Source Control Options for Reducing Emissions of Priority Pollutants
3rd Annual meeting of the Danish Water Research Platform (DWRP, Forsknings¬platformen Vand), The Geological Survey of Denmark and Greenland (GEUS), 29 January 2009

Technical University of Denmark DTU

Source Control Options for Reducing Emissions of Priority Pollutants (from Urban Areas)

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DTU Environment
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3rd Annual meeting of the Danish Water Research Platform
(DWRP, Forskningsplatformen Vand)
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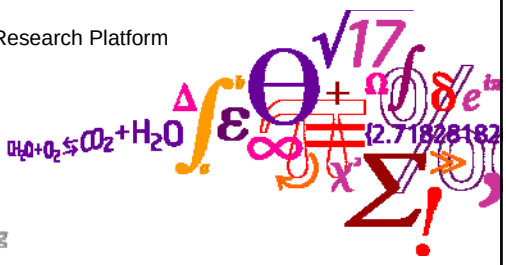

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The ScorePP project

- A Specific Targeted Research Project (STREP)
- Funded by the European Commission under the 6th Framework Programme (4th Call), sub-priority 1.1.6.3 "Global Change and Ecosystems"
- Duration: 1 Oct 2006 + 36 (+6?) months
- Budget: 3.6 M EUR, 2.6 M EUR from the EC
- 9 partners
- 4 case cities
- www.scorepp.eu

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Partners and case study cities

Partners:

1. DTU, Denmark
2. MU, UK
3. UGent, Belgium
4. AR, France
5. ENVICAT, Belgium
6. UL, Slovenia
7. ESTUDIS, Spain
8. MF, Sweden
9. modelEAU, Canada

Case cities:

- Stockholm, Sweden
- St. Malo, France
- Prague, Czech Republic
- Quebec, Canada
- St. Sebastian, Spain

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Main ScorePP objectives

Develop comprehensive and appropriate source control strategies

that authorities, cities, water utilities and chemical industry can employ to

reduce emissions of priority pollutants from urban areas

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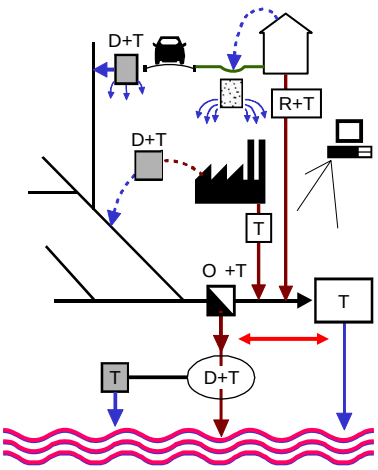
The ScorePP approach

Limiting release through:
- Substitution
- Minimising release from products
- Legislation and regulations
- Voluntary use reductions

Treatment options:
- Stormwater BMPs
- Household treatment & reuse of WW
- On-site industrial treatment
- WWTPs
- Sludge disposal

Sinks:
- Primary: Surface water (WFD)
  ELV ... ✝ ☹
- Secondary: Sediments, soils/gr., water, humans, ...

Example: Combined system:



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Project plan

Now!

WP	Mth	Resp.	1-12	13-24	25-36
WP1: User requirement a end-users					
WP2: Analysis of case studies					
WP3: Source characterisation of pri		TU			
WP4: Limiting release of p					
WP5: Treatment options					
WP6: GIS-based identification of emission cont measures					
WP7: Models and monitoring strategies					
WP8: Socio-economic analysis of source control measures		ESTUDIS			
WP9: Integration of know emission control strategie					
WP10: Project management and coordination		DTU			

Advisory board, PPRIS

Case studies

Establishing technical-scientific facts

GIS, models, monitoring

Socio-economic and integrated analyses

+6

Substances selected for further work – I

Substances chosen for further work with respect to source characterisation are printed in black. Priority substances (PSs), EQS-proposal (EQS), example chemicals (EX), "organometallics" (OM). Priority hazardous substances (PHSs) are printed in **bold**.

	Class[a]			
	PS (33)	**EQS (11)**	**EX (11)**	**OM (13)**
Biocide (31)	Trifluralin **Hexachlorocyclohexane** Alachlor Pentachlorophenol Endosulfan Simazine Atrazine Chlorfenvinphos Isoproturon Diuron Chlorpyrifos **Hexachlorobutadiene** **Tributyltin compounds**	Aldrin Endrin Isodrin Dieldrin Para,para'-DDT Para,para'-DDE[b] Para,para'-DDD[b] Orto,para'-DDT[c]	Tributyltin-cation Alpha-endosulfan Gamma-isomer lindane 1,2,4-trichlorobenzene	Tetra-N-Butyltin Bis(tributyltin) oxide Phenylmercuric acetate Tributyltin methacrylate Tributyltinchlorostannane Methylmercury
Chlorinated solvent (6)	Ethylene chloride Dichloromethane Chloroform	Trichloroethylene Tetrachloroethylene Carbontetrachlorid		
Combustion (6)	PAH		Indeno(1,2,3-cd)pyrene Benzo(k)fluoranthene Benzo(g,h,i)perylene Benzo(a)pyrene Benzo(b)fluoranthene	

[a]: Classified according to the WFD and the EQS-proposal. The numbers in brackets represent the number of chemicals in each class; [b]: Degradation product of para,para'-DDT; [c]: Impurity of para,para'-DDT; [d]: The term "various" covers a range of uses like alloys, catalysts, pigments, batteries, dentistry, measuring and control equipment, biocide, impurity, cables, stabilisers, intermediate; [e]: The individual metals represents the ionic form(s).

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Substances selected for further work - II

Substances chosen for further work with respect to source characterisation are printed in black. Priority substances (PSs), EQS-proposal (EQS), example chemicals (EX), "organometallics" (OM). Priority hazardous substances (PHSs) are printed in **bold**.

	Class[a]			
	PS (33)	**EQS (11)**	**EX (11)**	**OM (13)**
Flame retardant (2)	**Pentabromobiphenylether** **C_{10-13} chloroalkanes**			
Fuel additive (5)				Tetramethyl lead Ethyltrimethyl lead Tetraethyl lead Methyltriethyl lead Diethyldimethyl lead
Intermediate (11)	Naphthalene Anthracene **Nonylphenol** Fluoranthene Benzene Trichlorobenzenes Octylphenol **Pentachlorobenzene**		4-(para)nonylphenol Para-tert-octylphenol	Dimethylmercury
Plasticizer (1)	DEHP			
Various[d] (6)	**Hexachlorobenzene** Nickel[e] **Mercury**[e] Lead[e] **Cadmium**[e]			Diethylmercury

[a]: Classified according to the WFD and the EQS-proposal. The numbers in brackets represent the number of chemicals in each class; [b]: Degradation product of para,para'-DDT; [c]: Impurity of para,para'-DDT; [d]: The term "various" covers a range of uses like alloys, catalysts, pigments, batteries, dentistry, measuring and control equipment, biocide, impurity, cables, stabilisers, intermediate; [e]: The individual metals represents the ionic form(s).

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Physico-chemical properties database, Deliverable 3.1, see www.scorepp.eu

- Chemical IDs; CAS#, EINECS, Merck #
- Molecular formula
- Physical appearance
- Density (n), g/mL
- Molecular weight (M_w), g/mole
- Melting point (T_m), °C
- Boiling point (T_b), °C
- Solubility in water (S_w), mg/L
- Lipid solubility of neutral species (log K_{OW})
- Lipid solubility of ionized species (log D_{OW})
- Vapour pressure, mm Hg
- Acid dissociation constant (pK_a)
- Henry's law constant (K_h), atm×m^3/mole
- Diffusion coefficient, m^2/d

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Source characterisation based on "Emission Strings"

- "Emission Strings" combine three classification codes
  - CAS #: unique identitication of each substance
  - NOSE-P: unique identification of emission processes
  - NACE: unique identification of specific economic activities realted with each emission proces

- We develop the classification codes further in order to cover households and also natural sources
- This approach will potentially allow data to be obtained from Eurostat, and extrapolation to the whole of Europe should be possible => GIS !

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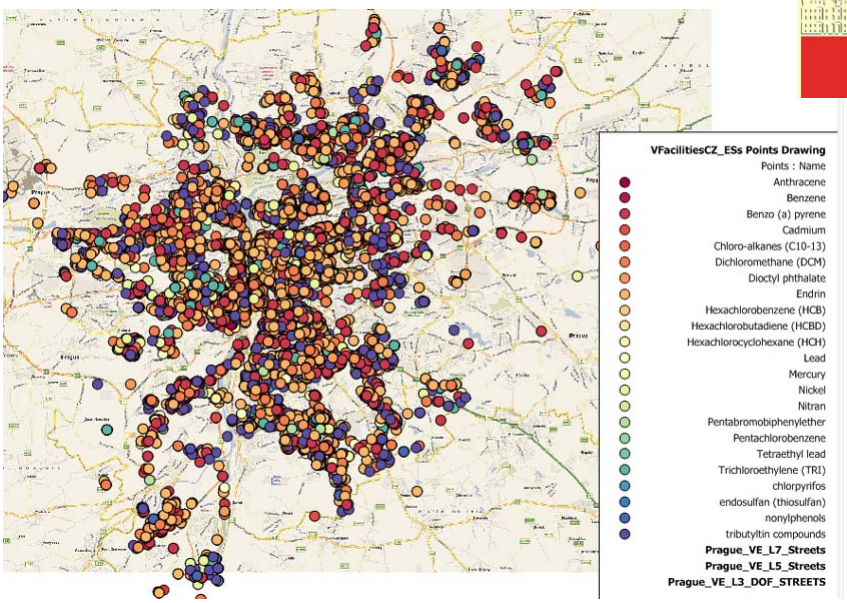
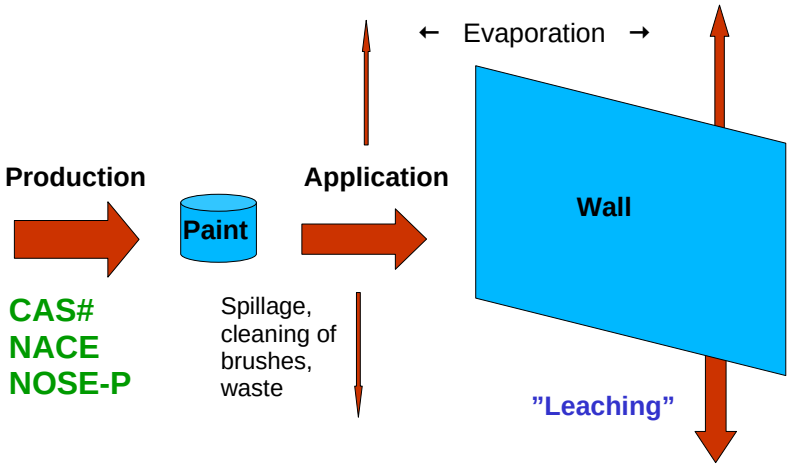
Example of source mapping



Example of Emission Strings: – Paint on a wall

(PPs of relevance: pesticides and solvents)



Leaching from paint is a long-term process, which happens intermittently
=> ”Release patterns” and ”release factors” are developed !

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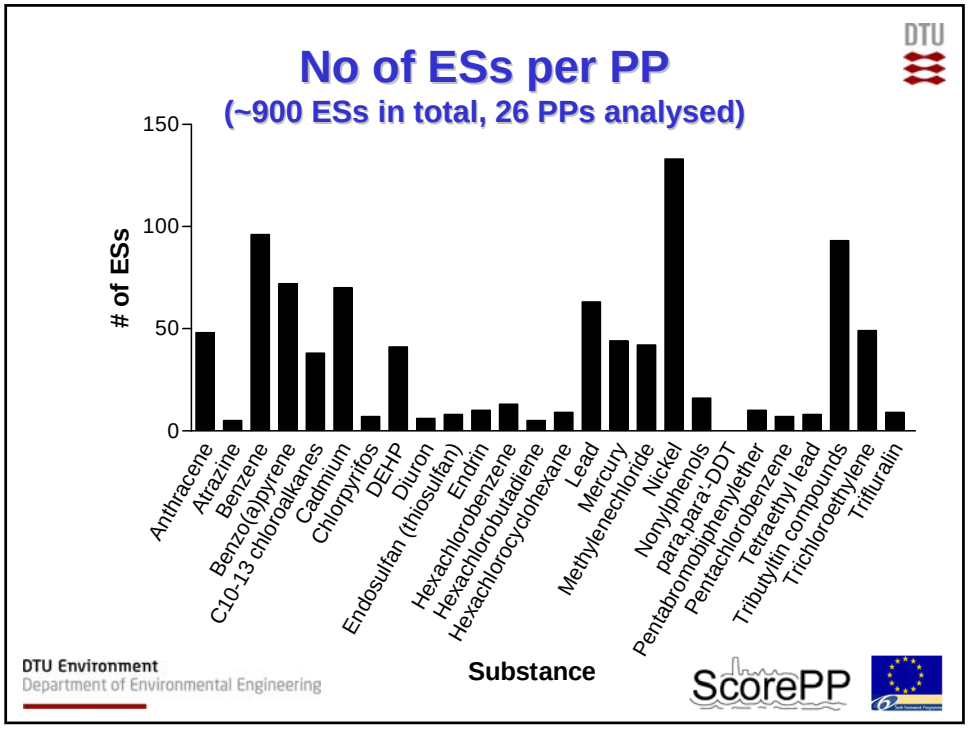

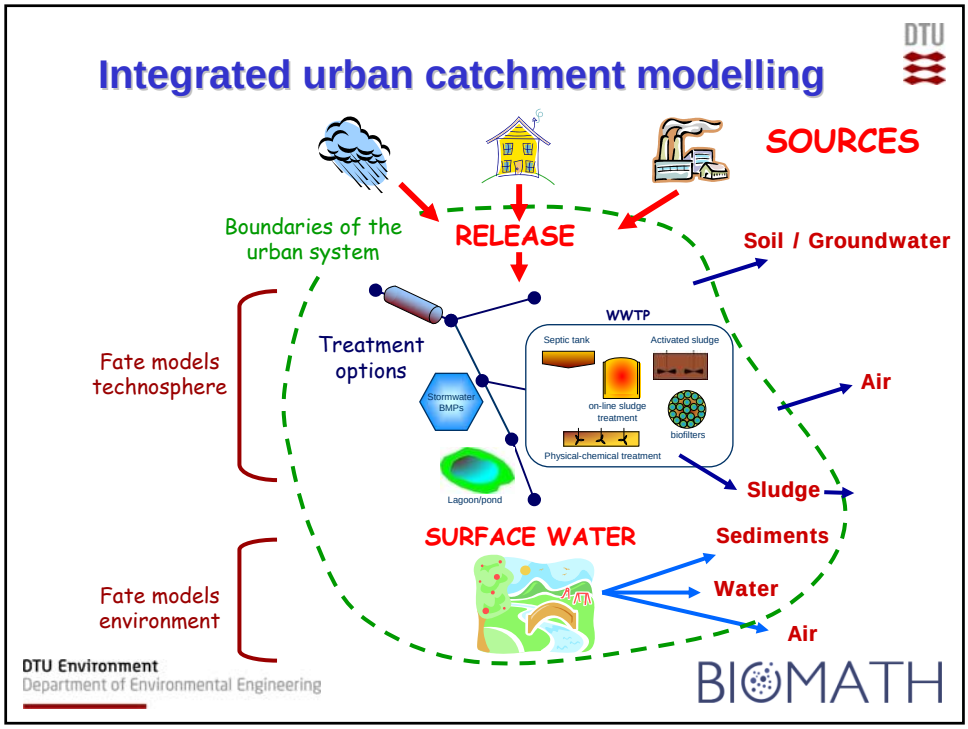

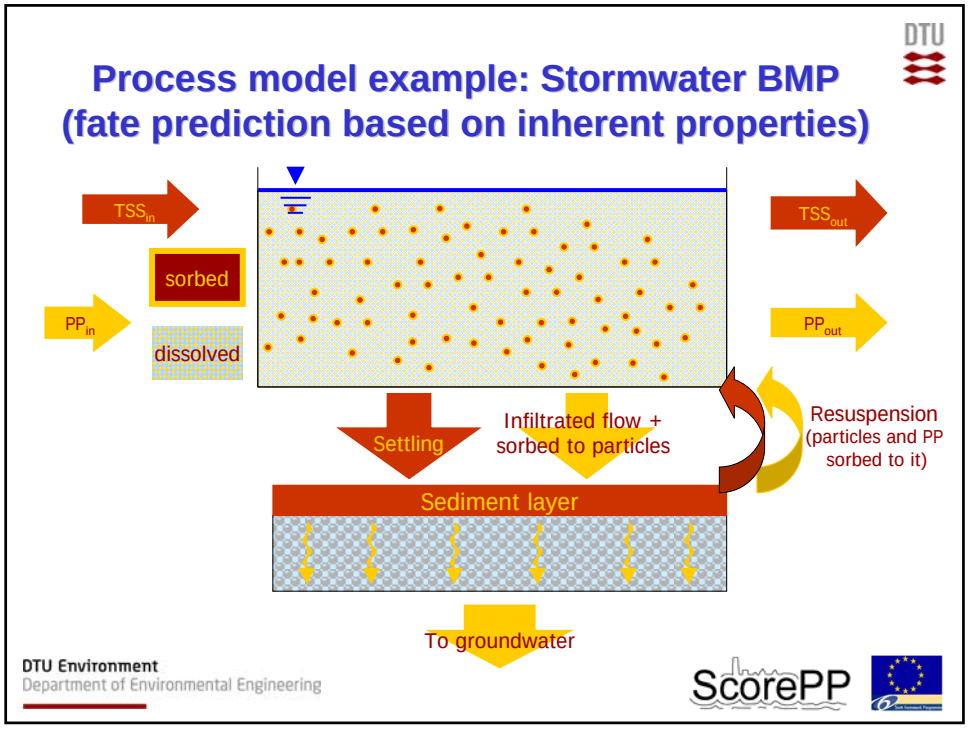
Process model example: Stormwater BMP
(fate prediction based on inherent properties)
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TSS$_{in}$
sorbed
PP$_{in}$
dissolved
TSS$_{out}$
PP$_{out}$
Settling
Infiltrated flow + sorbed to particles
Resuspension (particles and PP sorbed to it)
Sediment layer
To groundwater
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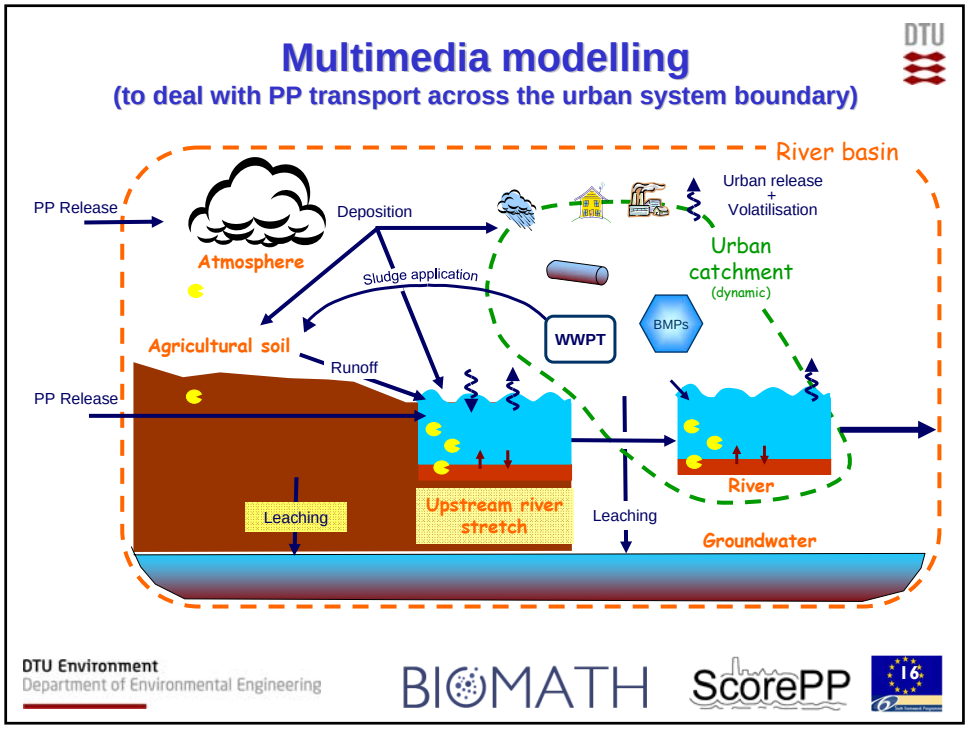
Multimedia modelling
(to deal with PP transport across the urban system boundary)
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River basin
PP Release
Deposition
Atmosphere
Urban release + Volatilisation
Urban catchment (dynamic)
Sludge application
WWPT
BMPs
Agricultural soil
Runoff
PP Release
Leaching
Upstream river stretch
Leaching
River
Groundwater
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BIOMATH
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Next steps in ScorePP

- Analyse and synthesize information
  - Identify the most important sources
  - Determine what control options are promising (at source as well as end-of-pipe treatment, ”soft” as well as ”hard”)
  - Further delop technology (e.g. models)
- Map out conditions in case cities, results of monitoring
- Define ”semi-hypothetical case city archetypes”
- Define and analyse emission control strategies, i.e.
  - Combination of several control options that work across a range of PPs
  - Realistic temporal evolution
  - Quantitative assessment – do we reach the (?) goals
  - Multi-criteria assessment – costs, related impacts
- Interact with external stakeholders (Advisory Board)
- Conclude

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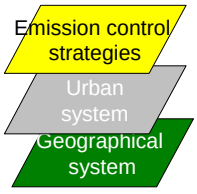
Emission Control Strategies for “semi-hypothetical case city archetypes”

- Emission control strategies
  - Trends and prospects – case city 2025
- Urban system
  - Economical
  - Social
  - Stakeholder involvement
  - Technical
  - Urbanisation (% impermeable surfaces, housing density etc)
  - Industrialisation (%: heavy & light industry, white-collar business, agriculture etc)
  - Logistics (types and amounts of transport)
  - Government, legislature
  - Non-governmental organisations, voluntary initiatives
  - Resources (raw materials, refinement)
  - Economics: GNP, Gini coefficient
  - Social: Human Development Index (HDI)
  - Public/private waterworks and wastewater treatment plants
- Geographical system
  - Climate
  - Environmental
  - Size (area, population, density)
  - Climate (inland/coastal; southern/northern)
  - Water resources (groundwater, surface water, desalination)



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ScorePP partners and key persons

1. **Technical University of Denmark**, Department of Environmental Engineering (**DTU**)
   - P.S. Mikkelsen, H.-C. Holten Lützhøft, E. Eriksson, L. Vezzaro, H. Birch, A. Ledin, B.K. Rasmussen
2. **Middlesex University**, School of Health and Social Sciences (**MU**)
   - Mike Revitt, Lian Scholes, Erica Donner, C. Viavattene
3. **Gent University**, Dept. of Applied Mathematics, Biometrics and Process Control (**UGent**)
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4. **Anjou Recherge**, Municipal Wastewater Department (**AR**)
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5. **ENVICAT** Consulting (**ENVICAT**)
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7. **Dosenvolupament i Societat ESTUDIS SA** (**ESTUDIS**)
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8. **Stockholm City**, Envionmental Monitoring (**MF**)
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9. **Université Laval**, Département Génie Civil, model*EAU* (**model*EAU***)
   - P. Vanrolleghem, L. Rieger

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Source Control Options for Reducing Emission of Priority Pollutants from Urban Areas

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www.scorepp.eu

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- **ENVICAT Consulting, Belgium**
- **University of Ljubljana, Slovenia**
- **ESTUDIS, Spain**
- **Environmental Monitoring, Stockholm City, Sweden**
- **modelEAU, Canada**

and to the European Commission: