# Water quality along the Zenne river
# Past – Present - Future

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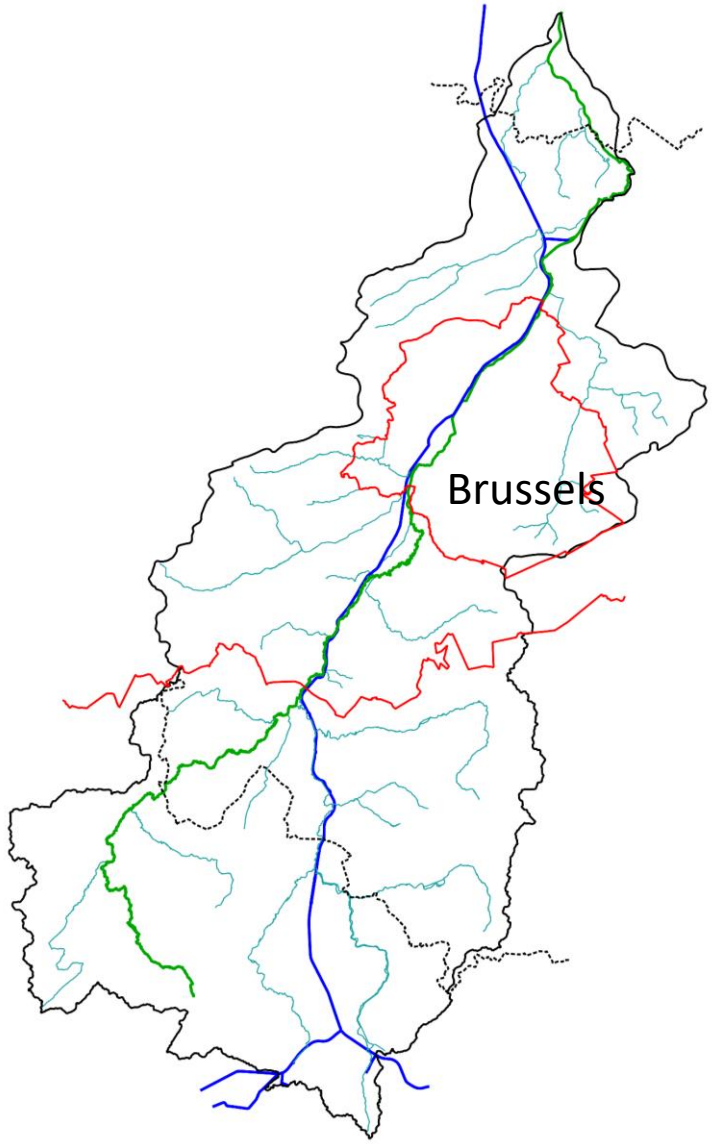
# Context: The Zenne River and it's basin



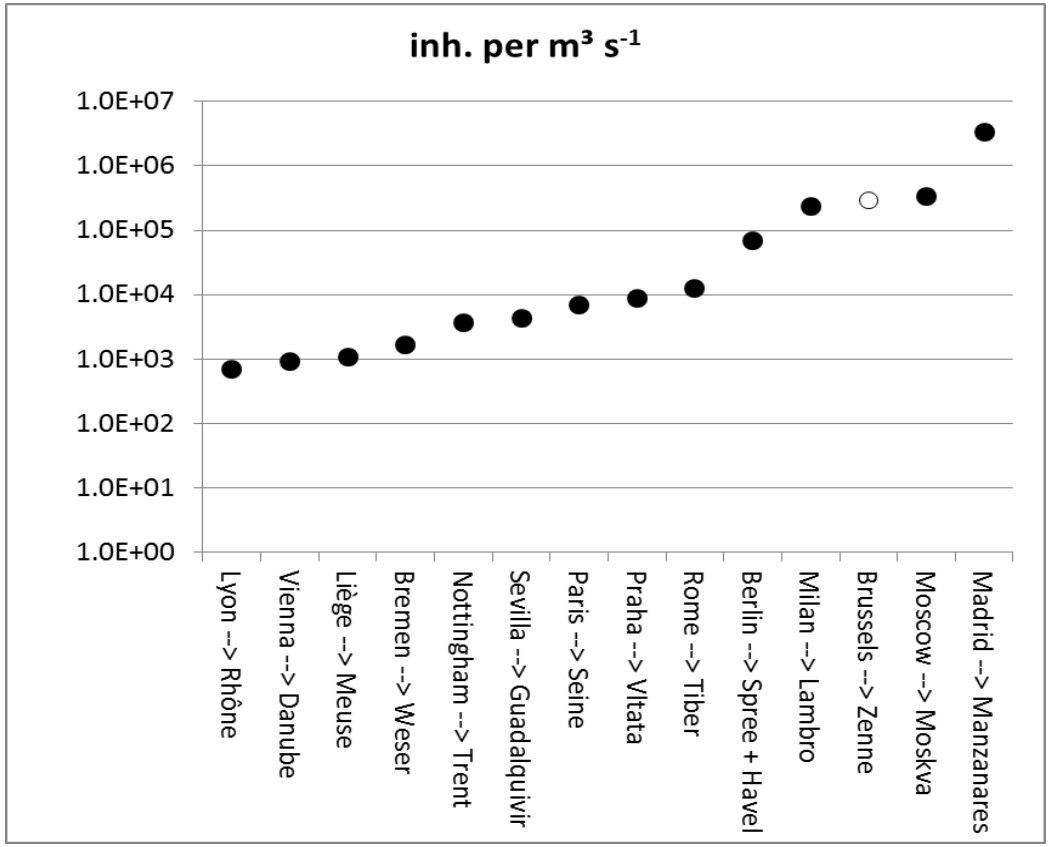

- Sub-basin of the Scheldt River
- 1160 km² - 9.6 m³/s at the outlet
- Exchange with Canal for flood protection

- 1260 inhab/km²

→ Very strong human impact on a small river catchment

- Below Brussels: more than 50% of the water comes from sewage!

Population stress of a city on its river:

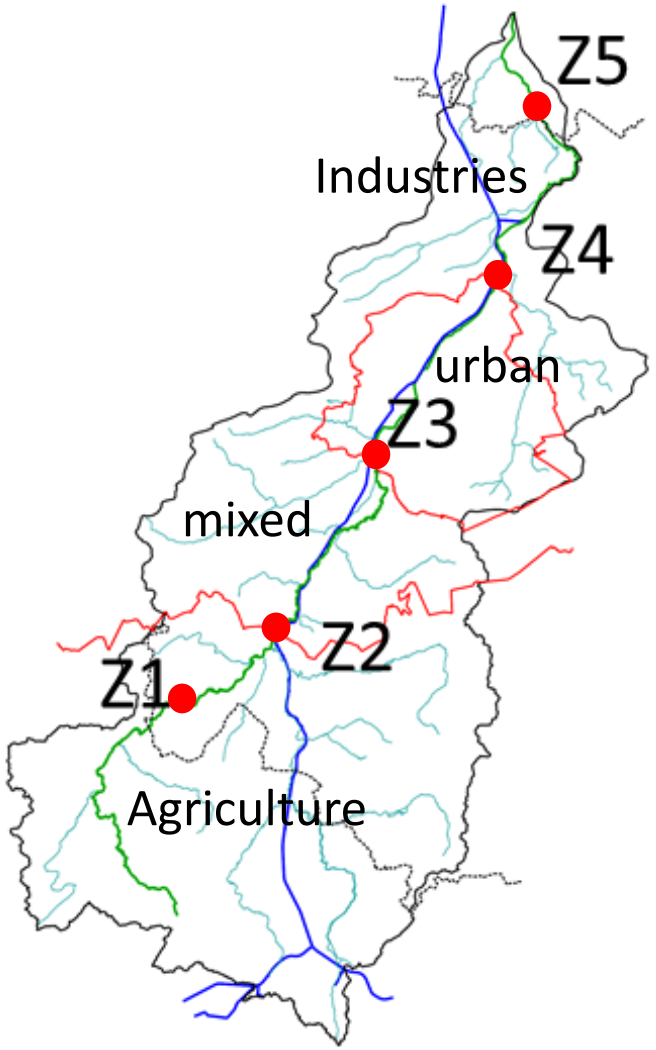


# Water quality along the Zenne - stations

Z4 – Haren/Vilvoorde

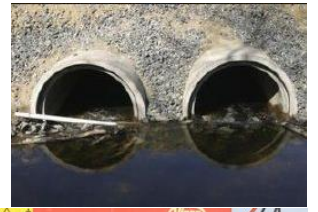
Z3 – Drogenbos/Anderlecht

Z2 - Lembeek



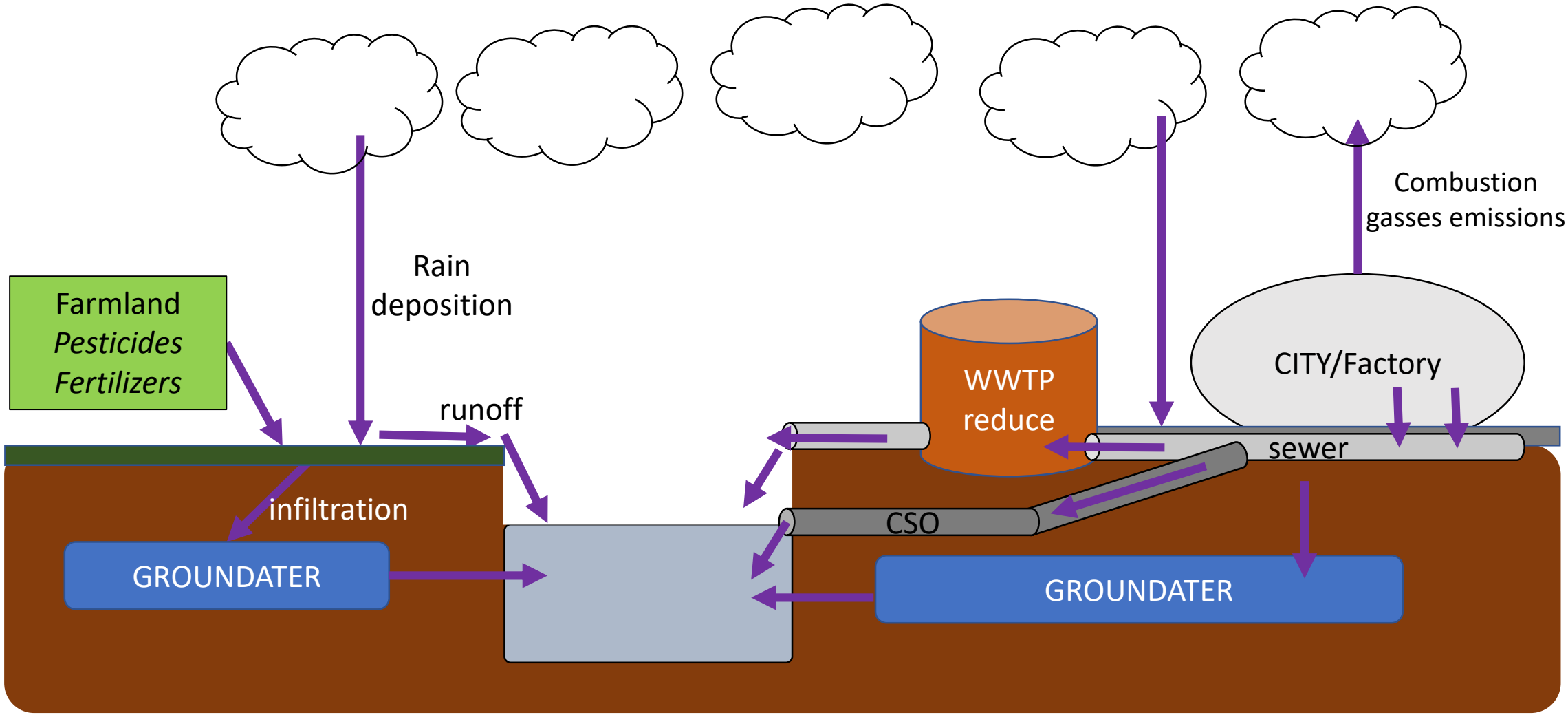
# Pollutants considered: tracers of human activity

- **Organic matter and oxygen:** BOD and COD
  - Domestic wastewaters
  - Respired → low dissolved oxygen
- **N and P:** total N, total P, ammonium, nitrate, phosphate
  - Domestic wastewaters and in fertilizers
  - Increase plant growth → too much=eutrophication
- **Metals:** Cd, Pb, Ni, Zn, Cu
  - Specific industrial wastewaters, urban runoff
  - (bio)accumulate, toxic (Cd, Pb, Ni)
- **PAHs:** Fluoranthene, B(b)Flu, B(k)Flu
  - Dust/fumes from combustion processes: road and urban runoff
  - Toxic: cancer, endocrine disruption, …
- **Pesticides:** Diuron, Isoproturon
  - Weed and pest control
  - Toxic: block photosyntheses, endocrine disruption,…





# How do they reach the river?



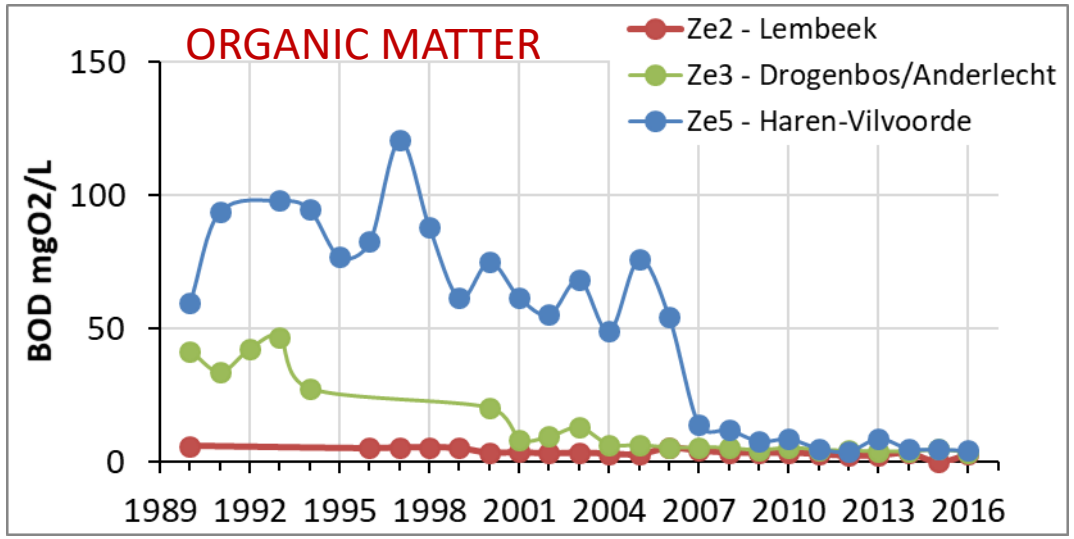
# Past

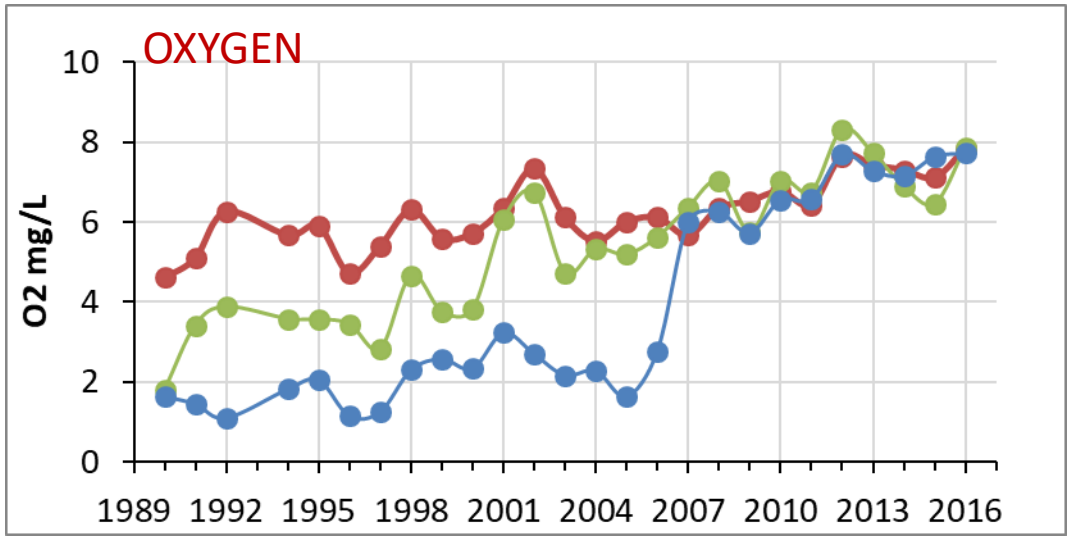
Evolution of the water quality since 1990

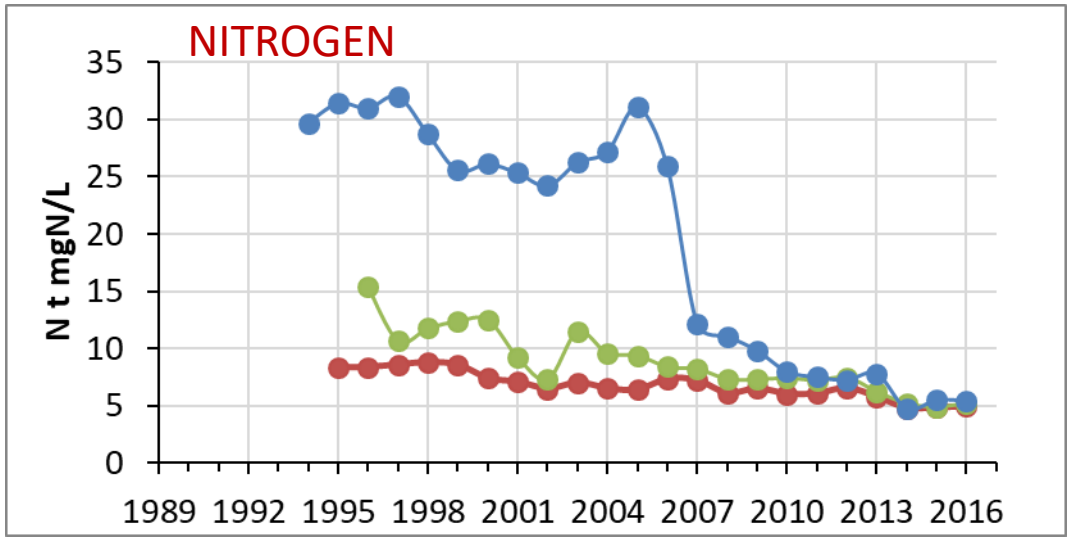
*The Zenne In Anderlecht (Musée des égouts)*

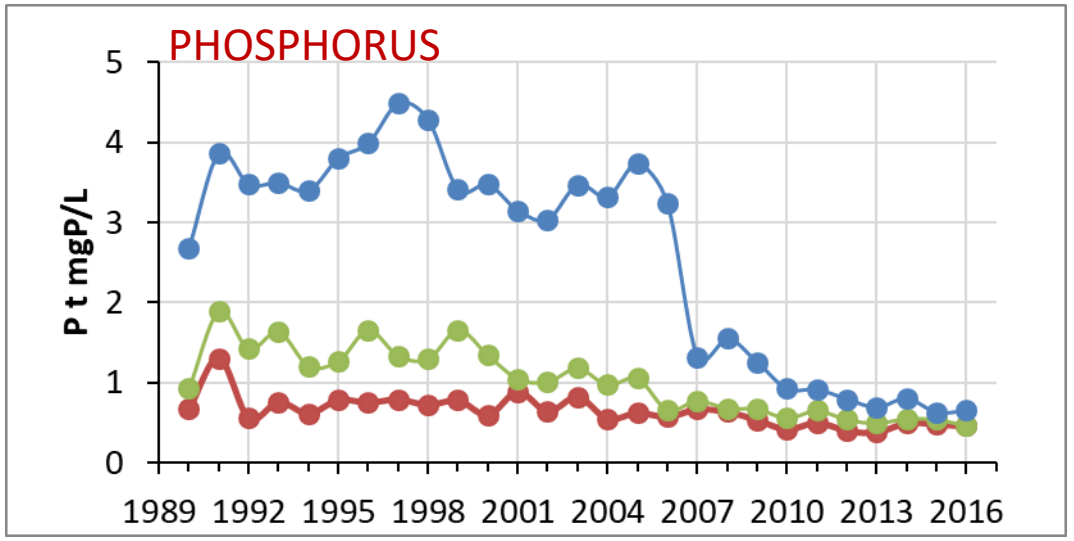
*Outlet WWTP-North - Haren*

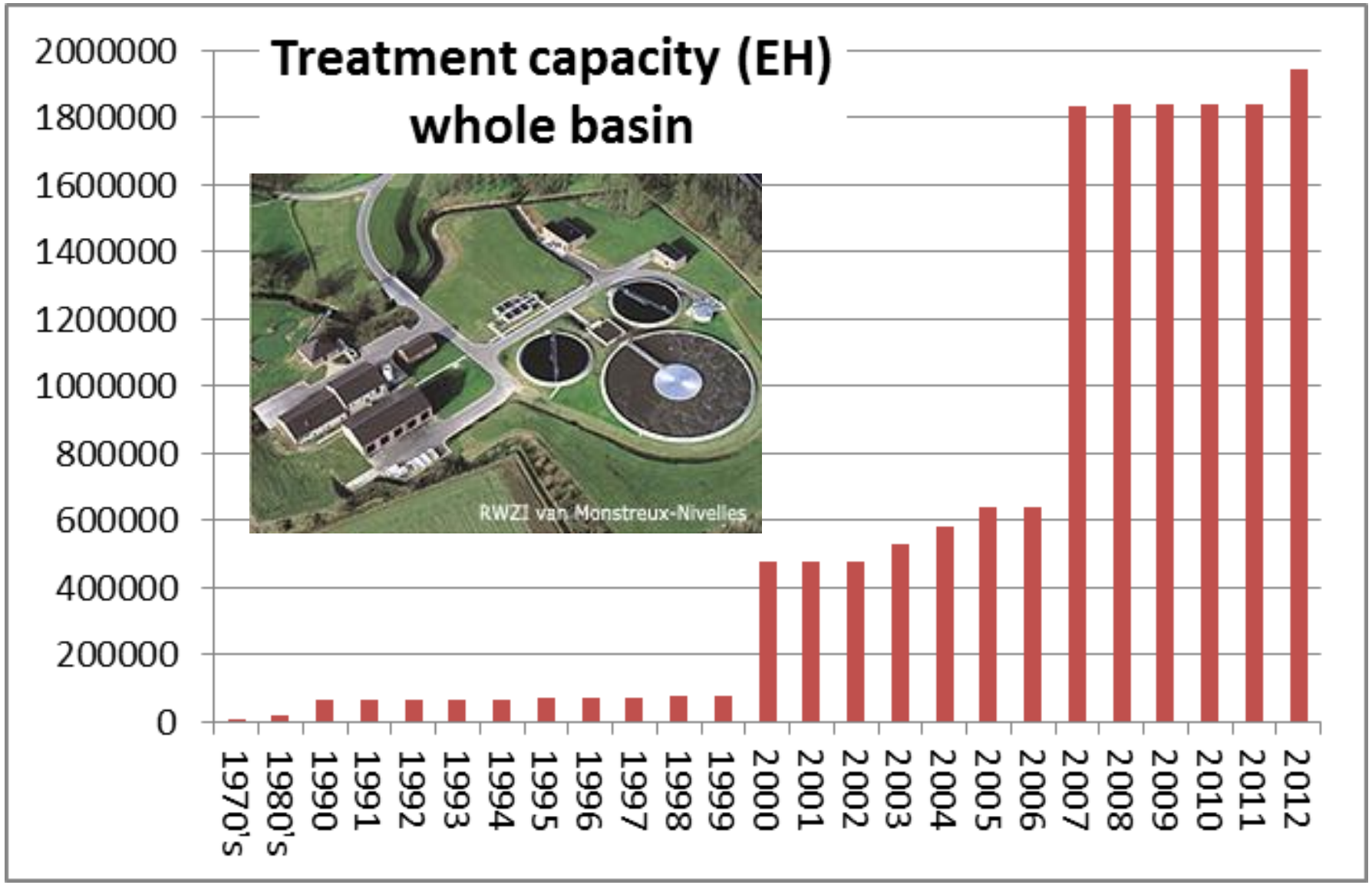
# Organic matter, Oxygen, N and P



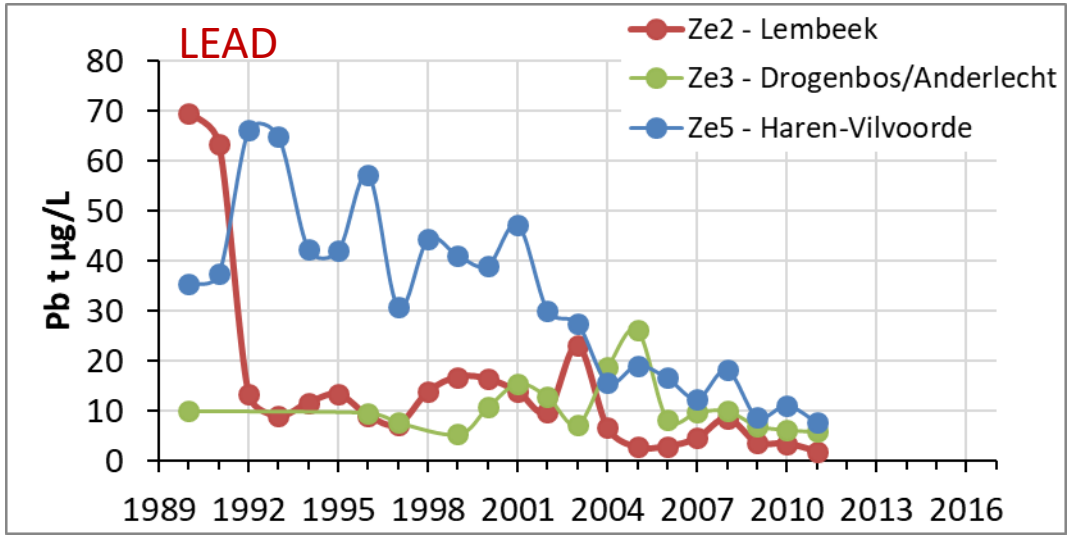



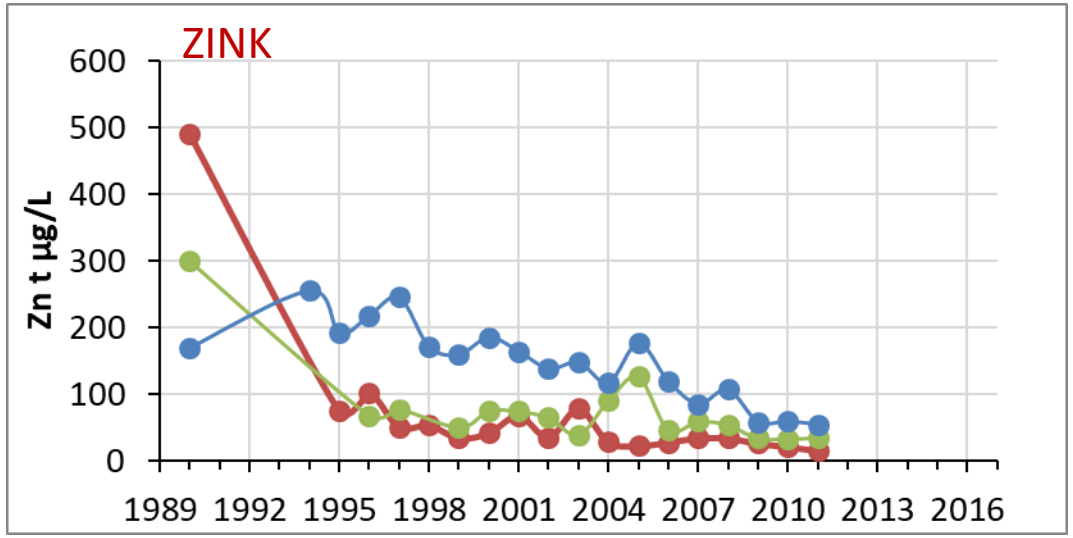



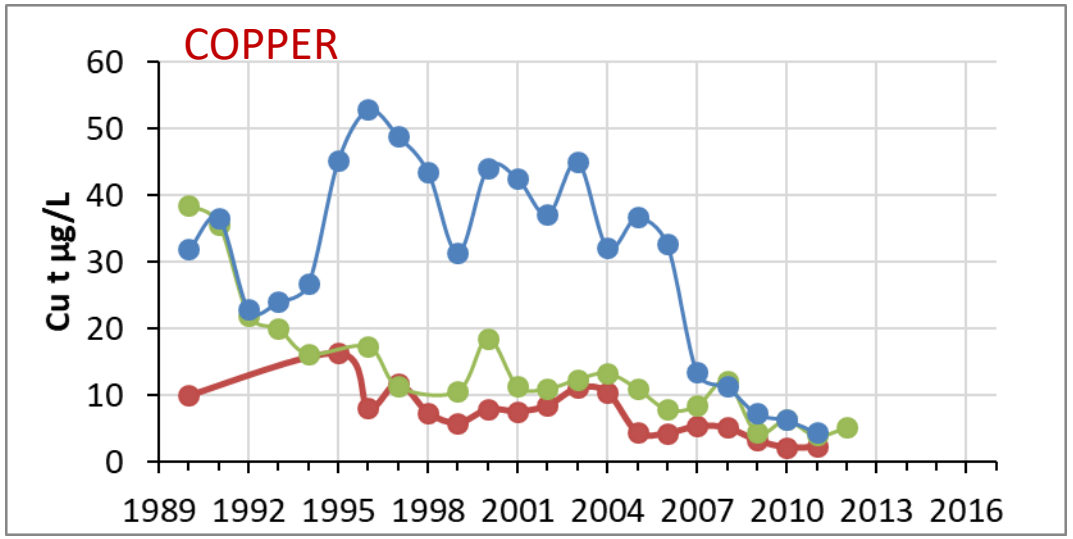



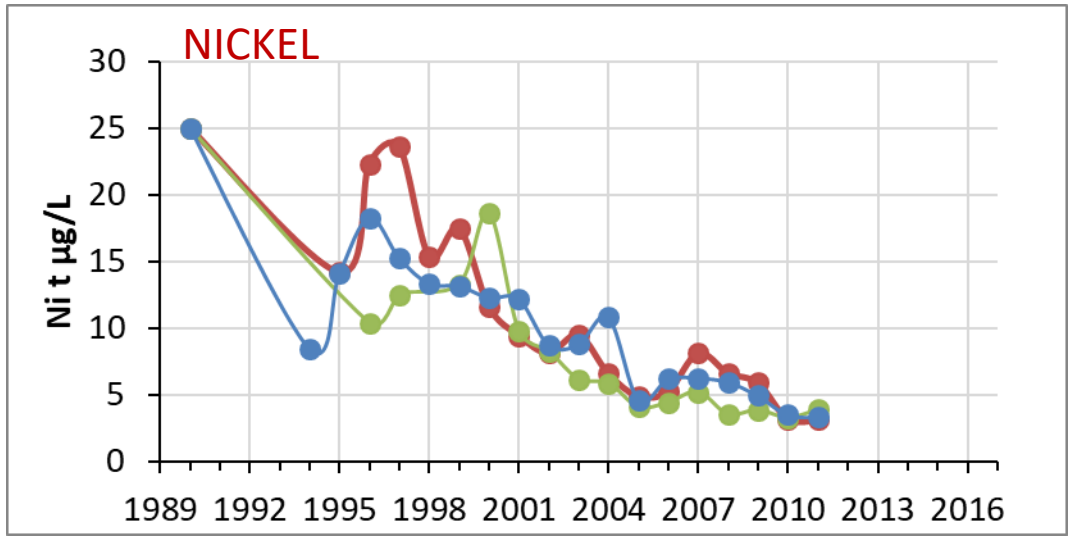

Treatment capacity (EH)
whole basin
RWZI van Monstreux-Nivelles
2000000
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
1970's
1980's
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

# Metals: Pb, Zn, Cu, Ni

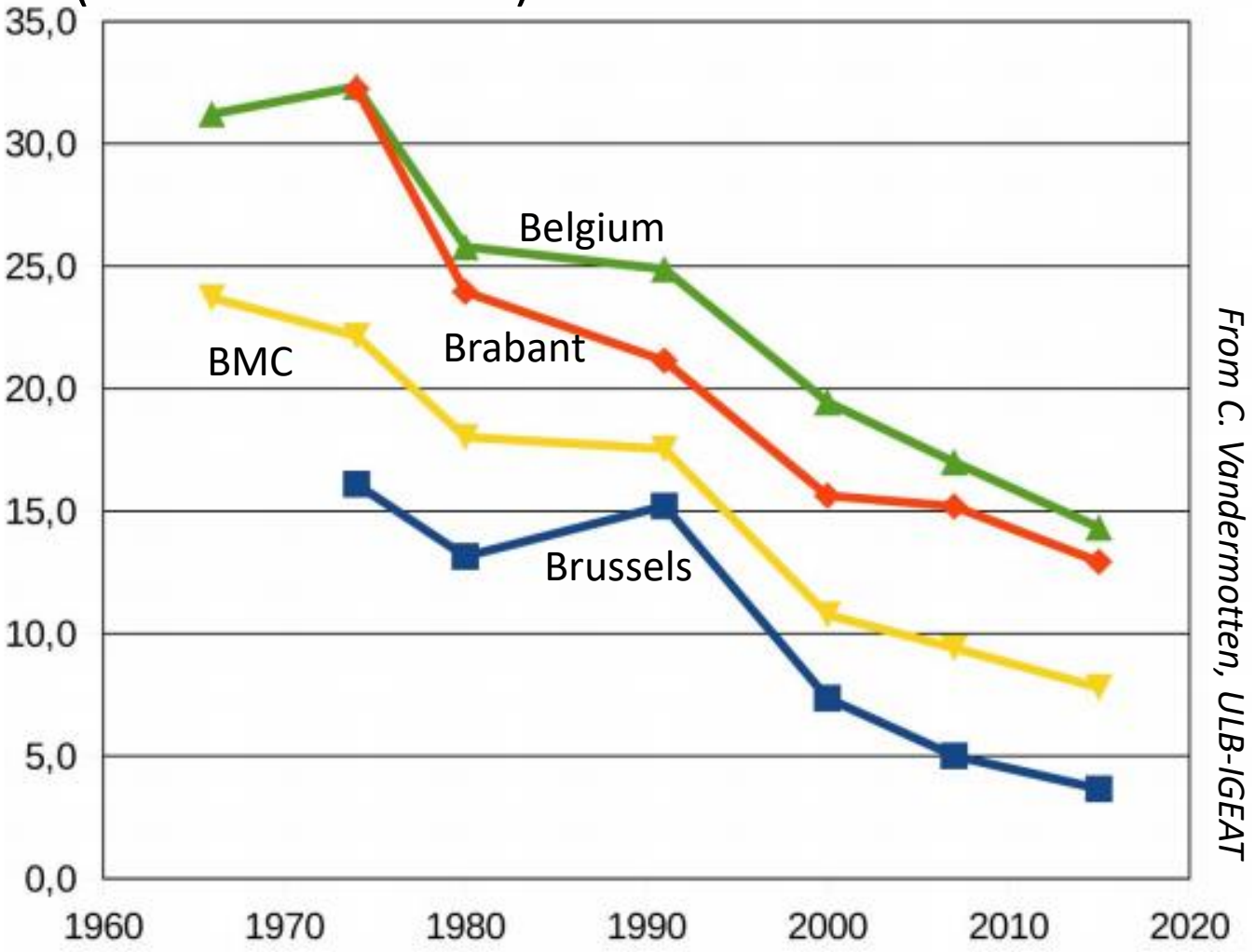


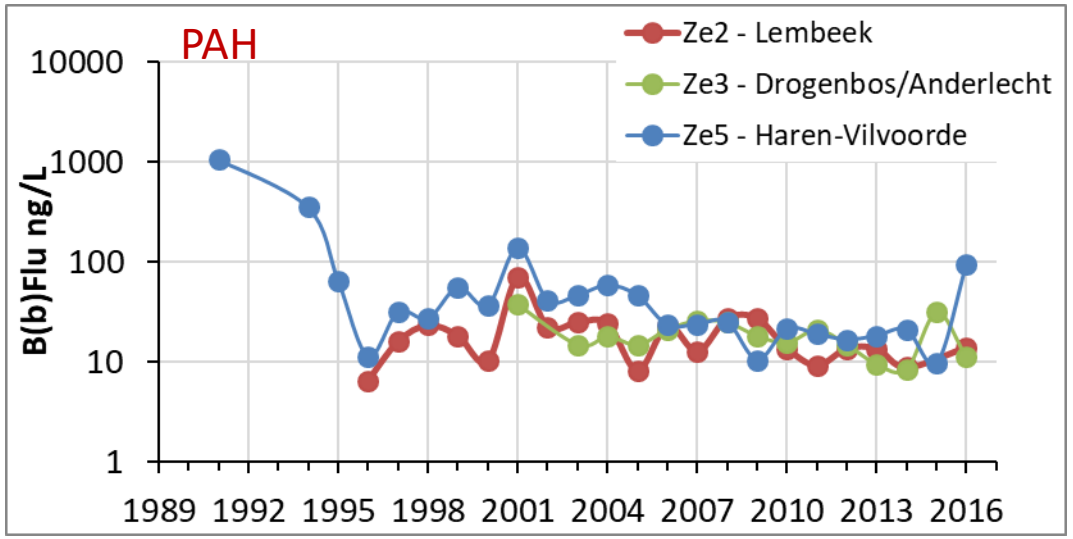



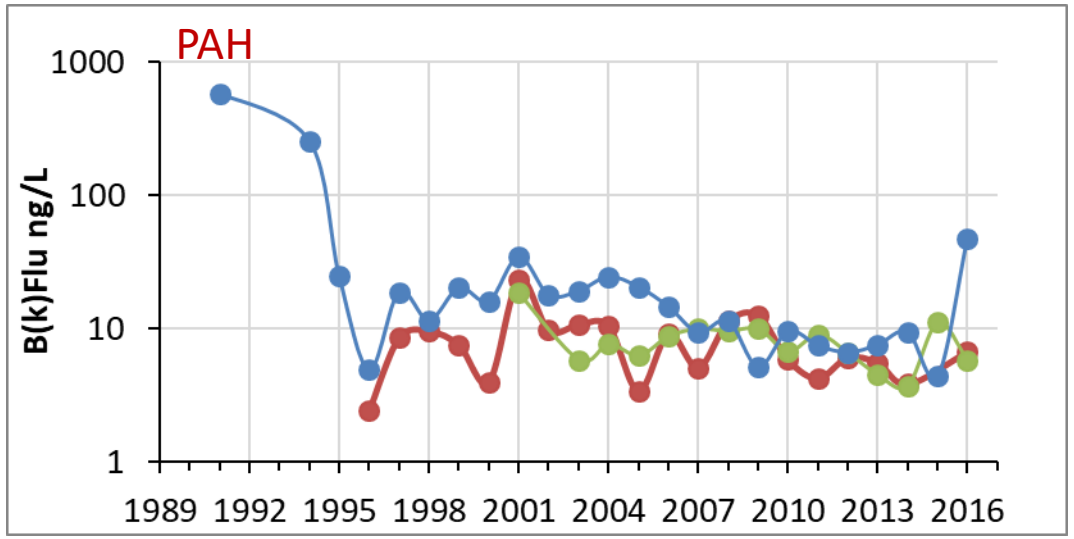
# Industrial fraction of Regional Economy (% of Added Value)

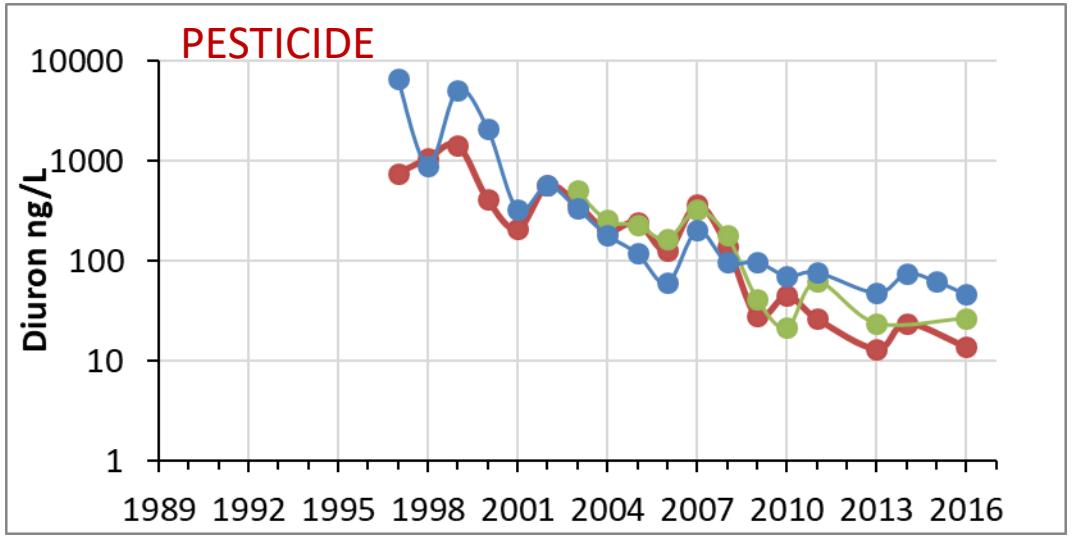


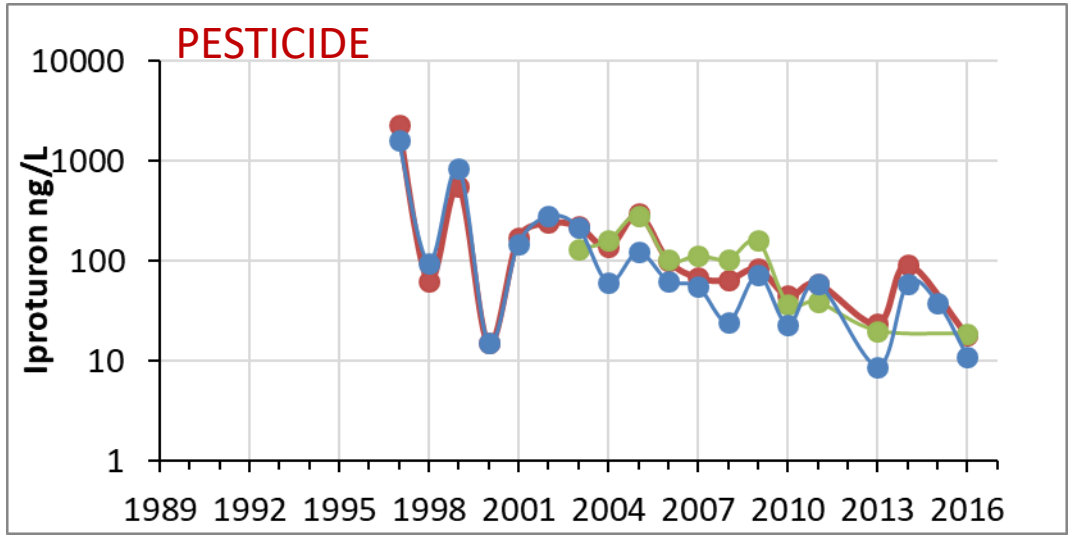

*From C. Vandermotten, ULB-IGEAT*

# PAHs and pesticides



# AMOUNT OF TOTAL PESTICIDES SOLD IN BELGIUM




*http://etat.environnement.wallonie.be/files/Studies/Rapport_final-Convention_7.pdf*

# Today?

Quality vs environmental standards – critical situations

The Zenne in Tubize during high flow

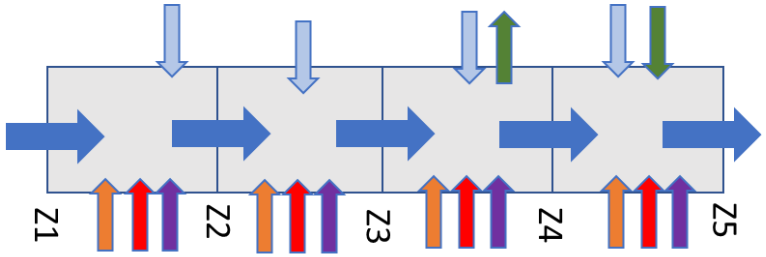
# Today? Concentrations vs regional targets

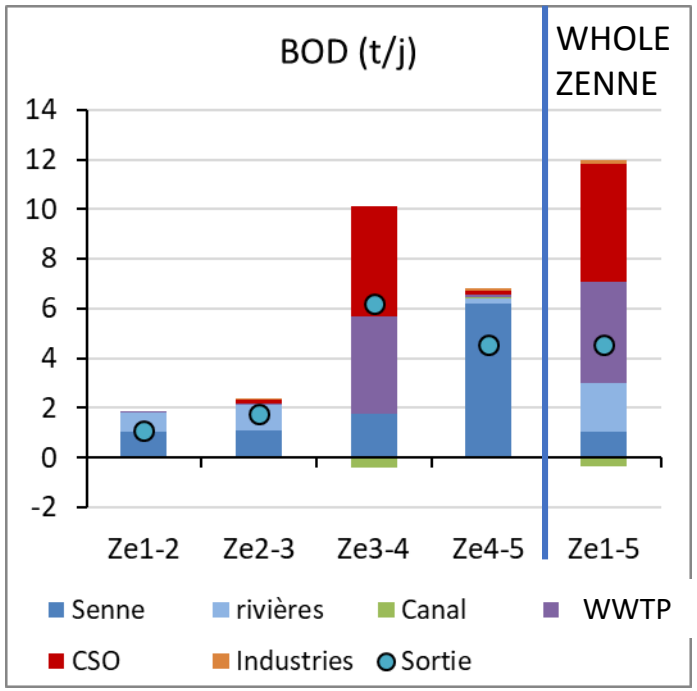
Data 2012 - 2014

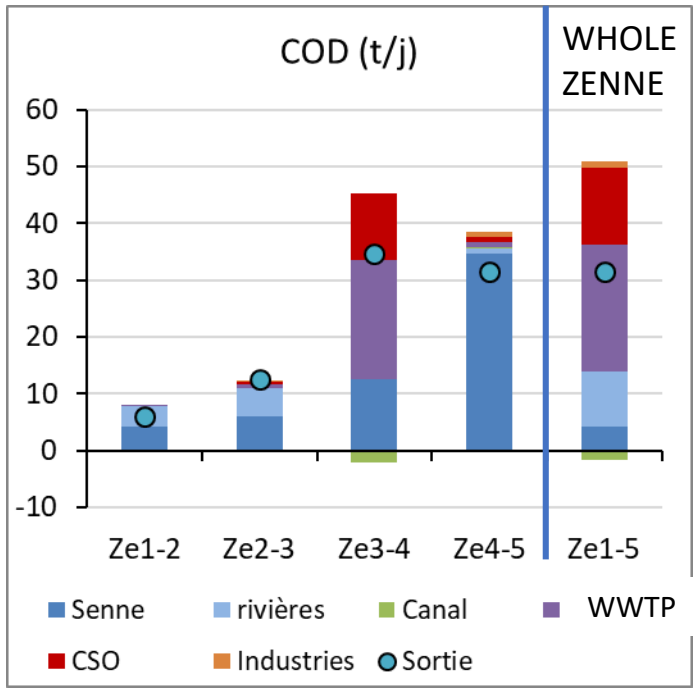
Upstream ---------- Downstream

| Type | variable | unit | criteria | region | target | Bckg | S1 Tubize | Ze1 Tubize | Ze2 Lembeek | Ze3 Drog. | Ze4 Haren | Ze5 Eppeg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Organic Matter and Oxygen | O2 | mg/L | P10%-min | Vl-BXL | 6 | 6.7 | 7.6 | 6.5 | 4.7 | 5.0 | 5.9 | 2.8 |
| | O2 sat | % | average-median | BXL-Wal | 50 | 86 | | | 68 | 72 | 71 | 52 |
| | BOD | mgO2/L | P90% | BXL-Vl | 6 | 5.3 | 20.8 | 8.8 | 6.0 | 6.1 | 7.6 | 5.0 |
| | BOD | mgO2/L | median | Wal | 6 | 1.5 | 6.4 | 4.25 | 3 | 4 | 4 | 3 |
| | COD | mgO2/L | P90% | BXL-Vl | 30 | 37 | 62.6 | 42.5 | 31 | 34 | 39.6 | 35 |
| Nitrogen | KjN | mgN/L | average-median | BXL-Wal | 8-6 | 2.1 | 2.2 | 1.7 | 1.8 | 1.9 | 3.8 | 3.8 |
| | KjN | mgN/L | P90% | Vl | 6 | 3.9 | 3.0 | 2.5 | 3.4 | 3.6 | 6.5 | 5.5 |
| | N t | mgN/L | average | BXL | 12 | 4.8 | 7.9 | 5.7 | 6.1 | 6.7 | 9.2 | 9.3 |
| | N t | mgN/L | summer average | Vl | 2.5 | 5.0 | 8.3 | 4.8 | 5.7 | 6.5 | 7.2 | 7.3 |
| | NH4+ | mgN/L | average-median | BXL-Wal | 3-2 | 1.2 | 0.8 | 0.8 | 0.9 | 1.1 | 2.0 | 2.4 |
| | NO3- | mgN/L | average | BXL | 10 | 5.2 | 5.5 | 3.3 | 3.7 | 4.0 | 2.8 | 3.1 |
| | NO3- | mgN/L | P90% | Vl | 5.65 | 9.6 | 6.7 | 4.5 | 4.8 | 5.0 | 3.4 | 3.8 |
| Phosphorus | P t | mgP/L | average-median | BXL-Wal | 1 | 0.4 | 0.3 | 0.4 | 0.4 | 0.6 | 1.0 | 0.8 |
| | P t | mgP/L | summer average | Vl | 0.14 | 0.5 | 0.3 | 0.4 | 0.5 | 0.6 | 0.9 | 0.8 |
| | oPO4 | mgP/L | average | BXL-Vl | 0.15-0.14 | 0.16 | | 0.27 | 0.22 | 0.31 | 0.51 | 0.37 |
| Metals | Cu-diss | µg/l | average | BXL-Vl | 7 | 0.8 | 0.7 | 0.9 | 1.1 | 1.5 | 1.0 | 1.0 |
| | Zn-diss | µg/l | average | BXL-Vl | 20 | 4.1 | 5.3 | 5.2 | 4.9 | 10 | 25 | 16 |
| | Cd-diss | µg/l | average | all | 0.25 | 0.02 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 |
| | Ni-diss | µg/l | average | all | 4 | 1.3 | 1.7 | 3.9 | 2.3 | 3.4 | 2.4 | 2.6 |
| | Pb-diss | µg/l | average | all | 1.2 | 0.1 | 0.2 | 0.2 | 0.5 | 1.2 | 0.5 | 0.5 |
| PAHs | B(b)Flu | ng/L | max (P90) | all | 17 | 6 | 7 | 19 | 52 | 3.15 | 120 | 370 |
| | B(k)Flu | ng/L | max (P90) | all | 17 | 3 | | | 21 | 5 | 44 | 150 |
| | Flu | ng/L | average | all | 6.3 | 10 | 7 | 8 | 30 | 5 | 37 | 220 |
| | Flu | ng/L | max (P90) | all | 120 | 25 | 14 | 39 | 180 | 5 | 300 | 800 |
| Pesticides | Diuron | ng/L | average | all | 200 | 25 | 24 | 16 | 26 | 14 | 44 | |
| | Isoproturon | ng/L | average | all | 300 | 18 | 13 | 41 | 72 | 15 | 26 | |

# Origin of excess Organic matter?

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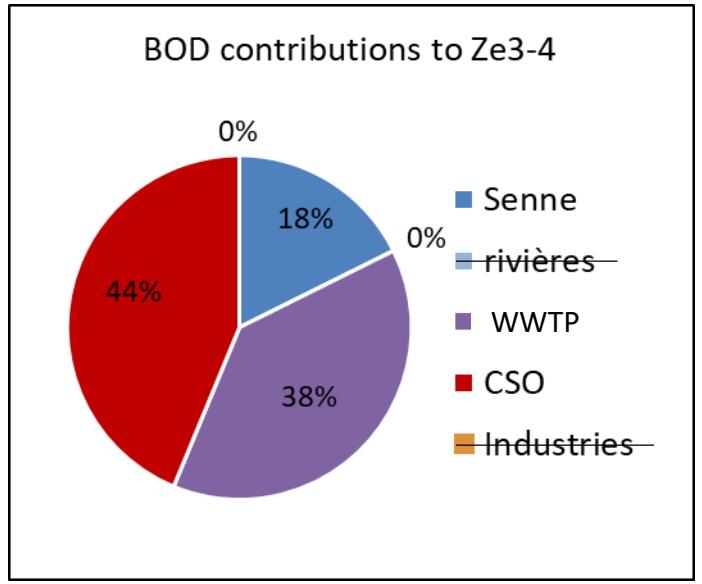
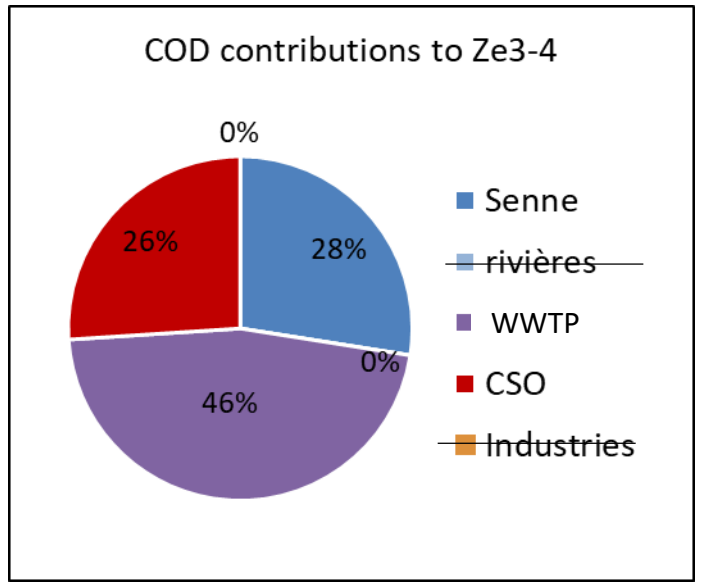
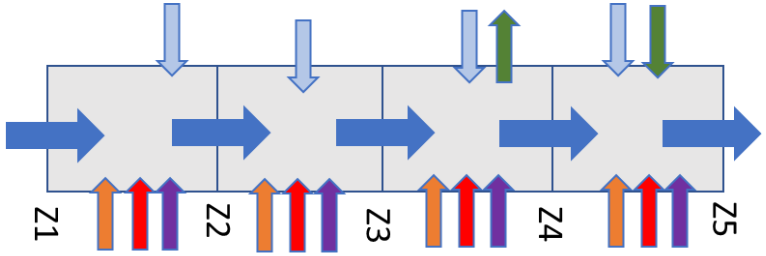
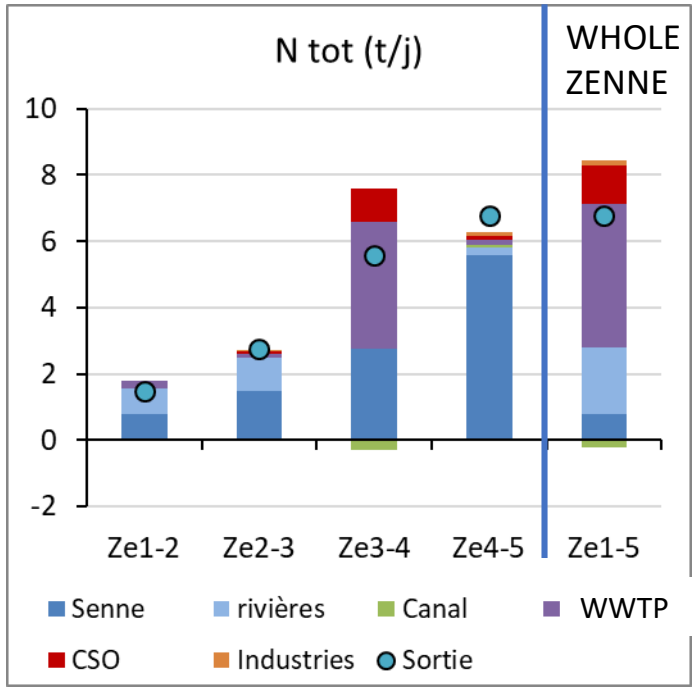
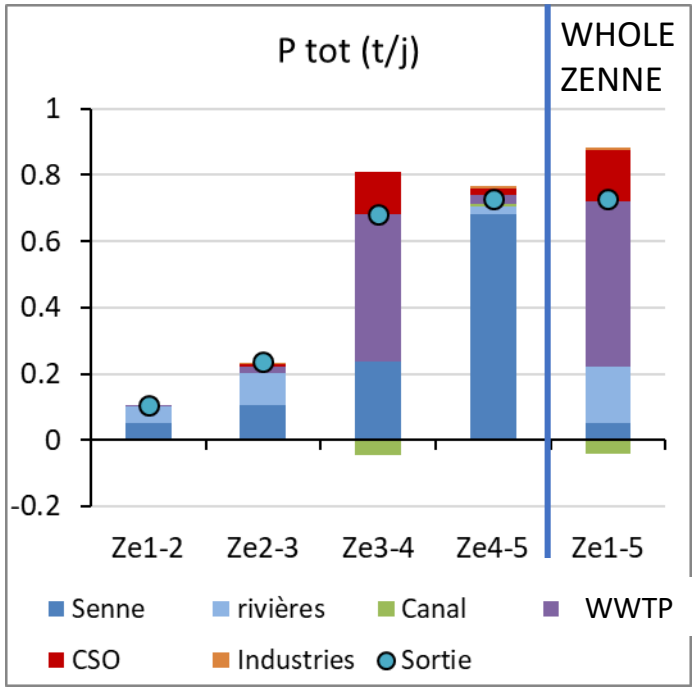


# Origin of excess N and P?

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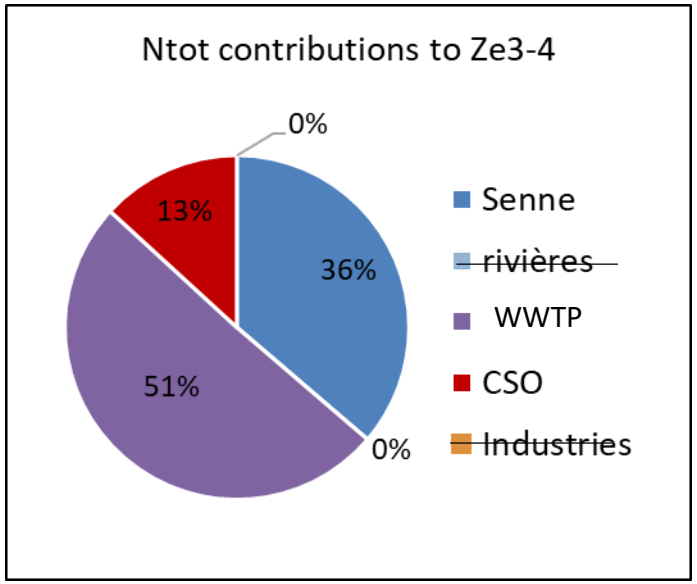
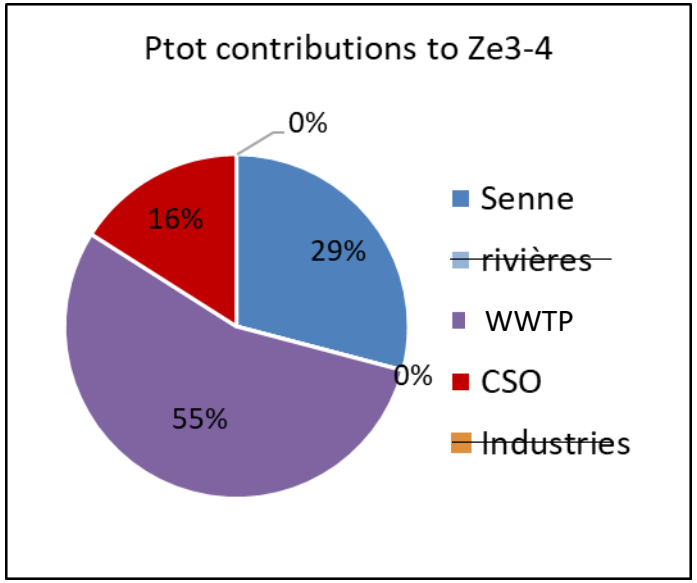
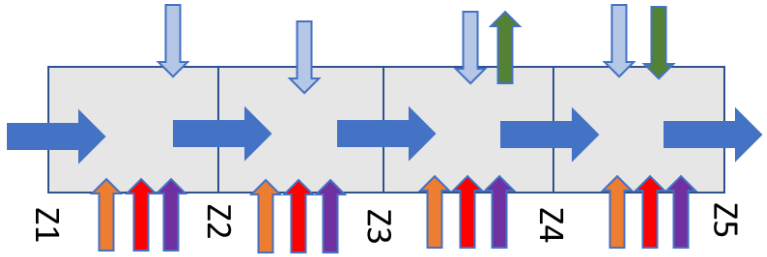
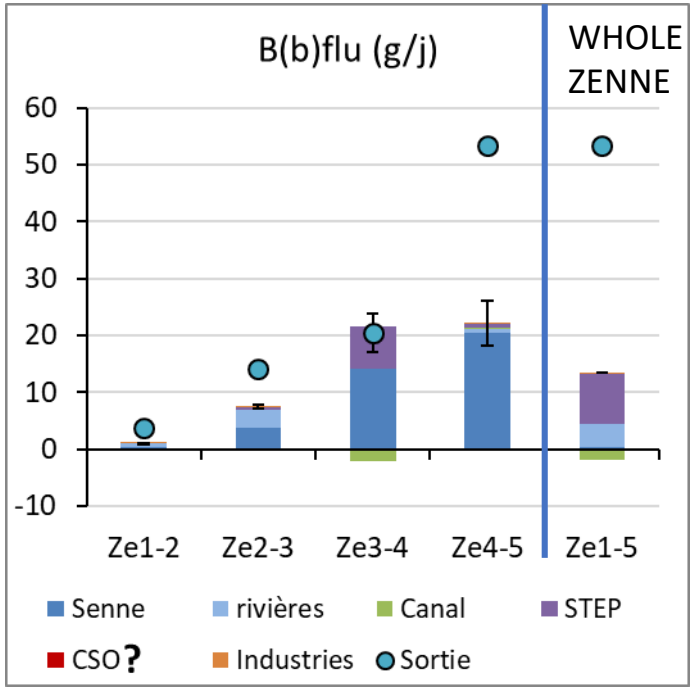


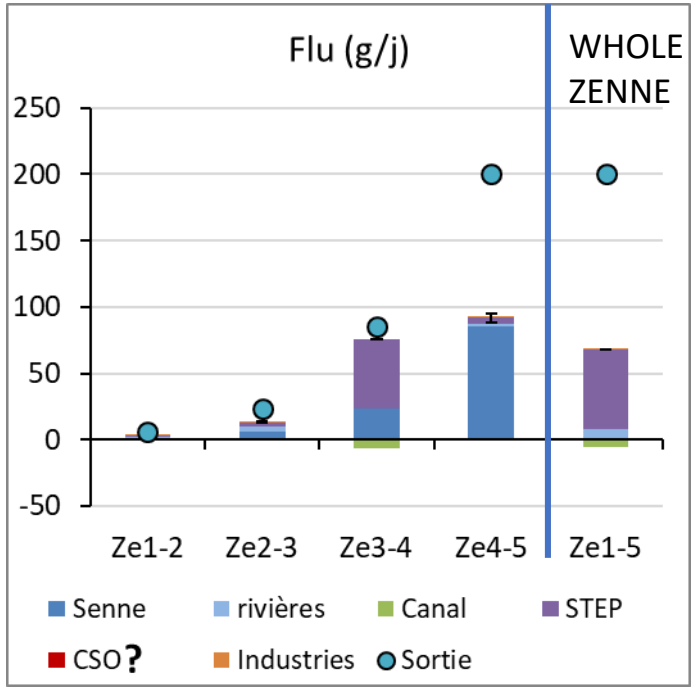



# Origin of excess PAHs?

## Large uncertainties

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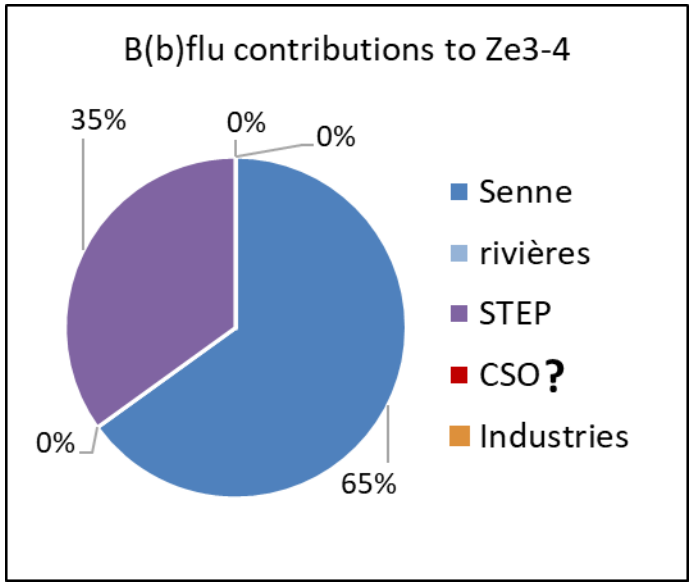
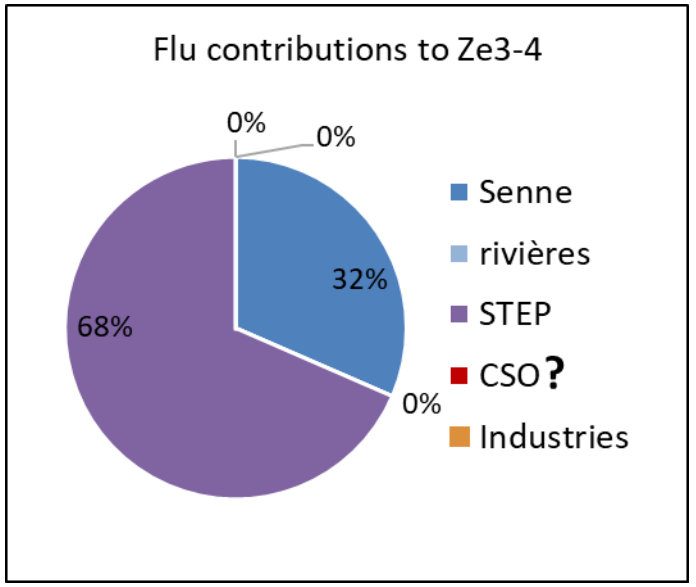
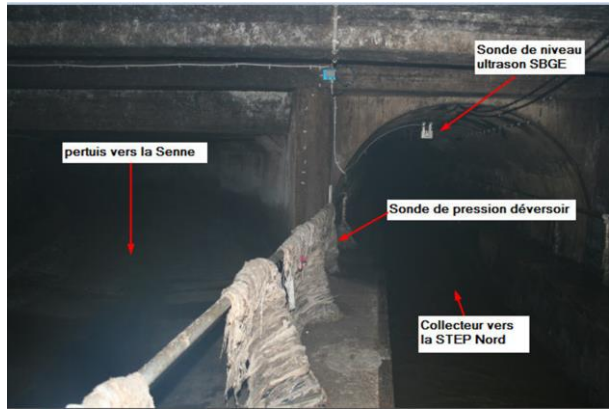


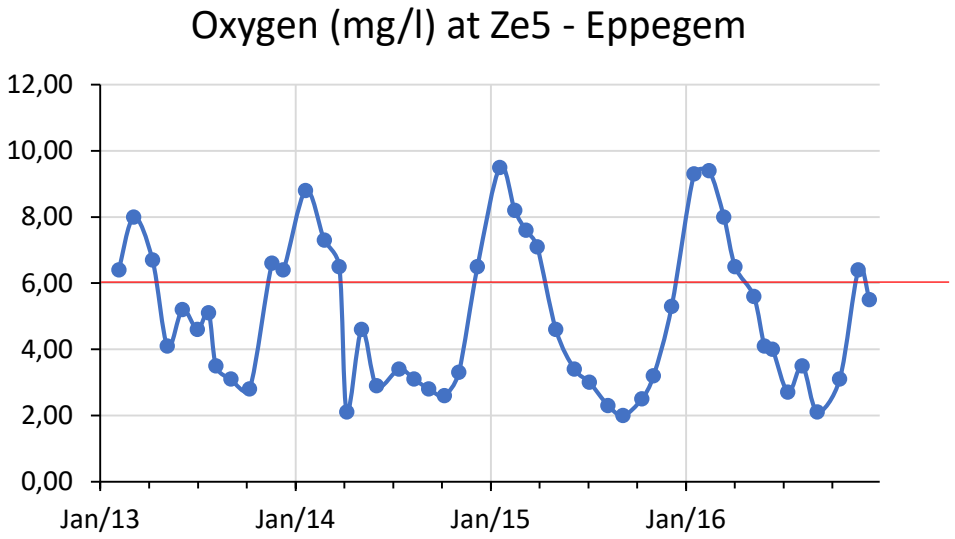



# Today: critical situations?

Summer warm low flow conditions: critical for O2




Combined sewer overflow



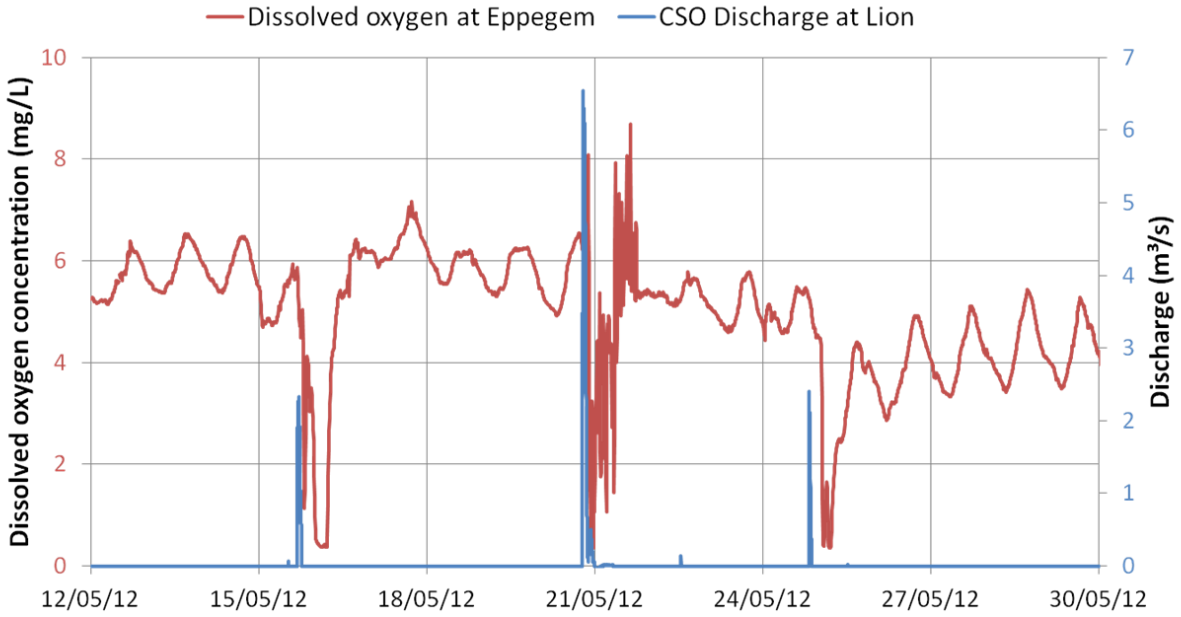




**Table 3** | DO deficit statistics at Eppegem related to Lion CSOs from November 2011 to October 2012

| | |
|---|---|
| Number of CSOs followed by DO deficit | 91 |
| Number of CSOs where DO deficit is unequivocally attributable to Lion CSO | 73 |

# Future?

Climate change – Population growth – New Regulations

The Zenne in Vilvoorde – new constructions

# Future?

## In a climate change perspective?

- More frequent periods of low flow

→ Increase the importance of critical situation

## In a population growth perspective?

- Population increase by 28 % by 2060
- WWTP loads will increase in proportion

## New EU regulations on wastewaters?

- CSO occurrence = limited!
- Include new emerging pollutants: EDC, microplastics, pharmaceuticals, …

SSD
SCIENCE FOR A SUSTAINABLE DEVELOPMENT

CLIMATE CHANGE IMPACT ON HYDROLOGICAL EXTREMES ALONG RIVERS AND URBAN DRAINAGE SYSTEMS IN BELGIUM

«CCI-HYDR»

P. WILLEMS, P. BAGUIS, V. NTEGEKA, E. ROULIN

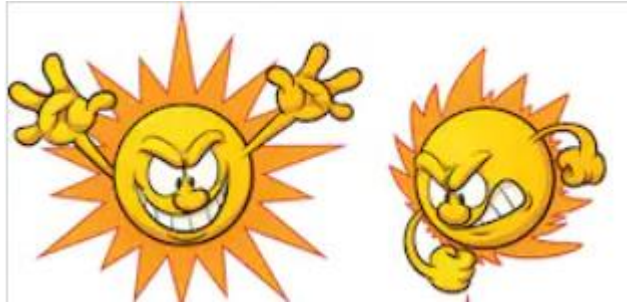


Table XIV: Yearly frequencies (number of days/year) of low flow days for control and climate change scenario simulations; change (%) between mean scenario and control.

| | | Control | Scenario | | | Change (%) |
|---|---|---|---|---|---|---|
| | | | Minimum | Mean | Maximum | |
| Scheldt | Scheldt at Antwerp | 18.5 | 26.6 | 60.3 | 95.1 | 225.9 |
| | Scheldt at Asper | 18.4 | 24.9 | 54.5 | 90.2 | 196.2 |
| | Demer at Diest | 18.3 | 31.0 | 60.8 | 94.7 | 232.2 |
| | Dendre | 18.6 | 29.8 | 60.3 | 89.4 | 224.2 |
| | Dijle at Wilsele | 18.4 | 19.5 | 93.8 | 156.5 | 409.8 |
| | Grote Nete at Hulshout | 18.3 | 28.1 | 55.6 | 84.1 | 203.8 |
| | Kleine Nete at Grobbendonk | 18.3 | 24.5 | 53.2 | 81.3 | 190.7 |
| | Leie at St Baafs | 18.5 | 15.8 | 42.8 | 73.6 | 131.4 |
| | Zenne at Eppegem | 18.4 | 28.1 | 73.1 | 113.8 | 297.3 |

**Tableau 7 Croissance de la population et des ménages privés par région**
*Taux de croissance entre le 1er janvier et le 31 décembre (%)*

| | Croissance annuelle moyenne | | | | Croissance |
|---|---|---|---|---|---|
| | 1991-2016 | 2000-2016 | 2016-2040 | 2040-2060 | 2016-2060 |
| **POPULATION** | | | | | |
| Région de Bruxelles-Capitale | 0,9% | 1,3% | 0,6% | 0,5% | 28,1% |
| Région flamande | 0,5% | 0,5% | 0,4% | 0,2% | 14,5% |
| Région wallonne | 0,4% | 0,5% | 0,4% | 0,2% | 14,2% |
| **MENAGES PRIVÉS** | | | | | |
| Région de Bruxelles-Capitale | 0,5% | 0,9% | 0,5% | 0,4% | 20,5% |
| Région flamande | 0,8% | 0,9% | 0,6% | 0,3% | 20,4% |
| Région wallonne | 0,7% | 0,7% | 0,6% | 0,3% | 23,0% |

Source : 1991-2016 : observations, RN-DGS, 2017-2060 : Perspectives démographiques 2016-2060, BFP-DGS.
Note : observations jusque et y compris le 01/01/2016 ; projection au-delà.

# Conclusions

- The water quality of the Zenne strongly increased since the 1990's ☺
- But water quality does not yet satisfy environmental requirements ☹
  - →Low discharge
  - →High population → High pollution loads
  - →CSO in Brussels
  - →Critic: summer low flow
- Future?
  - In a climate change/population growth perspective: pressure on the river increase! ☹
  - EU rules should become more stringer on CSO occurrence and pollutant emissions by WWTP → could mitigate effects ☺
  - However technological solutions are expensive and at the limit ! ☹

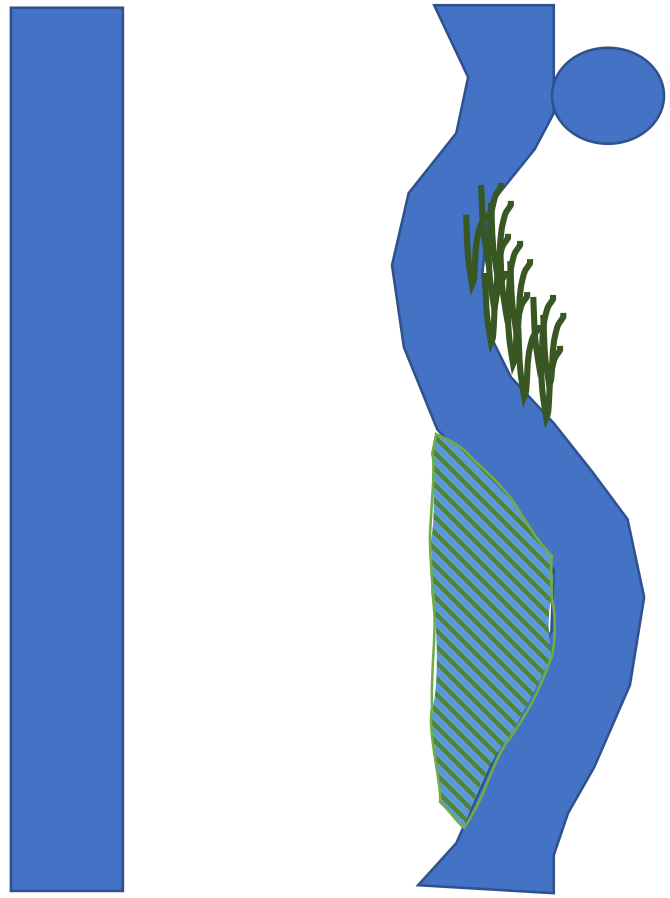
# Perspectives?

- Nature based solution? Enhance the self-cleaning capacity of the river:
  - Meanders
  - Ponds
  - Connected Wetlands
  - Vegetation on banks

  →Polutant traps!
- Reduce the emission of pollutants at the source:
  - Optimize use of infrastructure:

  →clean-up sewers

  →Install sediment traps in sewers
  - Promote reduced water consumtion : dry toilets



# THANK YOU