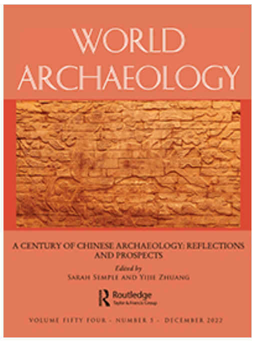

World Archaeology

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rwar20

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To cite this article: Astrid J. Nyland & Hege Damlien (29 May 2024): Lithic stories of broken relations after the Storegga tsunami in Mesolithic western Norway?, World Archaeology, DOI: 10.1080/00438243.2024.2357384

To link to this article: https://doi.org/10.1080/00438243.2024.2357384

Published online: 29 May 2024.

WORLD ARCHAEOLOGY
https://doi.org/10.1080/00438243.2024.2357384

Lithic stories of broken relations after the Storegga tsunami in Mesolithic western Norway?

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ABSTRACT
Major changes in lithic technologies are often explained by either migration or crisis. Here we argue that continuity and minor adjustments in lithic production can tell equally dramatic tales of altered social situations. We base our interpretations on identified lithic blade production concepts and raw materials at 30 sites dating 7500–5000BC, i.e. from before and after the massive Storegga tsunami hit the coast of western South-Norway around 6150BC. Regional continuation, but also local variations in lithic production are interpreted inspired by a machine-oriented ontological framework. The tsunami disrupts the environment, society and its lithic traditions are affected. Although no immediate major breaks are observed, sometime after the tsunami, societies or lithic production as 'machines' in separate regions had begun to hum to different tunes. We suggest that variation in tsunami impact had created differing local social contexts which in turn pushed the lithic traditions down diverging paths.

KEYWORDS
Lithic technology; Storegga tsunami; Mesolithic west Norway; crisis; ontology

Introduction

Due to poor organic preservation at Mesolithic sites in western Norway, lithics are often the only remains left as a source for investigating human relations. However, much can be inferred from lithics when recognizing the extended role they had in human societies, such as expressing stability or intensification of social or geographic affinity via knowledge transmission. For example, the continental Ahrensburgian technocomplex is suggested to have been a 'social anchor' to a North-European continental origin for the Late Glacial – Early Mesolithic pioneers of the Norwegian coast (Berg-Hansen 2017; Fuglestvedt 2007). In South Norway, this Early Mesolithic technocomplex and concept was first replaced at the transition to the Middle Mesolithic around 8000 BC, as a second wave of newcomers arrived (Damlien 2016a, 2016b; Fuglestvedt 2012; Kashuba et al. 2019; Sørensen et al. 2013) (see chronology Table 1). Whereas continuation in lithic tools and technology are perceived as expressions of a social connection to one's past, geographical or group affinity, changes to technology are often explained as a consequence of human mobility, migration, or other changes in contact networks.

During the subsequent Middle and Late Mesolithic periods in western Norway, there were no similar large changes in lithic technology or raw material procurement practices (Bjerck 2008; Nyland 2017b). This does not, however, mean the period was eventless. On the contrary,

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Table 1. Overview of the duration of Norwegian Mesolithic time periods and the phase names colloquially applied in Norwegian archaeology (based in particular on Bjerck 1986, 2008; Olsen 1992). The tsunami happened ca 6150 BC/8200 BP.

Time period	Incorporated phase names/characteristics	uncal BP	calBC
Early Mesolithic	Pioneer phase	10 000–9000	9200–8200
Middle Mesolithic	Early microblade tradition	9000–7500	8200–6400
Late Mesolithic	Late microblade tradition	7500–5200	6400–4000

a potential catastrophe hit the west coast approximately 6150 BC. A massive tsunami was triggered by, to date, the largest known submarine landslide off the coast of Møre, the north-western coast of South Norway (Bondevik et al. 1997; Bondevik, Storm, and Skjerdal 2012). This happened 8200 years ago, just prior to the shift in chronological period from the Middle to the Late Mesolithic (in a Norwegian context) (Table 1).

The tsunami encounter may have caused a temporary crisis. *Crisis*, or the consequences of such, is another major interpretative framework used to explain changes in material culture. Whether the crisis is caused by diseases, abrupt socio-political situations, climate change, or other natural hazards, like a tsunami, it may cause changes in society and material culture (*e.g.* Goff et al. 2012; Riede and Sheets 2020). Across the Middle and Late Mesolithic transition (c. 6000 BC), there are apparently no major changes in the lithic technology in western South Norway, only gradual adjustments, and minor alterations in existing technological concepts. Again, this does not mean that the tsunami caused no damage or social impact on the western coast. Yet our expectations of major changes in lithics as a materialisation of the impact of a crisis, might have limited our ability to identify the variety of human responses to transitory changes in social or ecological settings. But lithics can tell tales of societal devastation and broken relations, or illustrate the immanent capacities, robustness, and social strategies of Mesolithic societies too. Little evidence of the social impact of the Storegga tsunami has been identified. We suggest that one reason for this is due to an inappropriate scale and focus of investigation. Perhaps we have looked in the wrong places or used the wrong scale?

Ontologically, objects/lithics have a strong agency and they influence human lives (Bjerck 2022). What are we without things? In a Machine Oriented Ontology (cf. Bryant 2014, 2018), everything in the world can be described as filled with machines and every element matters equally. A world of things or beings is not a world in 'stasis' (Bryant 2018, 163). On the contrary, everything is fundamentally in the process of becoming. This and similar ideas are seen by some as process-oriented ontology, new materialism, and part of a post-humanist perspective (cf. Barad 2003; Heidegger 1971; Ingold 2013; Olsen 2010). Although one cause may have different effects, and different causes may have the same effect, the material world's capacity to affect and be affected by humans is the main point here (cf. DeLanda 2018, 33). Things influence us, yet things and their meaning are also always on the move themselves, fluid and unfixed. To conceptualise this as an ontological 'machine' is in this paper a way to underline this notion. That is, we explore ideas of what things, or any other element of the world, do, how they operate and 'flow', but also how we as archaeologists detect the entanglements of elements, recognising that a 'product of a machine need not be an output that departs from the machine like a chicken laying an egg. The product can also be a quality, or state of the machine' (Bryant 2018, 166). A change in setting or a replacement of one element in a machine/world/phenomena/society will then have ripple effects, causing changes to what it does, affecting the other elements which in turn may

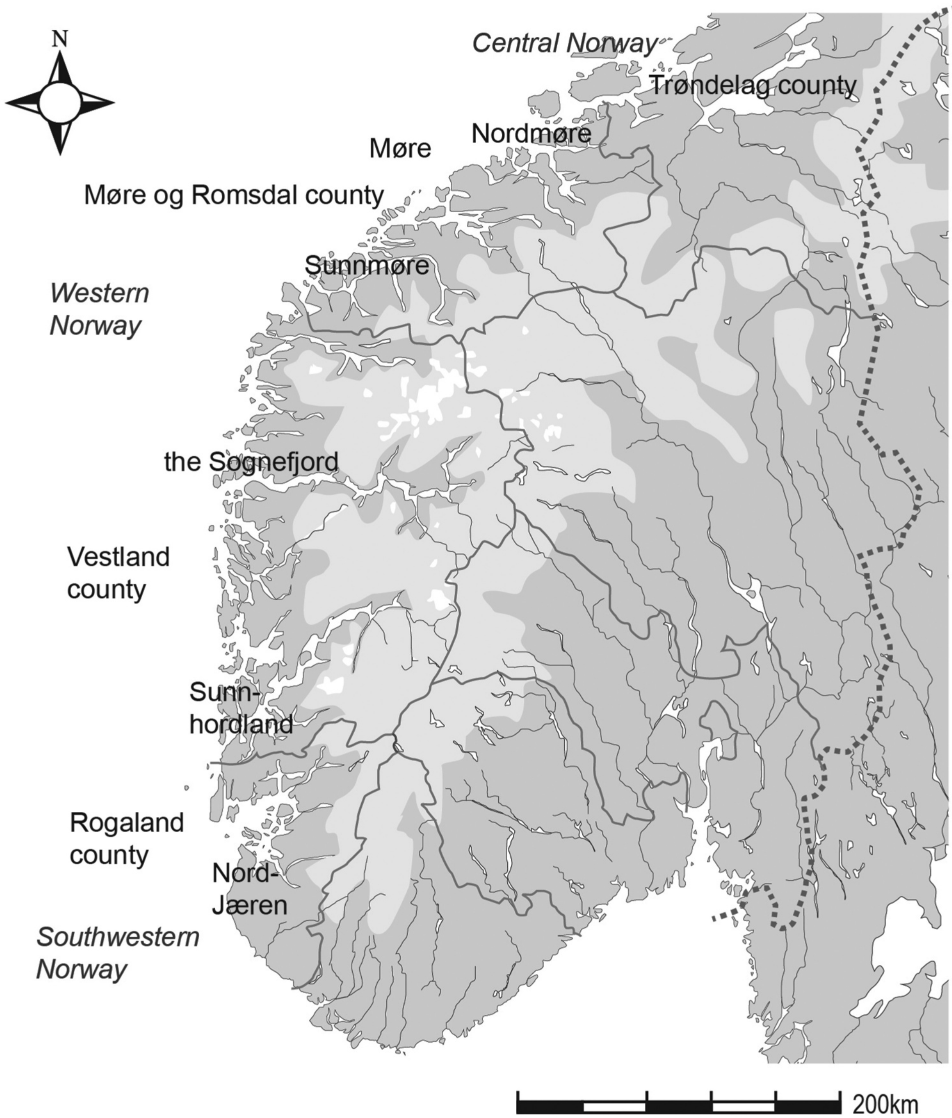

Figure 1. Map with place names and regions mentioned in the text. (Illustration: A.J.Nyland).

shift its movements. In our paper, we address Middle and Late Mesolithic lithic technology of western South Norway in its social and physical environment, constantly affected and entangled in it, making the churning machine, or rather machines, come into being.

To explore technological developments, the results from a study of lithics from 30 selected coastal settlement sites from six demarcated areas are considered. The studied sites and assemblages are located from Nord-Jæren in the southwest, to Nordmøre in the northwest, a distance covering nearly 600 km (Figure 1, Table 2). The sites selected are primarily excavated within the last 30 years, contain sizeable lithic assemblages, and are C14-dated within the period c.7500–5000 BC. That is, we have studied lithics at sites dated to either before or after the tsunami event.

Table 2. List of studied sites, their dates, and name of assigned region. They are sorted more or less chronologically within region, the light green rows are dated before, the dark green after, and sites with more phases (before and after) are white. All focus areas contain sites with sites and/or phases with dates to before and after the tsunami.

5710–5640 Reg.	County/region	Site name	14C-date (cal BC)	Before/after the tsunami
1	Sunnmøre, Møre and Romsdal	Dysvikja	7100–6500, 7200–6600 and 6500–6300	Before
	Møre and Romsdal	Meisingset lok 1, fase 1	7000–6000	Before
	Møre and Romsdal	Henda	6640–6000, 5700–5200	Before/after
	Møre and Romsdal	Lok 62 Grunnvika	6690–6000	Before
	Møre and Romsdal	Sætergarden	6067–5760, 5986–5726	After
	Møre and Romsdal	Lok 50 Søndre Steghaugen	6000–5200	After
	Møre and Romsdal	Kvernberget 4	5980–5400	After
	Møre and Romsdal	Kvernberget 6	5980–5700	After
	Møre and Romsdal	Meisingset lok 1, fase 2	5875–5667, 5839–5671, 5208–4797	After
	Møre and Romsdal	Meisingset lok 2	5215–5041, 5208–4999,	After
2	Sogn and Fjordane	Båtvik II	7519–6829, 7340–6535, 6568–6080, 6501–5670, 5216–4841	Before/after
3	Nordhordland	Flatøy 1	5526–5075	After
		Vindenes 55	5745–5373	After
		Revarvika 6	6639–6246, 6638–6263	Before
		Gjeddevatn 1	5290–5040	After
		Skiparviken	5230–5051, 5081–4944	After
4	Sunnhordland	Svortland 4	7020–6655, 6430–6260	Before
		Grunnavåg 3, S	5842–5718	After
		Grunnavåg 3, N	'Late Mesolithic'	After
5	Nord-Rogaland	Lindøya 1b	7060–6820	Before
		Botten 1	6830–6650	Before
		Lindøy 4	5800–5670, 5710–5560	After
		Fosnaneset Ib	5710–5615, 5710–5640	After
6	Sør-Rogaland/ Nord-Jæren	Sola site 10 (Melå)	7919–7170	Before
		Hå gamle prestegård	7610–6690	Before
		Lego II	6700–6370	Before
		Nedre Kvinnesland 4	6465–6395, 6650–6510	Before
		Storhiller	6340–5723	After
		Tjora	6076–5982	After
		Sola sentrum, A3	6410–6247; (6061–5980, 5944–5926); 5720–5631	After

A tsunami as disturbance to the technology and social 'machines'

The Storegga tsunami caused havoc with the coast on both sides of the North Sea basin with evident wave heights between 3–15 metres (Bondevik et al. 1997, 2005; Dawson and Smith 2000; Dawson, Smith, and Long 1990; Løvholt et al. 2017). The wave hit areas as far away as Greenland, Scotland, and the Netherlands (Bateman et al. 2021; Bondevik et al. 2003; Bondevik, Storm, and Skjerdal 2012; Long et al. 2016; Nyland, Walker, and Warren 2021; Waddington and Wicks 2017; Wagner et al. 2006; Walker et al. 2020).

The geological evidence, *i.e.*, thick layers of mixed sand, gravel, and ripped up turf, are found in sediment traps, that is lakes and bogs along the coast on both sides of the North Sea (Åstveit et al. 2016; Bondevik, Svendsen, and Mangerud 1998; Bondevik et al. 2005; Dawson, Smith, and Long 1990; Prøsch-Danielsen 2006; Walker et al. 2023). The layers demonstrate a formidable physical impact on the coast. The social impact of the tsunami has previously been suggested as severe, and together with the climatic 8.2 ka cold event, potentially causing a societal 'wipe-out' in Mesolithic Scotland (Waddington and Wicks 2017).

Recorded Mesolithic sites on the west coast of Norway tell us that the inhabitants were marine oriented. Their sites are so-called 'shore bound', i.e. located at or close to beaches. In the tsunami layers there were finds of a particular type of green moss (*Hylocomium splendencs, Pleurozium schreberi*, and *Rhytidiadelphus triquetrus*) that flowers in October-November. Based on this it has been inferred that the tsunami happened late fall approx. 8200 years ago (Bondevik, Storm, and Skjerdal 2012, 3). Hence, when the tsunami happened, people were back from their autumn hunting in the inland/mountains. In fact, the ongoing 8.2 ka climatic cold anomaly had perhaps driven people down from the mountains early. Hence, people were at their coastal winter camps and their winter storages were full. The Storegga tsunami could not have hit them at a worse time and the encounter may have been devastating to the areas hit the hardest (Nyland forthcoming).

The Storegga tsunami would have been a dramatic, disruptive, and potentially traumatic event. And we know that while it was shared by several coastal communities, not all regions experienced its full force. As a newly generated simulation model of the tsunami's regional impact shows (Walker et al. 2023), in some areas the tsunami was perhaps barely a disruptive transitory event and a scary reminder of the risks of living close to the sea. The variability of experience of this potentially monstrous encounter created different local and regional social contexts, that is, the imprint and scale of human or social trauma would have differed. The landscapes also vary geologically, influencing lithic raw material accessibility and sometimes very different sea level changes would have produced varying 'coastal histories' (cf. Nyland 2020). The region 'western Norway' would thus have been made up of smaller areas with distinct local stories. Moreover, seeing that practices and knowledge transmission are socially, historically, culturally, and physically situated, that is in a perpetual state of change and becoming (Ingold 2003; Stoetzler and Yuval-Davis 2002), we wondered whether technological developments reflected this too.

Returning to the ontological machine, acknowledging the agency or frames set by people's physical environment, variation in any of the social and physical elements mentioned above would push the 'machines' down different paths. To expect lithic technology to change simultaneously all along the western coast of South Norway may therefore be futile. Although overall similarities in technology and cultural traits dominate, we should expect the development of local variations. It follows that we need to investigate and compare developments on a smaller geographical scale if we are to have any hope of identifying the potential social impact and responses to the tsunami encounter.

Mesolithic blade technology in western Norway: regional continuation and change

The overarching Middle Mesolithic lithic blade technology found across South Norway prior to the tsunami has been well documented through several technological analyses over the last decade (Damlien 2015, 2016a, 2016b; Sørensen et al. 2013). The blade production concept is characterized by the production of very regular blades from conical and sub-conical cores with faceted platforms, by pressure and indirect percussion techniques (Figure 2). The concept includes the production of a consistent range of blade blanks, which in turn allows the production of a variety of blade tools. The lithic technology and types appear to be more or less the same along the west coast and the conical core blade production concept continues throughout the Late Mesolithic with only minor adjustments and modifications marking a slight chronological distinction, recognized as the shift

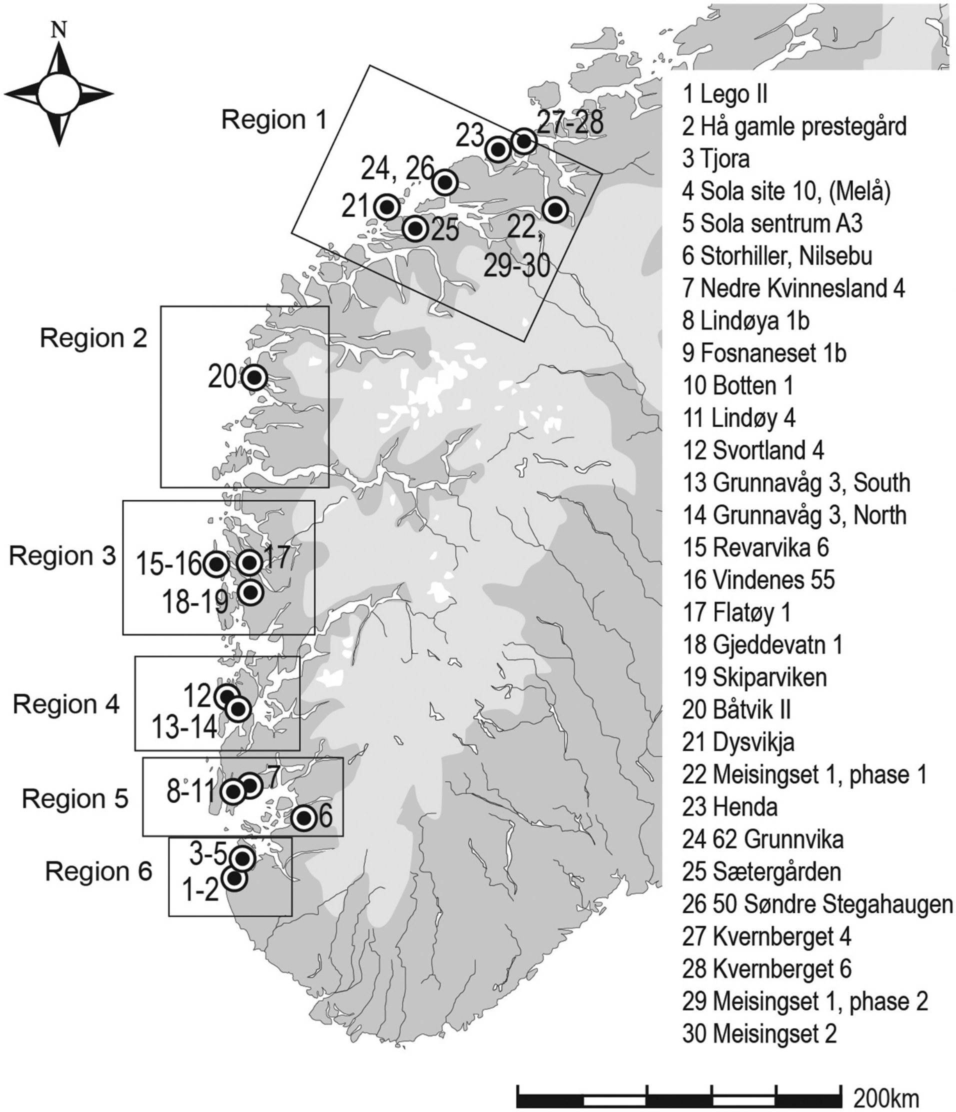

Figure 2. Map with the location of studied sites and demarcated regions (Illustration: A.J.Nyland).

between the Early and Late Microblade tradition (cf. Bjerck 1986, 2008). Microblades[1] dominate, whereas blades[2] and macroblades[3] are rare.

A lack of a more nuanced or detailed understanding of developments in the lithic tradition on the west coast may partly be a result of an unfortunate bias in the material; the recorded settlement sites from the Middle Mesolithic and start of the Late Mesolithic are low in frequency and find distribution and stratigraphy at recorded sites often lack clarity. This situation is a result of rising sea level, the so-called Tapes transgression, in the Mesolithic. This encroaching transgressing sea on the Norwegian west coast covered sites with layers of beach gravel, making sites either hard to find or disturbing lithic distribution on sites (Bjerck 2008). Consequently, the Mesolithic material from the northern, mid, and southern part of the west coast of South Norway are predominantly synthesised and presented together as one coherent region (Bjerck 1986, 2008). However, some work has also been undertaken on specific material categories or raw materials that has identified some regional variation and 'social territories' in the Mesolithic (e.g. Bergsvik et al. 2003; Olsen and Alsaker 1984; Skjelstad 2003).

Main results from a study of lithics from 30 sites on the western coast

In our study, we follow up these earlier studies, but have investigated blade production concepts (i.e. methods and techniques for blade production), and raw material use from 30 sites and/or phases (before and after the tsunami), from six demarcated areas located along the western coast of South Norway (Figure 3, Table 2).

Since studies attempting to identify and distinguish the precise technology(ies) in the Middle and Late Mesolithic blade production in western Norway are rare, we made this our primary focus. We applied dynamic technological classification and attribute analyses of lithic material from our sites which has enabled us to make inferences on the technological tradition (Damlien 2016a; Sørensen 2006, 2013), and we documented the blade production concepts used at the sites dated to before or after the tsunami occurring approx. 6150 BC. We also used 'Minimum Analytical Nodule Analysis' (MANA) as a method to document raw material strategies, use, and on-site lithic production to enable us to make inferences on the mobility and settlement system, as well as the contexts of knowledge transmission (Damlien 2016a; Larson and Kornfeld 1997).

The technical details of this study will be published thoroughly elsewhere (Damlien, Nyland, and Redmond forthcoming), but for our argument here about how *the lithic technology machine* may start to diverge from a trodden path and what that may represent, we present the following summary of the overall results: In general, our study confirmed current knowledge: there are no major 'dramatic' breaks in the Middle Mesolithic blade production concept during the period covering 7500–5000 BC, only the already known mentioned modification- moving into the 'Late micro blade tradition'. However, we also observed that by 5000 BC, there had been a development towards specific regional changes in the operating mode of the existing concept, an introduction of new concepts, an increase in variation of core types, and increased variation in lithic raw material procurement strategies. We found that by 5000 BC, there were regional differences both in Late Mesolithic technological concepts and lithic raw material procurement practices corresponding with the areas most and least affected by the tsunami within our study area. Distinct variations were prominent between areas 1–2 (and 3)) – the area closest to the propagation centre of the Storegga tsunami – and the southwestern coast (5–6), *i.e.*, the areas further away to the south (Table 3, Figure 2).

There are changes shared by all the study areas after the tsunami, but the inter-regional variation is evidently more extensive than previously assumed. Furthermore, although similar practices were identified, these also had specific local expressions. For example, lithic procurement practices involved collection of local, so-called 'beach flint', collected from beach moraine deposits in all areas. Although continuing after the tsunami, we found that the blade cores coastal communities used at Late Mesolithic sites were primarily made from nodules of more varying quality and size than earlier. Tested and partly prepared nodules decreased at most sites. Although flint continued to dominate, its dominance decreased, while the use and variation of other types of rock increased. This was evident in areas 1–5. Compared to the Middle Mesolithic, the most prominent differences in raw material variability, rock types, and use of non-flint raw materials, was found in areas 2–4.

Figure 3. Middle Mesolithic cores and blades from Lego, Rogaland C, platform preparation cores from Båtevik II (Vestland). (photo and collage: H.Damlien).

Table 3. Summary of regional specific changes and continuity in the investigated regions by 5000 BC.

	Regions (N – S)					
Presence technological concepts by 5000 BC	1	2	3	4	5	6
Middle Mesolithic Pressure blade technology	X	X	X	X	X	X
Increase of microblade production (%)	X	X	X	X	X	X
Handle core tradition clearly/dominantly present	X	X				
Largest increase of bipolar technique	X	X				
New concept: small one-sided platform cores on flint nodules					X	X
Increased raw material variation	X	X	X	X		
Economisation of raw material	X	X	X	X	X	X

The Middle Mesolithic blade production concept continues also after the tsunami event in all regions. Despite a trough in modelled demography curves and knowledge of a fluctuating climate around 6200 BC in western South Norway (Bergsvik et al. 2021; Lundström 2023), the tsunami does not seem to have caused permanent damage to knowledge transmission, in this case: lithic technological concepts. Our overall impression is that the execution of the Middle Mesolithic blade production concept becomes less rigid in the first half of the Late Mesolithic and modifications to the blade concept on conical cores emerges (Damlien, Nyland, and Redmond forthcoming). For example, in the Middle Mesolithic there is no indication of a separation between macro- and microblade production. Instead, there is a gradual reduction of the core from the widest to the narrowest blades. By contrast, in the Late Mesolithic, blades are in general both shorter and narrower, indicating a tendency to increase the standardization of microblade production, although the cores these are produced on vary more (Damlien, Nyland, and Redmond forthcoming). For instance, the bipolar technique is used in the final stage of core reduction increases in area 1–2. We also documented new blade production concepts emerging in the Late Mesolithic. In the northwest, standardized production of micro-blades from handle cores appears in areas 1–2 (Figure 4). In the southwest (areas 5–6), another

Figure 4. Handle core from Lok.50, Nyhamna, Aukra, Møre. (Photo and collage: H.Damlien).

Figure 5. A characteristic new concept emerged by 5000 BC in the southwestern region. (Photo: H.Damlien).

concept becomes prominent in the same period: the production of short and thin blade-like flakes on small, one-sided, platform cores made on small beach flint nodules (Figure 5). The rise in utilized core types indicates a less strict concept operation. Another observation is that the Late Mesolithic blade production concept slowly abandons the Middle Mesolithic strategy of systematic core platform and core preparation. These technological modifications in blade production, combined with the use of bipolar technology in the final stages of cores, may be perceived as ways to economize lithic raw materials. This tendency is also accompanied by finds indicating that access to suitable flint raw materials was more varied along the coast in the Late Mesolithic than earlier (Damlien, Nyland, and Redmond forthcoming).

Minor changes in lithics as expressions of a dramatic event

From an anthropological perspective, interaction, and meetings between people of different cultural origin, are among the strongest driving forces of societal and cultural developments (Barth 1961, 1969). In our case, the sudden emergence of new concepts and tool types may signal changes in contact networks and mobility patterns through which people met and learned new techniques to better or differently exploiting existing or new raw materials. On one hand, significant material changes may indicate altered, new, or broken, relations within or between groups. On the other, synchronous, spatial similarities in lithic technology may be indications of maintained and continued human relations over space and time.

How then should we understand subtle changes and minor modifications developing within regions over time? Detected minor changes in the Late Mesolithic blade production concepts may be 'just' a matter of practicalities, a testament to humans forever trying to optimise and improve their tools (Leroi-Gourhan and Berger 1964). Looking at the overall trends, there is a lot of continuation in the existing lithic technology from the Middle to the Late Mesolithic. The sudden, yet transitory, Storegga tsunami did apparently not rupture historical contingency nor immediately, or significantly, alter local lithic technology. Yet our results indicate that *something* is affecting knowledge transmission and the possibilities or preferences to maintain tradition *as is*.

As mentioned in the introduction, obfuscating understanding may be our tendency to study too large regions. Normally, lithics on the western coast of South Norway are presented and understood as representing the technological developments of 'one region' (e.g. Bjerck 1986, 2008). Yet at the same time, there is a consensus that two social territories divide the coast approximately where the Sognefjord starts (Bergsvik et al. 2003; Bjerck 2008; Olsen and Alsaker 1984). There are also other categories of archaeological material that attest to the presence of demarcated social territories. There are, for example, regional differences in rock art production and imagery (e.g. Fuglestvedt 2017); settlement patterns (e.g. Bjerck 2008; Bjerck et al. 2008; Walker et al. 2023), axe production and raw material distribution from specific rock sources (e.g. Bergsvik 2002; Bergsvik et al. 2003, 2021; Bjerck 1986, 2008; Olsen and Alsaker 1984), as well as quarrying and other raw material procurement practices (Nyland 2017a, 2020, 2021). Our technological study strengthens the impression of this western coast's North-South divide too.

The maintenance of the overall Middle Mesolithic technological concept, as well as similarities in the production and use of adze types (despite differences in raw materials), the establishment of large quarries, and a continual rock art tradition, along the coast at least until 5000 BC, implies active and continuing lines of communication and social connection between these two main social territories of the west coast. The material thus implies people being part of the same social and cultural sphere. Yet by looking at the large region at a more detailed scale, our investigations into local developments over time (areas 1–6, c.7500–5000 BC), we found that although there are no signs of dramatic changes in lithic blade technology at the time of the tsunami, regional specific differences did develop in its aftermath. We suggest that these minor and perhaps slowly developing lithic technological changes are by some means related to the Storegga tsunami encounter.

Returning to our point that lithics and lithic technology mattered as potential ways for societies to remember their past, anchoring notions of origin and roots, making sure knowledge was broadly shared among group members locally and regionally must have been an important social strategy. Indeed, sharing knowledge of various practices, including lithic technology and raw material procurement, can function as a risk-reducing strategy for communities living with natural hazards (Nyland forthcoming). Subsequently, lithic technology could have been part of anchoring people's ontological security. Variations within an overall continuity does not diminish the power or agency of lithics. That technological concepts continue through crises or challenging times is not a sign of vulnerable societies, on the contrary, it can be a testimony to the institutional power of craft, social practices and technological traditions, and the strong agency of all elements and social contexts.

Accordingly, even minor modifications in lithics may tell tales of breaches in historical contingency, of broken relations. In the Late Mesolithic, sometime after 6150 BC and by 5000 BC, something had affected the tacit relation between the inhabitants of western South Norway and their lithics. Our interpretation is that the identified regional variations could be a result of people's encounter with the Storegga tsunami. A sudden occurring situation might have required creativity and an initiation of new practices. For example, since a tsunami will alter beach moraine deposits through heavy erosion or by redepositing materials, the availability or quality of beach flint nodules may for a period have been restricted in some regions. Having to search in other locations for other types of rock or having to alter current communication networks geographically or socially, *i.e.*, shifting relations and practices, may have been equally influential. Returning to lithic technology-as-machine, something made this move in a slightly different direction than the one in its neighbouring region. The result was that the machine's 'outputs', here: the lithics we as archaeologists can observe, display local and regional variation, be they minor or major. In our case, the material indicated specific regional variation (increase) in the exploitation of lithic raw materials, together with a reduction in size and quality of the utilized beach flint nodules, and in some areas, new concepts were introduced.

Evidently, nowhere in western Norway is the conical core production concept completely replaced in the Late Mesolithic. Hence, the tsunami did not sever social relations completely, there cannot have been a wipeout of the whole coastal population. On the contrary, clear continuation in knowledge transmission over time indicate that communities not too affected by the tsunami kept the concept going. However, the concept may have had to be re-introduced into areas where communities had been lost or had moved due to the landscape becoming uninhabitable after the tsunami. This kind of 're-orientation', change of contacts and environment, even temporarily, would have disrupted everyday life enough to affect the technological machine and tradition.

For example, the use and spread of the handle core tradition is a distinct technological choice and concept. Handle cores enable production of more standardized microblade production and is considered a more economic use of rock sources. The use of handle cores is also a cultural trait shared by hunter-gatherers from northern Germany and western Poland to northernmost Sweden, around 6000 BC (Knutsson et al. 2003), although recent excavations in central-northern Sweden (Hälsingland) have revealed handle cores at sites dating to around 7000 BC, hence predating the southern tradition (Ahlbeck and Guinard 2016). The handle core concept is well-documented in eastern Norway (e.g. Eigeland 2014; Solheim, Damlien, and Fossum 2020), but less discussed for the western coast. Our studies showed handle cores at Middle Mesolithic sites in areas 1–3 too,[4] and (Knutsson et al. 2003), although more detailed studies need to be undertaken, it seems the tradition was established in all areas by the Late Mesolithic. The adaptation of this type of core can be perceived as a concrete example of a re-orientation that established new lines of contact and mobility and in turn sparked the diverging developments that followed in different regions.

Some regions were struck hard by the tsunami, others less so. Hence, one should expect varying social and environmental conditions in its wake. This would in turn affect orientation, direction or character of social networks and communication lines, and developing technological traditions. For example, if people in areas 1–2 were gone after the tsunami, this situation may have required people in area 3 turning towards people in area 4 or elsewhere, instead of areas 1–2. These new contact networks and meetings between new groups may have initiated processes of transcending cultural differences, or the establishment of new boundaries, ethnic or cultural, around or between people (cf. Barth 1969, 14–15). Returning to the argument of human societies, landscapes, and technology as machines, if indeed the communities and landscapes in the northwestern areas 1and 2 were severely impacted by the tsunami, this might have been enough to cause this region's technology and societal structures to diverge from those found further south. Re-orientations due to a devastated landscape and broken social bonds, even temporarily, could have made technology or social networks start to hum to a slightly different tune than in the southwestern areas.

Dramatic events becoming memories and myths with transformative power?

Recent anthropological disaster research has shown how catastrophes or dramatic encounters with destructive natural hazards can, albeit transitory, act as catalysts for institutional change (cf. Barrios 2016, 2017; Oliver-Smith 2010). They can be part of transformative changing behaviour, prompting power struggles or social re-orientation initiated by the surviving societies. Hence, chaotic situations that disrupt social positions or hierarchies, can create openings. Turbulent periods can open the scene for something new, but experiencing something traumatic may also cause psychological

Figure 6. Swimming porpoises carved during the late Mesolithic at Averøy, Møre. (Photo: A.J.Nyland).

distress that continues to reverberate over generations (Hoffman 2004, 185; Sattler, Kaiser, and Hittner 2000, 1414).

The latter phenomenon has been conceptualised as *post-memories*, meaning memories of proximity charged with feeling (Hoffman 2004, 180). This makes stories of tragic encounters or periods extend beyond any personal connection to a traumatic event. Moreover, memories can live on beyond first-hand experience and eyewitnesses, and memories of experiences are passed on and can become myths. Material culture in the form of lithic technology, the utilisation of familiar raw materials, or indeed particular places for procuring certain rock types, may all in the Mesolithic have facilitated the remembrance and anchoring of stories and myths. The story of the Storegga tsunami could also over time have become something that stimulated change, or in another way anchored the Mesolithic world, for example by inspiring societies to keep safe (Nyland forthcoming). In the chaotic aftermath of the Storegga tsunami, as societies searched to find their footing, to explain the unexplainable and regain ontological security, a spiritual re-orientation may also indicate the tsunami's social impact. As mentioned, clear regional particularities developed in the Late Mesolithic. An expression often associated with more cosmological or ritual oriented aspects of life is rock art. By 5000 BC, there is a rich Late Mesolithic rock carving tradition in the Trøndelag – Møre – Vestland Counties (areas 1–4) on the one hand (cf. Fuglestvedt 2017), compared to a conspicuous lack of Late Mesolithic rock carvings in Rogaland (areas 5–6) on the other. There are also local variations within the spectre of carved and painted images or figures. In areas 1–2 there is a higher frequency of depicted marine mammals (Figure 6) compared to further south on the western coast (areas 3–4) where game dominates the imagery. We see these differences as expressions of diverging practices of worlding and storytelling. If rock art imagery expresses living oral traditions of Late Mesolithic coastal worlds (Nyland forthcoming; Nyland and Stebergløkken 2021), these variations could signal that the stories of the dreadful day of the tsunami and its aftermath varied within the different areas. Varying coastal histories may have instigated differences in worlding stories, making the people of the various social territories as mentioned earlier consider themselves as different to each other.

Final remarks

That the material world is constantly engaging with us, and we engage with it, has been a key premise throughout this paper. Ontologically and epistemologically, we acknowledge how any phenomena comprise numerous relations that relate and potentially impact one another (cf. Barad 2003). This is not limited to physical entities and tangible aspects of the world, like elements of nature or other humans, but also stories, myths and memories of events, people, or monsters. Through storytelling, societies remembered essential knowledge needed as a strategy for risk reduction (Nyland forthcoming). The Storegga tsunami may have bound people together because of the stories or myths that no doubt would have been spun in its wake. Over time, the stories about that day may have gained transformative power, and in that capacity continued to be an active, influential agent pushing, forcing, or inspiring people to adjust ways of being. Changes in ways of being and relations between people and land may in turn have caused the societal machine to shift slightly, resulting in the variations we have detected in lithic technology.

The theoretical foundation for our argument of regional or local variations in lithics, even if minute, telling tales of some kind of disturbances of a world, society, or indeed 'machines', finds philosophical support in post-humanist theories. It also concurs with a point highlighted by other researchers studying disasters as not necessarily 'events', nor linear processes (e.g. Nielsen, Sørensen, and Riede 2020, 890). Occurrences and processes affect socio-spatial formations as open-ended becomings, or lines of flight (cf. Deleuze and Guatarri [1980] 2005). The recognition of how everything is connected and affective, also brings Karen Barad's (2003, 815) post-humanist performative and relational theories of phenomena to mind. Barad defines this as the 'ontologically inseparability of agential intra-acting "components"'. There may be boundaries between entities within a phenomenon, but they are nevertheless transversally linked. In Barad's theories, performativity is key for understanding the configuration of worlds and matter, and how the material condition is 'always already ongoing historicity' (Barad 2003, 821). We believe our results show how developments in lithic technology reflect locally situated practices too. Environmental aspects, access to raw material and social networks and communication, would all have contributed to making diverging social and historical contexts. In our investigations we dissolved the large region 'western Norway' into smaller areas; in this we attempted to get closer to situated practices. The result is indeed a more nuanced picture, pointing to local and regional diverging traditions in lithic technology in the Late Mesolithic.

As mentioned, a crisis is not necessarily only a destroyer of worlds, but may also create room for change, innovations, and creativity (Oliver-Smith 1996, 312–314). The notion of 'spurious correlation' may be one that haunts all research which cannot conduct controlled laboratory experiments (Riede 2014). Admittedly, we did not find a 'smoking gun' irrefutably pointing to the tsunami as the reason for changes in lithic technologies and traditions. However, our material shows that after the event, there seem to be re-orientation or shifts in communication lines and diverging lithic developments. Although slow and subtle, by c.5000 BC, the blade production concept had become more flexible and regional specific variations had developed (*i.e.*, using other types of cores). Returning to the capacities of materials and humans to affect each other, conceptualized here as a 'machine', in our study we perceive the environmental situation affecting the availability and utilization of certain raw materials. This in turn may have caused humans to include new concepts, or adapt existing technology, utilize raw materials more economically. Humans, environment and lithics coexist, interact, and correspond through time.

By dissolving the region of 'western Norway', which normally serve as the investigation 'unit' for lithic studies in this region, both chronological and spatial variation within practice could be detected. Local variations in lithic technology in the six areas correlates with the areas most and least impacted by the tsunami. Moreover, in the Late Mesolithic, the material of South Norway sees a continual increase in regional expressions, not only in lithic production, but also in expressions such as rock art. Considering the minor changes and modifications in lithics as reflections of broken bonds and devastation, we have argued that the environmental and social impact of Storegga tsunami may be the initial push that caused the increased regionalization we see.

Notes

1. i.e., blades <8 mm wide
2. i.e., blades 8–12 mm wide
3. i.e., blades <12 mm wide
4. Recent studies have shown discrepancies between what are recorded as handle cores in museum storages and what, after our analyses, should be considered part of the handle core concept. More details on the developing tradition and distribution of the handle core concept will be published thoroughly in (Damlien, Nyland, and Redmond forthcoming).

Acknowledgments

The authors would like to thank colleagues at the Museum of Archaeology in Stavanger, the University Museum in Bergen, and the University Museum of Science in Trondheim for their patience with our endless lists of sites and kilos of lithics that we needed them to carry from storage to the study rooms. The research has been funded by the Norwegian Research Council (The Storegga tsunami c. 6150 BC - a wave of destruction or transformative disruption for a prehistoric society? FRIPRO-project no. 302858 owned by the Museum of Archaeology, University of Stavanger). We would also like to thank Gabriel Cooney for his helpful final comments and three anonymous reviewers for their constructive comments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the The Research Council of Norway [project number: 302858].

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Author contributions

Astrid J. Nyland is the project leader and PI of the 'The Storegga tsunami c. 6150 BC – a wave of destruction or transformative disruption for a prehistoric society?' that serves as this paper's point of departure. Accordingly, she designed the research questions, applied, and written the theoretical perspectives in the paper. Hege

Damlien oversaw and conducted most of the lithic and MANA analyses, wrote the results of the lithic studies and commented on the content of the paper.

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