flanders HYDRAULICS RESEARCH

De Schutter J.; Vanlede J.

Flanders Hydraulics, Flemish Government, Berchemlei 115, 2140 Borgerhout, Belgium

Sediment research by Flanders Hydraulics Research in the Scheldt basin

Research based on monitoring and modelling

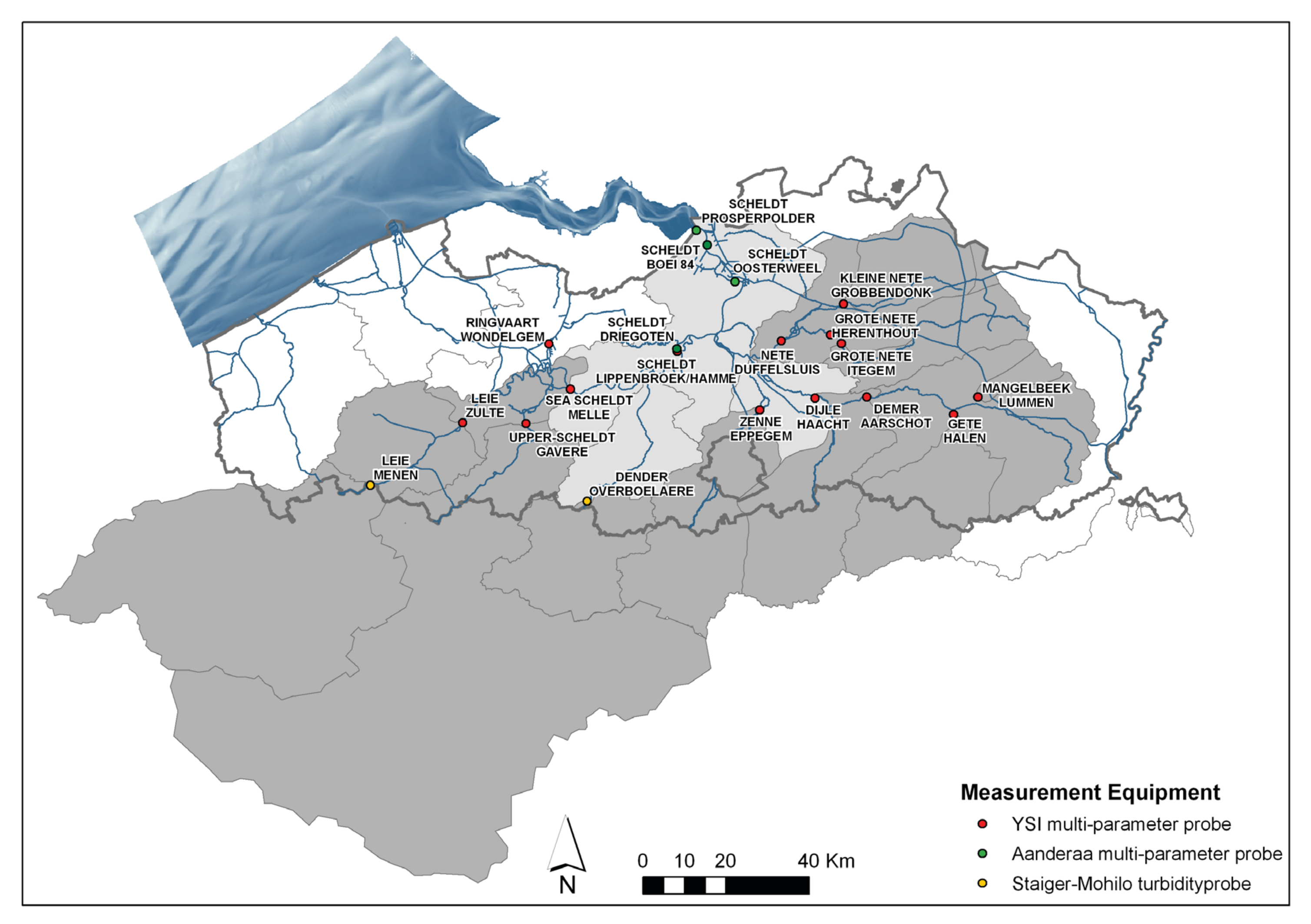

Figure 1. Monitoring & Modelling Sediments in the Scheldt basin

Monitoring

Localisation and goals of the monitoring network

Besides exploiting a monitoring network in the tidal area of the River Scheldt basin, Flanders Hydraulics Research (FHR) also monitors sediment transport and water discharges in a network upstream of the tidal area (http://www.waterstanden.be) (see Figure 1). The monitoring started in 1993, and has been extended and optimized since then.

The goals of the monitoring network are both the budgeting and the characterisation of sediment fluxes in the tributaries of the River Scheldt, as sources of fluvial sediment to the downstream tidal area. This data is used i.a. in the mud-transport model, that has been developed in FHR, but it also increasingly finds its way towards policy documents like the river basin management plan of the Scheldt.

Monitoring methodology

An important evolution in the methodology of the measurements has occurred: initially the monitoring was comprised of weekly manual sampling to determine suspended sediment concentration (SSC) which was later complemented with 7-hourly automated sampling (Figure 3) and later on with turbidity probes (which measured every 15 minutes). These measures were executed to create a more continuous sampling schedule, which lead to obtaining insight in the dynamics of sediment fluxes in several river systems. From 2005 onwards, the turbidity probes have been replaced by multi-parameter probes (Figure 3, Figure 4), which monitor several parameters relevant to the ongoing research in the Scheldt basin (MONEOS, dredging-related research,…). Furthermore, the point measurements of SSC and turbidity are being related to cross-sectional sampling (Equal-Width Increment sampling (EWI)), by use of a depth integrated sampler.

Figure 3. Multi-parameter probe and ISCO sampler

Figure 4. YSI deployment at Boven-Scheldt

Flux calculation methodology

For every monitoring location, a continuous time-series for SSC needs to be composed. This is procured by initially using the available 7-hourly automatically pumped sediment data, and consequently extending this to 15-minute values by using rating curves to fill in the blanks.
The applied rating curves can be based on relationships between turbidity and SSC or between water discharge and SSC. When available, the point measurements are corrected to cross-sectional SSC-values.
Afterwards, the 15-minute SSC values are multiplied with their respective discharge values measured at the same time, to calculate the sediment flux.
Figure 5 shows the results of these calculations for the period 1999 – 2009; while Figure 6 shows the specific sediment export per ha for the same period.

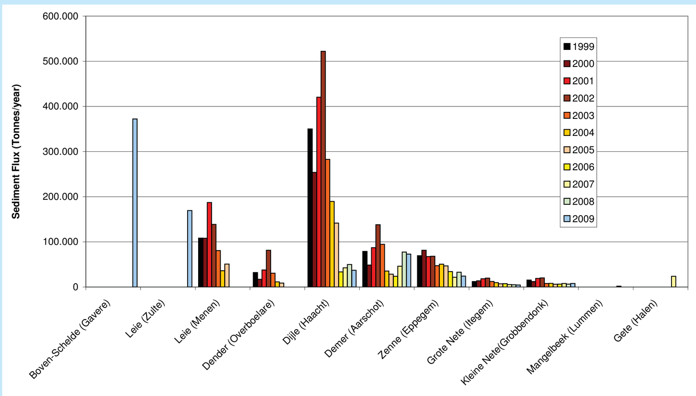

Figure 5. Sediment Fluxes as observed in various tributaries of the River Scheldt

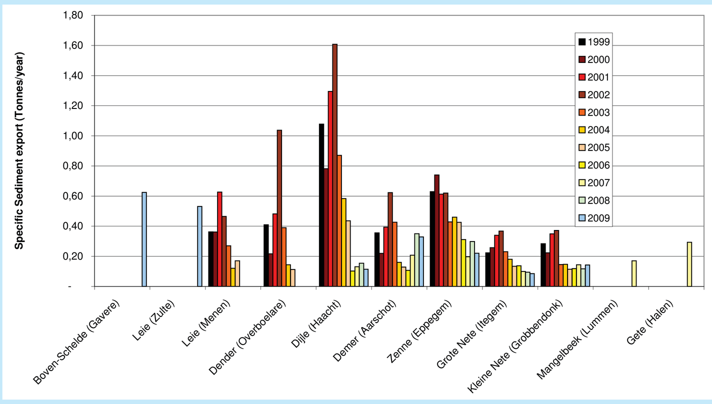

Figure 6. Specific Sediment Export fluxes 1999-2009

Modelling

Introduction

A mud-transport model for the Scheldt Estuary has been developed within the framework of the Long Term Vision project (LTV O&M). LTV is a joined Dutch-Flemish research and monitoring programme initiated in 1999, dealing with accessibility of the ports, safety against flooding and preservation of nature. In 2006 it was decided to develop a numerical transport model of the Scheldt Estuary with the purpose to support governmental managers with the tools to evaluate managerial issues. The development of the model is a joint effort of Deltares (Delft, the Netherlands) and Flanders Hydraulics Research (Borgerhout, Belgium).

Figure 2. Modelled depth-averaged SPM concentration

Long Term Vision Research and Monitoring programme
Scheldt Estuary: Accessibility, Safety, Sustainability
Joined Dutch – Flemish effort
Transport model developed by Deltares and Flanders Hydraulics Research

Model Description

The model is a full three-dimensional CFD-based (Computational Fluid Dynamics) Eulerian transport model. The model covers the whole Scheldt Estuary, including downstream a part of the North Sea and the Port of Zeebrugge. At the upstream boundaries the model includes part of the rivers KLeine Nete, Grote Nete, Dijle, Zenne, Dender and Bovenschelde. Time series of fresh water inflows from these rivers are provided by Flanders Hydraulics Research.

Transport of mud and sediment is driven by advection and dispersion. The flow currents and dispersion coefficients are precompiled by a decoupled hydraulic model: TRIWAQ, a module of SIMONA, developed by Deltares. This model solves the 3D Shallow Water Equations on a grid consisting of 224.423 grid cells in horizontal direction and 6 vertical layers (≈ 1.35 mlj grid cells). The hydraulic model is driven by tidal waves at the see-ward side and fresh water discharges from upstream boundaries. The model takes into account wind forcing and gravitational forces caused by salinity differences.

The transport model is implemented within the Delft3D-WAQ software. The model accounts for inorganic marine and fluvial sediment fractions separately. Next to the transport driven by the currents, the model also accounts for sedimentation and bottom layer erosion. To account for the effects of dredging activities for long term computations the model is coupled with a dredging/disposal module taking into account dredging frequencies and disposal location. Typically one model run covers one year in order to take into account seasonal effects.

Hydraulic model:

- TRIWAQ (Simona, Deltares)
- 3D Shallow Water Equations
- 224.423 grid cells in horizontal direction, 6 layers vertically
- Tidal Waves, fresh water discharges, salinity, wind forcing

Transport model (offline):

- Delft3D-WAQ
- Martime and fluvial (inorganic) sediment
- Advective – diffusive transport
- Sedimentations and erosion
- Dredging/disposal module
- One Year simulations

www.watlab.be

department Mobility and Public Works