Landscape Archaeology between Art and Science

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1.10 From feature fetish to a landscape perspective: A change of perception in the research of pingo scars in the late Pleistocene landscape in the Northern Netherlands

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ABSTRACT

In the northern part of the Netherlands a number of frost mound remnants are known. Some of these have been interpreted as pingo scars which have historically been regarded as good habitation locations for hunter-gatherers because of their relatively high position in the landscape and their easy access to water. The existence of a direct association between the higher ridges, known as ramparts, of the pingo scars and finds from early prehistory has been a common idea in archaeology in the northern provinces of the Netherlands. Indisputably, pingo scars provide an excellent base for environmental reconstruction as they have been filled with organic sediments from the early Holocene onwards and have proven to be an effective pollen trap, making them indispensable for local palynological research.

In a recent study the connection between archaeological remains, pingo scars and the corresponding landscape was investigated, resulting in an unexpected outcome. The historically assumed association between the pingo scars as isolated features and human occupation thereof seems to be nonexistent when researched on a metadata scale. It was concluded that other parameters lie at the basis of this assumption. The human occupation and its interaction with the landscape seem to be based on much larger environmental elements than these specific features themselves.

KEYWORDS

pingo scars, Pleistocene, Stone Age, landscape archaeology, Netherlands
INTRODUCTION TO PINGO SCARS: DEFINITIONS AND DATES

Frost mounds in general and pingos in particular, are ice-pushed mounds growing in periglacial conditions, such as those at the end of the Weichselian in Europe. When the soil cover of a pingo is pushed upwards due to the growth of the ice lens underneath it, the top of the mound will tear at a certain height and the material will start to slide down (gelification), which leads to the formation of a rampart. The height at which this happens depends on the thickness of the soil cover or overburden. After a while, the top of the ice core will be exposed and can subsequently melt from the radiation of the sun. Eventually, this leads to the melting of the greater part (or the whole) of the ice lens. The mound collapses and a lake surrounded by rampart, also known as pingo scar, is formed (amongst others, Mackay 1972; Watson 1972; Mackay 1979; De Gans 1988).

It is generally assumed that pingo scars in the Netherlands are remains of the Weichselian Ice Age. The exact dates of their formation are hard to obtain because organic material from underneath ramparts is scarce. Accepting that they were formed during the Weichselian glacial places their age at a maximum between 25,000 and 22,000 BP, at which time the Netherlands were part of the continuous permafrost zone. The erosion of the pingos into pingo scars probably took place when the continuous permafrost degraded between 22,000 and 17,000 BP (according to OSL dates on the Lutterzand section from Bateman & Van Huissteden 1999, 282). Weichselian pingo scars in the Netherlands collapsed due to a temperature rise at the start of the Bølling rather than as a result of reaching their maximum height. Lacustrine deposition in pingo scars therefore roughly coincides with the Bølling period and started around 14,700 BP at the very earliest (De Gans 1988, 307). Precise dating of these events is difficult, as the first registration in pingo scars depends on local hydrological conditions and possibly the moment at which the ice lens was formed. Preliminary results of pollen analyses of the infill of a pingo near Twijzel and Jistrum (Frys-

Figure 1. Three stages of pingo scar development after pingo collapse. Stage 1: the pingo becomes a water-filled depression in which gyttja settles. Stage 2: peat grows, following the ground-water level; and Stage 3: a raised bog covers the entire feature.
lân) demonstrate that filling of that particular feature starts late in the Younger Dryas (dated to 10,950 to 10,150 BP) rather than in the Bølling (De Kort 2010). In general, after pingo collapse, there are roughly three stages of pingo scar development (fig. 1).

**PREREQUISITES FOR RESEARCH INTO THE RELATIONSHIP OF MAN AND FEATURE**

The association between pingo scars and archaeological finds is based on the present-day idea of usefulness of these features to prehistoric man. Reasons for visiting pingo scars in prehistory can be twofold at least, the most frequently named being the presence of water. Apart from being of use to man himself, the water in the pingo scar may have been an incentive for animals to visit the spot, making it easier for hunters to find the animals. The second reason may be the (slightly) raised rampart, which may have been a dry location for a viewpoint and camping. The different uses of a pingo scar will not have been evident at all stages of its development. When the accumulated gyttja has reached the water level and peat starts growing, the amount of open water will diminish. At this stage of development, water could still be originating from the swampy conditions of the inside of the pingo scar and as long as the peat does not completely fill the depression, the spot could still be usable for shelter or water supply. The rampart could also still be used as a camp site. All these uses disappear in the third stage, when the pingo scar is fully overgrown with a raised bog. In this stage, it is most likely indistinguishable from the surrounding landscape, which will be a marshy area by then. The most important reason for assuming a significant relationship between prehistoric man and pingo scars is that of the raised rampart in combination with the vicinity of water. As the exact dating of the infill of pingo scars is problematic and, therefore, conditions for research of this hypothesis are unfavourable, the focus will be on the association of archaeological finds and the slightly higher points at which the ramparts will have been placed in the landscape. In order to be able to make specific statements on the association between ramparts and finds, the width of a pingo scar’s rampart was calculated.

**SCOPE OF A PINGO SCAR**

In this paragraph, the width of the rampart is calculated in order to examine the scope of a pingo scar. The definition of ‘scope’ in this respect is the area that can be seen as part of the pingo scar, consisting of the depression and the rampart. Examining the scope of a pingo scar is necessary in order to be able to make statements about which finds can be considered as being on the rampart and therefore in direct association with the feature. Finds beyond the width of the rampart can, in the strictest sense, not be considered to be in association with the rampart.

Using a formula for this exercise may be regarded as an effort to be too precise, while prehistoric people obviously did not use any formula for making decisions as to where they were going to leave their mark, but calculating the width of the rampart is a way of getting a better grasp of what constituted the feature ‘pingo scar’ in prehistoric times. Another important reason for calculating the rampart’s width rather than measuring it in the field or on maps lies in the fact that ramparts have often been flattened and as such are not visible in the field. On contour maps like the ‘Actuele Hoogtebestand Nederland’
(AHN: Digital Elevation Model), their visibility is also limited due to the fact that most of them are located on the banks of (fossil) stream valleys, often making the distinction between the riverbank and rampart difficult.

If, for simplicity the shape of a pingo is considered a cylinder, the formula that can be used for calculating the width of the rampart \( b \) is

\[
 b = \sqrt{r^2 + \frac{V}{\pi d}} - r
\]

in which \( r \) is the radius of the depression, \( V \) is the volume of rampart material and \( d \) is the average height of the rampart (fig. 2).

![Figure 2. Visual explanation of the variables used in the formula for calculating the scope of a rampart.](image)

The formula is based on the calculation of the volume of the rampart material \( V \) as the volume of a cylinder with radius \( b+r \) minus the volume of a cylinder with radius \( r \).

To fill out this formula the radius of the depression \( r \), the average height of the rampart \( d \) and the volume of material constituting the rampart \( V \) are needed. The radius of the depression \( r \) is practically always known, because the diameter of the depression is often still visible in the field or on AHN maps. The average height of the rampart \( d \) is more problematic. The height could be inferred from the AHN data or field measurements, but as said before, most ramparts are not intact and therefore, their height is not the same as it would have been in prehistoric times. The location of most pingo scars on the edges of stream valleys, making them slightly asymmetrical, also means that the rampart is not entirely visible on maps or in the field, making educated guesses to the stretch of a rampart very hard. Assessing the volume of material constituting the rampart \( V \) is even more problematic. The ice lens in the growing pingo will also have been partially below the surface, making the depression slightly larger than the pushed up soil material (overburden) could fill. Soil will also have slid into the depression on the thawing of the ice, leaving less material on the rampart. Finally, some of the sediment could have been blown away while the pingo was growing. Based on these three assumptions, calculating the volume of the infill of the pingo scar will thus generate a number that is too high for the volume of rampart material. A number or formula for the thickness of the soil cover of the ice lens must be found in order to calculate the volume of the rampart material.
OVERBURDEN AND RAMPART VOLUME

In literature, there is little mention of heights of ramparts or overburden (the original soil material that is pushed up by the ice core). The general assumption, when looking at figures in publications seems to be that the overburden is a couple of metres thick, at most. A more detailed written overview will be published in the author’s PhD thesis. Some modern-day active pingos known from literature and their characteristics are listed in Table 1.


<table>
<thead>
<tr>
<th>Name</th>
<th>Diameter (m)</th>
<th>Height (m)</th>
<th>Overburden (m)</th>
<th>Maximum height rampart (m)</th>
<th>Width rampart (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active pingos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverbed¹</td>
<td>90 and 50</td>
<td>12</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Innerhytte¹</td>
<td>400 and 200</td>
<td>28</td>
<td>1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>McKinley Bay²</td>
<td>90</td>
<td>9</td>
<td>1,5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Banks Island³</td>
<td>45</td>
<td>3,4</td>
<td>1,5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Yakutsk³</td>
<td>100</td>
<td>15</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Yakutia⁴</td>
<td>100</td>
<td>13</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ibuk⁵</td>
<td>300</td>
<td>50</td>
<td>15</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pingo scars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pingo L, Cledlyn⁶</td>
<td>135</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>65</td>
</tr>
<tr>
<td>East Greenland⁷</td>
<td>105</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>65-70</td>
</tr>
</tbody>
</table>

CALCULATING RAMPARTS

As stated above, the variables needed to calculate the width of a rampart are the radius of the depression, the average height of the rampart and the volume of rampart material. The first is easily measured in the field or on maps; the second is nearly impossible to measure and is therefore better inferred from modern day active pingos. The third variable can be calculated using the information of modern-day pingos in Table 1. The maximum volume of the rampart material can be calculated by using the general formula for the volume of a sphere cap:

\[ V = \frac{1}{6} \pi \cdot h \left( 3r^2 + h^2 \right) \]

Here \( V \) is the volume of the sphere cap, \( r \) the radius and \( h \) the height of the sphere cap (fig. 3). In order to calculate the volume of material available for the rampart, this formula has to be filled out twice: once
with $h_1$ as the height of the entire pingo and once with $h_2$ as the height of the ice lens (pingo height minus overburden, Table 1). The latter result has to be subtracted from the former and the number thus found is the volume of available rampart material.

The width of hypothetical ramparts was calculated based on the present-day pingos in Table 1 if they were to become pingo scars. This was done in order to achieve a number for the maximum rampart width based on the overburden, which is the available soil material that was pushed up by the ice. The width of the rampart was calculated for three different average heights of the rampart: 0.5, 1 and 2 m. These numbers were used because a rampart will generally be relatively wide and not very high: the material slides down while the ice core is already exposed and is fanned out rather than heaped at the foot of the ice core, much like material sliding down from mountains. Ramparts in the Netherlands are mentioned to have maximum heights of less than 1.5 m (Maarleveld 1976, 58), and are seldom reported to exceed that height in Scandinavia (Svensson 1976, 35). The highest rampart reported in Wales is 7 m, whereas the highest known Belgian rampart is 5 m (Maarleveld 1976, 61). Average heights for the entire rampart will obviously be lower than the maximum height of the top of the rampart and therefore the calculations performed use a maximum average height of 2 m.

Because the pingos of Riverbed and Innerhytte are asymmetrical, the average diameter (and thus radius) was used. With 15 m the Ibyuk pingo has a very high overburden and is probably the highest in the world (Pissart 1988). The depth at which the ice core usually starts is roughly between 2 and 10 m below ground surface (Castel & Rappol 1992, 131; Jorgenson & Osterkamp 2005, 2102), making 2 to 10 m the accepted thickness for overburden. Most of the overburdens seem to be closer to the lower estimate than the higher one (see figures in, for instance, Maarleveld & Van Toorn 1955, 348; Castel & Rappol 1992, 130;Ross et al. 2005, 133-135; Pissart 1988, 282-283).

After calculating the volume of soil material (overburden) that would make up the rampart for the pingos in Table 1, the formula $b = \sqrt{(r^2 + V/\pi d) - r}$ could be used for these pingos, calculating the maximum width of their ramparts at an average rampart height of 0.5, 1 and 2 m respectively. The results of this exercise are listed in Table 2. It is obvious that in this survey, the Ibyuk pingo is an outlier at almost ten times as wide a rampart can stretch compared to any other pingo used for this calculation. It is a large pingo in all respects, with a diameter of 300 m and a height of 50 m. Even though it is an extraordinary pingo, it was included in the calculations, because a few of the pingo scars in the Netherlands have a de-
pression of (almost) 300m, and not using it might be biasing the outcome of the calculations. It has to be mentioned however that none of the pingos in the research area used in this paper are that large. When the characteristics for the individual pingos were calculated, the average width or stretch of a rampart was calculated for the average rampart heights of 0.5, 1 and 2m. These widths are 102, 63 and 37m respectively, which means that a very slight rampart height of 0.5m the distance the rampart material stretches from the edge of the depression of the pingo scar is 102m at most. Finds beyond that distance can, in the strictest sense, not be considered to be in association with the pingo scar or its rampart.

The average scope of a pingo’s rampart was calculated in order to have a number that could be used as a rule of thumb for what should be considered as part of a pingo scar. By calculating the average maximum stretch of a rampart, a tentative distance from the depression’s edge can be quantified, rather than saying something is ‘near’ or ‘close’ to the pingo scar. In the next paragraph, the actual scope of a rampart will be discussed and a finer definition for ‘in association’ will be suggested.

Performing such a suggestively exact calculation was considered necessary for a number of reasons, the first being that simply measuring ramparts on maps will give insufficient data. Most ramparts have been disturbed or flattened and will not represent the rampart’s width as it must have been in prehistory. A second problem is the result of the location of pingo scars on the banks of (former) river systems and in stream valleys. On contour maps made with GIS, it is often hard or impossible to distinguish (part of) the rampart from the river bank or sand ridges they lie adjacent to. When in literature pingo scars are mentioned as being nearby archaeological sites, there is no way of knowing what is considered to be ‘nearby’ by the authors, or if a (palaeo) water source was responsible for the choice of location. Even setting aside the fact that there may be an underlying topography the prehistoric people used (that we need to study in order to get a better understanding of the landscape they moved in), we need to get a clearer picture of

### Table 2. Results of the calculations of the scope of a rampart of Arctic pingos mentioned in Table 1. The width of the ramparts is given for an average height of the rampart of 0.5m, 1 and 2m.

<table>
<thead>
<tr>
<th>Name</th>
<th>Diameter (m)</th>
<th>Overburden (m)</th>
<th>b (m) at d=0.5</th>
<th>b (m) at d=1</th>
<th>b (m) at d=2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverbed</td>
<td>90</td>
<td>1</td>
<td>19</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Innerhytte</td>
<td>400</td>
<td>1</td>
<td>64</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>McKinley Bay</td>
<td>90</td>
<td>1.5</td>
<td>27</td>
<td>15</td>
<td>8</td>
</tr>
<tr>
<td>Banks Island</td>
<td>45</td>
<td>1.5</td>
<td>13</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Yakutsk</td>
<td>100</td>
<td>4</td>
<td>65</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td>Yakutia</td>
<td>100</td>
<td>3</td>
<td>52</td>
<td>30</td>
<td>17</td>
</tr>
<tr>
<td>Ibuk</td>
<td>300</td>
<td>15</td>
<td>472</td>
<td>303</td>
<td>187</td>
</tr>
<tr>
<td>Averages</td>
<td>160</td>
<td>3.9</td>
<td>102</td>
<td>63</td>
<td>37</td>
</tr>
</tbody>
</table>

### NEARNESS

The average scope of a pingo’s rampart was calculated in order to have a number that could be used as a rule of thumb for what should be considered as part of a pingo scar. By calculating the average maximum stretch of a rampart, a tentative distance from the depression’s edge can be quantified, rather than saying something is ‘near’ or ‘close’ to the pingo scar. In the next paragraph, the actual scope of a rampart will be discussed and a finer definition for ‘in association’ will be suggested.

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what is ‘close’ and what constitutes as part of the pingo scar. Based on the characteristics found in literature, the maximum average scope or width of a pingo scar’s rampart was calculated to be about 100m, but would often be much less as one very large example was included in the calculations (Table 2). Any finds beyond that distance will have to be seen as being outside the rampart and therefore, not directly associated with the pingo scar. A recent study into the location of prehistoric finds in regards to water sources has shown however that most finds concentrate in an area between 100 to 250m from the water’s edge (fig. 4).

**QUANTIFYING NEARNESS**

Using the outcome of the calculations of the average width of a rampart for quantification of association is done using statistics. The results obtained from calculating the radius of ramparts were used as a starting point for a statistical test of several areas in Friesland.

In Archis, a Dutch database of the Cultural Heritage Agency, archaeological finds and monuments
can be plotted on different maps and, when plotting them on the geomorphological map, the link between pingo scars and archaeology seems to be missing. A simple statistical test was performed using such maps based on the geomorphological map and registered archaeological finds. The aim of the test was to determine whether or not there is a significant difference between the amount of finds reported in or directly adjacent to pingo scars and the amount of finds not associated directly with pingo scars.

The null hypothesis ($H_0$) is that there is no statistically significant difference between the number of finds near pingo scars and finds in other locations. The alternative hypothesis ($H_1$) is that there is a significant difference. Because the $H_1$ is expected to occur in one way only (namely, the significant difference will be in the association of pingo scars with archaeological finds, not the area outside the pingos), the test was performed one-tailed. In statistics, there are two classes of mistakes possible as a result of an either too strict or too broad significance level. An $\alpha$ mistake means the null hypothesis is rejected although it is correct, whereas a mistake of the $\beta$ kind means the null hypothesis is wrongly accepted (Siegel & Castellan 1988, 8-9). The significance level in this case should be the stricter .01 level to correct for mistakes of the $\beta$ kind, because of the diversity in sampling due to the provenance of the data: coming from an open source such as ARCHIS, chances for differences in methods of collecting and sampling are large.

Several geomorphological maps of areas with a lot of known pingo scars were created. The areas chosen have the highest density of pingo scars in Friesland (and indeed in the Netherlands) and in-

Figure 5. Example of one of the maps made in Archis, showing pingo scars as water-filled depressions on the geomorphological map. Archaeological finds present in the Archis database are shown on the map as red dots. One square on the map represents one hectare (100 x 100m). Created in Archis, Rijksdienst voor Cultureel Erfgoed. See also full colour section in this book
clude the environs of Twijzelerheide, Waskemeer, Siegerswoude, Surhuisterveen, Bergum, Wijnjewoude, Drogeham and Ureterp. The locations of registered finds were plotted onto these maps in Archis (fig. 5).

The criterion used in deciding whether a find was in association with a pingo scar or not was that it lay within 102 metres of the edge of the pingo scar. This number is the maximum average width of ramparts of the pingos in Table 1 at a rampart height of 0.5m. The smallest height was chosen for this exercise, as it gives the biggest area for a rampart. This way, the chances of a find being within the width of a rampart and thus being in association with a pingo scar were greatest. Using a higher rampart in the calculations would lead to a smaller area of that rampart, thus diminishing the chances of archaeological material being found within the range of the rampart. By using the slightest height, the conditions for finding an association between pingo scars and archaeological finds were at its most favourable.

Each map represented an area of 23 km$^2$. Per map, the total area occupied by pingo scars including the average rampart width of 102m was calculated. $\pi r^2$ was used to calculate the area of each individual pingo scar. To ensure the best chances of an association between pingo scars and archaeological finds being revealed, the depression within the rampart of each of these pingo scars was taken out of the equation. The reason for that is to be found in a research bias: all of the pingo scars visible on the soil maps have a water-bearing depression. These depressions will therefore positively never be included in field work, as coring in them is time consuming and difficult (one has to use a boat or wait for a severe winter to freeze the water into ice strong enough to carry people). Including these water features in the area of the pingo scars could lead to the conclusion that there are no finds from these areas, which in the end could then lead to the conclusion that prehistoric people avoided these areas, because nothing will be found in them. That would however be the result of a lack of work of modern researchers, not of negative favouritism on the prehistoric people’s part. The area that was included in the statistical analyses is therefore made up of the ramparts of all the pingo scars on the maps. As stated before, these have been calculated to be 102m wide on average at maximum.

The sum of all ramparts per map together is used as the area belonging to the pingo scars. The strongest statistical test for analysing 2x2 contingency tables is Fisher’s Exact (Siegel & Castellan 1988, 95-104). This test was used in all cases. The results are displayed in Table 3. The p values range from .17 to .78, which means the relationship is highly insignificant (the significance level was .01), in other words, the distribution of finds has a great chance of being random rather than showing a specific preference for pingo scars. It therefore seems reasonable to accept the $H_0$ in all cases, which means that based on statistical analysis, there is no reason for assuming a significant difference between the number of archaeological finds on ramparts of pingo scars and those outside these features.

There are some comments to be made on the source of the data used in this statistical exercise. The Archis database is filled out by a large number of people over a long period of time and therefore, not all finds in the database have the same level of detail. Not all records in the database will really be archaeological finds either: some may only be secondary indicators such as charcoal or unworked flint. Besides that, not all material found will be entered in the database, like single finds by amateur archaeologists wanting to keep their find locations secret. However, it is the only national archaeological database we have and errors were deemed as possible on the one side as on the other. For instance, the chance that a find associated with a pingo scar is not a primary indicator is thought to be just as large as the chance that a find in the non-pingo area is not a primary indicator. Therefore, the outcomes of the statistical tests keep their validity, even if not all variables are known to the same detail.
The above table shows that all areas under investigation yield no significant statistical result for the association of archaeological finds and pingo scars. This means that the variation seen in the distribution of archaeological finds in these areas is the result of sampling, measuring and analytical errors, not of actual variation in the archaeological record. In other words, this does not imply that there is any statistical basis to assume prehistoric man favoured pingo scars over other spots in the landscape. It does however give a hint that the idea of pingo scars as a preferable location may be more of a modern-day archaeological provenance than an etic prehistoric view.
PINGO SCARS AND ARCHAEOLOGY: ASSOCIATION OR ASSUMPTION?

With all prerequisites in place for research into the relationship between prehistoric man and pingo scars, research into the origin of this idea can commence. After conducting a literature study and talking to international scholars in both archaeology and geology, the pre-emptive conclusion had to be that the idea of the existence of this relationship is limited to the Netherlands. The suspicion arose that the emphasis put on pingo scars as important prehistoric features is a modern artefact rather than a prehistoric one. Academic archaeological publications of excavations of ramparts or infills of pingo scars are unknown. Pingo scars are mentioned in results of prospective research in gray literature, but none of those have been excavated. The archaeological material presented in these reports is hardly ever unequivocally connected to the pingo scars, and often concerns secondary indicators.

The assumed association between pingo scars as isolated features in a prehistoric landscape and man’s use thereof seems highly contestable. Another hypothesis is that pingo scars as isolated elements within a landscape had no traceable special attraction for prehistoric people and the reasons for choosing a certain location for a certain task has to be found elsewhere. The hypothesis that there is no direct association between pingo scars and archaeology could only be tested adequately if there was a clear definition of the surface and ground cover of a pingo scar and its rampart. A literature survey was performed to gather data on the characteristics of pingos and pingo scars. These characteristics were then used as a basis for defining what can be seen as ‘part of a pingo scar’. To avoid discussions about whether or not something should be considered in association with a pingo scar, these characteristics where also used as a basis for a statistical test. The aim of the test was to see whether there was a significant difference between archaeological finds from within the ‘pingo scar area’ and those outside that area.

A BROADER VIEW

There is no doubt that valuable source pingo scars act as geological elements and as an archive of ecological evidence in earlier times (See for instance Bakker 2003; Hoek 1997; Mook-Kamps & Bottema 1987; De Gans & Cleveringa 1981). Their value as archaeological archives however remains to be seen. Based on the results of this study there are little unambiguous associations between pingo scars and archaeological sites. Most finds associated with pingo scars come from disturbed ramparts or are surface finds in the vicinity of pingo scars. From inside pingo scars, hardly any material is known. There may be a research bias here due to the fact that most pingo scars these days are lakes or completely filled with peat. Research on areas deeper within the depression will be difficult and expensive and therefore not often undertaken. In the cases where pingo scars have been dug out for other than archaeological reasons, finds are seldom mentioned either.

Most artefacts associated with pingo scars are flint tools or débitage. From the periods in which the pingo scars may have been used in prehistoric times (mostly Late Palaeolithic and Early Mesolithic), we often find flint to be the only finds category available. As with all sites above, the flint assemblage is usually made up of surface finds. This assemblage is sometimes combined with artefacts from excavations, though that is virtually never the case in pingo scar research. Most finds in areas around pingo scars have been moved either vertically or horizontally, or both, which makes these find spots unsuitable for spatial
The information that can be gathered from the flint assemblages is in most cases limited to a typological overview of the site, with no direct indications for further use of the environment by prehistoric man.

Pingo scars have a definite value as a research area that is well-defined, both in terminology and physical appearance. Its enclosed structure, combined with organic infill, makes it a potentially undisturbed catchment area for pollen and for dating sediments. If archaeological organic materials such as bone, wood or fibres are present inside pingo scar infill, they have a good chance of being preserved. Even though all these conditions for pingo scars are good to be of value for archaeology, the fact is that there is no reason to assume a particular prehistoric preference for pingo scars. The idea that these small ponds were favoured as a water source and a location on the transition between higher, drier grounds and wet areas seems to be based on their visibility in the current landscape rather than their place in that of prehistoric times. Besides the considerable amount of pingo scars located on the Drents-Friese till plateau, pingo scars in the Netherlands are practically always situated on the slopes of stream valleys or river banks. Most of this relief was formed in the Saalian and is invisible in the current landscape. However, the original relief from that period can be traced on contour maps made with the ‘Actueel Hoogtebestand Nederland’ (AHN: Digital Elevation Model) as a basis. It seems far more likely that river systems as a whole had a strong attraction for prehistoric people. To focus archaeological research on the small parts that are still visible of that prehistoric landscape is neglecting the landscape in its entirety.

In conclusion, these Ice Age features can only be valuable from an archaeological point of view if we see them for what they are: indicators of a now mostly disappeared landscape, capable of inferences to that landscape on a very local scale. Clues for specific prehistoric use or indeed a preference for pingo scar locations have not been found, and are not expected to be unearthed. Rather, this preference is found in modern research questions and as such is a far likelier artefact of these times than of prehistoric origin.

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