INNOV IRIS
EMPOWERING RESEARCH

GESZ

20 ans d'évolution de la qualité des eaux de la Senne et du Canal

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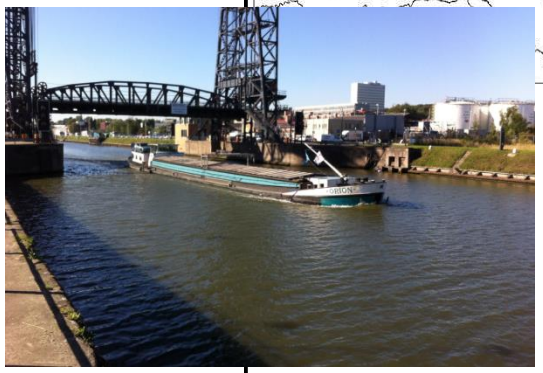

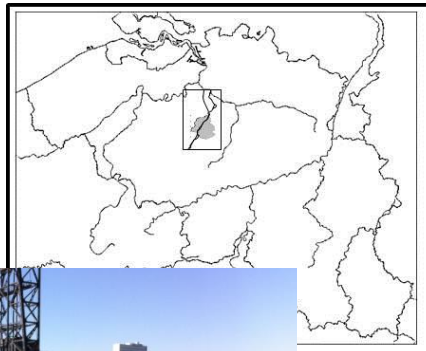

OSIRIS

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Rupel
Z13
Dijle
Z12
Zenne
canal
Z11
Overflow from canal
Z10
Z9b
Z9c
Woluwe
Vilvoorde
Z9
WWTP Brussels North
Z8
Z7
Overflow to canal
Z6
Overflow to canal
Z5
WWTP Brussels South
Zuunbeek
Z4
Drogenbos
canal
Z3
Z2
Zenne
Overflow to canal
Z1
Lembeek
10 km

Evolution of the water quality

- The last 25 years:
  - * Organic matter, N, P and O_2
  - * Metals: Cu, Zn, Pb, Ni, Cd
  - * PAHs: B(b)Flu, B(k)Flu, Flu
  - * Pesticides: Diuron, Isoproturon

Selected chemicals as tracers

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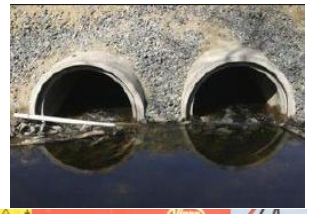
- organic matter and oxygen: BOD and COD
  - Domestic wastewaters
  - Respired → low dissolved oxygen
- N and P: total N, total P, ammonium, nitrate, phosphate
  - Domestic wastewaters and in fertilizers
  - Increase plant growth → too much=eutrophication
- Metals: Cd, Pb, Ni, Zn, Cu
  - Specific industrial 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: blocks photosyntheses, endocrine disruption,…



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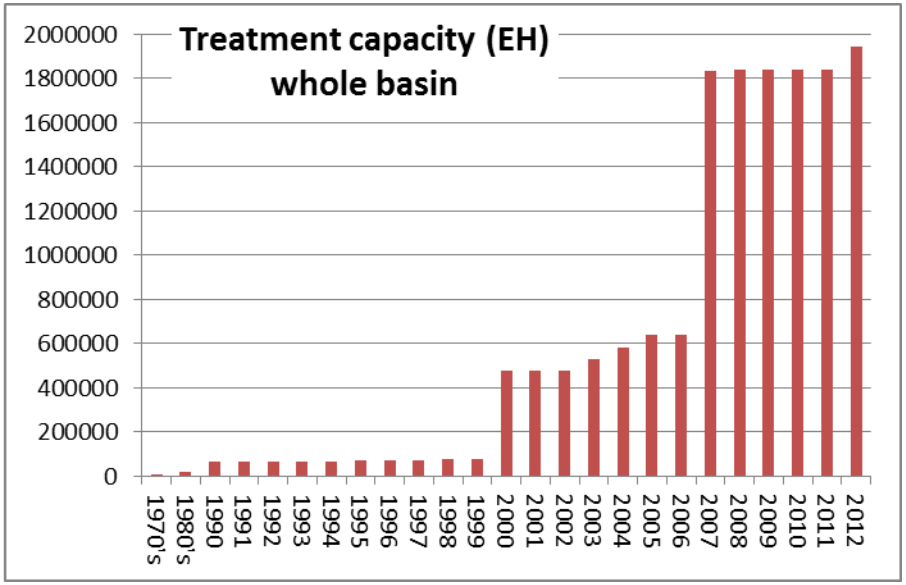
History of wastewater treatment in the Zenne basin

- Consequences ?
- Data VMM, BE
- Lembeek, Drogenbos, Vilvoorde
- 1990-2015



Evolution – yearly average OM, O_2

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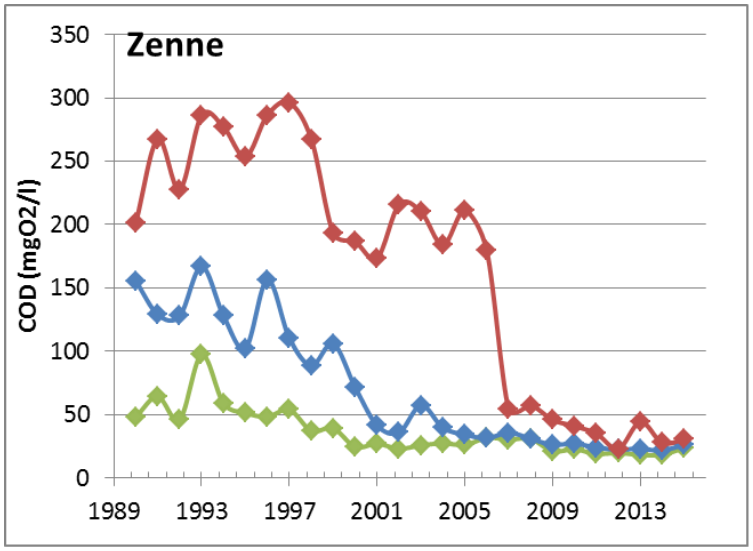

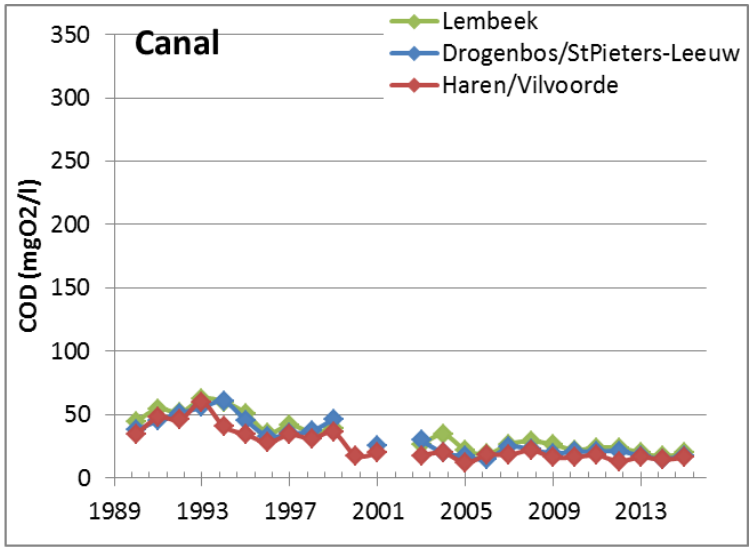

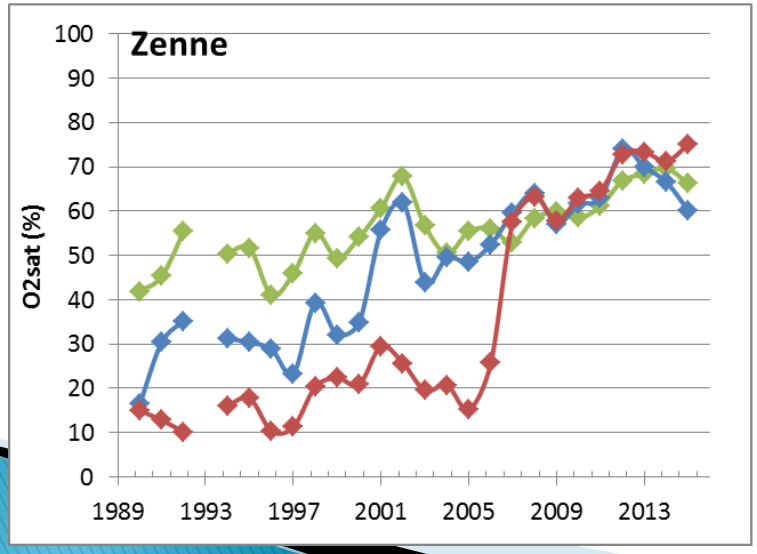

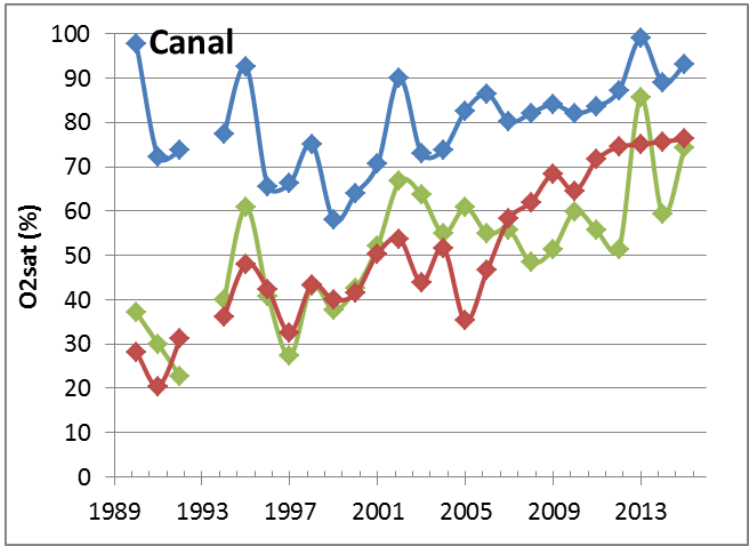

Evolution – yearly average N and P

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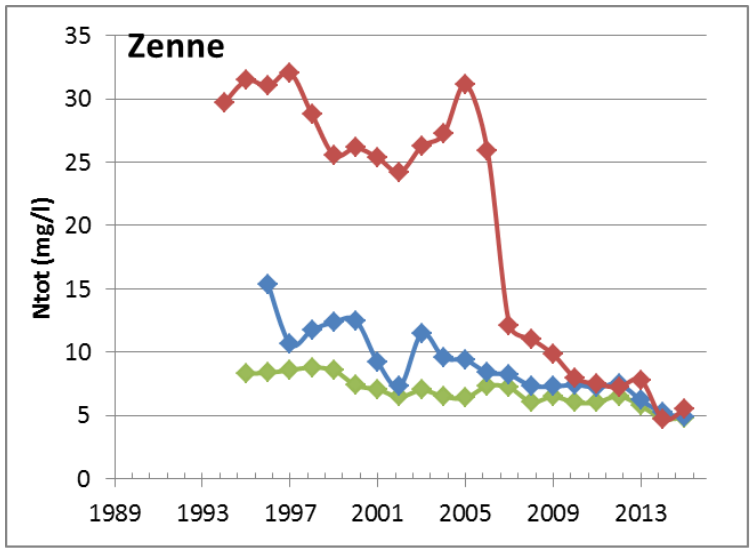
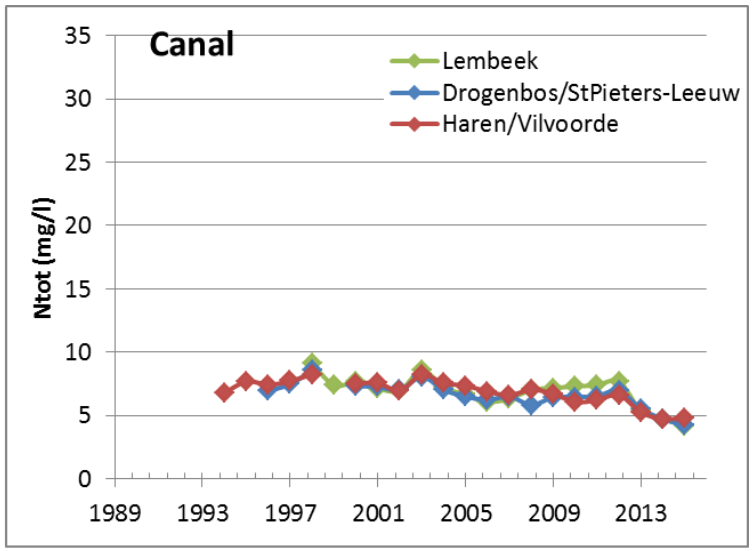
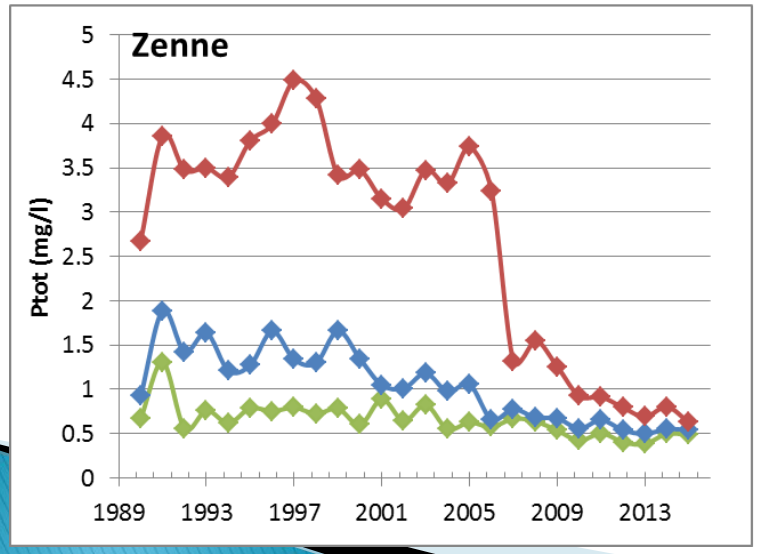
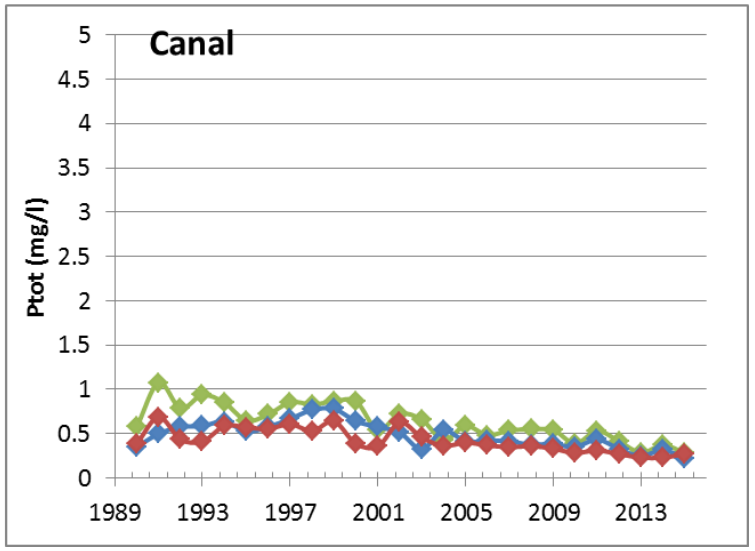
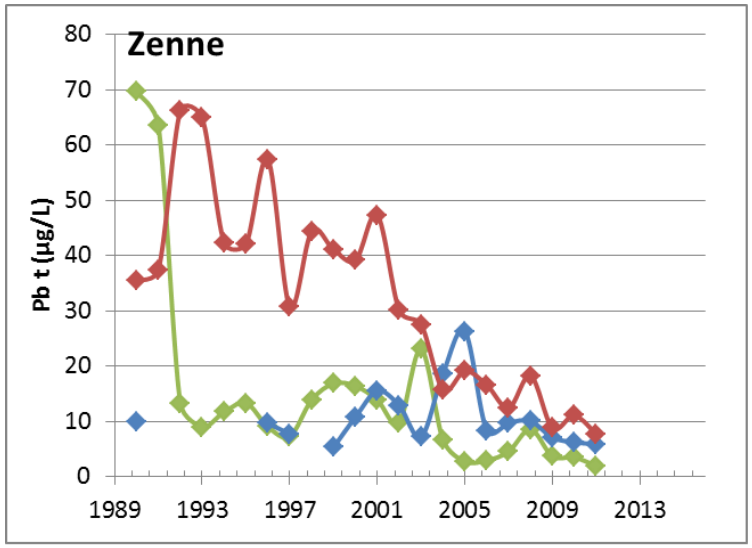


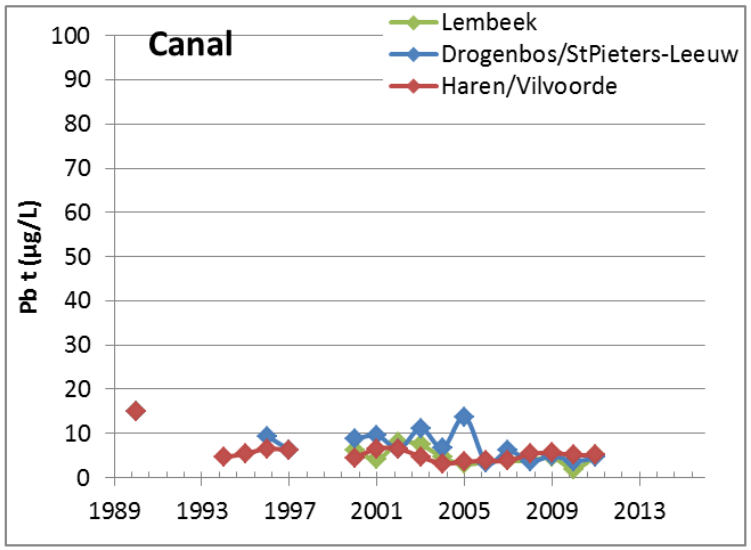


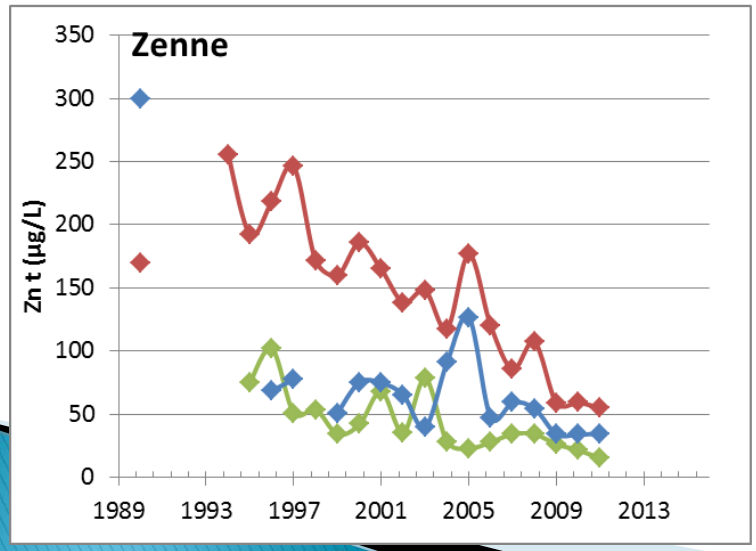


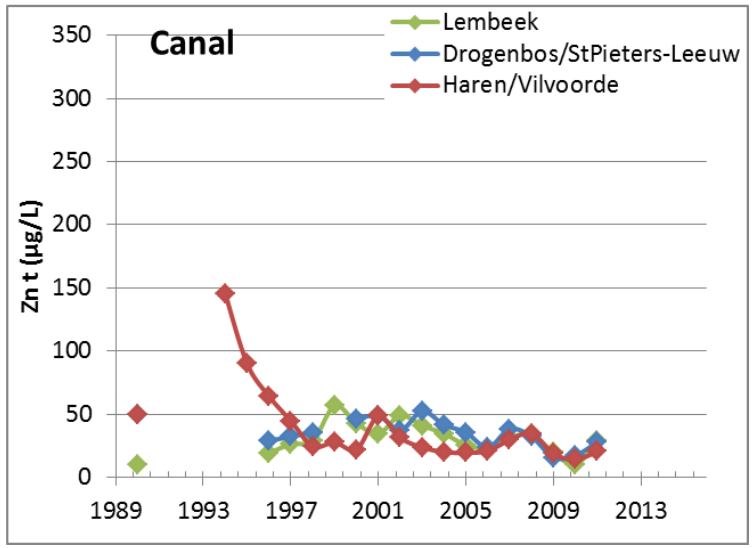


Evolution – yearly average Pb and Zn



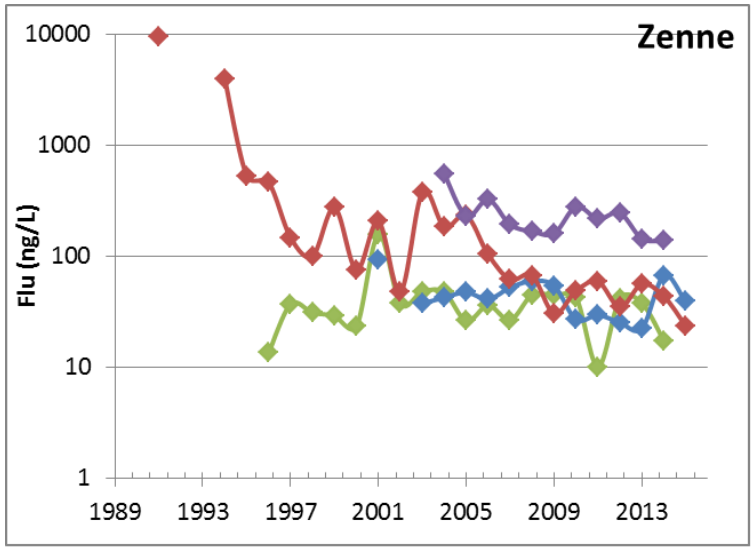


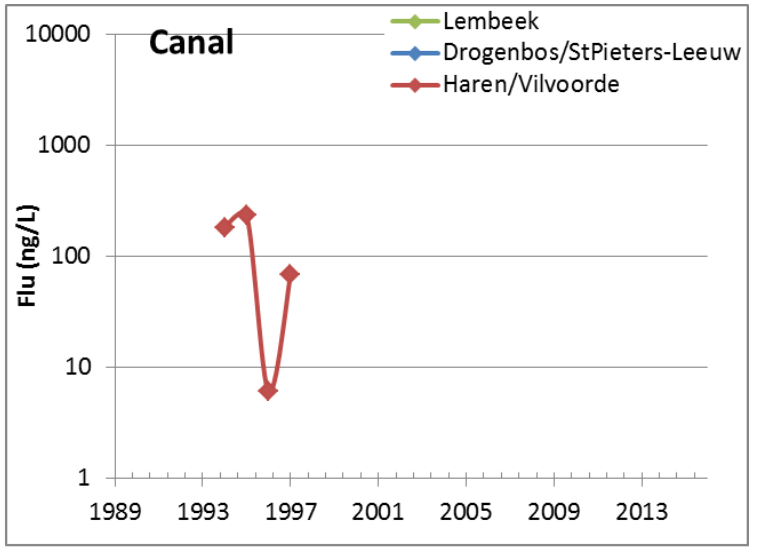


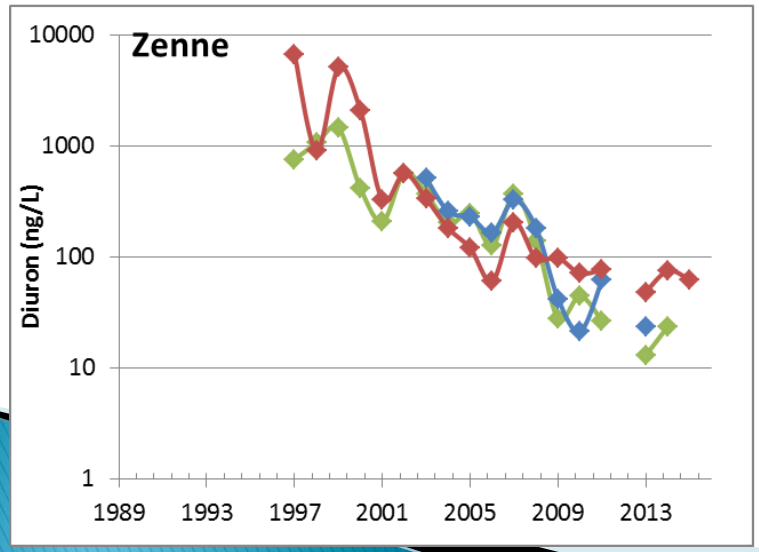


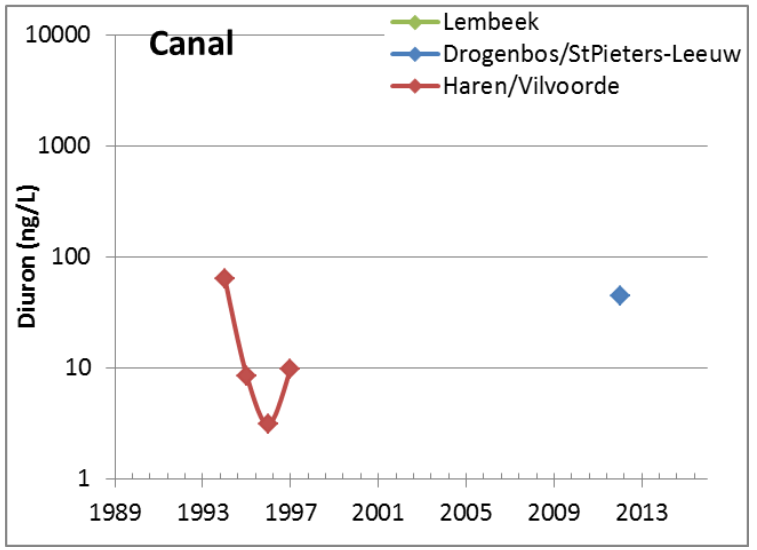
Evolution – yearly average Fluoranthene and Diuron – log scale

GESZ









Today

- Water quality vs norms and background

From source to mouth

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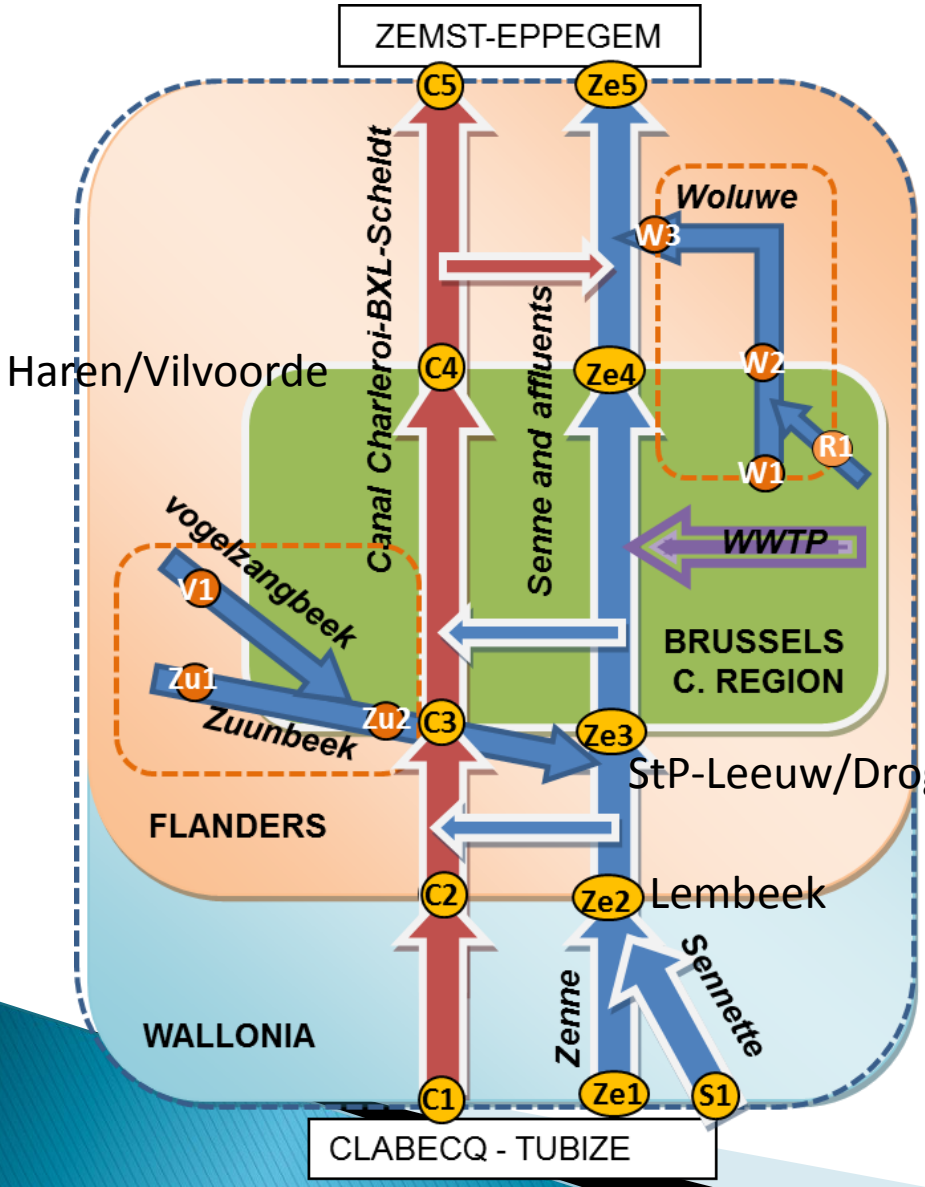

Data 2009-2014:
SPW-DG03
VMM
BE
SBGE

\+ Background: small rivers in the upstream Zenne river catchment

Today – 2009-2014

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Sennette-Zenne

Type	variable	unit	criteria	region	target	Bckg	S1 Tubize	Ze1 Tubize	Ze2 Lembeek	Ze3 Drog.	Ze4 Haren	Ze5 Eppeg.
	O2	mg/L	P10%-min	Vl-BXL	6	6.7	7.6	4.8	4.3	4.6	3.7	2.5
Organic Matter	O2 sat	%	average-median	BXL-Wal	50	86			65	69	64	48
and	BOD	mgO2/L	median	Wal	6	1.5	6.4	5.2	3	4	4.2	4
Oxygen	BOD	mgO2/L	P90%	BXL-Vl	6	5.3	21	21	5.1	6.7	16	11
	COD	mgO2/L	P90%	BXL-Vl	30	37	63	64	35	41	94	59
	KjN	mgN/L	average-median	BXL-Wal	8-6	2.1	2.2	2.4	2.5	2.4	7.0	6.2
	KjN	mgN/L	P90%	Vl	6	3.9	3.0	4.0	4.0	4.2	11.0	11.0
Nitrogen	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	5.3	5.8	6.4	7.6	8.2
	NH4+	mgN/L	average-median	BXL-Wal	3-2	1.2	0.8	1.3	1.4	2.2	3.6	3.7
	NO3-	mgN/L	average	BXL	10	5.2	5.5	3.1	3.4	3.7	2.4	2.8
	NO3-	mgN/L	P90%	Vl	5.65	9.6	6.7	4.6	4.5	4.8	3.6	3.9
	P t	mgP/L	average-median	BXL-Wal	1	0.4	0.2	0.4	0.4	0.6	0.8	0.8
Phosphorus	P t	mgP/L	summer average	Vl	0.14	0.5	0.3	0.6	0.5	0.6	1.0	0.9
	oPO4	mgP/L	average	BXL-Vl	0.15-0.14	0.16		0.36	0.27	0.32	0.53	0.49
	Cu-diss	µg/l	average	BXL-Vl	7	0.9	0.7	1.0	1.0	2.0	2.3	1.0
	Zn-diss	µg/l	average	BXL-Vl	20	5.5	5.3	4.9	4.2	16	33	16
Metals	Cd-diss	µg/l	average	all	0.25	0.01	0.01	0.01	0.02	0.05	0.07	0.02
	Ni-diss	µg/l	average	all	4	1.8	1.7	4.1	2.4	3.7	4.0	3.0
	Pb-diss	µg/l	average	all	1.2	0.2	0.2	0.2	0.4	2.6	3.9	0.4
	B(b)Flu	ng/L	max (P90)	all	17	6	6	8	28	27	38	79
PAHs	B(k)Flu	ng/L	max (P90)	all	17	3			12	14	24	35
	Flu	ng/L	average	all	6.3	10	7	8	31	28	47	210
	Flu	ng/L	max (P90)	all	120	25	13	12	67	48	120	374
Pesticides	Diuron	ng/L	average	all	200	25	24	24	29	36	61	
	Isoproturon	ng/L	average	all	300	18	13	50	67	24	32	

- General: BOD and COD peaks, O_2 minimum, N (Vl) and P (Vl and BXL), PAHs (Flu)
- Local: NH_4, KjN peaks, Pb, Zn, (Ni), PAHs peaks

Today – 2009-2014

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Canal

Type	variable	unit	criteria	region	target	Bckg	C1 Tubize	C2 Lembeek	C3 StP-L	C4 Haren	C5 Zemst
	O2	mg/L	P10%-min	Vl-BXL	6	6.7	3.5	3.4	6.2	5.1	3.9
Organic Matter	O2 sat	%	average-median	BXL-Wal	50	86		61	88	72	57
and	BOD	mgO2/L	median	Wal	6	1.5	2.9	3	1.5	1.5	1.5
Oxygen	BOD	mgO2/L	P90%	BXL-Vl	6	5.3	7.4	5.0	3.5	3.0	2.5
	COD	mgO2/L	P90%	BXL-Vl	30	37	33	29	33	26	23
	KjN	mgN/L	average-median	BXL-Wal	8-6	1.7	2.1	2.8	1.9	1.5	1.0
	KjN	mgN/L	P90%	Vl	6	3.9	4.4	4.9	3.1	2.4	4.1
Nitrogen	N t	mgN/L	average	BXL	12	4.8	6.1	6.6	6.1	5.9	6.9
	N t	mgN/L	summer average	Vl	2.5	5.0	6.0	6.0	5.6	5.4	5.9
	NH4+	mgN/L	average-median	BXL-Wal	3-2	1.2	1.4	1.8	0.8	0.6	1.0
	NO3-	mgN/L	average	BXL	10	5.2	3.4	3.6	4.2	4.5	4.6
	NO3-	mgN/L	P90%	Vl	5.65	9.6	4.4	5.0	5.4	5.6	5.9
	P t	mgP/L	average-median	BXL-Wal	1	0.4	0.3	0.4	0.3	0.3	0.3
Phosphorus	P t	mgP/L	summer average	Vl	0.14	0.45	0.35	0.42	0.29	0.24	0.37
	oPO4	mgP/L	average	BXL-Vl	0.15-0.14	0.16	0.21	0.19	0.17	0.14	0.18
	Cu-diss	µg/l	average	BXL-Vl	7	0.9	1.0	0.9	2.5	1.5	1.0
	Zn-diss	µg/l	average	BXL-Vl	20	5.5	6.8	6.0	9.9	8.9	3.7
Metals	Cd-diss	µg/l	average	all	0.25	0.01	0.01	0.02	0.04	0.04	0.02
	Ni-diss	µg/l	average	all	4	1.8	2.5	2.3	3.3	3.5	1.6
	Pb-diss	µg/l	average	all	1.2	0.2	0.3	0.7	1.5	1.9	1.0
	B(b)Flu	ng/L	max (P90)	all	17	6			14	14	
PAHs	B(k)Flu	ng/L	max (P90)	all	17	3			5	5	
	Flu	ng/L	average	all	6.3	10	35		11	9	
	Flu	ng/L	max (P90)	all	120	25	81		19	20	
Pesticides	Diuron	ng/L	average	all	200	25	59		27	21	
	Isoproturon	ng/L	average	all	300	18	48		16	14	

- General: O_2 minimum, N (Vl) and Pt (Vl), PAHs (Flu)

Today

- Identified Critical situations

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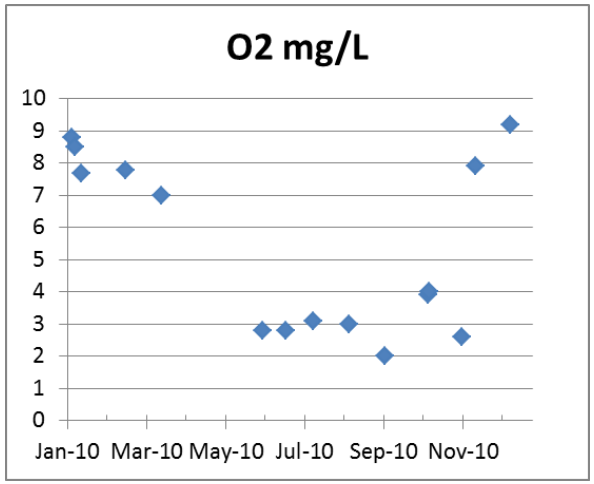
Critical problematic situations

- For O_2: Summer high temperature – low flow situations in Zenne
  - Low dilution capacity
  - High respiration rates of OM: low O_2 levels



- Combined Sewer Overflow (CSO) events – in particular those from Brussels sewers

- Any technical problem that results in the interruption of wastewater treatment

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CSO – frequency in BXL and global importance as a source of pollutants

Lion CSO characteristics

Brussels-City main sewer basin area (km²)	59
Number of daily equivalent inhabitants collected	509,000

Table 2 | CSOs statistics from November 2011 to October 2012 at the Lion study site

	Lion overflow	
Total number of CSO events in one year	101	
Over the total number of CSOs:	Average	Maximum
Maximum discharge (m³/s)	5.28	25.85
Duration (h)	4.06	15.88
Volume (m³)	38,600	345,000
CSO volume/ Total downstream river volume (%)	16.6	46.0
	Total in one year	
Duration (d)	19.68	
Volume (m³)	3,900,000	

CSO – contribution to year loads

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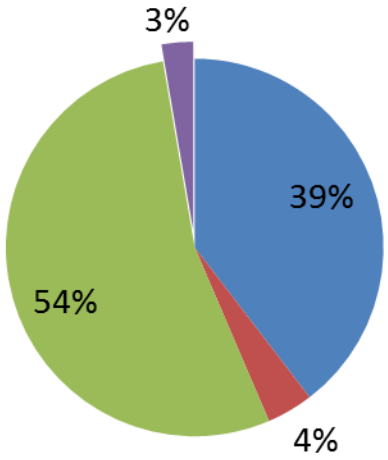
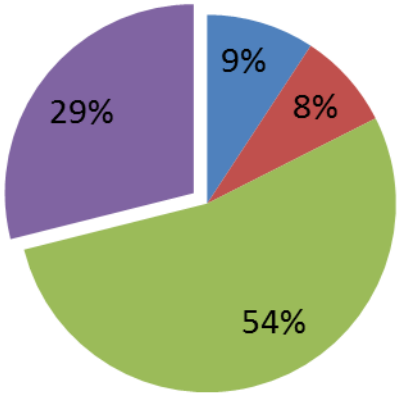
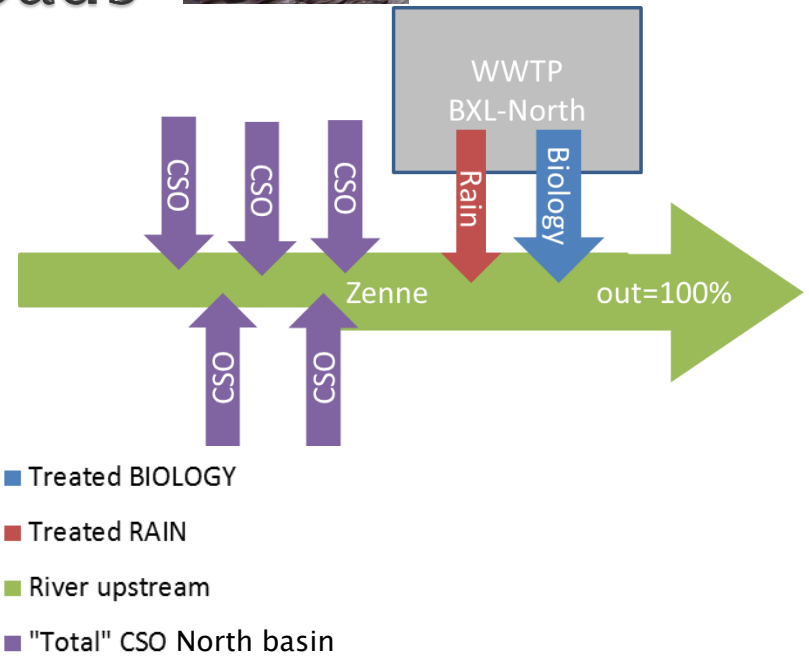
Volume - 265 E+6 m³/y

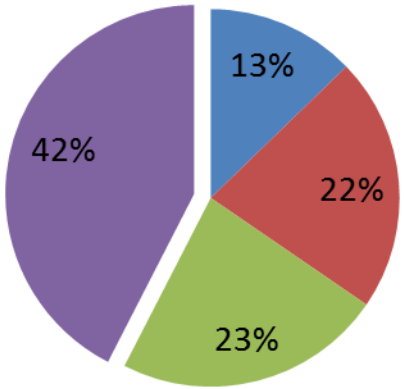


SPM load - 10.9 kT/y

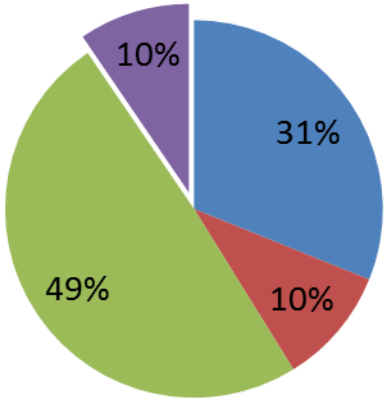




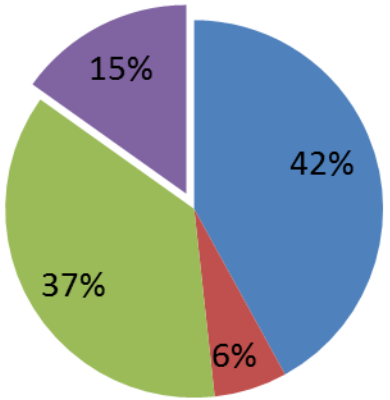
BOD load - 3.00 kTO$_2$/y



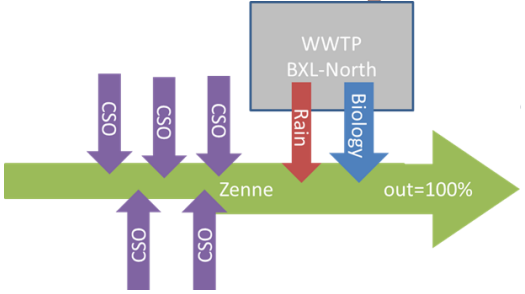
Ntot load - 2.20 kT/y



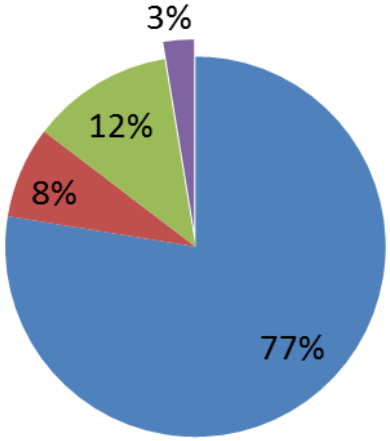
Ptot load - 0.21 kT/y



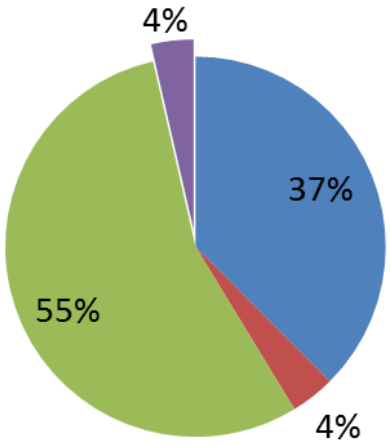
CSO – contribution to year loads



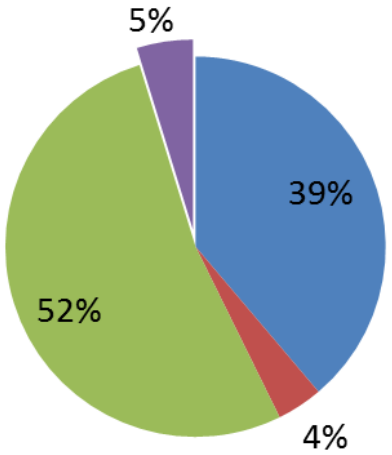
diss Zn load - 7.12 T/y



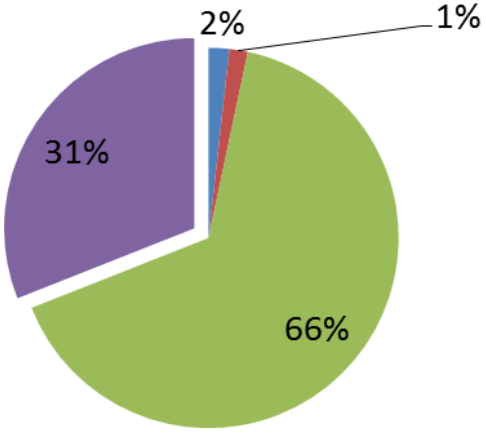
diss Cd load - 6.24 kg/y



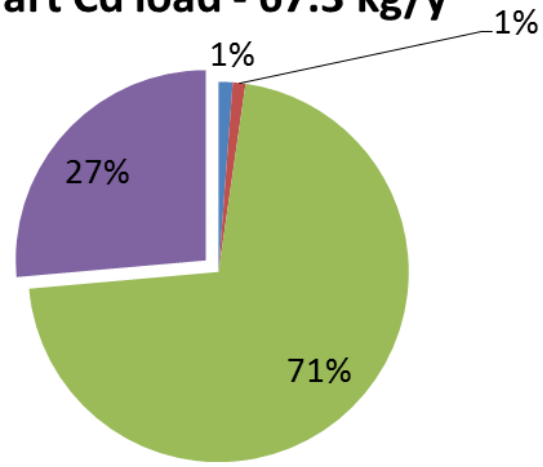
diss Pb load - 136 kg/y



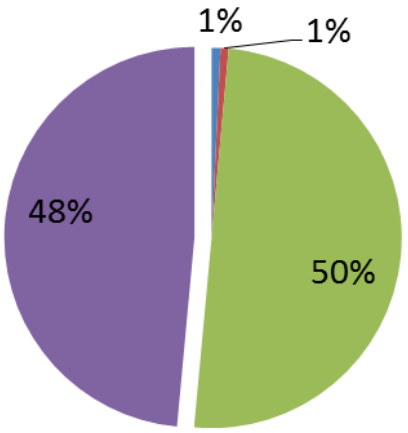
Part Zn load - 20.8 T/y



Part Cd load - 67.3 kg/y



Part Pb load - 7623 kg/y



CSO – local effects Eppegem

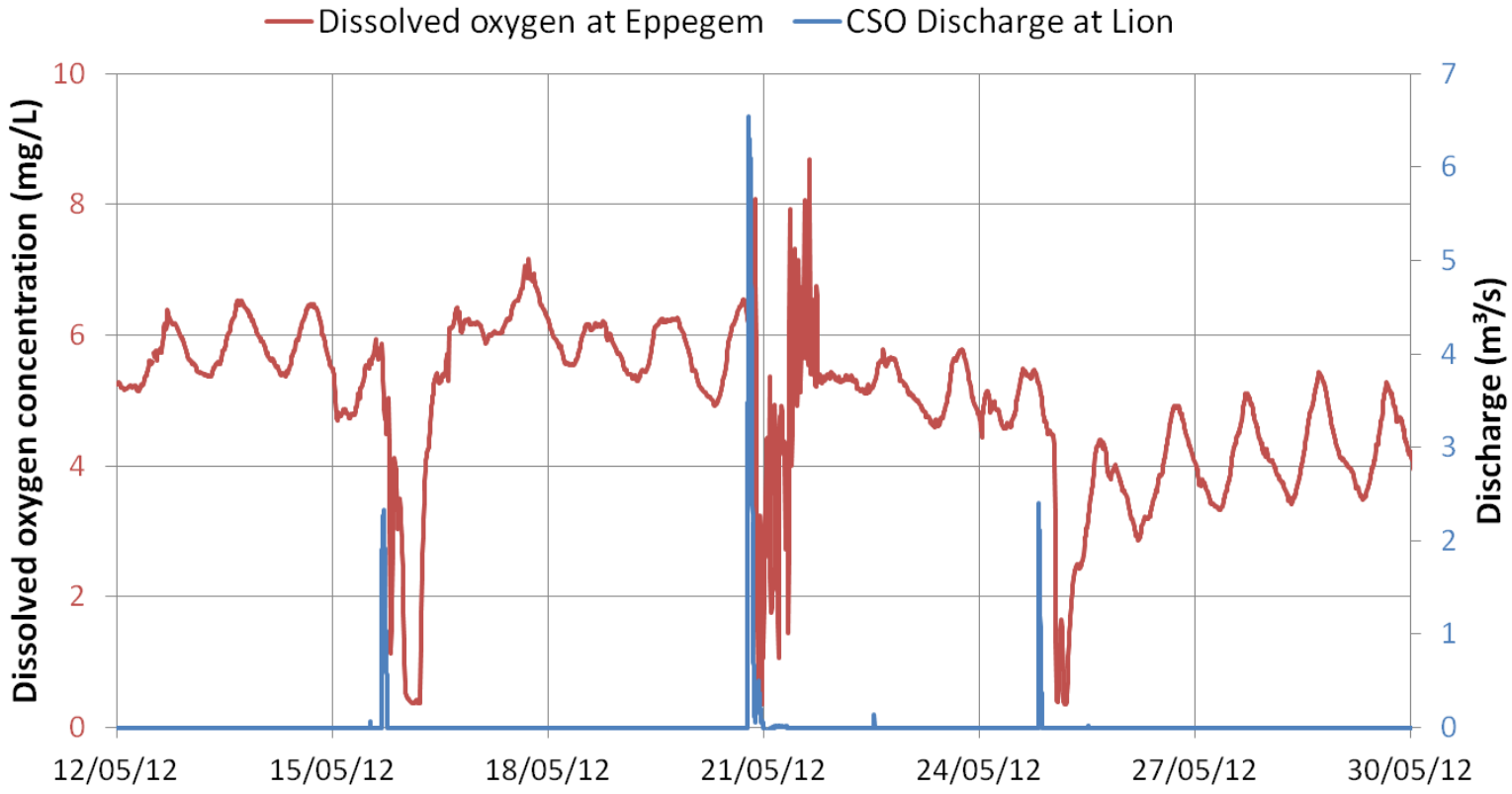


Table 3 | DO deficit statistics at Eppegem related to Lion CSOs from November 2011 to October 2012

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

Conclusions

GESZ

- Problems:
  - N and P – in the whole Zenne system including most upstream sources. Less important in Canal
  - O_2 minimum and BOD-COD peaks: summer low flow
  - Pb in Zenne central VL-BXL parts
  - Ni at the limit in some places (Zenne in Tubize)
  - HAPs – especially Fluoranthene – in whole system including background!
  - Locally peaks of HAPs (especially high in Eppegem)

Critical situations: summer low flow and CSO

Possible Improvements?

- Reduce CSO:
  - Modernization and clean-up of old sewer pipes…
  - Stormwater reservoirs
  - Promoting water infiltration/retention areas in urban landscape

- Enhance water discharge with clean waters during summer low flow periods?

Publications

GESZ

Environ Sci Pollut Res
DOI 10.1007/s11356-015-4493-8

RESEARCH ARTICLE 2015

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Natacha Brion[1] · Michel A. Verbanck[2] · Willy Bauwens[3] · Marc Elskens[1] · Margaret Chen[3] · Pierre Servais[4]

Journal of Marine Systems 128 (2013) 62–76

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Josette Garnier [a,b,*], Natacha Brion [c], Julie Callens [a], Paul Passy [a], Chloé Deligne [d,f], Gilles Billen [a,b], Pierre Servais [e], Claire Billen [f]

In: Lestel, L, Carré, C. (dir.), Comment les métropoles ont sacrifié leurs rivières : Berlin, Bruxelles, Milan et Paris (1850 – 2010), à paraître :

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In: Technology day on "Bridges over troubled water", 2012 Crosstalks, VUB.

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