



# ***Is Rotterdam digging its own extinction?***

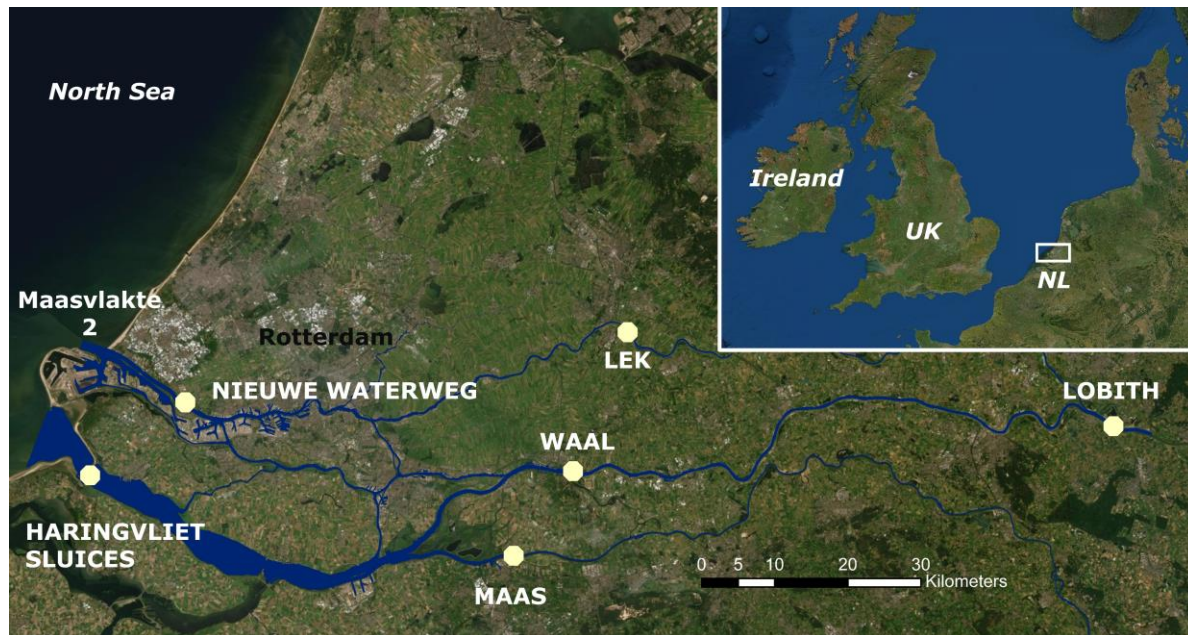
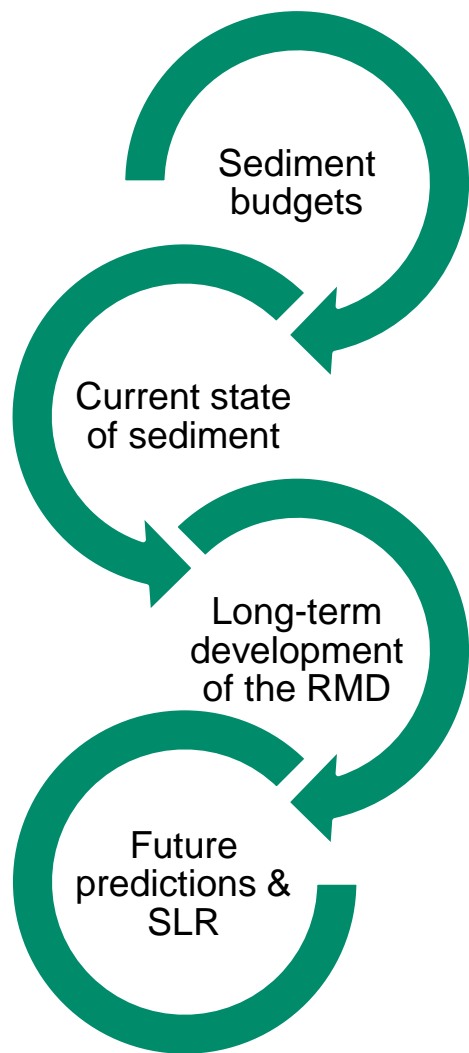


150-year New Waterway  
October 2022

Jana Cox

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# Making a sediment budget

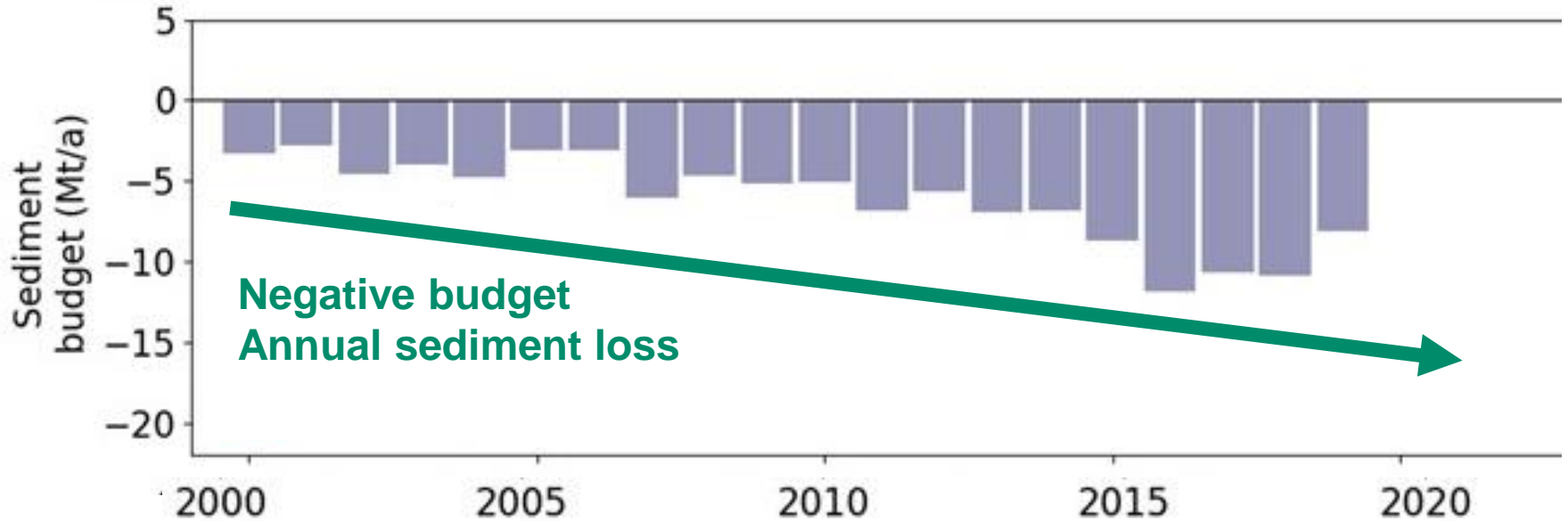


$$\Delta_{dredging} + \Delta_{mud} + \Delta_{sand} = \Delta_{bed\ level}$$

# Present situation



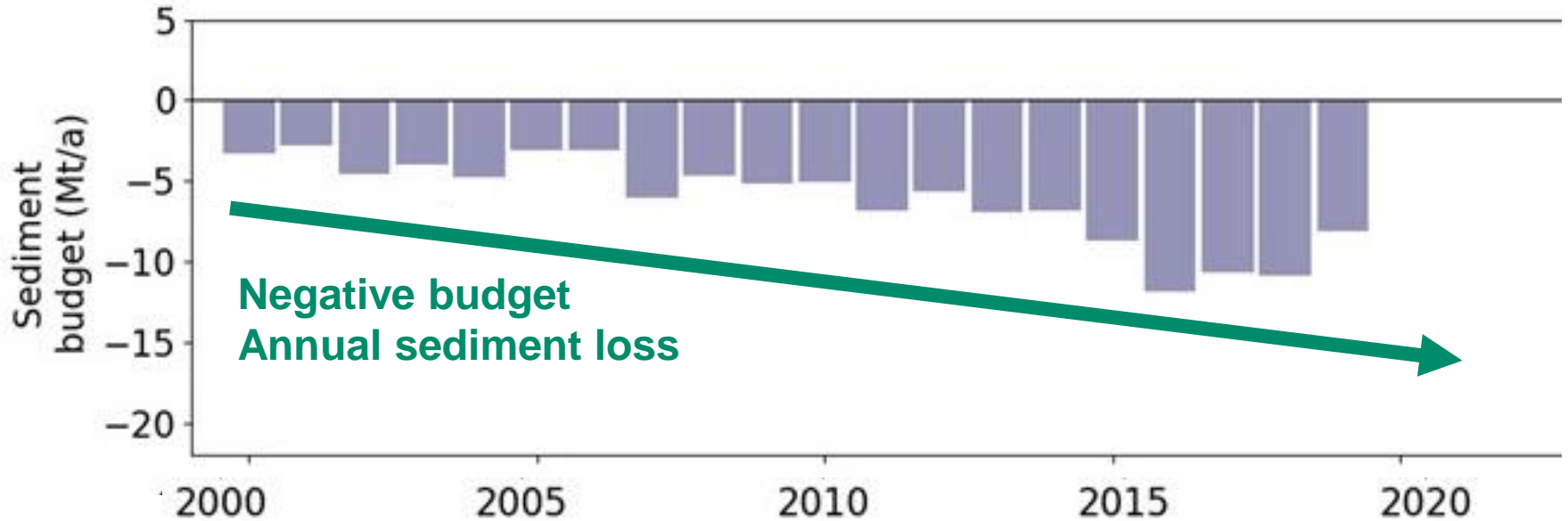
Budget from 2000-2018



# Present situation



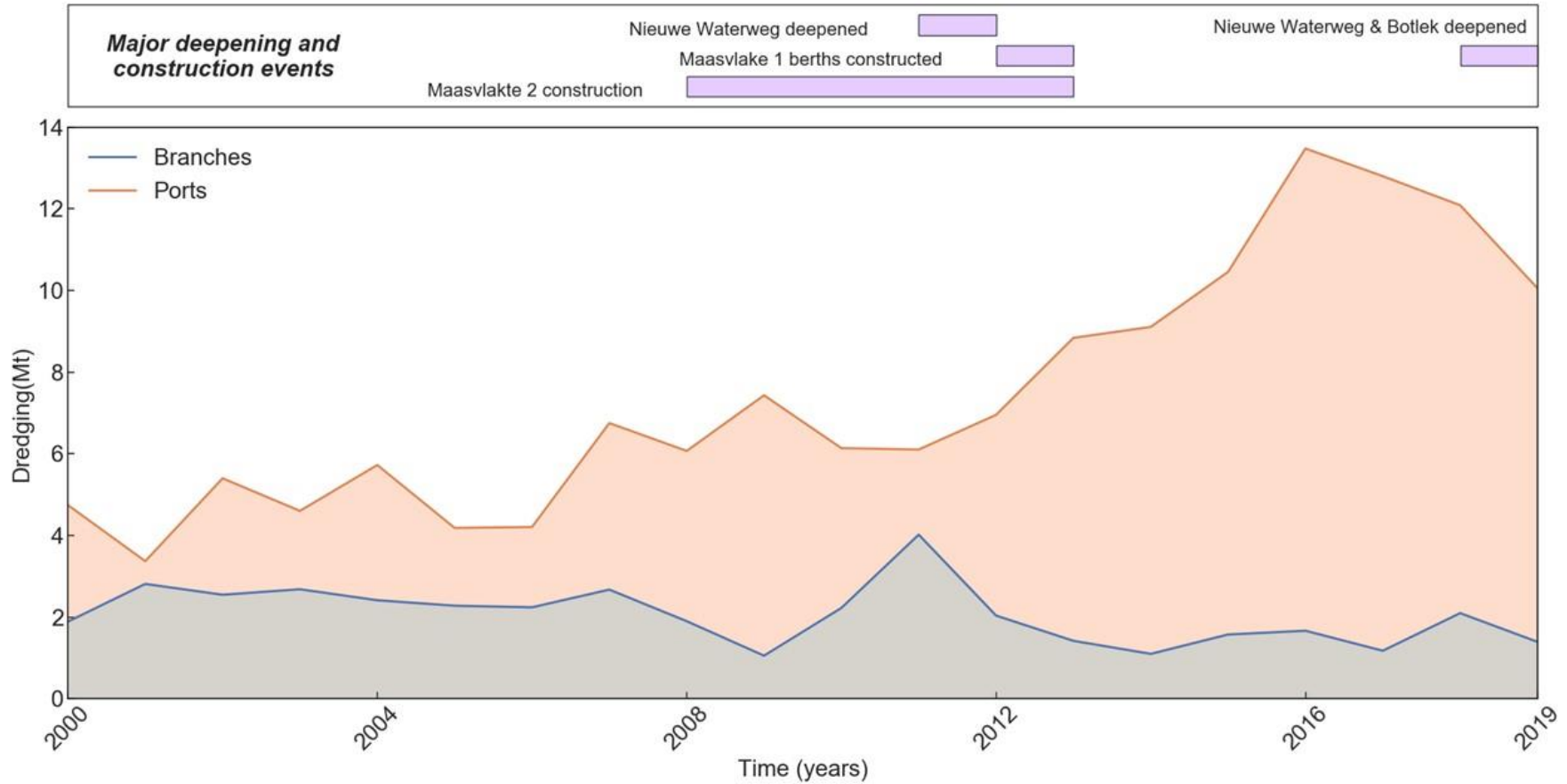
Budget from 2000-2018



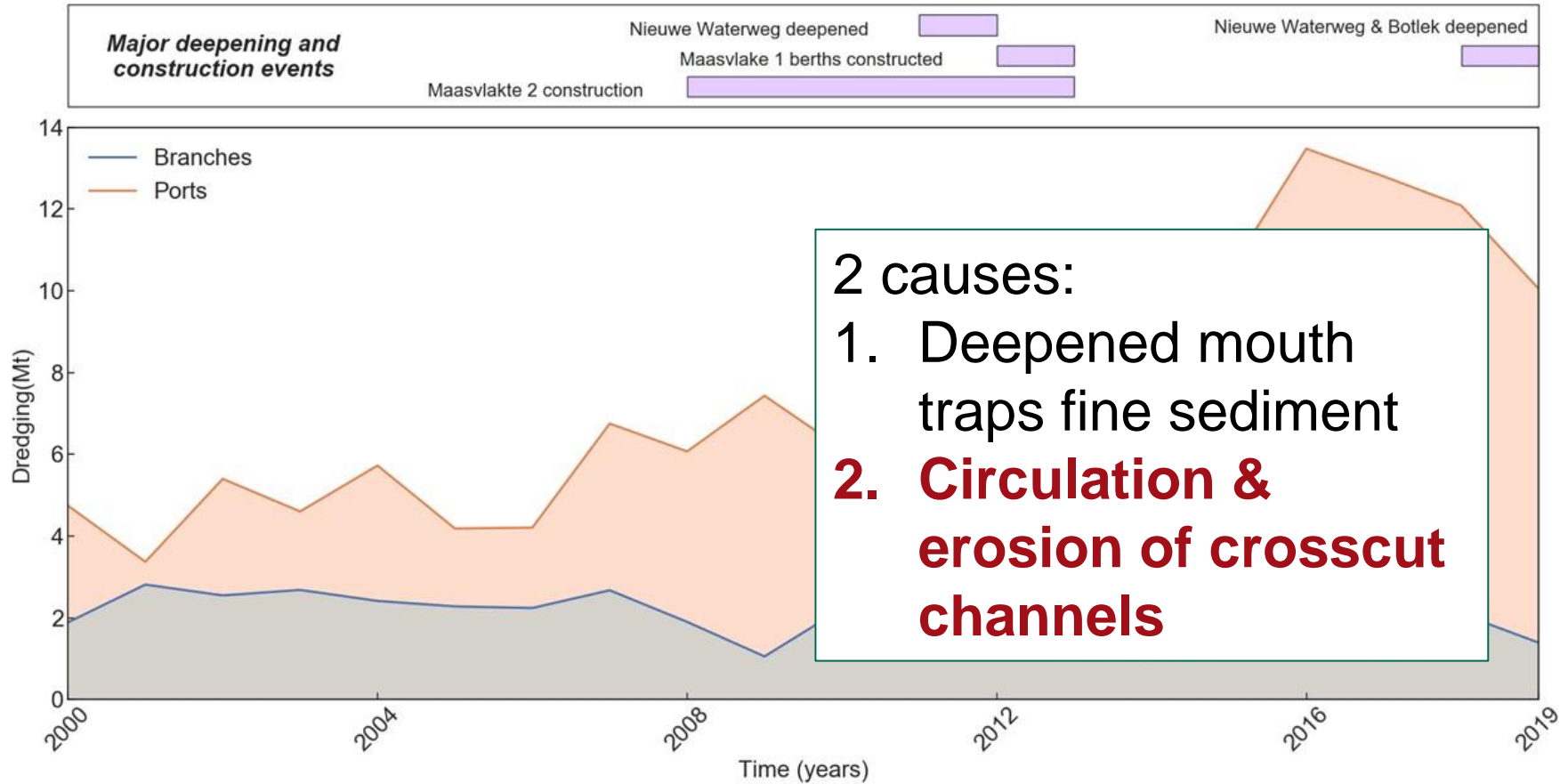
**2Mt/yr = 60 billion stroopwaffels**



# Increased dredging

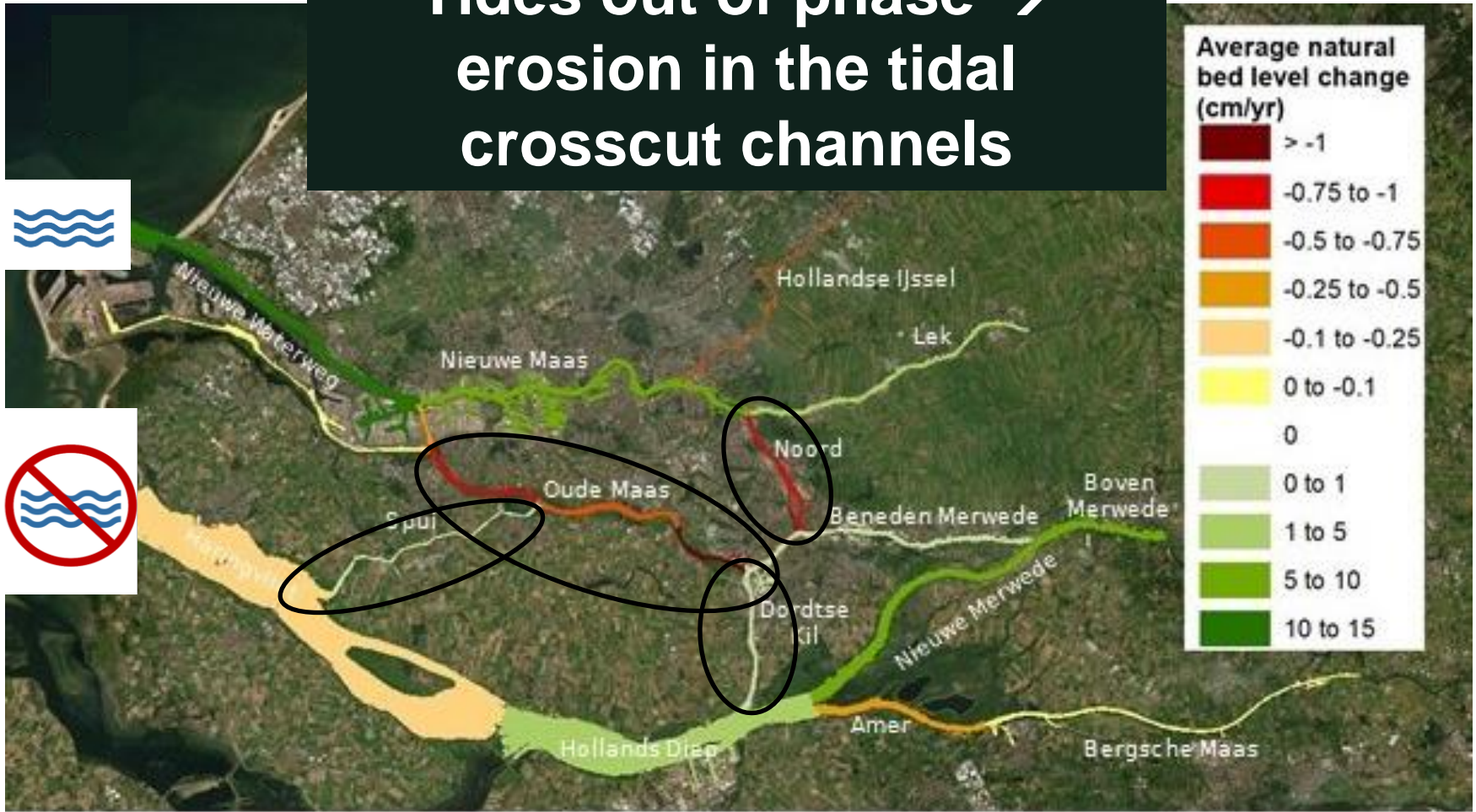


# Changes to dredging





# Tides out of phase → erosion in the tidal crosscut channels





**Under normal conditions,  
eroded sediment is driven  
north into the N.Waterweg**



# Circulation issues and uneven distribution



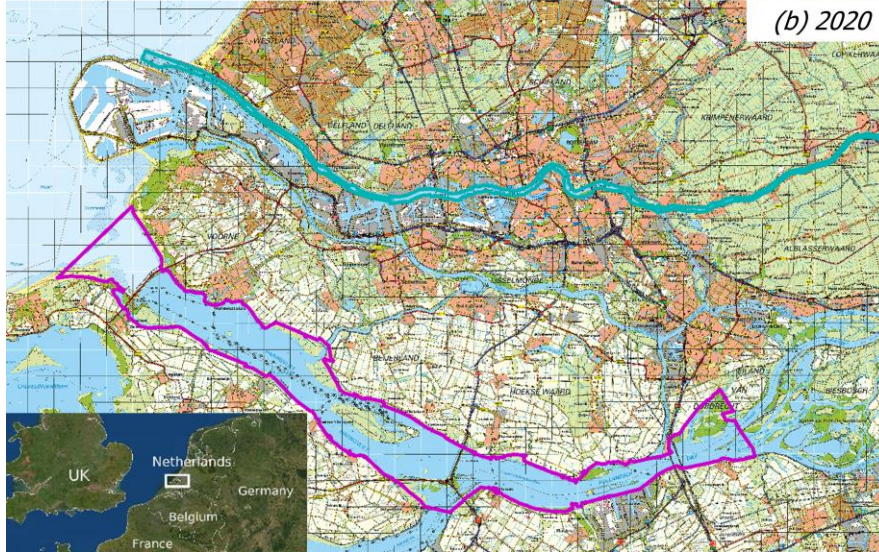
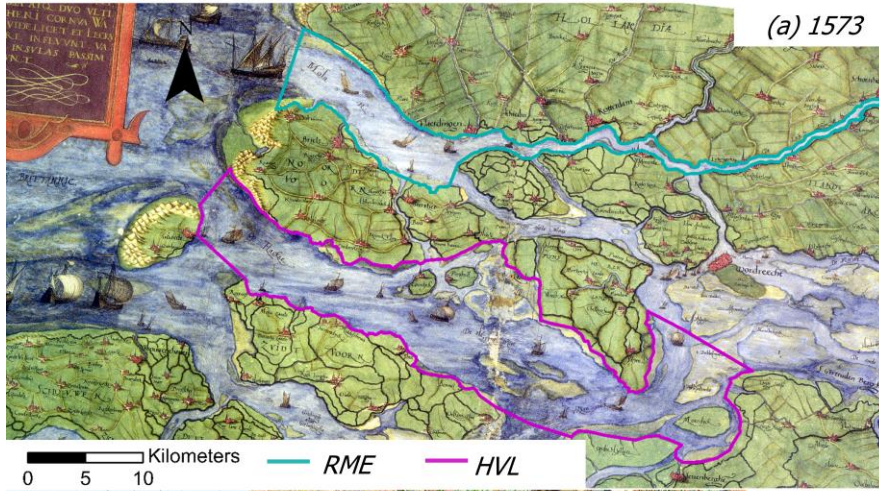
- North (ports) → more sediment → more dredging
- Middle – eroding
  - Bank instability?
  - Bed degradation (cables and tunnels)
- South – intertidal areas not able to maintain elevation





# How did we get here?

The past



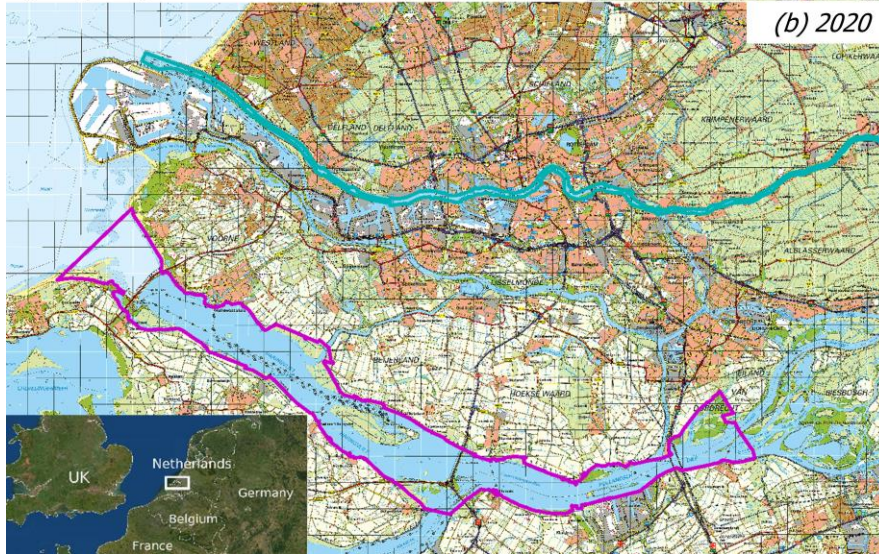
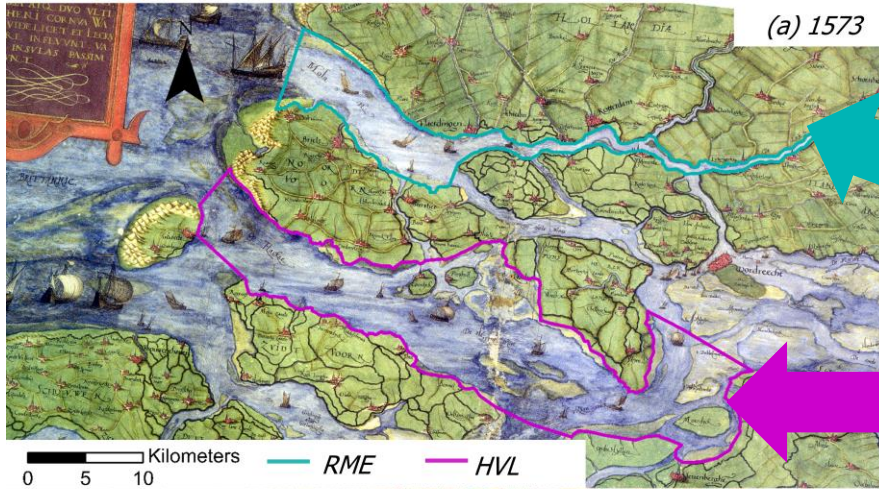
The present

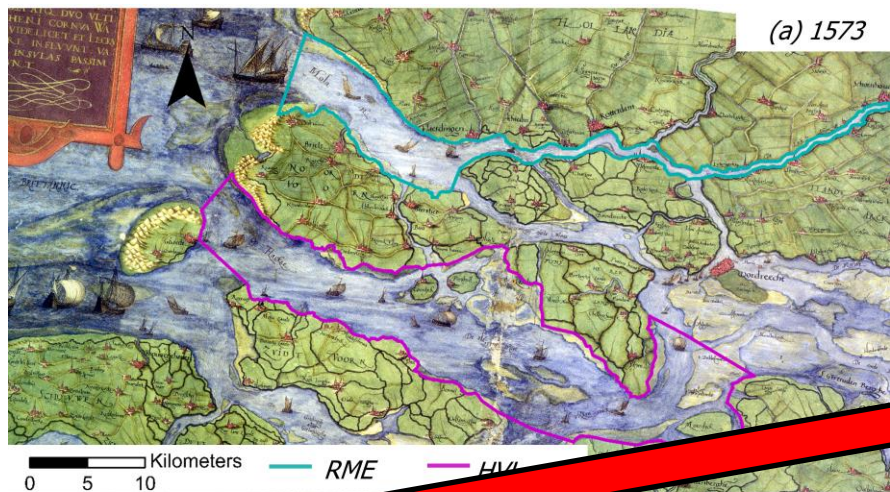


# How did we get here?

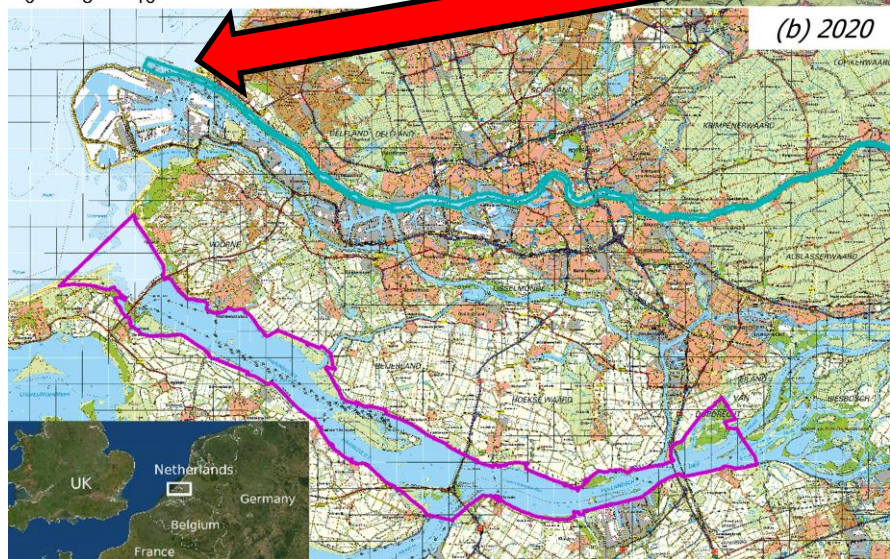
Rhine

Meuse



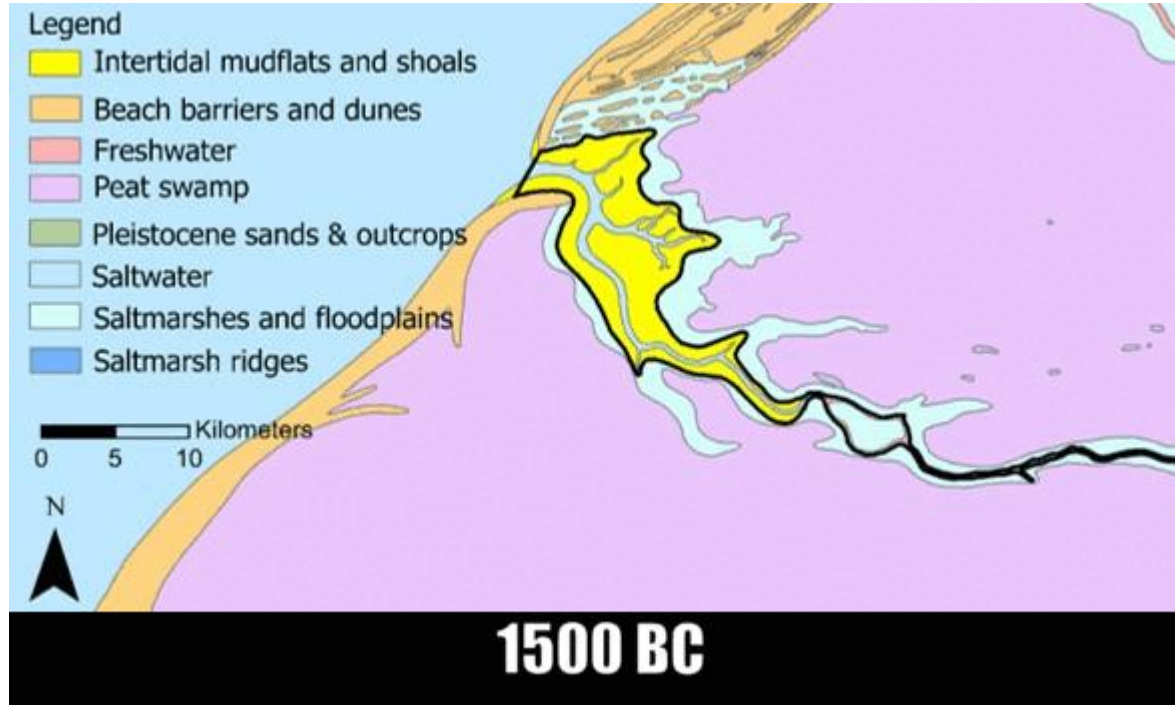


Narrow  
mouth



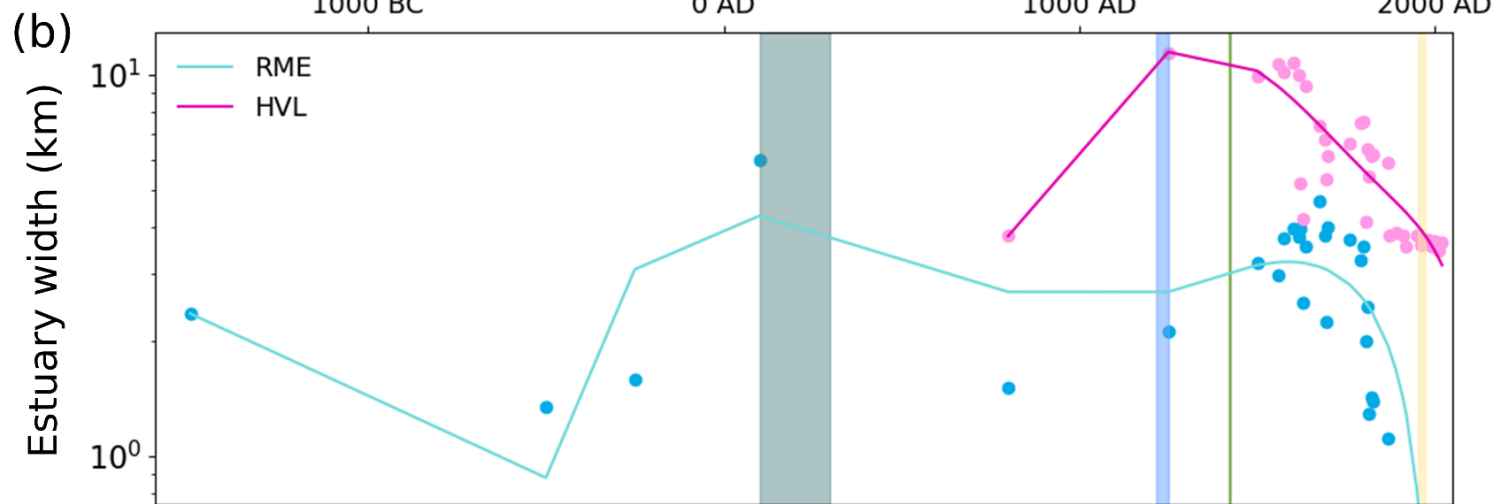
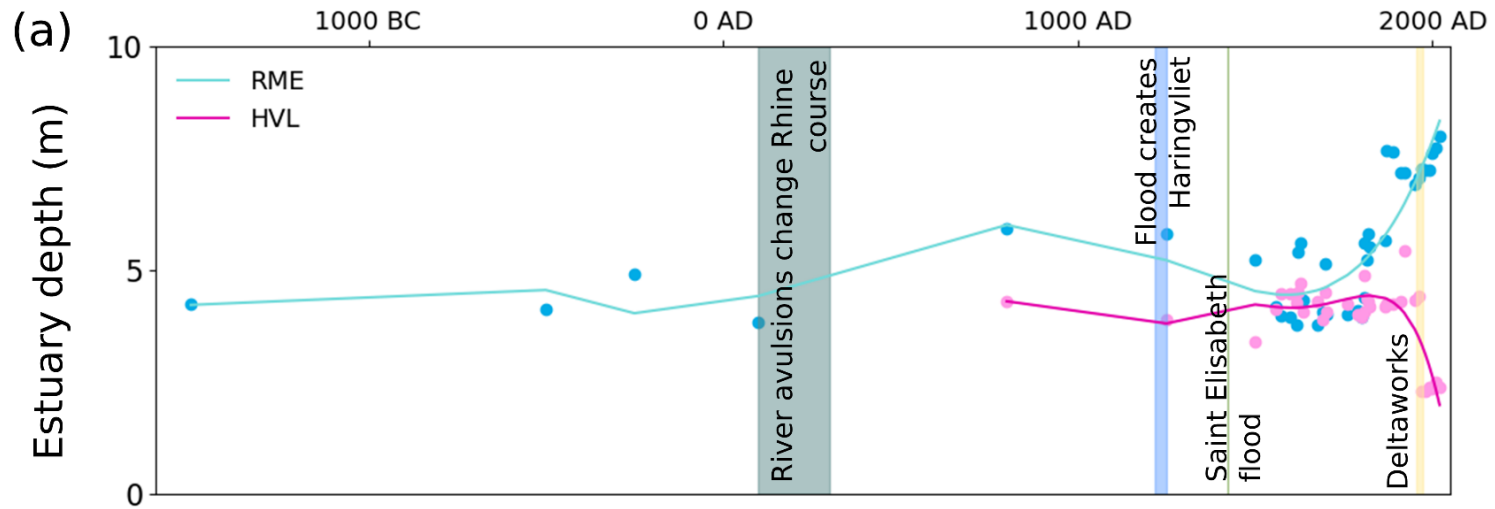


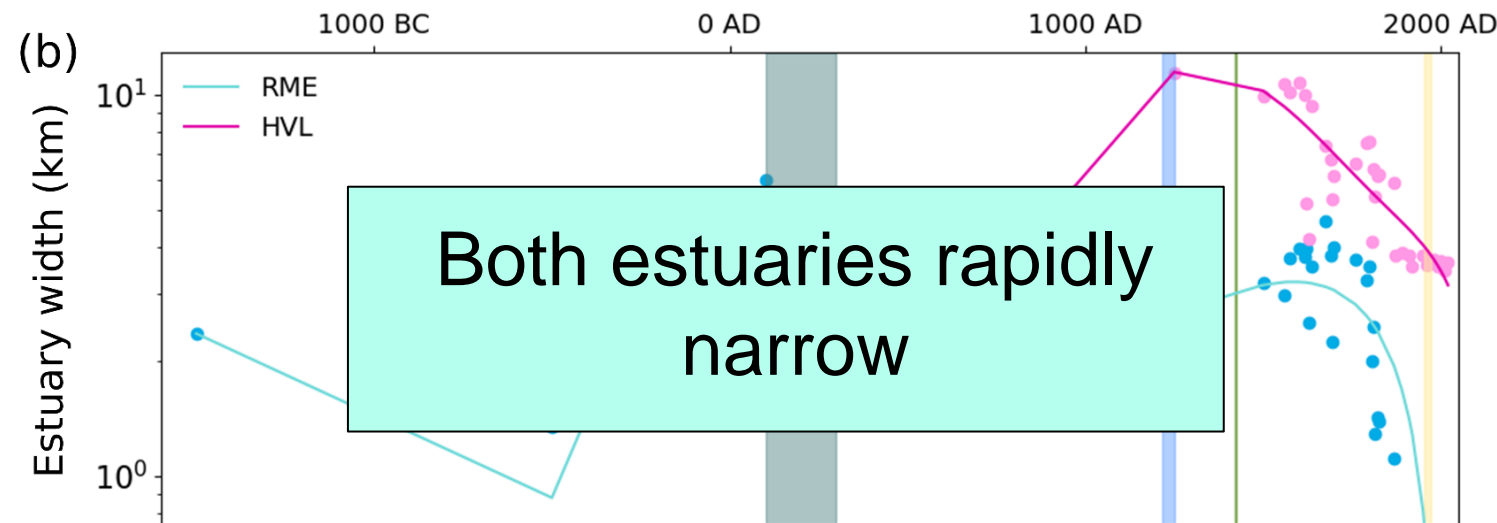
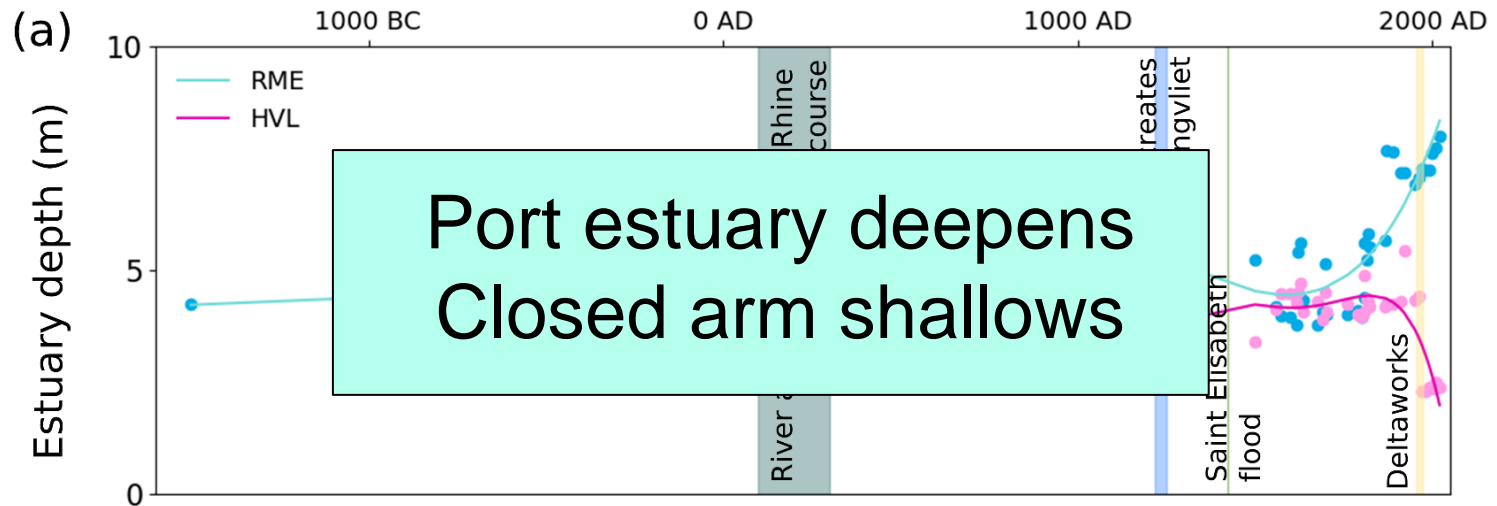
# Analysis based on maps

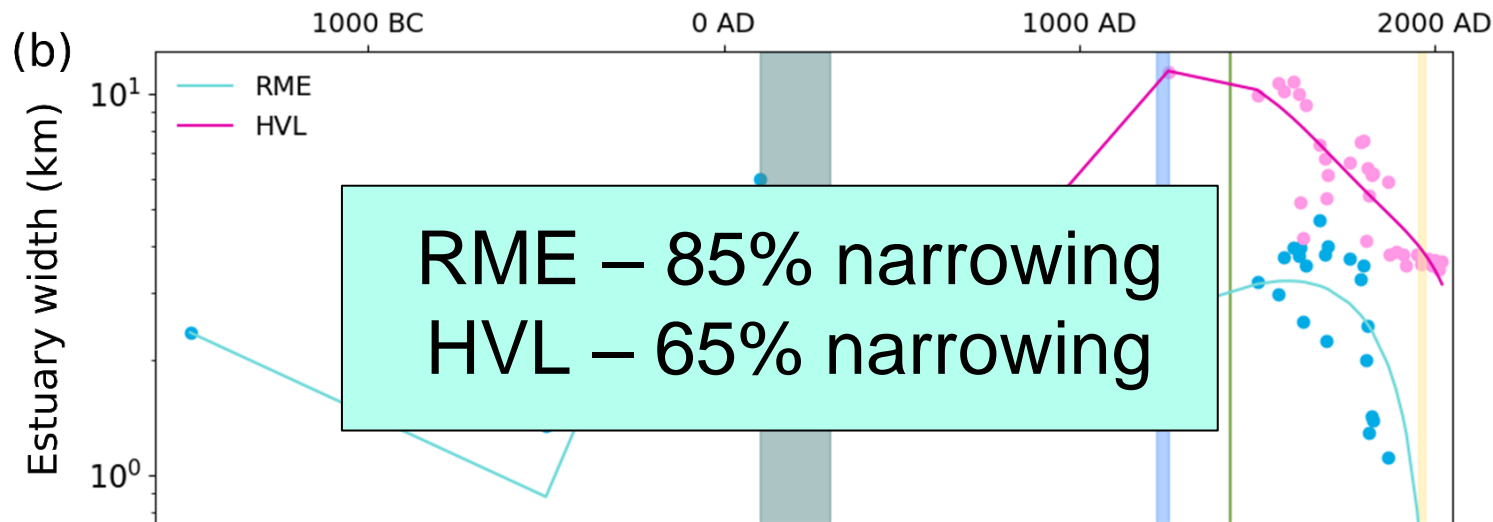
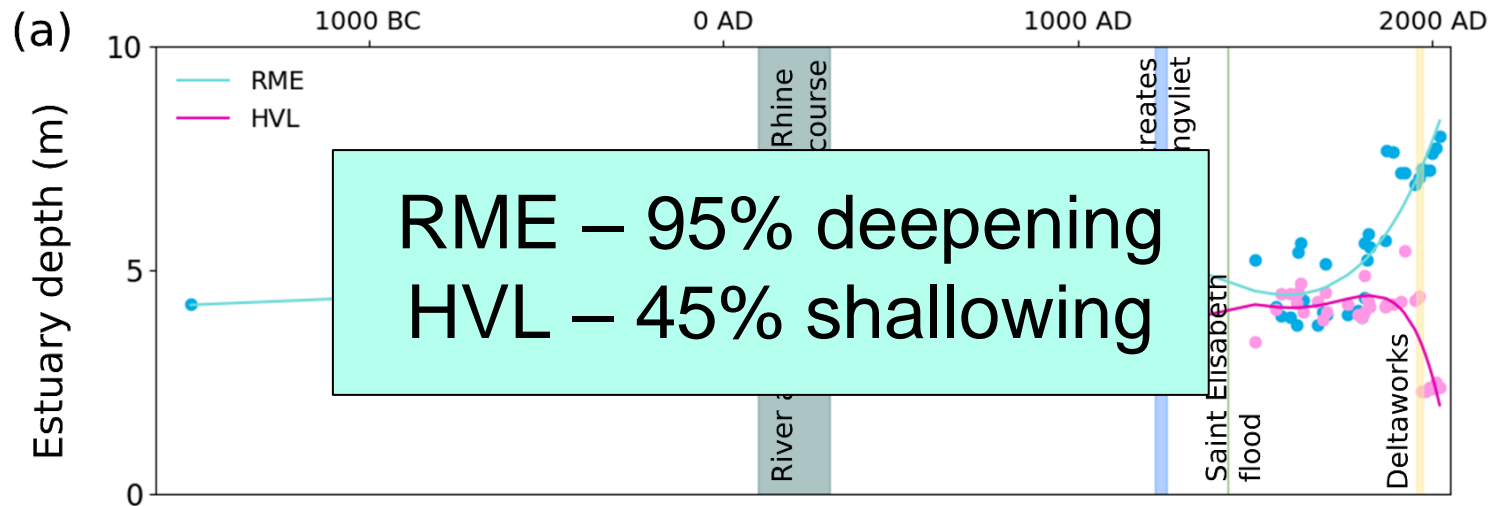


40 timesteps (geological  
reconstructions and old maps)









# Making a future budget

Use KNMI scenarios for discharge change & sea level rise for next 100 years

Dredging component → Jana Cox

$\Delta_{dredging}$

River input  
(Discharge)

BQART →

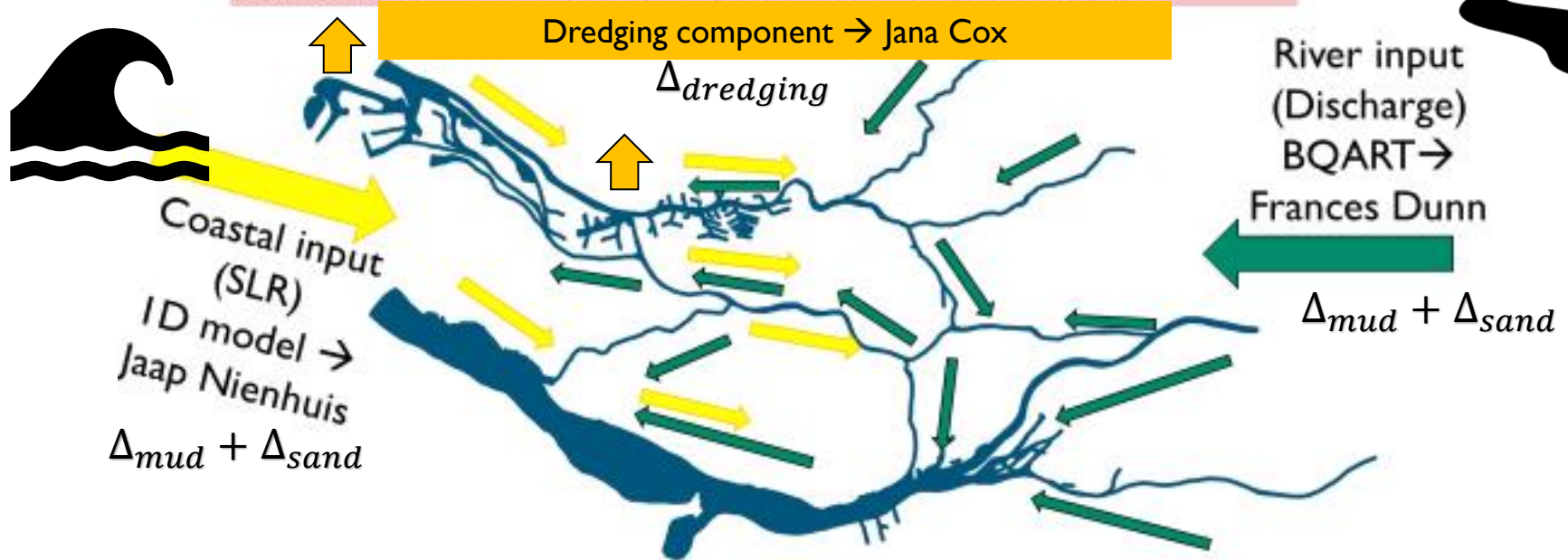
Frances Dunn

$\Delta_{mud} + \Delta_{sand}$

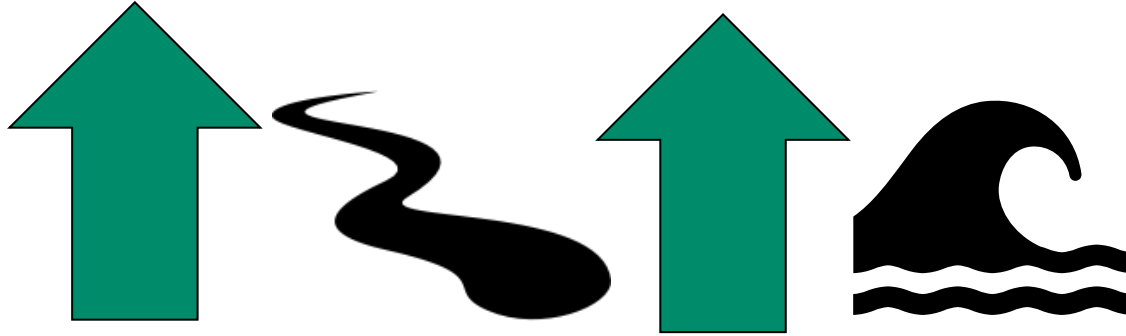
Coastal input  
(SLR)

ID model →  
Jaap Nienhuis

$\Delta_{mud} + \Delta_{sand}$



# Making a future budget

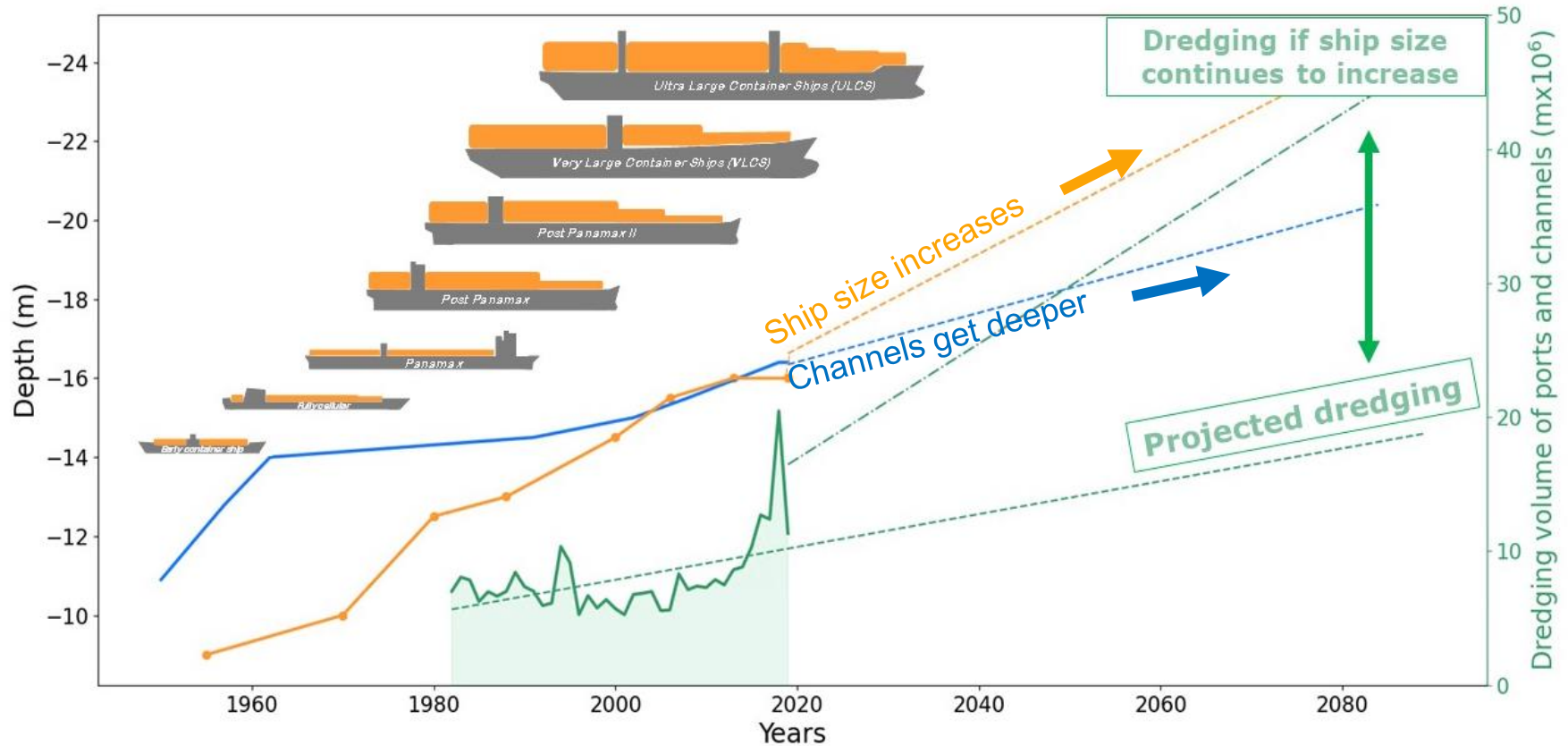


Glacier melt –  
small additional  
flux

Sea-level rise brings  
additional coastal  
sediment

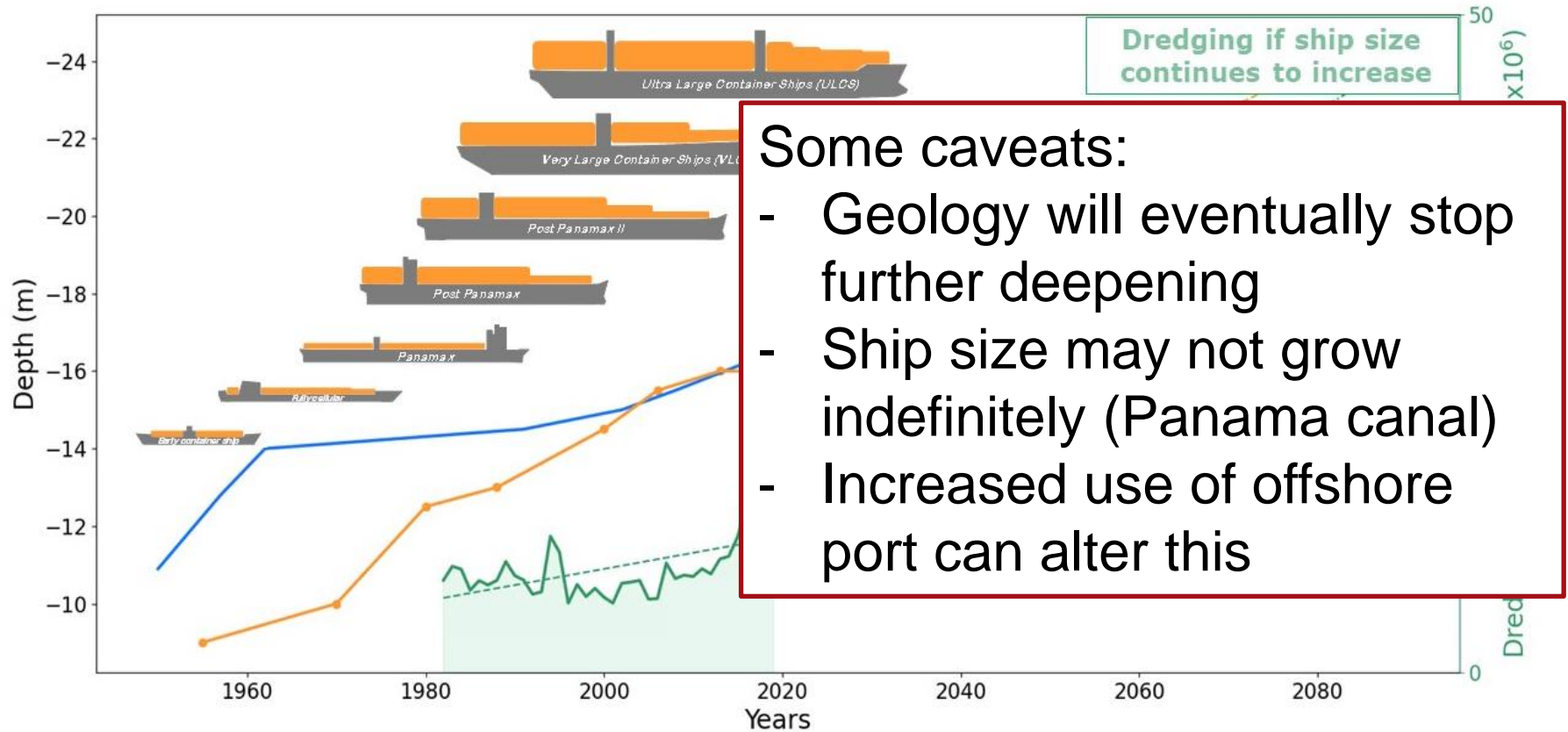


# Estimating dredging

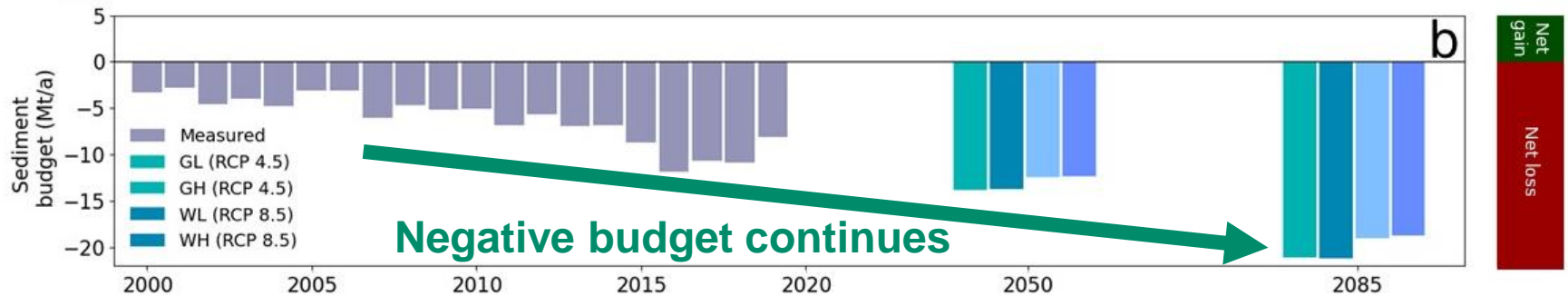
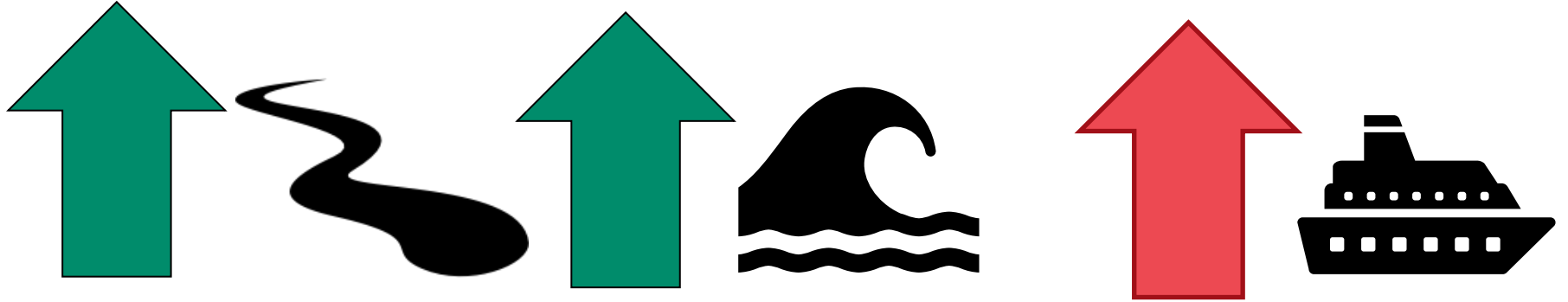




# Estimating dredging



# Making a future budget



Budget	Timespan	Average annual sediment budget (Mt/a)	Source	Comments
Present	2000-2018	-2	Cox, Huismans, et al. 2021	volume gain, sediment loss
Future	2018-2085	-12 to -18	Cox, Dunn, et al. 2021	volume gain, sediment loss
Geological*	1500 BC - 250 BC	-1.90		volume gain, sediment loss
Early human	250 BC - 1500 AD	-2.86	Cox, Leuven et al. 2022	volume gain, sediment loss
City and port development	1500 - 1900	10.3		volume loss, sediment gain
Recent growth	1900-2020	-1.2		volume gain, sediment loss

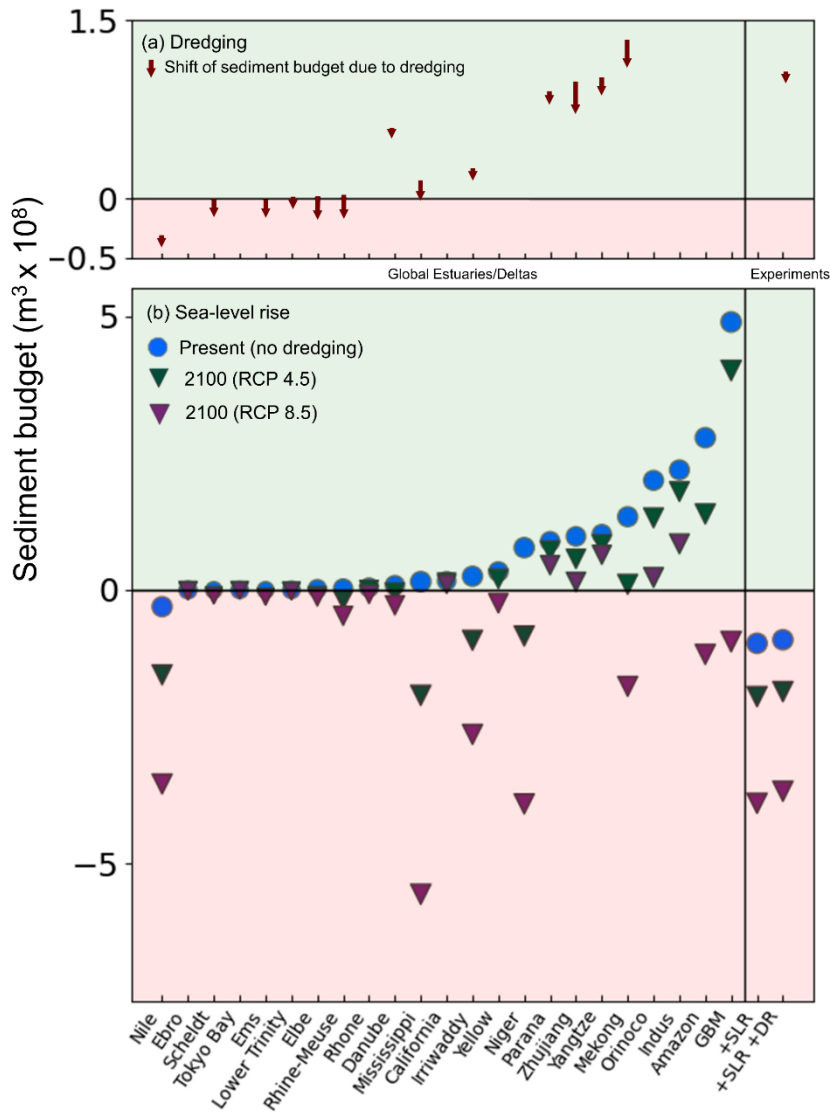
\*RME only, HVL had not yet formed

Table 1: Comparison of sediment budgets through time

**Predicted future rate of sediment loss is the highest in the 3500 year history of the delta**

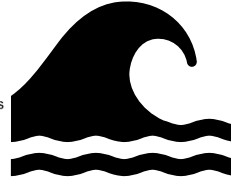
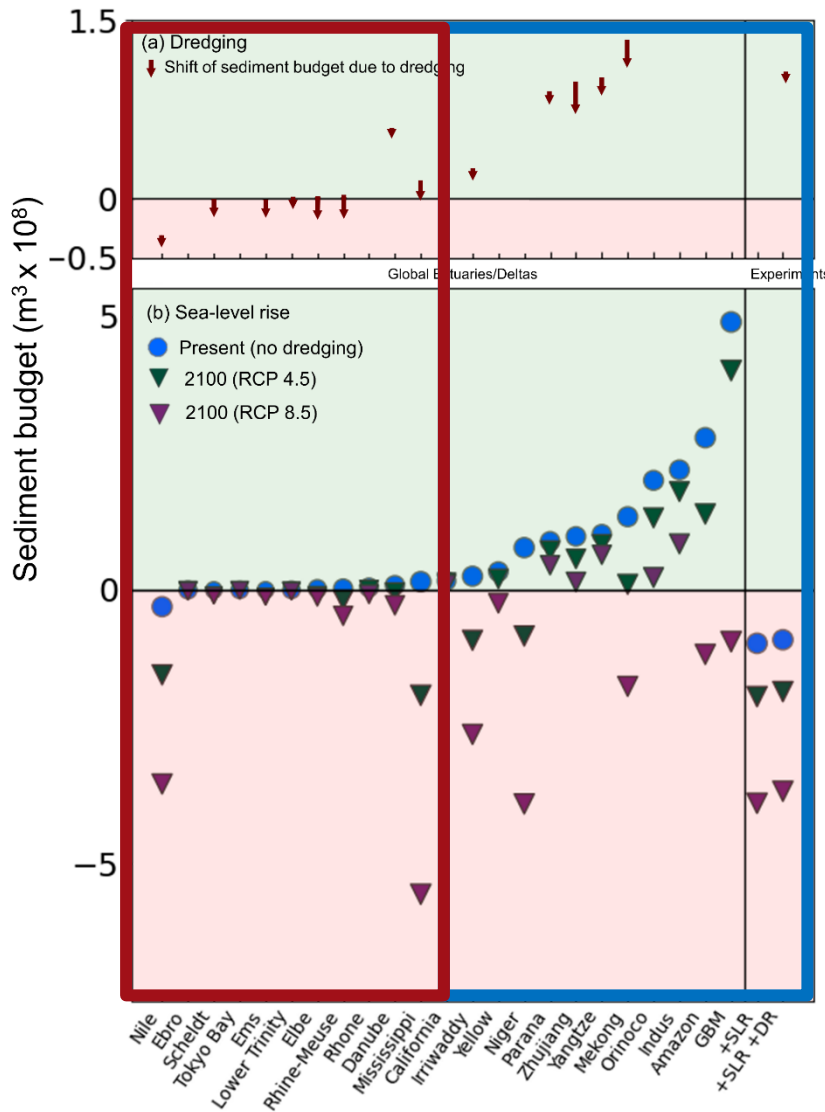
**But!**  
**The Rhine–Meuse  
delta is not alone...**





**Big mega deltas face  
greatest threats due to SLR,  
European estuaries will face  
more land loss due to  
sediment management**

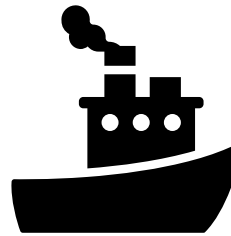
*Data courtesy of Nienhuis & van der Wal 2021*



**Mega deltas**  
**High sediment feed**  
**Range of dredging**



**Asia, S.America**



**Smaller area**  
**Less sediment input**  
**High dredging**



**Europe, USA**

Data courtesy of Nienhuis & van der Wal 2021