

# STORM SURGE BARRIERS

## *in the Netherlands & I-STORM*

Historical perspective, lessons learned and personal experiences

Marc Walraven  
Venice 1<sup>st</sup> of June 2023



Venice, November 1966



New Orleans, after Katrina in 2005



London, 1953



Netherlands, 1953





# History of the Netherlands

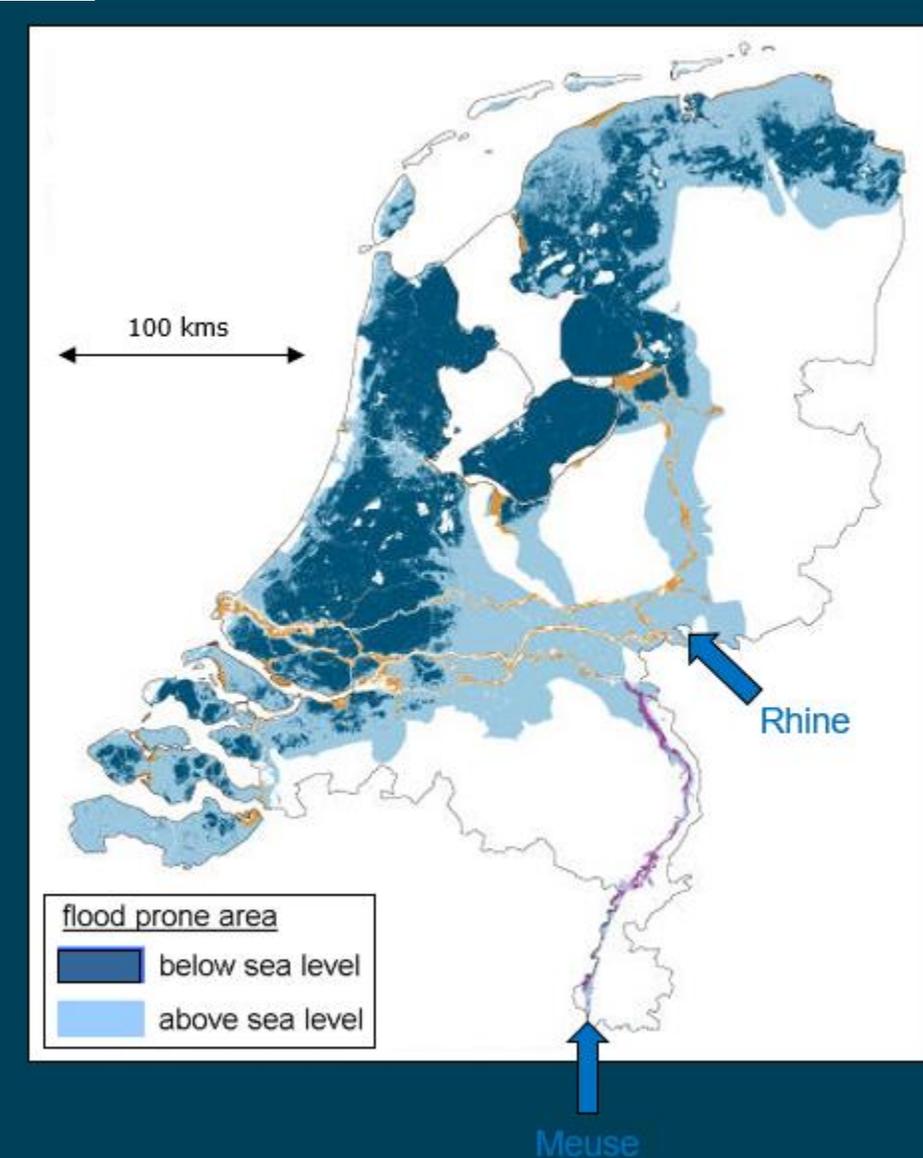
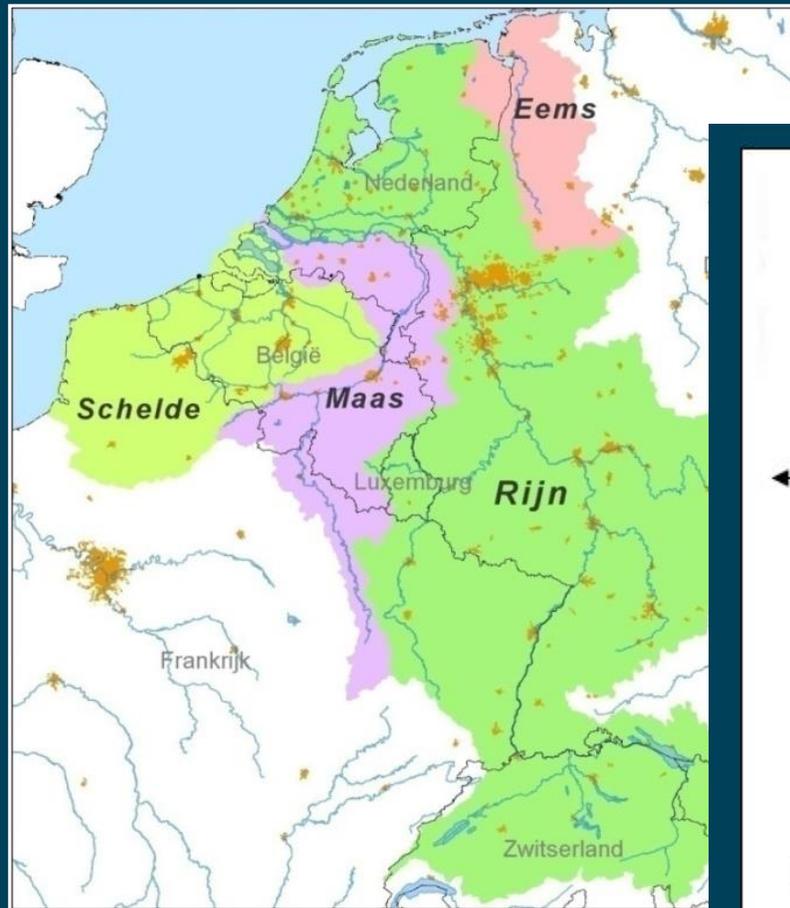


- Swamps, regular flooding, houses and farms on mounds
- Fertile and productive ground due to sedimentation, accessible for ships
- Regular flooding : 25 major floods between 1500 and 1953!



# The Netherlands at present

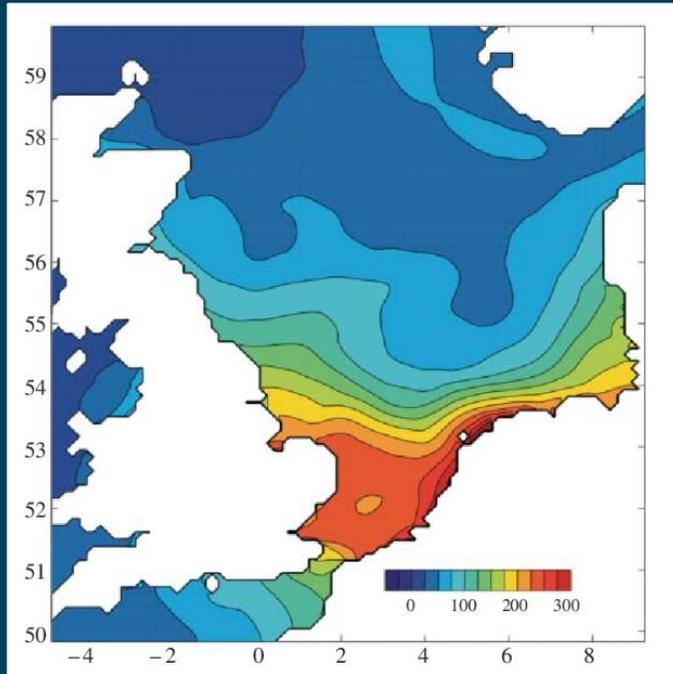
- 17 million inhabitants
- Flat country with deep polders
- 45% of Dutch borders is coastal
- Coastal Delta of Northwest Europe with European rivers discharge in the North Sea
- 55-60% of the country is in floodplain
- Subsidence is very serious and increasing challenge



## *Last 100 years of serious Floods in the Netherlands*

1916	- North	(Northsea)
1953	- South West	(Northsea)
1993/1995	- Center	(River)
2021	- South East	(Rainfall)

# 1953 flood – Start of the Delta Works



- 1836 inhabitants died
- Ten thousands of cattle drowned
- 100.000 inhabitants lost their houses
- Political statement **'this never again'**
- Start of Delta Commission – **Delta Works**





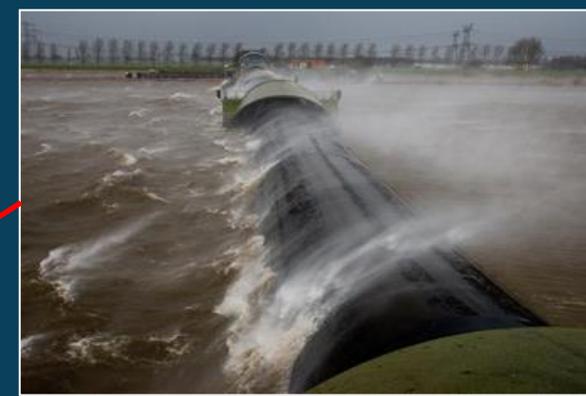
Maeslant Barrier - 1997



Haringvliet Sluices / Barrier - 1971



Eastern Scheldt Barrier - 1986



Ramspol Barrier - 2002



Hollandse IJssel Barrier - 1958



Hartel Barrier - 1997

# 1993/95 floods

## 1993/1995 river flooding (Center)

- Evacuation of 200.000 people
- Start of spatial solutions (Room for the river / Meuse Projects)



# 1993/95 floods – Catalyst for ‘Room for the River’-concept





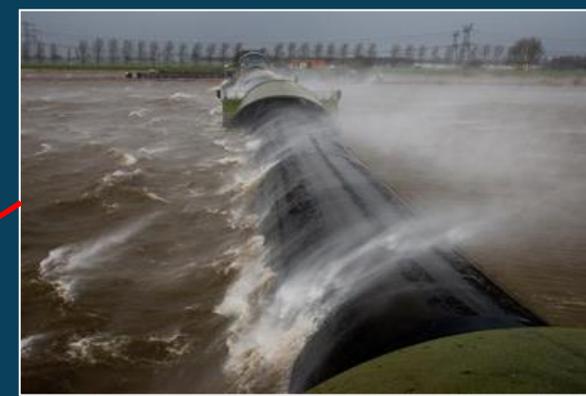
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# Hollandse IJssel Barrier - 1958

Lowest point of the Netherlands: -6,74m / -22 ft



- 1<sup>st</sup> of Delta Works
- 2 vertical lift gates
- 1 sluice
- 80m / 250ft width





# Eastern Scheldt Barrier - 1986



- 62 gates
- 42m / 138ft width per gate
- 6-12m/ 20-40ft height per gate
- 1 sluice
- 2 artificial islands
- Total stretch 9km/5.6mi





750 m / 2460 ft

750 m / 2460 ft

1500 m / 4920 ft

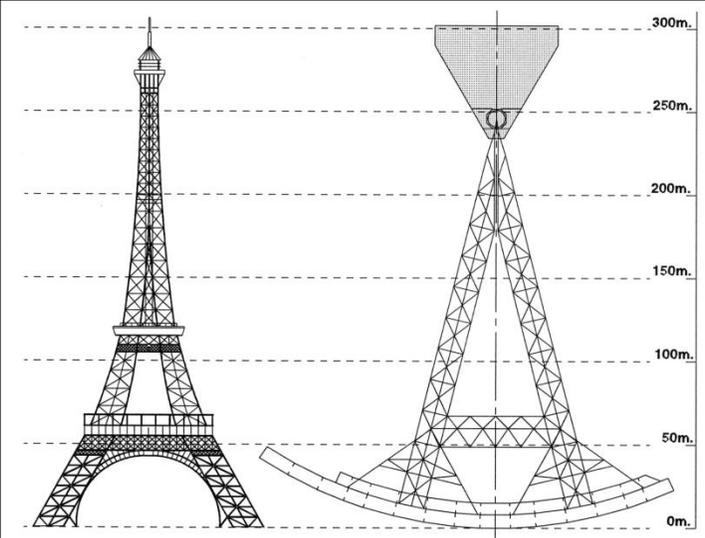
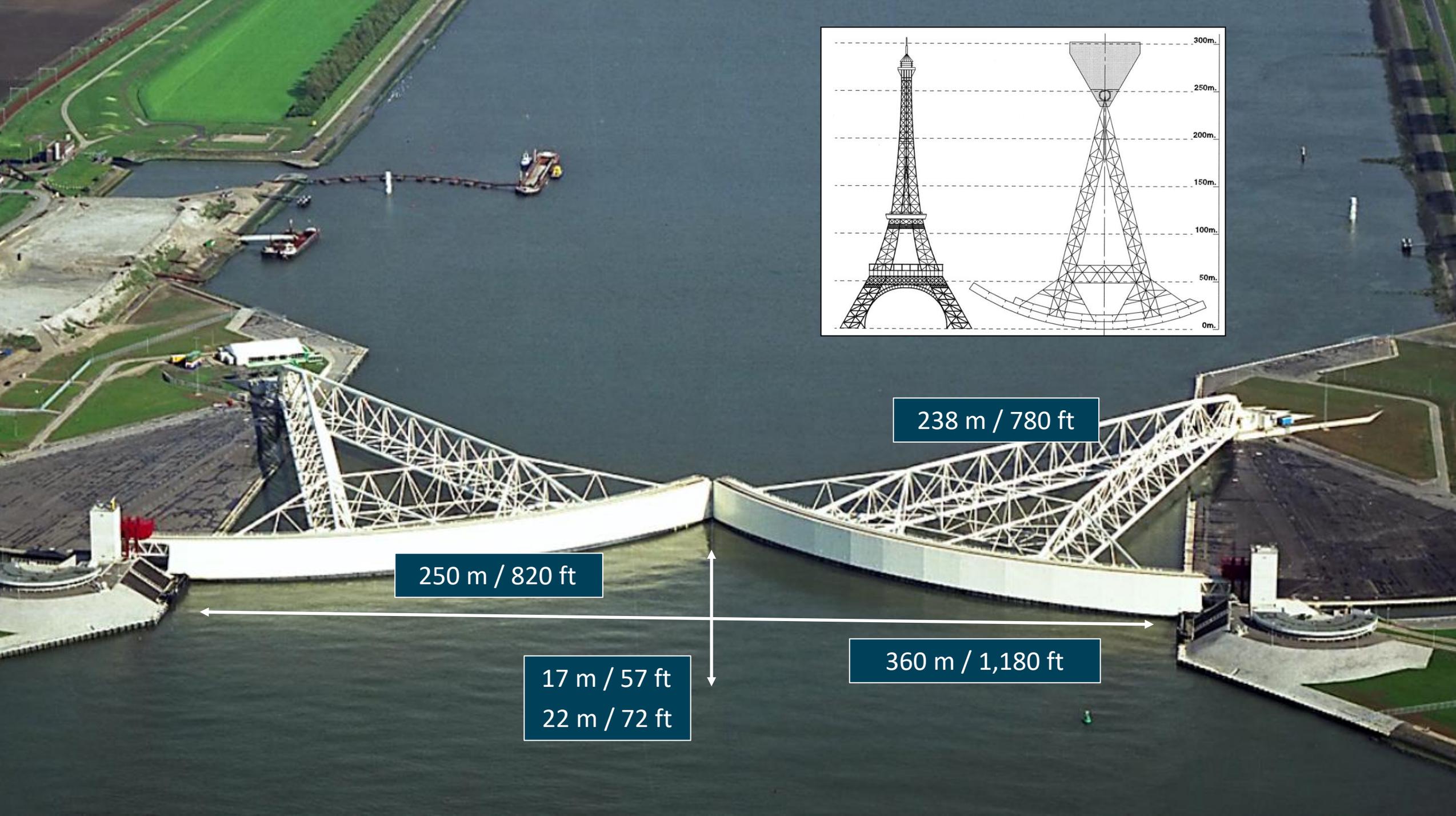


# Maeslant Barrier - 1997



- 2 horizontal floating gates
- No sluice
- 360m / 1180ft width
- 22m / 72ft height





238 m / 780 ft

250 m / 820 ft

17 m / 57 ft  
22 m / 72 ft

360 m / 1,180 ft



But after construction . . . . the challenge begins with

**Management, Maintenance & Operations  
as a daily business**

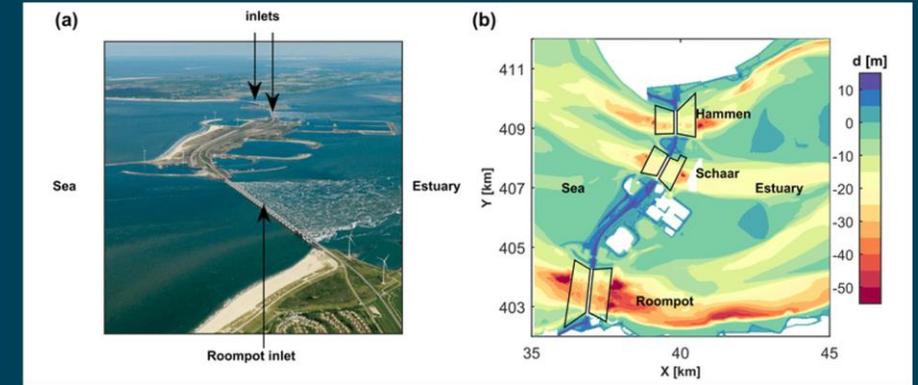
**for another 100-200 years**



### Example 1: Ball Joint



### Example 2: Scour Holes



- Early 2012 scour holes were 'discovered'
- Repair time with rock armour from 2012 – 2015
- Unforeseen in maintenance planning and very expensive



### Example 3: Butterfly valve pipeline

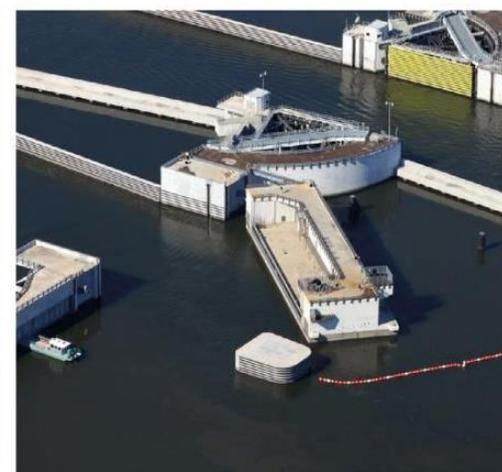
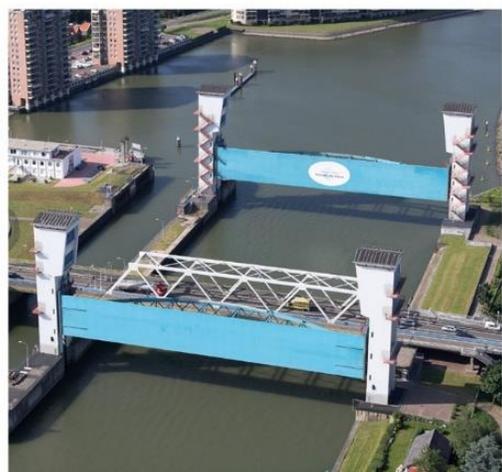
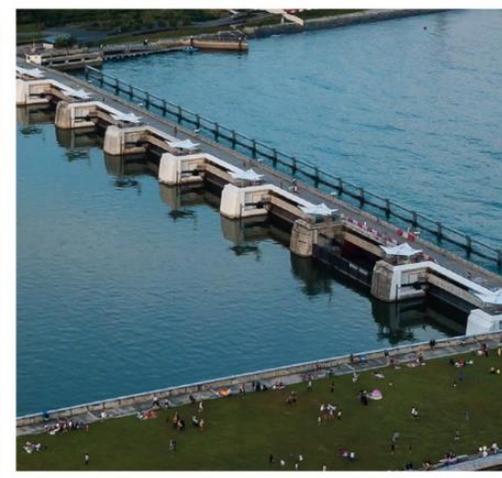
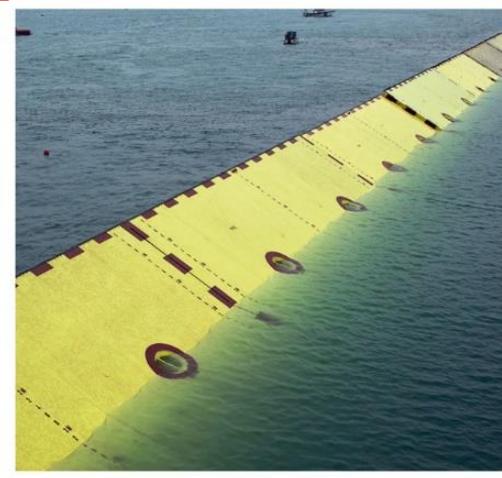
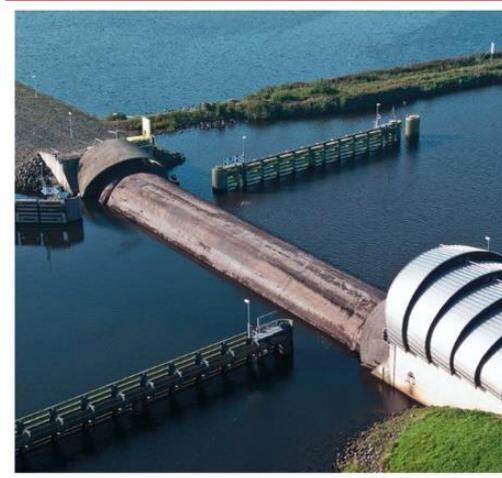


- During 'after storm season inspections' one butterfly valve pipeline was found to have almost failed because of corrosion
- Other pipelines could only be inspected by removing it's sleeve
- Removing a sleeve meant replacement of full pipeline
- Unplanned replacement was needed within 3 months for 3 km of pipeline serving 60 valves



### Example 4: Software issues

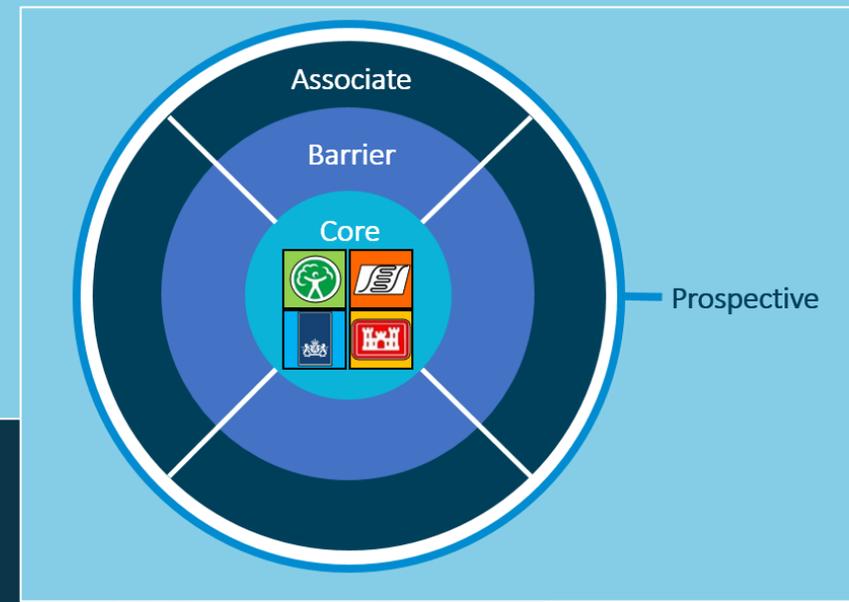




# *Introduction to I-STORM*



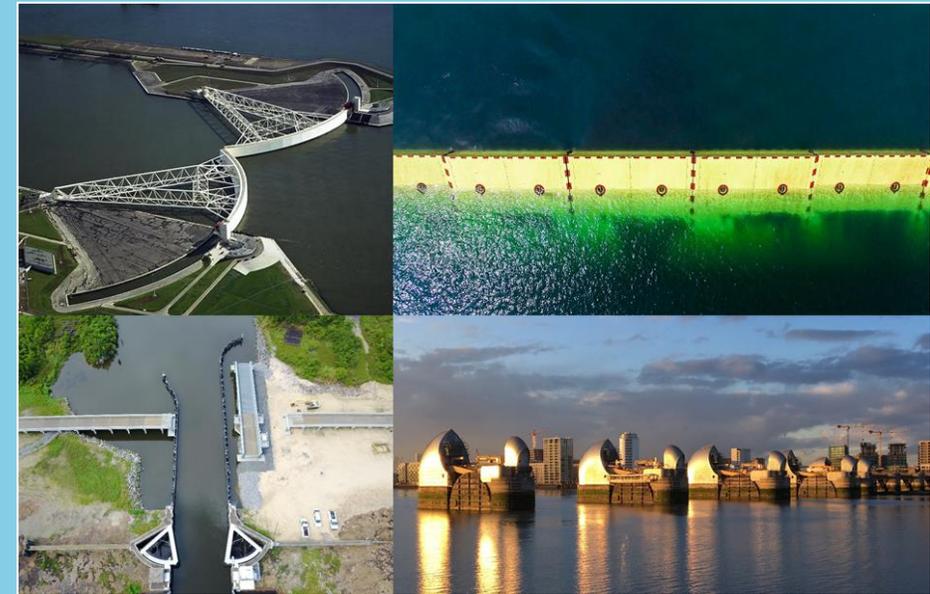
# Introduction to I-STORM



# *Introduction to I-STORM*

## **An international knowledge sharing network**

- For Storm Surge Barrier (SSB) professionals around the world
- To better protect people, places and property from flooding
- Sharing knowledge and experience to improve management, maintenance and operation of SSBs
- To integrate lessons learned into new design
- Established in 2006



# Our philosophy

We're not about right or wrongs

Different countries have different history  
and policies

which logically leads to different priorities  
and solutions

whether an existing operation or just in  
design

everyone has something to contribute

Members of I-STORM share knowledge  
and experiences

to learn from each other

# La Nostra Filosofia

Per noi non esiste giusto o sbagliato

Paesi diversi hanno passati diversi e  
prendono decisioni politiche diverse

Logicamente ciò porta ad avere  
differenti priorità e soluzioni

Sia quando un'organizzazione è attivamente  
impegnata che quando è in fase progettuale

Ognuno può dare il suo contributo

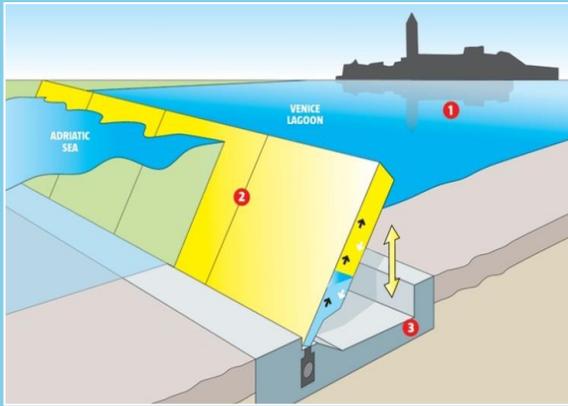
I membri di I-STORM condividono le proprie  
conoscenze ed esperienze per poter

imparare gli uni dagli altri



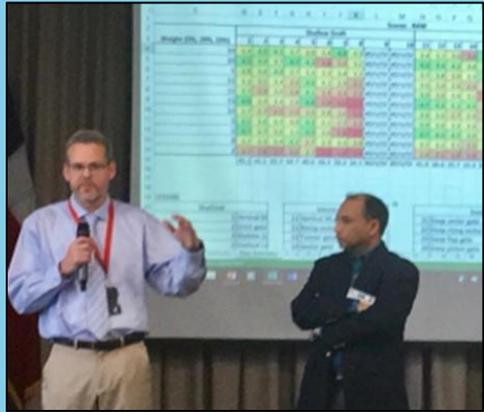
# Operational Review

## MOSE Barrier, Venice Italy 2019



# Gate Design Workshops

- Galveston, US (2019)
- Philadelphia, US (2022)
- London, Thames Barrier II, UK (September 2023)



# Annual Meetings Rotterdam June 2022



**I-STORM**  
ANNUAL MEETING

Rotterdam  
07-10 June 2022



## Some personal experiences to take away:

- Storm Surge Barriers are complex, one-of-a-kind structures
- After construction one has to 'discover' how to best maintain and operate
- Special attention is needed to secure the original design knowledge and understanding the choices that have been made within the design
- To achieve high standards of reliability: professional and committed staff is crucial



## **An introductory movie**

to address the relationship between  
committed staff and the barriers

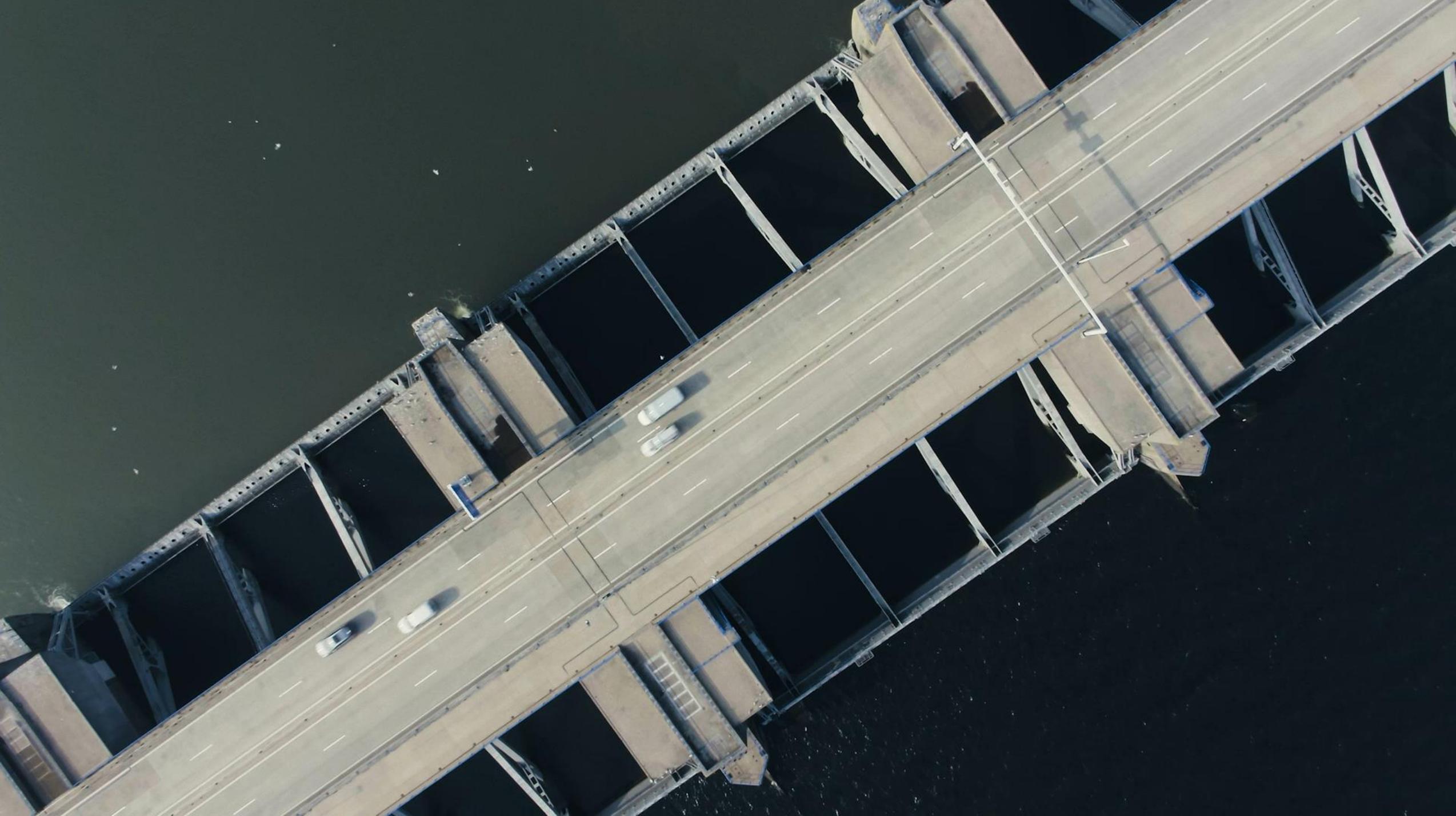
(sulle spalle dei giganti)





OP DE  
**SCHOULDERS**  
VAN  
**REUZEN**

Sulle spalle dei giganti



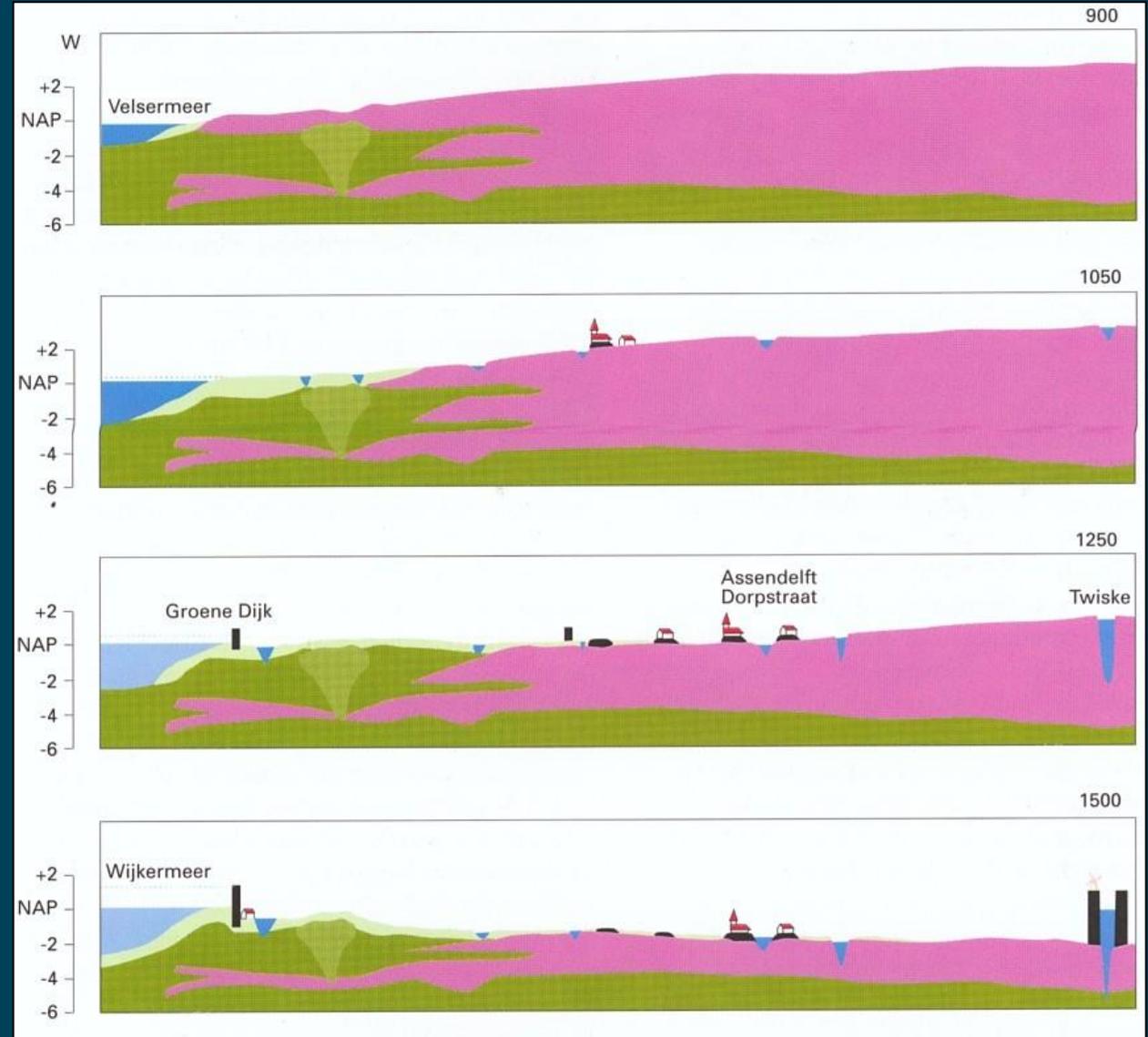
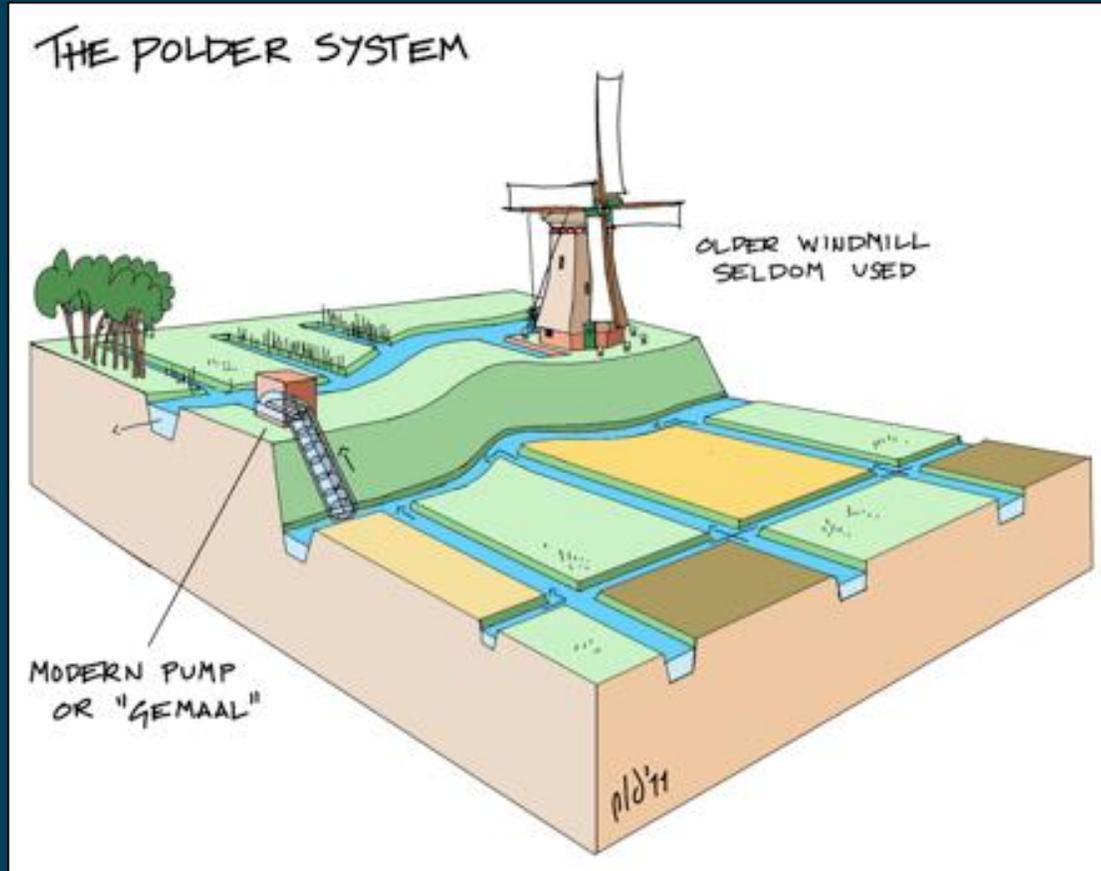
# THANK YOU



*Possible slides in case useful to answer questions*

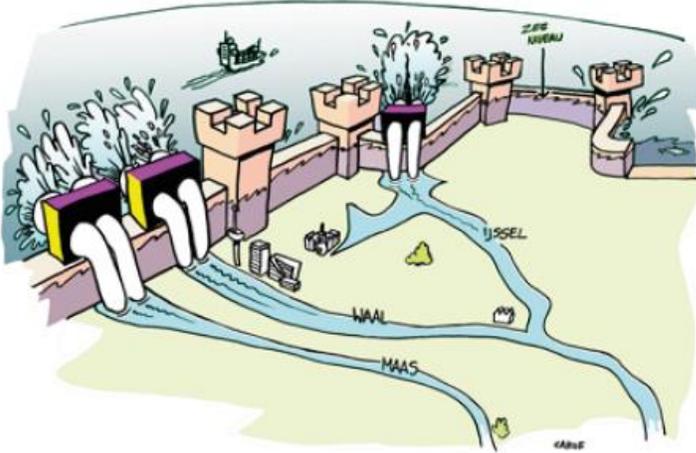


# Building the Netherlands and it's consequences

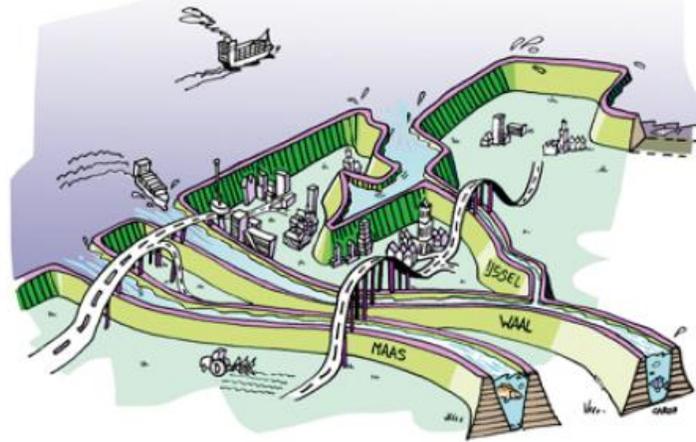




Protect-closed



Protect-open



Advance



Accommodate



Cartoons developed by Carof for Deltares

# I-STORM Communications

- Surge newsletter
- Webinars
- Website ([www.i-storm.org](http://www.i-storm.org))
- Twitter ([twitter.com/ISTORMnetwork](https://twitter.com/ISTORMnetwork))
- LinkedIn (<https://www.linkedin.com/groups/8959685/>)
- I-STORM international team: [enquiries@i-storm.org](mailto:enquiries@i-storm.org)

