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THE AIR QUALITY IMPACT OF THE PORT OF AMSTERDAM ON ITS ENVIRONMENT: DEVELOPMENT OF AN AIR QUALITY TOOL

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Abstract: Air pollution levels are about to exceed European guidelines in and around Amsterdam. To assess the impact of the emissions in the port of Amsterdam on its environment, an air quality tool has been developed. It calculates the contribution from the port emissions to the total air pollution for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) and identifies the contribution of the individual emission sources in the port area to the air pollution levels in and outside this region. The tool enables strategic selection of new industrial sites in future scenarios. It takes into account emissions from traffic, industrial facilities, trans-shipment, navigating ships and ships in the port. For the year 2009, calculations show a relatively small annual mean contribution of the port emissions on the NO_2 and PM_{10} levels outside the port region of Amsterdam.

Key words: *air quality, port emissions, particulate matter, nitrogen dioxide*

INTRODUCTION

The port of Amsterdam (Figure 1) has the ambition to expand. At present, it ranks as Europe's number 4 port and handles almost 91 million metric tons of cargo annually. The aim is to double the trans-shipment business by 2020, with no increase in land usage. At the same time, the urban area of Amsterdam with its residential areas is growing, new highways are being built and background air pollutant concentrations are high. In this situation, the air quality is a critical aspect and information about the impact of the port emissions on the air pollution levels in and around the port region is essential. For this reason, an air quality tool was developed for the Port of Amsterdam.

The air quality tool calculates annual mean nitrogen dioxide (NO_2) and particulate matter (PM_{10}) concentrations in and around the port region, and assesses the contribution from the emissions in the port to the total pollutant concentrations. It takes into account the port emissions from industrial facilities, trans-shipment, navigating ships, ships at berth and road traffic. The tool is useful to identify the emission sources that cause highest air pollutant concentrations. Besides, the air quality tool is able to asses future scenarios, in which new companies will be established or activities in the port will be intensified. Also, the effect of reduction measures can be investigated. In this extended abstract, the air quality tool is briefly described and illustrated with some calculation examples for the year 2009.

Figure 1. Map of the port region for which concentrations are calculated. The port of Amsterdam is indicated by the red line. The total area measures 21 x 15 km.

AIR QUALITY TOOL

The air quality tool calculates annual mean PM_{10} and NO_2 concentrations for the years 2009, 2015 and 2020. All concentrations are calculated at a 100 x 100 m grid for the port region and its surrounding area, shown in Figure 1. Scenarios can be investigated by assigning scenario factors to several emission sources in the port and by adding new point sources in the port region. The graphical user interface of the air quality tool is shown in Figure 2. The tool also visualizes the concentrations.

The air quality tool is based on the model Urbis (Beelen *et al.*, 2010). This urban air quality model includes several dispersion models to assess the concentrations of air pollutants in urban areas. Concentrations of air pollutants from industrial facilities, mobile machinery, storage and trans-shipment of bulk materials in the port area, and from maneuvering ships and ships at berth are simulated with OPS (Van Jaarsveld, 2004). The dispersion model CAR is used to assess air pollutant levels from emissions by traffic in streets and a Gaussian line source model (Pluim-Snelweg) is used for pollution by motorways. A simplified version of the Dutch standard calculation method for point sources (New National Model) calculates the concentrations of emissions from new point sources in the port region. In order to determine the total air pollutant levels in and outside the port region, the concentrations from all these emissions are added to official reported background concentrations in the Netherlands provided by Velders *et al.* (2010).

Necessary input data for the air quality tool is first of all information on the emissions in the region. For this reason, a detailed inventory of emission sources was carried out for the Port of Amsterdam. Emissions from large industrial facilities were taken from the national PRTR-database and supplemented with emissions from diffuse industrial sources mainly derived from background documents of environmental permits. Emissions of seagoing ships were based on AIS-data and detailed harbour statistics in combinations with national shipping emission factors (Denier van der Gon and Hulskotte, 2010). Emissions of inland shipping were derived from national inland shipping traffic data and national shipping emission factors.

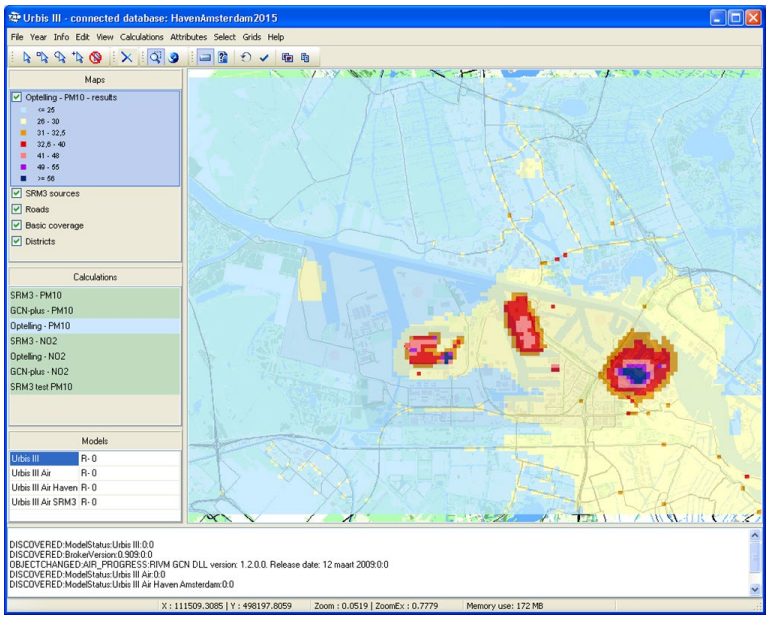

Figure 2. User interface of the air quality tool.

RESULTS

To investigate the air quality in and around the port area for the present situation, annual mean PM_{10} and NO_2 concentrations were calculated for the year 2009. The model results show high PM_{10} concentrations (Figure 3) in the port area near a number of important emission sources from storage and trans-shipment activities and industrial facilities . Outside the port area, elevated concentrations are found along some roads and motorways due to pollution by road traffic.

Figure 4 shows the calculated contribution of the PM_{10} emissions in the port area, *i.e.* from industrial facilities, mobile machinery, storage and trans-shipment, maneuvering ships and ships at berth to the total PM_{10} concentrations. Outside the port region, the contribution is generally small (< 3 $\mu g \cdot m^{-3}$), except for a small area to the east of the port, where the contribution to PM_{10} levels is about 30 $\mu g \cdot m^{-3}$. Additional calculations (not shown) indicated that emissions from storage and trans-shipment of bulk materials in the port area are the main contributors. The emissions from maneuvering ships and ships at berth cause a very small increase in the calculated air pollutant levels (< 1 $\mu g \cdot m^{-3}$).

Calculations of the NO_2 concentrations are shown in Figure 5. In the port region, NO_2 concentrations are relatively low (< 35 $\mu g \cdot m^{-3}$) compared to the concentrations along some motorways and in the city centre of Amsterdam, which is located in the lower right corner of the figure. The emissions from the port region do not lead to substantial elevated NO_2 concentrations and contribute on average 1 $\mu g \cdot m^{-3}$ to NO_2 levels outside the port region (not shown).

The calculated annual mean concentration levels were also compared to measurements carried out at four measurement stations in the region. The average difference between calculations and measurements is 3 $\mu g \cdot m^{-3}$, for both PM_{10} and NO_2. This is a reasonable agreement, since it equals the uncertainty in the background concentrations that were used.

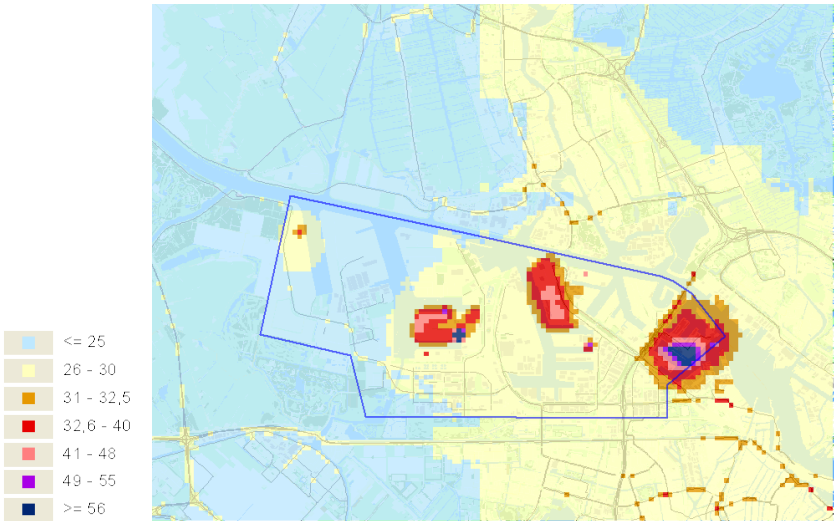

Figure 3. Calculated annual mean PM_{10} concentrations for 2009 ($\mu g \cdot m^{-3}$). The port region is indicated by the blue line.

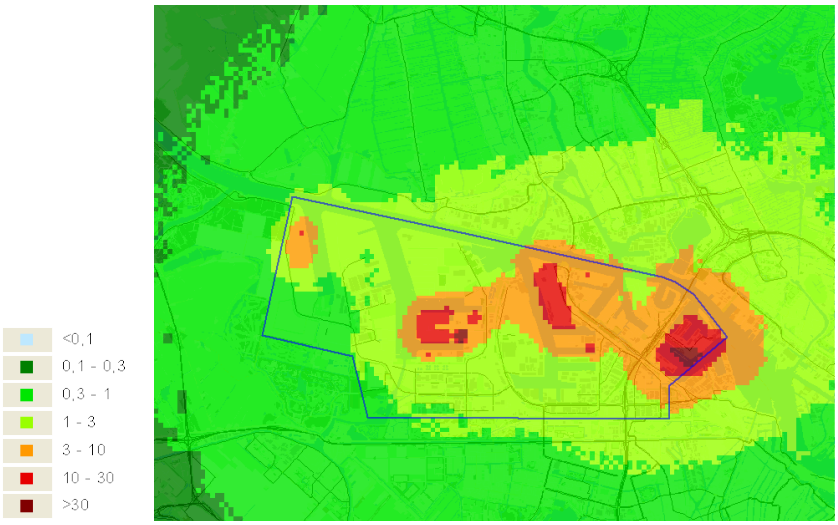

Figure 4. Calculated annual mean PM_{10} concentrations due to emissions from the port region ($\mu g \cdot m^{-3}$). The port region is indicated by the blue line.

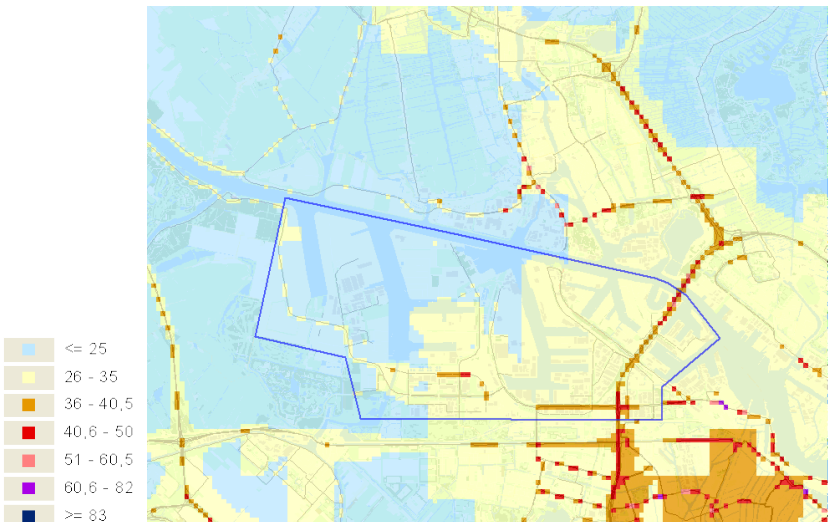

Figure 5. Calculated annual mean NO_2 concentrations for 2009 ($\mu g \cdot m^{-3}$). The port region is indicated by the blue line.

CONCLUSIONS

The air quality tool, developed for the Port of Amsterdam, gives detailed information about the air quality impact of the port emissions on the local environment. It is a useful tool to identify the contribution of the individual emission sources in a port area to the air pollution levels in and outside the port region. The tool enables strategic selection of new industrial sites in future scenarios.

For 2009, the air quality tool calculated a relatively low annual mean contribution from the port emissions to the PM_{10} levels outside the port area. The contribution is generally smaller than 3 $\mu g \cdot m^{-3}$, whereas it ranges up to 30 $\mu g \cdot m^{-3}$ for locations in the port region. For NO_2, the annual mean contribution is smaller: on average 1 $\mu g \cdot m^{-3}$ outside the port region. Concerning PM_{10}, storage and trans-shipment activities are the most important port emissions with regard to the elevated PM_{10} levels. Therefore, in view of the expansion of the Port of Amsterdam, PM_{10} concentrations, in particular from storage and trans-shipment activities, seem to be most important to take into account.

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