PM$_{2.5}$ in the Netherlands
Consequences of the new European air quality standards
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Introduction
Thus far, air pollution policy in the Netherlands has been focused on PM$_{10}$ as the target fraction for particulate matter. Based on new findings of the World Health Organization (WHO) policy attention in the EU has shifted towards the finer fraction (PM$_{2.5}$). This requires that policy, monitoring and models in the Netherlands have to be adapted. A new EU Air Quality Directive is in the final stage of decision making and will probably go into force in 2008. This Directive results from the Thematic Strategy on air pollution that was adopted in 2005. The new Directive combines four existing EU directives that include legislation on PM$_{10}$, and it establishes new air quality standards for fine particulate matter.

This paper is the abstract of a more comprehensive study on PM$_{2.5}$ (Matthijsen and ten Brink, 2007). This study has been conducted under the auspices of the Netherlands Research Program on Particulate Matter (BOP, 2007), a national program on PM$_{10}$ and PM$_{2.5}$, which is funded by the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM). The study takes advantage of the lessons drawn from the policy concerning PM$_{10}$ and aims to anticipate possible policy actions concerning PM$_{2.5}$. This is approached by summarizing the proposed particulate matter standards and projecting whether or not the Netherlands can meet these standards. Matthijsen and ten Brink (2007) make an inventory of the national knowledge on which the conclusions given below are based, taking into account that some aspects of the new Directive are still undecided.

What is PM$_{2.5}$ and where does it come from?
Particulate matter, or PM, is the term for particles found in the air. PM$_{10}$ and PM$_{2.5}$ are good approximations of particles smaller than 10 and 2.5 micrometers in diameter, respectively. PM$_{2.5}$ is the finer fraction in PM$_{10}$. Many man-made and natural sources emit PM directly. Man-made sources include industrial processes and all types of combustion activities such as motor vehicles, power plants and wood burning. Other particles may be formed in the air due to chemical processes. They are formed indirectly when gases, from burning fuels and ammonia from manure, react in the atmosphere. Natural sources of PM$_{2.5}$ include, for instance, sea salt.
Why has PM$_{2.5}$ been chosen as the new metric in the EU?

There are two main reasons:
1. In general PM$_{2.5}$ is considered to be more hazardous to human health than PM$_{10}$ (WHO, 2006a; Brunekreef and Forsberg, 2005), and because it penetrates more deeply into the lungs.
2. PM$_{2.5}$ originates more from man-made sources than PM$_{10}$ and is therefore in principle more manageable.

Health studies have shown that there is a significant association between short-term and long-term exposure to fine particles and premature death. Other important effects include aggravation of respiratory and lung disease, asthma attacks, heart attacks and irregular heartbeat. PM$_{2.5}$ consists of many compounds originating from many sources. PM$_{2.5}$ mass is regulated instead of individual components, because up to now all PM$_{2.5}$ is considered as equally harmful - although some components are believed to be more harmful than others - and because the health benefits of reducing the components individually are unknown.

What are the standards for PM$_{2.5}$ in the new EU Directive on air quality?

The common position adopted by the Council (CS, 2007a) has been used as the basis for the present report. The main thrust with respect to PM$_{2.5}$ is that two standards are proposed, a limit value and an exposure reduction target value; the latter is new.

- Applied throughout the EU, the proposed limit value must be attained at every public location by 1 January 2010; it has been set at 25 µg/m$^3$ as an annual average target value. By 1 January 2015, the target value will become a legally binding limit value. The recent draft recommendation for amendments by the European Parliament (CS, 2007b) refers to a value of 20 µg/m$^3$ instead of 25 µg/m$^3$.
- For the Netherlands, the proposed exposure reduction target value implies a 20% decrease in exposure to PM$_{2.5}$ in urban agglomerations in 2020 compared to the exposure in 2010. In 2013, the provisions for PM$_{2.5}$ will be reviewed and the reduction target value could then become legally binding.

The question addressed is whether these standards can be attained in the Netherlands. This is discussed below.

Attainability of the standards in the Netherlands

Limit value
- The available data on the current levels of PM$_{2.5}$ suggest that the proposed limit value of 25 µg/m$^3$ can probably be attained in 2015, apart from a very limited number of hot spots (see Figure 1). Under current legislation, the value of 20 µg/m$^3$ will probably still be exceeded in busy streets in urban agglomerations and at several locations in agricultural areas. Due to the recently outlined additional measures for the Netherlands, the number of exceedances of the value of 20 µg/m$^3$ will decline towards 2015, but even then the number of exceedances is expected to become very limited only by 2020.
• The Directive aims at regulating both PM$_{10}$ and PM$_{2.5}$. Since these parameters are strongly interrelated, it makes sense to review the stringency of the limit values proposed. The current status in the Netherlands is the following. The strictest limit value for PM$_{10}$ concerns 24-hour concentrations, which are not to exceed 50 $\mu$g/m$^3$ more than 35 times in a calendar year. This limit value appears to be more stringent than the proposed PM$_{2.5}$ limit value of 25 $\mu$g/m$^3$. However, a value of 20 $\mu$g/m$^3$ for PM$_{2.5}$ could be more stringent than the PM$_{10}$ limit value for 24-hour concentrations. Note that the stringency is viewed with respect to PM$_{10}$ and PM$_{2.5}$ levels per year. The fact that the limit values go into force in different years has not been taken into account.

![Figure 1 Estimates of the PM$_{2.5}$ concentration ranges for streets in urban agglomerations in the Netherlands in 2006 and 2015. On the left, ranges for average values and, on the right, ranges for hot spots. The estimates are based on a combination of model calculations and measurements. The emission projections are based on current legislation. The uncertainties shown represent a lower limit, because not all sources of uncertainty have been quantified (e.g. the effect of uncommon meteorological conditions on yearly average concentrations).](image)

**National exposure reduction target value**

• A reduction of 20% in the exposure between 2010 and 2020 will almost certainly not be reached under current legislation (see Figure 2). Moreover, it is likely that the recently outlined additional measures for the Netherlands will also be insufficient to reach the reduction target value. Therefore, extra national and local measures will probably be necessary.
• Average urban background concentrations in the Netherlands are largely due to sources abroad. Consequently, the effect of national policies is limited and the attainability in the Netherlands of the proposed exposure reduction target value depends for an important part on the implementation of policy measures abroad.

• Future levels will be affected by reductions in the EU and especially the neighboring countries. The present analysis is based on the assumption that countries will meet their emission goals as set by existing agreements: for 2010 by the National Emission Ceilings Directive and for 2020 by the Thematic Strategy on Air Pollution. Therefore, larger reductions than those shown in Figure 2 can only be expected if Member States apply measures that go beyond their national emission goals. At present, not all Member States expect to be able to meet their emission goals in time.

• Other Member States probably also need to make plans for further emissions reductions in order to meet the new PM2.5 standards. At what time this may lead to substantial extra emission reductions is yet unclear. Therefore, further concentration reductions should only be expected from extra national and local measures in the Netherlands, at least until 2015.

Figure 2 PM2.5 reductions (%) between 2010 and 2020 of the average background concentration in urban agglomerations in the Netherlands calculated for emissions based on current legislation and if additional measures (recently outlined) are also taken. The margins show the highest and lowest calculated reductions.

Attainability of the standards in the rest of Europe
An assessment of the attainability in the EU was published by the Institute for European Environmental Policy (IEEP, 2006). It was based on an extrapolation of PM2.5 measurements in Europe for 2004. It concluded that only a limited number of exceedances of the proposed
limit value of 25 $\mu g/m^3$ can be expected after 2010. However, under current legislation – and even including the emission reduction called for in the Thematic Strategy – the same information suggests that the value of 20 $\mu g/m^3$ will very probably not be attained everywhere in Europe in 2015. Specifically, urban background concentrations may then be close to, or exceed, the annual average concentration of 20 $\mu g/m^3$ in densely populated and industrialized areas (such as the Po-valley), certain areas in Central European countries, the Ruhr area, the Benelux countries, and certain large cities in Europe. At the street level, the attainability problems will probably be more severe.

Attainability problems regarding the PM$_{2.5}$ limit value in the Netherlands thus appear similar to those in other densely populated and industrialized regions in Europe. However, it is unclear whether the relevant Member States will face similar problems meeting the proposed exposure reduction target value of 20%, because the level of implementation of technical and non-technical reduction measures differs throughout Europe.

**How to proceed?**

A number of steps will be taken. Some follow directly from the new Directive as a legal obligation, and others are necessary to reduce the uncertainties about PM$_{2.5}$ in order to provide more robust support to policy decisions regarding PM$_{2.5}$.

The underlying PM$_{2.5}$ data of this report are rather uncertain. This is because the instruments that are used to support PM$_{2.5}$ policy development (measurements, models and emissions, etc.) are still at an initial or research phase. The conclusions regarding PM$_{2.5}$ are often based on preliminary data and extrapolation of information on PM$_{10}$.

- The most urgent step is to prepare for and comply with the measurement obligations in the guidelines of the new Directive. National preparations are being made to start measurements of PM$_{2.5}$ by 2008, in accordance with the Directive guidelines.
- Such measurements form the basis for further assessments of PM$_{2.5}$ levels and the associated health effects. In addition, focused measurements seem necessary, especially concerning 1) the contribution of sources to exceedances that occur at the local level and 2) the association of health effects with specific local sources such as traffic.
- Additional steps include several actions to improve models and emissions, especially regarding primary and secondary organic particles. Model performance in urban agglomerations and streets should be improved this can lead to a better assessments of measured or modeled values compared to limit values and to a better understanding of source contributions.
- A more accurate inventory of primary PM$_{2.5}$ emissions is also necessary in the process of defining and monitoring of a national emission ceiling for PM$_{2.5}$.
- At the same time it is important to assess which additional national, local and possibly European policy measures would be necessary to attain the proposed standards in the Netherlands in time. Planned national and European legislation to combat climate change can affect particulate matter levels, and should therefore be integrated.
Instruments for policy support

Given the uncertainties, the quality of the measurements and models currently used for policy support is insufficient at present to assess the levels of PM$_{2.5}$ with an accuracy required by the Directive guidelines. Especially in urban agglomerations, which have large emission dynamics and complex terrain, the uncertainties are large. However, the current models may be adequate to assess the relative effect of given emission reductions on the concentrations.

Better information will become available when the steps indicated above are taken. This information will reduce the currently large uncertainties about PM$_{2.5}$. Even then, however, the uncertainties will probably remain substantial. If these uncertainties can be taken into account in the implementation of the new Directive, the enforcement in practice could become more effective.

References

BOP, 2007. A Dutch national research program on PM$_{10}$ and PM$_{2.5}$. (Beleidsgeoriënteerde Onderzoeksprogramma PM). See http://www.mnp.nl/nl/dossiers/fijn_stof/nieuws/index.html.


