The Rhine-Meuse Delta

Deltas of the World: Similarities and Differences

TNO Built Environment and Geosciences
Geological Survey of the Netherlands

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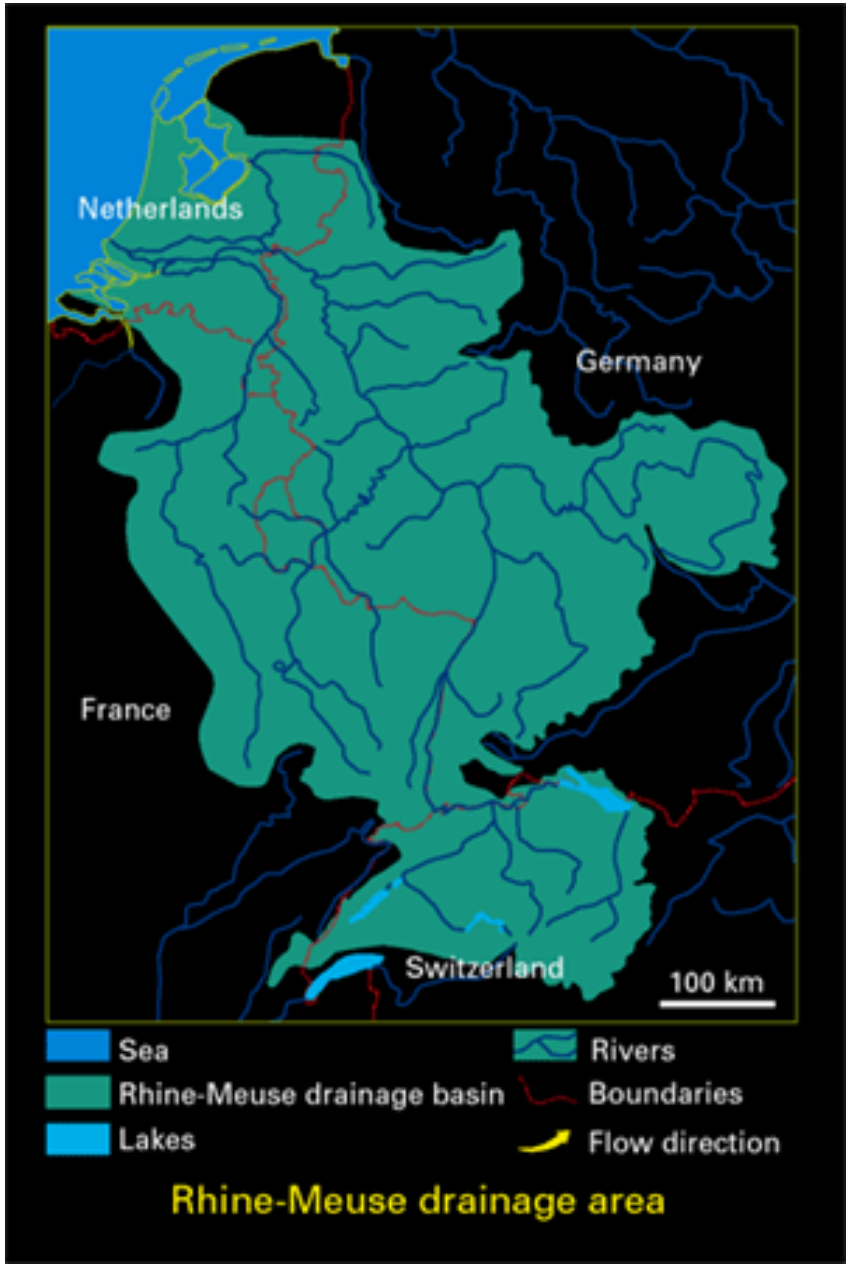
Outline

- Introduction of the area
- The geology and morphology of the Dutch lowlands
- From living with water to control over water
- Major engineering works
- Soft measures
- A paradigm shift in river management
- Global change?

- *Focus on safety*

Comparing deltas

Rhine-Meuse drainage area



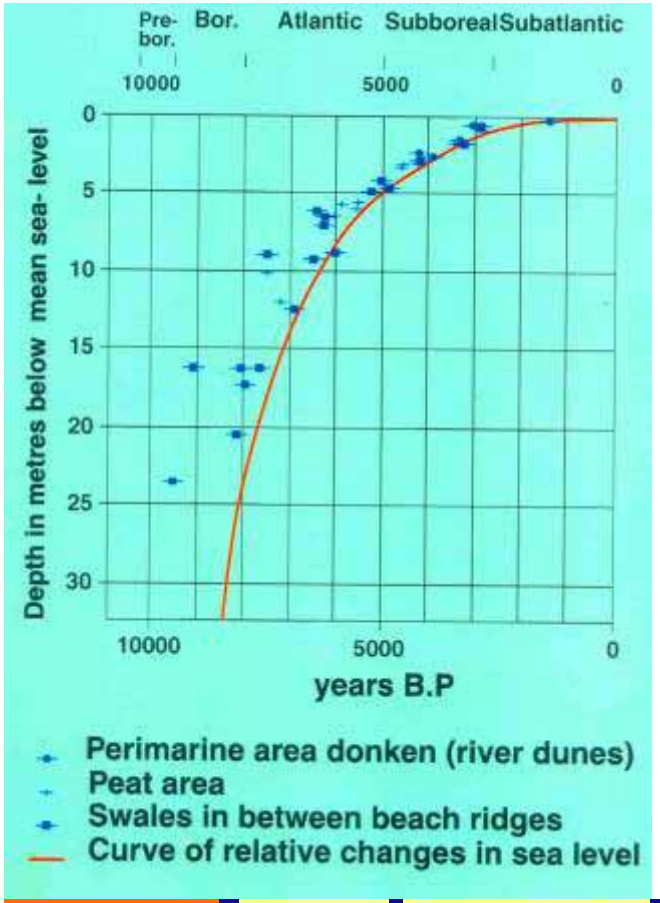
Main morpholo-gical features

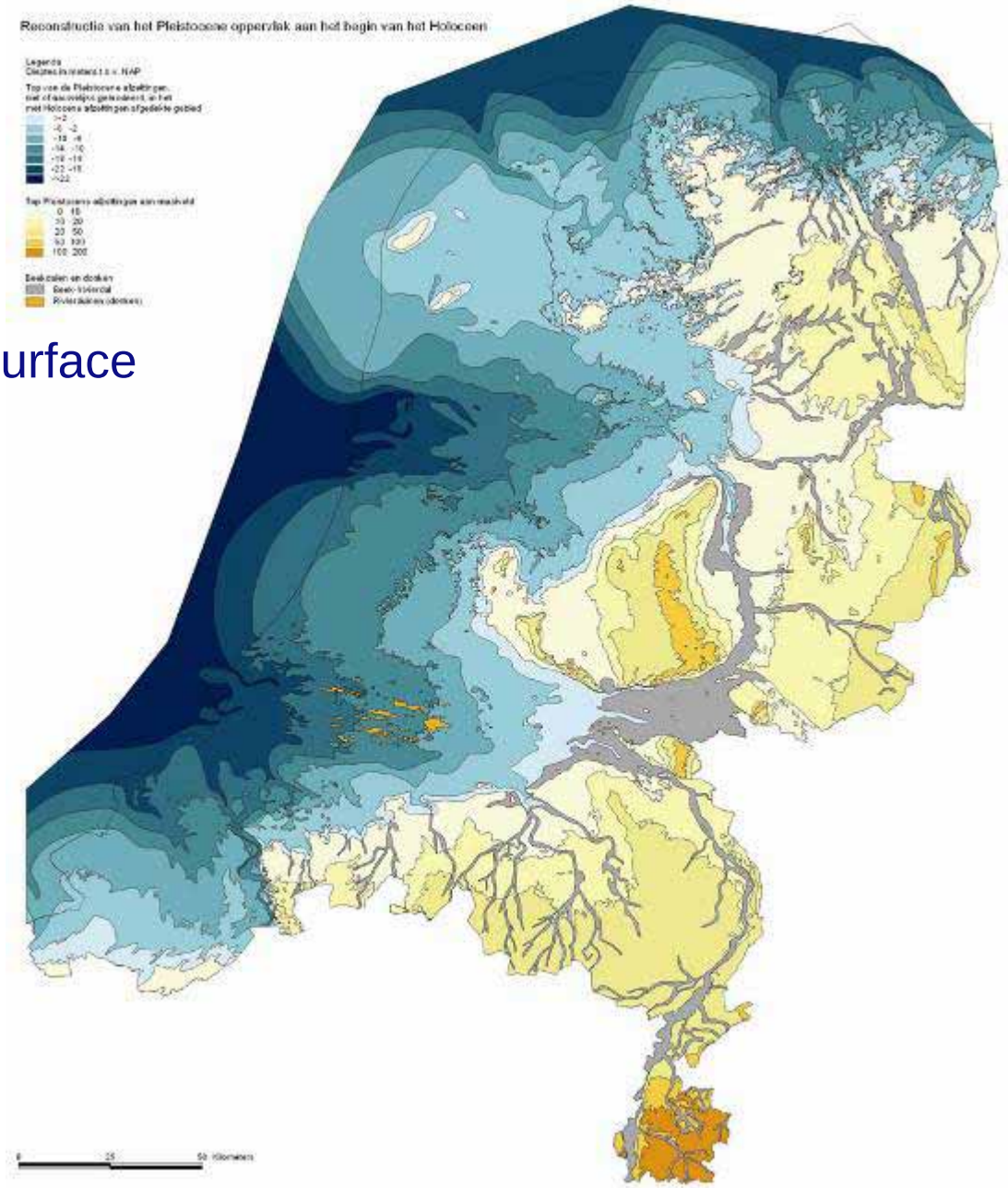
Coast:
- *Wadden*
- *Holland*
- *Delta*

Rivers:
- *Rhine*
  - *Inactive branches*
- *Meuse*

Holocene development

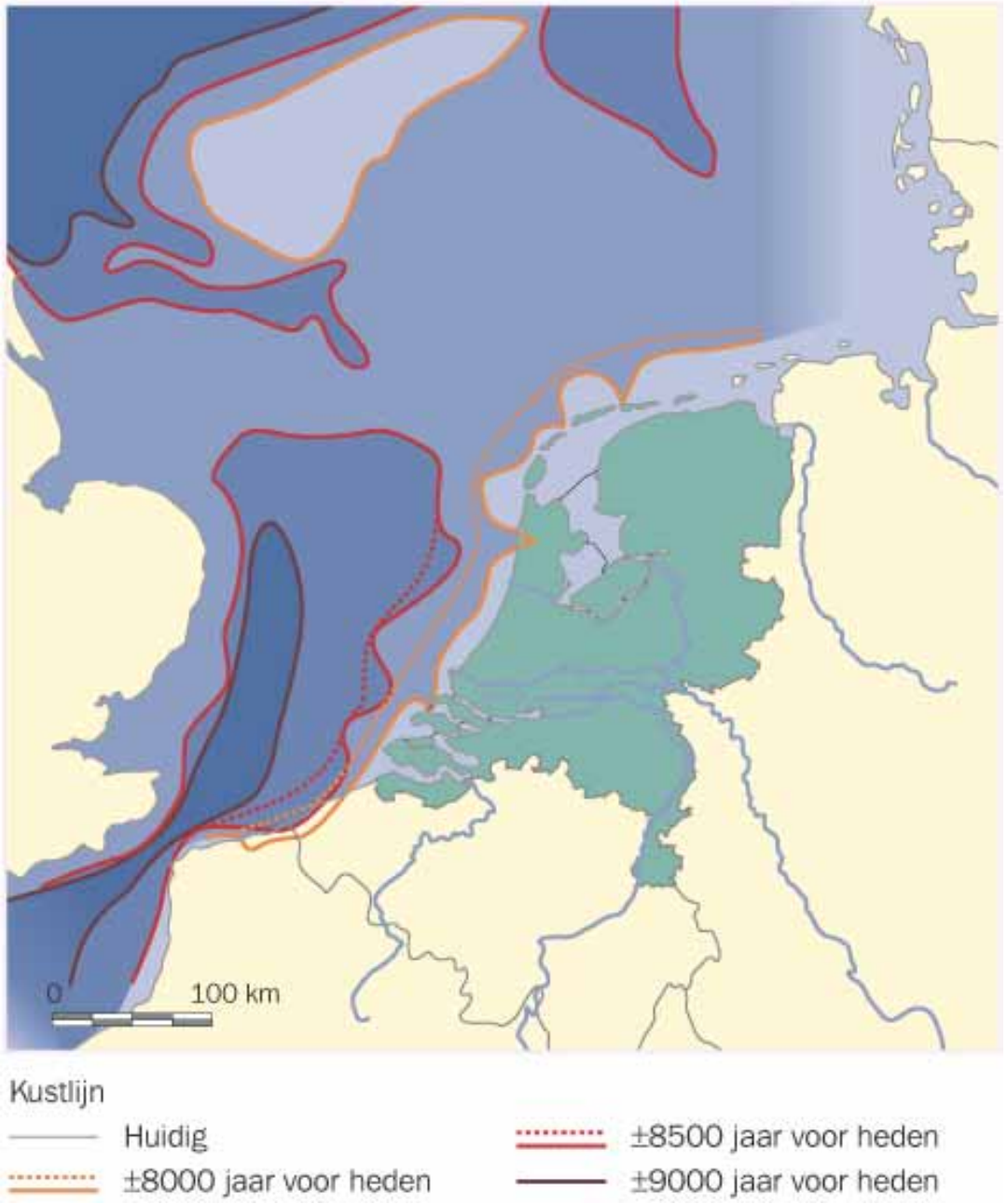
- Flooding of Weichselian surface
- Aggradation





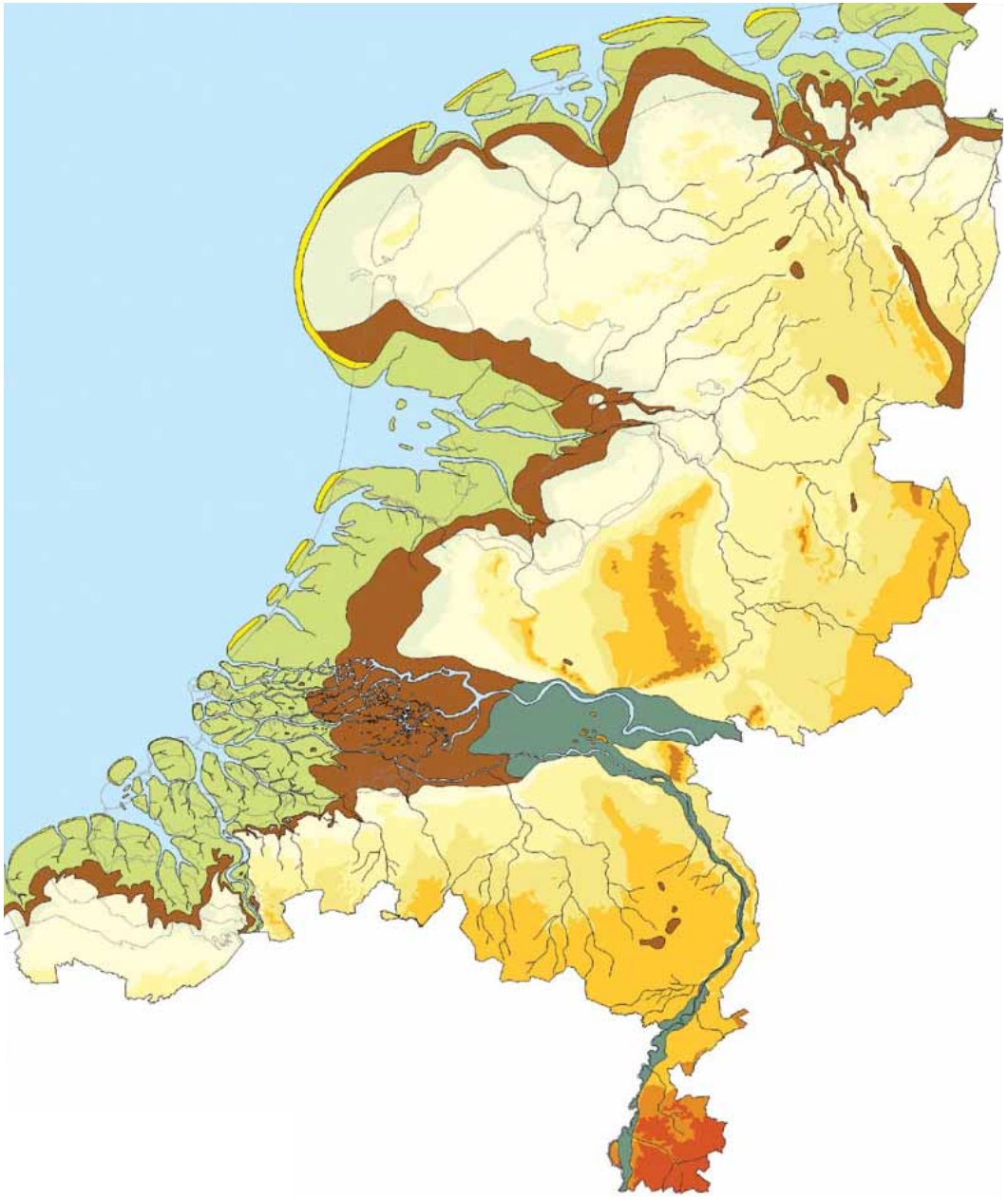
9000 – 8000 BP

- separation: land bridge
- rapid flooding



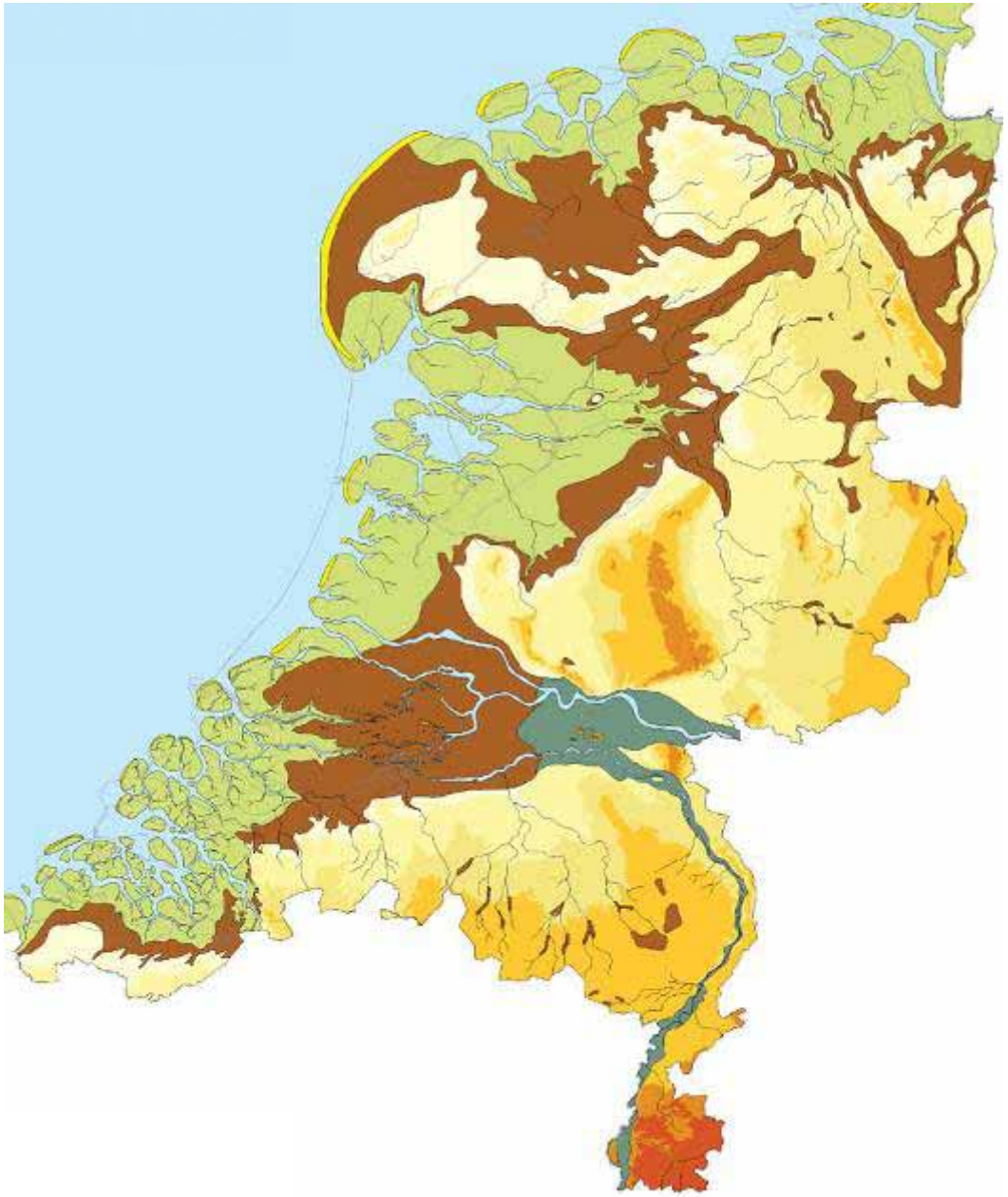
7200 BP

- Transgression !



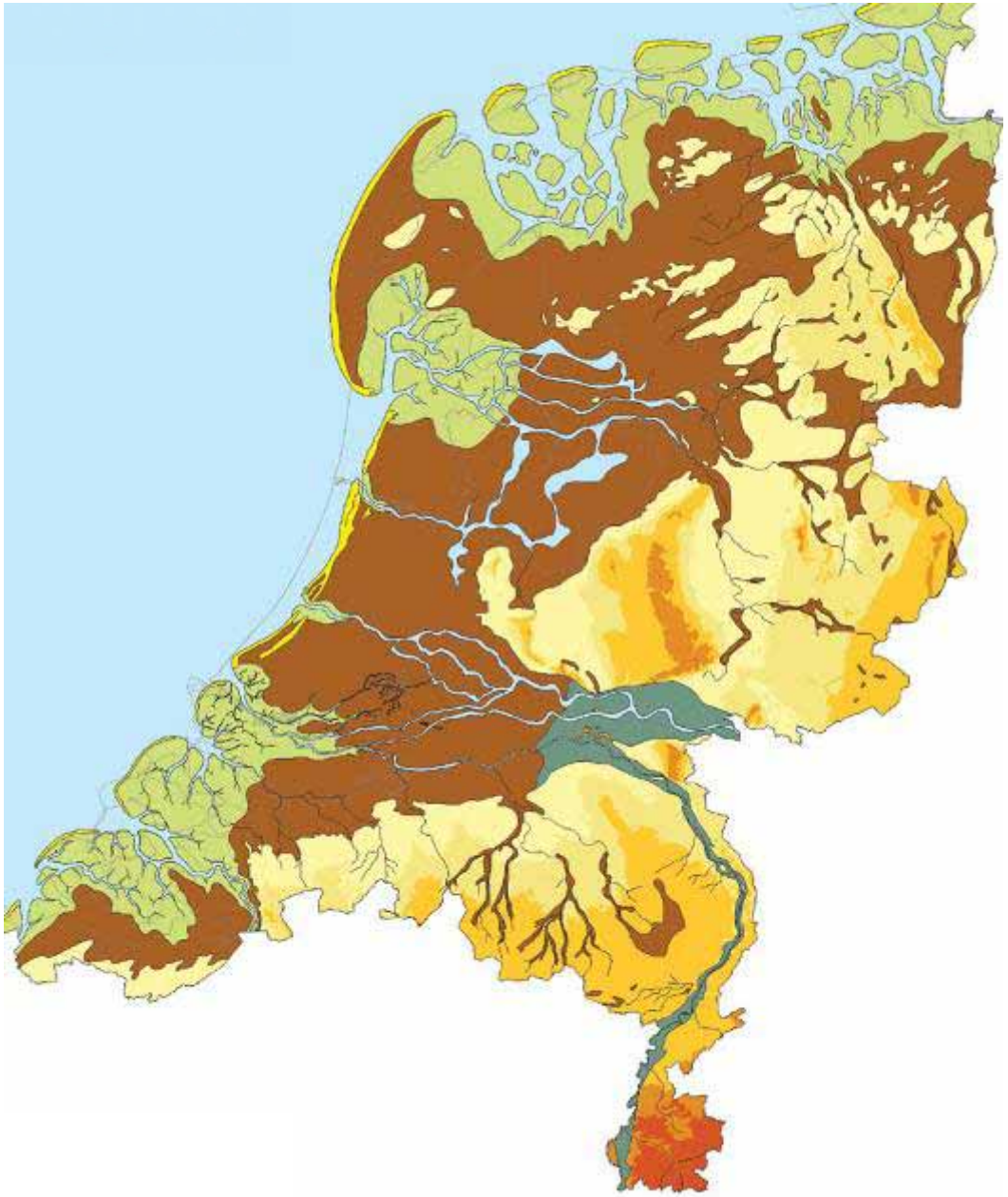
6300 BP

- Expanding tidal basins



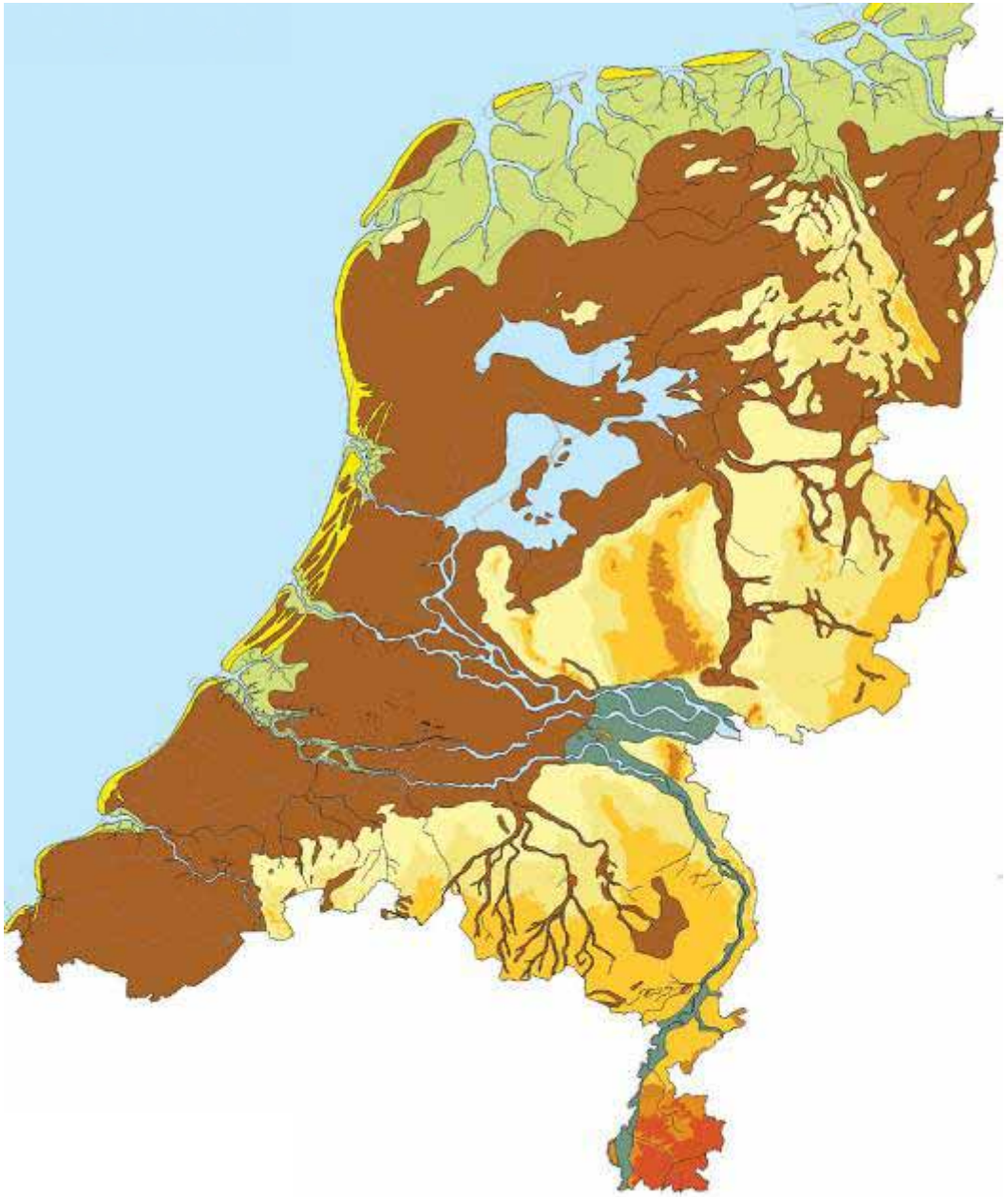
4800 BP

- Silting up



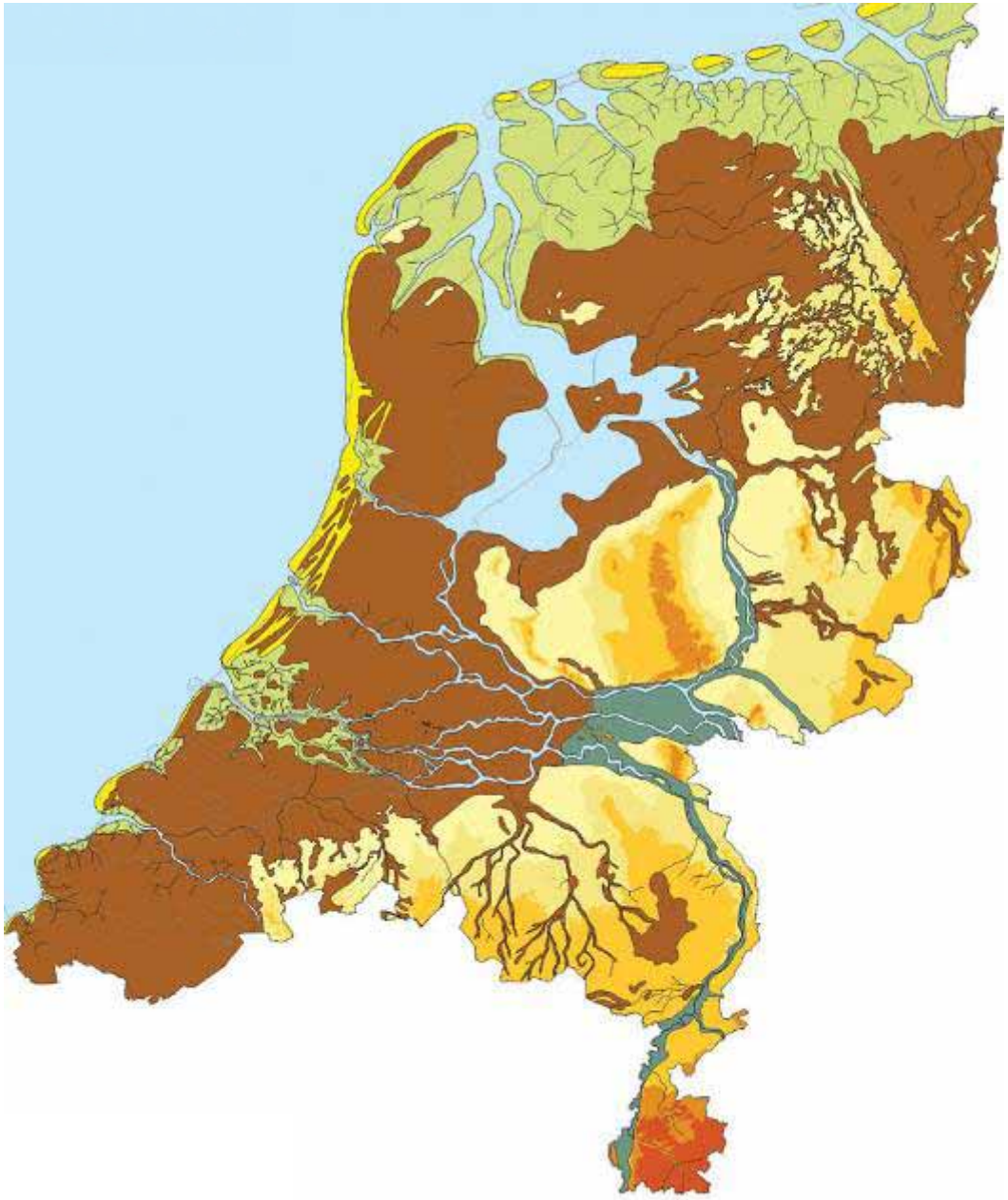
2500 BP

- Coastal swamp



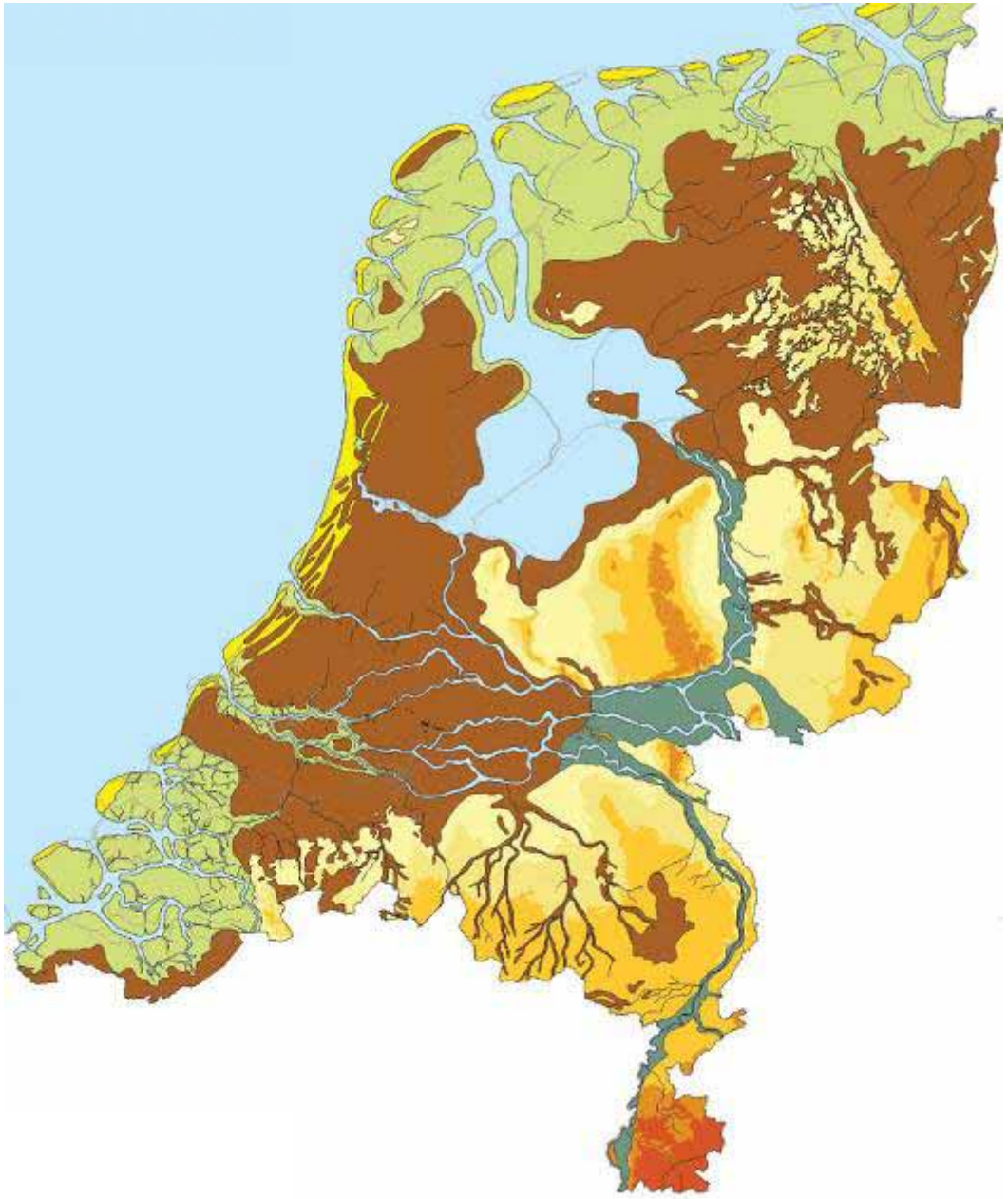
2000 BP

- Coastal lagoon



800 AD

- New tidal basins
- Human influence

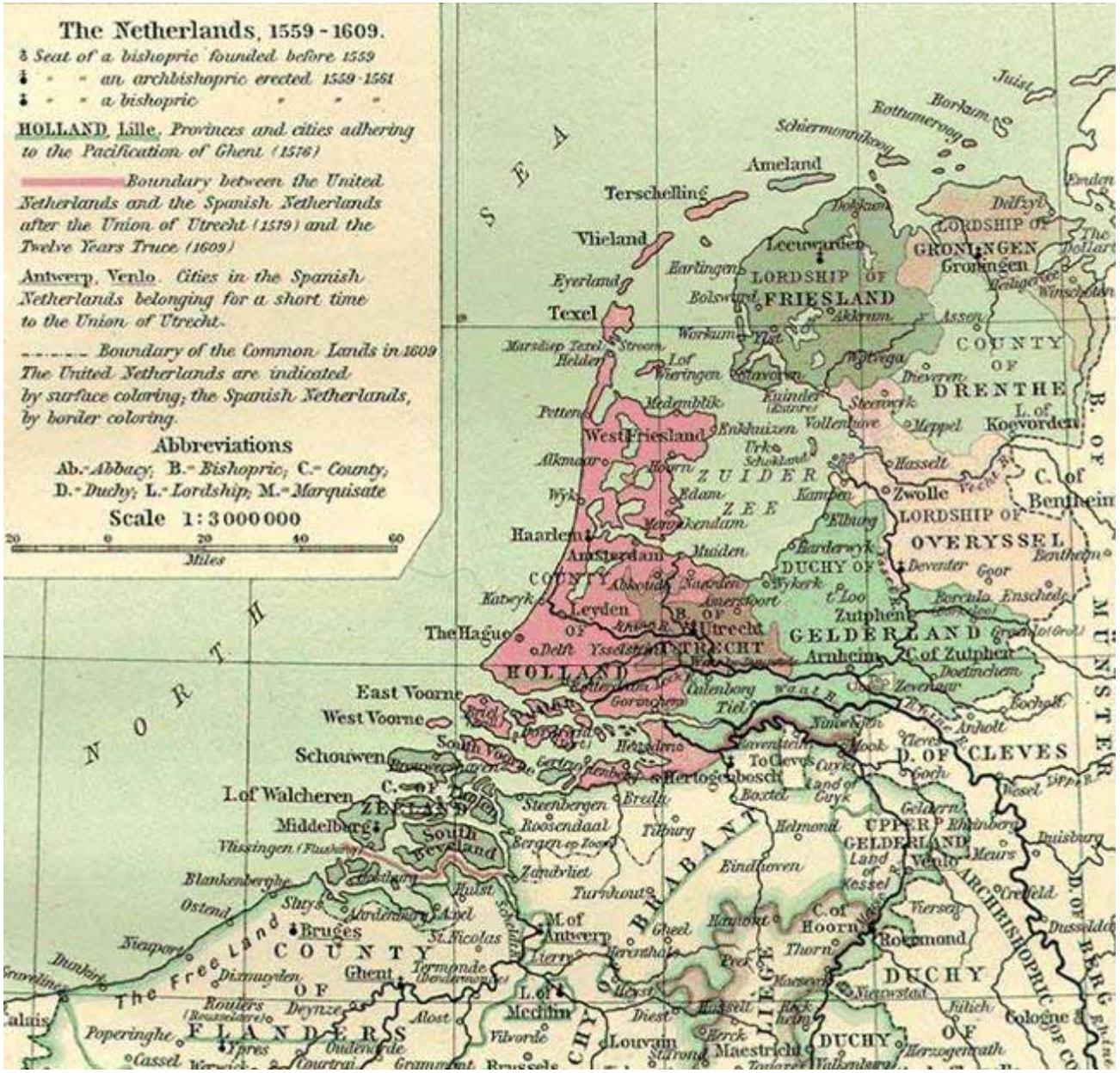


1250 AD

- Diking
- Water boards: oldest democratic institutions in the Netherlands

16th century

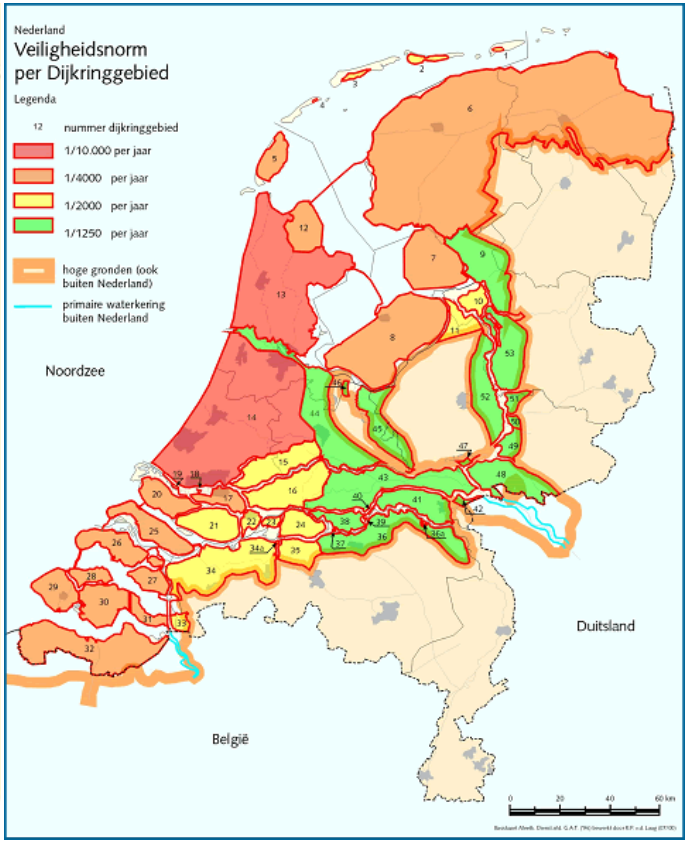
- Diking
- Reclamation
  Land subsidence
- Peat extraction



Subsequently ...

- Increasing control over water
- Dike rings
- Flooding: from ‘natural’ to disastrous process

- Floods → major water engineering works

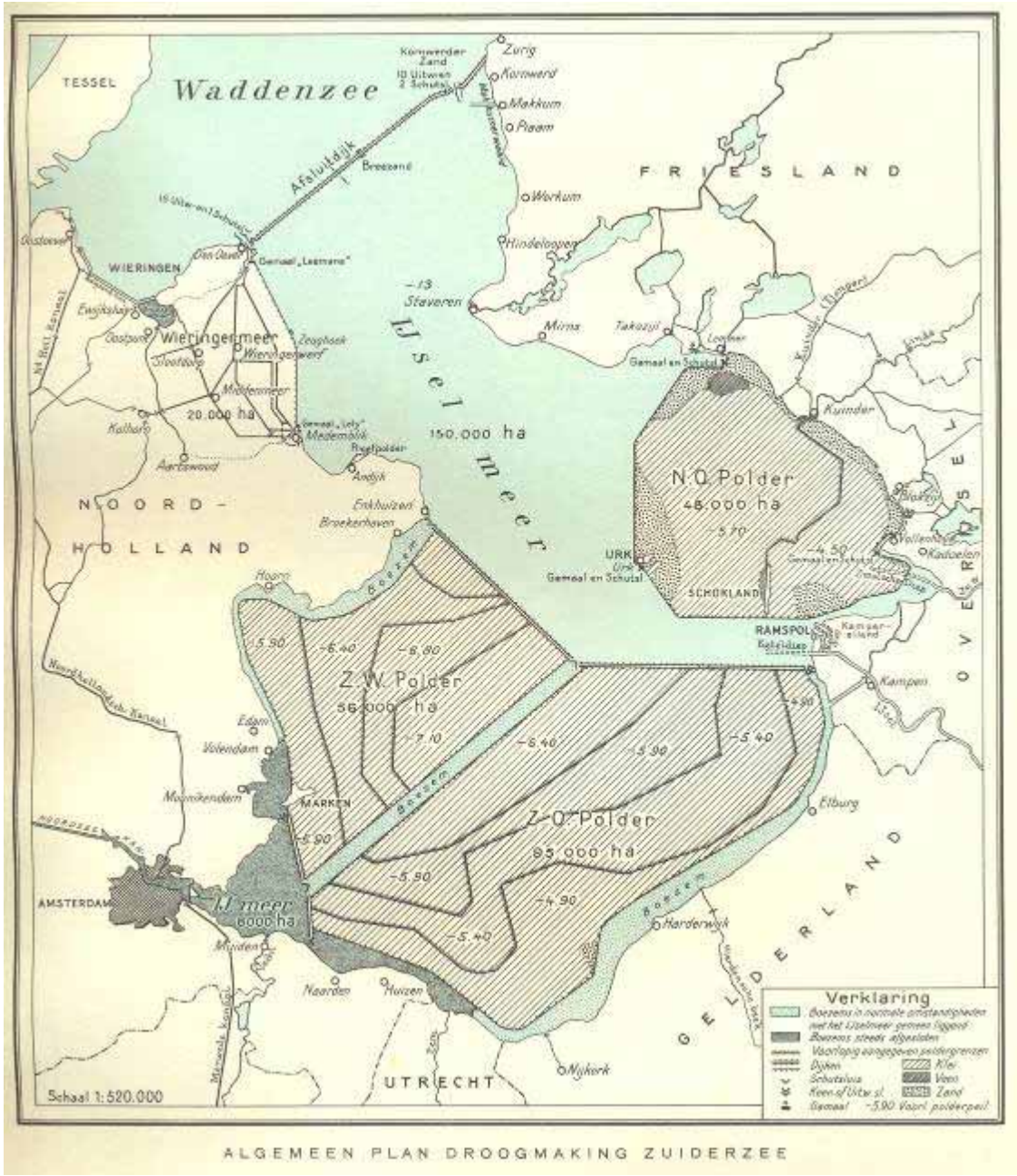


Watersnood 1916
Soldaten drijven vee naar de noodstallen

Zuiderzeewerken

- 1918 - 1975
- Closing ‘interior sea’
- Land reclamation
- Fresh water resource

- Not only safety, also agriculture



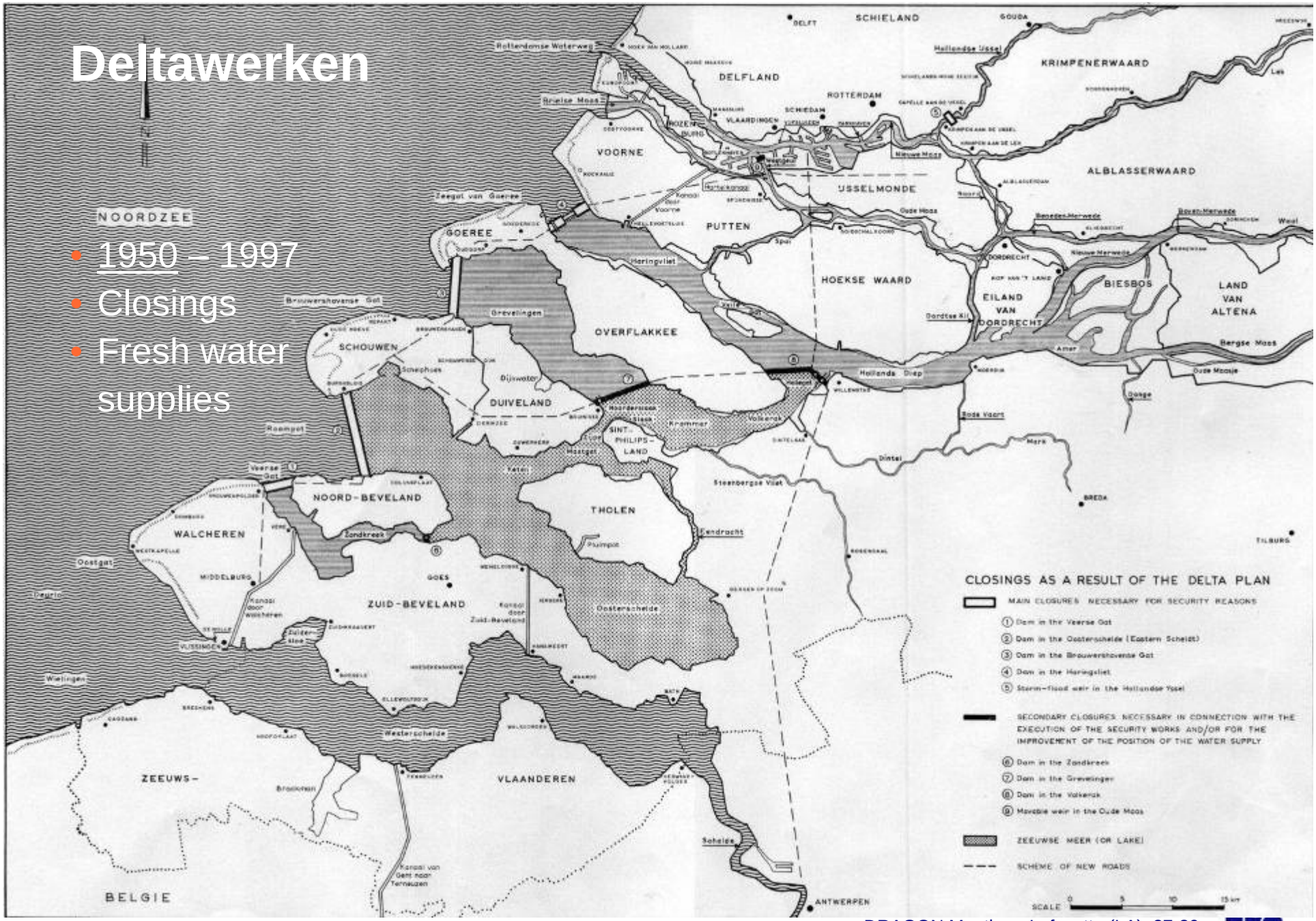
Zuiderzeewerken

- 1918 - 1975
- Closing ‘interior sea’
- Land reclamation
- Fresh water resource

- Not only safety, also agriculture

Deltawerken

- 1950 – 1997
- Closings
- Fresh water supplies



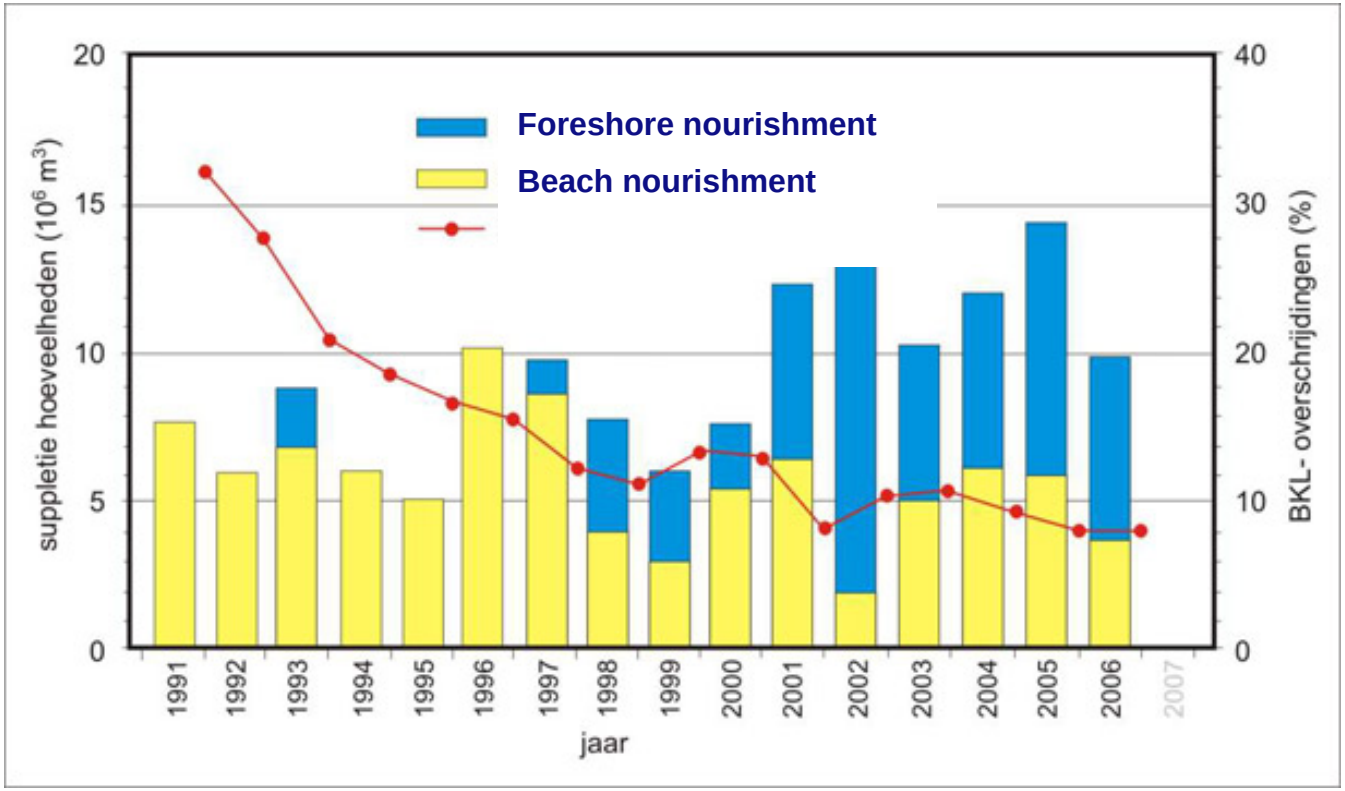
See: www.deltawerken.com

Coastal protection

- Not only hard, but also soft measures
- Coastal nourishment: maintaining the coast line of 1990
- ~12 mln m^3/jr (i.e. 2-3 $/capita/yr)

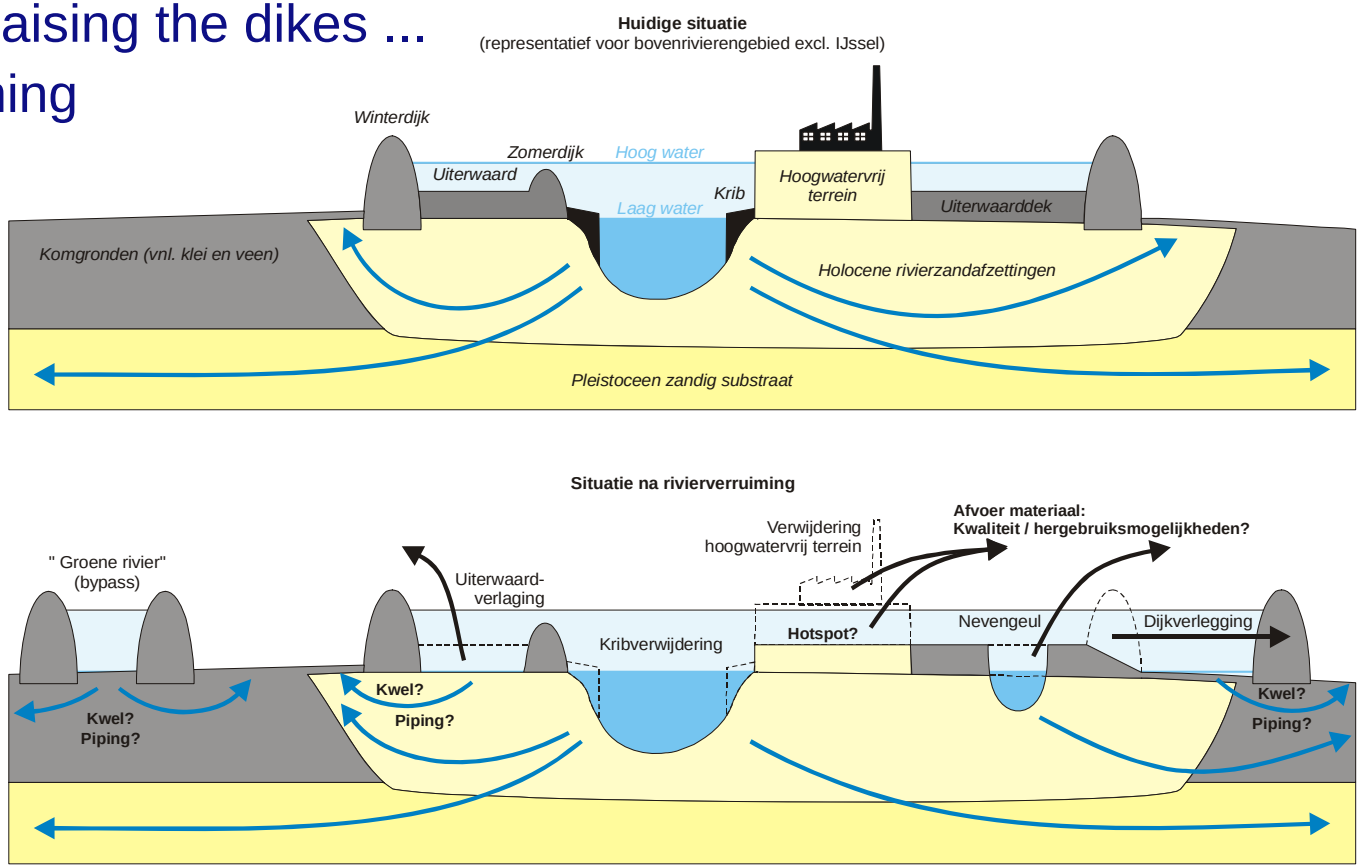
- Lecture Ad van der Spek!

Coastal protection



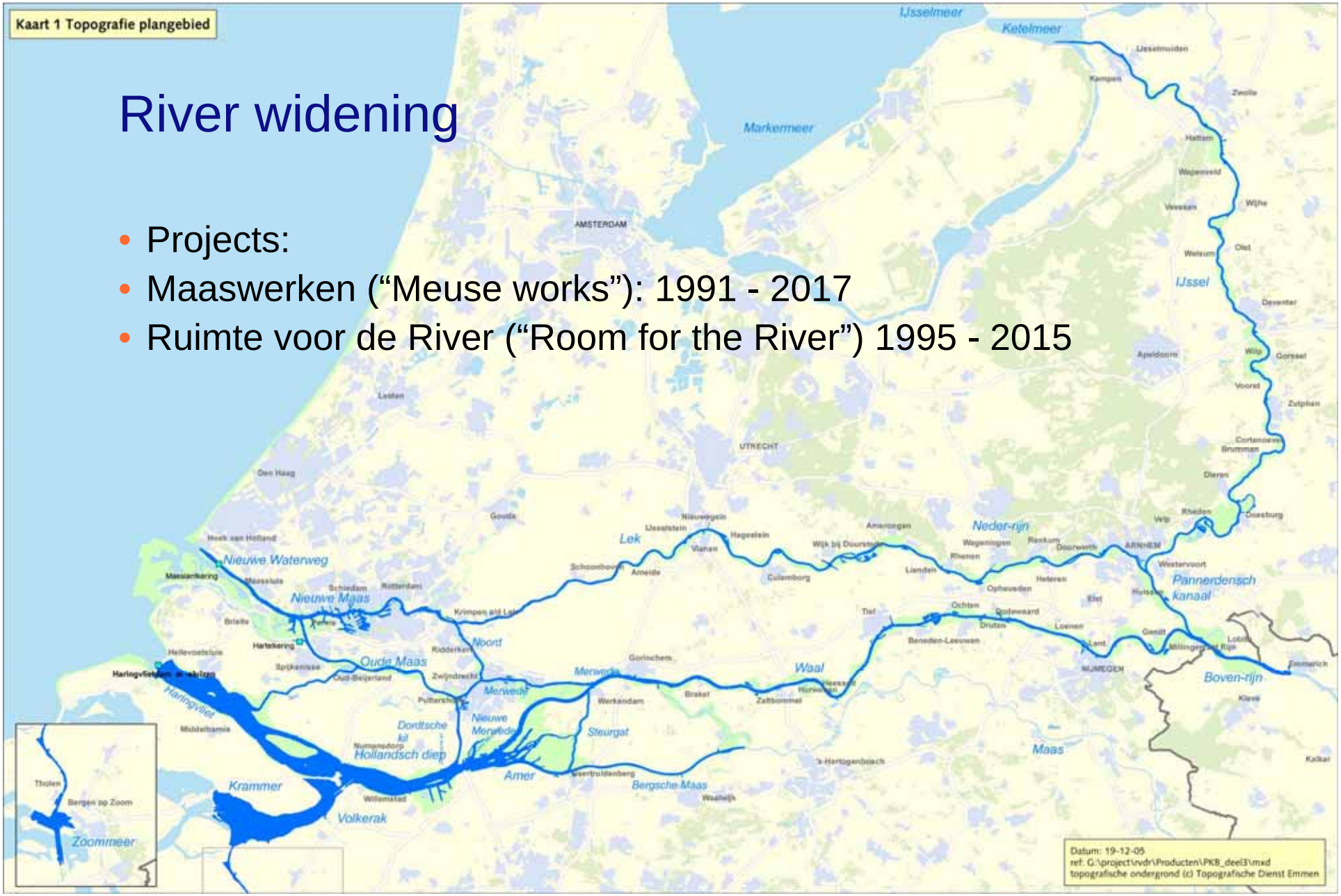
Paradigm shift in river management

- Provoked by imminent flooding in 1993 and 1995
- Rather than raising the dikes ...
- ... river widening



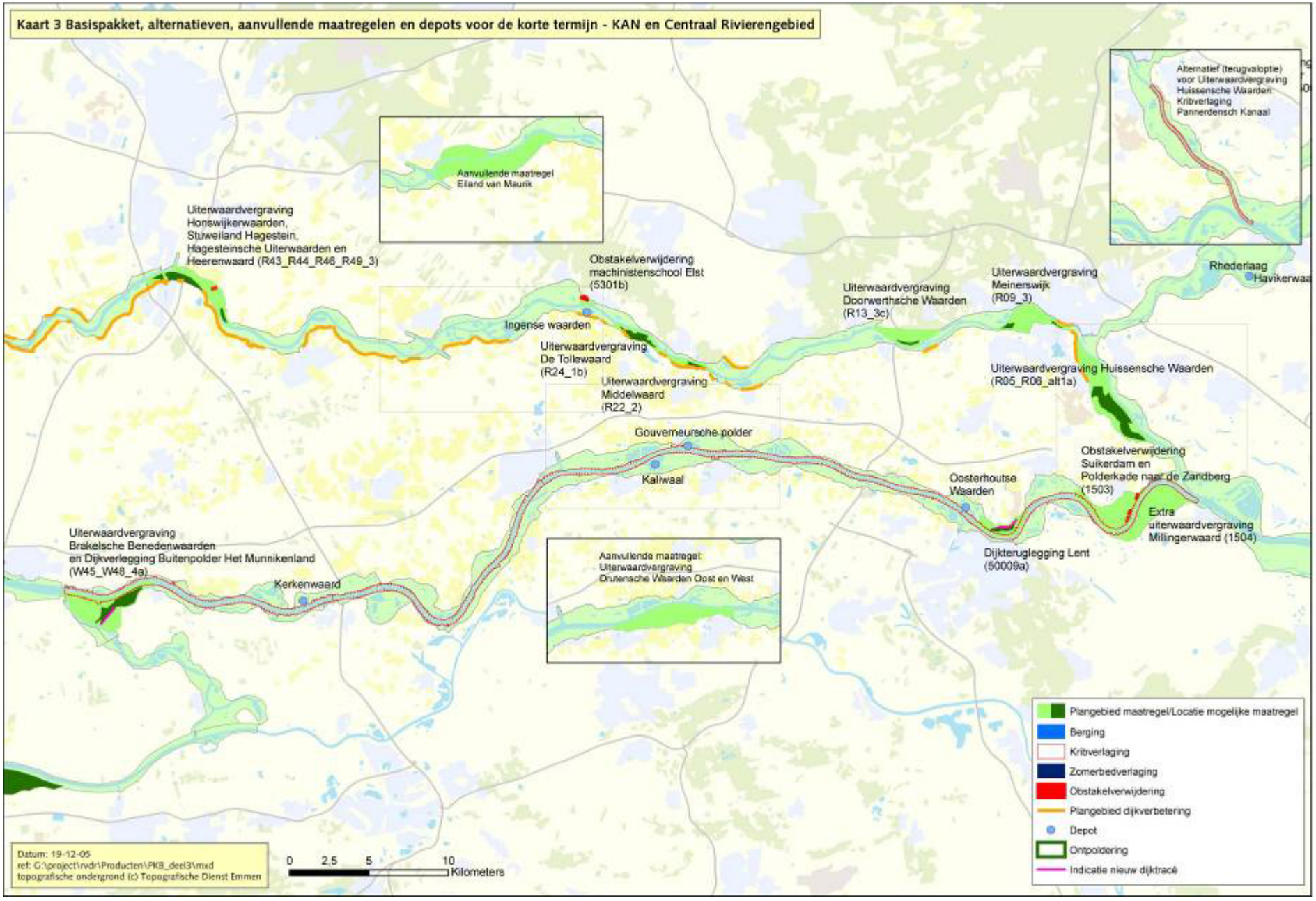
River widening

- Projects:
- Maaswerken (“Meuse works”): 1991 - 2017
- Ruimte voor de River (“Room for the River”) 1995 - 2015



Ruimte voor de Rivier

- 41 projects
- 6 types of measures
  - Lowering embanked floodplains
  - Obstacle removal
  - Moving dikes
  - High-discharge channels
  - Groyne lowering
  - Channel deepening

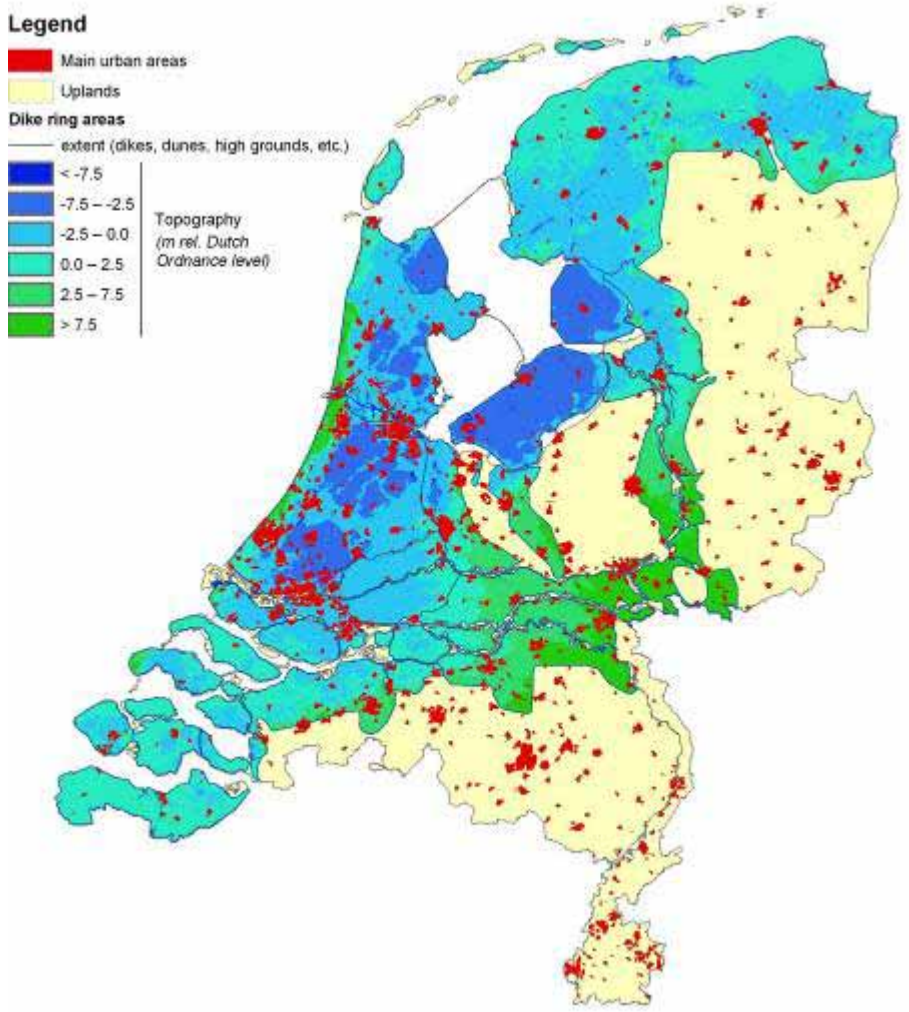

Kaart 3 Basispakket, alternatieven, aanvullende maatregelen en depots voor de korte termijn - KAN en Centraal Rivierengebied
Aanvullende maatregel
Eiland van Maurik
Alternatief (terugvaloptie)
voor Uiterwaardvergraving
Huissensche Waarden:
Kribverlaging
Pannerdensch Kanaal
Uiterwaardvergraving
Honswijkerwaarden,
Stuwwiland Hagestein,
Hagesteinsche Uiterwaarden en
Heerenwaard (R43_R44_R46_R49_3)
Obstakelverwijdering
machinistenschool Elst
(5301b)
Ingense waarden
Uiterwaardvergraving
De Tolkewaard
(R24_1b)
Uiterwaardvergraving
Middelwaard
(R22_2)
Uiterwaardvergraving
Doorwerthsche Waarden
(R13_3c)
Uiterwaardvergraving
Meinerswijk
(R09_3)
Rhederlaag
Havikerwaa
Uiterwaardvergraving Huissensche Waarden
(R05_R06_alt1a)
Gouverneursche polder
Kalkwaal
Obstakelverwijdering
Suikerdam en
Polderkade naar de Zandberg
(1503)
Oosterhoutse
Waarden
Extra
uiterwaardvergraving
Millingerwaard (1504)
Dijkteruglegging Lent
(50009a)
Uiterwaardvergraving
Brakelsche Benedenwaarden
en Dijkverlegging Buitenpolder Het Munnikenland
(W45_W48_4a)
Kerkenwaard
Aanvullende maatregel:
Uiterwaardvergraving
Drutensche Waarden Oost en West
Plangebied maatregel/Locatie mogelijke maatregel
Berging
Kribverlaging
Zomerbedverlaging
Obstakelverwijdering
Plangebied dijkverbetering
Depot
Ontpoldering
Indicatie nieuw dijktracé
Datum: 19-12-05
ref: G:\project\rvdr\Producten\PKB_deel3\mxd
topografische ondergrond (c) Topografische Dienst Emmen
0 2,5 5 10
Kilometers

And now?

- Coastal protection ✓
- River protection ✓

- But behind the dikes:
  Lowlands is an understatement!
- Water management = sediment management
- Defense vs. resilience

- Global change?
- Lecture tomorrow



Thank you for your attention