

Effects on road run-off to the nearby environment in Denmark



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Introduction

Rainwater detention basins along the road are constructed to collect rainwater, delay large rain events and to prevent oil-based products and suspended substances to run further out into the recipient. The Danish motorway network is continuously being extended and this presents some specific problems in relation to the handling of sediment collected from the detention basins. There are some 2,000 detention basins along the Danish national roads and a rule of thumb says that one detention basin is constructed every second kilometre. In general, they are closed systems which ensure that only water from roads, direct rain and run-off from the sides end in the basins. Consequently, the sediment in the basins comes from materials brought with water from the roads, through side erosion or from the atmosphere.

Material from wear of vehicles, corrosion from brakes, wear of road surfaces, loss of fuel as well as salt from winter maintenance constitute the elements, which cause waterborne pollution from the roads. All of these residual products will either swirl up together with dust and be led away by the wind or they will go with rainwater into the drainage system and thereby end in the detention basins.

The detention basins act as sedimentation basins, such that the water runs very slowly or stands still when the weather is dry. Thus, the particles deposit if they are not sufficiently small to remain in suspension until the water runs out of the outfall. Many substances, injurious to the environment, sorb to larger particles (mineral grains and organic materials) which means that they sediment together with the particles and therefore remain in the basin. The most problematic particles are often difficult to degrade, or they cannot be degraded at all, and they therefore accumulate easily in various recipients. Detention basins are therefore an important reservoir for these substances.

This abstract will focus only on the amount of pollution in the sediment with examples from hydrocarbons, and the relation to the pollution criteria set by the Danish Environmental Protection Agency.

Methods

Sediment from 70 detention basins along the Danish main road network has been sampled and from each basin ten chemical parameters (lead, cadmium, copper, zinc, nickel, chromium, PAH and hydrocarbons as well as chlorines and sodium) have been measured at an accredited laboratory and nine physical parameters have been determined (e.g., the surface area of the basin, distance to the road, annual daily traffic). In each basin, sediment has been collected with a russian core to obtain the material needed for analysis. The concentrations have been evaluated in relation to the criterion set out by the Danish Environmental Protection Agency (EPA) for slightly polluted soil (soil quality criterion) and polluted soil (cut-off criterion) (EPA 2010).

Results from the chemical analyses

The threshold values are determined for a large number of substances injurious to the environment, and they are important for classification of sediment and for the procedures for treating the sediment if this is removed. The concentration of substances injurious to the environment can also give an indication of the severity concerning substances in the water.

Table 1. The number of detention basins in per cent, which are above the soil quality criterion and cut-off criterion. Samples of the sediment at the bottom of the basins were analysed for hydrocarbons, PAH and heavy metals and the results show that at least 90 percent of the basins contain sediment which is slightly polluted (based on the sum of hydrocarbons) and at least 61 per cent contain sediment which is polluted (based on heavy hydrocarbons, C20-C35). In 20 per cent of the basins, nickel concentrations are so high that the sediment must be classified as polluted.

Substances	Per cent above the soil quality criterion (slightly polluted sediment)	Per cent above the cut-off criterion (polluted sediment)
Lead	49	0
Cadmium	62	0
Chrome	60	0
Nickel	20	20
Copper	1.4	0
Zinc	24	8.6
Hydrocarbons	90	61
PAH	17	0
Highest value	90	61

Table 1 presents an overview of the parameters determined as well as the degree of pollution. The variation in hydrocarbons is very large as it varies from below the limit of detection of 0.1 mg/kg dried matter (dm) to 11,000 mg/kg dm. There are only seven basins below the soil quality criterion of 100 mg/kg dm for the total of all hydrocarbons (Figure 1). In other words, 90 per cent of the basins contain sediment slightly polluted with hydrocarbons. There is no cut-off criterion for the total of all hydrocarbons, but for the concentration of heavy hydrocarbons (C20-C35), the threshold value is 300 mg/kg dm. In Figure 2, the total of heavy hydrocarbons is presented and the concentrations show that 43 basins have concentrations above the cut-off criterion. In many cases the concentrations are far above the limiting criterion. Thus, 61 per cent of the basins in the study contain sediment which is polluted with heavy hydrocarbons. 16 of the basins have concentrations over 2,000 mg/kg dm. This is more than six times the cut-off criterion, and the sediment in these basins must be characterized as severely polluted.

Nickel and zinc are those heavy metals found in the highest concentrations in relation to the cut-off criterion. Copper, chromium, lead and cadmium were found in all 70 basins, but they are not above the cut-off criteria. The PAH content is low and therefore there is no concern from a pollution point of view (Table 1). There is large variation in the concentrations between analysed parameters. However, only one parameter needs to exceed the threshold value for the soil to be characterized as slightly polluted or polluted. Since the hydrocarbons are such a large source of pollution in relation to all other sources, many basins are characterized as polluted. The number of polluted basins could be reduced from 61 per cent to 20 per cent, if the content of hydrocarbons were reduced to a value below the cut-off criterion for polluted soil.

Conclusions

70 detention basins have been examined for a number of chemical substances and the concentration have been evaluated in relation to the Danish criteria for slightly polluted and polluted soil, respectively. The number of basins which exceeds the threshold values differs greatly from substance to substance. Since it only requires one value exceeding the threshold to make it necessary to treat the soil accordingly, the overall picture is that the sediment is at least slightly polluted or polluted. This is due to the fact that hydrocarbons are such a large source of pollution compared to other substances. The result of the study is that at least 90 per cent of the detention basins contain slightly polluted soil and at least 61 one per cent contain polluted sediment. Apart from hydrocarbons, nickel and zinc are the only substances with concentrations beyond the limit for polluted soil.

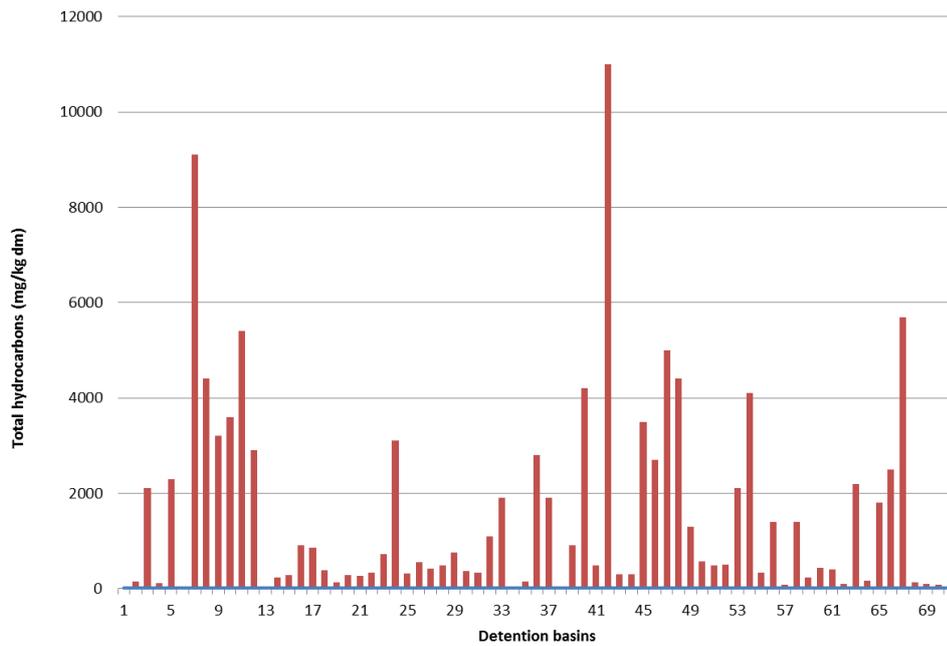


Figure 1. Sum of hydrocarbons in 70 detention basins distributed over Denmark's main road network. The soil quality criterion for slightly polluted sediment is 100 mg/kg dm (blue line). There is no cut-off criterion for the sum of all hydrocarbons for polluted soil, but for heavy hydrocarbons the limit is 300 mg/kg dm.

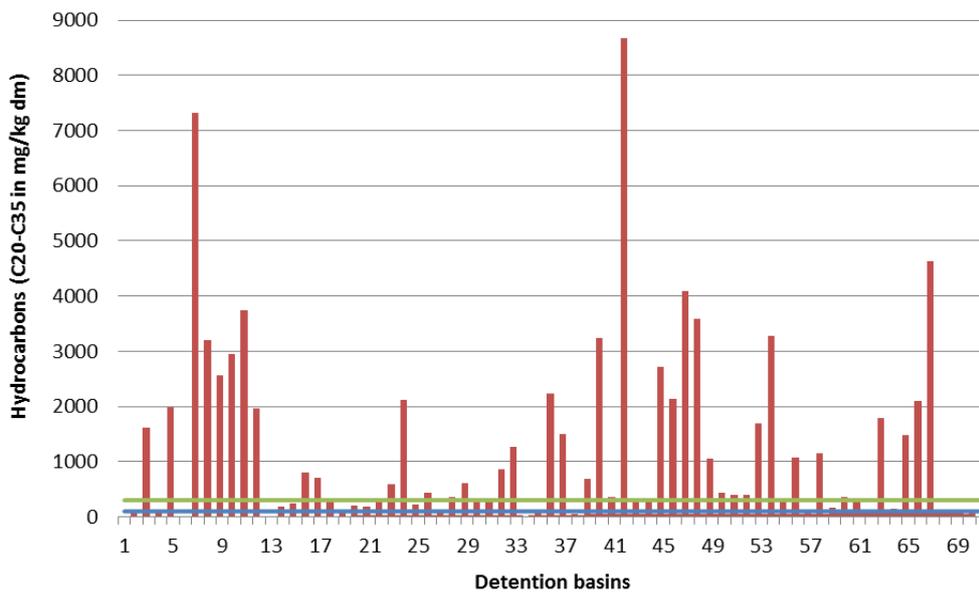


Figure 2. Content of heavy hydrocarbons (C20-C35) in sediment from detention basins. The criterion for slightly polluted sediment is 100 mg/kg dm (blue line) and for polluted sediment 300 mg/kg dm (green line). 61 per cent of the basins contain polluted sediment.

Reference

EPA (2010), Danish Environmental Protection Agency, http://www.mst.dk/Virksomhed_og_myndighed/Jord/Nyheder_jord/kriterier-jord.htm/