



Sediments: a source of chemicals for the marine environment, in more than one way

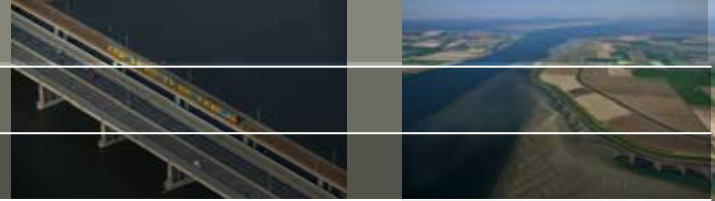
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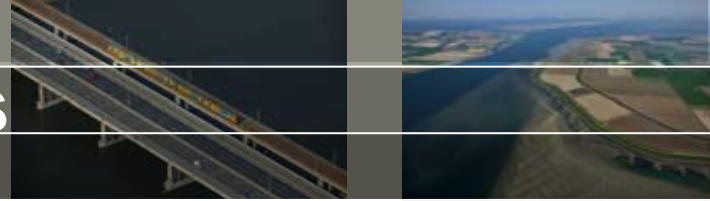
The Role of Sediments in Coastal Management, 6th International SedNet conference on 7-8 October 2009, Hamburg, Germany

Introduction: background



- In 2000 the Water Framework Directive (WFD) became the legal instrument for water management in Europe
- Among other things, the WFD defines binding Water Quality Objectives (WQO's) for priority pollutants and basin specific target pollutants
- In 2009 the first generation River Basin Management Plans under the WFD needs to be completed
- These plans contain measures to achieve the WQO's (if these are not achieved today)

Introduction: study objectives

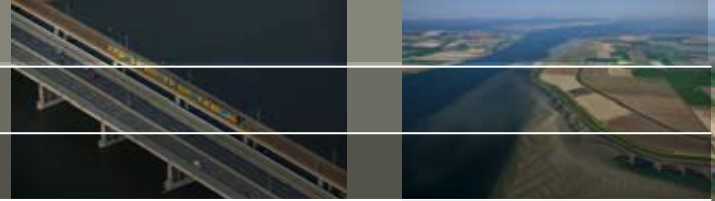


Answer the question:

Will the planned emission reduction measures to achieve the relevant WQO's in the Dutch coastal waters in 2015 and 2027 be effective?

Sediment related sub-questions:

- *What are the chemical fluxes related to dredging spoil distributed in the Dutch coastal waters?*
- *Can marine and estuarine sediments act as a (temporary) source of chemicals in a situation where the emissions show a strong decrease over time?*



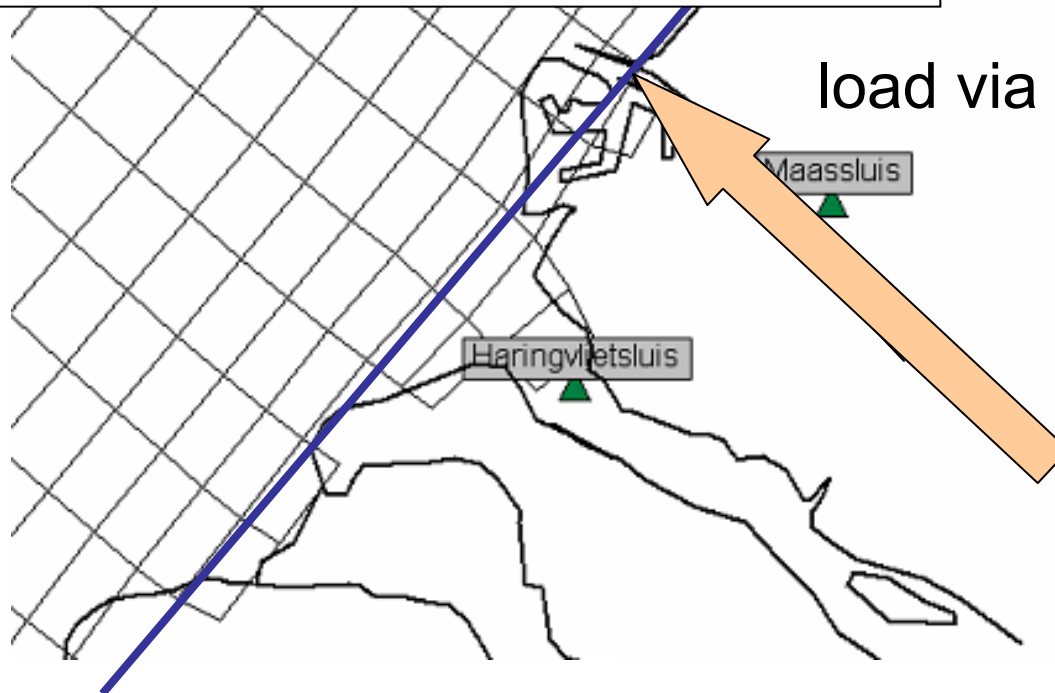
What are the chemical fluxes related to dredging spoil distributed in the Dutch coastal waters?

Chemical fluxes to the coastal waters



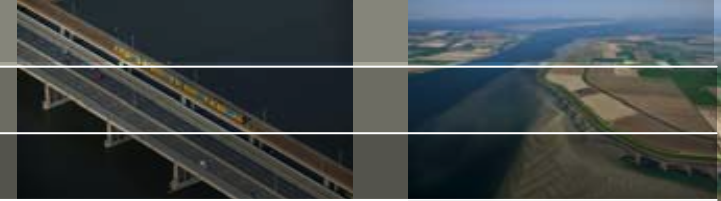
Is this really a flux of chemicals to the coastal waters?? The material is mostly of marine origin!

*Rhine-Meuse estuary
Rotterdam Harbour*



load via Nieuwe Waterweg
(station Maassluis)

Approach



Mass balancing for fine particles $< 63\mu\text{m}$

Mass balancing for selected chemicals adsorbed to these particles

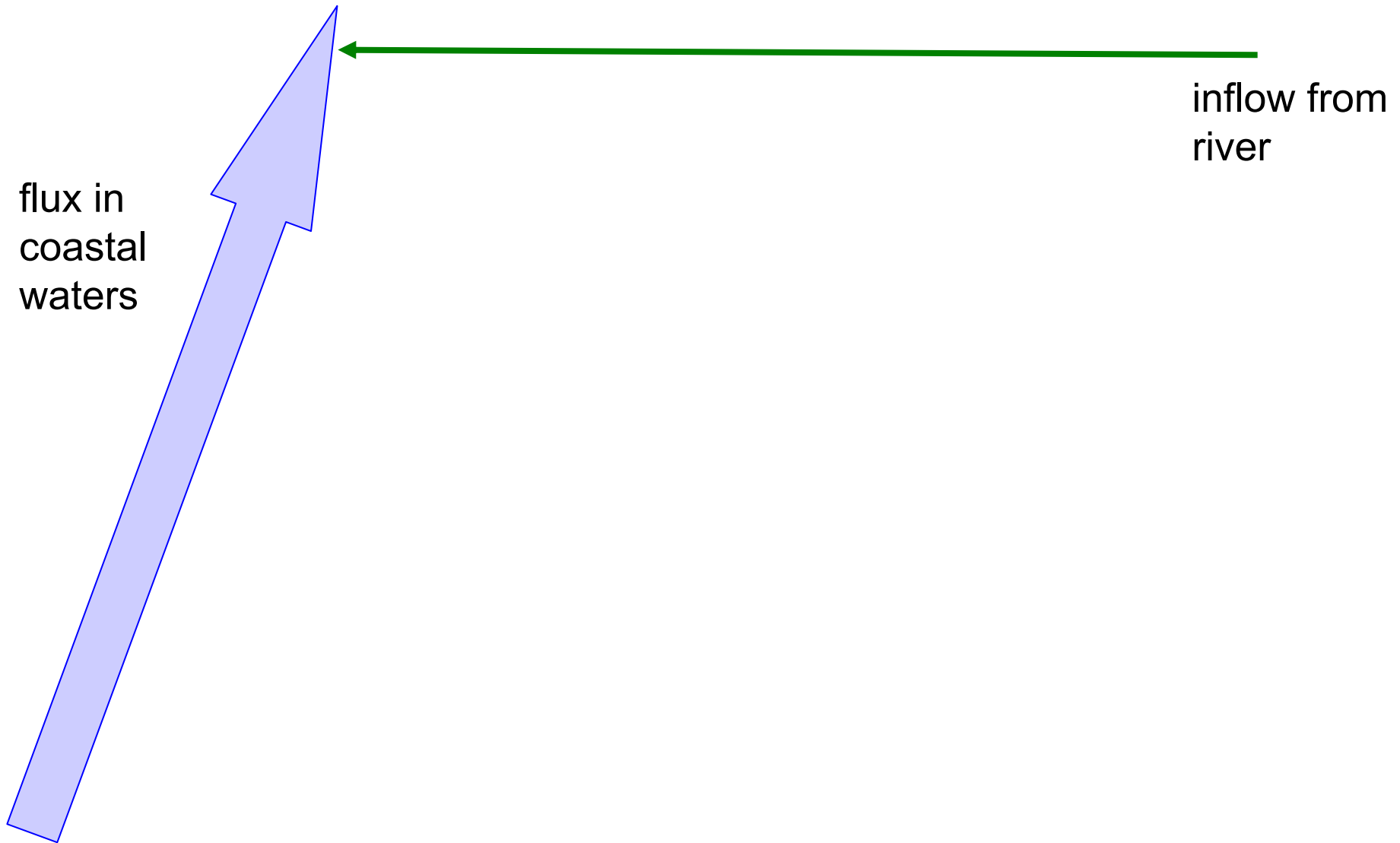
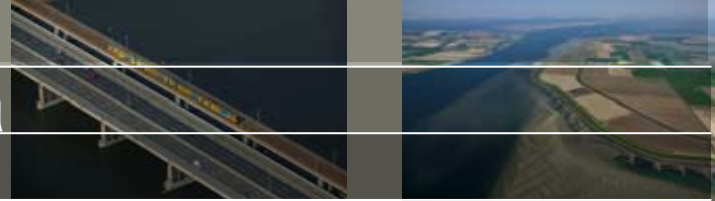
- following similar approaches reported in existing grey literature since 1980s
- using recent data

Mass balancing: river and sea

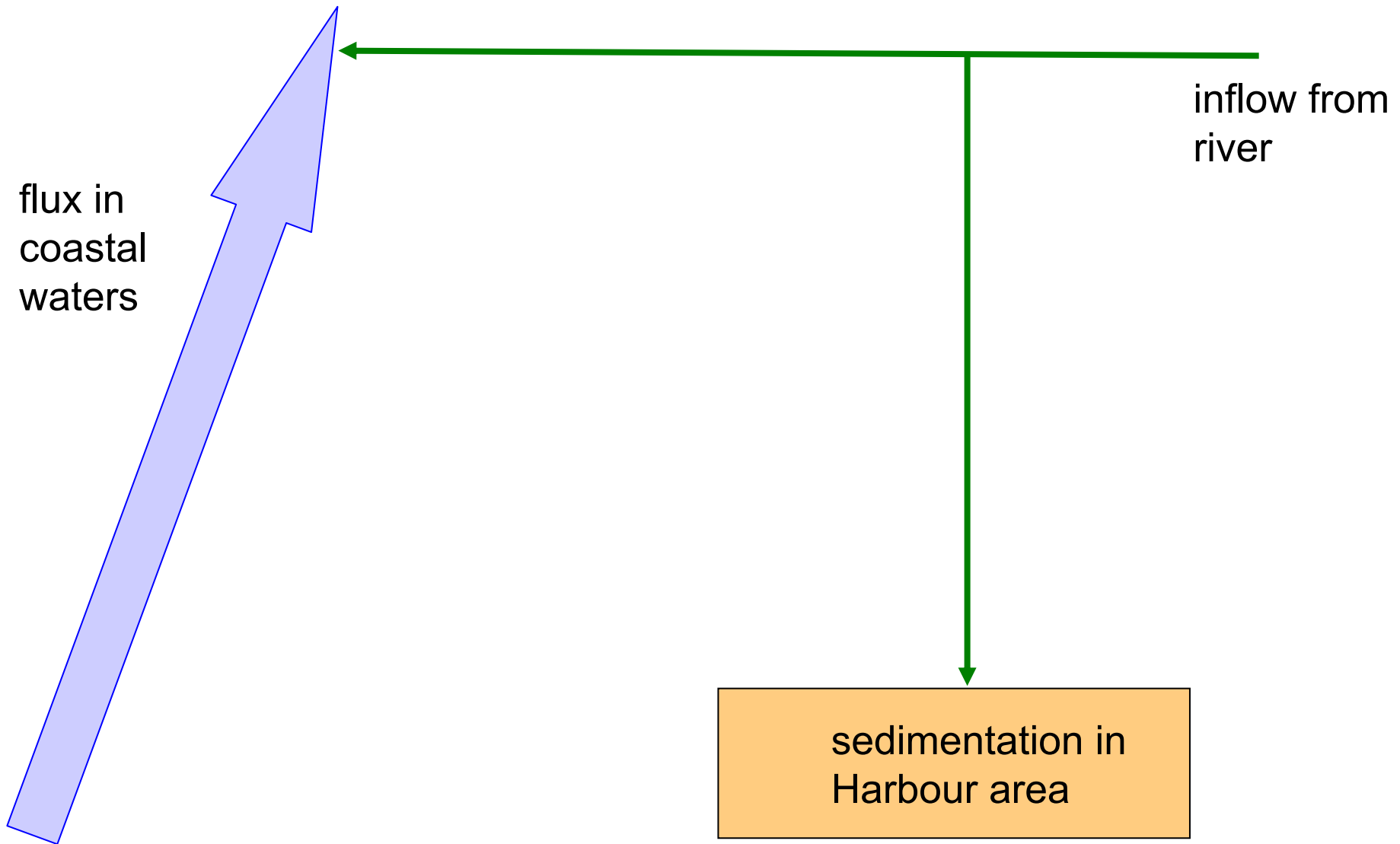
flux in
coastal
waters



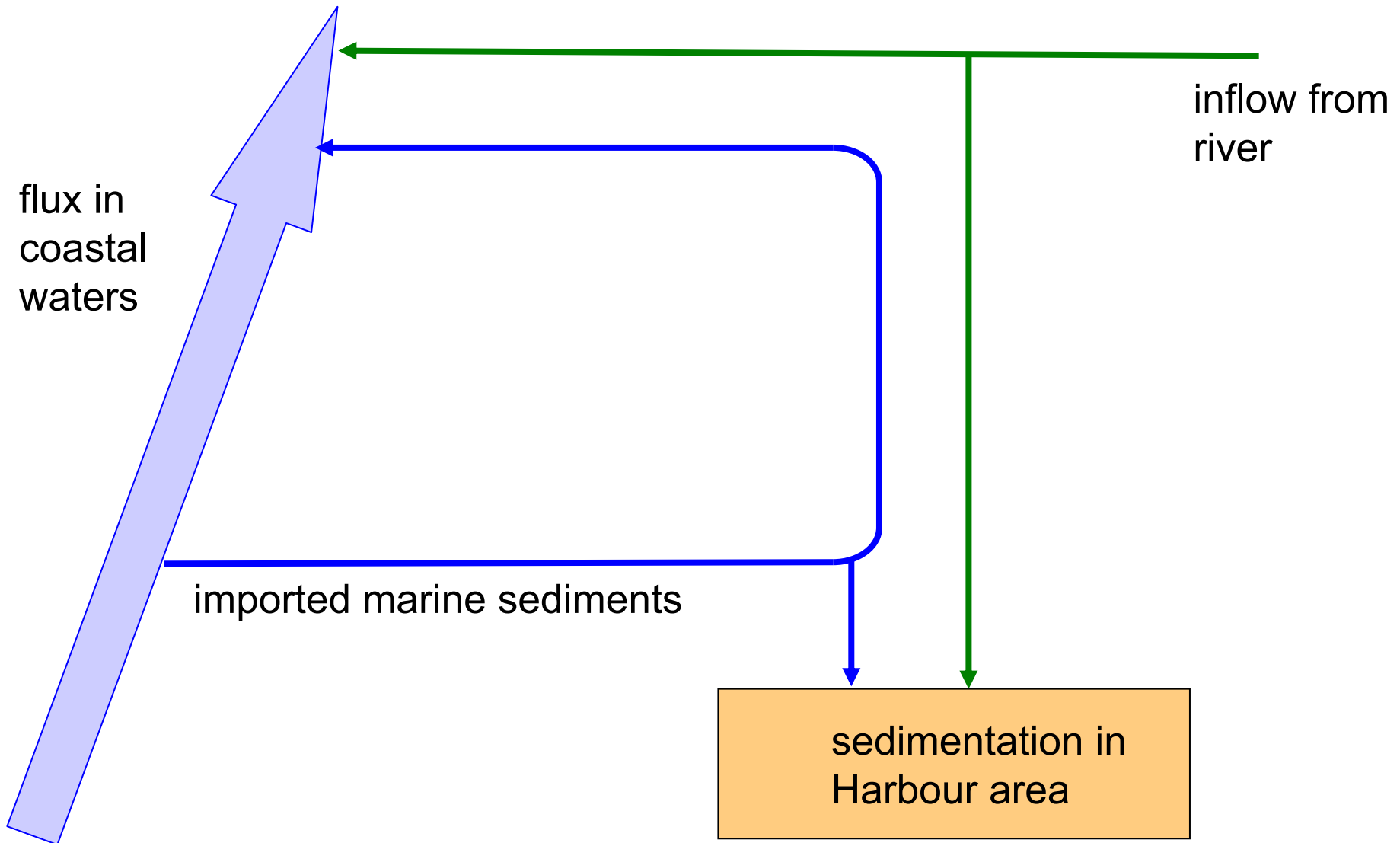
Mass balancing: river and sea



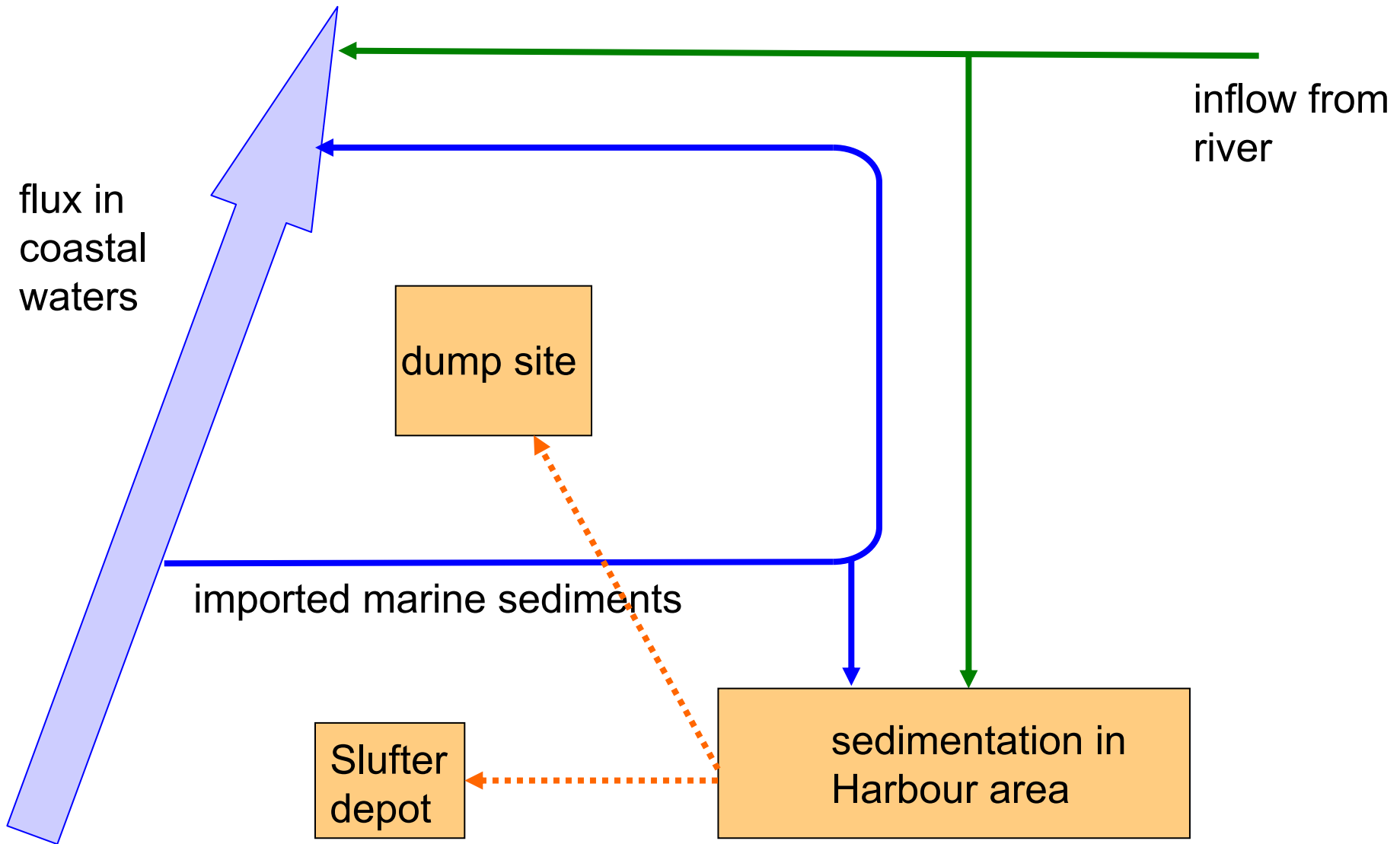
Mass balancing: sedimentation and dredging



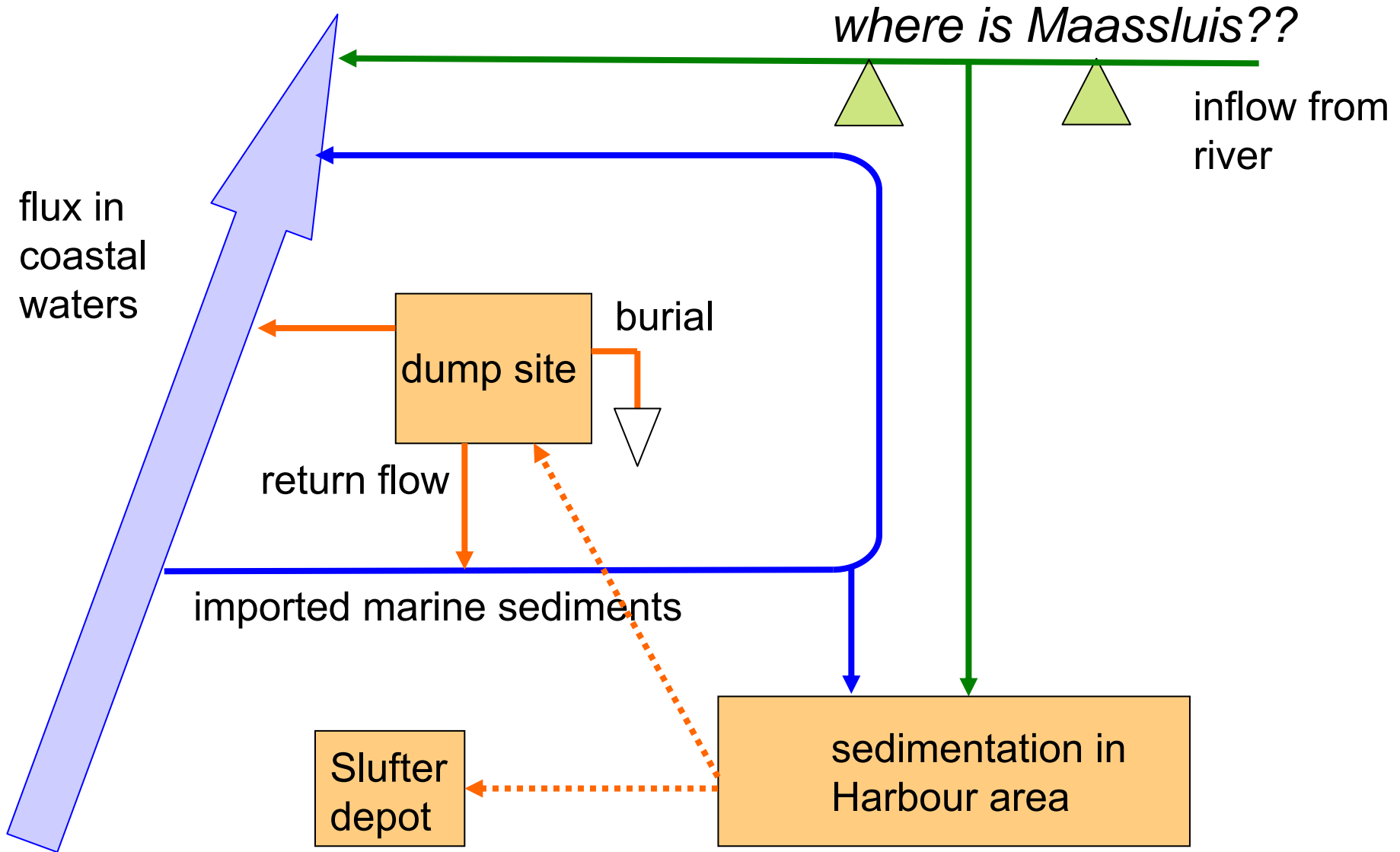
Mass balancing: import of marine silt



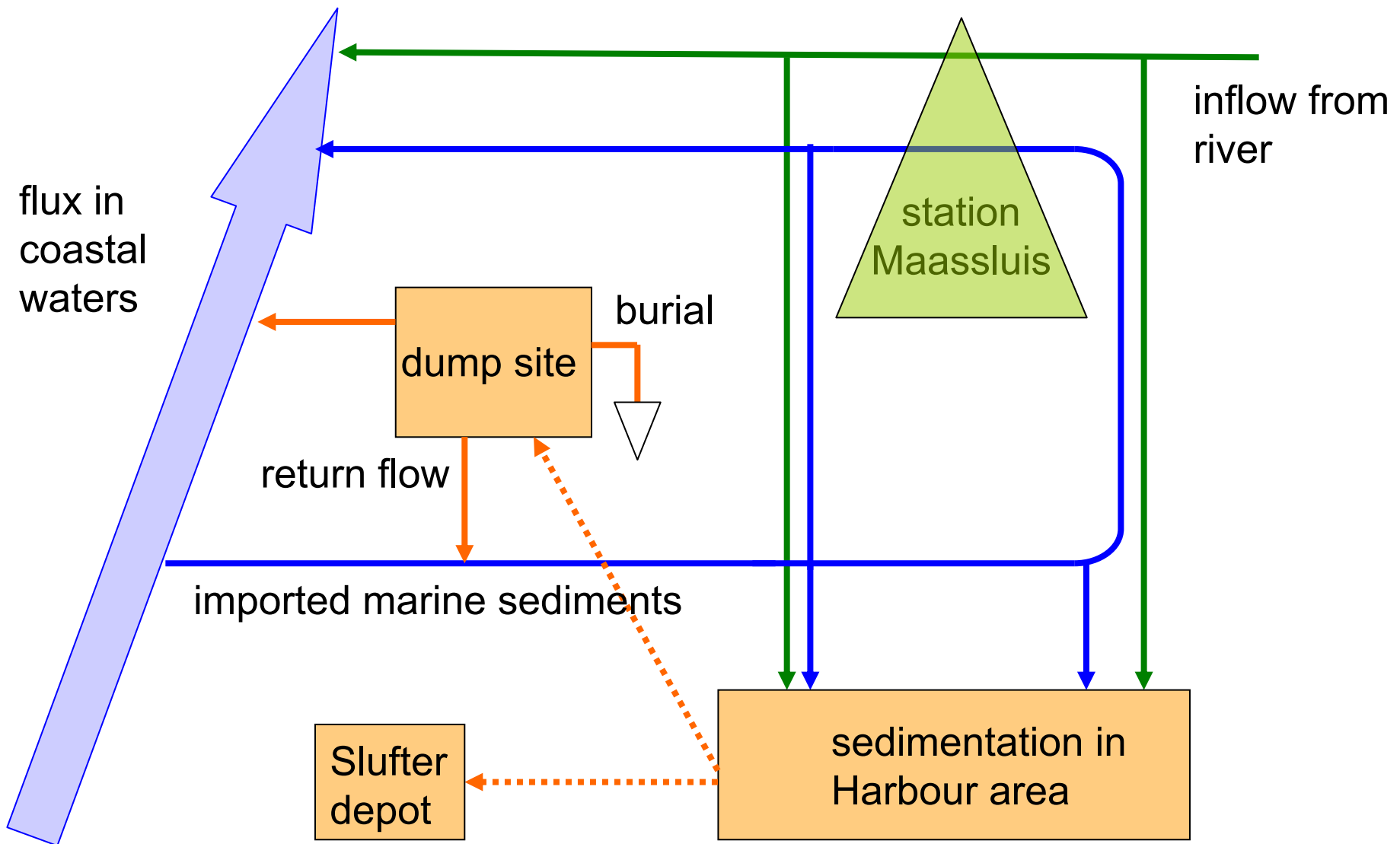
Mass balancing: dredge spoil management



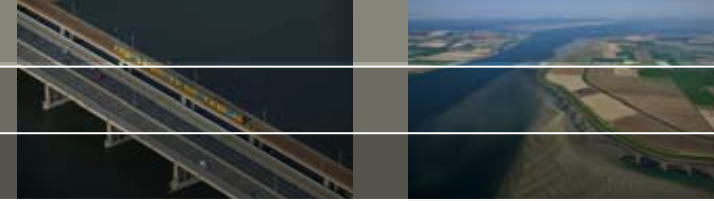
Mass balancing: fate of dumped material



Mass balancing: station Maassluis



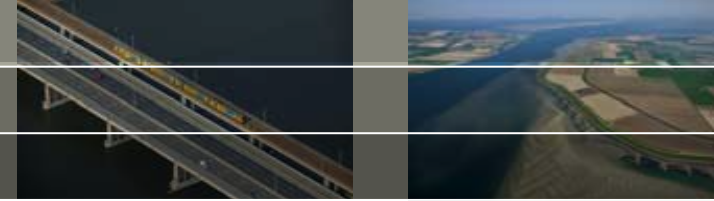
Interpretation (a)



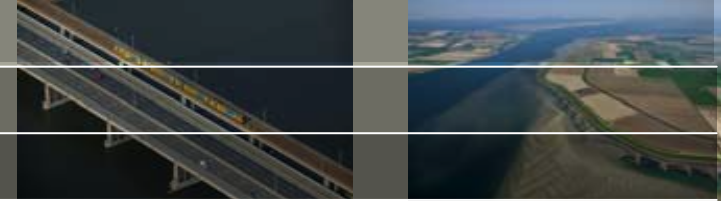
To obtain the “real” flux to the coastal waters, the dumped amounts of chemicals need to be scaled with ≈ 0.4 , due to:

- burial and return flow at dump site
- part of chemicals are of marine origin

Interpretation (b)



- The station Maassluis overestimates the net chemical fluxes flowing towards the North Sea. Correction factors
- ≈ 0.5 (PAHs, Zn, TBT)
 - ≈ 0.7 (Cu, Cd)
- due to
- the SPM passing at Maassluis is partly marine
 - part of the SPM passing at Maassluis will settle in the harbour basins and not directly reach the North Sea



Can marine and estuarine sediments act as a (temporary) source of chemicals in a situation where the emissions show a strong decrease over time?

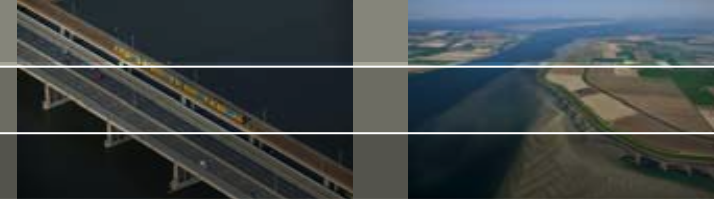
Sediment dynamics in the southern North Sea



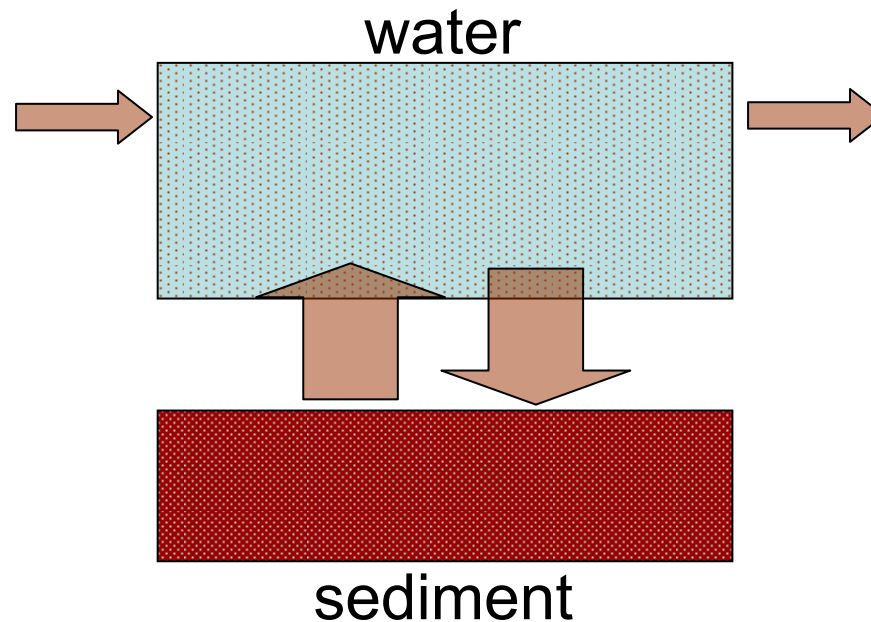
There is a large pool of fine particles in the seabed (as witnessed by increase of concentration during storms over large areas), this pool is much larger than the pool of particles in the water column

There is a strong exchange of particles between the seabed and the water column

Impact of sediment dynamics

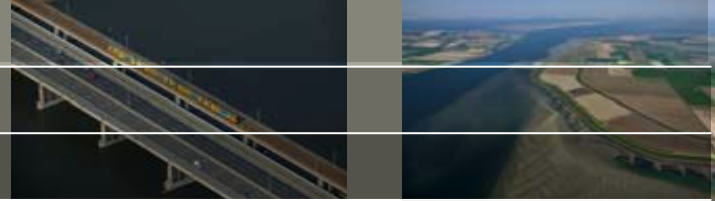


The sediment dynamics affect the water quality, for chemicals sorbed to fine particles



delay and mixing with older particles!

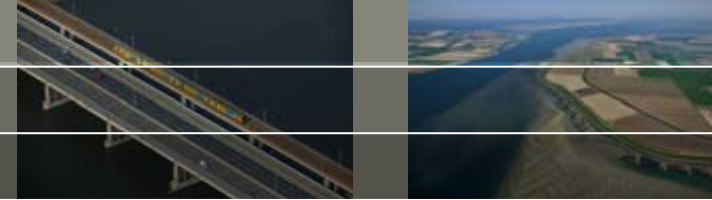
Mathematical modelling



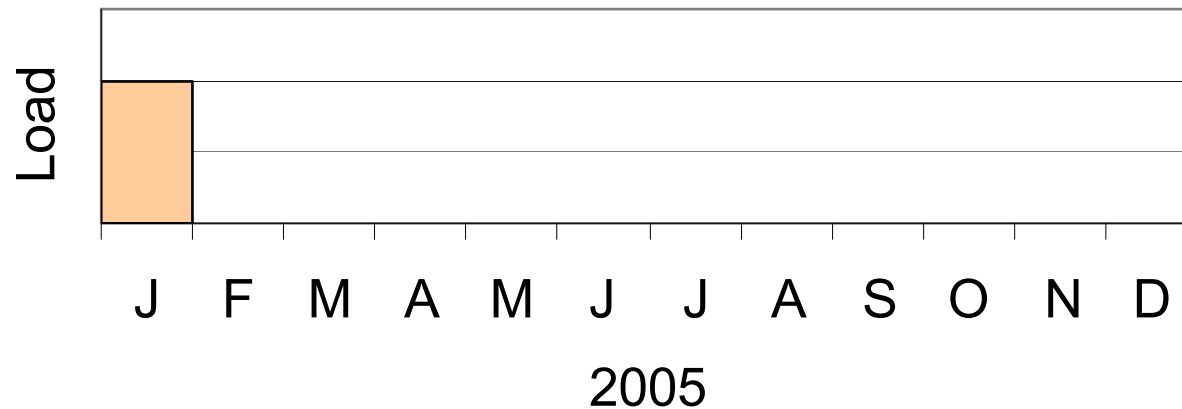
This effect has been quantified using mathematical water quality modelling of the Southern North Sea for priority pollutants

water quality model is 2D, steady state (Scremotox)

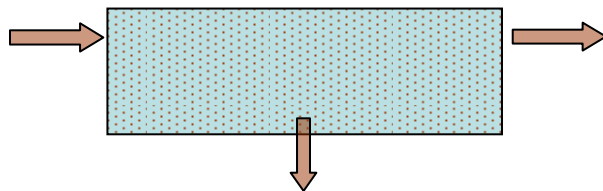
Numerical experiment



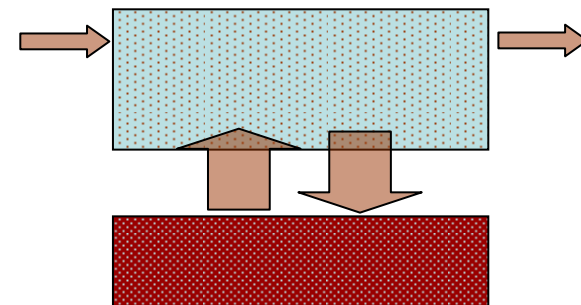
load of strongly adsorbed chemical from Nieuwe Waterweg:



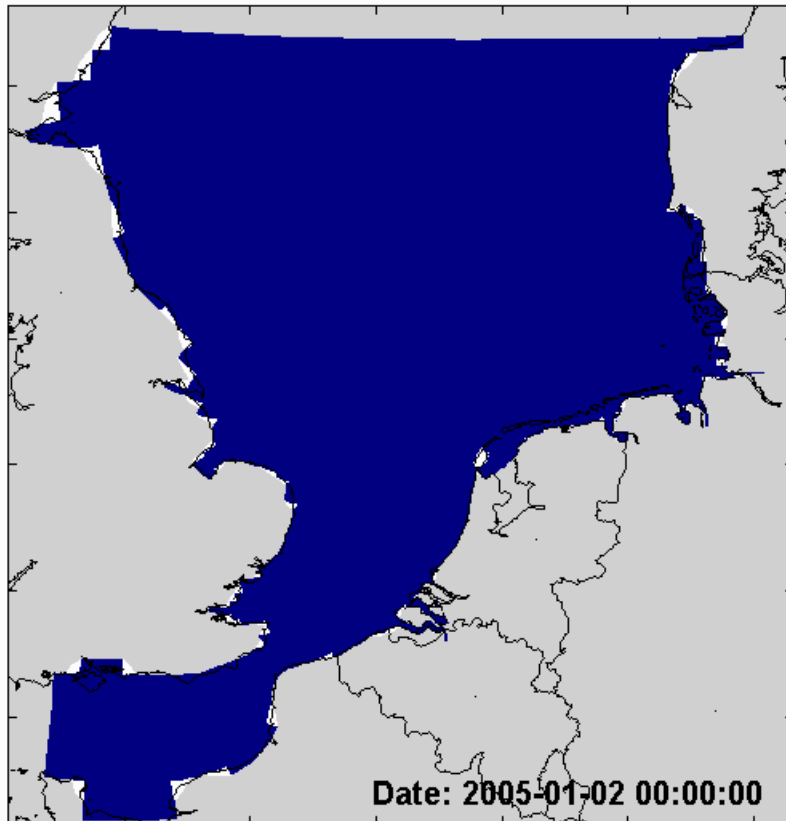
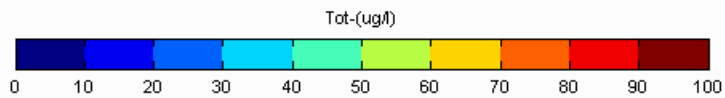
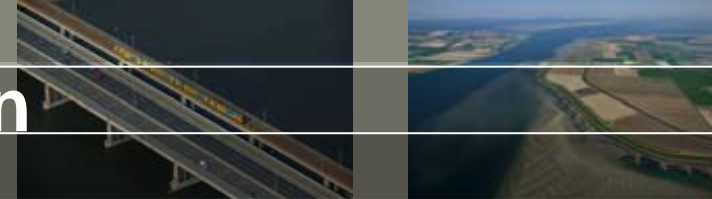
animation left



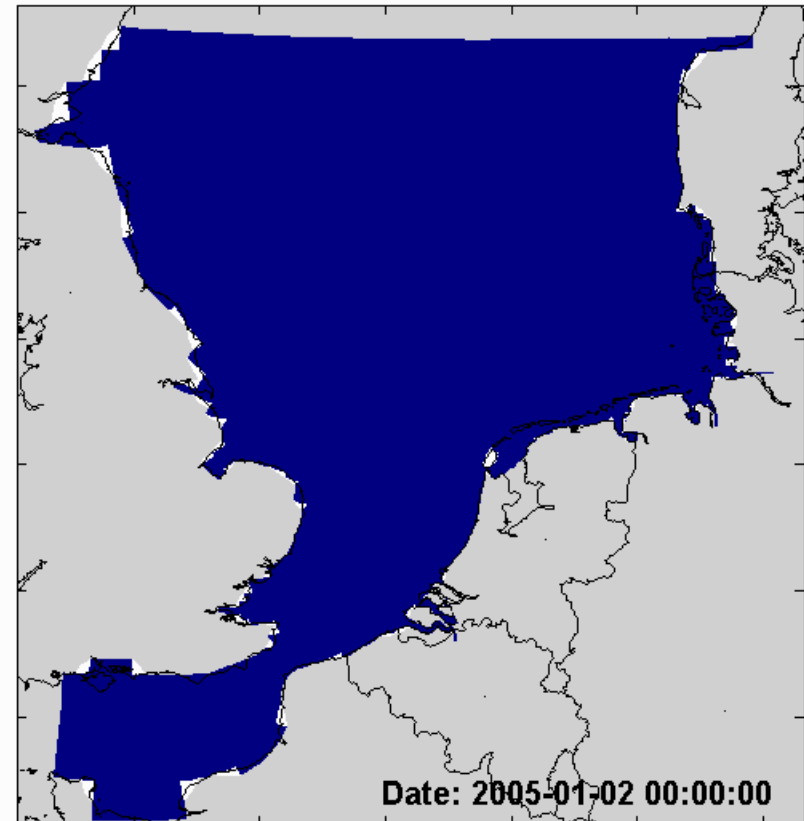
animation right



Impact of sediment interaction

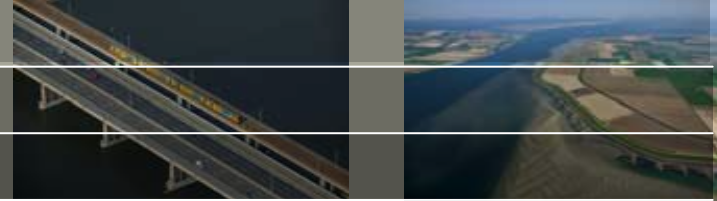


— without sediment interaction



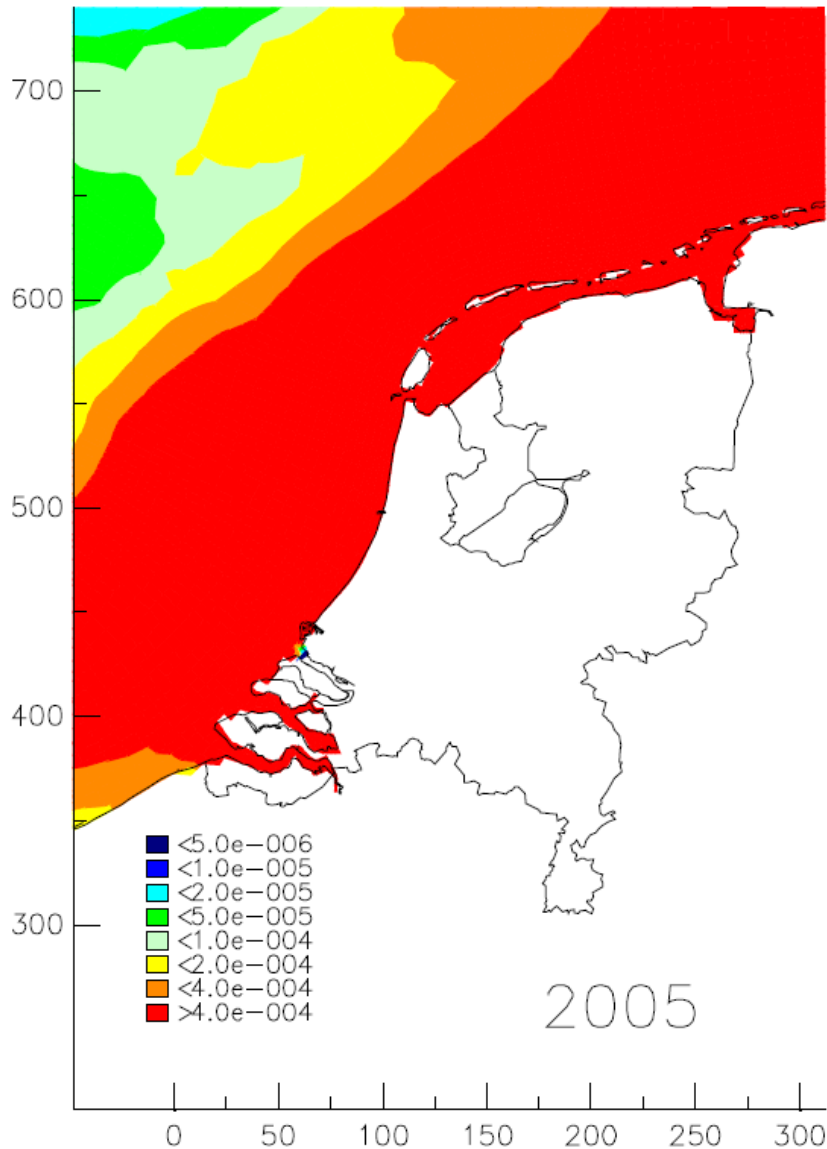
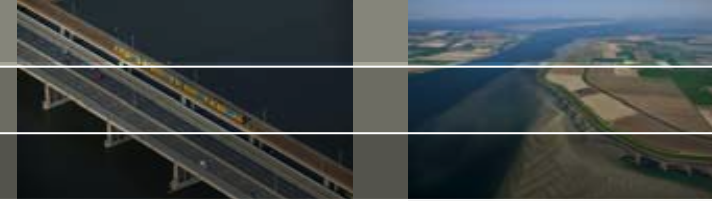
— with sediment interaction

the TBT case



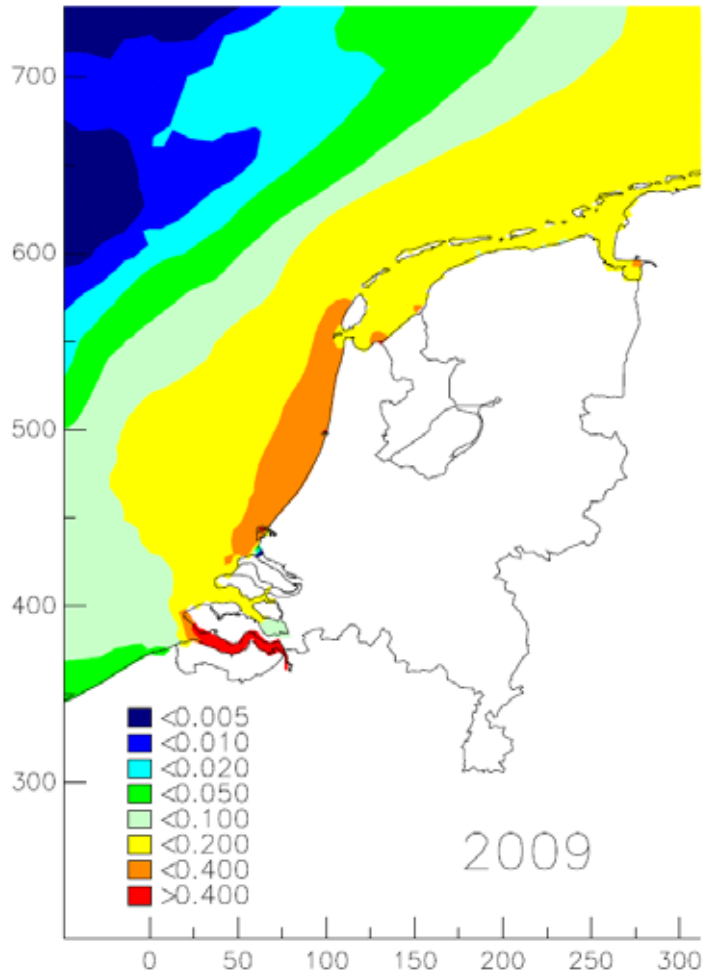
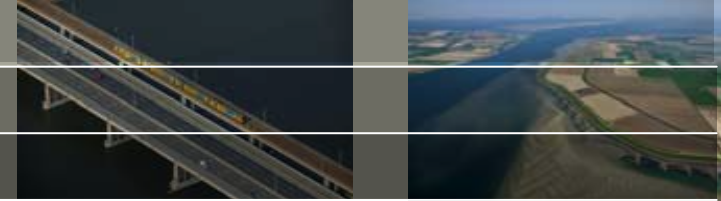
- WFD Water Quality Objectives exceeded over large areas
- Antifouling paints containing TBT have been replaced by other products and are forbidden since 2008
- A strong reduction of the emissions of TBT to the marine environment is taking place
- How will the coastal water quality respond?

hindcast for TBT in 2005

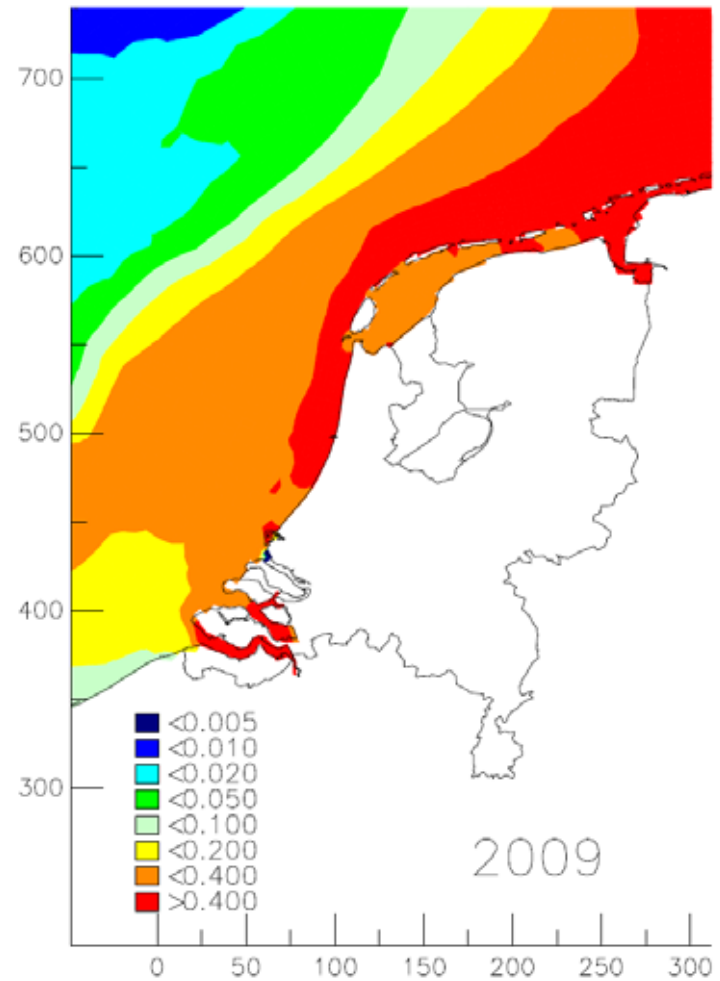


orange and red colour
indicate exceedence of WQO

Prognosis TBT for 2009

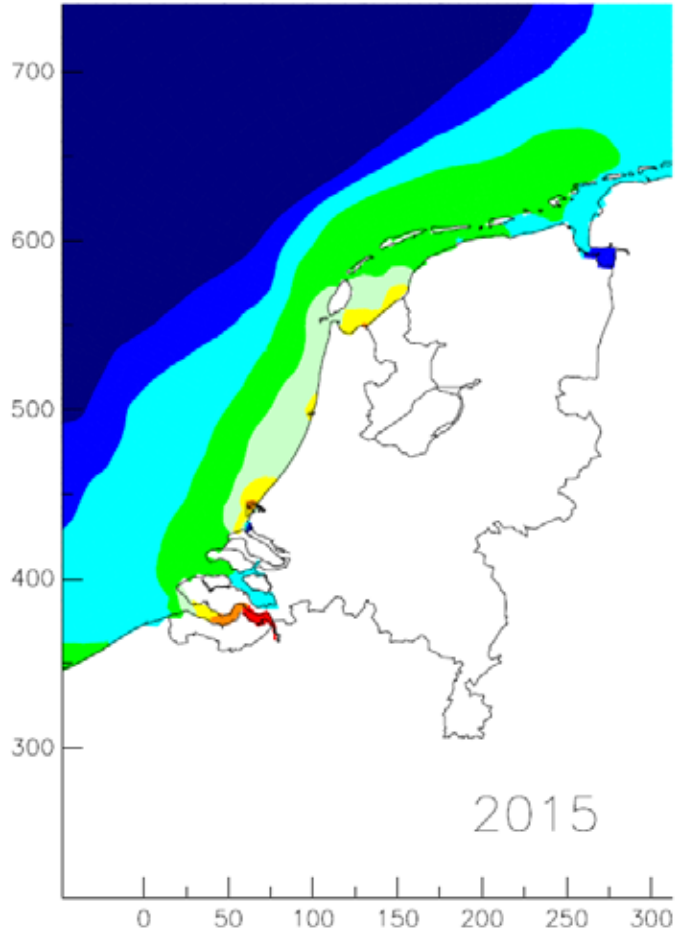
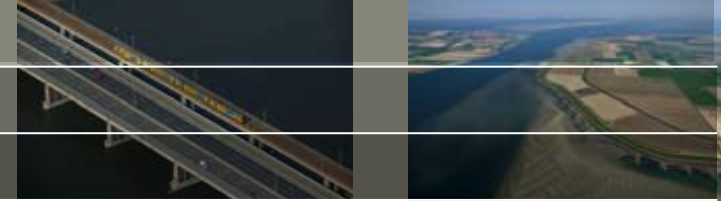


without sediment storage

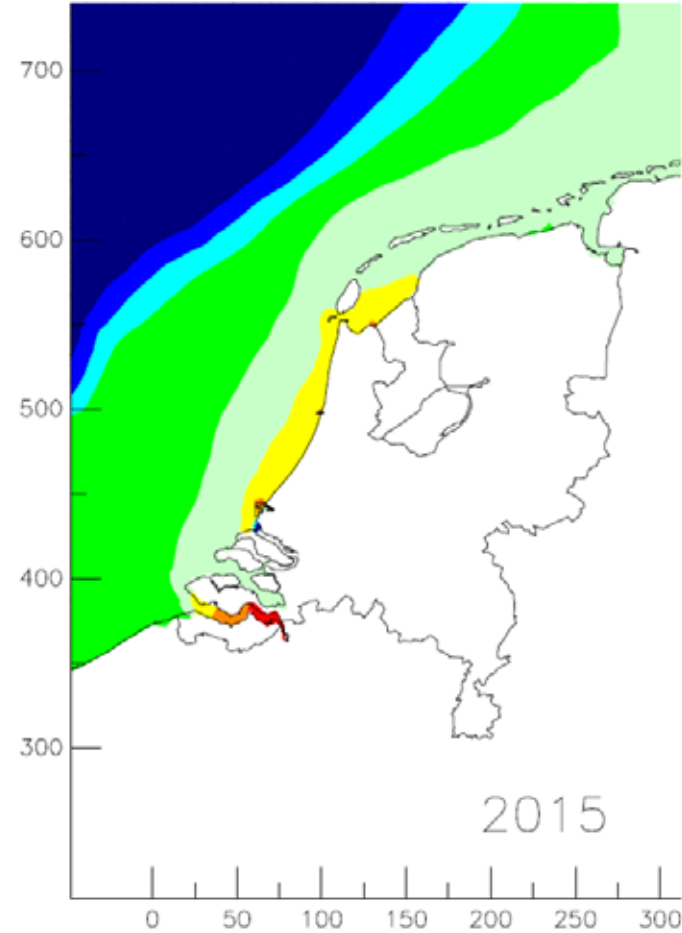


with sediment storage

Prognosis TBT for 2015

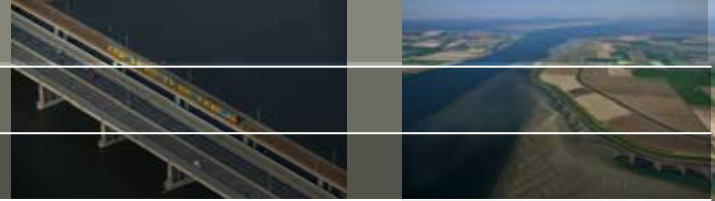


without sediment storage

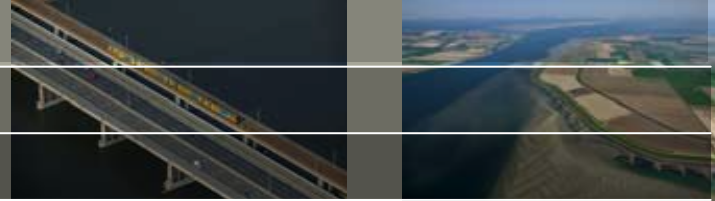


with sediment storage

Conclusions



- Sediment issues are important for WFD compliant water quality management in the Dutch coastal waters
- On the basis of data analysis and mathematical modelling these issues have been successfully quantified:
 - the management of dredge spoil is very relevant in the case of estuarine harbours (like Rotterdam)
 - “fresh” monitoring stations like Maassluis are not always representative for the river loads
 - marine and estuarine sediments act as a temporary source of chemicals in a situation where the emissions show a strong decrease over time



Thank you for your attention