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Orientations and Placement of the Middle and Late Neolithic Housepits of Ostrobothnia: A First Investigation Based on On-site and Lidar Observations

The orientations and placements of 349 single-room and 72 multi-room housepits or 'longhouses' of Middle and Late Neolithic Ostrobothnia have been analysed and compared with each other and the orientations and placement of the Giants' Churches. It was found that while the housepits in general were often oriented along the local terrain, some of them were oriented towards certain, probably astronomically determined directions. The astronomical orientations seem to be related to hitherto unrecognized subgroups of the housepits, which were partly covered but not exhausted by the selected subgroups of this study. The multi-room pithouses a.k.a. terraced houses and 'longhouses' had an orientation distribution different from all other subgroups of housepits and the Giants' Churches, and may have been deliberately oriented perpendicular to the Giants' Churches. The doorways of rectangular housepits were found to mostly reflect the axial orientations of the housepits, and there may have been regional differences: in the large dwelling sites of Kokkola-Kruunupyy-Pedersöre region, the doorways of the housepits seem to have been preferably oriented towards the four cardinal directions. The astronomical orientations of the housepits may indicate the existence of a lunar or lunisolar "seasonal pointer" calendric system, the kinds of which have previously been detected in the Giants' Churches and European megalithic monuments. It was observed that in addition to possible astronomical orientations, also cairns and other signs of ritualization, which are frequently encountered with the Giants' Churches, are seen around some middle-sized and large housepits. The ritualization of a housepit could be connected to beliefs concerning the 'death' of a house, and the process of turning a decaying pithouse into a ritual site, perhaps a mortuary or ancestral monument. Among the housepits, the existence of the class of 'central', i.e. prominently placed middle-sized or large housepits is suggested. The central housepits cannot be distinguished from the Giants'

Churches by their placement among other housepits or orientations alone, and together these two categories of prominent structures may indicate the existence of social and/or regional hierarchy with different levels in Late Neolithic Ostrobothnia.

1. Introduction

Since the 1970s, it has become clear that in Neolithic Europe, many different types of monuments and structures were oriented towards certain astronomically significant directions that probably had religious importance (see, e.g. Ruggles (ed.) 2014: 1133–1430). Not only were religious structures like graves and temples astronomically oriented, but there is evidence that also the orientations of profane spaces such as houses were affected not only by practical – such as the directions of strong winds, the amount of solar radiation and the features of the local terrain – but also ritual considerations (see, e.g. Topping 1996; Bradley 1998, 2001). For example, the longhouses of the Linearbandkeramik culture (ca. 5500 BCE) and its successors, e.g. the Lengyel culture in any given site usually followed a certain direction that may have had cosmological or other religious significance, e.g. the cardinal north-south (N–S) direction, the direction of the winter solstice sunrise or the direction of the ancestral homeland of the builders (Bradley 1998: 43; Bradley 2001; Pásztor & Barna 2014, and refs. therein). The houses in Neolithic Britain and Ireland seem to have followed orientation principles similar to the Central European ones (see Topping 1996: 161–163). There may have been several different factors simultaneously at play, when the practical issues such as the wind directions were taken care of as well as, e.g. the solar position of an important festival day.

It is not surprising that a house, a dwelling that is an important place of living, working and social interaction should have been carefully oriented following also ritual considerations in a society that was likely more fundamentally dependent on religious beliefs than our modern Western society (see Rappenglück 2013, and refs. therein). It can be suggested that the relative ritual importance of a dwelling increased with increased sedentariness, when the concept of the house as a permanent or semi-permanent dwelling developed (see Hodder 1990). In Neolithic Ostrobothnia, were increased sedentariness has been proposed from the Middle Neolithic on (see below), these considerations consequently become ever more important from that period on. It can therefore be suggested that studying the orientations of the Ostrobothnian Neolithic dwelling remains could perhaps also reveal something about the ritual practices of their builders.

The most common visible remains of the Middle and Late Neolithic in Finland are housepits, which are the remains of pithouses, i.e. semi-subterranean houses.[1] The sizes of the housepits range from a few metres to as much as over 25 m for a single pithouse and more than 60 m for a multi-room pithouse, also called a terraced house (see Pesonen 2002 and Table 1). A housepit can be rectangular, square, oval, or round, but all excavated Neolithic pithouses have so far turned out to have been either rectangular or square (Pesonen 2002: 29–30). This seeming controversy is obviously the result of the decaying processes that transform a pithouse into a housepit: a square pithouse may have deformed into a circular pit, and a rectangular house into an oval pit. Thus, there is some uncertainty to whether a round or an oval housepit reflects the shape of the house as it originally was (Mökkönen 2011: 26–27; see also the reconstructions in Vaara 2000). It is of course possible that circular houses will be discovered in the future.

The dwelling sites of the early Neolithic in Finland were relatively invisible and had fewer dwellings than those of the Middle and Late Neolithic. The pithouse (cf. a *house* as compared to a more temporary type of dwelling, e.g. the Sami *goahti* or *lavvu*) becoming more common from the Middle Neolithic on has been seen as a sign of (semi-)sedentary style of habitation (Mökkönen 2011: 21–23, 43–44, and refs. therein).

Research of the last decades has revealed that the Neolithic period in Ostrobothnia on the western coast of Finland was a time of economic prosperity and increasing social complexity (see, e.g. Koivunen 1996, 2002; Schulz 1996, 2000; Okkonen 1998, 2003, 2009; Vaneeckhout 2008, 2010; Costopoulos et al. 2012). This development had its concrete demonstrations in the construction of larger and larger dwelling sites and individual houses and, eventually, in the Middle and Late Neolithic, the large stone enclosures traditionally known as "Giants' Churches" (Finn. *jätinkirkot*, hereinafter also referred to as the GCs; Okkonen 2003: 167–172, 240–242; Mökkönen 2011: 55–60; Vaneeckhout 2008; Costopoulos et al. 2012).

In the Middle Neolithic, large villages of pithouses appeared in the river estuaries of Ostrobothnia. This development has been connected to

1 Due to open questions in the reconstruction of the Neolithic buildings, I have made no distinction between the concepts of a house (i.e., a building with walls) and a *kota*-type hut, where the walls are part of the roof structure. Consequently, the walls of a housepit may have been slightly bended instead of being strictly rectangular (see Halinen et al. 2002); in a housepit, these remnant features cannot be separated from the effects of decaying. Also, I have included the housepits without earthen or stone walls (Finn. *asuinpainanne*) and those with easily detectable walls (*asuinpaikkavalli*) in the same category of housepits. I also make no distinction based on whether the structure was built into a moraine, a sandy soil, or a *rakka* boulder field. These decisions were based on the observations made during the fieldwork. See also Mökkönen (2011) on the terminology.

increased sedentariness in the region (Vaneeckhout 2008). The economy was based mostly on marine resources, especially seal products (Okkonen 2003: 221–222). There is also evidence of extensive and prosperous trade, and possible protection of resources (Koivunen 1996, 2002; Okkonen 2009). During this period, the so-called terraced houses, i.e. multi-room housepits sometimes seen as imitating the idea of a longhouse, appeared in Ostrobothnia (see, e.g. Mökkönen 2008, and refs. therein).

From the Middle to the Late Neolithic and the end of the period, the number of pithouses in a site decreased, while the sizes of individual pithouses grew (Okkonen 2003: 167–172; Mökkönen 2011: 55–60). At the same time, the habitation concentrated even more densely onto the coast and some new habitats were even built in the outer coastal region and archipelago, away from the more sheltered locations (Vaneeckhout 2008, 2010; Mökkönen 2011: 58). In the Late Neolithic Ostrobothnia, the sizes of the houses could vary from large single-room pithouses over 25 m long to small pithouses less than 5 m in length. The development towards the varying house sizes from the Middle Neolithic on has been seen as a sign of the rise of social inequality related to the controlling of the natural resources and probably also foreign trade (Okkonen 2003: 219–227; Vaneeckhout 2010; Costopoulos et al. 2012).

On the coastal regions of the late Middle Neolithic, the construction of two new types of monuments started: round stone cairns and the huge stone enclosures, Giants' Churches (Forss 1996; Okkonen 1998; 2001; 2003). The stone cairns may have been used for burial or sacrifices (Okkonen 2001). The cairns were often built in or near the dwelling sites. Around 1800 BCE, at the very end of the Late Neolithic and the start of the Bronze Age, the construction of long cairns started to dominate and the GCs fell out of use (Okkonen 2003: 223).

The time of the Giants' Churches lasted from ca. 3000 BCE to 1800 BCE, based on dating by the isostatic land uplift method, supported by the radiocarbon dates from the sites (Okkonen 2003, and refs. therein). The GCs are large, rectangular or round enclosures built of stones of the size of a man's head, with occasional larger boulders (see Figure 1 for examples of the GCs as seen in the lidar data). The size of structures classified as GCs varies from ca. 20x10 m to more than ca. 70x30 m (Ridderstad 2015b; Ridderstad & Okkonen 2015). The small and middle-sized GCs are thus of the same size as the largest single-room housepits. There are also other similarities: the GCs have "gates" or doorways, and are often surrounded by cairns and occasional standing stones – both features also encountered in or near the housepit sites. Indeed, the smallest GCs cannot really be distinguished from dwelling remains built in the natural *rakka* boulder fields based on their outer appearance alone; the distinction is mostly based on the gigantic size of the largest GCs, which would have been impossible to cover with a single roof structure, and on the relative scarcity of excavation finds inside especially the largest GCs (although it has to be noted that only a handful of structures have been excavated; see Forss 1991; Okkonen 2003: 124; Schulz 2009). Many different hypotheses have been presented for the original function(s) of the GCs. They have been seen as e.g. temples, graveyards, storages, or seal hunters' shelters (see, e.g., Forss 1996, and refs. therein). A common feature in many of these hypotheses is that the GCs were communal spaces related to some central function of the society that built them. They may also have had multiple purposes. A recent study suggested that they may have been used in the Neolithic warfare, which does not rule out their use as communal ritual spaces also (Sipilä & Lahelma 2006).

The orientations of the Neolithic house remains of Ostrobothnia have so far not been quantitatively studied. On the other hand, archaeoastronomical orientation studies of the GCs have suggested that especially the largest ones, those over ca. 35 m in length, had axis and gate orientations towards the main solar events of the year, especially the sunrises and sunsets of the solstices (Okkonen & Ridderstad 2009; Ridderstad 2015a; 2015b; Ridderstad & Okkonen 2015). Orientations towards important lunar events, the so-called megalithic equinox and the minor lunar standstill have also been indicated (Ridderstad 2015a; 2015b). The most recent study pointed towards a tradition of orientations based on a lunar or lunisolar "seasonal pointer" calendric system (Ridderstad 2015b). The orientation studies have indicated that the orientations of the small and middle-sized GCs differ from the largest ones (Okkonen & Ridderstad 2009; Ridderstad & Okkonen 2015; Ridderstad 2015b). This suggests that some or all of the smallest GCs may in fact be remains of large dwellings or other kinds of large buildings – a suggestion supported by the excavation finds in some of the small and middle-sized structures traditionally classified as GCs (e.g. Pikku Liekokangas and Honkobackharju, both of which also showed evidence of fireplaces; see Forss 1981; Schulz 2008, 2009).

To date, relatively little has been written on the mutual relations of the housepits and the GCs. Not even the size limit or other features that can be used to characterize a GC are well-defined, and the related question of the original function of the GCs remains equally unclear. Yet the GCs and the dwelling remains obviously have many common features, and the suggestion has been put forward that the former might even be some kind of ritualized replica of the latter (Ridderstad 2015a).

In this study, the orientations of 349 Middle and Late Neolithic single-room housepits and 72 terraced houses or 'longhouses' of Ostrobothnia were measured, examined and compared to reveal the possible existence of subsets and different traditions of orientations, and the differences and sim-

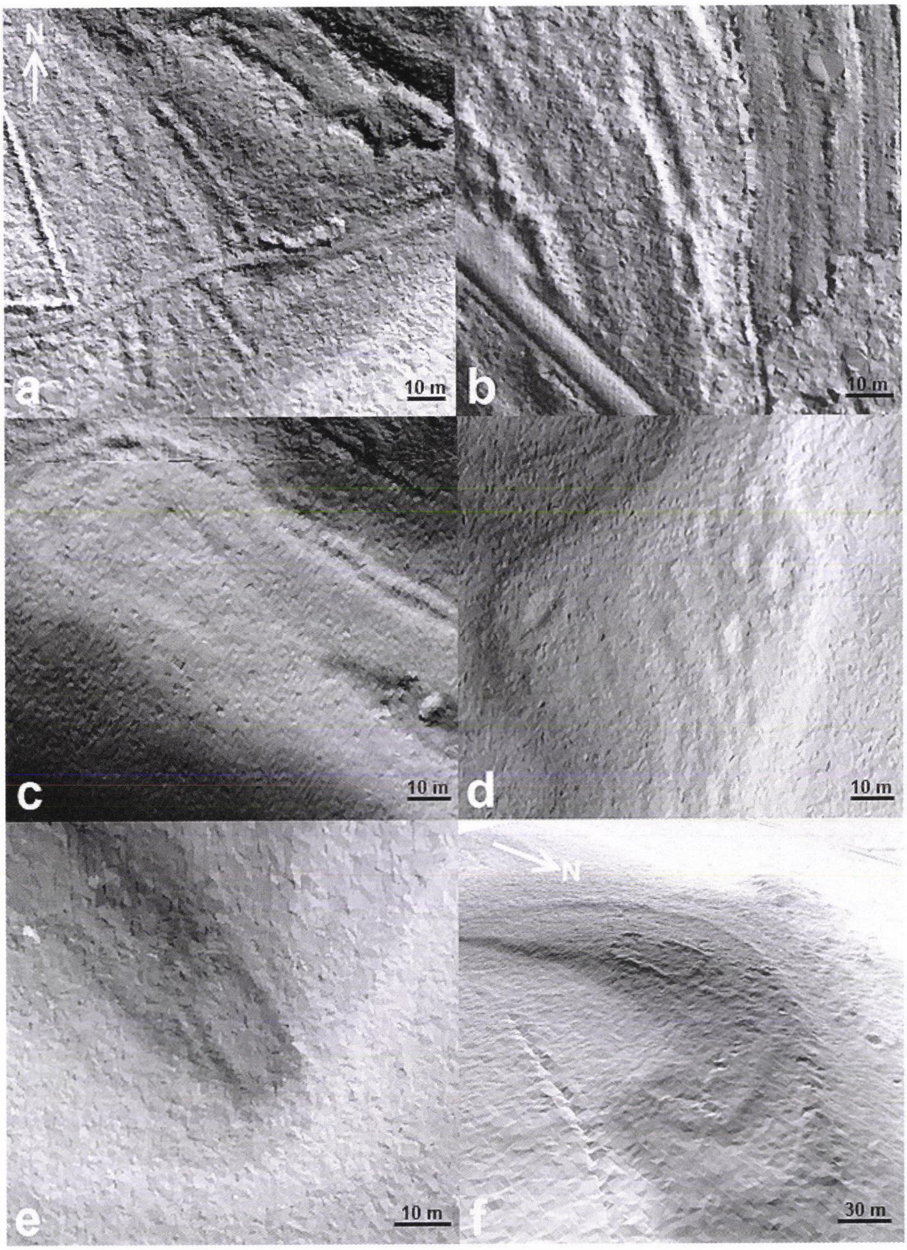

Figure 1. Examples of the sites and structures of this study as seen in the lidar data (NLS 2014). (a) The large housepit site of Heikinkangas in Tyrnävä, (b) the terraced house of Voima-Kuusela in Oulu, (c) the housepit site of Niilonkangas in Liminka, (d) the housepit site of Mastomaansuo in Oulu, (e) the Giant's Church of Mustosenkangas in Liminka, (f) the Giant's Church of Pirttivaara and its surrounding dwelling site in Raahe.

ilarities between those. Also the comparison of the orientations of the GCs with the orientations of the Middle and Late Neolithic house remains of Ostrobothnia was performed to reveal possible similarities and differences, with the hope that this might also help in defining the GCs and, ultimately, revealing their enigmatic function(s).

2. Measurements

The sample of this study included 349 single-room housepits and 72 multi-room housepits a.k.a. terraced houses or 'longhouses'. The housepit sites were selected from the area approximately corresponding to the area in Ostrobothnia where the Giants' Churches are encountered, i.e. between Yli-Ii and Vöyri, using the list by Pesonen (2002) and the database provided by NBA (2014); in addition, some new clusters of housepits were detected close to the previously known sites.[2] All the housepit sites selected were Middle or Late Neolithic, thus being contemporary to the GCs. The rough dating of the sites for this study was based on their heights from the present sea level (their HFSL values).

The housepits were measured partly on-site, partly from the site maps provided by the National Board of Antiquities (NBA 2014) and the airborne laser scanning (lidar) data provided by the National Land Survey of Finland (NLS 2014). 154 single-room housepits were measured on-site, 189 from lidar data, and 6 from archaeological site maps; 19 multi-room housepits and 'longhouses' were measured on-site, 50 from lidar data, and 3 from archaeological site maps. The results of the measurements for the housepits are presented in Table 1, where the azimuthal values for the orientations of the axes and doorways, along with other relevant data, are presented. The azimuthal values were then used to calculate the astronomical declinations for the relevant epoch, which are more suitable for the analysis of astronomical orientations in a large area as they are independent of the observer's geographical latitude. In Figure 2, the relation between the azimuths and the declinations for the latitudes of Ostrobothnia are illustrated.

The on-site measurements were made with a compass in 2009–2013. The axis of a housepit was measured towards both directions. If available, the

2 One may notice in Table 1 that not all housepits in a site are presented and that some well-known sites were left out from the sample. This is mostly due to the restrictions posed by the resolution of the lidar data. However, neither did the *in situ* observations sometimes allow unambiguous determination of the axes of the housepits (e.g. in the cases of Veeliksinaitaus of Oulu, and Ojastenneva and Kissakangas of Raahe), in which cases the structures had to be left out of the sample.

solar position was used as a reference direction for each orientation. For the largest and sufficiently well-preserved housepits, the walls of the structure were also measured and used in the calculation of the axis orientation. The orientations towards the doorways of a housepit were measured from the centre of the structure. Some sites were visited more than once, in which case the final result is the average of the measurements of the different visits, corrected for the magnetic declination values of the respective dates. The average error of the compass measurements was estimated to be +/−1.0 degrees in azimuth.

To estimate the error resulting from the use of the lidar measurements, the differences between the on-site and the lidar measurements were calculated for 69 structures. The average absolute difference between the orientations of the housepits measured from the lidar data versus the measurements made in situ was 3.8 degrees in azimuth. This corresponds to 1–2 degrees in declination so that the error is largest near the equinoxes, i.e. close to the declination 0. It should be noted that the larger the housepit was, the smaller the error of the lidar measurement; therefore, for the largest housepits that had the size of the order of a small GC, the average absolute difference between the lidar and the on-site measurements was smaller than the above value, being ca. 1.5 degrees in azimuth, which is of the order of the error of the compass measurements. As it turned out that the majority of the housepits were oriented away from the declination 0, the error in declination resulting from the uncertainty of the use of the lidar data was therefore usually not more than ca. 1 deg.

The axes of circular housepits obviously could not be measured; neither was there much point in measuring the axis orientations of square housepits, as those are ambiguous. Unfortunately, many of the largest sites have mainly either circular or squarish housepits (e.g., Rekikylä). Also the resolution of the lidar data posed some restrictions. The smallest housepits did not show well enough to be measured (see further discussion below in Section 3.1). Measuring the doorway orientations from lidar data was equally difficult and most of the doorways showing up in the lidar data were from large housepits (see Section 3.3). On the other hand, it was observed that the doorways of large housepits clearly visible in situ were also usually well observable in the lidar data, which can be taken as a sign of fairly good reliability for the observations made from the lidar data alone.

Because the isostatic land uplift caused by the post-glacial rebound has slowly moved the Neolithic shoreline and the related human-made structures 10 to 30 km inland, the original horizon heights for the measured structures were in most cases no longer observable. Due to the large number of the housepits, calculating the horizon heights from maps individually for each structure was not feasible. Therefore, a different approach to model-

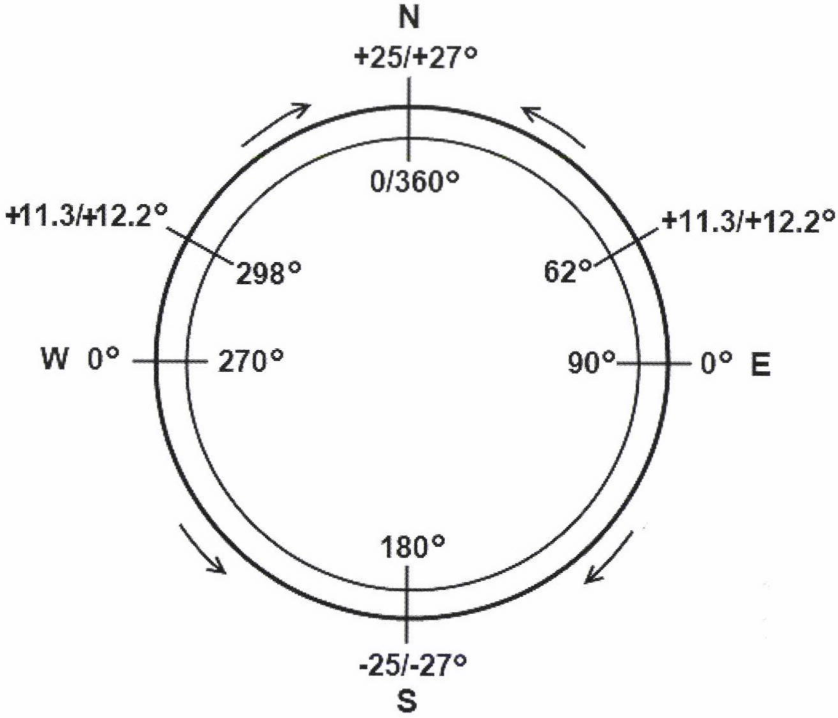

Figure 2. Relation between the orientations given in azimuths and declinations. The two circles correspond to the zero horizon around an observer at the latitudes of Ostrobothnia. The inner circle gives the azimuths, which grow clockwise from the north (N) to form a full circle of 360 degrees. The outer circle gives the declinations corresponding to the latitudes near Oulu/Vaasa. At the zero horizon, the declinations grow northwards from the true east (E) and west (W), and decrease towards the south (S). For an observer looking towards the azimuth of 62 degrees at the horizon line near Oulu, a celestial object rising at that position has the declination of ca. +11.3 deg, while in Vaasa, the same azimuth points towards an object that has the declination of ca. +12.2 deg. Vice versa, for example the sun rises at the azimuth of 62 deg on different annual dates in Oulu and in Vaasa.

ling the horizon heights was taken. The declinations were calculated for the horizon heights of 0, 0.5 and 1 degrees, based on observations made of the horizon heights visible from the coastal regions in the present archipelago of south-western Finland. This kind of model of relatively low horizon heights and open views was considered apt since the Ostrobothnian Middle and Late Neolithic dwelling sites were often situated in relatively open environments due to their locations on the shores, the effects of the land uplift, and human influence on the vegetation (see Okkonen 2003: 107–108; Tranberg 2006). Furthermore, if an astronomical orientation was aimed at for a house, the house probably would have been placed so that a good view towards the horizon could be achieved in the first place.

In general, increasing the horizon height has the effect of increasing the declination value. Comparison revealed, however, that changing between the different horizon models did not create substantial differences to the declination distributions. The differences in the exact positions of the peaks between the orientation distributions obtained using the models of 0.5 and 1 deg horizon heights were in most cases negligible; using the models of 0 and 1 deg horizon heights the corresponding differences were ca. 1 degree at maximum. In the following analysis, only the results obtained using the horizon model of 1.0 degree are shown.[3]

3. Results

3.1 Orientations of the single-room housepits

In Figure 3, the declination distribution for the axes of the 349 Middle and Late Neolithic housepits is presented. Only the orientations towards the east are shown, since the orientations towards the western horizon form a mirror image of the eastern ones due to the similar horizon heights used in the modelling. At first sight, the distribution appears to be a skewed random distribution, with the orientations close to the North-South (N–S) line and those on the SE side being higher in number than those towards the NE on the other side of the distribution.[4]

The concentration of the declinations on the SE side of the horizon in the distribution of Figure 3 could be due to the prevalent direction of the glacially formed ridges in the research area, which likely has affected the directions of the axes of the housepits. To conclude that the orientations of the housepits were determined by the orientations of the ridges alone would, however, be circular reasoning. It was observed that as much as 80% of the housepits in the sample were aligned more or less along the ridge they were built on, but also that there were ridges along all directions in the sample, not just along the main direction of the terrain (NW–SE), and therefore the left side of the distribution, too, has a contribution from the effect of the

3 Note that the horizon heights for the orientations of the GCs presented for comparison in Section 3.5 were calculated using a different model, where the horizon heights and also the effect of possible vegetation were estimated for each structure individually (Ridderstad 2015b).

4 The concentration of the N-S orientations at the northern end of the distribution is mostly due to the definition of the N-S direction as the azimuth of 0 deg instead of 180 deg.

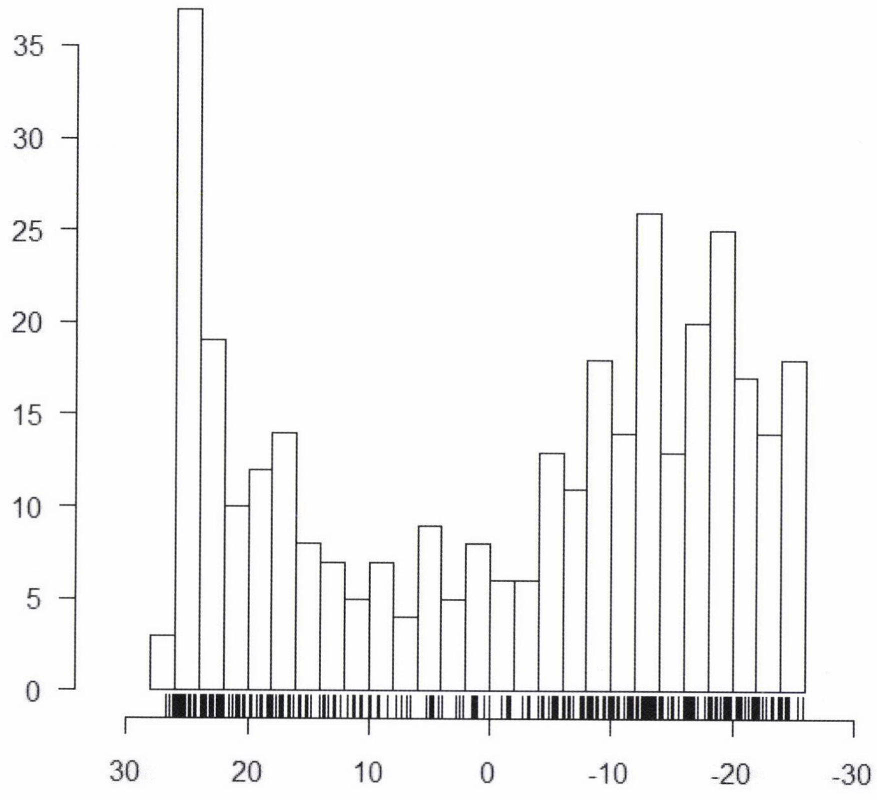

Figure 3. Orientations of the axes of the 349 single-room housepits towards the eastern horizon. All declinations were calculated for the centre of the solar disk and using the refraction model of Bennett (1982).

ridge directionality. It was also observed that independent of the general 'macro' directions of the ridges, the local 'micro' features of the terrain could be along any direction. Thus, even when the housepit rows were along the 'macro' direction of the main ridge formation at the large scale, the axes of the individual housepit orientations could vary as much as 90 degrees and usually spanned at least 20–30 degrees in azimuth in one site. A small housepit could also be easily built perpendicular to the ridge direction and several examples of this kind were detected on-site. Thus, the orientation of a housepit could, in practice, have been chosen at will.

At the large scale, the distribution of Figure 3 thus seems to be a combination of a random distribution of orientations with the 'glacial ridge effect'. However, the housepits in the sample were from a large area and their datings obtained by the land uplift method span the period of more than one thousand years. The seemingly random form of the distribution in Figure 3 may thus result from the superposition of several individual groups of preferred orientations for the housepits built on different areas during

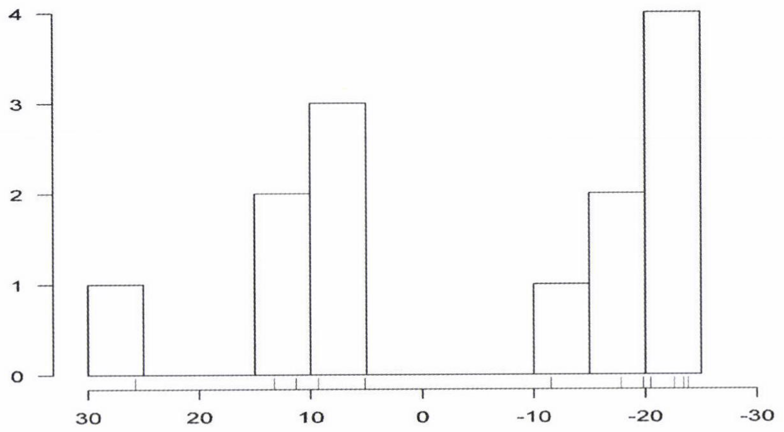

Figure 4. Orientations of the axes of the housepits of Pirttivaara and Laivavaara towards the eastern horizon.

many periods. At closer inspection, the distribution of Figure 3 indeed appears to have some individual peaks superposed on the large scale features of it. To reveal the possible sub-groups of orientations in Figure 3, resulting from the different orienting practices of different traditions, several different subgroups were drawn from the sample for comparison. For example, it is known that the average size of housepits grew from the Middle to the Late Neolithic (Mökkönen 2011: 44, 46, 56–60, and refs. therein). Therefore, the orientations of the housepits of different sizes could be related to the possible temporal change in the orientation practices of the housepits. The housepits could also be classified by their prominence, i.e. their size and placement among other housepits in the sites and in the nearby region. Also, the orientations of the special group of the terraced houses were separately investigated.

At first, the investigation of the orientations of the housepits of individual sites was attempted. Unfortunately, in the sites with the largest number of housepits, the housepits were mostly roundish or squarish, or most of them were so small that the form of the majority of those could not be reliably observed from the lidar data. On the other hand, on the sites where all of the housepits were large enough or all of the measurements were made in situ, the total number of the housepits was low, which makes the results derived from those samples statistically more unreliable. This only left a handful of sites suitable for comparison.[5] The orientation distributions of those sites

5 The sites were Heikinkangas of Tyrnävä, Lehdonpalo of Kokkola, Mastomaansuo of Oulu, Miilukangas of Raahe&Siikajoki, and Pirttivaara-Laivavaara of Raahe. Due to the limited resources of the present study, further investigation of individual sites had to be left for future studies.

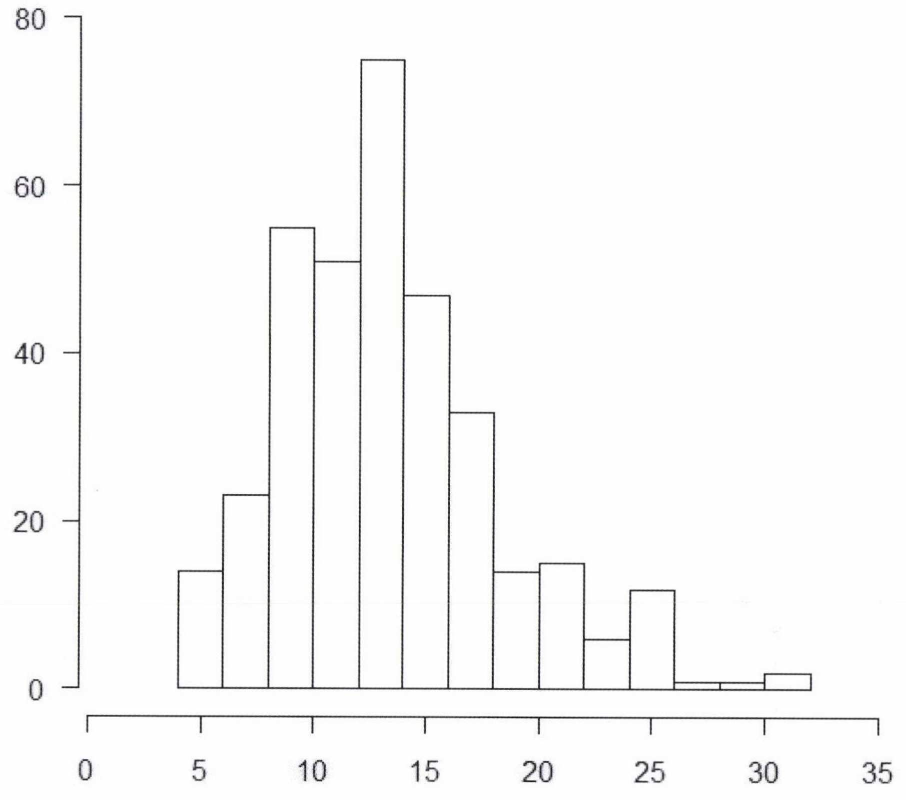

Figure 5. Size distribution of the single-room housepits.

mostly peaked at or close to the declinations of +/−10 deg and/or +/−20 deg, as well as close to the N–S line. In Figure 4, an especially interesting example is shown: the orientation distribution of the site of Pirttivaara-Laivavaara, where all of the orientations were measured on-site.

The orientations of other possible subgroupings of the housepits were then investigated. One feature by which the pithouses could have been classified is obviously their size. The size distribution of the 349 single-room housepits is shown in Figure 5. The mean and median sizes of the single-room housepits of the sample were calculated to be 12.8 m and 12 m, respectively. It can be seen that the distribution in Figure 5 is biased towards housepits longer than 7 or 8 m. This is due the fact that reliably observing a housepit smaller than ca. 7 m in the lidar data was difficult, and, therefore, almost all of the housepits shorter than 7 m were observed on-site. On the other hand, also many of the sites selected for on-site measurement were sites with predominantly large housepits (for those were considered more interesting for comparison with the GCs), which caused the total relative number of small housepits to become low.

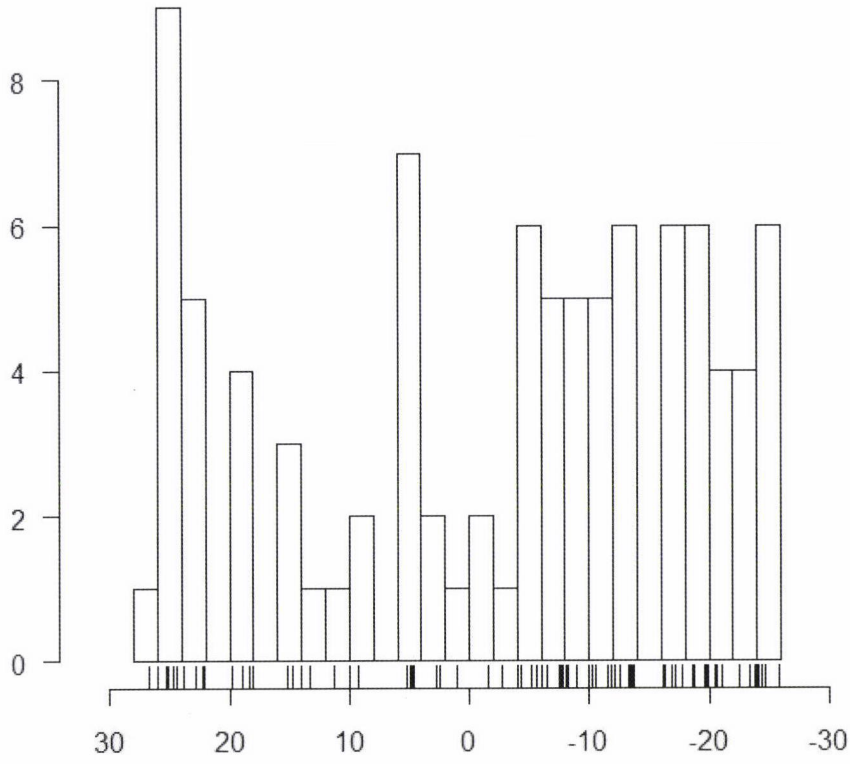

Figure 6. Orientations of the axes of the housepits shorter than 10 m towards the eastern horizon.

To investigate the orientations of the housepits of different sizes, those with axes shorter than 10 m and longer than 19 m were separately examined. The respective orientation distributions are shown in Figures 6 and 7. (The horizon model used was again the 1.0 deg model and, thus, only the orientation distributions towards the east are presented.) In the orientation distribution for the 92 smallest housepits, shown in Figure 6, there is a tall peak at ca. +5 deg, while otherwise the overall form of the distribution somewhat resembles that of Figure 3, the distribution of all housepits. At the large scale, clustering can be seen around the declinations of −10 deg, −20 deg, and −24 deg, as well as close to the N–S line. Interestingly, the individual housepits corresponding to the +5 deg peak all were from sites, where the orientations of the terrain had not significantly affected the orientations of the houses. The average size of the housepits in this sample was 7.5 m, and the mean and median HFSL values for the sites of this sample were 53.9 m and 53 m, respectively. In the declination distribution of the axis orientations of the 34 housepits longer than 19 m (Figure 7), there is clustering around the declinations of −20 deg, −10 deg, and +10 deg. There is also a cluster of orientations around the declination of ca. +26 deg, which

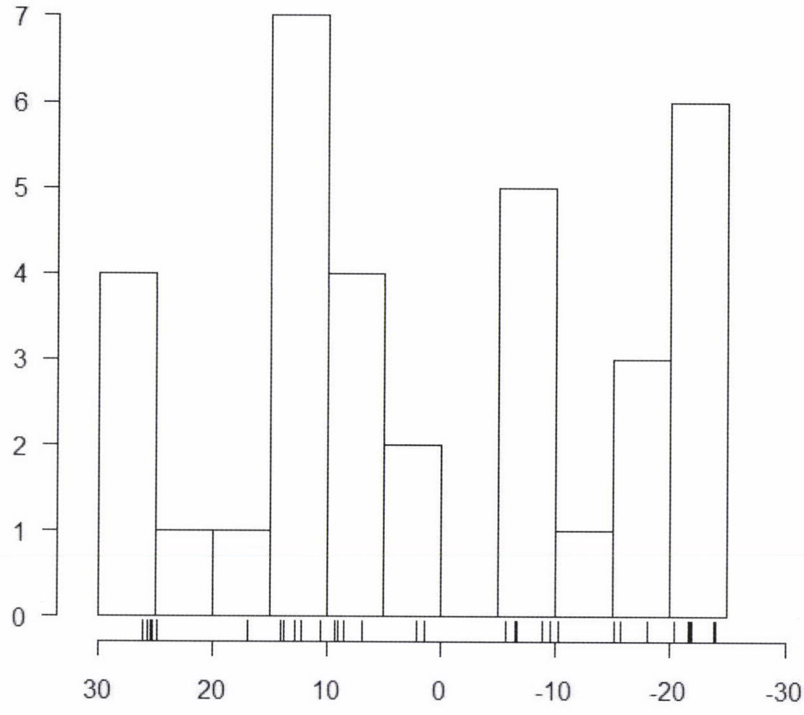

Figure 7. Orientations of the axes of the housepits longer than 19 m towards the eastern horizon.

approximately corresponds to the N–S direction. The average size of the housepits in this sample was 23.1 m, and the mean and median HFSL values of the sites were 52 m and 52 m, respectively.

Apart from size, there might have been other criteria by which a pithouse was considered 'special' and deserved a special orientation. A hint of possible 'specialisation' of the pithouses could be observed, e.g. on the site of Mastomaansuo (see Figure 1d). There, most of the housepits were oriented roughly along the N–S line (see Table 1). One of them, however, was located on the highest point of the terrain and was oriented NE–SW. On some other sites, too, there appeared to be 'special' or 'central' housepits that were positioned differently from the others (e.g. Niilonkangas, see Figure 1c). The central housepits were usually larger than the others, as well as built on special locations: on higher terrain, at the tip of a prominent local drumlin, or at some distance from the others. It was especially noticed that the positioning of some of these housepits resembled the preferred observed locations of the GCs on the SE sides of ridge formations (see Ridderstad 2015b). The orientations of these 'central' housepits observed on some sites were therefore separately considered.

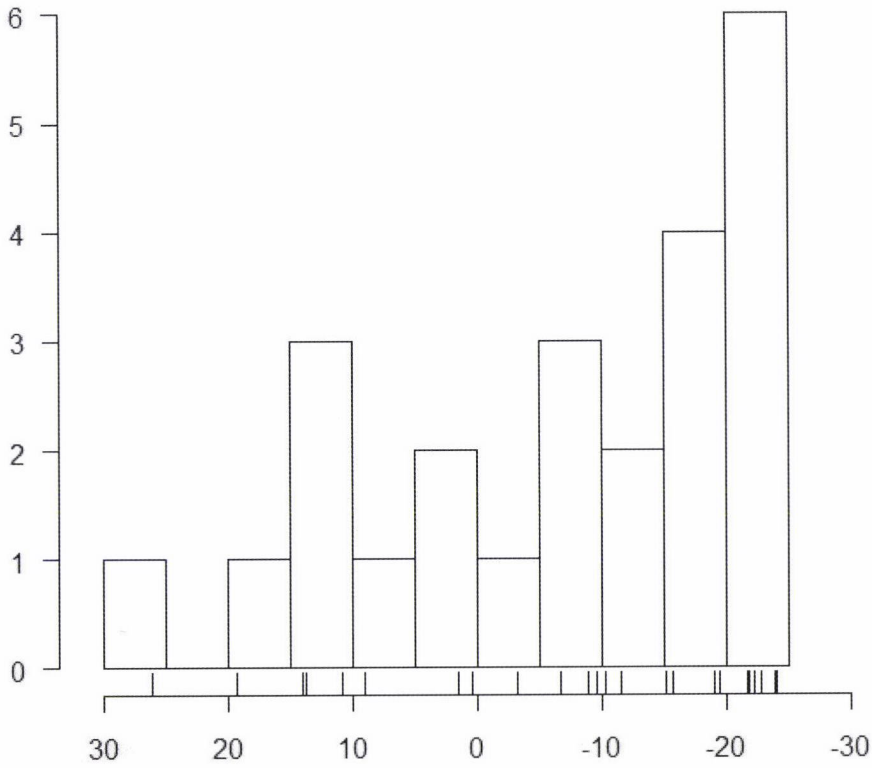

Figure 8. Orientations of the axes of the 'central' housepits towards the eastern horizon.

The group of the central housepits became to include 24 housepits, all of which were longer than 13 m, i.e. longer than the average size of the single-room housepits in this study. The average size of a housepit in this group was 20.4 m, which is of the order of a small GC. The mean and median HFSL values of the sites were 53.7 m and 52.5 m, respectively. The orientations of the central housepits, shown in Figure 8, concentrated on the SE side of the horizon, around the declinations of ca. –10 deg and –23 deg, with the highest peak of the distribution situated between –22 and –24 deg.

Naturally, a house could have been 'central' also for a certain larger region, not just a single site. Moreover, there might have been more than one large pithouse with a special status in a dwelling site. Thus, the above group of the 'central' housepits does not exhaust all of the housepits with a possible central status. To define a larger group including all possible 'central' housepits, all housepits fulfilling the following criteria were added to the first group of 'centrals' and the orientations of this new group were separately examined: (1) all large (over 10 m) 'central' housepits in a site, even if there was more than one candidate (not more than three, however);

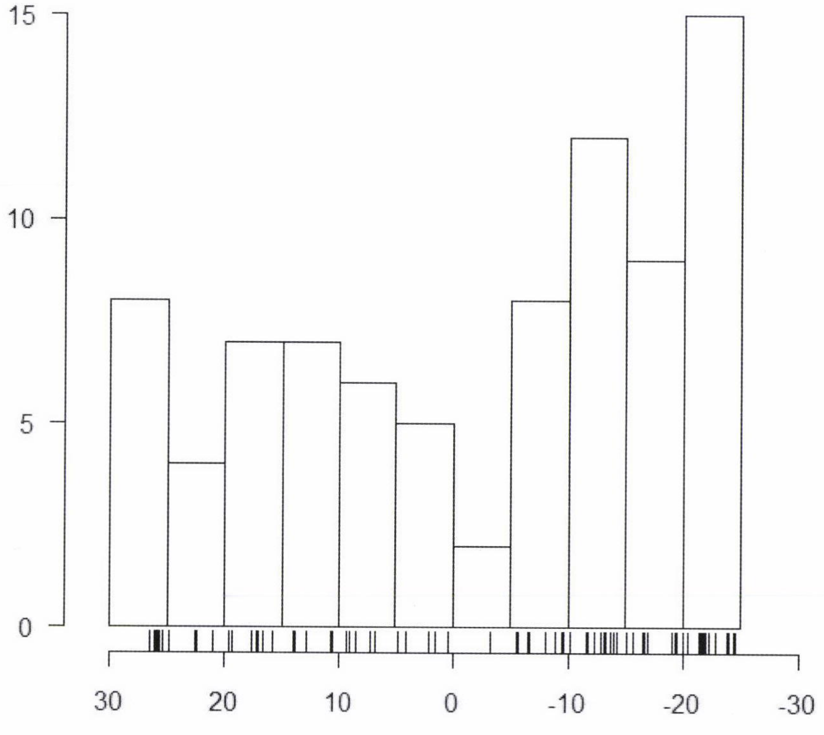

Figure 9. Orientations of the axes of the large single and 'central' housepits towards the eastern horizon.

(2) a large (over 10 m) single housepit not known to belong to any nearby dwelling site (the minimum distance of a 'single' housepit from the nearest dwelling site was taken to be about half a kilometre). Also very large housepits in a tight group of 2 or 3 were included in this sample (as these kinds of groupings may have had some special meaning, cf. the Pikku Liekokangas, Hevoskorpi, and Brantbacken-Ollisbacken sites, see also Okkonen & Ridderstad 2009). The average size of the 83 housepits belonging to this group became 18 m, and the mean and median HFSL values of the sites were 52.2 m and 52 m, respectively.

Incidentally, the above criteria for the possible regional centrality of a pithouse partly match the characteristics of the development of the size and location of the Late Neolithic pithouses on both sides of the Bothnian Bay: they grew in size, but there were fewer and fewer in a single site, (see Norberg 2008: 58; Mökkönen 2011: 57–58). In Norrbotten, also their locations moved from more sheltered locations towards the open sea, i.e. onto the tips of islands, capes and other prominent 'marine' locations with good views towards the surroundings and the horizon (Norberg 2008: 58); in Ostrobothnia, this kind of placement is typical for the GCs, but also many of the largest housepits of this study were observed to occupy similar locations. Thus, this second group of 'centrals' partly draws from the group of the typical 'marine' housepits of the latest phase of the Neolithic.

The orientations of this wider group of the possible central housepits are shown in Figure 9. At the large scale, the distribution in Figure 9 is mostly of the form of the combination of the distributions of Figures 3, 7 and 8. Clustering can be observed close to the N–S direction and around the declinations of ca. −13 deg and −22 deg, i.e. close to the maxima of Figure 8. These features indicate that this group may include some unrecognized 'central' housepits not included in Figure 8. However, they are currently impossible to separate from the rest of the distribution with certainty.

3.2 Orientations of the terraced houses

A special type of pithouse in Middle and Late Neolithic Finland was the so-called terraced house, a multi-room pithouse, which consisted of single rectangular or square pithouses, 'rooms' that were connected via narrower passages, 'vestibules'. This type of house could be seen as an imitation of the idea of a longhouse manifested in the Central European Neolithic longhouses built by, e.g., the Linearbandkeramik culture and its successors ca. 5500–4000 BCE (see, e.g., Whittle 1996: 144–210). However, there is also an early example from Karelia ca. 4500 BCE and one from River Kalix in Sweden ca. 3900 BCE (Halén 1994; Zhulnikov 2003: 101–102). The terraced house may just as well have been a local invention, too; one that developed from closely built pithouse rows connected via vestibular structures. Only some of the Finnish multi-room housepits have been excavated, but more have been identified in on-site observations (see Mökkönen 2008, and refs. therein).

It turned out during this study that some of the individual housepits, i.e. 'rooms' of the terraced houses that had been observed on-site did not show particularly well in the lidar data. Therefore, it was deduced that also many of the notably oblong previously unrecorded housepits that were observed in the dwelling sites in the lidar data may in fact be multi-room housepits, although the resolution of the lidar data was not able to reveal this unambiguously. In many cases, though, there were faint features observable in the lidar data that could be interpreted as individual 'rooms' of the structure. Thus, these 'uncertain' terraced houses or longhouses were also taken into the sample – after all, defined by its outer appearance alone, a "longhouse" is a long house. Vice versa, some of the structures appearing as connected in the lidar data might eventually turn out to be separate, but very closely

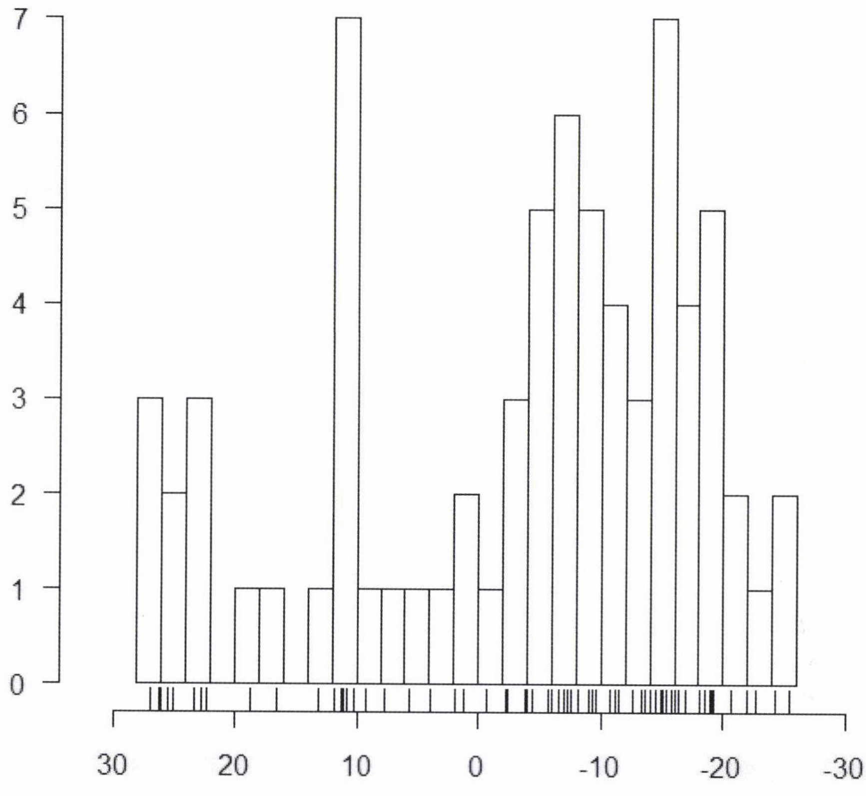

Figure 10. Orientations of the axes of the terraced houses and 'longhouses' towards the eastern horizon.

built individual houses; however, if the terraced house originally developed from closely built pithouse rows, the few misinterpreted structures from the same period should not distort the results too much. The mean and median HFSL values of the sites in the sample were 52.8 m and 53.5 m, respectively.

In Figure 10, the orientations of the axes of the 72 terraced houses or longhouses towards the east can be seen. In the declination distribution, most of the orientations are concentrated towards the SE direction. The tallest peaks correspond to clusters of orientations around ca. +11 deg, –7 deg, –15 deg and –19 deg. There is also a small group of orientations centred at +26 deg, corresponding to the N–S direction.

3.3 Orientations of the doorways of the housepits

The orientations of the doorways of the housepits were separately considered. The locations of the housepit doorways were sometimes easily recognizable both on-site and from lidar data, and sometimes neither. Therefore, the orientations of the doorways only became measured for part of the housepits. This uncertainty is related to the issue already discussed above that the outer appearance of a housepit does not necessarily reflect the original appearance of the pithouse, including the original locations of the doorways. The original doorways are always not observable as depressions in the walls; vice versa, there may be false doorways, i.e. recent depressions resembling doorway openings. These uncertainties are more prominent for the smaller housepits, as larger structures are usually better preserved. The doorways were indeed more easily observable in large housepits; it was especially observed in situ that many of them had 'pier stones' flanking their doorways – an observation indicating that the original doorways were in most cases probably correctly identified by observing the clear depressions in the walls also in the cases where there were no flanker stones. Moreover, the well visible doorways observed on-site could usually also be clearly seen in the lidar data (e.g. the doorways in the site map of Purmo-Hundbacken in Pedersöre by Miettinen (1981) are mostly well observable in the lidar data, too). However, only excavations can ultimately determine the true orientation distributions for the housepit doorways, and the analysis presented in the present study, being based mostly on the outer appearances of unexcavated structures, is thus of preliminary nature.

Figure 11 shows the declination distribution for the orientations of all of the recorded doorway directions of the housepits towards the east. The orientations are mostly towards the SE segment of the horizon, clustering around the declinations of ca. –7 deg, –13 deg, and –21 deg. There are also many orientations close to the N–S line. The N–S orientations also show up in the declination distribution of the orientations of the doorways towards the west, presented in Figure 12. There are other notable peaks around the declinations of ca. +15 deg, –5 deg, –10 deg, and –21 deg.

The orientations of the doorways mostly reflect the axis orientations of the housepits (see Figures 5–9). This can be understood on the basis of the fact that the doorways of a rectangular housepit were often placed at either or both ends of its long axis.

Most of the cardinally oriented doorways of the sample seen in Figures 11 and 12 were found in the housepits of the Kokkola-Kruunupyy-Pedersöre region and were therefore separately examined. There, many large housepits in the sites were close to circular, which means that the original pithouse must have been either circular or a square that had collapsed into a housepit with rounded corners. In the sites of Lehdonpalo, Pahanportaanräme, Lintukangas, Miekkakaara, Köyrisåsen, Bläckisåsen, and Purmo-Hundbacken, all of which are ca. 57–66 metres above the sea level, the number of the housepits was in average larger and they were rather more closely packed

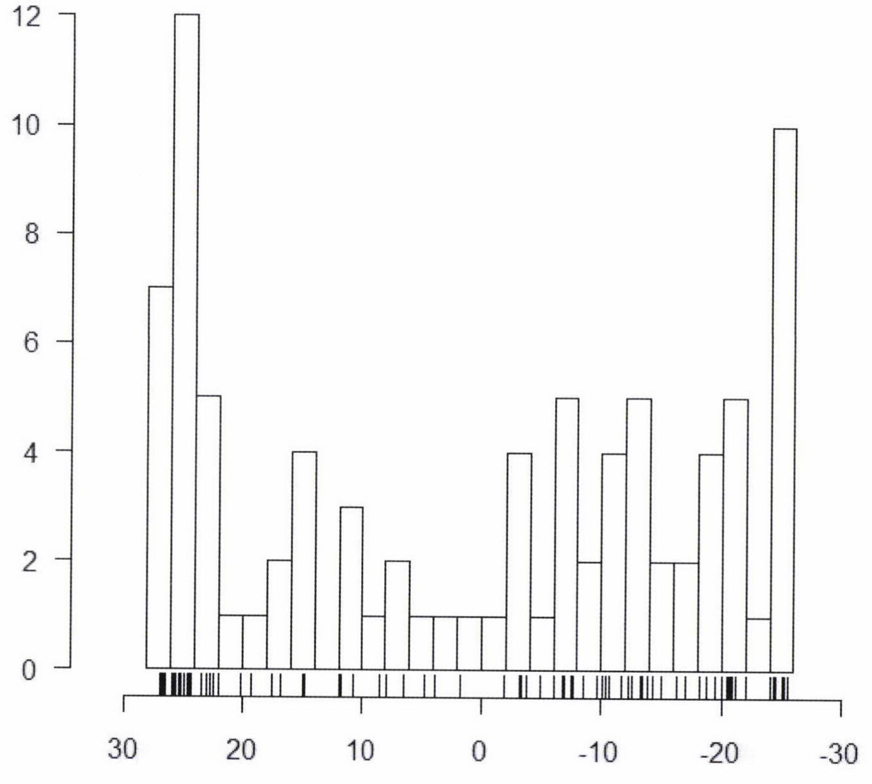

Figure 11. Orientations of the doorways of the housepits towards the east.

together relative to the housepits of the sites with lower HFSL values in the region (Morruttajankangas seems to be an exception, but with its HFSL of 40 m it is younger than the others). In Northern Ostrobothnia, sites comparable in appearance would be, e.g., Hiidenvaara 2, Karttiokangas, and Rekikylä, which have the HFSL values of 57.5 m, 57, and 64 m, respectively.[6]

Unfortunately, for none of the sites of the Kokkola-Kruunupyy-Pedersöre-region could the orientations of all doorways of the housepits measured. This was partly due to the limitations of the fieldwork and partly to the low resolution of the lidar data, from which only the most clearly visible structures could be measured; there were more faintly visible ones, but these were left out. Leaving out part of the doorways probably had no significant effect on the orientation distribution at the large scale. This was investigated by comparing the doorway directions of the site of Purmo-Hundbacken in Pedersöre measured both from the detailed site maps by Miettinen (1981)

6 Unfortunately, due to the resolution of the lidar data and limited resources for fieldwork, a similar comparison of the orientations of the housepit doorways of the round or squarish housepits was not possible for the sites of Northern Ostrobothnia.

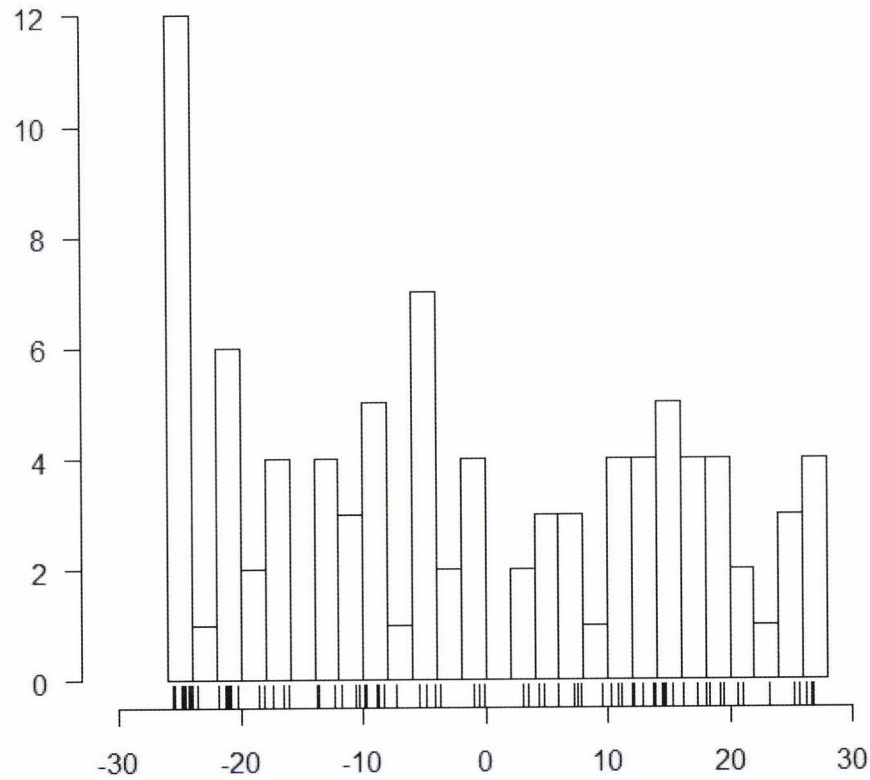

Figure 12. Orientations of the doorways of the housepits towards the west.

and from the lidar data. Both measurements supported the conclusion that the doorways were placed at the opposite ends of the circular housepits and were all oriented towards the NE–E and SW–W directions. Considering the effect of the horizon heights on the site (which were estimated from maps), the results suggested that most of the doorways were probably intended towards the cardinal E or W directions.

The orientations of the sample of the housepit doorways in the sites of the Kokkola-Kruunupyy-Pedersöre region are shown in Figure 13. The azimuth distribution reveals that almost all orientations are close to the N–S and the E–W directions.[7] The E–W orientations are almost exclusively from Purmo-Hundbacken, which has the HFSL value of ca. 57 m, while the N–S orientations are from the other sites, which are located on slightly higher grounds (60–66 m from the sea level).

The simplest explanation for the cardinal orientations is that most of the sites are located on ridges that run along the N–S direction; Purmo-Hund-

7 Note that the azimuth distribution does not take into account the effect of the horizon heights, which, however, were estimated to be low for all but the site of Purmo-Hundbacken.

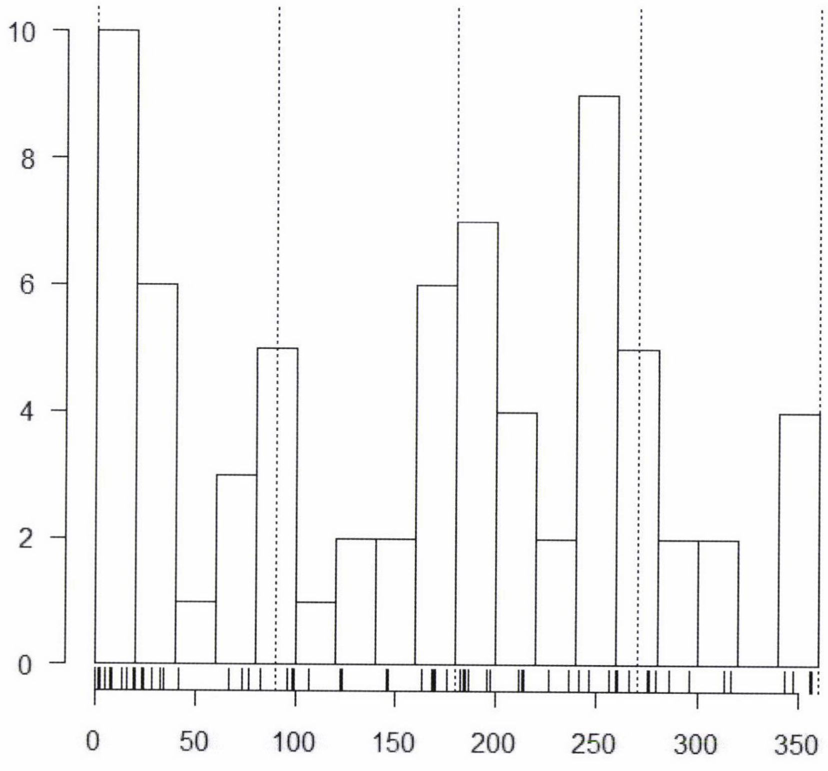

Figure 13. Distribution of the azimuthal orientations of the doorways of the Kokkola-Kruunupyy-Pedersöre region. The dashed lines show the locations of the cardinal directions (see also Figure 2).

backen with its E–W orientations is a notable exception.[8] The housepit rows, with occasional 'yard' areas of flattened ground in between the houses, run along the ridge direction, and the doorways open to the yard areas. Thus, the doorways became oriented along the main ridge direction probably because this enabled a direct, easy access from one yard and housepit into another. Sometimes the distance between similar consecutive housepits was so small that it was not clear from the lidar data whether the houses might in fact have been connected via some kind of additional structure to form a terraced house-type building. Perhaps it was via this kind of arrangement of the pithouses that the terraced house was developed in Neolithic Finland. In that case, it would have been an indigenous invention, not a cultural import.

In summary, it can be concluded that irrespective of the shape of a housepit – rectangular, circular or oval – the doorways were usually placed at two opposite ends of the housepit. For the rectangular and other elongated housepits, this means that the orientations of the doorways are found

8 The dwelling site of Purmo-Hundbacken/Myllykangas was located in a Neolithic river estuary. Ceramics from the site was mostly of the late Neolithic Comb Ceramic III style (Miettinen 1981, 1982).

to replicate the axis orientations to a large degree. In the future, the doorway orientations of all sites should be separately measured on-site, preferably in the context of excavations to create a more complete picture of the orientation practices of the builders.

3.4 Interpretations for the orientations

3.4.1 Shoreline

It is well known and easily observable that the Neolithic housepits in Ostrobothnia were often placed along the local shoreline. This follows from the fact that the sites were shore-bound and the housepits were built on the beach terraces, often their long axes approximately along the local ridge direction. However, there were, as already observed above in Section 3.1, exceptions to this rule, which raises the suspicion that there were also other factors at play in orienting the individual housepits.

3.4.2 Winds

There are no prevalent directions of strong seasonal winds (such as sirocco, the etesians, etc.) in the present-day Ostrobothnia, and one may assume that this was the case also in the Neolithic. The strongest winds thus would have been the ones blowing from the open sea, i.e. from the west on most sites. The coldest winds would have been those from the north or northwest, especially in the winter.

The general locations of the housepits do not show strong avoidance of winds. On the contrary, many of the sites were located on the northern or NW sides of islands and capes or at the tips of capes with clear views towards the open sea (e.g., Haaramoukku, Hiidenkangas, Hiidenvaara, Rekikylä, Tiperonkangas, and Morruttajankangas, to name a few facing the northern winds) – locations that must have been exposed to strong, occasionally cold winds. Also individual housepits show similar disregard towards the windiness of the locations: the tip of the cape seems to have been occupied on most sites and often large sole housepits were placed on the highest point of the local ridge or drumlin (cf. the Giants' Churches and the housepits of the late Neolithic Norrbotten that also occupy similar locations, see Section 3.1 and Ridderstad 2015).

Housepit group	Orientations to East (dec/az)
Pirttivaara-Laivavaara site, axis	+10, −20 deg (dec)
Under 10 m, axis	−24, −20, −10, +5, +25 deg (dec)
Over 20 m, axis	−20, −10, +10, +26 deg (dec)
Central 1, axis	−23, −10 deg (dec)
Central 2, axis	−22, −13, +26 deg (dec)
Longhouses, axis	−19, −15, −7, +11, +26 deg (dec)
All doorways	−25, −21, −13, −7, +25 deg (dec)
Kokkola-Kruunupyy-Pedersöre region, doorways	10, 90, 180 deg (az)

Housepit group	Orientations to West (dec/az)
Pirttivaara-Laivavaara site, axis	−10, +20 deg (dec)
Under 10 m, axis	−25, −5, +10, +20, +24 deg (dec)
Over 20 m, axis	−26, −10, +10, +20 deg (dec)
Central 1, axis	+10, +23 deg (dec)
Central 2, axis	−26, +13, +22 deg (dec)
Longhouses, axis	−26, −11, +7, +15, +19 deg (dec)
All doorways	−25, −21, −10, −5, +15, +25 deg (dec)
Kokkola-Kruunupyy-Pedersöre region, doorways	260 deg (az)

Table 2. Orientations of the axes and doorways of the different housepit groups presented in Figures 4 and 6–13; see the text for further information.

3.4.3 Natural light

In a semi-subterranean house, the only natural light available (which was mostly sunlight, occasionally also moonlight) would have been through the door openings. The many doorways (often two or three, sometimes as many as four) of a pithouse could therefore be at least partly explained by the desire to have as much natural light available as possible. The question of the exposure of the doorways to the sunlight is also in a natural way partly related to the possible ritual orientations towards the sun.

Taking the solar path and altitude into account, the maximum penetration of light through the doorways and onto the pithouse floor would have been through the doorways facing between NE–SE and SW–NW. Also the south-facing doorways would have contributed in the winter, but not so much during the summer, since the noon sun was then too high on the sky for the light beam to reach through the low doorways.

These preconditions, however, still leave many questions open. For example, if a pithouse was used mainly in summer, four doorways facing the NE, SE, SW and NW directions would have provided maximal daily sunlight. On the other hand, the northern doorways would at the same time have left the inside of the house exposed to the colder northern winds especially if the house was to be used also in early spring or late autumn. Then, having just two doorways facing the E and W directions would perhaps have been more desirable. The rough orientations towards certain segments of the horizon also leave a lot of room for possible ritual astronomical orientations of the doorways.

Judging by the amount of the natural light available, the observed four doorways in some housepits could perhaps be a sign that those houses were meant to be used throughout the year. However, the strictly symmetrical placement of the doorways opposite to each other may also point towards ritual, perhaps cosmological considerations among the builders.

3.4.4 Cosmological and astronomical interpretations of the observed orientations

Ritual orientations built guided by cosmological conceptions form perhaps the most important non-trivial group of explanations for the observed orientations of the housepits. Cosmological orientations include the symmetrical cardinal orientations and orientations to astronomical events. There are also other possible types of mythological orientations related to cosmology or cosmogony, e.g. the possible orientations towards for example the far-away land of the dead or the original ancestral homelands as suggested by Bradley (2001); the latter might be relevant for the Ostrobothnian longhouses and are discussed below in Section 4.

Most of the structures investigated in this study were situated between the HFSL values of 40 m and 65 m, with the lowest mean HFSL value of 52 m for the different subtypes of the housepits. Most of the housepits were from Northern Ostrobothnia, where these HFSL values correspond to ca. 3700 BCE, 1800 BCE, and 2800 BCE. In Central and Southern Ostrobothnia, the same HFSL values give in general some hundreds of years younger dates for the sites (see Okkonen 2003: 92–93).[9] The GCs of the sample of Okkonen (2003), who dates them to 3000 – 1800 BCE, had the mean HFSL value of 56.7 m. For the sample of the GCs in the present study, the mean HFSL value was 56 m (see Ridderstad 2015b), and the above dates by Okkonen (2003) thus approximately apply. The mean date and the year for calculating the celestial events for all of the above mentioned structures was thus taken to be ca. 2600 BCE.[10]

9 Note that Southern Ostrobothnia in this study includes both the territories of Etelä-Pohjanmaa and Pohjanmaa/Österbotten.

10 The declinations of the annual solar extremes have changed by the amount of ca. 0.5 degree since the Late Neolithic, which means the changes in the solar movement can be taken as negligible within the extreme limits of the building

The observed orientations, the most important groups of which are presented in Table 2, corresponded to various celestial events in 2600 BCE. First, it can be noticed that the orientations between the declinations of ca. –25 and –27 deg, as well as those between +25 and +27 deg, which are very common in the orientations of the housepits, were close to the N–S line in Ostrobothnia and may thus indicate deliberate orientations towards the cardinal directions. All of the four cardinal orientations also have astronomical relevance: the N–S orientation corresponds to the meridian line that the sun crosses at noon, as well as to the direction of the celestial pole, while the E–W direction corresponds to the solar and lunar risings and settings on or near the equinox. Also various other orientations to the risings and settings of the sun, the moon and the stars were common in ancient cultures. In the following, the solar, lunar and stellar orientations are considered, each in turn.

Solar orientations

The declinations of –24 and +24 deg corresponded to the sunrises and sunsets of winter solstice (WS) and summer solstice (SS), respectively, in Neolithic times, while the declination of 0 deg corresponds to the directions of the true east (E) and west (W), and the sunrise and sunset of the equinoxes. The declinations of ca. +/–16 deg corresponded to the sunrises and sunsets of the solar mid-quarter days in early November, February, May, and August (see Ruggles 2005: 265). Individual orientations to the solstices can be seen in Figures 4 and 6–12, and orientations to the mid-quarter days in Figures 6 and 9–12. Both thus seem to be fairly common in the housepits. Orientations along or close to the equinoxes, i.e. the E–W line are rare in the axes and doorways of the housepits, except for some doorways towards the west (Figures 12 and 13). However, neither of these orientation groups is particularly prominent.

In addition to the N–S orientations, the most prominent concentrations of orientations of most subsets of the housepits are at or near the declinations of +/–10 deg and +/–20 deg (see Table 2). These declinations correspond to the sunrises about one month after or one month before the equinoxes and one month after or one month before the solstices, respectively, thus forming a kind of potential 'seasonal pointer' system of orientations for the houses. In practise, these kind of orientations towards the sunrises ca. one month before or one month after an equinox or a solstice would probably have belonged to a simple lunisolar calendric system with 12 or 13 lunar months, which could have been calibrated against the solar year using an

periods of the housepits. It is also estimated that the basic lunar movements have not significantly changed since the Neolithic.

equinox or a solstice as a 'starting point' for the calendric count. The existence of this type of system in Neolithic Ostrobothnia would not be surprising. The everyday practical calendar in Neolithic Ostrobothnia, as in most ancient cultures, was probably based on lunar phases, i.e. the lunar synodic months. In addition to the simple lunar count, especially in a society that had already experienced the influences of agricultural practices, one might then also expect the existence of a simple lunisolar calendar combining the basic cycles of the sun and the moon – the tropical year of 365.25 days and the synodic month of 29.53 days – having been developed.[11]

A well-known example of a 'seasonal pointer' calendric system can be found in the medieval Nordic folk calendars, where the year was divided into four equal parts by four important dates: the Heart of Winter in the middle of January, the Summer Nights in mid-April, the Midsummer in mid-July, and the Winter Nights in mid-October.[12] It can be shown that in historical times in Finland, the Heart of Winter and the Midsummer have corresponded to the times of the thermal minima and maxima of the year, and the Summer and Winter Nights have approximately coincided with the permanent rise and decrease of the daily averaged temperatures above and below zero in the spring and in the autumn, respectively. Although in the Middle and Late Neolithic Ostrobothnia the average temperatures were warmer than today, being close to the warm medieval and present-day temperatures (see Solantie 2005), a lunisolar calendric system of the kind described above could have worked as a 'seasonal pointer' in the late Neolithic times, too. The declination of +10 deg would have indicated the solar position at the time when the warm spring and summer period started. Similarly, the declination of ca. –10 deg would have corresponded to the start of the cold nights and the 'winter half' of the year. The declinations of ca. +20 deg and –20 deg would have corresponded to the solar positions of the warmest summer and the coldest winter time, respectively.

The Heart of Winter, the Midsummer, the Summer Nights and the Winter Nights all lasted three days and three nights. The three days period suggests a relation to the movements of the moon, since the fullest, brightest phase of the moon lasts about three days. The Heart of Winter, for exam-

11 As is well known, 12 synodic months fall ca. 11 days short of one solar year, and in a simple lunisolar calendar, a 13th month must be inserted after every 2 or 3 years to prevent the months from moving away from their respective seasons.

12 This calendric system had probably been at use already in the late Iron Age and it has been proposed that it may be even older, having been established in hunter-gatherer times (see Vilkuna 1950: 284, 359). Indeed, the simple medieval Nordic calendar staffs are not that different from the oldest known calendric devices depicting lunar counts that date as far back as to the Palaeolithic era (see Rappenglück 2014).

ple, probably originally was the time of the full moon of the first or second month, or the first full month after the winter solstice (see Vilkuna 1950: 13, 184, 284). The full moon is known to have been ritually important in many ancient cultures and it also provided natural light for winter gatherings (e.g. the Disting in Sweden, see Nilsson 1920: 303). The full moon of the first full month after the WS occurs, in average, about 27 days after the WS. In 2600 BCE, the sun was then at the declination of ca. –21 deg. Considering that the daily variation in the solar rising and setting positions around the solstices is so small that it is undetectable by the human eye, the calendric count could also have been started a few days after the actual solstice, once the movement of the sun could again be detected.[13] In that case, the solar declination marking the time of one month after the WS would have been closer to ca. –20 deg. A similar calendric arrangement, but starting at the summer solstice, vernal equinox, or autumnal equinox leads to the solar declinations of ca. +20 or +21 deg, +10 deg, and ca. –10 deg, respectively, for the year 2600 BCE.

Also the times of the other full moons of the year could have been important for orientation purposes. The period between two consecutive full moons is one synodic month, i.e. ca. 29.5 days. At the time of the full moon of the second full month of the year starting at the WS, the sun would then have been at the declination of ca. –13 deg (or closer to –11 deg, allowing for a few extra days for the observational reasons described above). For the calendric counts starting at the SS, VE, and AE, the respective solar positions of the second month of the year would have been the declinations of +13 deg (or max. +11 deg), +19 deg, and –20 deg. The days of the third full moon before the following solstices would already have been so close to the solstices that the solar declination would have been ca. +24 deg or –24 deg. Similarly, the declinations of the third full moon before the equinoxes would have been close to the true east.

In addition to the time of the full moon, also the start of month may have been important as a calendric marker used for orientations. It is well known from the historical records of ancient cultures that a month often started by observing the last lunar crescent visible in the east before sunrise, the first lunar crescent in the west after sunset, or at the full moon. If the lunar count had been started, e.g. at the time of the first crescent or the first full moon after the WS, it would have started ca. 14 days after the WS in average.[14] The

13 Because of this phenomenon, in the Finnish folklore the days around the solstices were known as the 'nesting days' of the sun, i.e. the days when it stayed immobile in its 'nest' (see Vilkuna 1950: 152, 335).

14 There is a 'delay' of 1-3 days, since the thin first crescent is not visible to the unaided eye until it is ca. 16 hours old at the minimum, and not well observable until it is 2-3 days old.

solar position on that day would have been at the declination of ca. –23 deg. The next month would have begun 29 or 30 days later, when the sun would have been at ca. –17 deg or –16 deg (note that this is also the declination of a mid-quarter day), and the third month, when the sun would have been at ca. –7 deg or –5.5 deg. For a similar calendric count starting at the SS, the declinations of the sunrises and sunsets would have been ca. +23 deg, +17 deg or +16 deg (a mid-quarter day), and +7 or +5 deg (note that the declination of ca. +/–5 deg is only about 11–12 days from the equinox – a difference that also corresponds to the separation between one solar year and 12 synodic months). If, on the other hand, the lunar count had started at the vernal equinox, the solar declinations would have been slightly different: ca. +5.5, +15.5, and +22.5 deg. For the autumnal equinox, the declinations would have been ca. –6, –16.5, and –23 deg.

Looking at the orientations of the various subgroups of the housepits in Figures 4 and 6–10, many of the declinations of the small separate groups of orientations can be connected to the solar positions determined by the lunisolar calendric systems described above. Especially the most prominent orientation peaks of the single-room housepits and the housepits doorways (shown in Table 2) at ca. +/–5 deg, +/–10 deg, –13 deg, +15 deg, and –21 deg, as well as those of the terraced houses at the declinations of ca. +/–7 deg, +/–11 deg, +/–15 deg, and +/–19 deg can be connected to the solar orientations determined by the lunisolar calendars described above. The multitude of the observed lunisolar orientations could imply that there might have been several different calendars simultaneously at use. However, the orientations of a very specific type of houses, namely the THs and 'longhouses', which should perhaps be expected to have been determined according to a single calendar, do not seem to belong to one, at least not one that would be easily recognisable. Thus, at this point of research, the question of the precise form of the calendar(s) used in the possible 'seasonal pointer' system based on solar orientations must be left open.

Lunar orientations

In addition to orientations to the sun, determined by a lunisolar calendar, the orientations of the housepits could have been towards the moon itself. The movements of the moon on the sky are quite different from those of the sun. The declination of the moon changes much faster than that of the sun, and the moon reaches its maximum and minimum rising and setting points at the horizon once a month (cf. the annual maximum and minimum rising and setting points of the sun). However, the maximum and minimum declinations of the moon do not stay the same from one year to another, but vary from ca. +/–29 deg to +/–19 deg in a cycle that lasts about 18.61 years.

During this so-called Metonic cycle, the moon goes through its minimum and maximum standstills, i.e. its most extreme ranges of the monthly declination variation (cf. the solstices).

Due to the more complex movements of the moon, its basic cycles are not easily fitted together with the tropical year. For example, the first full moon after the spring equinox will not rise on the same date or at the same azimuthal position every year; instead, it takes one Metonic cycle for that to happen. Because the rising position of a certain full moon varies from year to year, the declinations of the rising position will over time form a rather wide non-Gaussian distribution that peaks at a certain point; this can be compared to solar orientations which are, essentially, defined by a single value of declination and thus often show up in orientation distributions as Gaussians centred around that value (see Silva 2014). Therefore, proving a lunar event can be difficult in case the number of observation points is low.

Looking at the latitudes of Ostrobothnia (ca. +63 – 65 deg N), one may readily observe that at the time of the maximum lunar standstill, the maximum and minimum declinations of the moon are well beyond the range of the declinations crossing the zero horizon line. Thus, the moon at that time either does not set or does not rise at all, and a lunar orientation is not possible.[15] However, some of the orientations of the THs and the single housepits correspond to the rising and setting points of the moon at its minimum standstill at +/−19 deg (see Figures 6, 8 and 10–12). A lunar orientation is also always possible during the intermediate years of the 18.61-year cycle, as long as the extreme lunar declination is less than the declination of the N–S line at the horizon line; the orientations towards these events would be situated between the declinations of +/−19 deg and those of the N–S line. It can also be noted that since the full moon is opposite to the sun, there would also in Neolithic Ostrobothnia often have been during the midwinter and the midsummer a situation where the full moon would have been seen at one end of a house and the sun at the other.

The declination of ca. +/−5 deg seen in the orientations of the small, under 10-m housepits corresponds to the so-called 'megalithic equinox' or the Spring (or Autumn) Full Moon (SFM/AFM), which is defined as the first full moon that rises at a more southerly (or northerly) declination than the sun around the vernal (autumnal) equinox (see da Silva 2004). In a sense, the SFM and the AFM could be taken to correspond to the equinoxes, while the minimum and maximum lunar standstills could be taken to correspond to the solstices. The SFM/AFM events and the midsummer and midwinter

15 If the horizon were sufficiently elevated, however, a setting and a rising event could potentially be observed for the moon at its maximum declination. The horizon heights of the present study are, however, generally too low for that to happen.

full moons (which include the full moons between the declinations of +/19 deg and the N–S line) could thus have formed a simple lunar seasonal pointer system for the orientations of the housepits. This model, however, leaves the orientations seen around the declinations of +/–10 deg unexplained.

Recently, it has been suggested by Clausen (2014; 2015) that both the orientations of Scandinavian passage graves and West Iberian megalithic tombs could be explained by a combined distribution of orientations to the moonrises of the SFM, the next full moon after the SFM ("the sowing moon"), the southernmost full moon, the AFM, and the full moon preceding the AFM ("the harvest moon"). The sowing moon would have happened from April to May and the harvest moon from August to September. The full moon would thus have acted as a seasonal marker similar to what I have suggested for the sun or the moon in the case of the housepits. The exact lunar seasonal pointer model is, however, not similar to the Danish one: while there could be an unrecognized type of Ostrobothnian single-room housepits showing also the sowing and the harvest lunar events, the present distributions do not show suitable declination peaks. However, the separations between the declinations of the highest peaks in the orientation distribution of the THs (Figure 10), which form a series close to an exponential one (18, 8, 4), could indicate lunar events, e.g. a series of certain full moons during one year. The lunar 'seasonal pointer' model provides an explanation why certain full moons might have been more important than others for the orientations of the terraced houses. If the +/–19 deg peak seen in the orientations of the THs corresponded to the full moon of the minor lunar standstill, then perhaps the other peaks at ca. +/–7 deg, +/–15 deg and –/+11 deg could have corresponded to the SFM/AFM, the sowing/harvest full moon, and the first full moon of the winter/summer time, happening around October/February, in those years of the Metonic cycle.[16]

<u>Stellar orientations</u>

It is well known that in some ancient cultures also the heliacal and acronychal risings and settings of bright stars were used to indicate the changing of seasons. One may notice that in Neolithic Ostrobothnia for example the many bright stars of the asterism of Orion that grazed the SE segment of the horizon in ca. 3300 – 1800 BCE could have been used for seasonal calendric orientation purposes. However, because of the precession of the equinoxes, the positions of stars change more than one degree in a century. Therefore,

16 The wide lunar orientation distribution might allow for the deviations in the locations of the SFM/AFM peaks if only certain years of the Metonic cycle are considered. The possibility of these kinds of orientations for the THs is currently under investigation.

any ancient monument has to be dated with a sufficient accuracy to prove an orientation to a star. Currently, there are not enough radiocarbon dates for the housepits of Ostrobothnia to suggest stellar orientations for most of the sites. Therefore, possible orientations to stars are difficult to evaluate. Hopefully, the situation may change in the future.

Summary of the astronomical orientations

In conclusion, regardless of whether the orientations were to the sun or to the moon, the orientations of certain types of housepits can be connected to lunar or lunisolar calendric systems and tracking the change of seasons.

3.5 Comparison of the orientations of the housepits with each other and with the orientations of the Giants' Churches

The orientation distributions of the various subgroups of the Neolithic housepits of Ostrobothnia shown in Figures 4 and 6–10 and Table 2 reveal some interesting similarities and differences. The clusters of orientations at or close to the declinations of ca. +/−10 deg and/or +/−20 deg, the possible solar and lunar calendric 'seasonal pointers' are seen in most subtypes of the housepits. However, they are especially prominent in the largest (over 19-m) and 'central' subgroups of the housepits (Figures 7 and 8), as well as for the Pirttivaara dwelling site (Figure 4). Not all of the subgroups show orientations to the same events: if one group has orientations to, say, the declination of −10 deg towards the eastern horizon, for another group the sign can be reversed, which means the reversal of the 'seasonality' of the solar or full moon events in question (as, e.g. in the winter the sun rises in the south and the full moon in the north, and vice versa). For example, unlike the orientations of the single-room housepits, the orientations of the multi-room housepits or the longhouses close to 'the 10 degree peak' at ca. +11 deg are more common towards the eastern horizon, while the eastward orientations of the single-room housepits are more often towards the declination of −10 deg. Thus, while the latter were often oriented to the sunrise about one month before the vernal equinox and one month after the autumnal equinox, the former were oriented to the sunrise one month after the vernal equinox and one month before the autumnal equinox.

Unlike the other single-room housepits, the smallest, under 10-m housepits show a clear peak of orientations towards the declination of ca. +5 deg towards the east and −5 deg towards the western horizon, i.e. towards the AFM and SFM events. At ca. −7 deg (+7 deg in the west), the THs have a peak, which could perhaps also be related to the SFM (AFM) event with the

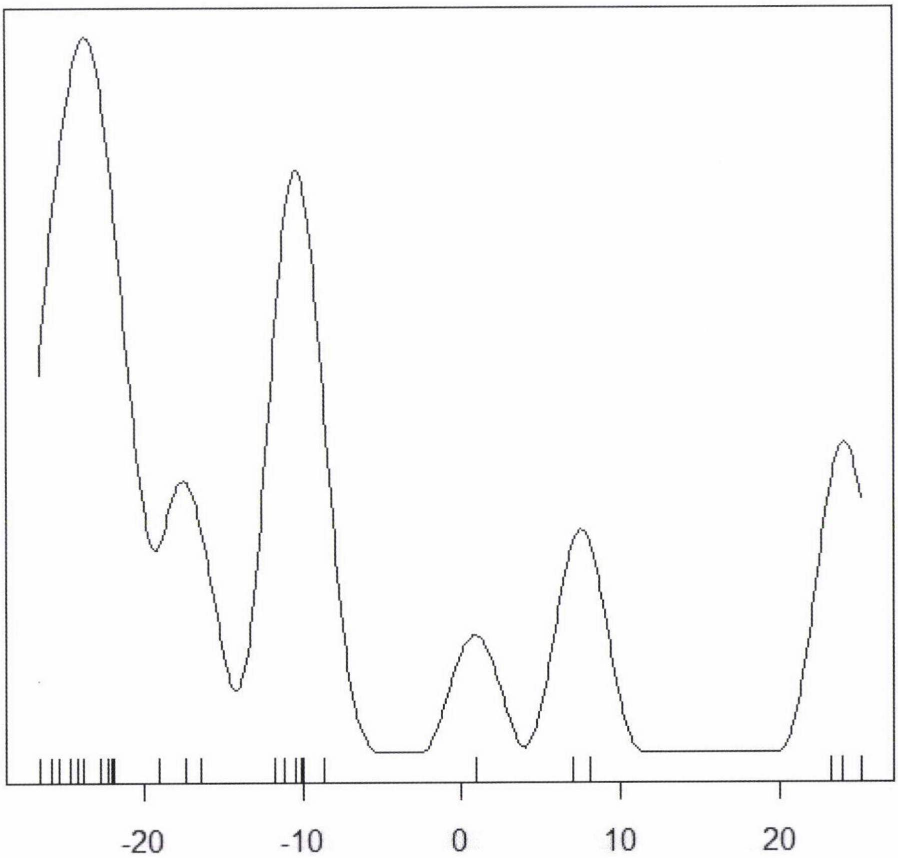

Figure 14. Orientations of the axes of the Giants' Churches longer than 35 m towards the eastern horizon (after Ridderstad 2015b). In the Figure, North is on the right.

centre of the peak shifted. When both the average and the median HFSL values of the housepit sites are taken into account, the sites with the housepits under 10-m and the THs have the largest HFSLs and appear to be a bit older than the other subgroups of the housepits of this study. Based on the HFSL values, the local tradition of orienting houses to the SFM/AFM could thus be older than that of 'the 10 degree peak'.

Comparing of the orientations of the housepits with the orientations of GCs of different sizes, some interesting similarities can be observed. In Figures 14 and 15, the declination distributions for the large, over 35-m GCs and the smaller, under 36-m GCs are shown. It can be seen that the largest GCs, which are less likely to be remains of dwellings, have orientations to the solstices and the declination of –10 deg in the east, while the smaller, under 36-m GCs show a prominent cluster of orientations towards the declination of –20 deg, as well as a smaller cluster at ca. +6 deg. It can be seen that the orientations of the largest and the smallest GCs are thus quite different

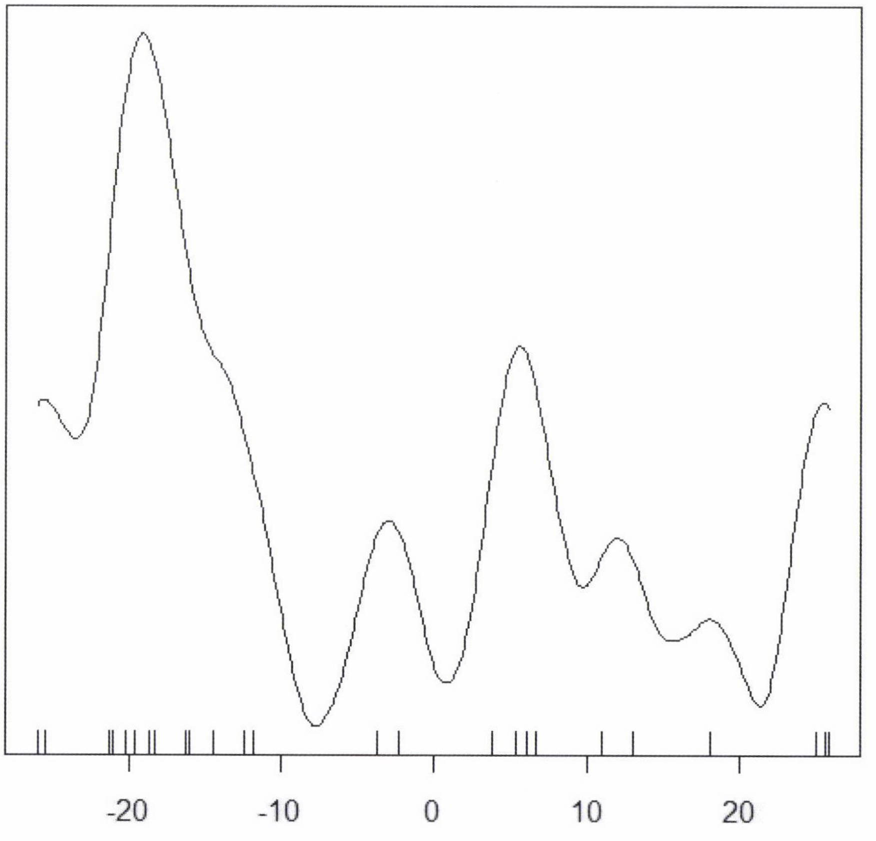

Figure 15. Orientations of the axes of the Giants' Churches shorter than 36 m towards the eastern horizon (after Ridderstad 2015b). In the Figure, North is on the right.

from each other, which can be interpreted as an indication that some of the smallest GCs might in fact be remains of large houses (see Okkonen & Ridderstad 2009; Ridderstad 2015b; Ridderstad & Okkonen 2015).

The mean HFSL values for the small, under 36-m GCs and the large, over 35-m GCs are 57.3 m and 54.7 m, respectively (Ridderstad 2015b). The largest GCs thus seem to be in average slightly younger than the smaller ones. Consequently, the tradition of orientations seen in Figure 15 may be older than that of Figure 14. Also, based on the HFSL values, the GCs would seem to be older than any of the housepits of this study. However, those values are for the enclosures themselves; the dwelling site around Kastelli, for example, has the lowest HFSL value of ca. 52 m, which makes it roughly contemporaneous with the over 19-m and the central housepits, which have the mean (median) HFSL values of 52 m (52), 53.7 m (52.5), and 52.2 (52) m. These values can be compared to the mean (median) HFSL values of 53.9 (53) m and 52.8 (53.5) m of the small housepit and the TH sites, respectively.

The few radiocarbon dates obtained for the GC sites indicate they are in general some hundreds of years younger than the THs, which have the average 1-sigma radiocarbon date of ca. 3200 BCE (Franzén et al. 1998; Schulz 2000; Okkonen 2003: 107; see also the discussion in Mökkönen 2008, and Mökkönen 2011: figure 13). The tradition of building the GCs thus appears to be in average slightly younger than the THs, while the GC sites may be only slightly older than or contemporaneous with the sites with the central housepits.

The largest single-room housepits of the present study are about 30 m long. Their sizes are thus of the same order as the 'small' GCs of the distribution of Figure 15, which are in average 27.6 m long. Therefore, the small GCs and the large housepits cannot be distinguished from each other by their size alone. Also their orientations are partly similar. Both the GCs and the subgroups of the largest and the 'central' housepits have many orientations at or close to the declination of –20 deg towards the eastern horizon. Both the largest GCs and the largest and central housepits have orientations to the declination of –10 deg towards the eastern horizon, while the terraced houses, on the other hand, show a peak at ca. –11 deg towards the western horizon only. The orientations of the largest and most prominent ('central') single-room housepits thus have common features with both the smallest and the largest GCs, while the orientation distribution of the terraced houses differs from both the orientations of those housepits and all GCs.

The orientations of the smallest, under 10-m housepits (Figure 6) have a possible common feature with the smaller group of the GCs: the AFM peak at ca. +5 deg towards the east could correspond to the peak at ca. +6 deg for the GCs in Figure 14. If the peak at ca. –7 deg in Figure 10 for the terraced houses is due to the same event, it differs from the orientations of the GCs and also the smallest single-room housepits, being towards a setting event while the other two would be towards the same event in rising. Or to put it another way: if the intended orientations were always towards rising events, the orientations of the THs would have been to the spring moon or the autumn sun, and the orientations of the GCs and the small housepits to the autumn moon or the spring sun.

It is interesting that the smallest housepits and the THs, which seem to be the oldest houses in the sample, have many orientations to the megalithic equinox, just like the small GCs, while the largest GCs do not show this feature. The largest GCs, on the other hand, have many orientations to the solstices – a feature missing in the orientations of the small GCs and the THs. Especially, three out of the five over 60-m GCs had axis orientations to the solstices (Ridderstad 2015b; Ridderstad & Okkonen 2015).

To sum up, the orientations of the smallest housepits and the orientations of the largest or otherwise most prominent housepits differ from each other and show common features with both the largest and the smallest GCs. The orientations of the terraced houses have certain features common with both of the above types of the single-room housepits, as well as the large and the small GCs, yet show a total distribution different from all of those.

The relation between the orientation distributions of the THs and the GCs is peculiar: apart from the orientations of the GCs to the solstices and within an error margin of one degree, they have similar orientations, except that some of the signs are reversed. Both have orientations to the N–S line and to the declinations of −19/−20 deg and −15/−16 deg. Towards the east, however, the GCs have orientations to the declinations of ca. +6 deg, −10 deg, and −22 deg, while the THs have clusters of orientations at ca. −7 deg, +11 deg, and +23 deg.

Moreover, calculated for the latitude of Northern Ostrobothnia in 2600 BCE, the summer solstice sunrise was perpendicular to the sunrise at the declination of −7 deg so that the difference in azimuth was almost exactly 90 degrees. A similar relation was valid for the mid-quarter day sunrise and the sunrise at ca. −20 deg; to the sunrise at ca. −10 deg and the sunrise at +23 deg; and to the sunrise at −22 deg and the sunrise at +11 deg. The GCs thus seem to have been built mostly towards directions perpendicular to the orientations of the THs.

Similar relations can be presented for the orientations of the single-room housepits and the GCs, too, but the 'pairing' per a type of housepits is not complete and some of the events would have been towards the west. It is known that more than 90% of the GCs were built on the eastern or SE sides of the ridges, implying an interest towards the eastern horizon (Ridderstad 2015b). Therefore, the relation between the orientations of the GCs and the subtypes of the single-room housepits of this study is not as clear as that for the GCs and the THs.

4. Discussion

Although many of the single-room housepits of this study were oriented along the directions of the local terrain, the orientations of the selected subgroups of the housepits revealed by this study hint at the existence of additional orientation practices for specific, as yet unrecognized types of housepits, partly covered by the selected groups of the present study. Those types of housepits appear to have been astronomically oriented. The multi-room housepits had a more complex, likely astronomically motivated orientation pattern, which perhaps was related to the orientations of the GCs.

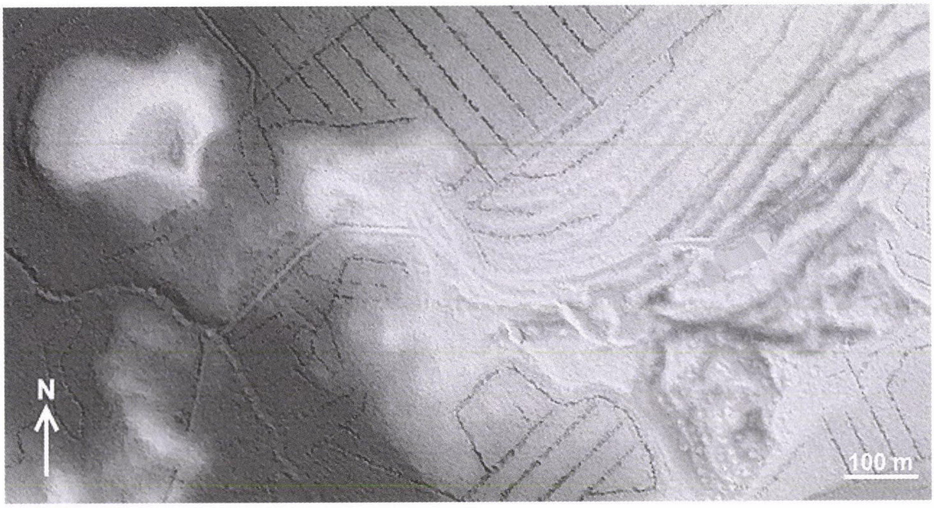

Figure 16. The large Neolithic dwelling site of Miekkakaara (lower right in the figure) and the Giant's Church of Hautakangas (on the 'island' in the upper left) in Kokkola, Central Ostrobothnia, as seen in the ground elevation model based on the lidar data provided by NLS (2014).

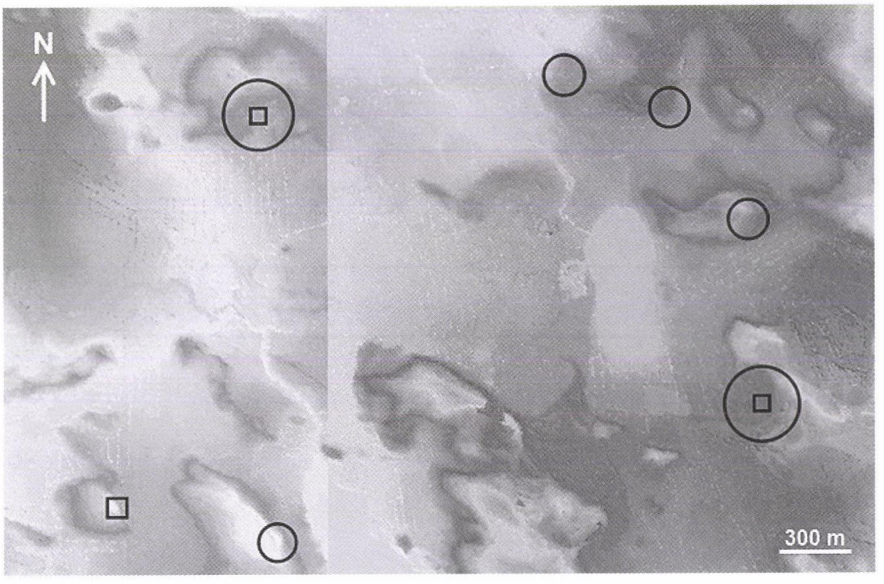

Figure 17. The Giant's Church of Linnasaari (marked with a square) in Oulu, Northern Ostrobothnia, and its surrounding housepit sites (the circles), with the sites with 'central' housepits (the circles with squares) separately marked, as seen in the ground elevation model based on the lidar data (see NBA 2014; NLS 2014).

The orientations of the doorways of the housepits turned out to replicate the axis orientations of the single- and multi-room housepits to a large degree. This is related to the observation that doorways were generally placed at either or both ends of a pithouse. In the Kokkola-Kruunupyy-Pedersöre region, the doorways were directed primarily towards the cardinal directions.

At this point of research, it is impossible to determine whether the observed orientations were primarily towards the sun or to the moon, or both.[17] There is also the possibility of a 'double-event', when the full moon at one end of a structure can be seen opposite to the sun at the other. In either case, the orientations seen in the housepits point to the existence of some kind of lunar or lunisolar 'seasonal pointer' calendric system, according to which some types of houses were oriented in Neolithic Ostrobothnia. Similar orientations have previously been detected in the GCs (Ridderstad 2015b).

Especially interesting are the possible orientations of some housepits towards the so-called megalithic equinox, which is also part of the "lunar seasonal pointer" system first suggested by Clausen et al. (2008) for the orientations of the megalithic graves of Denmark. Orientations to the megalithic equinox have so far been detected mainly in the burial monuments of the megalithic cultures of Western Europe (see, e.g., da Silva 2004; Clausen et al. 2008; Clausen 2014, 2015). Those monuments date to ca. 4500 – 3000 BCE and are thus earlier than the Ostrobothnian structures of this study. It is therefore possible that the practice of orienting buildings towards those types of calendric markers could have arrived in Ostrobothnia from the megalithic cultures, possibly from the TRB of Denmark via the Pitted Ware culture, which had a lifestyle similar to that of the seal-hunting cultures of Neolithic Ostrobothnia and lived in direct contact with both the TRB in Sweden and the Comb Ceramic and asbestos ceramic cultures in Southern Ostrobothnia (see Miettinen 1998, 1999; Larsson 2009: 14–16, and refs. therein).[18]

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17 Note that the situation is equally uncertain for many types of Neolithic structures currently investigated in Europe.

18 It must be emphasized, though, that astronomical and calendric knowledge, like any set of cultural memes, was always in the state of continuous transformation. While it is possible that there were strong influences from the megalithic cultures of Denmark and Western Europe, there may have equally well been an earlier wave of cultural influences concerning lunisolar calendars and the orientations of houses that had for example arrived already ca. 5300 BCE, simultaneously with the earliest signs of agriculture (see Alenius et al. 2013). It is also possible that those influences had been mixed with the already existing local traditions established in the Mesolithic.

It is possible that some of the orientations were to solar and some to lunar events. For example, the orientations of the largest, over 35-m GCs, which have lower HFSL values than the smaller, under 36-m GCs, show prominent orientations to the solstices unlike the smaller GCs (Ridderstad 2015b). The larger HFSL values, indicative of the greater age of the THs and the smallest housepits may then suggest that the youngest houses and GCs had orientations to the sun more often than the older ones. Perhaps the central role of the sun in the religion of the Bronze Age has implications on how the orientations should be interpreted towards the end of the Neolithic (for the Bronze Age solar cults, see, e.g. Kristiansen & Larsson 2005). There is evidence of solar orientations also among the Corded Ware culture (e.g. Schmidt-Kaler & Schlosser 1984), which may have affected the cultural traditions of the Late Neolithic in Ostrobothnia, too (see Tranberg 2001; Nordqvist & Häkälä 2014). To further address this question, the orientations of early Bronze Age monuments should be examined and compared with the orientations of the Late Neolithic structures.

The orientations of the structures traditionally classified as Giants' Churches are mostly the same as the orientations seen in the housepits. This leads to the conclusion that, with the possible exception of the THs, the GCs and the selected subgroups of the housepits of this study cannot be distinguished from each other based on any one type of orientation alone. However, not all of the subgroups of the housepits show all of the orientations seen in the GCs, and the total orientation distribution of the largest GCs is different from all distributions of the housepit subgroups examined, as well as from that of the smallest GCs.

Based on the on-site observations of this study, the following features can be used together to characterise the class of GCs – whatever their function turns out to be – and to separate a GC from a large housepit without excavation: a) a very large, over 35 m length; b) a double, triple or open wall structure; c) stone as the building material; d) a large number of cairns, often symmetrically placed around the structure; e) cairns or boulders inside the walls. Some of these features may not be independent of each other. For example, only for the largest structures (longer than ca. 40 m) is the average number of cairns greater than for the small GCs, some of which could be house remains, ritualized by the addition of cairns or other structures (see Ridderstad 2015a). In addition, more than 90% of the GCs are situated on the eastern or SE sides of the ridge they were built on (Ridderstad 2015b); a similar phenomenon is not observed for the largest, over 19-m housepits to the same extent, although most of the large housepits that also belong to the group of the 'central' housepits also seem to have been facing preferably eastern and southern views.

The orientation distributions of the THs are different from both the other types of pithouses in this study and the GCs. Their orientations can be compared for example to the earlier orientations of the Linearbandkeramik (LBK) longhouses of Central Europe, many of which were oriented SE–NW (see Bradley 2001). Unfortunately, a detailed orientation study of all of the Central European longhouses that would have satisfied sufficient astronomical accuracy has not yet been performed, even though regional and quantitative studies have been made, some of which suggest astronomical motivations (see Section 1). Bradley (2001) suggested that the orientations of the LBK longhouses were towards the ancestral lands of the builders. This kind of hypothesis can be presented for the THs and longhouses of Ostrobothnia, too: the majority of them have orientations to the SE, towards the great river routes leading to inland, where the ancestral lands of the Pöljä and Comb Ceramic cultures may have resided. This hypothesis does not contradict the existence of the calendric orientations, but can be seen as a complementary feature: the sunrises or moonrises at certain times of the year would have also pointed towards the direction of the ancestral homeland. Of course, this hypothesis does not necessarily imply the existence of any cultural contact between the builders of the Ostrobothnian THs and the LBK longhouses.

Based on the sample of the present study, the first housepits connected to each other to form TH type houses were built on sites at the HFSLs of 65 m and 63 m in Pahkakoski 7 in Oulu and in Pahanportaanräme in Kokkola, respectively. This suggests that the idea of a multi-room pithouse was known already during ca. 3700 BCE, in the times of Typical Comb Ceramic. Based on the dating of a longhouse in NW Sweden to ca. 3900 BCE (Halén 1994), the idea of a longhouse could have arrived from there. Alternatively, it might have arrived via the eastern continental route, in which case its origin could have been in the indigenous development of the Karelian house types (note the early example of a multi-room housepit ca. 4500 BCE; Zhulnikov 2003), or even the early Central European farming cultures such as the LBK (although any direct cultural relationship seems unlikely due to the large structural differences between the LBK and the Ostrobothnian longhouses; the influence would then have been only ideological, e.g. in the form of an idea of communal buildings). The idea of a terraced house may also simply have developed locally from the tightly packed rows of housepits on the large dwelling sites of the Middle Neolithic.

The results obtained suggest that the GCs were deliberately oriented perpendicular to the THs. This can be explained considering the structure of the social spaces seen in the Late Neolithic dwelling sites. Costopoulos et al. (2012) have suggested that towards the end of the Neolithic, constructing large social spaces such as the GCs may have compensated for the collective spaces lost when the terraced house fell out of use. The simplest explanation for the observed relation in the orientations would be that the GCs once enclosed small buildings arranged side by side so that their long axes were oriented along the short axis of the enclosure. In that case, what we now see as big GC would once have been a kind of terraced house with its rectangular rooms arranged parallel to each other, instead of them having been arranged in a row in the usual manner. This possible explanation is however not directly supported by the observed inner structures of the GCs, except perhaps in the Central Ostrobothnian Pahikaisharju and Tressunharju, where the division of the GCs into two parts with the sizes of 1/3 and 2/3 of the area of the total enclosure supports the idea that there may have been 'rooms' inside the GCs. In other cases where a GC has inner structure, it is in the form of a smaller inner enclosure with its long axis oriented along the main axis of the GC.

Different temporal levels can be recognized in the development of the various human made structures of Middle and Late Neolithic Ostrobothnia. First, there is the temporal development seen in an individual site or on several sites harbouring certain types of structures: a former dwelling site may have transformed into something else, and especially the GC sites were likely altered many times during their period of use. Second, there is the temporal sequence in which the different kinds of structures emerged: first the sites with large numbers of housepits and the THs; then the GCs, the larger 'central' houses and the overall increase in the housepit sizes; and, finally, the decrease in the numbers of pithouses in a site.

I have previously suggested that the GCs may have once enclosed former dwellings or perhaps even mortuary houses that would presently show up as the smaller inner wall structures seen in many GCs (Ridderstad 2015a). This suggestion was based on the fact that cairns, standing stones and other signs of ritualization can also be found attached to and around some apparent remains of dwellings, as well as with the GCs.[19] Moreover, the enclosures of Pikku Liekokangas and Honkobackharju, traditionally classified as small GCs, have cairns around them, yet can be interpreted as building remains based on the excavation finds (both not only show many finds typical for a residential area, but also evidence of fireplaces; see Forss 1981; Schulz 2008, 2009; Okkonen & Ridderstad 2009). Honkobackharju also showed evidence of a fire that had destroyed possible wooden (log) walls (Schulz 2009). Forss (1981) noted that the cairns on Pikku Liekokangas seem to have been built

19 During this study, standing stones were observed e.g. in Roskikangas 1&2 and Kämppäkangas; cairns e.g. in Heikinkangas, Kissakangas, Hevoskorpi, Veneharju and Köyrisåsen 3; and both cairns or other stone settings and standing stones e.g. in Mustikkakangas and Brantbacken-Ollisbacken. See Table 1.

on the top of the earlier cultural layers on the site. Thus, the appearance of cairns and other signs of ritualization could be related to the temporal development of a site and how it was perceived (Bradley 1998: 132–143; Okkonen 2001). The last phase of a dwelling site may have been as a site of burial and ritual, a place of ancestral remembrance and a permanent landmark. In this context, also the similarity of the orientations of the GCs with those of the housepits becomes understandable.

The motivation for the ritualization of a housepit can be explained via the concept of the 'death' of a house (see Bradley 1998: 36–48, 162, and refs. therein). In a non-sedentary, nomadic hunter-gatherer lifestyle, the home was always where one stayed for the night, and a temporary or portable dwelling did not exist without the inhabitant; in a sense, the dwelling was a part of the individual who lived in it. In a sedentary or semi-sedentary life, the dwelling had a permanent existence in a certain place at all times, independently of its inhabitant. However, the old way of seeing the dwelling as part of the individual may still have persisted. Therefore, once the inhabitant(s) of a pithouse died, the house of the dead may itself have become 'dead'. This kind of belief would have been reinforced by the observations made on decaying pithouses and housepits, former houses of the living, now abandoned and 'dead', in the woods, where the (semi-)sedentary hunter-gatherers moved around. In the light of this kind of development, the construction of cairn burials either in dwelling sites or in special locations becomes understandable: not everyone could have a pithouse of her own, yet deserved a permanent place of remembrance for herself. Similarly, the largest GCs, which likely were communal spaces, could be seen as desirable locations to be buried next to and thus to be remembered whenever the place was used; and even if a large GC had already fallen out of use, it would still have appeared as a permanent monument of the activity of a human society to anyone who came across it, and thus carried the 'ancestral aura' of a desirable burial ground within it.

Thus, the housepits, the remains of what once used to be pithouses with human inhabitants, and the cairns, possibly used for burial and tell-tale of past ritual action, could be perceived as permanent signs of human activity among the wilderness, fixed points in the landscape, places of remembrance and continuing ritual activity related to the conditions of the functioning of the society: the family, the household, the territory, the surrounding natural resources, the spirit world, and the human-ancestor relations. The large enclosures and central buildings as places of social gathering and interaction served partly similar purposes, but their social significance started with the building and maintaining of the structures, which strengthened the social ties and reinforced the possible new hierarchical form of social structure.

While the varying sizes of the housepits can probably be related to their social significances, the communal status of the original pithouse likely had not correlated with size alone. It was observed during the study that many middle-sized housepits had signs of ritualization around them, while some of the largest housepits did not. This feature may be related to the existence of the suggested class of the 'central' housepits.

If the GCs are, in general, roughly contemporaneous with the dwellings around them, the local topology shows that the GCs were built on a higher ground than the surrounding dwellings on the same sites. The same is true for some of the 'central' type of housepits, but not all of them, which hints at the existence of an unrecognized type of housepits, one that was probably defined more by its function or status than its outer appearance. On the other hand, the similarities of the GCs with the large central housepits may be related to the status of the GCs as communal spaces. Perhaps the largest GCs served as the central gathering spaces of larger regions, while some of the smaller GCs, as well as some of the pithouses classified in this study as central housepits, served the needs of a smaller community, a single dwelling site or a few of them.

In social hierarchy models, the appearance of dwellings larger and more prominently placed than others in villages is seen as indicative of the development of a more complex social hierarchy, i.e. the appearance of leaders (Kent 1990; Groen 1991). The above type of hierarchy in the communal spaces might thus imply the existence of a rather strong and well-developed social hierarchy, possibly one with regional leaders as well as upper administrative organs in the next-level larger regional social hierarchy. However, in a non-egalitarian society the house of the leader(s) often is the centre of the same functions than a communal gathering place in a democratic or egalitarian society. Both can have the status of 'the heart of the village', where various social, religious and political issues are dealt with. Therefore, in this context it is actually not relevant whether there was a non-egalitarian social system with a single strong leader or a more democratic system (e.g. councils of elders) at work in Neolithic Ostrobothnia. What is implied is a *regional* hierarchy, where representatives of different villages and areas would interact and form larger alliances.

Vaneeckhout (2010) identified a class of larger, more centrally placed pithouses in the Middle and Late Neolithic dwelling sites of the Kierikki region in Northern Ostrobothnia. He identified two classes of houses, smaller ones situated next to each other and larger, more centrally placed ones (including also the terraced houses) at some distance of the former, and interpreted the appearance of the larger houses as a sign of growing social inequality: he saw the larger houses as evidence of the appearance of "Houses", i.e. leading households or alliances between those. The 'central' houses as identified by Vaneeckhout (2010) could by definition belong partly to the same class as the largest and the central housepits presented in the current study, since both are identified by their prominent size and location. He also noted the existence of a central space around which the houses were clustered at in the earliest sites of the Kierikki region; those kinds of central areas may have preceded the appearance of communal buildings. The development seen in the sizes and densities of the houses described by Vaneeckhout (2008, 2010) is thus likely related to the appearance of the 'central' pithouses seen in the present study, although his definition of the centrality of a pithouse is a bit different: he uses the concept to describe clusters of houses rather than single central pithouses as in the present paper. In the Kierikki region, the classes of the housepits characterised by the two definitions may even be partly the same: while I could not observe any 'central' housepits in the dwellings sites of the Kierikki area (which may be partly due to the quality of the lidar data), Vaneeckhout showed the existence of central clusters of housepits in that region. Moreover, he noted that in Vuornos, the youngest site of the region, there is only one larger housepit. On the other hand, the group of the three large parallel housepits in Brantbacken-Ollisbacken in Kruunupyy may represent the custom of building a whole group of central housepits; this can be compared to the three parallel GCs of Storbacken in Evijärvi.

Combining the observations made in the studies presented in Vaneeckhout (2010) and this paper, the custom of constructing several central houses could thus be the first phase in the development that eventually led to the building of the very largest GCs. Indeed, following Vaneeckhout (2008, 2010), Costopoulos et al. (2012) have suggested a hierarchical model with the GCs as the top level structures for the Middle and Late Neolithic communities in Northern Ostrobothnia. They also mention the possibility of nested hierarchies. Those could be what we see here with the central housepits vs. the (largest) GCs, the former being the lower level structures meant for the activities of families or a small number of villages located close to each other, while the GCs would have been built for the needs of clans or the allies formed of the small groups of villages. The present study indicates that this type of system would not only apply in Northern and Central Ostrobothnia but also to the Neolithic communities of Southern Ostrobothnia as well (see Figures 16–17; see also Costopoulos et al. 2012: figure 5; and Schulz 2009: figure 8).

When the GCs were built, the ample natural resources of the early Middle Neolithic coastal Ostrobothnia had already started to decrease (Okkonen 2003: 226). At the same time, the population on the coast had reached a high level due to the more favourable conditions of the earlier period: Vaneeckhout (2008, 2010) argued that in coastal Northern Ostrobothnia ca.

6000–3500 BCE there was an increase in population density due to environmental changes, namely to the shortening coastline, instead of actual population growth. The hunter-gatherers following the shortening coastline were forced to settle close to each other. He suggested that it was this change which resulted in sedentarism and more complex social relations, which led to the forming of allies and a development where most of the prosperous foreign trade, for example, was controlled by the leading "Houses". The said changes show up as the clusters of larger houses on the sites. At the same time, there also existed a poorer population, whose small dwellings were situated on the periphery of the dwelling sites, where the larger and richer households dominated.

Following Okkonen (2003), Vaneeckhout (2010) and Costopoulos et al. (2012), I suspect that the building of the GCs and the central housepits somehow was the consequence of the ever-increasing competition on the natural resources, which grew scarcer towards the end of the Neolithic in Ostrobothnia. However, I wish to suggest that the (semi-)sedentary lifestyle had resulted from an actual growth in the overall population of the hunter-gatherer population of Finland during the warm Atlantic period. In any reasonably favourable natural conditions, the human population will continue to increase until it reaches a critical level where each community is forced to stay in some restricted area (this is a form of the process called circumscription as established by Carneiro 1970). It is merely the size of the area that varies, and the conditions for meeting the critical population level were probably met already during the Mesolithic, right after the climate had sufficiently warmed after the Last Glacial Maximum. The shortening of the coastline of Ostrobothnia only made the competition fiercer by forcing the seal hunters to pack next to each other while they were already feeling the pressure from the inland hunters, who needed a much larger land area per capita to survive than the marine population. The competition on the natural resources and the related best dwelling sites would have caused increasing tension between the communities both locally and in the context of larger regions (connected via, e.g. clan relations). This would have necessitated the formation of a more developed, strict and multi-level social hierarchy: the communities would have had to negotiate on the sharing of the local resources, which in turn would have driven the formation of allies among the local communities, leading to a larger regional system (see Carneiro 1970; Costopoulos et al. 2012). Considering the worldview of the period, the contracts and allies would probably have been strengthened by periodical rituals, likely in the form of ritual gatherings in suitable communal spaces – large communal houses or enclosures (the GCs). The communal gathering places would probably also have served as defensive bases at times of war, as suggested by Sipilä & Lahelma (2006).

When the natural conditions deteriorated even further (see Solantie 2005 for the climatic conditions during the Neolithic and early Bronze Age), this kind of system of well-developed regional hierarchy would eventually have collapsed in spite of the practices of sharing and common rituals. In the last phase, the size of the dwellings would probably have diminished and they would appear in small groups or as singular constructions. This kind of development is indeed seen in the dwellings sites on both sides of the Bothnian Bay (Okkonen 2003: 168–169, 231; Norberg 2008: 65–66). The dwellings in the period following the collapse would have been in locations that were easily defended and close to the natural resources. The features suit to some sites of the end of the Neolithic or early Bronze Age in Southern Ostrobothnia, which were small and tightly built on small, stony islands (e.g. Vitmossen in Vöyri; see NBA 2014; Kotivuori 1993; Okkonen 2003: 127). In Dalalandet in Jepua, there even is a possible communal space or ritual enclosure: Hednatemplet at the HFSL of 38 m has three parallel 'rooms' and was oriented to some of the main solar events of the year.[20] It has cairns both in its walls and nearby, which is reminiscent of the GCs. Perhaps the building of ritual spaces continued little longer in Southern than in Northern Ostrobothnia?

5. Conclusions

In this study, the orientations of 349 single-room and 72 multi-room housepits of Middle and Late Neolithic Ostrobothnia have been measured from on-site and lidar data, analysed and compared with each other and the orientations of the Giants' Churches. The main findings of this study are the following:

1) The orientations of the single-room housepits included contributions from the directions of the local terrain and orientations towards certain astronomically significant directions for specific types of pithouses. Some of those special classes of pithouses were included in, yet likely were not exhausted by the subgroups of the under 10-m, the over 19-m, and the 'central' housepits.

20 The rectangular 'rooms' of Hednatemplet were oriented approximately to the sunrises of the mid-quarter days of early November and February and to the sunsets of the mid-quarter days of early May and August. The long axis of the total structure was oriented from the summer solstice sunrise to the winter solstice sunset. The doorways of the structure are towards the eastern horizon, but it is located on the western side of the rock formation it was built on – a feature that is contrary to the characteristics of the majority of the GCs.

2) The multi-room terraced houses and 'longhouses' have an orientation distribution different from all other subgroups of housepits and the Giants' Churches. The terraced houses may have been deliberately oriented perpendicular to the Giants' Churches.

3) The orientations of the doorways of rectangular housepits mostly replicate the orientations of the long axes of the housepits. Also the doorways of circular or square pithouses had usually been at two opposite ends of the house. In the large dwelling sites of the Kokkola-Kruunupyy-Pedersöre region containing mainly circular housepits, the doorways were oriented primarily towards the cardinal directions, which points towards the existence of possible regional preferences in the orientation practices. Whether the emphasis of the pithouse builders had been on the axis or the doorway orientations could not be deduced based on the sample of the present study.

4) The orientations and placement of the pithouses seem not have been affected by strong winds; most of them were near the shore and often on windy locations, e.g. the tips of capes or on the northern sides of the islands. The local terrain has, at the large scale, apparently had some effect on the placement of the housepits. The large number of symmetrically placed doorways observed in some housepits may be related to the maximum amount of natural light available inside the houses or to the cosmological beliefs of the builders. The astronomical orientations of the housepit axes and doorways may suggest the existence of a lunar or lunisolar seasonal pointer calendric system. Orientations indicating the existence of similar calendric systems have previously been detected in the Giants' Churches and European megalithic monuments.

5) Cairns and other signs of ritualization were observed around some middle-sized and large housepits, similar to what has been observed in connection with the Giants' Churches. Only the very largest Giants' Churches show features not seen with any housepits. This supports the suggestion that some of the smallest Giants' Churches may have been houses or otherwise belonged to the same building tradition as the said housepits. The observed ritualization of the housepits suggests a connection to the concept of the 'death' of a house, and the continued existence of a decaying pithouse as a ritual site, perhaps as a mortuary or ancestral monument.

6) The existence of the class of special, prominently placed middle-sized or large housepits, partly covered by the subgroup of the 'central' housepits of this study, is suggested. Those central housepits cannot be distinguished from the Giants' Churches by their placement among the other housepits

of the sites or orientations alone. It is suggested that the coexistence of the central pithouses and the Giants' Churches may indicate the existence of a social and regional hierarchical system with different levels in Late Neolithic Ostrobothnia.

Finally, it is suggested that in the future, the orientations of the housepits in each individual site and larger, geographically connected region should be examined in detail. Especially, the orientations of the doorways of the housepits, preferably measured from excavation data, should be further compared with the axis orientations to determine whether the main interest of the builders had been towards the orientation of the pithouse axes or their doorways usually placed at either or two opposite ends of a house. Also, a detailed analysis of all orientations of the 'central' structures, i.e. the central housepits and the Giants' Churches should, following the example of the orientations analyses of the large Central European Neolithic communal structures, such as the henges of Britain, be performed individually for each site, including not only the axis and gate orientations, but also the orientations towards cairns, standing stones, and other prominent features on the sites.

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Table 1 (pages 59–74). The housepit data. The columns are: the name of the site and the number of the housepit, with a possible "TH" indicating a terraced house; the site location (parish); whether the measurements were made on-site (i), from lidar (l) data, or from a site map (m); the latitude of the site; the type of the housepit: square (Q), oval (O), round (R), square (N), or a terraced house (TH; note that Q/TH indicates a very oblong housepit, a possible TH); the size of the housepit with the walls included; the orientation of the housepit axis towards the eastern horizon in degrees of azimuth; the orientations of the doorways of the housepit in degrees of azimuth; the possible additional features observed on the site during the fieldwork of this study: cairn (C), other stone setting (Cf), rakka pit (R), standing stone (M), viisarikivi stones, i.e. a row of small standing stones (V); an "X" indicates that there is a GC on the same site (i.e., in the immediate surroundings of the housepits). A question mark after the housepit indicates a site discovered during the present study and, thus, previously unrecorded in the catalogues of NBA (2014). For the site maps, see the References section.

Name	Location	i/l/m	HFSL	Latitude	Shape	Size	Axis, az (deg)	Gates, az (deg)	Other feat.
Mustalampi länsi	Ii	i	52	65.55409939	Q	13x9	158.2	338.2	
Mustalampi länsi, E-most 1?	Ii	l	52	65.55409939	Q	12x10	5.5		
Mustalampi länsi, E-most 2?	Ii	l	52	65.55409939	Q	11x10	19.5		
Huhtaharju, 1	Ii	i	54	65.54872327	Q	13x7	75.5		
Huhtaharju, 2	Ii	i	54	65.54872327	Q	8x6	80		
Huhtaharju, 3	Ii	i	54	65.54872327	Q	6x4	106		
Huhtaharju, 4	Ii	i	54	65.54872327	Q	6x4	80		
Ritamaa 2	Ii	i	52	65.54442329	Q	15x11	79.7	79.7, 259.7	
Konttioja	Ii	i	58	65.47147524	Q	7x4	117.7		
Mustikkakangas SW	Ii	i	45	65.43056995	Q	13x10	81.3		V
Hankopalo	Ii	i	47.5	65.4263584	Q	12x8	134.8		C, R
Halajärvenkangas, 1	Oulu	l	60	65.39687122	Q/N	13x12	33.9	61.9, 246.9	
Halajärvenkangas, 2	Oulu	l	60	65.39687122	Q/N	13x12		256.9	
Halajärvenkangas, W	Oulu	l	60	65.39687122	Q	13x10	143.9		
Pikku Porkonmaa, 1	Oulu	l	50	65.38226023	Q	16x8	178.9		
Välikangas SW, 1?	Ii	l	55	65.37955729	Q	10x8	145.7		
Välikangas SW, 2?	Ii	l	55	65.37955729	Q	10x8	143.7		
Välikangas SW, 3?	Ii	l	55	65.37955729	Q	10x8	142.7		
Välikangas SW, 4?	Ii	l	55	65.37955729	Q	15x8	127.7		
Välikangas, 1	Ii	l	55	65.37955729	Q	16x10	158.7		
Välikangas, SE?	Ii	l	55	65.37955729	Q	9x5	133.7		
Tallimaa, 1	Oulu	l	52.5	65.37633588	Q/TH	20x7	27		
Tallimaa, 2	Oulu	l	52.5	65.37633588	Q/TH	20x7	22		
Tuoremaa NE, 1	Oulu	l	52.5	65.37540269	Q	23x14	114.9		
Tuoremaa NE, 2	Oulu	l	52.5	65.37540269	Q	13x8	103.9		
Tuoremaa NE, 3	Oulu	l	52.5	65.37540269	Q	14x7	114.9		
Harjumaa, 1	Oulu	i	55	65.36979698	Q	22x13	107.5		
Harjumaa, 2	Oulu	i	55	65.36979698	Q	13x11	111.8	110, 150, 243, 310	
Harjumaa, 3	Oulu	i	55	65.36979698	Q	13x9	134	134, 314	

Harjumaa, 4	Oulu	i	55	65.36979698	Q	14x12	130	130, 310
Harjumaa, 5	Oulu	i	55	65.36979698	Q	14x11	123	123, 303
Harjumaa, 6	Oulu	i	55	65.36979698	Q	15x12	103	103, 283
Purkajasuo Vuornos, 1	Oulu	l	51.5	65.36893505	Q	17x10	118	
Purkajasuo Vuornos, 2	Oulu	l	51.5	65.36893505	Q	10x6	145	
Purkajasuo Vuornos, 3	Oulu	l	51.5	65.36893505	Q	12x6	147	
Purkajasuo Vuornos, 4	Oulu	l	51.5	65.36893505	Q	12x6	136	
Purkajasuo Vuornos, 5	Oulu	l	51.5	65.36893505	Q	12x6	142	
Purkajasuo Vuornos, 6	Oulu	l	51.5	65.36893505	Q	12x8	135	
Purkajasuo Vuornos, 7	Oulu	l	51.5	65.36893505	Q	12x7	141	
Purkajasuo Vuornos, 8	Oulu	l	51.5	65.36893505	Q	12x8	146	
Purkajasuo Korvala, 1	Oulu	l	52	65.36716211	Q	10x6	115	
Purkajasuo Korvala, 2	Oulu	l	52	65.36716211	Q	8x5	95	
Purkajasuo Korvala, 3	Oulu	l	52	65.36716211	Q	10x8	135	
Purkajasuo Korvala, 4	Oulu	l	52	65.36716211	Q	8x5	125	
Purkajasuo Korvala, 7	Oulu	l	52	65.36716211	Q	10x6	116	
Purkajasuo Korvala, 8	Oulu	l	52	65.36716211	Q	10x5	122	
Purkajasuo Korvala, 9	Oulu	l	52	65.36716211	Q	9x5	134	
Purkajasuo Korvala, 10	Oulu	l	52	65.36716211	Q	9x5	104	
Purkajasuo Korvala, 11	Oulu	l	52	65.36716211	Q	9x5	126	
Purkajasuo Korvala, 12	Oulu	l	52	65.36716211	Q	8x5	105	
Purkajasuo Korvala, 13	Oulu	l	52	65.36716211	Q	10x5	122	
Purkajasuo Korvala, 14	Oulu	l	52	65.36716211	Q	9x5	137	
Purkajasuo Korvala, 15	Oulu	l	52	65.36716211	Q	7x5	121	
Purkajasuo Korvala, 16	Oulu	l	52	65.36716211	Q	6x4	123	
Purkajasuo Korvala, 17	Oulu	l	52	65.36716211	Q	8x7	142	
Purkajasuo Korvala, 18	Oulu	l	52	65.36716211	Q	11x7	135	
Purkajasuo Korvala, TH1 (NE-most)	Oulu	l	52	65.36716211	3-4xQ/N	35x10	82	
Purkajasuo Korvala, TH2	Oulu	i	52	65.36716211	2xQ	20x9	118	
Purkajasuo Korvala, TH3 (Schultz 1997, 2000)	Oulu	m	52	65.36716211	4xQ	30x10	110	

Purkajasuo Korvala, TH4 (Schultz 1997, 2000)	Oulu	m	52	65.36716211	2xQ	20x9	106
Voima-Kuusela, 1	Oulu	1	54	65.36485871	Q	12x9	150
Voima-Kuusela, 2	Oulu	1	54	65.36485871	Q	16x11	150
Voima-Kuusela, 3	Oulu	1	54	65.36485871	Q	12x8	130
Voima-Kuusela, TH1	Oulu	i	54	65.36485871	7xQ	64x10	161
Kuuselankangas, 1	Oulu	1	60	65.36063001	Q	15x10	173
Kuuselankangas, 2	Oulu	1	60	65.36063001	Q	10x6	16
Kuuselankangas, 3	Oulu	1	60	65.36063001	Q	8x6	19
Kuuselankangas, 4	Oulu	1	60	65.36063001	Q	12x6	134
Kuuselankangas, 5	Oulu	1	60	65.36063001	Q	10x8	152
Kierikinkangas, 1	Oulu	1	60	65.36054402	Q	16x8	149
Kierikinkangas, 2	Oulu	1	60	65.36054402	Q	12x7	149
Kierikinkangas, 3	Oulu	1	60	65.36054402	Q	9x5	126
Kierikinkangas, 4	Oulu	1	60	65.36054402	Q	10x5	103
Pahkakoski 7, TH1	Oulu	i	65	65.35818377	3xQ	48x12	143
Porrassuo, 1	Oulu	1	60	65.35805833	Q	10x6	104.1
Porrassuo, 2	Oulu	1	60	65.35805833	Q	9x5	101.1
Porrassuo, 3	Oulu	1	60	65.35805833	Q	9x5	101.1
Porrassuo, 4	Oulu	1	60	65.35805833	Q	9x5	98.1
Juutisenkangas, 1	Oulu	1	56	65.35565888	Q	8x5	12
Juutisenkangas, 2	Oulu	1	56	65.35565888	Q	10x8	20
Juutisenkangas, 3	Oulu	1	56	65.35565888	Q	11x8	158
Juutisenkangas, 4	Oulu	1	56	65.35565888	Q	15x10	9
Juutisenkangas, 5	Oulu	1	56	65.35565888	Q	15x10	19
Juutisenkangas, 6	Oulu	1	56	65.35565888	Q	10x6	32
Juutisenkangas, 7	Oulu	1	56	65.35565888	Q	7x4	14
Juutisenkangas, 8	Oulu	1	56	65.35565888	Q	7x4	4
Rahkasuo, 1	Oulu	1	53	65.35287867	Q	11x6	2
Rahkasuo, 2	Oulu	1	53	65.35287867	Q	7x5	179
Rahkasuo, 3	Oulu	1	53	65.35287867	Q	9x4	179

Rahkasuo, 4	Oulu	l	53	65.35287867	Q	9x6	5		
Rahkasuo, 5	Oulu	l	53	65.35287867	Q	9x5	28		
Rahkasuo, 6	Oulu	l	53	65.35287867	Q	8x6	41		
Rahkasuo, 7	Oulu	l	53	65.35287867	Q	8x6	54		
Rahkasuo, 8	Oulu	l	53	65.35287867	Q	8x4	56		
Rahkasuo, 9	Oulu	l	53	65.35287867	Q	10x6	34		
Rahkasuo, 10	Oulu	l	53	65.35287867	Q	10x6	40		
Toukokangas, 1?	Oulu	l	50	65.28783557	Q	24x10	60.9		
Toukokangas, 2?	Oulu	l	50	65.28783557	Q	9x6	37.9		
Toukokangas, 3?	Oulu	l	50	65.28783557	Q	12x9	23.9		
Toukokangas, 4?	Oulu	l	50	65.28783557	Q	9x6	14.9		
Toukokangas, 5?	Oulu	l	50	65.28783557	Q	24x10	131.9		
Toukokangas, E?	Oulu	l	48	65.28783557	Q	25x10	104.9		
Hietakangas, 1	Oulu	i	45	65.27507151	Q	18x6	120		
Hietakangas, 2	Oulu	l	45	65.27473546	Q	14x8	73.8		
Iso Kiviharju	Oulu	i	50	65.27443727	Q	5x3	149.9		R
Isomaa N, TH1	Oulu	i	52.5	65.26957659	3xQ	50x14	140		
Isomaa N, TH1, W-most	Oulu	i	52.5	65.26957659	Q	23x14	140	140, 320	
Mäntyselkä N1	Oulu	i	50	65.26934333	Q	13x8	127	305	
Haaramoukku NW, 1	Oulu	l	47.5	65.26788399	Q	12x6	43.8		
Haaramoukku NW, 2	Oulu	l	47.5	65.26788399	Q	12x6	178.8		
Haaramoukku NW, TH1	Oulu	l	47.5	65.26788399	3-4xQ	50x8	122.8		
Mäntyselkä N2, 3	Oulu	i	50	65.26680915	Q	25x15	70.8	70.8, 250.8	
Mäntyselkä N2, 4	Oulu	i	50	65.26661163	Q	28x17	86.1	87.3, 267.3	
Haaramoukku N1, 1	Oulu	i	48.2	65.26596957	Q	7x4	52.8		
Haaramoukku N1, W-most	Oulu	l	48.2	65.26596957	Q	16x7	68.8		
Mäntyselkä N, 2	Oulu	l	50	65.26540283	Q	16x9	1.8		
Mäntyselkä N, 1	Oulu	l	50	65.26522523	Q	17x10	161.8		
Haaramoukku N3, 1	Oulu	l	50	65.26467541	Q	18x10	38.8		
Mastomaansuo etelä, 1	Oulu	i	50	65.26270278	Q	17x11	40	40, 220	
Mastomaansuo etelä, 2	Oulu	i	50	65.26270278	Q	18x11	0.5	0.5, 180.5	

Mastomaansuo etelä, 3	Oulu	i	50	65.26270278	Q	18x11	1	1, 181	
Mastomaansuo etelä, 4	Oulu	i	50	65.26270278	Q	22x14	5.5	5.5, 185.5	
Mastomaansuo etelä, 5	Oulu	l	50	65.26270278	Q	20x10	154.9		
Mastomaansuo etelä, 6	Oulu	l	50	65.26270278	Q	15x8	1.9		
Mastomaansuo etelä, 7	Oulu	l	50	65.26270278	Q	15x10	1.9		
Mastomaansuo etelä, 8	Oulu	l	50	65.26270278	Q	15x8	0.9		
Mastomaansuo etelä, 9	Oulu	l	50	65.26270278	Q	14x9	179.9		
Mastomaansuo etelä, 10	Oulu	l	50	65.26270278	Q	15x8	0.9		
Mastomaansuo etelä, 11	Oulu	l	50	65.26270278	Q	16x9	28.9		
Mastomaansuo etelä, 12	Oulu	l	50	65.26270278	Q	9x6	173.9		
Mastomaansuo etelä, 13	Oulu	l	50	65.26270278	Q	10x8	148.9		
Toukokangas, 3?	Oulu	l	50	65.28783557	Q	12x9	23.9		
Toukokangas, 4?	Oulu	l	50	65.28783557	Q	9x6	14.9		
Toukokangas, 5?	Oulu	l	50	65.28783557	Q	24x10	131.9		
Toukokangas, E?	Oulu	l	48	65.28783557	Q	25x10	104.9		
Hietakangas, 1	Oulu	i	45	65.27507151	Q	18x6	120		
Hietakangas, 2	Oulu	l	45	65.27473546	Q	14x8	73.8		
Iso Kiviharju	Oulu	i	50	65.27443727	Q	5x3	149.9		R
Isomaa N, TH1	Oulu	i	52.5	65.26957659	3xQ	50x14	140		
Isomaa N, TH1, W-most	Oulu	i	52.5	65.26957659	Q	23x14	140	140, 320	
Mäntyselkä N1	Oulu	i	50	65.26934333	Q	13x8	127	305	
Haaramoukku NW, 1	Oulu	l	47.5	65.26788399	Q	12x6	43.8		
Haaramoukku NW, 2	Oulu	l	47.5	65.26788399	Q	12x6	178.8		
Haaramoukku NW, TH1	Oulu	l	47.5	65.26788399	3-4xQ	50x8	122.8		
Mäntyselkä N2, 3	Oulu	i	50	65.26680915	Q	25x15	70.8	70.8, 250.8	
Mäntyselkä N2, 4	Oulu	i	50	65.26661163	Q	28x17	86.1	87.3, 267.3	
Haaramoukku N1, 1	Oulu	i	48.2	65.26596957	Q	7x4	52.8		
Haaramoukku N1, W-most	Oulu	l	48.2	65.26596957	Q	16x7	68.8		
Mäntyselkä N, 2	Oulu	l	50	65.26540283	Q	16x9	1.8		
Mäntyselkä N, 1	Oulu	l	50	65.26522523	Q	17x10	161.8		

Haaramoukku NW, 1	Oulu	l	47.5	65.26788399	Q	12x6	43.8	
Haaramoukku NW, 2	Oulu	l	47.5	65.26788399	Q	12x6	178.8	
Haaramoukku NW, TH1	Oulu	l	47.5	65.26788399	3-4xQ	50x8	122.8	
Mäntyselkä N2, 3	Oulu	i	50	65.26680915	Q	25x15	70.8	70.8, 250.8
Mäntyselkä N2, 4	Oulu	i	50	65.26661163	Q	28x17	86.1	87.3, 267.3
Haaramoukku N1, 1	Oulu	i	48.2	65.26596957	Q	7x4	52.8	
Haaramoukku N1, W-most	Oulu	l	48.2	65.26596957	Q	16x7	68.8	
Mäntyselkä N, 2	Oulu	l	50	65.26540283	Q	16x9	1.8	
Mäntyselkä N, 1	Oulu	l	50	65.26522523	Q	17x10	161.8	
Haaramoukku N3, 1	Oulu	l	50	65.26467541	Q	18x10	38.8	
Mastomaansuo etelä, 1	Oulu	i	50	65.26270278	Q	17x11	40	40, 220
Mastomaansuo etelä, 2	Oulu	i	50	65.26270278	Q	18x11	0.5	0.5, 180.5
Mastomaansuo etelä, 3	Oulu	i	50	65.26270278	Q	18x11	1	1, 181
Mastomaansuo etelä, 4	Oulu	i	50	65.26270278	Q	22x14	5.5	5.5, 185.5
Mastomaansuo etelä, 5	Oulu	l	50	65.26270278	Q	20x10	154.9	
Mastomaansuo etelä, 6	Oulu	l	50	65.26270278	Q	15x8	1.9	
Mastomaansuo etelä, 7	Oulu	l	50	65.26270278	Q	15x10	1.9	
Mastomaansuo etelä, 8	Oulu	l	50	65.26270278	Q	15x8	0.9	
Mastomaansuo etelä, 9	Oulu	l	50	65.26270278	Q	14x9	179.9	
Mastomaansuo etelä, 10	Oulu	l	50	65.26270278	Q	15x8	0.9	
Mastomaansuo etelä, 11	Oulu	l	50	65.26270278	Q	16x9	28.9	
Mastomaansuo etelä, 12	Oulu	l	50	65.26270278	Q	9x6	173.9	
Mastomaansuo etelä, 13	Oulu	l	50	65.26270278	Q	10x8	148.9	
Mastomaansuo etelä, 14	Oulu	l	50	65.26270278	Q	9x6	145.9	
Mastomaansuo etelä, N-most	Oulu	l	50	65.26270278	Q	18x10	100.9	
Haaramoukku etelä	Oulu	i	50	65.2604936	Q	20x15	75	
Isokangas etelä, 1	Oulu	l	51	65.25929819	Q	5x4	115.8	
Isokangas etelä, 2	Oulu	l	51	65.25929819	Q	8x6	101.8	
Hiidenkangas, 1	Oulu	l	50	65.25429496	Q	9x5	146.9	
Hiidenkangas, 2	Oulu	l	50	65.25429496	Q	8x4	110.9	
Hiidenkangas, 3	Oulu	l	50	65.25429496	Q	10x5	63.9	

Hiidenkangas, 4	Oulu	l	50	65.25429496	Q	9x5	66.9		
Hiidenvaara 2, 1 (S-most)	Oulu	l	57.5	65.23964061	Q	11x8	153.4		
Hiidenvaara 2, 2	Oulu	l	57.5	65.23964061	R/N	9x9		13.9	
Hiidenvaara 3, 1	Oulu	l	57	65.23724213	Q	9x6	148.9		
Kivisuo etelä, TH1 (W-most)	Oulu	l	53	65.23211922	4-5xQ	45x10	41.9		
Kivisuo etelä, TH2	Oulu	l	53	65.23211922	4-5xQ	45x10	58.9		
Kivisuo etelä, TH3	Oulu	l	53	65.23211922	4-5xQ	45x10	68.9		
Kivisuo etelä, TH4	Oulu	l	53	65.23211922	4-5xQ	45x10	63.9		
Kivisuo etelä, TH5	Oulu	l	53	65.23211922	4-5xQ	45x10	63.9		
Kivisuo etelä, TH6 (E-most)	Oulu	l	53	65.23211922	4-5xQ	45x10	48.9		
Kivisuo kaakko, TH1	Oulu	l	54	65.23127475	3-4xQ	40x12	100.9		
Kivisuo kaakko, TH2	Oulu	l	54	65.23127475	3-4xQ	40x12	101.9		
Kivisuo kaakko, TH3	Oulu	l	54	65.23127475	2-3xQ	30x12	101.9		
Saukko-oja, S-most	Oulu	l	53	65.22964921	Q	24x10	56.9		
Pyöriäsuo, 1	Oulu	i	52	65.22744741	O	8x5	80		
Pyöriäsuo, 2	Oulu	i	52	65.22744741	O	9x6	80		
Navettakangas kaakko, 1	Oulu	l	42.5	65.22634209	Q/TH	17x11	124.8		
Navettakangas kaakko, 2?	Oulu	l	42.5	65.22634209	Q/TH	35x10	143.8		
Rönkölänkangas länsi, TH1	Oulu	l	56	65.22158889	3xQ/N	28x10	132.9		
Rönkölänkangas länsi, TH2	Oulu	l	56	65.22158889	4xQ	54x12	126.9		
Rönkölänkangas länsi, TH3	Oulu	l	56	65.22158889	3xQ	32x8	130.9		
Rönkölänkangas länsi, TH4	Oulu	l	56	65.22158889	3xQ	35x8	129.9		
Rönkölänkangas etelä, 1	Oulu	i	57.5	65.21689224	Q/N	14x13	100	100	Cf
Rönkölänkangas etelä, 2	Oulu	i	57.5	65.21689224	Q	15x9	123	213	
Rönkölänkangas etelä, TH1	Oulu	i	57.5	65.21689224	5xQ	50x10	93		
Rönkölänkangas etelä, TH2	Oulu	i	57.5	65.21689224	4-5xQ	40x10	102		
Rönkölänkangas etelä, TH3	Oulu	i	57.5	65.21689224	3xQ	25x10	118		
Rönkölänkangas etelä, TH4	Oulu	i	57.5	65.21689224	3-4xQ	35x10	134		
Rönkölänkangas etelä, TH4, W-most	Oulu	i	57.5	65.21689224	Q	8x4	95		
Teeriselän vedenottamo, 1	Oulu	l	57.5	65.21477656	Q	15x9	119		
Teeriselkä, 1	Oulu	i	57.5	65.21406511	Q	13x10	116	116, 296	C

Teeriselkä, 2	Oulu	i	57.5	65.21406511	Q	12x10	112	112, 292
Teeriselkä, TH1	Oulu	i	57.5	65.21406511	4xQ	38x11	109	
Teeriselkä, TH1, W-most	Oulu	i	57.5	65.21406511	Q	8x5	121.5	
Teeriselkä, TH2	Oulu	i	57.5	65.21406511	4-5xQ	40x10	105	
Satulakangas, 1	Oulu	l	60	65.21145666	Q	12x8	124.1	
Satulakangas, 2	Oulu	l	60	65.21145666	Q	10x8	127.1	
Satulakangas, 3	Oulu	l	60	65.21145666	Q	12x8	124.1	
Satulakangas, 4	Oulu	l	60	65.21145666	Q	12x8	108.1	
Kalliomaa itäosa, TH1	Oulu	i	56	65.09445132	5-6xQ	105x12	0.5	
Kalliomaa itäosa, TH1, N-most	Oulu	i	56	65.09445132	Q	20x16	21.7	15
Kalliomaa itäosa, TH2 sähkölinja	Oulu	i	56	65.09445132	5-6xQ	75x10	10	
Kokonpää etelä	Oulu	i	52.5	65.07644167	Q	13x10	39	219
Kokkokangas, 1	Oulu	i	51	65.07355271	Q	20x13	112.8	115, 295
Kokkokangas, 2	Oulu	i	51	65.07355271	Q	14x10	106	25, 106, 286
Paasonsadinmaa W	Oulu	l	55	65.06359185	Q	32x15	169.9	
Paasonsadinmaa, 1	Oulu	l	57.5	65.06167943	Q	10x8	43.9	
Paasonsadinmaa, 2	Oulu	l	57.5	65.06167943	Q	24x16	168.9	
Paasonsadinmaa SW	Oulu	l	55	65.05993699	Q	16x12	123.9	
Sivukangas, 1	Oulu	l	55	65.05432322	Q	13x7	148.9	
Sivukangas, 2	Oulu	l	55	65.05432322	Q	12x6	178.9	
Sivukangas, 3	Oulu	l	55	65.05432322	Q	12x6	7.9	
Miehonselkä, 1	Oulu	l	47.5	64.98364582	Q/TH	20x8	118.9	
Miehonselkä, 2	Oulu	l	47.5	64.98364582	Q	12x10	133.9	
Miehonselkä, 3	Oulu	l	47.5	64.98364582	Q	20x12	138.9	
Miehonselkä, 4	Oulu	l	47.5	64.98364582	Q	16x8	133.9	
Miehonselkä, 5	Oulu	l	47.5	64.98364582	Q	15x8	123.9	
Miehonselkä, 6	Oulu	l	47.5	64.98364582	Q	12x8	126.9	
Miehonselkä, 7	Oulu	l	47.5	64.98364582	Q	15x8	123.9	
Miehonselkä, 8	Oulu	l	47.5	64.98364582	Q	10x8	138.9	
Karttiokangas, 1	Oulu	i	57	64.96585609	Q	11x9	30	30, 210
Karttiokangas, 2	Oulu	i	57	64.96585609	Q	13x12	2.3	176

Karttiokangas, 3	Oulu	i	57	64.96585609	Q	13x10	170		
Karttiokangas, 4	Oulu	i	57	64.96585609	Q	11x10	170	170, 350	
Karttiokangas, 5	Oulu	i	57	64.96585609	Q	13x10	170		
Karttiokangas, 6	Oulu	i	57	64.96585609	Q	9x6	175	175	
Mustikkakangas N, N1	Oulu	i	47.5	64.96153376	Q	13x7	49.8		Cf
Mustikkakangas N, N2	Oulu	i	47.5	64.96153376	Q	8x5	43.8		
Mustikkakangas N, N3	Oulu	i	47.5	64.96153376	Q	5x3	29.8		
Mustikkakangas N, S1	Oulu	i	50	64.96015656	Q	12x8	46.8		M
Mustikkakangas N, S2	Oulu	i	50	64.96015656	Q	6x4	44.8		
Mustikkakangas N, S3	Oulu	i	50	64.96015656	Q	11x7	36.8		
Mustikkakangas N, S4	Oulu	i	50	64.96015656	Q	9x6	29.8		
Mustikkakangas N, S5	Oulu	i	50	64.96015656	Q	12x7	29.8		
Peurasuo N	Oulu	i	38	64.90818597	Q	24x12	59.9		
Peurasuo W	Oulu	i	38	64.90476177	Q	25x10	14.9	194.9	
Kettukangas	Muhos	i	49	64.84490905	Q	20x10	116.1	117.3	Cf, M
Kettukangas SW, 1?	Muhos	l	49	64.84364764	Q	11x8	89		
Kettukangas SW, 2?	Muhos	l	49	64.84364764	Q	14x10	102		
Kettukangas SW, 3?	Muhos	l	49	64.84364764	Q	16x10	139		
Kettukangas SW, 4?	Muhos	l	49	64.84364764	Q	12x9	139		
Mustosenneva luode, W	Lumijoki	i	49	64.7533836	Q	15x8	143.6	143.6, 323.6	
Mustosenneva luode, 1	Lumijoki	i	49	64.7528205	Q	8x6	119.6		
Mustosenneva luode, 2	Lumijoki	i	49	64.7528205	Q	12x8	88.6		
Mustosenneva luode, 3	Lumijoki	i	49	64.7528205	Q	12x8	93.6		
Niilonkangas iso keskuspainanne	Liminka	i	47.5	64.75207639	Q	23x12	129.4		
Niilonkangas N, 1?	Liminka	l	47.5	64.75207639	Q/TH	25x10	148.4		
Niilonkangas N, 2?	Liminka	l	47.5	64.75207639	Q/TH	18x8	119.4		
Niilonkangas N, 3?	Liminka	l	47.5	64.75207639	Q/TH	20x8	127.4		
Niilonkangas N, 4?	Liminka	l	47.5	64.75207639	Q/TH	25x9	131.4		
Niilonkangas, TH1	Liminka	i	47.5	64.75207639	9-10xQ	85x8	113		
Niilonkangas, TH1, W-most	Liminka	i	47.5	64.75207639	Q	15x9	124.6		
Niilonkangas, TH2	Liminka	i	47.5	64.75207639	4-5xQ	56x12	88.4		

Niilonkangas, TH2, W-most	Liminka	i	47.5	64.75207639	Q	12x7	94.6	
Mustosenneva itä, 1	Liminka	l	50	64.74584412	Q/TH	40x10	100.4	
Mustosenneva itä, 2	Liminka	l	50	64.74584412	Q/TH	28x8	64.4	
Mustosenkangas luode	Liminka	i	50	64.74195154	Q	8x5	106.6	
Korkiakangas 1-2, 1	Lumijoki	i	52	64.74020291	Q	25x15	106.6	286.6
Korkiakangas 1-2, 2	Lumijoki	i	52	64.74020291	Q	18x12	134.6	314.6
Korkiakangas 1-2, 3	Lumijoki	l	52	64.74020291	Q	13x10	104.3	
Mustosenkangas itä, 1	Liminka	l	52	64.73875671	Q	16x10	125.4	
Mustosenneva etelä, 1	Lumijoki	i	54	64.73820051	Q	14x11	124.1	124.1, 304.1
Mustosenneva etelä, 2	Lumijoki	i	54	64.73820051	Q/O	4x2	179.6	
Mustosenneva etelä, 3	Lumijoki	i	54	64.73820051	Q/O	4x2	179.6	
Korkiakangas, 1	Liminka	i	53	64.73542901	N	4x4	27.6	297.6
Korkiakangas, 2	Liminka	i	53	64.73542901	Q	8x7	104.6	
Korkiakangas, 3	Liminka	i	53	64.73542901	Q	8x7	109.6	
Korkiakangas, 4	Liminka	i	53	64.73542901	Q	16x12	119.6	119.6
Korkiakangas, 5	Liminka	i	53	64.73542901	Q	6x4	124.6	304.6
Korkiakangas, 6	Liminka	i	53	64.73542901	Q	7x4	134.6	314.6
Korkiakangas, 7	Liminka	i	53	64.73542901	Q	5x4	134.6	
Tiperonkangas, 1	Siikajoki	l	54	64.73095151	Q	16x9	133.8	
Tiperonkangas, 2	Siikajoki	l	54	64.73095151	Q	10x8	134.3	
Tiperonkangas, 3	Siikajoki	l	54	64.73095151	Q	10x8	123.3	
Tiperonkangas, 4	Siikajoki	l	54	64.73095151	Q	12x9	128.3	
Tiperonkangas, 5	Siikajoki	l	54	64.73095151	Q	12x9	140.3	
Tiperonkangas, 6	Siikajoki	l	54	64.73095151	Q	12x9	138.3	
Tiperonkangas, 7	Siikajoki	l	54	64.73095151	Q	12x9	95.3	
Tiperonkangas, 8	Siikajoki	l	54	64.73095151	Q	12x9	148.3	
Tiperonkangas, 9	Siikajoki	l	54	64.73095151	Q	16x10	158.3	
Kiikkukaarto SW, 1	Tyrnävä	i	45	64.71193913	Q	10x5	9.9	
Kiikkukaarto SW, 2	Tyrnävä	i	45	64.71193913	Q	12x5	62.9	62.9, 242.9
Kiikkukaarto SW, 3	Tyrnävä	i	45	64.71193913	Q	11x5	45.9	
Käyräkangas NW, 1	Tyrnävä	l	45	64.70936823	Q	12x8	81.9	

Käyräkangas NW, 2	Tyrnävä	1	45	64.70936823	Q	15x8	81.9	
Käyräkangas NW, 3	Tyrnävä	1	45	64.70936823	Q	16x7	88.9	
Käyräkangas NW, 4	Tyrnävä	1	45	64.70936823	Q	9x8	88.9	
Käyräkangas NW, TH1	Tyrnävä	1	45	64.70936823	3xN	24x8	62.9	
Nähinmaa, 1	Liminka	1	45	64.70324676	Q/TH	18x9	110.6	
Nähinmaa, 2	Liminka	1	45	64.70324676	Q/TH	20x6	113.6	
Nähinmaa, 3	Liminka	1	45	64.70324676	Q/TH	16x8	97.1	
Nähinmaa, 4	Liminka	1	45	64.70324676	Q/TH	17x8	96.6	
Nähinmaa, 5	Liminka	1	45	64.70324676	Q	11x8	122.6	
Peurapirtinkangas NW, 1	Tyrnävä	i	55	64.68513045	Q	18x12	126.9	
Peurapirtinkangas Vuovakangas, TH1?	Tyrnävä	1	55	64.68513045	5xQ/N	50x14	78	
Peurapirtinkangas Vuovakangas, TH2?	Tyrnävä	1	55	64.68513045	2(3-5?)xQ/N	24(48)x14	67	
Heikinkangas, 1	Tyrnävä	i	47.5	64.66314072	Q	20x11	69.8	C
Heikinkangas, 2	Tyrnävä	i	47.5	64.66314072	Q	6x3	144.8	
Heikinkangas, 3	Tyrnävä	i	47.5	64.66314072	Q	7x4	79.8	
Heikinkangas, 4	Tyrnävä	i	47.5	64.66314072	Q	8x6	84.8	
Heikinkangas, TH1	Tyrnävä	i	47.5	64.66314072	2xQ	25x7	139.8	
Heikinkangas, TH2	Tyrnävä	i	47.5	64.66314072	2xQ	14x6	153.8	
Heikinkangas, TH3	Tyrnävä	i	47.5	64.66314072	3-4xQ	30x11	169.8	
Heikinkangas, TH4	Tyrnävä	i	47.5	64.66314072	3-4xQ	35x12	141.8	
Heikinkangas, TH5	Tyrnävä	i	47.5	64.66314072	3-4xQ	35x10	128.8	
Heikinkangas E, 1?	Tyrnävä	1	47.5	64.66314072	Q	18x8	131.8	
Heikinkangas E, 2?	Tyrnävä	1	47.5	64.66314072	Q	15x6	128.8	
Heikinkangas E, 3?	Tyrnävä	1	47.5	64.66314072	Q	9x6	115.8	
Heikinkangas E, 4?	Tyrnävä	1	47.5	64.66314072	Q	11x7	112.8	
Heikinkangas E, 5?	Tyrnävä	1	47.5	64.66314072	Q	12x7	118.8	
Heikinkangas E, 6?	Tyrnävä	1	47.5	64.66314072	Q/TH	25x7	106.8	
Heikinkangas E, 7?	Tyrnävä	1	47.5	64.66314072	Q/TH	25x8	124.8	
Heikinkangas E, 8?	Tyrnävä	1	47.5	64.66314072	Q	9x6	115.8	
Heikinkangas E, 9?	Tyrnävä	1	47.5	64.66314072	Q	15x6	113.8	
Heikinkangas E, 10?	Tyrnävä	1	47.5	64.66314072	Q	10x6	109.8	

Heikinkangas E, 11?	Tyrnävä	l	47.5	64.66314072	Q	7x5	110.8		
Heikinkangas E, 12?	Tyrnävä	l	47.5	64.66314072	Q	8x5	109.8		
Miilukangas, W	Siikajoki & Raahe	l	50	64.65270688	Q	19x10	171		
Murha-aro, 1	Siikajoki	i	52.5	64.64872041	Q	16x10	29.4		
Murha-aro, 2	Siikajoki	i	52.5	64.64872041	Q	18x9	35.4		
Murha-aro, 3	Siikajoki	l	52.5	64.64872041	Q	20x9	7		
Linnamaa N, southern	Liminka	i	50	64.64834735	Q	10x6	173.8		
Murronmäki, 1	Siikajoki	l	52.5	64.6473517	Q	12x5	51		
Linnamaa 2	Liminka	i	53.5	64.644064	Q	20x16	146.8	146.8, 324.8	X, C
Linnamaa 1	Liminka	i	57.5	64.64341865	Q	15x10	145.1	134.8, 325.1	X, C
Karjokangas	Tyrnävä	i	47.5	64.63426648	Q	16x13	119.8	299.8	
Huitunen SE, 1	Raahe	i	62.5	64.58031913	Q	17x8	65.6	249.1	
Huitunen SE, 2	Raahe	i	62.5	64.58031913	Q	13x8	91.1		
Huitunen SE, 3	Raahe	l	62.5	64.58031913	Q	13x7	52.9		
Huitunen SE, 4	Raahe	l	62.5	64.58031913	Q	15x7	53.9		
Kumisevankangas	Raahe	i	47	64.570261	Q	13x11	3.8		
Laivavaara 5, 1	Raahe	i	53	64.55040072	Q	10x6	8.2		
Laivavaara 5, 2	Raahe	i	53	64.55040072	Q	7x4	79.2		
Laivavaara 5, 3	Raahe	i	53	64.55040072	Q	5x4	59.2		
Pirttivaara, 1	Raahe	i	55	64.54814349	Q	4x3	79.2		X, R
Pirttivaara, 2	Raahe	i	55	64.54814349	Q	5x4	69.2		
Pirttivaara, 3	Raahe	i	55	64.54814349	Q	6x4	164.2		
Pirttivaara, 4	Raahe	i	55	64.54814349	Q	6x4	64.2		
Pirttivaara, 5	Raahe	i	55	64.54814349	Q	15x14	119.2		
Pirttivaara, 6	Raahe	i	55	64.54814349	Q	6x4	144.2		
Pirttivaara, 7	Raahe	i	55	64.54814349	Q	6x5	161.2		
Pirttivaara, 8	Raahe	i	55	64.54814349	Q	7x6	146.7	181.2	
Pirttivaara, 9	Raahe	i	55	64.54814349	Q	8x7	137.2	214.2	
Pirttivaara, 10	Raahe	i	55	64.54814349	Q	9x8	156.2		
Kursunneva 1	Raahe	l	45	64.52854231	Q/TH	32x8	66.8		
Hautalankangas	Pyhäjoki	i	52.5	64.44343682	Q	9x6	14.2		

Linnankangas	Kannus	i	52	64.05543052	Q	16x12	90.2	268.6	C
Hevoskorpi, 1	Kannus	i	45	63.96429522	Q	15x10	53.35	55.85, 151.4, 235.9	C
Hevoskorpi, 2	Kannus	i	45	63.96429522	Q	15x10	51	56, 236	
Morruttajankangas, 1	Kokkola	l	40	63.89746504	Q	14x12	30		
Morruttajankangas, 2	Kokkola	l	40	63.89746504	Q	16x8	32		
Lehdonpalo, 1	Kokkola	i	63	63.8373361	Q	15x12	98.6		
Lehdonpalo, 2	Kokkola	i	63	63.8373361	Q/O	5x3	23.6	20.6, 213.6	
Lehdonpalo, 3	Kokkola	i	63	63.8373361	Q/O	7x5	3.6	183.6	
Lehdonpalo, 4	Kokkola	i	63	63.8373361	Q/O	5x3	13.6	13.6	
Lehdonpalo, 5	Kokkola	i	63	63.8373361	Q	9x5	146.6		
Lehdonpalo, 6	Kokkola	i	63	63.8373361	Q	10x6	111.6		
Lehdonpalo, 7	Kokkola	i	63	63.8373361	Q	9x5	108.6	23.6	
Lehdonpalo, 8	Kokkola	i	63	63.8373361	R	16x16		0.6, 184.6	
Lehdonpalo, 9	Kokkola	i	63	63.8373361	R	16x16		5.6, 195.6	
Lehdonpalo, 10	Kokkola	i	63	63.8373361	Q	10x4	93.6		
Lehdonpalo, 11	Kokkola	i	63	63.8373361	Q	10x4	98.6		
Lehdonpalo, 12	Kokkola	i	63	63.8373361	Q	15x8	88.1		
Lehdonpalo, 13	Kokkola	i	63	63.8373361	Q	14x13	13.6		
Lehdonpalo, 14	Kokkola	i	63	63.8373361	Q	14x6	73.6		
Lehdonpalo, 15	Kokkola	l	63	63.8373361	Q	22x13	149.1		
Pahanportaanräme, 1	Kokkola	l	63	63.82855065	R/N	16x16		24.1, 197.1	
Pahanportaanräme, 2	Kokkola	l	63	63.82855065	R/N	14x14		16.1	
Pahanportaanräme, TH1	Kokkola	l	63	63.82855065	3xN/R	43x12	12.1	19.1	
Pahanportaanräme, TH2	Kokkola	l	63	63.82855065	3xN/R	32x12	174.1		
Pahanportaanräme, TH3	Kokkola	l	63	63.82855065	3-4xN/R	40x12	66.1		
Miekkakaara, 1	Kokkola	i	62	63.82469931	Q/O	5x3	138.6		
Miekkakaara, 2	Kokkola	i	62	63.82469931	Q	13x10	121.6		
Miekkakaara, 3	Kokkola	l	62	63.82469931	Q	16x7	40.1		
Miekkakaara, 4	Kokkola	l	62	63.82469931	Q	25x12	12.1		
Miekkakaara, 5	Kokkola	l	62	63.82469931	R/N	14x14		9.1, 186.1	
Miekkakaara, 6	Kokkola	l	62	63.82469931	R/N	14x14		8.1, 182.1	

Miekkakaara, 7	Kokkola	l	62	63.82469931	R/N	14x14		3.1, 176.1	
Roskikangas 1	Kokkola	i	50	63.79413906	Q	12x10	8.4		M
Roskikangas 2	Kokkola	i	50	63.79411704	Q	12x8	15.9	15.9, 195.9	M
Veneharju 2	Kokkola	i	52.5	63.79178112	Q	16x12	121.5	138.5, 301.5	C, R
Veneharju 1	Kokkola	i	52.5	63.7908024	Q	16x12	48.5	48.5, 115.5, 228.5	
Veneharju 3	Kokkola	i	52.5	63.79012802	Q	16x12	125.3	125.3, 305.3	M?
Kämppäkangas 2	Kokkola	i	51	63.78549	Q	13x10	109.7		
Kämppäkangas	Kokkola	i	52.5	63.78319944	Q	16x10	113	107.1, 292.6	M
Rahkalampinkangas	Kokkola	l	53	63.77604547	Q	13x8	32.9		
Ristineva, 1	Kokkola	l	55	63.7669773	Q/TH	27x8	86.9		
Ristineva, 2	Kokkola	l	55	63.7669773	Q/TH	27x8	73.9		
Runtele, 1	Kokkola	i	57	63.74265348	Q	27x16	58.3	268.6	C, M?
Runtele, 2	Kokkola	l	57	63.74265348	Q	21x13	67		
Runtele, 3	Kokkola	l	57	63.74265348	Q	21x13	70		
Lintukangas	Kokkola	i	65	63.73714677	R	14x14		28.4, 145.4, 213.4	
Köyrisåsen 1-4, 1	Kruunupyy	l	62	63.7069057	R	16x16		356	C
Köyrisåsen 1-4, 2	Kruunupyy	l	62	63.7069057	R	14x14		348	
Köyrisåsen 1-4, 3	Kruunupyy	l	62	63.7069057	R	12x12		2, 169	
Köyrisåsen 1-4, 4	Kruunupyy	l	62	63.7069057	R	12x12		170, 357	
Köyrisåsen 1-4, 5	Kruunupyy	l	62	63.7069057	R	12x12		2	
Köyrisåsen 1-4, 6	Kruunupyy	i	62	63.7069057	R	16x15		168.4, 343.4	
Köyrisåsen 1-4, 7	Kruunupyy	i	62	63.7069057	R	15x14		163.4, 313.4	
Köyrisåsen 1-4, TH1	Kruunupyy	l	62	63.7069057	3-4xR/N	48x12	2		
Brantbacken-Ollisbacken, 1	Kruunupyy	i	55	63.70635944	Q	13x10	172.8	172.8, 352.8	C, M
Brantbacken-Ollisbacken, 2	Kruunupyy	i	55	63.70635944	Q	12x10	55.8	55.8, 145.8	
Brantbacken-Ollisbacken, 3	Kruunupyy	l	55	63.70635944	Q	14x10	158.8	338.8	
Brantbacken-Ollisbacken, 4	Kruunupyy	l	55	63.70635944	Q	14x10	121.8	121.8, 301.8	
Brantbacken-Ollisbacken, 5	Kruunupyy	i	55	63.70572871	Q	20x15	50.3	50.8, 229.8	
Brantbacken-Ollisbacken, 6	Kruunupyy	i	55	63.70572871	Q	20x15	58.3	55.8, 239.8	
Brantbacken-Ollisbacken, 7	Kruunupyy	i	55	63.70572871	Q	20x15	49.8	229.8	
Brantbacken-Ollisbacken, 8	Kruunupyy	l	55	63.70572871	Q	13x10	131.8		

Seljesskog, 1	Kruunupyy	i	52.5	63.69829936	Q/O	13x7	105.5	108.5	
Seljesskog, 2	Kruunupyy	i	52.5	63.69829936	Q	16x7	98.5		
Seljesskog, 3	Kruunupyy	i	52.5	63.69829936	Q	16x13	98.5	98.5, 278.5, 303.5	
Seljesskog, 4	Kruunupyy	i	52.5	63.69829936	Q	?30x18	61.5	248.5	
Seljesskog, 5	Kruunupyy	i	52.5	63.69829936	Q	14x8	123.5		
Seljesskog, S-most	Kruunupyy	l	52.5	63.69829936	Q	25x13	87.9		
Säksholmen	Kruunupyy	i	52	63.69240141	Q/O	14x7	120	120	C
Bläckisåsen 1-3, 1	Kruunupyy	l	60	63.68423262	R	16x16		168	
Bläckisåsen 1-3, 2	Kruunupyy	l	60	63.68423262	R	14x14		147	
Kitisolaktbacken 1	Kruunupyy	i	60	63.67886955	Q	10x6	140		R
Kangas, TH1 (Halinen et al. 1996)	Kaustinen	m	55	63.56700526	2-5xR/O	60x10	113.4		
Svedjebacken, 1	Pedersöre	i	57.5	63.51118357	O	9x7	85.6		X
Kotikangas, 1 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	10x7	59.7		
Kotikangas, 2 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	10x7	68.7		
Kotikangas, 3 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	13x9	49.7		
Kotikangas, 4 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	12x8	154.7		
Kotikangas, 5 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	12x8	36.7		
Kotikangas, 6 (Vanhatalo 2000)	Evijärvi	m	64	63.44679241	Q/O	7x5	175.7		
Purmo-Hundbacken/Myllykangas, 1	Pedersöre	l	55	63.36188025	R	18x18		123.5	
Purmo-Hundbacken/Myllykangas, 2	Pedersöre	l	55	63.36188025	R/N	16x16		66.5, 226.5	
Purmo-Hundbacken/Myllykangas, 3	Pedersöre	l	55	63.36188025	R/N	16x16		266.5	
Purmo-Hundbacken/Myllykangas, 4	Pedersöre	l	55	63.36188025	R/N	18x18		73.5, 260.5	
Purmo-Hundbacken/Myllykangas, 5	Pedersöre	l	55	63.36188025	R/N	16x16		76.5, 236.5	
Purmo-Hundbacken/Myllykangas, 6	Pedersöre	l	55	63.36188025	R/N	12x12		82.5, 241.5	
Purmo-Hundbacken/Myllykangas, 7	Pedersöre	l	55	63.36188025	R/N	8x8		197.5	
Purmo-Hundbacken/Myllykangas, 8	Pedersöre	l	55	63.36188025	R/N	14x14		316.5	
Purmo-Hundbacken/Myllykangas, 9	Pedersöre	l	55	63.36188025	R	20x20		95.5, 275.5	
Purmo-Hundbacken/Myllykangas, 10	Pedersöre	l	55	63.36188025	R/N	12x12		99.5, 259.5	
Purmo-Hundbacken/Myllykangas, 11	Pedersöre	l	55	63.36188025	R/N	14x14		211.5	
Purmo-Hundbacken/Myllykangas, 12	Pedersöre	l	55	63.36188025	R/N	15x15		106.5, 279.5	
Purmo-Hundbacken/Myllykangas, 13	Pedersöre	l	55	63.36188025	R/N	12x12		41.5, 246.5	

Purmo-Hundbacken/Myllykangas, 14	Pedersöre	1	55	63.36188025	R/N	22x16		32.5
Purmo-Hundbacken/Myllykangas, 15	Pedersöre	1	55	63.36188025	R/N	16x16		246
Purmo-Hundbacken/Myllykangas, 16	Pedersöre	1	55	63.36188025	R/N	16x16		256.5
Purmo-Hundbacken/Myllykangas, 17	Pedersöre	1	55	63.36188025	R/N	14x14		276.5
Purmo-Hundbacken/Myllykangas, 18	Pedersöre	1	55	63.36188025	R/N	16x16		296.5
Purmo-Hundbacken/Myllykangas, 19	Pedersöre	1	55	63.36188025	R/N	15x15		99.5, 256.5
Purmo-Hundbacken/Myllykangas, 20	Pedersöre	1	55	63.36188025	R/N	14x14		122.5, 286.5
Purmo-Hundbacken/Myllykangas, 21	Pedersöre	1	55	63.36188025	R/N	14x14		98.5, 256.5
Purmo-Hundbacken/Myllykangas, 22	Pedersöre	1	55	63.36188025	R/N	12x12		256.5
Purmo-Hundbacken/Myllykangas, 23	Pedersöre	1	55	63.36188025	R/N	12x12		256.5
Purmo-Hundbacken/Myllykangas, TH1	Pedersöre	1	55	63.36188025	3xR/N	30x12	16.5	
Purmo-Hundbacken/Myllykangas, TH2	Pedersöre	1	55	63.36188025	3xR/N	40x14	32.5	34, 214