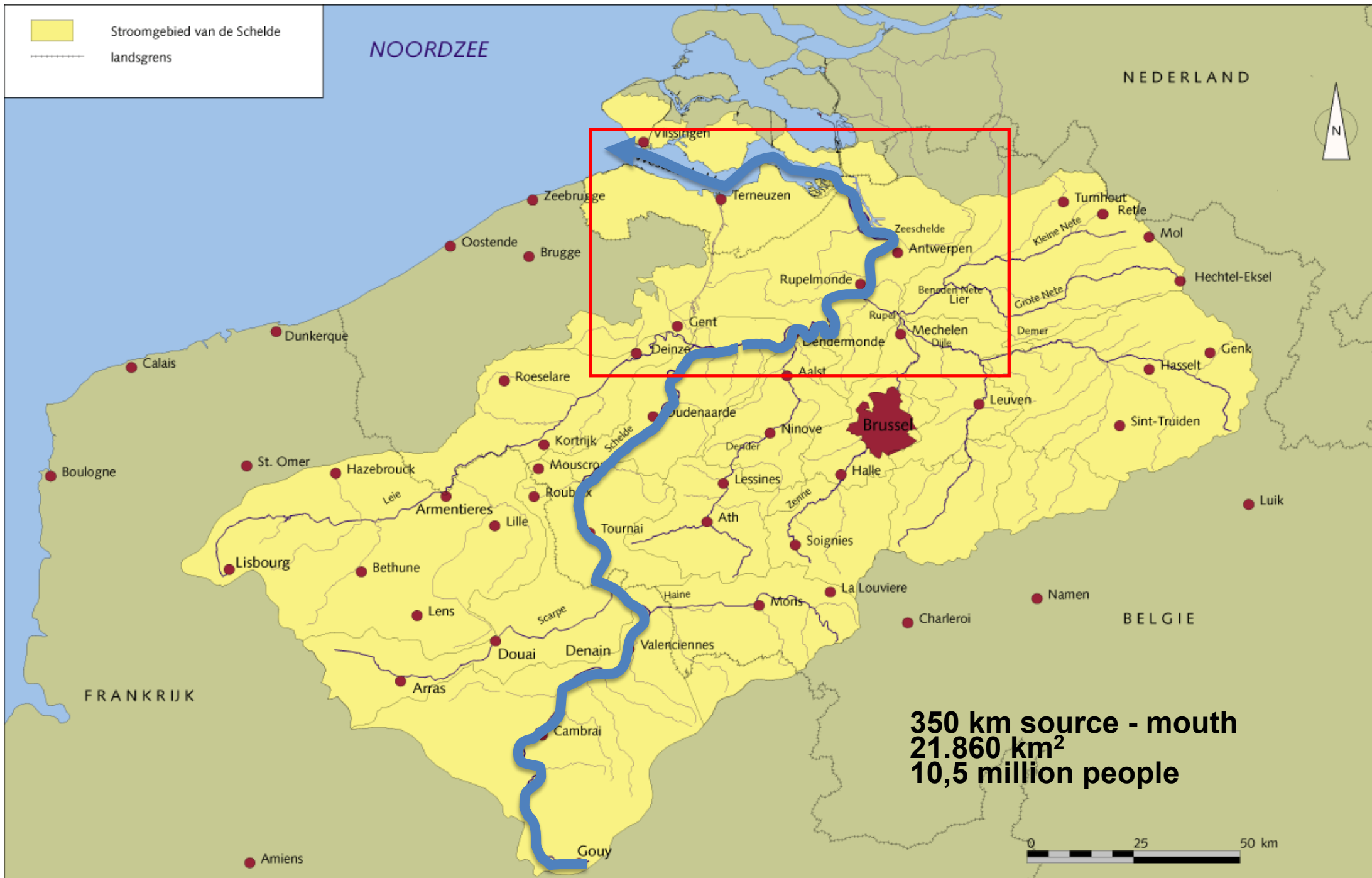


ir. Hans Quaeyhaegens, MSc.

The flood protection programme “Sigmoplan”





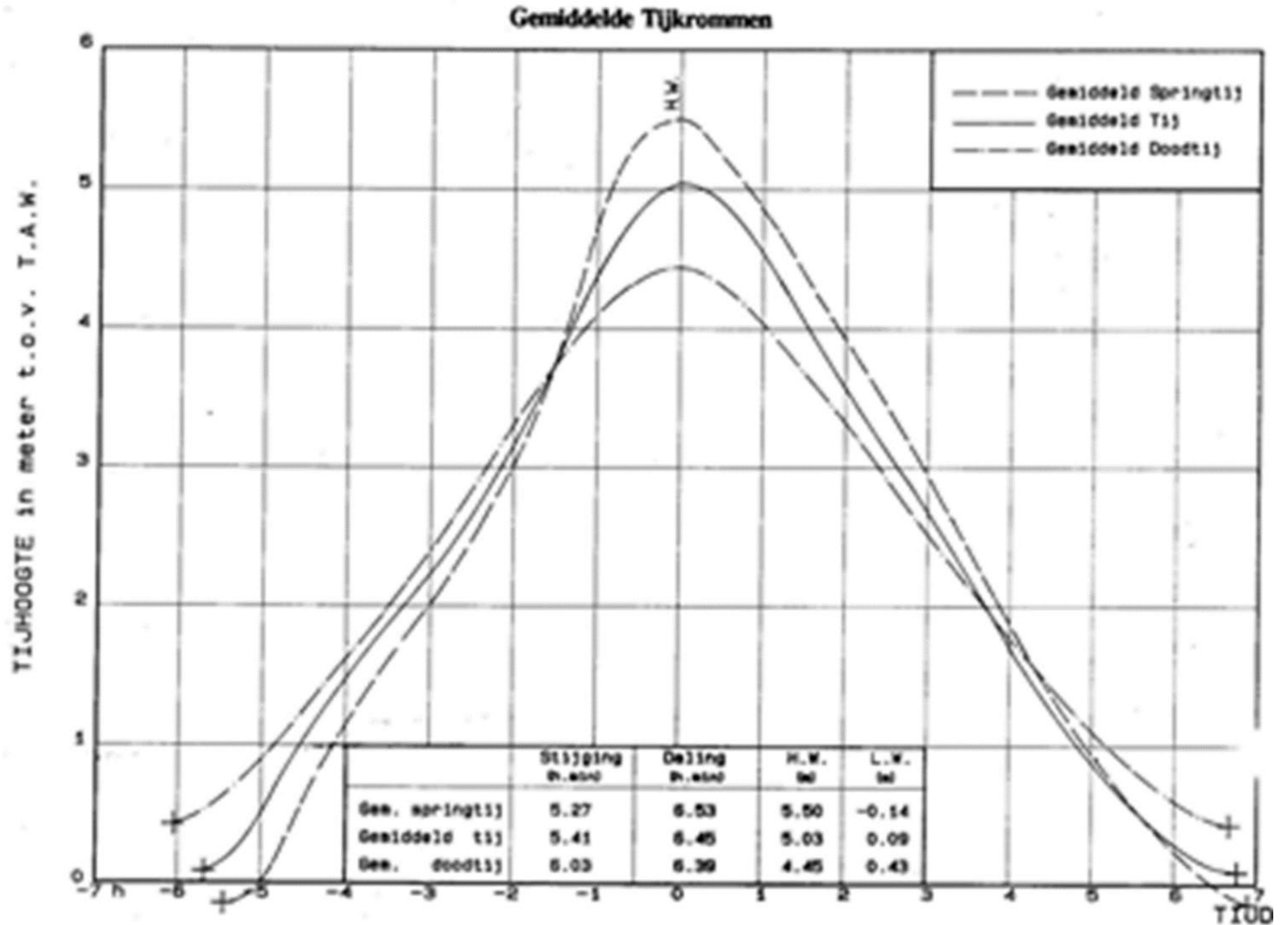
Scheldt versus other streams

| | gem. afvoer m ³ /s | getijvolume milj. m ³ | lengte km | stroomgebied km ² | inwoners per km ² |
|---------|-------------------------------|----------------------------------|-----------|------------------------------|------------------------------|
| Schelde | 120 | 2200 | 350 | 21.860 | 200-500 |
| Elbe | 720 | 1300 | 1100 | 146.500 | 100-200 |
| Loire | 825 | 480 | 1010 | 112.000 | 50-100 |
| Rijn | 2.200 | - | 1300 | 252.000 | 200 |
| Nijl | 3.000 | 0 | 6700 | 2.813.200 | 20-2200 |
| Yangtze | 32.180 | 7000 | 5990 | 1.833.000 | 185 |
| Amazone | 174.890 | 0 | 6570 | 6.175.000 | 20 |

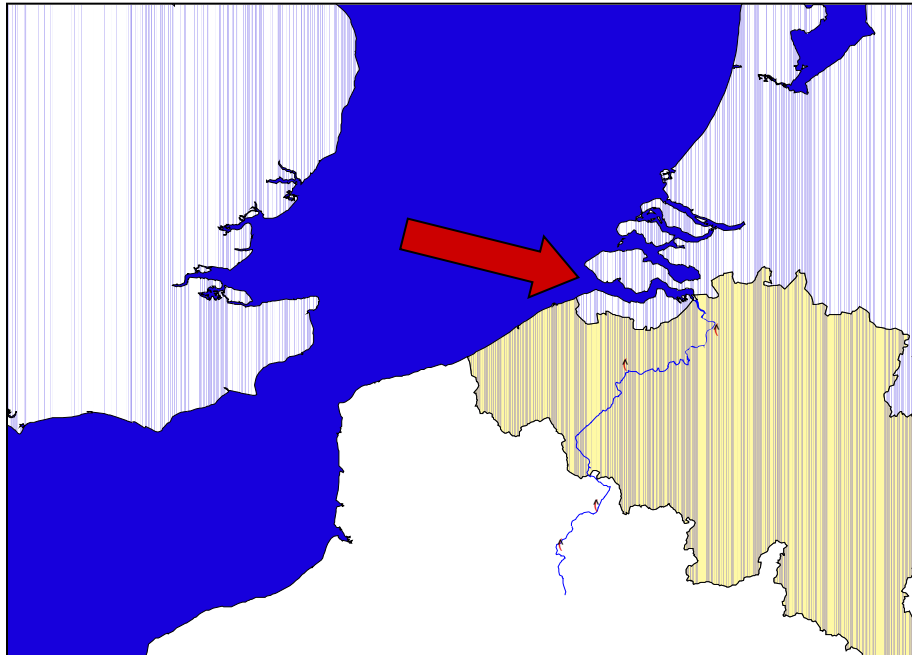
- ▶ discharge, length and basin surface
→ **relatively small**
- ▶ tidal volume and population density
→ **relatively large**

Scheldt tide

Spring tide
Average tide
Neap tide



Storm surge



Storm surge

Water level Antwerp

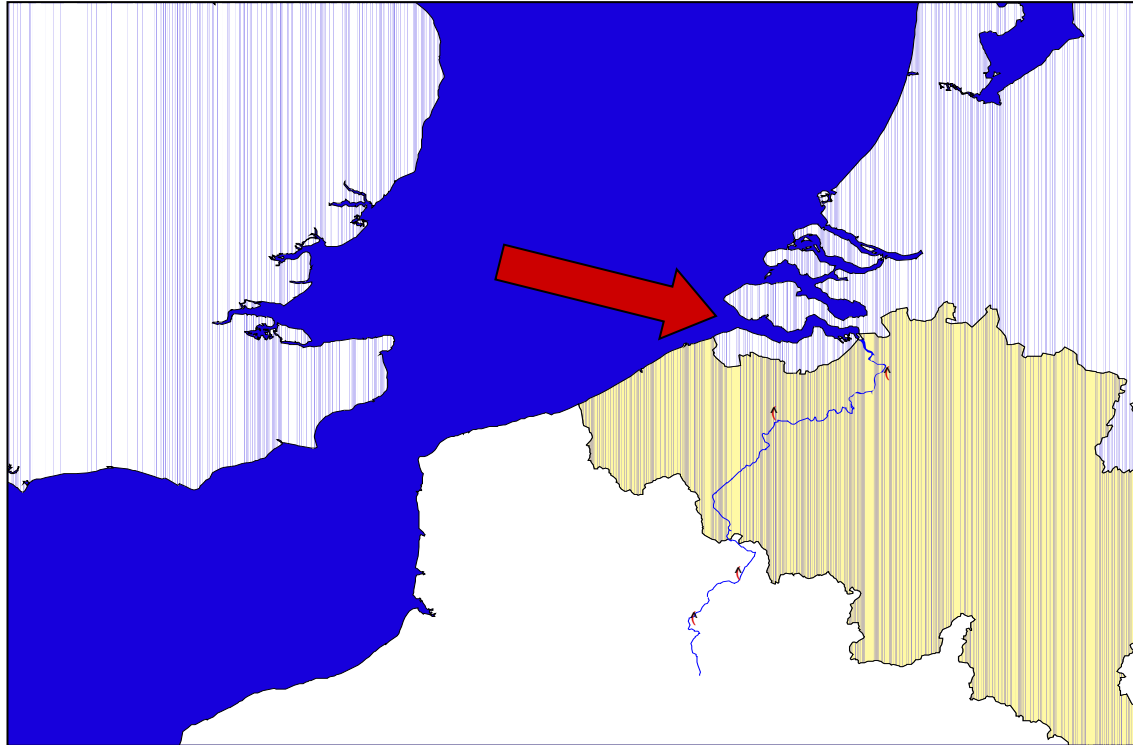
> 6,60 m TAW

Dangerous storm surge

Water level Antwerp

> 7,00 m TAW

Origin of the Sigmoplan



| Datum | Waterstand in TAW te Antwerpen | Opzet |
|-------------------|-----------------------------------|--------------|
| 12.03.1906 | 7,07m | / |
| 26.11.1928 | 7,07m | / |
| 23.11.1930 | 7,22m | 1,25m |
| 01.03.1949 | 7,00m | 1,93m |
| 01.02.1953 | 7,77m | 2,79m |
| 23.12.1954 | 7,03m | 2,23m |
| 14.12.1973 | 7,10m | 1,60m |
| 03.01.1976 | 7,31m | 1,38m |
| 15.11.1977 | 7,24m | 1,53m |
| 02.02.1983 | 7,07m | 1,60m |
| 24.11.1984 | 7,13m | 1,51m |
| 20.10.1986 | 7,20m | 1,62m |
| 27.02.1990 | 7,02m | 1,25m |
| 27.02.1990 | 7,52m | 1,49m |
| 28.02.1990 | 7,25m | 1,62m |
| 01.03.1990 | 7,14m | 1,61m |
| 11.11.1992 | 7,39m | 1,55m |
| 14.11.1993 | 7,53m | 1,47m |
| 15.11.1993 | 7,05m | 1,18m |
| 28.01.1994 | 7,35m | 1,80m |
| 02.01.1995 | 7,09m | 1,27m |
| 02.01.1995 | 7,04m | 1,22m |
| 29.08.1996 | 7,06m | 1,17m |



0. Sigmaplan 0.0 (1953)

February 1, 1953



February 1, 1953

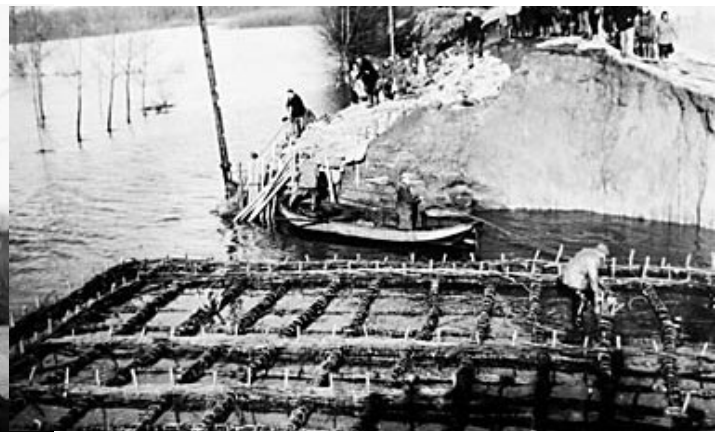
Baasrode (Dendermonde)

Antwerp



Notelaer Bornem

Wintam



1 february 1953

Death toll Belgium: 28

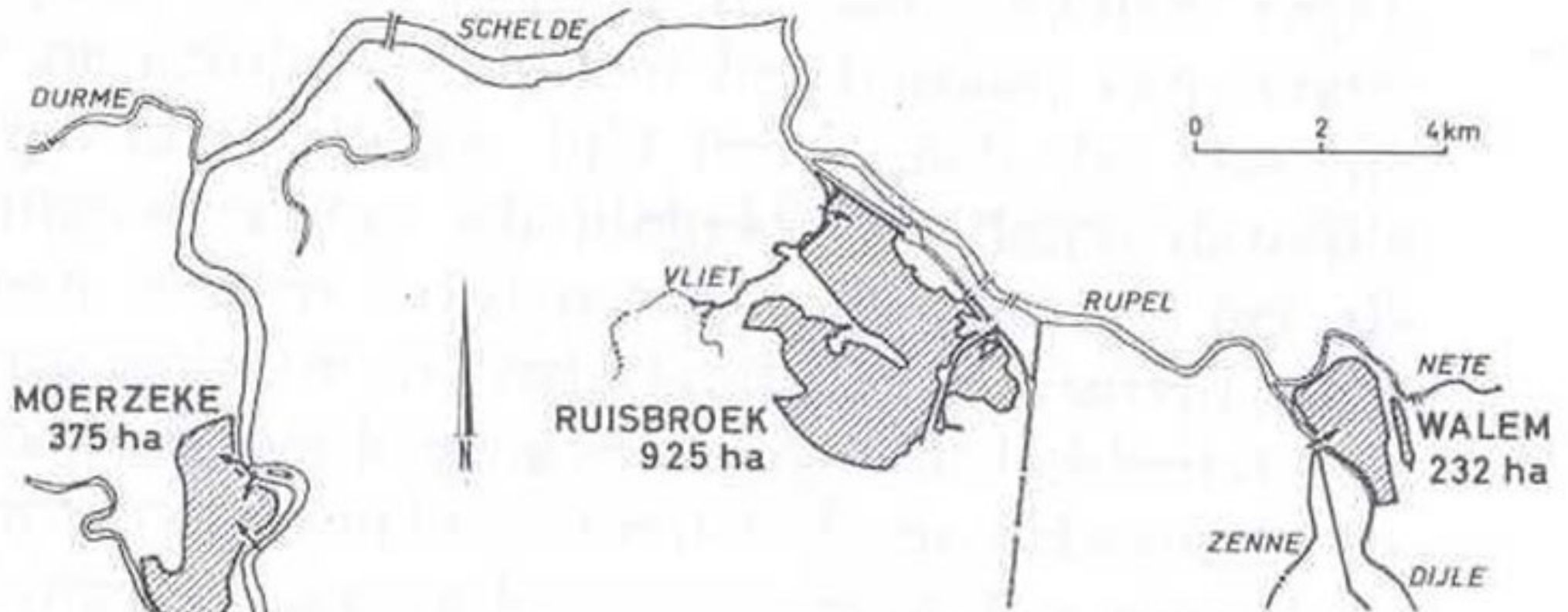
Death toll the Netherlands: 1836



Origin of the Deltaworks in the Netherlands



January 3, 1976



OVERSTROMINGEN
3 JANUARI 1976

January 3, 1976



Tussende woede te Ruisbroek
**Overstroomd gebied
wordt alsmat groter**
Staat geeft 50 miljoen voor eerste help
Futuristische uitbreiding aan gemeentebestuur

Ruisbroek hardst getroffen
Op zondag 4 januari stroomt
meer dan 800 ha grondgebied
water toe. Twee du
gemeente Ruisbroek de lig
het zwaar te verduren. Bijna
1000 woningen liggen onder
water.
Maar ook eiken stroomt de
Ruisbroek over de dijken.
De bewoners van de gebied
ten dorp en veld.
Politici krijgen verweten en
niet om te zien aan het hoofd
geplaatst. Er is dringend
nodig aan een streng ontwerp

**Koning Boudewijn bezoekt
verdrinken rampgebied**

**Meneer,
wat is
dit
voor een
land?**

De confrontatie van boze Ruisbroekenaars met Koning
Boudewijn is legendarisch. Op 6 januari 1976 verweten ze
onze vorst " dat er wel 30 miljard BEF is voor vliegtuigen
die boven onze kop razen, maar onvoldoende geld voor de
versterking van dijken."

HET LAATSTE NIEUWS BRABANT
Westenwind en springtij
zetten West-Europa blank
BIJNA ALS IN 1953
Terwijl ene
korps het

3 january 1976





Decision of the Council of Ministers on February 18, 1977

Three measures to improve flood protection

1. Raising and strengthening of 500 km of dikes
2. Construction of a chain of 13 flood reservoirs
3. Construction of a storm surge barrier downstream from Antwerp





2. Sigmaplan 2.0 (2005)

Update of the Sigmaplan at the end of the 20th century

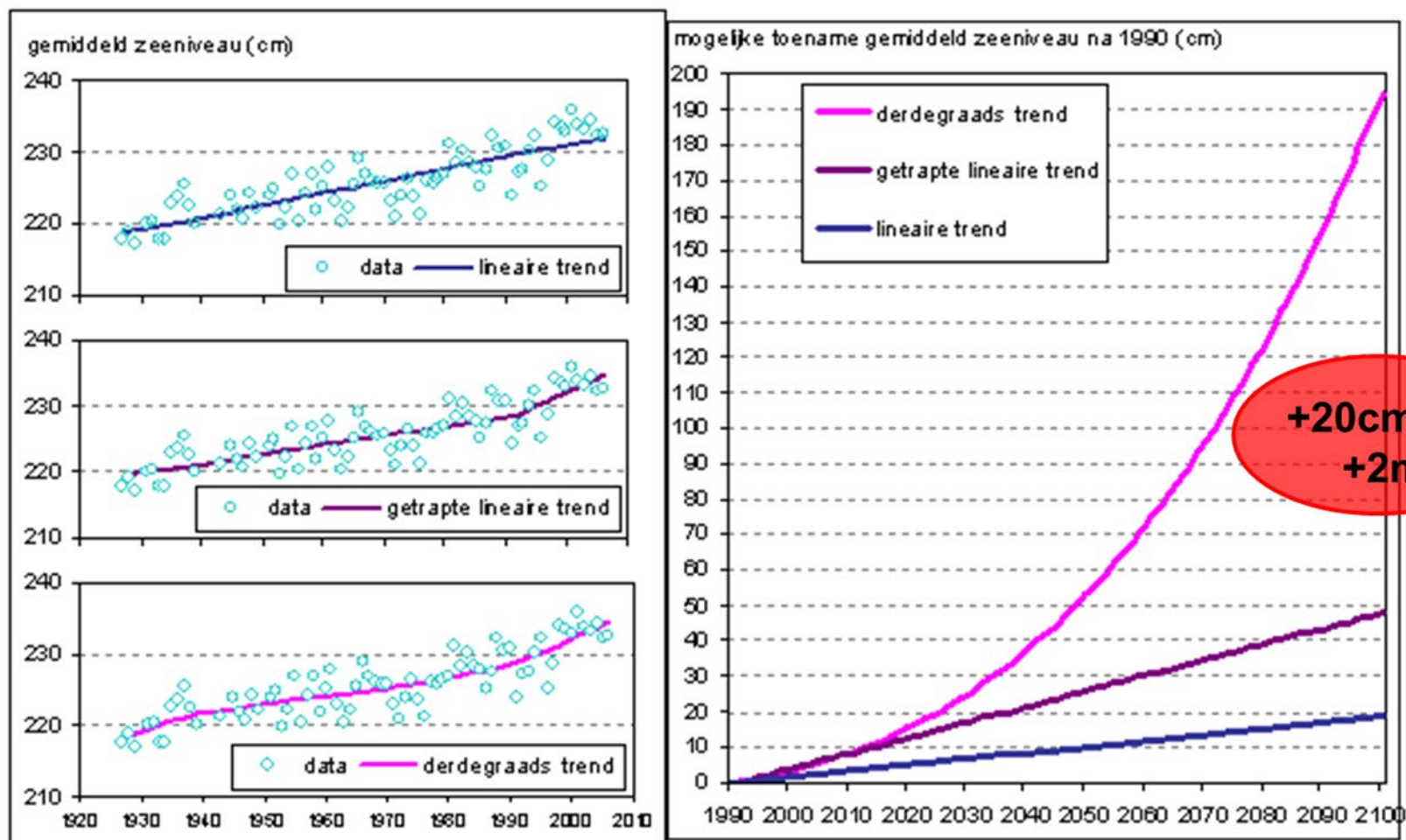
- Implementation of original Sigma plan not yet completed
- Climate change!
- New ideas on water management: create more space for rivers



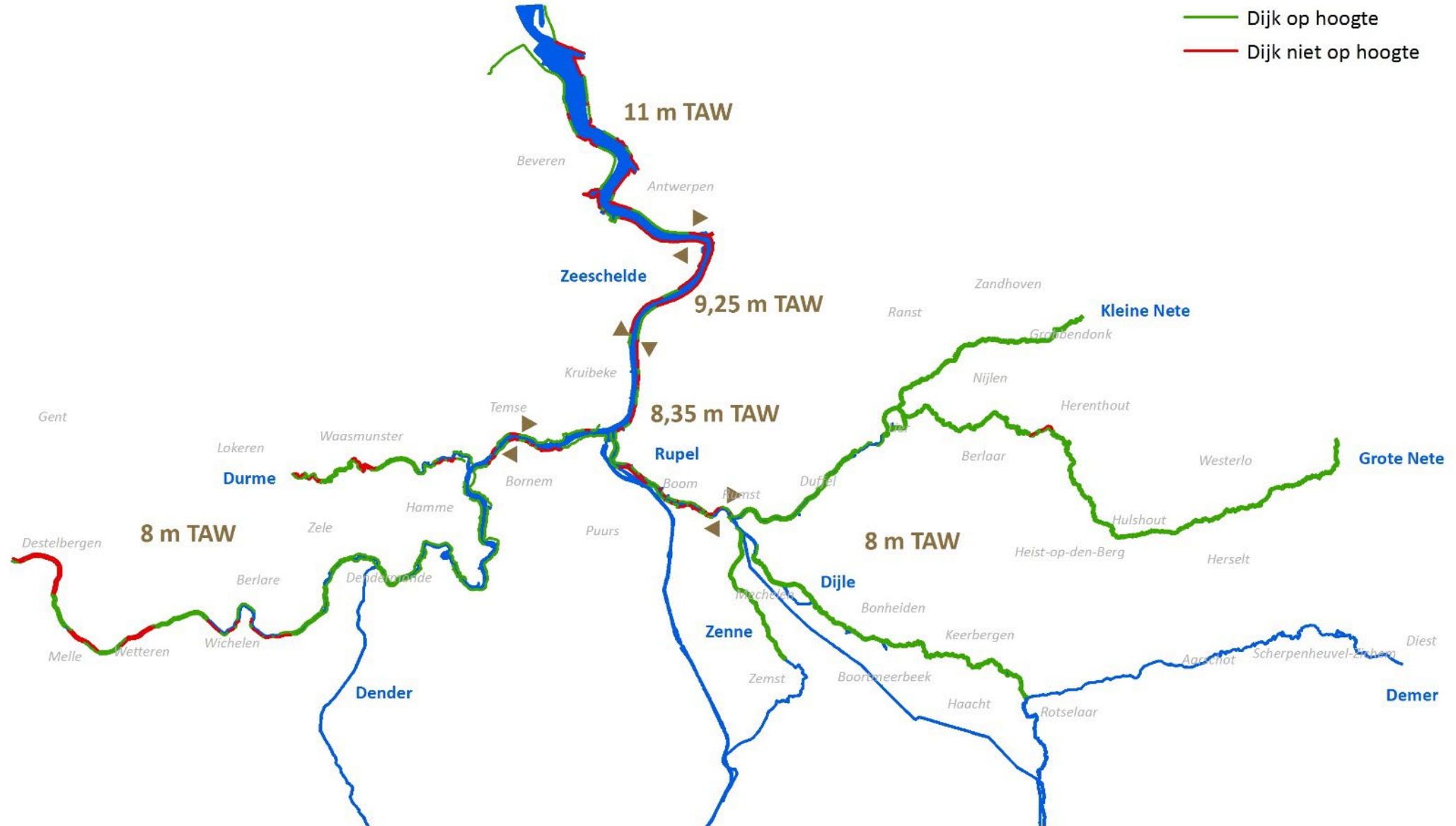
Approval by the Flemish Government on July 22, 2005



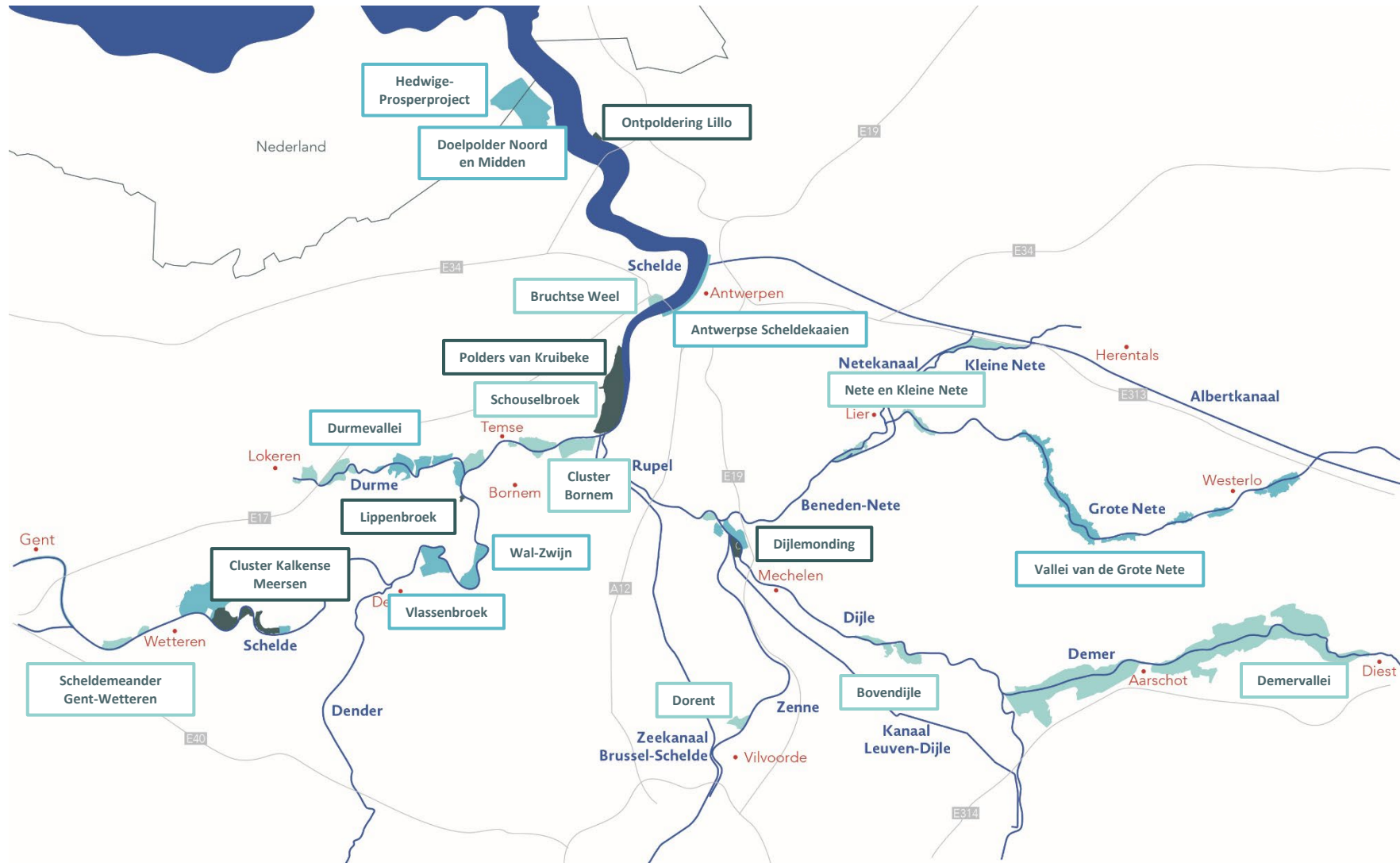
- Zeespiegelstijging



Updated crest heights for embankments



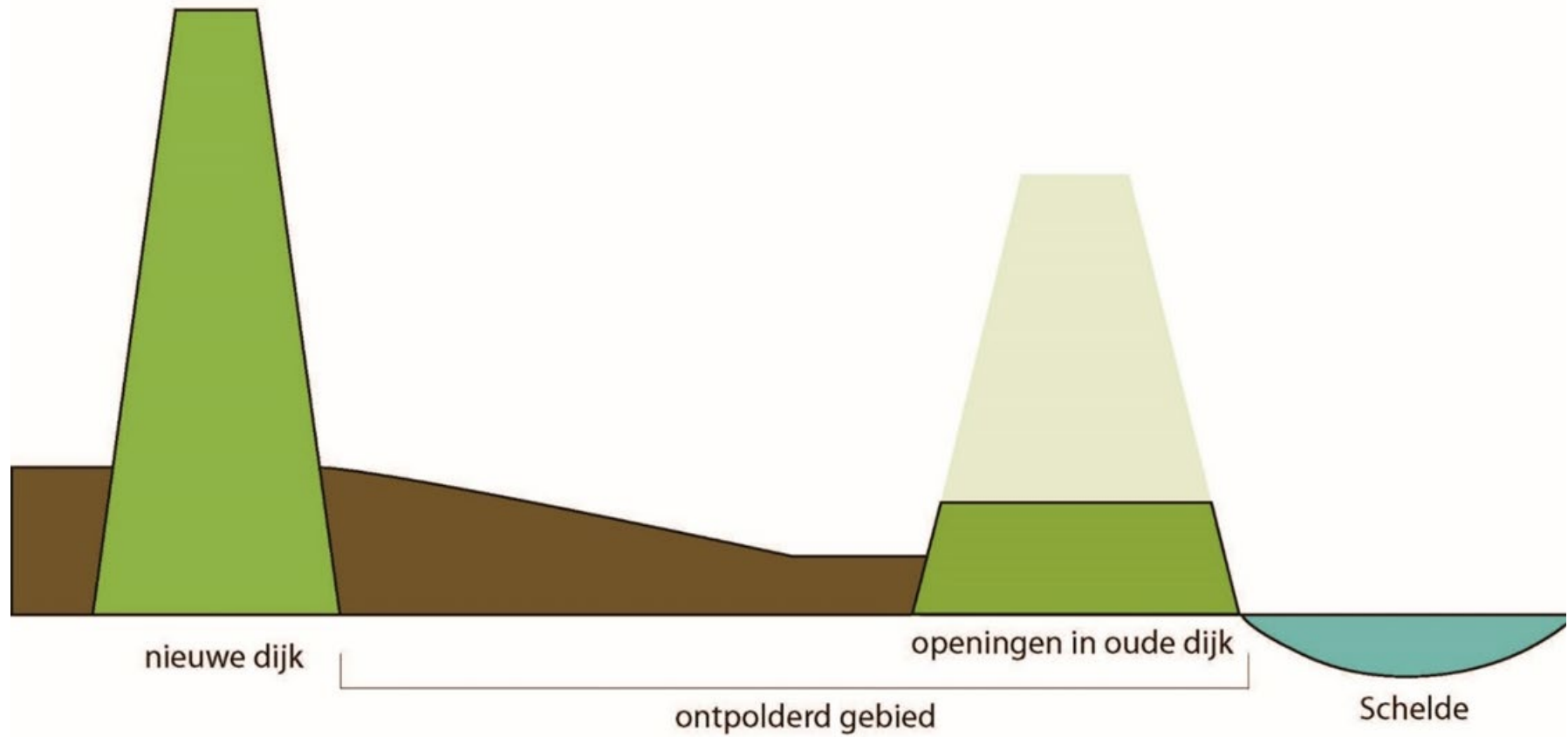
Creating more space for rivers





Creating flood protection areas
combined with wetlands, mud flats,
freshwater & saltwater marshes
645 km embankments
9.000 ha nature development
2.500 ha flood reservoirs

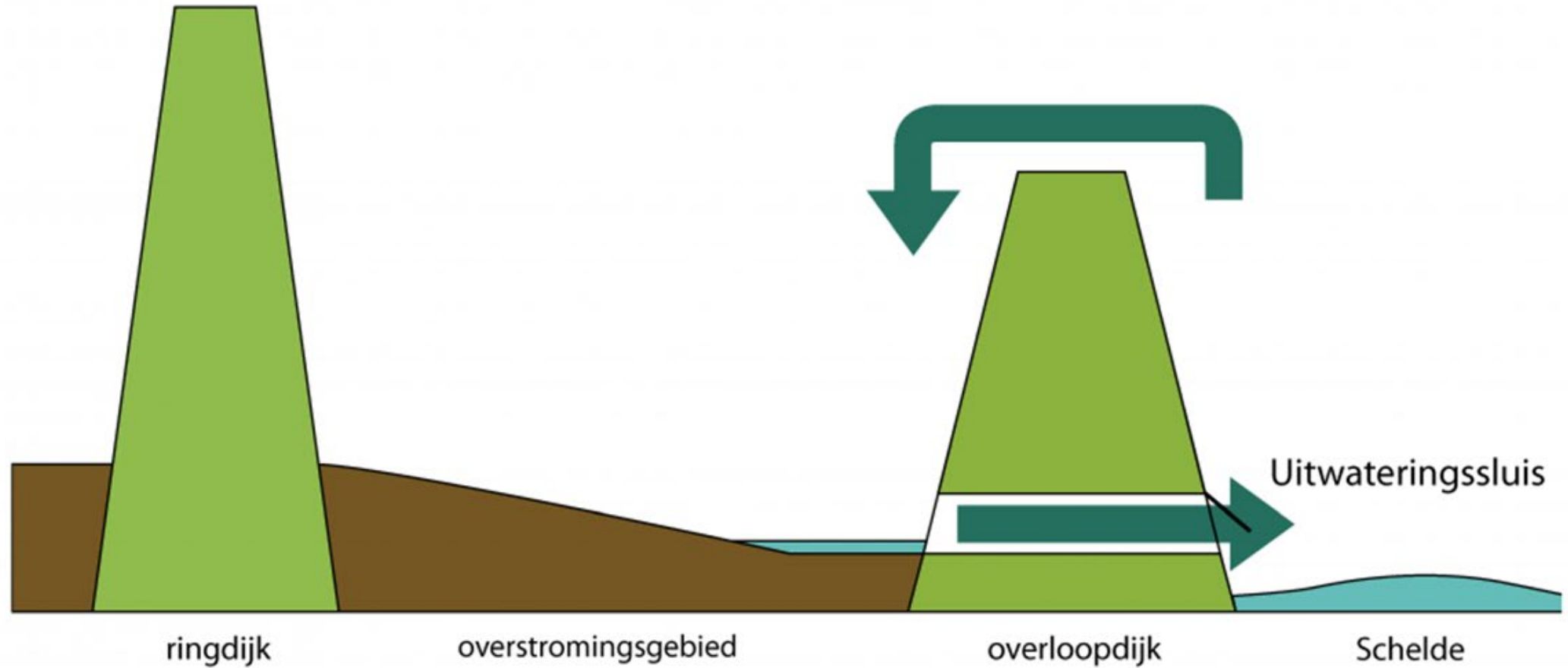
1. More space for rivers: depoldering





Depoldering Hedwige-Prosperpolder

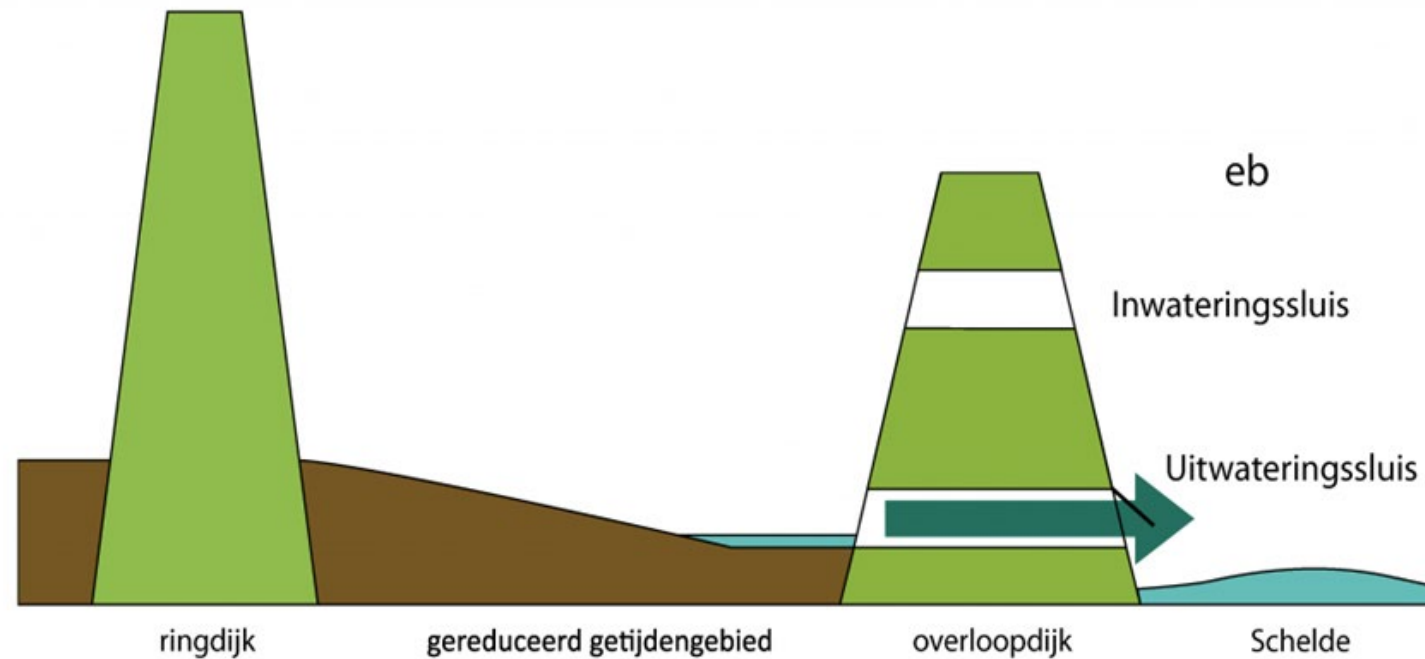
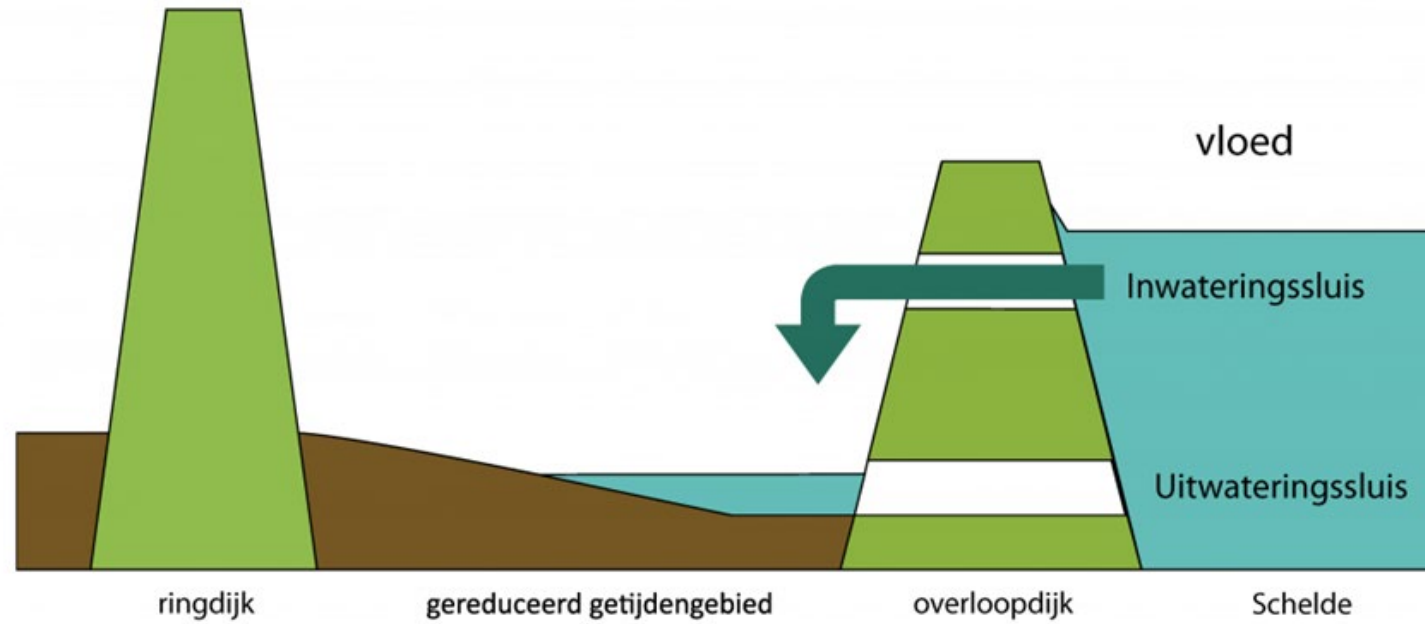
2. More space for rivers: flood control area





Kruibeke Polders

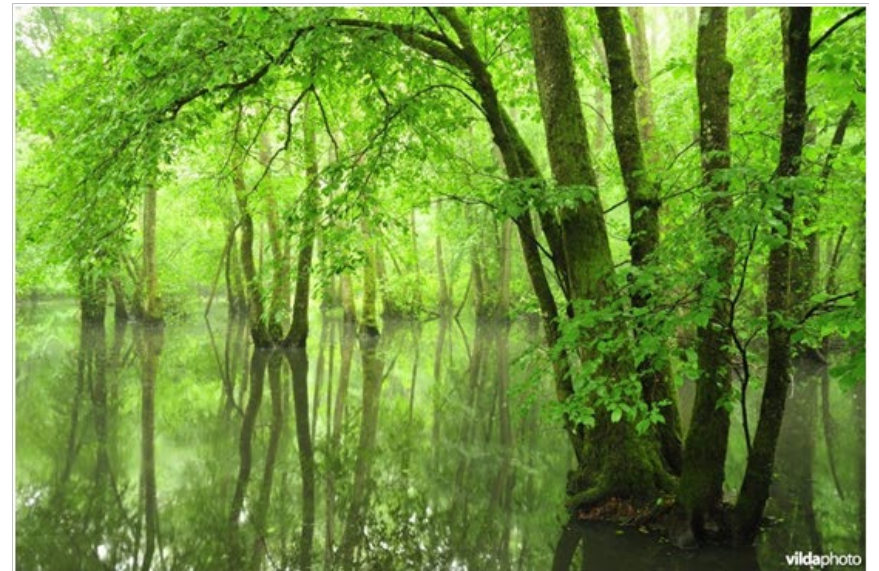
3. More space for rivers: flood control area with reduced tides





FCA CRT Bergenmeersen te Wichelen

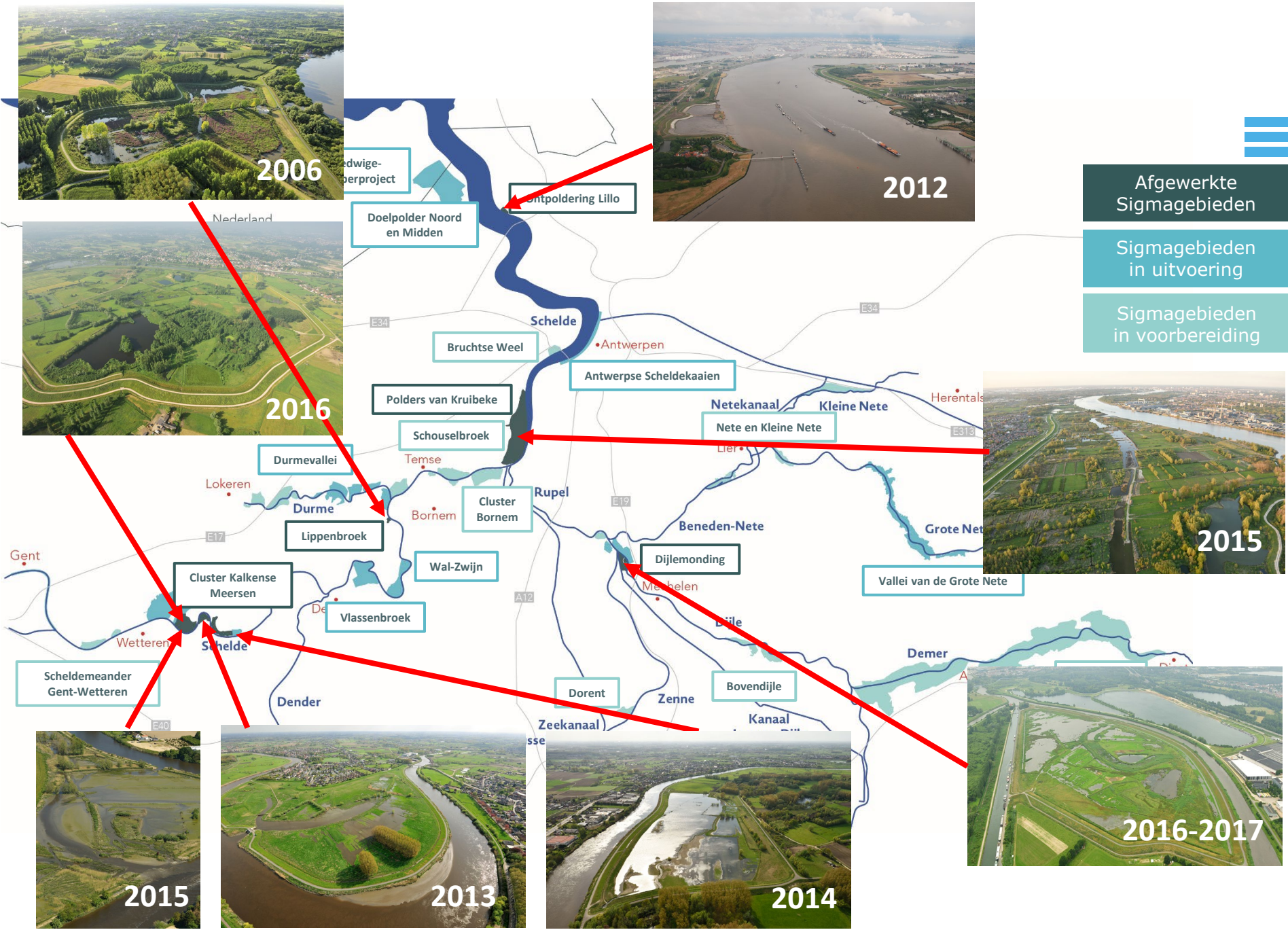
4. Slowing down upstream discharge: wetlands





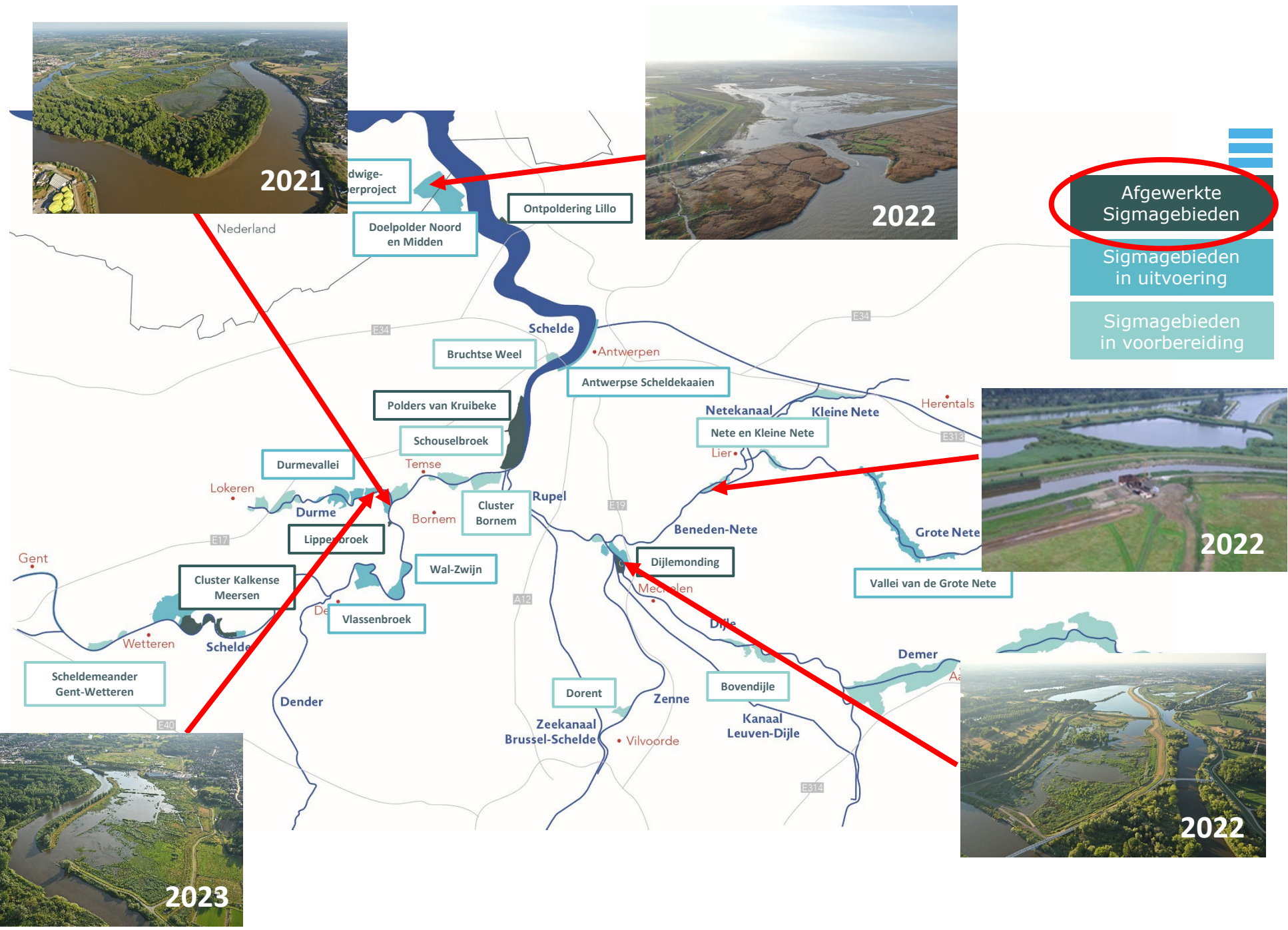
Kalkense Meersen Wetlands

Completed projects



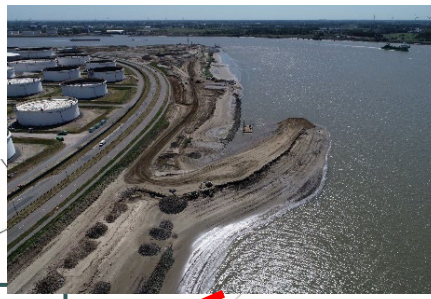
- Afgewerkte Sigmagebieden
- Sigmagebieden in uitvoering
- Sigmagebieden in voorbereiding

Completed projects



- Afgewerkte Sigmagebieden
- Sigmagebieden in uitvoering
- Sigmagebieden in voorbereiding

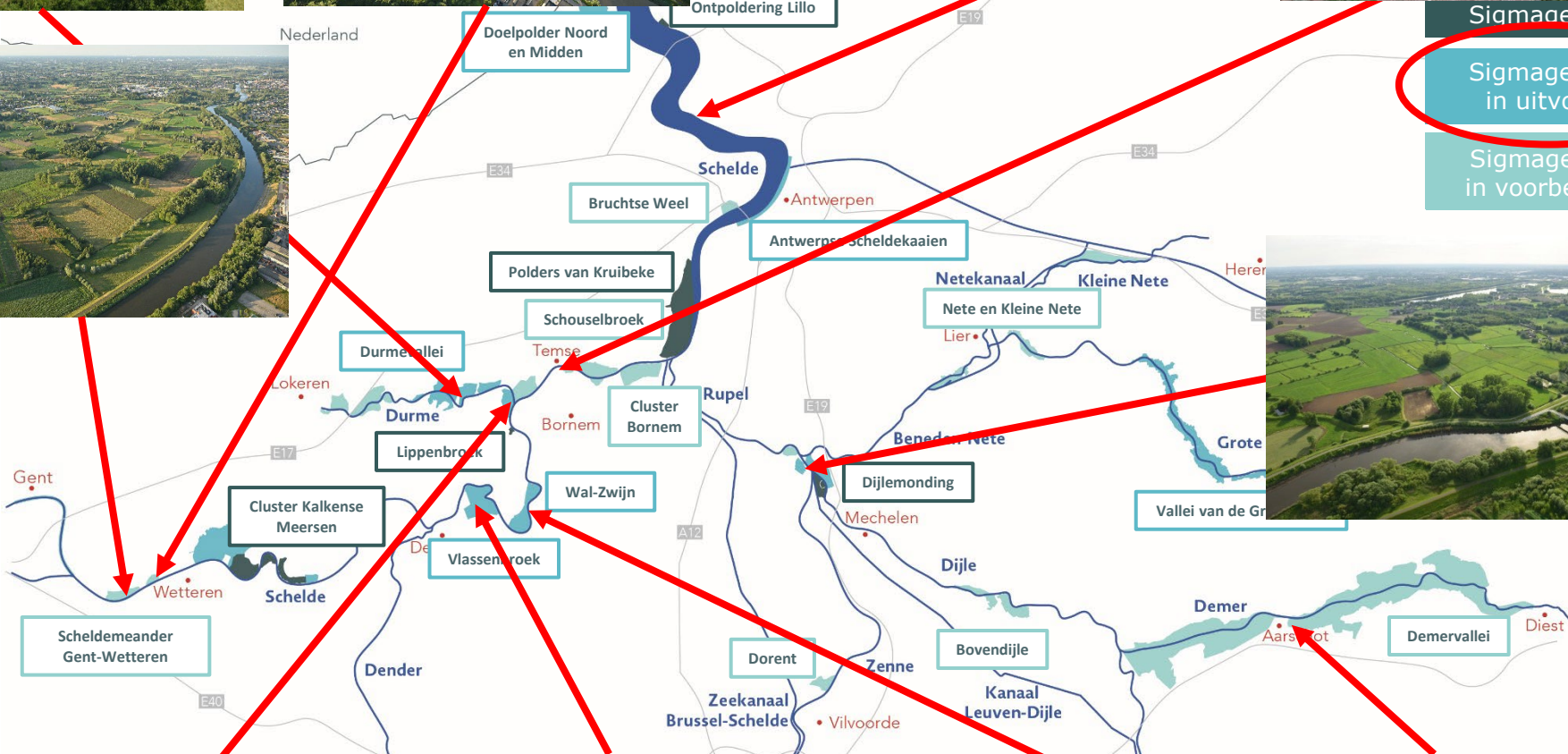
Under construction



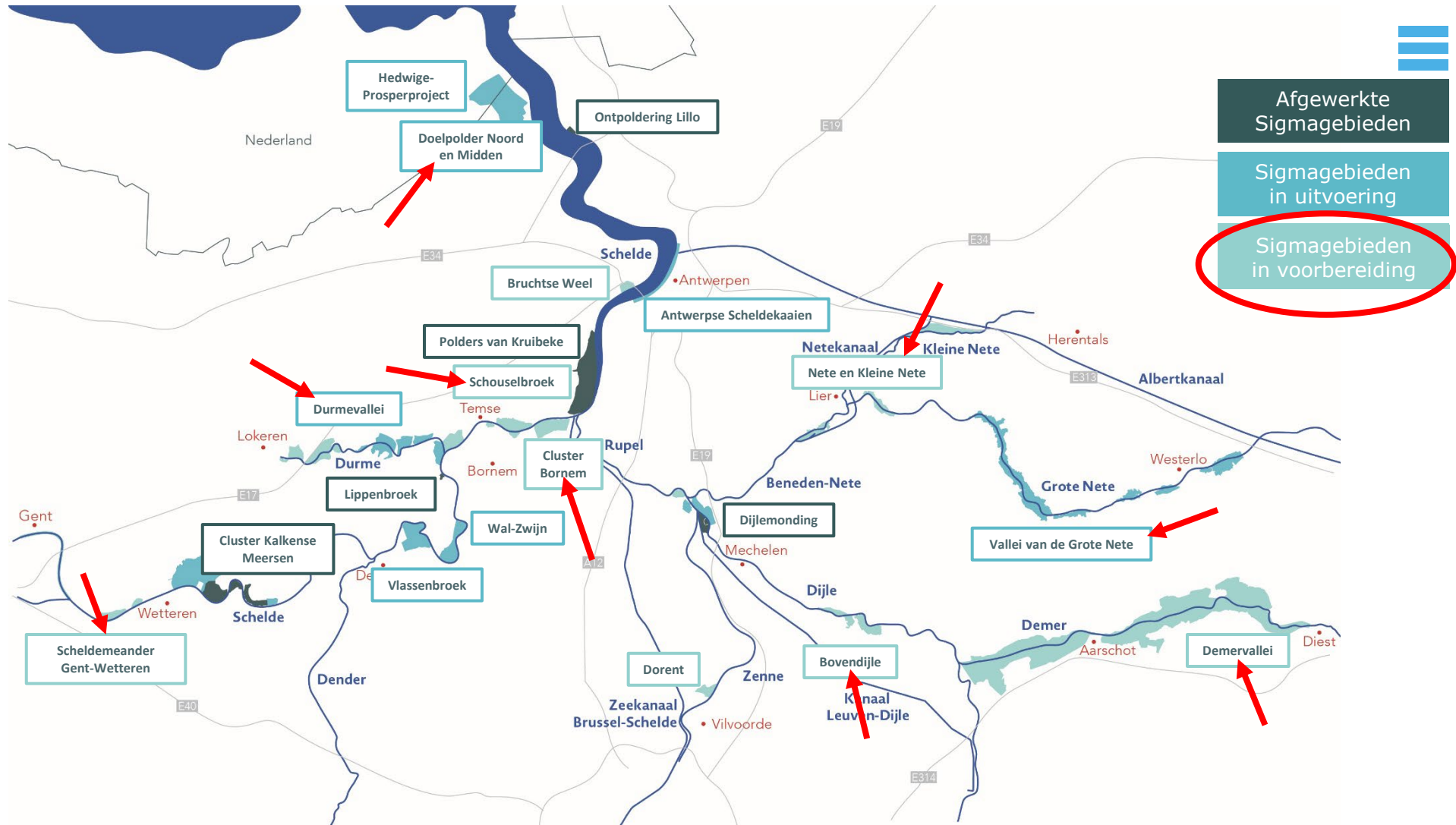
Sigma-gebieden

Sigma-gebieden in uitvoering

Sigma-gebieden in voorbereiding



To be



5. Strengthening flood defences



Masterplan Scheldt Quays Antwerp



| Datum | HW Antwerpen in mTAW | Datum | HW Antwerpen in mTAW | Datum | HW Antwerpen in mTAW | Datum | HW Antwerpen in mTAW | |
|------------------|----------------------|------------------|----------------------|------------------|----------------------|------------------|----------------------|-------------------|
| 19/01/1945 7:53 | 6.66 | 22/03/1981 17:45 | 6.60 | 21/02/1993 3:46 | 6.66 | 11/03/2005 16:22 | 6.66 | |
| 1/03/1949 16:00 | 7.00 | 11/03/1982 4:14 | 6.94 | 21/02/1993 16:00 | 6.77 | 12/03/2005 17:05 | 6.63 | |
| 1/02/1953 3:49 | 7.77 | 1953 | 16/12/1982 4:12 | 6.60 | 14/11/1993 15:43 | 7.53 | 18/03/2007 15:27 | 6.81 |
| 1/02/1953 16:36 | 6.63 | 31/01/1983 5:04 | 6.64 | 15/11/1993 3:56 | 7.05 | 9/11/2007 4:01 | 7.08 | |
| 23/12/1954 14:14 | 7.03 | 2/02/1983 6:43 | 7.07 | 28/01/1994 4:03 | 6.86 | 9/11/2007 15:26 | 6.63 | |
| 16/10/1958 17:07 | 6.60 | 26/03/1983 2:25 | 6.61 | 28/01/1994 16:17 | 7.37 | 25/11/2007 15:33 | 6.71 | |
| 12/01/1959 4:38 | 6.60 | 3/03/1984 4:45 | 6.81 | 30/01/1994 17:21 | 6.61 | 21/03/2008 15:48 | 6.99 | |
| 21/09/1960 3:12 | 6.66 | 24/11/1984 3:37 | 7.13 | 1/01/1995 15:22 | 6.82 | 10/02/2009 15:57 | 6.89 | |
| 21/03/1961 5:42 | 6.89 | 24/11/1984 16:06 | 6.60 | 2/01/1995 3:55 | 7.09 | 28/02/2010 16:33 | 6.68 | |
| 10/12/1965 16:34 | 6.91 | 15/01/1986 7:04 | 6.72 | 2/01/1995 16:11 | 7.04 | 6/12/2013 5:27 | 7.30 | Sinterklaas-storm |
| 16/11/1966 18:08 | 6.95 | 20/10/1986 16:47 | 7.20 | 3/03/1995 4:10 | 6.66 | 6/12/2013 17:52 | 6.79 | |
| 28/02/1967 18:40 | 6.77 | 19/12/1986 5:20 | 6.72 | 20/03/1995 17:50 | 6.69 | 22/10/2014 2:46 | 6.78 | |
| 11/07/1968 17:00 | 6.60 | 2/03/1987 17:45 | 6.79 | 28/09/1995 5:24 | 6.63 | 28/11/2015 5:01 | 6.76 | |
| 3/04/1973 3:28 | 6.76 | 22/01/1988 17:33 | 6.72 | 29/08/1996 3:53 | 6.99 | 15/01/2016 7:07 | 6.71 | |
| 13/11/1973 17:11 | 6.80 | 14/02/1989 9:39 | 6.69 | 29/08/1996 15:48 | 7.06 | 13/01/2017 3:33 | 6.72 | |
| 14/12/1973 6:29 | 6.76 | 26/02/1990 16:38 | 6.91 | 30/08/1996 4:11 | 6.70 | 14/01/2017 4:48 | 6.65 | Dieter |
| 14/12/1973 18:58 | 7.10 | 27/02/1990 4:26 | 7.02 | 29/10/1996 17:17 | 6.83 | 2/03/2017 5:38 | 6.61 | |
| 28/11/1974 14:08 | 6.90 | 27/02/1990 16:56 | 7.52 | 28/02/1998 16:39 | 6.86 | 3/01/2018 16:06 | 7.10 | Eleanor |
| 3/01/1976 16:57 | 7.31 | 1976 | 28/02/1990 5:09 | 7.25 | 17/02/1999 16:28 | 6.60 | 30/09/2019 3:58 | 6.66 |
| 20/01/1976 17:26 | 6.73 | 28/02/1990 17:28 | 6.85 | 27/04/2002 3:11 | 6.62 | 10/02/2020 15:56 | 6.87 | |
| 21/01/1976 6:07 | 6.80 | 1/03/1990 5:36 | 7.14 | 7/11/2002 4:43 | 6.68 | 11/02/2020 4:27 | 6.69 | |
| 13/11/1977 4:18 | 6.78 | 2/03/1990 6:55 | 6.61 | 21/12/2003 13:56 | 6.64 | 11/02/2020 17:03 | 6.83 | Ciara |
| 13/11/1977 16:39 | 6.68 | 24/12/1991 5:07 | 6.60 | 8/02/2004 17:19 | 7.05 | 12/03/2020 17:17 | 6.74 | |
| 15/11/1977 5:35 | 7.24 | 11/11/1992 15:26 | 7.39 | 13/11/2004 3:32 | 6.63 | 7/11/2021 16:55 | 6.62 | |
| 15/11/1977 18:10 | 6.60 | 26/11/1992 4:20 | 6.99 | 12/02/2005 17:51 | 6.72 | 5/01/2022 17:20 | 6.72 | |
| 2/01/1979 17:57 | 6.94 | 11/01/1993 17:07 | 6.78 | 13/02/2005 6:24 | 6.86 | 31/01/2022 15:01 | 6.93 | Corrie |
| 6/11/1979 16:45 | 6.66 | 25/01/1993 5:05 | 6.72 | 13/02/2005 18:50 | 6.61 | 21/02/2022 6:53 | 6.91 | |
| 20/04/1980 7:25 | 6.67 | 25/01/1993 17:25 | 6.89 | | | | | |



Sigmaplan 3.0

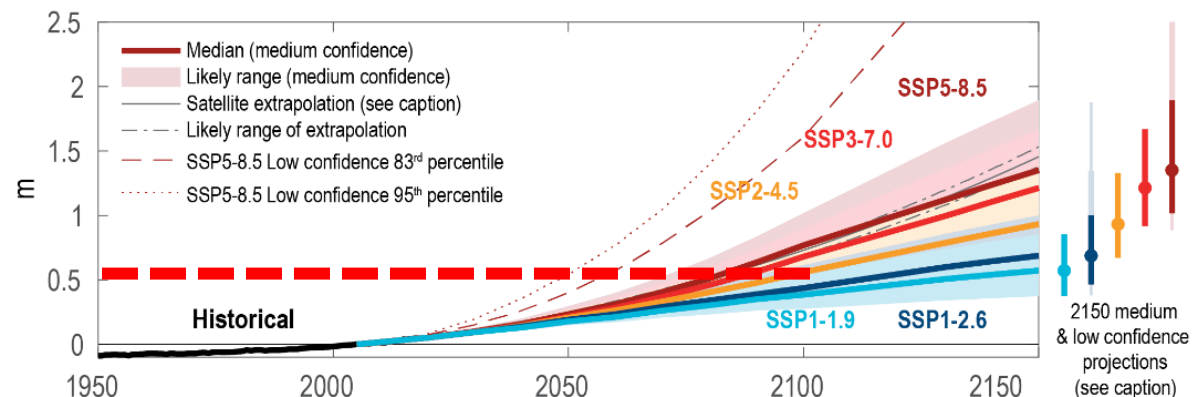
Launch of Sigmaplan 3.0

- IPCC AR6 sea level rise projections < > Sigmaplan assumptions
 - Preparations to implement reserve areas of the actual Sigmaplan
- Recommendations of the Expert Panel on Flood Protection
 - Aiming for a more comprehensive climate plan: drought, low groundwater levels, intense rainfall,...

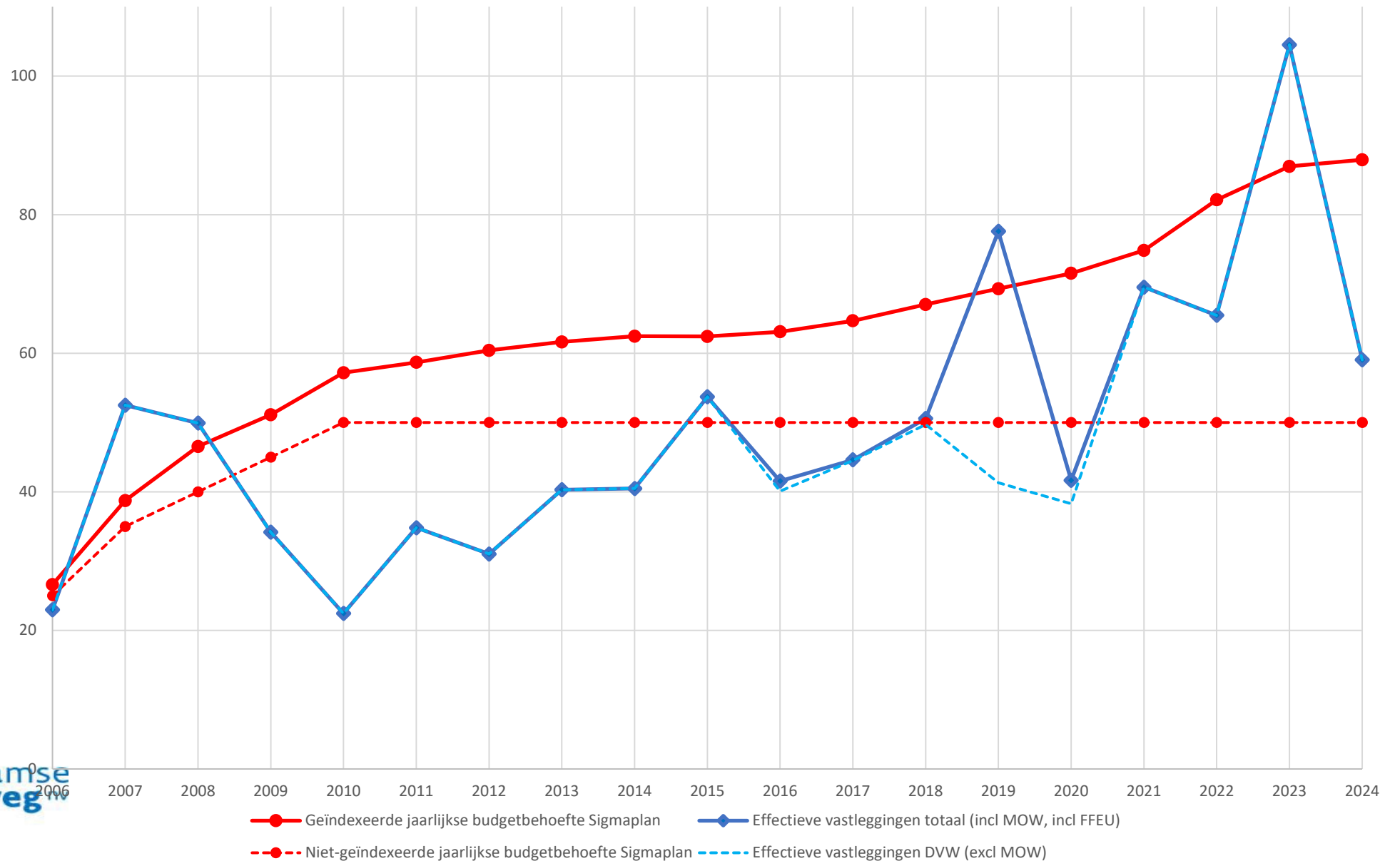
Climate change is changing assumptions

- IPCC 6th Assessment Report (2023)
 - Different climate scenarios based on warming: low (2°C) – medium (3°C) – high (4°C)
 - Sea level rise in 2100:
 - Low: 0,3-0,6m
 - Medium: 0,4-0,8m
 - High: 0,6-1m

Projected global mean sea level rise under different SSP scenarios



Budgetary constraints



Other challenges

- Space is scarce in densely populated Flanders
- Changes in (environmental) legislation: objections, revocation of permits
- Increase in project complexity
- Management of existing flood protection areas: beavers, insects, invasive species, balance between nature and recreation,

“The river ahead”

- Sigmoidplan has a proven track record: hydraulic engineering and improving ecology go hand in hand
- Continued effort to implement the Sigmoidplan
 - phased, "step by step", in accordance with budgets and procedures
 - optimization and acceleration when possible
- Increase awareness among decision makers and population
- Continued and improved monitoring
- Collaboration across different institutions and internationally

Participative approach to new projects



More information?

www.sigmoplan.be

