

Protection of Coasts

[Coastal Zones]

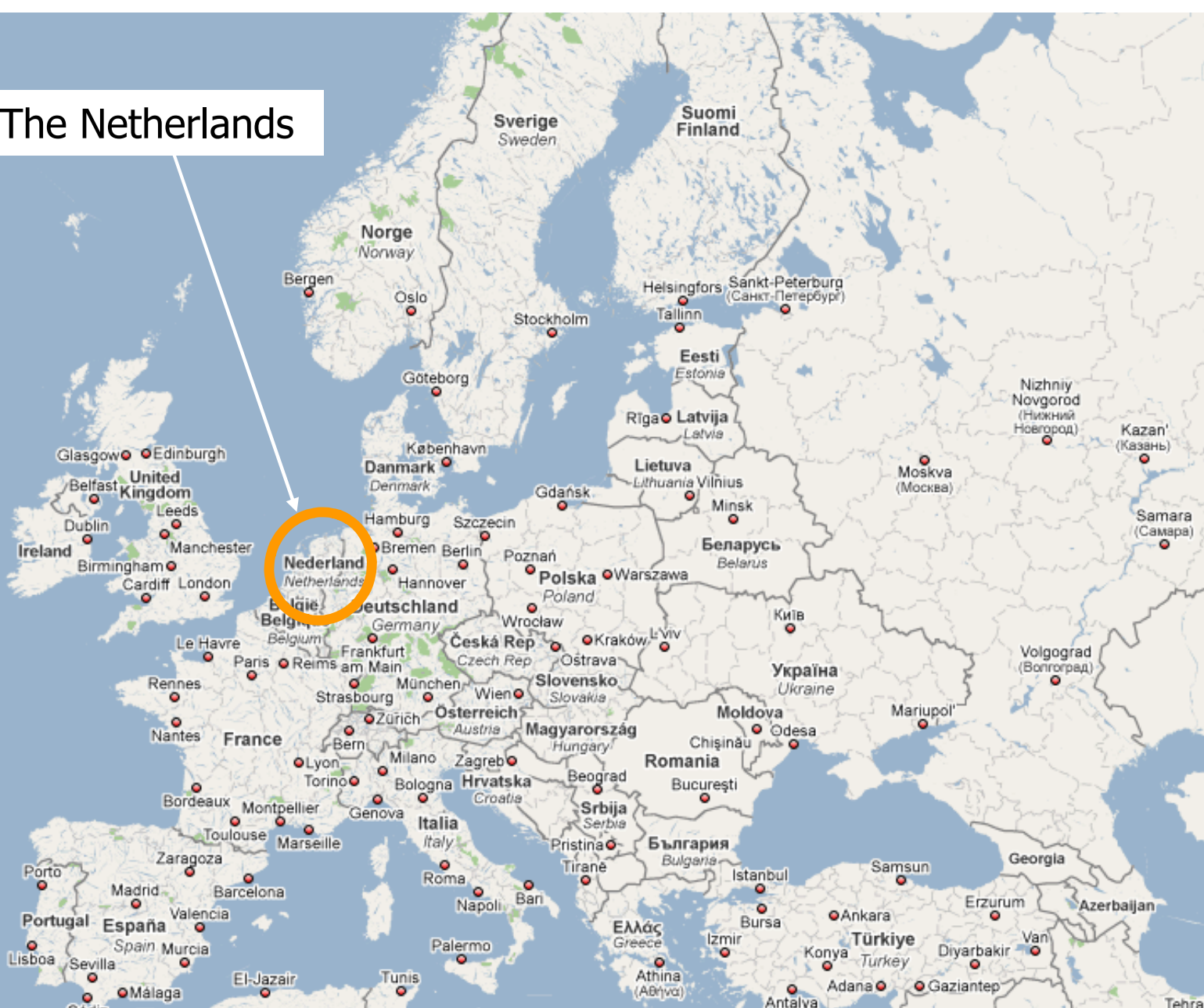
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Coastal Zone:

- many definitions
- here: rather narrow strip of land adjacent to sea or large inland water (say: 150 m)
- many 'functions'; e,g.:
 - safety low-lying mainland
 - recreation
 - housing / hotels
 - infrastructure

The Netherlands

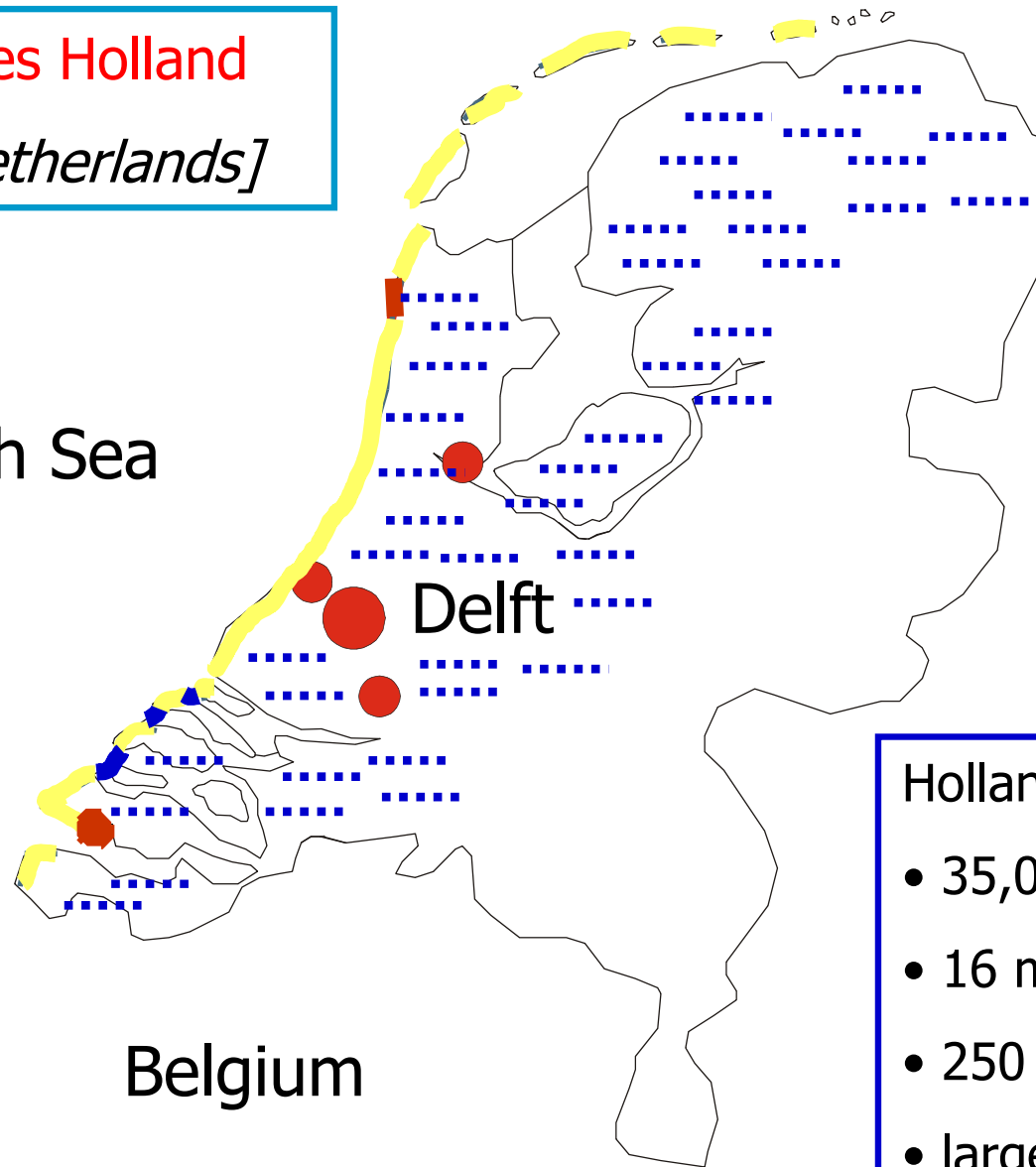


Novosibirsk
(far) →

Siberia \approx 300 times Holland

[Holland = The Netherlands]

North Sea

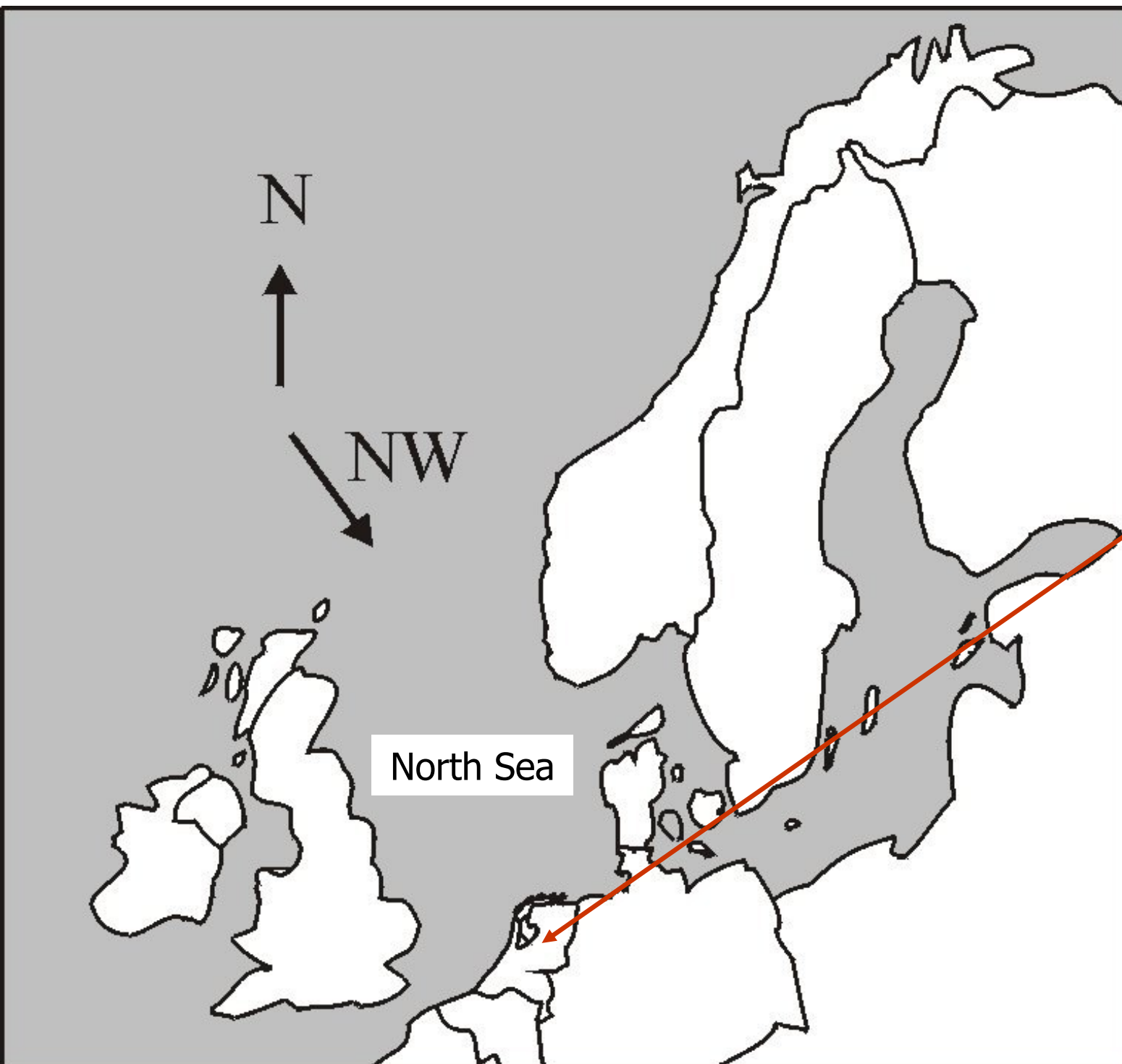


Germany

Belgium

Holland:

- 35,000 km²
- 16 million inhabitants
- 250 km dunes
- large part below MSL



Severe storm NW

- North Sea like a funnel
- water is piled up

(water cannot escape through Channel)

The Netherlands:

- high water levels

design: ≈ 5 m more than normal

- high waves

design: $H_{sig} \approx 9.0$ m



Recreation, housing, hotels and infrastructure along coast of Scheveningen



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Many (most) coastal zones all over the world:

- nature / environment main functions
- accretion and erosion occur
- no serious human interests
- no special attention
- no protection needed
- *coasts are allowed to behave as coasts usually do!*
- 'free' morphological developments

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(Still) relatively few coastal zones all over the world:

- many, often conflicting, functions
- human interests
- huge investments
- *coasts must behave as we dictate!*
- no 'free' morphological developments
- clear boundaries sea – land required
- protection of mainland needed to suppress the caprices of sea

Present situation with respect to coastal protection:

1. knowledge of occurring processes sufficient ??
2. various tools and concepts are available
3. many well-functioning protection projects
4. also too (??) many examples of malfunctioning projects
5. never ending flow of 'new' and 'better' protection tools

5. is strongly related to 1. and 4.















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Trends in future:

- more and more type **2** cases
- global sea level rise / climate changes
- more and more protection needed
- huge costs in protection schemes
- adequate and sustainable projects required
- development of knowledge of underlying processes
- call and room for new protection concepts
- proper use of ICZM techniques

Position of natural (sandy) coast fluctuates:

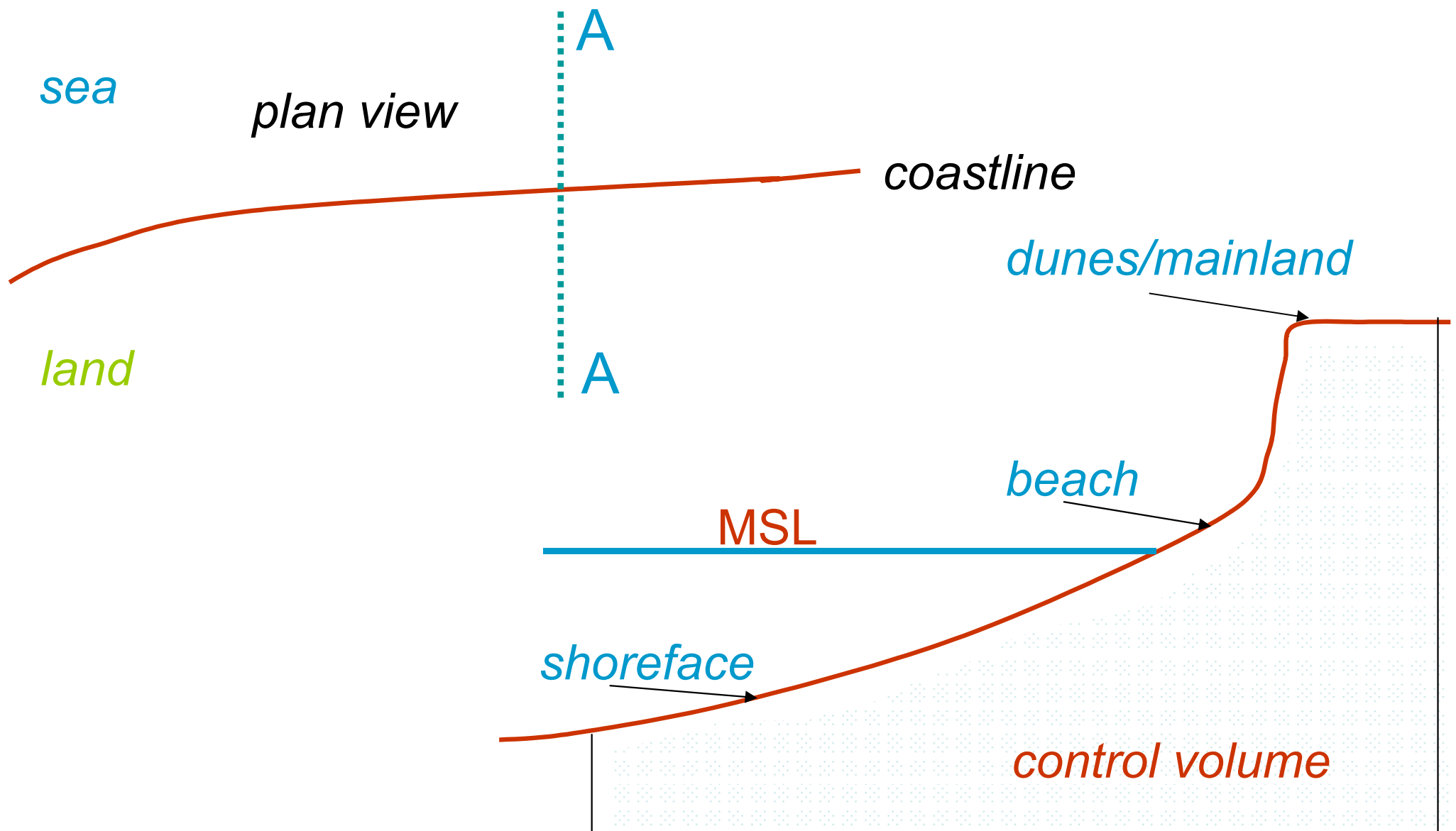
- stable (seen over many years)
- accreting
- eroding

‘erosion’ is often most important to CZM Manager

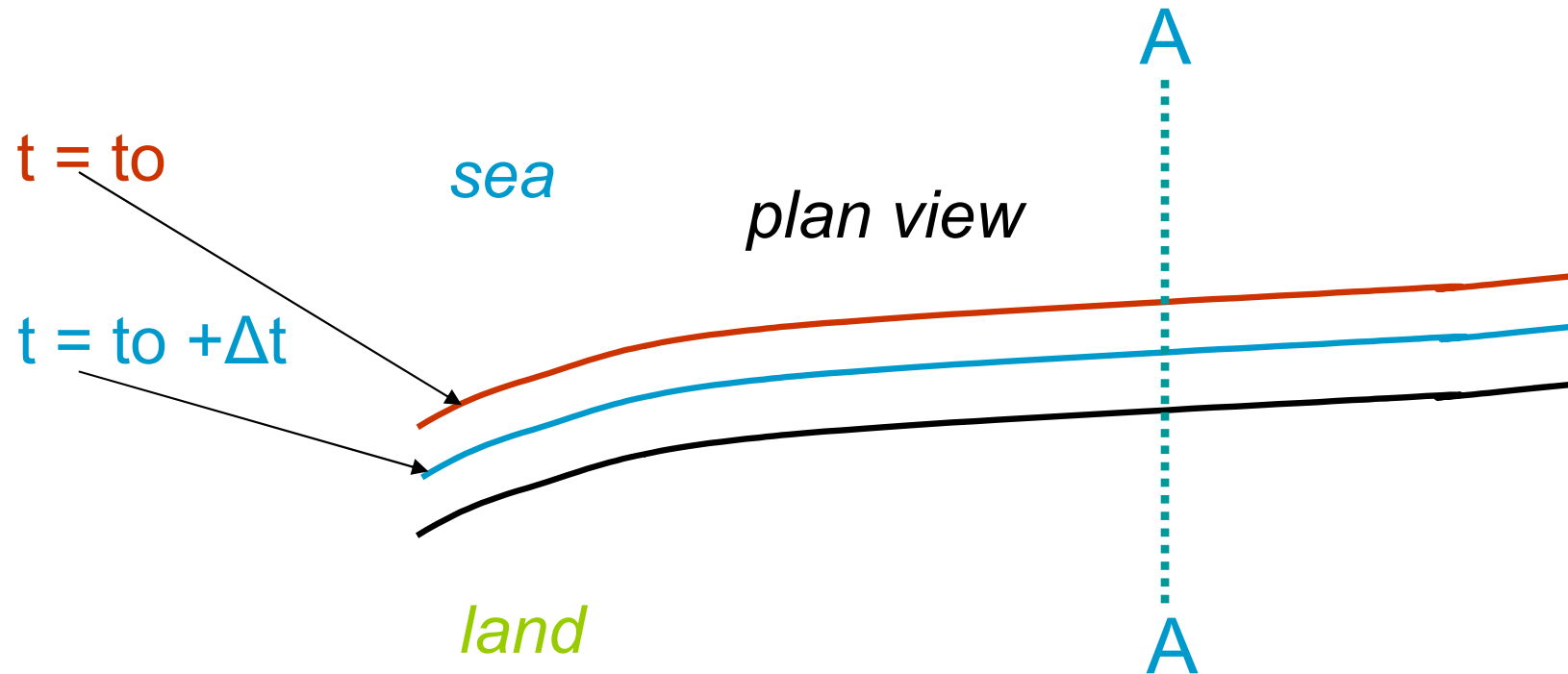
‘Erosion’ is in fact a tricky notion

Distinction in two types of ‘erosion’

- structural, gradual, long term erosion (year after year)
- episodic, dune erosion [due to a storm (surge) event]



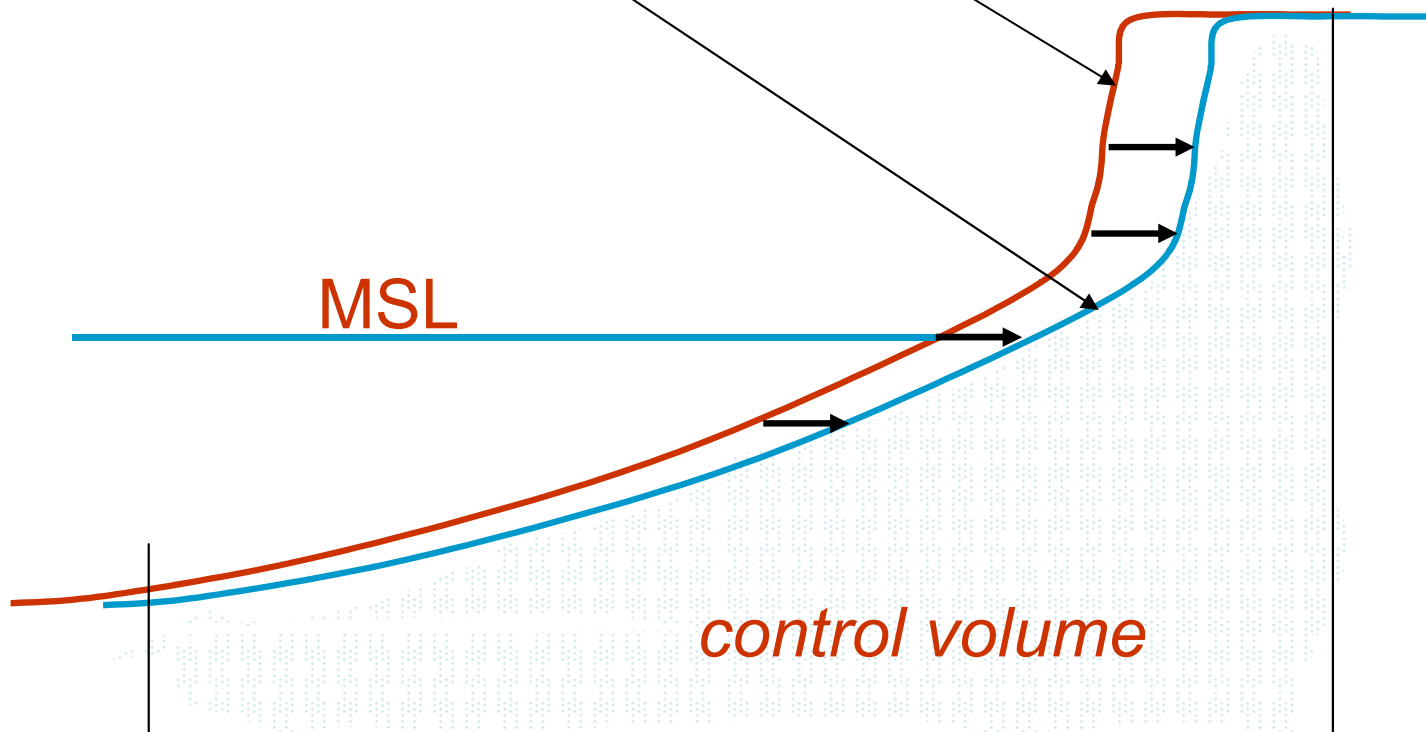
Structural erosion



cross-section A - A

$t = t_0$

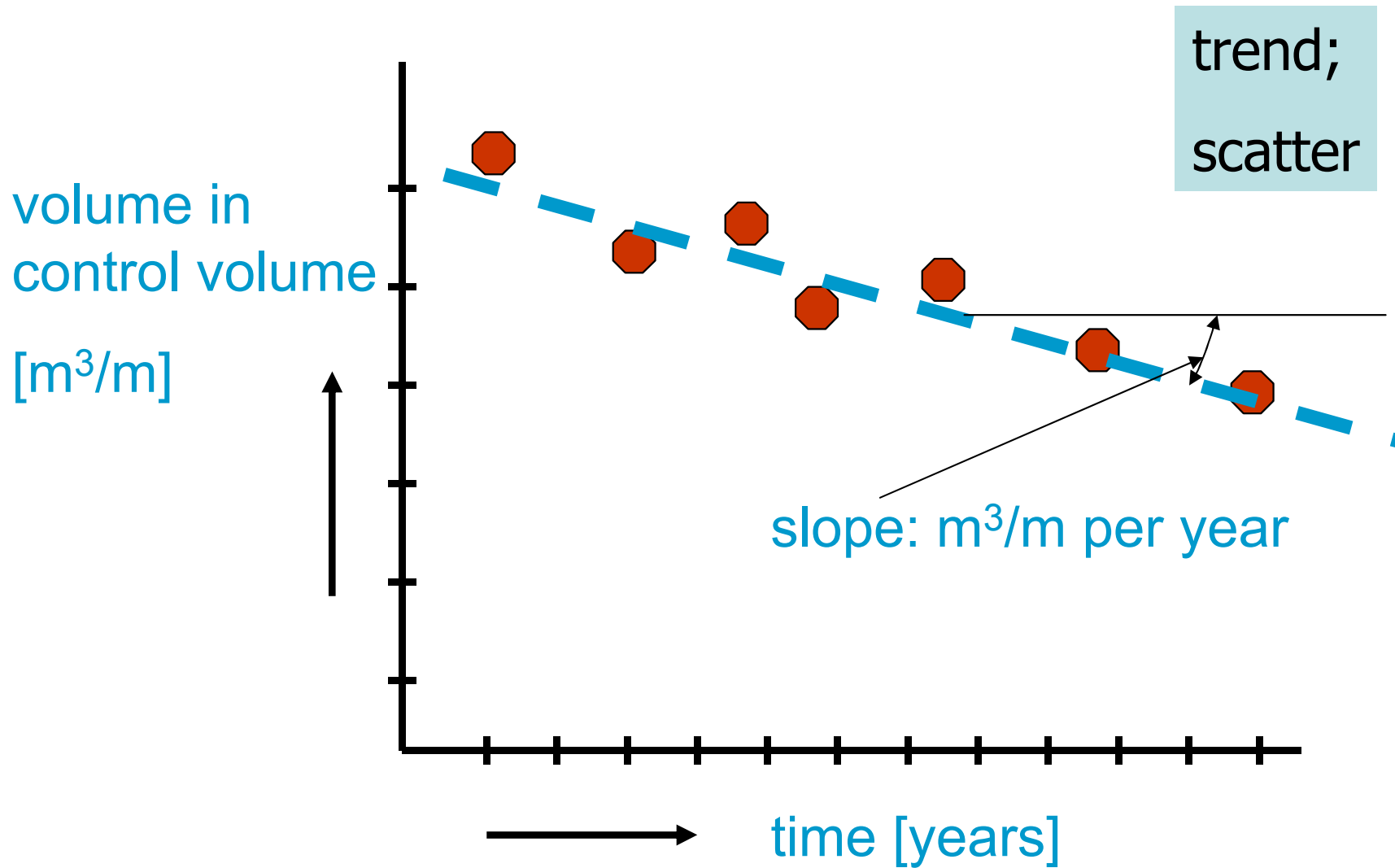
$t = t_0 + \Delta t$



Structural erosion:

(structural does not mean: due to structures)

- often due to gradient in longshore sediment transport
- loss of material out of control volume
- permanent retreat of coast
- all depth contours shift in landward direction
- gradual, structural, year after year
- a few m retreat per year
- at the end of the day loss of properties at dunes / mainland



So far rather straightforward:

- it seems simple and logic
- however, this type of analysis can only be made if sufficient data is available
 - complete cross-shore profiles (from dunes to rather large depths)
 - mutual distance between cross-shore profiles not too large
 - series of measurements over long time period (trend / scatter)
- *systematic and long lasting series of measurements are extremely important*

How to resolve structural erosion problems?

- structural erosion may bother mankind and CZM Manager
(no fixed limits in ICZM project area)
- ‘behaviour’ of coast is not according to our wishes
- redress ‘behaviour’ of coast !

How to do that?

- with ‘soft’ measures (e.g. artificial beach nourishments)
- with ‘hard’ measures (structures)

'Soft' measures

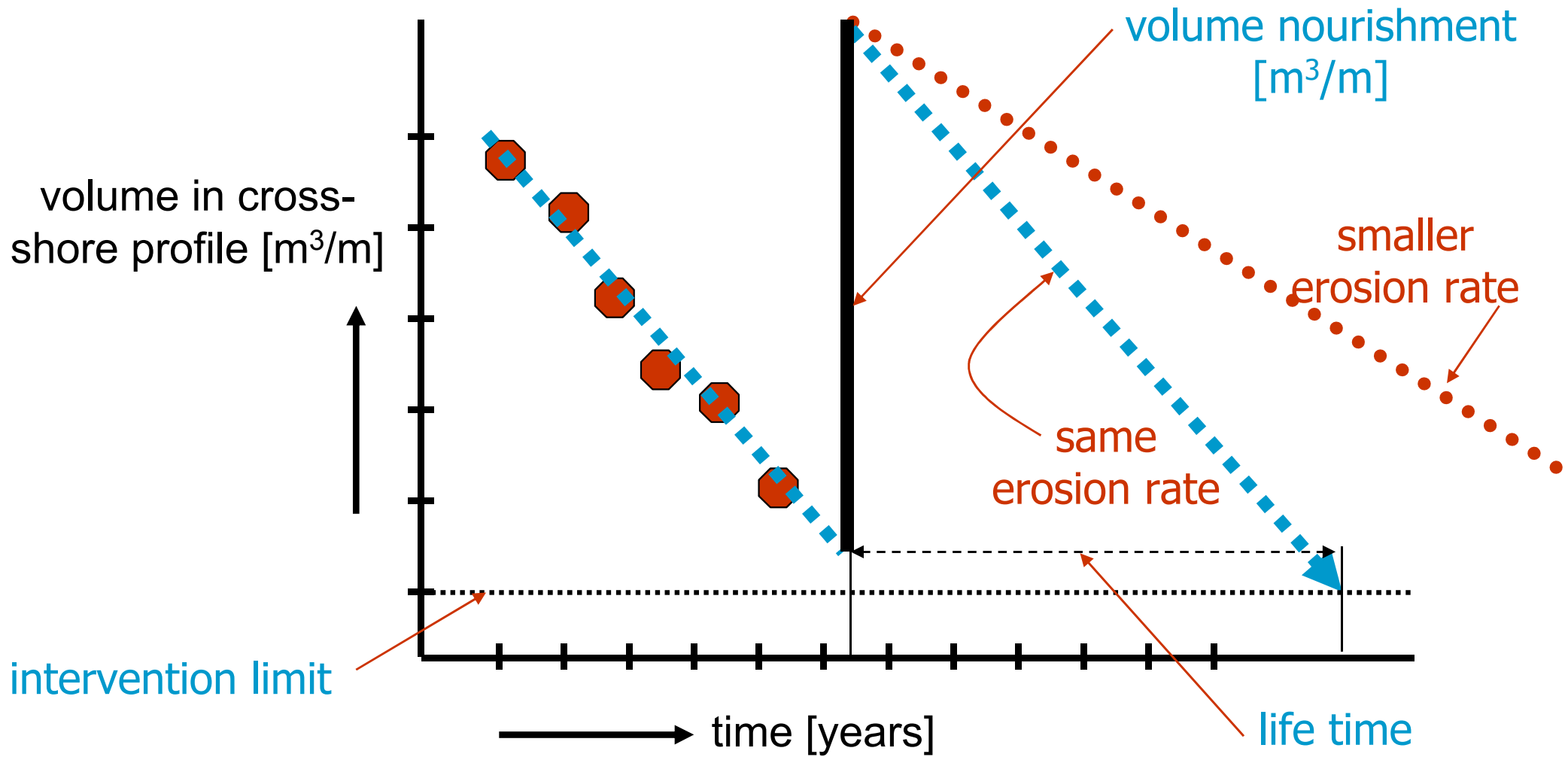
- artificial beach nourishments
- shoreface nourishments

Nourishments:

- have to be repeated
- no lee-side effects
- looks so 'soft', but nourishments are a very good solution
- at the end of the day: rather cheap



Beach nourishments along Dutch coast



'Hard' measures to resolve structural erosion problems

- series of groynes
- shore parallel detached offshore breakwaters
- [seawalls and revetments are a very bad solution to resolve a structural erosion problem]
- solution must interfere in occurring sediment transport processes
- proper solution is always at the spent of the lee-side area
- tuning of a proper protection scheme is very difficult



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Impact of coastal structures: Detached breakwaters





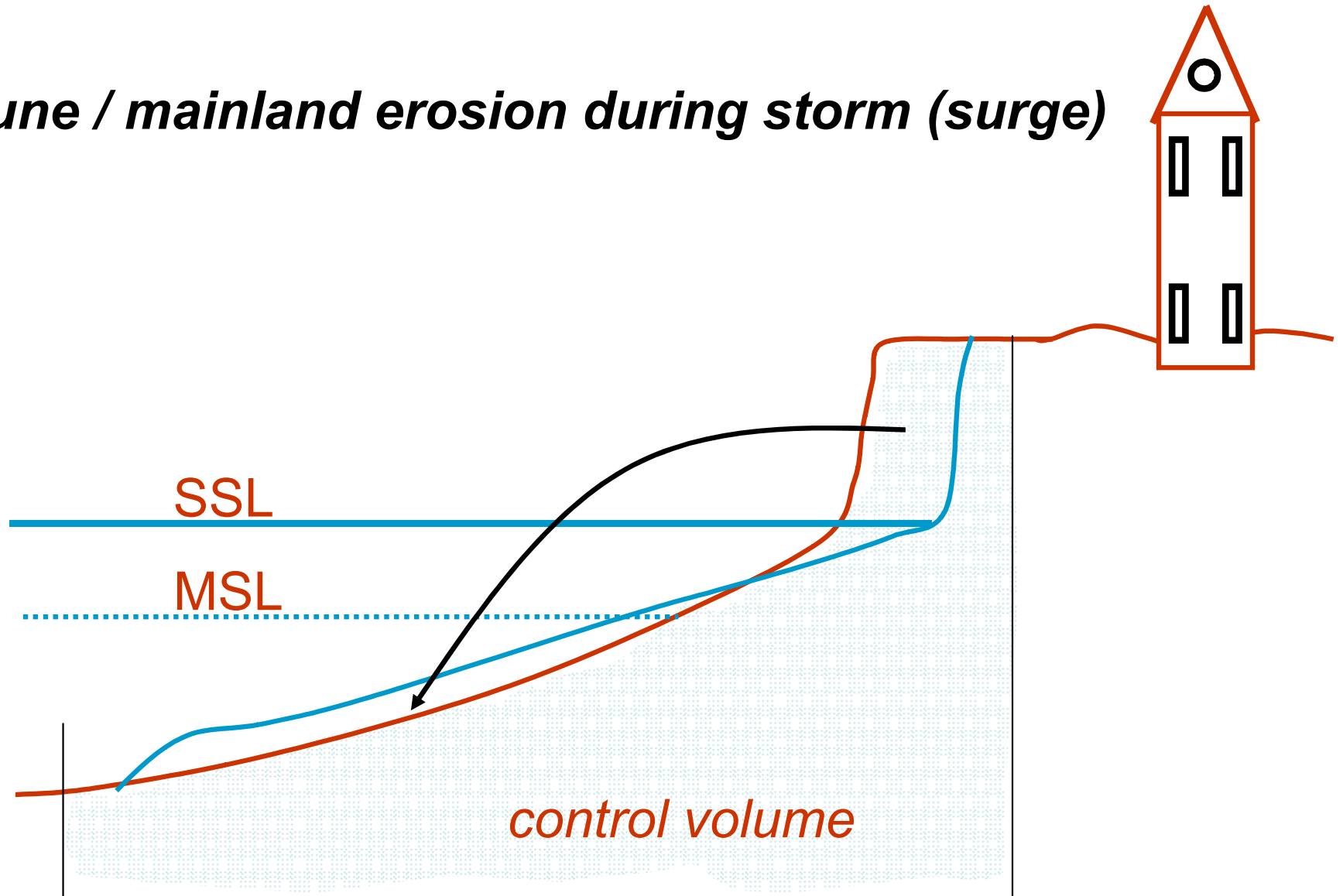
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Dune / mainland erosion during storm (surge)















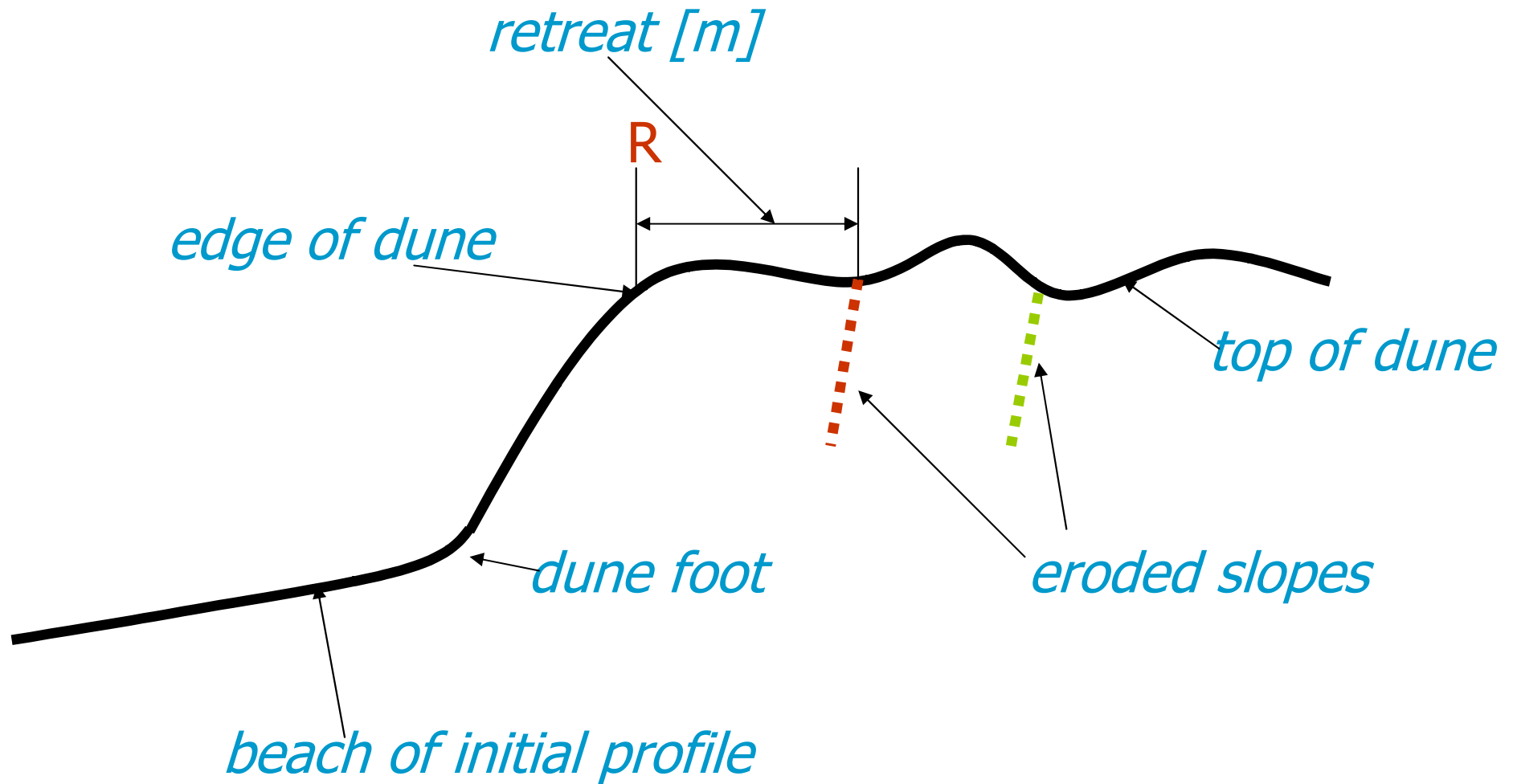


Dune erosion

- (heavy) storm at sea
- high waves; high water levels (storm surge level; SSL)
- dunes / mainland retreat
 - (to be understood with equilibrium profile notions)
- no volume lost out of control volume !
- only redistribution of sediment over cross-shore profile
- properties at top of dune lost
- retreat of edge of dune depends on storm characteristics
- (recovery during ordinary conditions again)

rate of dune / mainland erosion during storm:

- highly stochastic process
- nobody 'knows' how severe next storm will be
- computation models and probabilistic methods
- retreat of dunes versus frequency of exceedance



retreat [m]

5

20

40

60

85

freq. of exceedance [per year]

1/10

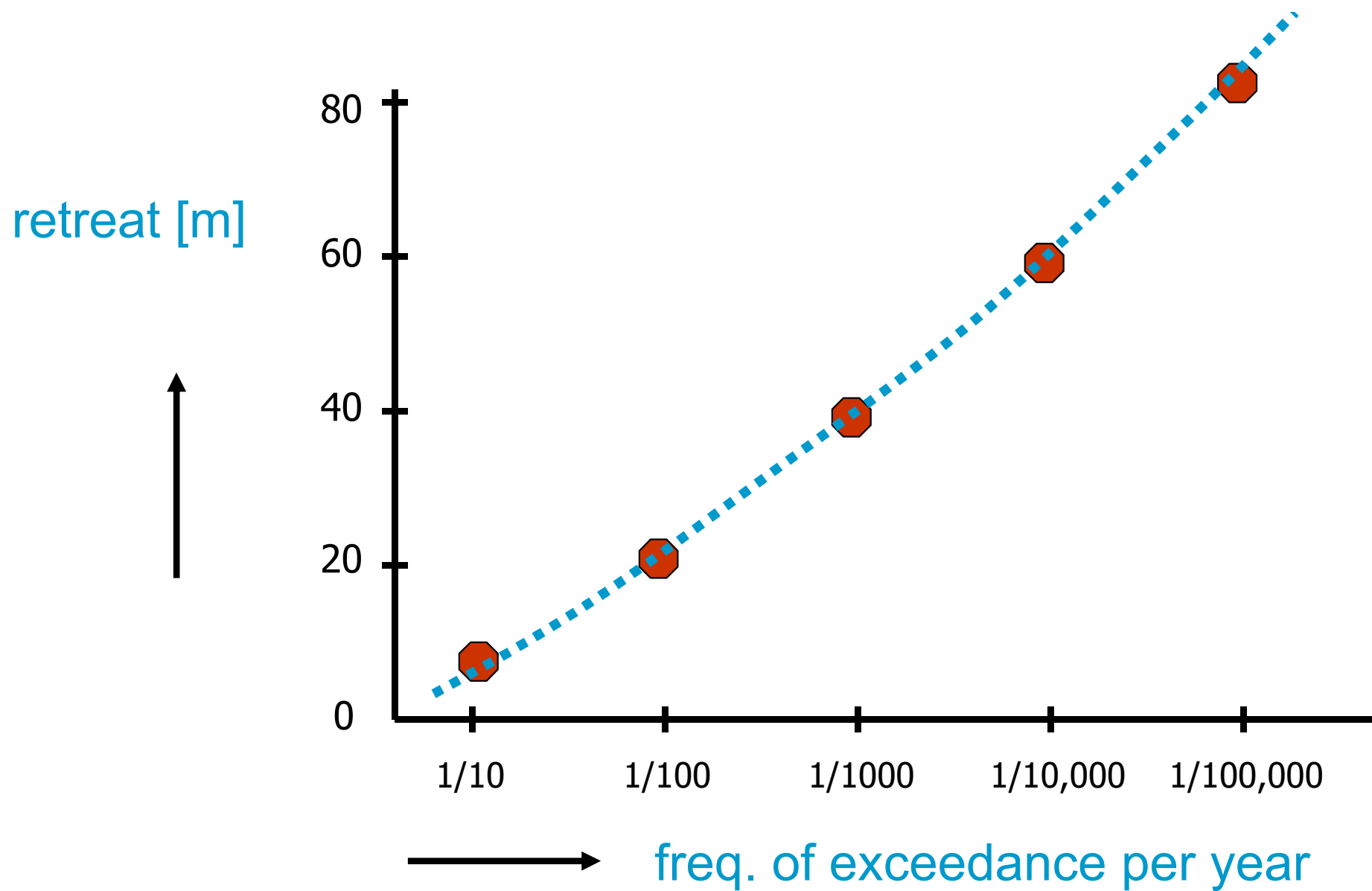
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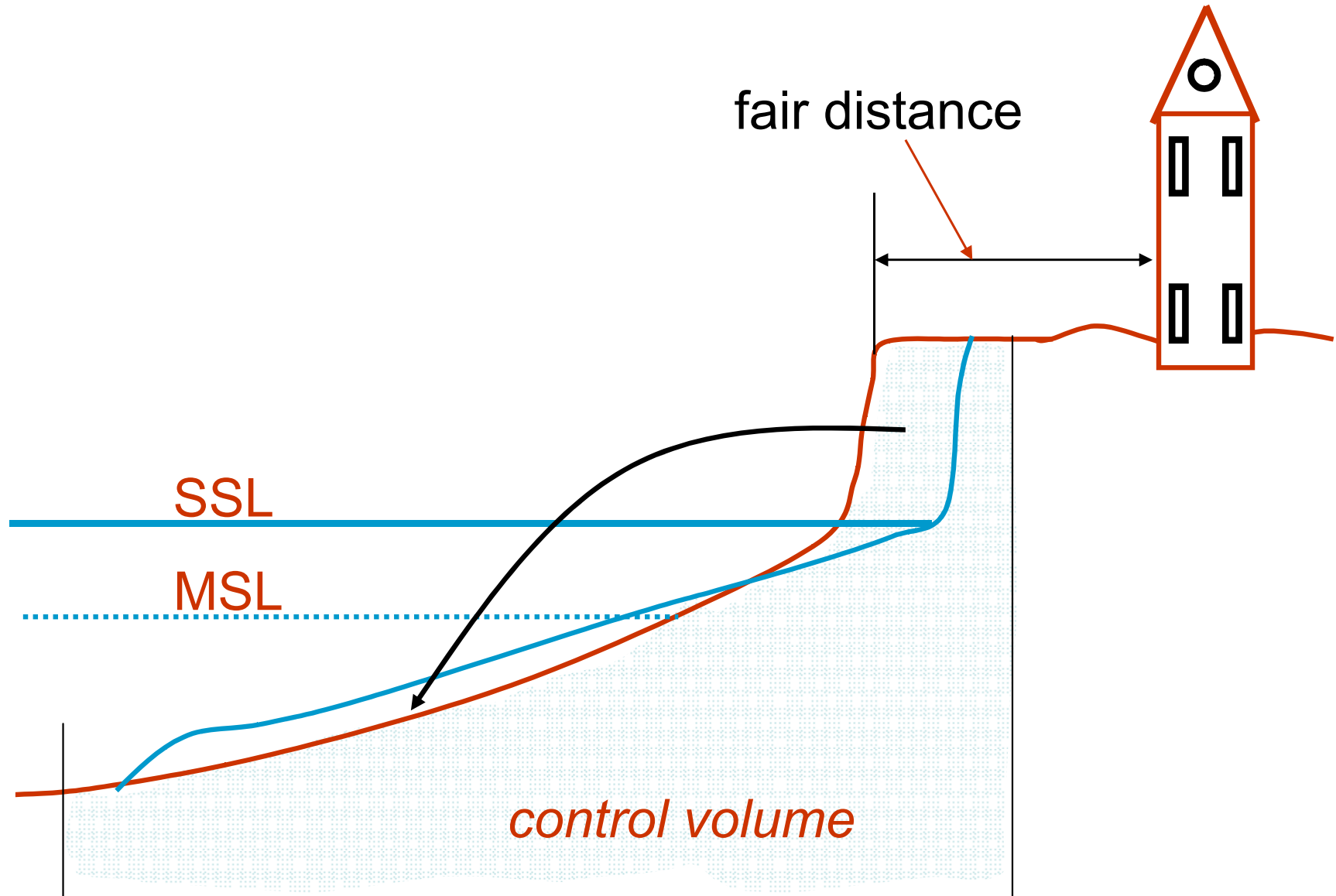
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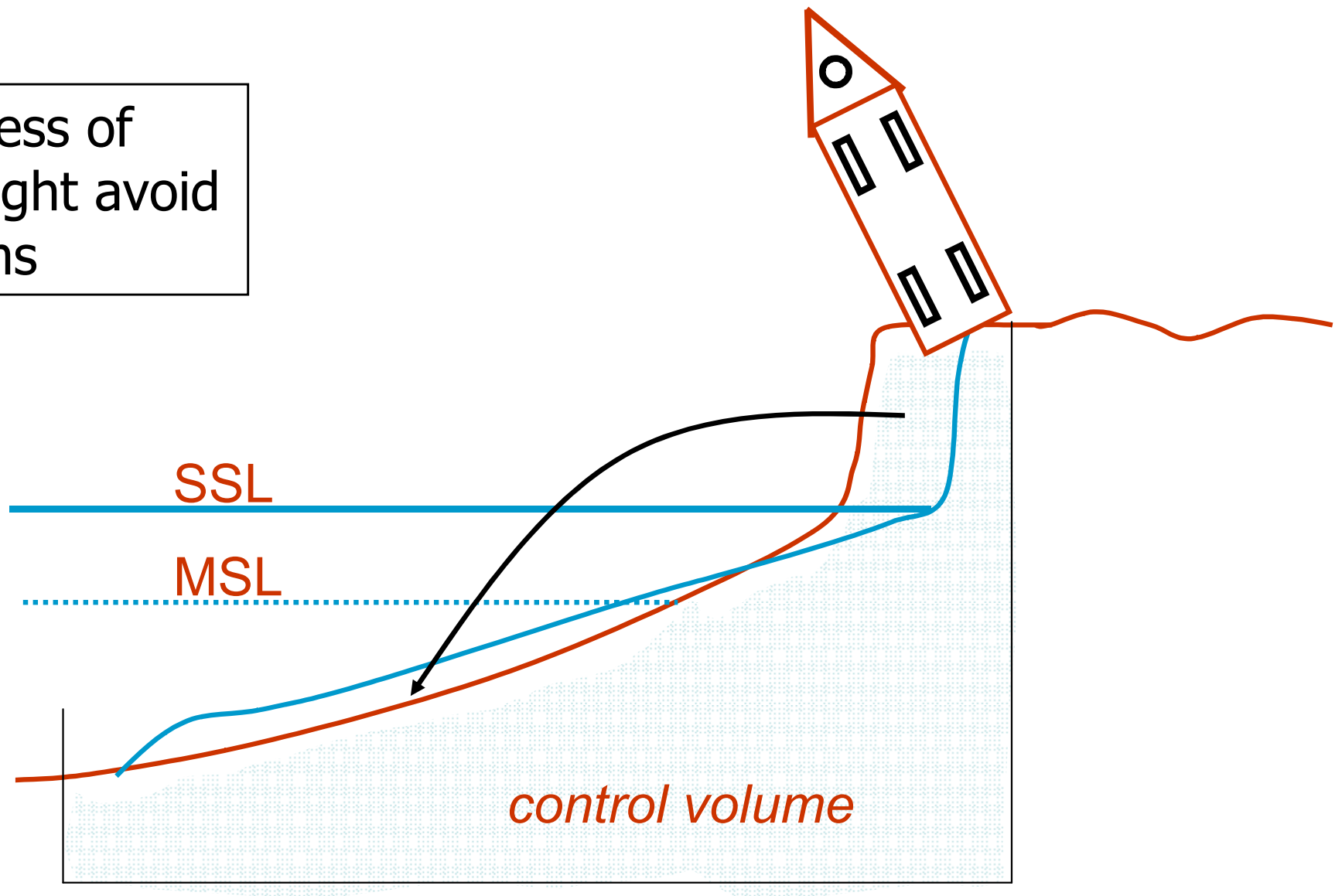
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(example only; reasonable for Dutch conditions)





awareness of risks might avoid problems



Distinction in two types of 'erosion'

- structural, gradual, long term erosion (year after year)
- episodic, dune erosion [due to a storm (surge) event]

Each type calls for often 'own' specific protection tool

- hardly protection tools available which are able to 'serve' both
- tool which is meant for one problem (e.g. reduction of erosion during severe storm) is also present while (in this case) the day to day processes occur. And vice versa.

Most important in each protection project:

- clear insight in reason of erosion problem
- realistic set of requirements a protection concept has to fulfil, e.g.:
 - yes or no leeside erosion allowed
 - a beach for recreation always required or not
 - (realistic) small chance of damage allowed, in stead of 'never'
 - proper time scales
 - proper estimates of sea level rise and climate change

Concluding remarks:

- more and more proper functioning protection schemes required
- sustainable concepts are available
- skilful experts required to design proper projects
- open for new concepts
- first definition of 'problem' and next try to find a proper 'solution'

The sequence:

"The solution is already available, so let us find and tackle a problem which fits with the solution"

does not reflect a proper attitude of a coastal engineer.