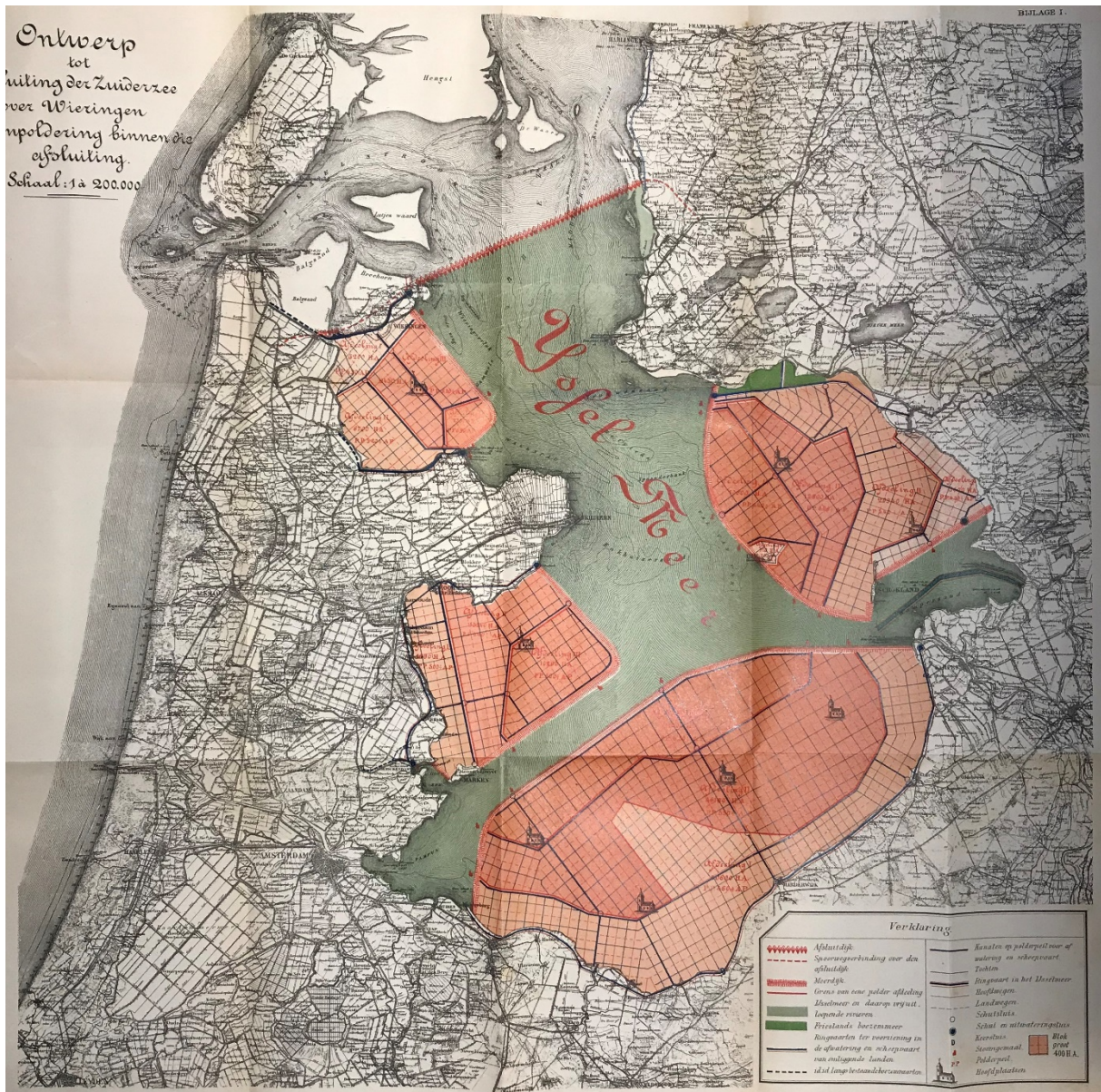


The Wadden Sea region: safety between salt and fresh waters

Meindert Schroor

In a report on public health, written in 1909 on behalf of the Dutch Zuiderzee-society, aiming to promote the enclosure of the Zuiderzee-inlet (realized in 1932 and since called IJsselmeer), president of the Leeuwarden Sanitary Board, Johan Baart de la Faille, laid emphasis on the age-old injurious effects of malaria in the coastal areas around the Dutch Wadden Sea. Among several scientists and politicians, he pleaded for the closing of this southern bay-like extension of the Wadden Sea, thereby creating a large freshwater reservoir. Such a lake would be suitable as a buffer against salinization and its detrimental influence on agriculture and public health. At the time Baart de la Faille wrote, science just recently had discovered the connection between brackish, sluggish water combined with warm, humid summers on the one hand and on the other hand the proliferation of *anopheles* (mosquitoes) as conveyors of the malaria-parasite. Floods aggravated the extent and effect of malaria. The February-flood of 1825, by inundating one-third of the provinces of Fryslân and Groningen and other areas all along the entire Wadden coast, not only brought drainage to a standstill. It – much worse – left behind pools and fields for months under brackish water, creating by all means an ideal environment for malaria-infested mosquitoes bringing intermittent fevers. Though not necessarily lethal, these fevers nonetheless propelled mortality by making the population of the marshes receptive for and less resistant to diseases as such often proving fatal. Traditionally towns and places at the seaside, like Harlingen and Emden, where fresh inland waters meet salt marine waters, experienced higher mortality-rates than their inland counterparts such as Leeuwarden and Groningen. Moreover, outbreaks of malaria could also be triggered by public works. A contaminated workforce for instance engaged in digging and deepening canals could cause a sharp rise in mortality as was the case in both Groningen (1622/1623) and Leeuwarden (1859). Malaria was a disease almost tailor-made for the Wadden Sea environment with its mixing of salt and fresh water and its lack of substantial relief (sc. height differences).



The original plan to dam the Zuiderzee and create new land (polders) in this former sea, as conceived by Cornelis Lely – the later minister for Water Management – in 1891, was – including some marginal adjustments – approved by a State Commission in 1894 (collection of the author).

Already in 1591, the English traveller Fynes Moryson journeying through Europe, found the water between Harlingen and Leeuwarden "salt in taste". A situation extant in the embanked marshlands bordering the Dutch Wadden Sea until the closing of the Zuiderzee and the resulting improvement of drainage and fresh water-supply in the 1930s. We can safely assume that, albeit indirectly, endemic malaria proved more lethal than the far more 'appealing' yet incidental storm disasters in the Wadden environment.

This example shows the relativity of safety in a flat and open coastal landscape like the Wadden Sea Area where the obvious menace traditionally and even now seems to be disastrous flooding. To outsiders safety seems to be permanently in jeopardy in a coastal landscape like the Wadden Sea area, although the perpetual forces of the tides and the

regular, mostly western winds were/are actually so much more important to the evolution of the Wadden Sea Area than storms and flooding. In fact the daily ebb and flood, the monthly spring- and neap-tides, the seasonal fluctuations of the sea and the Holocene sea level rise plus the human factor have had a greater impact on its formation and living conditions – gradual change that is – than the incidental disasters of storm surges. These nonetheless did have serious impacts through the ages, though often triggered by human mismanagement.

Settling the area

The abovementioned sea level fluctuations is the predominant factor in distribution pattern and living conditions of both animal species in the Wadden Sea proper and the plant life in the salt marshes, but these everchanging water levels have always been the main driving force to human constraints but also its potential for settlements and other living conditions in the Wadden Sea coastal area and way inland along the rivers and streams. Moreover, the introduction of this essay exemplifies how *water* also has another vital influence on human presence and survival in the past – and questions what human safety traditionally has been perceived in this amphibian landscape.

In and around the Wadden Sea Area – apart from the Wadden Sea with its gullies and shallows – basically four main landscapes can be discerned, two of them directly forming the Wadden Sea Area like dunes and marshes. The other landscapes, moorlands and Pleistocene sands (*Geest*) are mostly fringing this area, though the *Geest* locally surfaces e.g. on Texel, Wieringen, Sylt, Föhr and Amrum or penetrates the area, as is the case near Dangast and Cuxhaven and in the Danish part of the Wadden Sea Area (e.g. the Emmerlev-Ballum and Vedsted-Hviding ridges). West of the Elbe river marshes and *Geest* are usually separated from each other by a band of mostly reclaimed moors. Injudicious reclaiming of this soil type during the Middle Ages have turned many moorlands into (Wadden) Sea as has been the case in the westernmost part of the Wadden Sea near Texel and Vlieland and in North Frisia. There the *halligen* are the remnants in what was once a large moorland, a scattered marshy archipelago.

Initially the higher sandy Pleistocene areas, including the corresponding ice-age nuclei of Texel, Amrum, Föhr and Sylt, although marked by poorer soils, were more attractive to permanent settlement. This was primarily for reasons of safety as the fluctuating level of the sea could not threaten their habitations. Mesolithic megalith fragments have been found on the islands of Texel as well as on Sylt, Amrum and Föhr. The same was true for Dithmarschen where up till the 1st century AD the marshes were exploited by a population living in settlements on the edge of the *Geest*, a situation still existing on the Danish Wadden-mainland north of Tønder. In that century the first line of mound settlements developed between Wesselburen and Wöhrden.

From about 600 BC parts of the salt-marshes west of the Weser river were already high, large and relatively safe enough to attract settlers from the hinterland. People were lured by their high organic productivity, a result of the natural fertility of these mineral-rich clay soils

and furthermore by their light texture and calcareous nature. They moreover were lying in an area with a high organic productivity, that is to say rich in fish and fowl. In the end the risks of settlement in the marshes, compared to their Pleistocene sandy counterparts, were outweighed by the advantages named previously. Permanent settlement was preceded by a seasonal use of the marshes as pastures as well as purveyors of fish and poultry by people from the adjacent hinterlands. Very soon, from the 5th century BC onwards, people started to settle permanently in the salt marshes itself. Human settlement initially preferred the higher marsh bars and natural levees bordering the estuaries, raising their living places there by means of throwing up artificial mounds, called *terpen*, *wierden*, *wurten*, *warften* or *værfter*, their names depending on which region you are dealing with. Hundreds of these dwelling mounds can still be found from Schagen in North-Holland and Westergo in Fryslân/Friesland, through the German areas of Lower Saxony and Schleswig-Holstein up till Ballummarsken in Southwest Jutland. In North Frisia the settlement of the marshes was basically initiated by colonists from the West- and East Frisian parts of the Wadden Sea Area as of the 8th century AD. They occupied the coastal area from the mouth of the river Eider up till Sylt, building mounds on expanding marshlands that had been recently developed on the inland-bogs through breaches of the sea in the coastal dunes and ultimately reached the mainland marshes. North of Tøndermarsken these mainland marshes, here called *enge* (meadows) – though possibly initially having inhabited mounds – remained uninhabited. Even today they are exploited by farmers living on the edges of the protruding hill islands (Danish: *bakkeøer*). Where the marshlands are at their widest, history also has the oldest habitation, especially between Den Helder and Norden (East Frisia), in places having a width of 30 kilometres. This is the case between Den Helder and Alkmaar – consisting, apart from the land within the medieval ring dike, mainly of early modern polders – and all the more so in what are the oldest inhabited marshes of the Wadden Sea Area in Westergo (Harlingen-Sneek area) as well as in the Middag-Humsterland northwest of the city of Groningen. However along the Weser and Elbe rivers, though rather narrow, they reach farthest inland, up till the Vierlande southeast of Hamburg. In Central Westergo (around Tzum) seasonal habitation started from 600 BC onwards; permanent habitation arrived some two centuries later on mounds and since was there to stay. Eventually the construction of mounds spread over the entire Wadden Sea Area.



The town of Ribe is situated on a Pleistocene spur ending at Slotsbanken (the earthen wall at left in which a few remains of a medieval royal palace) and stretching into the marshland in the fore-front (photo: Meindert Schroor)

It was especially in the broad western marshes that towns developed such as the historic Zuiderzee harbour towns Enkhuizen, Medemblik and Hoorn on the extreme southwestern edge, the iconic eleven Frisian towns and furthermore Appingedam, Emden, Tönning and Friedrichstadt. Their 'marshy' urban counterparts, like Den Helder, Wilhelmshaven and Bremerhaven are deliberate and more recent creations, mainly for military reasons. However most other towns in the Wadden Sea Area are settlements on the edge of the *Geest*: Alkmaar, Groningen, Norden, Esens, Wittmund, Jever, Varel, Cuxhaven, Heide, Husum, Bredstedt, Tønder and Ribe.

Interaction between marsh and geest

From a cultural-historical perspective the Wadden Sea Area has been a laboratory of water management and environmental coping for at least 2,500 years. One of the main characteristics of the area was its insular character, obviously not only the islands but also the marshes on the mainland, predominantly in the Netherlands and Germany, mutually divided by inlets and estuaries into peninsulas. Moreover, west of the river Elbe those marshy peninsulas were isolated from their hinterlands by the large raised bogs. Another characteristic of the Wadden environment is its essentially brackish nature, basically the result of a lack of relief, a precipitation surplus and its fragmented geography making the balance, interaction and mingling of salt and fresh waters constantly recurring environmental themes.

The first permanent human settlement in the past Wadden Sea Area took place before the lowlands came into appearance on the ice-age nuclei of the four islands: Texel, Amrum, Föhr and Sylt and the geest areas on the mainland, penetrated by a dense network of large rivers and waterways. Here, on the fringes of these moraine cores the Neolithic Stone Age (4000-2000/1700 BC) and in the later Bronze Age (2000/1700 – 500 BC) farmers established their homes in safe altitude from sea and river flooding. Although in many locations marked by poorer soils, they became attracted by the salty Wadden Sea and the fresh- and brackish waters of the rivers which provided them with rich abundances of fowl, fish and shellfish. Neolithic megalith graves and Bronze Age burials, together with remains of these settlements, have been found in many locations throughout the Wadden Sea Area, often buried under younger, Holocene deposits of sand, peat or clay, e.g. Groetpolder in the province of North-Holland and at Delfzijl in the province of Groningen. At the mouth of the Ems River, a megalithic chambered tomb has been discovered under several feet of clay and peat, which also was the case in Gammeleng, north-east of Højer in Denmark. On the islands of Sylt and Amrum, the remains of settlements from the Neolithic Stone Age up to the Early Middle Ages (second half of 1st millennium), lie hidden under dunes and mudflats. These are occasionally revealed by low tides, e.g. south of Archsum on Sylt.



Remnants of Stone Age Megaliths in the Wadden Sea off Archsum (Sylt)
(<https://presse.sylt.de/pressreleases/steingraeber-im-watt-1332606>)

The attractiveness of the Geest fringes for habitation can still be displayed in the huge numbers of settlements at many locations, e.g. Flögel-Eekhöltjen, southeast of Cuxhaven,

Albersdorf, east of Heide in Dithmarschen and at Emmerlev, north of Højer in Denmark. Even as impressive are the numbers on these prehistoric monuments on the geest islands: as many as 77 megalithic graves and 1,000 Bronze Age barrows have been located on Sylt, Amrum and Föhr. Around the birth of Christ, there was a marked increase in population in the Wadden Sea coastal area, and many of the still extant villages can trace their history back to the early Iron Age: farm has replaced farm and village has followed village. Up to the 13th century, villages and single farms, especially in Germany and Denmark, were often relocated but are within the same area of resources. In Fryslân people from the salt marshes in Roman times started to colonize the adjacent – and at that time higher – moors. As off that time, these moors started to subside and were inundated, ultimately resulting in new growth of moors. A second wave of colonization started from Carolingian times onwards and lasted into the 13th century. The situation in the western Wadden area was quite different from the eastern and northern parts because of the larger extension of the salt marshes and the greater distance to the geest areas.

A model for the development of geest settlements and the interaction between villages and individual farms over three millennia has been demonstrated by the excavation in 1988-94 of a 22-hectare site at Grønnegård, east of Esbjerg. Here, the largest archaeological excavation site in the Wadden Sea Area has documented that the first, sporadic settlements took place in the Neolithic Stone Age and that permanent settlement can be demonstrated even from the middle of the Bronze Age up to the 13th century. The distribution of farmhouses expresses a broad-spectrum economy, where the available resources were used to a maximum during periods and at the same time determining the distance to the farm's location. The farmers did not want long distances, which is why the settlements were as close to the geest edge as possible – between arable fields and marshes. This avoided the risky settlement in the flood-threatened marsh. The distance between the individual buildings, their location in relation to the topography of the landscape and the agricultural potential clearly point to well-organized communities, where the distribution of private and communal property was carefully determined.



At Dangast a wooded spur of the Oldenburg Geest meets the open marshlands surrounding the Jade-bay (photo: Meindert Schroor)

Returning to the present, many excellent examples on how settlements marks the sharp transition between marsh and geest, between wet and dry, can be seen all over the Wadden Sea Area; e.g. the row of villages on the island of Föhr: Boldixum, Wrixum, Oevenum, Midlum, Alkersum, Nieblum, Borgsum, Süderende, Toftum, Klintum, Oldsum, Dunsum and Utersum, and within a distance of only 15 kilometers. Similar striking demarcations are found on the mainland; e.g. Langenhorn, north of Husum, Vesterende-Ballum at Skærbæk and Kjelst on the very north of Ho Bugt.

More blurred is the transition between the geest and the marsh in today's larger urban communities. Towns or cities that emerged from the geest at a safe altitude from sea or inland floodings, have gradually developed downward onto the marshland low levels. Numerous examples of such developments can be observed throughout the coastal area; e.g. Groningen in the Netherlands, Norden, Wittmund and Jever in Germany and Tønder and Esbjerg in Denmark. Although at very different times.



The city of Groningen developed on a Pleistocene spur (yellow/orange) penetrating into the marshes (blue) that some 1000 years ago were partly covered by peat (grey) (<http://objects.library.uu.nl/reader/viewer.php?obj=1874-327059&pagenum=1&lan=nl>) (University of Utrecht)

During the Iron Age and Viking Age (500 BC – AD 1050) the settlement and occupation in the emerging and fertile marsh landscapes and peaty moorlands became the major change in the coastal habitation pattern in the Netherlands and Germany. Settling onto the marshlands, water became the erratic neighbour. In Denmark, however, the narrow salt marsh creations could still be exploited from the geest fringes nearby which meant that the settlers could use both the fertile salt marshes for grazing and the cultivation on the geest. Compared to the Dutch and German marsh settlements the first Danish marsh habitations origin from 13th century.

From 500 BC onwards, people started to settle permanently in the salt marshes in the northwest of today's provinces of Fryslân and Groningen. The first human settlement initially preferred the higher marsh ridges and natural levees bordering the creeks and estuaries, raising their living places there by means of elevated platforms and throwing up higher artificial dwelling mounds. However, along the Weser and Elbe rivers, though rather narrow, they reach farthest inland, up till Vierlande, southeast of Hamburg.



Reconstruction of a sod-house in Firdgum (Fryslân). The first settlers on the mainland Wadden coasts, induced by lack of building materials, probably built their houses by means of sods dug in the salt-marshes (photo: Meindert Schroor)

Like the development of the aforementioned, and larger geest towns has blurred the impression of the original height contours, this is also the case for the dwelling mound societies. This applies to several of the Dutch cities such as Leeuwarden and Dokkum in Fryslân, initially located at natural waterways to the Wadden Sea, Emden in East Frisia, Büsum in Dithmarschen and Tønning in North Frisia. Den Helder, Wilhelmshaven and Bremerhaven are not elevated marsh cities but of more recent creations, founded mainly for strategic (naval) reasons.

Between the Pleistocene geest and the Holocene marsh lie large freshwater swamps and bogs, which in Fryslân and Groningen, Lower Saxony west of the Weser River, in particular but in North Frisia too had their widest extent. In periods where the sea level rise slowed down, swamps were turned into freshwater bogs at their landward side. Between the 10th and 14th century the area from around the present Zuiderzee to Weser was inhabited and cultivated by people from the adjacent densely populated marshes. Like many geest settlements, the habitation here also took place in characteristic ribbon villages, on riverbanks or levees consisting of farms on elongated lots reaching far into the bogs. In those days the westernmost

part of the Wadden Sea Area between Wieringen, Texel and Harlingen was still predominantly land of mainly raised bogs with settlements like Breitenmore, Langenmore and Austmora, as yet untraceable, but most certainly vanished in an expanding western Wadden Sea. The ending *-more* pointing to salt extraction activities or at least the existence of high moors. These raised bogs suffered from shrinking and therefore soil subsidence through drainage, agricultural activities, peat-digging and the extraction of salt from salinized peat. The effect of wind and water in these subsided wetlands likewise to the growth of lakes in size and number, especially in the southwestern lake district of today's Fryslân. More to the southwest, in the central parts of the county of Holland, behind the dunes, the lowered and waterlogged moorlands proved an ideal training field for hydraulic engineering innovations that in the end laid the foundation for the worldwide Dutch reputation in the field of water management (see below). North of the river Elbe, in North Frisia, bogs and mires also expanded in wide scale, covering the present area of the Wadden Sea there and then sheltered from the North Sea by the ice-age nuclei on the islands of Sylt, Amrum and Föhr and a growing sandy barrier.

Geographical fragmentation reflected in political divisions

Already bishop Adam of Bremen qualified the Wadden Sea Area ('Fresia regio') west of the Weser river about 1070 as a coastal land sealed off from the hinterland by peat bogs and articulated by estuaries and bays into 17 Frisian districts. One-third of these belonged to Bremen diocese, whereas the western parts ecclesiastically belonged to the dioceses of Münster and Utrecht. During the 14th century the seven so-called Frisian Sea districts (Zeelanden) between the County of Holland and the river Weser formed a loose union. Historical landscapes of today bear witness of this internal division of old, so often confusing to modern man and people from elsewhere. For instance from a Dutch perspective today's West-Friesland is the northern part of the province of North Holland, whereas to Germans and Danes it is the Dutch part of the Wadden Sea Area, lying between Harlingen and the Dollard inlet. In the Netherlands though, by Friesland/Fryslân the province of the same name is meant. Medieval districts like Westergo and Oostergo in Dutch Fryslân were originally separated from each other by the Bordine of Middelzee. This was until the Late Middle Ages both an estuary and arm of the Wadden Sea on which the present capital of Fryslân, Leeuwarden developed. Likewise Oostergo and Hunsingo were separated by the Lauwers gulf (Lauwerszee). Nowadays tiny Lauwers river and Lauwersmeer (the gulf being shut off from the sea since 1969) still separate the provinces of Fryslân and Groningen. The latter was formerly named Stad Groningen & Ommelanden. Until the beginning of the 17th century this rural part of Groningen province used to call itself Friese Ommelanden or Friesland between (rivers) Ems and Lauwers. In Germany – administratively at least – Friesland is a district (*Kreis*) in Lower Saxony, formerly part of the Duchy of Oldenburg and as such encompassing the Lordships of Jever, Kniphausen and Varel. From a geographical viewpoint however, it is the eastern part of the East-Frisian peninsula between the Ems river and the

Jade gulf; East-Frisia being the former (1464-1744) county that covered three-quarters of that peninsula. Then there is the district of North-Frisia belonging to Schleswig-Holstein and established in 1970 by merging the districts of Südtondern, Husum and Eiderstedt. In Denmark a Frisian dialect is not spoken, therefore 'Frisian' is not a viable term, although many historic similarities with the Frisian areas, e.g. occupation and traditions can be found here. The same goes for German Saxon Dithmarschen, between the rivers Eider and Elbe. Thus, the Wadden Sea Area remains a patchwork of states, 'Länder', provinces, districts and large municipalities, no longer divided by bays, inlets of gulfs such as Harlingerland and Wangerland on the German East Frisian peninsula once were by the Harle gulf, and Dithmarschen and Eiderstedt still are by the Eider estuary. In the past millennium many bays and estuaries disappeared through diking and reclaiming land thereby physically uniting districts. However, from a cultural and landscape-genetic perspective and often even politically, these historical divisions still matter.

Shifting sands on the islands

A first migration wave of Frisian settlement from the southern part of the Wadden Sea Area commenced already in 8th century on these islands and on the sandy ridges at the present peninsula of Eiderstedt. Probably due to a combination of over exploitation in the area between Zuiderzee and Weser there and the onrushing Frankish empire. During the 10th century the sandy barrier was breached by salty North Sea waters, followed by deposition of clay on the moors and a second wave of Frisian migration from the south began around 1000 AD on the newly formed salt marsh archipelago taking with them their techniques of land and water management. They embanked these marshlands whereas they occupied the bogs at their landward side by cultivating them. The latter were consequently lowered, and as such became prone to extensive flooding. A disaster that indeed happened in 1362 and again in 1634 when the sea broke through the row of dunes and dikes from Föhr to Eiderstedt, thereby destroying much of the marshlands and wasting practically all the moorland further inland, leaving behind a devastated area of mud flats and a scattered marsh archipelago .

Also, the settlements on the Holocene sandy barrier islands, had to take account of the potential risk of flooding and the habitation has originally been located on the higher dune ridges primarily at the leeside of the prevailing wind direction. Settlement patterns are however quite diverse. The first settlements of Rømø are characterized by a row of ribbon or linear villages, whereas e.g. Fanø, Mandø, and Borkum have irregular clustered villages. More recent settlements such as Keitum on Sylt, the villages on Spiekeroog, Schiermonnikoog, and Oost-Vlieland have a main street with side-alleys.

Besides potential risk of flooding, on these islands sand drift in the Wadden Sea has always caused problems for the location of settlements, especially in the Netherlands and East Frisia. Written sources indicate that throughout times island villages here had to be abandoned due to a loss of land in the west and north and resettled to the east and south – e.g. on Spiekeroog

and Langeoog around 1700, on Juist in 1717, and on Wangerooge in 1854-55. Perhaps the most spectacular demise was that of the large village of West-Vlieland between 1727 and 1736. Another aspect of extensive sand drift can be recognized in today's landscape on some of the islands that prevailed before the planting of forests from the end of the 19th century onwards put an end to the worst consequences. For instance, on Norderney and Rømø gardens and small plots of land are surrounded by low sand dykes that emerged when the cultivated areas had to be shoveled free of the flying sand. Elsewhere, e.g. on Terschelling rows of trees protected the fields bordering the dunes against drifting sand.



The so-called Wanderdüne near List on the island of Sylt. The largest sand-drift area in the Wadden Sea Region (photos: Meindert Schroor)

As stated above the Pleistocene core of Texel became inhabited already in the Neolithic period and the neighboring barrier island of Vlieland was visited maybe already from the 10th century BC onwards. Further to the east, the islands are not only geologically younger, but they were permanently settled much more recent too. On Terschelling (9th century) and on Ameland the villages date from the 10th or 11th century at the latest, while Schiermonnikoog and the East Frisian islands were populated from 13-14th centuries. The habitation on the Danish islands is probably somewhat earlier, from the 13th century onwards.

In Denmark King Valdemar already in 1231 has recorded an overview of all royal estates and taxes (*Jordebog*), which provides us with recordings of fx the conditions on Danish Wadden islands, “Rym”, and “Mannø”; those days also “Syld”, “Ambrum” and “Føøø”.

Apart from Stavoren, towns initially only developed at the edge of the Pleistocene, such as Groningen, Norden, Jever, Stade, Hamburg, Husum and Ribe, though from the 11th century onwards embryonal towns, being minting- and market-places developed in the marshes such as Bolsward, Leeuwarden, Dokkum, Emden and Jever. Groningen already in the 12th century was the only minting-place between the rivers Lauwers and Ems, laying the foundation of its domination over its surroundings, the so-called *Ommelanden* from the 1360-s onwards. Leeuwarden, though the largest town between Vlie and Lauwers, had to compete with a host of other Frisian towns. These, ultimately eleven by 1500, prior to 1578, weren't even represented – next to the three rural districts, in the provincial administration. Emden, location of a toll since 1253, had a short very intense flowering as an important seaport in the 16th and early 17th century, partly as a result of the Dutch Revolt (1568-1648) leading to an influx of entrepreneurial religious refugees from the Netherlands. Only to revive at the end of the 19th century as a trading port, partly thanks to the opening of the Dortmund-Ems Canal linking its harbour to the Ruhr Area.

Cause of Disasters – Impetus to Innovation

From the middle of the 12th century onwards climate change expressed itself in more precipitation and heavier storms playing havoc on the peat lands in the Wadden Sea Area. During late medieval times mismanagement and growing expertise went hand in hand, for instance in salt extraction. Salt being seasoning and indispensable preservative until about 1300 AD (since when it was imported from Lüneburg and the Atlantic coasts of France and Portugal) was won out of peat that had been permeated with salt by previous flooding. This activity of burning peat and refining salt from its ashes and brine was practised throughout the largest part of the Wadden Sea Area and the Rhine Delta in the Netherlands until the 14th century; in North Frisia even in places up to late 18th century. In the Netherlands salt extraction often took place in spots far inland, indicating that the profound influence of the sea in the past, as can be derived from 16th century surviving Dutch place names, e.g. the fishing village of Zoutkamp in north-east of the Groningen province.

The impact of the salt industry differed from one area to another. In large parts of the southwestern Rhine Delta, salt extraction was most intensive, and here several areas were reclaimed. Between Texel and Harlingen and also in North Frisia large tracts in the 13th - 17th centuries were lost to an expanding sea, never to be reclaimed. We can put forward three reasons for the fact these lost ‘Waddenlands’ in the Netherlands were never recovered, being demographic, political and physical. For one thing: the lost districts in the Wadden Sea Area were not surrounded by densely populated, highly urbanized areas like Flanders, Brabant and Holland, lying around the southwestern delta. Besides, large parts of the Wadden Sea Area

lacked a real central authority represented by the duke in Brabant or a count in Flanders, Holland or Zeeland. Finally, a much greater and dangerous tidal hub in Zeeland proved a stronger impetus on action. How much further hydraulic engineering techniques had meanwhile developed in these more centralized, urbanised and southern parts of what were at the time the *Burgundian Netherlands*, turned out when Friesland – effectively from 1524 onwards – also came under the Burgundian King Charles V. Already in 1525 diking experts from Zeeland were ordered to Friesland to teach the latest coastal defence practices to the Frisians. There they introduced tidal locks, groynes and fascine works – the latter two meant to give especially dikes without foreland a better protection – which from there spread out further over the areas around the Wadden Sea. At the same time water management organization was put to order in the western part of Friesland in 1533. There coastal defence transformed from individual forms of dike maintenance by coastal dwellers into a system of collective responsibility including inland territories and organized in so-called *waterschappen* (water boards).



The Rozema pumping station on the Ems estuary at Termunterzijl is ordained to drain the Oldambt-area in Groningen and was opened in 2000 to replace its predecessor Cremer pumping station, built in 1931. In the foreground drying mudflats at ebb-tide (photo: Meindert Schroor)

Communicating vessels, inland lakes and waterways

The interaction between salt and fresh water remained a basic characteristic of the Wadden marshes, even when – from 1100 AD onwards – most of the area was closed off from the sea by means of dikes. It was not until the improvement of drainage by large pumping stations –

in the western part of the Netherlands, from 1844 onwards – that the seasonal inundations of the lower marshes disappeared. In Tøndermarsken and Gotteskoog in North Frisia this happened between 1927 and 1933. In the Danish part by means of four pumping stations, and construction of more than 100 kilometres of river dikes. Before then, up to 4,000 hectares marshland was submerged every winter. An old saying describes the situation before the dewatering in Tøndermarsken this way: *“if we do not drown in saltwater we drown in freshwater”*. In the German part smaller drainage units led to a greater number of large pumping stations, starting with Otterndorf in Land Hadeln and Moormerland in East Frisia in 1928 and 1935. In Fryslân and the western part of Groningen large drainage pumping stations (*boezemgemalen*) – among which the World Heritage Woudagemaal at Lemmer, the largest steam driven pumping station in the world with a capacity of 4.000 m³ water per minute – appeared in 1920. In Friesland it was only after the closing of the Zuiderzee (1932) and the commissioning of a second large pumping station at Stavoren in 1967 that the extensive wintery inundations of its lower marshlands and low moorlands ceased. In Groningen lowest-lying Duurswold got its so-called drainage pumping station at Farmsum in 1933.

These inland, seasonal flooding's were yearly routine. Nowadays, against the backdrop of shrinking peat-lands and climate change, it is even gradually reconsidered making them annual practice again, just because the remedy of continuous drainage seems to be even worse than the original disease of water nuisance. Less part of these yearly flooding's and more appealing to the imagination however were the disastrous floods caused by heavy storms breaching dikes. In parts of the Wadden Sea Area some of the storm surges at least in the years 1362, 1570, 1634, 1717, 1825, 1962, 1976, 1981, 1999 and 2007 seem to have settled themselves not only in the history books but also in the collective memory of the population. Apart from the immediate casualties and the loss of lands, these inundations have had two major effects. The first and most important one seems to be the compensating accretion of land elsewhere thanks to the principle of communicating vessels. Thus, the loss of lands in the westernmost part of the Wadden Sea was – albeit partly – compensated by the silting up of estuaries elsewhere; e.g. the Marne and Middelzee estuaries in Friesland. The same was true for the expansion of the Dollard making possible the silting up of the medieval Fivel estuary in the province of Groningen, and Sielmöncken and Leybucht in East Frisia. In addition, the great loss of land in North Frisia in 1362 and 1634 eventually induced the reclaiming of extensive marshes on the mainland. And the other way around: the embankment of Margrethe Kog in Tøndermarsken after the 1976-surge accelerated the disappearance of Danish hallig Jordsand by 1999.

Fresh water: Lakes and Inland Waterways

The Wadden Sea Area is mostly characterized as a maritime region, all the more so by people from outside the area. Far less known is the fact that the population of the mainland marshes, apart from agriculture, peat extraction and primary based industries like brick making,

producing lime, grain- and industrial milling as well as in producing luxury goods (silver- and glass-works, clock making etc.), was *extremely active in inland shipping*, especially west of the Elbe river. Anyway, water until the 1920s was the main mean of transport in the Wadden Sea marshes and almost every village and farmyard was connected to an extremely intricate network of waterways, stretching deep into the adjacent hinterland. The marshes harbored many lakes, and especially in these places many still exist, such as the lake-studded southwestern corner of Fryslân (the Frisian 'Lake District'), Schildmeer in the province of Groningen as well as Großes Meer near Emden. Part of these lakes owe their existence to former peat and salt extraction and the resulting subsidence. In North Frisia, Bottschlotter See, and in Denmark, Rudbøl Sø, are the few remaining marsh lakes where elsewhere in the 'Waddenland' these did not survive the improvement of drainage from the 18th century onwards. Within new embankments after World War II, new lakes have emerged, the purpose of which is mainly to store freshwater from the inland during a prolonged closure of the sea sluice. This applies, for example the lakes in Margrethe Kog and Rickesbüller Koog at the Danish-German border (1982), Hauke-Haien-Koog (1959) and Beltringharder Koog (1987) in North Frisia. Nowadays, many lakes, mainly in Fryslân, are used for leisure purposes. The so called 'skûtsjesilen' (regattas in August with former flat-bottomed sailing cargo ships on the lakes and canals) are a popular attraction for Frisians and tourists. They refer to the immense importance the fresh inland waters in the Wadden mainland did have until less than a century ago. Even more popular for that matter is distance skating. It used to be *the* form of individual transport when the waters were frozen, throughout the whole marshland from Tøndermarsken till deep into the western part of the Netherlands. 'Elfstedentocht', a skating tour of 200 kilometers passing the eleven chartered towns of Fryslân in one day – but held only fifteen times between 1909 and 1997 – is by far the most spectacular single-day sporting event in the Netherlands, when taking place. The famous American geographer Samuel van Valkenburg, born in Leeuwarden in 1891, in an American handbook on Europe published in 1935, brings into mind the Frisian lakes: "*much used for the sport of sailing*", but even more striking continues: "*when they freeze during severe winters, they are so much used for the national sport of skating that industry is almost crippled for the short time the ice remains good*".

Another mutual phenomenon is pole jumping (*fierljeppen* in the Frisian language). Former gullies were used as ditches after the dikes locked off the salt marshes from the sea. Thereto a great many new ditches were dug to improve and extend drainage as well as to separate fields, thereby hampering land-traffic. Leaping- or fen-poles as a rule were about 3.7 meters long and used throughout the marshlands all along the Wadden Sea by individuals not only as a means to cross ditches and travel over land, but during the middle ages as a weapon (trident) too. The trident in the end being replaced by a transverse block preventing the pole to sink too deep into the mud.

Laboratory of environmental coping

As stated before the Wadden Sea Area has been a laboratory of water management and environmental coping for at least 2,500 years. From the western Wadden Sea Area settlement practices were taken by Frisians to the fenlands between Amsterdam, Utrecht and Rotterdam, in today's provinces of South Holland and Utrecht.

The Wadden Sea Area features one of the most extensive, well-preserved cultural landscapes in the western world. During the first millennium AD the salt marshes were one of the densest populated parts of Western Europe, whereas in the 7th and 8th centuries the land west of the Weser, called Frisia, was the trading hub of Western Europe. In the northeastern corner of the Wadden Sea Area trading centers like Haithabu (Hedeby/Schleswig) and nearby Ribe acted as turntables in the traffic between the North Sea and the Baltic regions. Commerce not only fostered prosperity but also led to an increasing population. Beginning in the 9th century in the western parts, the Frisian coastal economy drifted away from overseas trading and shifted to the settling and cultivation of inland bogs. This was partly the result of the competition of Viking traders and Viking raids, though population pressure proved a more forceful impetus evoking this movement inland. A shift that confronted the Wadden Sea marshes with new challenges. For a start, there was the growing amount of fresh water unleashed from shrinking inland bogs which as a result of colonization and cultivation rapidly lost their capacity as water buffers. Parallel, elongated parcel boundaries are evidence of the colonization of the adjacent moorlands, where in addition subsidence by drainage and peat extraction for heating and the procurement of salt was reflected in the increasing number and size of inland lakes. The nearer the sea, the more the intermingling of fresh and salt water and sluggish drainage caused high mortality rates. This environmental factor was hardly understood until the first half of the 20th century.

The 11th century saw the appearance of the first ring dikes in the western Wadden Sea Area, in Westergo. Technologies in embanking of the coastal marshes as well as developing the inland bogs were developed in the western Wadden Sea Area and exported, initially into the heart of Holland, then to the North German coastal and riverine bogs and eventually into Great Britain. Culverts (*pomp, pump*) were developed to lead the surplus of water through the dikes. Portages (*overtoom, rollen*) came into use to let ships cross dikes at all tides and water levels. The sluice (*zijl or Siel*) evolved from the culvert and made possible the passage of ships at equal tides and finally locks facilitated the passage of ships independent of tides and water levels. They were in use since the closing of the Middle Ages. From the late 12th century onwards Cistercian and Norbertine monasteries took a lead in manning and organizing the struggle against the waters. The relation between the population of the marshes and the nearby sea since has been a alternation of inundations and reclamations, as well as dike and water management and mismanagement.

Influence on water and coastal management worldwide

Already from the 12th century onwards the name of Friesland gradually disappeared in this coastal area and west of the Zuiderzee being replaced by the name 'Holland', which to many foreigners today is equal to the entire country: the Netherlands. Thus, quite a few medieval settlers in nowadays Germany or Poland designated as coming from 'Holland' or the Utrecht diocese, to which both the present provinces of North and South Holland as well as Fryslân belonged, were in fact Frisians from around the Wadden Sea and its ever growing southern extension, the inlet of the Zuiderzee. Due to their skills and reputation, these so-called 'Holländer' often invited by local rulers established themselves in the marshes and bogs around Bremen (Hollerland and Stadland, since 1113) and in the Elbe marshes (Altes Land, Hadeln, Kehdingen, Kremper- and Wilstermarsch, since 1130). By means of contracts with the archbishop of Bremen they partly reintroduced dwelling mounds, but more importantly polders with their main dikes, spare dikes – so-called *slaperdijken* or literally sleeping dikes –, main drains and culverts. Dutch hydraulic engineering expertise furthermore reached Poland already in the High Middle Ages, e.g. in the Vistula Delta nearby Gdansk, in Pastek, alias Preußisch Holland. In this region it was perfected by Mennonites, 16th century religious refugees likewise from the Netherlands, the so-called Olędrzy or Holender, meaning Dutch. It also appeared in the 17th century in Eastern England (Bedford Levels, Hatfield Chase, Romney Marsh) and in France (Poitevin Marsh, Médoc-Gironde).

In the 17th century Dutch hydraulic expertise reappeared in North Frisia, through the foundation of Friedrichstadt in 1621, the attempt to embank the Bottschlotter marsh in 1633 and reclaim parts of the former island of Nordstrand in the 1650s after the great flooding of 1634. In 1619-1621 Dutch engineers built the first artificial harbour in Germany at Vegesack near Bremen. Two centuries later the Amsterdam engineer Jacobus Johannes van Ronzelen designed and built the first harbour basins of Bremerhaven in 1827-1830, resp. 1847-1852. Even the initial – though non-implemented – plan from 1851 for a port on the spot of current Esbjerg, actually founded from 1868 onwards, was conceived by the Dutch engineer J.A. Beijerinck. Of course, Dutch hydraulic engineering also reached its colonies. In 1892 the new-built port Emmahaven on the island of Sumatra was opened for traffic, followed in 1895 by Tanjung Priok; being the port of Batavia, nowadays Jakarta on the island of Java.



Apart from their natural beauty, the Frisian of Wadden Islands have also been wave-breakers of old for the mainland, as can be seen by this areal picture of the island of Vlieland. Islands that by themselves need protection too, as can be seen by the breakwaters that protect the North Sea coast at Vlieland since 1854.(photo: Jolmer Tilstra)

So, all in all a quest, initiated in the Wadden Sea Area, that from the 16th century onwards laid the foundation of the Dutch idea of triumphing over the forces of nature: down-to-earth and pragmatic, as ever with an eye on efficiency, economies and profit. In the end they culminated in two large scale projects that from an international viewpoint still strike the eye. Most appealing was the restraining of the Zeeland-delta followed by the strengthening of the whole Dutch coast in the context of the so-called Deltaplan that was implemented after the 1953 flooding. A comparable flood-barrier over the Oosterschelde was built across the Eider river between Dithmarschen and Eiderstedt in 1967-73. The Zuiderzee-plan of 1891, implemented from 1918 onwards, that preceded the Deltaplan was even more spectacular as a lot of land was won from the sea. This plan started with the closing of the Zuiderzee in 1932 at which its northern part now became renamed 'Wadden Sea' and extended the geographical term of the traditional, Dutch perception of Wadden Sea, which until then stretched, called Wadden, only from Ameland to the east. The Afsluitdijk (the enclosing dike) links the two westernmost parts of the Wadden Sea Area: the marshlands of North Holland and Fryslân, and it carries the statue of the designer of the Zuiderzee-plan Cornelis Lely, looking out over this seawall and the monument standing opposite. Lely had perhaps the most Dutch profession one can imagine: hydraulic engineer. As Minister of Public Works, he succeeded to guide his own plan, already formulated in 1891, through parliament. The monument was built on the spot where the Afsluitdijk was closed and paid by the consortium of contractors that was formed by the

government to bring this giant job to a successful end. This enclosing dike and the ensuing polders in the former Zuiderzee, today's IJsselmeer, in themselves are milestones in the historical development of water management techniques. They had a profound influence in transforming humanity's understanding of the relationship with the natural world in general and the sea, in particular.



In 1921 provincial authorities of North-Holland province were urging the population to eradicate mosquitoes in order to prevent malaria.

This watery inland world of the marshes has for some thousand years been separated from the actual Wadden Sea by dikes, but as a matter of fact always formed a part of it. Although it appears that the only connection between the sea and the people behind the dikes remaining is the obvious fear for dike breaches and flooding. Less spectacular but ultimately deadlier seems to have been the further salinization of an already brackish environment, but this danger was recognized late or not at all. Like a bone fraction that's easier to recognize than a mental illness. Yet after dikes broke through, the slight relief sometimes left the fields for months under saltwater, thereby aggravating malaria turning from endemic into epidemic. Though the marshes on both sides of the North Sea have been associated with fevers already very early, it took centuries before the real cause was found. And so what became a typical North Sea, and consequently Wadden Sea Area, disease was able to rage from Saint Guthlac (674-715) in the Fens of Lincolnshire "racked by rheumatism and fever", through abbot Emo of Wittewierum in the marshes near Groningen dying of tertian fever in 1237, till the

construction of the naval port of Wilhelmshaven, where in the 1860s mortality was propelled by malarial intermittent fevers. In Butjadingen these fevers were considered as the scourge of the population and called “*Butjadinger Seuche*”, taking an epidemic form in 1808 when hundreds of people on Butjadingen peninsula perished. As “*Marschkrankheit*” it was a plague in the entire German Wadden marshlands. Elsewhere in the Wadden Sea Area it was no different, as Groningen had its “*Groninger ziekte*”. It was the use of insecticides but above all the decrease of brackish water by taking in fresh water and flushing lakes, canals and ditches with it that from 1950 putted an end to this endemic disease. All the same, malaria did not prevail everywhere throughout the Wadden Sea Area. The Wadden islands with their sandy or light clayey soils and more natural drainage were practically free from it. The same was true for the almost uninhabited Danish Wadden Sea marshes.

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