36th IAHR World Congres

Sediment transport in the Schelde-estuary: a comparison between measurements, transport formula and numerical models

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Acknowledgement: *G. Vos, S. Ceuppens, M. Darcis*

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Introduction

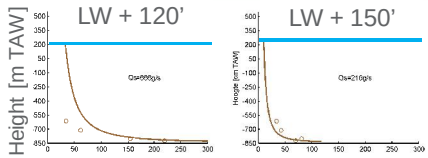
- Research programme “Agenda for the future” (2014-2017)
- Priority topics Schelde-estuary, among others:
  - Tidal propagation
  - Regime shift
  - **Sediment strategy**
  - **…**
- First phase (2014-2015)
  - System understanding
  - Validated research tools

=> Need for sediment transport data

Measurements (2014)

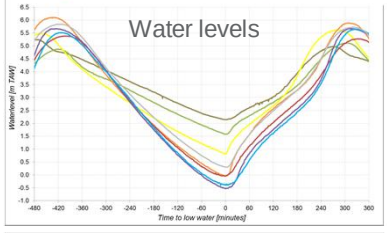
- 8 locations in Zeeschelde, 3 locations at Vlakte van de Raan
- Full tidal cycle (13h)
- Stationary + transects
- Direct and indirect techniques
  - **Delft bottle (4 heights)**
  - **OBS, ADCP-BS**
  - **Pump samples**
- Calculation total transport

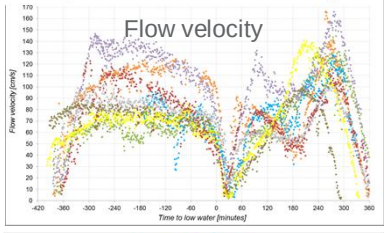
Schellebelle, Schoonaarde, Kruibeke, Oosterweel

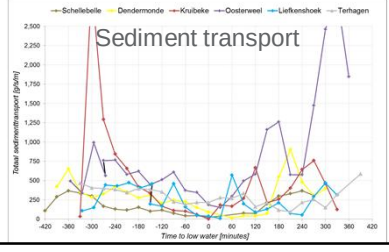


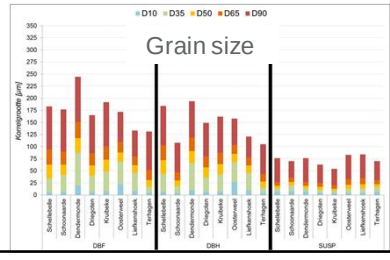
Field measurements: Zeeschelde

Schellebelle, Schoonaarde, Dendermonde, Driegoten, Kruibeke, Oosterweel, Liefkenshoek, Terhagen

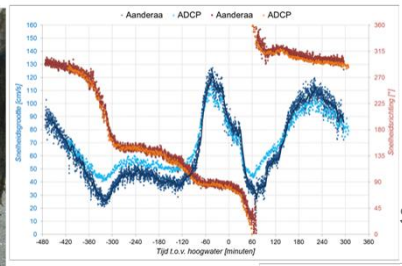






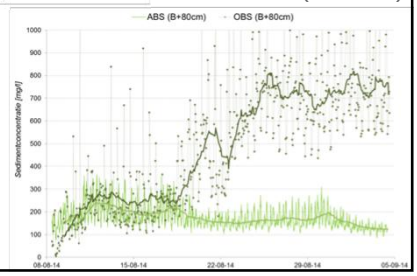


Field measurements: Vlakte van de Raan



Flow velocity (13h)

Sediment concentration (4 weeks)



Sediment transport formula

- Selection based on availability in Delft3D
  - **Van Rijn: bed load (200 – 2000 µm) + suspension load (100 – 500 µm)**

$$q_b = 0{,}1.(s-1)^{0{,}5}.g^{0{,}5}.d_{50}{}^{1{,}5}.D_*^{-0{,}3}.T^{1{,}5} \quad | \quad q_s = F.\overline{u}.h.c_a$$

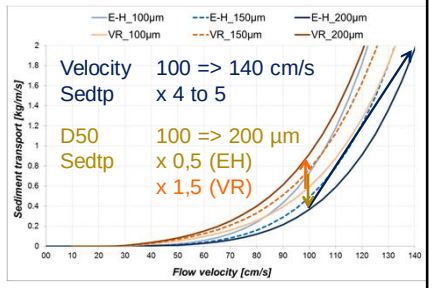
  - **Engelund-Hansen: total load (> 150 µm)**

$$q_{t,c} = \frac{0{,}05\overline{u}^5}{(s-1)^2.g^{0{,}5}.d_{50}.C^3}$$

  - Bijker
  - Meyer-Peter Müller
  - Soulsby - Van Rijn

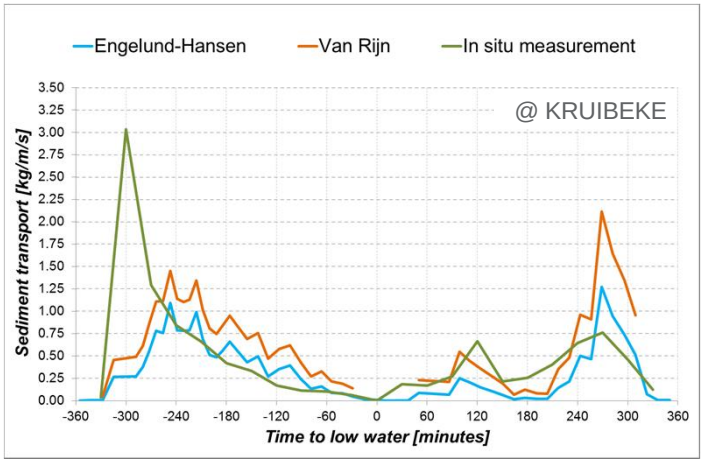
Sediment transport formula: sensitivity analysis

- Variation of some parameters:
  - Flow velocity: 0 – 140 cm/s
  - Grain size: 100 – 200 µm
  - Formula: E-H, VR
- Other parameters fixed:
  - Water depth: 10 m
  - Water slope: 3,2 x 10^{-5}
  - Chézy: 60 $m^{1/2}/s$
  - Water density: 1005 kg/m^3
  - Sediment density: 2650 kg/m^3



Adapted from Ceuppens & Darcis (2015)

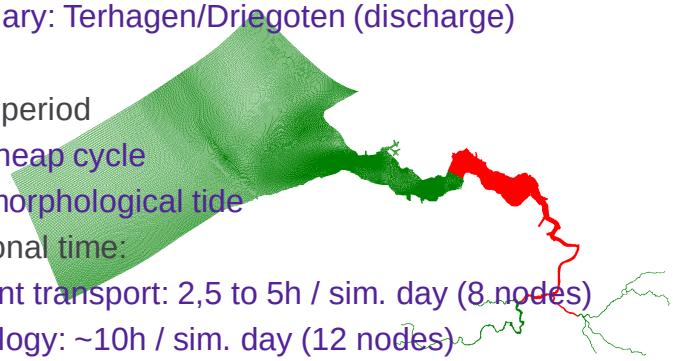
Sediment transport formula



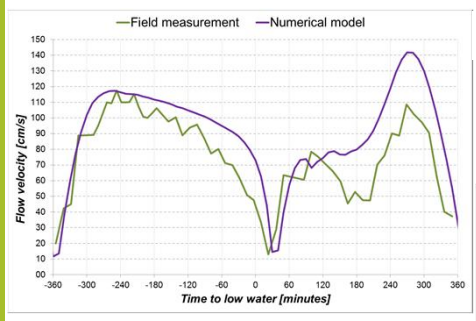
Adapted form Ceuppens & Darcis (2015)

Numerical model Delft3D

- Project: future sediment strategy Beneden-Zeeschelde
- Grid (nested in Nevla) – resolution ~ 25 x 15 m:
  - Down-estuary: Ossenisse (water level)
  - Up-estuary: Terhagen/Driegoten (discharge)
- 2D-model
- Simulation period
  - Spring-neap cycle
  - Cyclic morphological tide
- Computational time:
  - Sediment transport: 2,5 to 5h / sim. day (8 nodes)
  - Morphology: ~10h / sim. day (12 nodes)



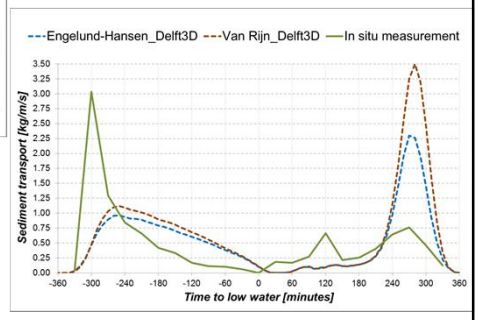
Numerical model Delft3D



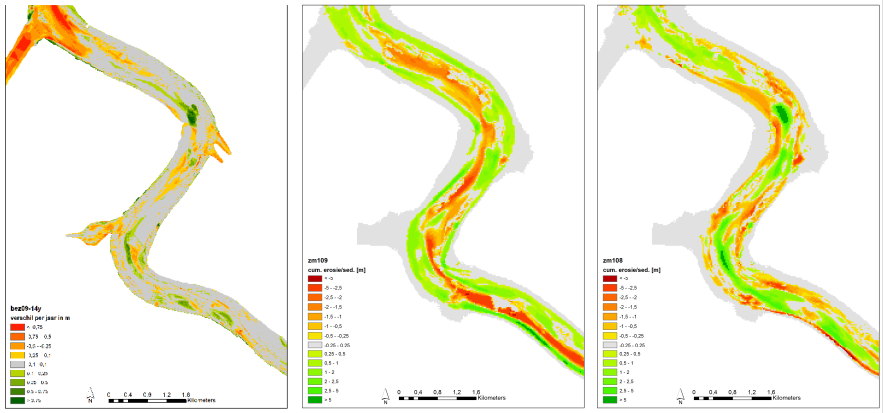
Flow velocity

@ KRUIBEKE

Sediment transport



Morphological model



Measurements | Van Rijn (150 µm) | Engelund-Hansen (150 µm)

Conclusions

- Measurements
  - **Optimal measurement strategy and techniques**
  - **Uncertainties on results**
- Formula
  - **Limited applicability**
  - **Dependance of flow velocity ⇔ importance of inertia**
- Numerical modelling
  - **Limitations due to formula's**
  - **Spatial and temporal variation (e.g. sediment)**
  - **Morphological respons**

Need for reliable sediment transport & morphological data !!

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