Effectiveness of street cleaning for reducing ambient PM10 concentrations

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Keywords: traffic emissions, PMx reduction, abatement strategies, street sweeping.

Introduction
Exceedences of the PM10 limit values set by the EU are frequent at urban traffic hot spots, especially in street canyons*. As street cleaning is discussed as a method to reduce ambient PMx concentrations in cities, a research project was initiated to evaluate its effectiveness.

Methods
Street cleaning by high pressure watering was carried out from 03/08/04 until 19/09/05 in the Corneliusstrasse (4 lane main road, ca. 40.000 cars/day, street canyon) in Düsseldorf, Germany. Cleaning was carried out in the early morning hours, once a week until March 2005, then daily and from June 2005 twice per week.

PM10 concentrations were measured simultaneously at the site "Düsseldorf Corneliusstrasse" (DDCS/DENW082) of the North Rhine-Westphalian Air Quality Monitoring Network. Data of other traffic and urban monitoring sites in Düsseldorf were used for comparison and to correct for changes in meteorological conditions and DTV e.g. during holiday seasons.

Results and Discussion
Different methods of data analyses showed reductions of ambient air PM10 concentrations on street cleaning days between 0,6 µg/m³ and 5,8 µg/m³ compared to non-cleaning days.

On average, the reduction of the daily mean PM10 concentration was 1,8 µg/m³ per cleaning day, taking into account all days with and without precipitation. When only days without precipitation are considered, the average reduction was 2,9 µg/m³. This larger reduction potential for PM10 ambient air concentrations by street cleaning on "dry" days compared to "dry" and rainy days is important especially considering a cost/benefit analysis, as each cleaning of the Corneliusstrasse (length: 1,6 km) adds up to 460 € to 1.650 €, depending on the amount of water used per m².

Considering the effectiveness of street cleaning with respect to the PM10 yearly and daily limit values, a reduction of 1,8 µg/m³ per cleaning day corresponds to a reduction of the yearly average of ca. 0,3 µg/m³ for cleaning once per week and of ca. 0,5 µg/m³ for cleaning twice per week.

* Corneliusstrasse: 83 days > 50 µg/m³ and 41 µg/m³ yearly average (2004); 69 days > 50 µg/m³ and 38 µg/m³ yearly average (2005)

With regard to the daily limit value of 50 µg/m³, figure 1 shows the distribution of PM10 in concentration classes of 1 µg/m³.

Figure 1: Number of days per PM10 concentrations for the Corneliusstrasse, Düsseldorf, 01/01/03-19/09/05.

About 6% of the exceedences of the PM10 daily limit value could have been avoided assuming an average reduction of 1,8 µg/m³ (ca. 9% for a reduction of 2,9 µg/m³ on dry days). As these exceedence days are more or less evenly distributed over the days of the week, the effective reduction of daily limit value exceedences will be lower when routine cleaning (1-2x per week) is done. Additional street cleaning could be carried out when limit value exceedences are predicted.

A reduction of the daily PM10 average of about 2 µg/m³ by street cleaning is quite effective being only a single action. However, this reduction is only achieved for a limited area, which has to be taken into account when evaluating different abatement strategies.

Further Information
Together with detailed results from the street cleaning investigations, information on related aspects such as use of different water qualities, use of surfactants and different street cleaning technologies will be given in the presentation.

Acknowledgement
This work was supported by the Environmental State Agency of North Rhine Westphalia (LUA NRW), now: North Rhine Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV).