln, creating a depression which may also be used to store water. A space is cleared and levelled and wood is burned to create charcoal as a parallel activity, or to fuel the kiln.

While there is a remarkable concentration of 'feature sets' in the Bois de la Lave in the north-west part of the Chailluz forest and another concentration in its centre, there does not appear to be any internal organisation of the groups of features. Based on their shape and small size (4-5m), the kilns were probably built for one-time use, individual-scale production. This differs from what has been observed in Forêt de Haye (Lorraine, France) or in Karst (Slovenia), where bigger kilns with a different shape were more likely dedicated to production for the whole community (personal communication with M. Leroy, A. Marsetic). The dense concentration of kilns suggests the sporadic or continuous use of this area for lime production, possibly over a long period. The unorganised yet concentrated character of the distribution may point to a combination of collective rules or practices and individual actions.

The clearly organised pattern of many of the charcoal platforms, and their distinctive half-cut half-built construction, using semi-circular dry-stone walls used to create small terraces on the hillslope, indicates a strong collective framework which organised production, possibly linked to the management of the forest. The regularity of the structures and their distribution suggests a short period for this activity, and may point to regional production (see Beyrie et al. 2003 for a metallurgy example), rather than purely local industry. Further archival and field research is needed to provide confirmation for these interpretations.

The limekilns and charcoal platforms represent a substantial effort invested in non-agricultural production over an extended period or several discrete periods. The forest, which could easily remain largely blank on a survey-based map, is shown through the LiDAR survey to be an important production zone. This example illustrates that activities in the forest need to be understood to create a complete picture of the rural economy around Besançon.

CHALLENGES IN INTEGRATION AND INTERPRETATION

Systematic fieldwalking surveys have had a major impact on how we study the rural world (For an overview, see Ammerman 1981; Cherry 1983, 2003; Banning 2002; Athanassopoulos & Wandsnider 2004.) To analyse and interpret the findings from LiDAR surveys in the context of broader research on landscape change or regional development, they must be integrated with fieldwalking survey data. Perhaps a useful analogy for how this might be accomplished is the integration of off-site material within archaeological surveys and regional studies. Like records of manuring scatters, LiDAR survey provides data for areas that were previously empty and for non-habitation aspects of past landscapes. One way of integrating the two at the analytical level is the treatment of the different types of evidence as related distributions (e.g. Bertoncello & Nuninger 2010; Poirier et al. 2008), or the evidence could be combined during the final interpretation. However, there are two basic problems specific to the integration of LiDAR survey: first, the absence of good chronological information for many features detected through the LiDAR survey and second, the lack of overlap between LiDAR and fieldwalking survey distributions.

Chronologically-challenged features

While the data from the LiDAR survey permits the study of the overall intensity of the use of 'marginal' areas for various activities, a detailed chronology must be established for these features to truly integrate the results of LiDAR and fieldwalking surveys. While it is possible to study in some detail the purpose of

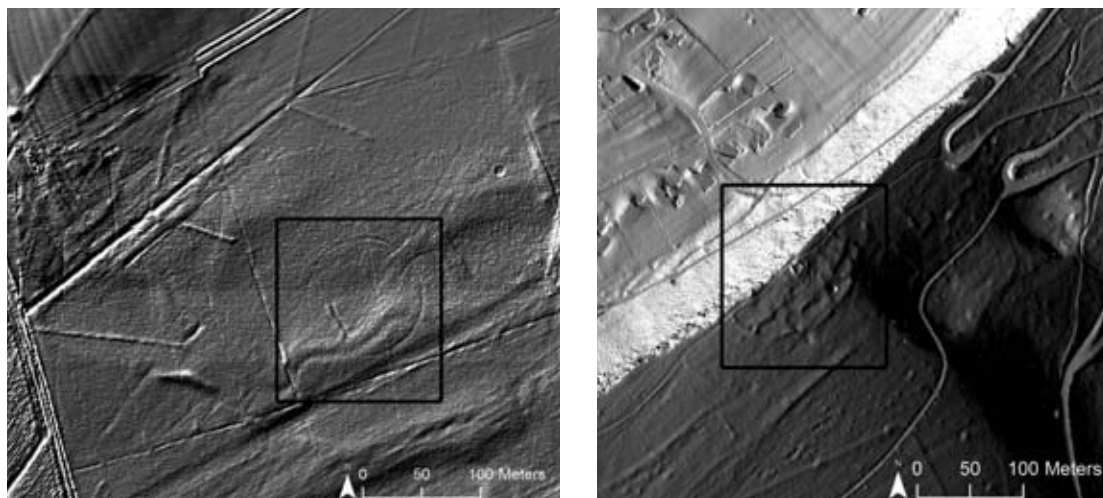
these features, based on close observation of their forms and comparison with excavated or otherwise well known examples, LiDAR models have a somewhat difficult relationship with chronology. As with any remote sensing or cartographic method, we can build relative chronologies based on the superposition of features, such as the lime kiln cut into a field boundary which in turn cuts the remains of a building, shown in Figure 7. The current fieldwork campaign combines surface prospection, GPS mapping, metal detection and test pitting, targeting locations where features have been identified in the LiDAR model. Experience shows that most features have few or no reliably datable surface ceramic or metal remains, so to obtain absolute dates further test trenching or coring and absolute dating are needed. An exploratory project has been established to date several lime kilns, using C14, in order to estimate a *terminus post quem* for the otherwise difficult to date structures cut by the kilns.

Despite difficulties in establishing a strong chronology for individual features in the Forêt de Chailuz, it has been possible to identify some broad trends based on spatial distributions, overlaps and relative positioning. For now, based on the relative chronology established by superimposed features and the limited dating evidence available, this local landscape can be studied within the overall picture, analysing relationships (proximity, accessibility, purpose) of features to the antique and medieval agglomerations, the existing road networks and religious landscapes. However, to integrate features found through LiDAR into phase-by-phase distributions widely used to interpret survey data at the micro-regional and regional scales, dates for individual features must be established.

Mutually exclusive distributions

We have noted that LiDAR data is almost inversely biased to fieldwalking data – it performs best outside the ploughzone (fig. 9). At the same time, LiDAR survey reveals a very different collection of features from those usually produced by fieldwalking survey; many lime kilns, quarries for stone and lime, charcoal burning platforms, field boundaries, drainage ditches and terraces (fig. 10) have been found.

Figure 9. Earthworks in the ploughzone (left), while still visible, have been substantially flattened and details of the feature are not clear. Contrast this with the details visible in the well preserved remains in the forest (right). Image: R. Opitz, Lieppe / MSHE C.N. Ledoux



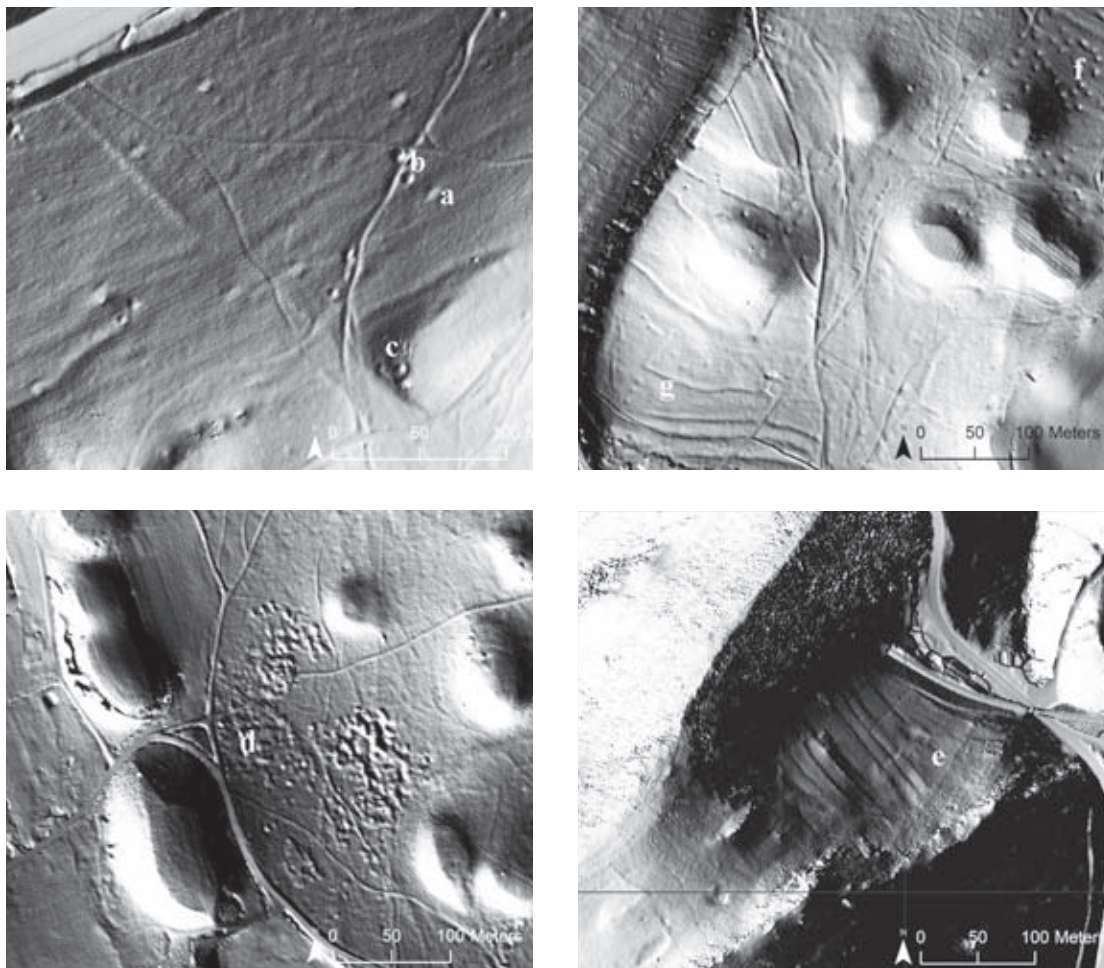


Figure 10. Examples of the appearance of common types of features identified through the LiDAR survey. None of these feature classes are common in survey datasets based on fieldwalking. This poses certain complications in terms of integration and comparison. a: charcoal burning platform, b: limekiln; c: limestone quarry; d: gypsum or slate quarry; e: viniculture terraces; f: field clearance cairns; g: field boundary. Image: R. Opitz, Lieppeg / MSHE C.N. Ledoux.

The identification of a wide variety of feature types recalls a point raised by Alcock and Rempel (2006): How does (and perhaps more importantly, how should) survey archaeology deal with sites and features that do not fall nicely into a settlement-centric classification – the ‘special-purpose sites’ and practices other than habitation – the Laconia Survey’s (Cavanagh et al. 2002) ‘other forms of human activity’? In their case there are not enough of these sites to develop strong spatial or chronological trends, but their presence undeniably adds texture to the landscape and they provide an impetus for thinking beyond spacio-chronological trends. They conclude that work on these sites, the ‘wells, threshing floors, burial mounds, kilns, bridges, mills, knapping debris, drainage ditches, pathways, caves, quarries, terraces,

shrines and dumps,' (Alcock & Rempel 2006, 42) is both worthwhile and necessary as, 'without the nuance they provide, the questions we can ask of our regional data become unnecessarily limited, reverting largely to the purely economic, the demographic, the functional,' (Alcock & Rempel 2006, 42).

The preliminary results of the Besançon survey show that LiDAR effectively resolves the problem of not having enough data on some types of special-purpose sites. Rapid detection provides an abundance of evidence, allowing us to consider the distribution of these features on the micro-regional scale. The result is a more nuanced understanding of the use of the landscape and of micro-regional development. In future work, there is the potential to include these features in spatial analyses, for example estimating the overall intensity of the use of marginal zones (as illustrated in Georges-Leroy et al. 2008b; Poirier et al. 2008).

In spite of the difficulties of integration, the development of survey-style distributions of sites and features outside the ploughzone will have a significant, enriching impact on our knowledge and understanding of the rural world as a whole. Beyond adding many new sites and features to the record and populating previously empty landscape zones, the LiDAR model can be used to explore and strengthen links between feature, site, distribution and landscape by taking advantage of the spatial continuity of the data to work across multiple scales, an approach we introduce in the next section.

MEASURED AND EXPERIENCED SCALES

A tension exists between theoretical conceptualisations of scale and the treatment of scale within GIS-based spatial analyses (Gaffney & Gaffney 2006; Lock 2009; Kvamme 1999). GIS tend to be used, perhaps because of their database quality, to work on large-scale trends and patterns, such as site distributions and the changing impact of geology or slope as seen over large areas (e.g. Ebert et al. 1996; Allen et al. 1990; Boos et al. 2007). On the other hand, the lived or experienced scale (as conceived in the phenomenological sense, e.g. Tilley 1994; David & Thomas 2008; Ashmore & Knapp 1999) at which people encounter the landscape is of great interest to those invested in individual behaviours, and should not be neglected. Bringing the two together, being multiscale, is easier said than done. To explore how very high resolution topographic models derived from LiDAR might contribute to modelling this relationship we return to the example of lime production.

People working at lime burning sometimes took advantage of the sides of the dolines, treating them as open-faced quarries for easy stone extraction, siting the kiln conveniently in the base of the doline. The location in the landscape for any particular kiln may, on the larger scale, have been chosen to be close to a number of other kilns. Following this decision this kiln becomes part of the process of the creation of a cluster, making the area more attractive for future lime production. It is both the result of and a participant in the process of creating the final pattern. The landscape becomes characterised in part by the sites it attracted.

On another scale, being inside the doline simultaneously takes advantage of and reshapes the natural physical form of the depression. The quarrying, as it provides stone for the kiln, reinforces the steep-sidedness of the doline. The quarrying generally follows the natural contours of the doline, although some squaring off occurs. The form of the doline today is both the attractor for as well as the result of these activities.

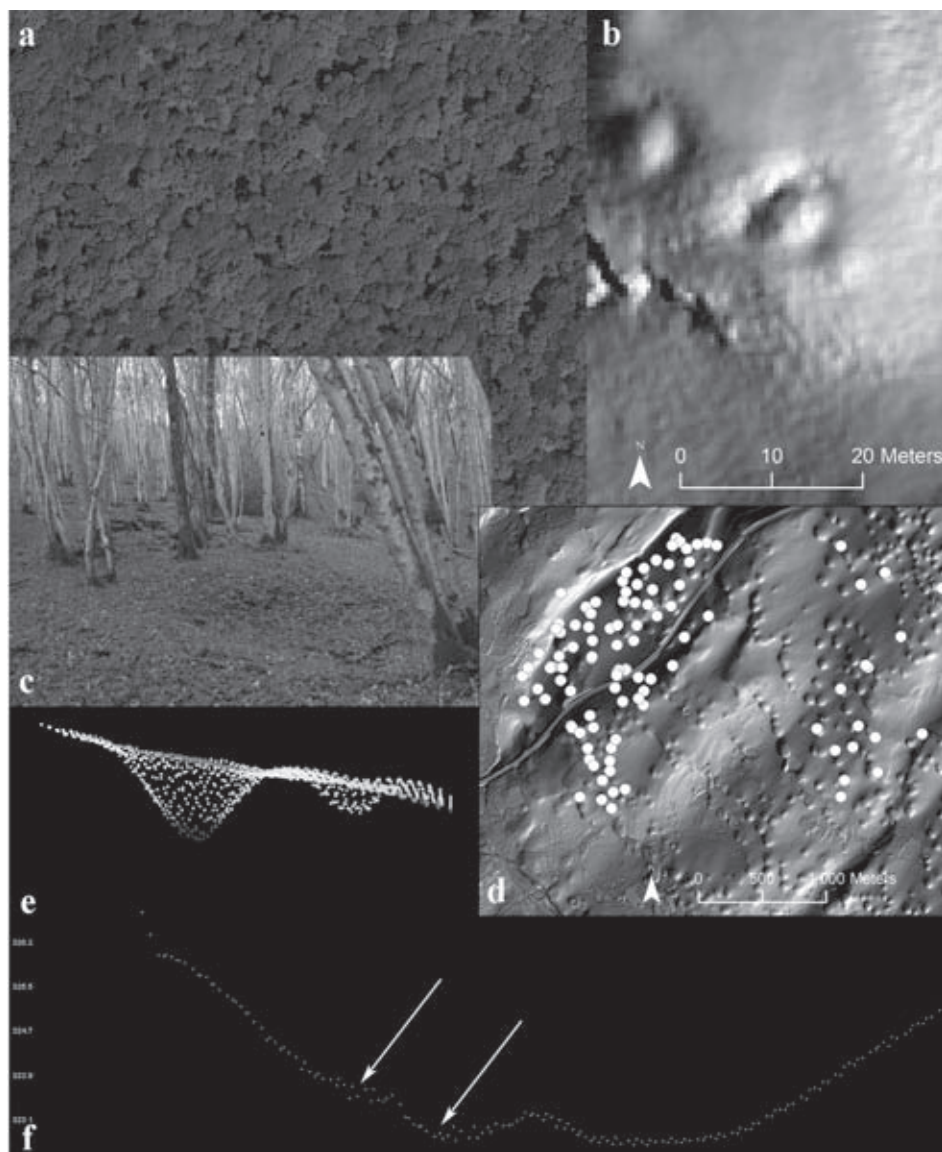


Figure 11. Multiple visualisations of the same data are used to explore relationships between feature, site, landscape and distribution. (a) Air photo of the forested location of the limekiln. (b) Hillshaded DTM of the limekiln. (c) Photo of the remains of the limekiln taken from about 4M away. (d) Yellow dots show the distribution of lime kilns in the local area. (e) The limekiln's appearance in the point cloud, with points coloured by elevation. (f) A profile section through a limekiln situated in the bottom of a doline. Image: R. Opitz, C. Fruchart, Lieppe / MSHE C.N. Ledoux. See also the full colour section in this book

This tight-knit connection between feature and context on several scales is partly because when looking at LiDAR, one naturally moves across scales, closely inspecting the physical form of a feature, trying to characterise it, zooming out to look at it from a distance, seeing it together with other features, looking at how it fits with or seems to have altered the terrain. The process is one of simultaneously examining linked displays showing the site and its context in plan, usually as a hillshaded dtm, at a 3D point cloud (fig. 11), and at statistical graphs, adding or removing layers, trying different visualisations to gain an overall understanding of how the place works. In this way, exploiting the connection across scales and visualisations can play an important role in the exploitation and interpretation of the terrain models created with LiDAR data.

CONCLUSIONS: LIDAR AS CONTEXTUAL TOPOGRAPHY

Topographic data, increasingly acquired in great detail and over large areas through LiDAR survey, can and should be more than just another source of new sites and features or an environmental backdrop. Working with these massive topographic datasets gives us an opportunity to rethink our approach to the rural landscape, taking into account more diverse areas and activities. The Besançon surveys have shown LiDAR and fieldwalking to be both interdependent and complementary. The LiDAR survey is also essential as a source of data on the micro-regional scale for forested or otherwise ‘marginal’ parts of the landscape. The broader implication of having LiDAR data, if it can be well integrated with (micro-) regional surveys, is that it can help bridge the gaps between historical descriptions of the rural world, especially the rural economy, which include a wide range of ‘special-purpose sites’ and what is commonly found through fieldwalking surveys or through rescue excavation. (For contrasting perspectives see among others Brun 2005; Greene 1991, especially chapter 5; Snodgrass 1991; Witcher 2006; Duncan-Jones 1990; Kehoe 2007.) It also encourages us to work flexibly across scales, thinking continually about sites and their surroundings together.

Thinking across scales, linking an individual feature to a distribution or group of features to long-term changes in the form of the landscape leverages the fluidity of scale and uniformity of the data we have in LiDAR-based terrain models, leading to a more contextualising approach. Hyper-realistic modelling, employing the level of detail and flexibility of visualisation provided through LiDAR models, may be the crux between the statistical and computational, database-centric world of GIS-based analyses, and the experiential, lived-scale, phenomenological approaches to landscape (as suggested by Gaffney & Gaffney 2006, and by the work of Gillings & Goodrick 1996; Gillings 2004; and esp. Cripps, Earl & Wheatley 2006). If so, LiDAR data may play an important role by providing lived-scale data across landscape-scale areas, and the means to move fluidly between these scales.

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