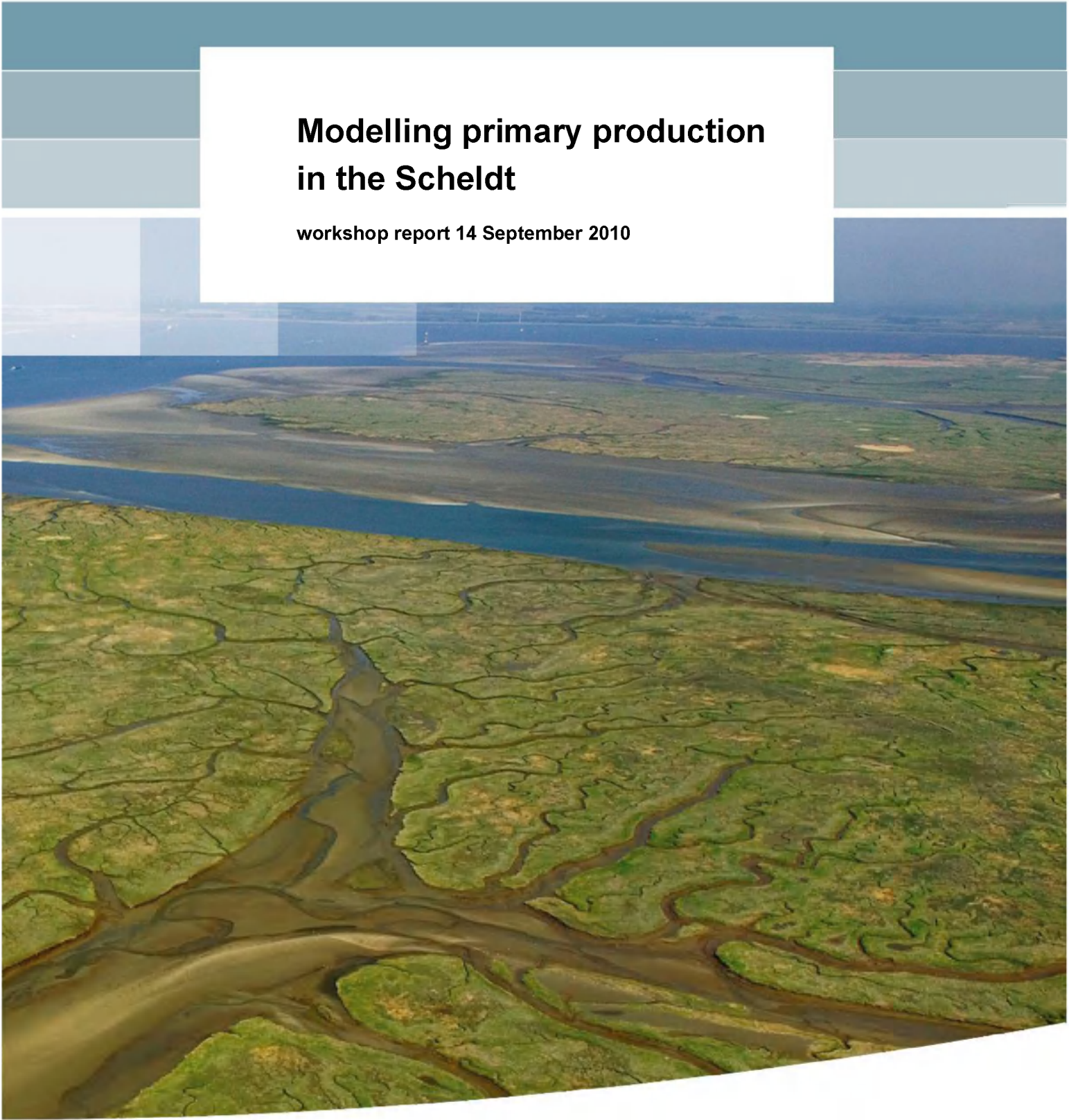


Modelling primary production in the Scheldt

workshop report 14 September 2010



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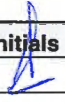

Keywords

Primary production, modelling, measurements, LTV-O&M, Schelde

Summary

On the 14th of September 2010 a workshop was held with a small group of experts on modelling primary production in the Schelde and factors regulating production. The results of the modelling exercises within LTV-O&M were presented. Furthermore, presentations on Flemish projects (past and present) on primary production, methods of modelling benthic primary production and measurements on benthic algal biomass and primary production were given.

Improvements, errors and future efforts regarding the Deltares model were discussed, as well as cooperation with other institutes. The need for validation and calibration data was discussed.

Version	Date	Author	Initials	Review	Initials	Approval	Initials
	nov. 2010	dr. L.A. van Duren		dr. F.J. Los		ir. T. Schilperoort	
		dr. W. Stolte					

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1 Participants

The following persons participated in the workshop

Participants

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The following persons had indicated an interest in the workshop, but could not be present.

Not present

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Erika Van den Bergh	INBO	Erika.vandenbergh@inbo.be
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2 Programme

The workshop was held at Best Western hotel Goderie in Roosendaal.

time	subject	presenter
10:00 - 10:30	Arrival + Coffee	
10:30 - 10:40	Introduction to the workshop	Luca van Duren
10:40 - 10:50	Introduction round of all participants	
10:50 - 11:30	Presentation of Deltares Primary production model	Erika Martini
11:30 - 12:00	Modelling Primary production in the Scheldt at the University of Antwerp	Tom Cox
12:00 - 12:20	Modelling benthic primary production	Karline Soetaert
12:20 - 12:40	Measuring primary production	Jacco Kromkamp
12:45 - 13:30	Lunch	
13:30 - 14:45	Discussion future developments	
14:45 - 15:00	Wrap-up, summary of conclusions	Luca van Duren

15:00 Drinks

3 Presentations

3.1 Introduction (Luca van Duren)

This presentation gave a brief overview of the background of the LTV O&M programme, the aim of the project on primary production modelling and an outline of the purpose of the workshop. Specifically the goals of the workshop were:

- A discussion of the current state of play with experts. What is good, what needs improving, what are the first priorities for improvement (bearing in mind that there are several issues that can be improved)
- Future developments
- benthic primary production
- Scenarios
- Possible cooperation with ongoing projects
- Datasets for validation and calibration
- Available
- Wish list from monitoring programs
- Level of detail required
- Requests to Thijs and Joris regarding the silt model

3.2 Primary production model for the Westerschelde (Erika Martini)

This presentation gave an overview of the setup of the model, the parameters, the forcings, grid details and the results so far. Currently the model only includes pelagic primary production. There is a basic option in the model to include benthic production. There are some routines available at Deltares, but the most sophisticated one (and probably the most suitable for this model) has not been properly validated. Currently there is a problem with the data available from the Flemish part of the Schelde. There are better data available at Antwerpen, and these will be used in the near future. There are discrepancies between the data and the model predictions regarding nutrients near the border, but this is almost certainly due to the fact that the loads from the upstream part are not correct.

3.3 Primary production modelling in the Scheldt (Tom Cox – NIOO & University of Antwerp)

Tom Cox gave a historic overview of the various types of models that have been developed over the years, some with very elaborate transport details, but less sophistication on the biological side and some focussing on the biological processes but with less emphasis on hydrodynamics, sediment and nutrient transport.

This presentation also stressed the importance of long-term data sets. These indicate that major changes have taken place in the estuary over the past decades and these trends are continuing. There are major changes in the zooplankton abundance and composition. Part of this change can be explained by the improved oxygen levels in the system. The onset of this change predates the start-up of the waste-water treatment plant near Brussels. This is expected to augment the trend, but the water purification plant is not the only cause of improvement of the system. This presentation illustrated the need for an accurate assessment of the grazing component for primary production modelling, i.e. for the Schelde:

zooplankton. There are data regarding zooplankton in the Belgian part of the estuary, but no recent data in the Dutch part.

3.4 Modelling benthic primary production (Karline Soetaert – NIOO)

The presentation gave an overview of the modelling efforts at NIOO, specifically on benthic primary production and the relationship between production, diagenetics and hydrodynamics and also the effects of pH (within ocean acidification frameworks). Currently the focus is less on the Schelde estuary but more on e.g. the Wadden Sea and also on conceptual modelling (regardless of specific systems). Benthic nutrient fluxes are important as the sediment acts as a buffer with respect to the water. To what extent these benthic fluxes affect ecosystem wide estimates of primary production is difficult to say without any available data.

3.5 Measuring benthic algal biomass and primary production (Jacco Kromkamp)

This presentation showed that benthic production can sometimes be of the same order of magnitude as pelagic primary production. Particularly the patchiness and the temporal variability in benthic algal cover and therefore primary production makes integrated estimates of these parameters difficult. The presentation showed the advantages and disadvantages of various techniques of estimating biomass as well as primary production. Technologies for estimating biomass as well as production using optical techniques that integrate over a larger area have been improved. In order to model benthic primary production knowledge is required of inundation times and exposure, but also of sediment optics and vertical migration of diatoms through the sediment.

4 Discussion

The report of the discussion below is not an entirely chronological reflection as it took place at the workshop. Certain remarks were made during the talks, and sometimes the discussion returned to previous topics. The issues have been grouped by topic.

4.1 LTV-Model

- Phytoplankton currently does not specifically include *Phaeocystis*. As this single species sometimes can make up 50% of the total biomass this should be added as a separate species, rather than be included in the bulk of marine green algae. (Jacco)
- Respiration appears not to be realistic. There should be net oxygen production at time and space (Jacco)
 - This is actually the case, but may not have been visible due to colour coding. However, this will be checked and if necessary addressed
- Microphytobenthos is currently not in the model is the defect with the highest priority
 - There is currently a simple module available, which is a modification of phytoplankton module. It contains one species of diatom, no variation of light variation compared to tides etc.
 - A more complex option is available from earlier developments (Waddenzee). It includes 2 kinds of diatoms and includes effects of tide on light climate. Although it has been developed 7 years ago it has not been validated and is not proven technology. (This is the best option, but takes more time to include and test than other alternatives)
- Grazing by bivalves/zooplankton

- Zooplankton influences standing stock phytoplankton. To what extent primary production may be influenced, remains to be assessed. It is essential for primary production modelling to get a realistic estimate per compartment of the grazer impact on the system.
- Bivalve effects are unknown, but this effect is probably not important for nutrient regeneration (as opposed to e.g. the Oosterschelde where this is a major issue to take into account). (Hyper)benthic grazers (such as *Corophium*) affect microphytobenthos standing stocks and the stability of mats. In a next phase of the project this may be important to take into account. Benthic grazers are potentially important for higher trophic levels, such as birds. These higher trophic levels are the prime target of conservation laws and regulations, i.e. relevant for policy makers.
- Low oxygen stress for primary producers occurred only in historical times. In the past this may have had a serious impact on productivity, but over the past decade this has diminished considerably. It is not recommended to include effects of oxygen stress on primary production (Tom).
- Production of phytoplankton above mud flats
 - The effects of erodibility of mudflats on production in the water column are difficult to assess. There is a miss-match in the time scales of phytoplankton production and residence times above mud flats. It is not clear if these factors are important to include in the model, in order to calculate primary production significantly.

4.2 Measurements and required input data

- Belgian nutrient loadings
 - Nutrient data readily available. In a separate meeting the further participation of the University of Antwerp group and data exchange will be discussed.
- Complete lack of benthic biogeochemistry monitoring data
 - Nutrient fluxes from the sediment are important for the time scale of processes. Sediments are the memory of the system. A Belgian research vessel in the North Sea coast was able to include flux measurements in their programme without much extra cost (Karline).
- Complete lack of zooplankton data
 - This is a serious problem and will have an impact on the timing of the bloom breakdown
- Modelled loads
 - The model Pégase from VMM and the University of Liège could be used as an additional input for nutrients, but it is poorly documented. There is probably little additional value in using Pégase over the measured data from the OMES database.
 - Scheldt model Billen should be available
- Benthic cyanobacteria are currently not in the model
 - They tend not to be very dominant. Therefore this omission is low on the priority list
- Anoxic benthic photosynthesis – nothing is known about the magnitude and therefore the importance.

4.3 Requirements monitoring programme

- Zooplankton. There are some data available in the Belgina part of the Schelde, but the Dutch part needs better input. This is crucial both for the modelling of algal

biomass and productivity, but also for the translation of effects of changes in productivity to higher trophic levels.

- Primary production, particularly benthic production. Currently data are available on biomass, but as turnover times can vary by orders of magnitude, production data are important for validation of the model and for general understanding of ecosystem functioning (beyond the numerical model).
- Nutrient fluxes from the sediment. Importance is difficult to assess due to a total lack of data. This will particularly have an impact on the time-scale of nutrient cycling.

4.4 Feedback to silt model due to EPS in relation to benthic diatoms

- EPS (extracellular polymers) stabilise sediment
- Traps silt
- There are feedbacks on the silt dynamics that are currently not taken into account in the silt model
 - Including this is possible in principle, but difficult depending on spatial scale (Thijs). Question to what extent it is important to calculate exact mud concentration above mud flats. The process is scale-dependent. It averages out on sufficiently large scales. We should compare grid size with patchiness. In the longer term it may be an important issue for improvement, but the first step would be to get a benthic primary production module set-up and running.

4.5 Scenarios

- Full year model run 2006. This has highest priority.
 - 2006 shows anomalies, however very few years are really average years.
- Effects of the wastewater plant
 - The idea to compare one year before and one year after the wastewater treatment plant is operational is not useful (Patrick). The trend of improved water quality had already started well before the plant became operational. There is a regime-shift due to the disappearance of the strong hypoxia. There are too many other factors (irradiance, precipitation) that cause large-scale year-to-year variability so a simple before-after comparison of 2 random years will not teach us much about the system or the impact of the plant.
 - A 10-year simulation is a more useful exercise. If data are available it is not a real problem to include more years and longer simulations. Data availability over a full 10 year period may be a bottleneck.

4.6 Ecosystem functioning on either side of the border

Would it be sensible to run separate modules for production for the Belgian and the Dutch part?

- Pro: in the two systems different processes are dominant and processes run on different time scales
- Contra: There is strong interaction between systems
 - It may be sensible to investigate the possibility to develop two strongly coupled modules.
 - *Note from Hans Los after the workshop: It is important that the total area where tidal influence is felt is included in one single model, otherwise boundary conditions in the area where the two models connect are virtually impossible to get right. This is a strong argument for keeping the current domain in one single model.*

4.7 Cooperation possibilities

- Lots of possibilities, further discussion is required (Patrick)
- NIOO is slowly going back to modelling primary production in the Scheldt in research, so there may be future cooperation possibilities.