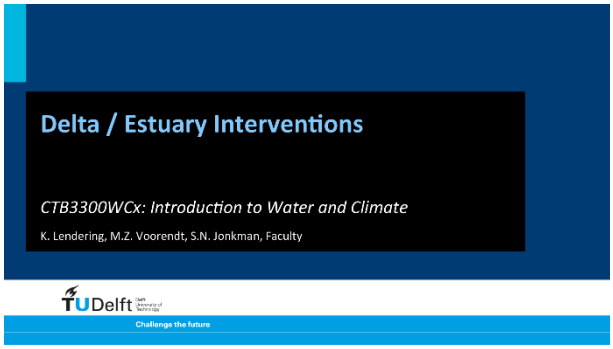
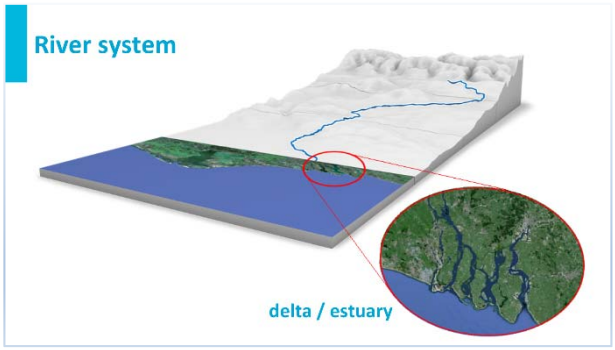
CTB3300WCx – Introduction to Water and Climate

IN3 – Delta and Estuary intervention

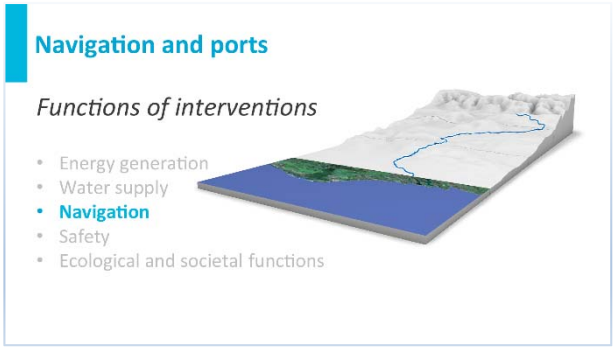
Mark Voorendt



Hello my name is Mark Voorendt. I am researcher and lecturer on hydraulics structures at the Delft University of Technology.

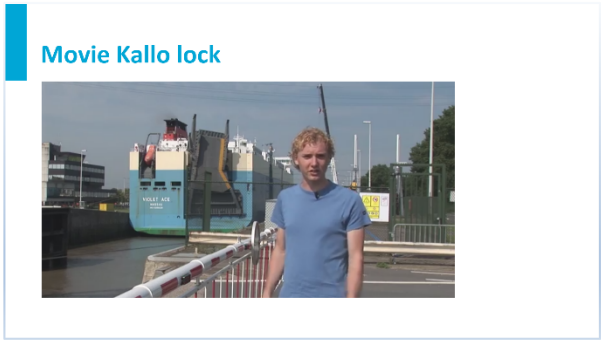


As explained in the 'water systems module', estuaries and deltas are partly enclosed coastal bodies of water with one or more rivers flowing into them. An estuary is a tide dominated basin wherein the sedimentation is controlled by import from the coast. The sedimentation in a Delta is dominated by the river discharge. As a result also the salt intrusion in both systems is different: in an estuary it is larger than in a delta. This sub-module discusses typical interventions in estuaries and deltas.



We start with interventions for navigation and ports. Transport of goods and traffic over water fulfils an important societal function. To facilitate this function, interventions to enable shipping are often needed. These interventions consist of adaptations of natural or manmade waterways through structures like navigation locks and quays, and by carrying out dredging works.

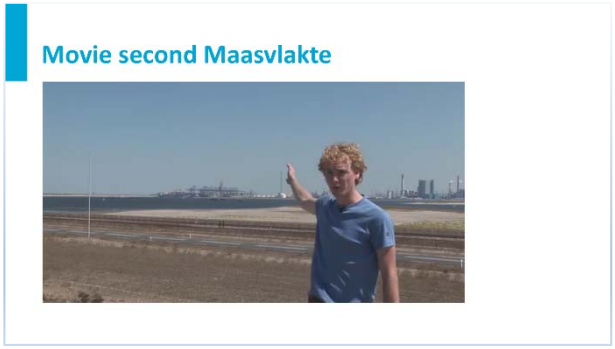
Navigation locks are structures which allow ships to overcome water level differences between waterways, as was explained in the river interventions sub-module. In deltaic areas locks are also used to protect vessels in ports from large tidal differences and to ensure sufficient clearance below the vessels in inland waterways.



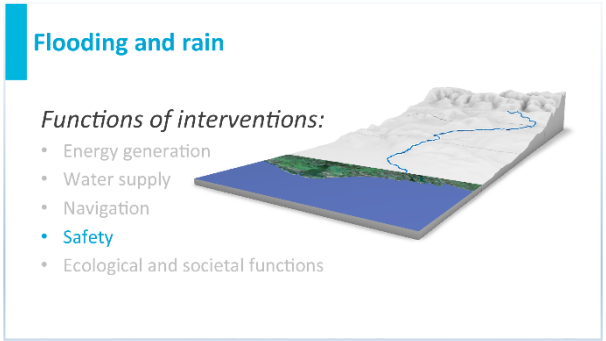
This is the Kallo lock in the Antwerp harbor, which lies in the delta of the Scheldt River. Water levels here can rise up to 5 meters due to tidal influence of the sea. This lock serves to protect the vessels from the tidal influence. The vessels that moore behind this lock, they have a constant water level. Currently, at another location in this harbor, the Duergangckdok lock is constructed, which is going to be the largest lock in the world. It has a lock chamber of 500 meters long, 68 meters wide and 17.8 meters deep. And it serves to facilitate the largest container vessels in the world, with a capacity of 14,000 TEU.

Dredging works are carried out to increase or maintain the depth of natural waterways or manmade channels, for vessels to reach their destination. For example, in the port of Rotterdam yearly 15 million cubic metres of maintenance dredging is done.

Quays and other port facilities enable the loading and unloading of cargo and passengers. These structures include mooring locations, and also piers, warehouses, or other facilities necessary for handling the ships.



We are here at the second Maasvlakte (which means 'Meuse plain'). This project consists of a large port expansion into the North Sea. Due to the ever increasing dimensions of sea going vessels, the old harbours of Rotterdam, upstream of the river mouth could not facilitate shipping any longer, and the Port of Rotterdam gradually moved sea-ward. This Second Maasvlakte is located outside the flood protected areas of the Netherlands. And therefore, to prevent this port from flooding, it has been constructed 5 m above mean sea level.

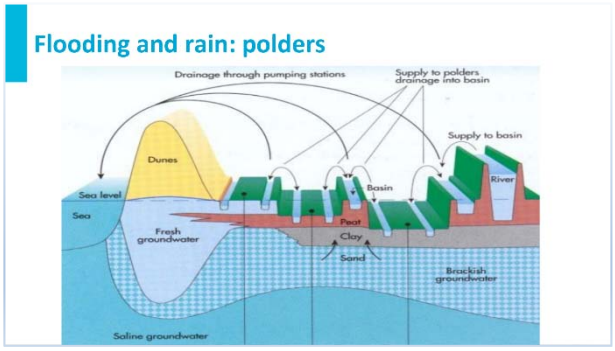


The next type of interventions treated in this sub-module is intended to provide safety against floods and heavy rain fall. Deltaic areas are especially prone to flooding due to threats of storm surges at sea and river discharges or heavy, long lasting rain in the low hinterlands. In 1953 large floods occurred in the Netherlands due to a severe storm surge on the North Sea, which caused over one thousand eight hundred casualties. After these floods the Dutch government decided to shorten the coast line with help of a series of dams and barriers. This appeared to be a most

effective strategy compared to reinforcing all the dikes along the estuary. The project was called the Dutch Delta Works.

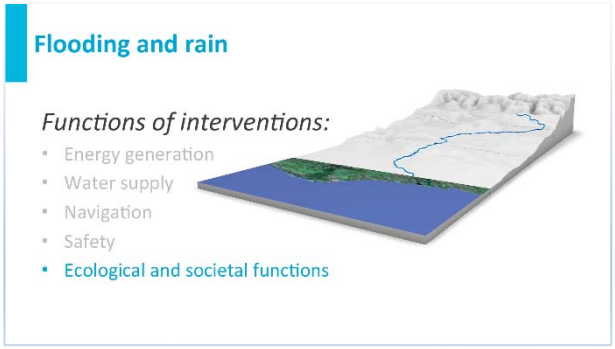
The Delta Works consist of a series of structures that protect a large area of land around the Southwestern delta in the Netherlands from the sea. It consist of dikes, dams, sluices, navigation locks and storm surge barriers. Large dams, such as the Brouwersdam, Haringvlietdam and Oosterscheldedam, were built as a short-cut to reduce the total length of the flood protection line.

The last intervention built as part of the Dutch Delta Works is the Maeslant barrier, which is a storm surge barrier protecting the greater Rotterdam area. A storm surge barrier is a partly moveable barrier in an estuary or river branch which can temporarily be closed. In this way it protects the area behind the barrier against flooding. Different types of barriers exist. The choice for a specific type depends among others on the expected water levels and wave heights, the subsoil and navigational requirements.

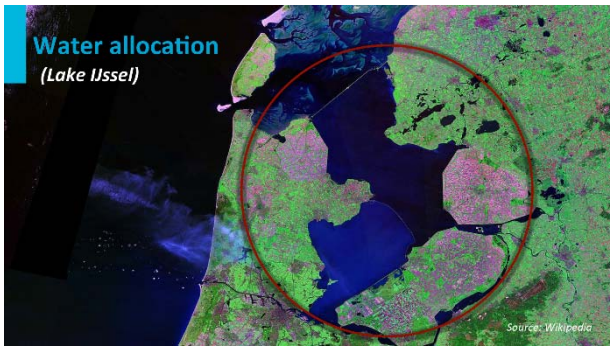


The low hinterlands in the flood plains of the Netherlands are protected from flooding due to rainfall through an extensive system of ditches, canals and storage basins together with pumping stations. This system is used to drain excess water out of the polders.

The inhabitants of the Netherlands reclaimed land, not only from the sea, but from entire lakes as well. Most of these lakes originated from large-scale peat excavation. At first, the famous wind mill assisted the Dutch in pumping the excess water out, but since the invention of the steam engine, larger areas could be reclaimed. An example is the Haarlemmermeerpolder, where the Dutch national airport 'Schiphol' is located, It was the first polder to be reclaimed by making use of steam engines and is one of the largest in the Netherlands as well.



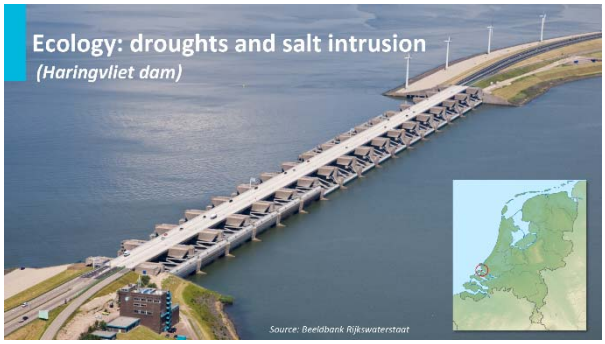
The last type of interventions treated in this sub-module serve ecological and societal functions.



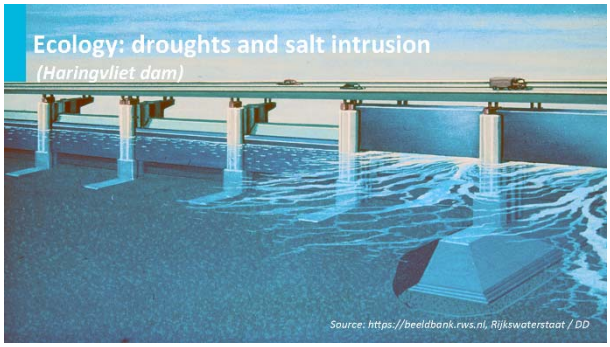
In the North of the Netherlands storms intruding the former Zuiderzee frequently caused floodings of the hinterland. Early in the twentieth century it was therefore decided to close-off the Zuiderzee by constructing a closure dam.

This dam, with a length of 32 kilometres, indirectly protects parts of the Netherlands against storm surges from the North Sea. Resulting from this closure lake IJssel arose: a shallow artificial lake of 1100 square kilometres in the central Netherlands with an average depth of 5 to 6 m. It is filled by water mainly coming through the IJssel river, which is a branch of the Rhine. In order to manage the level of fresh water in the lake IJssel, two sets of discharge sluices were constructed in the closure dam. After construction of the dam, the water in the lake became fresh, so that it could serve as a major fresh water reserve for agriculture and drinking water. An advantage of the creation of such a large lake with fresh water namely is that it can be used for water supply during long dry periods without rainfall.

During long dry periods the river discharges are decreased and the water levels drop down.
In deltaic areas this can also lead to undesired salt intrusion from the sea. This dam in the Haringvliet was constructed to protect a branch of the Rhine / Meuse delta and the hinterland from flooding, but also from undesired salt intrusion which created another fresh water lake. Since this dam is constructed in the mouth of one of the river branches, it also contains a 1 kilometre long discharge sluice with 17 gates, and also a navigation lock to allow for shipping.



The Haringvliet dam is one of the Deltaworks. It was constructed to provide safety against floods, but meanwhile had to take care of the drainage of water from the rivers Rhine and Meuse into the North Sea. This dam was therefore equipped with gates. By opening or closing the gates, discharge from the river is regulated. At the same time, intrusion of salt water from sea was prevented.



In 2013, however, it was decided to slightly re-open the gates of the Haringvliet dam in periods when the inner water level is lower than the sea water level, reintroducing salt water in the estuary behind the Haringvliet dam. Reintroduction of brackish water in the estuary was necessary for ecological reasons: Migrating fish like salmon and sea trout can now again pass the sluices to reach their spawning areas upstream. A disadvantage of this measure is that the intake points for fresh water, for agriculture and drinking water, will have to be moved further upstream.