Riverine nutrients fluxes to the North Sea and harmful algal blooms, what changed since 1984?


EGU 2013 BG 3.2
12/04/2013 - Vienna
OSPAR objectives → decreasing by 50% the N and P fluxes from 1985 to 2007
I – Introduction - Study area
Modeling of the aquatic continuum

Hydrological network
Morphology and Strahler ordination

Hydro-climatic constraints
Land use and agricultural practices
Point sources (WWTP, industries ...)

Seneque/Riverstrahler model

Water quality within the hydrological network

N, P, Si delivered to the sea

MIRO model

Algal blooms in the coastal zone

Algal blooms

II – Constraints - Hydrology leads fluxes

Similar hydrology

Discharge (m$^3$.s$^{-1}$)

- **Poses (Seine)**
- **Doel (Scheldt)**

Discharge (m$^3$.s$^{-1}$)

- **Simulations**
- **Observations**
II – Constraints - Hydrology leads fluxes

Similar hydrology

Poses (Seine)

Doel (Scheldt)

Wet years 1995 or 2001

Dry years 1992 or 2005
Changing point sources

Better sewage connection rate and better treatment in WWTP
Toward a specialization of agricultural areas

Areas dedicated to breeding

Livestock density (LU/ha)

Synthetic fertilizers (kg N/ha·yr⁻¹)

- Campine
- Belgian loamy R.
- Belgian sand-loamy R.
- Belgian sandy R.
Toward a specialization of agricultural areas

Areas dedicated to industrial crops production

Livestock density (LU/ha)

Synthetic fertilizers (kgN/ha·yr⁻¹)

- Campine
- Belgian loamy R.
- Belgian sand-loamy R.
- Belgian sandy R.
- Argonne
- Brie-Beauce
- Champagne
- Yonne
- Loamy R.
- Morvan
- Jurassic Plateau
- Normand Plateau
III – Results - Simulation at the outlet of the Seine (Poses)

Slight NO$_3^-$ increase
III – Results - Simulation at the outlet of the Seine (Poses)

NH\textsubscript{4}^+ decrease

NH\textsubscript{4}^+ (mgN L\textsuperscript{-1})

NO\textsubscript{3}^- (mgN L\textsuperscript{-1})

Simulation
Observations

III – Results - Simulation at the outlet of the Seine (Poses)

Total P decrease
III – Results - Simulation at the outlet of the Seine (Poses)

No trends for Si and Phytoplankton despite the sharp P decrease
III – Results - Simulation at the outlet of the Scheldt

NO\textsubscript{3}\textsuperscript{-} stabilization

Simulation Kruibeke
Simulation Temse
Observations Kruibeke
Observations Temse

Phy (mg Chla l\textsuperscript{-1})

III – Results - Simulation at the outlet of the Scheldt

NH₄⁺ decrease

NO₃⁻ (mgN L⁻¹)

NH₄⁺ (mgN L⁻¹)

Simulation Kruibeke

Observations Kruibeke

Simulation Temse

Observations Temse


Phy (mg Chl a L⁻¹)

SL (mg SO₂₄⁻ L⁻¹)

Tot P (mg P L⁻¹)
III – Results - Simulation at the outlet of the Scheldt

Total P decrease

NO₃⁻ (mgN.l⁻¹)

NH₄⁺ (mgN.l⁻¹)

Tot P (mgP.l⁻¹)

Simulation Kruibeke, Simulation Temse, Observations Kruibeke, Observations Temse

Total P decrease

Phy (mgChl.a.l⁻¹)
No trends for Si and Phytoplankton despite the sharp P decrease.
N, P, Si fluxes at Poses

N and Si come from diffuse sources = very sensitive to the hydrology

N OSPAR objective not reached
N, P, Si fluxes at Poses

N and Si come from **diffuse sources** = very sensitive to the hydrology

N – Si fluxes at Poses

Fluxes (kgN-Si.km⁻².year⁻¹)

P fluxes at Poses

P comes from **point sources** = less sensitive to the hydrology

P OSPAR objective reached

P OSPAR threshold

Discharge

Q (10⁶ m³.s⁻¹)

P fluxes (kgP.km⁻².year⁻¹)

Q (10⁶ m³.s⁻¹)
N, P, Si fluxes at the Scheldt's outlet

N and Si come from **diffuse sources** = very sensitive to the hydrology

N OSPAR objective not reached
N, P, Si fluxes at the Scheldt's outlet

N and Si come from **diffuse sources** = very sensitive to the hydrology

P comes from **point sources** = less sensitive to the hydrology

**P OSPAR objective reached**
III – Results - Coastal zone

Intensity of the *Phaeocystis* bloom in the North Sea

Changes from 1984

Decrease from 60 million to 30 million of cells

Still highly above the threshold of a healthy environment
*(Lancelot et al. 2009)*
Phaeocystis development in the North Sea

Duration of blooms

Decrease from 51 to 28 days
What changes in terms of fluxes delivered to the sea?
Which impacts at the coastal zone?

1984

**Nutrients**

- N
- P
- Si

**Ratio:** 16 : 1 : 40

imbalance ratio >> 16

**Uptake**

**ratio C:N:P:** (Si)

**Algae**

- Phaeo.

- Phaeocystis blooms

- N limiting

Non si. algae
What changes in terms of fluxes delivered to the sea?

Which impacts at the coastal zone?

1984 → 2007

**Nutrients**

<table>
<thead>
<tr>
<th>N</th>
<th>P</th>
<th>Si</th>
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<tbody>
<tr>
<td>16</td>
<td>1</td>
<td>40</td>
</tr>
</tbody>
</table>

imbalance ratio >> 16

**Algae**

- **Phaeocystis blooms**
- **Non si. algae**

uptake

ratio C:N:P:(Si)

N limiting
What changes in terms of fluxes delivered to the sea?
Which impacts at the coastal zone?

1984 → 2007

**Nutrients**

- **N**
- **P**
- **Si**

**imbalance ratio > 16**

**ratio C:N:P:(Si)**

16 : 1 : 40

** uptake**

**Algae**

- **Phaeo.**
- **Phaeocystis blooms**

**P limiting**

**Non si. algae**
Thank you for your attention

Vielen Dank für Ihre Aufmerksamkeit!