NORDKYSTENS FREMTID

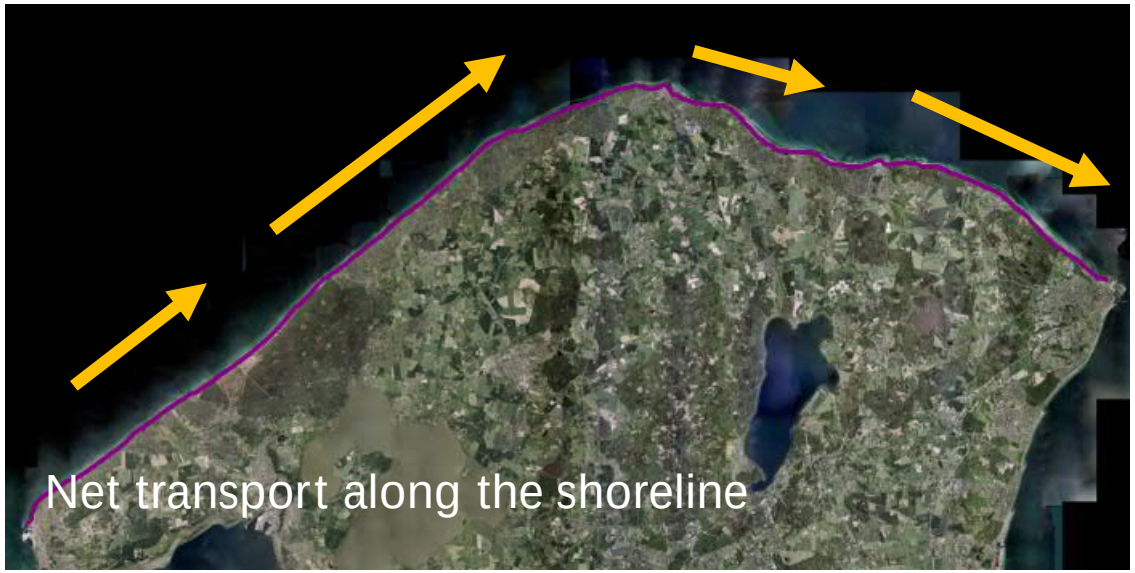
Intermunicipal coastal protection project

11-10-2022 Signe Schløer

What is the problem?

North coast of Zealand

- Chronic coastal erosion
- Net sediment transport from Hundested to Helsingør
- Developed part protected with coastal protection (revetments)



North coast of Zealand

Pictures after the storm Bodil / Sven 6/12-2013

Pictures: Christian Helledie

Nordkystens Fremtid

Intermunicipal coastal protection project

Beach is eroding

Sea level rise

Nordkystens Fremtid

Intermunicipal coastal protection project

Beach is eroding

Sea level rise

Damage on the hillsides/cliffs

Damage on the revetments

The beach disappears

Damage on detached breakwaters and groynes

Nordkystens Fremtid

Intermunicipal coastal protection project

Beach is eroding

Sea level rise

Damage on the hillsides/cliffs

Damage on the revetments

The beach disappears

Damage on detached breakwaters and groynes

Increasing need for protection of
the coastline

Agenda

- Objective
- Preliminary study
- Assessment of existing coastal protection
- Final project

Objective

Nordkystens Fremtid

- 50 year return period (storm)
- 50 year lifetime (year 2075)
- 64% probability that the storm will occur during the lifetime

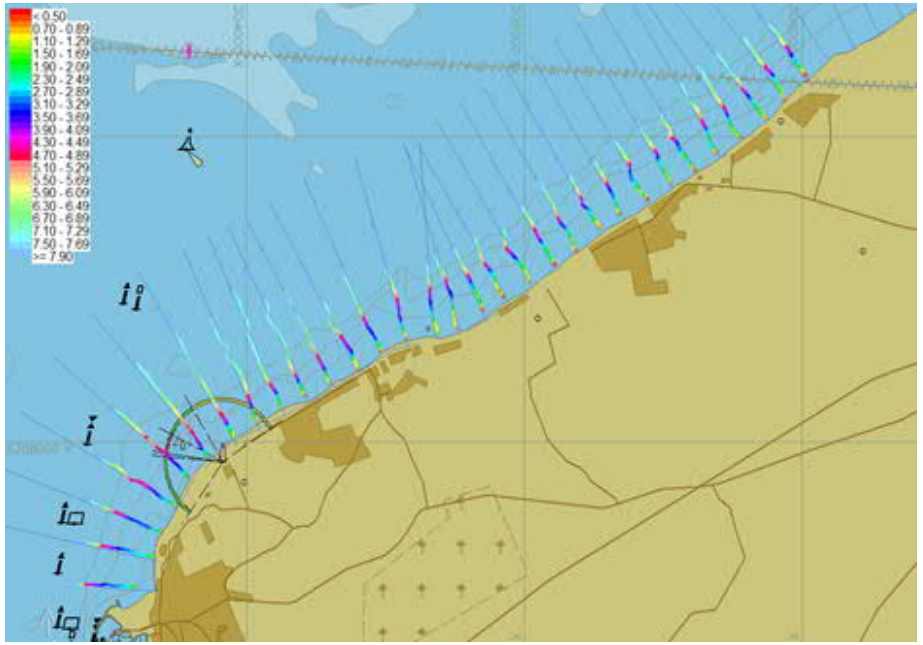
NIRAS

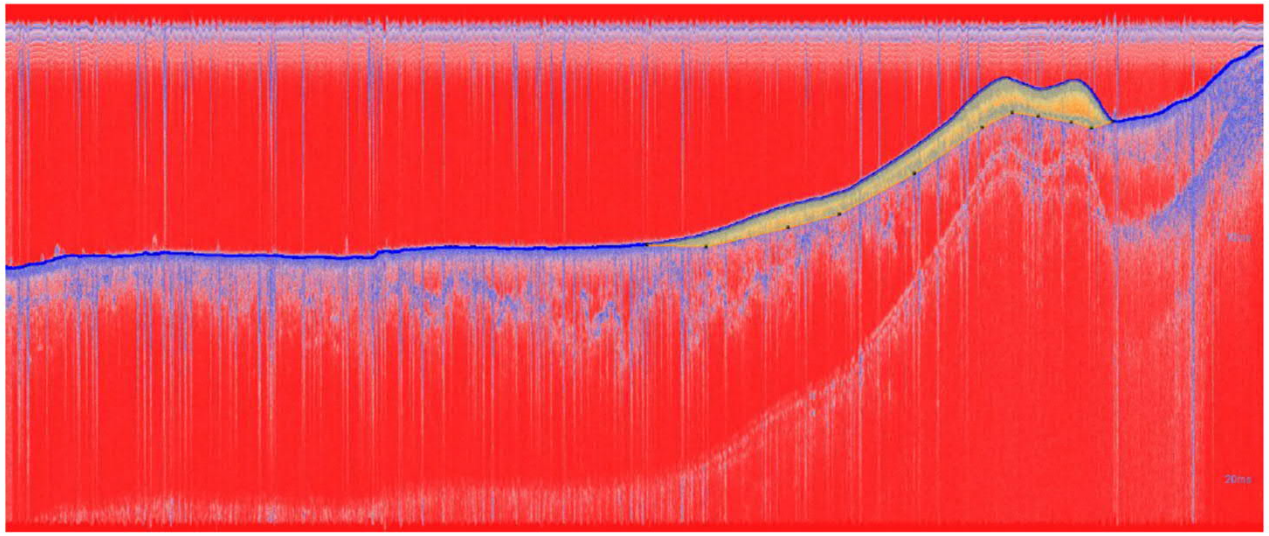
Preliminary study

- Bathymetrical survey and sediment sampling
- Topographical survey
- Geotechnical desk-study
- Registration of coastal defences
- Design parameters

Preliminary study

Deep-sea sounding and sediment sampling – DHI (boat)





Figur B.1 Linje 256 processeret i Hypack Max™ Sub Bottom Processing. Havbunden er markeret med den blå linje, mens sandaflejringerne er markeret med transparent gul.

Preliminary study

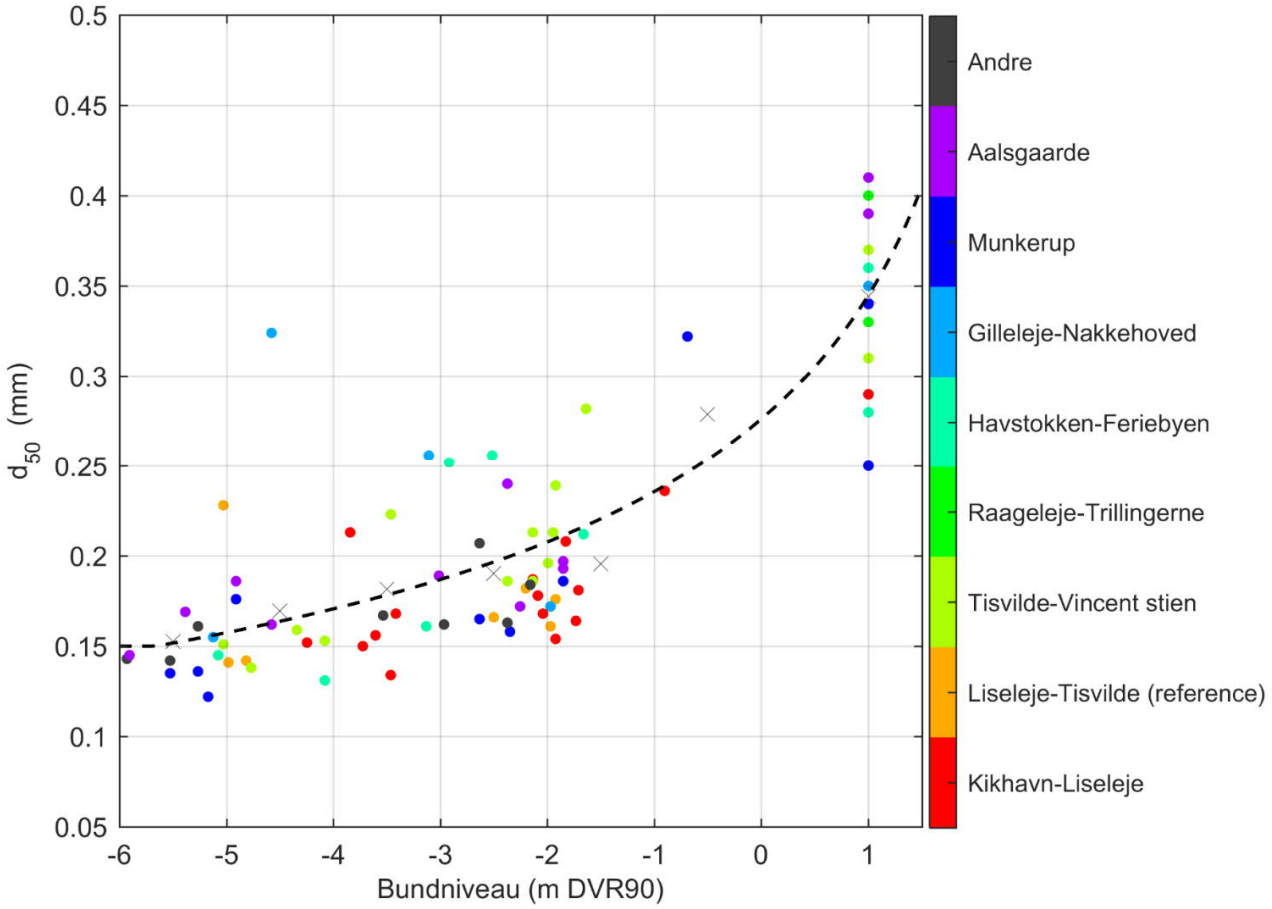
Deep-sea sounding and sediment sampling – DHI (boat)

Sand fraction on beach

- d_{50} = 0.35 mm

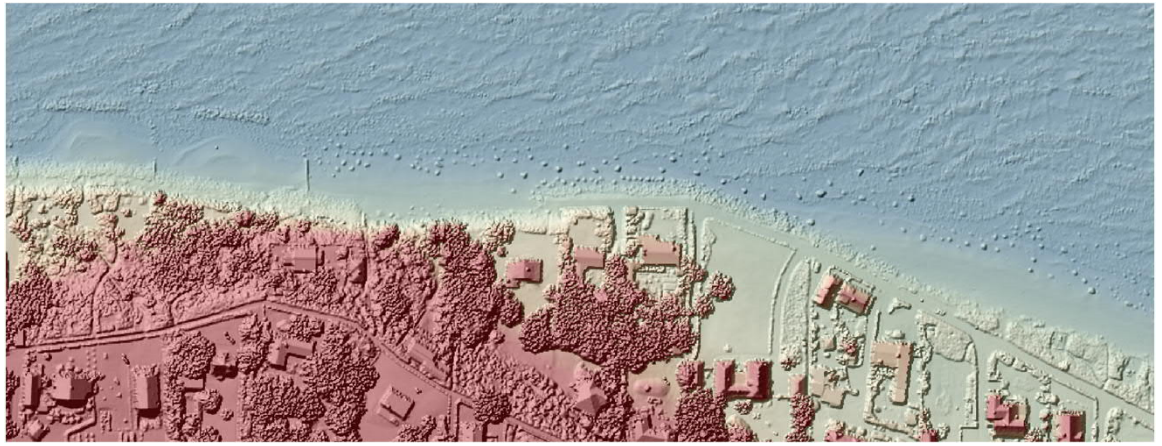
At depths larger than 0.8 m

- 0.12 mm < d_{50} < 0.25 mm.



Preliminary study

Topographical survey – LiDAR and orthophoto



Preliminary study

Registration of existing constructions

40/80 cm
Collapsed
St. 28350

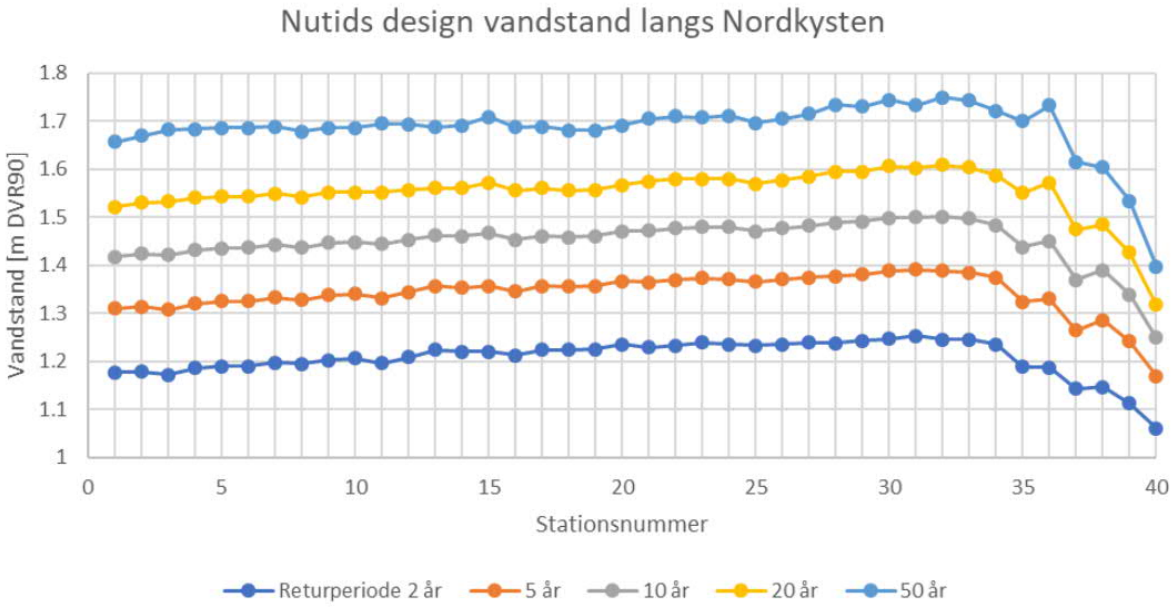
40/100 cm, 1/2.05
Rocks largest in the bottom
St. 28310-28400

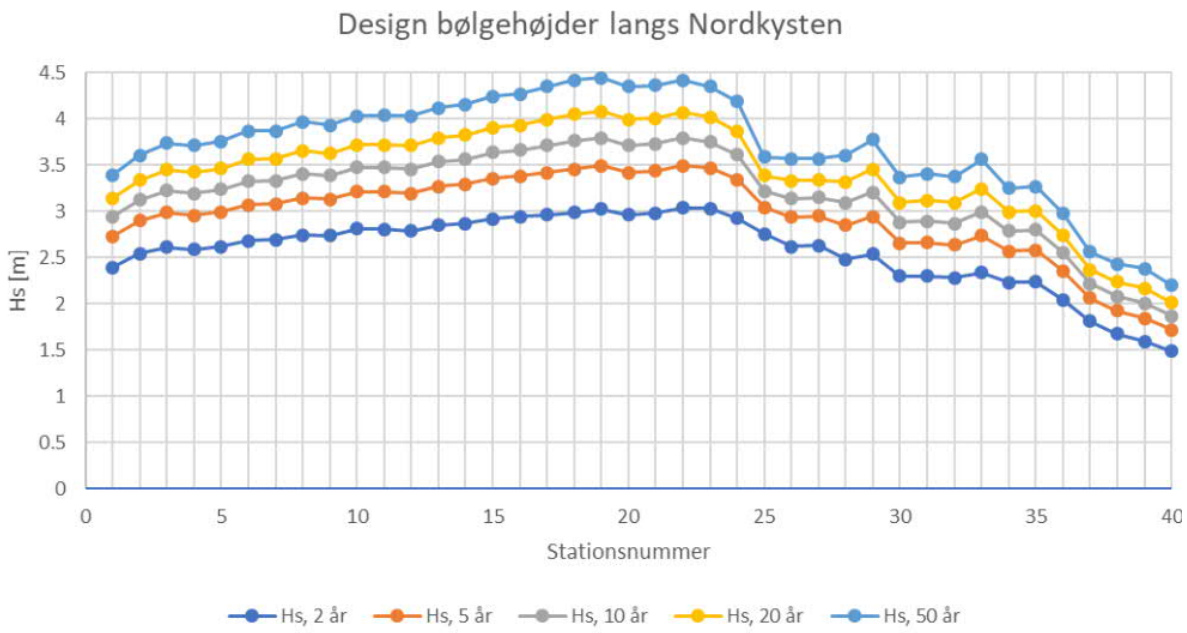
Preliminary study

Design parameters (DHI)

Extreme value analysis

- Water levels (~1.7 m)
- Wave heights (4.4 and 3.6 m)

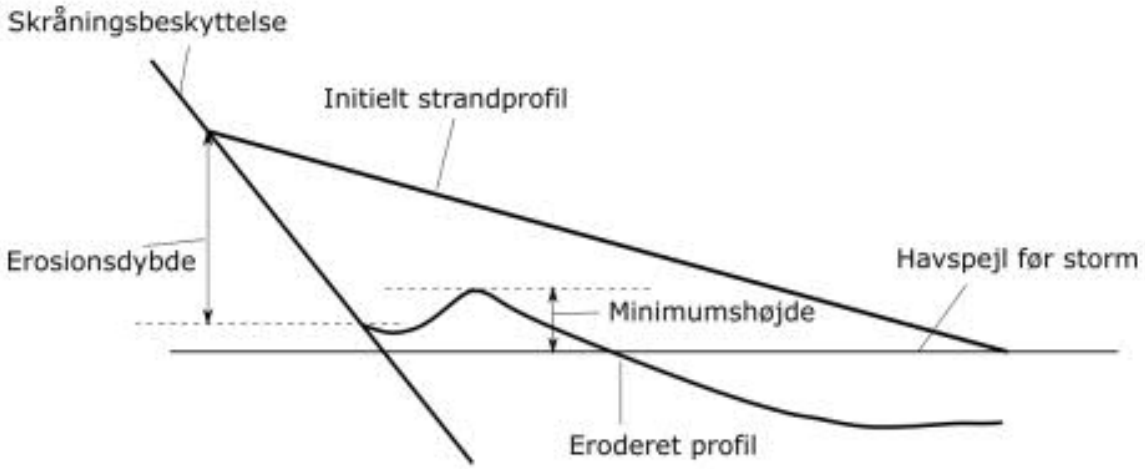




Preliminary study

Design parameters (DHI)

Erosion during a storm (0.9-1.8 m)



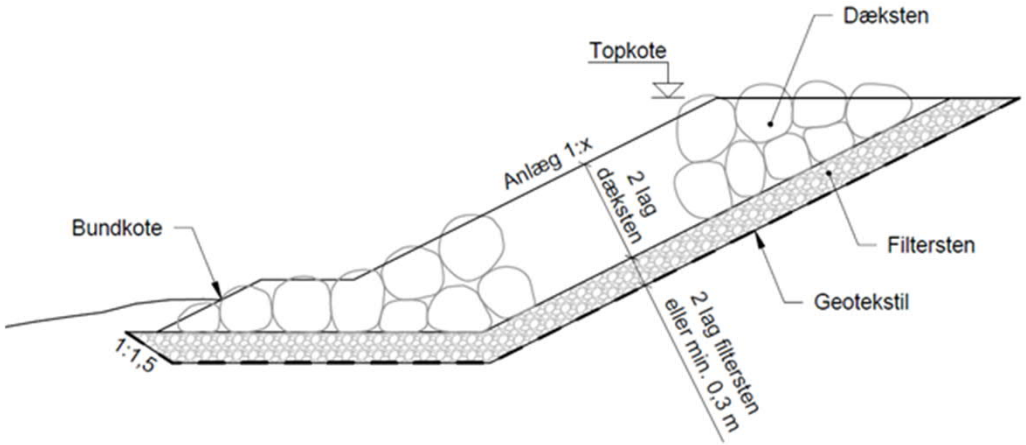
	Total akut erosion volumen (m^3/m)		
Initial minimumshøjde af strand foran konstruktionen (m)	50 års hændelse, Vest	50 årshændelse, Øst	Bodil
- 0.5	5.0	4.7	7.2
+0.0	5.6	5.3	8.1
+0.5	7.1	6.9	9.9
+1.0	8.7	8.4	12.1
+1.5	10.3	9.9	14.4
+2.0	12.2	11.6	16.8
+2.5	14.0	13.5	19.9

Assessment of existing coastal protection

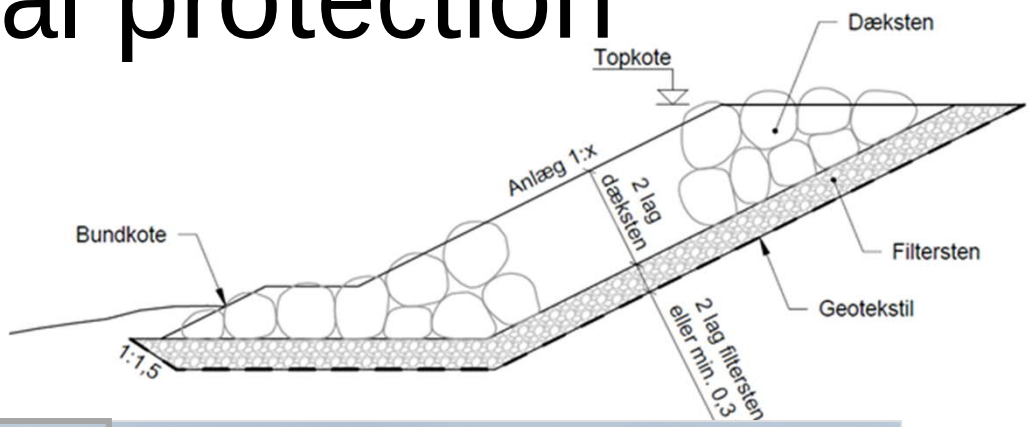
Now and in the future

Starting point: Water depth in front of coastal protection

- Water level
  - Storm surge
  - Wave set-up
  - Seal level rise
- Terrain level
  - Isostatic rebound
- Erosion
  - Chronic erosion
  - Erosion during a storm
  - Erosion due to sea level rise
- Beach nourishment



Assessment of existing coastal protection



Water level
- Beach level

Registered layout

Armour rock:
D_{50} = 57 cm

Top level:
+4.5 m

Beach level at toe:
0.0 m DVR90

Slope:
1:2.14

Input Data

Slope: 1:1.5

Slope: 1:2.0

Slope: 1:2.5

Slope: 1:3.0

Water depth: 4.0 m

Water depth: 3.5 m

Water depth: 3.0 m

Water depth: 2.5 m

Water depth: 2.0 m

Water depth: 1.5 m

Water depth: 1.0 m

Water depth: 0.5 m

Calculated Output

Amour rock:
D_{50} = 102 cm

Top level:
+4.6 m

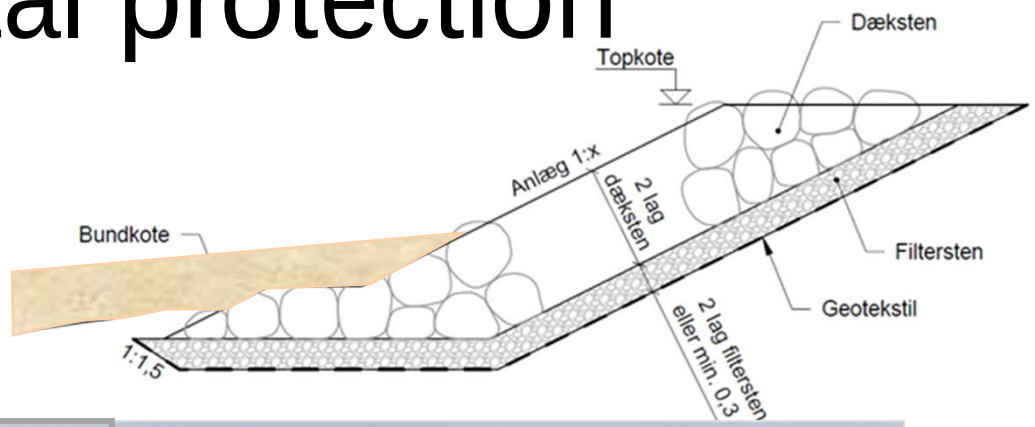
Condition:

Bad:
Rebuild

Extension:
Increase top level

OK:
Secured to 50/50

Assessment of existing coastal protection



Water level
- Beach level

Registered layout

Armour rock:
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Water depth: 3.0 m

Water depth: 2.5 m

Water depth: 2.0 m

Water depth: 1.5 m

Water depth: 1.0 m

Water depth: 0.5 m

Calculated Output

Amour rock:
D_{50} = 51 cm

Top level:
+4.6 m

Condition:

Bad:
Rebuild

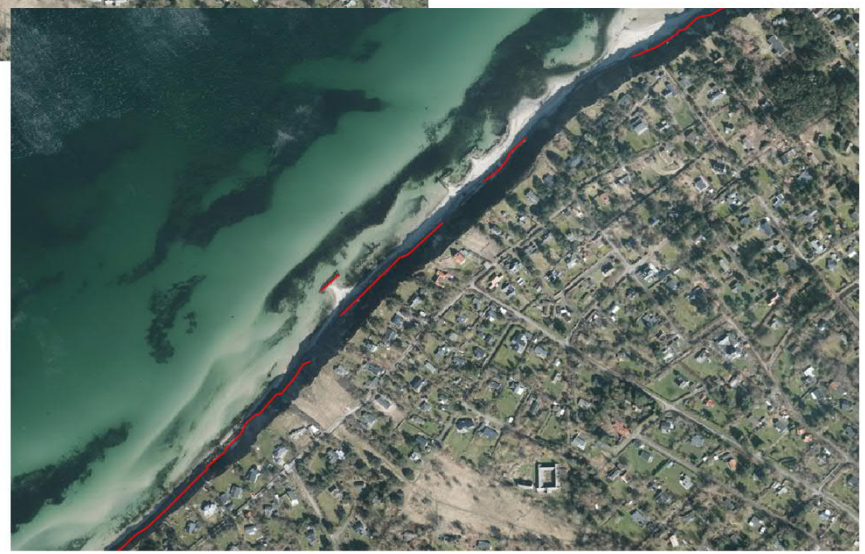
Extension:
Increase top level

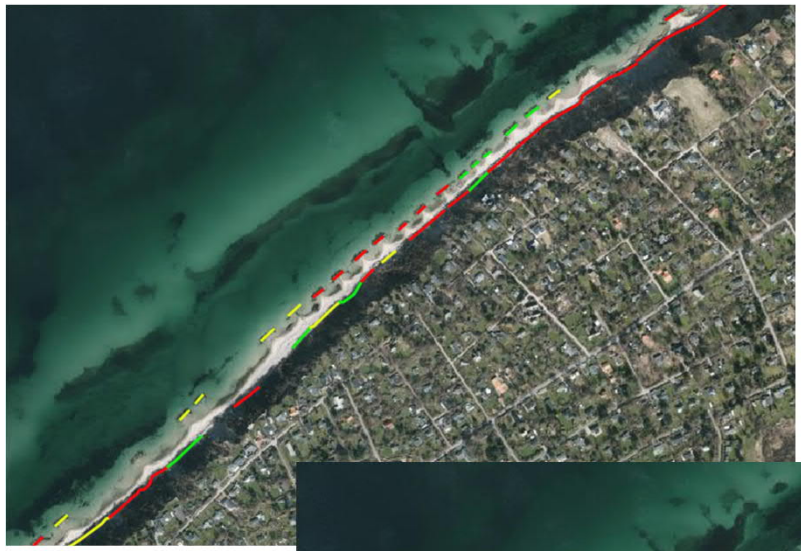
OK:
Secured to 50/50

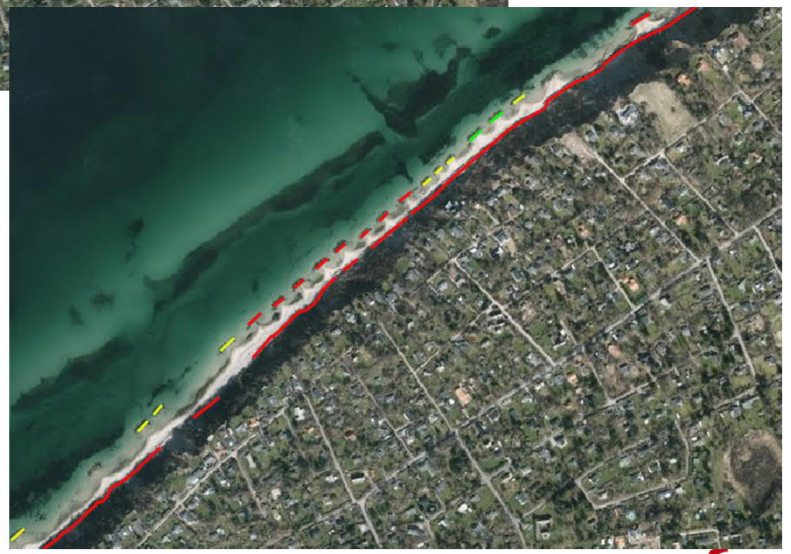
Assessment of existing coastal protection

Assessment of existing coastal protection

Today and in 50 years

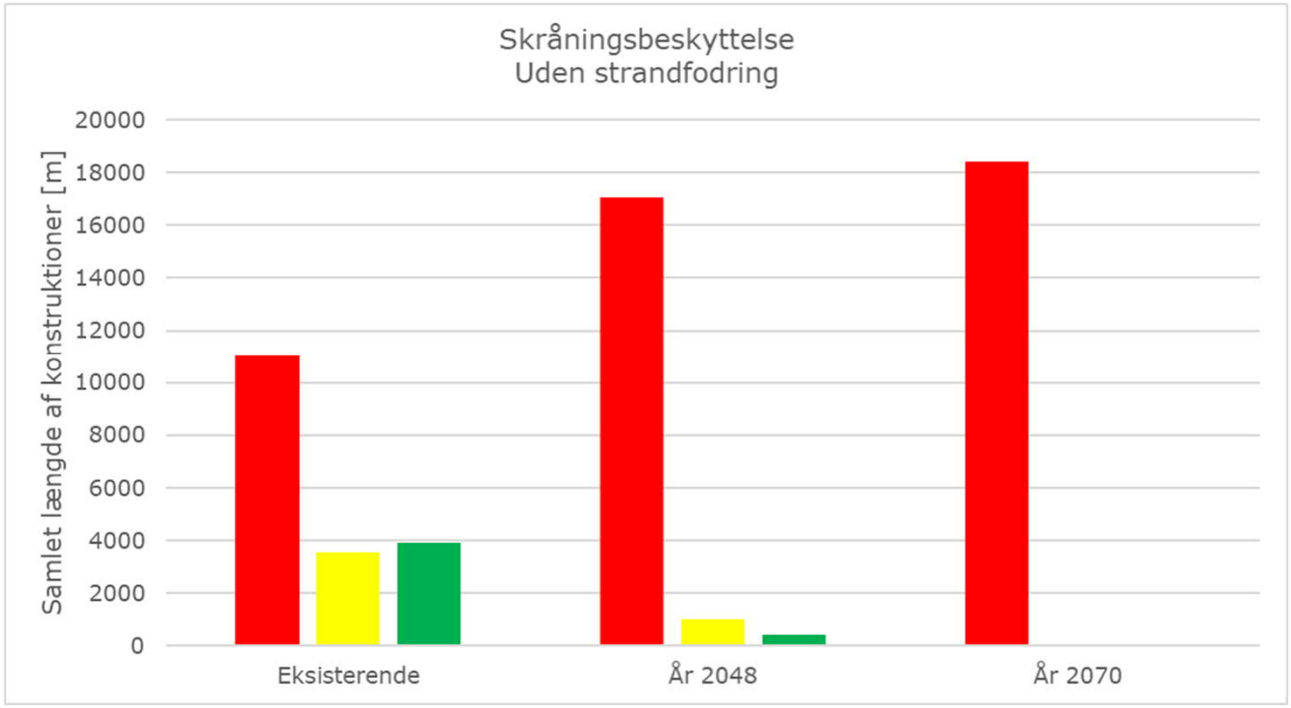






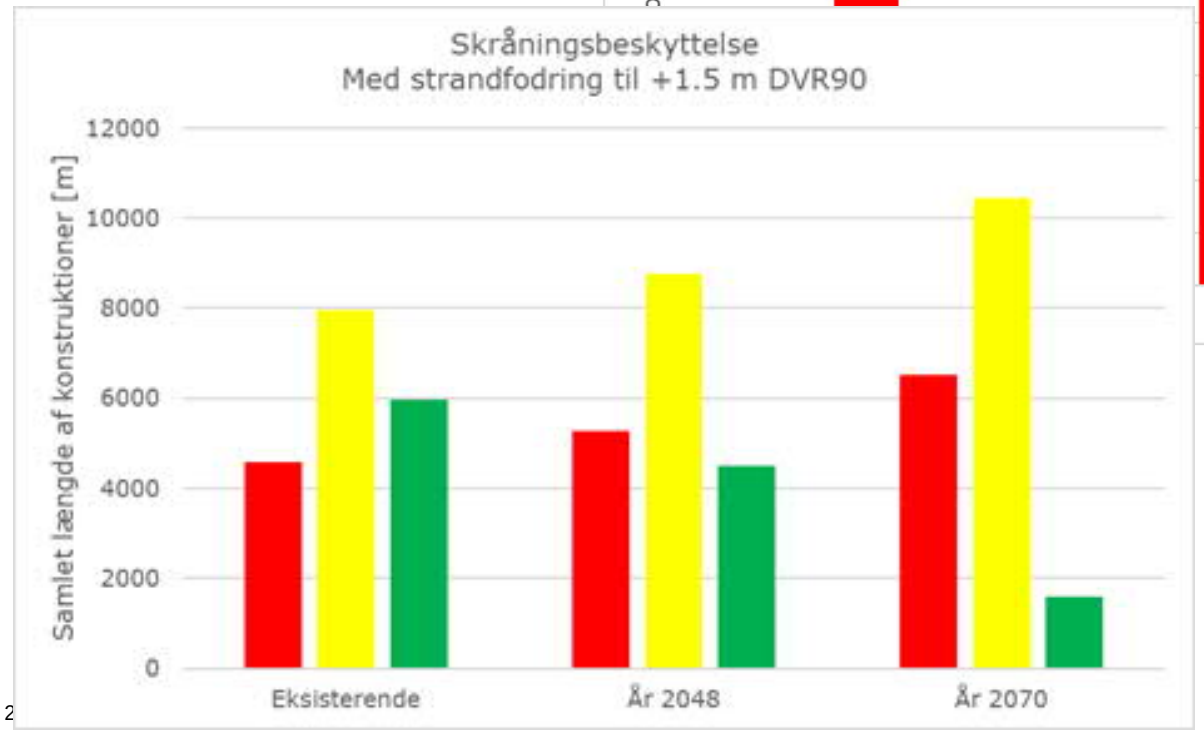
Assessment of existing coastal protection

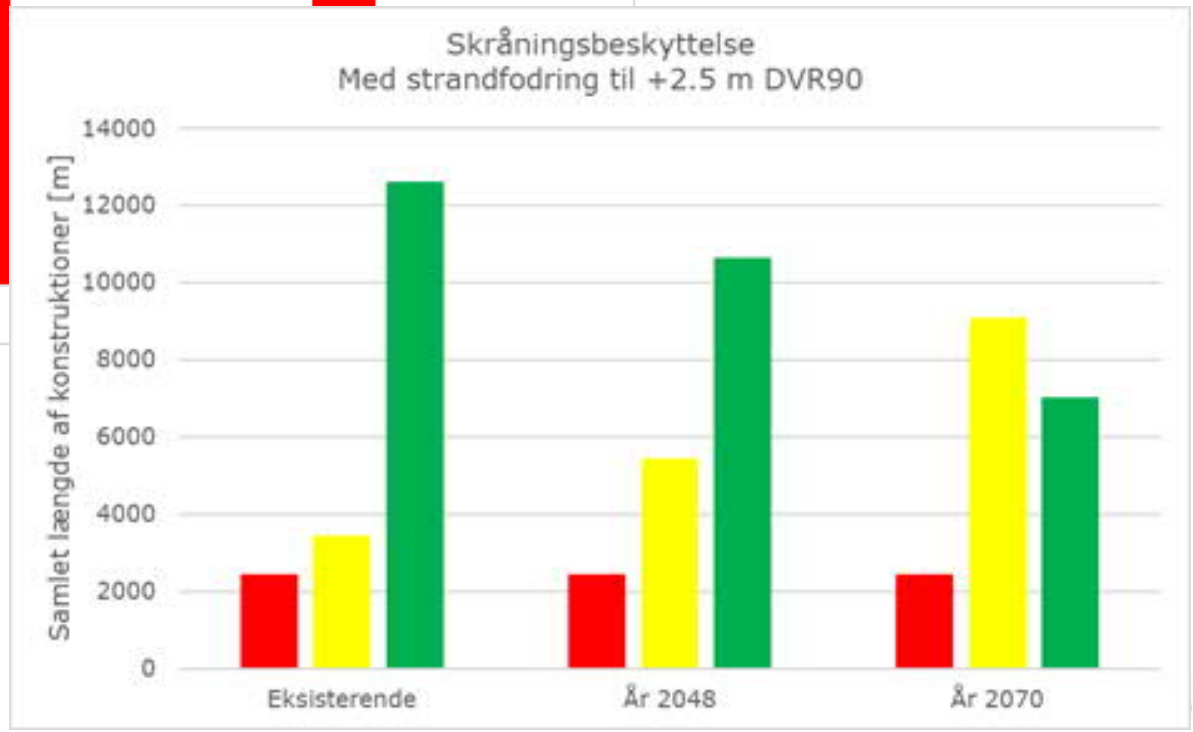
Today and in 50 years without beach nourishment



Assessment of existing coastal protection

Today and in 50 years with beach nourishment

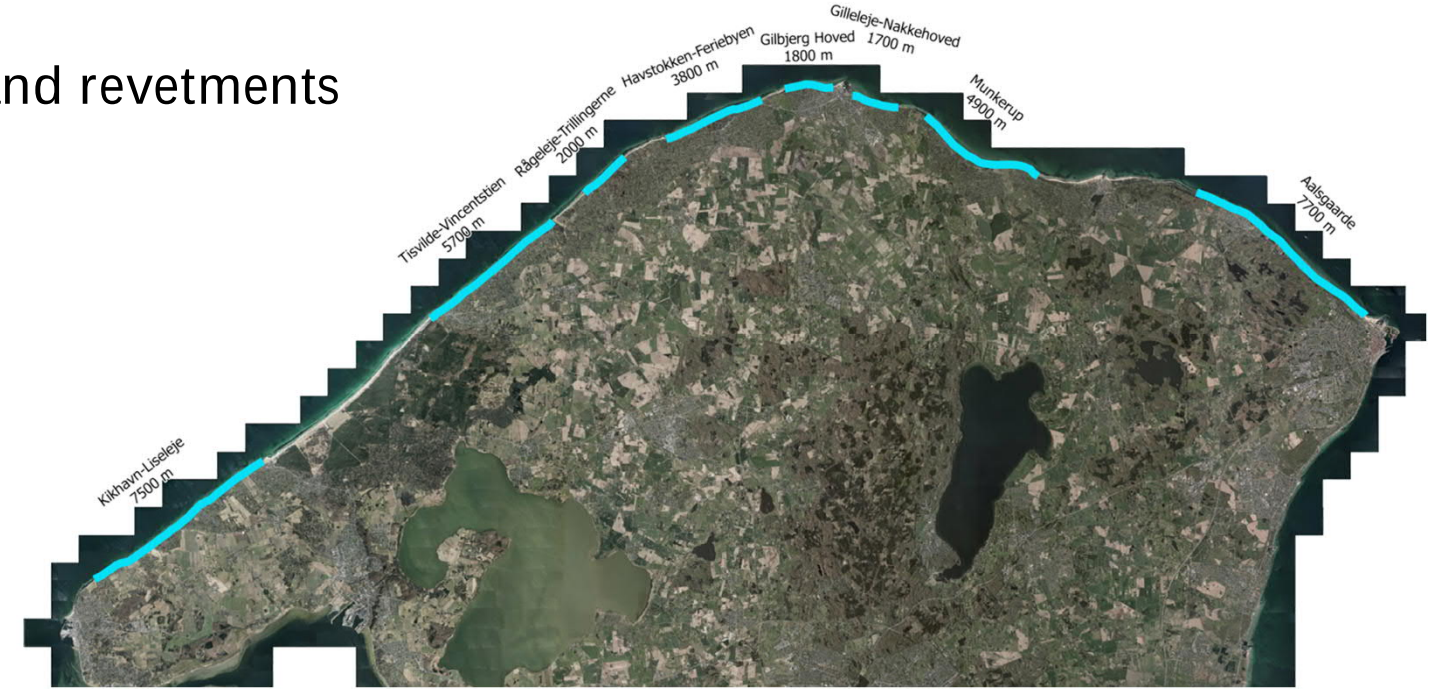




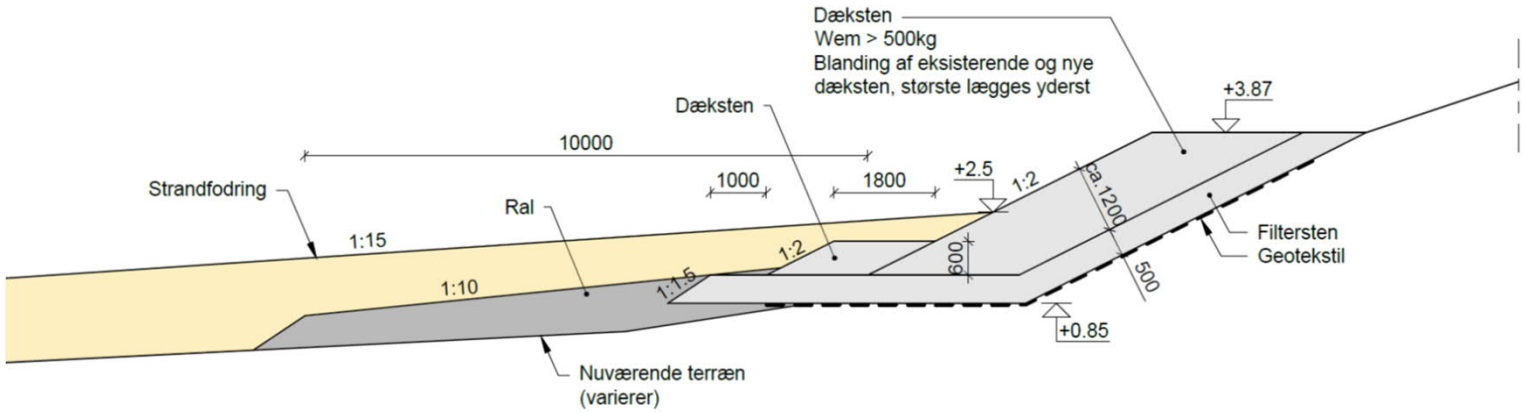
Final project

Combination of beach nourishment and revetments

1. Communal beach nourishment where the coast is developed
   - Initial beach nourishment
   - Maintenance every five years
   - +2.5 m west of Gilleleje
   - +2.0 m east of Gilleleje

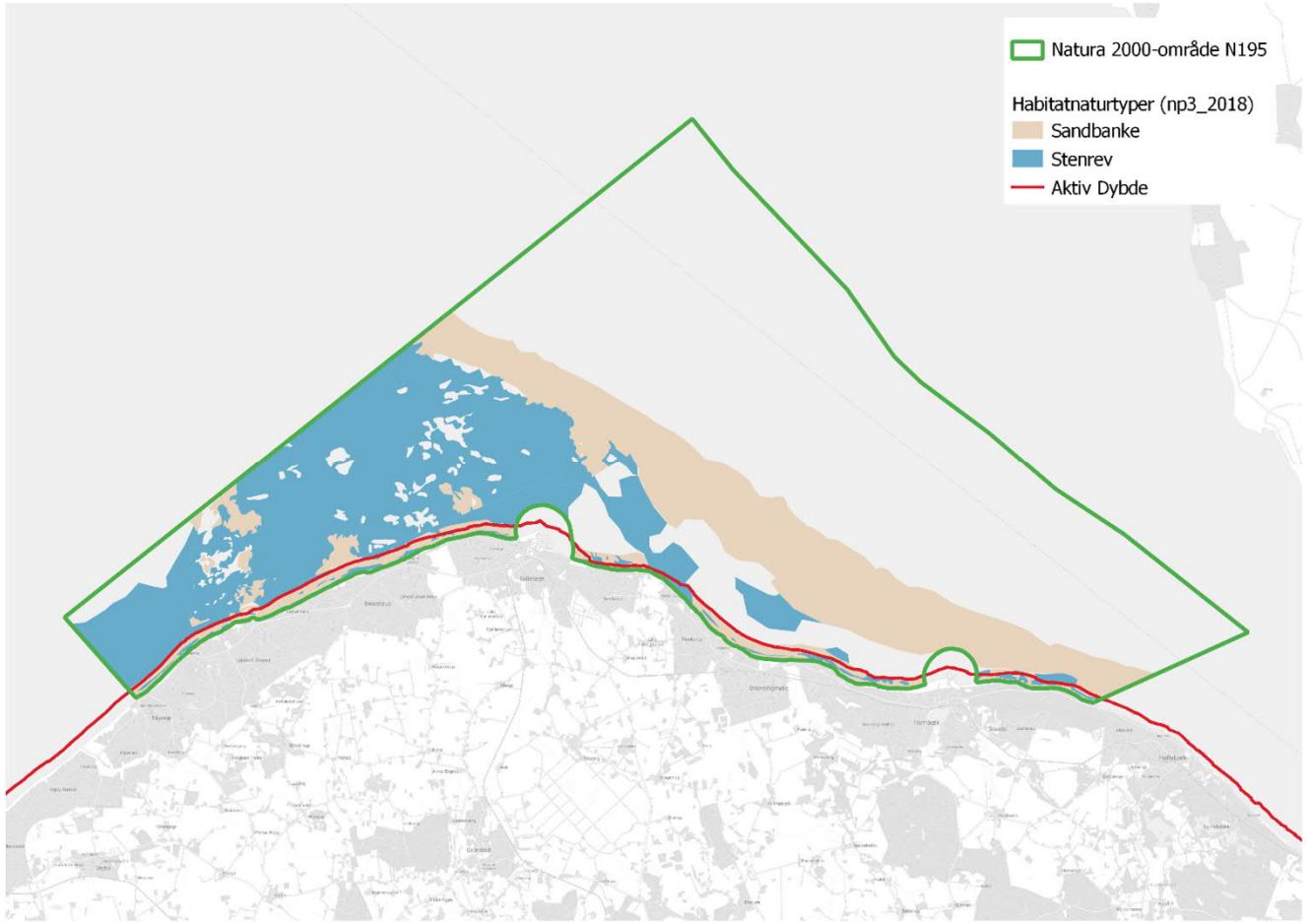


2. Inspiration on upgrading of the coastal protection (landowners)
   - Revetments which can withstand a 50 year storm in 50 years



Final project

Natura 2000 N195



Final project

Visualisation