Investigating Long-Term Human Ecodynamics in the European Arctic: Towards an Integrated Multi-Scalar Analysis of Early and Mid Holocene Cultural, Environmental and Palaeodemographic Sequences in Finnmark County, Northern Norway

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Abstract

Most parts of the Circumpolar Arctic have only discontinuous evidence for long-term human settlement. In contrast, Northern Norway has an unbroken archaeological record that extends back to the early Holocene. Numerous high-resolution archaeological and palaeoenvironmental records have been generated by commercial excavations and surveys, offering archaeologists unique opportunities to investigate long-term human ecodynamics in an Arctic coastal setting. To date, however, deeper analysis of the new datasets has yet to be undertaken. This paper aims to present a new synthesis of early and mid Holocene archaeological and paleoenvironmental sequences for Western Finnmark (11500-2000 cal BP). This enables us to identify three major phases of culture change that broadly correlate with climatic and environmental shifts. We then present emerging results from our multi-scalar analysis of the processes driving these transformations. At supra-regional and regional scales, our palaeodemographic modelling indicates major population events centered around 6000 cal BP and 4000 cal BP. At intra-regional scales, we are identifying spatial clustering of prehistoric settlements into local socio-economic communities. At the scale of local settlements, our analysis of house-pit chronologies is clarifying the degree of simultaneous occupation and re-use. We also draw on recent research into rock art and ritual landscapes in an effort to reconstruct the relationship between settlement clusters and general interaction patterns. Integration of these diverse lines of evidence is generating a vivid picture of thriving Arctic coastal communities, with indications that the timing and pace of cultural responses to climatic and environmental changes were more complex than previously thought.

1.0 Introduction: Investigating Human Ecodynamics in the Circumpolar Arctic

There is a long history of research into long-term human ecodynamics – the complex relationship between climate, environmental change and human activity (see: Fitzhugh et al., 2018 for a wider discussion). Arctic archaeology offers some of the best opportunities for studying these interactions over multi-generational timescales given the extreme climates, inherent instability of higher-latitude ecosystems and the exclusive human reliance on local resources for prehistoric survival. However, reconstructing long-term human ecodynamics in the Arctic requires careful integration of high-resolution cultural and environmental datasets, combined with a multi-scalar approach because climatic change may affect multiple regions simultaneously, whereas human responses involve shifts in local social and economic strategies. It may also take considerable time for environmental dynamics to impact on the wider social-ecological system. The observable responses by the cultural system may emerge long after the initial onset of climatic and environmental change, and only after thresholds of significant scale and magnitude have been passed.

Many parts of the Arctic have seen only an intermittent human presence, with dispersals and occupations inter-spaced with long hiatus periods (Friesen and Mason 2016). Greenland, for example, was settled numerous times by different cultural groups, most of whom remained for relatively short periods. Some of the earliest pioneering Arctic groups were highly mobile, and left only ephemeral records behind. In contrast, regions with an unbroken human occupation tend to offer more substantial and unbroken archaeological records, generating continuous datasets that offer better scope for reconstructing long-term human ecodynamics.

The northern coastline of Norway is one of the few parts of the Arctic that have witnessed continuous human occupation throughout the Holocene. The warming effects of the Norwegian Atlantic Current result in a relatively mild climate for the Arctic, limiting sea ice, while the broken coastline – consisting of headlands, deep inlets, islands, skerries, sheltered bays and broad river mouths - offered ready access to abundant marine resources. The lakes, rivers and landscapes of the interior were also easily reachable from these coastal locations. From the start of the Holocene, the rich resources of Norway's Arctic coastline (Breivik, 2014) was supporting early, substantial and sustained human occupations, resulting in a rich archaeological record. These past occupations remain highly visible in the modern landscape thanks to post-glacial uplift of prehistoric shorelines, with house-pits and rock art sites offering the most direct and intriguing glimpses into these earlier coastal lifeways.

We focus on Finnmark County in Northern Norway (Figure 1). Large commercial excavations and surveys of the western part of this county in the last thirty years have resulted in this extensive area now being relatively well-documented, though these datasets are poorly integrated and analyzed. Our overall aim in this paper is to identify the main patterns of prehistoric culture change in Western Finnmark and present preliminary efforts to reconstruct the processes that generated them. We draw on: (a) a new palaeoenvironmental synthesis based on pollen records (b) new palaeodemographic modelling at the supra-regional and regional scales; (c) an intra-regional analysis of settlement systems; plus (d), an exploration of pit house occupation chronologies and associated re-use sequences. We also include information about rock art sites and shifts in technological traditions like lithics and pottery to better understand possible changes in mobility and interaction networks. The combined results present a compelling portrait of dynamic and resilient coastal communities whose responses to climatic and environmental changes were not necessarily immediate nor abrupt.

2.0 Geography of Finnmark County, Arctic Norway

Finnmark County covers 48 618 km² (Fig. 1). Situated between 69 and 71 degrees North, it lies at the extreme northwestern edge of the Eurasian landmass, occupying a similar latitude to central Greenland, Baffin Island, Northern Alaska, as well as large parts of the Russian Arctic, including the Taimyr Peninsula and northern Chukotka. Within a European setting, Finnmark forms the northernmost extension of the Scandinavian Peninsula into the Barents Sea. It is also the most northerly and easterly county of Norway; to the west it is flanked by Troms County, and to the east, by the Kola Peninsula of Russia. It also shares a long border with Finland to the south.

Figure 1 about here

Topographically, Finnmark County is defined by a series of deep fjords that gouge deeply into the mainland. They extend between 60 and 120 km, with most orientated along a north-south axis, resulting in a sharply indented coastline. The exposed islands and headlands of the outer coast are exposed to harsh weather conditions and typically rugged, with exposed bedrock, steep mountain sides and very sparse vegetation. Deeper into the sheltered inner fjords the level of sedimentation increases, supporting richer vegetation, which today is predominantly birch forest; small favourable micro-climates with occasional stands of pine woodland are also found. On the landward side, Finnmark also includes an interior plateau rising to between 300-500 masl, which is dominated by tundra shrubs and small stands of birch. Several large rivers connect the interior with the inner fjords, forming relatively sheltered valleys that support stands of coniferous forest; these form the westernmost extension of the vast Eurasian taiga belt.

Located above the Arctic Circle Finnmark County has two months of midnight sun in the summer, plus two months in the winter when the sun never rises above the horizon. Despite its Arctic location, the coastal climate is rather mild due to the influence of the relatively warm Norwegian Atlantic Current. Mean July temperatures are in the range of 9–13°C, with the highest temperatures in the interior SE and the coldest at the NE coast. In winter mean January temperature show a steep gradient from just below zero at the outer NW coast to well below -15°C in the interior SE (1961–1990, https://www.met.no/; Dannevig & Harstveit, 2013). The mild Atlantic sea waters also prevent the formation of coastal sea-ice, with exception of shallow bays in the inner fjords.

A further climatic distinction separates Western and Eastern Finnmark. Western Finnmark is somewhat warmer, with higher precipitation. In contrast, much of Eastern Finnmark is drier and colder, though warm continental winds in the summer can raise temperatures above 30 °C. The limited precipitation means that the landscape is rather barren in vegetation, giving it a more 'Arctic' character; stretches of the outer coastlands exhibit 'true' Arctic vegetation in the strict bioclimatic sense. Eastern Finnmark also includes Varanger Fjord, which is the only fjord that runs on an East-West axis. Vegetation zones run in parallel with this orientation, so that the northern shoreline has mainly tundra, whereas the southern shoreline has richer vegetation, with easy access to pine woodland via the major river systems that drain from the interior to Varanger's southern shore.

Figure 2 about here.

The broken coastline of Arctic Norway also exhibits important local variation - the opening of the Alta Fjord in Western Finnmark (Fig. 2) is screened by a row of inner islands, and is further protected by the large outer island of Sørøya which faces out to the open sea. This serves to create a maze of sheltered sounds, inner passages and short boat crossings. The major Alta-Kautokeino river system connects to the south of the Alta fjord, offering further boat access deep into the interior. In contrast, the four fjords of Eastern Finnmark are all open all the way to the sea, giving them a bleaker and more exposed character.

Postglacial uplift, slow accumulation of Holocene sediments and sparse industrial development of Finnmark County all mean that traces of prehistoric activity are well-preserved in the modern coastal landscape. Prehistoric habitation sites are easily identifiable, typically marked by extended rows of house-pit depressions (Fig. 3). These lines of dwellings run along the prehistoric shorelines that formed the focus of past activity; thanks to post-glacial uplift they now occupy higher positions in the landscape with the relative age indicated by the height of the housing rows above modern sea level.

Figure (3) about here:

There are clear indications that the prehistoric coastlines of Finnmark were extensively settled. Overall numbers of house-pits sites are approximately eight times higher per km2 than in comparable areas of Finland, and approximately 18 times higher than in Norrbotten County in northern Sweden (Pesonen, 2002; Norberg, 2008). Importantly, house-pit numbers appear to peak around 6000 cal BP, suggesting that overall population levels in Finnmark fluctuated significantly over time, rather then being stable or in steady growth. Moreover, many habitation sites have multiple rows or clusters of house-pits – in some cases running into hundreds – while others have just two or three, raising important questions about settlement hierarchies and population concentrations, but also the extent to which all houses were ever occupied simultaneously and whether older house-pits were re-used by later generations. All this variability generates intriguing questions about how past communities were settling in the prehistoric landscape, and the strategies they used to exploit local ecosystems. For example, most of these coastal sites also had ready access to the terrestrial resources such as reindeer, elk and ptarmigan; fish may have been caught at inland lakes or during annual salmon runs on the major rivers. Annual exploitation of these diverse resources may have involved a degree of seasonal mobility between fixed sites, or perhaps structured interactions between more coastal- and interior-focused groups.

Beyond the abundant archaeology of habitation sites, other lines of evidence are more limited. Human burials are scarce and lack bone material due to Finnmark’s acidic soils, making it impossible to undertake isotopic analyses to investigate human diet. Some faunal assemblages have been recovered from house middens in Eastern Finnmark, and confirm the importance of marine resources, primarily seal, dolphins and cod. Sea birds such as auks were also harvested (E. Helskog, 1983; Engelstad, 1984; Renouf, 1989; Hodgetts, 2010). Unfortunately, no middens containing osseous material have been uncovered in Western Finnmark, limiting inferences about subsistence practices to analysis of toolkits and settlement patterns.

3.0 Archaeological Research Intensity in Eastern vs Western Finnmark County

The prehistory of Finnmark County has been the focus of archaeological research for almost a century. However, the geographic coverage has been uneven, largely favouring Eastern Finnmark. Targeted investigations into the Stone Age began in the 1920’s (Nummedal, 1929), with the first excavations of house-pits in the early 1930’s (Nummedal, 1936; Gjessing, 1942). The general intensity of archaeological fieldwork increased after World War II, with large regional surveys and more intensive excavation campaigns in Eastern, and to a lesser extent, Western Finnmark. Unfortunately, mainly results from Eastern Finnmark were published, greatly raising the visibility of the Varanger fjord area, at the expense of other areas (Simonsen, 1961 1963; Engelstad, 1984; Helskog, 1984; Renouf, 1989; Schanche, 1994).

The published field campaigns from Eastern Finnmark reported on rich datasets whose interpretation continues to dominate culture historical accounts of all northern Norway. For example, sites with multiple substantial dwelling structures hinted at dense populations and increased sedentism, all supported by the relative ecological abundance of the Varanger Fjord. These interpretations converged with international interest in Arctic coastal economies, with Varanger representing the ‘Maritime Core Area’ of the European Arctic (Fitzhugh, 1975, 2010). They also figured in debates about the emergence of prehistoric social complexity among non-agricultural societies (e.g. Renouf, 1984), with explicit parallels drawn between prehistoric Varanger Fjord and the stratified societies of the Pacific Northwest Coast that had been documented in the ethnohistoric period. Within northern Norway, the interpretations developed for Varanger and Eastern Finnmark were also projected onto Western Finnmark; it was assumed that both areas had followed the same sequence of cultural developments (Olsen, 1994).

In the last thirty years this situation has reversed. There has been little further research at Varanger Fjord, while Western Finnmark has seen an exponential growth in new archaeological data thanks to commercial excavations and surveys (Hesjedal et al., 1996; Hesjedal et al., 2009; Henriksen and Valen, 2013). Excavation of house-pit sites has delivered extensive lithic and pottery assemblages, and a range of new sites have been documented, including chert and slate quarries, and reindeer hunting pit systems in the interior. However, almost all this new information has only been published in Norwegian. In contrast, the discovery of numerous rock art sites – including the World Heritage Site of Alta – has been widely reported in the international literature. A more comprehensive integration of the rock art data with information on prehistoric settlement, subsistence and interaction patterns has yet to be completed, and offers scope for a much more holistic interpretation of prehistoric lifeways in Western Finnmark.

To summarize, the current state-of-knowledge highlights three research priorities: (a) a new synthesis of the data from Western Finnmark needs to be made available to an international readership; (b) the prehistoric cultural sequences from Western and Eastern Finmark need to be properly integrated; (c) a more in-depth programme of research is needed in order to better understand what drove long-term human ecodynamics in this part of Northern Norway. Since 2016 the Stone Age Demographics Project has been addressing these challenges. The current paper forms our first extended attempt to synthesize emerging results and identify key areas for future research.

4.0 Identifying General Patterns: Cultural and Climatic Sequences in Western Finnmark

We start by reconstructing the general cultural and palaeoecological sequences in Western Finmark (Fig 2 and 4), and then move on to look at how the project aims to address human ecodynamics at inter-locking spatio-temporal scales.

Figure 4 about here

4.1 Overview of Palaeoenvironmental and Cultural Sequences in Holocene Finnmark

To understand the general environmental context of early to mid Holocene cultural developments we synthesized data from 59 pollen cores to identify regional and sub-regional spatiotemporal variability in vegetation change (Sjögren and Damm, 2019). The most important patterns are:

Pleistocene- Holocene Transition: At the close of the Pleistocene c. 11500 cal BP an abrupt climatic warming took place, hastening ice sheet retreat across Northern Fennoscandia. The north Norwegian coastline had already been largely ice free from around 15000 cal BP, and offered abundant maritime resources (Breivik 2014). Initial Holocene vegetation cover was sparse and tundra-like, and persisted for some time due to further cold spells, but was eventually replaced by pioneer birch woodland. This woodland appeared somewhat earlier in Eastern Finnmark and later in Western Finnmark. From 10000 cal BP the inner parts of the region were covered with extensive birch woodland, with some pine stands in the most favourable locations, though birch was only found in sheltered areas in the exposed outer regions.

The 8.2 K Event: the general warming trend continued through to the Holocene optimum at c.8000-6000 cal BP, but was interrupted by the 8200 cal BP cold event, which registers in some of the paleoclimatic records of the region (e.g. Korhola et al., 2000; Bigler et al., 2003; Kullman, 2013). This event coincides with the Storeggen tsunami off the Norwegian coast (Bondevik et al., 2012; Blankholm, 2019). Waves up to 3-4 m above the contemporary shoreline have been documented in Western Finnmark (Romundset & Bondevik, 2011).

Early Holocene Vegetation and Climate: Around 8000 cal BP pine forest spreads across Finnmark in both interior and the inner fjord areas; this expansion starts earlier in eastern areas and somewhat later in the west and southwest. The outer coast and higher elevations had limited birch woodland, interspaced with areas of grassy moorland. This contrast in vegetation between inner and outer coastal areas is more pronounced in Western Finnmark with Sørøysund in the north and the inner parts of Altafjord in the south, than in the E-W oriented Varanger fjord. Climatically the period 8000-6000 cal BP is warm, dry and stable (Allen et al., 2007).

Marine Transgression and Warming Sea Temperatures: Continuation of global deglaciation and the slowing of isostatic uplift in many outer coastal areas leads to a marine transgression, which peaks at around the Holocene climatic optimum c.7000-6000 cal BP. The coastal sea surface temperatures peak just after 6000 cal BP, followed by a gradual cooling trend (Husum and Hald, 2004). Some pollen records show a marked cold event at 5600 cal BP (Jørgensen, 2019), but pine and birch-alder woodland persists in both the interior and inner fjord areas after this.

Mid-Holocene Cooling: A climatic downturn starts around 6000 cal BP, becomes more significant in the period 4500- 3500 cal BP, and continues through to 2000 cal BP and beyond, resulting in substantially colder and wetter conditions. Pine forest retreats southwards, a trend again starting first in eastern areas, where it is replaced by birch woodland. Open moorland gradually start to dominate along the outer coast.

4.2 A New Synthesis: Prehistoric Cultural Developments in Finnmark

The culture history of Finnmark County has traditionally been divided into three major periods:

- **Early Stone Age (11500-7000 cal BP):** represents the pioneering settlement and is characterised by use of chert, quartzite, quartz and similar hard lithic materials, with the lithic repertoire typically limited to small points, knives and scrapers in addition to some adzes. Tent rings and shallow house-pits are recorded in low numbers.

- **Late Stone Age (7000-3800 cal BP):** marked by extensive use of polished slate artefacts such as knives, arrowheads, spearpoints and adzes. The majority of the excavated house-pits date to this period.

- **Early Metal Period (3800-2000 cal BP):** associated with the first widespread introduction of pottery. Use of slate continues and bifacial quartzite points are typical. House-pits are smaller in size and few in number.

This older framework has very low chronological resolution and glosses over substantial diversity and spatiotemporal variability in a range of important developments. Integration of more recent evidence generates a more detailed account of the major cultural developments:

Pioneer Settlement of Arctic Coastlines: Finnmark was initially colonised c. 11500-11000 cal BP (Kleppe 2018). Early site and artefact types materials including tanged arrowheads bear close similarities to evidence from coastal areas located further south indicating that pioneering groups dispersed northwards into the Arctic following the resource rich Atlantic coast (Bjerck, 2008). However, some initial colonisation from the east has also been proposed (Kleppe, 2018). The lithic raw materials employed in this phase are highly varied, and include chert, quartzite and rock crystal.

The Rise and Demise of Blade Technology: A slightly later dispersal followed an alternative interior route through Finland, which opened up as the ice withdrew further inland. This influx brought a new lithic technology to Finnmark at around 10200 cal BP (Rankama and Kankaapää, 2008; Sørensen et al., 2013; Damlien, 2014). It involved pressure technique on conical cores to produce regular blades and microblades for inserts into composite tools. This new technology eventually went on dominate all northern Fennoscandia, including the entire Norwegian coastline, a process that may have involved either substantial migration or the spread of knowledge via open social networks (Günther et al., 2018). Either way, uptake of the new technology coincided with the first settlement in interior Finnmark (Hood, 2012). Chert became the preferred lithic material, with quarry sites at Melsvik in Western Finnmark from as early as 10400-10300 cal BP (Niemi, 2018), which fed raw materials into a wider exchange and interaction network.

Reorientation of Interaction Networks towards the East: Subsequent developments are poorly understood, but from about 8500-8000 cal BP blade technology falls out of use in Finnmark. Lithic technology shifts to flake production (Hesjedal et al., 2009, p. 393) as seen in transverse or oblique points (Manninen and Knutsson, 2011). This forms part of a wider shift from use of a demanding technology requiring fine quality cherts to use of quartz as part of an expedient technology that leaves few diagnostic artefacts (Damm, 2006). This shift in material choices signals a break with technological traditions still maintained further south along the Norwegian coastline, and points to emergence of closer links with eastern parts of Fennoscandia.

Introduction of New Technologies: Around 7000 cal BP a series of innovations were established amongst the communities in Finnmark. Bifacial arrowhead technology was briefly introduced to the area via inland areas of Finland. Local practice of this tradition (different reduction sequences in Western and Eastern Finnmark respectively (Skandfer, 2009) and experimentation with the technique on slate in Western Finnmark (Hesjedal et al., 1996)), demonstrates distinct technological learning networks. The technology fell out of use just before 6000 cal BP. Also polished slate tools emerge in northern coastal Norway around 7000 cal BP. Slate tools went on dominate the lithic inventory in coastal Finnmark between 6000 and 4000/3500 cal BP, with the use persisting until 3000-2500 cal BP. Knives and daggers were especially common in the early slate-using phase, perhaps linked to an increased demand for seal skins. Other slate tools including arrowheads, spearpoints, adzes and chisels were also widely made. In addition Early Northern Comb Ware ceramics were introduced prior to 7000 cal BP, spreading from interior Finland into the Varanger area in Eastern Finnmark (Skandfer, 2009), but was not adopted further into Western Finnmark. It fell abruptly out of use in Eastern Finnmark after c. 6500 cal BP.

Sacred Landscape Geography: Around the same time as the introduction of these new technologies there is an 'explosion' of rock art across northern Fennoscandia. Rock art sites are particularly numerous in Western Finnmark (Helskog, 1999, 2014; Andreassen, 2008; Gjerde, 2010), starting around 7000 cal BP at the major site of Alta, and continuing until at least 2000 cal BP. Alta itself is situated at the nexus of a complex maze of marine passageways that link the outer coastal waters, via Sørøysund, with the inner fjord, while the major river system at the head of the fjord provides a 'gateway' into the interior. Larger sites like Alta contrast with smaller sites that are located further out in the fjord and sounds, perhaps indicating a hierarchy of sacred places, where larger sites served as regional aggregation points for collective rituals (Hood, 1988). The sites in Western Finnmark display considerable temporal diversity as well as variation in technique (carvings and paintings) and locations. The most common motifs are large terrestrial mammals (reindeer, elk (*Alces alces*) and bear), and humans interacting with these, but fishing scenes, boats, birds, and other cosmological scenes are also found. Many images and themes depicted in the Finnmark rock art are shared across Finland, Norway, Sweden and NW Russia, suggesting that local groups were embedded into much wider interaction networks. Common lithic and ceramic traditions across the wider region also support this interpretation.

Consolidation of Coastal Habitation: From around 6500 cal BP there is a major increase in the number of house-pits in coastal areas, suggesting increased investment in particular places, and perhaps increasing seasonal sedentism. These house-pits are typically oval or rectangular and vary in size (9 – 20 m^2), typically with central hearths. Construction is generally much more substantial than in the Early Stone Age dwellings. For example, habitation sites like Melkøya island and Slettnes in Western Finnmark have been the focus of large-scale excavations, which identified numerous built structures, external activity areas, accumulation of middens, heaps of fire-cracked rocks and also local deforestation (Hesjedal et al., 1996, pp. 65-75; Hesjedal et al., 2009, pp. 398-399).

Emergence of New Architecture and Settlement Patterns: The character of house-pits undergoes a shift during the centuries towards 4200 cal BP, when relatively small house-pits with more rounded corners and a single hearth are replaced by larger and more sharply rectangular constructions, some with double hearths and several entrances. In Western Finnmark these later house-pits have an average floor-space of 20 m^2 (Johansen, 1998, pp. 67-68), and there are generally only two or three large house-pits at each site. In Eastern Finnmark rows of 6-10 house-pits are not unusual, with some sites counting 30. The house-pits here vary between 20 and 60 m^2 with an average of 30 m^2. Some of the largest examples are the classic 'Gressbakken Houses' from Varanger Fjord in Eastern Finnmark, which can be 1 m in depth. These larger dwellings have been used to support the idea of fully sedentary maritime communities in this area (E. Helskog 1983, Renouf, 1989; Engelstad, 1990; Schanche, 1994), though there is substantial variability in depths, sizes and seasonality (Hodgetts 2010), which is often glossed over. Importantly, the building of such large houses appears to have been a short-lived phenomenon in Eastern Finnmark (until c. 3800 cal BP), but may have lasted longer in western coastal and inland areas, where smaller dwellings only dominate again after c. 3300/3000 cal BP (Johansen 1998:76; Skandfer, 2012, p. 132).

Adoption of New Lithic and Ceramic Traditions: Around 4000 cal BP pottery tempered with crushed asbestos fibres was introduced into Finnmark from eastern areas (Jørgensen and Olsen, 1988). Early usage was initially restricted to the easternmost inland regions of Finnmark, but use soon spread to the coast. A second, more extensive phase of asbestos pottery use appears to start around 3800 cal BP (Jørgensen and Olsen, 1988, pp. 67-68; Olsen, 1994, p. 105), loosely coinciding with the gradual abandonment of large house constructions between 3800 and 3000 cal BP. These so-called Textile and Imitated Textile- imprinted pottery types spread to all parts of Finnmark, but became more common in Western than in Eastern Finnmark (Skandfer, 2012, pp. 132, 137-138). Sources of asbestos are known from around Alta and finds of raw asbestos fibres at habitation sites suggest local production at coastal settlements. Simultaneously, bifacial reduction techniques appear again in the region, with production of points with typologically distinct bases from hard, fine-grained material (Hood and Olsen, 1988; Hesjedal et al., 2009). The distinct 'Sandbukt Point' microstyle is found only in Western Finnmark, and at both coastal and inland sites, suggesting connectivity and the sharing of knowledge between these areas. This may signal increasing use of interior resources or closer contact between economically specialised coastal and interior populations. Inland activity increases with construction of wild reindeer hunting-pit systems peaking around 4400 cal BP and the number of inland pit houses slightly later (Skandfer, 2012; Blankholm and Skandfer, in press; Hood, in press).

4.3 Correlating Cultural and Palaeoenvironmental Sequences

To summarize, this synthesis of new data highlights three major cultural transitions after initial human colonization:

(1) Introduction of blade technology from interior areas into existing coastal networks around **10200 cal** BP
(2) Introduction of new technologies and traditions into coastal areas (pottery, lithics, rock art) after **7000 cal BP** combined with major increase in the number of house-pits
(3) Events preceding the short-lived 'boom' in large houses (**4200-3500 cal BP**), including introduction of asbestos pottery and bifacial lithic technology, followed by their abandonment and the greater use of inland areas

There also appears to be broad correlation between the timing of these transitions and wider environmental changes:

(a) While some scholars argue for the possibility of pioneering groups venturing across land to Eastern Finnmark even earlier (Kleppe, 2018), the adoption of blade technology around 10 200 cal BP and the first evidence for use of inland areas, coincide with the establishment of widespread birch woodlands, creating recognizable environmental conditions for mobile groups from the southeast already adapted to terrestrial resources.
(b) The expansion of inter-regional interaction networks indicated by the many technologies takes place at the run-up towards the Holocene climatic optimum, with the remarkable increase in house-pit numbers from c 6500 cal BP.
(c) The abandonment of larger dwellings c. 3800-3000 cal BP coincides with a marked cooling trend; the accumulating environmental changes eventually cross a threshold that required a major socio-economic re-organisation (see also Jørgensen and Riede in prep.).

These are very broad correlations, which serve as initial recognition of patterns to be followed up in future research. More in-depth studies are required to investigate the concrete impact of the environmental change on each of these the cultural transitions. In particular we need higher resolution data to be able to discuss the extent to which cultural responses have been immediate or subject to significant delay. The substance, pace, and severity of these major climatic and environmental changes differ significantly, and they must have affected human populations in different economic, demographic and cultural circumstances; hence we should expect the impact and effects to have been different in each case, rather than envision a direct one-on-one correlation. As noted by others (Manninen et al. 2018: 288), it is important that we investigate correlations between climate changes and changes in archaeological records at a range of scales in order to fully understand local impacts and responses.

5.0 Understanding '<u>Process</u>': A Multi-Scalar Approach to Long-Term Human Ecodynamics

Our new work is addressing the nature of these transitions and the impact of environmental change at supra-regional, intra-regional and local scales.

<u>5.1 Supra-Regional Palaeodemographic Trends and Correlations</u>

At the supra-regional scale, the project has reconstructed past population trends and correlated them with palaeoecological data. The underlying assumption that we wanted to test was whether changing environmental conditions would have had a relatively direct effect on local population size, triggering either increase in more favourable conditions or decline with the onset of colder conditions. Jørgensen (2019) represents the first attempt to apply this approach to Arctic Norway. He employed the Summed Probability Distribution (SPD) of 873 binned dates (1205 individual dates) to explore major demographic shifts for the period 11500 -1500 cal BP in both Troms and Finnmark counties. The available data set is particularly suited for this approach – it is unusally homogenous, consisting primarily of dates from settlements and individual dwellings, with few inherent researcher or research biases. This led to identification of several significant population events; major fluctuations were identified around 6000, 4000 and 2200 cal BP (Jørgensen, 2019, p. 6, fig. 4). The pilot-study also conducted a smaller, more regionally focused analysis of coastal sites in Western Finnmark (503 binned dates). This identified the same general demographic trends, but highlighted an even more pronounced population decline at 5500 cal BP (fig 4; Jørgensen, 2019, fig. 6). This event may have been the culmination of an substantial "boom and bust" cycle, involving steady growth in population from around 7000 cal BP, followed by a major demographic downscaling by 5500 cal BP. Interestingly, the timing of these events overlaps with the important cultural changes described above, including new lithic technologies and the increase in house-pits.

The case-study also examined the extent to which these demographic fluctuations correlated with past environmental shifts. The closest associations were found between human population fluctuations and changes in coastal sea-surface temperatures. Whereas most previous studies had focussed on changes in the terrestrial environment, this study highlighted that maritime environments – especially marine productivity - had had the greatest impact on overall population levels, both in the coastal parts of Western Finnmark, as well as across Northern Norway (both Troms and Finnmark counties).

Exploring links between these substantial palaeodemographic fluctuations and other cultural processes generates some interesting insights. The sparsity of Early Holocene (pre-8000 cal BP) dates make it difficult to assess whether there was significant immigration into coastal areas connected to the 10200 cal BP arrival of a new blade technology. Likewise, the demographic consequences of the 8200 cal BP cold event and the Storeggen tsunami can not at present be assessed for Finnmark, due to the limited data set and insufficient resolution of the archaeological record. Never-the-less the changes in lithic inventory at this time may indicate a response, although the details of why and how escape us at present (see also Manninen, 2014; Manninen et al., 2018 for considerations of these event in Eastern Fennoscandia).

For later periods, the increasing population after 8000 cal BP – particularly the 6000 cal BP peak in population that appears to coincide with the Holocene climatic optimum – creates an impression of expanding and well-connected populations that are highly reliant on marine resources, but also involved in exploitation of inland areas (Skandfer et al., in press). This consolidation process may have involved a more general 'packing' of population, especially in the primary coastal areas, as evidenced archaeologically by increasing house-pit numbers. In turn, this may have been linked not only to a warmer and drier climate, but also to higher marine productivity and a greater degree of landscape forestation. Equally important may have been the emergence of a relatively stable and predictable ecological baseline. Together this facilitated a steady population increase and longer-term seasonal habitation of the richest resource areas. The socio-economic changes appear to have supported (inter)regional contacts, as suggested by shared participation in a common set of rock art motifs and traditions. In turn, this may also have facilitated the introduction of a wide range of new traditions, including bifacial points and polished slate tools.

The abandonment of large dwellings and the return to smaller house forms appear to coincide with the sharp demographic downturn at c. 3500 cal BP, and may have been linked to a general thinning out of populations across the landscape. In contrast, the adoption of asbestos tempered pottery and the re-introduction of bifacial lithic technology both took place prior to the demographic decline.

Interestingly, this later demographic downturn may also have been linked to changing use of inland areas. From 4800 BP use of inland areas had increased, but the marked forest recession that also took place around 3800 cal BP would probably have reduced access to elk (*Alces alces*) in the coastal regions, except in a few lingering refugia areas. In contrast, attention may have switched to reindeer hunting in the increasingly open landscapes. Reindeer hunting pits from interior Finnmark, Troms and northern Finland can be dated to two main episodes, 4700-3800 BP, and then 3400-2600/2100 BP.

In this latter phase, the declining forest cover and expanding lichen-heath areas at higher altitudes may have shifted the reindeer migration patterns from more stationary herds towards long-distance interior-coast routes (known from historical times), which may have greatly reduced the numbers of reindeer present at the coast except in particular seasons. This may have forced people living along the coast to abandon year round settlement along the beaches, and undertake seasonal migrations to the interior to access reindeer herds for food, hides for clothes and bone and antler for tool production (Skandfer et al., in press).

5.2 Intra-Regional Settlement and Interaction Systems

Identifying general correlations between climate, population and cultural processes at supra-regional scales eventually raises questions that can only be addressed at more localised research scales. For example, the ways in which settlement and mobility systems were organised in different periods, and how these strategies shifted under – or perhaps resisted – the impact of new environmental and demographic conditions. In this section we focus in particular on the period circa 7000-3000 cal BP as the high numbers of house-pits from this period provide large datasets that enable us to explore spatiotemporal variability in settlement systems. Similar to work done in other Arctic regions (see: Savelle et al., 2012; Jensen, 2009), we generate a high-resolution dataset of habitation sites for the Western Finnmark. This integrates data derived from older reports and surveys with results of new fieldwork on Sørøya Island, demonstrating the presence of sites at more or less every habitable coastal area.

Figure 5 about here.

One important outcome of this exercise has been identification of distinct grouping of sites into small habitation 'clusters' (Figure 5). Within each cluster, numerous habitation sites are mutually inter-visible, often situated only short water crossings from each other. Our fieldwork suggests that this clustering pattern is mainly a function of topographical constraints, such as steep cliffs, rocky shores and lack of well-drained boulder-free spaces. In addition, some apparently favorable locations were not occupied, probably due to poor landing beaches, lack of local shelter from winds funnelled down valleys from the interior, or the presence of dangerous offshore currents. However, clear spatial clustering of habitation areas must have had a structural and organisational impact on local societies. For example, many clusters are separated by treacherous sea crossings that may have been undertaken on a less frequent basis.

Subsistence activities in each cluster may have focused on different constellations of local resources, ranging from ocean fish and sealing in outer areas, through to salmon and reindeer in areas around the Alta fjord. This may have affected the extent to which habitation in each local cluster was able to respond to general environmental shifts. Some shifts may have had little impact on resources in some clusters but may have triggered major changes in others.

The precise links between the habitation clusters and local social structures is intriguing. On the one hand, distinct local communities (or kinship groups) may have been anchored into particular clusters, perhaps claiming ownership and identity in relation to local places and resources. The repeated use of sites as evidenced by rows of house-pits hints at groups residing repeatedly within each local area. On the other hand, groups may have practised a more rotating strategy, relocating at internals between different locations. At present, however, we refrain from any conclusions regarding the relation between settlement clusters and socio-economic units.

However, we do note that analyses of material culture in other parts of Northern Fennoscandia does support the impression of small communities adhering to geographically limited regions. Local sharing of knowledge and tradition may be reflected in the emergence of regional micro-styles for the reduction sequences of bifacial points (Manninen et al., 2003; Skandfer, 2009), as well as site-specific styles in early ceramics (Skandfer, 2005), which persisted despite widespread participation in longer-range exchange networks as evidenced in rock art and lithic types and material. More work on bifacial technologies - as well as slate and chert sourcing in Western Finnmark - is underway to clarify these issues.

5.3 Investigating Cultural Transformations at the Local Scale

In general then, our recent fieldwork is suggesting that after a mid-Holocene population peak the population in Western Finnmark stabilised at a lower equilibrium. The population appears to have mapped onto local resource areas within favourable topographical settings. Given this clustering of habitation sites, understanding cultural transitions – and any correlations with environmental changes – now requires working at much more local scales, both within each of the settlement clusters, but also at the scale of specific habitation sites and even house-pit features.

As most of our recent fieldwork has focused on the Sørøysund region in Western Finmark, we present emerging results from this area. Our most detailed records are from the southwestern part of Sørøya Island, which forms one of the habitation clusters identified in Figure 5. Our analysis of settlement patterns within this particular cluster indicates that some locations had a high density of house-pits, while others have only a few, even though the topography would allow for many more dwellings. Good harbours, shelter from harsh weather – especially wind – as well as views out to sea or across bays all appear to have influenced site choice. Access to local resources was also important – the waters around southwestern Sørøya remain well-known for abundant summer and winter fishing for salmon, cod and halibut and medieval records tell of substantial seal hunting (Andreassen and Bratrein, 2011, p. 319), with harbour and grey seal still present in the area today. There is also short distance to the lakes of the interior island, as well as the highlands grazed by reindeer. Exactly how settlement systems functioned within each cluster remains unclear, though a number of insights are starting to emerge. Our work has identified that sites used repeatedly between 6500 and3000 cal BP are typically located in the topographically most favourable places, with sheltered harbours in small bays, access to fresh water and short distances to a range of both coastal and inland resources. In contrast, some of the smaller sites - generally with fewer house-pits – appear to have access to a more limited range of resources and may have been specialised or seasonal extraction camps.

One major challenge that we are still working to resolve is the duration of house-pit occupation, the degree of re-use and the extent to which adjacent house-pits were in use at around the same time. Earlier debates on this issue left the question open, but better documentation during excavations, the major increase in higher quality radiocarbon dates, and new statistical methods opens scope for a more fine-grained treatment of these issues. The project is drawing on recent development-led excavations that have generated a sufficient number of radiocarbon dates to tackle these questions in a more systematic manner.

Our work includes a pilot-study of dates from 109 excavated house-pits from seven sites in the area around Sørøysund, which points towards extensive re-use of house-pits (Vollan, submitted). For example, 51 of the dwellings have two or more radiocarbon dates from the interior floor areas, of which at least one date falls prior to 2000 cal BP. Bayesian analysis suggests that at least 63% (n=32) of these dwellings were subject to reuse. The frequency and duration of reuse would also be expected to vary, but the trend appears to be that the number of separate habitation episodes correlates to the number of available radiocarbon dates (more dates reveal more occupation phases). For example, 61% of the dwellings that have three or more radiocarbon dates also have three or more occupation episodes. In some cases, as many as six separate habitation episodes were identified for the same dwelling. Similar trends were identified on all sites that were analysed. This result highlights the high degree of house-pit reuse, but also that it is vital to have a sufficient number of dates from the same dwelling in order to reconstruct the history of occupation. In turn, identifying exactly when each house-pit within each habitation site and cluster was used is vital for reconstruction of settlement and mobility strategies, as well as overall population size at given points in time.

Past studies of intra-site house-pit distributions, including at sites on Sørøya (Andreassen, 1985), noted that small groups of houses tend to be set apart from each other within the same sites. We have also identified this pattern in our new surveys. These intra-site clusters are not large, normally two or three houses, or even a single house, and may be a reflection of occupation history or the kinship dynamics of small residential units groupings that either live or build new houses close to each other. Clearly, much more work is needed to resolve the issue of house-pit occupation histories, the ways in which different house clusters were associated with different sets of resources, and how the local settlement system evolved and responded to climate changes and demographic fluctuations.

5.4 Interaction Patterns, Rock Art and Sacred Landscape Geography

The rock art sites found across Western Finnmark suggest common ideas and practices that are shared by communities living across the region. The most extensive panels are concentrated at the head of Alta Fjord (Helskog 2014). Particularly the first two phases (c. 7200-5000 cal BP) display a multitude of more complex narrative scenes showing hunting of reindeer (struck by arrows but also gathered in corrals), elk and bear. Motifs also include salmon jumping in a pool, fishing for deep-water halibut and humans holding large birds. Much work has addressed not only the cosmological significance of the site, but also past ecological knowledge and landscape use embedded in the panels (Helskog, 1999; Gjerde, 2010; Skandfer, in press;). In contrast, our work aims to understand how the sites functioned in wider interaction and exchange networks, including the extent to which they served as a focus of ritual obligations, but also the way in which they may have operated as a kind of nodal point in wider interaction and exchange networks (sensu Hood, 1988). Beyond the main site with extensive panels at Alta, rock art from the same general tradition is found on smaller boulders and outcrops across Western Finnmark. This may reflect a hierarchy in the sites, with local sites holding particular meanings for smaller groups and the main sites being the focus of wider regional veneration, perhaps in the form of seasonal meeting, interaction and exchange events (Damm, in press).

6.0 Discussion: Understanding Long-Term Human Ecodynamics in the European Arctic

In general, there appears to be a link between hunter-gatherer population densities, the extent of mobility and the robustness of social (and genetic) networks (Fitzhugh et al., 2011; Hertell & Tallavaara, 2011). It has been argued that high-density populations that have extensive and well-integrated social networks tend to be more resilient to environmental downturns. This is because important knowledge and useful new technologies are more easily shared, and neighbouring groups may be called upon if resources fail. In contrast, small and isolated populations exhibit many inherent vulnerabilities, which can result in the sudden loss of traditions or demographic crises if a few key individuals are lost through accident or disease (Riede, 2014).

There is consensus that hunter-gatherer social networks are mostly organised along multiple spatial scales: the local band, the regional band and also via interaction with other regional bands (Whallon, 2006, Lovis et al., 2006). Many small-scale coastal societies in the circumpolar region rely on social networks beyond the residential groups to reduce economic vulnerability and to maintain knowledge and technologies (Whallon et al., 2011). In other words, local residential units in small-scale, low-density societies tend to be integrated into regional and interregional networks, which provide mates, social and economic security, as well as a forum for the exchange of goods, technology and information. This strategy may also be relevant when evaluating what leads to resilience – or vulnerability – in particular socio-ecological systems in times of environmental change.

In this paper we have attempted to reconstruct a specific hunter-gatherer regional interaction network undergoing processes of long-term transformation. In particular, we have examined what happens when this socio-ecological system is confronted with environmental changes, and impacted by major demographic fluctuations. Some of the most visible shifts can be detected at a macro scale, whereas local cultural responses appear to be more variable, linked partly to the nature of specific socio-economic contexts. For example, from 7000 cal BP onwards there appears to be a gradual population increase, which is sustained by stable environmental conditions and higher marine productivity. While the increase in house-pits numbers suggests prolonged stays at particular locations, this did not lead to isolation. Instead the appearance of many new technologies and the similarities in rock art across vast areas of Northern Fennoscandia within the same period demonstrates significant cross-regional interaction. Dispersed communities – perhaps anchored in some of the distinctive habitation clusters (Figure 5) – remained in regular contact.

This period is followed by a marked population decline at 3500 cal BP, which appears to be linked to the climatic cooling that sets in at c. 3800 cal BP. While there is no immediate and abrupt response to this change, the environmental shifts do eventually appear to pass a threshold that requires a significant socio-economic transformation with direct impact on the demography. Interestingly, it appears that several new technologies are adopted *after* the onset of cooling, but *before* the sharp demographic decline, suggesting that local communities were at least attempting to deal with the changing situation by drawing on information from wider interregional contacts.

In both instances it seems that initially local hunter-gatherer communities were able to respond to the onset of new conditions without immediate reorganisation of the entire socio-ecological system. In the first case, these responses lead to gradual changes in the archaeological record. In the second case, we do eventually see a more abrupt set of changes, but only after significant economic thresholds have been passed. Reconstructing precisely what happened at more local and regional scales remains a major challenge, but we are making steady progress in understanding the complex histories of particular habitation clusters, including the house-pits and settlement sites contained within them. This will refine our current understanding of how local demography, settlement systems and interaction patterns were structured and transformed over time.

There are several other important lines of enquiry which we aim to explore in future work. The increasing 'packing' of the coastal population into distinct habitation and resource clusters may have been combined with formal rights to exploit adjacent resources, and could eventually have led to ownership of houses and landing sites. Such rights may have been held and inherited within families, lineages or larger kin groups. Emergence of local or regional group identities that were anchored in local clusters and the ownership and exploitation of rich local ecosystems (see also Rowley-Conwy and Piper 2017) may be behind the appearance of artefact micro-styles, and could also have played a role in other puzzling phenomena, such as the limited adoption of Early Comb Ware pottery into some parts of Varanger area, but its explicit rejection by other communities living close by.

The exact nature of interaction between the diverse local settlements is particularly important to understand as exchange networks and shared rock art traditions all point to at least some regular interaction between highly dispersed communities. One mechanism for regular inter-group contacts could have been the higher mobility of smaller task groups who may have encountered members of remoter communities more often. These occasional meetings would have created opportunities to meet new partners, and exchange objects and knowledge.

Shared commitments to some of the major rock art sites like Alta may have resulted in regular aggregations. The Alta site could for several millennia have functioned as a major regional aggregation point for the growing population of scattered communities that lived across the wider coastal region, including adjacent fjords. Ethnographic research among many coastal foragers indicates that populations gather at regional aggregation centres – these are coordinated events and have both a cosmological dimension but also social and political significance. They sustain trade, exchange and the forging of new relationships, even among groups that are actively hostile to each other at other times of the year (Burch 2005:180-202). Importantly, many of these regional gatherings were held where travel routes converged and where seasonal resource abundance could support large numbers of people. The Alta rock art site links coastal and interior worlds, is situated close to one of the major salmon runs in northern Norway, and also sits at the ‘gateway’ to the autumn reindeer migrations of the interior.

7.0 Conclusions

The long-term trajectory of Fennoscandian hunter-gatherers is an interesting one (Damm and Forsberg, 2014), suggesting capacity to respond resiliently to a variety of environmental and socio-cultural challenges. Our project provides new insights from Arctic Norway, and presents an emerging picture of dynamic coastal populations that inhabited local settlements clusters while also participating in longer-range interaction networks. In this paper we have presented a new synthesis of early and mid Holocene archaeological and paleoenvironmental sequences from Finnmark County, Arctic Norway, between 11500 and 2000 cal BP. The three main phases of cultural transformation correlate broadly with environmental shifts.

We then presented new results emerging from our multi-scalar analysis of long-term human ecodynamics: (a) at the supra-regional and regional scale we explored the major population fluctuations at circa 6000 cal BP and between 4200-3500 cal BP; (b) our work on settlement locations at intra-regional scales highlights a distinctive spatial clustering of habitation sites; (c) local scale investigations are confirming occupation histories of particular house-pits and settlements; (d) improved knowledge of rock art locations and prehistoric sacred landscape geography provides further insight into past interaction networks.

Many of these interpretations remain preliminary in nature, but serve to highlight several new lines of enquiry that we will develop in future publications. Importantly, the results are indicating that processes of cultural transformation - and in particular, the pace and timing of human responses to the onset of climatic and environmental changes - were both complex, variable and often delayed. Future work will further integrate analyses conducted at these three different scales, and will clarify the extent to which there was local variability in cultural responses to macro-scale climatic shifts.

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Figure texts:

Figure 1: Finnmark County. The Porsanger Fjord marks the transition between Western and Eastern Finnmark. Background map ©Kartverket.

Figure 2: Western Finnmark. Numbers mark the location of sites mentioned in the text; 1 = Melsvik, 2 = Slettnes, and 3 = Melkøya Island. Background map ©Kartverket.

Figure 3: House-pit located on beach ridge at Taborshamn, southwestern Sørøya. Photo by Marianne Skandfer.

Figure 4. Comparison between the main cultural development in Finnmark and the general environmental change. New traditions and technology: (1) Pioneer settlement; (2) Introduction of blade technology; (3) Introduction of bifacial arrowhead technology and early slate technology, expansion in rock art and settlements; (4) Large houses and asbestos pottery; (5) Small houses and textile pottery. See text for details and references. Cold events from the middle and early Holocene (8200, 5500, 3800 and 2800 cal BP) are interpreted from pollen-based climate reconstruction from NNW Norway and Finland by Seppä & Birks (2001, 2002), Bjune *et al.* (2004) and Jensen & Vorren (2008). Early Holocene cold events (11400, 9300 and 8200 cal BP) are derived from the NGRIP Greenland ice-core (Vinther *et al*. 2006). Vegetation reconstructions follow Sjögren and Damm (2018). Effective precipitation estimated based on Hyvärinen & Alhonen (1994), Eronen et al. (1999), Hammarlund et al. (2002), Seppä et al. (2002) and Korhola et al. (2005). Dashed line indicate uncertain reconstruction. Schematic temperature reconstruction primarily based on Jensen & Vorren (2008), Seppä et al. (2009), Birks et al. (2012), Kullman and Öberg (2015) and Sejrup et al. (2016). Dashed line indicate uncertain reconstruction. Summed probability distribution (SPD) based on 503 binned radiocarbon dates from the western ocast of Finnmark, exponential smoothing (spline 0.97) applied (Jørgensen, 2018).

Figure 5: Illustration of house-pit density in Western Finnmark. The number of recorded house-pits (n=2051) is based on the national cultural herritage database and supplemented by available reports. Only house-pits in Finnmark county are included. The density of house-pits (points) is calculated by using Kernel Density Estimation, which allows for easy identification of clustering of points. The illustration displays two merged density calucaltions; 0-150 house-pits within a radius of 3 km, and 0-600 house-pits within a radius of 1200 km. Background map ©Kartverket.

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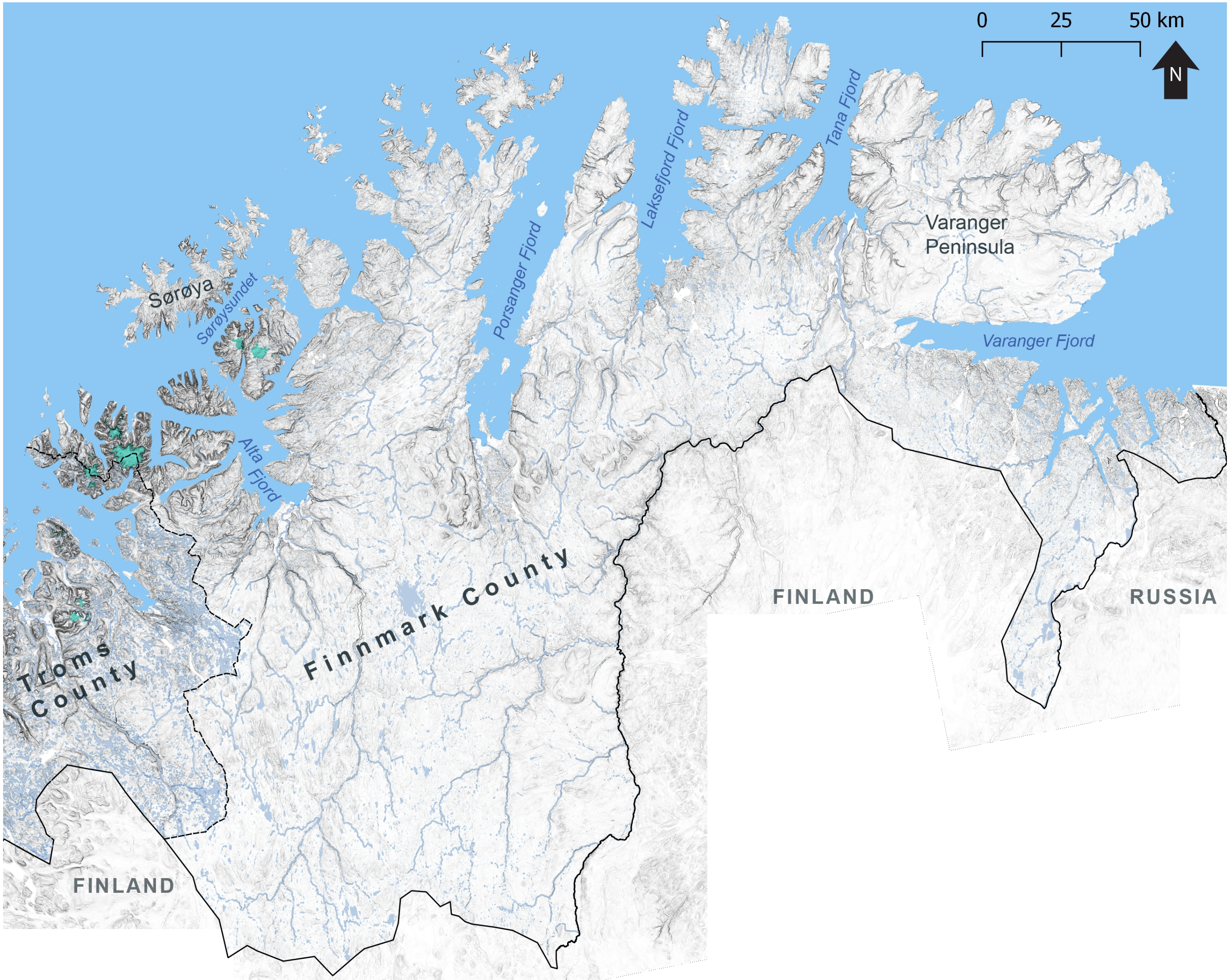
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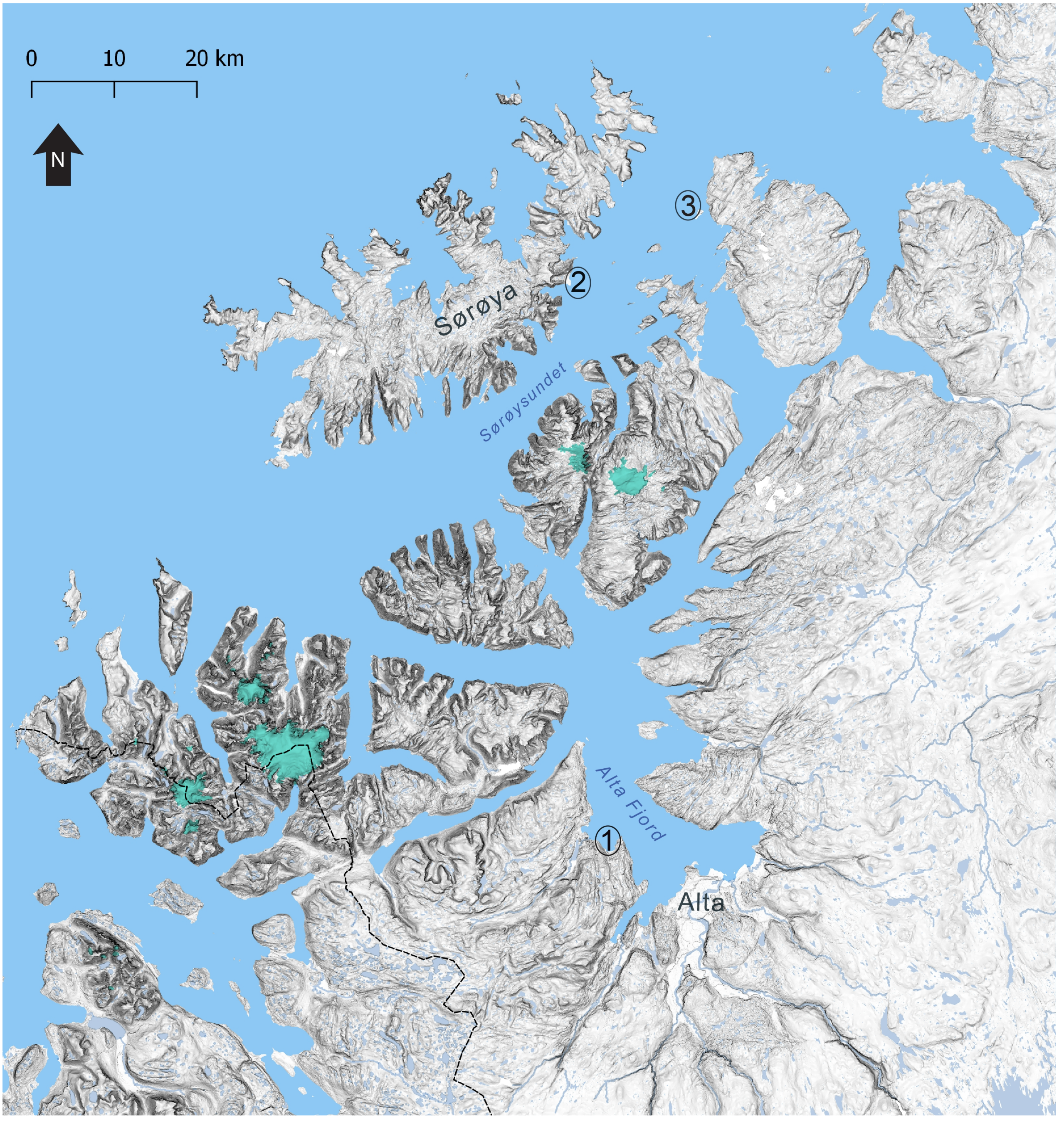

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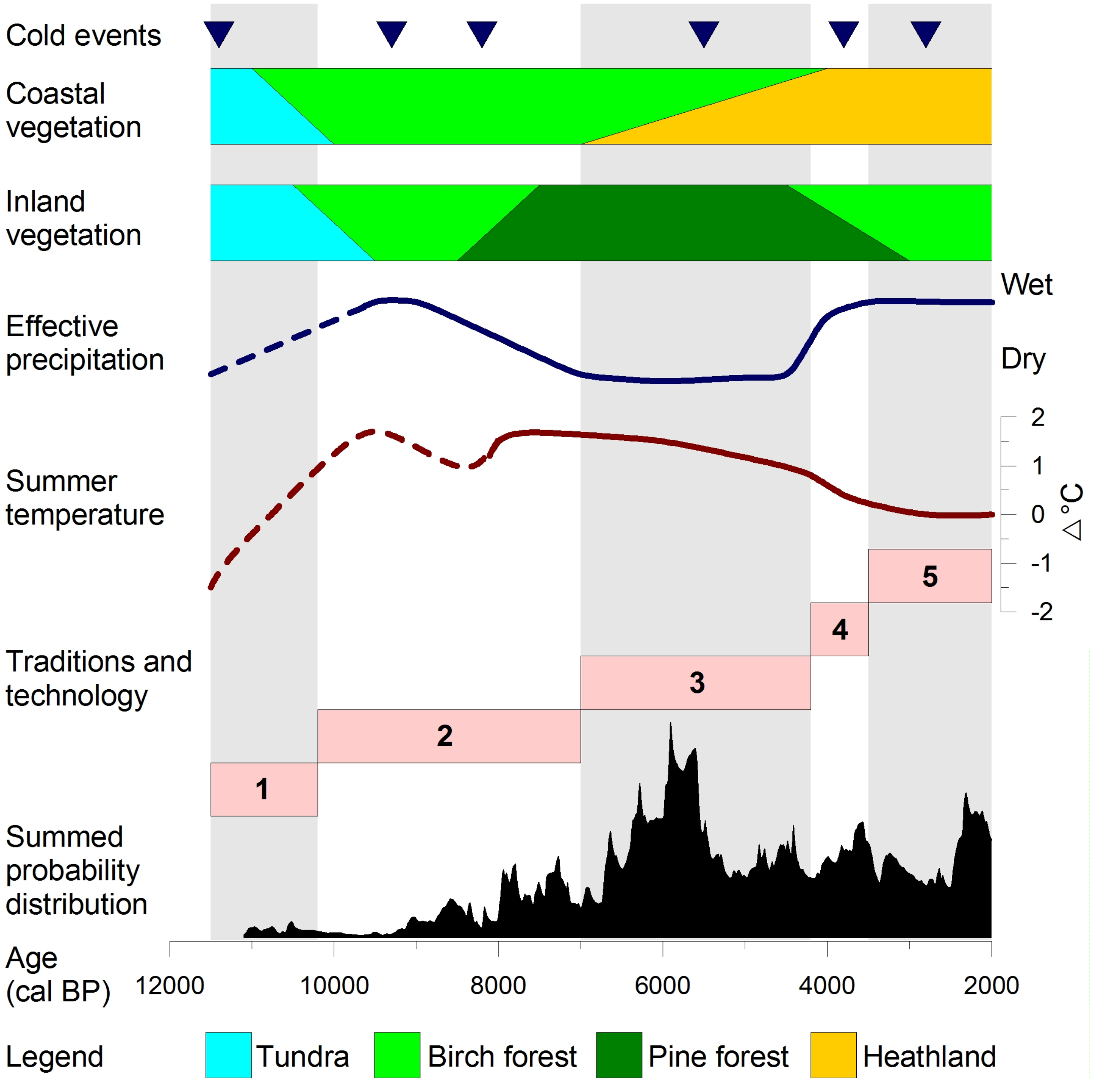

Cold events
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Inland vegetation
Effective precipitation
Wet
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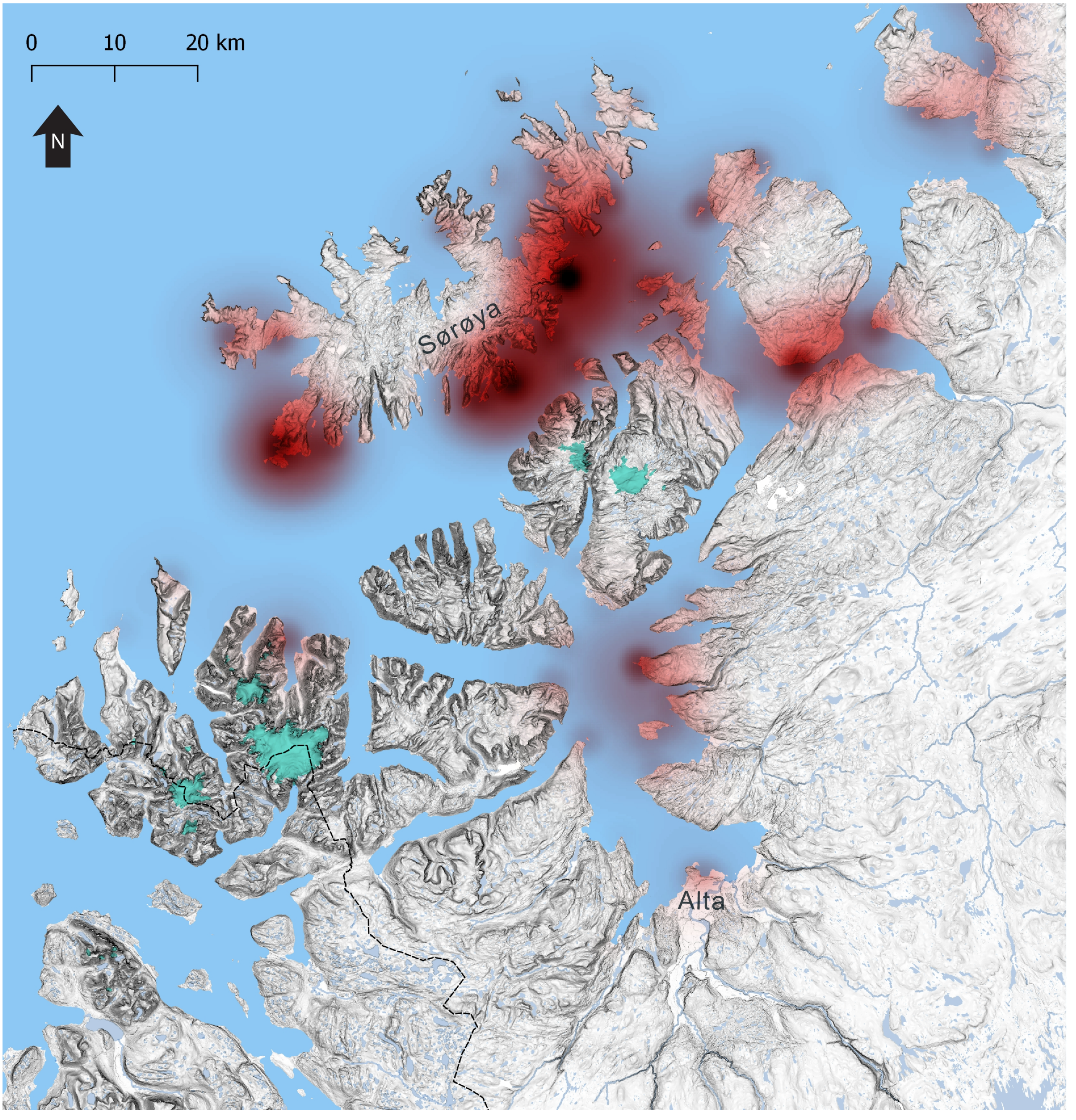

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