

Rijkswaterstaat
Ministerie van Verkeer en Waterstaat

Deltares
Enabling Delta Life 

Mud as a resource: reducing turbidity while keeping up with sea level rise

Applied research Deltares and Rijkswaterstaat in the Ems Estuary from 2011 to 2019

The Wadden Sea





The Wadden Sea

the Ems Estuary is also
part of the Wadden Sea!

(and of course the Wadden Sea is even larger)

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- Human activity in estuaries results in **high mud concentrations**. This leads to low visibility, anoxic conditions and high costs (port siltation, dredging)

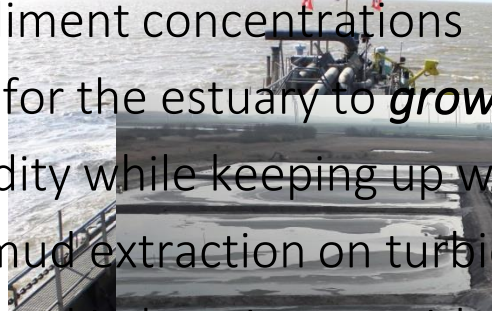
- Mud can be a resource** to strengthen dikes, raise low-lying land, produce construction materials, or enrich agricultural soils. Extraction of mud leads to lower sediment concentrations

- Mud may also be needed for the estuary to **grow with rising sealevels**

- So.... can we reduce turbidity while keeping up with sealevel rise?

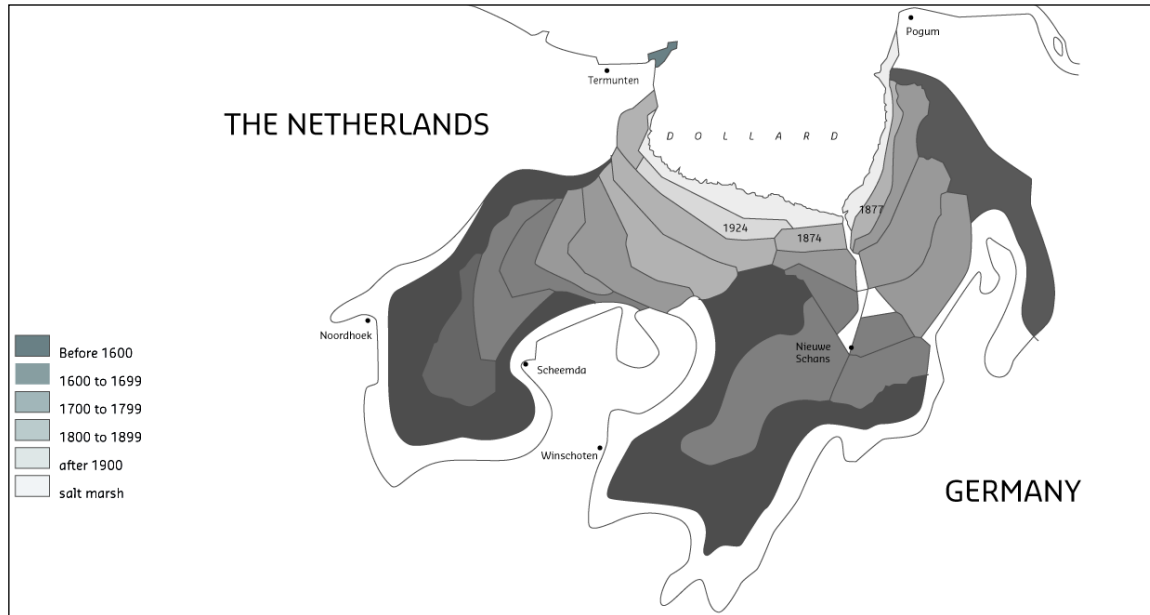
1. What is the role of mud extraction on turbidity?

2. What is the role of mud in keeping up with sealevel rise?



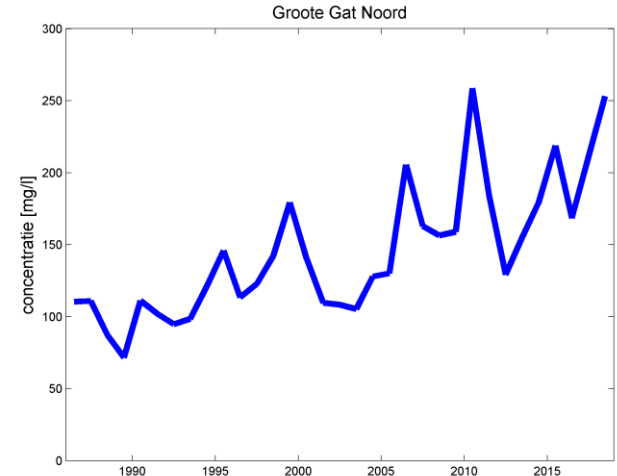
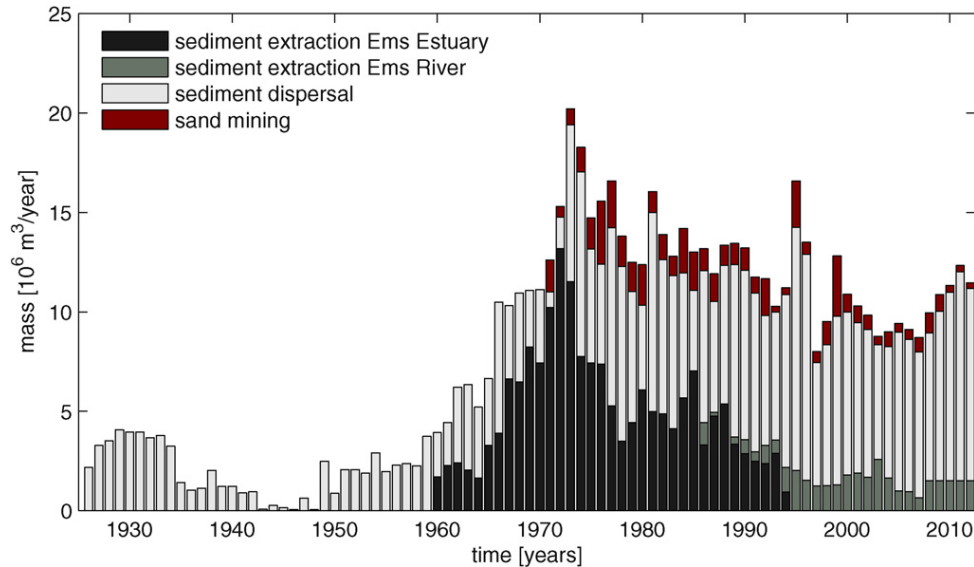
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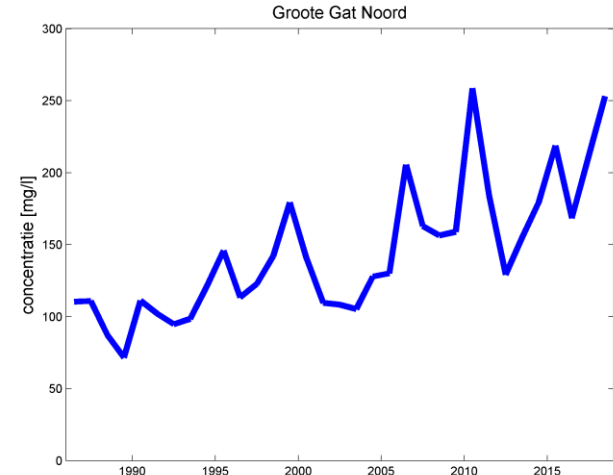
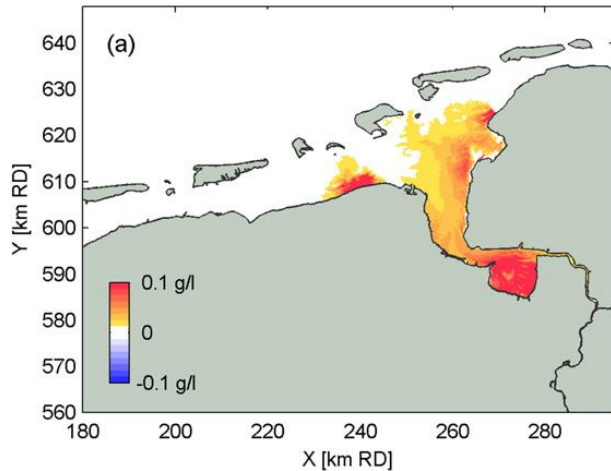
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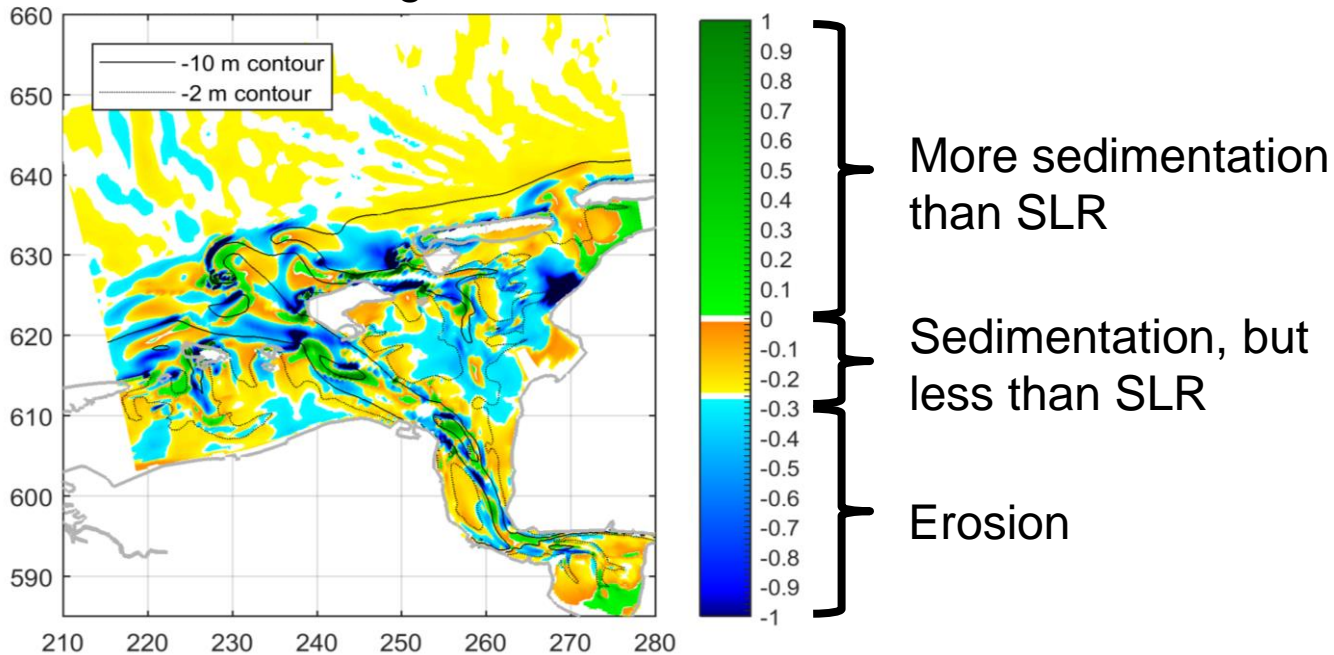
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- Therefore measures (such as the Kleirijperij) are presently designed and implemented to extract sediment from the system (or trap sediment in the system) in a sustainable way.

What is the response of the estuary to sealevel rise?

- Sand-mud modelling Ems estuary with SLR of 0.28 cm in 2050: difference in bed level for a simulation WITH and WITHOUT Sea Level Rise

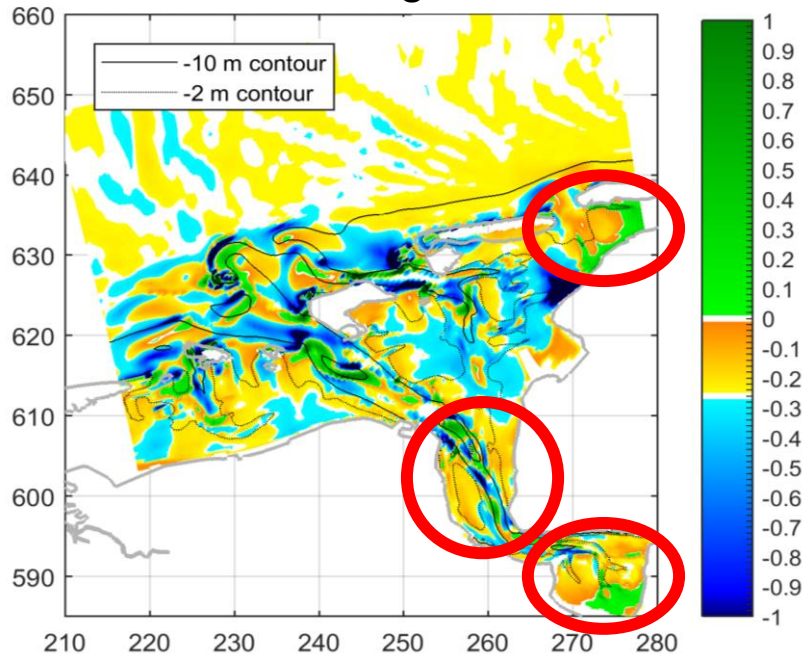
Bed level change due to SLR



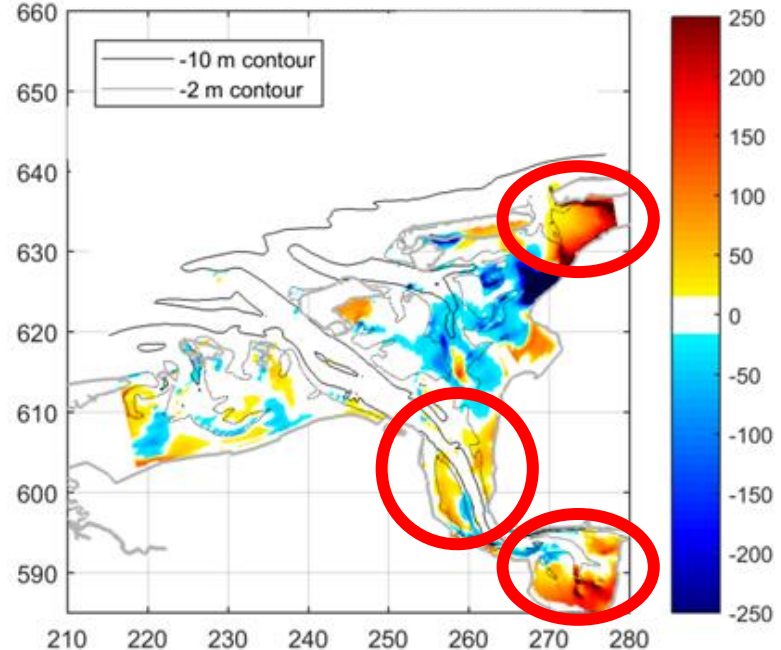
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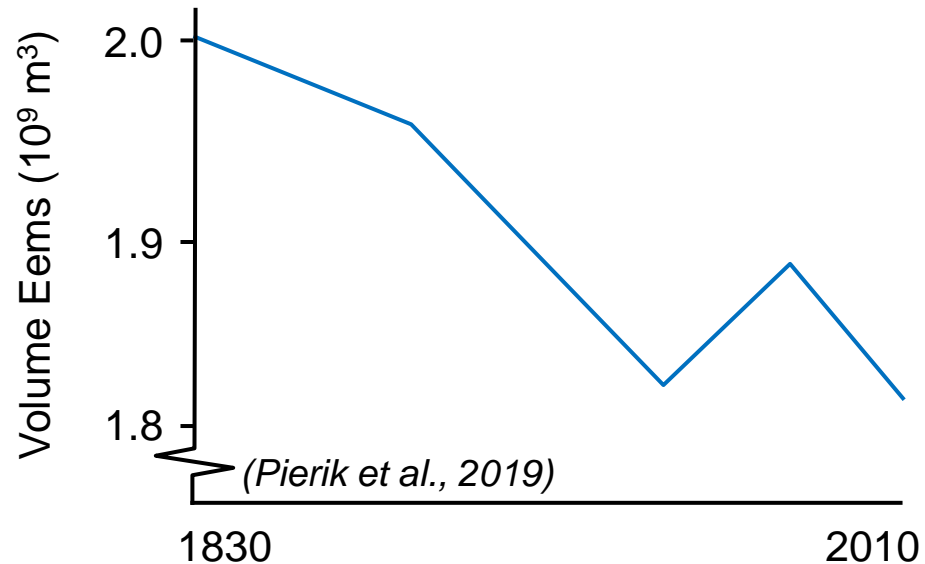


Mud content change due to SLR



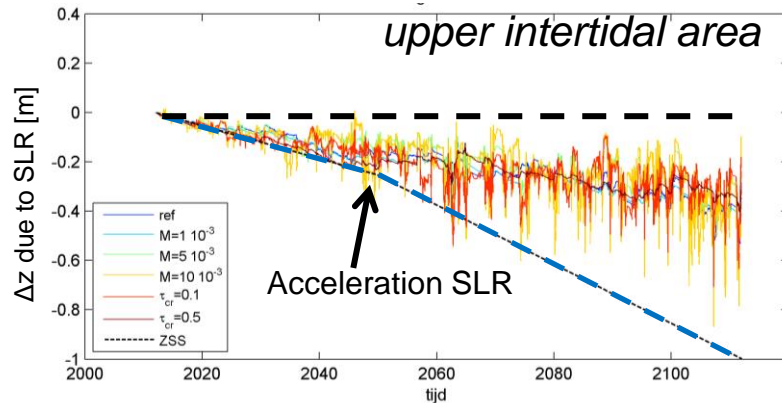
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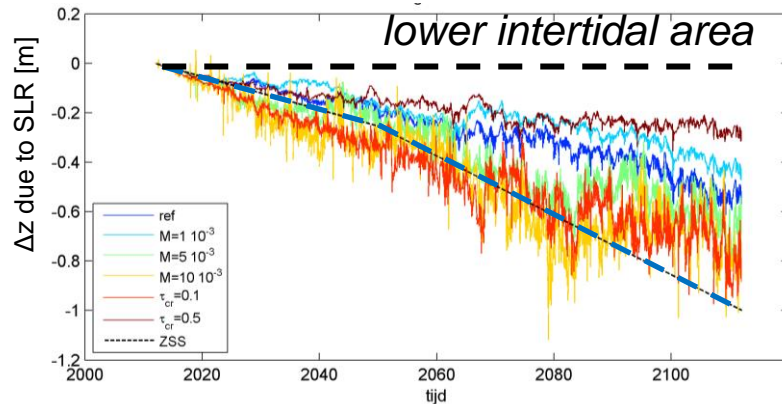


'completely following SLR'

'complete drowning'

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 - Modelled historic change in sediment budgets in line with historic observations
 - Response of the upper flats to SLR limitedly depending on model settings: mud deposition will largely follow SLR
 - Response of lower flats: much stronger dependence on model settings → higher uncertainty



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‘complete drowning’

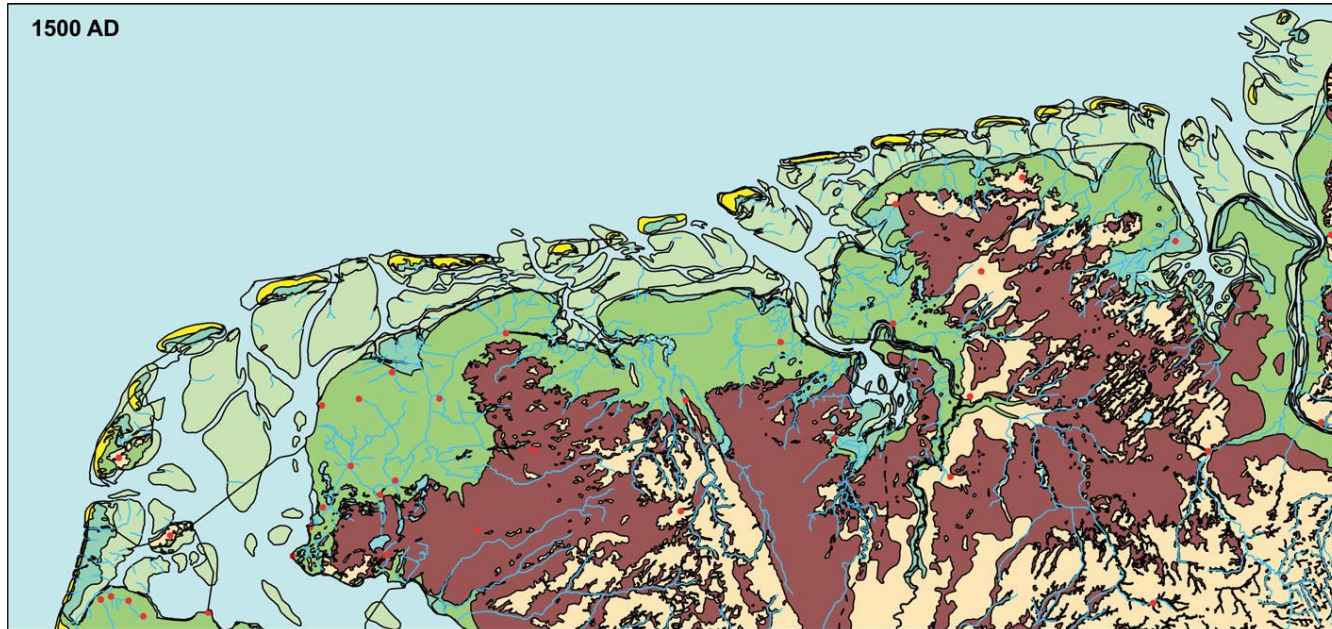
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- Sand-mud modelling Ems estuary with SLR of 0.28 cm in 2050: **only significant accretion of mud** to (nearly) keep up with SLR
- How certain are these predictions?
 - Modelled historic ... with historic observations
 - Re ... settings: mud
- Major uncertainty in evaluating the predicted response to SLR: absence of calibration / validation data.

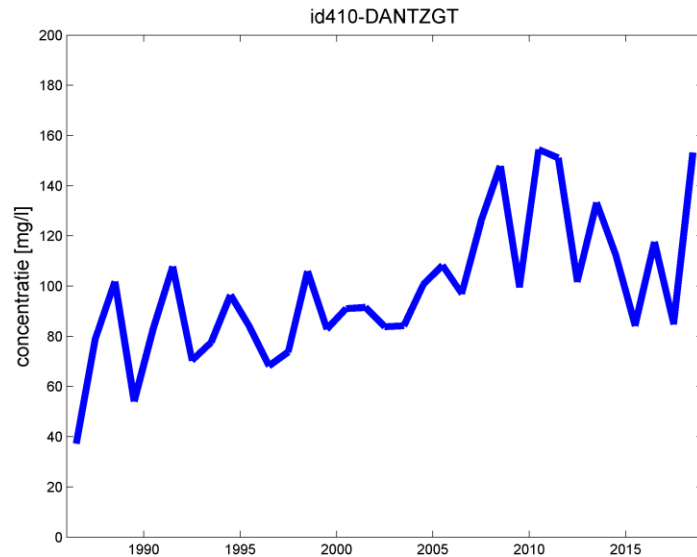
Way forward: predict impact of SLR with a range of different data and model-based tools to deal with this absence of validation data!



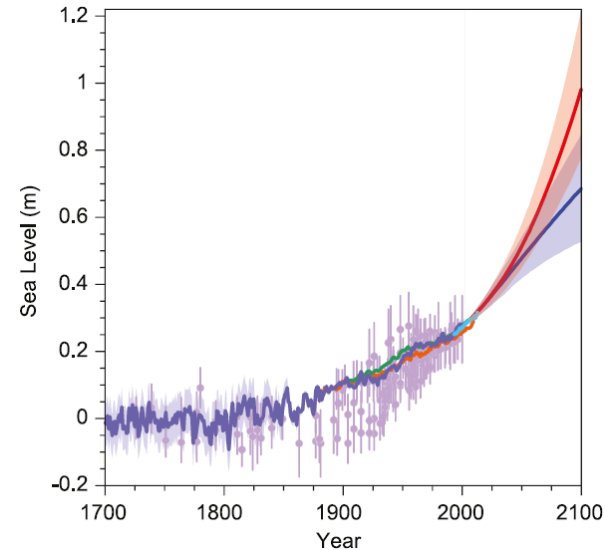
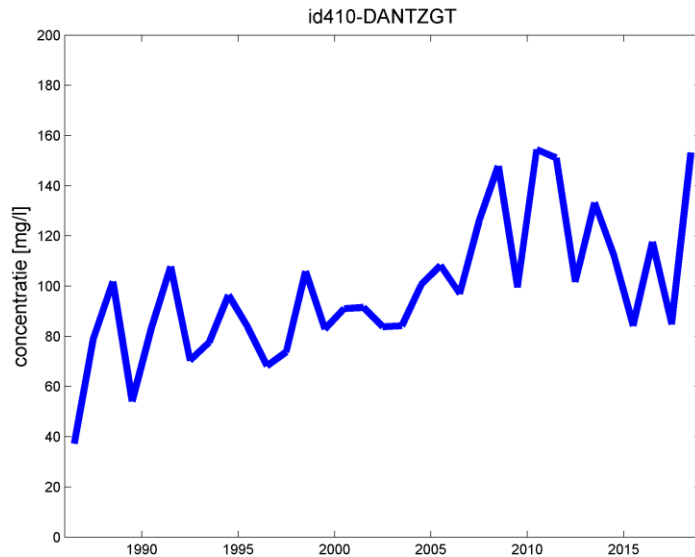
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- Concentrations in the Eastern Wadden Sea are also increasing
- Sealevel rise...



- The Ems Estuary is part of the Wadden Sea
- Extraction of sediment reduces turbidity
- SLR will lead to a muddier Ems Estuary
- Extraction of sediment has limited impact on the response of the upper flats to SLR; more on the lower flats
- Quantifying both the effect of extraction and of SLR is complex and cannot be verified with data → need for research lines and methodologies