# A Spaceborne View at Archeological Sites on Intertidal Flats on the German North Sea Coast

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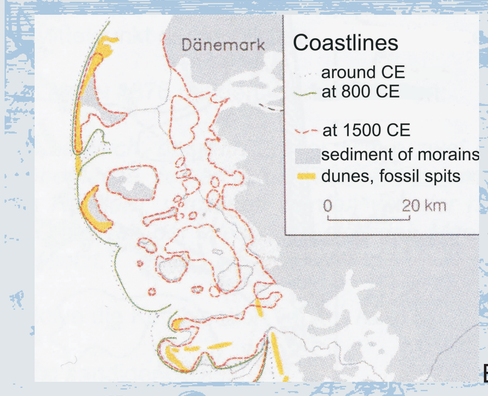
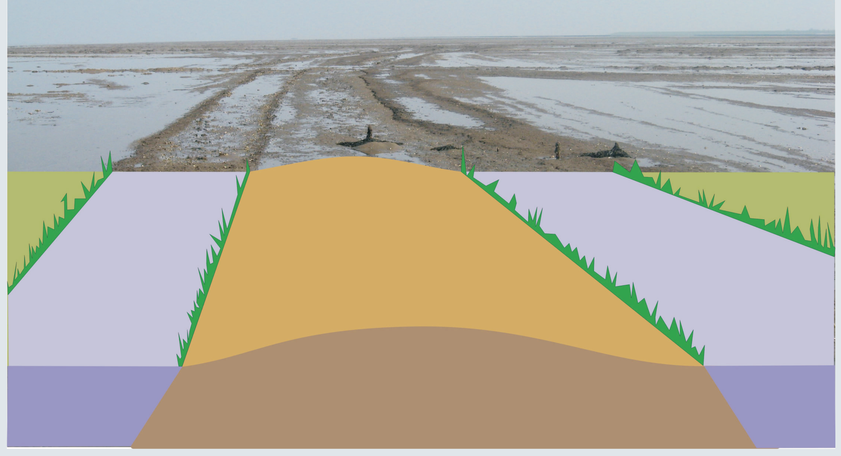
In the Middle Ages, farmsteads and villages were built along the German North Sea coast. The houses were mostly built on dwelling mounds and ditches were built to take out the water of the farmlands. In the mid 14th century, a period of bad harvests due to cold summers, corresponding hunger, and the Black Death in 1350, the population in that area was reduced by about 75%. As a result, the dykes had been in a bad condition. On January 16, 1362, after more than 24 hours of severe storm, the small dykes broke and a great number of both cattle and men died. During that storm surge, large land areas used as farmland were lost to the sea.




Behre 2009, modified

After this biggest catastrophe of the late Middle Ages in northern Europe it took a long time until new dikes were built to protect the marsh land. This new farmland was structured by a wide-meshed system of ditches. Dykes enclosed polders and farmhouses on terps were connected by narrow lanes. Than another major storm surge occurred on October 11, 1634, again destroying farmland, farms, and whole villages, and killing cattle and men. The big (second) "Manndränke" is still the most known storm surge in history in the area of the North Frisian Wadden Sea. Major parts of the populated area were destroyed and the swampy land changed its face and became the Wadden Sea as it is known in modern times. The farmland was buried by muddy and sandy sediments.

Aerial photograph taken on July 29, 2009, at low tide and showing residuals of former settlements in the German Wadden Sea, close to a tidal creek (upper left). Image by Bernd Hälterlein (LKN).



Reconstruction of a medieval lane, later crossed by a ditch, which could be recognized as horizontal structure in the background. Image and drawing Kohlus (LKN), 2008.

Section (1900 m × 2000 m) of a TerraSAR-X image of dry-fallen intertidal flats north of Pellworm. Residuals of historical land use can be delineated through linear bright and dark structures. © DLR 2009.

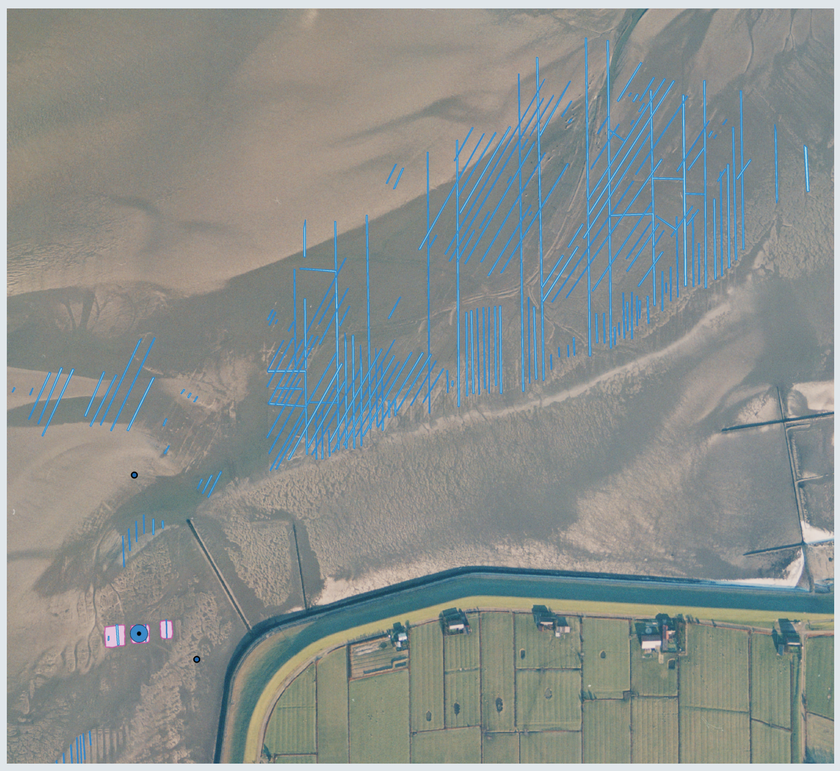
When today erosion moves away the muddy and sandy marine sediments on intertidal flats, banks of peat, old clay, and structures of farmland and settlements appear again on the dry-fallen surface. Its structures, mostly ditches, but also lanes or dykes, cannot be observed through their relief of less than 10 cm. Rather it is the sediment on the lost pastures that are different from those in the linear structures of ditches.

Foto: Kohlus, 2009

Typical wadden sediments on the flat sand banks consist of marine fine sand. The surface of the fossil ditches is different. In the center there are pillowy sediments while the ditch edges are often stabilized by fossil roots and other plant material connected with the sediment. This causes narrow ridges with thicknesses of only 10 cm to 20 cm, which can still be observed.

The high-resolution X-Band synthetic aperture radar (SAR) aboard the German TerraSAR-X allows for mapping the Wadden Sea surface from space, and SAR images with a pixel spacing of less than 1 m can be used to detect small-scale surface structures if they are linked with a variation of the surface roughness of the Wadden Sea sediments. The Figure left shows a small section of a TerraSAR-X image acquired on August 3, 2009, over the same area as shown right. The residuals of the historical structures can clearly be delineated as linear bright and dark signatures. For the first time, thus, residuals of historical land use in the North Frisian Wadden Sea are detected by a spaceborne SAR sensor.

Since those areas are difficult to reach and, thus, to observe from the ground, spaceborne sensors have proven to be advantageous for a systematic observation of the residuals of those historical places.



Aerial photograph of dry-fallen intertidal flats north of Pellworm. Fossil terps and and field structures provided by the State Archeological Department of Schleswig-Holstein (purple and blue). Ditches of the 17th century create a vertikal grid; narrow, mostly bias structures indicate farmland of the Middle Ages.