EVOLUTION AND ECOLOGY OF COASTAL LANDSCAPES AROUND THE SOUTHERN NORTH SEA

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EVOLUTION

During the last Ice Age the southern North Sea was dry land. When the ice caps melted the rising sea level reached the coasts of the present countries England, France, Belgium, the Netherlands, Germany, and Denmark about 4,000 – 5,000 years ago. After sea level rise slowed down a flat coastal landscape developed around a tidal sea. This resulted in many areas in a sequence of different landscapes from the North Sea land inward:

- sandy barrier islands with beaches and sand dunes;
- salt marshes at the landward side of the barrier islands;
- tidal flats intersected by tidal channels;
- salt marshes along the mainland coast;
- brackish marshes;
- fresh marshes and swamp forests;
- peat moors;
- and finally dry sand hills in the hinterland.

Around 500 BC people from the hinterland colonized the marshes along the mainland coast. It is likely that they first exploited the marshes as grazing land for cattle, but eventually people settled permanently at the highest places in the marsh, such as levees of tidal channels. No doubt in response to high floods, the next step was that they heightened their dwelling places by bringing in sods from the marshes. Five centuries later the Romans encountered a population living on artificial mounds “who looked like seafarers at high tide and like ship-wrecked people at low tide”.

However, the Romans apparently failed to observe that this coastal area was one of the most densely populated areas of the region. In this period we also notice the first attempts to build dikes or seawalls, probably to protect their agriculture against summer-floodings.

During the early Middle Ages, the period of the Migration of Nations, the art of reclamation apparently was lost and large parts of the coastal area lost their population. The few remaining people continued to live on artificial mounds from where they exploited the coastal landscape. The coastal landscape was recolonized, however, and the increasing population pressure resulted in two new developments, dike building in the coastal area and drainage of peat marshes in the hinterland. Both developments started about 1,000 AD and both aimed at increasing the agricultural production capacity.

The earliest reclamations probably were initiatives at the scale of local villages, but soon more powerful organizations took over. These were the regional counts and dukes as well as the monasteries. This resulted in large-scale projects which in the coastal areas aimed at the protection of agricultural land against flooding and which in the peat landscape of the hinterland aimed at drainage of marshes to cultivate various crops in the dry top layer.

The large-scale coastal reclamations mainly occurred in the 11th – 13th century; after this period many smaller reclamations were carried out by building dikes around newly accreted salt and brackish marshes. This practice has continued until very recently. The large-scale drainage projects in the peat landscape in the hinterland occurred slightly later and continued until about the 15th century.

Because the area around the North Sea has a surplus of precipitation over evaporation, all reclaimed areas need drainage facilities. Originally, all drainage was based on gravity flow. This was no problem because reclaimed areas in the coastal area always were situated above mean high-tide level and the tidal range varied between about 1 and 4 m. Drainage in the peat areas was even easier because many peat moors were several meters above high-tide level. Draining the land, however, resulted in subsidence of the land, partly due to compaction, but especially in the peat areas due to oxidation of the peat. The resulting subsidence rates amounted to over 1 m per century and within a few centuries the surface of the drained land was level with the sea. Because this hampered further drainage the rate of subsidence temporarily decreased until windmill technology was introduced in the 15th century. Windmills could pump water out of reclaimed areas also when the drained area was lower than sea level. This started a new period of subsidence and in its turn this was reinforced when steam technology enabled larger pumping capacity. And diesel and electric engines came next.

So, a major result of reclamation was subsidence of the land by several meters. On the other hand sea level rose; measurements at Amsterdam starting in 1683 and elsewhere since the 19th century show a rise of mean sea level of about 60 cm and an even stronger rise of mean high-tide level. The problem is reinforced by the absence of deposition of sediment in reclaimed areas; whereas tidal marshes generally keep pace with sea level rise due to sedimentation of clay and silt, this process is absent in in reclaimed areas. As a result large areas around the North Sea are now lying below mean high-tide level and even below mean sea level. For example, the centre of the island of Schouwen will have been above mean high-tide level at its reclamation in the 12th century, whereas nowadays the level of the land is more than 3 m below the present mean high-tide level.

Subsidence of the land and rise of the sea create a potentially dangerous situation, especially along tidal coasts and even more so along coasts with frequent storm surges. The history of the coasts along the southern North Sea bristles with dike bursts resulting in flooding of large areas. Especially when the flooded area was large and the tidal range in the adjoining estuary was large as well, our forebears have often been unable to close the breached dikes because of the strong tidal currents through the gap, meaning that the land was permanently lost. The years 1421, 1530 and 1570 are still remembered in the Netherlands for their disastrous floods, as are the years 1362 and 1634 in Germany.

However, in several cases the loss of low-lying land proved to be a blessing in disguise. Accretion of new saltmarshes in the drowned area was followed by piecemeal reclamation

resulting in some of the most fertile soils of the region, situated, moreover, at much higher level relative to mean high-tide level.

Another category of land loss occurred when reclaimed areas fell victim to coastal erosion. Reclaimed areas exposed to wave attack or to erosion of the shore by laterally moving tidal channels were lost many times, although in this case the loss often could be predicted. If so, a new seawall often was built behind the exposed one.

Although the level of the land is still going down relative to mean high-tide level, modern technology has caught up with the increasing danger of flooding. Shortening of the length of sea walls, construction of storm surge barriers, vastly improved dike building technology, and a better management organization all have contributed considerably to a safer situation. However, this is based on an evolutionary process of many centuries in which survival of the best adapted reclamations and loss of the unsuitable ones prepared the stage for the present situation.

ECOLOGY

Reclamations around the southern North Sea have had a clear impact on the ecological conditions, both in the reclaimed areas and in the adjacent areas at the other side of the seawall.

Inside the seawall a marine or brackish habitat is changed into a freshwater or terrestrial habitat. Consequently, almost all salt-water and brackish plants and animals disappear to be replaced by inland species. We have little information on what happened exactly during the large-scale mediaeval reclamations. From the 20th century, however, we have a number of studies from several North Sea countries showing that the process can be very rapid. Freshwater replacing salt or brackish water is colonized within a few years by freshwater species. Emerged tidal flats subjected to freshwater precipitation are rapidly colonized by terrestrial plants, insects and birds. In this case, however, the succession takes longer: at least several decades of change have been described so far, and the ultimate situation may need more than a century to develop.

A small reclamation has no measurable impact on the remaining estuary. However, the reclamation of the 3,800 km^2 brackish Zuiderzee in the Netherlands in 1932 proved to be a clear demonstration of such effects. The tidal range in the remaining estuary increased from 0.9 m to about 1.5 m causing widespread erosion of saltmarshes. Vast eelgrass beds disappeared, probably due to a disease, but afterwards never returned. Characteristic animal species of the seagrass beds such as two species of snails and two species of fish disappeared also. A local race of herring lost its spawning grounds and was extirpated as well. Bottlenose dolphins feeding on the schools of herring also disappeared from the estuary. No new species arrived making up for the losses.

A general type of loss due to reclamations is the loss of gradual transition zones: both from land to sea and from freshwater to seawater. Whereas in former periods an extensive brackish zone will have been present, we now find a sharp boundary. On the one side of the seawall the environment is terrestrial or freshwater, on the other side it is seawater.

Whether all changes have had an impact on the productivity of the systems is hard to say because most changes occurred long ago. Anyhow, we have no indications that major nurseries for shrimp of fish have been lost.

LOUISIANA VS NORTH SEA

What can be learned in Louisiana from the North Sea experience?

First of all a warning. The southern North Sea is a tidal environment with tides ranging from about 1 to 4 m in contrast to the microtidal situation of the Gulf of Mexico. This difference is responsible for major differences in hydrology, sediment behavior and the ecology.

Second, the southern North Sea shows that an area behind seawalls necessarily is different from an area outside the seawall. On the other hand this does not mean that a quality difference exists. A stable ecological situation may need more than a century to be reached but both during the succession as well as in its final form ecological quality may be present.