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Chapter 8

Northern and central Veluwe

In the northern and central part of the Veluwe (the Netherlands), palynological data was obtained from several barrows that exist in an area of approximately 20 by 20 km (see figure 8.1). In the following sections the palynological results of these barrows will be described and discussed, based on the theory set out in part two of this thesis (Chapter 4-7). This chapter will start with two barrows at the Echoput. All the data from these barrows were collected by the author. Most of the methods described in Chapters 4-7 have been applied to the barrows of the Echoput and therefore these barrows will feature first. The second group of barrows that will be discussed in this chapter is located at Niersen-Vaassen. The data from two barrows of Niersen were collected by the author. The data of all other barrows in this chapter were obtained from other researchers and they will be discussed after the discussion of the Echoput barrows and the barrows of Niersen-Vaassen. At the end of this chapter a pollen diagram derived from a lake sediment (Uddelermeer, see section 8.11) will be presented after all the barrows have been discussed. This pollen diagram will provide more information about the vegetation in the wider surroundings of the barrows.

Figure 8.1. Detailed map of the Echoput and surroundings with the location of all discussed barrows. The map is based on digital elevation model of the AHN (copyright www.ahn.nl).
8.1 Echoput

Close to Apeldoorn two barrows are situated on a small hilltop. The site that these barrows are located at is known as the Echoput. Excavation of these barrows took place in the summer of 2007 (see figure 8.2). For an extensive description of the excavation results see Fontijn et al. (Fontijn et al. 2011)

8.1.1 Site description

Both barrows showed similarities in construction and soil properties. They were both built on a surface in which an Umbric Podzol (Dutch soils classification: Holtpodzol gY30 [see Bodemkaart van Nederland]) had developed. The barrows were constructed of sods that were still clearly visible, which were taken from a Holtpodzol identical to the one they were placed on top of. The old surface was well recognizable in the soil profile (see figure 8.3). The barrows were dated to

9 Bodemkaart van Nederland 1:50.000 toelichting kaartblad 33 west Apeldoorn, p. 27, 67-8.

Figure 8.2. The Echoput barrows one year after they were excavated.

Figure 8.3. A section of Echoput barrow 2 (section 2.1 of barrow 2 in trench 2) with the old surface clearly visible. Photograph by Bourgeois 2012, figure 3.2).
the Middle or Late Iron Age, based on $^{14}$C of charcoal from both ring ditches: 2225±30 BP (GrA-44706; 331-203 cal BC, calibrated with Oxcal 4.2; mound 1) and 2240±35 BP (GrA-44879; 326-204 cal BC, calibrated with Oxcal 4.2; mound 2) as post quem dates. In addition, a terminus ante quem date for mound 1 of 2190±35 BP (GrN-32158; 376-171 cal BC, calibrated with Oxcal 4.2) was derived from charcoal from a pit (S1) that was dug into the mound. The combination of post and ante quem dates and the similarity of both mounds make it likely that both mounds were constructed in the 4th or 3rd century cal BC (Fontijn 2011, 152-153).

Excavation of the surroundings revealed a large amount of features including a round post structure and two other post structures (see figure 8.4). Traces dating to the Late Mesolithic and the Late Neolithic B period have been found underneath both mounds (van der Linde and Fontijn 2011, 60-61; Bourgeois and Fontijn 2011, 85).

The Echoput is a somewhat aberrant place in the local environment. It is one of the highest places in this part of the Veluwe (95 m above Amsterdam Ordnance Datum). The Veluwe exhibits an average yearly precipitation sum that is considerably higher than in most parts of the Netherlands, since orographic precipitation occurs on the elevated parts, like at the Echoput. The moist air is forced to ascend where the landscape is elevated, causing the air to cool down, form clouds and rain out. The local (loamy) soil conditions prevents the water from draining off immediately, which makes the Echoput hill a rather wet place, with pools of water forming regularly (see for a more detailed description Fontijn 2011a, 29-31). The surrounding area is covered with mixed forest (deciduous and coniferous forest). The modern deciduous forest consists mainly of oak coppice (Quercus sp.), with an undergrowth of blueberries (Vaccinium myrtillus) and grasses, but also birches (Betula sp.) and beeches (Fagus sylvatica) are present. The
Figure 8.5a-c. Profile sections of Echoput barrow 1 (a-b) and barrow 2 (c) with the location of the pollen samples indicated. Figure 4a-b after van der Linde and Fontijn 2011, figure 2.17 and 2.18 with changes; figure after Bourgeois and Fontijn (2011, figure 3.8 A with changes).

Figure 8.5a
Figure 8.5b
Figure 8.5c
coniferous forest consists mostly of pines (*Pinus sp.*), together with some Douglas-firs (*Pseudotsuga menziesii*) and Larches (*Larix sp.*). The barrows were located in the forest, overgrown with trees and other vegetation, making them difficult to spot. In 1999 both barrows were consolidated. The above ground parts of the trees found on and around the barrows were removed, and the barrows were covered with white sand to regain their presumed original shape.

### 8.1.2 Pollen sampling and analysis

During the excavation samples were collected for pollen analysis. For each mound, individual samples were taken from different locations in and under the barrows by Bakels and Achterkamp (University of Leiden, the Netherlands). From each mound several samples were taken from the old surface underneath the mounds, where the old surface was clearly visible. In addition several samples from the top (*e.g.* the old surface) of different good recognizable sods of both mounds were taken. The bottom of the ditch around mound 1 and the fill of a small pit (structure 17) that was found underneath mound 1 were also sampled. Sampling was done using methods described in Chapter 4. From these samples a selection was made for analysis, based on the quality (colour and texture) of the soil. An overview of the samples that were taken and analysed is shown in Table 8.1. The location of the analysed samples in the mounds is given in figure 8.4 and 8.5. os = old surface underneath mound.

<table>
<thead>
<tr>
<th>Sample location</th>
<th>Sample name</th>
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<tbody>
<tr>
<td>Echoput 1</td>
<td>Profile 1.9</td>
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<td>Profile 1.9</td>
<td>Sod samples</td>
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<td>Profile 1.10</td>
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<td>Sod samples</td>
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<td>Profile 1.10</td>
<td>Old surface samples</td>
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<tr>
<td>Level 10</td>
<td>Structure 17</td>
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<tr>
<td>Echoput 1</td>
<td>Profile 2.1</td>
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<td>Profile 2.1</td>
<td>Soil profile series</td>
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<td>Profile 2.1</td>
<td>Sod samples</td>
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<td>Profile 2.1</td>
<td>Old surface samples</td>
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<td>Profile 2.1</td>
<td>Old surface samples</td>
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<tr>
<td>Trench 9</td>
<td>Level 1</td>
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<td>Trench 9</td>
<td>Post 27</td>
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<td>Trench 16</td>
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<td>Trench 18</td>
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<tr>
<td>Trench 21</td>
<td>Level 1</td>
</tr>
<tr>
<td>Trench 21</td>
<td>Post 12</td>
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</tbody>
</table>

Table 8.1. Overview of the samples taken from the Echoput barrows and their surroundings. The samples that have been analysed are indicated by a shade. Those with a darker shade did not contain any or not enough pollen. For the exact location of the analysed samples, see figure 8.4 and 8.5. os = old surface underneath mound.
were analysed. These four post features belonged to four different structures (see figure 8.4). A description of the sampling method and discussion can be found in 4.1.5. Chemical treatment and analysis of the samples took place as described in 4.2. For all pollen spectra a pollen sum of ΣAP–Betula (chapter 6) has been used, except for the AP and NAP. These percentages have been based on a total pollen sum. A minimum of 300 arboreal pollen grains (excluding Betula) per sample have been counted by the author of the present work.

8.1.3 Results

For mound 1 four samples of the old surface, four sod samples, a sample taken from the ditch (profile 1.10) and a sample from a small pit (level 10, structure 17) underneath mound 1 have been analysed (see table 8.1). Sample 2 from the old surface did not contain enough pollen to count, as did the ditch sample and the sample from the pit. The remaining samples contained sufficiently preserved pollen. In addition the soil profile underneath mound 1 was sampled, from which pollen could be obtained from 1 to 19 cm below the old surface. From mound 2 the three samples from the old surface and the three sod samples gave good results, although pollen preservation was relatively poor. From the pollen series that was taken the soil profile underneath mound 2 results could be obtained from 1 until 25 cm below the old surface. The samples derived from 25-29 cm were very poor in pollen numbers. Below the results will be described.

Pollen from the old surface underneath the mounds and from the sods

The pollen spectra from the two barrows show no clear differences and therefore they will be discussed together. In addition, no differences could be noted between the pollen spectra from the old surface and the sods of both mounds, so the result description below counts for both the old surface and the sod spectra. The percentage of non arboreal pollen (NAP) exceeds the percentage of arboreal pollen (AP) in all samples (see figure 8.6). Especially heather (Calluna vulgaris) and less but still in considerable amounts Poaceae (grasses) show high percentages. The most abundant tree pollen types are Alnus (alder, 35-70%), Quercus (oak, 15-40%) and Corylus (hazel, 15-25%). The presence of Carpinus (hornbeam) in some of the spectra should be noted. Some Pinus (pine) pollen is present, but it is unlikely that this tree was present in the surrounding forest. Pinus is not a common native tree in the Netherlands in the time period after the Boreal but before the large scale Pinus plantation starting in the 19th century AD (Janssen 1974, 57) and therefore the Pinus pollen in the pollen spectra most likely came from long-distance. This accounts for all pollen spectra that will be discussed. Anthropogenic indicators (cf. Behre 1986) and grazing indicators (cf. Hjelle 1999) are present in all the samples. One pollen grain of Secale (rye) was found in one of the sods (2) of mound 2. Non-pollen palynomorphs were mostly represented by Sphagnum (peat moss) and moss spores, but also algae like Debarya glyptosperma and Zygnema type 314 (van Geel in: van Hoeve and Hendrikse 1998) are notable.
Figure 8.6. Pollen spectra from the soil and old surface samples taken from Echoput barrow 1 and 2. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (= non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours. MIA= Middle Iron Age, LIA= Late Iron Age.
Pollen from the soil profile underneath mound 1

The zones described below are biostratigraphical units, based on palynological changes in the diagram (see figure 8.7). This means they are not automatically equivalent to geochronological zones.

Zone 1

A slight decrease in the arboreal pollen component from approximately 40 to 25% can be seen. This is mainly due to a decrease in Tilia pollen, which starts at 20% and decreases to around 2%. The forest cover in the surroundings of the Echoput was dominated by Alnus. In addition the forest consisted mainly of Quercus and Corylus. A high percentage of heather is present which even starts to expand further at the end of this zone. Besides Calluna vulgaris grasses (Poaceae) were present in considerable amounts as well as Polypodium vulgare (common polypody). Pollen of anthropogenic and grazing indicators such as Artemisia (mugwort) and Plantago lanceolata (ribwort plantain) are present in low amounts.

Zone 2

The expansion of Calluna vulgaris, which started in Zone 1, continues followed by an expansion of Poaceae. The forest cover does not appear to be subject to extreme changes in total, there is however an increase in Quercus and a decrease in Corylus pollen percentage. In addition an increase in Fagus pollen is shown. The anthropogenic and grazing indicators have expanded to some extent.

Zone 3

In zone 3 an increase in Tilia pollen percentage can be seen, together with a decrease in Calluna vulgaris. Poaceae shows an increase as well as most other herbs and ferns.

Pollen from the soil profile underneath mound 2

The zones described below are biostratigraphical zones, based on palynological changes in the diagram (see figure 8.8). This means they are not automatically equivalent to geochronological zones.

Zone 1

In this oldest part of the diagram, a decrease in AP can be seen, from 40% to 20%. The forest at the beginning of this period consisted mainly of Tilia (lime), Quercus and Alnus. A decline of Tilia pollen is notable in this zone, as well as the appearance of Fagus (beech) pollen. The percentage of Alnus pollen shows an increase as well. Heather shows an expansion, as well as Poaceae. Anthropogenic indicators, like Artemisia and Asteraceae tubuliflorae are present in low amounts, grazing indicators like Poaceae, Asteraceae liguliflorae and Plantago lanceolata are present in higher amounts.

Zone 2

In Zone 2 Tilia decreases further until almost no Tilia pollen is found. Corylus shows an increase and the other tree species remain quite stable. Calluna vulgaris fluctuates between 100 and 200%, Poaceae between 50 and 100%. Anthropogenic and grazing indicators are present in higher amounts than in Zone 1. The percentages of ferns and mosses have decreased, as well as Sphagnum.
Zone 3

Zone 3 shows a peak in *Tilia* pollen numbers and a decrease of *Calluna vulgaris*. This is also shown in Zone 3 of Diagram 1. Zone 3 of Diagrams 1 and 2 is based on the top samples taken from the soil profile and it is very well possible that part of the sod above the old surface has been included in these samples. This sod also contains a soil profile, similar to the soil profile underneath the barrow. As a consequence it is likely that these samples do not represent the youngest vegetation composition in this diagram, but older, comparable to part of Zone 2 in the diagram.

In all samples from both soil profiles particles of charcoal have been found.

Pollen from the post features

*Trench 9*

A very low percentage of arboreal pollen grains, 15-20%, can be seen (see figure 8.9). The absence of *Tilia* is notable in comparison to the pollen spectra obtained from the barrows, as well as fairly high percentages of *Fagus* pollen and the presence of *Carpinus*. The herb pollen types are dominated by *Calluna vulgaris*, with percentages over 500%. Grasses show high percentages as well, around 70%. Anthropogenic indicators are present in low amounts; however, the percentage of *Secale* is relatively high.

*Trench 16*

This spectrum also shows a low percentage of arboreal pollen, around 15%. *Tilia* is absent, *Fagus* and *Carpinus* are present in considerable amounts. *Calluna vulgaris* is the dominating species, together with a high percentage of Poaceae. The presence of *Fagopyrum* and *Centaurea cyanus* (cornflower) should be noted.

*Trench 18*

This spectrum is similar to the spectrum from Trench 16, except for a lower percentage of Poaceae.

*Trench 21*

These spectra looks very much like the spectrum of Trenches 16 and 18 as well, including the presence of *Fagopyrum* and *Centaurea cyanus*. Remarkable is the very high percentage of *Calluna vulgaris* found in one of the spectra.

The size of the open space

The minimum size of the open space can be estimated by the amount of sods that was used to build the barrows as has been explained in section 7.1. Knowing the height and the diameter of the mounds and the thickness of the sods the minimum size of the open area that was stripped can be calculated (see also table 8.2).
Figure 8.7. Pollen diagram derived from the series of samples taken from underneath Echoput barrow 1. A percentage diagram is shown, with % based on a tree pollen sum minus Betula. In the AP (= arboreal pollen) Betula is included. In the total NAP (= non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
Figure 8.8. Pollen diagram derived from the series of samples taken underneath Echoput barrow 2. A percentage diagram is shown, with % based on a tree pollen sum minus Betula. In the AP (= arboreal pollen) Betula is included. In the total NAP (= non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
Figure 8.9. Pollen spectra derived from the post hole fill samples. A percentage diagram is shown, with % based on a tree pollen sum minus Betula. In the AP (= arboreal pollen) Betula is included. In the total NAP (= non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
The measurements of the barrows are (van der Linde and Fontijn 2011, 33; Bourgeois and Fontijn 2011, 65):

Barrow 1: \( r=9.5 \text{ m} \) (\( d=19 \text{ m} \)), \( h=1.08 \text{ m} \)
Barrow 2: \( r=7.25 \text{ m} \) (\( d=14.5 \text{ m} \)), \( h=1.0 \text{ m} \)
Sods: average \( h=0.25 \text{ m} \)

The calculated area to be stripped for Mound 2 is 332 m\(^2\). For Mound 1 a correction should be made, because this barrow was not completely spherical, but had a flattened top. Taking this into account, the stripped area for Mound 1 was 902 m\(^2\). A total area of 1234 m\(^2\) was used for sod cutting (see figure 8.10).

The size of the open space can also be estimated by the percentage of arboreal pollen as has been described and discussed in section 7.2. The arboreal pollen percentage of the Echoput barrows is on average only 29%. This implies an open space with an average distance to the forest (ADF) of approximately 300 m.

8.1.4 Discussion

Dating the barrows

The first thing to point to in the palynological results is the resemblance between the two barrows. Pollen spectra from the old surfaces indicate a similar vegetation pattern at the time the barrows were built, which makes it likely that they were built in the same period. This is in line with what was expected on the basis of the \(^{14}\text{C}-\text{datings and the general similarities between the mounds. The occurrence of Carpinus suggests that this period can be placed in the Iron Age (Janssen 1974). Both their contemporaneity as well as their Iron Age dating are in agreement with the excavation results, on the basis of which the dating could be further specified to the late Middle or earlier Late Iron Age (van der Linde and Fontijn 2011, 62; Bourgeois and Fontijn 2011, 87).
The barrow landscape

The similarity of the pollen composition of the old surface and the sods indicates that the sods were cut in the close surroundings of the barrows, where vegetation composition was similar to the spot where the barrows were built. The following discussion about the barrow landscape is based on the results of the samples of both the old surface and the sods of the two mounds, which represent the vegetation composition at the time just before the barrows were built.

Figure 8.6 shows the pollen spectra of the mentioned samples. They indicate that herbs are much more abundant than trees. Especially heather (e.g. *Calluna vulgaris*) and less, but still in considerable amounts, grasses (e.g. *Poaceae*) dominate the herb species. Heather pollen tends not to spread outside the heathland where the pollen is produced (de Kort 2002). This implies that the Echoput barrows were built in an open spot, where heather was the most dominant species. Non-pollen palynomorphs such as *Debarya glyptosperma* and *Zygnema* type 314 (van Hoeve and Hendrikse 1998) suggest the presence of some water at the site, at least part of the year, conditions which nowadays still exist (the pools of water that remain after rain for some time). Anthropogenic indicators are present amongst the herbal pollen. These are dominated by *Plantago lanceolata* and Asteraceae tubuliflorae. Remarkable is the find of one pollen grain of *Secale* in the pollen spectrum from sod 2 of Mound 2. This cereal species (rye) had not been commonly introduced in the Netherlands during the Iron Age yet, however, some early Iron Age finds in northern and western Europe have been reported (van Zeist 1976, Behre 1992). The anthropogenic indicators suggest the presence of human activity at the site, which is consistent with the find of pottery sherds and flint fragments in the sods and the old surface (van der Linde and Fontijn 2011, 59-60; Bourgeois and Fontijn 2011, 87). However, the pollen percentages of anthropogenic indicators are too low to conclude the site was a settlement area or with (former) arable fields nearby. This is consistent with the data from the excavations in the close surroundings of the barrows (Valentijn and Fontijn 2011).

The tree pollen that is present in the pollen spectra is mainly *Alnus, Quercus* and *Corylus*. *Alnus* is likely to have grown on the lower sites in the surroundings of the heathland, where hydromorphic soils occurred like Gleyic Podzols, Umbric and Histic Gleysols. This indicates that alder carr was probably present in the stream valleys in the surroundings of the Echoput hill. The dominance of *Alnus* pollen within the total arboreal pollen content could imply an open landscape where the alder pollen was free to travel in from out of the alder carr, since no other sizeable forest blocked their way. In addition, *Alnus* blooms before *Quercus* and *Corylus* get their leaves, making it easier for *Alnus* pollen to travel freely. *Corylus* is a tree that requires light conditions to grow; it will not be able to survive in the reduced light conditions in a closed forest. The tree requires moist soil, but not wet conditions. It is very likely that *Corylus* grew on the slopes around the Echoput hill, together with *Quercus*, a tree that has also has a preference for soil that is not very wet (Weeda *et al.* 1985, 113). The presence of alder carr in the valleys and the more open vegetation in the surroundings of the barrows indicates that forest clearing had only taken place in the higher and drier places around the Echoput hill. The forest was not cleared recently before the barrows were built, indicated by the presence and the diversity of the herb vegetation. The herb vegetation had already had some time to establish and to develop and the open place must have existed some time before the mounds were constructed. Heath vegetation is not a natural vegetation type in the Netherlands (with exception of the coastal area). This implies that the barrow landscape was already managed to maintain the heathland. The amount of grasses (Poaceae) together with *Plantago lanceolata,*
Asteraceae liguliflorae, *Succisa* (and *Galium*-type could be an indication that the heathland was kept open by grazing (Hjelle 1999) and as such was part of the economic zone of settlements.

The size of the open space

It has already been mentioned that the barrows were built at the same time, or one relatively quickly after the other. The similarity of the pollen spectra from the old surface and the sods indicates that the sods were taken in the near surroundings of the place where the barrows were built. In addition, the similarities between pollen from sods and the old surface underneath the mound and in lithology of sods and the Echoput hilltop all imply that the sods were cut from the Echoput hilltop and not from the hill flanks. Regeneration of heath after sod-cutting takes a period of 5-40 years, depending on the thickness of the sods. Thin sods, preferably containing only the F horizon of the soil, were traditionally used as fuel or as bedding in stables. Regeneration after cutting thin sods takes only 5-8 years (Pape 1970). When thicker sods were cut, containing the A- and E-horizon, regeneration takes up to 40 years. Such sods were for example used as construction material (Stoutjesdijk 1953, cf. Bakels and Achterkamp 2013). Assuming that the period between the construction of the first and the second burial mound had been too short for the heath vegetation to regenerate the open place had to be large enough to cut sods for building two barrows. The soil profile shows that the surface beneath both barrows was not used for sod cutting (Fontijn 2011b, 154), which also implies that the barrows were built at the same time or that at least part of the area had already been kept free from sod-cutting as a reservation for the construction of the second burial mound.

As has been shown in the results, the area to be stripped for Barrow 1 is 902 m² and for barrow 2 332 m², so a total area of 1234 m² was used for sod-cutting. This implies that a minimum area of 1683 m², the surface beneath the barrows included, consisted of open vegetation. Based on the arboreal percentage the open space had an ADF of approximately 300 metre, implying an open area of about 28 ha \((\pi r^2 = \pi \cdot 300^2 = 282743 \text{ m}^2)\). Although this size could have been overestimated (see section 7.3, according to palynological modelling the ADF was probably about 200 m) the open space is considerably larger than based on the amount of sods that had been used to construct the burial mounds. The combination of these two methods builds an image of how the burial mounds were situated in the landscape. The barrows were located in an area that was dominated by a heath and grass vegetation. Trees could probably not be found in the first 200 to 300 metre around the mounds. The barrows, already located on a relatively high place in the environment, were probably even more prominent in the landscape, knowing that the direct surroundings were cleared from both vegetation and the topsoil, creating a bare environment (see figure 8.10). This will have increased their visibility in the surrounding landscape.

The pre-barrow landscape

Based on the theory presented in Chapter 5, the pollen diagrams derived from the soil under Barrows 1 and 2 represent the vegetation development of a certain period before the barrows were built. Since the soil profiles have not been dated the duration of the period represented is not clear (see Chapter 5). The pollen diagrams show that heath was already present at the place where later on the barrows were built since at least the time span that is represented by the diagrams. The presence of an Umbric Podzol (Dutch classification: Moderpodzol) suggests that heath vegetation could not have been present for a very long time, since
ancestral heaths

underneath heath vegetation a Carbic Podzol (Dutch classification: Humuspodzol) soil would develop. This could however take several centuries (Andersen 1979). During the oldest zone represented in the diagram the AP is higher than at the time the barrows were built, 40% compared to 20%. The forest was mainly dominated by *Tilia* and *Quercus* at the drier sites and *Alnus* at the wetter sites. Despite the low pollen counts in some of the lower samples of diagram 2 clear trends can be seen in both diagrams. A decline of *Tilia* is indicated by decreasing *Tilia* pollen percentages. Such developments in forest cover is presumed to have taken place generally in the Netherlands as has been shown by several pollen analyses of lake and peat sediments (Janssen 1974, van Geel 1978). At the same time an increase of *Fagus* is visible in the diagram, comparable to the general increase of *Fagus* in several parts of the Netherlands, since its arrival between ca. 3700 cal BC and ca. 500 cal BC (Fanta 1995). An increase of *Alnus* pollen that can be noticed might be primarily related to the decrease of *Tilia* or could indicate an expansion of the wet forest. The decrease of forest cover seems to go hand in hand with an expansion of the heath vegetation.

At the time the barrows were built vegetation was dominated by heather, at least locally. It is not entirely clear how the open place was created nor what it was used for in the period before the barrows were built. Indications of the presence of human activities at the site in several periods before the barrows were built are evidenced by finds from below and beyond the mounds, although they certainly do not indicate a very intensive use of this site in the Bronze Age or early Iron Age (Louwen *et al.* 2011, 141). The absence of cereal pollen grains and low amounts of arable weeds like *Artemisia vulgaris* in the diagram demonstrate that the location had not been used for crop cultivation. The size of the heathland can be estimated. Based on the ratio of arboreal pollen versus non arboreal pollen, the size of the open space is estimated to have been from approximately 200 metre ADF to approximately 300 metre ADF at the moment the barrows were built. To maintain the heath, the landscape must have been managed. Methods of heath management can involve sod-cutting, grazing, mowing and burning (Stortelder *et al.* 1996, 287).

Sods were cut in the area, at least with the purpose of building barrows. With sod cutting the soil is stripped from all vegetation. For heath to recover it is dependent on re-establishment by seeds that were present in the deeper soil layers or by expansion of surrounding heath vegetation. Recovering of the heath vegetation after sod cutting will take 5-40 years, depending on the thickness of the sods that were removed (see above). The area needed for building the barrows was most likely much smaller than the total heath area in which the barrows were built (see above, r=200 to 300 m). Consequently, sod cutting for the purpose of building the barrows would not be sufficient to maintain the entire heath area. Large scale sod cutting in heathland areas is mainly known from the Medieval Period into the 19th century, when the sods were laid in stables to catch animal dung and subsequently were used on arable fields as fertilizer. Small scale practise of this way of farming may have taken place at the time the *Echoput* barrows were built. There are however no indications of such arable fields in the environment. In addition, manual sod cutting is quite labour-intensive and it is not likely that this heath area was managed by sod cutting alone.

The amount of grasses (Poaceae) together with *Plantago lanceolata*, *Asteraceae liguliflorae*, *Succisa* and *Galium* type could be an indication that the heathland has been grazed (Hjelle 1999). Mowing and grazing are comparable since they both keep the plants down. Grazing is more selective than mowing, with animals having a preference for certain species. Sheep prefer young *Calluna* heath and grass and herb vegetation in between the heath vegetation. They are not very
fond of older Calluna plants (Elbersen et al. 2003). Cattle eat mainly grasses, although some landraces also eat young Calluna plants (cf. Lake et al. 2001, 31). Archaeozoological evidence from several excavations suggests that prehistoric farming communities kept mainly sheep and cattle (Brinkkemper and van Wijngaarden-Bakker 2005, 493). Both sheep and cows are used in present times to maintain heathland areas by grazing. Historical data show that in Medieval Period grazing using only sheep was sufficient to maintain heathland vegetation. A stocking rate of 1 sheep/ha is assumed (Piek 2000). Also in present heathlands several studies mention that an average of 1 sheep/ha/yr should be sufficient to manage the heathland (Elbersen et al. 2003, Verbeek et al. 2006). The size of the stocking rate of cattle in the past is not clear, although it is clear that cattle grazing in Dutch heathlands occurred on large scale before the 18th century (Bieleman 1987). Bokdam en Gleichman investigated the influence of grazing cattle on the development of Calluna heath (Bokdam and Gleichman 2000). A stocking rate of 0.2 livestock unit per hectare per year appeared not to be adequate against invasion by grasses and tree growth. Natuurmonumenten, a Dutch organization that protects and manages nature reserves in the Netherlands, has over 30 years of experience with grazing in heathland areas. They experienced that in dry heathland areas 1 head of cattle per 5-6 ha is sufficient to prevent grasses from getting dominant in heathland areas (Siebel and Piek 2001). This is however in the present environmental circumstances with higher deposition of nutrients, and it is likely that in the past less cattle would have been adequate enough for maintaining heathland vegetation. When an indication of the minimum size of livestock from a prehistoric farming community should be calculated that was responsible for managing the heathland area where the barrows are being built in, an average of 1 sheep per hectare and/or 1 head of cattle per 6 hectare will be used. At the Echoput, based on the ratio of arboreal versus non arboreal pollen grains the area that was covered with heath vegetation at the time the barrows were built is estimated to have been 28 hectare (π . 300²), implying a livestock size of approximately 28 sheep and/or 4-5 head of cattle. Mowing can be seen as a kind of grazing, although grazing is more selective.

Regular burning is also a traditional way of heath management. When the heath is being burnt every 10-20 years the heath vegetation can be maintained by rejuvenating the heath (Mallik and FitzPatrick 1996, Yallop et al. 2006). A combination of burning and grazing is nowadays often applied, which seems to be very effective. Small scale burning provides young vegetation, which is more nutritious to the grazing stock. The remains of charcoal found in all the pollen samples from the Echoput barrows may be an indication that human burnt the heath vegetation. Particles of charcoal have been found elsewhere as well during excavations of barrows and in soil samples that were taken for palynological analyses (Karg 2008). A combination of grazing and burning and perhaps some sod cutting seems a plausible explanation of how the heath was managed at the Echoput.

Posts at the barrow site

The pollen spectra from the four possible structures that have been sampled have a different composition than the barrow spectra. As was discussed in section 4.1.5 the posts might be dated based on their pollen spectra. The pollen spectra from the four posthole structures (see figure 8.4) show a vegetation composition that can be dated to a much younger period than the period the barrows were mainly built in. This is implied by the presence of Secale, which is known as a common crop in the Netherlands only after being introduced during the Roman Period (Behre 1992,
RADAR 2006). In addition, the relatively high percentages of *Carpinus* and *Fagus* indicate a rather young pollen composition. Both species show an increase during the Holocene vegetation development in the Netherlands since the Subatlantic period up to the Medieval Period (Janssen 1974). In addition, all posthole fillings, with exception of the postholes from Trench 9, contained pollen from *Fagopyrum* and *Centaurea cyanus*, which are only present in the Dutch pollen spectra from the Late Medieval period (Bakels 2000, 2012). However, can the dating of the pollen spectra be coupled to the dating of the posts? In other words, can the posts also be dated in the Late Medieval Period? As has been discussed in section 4.1.5, the Medieval pollen could have come from the vegetation that was present at the Echoput hill at the time the posts were placed or they could have infiltrated in the soil from some time before the posts were placed. The posts could then be dated in the Late Medieval Period or later (as a terminus post quem date). The pollen spectrum from the posthole from Trench 9 lacked pollen that indicates the Late Medieval Period and consequently the Roman Period can be assessed as a terminus post quem date for this posthole filling.

What did the landscape look like at the time the posts were placed? The posthole fill pollen spectra indicate a landscape that was more open than during the time the barrows were built. The amount of *Alnus* had decreased. This implies deforestation of the lower sites as well, or a change in soil water content. The barrow site was at this time an open spot as well, but the character of the place had slightly changed compared to the barrow landscape. *Calluna* had expanded at the cost of the forest. The diversity and quantity of other herbs increased. At Trench 21 a very high percentage of *Calluna* pollen can be seen, which is not visible in any of the other samples. This could indicate a local abundance of heather, for example the covering of the roof of the structure could have been made of it.

8.1.5 In conclusion: the history of the Echoput barrow landscape

It is generally assumed that most barrows were built in open spaces in a forest area. However, the origin of these open spaces is little known. The pollen analyses of two barrows at the Echoput show the vegetation history of the open space from a period before the barrows were built. This showed that the clearing in the forest was indeed much older than the barrow, as has been suggested in section 2.3. When and how the open space was created is not known.

From the beginning of the period that our data represent, the open spot was mainly covered by heath vegetation mixed with grasses and several other herbs. The open space, surrounded by a forest of *Tilia* and *Quercus*, had been used for at least a few centuries by prehistoric man. This is indicated by several features dating to the Middle Bronze Age period. The presence of anthropogenic indicators confirms the influence of prehistoric man in the environment. Mesolithic and Bell Beaker features were also present (Louwen et al. 2011), though it is not known if the forest was already cleared by then. Although we did not uncover any evidence for a settlement near the mounds, it is clear that the area has been used by prehistoric man. However, what did they use the open place for since the Bronze Age? It is very likely that it was included in the economic zone of farming communities as grazing grounds, keeping the vegetation open. Based on the high percentage of pollen from Poaceae, in combination with the presence of *Plantago lanceolata*, *Asteraceae liguliflorae*, *Succisa* and *Galium* type, the use of this open spot as pasture is very plausible (following Hjelle 1999). Furthermore, regular burning of heath could have occurred, indicating that a form of heath management was used to keep the area open. The use of fire is indicated by the amounts of charcoal found in the pollen records.
Before the barrows were built the open area seems to have been used solely as a place for the living, since no indications have been found that people were buried there. This changed when the burial mounds were constructed in the later Middle Iron Age or early Late Iron Age. At this time the vegetation surrounding the Echoput hill had changed. The *Tilia* dominated forest had shrunk and forest with a more open character mainly consisting of *Quercus* and *Corylus* had taken its place. The heath vegetation at the open place at the top of the Echoput hill had expanded. This change in vegetation was probably due to human activities, such as burning and cattle grazing. The upper surface of a large part of the heathland at the Echoput hill was stripped in order to get sods for the construction of the barrows. The surface where the barrows were going to be located was left untouched. Whether the barrows were built at exactly the same time or with a short period in between does not change the fact that both places had already been designated as barrow location, based on the observation that the surface underneath both barrows were not used for sod-cutting. The two barrows must have been quite pronounced features in the landscape; placed on one of the highest locations in the area, cleared from surrounding vegetation. It is unknown whether the surrounding landscape was kept open after the barrows were built. However, one of the mounds had been re-used as a burial location (van der Linde and Fontijn 2011, 64). In addition, during the Roman Period and the Late Medieval period (based on palynological dating of the post hole fillings) there was a very large open spot covered with heath vegetation. It is likely that the place had been kept open all this time.

### 8.2 Niersen-Vaassen

In the north-eastern part of the Veluwe several barrow alignments are situated. Several of these barrows were excavated over a series of campaigns. An extensive description and analysis of the barrow alignments have been made by Bourgeois (2013). Barrows not part of alignments are also present in this area. Dating and palynological data are available for five barrows in the area, of which two were part of a larger alignment. In addition palynological data are available from samples taken from a Celtic field present in the same area (see figure 8.11). Combining these data makes it possible to reconstruct the vegetation development in this area from the Neolithic until the Iron Age.

#### 8.2.1 Site description and sample locations

**Niersen, barrow 4 and 6**

The two investigated barrows of Niersen form part of a 6 km long alignment containing at least 46 barrows (Bourgeois 2013). The original excavation of Niersen 4 and 6 took place in 1907 by Holwerda (Holwerda 1908). Holwerda described Niersen 4 as a Bell Beaker tumulus with a height of 1.65 m and a diameter of 36 m. He noticed that this barrow was situated approximately 2.25 m higher than the other barrows in this area. In the barrow a grave was found in which skeletal remains of more than one individual were present. Holwerda decided to take out the entire grave-area after plastering to be able to examine the remains later. This plaster box has recently been rediscovered in the collection of the National Museum of Antiquities in Leiden and has been subject of research by the museum in cooperation with the University of Leiden (Bourgeois et al. 2009). They dated the grave, on the basis of stylistic parallels, to the late Neolithic period (2600-2200 cal BC). Samples for pollen analysis were taken from the sediment in between
the skeletal remains, but unfortunately pollen could not be obtained from these samples. In 1984 the Niersen 4 barrow was consolidated by the ROB (presently known as the Cultural Heritage Agency of the Netherlands). They described the tumulus as a bank-and-ditch barrow with a diameter of 28 m. Niersen 6 was a barrow with a height of 1.50 m and a diameter of 16 m. The tumulus probably dates to the early Bronze Age (Bourgeois 2013). The ROB report corrects the size of the barrow to a diameter of 19 m. During the conservation carried out on the barrow, pollen samples were taken from the old surface underneath both mounds and from the mounds themselves by Groenman-van Waateringe. One sample of the old surface per mound was prepared and analysed by the author. Methods of sample preparation have been described in Chapter 4.

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10 Due to poor documentation it is not completely certain that during reconstruction of the barrows by the ROB the barrows were identified correctly as barrow 4 and 6 (Bourgeois et al. 2009). Samples for pollen analysis were taken during this reconstruction.
Three barrows at Vaassen were excavated by Bursch and Tromp in 1941; re-excavation took place in 1970-1971 by Lanting and van der Waals (1971). During that last excavation samples were taken and analysed for pollen by Casparie and Groenman-van Waateringe (1980, 28, 35).

Vaassen 1 (V1) is a single period barrow radiocarbon dated to 2850-2600 cal BC (Bourgeois 2013, 53). Underneath V1 a sherd of a PF beaker and some flint was found. The original dimensions of the barrow were probably a diameter of 13 meter with a height of approximately 1 metre. Samples for pollen analysis were taken from the old surface. Vaassen 2 (V2) is a two-period barrow of which the first period can be dated to the Bell Beaker Period based on the find of a Veluvian Bell Beaker (Lanting and van der Waals 1971a). The second period is dated to the Middle Bronze Age. The primary barrow was approximately 8 m in diameter and approximately 30 cm high. For the secondary period the barrow was expanded to a diameter of approximately 15 m and a height of 1.40 m. The thickness of the sods used for the second period is approximately 25 cm. Samples were taken from the old surface of the primary mound and from sods belonging to the second period. Vaassen 3 (V3) is also a two-period barrow of which the first period has been radiocarbon dated to 2885-2625 cal BC (Bourgeois 2013, 53). The second period has been dated to the Bell Beaker period. The diameter of the barrow is not known; its surrounding feature measured approximately 7.5 m across. The height
of the barrow was about 0.3 m. Samples for pollen analysis have been taken from the first period from the intermediate ditch and the outermost palisaded ditch (Casparie and Groenman-van Waateringe 1980, 28).

Vaassen, Celtic Field

In the woods west of Vaassen (municipality of Epe), a Celtic field is situated on a 15 hectare heathland and continuing over a surface of almost 100ha. Three parts of the Celtic field were excavated: Vaassen I, II and III (Brongers 1976). Vaassen I was situated at the south boundary of the Celtic field, Vaassen II was situated west of Vaassen I and Vaassen III could be found at the east side of the heathland (see figure 8.12). Sections were made at these locations, revealing a sequence of several layers. These layers, an old surface and three agricultural layers, represent several phases. Local agricultural activities started on an old surface that became partly denuded. Part of the A-horizon of the podzol belonging to this old surface was homogenized and changed into an arable layer. The remaining part of the A-horizon of this podzol is called the denuded old surface (DOS). The arable layer, which does not belong to the bank system of the Celtic field (CF), is called the pre-Celtic field (PCF) layer. On top of the PCF-layer a bank system was constructed, forming a Celtic Field. At Vaassen III an older arable layer was present (OAL) on top of the DOS and underneath the PCF layer. This OAL layer was not present at the other two locations. Underneath the banks the DOS and/or OAL, PCF and CF layers were clearly visible. In between the banks the DOS was seriously disturbed and the PCF and CF layer could not be differentiated from each other. Soil samples were taken for pollen analysis from all layers (see figure 8.12). At Vaassen I samples were taken from or underneath a bank. Three samples were taken from the DOS, one sample from the PCF and one sample from the CF. At Vaassen II a sample was taken from the DOS, underneath a PCF layer that was covered by a bank. At Vaassen III two samples were taken. One sample was derived from the OAL layer that was overlain by the PCF layer. The second sample was taken from the CF layer in the bank that covered this PCF layer. The samples were analysed by Casparie. The pollen data that were published in 1976 (Casparie 1976) were re-used in this research, in addition to the barrow data in the Epe area.

Dating the Celtic Field

Several locations in the Celtic field and the layers underneath were sampled for $^{14}$C. Remains of a farmhouse (Haps type) were discovered at Vaassen I. The house plan was covered by the CF-layer and possibly also the PCF layer (CF and PCF could not be differentiated here). The house was dated by fragments of charcoal to 2420 ± 65 BP (GrN-5498; 671-396 cal BC, calibrated with Oxcal 4.2), dating the part of the Celtic field that was situated on top of the house to 671-396 cal BC terminus post quem. Such farming houses were often found associated with Celtic fields and it well is possible that part of the Celtic field had already been developed when the farmhouse was still in use (Brongers 1976). The DOS is difficult to date and the dating of the samples from the DOS depends on the depth at which they are taken. At Vaassen I the dating of the house plan can be interpreted as a terminus ante quem date for the DOS layer (e.g. 671-396 cal BC); samples were taken approximately 25m west of the house. The pollen spectra, which will be discussed in more detail below, show the presence of Fagus and Carpinus. Carpinus appears in the Netherlands around 1500 cal BC and both...
Figure 8.13. Pollen spectra from samples taken from the barrows at Vaassen, the barrows at Niersen barrows and the Celtic Field at Vaassen. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (arboreal pollen) Betula is included. In the total NAP (non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
Species are known to expand in the Netherlands since the Iron Age (Janssen 1974). Since the percentages of Fagus and Carpinus are still low (<1.5%) a dating of around 1000 – 400 cal BC is suggested.

Traces of post holes have also been found at Vaassen III, covered by the OAL-layer. Charcoal from one of the post holes was dated to 3020 ± 55 BP (GrN-5895, 1418-1114 cal BC, calibrated with Oxcal 4.2). This implies that the first agricultural activities started after 1418-1114 cal BC. The presence of Fagus and Carpinus (respectively 1.5 and 1.3%) suggests a date around 1000 cal BC.

The third date is provided by charcoal found in a pit underneath the CF layer. The pit was dug into the CF layer, since part of the arable layer (PCF and/or CF) had sunk down into the pit. The 14C-date of 1800 ± 55 BP (GrN-5495, 82-352 cal AD, calibrated with Oxcal 4.2) can be considered as a terminus post quem date for the end of the agricultural activities at the Celtic Field. Brongers (1976, 64) argued that this date coincides with the period the Celtic Field came to an end, since this disturbance of the arable layer is probably the result of unstable times during the Roman occupation.

8.2.2 Results

Figure 8.13 shows the results of the pollen analyses of all barrows and the Celtic field. The pollen spectra were placed in chronological order to see the vegetation development in the area. It should be noted that the different phases show some gaps or overlap in time, so the spectra do not show a continuous vegetation development. Secondly, the spectra belonging to the Celtic field could only very roughly be dated (see above). Although the spectra have been derived from different types of samples (barrow versus agricultural layers) it has been decided by the author to all compare them with each other. All Celtic Field spectra probably represent a longer period of time, since the soil has been mixed up due to agricultural activities. The herbal vegetation composition shown by the spectra is very local and cannot be expanded to the barrow sites nearby, but the extra-local and regional forest vegetation probably can.

Phase 1: 2800-2600 cal BC

**Vaassen 1**

The amount of forest pollen represents approximately 57% of all pollen (including spores). The herbal vegetation consisted mainly of grasses and Calluna heath. The surrounding forest mainly consisted of Betula with some Quercus and Tilia, although Betula might also have been present locally on the heathland. Corylus was present in high amounts. In the wetter areas Alnus was the dominating tree.

**Vaassen 3, period 1**

The ratio between arboreal and non-arboreal pollen is the same as that of barrow of Vaassen 1. There seem to be some differences in the forest composition: Quercus decreased, while Tilia increased. There is a considerable decrease in Betula pollen. Grasses have decreased, while heather was able to expand a little. Together with the decline of Betula this could indicate some heath management, for example by grazing activity. This prevented new Betula trees from establishing and grasses from flowering.
Phase 2: 2500-2200 cal BC

*Niersen 4*

Compared to the barrows at Vaassen, which are at almost 2 km of distance apart, there is a great difference in the vegetation composition at Niersen. At Niersen there seems to have been a larger open space, dominated by heather (*Calluna vulgaris*), in which the barrow has been built (AP=32%). There were hardly any *Betula* trees present and the amount of grass was considerable, indicated by pollen percentages of 25-50%. This species-poor heathland could have been maintained by heath management, preventing *Betula* to re-establish and *Calluna* to expand. The surrounding forest consisted mainly of *Quercus*, *Tilia* and *Corylus*. In addition, some peaks can be seen in *Succisa* pollen and fern spores, indicating moist conditions. The *Alnus* forest in the stream valleys seems not to show any differences with that of Vaassen.

*Vaassen 2, period 1*

The vegetation character derived from the pollen analysis of Vaassen 2 is comparable to Vaassen 1 and 3. The percentage of *Betula* pollen is comparable to Vaassen 3. This means that the percentage of *Betula* is higher than in Niersen, but considerably lower than at Vaassen. There seems to be a slight increase in *Quercus* pollen compared to the other barrows of Vaassen.

Phase 3: 2000-1800 cal BC

*Niersen 6*

Compared to the other barrow at Niersen, Niersen 4, there has been an increase in trees (AP=57%). The percentage of tree pollen is comparable to Vaassen II. This increase of trees is probably mainly caused by a decrease in heather pollen. An increase of *Betula* can be seen, although the amount of *Betula* pollen is still very low compared to Vaassen. Re-establishment of *Betula* might have been possible because heath management has been less intensive, also causing the heathland to decrease in size.

Phase 4: 1600-1400 cal BC

*Vaassen 2, period 2*

There has been an increase of tree pollen, compared to all previous phases (both Niersen and Vaassen). All arboreal pollen has increased, except *Quercus* and *Corylus*. Heath seems to remain unchanged. Some Cerealia pollen is present, but only in very low amounts and other anthropogenic indicators are also not very numerous.

Phase 5: 1000-400 cal BC

*DOS, Celtic field*

The percentage of tree pollen is high, accompanied by a low percentage of herbal pollen. The percentage of anthropogenic indicators is very low as well. This suggests that forest was present at this site before the start of agricultural activities. This forest, with mainly *Quercus* and *Corylus*, might have been present when the barrows were constructed, although at that time *Carpinus* and *Fagus* were not part
of it. *Tilia* pollen is present in very low amounts and might have been replaced by *Fagus* and *Carpinus*, confirming a younger dating than the barrows. Alder carr is present in the stream valleys, as in the barrow period.

Phase 6: 1000 cal BC- 150 cal AD

**OAL, Celtic field**

The pollen spectrum of the OAL might represent a period that is older than the period represented by the DOS samples, since this arable layer was present at another location. However, the higher percentage of *Carpinus* and *Fagus* suggests that this spectrum represents a slightly younger period (see also 2.1 and 8.1.4). The percentage of arboreal pollen is considerably lower than in the DOS-spectra, while the amount of cereal pollen and other anthropogenic indicators is much higher. *Calluna* is also present in considerable amounts.

**PCF, Celtic Field**

The sample from the Pre Celtic Field layer is taken from the layer above one of the DOS-samples at Vaassen I described above (DOS1). Compared to this spectrum the percentage of arboreal pollen has decreased, while the percentage of anthropogenic indicators and Poaceae has increased. The amount of cereal pollen is in contrast to the OAL-spectrum very low.

**CF, Celtic Field**

One CF-sample is taken from the layer above the PCF-layer, the spectrum of which is described in the previous paragraph; the other sample is coming from Vaassen III, from the layer covering the PCF layer above the OAL. At both locations the amount of tree pollen has further declined. The *Alnus* forest had not changed or increased some, but the dry forest had decreased in size. Cerealia and other anthropogenic indicators are present, but there is a difference between the CF at Vaassen I and the CF at Vaassen 3: at Vaassen 3 the percentage of cereals is much higher than at Vaassen 2.

The size of the open spaces

The minimum size of the open spaces can be estimated by the measurements of the barrows and the height of the sods that had been used in the construction of the mounds (see 7.1).

The height of the sods is only known for the second period of the Vaassen 2 barrow (0.25 m). Fontijn et al. (2013, 99-100, figure 4.25) have measured the length and thickness of many sods at a barrow site called Oss-Zevenbergen (see also 12.1) and concluded that the average thickness of sods used at that site was on average 20-35 cm. In addition, the thickness of the sods of the Echoput was approximately 0.25 m as well and apparently this is a suitable thickness to build barrows. For the calculations of the other barrows a height of 0.25 m will be assumed as well. This leads to the following minimum areas to be stripped per barrow (see also table 8.2):

Niersen4: 2041 m$^2$, $r_{\text{openarea}}$=25.5 m, based on a circular open spot
Niersen6: 858 m$^2$, $r_{\text{openarea}}$=16.5 m
V1 540 m$^2$, $r_{\text{openarea}}$=13 m
V2 period 1: 30 m$^2$, $r_{\text{openarea}}$=3 m
V2, period 2: 268 m$^2$, $r_{\text{openarea}}$=9 m
V3: 30m$^2$, $r_{\text{openarea}}$=3 m
These numbers indicate minimum areas. The dating of the barrows is not detailed enough to determine whether some of the barrows were built at the same time as was probably the case with the Echoput barrows (see 8.1). Hence, the calculated areas of the Vaassen 1 and Vaassen 3 barrows cannot be added together. Based on the ratio of arboreal versus non arboreal pollen percentages (see 7.2) the open spaces were larger than the stripped area. The ADF of the Vaassen open spot is estimated at 25-100 m. The ADF of the open area at Niersen was at the oldest phase (Niersen 4) 100-200 m and was somewhat smaller (around 50-100m) when Niersen 6 was built.

8.2.3 Discussion

The pollen spectra show that the barrows at both Vaassen and Niersen were built in open places with heath vegetation. The barrows of Vaassen were built in an open spot with an ADF of approximately 100 m based on the ratio AP versus NAP. The open place in which the Niersen barrows were built was larger with an ADF of more than 100 m. Both open spaces were dominated by Calluna heath and grasses. The arboreal pollen percentage is dominated by Alnus, which is probably the result of an alder carr in the lower and wetter parts of the area. The forest of the drier area consisted mainly of Quercus and Corylus, the latter likely to be found at the forest rim. The vegetation of the open space seems stable, since the barrow spectra from all represented periods show similar vegetation patterns: an open place with species-poor grassy heathland surrounded by oak forest with an alder carr nearby. Some Neolithic finds underneath barrow V1, together with the relatively high percentage of anthropogenic indicators in the samples from V1 might indicate that the open space of the Vaassen barrows was used as a settlement area prior to the barrow building. After the barrow was built archeologically visible human activity decreased, leading to the decreased amount of anthropogenic indicators present at the when time barrow V2 was built. This could be an indication of change in function: a place for the living changed into a place for the dead with only the necessary management activities being maintained. The continued maintenance of the heath vegetation from when the oldest barrows (V1, V3) were built continuing to when the younger barrow (V2) was constructed strongly indicates conscious management. This also accounts for the Niersen barrow area in an even more pronounced way. The Niersen barrows formed a long alignment of barrows\(^{11}\) (Bourgeois 2013, 51-66). From this alignment only two barrows were analysed for pollen. However, based on the results of barrows that formed part of other alignments (see Chapter 9) and on the palynological data of all other barrows in the southern and central Netherlands (see the remaining of this chapter and Chapters 9-12), it can be assumed that all barrows belonging to the Niersen alignment were built amongst heath vegetation. During the earliest phase (late Neolithic A) the alignment was at least 1.6 km long containing 6 barrows. With an ADF of 100-200 m it is very likely that the heath areas the barrows were built in were connected to each other, forming a long-stretched heath area. The alignment was extended in the Bell Beaker phase implying an even more extended heath area; Heath that had to be managed to remain in existence. Comparable to the Echoput, barrow management could have taken place by grazing, burning and/or sod cutting. It is not clear from the results whether there are indications of burning the heath. Grazing is indicated by the presence of Poaceae in combination with Plantago lanceolata, Asteraceae liguliflorae and Succisa (Hjelle 1999). A notable difference between the Vaassen

\(^{11}\) The alignment might even have been more extended while part of it might have been destroyed by modern land use
and the Nierson barrows are the high amounts of Betula pollen at Vaassen and the almost absence of this taxon at Nierson. *Betula* is a pioneer tree, meaning that it is one of the first to appear when no management is applied to prevent the tree from establishing. Young *Betula* trees are easily removed by grazers. This could indicate a difference in grazing intensity or management method (grazing versus not grazing) between the two barrow locations. Either this could mean that the barrows of Niersen belonged to another community with different management regimes or perhaps this could mean a difference in importance between Niersen and Vaassen is indicated. Niersen being part of a barrow alignment, while the Vaassen barrows might not be related to this.

The next phase is represented by the DOS (denuded old surface) layer, the surface at which the first cultivation of crops started. This phase shows a higher percentage of arboreal pollen compared to the barrow phases. Although the dating of this layer is very coarse it is likely that this pollen spectrum represents the phase prior to the arable activities, since the amount of cereals and arable weeds is still very low. Probably forest was present at this site, which might very well be the forest that has been recorded in the barrow pollen spectra. The amount of anthropogenic indicators is very low. This could indicate that there was not a lot a human activity in the area. The absence of human influence in the area is also indicated by the sparseness of archaeological finds in the area. From the Middle Bronze Age period onwards there is hardly any evidence for the building of new barrows (Bourgeois 2013). However, older barrows have been frequently used for secondary graves indicating not a total absence of humans in the area. In addition urnfields have been found in the area, including one in the Celtic field of Vaassen.

At the Celtic field sections of Vaassen III the first agricultural activities have been recorded (OAL). The forest had probably decreased in size and at least this site was cleared of trees. The amount of anthropogenic indicators, including Cerealia, and arable weeds like *Artemisia*, is a clear indication for crop cultivation and more specifically the cultivation of cereals. Heather is well represented in the pollen spectrum. Since this spectrum probably represents a longer period, it is likely that heath vegetation was present at the site before agricultural activities started or perhaps during times when the arable fields were abandoned. Another possibility is the presence of heath very close to the agricultural field.

At the Pre-Celtic Field phase the forest that was first present (Vaassen I, DOS) was cleared and agricultural activities were started. The amount of cereals is not very high, but considering that prehistoric cereal pollen do not spread (Diot 1992) it is likely that this spot was used for crop cultivation. The agricultural activities were probably expanded during the next phase, when the Celtic Field system was created. The forest clearance had been furthered at this stage. At Vaassen III cereal cultivation was continued (started at the OAL) and at Vaassen I other crops might have been cultivated.

### 8.3 Ermelo

In the area of Ermelo over a hundred barrows are known to be located, of which 55 have been excavated. During a great campaign in 1952, Modderman excavated 34 of these barrows (Modderman 1954) providing high-quality information on the mounds (Bourgeois 2013). In 1971 a re-excitation took place by Lanting and van der Waals during which two barrows (Ermelo I and III) were sampled and analysed for pollen (Casparie and Groenman-van Waateringe 1980, 29-30, 31).
8.3.1 Site description and sample locations

Several barrow alignments were recognized in this region. The two investigated barrows formed part of one of these alignments and are situated about 125 m from each other (Bourgeois 2013, 78-88; figure 8.14). This barrow alignment is situated at the bottom of a valley on the northern slope of the ice-pushed ridge of Garderen. Ermelo I is a single period barrow, originally excavated by Modderman (1954). The mound probably was surrounded by a palisaded ditch (diameter=5.5 m), that consisted of a broad trench which was filled up after posts were placed. Part of an AOOb-beaker was found in the upper part of the ditch fill (see figure 8.15), dating the barrow to the late Neolithic A. The barrow was re-excavated by Lanting and van der Waals in 1971 (Lanting and van der Waals 1971b, 1976). Samples for pollen analysis were taken from the old surface in and outside the encircling ditch, from the ditch fill (referred to as turfs by Casparie and Groenman-van Waateringe 1980) and from upper part of the ditch fill (referred to as the old surface by Casparie and Groenman-van Waateringe 1980, 31; see figure 8.15). Ermelo III
is a single period barrow. The barrow was originally excavated by Modderman (1954). Two PF-beakers and a flint blade have been found, dating the barrow to the Neolithic A. This barrow is like Ermelo I approximately 0.5 m of height and has a diameter of about 6.5 m. The barrow was re-excavated by Lanting and van der Waals in 1971 (Lanting and van der Waals 1971b). Samples for pollen analysis were taken from the old surface underneath the mound (Casparie and Groenman-van Waateringe 1980, 29-30).

8.3.2 Results

Results will be described per barrow in chronological order. See figure 8.16.

Ermelo III (2900-2500 cal BC)

The pollen spectra from the old surface of Ermelo III show an arboreal percentage of approximately 50%. This arboreal pollen percentage consists mainly of Alnus. Corylus is present in considerable amounts of approximately 35%. Other trees are Quercus (5-10%), Tilia (10-15%) and Betula (5%). The herbal vegetation is dominated by Calluna vulgaris and Poaceae. Some anthropogenic indicators are present in the form of Chenopodiaceae and Asteraceae tubuliflorae. A few pollen grains of Cerealia were also noticed. Grazing indicators are mainly represented by Poaceae and Plantago lanceolata.
Figure 8.16. Pollen spectra from samples taken from the Ermelo barrows. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (arboresal pollen) Betula is included. In the total NAP (non arboresal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
Ermelo I (2600-2500 cal BC)

Compared to Ermelo III the arboreal pollen percentage seems to have slightly increased to 55%. The main tree is still *Alnus*. *Corylus* is also still present in high amounts (35%). The amount of *Tilia* seems to have decreased to 5-10%; the amount of *Quercus* seems to have slightly increased to 10-15%. *Fagus* has appeared, although still in very low numbers. *Betula* expanded from 5% at Ermelo III to 20% at Ermelo I. The heather seems to have expanded with percentages up to 125% at cost of *Poaceae*. No indications of *Cerealia* have been found. Other anthropogenic indicators such as Asteraceae tubuliflorae and Chenopodiaceae are present in low amounts.

The size of the open space

Based on the measurements of the barrows the minimum size of the open area has been calculated (see also table 8.2). Since the height of the sods is not known a standard height (known from the Echoput and Vaassen barrows) of 0.25 m has been applied. This gives the following estimates of open area:

- Ermelo I: 33.4 m², \( r_{\text{openarea}} \approx 3.3 \) m, based on a circular open spot
- Ermelo III: 24 m², \( r_{\text{openarea}} \approx 2.7 \) m

Based on the ratio AP:NAP, the open space had an ADF of approximately 50-100 m. The open spot might have decreased a little at the time Ermelo I was built (AP=55% for Ermelo I and AP=50% for Ermelo III). The relation found between arboreal pollen percentage and size of the open space (see 7.2) is not detailed enough to explain this difference in percentage by a difference in distance to the forest.

8.3.3 Discussion

The vegetation composition in the area of the Ermelo barrows in the late Neolithic seems to be quite similar to the late Neolithic phase of Vaassen (8.1.2). The barrows were built in an open space with an ADF of 50-100 m with a vegetation cover of mainly heather and grasses. When the first barrow (Ermelo III) was built the heath seemed to more grassy than when Ermelo I was built. The two investigated barrows were part of a barrow alignment implying that they were built in a long-stretched heath area (see also 8.2.3 and chapter 9). Management is required to maintain such areas of heath. The increased amount of *Betula* could indicate a change in management regime making it possible for *Betula* to expand. This is also indicated by a slight decrease in anthropogenic and grazing indicators. An extensive alder carr must have been present in the stream valleys close to the barrows indicated by *Alnus* pollen percentages of approximately 45%. The dry forest was most likely quite open with mainly *Corylus* and some *Quercus* and *Tilia*.

8.4 Putten

8.4.1 Site description and sample locations

Close to the village of Putten, approximately 5 km to the southwest of the Ermelo barrows, a burial mound is situated (see figure 8.1). This barrow was excavated by van Giffen in 1947 and a sample from the old surface was analysed for pollen by Waterbolk (1954, 93-94). During this excavation a PF-beaker was found together with a battle axe, a Grand Pressigny dagger, a flint axe and four flint flakes. Three secondary interment Bell Beakers were buried in the mound.
Figure 8.17. Pollen spectra from the samples taken from the Putten barrow. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours. LNEO-A= Late Neolithicum A.

Figure 8.18. Pollen spectra from the samples taken from the Vierhouten barrow. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
(Waterbolk 1954, 93). The old surface contained fragments of PF-Beakers that might indicate a former settlement site (Casparie and Groenman-van Waateringe 1980, 30). Re-excavation of the barrow took place in 1971 for pollen sampling. Samples were taken from the old surface. Results have been published by Casparie and Groenman-van Waateringe (1980, 30). Measurements of the mound are not known.

8.4.2 Results and discussion

See figure 8.17

The first thing to notice is the difference in pollen spectra from the sample published by Waterbolk and those published by Casparie and Groenman-van Waateringe. The Waterbolk spectrum shows an arboreal pollen percentage of approximately 75%, while the arboreal pollen percentage in the spectrum published by Casparie and Groenman-van Waateringe is only 30%. The differences seem mainly to have been caused by high percentages of Poaceae and ferns in the Casparie and Groenman-van Waateringe spectra, which are very low or absent in the Waterbolk spectrum. Waterbolk mentioned the bad conservation of pollen in his sample. He did not reach a pollen sum of 300 arboreal pollen grains and as a consequence this spectrum might not be representative. However, it is difficult to conclude this being the cause of the dissimilarities. Yet, it is difficult to interpret these results. Some similarities can be seen. All pollen spectra show very low percentages of Calluna vulgaris, indicating that the open space did not contain a lot of heather. This could be the result of a small open space (as in the Waterbolk spectrum) or a larger open space that was dominated by grasses (as in the Casparie and Groenman-van Waateringe spectra).

8.5 Vierhouten

8.5.1 Site description and sample locations

Close to Vierhouten (see figure 8.1) a single period barrow was excavated in 1939 by A.E. van Giffen. Two Veluvian Bell Beakers and a wrist guard were found dating the barrow to the late Neolithic B period (2500-2000 cal BC, see table 2.1). Measurements of the mound are not known. In 1972 a re-excavation took place by Lanting and van der Waals (1972c). At that time samples for pollen analysis were taken from the old surface. One sample was analysed and published by Casparie and Groenman-van Waateringe (1980, 36).

8.5.2 Results and discussion

The pollen spectrum (see figure 8.18) shows an arboreal pollen percentage of approximately 56%, which indicates an open place with an ADF of approximately 50-100m. Trees in the surroundings are dominated by Alnus and Corylus, which both occur with pollen percentages of approximately 40%. Quercus, Tilia and Betula are present in less but still considerable amounts of circa 10%. The open spot was mainly covered with Ericaceae, most likely Calluna vulgaris. Other herbs were almost absent. The situation is comparable to the late Neolithic B-phase of Niersen-Vaassen.
Figure 8.19. Pollen spectra from the samples taken from the Ems t barrow. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.

Figure 8.20. Pollen spectra from the samples taken from the Uddermeer barrows. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
8.6 Emst

8.6.1 Site description and sample locations

Near Emst a barrow of probably four periods is situated. The barrow was first excavated in 1932 by J. Butter. The first period was dated to the late Neolithic B period based on the bodies being buried semi-flexed (Hulst 1972). The original measurements of the barrow are not known. Samples for pollen analysis were taken from the old surface of all periods. The results were published in Casparie and Groenman-van Waateringe (1980, 36-37).

8.6.1 Results and discussion

See figure 8.19

The pollen spectrum of the late Neolithic B period shows an arboreal pollen percentage of approximately 65% dominated by *Alnus* (60%) and *Corylus* (30%). This indicates an open space with an ADF of approximately 50 m at the oldest phase, which is very small compared to most of the other barrows in this region. This open spot is mainly covered with heath vegetation and grasses and most likely some *Betula* trees. In the next periods (which are not dated) the amount of arboreal pollen decreases, accompanied by an increase of heath. This indicates an increase of the open spot to an ADF of approximately 150 m.

8.7 Uddelermeer

8.7.1 Site description and sample locations

Two barrows at the edge of the Uddelermeer (see figure 8.1) were excavated in 1911 by Holwerda. Uddelermeer 1 measured approximately 20 m in diameter and 1.0 m in height. Uddelermeer 2 was approximately 18 m in diameter and 1.5 m high. Both barrows were dated to the late Neolithic B period based on sherds from Bell Beaker pottery (Holwerda 1912), however, since these finds were small this dating could be questioned (Q. Bourgeois pers. comm., October 2012). In 1989 both mounds were the focus of conservation by the ROB (presently known as Cultural Heritage Agency of the Netherlands). Samples for pollen analysis have been taken from the profile in trenches during consolidation. The soil samples were taken in small glass tubes, which were sealed and sent to the University of Amsterdam, to Prof. Groenman-van Waateringe. The samples were stored until July 2009 and then taken to Leiden University for analysis. From both mounds a sample from the old surface was prepared and analysed by the method described in Chapter 4. It should be noted that samples were derived from trenches. This makes it difficult to relate these samples exactly to the barrow, since only a small part of the barrow was exposed. Therefore properly dating of the pollen spectra is difficult as well, what with the dates of the barrows themselves being already in doubt.

8.7.2 Results and discussion

The preservation of pollen was poor in both samples resulting in a high amount of indeterminable pollen grains. The ratio arboreal versus non arboreal pollen is approximately 65-35% for Uddelermeer 1 and approximately 45-55% for Uddelermeer 2 (see figure 8.20). When an average thickness of 0.25m for the sods is assumed (see 8.2.2) the area that needed to be stripped to build Uddelermeer 1...
is approximately 630 m² indicating an open space with a radius of approximately 14 m. To build Uddelermeer 2 approximately 770 m² (radius ≈ 15.5 m) was necessary. Based on the arboreal pollen percentage the size of the open area had an ADF of approximately 50 m for Uddelermeer 1 and approximately 150 m for Uddelermeer 1. This might indicate that Uddelermeer 1 was built first in a small open space and that Uddelermeer 2 was constructed later when the open space had expanded. Both barrows were built in heath and grass vegetation. The forest in the surroundings was probably quite open and consisted mainly of Corylus. Alder carr was present in the wetter areas.

8.8 Boeschoten

8.8.1 Site description and sample locations
In the area of Boeschoten (see figure 8.1) a barrow was excavated by Glasbergen and van der Waals in 1952. The old surface contained lots of charcoal particles. The excavators dated the barrow to the Early Bronze Age or the late Neolithic B period, based on sherd s of ceramics found in the old surface. Measurements of the barrow are not known. Samples for pollen analysis were taken from the old surface underneath the mound and from the fill of the ditch surrounding the barrow. The results of the pollen analysis were published by Waterbolk (1954, 93-95).

8.8.1 Results and discussion
The pollen spectra from both samples show rather similar results (see figure 8.21). The arboreal pollen percentage is approximately 65%. This indicates a small open space with an estimated ADF of approximately 50 m. The surrounding forest consisted mainly of Quercus and Corylus with nearby an alder carr in the wetter parts of the area. The amount of herbal pollen is low and consists of 13-28% Calluna and approximately 15% Poaceae. The pollen spectra show very poor variety of species. Some anthropogenic indicators are present, however, in such low amounts that they cannot be linked to the activity of man.

8.9 Ugchelen

8.9.1 Site description and sample locations
Near Ugchelen four barrows were excavated in 1947. All barrows were heavily damaged prior to the excavation and the original measurements of the barrows could not be reconstructed. Two of the barrows (Ugchelen 1 and 4) could be sampled for pollen analysis. These barrows could not be dated. The obtained pollen spectra from the old surfaces of both barrows have been published by Waterbolk (1954, 94-95).

8.9.1 Results and discussion
See figure 8.22
Like the barrow of Boeschoten, the barrows of Ugchelen were built in a small open space with an ADF of approximately 50 m covered with heather and grasses surrounded by a forest of mainly Quercus and Corylus. Alder carr in the wetter surroundings was probably responsible for the high percentage of Alnus pollen in the spectra. A remarkable difference in Tilia pollen between the two barrows (approximately 20% for Ugchelen 1 and approximately 2% for Ugchelen 4) makes
Figure 8.21. Pollen spectra from the samples taken from the Boeschoten barrow. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.

Figure 8.22. Pollen spectra from the samples taken from the Ugchelen barrows. Spectra are given in % based on a tree pollen sum minus Betula pollen. In the total AP (=arboreal pollen) Betula is included. In the total NAP (=non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
it unlikely that they were built in the same period. Although the barrows have not been dated, Barrow 1 can be assumed the older of the two based on the rather high percentage of *Tilia* pollen. However, based on only one sample this cannot be concluded with certainty. Also remarkable are the high percentage of *Plantago lanceolata* in the spectrum from Barrow 1 and the presence of Cerealia. This may indicate an increase in human activity in the area around the period Barrow 1 was constructed than when Barrow 4 was built.

### 8.10 Stroe

Near Stroe (see figure 8.1) a barrow is located that was excavated several times (by Pleyte and Nairac in 1877, by Westendorp in 1926-1929 and by Lanting and van der Waals in 1971). The barrow might contain two periods, although this cannot be confirmed with certainty based on the excavation data. The first (?) period of the barrow was dated to the Late Neolithic B, based on the find of a copper tanged dagger, a wrist guard and a Veluvian Bell Beaker. Below the mound some PFB sherds were found. Some fragments of charcoal that were scattered on the old surface were ¹⁴C-dated to 3955 ± 55 BP (GrN-6350; 2600-2287 cal BC, calibrated with Oxcal 4.2) and might be associated to the PFB material. The barrow was re-excavated by Lanting and van der Waals in 1971 (Lanting and van der Waals 1971c, 1976). Samples for pollen analysis were taken from the old surface of the primary mound and from the old surface of the presumably secondary mound in 1971. The results of the pollen analysis were published by Casparie and Groenman- van Waerdinghe (1980, 34).

#### 8.10.1 Results and discussion

The barrow was built in a very small open place with an ADF of less than 50 m. In contrast to all other analysed barrows this mound was not built in heath vegetation (see figure 8.23). Instead, the vegetation at the open spot was probably covered with grass, indicated by the relatively high percentages of Poaceae found in the pollen spectra (ca. 15%). The forest in the surrounding area mainly consisted of *Corylus, Quercus* and probably also *Betula*. Alder carr was present in the wetter parts of the area. The barrow was possibly built on a former settlement, given the finds of PFB material. The presence of heath and grazing indicators suggests that the site was used as pasture before the barrow was built and after abandonment of the settlement.
8.11 Palynological results from peat and lake sediments

8.11.1 Site description and sample locations

The Uddelermeer is one of the largest pingo ruins in the Netherlands created in the Last Glacial period of the Pleistocene. It is very deep, around 17 m, and has slowly been filled up with organic mud. Pollen was caught in every layer of organic mud and an archive of vegetation development was formed. Polak took samples for pollen analysis at four places, the results of which were published in Polak (1959).

8.11.2 Results and discussion

Polak (1959) made several pollen diagrams that show the regional vegetation development of the area. In figure 8.24 a summarized pollen diagram of the Polak diagrams is shown. The diagram is based on the results of two different sample locations: a deeper location with the older organic layers, the results of which are shown in the part below the dashed line. The part above the dashed line shows the more recent vegetation development, derived from the upper organic layers. The pollen sum used in this diagram is based on the arboreal pollen sum minus *Betula* to be able to compare it to the barrow pollen spectra. The total arboreal and non arboreal percentages are based on a total pollen sum of which the aquatic vegetation has been left out (Poaceae are included although the marsh plant reed belongs to this family and could have been locally present). Although the diagrams have not been 14C-dated, pollen zones according to Jessen and Iversen have been applied to the lake samples, based on the stratigraphy of the lake sediments and the palynological results. The results from the Preboreal (zone IV) until the Subatlantic (zone IX) will be discussed here. The pollen diagram shows the regional vegetation development of the area where the barrows described above are situated in. Although not directly linked in time to the barrows due to the lack of exact dating, the pollen diagram shows the general development of the environment of the barrows.

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Table 8.2. The minimum size of the open space per barrow based on the sods used to build the barrows.
Figure 8.24. Pollen diagram from the Uddelemeer, composed and redrawn from three pollen diagrams by Polak (1959, diagrams I, VI and VII). Pollen zones have been applied according to Jessen and Iversen. A percentage diagram is shown, with % based on a tree pollen sum minus Betula. In the AP (= arboreal pollen) Betula is included. In the total NAP (= non arboreal pollen) spores are included, non pollen palynomorphs are excluded. Different scales have been used, indicated with different colours.
In the Preboreal (IV) the percentage of arboreal pollen increased due to a decrease of herbs like Poaceae, Cyperaceae and Artemisia. The arboreal pollen percentage consisted mainly of Pinus and Corylus, of which the latter appeared in the preceding period. In the Boreal (V&VI) period percentages around 80% of total pollen (minus aquatic plants) were reached. During this period Alnus and Quercetum-mixtum (e.g. tall deciduous dryland trees) appeared. Alnus reached percentages of around 25-30% and Quercetum-mixtum increased even further until 35-40%. At the same time Pinus, probably a long distance element at this time, decreased to around 5% (of ∑AP-Betula). Corylus decreased as well, although less dramatically until around 20%. Tilia, Ulmus and Fraxinus appeared in this period. Ericaceae were present with percentages of approximately 2-4%. This situation remained quite stable until the last part of the Subboreal period, although the amount of herbs gradually increased. This is mainly due to the increase of Poaceae until percentages of around 10-15%. The amount of Ericaceae increased slightly too up to 10%. Anthropogenic indicators like Plantago lanceolata and Rumex rose up to around 3%. Cereal pollen grains increased until 3-4%.

Towards the end of the Subboreal period (which ends at 800 cal BC, see table 2.1) the arboreal-non arboreal ratio changed in favour of the non-arboreal pollen. The percentage of non-arboreal pollen increased until around 45%. This is mainly caused by the further increase of grasses (until around 30%) and Ericaceae (around 25%). A slight decrease in Quercetum-mixtum pollen can be seen, while the percentage of Alnus pollen seemed to increase slightly. This change in vegetation composition could be indicative for the influence of humans in the area.

The Subatlantic (zone IX, from 800 cal BC, see table 2.1) started with a further decrease of total arboreal pollen and an expansion of Ericaceae and Poaceae. Cereal pollen grains continued to increase slowly as well. Halfway through this zone Secale appears in the diagram, which probably coincides with the Roman Iron Period (Behre 1992). At this time there seems to be a slight regeneration of the forest (mainly Quercetum-mixtum) and some decrease of heath. Then the non arboreal vegetation expanded again at cost of the forest, with further increase of heath and cereal pollen, including Secale. The end of the diagram probably represents the early Middle Ages (according to Polak 1959).

8.12 Summary: the barrow landscape of northern and central Veluwe

In this chapter the palynological results of barrows at the northern and central part of the Veluwe have been discussed in order to answer the question: What did a barrow landscape look like before and after the barrows were built? And, what was the role of prehistoric human?

Barrows from the late Neolithic A period until the Iron Age were built in open spaces that generally had an average distance to the forest (ADF) of approximately 50-100m, shown by arboreal pollen percentages of 55-60%. Most herb pollen is coming from local vegetation. All barrows except one (Stroe; 8.10) were built in a heath vegetation type, according to the percentages of Calluna vulgaris found in all pollen spectra. These percentages are on average lowest in the oldest barrow spectra (around 20%) and highest in the youngest, with percentages up to 100%. However, percentages over 100% did also occur during the late Neolithic, shown by the pollen spectra from Ermelo (8.3). This implies that heath was present in the whole area during the entire period. These heath areas varied from small to rather large, and in general the heath areas expanded over time. Besides Calluna vulgaris, the heath vegetation consisted for a considerable part of grasses. Anthropogenic
indicators are present in all barrow spectra, although in low percentages. The most dominant anthropogenic indicator is *Plantago lanceolata*, indicating that the area had been significantly disturbed by human hands. The open places with heath vegetation where the barrows were built in were not recorded as such in the Uddelermeer diagram, indicating the local spread of pollen of heath species. The Uddelermeer diagram suggests that the vegetation consisted of mainly forest and human activity was slight. The barrow pollen spectra however, indicate otherwise. Open places with heath vegetation must have been present in considerable numbers from the Neolithic onwards.

In all pollen spectra *Alnus* was the dominant arboreal pollen type. It is very likely that alder carr forests were present in the wetter parts of the area, probably the stream valleys. The drier forest in the surroundings consisted mainly of *Tilia*, with pollen percentages of 5-20%, *Quercus*, with pollen percentages of approximately 10% and *Corylus* at the forest edge, with pollen percentages of 30-40%. The remaining tree species occur with somewhat fluctuating but low percentages during the entire period. This general view on forest composition in the area is also shown by the pollen diagram from the Uddelermeer, where zone VI-VIII probably represent the situation that has also been registered in the barrow pollen spectra: the high percentages of *Alnus* in the wetter parts of the area; the drier forest consisting mainly of *Quercus* and *Corylus*.

In the Middle/Late Iron Age the barrow landscape seems to have changed, according to the palynological data of the Echoput barrows (8.1). These barrows were built in much larger open spaces, with an ADF of approximately 200-300 m (arboreal pollen percentage is around 20%). *Calluna vulgaris* and *Poaceae* are, as at the older barrow locations, the dominating species at the open space. Percentages of *Calluna vulgaris* now substantially exceed 100%, while grasses (*Poaceae*) fluctuate around 60%.

The forest composition in the Middle/Late Iron Age period at the Echoput was slightly different from the forest composition shown by the older barrows in the area. The amount of *Tilia* (pollen percentages of 1-2%) and *Corylus* (pollen percentages of less than 20%) seem to have decreased, while *Quercus* (pollen percentages until 40%) and *Fagus* (pollen percentages until 5%) seem to have increased. In addition, *Carpinus* has appeared in the pollen spectra. Alder carr is still present in the wetter areas.

As mentioned above, at the time the Echoput barrows were built, heath vegetation had expanded in the area. This spreading out of heath vegetation most likely continued. At the time posts were placed close to the Echoput barrows, probably in the Medieval period (see 8.1.4), arboreal pollen percentages were only around 15%. These low percentages indicate an ADF over 600 m (see table 7.2). This large scale expansion of heath in the Medieval Period is also recorded in the Uddelermeer diagram (when *Fagopyrum* and *Secale* have appeared as well). This is most likely due to the large scale opening up of the landscape caused by intensified human activities.

In this chapter it has been shown that the barrows from the Late Neolithic A period until the Late Iron Age were built in heath vegetation. It was also shown that during the late Neolithic A period long alignments of barrows were present (8.2 Niersen-Vaassen and 8.3 Ermelo). These barrows alignments were probably built in long stretched heathland areas, where visibility from one barrow to the next is likely (Bourgeois 2013, 154-155). The fact that heath and herb vegetation had already developed at the barrow places, suggests that these long stretched heath areas were already present some time before the barrows were built. Moreover, these open spaces must have been kept open until the barrows were
built. This also accounts for the smaller heath areas where barrows were built in that not formed such alignments. It is important to realise that management was required to maintain these heath areas. This indicates the activity of humans in the area, at least and perhaps specifically at the places where the barrows were going to be built. Some open spaces might have been used as settlement area prior to the barrow building (8.2 Vaassen I and 8.4 Putten). These sites must have been abandoned for some time before the mounds were raised. For the other barrows in this region no such indications have been found, nor for the cultivation of crops. As has been discussed extensively in paragraph 8.1.4 (Echoput) it is likely that most of these open spaces have been kept open by grazing.