Mixed coast protection and shore protection measures are schemes which combine **structures and nourishment**, or rather, initial filling. It is an attempt to find a solution which combines the capability of structures to directly protect a section of the coast with the capability of the structure to supporting and maintaining sand filling nourishment.

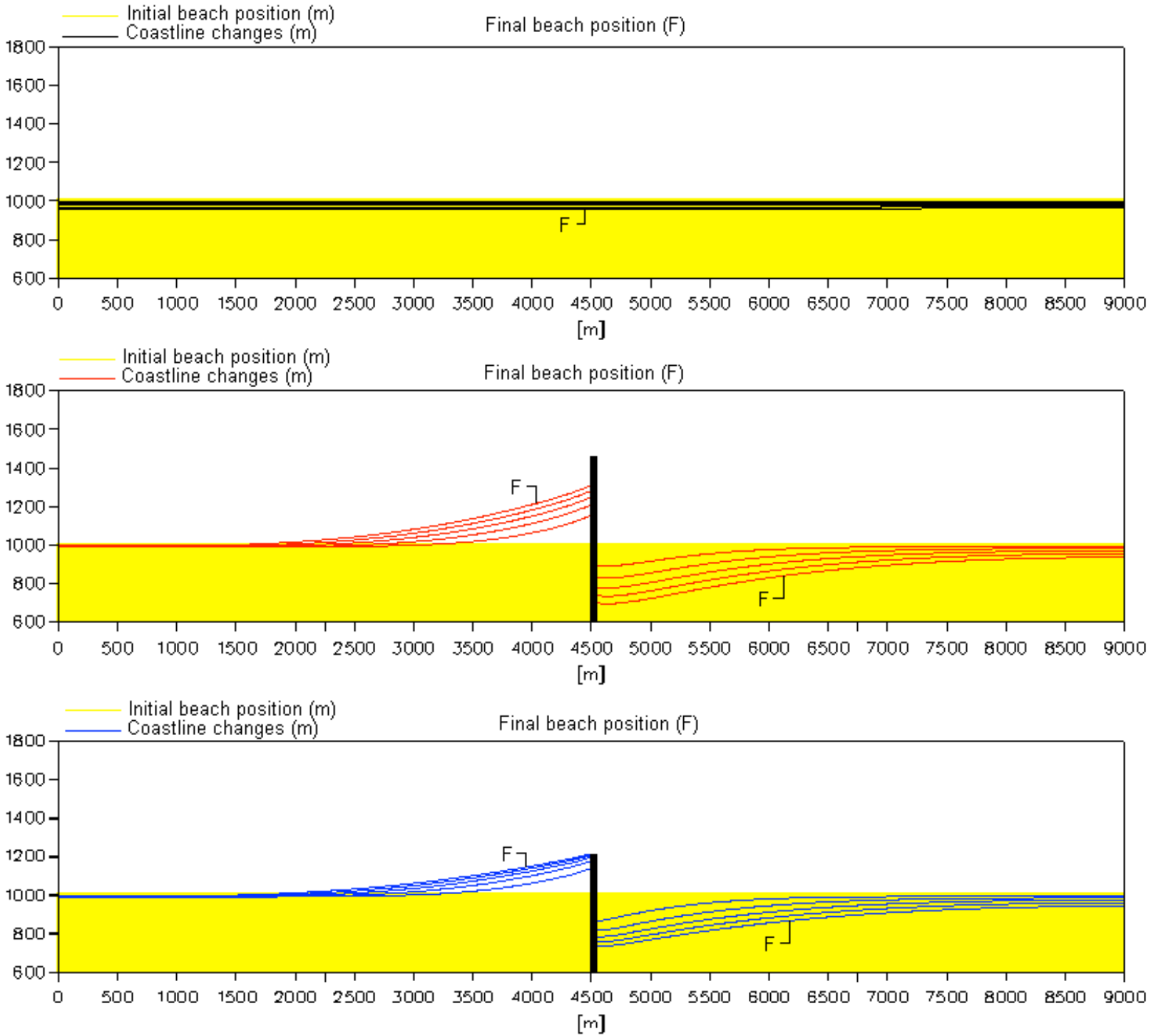
The result is a beach combined with the protection of the coast behind the beach. The advantage of this combination is that it minimises the requirement to regular recharge of the nourishment.

Source: Shoreline Management Guide, DHI, 2001, 2017

- **Groynes** which are straight structures perpendicular to the shoreline. They work by blocking (part of) the littoral drift, whereby they trap/maintain sand on their upstream side. Groynes can have special shapes, they can be emerged, sloping or submerged, and they can be single or in groups, the so-called groyne fields.

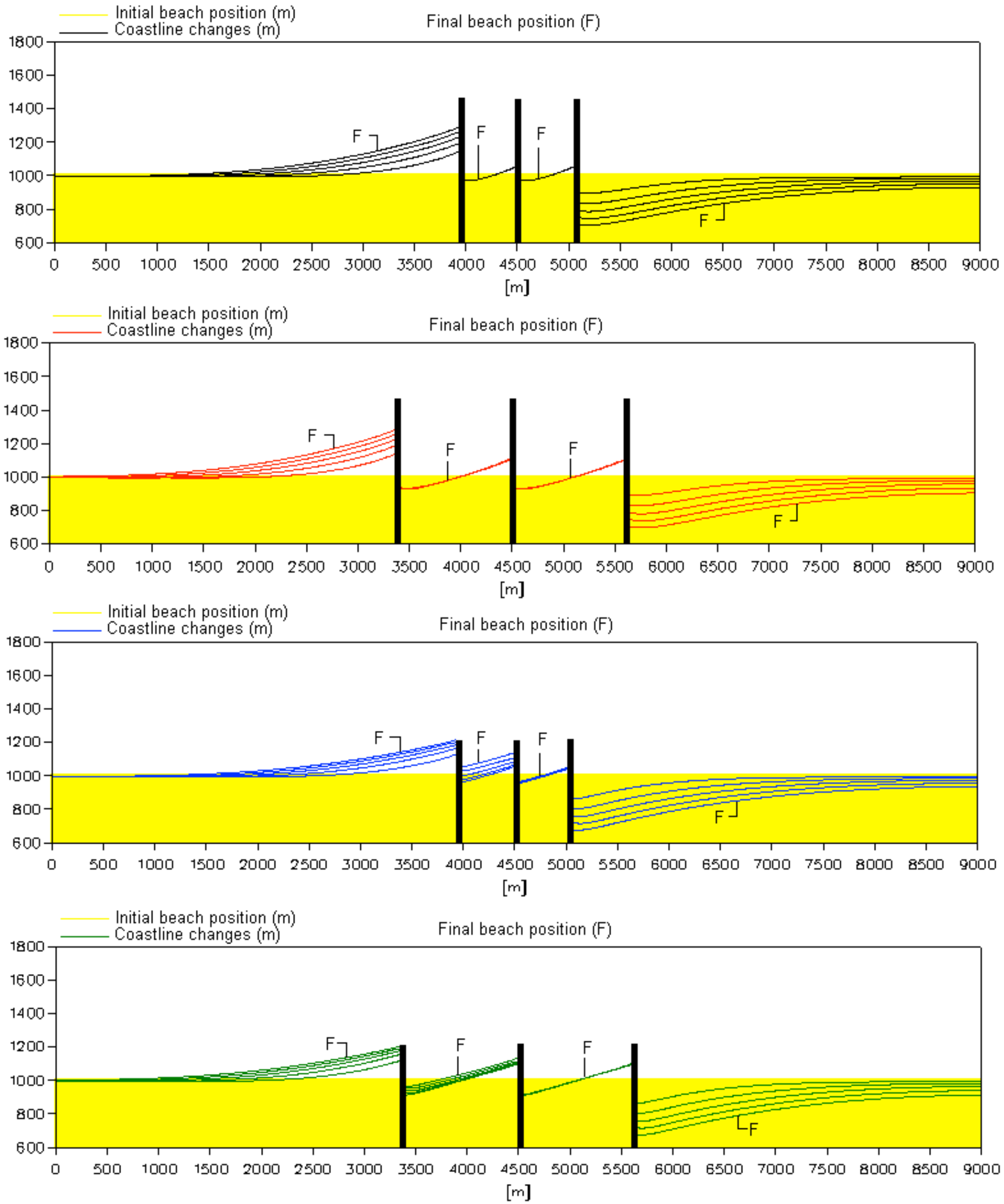
- **Detached breakwat**ers, which are straight shore-parallel structures, provide partly shelter in their lee, whereby they protect the coast and decrease the littoral transport between the structure and the shoreline. This decrease of transport corresponds to trapping of sand in the lee zone and some distance upstream. Breakwaters can also deviate from the straight and shore-parallel layout, and they can be emerged and submerged, and they can be single or in groups, the so-called segmented breakwaters.

Source: Shoreline Management Guide, DHI, 2001



Source: Shoreline Management Guide, DHI, 2001

Source: Shoreline Management Guide, DHI, 2001



General comments

Groynes tend to trap seaweed and floating debris on the upstream side as well as on the lee side.

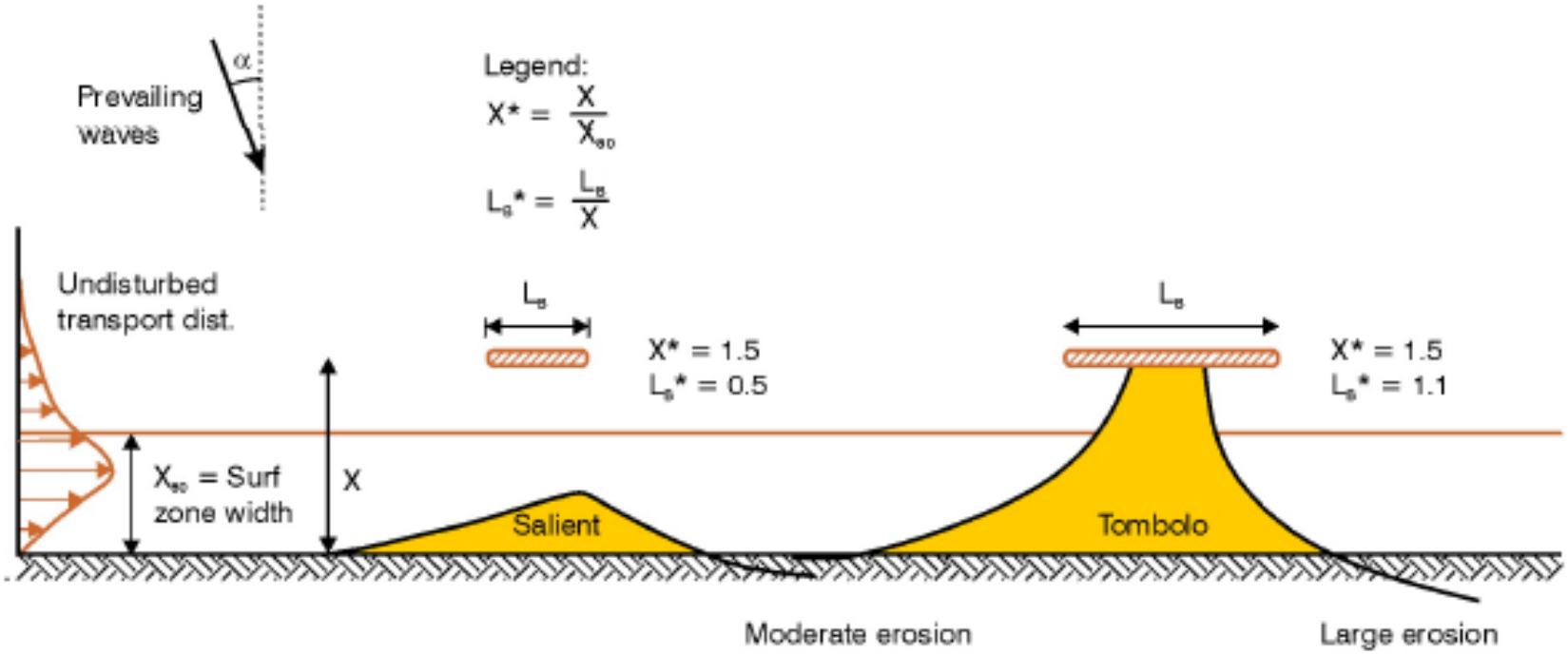
Groynes obstruct passage along the beach.

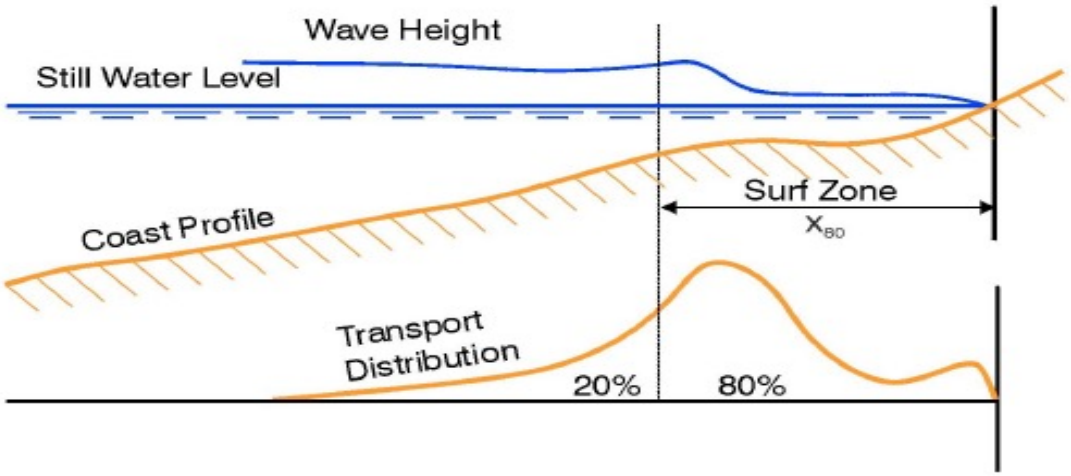
Groynes are often dangerous to walk on; however, if they are built to allow passage on the top, they are popular for promenade and fishing.

The lee zone eddy as well as the upstream rip current can be dangerous for bathers.

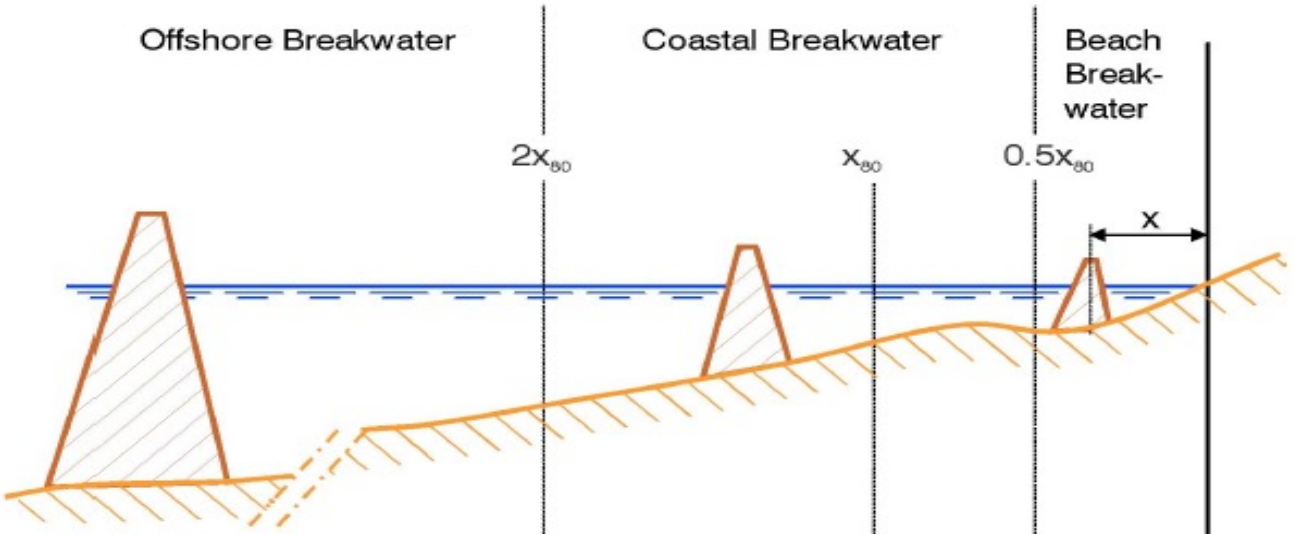
Groynes constitute a foreign element in the coastal landscape due to their unnatural shape being perpendicular to the shoreline.

Source: Shoreline Management Guide, DHI, 2001


Prevailing waves
α
Legend:
X* = X / X_so
L_s* = L_s / X
Undisturbed transport dist.
L_s
X* = 1.5
L_s* = 0.5
L_s
X* = 1.5
L_s* = 1.1
X_so = Surf zone width
X
Salient
Tombolo
Moderate erosion
Large erosion



Breakwater Types



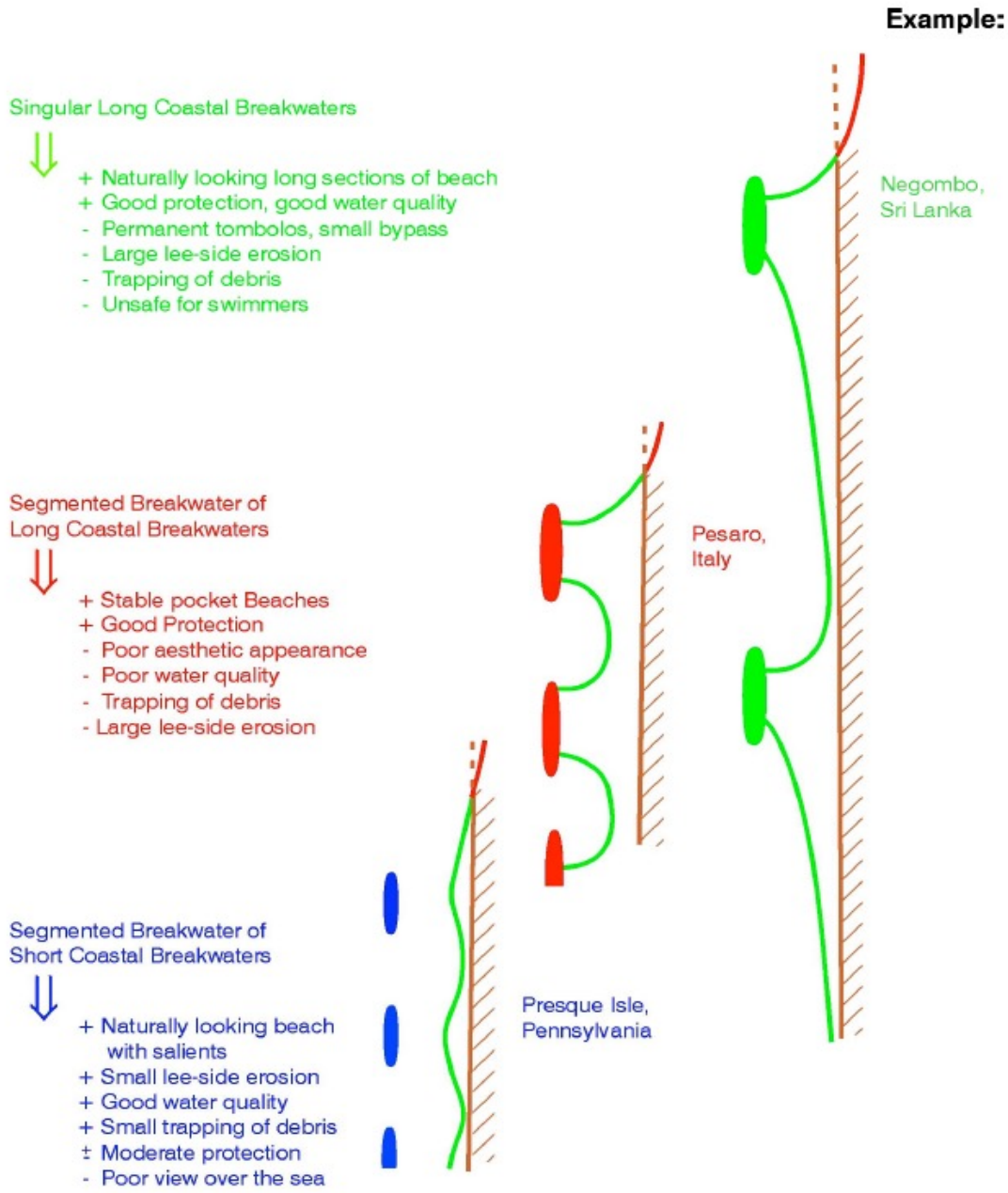
Impact on Littoral Transport

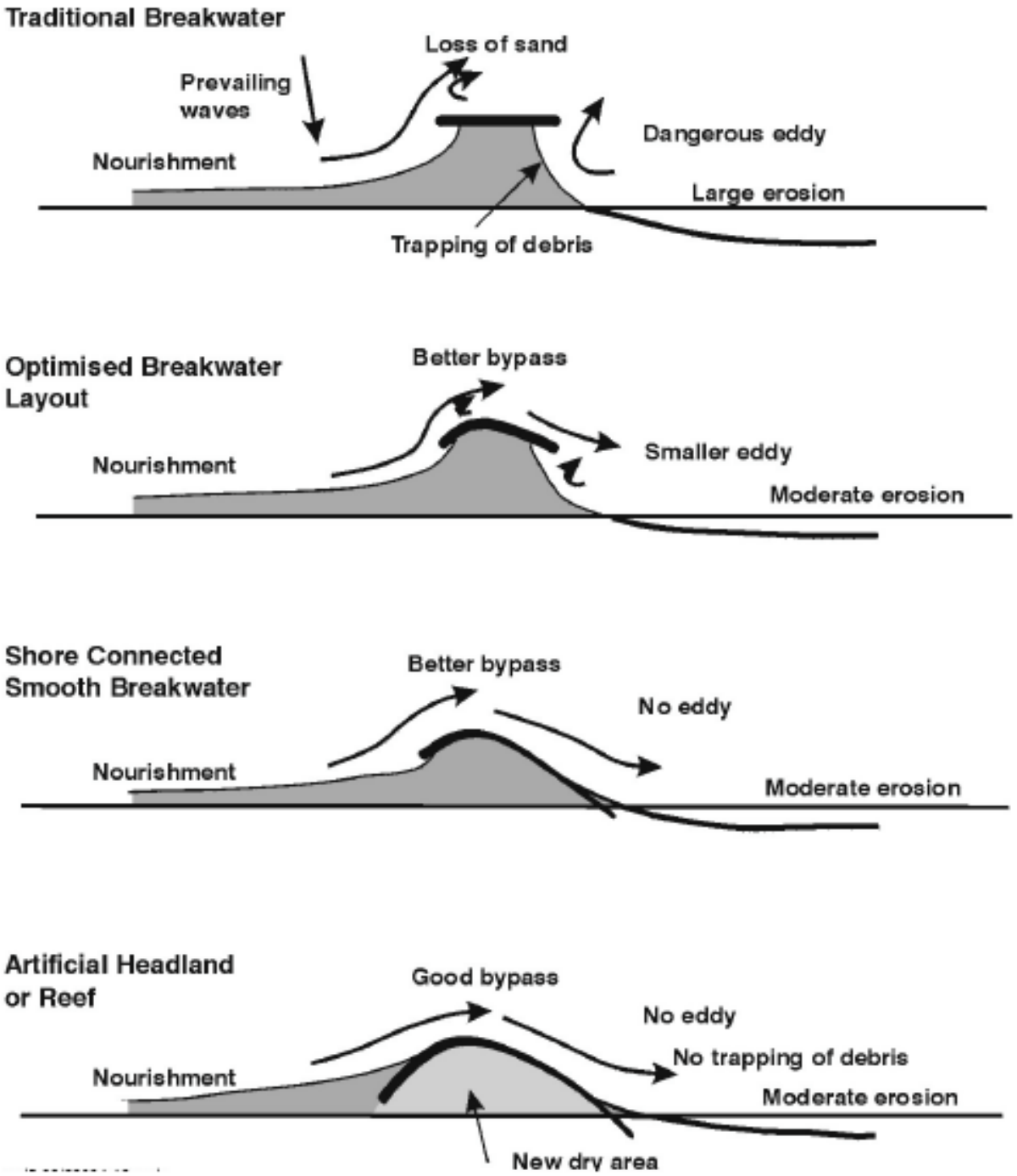
Small	Moderate	Large	Mod.	Small

Dimensionless Breakwater Distance: $x^* = \frac{x}{x_{80}}$

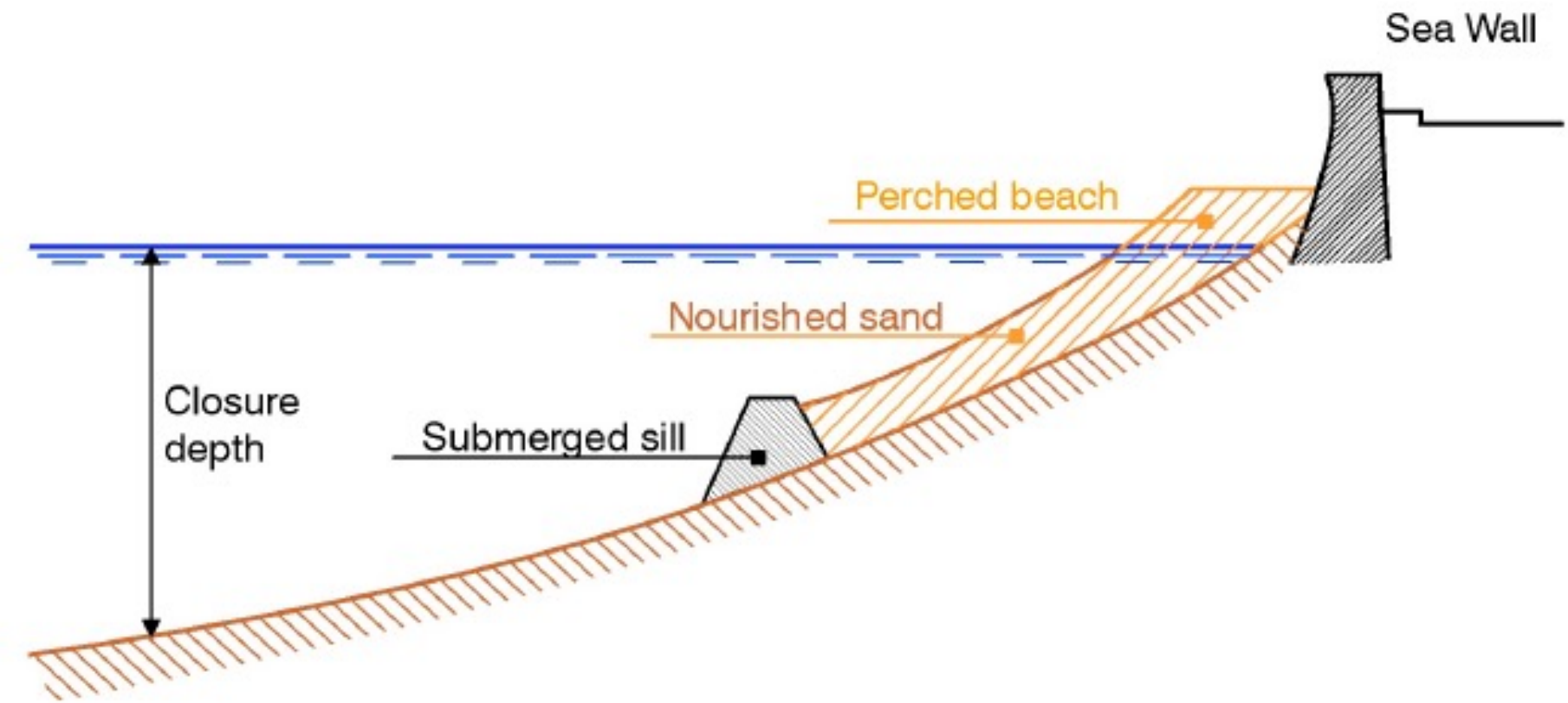
$x^* > 3$	2.0	1.0	0.5	0

Source: Shoreline Management Guide, DHI, 2001





Source: Shoreline Management Guide, DHI, 2001



Source: Shoreline Management Guide, DHI, 2001

Cove

Definition:

A cove is a pocket beach suspended between two oblique coastal structures, see Fig 12.27.

Source: Shoreline Management Guide, DHI, 2001

- **Headlands** which are smooth structures built from the coastline over the beach and some distance out on the shoreface. They work by blocking (part of) the littoral transport. A headland combines the effects of groynes and detached breakwaters and at the same time they minimise some of the disadvantages of groynes and breakwaters.
- **Ports or marinas** which may act as headlands at the same time as they serve their primary purpose of servicing vessels.
- **Perched beaches** which are natural or nourished beaches at locations with a steep shoreface. They are supported at their lower part by a submerged structure.
- A **cove** which is a semi-protected sandy bay, formed by two curved shoreconnected breakwaters at a coastline which is otherwise protected by revetments

Nourishment

Nourishment can be divided into three types**: Backshore nourishment, beach nourishment and shoreface nourishment**.

Nourishment as part of a shoreline management project, which combines structures and initial nourishment

Nourishmen it can be regarded as a very natural way of combating coast erosion and shore erosion as it artificially replaces a deficit in the sediment budget over a certain stretch with a corresponding volume of sand.

However, if the cause of the erosion is not eliminated, the erosion will continue in the nourished sand.

This means that nourishment as a stand-alone method normally requires a longterm maintenance effort. In general, nourishment is only suited for major sections of shoreline; otherwise the sand loss to neighbouring sections will be too large.

Regular nourishment requires a permanent well-functioning organisation, which makes nourishment as a stand-alone solution unsuitable for privately owned coastlines.

Source: Shoreline Management Guide, DHI, 2001

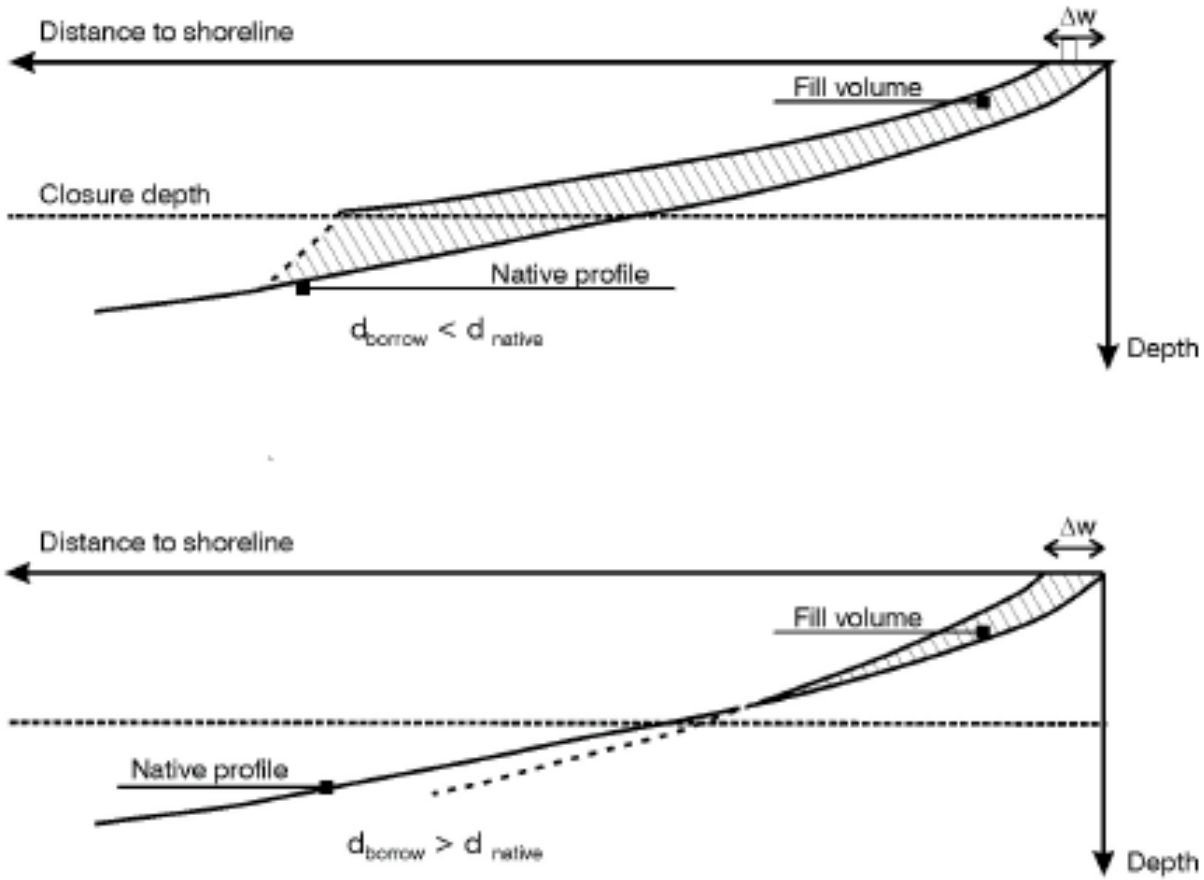


Fig 12.28 ***Equilibrium conditions for nourished beaches required to obtain an additional beach width of Δw with borrow sand which is finer and coarser than the native sand (upper and lower, respectively).***

Source: Shoreline Management Guide, DHI, 2001, 2017

Fig 12.29 Principles in backshore nourishment, beach nourishment and shoreface nourishment.

Beach Scraping

Definition:

Beach scraping is recovering material from the berm at the foreshore and placing it on the backshore at the foot of the dunes or the cliff.

Method:

A beach berm consisting of coarse sand or gravel is sometimes formed during relatively mild summer wave conditions, which tend to transport seabed material towards the beach. Beach scraping is normally performed by the use of front loaders.

Functional characteristic:

The purpose of beach scraping is to strengthen the upper part of the beach profile and the foot of the cliff. The material is placed in a position that reduces the erosion occurring under storm surge conditions.

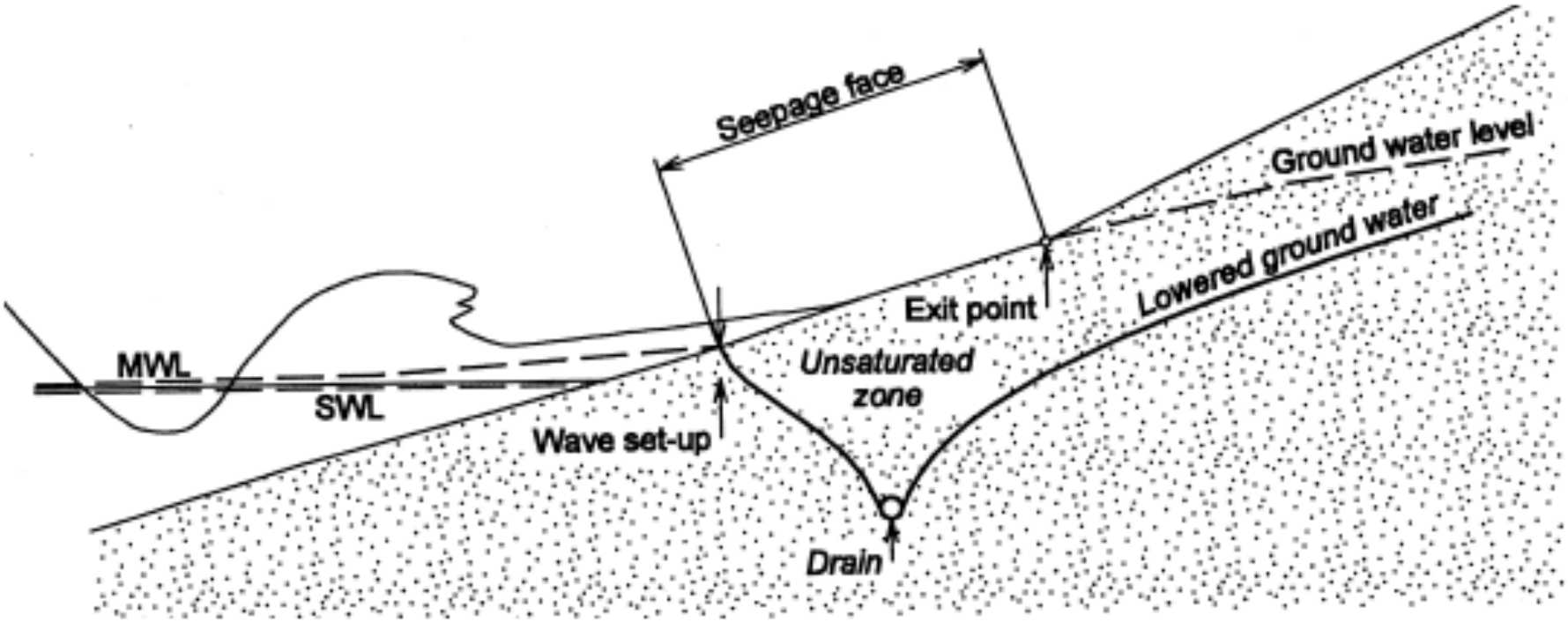


Fig 12.31 Principle of beach drain function

Source: Shoreline Management Guide, DHI, 2001, 2017

Dike

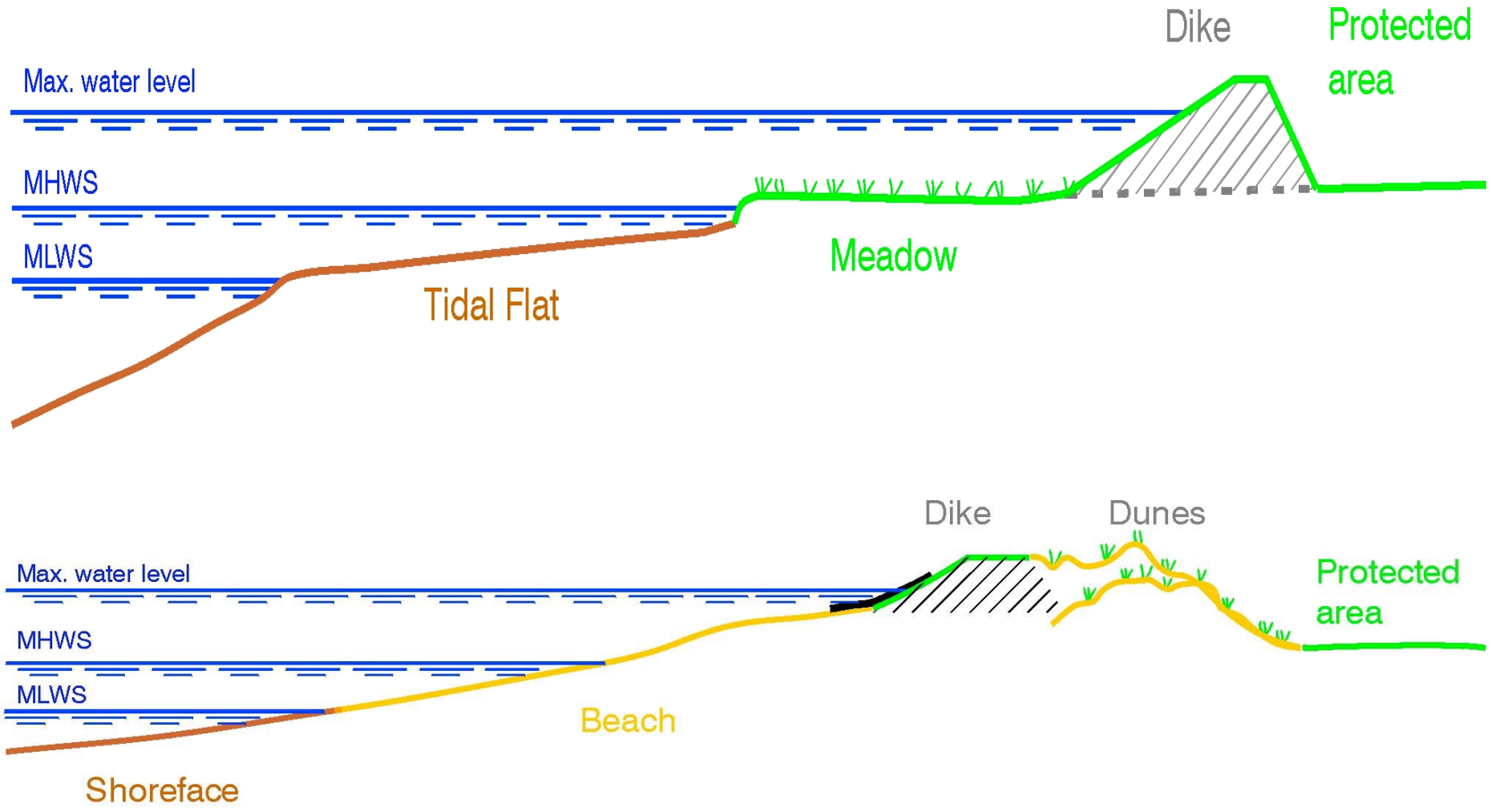
Definition:

A dike is **a sea defence** structure protecting low coasts and coastal hinterlands from being flooded during high storm surge and tide. Normally, the dike consists of sand with a layer of meadow soil with grass; however, severe wave action can make it necessary to protect the front of the dike with a revetment. In that case the defence structure can also be characterised as a seawall.

Method:

Dikes are often constructed in areas with tidal flats and where the coast consists of low meadows or mangroves, and where there is no erosion problem.

Under such conditions the dike is most often constructed well above the high water-line, which means that the dike is fronted by a low-lying coastal foreland. In such cases the dike will typically consist of sand covered with meadow soil planted with grass.


Dike
Protected area
Max. water level
MHWS
MLWS
Meadow
Tidal Flat
Dike
Dunes
Max. water level
Protected area
MHWS
MLWS
Beach
Shoreface

Artificial Dune

Definition:

A natural dune is nature own flexible protection against coast erosion and flooding

In areas with natural dunes, which suffer from coast erosion, beach degradation and flooding, artificial dunes are applicable as a combined protection measure.

This can be done in different ways, and there is a gradual transition from dune restoration to artificial dunes. An artificial dune can also be categorised as a *soft seawall, dune nourishment or backshore nourishment.*

Source: Shoreline Management Guide, DHI, 2001, 2017

Method:
The two principal methods of constructing artificial dunes are:

• To introduce measures on the backshore, which trap sand, such as planting of marram grass or placing of spruce fences. A new dune will thereafter form automatically. However, this is a slow process and it is difficult to forecast the result. The method is useful for fighting coastal erosion, whereas it is not suitable as protection against flooding

• To build artificial dunes by importing sand from outside the project area.
The dune is normally constructed on the backshore close to the coastline. In order to protect the dune and to enhance the natural dune building process, an artificial dune is normally planted with marram grass and protected by spruce fences. Such an artificial dune works as a **combined coast protection and sea defence measure.**