

Sea Level Rise as a Threat to Cultural Heritage

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The historical landscape of the Wadden Sea Area bears the traces of many centuries of piecemeal human intervention. Local communities have to cope with the risks of living near the sea. Besides storm surges, also coastal erosion and sandstorm, salting up of natural resources, drainage problems and malaria outbreaks have posed important challenges. Sea-level change has always been a secondary problem, as its fluctuations were relatively insignificant as compared with the total impact of human activity. During the 20th century, however, the scale of human intervention has increased considerably. Sea-level rise poses a threat to the cultural heritage of the area, not because of its effects, but because of the scale of the available cures.

Human Settlement

Homo Sapiens have inhabited the Wadden Sea Area for many centuries. The marshland amphibian environment with its diversity of fish, shellfish, fowl and wild plants has been exploited since the 5th millennium BC by the sedentary Ellerbek-Ertebølle and Swifterbant cultures. Subsequently, Neolithic, Bronze and Iron Age settlers learned to use the fertile salt marshes and riparian thickets for pasturage and agriculture.

For long, permanent settlement was largely restricted to the edges of the coastal area. Dozens of sites were located on moraine hillocks and river dunes, where they were subsequently buried under marine or riverain sediments or became overgrown by the mires. Near Delfzijl (Netherlands) Neolithic settlers built a megalithic chambered tomb about 3350 BC. After 2200 BC, the site disappeared under several feet of clay and peat. As many as 77 megalithic graves are located on the North Frisian Islands alone, whereas the adjoining mudflats and sandbanks provided dozens of flint daggers and sickles.

As sea level rise slowed down, the local tribesmen began to reclaim the coastal plains. About 1200 BC, Bronze Age farmers settled down at a former river-estuary North of Amsterdam. The Weser and Ems riverbanks were first colonized during the 9th and 8th centuries, the Elbe riverbanks



Hallig Hooge
Photo: Walter Raabe

at the latest during the 4th century BC. These Bronze and Iron Age settlers adapted to the amphibian environment by expanding their stocks and supplementing their diets with fish and fowl. Farmsteads were situated as deep as 1 meter below the present sea level. When forward pushing mires submerged their fields and pastures people had to give up their quarters.

It took even greater efforts to establish hamlets in the expanding salt marshes, as people had to cope with shortages of fuel, wood and drinking water, as well as with the risk of storm surges. The first settlers may have been pastoralists, who spent the winters on higher grounds. The legend of the Cimbri, Teutonic and Ambrones warriors, who sacked Northern Italy 101 BC, suggests that they had left the Jutland peninsula after a storm surge some two centuries earlier. This may imply that their tribal economy had become largely dependent on coastal resources by then. Moreover, the expansion of inland bogs reduced their means of subsistence and made them look for alternatives.

The Frisian and Groningen coastal marshes have been inhabited since about 500 BC at the latest, the other coastal districts from Holland to Schleswig-Holstein since Roman or Pre-Roman times. In each case, the first settlements were established on the surface just above the present sea

level. In Frisia, archaeologists recently discovered that Roman-time settlers sometimes surrounded their infields with quays measuring three to four feet in height. Only after several generations people started to build elevated mounds on which they situated their farms and infields.

Various tribes shared virtually the same culture, which was well adapted to the risks and possibilities of living near the sea. They had brisk sea-borne contacts with the Roman borderlands from which they borrowed many items of material culture as well as ideas. But though Roman engineers mastered the skills of building canals, large-scale embankments and sluices, there are no indications that the local population adopted these innovations.

Sea Level Fluctuation

For long, archaeologists have presumed that mounds were created instead. Their construction would indicate that sea levels were rising rapidly. Most of these mounds were abandoned during the 5th and 6th century, whereas their fields and meadows were buried under several feet of sand and clay. In Holland, relative sea levels in Roman times may have been 0.6 to 2.0 meters lower than they are today. On this basis geologists and palaeobotanists reconstructed sequences of maritime transgression and regression, corresponding with layers of sediment (such as Dunkirk I-IV) and periods of renewed settlement. But recent findings suggest that worldwide temperature fluctuations can hardly be made responsible for all of the sea level changes observed. In fact, one degree of temperature rise may account for a rise of sea level of just 0.15 to 0.20 meter. Moreover, ongoing international cooperation has shown that the presumed sequences of transgression and regression do not correspond at all in different parts of the Wadden Sea area.

Consensus is growing now that our scientific models need to be readjusted. Regional and local circumstances may better account for changes in high-tide marks and storm surge levels than general models of sea level change. More attention should be paid to tectonic influences, compression of subsoil strata, the erosion of foreshore banks and barrier islands and the widening or silting up of river estuaries. Furthermore, substantial parts of the Wadden Sea were filled up with huge mires, which only gradually died off and eroded. Dozens of stories about floating islands of peat, sometimes with trees and cattle still on them, have been recorded. According to the 12th-century historian Saxo Grammaticus "many fields have been undermined and torn away, and carried to other parts, leaving a void

in their place, and they can be annexed by the owners of wherever they settle". As these floating peat banks disappeared, the coastal marshes became more liable to floods.

Hence, the abandonment of the coastal area during the Migration Period cannot be explained by rising sea levels alone.

Probably it was, to a large extent, the consequence of political turmoil and economic collapse, aggravated by health problems due to the introduction of malaria. Resettlement since the 6th and 7th centuries has followed the same cultural patterns as before. The first generations settled down between 1 and 2 meters above the present sea level, before they started to build artificial mounds. Subsequent generations reconstructed and enlarged these mounds, often far above the level of the highest storm surges. We might expect that these activities had more to do with other objectives, such as the intended reduction of the risk of storm surges, than with an actual rise of sea levels. Moreover, the highest mounds had a military and political function as well.

By the 9th and 10th centuries, Frisian colonists also settled down at the edges of the North Frisian mires, which were recently made accessible by drought and coastal erosion, and at the fertile lee-side of the barrier islands. Human activity, especially salt-making and draining, accelerated the ruin of the coastal peat banks until most of them had disappeared by the end of the Middle Ages. On the islands, excessive grazing as well as the introduction of the rabbit in the 13th century reinforced the process of wind-erosion, thereby contributing to the inherent instability of the coastal dunes. Whole villages have been covered by sand or washed away into the sea.

A Man-made Landscape

The typical scenery of the coastal marshes, with its closed villages, scattered farmsteads, endless canals and numerous ditches is the result of the process of embankment that started in the 11th or 12th century. Essentially, it is a handmade landscape, molded by centuries of piecemeal human intervention. During many generations, innumerable spits of earth had been moved until minimal differences in height had the desired effect on water management. Sometimes neighbors just started with a dike around their fields, sometimes dozens of villages collaborated from the beginning. By the 14th century, a 1 to 2.5 meter earthen wall surrounded most districts, with valve sluices at its lowest points.

Again, we must stress that a moderate sea level rise, caused by the climatic optimum, could hardly be the immediate cause for dike-building. Rather, such huge investments in infrastructure represent a social innovation, accompanied by novel patterns of co-operation and organization. The process of transformation was fairly irreversible; it created completely new forms of administration and control. Nevertheless, most embankments were not able to stand up against storm surges. Instead, they had mild slopes, so that the waves could do limited damage. According to an East Frisian author writing in the 1530s, people were still used to frequent flooding, as it fertilized their meadows. To get rid of redundant seawater, they just opened the sluice gates.

Colonization of the inland bogs, however, caused severe hydrological problems, as the newly reclaimed peat lands rapidly subsided until their surface almost reached ground water levels. Vast areas were depopulated because of frequent inundation; others were overwhelmed by the sea, because their embankments did not hold. As late as 1634, 200 square kilometers of fenland on the North Frisian island of Nordstrand were greatly destroyed as their dikes broke down. The North Holland peninsula could only be saved by building 4 to 6 m high seawalls, strengthened by palisades, seaweed, twigs, thatch and boulders.

By the 16th century, finally, it became more common to construct embankments that could endure the ordinary storm surges. As the result of subsequent reclamation that reduced the salt marshes and mudflats, the tides were pushed up against the sea-banks and into the river estuaries. With each embankment, the floods mounted higher. Methods and organizational skills, mainly borrowed from the Netherlands, enabled the inhabitants of the coastal area to reduce the risk of inundation. Dikes were reconstructed, strengthened and heightened, from 2 to 4 meters in the 16th century, 3 to 5 meters in the 17th century, up to 4 to 6 meters in the 18th century. By then, storm surges had become an exception. When they occurred, however, their effects were more detrimental than ever before, as could be seen in 1717, 1825 and 1962. Nowadays, most dikes have reached a height of 7 to 9 meters at least.

The Heritage of Agricultural Prosperity

To a substantial extent, the cultural heritage of the coastal marshes is the product of their 18th and 19th century agricultural prosperity. This could not have been possible without the preceding reconstruction of the embankments. Without dike building, the ongoing investments in land amelioration, drainage equipment, farm buildings, herds and tools could not have paid off. In return, the dikes were raised even further, because too much was at stake. Risks had to be reduced all over. Additionally, the enhanced storm frequency due to climatic change may have offered some incentive for dike building. But, sea level changes were rather insignificant as compared with the measures taken.

Nonetheless, the *idea* of rising sea levels, or, alternatively, submerging landmasses gained ground during the 19th and 20th century. As such, it served as a legitimization for further embankments. As the amount of human investments grew, the urge to control the embodied risk grew even more. Since the 19th century, the scale of human intervention has increased considerably. Embankments, sluices, canals and flood control dams have been enlarged to an unprecedented stature. Nowadays, a dragline can do as much work in a day, as one man previously did in a whole season.

Modern technology, then, has transformed the historical landscape faster than even the most pessimistic scenarios of sea level change would have required. Many cultural and natural values have been severely damaged. The fruits of many centuries of piecemeal human intervention are at stake. Future large-scale interventions may even be more detrimental.

Rising sea levels pose a threat to the heritage of the coastal area, not just on behalf of their effects, but also because of the scale of the available cures. Only a deliberate balance between general safety measures, controlled risks and custom-made adjustments can help to contain these damaging effects.

Literature

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