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Coasts of catastrophe? The incidence and impact of aeolian sand on British medieval coastal communities

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Natural hazards exert a considerable influence on vulnerable populations living in risk-prone areas. Archaeological and historical evidence offers a unique perspective from which to explore this relationship. This paper examines the hazard of wind-blown sand in relation to British medieval coastal communities focussing in particular on the factors influencing inundations of sand in addition to the material and spiritual reactions adopted in the face of aeolian sand. By contextualizing past discoveries, new light can be shed on these human/environment interactions while simultaneously exploring wider implications for the underlying climatic changes of the Little Ice Age across Europe.
Keywords: little Ice Age, natural hazards, sand, land-use, medieval religion

Le catastrofi naturali hanno un notevole impatto sulle popolazioni che vivono in zone a rischio e l'evidenza storico-archeologica offre una prospettiva unica per analizzare questa relazione. L'articolo si concentra sui fattori di rischio causati dalle sabbie eoliche (es. inondazioni di sabbia) sulle coste britanniche, esaminando anche le risposte materiali e religiose delle popolazioni. Contestualizzando scoperte non recenti, può essere fatta nuova luce sulle interazioni uomo-ambiente, proponendo anche più ampie implicazioni riguardo i cambiamenti climatici durante la "piccola era glaciale" che interessò l'Europa nel medioevo.
***Parole chiave**: piccola era glaciale, rischi naturali, sabbia, uso suolo, religione medievale*

1. Introduction

Recent scholarship on "natural" disasters in the European Middle Ages has re-evaluated the relationship between medieval communities and "natural" hazards. Although medieval societies often inadvertently put themselves at risk, Gerrard and Petley (2013) argue that far from being helpless onlookers, medieval populations faced disaster with a multitude of coping strategies underpinned by their religious views. Specific

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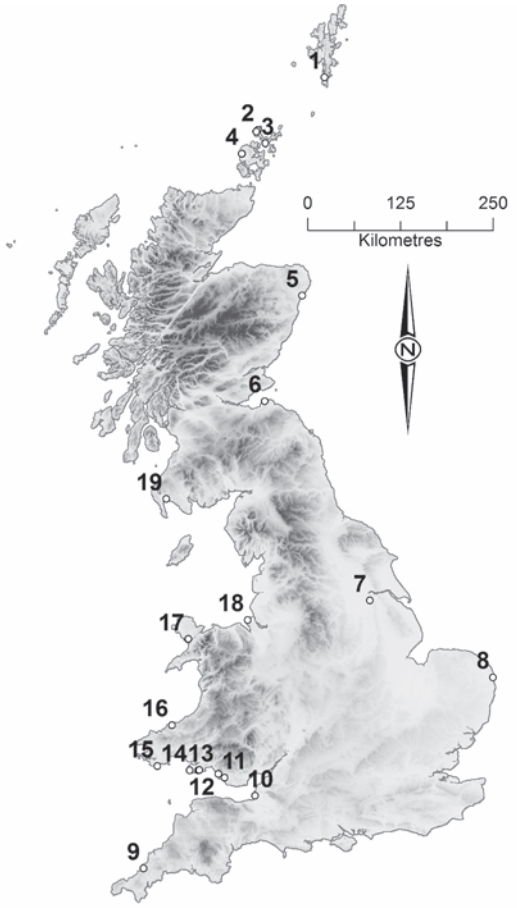
hazards or geographic areas, however, require further study to examine how far this was the case. This paper therefore, considers the role humans played in exacerbating vulnerability to wind-blown sand inundation in medieval Britain and the responses they adopted in the aftermath.

Although aeolian sand may not register highly on the list of hazards currently facing Britain, archaeological evidence does attest to major sand inundations in the past. Skara Brae (besanded c. 2470-2190 cal. BC: Sommerville *et al.* 2007, p. 634) on Orkney (Childe 1931, p. 64) and Gwithian in Cornwall (inundated throughout the Bronze Age: Nowakowski 2007, p. 22) are well known examples from prehistory. In Britain sand (sediments between c. 0,06-4 mm) is typically derived from glacial deposits (Doody 2013, p. 6). Dune environments develop where wave action is sufficiently powerful to transport these deposits onshore, strong winds occur to drive sediments inland and topography does not impede movement and expansion (*ibid*). Although aeolian forces mainly drive sand horizontally inland, sand can also be transported to considerable heights threatening surrounding cliffs and high ground (Toft 1988, p. 24). In the short term, extreme storm events can precipitate rapid, high volume sand inundations but winds of just 10 m/s (Sherman, Nordstrom 1994, p. 263) can cause more gradual sand movement. Over longer intervals this can cause extensive areas to become entombed. Depending on local conditions, blown-sand can therefore be categorized as either a creeping or sudden-onset hazard. Multiple variables affect the mechanics of the hazard, including sand moisture content, grain size, wind speed and direction, vegetation coverage and species (Pye *et al.* 2007). Today, a good understanding of these variables and the natural processes influencing sand movement combined with active monitoring and sustainable land-use practices has increased the resilience of Britain's coasts (Pye *et al.* 2007). This has made sudden extreme sand inundations largely a thing of the past, although risk is omnipresent and current climatic changes make the future uncertain.

The modern picture contrasts starkly with medieval exposure to the hazard, with a considerable number of examples known archaeologically of major losses to wind-blown sand. Past studies have considered this issue in specific areas, such as Higgins' (1933) pioneering study of sand movement on the South Wales coast, reviewed and refined by Toft (1988) and Sommerville's (2003) PhD thesis on luminescence dating methods applied to wind-blown sand in Northern Scotland. These however, have emphasised climatic forcing while the human element, a key aspect to any "natural" disaster (Wisner *et al.* 1994), has only received limited attention (Clarke, Rendell 2011). Although it has been demonstrated that weather patterns and wider climatic changes played



1 - St Ninian's Isle
2 - Evertaft and Pierowall
3 - Sandhill
4 - Bay of Skaill and Mound of Snusgar
5 - Forvie
6 - Eldbotle
7 - Flixborough
8 - Fuller's Hill
9 - Perranzabuloe
10 - Berrow
11 - Merthyr Mawr
12 - Kenfig
13 - Pennard and Penmaen
14 - Rhossili
15 - Stackpole
16 - Y Ferwig
17 - Newborough and Llys Rhosyr
18 - Meols
19 - Glenluce

Fig. 1. Locations discussed in the text (created by the author).

a key role in precipitating sand inundations, the extent to which human land use strategies increased vulnerability to the hazard and the strategies that medieval communities adopted to cope with sand inundation and protect themselves from future losses has not been considered in detail beyond individual sites.

2. Wind-blown sand in the British Middle Ages

Archaeological evidence for the effect of the hazard in the medieval period can be found throughout Britain at a wide variety of sites. Perhaps the best known is the Welsh town of Kenfig, Bridgend, which developed into a walled town with an extra-mural settlement centred around the early 12th century castle (Gray 1909; Wessex Archaeology 2012). When

precisely the town became overrun by sand is unknown but a *terminus ante quem* is provided by the description of the Elizabethan antiquarian John Leland (1906, p. 29) who visited the site in 1538 or 1539, remarking that the town was "in Ruines and almost shokid and devourid with the Sandes that the [Severn Sea] ther castith up". Sand may already have been beginning to pose a problem by 1262 when a new church was built some distance from the sands on higher ground and documentary evidence alludes to growing concerns throughout the 14th century (Higgins 1933, p. 34). The archaeological remains however suggest Kenfig was not totally abandoned until the 15th or 16th centuries (Wessex Archaeology 2012, p. 24). Morris (1907, p. 6) re-tells a story of rescuers frantically digging people out from a house so suddenly engulfed by sand that the occupants had no time to escape. In contrast, archaeological evidence suggests there was ample time to save building fabric for re-use (Wessex Archaeology 2012, p. 24). If the folk-tale is true there must have been high variability in the effect of the hazard across the settlement. Comparable inundations occurred at many locations along the coasts of the Bristol Channel, on the South Wales coast at Pennard (Lees, Sell 1983), possibly at Penmaen (RCAHMW 1982) although the existence of a settlement there has been debated (Seyler 1920), Merthyr Mawr (Stradling 1598-1603, p. 119) and Stackpole (Benson *et al.* 1990). Only very limited archaeological investigations have been undertaken but evidence from the English side of the Bristol Channel can be found at the medieval settlement around the church at Berrow in Somerset, which became covered by sand sometime in the later medieval period (Rippon 2000, p. 152; Rippon pers. comm.). Further north, inundations occurred at Meols, Merseyside (Griffiths *et al.* 2007), and Glenluce, Dumfries and Galloway (Jope, Jope 1959). Settlements on the British east coast were also inundated by sand in the later Middle Ages at Forvie, Aberdeenshire (Milek 2012), Eldbotle, East Lothian (Hindmarch, Oram 2012), and at Flixborough, Lincolnshire (Loveluck 2007, p. 21). An earlier phase of sand movement also took place throughout the Orkney and Shetland Islands (Griffiths 2011; Sommerville 2003; Barrowman 2011) and at Perranzabuloe, Cornwall (Ravenhill 1955, p. 240).

Wind-blown sand could be particularly damaging when combined with other hazards. This seems to have occurred at Pennard, Swansea, where excavations of a house dated to the 13th century (Moorhouse 1985, p. 1) provide evidence of a medieval settlement which, according to documentary sources, declined and then became deserted amidst sand inundations in the later Middle Ages (Lees, Sell 1983, p. 46). The house had been razed by fire and rapidly abandoned with the positioning of pottery recovered from the floor consistent with ceramics falling from

hooks, furniture or shelving as the building burned (Moorhouse 1985, p. 5). Although in isolation this is unremarkable, an interesting parallel is found at Fuller's Hill, Great Yarmouth, where Rogerson (1976, p. 159) links the evidence for intense burning across the numerous levels of occupation with the pressure of wind and sand on buildings which then collapsed in upon active hearths. This is also a likely scenario for the house at Pennard as it is unlikely the pottery sherds would have gone undisturbed, remaining *in-situ* where they had fallen, had the house not quickly been covered over by sand.

Despite the above examples, it can be difficult to identify sites abandoned because of wind-blown sand. Due to difficulties in dating the sand itself, especially prior to the development of luminescence dating techniques, there is often uncertainty over the date be-sanding occurred (Toft 1988, p. 34). It is perfectly possible for an abandoned medieval coastal site to suffer wind-blown sand encroachment significantly later than the date of abandonment. Differentiating between those abandoned because of sand and those abandoned for other reasons can therefore be challenging. A grange of Margam Abbey, Neath Port Talbot, known as the Hermitage of Theodoric for example, was discovered buried beneath sand and dated based on the available archaeological and documentary evidence to c. 1300 (Gray 1903, p. 142). In particular, the remarkable preservation of ironwork and structural remains convinced the excavator (Gray 1903, pp. 126-143) that the grange had been entombed suddenly in one episode. A re-analysis of the historical documents however, convincingly demonstrated that this grange was still in use by 1535 thereby significantly advancing the date at which the grange fell victim to the sands (Cowley 1963). Similarly, excavations at the be-sanded medieval church and associated settlement at Rhossili, Swansea, were interpreted, with a degree of uncertainty, not as a case of abandonment in the face of wind-blown sand but as a gradual desertion as people moved a short distance to higher, more favourable ground. An inundation at some point after c.1540 then buried the remains of the near derelict church and settlement (Davidson *et al.* 1987, pp. 260-261).

3. Factors influencing aeolian sand

Medieval sites became inundated by sand through a combination of natural and cultural factors. Environmental changes were clearly important and a significant body of evidence exists attesting to periods of heightened storm activity caused by climatic fluctuations throughout the Little Ice Age c.1350-1850 (Meeker, Mayewski 2002; De Kraker 1999).

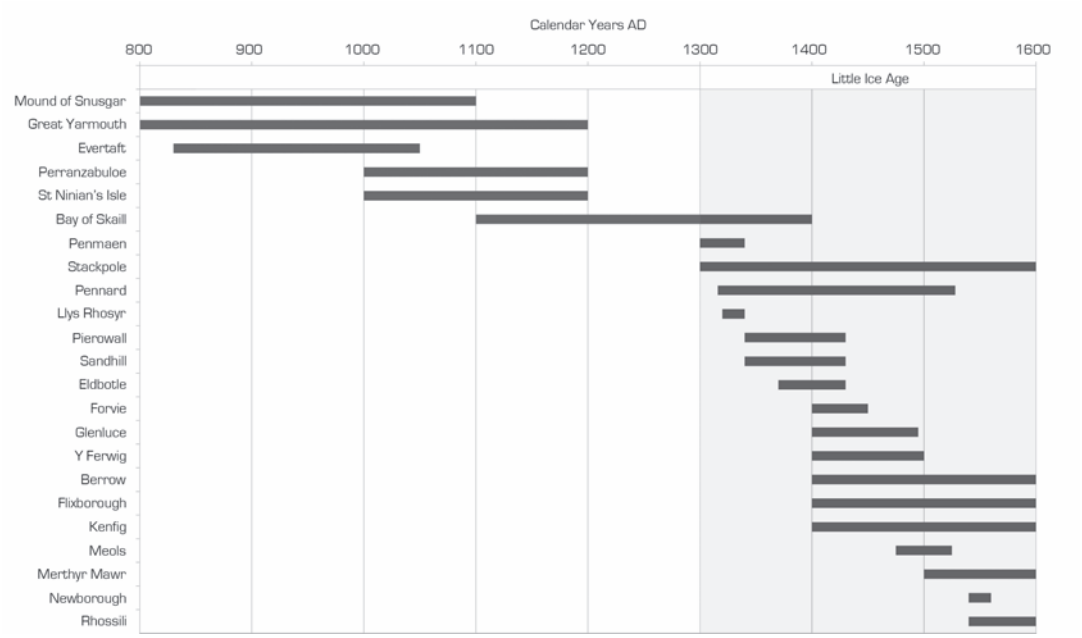


Fig. 2. Timeline of wind-blown sand inundations at sites discussed in the text. The majority can be seen to have occurred after c.1300 in the LIA (created by the author).

This in turn has been linked to sand movements across Europe, often in areas where humans exerted limited influence such as along the Northumberland coast (Wilson *et al.* 2001), in Northern Ireland (Wilson *et al.* 2004) and in Orkney at Pierowall and Sandhill (Sommerville 2003, p. 350). Higgins (1933, p. 64) described this as a "sharply defined change" compared to previous conditions and many of the sites covered accord well with this chronology (fig. 2). At Meols, Merseyside, for example, historical and archaeological evidence attests to the disappearance of other nearby coastal settlements at around the same time (Lewis 2002, pp. 40-44). Likewise, the inundations at Forvie, Eldbotle, Glenluce and the majority of the Bristol Channel sites also fit into this phase. Earlier inundations, including sites in Orkney and Shetland however, illustrate that storms precipitating sand inundation occurred prior to the climatic downturn of the Little Ice Age. Whilst storms can occur independently of any wider climatic changes, it is also possible that other factors may have influenced these inundations, which seem to have particularly affected areas of medieval settlement throughout the Little Ice Age.

As the influence of aeolian forces on sand accumulations can be heavily influenced by anthropogenic activity, human land-use decisions affect

a community's vulnerability to sand inundation. This is illustrated by the Hoge Veluwe, The Netherlands, where mapping the spread of blown sand deposits demonstrated a correlation with parish boundaries (Heidinga 1987, pp. 145-149). Heidinga's interpretation is that in marginal areas, relatively low human impact meant woodland was more likely to survive, covering and thereby stabilizing the sand, while the concentration of activity in central areas stripped protective vegetation, increasing exposure to the hazard. Whether this holds true for British examples requires further research but it can be similarly assumed that activity contributing to erosion would generally be focused close to settlements, exacerbating risk from wind-blown sand.

Medieval land use strategies were frequently damaging to sand dune environments. The most harmful exploitation strategies in relation to aeolian sand are those resulting in swathes of unprotected sand; such as stripping of vegetation, deforestation, overgrazing and erosion from traffic along paths and roads (Doody 2013, pp. 39-40). Sand dunes were commonly used as pasture for livestock, for example, documentary evidence attests to widespread grazing in the 14th century in the sands at Merthyr Mawr (Stradling 1598-1603, p. 118). Following the Black Death this may have been compounded by a switch in focus from arable agriculture to pastoralism across Britain (Campbell *et al.* 1996). Furthermore, in Scotland, it has been proposed that the climatic downturn of the Little Ice Age resulted in a shortened growing season with reduced yields (Dodgshon 2005, p. 334). This would have negatively affected available pasture forcing populations to exploit marginal land, such as sand dunes, to counterbalance the shortfall. The excavators propose this as a likely scenario in exacerbating wind-blown sand at Eldbotle (Hindmarch, Oram 2012, p. 287). In addition, from the early 13th century the canons of Dryburgh were granted freedom to take as much turf as they required for roofing materials (Anon 1847, p. 74) which would have left large expanses of sand exposed to the wind (Hindmarch, Oram 2012, p. 280).

Another type of land-use that was particularly damaging was rabbiting. As rabbits are not native to Britain, throughout the medieval period they were poorly adapted to the British climate, favouring dry habitats such as large areas of well-drained sand (Bailey 1988, p. 2). Rabbits were highly valued by landowners for their meat and fur which frequently led to the conversion of marginal or unprofitable land into rabbit warrens. In addition, rabbiting required reduced manpower and offered higher profits compared to cereal agriculture and as the market for meat and fur expanded in the post-Black Death era many landlords decided to make the switch (Bailey 1988). In order to maximise profit, warrens were artificially constructed, destroying protective vegetation, and although they were occasionally af-

Fig. 3. A depiction from Queen Mary's Psalter of a rabbit warren illustrating the exposed nature of the sand and use of ferrets in rabbiting (© British Library Board, Royal 2 B VII f84r).

forested with gorse to discourage predators, most warrens were left unvegetated (Bailey 1988, pp. 8, 4). Additionally, rabbits negatively impact nearby vegetation, heavily affecting plant coverage, whilst simultaneously creating large deposits of loose sand (Rutin 1992). The problems this created in relation to wind-blown sand are illustrated by numerous post-medieval examples of sand movement on rabbit warrens (Sheail 1971, pp. 55-57). Therefore, from the 14th century, the proliferation of rabbit warrens in Britain spread an extremely unstable land use practice which increased vulnerability to sand inundation in many areas.

Extensive rabbit burrows are documented at many sites affected by aeolian sand. At Kenfig for example, documentary evidence records their presence by 1314, although only two years later they had become partially inundated by sand (Gray 1909, pp. 23-24). Sand movement at Y Ferwig, Dyfed, could have been initiated or exacerbated by rabbiting. The nearby place name "Towyn Warren" indicates the area had long been inhabited by rabbits and Davies and Kirby (1994, p. 80) believe that the warren probably evolved from a seigniorial medieval burrow perhaps belonging to Coedmor or Cardigan Castle. Rabbits were also farmed at Stackpole in the 14th century (Benson *et al.* 1990, pp. 182-184) and at Pennard where a charter from c. 1320 grants rights to take animals from the Lord's warren (Clark 1866, pp. 288-289). Further evidence comes from a pillow mound at nearby Penmaen where a medieval settlement may also have become be-sanded by 1320 (Fisher 1920, p. 298; RCAHMW 1982, p. 331). At Eldbotle a record from 1300 of the purchase of ferrets from the area by the Constable of Edinburgh demonstrates that rabbit farming was practiced there by this date (Watson

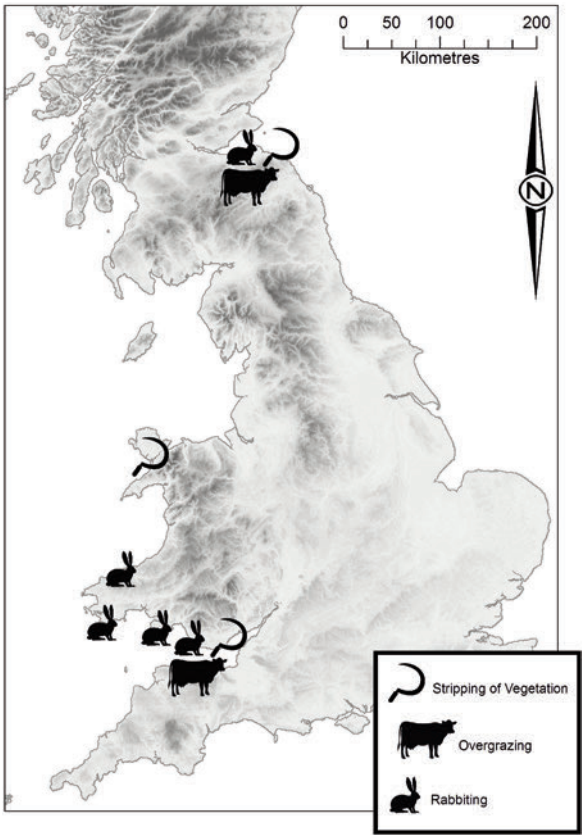


Fig. 4. Map of unsustainable land-use strategies practiced at sites discussed in the text (created by the author).

1991, p. 157; fig. 3) either as a managed burrow, probably belonging to the de Vaux family of nearby Dirleton, or escapee animals from a nearby warren which took up residence in the sands (Hindmarch, Oram 2012, p. 291). The former is more likely as feral populations were uncommon until the 18th or 19th centuries (Bailey 1988, p. 2; Davies, Kirby 1994, p. 80).

In contrast to these British examples, van Haperen's (2013, p. 124) study of the dune landscapes of the islands of the south-west Netherlands suggests that here, despite the widespread exploitation of the dunes for rabbit warrens and cattle pasture, humans managed to maintain the balance between vegetation growth and overgrazing as blown sand only became a problem following land use changes in the 19th century. It therefore appears that, following the onset of the Little Ice Age which coincided with the Black Death, the proliferation of unsustainable land-use strategies (fig. 4) equipped British medieval populations in susceptible areas with a "deadly cocktail" which in combination with increased storm activity exposed these communities to particularly hazardous sand inundations.

4. Response strategies

Despite their own role in increasing vulnerability, medieval populations did try to mitigate the hazard once it began to encroach onto areas of human settlement. The fact they were partially successful in this is demonstrated by sites where occupation continued following inundation. The Viking-Age site of Evertaft, Orkney, for example, when excavated, revealed layers of sand interspersed with occupation layers signalling a hazard which was chronic rather than critical. This view has been strengthened by analysis of the sand grains for OSL dating which indicate they were most likely deposited in multiple episodes (Sommerville 2003, pp. 316-317). Midden material interspersed throughout the stratigraphic sequence was interpreted by the excavators as an attempt at mitigating the encroaching sand by spreading the heavier midden material over the sand's surface to halt further movement (Barrett *et al.* 2000, p. 21). This may have permitted continued habitation for longer than would otherwise have been possible. Midden material was also found at the Mound of Snusgar, Orkney, where it was re-deposited in order to create a stable surface for habitation and agriculture following inundation by sand. This can only have been a short-term solution however, as the heightening effect of the midden material only increased the ability of the mound to trap blown sand, initiating a vicious cycle that ultimately accelerated the mound's abandonment (Griffiths 2011, p. 19). Parallels may be found at Carmarthen Bay (Higgins 1933, p. 30) and Pennard (Lees, Sell 1983, p. 47) where midden material also overlay layers of sand. The effectiveness of this method is debatable however. If it was successful, it would have required considerable manpower as well as extensive quantities of midden material to cover large areas of sand. The Mound of Snusgar and the Welsh examples were all eventually overcome by sand which seems to prove that if midden material was a deliberate preventive strategy it can only have been a temporary solution. Rather than to stabilize, midden material may also have been used to fertilize (Harrison 2013, pp. 100-101), perhaps a requirement of soils inter-mixed with wind-blown sand. This is seemingly verified by extensive manuring regimes associated with medieval blown sand sites. In the Hoge Veluwe for example, once sands had begun to move, communities responded to the worsening soil conditions by stripping land of its turf which was then applied to the farmland as a fertilizer. Ironically, this exacerbated the problem by removing swathes of turf, exposing large volumes of sand to the influence of the wind (Heidinga 1987, p. 142). Comparably, geomorphological sections from Forvie indicate that once land became inundated by sand, manuring may have

taken place to preserve the agricultural vitality of previously fertile farmland (Milek 2012), although a lack of charcoal has made it impossible to date these soil horizons definitively (Milek pers. comm.).

Where sand was a known problem, attempts were made to prevent it inundating settlements and agricultural areas. Physical defences against wind-blown sand dating from the medieval period, however, are rare in Britain. This may relate to difficulties in identifying ephemeral features in a challenging environment in which to excavate (Griffiths 2011, p. 13). Additionally, abundant embankments in coastal areas traditionally recognised simply as flood defences were probably intended to prevent inundations from both water and sand (Toft 1988, p. 28). At Stackpole for example a wall dividing the rabbit warren from the land to the north may have been intended, in addition to enclosing the rabbits, to prevent sand progressing inland (Benson *et al.* 1990, p. 182). The erratic nature of the hazard also made it difficult to erect defences as where sand movement was sudden and high volume, such as in an unpredictable storm event, there would have been no time to intervene. Analogies discovered in the Netherlands however, demonstrate that fencing and screens, in some cases over 100 m long (Heidinga 1987, p. 139), were employed to keep farmland free of sand. These however, were invariably overtopped illustrating the protection they provided was only short-term (Heidinga 1987, p. 139; van Doesburg 2009, p. 188). A barrier against sand does not prevent the action of the hazard, only buying time until the barrier is overtopped as layers form a rising sand bank. At this point a higher barrier at the original location or an additional barrier further inland is required to provide continued protection (Sherman, Nordstrom 1994, p. 270). Physical barriers therefore, are not a simple solution to the threat of besanding.

Interestingly, two examples of natural barriers providing protection from sand inundation in the medieval period are known. At Perranzabuloe, Cornwall, the 6th century shrine of Saint Piran became be-sanded by c. 1150 at which point a replacement church was constructed further inland (Ravenhill 1955, p. 240). This church was separated from the site of the older shrine by a stream which was thought to provide protection against further sand encroachment. This seems to have been the case as the church was remodelled in 1420 suggesting no imminent danger was perceived at this point. When the stream was diverted in the late 18th century however, the sands quickly began to progress inland, requiring a second relocation in 1803 (Haslam 1844, pp. 40-41). Similarly at Merthyr Mawr, Bridgend, documentary evidence records the diversion of the River Ogmore in the mid-16th century to prevent sand progressing further inland (Stradling 1598-1603, p. 119). Sometime in the early

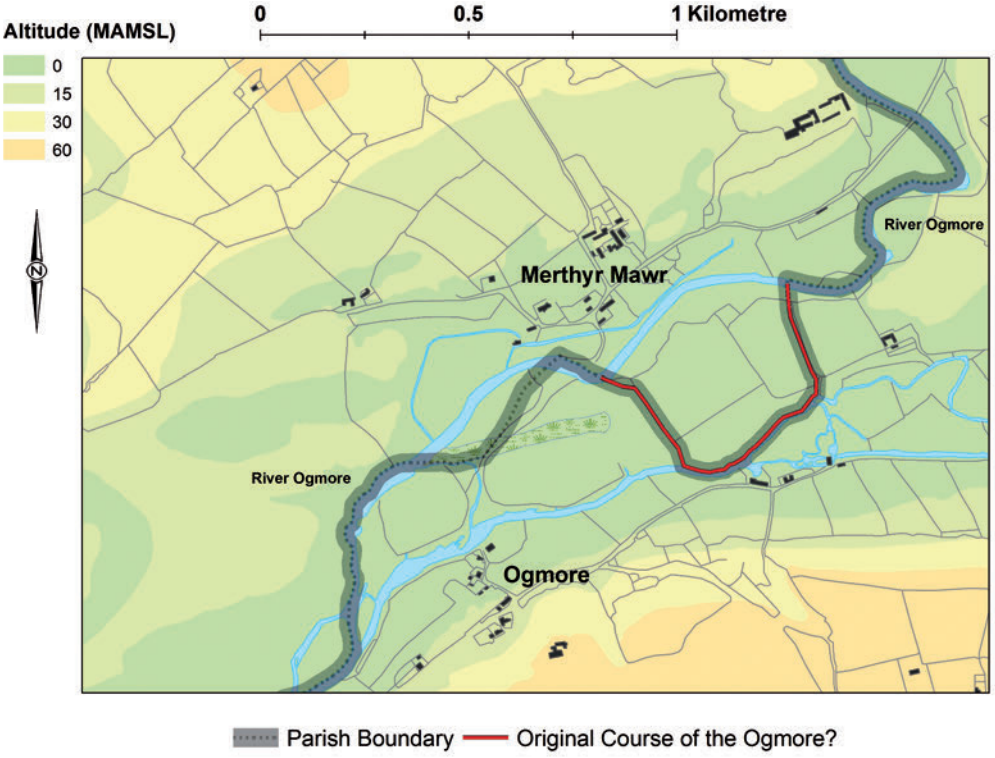


Fig. 5. Map of the parish boundary and river at Merthyr Mawr, indicating where the medieval river diversion may have occurred. The Ogmore flows from right to left (redrawn by the author from Stradling 1598-1603, map 1).

15th century 60 shovels had been purchased "for casting the sandes out of the mouth of Ogmor river neer the sea", perhaps to allow access to ships (Stradling 1598-1603, p. 165), demonstrating a historical precedent for works to alter the morphology of the river channel. Although the precise location of these works is unknown, the fact that the parish boundary, which follows the course of the river, diverts from the river at Merthyr Mawr may preserve the original route of the Ogmore prior to its diversion (Stradling 1598-1603, p. 163; fig. 5). The precise mechanics of how a river would have prevented the movement of Aeolian sand in these case studies is unclear. By increasing the sand's moisture content the river may have impeded the action of the wind on exposed areas of sand, slowing movement inland, and at Merthyr Mawr the Ogmore's diversion may have washed sediments out to sea, preventing them progressing inland onto areas of human settlement. It seems probable, how-

ever, that in an extreme storm event the protection offered by these rivers would have quickly been overcome.

For medieval Christians, more immediate protection could be accrued through the intercession of God or the saints. The ubiquity of responses relying on divine help in the face of other natural disasters is well documented across later medieval Europe, frequently taking the form of processions, sermons and prayers (Hanska 2002). Compared to more universal hazards, such as floods, droughts and earthquakes, the effect of wind-blown sand was highly localized and it is therefore unsurprising that few textual references have survived detailing spiritual responses. The 15th century Welsh poet Dafydd Nanmor however, alludes to saintly intervention against wind-blown sand in his poem *I Bedrog Sant am Yrru'r Tywod o'r Tywyn*. In this work prayers are offered to Saint Pedrog (also Saint Petroc) for his assistance in driving back sands which inundated the parish of Verwick (today Y Ferwig), Cardiganshire (Nanmor 1923, pp. 15-17, 132). Saint Pedrog is the patron of the parish church (Bowen 1955, p. 202) which together with the fact that archaeological evidence attests to medieval sand inundation (Dyfed Archaeological Trust 2013), perhaps exacerbated by rabbiting as discussed above, suggests that the poem is essentially factual and indeed closely matches contemporary accounts of spiritual responses to other natural disasters (Hanska 2002, pp. 91-93). Although evidence is limited due to the scale of the hazard, it appears that British communities relied on similar spiritual protection against aeolian sand as other contemporary communities facing other hazards across Europe (Gerrard, Petley 2013).

Some support for this comes from the archaeological evidence for hoards at sites affected by sand. The Skaill hoard at the Mound of Snusgar, Orkney, a coin hoard at Glenluce, Dumfries and Galloway, and the St Ninian's Isle treasure on Shetland were all deposited in blown sand environments. The latter was deposited sometime after c. AD 800 and St Ninian's Isle was occupied by the Norse up until sometime in the 11th or 12th centuries when a layer of wind-blown sand accumulated (Barrowman 2011, p. 187). Following this, a Christian chapel was constructed on the sand (fig. 6), perhaps signalling that the location held long-standing ritual significance. While the disparity in date between the burial of the hoard and the onset of wind-blown sand does not preclude a connection, as curation and deposition in a later period is a distinct possibility (Barrowman 2011, pp. 201, 203), it is the least certain of the three sites. In common with St Ninian's Isle, The Mound of Snusgar, a high-status Norse secular site (Griffiths 2013), and Glenluce, a

Fig. 6. Remains of the chapel below which the hoard was buried on St Ninian's Isle, Shetland (photograph by Christopher Gerrard).

dwelling or hunting lodge dating to the early 15th century (Jope, Jope 1959, p. 263), would similarly have been well-known locales within the landscape which, following their be-sanding may have become foci for deposition in an effort to prevent further losses. Although the date of the Skaill hoard, 950-970, closely matches C14 dates from midden material deposited to stabilize the sands (Griffiths 2013, pp. 501, 520), precise information regarding the context of the hoard's discovery in 1858 is a major problem (Griffiths 2013, p. 504). The geographic spread of these sites, all from Scottish coastal areas with Norse links, may attest to a pagan tradition which, in the case of Glenluce, permeated into later popular Christian practice. Analogies of Northern European prehistoric hoard depositions are increasingly viewed as communal offerings to deities for favourable treatment such as protection from natural hazards (Menotti *et al.* 2014, p. 466) and in common with English Bronze Age hoards deposited in bodies of water "it is hard to support the argument that their deposition was purely a practical procedure" (Yates, Bradley 2010, p. 66). Certainly, the decision to bury hoards of valuable numismatics and metalwork in highly dynamic landscapes was a poor choice if safekeeping and later recovery, the traditional explanation for hoards in this period (Graham-Campbell, Batey

1998, pp. 243, 246), had really been the primary intention. Spiritual responses were guaranteed to work eventually as inevitably storms or high winds influencing sand movement would die down demonstrating that the relevant deity or saint had interceded on behalf of the community. If the hoard deposition or prayer was perceived to be successful this reinforced the belief and, provided that memory of the response survived to the next occurrence of the hazard, it increased the chance of it being employed in the future.

In extreme circumstances populations were forced to abandon sites where aeolian sand made continued settlement untenable. One of the clearest examples of this is on the Merseyside coast at Meols[1], where a large quantity of later medieval finds, chiefly discovered in the 19th century, attest to the presence of a significant settlement. The fact that chronologically the assemblage terminates abruptly in the early 16th century, with a prior continuity of settlement from the Roman period, appears conspicuous and has been linked to a natural disaster from the time of discovery, probably an extreme wind-blown sand inundation (Hume 1863, p. 383; Griffiths *et al.* 2007, p. 436). Antiquarian excavations revealed a layer of "drift-sand" overlaying layers of medieval cultivation and occupation (Ecroyd Smith 1866, plate II) and their observations also record buildings and cultivation ridges emerging from beneath sand dunes as a result of 19th century erosion (Hume 1863, p. 10). Following the sand inundation, which the high volume of finds suggest was both swift and severe, some of the population relocated inland to a site now known as Great Meols where artefactual evidence demonstrates increased activity between 1500 and 1550. Analysis of field names and tithe mapping suggests this site was formerly marginal land, re-organised in response to the loss of Meols to provide the survivors with a new home (Griffiths *et al.* 2007, pp. 414, 409-411). It is also likely however, that some refugees would have moved to other nearby settlements. A smaller scale abandonment may have occurred at the Bay of Skaill, Orkney, where James (1999, p. 771) hypothesizes the presence of a medieval chapel, evidenced by undated burials, remnants of walls and midden deposits, which was deserted and replaced by another church c. 1 km to the north in response to sand inundation.

Churches, as the spiritual hub of the community, would have been the most important communal structure in a settlement and were believed to offer divine protection (Biraben 1976, p. 83). Populations

[1] The Meols place-name is of Norse origin meaning "sand-bank" (RCAHMW 1982, p. 267).

were therefore especially keen to ensure their safety and survival, making them a reliable means by which to gauge the movement of communities. This is illustrated by the site of Forvie, Aberdeenshire, where there was a settlement focused on a church dedicated to Saint Adamnan from at least the late 12th century. Irregular sand movements must have occurred throughout the 1st millennium (Milek 2012) but an extreme event, possibly in 1413 when an extreme low tide, exposing a large swathe of sand, coincided with a southerly storm (Lamb 1982, p. 185), caused the town to be buried by up to 30 m of sand, precipitating its total abandonment. This is supported by excavations on the site of the church which recorded burials from the 13th and 14th centuries with a cessation at the time of the storm (Kirk 1957, p. 4; Kirk 1958, p. 2). Sometime before 1499 however, a new chapel dedicated to Saint Adamnan had been constructed 6 km to the north at Leask (MacGibbon, Ross 1897, p. 388; Rust 1845, p. 593). This could have been built by refugees from Forvie who required a new shrine for their local saint due to the original church's ruin. Similarly, at Kenfig the old church of Saint James appears to have been partially dismantled following the encroachment of sand with burials and worked stones, including coffin lids, observed and retrieved from the vicinity in the 19th century (Gray 1909, pp. 83-84). By around 1485 a new church dedicated to Saint James was built at Pyle, roughly one mile from Kenfig, which Gray (1909, p. 95) interprets as a replacement for the old church which by that point was either buried or at substantial risk from sand.

5. Adapting to aeolian sand

There is limited evidence for long-term adaptation to the stresses of Aeolian sand in the medieval period. This could be because in most cases, areas plagued by problems were abandoned in favour of more suitable locations. At some sites where populations hung on, they may have been forced to resort to unconventional sources of sustenance. At Eldbotle, for example, the pressure of wind-blown sand apparently forced the inhabitants to eat limpets which are usually only consumed by humans in famine situations (Hindmarch, Oram 2012, p. 283). These "famine foods" may also be glimpsed at Pennard where limpet and mussel shells were retrieved from middens perhaps signalling comparable conditions (Lees, Sell 1983, p. 47).

Social reactions to inundation also attempted to increase resilience. While artificial defences could prevent individual inundations, long term

safety could only be achieved by preventing the action of wind from influencing large bodies of sand. This can be achieved through the afforestation of sand dunes with plant species such as pine or marram grass, the roots of which stabilize the sand preventing aeolian erosion (Doody 2013, pp. 202-203). While there are many examples of unsustainable land use strategies, detailed above, later examples from across Northern Europe attest to an enhanced appreciation of the maintenance of sand dune environments. An early example of this is the island of Voorne, off the coast of the Netherlands, where it appears land use was particularly sensitive to the dangers of wind-blown sand (Van Haperen 2013, p. 124) and marram grass planting is recorded in 1423 (van der Putten 1989, p. 20). In Denmark from 1539 royal orders restricted exploitation of woodland in the district of Thy due to encroachments by sand onto farmland (Sortfeldt 1920). A number of similar documents exist for Britain. For example in 1554, Queen Mary extended the remit of the Commissions of Sewers in Glamorganshire to include "the redress and saving the said Grounds from hurt or destruction by reason of the said Sands" (1 Mar. Sess. 3 c. 11). In 1561 a decree from Elizabeth I to the bailiffs of Newborough, on Anglesey, following complaints made to the Crown regarding the "great ruin and decay the said Town is [likely] to run into by reason of the sands … overrunning their lands and oppressing and overthrowing their houses". This document instructed the bailiffs to fine anyone who "have cut digged rooted up or carried away" any of the coastal vegetation within two miles of Newborough (Ellis 1838, p. 298). The phrase "it is thought *by men of experience* that … permitting the rushes … to stand and grow will in short time help very much to the avoiding of the said inconveniences" demonstrates the idea that sustainable exploitation of the vegetation growing in the sands could prevent further encroachment was by no means a novel concept in the mid-16th century, and 15th century Cornish manorial records support this (Clarke, Rendell 2011, p. 231).

6. Discussion

A significant number of medieval coastal communities were heavily affected by wind-blown sand. Most but not all of these events occurred in the general climatic downturn of the Little Ice Age. Throughout this period, the number of severe storms which could have influenced sand accumulations is presumed to have risen which increased the occur-

rence of wind-blown sand inundations. The human element to the situation was however, equally important with land use decisions exerting a parallel force increasing vulnerability. Overgrazing, stripping of vegetation, rabbiting and other land use practices greatly increased the amount of loose sand in close proximity to human settlements and productive areas. These decisions were influenced by the contemporary socio-economic situation which, especially in the aftermath of the Black Death, favoured pastoralism and rabbiting. This meant that when the Little Ice Age storms arrived, areas of human occupation were especially vulnerable to besanding.

Medieval communities had few options open to them to deal with the hazard of sand inundation. In common with other hazards, religious responses were probably the most commonly employed against the hazard but due to the limited geographic areas affected, limited evidence for religious responses has survived. In less severe cases where sand posed a chronic problem, stabilization strategies allowed populations to live with the hazard for considerable periods. Although there are few definite British examples, barriers were also used to keep sand at a manageable distance. When an extreme storm occurred however, there was nothing that could be done and total abandonment was the only realistic recourse. The resulting movement of populations can be seen at Meols and in the relocations of churches at Kenfig and Forvie. Although the role of stabilizing vegetation in relation to vulnerability from wind-blown sand was appreciated from an early date, legislation protecting plants in dune environments from exploitation only appears in Britain from the 16th century, perhaps as a result of the multitude of losses experienced in recent decades.

7. Conclusion

To conclude, the hazard of wind-blown sand exerted a localized but frequently calamitous influence on medieval populations occupying vulnerable areas. Climatic changes drove long term trends in sand movement across Europe but anthropogenic factors, especially land use decisions such as rabbiting, overgrazing and the stripping of vegetation, focussed risk into areas of human settlement and exploitation. Populations responded to inundation with a variety of strategies including earthworks, barriers and midden material either to stabilize exposed areas or increase its fertility. Spiritual reactions, such as prayer, closely match contemporary methods employed against other hazards such as

droughts, floods, and epidemics in Britain and throughout Europe. In terms of folk beliefs, a relationship between the deposition of hoards may be linked to the encroachment of sand, although this remains hypothetical. Towards the close of the period, attempts were made to stabilize the sands through legislation prioritizing the protection of plant species but these only covered limited areas and came too late to prevent the inundation of many settlements.

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