Air pollution in the Netherlands

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Backgrounddocument to:

Health benefits through cleaner air

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Health Council of the Netherlands

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01 introduction

Within the framework of the National Air Quality Cooperation Programme, the National Institute for Public Health and the Environment (RIVM) prepares air quality maps each year for the Netherlands, the so-called Large-scale concentration and deposition maps of the Netherlands (GCN maps).[1] The GCN maps reflect only large-scale concentrations and do not reflect small-scale local increases in concentration, such as those found near busy traffic routes or in busy city streets. Dispersion models were used to prepare these maps. These models calculate the annual average concentrations of the most important components of air quality based on estimates of the local as well as large-scale contribution from all emission sources of air pollution on a scale of 1 x 1 kilometre. The measurements from the monitoring network are needed to be able to calibrate the dispersion models.

02 particulate matter concentrations

Monitoring stations of the Dutch National Air Quality Monitoring Network measure the concentrations of particulate matter every hour. There are regional and city monitoring stations as well as monitoring stations in streets with a great deal of road traffic. The components measured are total particulate matter (since 1972 in Rotterdam), PM10 (since 1993) and since 2008 also PM2.5. The black carbon fraction (as elemental carbon) has been measured at a limited number of monitoring locations since 2014.[2] The concentrations of particulate matter measured show a decreasing trend throughout the Netherlands.[3] In 2016, the annual average PM2.5 concentration in the Netherlands was between 10 and 12 micrograms/m^3.[1] Figure 1 shows the trend for PM10 since 1993.

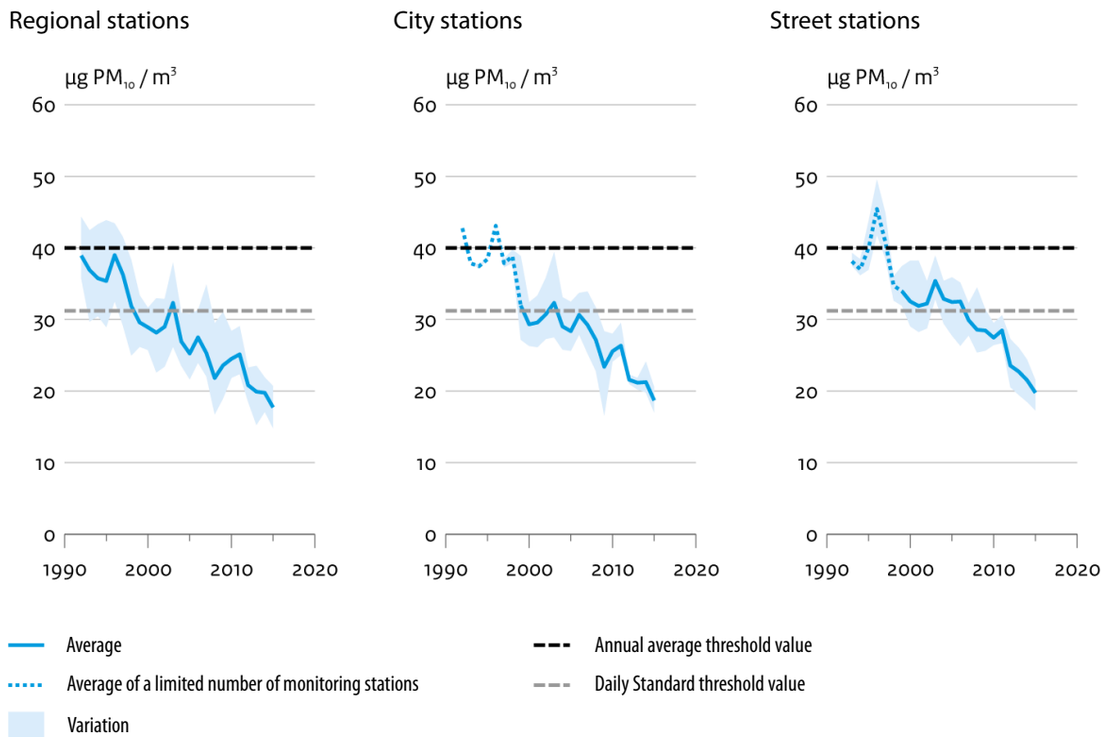

Figure 1. Trends in measured concentrations of particulate matter (PM10) over the period 1993-2015
Source: Environmental Data Compendium (www.clo.nl) based on data from RIVM/ DCMR/GGD Amsterdam 2016

The decrease in PM10 turns out to be practically the same as for PM2.5 and does not differ between the street, city, and regional monitoring stations.[3] The decrease for the coarser fraction turns out to be much less.

2.1 Black carbon concentrations

Black carbon is generated by the incomplete combustion of fossil fuels and biomass for energy production. The contribution from road traffic consists primarily of emissions from diesel-powered vehicles. The concentration of black carbon in the air can be characterised using various measurement methods. In previous decades, it was measured as *Black Smoke*, a measurement method based on reflection, but this has become outdated. In the National Air Quality Monitoring Network, black carbon is now being measured as *Black Carbon*. In model calculations (GCN, Monitoring tool), the black carbon concentration is calculated based on the emission of elemental carbon.

Black Carbon: elemental and organic carbon

The measurement method for *Black Carbon* is based on the light-absorbing capacity of particles containing carbon. *Black Carbon* consists of a carbon core (elemental carbon: EC) with organic carbon compounds attached to it (organic carbon: OC). However, a part of these organic carbon compounds is not included in the measurement of *Black Carbon*, as OC absorbs light less strongly than does EC. The total carbon concentration (TC), which is the sum of EC and OC, is therefore greater than the concentration of *Black Carbon*. OC and EC can be differentiated from each other using thermal-optical means: when a filter loaded with particulate matter is heated, the OC component is volatilised first. Above a certain temperature, all the OC has already been burned off and only EC is measured, although it is difficult to determine the exact turning point. The combustion of fossil fuels results primarily in the emission of EC, whereas the combustion of biomass results primarily in the emission of OC.

Trends in black carbon concentrations

As the measurement method used for black carbon in the National Air Quality Monitoring Network has been changed and the different measurement methods used (*Black Smoke* and *Black Carbon*) cannot objectively be compared to each other, it is not possible to determine the long-term trend for black carbon concentrations. In spite of the limited number of measurements available and the uncertainties involved in modelling black carbon, it's clear that the black carbon concentrations, also in urban areas, have steadily been decreasing since 2011.[1]

2.2 Uncertainties in determining the origin of particulate matter concentrations

More than half of the particulate matter in the Netherlands consists of secondary particulate matter that is formed in the air after chemical reactions with various precursor gases. As chemical processes in the air

and weather conditions play a major role and precursor gases are emitted by many sources, it is not really possible to deduce the origin of particulate matter directly from measurements of concentration. In addition, the concentration and origin of particulate matter varies from one place to another and also as a function of the distance from major sources. Determining the source of particulate matter in the Netherlands is therefore done via dispersion models that make use of process-based knowledge and data from the Netherlands Pollutant Release and Transfer Register (based on emission data reported by countries and companies).[4] Specific identifying components that indicate the source of the emission are available for only a few sources – such as sea salt, the metal industry, and the combustion of heavy oil – making it possible to determine the source of the particulate matter on the basis of concentration measurements. The quality of the modelling results for the source determination depends upon the quality of the input data (emissions) and of the model itself. The calculated concentrations of particulate matter are systematically lower than the measured concentrations. In comparison, when it comes to modelling the concentrations of nitrogen dioxide and black carbon, the calculated concentrations correspond reasonably well with the measured concentrations.

Uncertainties in emission data

Uncertainty margins in the emission data for the precursors of secondary particulate matter provide a range of values (confidence margin) within which the calculated concentrations of particulate matter can vary. For example, uncertainties exist in the emissions from diesel engines of agricultural machines and in the gaseous emissions from agricultural land. With regard to the emissions of ammonia, uncertainties exist in the level of compliance with the manure policy, including the efforts made to minimise emissions during the spreading of manure on the land and the use of air scrubbers.

Uncertainties in emissions from wood-burning activities

The origin of roughly 30% to 40% of the PM2.5 concentration cannot be adequately accounted for. There are various ideas about the reason for this systematic underestimation. According to Hendriks et al. (2013), the contribution of the organic material to the PM2.5 concentration is underestimated the most, as it is not really possible to obtain reliable estimates of the emissions from residential wood-burning.[4] For heating facilities, in particular via wood-burning, the quantity of condensed organic particulate matter is underestimated. Based on measurements in Flanders, wood-burning is estimated to contribute approximately 5% of the PM10 concentrations in cities.[5] The Joaquin Interreg study estimates the contribution from the combustion of biomass to be approximately 4%-5%.[6] If new insights into the formation of particles via the condensation of volatile organic substances are taken into account, the emissions from wood-burning can be a factor 3 to 5 times higher.[5]

Uncertainties in the model

A significant part of the unexplained 'missing' fraction can also consist of secondary organic material formed from naturally occurring as well as anthropogenic organic compounds. Other potential sources that are not included in the models are primary biological material (plant remains, spores), roasting, frying and barbecuing, and cigarette smoke. These sources can also explain part of the missing fraction.

03 nitrogen dioxide concentrations

The concentrations of nitrogen dioxide show a decreasing trend over the past years (see Figure 2). However, the average concentration in most of the Netherlands in 2016 was higher than in 2016: 15.2 compared to 14.7 micrograms/m^3.[1,7] Alongside busy roads, the EU threshold value and the health-based WHO air quality guideline are still being exceeded – in both cases 40 micrograms/m^3.

As road traffic and in particular diesel-powered vehicles are the most important source of nitrogen dioxide, the concentrations measured at the city stations and in particular the street stations are clearly higher than those measured at the regional monitoring stations.

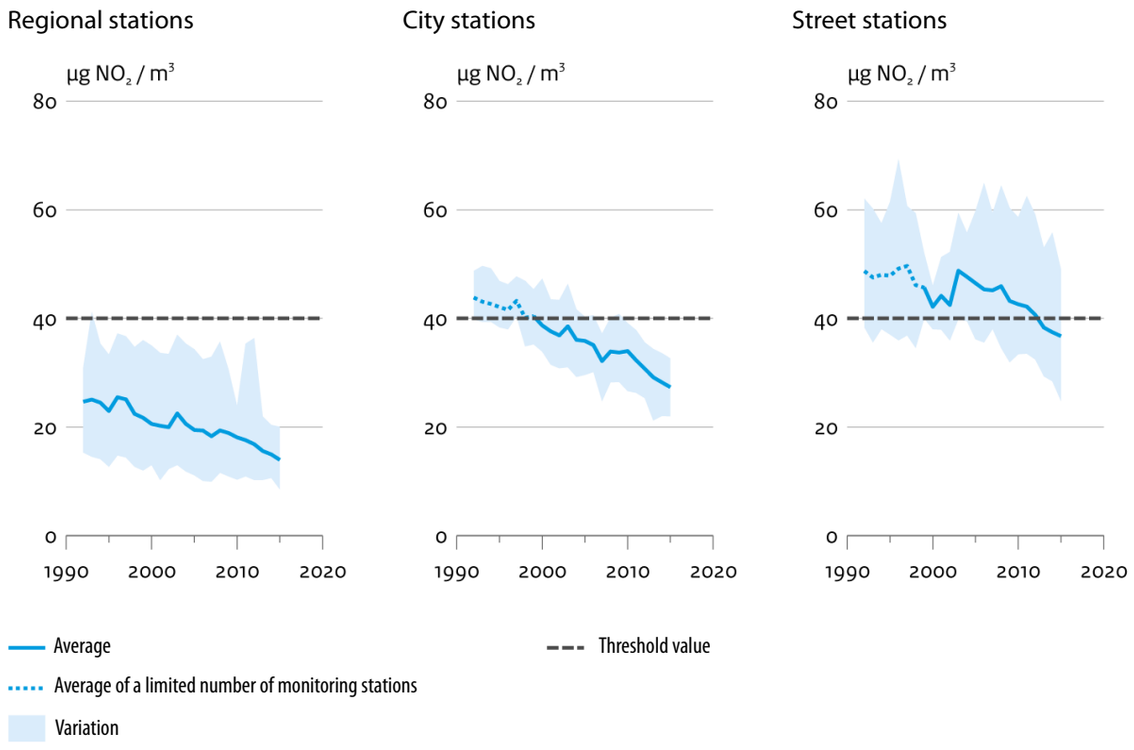

Figure 2. Trends in nitrogen dioxide concentrations measured at different types of monitoring stations during the period 1992-2015
Source: Environmental Data Compendium (www.clo.nl) based on data from RIVM/ DCMR/GGD Amsterdam 2016

04 ozone concentrations

The number of days per year with higher ozone concentrations depends in large part on the meteorological conditions during the year in question. Warm summer days are associated with higher ozone concentrations.[8]

The number of smog days has decreased since the 1990s, in particular due to the efforts made to reduce the emissions of the precursor gases, including nitrogen oxides and volatile hydrocarbons. According to the European short-term target value, the maximum 8-hour average ozone concentration of 120 micrograms/m^3 may not be exceeded more than 25 days per calendar year on average over a period of three years. Figure 3 shows that the peak ozone concentrations have decreased over the past 30 years. This is the result of European policy focused on reducing the emissions of the ozone precursors. Since the turn of the century, the number of days per year during which the maximum 8-hour average ozone concentration exceeded 120 micrograms/m^3 has stayed at about 10 and is not decreasing any further. In 2014, there was not a single day on which the target value was exceeded and the health-based WHO air quality guideline of 100 micrograms/m^3 was complied with on 95% of the days.[9] The downward trend in the occurrence of peak concentrations has therefore continued in recent years.

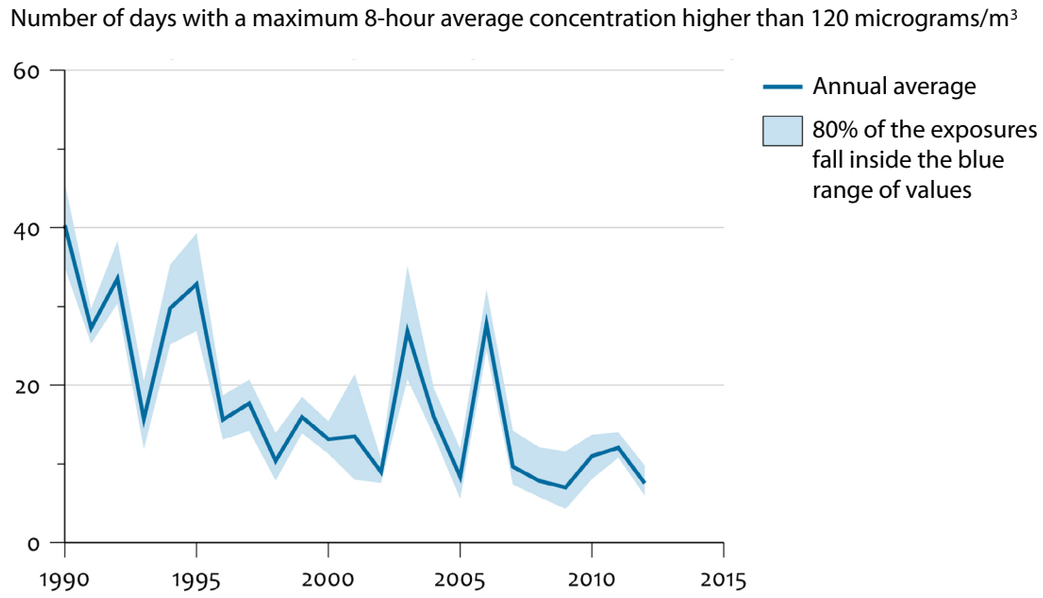

Figure 3. Trend in the number of days with maximum 8-hour average ozone concentration higher than 120 micrograms/m^3 (progressive 3-year average)
Source: Environmental Data Compendium (www.clo.nl) based on data from RIVM 2013

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