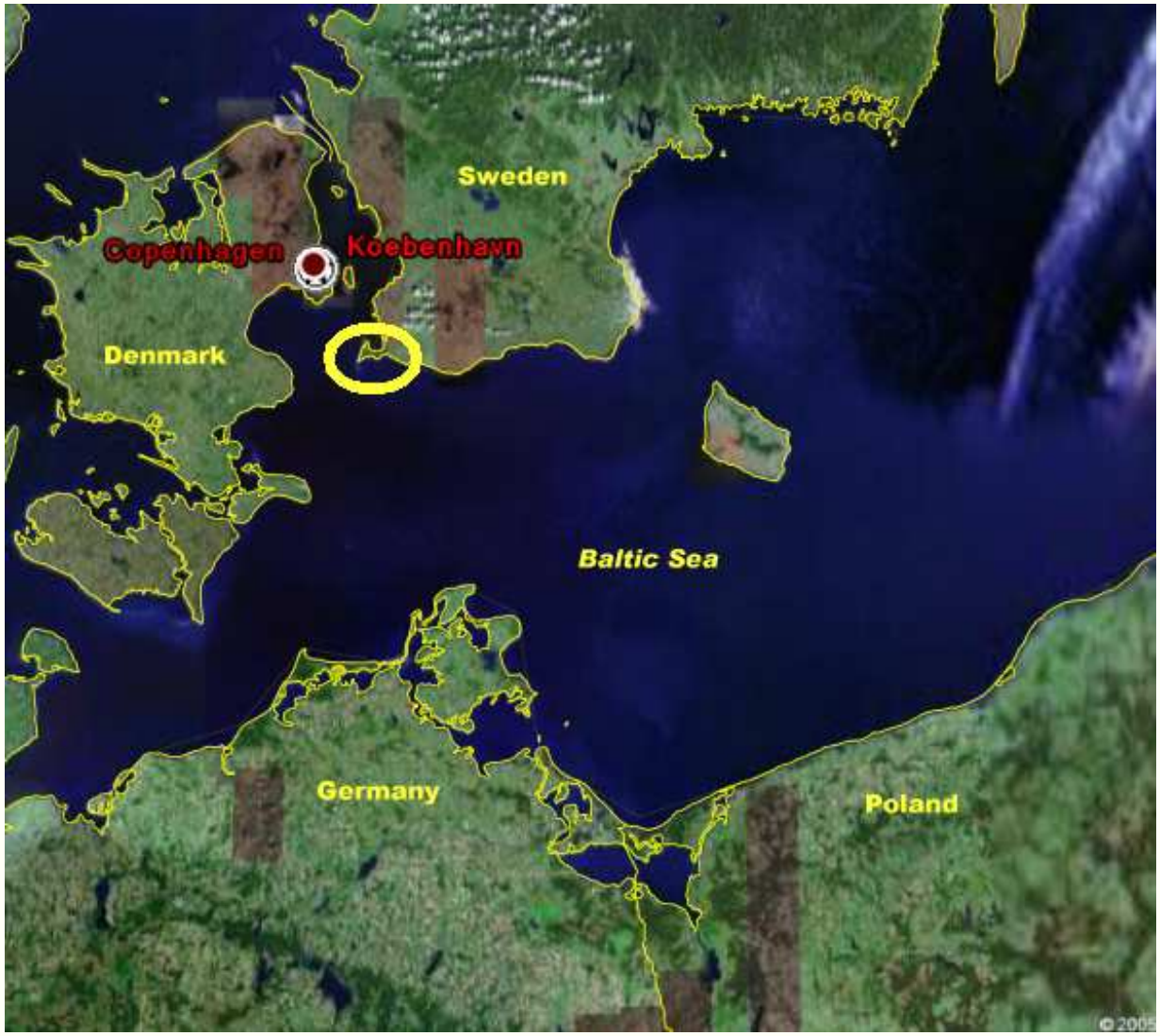
Documented Long-Term Trends in MSL and NHW in the South Baltic Sea

- What do we know?
- What do we think?
- What can we do?

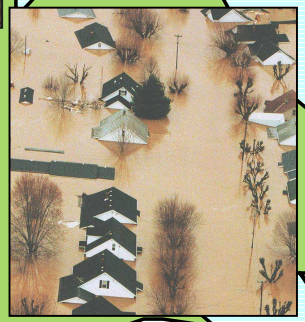
Possible Threats

WHAT DO WE KNOW?

Study Site

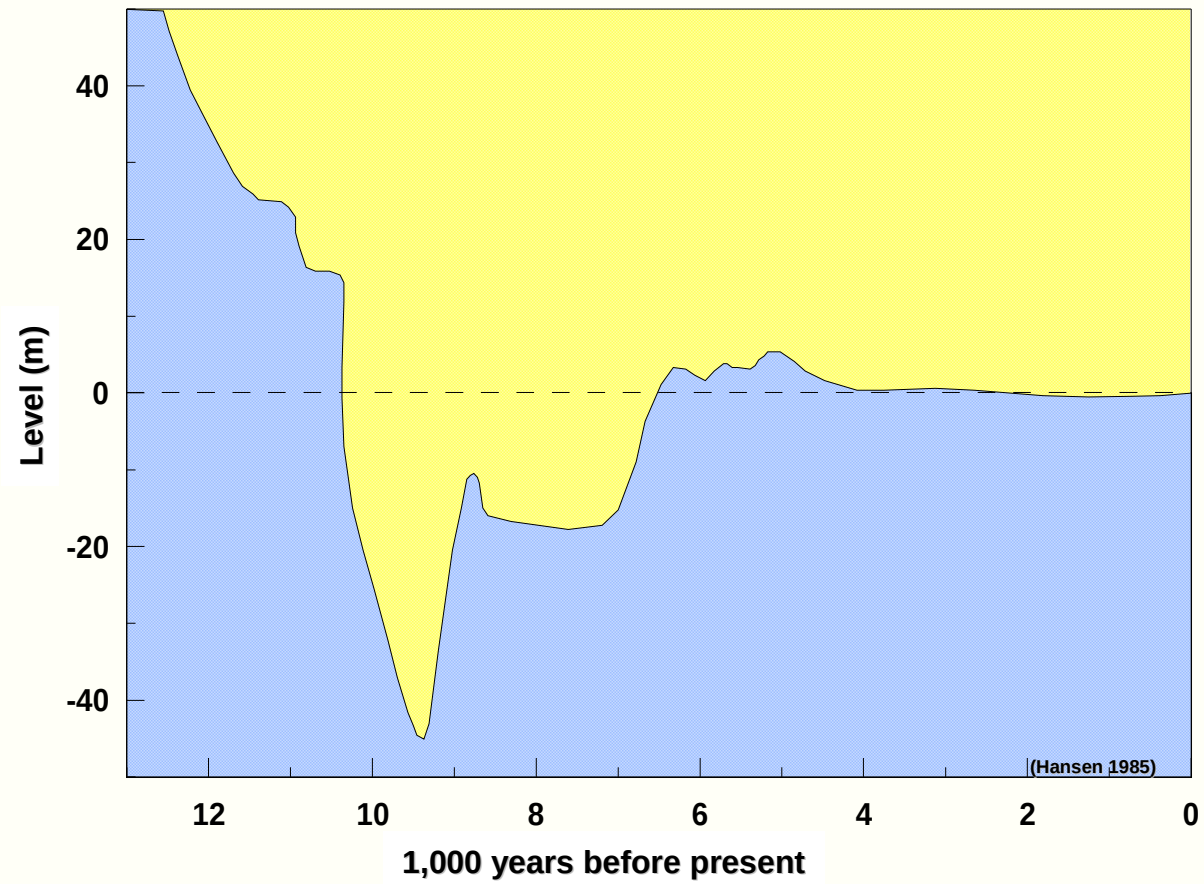

Sweden
Copenhagen
Koebenhavn
Denmark
Baltic Sea
Germany
Poland

Study Site

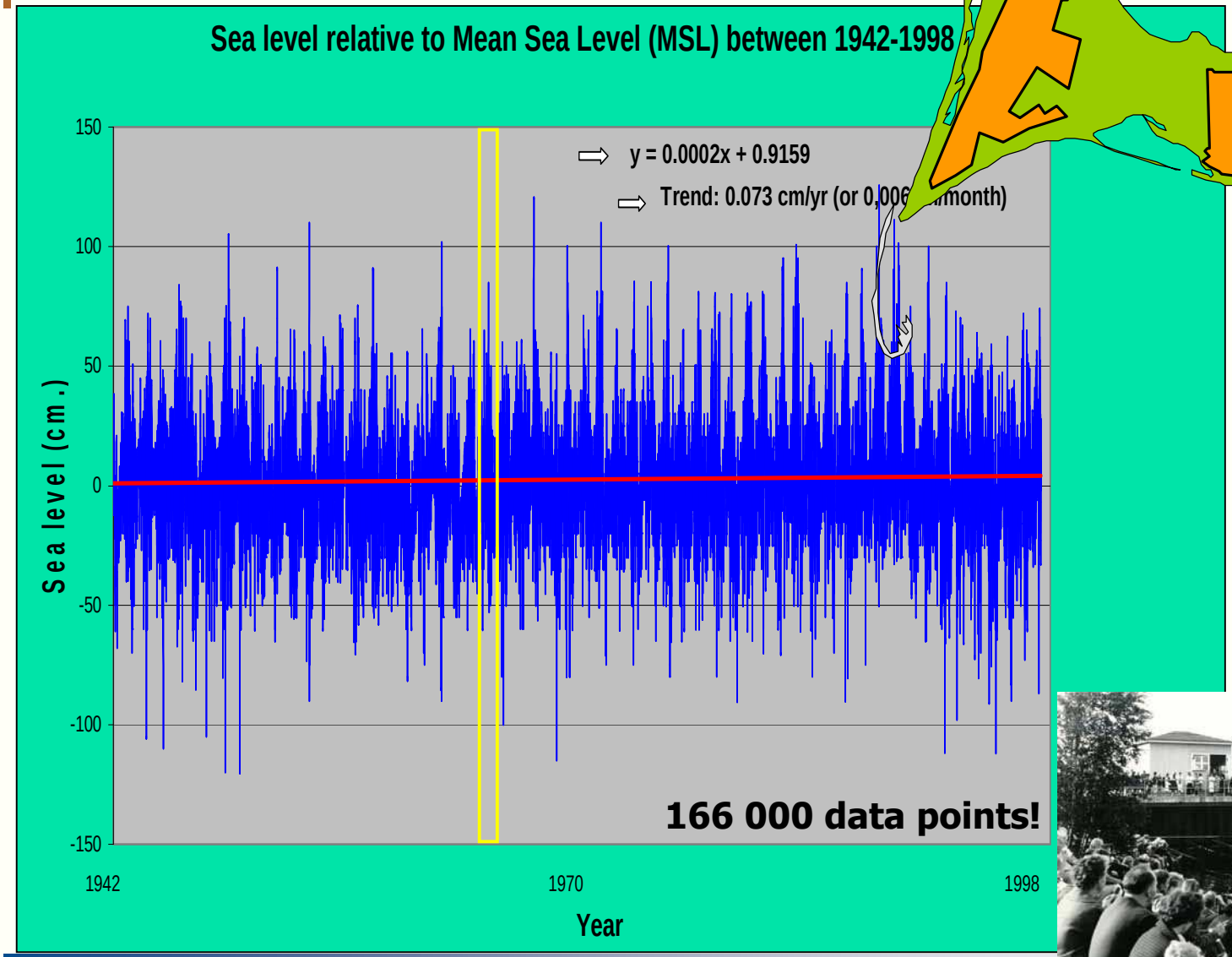


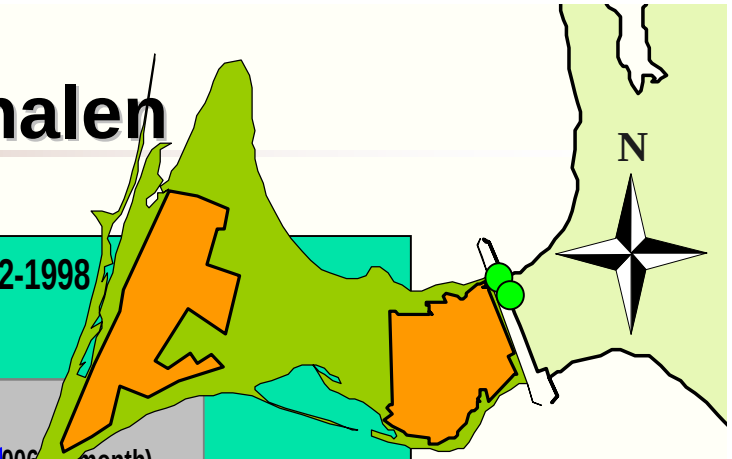
Low-laying terrain built by sand; sensitive to high winds, water levels, and waves.

Water level fluctuations in the S Baltic Sea

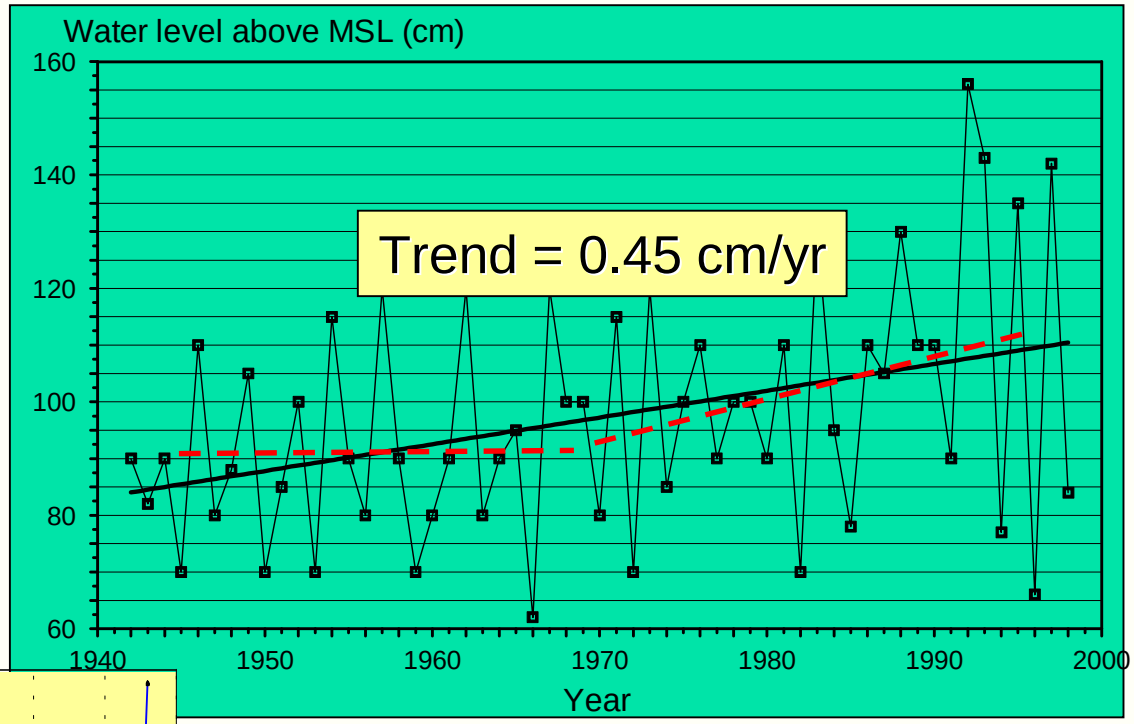


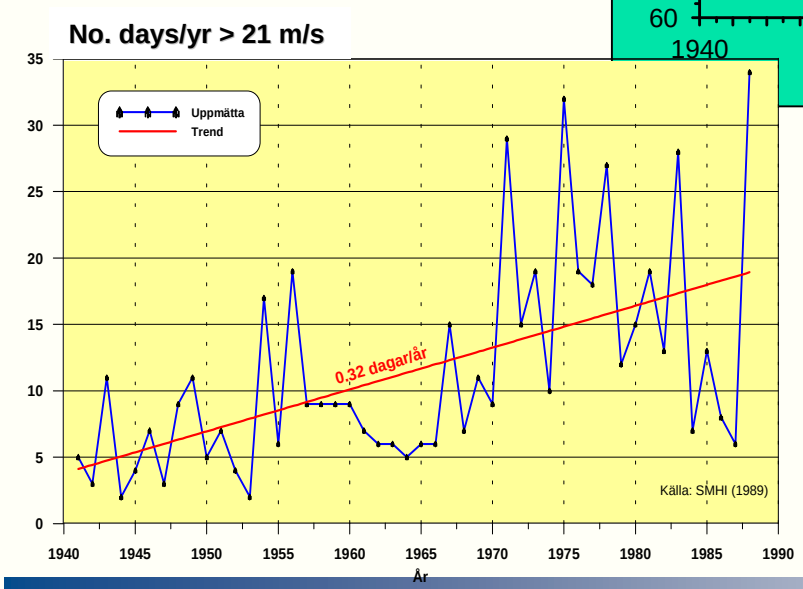
Water Levels in Falsterbokanalen



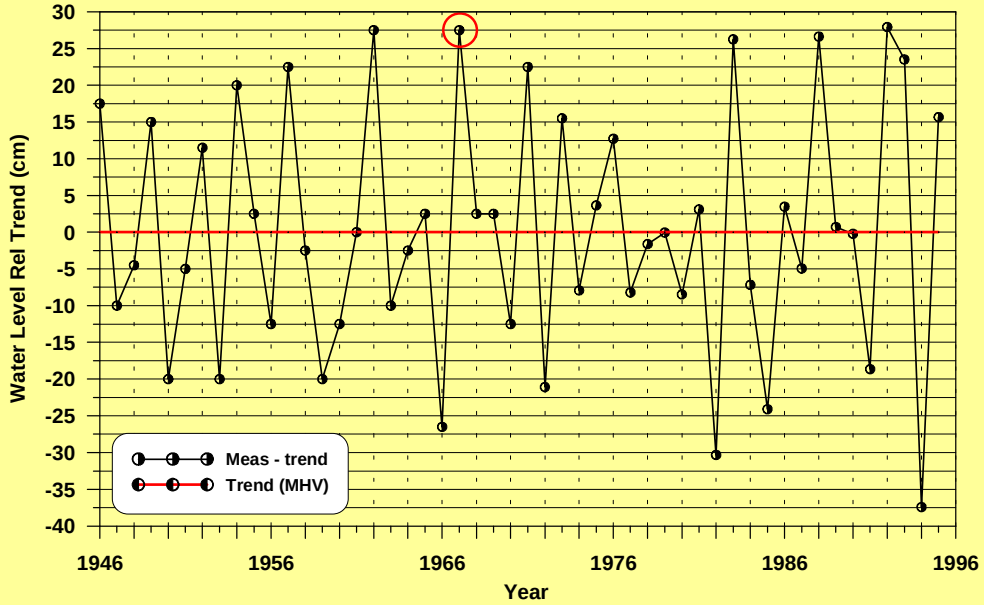


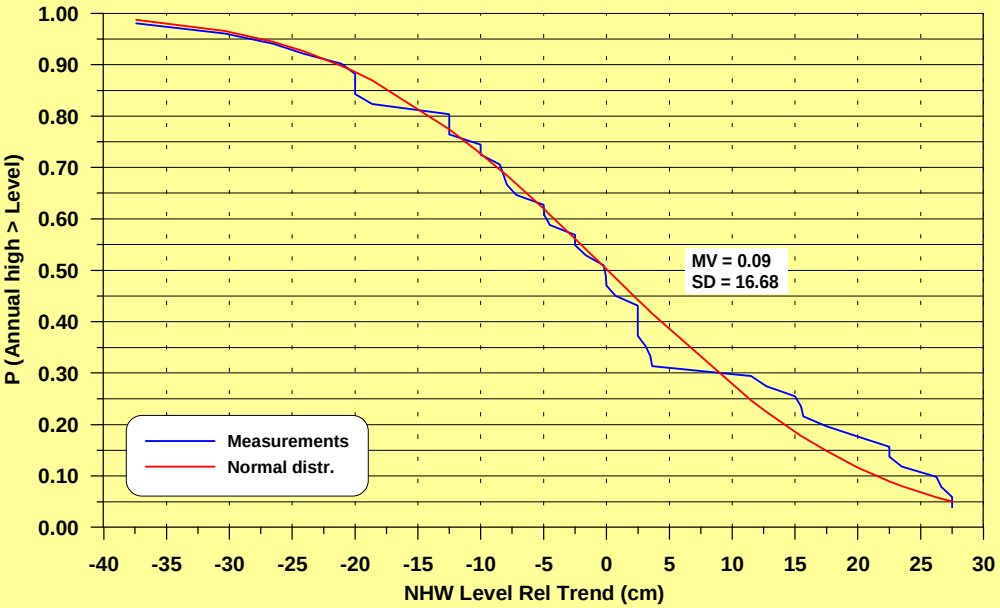
Annual High Water Levels (corrected for MSL change)





Distribution of ’Detrended’ NHW Levels

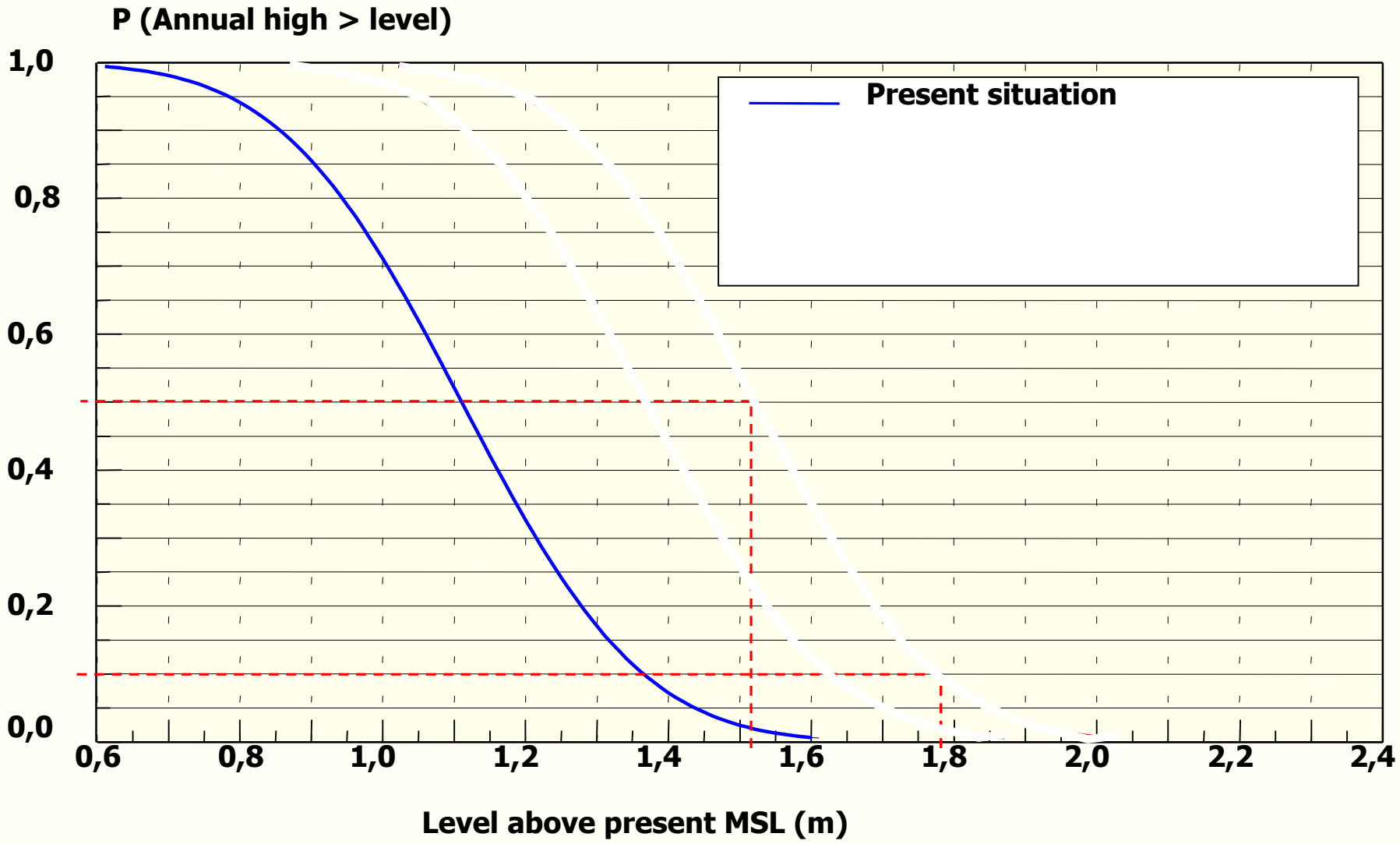




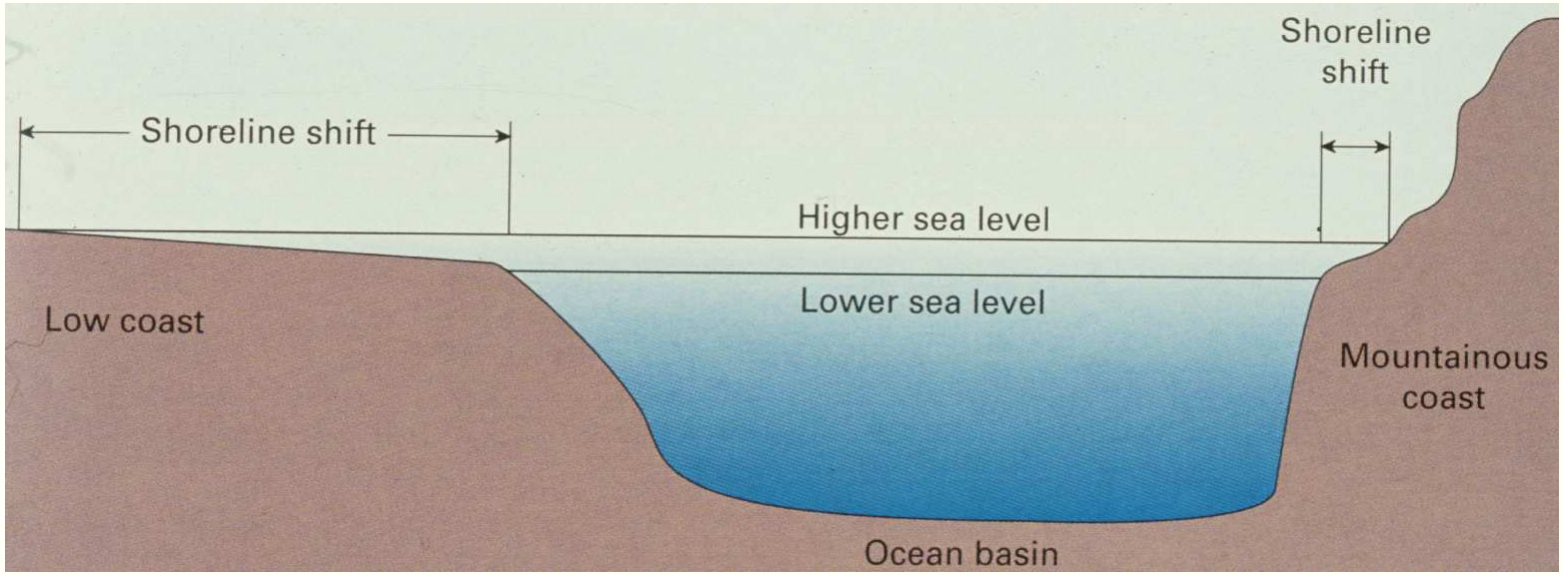
Present Conditions

2050?

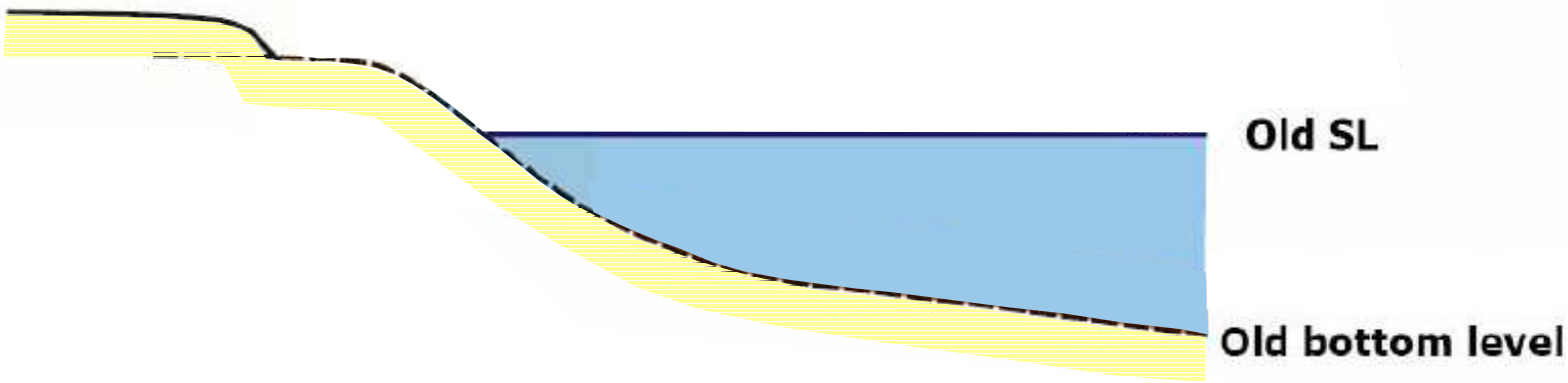
Water level probability



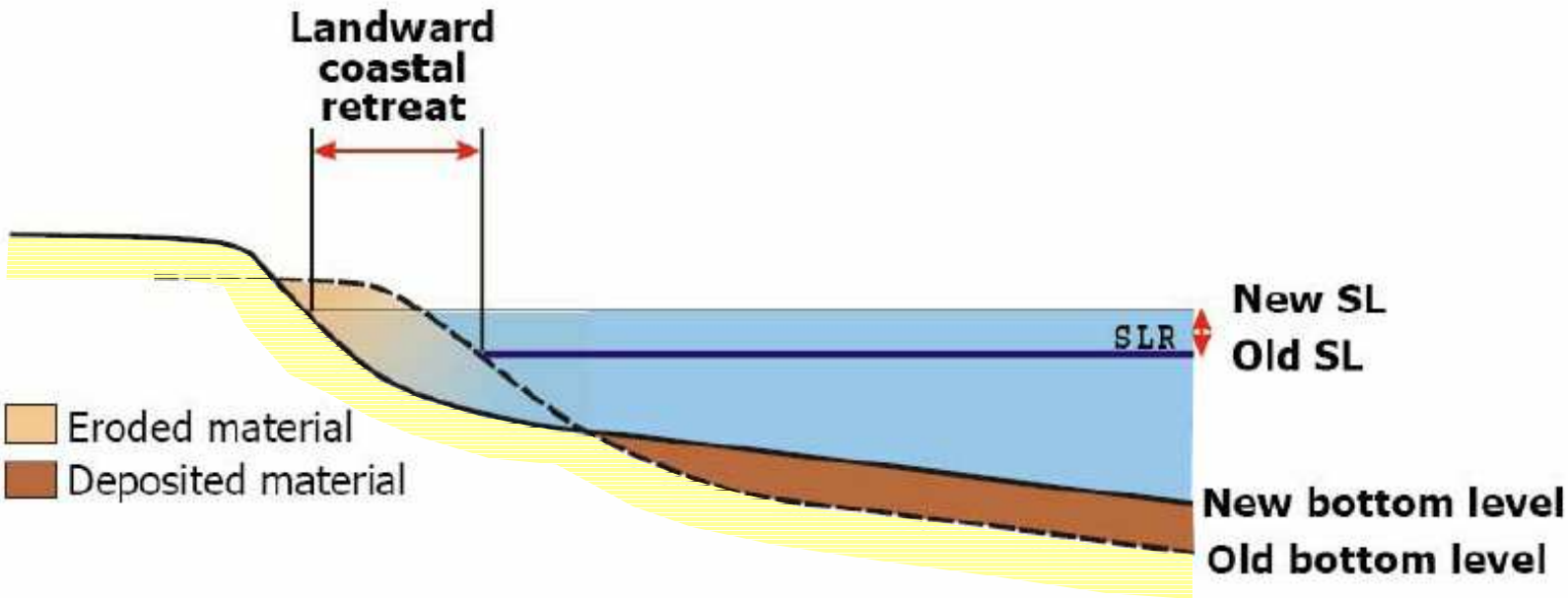
Consequences of SLR



SLR – Morphological Response



SLR – Morphological Response



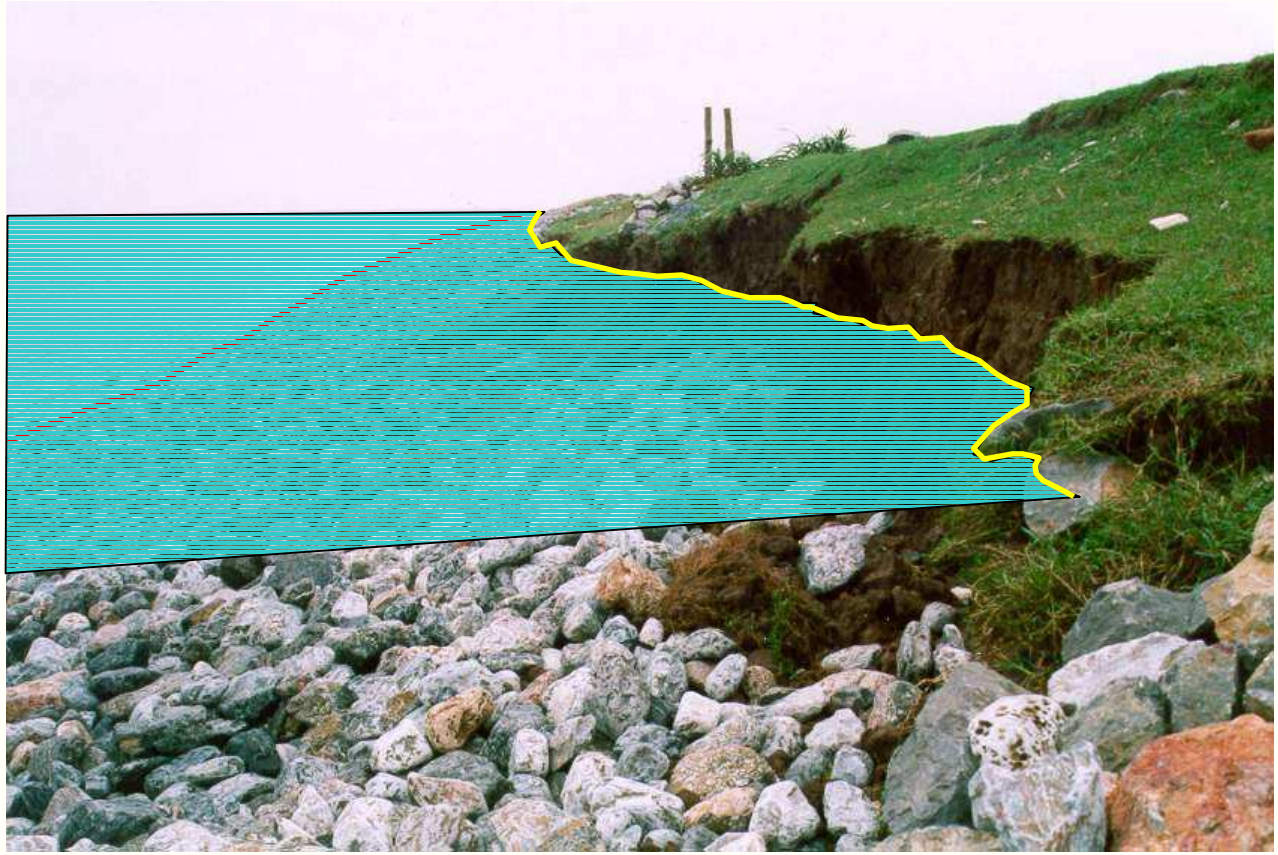
$$R = \frac{1}{\tan\theta} S$$

R = shoreline recession and $\tan\theta$ = beach slope.

Since beach slope often between 0.01 and 0.02, *rule of thumb* is that Recession approximates 50S to 100S, where S is sea level rise.

Bruun, 1962

HWL - Erosion of upper profile

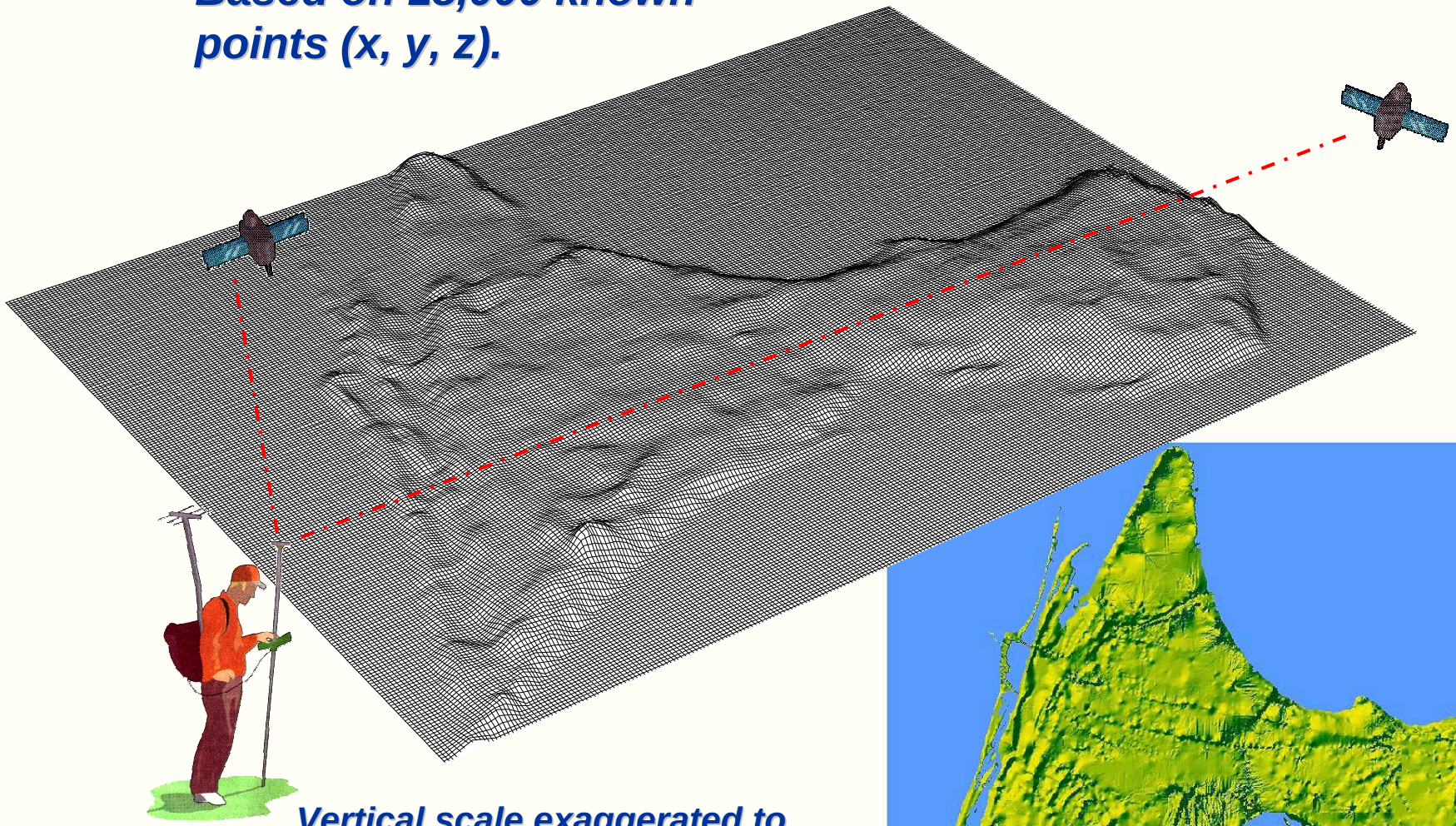


SLR – What becomes flooded?

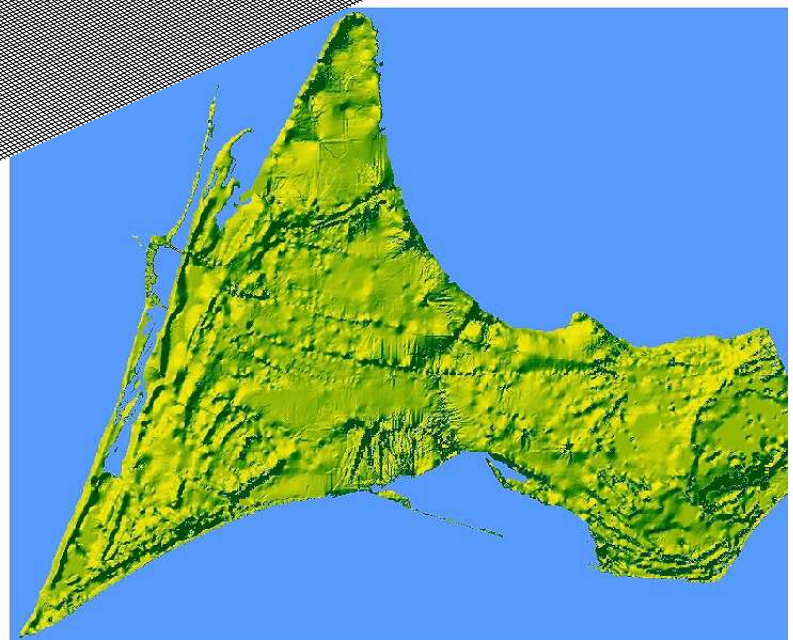
Digital Elevation Modell – Existing (x,y,z)

Digital Elevation Model – New Data

Based on 18,000 known points (x, y, z).

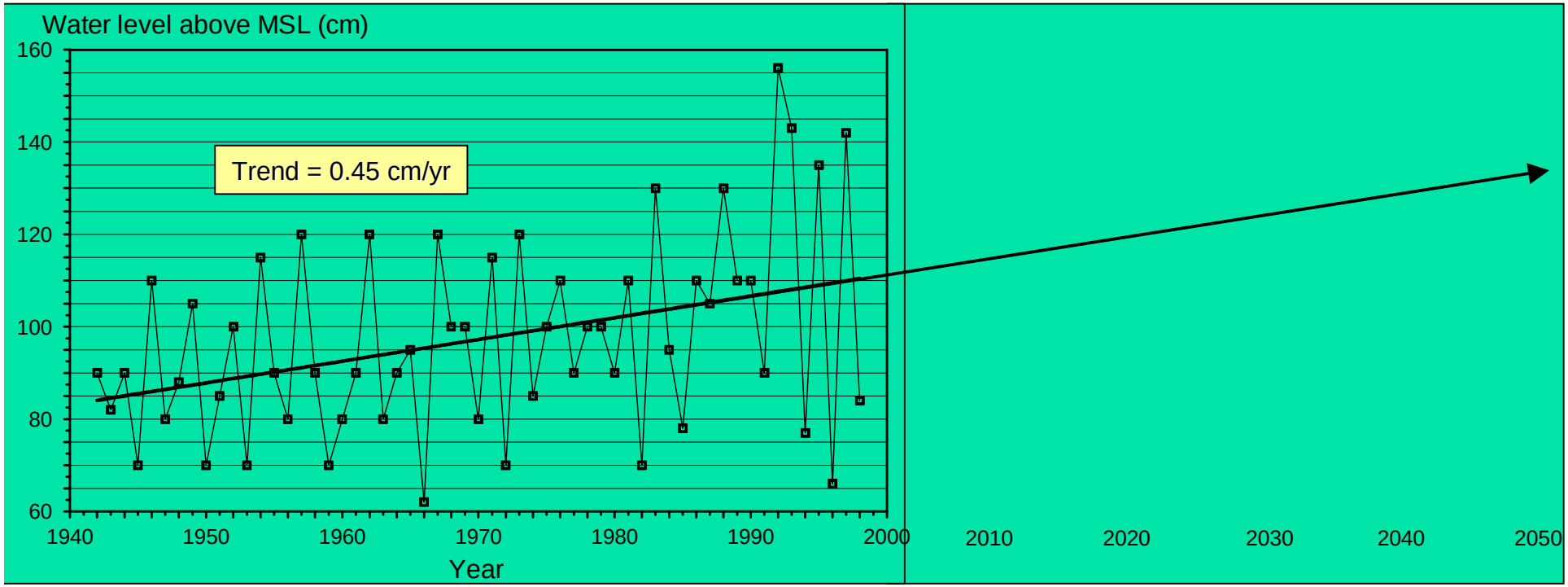


Vertical scale exaggerated to enhance 3D-effekt.

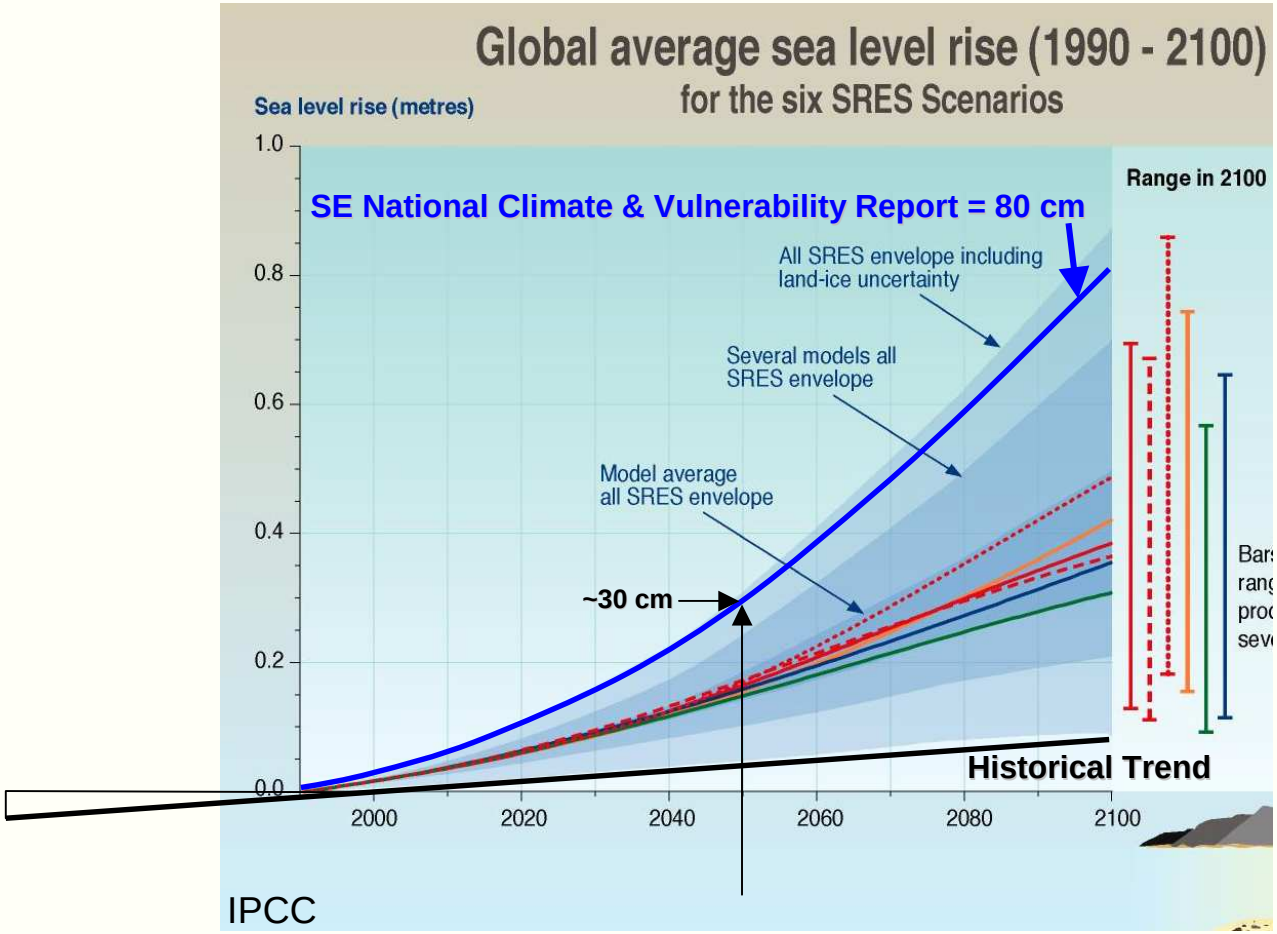


WHAT DO WE THINK?

NHW trend continues?



Future SLR? - Uncertainty



Only probable

Uncertainty = f(time)

Uncertainty + & -

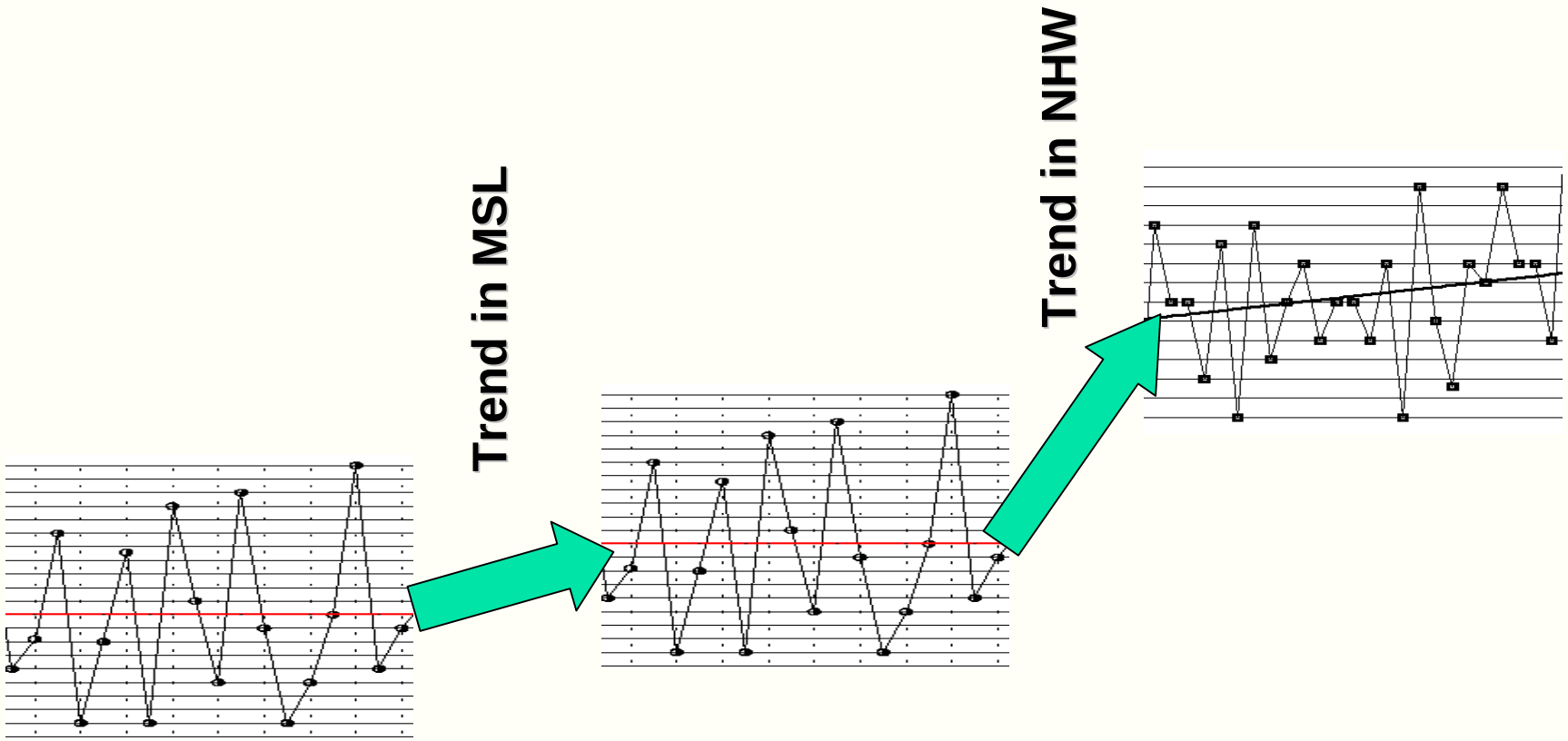
Now all similar

Change of scenario

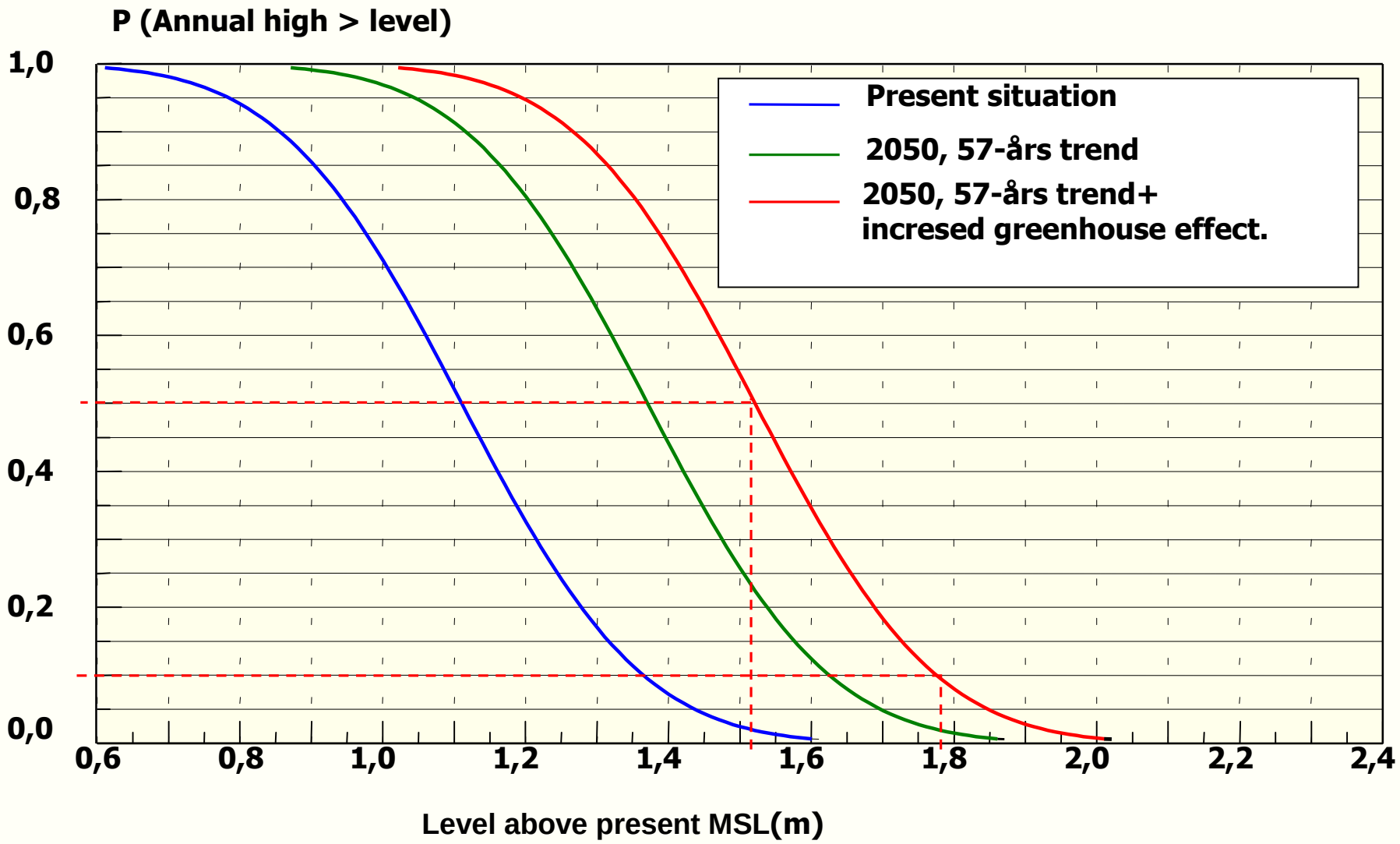
Continuously revise plans

Reality often cyclic

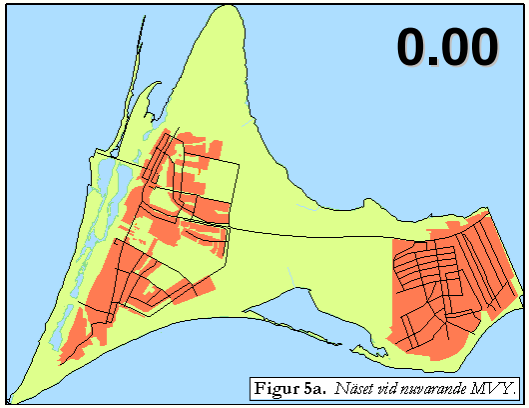
Increase in SL 2000 - 2050



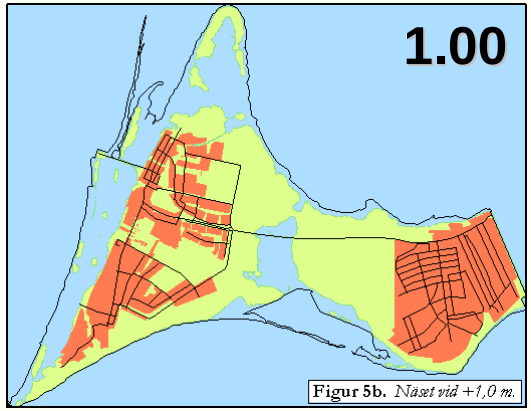
Water level probability



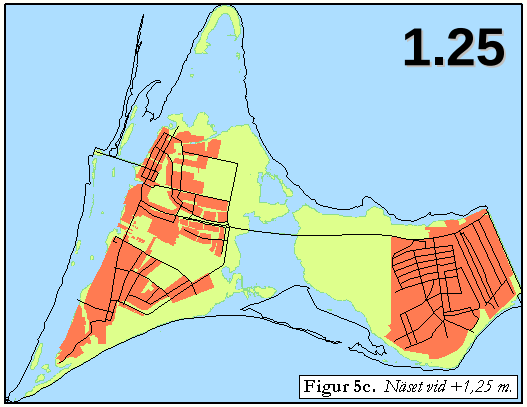
Digital Elevation Model – WL Scenarios



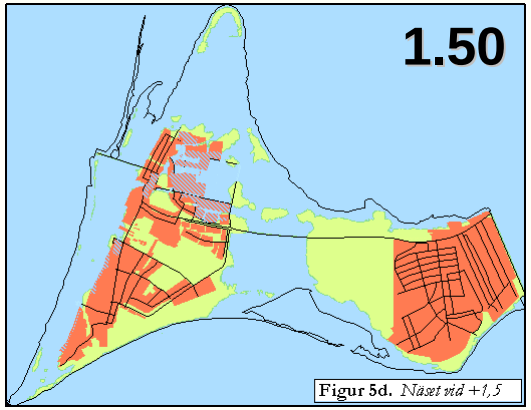
Figur 5a. *Näset vid nuvarande MVY.*



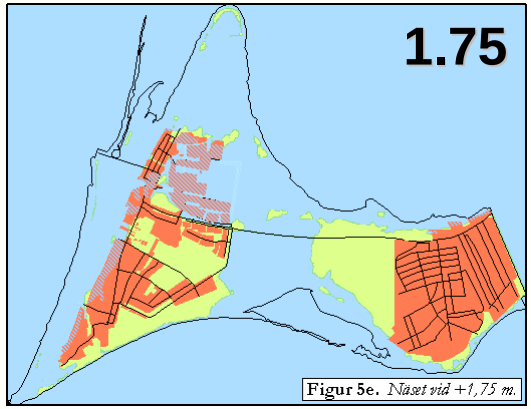
Figur 5b. *Näset vid +1,0 m.*



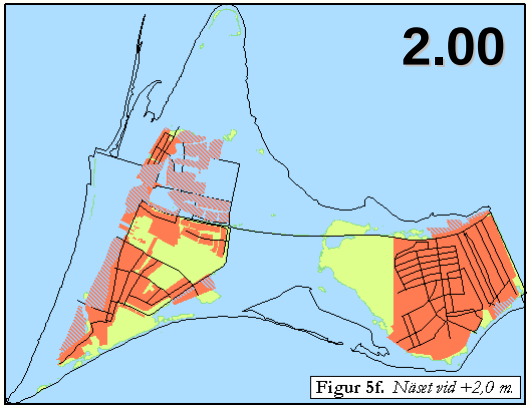
Figur 5c. *Näset vid +1,25 m.*



Figur 5d. *Näset vid +1,5*



Figur 5e. *Näset vid +1,75 m.*

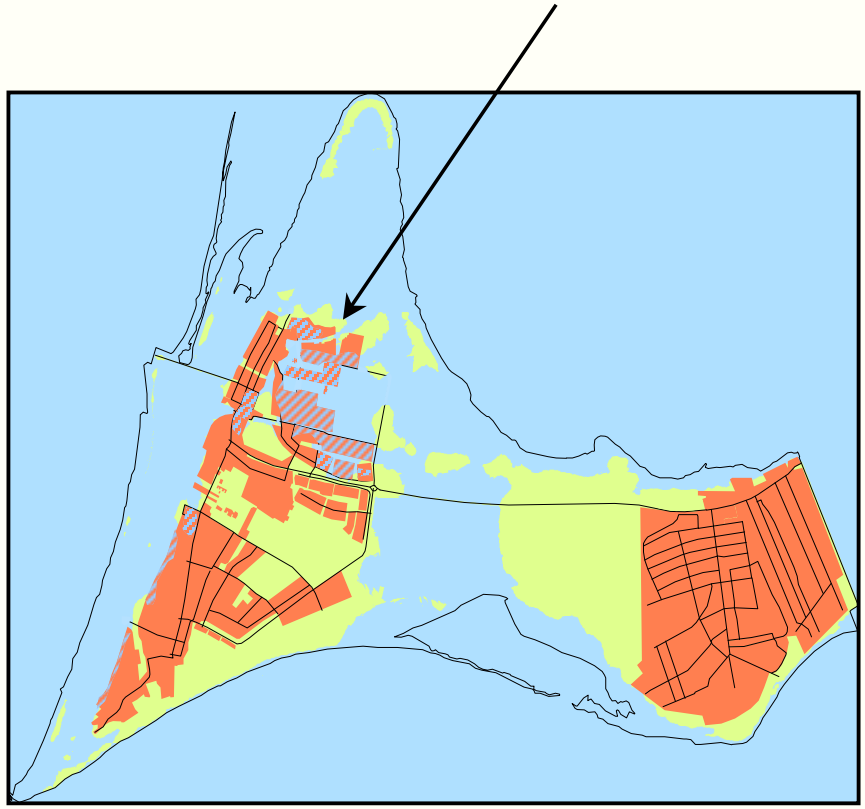


Figur 5f. *Näset vid +2,0 m.*

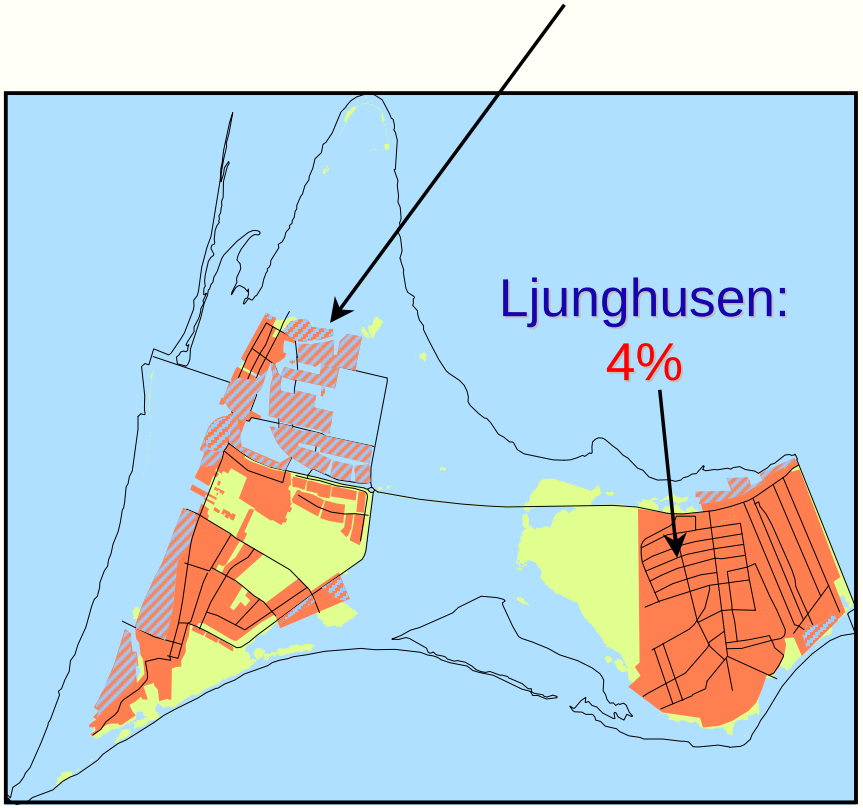
Digital Elevation Model – WL Scenarios

Flooding of housing areas in Skanör/Falsterbo at...

...+1,5 m: 18%



...+2,0 m: 42%



WHAT CAN WE DO?

Possible Strategies?

Do nothing

Planned retreat

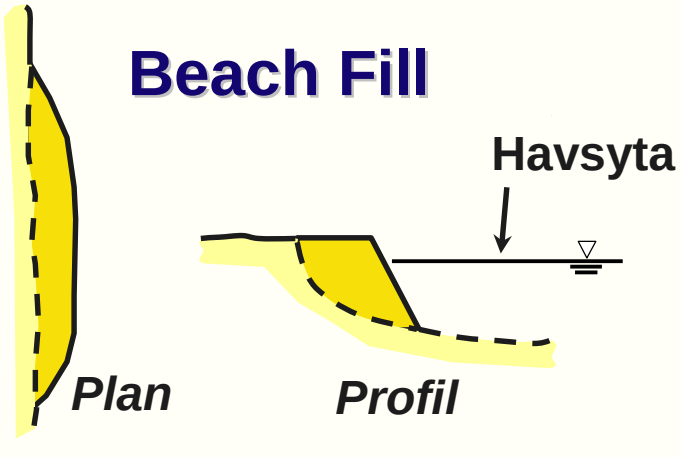
Accomodation

Stabilization/Nourishment

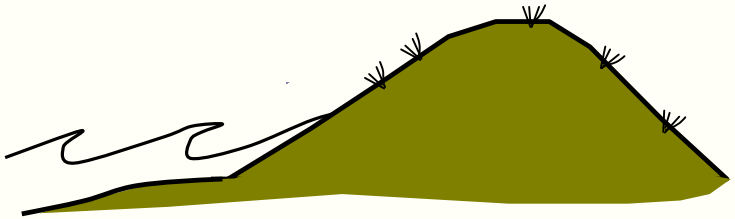
Stabilization – hard measures

Possible measures

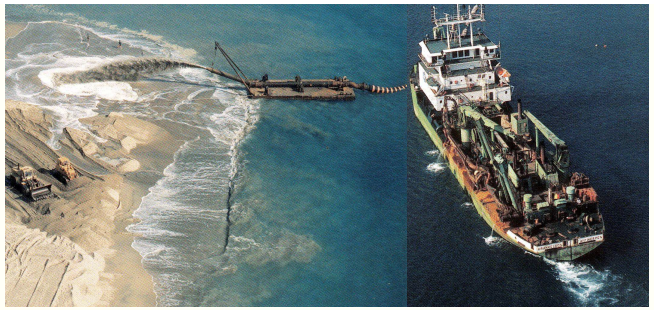
Beach Fill

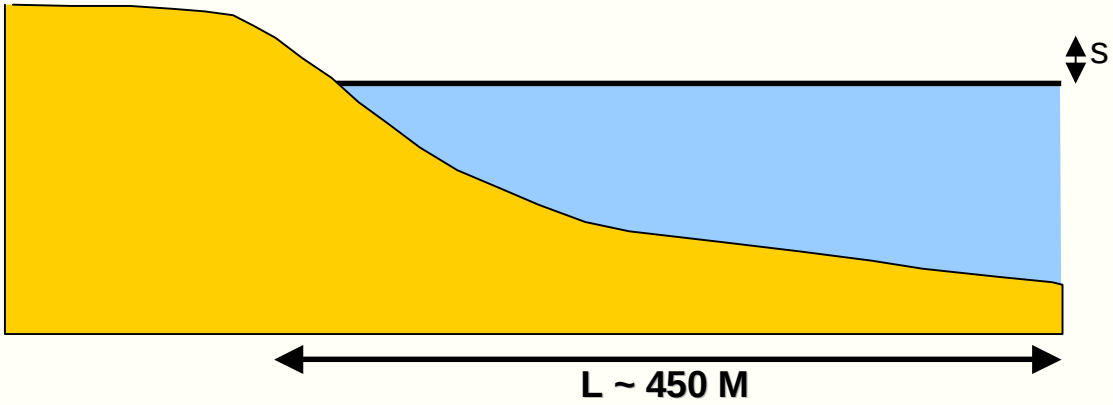


Vegetated earth dams



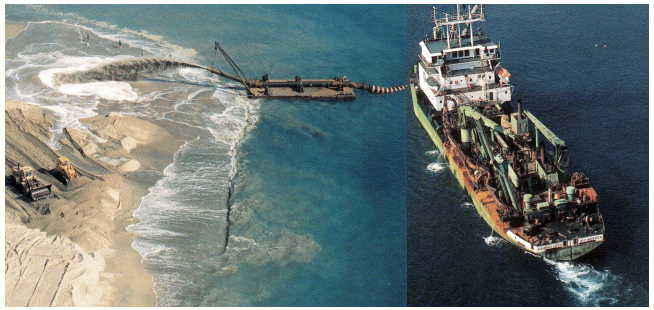
Possible measures – Beach nourishment



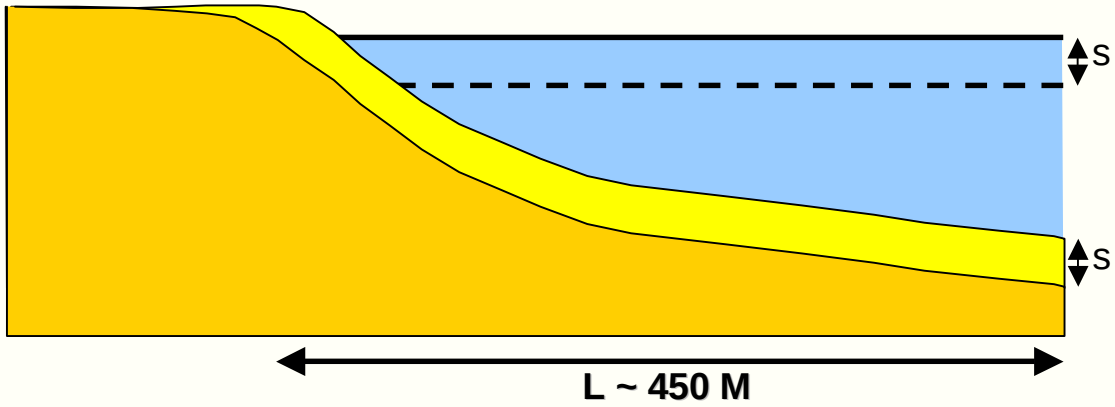


S = 0.33 m yr 2050

Possible measures – Beach nourishment



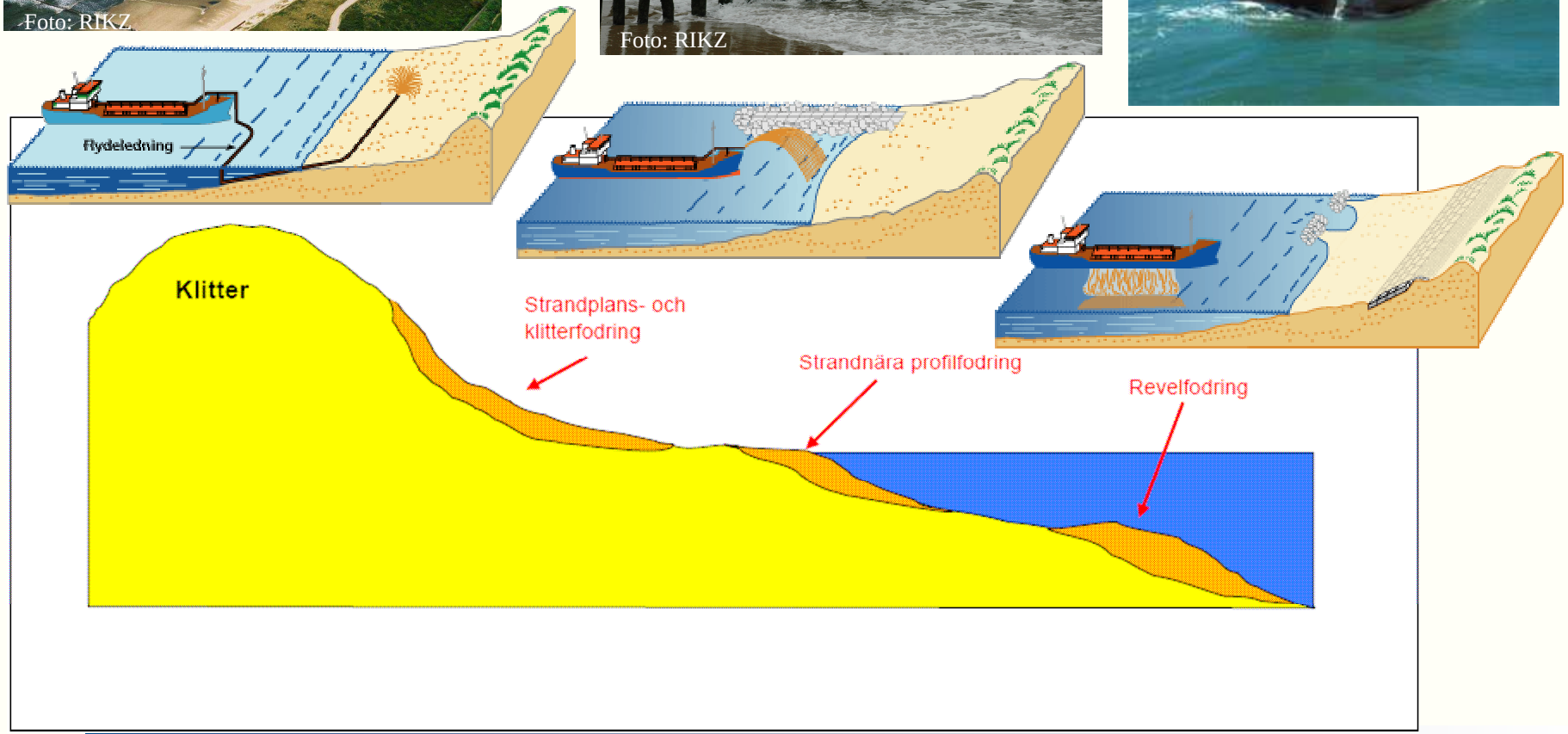
Fill volume V = S*L m^3/m beach



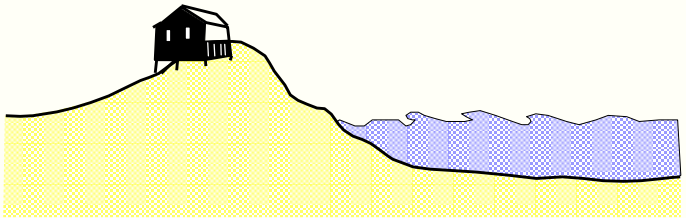
S = 0.33 m yr 2050

V ~ 150 000 m³/km ~ 3 000 m³/km per yr ~ 30 000 Euro/km/yr for 50 years!

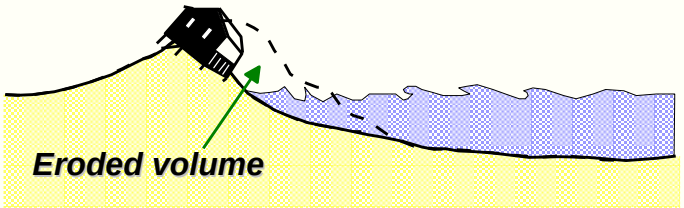
Possible measures – Beach nourishment



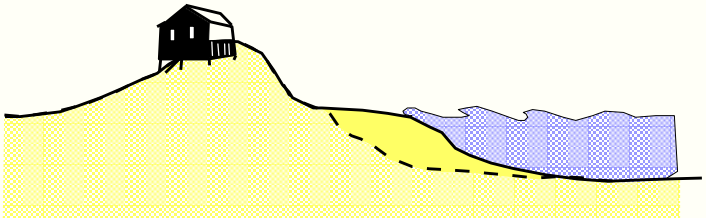
Hur much sand remains?



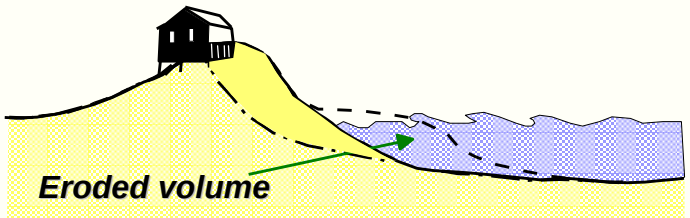
Conditions 2008
without fill



Conditions 2018
without fill



Conditions 2008
with fill



Conditions 2018
without fill

What is a beach worth?

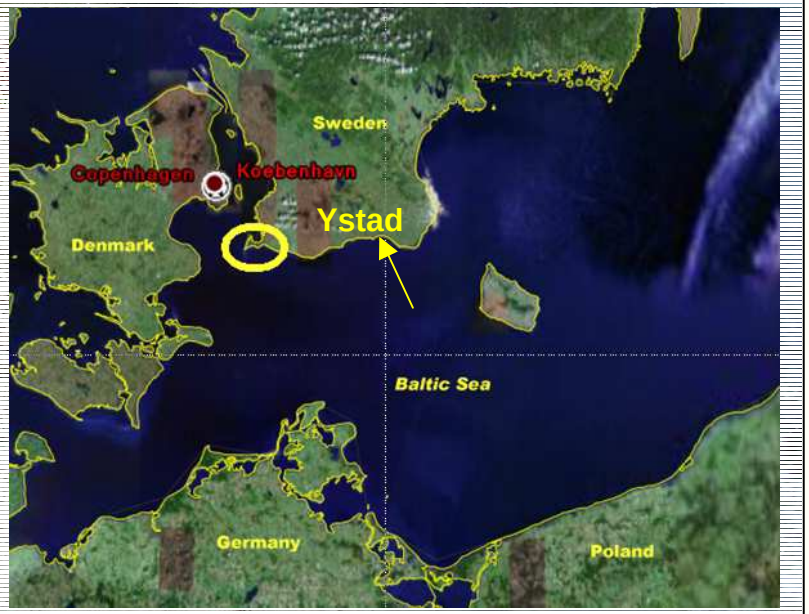
How do we manage our beaches?!

The beaches in Ystad turn around about 80 milj Euro/yr 2007.

The municipality invests about 220 000 Euro/yr in beach maintenance.

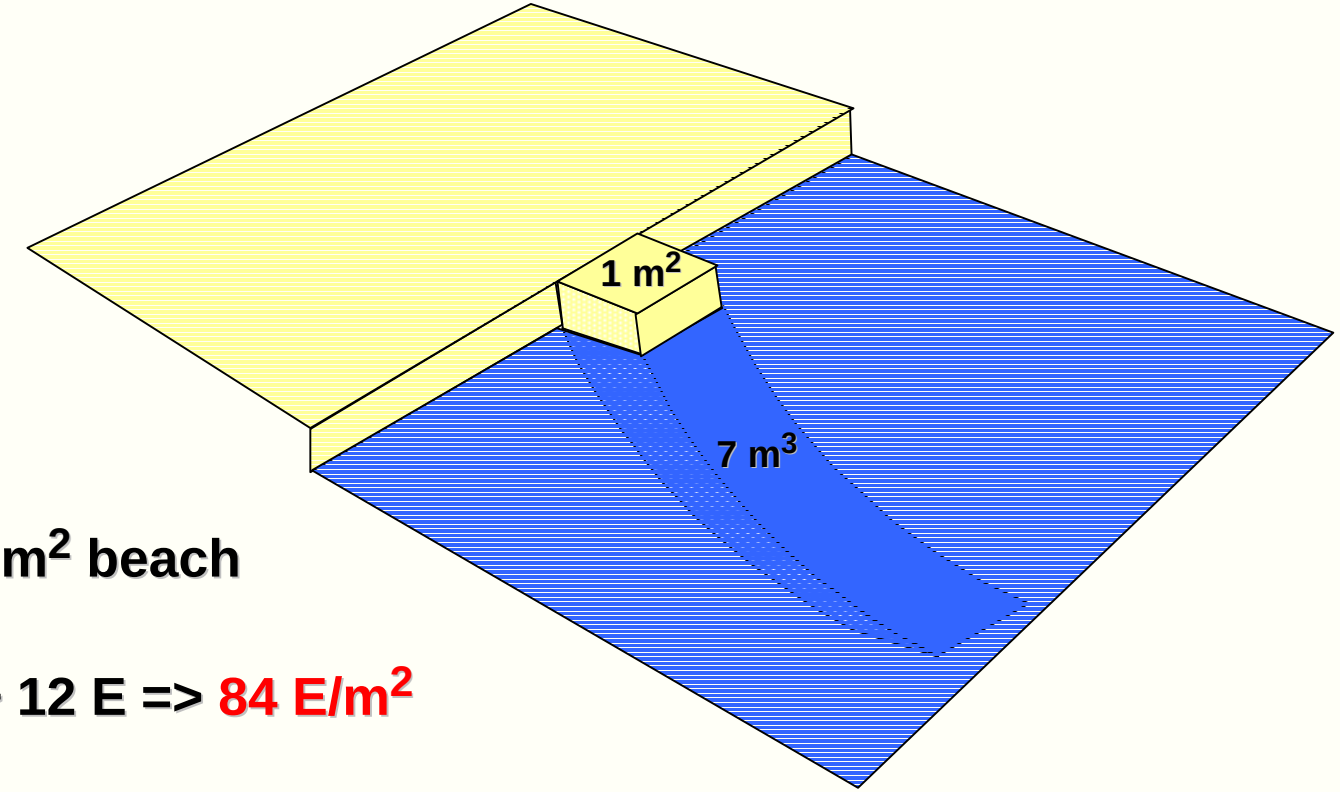
Sound business strategy?

Long-term sustainable?



Estimations based on the municipality´s own studies.

Is beach nourishment economical?



7 m^3 sand / m^2 beach

1 m^3 sand ~ 12 E => 84 E/m^2

Coastal real estate value Ystad ~ 300 E/m^2

Turn around Ystad beaches ~ 5000 E/m^2/yr = 70 000 E/m/yr

SLR => 30 E/m/yr

Thank you for your attention!