EMISSION CONTROL STRATEGIES FOR SELECTED PRIORITY POLLUTANTS IN STOCKHOLM, SWEDEN

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Introduction

The Source Control Options for Reducing Emissions of Priority Pollutants (ScorePP) project was a European 'Specific Targeted Research Project' aiming to develop source control strategies that cities, water utilities and industry can employ to reduce emissions of priority pollutants (PPs) from urban areas into the receiving water environment. Focus was on the 33 priority and priority hazardous substances (PS and PHS) identified in the European Water Framework Directive (WFD) and for which Environmental Quality Standards (EQS) have been adopted [1].

One topic within the ScorePP project was to identify appropriate emission control strategies (ECS) for selected PPs in case cities, of which one was Stockholm, Sweden.

Material & Methods

In proposing ECSs for Stockholm, focus was on PPs present in the effluent streams or in sludge from local wastewater treatment plants [2].
Within the ScorePP project an emission string database [3] was produced. This database together with more local specific information from the city and substance flow analyses made within the project provided valuable insight into the relative importance of the various sources for each of these PPs.

The chosen PPs & identified major sources [4 and 7]**:**

- di(2-ethylhexyl)phthalate (DEHP) Abrasion particles ("waste in the environment"), floor and wall coverings, coated textiles and lacquers and paint.
- Cadmium (Cd) Long range transport, car wash and artist paint.
- Mercury (Hg) Erosion of tyres, erosion of roads and human excrements (due to amalgam fillings).
- Benzo[a]pyrene (B(a)P) Domestic greywater (bath, shower, kitchen sink, wash basin, dish washer and washing machine).
- Pentabromodiphenyl ether (PBDE) Abrasion particles from polyurethane articles.

Evaluated emission control strategies:

- Voluntary initiatives by municipalities or households.
- Advanced waste water treatment plant (WWTP) processes.
- Stormwater treatment by constructed best management practices (BMPs) systems.

Criteria for scoring of strategies	Scoring (timeframe10 years)		
	1	2	3
Technical feasibility – The potential to use a given ECS	The technology is not available	The technology is under development	The technology is available
Technical efficiency – The assumed reduction of a PP to be expected when applying a specific ECS	Technical efficiency is below 70%	Technical efficiency is between 70 and 85 %	Technical efficiency is above 85%
Financial consideration – The operation and maintenance costs for a given ECS	Cost is more than 1 million €	Cost is between 5000 and 1 million €	Cost is less than 5000 €
Environmental impact – To what degree a given ECS is foreseen to reduce PP discharges into the surfaced water recipient	A negligible reduction in discharge is foreseen	A reduction in discharge is foreseen	A significant reduction in discharge is foreseen
More criteria can be added	If enough information is available change to more precise scoring criteria		

Results & Discussion

For each chosen substance ECSs were listed and evaluated [5]. Scoring can be seen in the Table below.

DEHP is presented as an example (with reference to the four criteria)**:**
Voluntary: Initiate campaigns directed towards public and private house owners to promote replacing DEHP-containing flooring, wall coverings, coated textiles etc with materials without DEHP.

- There is limited experience in applying such strategies to already existing materials.
- The life lengths of the materials releasing DEHP is about 20 years and DEHP was phased out around 2000, indicating that within 10 years the releases from these sources will decrease anyhow. Speeding up this process could increase the efficiency to some extent.
- There is a lack of information concerning costs associated with voluntary initiatives in general. Estimations of the costs associated with previous public awareness campaigns indicate that the costs are relatively limited. However, the cost of an early replacement of DEHP-containing products such as floorings and wall coverings could be significant for the house-owners.
- As most of the load to surface water comes from stormwater, this initiative will have limited impact.

Advanced WWTP process: Ozonation (low dosage, 5-7g/m^3)

- Ozonation is regularly used as tertiary treatment and is therefore feasible. Space wise the constructing of such a process within the existing WWTP facility would be feasible.
- The process has proven to remove up to 80% of DEHP from wastewater.
- The price calculated for the investments, operation and maintenance would be 15M€ (or 0,06€/m3 [6]), with a 50 year depreciation period the cost will be 3M€/10 years (not taking into account inflation, interest etc).
- As most of the load to surface water comes from stormwater, improving the wastewater treatment will have limited impact.

Stormwater treatment: Infiltration basin (the highest ranked BMP for DEHP)

- Infiltration basins across the city at strategic places is feasible but would require modification in the actual land planning.
- A significant reduction is expected as this technique is efficient to reduce DEHP.
- The cost for constructing and maintaining these BMPs was calculated to be between 50 and 9 330 thousand €/10 years.
- As the dominating source (waste in the environment) is emitted into stormwater an important reduction is expected.

For the other PPs:

For **Cd** the evaluated voluntary initiative was information campaigns to encourage a replacement of Cd containing artist paint, the WWTP process was nano-filtration and the stormwater treatment was infiltration basin.

For **Hg** no voluntary initiative was identified, nano-filtration and infiltration basins were chosen for WWTP resp. BMP.

For **B(a)P** the knowledge on the relative importance of different sources was not enough to evaluate ECSs, as outdoor sources were not included (see [7]).

For **PBDE** the evaluated voluntary initiative was campaigns promoting replacement of PBDE containing products such as PU foam upholstery furniture already in use (as PBDE is substituted in new products). No WWTP process targeting PBDE was found, but infiltration basin was described to be the most efficient option as stormwater treatment.

Summary Table for scoring	Criteria	Technical feasibility	Technical efficiency	Cost efficiency	Environmental impact	Total score
Substance	Strategy					
DEHP	Voluntary initiatives	2	2	2	2	8
	Advanced WWTP process	3	3	1	2	9
	Stormwater treatment	2	3	2	3	10
Cd	Voluntary initiatives	3	1	3	2	9
	Advanced WWTP process	3	3	1	2	9
	Stormwater treatment	2	3	2	3	10
Hg	Voluntary initiatives	1	-	-	-	-
	Advanced WWTP process	3	3	1	3	10
	Stormwater treatment	2	1	2	1	6
B(a)P	Voluntary initiatives	-	-	-	-	-
	Advanced WWTP process	-	-	-	-	-
	Stormwater treatment	-	-	-	-	-
PBDE	Voluntary initiatives	2	2	3	2	9
	Advanced WWTP process	2	-	-	-	-
	Stormwater treatment	2	3	2	3	10
	Stormwater treatment is the most favourable for the majority of evaluated substances according to scoring					

The evaluation of ECSs will be much dependant on the relative importance of different sources and whether these sources emit to stormwater or waste water or if the substance can be controlled at source or not. This information is therefore needed. Using the proposed methodology of multi-criteria analysis will ameliorate comparison of completely different control strategies and will also increase the transparency of decisions. This methodology can also be refined by more precise scoring or by introducing weighting factors depending on other considerations specific for the city. Results from this study gave very small differences in scoring between the strategies, which might be far from reality, but is due to the choice of scoring of criteria.

Conclusions

The reduction of priority pollutants demands both source control and treatment options in urban catchments. Reliable data on sources is required knowledge for evaluation of ECSs. In Stockholm for the substances DEHP, Cd and PBDE outdoor sources were found to be most important and stormwater treatment was also considered the most favourable ECS. If the method of scoring would be more developed, the evaluation would be more robust.

References

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www.scorepp.eu
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