Effects of de-eutrophication and changes in turbidity on phytoplankton blooms in the freshwater and brackish tidal reaches of the Schelde estuary (Belgium)

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Estuarine ecosystems worldwide are changing as a result of human activities. The observed changes are complex however, most probably reflect composite and interacting effects of multiple stressors. Changes in biogeochemistry [e.g. (de-)eutrophication affecting nutrient dynamics and oxygenation], morphology (e.g. dredging and infrastructural works impacting suspended matter dynamics) and climate (e.g. global warming, weather patterns affecting temperature, discharge, salinity, etc.) directly impact estuarine phytoplankton, but also indirectly through concomitant changes in the food web structure.

We used a long-term data set of 17 years of phytoplankton and environmental monitoring in the freshwater and brackish zone of the Schelde estuary, obtained in the framework of the OMES project (http://www.omes-monitoring.be), to assess how human-induced environmental change affects estuarine phytoplankton bloom dynamics and community structure. Three main periods could be distinguished:
(1) 2002 (representative of the period before phytoplankton monitoring started), characterized by high levels of ammonium and oxygen depletion, with the dominance of the centric diatom order Thalassiosirales and green algae (*Tetrastrum, Crucigenia* and *Scenedesmaceae)*;
(2) 2003-2011, with decreasing nutrient levels and increasing dredging and channel deepening activity (after 2008), dominated by the centric diatom genera *Actinocyclus* and *Aulacoseira* and cryptophyte algae;
(3) 2012-2018, with the phytoplankton community being characterized by a high relative abundance of Thalassiosirales when turbidity was higher and discharge lower, and characterized by an increase in cyanobacteria and green algae when the discharge was higher and turbidity and total phosphorous lower.

The recent increase of cyanobacteria blooms could have negative consequences for human and animal health and increasing costs for water treatment and may require future management actions. Our study shows modifications in suspended matter and nutrients dynamics but also hydrodynamics in the Schelde estuary have significantly altered the phytoplankton dynamics and community structure in the Schelde estuary.

Keywords: Long-term; Phytoplankton; Scheldt estuary; Biodiversity; Turbidity