Erosion Pressure on the Danish Coasts

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Coastal Erosion and Climate Change

Coastlines around the world are receding due to coastal erosion.
With rising sea levels and a potential climatic deterioration due to climate change, erosion rates are likely to increase at many locations in the future.
Together with the current preference of people to settle near or directly by the ocean, coastal erosion issues become increasingly more important to the human values at risk. Along many Danish coastlines, hard structures already act as coastal protection in the form of groins, breakwaters, revetments etc. These eroding coasts however still lack sand and where the public, in general, neglects the need for sand replenishment i.e. in the form of repeated sand nourishments.

Here we present a conceptual model and method for dividing coastal erosion into acute and chronic erosion pressure, respectively. We focus on the model use for management and climate change adaptation purposes and on how to make coastal processes and the impacts of climate change on the coasts more comprehendible to the public.

Coastal Erosion Pressure

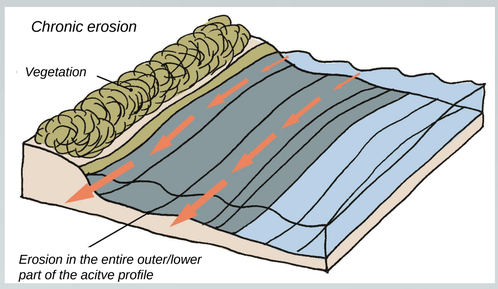
At unprotected coasts it is fairly easy to assess erosion rates (e.g. in m/y) from historical measurements. At protected coasts it is more difficult to assess the autonomous erosion had there been no coastal protection measures. Still, some erosion is likely to occur beneath the water surface which in time will lead to more energetic conditions in front of and failure of the hard structures to serve their purpose of yielding protection.

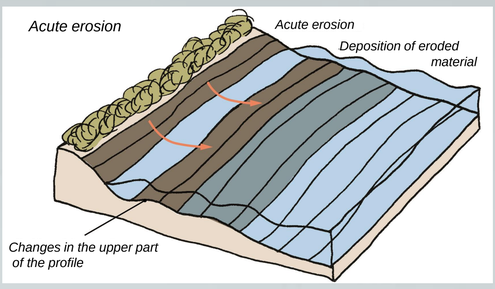
The concept of erosion pressure is thus a measure of how much erosion can be anticipated along on a coastline independently of the current degree of coastal protection. This allows us to compare coasts with and without protection measures to i) assess longer coastal stretches as dynamic and coherent units; ii) to address explicitly the nature and causes of erosion at individual sites, and iii) to address the erosion challenges faced ahead in relation to different protection options.

Chronic Erosion *versus* Acute Erosion

Chronic erosion describes the everyday under water depletion of sand in the alongshore direction by currents.

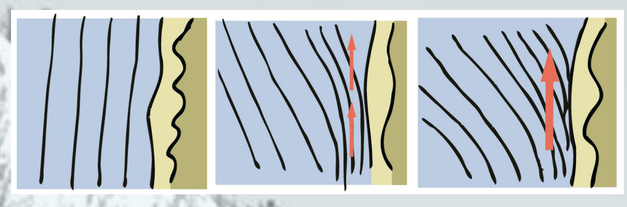
Acute erosion occurs infrequently during storm surges and leads to beach and cliff erosion by cross-shore transport.



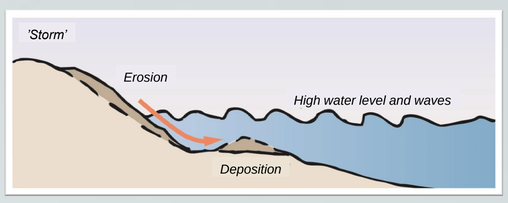


Chronic erosion is estimated from wave energy climate and coastline orientation in relation to the prevailing waves

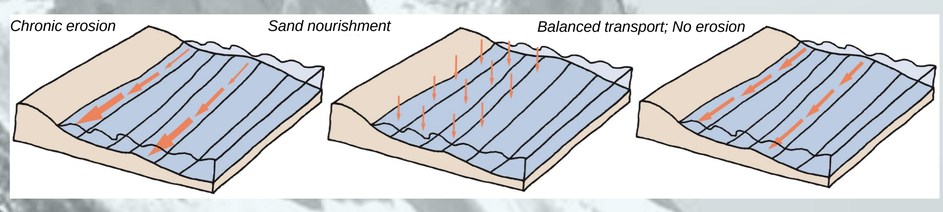
Acute erosion is estimated from the correlation between extreme high water levels and waves.



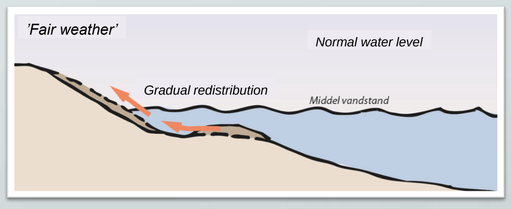
Chronic erosion is invisible from the beach and will increase if upstream sources of sediment for transport are reduced e.g. due to coastal protection.



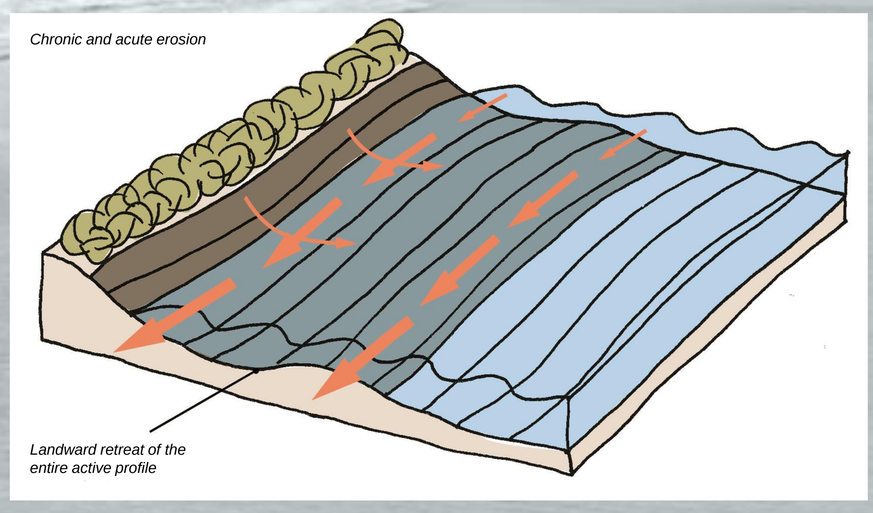
Acute erosion is very visible. Although of a dramatic visual impression, it may be limited to a few incidences per century making the average erosion rates small.



A coast with chronic erosion experiences a constant deficit of materials. By sand nourishments a balanced alongshore transport without net erosion is obtained.



Materials from acute erosion are often not lost from the profile and will under fair weather conditions be transported back to the beach.



A coast may experience either chronic or acute erosion, or, both. The erosion pressure on a longer timescale will often be a combination of both and leads to a retreat of the entire profile. If rates of acute erosion are large, and dependent on the coastal type (e.g. a cliff coast or a sandy dune coast) artificial dunes to act as a buffer, or, hard measures like sea walls may be built; the latter however will often become in need of sand replenishment as well.

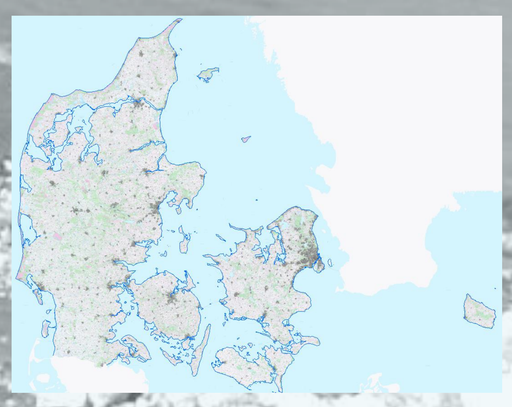
A Coastal Erosion Atlas of Denmark

kystatlas.dk

To address national coastal erosion issues towards landowners, to support policy & decision makers, and to enhance sound coastal management approaches and practices the Danish Coastal Authority, DHI and University of Copenhagen are collaborating on a coastal erosion atlas tool that takes into consideration the great variability of change and challenges along the 7,300 km long Danish coastline. Currently we are elaborating on a further assessment of the impacts of climate change on the coasts.

The erosion tool is, together with tools on flooding hazards and risks, publicly available to inform and to serve as a fairly non-technical guidance towards coastal development and coastal protection issues (the scientific approaches and methodology is available as well at kyst.dk).

The coastal erosion atlas tool contains (or is soon to be updated with):



Chronic erosion *Accretion; Minimal; Moderate; Large; Very large*
Acute erosion Little, Moderate, Large, Very large
Sediment transport directions
Off-shore wave climate today and climate change projections from hind cast modelling
Wave energy levels
Extreme water levels statistics for 68 tide gauges + coastline for 20, 50 & 100 y events today and 3 CC scenarios in 2100
Coastal classification Soft cliff; Sandy or dune, Rocky, Marsh/Wadden Sea, Accretion
West coast profile lines (Jutland west coast only)
Historic coastline changes total and average rates of change
Coastal protection measures Groins, Breakwaters, Seawalls & Revetments, Dikes, Nourishments etc.
..in addition to which are featured:
Potential flooding extents and risk maps (the latter still for parts of DK only)
Glacio-isostatic uplift rates (in collaboration with DTU Space)
Areas susceptible to local land subsidence (in collaboration with the Danish Geodata Agency and DTU Space)
Ortho-photos and digital elevation model (from the Danish Geodata Agency)

DTU
Danish Ministry of the Environment
Coastal Authority
DHI
HASLØV & KJÆRSGAARD

2nd European Climate Change Adaptation Conference, Copenhagen, Denmark, 12-14 May 2015 (ECCA2015.eu)

ECCA

Photos by swat.dk
Sketches by Hasløv & Kjærsgaard – hogk.dk, and DHI.