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# Measuring the relative topographic position of archaeological sites in the landscape, a case study on the Bronze Age barrows in northwest Belgium

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A B S T R A C T

Local topography is an important parameter determining the erection of a certain type of site on a certain location in the landscape. Despite the importance of topography in archaeological landscape research, the role of local topography has remained rather unexplored compared to other specific topographic parameters such as slope, aspect, curvature or visibility. Therefore, three methods to assess the relative topographic position of sites are applied and discussed here. The Bronze Age barrow dataset of northwest Belgium acts as the subject for this methodological case study. First, elevation percentile calculates the area that is lower than the central point within a predetermined neighborhood. Secondly, difference from mean elevation measures the relative topographic position of the central point as the difference between the elevation of this central point and the mean elevation within a predetermined neighborhood. And finally, deviation from mean elevation calculates the relative topographic position of the central point as the difference from mean elevation divided by the standard deviation of elevation, within a predetermined neighborhood. These three methods, each with their advantages and disadvantages, prove to be an added value for archaeological landscape research.



## 1. Introduction

In theories about the relation between archaeological sites and their surrounding landscapes, topographic position and local topography are often described as important parameters determining the raising of a certain type of site (settlements, ritual and burial sites, military or defensive structures, etc.) on a certain location in the landscape. For example, Tilley (1994) mentions the importance of the location and orientation of Early Neolithic barrows in relation to the local topography and the presence of certain landscape features on the Cranborne Chase in southern England. However, his conclusions are based only on field observations, thus making the strength of these conclusions rather limited and only applicable on small-scales, or as stated by Fleming (1999) in his critique on landscape phenomenology "*these 'mindset' approaches are interesting and stimulating, but there is a risk that, without more sourcecritical rigour, they will themselves constitute a form of 'dreaming'* ".

Despite the importance of local topography, only few examples of systematic and thorough analyses of the relative topographic position of archaeological sites or features, as part of an extensive dataset, are known. Even with the advent of new methodologies and computer applications, such as geographic information systems (GIS), local topography has remained rather unexplored. The GIS-based analyses of the (topographic) location of archaeological sites in the landscape were, for example, more frequently performed as a broad range of different types of visibility (viewshed) analysis (e.g. Lake and Woodman, 2003; Llobera, 2007; Wheatley and Gillings, 2000). Among these, several studies have concerned the placement of (burial) monuments in the landscape. Studies by Fisher et al. (1997) and by Lagerås (2002) showed the deliberate placement of Bronze Age monuments so as to overlook the sea on the Scottish island of Mull and in Scania, Sweden respectively. Other studies analyzed the intervisibility or the reciprocity of view between burial monuments (Wheatley, 1995; Woodman, 2000). Woodman (2000) relates places with higher

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visibility to more prominent locations in the landscape by using "completeness of viewshed". Other frequently analyzed parameters associated with topography are slope, aspect and curvature (e.g. Bevan et al., 2003; Kvamme, 1992). For example, Löwenborg (2009) implements the topographic features slope, aspect and curvature, next to several other environmental, typological and ritual parameters, in a statistical analysis to predict the chronology of the burial mound cemeteries in Västmanland, Sweden.

One of the first to explore the local topography of archaeological sites was Kvamme (1992), by developing two algorithms, the *Rim Index* and the *Ridge-Drainage Index*. Relative topography however, was first identified as important in a pilot research by Llobera (2001) investigating *topographic prominence* in the Yorkshire Wolds, UK, where the relative topographic position of Bronze Age round barrows, Late Bronze Age linear ditches and Iron Age square barrows was analyzed and compared. This analysis enabled the determination of shifting patterns of topographic site locations through time and clearly illustrated the importance of local topography within archaeological landscape research.

Ten years after the publication of Llobera's paper, such types of topographical research are still limited. There are, however, notable exceptions. Christopherson (2003) combines Kvamme's *Rim Index* and *Ridge-Drainage Index* to study the topographic prominence of sites in the region of Tall al-Umayri, Jordan. Roughly (2001) and Fairén-Jiménez (2007) incorporated topographic prominence in their research to understand the Neolithic landscapes in Morbihan, France and Northumberland, UK, respectively. Measures of terrain ruggedness, using neighborhood statistics, have been implemented by Warren and Asch (2000) in a model to predict the location of archaeological sites in the Eastern Prairie Peninsula, US and in the research by Bevan (2002) and Bevan and Conolly (2004) on the Greek Island of Kythera. The topographic prominence of archaeological sites is also, sometimes briefly, mentioned in the research of Chapman (2003), Diez-Martin et al. (2008), Gillings (2009), Jones (2010) and Posluschny (2008) and in reference works on the use of GIS in archaeology, in particular in the manual by Conolly and Lake (2006) and the review papers by Lake and Woodman (2003) and McCoy and Ladefoged (2009).

Remarkable is that Llobera (2001), Christopherson (2003), Roughly (2001) and Fairén-Jiménez (2007) all applied or developed different methods or algorithms to investigate a similar problem, the relative topographic position of sites in the landscape. Therefore, this paper seeks to evaluate and discuss different methodological approaches for investigating the local or relative topographic position of (archaeological) sites. The extensive dataset of Bronze Age barrows in the Sandy Flanders region in northwest Belgium is acting as the subject for this methodological case study. Given the non-random distribution of these monuments in the landscape, another aim is to analyze whether there is a spatial relation between the micro-topography of the landscape and the location of the burial monuments and to investigate if the local topography was a parameter influencing the selection of a suitable location for the erection of a barrow.

## 2. Bronze Age barrows and elevation data in Sandy Flanders

The research area, Sandy Flanders, is situated in northwest Belgium, largely between the North Sea coast in the west, the lower course of the Scheldt River in the south and east and the Polder area, an area characterized by alluvial and marine sediments, in the north (Fig. 1). It is a low-lying area, between 3 and 15 m above sea level, mainly covered by coversand sediments (Heyse, 1979). The general topography is characterized by a subtle micro-topography with height differences of only a few meters. Typical for this micro-topography is the succession of hundreds of rather small, low (ca. 1–2 m height) and elongated sandridges and shallow depressions and stream valleys. One sandridge, the so-called Great Ridge, crosses Sandy Flanders from west to east and stands out by its larger dimensions (Heyse, 1979). The ridge is 80 km long by 1.5–3 km wide and rises up to 5 m above the landscape. It has a typical dune profile characterized by a rather steep southern edge (1–4%) and a gently sloping northern slope (1–1.5%). Other

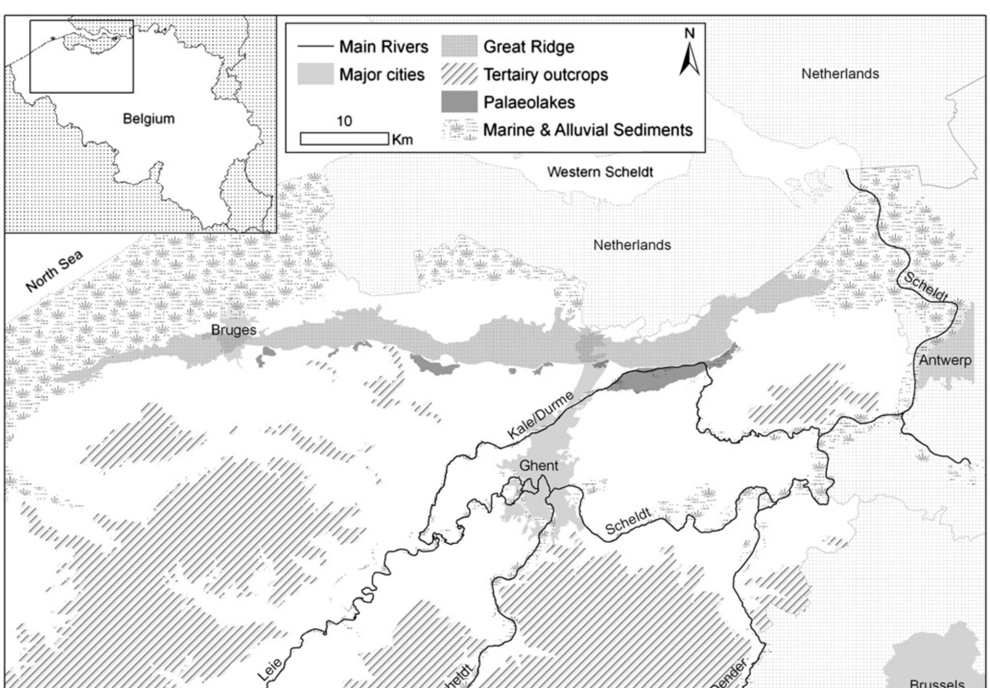


Fig. 1. Map of Sandy Flanders in northwest Belgium showing the main landscape features.

topographically important features are some tertiary outcrops, so-called cuestas, which dominate the landscape by their height, as these rise up to 25 m above the surrounding landscape.

For the study area a Digital Elevation Model (DEM) based on high density airborne LiDAR (Light Detection and Ranging) data, registered between 2001 and 2004, is available (AGIV, 2003; Werbrouck et al., 2011). For common applications, the data is available in standard and practical grid formats with cell sizes of 5, 25 and 100 m generalized through Inverse Distance Weighting. Objects like vegetation and buildings are filtered before delivery. However, other artificial structures such as road banks and waste dumps were not the subject of the filtering (Werbrouck et al., 2011). The $5 \times 5$ m DEM was used in this research (AGIV, 2004).

Since the beginning of the eighties, under the guidance of the Department of Archaeology of Ghent University, Sandy Flanders has been the subject of systematic and intensive aerial photographic surveys, with the discovery of archaeological sites as a main purpose (Bourgeois et al., 2005). One of the major results of these aerial surveys can be found in the Bronze Age barrow research with the discovery of several hundreds of monuments. In addition, some of these sites have been further investigated during excavations (De Reu et al., in press) or by means of geophysical surveys (Simpson et al., 2010; Verdonck et al., 2009). During the last few years, this dataset was the subject of a thorough, GIS-based inventory, resulting in 1105 identified and precisely located Early/Middle Bronze Age barrows (De Reu et al., 2010, 2011, in press) (Fig. 2).

Thus, the Bronze Age landscape of northwest Belgium is archaeologically very rich, but topographically subtle. This combination provides an interesting and important challenge for GIS approaches.

## 3. Relative topographic position analysis: methods and results

Several methodological approaches for quantitative land-surface analysis are being developed, described and applied in (landscape) geomorphometry (Hengl and Reuter, 2009). A number of elevation residuals, topographic parameters to measure the relative position of a point within the surrounding terrain, are described by Gallant and Wilson (2000) in their reference book on digital terrain analysis. These elevation residuals, summarized in Table 1, are extracted from a DEM using neighborhood statistics. Three specific algorithms, *elevation percentile* (PCTL), *difference from mean elevation* (DIFF) and *deviation from mean elevation* (DEV), were found to be very useful for analyzing the relative topographic position of the archaeological site, feature or location. Except for PCTL, all land-surface parameters described by Gallant and Wilson (2000) can be analyzed in ESRI's ArcGIS using the focal operators or by means of Reuter's elevres.aml (Reuter and Nelson, 2009). Besides ArcGIS, other (open source) GIS packages also offer opportunities to implement Gallant & Wilson's elevation residuals and/or to develop different approaches to measure the relative topography (Hengl and Reuter, 2009).

### 3.1. Elevation percentile (PCTL)

PCTL simply calculates the area that is lower than the central point within a predetermined neighborhood, resulting in a percentile range from 0 (central point is the lowest point within a predetermined neighborhood) to 100 (central point is the highest point within a predetermined neighborhood) (Table 1) (Gallant and Wilson, 2000). Values less than 50% are associated with lower locations (valleys, depressions, downslope areas, etc.), while values of more than 50% are associated with higher places in the landscape (ridges, upslope areas, etc.). This method was applied in the already mentioned research by Llobera (2001) towards the *topographic prominence* of Metal Age sites in the Yorkshire Wolds. In his paper, Llobera (2001) defines topographic prominence as *"a function of height differential between an individual and his/her surroundings as apprehended from the individual's point of view. More precisely, it is defined as the percentage of locations that lie below the individual's location (terrain altitude plus individual's height) within a certain*

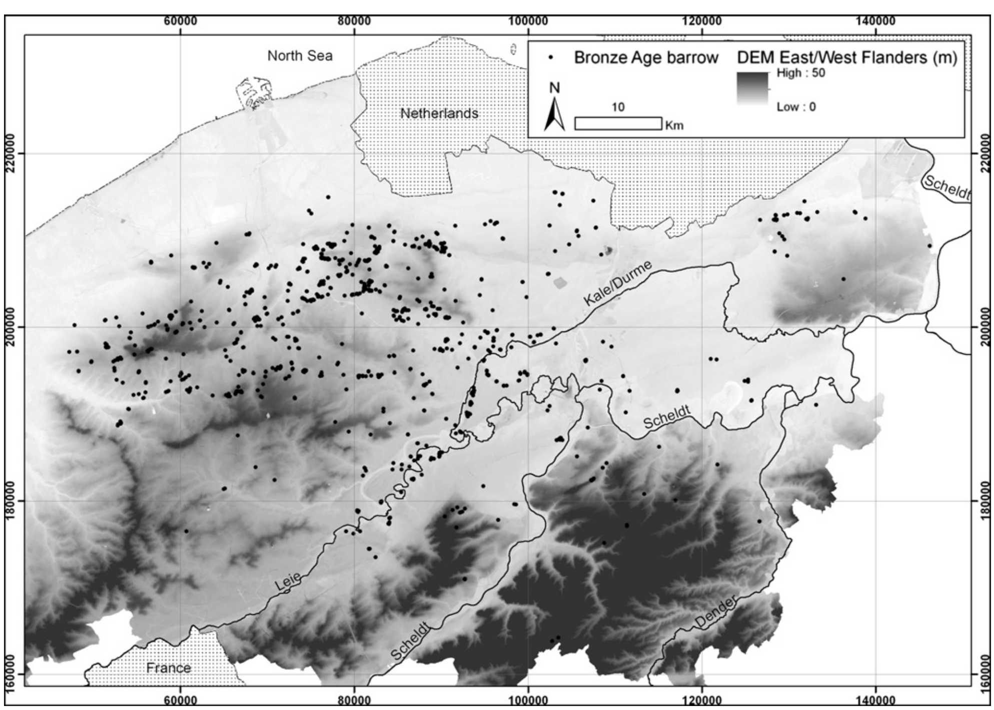


**Fig. 2.** Distribution map of Early/Middle Bronze Age barrows in northwest Belgium, presented on the DEM Flanders (AGIV, 2004).

**Table 1**
Methods for relative topographic position analysis (adapted from Gallant and Wilson, 2000).

| Method | Algorithm | Comment |
|---|---|---|
| Mean elevation (MEAN, $\bar{z}$) | $\frac{1}{n_R}\sum_{i\in R} z_i$ | Calculates the mean (average value) of the cell values in a DEM, around a central point ($z_0$), within a predetermined neighborhood (R). |
| Elevation range (*RANGE*) | $\max_{i\in R} z_i - \min_{i\in R} z_i$ | Calculates the range (difference between highest and lowest value) of the cell values in a DEM, around a central point ($z_0$), within a predetermined neighborhood (R). |
| Standard deviation of elevation (*SD*) | $\sqrt{\frac{1}{n_R-1}\sum_{i=1}(z_i-\bar{z})^2}$ | Calculates the standard deviation (variability) of the cell values in a DEM, around a central point ($z_0$), within a predetermined neighborhood (R). |
| Percentile as percentage of elevation range (*PCTG*) | $100\frac{z_0 - \min_{i\in R} z_i}{RANGE}$ | The ranking of the central point ($z_0$), as a percentage of the elevation range (RANGE), within a predetermined neighborhood (R). |
| (Elevation) percentile (*PCTL*) | $\frac{100}{n_R}\underset{i\in R}{\mathrm{count}}(z_i < z_0)$ | The ranking of the central point ($z_0$), relative to the cell values in a DEM, within a predetermined neighborhood (R). |
| Difference from mean elevation (*DIFF*) | $z_0 - \bar{z}$ | Calculates the difference between the central point and the mean elevation around this central point ($z_0$), within a predetermined neighborhood (R). |
| Deviation from mean elevation (*DEV*) | $\frac{z_0 - \bar{z}}{SD}$ | Calculates the relative topographic position of the central point ($z_0$), as the difference from the mean elevation divided by the standard deviation of the elevation, within a predetermined neighborhood (R). |

*radius*", thus, adding the individual's height to the height value of the DEM at the site location.

For this research, the individual's height is not added to the values of the DEM, as the location before the barrows were erected is being analyzed. The selected neighborhood is a circular area with a 300 m radius. The results indicate that the barrows are located on locations with medium to high PCTL values, as 83.76% of the monuments have percentiles higher than 50% (Fig. 3). The peak can be found around the 60th and 70th percentile levels, illustrated by 22.14% of the monuments having a percentile between 60 and 70 and an average percentile of 66.95.

Unfortunately, the calculations turned out to be very time-consuming and computationally intensive, thus making it unrealistic to attempt to calculate the PCTL for every DEM-cell ($5 \times 5$ m) in the entire study area. Even to test the significance of the results with a significant number of random distributed points (Monte-Carlo simulation of 100 up to 1000 samples containing 1105 random points), which act as a background area, turned out to be unrealistic. This computational disadvantage was also mentioned by both Llobera (2001) and Gallant and Wilson (2000). Considering these time-consuming and computational problems, alternative methods were applied and evaluated in order to test the significance of the results and to use multiple neighborhood sizes.

### 3.2. Difference from mean elevation (DIFF)

DIFF measures the relative topographic position of the central point as the difference between the elevation of this central point and the mean elevation within a predetermined neighborhood (Table 1) (Gallant and Wilson, 2000). The result is a positive value when the central point is situated higher than its average neighborhood, while a negative value indicates a lower location than the average neighborhood. More precisely, this metric value represents the exact difference in height between the central point and the average height of the neighborhood. Consequently, the range of the outcome values depends on the elevation differences in the DEM within the selected neighborhood. Large differences in elevation values result in a wide range of output values. Also, the larger the size of the neighborhood, the wider the range of the output values; a small neighborhood will highlight small environmental features, such a micro-ridges and small stream valleys, while a large neighborhood will mainly delineate the larger, major landscape units. Choosing the most insightful neighborhood size happens through the course of experimentation by formally testing several options beforehand to identify the most useful neighborhood sizes. The calculations can be fast and easily done in ESRI's ArcGIS (Fig. 4) or other GIS packages (e.g. Ducke's GRASS add-on r.prominence uses this algorithm). Also important to mention is that the DIFF algorithm is similar to a high-pass filter (Burrough and McDonnell, 1998; Conolly and Lake, 2006). Fairén-Jiménez (2007) applied DIFF to analyze the relative topographic position of the British Neolithic rock art.

Four circular neighborhoods with radii of respectively 150, 300, 600 and 1200 m were selected for analyzing the relative topographic position. Within the four radii, the large majority of the barrows are situated on grounds which are higher than their neighborhood, respectively 79.60% (150 m), 82.96% (300 m), 81.23% (600 m) and 70.72% (1200 m). A Monte-Carlo simulation of 1000 samples containing 1105 random distributed points acts as background area, allowing comparisons between the barrow distribution and the landscape. The background landscape is subdivided into 20 classes, each 5th percentile, based on their DIFF values. Every class comprises exactly 5% of the background landscape, which allows analyzing the distribution of the barrows over the landscape-representing classes (Fig. 5). The first class, below the 5th percentile, represents the lowest places in the landscape compared to their surroundings, while the highest class, above the 95th percentile, represents the highest places.

Within the 150 m radius, an overrepresentation of the monuments, against the background values, is present between the 65th and 95th percentile, representing grounds which are at least 13.0 and maximum 83.0 cm higher than their surroundings. A random representation occurs between the 30th and 35th, between the 40th and 65th and between the 95th and 100th percentile. An under representation is attested below the 40th percentile, except in between the 30th and 35th percentile. These grounds are at least 8.2 cm lower than their surroundings. Regarding the 300 m radius, an overrepresentation is noticed between the 70th and 95th percentile, grounds between 25.8 and 155.7 cm higher than their surroundings, while an under representation is attested below the 50th percentile, or grounds which are at least 1.3 cm lower than the surroundings. Within the 600 m radius, a similar distribution occurs, with an overrepresentation of the monuments between the 70th and 95th percentile or grounds between 35.9 and 294.6 cm higher than their surroundings. An under representation is attested below the 55th percentile or grounds which are lower than 4.2 cm. Within the 1200 m radius, the observed pattern is different as the distribution shows a "closer" to random pattern. A random distribution appears between the 15th and 20th, the 25th and 40th, the

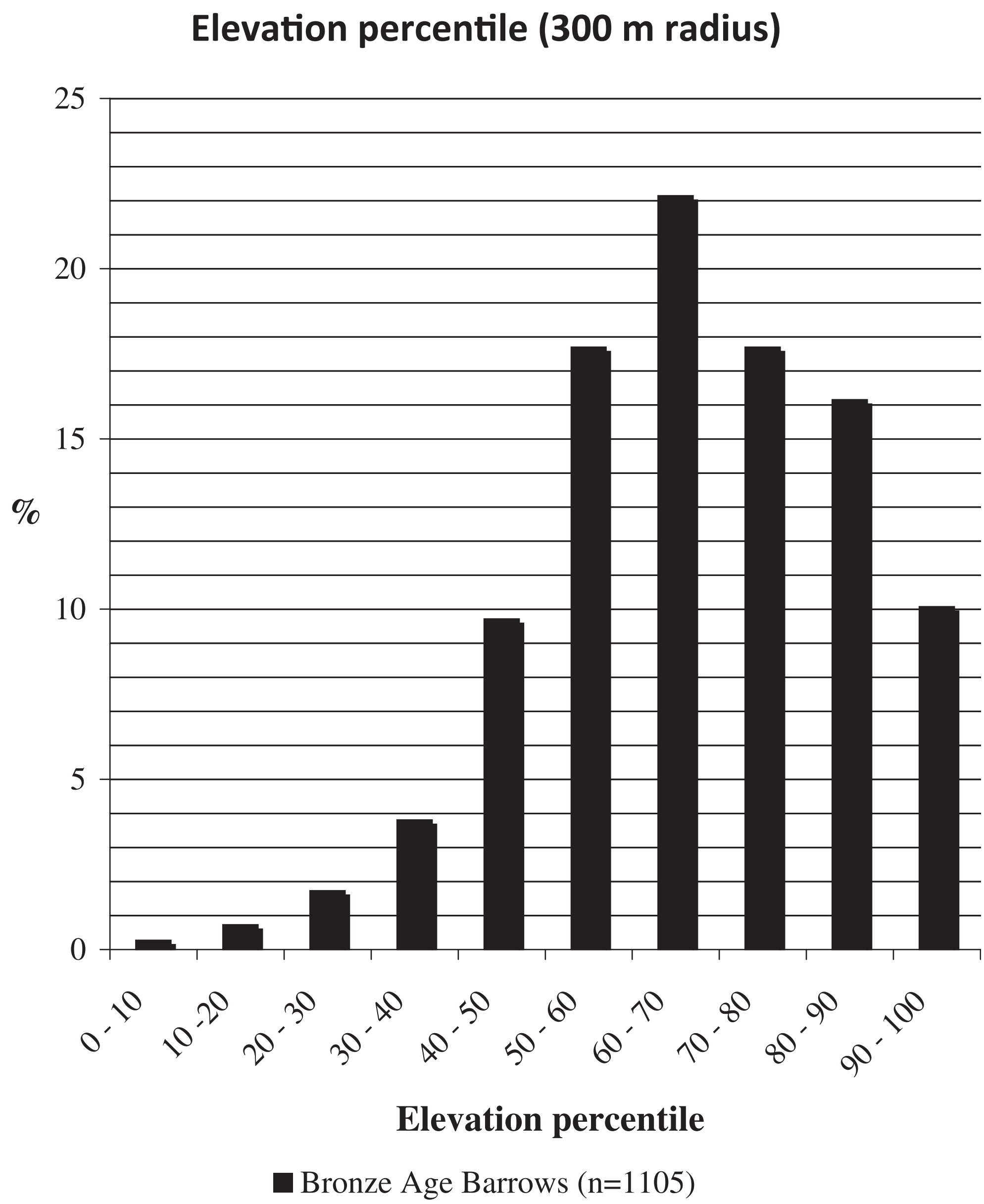


**Fig. 3.** Relative topographic position, within a 300 m radius, of the Bronze Age barrows in Sandy Flanders (NW Belgium), using PCTL.

45th and 70th and above the 90th percentile. An over-representation is attested between the 70th and 90th percentile, representing grounds which are at least 49.7 and maximum 275.4 cm higher than the surroundings.

Important is the global image which can be derived from these analyses indicating that the barrow builders tended to erect their monuments on higher grounds, while avoiding the lower areas. Especially within the 300 and 600 m radii, these observations are most significant. Within the 150 and 1200 m radii, the difference between the background area and the barrow distribution is also significant, however less so than within the 300 or 600 m radii.

A methodology to classify the landscape into morphological classes representing landscape-entities, such as ridges and valleys, is derived from Guisan et al. (1999), Weiss (2001) and Tagil and Jenness (2008). However, also other landform classification methods and algorithms exist (e.g. Deng, 2007; Evans et al., 2009; Park et al., 2001; Pennock et al., 1987; Reuter et al., 2006). The method uses the standard deviation (SD) of the DIFF values of the background landscape. Values higher than 1 SD indicate ridges, while values lower than −1 SD represent valleys. Upslope areas are higher than 0.5 SD, but lower than or equal to 1 SD and lower slope areas are below −0.5 SD, but higher than or equal to −1 SD. The middle slope or flat areas are situated between 0.5 SD and −0.5 SD A threshold slope value of 6° is used to distinguish flat and mid-slope areas (Weiss, 2001) (Table 2). Regarding the Sandy Flanders area, the middle and flat slope categories were grouped and no distinction was made based on slope degrees, as no large slope values appear in the region. Nevertheless, this group was subdivided into two categories based on their DIFF value. The first group of locations has positive values and elevations that are slightly higher than their average neighborhood (0.5 SD $> z_0 \geq 0$ SD), while the second group of locations has negative values and elevations that are slightly lower than their average neighborhood (0 SD $> z_0 > -0.5$ SD) (Table 2).

When applying this classification method to the Sandy Flanders study area, the results are far less satisfying (Fig. 6). On the

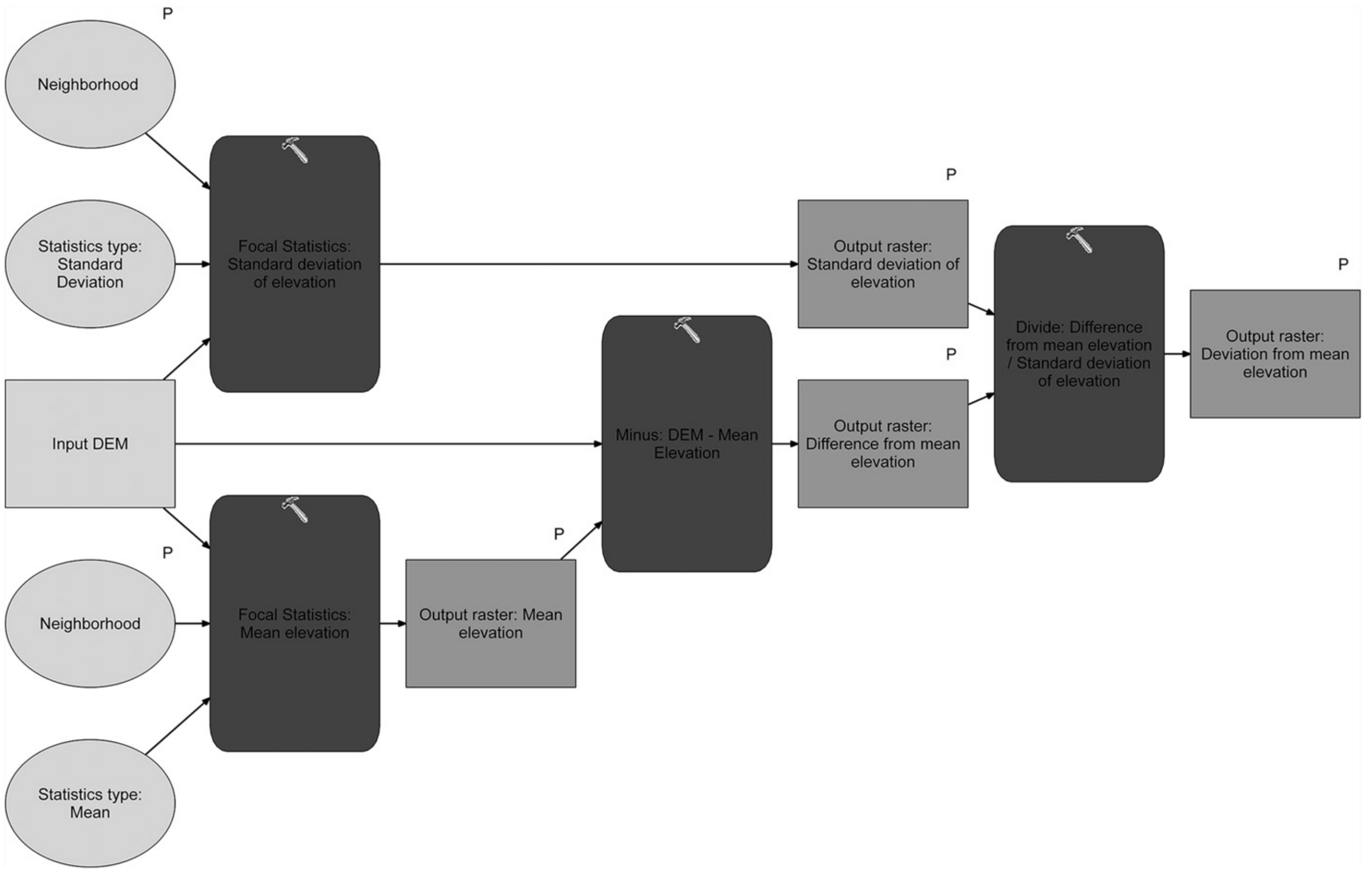


**Fig. 4.** Calculating DIFF and DEV using in ESRI's ArcGIS.

one hand, ridges and valleys only appear in areas with a more pronounced topography, mainly around the tertiary clay outcrops and the major river valleys. On the other hand, the regions characterized by a micro-topography are largely defined as upper, middle and lower slope areas. For example, the small, elongated sandridges along small stream valleys, which are prominent locations compared to their near surroundings, are defined as upslope to downslope areas in this model, as the differences in height are smaller than in areas around the tertiary outcrops. This indicates the influence from the larger (study) area, as the range of the values is still strongly affected by the surface roughness. To reduce the influence of the surface roughness, DEV was applied.

### 3.3. Deviation from mean elevation (DEV)

DEV measures the relative topographic position of the central point as the DIFF divided by *standard deviation of elevation* (SD), within a predetermined neighborhood, where SD measures the variability of the cell values in a DEM, around this central point, within the predetermined neighborhood (Table 1). Thus, the relative topographic position is measured as a fraction of local relief, normalized to the local surface roughness (Gallant and Wilson, 2000). The results from DEV are positive, when the central point is situated higher than its average neighborhood, or negative, when the central point is situated lower than its average neighborhood. The values are mostly ranging between $-1$ and $+1$, although values outside this range are possible. Large values can indicate anomalies in the DEM. Measuring DEV can be easily performed in ESRI's ArcGIS (Fig. 4) or in other GIS packages.

The methodological approach is similar to DIFF. Again, four circular neighborhoods with radii of respectively 150, 300, 600 and 1200 m were selected and the same 1000 samples of 1105 random distributed point act as background landscape. The background landscape is, based on the percentiles, divided in 20 classes, each class comprising exactly 5% of the background landscape, which allows an analysis of the distribution of the barrows over the different classes (Fig. 7).

Within the 150 m radius, an overrepresentation of the barrows appears above the 70th percentile, a random representation between the 40th and 70th percentile and an under representation below the 40th percentile. Within the 300 and 600 m radii distributions are similar. An under representation is attested below the 40th percentile, while an overrepresentation appears above the 75th (300 m) and 80th (600 m) percentile respectively. Within the 1200 m radius, the observed pattern is clearly different, as the pattern shows a random distribution between the 35th and 55th and between the 60th and 85th percentile. An overrepresentation is only attested between the 55th and 60th and above the 85th percentile, while an under representation occurs below the 35th percentile. Again the most significant result can be found within the 300 and 600 m radii, while the results using the 150 and 1200 m radii are "closer" to random (Fig. 7). The results are similar to those derived from DIFF, except for the more right distributed overrepresentation areas in the histogram.

The next step is to divide the background area into several morphological classes representing landscape entities, such as ridges and valleys (Fig. 6). For this, the same methodology and landscape classes are used as described above. This time, however, the picture is more balanced and corresponds more with the local

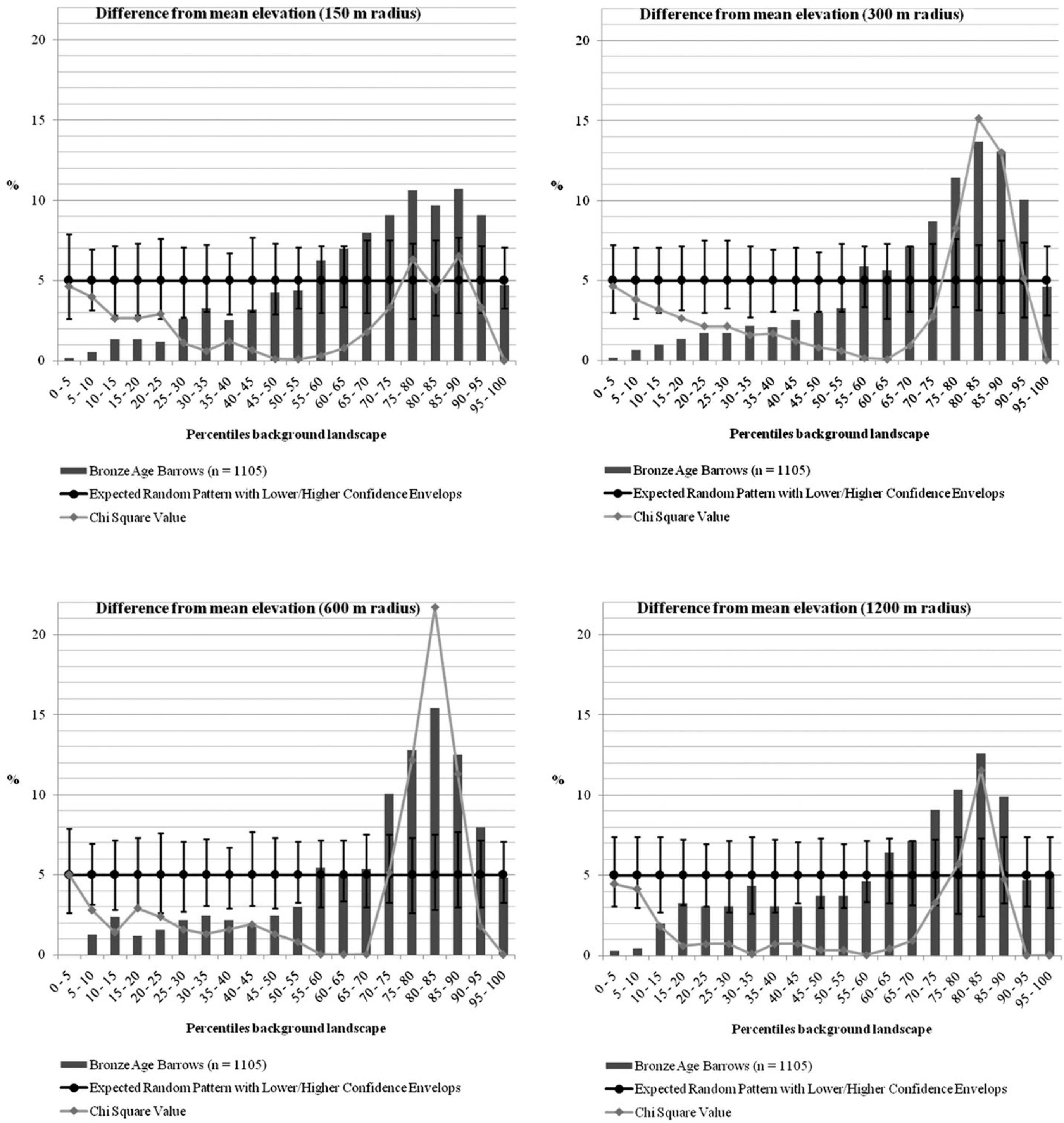


**Fig. 5.** Relative topographic position, within 150, 300, 600 and 1200 m radii, of the Bronze Age barrows in Sandy Flanders (NW Belgium), using DIFF.

topographic reality. Areas defined as ridges correspond in the lowlands with the higher places in the landscape, e.g. the elongated sandridges along the stream and river valleys, while around the tertiary clay outcrops the ridges correspond with the tops of these small hills. The areas defined as valleys correspond in both regions with stream and river valleys or depressions. Also, the middle categories upper, middle and lower slope show a truer and more balanced picture. Thus, DEV results in a more solid, truthful model where the relative topographic position can be approached on a local scale without influences from the larger (study) area.

Regarding the barrow distribution, the most significant results appear within the 300 and 600 m radii (Fig. 8). An over-representation of the monuments is attested on the ridges and the upper slopes, with ±35% and ±25% of the barrows respectively. A close to random distribution appears on the positive middle/flat slopes where ±23% of the monuments were found on ±20% of the surface. An under representation is attested on the lower grounds. About 12% of the barrows appear on the negative middle/flat slope grounds, which represent ±22% of the area. The lower slopes and the valleys seem to be avoided by the barrow builders as less than

**Table 2**
Classification of the landscape in morphological classes.

| Morphologic class | Weiss, 2001 | Sandy Flanders |
|---|---|---|
| Ridge | $z_0 > 1$ SD | $z_0 > 1$ SD |
| Upper slope | 1 SD $\geq z_0 > 0.5$ SD | 1 SD $\geq z_0 > 0.5$ SD |
| Middle slope | 0.5 SD $\geq z_0 \geq -0.5$ SD, slope $>5°$ | Pos. values: 0.5 SD $\geq z_0 \geq 0$ SD |
| Flat slope | 0.5 SD $\geq z_0 \geq -0.5$ SD, slope $\leq 5°$ | Neg. values: 0 SD $> z_0 \geq -0.5$ SD |
| Lower slope | $-0.5$ SD $> z_0 \geq -1$ SD | $-0.5$ SD $> z_0 \geq -1$ SD |
| Valley | $z_0 < 1$ SD | $z_0 < 1$ SD |

5% of the monuments appear on these grounds, which represents ±30% of the area.

## 4. Discussion

Based on these topographic analyses, it can be stated that the Early and Middle Bronze Age populations in the Sandy Flanders region built their burial monuments, despite the micro-topography with small differences in height, on the more prominent locations in the landscape. Ridges and upslope areas were clearly preferred

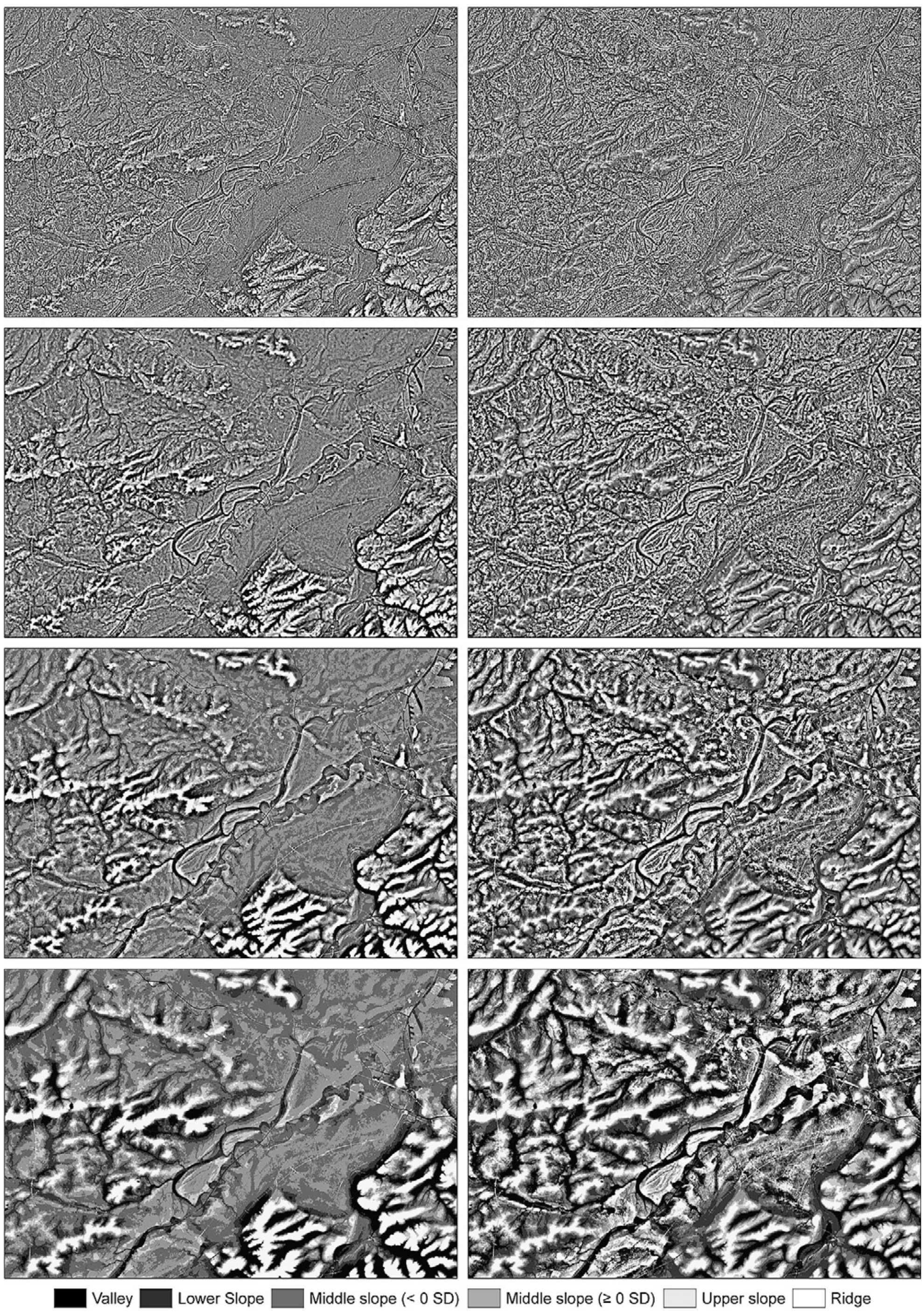


**Fig. 6.** Comparison between DIFF (left) and DEV (right) using 150 (up), 300, 600 and 1200 m (bottom) radii. The output results are subdivided in six morphologic classes (see Table 2).

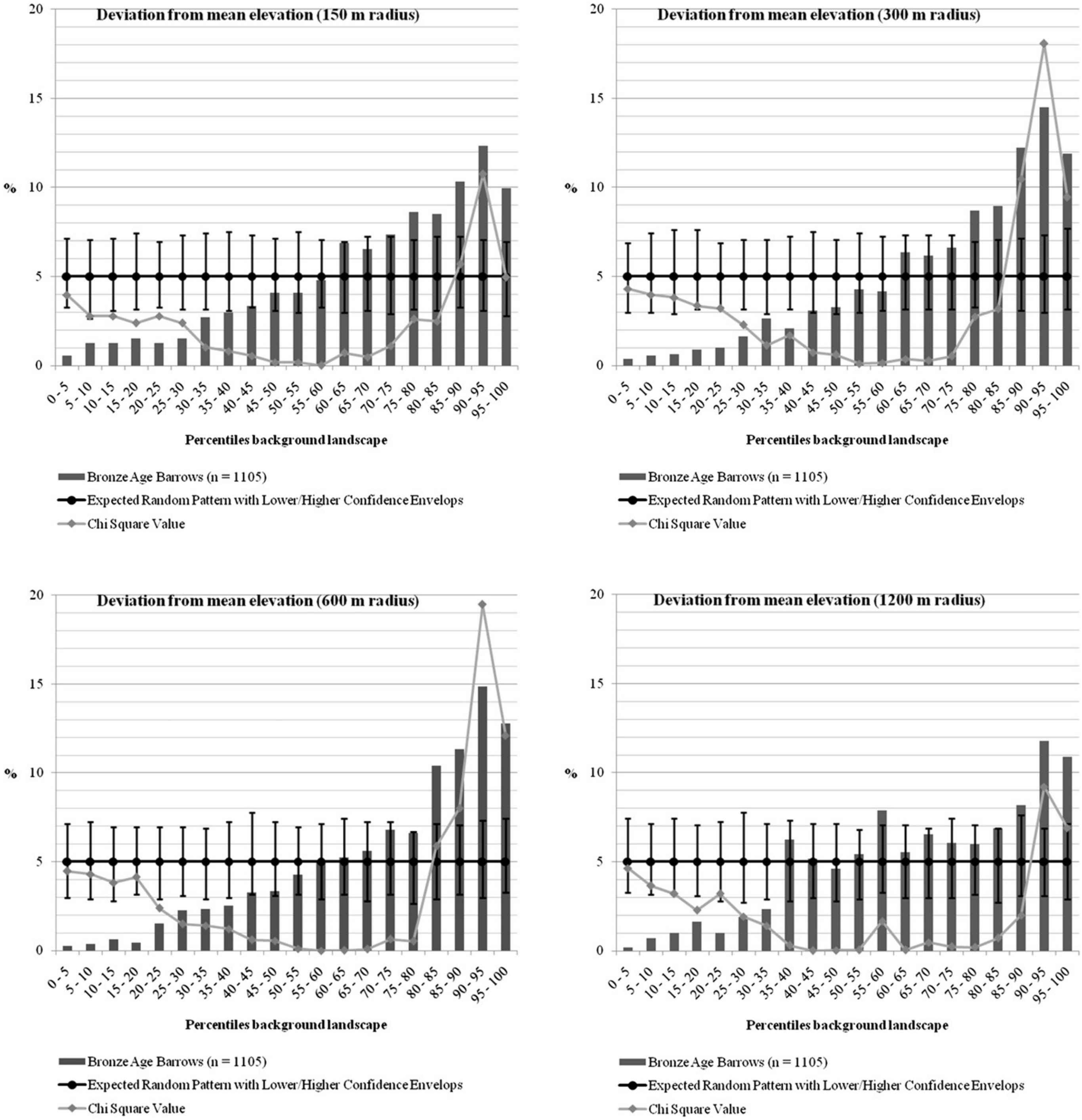


**Fig. 7.** Relative topographic position, within 150, 300, 600 and 1200 m radii, of the Bronze Age barrows using DEV.

over lower-lying areas. The topographic prominence of the barrows is particularly significant at medium short distances (e.g. 300 and 600 m). The larger the radius, the less significant the topographic position, which is partly related to the micro-topography of the region. It is clear that the non-random distribution of the monuments, with clustering on the higher grounds, is the result of structured and intentional decisions. Their prominent topographic location makes them highly visible and it can be suggested that visibility seems to have been an important parameter in choosing where to erect a barrow (e.g. Fisher et al., 1997; Lagerås, 2002; Wheatley, 1995; Woodman, 2000). Barrows were erected on certain prominent locations in the landscape in order to be seen. A reverse viewshed analysis (e.g. reciprocity, Wheatley and Gillings, 2002) indicates that, within a 1.200 m radius (1200 m is the critical viewing distance in the Sandy Flanders landscape, Antrop, 2007), the monuments are visible from, on average, about 77,5% of the surrounding landscape. Barrows also become more visible and prominent when being approached (e.g. Llobera, 2007). Within their visible range barrows dominated the landscape and stood against the horizon. Through their location the barrows acquire

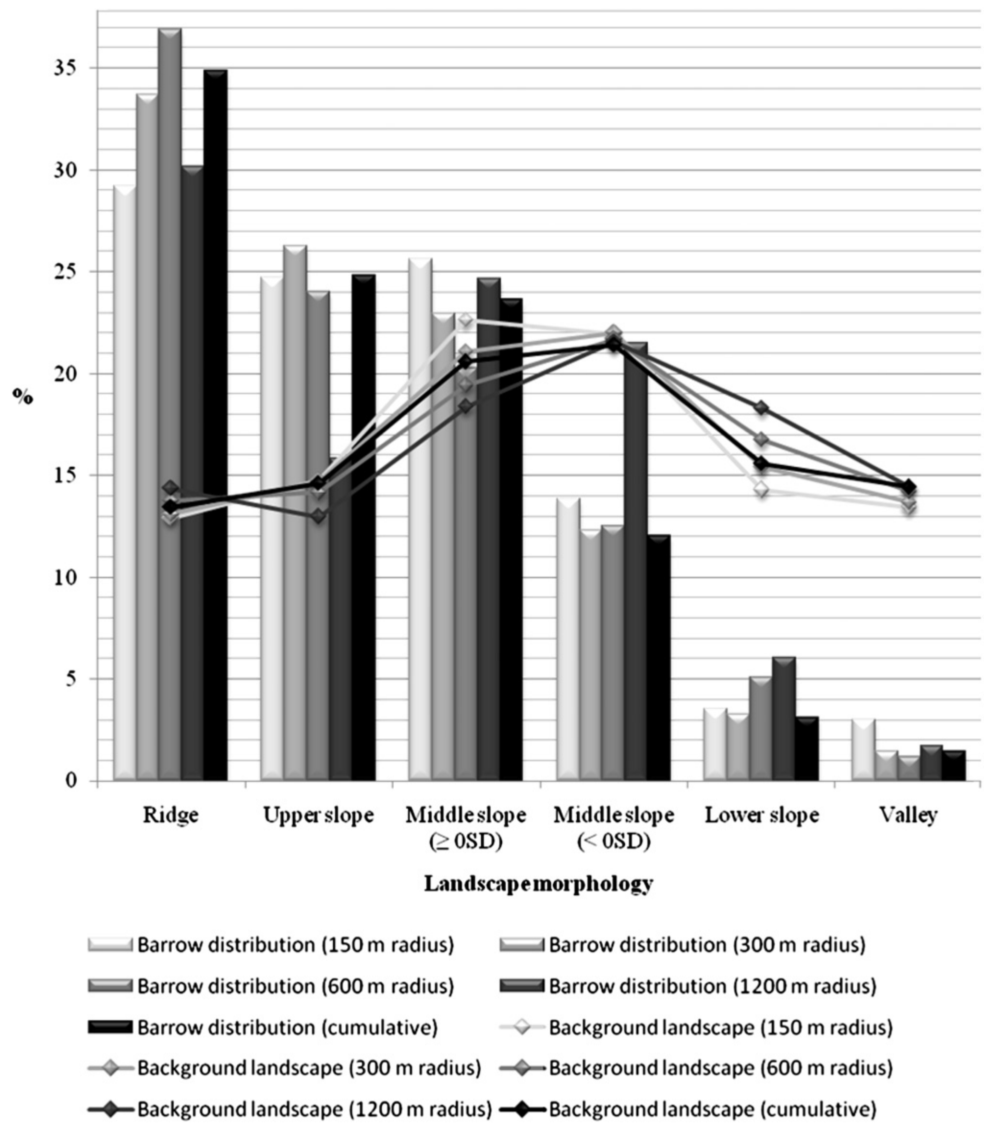


**Fig. 8.** Distribution of the Bronze Age barrows in Sandy Flanders (NW Belgium) over the six landscape morphology classes (see Table 2), using DEV.

a high visual and theatrical potential and renders them marker points in the landscape. As such they can be associated with paths and with channeling movement and travel through the landscape (e.g. Bakker, 1976). Both local people, members of neighboring communities and strangers had to give note to these burial monuments when exploiting, traveling through or entering the territory.

To assess the relative topographic positions of these Bronze Age barrows in the landscape, this paper explored and discussed three algorithms to measure the relative position of a point within the surrounding terrain, each with their advantages and disadvantages. PCTL proved to be useful for investigating relative topographic position in Llobera's (2001) research. For the Sandy Flanders study too the first results were promising. The major disadvantage was that the calculations turned out to be time-consuming and computationally intensive, thus encouraging the need for alternative methods. The first of these alternative methods to investigate the relative topographic position is DIFF, which has proven to be useful especially in regions with few variations in landscape types and a pronounced topography, such as hilly regions incised by numerous streams as shown in the studies by Weiss (2001) around Mt. Hood in Oregon, US, or by Tagil and Jenness (2008) around the Yazoren Polje, Turkey. However, areas characterized by several different landscape types and/or a less pronounced topography—such as Sandy Flanders, characterized by a subtle micro-topography with height differences of only a few meters (lowlands) and tertiary clay outcrops with a more pronounced difference in height up to several meters and higher—turned out to be less suitable, as the range of the values is still strongly influenced by the surface roughness. An advantage of DIFF is the metric output value which represents the exact difference in height between the central location and the surrounding landscape. The last method, DEV, has the major advantage of reducing the influence of surface roughness. This enables the detection of prominent locations in the landscape or analyses of the relative topographic position of archaeological sites irrespective of a pronounced variability in topography or landscape types. The output value is no longer metric, which can be a possible disadvantage. Finally, DIFF and DEV are quickly and easily calculated and thus suitable for implementation in archaeological landscape research, where these methods can offer an added value to other, frequently analyzed topographic parameters such as slope, aspect and curvature.

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