

In the wake of the wake. An investigation of the impact of the Storegga tsunami on the human settlement of inner Varangerfjord, northern Norway.

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Abstract

The Storegga tsunami (8175-8120 cal. BP, Bondevik et al., 2012) has often been described as a catastrophe spelling major disaster and demographic decline for the people in the danger zone. More nuance is needed if we are to understand the effects. Most studies have had a supra-regional or regional character; less effort seems to have put into studies at the sub-regional level. The Norwegian coast, for example, is a topographic, bathymetric and environmental mosaic and the sub-regional and local effects must surely have been different. This paper discusses the possible effects of the Storegga tsunami on the human settlement of inner Varangerfjord in northern Norway some 2000 km from the point of origin. Central to the discussion are the questions of: a) actual presence of people at the time of the event, b) safe altitudes above sea-level for settlement, c) the geological record and the compounding effects of the Tapes transgression, d) the archaeological record, and e) the combined effects of the Storegga tsunami and the 8200 cal. BP cold event and hunter-fisher-gatherer resilience. It is concluded that 1) the vertical run-up of the Storegga tsunami in inner Varangerfjord probably was 2 m or less, 2) the impact of the 8200 cal. BP cold event on the ecology of Finnmark was relatively weak, and 3) the combined effect of both on human life probably was minor given a high degree of resilience among the population.

Keywords: Storegga tsunami, 8200 cal. BP cold event, hunter-fisher-gatherer resilience, northern Norway.

1. Introduction

Following Fitzhugh (2016:19), there has recently been an increased interest for “... retrospective studies of historical pattern and periodicity in earthquakes, tsunamis, volcanic eruptions, flood, drought, climate change and other natural hazards.” in order “...better to understand human responses to hazardous events and environmental change...” (e.g., Blaikie et al., 1994; Oliver-Smith and Hoffman, 1999; Torrence and Grattan, 2002; Sidle et al., 2004; Estévez, 2005). The Storegga tsunami (8175-8120 cal. BP) was one such event. The Storegga landslide originated under the sea c. 100 km offshore of Møre and Romsdal county in western Norway. It released roughly 290 km of coastal shelf and approximately 3500 km³ of deposits and is thus among the largest landslides ever recorded (Bondevik et al., 1997, 1998).

Estimates of the run-up above contemporary sea-level varies among the northwestern coast of Norway (9-13 m), the southwestern coast of Norway (3-5 m), the eastern coast of Scotland (3-6 m), the Shetland Isles (> 20 m), and the Faroe Islands (> 14 m) (Fig.1 and Bondevik et al., 2005).

Much research has taken place over the past couple of decades at supra-regional, regional and local scales in order to unravel the aftermath of the tsunami, notably around the eastern shores of the North Atlantic and in areas where the tsunami has been supposed to have hit the hardest – western Norway, Scotland and the Northern Isles, the Faroe Islands, and the North Sea with its former “Doggerland” (e.g., Bondevik, 2003; Bondevik et al., 1997, 2003, 2005, 2006, 2012; Dawson and Smith, 2000; Dawson et al., 1988, 1990, 1993; Fruergaard et al., 2015; Gaffney et al., 2007; Grauert et al., 2001; Harbitz, 1992; Haflidason et al., 2005; Hill et al., 2014; Long and Dawson, 1989; Long et al., 1989; Riede et al., 2009; Rydgren and Bondevik, 2015; Shennan et al., 2000; Smith et al., 2004, 2013; Waddington, 2015; Waddington and

Wicks, 2017; Wagner et al., 2007; Weniger et al., 2008). However, the effects of the Storegga tsunami on prehistoric communities in regions more distant from its point of origin are not well known. In the following, the questions raised above are discussed regarding inner Varangerfjord, northern Norway, some 2000 km from the point of origin as the sea flows. The study area is shown in Fig. 2A.

2. Were people present at the coast?

Even in parts of the Norwegian coast where the Storegga tsunami must have briefly inundated contemporary archaeological sites, the people who used them may not have been present at the particular time of the year when it struck. According to Rydgren and Bondevik (2015), the Storegga tsunami happened in late autumn, most likely sometime between October and December. They also claim (*ibid.*) that this was the time when people returned to their winter quarters along the coast after having hunted reindeer in the mountains during the summer and that the tsunami thus must have affected a large amount of the people then living along the shores of western Norway. Those who did survive the tsunami would have faced the loss of dwellings, boats and other equipment, making life in the aftermath very difficult.

There are two basic problems with this argument. First, there is little in the way of archaeological evidence for seasonality during the period in question; models of settlement patterns are still very much based primarily on circumstantial evidence and the dates for the high mountain sites in southwestern Norway predate the tsunami by approximately 1500 calendar years (Bang-Andersen, 2017). Secondly, even if the model may fit and apply to western Norway, the situation in northern Norway may have been quite different. For this region, it is generally assumed that the reindeer, just like in recent times, spend the winter in the high plains beyond the Caledonian mountain chain and the summer at the coast, with migration to the coast taking place in the spring (May) and the return to the inland occurring in late September through October; that is, a migration pattern opposite to the one suggested

for western Norway (Bang-Andersen, 2017). Reindeer are at their prime as a human resource at the time of the fall return migration to the plains. It may thus have been the case that many hunters and their kin were on the track of the reindeer away from the coastal area when the tsunami struck.

3. Living at the edge of the water?

Obviously, and for various reasons, people did not settle in the tidal zone or right at the high tide line save for short stops, but equipment of various sorts may have been placed near and above the high tide or spring tide level. The main reason for not living at the edge of the high or spring tide zone is storm surge and surf; the effects of both are dependent on geography, topography, bathymetry, wind-speed, the duration of powerful winds and the length of the stretch of open water they cross (e.g., Fletcher et al., 1993). Storm surge is a common phenomenon in northern Norway and may raise the sea-level by several meters. Surf also relates to the degree of direct exposure, the geological composition of the ground and gradient of the shore. The impact may often be vastly different from one end of a beach to the other, even within a few hundred meters (Sanjaume and Tolgensbakk, 2009). Wave heights of 4 m+ are common on the outer coast of the Varanger peninsula (a maximum 9.80 m was recorded at Berlevåg), while they seldom reach heights of more than 2-3 m in inner Varangerfjord. Safe altitudes for prehistoric settlement above sea-level have been estimated by a number of authors. K. Helskog (1978) found a consistent altitude of 2.5-3.0 m above the contemporary sea-levels in Finnmark and Møller (1987) estimated an average of 4.8 m for the same region. In an attempt to correct for sea-surf, Barlundhaug (1997) used a range of 2-6 m for sites on the outer coast of Troms county, while Sandmo (1986) used 6 m. A safe altitude of 4-6 m above the contemporary sea-level (high tide) would seem reasonable for most of the more exposed parts of the Varanger area. If this were the case, and presuming that people were actually present at the coast, they would have been able to avoid casualties and most of the detrimental

effects of the Storegga tsunami (see below). However, it is highly dubious that there were conventions in place that people had to live a specified altitude above sea-level. Rather, a safe altitude above the sea could be anything from 2 m and above according to local conditions and preferences based on experience.

4. The geological record and the compounding effects of the mid-Holocene (Tapes) transgression.

As indicated above, most studies pertaining to the Storegga tsunami have centred on regions relatively close to the point of origin. Only two studies (Corner et al., 1999; Romundset and Bondevik, 2011) have focused on northeastern most Norway and explicitly commented upon or dealt with the tsunami. In the absence of diagnostic evidence, Corner et al. (1999:164), working along a transect between Nikel in Russia and Kirkenes in Norway, tentatively concluded "... that the Storegga tsunami had little or no effect in this relatively remote northeastern area". Romundset and Bondevik (2011), on the other hand, reconstructed a vertical run-up of 3-5 m on the islands of Sørøya and Rolvsøya, west and north of Hammerfest, and on the western shores of the Nordkinn peninsula. As to this discrepancy, Corner et al. (1999) indicate that it may be because the then existing skerry seascape off Kirkenes distributed the energy to such an extent that no geological effect can be detected. It may also be the case that it is difficult to find indisputable tsunami deposits; lake basins need to be both well-located and well-suited with regard to detecting tsunami traces (Anders Romundset, Norwegian Geological Survey, pers. com. 2017). Moreover, it may be argued that the tsunami lost considerable power over the c. 200 km stretch from the Nordkinn peninsula to the mouth of the Varangerfjord and/or was not deflected the approximately 90-180 degrees backwards towards the west with sufficient energy to create large waves or significant disruptions. Yet, a run-up of 3 m or less would seem plausible (Stein Bondevik, pers. com. 2017).

However, the study of the impact of the Storegga tsunami is compounded by the effects of the mid-Holocene sea-level rise culminating c. 6600 cal. BP (Bondevik et al., 1998); in northern Scandinavian archaeology this rise is generally referred to as the Tapes transgression. The latter term is used in the following. Palaeo-shoreline formation in Varanger and neighbouring regions, including those of the Tapes transgression, has been studied for about a century (e.g., Corner et al., 1999; Donner et al., 1977; Fletcher et al., 1993; Helskog, 1978; Marthinussen, 1960; Møller, 1987, 1989; Rose and Synge, 1979; Rosendahl, 1931; Sanjaume and Tolgensbakk, 2009; Snyder et al., 1996; Sollid et al., 1973; Tanner, 1930).

Because of continuous Holocene isostatic uplift, the Varanger area with its multitude of palaeo-shore ridges offers an excellent opportunity to study beach formation and relative sea-level change. However, those beach-ridge series (see Fig. 3) cannot be understood like a sequence of tree-rings (e.g., Fletcher et al. 1993; Sanjaume and Tolgensbakk 2009). A quotation from Fletcher et al. (1993:118) on beach-ridge series underscores the point:

It is apparent that each successive storm in this series would partially (or wholly) destroy and recycle the cobbles of preceding ridges and terraces in the same set. On the seaward end, a prominent ridge caps the set and records a much larger storm, culminating the episode of storminess producing the set and probably consuming several preceding beach ridges in its formation.

Add to this that the Varanger area was subjected to varying degrees of isostatic uplift (e.g., Marthinussen, 1945; Møller et al., 1987, 1989; Snyder et al., 1996; Sørensen et al., 1996) and that even within smaller bays, the ridges correlating with a particular sea-level may not occur at level height (Sanjaume and Tolgensbakk, 2009).

Despite all this, many attempts have been made to generate shoreline isobases and shoreline displacement curves (e.g. Corner et al., 1999; Fletcher et al., 1993; Marthinussen, 1945;

Møller et al., 1987, 1989; Snyder et al., 1996; Sørensen et al., 1996). These efforts, however, often differ considerably geographically and with respect to inferred altitudes above sea-level. The southern shore of inner Varangerfjord is a good example. This is a relatively sheltered area compared to the outer Varanger coast, but also an area that would have been prone to the effects of a tsunami funneling through the fjord. On the southern side of inner Varangerfjord, Møller and Holmeslett's (2003) shoreline simulation program SEALEV places the sea-level at the time of the tsunami (8100 cal. BP) at c. 45 m above the present sea-level, while Fletcher et al. (1993), based on local and more reliable data, place it c. 23 ± 3 m above sea-level (1993: Fig. 3). According to Møller and Holmeslett's program, the Tapes transgression is merely marked by an inflection point in the sea-level graph, separating an earlier and significant period of isostatic uplift from a later period of less (but net) uplift. In contrast, the graphs provided by Corner et al.'s (1999) lake isolation studies, and Fletcher et al.'s equally incisive studies at Brannsetta (1993) in particular, show different patterns. Corner et al. (1999: Fig. 16) show a c. 2000-year long period of less (net) isostatic uplift and no transgression followed by an increase in shoreline displacement rate. Fletcher et al. (1993: Fig 3) show an equally long "plateau-like" interval, marked as a "record gap" in another figure (Fletcher et al. 1993: Fig. 6A), going from iso/eustatic (near) equilibrium to a relatively small transgression of c. 2 m at c. 6600 cal. BP (see also Manninen and Knutson, 2011; Manninen, 2014). This not only means that shoreline displacement curves must be taken with reservation, but also that they may at best be valid for short stretches of coast.

Returning to inner Varangerfjord, Fletcher et al.'s (1993) estimate of the sea-level at the time of the tsunami of 23 ± 3 m (Fig.4) is probably the best estimate as it is based on detailed research on the huge Brannsetta beach-ridge series. The time of the Storegga tsunami, however, is also at the incipient phase of the Tapes transgression, which culminated at 25 ± 2 m, roughly 1500 calibrated ^{14}C years later at around 6600 cal. BP. This corresponds

reasonably well with Rose and Synge's (1979) estimate for the Tapes transgression maximum for the same area at 27-29 m. This opens the possibility that up to 4 vertical meters of diagnostic evidence of the tsunami may have been disrupted or transgressed with the further implication that this may also have been the case with archaeological sites (see below) used or occupied at the time of the event (see also Manninen, 2014).

5. The archaeological record

Several surveys with different research aims, chronological periods, and focus areas in mind have taken place in the Varanger area since the 1920s (e.g., Nummedal, 1927, 1929; Bøe and Nummedal, 1936; Simonsen, 1961; Odner, 1966; Schanche, 1988; Grydeland, 2002, 2006; Kleppe, 2010, 2017; Blankholm, 2017). Among those, Grydelands (2006) investigation of the the Mesolithic of the southern side of inner Varangerfjord is probably the one that best covers the time period around the Storegga tsunami (Fig. 2B). Conveniently, this area is also geographically situated next to Fletcher et al.'s (1993) detailed studies at Brannsletta. Grydeland's survey extended over a stretch of c. 25 km and generally covered the area between the Postglacial marine limit and 26 m above sea-level, the latter roughly corresponding to the Tapes maximum line. His survey technique consisted of field-walking beach-ridges and other potential *loci* for archaeological sites, but did not involve statistical sampling or site-specific survey grids. All finds and contextual information were carefully recorded on a standard form. Some parts of the area, apparently, were surveyed more intensively and systematically than others, and very few ¹⁴C dates were obtained. Most sites were dated by shoreline displacement, with all the problems this entails, and altitudes above present day sea-level were mostly obtained by interpolation from 5 m curves on 1:10.000 maps, which have a margin of error of several meters.

A Tapes transgressed site was excavated in the late 1920s near Vadsø on the other side of the fjord, some 25 km distant as the crow flies. At this site, the Tapes maximum sea-level was

measured in a geological trench to 25 m above sea-level and with a beach-ridge deposit reaching c. 28 m (Rosendahl 1929). According to Grydeland (2006), there are no signs of transgressed sites within his surveyed area, but since his survey focused on surface finds, this does not preclude that some sites may be buried. Tapes abrasion (see also Rosendahl, 1929; Fletcher et al., 1993) – where the sea cuts into morainic and uplifted marine deposits – may also have destroyed sites (Fig. 5). The same pertains to a massive landslide at Karlebotn (Harald Sveian, Norwegian Geological Survey, pers. com., 2007), possibly caused by seismic activity (see also Nikilaeva, 2005), which at some time unknown slid out into the sea from around the 50 m contour, corresponding to c. 8500 cal. BP. It took about one fourth of the potential area for settlements in Karlebotn bay with it (Fig. 6). It is presently impossible to evaluate to any exact degree how all these sources of error have affected the numerical and altitude above sea-level representativity of the sites, and in consequence one need to use Grydeland's data with reservation.

The 138 sites recorded along the southern shore of inner Varangerfjord may loosely be grouped into three clusters: one around Karlebotn, another around Gressbakken, and a third between Čåkka and Gandvik. This may, of course, have behavioural connotations. However, the number of sites per altitude meter within each of those three areas is generally very low. This may, of course, also have behavioural connotations, but for the purpose of investigating whether sites may have been affected by the Storegga tsunami, those at relevant altitudes above sea-level may be lumped together. The result is shown in Tab. 1.

Following Fletcher et al. (1993), and setting the sea-level at c. 8100 cal. BP to 23 m above sea-level, observing the Tapes maximum limit at 25 m above sea-level, and correcting for the 3 m amplitude of the tide, a 2 m tsunami would have reached 1.5 m above and 1.5 m below the Tapes limit at high and low tide, respectively. A 3 m tsunami would have reached 2.5 m above the Tapes limit at high tide and 0.5 m below at low tide. The corresponding figures for

a 4 m tsunami are 3.5 and 0.5 m above the tapes limit, and for a 6 m tsunami 5.5 and 2.5 m. If the sites were situated around 2 m above high tide, at 26.5 m above sea-level, a 2 m tsunami would only just have reached them at high tide and a 3 m tsunami would have overrun them by a meter. A 4 m tsunami would have overrun the sites at high tide with 2 m (up to the 28.5 m level) , and a 6 m tsunami would have done the same with 4 m (up to the 30.5 m level). The corresponding figures for a low tide situation would have been 2.5 m (25.5 m above sea-level) and 4.5 m (27.5 m above sea-level), respectively. However, following Grydeland (2006), there are no signs of transgressed or disrupted sites from the 26 m contour and above. This could indicate that they were never run over by the sea. It is the 23-25 m interval, covered by the transgression, which seems more muted in the archaeological record. Yet, even if there were some now buried sites within this range, they would not have been run over by a 2 m tsunami at low tide.

It has been argued that the Storegga tsunami led to demographic decline in regions closer to its point of origin, reflected in a drop in site frequencies (e.g., Waddington and Wicks, 2017). Taken at face value, it could be tempting to see the drop in Varangerfjord site frequencies (from 8 to 2) between 28 and 27 m above sea-level in Tab.1 as an effect of a 4 m tsunami. However, and as noted above, the numbers are small and prone to error and do not favour, or invite, meter by meter comparisons. And, as also indicated above, it is highly dubious that there were conventions in place that people had to live at a specified altitude above sea-level. Also, we should consider that site frequencies may change according to exploitation pattern and resource-use schedules and not necessarily imply changes in demography. Again, looking at Tab. 1 there is an apparent general rise in site frequencies between 26 and 29 m above sea-level, with no records further below. The latter is an artifact of Grydeland's survey; it did not extend further down towards the sea and the apparent lack of sites cannot be taken at face value for a possible decline in population. Rather, the higher frequencies perhaps reflect a

phenomenon also observed along other parts of the Norwegian coast. In areas with extended periods of isostatic and eustatic (near) equilibrium or only minor changes in sea-level that did not result in much extended distances to the contemporary beach, sites tended to accumulate for a very long time at around the same altitude above sea-level (Bjerck, 2008). Changing the sea-level at 8100 cal. BP to Fletcher et al.'s (1999) maximum (25 m above sea-level) or minimum (21 m above sea-level) level of uncertainty would only marginally change the picture.

If the Storegga tsunami hit inner Varangerfjord, but did not leave a geological signature (Corner et al., 1999), the presented data may be interpreted to suggest that it was probably low (less than 2 m) and probably would have had little effect other than perhaps disrupting gear stored on the beach (see also Rydgren and Bondevik, 2015).

6. The Storegga tsunami and the 8200 cal. BP cold event.

The 8200 cal. BP cold event was the most sudden and conspicuous cold snap during the Early Holocene with a relative decrease in temperature of 2-3° C and lasting for approximately 160 years. It was likely caused by the collapse of the Laurentian Ice Sheet in North America; the effects are most notable in the northern hemisphere, particularly in the North Atlantic region (Bond et al., 1997; Alley and Ágústsdóttir, 1997; Kabushi et al., 2007; Matero et al., 2017).

In a recent study of Scotland and northeast England, Waddington and Wicks (2017) have argued that the 8200 cal. BP event had already impacted the economy, demography and organization of the Mesolithic communities when they were hit again by the Storegga tsunami. In other words, the Storegga tsunami would have greatly augmented or reinforced the detrimental effects of the 8200 cal. BP. cold event on human life. This raises issues about “weakened” communities being hit by further external stressors at vulnerable moments and in turn questions regarding hunter-fisher-gatherer resilience.

How the situation was in northern Norway, and in the Varanger area in particular, is a challenging question given the above considerations. Looking at the botanical record, Seppä et al. (2007) found that the cold event had no, or very little, effect in the mountainous tree-line section of the tri-state (Norway, Sweden, Finland) border region. In contrast, Huntley et al. (2013, see also Allen et al., 2007) found cyclical, spatial variations in the *Betula-Pinus* ecotone and evidence for the cold event at all three of their sites along the northern coast of Finnmark. However, generally the effect diminished with longitude towards the east and no map was provided to indicate the position of the ecotone according to time. From this it may be inferred that the impact of the cold event in eastern Finnmark was relatively weak and that the birch-pine (*Betula-Pinus*) ecotone probably was somewhere near its present location. In other words no sudden (after all, we are considering processes occurring over centuries or several decades) or extensive changes in the ecology.

The observed changes would hardly seem challenging to an experienced hunter-fisher-gatherer population that had already been mapping on to the resources for about 1500 years and had faced previous warm and chilly periods (see below) and which would seem to have lived way below carrying capacity in a non-optimal foraging way in this generally extremely rich environment (Blankholm, 2017; Kleppe, 2017). Some resources, terrestrial or marine, may have oscillated in frequency, density, spatial distribution or shifted their migratory patterns, but it would be difficult to tell the difference between inherent natural fluctuations among species and those that may have been generated by the cold event. Taking the present archaeological evidence at face value and looking at the long *durée* from c. 8500 to 7500 cal. BP, the situation may be tentatively interpreted to suggest that the inhabitants of the Varanger area did not seem to change their subsistence patterns, material culture or demography in any significant way (for a contrasting view see Manninen, 2014). In accordance with Fitzhugh (2016), dealing with the Kuril islands in the Pacific, one might argue that as hunter-fisher-

gatherers, they displayed a high degree of resilience with a seemingly robust technological, economic and social organization (Hald and Blankholm, 2009; Blankholm, 2017). However, it is difficult to corroborate this further, because it is exactly within this time bracket that our data are most confounded by the effects of the Tapes transgression.

7. Results and discussion.

This is how the situation stands today. According to the present evidence it is suggested: 1) that the vertical run-up of the Storegga tsunami in inner Varangerfjord probably was 2 m or less, 2) that the impact of the 8200 cal. BP cold event on the ecology of Finnmark was relatively weak, and 3) that the combined effect of both on human life probably had only minor consequences given a high degree of resilience among the population.

Another lesson learned is that making generalizations about the effect of a tsunami over long stretches of coast may very well end up as a futile enterprise as long as the details for its constituent segments are not properly understood within an acceptable margin of error. To disentangle the complex relationships among the Storegga tsunami, sea-level changes, the local or regional geology and human response, as well as whether or not it reinforced the possible effects of the 8200 cal. BP cold event, will, as also Waddington and Wicks (2017) have called for, require focused studies taking all the relevant questions and variables into consideration and a carefully crafted research design. A considerable number of studies on the effect of the Storegga tsunami and 8200 cal. BP cold event on human settlement and demography have drawn on disparate studies from various disciplines that did not address those questions in the first place and were not conducted at compatible or congruent geographical scales and chronological resolution. Any interdisciplinary study of the matter should minimally address and adequately resolve the following for an extended period on both sides of the events:

- Is the number and quality of the sites and pertinent data (archaeological or natural scientific) a representative sample? Are scales and resolution compatible and of sufficient detail?
- The economy and settlement, including seasonality, of the period in question. Do variations in site frequencies reflect variation in resource-use schedules and/or demographic fluctuations?
- The effects of eustatics and isostatics, including the stratigraphical and morphological effects of the Tapes transgression (overlay and abrasions).

It seems both right and timely to ask how human beings related to abrupt natural events, be they climatic or in the form of tsunamis, earthquakes or volcanic eruptions. From this we may become more enlightened about our past, but may also gain knowledge that may become useful in the future. However, as archeologists we should not lose sight of the forest for the trees; scale is important. One may ask the pertinent question: how much did those presumed and real set-backs matter for human endeavours on the broader continental or global canvas in the long *durée*?

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Blankholm. List of figures.

Please observe that all figures are to appear in greyscale in the printed version.

Fig 1. Map of Norway and the Norwegian Sea with the study area. The position of the Storegga slide and estimates of the tsunami run-up (after Bondevik et al. 2015, Fig.1). Map by Johan Arntzen.

Fig.2. A) Map of the study area with place names. Map by Johan Arntzen. B) Map of Grydeland's survey area (2006:3 Fig.1.1). Re-drawn with permission from Sven Erik Grydeland. Map by Johan Arntzen.

Fig. 3. The beach ridge field at Syltefjord - Sandfjorden, Varanger peninsula, with about half a square kilometer of fossil beaches covering the entire bay from the marine limit to the sea. © H. P. Blankholm 2010.

Fig 4. Local relative sea-level at Bransletta, Varangerfjord, Norway. Re-drawn (simplified) after Fletcher et al. (1993, Fig. 3). Drawing by Johan Arntzen.

Fig.5. A telling tale from Ytre Syltevik, Varanger. The Tapes abrasion has eroded away all fossil beaches from about 9000 cal. BP and down to the Younger Stone Age. Two Younger Stone Age semi-subterranean pit-houses are visible on the ridge closest to the grass-covered bottom of the slope. © H. P. Blankholm 2010.

Fig. 6. The Tapes abrasion at Gropbakkeengen and approximate limits of a massive landslide at Karlebotn. Note the semi-subterranean pit-dwellings on the site. Lidar map provided by Jan Ingolf Kleppe, Finnmark County Authority.

Blankholm. List of tables

Table 1. Number of Mesolithic sites at altitudes between 35 and 26 m above sea level on the southern shore of inner Varangerfjord. Data collated from Grydeland 2006.