# SUBSTANCE FLOW ANALYSIS IN RUSSIAN PART OF THE BALTIC SEA REGION

**Emissions of priority hazardous substances in the City of St Petersburg and the Leningrad Region have been identified and quantified within the framework of the COHIBA project using substance flow analysis (SFA).**

### METHODOLOGY

Sources were first identified, and then evaluations of the possible loads of the substances were conducted. Most estimates involved adoption of EU area SFAs data, and considerable uncertainties arose due to the lack of reliable data. Only a limited number of the substances prioritised in HELCOM's Baltic Sea Action Plan (BSAP-substances) are currently controlled in Russia in terms of emission limit values defined as maximum permissible concentrations (MPCs) for inputs into specific environmental compartments. PentaBDE, octaBDE, PFOS, PFOA, HBCDD, NPE, OPE, SCCP, MCCP and TPhT are not regulated.

### RESULTS: LACK OF REGULATION MAKES LOAD ESTIMATION DIFFICULT

The substances concerned are not produced in St Petersburg or the Leningrad Region, but may still be used in manufacturing processes and through the consumption of various goods and chemical products. Dioxins and furans are formed as unintentional by-products of combustion processes in manufacturing, energy production and accidental fires.

The total annual emissions of the BSAP-substances (excluding dioxins) by mass is estimated to be in the range of 150-200 tonnes. Emissions of dioxins amount to approximately 44.5 g I-TEQ annually. The most important sources of environmental emissions of the substances are: emissions during the lifetimes of consumer goods including chemical products consumed within the region (about 49% of annual emissions by total mass), long-range transboundary air pollution of substances emitted outside the region (about 18%), sewage effluents and sludge (about 3%) and the waste management sector (about 0.8%). Emissions of the target substances from manufacturing processes were not included in this study because of the lack of accurate data from this sector in Russia.

In this region the most important pollutants among the BSAP-substances are cadmium, OPE, NPE, NP, SCCPs, PBDEs and mercury. These substances together account for almost 99.4% by weight of the total annual emissions of the BSAP substances within this region of Russia. The annual emissions of HBCDD, PFOS/PFOA, TBT/TPhT, OP and Endosulfan were all considered to be negligible, since taken together they make up just 0.6% of the region's total emissions of the BSAP-substances. By far the largest proportion of the total emissions is released into surface waters (about 84%).

Use of controlled substances has decreased in recent years, resulting in declining environmental emissions. In the coming years these trends will most likely continue.

# RIGHT SOURCES WITH RIGHT MEASURES

**HELCOM's Baltic Sea Action Plan calls for a Baltic Sea with life undisturbed by hazardous substances. To reach this environmental target, effective measures to reduce the emissions of 11 hazardous substances of special concern to the Baltic Sea have to be identified and implemented. In order to find appropriate measures and ensure that the available resources are allocated efficiently, the various possible measures have to be compared in terms of effectiveness and costs.**

One major problem in terms of identifying cost-effective measures is the complexity of emission patterns. The knowledge base on the sources, loads and environmental fates of these substances is not complete yet, and regional differences within the Baltic Sea Region are considerable. Based on an up-to-date analysis of sources, COHIBA will recommend reduction strategies for each of the 11 substances, as well as blanket measures that will simultaneously address several substances.

### RECOMMENDATIONS FOR STRATEGIES

The related substance-specific analysis is to be compiled in 11 COHIBA guidance documents. These documents aim to provide all the information needed to help control each substance, starting with a brief account of the substances' characteristics, the legal background, their important applications and uses, and their environmental fate. An analysis of important emission sources in the Baltic Sea Region follows, pinpointing sources with a large reduction potential. For these selected sources, appropriate measures are identified, evaluated and compared, using four important guiding questions:

**Primary effects:** How effective will this measure be in terms of reducing emissions of the specific substance?
**Cost:** How much will the measure cost?
**Technical feasibility and ease of implementation:** How well does this measure perform, taking into account the very different conditions in different countries (e.g. political, technical and geographical parameters)?
**Secondary effects**: What are the anticipated secondary environmental and socio-economic impacts of this measure (e.g. impacts on energy consumption, emissions of pollutants other than the 11 targeted substances, and product costs for consumers)?

### USEFUL GUIDANCE MATERIALS FOR DECISION MAKERS

The information compiled in the 11 COHIBA guidance documents will help decision-makers across the region to target the right sources with the right measures. In addition to this substance-specific perspective, a wider-ranging recommendation report will sum up and synthesize results from the substance-specific assessments and work towards a holistic strategy for reducing emissions of all 11 substances. Regional differences and cross-substance effects are important issues to consider in this context. All of the guidance documents will be available on the COHIBA website by the end of this year.

Through these activities the Federal Environment Agency of Germany, supported by the Fraunhofer Institute for Systems and Innovation Research and all the other COHIBA project partners together are contributing to build up a useful knowledge base for decision-making regarding hazardous substances in the Baltic Sea Region.

## EVENTS

2ND ANNUAL FORUM OF THE EU STRATEGY FOR THE BALTIC SEA REGION AND BALTIC DEVELOPMENT FORUM
24–26 OCTOBER 2011, GDANSK, POLAND

FINAL REPORT WORKSHOP FOR COHIBA WP4
1–2 DECEMBER 2011, STOCKHOLM OR GOTHENBURG, SWEDEN

COHIBA WP6 STAKEHOLDER EVENT FOR EASTERN BALTIC SEA REGION AND RUSSIA
7–8 DECEMBER 2011, RIGA, LATVIA

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# COHIBA NEWS

CONTROL OF HAZARDOUS SUBSTANCES IN THE BALTIC SEA REGION | OCTOBER 2011

## SOURCES AND PATHWAYS IN THE BALTIC SEA REGION

RIGHT SOURCES WITH RIGHT MEASURES

PRIORITIZATION AND MODELLING OF HAZARDOUS SUBSTANCES IN COPENHAGEN

SUMMARY OF SUBSTANCE FLOW ANALYSIS RESULTS IN RUSSIA

# SOURCES AND PATHWAYS IN THE BALTIC SEA REGION

**In order to investigate the main sources and pathways of the hazardous substances prioritised in the Baltic Sea Action Plan (BSAP-substances), substance flow analyses (SFA) were conducted in each of the countries participating in the COHIBA project, covering areas draining into the Baltic Sea.**

The main focus was on the sources of emissions entering the environment (surface waters, land and air), and to wastewater fed into municipal wastewater treatment plants (M-WWTP). The results are still preliminary, but analyses of emission patterns have already revealed differences between substances and countries.

### SOURCES AND PATHWAYS: COMMON PATTERNS AND DIFFERENCES

In many areas the importance of industrial point sources has evidently declined, and diffuse sources related to consumption, including construction materials, traffic, personal care products and commodities such as textiles and electronics have become more significant. Examples of substances for which these diffuse sources are of importance include polybrominated diphenyl ethers (PBDEs), alkylphenols and short-chain chlorinated paraffins (SCCPs). In cases where the use of the substance is banned within the Baltic Sea region these substances may either be imported in articles manufactured outside the region, or be contained in stocks of materials manufactured before the bans on their industrial use. Emissions may also occur due to historic contamination, as is the case with the highly restricted substance tributyl tin (TBT), which may still be released from contaminated sediments.

Some of the listed substance groups are still in industrial use in the region. Industrial sources have been identified as important for substances such as perfluorooctane sulfonate (PFOS), hexabromocyclododecane (HBCDD), the nonylphenols, and medium-chain chlorinated paraffins (MCCPs). The pesticide endosulfan is now banned but seem to still enter the region via long-range atmospheric transport and also possibly in imported foodstuffs. Emissions of other substances may be due to their unintentional formation. This is the case for the dioxins, furans, dioxin-like polychlorinated biphenyls (dl PCBs), and also to some extent for perfluorooctanoic acid (PFOA). The metals mercury and cadmium are released via combustion processes. For mercury this seems to be very important, while for cadmium non-combustion-related industrial sources are also highly important.

Regional variations can be seen, partly because different sectors are established to varying levels in different parts of the region, but also because of regional differences in the energy sector and varying land use patterns.

### UNIQUE DATASET AND INFORMATION: DATA QUALITY STILL TO BE IMPROVED

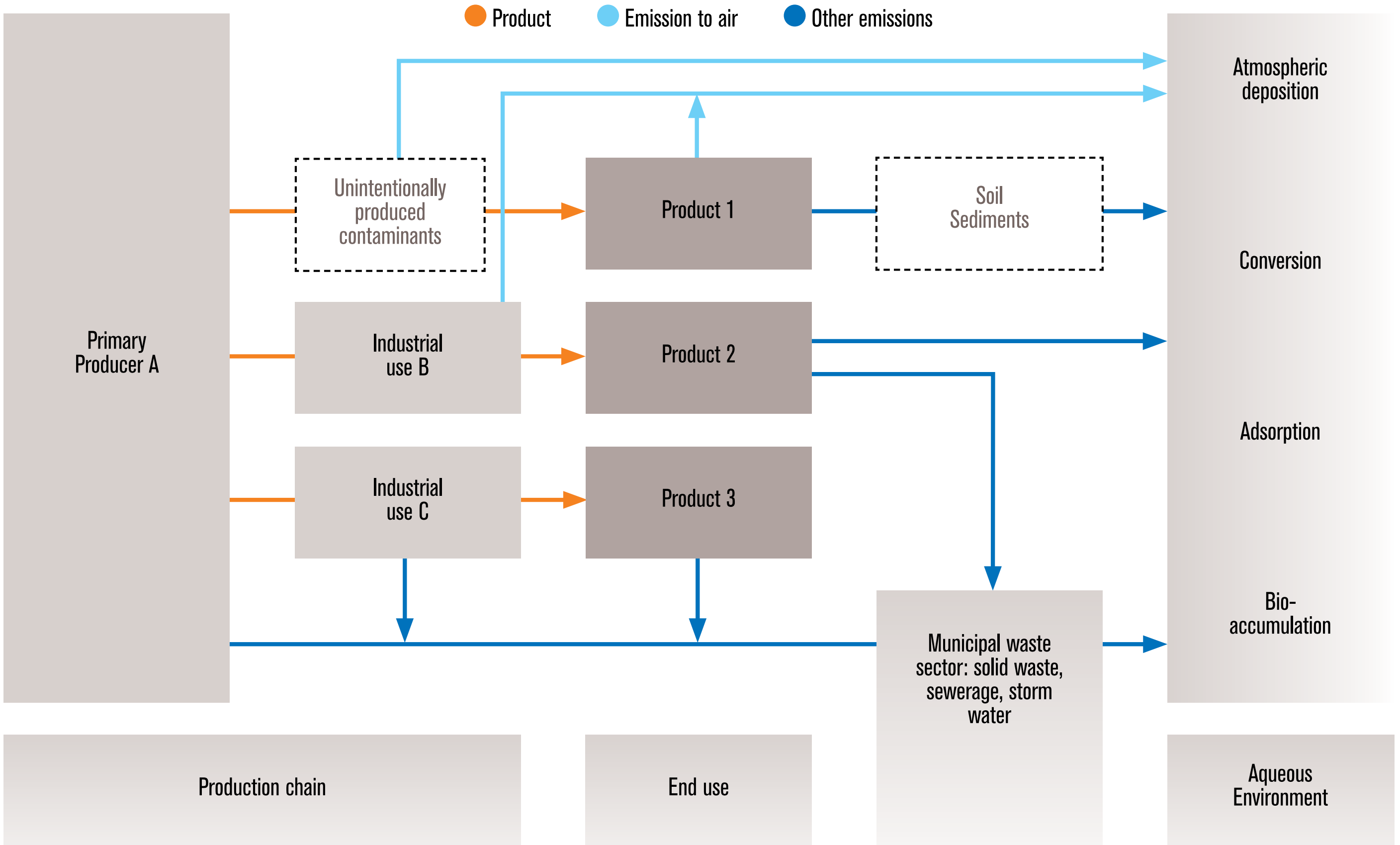
The SFAs are in many cases based on rather limited datasets. This introduces uncertainties, and estimates for emissions are consequently wide-ranging. There are data gaps where it is not possible to quantify emissions, or maybe even identify the main sources. This is the case for triphenyltin compounds (TPhT), for instance. Our results make it clear that there is still a great need for more data in this area, and also for reliable registers with information on the use and emissions of substances in each country. Even so, the dataset developed within the project provides a unique and valuable source of information on emissions of the BSAP-substances in the Baltic Sea region. The compiled data contains almost 2,000 emission estimates.

### MODELLING FATE OF CHEMICALS IN THE ENVIRONMENT

The consequences of these emissions within the region with regard to input to the Baltic Sea are being assessed with the use of chemical fate models for selected BSAP-substances. Using the **POPCYCLING-Baltic model**, we will investigate whether emissions within the region can explain the occurrences of these substances in the Baltic Sea, or whether they are due to long-range atmospheric transport from outside the region. Different scenarios and regional variations will also be assessed. The importance of urban areas as sources of hazardous substances is being investigated through two case studies in Copenhagen and Stockholm, applying also carefully devised models. A case study and SFAs have also been conducted in St Petersburg and the Leningrad Region.

More detailed findings on identified major sources and flows will be presented at the COHIBA Final Seminar in October 2011. Related reports will be published on the project website as this work is finalised.

### PATHWAYS OF HAZARDOUS SUBSTANCES – INDUSTRY, APPLICATION AND EMISSION PATTERNS




## Dear Reader

*The project on the Control of Hazardous Substances in the Baltic Sea Region (COHIBA) is gradually approaching its end.*

*We would like to share our topical project news with You. The newsletter highlights some results of the project's work on sources and pathways of hazardous substances, the ways and methods to detect/identify them, as well as on effective measures to prevent pollution of the Baltic Sea.*

*We have enjoyed working in a multinational team of experts from 22 partner organizations of the Baltic Sea countries and we are happy on the comprehensive first results we have achieved in these issues. After feedback in the COHIBA Final Conference 11-12 Oct 2011 in Helsinki and in other events, the project will finalise results to be published in early 2012.*

*COHIBA Team*

# PRIORITIZATION AND MODELLING OF HAZARDOUS SUBSTANCES IN COPENHAGEN

**The Danish COHIBA activities have demonstrated how to prioritize flows of hazardous substances in relation to urban land-based point sources through a case study covering the Copenhagen Harbour district.**

A combination of measuring campaigns, load estimations and hydrodynamic modelling has made it possible to determine whether or not point sources are important in emissions of the hazardous substances listed in the Baltic Sea Action Plan.

The study shows that out of the 11 BSAP-substances land-based point sources are important for:

- Perfluorinated compounds (PFC)
- Nonylphenol ethoxylates (NPE)
- Bisphenol A (not a BSAP-substance itself, but analysed using the same method as NPE)
- Mercury

This result provides a very useful decision-support tool for the local urban authorities and planners. Measures can now be focussed on the relevant point sources of the prioritized substances. In a future, as the numbers of emerging pollutants increase (including WFD Prioritized Substances), the same methodology can be used to decide whether actions targeting point sources are necessary and beneficial.

### METHODOLOGY

Measuring campaigns have been carried out for 13 different land-based point sources. The following categories of point sources were identified in the Copenhagen Harbour area: large wastewater treatment facilities (both treated water and by-pass water), combined sewer overflows (CSO), urban run-off, waste deposits, and industrial facilities.

These specific sources are illustrated in Figure 1. All sources were screened to determine the concentrations of all the BSAP-substances. The results of chemical analyses and flow measurement were used to prepare load estimations for all substances. Example findings describing load estimates for PFC are included in Figure 1.

In the next phase of the project, hydrodynamic marine fate modelling (MIKE 3 and ECOlab) was carried out for selected substances. PFC and Bisphenol A were found to be present in the sources in concentrations that justified such modelling. The model takes substance specific fate data (biodegradation, photolysis and hydrolysis) and adsorption to suspended solids into account. Figure 2 shows an example of the fate modelling of PFC.

### RESULTS: PERFLUORINATED COMPOUNDS, NONYLPHENOLS, MERCURY AND BISPHENOL A ARE RELEVANT

The monitoring, load estimation and modelling activities have enabled the prioritization of actions addressing point sources of BSAP-substances in Copenhagen. The results of the methodology are illustrated for PFC in Figures 1 and 2. The pie chart in Figure 1 illustrates that the combined sewer overflows and urban run-off account for 64% of total point source discharges of PCF into Copenhagen Harbour (7.9 kg/year). Large urban wastewater treatment plants contribute a further 33%. As shown in Figure 2, marine fate modelling predicts that concentrations will exceed environmental quality standard-EQS (0.08 µg/L) in periods after heavy rain. Although the EQS is exceeded in shorter periods after heavy rain it should be noted that the yearly average concentration of PFC never exceeds the EQS at any point in the harbour area.

For more details, see the three Danish COHIBA reports for WP3, 4 and 5.

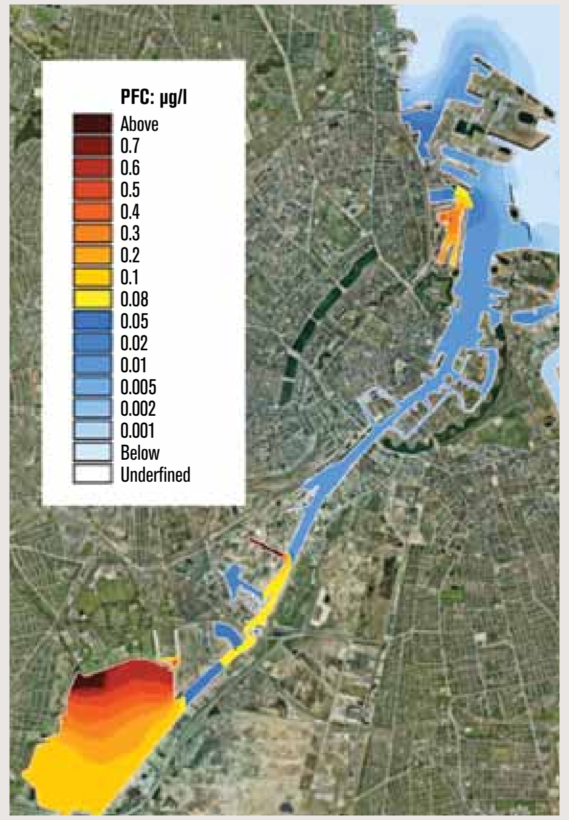



FIGURE 1. Monitoring points in the Danish case study in Copenhagen, and a pie chart illustrating PFC load estimates for these point sources.

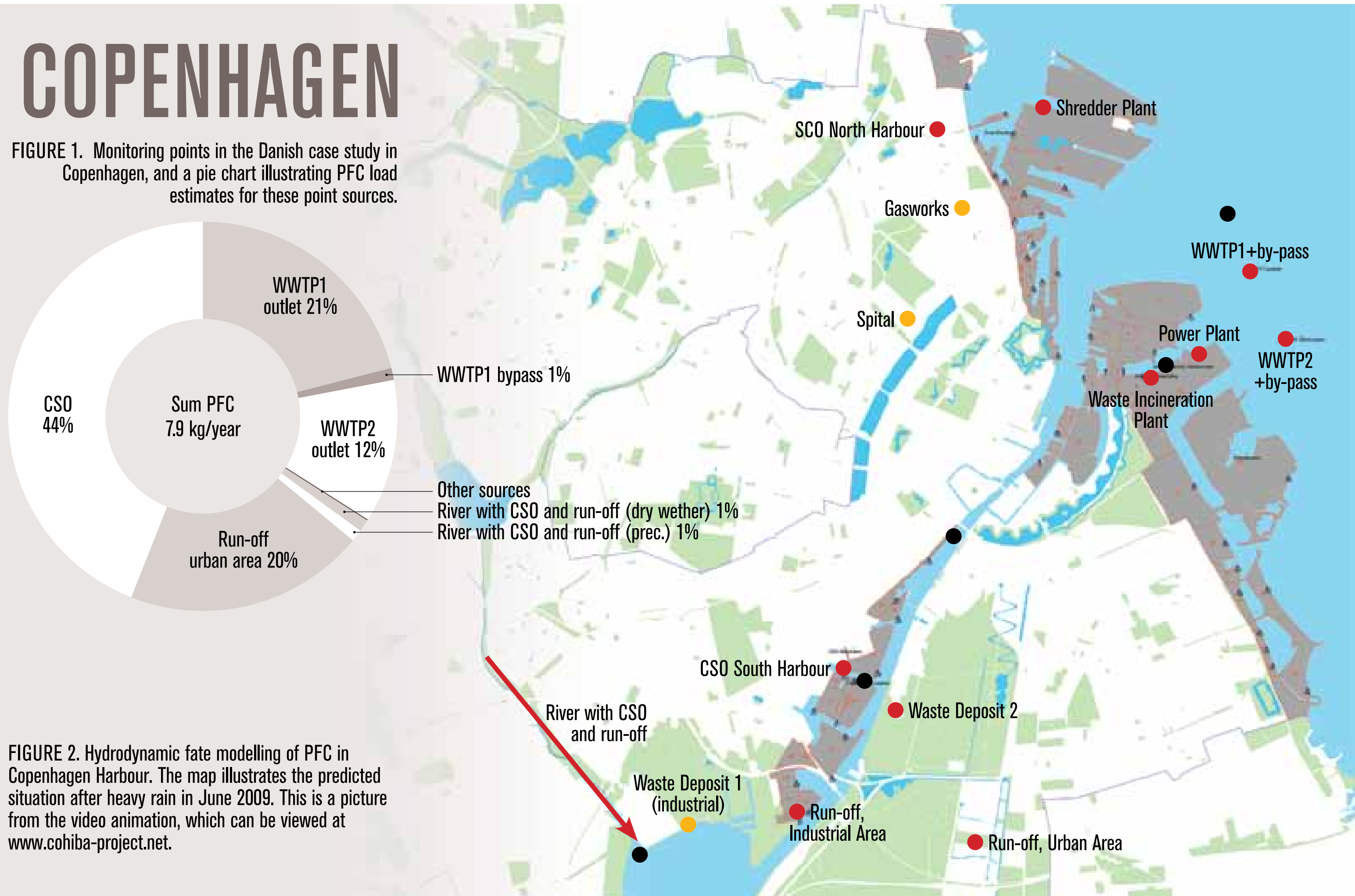



FIGURE 2. Hydrodynamic fate modelling of PFC in Copenhagen Harbour. The map illustrates the predicted situation after heavy rain in June 2009. This is a picture from the video animation, which can be viewed at www.cohiba-project.net.