Delta Committee

Preparing the low-lying Dutch Delta for climate change

Marcel Stive
Water Research Centre Delft
Delft University of Technology

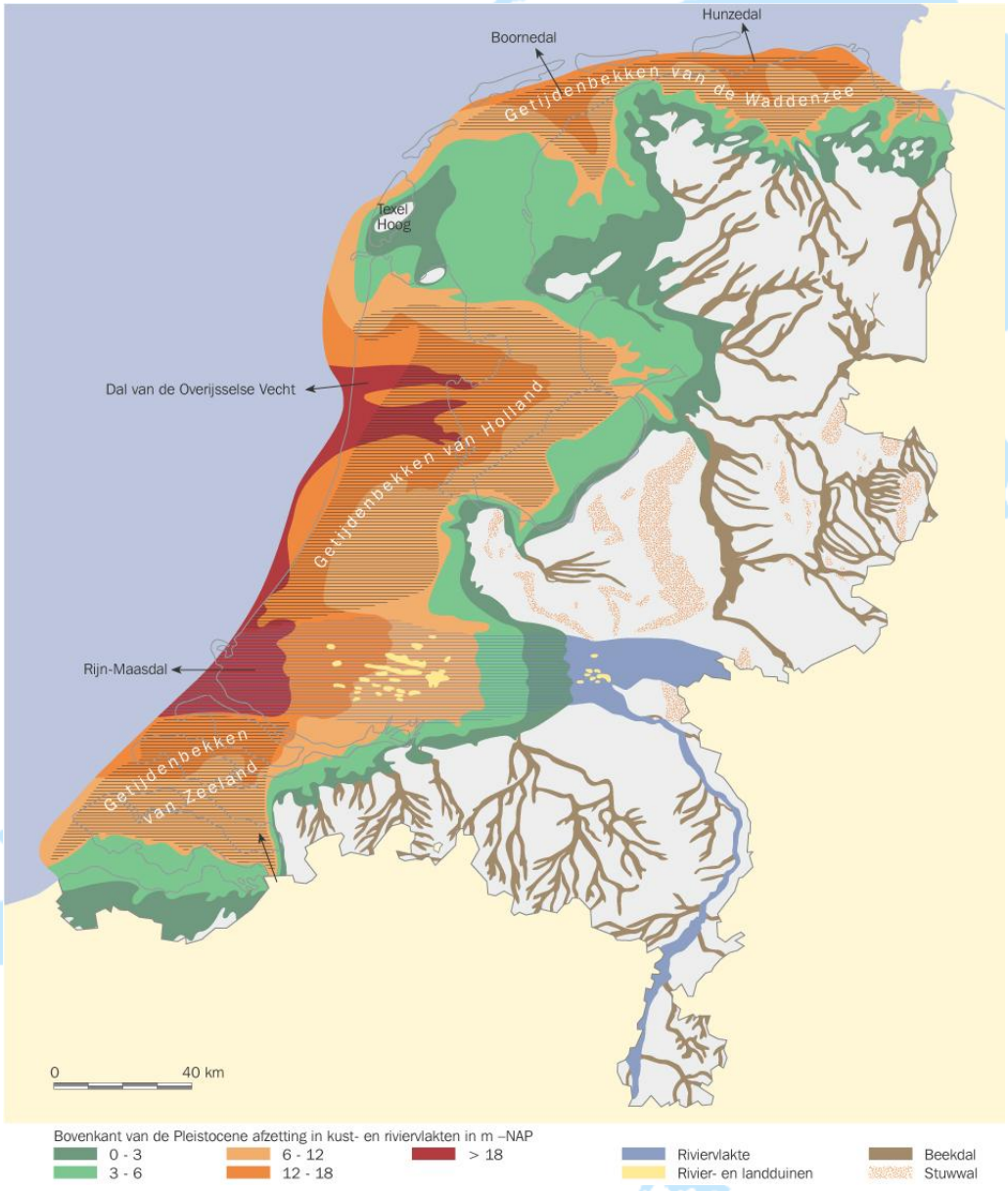
"Een land dat leeft,
bouwt aan zijn toekomst"

DELTA COMMISSIE

DELTACOMMISSIE

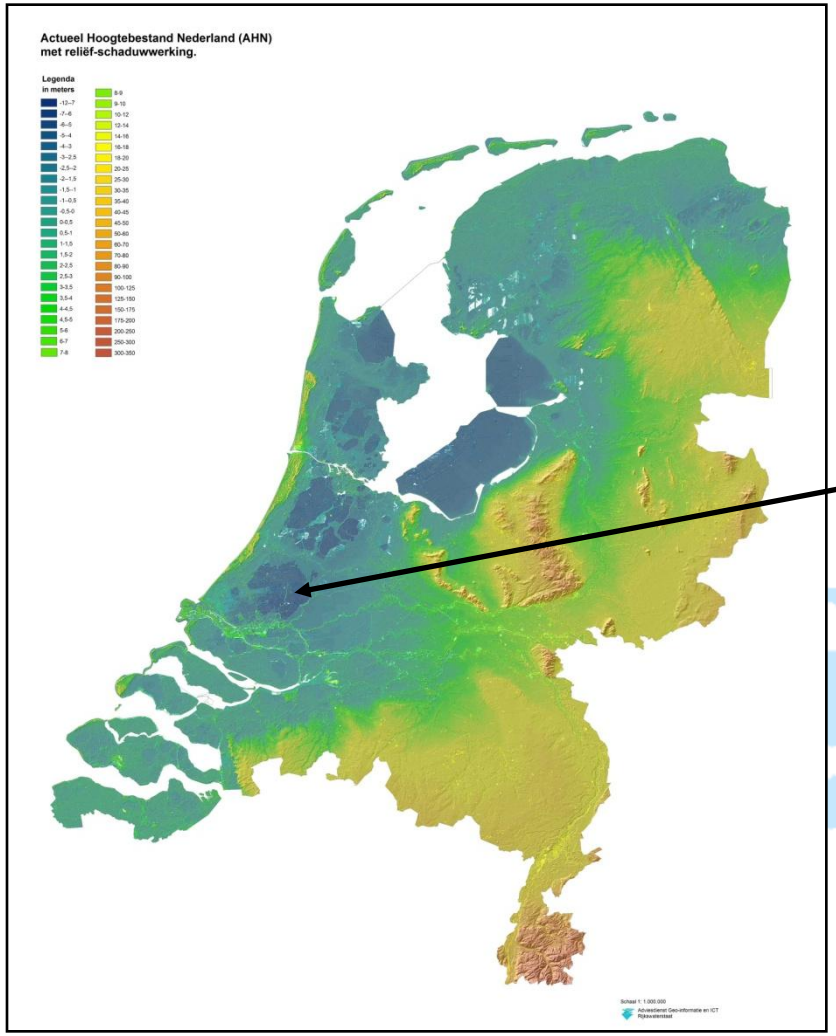
Basal topography

depth top
Pleistocene deposits



DELTACOMMISSIE

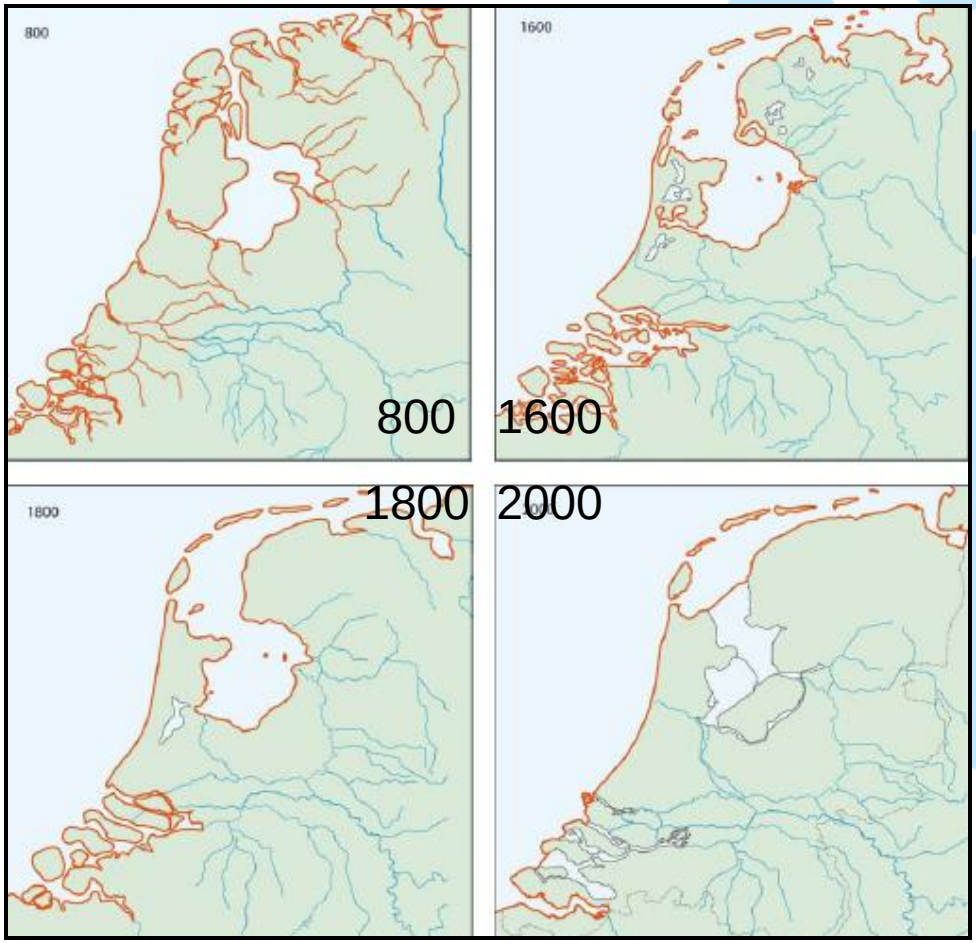
Topography



- 10 million people in floodprone areas
- Deepest location Zuidplaspolder around Nieuwerkerk aan den IJssel: MSL – 6,76 m.

DELTACOMMISSIE

Shortening of coastline in response to flooding events



DELTACOMMISSIE

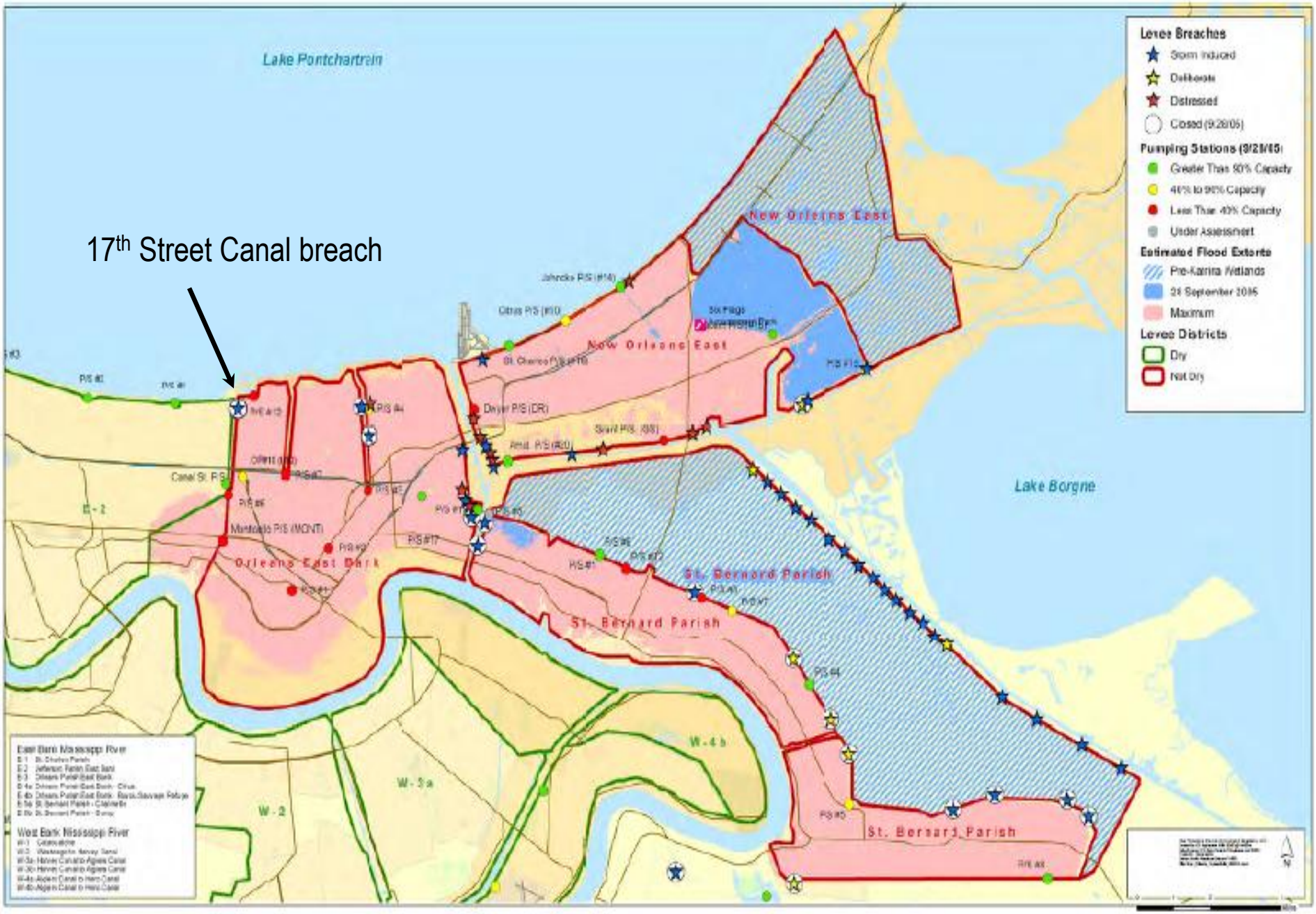
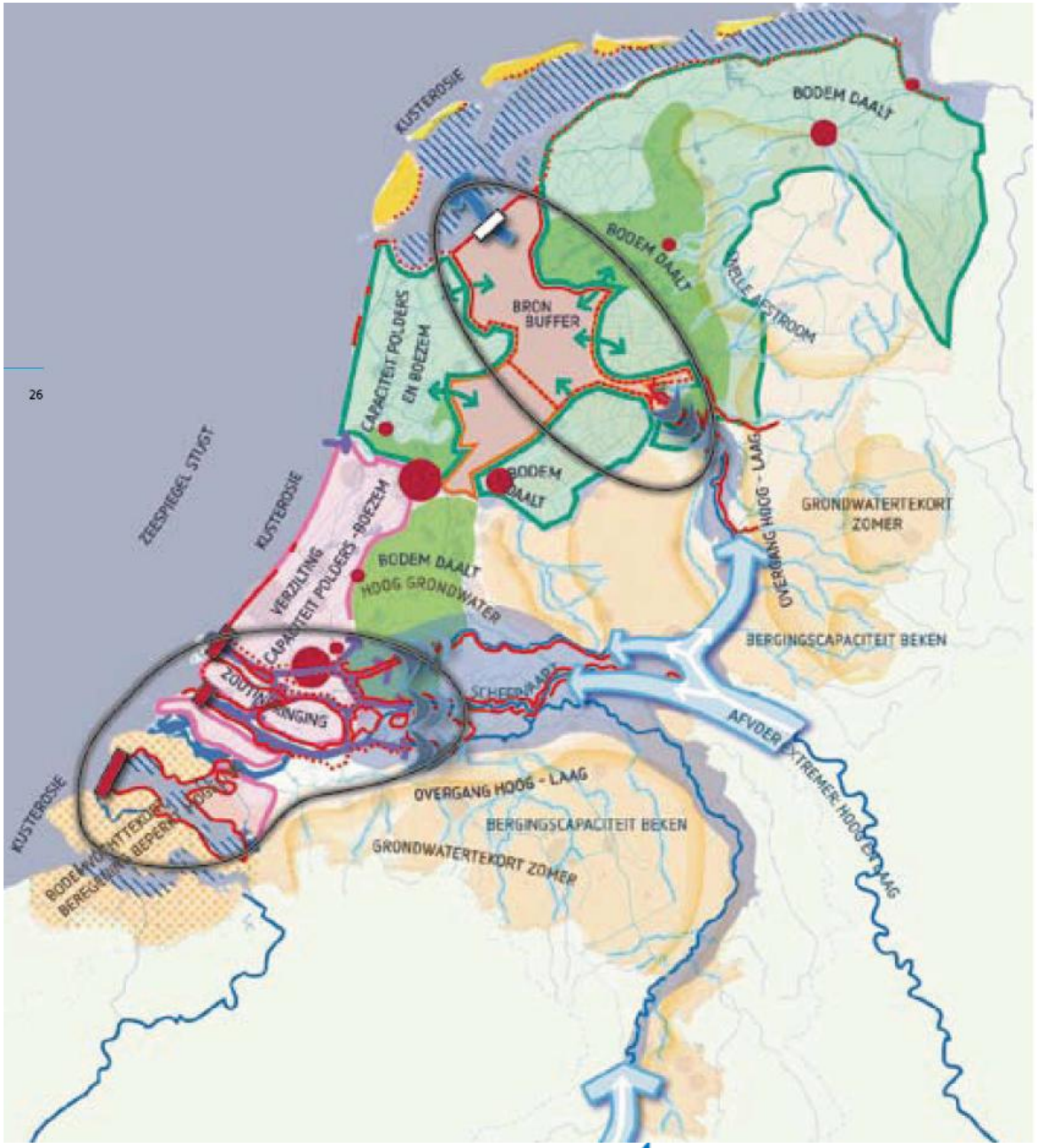


Figure 1.4: Map showing principal features of the main flood protection rings or "polders" in the New Orleans area. [Modified after USACE, 2005]

DELTA COMMISSIE

Kaart 3

Belangrijkste wateropgaven



- grote meervoudige opgave met regio-overstijgende invloed
- waterkwaliteit en zoetwateraanvoer onder druk
- wateraanvoer vanuit IJsselmeer onder druk
- zouttong schuift op, innamepunten onder druk
- potentieel bodemvochttekort
- aandacht voor peilbeheer en kwaliteit IJsselmeergebied
- gebied met bodemdaling
- stad in gebied met sterke bodemdaling
- toename extreem hoge rivierafvoer
- lagere gemiddelde zomerafvoer rivieren en vaker extreem laag
- overgangsgebied hoog - laag gevoelig voor wateroverlast
- periodieke wateroverlast beekdalen
- schorren en platen kunnen verdrinken bij zeespiegelstijging
- aandacht voor hoogte en stabiliteit waterkeringen (periode 2008-2050)
- aandacht voor hoogte en stabiliteit waterkeringen (periode 2050-2100)
- spuicapaciteit IJsselmeer onder druk bij zeespiegelstijging
- invloedsgebied zee/IJsselmeer verschuift rivieropwaarts als zeespiegel stijgt

Presentation, reflection and discussion

- Three steps towards a safe(r) delta
- A new safety standard
- Plausible high-end scenarios RSLR
- “Delta dike”
- Regional recommendations

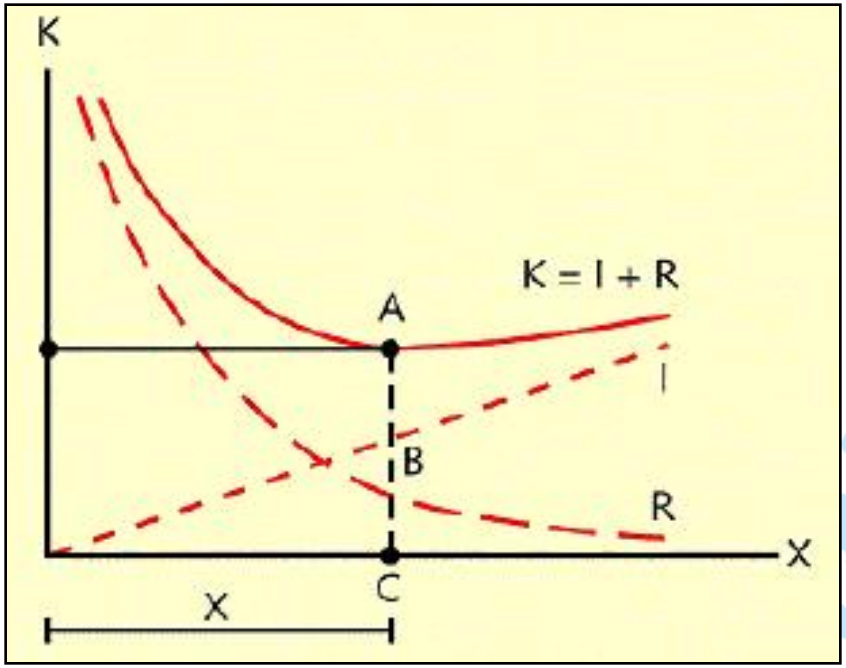
DELTACOMMISSIE

Acute? No, Urgent? Yes

- Water defences are not up to 1960 standards (following 1st Delta Committee)
- Current standards are inadequate (recommendation increase safety with a factor 10!)
- Climate change may accelerate

DELTA COMMISSIE

Risk approach: combination of probability and consequence

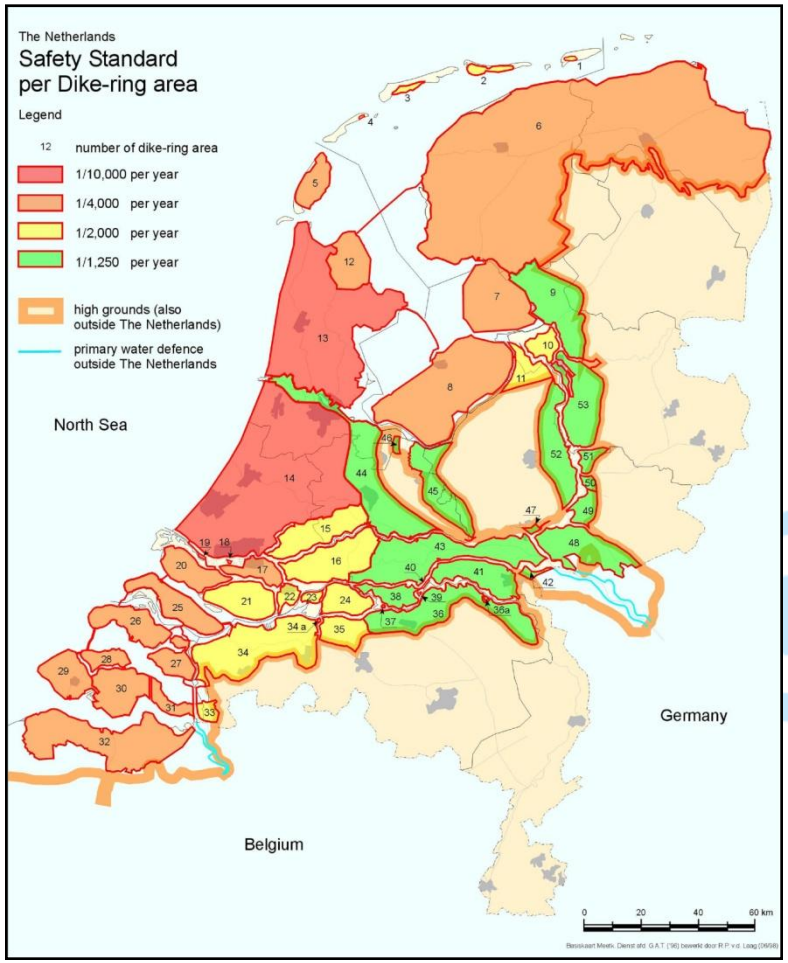


The principle of economic optimization

I – investments in safety measures
R – risk (economic damage)
K – total cost
X – optimal safety

DELTACOMMISSIE

Safety standard for 53 dike-ring areas



De facto a varying safety:

- NH and ZH 1/10.000 per year
- North and South 1/4.000 per year
- Yellow 1/2.000 per year
- Green: 1/1.250 per year

NB:

- Probability individual loss of life in a flooding is 1%, so that the probability due to flooding in the green areas is 1 in 125.000 per year!

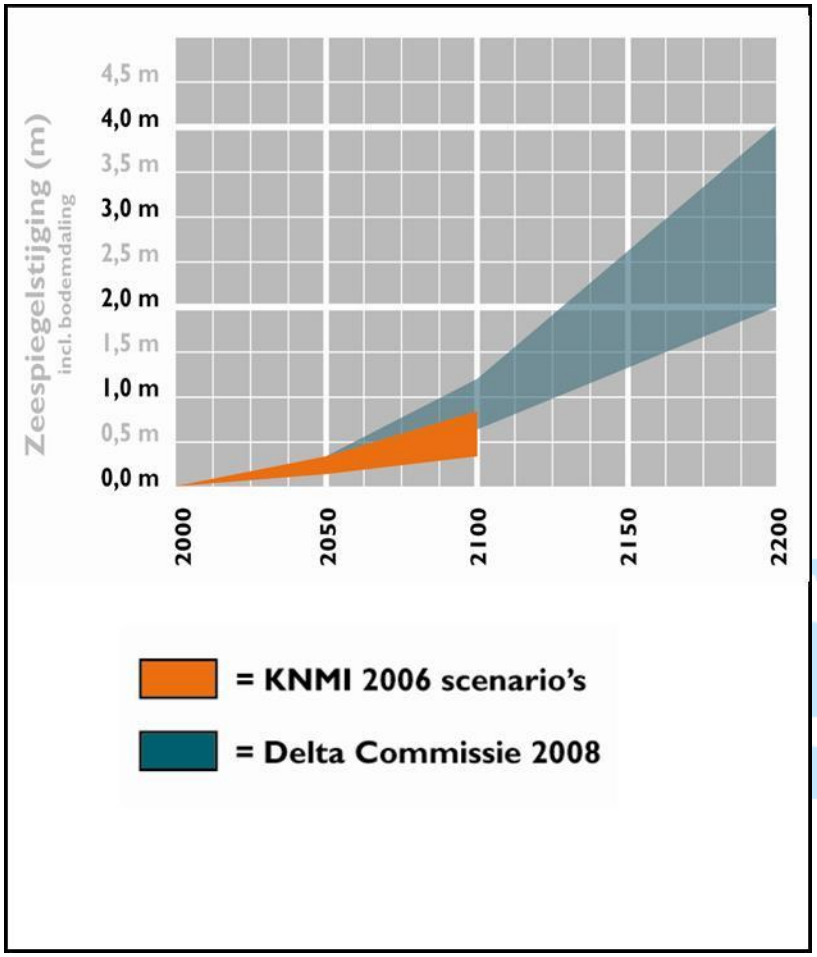
DELTA COMMISSIE

P per year

DELTACOMMISSIE

Sinkholes in inner embankment due to piping

Relative SLR



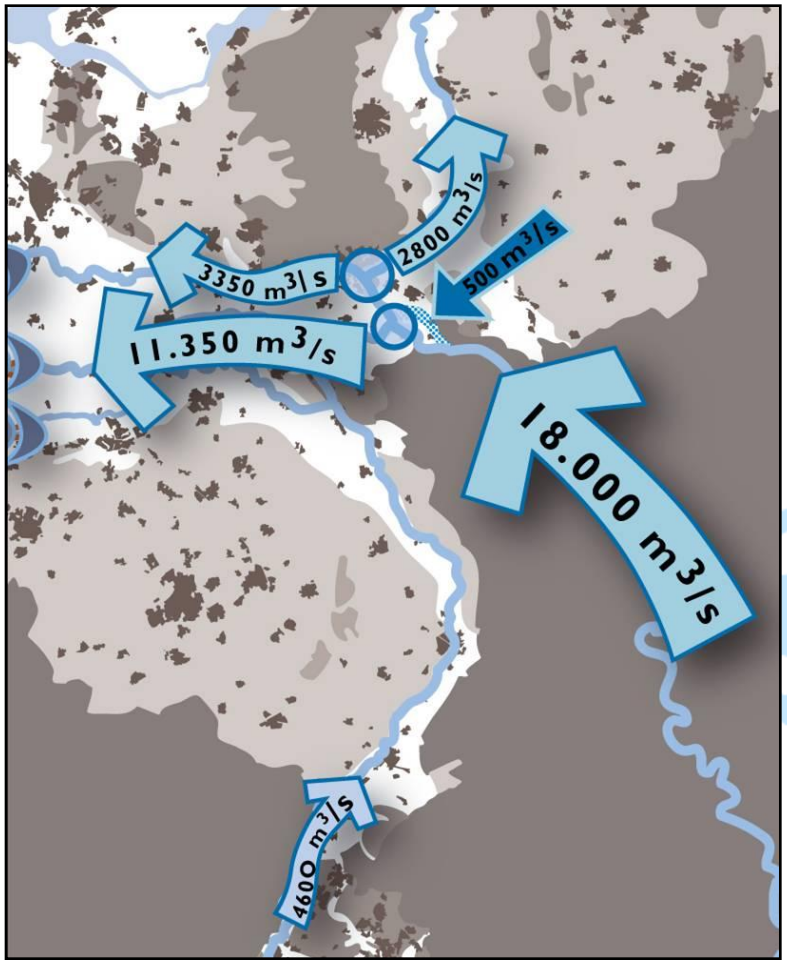
High-end scenarios:

- Round 2050: 40 cm/century
- Round 2100: 65 to 130 cm/century
- Round 2200: 2 to 4 m/century

NB: a bit confusing cause KNMI are best estimates

DELTA COMMISSIE

River discharge



Summer:

from1700 m^3/s now to 700 m^3/s in 2100

Winter:

from16.000 m^3/s now to18.000 m^3/s in 2100

DELTACOMMISSIE

Recommendations (1):
Principles “Building with nature”, multifunctional solutions and the “Delta dike”

DELTA COMMISSIE

Building with nature

- Adapt to changing conditions and predictions
- Minimize costs at the long term
- Seek potential for multifunctional and integrated approaches

DELTACOMMISSIE

“Delta dikes”

Dikes that through height, width or internal structure are practically breach resilient. Requires local optimization.

DELTA COMMISSIE

DELTACOMMISSIE

Popular view

- Plea for breach resilient, wide dikes
- Is not always THE solution
- Can be a solution, but (1) claims space and (2) there are more failure mechanisms that need to yield the same risk
- NB: a chain is strong as the weakest link!

Regional recommendations

- North Sea coast
- Wadden region
- SW Delta
- River regions
- Rijnmond
- IJssel Lake area

DELTACOMMISSIE

North Sea coast

- Building with nature through nourishment
- Beaches follow SLR naturally
- Great potential for coastal extension!

DELTA COMMISSIE

Coastal extension

DELTACOMMISSIE

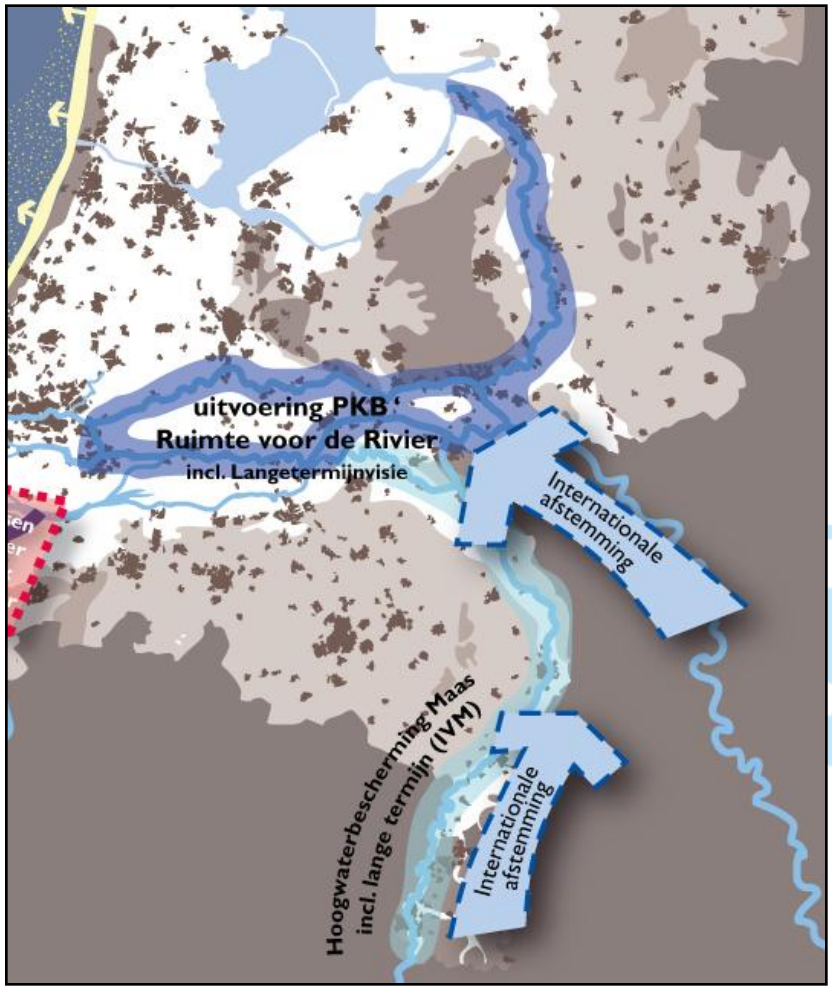
The sand engine at Ter Heijde

March 2011

May 2011

DELTACOMMISSIE

Rivers



- Complete execution of program ‘Room for the river’
- Idem Maas
- Acquire strategic grounds

DELTACOMMISSIE

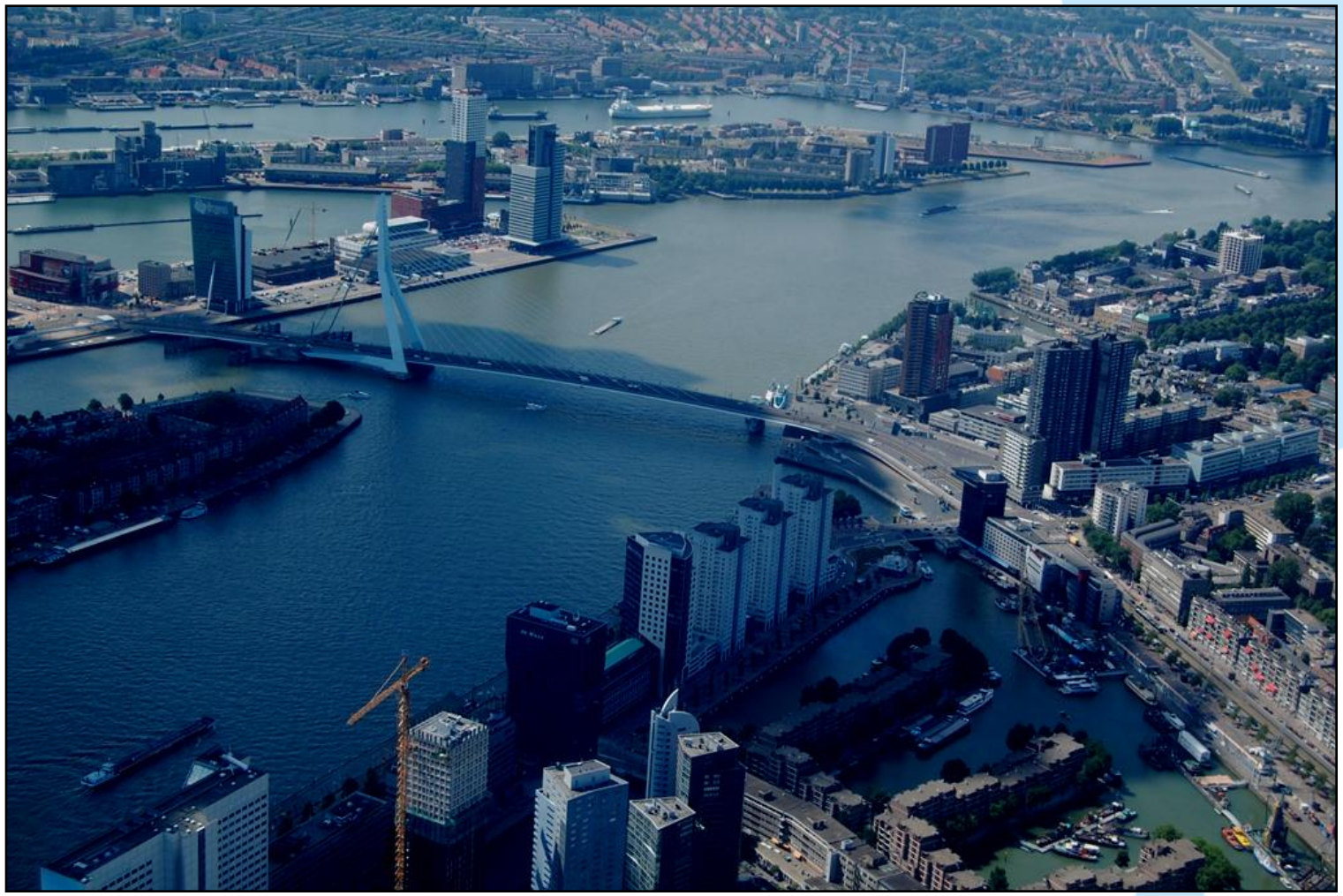
DELTACOMMISSIE

Space for the IJssel

Rivierverruiming langs de IJssel tussen Zwolle en Kampen

DELTACOMMISSIE

Nieuwe Maas at Rotterdam



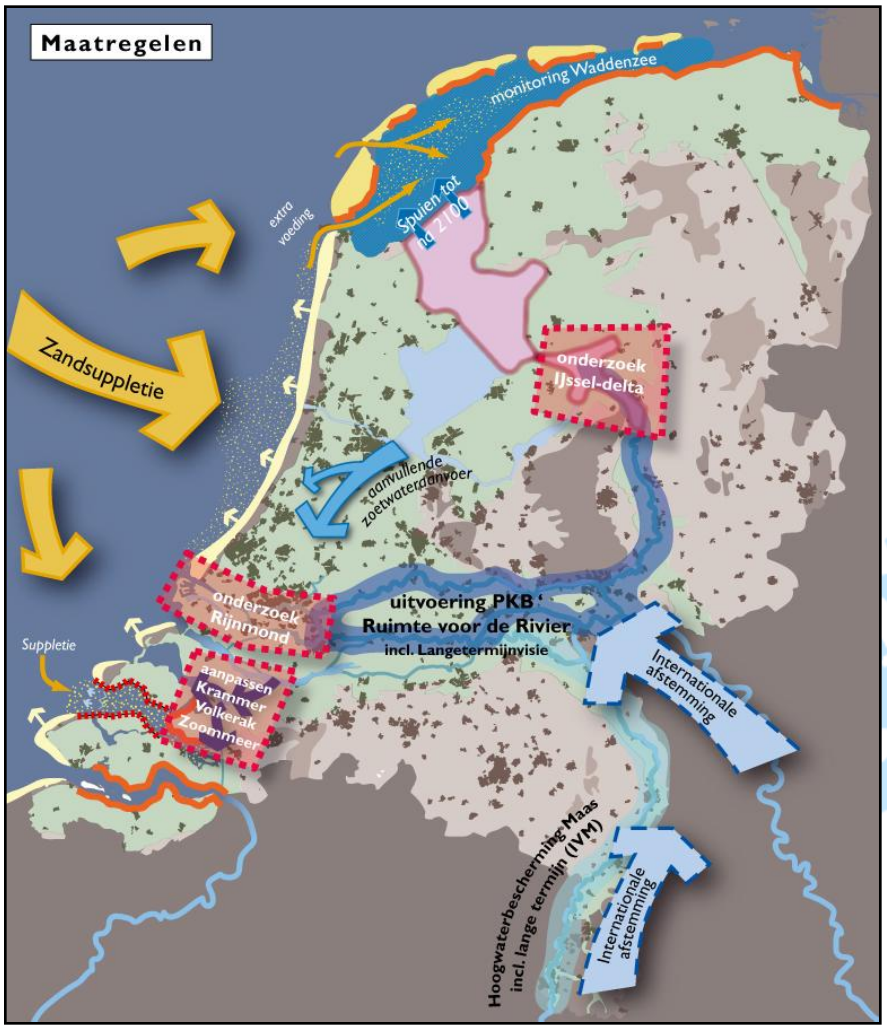
DELTACOMMISSIE

Rijnmond region

- Protection by a chain of open surge and discharge barriers
- Creation of potential for nature and urban development

DELTACOMMISSIE

Costs



- 1,2 to 1,6 billion euro per year until 2050 (order of 1% of BNP, order of 1 per mille of invested infrastructure)
- 0,9 to 1,5 billion per year for 2050-2100
- Exclusive costs of nourishment for coastal extension

DELTA COMMISSIE

Samen *werken* met water

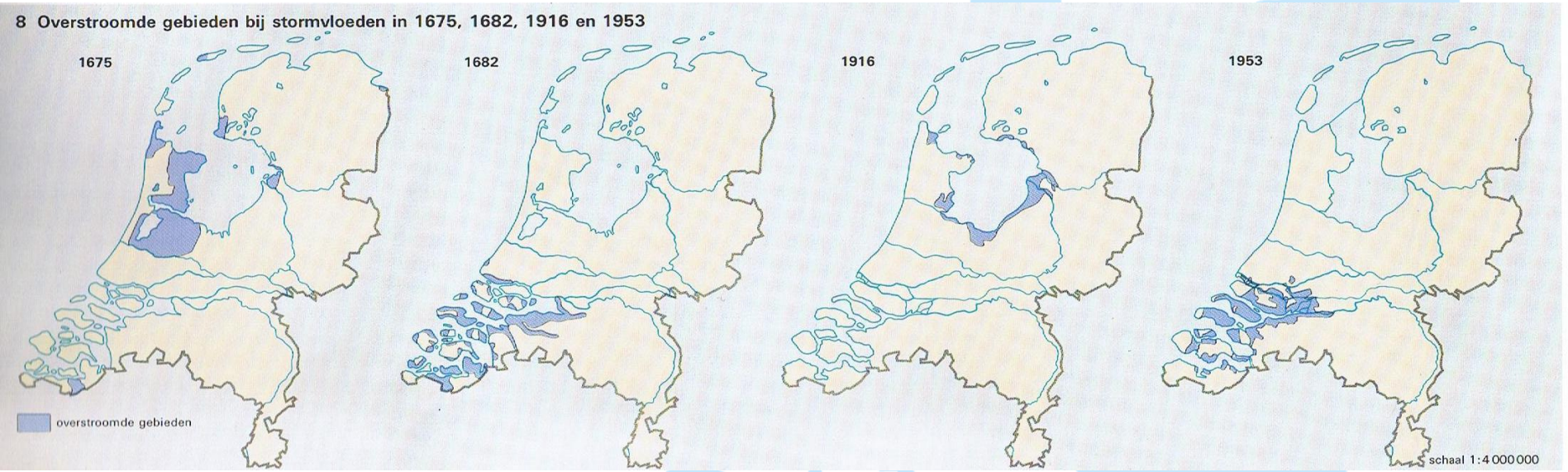
Working together with water (build with nature & co-operate)

DELTACOMMISSIE

17th Street Canal

DELTA COMMISSIE

Main flood events



1675 1682 1916 1953

DELTACOMMISSIE

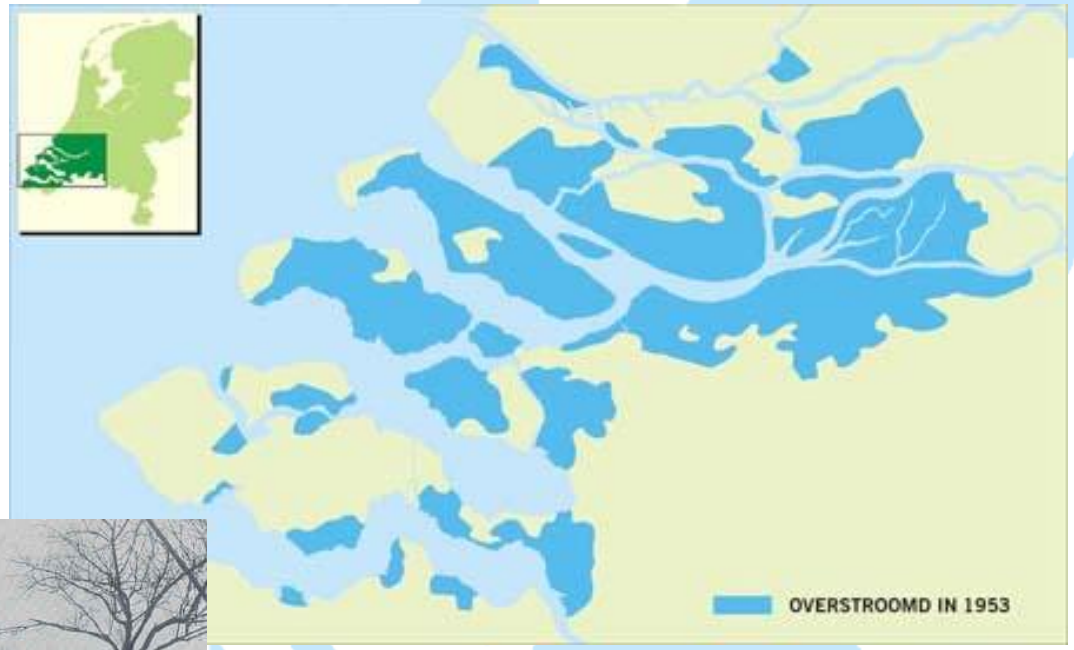
Following 1916

Creation of IJssel Lake and polders

DELTACOMMISSIE

1953 flood

Flood disaster in the SW Delta



DELTACOMMISSIE

The Delta works

- Dikes and barriers

DELTA COMMISSIE

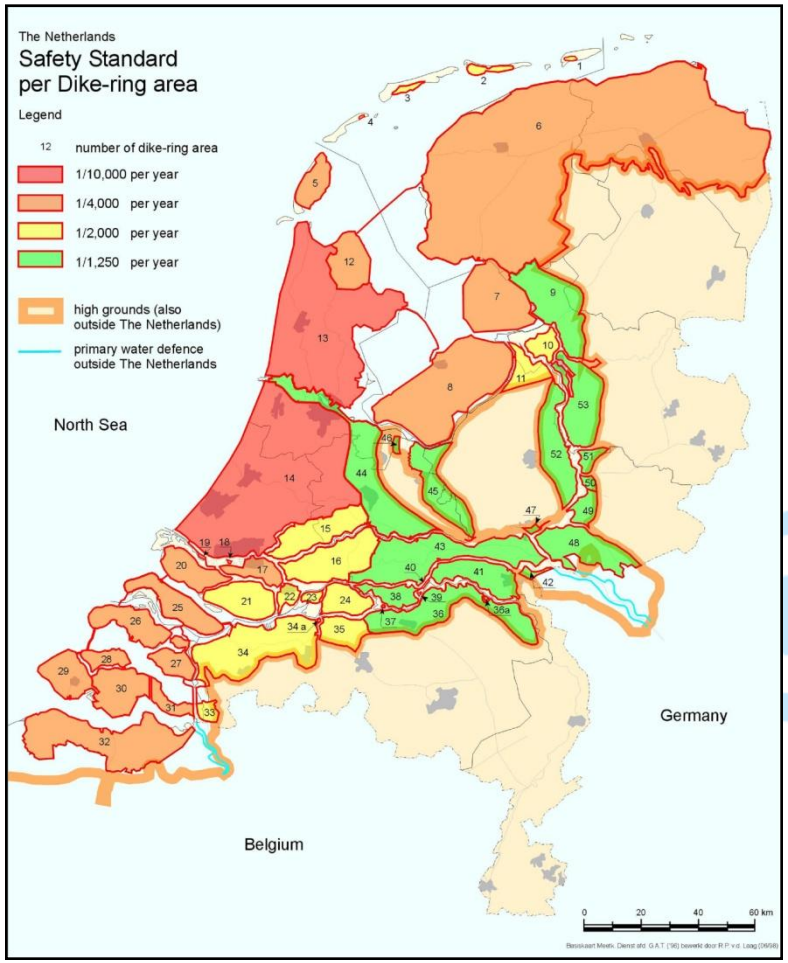
Safety check flooding

Results 2nd check (2006) primary defences:

- 24% no-pass
- 32% no check possible

DELTACOMMISSIE

Safety standards are not optimal



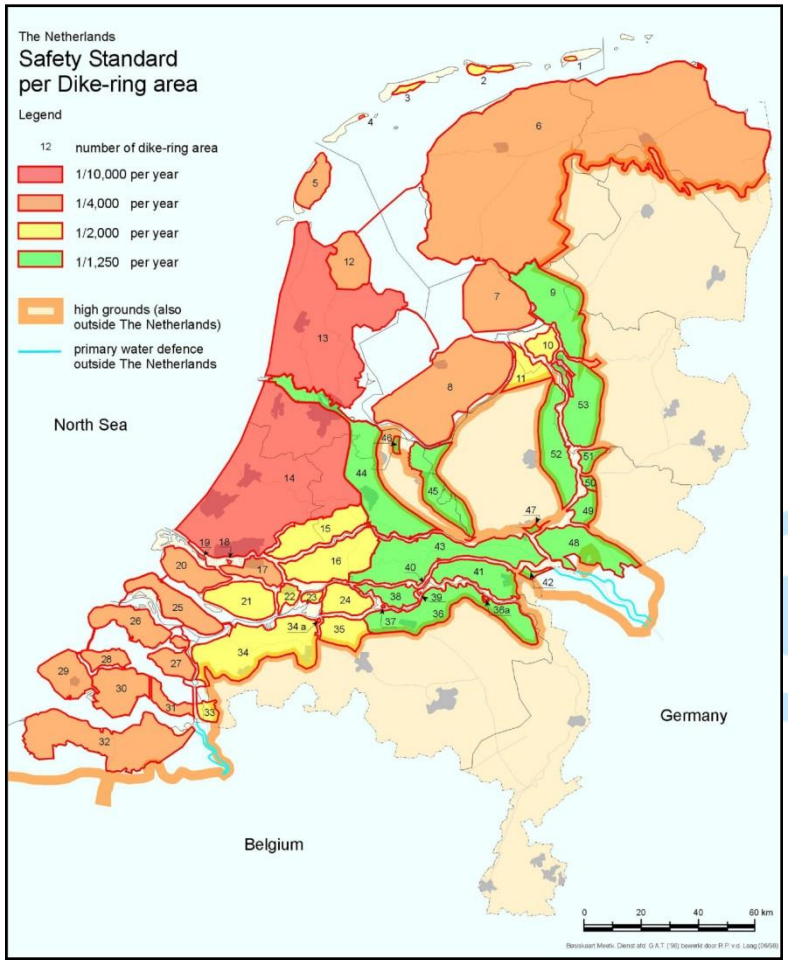
Since the 1960's:

- Economy increased 600%
- Population increased 50%
- Individual and group risk too high

(the negative factors)

DELTACOMMISSIE

Safety standards are not optimal



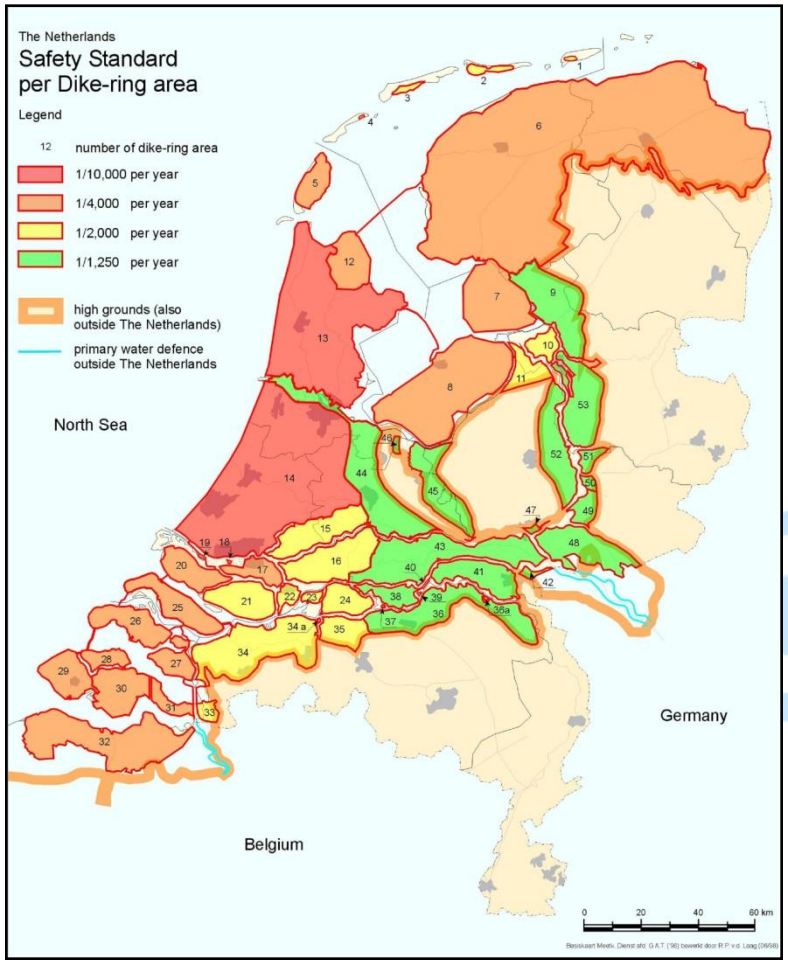
Since the 1960's:

- Advances in flood modelling
- Dike-rings are no bathtubs!

(positive factors)

DELTACOMMISSIE

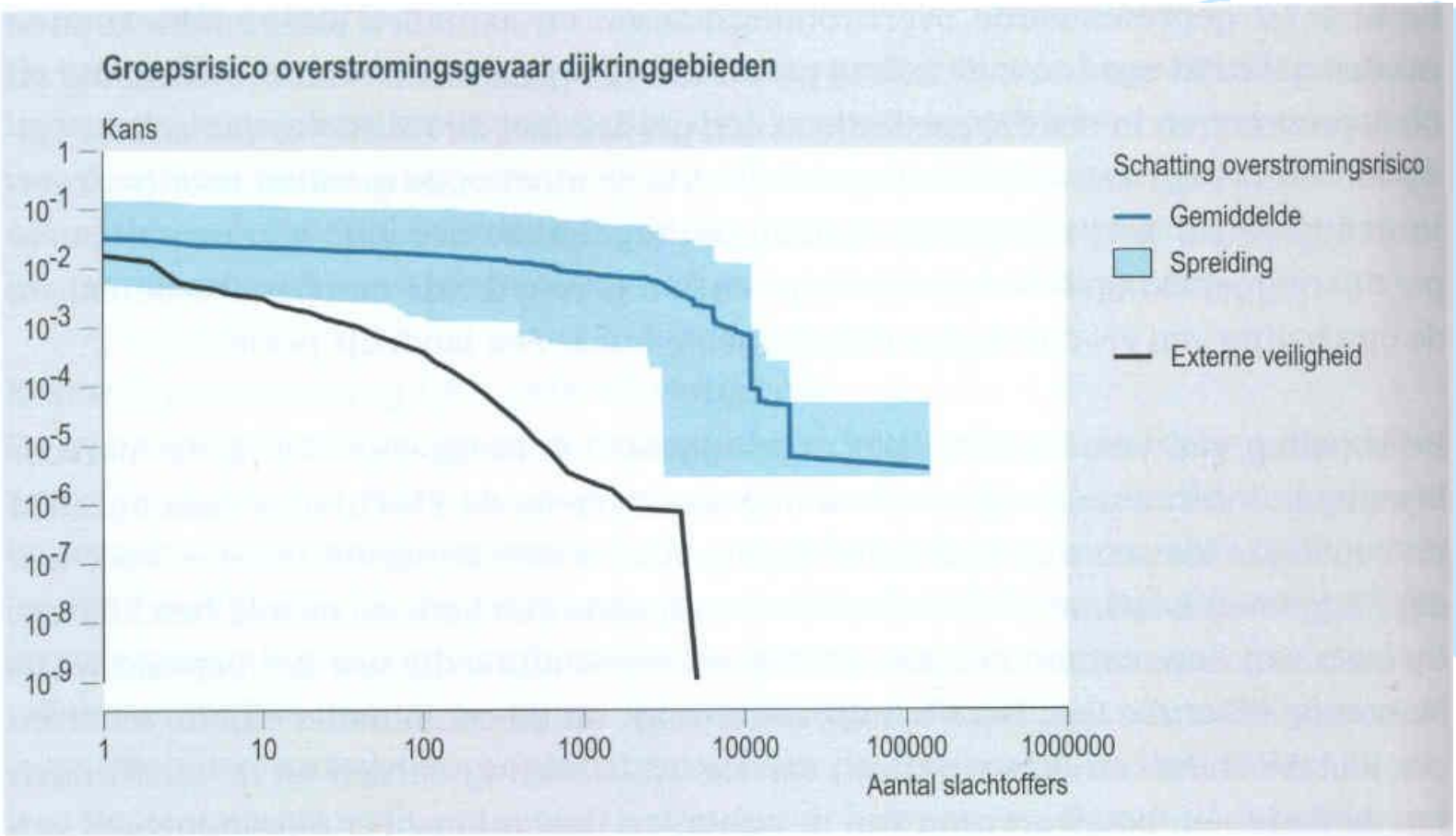
Safety standards are not optimal



Dike-ring 14 (ZH):

- Economic risk optimal for 1 in 20.000 to 40.000 per year
- For a factor of 10 on 1 in 10.000 increased standard of 5 to 2.5

DELTA COMMISSIE



Figuur 7.4.1 Het groepsrisico voor overstroming in Nederland in relatie tot de som van de groepsrisico's die tot nu toe in het kader van studies naar externe veiligheid in Nederland door het RIVM werden gepresenteerd.

Scour hole, partially refilled
Originally appr. 25 ft deep

Safety standards are not optimal

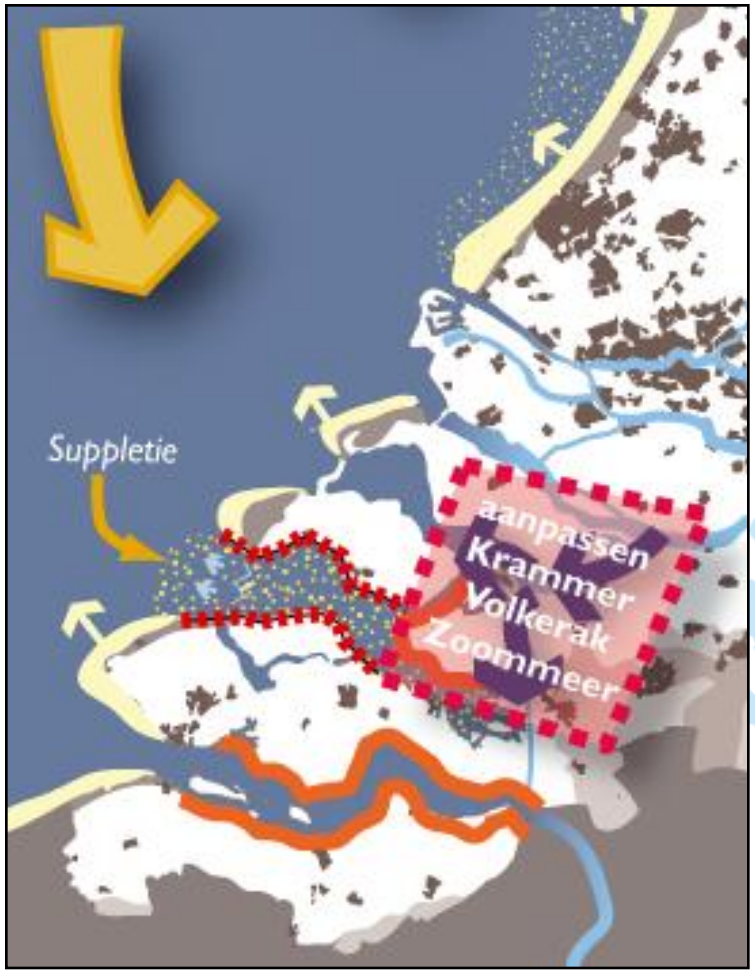
- Risk = probability x damage
- Insight in failure probabilities strongly changed (mainly negative)
- Insight in damage strongly changed (both positively and negatively)
- Individual and group risk too high

Relative SLR

- Plausible high-end scenarios necessary to judge the sustainability of our dike-ring concept
- High-end and low-end scenarios necessary for robust design
- What lacks is probabilities!

DELTA COMMISSIE

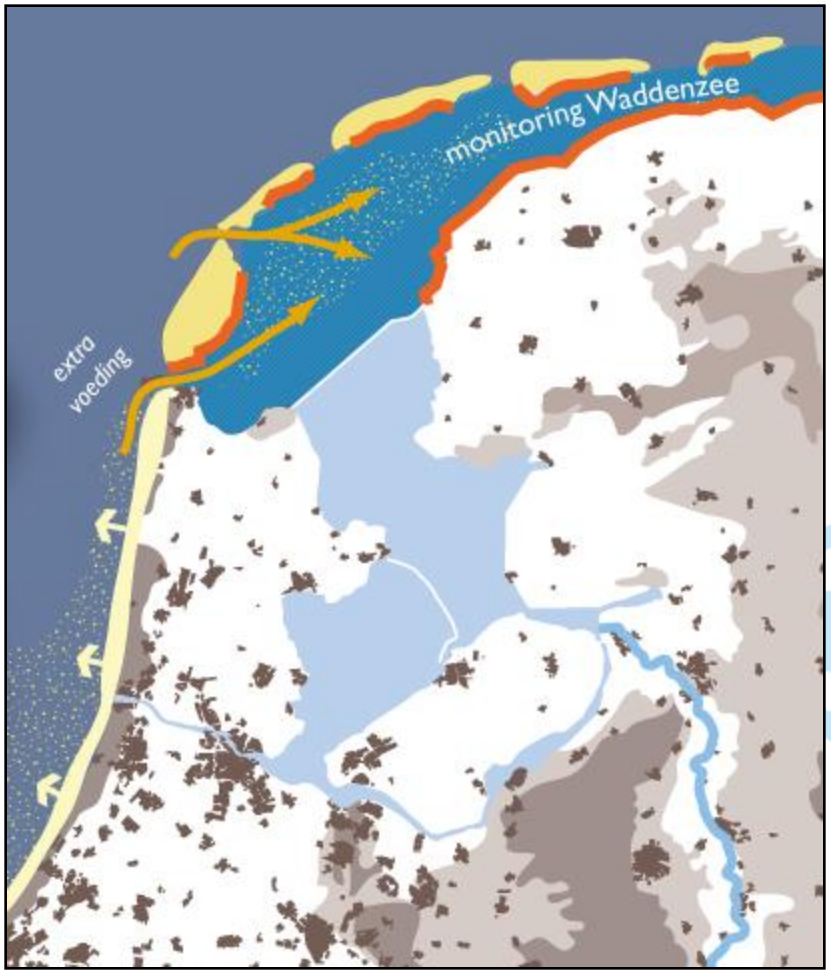
SW Delta



- Restore tidal dynamics for the Oosterschelde at the end of this century
- Raise Westerschelde dikes
- Volkerak-Zoommeer salt!
- Issue of fresh water!

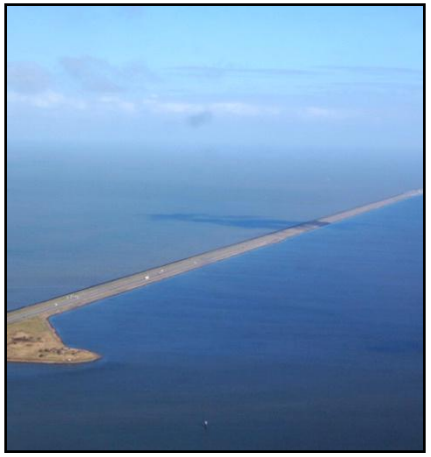
DELTA COMMISSIE

Wadden region



Coast nourishment garantees the availability of sand for the Wadden Sea and its ebb-tidal deltas

DELTA COMMISSIE



IJssel lake

- Mean level of IJsselmeer follows SLR (1.5 m is upper boundary!)
- IJsselmeer remains THE freshwater basin, available for drought periods
- Level of Markermeer unchanged