

SOURCES AND DISPERSION MECHANISMS OF PCBs IN AN URBAN ENVIRONMENT

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Introduction

There has been a large focus on polluted sediments in city harbors and fjords in Norway the last years. In 31 Norwegian fjords, the concentration of pollutants like PCBs, dioxins, PAHs and heavy metals, in sediments and marine organisms is very high. The Norwegian Food Safety Authority has set up advises against the consumption of seafood from these fjords and has in many cases introduced restrictions on sale of fish and shellfish. Many of these harbors and fjords are now to be cleaned up. The polluted sediments are either being dredged and deposited on a safe location or covered with uncontaminated materials. To provide empirical data on the active transport of pollutants from land-based pollution sources in an urban area to the harbor environment a study of some physical and chemical properties of sediments from urban runoff sediments trapped in small catch basins was performed in the city of Bergen, Norway.

The urban environment is affected by a wide variety of anthropogenic activities. Road networks, construction and demolition sites and industrial activities will tend to increase the concentration of different pollutants in urban soils, urban storm water and urban sediments. The urban environment has been polluted by several kinds of local sources throughout the history, and this contamination is a continuous and diffuse process. Materials that have accumulated on top of impervious surfaces are easily eroded during heavy rainfall and may be scoured off thoroughly and delivered to an inlet structure like a small catch basin and subsequently to a point of discharge often in a nearby water body. The sediments trapped in the bottom of a specific catch basin will possibly reflect the importance of local pollution sources in the definite geographic area draining to that basin.

Polychlorinated biphenyls (PCBs) have been found in high concentrations (> 300 mg/kg) of concrete plaster and paint in schools, apartment buildings and other type of buildings in Bergen erected or renovated between 1950 and ~ 70 ¹. PCBs have previously also been found in high concentrations in samples of asphalt and asphalt paint from the area of Fornebu airport in Oslo, Norway². A methodical chemical description of urban sediments that have been trapped in small catch basins has been performed in the urban area around Bergen harbor. This method has shown that there are several active sources of PCBs in an urban area, and further work is being carried out assessing the risk of contamination of nearby water bodies, like the city harbor.

Materials and Methods

Storm water from an urban area with a high fraction of impervious surfaces (often 80-90 %) is mostly directed to inlets that contain structures known as catch basins (Figure 1). The average catchment area for each inlet is about 600 m², and the maximum runoff distance on the surface is 50 m. Each catch basin has a diameter of 1 m and a depth of about 3 m. An effective sediment trap of > 60 cm is located in the bottom of each catch basin. The overflow from each catchment is directed either to a combined sewer system or directly into the harbor. Given the amount of rainwater in the Bergen area (average 2250 mm annually), the runoff from impervious surfaces is discharged directly into the harbor at least 30 % of the time.

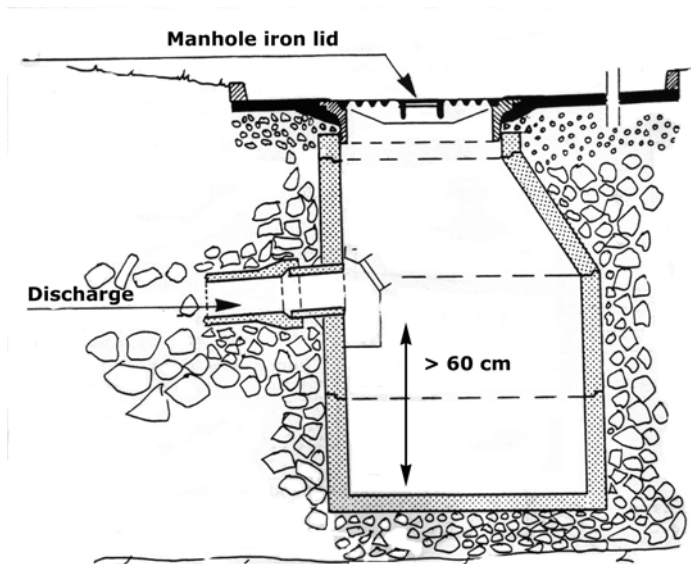


Figure 1: Typical catch basin that will collect urban storm sediments.

Samples of sediments from 68 different catch basins located in impervious urban surfaces around Bergen harbor were sampled in October and November 2004. Small catchments were selected in order to reflect local pollution sources. The method for the determination of PCBs was based upon the Nordtest Technical Report No. 329³. The seven Dutch PCB congeners (PCB₇) were determined (PCB no. 28, 52, 101, 118, 138, 153, 180) as is custom of Norwegian environmental studies. All the results are given as PCB₇.

Results and Discussion

Figure 2 (see the end of paper) shows the distribution and concentrations of PCB₇ in 68 samples of urban runoff sediments trapped in catch basins. The area includes the inner city of Bergen, Norway. The average concentration of PCB₇ in these sediments was 91 µg/kg, and the median concentration 31 µg/kg. 20 % of the samples had concentrations of PCB₇ exceeding 100 µg/kg, the highest being 704 µg/kg.

The content of organic material (TOC) in the urban runoff sediments seem to correlate fairly well with PCB₇. The concentration of PCB₇ have also been determined in different grain size fractions, showing that in samples where the possible source is building materials like paint or concrete plaster, the highest concentrations were found in the coarser region of the sediment sample. High concentrations of PCB₇ were also found in the finer fractions (silt) in some samples probably reflecting the influence of local waste sites.

The distribution of PCBs in the urban environment of Bergen shows that there are several active pollution sources contributing to a significant dispersion of PCBs over impervious surfaces. The results also indicate that this may be a straightforward method to investigate urban pollution sources and dispersion mechanisms for different pollutants. The materials that are trapped in catch basins are often fine grained, and are easily transported with storm water to a downstream point of discharge. This may often be the city harbor receiving highly polluted storm water from the urban area whenever a heavy rainfall or snow melt occur.

Further work is being done to estimate the amounts of different pollutants that reach the harbor sediments from the urban area.

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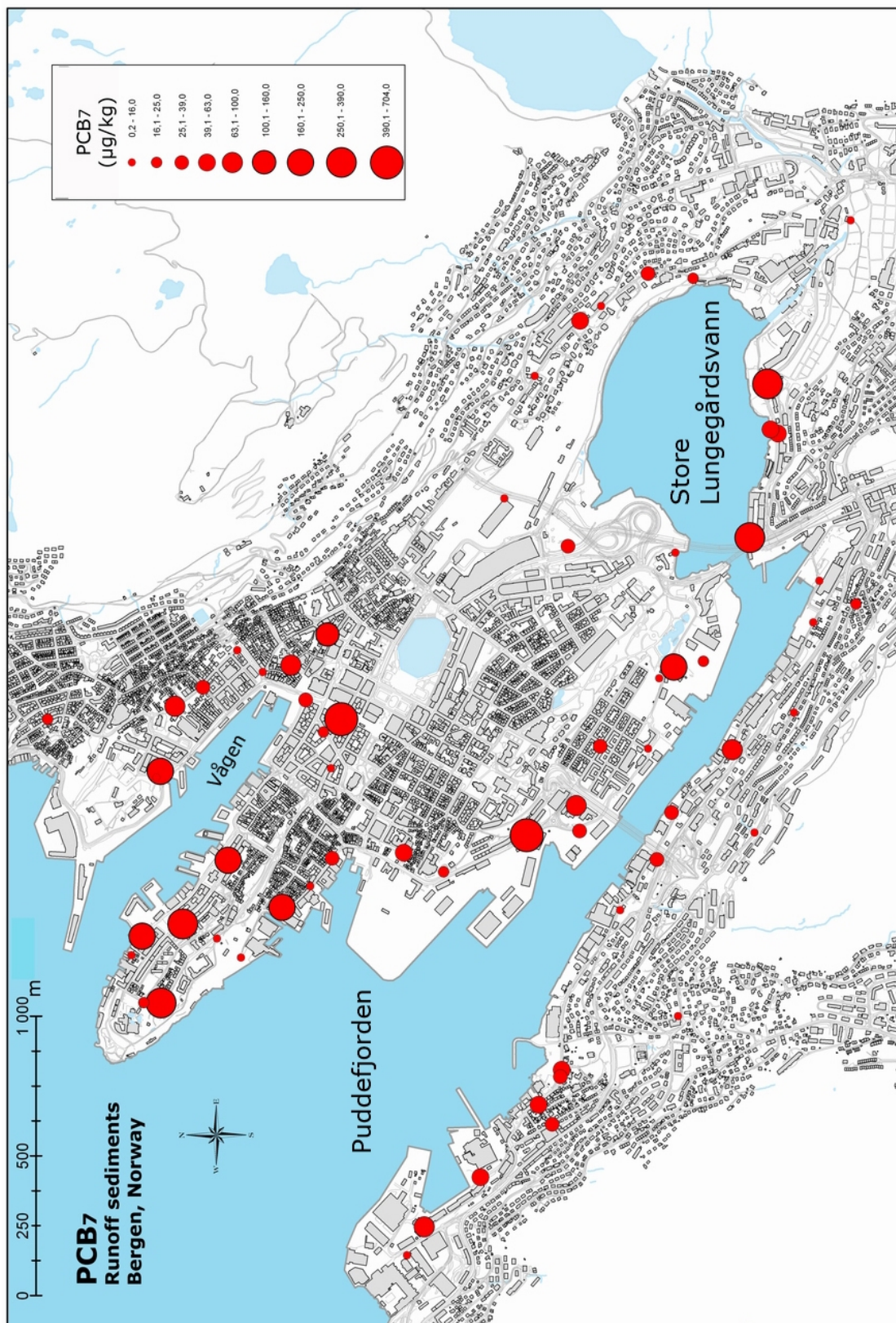


Figure 2: Geochemical map showing the concentrations of PCB₇ in samples of urban runoff sediments