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## Soil of the Year 2020

# The Intertidal Flat Soil (Wattboden)

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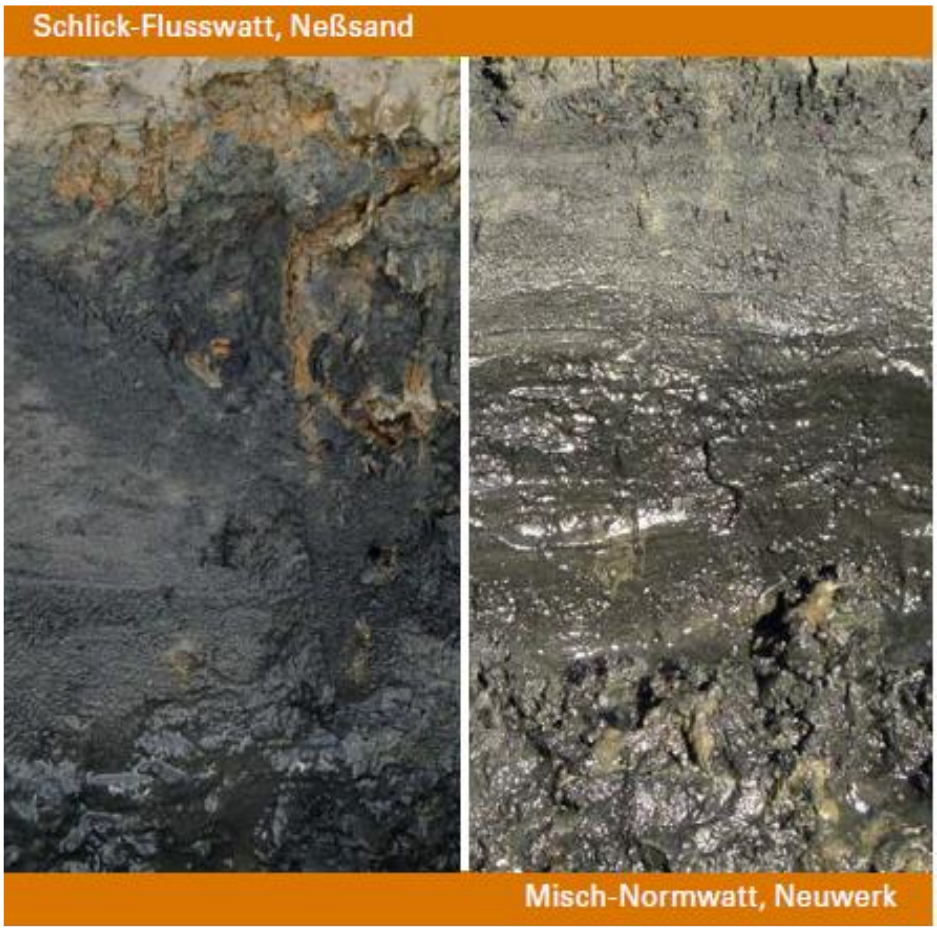
Sand estuarine tidal flat soils, Neßsand

The soil of the intertidal mudflats is a young soil that forms in the transition area between land and the sea under the influence of the tides. It occurs in the area that is regularly inundated by seawater during high tide, but is exposed to the atmosphere at low tide. Vegetation cover is mostly sparse or absent at all. Some pioneer plants are nonetheless able to colonise the intertidal flats, and in areas sheltered from surf, even productive reedbeds can occur. In the international soil classification WRB, intertidal mudflat soils belong to the Tidalic Gleysols..

**Formation**

Caused by the forces of wind, waves and flowing water, sediments deposit in the shallow waters along the sea coast and in the estuaries affected by the tides. They can be eroded by strong currents once again. Due to the normal tide range, which is more than three meters along the North Sea coast, these redistribution zones are permanently shifted laterally. High current velocities during storm tides can rearrange the mudflat landscape completely. Because of permanent sedimentation and redistribution of fresh sediments, mudflat soils are very young.




Different tidal flat soils

The sediments consist of sands redistributed in the coastal zones and the remnants of aquatic organisms deposited from the water, fine particles from eroded soils and anthropogenic inputs into the water courses and water bodies. The sediments reflect flow conditions and water quality. Intertidal flat soils are classified as semi-subaquatic soils in the German soil systematics which formed from tidal sediments. The German Soil Systematics subdivides the intertidal flat soils into the subtypes normal (marine tidal flat soil, “Normwatt”), brackish (“Brackwatt”) and fluviatile (“Flusswatt”). Based on particle size distribution, sand tidal flat soils ("Sandwatt“) are distinguished from mixed tidal flat soils ("Mischwatt“) and tidal mudflat soils ("Schlickwatt”).

**Occurrence**

Tidal flats occur on all continents and in all climate zones. They can be found along many coasts worldwide, e.g. along the coasts of Africa, Australia and North and South America, Bangladesh and China. In Europe, intertidal flats are almost entirely restricted to the flat coasts of the North Sea of Denmark, Germany, the Netherlands and Belgium and south-eastern England. Of all intertidal flats of the world, the Wadden Sea along the southern North Sea represents the largest continuous area, covering about 3,500 km². The marine intertidal flats contribute the by far largest area, while the distri-bution area of fluvial intertidal flats are comparatively small. Fluvial intertidal flats of Hamburg along the shores of the Elbe estuary are restricted to those areas, which receive enough sediments during high tide and which fall dry periodically under the influence of the tide


Distribution of intertidal flat soils in Hamburg

**Characteristics**

While sand intertidal flats are stable and can be entered, pure intertidal mudflats are soft and pasty, such that even wading birds sink into them. The colonisation with mussels, worms and other animals depends beside stability on the content of organic substance. The latter is higher in the mudflat soils than in the sand intertidal soils. The regular flooding of the soils accounts for water saturation of most voids in intertidal flat's soils. Atmospheric oxygen penetrates into mudflat soils only some millimetres deep, in sand flat soils centimetres.

Along biopores and root canals, oxygen can enter several centimetres deep during low tide. Also nitrate and sulphate trigger particular microbial oxidation and reduction processes.

The oxygen gradient and the amount of oxygen-depleting organic substances control the redox potential und hence the processes going on in soils on intertidal flats: iron oxide is dissolved in reduced zones and can be precipitated together with sulphur as black iron sulphide. In the oxidised, rust-coloured zone, divalent iron ions are precipitated as iron oxide. The colour of the intertidal soils is determined by these processes.

**Flora and fauna**


Live on the intertidal flats

Plants and soil organisms on the intertidal flats are subject to permanent alternation of falling dry and flooding, erosion and deposition of sediments, fluctuations of the water and soil temperatures, and are exposed to currents and waves. During low tide, they are affected by sun, wind and rain, during high tide they are translocated by the water current. In addition, the salt content of the intertidal soil significantly determines the colonisation by soil organisms and plants. The salt concentration in soils of marine intertidal flats, is about 35 grams per litre soil water, while in the fluviatile area it is about 0.5 grams per litre only. While one may believe these extreme conditions are hostile to life, intertidal flats are actually quite species-rich.

**Use of these soils**

Due to periodic inundations, permanent redistributions of sediments and wave strains, intertidal flats are suited to be priority areas for nature and species conservation. As the borderland between land and the sea, they provide an ecological niche and hence habitat for many rare and often highly specialised plant and animal species. A large part of the intertidal flats cannot be used directly by man and is left undisturbed for longer time periods.

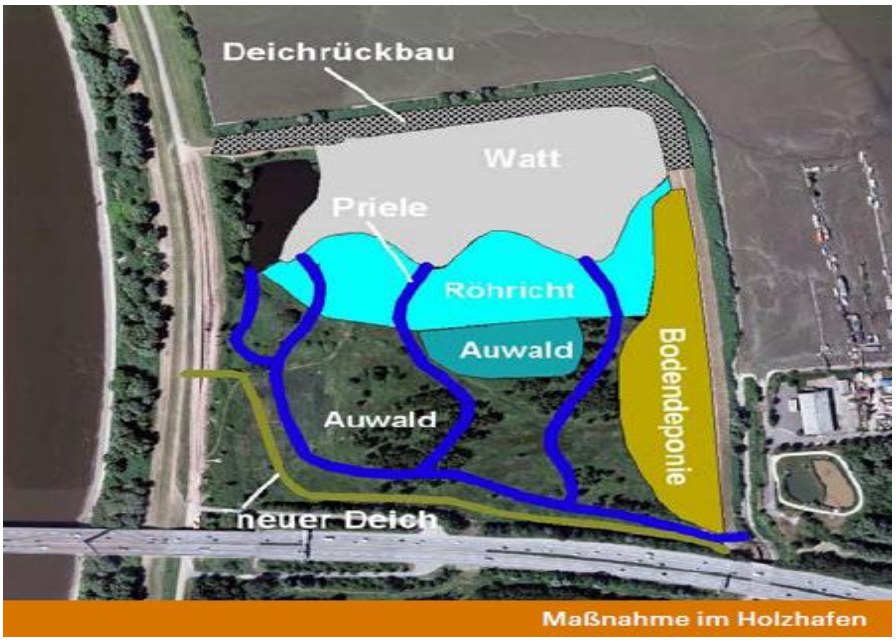
Oenanthe conioides (Schierlingswasserfenchel)

## Threats

Because they form in the zone of tidal influence, the changes in their soil composition are a result of natural processes and part of their special character. The habitat formed by the intertidal flats is threatened as a whole by hydro-engineering and coastal protection measures. In addition, nutrient and pollutant discharges, tourism and sea level rise in consequence of the climate change can adversely affect the ecological functions of these soils.

## Protection and Rehabilitation

Most intertidal flats are legally protected nature reserves or part of national parks and protected from direct interference.
Soils of the tidal flats are young soils and can therefore quickly be rehabilitated. The colonisation by soil organisms, and eventually the bird community, takes place quickly. As compensation measure for hydro-engineering measures, some intertidal flats were successfully rehabilitated in the Elbe fluvial tidal flats:
The area on the southern river banks of the timber harbour in Hamburg was dyked until 2008. The dyke was dismantled as a compensation measure for the extension of the motorway A1. Through the relocation of the old dyke, 18 ha tidal flats, important resting and foraging grounds for species like common teal, shelduck and the rare northern shoveler, and areas for tidal floodplain forests and reedbeds were newly formed.




Exemple for rehabilitätion

Deichrückbau: dismantled dike, Watt: tidal flats, Priele: tide ways, Röhricht: reedbeds,
Auwald: alluvial forest, Bodendeponie: dumpsite for soil materials, neuer Deich: new dike

**Further information provided by**

Website Soil of the Year / www.boden-des-jahres.de
Deutsche Bodenkundliche Gesellschaft / www.dbges.de
Bundesverband Boden / www.bvboden.de
Ingenieurtechnischer Verband für Altlastenmanagement und Flächenrecycling / www.itv-altlasten.de
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**Aegis for the Soil of the Year 2020** Jens Kerstan
Senator for the environment and energy of the Free and Hanseatic City of Hamburg

**Impressum**
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**Pictures**
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