

## Reconstructing visual Landscapes

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**Abstract:** The following paper reiterates the importance of studying past visibility patterns within the context of landscape archaeology. In spite of the many difficulties and criticisms revolving around this topic, efforts aimed at reconstructing these patterns and exploring their possible roles are considered to be central to the reconstruction of social landscapes. This paper extends previous GIS work done on intervisibility by making reference to the concept of 'co-visibility', by exploring the way in which visibility of any monument or set of monuments is shared with that of other monuments. A subset of round barrows from the Yorkshire Wolds (Northern England) is used to illustrate this work. The study also underlines the need to address the variability which is often present in archaeological data. Variability, in this case, of visibility patterns associated with the barrows due to our lack of precise chronological information.

**Keywords:** Visibility, GIS, round barrows, uncertainty, simulations

## On the study of visibility

While visibility has often been the focus of many archaeological studies (for an early seminal work see Fraser 1983), the topics and approaches that these have covered have remained limited. For the most part, these have revolved around questions on the relationship of visibility and territories, intervisibility amongst monuments, and on whether sites were aligned towards distant topographic features with astronomical significance. The scope of their inquiry has also been restrictive, focusing primarily on what was visible from a particular location. This is true in spite of the possibilities that the introduction of GIS has brought to the archaeological community.

Currently reference to visibility remains quite strong though in a more nuanced way. It can be found embedded in most, if not all, 'interpretative' approaches to archaeological landscapes. Investigators who have adopted this perspective rely heavily on observations in the field to explore possible links between different landscape features and monuments. These investigations have also broadened the ways in which visibility plays out onto the landscape. Questions about the sequence of views, their character, rhythm and changes in content, have become central to these narratives, eg Tilley, 1994, Barrett 1994, Thomas 1993, Criado and Villoch Vázquez 2000.

In recent years, such a reliance on visibility has been the focus of some criticism (Thomas 1993, 2004). Several authors have rightly pointed out the multi-sensorial and kinesthetic dimension, as opposed to purely visual, that accompanies any spatial experience (Bender 1998, Ingold 2000). Emphasis on the complexities surrounding the spatial experience in a landscape has resulted in attacks against studies focused on past visibilities. These studies represent, according to the critics, another imposition of western biases on the past, in this case by emphasizing vision as the most important source of knowledge (often referred to as Occularism or Visualism, Thomas 2004, Curry 1998), or by simply reducing the value of the senses to their information-gathering capacity (as opposed to their role in inducing emotions and memories).

Claiming that the totality of human experience and/or perception that occurred in the past can be accessed via a study of visibility patterns is clearly wrong. But so would be abandoning the pursuit of further work on this topic for fear that we are not capturing the entire picture. Here I shall argue that there are important reasons why we must continue addressing the importance of visibility in the past, and how such a study is not only desirable but necessary within a landscape archaeology context:

- a. For non-impaired individuals and within most environmental conditions, vision is the sense that provides most information about the structure of space to the brain compared to the rest (though it does not work totally independently from the rest of the senses). It integrates information from both the immediate surroundings and the distant. Hearing is largely a sequential sense and offers limited spatial information. Touch can only provide information within arm's reach

(thus is a near point sense), and can only collect data sequentially. Taste and smell are immediate senses and have a much narrower range of information-gathering abilities. It is through vision that we can perceive shape, size, color, distance, and spatial location all at once. Sight is mostly responsible for providing us information about the spatial order. This predominance of vision is reflected physically by the size of the visual cortex in the human brain (Hoffman 1998). Of course, it is possible to find exceptions, as recorded in ethnographic examples, in which the role played by other senses is as important or more than the one played by vision (eg. hearing among the *Umeda*, Gell 1995). ). But one can equally find other examples where humans have actively altered their landscape so as to favor the visibility of desired landscape features (e.g. *Zafimaniry*, Bloch 1995).

b. Perhaps most important for landscape archaeologists is the sense of permanency attached to visibility. While smells and sounds undoubtedly played important roles in the past (eg. Watson and Keating 1999, Mlekuz 2004), they are generally difficult to retrieve without a large degree of speculation. Even in those few cases when the source of the 'signal' (smell, sound) is permanent (e.g. Cummings 2002 on the sound of sea), or access to this information is possible (e.g. through residue analysis) it is interesting to note the scarcity of social dimensions that are associated to them. For instance, discussions regarding power and control seldom make reference to the manipulation of these senses. The visual or visibility patterns of landscape features, on the other hand, are often recognized as being both, accessible and unchanged (though not as straightforward as most authors would have it, see below).

c. As Criado (1995) and others (Tilley 2004a) have already pointed out, the fact that certain items of material culture, as in the case of prehistoric monuments and earthworks, were built to be noticeable provides us an entry point into past intentions. What archaeologists are left to decipher are the ways in which these intentions were articulated on the landscape (e.g. in what way did their erection of these monuments structure space?) and the possible roles ascribed to these patterns in the past. Such an understanding cannot be based on the examination of the monuments alone; it must include reference to their setting, to their relation with other monuments and topographic features, in resonance with information from a wider archaeological context.

The structuring of space that occurs as new features emerge on the landscape, and older ones get reworked, can be closely connected to the notion of the 'education of attention' first put forward by American psychologist J.J. Gibson and recently brought into anthropology by Tim Ingold (2000, 2001). Ingold has extended Gibson's original idea making it, to some degree, the basis of a mechanism for culture transmission. It is through 'guided rediscovery' that culture (and shared perceptions) is transmitted from one generation to the next. This process does not necessarily imply sharing factual information, or any sort of mental representation as some cognitive scientists, and most cognitive archaeologists, would claim. Instead, we end up sharing common world views by sharing the context in which we generate information about the world (Llobera

2006). This in itself has important implications; that the origin of our understanding of the world is ultimately an emergent property that depends on our style of engaging with the world. It is by studying this process and the 'staging' that surrounds such an engagement that we can access via archaeology (Moore 2005).

From an archaeological point of view, this opens the prospect of investigating the material conditions that were used to guide or structure people's attention in the past. Such a possibility is particularly attractive to landscape archaeologists who continuously study the way in which the landscapes are constantly modifying and informing people's scope for action

### Making sense of visual patterns

What landscape archaeologists in the 'interpretative' vein attempt to retrieve through their wanderings and field observations is often the visual structure generated by monuments and other elements on the landscape. It is this structure that forms the basis of many of their discussions. Such a structure can only be pieced together by positioning oneself within and moving around a landscape. For the most part, this endeavor has not been the subject of much debate. It is tacitly acknowledged that an order exists and that it can be recovered without major difficulties. A moment of reflection reveals that this is not as straightforward as one may initially conceive.

The project is plagued with all the common ailments that surround any landscape archaeology project. In the best of circumstances, the current landscape will be a close rendition to what it once looked like during some period in the past, at least in relation to its shape and size (what Tilley refers to as the 'bare bones', 1994). However, certain landscape features will not be 'noticeable' to the investigator as they will no longer be present though they may be identified through cropmarks or geophysical analyses. Often the current spatial layout of monuments and other features will not correspond to a configuration that existed at any one point in time. Without detailed chronological information it is hard to determine whether many of the features on which archaeologists base their observations are actually contemporaneous (Barrett 2004, Brück 2005, Cummings and Whittle 2002). Features are often associated with time periods that span several centuries (and human generations). In the end, even if detailed information about the chronological sequence of monuments was available, it is still questionable whether archaeologists would be able to 'switch off' from their minds (and bodies) those features that were not contemporaneous during their field examinations. All of these limitations severely undermine the validity of many of these studies and ultimately their acceptance into the wider archaeological community.

Before unraveling the role, if any, that the visual demarcation of space generated by the monuments played we need to determine what the nature of such structure. This cannot be properly done without attending to the variability (often due to uncertainty) inherent in our data.

Incorporating any sort of variability into our investigations is something that we seldom do at least in a formal or explicit way. This is not only necessary as a way to address the problem of 'periodization' but may also be desirable, as a way of investigating the process by which structure emerges in the landscape (Llobera 2006). There are no set rules on how to do this but what is clear is that there are several ways in which this can be done. What is perhaps more crucial is to recognize that the introduction of this factor poses some limitations on our interpretations. What is the nature of these limitations and ultimately, what can we actually say once variability has been factored, are difficult questions that we need to learn to address. The following work attempts to do this to some degree within a landscape context. Here variability is investigated using computer simulations. This is part of a long-term effort to develop formal methods as a central component of social/phenomenological approaches to the study of past landscapes. Models of this sort are not only desirable but necessary if we are to explore with some rigor some of the ideas put forth by these approaches.

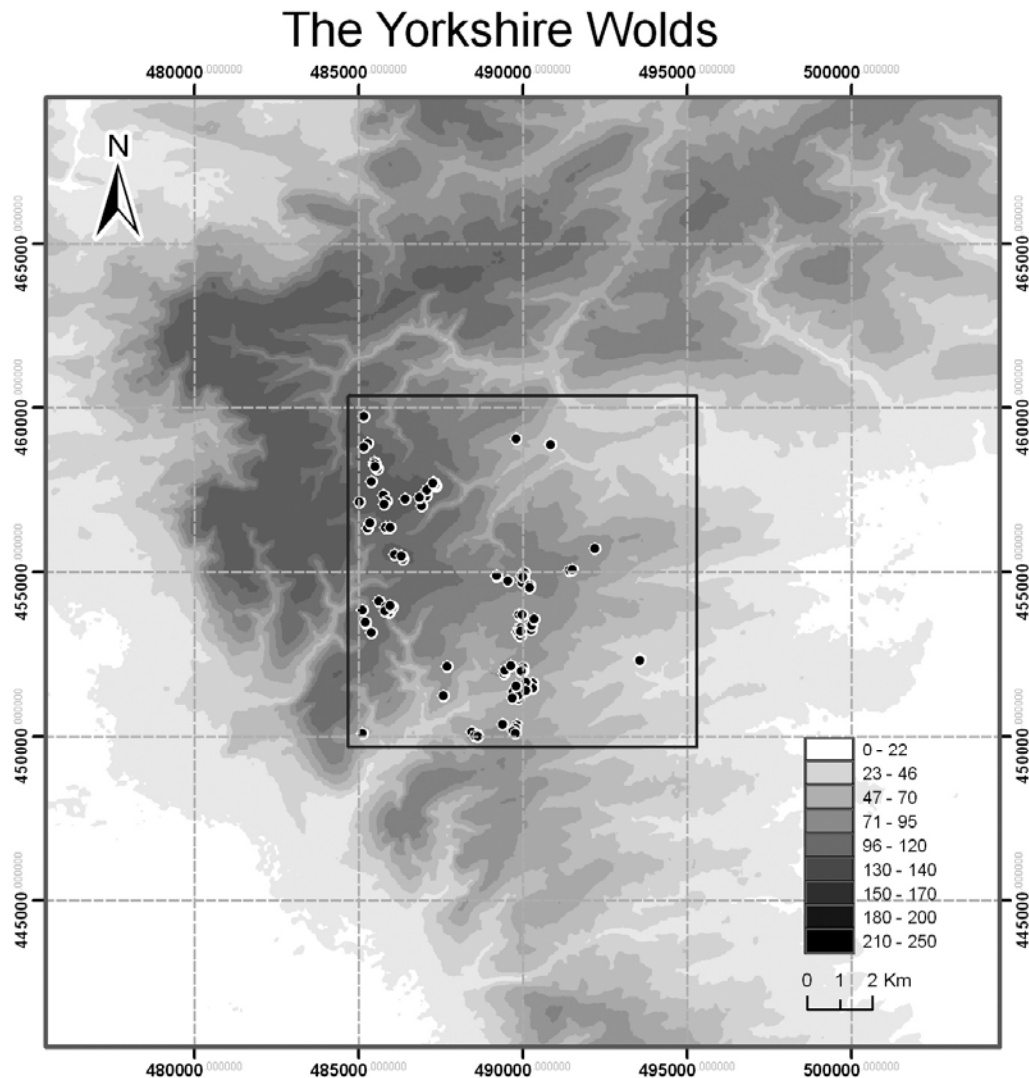
### Brief archaeological background

Apart from some exceptions (see Manby 1988, Manby et al. 2003) work on the Wolds has been surprisingly meager (a limitation that is currently being addressed, see <http://www.york.ac.uk/depts/arch/Wolds/index.html>). In recent years work by Stoertz (1997) revealed a landscape that possessed a complex history. The Wolds shows evidence of having been constantly transformed and modified from very early on through the construction of different types of monuments and earthworks. Information about the paleo-environment is equally scanty, however, work done by Bush (1988 and 1993) provides some evidence that the Wolds underwent several episodes of clearances as early as the mid-Holocene. Other circumstantial evidence found in the way of a rich distribution of surface stone axes (Manby et al 2003: 47) also suggests that this region was the focus of intense human activity, particularly clearances from the Early Neolithic onwards.

This paper investigates the visual patterns associated with a group of 118 round barrows (fig. 1) found within a 10 x 10 km window selected arbitrarily. These include barrows stored in the former RCHME Monarch database and others identified by Stoertz (later published in 1997). No additional information was used (or sought) for the following exercise. This was done partly on purpose because it reflects the amount of uncertainty often associated with this type of datasets.

Round barrows were grouped into clusters based on proximity and on whether they shared a similar topographical setting (see fig. 2). Only clusters with at least three barrows were considered. This meant that at times the sampling fraction used was indeed higher than the one nominally specified i.e. the minimum sampling fraction in a cluster size 3 is 0.333.

Contrary to the situation in lowland England, round barrows in North Yorkshire appeared as early as the Early Neolithic (Harding 1997:285). By the Early and Middle Bronze Age they had become well established throughout the entire area (Stoertz 1997: 33-34, Woodward 2000:). While the presence of round barrows since the Early Neolithic is unique to this area, these seem have been different from later ones, often including several individuals and being larger than those found during the Bronze Age (Woodward 2000:36).



<Fig 1. Selection of round barrows from the Yorkshire Wolds used in this study. DEM resolution 20m<sup>2</sup>. DEM obtained from combining OS with SRTM data. >

Harding has argued that the existence of round barrows early in the Neolithic points towards an early attempt at differentiation among individuals than it is not present in other parts England, in particular Southern England at the same time (1997:287). What seems clear is that the proliferation of round barrows is interpreted as an expression of a more exclusive use of social power across the landscape. This expression, based on the interment of whole individuals, would

have emphasized the power and status of particular lineages. This idea is further supported by the presence of prestigious and more specialized goods found in some of them (Woodward 2000:36-37, Manby et al 2003: 47).

An earlier study by Woodward and Woodward (1996) discusses the landscape setting of round barrows in relation to topographical features and their connection to earlier monuments (see Tilley 2004b for a more symbolic approach). These discussions, focusing on archaeological landscapes like Stonehenge, Avebury (So. England) present the idea of temporal and regional coherence amongst barrows that makes sense when looking at on a map but fail to explain how their spatial structure would have been recognized and utilized on the ground. A follow up to this study by Exon et al. (2000) investigated the Stonehenge landscape from a more 'grounded' perspective. While the incorporation of tools such as GIS provided some more insight into these patterns (often as a preliminary investigation before field visits), their treatment of visibility remained very similar to that found in other field based. The advantages of the computer were not fully exploited.

References to visibility patterns, particularly intervisibility amongst different types of barrows, are seldom associated explicitly with social interpretations. But they often make implicit reference to the establishment of some sort of hierarchy in the landscape, and to the recognition of an earlier spatial order via the visibility of past monuments (eg. Fraser 1983, Gaffney et al 1996). Barnatt (1997) noted that barrows in the Peak District were positioned on the edges of agricultural land that did not oversee any of the nearby settlements. Barrows were located so that they could be sighted over 'private' pasture lands associated with smaller social units. This model adds a visual component to the idea that the layout of barrow clusters was associated to kin or social lineages. It also suggests the possibility that the viewing of barrows clusters was perhaps meant to have been exclusive.

It is clear that the construction of round barrows structured space visually in some way. So far, most authors have reduced the analysis of this structure to a few questions, e.g., are monuments intervisible? But the significance of this question and its answer can only be examined within the wider context generated by the overall visibility patterns associated with these monuments. Visual patterns are complex not only because they are linked to movement but also because they changed as the landscape transformed. We need to explore this complexity. Parallel to this, we need to start investigating what possible roles, if any, did visibility patterns associated with a set of monuments play in society.

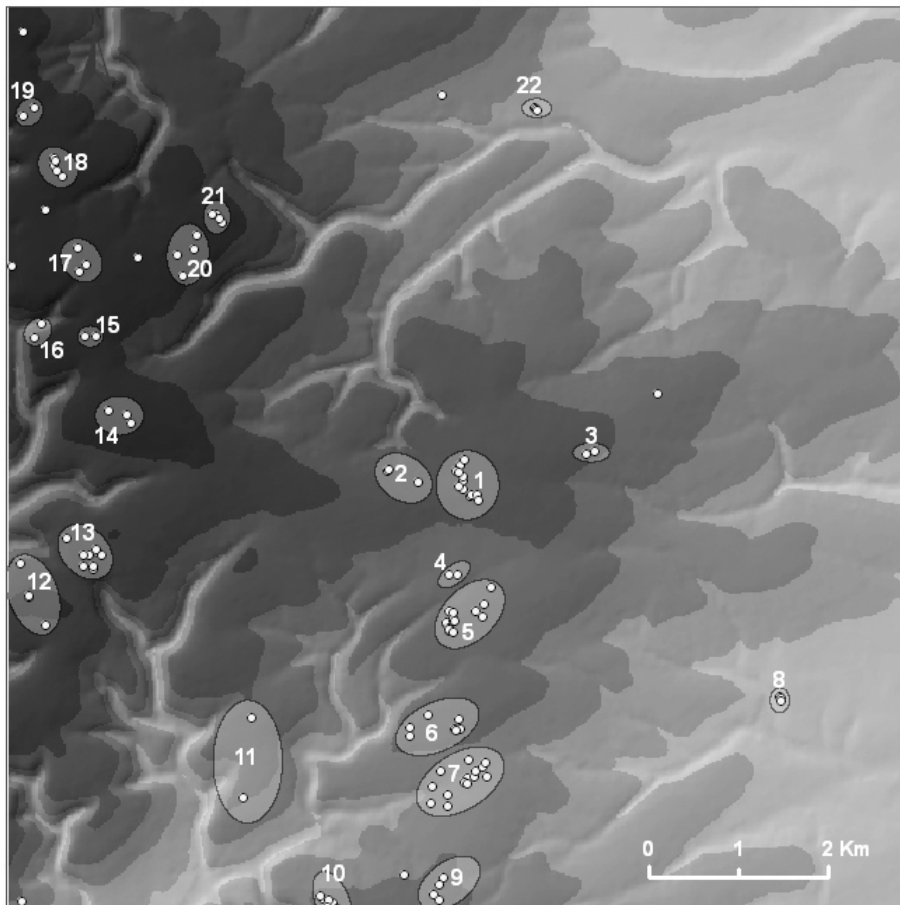
## Simulation

This work seeks to extend some of the earlier work done on visual patterns of prehistoric monuments (Wheatley 1995, Gaffney et al 1996) in various ways. It includes areas of co- or 'shared' visibility (locations from where two or more monuments clusters are visible) rather than focusing exclusively on the traditional intervisibility between monument locations. It distinguishes different ranges within the viewshed of a monument (where a monument can be seen from) based on its

size appearance. It also attempts to include an element of variability in the investigation due to the uncertainty surrounding the exact date of construction of round barrows.

This simulation does not test whether intervisibility was intentional i.e. whether the likelihood that a given visibility pattern emerged by chance was very low. Indeed any visibility pattern may be an unintended consequence of their location on the landscape. Emphasis here is on exploring the way in which visibility patterns emerge and are articulated within a concrete landscape. Understanding how these operate is the first step towards understanding their possible role. In this sense, 'traditional' intervisibility, i.e. between monument locations, represents just one aspect of the visualscape of a period (Llobera 2003). Of equal importance is determining the locations from where several barrow clusters are visible; to see in what way the level of visibility of surrounding clusters changes as an individual approximates any cluster or; to determine how (in what way and by how much) the pattern of visibility between clusters alters as new monuments are added to the landscape.

## The Yorkshire Wolds



<Fig. 2. Round barrow clusters (not all were used in the simulation)>

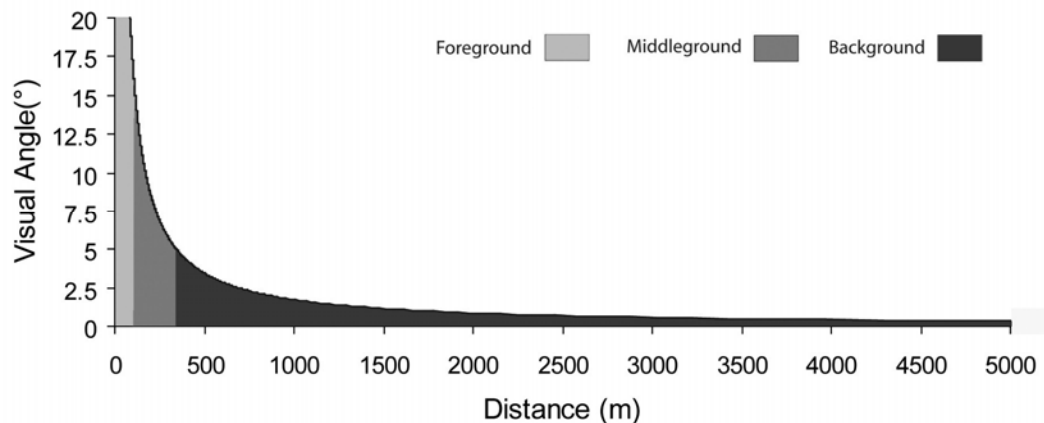


To construct the simulation the viewshed of each barrow was reclassified into three bands: foreground (which includes the barrow itself), middleground and background. This was done to acknowledge the possibility that the influence of barrows (or any landscape feature) is likely to be related to the amount they occupy in someone's field of view. In other words, the nature and location of landscape practices in which monuments play some role is likely to be related to their visual magnitude. These ranges were defined on the basis of the visual angle that the barrows would have subtended given a standard diameter of 30m.

There is no accepted criterion to establish exactly when one range starts and another finishes. All we can say is that this must be based on the viewing target (in this case the barrows) and therefore it is ultimately dependent upon the intention of the viewer. A proper discussion about the potential for action that each range may offer is pending future research. Books describing classical works on perception have traditionally associated certain angles with various visual thresholds: detection, resolution, recognition, etc (Schiffman 2001, Wolfe et al. 2006). These however can only be considered as absolute thresholds given that they were obtained indoors and it is unlikely that they will be very useful in outdoor conditions. Higuchi's work (1983) is still one of the few studies that has put forward some guidelines on this matter. He based his discussions using a tree as the viewing target and defined foreground/middleground/background ranges based on whether one could distinguish the leaves of a tree, the individual trees (their outlines), or an undistinguished pattern. A very practical way of obtaining some sort of 'intuition' about the magnitude of visual angles is by using one's own body as a reference. On most individuals the width of a clenched fist at arm's length tends to cover an angle of about 10°. The tip of a small finger at that same length is about 1°.

The ranges used here were defined somewhat conservatively and were based on the type of activities we would expect to be associated with the barrows at different distances from them (see figure 3). If  $\alpha$  refers to the visual angle occupied by a barrow at each location, we define the ranges as follows:

- Not relevant ( $0 < \alpha < 0.1^\circ$ ).
- (B)ackground ( $0.1^\circ < \alpha < 0.5^\circ$ ): Barrows act as reference points on the landscape, though at this range people can still be easily detected around them.
- (M)iddleground ( $0.5^\circ < \alpha < 15^\circ$ ): This would mark the area around the barrows where we would expect communal processions and other similar activities to take place (the avenue at Stonehenge and the cursus all refer to this scale).
- (F)oreground ( $\alpha > 15^\circ$ ): Defined as the area within which we expect certain communal activities closely related to the barrows to occur, e.g. feasting.



<Fig.3. Relationship between horizontal visual angles subtended by a standard barrow and distance.>

To determine the amount of co-visibility among round barrows the following procedure was used. Barrow clusters were taken two at a time. The visibility ranges for each cluster (see above description) were intersected. This procedure would potentially generate nine types of intersection (F1-F2, F1-M2, F1-B2, M1-F2, M1-M2, M1-B2, B1-F2, B1-M2, B1-B2) and six cases where no intersection occurred (F1, M1, B1, F2, M2, B2). Any location visible from a monument has to fall into one of these categories.

Given the way in which the foreground range was defined (smaller than the minimum distance separating clusters) the possibility for any foreground to foreground (F1-F2) intersections was zero.

To add more control to the simulation intersections were not calculated using all of the barrows in each cluster. Instead the procedure used a fraction of this number. For instance, if the sampling fraction was set to 0.2 (20%) and say a cluster A had 10 monuments and another B had 15, the intersection was calculated between the viewsheds of 2 monuments from A and 3 monuments from B. Given that these monuments were randomly selected the procedure was repeated a number of times (N=25) and an average value obtained for each visibility category.

Varying the sampling fraction allows us to assess how much visibility patterns among clusters change. Using a smaller fraction translates into fewer barrows being present. We are interested in seeing how much the patterns of co-visibility varied as the number of barrows increased and what the impact of increasing the number of barrows on visibility patterns.

While the results of the simulation were meant to be open-ended and exploratory, the simulation allowed for the investigation of several concrete questions:

- What is the nature of the intervisibility between barrow clusters? Were other clusters meant to be seen only upon arrival at any one cluster or was their existence evident before that?

-Was the visibility between clusters achieved exclusively at close proximity from a cluster i.e. in the traditional definition of intervisibility?

- Did the pattern of visibility between clusters change as more barrows were being added?

- Did the visibility of other barrows increase as one approach a cluster, did it decrease?

### Preliminary Results

The simulation generated vast amounts of information (more that could be presented in this article). Because of their changing character, untangling visibility patterns is not a trivial matter. Only a few of the many possible interpretations are considered in this article.

Two nominal sampling fractions were used: 0.2 and 0.6 to explore any possible changes in patterns of co-visibility. A sample of the information obtained for cluster 1 (sf= 0.2) is shown in table 1.

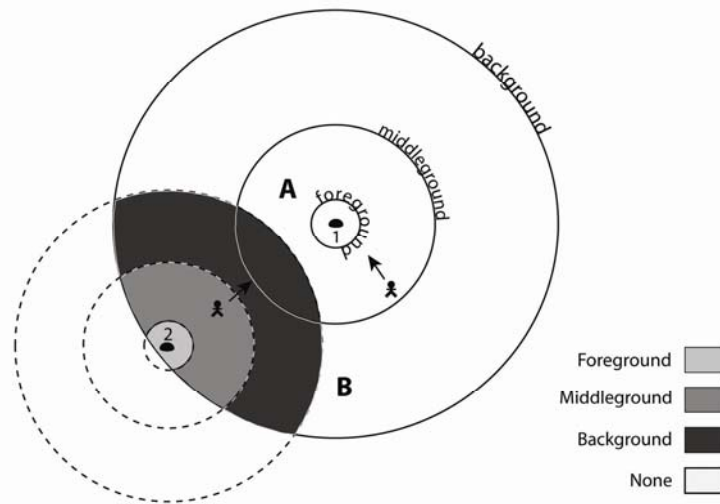
		c1	c2	c5	c6	c7	c8	c9	c10	c12	c13	c14	c17	c18	c20	c21	c22	
Cluster 1	F	x	0.00	0.17	0.42	0.99	1.00	0.05	0.00	0.89	0.31	0.00	0.49	1.00	0.00	0.02	1.00	
		f	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		b	1.00	0.83	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	M	x	0.79	0.70	0.53	0.72	0.40	0.39	0.46	0.65	0.62	0.47	0.55	0.57	0.60	0.38	0.66	
		f	0.00	0.01	0.00	0.02	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.00	
		b	0.20	0.29	0.47	0.26	0.59	0.51	0.54	0.35	0.38	0.53	0.45	0.43	0.30	0.58	0.34	
	B	x	0.52	0.77	0.80	0.92	0.99	0.92	0.93	0.98	0.95	0.88	0.95	0.90	0.92	0.91	0.99	
		f	0.09	0.17	0.09	0.01	0.01	0.03	0.02	0.01	0.02	0.05	0.01	0.00	0.06	0.05	0.00	
		b	0.01	0.05	0.11	0.04	0.00	0.05	0.05	0.02	0.02	0.07	0.01	0.01	0.02	0.04	0.01	
			b	0.37	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.09	0.00	0.00	0.00

< Table 1. Information about the co-visibility patterns between cluster 1 and the rest of clusters using a sampling fraction of 0.2.>

This table shows the average percentage area in each visibility category in cluster 1 that intersects with visibility categories in the remaining clusters. Category 'x' refers to the 'no intersection' category. For instance consider the relationship between cluster 1 and 5. Within 83% of the area from where cluster 1 appears in the foreground cluster 5 appears in the midground. The remaining 17% of cluster 1's foreground area is not intersected by cluster 5. This means that cluster 5 cannot be seen from 17% of the foreground area for cluster 1.

A useful way of thinking about these values is as probabilities. When cluster 1 is in the foreground, 83% of the times cluster 5 can be found in the midground

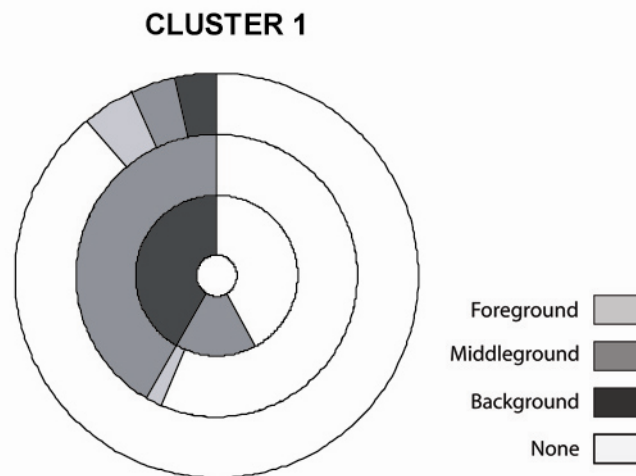
and 17% of the times it cannot be seen. This value is different for cluster 2 where it is 100% certain that cluster 2 will be found in the middleground. The following sketch (fig.2) helps explain what these numbers are describing



< Fig.4. Sketch showing how the visual ranges of two different monuments intersect. When moving towards monument 1, less than 25% of its middleground is intersected by the background area of monument 2 (A). More than 25% of its background is intersected by the part of the background, middleground and almost the entire foreground of monument 2 (B). >

Information found in table 1 is graphically summarized in fig X. It is important to spend time understanding this figure as it forms the basis of later ones (figs. Y, Z). Each ring represents a different visibility range (i.e. foreground, middleground and background). The area in each ring, the total visible area in this range, is subdivided into the same visibility categories. Each subdivision describes the proportion a certain visibility range is intersected by the visibility ranges of other clusters. Looking at cluster 1, most of its background<sup>1</sup> (c. 85%) is not intercepted by the visibility of any other cluster. Hence, there is an 85% chance that no other cluster will be visible. There is, however, 15% chance that other clusters will be seen either in as background (5%), middleground (5%) or foreground (5%). Moving closer to cluster 1, the chances that another cluster will appear in the middleground have increased dramatically (c. 45%) while there is a tiny chance (about 2%) that a cluster will be in the foreground. Finally when cluster 1 appears in the foreground the chances that we will see any other cluster has increased even more (c 55%). Interestingly this increase comes in the way of clusters appearing in the background (45%).

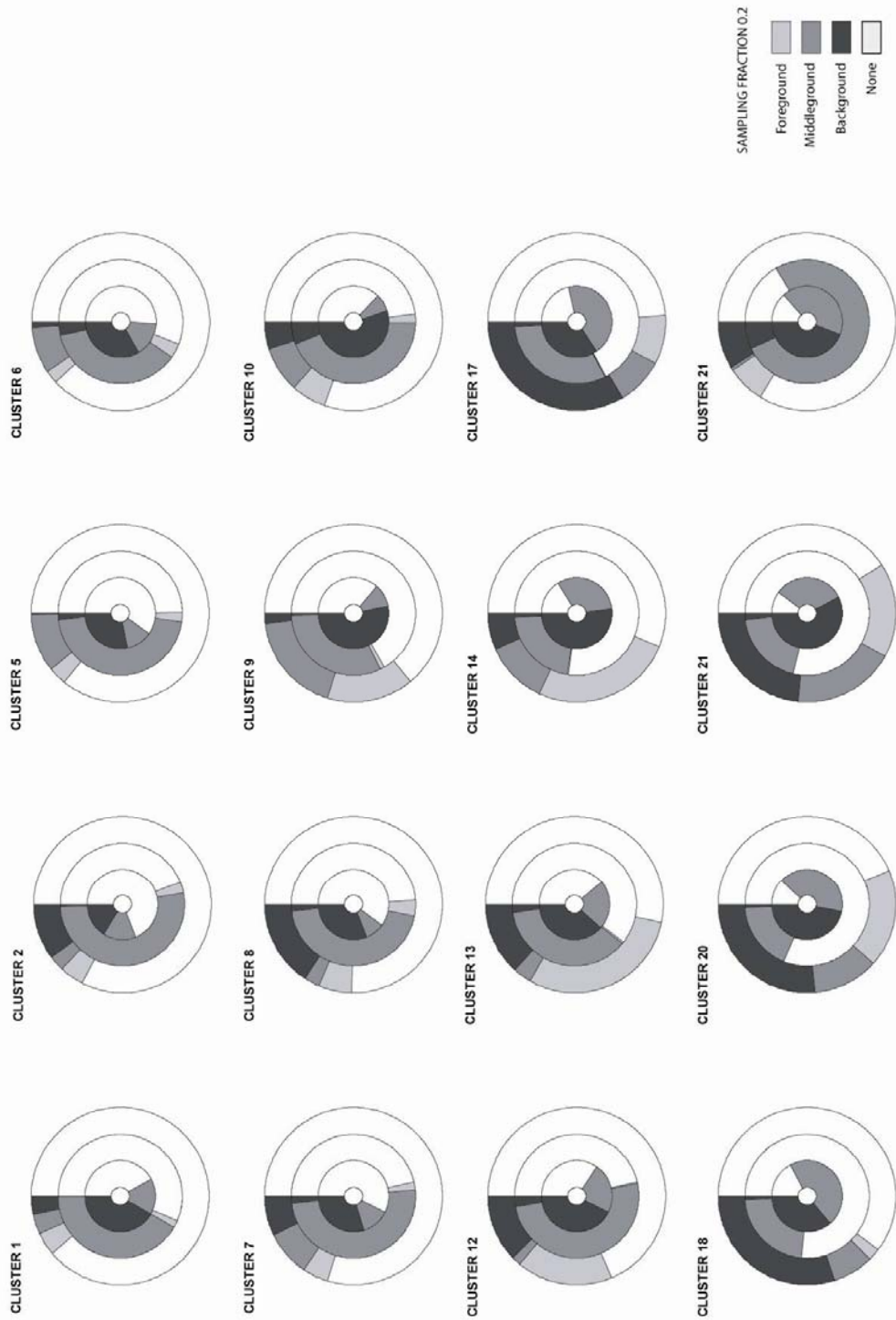
<sup>1</sup> When talking about the foreground/middleground/background of a cluster we are referring to the visual range in which that cluster appears. So the foreground of cluster 1 refers to the area from where this cluster appears in foreground ,



<Fig. 5 shows patterns of co-visibility between cluster 1 and the rest of the clusters calculated using 20% of barrows in any cluster.>

The following two figures (figs. 6, 7) describe the patterns of co-visibility for all of the clusters at different sampling fractions. These figures condense an enormous amount of information and allow for several readings. Only some of these readings are presented here.

When comparing the foreground breakdown that each cluster has after using 20% and 60% of the barrows in each cluster, we observe that the increase in barrows has not affected dramatically foreground composition. Except for some clusters like 21, 22, the total amount of area intercepted does not seem to have change significantly. The nature of the interceptions has not changed either except for a slight increase in middleground intercepts (mid-gray) found at clusters 6, 9, 10, 21, 22. We do observe some important changes with cluster 2. This cluster sees an increase in foreground intercepts and a decrease in background ones. As we shall see with other visibility ranges patterns of co-visibility for this cluster vary significantly when more barrows are present. This is due in part to the small number of barrows that make up this cluster (only three) and to its location in the landscape (relatively central). In summary the foreground hardly changes when more monuments are added. There is no appreciable increase in the visual connectivity with other clusters, only a slight increase in the number of clusters appearing in the middleground (instead of the background). If we think about these results in terms of probabilities, there are six clusters for which the likelihood of seeing other clusters is more than 0.75, other six for which the probability is between 0.5 and 0.75 and only four for which the probability is between 0.4 and 0.5. These probabilities remain very similar even after the number of barrows increases.

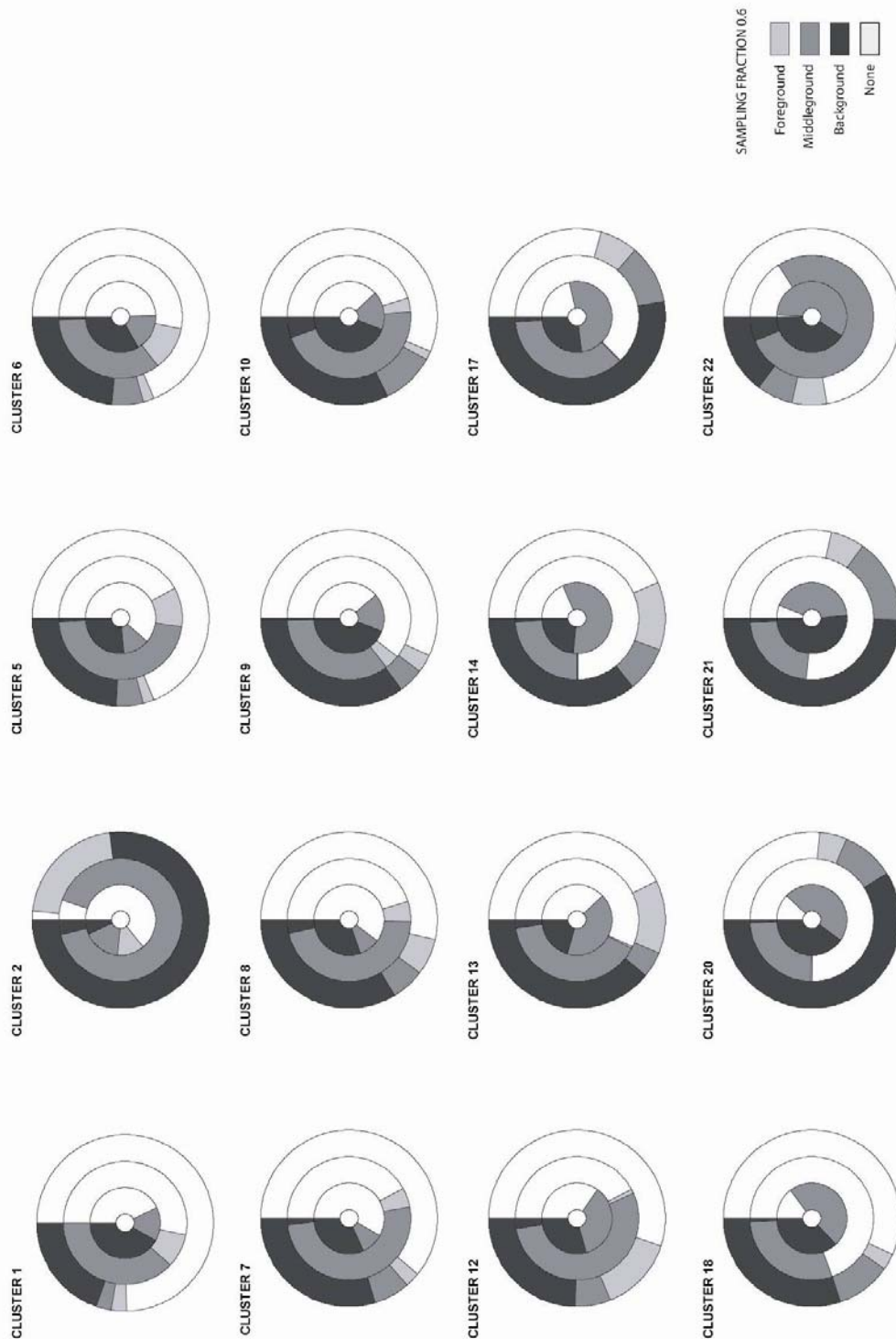


<Fig 6. Patterns of co-visibility for all clusters calculated for a sampling fraction of 0.2>

Next, we compare the middleground for each sampling fraction. We find a similar pattern than for the foreground. The presence of more barrows brings a slight overall increase in the proportion of the area that is intercepted at this range. This increase occurs mainly in the way of foreground intercepts and only for certain clusters (1, 5, 6, 7, 8, 9, 10, 12). For these clusters the probability of having other

clusters in the foreground increases. For the remaining clusters (14, 17, 18, 20, 21, 22), except for cluster 2, there is no perceivable change. Interestingly both batches of clusters correspond to different geographical zones (see fig. 2). We can also compare the likelihood of seeing other clusters as one moves from the middleground to the foreground. For clusters 9, 13, 14, 17, 18, 20, 21 the probability of seeing other clusters increases dramatically when moving into their foreground. This is also true for 1, 6, 10, 12, 22 but to a much lesser degree. For the remaining clusters 2, 5, 7, 8 this likelihood decreases. The relationship between the middleground and the foreground is hardly altered with the introduction of more barrows ( $sf=0.6$ ) except in the case of cluster 2 where it becomes much more accentuated. A property of this visibility range is that it the bulk of the intersections occur with the middleground of other clusters. This characteristic does not change regardless of the number of barrows present. We can then conclude that regardless of the increase in the number of barrows the amount and nature of the co-visibility patterns in the middleground did not change significantly.

We can now examine changes in co-visibility patterns that occurred in the background range. Here is where most of the changes are concentrated (as expected given the little variability in previous ranges). For a sampling fraction of 0.2 the background make-up is not surprisingly dominated by the intersection of other backgrounds. In clusters 1, 5, 6, 7, 9, 10, 12, 13, 14, the proportion of background intersections is smaller than for other visual ranges. In clusters 2, 8, 17, 18, 20, 21 the background range is the largest single category but with the exception 17, 18 these proportions are still smaller than the other two visual categories combined. For 20% of the barrows in each cluster the composition of the background range presents a variety of visual intersections with other clusters. In this range the overall probability of encountering clusters in the foreground, middleground and background is relatively even. As it has been the case with other ranges, though not as marked, changes that occur in this range can be of different types. It is clear that the increase in barrows brings an overall increase in the probability of seeing other clusters. In some occasions as the probability of encountering clusters in the background increases dramatically, the probability for the remaining visual ranges remains also the same as it is the case with cluster 1 (the middle- and foreground ranges appear shifted by the increase in background intersects). In this case, the number of both distant clusters and not so distant clusters increase proportionally. More cluster appeared in the distant but this increase did not outweigh the number of clusters that were present closer by.



<Fig 7. Patterns of co-visibility for all clusters calculated for a sampling fraction of 0.6>

On other occasions, however, it is the nature of the intersections that changes. For instance, with cluster 9 we go from a background where other clusters appear mostly in the foreground and middleground (sf=0.2) to one where the



probability of seeing another cluster in the background is far higher than for the other visual ranges ( $sf=0.6$ ). In this case (as with cluster 14, and to a less extent with clusters 10, 13, 20, 21) the probability of seeing another cluster in the background has increased far more rapidly than for other ranges. The number of background clusters intercepts outweighs by far that of other visual ranges. With the increase number of barrows, someone standing in the area were cluster 9 appears in the background would now notice the existence of more clusters in the distance than before. At a sampling fraction of 0.6 the chances of seeing other clusters in the background is not uniform. At clusters such as 1, 5, 6, 7, 22 chances are slightly over 0.25, for others like 8, 9, 10, 12, the likelihood is closer to 0.4. For the remaining clusters (2, 13, 14, 17, 20, 21) the probability is between 0.5 and 0.75, except for 2 which is almost about 0.95.

To end this section we now consider what happens when approaching any cluster. In each case the probability of seeing other clusters changes as the clusters comes into the foreground. Moreover, there are several ways in which the likelihood of seeing other clusters varies. To show this clearly we need to combine the visibility categories in each range (ring) into one large category ie. shaded versus white. At each cluster we can identify which ring has the highest probability of seeing other clusters and so on. If we label the ring with the highest probability as being 'Most' and the one with the lowest as being 'Least' we end up with the following change sequences ( $sf=0.2$ ):

Least – More – Most. Clusters 1, 6, 10, 12, 22.

Least – Most – More. Clusters 2, 5, 7, 8.

More – Least – Most. Clusters 9, 13, 14, 17, 18, 20, 20, 21.

These sequences do not change when using a larger sampling fraction, except for clusters 2 (Most – More - Least), and 8 (More – Most – Least). Perhaps it is not surprise that these sequences can be somewhat associated with different geographical areas in the study area.

## Preliminary interpretations and comments

The previous exercise has been useful in a variety of ways. First and foremost it provides a new way of summarizing and displaying patterns of co-visibility between monument clusters. It also allows us to see whether the addition of monuments altered the visual patterns generated by the barrows. All of these aspects are positive as they make data more explicit. In spite of this effort, interpreting the results remains a tantalizing endeavor. Capturing and trying to understand the dynamic aspect inherent in these patterns is not trivial.

What we know is that visibility patterns were established after few barrows were set and did not change much (especially close to the clusters) even after more barrows were added. To some this finding might not be surprising, after all monuments that are clustered are by definition near to each other and ought to have similar spatial properties (Tobler's first spatial analysis law). It is possible

however for barrows to be clustered on a hill or a ridge and to have viewsheds that do not overlap.

Was it possible to arrive at a cluster without seeing any other clusters? It varies. First of all, for the majority of clusters the greatest probability of seeing other clusters was near the cluster itself. This probability as we discussed previously would have varied, being as little as 0.35 to as much as 0.99. If we take the largest probability from both the middle- and foreground the minimum probability bumps up to roughly 0.5. So there was still the possibility of some areas for exclusive viewing. These values barely changed with the addition of new barrows. Not at least in the middle- and foreground areas. When they did change, it was to increase the chances of people becoming more aware of middleground clusters. Once in the foreground area of a cluster the chances of being more aware of distant clusters than middleground ones was, with some exceptions (12, 13, 14, 17), generally higher though not much higher in some cases (e.g. 18, 20, 21, 22). Activities occurring in this area were not closed out to more distant locations.

On the other hand activities occurring in the middleground, like processions, would have been bounded on occasions to other barrows, mostly in the middleground and some in the foreground. But the chances of making that process more exclusive was greater than when standing in the foreground. In only three occasions are the possibilities for visual contact in the middleground larger than in the foreground.

The addition of barrows brought much more change in the background areas of clusters. When viewed from a distance, people would have become aware of the existence of distant clusters and not just nearby ones (middle- and foreground). In this sense the landscape expanded (there were more reference points). If we were to consider all the visibility ranges together the probability of seeing other clusters remains 0.5 (6).

There was no overall consistency in the way that visual contact with other clusters changed when moving close to any particular barrow cluster. In some occasions people would have moved from a less connected space to a more connected one. In other occasions this sequence would have been reversed. It is worth pointing out some specific aspects surrounding a few of the results. Some of the largest clusters like 1, 5, 6, 7, were not particularly well connected with other clusters. These happen to occupy a central ridge in the study area. This may be due to limitations imposed by the number of clusters/monuments used and edge effects.

There is no clear evidence that barrows were viewed exclusively, in fact the chances that this might have happened reduces whenever we consider either the middle or foreground. This does not preclude that this might have happened.

There are obviously still several limitations with the procedure used here. One has to do with the way in which the sampling was done (restricted to each

cluster). Perhaps a similar procedure (checking co-visibility) should be used with monuments independently rather than having them as part of clusters. An important shortcoming of the current procedure is that it does not consider directionality, e.g. an individual can be in the middleground of a cluster and in the background of another cluster but this does not mean that both clusters were visible at the same time (see figure 4). There are other limitations that are common with GIS applications such as edge effects (Lake and Woodman 1998).

## Conclusion

While it would be wrong to pretend that we can reduce the complexities of past perception and experience to a reconstruction of past visibility patterns (regardless of how thorough the study is), such a study remains an essential component of any landscape project. But making sense of visibility patterns in the past is an ambitious endeavor. It requires a complex assembly of many parts: identifying how such patterns come to exist (what generates them?), capturing their structural properties, understanding the role that these may play in society, and how they are transformed through time. So far the study of the visual structure of past landscapes has been very limited and compromising.

The advent of GIS, and with it the use of viewsheds, added a new powerful tool to the archaeologist's arsenal. More importantly, it has outlined the possibilities of using computer simulations to explore past landscapes. However, these possibilities are far from being realized. In fact we are barely scratching the surface. This is in part due to our inabilities as archaeologists to fully embrace the possibilities that computation has to offer. But it is also due to conceptual limitations surrounding topics such as the importance of visibility, its possible roles and uses in societies in the past.

This paper started to address some of these issues. Unpeebing (I don't know this word) the visual structure of landscapes is hard, let alone interpreting this structure for a society. Often these difficulties are regrettably downplayed in current archaeological approaches to landscapes. Luckily for us we can tackle some of them through the development of simulations that not only pay attention to the intricate nature of such patterns in a landscape but do so in ways that allows us to deal with limitations inherent in our data.

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